GEF-8 PROJECT IDENTIFICATION FORM (PIF)

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General Project Information

Project Title	
Green hydrogen energy integrated demonstration application project in China	
Region	GEF Project ID
China	11271
Country(ies)	Type of Project
China	FSP
GEF Agency(ies):	GEF Agency ID
UNIDO	210197
Executing Partner	Executing Partner Type
International Hydrogen and Fuel Cell Association (IHFCA) Ministry of Industry and Information Technology (MIIT)	CSO Government
GEF Focal Area (s)	Submission Date
Climate Change	4/13/2023
Project Sector (CCM Only)	
Technology Transfer/Innovative Low-Carbon Technologies	
Taxonomy	
Focal Areas, Climate Change, Climate Change Adaptation, Innovation, Private sector, Climate resilience, Climate Change Mitigation, Sustainable Urban Systems and Transport, Energy Efficiency, Technology Transfer, Renewable Energy, United Nations Framework Convention on Climate Change, Enabling Activities, Influencing models, Transform policy and regulatory environments, Strengthen institutional capacity and decision-making, Convene multi-stakeholder alliances, Demonstrate innovative approache, Stakeholders, Civil Society, Academia, Type of Engagement, Information Dissemination, Consultation, Beneficiaries, Private Sector, SMEs, Capital providers, Large corporations, Communications, Public Campaigns, Awareness Raising, Gender Equality, Gender Mainstreaming, Capacity, Knowledge and Research, Capacity Development, Targeted Research, Knowledge Generation, Knowledge Exchange	
Type of Trust Fund	Project Duration (Months)
GET	60
GEF Project Grant: (a)	GEF Project Non-Grant: (b)
16,000,000.00	0.00
Agency Fee(s) Grant: (c)	Agency Fee(s) Non-Grant (d)
1,440,000.00	0.00
Total GEF Financing: (a+b+c+d)	Total Co-financing
17,440,000.00	160,900,000.00
PPG Amount: (e)	PPG Agency Fee(s): (f)
300,000.00	27,000.00

PPG total amount: (e+f)	Total GEF Resources: (a+b+c+d+e+f)
327,000.00	17,767,000.00

Project Tags

CBIT: No NGI: No SGP: No Innovation: Yes

Project Summary

Provide a brief summary description of the project, including: (i) what is the problem and issues to be addressed? (ii) what are the project objectives, and if the project is intended to be transformative, how will this be achieved? iii), how will this be achieved (approach to deliver on objectives), and (iv) what are the GEBs and/or adaptation benefits, and other key expected results. The purpose of the summary is to provide a short, coherent summary for readers. The explanation and justification of the project should be in section B "project description".(max. 250 words, approximately 1/2 page)

China is the the relatively large contributor of carbon emissions in the world, accounting for one-third of global emissions.[1] Industry and transport were two of the key emitting sectors, 45% and 9%, respectively, of the country's total energy sector emissions in 2021.[2] A transition to clean and sustainable energy in China is urgently needed. China's targets on combating climate change include reaching a carbon peak by 2030 and achieving carbon neutrality by 2060, and setting green hydrogen as one of the critical energy paths to meet decarbonization pledges.

The objective of the project is to catalyze green hydrogen production and application in Ningdong, Dalian and Shenyang, China, especially in hard-to-abate sectors, with the aim to decarbonize and support the energy transition. This will be achieved through the mutual efforts of all stakeholders, particularly the government. The Chinese government has promulgated a series of policies to boost green hydrogen energy in the country. Local governments have committed budgetary funding to co-finance the project. UNIDO has been mandated by the government as the project implementing agency to lead the mobilization of resources for the project.

The key expected outcomes of the project include climate change mitigation, with the direct reduction of 17 million tCO2 eq, commercialization of green hydrogen fuel cell vehicles and enhanced energy security. The project aims to be transformative and innovative, and will be achieved with strong support from the government, incentive policies and international cooperation. Key barriers and enablers, and its risk mitigation strategy, are provided. The countries with green hydrogen programme, in particular GEF donor countries, are listed as one of the key stakeholders of the project promoting international cooperation and enhancing capacity building.

[1] https://www.iea.org/countries/china
[2] IEA: *An Energy Sector Roadmap to Carbon Neutrality in China*.

Indicative Project Overview

Project Objective

Goal: To demonstrate green hydrogen potential in China's less developed regions by using renewable energy for green hydrogen production and application to reduce energy consumption and greenhouse gas (GHG) and pollutant emissions. Objective: To achieve green hydrogen production and application in Ningdong in the

Ningxia Hui Autonomous Region, and Dalian and Shenyang in Liaoning Province, China, especially in hard-to-abate sectors, with the aim to decarbonize and support the energy transition.

Project Components

1. Policies, standards, regulations and information platform to promote the development of green hydrogen integrated supply chain and demonstration application

Component Type	Trust Fund
Technical Assistance	GET
GEF Project Financing ($)	Co-financing ($)
3,380,000.00	13,690,000.00

Outcome:

1.1

Draft and propose policies, technical standards and guidelines to provide regulatory and planning guidance to pilot city governments, hydrogen suppliers, fuel cell manufacturers and consumers to promote application of green hydrogen in multiple fields, to reduce energy consumption, greenhouse gas and pollutant emissions, establish an information platform, and carry out case study on the global environment benefits.

Output:

1.1.1
Policy suggestions, the related standards and regulations on green hydrogen supply and scaling up applications, in particular in hard-to-abate industrial sectors and transportation, formed.
1.1.2
Case study on green hydrogen trade mechanism carried out and business mode in its whole life cycle proposed.
1.1.3
The projection models for the green hydrogen industry under different macro scenarios to predict the industry's future development based on the experience of this GEF for green hydrogen applications formulated.
1.1.4

A database for the green hydrogen industry, the digital cloud platform to coordinate, manage and monitor the operation of the green hydrogen supply chain in real time built, and analysis report formed.

1.1.5

More than 8 conferences/workshops on policies and standards organized.

2. Multi-field application of green hydrogen.

Component Type	Trust Fund
Investment	GET
GEF Project Financing ($)	Co-financing ($)
10,750,000.00	134,710,000.00

Outcome:

2.1
Introduce green hydrogen production and clean technology in heavy transportation, and the hard-to-abate industry sector, and estimate GHG emission reduction potential.
2.2

Support for green hydrogen production, storage, end users and fuel cells application in the new technology and innovative enterprise.

Output:

2.1.1
Expanded demonstration for integrated green hydrogen supply chain established.
2.1.2
Multi-field applications of green hydrogen deployed. In **Ningdong**: four sets of high-efficiency hydrogen production plants by water electrolysis, the large-scale application of green hydrogen in the chemical industry built, with the aim to achieve 10,000 tonnes of green hydrogen coupling, and 300,000 tonnes of carbon dioxide in emissions reduction. In **Dalian and Shenyang**: an integrated green electricity (renewable power project) and green hydrogen on fishery at the coastal tidal area in Pulandian District, an integrated green hydrogen production plant near hydrogen refueling stations, introduced.
2.1.3
Hydrogen fuel cell vehicles applications at ports, free trade zone and chemical parks, and highway with hydrogen refueling stations initiated. In **Ningdong:** four hydrogen refueling stations, 250 hydrogen fuel cell heavy trucks in chemical industry parks deployed. In **Dalian and Shenyang**: 200 hydrogen fuel cell vehicles in Pilot Free Trade Zone and Port, 50 hydrogen fuel cell vehicles, four units of hydrogen refueling station along the Shenyang-Dalian Hydrogen Highway deployed.
2.1.4
A new power system up to 10MW with an integrated micro-grid of hydrogen energy storage built.

3. Strengthen capacity building.

Component Type	Trust Fund
Technical Assistance	GET
GEF Project Financing ($)	Co-financing ($)
600,000.00	1,500,000.00

Outcome:

3.1

Raising the awareness and management skills of national and local policy makers, business personnel and other relevant stakeholders on green hydrogen potential and benefits.

Output:

3.1.1
Trainings on green hydrogen for policymakers in energy, industry, city management, transportation and other departments such as Ministry of Industry and Information Technology(MIIT) and local government carried out, and about 5000 personnel trained.
3.1.2
10 Workshops on relevant policies, standards and planning framework for the development of hydrogen energy industry, and fuel cells conducted.
3.1.3
Written training materials on the green hydrogen and multi-field applications to policymakers developed and distributed.

4. Carry out gained knowledge dissemination, promote international cooperation and information exchange.

Component Type	Trust Fund
Technical Assistance	GET

GEF Project Financing ($)	Co-financing ($)
300,000.00	1,500,000.00

Outcome:

4.1.

Improve the awareness and capability of enterprises and other stakeholders in low-carbon technology development and use; enhance public awareness of environmental protection; promote international industry's knowledge exchange; enhance scientific research; improve manufacturing quality and maintenance capabilities.

Output:

4.1.1
Green hydrogen knowledge among industry players (hard-to-abate industry, fuel cell and vehicle manufacturers, hydrogen energy equipment suppliers and other relevant sectors) disseminated.
4.1.2
Green hydrogen public awareness and educational activities to enhance the awareness of low-carbon technology potential and importance in environmental protection established.
4.1.3
Publicity through multiple media channels and carbon neutrality application exhibition centres to increase and maintain public interest in green hydrogen strengthened and built.

M&E

Component Type	Trust Fund
Technical Assistance	GET
GEF Project Financing ($)	Co-financing ($)
210,000.00	2,000,000.00

Outcome:

5.1 A robust mechanism for M&E in place to ensure the attainment of project outcomes.

Output:

5.1.1
Project monitoring plan refined and executed in accordance with the provisions of the GEF and the UNIDO.
5.1.2
Data and information collected to measure certain of the project's outcome and output level indicators.
5.1.3
Project mid-term review and terminal evaluation conducted.
5.1.4

Recommendations and action plan for long term project sustainability as part of follow-up to terminal evaluation developed.

Component Balances

Project Components	GEF Project Financing ($)	Co-financing ($)

1. Policies, standards, regulations and information platform to promote the development of green hydrogen integrated supply chain and demonstration application	3,380,000.00	13,690,000.00
2. Multi-field application of green hydrogen.	10,750,000.00	134,710,000.00
3. Strengthen capacity building.	600,000.00	1,500,000.00
4. Carry out gained knowledge dissemination, promote international cooperation and information exchange.	300,000.00	1,500,000.00
M&E	210,000.00	2,000,000.00
Subtotal	**15,240,000.00**	**153,400,000.00**
Project Management Cost	760,000.00	7,500,000.00
Total Project Cost ($)	**16,000,000.00**	**160,900,000.00**

Please provide justification

Over the two decades, China has been developing hydrogen fuel cell vehicles (FCVs) technology starting from scratch, with the funding and support from the GEF. The FCV technology initiative, development and the roll-out were supported by three GEF projects, as well as by the Chinese government and the private sector. These projects have catalyzed the market-based commercial production and use of fuel cell buses (FCBs) and trucks in China: The first project (GEF ID 941 from 2003-2006) was implemented at the seedling stage of the development of China's FCVs, focusing on technology introduction and transfer. The second project (GEF ID 2257 from 2006-2010) was to kick-off the Chinese FCV market development, involving the demonstration of a small fleet of FCBs (twelve in total) in China to localize FCV equipment production. The third project (GEF ID 5728 from 2015-2019) involved in a small-scale demonstration and to set up commercial FC Buses manufacturing facilities to reduce costs of the vehicles. The development of China's FCV enters a new stage with the continued support from GEF. The previous projects were successful in introducing hydrogen technology to the transport sector to reduce carbon emissions in relatively small scale. The proposed project, based on the experience gained and lessons learned from GEF previous projects, expands the focus on green hydrogen industry and application. It focuses on a technology- and market-driven approach to promote the whole green hydrogen industry chain, including green hydrogen production and storage, infrastructure, application in the transport and industry sectors. In policy and technology demonstration, the project will contribute to carbon-neutral pilot cities in Ningxia Hui Autonomous Region and Liaoning Province, the project will try to build a green hydrogen economy in the transport and industry sectors across different regions, reducing energy consumption, GHG and PM2.5 emissions. The demo regions, which are well known as coal chemical industry and heavy industry zones, feature different energy characteristics and explore different energy transition pathways. The proposed project will be the first project applying green hydrogen in hard to abate coal chemical industry. It will enable the development and investment on "the first green hydrogen highway in China" between Shenyang and Dalian city in Liaoning Province. Furthermore, it will expand green hydrogen application to heavy duty trucks, public transport, highway, port in other cities.

PROJECT OUTLINE

A. PROJECT RATIONALE

Briefly describe the current situation: the global environmental problems and/or climate vulnerabilities that the project will address, the key elements of the system, and underlying drivers of environmental change in the project context, such as population growth, economic development, climate change, sociocultural and political factors, including conflicts, or technological changes. Describe the objective of the project, and the justification for it. (Approximately 3-5 pages) see guidance here

A project that will further facilitate FCVs using green hydrogen development, green hydrogen production and decarbonization of heavy industry in China is envisioned and presented in this proposal. The project aims to reduce greenhouse gas and pollutant emissions and explore a new holistic model of green hydrogen integrated development in heavy transportation and hard-to-abate industry sectors.

How an uncertain future could unfold, based on an understanding of trends and interactions between the key elements of the system and its drivers.

Global temperatures are rising and climate-related disasters have increased in number and magnitude, reversing development gains and affecting the poorest the most. Climate change remains the biggest threat to humanity in the long term. The footprints of human activity on the planet include the depletion of natural resources, biodiversity loss, environmental degradation and pollution. At the same time, millions of people still live without reliable access to sustainable energy and clean water. Increasing temperatures, changing precipitation patterns and extreme weather events directly impact agriculture, food production and food security.

A new generation of inequalities goes beyond income disparity to encompass the knowledge and skills that are needed to succeed in today's world. While the COVID-19 pandemic has led to an unexpected leap in the digitalization of learning, working and connecting with others, it has also exposed a serious digital divide that reinforces social and economic disparities. The digital transformation, the Fourth Industrial Revolution and the potential disruptive impact of technologies on the future of work have created uncertainties, but also unprecedented opportunities. Impact-driven partnerships are vital to drive inclusive and sustainable industrial development (ISID) at the scale needed to realize the 2030 Agenda. Convening multi-stakeholder partnerships for industrial development cooperation, impact investments, knowledge exchange and transformative leadership is central to UNIDO's value proposition.

In 2021, China's carbon dioxide emissions totaled 11.9 billion tonnes of CO_2, ranking first in the world. Among them, electricity emissions accounted for 34.11 per cent, industrial emissions accounted for 45.94 per cent, transportation accounted for 8.75 per cent, community emissions accounted for 4.97 per cent, and other emissions accounted for 6.23 per cent. China's growing energy needs are increasingly met by renewables and natural gas. The scale of China's future electricity demand and the challenge of decarbonizing the power supply explains why global investment in electricity overtook that of oil and gas for the first time in 2016, and why electricity security is moving firmly up the policy agenda. Cost reductions for renewables are not sufficient on their own to secure efficient decarbonization or reliable supply. Between 2019 and 2024, China will account for 40 per cent of global renewable capacity expansion, driven by improved system integration, lower curtailment rates and enhanced competitiveness of renewable energy. However, it still remains the world's largest emitter of carbon dioxide.

Chinese President Xi Jinping's announcement at the United Nations General Assembly won accolades from European leaders who have pressed China for stronger climate action, and from climate advocates who are hopeful it will lead developing countries to follow suit. President Xi told the UN in September 2020 that China aims to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060. He also pledged that China would scale up its commitment to the Paris Agreement by adopting more rigorous policies and measures.[1] The Chinese government is pushing for emissions reductions and improved air quality. The policy challenge is to ensure sufficient investment in electricity networks and in renewable energy generation technologies that are the best fit for power system needs.[2] The latter, together with

hydrogen energy technology, can provide the flexibility that is increasingly vital as the contribution of wind and small hydropower increases.

The greatest push for advancing climate adaptation and mitigation is the de-fossilization of energy systems. A key opportunity to replace fossil fuels across sectors is the use of green hydrogen. Since the 1990s, increasing economic wealth among the population has resulted in an increased demand for relatively cheap coal-based electricity and private and public transport. Since the turn of the century, major urban centres in China have suffered from severe air pollution from a growing number of vehicles and an industrial sector that creates smog, which is among the worst in the world. This is a similar situation in many newly industrialized countries, and because of this the demand to develop clean technologies have been mounting. The bulk of transport fuel consumption and hard-to-abate sectors in China are fossil fuel-based; its fossil energy reserves are limited. Since 1993, the country has become a net crude oil importer and since then annual oil imports have increased to 122.7 million tonnes a decade – an increase of almost 75 per cent, as Chinese consumption has continued to surge higher to meet industrial and transport sector energy demands. The electricity and heat production sector accounts for almost half of the CO_2 emissions of the country (mainly from coal), the industrial sector contributes about a third and CO_2 emissions from the transport sector accounts for about 7 per cent.

CO_2 emissions in China dropped during the COVID-19 pandemic – by 12 per cent in February 2020 relative to the same month in 2019, as economic activity was curtailed. In April 2020, China's economic recovery lifted its monthly CO_2 emissions above its 2019 level. For the remainder of the year, emissions in China were on average 5 per cent higher than 2019 levels. The latest annual figures indicate that the country's overall CO_2 emissions in 2020 were 0.98 per cent (or 100 Mt CO2) above the levels assessed at the end of 2019.[3]

Baseline in the absence of the project, and the outcomes that the project needs to achieve, how these will change the baseline, and what the key barriers and enablers are to achieving those outcomes.

Over the two decades, China has been developing hydrogen fuel cell vehicles (FCVs) technology starting from scratch, with the funding and support from the GEF. The FCV technology initiative, development and the roll-out were supported by three GEF projects, as well as by the Chinese government and the private sector. These projects have catalyzed the market-based commercial production and use of fuel cell buses (FCBs) and trucks in China: The first project (GEF ID 941 from 2003-2006) was implemented at the seedling stage of the development of China's FCVs, focusing on technology introduction and transfer. The second project (GEF ID 2257 from 2006-2010) was to kick-off the Chinese FCV market development, involving the demonstration of a small fleet of FCBs (twelve in total) in China to localize FCV equipment production. The third project (GEF ID 5728 from 2015-2019) involved in a small-scale demonstration and to set up commercial FC Buses manufacturing facilities to reduce costs of the vehicles.

The development of China's FCV enters a new stage with the continued support from GEF. The previous projects were successful in introducing hydrogen technology to the transport sector to reduce carbon emissions in relatively small scale. The proposed project, based on the experience gained and lessons learned from GEF previous projects, expands the focus on green hydrogen industry and application. It focuses on a technology- and market-driven approach to promote the whole green hydrogen industry chain, including green hydrogen production and storage, infrastructure, application in the transport and industry sectors. In policy and technology demonstration, the project will contribute to carbon-neutral pilot cities in Ningxia Hui Autonomous Region and Liaoning Province, the project will try to build a green hydrogen economy in the transport and industry sectors across different regions, reducing energy consumption, GHG and PM2.5 emissions. The demo regions, which are well known as coal chemical industry and heavy industry zones, feature different energy characteristics and explore different energy transition pathways. The proposed project will be the first project applying green hydrogen in hard to abate coal chemical industry. It will enable the development and investment on "the first green hydrogen highway in China"

between Shenyang and Dalian city in Liaoning Province. Furthermore, it will expand green hydrogen application to heavy duty trucks, public transport, highway, port in other cities.

About 77 per cent of China's annual transport sector CO_2 emissions come from road transport. The Chinese government sees this sector as important in promoting to energy users the importance of energy efficiency since mobility is the mainstay of people's daily economic, business and social activities. Addressing the high transport energy consumption in the country and the demand for more energy-efficient transport vehicles and alternative fuel vehicles (AEVs) has been driven by the Chinese government's desire to reduce air pollution, particularly in urban centres. Among the AEVs that are of the utmost interest are fuel cell vehicles (FCVs).

Transportation is the most important initial market for fuel cells (FCs) in China, and about 74 per cent of the application of FCs in the country focuses on transportation. About 54 per cent of FC technology in the country is based on proton exchange membrane fuel cells (PEMFCs), the most prominent FC technology for transportation applications worldwide. The bulk of the FCV initiatives in China has been through the government.[4] There has not been much private investment in green hydrogen, and so far, only a handful of private Chinese companies are working on this type of technology. However, China has seen significant investments from major car and bicycle manufacturers, some of which are already working with local research institutions on hydrogen applications.

Hydrogen poses several daunting technological hurdles that must be overcome before green hydrogen can help solve the energy challenge and pollution. The cost of FCs is still extremely expensive and in transportation applications. Storing and distributing hydrogen is still difficult because as a gas it contains very little energy by volume; hence, it must be either liquefied or stored under extreme pressure to deliver significant amounts of energy. In addition, green hydrogen must be manufactured using 'green' electricity and water.

While declining costs of green hydrogen production indicate that it may reach current fossil-based hydrogen production figures in the long term in some regions, there are various factors that need to be tackled in the short term to scale up green hydrogen use more broadly. The high cost of electrolyzers and variable renewable energy technologies has historically prevented green hydrogen from emerging as a significant clean energy technology until recently. Electrolyzer costs have declined over 50 per cent in the last five years, while efficiencies and system lifetimes have also increased considerably. However, these improvements fall short to compete with hydrogen production based on existing fossil fuel. The current cost of green hydrogen production falls within a range of $4-6/kg, compared to current grey hydrogen costs of $1-2/kg. Other cost parameters such as transportation and storage cost of hydrogen add up to the production cost, making green hydrogen less economically competitive, and further hindering its adoption.

The large-scale demonstration application of green hydrogen has many barriers, such as imperfect policies, standards and regulations, high cost and hydrogen safety awareness. The combustion range of hydrogen in normal temperature and atmospheric pressure air is 4-75 per cent. The leaked hydrogen diffuses and accumulates to a certain concentration in the space and will burn or even explode when it meets the ignition source, which has the characteristics of easy gasification, ignition and explosion. One of the biggest misunderstandings of the development and utilization of hydrogen comes from its safety. In a confined space, the combustion speed of hydrogen is about seven times that of natural gas and gasoline, and hydrogen is more prone to deflagration or even detonation than other fuels. However, in open space, the diffusion coefficient of hydrogen is 318 times that of natural gas and 12 times of gasoline gas. The leaked hydrogen will rise rapidly and spread rapidly in all directions, making it difficult to reach the required concentration for explosion.

Below is a summary of the key barriers in sustainable hydrogen development and how this project proposes to tackle them:

Barriers to hydrogen technology development	Project proposed solutions

Barrier 1: Lack of standards and regulating policy	This project plans to develop standards and policy to be used in China as well as globally.
Barrier 2: High cost	The project will facilitate development of innovative technologies (in cooperation with national and international research institutions) and promote economics of scale by creating large demonstration projects.
Barrier 3: Environment-friendly production life cycle	One of the goals of the proposed large-scale demonstration project will be to showcase how to solve the challenges in all aspects of production, storage, transportation and use.
Barrier 4: Production	The project will facilitate development of innovative technologies as well as promote green hydrogen production in cooperation with national and international research organizations to solve key challenges.
Barrier 5: Fuel cell technology	This project will facilitate development of innovative technologies with special focus on fuel cell technology in cooperation with national and research international institutions to solve key challenges.
Barrier 6: Application	Currently, China is mainly producing grey hydrogen; however, the project aims to work only with green hydrogen, therefore showcasing its potential.
Barrier 7: Green hydrogen trade	The project will cooperate with other research intuitions and government bodies to formulate and establish international trade standards and investigate carbon trading potential. It will carry out research on emissions of green hydrogen throughout its life cycle and propose trading the mechanism and policy suggestions for green hydrogen to participate in the carbon market.
Barrier 8: Hydrogen strategy	The project plans to develop international standards, national level green hydrogen roadmap as well as provide trainings for all stakeholders.
Barrier 9: FCV deployment and commercialization	The project will address all challenges associated with FCV deployment and commercialization by developing international standards, promoting R&D and international cooperation, improving hydrogen infrastructure, improving public-private partnership and raising awareness.

Why this particular project has been selected to address the drivers of environmental degradation and/or climate vulnerabilities in preference to other potential options, and how its outcomes will endure in the face of changes in the drivers described in the future narratives.

In the past decades, the GEF has successfully financed lots of projects related to energy efficiency, wind power, solar PV, lithium battery driven vehicles. It is the great time for China to receive GEF financial support catalyzing GHG reductions through green hydrogen.

The reason for proposing this project is mainly due to the fact that it is highly consistent with relative policies and regulations in China and national priorities. In March 2020, China's National Development and Reform Commission and the Ministry of Justice issued "The Opinions on Accelerating the Establishment of Green Production and Consumption Laws and Policies", which mentioned the need to study and formulate standard planning and supporting policies for the development of hydrogen energy. In April, 2020, the National Energy Administration issued "The Energy Law of the People's Republic of China (Draft for Opinion)", in which hydrogen was listed as an energy category. In December 2020, the State Council issued a white paper entitled "China's Energy Development in the New Era", which proposed to accelerate the development of hydrogen industry chain technology and equipment such as green hydrogen production, storage and usage, and promote the development of hydrogen fuel cell technology chain and hydrogen fuel cell vehicle industry chain. China will support the application of multi-scene energy storage in all aspects of energy and strive to promote the complementary development of energy storage and renewable energy.

In 2021, the State Council issued "The Guiding Opinions on Accelerating the Establishment and Improvement of a Green, Low-carbon and Recycling Economic System", which proposed to develop renewable energy such as hydrogen in light of local conditions and increase the proportion of its utilization.

In addition, it called for the green development level of transportation infrastructure to be promoted and the construction of supporting infrastructure for hydrogenation to be strengthened. In March, 2022, the National Development and Reform Commission of China issued “The Medium and Long-Term Plan for the Development of Hydrogen Energy Industry (2021-2035)”. The innovation ability will be significantly improved, the core technology and manufacturing process will be basically mastered, and a relatively complete supply chain and industrial system will be initially established.

In 2022, the Ningxia Development and Reform Commission issued “The Hydrogen Energy Industry Development Plan of Ningxia Hui Autonomous Region” for the pilot region Ningdong. The pilot region of Liaoning Province promulgated “Hydrogen Vision till 2035”, which highlighted the need to develop hydrogen energy in the cities of Dalian and Shenyang. Dalian also promulgated “The Development Plan of Dalian’s Hydrogen Energy Industry (2021-2035)”.[5]

This project supports the plan to strengthen its green hydrogen economy, explore the commercial mode of green hydrogen applications in Ningdong, Dalian and Shenyang.

By 2021, Ningxia installed 28.39 million kilowatts of renewable energy capacity accounting for 46 per cent of the total installed capacity, which is ranked third in China. By 2025, generation capacity for renewable power is planned to be 50 million kilowatts, accounting for more than 55 percent of local installed capacity, according to the local government.

The Ningdong Energy and Chemical Industry Base is one of China’s major energy production bases. Ningdong is enriched with natural resources, industry experience, established infrastructure and technical know-how to take the lead in China’s low-carbon transition toward green energy for sustainable development. With coal consumption expected to peak soon, Ningdong is increasingly tapping its strengths in renewable and hydrogen energy.

Ningxia plans to build an integrated technical innovation system of green hydrogen, including production and supply chain of renewable energy and applications for the chemical industry, and produce more than 300,000 tonnes of green hydrogen from renewable energy by 2030, which will mainly be implemented in Ningdong. With long sunshine duration of 3,000 hours per year, Ningdong boasts applications of green hydrogen and renewable resources. Green hydrogen production costs less than about $3 per kilogram. With new technologies, Ningdong is expected to save some 17 million tonnes of standard coal every year, cutting emissions of over 30 million tonnes of carbon dioxide. By 2025, its production of green hydrogen will reach 200,000 tonnes.[6]

The pilot demonstration in Ningdong will promote new technologies, establish and improve relevant standards and specifications, formulate and improve the hydrogen energy policy system, and form a large-scale supply application system of more than 200,000 tonnes of green hydrogen coupled with the chemical industry. Ningdong produces 40 million tonnes of coal, 24.5 million tonnes of raw chemical materials and products and has a wide range of green hydrogen energy application scenarios, such as coupling the chemical and refined chemical industry, and demonstrating high-efficiency electrolyzers with renewable power to produce green hydrogen.

It is projected by the end of 2025, total installed capacity of renewable power in Liaoning Province will increase from 14 million kW to 30 million kW. Among the newly installed capacity, renewable power will take 16 million kW. It will help Liaoning generate reliable electricity for the region’s green hydrogen production.

The proposed pilot project in Dalian will be conducted in the Dalian Free Trade Zone (DFTZ), which is a special economic zone where trading and manufacturing companies can benefit from advantageous policies towards import, export and trade in general. The DFTZ was founded in March 2017 and is located alongside the Yellow Sea Coast and consists of the Dayao Bay Bonded Port Area, Bonded Zone, Dalian Export Processing A Zone, Shipping Center, and Dalian Automotive Logistics Park. Major industrial clusters in the DFTZ include processing, trade, related logistics and storage.

By 2021, Dalian installed 13.29 million kilowatts of power capacity; non-fossil fuel power capacity takes 58.6 per cent, including 5.58 million kilowatts of nuclear power, 2.2 million kilowatts of renewable energy. The capacity of green hydrogen production in Dalian will reach 30,000 tonnes/year and more than 1,000 hydrogen fuel cell vehicles (including buses, passenger cars, heavy trucks, tractors, sanitation vehicles, etc.) will be operated in the city with GHG emissions estimated at 300,000 tonnes/year by 2025. Dalian strive to become China's hydrogen energy industry innovation source and equipment base by adapting key technologies, improving infrastructure, building an industry support platform, etc.

The city of Shenyang has abundant renewable energy including wind and biomass. By 2021, the city had installed 1.347 million kilowatts capacity, 1.251 million kilowatts of renewable energy including biomass. It is projected to build 2.3 million kilowatts more capacity from renewable power.

Shenyang is planning to promote green hydrogen production, mainly from renewable energy. The city will focus on the application and promotion of hydrogen fuel cell vehicles in different scenarios considering demand for the transformation of its automobile industry.

The proposed project intends to facilitate the realization of potential CO_2 emission reductions (aside from the reduction in emissions of other air pollutants) by removing identified barriers that until now has prevented China from achieving substantial GHG emission reductions that contribute to the country's climate change mitigation and adaptation targets. The project will address current problems facing the country's FCV industry by focusing 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 – establishment of a green hydrogen port, green hydrogen production facilities and hydrogen refueling facilities, and be a pioneer in decarbonizing heavy industry with green hydrogen.

The proposed project will also focus on removing several key barriers in local 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 using green hydrogen production and application technologies and techniques, as well as for green hydrogen production, green hydrogen refueling facilities and other infrastructure, such as a hydrogen port. The project will aim to build a carbon neutralization pilot in leading cities and regions, strive to build a green hydrogen economy and reduce energy consumption, GHG and pollutant emission, and build a comprehensive and systematic green hydrogen pilot demonstration and large-scale application in China.

With the existence of current barriers to the widespread production of green hydrogen and application of FCVs in the transport and heavy industry sector of China, the commercialization of this zero-emission type of technology will be much delayed, perhaps even beyond the anticipated 2035. Previous interventions that the government has done since the early 2000s through 2017 proved to be inadequate in spurring the development of the local AEV industry (which include FCVs), with weak participation of the private sector.

Green hydrogen applications in heavy industry still have no significant initiatives. Aside from the barriers, with the current AEV programme of the government tilting towards electric vehicles, the FCV commercialization process may be further slowed down. As a result, typical internal combustion engine vehicles (ICEVs) will remain dominant in the country's transport sector in the absence of this proposed GEF project. If the proposed GEF project will not happen, the Government of China's New Energy Vehicle Industry Development Plan (NEVIDP) will continue up to 2025, but will be limited to subsidies for vehicle purchase and will not encourage the R&D capabilities of the country's main automakers.[7] This is also the general view of local automotive industry observers. However, with the proposed project, which will bring about the removal of the current barriers to the widespread production and application of FCVs, the start of the commercialization phase of this type of AEV will be realized before 2030. The GEF's intervention through this proposed project will help spur interest among the local automotive manufacturers to carry out green AEV R&D activities on their own, or in collaboration with either or both local and foreign manufacturers, as well as promote green hydrogen production and application in various sectors, including heavy industry.

The current government funding in the ongoing 1^{4t}h Five Year Plan focuses on R&D to advance domestic fuel cell technology. This project can help further encourage manufacturers to seek such assistance from the government. Furthermore, the project will supplement and assist the government achieve its zero-emissions targets by 2060 and enable the realization of a scenario where AEVs, particularly FCVs, are not just funded by government subsidies or transport pollution control programmes, but also from private-owned FCVs and commercially operated FCV fleets.

By facilitating market transformation through traditional ICEs to AEVs (particularly FCVs), the potential significant energy saving and energy cost savings from the transport sector will be realized, including the co-benefit of reduced negative environmental quality impacts. Although there have been some policies issued and actions done to promote FCV production and applications in the country, these are rather limited and general actions are not sufficient to remove the identified barriers, create and sustain enabling environments, and facilitate or at least influence the 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 CO_2 emissions linked from the petroleum fuels that will be saved from the operation of ICEVs) would not be realized.

Relevant stakeholders, private sector and local actors and their roles in the system, and how they will be critical to deliver on the global environment benefits (GEB), and other proposed outcomes.

The roles of the relevant stakeholders, private sector and local actors are identified in below table.

Stakeholders	Role
Ministry of Finance (MOF)	As the focal point of the GEF, the MOF has the responsibility to monitor and evaluate the implementation of the project in China. In addition, as the policymaker, the MOF will review the incentive policies for the project and build capacity for the green hydrogen energy-integrated demonstration applications at scale.
Ministry of Industry and Information Technology (MIIT)	As the project executing agency for the project, the MIIT is responsible for overseeing project management, including coordination with partners, procurement, recruitment, administration and reporting. As the Chinese ministry responsible for industrial development, the MIIT will be closely involved in the project's relevant policy initiatives, including national initiatives, national- level policies, and industry standards. The MIIT will also act as the lead unit for the project activities and is committed to establishing an inter-agency coordination mechanism for the demonstration application of green hydrogen energy.
Ministry of Ecology and Environment (MEE)	As the government ministry in charge of planning and overseeing the implementation of ecological and environmental policies, the MEE will be involved in the development of policy standards and energy path selection and emission abatement, and will participate in capacity building.
Ministry of Science and Technology (MOST)	As the government ministry in charge of scientific research and technology development, the MOST will be involved in guiding the choice of technology development paths for green hydrogen energy production, storage and transportation, refueling and different applications.
National Development Reform Commission (NDRC)	As the government ministry in charge of overseeing planning, the NDRC will be involved in policy and technology planning during the implementation phase of the project and capacity building.
United Nations Industrial Development Organization (UNIDO)	As the GEF project implementing agency, UNIDO is responsible for the project design and preparation, and carries out supervision, oversight and evaluation functions. The related roles and responsibilities, including the national execution modalities will be reflected in the project implementation agreement with the MOF and an execution agreement to be concluded with the MIIT.

Stakeholders	Role
International Hydrogen Fuel Cell Association (IHFCA)	As the delegated executing entity entrusted by the MIIT to handle day-to-day operation of the project, the IHFCA, approved by the Chinese government, will be involved in ensuring coordination of national counterparts, and carrying out designated project activities. The PMO (project management office) shall be established within the IHFCA and will be responsible for project execution, including recruiting consultants and sub-contractors, keeping track of their progress, drafting technical and financial progress reports. The IHFCA team has experience in implementing GEF projects.
China Society of Automotive Engineers (CSAE)	The CSAE is a key knowledge partner for the China Green Hydrogen Demonstration Project. The CSAE will be involved in hydrogen and fuel cell vehicle policies, technical standards and guidelines development. The CSAE can also conduct trainings and awareness-raising pursuits.
Local Government Units (LGUs) in selected cities/provinces	Officials participating in the China Green Hydrogen Demonstration Project will participate in the training of local government officials during the implementation phase of the project. Part of their training will include designing plans and policies for their cities at a local level.
International Hydrogen Energy Center (IHEC)	UNIDO, in partnership with the Chinese government, launched the IHEC in 2021. It is a key knowledge partner for the UNIDO Global Programme for Green Hydrogen in Industry. The IHEC will be involved in technical activities, trainings and awareness-raising pursuits. It is envisioned to be one of the national co-executing agencies.
Entire vehicle companies, fuel cell manufacturers and hydrogen energy equipment manufacturers (private sector)	During project execution, manufacturing companies will be involved in the project's components, which includes capacity building for the industrial sector on standards and other topics related to hydrogen and fuel cells. As for the pilots, some manufacturing companies may provide equipment or services. The list of companies includes: Air Products and Chemicals, Gore of USA, Toyota and Iwatani of Japan, Hyundai Motor of South Korea, Faurecia of France, Linde and Mercedes-Benz of Germany.
Energy companies	During the project, energy companies will provide guarantees for the overall green hydrogen production and supply of the project, including generating electricity from renewable energy sources such as renewable energy, producing green hydrogen through electrolysis of water in electrolyzers, and distributing green hydrogen to various locations through suitable transportation methods. Hydrogen refueling station. For example, Sinopec, China's top energy company (which plans to deploy more than 1,000 hydrogen refueling stations in China) and CHN Energy, another top Chinese energy company.
Female (and youth) stakeholders	The project will carry out special outreach activities among women and youth groups to raise awareness of hydrogen energy and fuel cell vehicles among women and youth and enhance their awareness of environmentally friendly lifestyles and acceptance.
GEF Donor Countries	The project will promote international cooperation and enhance capacity building with countries developing green hydrogen energy in particular GEF donor countries including but not limited to, Austria, Italy, Germany and developed economies. The first three mentioned countries are also donor countries for UNIDO Global Green Hydrogen Programme. The officials/experts from Australia, Belgium, Canada, Denmark, France, Japan, Korea, Netherlands, New Zealand, Norway, UK, USA etc. are closely involving in IHEC's activities and will be cordially invited to participate in and contribute to the project's outcomes.

Stakeholders	Role
	Egypt, South Africa and transition economies. More than 10 countries have requested UNIDO and IHEC to provide guidance and support on its' green hydrogen programme. The countries will be cordially invited to participate in and contribute to the project's outcomes.

Relevant stakeholders, including the private sector and local actors, are critical to deliver on the global environment benefit and the overall outcome of the proposed GEF project due to their leading roles on the identified contribution areas to the proposed project in the country. The project development team will work to establish and strengthen linkages with them. During the project preparation grant (PPG) stage, numerous stakeholder consultations will be further organized to discuss related issues and concerns and prepare comprehensive structures for project implementation and management, including the log frame analysis. A detailed stakeholders involvement plan will also be designed to ensure complementarity and build on best practices and lessons learned by the stakeholders. During the implementation stage, the coordination mechanism will be further established to ensure proper coordination and involvement of the baseline project proponents.

Development of the result framework of the intervention

The inclusion of interventions focusing on the major support infrastructures for the FCV market, which are the facilities for green hydrogen production and hydrogen refueling, are among the innovations in this proposed project. This project will support innovative large-scale demonstration application of green hydrogen, and will lead breakthroughs in policies, standards and regulations; greatly increasing the proportion of green hydrogen energy in the energy structure and reducing carbon dioxide emissions. It will provide roadmap application scenarios of green hydrogen energy, and promote the supply side of the green hydrogen energy industry.

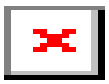
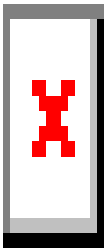
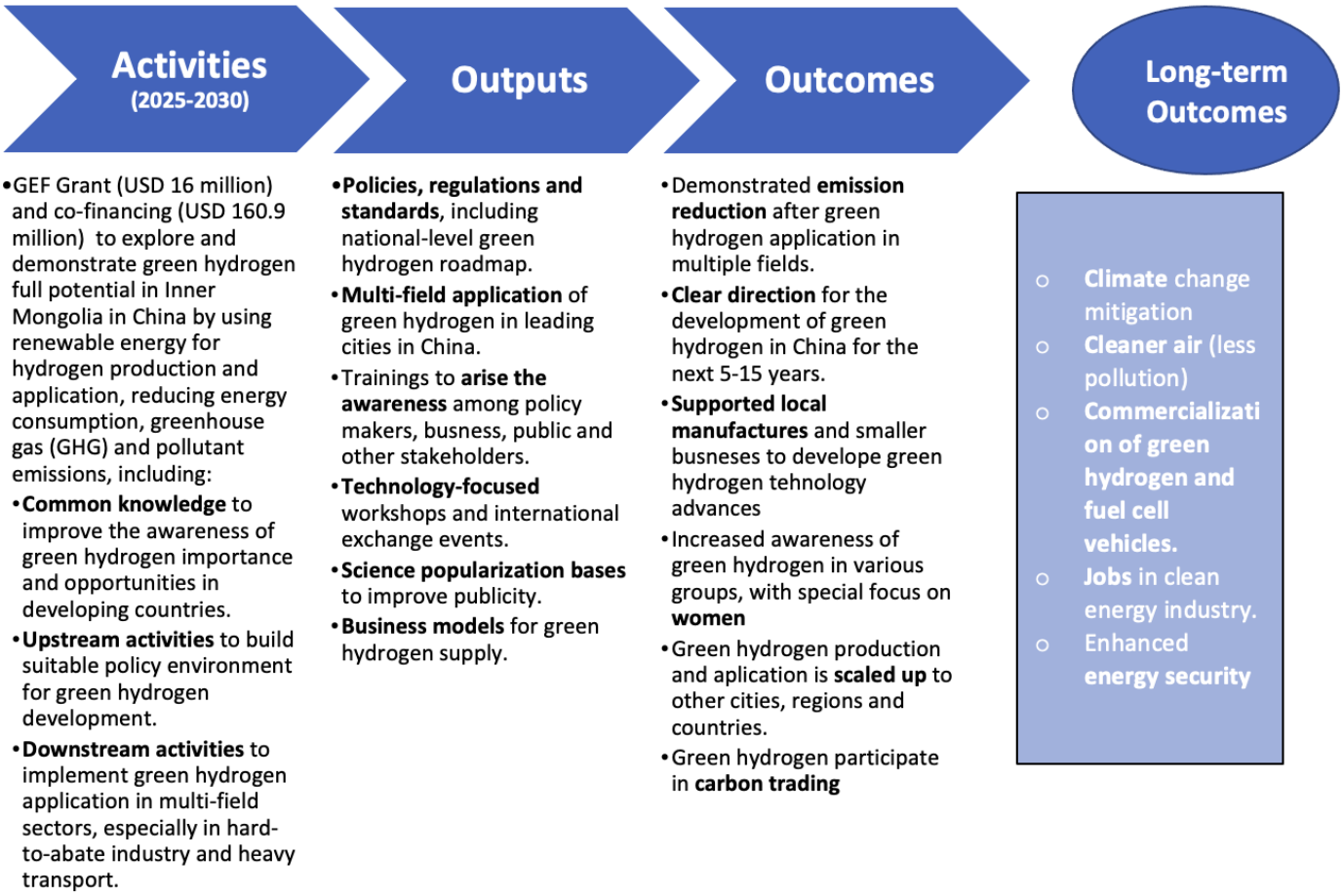


Figure 1. Result Framework of the Project's Interventions (Activities and Outputs)





How the project will fit within the current landscape of investments; how the project will build on the baseline and ongoing investments, both GEF and non-GEF, and on lessons learned from previous projects in the country and region, and more widely; and how this approach fits with country priorities. Provision of the incremental reasoning and GEF's role; Negotiation of the role of co-financing.

There have been initiatives carried out in the past in China aimed towards to commercialization of fuel cell technology in transportation; however, none in the proposed scale and multisectoral coverage. There are two related previous GEF-funded projects in China:

Demonstration for Fuel-Cell Bus Commercialization in China (Phase I- GEF ID 941 *and Phase II* GEF ID 2257*)*. This two-phased project specifically showcased the application of fuel cell bus technology in public bus transport systems in Beijing and Shanghai. Important lessons learned from this project, particularly on the logistical and administrative requirements of the implementation of the demonstrations, will be taken into account and put to good use in the design of the proposed project.

*Accelerating the Development and Commercialization of Fuel Cell Vehicles in China(*GEF ID 5728*)*. The project's objective is to facilitate commercialization of FCVs in China through a multi-pronged strategy that will enable China to promote its FCV durability/performance improvements and cost reductions far beyond what would be achieved in the baseline scenario, and to get more FCVs on the road by the end of the project than would occur in the baseline scenario.

While the GEF evaluation comments on these projects are by and large admissible during the time of the evaluation, several changes have happened in the past few years that would somehow indicate improvements from the conditions that were described in the evaluation conclusions. For example, current support in terms of financial incentives that the Government of China has provided since the 11th Five Year Plan and the current one has created a much better future for FCV (bus, car, industrial use and utility)

development in China. According to the current plan, by 2025, the sales of new energy vehicles (or alternative energy vehicles – AEVs) that include hybrid, electric and fuel cell vehicles in China is targeted to reach about 20 per cent of the total sales; the commercialization of FCVs is expected to be realized by 2035.

Since 2020, China started to adopt an overall subsidy method for FCV demonstration city clusters, with a total subsidy fund of cap 1.7 billion RMB ($257 million) for each city cluster. While the level of government support has increased, this is mainly focusing on the technical and financial aspects of FCV development. With limited support, it would be timely now to assist the government in facilitating the way towards commercialization of FCV and industrial decarbonization by developing large-scale demonstration projects and facilitating green hydrogen production for energy clusters.

There have been initiatives carried out in the past in China aimed towards to commercialization of fuel cell technology in transportation; however, none in the proposed scale and multisectoral coverage. The proposed project is expected to achieve a modest unit abatement cost (UAC) of about $0.94/ton CO2 (GEF US$ per ton GHG mitigated) by deploying 500 multi-function hydrogen fuel heavy trucks, 8 units of hydrogen refuelling stations, the large-scale application of green hydrogen in the chemical industry built, with the aim to achieve 10,000 tonnes of green hydrogen coupling, and a new power system up to 10MW with an integrated micro-grid of hydrogen energy storage,etc..

For the GEF's roles, GEF is expected in supporting the development and implementation of innovative technologies for green hydrogen in a more sustainable and environmentally friendly way. GEF can leverage funding and development, provide technical assistance to project stakeholders, and promote knowledge-sharing and capacity-building activities to help increase awareness and understanding of the potential environmental benefits of green hydrogen.

The sources of co-financing consist of the investment from the public and private sectors in the type of grant and in-kind such as the selected city-local government and the enterprises: Sinopec, CHN Energy, Meijin Energy, Baofeng Energy, and vehicle and infrastructure companies. At present, it is critical to receive GEF investment synergizing and mobilizing the investment at the up-taking phase of green hydrogen energy. Once the enabling market environment is built, it will enhance the confidence of investors for future projects on green hydrogen.

[1] https://www.scientificamerican.com/article/china-says-it-will-stop-releasing-co2-within-40-years
[2] https://www.iea.org/countries/china
[3] https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020
_ftnref4
[5] https://energyiceberg.com/hydrogen-14th-fyp-provincial-strategy
[6] http://www.gasprocessingnews.com/news/chinas-key-energy-production-base-turns-to-hydrogen-in-pursuit-of-green-development.aspx
[7] The existing support policies are limited to the transportation sector and there is little support for hydrogen energy supply and other sectors.

B. PROJECT DESCRIPTION

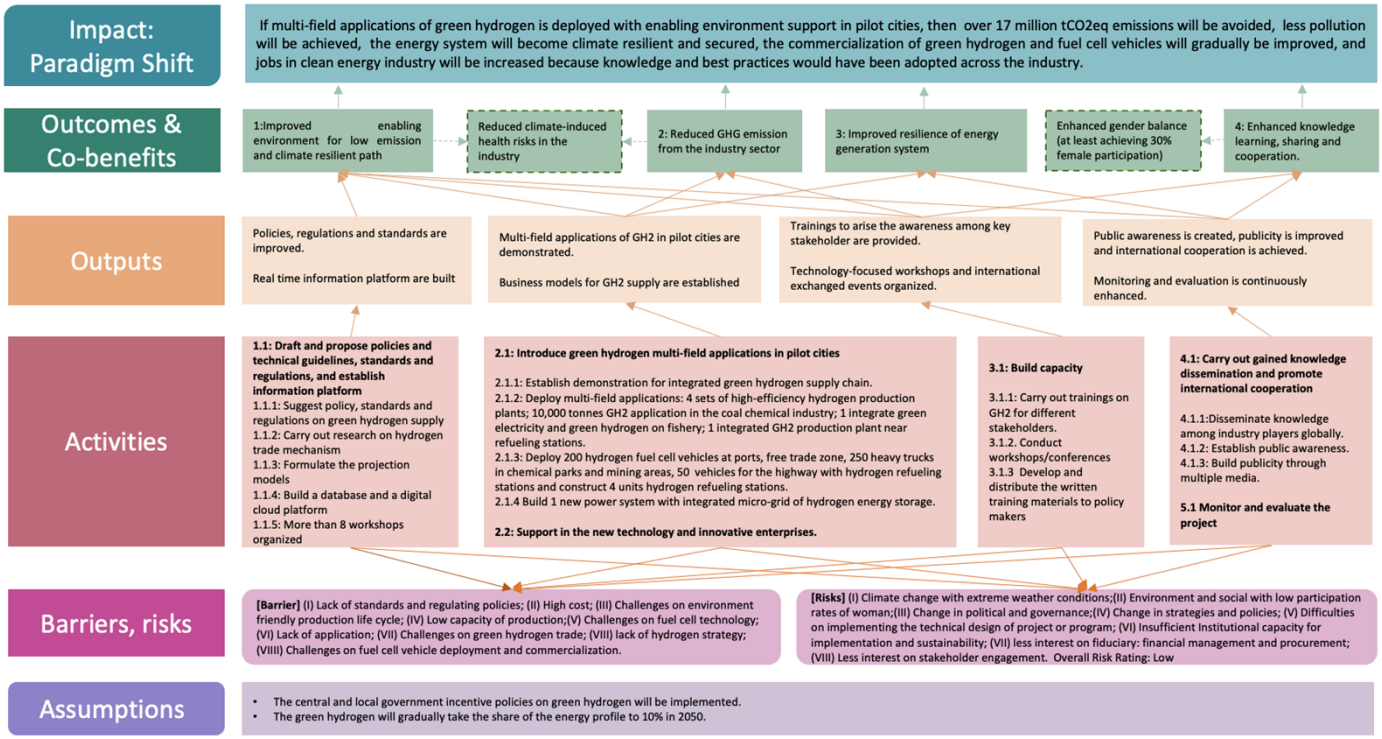
Project description

This section asks for a theory of change as part of a joined-up description of the project as a whole. The project description is expected to cover the key elements of good project design in an integrated way. It is also expected to meet the GEF's policy requirements on gender, stakeholders, private sector, and knowledge management and learning (see section D). This section should be a narrative that reads like a joined-up story and not independent elements that answer the guiding questions contained in the PIF guidance document. (Approximately 3-5 pages) see guidance here

A concise account of the theory of change that describes the project's logic for addressing the problems described and achieving the intended global environmental benefits. A diagram to help show the overall project's logic, outputs, and outcomes.

Figure below outlines the project's theory of change (ToC). The project solutions in the ToC are based on the root causes that lay under the unsustainable use of thermal energy and greenhouse gas pollution in the transport sector, industry and households in China, which leads to climate change hazards and poor air quality. The project outputs are structured to target these challenges, promoting renewable energy production, green technology advancement and application, as well as providing policy framework, standards and increase public awareness. Component five on monitoring and evaluation, gender mainstreaming and environmental and social impact assessment are considered cross-cutting and not shown in the ToC.

Figure 2.Project Theory of Change



The ToC shows that if the activities and outputs (project interventions) are conducted successfully, then the project will reduce GHG emissions, reduce air pollution resulting from a decarbonized transport and industry sector, and its energy system will become resilient because creating evidence through pilot technology demonstration, building capacity on green hydrogen technology solutions and business models, providing enabling policies, roadmaps and standards will accelerate the adoption of green hydrogen in China.

More detail the project components (interventions and activities) identified in the theory of change. Brief information on each intervention, the main thrust and basis (including scientific) of the proposed solutions, how they address the problem, their justification as a robust solution, the critical assumptions and risks to achieving them, and resilience to future changes in the drivers.

The alternative scenario that this proposed project will facilitate features a higher level of green hydrogen development and deployment in China by 2025-2030. While in the baseline scenario the forecast for FCV commercialization will happen around 2035 and industrial and other heavy sector decarbonization only by 2060, the proposed project will bring about an alternative scenario of FCV and green hydrogen commercialization by 2025-2030. Hence, the objective of the proposed project is the facilitation of green hydrogen production and FCV commercialization in China to decarbonize targeted sectors. To achieve this, identified barriers to the effective promotion and extensive application of green hydrogen and local manufacturing of FCVs that are at par with international standards must be removed, or at least significantly minimized.

China’s energy consumption has doubled since 2005, but the energy intensity of its domestic GDP has fallen sharply over the same period. However, it is not enough. China could be preparing to scale back domestic steel production to ensure it can reach carbon neutrality by 2060. It is important to decarbonize hard-to-abate industry sectors and to enhance hydrogen energy use to maintain China’s economic development trajectory. So far, China has done little to utilize green hydrogen in decarbonizing industrial sectors.

In 2021, China's auto production and sales volumes are both more than 26 million and it is forecast that car ownership in China will be more than 300 million. The transportation sector faces enormous pressure to reduce emissions; China’s CO_2 emissions of the fuel-oriented transportation industry account for about 1/4 of the global total, and the pollutant emission situation is equally grim. Taking automobiles as an example, the annual sales of heavy-duty transportation vehicles in China is less than 5 per cent of the total sales volume of all models, but the emissions of pollutants such as nitrogen oxides (NOx) and particulate matter (PM) account for 74 per cent and 52 per cent, respectively.[1] The transportation field, especially the heavy-duty field such as trucks and ships, bears the greatest pressure of energy conservation and emission reduction, so it is necessary to strengthen the promotion and application of clean hydrogen energy.

It is predicted that from 2000 to 2030 years, the number of large and medium-sized buses (7-18 meters) will increase at a rate of 5 per cent per year and reach 720,000 in 2030. If 30 per cent of buses (about 200,000) are FC buses in 2030, the annual transport CO_2 emissions can be significantly reduced. If the growth of the green hydrogen on hard-to-abate sectors is taken into consideration, the effect of reduction will be more pronounced, and the exhaust emissions of NOx and PM will also be significantly reduced. The successful implementation of the project will accelerate the industrial development and commercialization of FCVs in China, providing a new economic growth point for the community and businesses, and realizing substantial social and economic benefits. The commercialization of FCVs will also open opportunities for high-income generating jobs for men and women, both on the production floor and in the management and support areas. A project that will further facilitate FCV using green hydrogen development, green hydrogen production and decarbonization of the heavy industry in China is envisioned and is presented in this project proposal. The project aims to reduce greenhouse gas and pollutant emissions and explore a new holistic model of green hydrogen integrated development in heavy transportation and the hard-to-abate industry sector.

The proposed project ensures the resilience to future changes mainly by enhancing the climate technology and balance of its supply chains. The resilience-building needs coordinated effort with the public and private sectors. Green hydrogen is a conversion, not an extraction business, and has the potential to be produced competitively in many countries. China is one of them. As the costs of green hydrogen fall, new and diverse investors will enter the market, making hydrogen even more competitive comparing to oil or natural gas resources.

There are several key strategies that will be implemented to help promote the use of green hydrogen with the central and local governments’ action through the project implementation as foreseen:

Incentivize green hydrogen production: the governments will offer financial incentives for the production of green hydrogen. This could include subsidies, tax credits, or other incentives that make green hydrogen more cost-competitive with fossil fuels.

Develop infrastructure: the governments will invest in the development of green hydrogen infrastructure, such as refueling stations, pipelines, and storage facilities. This can help make it easier and more convenient for consumers to adopt green hydrogen technologies.

Mandate the use of green hydrogen: the governments will require that a certain percentage of fuel be derived from green hydrogen, similar to renewable energy development before in China. This could be done through a renewable fuel standard or similar regulation.

Promoting green hydrogen requires a multi-faceted approach and collaboration with industry stakeholders. By taking a comprehensive approach, it should be resilient and be possible to create an enabling market for green hydrogen that can withstand the challenges posed by cheap fossil fuels in China.

Up to now, China has issued a lot of incentive policies to promote the green hydrogen from central to the local government as addressed in the 5-year plan, which will be implemented and continuously supported in the country's future plans on the basis of the experience gained from other projects. The proposed project will work with the governments closely to continue above said strategies and actions.

The project will achieve its objectives through the implementation of five components and associated outputs outlined below.

Component 1: Policies, standards, regulations and information platform to promote the development of green hydrogen integrated supply chain and demonstration application

This section will address barriers related to insufficient policy and regulatory frameworks to support the promotion, application and commercialization of green hydrogen and fuel cells in China. It will also focus on effective implementation policies and regulatory frameworks that support the supply of green hydrogen and the application in heavy transportation, hard-to-abate industry, etc. Activities will include:

Outcome 1.1: Draft and propose policies, technical standards and guidelines to provide regulatory and planning guidance to city governments, hydrogen suppliers, fuel cell manufacturers and consumers to promote application of green hydrogen in multiple fields to reduce energy consumption, greenhouse gas and pollutant emissions; also establish information platform.

Key outputs and studies include the incentive policies for green hydrogen applications in the coal chemical industry and other hard-to-abate industries; the policies to support innovative technologies and enterprises of green hydrogen production, storage, transportation and application; incentive policies for hydrogen energy, fuel cell vehicles and related infrastructure, such as toll fee reduction on highways with hydrogen refueling stations; the relative standards and regulations; the effectiveness evaluation of the policy implementation; the hydrogen trade mechanism and business mode; the participation mechanism of green hydrogen in carbon trading system; the carbon emission reduction potential during its whole life cycle of green hydrogen; the projection models for the green hydrogen industry under different macro scenarios to predict the industry's future development; the hydrogen development and action plan of the demonstration cities; a database for the green hydrogen industry; the digital monitoring platform for data acquisition and analysis in order to monitor the operation of FCVs, hydrogen production and refueling stations.

Component 2: Multi-field application of green hydrogen

This section focuses on "market pull" activities to accelerate the verification of the emission reduction effect of green hydrogen in different fields through the application of green hydrogen production, heavy trucks, industry and other fields, and to enhance the application of FCV using green hydrogen production and application technologies and techniques, as well as that for the green hydrogen production, refueling facilities and other infrastructure.

Outcome 2.1: Green hydrogen technology in production, heavy transportation and hard-to-abate industry sector, estimating GHG emission reduction potential introduced. The key focus of the demonstration pilot cities is listed below:

Demonstration applications in Ningdong, Ningxia Hui Autonomous Region include a total of four sets of high-efficiency hydrogen production plants by water electrolysis will be built to demonstrate high-efficiency hydrogen production by water electrolysis technology; the construction and technology demonstration of four hydrogen refueling stations will be completed to demonstrate the green hydrogen refueling station technology; 250 hydrogen fuel cell heavy trucks in chemical industry parks, mining areas and other application scenarios will be deployed, and 80 of the 250 will be intelligent hydrogen fuel cell heavy trucks with multifunction; the project will promote the large-scale application of green hydrogen in the chemical industry, with the aim to achieve 10,000 tonnes of green hydrogen coupling, and 300,000 tonnes of carbon dioxide in emissions reduction; Other aspects include plans to finance the construction of a digital

monitoring platform and monitor the operation of vehicles and hydrogenation stations for data acquisition and analysis.

Demonstration applications in Dalian and Shenyang, Liaoning Province consist of integrate green electricity (renewable power project) and green hydrogen on fishery at the coastal tidal area in Pulandian District; an integrated green hydrogen production plant near hydrogen refueling stations will be constructed; 200 hydrogen fuel cell vehicles will be deployed in the Dalian Area of China (Liaoning) Pilot Free Trade Zone and Dayaowan Port, and 80 of the 200 will be intelligent hydrogen fuel cell vehicles including buses, sanitation vehicles and sweepers with multifunction; a new power system with an integrated micro-grid of hydrogen energy storage will be built; 50 hydrogen fuel cell vehicles will be deployed on the Shenyang-Dalian Hydrogen Highway, and 10 of the 50 will be intelligent hydrogen fuel cell vehicles with multifunction; Four units of hydrogen refueling station along the Shenyang-Dalian Hydrogen Highway will be built; Demonstrations of fuel cell vehicles in different scenarios are adopted in Shenyang.

Outcome 2.2: Support for green hydrogen production, storage, application and fuel cells application in the new technology and innovative enterprise.

Component 3: Strengthen institutional capacity building
Based on the policies, regulations and standards, demonstration technology and commercial model of the project, IHFCA/CSAE and IHEC will carry out trainings in the form of meetings and seminars (in person or virtual) to strengthen the capacity building of green hydrogen application in the heavy industry sector, FCV industry, relevant government departments and other stakeholders. The main purpose of this component is to enhance the awareness and management of hydrogen energy and fuel cells among policymakers at the national and local level. This component will address the need to enhance the technical capacity of the local transport vehicle manufacturing industry to enhance their knowledge and skills in the development of advanced and less costly green FCs and FCVs. With an enhanced capacity to develop and manufacture better, relatively lower cost but still quality FCs and FCVs that are at par with international standards, it is expected that the market demand for cost affordable FCVs will strengthen for both public and private transport uses. Part of the activities that will be carried out under this component will be in cooperation with the local transport vehicle manufacturers that are interested in venturing into the production and sales of FCVs, as well as the existing FCV producers. Some of them will be coordinated with responsible central government agencies for the implementation of The New Energy Vehicle Industry Development Plan (NEVIDP 2020-2035), as well as local financial institutions that may be interested in financing FCV manufacturing initiatives and FCV sales/dealership and FCV consumer-financing schemes.

Outcome 3.1: Raising the awareness and management skills of national and local policymakers, business personnel and other relevant stakeholders on green hydrogen potential and benefits.

Component 4: Carry out knowledge dissemination and promote international cooperation and information exchange
This section will focus on raising awareness of green hydrogen among businesses and consumers. In terms of enterprises, this part will implement some plans that can enhance corporate awareness and improve local fuel cell manufacturing technology, and at the same time conduct international conferences involving the participation of governments, industry organizations and enterprises from many countries. In terms of cognition, this part will focus on media promotion, including industry organization websites, online media, TV and online news, etc., and extend it to social media activities on the integration of hydrogen and renewable energy. The project will also build a green hydrogen science base in three demonstration cities to enhance the awareness of green hydrogen among enterprises and consumers. A Knowledge Management Plan and Communication Strategy/Plan for outreach, awareness raising and dissemination of outputs/results will be designed and implemented under the proposed project. The knowledge management, dissemination and communication actions will be linked to the exploitation of the project's activities and results. Efficient publicity and wide exposure of the project and its achievements will increase stakeholders' engagement with the initiative of the project on green hydrogen integrated applications and the use of the project results beyond the project's lifetime. The communication and dissemination activities will maximise project impact on prompting dialogues, cooperation, coordination and establishing connections on green hydrogen between China and worldwide players.

Outcome 4.1: Improve the awareness and capability of enterprises and other stakeholders in low-carbon technology development and use; enhance public awareness of environmental protection; promote international industry's knowledge exchange; enhance scientific case study; improve manufacturing quality and maintenance capabilities; and ensure at least 30% women's representation in the project and Project Steering Committee.

Component 5: Monitoring and evaluation
Achieve project objectives on time through effective monitoring and evaluation. Formal monitoring and evaluation (M&E) of the project will follow the principles, criteria and minimum requirements set out in the GEF Monitoring and Evaluation policy in its current version and the respective guidelines and procedures issued by the GEF Evaluation Office and/or the GEF Secretariat. At the same time, M&E will comply with the rules and regulations governing the M&E of UNIDO technical cooperation projects, in particular the UNIDO Evaluation Policy and the Guidelines for Technical Cooperation, both in their respective current versions. All monitoring and evaluation documents, such as progress reports, final evaluation reports and thematic evaluations (such as capacity needs assessment), as well as publications/reports on the project, will include attention to gender dimensions.

Outcome 5.1: Robust mechanism for M&E in place to ensure the attainment of project outcomes.

How the project will generate global environmental benefits and/or adaptation benefits which would not have accrued without the GEF project (additionality).

This proposed GEF project will facilitate the realization of the expected outcomes through barrier removal and other capacity development and technical assistance activities. The major direct CO_2 emission reductions that are attributable to the project will come from the FCV operation demonstrations and heavy industry decarbonization that will be carried out in the planned demonstration cities of Ningdong, Dalian and Shenyang in China. There are also expected CO_2 emission reductions from other FCV application replications and scale up. Potential CO_2 emission reductions can also be realized from the improved hydrogen production technologies that will be promoted under this project (e.g., ammonia-alkali process hydrogen to ammonia, water electrolysis using RE-generated electricity) as well as development of a hydrogen highway with green refueling stations. 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 and heavy industry decarbonized.

The lifetime direct CO_2 emission reductions that will be derived from the project will come at least from the FCV operation demonstrations that will be carried out. From the initially planned demonstrations in Ningdong, Dalian and Shenyang, CO_2 emission reductions will be about 17,000,000 t CO2 eq. This translates to a modest unit abatement cost (UAC) of about $0.94/ton CO2 (i.e., GEF US$ per ton CO_2). This 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 CO_2 emission reduction estimates.

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), currently the FCB is 1.5 times the price of EB in China, but their running cost differs. FCBs and EBs are comparable in running cost at travel distance of up 200 kilometers. If the travel distance is below 150 kilometers, 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 regard 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 km) than that of a FCC (@ 22 RMB/100 km). But at longer distances, the same conclusion can be drawn when comparing the running costs of an EB and an FCB. With the favorable enabling conditions and increased technical capacity and know-how that the proposed project will facilitate, the unit cost of the more environment-friendly FCC would

by 2030 (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 regard to buses, currently the cost effectiveness of the electric and fuel cell variety is almost the same. But 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).

The proposed project has the potential to contribute to the attainment several Sustainable Development Goals (SDGs) objectives, particularly SDG 11 (Sustainable Cities and Communities), SDG 3 (Good Health and Well-Being), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action) and SDG 17 (Partnerships for the Goals).

Without this proposed project, China would have limited success in promoting the widespread utilization of AEVs, especially FCVs in less developed regions. Such efforts will be at a relative low level, and in so doing, the potential contribution 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 will not be fully realized. GEF support for the incremental cost is needed to create the much-needed market pull and technology push to remove the barriers that will in turn facilitate the increased share of FCVs (and potentially other AEVs) in the local heavy transport vehicle market.

This GEF project will help realize China's expected global environmental benefits of reduced GHG emissions from the energy savings that will be derived from the widespread use FCVs and introduction of green hydrogen in heavy industry decarbonization.

To sum up, in the absence of the proposed GEF project:

- The areas rich in renewable energy will continue to have poor synergies in economic, social and environmental aspects, low utilization rate of hydrogen energy, high cost of hydrogen energy, slow technological innovation, and low efficiency of large-scale demonstration and application of green hydrogen energy.
- There will be a lack of ability to effectively promote and scale up demonstration of green hydrogen at the national and local levels; lack of coordination among different actors.
- There will be a lack of qualified, trained experts.
- Transfer of knowledge and technology will remain insufficient.
- There will be a lack of integrated approaches and policies to promote green hydrogen energy for use in transportation, heavy industry, homes, etc.
- Green development of eco-cities and infrastructure will not be realized.

With the help of proposed GEF project:

- International standards, national green hydrogen roadmap and policy support will be developed, and specific introductory trainings carried out.
- There will be accelerated comprehensive demonstration and application of green hydrogen energy in the leading cities with the integration of transportation, ports, high-speed service areas and heavy industry.
- A grant will be used to establish a structure, network and enabling environment for innovation that will be driven by investments for low-carbon transportation technologies.
- Co-financing will be secured through implementation of a business model that generates returns on the initial investment.
- The national suppliers will be brought on board by incentives such as reduced energy costs, upgraded systems, higher customer satisfaction and legislative policies to encourage reduced CO_2 emissions and mitigate air pollution.
- It will help promote the use of clean technology innovations related to the large-scale demonstration application of green hydrogen to reduce air and noise pollution related to urban transportation, thereby reducing greenhouse gas emissions.

How relevant stakeholders will contribute to developing and implementing the project, and their respective roles, and how they will benefit from the project to ensure that the global environmental benefits and/or adaptation benefits will be enduring (co-benefits).

The GEF Project Implementing Agency (PIA) is UNIDO. The Project Executing Agency (PEA) is MIIT and the Delegated Executing Entity (DEE) is IHFCA. UNIDO will play a close coordination and liaison role with the executing partner(s), and with the GEF Secretariat. The indicative structure of the proposed project will be confirmed by UNIDO, subject to the successful capacity assessments of the executing partners to be undertaken, as appropriate by UNIDO, during the PPG stage.

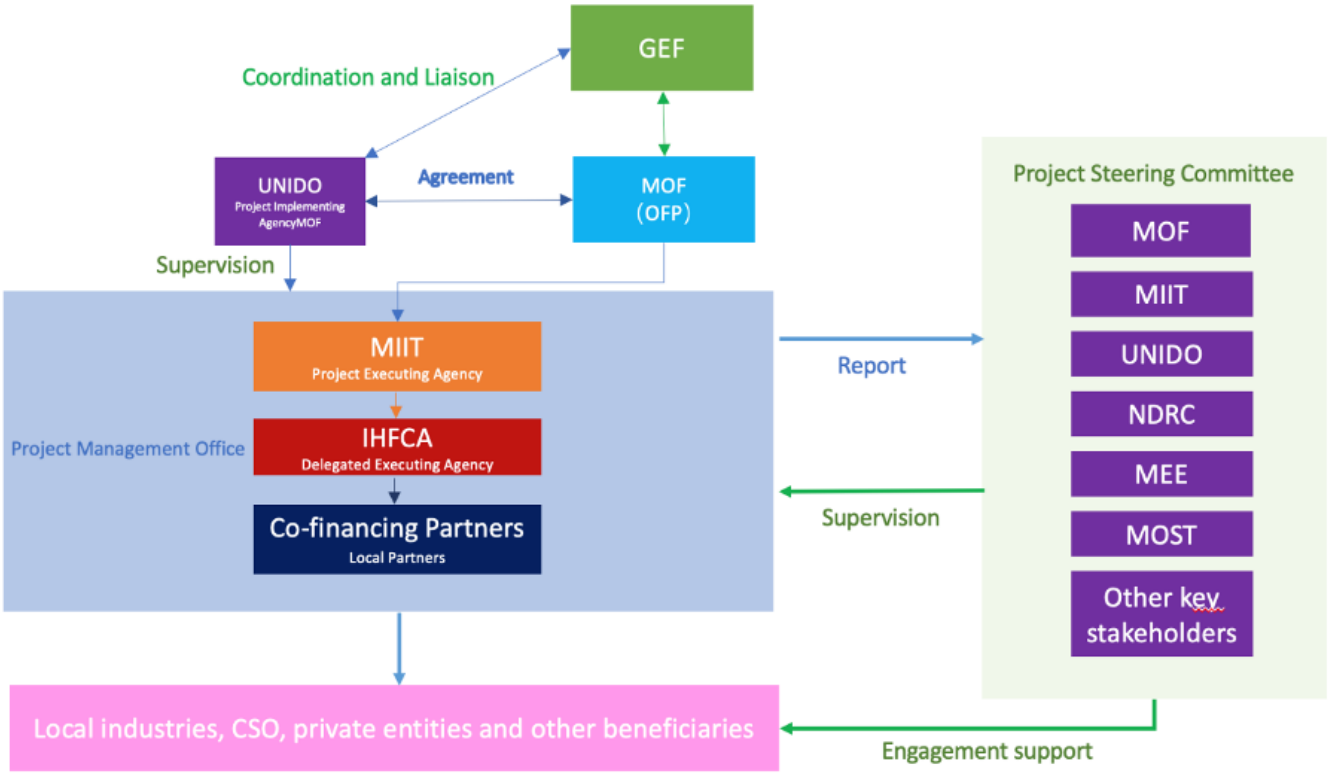
IHFCA is envisaged to act as the DEE for the project. Following the assessment and the approval of IHFCA as the DEE at the CEO level, collaboration between UNIDO and MIIT will be based on the Project Execution Agreement. The agreement defines the respective responsibilities of the DEE, including but not limited to activities, deliverables, financial, personnel, procurement and asset management components, as well as the reporting schedule and format.

The confirmed DEE will be requested to designate internally, or recruit directly, project management personnel to form a Project Management Office (PMO) to execute the activities of the national project. As the support unit, IHFCA will host the PMO that will be responsible for project execution, including recruiting consultants and sub-contractors, keeping track of their progress, drafting technical and financial progress reports. The PMO will be responsible for the day-to-day management of the project execution, monitoring and evaluation of project activities as in the agreed project work plan. The PMO will coordinate all project activities being carried out by project experts and partners. The DEE provides all related information to the evaluation experts for any mid-term review and final evaluations.

A Project Steering Committee (PSC) will act as an advisory mechanism to maximize synergies and ensure the successful design and implementation of the project. The main role of the PSC is to provide operational guidance as well as overall, high-level coordination and project validation forum during the implementation of the project. The PSC will meet regularly to track progress and provide opportunities for identifying potential synergies, as well as to increase uptake of lessons. UNIDO will act as a Chair to the PSC/Representatives from other members other than the Delegated Executing Entity (DEE) is envisaged to Chair the PSC by rotation, other members include the Ministry of Finance (MOF)， the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), National Energy Administration(NEA), etc.

The private sector will be engaged in adopting new technologies and best practices as they relate to green hydrogen large-scale demonstration application. Through its interventions, the project will improve the environmental performance and competitiveness of the firms, thereby contributing to urban sustainability within the pilot cities. Additionally, commitments will be sought for setting targets for GHG mitigation and investment in GHG mitigation efforts. The summary of the project implementation is shown in Figure 3.

Figure 3 Project Implementation Chart



The project development team will establish and strengthen linkages with other agencies and actors that are currently planning or implementing relevant projects, which will contribute to and benefit from the overall outcomes of the proposed GEF project. Partners currently active in this area include local private entrepreneurs, academia, etc. The project development team will identify the most relevant partners during the project preparation phase. During the PPG stage, numerous stakeholder consultations will be organized to discuss related issues and concerns and prepare comprehensive structures for project implementation and management, including the log frame analysis. A detailed stakeholders involvement plan will also be designed to ensure complementarity and build on best practices and lessons learned by the stakeholders. During the implementation stage, the coordination mechanism will be further established to ensure proper coordination and involvement of the baseline project proponents. Efforts will be made to establish synergies with on-going projects in China while, at the same time, avoiding duplication of efforts. The proposed project will benefit from existing support structures already built in from other projects.

How the project will generate knowledge, how that knowledge will be managed and exchanged, and how lessons learned will be captured to benefit future projects.

Knowledge management is inherent to UNIDO's operating modality by sharing experiences across its interventions worldwide. This has been demonstrated through many high-quality publications, organization of events, webinars and more. The establishment of and/or support to regional expert centers is one of the key elements to secure technology transfer, strengthen regional and global exchange and for locally building human capital and institutions. Examples are UNIDO's support for National Cleaner Production Centers, International Center on Small Hydro Power (China), various Centers for Renewable Energy and Energy Efficiency in African regions (ECREEE, EACREEE, SACREEE) and the Caribbean (CCREEE), collaborating in the hosting of the Climate Technology Center and Network (CTCN), and others. In the proposed project, a national knowledge platform is envisaged to be set up with the objective to define a solid exit strategy, facilitate the flow of information and knowledge to international and national stakeholders and beneficiaries, as well as to recollect experiences from the China during and after the project.

A Knowledge Management Plan and Communication Strategy/Plan for outreach, awareness raising and dissemination of outputs/results will be designed and implemented under the proposed project, which will

function as the basis for gathering and distributing all data, information and lessons learned generated during the implementation of the project, promoting the information and education to the interested communities, making the outcomes developed through the project available to the different target audience, receiving inputs and feedbacks from the various target group, enhancing results exploitation potential and ensuring the outputs sustained after the end of the project lifetime. The final aim is to create a community of knowledge around green hydrogen and emerging energy technology as well as best practices in servicing. As a first step, the plan will foresee a local, regional and international stock-taking of available and relevant information, paying particular attention to the networks of the stakeholders involved. The plan will also include the development of a knowledge management system and a website and associated platform with information accessible by the public as well as direct stakeholders. The knowledge management, dissemination and communication actions will be linked to the exploitation of the project's activities and results. Efficient publicity and wide exposure of the project and its achievements will increase stakeholders' engagement with the initiative of the project on green hydrogen integrated applications and the use of the project results beyond the project's result. The communication and dissemination activities will maximise project impact on prompting dialogues, cooperation, coordination and establishing connections on green hydrogen between China and worldwide players.

How this project will improve or develop national policies, including an improved alignment of existing policies (policy coherence).

Despite progress made so far with a hydrogen technology development, supply and implementation, there are still several barriers to the widespread application of green hydrogen in the China's heavy industry and transport sector, and in particular focus on competitive green hydrogen production and the commercialization of FCV using green hydrogen. Removing such barriers will facilitate or at least create the enabling environment for green hydrogen application and widespread use in China, and ultimately contribute to the application of FCV using green hydrogen transport systems globally. There are several ways how this GEF project will help China in policy on green hydrogen:

- China is the world's largest developing country and a relatively large carbon emitter. The 2060 carbon neutrality target set by China is of a great significance to the global achievement of the Paris Agreement targets and mitigation of global warming, but it is also very challenging. This GEF demonstration projects can help China acquire advanced expertise in climate governance and hydrogen energy industrial development in developed countries, and vigorously enhance the economic, social and environmental synergies among developing countries which are rich in renewable energy. It will also maximize the use of public and private capital and promote the innovation of hydrogen energy technology that will improve the efficiency of hydrogen energy utilization, greatly reduce the cost of green hydrogen energy, increase the gender balance in the sector, and help China to achieve the goal of carbon neutrality at an earlier date.
- The formulation and development of China's hydrogen energy policy is still mainly in the field of transportation, lacking the support on green hydrogen production/ application and use in other sectors. The proposed GEF project can promote the application and production of green hydrogen energy, carbon emission reduction, deployment of green hydrogen energy in various fields in China.
- In some industry sectors that are difficult to reduce carbon emissions, the progress on carbon reduction might be too slow to achieve the targets set by the Chinese government. Green hydrogen is seen as an essential tool to achieve carbon reduction in those fields. At present, green hydrogen production, storage and transportation are expensive. The GEF project can greatly support the large-scale production, storage and transportation of green hydrogen, reduce the cost of hydrogen supply, and facilitate the low-carbon development in hard-to-abate sectors.
- Small companies are the main source of employment and income generation in many developing countries, including China. This GEF project can effectively leverage external funds, encourage more small companies to participate in the development of the green hydrogen energy industry, and create more jobs and environmental benefits.
- China's technology in hydrogen energy and fuel cells is still relatively lagging, resulting in higher equipment costs. The GEF project can help China promote technological innovation, technology

transfer and achieve sustainable energy breakthroughs in green hydrogen energy production, storage and transportation and fuel cell technology.

If the project is specifically intended to be transformative, or innovative, how scaling up could be achieved.

The project has the potential for scaling up and induce changes beyond a one-off investment. The project will focus on the Chinese cities of Ningdong, Dalian and Shenyang to develop green hydrogen technologies throughout its entire supply chain. Ningdong, Dalian and Shenyang will serve as the demonstrations for the development and application of the interventions intended for the removal of barriers to FCV commercialization and industry application that will be carried out under the project. Several of the project interventions can be replicated in the other 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, long-distance transportation, heavy industry, 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 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.

Gender Equality and Women's Empowerment:
UNIDO recognizes that gender equality and the empowerment of women have a significant positive impact on sustained economic growth and inclusive industrial development, which are key drivers of poverty alleviation and social progress. Commitment of UNIDO towards gender equality and women's empowerment is demonstrated in its policy on Gender Equality and the Empowerment of Women (2019), and the UNIDO Strategy for Gender Equality and the Empowerment of women (2020-2023).

A guiding principle of this project is to ensure that both women and men can equally lead, participate in and benefit from the project (UNIDO Gender Policy 2019). Particularly, in the advanced accelerator and post-accelerator, gender-responsive activities will be streamlined to ensure the achievement of this goal. Special efforts will be made to promote equal participation of women and men, both at managerial and technical levels, as consultants, participants, entrepreneurs, mentors, etc. at all stages of project implementation.

UNIDO recognizes that interventions related to energy and the environment are expected to have an impact on people and are, therefore, not gender-neutral. This is also true for projects related to sustainable cities. In fact, due to diverging needs and rights regarding energy consumption and production, different exposure and thresholds relevant for women and men of different age, each individual is expected to be affected differently by the project (in terms of their rights, needs, roles, opportunities, etc.).

As a guiding principle, the project will ensure that both women and men are provided equal opportunities to access participate in and benefit from the project, without compromising the technical quality of the project results. In practical terms:

- A Gender Analysis Report and draft Gender Mainstreaming Action Plan will be developed during the PPG phase, which will also influence the ultimate project design. In the project design, UNIDO will ensure that the gender dimensions are considered, and that the project log-frame reflects key gender dimensions in the respective outputs, activities, indicators and targets.
- Efforts will be taken to ensure that both women and men have equal opportunities to participate in and benefit from all project activities, both at managerial and technical levels. This includes for instance applying a gender-lens investing approach and enhancing awareness on gender dimensions to reduce gender bias.
- Based on the Gender-responsive Terms of References, gender-sensitive recruitment will be practiced at all levels where possible, especially in selection of project staff, researchers and experts, as well as technical staff. In cases where the project does not have direct influence, gender-sensitive recruitment will be encouraged.

- Whenever possible, existing staff will be trained and their awareness raised regarding gender issues.
- When data-collection or assessments are conducted as part of project implementation, gender dimensions will be considered. This can include sex-disaggregated data collection, performing gender analysis as part of ESIAs, etc.
- All decision-making processes will consider gender dimensions. At project management level, efforts will be made for Project Steering Committee meetings to be gender balanced, and to invite observers that represent gender dimensions, including organizations/associations promoting gender equality and advocating women's empowerment. Also, at the level of project activity implementation, efforts will be made to consult with stakeholders focusing on gender equality and women's empowerment issues. This is especially relevant in policy review and formulation.
- Research, data and assessments will consider gender and age differentiated needs of women and men from different social groups.

During the PPG phase, gender-relevant aspects will be paid particular attention to in order to assure that the final project design fully accounts for its implications on men and women. That is, the gender relevance of the proposed project will be further assessed and the gender context of the proposed project analysed. This shall include the identification of the differentiated needs and roles of women and men with respect to the energy interventions of the project. For these purposes, women's groups, associations or stakeholders concerned with gender and energy will be consulted and a portion of the PPG funds allocated to specialized expertise to verify that the final project log frame is gender mainstreamed.

Furthermore, basic relevant data and qualitative information will be collected during the PPG stage to analyse and track gender issues. This will be refined and finalized in the beginning of the implementation phase, and the results will then be used to create relevant tools and methodologies to continue the analysis and tracking during implementation phase. In addition, gender markers will be assigned at the output level and special consideration will be given to the analysis of gender issues related to sustainable energy initiatives, as well as to outputs that are linked to awareness raising activities. To ensure that the results framework includes gender-responsive indicators, the baseline and targets to monitor gender equality will be defined during PPG stage. This will be initiated as minimum requirement to ensure the correct and targeted preparation and planning for effective monitoring during the implementation phase. Part of the budget will also be allocated, as required, during the implementation of the project to identify and address gender issues; this will include collecting additional baseline data.

[1] In 2012, the estimated annual total transport vehicle nitrogen oxides (NOx) were around 6.4 million tonnes (about 25 per cent of overall NOx emissions in the country), while particulate matter (PM) emissions were about 621,000 tonnes.

Coordination and Cooperation with Ongoing Initiatives and Project.

Does the GEF Agency expect to play an execution role on this project?

No

If so, please describe that role here. Also, please add a short explanation to describe cooperation with ongoing initiatives and projects, including potential for co-location and/or sharing of expertise/staffing

The proposed project will benefit from existing support structures already built in the following two projects:

Demonstration for Fuel-Cell Bus Commercialization in China (Phase I- GEF ID 941 and Phase II GEF ID 2257*)*. This two-phased project specifically showcased the application of fuel cell bus technology in public bus transport systems in Beijing and Shanghai. Important lessons learned from this project, particularly on the logistical and administrative requirements of the implementation of the demonstrations, will be taken into account and put to good use in the design of the proposed project.

Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (GEF ID 5728). The project's objective is to facilitate commercialization of FCVs in China through a multi-pronged strategy that will enable China to promote its FCV durability/performance improvements and cost reductions far beyond what would be achieved in the baseline scenario, and to get more FCVs on the road by the end of the project than would occur in the baseline scenario.

The project will create synergies with pre-existing interventions (i.e., projects, Programmes for Country Partnership and/or Country Programmes) in particular in terms of the facilitation of partnerships, networks, knowledge building and raising awareness.

Main examples of synergies with projects include:

- GEF-World Bank project "Green Hydrogen Support in Developing Countries" (GEF ID 10918)
- UNIDO Global Programme for Green Hydrogen in Industry
- GEF-UNIDO project "Integrated Adoption of New Energy Vehicles in China" (GEF ID 9226)
- GEF-World Bank projects "China Distributed Renewable Energy Scale-up" Project (GEF ID 9749), "Achieving Efficient and Green Freight Transport Development" (GEF ID 9682), "China Sustainable Cities Integrated Approach Pilot" (GEF ID 9223)

UNIDO Projects "Supporting establishment of IHEC", “Supporting the UNIDO Centre for South-South Industrial Cooperation (UCSSIC) in China (3rd Phase)”, “Development of a Knowledge Product and a Series of Expert Group Meetings (EGMs) on Best Practices and Pathways for Decarbonization of Industry and Utilization of Hydrogen Technology in Cooperation with KEA and KEEI”, and “Preparatory Phase for the Clean Energy Centre of the Economic Cooperation Organization”.

[1] https://www.thegef.org/projects-operations/projects/10918
[2] https://www.unido.org/green-hydrogen
[3] https://www.unido.org/our-focus/safeguarding-environment/clean-energy-access-productive-use/climate-policies-and-networks/global-cleantech-innovation-programme

Core Indicators

Indicator 6 Greenhouse Gas Emissions Mitigated

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO_2e (direct)	17000000	0	0	0
Expected metric tons of CO_2e (indirect)	130000000	0	0	0

Indicator 6.1 Carbon Sequestered or Emissions Avoided in the AFOLU (Agriculture, Forestry and Other Land Use) sector

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO_2e (direct)				
Expected metric tons of CO_2e (indirect)				
Anticipated start year of accounting	2023			
Duration of accounting	5			

Indicator 6.2 Emissions Avoided Outside AFOLU (Agriculture, Forestry and Other Land Use) Sector

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO_2e (direct)	17,000,000			
Expected metric tons of CO_2e (indirect)	130,000,000			
Anticipated start year of accounting	2023			
Duration of accounting	5			

Indicator 6.3 Energy Saved (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)

Total Target Benefit	Energy (MJ) (At PIF)	Energy (MJ) (At CEO Endorsement)	Energy (MJ) (Achieved at MTR)	Energy (MJ) (Achieved at TE)
Target Energy Saved (MJ)				

Indicator 6.4 Increase in Installed Renewable Energy Capacity per Technology (Use this sub-indicator in addition to the sub-indicator 6.2 if applicable)

Technology	Capacity (MW) (Expected at PIF)	Capacity (MW) (Expected at CEO Endorsement)	Capacity (MW) (Achieved at MTR)	Capacity (MW) (Achieved at TE)

Indicator 11 People benefiting from GEF-financed investments

	Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)
Female	25,000			
Male	25,000			
Total	**50,000**	**0**	0	**0**

Explain the methodological approach and underlying logic to justify target levels for Core and Sub-Indicators (max. 250 words, approximately 1/2 page)

The project will mainly contribute to the following indicators:

- Greenhouse gas emissions directly mitigated (metric tonnes of CO2e): 17,000,000t CO2 eq

Indirectly reduce

- Greenhouse gas emissions indirectly mitigated(metric tonnes of CO2e): 130,000,000 tCO2 eq.
- About 50,000 direct female and male (about equal share) beneficiaries

In 2021, China's GHG emissions is 11.9 billion tonnes. Among them, 6.5 billion tonnes is from the industry and transportation sectors. In 2020, China produced about 33 million tonnes of hydrogen, of which green hydrogen accounts for 1%. According to the Medium- and Long-Term Plan for the Development of Hydrogen Energy Industry (2021-2035), China will increase the application of hydrogen energy and green hydrogen in transport and industry. It is assumed that with the synergy of the project, the share of green hydrogen in industry and transport can reach 2%.

The proposed project focuses on reducing the GHG emission from the industry and transportation sector. The estimated direct GHG reduction is 17 million tCO2 during the project duration (5-year project). The estimated life GHG emission reduction is 51million tCO2 (estimated lifetime of the FCV, refueling stations and other industrial infrastructure are 15-year). The estimated indirect GHG reduction is 130 million tCO2 (2% GHG emission from the industry and transportation sector with the synergies of the project). The modest unit abatement cost (UAC) is about $0.94/ton CO2 (GEF US$ per ton CO2).

The number of people benefiting from GEF-financed investments is estimated by the total budge of the project divided by about US$ 3000 per person.

The figures 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.

Risks to Project Preparation and Implementation

Summarize risks that might affect the project preparation and implementation phases and what are the mitigation strategies the project preparation process will undertake to address these (e.g. what alternatives may be considered during project preparation-such as in terms of consultations, role and choice of counterparts, delivery mechanisms, locations in country, flexible design elements, etc.). Identify any of the risks listed below that would call in question the viability of the project during its implementation. Please describe any possible mitigation measures needed. (The risks associated with project design and Theory of Change should be described in the "Project description" section above). The risk rating should reflect the overall risk to project outcomes considering the country setting and ambition of the project. The rating scale is: High, Substantial, Moderate, Low.

Risk Categories	Rating	Comments
Climate	Low	Climatic change, including coastal storms, flooding, heat waves and other extreme weather conditions will influence the sustainability of the pilot demonstrations. Further analysis and management plan will be conducted during PPG phase.
Environment and Social	Moderate	The project deploys new green hydrogen integrated application in chemical and transportation industry posing the potential threat to a third party with hydrogen leakage. During the PPG-phase, an environmental and social management plan will be prepared to screen and avoid/minimize related risks, in particular when selecting locations for the pilot projects. Low participation rates of women in respective activities. Active promotion of gender equality. The project takes specific measures to ensure that women can actively participate in various activities and play a positive role. These measures include ensuring that women make up at least 35 per cent of participants and participants in various capacity building events and workshops. In addition, in the design popularization activities, add content that women's groups and youth groups are

		interested in to ensure the participation of women and youth.
Political and Governance	Low	Change in government priorities and capacities of government entities due to a possible re-instatement of COVID-19. COVID-19-related delays in project implementation will be mitigated by continuous monitoring of a potential outbreak in selected countries and aligning project timelines and resources accordingly. Operational teams and government counterparts are now used to work remotely and adequately equipped for that.
Macro-economic	Low	The Chinese economy has expanded rapidly over the past three decades, with annual growth averaging around 10 per cent per annum. Economic growth in China is projected to slow to 4.3 percent in 2022 before rebounding to 5.2 percent in 2023 largely reflecting the economic damage caused by the COVID-19 and recovery.
Strategies and Policies	Low	With the reduction of subsidies, fuel cell vehicle market in China will stagnate in the future, unable to achieve large-scale green hydrogen application in the country. The new ecological mode of integrated development of green hydrogen in China's energy, transportation and industry promoted by the project, as well as the key technologies of storage, transportation and application of green hydrogen production, will help to reduce the impact of the subsidy reduction. In addition, China's policy monitors FCVs and will adjust and dilute incentive policies according to market changes to ensure the stable and sustainable development of FCVs.

Technical design of project or program	Low	It is difficult to make breakthroughs in fuel cell technology on meeting requirements of heavy haul transportation and green hydrogen technology to meet the requirements of scale-up applications. The project will provide more financial support to the key technology of storage and transportation of green hydrogen production and fuel cell technology development on meeting requirements of heavy haul transportation, set technical assessment indicators, encourage the breakthrough of bottle-neck technology, and ensure that the technology reaches the target value set by the task.
Institutional capacity for implementation and sustainability	Low	Insufficient institutional capacity for implementation and sustainability of the project. The project includes capacity building as one of the key outputs ensuring all the key stakeholders involves in the activities and keeps continuous improvement.
Fiduciary: Financial Management and Procurement	Low	Private companies may be less interested in investing in green hydrogen. The project management includes information dissemination and promotion, to ensure that users are better informed about the related technologies and benefits of green hydrogen, and to encourage the active participation of the private sector.
Stakeholder Engagement	Low	The project will secure the participation of public and private stakeholders by maintaining constant communications with relevant governmental institutions, private developers and/or members of the civil society through remote means of communication and when possible, executing face-to-face

		stakeholder engagements through workshops, event, webinars, etc.
Other		
Financial Risks for NGI projects		
Overall Risk Rating	Moderate	

C. ALIGNMENT WITH GEF-8 PROGRAMMING STRATEGIES AND COUNTRY/REGIONAL PRIORITIES

Describe how the proposed interventions are aligned with GEF- 8 programming strategies and country and regional priorities, including how these country strategies and plans relate to the multilateral environmental agreements.

Confirm if any country policies that might contradict with intended outcomes of the project have been identified, and how the project will address this.

For projects aiming to generate biodiversity benefits (regardless of what the source of the resources is - i.e., BD, CC or LD), please identify which of the 23 targets of the Kunming-Montreal Global Biodiversity Framework the project contributes to and explain how. (max. 500 words, approximately 1 page)

The project is aligned with GEF-8 programming strategies[1] and will be categorized under the GEF focal area Climate Change Mitigation (CCM) since it supports the Chinese government in moving towards decarbonization of its industries and transportation systems. Furthermore, it puts forward a combined approach of market transformation and market barrier removal, and the promotion of innovative low-carbon as well as low-energy technologies.

The project and proposed interventions are aligned with China's national strategies and plans under the UNFCCC. The project directly contributes to China's goals on combating climate change, reaching a carbon peak by 2030 and achieving carbon neutrality by 2060. It is focusing its sights on the expected green hydrogen boom as part of its plans to meet decarbonization pledges.

The project is highly consistent with relative policies and regulations in China as well as national priorities. Through large-scale demonstration of green hydrogen energy, it will combine the priorities of integrated energy, transport and industrial development, which will introduce a new approach and model for China to achieve energy conservation and emission reduction targets and commitments at a level beyond what is possible. As for China's national priorities, advanced energy (including fuel cell technologies and renewable energy technologies such as hydrogen, wind power), new energy vehicles (including fuel cell vehicles), environmental protection and comprehensive utilization of resources are all priority areas identified by the Chinese government. Green hydrogen large-scale application has great potential – it can replace internal-combustion vehicles, petroleum used by ships, or replace current electric vehicles using fossil fuel-based power grid in China. It can also make China restrict the growth of greenhouse gas emissions, and eventually reduce the national traffic department's greenhouse gas emissions.

China gives priority to the development of new energy vehicles, including FCVs. The research of FCVs in China began during "the Tenth Five Year Plan" period. In 2010, the National "863 plan" began to support the development of FCVs. In 2012, the Ministry of Science and Technology issued the Special Project of "12th Five Year Plan" for Development of Electric Vehicle Technology, which determined "the Three Vertical and Three Horizontal" research and development layout, and FCVs became one of the key support fields. In September 2020, the Ministry of Finance and other five departments jointly issued the Notice on Developing the Demonstration Application of Fuel Cell Vehicles, which adjusted the original purchase subsidies to some selected qualified urban agglomerations, carried out the industrialization research and demonstration application of core technologies, and provided subsidies. In November 2020, the State Council issued the New Energy Vehicle Industry Development Plan (2021–2035), which defined the development goals and key tasks of hydrogen FCVs, and promoted the high-quality development of the hydrogen FCV industry. China attaches great importance to climate change mitigation, which is a significant benefit of large-scale demonstration and application of green hydrogen energy, and also a driving force for the implementation of the project plan.

[1] https://www.thegef.org/sites/default/files/documents/2022-01/GEF_R.08_17_GEF-8_Programming_Directions.pdf

D. POLICY REQUIREMENTS

Gender Equality and Women's Empowerment:

We confirm that gender dimensions relevant to the project have been addressed as per GEF Policy and are clearly articulated in the Project Description (Section B).

Yes

Stakeholder Engagement

We confirm that key stakeholders were consulted during PIF development as required per GEF policy, their relevant roles to project outcomes and plan to develop a Stakeholder Engagement Plan before CEO endorsement has been clearly articulated in the Project Description (Section B).

Yes

Were the following stakeholders consulted during project identification phase:

Indigenous Peoples and Local Communities:

Civil Society Organizations: Yes

Private Sector: Yes

Provide a brief summary and list of names and dates of consultations

Stakeholders	Brief Summary	Name and Dates of Consultations
Ministry of Finance (MOF)	Project theme and main context of the project design	Mr. PENG Xiang (GEF China OFP) Director February 2022–present
Ministry of Industry and Information Technology (MIIT)	The demonstration city and main context of the project	Ms. CHEN Chunmei Director February 2022–present
Ministry of Science and Technology (MOST)	Project design and main context	Expert group February–August 2022
International Hydrogen Fuel Cell Association (IHFCA) and China Society of Automotive Engineers (CSAE)	Project design and demonstration locations, financial proposals	Ms. WANG Ju Secretary-General 2021-present

Local Government Units (LGUs) in selected cities/provinces	Communicated and confirmed the demonstration content and supporting funds	Local governments August 2022
International Hydrogen Energy Centre (IHEC)	Communicated and confirmed the local government demonstration content	Ms. WANG Yanyan Director, Operation Management August 2022
Entire vehicle companies, fuel cell manufacturers and hydrogen energy equipment manufacturers	Project content and supporting funds	Local leading enterprises
Energy companies	Communicated and confirmed the project content and supporting funds	Local leading enterprises

In the above table, the consulted Civil Society Organizations during the project identification phase were China Society of Automotive Engineers(CSAE) and International Hydrogen Energy Centre(IHEC).

The core principles of GEF Stakeholder Engagement will be followed to make further efforts to develop a Stakeholder Engagement Plan prior to CEO endorsement.

(Please upload to the portal documents tab any stakeholder engagement plan or assessments that have been done during the PIF development phase.)

Private Sector

Will there be private sector engagement in the project?

Yes

And if so, has its role been described and justified in the section B project description?

Yes

Environmental and Social Safeguard (ESS) Risks

We confirm that we have provided indicative information regarding Environmental and Social risks associated with the proposed project or program and any measures to address such risks and impacts (this information should be presented in Annex D).

Yes

Overall Project/Program Risk Classification

PIF	CEO Endorsement/Approval	MTR	TE
Medium/Moderate			

E. OTHER REQUIREMENTS

Knowledge management

We confirm that an approach to Knowledge Management and Learning has been clearly described in the Project Description (Section B)

Yes

ANNEX A: FINANCING TABLES

GEF Financing Table

Indicative Trust Fund Resources Requested by Agency(ies), Country(ies), Focal Area and the Programming of Funds

GEF Agency	Trust Fund	Country/ Regional/ Global	Focal Area	Programming of Funds	Grant / Non-Grant	GEF Project Grant($)	Agency Fee($)	Total GEF Financing ($)
UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-1	Grant	6,300,000.00	567,000.00	6,867,000.00
UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-2	Grant	6,300,000.00	567,000.00	6,867,000.00
UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-4	Grant	3,400,000.00	306,000.00	3,706,000.00
Total GEF Resources ($)						**16,000,000.00**	**1,440,000.00**	**17,440,000.00**

Project Preparation Grant (PPG)

Is Project Preparation Grant requested?

true

PPG Amount ($)

300000

PPG Agency Fee ($)

27000

GEF Agency	Trust Fund	Country/ Regional/ Global	Focal Area	Programming of Funds	Grant / Non-Grant	PPG($)	Agency Fee($)	Total PPG Funding($)

UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-1	Grant	120,000.00	10,800.00	130,800.00
UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-2	Grant	120,000.00	10,800.00	130,800.00
UNIDO	GET	China	Climate Change	CC STAR Allocation: CCM-1-4	Grant	60,000.00	5,400.00	65,400.00
Total PPG Amount ($)						**300,000.00**	**27,000.00**	**327,000.00**

Please provide justification

Sources of Funds for Country Star Allocation

GEF Agency	Trust Fund	Country/ Regional/ Global	Focal Area	Sources of Funds	Total($)
UNIDO	GET	China	Climate Change	CC STAR Allocation	17,767,000.00
Total GEF Resources					**17,767,000.00**

Indicative Focal Area Elements

Programming Directions	Trust Fund	GEF Project Financing($)	Co-financing($)
CCM-1-1	GET	6,300,000.00	63900000
CCM-1-2	GET	6,300,000.00	62900000
CCM-1-4	GET	3,400,000.00	34100000
Total Project Cost		**16,000,000.00**	**160,900,000.00**

Indicative Co-financing

Sources of Co-financing	Name of Co-financier	Type of Co-financing	Investment Mobilized	Amount($)
Recipient Country Government	Selected City-Local Government	In-kind	Recurrent expenditures	17000000
Recipient Country Government	Selected City-Local Government	Grant	Investment mobilized	11900000

GEF Agency	UNIDO	Grant	Investment mobilized	100000
GEF Agency	UNIDO	In-kind	Recurrent expenditures	400000
Civil Society Organization	China Society for Automotive Engineers,International Hydrogen and Fuel Cell Association	Grant	Investment mobilized	200000
Civil Society Organization	China Society for Automotive Engineers,International Hydrogen and Fuel Cell Association	In-kind	Recurrent expenditures	200000
Private Sector	Sinopec, CHN Energy, Meijin Energy, Baofeng Energy etc. and vehicle and infrastructure enterprises	Grant	Investment mobilized	77500000
Private Sector	Sinopec, CHN Energy, Meijin Energy, Baofeng Energy etc. and vehicle and infrastructure enterprises	In-kind	Recurrent expenditures	53600000
Total Co-financing				**160,900,000.00**

Describe how any "Investment Mobilized" was identified

The Grants listed in the co-financing are investment mobilized including the recipient country government to promote the enabling investment environment for the enterprises, GEF Agency to motivate its Member States, Civil Society Organization to encourage its member enterprises, and, most of all, the Private Sectors to involve in the investment.

ANNEX B: ENDORSEMENTS

GEF Agency(ies) Certification

GEF Agency Type	Name	Date	Project Contact Person	Phone	Email
GEF Agency Coordinator	Mr. Ciyong Zou	9/15/2022			
GEF Agency Coordinator	Ms. Fatou Haidara	4/12/2023			
Project Coordinator	Mr. Heng Liu	4/12/2023	Mr. Heng Liu	+43 1 26026 3779	h.liu@unido.org
Project Coordinator	Ms. Xiaoping Li	4/12/2023	Ms. Xiaoping LI	+43 1 26026 3641	xp.li@unido.org

Record of Endorsement of GEF Operational Focal Point (s) on Behalf of the Government(s):

Name	Position	Ministry	Date (MM/DD/YYYY)
Mr. Xiang Peng	Director	Ministry of Finance	4/28/2023

ANNEX C: PROJECT LOCATION

Please provide geo-referenced information and map where the project interventions will take place

The project is located in Ningdong in the Ningxia Hui Autonomous Region, and Dalian and Shenyang in Liaoning Province, China. The map where the project interventions will take place is provided below,

Ningdong's coordinates is 38.1644° N, 106.5862° E

Dalian's coordinates is 38.9140° N, 121.6147° E

Shenyang's coordinates is 41.8048° N, 123.4330° E

ANNEX D: ENVIRONMENTAL AND SOCIAL SAFEGUARDS SCREEN AND RATING

(PIF level) Attach agency safeguard screen form including rating of risk types and overall risk rating.

Title
ES_Screening_Template_SAP_ID_210197__China_Green_Hydrogen

ANNEX E: RIO MARKERS

Climate Change Mitigation	Climate Change Adaptation	Biodiversity	Land Degradation
Principal Objective 2	No Contribution 0	No Contribution 0	No Contribution 0

ANNEX F: TAXONOMY WORKSHEET

Level 1	Level 2	Level 3	Level 4
Influencing models			

	Transform policy and regulatory environments		
	Strengthen institutional capacity and decision-making		
	Convene multi-stakeholder alliances		
	Demonstrate innovative approaches		
Stakeholders			
	Private Sector		
		Capital providers	
		Large corporations	
		SMEs	
	Beneficiaries		
	Civil Society		
		Academia	
	Type of Engagement		
		Information Dissemination	
		Consultation	
	Communications		
		Awareness Raising	
		Public Campaigns	
Capacity, Knowledge and Research			
	Enabling Activities		
	Capacity Development		
	Knowledge Generation and Exchange		
	Targeted Research		
	Innovation		
	Knowledge and Learning		
		Innovation	
Gender Equality			
	Gender Mainstreaming		
		Beneficiaries	
Focal Areas/Theme			
	Integrated Programmes		
		Sustainable Cities	
			Integrated Urban Planning
			Energy Efficiency
	Climate Change		
		Climate Change Adaptation	
			Climate Resilience
			Private Sector
			Innovation

		Climate Change Mitigation	
			Energy Efficiency
			Sustainable Urban Systems and Transport
			Technology Transfer
			Renewable Energy
			Enabling Activities
		Technology Transfer	
			Technology Needs Assessment
		United Nations Framework on Climate Change	
			Nationally Determined Contribution