GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

Naoko Ishii
CEO and Chairperson

March 03, 2016

Dear Council Member:

UNDP as the Implementing Agency for the project entitled: ***China: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China***, has submitted the attached proposed project document for CEO endorsement prior to final approval of the project document in accordance with UNDP procedures.

The Secretariat has reviewed the project document. It is consistent with the proposal approved by Council in May 2014 and the proposed project remains consistent with the Instrument and GEF policies and procedures. The attached explanation prepared by UNDP satisfactorily details how Council's comments and those of the STAP have been addressed. I am, therefore, endorsing the project document.

We have today posted the proposed project document on the GEF website at www.TheGEF.org. If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,

Naoko Ishii
Chief Executive Officer and Chairperson

Attachment: GEFSEC Project Review Document
Copy to: Country Operational Focal Point, GEF Agencies, STAP, Trustee

REQUEST FOR CEO ENDORSEMENT

PROJECT TYPE: FULL SIZE PROJECT

TYPE OF TRUST FUND: GEF TRUST FUND

For more information about GEF, visit TheGEF.org

PART I: PROJECT INFORMATION

Project Title: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China			
Country(ies):	China	GEF Project ID:[1]	5728
GEF Agency(ies):	UNDP	GEF Agency Project ID:	5349
Other Executing Partner(s):	Ministry of Science and Technology (MOST)	Submission Date: Resubmission Date:	5 November 2015 18 December 2015
GEF Focal Area (s):	Climate Change	Project Duration (Months)	48
Name of Parent Program (if applicable): ➢ For SFM/REDD+ ☐ ➢ For SGP ☐ ➢ For PPP ☐		Project Agency Fee ($):	782,188

A. FOCAL AREA STRATEGY FRAMEWORK[2]

Focal Area Objectives	Expected FA Outcomes	Expected FA Outputs	Trust Fund	Grant Amount ($)	Co-financing ($)
CCM-4	Sustainable transport and urban policy and regulatory frameworks adopted and implemented	Cities adopting low-carbon programs	GEFTF	2,660,810	4,750,000
CCM-4	Increased investment in less-GHG intensive transport and urban systems	Investment mobilized	GEFTF	5,572,750	48,750,000
Total Project Costs				8,233,560	53,500,000

B. PROJECT FRAMEWORK

Project Objective: Facilitation of the commercial production and application of fuel cell vehicles in China						
Project Component	**Grant Type**	**Expected Outcomes**	**Expected Outputs**	**Trust Fund**	**Grant Amount ($)**	**Confirmed Co-financing ($)**
Component 1: Improvement of Local Fuel Cell (FC) and Fuel Cell Vehicle (FCV) Production and Application	TA	**Outcome 1A :** Markedly reduced costs and improved performance and durability of FCVs in China	Output 1A.1.1: Completed individual technical assistance for China's vehicle manufacturers in the design and manufacture of FC buses. Output 1A.1.2: Completed group capacity development sessions for China's vehicle manufacturers in the design and manufacture of FCVs Output 1A.2: Published and disseminated information on improved FCV design and production in China achieved via project.	GEFTF	954,950	500,000

[1] Project ID number will be assigned by GEFSEC.

[2] Refer to the Focal Area Results Framework and LDCF/SCCF Framework when completing Table A.

			Output 1A.3: Multiple confirmed and implemented new sourcing agreements between Chinese FCV manufacturers and international suppliers that are each verified to lower costs, increase durability, and/or raise performance from start of project benchmarks. Output 1A.4: China-based FCV component manufacturers that achieve globally competitive durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels.			
	Inv	**Outcome 1B:** FCVs deployed in continuous operation by cities, organizations, and individuals in China	Output 1B.1: Completed procurement and production of 109 demo FCVs, including 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks Output 1B.2: Approved plans in each demo city for increasing visibility and effectively testing operating performance of demo FCVs. Output 1B.3: Completed demonstration of FCV operation and application. Output 1B.4: Clearly documented and disseminated results on continuous operation and public perception of procured FCVs (annual reports) and production costs (one-time report).	GEFTF	5,426,250	45,050,000
Component 2: Improvement of Hydrogen Production and Refueling System	TA	**Outcome 2A:** Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	Output 2A.1.1: Completed one-on-one technical assistance for investors in and managers of demo renewable energy based hydrogen production facilities Output 2A.1.2: Completed group capacity development for prospective investors in and managers of renewable energy based hydrogen production facilities, including publication and dissemination of capacity development materials Output 2A.2: Expanded knowledge-base on reducing production costs of transport hydrogen and establishing local hydrogen production facilities Output 2A.3.1: Completed one-on-one technical assistance for investors in and managers of project demo hydrogen refueling stations and manufacturers providing equipment to such stations (including manufacturers of hydrogen gas compressors and hydrogen refueling dispenses) Output 2A.3.2: Completed group capacity development for prospective investors in hydrogen refueling stations, manufacturers providing equipment to such stations, and relevant service	GEFTF	272,200	500,000

			providers including publication and dissemination of capacity development materials			
	Inv	**Outcome 2B:** Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen	Output 2B.1: At least four completed demonstrations of the application of reliable and cost-effective renewable energy-based hydrogen production, three of which are wind based and one of which is landfill methane based Output 2B.2: At least 4 and possibly up to 7 completed demonstrations of the operation of hydrogen refueling facilities via establishment of new stations or adoption of new approaches at existing stations. Output 2B.3: Clearly documented and disseminated results on operation and public perception of hydrogen refueling stations and hydrogen production units (annual reports), investment costs (one-time reports), and revenue and operational costs (annual reports).	GEFTF	146,500	3,300,000
Component 3: Policy and Regulatory Frameworks for the Application and Commercialization of FCVs	TA	**Outcome 3A:** Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	Output 3A.1: Approved and implemented national *China FCV and Hydrogen Refueling Roadmap* and local counterpart roadmaps Output 3A.2: Newly approved and enforced internationally compatible FCV, hydrogen station, hydrogen fuel transport, and associated parts standards, testing/ measurement methods, and certification, filling the gap in terms of standards/ testing/ certification not yet in place Output 3A.3: Expedited approval by MIIT of new FCV models, expedited local issuance of license plates for individual FCVs for long-term operation, and expedited local approval for new hydrogen stations Output 3A.4: Approved updated and enhanced incentive policy for FCV purchase Output 3A.5: Approved updated and enhanced incentive policy for hydrogen station establishment	GEFTF	400,250	500,000
	TA	**Outcome 3B:** Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations	Output 3B.1: Designed and agreed upon local-level FCV and hydrogen refueling station incentive policy pilots (at least two total) that are novel in China, but may have been implemented elsewhere in world Output 3B.2: Successfully implemented local-level policy pilots (as designed in 3B.1) with monitoring, annual documentation, and dissemination of results	GEFTF	116,700	400,000
Component 4: Enhancement of Information Dissemination	TA	**Outcome 4:** Enhanced acceptance of FCVs for both	Output 4.1: Completed FCV public advocacy program in at least 4 cities that both alleviates the public's safety concerns regarding	GEFTF	309,840	350,000

and Awareness about FCV Transport Systems		public and private uses via increased knowledge and awareness	hydrogen and attracts consumers to purchase FCVs Output 4.2: Completed knowledge and awareness program for policy makers (national and local), managers, experts, and associated plans adopted for replication of FCV demos in other cities Output 4.3: Established *China FCV Market and Technology Monitoring System*, which provides up to date information on FCV manufacturing and market in China as well as information on new technological developments and application worldwide			
Component 5: FCV Technology Capacity Development Program	TA	**Outcome 5A:** Increased technical capacity for O&M of FCVs and hydrogen refueling stations	Output 5A.1: Qualified contingent of persons to operate and maintain FCVs and qualified contingent of persons to operate and maintain hydrogen refueling stations in each of the four demo cities as well as other cities in which replication is taking place	GEFTF	169,200	175,000
	TA	**Outcome 5B:** Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/ commercial purchase of FCVs	Output 5B1: FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling associated value chain projects that are or will be financed by financial institutions/financial sector companies. Output 5B.2: Established and operational FCV purchase financing scheme in selected banks/FIs	GEFTF	45,600	175,000
Subtotal					7,841,490	50,950,000
Project Management Cost (PMC)[3]					392,070	2,550,000
Total Project Costs					8,233,560	53,500,000

C. SOURCES OF CONFIRMED CO-FINANCING FOR THE PROJECT BY SOURCE AND BY NAME ($)

Please include letters confirming co-financing for the project with this form**.**

Sources of Co-financing	**Name of Co-financier (source)**	**Type of Co-financing**	**Co-financing Amount** ($)
Local Government	Beijing Municipal Science & Technology Commission	Cash	5,800,000
Local Government	Department of Finance of Henan Province	Cash	2,000,000
Private Sector	Department of Finance of Henan Province (Zhengzhou Yutong Bus Co., Ltd.)	Cash	5,500,000
Local Government	Department of Finance of Guangdong Province (from Nanhai District Finance Bureau)	Cash	2,233,300
Private Sector	Department of Finance of Guangdong Province (from companies)	In-kind	2,566,700
Local Government	Shanghai Municipal Finance Bureau	Cash	5,000,000

[3] PMC is charged proportionately to focal areas based on focal area project grant amount in Table D below.

Private Sector	Shanghai Municipal Finance Bureau (from SAIC Motor)	Cash	30,000,000
GEF Agency	UNDP	Cash	400,000
Total Co-Financing			53,500,000

D. Trust Fund Resources Requested by Agency, Focal Area and Country[1]: N.A.

[1] In case of a single focal area, single country, single GEF Agency project, and single trust fund project, no need to provide information for this table. PMC amount from Table B should be included proportionately to the focal area amount in this table.
[2] Indicate fees related to this project.

E. Consultants Working on Technical Assistance Components:

Component	Grant Amount ($)	Co-financing ($)	Project Total ($)
International Consultants	565,600	2,000,000	2,565,600
National/Local Consultants	160,200	1,500,000	1,660,200

F. Does the Project Include a "Non-Grant" Instrument [Yes/No]?

(If non-grant instruments are used, provide in Annex D an indicative calendar of expected reflows to your Agency and to the GEF/LDCF/SCCF/NPIF Trust Fund).

No, project does not include a "non-grant" instrument.

PART II: PROJECT JUSTIFICATION

A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN OF THE ORIGINAL PIF[4]

The conceptual design of the project remains the same. However, there were changes made in the coverage of interventions in response to findings made during the project development stage (i.e., PPG Exercise), particularly during the logical framework analysis, as well as in response to the GEFSec, GEF Council and STAP Review comments and recommendations on the PIF. In that regard, there were several adjustments made in the outcome statements (same context but enhanced scope) and the outputs.

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	Project Document	
Outcome 1.1: Increased investments in the local production of FCVs for transport applications in Chinese cities	**Outcome 1A : Markedly reduced costs and improved performance and durability of FCVs in China**	Reduced FCV cost and improved durability/performance are prerequisites to increased investment in FCV production on a large scale. Thus, the PIF and ProDoc formulations of Outcome 1A are closely related. Expert team formulating project and stakeholders involved in LFA workshop believe situating the outcome at the "prerequisite" level will be most fruitful in focusing project strategy and activities on what needs to be achieved (lower costs and improved durability/ performance) in order to expand manufacturing investment on a large scale.
GEF: US$ 750K Co-Financing: US$ 500K	GEF: US$ 954.95K Co-Financing: US$ 500K	GEF TA amount has been expanded from US$750K to US$954.95K to accommodate technical assistance for eight different types of component manufacturers. Expert input during project formulation has identified component quality and costs as a major barrier to be addressed to achieve this outcome.
OUTPUTS: *• Completed comparative study on current*	Refer to Part I, Sec. B, Component 1, Outcome 1A Outputs	ProDoc Outputs 1A.1.1 and 1A.1.2 closely align with third PIF output for Outcome 1.1, which focuses on capacity development and technical assistance for local FCV manufacturers. The

[4] For questions A.1 –A.7 in Part II, if there are no changes since PIF and if not specifically requested in the review sheet at PIF stage, then no need to respond, please enter "NA" after the respective question.

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	**Project Document**	
technical features and operating performances of locally manufactured FCs and FCVs in China and those in other FCV producing countries *• Completed studies on the applicable improvements that can be cost-effectively done in the current locally manufactured FCs and FCVs in China* *• Completed capacity development and technical assistance for local transport vehicle manufacturers on the design and manufacturing of FCVs in 4 cities* *• Published and disseminated information on improved FC and FCV design and production, including the results and evaluation of the completed FCV operations demonstrations.*	1A.1.1, 1A.1,2, 1A.2, 1A.3 and 1A.4.	ProDoc outputs specify individual technical assistance (Output 1A.1.1) and group technical assistance (Output 1A.1.2). Output 1A.1.1 encompasses (as prerequisite for technical assistance) review of manufacturers' current situation and development of strategy for improvements that can be made. During formulation, experts and stakeholders agreed that this more results-oriented approach to achieving FCV manufacturing improvements in China would be preferable to "pure" studies as described in the first and second PIF outputs for Outcome 1.1. ProDoc Output 1A.2 ("published information") closely aligns with the fourth PIF output for Outcome 1.1. ProDoc Output 1A.3, newly introduced, targets sourcing agreements between Chinese FCV manufacturers and international component manufacturers. The project formulation identified lack of access to international components as a critical barrier to address in achieving Outcome 1A. ProDoc Output 1A.4, newly introduced, targets improved capabilities of China's component manufacturers in providing quality product and prices lower than currently available. The project formulation also identified the weak status of China's own FCV component manufacturers as a key barrier to achieving Outcome 1A. Further, addressing this barrier has the potential to lower world FCV component prices.
Outcome 1.2: Cities are deploying FCVs in their public passenger transport fleets. GEF: US$ 5,850K Co-Financing: US$ 45,050K	**Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China** GEF: US$ 5,426.25K Co-Financing: US$ 45,050K	ProDoc Outcome 1B is essentially the same as the PIF's Outcome 1.2, with scope expanded to include not only cities as operators of FCVs (in their public transport fleets), but also other organizations and individuals. During project formulation, the decision was to demonstrate not only public FC buses, but also FC delivery vehicles and FC cars. As part of the demos, delivery companies will participate. Further, the FCV autos will be available for consumer test drives in hope of stimulating future consumer purchase. Thus, the overall target of the demos and associated activities will be that cities, other organizations/companies, and individuals will purchase and deploy FCVs. Diversification of vehicle type has potential for greater overall adoption rates and thus GHG reduction rates. The GEF investment amount has been reduced by USD 423,750. As the great majority of this budget goes towards FCV purchase, the lower amount reflects higher project targets in FCV cost reduction that have been developed during project formulation.
OUTPUTS: *• At least 4 completed demonstrations of design and manufacturing using improved FC stacks* *• Completed demonstrations of FCV operations performance (various FCVs). 101 demo FCVs (13 GEF-funded, 88 co-financed)*	Refer to Part I, Sec. B, Component 1, Outcome 1B Outputs 1B.1, 1B.2, 1B.3 and 1A.4.	ProDoc Output 1B.1 corresponds to first PIF output under Outcome 1.2 with some adjustment. The PIF output emphasizes the use of improved FC stacks, whereas the ProDoc output emphasizes that the demo vehicles are to achieve performance, durability, and cost targets designated in the ProDoc. Clearly, improved FC stacks will be one of the means for achieving these targets. The FCV experts on the formulation team designed the targets. They recommend these targets as the best way to ensure the demo vehicles achieve the desired level of advancement over previous generations.

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	**Project Document**	
		ProDoc Output 1B.3 corresponds to the second PIF output under Outcome 1.2. Both target completed demonstrations of FCV operations. Adjustments on the numbers of vehicles and financing approach: Instead of 101 demo FCVs (PIF), there will be 109 (23 buses, 51 cars, 30 delivery vans, 5 delivery trucks). Further, instead of limiting the GEF funds to purchase of certain vehicles (13), those funds will represent a portion of the purchase price of all vehicles (around 30 percent). The negotiated amount was for achieving both a larger number of total vehicles and agreement to pursue targets beyond those planned in China's baseline demo project. ProDoc Output 1B.2 is a new one and focuses on developing well-designed demo plans to raise visibility and test performance and durability of FCVs. While in the PIF version, the development of such a plan is implied, because the GEF project will put more stringent requirements on the plans than in the baseline project, the formulation team concluded it will be more strategic to have as a specific output the type of plans desired. ProDoc Output 1B.4 is clearly documented results of the project demo operations. The formulation team believes that having a specific output will ensure this as a well-delineated work and receives the attention required.
Outcome 2.1: Increased investments in the FCV industry and its associated value chain businesses GEF: US$ 150K Co-Financing: US$ 500K	**Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations** GEF: US$ 272.200K Co-Financing: US$ 500K	Adjustment to the wording of ProDoc Outcome 2A as compared to Outcome 2.1 in the PIF (i) achieves greater specificity with regard to the part of the addressed value chain and (ii) focuses on the prerequisite of cost reduction/viability instead of the result of increased investments. As for specificity, the revised wording indicates hydrogen production and hydrogen refueling stations. Another key part of the value chain, FCV components, are already addressed in Outcome 1A and do not need to be addressed here. Reduced cost and improved viability of hydrogen production and hydrogen refueling stations are prerequisites to expanded investments in these areas. Thus, the PIF and ProDoc formulations the Outcome are closely related. Expert team formulating project and stakeholders involved in LFA workshop believe situating the outcome at the "prerequisite" level will be most fruitful in focusing project strategy and activities on what needs to be achieved (lower costs and improved durability/ performance) in order to expand investment in hydrogen production and hydrogen refueling stations on a large scale. The increase in the GEF TA amount from US$150K to about US$272K is to address needs and opportunities identified during project formulation. In particular, the project design has added individual TA for renewable energy-based hydrogen producers (both those using wind and those using land-fill methane) and for manufacturers of key parts for hydrogen refueling stations (hydrogen compressor and hydrogen refueling pump), as well as studies to help optimize hydrogen production options in China.
OUTPUTS: *• Completed studies on improvements that can be cost-effectively applied in the design, construction and commercial operation of H2 refueling*	Refer to Part I, Sec. B, Component 2, Outcome 2A Outputs 2A.1.1, 2A.1.2, 2A.2, 2A.3.1 and 2A.3.2.	Output 2A.1.1. (Individual TA for RE-based hydrogen producers) addresses the third output under Outcome 2.1 of the PIF ("capacity development and TA" for hydrogen production and hydrogen refueling stations) in a more specific fashion. Output 2A.1.2 (group capacity building for renewable energy based hydrogen producers), Output 2A.3.1 (individual TA for

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	**Project Document**	
facilities for FCVs in China *• Completed business promotional campaigns and survey for prospective investors on commercial H2 transport fuel production for FCVs, and commercial H2 refueling stations* *• Completed capacity development and technical assistance for prospective investors on commercial H2 transport fuel production for FCVs, and commercial H2 refueling stations in 4 selected cities* *• Published and disseminated information on the commercial H2 transport fuel production for FCVs, and commercial H2 refueling stations, including the results and evaluation of the completed H2 production and refueling demonstrations.*		hydrogen refueling stations), and Output 2A.3.2 (group capacity building for hydrogen refueling stations). Changed the first PIF output under Outcome 2.1 ("Completed Studies" related to HRS improvements) to identification of needs and development of action plans for hydrogen refueling stations (HRSs) and for manufactures of key components for HRSs. This is under Output 2A.3.1, which is TA for specific planned HRSs. The project formulation team believes that this more action-oriented approach to identifying areas for improvement will be more impactful than a "pure" study. The second PIF output under Outcome 2.1 ("completed business promotional campaigns and survey for prospective investors") is now part of the group capacity building (Outputs 2A.1.2 and 2A.3.2) and to Outcome 5B, which focuses on interesting the financial sector in investments in FCVs and the FCV-value chain. The written documentation of the developed hydrogen and HRS demos under Outcome 2B now addressed the fourth PIF output under Outcome 2.1 ("published and disseminated information"). ProDoc Output 2A.2 is an additional output and addresses a need identified during project formulation, the need for an expanded knowledge base on reducing production costs of transport hydrogen and establishing local hydrogen production facilities.
Outcome 2.2: Local government and private sector entrepreneurs in cities build and operate H2 production facilities and refueling stations GEF: US$ 100K Co-Financing: US$ 3,300K	**Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen** GEF: US$ 146.500K Co-Financing: US$ 3,300K	The meanings of Outcome 2.2 (PIF) and Outcome 2B (ProDoc) correspond quite closely in that both target an increased amount of hydrogen production facilities and hydrogen refueling stations in China. Adjustments made for the ProDoc version are two-fold: First, the mention of renewable energy based hydrogen production. During formulation, experts emphasized that one of the great challenges to FCV technology is ensuring that it is "green," as promised, so that it is important for the project to promote renewable energy based hydrogen production, which is currently not occurring on any significant scale in China. Second, the new version does not specify whether investors will be from the private sector or state sector/government. Experts on the formulation team emphasize that for now such projects are the domain of the government and state-owned enterprises in China. The hope is that private sector entrepreneurs in China will also get involved, though it may be premature to target certain achievement of such involvement for this project. The increase in ProDoc GEF TA amount by US 46,500 is to accommodate stronger inputs in designing a monitoring system for China's HRSs, implementing this system, and providing annual reporting on findings.
OUTPUTS: *• At least 4 completed demonstrations of the application of feasible and cost-effective H2 production technologies* *• At least 4 completed demonstrations of the commercial operation of H2 refueling facilities*	Refer to Part I, Sec. B, Component 2, Outcome 2B Outputs 2B.1, 2B.2, and 2B.3.	ProDoc Output 2B.1 corresponds to the first PIF output under Outcome 2.2. Both outputs target four completed demonstrations of feasible and cost effective hydrogen production. However, the ProDoc output specifies that these will be renewable energy based hydrogen production. During formulation, experts emphasized that it is important for FCVs to demonstrate "green" status via renewable energy based hydrogen production. Further, while China may be relatively advanced in some areas of fossil fuel based hydrogen production, there is little experience with

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	Project Document	
		renewable energy based hydrogen production. Thus, it was determined that renewable energy based hydrogen production would be the most construction target for the project hydrogen production demos. ProDoc Output 2B.2 corresponds closely to the second PIF output under Outcome 2.2, in that both target at least four hydrogen refueling station demonstrations. ProDoc Output 2B.3 focusses on documented results of the hydrogen production and hydrogen refueling station demos. As mentioned above (under the previous outcome), this corresponds to the fifth PIF output under PIF Outcome 2.1.
Outcome 3.1: Effective enforcement of policies and regulatory frameworks on supporting the application and commercialization of low carbon transport, e.g., FCVs and other alternative energy vehicles (AEVs) GEF: US$ 300K Co-Financing: US$ 500K	**Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs** GEF: US$ 400.250K Co-Financing: US$ 500K	The ProDoc wording of Outcome 3A is almost identical to the PIF wording of Outcome 3.1. The main difference is that the PIF version indicates that the addressed policies cover all of "low carbon transport," while the ProDoc version specifies that the focus of project policy work will be solely on FCVs. The Chinese experts involved in the formulation team suggest that general policy supporting "low carbon transport" and particularly policy supporting electric vehicles in China is quite strong. Indeed, their concern is that FCVs will be "left out" or at least "left behind" as a low carbon transportation option. Already, China has adopted a great many hybrid electric and pure electric vehicles, but almost no FCVs are on the road there. Thus, the formulation team decided that policy initiatives supported by the project would focus on FCVs alone. The proposed ProDoc GEF budget for Outcome 3A is about US$ 100,000 more than that in the PIF version. The main reason is that, with further formulation work, it was decided to put much more substantial resources (a total of about USD 177,000) than originally planned into development and vetting of national-level and local-level *FCV Roadmaps*. Experts on the formulation team deem *Roadmap* work a crucial policy aspect of driving the FCV industry forward in China. A more impactful *Roadmap* work will result from greater involvement of more key individuals (through workshops, extensive consultation, and more experts involved in drafting work). The substantial expansion of the budget for *Roadmap* work was countered with the reduction in budget to other initiatives (than originally envisioned), with the result being ae *net* budget increase of about USD 100,000. In particular, in the area of standards, the Chinese Government has already set up standards committees relevant to FCVs, hydrogen production, and hydrogen refueling stations. There are already many developed standards. The project's role will then be to review the standards and make recommendations for revisions and improvements. It will then be up to the standards committees (whose activities will be fully co-financed) to vet and adopt the recommendations, as relevant.
OUTPUTS: • *Completed research studies on the required enabling conditions for the widespread application and commercialization of FCVs in the transport sector in China* • *Completed policy research study (including*	Refer to Part I, Sec. B, Component 3, Outcome 3A Outputs 3A.1, 3A.2, 3A.3, 3A.4 and 3A.5	ProDoc Output 3A.1 ("national and local FCV roadmaps") corresponds to the fifth output under PIF Outcome 3.1 ("national FCV master plan and supportive infrastructure roadmap"). The main difference is that the new formulation adds the development of local FCV roadmaps, because of the importance of local-level governments in FCV adoption. ProDoc Output 3A.2 corresponds to the fourth output under PIF Outcome 3.1 ("FCV and hydrogen production facilities technical and energy performance standards including testing and

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	Project Document	
feasibility) on the establishment and support of a local FCV market in China *• Formulated FCV support policies including the relevant implementing rules and regulations (IRRs)* *• Established FCV and H2 production facilities technical and energy performance standards including testing and certification systems* *• Formulated and approved national FCV development master plan and supportive infrastructure roadmap and institutional framework supportive of low carbon transport development and applications (e.g., FCVs)*		certification systems"). The new formulation adds mention of hydrogen refueling stations and parts associated (with FCVs, hydrogen refueling stations, etc.) to the areas of FCVs and hydrogen production. It also makes a point of mentioning, "filling in the gap in terms of standards/testing/ certification not yet in place". Thus, the associated activities should not reinvent the wheel, but focus on supplementing/ enhancing what has been done so far. ProDoc Output 3A.3, focusing on expedited approval of FCVs and hydrogen refueling stations, is newly added. Based on the history of FCVs in China in which most demonstrations have been only short-term due to difficulties in gaining permanent, long-term approvals for the lifetime of the vehicles, it is important for this component to address the approval process and thus the adoption of this new output. ProDoc Output 3A.4 (incentive policies for FCV purchase) and Output 3A.5 (incentive policies for hydrogen refueling station establishment) correspond to the third output under PIF Outcome 3.1. The difference is that the new outputs offer greater specificity (one for FCV purchase and one for hydrogen refueling station establishment). The first two outputs under PIF Outcome 3.1 have been eliminated, though key aspects are found in other ProDoc outputs. These two PIF outputs were designed to consist of policy-related research studies. Based on experience, the formulation team was concerned studies alone, as outputs may not yield concrete results. Thus, the outputs of this outcome focuses on actual policies, regulations, and approvals, though experts involved in activities will need to conduct some targeted policy research to fulfill their policy design assignments. Thus, these two outputs overlap to some extent with all five of the ProDoc Outcome 3A outputs, in that early stage work will require some research. In addition, they overlap with Output 3B.1 (below), which requires the design of incentive polices new to China. (Such design will also require research as a prerequisite.)
Outcome 3.2: Effective enforcement of policies and regulatory frameworks on supporting the application and commercialization of FCVs in the transport sector. GEF: US$ 200K Co-Financing: US$ 400K	**Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations** GEF: US$ 116.7K Co-Financing: US$ 400K	The adjustment of wording of ProDoc Outcome 3B as compared to PIF Outcome 3.2 is related to the adjustment in wording of ProDoc Outcome 3A. As explained above, the greater need is to support FCVs through FCV-specific policy and thus the focus of Outcome 3A was narrowed to FCVs alone. In this way, PIF Outcome 3.2's wording (which also focuses specifically on FCVs) becomes somewhat redundant. Thus, the scope of Outcome 3B further focused on adoption of FCV related promotion policies that are new to China. Formulation experts see a need to broaden the policy options beyond what China is already doing and generate new ideas for FCV promotion support. ProDoc proposed GEF funding for Outcome 3B is US$ 83,300 less than that proposed in the PIF. The main reason for the reduction is that the scope of this outcome is to focus on FCV-specific policies alone and that Outcome 3A already covered some of the original scope.

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	**Project Document**	
OUTPUTS: *• Designed pilot schemes for the application of formulated and recommended policies supportive of FCVs :* *• Completed pilot schemes, and published and disseminated pilot scheme implementation, results and evaluation* *• Completed promotion and advocacy work on the approval of revised FCV policies and IRRs* *• Approved FCV support policies and IRRs*	Refer to Part I, Sec. B, Component 3, Outcome 3B Outputs 3B.1, and 3B.2.	ProDoc Output 3B.1 corresponds closely to the first output under PIF Outcome 3.2. The output for both is designed pilot policy schemes. The ProDoc formulation adds greater specificity, noting that policies are those that incentivize FCVs and hydrogen refueling stations and that the policy pilots should be novel to China. Product Output 3B.2 corresponds closely to the second output under PIF Outcome 3.2. The output for both focuses on implementation of the policy pilots and documentation/dissemination of results. The third and fourth outputs under PIF Outcome 3.2 have been eliminated from Outcome 3B due to the Outcome's narrowed scope and the fact that the two outputs' content overlaps with work that will be conducted under Outcome 3A (Outputs 3A.2, 3A.3, 3A.4, and 3A.5). These four Outcome 3A outputs include both promotion /advocacy for approval of new policies and approval of the policies themselves.
Outcome 4: Enhanced public acceptance of FCVs for transport systems and services GEF: US$ 200K Co-Financing: US$ 350K	**Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness** GEF: US$ 309.84K Co-Financing: US$ 350K	The wording of ProDoc Outcome 4 is quite similarly to the original PIF Outcome 4 with slight variation. The variation is, in the ProDoc version, to emphasize both public and private uses of FCVs and to specify that the means of increased acceptance of FCVs is increased knowledge and awareness. The second is more specific. The ProDoc proposed GEF budget for Outcome 4 is US$ 109.84K higher than that proposed in the PIF. The substantial difference results from decisions made during project design to devote more extensive resources than initially planned to some activities. These include, a total of USD 101,750 to the general-purpose study tour and annual international forums combined and a total of USD 68,000 to project website and issuance of monthly newsletter, thus pursuing more extensive, higher quality product for these activities than initially envisioned. Also contributing to the increased budget, a decision was made to add a high-impact TV documentary (budget of USD 40,000), which targets to be aired on a major network. Another reason for the relatively high budget for Outcome 4 is that some of its activities overlap closely with those of other components. Outcome 4 now includes such activities due to their relevance in building awareness and knowledge on FCVs. In particular, one Outcome 4 activity will be the annual workshops to promote results of the FCV demos of Outcome 1B (budget of USD 16,190).
OUTPUTS: *• Established and operational domestic and foreign academic exchange networks on fuel cell, FCV and H2 production technologies, as well as on commercial FCV production and business operations.* *• Completed riding public education and awareness-raising campaigns on FCV transport systems and*	Refer to Part I, Sec. B, Component 4, Outcome 4, Outputs 4.1, 4.2 and 4.3.	The ProDoc's Output 4.1 correlates closely with the second output under the PIF's Outcome 4. The PIF output is "completed riding public education and awareness-raising campaign," whereas the ProDoc output is "completed public advocacy program." While the current formulation of Outcome 1B calls for driving and riding opportunities to occur as a part of Outcome 1B rather than Outcome 4, Output 4.1 promotes public acceptance of FCVs through a media campaign, brochures, documentary on a major network, and "myth-busting" video regarding the safety of hydrogen as a fuel. The ProDoc's Output 4.2 correlates with the fourth output under the PIF's Outcome 4. The broader scope of Output 4.2: "completed knowledge and awareness program for policy

Expected Outcomes & Outputs		Rationale for Changes in PIF Outcomes/Outputs in the ProDoc
GEF-approved PIF	Project Document	
operations in at least 4 cities *• Established and operational FCV transport system performance and FCV market monitoring system* *• Sustainable follow-up plan for the replication of the FCV transport systems in other cities*		makers, managers, and experts, as well as associated plans for replication of FCV demos in other cities" now encompasses the "sustainable follow-up plan" indicated for that fourth PIF output. The ProDoc's Output 4.3 correlates with the third output under the PIF's Outcome 4. The "FCV transport system performance and FCV market monitoring system" of the PIF is in the ProDoc version of the output entitled *China FCV Market and Technology Monitoring System*. The elimination of the first output under the PIF's Outcome 4 based on findings during project formulation. That output was "established and operational domestic and foreign academic exchange networks on fuel cell, etc." Experts on the formulation team stressed that the more important and relevant exchanges, while more difficult, will be between parties in the commercial sector. For this reason, relevant Outcome 1A and 2A activities allocate a portion of their funding for international liaison support. This is support for Chinese commercial entities (such as FCV component manufacturers). Particularly, in connecting with and communicating with foreign counterparts with whom they may set up commercial cooperation.
Outcome 5.1: Increased local technical capacity and knowhow in the research and development, operation and maintenance of FCV technologies and the FCV industry GEF (Outcomes 5.1 & 5.2): US$ 291.49K Co-Financing (Outcomes 5.1 & 5.2): US$ 350K	**Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations** GEF: US$ 169.2K Co-Financing: US$ 175K	ProDoc Outcome 5A is quite similar to PIF Outcome 5.1 in its focus on increased technical capacity for O&M of FCVs and other aspects of the FCV industry. The difference is that the PIF outcome also covers increased capacity and knowhow in research and development. The formulation team has decided to leave out the "research and development" aspect and focus solely on O&M. The reason is three-fold: (1) There is a need to increase the focus of the work in an area that has proven to be a problem in the past (FCV O&M). (2) Domestic R&D is not the key barrier facing FCV development in China, whereas manufacturing and scale-up is. While R&D breakthroughs are needed globally rather than specifically in China. In general, China fuel cell R&D is closer to international levels than is its manufacturing in this area. (3) China fuel cell experts in the R&D area will gain increased exposure through the project via other components such as Outcome 4's international forums and study tours, or workshops of Outcome 1A and Outcome 2A. While the PIF did not separate the GEF budgets for Outcome 5.1 and Outcome 5.2, it presented a total of US$291.49K, which is US$ 76.69K more than the total ProDoc amount proposed for Outcomes 5A and 5B together. In the case of ProDoc Outcome 5A, this reduced amount (say about US$ 38,000 or half of the total reduction) can be explained by narrowed focus (leaving out the capacity building for R&D) and the coverage of capacity building for the R&D sector (FCV experts) to some extent through other components as described above.
OUTPUTS: *• Designed, conducted and completed training programs for FC and FCV operation, repair and maintenance; and safe and cost-effective operation of H2 production and cost-effective commercial*	Refer to Part I, Sec. B, Component 5, Outcome 5A, Output 5A.1	ProDoc Output 5A.1 corresponds closely to the one output under PIF Outcome 5.1. The main difference is that the PIF output covers O&M for hydrogen production (in addition to O&M for FCVs and hydrogen refueling stations). During project formulation, it was found that hydrogen production O&M in China is relatively advanced and that the main areas of need in O&M capacity building are FCVs and hydrogen refueling stations.

<table>
<tr><th colspan="2">Expected Outcomes & Outputs</th><th rowspan="2">Rationale for Changes in PIF Outcomes/Outputs in the ProDoc</th></tr>
<tr><th>GEF-approved PIF</th><th>Project Document</th></tr>
<tr><td>operation of FCV transport systems and H2 refueling stations.</td><td></td><td></td></tr>
<tr><td>Outcome 5.2: Strengthened market demand for cost-affordable FCVs for both public and private uses

GEF (Outcomes 5.1 & <u>5.2</u>): US$ 291.49K
Co-Financing (Outcomes 5.1 & <u>5.2</u>): US$ 350K</td><td>Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/ commercial purchase of FCVs

GEF: US$ 45.6K
Co-Financing: US$ 175K</td><td>ProDoc Outcome 5B correlates with PIF Outcome 5.2, though other project components cover some aspects of the latter. The PIF outcome focuses on a strengthened market for FCVs. To some extent, the awareness raising of ProDoc Outcome 4, as well as the FCV visibility and test-drive opportunities of the demos in Outcome 1B covers this. ProDoc Outcome 5B (like PIF Outcome 5.2) also stimulates demand by cooperating with financial institutions in developing FCV purchase loan programs for consumers. Yet, Outcome 5B is broader than this in that it also targets increased interest and capacity of the financial sector in investing in FCV manufacturing and the associated value chain. Lack of finance is a barrier strongly emphasized by Chinese experts during the LFA workshop for the PPG. The enhancement of the scope of Outcome 5B includes financing of FCV manufacturing, hydrogen refueling stations, etc.

While the PIF did not separate the GEF budgets for Outcome 5.1 and Outcome 5.2, it presented a total of US$291.49K, which is US$ 76.69K more than the total ProDoc amount proposed for Outcomes 5A and 5B together. In the case of ProDoc Outcome 5B, this reduced amount (say about US$ 38,000, or half of the total reduction) is due to the coverage of substantial aspects of PIF Outcome 5B in other parts of the project including Outcome 4 and Outcome 1B, as explained in the paragraph above.</td></tr>
<tr><td>OUTPUTS:
• Established and operational FCV value chain businesses such as the FCV service industry (e.g., design, construction, repair and maintenance of FCV infrastructures)
• Developed business models for local financial institutions to support FCV manufacturing, as well as in the sales of FCVs to supplement the government's New Energy Vehicle Industry Development Plan (2011-2020)
• Proposed financing scheme for FCV purchases for private transport users</td><td>Refer to Part I, Sec. B, Component 5, Outcome 5B Outputs 5B.1 and 5B.2.</td><td>ProDoc Output 5B.1 correlates with the second output under PIF Outcome 5.2. The emphasis, however, shifted from "developed business models" to actual "financed projects." The formulation team determined that the more important aspect to focus on is on introducing the financial sector to opportunities related to FCVs and their value chain, educating them on the sector, and providing liaison support to connect financiers and those in need of financing.

ProDoc Output 5B.2 correlates with the third output under PIF Outcome 5.2. Both have financing schemes for the purpose of FCV purchase as their target. Yet, the PIF output indicates the phrase "proposed financing scheme," while the ProDoc output indicates "established and operational financing scheme," thus pushing the project to higher levels of achievement.

Elimination of the first output under PIF Outcome 5.1 ("established and operational FCV value chain businesses, such as FCV service industry"). During formulation it was determined that the service industry is not a top priority area for specialized technical capacity building, compared to others addressed in Outcome 5A and 5B. In addition, the service industry will be able to gain capacity through workshops and other activities conducted under other components of the project. They will attend these events in conjunction with manufacturers and other relevant industry players. Further, other parts of the project such as Outcome 1A, Outcome 2A, and Outcome 2B now addresses other aspects of the FCV value chain (FCV components, refueling stations, equipment for refueling stations, hydrogen production).</td></tr>
</table>

A.1. National Strategies and Plans or Reports and Assessments under Relevant Conventions, if applicable, i.e. NAPAS, NAPs, NBSAPs, national communications, TNAs, NCSA, NIPs, PRSPs, NPFE, Biennial Update Reports, etc.: NA

A.2. GEF focal area and/or fund(s) strategies, eligibility criteria and priorities: NA

A.3. The GEF Agency's comparative advantage: NA

A.4. Baseline project and the problem that it seeks to address: NA

A.5. Incremental /Additional cost reasoning:

The aforementioned socio-economic benefits, in turn, have the potential to drive major global environmental benefits in the form of reductions in GHGs. China is the world's largest consumer and producer of energy, as well as its largest emitter of greenhouse gas emissions. In the case of carbon dioxide emissions from the energy sector, China's emissions substantially surpassed those of the US (the second largest emitter) by about 60 percent (2012). China's transport sector plays a significant and growing role in China's overall energy use. Experts indicate that the transport sector now accounts for 10 to 15 percent of China's final energy consumption. They expect that share to rise to 30 percent as urbanization levels stabilize. Indeed, comparisons to transport's share in the energy consumption mix of developed countries, such as the US (almost 40 percent) and Japan (around 25 percent), suggest an increasing role for transport in China's growing energy consumption and thus an increasing role for China's transport sector in the growing CO2 emissions from China's energy sector.

Potential reductions in CO2 emissions due to the project are substantial in the long run. In the short-run, direct incremental reductions in CO2 emissions by project close at the end of 2019 are 15,287 tons. This is a result of the project's 109 demo vehicles running for three years as well as its 4 renewable energy based hydrogen production demos running for two years. Due to the additional post-project lifetime of the hydrogen production demos, an additional 60,176 tons of incremental direct reduction in CO2 emissions will be achieved over 18 years after project close and another 28,095 direct post-project emission reductions will occur due to equipment put in service after project close, but directly due to project activities. Bottom up estimates for indirect CO2 emission reductions assume a four-time replication factor for the demo FCVs and a three time replication factor for the hydrogen production demos and (eliminating double counting for hydrogen used in the FCVs) achieve an additional net 237,374 ton direct CO2 emission reductions. Based on a top down approach, the estimated indirect CO2 emission reductions (due to FCVs and renewable energy based hydrogen production) during the 10-year influence period are about 124 million tons. This is on the assumption that post-project (starting in 2020), FCVs are able to achieve the same kind of growth seen with electric vehicles over the past five years (2009-2014). Moreover, this also on the premise that such growth continues for five more years along with substantial growth in renewable energy based hydrogen production (230 MW of wind and 40 landfill methane sites). With a causality factor of 50 percent, the top-down approach has estimated indirect CO2 emission reductions of around 62 million tons attributed to project influence.

A.6. Risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and measures that address these risks: NA

A.7. Coordination with other relevant GEF financed initiatives: NA

B. ADDITIONAL INFORMATION NOT ADDRESSED AT PIF STAGE:

B.1. Describe how the stakeholders will be engaged in project implementation.

A wide range of stakeholders will be relevant to overcoming the barriers to fuel cell vehicle (FCV) commercialization in China and thus be involved in project implementation. The types of stakeholders will include: National-level government officials; local-level government officials and staff; auto manufacturers based in China; FCV and fuel cell (FC) component manufacturers (both those based in China and those based abroad); hydrogen refueling station (HRS) investors and operators; hydrogen producers and potential producers of renewable energy based hydrogen; experts (experts on auto industry, experts on FCVs, and experts on hydrogen); public transport companies; delivery companies; consumers/general public; and financial institutions. The role and relevance of each of the aforementioned stakeholder groups in project implementation, as well as some specific entities within those groups, are below.

National-level government officials: National-level government officials will be critical in adopting policies and plans to promote FCVs and in ensuring the success of this project. For the project, key organizations include the Ministry of Science and Technology (MOST), the implementing partner for the project. MOST promotes R&D and development of new industries in China. As Implementing Partner (IP), MOST will handle communication and coordination with Ministry of Finance (MOF) and UNDP, liaison with local governments, project activity management, and project financial management. The Ministry of Industry and Information Technology (MIIT) has more recently joined MOST and MOF as a key player in driving new energy vehicle (NEV, including all types of electric vehicles and FCVs) demonstration. At the same time, its role in approving new FCV models will be critical to commercialization efforts. For this project, MIIT will provide assistance in the identification and design of replication demos for FCVs, HRSs, and hydrogen refueling. It will also interact with the project in developing streamlined approval procedures for new FCV models.

Local-level government officials: Local-level government officials will be instrumental in taking the lead from the National Government to promote actual adoption of FCVs at the local level, initially through demonstration and replication plans. For this project, key entities will be local level government organizations driving the project demos: (1) Beijing Science and Technology Commission, (2) Shanghai Science and Technology Commission, (3) Zhengzhou Bureau of Science and Technology, and (4) Development and Reform Commission of Guangdong Province, along with Nanhai District Development and Reform Bureau. For the project, these local entities will coordinate implementation of FCV and HRS demos and drive the process forward. They and their counterparts in other cities will be responsible for developing plans to replicate project demos. Many other local government organizations will be involved in the demos in each city. Other important entities at the local level will be public security bureaus and transportation management bureaus, which will play an important role in approving and issuing license plates for individual vehicles. Their further education regarding FCVs and safety methods will be critical to approval and thus success of the demos.

FCV and component manufacturers: FCV and FCV component manufacturers (and potential such manufacturers) will be major beneficiaries of the project and primary drivers of its progress. Due to the high subsidies for domestic-produced vehicles, involved FCV manufacturers will most likely be domestic-based manufacturers, whether fully Chinese-owned or joint ventures. Key FCV manufacturers likely to be involved include SAIC, Foton, and Yutong. Yet, the project will reach out to all interested vehicle manufacturers. In addition to involvement in the demos, FCV manufacturers will benefit from one-on-one technical assistance and group capacity building in the area of FCV manufacturing. As for component manufacturers, it is likely that both overseas entities (such as Ballard, Hydrogenics, etc.) and domestic entities will be involved through supplying components to demo vehicles. Project activities will enhance links between China's FCV manufacturers and potential overseas component manufacturers. Current or potential domestic component manufacturers will become beneficiaries of project technical assistance focused on building local capacity to manufacture excellent components at lower prices than are currently available.

Hydrogen refueling station investors and operators: HRS investors and operators, via fuel availability and provision, are critical to the development of the FCV industry in China. For the project, these parties will play the critical roles of providing hydrogen to project demo FCVs and providing data and lessons learned on HRS operation. HRS investors may include city governments, state-owned companies, or private sector companies. They will be beneficiaries of project one-on-one technical assistances and of group capacity building.

Hydrogen producers and potential producers of renewable energy based hydrogen: Availability of hydrogen at a low price will be critical to FCV commercialization; and availability of renewable energy based hydrogen will be important to realizing the "green" potential of FCVs. Existing hydrogen producers will play an important role in the project by providing hydrogen to demo HRS stations. Further, potential producers of renewable energy based hydrogen, by setting up hydrogen production facilities, will play an important role in demonstrating this important aspect of the future hydrogen value chain for FCVs. These potential producers may include current wind farms with excess power (state-owned or private) as well as investors in landfill methane based hydrogen production projects. The potential renewable energy based hydrogen producers will be the beneficiaries of project one-on-one technical assistance and group capacity building.

Experts on the auto industry, FCVs, and hydrogen: Currently, experts are playing a key role in the development of the FCV industry in China. Some of the nation's strongest capabilities for FCV power train development exist in university automotive centers. For the project demos, experts and their institutions will play an important role in designing and carrying out monitoring efforts (and analysis of collected data). Key institutions in this regard include Tsinghua University and Tongji University. Other important institutions associated with experts include: (a) Society of Automotive Engineers of China, which is important in advising the government on policy and will play a policy promotion role in the project; and (b) China Automotive Technology and Research Center, which will play a key role in housing the Project Management Office (PMO).

Public transport companies, delivery companies, and other institutional users of FCVs: Institutional users of FCVs, particularly public transport companies and delivery companies, are also a key link in promoting commercialization of FCVs. To date, public bus companies in China have adopted NEVs (mostly HEVs, PHEVs, and EVs) at a much higher rate within their overall purchases than other users. Further, given the visibility of public buses, public bus companies' adoption of FC buses will be important in building awareness of the technology. For the project, key public transport companies will be those in each of the four demo cities: Beijing Public Transportation Corporation, Shanghai Jiading Bus Company, Zhengzhou Public Transportation Company, and Nanhai Public Transportation Company. For the project, these organizations will have the role of ensuring selection of high visibility routes. They will also be responsible for ensuring smooth refueling and O&M of the buses. Their staff will thus need to master O&M practices. For replication of the demos, public transport entities in other cities will be similarly involved. Other companies of relevance to the project demonstrations include Shenzhou Taiyue, City 100, and Potevio, each of which will be responsible for ensuring high visibility routes, refueling, and O&M of their FC delivery vehicles. Another company of relevance to the demos will be the SAIC-invested car rental company that will operate a majority of the project's demo FC autos.

Consumers/general public: Consumers represent the largest ultimate market for FCVs in China. The need to raise their awareness and understanding of FCVs is critical, as is the need to inform them and alleviate their fears regarding hydrogen's safety issues. The project will engage consumers via its awareness raising activities, including opportunities to test drive FCV autos in Shanghai, a documentary aired on a major television station in China, etc. Consumers will also play a critical role as they begin to purchase FCVs for personal use. (To date, there have been no consumer FCV purchases in China.)

Financial Institutions: Financial institutions will ultimately be important to the growth and expansion of the FCV industry in China. Eventually, the financing of FCV manufacturing expansion, manufacturing of components, manufacturing related to hydrogen production and hydrogen refueling, and establishment of HRS stations, may need them. The stimulation of consumer purchase of FCVs through special bank loan programs may also need them. At present, these institutions are not very aware of the FCV industry and the industry potential. Key players that the project will build capacity in include banks and private equity/venture capital firms. The latter may fund some of the more risky investments in manufacturing and technology development, while the former may establish FCV loan programs and provide loans to manufacturers that they see as lower risk.

UNDP and GEF: UNDP's and GEF's role in promoting FCVs in China has been ongoing since initiation of the previous FC bus project. For implementation of the current project, UNDP will provide ongoing guidance and backstopping for implementation. This will range from technical inputs and idea generation for achieving project targets to ensuring reporting and financial processes are in order. The UNDP China Country Office as well as the UNDP Asia-Pacific Regional Coordination Unit in Bangkok will carry out UNDP's role. Both of these entities have played an active role in the previous project as well as a critical role in development of the current project.

B.2. Describe the socioeconomic benefits to be delivered by the Project at the national and local levels, including consideration of gender dimensions, and how these will support the achievement of global environment benefits (GEF Trust Fund/NPIF) or adaptation benefits (LDCF/SCCF):

By facilitating the commercialization of fuel cell vehicles in China, the project will deliver several socio-economic benefits at both the national and local levels. Benefits will support the achievement of global environmental benefits of reduction in greenhouse gas (GHG) emissions. At the national level, facilitation of the commercialization of fuel cell vehicles offers the long-term benefits. These include: (1) reducing urban air pollution across multiple cities in China, thus contributing to the health and satisfaction of urban residents; (2) reducing petroleum imports, or at least growth in petroleum imports, thus increasing China's level of energy security; and (3) developing a high value-add industry that can contribute to China's economic development and to growth in its high value-add employment opportunities.

Severe urban air pollution in China is increasingly recognized as a serious social problem that has resulted from growing energy consumption. Increasingly being recognized is the driving force behind urban smog in major cities is shifting from industry to transport, as factories moved out of urban areas, though indoor heating for buildings is also a major contributing factor in North China. According to analysis of data from China's Ministry of Environmental Protection, PM 2.5 (small particulates considered an important indicator in terms of health impacts of air pollution) levels in many cities far exceed the standard of 35 μg per m^3 set by the GoC in 2012. Reflecting the severity of the situation, in 2014, Chinese Premier Li Keqiang stated that China will "declare a war on air pollution." Among the key targets is managing vehicle emissions. Promotion of the commercialization of fuel cell vehicles offers a potential solution to the urban air quality problem to complement the benefits presented by electric vehicles (EVs), which is pursued in China more extensively than FCVs. At present, the charging of electric vehicles in China is mainly by coal-based electricity. Demo vehicles for this project will use a combination of industrial by-product hydrogen, hydrogen made from natural gas reforming, and wind power based hydrogen. All of these sources of hydrogen present substantially lower greenhouse gas (GHG) emissions than either EVs or internal combustion engine vehicles. Further, the project will promote the development of renewable energy based hydrogen production, paving the way for more FCVs that operate with very little impact on air quality.

China is the second-largest consumer of oil in the world after the US. Currently also second largest after the US in net oil imports, China is expected to become the world's largest oil importer once data for 2014 is in. China's net oil imports grew at a compound annual growth rate of about 10 percent between 2009 and 2013. About 60 percent of China's oil consumption is used in the transport sector, which over time has been accounting for a growing share of overall oil use, while industry's share has been diminishing. Forecasts indicate China's oil consumption, along with its dependency on oil imports, will grow substantially over the next 20 years. According to some forecasts, energy consumed for transport in China will almost double between 2015 and 2035. One forecast, for example, projects oil imports will grow from roughly 6 million barrels per day in 2013 to 13 million barrels per day in 2035. If this occurs, China will at that time, depend on imports for 75 percent of its oil consumption, as compared to 60 percent in 2013.[5] It is clear that the transport sector is a major driver of these trends. MIIT has indicated that new vehicle sales account for 70 percent of growth in China's annual gasoline and diesel consumption.[6] Increasing oil imports have raised GoC concerns about energy security. These concerns, along with air quality and GHG emissions issues, have stimulated great interest in alternative energy vehicles. Removal of barriers to the commercialization of fuel cell vehicles can potentially reduce China's dependence on imported oil and thus increase its energy security.

In addition to urban air pollution and energy security, China's interest in developing high value-add industry is a third pillar in the GoC's motivation to promote new energy vehicles (hybrid, plug-in hybrid, battery electric, and fuel cell vehicles) and other clean energy vehicles (namely, CNG, LNG, and LPG vehicles). In terms of developing a high value-add industry, the rationale is that NEVs are an area in which Chinese manufacturers have the potential to rise to prominence, as compared to internal combustion vehicles, in which it is hard to compete with entrenched global players. While China placed much effort in electric vehicles so far, FCVs are a dimension of the NEV opportunity that China has so far put a lot less effort.

Local level socioeconomic benefits of the project are also potentially substantial and related to the national level benefits though may appear on shorter timescales than nationwide socioeconomic benefits. The main benefits at the local level will be: (1) reduction in local air pollution, (2) economic opportunities/growth, and (3) building of human capital. Benefits of FCVs in terms of air pollution are at the local level as some specific cities adopt FCVs faster than others do. In terms of economic growth at the local level, the project will promote in certain locales the development of FCV manufacturing, production of hydrogen from renewable energy, establishment of hydrogen refueling stations (HRSs), development of the manufacturing of various FCV components, and opportunities in the finance sector to support FCVs. Clearly, these are all new areas, which, once they take off, present the potential for rapid growth and high value-add jobs. Also in the short-term, the project will directly build human capacity across the FCV, HRS, hydrogen production, FC components, HRS components, and finance areas. It will do so through multiple modes, including: one-on-one capacity building with various companies, group capacity building, and provision of written training materials, study tours, and direct involvement in demonstrations. While gender issues are not a main area of focus for this project, within many of the human capacity building efforts, particularly group capacity building and study tours, efforts will proactively be made to increase the number of women participants.

B.3. Explain how cost-effectiveness is reflected in the project design:

The project, with about USD 8.2 million in GEF funding, will leverage at least 53.5 million in co-financing, and likely much more. Yet, this incremental funding from GEF, as evidenced by comparing the baseline and alternative scenarios will make a critical difference in the advancement towards commercialization of FCVs in China, thus implying a high level of cost-effectiveness. The "leapfrog" in technical level and cost reduction achieved via the project, along with other project interventions, will result in FCVs that are much more attractive for replication and that are demonstrated on an ongoing, continuous basis over a period of over three years. In the alternative scenario, at least four times replication of the project's 109 demo vehicles via new demos in other cities and expansion in existing demo cities is expected due to the impressive results of the FCV demos, along with three time replication of the renewable energy based hydrogen production demos. This compares to only limited or sporadic replication of FCVs anticipated in the baseline case and no renewable energy based hydrogen production. In the baseline case, FCV demo results are disappointing due to limited technical advancement and cost reduction, as well as limited and discontinuous operation of the demo vehicles, so there is little incentive for replication. In the baseline scenario, there are 92 vehicles, while in the alternative scenario there are

[5] British Petroleum, *BP Energy Outlook 2035 – Country Insights: China* (2015)

[6] State Council Development Research Information Network, 2013, as quoted in Sabrina Howell et al "Leapfrogging or Stalling Out," 2014, Faculty Research Paper Harvard JFK School of Government.

109 vehicles.[7] Yet, the most important factor is the technical leap facilitated by the GEF investment in vehicles combined with GEF-supported technical assistance (via one-on-one support for vehicle manufactures in design, manufacturing, and sourcing of parts). This "leap" will be critical in achieving demo results of the level needed to prove the industry viable to government officials, end users, and other relevant stakeholders. Thus, a smaller proportion of the funding is provided by GEF funds, but an impact far beyond and in fact completely different from the baseline case is achieved.

Similar highly cost-effective differentiating results between the alternative and baseline scenario are seen in the area of HRS stations. Because the alternative scenario is able to ensure continuous operation of the demo vehicles and substantial expansion to more FCVs in China, HRS stations are able to achieve continuous operation and greater numbers. Yet, the basic investment for these stations will all be co-financed. Further, through its technical assistance and design, the project will achieve demonstration of different business models of HRSs in the alternative scenario, thus contributing to their greater viability in the early days of the FCV industry. For example, the project will pursue dual gasoline and hydrogen stations and other multi-fuel scenarios. In the baseline scenario, in contrast, stations would lack this diversity of business models. Further, in the baseline scenario, with relatively short-term operation of vehicles (estimated at a maximum of 1.5 years), the new HRSs are likely to encounter problems encountered in the past in China with HRSs being set up and later removed.

Hydrogen production aspects of the project will also present high cost-effectiveness. The project will achieve demonstration of renewable energy based hydrogen production in the alternative scenario, though the production infrastructure will be fully co-financed. The project will provide technical support to ensure that international best practice and other information is available to investors to ensure project success and replication. It will use these to leverage already existing interest from wind farms in utilizing excess power to produce hydrogen.

To achieve cost-effectiveness in the FCV components area, the project focuses on providing technical assistance to improve manufacturing and testing methods. It also focuses on providing facilitation support for joint ventures or other cooperative arrangements with foreign counterparts. These approaches are means of achieving technical improvement and potential cost reduction worldwide for FCV components at relatively low cost.

Finally, the project design also encompasses three other areas that present high potential for cost-effectiveness: policy, awareness building and information dissemination, and capacity building. As for policy, it is clear that policy in China has the powerful ability to drive industry development as has been seen in the electrical vehicle industry. Yet, FCVs lag EVs in policy support, though there is a basic framework of FCV subsidies and standards. The project design envisions that by building on this basic framework, very strong results can be achieved at low cost. For example, the project targets the development and adoption of a China FCV and HRS Roadmap. Currently, the industry lacks an official government roadmap, though such roadmaps have been known to push other industries forward substantially in China. Awareness building workshops, study tours, and disseminated materials will, at low cost, foster replication, by getting the word out to other local governments about the results of the demos. Lastly, capacity building, for relatively low cost will ensure avoidance of barriers encountered in the past and play the role of stimulating financial sector interest in the industry. In previous FCV efforts in China, for example, one major problem contributing to non-continuous operation of the vehicles was lack of O&M capacity among the operators, which will be an important activity area in this project. As for the financial sector, at present there is little if any activity in this sector in support of FCVs and related industries. For relatively low investment, the project will ensure the financial sector has the capacity to understand and evaluate the industry.

C. DESCRIBE THE BUDGETED M&E PLAN:

[7] These include one vehicle brought in by Toyota in the alternative scenario.

The PMO will coordinate with all the project partners in the monitoring and evaluation of the project activities. The continuous monitoring and evaluation of project activities, even after completion of the project period, will bring sustainability of the project with desired benefits in the long run. All evaluation reports will be uploaded to the project website for widespread dissemination. A formal Monitoring and Evaluation Plan will be developed and implemented in the full-scale project to track the activities implementation including that of the baseline activities that will be carried by all the project partners, as well as the co-financing contribution (in-cash and in-kind) as detailed in the co-financing letters. These M&E findings will be reported in the annual project reports and project implementation review reports, and verified and in the project's two in-depth independent reviews. The budget allocation for supporting M&E activities is US$ 110,000 as presented in the table below.

M & E Work Plan and Budget

Type of M&E Activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, UNDP GEF	Indicative cost: 10,000	Within first two months of project start up
Measurement of Means of Verification of project results	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members	Included in Component Budget	Start, mid, and end of project (during evaluation cycle) and annually when required
Measurement of Means of Verification for Project Progress on *output and implementation*	▪ Oversight by Project Manager ▪ Project team	Included in Component Budget	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	None	Annually
Periodic status/ progress reports	▪ Project manager and team	None	Quarterly
Mid-term Evaluation	▪ Project manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: 40,000	At the mid-point of project implementation.
Final Evaluation	▪ Project manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost : 40,000	At least three months before the end of project implementation
Project Terminal Report	▪ Project manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	▪ UNDP CO ▪ Project manager and team	Indicative cost: 20,000 (5,000/year)	Yearly
Visits to field sites	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	Paid from IA fees and operational budget	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US$ 110,000	

PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT(S) AND GEF AGENCY(IES)

A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT(S) ON BEHALF OF THE GOVERNMENT(S):

NAME	POSITION	MINISTRY	DATE
Wensong Guo	GEF Operational Focal Point	International Dept., Ministry of Finance	March 5, 2014

B. GEF AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF/LDCF/SCCF/NPIF policies and procedures and meets the GEF/LDCF/SCCF/NPIF criteria for CEO endorsement/approval of project.

Agency Coordinator, Agency Name	Signature	Date	Project Contact Person	Telephone	Email Address
Adriana Dinu Executive Coordinator UNDP/ GEF		18 December 2015	Manuel L. Soriano Sr. Technical Advisor Energy, Infrastructure, Transport & Technology	+66-2-3049100 Ext 2720	manuel.soriano@undp.org

ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).

This project will contribute to achieving the following Country Program Outcome as defined in CPAP or CPD: Policy and capacity barriers for the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed

Country Program Outcome Indicators: Low carbon and other environmentally sustainable strategies and technologies are adopted widely to meet China's commitments and compliance with Multilateral Environmental Agreements

Primary applicable Key Environment and Sustainable Development Key Result Area: 1. Mainstreaming environment and energy

Applicable GEF Strategic Objective and Program: Climate Change Mitigation: Promote energy efficient low-carbon transport and urban systems

Applicable GEF Expected Outcomes: Sustainable transport and urban policy and regulatory frameworks adopted and implemented. Increased investment in less-GHG intensive transport and urban systems.

Applicable GEF Outcome Indicators: Cities adopting in low-carbon programs; Investment mobilized

Strategy	Objectively Verifiable Indicators			Source of Verification	Critical Assumptions
	Description	Baseline	EOP Targets		
Goal: Reduced growth of GHG emissions from transport sector	Cumulative tons of GHG emissions from China's transport sector reduced from FCV applications by end of project (EOP), tons	0	132,707 tons CO_2[8]	GHG emissions reduction estimates based on demo and pilot monitoring reports, Project's FCV Market and Technology Monitoring System	-The source of hydrogen used for project vehicles and subsequent FCVs in China is sustainable, low, or renewable (a)
Objective[9]: Facilitation of the commercial production and application of fuel cell vehicles in China	Number of local transport vehicle manufacturers producing FCVs	4	10	Project survey of AEV manufacturers in China	-National subsidies continue at level that makes FCVs affordable to buyers (b)
	Cumulative investment in local FCV manufacturing, US$ million	$1 million	$10 million	Project survey of AEV manufacturers	
	Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations	1,000	10,000	Project survey	
Outcome 1A : Markedly reduced costs and improved performance and durability of FCVs in China	Average annual operating hours of newly produced Chinese FCVs, hours	670 (bus) 670 (car) 670 (DV)	3,300 (bus) 2,100 (car) 2,100 (DV)	Project survey of FCV manufacturers	

[8] The indicated emission reduction (ER) is a target by end of project (EOP). This differs from the GHG ER calculations presented in Annex 2, which are the expected ERs during the lifetime of FCVs and hydrogen production equipment involved, some of which operate beyond EOP. The above targeted emission reductions of 132,707 tons CO_2 by EOP are a combination of direct incremental net ERs (for 109 FCVs and 4 renewable energy based hydrogen production units) and indirect ERs (assuming total vehicles by EOP are 4,000 including original 109 and assuming an additional 12 renewable energy based hydrogen production units by EOP). The estimated direct incremental net ERs total of 15,287 tons, is comprised of 9,365 tons that are derived from the operation of the 109 FCVs for 3.2 years (with baseline scenario subtracted out) and 5,922 tons are due to the four renewable energy based hydrogen production facilities operating for two year. This expected before EOP (with double counting for the portion of hydrogen used in the demo FCVs subtracted out). The indirect ERs by EOP total 117,420 tons. About 108,537 tons are due to additional FCVs (891 of which come online by start of year 3 and another 1500 of which come online by start of year 4) and 8,883 tons are due to an additional 12 renewable energy based hydrogen production facilities (which come online by start of year four).

[9] *Objective (Atlas output) monitored quarterly ERBM and annually in APR/PIR*

	Reduction in high volume unit cost[10] of newly produced Chinese FCVs, %	0% (bus) 0% (car) 0% (DV)	50% (bus) 40% (car) 50% (DV)	Project survey of FCV manufacturers	
Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China	Annual FCV sales and average annual growth rate of FCV sales in China (units sold, % growth in units sold as compared to previous year)	0, 0%	400 – 7,000, 100%	Project *China FCV Market and Technology Monitoring System* GOC Official statistics	-(b), as above -consumer and government official concerns about FCV safety issues are allayed (d)
Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China	1 0 RE-based H2 station	5 3 RE-based H2 station	Survey of hydrogen refueling stations Project monitoring report	
Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen	Annual hydrogen production (MT) and number of refueling stations in China of substantial scale	0 H2 production 2 H2 refueling stations	1,000 MT 15	Project survey of renewable energy based hydrogen producers	
Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	Number of FCV manufacturing companies that are compliant to newly issued and enforced FCV product standards	0	10	Market survey of local FCV manufacturers and their FCV products Project activity report Project monitoring report	-(b), as above
Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations	Number of cities in which policies new to China promote FCV purchase and/or investment in hydrogen stations are implemented	0	6	Project monitoring report and project survey	
Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness	Number of local governments that are aware and have adopted FCVs in their public transport systems	0	10	Conduct of research survey Project activity report Project monitoring report	-(b), as above --Fear of users re FCV safety issues is allayed (e)
	Number of private vehicle owners that own and use a FCV	0	480 – 3,360		-(b), as above -(e), as above
Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	Number of individuals capable of satisfactorily operating and maintaining (a) FCVs; and, (b) hydrogen refueling stations, in China	20 5	>500 >100	Results of project post-training assessment	-Relevant work units willing to send key staff with required capabilities to trainings (f)

[10] Projection based on production volume of 500 units for buses and 5,000 units for cars, vans, and trucks

Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/ commercial purchase of FCVs	Cumulative investment by financial sector in FCV and FCV value chain manufacturing and in hydrogen stations and their value chain, US$ million	0	100	Market research survey Project activity report Project monitoring report	-(b), as above -financial sector becomes convinced of viability and potential returns of FCV manufacturing and hydrogen stations (g)

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).

Responses to GEFSec Comments (11 Nov 2015)

Comment & Response
15. Has the cost effectiveness of the project been sufficiently demonstrated, including the cost effectiveness of the project design as compared to alternative approaches to achieve similar benefits?

Comment:
Not completed at this time. Please compare cost-effectiveness of the project design with alternative approaches to achieve similar GHG emission reduction benefits in the Chinese transportation market. The alternative approaches may include electric vehicles, hybrid vehicles, compressed natural gas vehicles, and others.

Response:
Following further clarification from GEFSec, the cost effectiveness of fuel cell vehicles (FCVs) shall be presented in terms of total cost per kilometer (US$/km) and total cost per ton CO2 reduced compared to other alternative vehicle technologies that will also bring about GHG emission reduction benefits in the transport sector in China. By consensus, the project proponents agreed to make the comparison of bus transport vehicles employing different technologies that are currently either widely or starting to be deployed in the public bus transport systems of a number of cities in the country. The technologies considered are: Diesel internal combustion engine (ICE) bus, which is the baseline case; and the alternative bus technologies CNG Bus, Diesel Hybrid Bus, Battery Electric Bus, and Fuel Cell Electric Bus.

The analyses were done 2 ways: (1) Assessing the economic feasibility of each bus technologies to determine the net present value (NPV) of the annual costs, the total cost per km, and the technology cost effectiveness; and, (2) Incremental investment cost analysis – assessing the economic feasibility of the incremental cost needed to employ the alternative bus technology and not the base case Diesel ICE Bus. The summary of the bus technology specifications, costs, operations (fuel consumption, savings and GHG emissions, is shown in Annex 1 (see Note at end). The results of the economic feasibility analyses of each bus technology, and incremental investment cost analyses based on the base case Diesel ICE Bus technology are shown in Annex 2 (see Note at end).

The summary of the base case: Diesel ICE Bus, at various percentages of equity on the required investment cost is as follows:

Parameters	100% Equity	75% Equity	50% Equity
NPV Project, US$	(22,342.0)	(10,449.0)	(6,485.0)
NPV Annual Cost, US$	346,382.0	336,127.0	334,197.0
Project IRR%	(9.0)	(3.4)	(2.8)
Total Cost per km	0.73	0.69	0.66

Note that under the Government of China's New Energy Vehicle (NEV) program, subsidies are available only for BE Bus (US$ 128,000 per BE Bus) and FC Bus (US$ 160,000 per FC Bus). There are no subsidies provided for Diesel ICE Bus, CNG Bus, and Diesel Hybrid Bus. In this case, the analyses considered the application of loans for purposes of reducing the first costs burden of each of these bus technologies.

The following table summarizes the comparison of the economic feasibility (NPV Annual Cost, Total Cost per km, Cost Effectiveness, and Incremental Cost Effectiveness) of each bus technology compared to the base case Diesel ICE Bus.

Comment & Response

Alternative Bus Technology	Case	% Difference in NPV Annual Cost	% Difference in Total Cost per km	Cost Effectiveness, US$/ton	Incremental Cost Effectiveness, US$/ton
CNG Bus	0% Loan (No Subsidy)	-45.8%	-21.9%	1,851.7	783.4
	50% Loan (No Subsidy)	-49.4%	-33.3%	925.9	391.7
Diesel Hybrid	0% Loan (No Subsidy)	6.6%	35.0%	4,294.1	2,281.2
	50% Loan (No Subsidy)	3.7%	25.3%	2,147.1	1,140.6
BE Bus	0% Loan (No Subsidy)	30.3%	90.4%	5,322.2	4,112.6
	50% Loan (No Subsidy)	21.0%	61.3%	2,661.1	2,056.3
	0% Loan (with Subsidy)	-8.6%	21.9%	2,740.9	1,531.3
	50% Loan (with Subsidy)	-12.5%	9.4%	1,370.5	765.7
FC Bus	0% Loan (No Subsidy)	19.7%	70.6%	1,857.2	1,359.7
	50% Loan (No Subsidy)	12.1%	46.7%	928.6	679.9
	0% Loan (with Subsidy)	-28.9%	-15.1%	531.1	33.7
	50% Loan (with Subsidy)	-29.7%	-18.0%	265.6	16.8

From the above table, one would note the following:

NPV Annual Cost: *The BE Bus has the highest NPV Annual Cost, followed by the FC Bus, Diesel Hybrid Bus and CNG Bus. However, if subsidy is applied, the Diesel Hybrid Bus has the highest NPV Annual Cost, followed by the BE Bus, FC Bus, and the CNG Bus.*
Total Cost per km: *The BE Bus has the highest Total Cost per km, followed by the FC Bus, Diesel Hybrid Bus, and the CNG Bus. However, if subsidy is applied, the Diesel Hybrid Bus has the highest Total Cost per km, followed by the BE Bus, FC Bus, and the CNG Bus.*
Total Cost per km = (Bus Cost + Total Annual Cost x No. of Years Operation)/(Annual Distance Travelled x No. of Years Operation)
Cost Effectiveness: *The BE Bus cost the highest per ton CO2 reduced (compared to emissions from Diesel ICE Bus), followed by the Diesel Hybrid Bus, and then at equal level the FC Bus and CNG Bus. However, if subsidy is applied, the Diesel Hybrid Bus has the highest cost per ton CO2 reduced, followed by the BE Bus, FC Bus and CNG Bus.*
Cost Effectiveness = Investment Cost$_{ALTERNATIVE}$/(Emissions$_{BASE}$ – Emissions$_{ALTERNATIVE}$)
Incremental Cost Effectiveness: *The BE Bus requires the highest incremental cost (compared to that of Diesel ICE Bus) per ton CO2 reduced (compared to emissions from Diesel ICE Bus), followed by the Diesel Hybrid Bus, FC Bus and the CNG Bus. However, if subsidy is applied, the Diesel Hybrid Bus has the highest incremental cost per ton CO2 reduced, followed by the BE Bus, CNG Bus, and the FC Bus.*
Incremental Cost Effectiveness = (Investment Cost$_{ALTERNATIVE}$ – Investment Cost$_{BASE}$)/(Emissions$_{BASE}$ – Emissions$_{ALTERNATIVE}$)

Comment & Response
From the above table, considering no subsidies, the FC Bus is more cost effective than the Diesel Hybrid Bus and BE Bus, and in certain aspects also cost-effective compared to the CNG Bus. If there are subsidies applied as per the under the NEV program, the FC Bus is the most cost effective among the 4 alternative bus technologies. A minimum 30% price subsidy is required to make FC Bus and CNG Bus at parity level in terms of cost effectiveness. The current NEV program provides a maximum 71% (US$ 160,000) price subsidy for FC Bus. Overall, the cost effectiveness (actual and incremental) values show that it cost less to invest on FC Bus than on the other alternative bus technologies per ton of CO2 emission reduction. This result points to the need to reduce the production cost of locally manufactured FC Bus, and at the same time make its overall quality, durability, and performance at par with those produced in developed countries. The proposed UNDP-GEF project DevCom FCV involves aside from enabling and barrier removal activities (e.g., policy, awareness raising, capacity building, financing), interventions that will help facilitate markedly reduced costs and improved performance and durability of Chinese-made FCVs. These interventions under the project will help facilitate the commercialization of FCVs, in general, and FCBs, in particular, in China. **NOTE: Annex E of this CEO Endorsement Request Document contains Annexes 1 & 2.**

Annex B-1: Response to STAP Comments on PIF

Date of STAP Comments: April 16, 2014
STAP Advisory Response: Consent

STAP Guidance Comment 2*: Comparative fuel cell vehicle testing is a minor component, but seems to be underfunded if imported vehicles are to be purchased as part of the testing and compared with local manufacture that are also being improved over time. Are the vehicles to be tested buses, automobiles or 3- or 2- wheelers? Who will test them and using what comparative indicators? It later talks of "passenger transport fleets" and therefore we assume this implies buses.*

Response to Comment 2: As now fully designed, the project will allow for extensive monitoring of fuel cell vehicles. In the case of the buses, comparative testing of fuel cell vehicles with different make of fuel cell stack or engine will be pursued.[11] Fuel cell engines in the buses will include both imported ones (possibly from multiple manufacturers) and domestically manufactured ones (from Dalian Sunrise). There will be 109 demonstration fuel cell vehicles, comprising 23 buses, 51 autos, 30 delivery vans, and 5 delivery trucks. Vehicles will be purchased according to RFPs designed to meet durability and performance targets. For the buses, a key strategy is to couple China's comparative advantage in manufacturing buses (including its cost advantage and its abilities in EV bus manufacture) with foreign entities' advantages in fuel cell stack manufacture. Given cost advantage and because purchase of domestic-made vehicles will be eligible for substantial subsidy (while imported vehicles are not eligible), it is likely the buses will all be domestic-made, but that, as mentioned, imported fuel cell engines will be purchased for a portion of them. This strategy, coupled with the level of GoC subsidies, will make the number of targeted vehicles more achievable than would be otherwise possible. China's national subsidy for fuel cell buses is 500,000 RMB per bus (US 80,000), 200,000 RMB per car (US 32,000), and 300,000 RMB per delivery vehicle (US 48,000). Plans for all project demo vehicles call for continuous use in urban applications (e.g. urban bus routes for the buses, auto rental for the autos, and urban delivery for the delivery vehicles). Output 1B.4 calls for design and implementation of a monitoring system for the vehicles. Key indicators will include mean time between breakdown, annual operating hours, daily and annual distances driven, and lifetime hours of operation, actual unit cost, and project unit cost at high volume (assuming production of 500 vehicles in the case of buses). Fuel cell vehicle experts will be responsible for the design, data collection, and analysis. They will work with local counterparts to ensure day-to-day requirements in data collection are met.

STAP Guidance Comment 3*: 101 vehicles are to be demonstrated in 4 cities using around three quarters of the funding. From what source is the hydrogen to come? Is it low-carbon? If from high C factor electricity or from fossil fuels, this is unlikely to be the case.*

Response to Comment 3: Outcomes 2A and 2B of the project address hydrogen production and hydrogen refueling. Project design attaches a lot of importance to the development of low-carbon hydrogen sources in China and notes that at present there is little hydrogen production from renewable energy in the country. As such, technical assistance and demonstration in hydrogen production target renewable energy-based hydrogen production. The establishment of three hydrogen production facilities based on wind farms, using excess wind power to produce hydrogen via electrolysis is included. Also included is demonstration of hydrogen production at one landfill methane recovery site. Given logistics, some but not all of the project's demonstration hydrogen refueling stations (of which there will be a minimum of 4 and up to 7) will get their hydrogen from the renewable energy based hydrogen production demonstrations. Of the four main demo cities, at least two, Shanghai and Zhengzhou, will get most of their hydrogen from industrial by-product based hydrogen production. Industrial by-product based hydrogen, given that it is produced from the by-product of other industrial processes, has a relatively small carbon footprint compared to petroleum or to EVs charged by coal-

[11] This will also be true of the delivery trucks, though the data set will be much smaller with just one imported engine from Hydrogenics and the rest of the engines domestic-made.

fired power plant electricity, as is normally the case in China. Its footprint is also substantially lower than hydrogen produced by natural gas reforming. The Zhengzhou station will also have PV-powered electrolysis on site to produce a small portion of the hydrogen it uses. The Beijing station is expected to use a combination of wind-power based hydrogen and hydrogen produced by natural gas reforming, which has a relatively good carbon footprint- equivalent roughly to a natural gas powered vehicle. Nanhai's source of hydrogen is yet to be determined, but the project will ensure that the source is relatively low carbon. Another planned hydrogen refueling station is in Dalian. The Dalian station will have wind-PV hybrid powered electrolysis to provide up to 50 percent of its hydrogen needs on site. The source for the rest of the Dalian hydrogen is still to be determined, though it will be ensured that this too is relatively low carbon.

STAP Guidance Comment 4: *Much work has already been undertaken on hydrogen production and FC vehicle demonstrations in China. How is this project innovative above what has already been learned? What is GEF funding adding that has not already being undertaken? While Annex I to the PIF compares activities supported by the GEF previously in the FCB I and FCB II projects, lessons learned are not presented here, nor is it clear what particular focus this FCB III project has.*

Response to Comment 4: This project, whose title is abbreviated China DevCom FCV (for the "Development and Commercialization of FCVs"), rather than "FCB III", has key innovations beyond what has been done before that form the core of its strategy. To move FCVs towards commercialization in China, Outcome 1A includes technical assistance to China's FCV manufacturers to improve their design and manufacturing and assistance to overcome problems they are having in sourcing components internationally. The project strategy also requires these manufacturers, by utilization of this assistance, to "leapfrog" over the generation of technology they had targeted in the baseline scenario and achieve substantially greater improvements in durability and cost reduction (via Outcome 1B demos) than they would have without the project. Another important aspect of differentiation with previous projects is that 109 vehicles will be demonstrated in four cities and that there will be four different types of vehicles (buses, autos, delivery vans, and delivery trucks). This much larger number of vehicles, wider spread of cities and greater variety of vehicles will provide a much richer data and experience base, as well as serve as a much stronger tool for building awareness, than in previous projects. Outcome 1A also pushes commercialization forward in a potentially globally impactful way that was not pursued in previous projects: It calls for the provision of technical assistance to China-based manufacturers of key FC and FCV components, targeting global levels of durability and performance, but with lower prices. While work with the component manufacturers will not impact the project demo vehicles (as the vehicles will likely be launched in the second year of the project, while the component manufacturer work will occur over four years), it provides a key "second prong" of the project in pushing forward FCV commercialization.

As for hydrogen infrastructure (Outcomes 2A and 2B), the project presents new approaches both in hydrogen production and refueling stations. For hydrogen production, the project will assist in the development of renewable energy based hydrogen production at wind farms and at a landfill methane recovery site – neither of these have been demonstrated on substantial scale before in China. As for the hydrogen refueling stations, not only will there be more of these than in the past, thus providing a richer database for analysis, but new business and operational models for hydrogen refueling stations will also be pursued. These include dual hydrogen refueling – electric vehicle recharging station, onsite production of hydrogen at station via renewable energy, dual hydrogen and gasoline stations, etc. Again, none of these new business/operational models for hydrogen refueling stations has been demonstrated before in China. The project will also assist key equipment suppliers to hydrogen refueling stations to increase durability and decrease costs, an approach also not pursued before.

At the same time that the above innovations of this project will facilitate marked progress towards commercialization, it should be recognized that another differentiating feature of the China DevCom FCV project (compared to previous ones) is that it will benefit greatly from very positive external developments, which it in turn plans to leverage. Hyundai (2013), Toyota (2014), and Honda (expected

2015) now see commercialization of fuel cell vehicles as a reality internationally, with the release on a limited basis of the first commercial fuel cell autos. Great progress has been made in fuel cell engines, which will enable project demos to meet the "leapfrog" targets set. The Chinese Government has issued substantial subsides for both EV and FCV purchase and has eliminated its ten percent vehicle purchase tax on these. The ramp-up seen in sales of NEVs (mainly EVs and PHEVs) in China shows the major potential impact of policy: In 2013, around 17,600 NEVs were sold in China. In Jan. – Nov. 2014, the number rose to about 53,000. FCVs may have the opportunity to follow the path of EVs, but many interventions, such as those to be taken by this project, will be needed. Policy work, for example, calls for an *FCV and HRS Roadmap* (to match GoC's *EV Roadmap*) and sustaining FCV subsidies at current levels, while subsidies of EVs (which have reached a higher level of commercialization) have been designed drop starting in 2017.

Lessons learned from the FCB I and FCB II projects have been taken into consideration in project design. On the policy side, in particular, problems hindered achievement of previous projects. For example, in the past, FCVs in China have not been demonstrated on an ongoing basis (and were sometimes not even allowed to have human passengers) due to the lack of approval of models by MIIT and lack of issuance of long-term license plates by local authorities. This project squarely addresses these issues, with activities to ensure expedited issuance of approvals and clear designation from the start that demo plans call for continuous operation of the vehicles. This contrasts with previous demonstration of FCVs in China, which have often been event driven (e.g. Olympics, Shanghai Expo, etc.), with use of the demo vehicles stopping with the closing of the event. Another lesson learned is that lack of awareness regarding FCVs and misunderstandings about their safety has hindered progress. Thus, Outcome 4's awareness building is very focused on building awareness of FCVs among government officials and the public, while at the same time addressing some of the myths regarding safety. (Further, Outcome 3 arranges for the development of safety procedures for relevant organizations.) A third area of lessons learned has been in O&M capacity building. In FCB I, when manufacturer-provided maintenance contracts for imported vehicles expired, no one was available to maintain the vehicles. This project, via Outcome 4A, emphasizes O&M training for the organizations operating FCVs, with manufacturers (who will mostly be domestic) standing by to observe.

As for project focus, key elements have been referenced above. The project takes a multi-pronged approach to facilitating the commercialization of FCVs in China (this facilitation being the project objective and overall focus). Key areas of focus are: (i) "leapfrogging" to a higher level of FCV durability and cost reduction than in the no-project case; (ii) improving domestic production of components for further cost reduction; (iii) demonstration of a larger number of vehicles across more cities and vehicle types than in the past, thus yielding a richer data set of results and broader impact in awareness building; (iv) introduction of renewable-energy based hydrogen production and new business models for hydrogen refueling stations; and (v) policy interventions to leverage the power of policy to push vehicle purchase in China, as is now being seen in the case of EVs.

STAP Guidance Comment 5*: Terminal evaluation of the FCB II project stated that "the FCB Phase III would be essentially an expanded demonstration to remove the barriers that prevent its commercialization in China's city clusters and urban cities. Of course, among the main barriers to commercialization are: higher cost of the FCB unit relative to conventional fossil-fed engine buses; higher fuel cost of hydrogen compared to diesel, gasoline or CNG; need for higher efficiency to overcome higher fuel cost; shorter fuel cell stack lifetime and frequent replacement; durability and reliability issues; and safety concerns as it carries compressed hydrogen - all of which conspire to form a barrier to commercialization of FC hybrid technology." How these barriers are addressed explicitly by this project remains unclear. Particularly important is the high cost barrier. Since the project is largely focused on enabling environment, what financial incentives will be provided remains uncertain.*

Response to Comment 5: Explicit methods of addressing the barriers raised in Comment 5 are as follows:

a. *Higher cost of FCB relative to internal combustion vehicles*: Cost reduction of FCVs is a key area of focus. Explicit methods of addressing the cost barrier include one-on-one technical assistance to FCV manufactures in improving design and manufacturing, assistance to Chinese FCV manufacturers in overcoming barriers to sourcing parts internationally, and assistance to a range of China-based component manufacturers to improve product quality while driving down costs.
b. *Higher fuel cost of hydrogen as compared to other fuels*: One approach (as indicated in the barrier listed below) is to increase efficiency of the FCVs – initiatives listed under barrier (a) above will do this. The project will work to lower the cost of renewable energy based hydrogen (REH2) production via technical assistance to new producers in this area. While some efforts are made at wind farms to produce hydrogen from wind power, China continues to lack REH2 production on a significant scale due to high costs, lack of knowhow, and lack of dissemination. The one-on-one technical assistance for investors in and managers of demo REH2 production facilities will them to incorporate international best practice into their efforts specifically with the objective of improving the viability and reducing the cost of REH2 production in China. Moreover, capacity development for other prospective investors in the REH2 production business will be developed and implemented to bring knowledge of international best practice to a large group of beneficiaries, thus stimulating further investment in this area as well as improved technical levels and cost reduction. While the project will not work directly with non-renewable energy based hydrogen producers, two studies relevant to lowering costs of hydrogen for FCVs will be conducted and provide the results in a database that will be set up. The first will include a comparative economic analysis of different hydrogen sources in China. The second will assess means of improving energy efficiency of various means of producing hydrogen from industrial by-products, thus lowering the cost of those secondary processes.
c. *Need for higher efficiency to overcome higher fuel cost*: High efficiency will be pursued through one-on-one technical assistance to FCV manufacturers in design and manufacture, one-on-one assistance to component manufacturers (such as fuel cell stack manufacturer), and assistance to FCV manufacturers in sourcing of international components.
d. *Short fuel cell stack lifetime and frequent replacement*: The barrier of short fuel cell stack lifetime and frequent replacement will be pursued through two avenues. First, the project will support Chinese FCV manufacturers in efforts to procure imported fuel cell stacks with lifetime of 10,000 hours. Further the project will seek to improve domestically available stacks through technical assistance to domestic FC stack manufacturers and providers of key parts/components to the domestic FC stack industry.
e. *Durability and reliability issues*: Durability and reliability issues will be pursued through one-on-one technical assistance to FCV manufacturers in design and manufacture, one-on-one assistance to component manufacturers, and assistance to FCV manufacturers in sourcing international components including fuel cell stacks.
f. *Safety concerns due to compressed hydrogen on board*: Project addresses safety concerns from two angles. As a part of Outcome 3A, it develops safety procedures and regulations for relevant organizations and educates those organizations on FCV safety issues. As part of Outcome 4, the project seeks to alleviate myths related to the safety concerns through a specially produced video and other awareness building activities.
g. *Need for financial incentives*: The GoC currently offers significant subsidies for purchase of domestically manufactured FCVs (US$ 80,000 for buses, US$ 32,000 for autos, and US$ 48,000 for delivery vans and delivery trucks) and has eliminated the ten percent vehicle purchase tax on such vehicles. Locally, some cities offer additional incentives, such as being able move to the front of the queue in vehicle purchase or being able to purchase a vehicle without having to pay at an auction for the privilege. The project will work to continue and enhance these incentives through the activities of Outcome 3A. Activities of Outcome 3B will introduce additional incentives that are novel to China for the promotion of FCVs and hydrogen refueling stations.

STAP Guidance Comment 6*: Electric vehicle costs may decline over time but the view in IPCC Mitigation (www.ipcc.wg3.de - see Transport chapter 8) is that by 2030 EVs will still be costly without major breakthroughs. This may help the proposed cost analysis in the PPG round. Overall system cost* *analysis should also include the distribution costs of the hydrogen where feasible. What period of life is expected for the on-board battery bank?*

Response to Comment 6: Substantial cost reduction of FCVs is envisioned during the course of the project. For FC buses, this reduction will be from a level of 4 million RMB (USD 640,000) at start of project to 2 million RMB (USD 320,000) at end of project. This is actual cost rather than the projected cost at high volume (e.g., 500 buses), which will be substantially lower. Assuming cost reduction progress is slower over the project period (up until 2020) for EV buses, which have already pushed the envelope much harder, costs of FCVs and EVs may be similar by EOP. (Current price of BYD K9 fully electric bus is 2.4 to 2.7 million RMB). It should be noted that EVs have come a long way down the cost reduction learning curve already. They are being sold in volume and have been for several years. While there will likely be some improvements in battery cost, there is much less room for improvement in EV costs than with the costs of FCVs, which are only being developed in prototype quantities. In addition, FC stack costs include many immature components such as MEA and catalyst. There is also a lot of room for cost improvements with these. Thus, regarding IPCC projections that the cost of EVs by 2030 will remain high without major breakthroughs: This is an important point to consider in the rationale for the GoC to pursue FCV development alongside EV development. As discussed in the response to Comment 8, pursuing multiple technology paths is a diversification strategy that will allow the country to benefit whether future breakthroughs, which are hard to predict, come along one path (e.g. EVs) or another (e.g. FCVs).

Because of the lower range and longer refueling/recharging time for electric buses, their costs per km have a cost advantage only for ranges of 150 km up to possibly 200 km. Over 200 km, FC buses have a cost advantage in cost per km. The project FC bus demos target travel distances of 250 km per day, six days per week. A further point in comparison of these two types of vehicles is that electricity used to charge FC buses is generated in China using coal, so is high carbon, as compared to the project FC buses, which will mostly use industrial by-product hydrogen (very low carbon footprint) or hydrogen produced by natural gas reforming (relatively low carbon footprint).

As for the on-board battery bank, for the EV buses, the battery is expected to last 1,000 to 1,200 charging cycles, whereas, if the FC bus is properly implemented, its on-board battery will only see limited changes in its state of charge (SOC) and not require replacement during the bus's lifetime. If EV buses are recharged only once daily (and the buses are used 6 days per week), the lifetime will be three years. If the distance travelled each day requires two recharges per day, the lifetime will be cut in half to 1.5 years. EV buses will by their nature see deep discharges down to a low state of charge. Battery life is badly impacted by the number of deep discharges. Relatively shallow, well-controlled discharge cycles that are kept in the "sweet spot" around 60 % SOC have very little impact on battery life of EVs. This is why the Prius battery can go ten years or more; and the much larger Leaf batteries struggle to go 6 years. Tesla gets a longer life by having such a giant battery that it is seldom discharged very deeply. Unfortunately, the bus cycle dictates that the battery will be almost completely discharged daily, quite possibly causing early failure. For FCV buses, standard battery recharging will not be required, as the battery will be recharged while in use by the fuel cell and see only limited changes in its SOC. This type of recharging does not degrade the battery as much and thus the battery is expected to last the full lifetime of the vehicle. If used 11 hours per day six days a week, the FC bus battery is expected to a have a lifetime of 3.2 years. An EV bus with the same usage pattern would have had to replace its battery after about 1.5 years.

STAP Guidance Comment 7*: Issues related to technology transfer and intellectual property rights impede further commercialization of FCB in China. How will the project address these bottlenecks, particularly for local manufacturers?*

Response to Comment 7: The project puts significant focus in its activities in facilitating international sourcing and international cooperation (e.g. joint ventures or other cooperative production relationships). China's FCV manufacturers feel impeded in their sourcing in that many component manufacturers will simply not sell to them. At times, this may be because the international component manufacturer is tied up in an exclusive relationship with a major OEM. At the same time, such relationships expire, and there is room for the project to assist in facilitating international sourcing agreements for Chinese FCV manufacturers. Further, some international fuel cell stack manufacturers are willing to sell their stacks to China and this is something that is pursued in the project. Further, the project puts considerable emphasis on assisting Chinese component manufacturers in improving their products, either on their own via one-on-one technical assistance or through facilitation of cooperative relationships (such as joint ventures) with international counterparts. Clearly, technology transfer and IPR are impediments, but experiences in other sectors show that increased effort in facilitating cooperation and structuring agreements can often overcome such barriers.

STAP Guidance Comment 8: *Project focuses squarely on supporting a particular technology FCB, although the goal of low-carbon public transportation will be achieved only with an optimal mix of reduced energy intensity and energy efficient modes of public transport. STAP recommends that project proponents explore further what market, policy and financial incentives could be provided to advance more EE and cleaner technologies for public transport beyond FCB.*

Response to Comment 8: This point of diversification of low-carbon transport modes is well taken and fits in with the strategy of the GOC. This project is not only focused on FCBs but also on other fuel cell vehicles (FCVs). Yet, diversification for China suggests focus on FCVs in the case of this project. The reasoning is that progress in energy efficient vehicles and EVs has been marked and policy incentives are already strong. As mentioned, EV and PHEV sales were 53,000 in Jan. – Nov. of 2014, ramping up from 17,600 in 2013. (This compares to 110,000 sold in the US in 2013 and 50,000 sold in Japan that year.) Subsidies for purchase, alleviation of the ten percent vehicle tax, and a requirement that 30 percent of central government vehicle purchases be NEVs (all types of EVs or FCVs) by 2016 and that provincial governments follow this requirement starting in 2017, ensure that the push for EVs is very strong. What is needed is help for FCVs to become commercial enough to benefit from these policies as well and thus provide China with more diversified choices of technology. In this way, China will have better options if one technology achieves cost breakthroughs while the other does not.

STAP Guidance Comment 9*. Component 4 on information dissemination is only satisfactory once the fuel cell data have been conducted.*

Response to Comment 9: Point is well taken in that demo results can only be disseminated once sufficient data has been collected. At the same time, there are some structural points with regard to awareness building and dissemination activities that should be pointed out here. Monitoring, reporting, and dissemination of demo results will occur on an annual basis under Outcome 1B along with the demonstrations themselves, so thus will need to wait until the demo FCVs are operational (which is targeted for early in year 2 of the project). Outcome 4 targets broader awareness building and dissemination as well as replication. Thus, some activities will appropriately occur before demo completion. In particular, public awareness building about FCVs in general through brochures and a documentary aired on television can begin work immediately. Outreach to the press can be continued throughout the four years of the project. In addition, preparation of a video to counter myths regarding to the safety of hydrogen can be done independently of the FCV demos. The other major prong of Outcome 4, however, fits more closely with the above STAP comment. The design of a replication plan will not occur until the second half of the project, when enough data and lessons learned have been obtained from the FCV and HRS demos. During the project, there will be annual workshops for the demo cities and other interested cities to share demo experience to date and these will begin in Year 2.

STAP Guidance Comment 10*: Complementarities and potential overlap exist between this project and GEF ADB project (GEF ID 5627: ASTUD PRC Clean Bus Leasing). Project proponents are recommended to explore links and avoid overlap in the activities of the two projects.*

Response to Comment 10: Review of plans for GEF-ADB PRC Clean Bus Leasing project show that there is no negative overlap and possibly some complementarities with the China DevCom FCV Project. The GEF-ADB Clean Bus Leasing Project allocates USD 275 million total to be used as loans to finance leasing of clean buses in China. The maximum loan to any one entity is to be USD 100 million. The scope for the leasing loans of the ADB Project is to include energy efficient buses, clean fuels buses, buses using new energy sources, and conventional buses that meet extremely stringent emissions standards. Project indicators of the ADB Project include targets for CNG and LNG buses as well as targets for electric and hybrid buses. Fuel cell buses are not included in the indicators/targets. Given the PRC Clean Bus Leasing Project's lack of attention to FCVs and its overriding focus on the financing of clean bus leasing, there appears to be no problem of overlap of activities of the two projects. The China DevCom FCV project focuses exclusively on FCVs. Further, while its Outcome 5B builds capacity in the financial sector, the focus is quite different from that of the GEF-ADB project. Outcome 5B of the China DevCom FCV Project builds financial sector capacity related to supporting investments in FCV, FC parts, and HRS related manufacturing. It also builds capacity and promotes programs supporting purchase of FCVs, but does not have any activities related to leasing. Further, the FCV financial sector purchase program is focused on consumer purchase of autos rather than buses, which are the focus of the GEF-ADB Clean Bus Leasing project.

Due to GoC directives on NEVs, interest in FCVs is emerging in a number of cities beyond the China DevCom FCV Project demo cities. Thus, there may be the possibility of synergies between the UNDP project and the ADB project, were the latter to finance lease of any FCV buses. As the UNDP-GEF project will be conducting outreach for interested cities, it makes sense that the GEF-ADB opportunity be presented to these other cities as a possible means of achieving replication of the UNDP project demos. The project's Implementing Partner, its Implementing Agency, and the Project Management Unit for future reference note this opportunity during project implementation.

STAP Guidance Comment 11. *Careful examination of what is already known elsewhere in this domain is warranted at the PPG stage.*

Response to Comment 11: The project design during the PPG stage achieved consideration of state of the art and worldwide and China-specific knowledge on FCVs and hydrogen by retaining a top team of six fuel cell vehicle and fuel cell experts and one China automotive policy expert to engage in project design. The project development team further consulted hydrogen and hydrogen refueling experts on Outcomes 2A and 2B. As such, the situation of FCVs/hydrogen in China and abroad are taken into consideration in design of all activities and indicators.

Further, given the considerable knowledge base existing on fuel cells and FCVs, the project design team made an effort in its design of project activities to avoid activities consisting primarily of studies. Instead, project activities are focused on tangible outputs in FC vehicle, FCV component, hydrogen production, and hydrogen refueling station demonstration. They are also focused on "live" or "face-to-face" activities in technical assistance and capacity building. This include one-on-one technical assistance and group trainings.

Annex B-2: Response to GEF Secretariat Comments of March 21, 2014

Issues on the China Fuel Cell Buses Phase I (GEF #941) and Phase II (GEF #2257) Projects:

Comments	Responses
1. Unsuitable technologies and approaches - The two projects did not lead to	While we agree that the FCB technology was not ready for wide adoption at the time of the Phase I and Phase II China FCB projects, we disagree with the statement that the technologies and approaches of those projects were "unsuitable." Instead, at that earlier stage of

mainstreaming due to the technology's lack of maturity. The technologies used in the two projects were greeted with skepticism or not adopted, as they did not match local preferences in fuel cell busses in China. The technologies were in stages of development where replication in the private sector was not yet feasible for reasons of technological maturity. These projects were not able to generate large savings since they were not ready for broad adoption in the countries. Their market size was limited, and the projects had no replication or follow-up activities.	technology development, the projects resulted in experience and knowledge that have set the stage for wider adoption under the currently proposed project and the now enhanced technological level, internationally, for FCVs. The suitability of the earlier technologies in "setting the stage" is evidenced in that the Phase I and Phase II China FCB projects led to field tests of substantial scale (at Beijing Olympic Games in 2008 and at Shanghai Expo in 2010) that gave Chinese industry/experts valuable experience in the area. For example, at the Shanghai Expo, 196 fuel cell vehicles (FCVs) transported people to and within the Expo site. This included 9 FCBs, 90 FC autos, and 100 fuel-cell site-seeing trolleys, all operated over a period of almost six months. These field tests increased experience and knowledge of FCVs (among experts, officials, and the public), setting the stage in the currently proposed project for a more extended demonstration (over a longer time period) of technologies now at a higher level and poised for replication. In other words, the Phase I and Phase II projects played a useful role in advancing experience and knowledge of these technologies in China and setting the stage for the currently proposed project, which has high replication potential. The FCB projects were meant for demonstration for a limited period of time and mileage to test not only their operational performance, but also their adaptability for public transport service. The cessation of the Daimler-Chrysler technical and maintenance service contract eventually led to the non-operation of the Beijing FCBs. The Shanghai FCBs (which are locally manufactured by SAIC) were given limited operating permits after the Shanghai Expo 2010 and were able to complete the target demo mileage, and realized the target direct CO2 emission reduction. The higher replication potential of the current project is due both to the nature of interventions that will be undertaken and the very positive external developments towards commercialization of FCVs that have occurred recently. Key project interventions in this regard include one-on-one and group technical assistance to FCV manufacturers (in design, manufacturing, and international sourcing of components) and the requirement that they "leapfrog" over the generation of technology they would have targeted in the baseline scenario. One-on-one technical assistance to FCV component manufacturers will target quality improvement and cost reductions that will benefit the industry in China and potentially internationally. As for acceptance of FCV technologies, design of the current projects puts strong emphasis on knowledge and awareness building (Component 4), for both policy makers and the public. Activities range from workshops and study tours for officials and industry personnel to a documentary on FCVs to be aired on a major network for the public and a video to dispel myths associated with the safety of hydrogen. As for the external environment, commercialization of fuel cell vehicles is now seen as a reality internationally, with the release on a limited basis of the first commercial fuel cell autos by Hyundai (2013), Toyota (2014), and Honda (expected 2015). Great progress has been made in fuel cell engines, which will enable project demos to meet the "leapfrog" targets set. Also reflecting an important

	change in the external environment, the Chinese Government has issued substantial subsides for both EV and FCV purchase and has eliminated its ten percent vehicle purchase tax on these.
2. Lack of licensing and legislation for the technology in commercial use - The operation of GEF project-supported investments has been discontinued in these two projects. For GEF #941, the agreement with Daimler Chrysler for procurement of fuel cell buses was discontinued for fear of counterfeiting. For GEF #2257, permit for passenger transportation could not be obtained for the procured buses. Non-energy-specific legislation such as safety standards, tariffs, etc. posed a barrier for broader adoption of fuel cell bus technologies in China, which did not make the technologies accepted as a safe, useful, and sustainable option for local transport.	Indeed, the China FCB I and FCB II projects both faced issues that have become lessons learned and key considerations in designing the current project. During FCB I, a key problem is that local capacity was not built for the O&M of imported fuel cell buses. Thus, once the maintenance contracts with the original international manufacturers expired, maintenance staff left the country, and capability for continued maintenance was not available. In FCB II, long-term permits were never issued for public use of demonstration vehicles. This is due to lack of streamlined approval process and, most importantly, lack of confidence of officials in the safety of fuel cell vehicles. Thus, due to lack of licenses, testing of vehicles outside of the Expo environment was more limited than hoped. Taking such issues as key concerns in project design, the current project squarely addresses: (1) extended demonstration of vehicles, (2) approval of vehicles (which has been a barrier to the prior item), (3) safety concerns, and (4) O&M capacity building. The project designates from the start that demo plans call for continuous operation of the vehicles and requires that clear plans for ongoing vehicle operation be designed as a part of project activities. This contrasts with previous demonstration of FCVs in China, which have often been event driven (e.g. Olympics, Shanghai Expo, etc.), with use of the demo vehicles stopping with the closing of the event. As for barriers to government approval of FCVs, these have occurred in the past at both the central government level (approval of new models of FCVs) and local government level (issuance of license plates). The project has specific activities to expedite the approval process at both levels by educating policy makers and making recommendation as to how they can expedite their processes. Further, the project addresses safety concerns of these officials through a workshop to educate them and through technical assistance to support them in designing safety policies. Finally, as for standards issues, the project has activities designed to fill in the gaps in testing, standards, and certification. At the same time, it should be noted that substantial progress in China has already been made with regard to FCV related standards. Several standards have been established by the Standards Association of China (SAC): (a) for Hydrogen (SAC/TC 309) covering among other things, H2 refueling facilities and H2 storage; and (b) for Fuel Cells (SAC/TC 342) and (c) FCVs (SAC/TC114/SC27). As for O&M, the project has specific activities for capacity building in the O&M of both FCVs and hydrogen refueling stations.
3. Smallest global environment benefits - The GEF #2257 project had the smallest measureable impact of GHG emission reduction among all evaluated CCM projects in the GEFEO's evaluation in 2013, which was at	As explained above, the FCB projects were meant for demonstration for a limited period of time and mileage to test not only their operational performance, but also their adaptability for public transport. While global environmental impact was low and potential for immediate replication was lacking, the projects built up China's knowledge and experience in the FCV field, setting the stage for the current project, which has strong potential for replication. Note: Only 1 of the Beijing FCBs from the Phase I China FCB project ended up in a museum. The rest went to research institutions. Further, the Shanghai FCBs, from Phase II, following the Expo, were able to

10,000 tons in one year without ongoing impact. The buses procured from the GEF #941 project had been relegated to museums.	complete their demonstration mileage and realize target direct CO2 emission reductions. With anticipated replications, the current project will result in substantially more GHG emission reductions than the Phase I and II China FCB projects. Total reductions at EOP (including both direct reductions from 109 vehicles and 4 renewable energy based hydrogen installations and indirect reductions from operation of replications before EOP) are expected to be 132,707 tons CO_2. Including impacts/emission reductions beyond project close, the conservative bottom up analysis yields an estimate of 313,377 tons of CO_2 reductions and the top down analysis, which is much less conservative, projects 62 million tons CO_2 indirect emission reductions by ten years post- project close.

By CEO Endorsement Request, the Agency needs to present measures taken to address the above issues and to explain further, how the proposed initiative will have the intended impacts on technology adoption that the earlier projects failed to deliver. In particular:

Comments	Responses
1. Sustainability of technologies and approaches	
a. Explain how the level of technology maturity has changed since the GEF #941 and GEF #2257 projects.	Both domestically in China and internationally, substantial advances have been made in durability (lifetime hours of operation), performance (e.g. time between breakdown), stack power, and cost of FCVs. For China-made FCBs, for example, the lifetime hours of operation in 2015 is 2,000 hours as compared to 200 hours in 2000, time between breakdowns is 300 hours in 2015 as compared to 50 hours in 2000, and unit cost is USD 640,000 in 2015 as compared to USD 3million in 2000. Internationally (international best level) for FCBs, the lifetime hours of operation has gone from 1,200 hours in 2000 to 10,000 hours in 2015. The latter, 10,000 hours of operation, incidentally, is the project's target for China-made FCBs by 2019. Comparison of these and other parameters for the years 2000 and 2015 are given in the table directly below this one, both for China-made FCB's and for international best level FCBs. From the perspective of the project China FCB I, the original 2003 program, which used the best international system at the time (2003) had a lifetime goal of 2000 hours (and a plan for one replacement stack to get to a total of 4000 hours of operation). The investigation at the time did not indicate that there was any domestic stack that come close to those requirements. Thus, it can be seen that, since the time of FCB I, considerable progress has made domestically, so that China-made FCVs will be a main target for technical improvement in the currently proposed project. By 2019 with no GEF support, it is anticipated China-made FCBs would have reached 6,000 hours lifetime operation, while with GEF support; it is targeted that they will reach lifetimes of 10,000 hours of operation. Without GEF support, it is estimated that mean operational time between breakdowns for China-made FCBs would have reached 650 hours by 2019. With GEF support, this parameter is targeted to reach 1,000 hours by 2019. Finally, as for actual unit costs of China-made FCBs, without GEF support, this would have been expected to be reduced to USD 480,000 by 2019. With GEF support, the actual unit cost of China-made FCBs is targeted to drop to USD 320,000 by 2019.

	As mentioned, great strides have also been made in the external environment in that commercialization of fuel cell vehicles is now seen as a reality internationally with the release on a limited basis of the first commercial fuel cell autos by Hyundai (2013), Toyota (Dec. 2014), and Honda (expected 2015). To give an idea of cost levels, Toyota's Mirai, released in Tokyo in Dec. 2014 and expected to be released in California, USA, in summer of 2015, retails for USD 57,000.
b. Justify how FCV technologies and approaches proposed at the GEF5 project are sustainable.	The proposed project will achieve sustainability and replication through a multi-pronged approach that creates an enabling environment for commercialization of FCVs in China. Incremental activities will result in a higher level of FCV durability and greater cost reductions, thus contributing to sustainability and replication of results. Efforts to support component sourcing and development of a high quality, low-cost domestic component base will also contribute to ongoing progress in the durability, cost-reduction, and increased numbers of FCVs on the road in China. The project's work will further promote continuous operation of an expanded group of HRSs, which will be replicated in conjunction with expansion of FCV demos to additional cities. Policy efforts, particularly in the areas of developing an *FCV Roadmap* and maintaining and enhancing subsidy policies, will further contribute to sustainability and replicability, as will efforts in awareness building, capacity building for O&M, and capacity building for the financial sector. Replication plans will be designed as a part of project activities and will be facilitated by involving officials from potential replication cities as key attendees at annual workshops on demo results. All of these project initiatives, in conjunction with the Government of China's commitment to alternative energy vehicles (including substantial subsidies for FCVs); will ensure sustainability of project results.
c. Further elaborate that the current and near future market size and cost implications are promising for the development of FCV technologies.	As for the current market, during project formulation, accelerating interest in FCVs by municipalities was evidenced by the additional cities that wish to join the demo efforts. Queries that Chinese FCV and FCV component manufacturers have received regarding potential orders for FCBs are also among the evidences. Strong policy support in terms of subsidies for FCVs and hydrogen refueling stations enhance the market, as does the Central Government's declared "war on air pollution" and the impact of this "war" on local-level decision making. The rapid ramp-up in the number of electric and hybrid electric vehicles on the road in China, from 16,000 at the end of 2010 to 160,000 by June 2014 (see ProDoc, Exhibit 1-5) show policy's substantial impact on the growth of the number of alternative energy vehicles on the road. Assuming FCV cost reductions combined with Chinese Government subsidies for FCVs make their purchase attractive, as well as success of the project in achieving substantial technical improvements in China's FCVs, a similar ramp up is expected in the number of FCVs on the road in China. With project implementation, 4,000 FCVs are expected to be on the road in China by end of project. Ramp-up could then continue at an ongoing rapid pace thereafter, similar to what has been seen with EVs in China so far. Substantial price reductions are expected to be achieved via this project. For example, actual unit costs for China-made FCBs are expected to be reduced from 2015 levels of USD 640,000 to 2019 level of UDS 320,000. Further, given that FCVs are currently not produced on commercial scale, under the assumption of no major commercial breakthroughs for either EVs or FCVs, FCVs have much more potential for cost reduction than EVs as the latter are already being produced on commercial scale.

d. Clarify what policy-regulatory measures are taken and enforced to address the barriers that limited private sector investments during the implementations of the GEF #941 and GEF #2257 projects.	Currently, the Chinese Government has already adopted three major measures to address the barrier of limited private sector investments in FCVs and hydrogen refueling stations. There is a subsidy for purchase of FCVs. Currently; the subsidy level for the purchase of a FC auto is s are 200,000 RMB. There is a subsidy of 4 million RMB per hydrogen refueling station built. There is a ten percent purchase tax waiver for autos in the case of FCVs (as it is in the case of EVs). The project will in addition promote new policy and regulatory measures to overcome barriers to private sector purchase of FCVS: One of the most important policy-regulatory measures of the project will be design and adoption of a *China National FCV Roadmap* as well as local-level supporting roadmaps. Roadmaps will increase the confidence of both manufacturers and purchasers. Further, the project will address problems in approval of FCVs in China for long-term operation on the road. It will address these issues both at the central level (where new vehicle models are approved) and at the local level (where license plates are issued). The project will assist local departments in developing safety protocols related to FCVs and hold a seminar on FCV fire safety, thus enhancing confidence of local officials in the technology and their ability to deal with it. Further, the project will enhance the standards, testing, and certification system for FCVs and hydrogen refueling, supporting standards bodies by providing recommendations and needed information for enhancing current standards system. Lastly, the project will also support extension and enhancement of FCV and hydrogen refueling policy incentives. It will work for extension of current subsidies and implement policy pilots showcasing FCV and hydrogen refueling station incentive policies that are new to China.
e. Clarify further the replication and scale-up activities, and provide specific targets and timeline.	Key replication and scale up activities will be: (1) annual FCV workshops for demo cities and other interested cities (at which results to date will be presented); (2) design of replication/scale-up plan for FCVs and HRSs (including liaison with potential replicators); (3) design of a replication/scale-up plan for renewable energy based hydrogen production (including liaison with potential replicators); and, (4) bank financing program for loans for FCV purchase. While the project will be directly involved in the purchase of 109 FCVs for demonstration, by end of project (end of 2019) it is targeted that there will be 4,000 FCVs on the road in China. The project also targets that there will be at least 8 renewable energy based hydrogen production facilities by EOP. Four will be directly supported by project TA, while the others will be replications. At least 15 or more hydrogen refueling stations by EOP (2 existing at start of project, at least 4 more being a part of project demos, and the other 9 or more being replications).
f. Articulate why the private sector is interested in this proposed project and would like to provide major capital co-financing, and what the government or the market incentives are to attract private sector investments.	A number of commercial sector companies are very interested in this project. (We use the term commercial sector to encompass both state-owned enterprises and private companies involved in FCV or FCV component manufacture.) These companies see FCVs as a strong future market opportunity and the project as a way to ensure their role in that future opportunity. Strong government subsidies for FCV purchase and encouragement of cities to include FCVs in their public transport and other fleets, along with strong government subsidies for hydrogen refueling stations, are the main incentives attracting commercial sector investment. The commercial sector sees the incentives for FCV purchase and is thus concluding that the FCV market will be realized in China soon. It also sees that now is the time to enhance their capabilities and investments in the area. The commercial sector is further attracted to the special benefits that

	the project will provide, including technical assistance to resolve issues they face, such as lack of access to international components, and the benefits a wide scale demonstration (in four cities) of FCVs will bring in accelerating development of the FCV market.
2. Licensing and legislation for commercial use	
a. Clarify the changes in licensing and legislation (safety standards, tariffs, etc.) and policies (such as permits etc.) that were identified as barriers in GEF #941 and GEF #2257.	In recent years and since the year 2000, the Standardization Administration of the People's Republic of China (SAC) has established over 20 standards on hydrogen storage, hydrogen refueling system (SAC/TC 309), fuel cell (SAC/TC 342), and fuel cell vehicle (SAC/TC114/SC27), etc. Please refer to the list given in the second table below for the detailed name of each of 12 fuel cell vehicle related standards as well as five more that are currently under discussion. As for tariffs, the import of FCV-related products needed for the project are and have been tariff-free, so this is not a major issue. At the same time, imported FCVs will not benefit from the FCV purchase subsidies that have been instituted since the earlier projects. Barriers identified during China FCB Phase I and Phase II include difficulties in getting new FCB models approved by Ministry of Industry and Information Technology and difficulties in getting local licensing bodies to approve individual FCBs for long-term use. In some cases, these problems were due to concerns about safety and lack of safety protocols. An incomplete standards system may also have been a contributing factor. A lack of Government "roadmap" for the sector may have also contributed to lack of problems in the licensing areas. Finally, high costs of FCVs (without corresponding subsidies or other preferential treatments) hindered the purchase of FCVs. When implementing this project, we will take a full consideration of the barriers caused by gaps in the policy and supervision framework for commercializing FCVs in China. Concrete measures to be taken include: (1) to make additional laws and regulations supporting FCV development and to facilitate their implementation; and (2) to establish technology and energy efficiency standards that are related to FCV and hydrogen production facilities, including test and certification systems. By the end of this project, it is expected that we will have achieved substantial further standards on FC vehicles and hydrogen, as well as regulations, supporting policies, certification system and so on, which will then greatly promote large-scale FCV commercialization in China.
b. Articulate the current status of removing barriers in licensing and legislation.	"Product Announcement," which refers to Central Government level approval by Ministry of Industry and Information Technology (MIIT) to have a new vehicle model registered, was a barrier for FCVs at the time of the FCB projects since FCVs were not successfully achieving Product Announcement. Since that time, progress has been made in removing the barrier. In particular, China Vehicle Technology Service Center (CVTSC), which acts as the technical supporter for MIIT vehicle product announcement management, has released *Notice on Relevant Technical Requirements for FCV Product Announcement Management* (May 5th, 2014). This document clarifies the technical requirements FCV products should meet when reported by the vehicle producers to MIIT, as well as special FCV test items and standards, providing preliminary technical instructions for applying for FCV permitting and licensing. Currently, MIIT has already issued Product Announcement for one SAIC model of FCV (a sedan) and other models of FCVs are expected to achieve this given the clearer requirements now available. The SAIC FC autos have also been

	issued license plates by Shanghai authorities for long-term operation. (Local license plate issuance for long-term operation is another key barrier faced during the FCB projects.) It is expected that, with this precedent and clearer technical instructions mentioned above, other local approvals of this sort will follow. The project will further build on this progress by supporting central and local government authorities in expediting their approval processes and providing support to them in developing safety protocols that should enhance their confidence in the technology. There is still no national FCV roadmap and this is an area the project will address. In addition, the project will have activities to address remaining gaps in standards, testing, and certification and provide recommendations to SAC in these areas. Regarding vehicle tax and subsidy incentives, on August 1st, 2014, MOF (Ministry of Finance), SAT, and MIIT released an announcement on *NEV (New Energy Vehicle) Exemption from Vehicle Purchase Tax*, which applies to NEVs purchased between September 1, 2014 and December 31, 2017. Moreover, on April 22, 2015, MOF, MOST, MIIT, and NDRC (National Development and Reform Commission) released an announcement of *The Financial Support Policy to Promote NEVs from 2016 to 2020*. This document confirms that the government will continue its fiscal support for domestically made NEV purchase via subsidies to the purchaser. In particular, FCV subsidies will continue to stay at the same level through 2020, while subsidies on EVs and PHEVs are reduced and will continue to go down in further in stepwise fashion over up through to 2020.
3. Global environment benefits	
a. Analyze the key reasons that limited the global environment benefits and other impacts from the GEF #941 and GEF #2257 projects.	The key reasons for the rather limited global environmental benefits realized (compared to what was anticipated) from the China FCB Phase I and Phase II are: (1) The level of fuel cell technology at that time was not advanced enough to stimulate wide-scale adoption. Costs were too high, performance/durability too low; (2) Policy was not supportive enough to stimulate adoption beyond the field tests achieved; and, (3) Problems in achieving approval for long-term use of the demonstration FCBs.
b. Articulate further measures in the proposed GEF-5 project to ensure that measureable global environment benefits and impacts should be achieved from the proposed project.	The current design ensures measurable global environmental benefits by the following: (1) The project ensures that the technical capabilities and cost parameters of China's FCVs are pushed to a level that will ensure replication of the demos is possible. The targets push Chinese manufacturers to "leapfrog" beyond what their targets would have been in the baseline scenario and supports them through technical assistance to achieve these targets. (2) With the policy environment already improved, the project supports additional policy environment improvements, including an FCV roadmap at the national level and corresponding roadmaps at the local levels, enhanced/expedited approval processes, extended and expanded incentive policies, and support and education for policy makers and regulators in FCV fire safety. (3) The project has a number of interventions targeted specifically at replication and acceptance of officials and the public of FCVs. These include workshops for officials annually on progress of the demos and study tours. They also include a documentary to be aired on a major network and FCV purchasing support program by a Chinese bank. Finally, they include specific work on designing and promoting replication plans.

	In sum, the current project ensures expanded environmental benefits by: (a) addressing barriers inhibiting more expansive global environment benefits in the earlier projects; (b) taking advantages of improvements in FCV technologies and costs as well as in the policy environment in China; and (c) having specific activities focused at stimulating and achieving replication so that GHG reduction emissions will be multiplied beyond that achieved by the demonstration vehicles alone.

Addendum to Item 1a in Table Directly Above:
Changes in Level of FCB Technology Maturity between 2000 and 2015

Parameter	**China FCV**		**International Best Level FCB**	
	Year 2000	**Year 2015**	**Year 2000**	**Year 2015**
Lifetime hours of operation	200 hours	2000 hours	1,200 hours	10,000 hours
Hours between breakdown	50 hours	300 hours	300 hours	800 hours
Max. efficiency of system	50%	55%	55%	59%
Stack power	10 kW	60 kW	70 kW	150 kW
Actual unit cost	USD 3 million	USD 640,000	USD 1.5 million	USD 800,000

Addendum to Item 2a in Table Preceding the Small Table Directly Above:
New Fuel Cell Vehicle Related Standards Instituted in China since Year 2000 or Currently in Pipeline for Approval

"National Standards"	
Year	**Standard**
2009	GB/T 24548-2009 Fuel cell electric vehicles—Terminology
2009	GB/T 24549-2009 Fuel cell electric vehicles—Safety requirements
2009	GB/T 24554-2009 Performance test methods for fuel cell engines
2009	GB/T 24347-2009 The DC/DC converter for electric vehicles
2009	GB/T 23645-2009 Test methods of fuel cell power system for passenger cars
2010	GB/T 25319-2010 Fuel cell power system used for motor vehicles—Technical specification
2011	GB/T 26779-2011 Fuel cell electric vehicles— Refueling receptacle
2011	GB/T 26990-2011 Fuel cell electric vehicles—Onboard hydrogen system—Specifications
2012	GB/T 26991-2011 Fuel cell electric vehicles—Maximum speed test method
2012	GB/T 29126-2012 Fuel cell electric vehicles—Onboard hydrogen system—test methods
2012	QC/T 816-2009 Specification of mobile hydrogen refueling vehicles
2012	GB/T 29124-2012 Hydrogen fuel cell vehicles facilities for demonstration specifications
"Industry Standards"	
2009	GB/T 29123-2012 Specifications for hydrogen fuel cell vehicles in demonstration
Standards in the Pipeline for Approval	
GB/T XXXX-XXXX Hydrogen emission test methods for fuel cell engines (*submitted for approval*)	
GB/T XXXX-XXXX Hydrogen dispenser for fuel cell vehicles (*submitted for approval*)	
GB/T XXXX-XXXX Hydrogen emission test methods for fuel cell vehicles	
GB/T XXXX-XXXX Energy consumption capacity test methods for fuel cell vehicles	
GB/T XXXX-XXXX Fuel cell vehicles—electric stack safety	

Annex B-3: Response to GEF Council Comments

Comment	Response
Germany welcomes the PIF and the STAP comments. Germany requests clarification for the following issue:	
The proponent should clearly describe if the project targets the increase of market readiness of fuel cell vehicles in China, or if research and development of the same technology is foreseen to be promoted by the GEF funds.	The project targets the removal of existing barriers that hinder China from progressing into its plan of commercializing fuel cell vehicles (FCVs) in the country. The facilitation and enabling of the various requirements effectively lead the country's automotive industry towards the commercialization of FCVs will also, among others, involve actions that can be considered as part of "market readiness". R&D is part of the baseline activities of the project, and these will mostly be those currently being done and planned by local automotive manufacturers interested in alternative energy vehicles like FCVs. However, there will also be incremental R&D activities that will focus mainly on the application of advanced features of new generation of FCVs as well as for RE-based hydrogen production and refueling systems.

Annex B-4: Response to GEF Secretariat Comments of March 11, 2014

Comments & Responses	Reference
5. Is the project consistent with the recipient country's national strategies and plans or reports and assessments under relevant conventions, including NPFE, NAPA, NCSA, NBSAP or NAP?	
Comment: *However, the PIF does not contain review information on China's national strategies and plans or reports and assessments under the Technology Needs Assessment (TNA) (see http://www.worldbank.org/projects/P120932/chinatechnology-needs-assessment-tna?lang=en) and in the Second and the Third National Communications. Please review the country's TNA and the National Communications, and clarify consistency with national needs and priorities as articulated in these climate change Convention related documents.*	
Response:	
China has several plans for the development and application of technologies for mitigating climate change, and this proposed project is in line with such plans. As its economy grows the country endeavors to develop and manufacture products and commodities that meet the technological standards of developed countries such as those within OECD. The Chinese government continuously stresses the role of advanced technologies for climate change mitigation and environmental protection, among others, to meet its sustainable development goals in a timely manner and at a minimum cost that does not threaten economic development and poverty alleviation. Both the transfer of best available global technologies to China and the enhancement of the local science, technology, innovation capacity and diffusion are necessary to make the most relevant and advanced technologies widely available for deployment. The ongoing WB-GEF project on technology needs assessment supports China's efforts to assess climate change mitigation and adaptation technology needs and adopt corresponding global best practices. Said project will, among others, identify barriers to technology transfer, and design one or more technology transfer mechanisms that would accelerate the ultimate deployment of prioritized technologies in both climate mitigation[12] and adaptation.	PIF: Sec. B.1. 2nd Para; Footnote 22
The project is also in line with the plans and recommendations set out in the country's national communications to the UNFCCC. The most recent national communications (i.e., 2nd National Communications), includes the fuel cell vehicles (FCVs) as among the new energy industries that shall be vigorously developed during the 12th Five Year Plan period (projects to promote energy efficiency products for the benefit of people) . FCVs are among the products that were included in the Chinese government's energy-conservation and new energy technology demonstration projects, particularly the 'Ten Cities-Thousand New Energy Vehicles', wherein FCVs (as well as EVs and PHEVs) are showcased for public transport applications in selected cities. As part of its continuing partnership with NDRC, the UNDP is currently assisting China in the development of its proposal for GEF funding of the preparation of its 3rd National Communications. It is expected that the application of alternative energy vehicles such as FCVs will be among the climate change mitigation technologies that will be prioritized.	PIF: Sec B.1, 2nd Para
Follow-up Comment:	

[12] The WB's TNA Project Appraisal Document pointed out China's 12th Five Year Plan (2011-2015) that includes support to the development of seven strategic emerging industries (environmental protection and energy efficiency, new energy, next generation information technology, biotechnology, high-end manufacturing, clean-energy vehicles, and high-tech materials) which are all highly correlated with emission reduction. Within those seven industries, 35 projects have been identified, including: high-efficiency energy saving technologies, e.g., lighting; high-end manufacturing in aerospace, rail, nuclear, renewable power technologies, smart grids, and advanced materials and composites; and smart assembly in electric and fuel cell cars.

Yesterday (March 18, 2014), Mr. Xie Zhenhua, vice chairman of the NDRC make a presentation at The World Bank. He stressed that improving energy efficiency for heavy-duty vehicles one of the four major areas (other three are CCS, Smart Grid, and Energy Efficiency) for GHG emission reduction over the next five years. I believe that heavy duty FCVs have advantage to compete with heavy-duty electrical vehicles and other conventional heavy-duty vehicles. Can you add more information on this? **<u>Response:</u>** In the context of alternative energy vehicles, the term "heavy duty" could mean the duration by which the vehicle can operate per energy input, as well as durability and reliability of the power source, which is the hydrogen fuel cell for FCVs and the battery for electric vehicles. FCVs can run up to five times longer than their all-electric counterparts can. These are comparable to regular ICE vehicles with 300–400 miles between refueling, and the refueling time is very quick, at 3 to 5 minutes. Electric vehicles usually cannot go as far on a single charge as the typical ICE vehicle that has a full tank of gasoline/diesel. In addition, there is the charging challenge – which is the long time to charge an electric vehicle. For example, an electric car can take about 6 hours from zero to full charge with a 240-volt power source. Fueling time- 3 to 5 minutes for a fuel cell car versus hours for a battery-electric vehicle is indeed a great advantage. According to Toyota, in particular, an all-electric car technology is good enough to power only tiny city cars - not powerful enough for larger cars (i.e., heavy duty). Fuel cells offer advantages in terms of longer runtimes and longer lifetimes than the batteries used in electric vehicles, and considering the environmental benefits are becoming increasingly attractive. The fuel cell cars now coming onto the market have triple the range of most battery electric cars and can be refueled in minutes rather than recharged in hours. In addition, hydrogen technology can be scaled up to fuel buses, long-haul trucks and other big vehicles that most current battery packs are too small to power. Indirectly, the term "heavy duty" can also refer to how the vehicle is utilized more extensively and optimally in terms of passenger-kilometers or ton-kilometers. With the difference in runtimes, the FCVs would optimally be more useful in transporting either passengers or goods.	
6. Is (are) the baseline project(s), including problem(s) that the baseline project(s) seek/s to address, sufficiently described and based on sound data and assumptions?	
<u>Comment</u>: *a) On page 7 of the PIF, it reads "In September 2013, the MOF, MOST, MIIT and NDRC jointly launched and implemented a support program for new energy vehicles providing incentives for the commercialization of FCVs. In 2014, the subsidy support provided under the program is reduced by 5%, and will be reduced by 10% in 2015. In 2013, the production and sales of automobiles both exceeded 20 million, a world record. Moreover, China is the world's largest producer and user of buses. Chinese auto makers are keen on FCV R&D and have formulated long-term development strategies." Please articulate the incentives of the government.* **<u>Response</u>**: In a joint directive issued by the Ministry of Finance, the Ministry of Science and Technology, the Ministry of Industry and Information Technology and the National Development and Reform Commission on 17 September 2013, manufacturers of pure electric automobiles, plug-in hybrid electric vehicles and fuel cell cars will be eligible for subsidies under the New Energy Vehicle Industry development Program. Government organizations, public institutions and public transportation will be key targets for the policy. The subsidy standards will be rated following basic price differences between new energy vehicles and their traditional counterparts. The subsidies are as follows: Battery electric car (battery charge range over 155 miles) -	PIF: Sec. A.1.2, Footnote 17

60,000 RMB (US$ 9,800); Battery electric car (battery charge range over 90 miles) – 50,000 RMB (US$ 8,100); Battery electric car (battery charge range over 50 miles) – 35,000 RMB (US$ 5,700); Battery electric bus (length = 6 to 8 meters) - 400,000 RMB (US$ 65,000); Battery electric bus (length ≥ 10 meters) - 500,000 RMB (US$ 81,000); Special type battery electric vehicles (for postal service, logistics, sanitation, etc.) - 2000 RMB (US$ 325) per KWh of battery capacity) but not more than 150,000 RMB (US$ 25,000) per special type BEV; Fuel cell cars - 200,000 RMB (US$ 32,500); and Fuel cell bus - 500,000 RMB (US$ 82,000). Per the directive, in 2014, the subsidy support provided under the program is reduced by 5%, and will be reduced by 10% in 2015 due to the anticipated scale of production and technological progress that is expected to happen. See also Footnote 20 of the PIF. To enhance the uptake of NEVs, the joint directive imposed target NEV purchase volumes and guidelines for municipal governments. In large cities and areas – mainly Shanghai, Beijing, and Guangzhou it seems – the number of NEVs should reach no fewer than 10,000 by 2015. All other cities and/or areas should have no fewer than 5,000. When buying new vehicles for municipal fleets, at least 30% of the purchases should be NEVs. The directive sets even stricter criteria on the NEV source of origin, stipulating that 30% or more of these should come from a non-local automaker. There will be no discriminative measures favoring domestic brands and squeezing out non-local players, which effectively rule out unfair competition against non-local brands.	
Follow-up Comment: Referring to subsidies under the NEVIDP for FCVs*: Can you put these numbers in the main body of the PIF?* **Response:** The information: Fuel cell cars - 200,000 RMB (US$ 32,500); and Fuel cell bus - 500,000 RMB (US$ 82,000) have been included in the main body of the PIF.	PIF: Sec A.1.2
Comment: *b) Footnote 16 shows that "the largest subsidy is for cars with ranges of over 155 miles at 60,000 RMB (US$ 9,800)". What does the "with ranges of over 155 miles" mean? Is it the vehicle running miles of per hydrogen refueling?* **Response**: The footnote refers to the specific criterion for the subsidy for battery electric cars with battery charge range of over 155 miles, i.e., a single charge will last to at least 155 miles of driving. In the case of FCVs, there is no set criterion for the subsidy as to the travel distance between H2 re-fueling.	
Comment: *c) If a Fuel Cell car is eligible for up to $81,670 of subsidies, what is the full sale price of the car?* **Response**: Currently, the price of a locally made FC car (considered as luxury sedan) is quite high at about 745,000 RMB (US$ 122,000). As in other developed countries (e.g., Japan and South Korea), it is expected that starting 2015, FC car costs will significantly be reduced down to the US$ 50,000 – US$ 100,000 range. It is forecast that by 2017, the cost of locally made FC cars would be within the US$ 80,000 – US$ 90,000 range.	PIF: Annex 1
Comment: *d) The total GEF budgeted fund in this project can only subsidize about 100 cars. Please describe what will happen to the MOF/MOST/MIIT and NDRC September 2013 program, and to the Chinese New Energy Vehicle Demonstration and Industrial Development Plan, if the GEF does not finance this project (or does not subsidize the 100 cars).*	

Response: The GEF budget is not intended for subsidizing fuel cell cars. As part of the capacity development and the creation of the much needed enabling conditions that will facilitate the commercialization of fuel cell vehicles (FCVs), the proposed project will consists mainly of barrier removal activities that will facilitate the way towards the commercialization of FCVs in the country starting with the GOC's identified 28 Chinese cities and city clusters that will promote the use of new energy vehicles (electric vehicles and fuel cell vehicles)[13]. Part of the capacity development activities will be on the demonstrations of the application of improved FC and FCV design and manufacturing, which will involve the provision of technical assistance to selected FCV manufacturers and new transport vehicle manufacturers venturing into the FCV business on the design and manufacturing of high performance FCVs (e.g., FC engine and FC stack life and durability, H2 fuel economy, etc.), the prototype production of selected FC engine designs, including FC engine product testing and FCV on the road test runs on a demonstration basis. In addition, part of the capacity development activities will be on the demonstrations of the application of improved H2 production technologies (based on available and feasible H2 sources) and in design and safe operation of H2 storage, handling and refueling, as well as the commercial operation of such facilities. Part of the investment-related activities of the project will involve the purchase of demonstration FCVs that will be used to showcase the application and performance of new generation of FC cars, buses and utility vehicles from developed countries that are well advanced in fuel cell technology transport applications. The initial estimate is for 13 FCVs (to be verified and confirmed during the PPG exercise) that will be funded using GEF resources for the demonstrations, which will apart from showcasing operating performance will also test various schemes for integrating the FCVs into the city day-to-day operations and city life, such as FCV sharing, FCV rental, FCV test driving for the public and FCV maintenance service. Different business models for the sales or dealership of FCVs can also be studied, in the pursuit of finding the best way to have a viable FCV market. If the proposed GEF project will not happen, the GOC's NEVIDP will continue up to 2015 but will be something that simply give subsidies for vehicle purchases and will not encourage the R&D capabilities of the country's main automakers. This is also based on the comments from the local automotive industry observers. With the existence of the current barriers to the widespread production and application of FCVs, the commercialization of this zero emission type of transport vehicle, if at all will happen, will be much delayed – perhaps even beyond the anticipated 2020-2030 period. The previous interventions that the government (central and local) have done since the early 2000s proved to be inadequate in spurring the development of the local AEV industry (which include FCVs) and most conspicuously had only stimulated a rather weak participation of the private sector. The NEVIDP aims to put 500,000 AEVs on the roads by 2015 and 5 million by 2020. However, just 12,791 such vehicles were sold in2012, according to the China Association of Automobile Manufacturers. By March 2013, China had around 39,800 electric vehicles, about 80 percent of which were used for public transportation. If there will be AEVs like FCVs plying the streets	PIF: Part 1; Footnotes 6, 7, 8, 9 & 10 PIF: Sec A.1.3. Component 1 (p. 9); Component 2 (p. 10) PIF: Part 1; Footnote 11 PIF: Sec A.1.3.; Component 3 (p. 11) PIF: Sec. A.1.4. Pars 1 & 2 (p. 13)

[13] Shanghai, Beijing, Tianjin, Taiyuan, Jincheng, Dalian, Ningbo, Hefei, Wuhu, Qingdao, Zhengzhou, Xinxiang, Wuhan, Xiangyang, Guangzhou, Shenzhen, Haikou, Chengdu, Chongqing, Kunming, Xi'an and Lanzhou, as well as the three-city region of Changsha, Zhuzhou and Xiangtan in Hunan Province. It also consists of city clusters each comprising four to 10 cities in five provinces — Hebei, Zhejiang, Fujian, Jiangxi and Guangdong. On 27 January 2014, additional cities were included in the program. These are: Shenyang, Changchun, Harbin, Zibo, Linyi, Weifang, Liaocheng, Luzhou, as well as 4 city clusters in four provinces—Neimenggu (Huhehaote, Baotou), Jiangsu (Nanjing, Changzhou, Suzhou, Nantong, Yancheng, Yangzhou), Guizhou (Guiyang, Zunyi, Bijie, Anshun, Liupanshui, Qiandongnan), Yunnan (Kunming, Lijiang, Yuxi, Dali).

of some cities, these will most likely be from some forms of government-subsidized environment improvement or transport pollution control programs. There will be limited private-owned FCVs and new additions to the transport vehicle population in cities will mostly be the usual internal combustion engine vehicles (ICEVs). Considering the current trend and practices of using ICEVs, the potential for utilizing locally made zero emission transport vehicles will not be realized if the proposed project will not materialize. The potential energy saving and energy cost savings that can be derived from the use AEVs, particularly FCVs in the country will not be realized without the removal of certain barriers that hinder the promotion, production, application and commercialization of FCVs in the country.	
Follow-up Comment: Can you articulate how the GEF INV resources ($5,850,000 and $100,000) will be used? In the PIF, please specify the ways that are different from those in Phase I and Phase II of the projects. You may briefly review what the GEF invested in the FCV area during the precious two phases. **Response:** Please refer to Annex A of this document for the explanations on how the incremental GEF funds are allocated for the demonstration activities of the proposed project. The comparison between the previous UNDP-GEF FCB I & II Projects and the proposed FCV project has been added to the revised PIF (as Annex 1).	This Doc.: Annex A PIF: p.6 Annex 1
Follow-up Comment: Referring to investment-related activities of the project involving the purchase of demonstration FCVs: This happened during Phase I and Phase II. It might be better to avoid this way of using GEF funds, unless the demonstration vehicles are very different from those in Phase I and Phase II. **Response:** The GEF funds that will be used for the demonstrations that will be carried out under this project will be partly for the purchase of incremental FCVs. Per initial estimates (to be verified and confirmed during the PPG exercise) is 13 units of FCVs. Four of these are imported FCBs with improved power train and control system, including improved fuel cell system, e.g., FCvelocity®-HD7 which is a new generation Ballard fuel cell power module, designed specifically for integration into bus applications. Bulk of the FCVs will be financed through co-financing from the local governments of the 4 demonstration cities.	PIF: Part 1, Sec. B, p. 2 This Doc.: Annex A
Follow-up Comment: Referring to the BAU scenario that shows local transport vehicle manufacturers capabilities R&D not being encouraged: Please be aware that the GEF does not support R&D in any technologies, neither. Can you put a short version of the above paragraph in the PIF to highlight the GEF role? **Response:** The proposed project does not suggest the funding of R&D activities by GEF. What is being suggested is that with the capacity building that the project will facilitate (mainly through barrier removal and creation of enabling conditions) the local automotive manufacturers can be become encouraged to carry out R&D activities on their own or in collaboration with either or both local and foreign manufacturers. The current government funding in the current 12th Five Year Plan is now focusing on R&D, to advance domestic fuel cell technology. The project can help in further encouraging the manufacturers to avail of such assistance from the government. In addition, a short version of the response to the specific paragraph cited is now included in the revised PIF.	PIF: Sec A.1.4, 2nd Para, p. 13
Comment:	

e) Please comment on the ability of this project demonstration of a small number of vehicles to help manufacturers reduce technology costs for FCVs to cost-competitive levels. **Response**: The technical assistance to manufacturers will not be done by just showcasing the operation of a number of FCVs. The assistance will be done directly (through capacity building). In addition to workshop-based training activities, hands-on technical assistance (TA) will be organized and implemented in selected local transport vehicle manufacturers (particularly those that already started venturing on FCV manufacturing). The TA, which will be provided by international FCV experts, will primarily involve assisting the manufacturer (i.e., company management, production and engineering) in the application of advanced design of FCV components, as well as in, but not limited to, the following: (1) Proposed design for setting up a new, or modifying an existing, production line for the manufacturing of FCVs; (2) Design of FCVs, e.g., FC engine and FC stack life and durability, H2 fuel economy, etc.; (3) Technical requirements in the application of proven technologies for improving the performance of FCVs; (4) Adopting manufacturing processes to comply with international standards; and, (5) Research and development on the design of FCVs, e.g., prototype production of selected FC engine designs. Technical advice will also be provided in the addressing problems related to R&D on FCV design and manufacturing. The hands-on TA to manufacturer design and engineering staff, consisting of technical Q&A sessions, review and assessment of existing manufacturing capabilities and provision of suggested improvements on FCV designs and manufacturing (including FC engine product testing and FCV on the road test runs), and other hands-on support which manufacturers otherwise are unable to obtain, particularly from high-level international experts.	PIF: Sec. A.1.3. Component 1 (p. 9)
7. Are the components, outcomes and outputs in the project framework (Table B) clear, sound and appropriately detailed?	
Comment: *Please indicate the number of cars that will be financed by the GEF fund.* **Response**: Most of the 101 FCVs that will be demonstrated in the project will be financed through co-financing. Initial estimate of the additional FCVs (cars and buses) that will be financed using GEF funds is about 13. This will be verified and confirmed during the PPG exercise.	PIF: Part I, Sec. B
Follow-up Comment: Referring to number of FCVs that will be financed with GEF funds: *Can you put this number in Table B PROJECT FRAMEWORK?* **Response:** This information is indicated in Part I, Sec B (Project Framework) of the revised PIF.	PIF: p. 2
8. (a) Are global environmental/ adaptation benefits identified? (b) Is the description of the incremental/additional reasoning sound and appropriate?	
Comment: *The target of GHG emission reduction in this project is 130,000 tonnes of CO2 equivalent. Please explain the cost-effectiveness of this investment compared to other advanced vehicle and fuel technologies that could be supported.* **Response**: In its effort to combat rising air pollution in its major cities, China is supporting (through financial incentives, i.e., subsidies) the widespread production and use of fuel-efficient vehicles. This applies to all electric, “near all-electric” and H_2 vehicles	

until 2015. This is aimed at "accelerating the development of new-energy vehicles, promoting energy saving and reducing air pollution". Among these new or alternative energy vehicles (AEVs) that have been considered by the GOC (based on the collective agreement of Chinese experts) the H2 vehicles (FCVs) are regarded as a more viable alternative to gasoline-powered cars than electric vehicles, mostly because they have a far better range. FCVs are regarded as the real zero emission vehicles since EVs are still using an energy form (electricity) that is produced in China mainly with coal. In that perspective, and in view of the objective of the government to improve air quality and reduce CO2 emission reductions, the government (central and local) tend to favor FCVs over EVs. Many EV manufacturers are also facing problems related to the batteries and complaints from the power utilities that have to install additional generating capacities to serve EV charging stations. Cost-effectiveness in terms of GHG emission abatement will definitely favor the AEVs that are less costly to purchase and operate. Comparing an electric bus (EB) and FC bus (FCB), their unit prices are more or less the same, but their running cost differs. FCBs and EBs are comparable in running cost at travel distance of up 200 kms. If the travel distance is below 150 kms, an EB has more advantage in terms of running cost. On a passenger-km basis, more GHG emissions are released from the use of EBs. In regards to cars, the unit price of a fuel cell car (FCC) is much higher than that of an electric car (EC). The running cost of an EC is lower (@ 16 – 18 RMB/100 kms) than that of a FCC (@ 22 RMB/100 kms). However, at longer distances, the same conclusion can be drawn when comparing the running costs of an EB and a FCB. With the favorable enabling conditions and increased technical capacity and knowhow that the proposed project will facilitate, the unit cost of the more environment-friendly FCC would by 2019 (end-of-project) be very competitive compared to an EC. In that case, the cost-effectiveness of FCCs compared to ECs will be higher. In regards to buses, currently the cost effectiveness of the electric and fuel cell variety are almost the same. However, by end-of-project, FCBs will be more cost effective. The estimated cost effectiveness will be verified and confirmed during the project preparation stage i.e., PPG exercise).	PIF: Sec. A.1.5. Para 3 (p. 14) Annex 1
13. Comment on the project's innovative aspects, sustainability, and potential for scaling up.	
<u>Comment</u>: *The project is innovative, because FCV technology is still very innovative in China and in the world, requiring substantial demonstration and validation. The project will be sustainable because the Chinese government has policy and a long-term development plan for FCVs, however, technology costs, must drop by a factor of 10 or more before fuel cell vehicles can be cost-competitive. There is great potential for scaling up because the private sector is the major investor with cash investments in the project, however, this will only happen if the technology costs improve as noted. Please write one paragraph for each of the three topics: innovation, sustainability, and scaling-up.* **<u>Response</u>**: The 3 paragraphs in the PIF are actually describing individually the aspects of innovation, sustainability and scaling up of the proposed project. Nonetheless, these were also revised to as follows: 1. Innovation: The proposed project is intended to supplement the efforts of the GOC to promote a transport technology that is considered innovative in China. In addition, since it is still evolving even in the developed world, it would require substantial demonstration of its viability as a means of saving energy used in transport and consequently reduce GHG emissions from the Chinese transport sector. The application of this innovative technology is also very timely since its major co-benefit is environmental quality conservation – something that is very important in many of China's big and still expanding urban areas. The inclusion of interventions focusing on	 PIF: Sec. A.1.6., pp. 14-15

the major support infrastructures for the FCV market, which are the facilities for H2 production and H2 refueling are among the innovations in this proposed project. The participation of the private sector in improving the sales and use of FCVs to transform the market from the current government-supported programs to a market dominated by FCV use for private transport is also among the innovative features of this project. Also, a clear innovation in the project is the fact that the demonstrations will be linked to ongoing and planned researches on fuel cell durability and environment-adaptability to determine improvements in reliability and safety, and develop standard procedures for the, operation and maintenance of FCVs, as well for reducing costs and longer service time of FCVs. 2. Sustainability: The proposed project will be sustainable not only because of the Chinese government's policy and long term development plan for FCVs, but also because the expected outputs that will be delivered are meant not only to provide the enabling conditions for cohesive efforts to sustain and guide the commercial development of the industry. In this regard, the proposed project is essential for the local transport vehicle manufacturing industry development. The strategy to continuously facilitate the effectiveness of these enabling conditions involves their development, establishment and institutionalization, and in so doing sustain them. The demand for mobility by people, the necessity of transport for socio-economic development, the current efforts of the government (central and local) to develop and support, and the need to address current transport-based air pollution are the major drivers for the sustained development efforts towards the commercialization of AEVs, in general, and FCVs, in particular. To ensure avoidance of the recurrence of the barriers and the continuance of the enabling environments that will be created and/or facilitated by the project, appropriate sustainable follow-up actions will be planned as part of the project activities. Such action plan will be implemented after the project as per the institutional arrangements that will be developed for such purpose. 3. Potential for scaling up: The project will focus on 4 of the 28 cities that were identified by the GOC to use AEVs. The 4 cities will serve as the demonstration for the development and application of the interventions intended for the removal of barriers to FCV commercialization that will be carried out under the project. Several of the project interventions can be replicated in the other 24 cities, as well as in other regions of the country where the citizens and/or local governments are keen in the application of FCV technologies for private transport and public transport, or where interest and potential for local FCV manufacturing is present. The policies and implementing rules and regulations that will be developed under the project and adopted in these other cities can be replicated or further enhanced to promote the utilization of FCVs and other environment friendly transport systems. In addition, the planned demonstrations can be scaled up to involve more local transport vehicle manufacturers, and transport vehicle distributors and retailers in the promotion efforts.	
24. Is PIF clearance/approval being recommended?	
<u>Comment</u>: *Not at this time. Please see comments above in Boxes: 5, 6, 7, 8, and 13. In addition, the total Agency Fee (9.67%) exceeds 9.5%. Please revise it accordingly.* **<u>Response</u>**: The stated Agency Fee (US$ 796,440) is <u>inclusive of the Agency Fee for the Project and Agency Fee for the PPG Exercise. The total project cost is US$ 8,233,560, and 9.5% of that is US$ 782,190. The PPG cost is US$ 150,000 and 9.5% of that is US$ 14,250</u>. Hence, the total Agency Fee is US$ 782,190 + US$ 14,250 = US$ 796,440, which is 9.5% of combined total project cost and PPG cost, i.e., [796,440/(8,233,560 + 150,000)]*100 = 9.5%. All the comments in Boxes 5, 6, 7, 8 & 13 have been adequately addressed.	PIF: Part 1; Agency Fee

Attachment to Annex B-4 (note: part of previously submitted March 11, 2014 response, continued)
Acceleration of the Development and Commercialization of FCVs Project
Demonstration Activities – Baseline & Incremental

Component 1.A-1:

Demonstration on the Application of Improved FCV Technologies	
Baseline	**Incremental**
• Government program to help car companies strengthen new-energy vehicle design, batteries and other related technologies. • Individual local transport vehicle manufacturer (e.g., SAIC, Yutong) FCV R&D activities and FC system parts and components production **Total Cost: US$ 12,050,000**	• Demonstration of the application of improved FC application and FCV design (FC engine and FC stack life and durability, H2 fuel economy, etc.) and manufacturing in local transport vehicle manufacturers ▪ Direct technical assistance to manufacturers on improved FCV vehicle design (e.g., power train, fuel system, power train control system) **Cost =US$ 60,000** ▪ Prototype production of selected FC engine designs **Cost = US$ 1,000,000** ▪ Prototype FC engine product testing and FCV on the road test runs **Cost = US$ 100,000**

Component 1.A-2:

Demonstration of Operating Performance of Improved FCVs and the Commercial Applications of FCVs	
Baseline	**Incremental**
• Beijing FCV Demonstration (8 FCB and 3 urban utility vehicles, total distance = 339,000 kms) – locally produced • Shanghai: Jiading International FCV Demonstration Area (9 FCBs, 18 FC Taxis and 46 FCCs; total distance = 1,022,000 kms) – locally and imported FCVs • Zhengzhou City NEVDIP Action Plan (2013- 2015) (2 FCB, total distance = 267,000 kms) – locally produced • Foshan FCV Demonstration Project (2 FCB, total distance = 100,000 kms) – locally produced **Total Cost: US$ 33,000,000**	• Beijing FCV Demonstration (1 imported FCB and 3 urban utility vehicles, total distance = 121,000 kms) – *demo of operation of new generation FCVs. Demo of FCV fleet operations – public bus transport, government general services and transport fleet, fixed-route delivery truck fleet. – For expanding the FCV market.* **Cost = US$ 1,090,000** • Shanghai: Jiading International FCV Demonstration Area (1 FCB, 2 FC Taxis and 4 FCCs; total distance = 98,000 kms) - *demo of operation of new generation FCVs, demo of FCV fleet operations - buses, taxi and car rental fleet, government general services transport flee,. For expanding the FCV market.* **Cost = US$ 1,600,000** • Zhengzhou City NEVDIP Action Plan (2013- 2015) (1 FCB, total distance = 133,000 kms) - *demo of operation of new generation FCB in local passenger transport sector* **Cost = US$ 1,000,000** • Foshan FCV Demonstration Project (1 FCB, total distance = 50,000 kms) - *demo of operation of new generation FCB in local passenger transport sector* **Cost = US$ 1,000,000**

Component 1.B

Demonstration on the Application of Feasible and Cost-Effective H2 Production Technologies and Commercial Operation of H2 Refueling Facilities	
Baseline	**Incremental**

• Construction of 2 new H2 refueling facilities (Zhengzhou and Foshan) by Air Liquide and China Petrol
• Enhancement of Beijing H2 production and refueling facilities by SinoHytec
• Commercial operation of existing and new H2 refueling stations operated by partner companies showcasing:
  ▪ Enhanced storage, handling, distribution and dispensing of hydrogen gas
  ▪ Safe and proper operation of hydrogen production and refueling facilities
Total Cost: US$ 3,300,000
	• Additional technical and logistical inputs to showcase the baseline H2 production projects as demonstration of improved petroleum fuel (liquid or gas) reforming and syngas technologies for H2 production, or the electrolysis of water using renewable energy-generated electricity.
	Cost: US$ 40,000
	
	• Additional technical and logistical inputs to showcase the commercial operation of H2 refueling facilities and to test the effectiveness of the demonstrated H2 refueling network design, the standard protocols for complying with the operational, safety, health, and environmental (OSHE) procedures/requirements to be applied to H2 refueling facilities.
	Cost: US$ 60,000

ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS[14]

A. PROVIDE DETAILED FUNDING AMOUNT OF THE PPG ACTIVITIES FINANCING STATUS IN THE TABLE BELOW:

PPG Grant Approved at PIF: US$ 150,000			
Project Preparation Activities Implemented	***GEF/LDCF/SCCF/NPIF Amount ($)***		
	Budgeted Amount	***Amount Spent to Date as of June 30, 2015***	***Amount Committed***
1. Conduct of studies and surveys (*not done – decision made to focus on leveraging existing knowledge of experts and subcontractor in demo and activity design*)	40,000	28,359.19	11,640.81
2. Conduct of Logical Framework Analysis (LFA) workshop (*completed*)	25,000	16,914.9	0
3. Identification and assessment of demonstrations that will be implemented in the project (*FCV demos; FCV component manufacturing demos; HRS demos; and hydrogen production demos identified and assessed*)	15,000	32,310.77	0
4. Detailed design of project components and activities (*done*)	40,000	35,792.85	2,682.19
5. Conduct of stakeholder and project partner coordination meetings and establishment of appropriate project implementation and management arrangements (*done*)	10,000	0	10,000
6. Preparation of UNDP-GEF Project Document (ProDoc) and GEF CEO Endorsement Request (CER) Document (*done*)	17,500	9,799.29	0
7. Finalization of ProDoc and CER Document (*almost done*)	2,500	0	2,500
Total	**150,000**	**123,177**	**26,823**

Overall, the PPG Exercise has achieved the PPG objective of designing, developing and documenting the DevCom FCV project document.

MOST as the project-implementing partner assembled a project development team made up of national and international experts in the fields of fuel cell vehicle (FCV) design and development, fuel cell stack production and performance, hydrogen gas production and dispensing, as well as an international expert in climate change project design, that carried out the PPG Exercise. The team worked together to discuss, analyze and assimilate most of the available data and information in China and in other developed countries that were utilized in the project design. The data gathering, processing and analyses have made possible the clear understanding of the current situation concerning the issues and concerns regarding the intentions and plans of the local automotive industry to enhance the manufacturing and

[14] If at CEO Endorsement, the PPG activities are not completed and there is a balance of unspent fund, Agencies can continue undertake the activities up to one year of project start. No later than one year from start of project implementation, Agencies should report this table to the GEF Secretariat on the completion of PPG activities and the amount spent for the activities.

sales of locally made FCVs taking advantage of the governments support for the promotion and development of new energy vehicles (NEVs) that includes electric vehicles, hybrid vehicles and FCVs. The discussions with the key stakeholders and project partners (e.g., major car and bus manufacturers that have ventured into the production of NEVs, universities and research & development institutes, as well as local governments such as the 4 demo cities of Beijing, Shanghai, Zhengzhou and Foshan) made possible the identification of relevant issues and barriers that need to be addressed and considered in the development and implementation of the DevCom FCV project. The international experts were also able to discuss with, and get useful information from, international car manufacturers that have already developed and started manufacturing FCVs, as well as with some fuel cell stack manufacturers. These, on top of the information gathered from the local automotive industry have made it possible for the project team fully understand the nature and extent of these issues/barriers. The logical framework analysis (LFA) that was carried out by the team together with the stakeholders (and with full support of the MOST) has enabled the confirmation of the previously defined project goal and objective, and expected outcomes. Their inputs during the situation analysis and problem analysis portions of the LFA gave the project development team a clearer understanding of the technical capacity development needs, and manufacturing issues (e.g., difficulties in international sourcing of FC and FCV components). These became the bases of the demonstrations and specific technical assistance in various aspects of FCV, and FC/FCV component manufacturing interventions that were designed as part of the project. Issues concerning the RE-based hydrogen gas production (including safety) were also discussed with current and potential hydrogen refueling station owners/operators. The discussions with the stakeholders and project partners also resulted in getting commitments for the co-financing of the baseline activities that were subsumed into the project; as well as in the agreed project coordination mechanisms and the project implementation arrangements. The outputs of the various PPG exercise activities were used in the detailed design of the DevCom FCV project components and activities.

ANNEX D: CALENDAR OF EXPECTED REFLOWS (if non-grant instrument is used**)**

Provide a calendar of expected reflows to the GEF/LDCF/SCCF/NPIF Trust Fund or to your Agency (and/or revolving fund that will be set up): N/A

Annex E: Annexes to Response to GEFSec Comments (11 Nov 2015)

Annex 1: Comparative Analysis of Different Bus Technologies

Data & Assumptions:
Specifications: Public transit bus, city operations; 12 m long; 60 pax passenger capacity, load factor = 100%; Design lifetime travel distance = 600,000 kms; Bus lifetime (min) = 5 years.
Vehicle Operation: 10 trips/day; 50 km/day; 70% availability factor; 127,750 kms distance travelled yearly; US$ 76,650 bus service annual revenue @ US$ 0.5/pax bus fare.
Maintenance costs: Diesel ICE Bus (Tyres @ 1.5 US cents/km-yr, Maintenance service @ 7.5 US cents/km-yr); CNG Bus: (Tyres @ 2.0 US cents/km-yr, Maintenance service @ 9.0 US cents/km-yr; Diesel Hybrid: (Tyres @ 1.9 US cents/km-yr, Maintenance service @ 7.5 US cents/km-yr); BE and FC Buses: (Tyres @ 1.5 US cents/km-yr, Maintenance service @ 8.5 US cents/km-yr)
Other information: Loan tenure = 5 years; Interest rate = 5% (average commercial lending rate in China); straight-line depreciation; income tax = 35%; inflation rate = 0% (average is 2% per year); labor cost (driver & conductor) = US$ 2,500/yr.
NOTE: For purposes of the comparative analysis, except for the maintenance costs, all of the other data & assumptions apply to all bus technologies.

Bus Technology	Diesel ICE Bus	CNG Bus	Diesel Hybrid Bus	Battery Electric Bus		Fuel Cell Bus	
Description & Specifications							
Fuel Used	Diesel Fuel Oil	Compressed Natural Gas	Diesel Fuel Oil	Electricity	Electricity	Hydrogen	Hydrogen
Fuel Unit of Measure	liter	Nm3	Liters	Kilowatt-hours	Kilowatt-hours	kilograms	kilograms
Travel Distance per Unit Fuel Usage, kms	2.2	20.3	8.7	0.7	0.7	12.0	12.0
GHG Emissions grams CO_2/km	1,338	850	1,079	907	907	290	290
Vehicle Cost, US$							
Base Price, US$	60,000	104,000	128,000	264,000	264,000	224,000	224,000
Subsidy/Rebate, % of base price	0	0	0	0	128,000	0	160,000
List Price, US$	60,000	104,000	128,000	264,000	136,000	224,000	64,000
On-the-Road Price, US$	66,600	115,440	142,080	293,040	150,916	248,640	71,111

Bus Technology	Diesel ICE Bus	CNG Bus	Diesel Hybrid Bus	Battery Electric Bus		Fuel Cell Bus	
Annual Standing Cost, US$							
Depreciation Cost	13,320	23,088	28,416	58,608	30,183	49,728	14,222
Loan Repayment Cost	Depends on Applied Loan	Depends on Applied Loan	Depends on Applied Loan	Depends on Applied Loan	Depends on Applied Loan	Depends on Applied Loan	Depends on Applied Loan
On Roads, Registration, Insurance, etc.	3,330	5,772	7,104	14,652	7,546	12,432	3,556
Total Annual Standing Cost, US$	16,650	28,860	35,520	73,260	37,729	62,160	17,778
Annual Running Cost, US$							
Fuel Unit Cost, US$	0.85	0.65	3.22	0.16	0.16	3.00	3.00
Fuel Unit Cost, US$/GGE	2.79	2.33	2.82	5.16	5.16	3.00	3.00
Annual Fuel Consumption	58,068	6,298	14,740	190,672	190,672	10,646	10,646
Annual Fuel Consumption, GGE	17,722	1,757	16,803	5,911	5,911	10,646	10,646
Annual Fuel Cost, US$	49,358	4,094	47,422	30,507	30,507	31,938	31,938
Tyres, US$/km-yr.	1,916	2,555	2,427	1,916	1,916	1,916	1,916
Maintenance Service, US$/km-yr	9,581	11,498	9,581	10,859	10,859	10,859	10,859
Labor Cost, US$/year	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Total Annual Running Cost, US$	63,355	20,646	61,930	45,782	45,782	47,213	47,213
Total Annual Cost, US$	80,005	49,506	97,450	119,042	83,511	109,373	64,990
Energy Savings & GHG Emissions							
Annual GHG Emissions, tons	170.9	108.6	137.8	115.9	115.9	37.0	37.0
Annual Fuel Savings	-	15,965	919	11,812	11,812	7,077	7,077
Annual Equivalent Fuel Savings	-	57,223	3,294	381,019	381,019	7,077	7,077

Bus Technology	Diesel ICE Bus	CNG Bus	Diesel Hybrid Bus	Battery Electric Bus		Fuel Cell Bus	
Annual Fuel Cost Savings, US$	-	37,195	10,598	60,963	60,963	21,230	21,230

Vehicles Costs are based on information provided by local bus manufacturers in China, and are projected 2017 costs.
Cost of Battery Electric Bus includes replacement cost for battery.

Fuel Economy values are from various references used in the DevCom FCV Project design.

- *Fred Joseck, Michael Wang, and Ye Wu, "Potential Energy and Greenhouse Gas Emission Effects of Hydrogen Production from Coke Over Gas in US Steel Mills," International Journal of Hydrogen Energy, 2008, pages 1445-1454.*
- *Calculating Electric Driver Vehicle GHG Emissions, Ed Pike for ICCT, 2012.*
- *US Department of Energy Well to Wheels Analysis*

Emission Factors are based on information used in the DevCom FCV Project design:
Diesel ICE Bus: 1,338 g/km is based on current emission levels from locally made diesel ICE buses. Euro V buses has 1,000 g CO2/km (2012).
CNG Bus: 900 g/km is average of quoted figures in various web-based documents on CNG buses. Euro V buses has 850 h CO2/km (2012)
Diesel Hybrid: Assumes 60%-40% battery-diesel ICE. Battery is assumed charged with grid electricity.
Battery Electric Bus: Assumes battery charging using grid electricity; Fuel Cell Bus: Assumes 50-50 mix natural gas-based (steam methane reforming) and wind power based.

Annex 2A: Results of Economic Feasibility of Bus Technologies

The following are the results of the economic feasibility of each alternative Bus Technology (based on the data and assumptions shown in Annex A); and the economic feasibility of the incremental investment on alternative bus technology (considering the bases case of Diesel ICE Bus).

Base Case: Diesel ICE Bus

Parameters	100% Equity	75% Equity	50% Equity
NPV Project, US$	(22,342.0)	(10,449.0)	(6,485.0)
NPV Annual Cost, US$	346,382.0	336,127.0	334,197.0
Project IRR, %	(9.0)	(3.4)	(2.8)
Total Cost per kilometer, US$/km	0.73	0.69	0.66

Alternative 1: CNG Bus

Parameters	100% Equity	75% Equity	50% Equity
NPV Project, US$	157,694.0	172,383.0	178,140.0
NPV Annual Cost, US$	187,668.0	172,104.0	169,176.0
Project IRR, %	48.4	65.7	94.4
Total Cost per kilometer, US$/km	0.57	0.49	0.4
Cost Effectiveness, US$/ton CO2	1,851.7	1,388.8	925.9
Incremental Investment Economic Feasibility Analysis: CNG Bus vs. Diesel ICE Bus			
NPV Incremental Project, US$	175,193.0	181,408.0	183,843.0
NPV Incremental Annual Cost, US$	(132,046.0)	(139,566.0)	(140,981.0)
Incremental IRR, %	107.2	141.5	204.9
Incremental Cost Effectiveness, US$/ton CO2	783.4	587.6	391.7

Alternative 2: Diesel Hybrid Bus

Parameters	100% Equity	75% Equity	50% Equity
NPV Project, US$	334,798.8	352,878.0	359,963.0
NPV Annual Cost, US$	369,412.8	350,258.2	346,653.8

Project IRR%	76.70	100.2	144.3
Total Cost per kilometer, US$/km	0.99	0.89	0.83
Cost Effectiveness, US$/ton CO2	4,294.1	3,220.6	2,147.1
Incremental Investment Economic Feasibility Analysis: Diesel Hybrid Bus vs. Diesel ICE Bus			
NPV Incremental Project, US$	352,298.0	361,902.6	365,666.4
NPV Incremental Annual Cost, US$	75,526.5	63,904.6	61,717.6
Incremental IRR%	134.4	177.0	257.6
Incremental Cost Effectiveness, US$/ton CO2	2,281.2	1,710.9	1,140.6

Alternative 3: Battery Electric Bus

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
NPV Project, US$	12,345.0	49,633.7	64,246.4	125,726.0	144,929.5	152,455.0
NPV Annual Cost, US$	451,265.00	411,758.2	404,324.1	316,574.0	296,228.0	292,399.4
Project IRR%	6.60	13.2	20.4	32.8	46.0	66.5
Total Cost per km, US$/km	1.39	1.19	1.06	0.89	0.79	0.72
Cost Effectiveness, US$/ton CO2	5,322.20	3,991.6	2,661.1	2,740.9	2,055.7	1,370.5
Incremental Investment Economic Feasibility Analysis: Battery Electric Bus vs. Diesel ICE Bus						
NPV Incremental Project, US$	29,844.00	58,658.2	69,949.9	143,225.0	153,954.1	158,158.5
NPV Incremental Annual Cost, US$	169,010.00	134,144.0	127,583.1	15,179.0	2,196.4	(246.6)
Incremental IRR%	9.9	17.3	26.2	57.7	77.5	111.4
Incremental Cost Effectiveness, US$/ton CO2	4,112.6	3,084.4	2,056.3	1,531.3	1,148.5	765.7

Alternative 4: Fuel Cell Bus

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
NPV Project, US$	(79,144.3)	(34,744.3)	(19,944.3)	79,066.6	88,115.2	91,661.2
NPV Annual Cost, US$	414,607.8	381,087.2	374,779.5	246,364.2	236,777.3	234,973.3
Project IRR%	(8.2)	(2.4)	(1.3)	41.1	56.4	81.2

Total Cost per kilometer, US$/km	1.25	1.08	0.97	0.62	0.57	0.54
Cost Effectiveness, US$/ton CO2	1,857.2	1,392.9	928.6	531.1	398.4	265.6
Incremental Investment Economic Feasibility Analysis: Fuel Cell Bus vs. Diesel ICE Bus						
NPV Incremental Project, US$	(56,802.6)	(24,295.5)	(13,459.8)	96,565.8	97,139.8	97,364.7
NPV Incremental Annual Cost, US$	127,143.9	99,114.5	93,840.1	(65,007.9)	(65,702.5)	(65,833.2)
Incremental IRR, %	(7.9)	(2.1)	(0.8)	542.2	719.4	1,070.0
Incremental Cost Effectiveness, US$/ton CO2	1,359.7	1,019.8	679.9	33.7	25.3	16.8

Annex 2B: Comparison of Fuel Cell Bus and Battery Electric Bus

EVs now in China are powered mainly by grid-based electricity, which has a high "coal content," which has quite a high emissions factor (assumed here at 907 g CO2/km, whereas FCVs are/ will be powered mostly by byproduct hydrogen in the near term, which has quite a low emissions factor. This is a key reason how FCVs are cost competitive in terms of emissions reduction in the near term giving China time to get the FCV cost down to continue to be competitive by the time EVs are powered by cleaner electricity.

It is a country-driven priority in China to diversify among multiple alternative energy vehicles, inasmuch as it is not clear for now which will have the best technical breakthroughs and thus end up being the most cost effective technology in the long-term. This is evidenced by the existence of GOC subsidies for both FCVs and EVs, with FCV subsidies being higher to compensate for their higher cost at present.

Even with technological breakthroughs, FCVs are considered to have much more room for cost reduction than EVs, as EVs are already mass-produced and FCVs are not.

Base Case: Battery Electric Bus (Using Grid Electricity); Alternative Case: Fuel Cell Bus (Using 50-50 mix SMR-based and RE-based H2)

FC Bus vs. BE Bus

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
NPV Project, US$	-91,489.3	-84,377.9	-84,190.6	-46,659.4	-56,814.3	-60,793.8
NPV Annual Cost, US$	-36,657.2	-30,670.9	-29,544.5	-70,209.8	-59,450.6	-57,426.1
Project IRR, %	-14.8	-15.6	-21.7	8.3	10.4	14.7
Total Cost per kilometer, US$/km	-0.14	-0.12	-0.10	-0.27	-0.22	-0.18
Cost Effectiveness, US$/ton CO2	-3,465.0	-2,598.8	-1,732.5	-2,209.8	-1,657.3	-1,104.9
Incremental Investment Economic Feasibility Analysis: Fuel Cell Bus vs. Battery Electric Bus						
NPV Incremental Project, US$	-86,646.6	-82,953.7	-83,409.6	-46,659.2	-56,814.3	-60,793.8
NPV Incremental Annual Cost, US$	-41,866.1	-35,029.4	-33,743.0	-80,186.9	-67,898.9	-65,586.6

Incremental IRR, %	-17.8	-19.4	-27.0	484.5	641.9	958.6
Incremental Cost Effectiveness, US$/ton CO2	-2,752.9	-2,064.7	-1,376.4	-1,497.6	-1,123.2	-748.8

Magnitude of Difference (FC Bus vs. BE Bus)

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
% Diff in NPV Annual Cost	-8.1	-7.4	-7.3	-22.2	-20.1	-19.6
% Diff in Total Cost per km	-10.4	-9.7	-9.0	-30.3	-27.4	-25.1
% Diff in Cost Effectiveness	-65.1	-65.1	-65.1	-80.6	-80.6	-80.6
% Diff in Incremental Cost Effectiveness	-66.9	-66.9	-66.9	-97.8	-97.8	-97.8

Conclusions: The mostly negative values in the tables above indicate that the costs involved in the application and operation of FC Bus is lower compared to the BE Bus. The negative values for the cost effectiveness (actual and incremental) show that it cost less to invest on FC Bus than on a BE Bus per ton of CO2 emission reduction. The negative IRR values (actual and incremental) when no subsidy is provided indicates that in terms of economic viability BE Bus would be better than FC Bus. However, if subsidies are applied, FC Bus is significantly more economically viable than BE Bus.

Base Case: Battery Electric Bus (Using Cleaner Electricity); Alternative Case: Fuel Cell Bus (Using 50-50 mix SMR-based and RE-based H2)

FC Bus vs. BE Bus (assume the same emission factor = 290 g CO2/km)

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
NPV Project, US$	(91,489.3)	(84,377.9)	(84,190.6)	(46,659.4)	(56,814.3)	(60,793.8)
NPV Annual Cost, US$	(36,657.2)	(30,670.9)	(29,544.6)	(70,209.8)	(59,450.6)	(57,426.1)
Project IRR, %	(14.8)	(15.6)	(21.7)	8.3	10.4	14.7
Total Cost per kilometer, US$/km	(0.14)	(0.12)	(0.10)	(0.27)	(0.22)	(0.18)

Cost Effectiveness, US$/ton CO2	(331.6)	(248.7)	(165.8)	(596.1)	(447.0)	(298.0)
Incremental Investment Economic Feasibility Analysis: Fuel Cell Bus vs. Battery Electric Bus						
NPV Incremental Project, US$	(86,646.6)	(82,953.7)	(83,409.6)	(46,659.2)	(56,814.3)	(60,793.8)
NPV Incremental Annual Cost, US$	(41,866.1)	(35,029.4)	(33,743.0)	(80,186.9)	(67,898.9)	(65,586.6)
Incremental IRR, %	(17.8)	(19.4)	(27.0)	484.5	641.9	958.6
Incremental Cost Effectiveness, US$/ton CO2	(580.4)	(373.1)	(165.8)	(844.8)	(571.4)	(298.1)

Magnitude of Difference (FC Bus vs. BE Bus)

Parameters	No Subsidy			With Subsidy		
	100% Equity	75% Equity	50% Equity	100% Equity	75% Equity	50% Equity
% Diff in NPV Annual Cost	-8.1%	-7.4%	-7.3%	-22.2%	-20.1%	-19.6%
% Diff in Total Cost per km	-10.4%	-9.7%	-9.0%	-30.3%	-27.4%	-25.1%
% Diff in Cost Effectiveness	-15.2%	-15.2%	-15.2%	-52.9%	-52.9%	-52.9%
% Diff in Incremental Cost Effectiveness	-29.9%	-26.8%	-19.6%	-96.2%	-95.8%	-94.7%

Conclusions: As in the previous case, the mostly negative values in the tables above indicate that the costs involved in the application and operation of FC Bus is lower compared to the BE Bus even if these are using clean electricity. The negative values for the cost effectiveness (actual and incremental) show that it cost less to invest on FC Bus than on a BE Bus per ton of CO2 emission reduction. The negative IRR values (actual and incremental) when no subsidy is provided indicates that in terms of economic viability BE Bus would be better than FC Bus. However, if subsidies are applied, FC Bus is significantly more economically viable than BE Bus.

United Nations Development Programme
Country: CHINA
PROJECT DOCUMENT[1]

Project Title: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China

UNDAF Outcome: Government and other stakeholders ensure environmental sustainability, address climate change, and promote a green, low carbon economy

Expected CP Outcome: Low carbon and other environmentally sustainable strategies and technologies are adopted widely to meet China's commitments and compliance with Multilateral Environmental Agreements

Expected CPAP Output: Policy and capacity barriers to the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed

Executing Entity/Implementing Partner: Ministry of Science and Technology, P.R. China (MOST)
Implementing Entity/Responsible Partners: Ministry of Science and Technology, P.R. China (MOST)

[1] For UNDP supported GEF funded projects as this includes GEF-specific requirements

Programme Period:	4 year
Atlas Award ID:	00086819
Project ID:	00094022
PIMS #	5349
Start date:	Oct. 2015
End Date	Oct. 2019
Management Arrangements	NEX
PAC Meeting Date	May 8, 2015

Brief Description

The project's objective is to facilitate commercialization of fuel cell vehicles (FCVs) in China. It will achieve this through a multi-pronged strategy that will enable China to (a) "leapfrog" in its FCV durability/performance improvements and cost reductions far beyond what would be achieved in the baseline scenario and (b) get many more FCVs on the road by end of project than would occur in the baseline scenario. The strategy will consist of components covering the areas of: (1) FCV and FC technology improvement/cost reduction (raising technical abilities and international sourcing connections of China's FCV manufacturers, raising technical abilities of its FCV component manufacturers, and demonstrating 109 FCVs across 4 demo cities); (2) hydrogen production and hydrogen refueling stations (introducing in China renewable energy-based hydrogen production of substantial scale and demonstrating at least 4 hydrogen refueling stations with varied business models); (3) policy (covering national *FCV Roadmap*, standards and certification, expedited approval processes, and stabilized and expanded incentive policies, including two policy pilots); (4) awareness and information dissemination (addressing the general public, government officials, etc. and ensuring replication); and (5) capacity building (covering FCV and hydrogen refueling station O&M and the financial sector's knowledge of and ability to assess investments and loans in FCV-related areas).

Total resources required	USD 61,733,560
Total allocated resources:	
• Regular	
• Other:	
○ GEF	USD 8,233,560
○ Government	USD 15,033,300
○ In-kind	USD 2,566,700
○ Other	USD 35,500,000
○ UNDP	USD 400,000

Agreed by (Government):
Date/Month/Year

Agreed by (Executing Entity/Implementing Partner):
Date/Month/Year

Agreed by (UNDP):
Date/Month/Year

CONTENTS

LIST OF ANNEXES

List of Acronyms

AEV	Alternative energy vehicle: In China includes NEVs and alternative fuel vehicles, namely CNG, LNG, and LPG vehicles.
APR/PIR	Annual Project Review/Project Implementation Reports
ATLAS	UNDP financial management system
AWP	Annual work plan
BEV	Battery electric vehicle
BOS	Balance of system: Refers to parts other than a key sub-system. For example, for an FCV's fuel cell system, the fuel cell stack is the key sub-system and all other parts are considered BOS.
BTOR	Back to Office Report
BTU	British thermal unit
CAGR	Compound annual growth rate
cm^2	Square centimeters
CCM-4	Climate Change Mitigation Strategy 4: GEF strategy for climate change mitigation that entails energy efficient, low-carbon transport and urban systems.
CECEP	China Energy Conservation and Environmental Protection Corporation
CNG	Compressed natural gas: natural gas under pressure
CO	Country Office (UNDP Country Office)
CO_2	Carbon dioxide
CPAP	Country Program Action Plan: UNDP term for its overall plan for assistance for a particular country designed in conjunction with that country
DevCom FCV	Development and Commercialization of Fuel Cell Vehicles: abbreviated title of this project.
EIA	Energy Information Administration of US Department of Energy
ESCOs	Energy service companies: Companies that help other companies save energy. Often these companies are paid from the energy savings they facilitate.
EOP	End of project
ERC	Evaluation Resource Center: Resource of UNDP Corporate Evaluation Office to which terminal project evaluations are uploaded.
EV	Electric vehicle
FC	Fuel cell
FCB	Fuel cell bus
FCV	Fuel cell vehicle
G	Gram
GEF	Global Environment Facility
GoC	Government of China
GHGs	Greenhouse gases
H_2	Hydrogen
HRS	Hydrogen refueling station
HV DC-DC converter	High voltage direct current to direct current converter: an FCV part
ICE, ICEV	Internal combustion engine, internal combustion engine vehicle
IEA	International Energy Agency
IP	Implementing partner: For this project, MOST.
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
Kg	Kilogram
Km	Kilometer

kW	Kilowatt
LD	Light duty: refers to light duty vehicles, such as cars or light trucks
LFA	Logical framework analysis: Exercise undertaken early in project design to identify problems/barriers and corresponding outcomes and outputs that are targeted by the project.
LNG	Liquefied natural gas: natural gas that has been converted to liquid for ease of use or transport
LPG	Liquefied petroleum gas: consists of propane and/or butane
m^3	Cubic meters
M&E	Monitoring and evaluation
MEA	Membrane electrode assembly: Key part of fuel cell stack (or engine), accounting for almost half of fuel cell stack costs.
µg	Microgram: one millionth of a gram
MIIT	Ministry of Industry and Information Technology
MOE	Ministry of Environment
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
NEV	New energy vehicle: In China, includes all types of hybrid electric and fully electric vehicles as well as fuel cell vehicles.
NEVIDP	New Energy Vehicle Industry Development Plan (2012 – 2020), issued by China's State Council
NPD	National Project Director
OECD	Organization of Economic Cooperation and Development
OEM	Original equipment manufacturer: In the context of this document, refers to vehicle manufacturers (as opposed to component manufacturers)
O&M	Operations and maintenance
PEMFC	Proton exchange membrane fuel cell
PHEV	Plug-in hybrid electric vehicle
PIMS	Project Information Management System: a system of UNDP
PM	Project Manager
PM 2.5	Particulate matter 2.5: fine particles in ambient air of 2.5 µm or less (2.5 millionths of a meter or less); considered a component of air pollution that is particularly harmful to human health
PMO	Project Management Office
PPR	Project Progress Report
PSC	Project Steering Committee
P-to-G	Power to gas: For example, can refer to provision of hydrogen via wind-power based electrolysis.
PV	Photovoltaic
QPR	Quarterly progress report
R&D	Research and development
RCU	Regional Coordinating Unit
RE	Renewable energy
RFP	Request for proposals
RMB	Renminbi: China's currency
SAIC	Shanghai Automotive Industry Corporation
SBAA	Standard Basic Assistance Agreement: UNDP term for a standardized type of agreement it has with certain countries.
TOR	Terms of Reference
UAC	Unit Abatement Cost: the cost per unit mass of abating a certain type of GHG
UNDP	United Nations Development Programme

UNDP CO	United Nations Development Program Country Office
UNDP EEG	United Nations Development Program Energy and Environment Group
UNDP RCU	United Nations Development Program Regional Coordination Unit
UNFCCC	United Nations Framework Convention on Climate Change
USD	US dollar: the currency of the United States of America
WB	World Bank
WHO	World Health Organization

1. Situation Analysis

1.1. Context and Global Significance

Energy, Emissions, Air Quality, and China's Transport Sector

1. China is the world's largest consumer and producer of energy, as well as its largest emitter of greenhouse gas emissions.[2] In the case of carbon dioxide emissions from the energy sector, China's emissions substantially surpass those of the US (the second largest emitter) and have been estimated to do so by 60 percent (2012).[3] (See Exhibit 1-1 for data.) Rapid industrialization and urbanization, as well as increasing economic wealth amongst the population since the 1990s, have resulted in rapidly increasing demand for energy. Demand increases have been particularly notable in the case of coal, as a relatively cheap fuel for electricity, and the case of petroleum, for both private and public transport.

Exhibit 1-1: China's Global Rank in Energy Consumption/Production and CO_2 Emissions[4]

China's Current Rank Among Nations		Annual Amounts: Energy in quadrillion BTU; CO_2 in billion metric tons					
		Country	2008	2009	2010	2011	2012
Primary Energy Consumption	#1	China	78	85	94	103	110
		US (#2)	99	94	98	97	95
Primary Energy Production	#1	China	72	77	84	90	95
		US (#2)	73	72	74	77	79
CO_2 Emissions from Energy	#1	China	6.17	6.82	7.44	8.13	8.55
		US (#2)	5.84	5.43	5.63	5.48	5.27

Exhibit 1-2: Air Pollution Data, 2013: Chinese Cities Ranked by PM 2.5 Level in µg per m^3
Numbers are annual averages; national standard for annual average is <35 µg per m3[5]

City	PM 2.5 (Average)	City	PM 2.5 (Average)	City	PM 2.5 (Average)	City	PM 2.5 (Average)
Xingtai	155.2	Beijing	90.1	Xuzhou	74.9	Suzhou	67.1
Shijiazhuang	148.5	Wuhan	88.7	Taiyuan	74.2	Yancheng	67.0
Baoding	127.9	Chengdu	86.3	Huzhou	73.5	Jiaxing	66.9
Handan	127.8	Urumqi	85.2	Shenyang	72.7	Quzhou	66.5
Hengshui	120.6	Hefei	84.9	Zhenjiang	71.6	Shaoxing	66.4
Tangshan	114.2	Taizhou	80.9	Yangzhou	71.1	Hangzhou	66.1
Jinan	114.0	Huai'an	80.8	Suqian	70.7	Qinhuangdao	65.2
Langfang	113.8	Changsha	79.1	Nantong	70.2	Chongqing	63.9
Xi'an	104.2	Wuxi	75.8	Changchun	69.2	Xining	63.2
Zhengzhou	102.4	Harbin	75.7	Nanchang	69.1	Qingdao	61.7
Tianjin	95.6	Changzhou	75.6	Jinhua	69.0	Shanghai	60.7
Cangzhou	93.6	Nanjing	75.3	Lianyungang	68.0	Hohhot	59.1

2. With growing energy consumption, the major urban centers of the country have suffered from severe air pollution. The driving force behind this urban smog in major cities is increasingly recognized to be shifting from industry to transport, as factories are moved out of urban areas,

[2] The International Energy Agency (IEA) has indicated China surpassed the US as the world's top consumer of energy in 2009. Data from the US Energy Information Administration (EIA) indicate China took that lead position in primary energy consumption in 2011 and that China surpassed the US in 2009 as the world's largest producer of primary energy. Analysis of some experts suggests that, since 2006 or 2007, China has been the world's largest emitter of GHGs. In 2010, China acknowledged its role as the world's largest emitter of GHGs.

[3] Based on EIA statistics, carbon dioxide emissions from China's energy sector in 2012 were 8.55 billion metric tons and that from the US's energy sector were 5.27 billion metric tons. Other sources suggest similar numbers.

[4] Source: EIA statistics

[5] Source: Greenpeace analysis of MoE data for 74 cities (2014).

though indoor heating for buildings is also a major contributing factor in North China. According to analysis of data from China's Ministry of Environmental Protection, PM 2.5 (small particulates considered an important indicator in terms of health impacts of air pollution) levels in many cities far exceed the standard of 35 μg per m^3 set by the GoC in 2012 (see Exhibit 1-2).[6] Reflecting the severity of the situation, in 2014, Chinese Premier Li Keqiang stated that China will "declare a war on air pollution." Among the key targets in this "war" is managing vehicle emissions.

3. China's transport sector plays a significant and growing role in China's overall energy use. Experts indicate that the transport sector now accounts for 10 to 15 percent of China's final energy consumption.[7] They expect that share to rise to 30 percent as urbanization levels stabilize. Indeed, comparisons to transport's share in the energy consumption mix of developed countries, such as the US (almost 40 percent) and Japan (around 25 percent), suggest an increasing role for transport in China's growing energy consumption.

4. China is the second-largest consumer of oil in the world after the US and, as of 2014, became the world's largest oil importer.[8] Exhibit 1-3 below provides data on China's oil consumption, production, and net imports. Net imports grew at a compound annual growth rate of about 10 percent between 2009 and 2013. About 60 percent of China's oil consumption was used in the transport sector, which over time has been accounting for a growing share of overall oil use, while industry's share has been diminishing. Increasing oil imports have raised GoC concerns about energy security. These concerns, along with air quality and GHG emissions issues, have stimulated great interest in alternative energy vehicles.

Exhibit 1-3: China's Daily Oil Consumption, Production, and Imports, million barrels[9]

Item	2009	2010	2011	2012	2013
Consumption	8.07	8.93	9.50	9.98	10.30
Production	4.07	4.36	4.35	4.37	4.46
Net imports	4.00	4.58	5.16	5.61	5.84
Growth	Net imports compound annual growth rate (2009-2013): 10% Consumption compound annual growth rate (2009-2013): 6%				
Rank	Consumption: 2nd after the US, which consumed 18.9 million barrels per day in 2013 Imports: 2nd after the US, but expected to rank 1st once 2014 data is in				

5. Indeed, forecasts indicate China's oil consumption along with its dependency on oil imports will grow substantially over the next 20 years. According to one forecast, energy consumed for transport in China will almost double between 2015 and 2035. Along with it, oil imports will grow from roughly 6 million barrels per day in 2013 to 13 million barrels per day in 2035. If this occurs, China will at that time depend on imports for 75 percent of its oil consumption, as compared to 60 percent in 2013.[10] It is clear that the transport sector is a major driver of these trends. MIIT has indicated that new vehicle sales account for 70 percent of growth in China's annual gasoline and diesel consumption.[11]

6. Comparisons of China's motor vehicle fleet size (total number and type of motor vehicles on the road) to that of other countries is difficult due to differences in categorization. Yet, China's fleet

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[6] The standard is currently applicable in some major cities, such as Beijing, and will be applied across all cities in 2016.
[7] Hailin Wang, Xi Yang, and Xunmin Ou, "A Study on Future Energy Consumption and Carbon Emissions of China's Transportation Sector," in *Low Carbon Economy*, 2014.
[8] Source: EIA.
[9] Source: EIA International Energy Statistics
[10] British Petroleum, *BP Energy Outlook 2035 – Country Insights: China* (2015)
[11] State Council Development Research Information Network, 2013, as quoted in Sabrina Howell et al "Leapfrogging or Stalling Out," 2014, Faculty Research Paper Harvard JFK School of Government.

appears to be second only to the US in size and is growing rapidly. According to the Ministry of Public Security, in 2013 China had 154 million registered autos and a total of about 260 million registered vehicles, including 3-wheelers, motorcycles, buses, and large trucks. For comparison, according to the US Department of Transportation, there were about 254 million registered vehicles in the US in 2012, including about 233 million autos or light duty trucks. Rapid growth in China's auto market has launched the nation to the top spot in annual auto sales, for which it first surpassed the US in 2009. Sales growth has been rapid, with an 18.1 percent compound annual growth rate (CAGR) between 2005 and 2012. While this is expected to slow during 2012 to 2020, with some slowing already apparent, growth will still be substantial (e.g. 6 percent) out to 2020.[12] Exhibit 1-4 provides data on annual auto sales in China.

Exhibit 1-4: China's Annual Sales of Light Vehicles (millions of units)[13]

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 (e)
5.9	7.1	8.3	8.9	13.3	17.3	18.0	19.3	22	23.5	31.0
Growth	2005-2012 CAGR: 18% 2012-2020 forecast CAGR: 6%									

Alternative Energy Vehicles

7. The issues cited above, namely energy security, urban air pollution, and global warming, along with an interest in developing high value-add industry, has led the GoC to promote new energy vehicles (hybrid, plug-in hybrid, battery electric, and fuel cell vehicles) and other clean energy vehicles (namely, CNG, LNG, and LPG vehicles). In terms of developing a high value-add industry, the rationale is that NEVs are an area in which Chinese manufacturers have the potential to rise to prominence, as compared to internal combustion vehicles, in which it is hard to compete with entrenched global players. China began concerted R&D and demonstration work on new energy vehicles (NEVs) in the 1990s. In 2009, MOF and MOST launched a new demonstration and promotion program known as *Thousands of Vehicles Tens of Cities* ("Cities Program") to promote NEVs on a larger scale. The program focuses on demonstration via public sector vehicles such as buses, taxis, and postal and sanitation vehicles. MOF and MOST began the program with 13 Tier I cities. In 2010, MIIT and NDRC joined the effort, adding seven Tier II cities and 5 Tier III cities for a total of 25 cities.[14] In 2010, these 25 cities accounted for 18 percent of China's population and 33 percent of its vehicle stock.[15] In 2013, the group of 25 cities was expanded to include 40 "promotion regions", including a total of 86 cities.

8. As a result of the *Cities Program* and incentives for NEV promotion, a significant number of NEVs are in operation on China's roads, though numbers are far below government targets. The total number of NEVs on the road in China is estimated to be 160,000 (as of end of the first half of 2014), with an annual growth rate in sales of around 100 percent (see Exhibit 1-5 for cumulative total on an annual basis). China targets to have five million NEVs on the road by 2020. Data shows China lagging in NEV auto sales to countries such as the US and Japan, though China leads the world in new NEV buses being deployed annually. China's numbers of electric buses are ramping up rapidly.[16] This phenomenon (relatively fast penetration of EVs in public buses, low penetration in consumer auto purchases) reflects the government-driven nature to date

[12] Accenture, *China's Automotive Market*, 2013.
[13] Op. cit., Accenture; Bloomberg.
[14] In China, Tier I cities are the largest, most densely populated, such as Shanghai, Beijing, Guangzhou, Shenzhen, and Tianjin. Tier II cities are generally made up of provincial capitals and similarly developed cities, where incomes are somewhat lower than in Tier I cities. Tier III cities generally have a lower administrative rank than Tier II cities, are smaller, and have yet lower incomes.
[15] Huiming Gong, Michael Q. Wang, and Hewu Wang, "New Energy Vehicles in China: Policies, Demonstrations and Progress," in *Mitigation and Adaptation Strategy and Global Change*, Jan. 2012.
[16] *South China Morning Post* on July 15, 2014 offered the following comparative data for NEV auto sales for 2013: US: 110,000, Japan: 50,000, and China: 17,600.

of China's NEV program. Data on China's production of NEVs in China through end of the first half of 2014 is given in Exhibit 1-6. The data shows an initial surge of hybrid vehicles, apparently now shifting (along with subsidies) to greater emphasis on PHEVs and BEVs. FCVs, with a total of only 96 manufactured in China between 2009 and the first half of 2014, clearly are not taking off in the way that other NEVs are. Instead, the vast majority of NEVs on the road in China are some form of electric vehicle.

Exhibit 1-5: Cumulative Total of New Energy Vehicles on the Road in China[17]

End of 2010	End of 2011	End of 2012	End of 2013	June 30, 2014
16,000	30,000	58,000	110,000	160,000

Exhibit 1-6: China's Production of New Energy Vehicles (2009 – 1st Half 2014)[18]

Type of Vehicle	2009	2010	2011	2012	2013	1st half 2014	Total
HEV bus	1,515	2,676	4,305	6,372	4,793	856	20,517
HEV car	539	2,293	1,972	8,377	7,929	3,857	24,967
PHEV bus	70	280	197	277	4,736	3,513	9,073
PHEV car	37	345	289	262	718	3,935	5,586
BEV bus	78	655	1,360	1,904	1,607	2,200	7,804
BEV car	37	1,141	4,759	9,699	14,478	9,993	40,107
BEV special car	60	167	588	1,869	2,036	238	4,958
FCV bus	0	6	0	0	0	0	6
FCV car	0	90	0	0	0	0	90
Total	**2,336**	**7,653**	**13,470**	**28,760**	**36,297**	**24,592**	**113,108**

9. A number of policy incentives and requirements in China bode well for the future expansion of NEVs in the country. At the national level, key among these are: subsidies for NEV purchase, waiving of tax for vehicle purchase in the case of NEVs, and requirement that a minimum portion of government vehicle purchases are NEVs. Subsidies apply only to domestically manufactured NEVs. At present, national subsidies for NEV autos are available for PHEVs, EVs, and FCVs at levels of 35,000 RMB, 60,000 RMB, and 200,000 RMB, respectively. As for the vehicle purchase tax, it is ten percent across all vehicles. As of September 2014 and through end of 2017, it will be waived for all NEV purchases. As for the procurement mandate, it requires that 30 percent of all vehicles purchased by national-level government entities be NEVs by end of 2016. After 2016, provincial governments will also be required to meet this target. In addition to the foregoing, some local governments have additional incentive policies. Some are providing additional subsidies for vehicle purchase on top of the national subsidy. And some governments are also providing incentives specific to the car purchase situation in their cities. Shanghai, for example, is providing free license plates for NEV buyers, so that they can avoid Shanghai's public auction plates, which add a cost to buyers ranging from USD 10,000 to USD 15,000. Beijing is allowing NEV owners to bypass the vehicle purchase lottery. Normally, Beijing residents wishing to purchase a small vehicle with less than five seats must participate in a monthly online lottery to purchase a vehicle and, as such, may face a very long wait.

Fuel Cell Vehicles

10. China, which conducted its first research on fuel cells in the 1950s, considers transportation to be the most important initial market for fuel cells. Over half of the fuel cell technology being used in the country is based on proton exchange membrane fuel cell (PEMFC), which is the most prominent FC technology for transportation applications worldwide. The bulk of fuel cell vehicle

[17] Tsinghua University *New Energy Vehicle Database*

[18] Tsinghua University *New Energy Vehicles Database*. Note: Gap between Exhibit 1-5 and 1-6 totals consists of net imports.

initiatives in China to date have been through the government and have ranged from R&D work (under the broader NEV R&D umbrella) to, more recently, field tests. Now, longer term demonstrations are targeted under the aforementioned *Cities Program* for NEVs.

11. To date, China's efforts in showcasing and testing FCVs have been on a non-continuous basis, driven by either events or a short-term testing approach. Of particular note, during the Beijing Olympics in 2008, three fuel cell buses and 20 fuel cell cars were demonstrated. Also noteworthy, during the six-month long Shanghai Expo in 2010, 196 FCVs were demonstrated, constituting the largest field trial of fuel cell vehicles in the world to date.[19] In addition, a previous GEF funded project in China, *Demonstration for Fuel-Cell Bus Commercialization in China* (*Phase I and Phase II*), sought to showcase the application of fuel cell bus technology in the public bus transport systems of Beijing and Shanghai.[20] Important lessons learned from this earlier project, particularly on the logistical and administrative requirements of the implementation of the demonstrations, are taken into account in design of the current project and discussed later in this document. While long-term use of the prior project's vehicles as intended was not achieved, field testing, including the aforementioned achievements at the Olympics and the Expo, was conducted and expanded the knowledge and experience base of Chinese experts and institutions working in the fuel cell vehicle field.

12. At present, a handful of Chinese manufacturers are gearing up to participate with fuel cell vehicles in opportunities presented by the *Cities Program*. Manufacturers with notable FCV programs include SAIC, Yutong, and Foton. Others are exploring launching such programs to serve interested customers (municipalities considering purchase of fuel cell buses). In some cases, manufacturers are supported by expert teams in academia. In particular, Tsinghua University and Tongji University are known for their work in fuel cell vehicles and ability to assist manufactures with the needed power train.

13. Given the track record of past efforts, FCV cost and durability issues, and the very limited number of FCVs manufactured to date in China, the general motivation behind this project warrants further explanation. Reviews of the previous GEF-funded project emphasize the technology's lack of maturity as a barrier to that project's success. Yet, a major change from the previous project is that, since that time, international advancement in fuel cell vehicles has reached a turning point providing strong motivation for this project. International efforts in setting up hydrogen refueling infrastructure have correspondingly begun to ramp up. Fuel cell autos for the first time in history have been released on a limited commercial basis, including Hyundai's Tucson in 2013, Toyota's Mirai in December 2014, and Honda's FCV, expected in 2015. In addition, Toyota in January 2015 announced it will make over 5,600 patents available through 2020 to interested car and part makers. Non-OEM manufacturers of fuel cell engines, such as Ballard and Hydrogenics, have also released high durability, commercial-grade products. Other countries, such as Japan, the US, Germany, and South Korea have launched ambitious fuel cell vehicle development programs and made marked progress in initiating ramp up of hydrogen infrastructure. Exhibit 1-7 below shows number of hydrogen refueling stations reported as already operational, as well as future targets, for these countries.

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[19] The 196 FCVs included 9 FC buses, 90 FC cars, and 100 FC sight-seeing trolleys. The trolleys transported visitors within the Expo. The 9 buses and 50 cars were used to transport visitors in and around the Expo grounds. The 40 other FC cars were demonstrated in Shanghai Automotive City, located in the Shanghai's Jiading District. Source: Pan Xiangmin et al, "Design and Operation of Hydrogen Supply Chain for Fuel Cell Vehicles in Shanghai Expo 2010," paper for *EVS25 World Battery, Hybrid, and Fuel Cell Electric Vehicle Symposium*, Nov. 2010, Shenzhen, China.

[20] This earlier "proof-of-concept" project has been regarded as not successful in view of the very limited direct GHG emission reductions generated and of the limited outcomes achieved. The evaluation pointed out that the FCB technology promoted by the project was not locally accepted as safe and useful, sustaining did not take place, and the project did not really lead to mainstreaming due to the technology's lack of maturity.

Exhibit 1-7: Hydrogen Refueling Stations Operational and Targeted, by Country[21]

Item	US	Japan	Germany	South Korea	China
Operational	62 as of April 2014	31 as of May 2014	15 as of May 2014	13 as of April 2014	2 as of Dec. 2014
Targeted	*California*: 51 by 2016 100 by 2021	100 by 2015 1,000 by 2025	50 by 2015 100 by 2017 400 by 2023	43 by 2015 168 by 2020	NA

14. Pursuit of FCV commercialization for China in this project is also motivated by the potential benefits of pursuing a diversified NEV strategy. As it is unclear what future technology developments will bring, China is interested in diversifying its risk and potential benefit by pursuing both EVs and FCVs; and this project will be a key link in such a diversification strategy. Looking at potential progress in cost reduction, the *IPCC Mitigation Report* has pointed out that by 2030, EVs will still be relatively costly without major breakthroughs. EVs have come a long way down the cost reduction learning curve. They are being sold in volume and have been for several years. While there will likely be some improvements in battery cost, there is much less room for reduction in EV costs than is the case with the costs of FCVs, which to date have only been developed in prototype quantities. In addition, FC stack costs include many immature components, such as MEA and catalyst. There is also a lot of room for cost improvements with these.

15. Indeed, credible studies have determined that the long-term high-volume cost of fuel cell vehicles will be lower than that of battery electric vehicles.[22] Further reduction in battery cost is limited by physics/chemistry and the fact that batteries are already manufactured in high volumes (commercial batteries for computers, etc.). Elon Musk's Giga-scale factory will reduce costs via economies of scale, but this reduction is not expected to surpass 20 percent. There have been several reports of major technological breakthroughs in batteries (via different chemistry) by universities, but none have been substantiated in commercial applications. In contrast, FCVs have the potential for cost reduction via: (1) technological advancements without the need for breakthroughs (because they are a less mature technology), (2) high volume manufacturing (i.e. economies of scale), and (3) development of a supply landscape. Economies of scale alone are expected to reduce cost/kW of the fuel cell stack by a factor of five or more.

16. Diversification that includes concerted efforts in both EVs and FCVs makes sense for China for additional reasons. EVs and FCVs have different strengths and weaknesses to consider. While FCVs present the current challenge of hydrogen availability, they also present several advantages over EVs. The first of these is range. Projected range of FCV buses (between refueling events) is in the 250 km range, as compared to the 100 km-plus range for EV buses. In addition, recharging of EVs can be a slow process, as compared to hydrogen refueling, which can occur quickly, just like gasoline refueling. For a busy bus to stop midday for a long recharging session can be problematic to operations.

17. Another issue with EVs is that of the battery wearing out. Particularly in the case of EV buses, where driving patterns mean that the battery will be drawn down to a relatively low level between recharging events, the lifetime of the battery may be much less than that of the vehicle. FC buses of the series hybrid type (which run off a battery recharged by the fuel cell rather than directly off the fuel cell) do have a battery, but it is never drawn down much, so battery replacement will not

[21] Pan Xiangmin, Professor at Tongji University, "Development of Hydrogen Refueling Stations," presentation at *FC Expo China*, Sept. 2014

[22] For example: (1) Kromer/Heywood: "A Comparative Assessment of Electric Propulsion Systems in the 2030 US LD vehicle fleet," in SAE 2008-01-0459 and "Mass Production Cost Estimation of Direct H2 PEM Fuel Cell Systems for Transportation Applications: 2013 Update. Strategic Analysis," January 2014 for DoE/Fuel Cell Technologies Office.

be an issue during vehicle lifetime. Indeed, there is not yet any experience with the long-term life of full battery electric vehicles, as they haven't been out long enough. There is, however, plenty of experience with fuel cell buses, which confirm lifetimes over 10,000 hours and over 4 years of age (e.g. Whistler buses). These buses were fuel-cell dominant buses, which put more load and variability on the fuel cell than do series hybrid fuel cell buses, which can thus be expected to achieve further increases in fuel cell life.

18. Lastly, in the case of China, the vast majority of EV recharging uses electricity made from coal and thus is "high carbon." In contrast, the majority of hydrogen that will be used in the near-term for FCVs in China is likely to be by-product hydrogen and hydrogen produced from natural gas reforming. FCVs powered by a mix of these types of hydrogen have substantially smaller carbon footprints than EVs powered by coal-based electricity from the grid.

19. A further area of motivation for this project is the opportunity to leverage China's comparative advantages in combination with international advancements in fuel cell technology to drive the FCV industry further towards commercialization both in China and abroad. First, China, with the largest bus market and bus production capacity in the world, has great strengths in bus manufacturing generally. Its bus manufacturers have also developed strengths in EV buses. Thus, there is an opportunity to bring in international advanced fuel cell stack technology and integrate it with Chinese EV bus technology in series hybrid fuel cell buses.[23] Secondly, China is known for its manufacturing prowess and ability to reduce production costs. This may be of benefit to the fuel cell industry both in China and internationally if the cost of certain components of fuel cell vehicles can be reduced through China-based production.

FCV and Hydrogen Value Chains in China

20. Beyond the situation of China's FCV manufacturers (or potential FCV manufacturers), which has been touched on above, another important aspect of the context for this project is the current situation in China with regard to the FCV and hydrogen value chains. For the FCV value chain, the foremost issue is FCV components. For the hydrogen value chain, key issues are hydrogen production, hydrogen refueling stations, and equipment and parts for hydrogen refueling stations. The current situation of each of these areas is discussed briefly below.

21. **FCV Components**: China has domestic manufacturers of a number of key FCV components. Generally, however, there are not very many of these manufacturers in each key component area (often just one per area) and technological levels are usually substantially below global best levels. Exhibit 1-8 shows a rough cost break down of the FC system, of the FC Stack (a major component of the FC system), and the MEA (a major component of the FC Stack). Exhibit 1-9 incorporates the components of the stack and MEA into the overall FC system cost structure, so that it is more clear which items are major contributors. Finally, Exhibit 1-10 shows the status and availability of some key components from domestic manufacturers.

[23] Series hybrid fuel cell buses have both a battery and a fuel cell. The bus runs off of the battery, which is recharged by the fuel cell and requires no external recharging. This reduces the load on the fuel cell, so that the wattage of the fuel cell can be lower than in an FCB with no battery. This approach also reduces variability on the fuel cell, which should extend its lifetime.

Exhibit 1 -8: Cost Structure of FC System, FC Stack, and MEA

FC System Cost structure		FC Stack Cost Structure (FC stack is one part of FC system)		MEA Cost Structure (MEA is one part of FC stack)	
Stack	49%	MEA	47%	Catalyst	44%
Hydrogen Tank	17%	Metallic bipolar plate	42%	Membrane	31%
H2 Supply System Int†	12%	End plate	4%	Carbon paper	17%
Air Compressor	12%	Auxiliary for stack	3%	Subsidiary materials	8%
Humidifier	3%	Auxiliary for module	2%	Total	100%
Injector	1%	Manifold	1%		
Others	6%	Current collector plate	1%		
Total	100%	Total	100%		

†Hydrogen Supply System Integration

Exhibit 1-9: Overall Cost Structure of FC System, incorporating Stack and MEA Components

Component of FC system	Share in Total Cost
Metallic bipolar plates (part of stack)	21%
Hydrogen Tank	17%
Hydrogen Supply System Integration	12%
Air Compressor	12%
Catalyst (part of stack's MEA)	10%
Membrane (part of stack's MEA)	7%
Carbon paper (part of stack's MEA)	4%
Humidifier	3%
End Plate (part of stack)	2%
Injector	1%
Auxiliary for stack (part of stack)	1%
Auxiliary for module (part of stack)	1%
Manifold (part of stack)	0.5%
Current Collector Plate (part of stack)	0.5%
Others	6%
Subsidiary materials (part of stack's MEA)	2%
Total	100%

Exhibit 1-10: Availability/Status of Key FCV Components in China

Component	Status in China	Component	Status in China
Fuel Cell Stack	One or two manufacturers; below global best levels, but usable in China's FCVs: need to increase durability	HV DC-DC converter	One manufacturer in China: not up to international best levels
MEA	One or two manufacturers; below global best levels, but usable in China's FCVs: high discard rate	Air compressor for FCV	One manufacturer in China; below international best levels, but less expensive: need to improve quality control and technology
Bipolar plates	Handful of manufacturers; below global levels, but usable in China's FCVs: need to reduce thickness and corrosion	Catalyst	One potential manufacturer in China, but currently must be imported: need to improve testing and processing
Hydrogen tank	A number of manufacturers; up to international levels	Membrane	One manufacturer in China: may be up to international levels, but needs to improve durability, etc.
Hydrogen recirculation pump	No manufacturers in China		

22. **Hydrogen refueling stations**: China currently has two operating hydrogen refueling stations. One is located in Shanghai in Jiading District and is servicing a handful of SAIC FC autos at present. The other is in Northwest Beijing and is available for FC vehicles when they are tested. These two stations provide hydrogen only and no other fuels at present. During the Shanghai Expo, there was a second hydrogen refueling station (HRS) in Shanghai, but it was closed down after the Expo. There also previously was a station in Shenzhen that is no longer being used. One of the major challenges for setting up new HRSs in China is the scarcity and high cost of land in city centers. The GoC, however, is currently offering a subsidy of 4 million RMB for new HRSs that meet the minimum capacity requirement of being able to deliver 200 kg of hydrogen per day. Some localities are planning to provide additional subsidies to supplement the national one.

23. The equipment supply chain in China for hydrogen refueling stations is understandably in its infant stage. There is at least one Chinese company that can provide hydrogen refueling dispensers. Compressors at the two operational stations are imported, though the Shenzhen Station, when operational, used a domestic-made compressor from a company based in Beijing. It is believed the domestic compressor product is substantially behind international best levels in durability. Other key parts, such as key valves, pipes for hydrogen, and hydrogenation spears must be imported at high cost as no acceptable product exists in China.

24. **Hydrogen production**: Hydrogen production in certain areas of China, such as Shanghai, is considered to be at world class levels, with prices that are reasonable by world standards (e.g. US8/kg in Beijing). Locations with less industrial activity, however, face a challenge in procuring hydrogen and may need to pay significantly higher prices. Industrial by-product hydrogen is one of the most common forms of hydrogen that is becoming available on the commercial market in China. It has a very limited carbon footprint, making it an attractive transitional form of hydrogen for FCVs. Other methods of hydrogen production include natural gas reforming. When such hydrogen is used in FCVs, it has a similar carbon footprint to natural gas vehicles. Hydrogen is also available by electrolysis (use of electricity to make hydrogen and oxygen from water). If coal powered electricity is used to power electrolysis, the footprint is quite carbon heavy. While the majority of China's electricity is coal-powered, electrolysis presents the opportunity to use excess wind power or solar panels to generate hydrogen whose only carbon footprint is its transport to the refueling station. At present, however, there is no large-scale wind or solar based hydrogen production in China. China manufactures large-scale water electrolysis units, which can perform the electrolysis function. The quality is considered good and the price reasonable, with Chinese-made water electrolysis devices being exported to other countries, as well as being sold domestically. An alternative form of renewable energy based hydrogen production would be steam reforming of the natural gas from biogas or landfill methane. This method has not been used on a substantial scale in China to date, though there have been some small-scale experiments.

FCV and Hydrogen Value Chain Safety Issues

25. Among those in the general public familiar with the concept of FCVs or "hydrogen vehicles," many have the impression that the safety risk posed by hydrogen vehicles and hydrogen infrastructure is much greater than that of other types of vehicles and their associated infrastructure. While safety issues are acknowledged and deserve careful attention, there is in a sense also a certain level of myth with regard to hydrogen safety issues. First, hydrogen has some substantial advantages that limit the impact of any incident: It is so light that, upon leakage, it immediately evaporates upwards and disappears. It is also non-poisonous, so that there is no contamination or health impact to affected people or environment (except fire/explosion). Finally, because hydrogen is so light, any fire will be gone quickly (much faster than a gasoline/natural gas fire).

26. The only safety risks of hydrogen, then, are explosion (because it's stored under high pressure) and fire (if leaking hydrogen above a certain hydrogen to air concentration is ignited by a spark).

In the case of FCVs, international vehicle manufacturers producing such vehicles pay special attention to the design of components and the whole system architecture to avoid and mitigate these risks. Extensive testing is performed. There have been many tests (e.g. massive tank damage, shooting at tanks, etc.) that confirm the low impact of potential incidents. Further, the impact of a hydrogen fire is lower than that of a gasoline or natural gas fire: Spatially it will be very limited; and the fire will be out in short time. Comparative tests have been done to prove this. In case of an incident, only the directly involved people will be affected. Even bystanders at a certain distance won't be affected. Safety of FCVs is at least as good as for natural gas vehicles – and nobody is really concerned about the safety risk of natural gas vehicles these days. Much of the standards work for FCVs and their associated value chain is particularly targeted at safety aspects. As for hydrogen refueling stations, because of the pressure-tight connection of the hose with pump and vehicle, hydrogen leaks/spills are excluded by design. Should components fail, installed hydrogen sensors and the control system shut the system off immediately.

27. Exhibit 1-10 below summarizes the potential impact, probability of occurrence, type of incidents, and countermeasures taken with regard to FCV, HRS, hydrogen production, and hydrogen transport safety, respectively.

Exhibit 1-10: Hydrogen Safety Risks and Countermeasures

Topic	Impact	Probability	Potential Incidents	Countermeasures Taken
FCVs	minor	slight	Hydrogen leaks (due to part failure or rupture due to impact) could lead to fire or explosion.	vehicle and component design (special hoses, valves, position of tank in vehicle), hydrogen sensors, shutoff-valves
hydrogen refueling station	minor	slight	Hydrogen leaks (due to part failure or misuse) could lead to fire or explosion.	station design, safety/shutoff mechanisms, control of station, and location of pump and equipment
hydrogen production	negligible	slight	Hydrogen leaks (due to part failure) could lead to fire or explosion.	design, shutoff mechanisms, and operator training
hydrogen transport	minor	slight	Hydrogen leak at tanker truck (due to part failure or accident) could lead to fire or explosion.	tanker and component design, safety/shutoff mechanisms, and operator training

28. During its early days, the California Fuel Cell Partnership did a great deal of work on safety and developed full sets of standards for fuel storage, fueling stations, etc. It even simulated the total release of a vehicle's hydrogen in a partially enclosed space (a parking garage) and a partial release in a completely enclosed space (a residential garage). Both incidents were easily contained, and were certainly no worse than a gasoline fire would have been.

29. Also, there has been a real life failure on a very large hydrogen storage tank at Ballard that has been thoroughly studied and used as an example. A fitting failed during a fill exercise and a very large plume of hydrogen ignited and burned for some time. This caused a lot of excitement, but no damage. The leak and fire were put out by turning off a valve. This is an example of a massive leak. Although it was certainly dangerous, there was not much damage.

1.2. Barrier Analysis

30. Barriers to the commercialization of FCVs in China occur across a range of areas that need to be strategically addressed to facilitate marked progress. Key barriers include those related to: (1) FCV technology, (2) hydrogen infrastructure, (3) policy for FCVs and hydrogen infrastructure, (4) awareness of and information available to the public and national and local government

officials, and (5) human capacity in O&M of FCVs and HRSs, as well as in financing FCV related manufacturing and sales. Each of these areas is covered in turn below.

31. **FCV Technology Barriers:** FCV cost, durability, and performance are key barriers to FCV commercialization in China and, despite great progress, worldwide. Due to the high cost of FC stacks, FCVs are not cost competitive compared to internal combustion engine (ICE) vehicles. The price of a locally made FCB in China, for example, is currently around USD 640,000, which is about seven times the price of a conventional diesel bus with similar configuration and performance. One of the key cost issues is economies of scale, with the cost of fuel cell stacks to be reduced by a factor of 5 once significant production capacity is reached.

32. As for durability and performance, substantial progress has been made in these areas internationally and within China. Internationally, fuel cell vehicles are now being sold on a limited commercial basis. Yet, in China, durability (measured in lifetime hours of operation over a specified test cycle), which for a fuel cell bus is around 2,000 hours, lags substantially behind international levels, which have reached 10,000 hours.

33. Cost, durability, and performance barriers, are, in turn, related to barriers with regard to FCV and FC components and with regard to the technical capacity of China's FCV manufacturers. Chinese FCV manufacturers lack access in many cases to best quality, world class components; and the cost of components is also high. Most China-made FCV and FC components, when available, are below international best achievement in durability and performance. Yet, Chinese FCV manufacturers are in many cases unable to get access to the foreign components they wish due either to lock-up agreements component suppliers have with other vehicle manufacturers or to IPR concerns of such suppliers. Localizing production of these components in China presents the potential for addressing both access and cost barriers, but local component manufacturers lack the know-how and scale to achieve needed quality at cost-competitive prices. Finally, quality issues of Chinese FCVs are also related to the limited capacity of Chinese FCV manufacturers. At present, they have only very limited experience with FCVs. Further, most rely on outside know-how (from top research groups at universities) to develop their power train.

34. **Hydrogen Infrastructure Barriers**: Lack of hydrogen refueling stations is a key barrier to the commercialization of FCVs; and lack of low-cost, low-carbon hydrogen is also a barrier to realizing the environmental potential represented by FCVs. Potential buyers of FCVs, whether they be public transport companies, delivery companies, government organizations, or consumers, will understandably be hesitant to purchase FCVs without sufficient locales at which they can refuel. Currently, China has only two hydrogen refueling stations that are available to those who wish to refuel. One is in Shanghai; and one is in Beijing. Lack of hydrogen refueling stations and lack of customers for those stations (FCVs) together present a classic "chicken and egg" challenge to the commercialization of FCVs not only in China, but worldwide.

35. Lack of availability of low-cost, low-carbon hydrogen presents both a basic challenge to FCV commercialization (hydrogen cost) and to that commercialization occurring in a way that honors the intention of FCV promotion as a means of "greening" the transport sector (hydrogen production "carbon content"). At present, the cost of hydrogen is considered relatively high as a transport fuel (though its competitiveness depends on the price of gasoline, which fluctuates widely). This is true even of hydrogen that is not produced by renewable energy. (Hydrogen produced by renewable energy tends to have even higher production costs.) Prices in Beijing in Jan. 2015 for hydrogen produced by natural gas reforming were USD 8 per kg, similar to international levels. There is a lack of information about the specific requirements for hydrogen used as a transport fuel, though such information may reveal opportunities for cutting costs. Yet, there is also a lack of methodologies to reduce costs by producing vehicle-specific hydrogen. Further, while large cities, such as Shanghai, have good hydrogen availability and prices similar to that of the world market, other locales without locally produced hydrogen, such as Foshan, face much higher prices.

36. While the availability of by-product hydrogen in China is attractive transitionally due to its relatively small carbon footprint current, more radical reductions in carbon emissions will require a shift to renewable energy based hydrogen production. Hydrogen produced from electrolysis powered by China's electricity grid (in which coal-fired power plants predominate) is very high carbon. Natural gas reforming has a substantially lower carbon footprint than hydrogen from grid-based electrolysis, but renewable-energy based hydrogen production is what really presents the greatest potential for a "green" hydrogen source. Hydrogen produced from wind or solar-based electrolysis will essentially have no carbon footprint, aside from that generated in transporting the hydrogen from place of production to the hydrogen refueling station. Hydrogen produced from biogas/landfill methane will also have quite a small carbon footprint. Yet, China has no experience with producing hydrogen from renewable energy on a substantial scale. Further, while recent progress in this area has been made internationally, there is a lack of knowledge of these international developments in China.

37. Significant barriers to the development of hydrogen refueling stations in China also exist. Key HRS issues include reliability of stations, financial viability of stations, and high costs of equipment and land to set up such stations. There is a lack of experience in the design and business models for such stations; and lack of knowledge of latest international developments in these areas. Given the situation of low numbers of FCVs on the road, a key challenge (despite the significant subsidy of US 640,000 per station) lies in developing a business model to make these stations economically viable in China. While some ideas have been proposed, such as addition of hydrogen refueling to existing gasoline stations or development of multi-fuel stations with options of hydrogen, CNG, LPG, etc., none have moved past the initial concept stage. Costs of imported equipment, such as compressors, high quality valves, hydrogenation spears, and hydrogen piping, keep overall costs of these stations high. Yet, at the same time, domestic counterpart products have not achieved the quality needed to ensure the reliability and safety desired. Further, there is a lack of data on Chinese operation of such stations from which to gather lessons learned to improve.

38. **Policy Barriers**: The pertinent support policy and regulatory frameworks for FCVs and hydrogen refueling stations in China are inadequate. The Government's rather unclear and vacillating policy signals to date have made it difficult for the local FCV industry and market to develop. Areas in which policy and regulatory frameworks are lacking include: development roadmap, standards and certification, approval processes (and knowledge level of relevant authorities), and incentive policies. While China has developed clear plans and targets for other areas requiring technology development and demonstration roll-out (notably EVs), for FCVs and hydrogen refueling stations, there is no such official plan. This impedes progress and reduces the confidence of localities and potential investors in pursuing FCV development.

39. As for standards and certification, while a significant standards base for both FCVs and hydrogen refueling stations exists, there are gaps. There is further a need to ensure Chinese standards are harmonized with international standards. There is also a need to develop a certification system. The absence of a complete standards and certification system creates challenges in both national-level and local level approval of FCVs, as discussed below.

40. To date and in the previous GEF FC bus project, approval of FCVs at both the national and local levels has been a major barrier. In the previous GEF project, at one point, government officials, due to their safety concerns, allowed the FC buses to be tested only with sandbags and not with human passengers. Further, all of China's FCV demonstrations to date, whether for the Olympics, the Shanghai Expo, etc., have been short-term. Approvals for using these vehicles have been issued only on a basis limited in space and time. After demonstration, the vehicles sit unused, though their lifetimes have not expired. A valuable opportunity to collect test data is lost. At the national level, the barrier is lack of streamlined approval processes at relevant agencies. Approval issued by relevant national-level authorities to the manufacturer for a certain model allows the

manufacturer to produce the model for sale. Currently, only one model (an FCV auto produced by SAIC) has achieved such approval from relevant authorities. At the local level, operators of FCVs are required to get license plates for operation of each vehicle on public roads. This has also been a significant barrier in the past, with only temporary license plates issued. Local public security bureaus and transport management bureaus are key entities in this regard. Their staff often have safety concerns regarding FCVs.

41. Finally, while there are significant incentive subsidies for both FCVs and HRSs at present, a barrier to more substantial progress is the lack of robustness and completeness of the incentive system. For both FCVs and HRSs, there is a lack of government commitment to maintain current subsidy levels for a strategic amount of time. Further, at present, incentive policies are quite narrowly focused on subsidies. There is a lack of more innovative incentive policies, such as preferred parking spaces or preferred lane usage for FCV drivers.

42. **Awareness and Information Barriers**: A key barrier to broader adoption of FCVs is lack of awareness about FCVs and lack of information about them, as well as lack of substantial proof on the roads in China to stimulate this awareness and information provision. Much of the general public is unaware of FCVs. Those that have heard of them are not clear on key aspects of FCVs. Further, there is fear and lack of understanding among the public about hydrogen-related safety issues. Policy makers, managers, and experts also lack the awareness and information needed to give them the confidence to develop plans for the use of FCVs in their locales. They will continue to be hesitant to pursue FCV plans in the absence of solid results of FCVs on the road in China. Further, these groups lack information on the latest progress and results internationally with FCVs. Finally, there is lack of a good, reliable information source within China to inform experts and investors on the FCV market and technological developments.

43. **Barriers in O&M and Financial Sector Capacity**: Human capacity barriers in O&M of FCVs and HRSs and in financing of FCV related manufacturing facilities and FCV sales also inhibit commercialization of FCVs. In the prior GEF FC bus project in China, lack of FCV O&M capabilities was found to be a major problem. O&M services were provided for imported buses by the manufacturers for a certain period of time, but once this time period was over, no one remained on site who could perform the needed O&M function. HRSs may face a similar problem in that suppliers from out of town provide O&M for a certain time period, but sustainability via capacity building of local persons is lacking.

44. As for the financial sector, at present there is little knowledge within this sector about FCVs and lack of capacity to evaluate FCV related investment opportunities. Both banks and equity investors, such as venture capital and private equity firms, lack the needed capacity to evaluate opportunities to support FCV or FCV component manufacture. Similarly, these groups also lack the capacity to evaluate opportunities to support hydrogen refueling stations or related value chain initiatives. Lastly, there is also an absence of financial institution programs to support consumer purchase of FCVs, such as a dedicated loan facility.

1.3. Stakeholder Analysis

45. A wide range of stakeholders will be relevant to overcoming the aforementioned barriers and thus be involved in this project. The types of stakeholders will include: national-level government officials, local-level government officials and staff, vehicle manufacturers based in China, FCV and FC component manufacturers (both those based in China and those based abroad), HRS investors and operators, hydrogen producers and potential producers of renewable energy based hydrogen, experts (on the auto/vehicle industry, FCVs, and hydrogen), public transport companies, delivery companies, consumers/general public, and financial institutions. The role and relevance of each of the aforementioned stakeholder groups, as well as specific entities within those groups, are given below.

46. **National-level government officials**: National-level government officials will be critical in adopting policies and plans to promote FCVs and in ensuring the success of this project. For the project, key organizations include the Ministry of Science and Technology (MOST), the implementing partner for the project. MOST promotes R&D and development of new industries in China. As IP, MOST will handle communication and coordination with MOF and UNDP, liaison with local governments, project activity management, and project financial management. MIIT has more recently joined MOST and MOF as a key player in driving NEV demonstration. At the same time, its role in approving new FCV models will be critical to commercialization efforts. For this project, MIIT will provide assistance in the identification and design of replication demos for FCVs, HRSs, and hydrogen refueling. It will also interact with the project in developing streamlined approval procedures for new FCV models.

47. **Local-level government officials**: Local-level government officials will be instrumental in taking the lead from the National Government to promote actual adoption of FCVs at the local level, initially through demonstration and replication plans. For this project, key entities will be local level government organizations driving the project demos: (1) Beijing Science and Technology Commission, (2) Shanghai Science and Technology Commission, (3) Zhengzhou Bureau of Science and Technology, and (4) Development and Reform Commission of Guangdong Province, along with Nanhai District Development and Reform Bureau. For the project, these local entities will coordinate implementation of FCV and HRS demos and drive the process forward. They and their counterparts in other cities will be responsible for developing plans to replicate project demos. Many other local government organizations will be involved in the demos in each city. Other important entities at the local level will be public security bureaus and transportation management bureaus, who will play an important role in approving and issuing license plates for individual vehicles. Their further education regarding FCVs and safety methods will be critical to the approval and thus success of the demos.

48. **FCV and component manufacturers**: FCV and component manufacturers (and potential such manufacturers) will be major beneficiaries of the project and primary drivers of its progress. Due to the high subsidies for domestic-produced FCVs, involved FCV manufacturers will most likely be domestic-based manufacturers, whether fully Chinese-owned or joint ventures. Key FCV manufacturers likely to be involved include: SAIC, Foton, and Yutong. Yet, the project will reach out to all interested vehicle manufacturers. As for component manufacturers, it is likely that both overseas entities (such as Ballard, Hydrogenics, etc.) and domestic entities will be involved through supplying components to demo vehicles. Current or potential domestic component manufacturers may also become beneficiaries of project technical assistance.

49. **HRS investors and operators:** HRS investors and operators, via fuel availability and provision, are critical to the development of the FCV industry in China. For the project, these parties will play the critical roles of providing hydrogen to project demo FCVs and providing data and lessons learned on HRS operation. HRS investors may include city governments, state-owned companies, or private sector companies.

50. **Hydrogen producers and potential producers of renewable energy based hydrogen**: Availability of hydrogen at a low price will be critical to FCV commercialization; and availability of renewable energy based hydrogen will be important to realizing the "green" potential of FCVs. Existing hydrogen producers will play an important role in the project by providing hydrogen to demo HRSs. Further, potential producers of renewable energy based hydrogen, by setting up hydrogen production facilities, will play an important role in demonstrating this important aspect of the future hydrogen value chain for FCVs. These potential producers may include current wind farms with excess power (state-owned or private) as well as investors in land-fill methane based projects.

51. **Experts on the auto industry, FCVs, and hydrogen**: Currently, experts are playing a key role in the development of the FCV industry in China. Some of the nation's strongest capabilities for

FCV power train development exist in university automotive centers. For the project demos, experts and their institutions will play an important role in designing and carrying out monitoring efforts (and analysis of collected data). Key institutions in this regard include Tsinghua University and Tongji University. Other important institutions associated with experts include Society of Automotive Engineers of China, which is important in advising the government on policy and will play a policy promotion role in the project, and China Automotive Technology and Research Center, which will play a key role in housing the PMO, which will be responsible for coordinating implementation of all project activities.

52. **Public transport companies, delivery companies, and other institutional users of FCVs**: Institutional users of FCVs, particularly public transport companies and delivery companies, are also a key link in promoting the commercialization of FCVs. To date, public bus companies in China have adopted NEVs (mostly HEVs, PHEVs, and EVs) at a much higher rate within their overall purchases than other users. Further, given the visibility of public buses, the companies' adoption of FC buses will be important in building awareness of the technology. For the project, key public transport companies will be those in each of the four demo cities: Beijing Public Transportation Corporation, Shanghai Jiading Bus Company, Zhengzhou Public Transportation Company, and Nanhai Public Transportation Company. For the project, these organizations will have the role of ensuring selection of high visibility routes. They will also be responsible for ensuring smooth refueling and O&M of the buses. Their staff will thus need to master O&M practices. For replication of the demos, public transport entities in other cities will be similarly involved. Other companies of relevance to the project demonstrations include Shenzhou Taiyue, City 100, and Potevio, each of which will be responsible for ensuring high visibility routes, refueling, and O&M of their FC delivery vehicles. Another company of relevance to the demos will be the SAIC-invested car rental company that will operate a majority of the project's demo FCV autos.

53. **Consumers/general public**: Consumers represent the largest ultimate market for FCVs in China. The need to raise their awareness and understanding of FCVs is critical, as well as the need to inform them and alleviate their fears regarding hydrogen's safety issues. The project will engage consumers via its awareness raising activities, including opportunities to test drive FCV autos in Shanghai. Consumers will also play a critical role as they begin to purchase FCVs for personal use. (To date, there have been no consumer FCV purchases in China.)

54. **Financial Institutions**: Financial institutions will ultimately be important to the growth and expansion of the FCV industry. Eventually, they will be needed to finance FCV manufacturing expansion, manufacturing of components, manufacturing related to hydrogen production and hydrogen refueling, and establishment of HRSs. They will also be needed to stimulate consumer purchase of FCVs through special bank loan programs. At present, these institutions are not very aware of the FCV industry or the industry's potential. Key players that the project will need to build capacity in include banks and private equity/venture capital firms. The latter may fund some of the more risky investments in manufacturing and technology development, while the former may establish FCV loan programs and provide loans to manufacturers that is sees as relatively low risk.

55. **UNDP and GEF**: UNDP's and GEF's role in promoting FCVs in China has been ongoing since initiation of the FC Bus Project. For implementation of the current project, UNDP will provide ongoing guidance and backstopping for implementation. This will range from technical inputs and idea generation for achieving project targets to ensuring reporting and financial processes are in order. UNDP's role will be carried out by both the UNDP China Country Office as well as the UNDP Asia-Pacific Regional Coordinating Unit in Bangkok. Both of these entities have played an active role in the previous project as well as a critical role in development of the current project.

1.4. Baseline Analysis

56. The baseline scenario presents a situation in which actions are taken and money spent to demonstrate FCVs in each of the four cities of Beijing (5 buses and 5 delivery trucks), Shanghai (50 autos and 30 delivery vans), Zhengzhou (1 bus), and Foshan (1 bus). Yet, in this scenario, durability of vehicles is weak and demonstration periods are short and non-continuous. Demo vehicles do have new advanced features as compared to the previous generation of FCVs manufactured in China and are thus referred to as a "new generation". But this progress is not enough to ensure high durability vehicles with continuous operation over multiple years. Different manufacturers refer to this new generation in the baseline scenario differently. As a group, for the purpose of this project, this new generation is indicated as "Generation B."

57. Parameters reached with the buses, for example, will be at best: 6,000 hours lifetime operation, 650 hours between breakdowns, 25 percent cost reduction (projected for high volume production and as compared to 2015 values), 2,000 annual hours of operation, and 44,000 km driven per year. (See Annex VI, Exhibit VI-2 for best case parameters achieved in the baseline 2019 case for autos and delivery vehicles.) In the baseline scenario, public bus companies and other operators of vehicles do not gain the capacity to handle their own maintenance; and this causes problems in the smooth and continuous operation of the vehicles. In the end, due to unattractive durability and high costs of vehicles, as well as weak results in other areas, replication (by end of project in 2020 and out to 2025) is not achieved on a significant scale.

58. Other factors, in addition to the low technical capacity of vehicle manufacturers that contribute to this low durability, high cost, and low replication baseline scenario are related to FCV and FC components. In the baseline scenario, domestic components continue to lag international levels significantly (by 2020 and 2025), while China's FCV manufacturers continue to have difficulties importing components or continue to find the price of imported components too high.

59. Hydrogen refueling stations in the baseline scenario continue to exhibit the same phenomena seen in previous efforts to promote FCVs in China. Some stations are opened for demonstrations, but later closed down when operation of demonstration vehicles is discontinued (often after only a short period of time). Only a few stations (perhaps one in Beijing and one in Shanghai) continue to be operated for the long term. The stations that have been set up continue to exhibit only a single "business model" (hydrogen only). Costs of stations remain high; and expensive equipment must be important due to reliability issues with domestic products.

60. In the baseline scenario, hydrogen used for demo FCVs continues to be a mix of industrial by-product based hydrogen, hydrogen produced from natural gas reforming, and hydrogen produced from coal-heavy grid-based electrolysis. No progress is made in reducing hydrogen costs; and costs remain high in some areas, such as Foshan, which lack the relevant industries. While some efforts are made at wind farms to produce hydrogen from wind power, China continues to lack renewable energy based hydrogen production on a significant scale due to high costs, lack of know-how, and lack of dissemination.

61. In the policy arena of the baseline scenario, policy and regulatory support for FCVs remains unstable and incomplete. While having its more general *New Energy Vehicle Plan*, China continues to lack a roadmap specific to FCVs; and this situation contributes to cities losing confidence that demonstration of FCVs is a promising effort. Lack of a complete standards and certification system, as well as lack of harmonization with international FCV standards in some cases, causes difficulties in gaining approval for vehicles. Local authorities continue to be concerned about safety hazards of FCVs and lack specific safety procedures to address these concerns. This in turn inhibits successful demonstration programs, which instead become limited in space and time, and result in vehicles being parked after short demonstration periods rather than utilized for their full lifetime.

62. In the baseline scenario, public awareness of FCVs remains very limited. Most are unclear what an FCV is and have very little interest or concept of ever owning one. FC autos continue to be unavailable in China to individual consumers, who would be unlikely to buy them if they were available.

63. In the baseline scenario, the financial sector also remains unaware and/or skeptical of opportunities to finance FCV-related activities. Some auto makers continue to finance limited R&D from their general funds, but no FCV-specific loans exist. Domestic FCV component manufacturers are unable to scale up and become competitive on a global level due to lack of funds. HRS development and related value chain development remains constricted due to lack of funds. Financing for individual purchase of FCVs, in the absence of both availability and demand for vehicles, as well as lack of financial sector interest, is also absent.

64. Estimates for carbon dioxide reductions for the FCV demos in the baseline scenario are given in Exhibit 1-11 and explained in more detail in Annex III. The estimates conclude that by 2020 (equivalent to end of project), the demo vehicles will have resulted in direct reduction of CO_2 emissions of 1,449 tons. Given the less than inspiring results outlined above, the demos are only replicated on a 1:1 ratio in the five years following the project, so that indirect additional emissions reductions are also 1,449 tons. For these calculations, it is assumed that all of the demo vehicles remain operational for 1.5 years (exceeding achievements with past vehicles, but below lifetime expectations given mileage driven in the one year). It is assumed that an average of 125 km per day is achieved for the buses six days per week and 75 km per day is achieved for the other vehicles, also operating six days per week. The emissions estimates assume a mix of natural gas based hydrogen production and grid-based electrolysis made hydrogen for Beijing and by-product hydrogen for the other cities (more details in Annex III). There is no renewable energy based hydrogen production of substantial scale in the baseline scenario.

Exhibit 1-11: Direct CO_2 Emission Reductions in the Baseline Scenario

City or cities	Vehicle Type (All Generation B[24])	No. of vehicles (C)	Gasoline/ diesel emission factor (g CO_2/km) (D)	FCV baseline emission factor (g CO_2/km) (E)	Emission reduction factor (g CO_2/km) (D-E) = (F)	Km driven per year (G)	Years driven (H)	Emission reduction (tons CO_2) ($C*F*G*H*10^{-6}$) = (I)
Beijing*	Bus	5	1,338	766	572	39,062	1.5	167.58
	DV Truck	5	821	470	351	23,438	1.5	61.70
Shanghai, Zhengzhou, Foshan**	Bus	2	1,338	290	1,048	39,062	1.5	122.81
	Auto	50	304	66	238	23,438	1.5	418.37
	DV Van	30	821	178	643	23,438	1.5	678.18
Total	---	**92**	---	---	---	---	---	**1,448.63 tons**

*Beijing's baseline FCV hydrogen is assumed to be 50 percent natural gas-based (steam methane reforming) and 50 percent electrolysis-based (grid electricity).

**Baseline FCV hydrogen for the three other cities is assumed to be by-product hydrogen from coke oven gas, 80 percent of which would normally be unutilized and the other 20 percent of which would have been utilized for process heat.

Note: More details on emission factors used are given in the Annex III.

[24] "Generation B" FCVs across all vehicle types present, in this baseline scenario, incorporate some improvements in durability, performance, and cost over previous FCVs demonstrated at the 2010 Shanghai Expo and achieved via UNDP-GEF China Fuel Cell Bus Project Phase 2. Yet, improvements are limited and not of a magnitude large enough to ensure continuous operation over multiple years.

2. STRATEGY

2.1. Project Rationale and Policy Conformity

Rationale

65. Project rationale considers: (1) the great potential benefits for reducing emissions from China's transport sector, (2) the strong potential for advancing FCVs towards commercialization given the current situation of the FCV industry and the climate in China, and (3) the need for the project's incremental contribution in moving China beyond the baseline scenario. As has been mentioned, China is the world's top producer and consumer of primary energy and top emitter of GHGs, surpassing in its emissions of CO_2 from the energy sector the second largest emitter, the US, by 60 percent. Further, the transport sector accounts for 10 to 15 percent of China's final energy consumption; and this share is expected to grow substantially. China's oil consumption and net oil imports continue to grow, with China having risen to the position of top net oil importing nation in 2014 and expected to get 75 percent of its oil supply from imports by 2035. Transport is the largest contributor to the growth in China's oil consumption; and China now surpasses all other nations in annual new car sales. Local air pollution in many Chinese cities far exceeds the government's targeted standards; and the transport sector is considered an increasingly important contributor to this problem. All of these factors clearly provide rationale for a clean vehicle project that will contribute to potentially major transformations in China's vehicle sector, reducing GHGs, reducing local air pollution (congruent with the GOC's "war on air pollution"), and reducing oil imports (and thereby increasing energy security).

66. A project in the NEV space further fits with China's strategy to be competitive in this sector and facilitates diversification of China's NEV options, which are currently focused only on the various types of EVs. In contract to ICEVs, with their entrenched producers, NEVs are a new industry, which may allow Chinese entrants to become competitive. Further, while China has put most emphasis on EVs, diversification into FCVs has many benefits and should be considered vis-à-vis FCV strengths. These comparative advantages of FCVs include: (1) greater future cost reduction potential as compared to EVs, (2) longer range, (3) alleviation of need to replace battery, and (3) much lower GHG emissions in the short-run (as China's EVs use mostly coal-generated power for recharging).

67. The opportune timing for this project provides further rationale: Currently, the international FCV industry has made marked advances towards commercialization in terms of cost and durability. At the same time, China has created a more favorable policy environment for FCVs with substantial subsidies for vehicles and efforts to promote demonstrations in various cities.

68. Finally, despite the improved environment for FCVs, the baseline scenario presents results that fall far short of what is needed to achieve replication on substantial scale. Input from a project such as this one is needed to push FCV durability improvement and cost reduction to more substantial levels, ensure continuous operation of FCVs and HRSs, and provide other strategic support in areas such as renewable energy based hydrogen production, awareness, and policy. Without such support, past problems, such as limited operation followed by termination of use of vehicles long before their lifetime is expired, may occur. And, with limited improvements, stakeholders will continue to find FCVs lack attraction for them. This project has strong potential for leveraging incremental funds to create much better outcomes than in the baseline scenario.

Policy Conformity

69. The proposed project is consistent with China's national energy strategy and planning since the mid-2000s. It is in response to *China's National Medium and Long-Term Science and Technology Development Plan* (2006 - 2020), in which low energy consumption and new energy vehicles are stated as one of the 68 priorities in the 11 focal areas of national economic and social

development. As a follow-up to the previous UNDP-GEF *Fuel Cell Bus Demonstration Project*, this project is clearly in line with all AEV support programs of the government (e.g., 2009 State Council issued *Readjustment and Reinvigoration Plan for Automobile Industry*; 2012 State Council published *Accelerating the Cultivation and Development of Strategic Emerging Industries*; 2012 *Energy Saving and New Energy Automotive Industry Development Plan*; and, 2013 *New Energy Vehicles Industry Development Plan* (NEVIDP 2012-2020). The project will build on the activities of this last Plan. This project is also in line with the Chinese Government's new energy technology demonstration projects, particularly the *Ten Cities Thousand New Energy Vehicles* program where the use of hybrid-electric, all-electric, and fuel cell vehicles in the public transport sector in many cities will be carried out in a modular manner.

70. The proposed project is in line with China's several plans on the development of climate technologies, such as that being developed under the WB/GEF project on *Technology Needs Assessment*[25]. While the nation of China has yet to meet the technological standards of OECD countries, the Chinese Government continuously stresses the role of advanced technologies for both climate change mitigation and adaptation to meet its sustainable development goals in a timely manner and at a minimum cost that does not threaten economic development and poverty alleviation. Both the transfer of best available global technologies (in this case FCV and hydrogen production and distribution/dispensing) to China and the enhancement of the local science, technology, innovation capacity, and diffusion are necessary to make the most relevant and advanced technologies widely available for deployment. The project is also in line with the plans and recommendations set out in the country's national communications to the UNFCCC. The most recent national communications (i.e., *Second National Communications*) mention the vigorous development of new energy industries, focusing on, among others, the deployment of plug-in hybrid vehicles, electric-drive vehicles, and fuel cell vehicles.

71. This proposed project is also in line with the GEF Climate Change strategic objective to promote energy efficient, low-carbon transport and urban systems (CCM-4). As a sustainable energy technology advocator, GEF supports the implementation of FCVs (particularly fuel cell buses) in selected developing countries, like China. By supporting interventions to facilitate the widespread and sustainable application of FCVs in China's transport sector, GEF can help the developing countries acquire early experience and knowledge in the application and local manufacturing of this type of energy efficient and environment-friendly transport vehicle.

2.2. Country Ownership/ Country Eligibility

72. China ratified the UNFCCC on January 5, 1993. It has completed and submitted its *Second National Communications* to the UNFCCC, which highlighted that improvements in the transport sector's specific energy consumption are among the strategies adopted to contribute to the achievement of the country's target GHG emission reductions.

2.3. Country Drivenness

73. Stakeholder consultations have been held in conjunction with the LFA exercise and in order to obtain FCV manufacturer and other stakeholder input regarding project-related issues, concerns, and barriers regarding development and commercialization of FCVs. This exercise was the basis for the activities proposed to be carried out under the DevCom FCV Project, including project implementation and management arrangements.

[25] The ongoing WB-GEF project on technology needs assessment supports China's efforts to assess climate change mitigation and adaptation technology needs and adopt corresponding global best practices. Said project will, among other actions, identify barriers to technology transfer, and also design one or more technology transfer mechanisms that would accelerate the ultimate deployment of prioritized climate change mitigation and adaptation technologies.

2.4. Design Principles and Strategic Considerations

74. The proposed project intends to facilitate the realization of the potential CO_2 emission reductions (aside from the reduction in the emission of other air pollutants) by removing the identified barriers that up until now have prevented China from realizing substantial GHG emission reductions that would contribute to the achievement of the country's climate change mitigation targets. The project will address current problems in the FCV industry in China via focus on the improvement of the efficiency and durability of the FC engine, FC stacks, and overall FCV operating performance, as well as improvements in the main support infrastructures – hydrogen production facilities and hydrogen refueling facilities. The proposed project will focus on removing a number of key barriers in China's FCV initiatives. A combination of "technology push" and "market pull" activities will be employed to enhance the overall performance levels of locally produced FCs and FCVs by facilitating/enabling the effective promotion and application of FCV production and application technologies and techniques, as well as that for hydrogen production and hydrogen refueling facilities.

75. Based on the barriers identified, project outcomes and outputs have been designed to contribute to the project's overall objective of facilitating the commercialization of FCVs in China. Outcomes and outputs have been arranged along topical components including: (1) FCVs, (2) Hydrogen and HRSs, (3) Policy, (4) Awareness and Information, and (5) Capacity Building. An overriding theme in project design strategy has been to emphasize tangible results with clear links towards commercialization. As such, efforts have been made to reduce studies that may not be read and instead focus on demonstration and active events, such as one-on-one technical assistance sessions or group workshops. Indeed, a demonstration strategy is adopted in many key areas of the project. Central to the project will be the FCV demonstrations, covering four cities and involving a total of 109 vehicles of four different types (buses, autos, delivery vans, and delivery trucks). The project will also demonstrate renewable energy based hydrogen production and HRSs with different business models. In the areas of FCV and HRS components, the project will demonstrate manufacturers that are able to improve quality and/or reduce costs. Like the FCV demos, these component manufacturer demos will contribute to improved durability and cost reduction of FCVs. Yet, they will do so on a different and longer timescale, as the improved components are unlikely to be available at the time the demo FCVs are manufactured. Finally, the project will also pilot innovative FCV and/or hydrogen refueling station incentive policies that are new to China.

76. The proposed project adopts several innovations, not pursued before with regard to FCV commercialization in China. With regard to the FCV manufacturers, the project will provide support in sourcing of FCV parts from international manufacturers. Further, the support of domestic component manufacturers is a new approach. This latter support will combine one-on-one technical assistance through the retaining of experts, as well as facilitation of international cooperation that may lead to joint ventures or other types of cooperation. This latter (facilitation) approach is also quite new to this type of project. The inclusion of interventions focusing on the major support infrastructures for the FCV market, which are the facilities for hydrogen production and hydrogen refueling, are among the innovations in this proposed project. And, within these areas, the support will include aspects new to China, such as renewable energy based hydrogen production on substantial scale and different business models (such as multi-fuel provision) at hydrogen refueling stations. In the awareness area, consumer testing of FCVs is a new approach, not conducted before in China, as will be a televised documentary shown on a major television network and a video of an experiment showing how hydrogen cylinders behave on impact. Exposure of the financial sector to FCV-related opportunities is also completely new to China. Finally, databases including *China HRS Reliability Database* and *China FCV Market and Technology Monitoring System* will be innovative in providing relevant information to stakeholders.

2.5. Alternative Scenario

77. In the alternative scenario, demo FCVs in Beijing (10 buses and 5 delivery trucks), Shanghai (8 buses, 51 autos, and 30 delivery vans), Zhengzhou (3 buses), and Foshan (2 buses) leapfrog beyond the durability, performance, and cost reduction parameters that would be achieved if there were no GEF project. Further, with strong durability, performance, and an enhanced plan for demonstration, the vehicles are operated on a continuous basis (six days per week) over their full lifetime, expected to be 3.2 years or more. Different vehicle manufacturers use different terminology to refer to this "leapfrog" generation of vehicles in the alternative scenario. For the purpose of this project, these vehicles are collectively referred to as "Generation C," to indicate their substantial advancement beyond "Generation B," which is the target generation in the baseline scenario.

78. Parameters reached with the buses, for example, will be 10,000 hours lifetime operation, (compared to a maximum of 6,000 hours in the baseline scenario), 1,000 hours between breakdowns (compared to a maximum of 650 in the baseline scenario), 50 percent cost reduction (projected for high volume production and as compared to 2015 values; compared to 25 percent reduction in baseline scenario), 3,400 annual hours of operation (compared to maximum of 2,000 hours in baseline scenario), and 78,000 km driven per year (compared to a maximum of 44,000 km in the baseline scenario). (See Annex VI, Exhibit VI-2 for parameters achieved for autos and delivery vehicles in the alternative scenario, "with GEF project," as compared to best case parameters achieved in the baseline case.) In the alternative scenario, public bus companies and other operators of vehicles gain the capacity to handle their own maintenance, resulting in smooth and continuous operation of the vehicles. In the end, due to attractive durability and substantially reduced costs of vehicles, as well as positive results in other areas of the project, replication (by end of project in 2020 and out to 2025) is achieved on significant scale.

79. Other factors, beyond improved technical capacity of vehicle manufacturers that contribute to enhanced durability, lowered costs, and high levels of replication in the alternative scenario are related to progress with FCV and FC components. In the alternative scenario, China's FCV manufacturers are able to procure internationally-produced components that were previously inaccessible to them. At the same time, domestic components that reach international best levels, while having lower prices become available (by 2020).

80. In the alternative scenario, the number of hydrogen refueling stations operating in China on an ongoing/permanent basis is increased substantially from its currently level of 2 stations to 10 or more. The set of stations exhibits new business models, such as dispensing of both hydrogen and gasoline, and thus have improved viability. Station costs are reduced by the availability of lower cost domestic equipment and parts that, by 2020, reach international best levels.

81. In the alternative scenario, methods for reducing costs of hydrogen produced for vehicles are identified; and renewable energy-based hydrogen becomes available on substantial and growing scale. Wind farms produce hydrogen with excess power and landfill methane sites are also used to produce hydrogen, with both types of entity having gained access to information on international best practice. Areas wishing to develop FCV demonstration programs where costs of hydrogen were previously high are able to develop plans for local hydrogen production at lower costs.

82. In the alternative scenario, policy also contributes strongly to replication of the project demos, along with substantial purchase of FCVs by consumers. China develops an *FCV Roadmap,* increasing the confidence of cities that demonstration of FCVs is a promising effort. Approval of vehicle models by the national government and issuance of license plates by local government organizations is streamlined, so that these occur in an expedited fashion. This is partially due to development of a complete standards and certification system, harmonized with international standards, and partially due to successful efforts in lobbying and educating relevant officials. In addition, specific safety procedures are developed for dealing with FCV accidents, further

enhancing the confidence of officials. In the end, license plates are issued on a long-term, permanent basis, a major improvement over past demo programs in which the issuance of only short-term permits resulted in the vehicles being permanently parked after short demonstration periods rather than utilized for their full lifetime. Finally, in the alternative scenario, subsidy policies are extended at current levels and additional incentives, such as preferential parking spaces, are added at the local level. This strongly contributes to the growth of the number of FCVs on the road in China.

83. In the alternative scenario, a substantial portion of the public becomes aware of FCVs and comes to understand basic concepts associated with these. They learn about FCVs through the media, including a documentary aired on a major television network. Their fears regarding hydrogen are allayed through the project's awareness work, including a video demonstrating the results of impact on hydrogen canisters. In Shanghai, consumers also have substantial opportunities to test drive FCVs. As a result of this awareness building, combined with attractive subsidies and other incentives, a substantial number of FCVs are sold to individual consumers by 2025.

84. In the alternative scenario, the financial sector becomes aware of and more interested in opportunities to finance FCV-related activities. Banks make loans to auto makers specifically targeted at expanding FCV production capacity. Private equity and venture capital firms also become interested in the industry and its value chain and provide equity for higher risk situations. As a result of the increased availability of financing, domestic FCV component manufacturers are able to scale up and become competitive on a global level. HRS development and related value chain development similarly is able to scale up due to the availability of financing. In addition, individual purchase of FCVs by consumers is increased by the availability of special FCV purchase financing programs provided by Chinese banks.

85. Estimates for carbon dioxide reductions from FCV demos in the alternative scenario are given in Exhibit 2-1. The estimates conclude that by 2020 (equivalent to end of project), the demo vehicles will have resulted in direct reduction of CO_2 emissions of 10,814 tons (compared to 1,449 in the baseline case). Given the inspiring demo results outlined above as well as the many other contributing factors facilitated by the project (e.g. availability of competitive domestic components, substantially enhanced policy, and increased awareness), the FCV demos are expected to be replicated on a 4:1 ratio by the end of the project, so that additional emissions reductions via FCVs (out to five years after end of project and indirect via the bottom up approach) are 43,256 tons CO_2. For these calculations, it is assumed that all of the demo vehicles remain operational for 3.2 years (far exceeding achievements with past vehicles, though a conservative estimate given expected improvements in vehicles). It is assumed that an average of 250 km per day is achieved for the buses six days per week and 150 km per day is achieved for the other vehicles, also operating six days per week. The emissions estimates assume half of the hydrogen used in the Beijing vehicles comes from one of the project's wind-based hydrogen production demos (replacing the share of grid-based electrolysis in the baseline scenario), while other sources of hydrogen remain the same as in the baseline case.

86. The project's renewable energy based hydrogen production demos, including three hydrogen production installations at wind farms and one at a landfill methane site, add substantially to direct emission reductions. Some of this renewable energy based hydrogen is used to power project FCVs, resulting in 824 tons of emission reductions (during the project's lifetime) that have already been included above in the calculation for alternative scenario FCV emission reduction. During the project lifetime and excluding the already-counted foregoing amount used in the demos FCVs, they add 5,922 tons CO_2 reductions. This amount is for renewable energy based hydrogen used for purposes other than the demo FCVs. It too provides emissions reductions by replacing hydrogen produced by higher carbon methods. If well maintained, the installations last an additional 18 years beyond end of project, adding an additional 60,716 tons direct CO_2 emission reductions post-project.

Exhibit 2-1: Direct CO_2 Emission Reductions in the Alternative Scenario

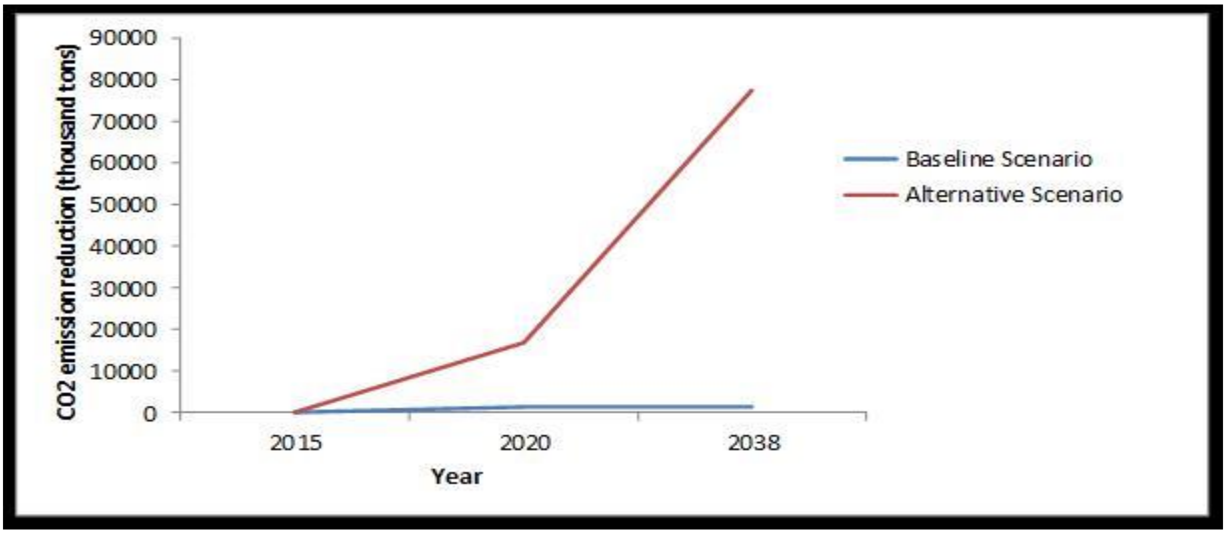
City or cities	Vehicle Type (Generation C[26])	No. of vehicles (C)	Gasoline/ diesel emission factor (g CO_2/km) (D)	FCV alternative emission factor (g CO_2/km) (E)	Emission reduction factor (g CO_2/km) (D-E) = (F)	Km driven per year (G)	Years driven (H)	Emission reduction (tons CO_2) (C*F*G*H * 10^6) = (I)
Beijing*	Bus	10	1,338	428	910	78,124	3.2	2,274. 97
	DV Truck	5	821	263	558	46,876	3.2	418.51
Shanghai, Zhengzhou, Foshan**	Bus	13	1,338	290	1,048	78,124	3.2	3,405.96
	Auto	51	304	66	238	46,876	3.2	1,820.74
	DV Van	30	821	178	643	46,876	3.2	2,893.56
Total	---	**109**	---	---	---	---	---	**10,814 tons**
Direct incremental emission reductions: 10,814 tons (alternative) – 1,449 tons (baseline) =								**9,365 tons**

**Beijing's baseline FCV hydrogen is assumed to be 50 percent natural gas-based (steam methane reforming) and 50 percent wind power based. The benefits of wind power based hydrogen have been incorporated into the emission factors for Beijing which, for example, are reduced in the case of buses from 766 g CO_2/km in the baseline scenario to 428 g CO_2/km in the alternative scenario.
**Baseline FCV hydrogen for the three other cities is assumed to be by-product hydrogen from coke oven gas, 80 percent of which would normally be unutilized and the other 20 percent of which would have been utilized for process heat. It is quite possible that these emission factors for some of these three other cities will be reduced further by use of hydrogen from the project's demo land fill methane hydrogen generation or from its other demo wind powered hydrogen generation for their demo FCVs. Thus, the approach taken here is conservative; and total emission reductions realized in the alternative scenario may be even greater.
Note: More details on emission factors used are given in the Annex III.

87. Exhibit 2-2 below compares direct emission reductions in the baseline and alternative scenarios, showing the cumulative direct emission reductions over time. It has data points at 2020, for direct emissions reductions achieved by end of project and at 2038, for total direct emissions reductions achieved both during and after project. It does not show the project indirect emission reductions from replications mentioned above. There are substantial and estimated to add an additional 117,420 tons CO_2 emission reductions to direct reductions of 15,287 tons by end of project for a total emission reduction by end of project of 132,707 tons CO_2. Neither does Exhibit 2-2 show the direct post-project emission reductions, defined as those reductions directly attributable to project activities, but associated with equipment put in place after end of project. For more information on these, see Annex III.

Exhibit 2-2: Comparison of Cumulative Direct Project Emission Reductions in Baseline and Alternative Scenarios

[26] "Generation C" refers to vehicles that go beyond the "Generation B" vehicles targeted in the baseline scenario. As such, Generation C vehicles of the alternative scenario achieve higher durability and performance and better cost improvement as compared to Generation B. The project enables China to "leapfrog" Generation B vehicles, going directly to Generation C.



2.6. Project Goal, Objective, Outcomes, and Outputs/ Activities

Project Goal and Objective

Goal: Reduced growth rate of GHG emissions from transport sector

Objective: Facilitation of the commercial production and application of fuel cell vehicles in China

Project Components, Outcomes, and Outputs

88. **Component 1: Improvement of Local Fuel Cell (FC) and Fuel Cell Vehicle (FCV) Production and Application**: This component will focus on achieving marked improvement of China's FCVs and the demonstration of such FCVs in continuous, long-term operation. It will do so from multiple angles, achieving "leapfrog" levels of FCV improvement in durability, performance, and cost by addressing barriers in: capabilities of local FCV manufacturers, access of those manufactures to international components, and capabilities of local component manufacturers. It will address the barrier of lack of data from continuous operation of FCVs in China and lack of proof of FCVs in China via such continuous operation through demonstration of 109 FCVs (including buses, autos, delivery vans, and delivery trucks) across four demo cities. Outcomes expected from the activities of this component are: (1) markedly reduced costs and improved performance and durability of FCVs in China; and (2) FCVs deployed in continuous operation by cities, organizations, and individuals in China.

Outcome 1A: Markedly reduced costs and improved performance and durability of FCVs in China

89. Output 1A.1.1: Completed individual technical assistance for China's vehicle manufacturers in the design and manufacture of FC vehicles. This technical assistance will enable manufacturers to improve FCV durability and performance and reduce costs, thus contributing to overall improvement in these areas key to FCV commercialization. *(One-on-one technical assistance in FCV design and manufacture)*

Activity 1A.1.1.1: Assistance to selected Chinese FCV manufacturers to help them achieve targets in increased durability and reduced cost of FCVs. The specific assistance will enable manufacturers to develop their own power train.[27] Durability will be increased via coaching on attaining extremely well-defined and favorable operating conditions for the FC stack. This, in turn, will be achieved by improvements in architecture, air control, and using the battery to optimize the stack operating cycle. The manufacturers will be coached in optimization of the stack, system, power train, and vehicle via integration, operating strategy/conditions, controls in the power train, and associated software. Considerable attention will also be given in design guidance to safety issues. This activity will be carried out through the following steps: (a) selection of appropriate manufacturers for assistance in design and manufacture of FCVs; (b) development of action plan tailored to each selected manufacturer in order for them to meet project targets; and (c) one-on-one technical assistance to selected manufacturers via site visits and conference calls. All three steps will be carried out by FCV experts. FCV manufacturers will be selected based on a combination of proven capabilities and a willingness to cooperate and accept assistance. The action plans and technical assistance are meant to enable each manufacturer to reach the following FC vehicle targets: (i) durability of 10,000 lifetime hours of operation for buses and 6,000 hours for cars and delivery vehicles with specified driving cycle (an ambitious target which, if met, will be a strong verifier of project success) – up from 2,000 lifetime hours at start of project; (ii) 1,000 minimum hours between breakdowns (up from 300 hours at start of project); (iii) 2 million RMB (USD 320,000) of actual cost per bus (down from start of project costs of 4 million RMB per bus), USD 80,000 of actual cost per car (down from USD 150,000 at start of project), and USD 150,000 per delivery vehicle (down from USD 250,000 at start of project); (iv) cruising range target; and (v) stack power density target. [*GEF support is required for the provision of technical assistance services by FCV expert(s)*.]

90. <u>Output 1A.1.2</u>: Completed group capacity development sessions for China's vehicle manufacturers in the design and manufacture of FCVs. Group capacity development sessions will enlighten manufacturers as to means of improving FCV durability and performance and reducing costs, thus contributing to overall improvement in these areas key to FCV commercialization. FCV manufacturers will also be briefed on and thus motivated by improvements achieved in China-based FCV manufacturing via the one-on-one technical assistance of Output 1A.1.1. *(Capacity development sessions in FCV design and manufacture)*

Activity 1A.1.2.1: Conduct of a series of at least four workshops to address the needs of China's vehicle manufacturers in producing FCVs that can meet project document-defined commercialization targets. Topics will include, but not be limited to: (i) global and Chinese situation of FCV technology, policy, and market; (ii) FCV architecture; (iii) air control; (iv) use of battery to optimize the stack operating cycle; (v) FCV integration; (vi) operating strategy/conditions implemented via controls in the power train, and associated software; (vi) global and domestic sourcing of high quality and lowest cost FCV components; and (vii) ensuring safety of FCV vehicles. In additional, presenters will provide updates on improvements achieved in China-based FCV manufacturing via the one-on-one technical assistance of Output 1A.1.1. FCV experts will be retained to design the training curriculum, lead the workshops, and provide written training materials. Prior to workshops, outreach for attendance will be conducted with all Chinese vehicle manufacturers producing FCVs or having the interest and potential to do so. Special efforts will also be made to include as many women technical personnel as possible. [*GEF support is required for the technical services in the design, organization, conduct, and evaluation of the group capacity development sessions.*]

91. <u>Output 1A.2</u>: Published and disseminated information on improved FCV design and production in China achieved via project.[28] This information will enable a wide group of stakeholders to gain

[27] Most currently depend on outside parties for this.
[28] Information will include baseline situation, project commercialization targets, steps to reach targets, results achieved, and lessons learned.

insights on means of FCV durability/performance improvement and cost reduction and thus contribute to overall improvement in these areas key to FCV commercialization. *(Disseminated information on improved FCV design and manufacturing achieved via project)*

Activity 1A.2.1: Preparation of two written reports (one at end of year two, one at end of year four) on project's achievements in improved FCV design and production and steps taken to reach those achievements. Independent consultants will prepare the reports; and the PMO will be responsible for wide dissemination among relevant stakeholders in industry, academia, and the government. [*GEF support is required in the technical services in the report preparation, publishing and dissemination*.]

Activity 1A.2.2: Design and conduct of survey of individuals (as distinct from companies) attending group FCV training and/or receiving FCV training materials. This is for the purpose of verifying relevant project indicators associated with Outputs 1A.1.2 and 1A.2. This survey will gather information on whether training has impacted the work of these individuals and will be conducted at EOP. [*GEF support is for the technical services required in the design and conduct of the survey*.]

92. Output 1A.3: Multiple confirmed and implemented new sourcing agreements[29] between Chinese FCV manufacturers and international suppliers that are each verified to lower costs, increase durability, and/or raise performance from start of project benchmarks. Overcoming current barriers to international sourcing of key parts, such agreements will enable enhanced durability and performance of China's FCVs. *(International sourcing agreements for China FCV industry)*

Activity 1A.3.1: Comprehensive assessment of sourcing challenges faced by Chinese FCV manufacturers, evaluation of various feasible international sources of FCV components, and preparation of comprehensive compendium of recommended component suppliers in international market. Through individual consultations with each Chinese manufacturer currently producing FCVs, an assessment to determine how each major FCV-related component is currently sourced, whether it is up to international standard, and how its price compares to internationally competitive prices will be carried out. Based on findings of the assessment work, evaluation of various feasible international sources will be done, including preparation of a compendium of suitable sources.[30] The compendium will be shared with all interested vehicle manufacturers in China. [*GEF support is required for the technical services needed in the comprehensive assessment of sourcing challenges and various feasible international sources of FCV components, as well as in the preparation of the comprehensive compendium of recommended international suppliers of FCV components*.]

Activity 1A.3.2: Conduct of targeted individual assistance to selected FCV manufacturers in achieving new advantageous sourcing agreements for FCV-related components from international suppliers. The technical assistance will take into consideration sourcing challenges determined in Activity 1A.3.1. FCV expert(s) will assist the China-based manufacturers in liaising with relevant international component suppliers and in negotiating of sourcing agreements. This work will be completed early enough in the project so that newly sourced components that achieve cost reductions, durability improvements, and/or performance improvements are available to be incorporated into demo vehicles manufactured for the project. Assistance will be provided to all FCV manufacturers that are considered to have high potential to meet project commercialization targets. The expert(s) selected for this activity will be those that are well-connected in the international FCV component community. This work will include, but not be limited to, outreach to international manufacturers (including auto OEM and non-auto OEM) for purchase of world

[29] This will include FC engine sourcing agreements with top OEM and/or non-OEM providers, if possible.
[30] To be carried out by a FCV expert familiar with international component manufacturers. Building on the FCV expert's own previous knowledge and contact base, the compendium will provide contact information, details on products offered, quality of supplier compared to others in the market, typical price points, etc.

class FC engines. If generally attractive terms are obtained, activity will also include support to Chinese manufacturers in negotiating details of FC engine sourcing agreements. More than one make of engine may be sought to enable comparison of results. Regardless of results of engine sourcing work, this activity will also emphasize support to China FCV manufacturers in the international sourcing of other components. Other priority areas in this regard include: hydrogen recirculation pump, compressor, MEA, and hydrogen valve with high quality seal. [*GEF support is required for the provision of the specific technical services to each selected local FCV manufacturer*.]

Activity 1A.3.3: Design and conduct of a survey of China's FCV manufacturers to obtain information needed for project monitoring indicators. This is for the purpose of verifying relevant project indicators associated with Outputs 1A.1.1, 1A.1.2, 1A.2, 1A.3, 1B.1, 1B.2, and 1B.3. There will be a standard version of the survey for all FCV manufacturers and an expanded version for those that have received one-on-one technical assistance, or accessed training materials. Targeted information for the standard version will be: (a) number of companies producing FCVs; (b) number of new FCV production lines; (c) cumulative investment in FCV manufacturing; (d) lifetime hours of operation of FCVs; (e) actual cost and cost projections at high volume for FCVs; (f) employment related to FCVs at start of project and at time of survey; and (g) proportion of FCV-related jobs held by women at start of project and at time of survey. For those obtaining one-on-one assistance, information on mean time between failure, lifetime mileage, cruising range, and fuel cell stack power density will also be obtained. For those obtaining sourcing assistance, information on newly signed sourcing agreements and total value of these agreements will be obtained. For those organizations receiving training materials, information on impact of these materials on their activities will be sought. [*GEF support is for the technical services required in the design and conduct of the survey*.]

93. <u>Output 1A.4:</u> China-based FCV component manufacturers that achieve globally competitive durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels. Such China-based manufacturers will be able to provide quality components to domestic FCV manufacturers (and possibly international FCV manufacturers) at a lower price than currently available, thus contributing to driving down the cost of FCVs. [*Domestic component manufacturers with globally competitive products at lower than pre-project prices*]

Activity 1A.4.1: Assistance to China-based FC membrane manufacturer (Shandong Dongyue) to achieve reduced cost and increased quality (manifested in increased durability, reduced thickness, and improved hydrogen cross-over, performance, and manufacturing quality). Reduced cost will be sought in part by targeting scale up of production/demand from the current level to further leverage Dongyue's vertical integration (from mine to membrane) cost advantage. Technical assistance will consist of: (a) assessment of current production processes and membrane quality and development of action plan to implement recommendations based on the assessment; (b) one-on-one technical assistance to improve production and testing; (c) incremental support to Dongyue's purchase of selected FC membrane quality testing/assessment equipment that will enable procurement of higher quality/enhanced feature equipment as compared to Dongyue's purchase in the baseline case; (d) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of membranes; and (e) facilitation of expanded opportunities with potential FCV clients internationally. Items (a) and (b) will be provided by experts in membrane testing and production, preferably those with membrane experience at Dupont, Gore, 3M, or Asahi Glass. Items (d) and (e) will be provided by expert in international facilitation. The technical assistance will complement Dongyue's realized and planned investment in FC membrane production and testing, targeting expanded production and increased product stability and consistency. [*GEF support is required for expert technical assistance in improving membrane testing and product quality, incremental support in purchase of selected testing* *equipment with enhanced features* [31] *, and facilitation of international cooperation with counterpart membrane manufacturers and customers*.]

Activity 1A.4.2: Assistance to China-based FC catalyst manufacturer (Guiyanboye) to achieve improved processing and scale-up and thus be able to offer a lower cost catalyst source to FCV manufacturers, which are currently importing catalyst. Leveraging Guiyanboye's platinum trading and recycling platforms, a 20 to 30 percent cost advantage over international sources is targeted. The technical assistance will consist of: (a) assessment of current manufacturing process and quality of FC catalyst products and preparation of action plan to implement the recommendations resulting from the assessment; (b) one-on-one technical assistance to improve production and testing; (c) incremental support to Guiyanboye's purchase of single fuel cell test platform and provision of related training that will enable procurement of higher quality/enhanced feature equipment as compared to Guiyanboye's purchase in the baseline case; (d) incremental support to Guiyanboye's purchase of a pilot preparation platform (to facilitate move from laboratory to batch production) that will enable procurement of higher quality/enhanced feature equipment as compared to Guiyanboye's purchase in the baseline case; and (e) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of catalyst. Items (a) and (b) will be provided by expert in FC catalyst production. Along with other efforts, these will target performance improvement from current level of 0.6 mg Pt per cm^2 to international level of 0.3 mg Pt per cm^2, or even beyond (0.2 mg Pt per cm^2). Item (e) will be provided by expert in international facilitation. [*GEF support is required for expert technical assistance in improving the testing and production of FC catalyst in the selected local FC catalyst manufacturer (Guiyanboye), incremental features/quality of equipment for catalyst testing and manufacturing at Guiyanboye*[32]*, and facilitation of international cooperation between Guiyanboye and counterpart international catalyst manufacturer*.]

Activity 1A.4.3: Assistance to China-based MEA (membrane electrode assembly) manufacturer to improve processing and reduce discard rate, thereby enabling provision of lower cost MEA to FC stack and FCV manufacturers. Improvement from current 20 percent discard rate in China to internationally competitive two percent discard rate will be targeted. MEA manufacturer to be supported will be either a stand-alone manufacturer based in Wuhan or Dalian Sunrise (which produces MEA as one component of the FC stacks it produces). Technical assistance will consist of: (a) assessment of current production process and quality of MEA and development of action plan based on recommendations emerging from assessment; (b) one-on-one technical assistance to improve processing; and (c) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of MEA. Items (a) and (b) will be provided by expert in MEA processing. Item (c) will be provided by expert in international facilitation. [*GEF support is required for the expert technical guidance in improving MEA production and for facilitation of international cooperation with counterpart international MEA manufacturer*.]

Activity 1A.4.4: Assistance to China-based bi-polar plate manufacturer to improve process and technology for coating and stamping (and for welding and sealing, if needed) thereby enabling provision of lower cost bi-polar plate to FC stack and FCV manufacturers. The target in stamping is the reduction of plate thickness from China's current level of 0.7 mm to international level of 0.4 mm, thus increasing power density to international level of 3.1 kW per L. Through improved technique for coating stainless steel, reduced corrosion is expected and, thus, extended lifetime. The bi-polar plate manufacturer to be supported will be either a stand-alone manufacturer based in Dalian or Shanghai (such as Shanghai Jiaotong Manufacturing Research Institute) or the FC stack manufacturer Dalian Sunrise (which produces bi-polar plates as one component of the FC stacks it

[31] Dongyue-provided co-financing of USD 3.2 million annually will support baseline cost of standard testing equipment purchase and cost of all other equipment purchase and scale-up.
[32] This will be for the enhanced features/quality of the planned single fuel cell test platform and of the 0.5 to 1.0 kg scale pilot preparation platform that Guiyanboye intends to purchase and install. Once the production process is confirmed, the company will build a 2 to 5 ton per year FC catalyst production line.

produces). Technical assistance will consist of: (a) assessment of current manufacturing processes and product quality and development action plan to implement recommendations emerging from assessment; (b) one-on-one technical assistance to improve processing and technology; and (c) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of bi-polar plates. Items (a) and (b) will be provided by bi-polar plate expert, who has strong experience in coating and stamping. Item (c) will be provided by expert in international facilitation. [*GEF support is required for the expert technical guidance services in improving bi-polar plate manufacturing, particularly the process and technology for coating and stamping, and for facilitation of international cooperation with counterpart international bi-polar plate manufacturer*.]

Activity 1A.4.5: Assistance to China-based FC stack manufacturer Dalian Sunrise to optimize stack and balance of system (BOS) and thereby reduce cost to FCV manufacturers for globally competitive FC stack. Targets include: (i) increasing stack maximum efficiency from current level of 60 percent to 65 percent, (ii) increasing stack lifetime at specified test cycle from current level to 10,000 hours, and (iii) increasing performance from 1.0A@0.65V to 1.5A@0.65V. The technical assistance will consist of: (a) assessment of current manufacturing processes, components, and quality of the FC stack and development of action plan to implement recommendations emerging from the assessment; (b) one-on-one technical assistance to optimize stack and balance of plant as a system; and (c) facilitation of joint venture or other cooperative relationship with international counterpart stack manufacturer and, as needed, of relationships with international FC stack component manufacturers. Items (a) and (b) will be provided by FC stack expert who has strong experience in optimization. Item (c) will be provided by expert in international facilitation. [*GEF support is required for the technical service in optimizing the manufacturing of FC stack and BOS and for facilitation of international cooperation with counterpart international FC stack manufacturer and, as needed, international FC stack component manufacturers*.]

Activity 1A.4.6: Assistance to China-based FCV air compressor manufacturer Foshan Guangshun to improve quality control processes, technology, and sourcing of compressor parts, thereby reducing cost to FCV manufacturers for globally competitive FCV air compressor. Improvements will include those in the areas of air bedding and better high speed motors. Targets will be to increase power density and durability (lifetime) to internationally competitive levels. Assistance will consist of: (a) assessment of manufacturing processes of, quality of, and sourcing of parts for the FCV air compressor and development of action plan based on recommendations emerging from the assessment; (b) one-on-one technical assistance; and (c) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer. Item (a) will include assessment as to which compressor technology (conventional compressor or other) will be most strategic in terms of cost and durability potential. Items (a) and (b) will be provided by FC compressor expert. Item (c) will be provided by expert in international facilitation. [*GEF support is required for the technical services for expert guidance in improving FC system air compressor manufacturing (particularly on quality control and appropriate technology application) and for facilitation of international cooperation with counterpart international FC air compressor manufacturer.]*

Activity 1A.4.7: Identification of a potential China-based manufacturer of hydrogen recirculation pump and provision of technical assistance in the design/engineering of production/processing facilities and launch of production. Domestic production of hydrogen recirculation pump (currently unavailable in China) will be targeted to lower costs and other difficulties faced by Chinese FCV manufacturers in sourcing this component. Activity will consist of: (a) identification and vetting of China-based manufacturers currently interested in production of hydrogen recirculation pump, resulting in selection of one manufacturer; (b) assessment of needs of selected manufacturer in launching production of quality hydrogen recirculation pump and development of action plan to implement recommendations emerging from assessment; (c) one-on-one technical assistance to enable selected manufacturer to design and set up manufacturing line and ensure quality product; and (d) facilitation of joint venture or other cooperative relationship between selected manufacturer and international counterpart manufacturer of hydrogen recirculation pumps. Items (a), (b), and (c) will be conducted by hydrogen recirculation pump expert(s). Item (d) will be provided by expert in international facilitation. [*GEF support is required for the expert technical services needed in the design/engineering and operation of hydrogen recirculation pump production facilities and for facilitation of international cooperation with counterpart international hydrogen recirculation pump manufacturer*.]

Activity 1A.4.8: Identification of an existing or potential China-based manufacturer of FCV high voltage DC/DC converter and provision of technical assistance in design/engineering or improvement of production/processing facilities. Domestic production of FCV high voltage DC/DC converter will be targeted to lower costs and alleviate other difficulties faced by Chinese FCV manufacturers in sourcing this component. Activity will consist of: (a) identification and vetting of China-based manufacturers currently producing or interested in producing high voltage DC/DC converter for FCVs, resulting in selection of one manufacturer; (b) assessment of needs of selected manufacturer in launching or improving production of high voltage DC/DC converter for FCVs and development of action plan to implement recommendations emerging from assessment; (c) one-on-one technical assistance to enable selected manufacturer to launch production; and (d) facilitation of joint venture or other cooperative relationship between selected manufacturer and international counterpart manufacturer. Items (a), (b), and (c) will be carried out by high voltage DC/DC converter expert(s). Item (d) will be provided by expert in international facilitation. [*GEF support is required for the expert technical services needed in the design/engineering and operation and/or improvement of the high voltage DC/DC converter production facilities and for facilitation of international cooperation with counterpart international high voltage DC/DC converter manufacturer*.]

Activity 1A.4.9: Design and conduct of a survey of the FCV and FC component manufacturers that received technical assistance. This is for the purpose of verifying relevant project indicators associated with Output 1A.4. The survey will gather information on FCV/FC components newly sourced in China as a result of project, as well as information on cost reduction achieved by each manufacturer and durability/performance improvement achieved. This will be carried out towards EOP. Survey will also cover (i) employment related to FC/FCV business at start of project and at time of survey; and (ii) proportion of FCV/FC-related jobs held by women at start of project and at time of survey. [*GEF support is for the technical services required in the design and conduct of the survey.*]

<u>Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China.</u>

94. <u>Output 1B.1</u>: Completed procurement and production of 109 demo FCVs, including 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks.[33] Based on project strategy, demo FCVs will represent major advance towards commercialization (increased durability, improved performance, and reduced cost) from baseline at start of project and also "leapfrog" beyond the generation of vehicle intended in the baseline scenario. That is, while "Generation B" (an advancement from the situation in 2010 at the time of the Shanghai World Expo FCV demonstration) was targeted in the baseline scenario, in the alternative scenario incremental improvements taking all vehicles to "Generation C" will be achieved. These improvements will address many aspects of the FCVs including, in particular, the engine, the design, integration, and other components besides the

[33] Demo fuel cell vehicles will be operated in four cities with distribution by city and vehicle type as follows: (1) Shanghai: 89 vehicles, including 51 cars, 30 postal delivery vans and 8 buses. Fifty cars will be manufactured by SAIC and one manufactured and co-financed by Toyota. (2) Beijing will have 10 buses and 5 delivery trucks. (3) Zhengzhou will have 3 buses. (4) Foshan will have 2 buses.

engine.[34] Properly carried out procurement will ensure that vehicles meet enhanced technical standards to achieve alternative scenario targets. *(Procurement and production of demo vehicles)*

Activity 1B.1.1: Design of requests for proposals (RFPs) for the manufacture and procurement of the demo FC buses, FC autos, FC delivery vans, and FC delivery trucks and conducting of bidding and negotiation for all demo vehicles. Expert(s) designing RFPs will include requirements based on project document-defined targets for cost, durability, and performance and add to this other desired criteria. Targets are included in Exhibits VI-1 and VI-2 of Annex VI, which provides descriptions of the vehicle demos. In order to be considered part of the project, all vehicles must meet the project document defined parameters as stipulated in the RFPs. [*GEF support is required for expert design of RFPs for the demo FCVs that "leapfrog" the generation originally intended in the baseline scenario and for the conducting of bidding. The "leapfrogging" is achieved via improved FCV engines, improved design, improved integration, improvement of other components, etc.*]

Activity 1B.1.2: Production and purchase of 23 demo FC buses, 51 demo FC autos, 30 demo FC delivery vans, and 5 demo delivery trucks according to the specifications of the RFPs (Activity 1B 1.1). It is likely that at inception, other cities will join the demo, with an expansion of the total number of vehicles. In particular, it is likely that Yancheng City and Changshu City (both in Jiangsu Province) , as well as other interested cities, will join with the addition of eight FC buses to the original 23. FCV numbers designated for the cities may change and will be determined during project inception based on cities' interests and their commitment to co-financing. This activity will be carried out by selected vehicle manufacturers and organizations purchasing the vehicles. [*GEF support is required to achieve "leapfrogging" of vehicle generation from "Generation B" in the baseline scenario to "Generation C" in the alternative scenario. Based on provision of incremental GEF funding to be spread across the purchase of all vehicles, stakeholders have agreed to be bound by higher level requirements ("Generation C") for all vehicles in the areas of durability, performance, and cost reduction and to expand the number of FC buses from seven to 23, allowing for greater testing and for inter-comparison of results of buses with different engine types. GEF incremental financing will be USD 5.12 million which represents 31 percent of costs for all 109 vehicles (USD 16.69 million), when estimated with cost reductions targeted in the alternative scenario. Co-financing will cover the other 69 percent of vehicle costs.*]

95. Output 1B.2: Approved plans in each demo city for increasing visibility and effectively testing operating performance of demo FCVs. The plans will determine most effective use of and routes for all demo FCVs, design images/words promoting FCVs to be painted outside and affixed inside the vehicles, and allow for public test driving of passenger cars. These will also include arrangements for continued use of vehicles after project close. Demos to include 109 demo FCV vehicles, consisting of 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks.[35] Carefully crafted plans will ensure vehicles are continuously operated and that demos maximize positive impacts in areas of awareness building and providing data for FCV operation analysis. *(Approved plans for use, routes, and body paint/interiors of demo vehicles)*

Activity 1B.2.1: Preparation and building consensus to achieve approval of each of 4 plans for the operation of demo vehicles: (a) *Shanghai Plan*, (b) *Beijing Plan*, (c) *Zhengzhou Plan*, and (d) *Foshan Plan*. Plans will be approved both at the project/national and municipal levels. *Each city's plan* will include bus route selection that will achieve both high visibility and desirable testing situation for the buses (8 buses in Shanghai, 10 in Beijing, 3 in Zhengzhou, and 2 in Foshan). *Shanghai Plan* will select uses of the 51 FC autos that will ensure high visibility and good testing

[34] Project activities associated with Outcome 1A will enable achievement of "Generation C" targets. Such activities include (a) one-on-one technical support for FCV manufacturers, (b) group capacity development for FCV manufacturers, and (c) international sourcing support for FCV manufacturers.
[35] See footnote to first sentence of Output 1B.1 for specific demo plans by city or district.

situation for the cars. Similarly, the *Shanghai Plan* and *Beijing Plan* will select uses and routes of delivery vehicles (30 vans in Shanghai and 5 trucks in Beijing) that will achieve high visibility and good testing situation for these. *Each city's plan* will include for all vehicles detailed designation of how the painting of the vehicle exterior and signage in vehicle interior will raise rider and other viewer awareness of FCVs and the fact that the vehicle itself is an FCV. The *Shanghai Plan* will also designate a certain number of sites and days (around 200 days per year over three years during project period) for consumer test driving of the FCV autos. *Each city's plan* will also specify how required approvals will be obtained, how refueling will occur, and how maintenance of vehicles will be carried out. In general, plans will call for maintenance to be carried out by the operating organizations, so that they can learn and understand their vehicles, working side-by-side with resident engineer from manufacturer, who will then be able to provide feedback on results to his/her organization. In addition to repairs, scheduled maintenance will be carried out periodically at pre-defined intervals. Preliminary features of the plans are included in Exhibits VI-5 and VI-6 of Annex VI, which provides descriptions of the vehicle demos. Finally, *each city's plan* will emphasize continuous operation of the vehicles both during the project period and for the rest of the vehicles' lifetimes beyond project close. Arrangements for use of the vehicles after project close will be clearly designated and in most cases similar to uses before project close. *Each city's plan* will be prepared by the relevant local government and the FCV experts that support them. [*GEF support is required for the technical assistance for the improved FCV demo plans in each demo city, specifically for added requirements such as: special measures to demonstrate durability and performance of FCVs that "leapfrog" over the generation of FCVs that were originally planned as part of the baseline FCV program of each city; requirement of FCV promotion on the interior and exterior of vehicles; requirement of high visibility routes and uses; and requirement of continuous operation.*]

96. <u>Output 1B.3</u>: Completed demonstration of FCV operation and application. Per each locality's plan, demos will be in continuous operation during a defined timeframe and (with adjustments as needed based on findings of Output 1B.4) continue operation after end of project (EOP). Continuous operation per plans will ensure that the potential of demos is maximized in terms of building awareness, achieving proof of concept, and providing data for analysis and lessons learned. *(Completed FCV demos that have been in continuous operation and will continue to operate)*

Activity 1B.3.1: Operation of all the planned demo vehicles in each of the four localities according to their respective plans. The operations will be continuous and continue beyond end of project as lifetimes of the vehicles allow. Routine maintenance will be carried out at regular intervals and repairs will be made as needed. In Shanghai, in addition to their regular use, some autos will be made available for consumer test driving at certain times (around 200 days per year over three years during project period) and certain locations. [*Operating expenses for all 109 vehicles will be borne by co-financing from organizations utilizing the vehicles, or by the organizations owning the vehicles. Operation of the demo FCVs is a baseline activity, enhanced dramatically by the leapfrogging of intended generation of buses and, for all vehicles, by the many specific enhancements to demo design, as described in Activity 1B.2.1.*]

Activity 1B.3.2: Conduct of regular periodic evaluation of demonstration results for purposes of making of periodic adjustments as needed to the demo plans. This will involve the regular monitoring and periodic monitoring of each demo. Based on the results obtained and from information obtained under Output 1B.4, adjustments will be made to keep the demos on track to achieve the set targets, and if cases of other circumstances beyond the control of the demo implementers arise, adjustments in the demo plan and targets may be made. These adjustments include also the final adjustment to the demo plan for implementation beyond the end of project. Experts will recommend adjustments and cities/organizations operating the demo FCVs will implement them. [*GEF support is required for technical services in the analysis of demo results to date and recommendations for adjustments*.]

97. Output 1B.4: Clearly documented and disseminated results on continuous operation and public perception of procured FCVs (annual reports) and production costs (one-time reports). Based on evaluation reports, adjustments may be made in demo plans to be implemented annually and after GEF project close (Activity 1B.3.2). Documentation and dissemination will enable lessons learned and strong proof of concept of demos, thus maximizing the value achieved from the demos. *(Monitoring and documentation/dissemination of demo results)*

Activity 1B.4.1: Design of data collection plans and collection and analysis of data on operation of demo FCVs. In all cities, monitoring systems will be installed in the demo vehicles, determining period of operation and other important parameters indicated by experts designing the data collection plans. Experts will be responsible for design, data collection, and analysis. Group consultations among these experts should ensure that the types and frequency of data will be similar, thus allowing for eventual analysis of data across cities for each type of demo vehicle. [*GEF support is required for technical services for the design and implementation of the monitoring plan, which ensures that the monitoring approach of the four cities is unified and addresses the project-defined commercialization targets*.]

Activity 1B.4.2: Conduct of annual survey of public perception of FCVs. The survey will be designed and fielded by external experts. It will cover various segments of the public including in each city, as relevant, those who have ridden or seen FCV buses, those who have seen and/or test driven FCV cars, and those who have seen FCV delivery vans or trucks. In particular, the survey will probe consumer concerns about hydrogen as a fuel, understanding of environmental benefits of FCVs, general attraction to the FCV concept, and general understanding of FCVs. [*GEF support is required for the technical services needed in the design and conduct of the survey, and evaluation of the survey results*.]

Activity 1B.4.3: Assessment of FCV production costs and their break-down. Based on a template that will be designed for this purpose, FCV manufacturers participating in the demos will provide data on production costs of their FCV demos and the break-down of those costs. The data gathered from the FCV manufacturers will be analyzed to establish the typical FCV production cost distribution. Results will be presented at workshops under Output 1.1.2 and will also be used to measure achievement with regard to project indicators on FCV production cost. [GEF *support is required for the technical assistance in the design and assessment of the FCV production costs of each FCV manufacturing demonstration activity*.]

Activity 1B.4.4: Documentation of findings from Activities 1B.4.1 and 1B.4.2 into clearly written and attractively presented annual reports on FCV demo operation and of findings from Activity 1B.4.3 into a similarly attractive one-time report on FCV costs. The annual reports will cover both technical results of operation and results from surveys of the public regarding their perception of FCVs. The reports, prepared by experts, will be disseminated by the PMO to stakeholders in industry, government, and academia and used as the basis of workshop presentations associated with Outcome 4 of this project. [*GEF support is required for the technical services needed in the preparation, publication, and dissemination of the demonstration reports.*]

98. **Component 2: Improvement of Hydrogen Production and Refueling System:** This component will focus on achieving improvement in China's hydrogen production vis-à-vis fuel provision for FCVs and on achieving improvement in the situation of its hydrogen refueling stations (HRSs). In hydrogen production, barriers to be addressed include lack of information on the economics of different hydrogen production methods and lack of renewable energy based hydrogen production in China on substantial scale to facilitate realization of the full "green" potential of FCVs. In the HRS arena, the project will address the barriers of limited numbers of HRSs on the ground in China (only two operational at present), lack of viable business models for such stations, high costs of such stations, and lack of data on HRS operation in China. The expected outcomes from activities associated with this component are: (1) reduced cost and improved viability of hydrogen production (especially renewable energy based hydrogen production) and of hydrogen refueling

stations; and (2) increased number of transport hydrogen producers and hydrogen refueling stations on the ground in China, including some (both producers and stations) using renewable energy to produce hydrogen.

Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations

99. Output 2A.1.1: Completed one-on-one technical assistance for investors in and managers of demo renewable energy based hydrogen production facilities. Technical assistance will enable investors and managers to incorporate international best practice into their efforts thus improving the viability and reducing the cost of renewable energy based hydrogen production in China. *(One-on-one technical assistance for renewable energy based hydrogen production)*

Activity 2A1.1.1: Conduct of individual technical assistance via site visits and follow-up conference calls with wind farms planning to produce hydrogen with excess wind power. Assistance will emphasize reducing costs and improving reliability of wind-based hydrogen production. Safety issues will also be addressed. One project partner/wind farm will be China Energy Conservation and Environmental Protection Corporation (CECEP) and its Zhangbei Wind Farm located north of Beijing in Hebei Province. Another will be a wind farm in Yancheng City, Jiangsu Province, the province bordering Shanghai to the north. The other partner and associated wind farm will be selected based on their interest in investing in on-site hydrogen production to utilize excess wind power. Work will be carried out by expert(s) in wind-energy-based hydrogen production. [*GEF support is required for the provision of the technical assistance to wind farms that plan to produce hydrogen*.]

Activity 2A.1.1.2: Identification of interested party, conduct of individual technical assistance, and provision of international liaison support at one site for land-fill methane-based production of hydrogen. Emphasis will be on reducing costs and improving reliability of biogas-based hydrogen production system through provision of insights from international experience. Safety issues will also be addressed. Work will be carried out by expert(s) in landfill methane-based hydrogen production. [*GEF support is required for outreach and the provision of technical assistance and international liaison support to landfill methane-based hydrogen production site*.]

100. Output 2A.1.2: Completed group capacity development for prospective investors in, and managers of, renewable energy based hydrogen production facilities, including publication and dissemination of capacity development materials. Group capacity building will bring knowledge of international best practice in renewable energy based hydrogen production to a large group of beneficiaries, thus stimulating further investment in this area as well as improved technical levels and cost reduction. (*Group capacity building for hydrogen production*)

Activity 2A.1.2.1: Conduct of a series of at least two workshops to address the needs of China's potential renewable energy based hydrogen producers. The workshops will cover opportunities in wind-farm based hydrogen production, solar PV-based hydrogen production, and landfill methane based hydrogen production. Training will emphasize means of reducing costs and raising reliability of renewable energy based hydrogen production systems. Safety issues will also be addressed. Consultants will be retained to design the training curriculum, lead the workshops, and provide written training materials that will be distributed to attendees and other interested parties. Prior to workshops, outreach for attendance will be conducted with as many potential renewable energy based hydrogen producers as possible. Special efforts will also be made to include as many women as possible. [*GEF support is required for the technical and logistical services needed in the design, organization, conduct and evaluation of workshops on renewable energy-based hydrogen production*.]

Activity 2A.1.2.2: Organization and conduct of international study tour to Germany for site visits and international exchange on renewable energy-based hydrogen production ("P to G," power-to-gas) and distribution of hydrogen via natural gas networks. Planning, itinerary, and interpretation will be handled via this project activity and provided to individuals from Chinese organizations investing in or interested in investing in renewable energy based hydrogen production. Special efforts will be made to include as many women technical experts as possible. [*GEF support is required for the technical and logistical services needed in the planning, organization, conduct and evaluation of the study tour, including services of counterpart entities in Germany*[36].]

Activity 2A.1.2.3: Design and conduct of a survey of China's renewable energy based hydrogen producers. This is for the purpose of verifying relevant project indicators associated with Outputs 2A.1, 2A.2, and 2B.1. The standard survey of all producers will involve gathering information on cost and price of hydrogen produced from renewable energy, annual and cumulative hydrogen production from wind farms and landfill methane, respectively, cumulative investment in renewable energy based hydrogen production, and total number of sites producing renewable energy based hydrogen. The survey will be conducted towards the EOP. Survey will also cover (i) employment related to renewable energy based hydrogen business at start of project and at time of survey; and (ii) proportion of renewable energy based hydrogen jobs held by women at start of project and at time of survey. [*GEF support is for the technical services required in the design and conduct of the survey*.]

101. Output 2A.2: Expanded knowledge-base on reducing production costs of transport hydrogen and establishing local hydrogen production facilities, including database of information on all aspects and applicable processes of hydrogen production (both non-renewable energy and renewable energy based). The expanded knowledge base will contribute to the reduction of costs in both non-renewable energy and renewable energy based hydrogen production. *(Information base on hydrogen production*.)

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Activity 2A.2.1: Preparation and conduct of a study for Nanhai District, Foshan City on local establishment of hydrogen production to supply an expanding fleet of fuel cell vehicles and other applications. The study will compare the pros and cons of options for local hydrogen production, including industrial by-product, industrial (non by-product), and renewable energy-based. It will look at ways of reducing the relatively high price of hydrogen in Foshan. *[GEF support is required for technical services needed for the study.]*

Activity 2A.2.2: Conduct of a comparative economic analysis (including investment, operation, maintenance, etc.) of different hydrogen production models, including natural gas reforming, hydrogen recovery from industrial waste gas streams, other industrial hydrogen production processes, renewable energy based power generation (using wind and PV generated power for hydrogen production through water electrolysis), and biogas/landfill methane based hydrogen production.. *[GEF support is required for the technical services needed for the study.]*

Activity 2A.2.3: Conduct of a study on increasing the energy efficiency of hydrogen produced from recovery from industrial waste gas streams. The study will look at the main methods being used in China or likely to be used in China in the future and will propose methods of reducing use of fossil fuels in producing hydrogen from industrial waste gas streams. It will also assess baseline and potentially reduced GHG emissions associated with the different methods. *[GEF support is required for the technical services needed for the study.]*

Activity 2A.2.4: Preparation of database of information on all aspects and applicable processes of hydrogen production (both non-renewable energy and renewable energy based). Database will include the three studies produced via Output 2A.2's other activities, as well as other relevant materials. This activity will involve cooperation with china-hydrogen.org to house and

[36] Travel and accommodation expenses will be borne by the organizations of the individual industry attendees, while GEF funds will support travel of project management staff (one) and government officials (two) that attend.

disseminate the database and continue upkeep after project close. *[GEF support is required for database preparation, including collection of information on all applicable processes for hydrogen production.]*

102. Output 2A.3.1: Completed one-on-one technical assistance for investors in and managers of project demo hydrogen refueling stations and manufacturers providing equipment to such stations (including manufacturers of hydrogen gas compressors and hydrogen refueling dispensers). One-on-one technical assistance will contribute to increased viability and lowered cost of hydrogen refueling stations, via approaches such as improved business models and local availability of quality equipment. *(One-on-one technical assistance for hydrogen refueling stations and related equipment manufacturers)*

Activity 2A.3.1.1: Conduct of individual technical assistance to proposed Foshan hydrogen refueling station in developing a business plan for commercially viable operation. The plan may include multi-fuel strategy (e.g. hydrogen, petroleum, CNG, etc.) and will be designed by a hydrogen refueling system expert. [*GEF support is required for the technical assistance in the development of business plan for the commercially viable operation of hydrogen refueling station*.]

Activity 2A.3.1.2: Conduct of individual technical assistance to one hydrogen refueling station to improve reliability and output of its onsite wind-PV based hydrogen production in an interested city in China where the station is built during the project period. Efforts will focus on reducing costs and increasing proportion of the station's hydrogen that is supplied via hybrid renewable energy system to attain target of 50 percent. [*GEF support is required for the technical services needed in improving the reliability and performance of onsite RE-based (wind/PV) hydrogen production facility at the hydrogen refueling station*.]

Activity 2A.3.1.3: Conduct of technical assistance to hybrid hydrogen and gasoline stations (one in Shanghai and one in Beijing) that are intending to include hydrogen refueling as part of their transport fuel retail services. *[GEF support is required for the technical services needed in the design, planning, engineering, and commercial operation of hydrogen refueling dispensing facilities that are incorporated in existing petrol fuel retail service stations*.]

Activity 2A.3.1.4: Technical assistance and facilitation assistance to increase reliability and reduce cost of product of domestic compressor manufacturer supplying China's hydrogen refueling stations. The likely candidate is Beijing Tiangao. The support will include increasing reliability, control of production, and sourcing of parts. In addition to support from compressor expert, support in facilitating cooperation with international HRS compressor manufacturer will be provided. [*GEF support is required for the technical expert services needed for improving the reliability and performance, and reducing the cost of production of locally manufactured HRS gas compressor equipment/systems and for facilitation of international cooperation with counterpart international HRS compressor manufacturer*.]

Activity 2A.3.1.5: Technical assistance and facilitation assistance to lower cost and increase reliability of product of domestic hydrogen refueling dispenser manufacturer supplying China's hydrogen refueling stations. The likely candidate is Sunwise, based in Shanghai. The support will address three areas: sourcing, assistance in adjusting technical methodology, and liaison support for potential cooperation with counterpart international hydrogen refueling dispenser manufacturer. [*GEF support is required for the expert technical services needed for improving the reliability and performance and reducing the cost of production of locally manufactured hydrogen gas dispensing equipment/system and for facilitation of international cooperation with international counterpart manufacturer of hydrogen refueling dispensers*.]

103. Output 2A.3.2: Completed group capacity development for prospective investors in hydrogen refueling stations, manufacturers providing equipment to such stations, and relevant service providers, including publication and dissemination of capacity development materials. Group capacity building in hydrogen refueling stations and related areas will stimulate further activity in the sector and thus contribute to improved viability of business models and reduced cost of establishment. *(Group capacity development for hydrogen refueling stations and related equipment manufacturers and service providers)*

Activity 2A.3.2.1: Conduct of a series of two workshops to address the needs in the local hydrogen refueling industry in achieving lower investment costs, high safety performance, better reliability, and viable financial performance. Topics covered in workshops will include, but not be limited to: (i) global and Chinese situation of hydrogen refueling station establishment, operation, policy, and market; (ii) design of hydrogen refueling stations; (iii) sourcing of parts for hydrogen refueling stations (and potential alternatives to high-cost imports, such as key valves, hydrogenation spears, and hydrogen pipes); (iv) compression and cooling equipment for hydrogen refueling stations; (v) water electrolysis unit for onsite and off-site production of hydrogen using renewable energy; (vi) hydrogen refueling dispensers; (vii) financially viable business models for hydrogen refueling stations, such as multi-fuel offerings (e.g. hydrogen, gasoline, and CNG), and (viii) safety issues. Consultants will be retained to design the training curriculum, lead the workshops, and provide written training materials. Prior to workshops, outreach for attendance will be conducted with all existing investors in the hydrogen refueling sector, investors with interest in the sector, and key service and equipment providers. Special efforts will also be made to include as many women as possible. [*GEF support is required for the technical and logistical services needed in the design, organization, conduct, and evaluation of workshops on improving the operating cost, reliability, safety, and financial viability of hydrogen refueling businesses*.]

Activity 2A.3.2.2: Organization and conduct of international study tour to visit hydrogen refueling stations and discuss strategies with international counterparts. This project activity will include the conduct of planning and liaison, provision of itinerary, and provision of interpretation during visit. Current and potential investors in hydrogen refueling stations will be invited to attend the study tour. Special efforts will also be made to include as many women as possible. [*GEF support is required for the technical and logistical services needed in the planning, organization, conduct, and evaluation of the study tour, including services of counterpart entity in Germany*[37].]

Activity 2A.3.2.3: Design and conduct of a survey of China's HRSs. This is for the purpose of verifying relevant project indicators associated with Outputs 2A.3.1, 2A.3.2, and 2B.2. The standard survey will involve gathering and analysis information on the number and type of different business or operation models being used at China's hydrogen refueling stations, the cost of setting up HRSs (and associated scale), the total number of HRSs in China, and the cumulative hydrogen distributed through HRSs. For those stations participating in the project's one-on-one technical assistance, information will be gathered on whether and how the assistance impacted the station's strategy or operation. The survey will be conducted towards the EOP. Survey will also cover (i) employment related to HRS business at start of project and at time of survey; and (ii) proportion of HRS-related jobs held by women at start of project and at time of survey. [*GEF support is for the technical services required in the design and conduct of the survey.*]

Activity 2A.3.2.4: Design and conduct surveys of individuals that participated in: (a) group training for renewable-energy based hydrogen production; and (b) group training for HRS establishment. This is for the purpose of verifying relevant project indicators associated with Outputs 2A.3.1 and 2A.3.2. The surveys will each gather information on whether individuals

[37] Travel and accommodation expenses will be borne by the organizations of the individual industry attendees, while GEF funds will support travel of project management staff (one) and government officials (two) that attend.

are applying what they've learned through the training, and will be conducted towards the EOP. [*GEF support is for the technical services required in the design and conduct of the survey*.]

Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using renewable energy to produce hydrogen

104. Output 2B.1: At least four completed demonstrations of the application of reliable and cost-effective renewable energy-based hydrogen production, including wind based and landfill methane based, and plan for replication of demos. These demonstrations will introduce renewable energy-based hydrogen production of significant scale to China and increase the number of such hydrogen producers in the country. *(Demonstration of renewable energy based hydrogen production business units)*

Activity 2B.1.1: Planning, construction, and operation of four renewable energy based hydrogen production facilities including wind energy-based and landfill-methane based. Activity will include securing of financing, any permitting necessary, procurement and installation of equipment, and testing and commissioning. Work will incorporate recommendations from technical assistance of Activity 2A.1.1.1 and Activity 2A.1.1.2.[38] [*GEF support is not required; all expenses covered by co-financing*.]

Activity 2B.1.2: Design and initiation of plan for replication and scale-up of renewable energy based hydrogen production demos at other sites. Replication plan will incorporate liaison with other potential renewable energy based hydrogen producers, including those attending capacity building workshops and study tour under Activity 2A.1.2.1 and 2A.1.2.2. [*GEF support is required for expert input into replication plan*.]

105. Output 2B.2: At least four and possibly up to eight completed demonstrations of the operation of hydrogen refueling facilities via establishment of new stations or adoption of new approaches at existing stations.[39] These demonstrations will increase the number of hydrogen refueling stations that are operational in China, as well as the number of different HRS business models demonstrated. They will provide a critical mass for data collection and analysis of HRS operation in China. *(Establishment and operation of demo hydrogen stations)*

Activity 2B.2.1: Planning, construction, and operation of at least three new demo hydrogen refueling stations. Cities in which new stations will be constructed may include: Beijing, Shanghai, Foshan, Zhengzhou, and others. Beijing's station will be a second one for the city and may be located in the southeast part of the city. (Beijing's first and currently operational station is in the northwest part of the city.) Additional demo stations will include one in an interested city that will have wind-PV hybrid onsite hydrogen production. [*GEF support is not required; all expenses covered by co-financing*.]

Activity 2B.2.2: Addition and operation of electric vehicle charging facility (and associated solar PV system) to Anting Hydrogen Refueling Station in Shanghai. This will be China's first hybrid station that has both hydrogen refueling and electric vehicle recharging. This is to showcase a business model for diversified fuel dispensing services to make H2 refueling station investments more economically viable. The work on this activity will include design, procurement of equipment, testing, and commissioning. [*GEF support is not required, all expenses covered by co-financing*.]

[38] Monitoring, evaluation, reporting and dissemination of these four renewable energy based hydrogen production demos will be carried out under Activities 2.B.3.1, 2B.3.4, and 3B.3.5.
[39] Monitoring, evaluation, reporting and dissemination of these four to eight hydrogen refueling demos will be carried out under Activities 2.B.3.2, 2B.3.4, and 3B.3.5. Planning for replication and scale-up will be carried out under Activity 4.2.2.

Activity 2B.2.3: Outreach to existing gasoline stations for hosting of hydrogen refueling and technical assistance in the addition of hydrogen refueling to at least two such stations, one in Beijing and one in Shanghai. Hybrid operation of stations. Outreach will include identification of promising candidates and presentation to them of details of the opportunity and technical requirements. Assistance in the addition of hydrogen refueling to the two stations will include guidance in design and permitting, as well as other technical assistance, such as installation of equipment, testing, and commissioning. [*GEF support is required for the design and conduct of the outreach activity and the conduct of technical assistance.*]

106. Output 2B.3: Clearly documented and disseminated results on operation and public perception of hydrogen refueling stations and hydrogen production units (annual reports), investment costs (one-time reports), and revenue and operational costs (annual reports). Documented and disseminated results will allow both for proof of concept (which may stimulate replication) and lessons learned to enhance future design and operation of HRSs in China. *(Monitoring, documentation, and dissemination of results of investment in and operation of demo hydrogen stations and demo hydrogen production units)*

Activity 2B.3.1: Monitoring, annual reporting, and dissemination of results of renewable energy-based hydrogen production, as well as making of recommendations based on findings. This activity will cover the demo wind-based hydrogen production sites and the landfill methane based hydrogen production site. Work will be conducted by expert in renewable energy based hydrogen production and cover both technical and financial aspects of operation. [*GEF support is required for the technical assistance in the analysis, publication and dissemination of the findings and recommendations from the RE-based H2 production demos*.]

Activity 2B.3.2: Design of data collection plan and conduct of data collection/monitoring for operational phase of demo hydrogen refueling stations. Preparation and dissemination of annual reports on findings. Separate sub-sections will be prepared on each of (1) standard stations (Zhengzhou, Foshan, and second Beijing station), (2) on-site renewable energy based hydrogen production (other interested city), (3) if possible, hybrid hydrogen and gasoline station (targeted for one Beijing and one Shanghai gasoline station), which will require the development of a new standard and obtaining of permission for space utilized, and (4) addition of electric vehicle recharging to hydrogen refueling station (Shanghai's Anting station) in order to provide insights on these different models. Monitoring plan will include both financial and technical parameters. The technical parameters will serve as the basis of *China Hydrogen Refueling Station (HRS) Reliability Database*, modeled on international best practice. In addition to periodic recording of parameters, the monitoring plan will accommodate the recording of special issues or problems that may arise. It will be centrally designed via consultation with hydrogen experts, so that collected information can be compared across refueling stations. The *China HRS Reliability Database* may also be integrated with international efforts in HRS reliability data sharing. [*GEF support is required for the technical assistance in the design of the data collection system and in the conduct of the data collection work*.]

Activity 2B.3.3: Conduct of annual survey on the public's perception of hydrogen production and hydrogen refueling stations and reporting of findings. The survey will seek to see if the public continues to have safety concerns about hydrogen infrastructure and whether this has lessened via the awareness building activities of Outcome 4.[40] If any cities in which new HRSs will be built do not have a standard consultative process with nearby residents regarding new installations, survey in its first year will serve to initiate such a process in such cities. [*GEF support is required for the technical assistance in the design, conduct, and analysis of the public perception survey*.]

[40] These surveys will be distinct from the surveys of Activity 1B.4.2 in that they will focus on persons living or working in the vicinity of the hydrogen refueling stations or hydrogen production units. The other survey will focus on persons that have been exposed to FCVs.

Activity 2B.3.4: Collection of information from hydrogen production demo investors and hydrogen refueling demo investors on up-front investment costs using the project-designed data collection template, and reporting of findings from the data collection process. Expert(s) will design templates for collection of needed parameters, conduct the required analyses, and prepare report of findings. *[GEF support is required for the technical assistance in the design of the templates, data gathering work, and the reporting of the findings and recommendations from the hydrogen production demos and the HRS demos.]*

Activity 2B.3.5: Integration of reports prepared for Activities 2B.3.1, 2B.3.2, 2B.3.3, and 2B.3.4 into annual consolidated monitoring reports of hydrogen production demos and hydrogen refueling station demos that also include findings from one-time report on investment costs of these demos. Thus, the annual reports will cover both renewable energy based hydrogen production and hydrogen refueling stations of several types. Further, they will include technical and financial data related to operation, data from surveys of public perception of these installations, and one-time data on investment. Findings, prepared by consultants, will be presented in clear and attractive documents that will be widely disseminated by PMO to government officials, industry, investors, and relevant researchers/academics. [*GEF support is required for the technical services needed in preparation and publication of the M&E reports*.]

107. **Component 3: Policy and Regulatory Frameworks for the Application and Commercialization of FCVs:** This component focuses on achieving policy and regulatory frameworks that will facilitate the commercialization of FCVs in China. Key barriers to be addressed include: absence of a national *FCV Roadmap*, incompleteness of standards and certification systems (and lack of harmonization with international standards in some cases), difficulties in obtaining national-level approval for new models of FCVs and in obtaining license plates from local authorities that allow permanent operation of each individual FCV, lack of stability in incentive policies, and lack of broader approaches (beyond subsidies only) in incentivizing FCVs and HRSs. The component will address both national-level and local-level policy, regulation, and implementation and will include the conducting of pilots of incentive policies that are new to China. The expected outcomes from the activities that will be carried out under this component are: (1) effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs; and (2) adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations.

<u>Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs</u>

108. <u>Output 3A.1</u>: Approved and implemented national *China FCV and Hydrogen Refueling Roadmap* and local counterpart roadmaps. The roadmaps will increase confidence and interest of cities and other investors so that FCVs will be adopted at a more rapid pace in China. *(National and local FCV/hydrogen roadmaps)*

Activity 3A.1.1: Preparation of draft *China FCV and Hydrogen Refueling Roadmap* covering the areas of: (1) FCV cost reduction, durability improvement, and performance enhancement; (2) increased availability of key FCV parts at lower prices locally and/or through improved international sourcing; (3) reduced cost, increased volume, and improved reliability of hydrogen production in China, particularly of hydrogen produced via renewable energy; (4) establishment of hydrogen refueling stations; (5) availability of cost effective/reliable equipment and services for hydrogen refueling station establishment (including compressors and hydrogen refueling dispensers); (6) availability of qualified O&M personnel for FCVs and hydrogen refueling stations; and (7) availability of financing for FCV manufacture and associated value chain, for hydrogen refueling stations and associated value chain, and for FCV purchase. The roadmap will indicate targets in each of these areas and the steps that will be taken to reach them.

Functionally, the roadmap will cover the areas of policy, government funding/investment, and investment by businesses. In preparing the roadmap, the expert team retained for this task will review the roadmaps/strategies of other countries as well as take the special situation of China into consideration. [*GEF support is needed for the required technical services in the drafting of the Roadmap*.]

Activity 3A.1.2: Organization and conduct of national workshop on *China FCV and Hydrogen Refueling Roadmap*. At the workshop, sessions will be held on key topics covered in the *Roadmap*. The workshop will attract attendance of key policymakers and hold substantial discussions that will lead to consensus building on, adoption of, and implementation of the *Roadmap*. In the end, the adopted *Roadmap* may incorporate elements of attendees' draft proposals. [*GEF support is required for the technical and logistical services needed in the organization and conduct of the national workshop*.]

Activity 3A.1.3: Drafting, consensus building, and adoption of local-level *FCV and Hydrogen Refueling Roadmap* (as counterpart to the national *Roadmap*) in at least four cities. Local steering committees associated with the project in the four demo cities, as well as officials in other cities, will organize the development of their own local roadmaps with the assistance of experts. The local roadmaps will take their lead from and build upon the national *Roadmap* in their content. Local meetings will be held to build consensus on each of the draft local roadmaps. [*GEF support is required for expert input in designing the local roadmaps.*]

109. <u>Output 3A.2</u>: Newly approved and enforced internationally compatible FCV, hydrogen station, hydrogen fuel transport, and associated parts standards, testing/measurement methods, and certification, filling the gap in terms of standards/testing/certification not yet in place. A complete and robust system of standards and certification will increase confidence of approval bodies, thus leading to smoother adoption of FCVs. *(Standards, testing, and certification for FCVs, hydrogen stations, hydrogen transport, and associated parts)*

Activity 3A.2.1: Identification of priority gaps in China's existing standards for FCVs, hydrogen stations, and hydrogen production/transport, as well as priority areas in which harmonization with international standards may be increased. Experts with relevant expertise in each area will review existing Chinese standards, as well as international counterpart standards. Based on their review, they will identify gaps and propose areas for revision to the relevant committees responsible for designing standards in each area. [*GEF support is required for the technical services needed in the evaluation of existing local standards for FCVs, hydrogen refueling stations, and hydrogen fuel production and transport*.]

Activity 3A.2.2: Meetings on and deliberation of proposed standards by relevant officially-appointed standards committees. Based on recommendations generated from Activity 3A.2.1, standards committees will formulate and revise relevant FCV, hydrogen station, and hydrogen production and transport standards. New/revised standards will then be adopted and enforced. [*GEF support is not required; all work of officially-appointed standards committees will be co-financed*.]

Activity 3A.2.3: Development, promotion, and approval of testing and certification system for FCV vehicles, hydrogen refueling stations, and products supporting the FCV industry, such as hydrogen cylinders. Experts in each relevant area will review certification testing and certification needs, as well as international experience in these areas. Based on findings, experts will design testing and certification system. [*GEF support is required for the technical services needed in the development and promotion of testing and certification system*.]

Activity 3A.2.4: Design and conduct of a survey of FCV manufacturers and their products. This is for the purpose of verifying relevant project indicators associated with Output 3A.2. The purpose of the survey is to determine and evaluate how many of the products are compliant with new standards. The survey will be conducted towards the EOP. [*GEF support is for the technical services required in the design and conduct of the survey*.]

Activity 3A.2.5: Development, adoption, and enforcement of standard safety and fire protection regulations and procedures for FCVs and hydrogen infrastructure. Experts will identify needs with regard to safety and fire protection and also review international experience as a part of this process. Based on findings, they will design recommendations for relevant government regulatory departments. Departments will then meet to deliberate and adopt proposed measures, which will then be enforced. [*GEF support is required for identifying safety and fire protection needs for regulations and procedures and for proposing recommendations to relevant government departments*.]

110. Output 3A.3: Expedited approval by central government of new FCV models, expedited local issuance of license plates for individual FCVs for long-term operation, and expedited local approval for new hydrogen stations.[41] Expedited approval processes will eliminate what were previously major barriers to the smooth demonstration of FCVs and thus accelerate the FCV commercialization process. (*Expedited approval of FCVs and HRSs*)

Activity 3A.3.1: Conduct of advocacy and lobbying meetings and other forms of education for relevant national-level authorities and local officials to achieve: (i) expedited approval (*gongao*) of FCV manufacturers for production of FCV vehicles (by central government);[42] (ii) expedited issuance of long-term license plates to FCV operators for individual vehicles (by local officials); and (iii) expedited approval of hydrogen refueling stations (by local officials). Activity will include design and recommendation of processes and implementing rules and regulations (IRR) to expedite each of these approval/issuance processes. Meetings with central government will occur in Beijing. Meetings with relevant local officials will occur, at minimum, in the project's main demo cities (Shanghai, Beijing, Zhengzhou, and Nanhai/Foshan). In addition to the central government, key target organizations will include the local public security bureau (*gonganju*), local transportation management bureau (*jiaoguanju*), and others, as necessary. [*GEF support is required for the technical services needed in the formulation of policies, IRRs, licensing/certification procedures, and educational materials for central and local officials as needed; and in advocacy and lobbying work to secure approval of policies, IRRs, manufacturer model registration, and individual vehicle licensing requirements*.]

Activity 3A.3.2: Holding of seminar on fire safety of FCVs, hydrogen production, hydrogen fuel transport, and hydrogen refueling stations with participation of relevant officials, experts, and companies. Experts will design content of seminar based on identified issues and international experience. Targeted invitees will be national and local officials whose purview includes approval and/or management of motor vehicles and hydrogen infrastructure. [*GEF support is required for the technical and logistical services needed in the design, organization conduct and evaluation of the seminar-workshop*.]

111. Output 3A.4: Approved updated and enhanced incentive policy for FCV purchase. Enhanced and stable incentive policy will increase the confidence of cities in implementing FCV demos as well as increase the interest of consumers in purchase of FCVs for individual use. *(Enhanced incentive policy for FCV purchase)*

Activity 3A.4.1: Preparation of proposed extension and improvements to current incentive policy for FCV purchase. A primary aim is to extend the duration over which the current national FCV

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[41] At present, only one model of FCV in China (sedans produced by SAIC) has permission from relevant national-level authorities for production for public use and has license plates issued by local officials for long-term operation. Previous FCVs in China gained permission only for temporary use, such as during the Olympics. This output will benefit from the standards and certification work of Output 3A.2

[42] In some cases, as it will take time for the standards and certification system to be improved, the project will need to seek "exceptions" from relevant national-level authorities to expedite approval process.

subsidy will be applied to the period between 2016 and 2020.[43] Improvements or refinements in the national policy will also be recommended. These will reflect increases in the number and types of FCVs available in China. Meetings will be held with policy makers and/or briefs will be prepared for them, promoting adoption of the extension and other measures. In addition to national-level policy, certain local-level policies encourage new energy vehicles (without differentiation between electric vehicles and FCVs). This activity will also include initiatives to extend (for FCVs, in particular) local preferential new energy vehicle policies (such as free vehicle plates issuance in Shanghai and sped up position in the queue for auto purchase in Beijing) or to even enhance these for FCVs, in particular. [*GEF support is required for the technical assistance needed in the design and lobbying for enhanced incentive policies*.]

112. Output 3A.5: Approved updated and enhanced incentive policy for hydrogen refueling station establishment. An enhanced incentive policy for HRS establishment will accelerate the pace of investment in new stations, thus increasing FCV user confidence that they will have a place to refuel their vehicles. *(Incentive policy for hydrogen refueling station establishment)*

Activity 3A.5.1: Preparation of proposed extension and improvements to current national incentive policy for establishment of hydrogen refueling stations. A primary aim is to extend the duration over which the current hydrogen station subsidies will be applied to continue at the same level. Improvements or refinements in the policy will also be recommended. Meetings will be held with policy makers and/or briefs will be prepared for them, promoting adoption of the extension and other measures. Extension and enhancement of local-level incentive policies for hydrogen refueling stations will also be pursued. [*GEF support is required for the technical services needed in the design and lobbying for enhanced incentive policies*.]

Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations

113. Output 3B.1: Designed and agreed upon local-level FCV and hydrogen refueling station incentive policy pilots (at least two in total) that are novel in China, but may have been implemented elsewhere in world. Pilots will incentivize FCV purchase and investment in hydrogen refueling stations. Design and agreement on novel policies will extend the scope of incentive types available in China for FCVs. *(Designed and agreed upon local-level policy pilots)*

Activity 3B.1.1: Solicitation and vetting of ideas for novel FCV and hydrogen station incentive policies for discussion among experts and local policy makers. Incentive policies used elsewhere in the world (such as in the California Fuel Cell Partnership), but not yet in China, will be reviewed and considered. Preliminary ideas include: access to priority lanes (e.g. bus lanes) for FCVs, preferential or free parking spaces for FCVs, and standards and incentive policy for four-in-one, three-in-one, or two-in-one refueling stations (stations that include hydrogen fuel and other types of refueling on the same premises). Ideas will be discussed with local governments who are active in the FCV field and particularly the four cities that are the demo locations for the project's FCVs. [*GEF support is required for the technical assistance in development and assessment of new incentive policy ideas and recommendations on FCV and hydrogen refueling initiatives*.]

Activity 3B.1.2: Design of and reaching of consensus on policy pilots. Based on ideas vetted in Activity 3B.1.1, design will first involve liaison with local government and reaching of

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[43] At the time of project formulation, proponents of FCVs were already working on advocating an extension of FCV subsidies without reduction through the period of 2016 to 2020. For subsidies for pure battery electric vehicles and for plug-in hybrid electric vehicles in China, the years 2016 to 2020 will be divided into 3 phases. In 2016, the subsidy will be maintained; in 2017 and 2018, it will be reduced by 10%; and in 2019 and 2020, it will be reduced by 30%. As FCVs are just emerging on the market, it is targeted to secure for them more steady support via subsidies – at the same level as at present – up through 2020.

consensus on location(s) for policy pilots and on the nature of those pilots. Detailed design of policy pilots will then be carried out. There will be at least two local policy pilots. [*GEF support is required for the technical and logistical services needed in the design and implementation mechanisms for policy pilots*.]

114. Output 3B.2: Successfully implemented local-level policy pilots (as designed in 3B.1) with monitoring, annual documentation, and dissemination of results. Implementation of policy pilots will provide proof of concept and lessons learned so that these novel incentive policies can be extended to other locations in China and further stimulate the purchase of FCVs and/or investment in hydrogen refueling stations. *(Implementation, monitoring, documentation, and dissemination of local-level policy pilots)*

Activity 3B.2.1: Implementation of agreed upon local-level policy pilots, of which there will be at least two. This will include preparation and approval of required government notices or other documentation, outreach to potential investors/buyers, and granting of promised preferential treatment. [*GEF support is required for technical assistance in implementation; the expenses of actual implementation of the policy pilots are covered by co-financing*.]

Activity 3B.2.2: Design and implementation of plan to monitor results of the two or more local-level policy pilots. The activity will also include documentation of results and dissemination. The monitoring plan will assess the effectiveness of outreach to potential buyers/ investors and seek to understand how influential preferential policies were in impacting their FCV/HRS related behavior. It will further assess the numbers of stakeholders influenced by the relevant pilot policy. [*GEF support is required for the technical assistance in the design and implementation of the monitoring plan, as well as in the documentation, publication and dissemination of the results and recommendations from the policy pilots*.]

Activity 3B.2.3: Design and conduct of survey of cities to determine and evaluate how many have developed their own local *FCV and Hydrogen Refueling Roadmap*. This is for the purpose of verifying relevant project indicators associated with Outputs 3A.1, 3A.4, 3A.5, 3B.1, 3B.2. The survey will also gather information on how many cities have their own local incentive policy for FCVs and/or HRSs and evaluate whether these are traditional-type incentive policies or policies new to China. The survey will be carried out towards the EOP. [*GEF support is for the technical services required in the design and conduct of the survey*.]

115. **Component 4: Enhancement of Information Dissemination and Awareness about FCV Transport Systems:** This component will enhance awareness of FCVs by and achieve FCV-related information dissemination to the public, national-level and local-level officials, companies that are end users of FCVs, FCV experts, FCV manufacturers, and other relevant stakeholders. Key barriers to be addressed include: the public's lack of awareness of FCVs and (in cases they are aware) their concerns about hydrogen safety; government officials' lack of awareness of FCVs and lack of access to information that will increase their confidence in pursuing demonstration programs and enable them to implement such programs effectively; and lack of easy access by experts and FCV manufacturers to information on China's FCV market and on developments in FCVs around the world. The expected outcome of the activities undertaken as part of this component is: enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness.

Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness

116. Output 4.1: Completed FCV public advocacy program in at least four cities that both alleviates the public's safety concerns regarding hydrogen and attracts consumers to purchase FCVs. The advocacy program will result in a much large proportion of the public being aware of FCVs. It will also give them reasons to be less concerned regarding safety issues than they were

previously, thus resulting in enhanced acceptance of FCVs. *(Public awareness and info dissemination)*

Activity 4.1.1: Conduct of media campaign targeting the press in the four demo cities as well as nationally. Media campaign will both highlight the commercialization progress represented by the demos and provide information regarding the safety of FCVs and hydrogen. Print, online, and broadcast media will all be targeted. [*GEF support is required for the technical services needed in the design and implementation of the media campaign*.]

Activity 4.1.2: Preparation, production, and dissemination of leaflets/brief brochures on the characteristics and benefits of FCVs to be displayed in FCBs, at FCV auto test ride locations in Shanghai, and at relevant booths at public events. Brochures will discuss environmental benefits and consumer benefits, as well as provide information regarding the safety of FCVs and hydrogen. [*GEF support is required for the technical assistance in the design, preparation, production, and dissemination of leaflets/brief brochures*.]

Activity 4.1.3: Design and conduct of a survey of individuals that were involved in the project advocacy program. This is for the purpose of verifying relevant project indicators associated with Output 4.1, and in particular, assess how the program has changed their views about FCVs. [*GEF support is for the technical services required in the design and conduct of the survey*.]

Activity 4.1.4: Design, production and airing of a documentary on FCVs on TV in China. The documentary will feature the project demos as well as FCV developments around the world. It will discuss the future prospects of the hydrogen economy. It will also provide information regarding the safety of FCVs and hydrogen. The services of an experienced producer will be engaged to prepare the documentary and target getting it aired on a major program in China, such as *Discovery* (*探索*). [*GEF support is required for the technical and logistical services needed in the design and production of the FCV film documentary, as well as to ensure airing on prime time, if possible*.]

Activity 4.1.5: Design and production of video material to counter myths regarding the safety of hydrogen. The video will be presented as an experiment, but in a fun and attractive way. It will be uploaded to the internet and the link will be provided in materials generated by other activities under this output, as well as being promoted through other avenues. The project will target participation in well-known science documentary programs produced and aired on cable TV. *[GEF support is required for the technical and logistical assistance in the design and production of the video, including set-up and conducting of experiment as part of the video*.]

117. Output 4.2: Completed knowledge and awareness program for policy makers (national and local), managers, and experts and associated plans adopted for replication of FCV demos in additional cities and scale-up in existing demo cities. Program will encourage cities to deploy FCVs in their passenger transport fleets, set up hydrogen refueling stations, and adopt local policies to promote FCVs and will result in a sustainable follow-up plan to replicate the project FCV and HRS demos in other cities and scale it up in participating cities. This program will lead to enhanced acceptance of FCVs by policy makers and will be instrumental in achieving replication of project demos in other cities. *(Information dissemination to policy makers, managers, and experts for replication in other cities and scale-up in existing demo cities.)*

Activity 4.2.1: Conduct of annual workshops for city officials from the demo cities and from other cities that may have the potential for adopting their own FCV and hydrogen refueling programs.[44] The workshops will present findings and lessons learned from operation of the

[44] Cities like Dalian, Changshu, Guangzhou, Shenzhen, and Wuhan are known as key cities for demonstrations. Many other cities will also be of interest, including a number that, at time or project design, are seriously considering an FCV demo

demo FCVs, hydrogen production installations, and hydrogen refueling stations, as well as results of the policy pilots. Findings will include results from monitoring activities under Outcomes 1B, 2B and 3B. Presenters will include pertinent information to help existing demo cities improve their programs and to help other cities with an interest in pursuing FCV programs design their plans. [*GEF support is required for the technical and logistical services needed in the design, organization, conduct, and evaluation of the workshops*.]

Activity 4.2.2: Based on consultation with relevant national and city officials, design of a sustainable follow-up plan to replicate the project FCV and HRS demos in other cities and scale it up in participating cities. Plan will include strategies for procurement of high performance vehicles and for effective operation and monitoring of the new demos. Plan will be designed in second half of project, once sufficient data and lessons learned from the original project demos has been obtained. [*GEF funds will be required to support expert input to design of replication and scale-up action plan for FCVs and HRSs*.]

Activity 4.2.3: Annual international forums and international study tour on FCVs and hydrogen infrastructure. The purpose of these is to conduct technical and information exchange among counterparts and to strengthen understanding and acceptance of government policy makers on the development of fuel cell vehicles at home and abroad. Special efforts will also be made to include as many women as possible. The international forums will be conferences based in China, whereas the study tours will aim to educate policy makers on FCV related initiatives in other countries. [*GEF support is required for the technical and logistical services needed in the organization and conduct of international forums and study tour, including with regard to the study tour travel for four policy makers and one PMO staff member Organizations of other participating individuals will pay for their travel. Study tour expenses will also cover costs of services provided by counterpart entities in the country or countries visited.*]

Activity 4.2.4: Building and updating of project website; issuance of bi-monthly newsletter. Project progress and FCV and hydrogen refueling station operation results will be updated periodically on the website. Database of information on hydrogen production processes prepared through Activity 2A.2.4 will also be made available through the project website, along with links to partner organization in hydrogen production dissemination. [*GEF support is required for technical services needed in the design and establishment of the project website*.]

Activity 4.2.5: Design and conduct of broad survey of individuals, officials, and organizations that purchase/use vehicles regarding their awareness and perception of FCVs. This is for the purpose of verifying relevant project indicators associated with Outputs 4.1 and 4.2. This survey will be conducted both at beginning of project and by EOP. [*GEF support is for the technical services required in the design and conduct of the survey.*]

118. Output 4.3: Established *China FCV Market and Technology Monitoring System* that provides up to date information on FCV manufacturing and market in China as well as information on new technological developments and applications worldwide and assessment of which may be applicable and economically viable in China. The *Monitoring System* will further enhance acceptance of and information on FCVs in China by making information on China's FCV market and FCV technology globally available to anyone who has an interest. *(China and global FCV information base)*

Activity 4.3.1: Development, operation and maintenance of an online database and monitoring system on China's FCV manufacturing and market, as well as new FCV technological developments and applications worldwide. The system will be known as *China FCV Market and Technology Monitoring System*. The services of a firm or non-profit organization will be

program. At least one or two persons from each interested city will be encouraged to attend the project's annual workshops for cities.

retained to design and update this database and monitoring system. One candidate is Shanghai New Energy Vehicle Public Data Collection and Monitoring Research Center, which is currently maintaining a monitoring system of alternative energy vehicles in Shanghai. The monitoring work will require monthly contact with China's FCV manufacturers and distributors as well as with its registration bodies to determine technological developments, the number of new FCVs sold, and the total number of FCVs on the road in China. The contractor will also monitor a number of key information sources on developments in FCVs and hydrogen infrastructure internationally, providing links and summary translations of key articles. The contractor will further provide assessment of which technologies and other developments internationally are applicable and economically viable for China. As a part of this activity, a plan will be developed to sustain updating of the online FCV database and monitoring system after project close. [*GEF support is required for the technical and logistical services needed in the design, development, operationalization, and maintenance of the online database and monitoring system*.]

Activity 4.3.2: Design and conduct of a survey of individual experts utilizing the project's *China FCV Market and Technology Monitoring System*. This is for the purposes of verifying relevant project indicators associated with Output 4.3. The survey will involve gathering information on whether the technical updates of the system have been useful to the experts, and will be conducted towards the EOP. [*GEF support is for the technical services required in the design and conduct of the survey.*]

119. Component 5: FCV Technology Capacity Development Program: This component will build human capacity in the areas of O&M for FCVs and HRSs and of financing of the FCV sector. The key barriers that will be addressed include: lack of capacity for O&M of FCVs (a substantial problem in the past that led to discontinuation of FCV operation), lack of capacity for O&M of HRSs (an anticipated problem as the number of HRSs increases), lack of awareness of the financial sector of FCV-related financing opportunities, and lack of capacity of the financial sector to assess such opportunities. The expected outcomes that will be generated from the activities undertaken as a part of this component are: (1) increased technical capacity for O&M of FCVs and hydrogen refueling stations; and (2) increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/commercial purchase of FCVs.

Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations

120. Output 5A.1: Qualified contingent of persons to operate and maintain FCVs and qualified contingent of persons to operate and maintain hydrogen refueling stations in each of the four demo cities as well as in other cities in which replication is taking place. This qualified contingent of persons will ensure sustainability of project demos, overcoming a barrier encountered in previous efforts. With qualified personnel among the operators' ranks, O&M can be continued beyond the period guaranteed by manufacturers. MOST will be the government entity declaring the trained personnel qualified. *(Qualified persons for FCV O&M and for hydrogen refueling station O&M)*

Activity 5A.1.1: Conduct of group training program on FCV operations and maintenance before initiation of project demo FCV operation. Instructors will design the program and provide written materials. Attendees will come from demo city organizations planning to operate the demo FCVs as well as from other cities that hope to institute FCV programs. [*GEF support is required for the technical and logistical services needed in the design, organization, and conduct of the group training program*.]

Activity 5A.1.2: Conduct of on-site training in each of the demo cities of staff responsible for the operation and maintenance of the demo FCVs. Trainers will supplement training provided by FCV manufacturers, as needed, and may visit multiple times, if needed. Based on identified needs during visits, trainers will provide trainees with written materials on FCV O&M. [*GEF support is required for the technical and logistical services needed in the design, and conduct of the on-site FCV manufacturing training program*.]

Activity 5A.1.3: Conduct of on-site training in each of the demo cities of staff responsible for the operation and maintenance of hydrogen refueling stations. Trainers will supplement training provided by equipment suppliers/general contractors and will put a strong emphasis on safety issues. (It is expected that equipment manufacturers or general contractors building the stations will provide the bulk of O&M training needed and also that major repairs will be handled by equipment manufacturers. Stations like Shanghai's Anting Station, which has extensive experience in hydrogen refueling station O&M, will not need training.) Based on identified needs during visits, trainers will provide trainees with written materials on O&M of hydrogen refueling stations. [*GEF support is required for the technical and logistical services needed in supplementing the on-site training on the O&M of hydrogen refueling stations provided by equipment manufacturers or general contractors that have built the stations*.]

Activity 5A.1.4: Conduct of post-training assessment of qualification of trainees to operate and maintain FCVs and of post-training assessment of qualification of trainees to operate and maintain hydrogen refueling stations. This activity will include design of assessment tests that determine whether trainees have the requisite full set of skills to conduct O&M of FCVs or to conduct O&M of HRSs, respectively. Tests will include a hands-on as well as a written component. Local governments will be the government entities to assess and certify that the trainee is qualified in the area of FCV or HRS, respectively. [*GEF support is required for the technical assistance in the design, conduct, and analysis of the results of post-training assessments*.]

Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/commercial purchase of FCVs

121. Output 5B.1: FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling associated value chain projects that are or will be financed by financial institutions/financial sector companies. Financing of FCV-related projects by financial institutions will expedite commercialization of the sector. Successful initial financings will lead to increased interest among the financial sector and thus to further such financings. *(Financial sector finances FCV or FC component manufacturing facilities and hydrogen stations or associated value chain)*

Activity 5B.1.1: Holding of FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling value chain financing workshop. The workshop will educate financial sector on current and projected future situation of the FCV and FCV component industries and of hydrogen infrastructure industries. It will be attended both by the financial sector and by FCV and FCV component manufacturers and hydrogen infrastructure related companies wishing to attract investment. It will set up mechanisms, such as matchmaking sessions, to connect investors with projects. Financial sector organizations targeted to attend will include venture capital and private equity firms, as well as banks, which routinely provide loans to China's major vehicle manufacturers, but not for FCVs in particular. [*GEF support is required for the technical and logistical services needed in the design, organization, conduct, and evaluation of the workshop*.]

Activity 5B.1.2: Facilitation of meetings between banks, venture capital/private equity firms, etc. and individual FCV manufacturers, FCV component manufacturers, and hydrogen refueling or associated value-chain businesses seeking debt or equity financing. This activity will involve identification of appropriate interested parties on both sides (both financial institutions and those in the FCV or HRS industry seeking capital). It was also involve facilitating communications and meetings between relevant parties with the purpose of securing financing for the latter group. [*GEF support is required for technical assistance in the facilitation of meetings*.]

122. Output 5B.2: Established and operational FCV purchase financing scheme in selected banks/FIs. Financing schemes will enable expanded purchase of FCVs by consumers and other entities. Successful schemes will also further stimulate interest of the financial sector and lead to more such schemes. *(Program for financial sector support of FCV purchases)*

Activity 5B.2.1: Design of feasible financing scheme for consumer and other end user purchase of FCVs in China and holding of meetings with select financial institutions to promote adoption of scheme by at least one institution. Activity will include review of existing vehicle financing schemes in China as well as incentive-oriented bank loan schemes for other products/investments available in China or other countries. It will also include design of a financing scheme and meeting with financial institutions to explain, discuss, and promote the scheme. [*GEF support is required for the technical assistance in the design of feasible financing schemes and in the promotion of the selected scheme to financial institutions*.]

Activity 5B.2.2: Establishment and operationalization of the FCV purchase financing scheme. Banks that decide to adopt the FCV financing scheme will carry out work required for internal approval and setting up loan processes. They will also promote the scheme to consumers, utilizing links with manufacturers who sell FCVs, and then implement the financing arrangements with approved customers. [*GEF support is not required. All expenses are covered by co-financing from financial institution(s)*.]

Activity 5B.2.3: Design and conduct at EOP of survey of financial sector entities involved in FCV financing. This is for the purpose of verifying relevant project indicators associated with Output 5B.1 and 5B.2. This survey will be for financial sector entities involved in financing of FCV manufacturing, FCV value chain financing, HRS and HRS value chain financing, and/or financing of FCV purchase. It will involve gathering information on: (a) total investment by financial sector in FCV and FCV value chain manufacturing and hydrogen stations and their value chain; and, (b) on cumulative financing by financial sector of FCV purchase. It will further determine the number of financial institutions that are financing each of the aforementioned types of activities. Lastly it will determine the number of FCVs purchased through dedicated bank financial schemes. The survey will be carried out towards the EOP. [*GEF support is for the technical services required in the design and conduct of the survey*.]

2.7. Key Indicators and Risks

Key Indicators

123. Key indicators for project success are listed below:

Indicator	Target Value
Project Goal-level	
• Cumulative amount of GHG emissions from China's transport sector reduced by end of project (EOP), tons CO_2eq	• 132,707 tons
Project Objective-level	
• Number of local transport vehicle manufacturers producing FCVs by EOP	• 10
• Cumulative investment in local FCV manufacturing by EOP, USD Million	• $10 million
• Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations by EOP	• 1,000
Project Outcome-level	

FCV-related technical assistance:	
• Average lifetime hours of operation of newly produced Chinese FCVs by EOP	• 10,000 (bus) • 6,000 (car) • 6,000 (DV)
• Average high volume unit cost[45] of newly produced Chinese FCVs at EOP, USD	• $190,000 (bus) • $36,000 (car) • $120,000 (DV)
FCV demos:	
• Annual FCV sales in China by EOP, units • Average annual growth rate of unit FCV sales in China by EOP, %	• 1,500 • 100%
Hydrogen and HRS related technical assistance:	
• Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China	• 5 models • 3 RE-based H2 stations
Hydrogen production and HRS demos:	
• Annual hydrogen production (MT) and number of refueling stations in China of substantial scale	• 1000 MT • 15
Policy – national level:	
Number of FCV manufacturing companies that are compliant to newly issued and enforced FCV product standards	• 10
Policy – local level policy pilots:	
• Number of cities in which policies new to China promote FCV purchase and/or investment in hydrogen stations are implemented	• 6
Awareness and Information:	
Number of local governments that are aware and have adopted FCVs in their public transport systems	• 10
Number of private vehicle owners that own and use a FCV	• 480 – 3,360
Capacity building for O&M of FCVs and HRSs:	
• Number of individuals capable of satisfactorily operating and maintaining FCVs in China by EOP	• >500
• Number of individuals capable of satisfactorily operating and maintaining hydrogen refueling stations in China by EOP	• >100
Capacity building for financial sector:	
• Cumulative investment by financial sector in FCV and FCV value chain manufacturing and HRS and HRS value chain by EOP, USD Million	• $100 million

Risks

124. Key risks during project implementation that may prevent the project objective from being achieved are listed along with mitigating actions in Exhibit 2-3. Each key risk is also rated in terms of risk level. Based on the highest level of risk among these items individually, the overall risk level of the project is considered to be medium.

Exhibit 2-3: Key Project Risks

Risk	Level of Risk	Mitigating Actions
1. FCV operation demonstration activities will encounter the same implementation problems encountered in the FCB	Low	The demonstrations have been designed to address all the necessary permits and requirements from the city authorities. This work to comply with pre-requisites will be accorded sufficient time to ensure smooth and seamless transition to

[45] Projection based on production volume of 500 units for buses and 5,000 units for cars, vans, and trucks

Demonstration Project (Phases I & II)		the actual demonstration activities.
2. Local transport vehicle manufacturers as well as other stakeholders in the local and central governments may have conflicting objectives about FCVs, preventing the effective coordination of their participation and support of the project	Low	The project implementing partner has closely coordinated the project design with the project partners putting to good use its experience implementing UNDP-GEF projects. Moreover, apart from establishing an effective project team that will be comprised of competent local and international experts in transport systems and technologies, project proponents will also make use of their good working relationship with the transport vehicle industry developed in the previous UNDP-GEF FCB demonstration project.
3. The private sector will not be interested in investing in AEVs, in general, and in FCVs, in particular	Medium	The project design includes information dissemination and promotion to ensure end-users' better understanding about the use and benefits of using FCVs. The project also includes interventions aimed towards improving the local technical capacity to manufacture FCVs that are at least at par with international FCV standards, as well as other interventions that will help influence the production of cost-affordable but high quality FCVs that are expected to encourage private sector-led transport systems using FCVs.
4. Transport vehicle manufacturers may favor electric vehicles rather than FCVs.	Medium	The project will build capacity of transport vehicle manufacturers, so that they are more confident about FCV production and view it as complementary to their EV work. The project will further support the GoC to develop an FCV and HRS Roadmap that will delineate the role of FCVs within the larger NEV landscape.
5. Recommended policies may not be approved by the relevant authorities, or may be approved but not effectively enforced.	Low	The project will include the piloting of the application of the support policies for FCVs to gauge the effectiveness of said policies. That will help guide the relevant government authorities in the finalization, approval, and effective enforcement of such policies.
6. The level of co-financing amount may not support the project implementation promptly and sufficiently.	Low	Substantial co-financing commitment has been obtained. During project implementation, the project team will closely monitor and ensure co-financing is available by project partners and co-financers promptly and at least as per their respective committed amounts.
7. The pace of investments for the FCV support infrastructure may not be in sync with the growth of the FCV market	Medium	The project includes activities to expand the number of HRSs and improve their viability. It further includes activities to lower the cost of hydrogen production and launch availability of renewable energy based hydrogen.
8. Sustaining the outcomes and benefits of GEF investment in the activities implemented will not be fully achieved.	Medium	The project includes activities for the development of a sustainable follow-up plan for the replication of the FCV transport systems in other cities and expansion in existing demonstration cities. Implementation of the plan will be supported (financed) by the local governments. Officials from other cities will be key participants in annual workshops to disseminate results to date of the project's demos.

2.8. Cost Effectiveness

Incremental Results and Leverage of Co-financing via GEF Inputs

125. The project, with about USD 8.2 million in GEF funding, will leverage at least 53.5 million in co-financing, and likely much more. Yet, this incremental funding from GEF, as evidenced by comparing the baseline and alternative scenarios will make a critical difference in the advancement towards commercialization of FCVs in China. The "leapfrog" in technical level and cost reduction achieved via the project along with other interventions will result in FCVs that are much more attractive for replication and that are demonstrated on an ongoing, continuous basis over a period of over three years. In the alternative scenario, at least four times

replication of the project's 109 demo vehicles via new demos in other cities and scale-up in existing demo cities is expected, as compared to only one time replication in the baseline case. Similar differentiating results between the alternative and baseline scenario are seen in the areas of HRSs (more stations in continuous operation and demonstration of different business models in the alternative scenario) and hydrogen production (demonstration of renewable energy based hydrogen production in the alternative scenario), though these activities will be co-financed to a substantially greater extent than even the demo FCVs.

126. The wider impact of the project will be substantial. As it brings about the removal of the current barriers to the widespread production and application of FCVs, the start of the commercialization phase of FCVs will be realized even before 2020. The GEF's intervention through this proposed project will help spur interest among the local automotive manufacturers to carry out FCV R&D activities on their own or in collaboration with either or both local and foreign manufacturers. The current government funding in the current 12th Five Year Plan focuses also on R&D to advance domestic fuel cell technology. This project can help in further encouraging the manufacturers to avail of such assistance from the government. Furthermore, this GEF project will also supplement and assist the GOC's achievement of its NEVIDP targets and enable the realization of an alternative scenario wherein the future vehicle population in major Chinese cities includes FCVs that are not just funded by some government-subsidized environment improvement or transport pollution control programs, but also private-owned FCVs and commercially operated FCV fleets. With the facilitated market transformation from using traditional ICEVs to using AEVs (particularly FCVs), significant energy savings and energy cost savings from the transport sector will be realized, as will be the co-benefit of reduced negative environmental quality impacts.

127. Although there have been some policies issued and actions done (and planned) to promote FCV production and application in the China, these rather limited and general actions are not sufficient to remove the identified barriers, create and sustain enabling environments, and facilitate or at least influence increased investments of the private sector in FCV manufacturing and spur commercialization. Without GEF support for funding the incremental cost for removing the barriers that this proposed project will address, the expected potential additional global environmental benefits (in terms of avoided CO2 emissions linked to the petroleum fuels that will be saved from the operation of ICEVs) would not be realized. Without this proposed project, China would have limited success in promoting the widespread utilization of FCVs. Such efforts would be at a relatively low level. As a result, the potential contribution of FCVs to the country's GHG emissions reduction targets, as well as the country's aim to conserve energy and protect both the global and local environment (particularly in transport-intensive urban centers of the country), would not be fully realized. With the GEF support for the incremental cost needed to create the much needed market pull and technology push to remove barriers, an increased share of FCVs in the local transport vehicle market will be facilitated. This GEF project will help realize for China the expected global environmental benefits of reduced GHG emissions from the energy savings that will be derived from the widespread use of FCVs.

Global Environmental Benefits

128. The major direct CO2 emission reductions that are attributable to the project will come from the FCV operation demonstrations that will be carried out in the planned demonstration cities of Beijing, Shanghai, Zhengzhou and Foshan. There are also expected direct CO2 emission reductions from other FCV application replications that will occur prior to close of the GEF project. Potential CO2 emission reductions will further be realized from the improved renewable energy-based hydrogen production technologies that will be showcased under the project. All of these, at various levels, will be facilitated through the barrier removal activities and other capacity building and technical assistance activities that will be implemented. A major co-benefit from the project is the reduction of air pollution from cities where FCVs will be used.

129. With regard to the impact of replication on emissions abatement, this measure of the project's cost effectiveness (i.e., UAC) will be tracked using a monitoring and evaluation system that will be developed during the project. The UAC figure will be regularly re-evaluated and updated during the project implementation, particularly in quantifying the potential energy savings from projected replications, and in coming up with the CO2 emission reduction estimates.

2.9. Sustainability and Replicability

130. The proposed project will achieve sustainability and replication through a multi-pronged approach that creates an enabling environment for commercialization of FCVs in China. Incremental activities will result in a higher level of FCV durability and greater cost reductions, thus contributing to sustainability and replication of results. Efforts to support component sourcing and development of a high quality, low-cost domestic component base will also contribute to ongoing progress in the durability, cost-reduction, and increased numbers of FCVs on the road in China. The project's work will further promote continuous operation of an expanded group of HRSs, which will be replicated in conjunction with expansion of FCV demos to additional cities. Policy efforts, particularly in the areas of developing an FCV Roadmap and maintaining and enhancing subsidy policies, will further contribute to sustainability and replicability, as will efforts in awareness building, capacity building for O&M, and capacity building for the financial sector. Replication plans will be designed as a part of project activities and will also be facilitated by involving officials from potential replication cities as key attendees at annual workshops on demo results.

131. Sustainability of results will also benefit from the Chinese government's policy and long-term development plan for FCVs. The demand for mobility by people, the necessity of transport for socio-economic development, and the current efforts of the government (central and local) to develop and support, and the need to address current transport-based air pollution are the major drivers for the sustained development efforts towards the commercialization of AEVs, in general, and FCVs, in particular. To ensure avoidance of the recurrence of the barriers and the continuance of the enabling environments that will be created and/or facilitated by the project, appropriate sustainable follow-up actions will be planned as part of the project activities. Such action plans will be implemented after the project as per the institutional arrangements that will be developed for such purpose.

132. In terms of potential for scaling up, the project will initially focus on four of the 86 cities in 40 promotional regions that have been identified by the GOC for demonstration of AEVs. The four cities will serve as the demonstration sites for the development and application of the interventions intended for the removal of barriers to FCV commercialization that will be carried out under the project. Several of the project interventions can be replicated in the other 82 cities, as well as in other regions of the country where the citizens and/or local governments are keen about the application of FCV technologies for private transport and public transport, or where interest and potential for local FCV manufacturing is present. The policies and implementing rules and regulations that will be developed under the project and adopted in the four cities can be replicated to further enhance the efforts to promote the utilization of FCVs and other environment friendly transport systems. Also, the planned demonstrations can be scaled up to involve more local transport vehicle manufacturers and transport vehicle distributors and retailers in the promotion efforts.

3. Project Framework

3.1 Project Results Framework

This project will contribute to achieving the following Country Program Outcome as defined in CPAP or CPD: Policy and capacity barriers for the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed					
Country Program Outcome Indicators: Low carbon and other environmentally sustainable strategies and technologies are adopted widely to meet China's commitments and compliance with Multilateral Environmental Agreements					
Primary applicable Key Environment and Sustainable Development Key Result Area: 1. Mainstreaming environment and energy					
Applicable GEF Strategic Objective and Program: Climate Change Mitigation: Promote energy efficient low-carbon transport and urban systems					
Applicable GEF Expected Outcomes: Sustainable transport and urban policy and regulatory frameworks adopted and implemented. Increased investment in less-GHG intensive transport and urban systems.					
Applicable GEF Outcome Indicators: Cities adopting in low-carbon programs; Investment mobilized					
Strategy	**Objectively Verifiable Indicators**			**Source of Verification**	**Critical Assumptions**
	Description	**Baseline**	**EOP Targets**		
Goal: Reduced growth of GHG emissions from transport sector	Cumulative tons of GHG emissions from China's transport sector reduced from FCV applications by end of project (EOP), tons	0	132,707 tons CO_2[46]	GHG emissions reduction estimates based on demo and pilot monitoring reports, Project's FCV Market and Technology Monitoring System	-The source of hydrogen used for project vehicles and subsequent FCVs in China is sustainable, low, or renewable (a)
Objective[47]: Facilitation of the commercial production and application of fuel cell vehicles in China	Number of local transport vehicle manufacturers producing FCVs	4	10	Project survey of AEV manufacturers in China	-National subsidies continue at level that makes FCVs affordable to buyers (b)
	Cumulative investment in local FCV manufacturing, US$ million	$1 million	$10 million	Project survey of AEV manufacturers	
	Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations	1,000	10,000	Project survey	
Outcome 1A : Markedly reduced	Average annual operating hours of newly	670 (bus)	3,300 (bus)	Project survey of FCV	

[46] The indicated emission reduction (ER) is a target by end of project (EOP). This differs from the GHG ER calculations presented in Annex 2, which are the expected ERs during the lifetime of FCVs and hydrogen production equipment involved, some of which operate beyond EOP. The above targeted emission reductions of 132,707 tons CO_2 by EOP are a combination of direct incremental net ERs (for 109 FCVs and 4 renewable energy based hydrogen production units) and indirect ERs (assuming total vehicles by EOP are 4,000 including original 109 and assuming an additional 12 renewable energy based hydrogen production units by EOP). The estimated direct incremental net ERs total of 15,287 tons, is comprised of 9,365 tons that are derived from the operation of the 109 FCVs for 3.2 years (with baseline scenario subtracted out) and 5,922 tons are due to the four renewable energy based hydrogen production facilities operating for two year. This expected before EOP (with double counting for the portion of hydrogen used in the demo FCVs subtracted out). The indirect ERs by EOP total 117,420 tons. About 108,537 tons are due to additional FCVs (891 of which come online by start of year 3 and another 1500 of which come online by start of year 4) and 8,883 tons are due to an additional 12 renewable energy based hydrogen production facilities (which come online by start of year four).

[47] *Objective (Atlas output) monitored quarterly ERBM and annually in APR/PIR*

costs and improved performance and durability of FCVs in China	produced Chinese FCVs, hours	670 (car) 670 (DV)	2,100 (car) 2,100 (DV)	manufacturers	
	Reduction in high volume unit cost[48] of newly produced Chinese FCVs, %	0% (bus) 0% (car) 0% (DV)	50% (bus) 40% (car) 50% (DV)	Project survey of FCV manufacturers	
Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China	Annual FCV sales and average annual growth rate of FCV sales in China (units sold, % growth in units sold as compared to previous year)	0, 0%	400 – 7,000, 100%	Project *China FCV Market and Technology Monitoring System* GOC Official statistics	-(b), as above -consumer and government official concerns about FCV safety issues are allayed (d)
Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China	1 0 RE-based H2 station	5 3 RE-based H2 station	Survey of hydrogen refueling stations Project monitoring report	
Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen	Annual hydrogen production (MT), and refueling stations in China of substantial scale	0 H2 production 2 H2 refueling stations	1,000 MT 15	Project survey of renewable energy based hydrogen producers	
Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	Number of FCV manufacturing companies that are compliant to newly issued and enforced FCV product standards	0	10	Market survey of local FCV manufacturers and their FCV products Project activity report Project monitoring report	-(b), as above
Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations	Number of cities in which policies new to China promote FCV purchase and/or investment in hydrogen stations are implemented	0	6	Project monitoring report and project survey	
Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness	Number of local governments that are aware and have adopted FCVs in their public transport systems	0	10	Conduct of research survey Project activity report Project monitoring report	-(b), as above --Fear of users re FCV safety issues is allayed (e)
	Number of private vehicle owners that own and use a FCV	0	480 – 3,360		-(b), as above -(e), as above
Outcome 5A: Increased technical capacity for O&M of FCVs and	Number of individuals capable of satisfactorily operating and maintaining (a) FCVs; and, (b)	20 5	>500 >100	Results of project post-training assessment	-Relevant work units willing to send key staff

[48] Projection based on production volume of 500 units for buses and 5,000 units for cars, vans, and trucks

hydrogen refueling stations	hydrogen refueling stations, in China				with required capabilities to trainings (f)
Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/ commercial purchase of FCVs	Cumulative investment by financial sector in FCV and FCV value chain manufacturing and in hydrogen stations and their value chain, US$ million	0	100	Market research survey Project activity report Project monitoring report	-(b), as above -financial sector becomes convinced of viability and potential returns of FCV manufacturing and hydrogen stations (g)

3.2. Total Budget and Work Plan

Award ID:	00086819	**Project ID(s):**	00094022
Award Title:	Accelerating the Development and Commercialization of Fuel Cell Vehicles in China		
Business Unit:	CHN10		
Project Title:	Accelerating the Development and Commercialization of Fuel Cell Vehicles in China		
PIMS No.:	5349		
Implementing Partner (Executing Agency)	Ministry of Science and Technology (MOST)		

GEF Outcome/Atlas Activity	Responsible Party/ Implementing Agent	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Total (USD)	See Budget Note:
Component 1: Improvement of Local Fuel Cell (FC) and Fuel Cell Vehicle (FCV) Production and Application											
OUTCOME 1A: Markedly reduced costs and improved performance and durability of FCVs in China	MOST	62000	GEF	71200	International Consultants	121,100	121,100	121,100	121,100	484,400	1
				71300	Local Consultants	17,350	17,350	17,350	17,350	69,400	2
				71600	Travel	36,163	36,163	36,162	36,162	144,650	3
				75700	Trainings, Workshops and Conferences	5,625	5,625	5,625	5,625	22,500	4
				74200	Audio Visual & Print Prod Costs	2,250	2,250	2,250	2,250	9,000	5
				72100	Contractual Services – Company	2,500	2,500	2,500	2,500	10,000	6
				72200	Equipment and Furniture	100,000	100,000	0	0	200,000	7
				74500	Miscellaneous Expenses	3,750	3,750	3,750	3,750	15,000	8
				Total Outcome 1A		**288,738**	**288,738**	**188,737**	**188,737**	**954,950**	
OUTCOME 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China	MOST	62000	GEF	71200	International Consultants	1,750	1,750	1,750	1,750	7,000	9
				71300	Local Consultants	3,750	3,750	3,750	3,750	15,000	10
				74200	Audio Visual & Print Prod Costs	5,000	5,000	5,000	5,000	20,000	11
				72100	Contractual Services – Company	44,500	44,500	44,500	44,500	178,000	12
				72200	Equipment and Furniture	1,024,000	4,096,000			5,120,000	13
				74500	Miscellaneous Expenses	17,250	34,500	17,250	17,250	86,250	14
				Total Outcome 1B		**1,096,250**	**4,185,500**	**72,250**	**72,250**	**5,426,250**	

Component 2: Improvement of Hydrogen Production and Refueling System											
OUTCOME 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	MOST	62000	GEF	71200	International Consultants	11,200	11,200	11,200	11,200	44,800	15
				71300	Local Consultants	4,450	4,450	4,450	4,450	17,800	16
				71600	Travel	16,675	16,675	16,675	16,675	66,700	17
				75700	Trainings, Workshops and Conferences	7,625	7,625	7,625	7,625	30,500	18
				74200	Audio Visual & Print Prod Costs	1,250	1,250	1,250	1,250	5,000	19
				72100	Contractual Services – Company	24,250	24,250	24,250	24,250	97,000	20
				74500	Miscellaneous Expenses	2,600	2,600	2,600	2,600	10,400	21
				Total Outcome 2A		**68,050**	**68,050**	**68,050**	**68,050**	**272,200**	
OUTCOME 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using renewable energy to produce hydrogen	MOST	62000	GEF	71300	Local Consultants	2,500	2,500	2,500	2,500	10,000	22
				71600	Travel	850	850	850	850	3,400	23
				74200	Audio Visual & Print Prod Costs	3,750	3,750	3,750	3,750	15,000	24
				72100	Contractual Services – Company	29,525	29,525	29,525	29,525	118,100	25
				Total Outcome 2B		**36,625**	**36,625**	**36,625**	**36,625**	**146,500**	
Component 3: Policy and Regulatory Frameworks for the Application and Commercialization of FCVs											
OUTCOME 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	MOST	62000	GEF	71300	Local Consultants	3,750	3,750	3,750	3,750	15,000	26
				71600	Travel	1,100	1,100	1,100	1,100	4,400	27
				75700	Trainings, Workshops and Conferences	10,887	10,887	10,888	10,888	43,550	28
				74200	Audio Visual & Print Prod Costs	2,250	2,250	2,250	2,250	9,000	29
				72100	Contractual Services – Company	80,750	80,750	80,750	80,750	323,000	30
				74500	Miscellaneous Expenses	1,325	1,325	1,325	1,325	5,300	31
				Total Outcome 3A		**100,062**	**100,062**	**100,063**	**100,063**	**400,250**	
Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment	MOST	62000	GEF	71200	International Consultants	2,100	2,100	2,100	2,100	8,400	32
				71300	Local Consultants	1,000	1,000	1,000	1,000	4,000	33
				71600	Travel	200	200	200	200	800	34
				74200	Audio Visual & Print Prod Costs	375	375	375	375	1,500	35

in hydrogen refueling stations				72100	Contractual Services – Company	25,500	25,500	25,500	25,500	102,000	36
				Total Outcome 3B		**29,175**	**29,175**	**29,175**	**29,175**	**116,700**	
Component 4: Enhancement of Information Dissemination and Awareness about FCV Transport Systems											
OUTCOME 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness	MOST	62000	GEF	71200	International Consultants	5,250	5,250	5,250	5,250	21,000	37
				71300	Local Consultants	500	500	500	500	2,000	38
				71600	Travel	8,387	8,387	8,388	8,388	33,550	39
				75700	Trainings, Workshops and Conferences	16,097	16,097	16,098	16,098	64,390	40
				74200	Audio Visual & Print Prod Costs	34,750	34,750	34,750	34,750	139,000	41
				72100	Contractual Services – Company	12,475	12,475	12,475	12,475	49,900	42
				Total Outcome 4		**77,459**	**77,459**	**77,461**	**77,461**	**309,840**	
Component 5: FCV Technology Capacity Development Program											
Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	MOST	62000	GEF	71300	Local Consultants	5,250	5,250	5,250	5,250	21,000	43
				71600	Travel	1,400	1,400	1,400	1,400	5,600	44
				72100	Contractual Services – Company	35,650	35,650	35,650	35,650	142,600	45
				Total Outcome 5A		**42,300**	**42,300**	**42,300**	**42,300**	**169,200**	
Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/commercial purchase of FCVs	MOST	62000	GEF	71300	Local Consultants	1,500	1,500	1,500	1,500	6,000	46
				71600	Travel	400	400	400	400	1,600	47
				75700	Trainings, Workshops and Conferences	2,650	2,650	2,650	2,650	10,600	48
				72100	Contractual Services – Company	6,850	6,850	6,850	6,850	27,400	49
				Total Outcome 5B		**11,400**	**11,400**	**11,400**	**11,400**	**45,600**	
PROJECT MANAGEMENT											
	PMO & UNDP	62000	GEF	71200	International Consultants	0	15,000	0	15,000	30,000	50
				71300	Local Consultants	0	5,000	0	5,000	10,000	51
				71600	Travel	5,650	5,650	5,650	5,650	22,600	52
				74100	Professional Services	283,430	5,000	5,000	5,000	298,430	53
				72200	Equipment and Furniture	2,500	2,500	2,500	2,500	10,000	54
				72500	Office Supplies	2,500	2,500	2,500	2,500	10,000	55
				74200	Audio Visual & Print Prod Costs	900	900	900	900	3,600	56
				74500	Miscellaneous Expenses	543	543	544	544	2,174	57

				74500	Direct Project Costs (DPC)	5,266	0	0	0	5,266	58
				Total Management		**300,789**	**37,093**	**17,094**	**37,094**	**392,070**	
				PROJECT TOTAL		**2,050,848**	**4,876,402**	**643,155**	**663,155**	8,233,560	

Summary of Funds:[49]

Sources of Funds	Amount Year 1	Amount Year 2	Amount Year 3	Amount Year 4	Total
GEF	$2,050,848	$4,876,402	$643,155	$663,155	$8,233,560
UNDP (grant)	$100,000	$100,000	$100,000	$100,000	$400,000
Shanghai Science and Technology Commission (grant)	$1,000,000	$3,000,000	$500,000	$500,000	$5,000,000
Beijing Science and Technology Commission (grant)	$862,500	$3,212,500	$862,500	$862,500	$5,800,000
Zhengzhou Science and Technology Bureau (grant)	$420,000	$740,000	$420,000	$420,000	$2,000,000
Foshan District Government (grant)	$478,325	$798,325	$478,325	$478,325	$2,233,300
Foshan District Government (in kind)	$641,675	$641,675	$641,675	$641,675	$2,566,700
Selected Enterprises (e.g. SAIC, Yutong, etc.) (cash and in-kind)	$12,000,000	$4,500,000	$9,500,000	$9,500,000	$35,500,000
TOTAL	$17,553,348	$17,868,902	$13,145,655	$13,165,655	$61,733,560

Budget Notes:

Outcome 1

1. Total of USD 484,400 for international consultant (IC) services for Outcome 1A assumes a total of 692 IC days at a rate of USD 700 per day. The majority of these days are invested in one-on-one technical assistance (TA) and liaison support for Chinese manufacturers, including one-on-one TA/liaison support for each of eight different types of component manufacturer and 120 such days spread across a small group of selected FCV manufacturers. Another significant area, sourcing assistance for Chinese FCV manufacturers, calls for 50 IC days spread across two different activities. The large number of days is due mainly to the intensive and extended nature of one-on-one TA and liaison support needed to achieve project targets;

2. Total of USD 69,400 for national consultant (NC) services for Outcome 1A assumes a total of 347 NC days at a rate of USD 200 per day. NCs provide support for many of the aforementioned Outcome 1A one-on-one TAs involving ICs, but with a somewhat lesser number of days invested. These NC assignments will include one-on-one TA of various FCV manufacturers, one-on-one TA to eight component manufacturers, and input in assessing sourcing challenges of China's FCV manufacturers;

3. Total of USD 144,650 in travel for Outcome 1A consists of per diems, international airfare, and domestic airfare. Per diems cover 421 days of travel in China. The large number of travel days is due largely to the intensive and extended nature of one-on-one TA for FCV manufacturers and component manufacturers. A per diem rate of US250 is assumed for shorter trips. For longer visits (particularly for the one-on-one assistance to component manufacturers) per diem of USD 150 is assumed based on local assistance in securing preferential rates for long visits. For airfare, 37 international roundtrips of roughly USD 1,600 each are assumed, as well as 61 legs of domestic travel at roughly USD 200 each;

[49] *Summary table should include all financing of all kinds: GEF financing, co-financing, cash, in-kind, etc...*

4. Total of USD 22,500 for FCV manufacturer workshops (on at least 4 occasions; includes written materials) consists of 20 NC days at a rate of USD 200 per day, 10 days of travel with per diems USD 250, domestic flights (20 legs, at average cost of USD 200 per leg) and conference rent (6 days at USD 2000 per day);

5. Printing costs of USD 9,000 for Outcome 1A consist of the printing of 750 copies of the year 2 project FCV manufacturing progress report and 750 copies of the year 4 project FCV manufacturing progress report at unit cost of USD 2 and the printing of 1500 copies of materials for each of the FCV manufacturer workshops at unit cost of USD 4;

6. Contractual services of USD 10,000 for Outcome 1A consist of three small subcontracts, two for USD 3,000 and one for USD 4,000. The three small subcontracts are for surveys to measure indicators in the project results framework (PRF). The first will be for a survey of individuals attending the aforementioned FCV manufacturer workshops or obtaining related materials. The second will be for a survey of Chinese FCV manufacturers (one version for all such manufacturers and one for those receiving one-on-one training from the project). The third will be for a survey of the eight component manufacturers receiving one-on-one TA from the project. Each of these three subcontracts will have as its deliverables survey design, implementation, and results analysis. The main input for each will be person-days of local consultants;

7. Incremental support to China-based FC membrane manufacturer (USD 100,000) and catalyst manufacture (USD 100,000) to purchase equipment to achieve reduced cost and increased quality;

8. Miscellaneous communications costs (mail, telephone), transportation expenses, and exchange rate losses;

Outcome 1B

9. Total of USD 7,000 for international consultant (IC) services for Outcome 1B assumes a total of 10 IC days at a rate of USD 700 per day. These inputs are split among two activities, all of which are also supported by national consultants. The activities include: (1) preparation of RFPs for project FCV demo vehicles (5 days for ICs), (2) preparation of template on FCV manufacturing costs and analysis of results (5 days);

10. Total of USD 15,000 national consultant (NC) services for Outcome 1B assumes a total of 75 NC days at a rate of USD 200 per day. These inputs are split among three activities: (1) preparation of RFPs for project FCV demo vehicles (5 days for NCs), (2) analysis of demo results and recommendations for adjustments (40 days), (3) preparation of template on FCV manufacturing costs and analysis of results (30 days);

11. Printing costs of USD 20,000 for Outcome 1B consist of the printing of 2500 copies of the annual survey of public perception of FCVs (at USD 4 unit cost) and the printing of 2500 copies of the annual reports (that combine annual demo FCV operation report and public perception survey results and one-time report on FCV costs);

12. Contractual services of USD 178,000 for Outcome 1B consist of four subcontracts: (1) Design of FCV demo data collection system, collection of data, analysis (USD 70,000); (2) Annual survey of public perception of FCVs (USD 48,000); (3) Prep of template on FCV manufacturing costs and analysis of results (USD 30,000); (4) Annual reports on FCV demos (combining demo FCV operation and survey of public perception of this operation and one-time report on costs) (USD 30,000);

13. The total of USD 5.12 million in procurement of equipment for Outcome 1B represents 31 percent of the costs for all 109 FCV vehicles to be demonstrated as a part of the project. Total vehicle costs are estimated at USD 16.69 million, assuming cost reductions targeted in the alternative scenario are achieved. Co-financing will cover the other 69 percent of vehicle costs. This breakdown in cost-sharing between the GEF and domestic sources was achieved through negotiations. The negotiations resulted in agreement that the project will encompass more vehicles and vehicles meeting higher targets in durability, performance, and cost reduction than would have been achieved in China's baseline project. In addition to the 109 fuel cell vehicles considered here, there are likely to be a number of additions FCVs encompassed in the project activities (in cities such as Yancheng and Changsu, Jiangsu Province) that are 100 percent co-financed;

14. Miscellaneous communications costs (mail, telephone), transportation expenses, and exchange rate losses;

Outcome 2A

15. Total of USD 44,800 for international consultant (IC) services for Outcome 2A assumes a total of 64 IC days at a rate of USD 700 per day. The four activities with the greatest IC input are all one-on-one technical assistance (TA) and liaison support: (1) one-on-one TA/liaison support to HRS air compressor manufacturer (15 days), (2) one-on-one TA/liaison support to hydrogen refueling dispenser manufacturer (15 days), (3) one-on-one TA to wind farms for hydrogen production (10 days), and (4) one-on-one TA to land fill methane project for hydrogen production (10 days). Other Outcome 2A activities with IC input are hydrogen production and HRS study tours and workshops (14 days spread across four activities);

16. Total of USD 17,800 for national consultant (NC) services for Outcome 2A assumes a total of 89 NC days at a rate of USD 200 per day. The Outcome 2A activities with the greatest NC input include: (1) one-on-one TA to wind farms to produce hydrogen (10 days), (2) study on economics of different hydrogen sources (5 days), (3) study on improving energy efficiency in producing hydrogen from industrial byproduct (5 days), (4) preparation of database on all applicable processes of hydrogen production (including 3 foregoing studies) (5 days), (5) one-on-one TA to Foshan HRS to develop business plan (10 days), (6) one-on-one TA to improve reliability/hydrogen output of one interested HRS with RE-based hydrogen production (15 days), (7) assistance to HRS compressor manufacturer (10 days), (8) assistance to hydrogen refueling dispenser manufacturer (10 days), and (9) study tours and workshops on renewable energy based hydrogen production and on HRSs (total of 14 days across four activities);.

17. Travel of USD 66,700 for Outcome 2A consists of per diems (62 days at rates ranging from USD 150 per day to USD 250 per day), international flights (31 roundtrips, at average cost of USD 1600 each), and domestic flights (28 legs, at average cost of USD 200 per leg).

18. Total of USD 30,500 for (1) at least two workshops in RE-based hydrogen production (including written materials) (USD 13,800) and (2) Series of workshops on HRS, including prep of written materials (USD 16,700);

19. Printing costs of USD 5,000 for Outcome 2A consist of the printing of 2500 copies of materials for the two workshops in RE-based hydrogen production with unit cost of USD 2;

20. Contractual services of USD 97,000 for Outcome 2A include eight sub-contracts. (1) Survey of China's RE-based hydrogen producers to fulfill indicator measurement needs associated with PRF (USD 6,000); (2) Study for Foshan on options for local hydrogen production (USD 20,000); (3) Study on economics of different hydrogen sources (industrial, byproduct, renewable, etc.) (USD 18,,000); (4) Study on improving energy efficiency in producing hydrogen from industry byproduct (USD 15,000); (5) Prep of database on all applicable processes of hydrogen production (incl. above 3 studies) (USD 20,000); (6) One-on-one TA to Foshan HRS to develop business plan (USD 8,000); (7) Survey of China's HRS stations to fulfill indicator measurement needs associated with PRF (USD 7,000); (8) Survey of individuals attending group RE H2 or HRS training or receiving materials to fulfill indicator measurement needs associated with PRF (USD 3,000);

21. Miscellaneous communications costs (mail, telephone), transportation expenses, and exchange rate losses;

Outcome 2B

22. Total of USD 10,000 for Outcome 2B national consultant (NC) services cover 50 person-days at USD 200 per day. These services are spread among five activities: (1) replication plan for RE-based hydrogen production and liaison with potential replicators (10 days); (2) design of monitoring system and annual reporting on hydrogen production demos (10 days); (3) design of HRS monitoring system and annual reporting on China's HRSs (5 days); (4) design of template on hydrogen production and HRS demo costs and analysis of results (10 days), and (5) preparation of integrated report on project's hydrogen production demos and HRS demos (15 days);

23. Travel of USD 3,400 for Outcome 2B includes 17 legs of domestic flights with average cost of USD 200 per leg. Per diems will be covered by co-financing. There are no international travel expenses. International consultants will provide inputs to Outcome 2B remotely or when in China for other project activities. The four Outcome 2B activities with domestic travel are: (1) design of HRS database and monitoring; (2) design and implementation of hydrogen production demo monitoring; (3) replication plan and liaison with potential replicators and (4) outreach and technical assistance for gasoline stations to add hydrogen refueling;

24. Printing costs of USD 15,000 for Outcome 2B consist of the printing of 2500 copies of the report on upfront costs for RE hydrogen demos and HRS demos (unit cost of USD 2) and the printing of 2500 copies of integrated annual report on results on both RE based hydrogen production and on HRSs (reports will include annual monitoring and public perception findings as well as integrating one-time up front cost studies);
25. Contractual services totaling USD 118,100 for Outcome 2B cover four sub-contracts for (1) Design of monitoring, monitoring, annual reporting, and related recommendations of RE-based hydrogen demos (USD 20,000); (2) Design of monitoring/HRS database, monitoring/annual reporting of HRS demos (USD 20,000); (3) Annual survey of public's perception of hydrogen (USD 20,100); (4) Design of template on upfront costs for RE hydrogen demos and HRS demos, collecting of data, analysis of findings, and reporting (USD 8,000);

Outcome 3A

26. Total national consultant (NC) services of USD 15,000 for Outcome 3A cover 75 NC days at NC rate of USD 200 per day. This NC input is spread across seven activities: (1) drafting of national FCV roadmap (10 days); (2) drafting of local FCV roadmaps (consensus building aspect of this activity is included separately, in a subcontract) (15 days for drafting part); (3) identifying gaps in standards and recommending improvements (10 days); (4) developing of testing and certification system (10 days); (5) designing of safety procedures for departments (10 days); (6) preparation of improvements and proposed extensions to FCV incentive policies (10 days), and (7) preparation of improvements and proposed extensions to HRS incentive policies (10 days);

27. Total travel costs of USD 4,400 for Outcome 3A include domestic flights (22 legs of domestic flights estimated at average of USD 200 per leg). Per diems will be covered by co-financing. The Outcome 3A activities with travel inputs are: (1) drafting/building consensus on local FCV roadmaps; (2) identification of gaps in standards and making of recommendations for improvement; (3) development of testing and certification system; (4) and designing of safety procedures for departments;

28. Total workshop and training costs of USD 43,550 for two events: (1) workshop on national FCV Roadmap, consists of 30 NC days at a rate of USD 200 per day, 21 days of travel with per diems @USD 250, domestic flights (14 legs, at average cost of USD 200 per leg) and conference rent (3 days at USD 2500 per day) and (2) seminar on fire safety, consists of 20 NC days at a rate of USD 200 per day, 32 days of travel with per diems @USD 250, domestic flights (20 legs, at average cost of USD 200 per leg) and conference rent (3 days at USD 2000 per day);

29. Printing costs of USD 9,000 for Outcome 3A consist of the printing of 1500 copies of draft/build consensus local FCV roadmaps and 1500 copies of seminar on fire safety, both at unit costs of USD 3;

30. Contractual services of USD 323,000 for Outcome 3A cover seven activities: (1) draft on national FCV roadmap (USD 120,000); (2) building of consensus on local FCV roadmaps (USD 24,600); (3) identify gaps in standards; recommend improvements (FCV and HRS, etc.) (USD 24,000); (4) development testing and certification system (FCV, HRS, etc.) (USD 60,000); (5) survey of FCV manufacturers and their products to confirm compliance with standards (USD 4,400); (6) design safety procedures for departments (USD 70,000); and (7) conduct advocacy and lobbying meetings and educational materials (USD 20,000);

31. Miscellaneous communications costs (mail, telephone), transportation expenses and exchange rate losses;

Outcome 3B

32. Total international consultant (IC) services of USD 8,400 for Outcome 3B consist of 12 IC days at a rate of USD 700 per day spread over one activity: solicitation and vetting of policy ideas new to China (12 days);

33. Total national consultant (NC) services of USD 4,000 for Outcome 3B consist of 20 NC days at a rate of USD 200 per day spread over two activities: (1) solicitation and vetting of policy ideas new to China (10 days); (2) Design of novel policy plan monitoring and assessment of results (10 days);

34. Total travel of USD 800 for Outcome 3B consists of 4 legs of domestic flights at an average of USD 200 per flight. Per diems will be covered by co-financing. International consultants will provide input remotely or while in China for other activities;

35. Printing costs of USD 1,500 for Outcome3B consist of the printing of 1,500 copies of design of novel policy plan and monitoring and assessment of results (at unit cost of USD 1);

36. Contractual services of USD 102,000 for Outcome 3B consist of four subcontracts: (1) Solicitation and vetting policy incentive ideas new to China (incl. review of international) (USD 18,000); (2) Design and reaching consensus on policy pilots (40,000); (3) Implementation of agreed local level policy pilots (at least 2) (USD 40,000); (4) Survey of cities on local FCV roadmaps and incentive policies to assess relevant indicator in PRF (USD 4,000);

Outcome 4

37. Total international consultant (IC) services of USD 21,000 for Outcome 4 (30 days @USD 700 per day). All of this input is associated with the international study tour and the three annual international forums to be held in China. International consultants will be involved in recommending and facilitating the agenda for the study tour as well as speakers for the forums;

38. Total national consultant (NC) services of USD 2,000 for Outcome 4 consist of 10 NC days at a rate of USD 200 per day spread over only one activity: (1) consultation and preparation of replication plan for FCVs (10 days);

39. Total travel of USD 33,550 for Outcome 4 consists of 15 days of travel with per diems USD 250 (totaling USD 3,750 for per diems) and 18 roundtrip international airfares at USD 1600, all for the activity encompassing international study tour and annual international forum. Additional international flights and domestic flights are encompassed separately, under a training budget line for this activity.

40. Total of USD 64,390 for trainings cover two activities: (1) annual workshop for demo cities and other possibly replicating cities (total USD 16,190), consists of conference rent (8 days at USD 2000 per day) and printing of 190 copies at USD 1 per unit; (2) annual international forum and international study tour workshop budget line (USD 48,200) consists of 8 IC days at a rate of USD 500 per day, 50 NC days at a rate of USD 200 per day, 30 days of travel with per diems USD 250, 4 international roundtrips of roughly USD 1,600, domestic flights (20 legs, at average cost of USD 200 per leg), conference rent (8 days at USD 2000 per day), and miscellaneous expenses of USD 300;

41. Total printing and audiovisual costs of USD 139,000 for Outcome 4 are associated with five activities and constitute the full costs of these activities: (1) Media campaign in four cities and nationally (USD 11,000); (2) Preparation and dissemination of brochures (USD 10,000); (3) Design, production, airing of TV documentary on major TV network (USD 40,000); (4) Design and production of video to counter myth of danger of hydrogen production (USD 10,000); (5) Building/updating of project website, issuance of monthly newsletter (USD 68,000);

42. Total subcontracts of USD 49,900 for Outcome 4 cover five activities: (1) Survey of individuals exposed to advocacy program (USD 7,300) to measure indicator in PRF; (2) Consultation and design of replication plan (USD 10,000); (3) Two broad survey on individuals, officials, etc re awareness/perception of FCVs (beginning and EOP) (USD 9,600), both to measure indicator in PRF; (4) China FCV Market and Technology Monitoring System: Design/building,/and updating/upkeep (USD 20,000); (5) Survey of individuals utilizing China FCV Market and Technology Monitoring System (USD 3,000) to measure indicator in PRF;

Outcome 5A

43. Total national consultant (NC) services of USD 21,000 for Outcome 5A cover 105 days at USD 200 per day. Three Outcome 5A activities involve NCs (outside of subcontracts): (1) conducting of onsite FCV O&M training (40 days), (2) conducting of onsite HRS O&M training and preparation of training materials (40 days), and (3) design and conducting of post FCV and HRS O&M training assessment (25 days);

44. Total travel of USD 5,600 travel for Outcome 5A includes one international roundtrip airfare (estimated at USD 1,600) and USD 4,000 in domestic airfare (20 legs at an average of USD 200 per leg). These travel amounts cover three activities: (1) FCV O&M workshop: Travel for this activity alone is USD 1,600 for the IC. (2) Onsite FCV O&M training: Travel for this activity alone is 10 legs of domestic travel (average of USD 200 per leg). (3) Onsite HRS O&M training: Travel for this activity alone is 10 legs of domestic travel (average of USD 200 per leg). Per diems will be covered by co-financing;

45. Total contractual services of USD 142,600 for Outcome 5A are all attributed to two activities: (1) Group training session on FCV O&M held before FCV demos launched; prep of written materials (USD 72,600); (2) Conducting of onsite HRS O&M training; prep of training materials based on needs found (USD 70,000);

Outcome 5B

46. Total national consultant (NC) services of USD 6,000 for Outcome 5B cover 30 days at USD 200 per day. Three Outcome 5B activities involve NCs (outside of subcontracts): (1) FCV manufacturing, component, HRS, H2, etc. financing workshop (10 days); (2) facilitation of meetings between FCV manufacturers/value chain and financial sector (10 days) and (3) design of FCV financing scheme/meetings with banks to promote (10 days);

47. Total travel of USD 1,600 for Outcome 5B is domestic airfare (8 legs at an average of USD 200 per leg). These travel amounts cover two activities: (1) Facilitation of one-on-one meetings between FCV manufacturers/value chain and financial sector; (2) Design of FCV financing scheme and meetings with banks to promote. Per diems will be covered by co-financing.

48. Total of USD 10,600 for training budget line includes: (1) FCV manufacturing, component, HRS, H2, etc. financing workshop (which in turn consists of domestic flights and conference rental) (USD 7,600); (2) Facilitation of one-on-one meetings between FCV manufacturers/value chain and financial sector (USD 3,000);

49. Total contractual services of USD 27,400 for Outcome 5B cover two activities: (1) Design of FCV financing scheme; meetings with banks to promote (USD 20,000); (2) Survey of financial sector to determine FCV /related investments and FCV purchase programs to measure relevant indicator for PRF (USD 7,400);

Project Management

50. Total international consultant (IC) services of USD 30,000 for Project Management cover 50 days of IC services at a daily rate of USD 600. IC inputs are spread across two areas: mid-term review (25 days) and terminal evaluation (25 days);

51. Total national consultant (NC) services of USD 10,000 for project management cover 50 days of NC services at a daily rate of USD 200. NC inputs are spread across two areas: mid-term review (25 days) and terminal evaluation (25 days);

52. Total travel of USD 22,600 for project management includes per diem (60 days at USD 250 per day for total of USD 15,000), international round trip airfares (two roundtrips at USD 1,600 each for total of USD 3,200), and domestic airfare (22 legs at average of USD 200 per leg for total of USD 4,400);

53. Total professional services of USD 298,430 consists of; 1) USD 20,000 is set up for financial audit fees (USD 5,000 per year for 4 years); 2) USD 278,430 is for financial management services, representing project management and coordination for national PMO and 4 local PMOs.

54. Total equipment procurement of USD 10,000 for project management is to support office equipment purchased for PMO operation;

55. Total office supplies of USD 10,000 for project management is to support four years of office supplies (USD 2,500 per year) for PMO operation;

56. Total printing of USD 3,600 for project management is to support printing of various project promotional materials by the PMO at unit cost of USD 0.5 and total units of 7,200;

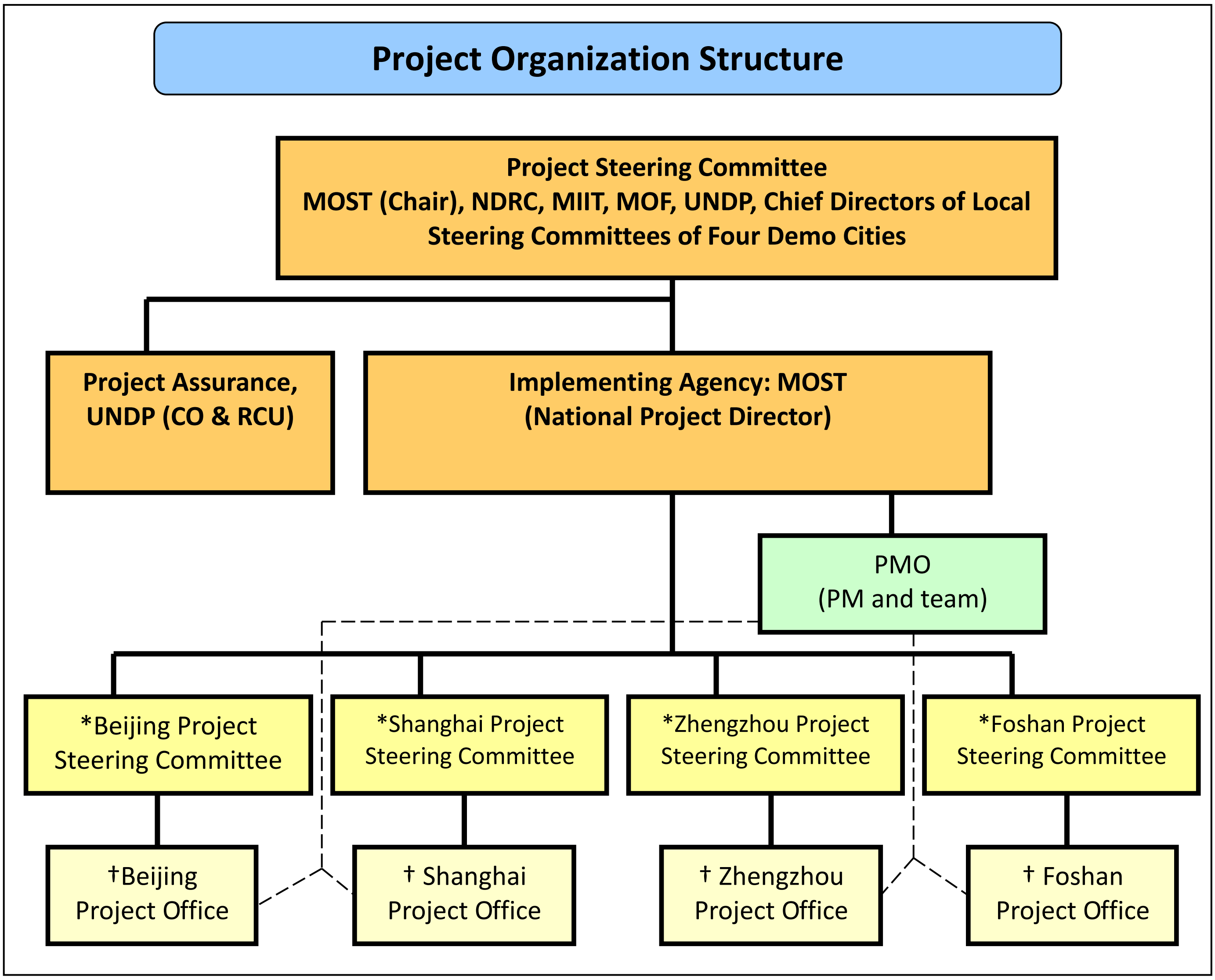
57. Total miscellaneous costs of USD 2,174 for project management are currently used mainly to balance the budget by a small amount and will be targeted at miscellaneous PMO costs;

58. "DPC" costs of USD 5,266 for project management refer to costs incurred and associated charges by UNDP CO for recruiting international consultants on behalf of the project;

4. Management Arrangements

133. Project Management Arrangements are displayed in Exhibit 4-1.

Exhibit 4-1: Project Management Arrangements



*Each city's project steering committee is led by a local chief director, with members from the committees, offices, or bureaus of: (1) technology, (2) industry, (3) transportation, and (4) vehicle demonstration.
†Each city's project office includes staff members responsible for: (1) operation of demonstration vehicles, (2) maintenance of demonstration vehicles, (3) operation and maintenance of hydrogen infrastructure, and (4) project management and coordination.

134. The Project Steering Committee will be responsible for major decisions and monitoring project progress. The IP, MOST, will direct overall implementation of the project and delegate day-to-day coordination work to the national level PMO. UNDP, both through its CO and its Asia-Pacific RCU will provide project assurance and backstopping. A local project steering committee in each city will direct that city's demo activities. Reporting to each local project steering committee will be a local project management office that will carry out day-to-day implementation. A dotted line is indicated between the national-level PMO and local PMOs in Exhibit 4-1 to indicate the significant level of liaison work that the former will conduct.

The project is nationally executed, in line with the Standard Basis Assistance Agreement between UNDP and the Government of China, and the Country Programme Action Plan (CPAP).

5. MONITORING FRAMEWORK AND EVALUATION

135. The project will be monitored through the following M& E activities. The M&E budget is provided in the table below.

Project Start

136. A Project Inception Workshop will be held within the first 2 months of project start with those with assigned roles in the project organization structure, UNDP country office, and, where appropriate/feasible, regional technical policy and program advisors, as well as other stakeholders. The Inception Workshop is crucial to building ownership for the project results and to plan the first year annual work plan.

137. The Inception Workshop should address a number of key issues including:

a) Assist all partners to fully understand and take ownership of the project. Detail the roles, support services and complementary responsibilities of UNDP CO and RCU staff vis-à-vis the project team. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.
b) Based on the project results framework and the relevant GEF Tracking Tool if appropriate, finalize the first annual work plan. Review and agree on the indicators, targets and their means of verification, and recheck assumptions and risks.
c) Provide a detailed overview of reporting, monitoring and evaluation (M&E) requirements. The Monitoring and Evaluation work plan and budget should be agreed and scheduled.
d) Discuss financial reporting procedures and obligations, and arrangements for annual audit.
e) Plan and schedule Project Board meetings. Roles and responsibilities of all project organization structures should be clarified and meetings planned. The first Project Board meeting should be held within the first 12 months following the inception workshop.

138. An Inception Workshop report is a key reference document and must be prepared and shared with participants to formalize various agreements and plans decided during the meeting.

Quarterly

139. The following are required for the quarterly reporting of the project progress:

- Progress made shall be monitored in the UNDP Enhanced Results Based Management Platform.
- Based on the initial risk analysis submitted, the risk log shall be regularly updated in ATLAS. Risks become critical when the impact and probability are high. Note that for UNDP GEF projects, all financial risks associated with financial instruments such as revolving funds, microfinance schemes, or capitalization of ESCOs are automatically classified as critical on the basis of their innovative nature (high impact and uncertainty due to no previous experience justifies classification as critical).
- Based on the information recorded in Atlas, a Project Progress Report (PPR) can be generated in the Executive Snapshot.
- Other ATLAS logs can be used to monitor issues, lessons learned etc. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard.

Annually

140. Annual Project Review/Project Implementation Reports (APR/PIR): This key report is prepared to monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements. The APR/PIR includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data, and end-of-project targets (cumulative)
- Project outputs delivered per project outcome (annual).
- Lesson learned/good practice.
- AWP and other expenditure reports
- Risk and adaptive management
- ATLAS QPR
- Portfolio level indicators (i.e. GEF focal area tracking tools) are used by most focal areas on an annual basis as well.

Periodic Monitoring through Site Visits

141. UNDP CO and the UNDP RCU will conduct visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the Project Board may also join these visits. A Field Visit Report/BTOR will be prepared by the CO and UNDP RCU and will be circulated no less than one month after the visit to the project team and Project Board members.

Mid-term of Project Cycle

142. The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation (currently estimated at Dec. 2017/ Jan. 2018). The Mid-Term Evaluation will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency, and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation, and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference, and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-term Evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Center (ERC).

143. The relevant GEF Focal Area Tracking Tools will also be completed during the mid-term evaluation cycle.

End of Project

144. An independent Final Evaluation will take place three months prior to the final Project Board meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of

Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

145. The Terminal Evaluation should also provide recommendations for follow-up activities and requires a management response, which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC).

146. The relevant GEF Focal Area Tracking Tools will also be completed during the final evaluation.

147. During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met, and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

Learning and Knowledge Sharing

148. Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.

149. The project will identify and participate, as relevant and appropriate, in scientific, policy-based, and/or any other networks, which may be of benefit to project implementation though lessons learned. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects.

150. There will be a 2-way flow of information between this project and other projects of a similar focus.

Communications and Visibility Requirements

151. Full compliance is required with UNDP's Branding Guidelines. These can be accessed at http://intra.undp.org/coa/branding.shtml, and specific guidelines on UNDP logo use can be accessed at: http://intra.undp.org/branding/useOfLogo.html. Amongst other things, these guidelines describe when and how the UNDP logo needs to be used, as well as how the logos of donors to UNDP projects needs to be used. For the avoidance of any doubt, when logo use is required, the UNDP logo needs to be used alongside the GEF logo. The GEF logo is accessed at: http://www.thegef.org/gef/GEF_logo. The UNDP logo can be accessed at http://intra.undp.org/coa/branding.shtml.

152. Full compliance is also required with the GEF's Communication and Visibility Guidelines (the "GEF Guidelines"). The GEF Guidelines can be accessed at: http://www.thegef.org/gef/sites/thegef.org/files/documents/C.40.08_Branding_the_GEF%20final_0.pdf. Amongst other things, the GEF Guidelines describe when and how the GEF logo needs to be used in project publications, vehicles, supplies and other project equipment. The GEF Guidelines also describe other GEF promotional requirements regarding press releases, press conferences, press visits, visits by Government officials, productions and other promotional items.

153. Where other agencies and project partners have provided support through co-financing, their branding policies and requirements should be similarly applied.

Audit Clause

154. The project will be audited in accordance with UNDP Financial Regulations and Rules and Audit policies.

155. **M & E Work Plan and Budget**

Type of M&E Activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, UNDP GEF	Indicative cost: 10,000	Within first two months of project start up
Measurement of Means of Verification of project results.	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific firms and institutions for studies, and delegate responsibilities to relevant team members.	Included in Component Budget.	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on *output and implementation*	▪ Oversight by Project Manager ▪ Project team	Included in Component Budget	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	None	Annually
Periodic status/ progress reports	▪ Project manager and team	None	Quarterly
Mid-term Evaluation	▪ Project manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: 40,000	At the mid-point of project implementation.
Final Evaluation	▪ Project manager and team, ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost : 40,000	At least three months before the end of project implementation
Project Terminal Report	▪ Project manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	▪ UNDP CO ▪ Project manager and team	Indicative cost: 20,000 (5,000/year)	Yearly
Visits to field sites	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	For GEF supported projects, paid from IA fees and operational budget	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US$ 110,000	

6. Legal Context

156. This document together with the CPAP signed by the Government and UNDP, which is incorporated by reference, constitute together a Project Document as referred to in the SBAA; and all CPAP provisions apply to this document.

157. Consistent with Article III of the Standard Basic Assistance Agreement, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner.

158. The implementing partner shall:

a) Put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried out;

b) Assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

159. UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

160. The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list is accessed via http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

Annex I. Risk Analysis

Key risks during project implementation that may prevent the project objective from being achieved are listed along with mitigating actions in Exhibit I-1, which is the project risk log. The risk log will be incorporated into ATLAS and updated periodically.

Exhibit I-1: China DevCom FCV Project Risk Log

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Management response	Owner	Submitted, updated by	Last Update	Status
1	FCV operation demonstration activities will encounter the same implementation problems encountered in the FCB Demonstration Project (Phases I & II)	Q1 2014	Regulatory	If the project demos are not able to get long-term approval to run on a continuous basis, the project's contribution to facilitating commercialization will be much less than targeted. Long-term operation, which will also verify extended durability, is critical to "proving" FCVs are more than test vehicles and can become a part of China's long-term vehicle fleet. P=1 I=5	The demonstrations have been designed to address all the necessary permits and requirements from the city authorities. This work to comply with pre-requisites will be accorded sufficient time to ensure smooth and seamless transition to the actual demonstration activities.	PMO	Project formulation (PPG) team updated this risk	March 2015	reducing
2	Local transport vehicle manufacturers as well as other stakeholders in the local and central governments may have conflicting objectives about FCVs, preventing the effective coordination of their participation and support of the project	Q1 2014	Strategic	Poor coordination and interest levels among local FCV manufacturers and local governments will slow the rate of replication of project results and thus commercialization of the industry. P = 3 I = 2	The project implementing partner has closely coordinated the project design with the project partner putting to good use its experience implementing UNDP-GEF projects. Moreover, apart from establishing an effective project team that will be comprised of competent local and international experts in transport systems and technologies, project proponents will also make use of their good working relationship with the transport vehicle industry developed in the previous UNDP-GEF FCB demonstration project.	PMO / MOST/ Demo cities	Project formulation (PPG) team updated this risk	March 2015	reducing
3	The private and	Q1 2014	Financial	Without sufficient investment,	The project design includes	PMO/	Project	March	reducing

	corporate sectors will not be interested in investing in AEVs, in general, and in FCVs, in particular			production of FCVs will not ramp up as quickly as hoped. P = 1 I = 3	information dissemination and promotion to ensure end-users' better understanding about the use and benefits of using FCVs. The project also includes interventions aimed towards improving the local technical capacity to manufacture FCVs that are at least at par with international FCV standards, as well as other interventions that will help influence the production of cost-affordable but high quality FCVs that are expected to encourage private sector-led transport systems using FCVs.	Demo cities/ MOST	formulation (PPG) team updated this risk	2015	
4	Transport vehicle manufacturers may favor electric vehicles rather than FCVs.	Q1 2014	Strategic	Currently the situation is that transport vehicle manufacturers favour EVs over FCVs. If this continues, growth of FCV production will stagnate. P=3 I=3	The project will build capacity of transport vehicle manufacturers, so that they are more confident about FCV production and view it as complementary to their EV work. The project will further support the GoC to develop an *FCV and HRS Roadmap* that will delineate the role of FCVs within the larger NEV landscape.	MOST/ Demo cities	Project formulation (PPG) team updated this risk	March 2015	reducing
5	Recommended policies may not be approved by the relevant authorities, or may be approved but not effectively enforced.	Q1 2014	Regulatory	China already has some policies supporting FCVs, but some, particularly extension of the incentive subsidies are critical to expansion of China's FCV fleet. Without continued incentive subsidies and other central government pressures to local governments, FCV numbers are unlikely to increase much in the near-term. P=1 I=4	The project will include the piloting of the application of the support policies for FCVs to gauge the effectiveness of said policies. That will help guide the relevant government authorities in the finalization, approval and effective enforcement of such policies.	MOST/ Demo cities	Project formulation (PPG) team updated this risk	March 2015	reducing
6	The level of co-financing amount may not support the project	Q1 2014	Financial	Lack of co-financing or lack of the full co-financing expected will, in particular, impact the number of vehicles to be demonstrated. Since	Substantial co-financing commitment has been obtained. During project implementation, the project team will closely	MOST/ Demo cities	Project formulation (PPG) team updated this	March 2015	reducing

	implementation promptly and sufficiently.			the greatest effort in technological advancement will be with FCBs, it's important to note that instead of 23 FCBs, without co-financing, there will be just 16 FCBs. A similar demonstration effect may be achieved anyway. Yet, depending on the degree of funding gap, the numbers of autos and vans/trucks will be reduced, thereby impacting the variety of FCVs demonstrated. Further, hydrogen stations, even more dependent on co-financing, may be fewer than planned and thus affect FCV fuel availability and therefore the attractiveness of FCVs. P=1 I=3	monitor and ensure co-financing is available by project partners and co-financers promptly and at least as per their respective committed amounts.		risk		
7	The pace of investments for the FCV support infrastructure may not be in sync with the growth of the FCV market	Q1 2014	Financial	Lack of hydrogen refuelling stations and/or continued high cost of hydrogen will inhibit expansion of the number of FCVs in China. P=3 I=3	The project includes activities to expand the number of HRSs and improve their viability. It further includes activities to lower the cost of hydrogen production and launch availability of renewable energy based hydrogen.	MOST	Project formulation (PPG) team updated this risk	March 2015	reducing
8	Sustaining the outcomes and benefits of GEF investment in the activities implemented will not be fully achieved.	Q1 2014	Strategic	If outcomes are not sustained, rreplication will not be achieved on the scale targeted and FCV growth in China will also be less than targeted. P=2 I=3	The project includes activities for the development of a sustainable follow-up plan for the replication of the FCV transport systems in other cities and expansion in existing demo cities. Implementation of the plan will be supported (financed) by the local governments. Officials from other cities will be key participant in annual workshops to disseminate results to date of the project's demos.	PMO/ MOST	Project formulation (PPG) team updated this risk	March 2015	reducing

Annex II. Agreements

Co-financing Letters are attached in a separate file.

Annex III. GHG Emission Reduction Estimates

This annex presents the steps for computing the incremental emission reductions that will be realized from the implementation of the proposed UNDP-GEF project.

1. First, direct GHG emission reductions due to the FCV demos in the baseline scenario are computed. These reductions are based on the reduced GHG emissions from using FCVs as compared to the use of the same type of vehicles that use internal combustion engines (ICEVs). The emissions from the latter are based on a typical gasoline-diesel consumption mix for ICEVs.

2. Second, direct GHG emission reductions due to the FCV demos in the alternative (project) scenario are computed. These are also computed based on comparison to the emissions from ICEVs based on a typical gasoline-diesel consumption mix.

3. Third, the difference between the alternative scenario direct emission reduction from the demo FCVs and the baseline scenario direct emission reduction from the demo FCVs is determined, to show the total direct emission reductions due to the project's demo FCVs ("incremental reductions"). A substantial gap between the two scenarios exists and may be attributed to the following reasons:

   - Alternative scenario FCVs are operated more hours of day and for more years than baseline scenario FCVs;
   - There are more vehicles in the alternative scenario case; and,
   - In the alternative scenario case, some of the hydrogen is renewable energy based.

   As for the last of these reasons, in the baseline scenario, hydrogen used for the demo FCVs is made from a mix of natural gas reforming, grid power based electrolysis (grid power being mainly coal based), and byproduct hydrogen. In the alternative scenario the mix is of natural gas reforming, wind power based, and byproduct hydrogen. The emission factors for various vehicles in the two scenarios reflect the expected hydrogen mix, respectively.

4. Fourth, incremental emission reductions due to wind farm based hydrogen production are taken into account. Wind based hydrogen exists in the alternative scenario but not the baseline scenario. Some of the hydrogen is used to fuel FCVs, while the rest is used for other non-vehicular purposes. To avoid double counting in emission reductions, a correction is made in step six (to be discussed), so that the emission reductions due to wind power based hydrogen used in FCVs is not double counted.

5. Fifth, incremental emission reductions due to land-fill methane based hydrogen production are determined. At present it is assumed that this hydrogen is used for purposes other than FCVs, though in the long-term it is expected land-fill methane based hydrogen production in China will serve a growing FCV base.

6. Sixth, total direct incremental emissions reductions from both the demo FCVs and the renewable energy based hydrogen production efforts are computed. It is at this point that a correction is made to eliminate double counting of hydrogen that is used in FCVs.

7. Seventh, indirect emission reductions using both the bottom up and top down scenarios are estimated, thus providing a range for the project's potential indirect emission reductions.

It is important to emphasize that the GHG emission reduction calculations in this annex, whether direct or indirect, are calculated for the *lifetime* of FCV or hydrogen production investments considered. This is in contrast to the GHG emission reduction calculations used for the targets in the project results framework (PRF). The PRF indicators are based on emission reductions achieved by *end of project* (EOP). Because much indirect replication occurs after close of project or equipment is in operation beyond close of project, total (indirect and direct) emission reductions based on the lifetime of the FCVs and hydrogen production equipment considered are substantially higher than emission reductions achieved by EOP.

Direct GHG Emission Reductions due to FCV Demos – Baseline Scenario

Exhibit III-1 shows emission factors and other parameters used to estimate GHG reductions in the baseline scenario (without the GEF project) for the total of 92 fuel cell vehicles that four Chinese cities (Beijing, Shanghai, Zhengzhou, and Foshan) collectively have planned for demonstration as part of their individual programs on new energy vehicles (NEVs). Each city has its own NEV program that includes alternative energy vehicles among which are FCVs. Considering only these four separate baseline FCV programs (i.e., without GEF incremental interventions), the demonstration FC vehicles are operated for a limited time of about one and a half years. Further, the total distance (kms) driven per year for each vehicle is on average about half of what will be expected in the alternative scenario, which will be facilitated by this proposed GEF project. Total emission reductions for the baseline scenario are 1,449 tons CO_2.

The limited overall operation of one and a half years and the limited daily kilometers driven as compared to the alternative scenario are explained by the following factors: (1) Low level of technological advancement, (2) weak demo planning, (3) lack of capacity building, and (4) weak policy progress. The result is that baseline scenario results are inferior to those achieved in the alternative scenario. In particular, the months of overall demonstration is much less than in the alternative scenario. FCVs break down relatively often (due to low level of technological advancement) and there is limited knowledge on how to repair them (due to lack of capacity building). Further, government permits granted for the vehicles are temporary rather than permanent (due to weak policy progress, which is in turn related to lack of confidence in FCVs due to the low level of technological advancement). As a result, full potential lifetime hours of operation are not met and vehicles are parked permanently before the end of their useful lifetime. The 1.5 years given in the baseline scenario is considered relatively optimistic based on past achievement, in which the Shanghai Expo (six months) represents the longest field test to date of FCVs in China. The explanation of fewer kilometers driven per day on average (as compared to the alternative scenario) is as follows: Due to more frequent breakdown (than in alternative scenario), less concerted planning, and operational issues, the daily hours of operation in the baseline scenario are only about half of that in the alternative scenario (i.e. for buses, 5.5 hours per day instead of 11, for cars and delivery vehicles 3 hours per day instead of 6), thus resulting in annual km travelled being half of that in the alternative scenario.

In order to compute emission reductions in the baseline scenario, we compare emission factors for a mix of gasoline and diesel ICE vehicles to emission factors for the baseline scenario FCVs. Subtracting the FCV emissions factor in each case from the gasoline/diesel emissions factor yields an “emissions reduction factor” used to compute total emissions reductions for each vehicle type. For the gasoline/diesel emission factors we use GEF TEEMP values of 304 grams CO_2 per vehicle km travelled for autos and 1,338 grams CO_2 per vehicle km travelled for buses. For delivery vehicles, we use an intermediary number, the average of the two foregoing emissions factors, 821 grams CO_2 per vehicle km travelled.

Because the Beijing vehicles will have different hydrogen source types than the vehicles from the other cities, we compute the Beijing FCV emission factors differently. In the baseline scenario, hydrogen for Beijing baseline FCVs will be provided by Capital Steel and be a mix of hydrogen produced from natural gas (steam methane reforming, SMR) and hydrogen produced from electrolysis. It is assumed that this mix is 50-50 (half from each source) and that, in the baseline scenario, the electrolysis is powered by the electricity grid. (The latter will not be allowed in the alternative scenario due to high CO_2 emissions.) For the natural gas (SMR) FCV "well to wheel" emission factor, we use 162 g CO_2 per km for autos, based on an emission factor of about 260 g CO_2 per mile used by Joseck and coauthors (from US Department of Energy and Argonne National Labs, also in the US).[50] For the auto grid electricity FCV emission factor, we use the California Energy Commission's estimate of 300 g CO_2 per mile to get 186 g CO_2 per km.[51] Assuming a 50-50 mix and taking the average of the natural gas and grid electricity FCV emission factors yields an overall auto emissions factor of 174 g per km for the Beijing baseline scenario. Further, this is scaled up by a factor of 4.4 times for buses and 2.7 times for delivery trucks (based on the ratios of gasoline/diesel emission factors by vehicle type) to get a Beijing baseline FCB emission factor of 766 g CO_2 per km and a Beijing baseline FC delivery truck emissions factor of 470 g CO_2 per km.

Exhibit III-1: Direct CO_2 Emission Reductions in the Baseline Scenario

City or cities	Vehicle Type	No. of vehicles (C)	Gasoline/ diesel emission factor (g CO_2/km) (D)	FCV baseline emission factor (g CO_2/km) (E)	Emission reduction factor (g CO_2/km) (D-E) = (F)	Km driven per year (G)	Years driven (H)	Emission reduction (tons CO_2) (C*F*G*H* 10^{-6}) = (I)
Beijing*	Bus	5	1,338	766	572	39,062	1.5	167.58
	DV Truck	5	821	470	351	23,438	1.5	61.70
Shanghai, Zhengzhou, Foshan**	Bus	2	1,338	290	1,048	39,062	1.5	122.81
	Auto	50	304	66	238	23,438	1.5	418.37
	DV Van	30	821	178	643	23,438	1.5	678.18
Total	---	**92**	---	---	---	---	---	**1,448.63 tons**

*Beijing's baseline FCV hydrogen is assumed to be 50 percent natural gas-based (steam methane reforming) and 50 percent electrolysis-based (grid electricity).
**Baseline FCV hydrogen for the three other cities is assumed to be by-product hydrogen from coke oven gas, 80 percent of which would normally be unutilized and the other 20 percent of which would have been utilized for process heat.
Note: More details on emission factors used are given in the text.

For the Shanghai, Zhengzhou, and Foshan baseline demo FCVs, it is assumed that hydrogen is derived from by-product hydrogen of industrial processes and specifically from coke oven gas (COG) produced in coking factories and steel mills in China. Shanghai, in particular, has confirmed that it will use hydrogen from the Shanghai Coking Factory. Zhengzhou has confirmed it will use by-product hydrogen and Foshan is still determining its hydrogen source. There are two major sources of by-product hydrogen in China: coke production and the chlor-alkali industry. As over 90 percent of this resource is estimated to be in China's coking industry, we use COG-based emission factors for the Shanghai, Zhengzhou, and Foshan demos.[52] Joseck, et al estimate three different FC auto emission factors for hydrogen made from coke oven gas, selection of which depends on system boundaries chosen for the analysis. For this project, it is assumed that the base industrial process of coke-making would have occurred anyway and therefore do not attribute associated GHGs with the hydrogen production. Hydrogen production, however, requires an additional one-step pressure-swing adsorption (PSA) system powered by the electric grid, which is considered in the GHG emission calculations. Further, as in some cases the COG is used to supply process heat, additional natural gas is assumed to be needed to replace the COG, thus adding to total GHG

[50] Fred Joseck, Michael Wang, and Ye Wu, "Potential Energy and Greenhouse Gas Emission Effects of Hydrogen Production from Coke Over Gas in US Steel Mills," *International Journal of Hydrogen Energy*, 2008, pages 1445-1454.
[51] California Energy Commission as referenced by California Fuel Cell Partnership in *Well to Wheels: A Guide to Understanding Energy Efficiency and Greenhouse Gas Emissions*, updated September 2012.
[52] Xue Deng, Hewu Wang, Hiyan Huang, and Minggao Ouyang, "Hydrogen Flow Chart in China," *International Journal of Hydrogen Energy*, 2010.

emissions. In COG Scenario 2 (considering just the PSA system input and transport to HRS), Joseck et al come up with a well to wheel emission factor of roughly 50 g CO_2 per km. In their Scenario 3 (considering the PSA system input and addition of natural gas to replace lost process heat utilized), they come up with a well to wheel emission factor of roughly 130 g CO_2 per km. Based on the analysis of the situation that China currently utilizes only about 20 percent of its COG for fuel, these emission factors were taken to be at 80 percent and 20 percent respectively, to come up with an overall COG FCV emission factor of 66 gm CO_2 per km (=0.8*50 g/km + 0.2*130 g/km). This factor is scaled up 4.4 times for buses and 2.7 times for delivery vans to yield FCV emission factors of 290 g CO_2 per km and 178 g CO_2 per km, respectively, for those vehicle types.

Direct GHG Emission Reductions due to FCV Demos – Alternative Scenario

Exhibit III-2 shows $C0_2$ reductions in the alternative scenario for the 109 alternative scenario vehicles (16 GEF-financed and 93 co-financed[53]). Total emission reductions in the alternative scenario are 10,814 tons CO_2 as compared to 1,449 tons CO_2 in the baseline scenario.[54] Three key factors result in the substantially higher reduction emissions in the alternative scenario. First and most importantly, due to focused technical assistance for achieving targets set by the project, assistance in achieving policy and long-term approvals for vehicle use, and assistance in designing enhanced plans for the demos, the vehicles operate for substantially longer hours per day (11 hours per day for buses instead of 5.5 hours and 6 hours per day for other vehicles instead of 3 hours) and are operated over a longer time period (3.2 years instead of 1.5 years). Secondly, there are more vehicles than in the baseline case, with the GEF funds supporting purchase of 16 FCBs, raising the number of buses from 7 to 23. In addition, existence of the UNDP-GEF project attracts Toyota to contribute one FC auto as well, raising the number of autos from 50 to 51. Thirdly, hydrogen produced from wind farms as facilitated by the project result in about half of the Beijing vehicles hydrogen supply being renewable energy based hydrogen, further increasing emission reductions. It is important to note, then, that incremental emission reductions are not only embodied in the buses purchased with GEF funds. The co-financed vehicles, which were to occur in the baseline case, benefit significantly from various forms of technical assistance and thus also operate more hours per day and over a longer period of time than in the baseline scenario.

In calculating emission reduction factors for the alternative scenario, the same emission factors for gasoline/diesel ICE vehicles as used in the baseline scenario were considered. For Beijing FCVs, assuming half of the hydrogen is provided by natural gas (steam methane reforming) and half of the hydrogen is provided by wind power based electrolysis, the new FCV emission factors are estimated by taking the average of the natural gas emission factor and the wind power based hydrogen emission factor for autos and then scaling it up by 4.4 times for buses and 2.7 times for delivery trucks. The auto natural gas hydrogen emission factor is the same as used above, 162 g CO_2 per km, based on Joseck et al. The FC automobile wind farm based hydrogen emissions factor is based on US Department of Energy well to wheel estimates, taking the average of 42 g CO_2 per mile (for 62-73 miles per gallon, 94 percent energy efficiency for hydrogen compression to 6,251 psig) and 63 g CO_2 per mile (for 42-48 miles per gallon, other parameters the same) and converting to g CO_2 per kilometer to get 32.6 g CO_2 per km for wind-based hydrogen fueled auto. Assuming half natural gas based hydrogen and half wind farm based

[53] The number of co-financed vehicles rises by one in the alternative scenario because, with the existence of the UNDP-GEF project, Toyota has decided to participate by donation of one of its fuel cell vehicle autos (the Mirai).

[54] Because Yancheng, Jiangsu Province, and several other cities have shown strong interest in joining the demonstration of this project, it is likely that the number of demo vehicles in the alternative scenario will substantially surpass 109 and that the direct GHG emission reductions will thus be larger than estimated here. Additional demo cities and vehicles will be officially incorporated into the project plan at inception and GHG direct emission reduction estimates (and direct incremental emission reduction estimates) will be revised accordingly. In the case of Yancheng, which is currently very likely to join the project demos, eight buses are expected, as is full provision of hydrogen by wind-based electrolysis. In the alternative scenario, this will add 2,389 tons (an additional 26%) to the direct incremental CO_2 emission reductions due to the project.

hydrogen yields an auto emission factor of 97.3 g CO_2 per km, which is then scaled up to 4.4 times for buses (428 g CO2 per km) and 2.7 times for delivery trucks (263 g CO2 per km). For the other cities' FCVs, the same FCV emission factors (based on China coke oven gas) as used in the baseline scenario is used. As before, the difference between the alternative scenario FCV emissions factors and the respective gasoline/diesel ICEV emission factors represent the "emission reduction factors." These are then used to compute total emission reductions. In the alternative scenario, then, net emission reductions are 10,814 tons. This represents an increment of 9,365 tons over the baseline scenario.

Exhibit III-2: Direct CO_2 Emission Reductions in the Alternative Scenario

City or cities	Vehicle Type	No. of vehicles (C)	Gasoline/ diesel emission factor (g CO_2/km) (D)	FCV baseline emission factor (g CO_2/km) (E)	Emission reduction factor (g CO_2/km) (D-E) = (F)	Km driven per year (G)	Years driven (H)	Emission reduction (tons CO_2) (C*F*G*H* 10^6) = (I)
Beijing*	Bus	10	1,338	428	910	78,124	3.2	2,274. 97
	DV Truck	5	821	263	558	46,876	3.2	418.51
Shanghai, Zhengzhou, Foshan**	Bus	13	1,338	290	1,048	78,124	3.2	3,405.96
	Auto	51	304	66	238	46,876	3.2	1,820.74
	DV Van	30	821	178	643	46,876	3.2	2,893.56
Total	---	**109**	---	---	---	---	---	**10,814 tons**
Direct incremental emission reductions: 10,814 tons (alternative) – 1,449 tons (baseline) =								**9,365 tons**

**Beijing's baseline FCV hydrogen is assumed to be 50 percent natural gas-based (steam methane reforming) and 50 percent wind power based.
**Baseline FCV hydrogen for the three other cities is assumed to be by-product hydrogen from coke oven gas, 80 percent of which would normally be unutilized and the other 20 percent of which would have been utilized for process heat.
Note: More details on emission factors used are given in the text.

Incremental Direct Emission Reductions Due to Demo FCVs

Currently, it is anticipated the 109 demo FCVs can complete their full duration of driving during the lifetime of the project, so that total incremental FCV demo direct CO_2 emission reduction of the project will be equivalent to the lifetime incremental direct emission reductions of the FCV demos. In this case, that is, there will be no lifetime post-project incremental direct emission reductions due to the demo FCVs. This situation is expressed in the first equation below. It is quite, possible, however, that the lifetime of the FCVs will extend beyond the conservative 3.2 years (and associated kms per year) currently targeted, thus yielding greater emission reductions than in this conservative analysis. Further, it is expected that the FCV financing scheme will result in USD 50 million of FCV financing by EOP and that the financed vehicles will operate for about 3.2 years post project and have a similar vehicle mix to the project demos. USD 50 million is about three times the USD 16.650 million cost of the 109 demo vehicles. Thus, the financing scheme should purchase about three times the amount of demo vehicles (if a similar mix is assumed) and the lifetime direct post project emission reductions will be at least three times lifetime direct emission reductions, as expressed in the second equation below.

Lifetime Direct Emission Reductions (DER) = 10,814 tons (alternative scenario direct emission reductions) – 1,449 tons (baseline scenario direct emission reductions) = 9,365 tons

Lifetime Direct Post Project Emission Reductions (DPPER) = 3*(Lifetime Direct Emission Reductions) = 3*9,365 tons = 28,095 tons

Direct GHG Emission Reductions due to Wind Farm based Hydrogen Production

The incremental emissions reduction from the wind-based hydrogen production facilities is assumed to be that hydrogen displaced from the natural gas reforming market and the coking by-product market in a 50:50 mix. Each of the three wind farm facilities are assumed to be 2 MW in scale, operating at a 35 percent capacity factor and with efficiency of 46 kWh of electricity needed to produce 1 kg of hydrogen. Thus, annual hydrogen production at each wind farm will be 2,000 kW*0.35*365 days/year*24 hours/day*1 kg/46 kWh = 133,304 kg of hydrogen per year. Assuming that the wind-based hydrogen production facilities are up and running by the start of year three of the project, they will run for two years during the project, so that total hydrogen produced will be: 3 wind farms * 133,304 kg/wind farm-year * 2 years =799,824 kg of hydrogen. This hydrogen production process is considered carbon neutral. The water electrolysis units used to produce the hydrogen from water are assumed with good maintenance to have a lifetime of 20 years, so that they are operated for an additional 18 years beyond project close.

The GHG emissions per kg of hydrogen produced by natural gas reforming and by-product (coke oven gas) are used as a comparison factor to estimate total emission reductions. A 50:50 mix of the two types of fossil-fuel based hydrogen production is assumed to be replaced. For natural gas reforming, an emission factor of 9 kg CO_2 per kg of hydrogen is assumed. This is a typical value found in the literature and, as mentioned, does not include transport to end use. Scaling the 66 g per km factor used for FC autos using by-product hydrogen in a similar way to the scaling suggested for the natural gas case (in both cases, 1 kg hydrogen per 100 kg auto travel distance is assumed), a CO_2 emissions factor of 3.67 kg CO_2 per kg hydrogen is arrived at. Thus, the average of these two fossil-fuel based hydrogen emission factors is 6.34 kg CO_2 per kg hydrogen. Emission reductions, based on this average factor, are computed below:

Lifetime Direct Emission Reductions (DER) = 3 wind farms * 133,304 kg/wind farm-year * 20 years * (6.34 kg CO_2 per kg fossil fuel based hydrogen production) = 50,709 tons CO_2

There are no lifetime direct post project emission reductions for the wind farms, as the project will not directly assist any wind farms that may initiate wind-based hydrogen production after EOP.

Direct GHG Emission Reductions due to Landfill Methane based Hydrogen Production

For the landfill methane based hydrogen production demonstration, the process is methane reforming ($CH_4 + 2H_20 = CO_2 + 4H2$) and the CO_2 emissions from this process is about 5.5 kg of CO_2 per kg of hydrogen produced. The demo will be constructed at economic scale which is considered 1,000 to 2,000 Nm^3 hydrogen per hour. Using a conversion factor of 1 Nm^3 hydrogen = 0.08988 kg and assuming the demo scale is 1,500 Nm^3 hydrogen per hour, the scale in kg of hydrogen produced is 135 kg per hour. Assuming 20 hour operation per day, annual output will be 985,500 kg of hydrogen. While we will use for comparison the fossil fuel hydrogen production CO_2 emission factor of 6.35 kg CO_2 per kg hydrogen as used above, it is noted that an additional important GHG emissions reduction benefit of landfill methane based hydrogen production is elimination of methane (CH_4) emissions from the landfill. Pound per pound, methane has 21 times the comparative impact that CO_2 does over a 100-year period. Emission reductions (considering only the CO_2 reduction benefit) are given below. It is assumed that the landfill methane hydrogen production equipment is up and running by the start of year three of the project and thus runs for two full years during the project lifetime. A 20 year lifetime of the land-fill methane hydrogen production equipment is assumed, so that the equipment continues to be used 18 years after end of project.

Lifetime Direct Emission Reductions (DER) = 1 landfill methane based hydrogen production site *20 years * 985,500 kg of hydrogen per year * (6.35 kg CO_2 per kg hydrogen – 5.5 kg CO_2 per kg hydrogen) = 16,754 tons CO_2

There are no lifetime direct post project emission reductions for the land fill methane based hydrogen production, as the project will not directly assist any additional sites that may initiate landfill methane-based hydrogen production after EOP.

Total Direct Incremental Emission Reductions

Total incremental emission reductions of the project are computed by summing the incremental reductions for the FCVs, the incremental reductions for the wind farm based hydrogen production, and the incremental reductions for the landfill methane based hydrogen production. As there is some double counting (wind farm based hydrogen production used in Beijing's fuel cell vehicles), this is then subtracted out. That is, the above calculations count the ERs related to wind energy based hydrogen being used in the FCVs twice – once as creating emission reductions via the FCVs and once creating ERs via replacing carbon-based hydrogen production. It should be noted that this wind energy based hydrogen used in the FCVs is only a part of the total hydrogen produced via wind energy, so that there is a need to consider the total ERs for the wind-based hydrogen production and then just subtract out that portion which has already been counted as ERs generated by the FCVs.

Total Incremental Lifetime Direct Emission Reductions (DER)
= FCV DER + wind farm H2 production DER + land-fill methane H2 production DER – double counting
= 9,365 tons + 50,709 tons + 16,754 tons - 824 tons[55] = 76,004 tons CO_2

Total Incremental Lifetime Direct Post Project Emission Reductions (DPPER)
= FCV DPPER + wind farm DPPER + land-fill methane DPPER – double counting
= 28,095 tons CO_2 + 0 - 824 tons*3[56] = 25,623 tons CO_2

Indirect Emission Reductions – Bottom Up

In the bottom up analysis (BOA), for the alternative scenario, we assume a four times replication factor for the FCVs and a replication factor = 3, for the renewable energy based hydrogen production. Replication factors of three to four are typically used for GEF market transformation projects. During project formulation, replication of the FCV demos already seems quite promising as other cities have shown an interest in purchasing such vehicles and/or joining the demos. Replication of the renewable energy based hydrogen production is less advanced, though there is interest among multiple wind farms.

In the bottom up analysis the indirect emission reductions are computed as the sum of the lifetime DER and the lifetime DPPER multiplied by the replication factor. Due to the different replication factors, this is computed below separately for the FCVs and hydrogen production in the first two equations, with the totals then summed in the third equation. To avoid double counting, the double counting factor is subtracted out in the FCV emission reductions calculation.

Indirect Emission Reduction for Bottom up Analysis for FCVs

[55] Hydrogen consumption amounts of 8 kg per 100 km for buses and 4 kg per 100 km for delivery trucks are used. As half of the hydrogen for Beijing in the alternative scenario is assumed to be wind farm generated hydrogen, we estimate 5 buses and 2.5 delivery trucks (half of Beijing demo vehicles) are served by the wind farm, with annual km travelled 78,124 km for the buses and 46,876 km for the delivery trucks, both over 3.2 years. The resulting total wind power based hydrogen consumption of the Beijing buses is 100 tons and that of the delivery vehicles is 30 tons. Thus, a total of 130 tons of wind based hydrogen is used. Assuming emissions avoided are 6.35 tons CO2 per ton hydrogen, total emission reduction due to the wind-based hydrogen used in FCVs is 824 tons of CO2.

[56] For the direct post project FCVs, it is assumed the hydrogen mix is similar to that of the original 109 demo FCVs and therefore that the double counting will be three times that based on the 109 demo FCVs.

= [(9,365 tons of CO_2 - 824 tons CO2) + (28,095 tons of CO2 – 824 tons CO2*3)]*replication factor of 4
= (8,541 + 25,623)*4 tons CO2 = 136,656 tons of CO_2

Indirect Emission Reduction for Bottom up Analysis for Renewable Energy Based Hydrogen Production
= [(50,709 tons + 16,754 tons) + 0]*3 = 202,365 tons

Total Indirect Emissions Reduction – Bottom up Analysis
= 136,656 tons + 202,365 tons = 339,021 tons CO_2

Indirect Emission Reductions – Top Down

In the top-down analysis, we refer to Exhibit 1-5 in the main text which shows the cumulative total number of NEVs on the road in China for each of 2010, 2011, 2012, 2013, and first half of 2014. The vast majority of these FCVs are some form of electric vehicle, including hybrid. We assume that starting year one post-project (2020), fuel cell vehicles show a similar type of ramp up as EVs had shown, just delayed by ten years from the case of EVs and then forecast for further growth from 2025-2029, though somewhat less aggressive growth than in 2020-2024. To simply computations, we also assume a mix of vehicle types similar to that of the 109 demo FCVs. Further we assume that the hydrogen mix is similar to that used for the 109 demo vehicles in the alternative scenario (and thus a mix of natural gas reforming based hydrogen, wind farm electrolysis based hydrogen, and by-product COG based hydrogen). Exhibit III-3 shows our computation for total emission reductions by FCVs in China from 2020 to 2029, which are estimated to be around 124 million tons CO_2. A causality factor of 50 percent is adopted, so that indirect top down FCV emission reductions are 62 million tons. The project is believed to have a relatively strong influence in future FCV adoption due to the policy pilots, the cost reductions in FCV components achieved via technical assistance and international cooperation assistance provided to China-based component manufacturers, and the initial very positive demonstration effect of the project FCV demos.

Exhibit III-3: Projected Indirect Emissions (Top Down) based on FC Vehicle Population in the Ten years following Project Close

Year	Cumulative number of FCVs on the road in China	Multiples of 109 represented by cumulative number [C]	Emission reductions for 109 vehicles over period of 1 year (CO_2 tons) [D]	CO_2 emission reductions (tons) [C] x [D]
2020	15,000	137	3,379	462,923
2021	30,000	275	3,379	929,225
2022	60,000	550	3,379	1,858,450
2023	110,000	1,009	3,379	3,409,411
2024	210,000	1,927	3,379	6,511,333
2025	340,000	3,120	3,379	10,542,480
2026	500,000	4,587	3,379	15,499,473
2027	690,000	6,330	3,379	21,389,070
2028	900,000	8,257	3,379	27,900,403
2029	1,140,000	10,459	3,379	35,340,961
Total emission reductions from FCVs in China in the ten years after project close				**123,843,729 tons**
Causality factor of 50% -> top down indirect emission reductions due to FCVs (E)				**61,921,865 tons**

During this period in the top down approach, it is also projected that 240 MW total of wind based hydrogen production is adopted and that the causality factor is also 50 percent. Finally, about 40 land-fill methane based hydrogen facilities are projected to be set up on a similar scale to the project demo. The total emission reductions yielded from all this renewable energy based hydrogen production is 632,880 tons CO_2, which with a causality factor of 50 percent suggest 316,440 tons of top-down indirect CO_2 emission reductions. While it is difficult to project that portion of this hydrogen production will be used for FCVs, it is envisioned that an increasing portion is indeed used in FCVs. In any event, as the value of top-down indirect CO2 emission reductions from H2 production is less than one percent of that estimated for FCV based emission reductions, it is assumed that all of hydrogen production ERs are double counted and thus can be ignored.

The total top down analysis (TDA) emission reductions are the sum of the top down indirect FCV emissions reductions and the top down indirect renewable energy based hydrogen production emission reductions. This total is 62,238,305 million tons CO_2.

Thus, the range for anticipated indirect emission reductions is from 339,021 tons CO_2 (bottom up analysis) to 62,238,305 tons CO_2 (top down analysis). This is the range of indirect emission reductions attributable to the project. The range is quite large due to uncertainty of the timing of the tipping point when FCVs will take off at a rate similar to EVs in China.

Annex IV. Annual Targets

Exhibit IV-1: Annual Targets for Project Results Framework Indicators

Strategy	Indicator	Baseline	Year 1 Target	Year 2 Target	Year 3 Target	Year 4 (EOP) Target
Goal: Reduced growth of GHG emissions from transport sector	Cumulative tons of GHG emissions from China's transport sector reduced by end of project (EOP)	0	0	3,121 tons	38,669 tons	132,707 tons
Objective[57]: Facilitation of the commercial production and application of fuel cell vehicles in China	Number of local transport vehicle manufacturers producing FCVs by EOP	4	4	6	8	10
	Cumulative investment in local FCV manufacturing by EOP, US$ million	$1 million	$2 million	$4 million	$7 million	$10 million
	Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations by EOP	1,000	3,000	5,000	7,500	10,000
Outcome 1A : Markedly reduced costs and improved performance and durability of FCVs in China	Average annual operating hours of newly produced Chinese FCVs by EOP, hours	670 (bus) 670 (car) 670 (DV)	670 (bus) 670 (car) 670 (DV)	3,300 (bus) 2,100 (car) 2,100 (DV)	3,300 (bus) 2,100 (car) 2,100 (DV)	3,300 (bus) 2,100 (car) 2,100 (DV)
	Reduction in high volume unit cost[58] of newly produced Chinese FCVs at EOP, %	0% (bus) 0% (car) 0% (DV)	0% (bus) 0% (car) 0% (DV)	50% (bus) 40% (car) 50% (DV)	50% (bus) 40% (car) 50% (DV)	50% (bus) 40% (car) 50% (DV)
Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China	Annual FCV sales China by EOP (units sold) Average annual growth rate of FCV sales in China by EOP (% growth in units sold as compared to previous year)	0 0%	109-200 >100%	175-1,000 100%	300-3,500 100%	400 – 7,000 100%
Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China	1	1	4	4	5
Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen	Number of hydrogen production units and refueling stations in China of substantial scale: • Annual H2 production, MT • No. of H2 refueling stations	0 2	0 4	500 8	750 12	1,000 15
Outcome 3A: Effective	Number of FCV manufacturing companies that	0	0 (N/A –	4	7	10

[57] *Objective (Atlas output) monitored quarterly ERBM and annually in APR/PIR*

[58] Projection based on production volume of 500 units for buses and 5,000 units for cars, vans, and trucks

enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	are compliant to newly issued and enforced FCV product standards by EOP		standards not yet issued)			
Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations	Number of cities in which policies new to China promote FCV purchase and/or investment in hydrogen stations are implemented by EOP	0	0	2	4	6
Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness	Number of local governments that are aware and have adopted FCVs in their public transport systems by EOP	0	0	6	8	10
	Number of private vehicle owners that own and use a FCV by EOP	0	0	0	250 – 1,500	480 – 3,360
Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	Number of individuals capable of satisfactorily operating and maintaining (a) FCVs; and, (b) hydrogen refueling stations, in China	20 5	100 25	250 50	350 75	>500 >100
Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/ commercial purchase of FCVs	Cumulative investment by financial sector in FCV and FCV value chain manufacturing and in hydrogen stations and their value chain by EOP, US$ million	20	40	80	130	200

Annex V: Terms of Reference

The sections below contain preliminary TORs for each of the PMO staff as well as most of the key consultants to carry out project activities. The TORs are organized into broad categories according to which project outcomes or outputs they related to. At present, the TORs are "skeleton" style, consisting mainly of required tasks, deliverables, and required qualifications. During implementation, these TORs will be expanded by the PMO. Further, it is possible that some TORs will be combined if qualifications overlap among assignments. Included TORs cover all international and national industry experts to be involved in project. Some of these experts may be assigned to the project via contracts with companies whereas others will hold individual contracts with the project.

V.1: PMO and PMO Technical Advisor TORs

1. PMO Project Manager

The Project Manager will be a full-time position throughout the four years of the project.

Required Tasks: Delegating and conducing work in the following areas:

- Preparation of annual work plans including targeted expenditures
- Liaison and coordination with four local PMOs regarding FCV and HRS demos
- Preparation of consultant TORs
- Recruiting of consultants
- Monitoring of progress and quality of consultant work
- Preparation of project reports including progress reports
- Liaison with various project partners and beneficiaries including liaison between international consultants and beneficiaries
- Outreach to beneficiaries and dissemination work

Deliverables

- Annual work, plans including targeted expenditures
- Expanded consultant TORs
- Consultant contracts
- Project progress reports

Required Qualifications

- Knowledge and experience in the automotive and fuel cell vehicles fields
- 15 or more years of experience managing and contributing to international cooperation projects
- Native speaker of Mandarin; fluent in spoken English and strong English writing skills
- Experience in preparing annual work plans
- Proven track record of delivering results in international development projects
- Evidence of experience in adaptive management – adjusting course of action based on results to date
- High level of personal integrity

2. PMO Monitoring and Evaluation Officer

The Project M&E Officer will spend up to 50 percent of time monitoring project activities. The rest of the M&E Officer's time will be spent in conducting other coordination and support activities of the PMO. The M&E Officer will work under the direction of the Project Manager. The M&E Officer will be a full-time position throughout the four years of the project.

Required Tasks:

- Updating of project indicators

- Site visits to demo cities to ensure that demos are proceeding as expected
- Site visits or phone interviews with beneficiaries of project technical assistance to ensure assistance is valuable and being delivered as expected
- Preparation of internal memos on findings from site visits and monitoring interviews
- Preparation of project reports, such as APRs, QPRs, and PIRs
- Strong backstopping for project MTR and Terminal Evaluation
- Management of various project surveys required to measure project indicators. This will include all activities in "Outcome 6" as well as other such survey activities spread throughout the project's other outcomes.
- Alerting Project Manager and UNDP in a timely fashion of any "red lights," such as indicators not on target for being met, activities not being implemented as intended, demo vehicles not operating, demo HRSs not operating, etc.
- Participating under guidance of CTA and PM in adaptive management and adjustments to PRF based on experience to date
- Liaison with local PMOs, consultants, and project beneficiaries
- Outreach to beneficiaries and other partners
- Support of report dissemination (including developing target lists, etc.)
- Review of quality of consultant materials
- Provision of interpretation and translation support as needed to international consultants

Deliverables
- Annually updated project indicators
- Back-to-office reports from visits to demo cities; reports on findings from phone calls with beneficiaries, etc.
- Project surveys required to measure project indicators (While these will be carried out by consultants, the M&E Officer will have responsibility for ensuring they get are done with high quality.)
- APRs, QPRs, and PIRs
- Outreach and dissemination target lists

Required Qualifications
- Experience or education in auto industry and, preferably, FCV industry
- Strong skills writing in English and in Chinese
- Strong organizational skills
- Demonstrated analytic skills; logical
- Native speaker in Chinese; fluent in English
- Task oriented self-starter who can handle multiple mini-projects at one time
- Proven attention to detail
- Talented at interviewing to gather required information; good at developing rapport with beneficiaries
- High level of personal integrity

3. PMO Communications and Dissemination Officer

Project Communications and Dissemination Officer will spend up to 50 percent of time providing communications and dissemination support to project activities, particularly for, but not limited to, Outcome 4. The Communications and Dissemination Officer will be a full-time position throughout the four years of the project.

Required Tasks
- Outreach to potential beneficiaries for attending workshops and/or participating in technical assistance

- Liaison with the press to ensure targeted organizations receive updates on project activities and particularly on progress of the demos
- Management of project activities as assigned by PM, particularly of Component 4 (Awareness and Information Dissemination) activities
- Review of consultant work to ensure timely and quality deliverables
- Preparation of TORs as relevant
- Liaison work with organizations that will print project publications and brochures
- Liaison with film company that will produce FCV documentary to be shown on major TV network in China
- Other outreach to beneficiaries and partners
- Support of report dissemination (including developing target lists, etc.)
- Provision of interpretation and translation support as needed to international consultants
- Contributing to project ideas of how to attract consumers and other end users to FCVs and of how to popularize FCV and hydrogen-related concepts
- Organization and implementation of project workshops

Deliverables
- Articles in the press regarding FCVs that can be directly attributed to the project
- TORs, especially for Component 4 activities
- Target lists for dissemination of reports
- Project brochures and promotional materials (Some may be designed by the PMO, others by outside consultants.)
- Airing of FCV documentary on major television network (Work will be handled by outside consultant or sub-contractor, but Communications Officer will monitor for quality and delivery.)
- Well attended and successful project workshops (Consultants may prepare workshop materials, but Communications Officer will play key role in workshop organization, outreach to potential attendees, and workshop implementation.)

Required Qualifications
- Three years of work experience in the communications field
- Native speaker of Mandarin; extremely strong written Chinese skills
- Fluent in English; very good English writing skills
- Experience liaising with the press preferred
- Experience preparing promotion and/or marketing materials preferred
- Strong organizational skills; experience in organizing and implementing workshops preferred
- Basic understanding of auto and NEV fields
- High level of personal integrity

4. PMO Chief Technical Advisor covering all technical areas with emphasis on FCVs

This may be a part time assignment, but will be carried out over the full lifetime of the project.

Required Tasks
- Refine project activities on annual basis, contributing to preparation of annual work plan
- Provide technical advice, with focus on project's Outcomes 1A, 1B, 2A, and 2B activities (covering FCVs, FCV components, hydrogen production, and hydrogen refueling stations). Technical advice will focus on how to improve activities, as well as quality control of ongoing activities.
- Support TOR design with technical input
- Assist PMO in recruiting appropriate international consultants for outcomes 1A, 1B, 2A, and 2B. This will include experts in FCVs, experts in various FCV and FC components, experts in hydrogen production (especially renewable energy based), and experts in hydrogen refueling stations. Assistance will include leveraging of CTA's network to identify promising candidates

- Review project reports on FCVs and FCV components and identify needed improvements
- Prepare RFPs for all types of project FCV demo vehicles (one for buses, one for autos, one for delivery vans, and one for delivery trucks). Ensure that RFPs will achieve “leapfrog” targets set by the project for durability and performance.
- Assist Chinese FCV manufacturers in liaising with relevant international manufactures of FCV components. (Note: This work may be conducted in concert with an international consultant recruited specifically for output 1A.3 of the project.)
- Provide needed technical assistance to Chinese FCV manufacturers to reach “leapfrog” targets set by project in durability and performance, as well as cost. (Note: This work may be conducted in concert with an international consultant (or consultants) recruited specifically for output 1A.1.1 of project.
- Review monitoring results of project FCV demos and provide recommendations for trouble shooting and improvement of demos

Deliverables
- Annual work plans (in conjunction with rest of PMO)
- Revision/expansion of technical aspects of project activities
- Memos describing current status of demos and actions for improvement
- Four RFPs (one for FCV demo buses, one for FCV demo cars, one for FCV demo vans, and one for FCV demo trucks)
- International sourcing agreements between China’s FCV manufacturers and domestic component suppliers (to be provided in conjunction with consultant handling output 1A.3)
- Step-by-step action plans for domestic FCV manufacturers to improve durability and performance and to cut costs (to be provide in conjunction with consultant(s) handling output 1A.1.1)

Required Qualifications
- Top world expert in FCVs
- At least ten years of experience in FCVs and NEVs generally
- At least 20 years of experience in auto industry
- Strong network within FCV and FCV/FC component industry
- Experience in designing FCV demos
- Experience in monitoring and reporting on FCV demo results
- High level of integrity

5. PMO Technical Advisor – Hydrogen Production and Hydrogen Refueling Stations

This may be a part-time assignment, but will be carried out over the four year lifetime of the project. It is very important that this person has expertise specifically in the area of hydrogen rather than generally in the area of FCVs.

Required Tasks
- Refine hydrogen related project activities on annual basis, contributing to preparation of annual work plan
- Provide technical advice, with focus on project’s Outcomes 2A and 2B activities (covering hydrogen production and hydrogen refueling stations). Technical advice will focus on how to improve activities, as well as quality control of ongoing activities.
- Support hydrogen related TOR design with technical input
- Assist PMO in recruiting appropriate international consultants for outcomes 2A and 2B. This will include experts in hydrogen production (especially renewable energy based) and experts in hydrogen refueling stations. Assistance will include leveraging of CTA’s network to identify promising candidates.
- Review project reports on hydrogen production and hydrogen refueling stations and identify needed improvements

- Provide needed technical assistance to Chinese renewable energy based hydrogen producers and Chinese hydrogen refueling stations. (Note: This work may be conducted in concert with international consultants recruited specifically to provide such technical assistance as a part of outputs 2A.1.1 and 2A.3.1 of project.
- Review monitoring results of project renewable energy based hydrogen production and project hydrogen refueling stations and make recommendations for improvement
- Review project-developed China HRS database and make recommendations for improvement
- Review quality of project's hydrogen related work and make recommendations for improvement

Deliverables
- Component 2 aspects of annual work plans (in conjunction with rest of PMO)
- Revision/expansion of technical aspects of project activities under Outcomes 2A and 2B
- Memos describing current status of hydrogen production and HRS demos and actions for improvement
- Step-by-step action plans for renewable energy based hydrogen producers (to be provided in conjunction with consultant(s) handling output 2A.1.1) and business plans for HRSs (to be provided in conjunction with consultants handling output 2A.3.1).

Required Qualifications
- Top world expert in hydrogen refueling and hydrogen production (Note: It is very important that this person be specifically a hydrogen expert rather than FCV expert in general.)
- At least ten years of experience in hydrogen production (especially renewable energy based) and hydrogen refueling
- At least 20 years of experience in industrial gas or related business
- Strong network within hydrogen refueling and hydrogen production industry
- Experience in designing demonstrations of hydrogen production and hydrogen refueling
- Experience in monitoring and reporting on hydrogen related demonstrations
- High level of integrity

V.2: TORS for Consultants to Support FCV Manufacturers, FCV Demos, and FCV O&M

1. FCV Expert to Provide One-on-One Technical Assistance to Selected Chinese FCV Manufacturers

One or more experts may be selected for this assignment, which focuses on providing one-on-one technical assistance to China's FCV manufacturers in the design and manufacture of FCV buses. The selected expert(s) will work closely with the Project CTA, who will also be providing such one-on-one technical assistance to the Chinese FCV manufacturers. The technical assistance will enable manufacturers to improve FC bus durability and performance and reduce costs, thus contributing to overall improvement in these areas key to FCV commercialization. Work will also include reports based on progress made.

The specific assistance will be targeted at achieving a number of improvements. It will enable manufacturers to develop their own power train. (Most currently depend on outside parties for this.) FCB durability will be increased via coaching on attaining extremely well-defined and favorable operating conditions for the FC stack. This, in turn, will be achieved by improvements in architecture, air control, and using the battery to isolate the stack from the operating cycle. The manufacturers will be coached in optimization of the stack, system, power train, and vehicle via integration, operating strategy/conditions, controls in the power train, and associated software. Considerable attention will also be given in design guidance to safety issues.

Required Tasks
- Select appropriate manufacturers for assistance in FCV bus manufacture, based on capabilities and willingness to participate and cooperate

- Develop action plans, one tailored to each selected manufacturer in order for them to meet project targets, including in the areas of durability (10,000 lifetime hours of operation with specified driving cycle, an ambitious target up from 2,000 hours lifetime at start of project), time between breakdown (1,000 hours minimum up from 300 hours at start of project), cost (2 million RMB or USD 320,000 cost per bus, down from 4 million RMB at start of project), cruising range, and stack power density.
- Provide one-on-one technical assistance to selected manufacturers via site visits and conference calls to achieve aforementioned targets
- Prepare two written reports, one at the end of project year two and the other at the end of project year four on project's achievements in improved FCV design and production and steps taken to reach these achievements. Content of reports will be based on one-on-one technical assistance and progress made by the selected manufacturers as a result. Reports will be targeted at stakeholders in industry, academia, and government.

Deliverables

- List of selected FCV manufacturers for one-on-one technical assistance and memo justifying their selection
- Action plans, one for each of the selected FCV manufacturers, that will enable achievement of project's FC bus targets
- Memos, one for each manufacturer coached, on implementation of action plans and results
- Two written reports, one at end of year two of project and one at close of project, on improved FCV design and production achieved and steps taken to reach achievements.

Required Qualifications

- Ten or more years of experience in FCV design and manufacturing, including experience with top OEM
- Recognition as expert in FCV field
- 15 or more years of experience in auto industry
- Track record of achieving improvements in FCV design and manufacture
- Strong communication and coaching skills
- Strong writing skills, including ability to write about technical matters so that non-experts can understand
- High level of integrity

2. FCV Expert to Design and Conduct Group Capacity Development Sessions in FCV Design and Manufacture

One or more expert(s) will be recruited for this assignment. The selected expert(s) will conduct group capacity development sessions for China's vehicle manufacturers in the design and manufacture of FCVs. Group capacity development sessions will enlighten manufacturers as to means of improving FCV durability and performance and reducing costs, thus contributing to overall improvement in these areas key to FCV commercialization.

Required Tasks

- Design training curriculum for series of at least four workshops. Training curriculum to cover: (i) global and Chinese situation of FCV technology, policy, and market; (ii) FCV architecture; (iii) air control; (iv) use of battery to achieve operating cycle that optimizes the stack; (v) FCV integration; (vi) operating strategy/conditions implemented via controls in the power train, and associated software; (vi) global and domestic sourcing of high quality and lowest cost FCV components; and (vii) ensuring safety of FCVs.
- Deliver the series of at least four workshops covering the foregoing curriculum
- Prepare written training materials covering the foregoing curriculum

Deliverables

- Written training curriculum

- Four training workshops
- Written training materials covering the eight required areas indicated above

Required Qualifications

- Ten or more years of experience in FCV design and manufacturing, including experience with top OEM
- Recognition as expert in FCV field
- 15 or more years of experience in auto industry
- Strong communication and coaching skills
- Strong writing skills, including ability to write about technical matters so that non-experts can understand
- Extensive experience in making presentations
- High level of integrity

3. Expert in International Sourcing of FCV Parts

The expert in international sourcing of FCV parts will be retained with the target of achieving multiple confirmed and implemented new sourcing agreements between Chinese FCV manufacturers and international suppliers that are each verified to lower costs, increase durability, and/or raise performance from start of project benchmarks. Overcoming current barriers to international sourcing of key parts, such agreements will enable enhanced durability and performance of China's FCVs. The sourcing agreements will include FCV engine sourcing agreements with top OEM and/or non-OEM providers, if possible. The expert will work in conjunction with the project CTA, who will also contribute expertise to the below tasks.

Required Tasks

- Conduct comprehensive assessment of sourcing challenges faced by Chinese FCV manufacturers through consultations with these manufacturers and relevant experts in China. Through consultations, expert will determine how each major FCV component is currently sourced, whether it is up to international standard, and how prices compare to internationally competitive prices.
- Evaluate various feasible international sources of FCV components based on findings from aforementioned assessment.
- Prepare comprehensive compendium of recommended component suppliers in international market. Compendium to be shared with all interested vehicle manufacturers in China.
- Conduct targeted individual technical assistance to selected FCV manufacturers in achieving new advantageous sourcing agreements for FCV-related components from international suppliers. Taking into consideration identified sourcing challenges, assist the China-based FCV manufacturers in liaising with relevant international component suppliers and in negotiating of sourcing agreements.

    - ➢ This work will be completed early enough in the project so that newly sourced components that achieve cost reductions, durability improvements, and/or performance improvements are available to be incorporated into demo vehicles manufactured for the project. Assistance will be provided to all FCV manufacturers that are considered to have high potential to meet project commercialization targets.
    - ➢ This work will include, but not be limited to, outreach to international manufacturers (including auto OEM and non-auto OEM) for purchase of world class FC engines. If generally attractive terms are obtained, activity will also include support to Chinese manufacturers in negotiating details of FC engine sourcing agreements. More than one make of engine may be sought to enable comparison of results.
    - ➢ Other priority areas to be covered include: hydrogen recirculation pump, compressor, MEA, and hydrogen valve with high quality seal.

Deliverables
- Memo on assessment of sourcing challenges faced by Chinese FCV manufacturers
- Compendium of recommended component suppliers in international market (Compendium should include explanation of why suppliers are recommended to Chinese FCV manufacturers, contact information of suppliers, and, if possible, price ranges and specifications of products.)
- Memos on results of one-on-one technical assistance to Chinese FCV manufacturers in international sourcing of components. Memos should include data on sourcing agreements achieved (e.g. contract size, etc., where possible).

Required Qualifications
- Over ten years of experience working internationally in the FCV business
- Well-connected in the international FCV component manufacturer community
- Track record of sourcing FCV components
- Fluent in English; strong English writing
- Talent/experience facilitating business relationships
- High level of integrity

4. Expert in Design and Analysis of FCV Demonstration
One or more experts will be retained to assist FCV demo cities in designing specific FCV operation plans, designing a monitoring system for the demos, collecting data on the demos, and assessing results of monitoring. The expert will also develop a template for FCV demo production costs, gather data, and analyze results. The expert will work closely with the project CTA.

Required Tasks
- Working with the local government of each of the four demo cities (Shanghai, Beijing, Zhengzhou, and Foshan) and in conjunction with project CTA, prepare plans for operation of the 109 demos vehicles ensuring:
    - Most effective use of and routes for all demo FCVs
    - Continuous operation of the vehicles
    - Design of images/words promoting FCVs to be painted outside and affixed inside the vehicles. This will include detailed designation of how the painting of the vehicle exterior and signage in vehicle interior will raise rider and other viewer awareness of FCVs and the fact that the vehicle itself is an FCV.
    - Maximized positive impacts of awareness building and providing data on FCV operation (i.e. high visibility and good testing situation)
    - Allowance for public test driving of passenger cars in Shanghai (with around 200 consumer test days per year at multiple sites)
    - Arrangements for continued use of vehicles after project close (In most cases this use will be similar to use before project close.)
    - Designation of how required approval will be obtained for vehicles
    - Designation of how refueling will occur
    - Designation of how vehicle maintenance will be carried out (In general, maintenance should be carried out by operating organization, so they will learn this skill, perhaps working side-by-side with manufacturer representative. Plans for both repairs and scheduled routine maintenance at specified intervals should be designated.)
- Participate in consensus building meetings with local government, as needed, and in achieving approval of plans at national and local level
- Design of monitoring/data collection plans for FCV demos: In all cities, monitoring systems will be installed in the demo vehicles, determining period of operation and other important parameters indicated in data collection plans. It should be ensured that the types and frequency of data collected across cities will be similar, thus allowing for eventual analysis of data across cities for each type of demo vehicle.
- Collection of data on FCV demos according to monitoring plan designed
- Analysis of data collected on operation of demo FCVs

- Conduct of regular, periodic evaluation of demo results for purposes of making of periodic adjustments as needed to the demo plans. Making of recommendations for adjustments to be made to the demo plans and targets. These recommended adjustments will include the final adjustment to the demo plan for implementation beyond the end of project.
- Preparation of template through which demo vehicle manufacturers can report costs of production
- Based on FCV manufacturer input in template, analysis/assessment of FCV demo production costs and their break-down
- Preparation of annual reports that include findings from vehicle monitoring work (technical results of operation) and also incorporate annual survey results of public perception of FCVs. (The latter will be conducted by another party through Activity 1B.4.2, but its results will be incorporated by the expert into the annual demo reports.) Annual reports should be clearly written and attractively presented for wide dissemination among a varied group of stakeholders and to be used as the basis of workshop presentations associated with Outcome 4 of the project.
- Preparation of one-time report on FCV costs. One-time report should be clearly written and attractively presented for wide dissemination among a varied group of stakeholders (e.g. industry, government, and academia) and to be used as the basis of workshop presentations associated with Outcome 4 of the project.

Deliverables
- Detailed demo plans for each of the four demo cities' FCVs
- Designed monitoring system for demo FCVs
- Collected data on operation of demo FCVs
- Memo documenting findings of analysis of collected data on operation of demo FCVs
- Periodic (at least annual) memos with recommendations for adjustment of demo FCV plans and/or targets based on findings from analysis of monitoring results
- Template for FCV demo manufacturers to report vehicle production costs
- One-time report providing analysis of FCV demo costs and break-down
- Annual reports on FCV demo operation, also incorporating results of surveys of the public (as provided by outside party)

Required Qualifications
- Recognized expert on FCVs
- Ten years of experience with work related to FCV and, more generally, NEV testing and demonstration
- Experience in developing vehicle monitoring systems, collecting data, and analyzing results
- Fluent in Mandarin
- Excellent writing skills, including ability to convey technical information in way that persons from various fields can understand
- Proven analytic skills
- High level of integrity

5. TOR for FCV O&M Training Expert

The purpose of this consultancy will be develop a qualified contingent of persons to operate and maintain FCVs in each of the four demo cities as well as in other cities in which replication is taking place. This qualified contingent of persons will ensure sustainability of project demos, overcoming a barrier encountered in previous efforts. With qualified personnel among the operators' ranks, O&M can be continued beyond the period guaranteed by manufacturers.

Required Tasks
- Design and conduct group training program on FCV operations and maintenance before initiation of project demo FCV operation.
- Provide written materials associated with the training program.

- Conduct on-site training in each of the demo cities of staff responsible for the operation and maintenance of the demo FCVs. Trainer will supplement training provided by FCV manufacturers, as needed, and may visit multiple times, if needed. Based on identified needs during visits, trainer will provide trainees with additional written materials on FCV O&M.
- Design and implementation of post-training assessment of qualification of trainees to operate and maintain FCVs

Deliverables
- Agenda for group training program
- Written materials associated with FCV O&M training program
- Memo on additional needs determined during onsite training
- Assessment test
- Analyzed results of assessment test

Required Qualifications
- Ten or more years of experience in FCV operation and maintenance
- Track record in training others in O&M
- Experience with top FCV manufacturer or operator preferred
- Strong presentation and writing skills

V.3: TORs for Consultants to Support FCV Component Manufacturers

1. TOR for International FC Membrane Expert

International FC membrane expert will assistant China-based FC membrane manufacturer (Shandong Dongyue) to achieve reduced cost and increased quality (manifested in increased durability, reduced thickness, and improved hydrogen cross-over, performance, and manufacturing quality). Reduced cost will be sought in part by targeting scale up of production/demand from current 200,000 m^2 per year to 1 million m^2 year to further leverage Dongyue's vertical integration (from mine to membrane) cost advantage. The technical assistance will complement Dongyue's 2014 investment of 50 million RMB (8 million USD) in pilot production equipment and its planned annual 20 million RMB (3.2 million USD) additional investment in FC membrane production and testing, targeting expanded production and increased product stability and consistency.

Required Tasks
- Assessment of current production processes and membrane quality
- Development of action plan to implement recommendations based on the assessment
- One-on-one technical assistance to improve production and testing
- Support in assessing potential procurement of membrane testing equipment
- Provision of input to international facilitation expert on potential international partners for Shandong Dongyue

Deliverables
- Memo on assessment of current production processes and membrane quality
- Written action plan
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications
- Recognized international expert in FC membranes
- Expertise in membrane quality testing and production
- Experience at known top provider (past or present) of FC membranes, including at Dupont, Gore, 3M, or Asahi Glass, preferred
- Strong communication skills
- High level of integrity

2. TOR for Expert in Facilitating International Cooperation
The key role of the international expert in facilitating international cooperation will be to serve as a liaison and facilitator between Chinese component and equipment manufacturers in the FCV or hydrogen value chains and international counterpart manufacturers that, through cooperation, may enhance the quality or reduce costs of the Chinese products. This expert's specialty will be in facilitating cooperation rather than in any of the specific technical fields covered. One or more such experts may be recruited by the project.

Required Tasks:

- Facilitate discussion and exchange targeting international cooperation for China FC membrane manufacturer Shandong Dongyue, including:
  - Utilizing input from the International FC Membrane Expert, input from Dongyue, and additional research, identify potential international membrane manufacturer partners and strategies for partnership. Input from Dongyue will include priorities for international cooperation.
  - Initiate contact with proposed international membrane manufacturer partners
  - Facilitate discussions and other forms of communication between Dongyue and potential international membrane manufacturer partners
  - Trouble-shoot problems/barriers to cooperation
  - Working with Dongyue and International FC Membrane Expert, identify potential international clients for Dongyue (i.e. international buyers of FC membranes) and facilitate initial contact and initial discussions
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese FC catalyst manufacturer Guiyanboye and international FC catalyst manufacturer counterpart
  - Utilizing input from the International FC Catalyst Expert, input from Guiyanboye, and additional research, identify potential international FC catalyst manufacturer partners and strategies for partnership. Input from Guiyanboye will include priorities for international cooperation.
  - Initiate contact with proposed international FC catalyst manufacturer partners
  - Facilitate discussions and other forms of communication between Guiyanboye and potential international catalyst manufacturer partners
  - Trouble-shoot problems/barriers to cooperation
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese MEA manufacturer and international MEA manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese bi-polar plate manufacturer and international bi-polar plate manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese FC stack manufacturer and international FC stack manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese FCV air compressor manufacturer and international FC air compressor manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese FCV hydrogen recirculation pump manufacturer and international hydrogen recirculation pump counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese FCV high voltage DC/DC converter manufacturer and international high voltage DC/DC converter counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)

- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese HRS compressor manufacturer and international HRS compressor manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)
- Facilitate discussion and exchange targeting joint venture or other cooperative relationship between Chinese hydrogen refueling dispenser manufacturer and international hydrogen refueling dispenser manufacturer counterpart (Sub-activities will be analogous to those listed above for Guiyanboye.)

Deliverables:

- FC membrane/Dongyue:
  - Memo outlining priorities for international cooperation for Dongyue
  - Written communications to facilitate cooperation
  - Memo summarizing results of facilitation work
- FC catalyst manufacturer/Guiyanboye (same deliverables as for Dongyue above)
- MEA manufacturer (same deliverables as for Dongyue above)
- Bi-polar plate manufacturer (same deliverables as for Dongyue above)
- FC stack manufacturer (same deliverables as for Dongyue above)
- FCV air compressor manufacturer (same deliverables as for Dongyue above)
- FCV hydrogen recirculation pump manufacturer (same deliverables as for Dongyue above)
- FCV high voltage DC/DC converter manufacturer (same deliverables as for Dongyue above)
- HRS compressor manufacturer (same deliverables as for Dongyue above)
- Hydrogen refueling dispenser manufacturer (same deliverables as for Dongyue above)

Required Qualifications:

- Ten or more years facilitating cooperation between international and Chinese companies/organizations
- Excellent communication skills
- Fluent in English and Chinese
- Attention to detail
- Strong presentation and writing skills
- High level of integrity

3. TOR for National Fuel Cell and Fuel Cell Component Expert

The National Fuel Cell and Fuel Cell Component Expert will work with the International FC Membrane Expert, the International FC Catalyst Expert, the International MEA Expert, the International Bi-Polar Plate Expert, and the International FC Stack Expert in providing technical assistance and other support to the demo FC membrane manufacturer (Dongyue), the demo FC catalyst manufacturer (Guiyanboye), the demo MEA manufacturer, the demo bi-polar plate manufacturer, and the demo fuel cell stack manufacturer (Sunrise), respectively. The National Fuel Cell and Fuel Cell Component Expert will also play a key role in identifying and confirming demo manufacturers for assistance. The National Expert will further work with the Expert in Facilitating International Cooperation to identify promising international partners and areas of cooperation for the Chinese demo component manufacturer companies.

Required Tasks

- FC membrane/Dongyue:
  - Work with International FC Membrane Expert in assessing current production processes and membrane quality and developing action plan
  - Work with international FCV Membrane Expert in providing one-on-one technical assistance to Dongyue
  - Provide suggestions to Expert in Facilitating International Cooperation of possible international partners for Dongyue
- FC catalyst manufacturer/Guiyanboye (analogous tasks to those for Dongyue above)

- MEA manufacturer (analogous tasks to those for Dongyue above)
- Bi-polar plate manufacturer (analogous tasks to those for Dongyue above)
- FC stack manufacturer (analogous tasks to those for Dongyue above)

Deliverables
- FC membrane/Dongyue:
    - Inputs to assessment of current production processes and membrane quality
    - Inputs to written action plan
    - Inputs to memo on improvements adopted and quality improvements and cost reductions achieved thereby
    - Suggestions to expert in facilitating international cooperation on promising international partners and areas of cooperation with Dongyue
- FC catalyst manufacturer/Guiyanboye (analogous deliverables to those for Dongyue above)
- MEA manufacturer (analogous deliverables to those for Dongyue above)
- Bi-polar plate manufacturer (analogous deliverables to those for Dongyue above)
- FC stack manufacturer (analogous deliverables to those for Dongyue above)

Required qualifications
- 15 years of experience in FC stack and component field
- Recognized expert in FC stacks and FC stack components
- Strong familiarity with FC stack and FC stack component situation in China, including challenges faced by Chinese manufacturers in reaching international best technical levels
- Native speaker of Mandarin; strong spoken English
- Familiarity with situation of international providers of FC stack and FC stack components
- High level of integrity

4. TOR for International FC Catalyst Expert

International FC catalyst expert will provide assistance to China-based FC catalyst manufacturer (Guiyanboye) to achieve improved processing and scale-up and thus be able to offer a lower cost catalyst source to FCV manufacturers, which are currently importing catalyst. Leveraging Guiyanboye's platinum trading and recycling platforms, a 20 to 30 percent cost advantage over international sources is targeted.

Required Tasks
- Assess current manufacturing process and quality of FC catalyst products
- Prepare action plan to implement the recommendations resulting from the assessment
- Provide one-on-one technical assistance to improve production and testing
- Advise on procurement of single fuel cell test platform and preparation platform

Deliverables
- Memo on assessment of current production processes and FC catalyst quality
- Written action plan
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications
- Recognized international expert in FC catalysts
- Expertise in FC catalyst testing and production
- Experience working at known top provider (past or present) of FC catalyst preferred
- Strong communication skills
- High level of integrity

5. TOR for International MEA Expert

International MEA expert will provide assistance to China-based MEA (membrane electrode assembly) manufacturer to improve processing and reduce discard rate, thereby enabling provision of lower cost MEA to FC stack and FCV manufacturers. Improvement from current 20 percent discard rate in China to internationally competitive 2 percent discard rate will be targeted. MEA manufacturer to be supported will be either a standalone manufacturer based in Wuhan or Dalian Sunrise (which produces MEA as one component of the FC stacks it produces).

Required Tasks:

- Assess current production process and quality of MEA
- Develop action plan based on recommendations emerging from assessment
- Provide one-on-one technical assistance to improve processing
- Assist with sourcing as needed

Deliverables:

- Memo on assessment of current production processes and MEA quality
- Written action plan, with strong attention to reducing discard rate
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications

- Recognized international expert in MEA
- Expertise in MEA testing and production
- Experience working at known top international provider (past or present) of MEA preferred
- Strong communication skills
- High level of integrity

6. TOR for International Bipolar Plate Expert

International Bi-Polar Plate Expert will provide assistance to China-based bipolar plate manufacturer to improve process and technology for coating and stamping (and for welding and sealing, if needed) thereby enabling provision of lower cost bipolar plate to FC stack and FCV manufacturers. The target in stamping is the reduction of plate width from China's current level of 0.7 mm to international level of 0.4 mm, thus increasing power density to international level of 3.1 kW per L. Through improved technique for coating stainless steel, reduced corrosion is expected and, thus, extended lifetime. The bipolar plate manufacturer to be supported will either be a standalone manufacturer based in Dalian or Shanghai (such as Shanghai Jiaotong Manufacturing Research Institute) or the FC stack manufacturer Dalian Sunrise (which produces bipolar plates as one component of the FC stacks it produces).

Required Tasks:

- Assess current production process and quality of bipolar plate
- Develop action plan based on recommendations emerging from assessment
- Provide one-on-one technical assistance to improve processing and technology
- Assist with sourcing as needed

Deliverables:

- Memo on assessment of current production processes and bipolar plate quality
- Written action plan based on assessment
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications

- Recognized international expert in bipolar plate manufacture
- Particular expertise in coating and stamping
- Experience working at known top international provider (past or present) of FC bipolar plates preferred

- Strong communication skills
- High level of integrity

7. TOR for International FC Stack Expert
International FC Stack Expert will provide assistance to China-based FC stack manufacturer Dalian Sunrise to optimize stack and balance of system (BOS) and thereby reduce cost to FCV manufacturers for globally competitive FC stack. Targets include: (i) increasing stack maximum efficiency from current level of 60 percent to 65 percent, (ii) increasing stack lifetime at specified test cycle from current level to 10,000 hours, and (iii) increasing performance from 1.0A@0.65V to 1.5A@0.65V.

Required Tasks:
- Assess current manufacturing processes, components, and quality of FC stack manufacture
- Develop action plan based on recommendations emerging from assessment
- Provide one-on-one technical assistance to optimize stack and balance of system
- Assist with sourcing as needed

Deliverables:
- Memo on assessment of current production processes and FC stack quality
- Written action plan based on assessment
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications
- Recognized international expert in FC stacks
- Special expertise in stack and BOS optimization
- Experience working at known top international provider (past or present) of FC stacks
- Strong communication skills
- High level of integrity

8. TOR for International FCV Air Compressor Expert
International FCV Air Compressor Expert will provide assistance to China-based FCV air compressor manufacturer Foshan Guangshun to improve quality control processes, technology, and sourcing of compressor parts, thereby reducing cost to FCV manufacturers for globally competitive FCV air compressor. Improvements will include those in the areas of air bedding and better high speed motors. Targets will be to increase power density and durability (lifetime) to internationally competitive levels.

Required Tasks:
- Assess current manufacturing processes of, quality of, and sourcing of parts for the FCV air compressor. This will include assessment as to which compressor technology (conventional compressor or other) will be most strategic in terms of cost and durability potential.
- Develop action plan based on recommendations emerging from the assessment
- Provide one-on-one technical assistance

Deliverables:
- Memo on assessment of current production processes, quality, and sourcing of FCV air compressor manufacturer Guangshun
- Written action plan based on assessment
- Memo on measures adopted and quality improvements and cost reductions achieved thereby

Required Qualifications
- Recognized international expert in FCV air compressors
- Experience working at known top international provider (past or present) of FCV Air Compressors, such as Eaton
- Strong communication skills

- High level of integrity

9. TOR for International FCV Hydrogen Recirculation Pump Expert

International FCV Hydrogen Recirculation Pump Expert will provide assistance in identifying China-based potential manufacturer of hydrogen recirculation pump and in design/engineering of production/processing facilities and launch of production. Domestic production of hydrogen recirculation pump (currently unavailable) will be targeted to lower costs and other difficulties faced by Chinese FCV manufacturers in sourcing this component.

Required Tasks:

- Identify and vet China-based manufacturers currently interested in production of hydrogen recirculation pump, resulting in selection of one manufacturer
- Assess of needs of selected manufacturer in launching production of quality hydrogen recirculation pump
- Develop action plan to implement recommendations emerging from assessment
- Provide one-on-one technical assistance to enable selected manufacturer to design and set up manufacturing line and ensure quality product

Deliverables:

- Memo on shortlisted potential hydrogen recirculation pump manufacturers in China and explanation of strengths
- Written assessment and action plan
- Memo on launching of production and on measures adopted to ensure quality and cost reduction

Required Qualifications

- Recognized international expert in FCV hydrogen recirculation pump
- Experience working at known top international provider (past or present) of FCV hydrogen recirculation pumps preferred
- Strong communication skills
- High level of integrity

10. TOR for International FCV High Voltage DC/DC Converter Expert

International FCV High Voltage DC/DC Converter Expert will provide assistance identifying China-based existing or potential manufacturer of FCV high voltage DC/DC converter and assistance in design/engineering or improvement of production/processing facilities. Domestic production of FCV high voltage DC/DC converter will be targeted to lower costs and alleviate other difficulties faced by Chinese FCV manufacturers in sourcing this component.

Required Tasks:

- Identify and vet China-based manufacturers currently interested in production of or currently producing FCV high voltage DC/DC converter, resulting in selection of one manufacturer
- Assess needs of selected manufacturer in launching production of quality FCV high voltage DC/DC converter
- Develop action plan to implement recommendations emerging from assessment
- Provide one-on-one technical assistance to enable selected manufacturer to design and set up (or improve) manufacturing line and ensure quality product

Deliverables:

- Memo on shortlisted potential or existing FCV high voltage DC/DC converter manufacturers in China and explanation of strengths
- Written assessment and action plan
- Memo on launching of (or improving) production and on measures adopted to ensure quality and cost reduction

Required Qualifications

- Recognized international expert in FCV high voltage DC/DC converter
- Experience working at known top international provider (past or present) of FCV high voltage DC/DC converters preferred
- Strong communication skills
- High level of integrity

<u>V.4: TORS for Consultants to Support Hydrogen Production and Hydrogen Refueling Stations, including Demos and HRS O&M</u>

1. TOR for Expert in Wind Power Based Hydrogen Production

Expert will provide one-on-one technical assistance for investors in and managers of wind power based hydrogen production facilities on wind farms in China hoping to utilize excess power. Technical assistance will enable investors and managers to incorporate international best practice into their efforts thus improving the viability and reducing the cost of wind power based hydrogen production in China. In doing this work, expert will work with Project Technical Advisor on Hydrogen.

Required Tasks

- Provision of technical assistance to three wind farms planning to produce hydrogen from excess wind power. Assistance will be focused on improving reliability and reducing costs. It will include:
    - ➢ Site visits
    - ➢ Follow-up conference calls
    - ➢ Sourcing support if needed
    - ➢ Guidance on safety issues

Deliverables

- Memo on initial assessment of needs of three wind farms planning to produce hydrogen from excess wind power
- Written action plan
- Memo reporting key measures taken based on technical assistance and improvements achieved

Required Qualifications

- Recognized expert in wind energy-based hydrogen production
- Five years of experience related to wind energy-based hydrogen production
- Technical knowledge related to improving reliability and reducing costs of wind energy-based hydrogen production systems
- High level of integrity
- Good communication skills

2. TOR for Expert in Landfill Methane Based Hydrogen Production

Expert will provide one-on-one technical assistance for investor in and managers of landfill methane based hydrogen production facilities at a landfill in China. Technical assistance will enable investor and managers to incorporate international best practice into their efforts thus improving the viability and reducing the cost of landfill methane based hydrogen production in China. In doing this work, expert will work with Project Technical Advisor on Hydrogen.

Required Tasks

- Provision of technical assistance to land fill site planning to produce hydrogen from land fill methane. Assistance will be focused on improving reliability and reducing costs. It will include:
    - ➢ Site visits
    - ➢ Follow-up conference calls

- ➢ Sourcing support if needed
- ➢ Guidance on safety issues

Deliverables

- Memo on initial assessment of needs of landfill methane project planning to produce hydrogen directly from landfill methane
- Written action plan
- Memo reporting key measures taken based on technical assistance and improvements achieved

Required Qualifications

- Recognized expert in landfill methane based hydrogen production
- Five years of experience related to landfill methane based hydrogen production
- Technical knowledge related to improving reliability and reducing costs of landfill methane based hydrogen production systems
- High level of integrity
- Good communication skills

3. TOR for Expert in Renewable Energy Based Hydrogen Production

Working with Project Technical Advisor on Hydrogen, expert will develop and implement group capacity building through workshops and an international study tour on renewable energy based hydrogen production. Group capacity building will bring knowledge of international best practice in renewable energy based hydrogen production to a large group of beneficiaries, thus stimulating further investment in this area as well as improved technical levels and cost reduction.

Required Tasks

- Design workshop training curriculum (see next item for content)
- Conduct series of at least two workshops to address needs of China's potential renewable energy based hydrogen producers. Training will emphasize means of reducing costs and raising reliability of renewable energy based hydrogen production systems, as well as safety issues. The workshops will cover:
  - ➢ Opportunities in wind farm based hydrogen production
  - ➢ Solar PV-based hydrogen production
  - ➢ Landfill methane based hydrogen production.
- Provide written training materials based on workshop content
- Identify priority organizations/sites to visit on study tour to Germany to study renewable energy based hydrogen production ("power-to-gas") and injection of hydrogen into natural gas network.

Deliverables

- Curriculum for at least two workshops on renewable energy based hydrogen production
- Written training material based on content of at least two workshops
- Recommended itinerary/target organizations and site visits for study tour to Germany

Required Qualifications

- Recognized expert in renewable energy based hydrogen production
- Broad knowledge of renewable energy based hydrogen production and worldwide projects in this area, covering wind, solar PV, and biogas/landfill methane based hydrogen production
- Skill in preparing training materials and presentations
- Strong communication skills
- Strong international network, particularly in Germany, of renewable energy based hydrogen production sector
- Strong technical knowledge in improving reliability and reducing costs of renewable energy based hydrogen production

4. TOR for Expert in HRSs and Hydrogen Production

Expert knowledgeable about China and fluent in Chinese will work closely with Project Technical Advisor on Hydrogen to carry out a number of project activities, many but not all of which are related to monitoring and reporting on hydrogen production demos and HRS demos.

Required Tasks

- Conduct study for Nanhai District, Foshan City on local establishment of hydrogen production to supply an expanding fleet of fuel cell vehicles and other applications. The study will compare the pros and cons of options for local hydrogen production, including industrial byproduct, industrial (non by-product), and renewable energy-based. It will look at ways of reducing the relatively high price of hydrogen in Foshan.
- Conduct a comparative economic analysis (including investment, operation, maintenance, etc.) of different hydrogen production models, including natural gas reforming, industrial by-product, other industrial, renewable energy based power (wind, PV, etc.), and biogas/landfill methane based.
- Prepare database of information on all aspects and applicable processes of hydrogen production (both nonrenewable energy and renewable energy based). Database will include study conducted for Foshan on hydrogen production options, study conducted on comparative economic analysis of different hydrogen production models, and study (conducted by another consultant) on increasing the energy efficiency of hydrogen produced via industrial by-product methods, as well as other relevant materials. This activity may cooperate with chinahydrogen.org or other relevant partner to disseminate the database.
- Design and initiate plan for replication and scale up of renewable energy based hydrogen production demos at other sites. Replication plan will incorporate liaison with other potential renewable energy based hydrogen manufacturers, including those attending capacity building workshops and study tour under other project activities.
- Conduct monitoring, annual reporting, and dissemination of results of renewable energy-based hydrogen production, as well as making of recommendations based on findings. This activity will cover the three demo wind energy-based hydrogen production sites and the one landfill methane based hydrogen production site.
- Design of data collection plan and conduct data collection/monitoring for operational phase of demo hydrogen refueling stations. Task will include preparation and dissemination of annual reports on findings. Separate subsections in these reports will be prepared on each of (1) standard stations (Zhengzhou, Foshan, and second Beijing station), (2) onsite renewable energy based hydrogen production, (3) addition of hydrogen to gasoline stations (if possible), and (4) addition of electric vehicle recharging to hydrogen refueling station (Shanghai’s Anting station) to provide insights on these different models. Monitoring plan will include both financial and technical parameters. The technical parameters will serve as the basis of *China Hydrogen Refueling Station (HRS) Reliability Database*, modeled on international best practice. In addition to periodic recording of parameters, the monitoring plan will accommodate the recording of special issues or problems that may arise. The monitoring plan will be centrally designed, so that collected information can be compared across refueling stations. The *China HRS Reliability Database* may also be integrated with international efforts in HRS reliability data sharing.
- Collect information from hydrogen production demo investors and hydrogen refueling demo investors on upfront investment costs using the designed data collection template, and report findings from the data collection process. Task will including designing of templates for collection of needed parameters, conducting of any needed analysis, and preparation of a report on findings.
- Integrate reports prepared under aforementioned tasks (annual reports on hydrogen production demos, annual reports on HRS demos, and onetime report on costs of hydrogen production demos and HRS demos), as well as survey of the public (conducted by separate organization) on perception towards hydrogen production and HRSs. Final products will be annual consolidated monitoring reports of hydrogen production demos and hydrogen refueling station demos that also include findings from onetime report on investment costs of these demos. Thus, the annual reports

will cover both renewable energy based hydrogen production and hydrogen refueling stations of several types. Further, they will include technical and financial data related to operation, data from surveys of public perception of these installations, and onetime data on investment. Findings should be presented in clear and attractive documents that will be widely disseminated by PMO to government officials, industry, investors, and relevant researchers/academics.

Deliverables

- Study with recommendations to Nanhai District on options for local hydrogen production
- Written report on comparative economic analysis of different hydrogen production models
- Database of information on all aspects and applicable processes of hydrogen production (both nonrenewable energy and renewable energy based)
- Written replication plan for renewable energy based hydrogen production in China
- Annual reports on results of renewable energy based hydrogen production demos
- Annual reports on results of HRS demos
- Onetime report on costs of renewable energy based hydrogen production demos and HRS demos
- *China Hydrogen Refueling Station (HRS) Reliability Database*
- Integrated annual reports including several of the above items (results of renewable energy based hydrogen production demos, results of HRSs, and onetime cost reports), as well as annual survey of public perception on hydrogen production and HRSs

Required Qualifications

- Ten years of experience in the hydrogen and hydrogen refueling fields
- Strong technical knowledge of hydrogen and use of hydrogen for FCVs
- Very strong writing skills and track record of writing reports that are clear to experts and non-experts alike
- Strong skills in developing monitoring plans
- Fluent in Mandarin; fluent in English

5. TOR for Expert in Energy Efficiency of Hydrogen Production via Industrial By-Product Methods

Required Tasks

- Conduct a study on increasing the energy efficiency of hydrogen produced via industrial by-product methods. Study will look at the main industrial by-product methods being used in China or likely to be used in China in the future and will propose methods of reducing use of fossil fuels in producing hydrogen from industrial by-products. Study will also assess baseline and potentially reduced GHG emissions associated with the different industrial by-product methods.

Deliverables

- Written report on findings on increasing the energy efficiency of hydrogen produced via main industrial by-product methods, including associated GHG emissions.

Required Qualifications

- Ten or more years of experience conducting research or actively involved in the business of hydrogen production or purification
- Knowledgeable about main methods of producing hydrogen from industrial by-products
- Expertise in energy efficiency and knowledge of methods of computing GHG emissions
- Strong research and analysis skills
- Strong writing skills

6. TOR for Expert in HRSs

Working with Project Technical Advisor for Hydrogen, expert will provide one-on-one technical assistance for investors in and managers of project demo hydrogen refueling stations One-on-one technical assistance will contribute to increased viability and lowered cost of hydrogen refueling stations, via approaches such as improved business models.

Required Tasks

- Conduct of individual technical assistance to proposed Foshan hydrogen refueling station in developing a business plan for commercially viable operation. The plan may include multi-fuel strategy (e.g. hydrogen, petroleum, CNG, etc.).
- Assist in conducting outreach to gasoline stations that may be interested in adding hydrogen refueling. Outreach will include identification of promising candidates and presentation to them of details of the opportunity.
- Conduct of technical assistance to two existing gasoline stations (one in Shanghai and one in Beijing) that are intending to include hydrogen refueling as part of their transport fuel retail services. Technical assistance will include guidance in design, permitting, equipment procurement, installation of equipment, testing, and commissioning.

Deliverables

- Business plan for Foshan station
- Business plan for combined hydrogen and gasoline stations, one in Shanghai and one in Beijing

Required Qualifications

- Recognized expertise in HRSs/ hydrogen refueling
- Five years of experience successfully running or developing hydrogen refueling stations
- Knowledge of business models for HRSs
- Technical knowledge and knowledge of sourcing for HRSs
- High level of integrity

7. TOR for Expert in onsite Renewable Energy Based Hydrogen Production at HRSs

Required Tasks

Conduct individual technical assistance to one hydrogen refueling station to improve reliability and output of its onsite wind-PV-based hydrogen production. Efforts will focus on reducing costs and increasing proportion of the station's hydrogen that is supplied via hybrid renewable energy system, so that it reaches targeted level of 50 percent.

Deliverables

- Action plan to improve a station's renewable energy based hydrogen production
- Report on improvements in a station's renewable energy based hydrogen production

Required Qualifications

- Known expert in onsite renewable energy based hydrogen production at HRSs
- Technical knowhow in improving reliability of renewable energy based hydrogen production at HRSs
- Track record of successfully working with renewable energy based hydrogen production systems
- General knowledge of other HRS issues

8. TOR for Expert in HRS Air Compressor Manufacture

The expert will provide technical assistance to increase reliability and reduce cost of product of domestic compressor manufacturer supplying China's hydrogen refueling stations. The likely candidate is Beijing Tiangao, which supplied the Shenzhen hydrogen refueling station. The support will include increasing reliability, control of production, and sourcing of parts.

Required Tasks

- Assess current situation of target China-based HRS air compressor manufacturer
- Develop action plan based on findings of assessment

- Provide one-on-one technical coaching to improve reliability and reduce cost of domestic HRS compressor

Deliverables
- Written action plan
- Memo outlining improvements achieved via one-on-one technical coaching

Required Qualifications
- Recognized international expert in HRS air compressor manufacture
- Experience working at top international provider of HRS air compressors preferred
- Demonstrated knowledge on means of improving reliability and reducing costs of HRS air compressors
- Strong communication skills
- High level of integrity

9. TOR for Expert in HRS Hydrogen Refueling Dispenser
The expert will provide technical assistance to lower cost and increase reliability of product of domestic hydrogen refueling dispenser manufacturer supplying China's hydrogen refueling stations. The likely candidate is Sunwise, based in Shanghai. The support will address two areas: sourcing and assistance in adjusting technical methodology.

Required Tasks
- Assess current situation of target China-based HRS hydrogen refueling dispenser manufacturer
- Develop action plan based on findings of assessment
- Provide one-on-one technical coaching to adjust technical methodology
- Provide advice on sourcing

Deliverables
- Written action plan
- Memo outlining improvements achieved via one-on-one technical coaching

Required Qualifications
- Recognized international expert in HRS hydrogen refueling dispenser manufacture
- Experience working at top international provider of HRS hydrogen refueling dispenser preferred
- Demonstrated knowledge on means of improving reliability and reducing costs of HRS hydrogen refueling dispenser
- Strong communication skills
- High level of integrity

10. TOR for Expert in HRSs and HRS Equipment
Working with Project Technical Advisor on Hydrogen, expert will develop and implement group capacity building through workshops and an international study tour on HRSs and associated equipment and service providers. Group capacity building will bring knowledge of international best practice in HRSs and HRS equipment to a large group of beneficiaries, thus stimulating further investment in this area, as well as improved technical levels and cost reduction.

Required Tasks
- Design workshop training curriculum (see next item for content)
- Conduct series of workshops to address the needs of the local hydrogen refueling industry in achieving lower investment costs, high safety performance, better reliability, and viable financial performance. Topics covered in workshops will include, but not be limited to:
  - global and Chinese situation of hydrogen refueling station establishment, operation, policy, and market

- design of hydrogen refueling stations
- sourcing of parts for hydrogen refueling stations (and potential alternatives to high cost imports, such as key valves, hydrogenation spears, and hydrogen pipes)
- compression and cooling equipment for hydrogen refueling station
- water electrolysis unit for onsite and offsite production of hydrogen using renewable energy
- hydrogen refueling dispensers
- financially viable business models for hydrogen refueling stations, such as multi-fuel offerings (e.g. hydrogen, gasoline, and CNG)
- safety issues

- Provide written training materials based on workshop content
- Identify priority organizations/sites to visit on international study tour to visit hydrogen refueling stations and discuss strategies with international counterparts

Deliverables

- Curriculum for series of workshops for HRS investors, potential HRS investors, equipment manufacturers for HRSs, and service providers for HRSs
- Written training material based on content of series of workshops for HRS investors, potential HRS investors, equipment manufacturers for HRSs, and service providers for HRSs
- Recommended itinerary/target organizations and site visits for international study tour for HRS investors, potential HRS investors, equipment manufacturers for HRSs, and service providers for HRSs

Required Qualifications

- Recognized expert in HRSs and HRS equipment and service provision
- Broad knowledge of HRS sector including technical aspects, business models, equipment, etc.
- Skill in preparing training materials and presentations
- Strong communication skills
- Strong international network in HRS sector, including both stations and equipment providers
- Strong technical knowledge in improving reliability and reducing costs of HRSs

5. TOR for HRS O&M Training Expert

The purpose of this consultancy will be to develop a qualified contingent of persons to operate and maintain HRSs in each of the four demo cities as well as in other cities in which replication is taking place. This qualified contingent of persons will ensure sustainability of project demos.

Required Tasks

- Conduct of onsite training in each of the demo cities of staff responsible for the operation and maintenance of hydrogen refueling stations. This training will supplement training provided by equipment suppliers/general contractors and will put a strong emphasis on safety issues. (It is expected that equipment manufacturers or general contractors building the stations will provide the bulk of O&M training needed and also that major repairs will be handled by equipment manufacturers. Stations like Shanghai’s Anting Station, which has extensive experience in hydrogen refueling station O&M, will not need training.)
- Based on identified needs during visits, provide trainees with written materials on O&M of hydrogen refueling stations.
- Design and implement post-training assessment of qualification of trainees to operate and maintain HRSs.

Deliverables

- Memo on needs determined during onsite training
- Written materials on HRS O&M
- Assessment test
- Analyzed results of assessment test

Required Qualifications

- Ten or more years of experience in HRS operation and maintenance
- Track record in training others in HRS operation and maintenance
- Experience with top HRS equipment manufacturer or owner preferred
- Strong presentation and writing skills

V.5: TORs for Consultants in Policy Area

1. TOR for China and Local FCV Roadmap Expert

One or more experts may be recruited for these tasks.

Required Tasks

- Prepare draft *China FCV and Hydrogen Refueling Roadmap* covering the areas of: (1) FCV cost reduction, durability improvement, and performance enhancement; (2) increased availability of key FCV parts at lower prices locally and/or through improved international sourcing; (3) reduced cost, increased volume, and improved reliability of hydrogen production in China, particularly of hydrogen produced via renewable energy; (4) establishment of hydrogen refueling stations; (5) availability of cost effective/reliable equipment and services for hydrogen refueling station establishment (including compressors and hydrogen refueling dispensers); (6) availability of qualified O&M personnel for FCVs and hydrogen refueling stations; and (7) availability of financing for FCV manufacture and associated value chain, for hydrogen refueling stations and associated value chain, and for FCV purchase. The roadmap will indicate targets in each of these areas and the steps that will be taken to reach them. Functionally, the roadmap will cover the areas of policy, government funding/investment, and investment by businesses. In preparing the roadmap, the expert will review the roadmaps/strategies of other countries as well as take the special situation of China into consideration.
- Provide presentation on draft national roadmap at national workshop on *China FCV and Hydrogen Refueling Roadmap*
- In conjunction with local governments, draft local level *FCV and Hydrogen Refueling Roadmap* (as counterpart to the national *Roadmap*) for at least four cities. Participate in local meetings to build consensus on these roadmap. The local roadmaps will take their lead from and build upon the national *Roadmap* in their content.

Deliverables

- Draft national *FCV and Hydrogen Refueling Roadmap*
- Presentation for national workshop on national *FCV and Hydrogen Refueling Roadmap*
- Drafts of at least four local level FCV and hydrogen refueling roadmaps

Required Qualifications

- Proven track recording in designing policy, roadmaps, etc. for China’s auto sector
- Strong experience in promoting NEVs in China via policy measures
- Ten or more years of experience advising Chinese Government on industrial policy
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

2. TOR for China FCV and HRS Standards, Certification, and Safety Expert

One or more experts may be recruited for these tasks.

Required Tasks:

- Identify priority gaps in China’s existing standards for FCVs, hydrogen stations, and hydrogen production/transport, as well as priority areas in which harmonization with international standards may be increased. Review existing Chinese standards, as well as international counterpart

standards, to identify gaps. Propose areas for revision to the relevant committees responsible for designing standards in each area.
- Develop and promote approval of testing and certification system for FCV vehicles, hydrogen refueling stations, and products supporting the FCV industry, such as hydrogen cylinders. Review certification testing and certification needs in relevant areas, as well as international experience in these areas. Based on findings, design testing and certification system.
- Develop and promote adoption and enforcement of standard safety and fire protection regulations and procedures for FCVs and hydrogen infrastructure. Identify needs with regard to safety and fire protection and also review international experience as a part of this process. Based on findings, design recommendations for relevant government regulatory departments.

Deliverables
- Written memo reporting gaps in China's existing standards for FCVs, HRSs, and hydrogen production transport and proposing areas for revision to the relevant committees responsible for designing standards in each area.
- Draft testing and certification system for FCVs, HRS, and products supporting the FCV industry.
- Draft standard safety and fire protection regulations and procedures for FCVs and hydrogen infrastructure.

Required Qualifications
- Proven track recording in designing technical standards for China, particularly in auto and hydrogen related sectors
- Strong experience related to NEV standards, testing and certification
- Strong familiarity with international standards for FCVs and HRSs
- Ten or more years of experience advising Chinese Government on standards, testing, and certification
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

3. TOR for China FCV Registration and Approval Expert
One or more experts may be recruited for these tasks.

Required Tasks:
- Conduct of advocacy and lobbying meetings and other forms of education for central government and local officials to achieve: (i) expedited approval (*gongao*) by FCV manufacturers for production of FCV vehicles (by central government) (note: In some cases, as it will take time for standards and certification system to be improved, project will need to seek "exceptions" from central government to expedite approval process.); (ii) expedited issuance of long-term license plates to FCV operators for individual vehicles (by local officials); and (iii) expedited approval of hydrogen refueling stations (by local officials). Design and recommend processes and implementing rules and regulations (IRR) to expedite each of these approval/issuance processes. Meetings with Central Government will occur in Beijing. Meetings with relevant local officials will occur, at minimum, in the project's main demo cities (Shanghai, Beijing, Zhengzhou, and Nanhai/Foshan). In addition to Central Government, key target organizations will include the local public security bureau (*gonganju*), local transportation management bureau (*jiaoguanju*), and others, as necessary.
- Design content of a seminar on fire safety of FCVs, hydrogen production, hydrogen fuel transport, and hydrogen refueling station with participation of relevant officials, experts, and companies. Content of seminar to be designed based on identified issues and international experience. Targeted invitees will be national and local officials whose purview includes approval and/or management of motor vehicles and hydrogen infrastructure. Make relevant presentations during seminar.

Deliverables

- Preparation of action plan for advocacy and lobbying meetings with central government and relevant local officials
- Preparation of memos and other educational materials for central government and relevant local officials
- Written design of fire safety seminar content
- Presentation materials for fire safety seminar

Required Qualifications

- Proven track recording in lobbying and advocacy work targeting Chinese policy makers with regard to vehicle acceptance and registration
- Strong experience related to NEV registration and licensing
- Ten or more years of advocacy and lobbying work with national and local governments in China
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

4. TOR for China FCV and HRS Incentive Policy Expert

One or more experts may be recruited for these tasks.

Required Tasks:

- Prepare proposed extension and improvements to current incentive policy for FCV purchase. A primary aim is to extend the duration over which the current national FCV subsidy will be applied to the period between 2016 and 2020. Recommend improvements or refinements in the national policy. These will reflect increases in the number and types of FCVs available in China. Hold meetings with policy makers and prepare briefs for them, promoting adoption of the extension and other measures. In addition to national level policy, certain local level policies encourage new energy vehicles (without differentiation between electric vehicles and FCVs). This task will also entail design of recommendations to extend (for FCVs, in particular) local preferential new energy vehicle policies (such as free vehicle plates issuance in Shanghai and sped up position in the queue for auto purchase in Beijing) or to even enhance these for FCVs, in particular.
- Prepare proposed extension and improvements to current national incentive policy for establishment of hydrogen refueling stations. A primary aim will be to extend the duration over which the current hydrogen station subsidies will be applied to continue at the same level. Recommend improvements/ refinements in the policy. Hold meetings with policy makers and prepare briefs for them, promoting adoption of the extension and other measures. Prepare recommendations for extension and enhancement of local level incentive policies for hydrogen refueling stations.
- Develop ideas for novel FCV and hydrogen station incentive policies for discussion among experts and local policy makers. Review incentive policies used elsewhere in the world (such as in the California Fuel Cell Partnership), but not yet in China. Preliminary ideas include: access to priority lanes for FCVs, preferential or free parking spaces for FCVs, and standards and incentive policy for four-in-one, three-in-one, or two-in-one refueling stations (stations that include hydrogen fuel and other types of refueling on the same premises). Discuss ideas with local governments who are active in the FCV field and particularly the four cities that are the demo locations for the project's FCVs.
- Design and participate in meetings to reach consensus on at least two different types of policy pilots. Based on ideas vetted in above task, design will first involve liaison with local government and reaching of consensus on location(s) for policy pilots and on the nature of those pilots. Detailed design of policy pilots will then be carried out. There will be at least two local policy pilots.
- Design and implement plan to monitor results of the two or more local level policy pilots. The monitoring plan will assess the effectiveness of outreach to potential buyers/ investors and seek to

understand how influential preferential policies were in impacting their FCV/HRS related behavior. It will further assess the numbers of stakeholders influenced by the relevant pilot policy.

Deliverables

- Memo/ policy brief on proposed extension and improvement to national FCV incentive policy
- Memo/policy brief on proposed extension and improvement to national HRS incentive policy
- Memo/policy brief on recommendations with regard to existing local level FCV and HRS incentive policies
- Memo on novel potential FCV and HRS incentive policies that may be pursued in China. (Memo will reference such policies pursued elsewhere in the world.)
- Draft of two novel local level incentive policies for FCVs and/or HRSs
- Report on result of monitoring of implementation of two or more novel local level incentive policies for FCVs and/or HRSs.

Required Qualifications

- Proven track recording in designing policies, especially incentive policies
- Proven track record in drafting policies and briefs for policy makers
- Strong experience related to China's NEV sector
- Ten or more years of advocacy with and policy design for national and local governments in China
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

V.6: TORs for Consultants in Awareness and Knowledge Dissemination Area

1. TOR for Communications and Media Consultant

The communications and media consultant will work closely with the PMO Communications Officer in carrying out the following tasks.

Required Tasks

- Conduct media campaign targeting the press in the four demo cities as well as nationally. Media campaign will both highlight the commercialization progress represented by the demos and provide information regarding the safety of FCVs and hydrogen. Print, online, and broadcast media will all be targeted.
- Preparation leaflets/brief brochures on the characteristics and benefits of FCVs to be displayed in FCBs, at FCV auto test ride locations in Shanghai, and at relevant booths at public events. Brochures will discuss environmental benefits and consumer benefits, as well as provide information regarding the safety of FCVs and hydrogen. Design dissemination strategy for leaflets.
- Provide advice on building and updating of project website and contribute to monthly project newsletter. Project progress and FCV and hydrogen refueling station operation results will be updated periodically on the website. Database of information on hydrogen production processes prepared through another project activity will also be made available through the project website, along with links to partner organization in hydrogen production dissemination.

Deliverables

- Memo on strategy for media campaign
- Leaflets/brochures on FCVs
- Articles contributed to monthly project newsletter

Required Qualifications

- Five or more years of experience in communications and media outreach

- Excellent writing skills in Chinese; native speaker of Mandarin
- Proven skills in design of written materials
- Track record in successfully getting write-ups/ airtime in the media
- High level of integrity

2. TOR for Documentary Sub-contractor
The documentary sub-contractor will work closely with the PMO Communications Officer in carrying out the following tasks.

Required Tasks
- Design, produce, and secure airing of a documentary on FCVs on TV in China. The documentary will feature the project demos as well as FCV developments around the world. It will discuss the future prospects of the hydrogen economy. It will also provide information regarding the safety of FCVs and hydrogen.
- Design and produce video material to counter myths regarding the safety of hydrogen. The video will be presented as an experiment, but in a fun and attractive way. It will be uploaded to the internet and the link will be provided in materials generated by other activities under the project's Awareness and Information Dissemination Component, as well as being promoted through other avenues. The project will target participation in well know science documentary programs produced and aired on cable TV.

Deliverables
- Documentary on FCVs to be aired on TV in China
- Video material countering myths regarding the safety of hydrogen

Required Qualifications
- Sub-contractor led by experienced producer that has good links with TV stations
- Team lead has ten or more years of experience in documentary production
- Sub-contractor has track record of quality documentaries aired on prime time
- Sub-contractor has enthusiasm for environment-related topics
- High level of integrity

3. FCV and HRS Demo Replication Consultant
The FCV and HRS Demo Replication Consultant will work closely with the Project CTA and Project Advisor on Hydrogen to carry out the following tasks:

Required Tasks
- Based on consultation with relevant national and city officials, design a sustainable follow-up plan to replicate the project FCV and HRS demos in other cities and scale it up in participating cities. Plan will include strategies for procurement of high performance vehicles and for effective operation and monitoring of the demos. Plan will be designed in second half of project, once sufficient data and lessons learned from demos has been obtained.
- Present above designed replication plan at annual workshop for city officials and in smaller meetings with officials from cities prioritized for replication.

Deliverables
- Written replication plan for FCV and HRS demos in other cities and for scale up in participating cities
- Presentation materials on replication plan

Required Qualifications
- Over ten years of experience with FCVs and other NEVs
- Track record of quality participation in designing demonstration programs

- Technical expertise in FCVs and HRSs
- Experience advising local governments in China
- Native speaker of Chinese

4. Expert on International Exchange on FCVs and HRSs

The Expert on International Exchange on FCVs and HRSs will work closely with the Project CTA and Project Advisor on Hydrogen to carry out the following tasks. The purpose of this work will be to conduct technical and information exchange among counterparts and to strengthen understanding and acceptance of government policy makers on the development of fuel cell vehicles at home and abroad.

Required Tasks

- Design of international forums on FCVs and hydrogen infrastructure. Identification of key topics to be covered and key speakers to be invited.
- Design of international study tour on FCVs and hydrogen infrastructure

Deliverables

- Agenda for international forums on FCVs and hydrogen infrastructure
- Itinerary for international study tour on FCVs and hydrogen infrastructure

Required Qualifications

- Ten years of experience in international liaison
- Strong knowledge of international players in FCVs and HRSs
- Track record in designing workshops and international forums
- Track record in designing study tours/delegations
- Fluent in English and Mandarin

5. Expert on Monitoring System for NEVs

The Expert on Monitoring Systems for NEVs will work closely with the Project CTA to carry out the following tasks.

Required Tasks

- Development, operation, and maintenance of an online database and monitoring system on China's FCV manufacturing and market, as well as new technological developments and applications worldwide. The system will be known as *China FCV Market and Technology Monitoring System*. The monitoring work will require monthly contact with China's FCV manufacturers and distributors as well as with its registration bodies to determine technological developments, the number of new FCVs sold, and the total number of FCVs on the road in China. The contractor will also monitor a number of key information sources on developments in FCVs and hydrogen infrastructure internationally, providing links and summary translations of key articles.
- Preparation of a plan to sustain updating of the online FCV database and monitoring system after project close.

Deliverables

- *China FCV Market and Technology Monitoring System*

Required Qualifications

- Three years of experience in monitoring NEVs in China
- Expertise in developing databases and monitoring systems
- Fluency in Chinese and English
- Proven expertise in auto industry
- Ability to develop good rapport with FCV manufacturers
- High level of integrity

V.7: TORs for Consultants to Build Capacity in Financial Sector

1. TOR for Consultant on Financing of FCV Manufacturing and Value Chain and HRSs and Value Chain

The purpose of this work will be to stimulate FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling associated value chain projects that are or will be financed by financial institutions/financial sector companies. Financing of FCV-related projects by financial institutions will expedite commercialization of the sector. Successful initial financings will lead to increased interest among the financial sector and to further such financings.

Required Tasks

- Design and hold FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling value chain financing workshop. The workshop will educate financial sector on current and projected future situation of the FCV and FCV component industries and of hydrogen infrastructure industries. It will be attended both by the financial sector and by FCV and FCV component manufacturers and hydrogen infrastructure related companies wishing to attract investment. It will set up mechanisms, such as matchmaking sessions, to connect investors with projects. Financial sector organizations targeted to attend will include venture capital and private equity firms, as well as banks, which routinely provide loans to China's major vehicle manufacturers, but not for FCV manufacturing in particular.
- Deliver presentations at financing workshop
- Facilitate meetings between banks, venture capital/private equity firms, etc. and individual FCV manufacturers, FCV component manufacturers, and hydrogen refueling or associated value chain businesses seeking debt or equity financing. This task will involve identification of appropriate interested parties on both sides (both financial institutions and those in the FCV or HRS industry seeking capital). It will also involve facilitating communications and meetings between relevant parties with the purpose of securing financing for the latter group.

Deliverables

- Financing workshop agenda
- Presentations for financing workshop
- Memos on achievements resulting from meetings facilitated

Required Qualifications

- Expertise in financial and business aspects of vehicle and vehicle parts manufacturing industry
- Five years of experience in NEV sector
- Experience designing workshops and giving presentations
- Proven track record in facilitating business meetings, negotiations, and deals

2. TOR for Consultant on FCV Purchase Financing Scheme

The purpose of this work will be to achieve an established and operational FCV purchase financing scheme in selected banks/FIs. Financing schemes will enable expanded purchase of FCVs by consumers and other entities. Successful schemes will also further stimulate interest of the financial sector and lead to more such schemes.

Required Tasks

- Design feasible financing scheme for consumer purchase of FCVs in China. Task will include review of existing auto financing schemes in China as well as incentive-oriented bank loan schemes for other products/investments available in China or other countries.
- Hold meetings with select financial institutions to explain, discuss, and promote the scheme, achieving adoption of scheme by at least one institution.

Deliverables

- Memo on designed financing scheme for consumer purchase of FCVs in China
- List of target institutions to which scheme will be promoted
- Memo on feedback from financial institutions on scheme

Required Qualifications

- Expertise in financial and business aspects of consumer vehicle financing programs
- Experience with and/or exposure to NEV sector
- Experience designing consumer loan programs
- Strong knowledge of and familiarity with Chinese banking sector
- Native speaker of Mandarin

V.9: TORs for Various Surveys Related to Project Outcomes and/or Project Monitoring

1. TOR for Social Science Survey Expert

In consultation with the Project's M&E Officer, the Social Science Survey Expert will field a number of surveys to support project monitoring as well as to conduct activities under some of the project's outcomes. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, conduct, and analyze results of annual survey of public perception of FCVs. Survey will cover various segments of the public including in each city, as relevant, those who have ridden or seen FCV buses, those who have seen and/or test driven FCV cars, and those who have seen FCV delivery vans or trucks. In particular, the survey will probe consumer concerns about hydrogen as a fuel, understanding of environmental benefits of FCVs, general attraction to the FCV concept, and general understanding of FCVs.
- Design, conduct, and analyze results of annual survey on the public's perception of hydrogen production and hydrogen refueling stations and report findings. The survey will seek to see if the public continues to have safety concerns about hydrogen infrastructure and whether this has lessened via the awareness building activities of Outcome 4. The surveys will be conducted in the neighborhoods of HRSs and hydrogen production facilities. If any cities in which new HRSs will be built do not have a standard consultative process with nearby residents regarding new installations, survey in its first year will serve to initiate such a process in cities.
- Design, conduct, and analyze results of a survey of individuals (as distinct from companies) attending group training on FCV manufacture and/or receiving training materials through the project. Survey will gather information on whether training has impacted the work of these individuals.
- Design, conduct, and analyze results of a survey of individuals attending group training for renewable energy-based hydrogen production and of a survey of individuals attending group training for HRS establishment. Surveys will each gather information on whether individuals are applying what they've learned through the training.
- Design, conduct, and analyze results of broad survey of individuals, officials, and organizations that purchase/use vehicles regarding their awareness and perception of FCVs. This survey will be conducted both at beginning of project and end of project.
- Design, conduct, and analyze results of survey of individuals exposed to project advocacy program to determine how this exposure has changed their views of FCVs.
- Design, conduct, and analyze results of survey of cities to determine how many have developed their own local *Hydrogen Refueling Roadmap*. Survey will also gather information on how many cities have their own local incentive policy for FCVs and/or HRSs and whether these are traditional type incentive policies or policies new to China.

Deliverables

- Template for survey on public perception of FCVs; results of survey
- Template for survey on public perception of HRSs/hydrogen production (by people living in the neighborhood of these); results of survey
- Template for survey of those attending group training on FCV manufacture or receiving training materials on this; results of survey
- Template for survey of those attending group training on renewable energy based hydrogen production; results of survey
- Template for survey of those attending group training on HRSs; results of survey
- Template for broad survey of vehicle purchasers and users; results from survey fielded at beginning of project; results from survey fielded at end of project.
- Template for survey of individuals exposed to project advocacy program; results of survey
- Template for survey of cities on FCV and HRS policies; results of survey

Required Qualifications

- Ten years or more experience in designing, fielding, and analyzing studies
- Proven track record of effective survey design and fielding
- Proven track record of high quality write-ups of survey findings
- High level of integrity

2. TOR FCV Manufacturer, FCV Component Manufacturer, Hydrogen Producer, and HRS Survey Expert

In consultation with the Project's CTA, Project's Technical Advisor on Hydrogen, and Project's M&E Officer, the FCV Manufacturer, FCV Component Manufacturer, Hydrogen Producer, and HRS Survey Expert will conduct surveys of FCV manufacturers, FCV component manufacturers, hydrogen producers, and HRSs. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, field and analyze results of survey of China's FCV manufacturers to obtain information needed for project monitoring indicators. There will be a standard version of the survey for all FCV manufacturers and an expanded version for those that have received one-on-one technical assistance, or accessed training materials. Targeted information for the standard version will be: number of companies producing FCVs, number of new FCV production lines, cumulative investment in FCV manufacturing, and lifetime hours of operation of FCVs, and actual cost and projected cost at high volume for FCVs. For those FCV manufacturers obtaining project one-on-one assistance, information on mean time between failure, lifetime mileage, cruising range, and fuel cell stack power density will also be obtained. For those obtaining sourcing assistance, information on newly signed sourcing agreements and total value of these agreements will be obtained. For those organizations receiving training materials, information on impact of these on their activities will be sought.
- Design, field, and analyze results of a survey of the eight FCV component and FC component manufacturers assisted by the project. Survey will gather information on FCV/FC components newly sourced in China as a result of project. It will also gather information on cost reduction achieved by each manufacturer and durability/performance improvement achieved.
- Design, field, and analyze results of a survey of FCV manufacturers and their products. The purpose will be to determine how many are compliant with new standards.
- Design, field, and analyze a survey of individual experts utilizing the project's *China FCV Market and Technology Monitoring System*. Survey will gather information on whether the technical updates of the system have been useful to the experts.
- Design, field, and conduct survey of China's renewable energy based hydrogen producers. Standard survey of all producers will gather information on cost and price of hydrogen produced from renewable energy, annual and cumulative hydrogen production from wind farms and landfill

methane, respectively, cumulative investment in renewable energy based hydrogen production, and total number of sites producing renewable energy based hydrogen.

- Design, field, and conduct survey of China's HRSs. Standard survey will gather information on the number and type of different business or operation models being used at China's hydrogen refueling stations, the cost of setting up HRSs (and associated scale), the total number of HRSs in China, and the cumulative hydrogen distributed through HRSs. For those stations participating in the project's one-on-one technical assistance, information will be gathered on whether and how the assistance impacted the station's strategy or operation.

Deliverables

- Template for survey of China's FCV manufacturers; results of survey, and required indicator values for Project Result Framework
- Template for survey of eight FCV component and FC component manufacturers and for gathering of information on FCV/FC components newly sourced in China; results of survey
- Template for survey of FCV manufacturers and product compliance; results of survey
- Template for survey of experts regarding project's *China FCV Market and Technology Monitoring System*; results of survey
- Template for survey of China's renewable energy based hydrogen producers; results of survey
- Template for survey of China's HRSs; results of survey

Required Qualifications

- Track record in conducting surveys of industry
- Track record of high quality presentation of survey results
- Technical/science background; ability to understand technical concepts and incorporate into survey
- Five years of experience in industry-related survey work

3. TOR for Financial Sector Survey Expert

In consultation with the Project's M&E Officer, the Financial Sector Survey Expert will conduct surveys of financial sector entities involved in the FCV and hydrogen refueling sectors. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, conduct, and analyze results of survey of financial sector entities involved in financing of FCV manufacturing, FCV value chain financing, HRS value chain financing, and/or financing of FCV purchase. Survey will gather information on total investment by financial sector in FCV and FCV value chain manufacturing and hydrogen stations and their value chain. It will also gather information on cumulative financing by financial sector of FCV purchase. It will further determine the number of financial institutions that are financing each of the aforementioned types of activities. Lastly it will determine the number of FCVs purchased through dedicated bank financial schemes.

Deliverables

- Template for survey of China's financial sector entities involved in FCV-related or hydrogen-related financing; results of survey

Required Qualifications

- Track record in conducting surveys of financial sector
- Track record of high quality presentation of survey results
- Financial sector and science/technical background; ability to understand financial and technical concepts and incorporate into survey
- Five years of experience in financial sector related survey work

Annex VI. Details of Demonstrations

This annex provides details on the project demonstrations. The project includes demonstrations in the following five areas. Each is discussed in turn below.

- 109 fuel cell vehicles (FCVs), comprised of 23 FC buses, 51 FC autos, 30 FC delivery vans, and 5 FC delivery trucks.
- Between 4 and 7 hydrogen refueling stations that are new or demonstrate a new business model
- 4 renewable energy based hydrogen producers of significant scale
- 2 FCV related local-level policy pilots that demonstrate policies new to China
- 8 domestic manufacturers of key FCV components that will improve their product and/or decrease costs, thus providing world class FCV components to domestic manufacturers (and possibly the world) at a price lower than previously available; and 2 domestic manufacturers of HRS equipment that will achieve world-class quality at prices lower than previously available

The FC vehicle and hydrogen refueling station demonstrations will be highly integrated in that most of the refueling stations will be in the same cities as the demo FCVs and be used for refueling those vehicles. Other demo areas share the same objective (facilitation of the commercialization of FCVs in China), though may have a different angle and/or approach. For example, the renewable energy based hydrogen production demos will have locations based on resource and partner availability, but will contribute to efforts to "de-carbonize" China's hydrogen supply. To the extent possible, these demos will provide hydrogen directly to the project's demo FCVs, such as in the case of Beijing and an expected additional demo city Yancheng, but in some cases due to geographic issues, it may not be possible. The two local-level policy pilots will most likely be located in some of the same cities as the project's demo vehicles and will aim to stimulate increased purchase of FCVs and/or investment in hydrogen refueling stations. The demonstration of domestic component manufacturers will have a similar aim as technical/cost targets for the FCV demos (and HRSs), but on a longer time scale. That is, while the component manufacturer demos should contribute in the longer term to achieving world class durability and performance for lower cost, new components from these efforts will not be available at the time of demo vehicle manufacture (or demo HRS establishment).

1. Fuel Cell Vehicle Demonstrations

Purpose and Differentiating Features: The purpose of the FCV demonstrations will be two-pronged. First, the demonstrations will push progress towards commercialization (both in raising technical levels and lowering costs) to a level beyond that which would be achieved in the baseline scenario. That is, with the UNDP-GEF project, the demos will "leap-frog" over a generation of FCVs in terms cost reduction and durability and performance improvement. That is, if in the baseline scenario China's FCVs would have advanced from "Generation A" (generation at time of Shanghai World Expo in 2010) to "Generation B," in the alternative scenario with the project, they "leapfrog" over Generation B to reach "Generation C." This will be achieved with targeted technical assistance to Chinese FCV manufacturers, as well as assistance in international sourcing of components. In the case of FC buses, in particular, an effort will be made to leverage China's strengths and cost advantage in bus making with recent breakthroughs towards FCV commercialization internationally, by sourcing foreign FC engines for Chinese built FC buses. Yet, autos and delivery vehicles will also "leapfrog" over the generation targeted in the baseline scenario through improvements in technology and sourcing.

Second, the demos will present a critical mass of FCVs demonstrated on a long-term/continuous basis. This will both markedly increase the exposure of government officials (both national and local), industry, the financial sector, and the public to the reality and benefits of FCVs *and* provide a substantial dataset of results for analysis. The demonstration of FCVs on a long-term/continuous basis is something that has not occurred before in China. Previous FCV demo efforts have been temporary and event driven (e.g., with permission to operate only during the Olympics or Shanghai Expo) or considered experimental (e.g. buses driven with sand bags rather than real passengers).

Technical and cost targets: The project will aim to achieve "leapfrog-scale" progress towards commercialization of China's FCVs in the demo vehicles via combination of targeted one-on-one technical assistance to China's FCV manufacturers, group training sessions, and assistance to Chinese FCV manufacturers in overcoming barriers to international sourcing. That is, the generation of vehicles targeted in the baseline scenario ("Generation B") will be surpassed for a higher level of durability, performance, and cost reduction ("Generation C") Exhibit VI-1 below shows project technical and cost targets for FC buses. Exhibit VI-2 summarizes targets for other demo vehicles.

Exhibit VI-1: Demo FC Bus Technical and Cost Targets

Parameter (FC Bus)	2015	2019 – no GEF support	2019 – with GEF support
Lifetime hours operation	2,000 hours	6,000 hours	10,000 hours
Mean time between breakdown	300 hours	650 hours	1,000 hours
Projected cost reduction at high volume[59]	0% (baseline)	25%	50%
Projected unit cost at high volume[60]	USD 380,000	USD 285,000	USD 190,000
Actual unit cost	USD 640,000	USD 480,000	USD 320,000
Annual operating hours	670 hours	2,000 hours	3,400 hours
Annual distance driven	NA	44,000 km	78,000 km
Daily distance driven	NA	NA	250 km

Exhibit VI-2: Technical and Cost Targets for other Demo FCVs

Vehicle	Scenario	Lifetime hours operation	Time between breakdown	Annual operating hours	Projected cost reduction at high volume[61]
Automobile	2015	2,000 hours	300 hours	402 hours	0% (baseline)
	2019 w/o GEF project	4,000 hours	650 hours	1,200 hours	25%
	2019 w/ GEF project	6,000 hours	1,000 hours	2,100 hours	40%
Delivery truck	2015	2,000 hours	300 hours	670 hours	0% (baseline)
	2019 w/o GEF project	4,000 hours	650 hours	1,200 hours	25%
	2019 w/ GEF project	6,000 hours	1,000 hours	2,100 hours	50%
Delivery van	2015	2,000 hours	300 hours	402 hours	0% (baseline)
	2019 w/o GEF project	4,000 hours	650 hours	1,200 hours	25%
	2019 w/ GEF project	6,000 hours	1,000 hours	2,100 hours	50%

Overall plans – vehicle types, numbers, and financing: Exhibit VI-3 below shows the breakdown of numbers of vehicles to be demonstrated among the four vehicle types that will be demonstrated: 23 FC buses, 51 FC autos, 30 FC delivery vans, and 5 FC delivery trucks. The rationale behind the selected numbers of vehicles is to have a critical mass to create robust data and experience sets, as well as create sufficient visibility in the selected cities.

Plans for each city: Exhibit VI-4 shows the breakdown of vehicles by city. The plans for each city are discussed in turn below, with further detail provided in Exhibit VI-5. Exhibit VI-6 provides preliminary plans for vehicle usage patterns.

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59 High volume projection at 500 units for buses.
60 High volume projection at 500 units for buses.
61 High volume projection at 5,000 units for cars, delivery trucks, and delivery vans.

Exhibit VI-3: Breakdown of Demonstration Vehicle Type[62]

Vehicle Type	Total
Buses	23
Cars	51
Delivery Van	30
Delivery Truck	5
Total	**109**

Exhibit VI-4: Breakdown of Demonstration Vehicles by Type and City

City	Bus	Car	Delivery Van	Delivery Truck	Total
Shanghai	8	51	30	0	89
Beijing	10	0	0	5	15
Zhengzhou	3	0	0	0	3
Foshan	2	0	0	0	2
Total	**23**	**51**	**30**	**5**	**109**

Shanghai: Shanghai will have 89 demo vehicles, comprised of 8 buses, 51 autos, and 30 delivery vans. These will be financed by a combination of support from MOST, other relevant national-level agencies, Shanghai Municipal Government, and the GEF. Based on agreement achieved via provision of GEF funding, all vehicles will be required to reach a much higher level of durability, performance, and cost reduction than had been targeted in the baseline scenario. The new generation demo FVBs will be used as public buses on short-distance routes in urban areas of Jiading District. Of the new generation FC autos, 50 will be manufactured by SAIC and one is expected to be provided by Toyota. Most of the SAIC autos will be used by a vehicle rental company of which SAIC has part ownership, while a few will be available for consumer test driving (around 200 days per year for three years during project period). The new generation FC delivery vans will be manufactured by Potevio New Energy and will be used for postal delivery within the city.

Beijing: Beijing will have 15 demo vehicles, including 10 buses and 5 delivery trucks. All buses will be used as public buses on short-distance routes in urban areas in the northwest of Beijing. Delivery trucks will be used for delivery within the city.

Zhengzhou: Zhengzhou, capital of Henan Province, will have 3 demo vehicles, all FC buses. All buses will be used as public buses on short-distance routes in urban areas of Zhengzhou.

Foshan: Nanhai, which is a district of Foshan City in Guangdong Province, will have 2 demo vehicles, both FC buses. The two Foshan FC buses will be used for mid-distance public transport from Foshan City center to an outlying tourist area.

Plans among the cities and vehicle types will share some important commonalities. For all vehicles, emphasis will be on ensuring high visibility routes suitable for collecting data on vehicle performance. Further, vehicle exteriors will include visible indication of the fuel cell status of the vehicle, so that viewers and riders are aware of this. Further, where relevant (such as in public buses) interior signage (and possibly brochures) will promote the FCV concept. Finally, continuous operation (with only one day off per week if needed) of all vehicles will be emphasized, as will continued operation after project close for those vehicles with remaining lifetime. A monitoring plan prepared by experts will ensure that necessary data for analysis is gathered from all vehicles.

[62] Because Yancheng and other potential cities have recently shown strong interest in participating in the demo aspects of this project, FCV numbers designated for the cities may change and will be determined during project inception based on cities' interests and their commitment to co-financing.

Exhibit VI-5: Basic Information on Each City's Demo Plans

Vehicles (number)	Use	Part of town/ visibility	Ownership after procurement; responsible for refueling costs	Party Handling Maintenance
Shanghai bus (8)	Short-distance public transport	Jiading District – known for auto industry	Jiading Public Transportation Co.	Jiading Public Transportation Co. with manufacturer assistance
Shanghai car (50)[63]	47 Rental cars and 3 for consumer test driving (around 200 days per year)	47 all over city (the rest for test driving at 3 different sites in Jiading)	Rental company (part-owned by SAIC)	Rental company with SAIC assistance
Shanghai delivery van (30)	Mail delivery sub-contracted from China Post	All over city	Potevio	Potevio (which will be both manufacturer and end user)
Beijing bus (5)	Short-distance public transport	North Beijing-Haidian District – high tech part of city	Beijing Public Transportation Co.	Beijing Public Transportation Co. and manufacturer(s)
Beijing delivery truck (5)	Delivery within city	All over city	City 100 and Shenzhou Taiyue	City 100 and Taiyue with assistance from Foton
Zhengzhou bus (3)	Short-distance public transport (route 600 or route 319)	Within Zhengzhou City	Zhengzhou Public Transportation Co.	Zhengzhou Public Transportation Co. with assistance from Yutong/manufacturer(s)
Foshan bus (2)	Mid-distance public transport	From district center to outlying area, which has tourism	Nanhai Public Transportation Co.	Nanhai Public Transportation Co. with assistance from manufacturer(s)

Exhibit VI-6: Preliminary Plans for Demo Usage Patterns

Type of vehicle	Hours per day	Km per day	Days per week	Total years in use (lifetime)	Total km (lifetime)
Buses	11 hours/day	250 km	6 days/week	3.2 years	250,000 km
Autos	6 hours/day	150 km	6 days/week	3.2 years	150,000 km
Delivery Vans	6 hours/day	150 km	6 days/week	3.2 years	150,000 km
Delivery Trucks	6 hours/day	150 km	6 days/week	3.2 years	150,000 km

Assumptions: Implementation of the above-described FC demo plan hinges on a couple of critical assumptions. First it is assumed that national government subsidies for domestically manufactured FCVs will continue through purchase date of the demo vehicles, substantially lowering costs so that the targeted number of vehicles can be purchased with the allocated funds. The second assumption is that approval for long-term use of these vehicles can be obtained from both relevant national level authorities (which authorize production of various models) and local authorities (which issue vehicles license plates). The project has activities targeted at ensuring both of these two assumptions hold.

Baseline and target values for energy savings and GHG reductions: Please see Annex III for estimated energy savings and GHG reductions directly associated with the above demo vehicles.

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[63] This includes plan for the 50 cars manufactured by SAIC, but not the Toyota car, plans for which are still under discussion.

Parties involved: At the local level, each of the four cities has set up a project steering committee, whose members are local government officials, to lead local management of the demo vehicles (and associated hydrogen refueling stations). Working level staff at the local level comprise a local PMO to support the local steering committee. Other involved parties will be the vehicle owners/operators. The owners/operators will be responsible for routine maintenance, though they will have manufacturer support in this area. National FCV and hydrogen refueling experts will support local efforts; and the central-level PMO will serve to coordinate and backstop demo efforts.

2. Hydrogen Refueling Station Demonstrations

Purpose and differentiating features: The project will have at least 4 and possibly up to 7 demonstration hydrogen refueling stations (HRSs), with the minimum of 4 being represented by one station in each of the 4 cities in which vehicles will also be demonstrated. The demos will each be either a new HRS (3 to 6 of them) or an existing HRS (1 of them) with new aspect added to its business model. The building, equipment, and installation for all of these HRSs will be funded by local entities. GEF funds will be used to support related incremental activities, such as developing new business or operational models, trouble-shooting problems, capacity building for O&M, and developing a *China Hydrogen Refueling Station (HRS) Reliability Database* and other monitoring processes to assess results and develop lessons learned.

The demo HRSs will have three important demonstration aspects compared to past efforts. First, an important demonstration aspect of the HRSs will be their continuous and ongoing (beyond project close) operation. China has had a small handful of hydrogen refueling stations in the past, but none have operated continuously since initiation due to the previously sporadic nature of FCV demos. At present, there are just two stations that are operational. One is in Shanghai has recently resumed almost daily operation to serve a small group of SAIC FC autos. The other is in Beijing and operates sporadically to serve test FCVs.

The second important aspect of the HRS demonstrations is that they will enable achievement of a “critical mass” of stations to provide monitoring data for analysis, lessons learned, and associated achievement of targets. Including an existing station in Beijing that will not be counted as a demo, the project HRS demos will result in a total of at least 5 and possibly up to 8 continuously operated HRSs in China. Targets for these stations will be reliability (to reduce down days per year to as few as possible), reduction in accidents (maximizing periods between incidents), and reduction in capital costs to build the stations.

The third demonstration aspect of the project HRSs will be to introduce new business or operational models for hydrogen refueling stations in China. Targeted models to be demonstrated include: addition of EV charging to HRS, on-site generation of hydrogen via renewable energy, possibly addition of hydrogen to existing gasoline station, and possibly other multi-fuel offerings for new stations (e.g. hydrogen and CNG).

Plans for Individual Stations: The plans of each relevant city with regard to project demo HRSs are discussed below and summarized in Exhibit VI-7.

Exhibit VI-7: Plans for Project Demo HRSs and Existing HRSs

City	New or existing	New business model or approach	Incremental project activities	Project demo? / Status
Shanghai	Existing in Jiading	Will add EV recharging to existing HRS	Monitoring/ reporting results	Project demo; plans confirmed
Shanghai[64]	Possibly, new or existing one	Hydrogen added to new or existing gasoline station	Outreach to potential gas stations; business plan; O&M capacity building;	Potential project demo: candidate gasoline station to be identified
Beijing	Existing in Northwest Beijing	Will be expanded to accommodate more vehicles, but no new approach	Monitor/report results	Not a project demo
Beijing	New in SE Beijing	NA (standard station planned)	O&M capacity building; monitor/ report results	Project demo; plans confirmed
Beijing	Possibly, new or existing one	Hydrogen added to new or existing gasoline station	Outreach to potential gas stations; business plan; O&M capacity building;	Potential project demo: candidate gasoline station to be identified
Zhengzhou	New	PV-powered water electrolysis unit onsite will supply small portion of hydrogen	O&M capacity building; monitor/report results	Project demo; under construction
Foshan	New	Business model not yet confirmed (possibly multi-fuel provision)	Business plan; O&M capacity building; monitor/ report results	Project demo; planning stage
Other interested city	New	Wind-PV hybrid powered water electrolysis unit on-site targeted to supply one-half of hydrogen	Trouble-shooting wind-PV system; O&M capacity building; monitor/ report results	Potential project demo; under construction

Shanghai: Shanghai has an existing hydrogen refueling station in Jiading District's Anting ("Anting Station"). Shanghai's project HRS demo will be achieved through a new addition to Anting. A second demo HRS in Shanghai is also targeted, in this case a gasoline station that adds hydrogen refueling capabilities. The Anting Station has been in existence for seven or eight years and is now providing refueling for several SAIC FC autos. Anting will become one of the project demos via co-financed addition of EV recharging capabilities to current hydrogen refueling capabilities. A solar panel will generate a small portion of the electricity used for recharging. With the new additions, Anting will become the first station in China to provide both hydrogen refueling and EV recharging on the same premises. The project will provide monitoring and reporting on the performance of Anting Station, including the EV recharging. There will be no provision of HRS O&M capacity building to Anting, as its owners and staff are already well versed in this area.

Hydrogen addition to existing gasoline stations is an important strategy for expanding hydrogen refueling infrastructure. As most central locations in Shanghai already have the required number of gasoline stations and land costs are a barrier to new HRSs, adding hydrogen to an existing station is the preferred strategy. The project will conduct outreach to owners of existing gasoline stations and business plan support for the addition of hydrogen once a candidate station in Shanghai is identified.

Beijing: Beijing at present has an existing hydrogen refueling station (not considered a project demo); and a second one (considered a project demo) is being set up. The project will further aim to establish a second project HRS demo in Beijing, in this case a gasoline station that adds hydrogen refueling

[64] Using existing hydrogen stations presents special challenges, including lack of standards and lack of space in Beijing and Shanghai.

capabilities. The existing station is in Yongfeng, which is in the northwest part of Beijing. Currently, with investment support from the Beijing Municipal Government, it is undergoing updating of its equipment and expansion so that it will be able to meet the needs of the ten project demo public buses and the five project demo delivery vans. Beijing's second HRS is being set up in an area in the Southeast corner of Beijing. Finally, as in the case of Shanghai, the project will conduct outreach to owners of existing gasoline stations and provide business plan support for the addition of hydrogen once a candidate station in Beijing is identified. The project will provide monitoring and reporting support to all Beijing stations and O&M capacity building support to new Beijing stations.

Zhengzhou: In Zhengzhou, Yutong Bus Company is currently building a hydrogen refueling station, which will be a project demo. Onsite, the station will include PV panels and a water electrolysis unit that will produce from water and sunlight a small portion of the hydrogen utilized by the station. The project will provide monitoring and reporting support and O&M capacity building support to the Zhengzhou HRS.

Foshan: A new HRS will be built in Nanhai, which will be a project demo. Land has already been secured, but final decisions on the business model have not yet been made. The project will provide business plan support for a possibly multi-fuel station. It will also provide monitoring and reporting support, as well as O&M capacity building.

Other interested cities: A new HRS that has a substantial wind-PV hybrid system powering a water electrolysis unit to produce hydrogen onsite will be built. This HRS will be a potential project demo. The wind-PV-powered water electrolysis system is targeted to provide 50 percent of the hydrogen used on-site, though there will be challenges in attaining this figure. The project will provide trouble-shooting support to the wind-PV-water electrolysis system and also provide monitoring and reporting and O&M capacity building.

Assumptions: Implementation of the above-described HRS demo plan hinges on a couple of critical assumptions. First it is assumed that national government subsidies for hydrogen refueling stations (currently at the level of 4 million RMB for stations that are designed to provide 200 kg or more of hydrogen per day to FCVs) will continue through the time of station establishment. The second assumption is that approval for new stations from local authorities will be timely. The project has activities targeted at ensuring both of these two assumptions hold.

Parties involved: There will be several parties involved in the hydrogen refueling station demos. These include local governments and companies (to date, largely state-owned) that invest in building the stations. Specialized organization designing and building the stations, as well as key equipment suppliers, are also important parties. They are likely to provide O&M training to the stations, so that project O&M capacity building will be supplementary to this base of vendor-supplied training. Through the project, experts will also be involved in the HRS demos. They will design the *China Hydrogen Refueling Station (HRS) Reliability Database* and other monitoring schemes and conduct analysis and reporting. They will provide outreach and business plan support to demos and potential demos. Further, they will provide O&M capacity building to demos.

Hydrogen source: Exhibit VI-8 shows the main source(s) of hydrogen anticipated for the demo HRSs in each city.

Exhibit VI-8: Main Source of Hydrogen Anticipated for Project Refueling Stations

Beijing	Shanghai	Zhengzhou	Foshan
(1) Capital Steel's natural gas reforming (currently 50 RMB per kg) and, later (2) Zhangbei Wind farm's wind power based hydrogen.	Shanghai coking factory: industrial by-product hydrogen	Hydrogen production to take place at Yutong Company: Method of production will be H2 recovery from industrial H2-laden gas streams. Also, small portion of hydrogen will be produced onsite with PV-powered electrolysis of water.	Hydrogen source still to be confirmed.
Other interested cities			
Up to 50% of hydrogen will be provided onsite by wind-PV hybrid powered electrolysis of water; source of the rest to be determined.			

3. Renewable Energy Based Hydrogen Production Demonstrations

Purpose: The purpose of the project's renewable energy based hydrogen production demos will be to promote and build technical capacity in a new area of hydrogen production that has the potential of "de-carbonizing" the fuel source and thus fulfilling the future FCV promise of zero carbon emissions. At present, hydrogen production through industrial by-product or natural gas reforming is relatively advanced in some areas of China. Yet, there is little experience with renewable energy based hydrogen production of substantial scale. Indeed, worldwide one criticism of FCVs is they have not yet fulfilled their promise of zero emissions due to use of carbon-based methods of hydrogen production. The renewable energy based hydrogen production demos of the project will demonstrate hydrogen production of substantial scale. In some cases the renewable energy based hydrogen production will directly supply project demo HRSs and thus project demo FCVs, though in others this may not be the case in the short term. The hydrogen production demos, however, will set the stage for replication and thus greater availability of renewable energy based hydrogen production. In a sense, then, they will lay the path for de-carbonizing China's hydrogen production just as the use of FCVs begins to grow.

Type of demos and demo partners: The project targets four renewable energy based hydrogen production demos of substantial scale. These will be wind-farm based hydrogen production and land fill methane based hydrogen production. Wind farm based hydrogen production on substantial scale is new to China. China Energy Conservation and Environmental Protection Corporation (CECEP) at its Zhangbei Windfarm (in Hebei Province north of Beijing) will be the first wind farm to pursue this and the first of the project's renewable energy based hydrogen production demos. CECEP and others are interested in hydrogen production as a way to capitalize on excess wind power not being fed into the power grid. In addition to CECEP, a wind farm based hydrogen production facility will be set up at a wind farm near Yancheng, Jiangsu Province. Work will also be done to establish other wind farm partners among interested parties for an additional demonstration. While biogas-based hydrogen production has been carried out on a test scale in China, no large scale biogas systems like landfill methane based hydrogen production has occurred. The project will seek out an appropriate partner for a demonstration in this area.

Financing and incremental activities: Equipment and installation for the renewable energy based hydrogen production demonstrations will be co-financed, while incremental activities will support technical capacity building and promotion of the renewable energy based hydrogen production opportunity. Already, through its *863 Program*, the Government of China is providing some support for wind farm based hydrogen production, including for the first of the project hydrogen production demos at Zhangbei Wind Farm in Hebei Province. The project will first of all conduct outreach to additional potential demo candidates. Then, project activities will include one-on-one technical assistance to each of the three demo wind farm partners and to the one demo landfill methane partner. This assistance will be focused on achieving lowest possible costs and highest possible reliability. International experience will be emphasized in group workshops as well as a study tour to Germany to learn about that country's work to date in "P to G" (power to hydrogen gas) and injection of hydrogen gas into the natural gas network.

4. Local-level Policy Pilots

Purpose of the policy pilots: The project will have two local-level policy pilots. The policies will incentivize FCV purchase and/or investing in hydrogen refueling stations. So far, China has developed subsidy-based incentive policies at the national level for FCV purchase and for the establishment of hydrogen refueling stations. At the national level, no other incentive policies for such vehicles/stations exist. In a few localities, new energy vehicles (NEVs, including both EVs and FCVs), are eligible for lower fees or avoidance of what can be a long queue in vehicle purchase. The aim of the policy pilots is to broaden the base of experience with incentive policies in China by introducing novel incentive policies that have not been used before in China.

The policy pilots will not have an impact on the direct CO_2 emission reductions of the project, as these demo FCVs and hydrogen production demos will likely be launched prior to the policy pilots. Instead, the policy pilots are expected to play a positive role in stimulating replication and thus indirect CO_2 emission reductions. The project will monitor the policy pilots to ascertain the number of replication vehicles and HRSs directly stimulated by them. In general, given the importance of this policy, it is considered that policy pilots and other policy work will be critical in working synergistically with other aspects of the project to stimulate replication. In this regard, policy's role may be preliminarily estimated to be 30 percent, while: technical assistance to the component/equipment manufacturers will play a 30 percent role, the FCV demos and associated technical assistance to the vehicle manufacturers will play a 20 percent role, and other factors will play the remaining 20 percent role.

Location and nature of the policy pilots: The project as a part of its activities will determine the nature and location of its two policy pilots. In scoping for concepts, international experience and particularly the *California FCV Project*, will be reviewed. Preliminary ideas include free or preferred parking spaces for FCVs and the right to use special lanes with less traffic. Locations for the policy pilots will likely be in some of the four cities in which the project's demo vehicles will be demonstrated. Shanghai and Beijing, given the greater scale of their FCV efforts, may be the most likely candidates.

5. Improved/Cost-Reduced Component Manufacturing Demonstrations

Purpose and nature of component manufacturer pilots: Reducing costs and improving reliability and performance of China-based production of components represents a critical medium-term path towards FCV commercialization. As such, the project will have 8 demonstrations of China-based FCV component manufacturers (each representing a different component) that progress to a level at which they are able to provide world-class FCV components at lower than start-of-project global prices. The main incremental activities of the project in this regard will be provision of both one-on-one technical assistance and facilitation of international cooperation to each of the demos. Because the vehicle demos are expected to be launched early in the second year of this four year project, the demo vehicles will not benefit directly from the component manufacturing demos. Yet, the latter are expected to make a critical contribution to medium-term progress towards FCV commercialization in China and possibly the world. They will do this by facilitating achievement of globally competitive component durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels.

In addition to the eight FCV component manufacturer demos, there will also be two hydrogen refueling station equipment manufacturer demos. These will be discussed, in turn, after details are presented on the FCV component manufacturer demos.

Given the timeline of the project, these FCV component manufacturer and HRS equipment manufacturer demos will not play a role in the project's direct emission reduction to be achieved by the 109 FCV demos and four hydrogen production installations. Instead, they will contribute to indirect emission reductions that will be realized by replication. By end of project, these demos should result in lower costs for components and in this way play a key role in stimulating replication. Different aspects of the project will together contribute synergistically to create indirect emission reductions. Preliminarily, we estimate that technical assistance to the component/equipment manufacturers will play a 30 percent role in indirect emission reductions, the demos and associated technical assistance to FCV manufacturers will play a 20 percent role, policy pilots and other policy work will play a 30 percent role, and other factors will play the remaining 20 percent role.

Selection of FCV component manufacturer demos – component type: The project formulation team selected type of demo FCV component manufacturers based on a combination of factors, key among which were: role in FCV overall cost structure, potential for improvement, and existence of a candidate company or companies taking or planning to take action-oriented steps towards serving/better serving the FCV sector.

To assess the role of various components in overall costs, cost structure estimates were collected from FCV experts. A representative example of cost structures provided by experts is given in Exhibits VI-9 and VI-10 below. The first (left-most) column in Exhibit VI-9 shows the cost structure of the overall "FC System," consisting of the fuel cell stack (engine), which accounts for 49% of costs, and various balance of system components, such as hydrogen tank. The middle column shows the cost structure of the fuel cell stack (or "engine") alone, for which the MEA makes up 47%. Finally, the right column shows a breakdown of MEA component costs. Exhibit VI-10 combines the three columns of Exhibit VI-9, thus incorporating stack and MEA individual components into the overall picture of the larger fuel cell system cost structure.

Exhibit VI-9: Cost Structure of FC System, FC Stack, and MEA

FC System Cost structure		FC Stack Cost Structure (FC stack is one part of FC system)		MEA Cost Structure (MEA is one part of FC stack)	
Stack	49%	MEA	47%	Catalyst	44%
Hydrogen Tank	17%	Metallic bipolar plate	42%	Membrane	31%
H2 Supply System Int†	12%	End plate	4%	Carbon paper	17%
Air Compressor	12%	Auxiliary for stack	3%	Subsidiary materials	8%
Humidifier	3%	Auxiliary for module	2%	Total	100%
Injector	1%	Manifold	1%		
Others	6%	Current collector plate	1%		
Total	100%	Total	100%		

†Hydrogen Supply System Integration

Exhibit VI-10: Overall Cost Structure of FC System, incorporating Stack and MEA Components

Component of FC system	Share in Total Cost
Metallic bipolar plates (part of stack)	21%
Hydrogen Tank	17%
Hydrogen Supply System Integration	12%
Air Compressor	12%
Catalyst (part of stack's MEA)	10%
Membrane (part of stack's MEA)	7%
Carbon paper (part of stack's MEA)	4%
Humidifier	3%
End Plate (part of stack)	2%
Injector	1%
Auxiliary for stack (part of stack)	1%
Auxiliary for module (part of stack)	1%
Manifold (part of stack)	0.5%
Current Collector Plate (part of stack)	0.5%
Others	6%
Subsidiary materials (part of stack's MEA)	2%
Total	100%

Specific FCV component manufacturer demonstrations: Details of each of the eight China-based FCV component manufacturer demos are given below. The demos are summarized in Exhibit VI-11.

Membrane: The project's demo membrane manufacturer will be China's top FC membrane manufacturer, Dongyue (located in Shandong Province). In this demo, Dongyue will be assisted to achieve reduced cost and increased quality, which are still needed despite this component already being domestically sourced from Dongyue by China's FCV manufacturers. Quality needs are: increased durability and reduced thickness, as well as improved: hydrogen cross-over, performance, and manufacturing quality. Dongyue possesses cost advantage in that it is vertically integrated, owning its own mines for membrane raw materials. Scale up from its current annual capacity of 200,000 m^2 per year to 1 million m^2 per year is expected to yield strong cost improvements. Planning/assessment and one-on-one TA and facilitation of joint venture or other international cooperation will be provided. One-on-one TA will be provided by a membrane testing and production expert, preferably with experience from a top international manufacturer of membranes. The facilitation with potential FCV clients internationally as a way of achieving enough demand for the scale-up targeted will also be carried out. Dongyue in 2014 invested 50 million RMB (8 million USD) in pilot production equipment and plans to continue to invest an additional 20 million RMB annually (3.2 million USD) in membrane testing and production. Incremental funds will be provided for the incorporation of enhanced features/higher quality of selected membrane quality testing/assessment equipment Dongyue is planning to purchase.

Catalyst: Chinese FCV manufacturers are currently importing catalyst. The project demo catalyst manufacturer will be Guiyanboye (based in Yunnan Province), which needs to achieve improved processing and scale-up in order to offer a lower cost catalyst to FCV manufacturers. A cost advantage of 20 to 30 percent, leveraging Guiyanboye's platinum trading and recycling platforms, is sought. Target performance improvements include reduction of indicator from 0.6 mg Pt per cm^2 to 0.3 mg Pt per cm^2, or even beyond to 0.2 mg Pt per cm^2 through the optimization of MEA structure and manufacturing. Incremental assistance from the project will include assessment/action plan and one-on-one technical assistance in production and testing. It will also include incremental funds for enhanced features/higher quality of single fuel cell test platform (and provision of related training) that Guiyanboye plans to purchase, incremental funds for enhanced features/higher quality of pilot preparation platform (to facilitate the move from laboratory to batch production) that Guiyanboye plans to purchase, and facilitation of joint venture or other international cooperation. Once basic methodology is proven, Guiyanboye plans to scale up by building a 2 to 5 ton per year FC catalyst production line.

Exhibit VI-11: Project FCV Component Manufacturer Demos

Component	Current Procurement	Selected Demo Manufacturer or Candidate	Key Needs	Incremental Activities
Membrane	China	Dongyue (Shandong) – top Chinese FC membrane provider; cost advantage via owning its own mines	Increase durability, reduce thickness; improve hydrogen cross-over, performance, and manufacturing quality. Scale up production to lower cost.	TA, facilitate international cooperation, equipment purchase
Catalyst	Imported	Guiyanboye (Yunnan)	Improved testing and processing; scale-up of production. Reduce indicator from 0.6 mg Pt/cm^2 to 0.3 or 0.2 mg Pt/cm^2 through the optimization of MEA structure and manufacturing.	TA, facilitate international cooperation, equipment purchase
MEA	China	Wuhan-based co. or Sunrise (Dalian)	Reduce discard rate from 20% to 2%	TA, facilitate international cooperation
Bi-polar plates	China	Shanghai or Dalian-based co., maybe Sunrise	Improve coating and stamping, thereby decreasing corrosion and reducing thickness from 0.7 mm to 0.4 mm	TA, facilitate international cooperation
FC stack	China	Sunrise (Dalian)	Increase stack maximum efficiency from current 60% to 65%; increase lifetime at specified test cycle from current level to 10,000 hours	TA, facilitate international cooperation
Compressor (for FCV)	China/ imported	Guangshun (Foshan)	Improve quality control, technology, and supply chain. (Include air bedding and better high speed motors in this work.)	TA, facilitate international cooperation
Hydrogen recirculation pump	Imported	Project to search for candidates	Launching of domestic manufacture, lowering costs and alleviating other obstacles faced by FCV manufacturers	Identify prospects, TA, facilitate international cooperation
HV DC-DC converter	China	Project to search for candidates	Lowering costs and alleviating other obstacles faced by FCV manufacturers	Identify prospects, TA, facilitate international cooperation

MEA: The project demo MEA manufacturer will be either a stand-alone MEA manufacturer based in Wuhan or Dalian Sunrise (which produces MEA as one component of the FC stack it produces). Final selection will occur during project inception. Assistance will consist of assessment/action plan, one-on-one technical assistance to improve processing, and facilitation of joint venture or other cooperative relationship with international counterpart.

Bi-polar plate: The project demo bi-polar plate manufacturer will either be a stand-alone bi-polar plate manufacturer based in Dalian or Shanghai or FC stack manufacturer Dalian Sunrise, which produces bi-polar plates as a component for its FC stacks. The manufacturer will be selected during project inception. The key issue will be to improve the process and technology for coating and stamping. Improved stamping will facilitate decreasing width of the plates from 0.7 mm to 0.4 mm. Improved coating is required to reduce corrosion. Incremental activities will include assessment/action plan, one-on-one TA, and facilitation of international cooperation.

FC stack: The project demo FC stack (engine) manufacturer will be Dalian Sunrise, which is believed to be the best manufacturer of its type in China. Targets for the demo will include increasing stack maximum efficiency from its current level of 60 percent to 65 percent, increasing stack lifetime at specified test cycle from current level to 10,000 hours, and increasing performance from 1.0A@0.65V to 1.5A@0.65V. Incremental assistance will include assessment/action plan, one-on-one technical assistance, and facilitation for international cooperation.

Compressor (for FCV): Foshan Guangshun will be the project's demo FCV compressor manufacturer. The purpose of the demo will be to improve quality control processes, technology, and supply chain. Areas of improvement will include air bedding and better high speed motors. Incremental activities will include assessment/action plan, one-on-one technical assistance, and facilitation of international cooperation.

Hydrogen recirculation pump: At present there are no China-based producers of hydrogen recirculation pumps in China. Yet, there are there are a number of interested and potentially qualified candidates. Thus, the project's first incremental sub-activity in this area will be to identify an interested, capable, and proactive manufacturer to assist in launching domestic production of the hydrogen recirculation pump. The aim of the demo will be to lower costs and reduce other difficulties faced by Chinese FCV manufacturers in sourcing this component. Other sub-activities will include one-on-one technical assistance and, facilitation of international cooperation.

High voltage DC/DC converter: This demo will be targeted to lower costs and other difficulties currently faced by Chinese FCV manufacturers in sourcing high voltage DC/DC converters. The first incremental sub-activity will be to identify a current or potential manufacturer with qualifications and interest in achieving needed improvements. Other sub-activities will include assessment/action plan, one-on-one technical assistance, and, facilitation of international cooperation.

Specific HRS equipment manufacturer demonstrations: As with the FCV component manufacturer demos, the HRS equipment manufacturer demos are intended to facilitate achievement of globally competitive component durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels. Details of the two China-based HRS component manufacturer demos are given below. The demos are also summarized in Exhibit VI-12.

Exhibit VI-12: Project HRS Component Manufacturer Demos

Component	Current procurement	Selected demo manufacturer or candidate	Key needs	Incremental activities
Compressor for HRS	Imported/ domestic	To be determined: likely candidate Beijing Tiangao	Improve reliability, control of production, sourcing of parts	Technical assistance, facilitation of international cooperation
Hydrogen refueling dispenser	Domestic	To be determined; likely candidate Shanghai Sunwise	Sourcing, adjusting technical methodology, support for international cooperation	Technical assistance, facilitation of international cooperation

Compressor for HRS: At present, China-based compressors supplied to HRSs lack the reliability of their international counterparts and often break down. Yet, imported HRS compressors are expensive. Currently, Shanghai's Anting Station and Beijing's HRS are using imported compressors. A station in Shenzhen (not currently operational) has used a domestic compressor supplied by Beijing Tiangao. Yet, operation of the station has not been continuous enough to get detailed data on performance. While the demo manufacturer has not yet been selected, Beijing Tiangao, as the only China-based company having supplied compressors to HRSs, is a likely candidate. The selected demo manufacturer will be confirmed during project inception. Assistance will target increasing reliability, control of production, and sourcing of parts. Facilitation of international cooperation will also be provided.

Hydrogen refueling dispenser: The demo hydrogen refueling dispenser manufacturer will likely be Shanghai Sunwise, though this will be confirmed during project inception. Incremental support will include assistance in sourcing, assistance in adjusting technical methodology, and liaison support for potential cooperation with international manufacturer.

Annex VII: Service Agreement between Country Office and Implementing Partner

**STANDARD LETTER OF AGREEMENT BETWEEN
UNDP AND THE MINISTRY OF SCIENCE AND TECHNOLOGY FOR
THE PROVISION OF SUPPORT SERVICES**

1. Reference is made to consultations between officials of the *Ministry of Science and Technology* (hereinafter referred to as "MOST") and officials of UNDP with respect to the provision of support services by the UNDP country office for the project. UNDP and MOST hereby agree that the UNDP country office may provide such support services at the request of MOST through its institution designated in the relevant project support document or project document, as described below.

2. The UNDP country office may provide support services for assistance with reporting requirements and direct payment. In providing such support services, the UNDP country office shall ensure that the capacity of MOST-designated institution is strengthened to enable it to carry out such activities directly. The costs incurred by the UNDP country office in providing such support services shall be recovered from the administrative budget of the office.

3. The UNDP country office may provide, at the request of MOST or its designated institutions, the following support services for the activities of the project:

   (a) Identification and/or recruitment of project and program personnel;
   (b) Procurement of goods and services; and
   (c) Other project related actions as needed and requested in addition to the country office's project oversight support covered under the GEF implementing Agency fee.

4. The procurement of goods and services and the recruitment of project personnel by the UNDP country office shall be in accordance with the UNDP regulations, rules, policies and procedures. Support services described in paragraph 3 above shall be detailed in an annex to the project support document or project document, in the form provided in the Attachment hereto. If the requirements for support services by the country office change during the life of a project, the annex to the project support document is revised with the mutual agreement of the UNDP Country Director and the designated institution.

5. The relevant provisions of the Standard Basic Assistance Agreement between the Government of China and the United Nations Development Programme in China signed on January 29 1979 (the "SBAA"), including the provisions on liability and privileges and immunities, shall apply to the provision of such support services. The Government shall retain overall responsibility for the nationally managed program or project through its designated institution. The responsibility of the UNDP country office for the provision of the support services described herein shall be limited to the provision of such support services detailed in the annex to the project support document or project document.

6. Any claim or dispute arising under or in connection with the provision of support services by the UNDP country office in accordance with this letter shall be handled pursuant to the relevant provisions of the SBAA and the project support document or project document.

7. The manner and method of cost-recovery by the UNDP country office in providing the support services described in paragraph 3 above shall be specified in the annex to the project support document.

8. The UNDP country office shall submit progress reports on the support services provided and shall report on the costs reimbursed in providing such services, as may be required.

9. Any modification of the present arrangements shall be effected by mutual written agreement of the parties hereto.

10. If you are in agreement with the provisions set forth above, please sign and return to this office three signed copies of this letter. Upon your signature, this letter shall constitute an agreement between the MOST and UNDP on the terms and conditions for the provision of support services by the UNDP country office for the project.

__________________________ __________________________________

Patrick Haverman
Deputy Country Director
United Nations Development Programme

Ministry of Science and Technology

[Date]

[Date]

Attachment

DESCRIPTION OF UNDP COUNTRY OFFICE SUPPORT SERVICES

1. Reference is made to consultations between MINISTRY OF SCIENCE AND TECHNOLOGY, the institution designated by the Government of China and officials of UNDP with respect to the provision of support services by the UNDP country office for the nationally managed project *China DevCom FCV: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China* **(PIMS#: 5349)**.

2. In accordance with the provisions of the letter of agreement signed on [*insert date of agreement*] and the project document, the UNDP country office shall provide support services for the project as described below.

3. Support services to be provided:

Support services (insert description)	Schedule for the provision of the support services	Cost to UNDP of providing such support services (where appropriate)	Amount and method of reimbursement of UNDP (where appropriate)
1. Recruiting two international and two national specialists	To be recruited as per AWP.	As per UPL, the service fee is US$ 5,265.6.	ATLAS billing -Estimated amount: US$ 5,265.6.
2.Financial service provider	Whole project period	3.5% of total budget	ATLAS billing -Estimated amount: US$ 298,430.
Estimated total			**US$303,696(estimated)**

4. Description of functions and responsibilities of the parties involved:

5. Description of functions and responsibilities of the parties involved is as per the project document. UNDP country office will provide the services as stated above upon the request of the Ministry of

Science and Technology. The reimbursement of the UNDP support cost will be recorded as per transactions based on the established UNDP financial regulations and rules.

Annex VIII. Social and Environmental Screening

Project Information

Project Information	
1. Project Title	Accelerating the Development and Commercialization of Fuel Cell Vehicles in China
2. Project Number	PIMS 5349
3. Location (Global/Region/Country)	China

Part A. Integrating Overarching Principles to Strengthen Social and Environmental Sustainability

QUESTION 1: How Does the Project Integrate the Overarching Principles in order to Strengthen Social and Environmental Sustainability?
Briefly describe in the space below how the Project mainstreams the human-rights based approach
The project does not have any activities specifically focused on mainstreaming the human rights based approach. It will, however, in general terms ensure it follows the human rights based approach, despite one identified risk, as explained below.
Briefly describe in the space below how the Project is likely to improve gender equality and women's empowerment
The project does not have any activities specifically focused on mainstreaming gender equality and women's empowerment. As such, it is not likely to improve these areas in a general way. Yet, efforts will be taken to promote gender equality and women's empowerment where possible and as follows: Throughout all its activities, the project will aim to include as many women as possible, both as recipients of various forms of technical assistance and as consultants retained by the project. In particular, six major project activities (group capacity building for FCV manufacturers, group capacity building for potential renewable energy based hydrogen producers, group capacity building for hydrogen refueling stations (HRSs), and three study tours, one for each of the aforementioned groups) include in their design efforts to include as many women as possible.
Briefly describe in the space below how the Project mainstreams environmental sustainability
This project's objective "facilitating the development and commercialization of FCVs" is motivated primarily by the potential of wide-scale FCV adoption to reduce greenhouse gas emissions and improve local air quality. In the scenario with the GEF project, demonstrated FCVs leapfrog beyond the durability, performance, and cost reduction parameters that would be achieved if there were no GEF project; and, as a result, FCVs become more attractive to end users. Further, international sourcing of FCV components and domestic production of such components are both improved, leading to further improvements in durability and reduction in price over the no-project scenario. With the GEF project, renewable energy based hydrogen production of substantial scale is introduced into China as are hydrogen refueling stations with varied business models. Policy promoting FCVs is enhanced as is awareness of FCVs. Human capacity in O&M (for vehicles and stations) is enhanced, as is capacity in the financial sector as relates to FCVs. Direct CO_2 emission reductions are 15,172 tons as compared to 1,329 tons in the no-project case. Indirect "bottom up" emission reductions in the GEF project scenario (assuming ten times replication of the FCV demos) are 151,724 tons as compared to 1,329 tons (assuming one time replication) in the no-project case.

Part B. Identifying and Managing Social and Environmental Risks

QUESTION 2: What are the Potential Social and Environmental Risks? *Note: Describe briefly potential social and environmental risks identified in Attachment 1 – Risk Screening Checklist (based on any "Yes" responses). If no risks have been identified in Attachment 1 then note "No Risks Identified" and skip to Question 4 and Select "Low Risk". Questions 5 and 6 not required for Low Risk Projects.*	**QUESTION 3: What is the level of significance of the potential social and environmental risks?** *Note: Respond to Questions 4 and 5 below before proceeding to Question 6*			**QUESTION 6: What social and environmental assessment and management measures have been conducted and/or are required to address potential risks (for Risks with Moderate and High Significance)?**
Risk Description	***Impact and Probability (1-5)***	***Significance (Low, Moderate, High)***	***Comments***	***Description of assessment and management measures as reflected in the Project design. If ESIA or SESA is required note that the assessment should consider all potential impacts and risks.***
Risk 1 (Principle 1-4): There is a possibility that residents of certain neighborhoods will not be included in decisions to site hydrogen refueling stations in those neighborhoods. Some cities, such as Shanghai, have regulations requiring public consultation before building certain facilities, such as refueling stations, but other cities may not have such a process.	I = 3 P = 3	Moderate		Project plans annual survey of public perception of hydrogen refueling stations in the neighborhood of the HRS demos. For cities that lack standard consultative process, first annual survey will serve to initiate consultation process. Stakeholder engagement via annual neighborhood surveys is in included in Outcome 2B, which demonstrates, among other things, hydrogen refueling stations. The specific activity through which the survey is conducted is Activity 2.B3.3.
Risk 2 (Principle 2-2): There is a possibility that the project will unintentionally reproduce discrimination against women based on gender, particularly with regard to participation in some project activities. While women are well-represented in the workplace in China, they may face a "glass ceiling" and as such may not be accorded equal opportunities for involvement in special activities, such as workshops and international study tours.	I = 3 P = 3	Moderate	The reason a probability of 3 "moderately likely" is given is that it will generally be the beneficiary work unit rather than the project itself that makes the decision as to who will be involved in project activities. Beneficiary work units may have a bias towards involving men in project activities over women. The impact is also rated 3 ("moderate"). With fewer women involved in project activities than might	Throughout all its activities, the project will aim to include as many women as possible, both as recipients of various forms of technical assistance and as consultants retained by the project. In particular, six major project activities (group capacity building for FCV manufacturers, group capacity building for potential renewable energy based hydrogen producers, group capacity building for hydrogen refueling stations (HRSs), and three study tours, one for each of the aforementioned groups) include written into their design that an effort to include as many women as possible will be made.

			be, the potential for them to be significantly involved in the FCV sector is further reduced.	
Risk 3 (Principle 3, Standard 3-3.1): It is possible that elements of project operation will lead to potential safety risks to the community, as relates to the production, transport, and refueling of hydrogen, as well as its use in vehicles. For FCVs the main risk relates to hydrogen leaks (due to part failure or rupture due to impact), which could lead to fire or explosion. For hydrogen refueling stations, the main risk relates to hydrogen leaks (due to part failure or misuse), which could lead to fire or explosion. For hydrogen production, the main risk is that hydrogen leak (due to part failure) could lead to fire or explosion. (If wind farms are used to produce hydrogen, they don't create any risk on the wind farm side of things.) As for hydrogen transport (from producer to station), the main risk is hydrogen leak at tanker truck (due to part failure, accident) that could lead to fire or explosion.	I = 2 P = 2	Low	While safety issues are acknowledged and deserve careful attention, there is in a sense also a certain level of myth in regard to hydrogen safety issues. Hydrogen has some substantial advantages that limit the impact of any incident: It is so light that it immediately evaporates upwards and disappears. It is also non-poisonous, so that there is no contamination or health impact to affected people or environment (except fire/explosion). Finally, because hydrogen is so light, any fire will be gone quickly (much faster than a gasoline/natural gas fire).[65]	Safety issues will receive prominent position in one-on-one and group technical assistance for FCV manufacturers and renewable energy based hydrogen production, as well as in group technical assistance for hydrogen refueling stations. Their coverage is specifically indicated in the text of the project design. Standards and testing work will further reinforce safety aspects. Finally, the project design also calls for the holding of a fire safety seminar covering all aspects of the FCV value chain (including hydrogen infrastructure). Specific countermeasures taken for each sub-area of risk and that will be adopted in the aforementioned activities include the following: (1) FCV risk: countermeasures in vehicle and component design (special hoses, valves, position of tank in vehicle), hydrogen sensors, and shutoff-valves; (2) hydrogen refueling station risk: station design, safety/shutoff mechanisms, control of station, and location of pump and equipment; (3) hydrogen production risk: design, shutoff mechanisms, and operator training; (4) hydrogen transport risk: tanker and component design, safety/shutoff mechanisms, and operator training.
Risk 4 (Principle 3, Standard 3-3.2): It is possible that elements of project operation will lead to potential occupational safety risks as relates to the production, transport, and refueling of hydrogen, as well as its use in vehicles. The specific risks for each of these areas is the same as outlined above under Risk 3.	I = 2 P = 2	Low		Same management measures as described in cell directly above (for Risk3).

QUESTION 4: What is the overall Project risk categorization?		
Select one (see SESP for guidance)		**Comments**
Low Risk	☐	
Moderate Risk	√☐	Of four risks, two are rated "moderate;" Two rated "low."
High Risk	☐	

[65] Additional background on hydrogen safety issues is provided at the end of Section 1.1 (Context and Global Significance).

	QUESTION 5: Based on the identified risks and risk categorization, what requirements of the SES are relevant?		
	Check all that apply		**Comments**
	Principle 1: Human Rights	√☐	Risk 1 relates to human rights – the right to be involved in decisions that impact one's community
	Principle 2: Gender Equality and Women's Empowerment	√☐	Risk 2 relates to gender equity and women's empowerment – the principle that women should be treated equally and have equal opportunity (in this case equal opportunity for participation in the project and related career advancement or business opportunity)
	1. Biodiversity Conservation and Natural Resource Management	☐	
	2. Climate Change Mitigation and Adaptation	☐	
	3. Community Health, Safety and Working Conditions	√☐	Risks 3 and 4 relate to safety of the community and employees with regard to hydrogen production, transport, refueling, and use in vehicles.
	4. Cultural Heritage	☐	
	5. Displacement and Resettlement	☐	
	6. Indigenous Peoples	☐	
	7. Pollution Prevention and Resource Efficiency	☐	

Final Sign Off

Signature	*Date*	*Description*
QA Assessor		UNDP staff member responsible for the Project, typically a UNDP Programme Officer. Final signature confirms they have "checked" to ensure that the SESP is adequately conducted.
QA Approver		UNDP senior manager, typically the UNDP Deputy Country Director (DCD), Country Director (CD), Deputy Resident Representative (DRR), or Resident Representative (RR). The QA Approver cannot also be the QA Assessor. Final signature confirms they have "cleared" the SESP prior to submittal to the PAC.
PAC Chair		UNDP chair of the PAC. In some cases PAC Chair may also be the QA Approver. Final signature confirms that the SESP was considered as part of the project appraisal and considered in recommendations of the PAC.

SESP Attachment 1. Social and Environmental Risk Screening Checklist

Checklist Potential Social and Environmental Risks	
Principles 1: Human Rights	**Answer (Yes/No)**
1. Could the Project lead to adverse impacts on enjoyment of the human rights (civil, political, economic, social or cultural) of the affected population and particularly of marginalized groups?	No
2. Is there a likelihood that the Project would have inequitable or discriminatory adverse impacts on affected populations, particularly people living in poverty or marginalized or excluded individuals or groups? [66]	No
3. Could the Project potentially restrict availability, quality of and access to resources or basic services, in particular to marginalized individuals or groups?	No
4. Is there a likelihood that the Project would exclude any potentially affected stakeholders, in particular marginalized groups, from fully participating in decisions that may affect them?	Yes
5. Is there a risk that duty-bearers do not have the capacity to meet their obligations in the Project?	No
6. Is there a risk that rights-holders do not have the capacity to claim their rights?	No
7. Have local communities or individuals, given the opportunity, raised human rights concerns regarding the Project during the stakeholder engagement process?	No
8. Is there a risk that the Project would exacerbate conflicts among and/or the risk of violence to project-affected communities and individuals?	No
Principle 2: Gender Equality and Women's Empowerment	
1. Is there a likelihood that the proposed Project would have adverse impacts on gender equality and/or the situation of women and girls?	No
2. Would the Project potentially reproduce discriminations against women based on gender, especially regarding participation in design and implementation or access to opportunities and benefits?	Yes
3. Have women's groups/leaders raised gender equality concerns regarding the Project during the stakeholder engagement process and has this been included in the overall Project proposal and in the risk assessment?	No
4. Would the Project potentially limit women's ability to use, develop and protect natural resources, taking into account different roles and positions of women and men in accessing environmental goods and services? *For example, activities that could lead to natural resources degradation or depletion in communities who depend on these resources for their livelihoods and well being*	No
Principle 3: Environmental Sustainability: Screening questions regarding environmental risks are encompassed by the specific Standard-related questions below	
Standard 1: Biodiversity Conservation and Sustainable Natural Resource Management	
1.1 Would the Project potentially cause adverse impacts to habitats (e.g. modified, natural, and critical habitats) and/or ecosystems and ecosystem services? *For example, through habitat loss, conversion or degradation, fragmentation, hydrological changes*	No
1.2 Are any Project activities proposed within or adjacent to critical habitats and/or environmentally sensitive areas, including legally protected areas (e.g. nature reserve, national park), areas proposed for protection, or recognized as such by authoritative sources and/or indigenous peoples or local communities?	No
1.3 Does the Project involve changes to the use of lands and resources that may have adverse impacts on habitats, ecosystems, and/or livelihoods? (Note: if restrictions and/or limitations of access to lands would apply, refer to Standard 5)	No
1.4 Would Project activities pose risks to endangered species?	No
1.5 Would the Project pose a risk of introducing invasive alien species?	No
1.6 Does the Project involve harvesting of natural forests, plantation development, or reforestation?	No
1.7 Does the Project involve the production and/or harvesting of fish populations or other aquatic species?	No
1.8 Does the Project involve significant extraction, diversion or containment of surface or ground water? *For example, construction of dams, reservoirs, river basin developments, groundwater extraction*	No
1.9 Does the Project involve utilization of genetic resources? (e.g. collection and/or harvesting, commercial development)	No
1.10 Would the Project generate potential adverse trans-boundary or global environmental concerns?	No
1.11 Would the Project result in secondary or consequential development activities which could lead to adverse social and environmental effects, or would it generate cumulative impacts with other known existing or planned activities in the area? *For example, a new road through forested lands will generate direct environmental and social impacts (e.g.*	No

[66] Prohibited grounds of discrimination include race, ethnicity, gender, age, language, disability, sexual orientation, religion, political or other opinion, national or social or geographical origin, property, birth or other status including as an indigenous person or as a member of a minority. References to "women and men" or similar is understood to include women and men, boys and girls, and other groups discriminated against based on their gender identities, such as transgender people and transsexuals.

	felling of trees, earthworks, potential relocation of inhabitants). The new road may also facilitate encroachment on lands by illegal settlers or generate unplanned commercial development along the route, potentially in sensitive areas. These are indirect, secondary, or induced impacts that need to be considered. Also, if similar developments in the same forested area are planned, then cumulative impacts of multiple activities (even if not part of the same Project) need to be considered.	
Standard 2: Climate Change Mitigation and Adaptation		
2.1	Will the proposed Project result in significant[67] greenhouse gas emissions or may exacerbate climate change?	No
2.2	Would the potential outcomes of the Project be sensitive or vulnerable to potential impacts of climate change?	No
2.3	Is the proposed Project likely to directly or indirectly increase social and environmental vulnerability to climate change now or in the future (also known as maladaptive practices)? *For example, changes to land use planning may encourage further development of floodplains, potentially increasing the population's vulnerability to climate change, specifically flooding*	No
Standard 3: Community Health, Safety and Working Conditions		
3.1	Would elements of Project construction, operation, or decommissioning pose potential safety risks to local communities?	Yes
3.2	Would the Project pose potential risks to community health and safety due to the transport, storage, and use and/or disposal of hazardous or dangerous materials (e.g. explosives, fuel and other chemicals during construction and operation)?	Yes
3.3	Does the Project involve large-scale infrastructure development (e.g. dams, roads, buildings)?	No
3.4	Would failure of structural elements of the Project pose risks to communities? (e.g. collapse of buildings or infrastructure)	No
3.5	Would the proposed Project be susceptible to or lead to increased vulnerability to earthquakes, subsidence, landslides, and erosion, flooding or extreme climatic conditions?	No
3.6	Would the Project result in potential increased health risks (e.g. from water-borne or other vector-borne diseases or communicable infections such as HIV/AIDS)?	No
3.7	Does the Project pose potential risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during Project construction, operation, or decommissioning?	Yes
3.8	Does the Project involve support for employment or livelihoods that may fail to comply with national and international labor standards (i.e. principles and standards of ILO fundamental conventions)?	No
3.9	Does the Project engage security personnel that may pose a potential risk to health and safety of communities and/or individuals (e.g. due to a lack of adequate training or accountability)?	No
Standard 4: Cultural Heritage		
4.1	Will the proposed Project result in interventions that would potentially adversely impact sites, structures, or objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture (e.g. knowledge, innovations, practices)? (Note: Projects intended to protect and conserve Cultural Heritage may also have inadvertent adverse impacts)	No
4.2	Does the Project propose utilizing tangible and/or intangible forms of cultural heritage for commercial or other purposes?	No
Standard 5: Displacement and Resettlement		
5.1	Would the Project potentially involve temporary or permanent and full or partial physical displacement?	No
5.2	Would the Project possibly result in economic displacement (e.g. loss of assets or access to resources due to land acquisition or access restrictions – even in the absence of physical relocation)?	No
5.3	Is there a risk that the Project would lead to forced evictions?[68]	No
5.4	Would the proposed Project possibly affect land tenure arrangements and/or community based property rights/customary rights to land, territories and/or resources?	No
Standard 6: Indigenous Peoples		
6.1	Are indigenous peoples present in the Project area (including Project area of influence)?	No
6.2	Is it likely that the Project or portions of the Project will be located on lands and territories claimed by indigenous peoples?	No
6.3	Would the proposed Project potentially affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples (regardless of whether indigenous peoples possess the legal titles to such areas, whether the Project is located within or outside of the lands and territories inhabited by the affected peoples, or whether the indigenous peoples are recognized as indigenous peoples by the country in question)? *If the answer to the screening question 6.3 is "yes" the potential risk impacts are considered potentially severe and/or critical and the Project would be categorized as either Moderate or High Risk.*	No

[67] In regards to CO_2, 'significant emissions' corresponds generally to more than 25,000 tons per year (from both direct and indirect sources). [The Guidance Note on Climate Change Mitigation and Adaptation provides additional information on GHG emissions.]

[68] Forced evictions include acts and/or omissions involving the coerced or involuntary displacement of individuals, groups, or communities from homes and/or lands and common property resources that were occupied or depended upon, thus eliminating the ability of an individual, group, or community to reside or work in a particular dwelling, residence, or location without the provision of, and access to, appropriate forms of legal or other protections.

6.4	Has there been an absence of culturally appropriate consultations carried out with the objective of achieving FPIC on matters that may affect the rights and interests, lands, resources, territories and traditional livelihoods of the indigenous peoples concerned?	No
6.5	Does the proposed Project involve the utilization and/or commercial development of natural resources on lands and territories claimed by indigenous peoples?	No
6.6	Is there a potential for forced eviction or the whole or partial physical or economic displacement of indigenous peoples, including through access restrictions to lands, territories, and resources?	No
6.7	Would the Project adversely affect the development priorities of indigenous peoples as defined by them?	No
6.8	Would the Project potentially affect the physical and cultural survival of indigenous peoples?	No
6.9	Would the Project potentially affect the Cultural Heritage of indigenous peoples, including through the commercialization or use of their traditional knowledge and practices?	No
Standard 7: Pollution Prevention and Resource Efficiency		
7.1	Would the Project potentially result in the release of pollutants to the environment due to routine or non-routine circumstances with the potential for adverse local, regional, and/or trans-boundary impacts?	No
7.2	Would the proposed Project potentially result in the generation of waste (both hazardous and non-hazardous)?	No
7.3	Will the proposed Project potentially involve the manufacture, trade, release, and/or use of hazardous chemicals and/or materials? Does the Project propose use of chemicals or materials subject to international bans or phase-outs? *For example, DDT, PCBs and other chemicals listed in international conventions such as the Stockholm Conventions on Persistent Organic Pollutants or the Montreal Protocol*	No
7.4	Will the proposed Project involve the application of pesticides that may have a negative effect on the environment or human health?	No
7.5	Does the Project include activities that require significant consumption of raw materials, energy, and/or water?	No

SIGNATURE PAGE
Country: China

UNDAF Outcome (s)/Indicator (s): Government and other stakeholders ensure environmental sustainability, address climate change, and promote a green, low carbon economy

CP Outcome (s)/Indicator (s): Low carbon and other environmentally sustainable strategies and technologies are adopted widely to meet China's commitments and compliance with Multilateral Environmental Agreements

CPAP Output (s)/Indicator (s): Policy and capacity barriers to the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed

Executing Entity/Implementing Partner: Ministry of Science and Technology, P.R. China (MOST)
Implementing entity/Responsible Partner: Ministry of Science and Technology, P.R. China (MOST)

Programme Period:	4 years
Atlas Award ID:	00086819
Project ID:	00094022
PIMS #	5349
Start date:	Oct.2015
End Date	Oct.2019
Management Arrangements	NEX
PAC Meeting Date	May 8, 2015

Total resources required	USD 61,733,560
Total allocated resources:	
• Regular	
• Other:	
○ GEF	USD 8,233,560
○ Government	USD 15,033,300
○ In-kind	USD 2,566,700
○ Other	USD 35,500,000
○ UNDP	USD 400,000

Agreed by (Government):

NAME SIGNATURE
Date/Month/Year

Agreed by (Executing Entity/Implementing Partner):

NAME SIGNATURE
Date/Month/Year

Agreed by (UNDP):

NAME SIGNATURE
Date/Month/Year