GEF-6 REQUEST FOR PROJECT ENDORSEMENT/APPROVAL

PROJECT TYPE: Full-sized Project
TYPE OF TRUST FUND:GEF Trust Fund

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PART I: PROJECT INFORMATION

Project Title: Demonstration of Mercury Reduction and Minimization in the Production of Vinyl Chloride Monomer in China			
Country(ies):	China	GEF Project ID:[1]	6921
GEF Agency(ies):	UNIDO (select) (select)	GEF Agency Project ID:	130309
Other Executing Partner(s):	Foreign Economic Cooperation Office, Ministry of Environmental Protection, China	Submission Date: Resubmission Date:	10/13/2016 12/21/2016 03/16/2017 05/29/2017
GEF Focal Area (s):	Chemicals and Wastes	Project Duration (Months)	60
Integrated Approach Pilot	IAP-Cities ☐ IAP-Commodities ☐ IAP-Food Security ☐	Corporate Program: SGP ☐	
Name of Parent Program	[if applicable]	Agency Fee ($)	1,458,000

A. FOCAL AREA STRATEGY FRAMEWORK AND OTHER PROGRAM STRATEGIES[2]

Focal Area Objectives/Programs	Focal Area Outcomes	Trust Fund	(in $)	
			GEF Project Financing	Co-financing
(select) CW-1 Program 1 (select)	Outcome 1.1 Countries have appropriate decision-making tools and economic approaches to promote the removal of barriers preventing the sound management of harmful chemicals and waste	GEFTF	1,000,000	6,000,000
(select) CW-2 Program 4 (select)	Outcome 4.1 Mercury is reduced	GEFTF	15,200,000	94,400,000
	Total project costs		16,200,000	100,400,000

B. PROJECT DESCRIPTION SUMMARY

Project Objective: To reduce risks of mercury on human health and the environment from industrial production of Vinyl Chloride Monomers (VCM) in China.

Project Components/ Programs	Financing Type[3]	Project Outcomes	Project Outputs	Trust Fund	(in $)	
					GEF Project Financing	Confirmed Co-financing
1. Strengthen institutional, regulatory, and enforcement (IRE) capacity in VCM production in China	TA	1. Institutional, regulatory, and enforcement capacity to fulfill obligations concerning VCM production sector under the Minamata Convention	Output: 1.1 National regulatory policy and regulatory frameworks developed to reduce and eliminate mercury use in industrial VCM production, with focus on mandatory policy to ban the use of high-mercury catalyst ;	GEFTF	550,000	3,300,000

[1] Project ID number remains the same as the assigned PIF number.
[2] When completing Table A, refer to the excerpts on *GEF 6 Results Frameworks for GETF, LDCF and SCCF*.
[3] Financing type can be either investment or technical assistance.

			Output: 1.2 National managerial capacity and enforcement capacity strengthened to coordinate and monitor the VCM production sector ;			
2. Promote technology transfer and investment for the widespread application of BAT/BEP	Inv	2. Mercury emission and dioxin release reduced from VCM production through promotion of BAT/BEPs and if economically and technically feasible eliminate mercury	Output 2.1 Private Public Partnership (PPP) established to promote R&D, venture capital investment and technology transfer; Output 2.2 Environmental Technology Verification (ETV) methodology established to verify the performance of low-mercury and mercury-free alternatives by an expert panel established; Output 2.3 Demonstration of low-mercury BAT/BEPs in 4 coal-based VCM companies and of mercury-free alternatives in a coal-based VCM company; Output 2.4 Incentive program designed and implementation of major green instruments (fiscal, monetary, venture capital, insurance etc.) to allow the private sectors to access the technologies and experience gained from demonstrations; Output 2.5 Replication of BAT/BEPs and feasible mercury-free alternatives in 15 coal-based VCM companies national wide;	GEFTF	10,780,000	67,880,000
3. Promote the recovery of mercury in mercury-containing waste from VCM production	Inv	3. Promote the recovery of mercury from mercury-containing waste in VCM production process.	Output 3.1 Development of a national inventory for high-mercury-containing waste; Output 3.2 Mercury recovery rate enhanced	GEFTF	2,400,000	14,400,000

			on mercury-containing waste nationwide;			
4. Contaminated site identification and risk reduction associated with VCM production	TA	4. Appropriate strategies developed for identifying and assessing mercury contaminated sites from VCM production	Output 4.1 Inventory of mercury contaminated sites developed from VCM production plants; Output 4.2 Preliminary risk assessment (level and scope) on typical mercury contaminated sites from VCM production; Output 4.3 Strategy proposal for the reduction of the health risk and environmental impact and remediation;	GEFTF	1,200,000	7,200,000
5. Information dissemination and awareness raising among stakeholders	TA	5. Promotion of knowledge, experience and lesson sharing and environmental awareness raising among stakeholder groups	Output 5.1 Training provided to disseminate project results (concerning component 1, 2 ,3); Output 5.2 Awareness raised among government, private and civil society stakeholder groups;	GEFTF	200,000	1,200,000
6.Monitoring & Evaluation	TA	M&E	Output 6.1 Periodic monitoring and evaluation; Output 6.2 Midterm and terminal evaluation report;	GEFTF	300,000	1,800,000
			Subtotal		15,430,000	95,780,000
			Project Management Cost (PMC)[4]	GEFTF	770,000	4,620,000
			Total project costs		16,200,000	100,400,000

C. CONFIRMED SOURCES OF CO-FINANCING FOR THE PROJECT BY NAME AND BY TYPE

Please include evidence for co-financing for the project with this form.

Sources of Co-financing	Name of Co-financier	Type of Cofinancing	Amount ($)
GEF Agency	UNIDO	Grants	200,000
Recipient Government	The Ministry of Environmental Protection	Grants	200,000
Recipient Government	The Ministry of Environmental Protection	In-kind	800,000

[4] For GEF Project Financing up to $2 million, PMC could be up to10% of the subtotal; above $2 million, PMC could be up to 5% of the subtotal. PMC should be charged proportionately to focal areas based on focal area project financing amount in Table D below.

Private Sector	Dezhou Shihua Chemical Co., Ltd.	Grants	500,000
Private Sector	Dezhou Shihua Chemical Co., Ltd.	In-kind	6,300,000
Private Sector	Dezhou Shihua Chemical Co., Ltd.	Equity	4,200,000
Private Sector	Zhongke Yigong (Xiamen) Chemical Technology Co., Ltd.	Grants	300,000
Private Sector	Zhongke Yigong (Xiamen) Chemical Technology Co., Ltd.	In-kind	2,340,000
Private Sector	Zhongke Yigong (Xiamen) Chemical Technology Co., Ltd.	Equity	1,560,000
Private Sector	Nixia Jinhai Chuangke Chemical Technology Co., Ltd.	Grants	1,100,000
Private Sector	Nixia Jinhai Chuangke Chemical Technology Co., Ltd.	In-kind	9,540,000
Private Sector	Nixia Jinhai Chuangke Chemical Technology Co., Ltd.	Equity	6,360,000
Private Sector	Xinjiang Tianye group Co., Ltd.	Grants	1,100,000
Private Sector	Xinjiang Tianye group Co., Ltd.	In-kind	16,140,000
Private Sector	Xinjiang Tianye group Co., Ltd.	Equity	10,760,000
Private Sector	Xinjiang Zhongtai chemical Co., Ltd.	Grants	1,100,000
Private Sector	Xinjiang Zhongtai chemical Co., Ltd.	In-kind	16,140,000
Private Sector	Xinjiang Zhongtai chemical Co., Ltd.	Equity	10,760,000
Private Sector	Inner Mongolia Wuhai Chemical and Industrial Co. Ltd	Grants	500,000
Private Sector	Inner Mongolia Wuhai Chemical and Industrial Co. Ltd	In-kind	5,700,000
Private Sector	Inner Mongolia Wuhai Chemical and Industrial Co. Ltd	Equity	3,800,000
Others	Beijing University of Chemical Technology	Grants	200,000
Others	Beijing University of Chemical Technology	In-kind	800,000
(select)		(select)	
Total Co-financing			100,400,000

D. TRUST FUND RESOURCES REQUESTED BY AGENCY(IES), COUNTRY(IES) AND THE PROGRAMMING OF FUNDS

GEF Agency	Trust Fund	Country Name/Global	Focal Area	Programming of Funds	(in $)		
					GEF Project Financing (a)	Agency Fee[a] (b)[2]	Total (c)=a+b
UNIDO	GEF TF	China	Chemicals and Wastes	Mercury	16,200,000	1,458,000	17,658,000
Total Grant Resources					16,200,000	1,458,000	17,658,000

a) Refer to the Fee Policy for GEF Partner Agencies

E. PROJECT'S TARGET CONTRIBUTIONS TO GLOBAL ENVIRONMENTAL BENEFITS[5]

Provide the expected project targets as appropriate.

Corporate Results	Replenishment Targets	Project Targets
1. Maintain globally significant biodiversity and the ecosystem goods and services that it provides to society	Improved management of landscapes and seascapes covering 300 million hectares	*hectares*
2. Sustainable land management in production systems (agriculture, rangelands, and forest landscapes)	120 million hectares under sustainable land management and 3 million corporate	*hectares*
3. Promotion of collective management of transboundary water systems and implementation of the full range of policy, legal, and institutional reforms and investments contributing to sustainable use and maintenance of ecosystem services	Water-food-ecosystems security and conjunctive management of surface and groundwater in at least 10 freshwater basins;	*Number of freshwater basins*
	20% of globally over-exploited fisheries (by volume) moved to more sustainable levels	*Percent of fisheries, by volume*
4. Support to transformational shifts towards a low-emission and resilient development path	750 million tons of CO_{2e} mitigated (include both direct and indirect)	metric tons
5. Increase in phase-out, disposal and reduction of releases of POPs, ODS, mercury and other chemicals of global concern	Disposal of 80,000 tons of POPs (PCB, obsolete pesticides)	*metric tons*
	Reduction of 1000 tons of Mercury	*360 metric tons*
	Phase-out of 303.44 tons of ODP (HCFC)	*ODP tons*
6. Enhance capacity of countries to implement MEAs (multilateral environmental agreements) and mainstream into national and sub-national policy, planning financial and legal frameworks	Development and sectoral planning frameworks integrate measurable targets drawn from the MEAs in at least 10 countries	*Number of Countries:*
	Functional environmental information systems are established to support decision-making in at least 10 countries	*Number of Countries:*

F. DOES THE PROJECT INCLUDE A "NON-GRANT" INSTRUMENT? No

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

[5] Update the applicable indicators provided at PIF stage. Progress in programming against these targets for the projects per the *Corporate Results Framework* in the *GEF-6 Programming Directions*, will be aggregated and reported during mid-term and at the conclusion of the replenishment period.

PART II: PROJECT JUSTIFICATION

A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN WITH THE ORIGINAL PIF[6]

A.1. *Project Description*. Elaborate on: 1) the global environmental and/or adaptation problems, root causes and barriers that need to be addressed; 2) the baseline scenario or any associated baseline projects, 3) the proposed alternative scenario, GEF focal area[7] strategies, with a brief description of expected outcomes and components of the project, 4) incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, and co-financing; 5) global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF); and 6) innovativeness, sustainability and potential for scaling up.

During PPG stage co-financing has been updated which resulted in an increase of commitments of USD 200,000 in comparison to the original PIF mentioned under table A,B, C in this document.

A.1.1 The global environmental and/or adaptation problems, root causes and barriers that need to be addressed

1. The Minamata Convention (MC) on Mercury was signed on October 10, 2013, with the objective to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. The Parties agreed in Article 5 to take measures to restrict the use of mercury or mercury compounds, in the processes listed in Part II of Annex B in accordance with the provisions set out therein. Specifically, to (1) reduce the use of mercury in terms of per unit production of Vinyl Chloride Monomer (VCM) by 50 per cent by the year 2020 versus 2010 use; (2) to take measures to reduce emissions and releases of mercury to the environment; (3) to prohibit the use of mercury five years after the Conference of the Parties has established that mercury-free catalysts based on existing processes have become technically and economically feasible;
2. China signed the MC on Oct. 10, 2013 in Kumamoto, Japan and deposited its instrument of ratification on 31st August, 2016. In line with the MC, the activities for the reduction and phase-out of mercury production and usage, as well as introduction of alternative technologies have been identified as high priority actions for mercury reduction in China.
3. China has a long history of use of mercury, as early as the 6th century BC. At present, China's total mercury usage is about 1200 t/y, which accounts for about 50% of the world's total usage. Thus, China has become the world's largest producer and consumer of mercury. The emission and release of the mercury in China could potentially cause local, regional and global impact.
4. With its high mercury consumption and high risk of mercury pollution, the calcium carbide process (CCP) VCM industry is the key Chinese industry targeted for prevention and control of mercury pollution under the Minamata Convention. To this end, China has made increasing efforts in prevention and control of mercury pollution of the VCM industry and developed and improved relevant policies and standards. However, there still are gaps that must be addressed in order to meet the Minamata Convention requirements. At present, the main barriers are:
    - Mercury process regulation in China involves different governmental departments. Mercury-related policy measures lack effective linkage, integrated management, information exchange and overall coordination;
    - The prevention and control of mercury pollution for CCP VCM production has not been included in the related national plan. EIA and industrial permit conditions do not ban the consumption of mercury or mercury compound as a catalyst in VCM production;

[6] For questions A.1 –A.7 in Part II, if there are no changes since PIF , no need to respond, please enter "NA" after the respective question.

[7] For biodiversity projects, in addition to explaining the project's consistency with the biodiversity focal area strategy, objectives and programs, please also describe which Aichi Target(s) the project will directly contribute to achieving..

- Existing mercury emission limits and standards do not match current processes and technologies. Emission reduction measures have no strict standards and no specific mercury limits for mercury point sources of CCP VCM enterprises;
- There is no mercury-related standard technology and management in the PVC industry. BAT/BEP guidelines and cleaner production technical guidelines have not been developed. The inventory of mercury emissions from the VCM Industry has not been conducted;
- Local capacity in prevention, control, monitoring and supervision of mercury pollution is in need of improvement. At present, some local environmental protection departments in China are weak in supervisory monitoring, lacking equipment and technical talents.

5. The development, demonstration and implementation of mercury-free technology must be done thoughtfully. Raw material availability, the product quality compared to the incumbent process and the economic cost of the alternative process must be considered carefully. The barriers to implementing mercury-free technology include:
    - Mercury-free technology has not yet matured and uncertainty still exists. Due to the development challenges for mercury-free industrial-scale technology, there is currently no operating demonstration plant in China. VCM producers are not in favor of adopting the mercury-free process;
    - Lack of independent evaluation and verification of the viability of the mercury-free technology, which limits its application and promotion;
    - Mercury-free technology R&D is still underfunded. Due to falling PVC market prices, China's PVC industry has been in a deficit position since 2011. Some mercury emission reduction technologies need large capital investment for plant reconstruction, which makes adoption difficult.
    - Lack of incentive measures and venture capital investment to companies for adoption of mercury-free technologies.
6. Barriers in mercury wastes management and disposal:
    - Lack of waste inventory, characterization of the generation and pollution characteristics of mercury wastes from CCP VCM Plants.
    - Need for enhancement of the current regulation and management system of mercury waste. Mercury is improperly handled and disposed of because of weak capability in some provinces.
    - Management of the current mercury recovery processes must be improved to reduce risk from mercury emissions.
    - Lack of integrated management of mercury-containing waste. Most operations are concerned with recycling mercury from waste catalyst and activated carbon; few are concerned with other mercury-containing wastes.
7. The barriers in management and remediation of mercury-contaminated sites:
    - There are still no strict requirements for management of contaminated sites. Historically some contaminated land has been reused very quickly with no or only rudimentary risk assessment. Later it was hard to carry out risk assessment on these sites when successor facilities were proposed and built.
    - Lack of necessary scientific guidance on when and how to carry out pollution investigation, risk assessment and remediation on mercury-contaminated sites, and how to evaluate the cost and benefit of such action.
    - Lack of an inventory of contaminated sites. Further investigation requires the cooperation of stakeholders including the local EPBs, associations and companies in order to conduct the inventory and site investigation.
8. The barriers in publicity and awareness raising:

- Related departments lack knowledge in mercury convention implementation and mercury pollution management, and lack awareness of the need for mercury pollution risk prevention. The professional policy ability needs to be improved;
- Companies producing and using mercury-containing materials in the CCP VCM production chain lack knowledge of mercury-related health risks and awareness in environmental protection. They have no incentive to promote mercury-free technologies;
- Mercury-related working personnel have insufficient environmental awareness and lack knowledge in mercury exposure and heavy metal occupational health protection;
- The public lacks knowledge about mercury pollution and the harm it can cause. This makes it difficult to create social pressure to limit mercury use and promote mercury reduction.

A.1.2 The baseline scenario or any associated baseline projects

A.1.2.1 Baseline Scenario

A) PVC PRODUCTION AND RELEVANT ENTERPRISES

9. China is the only country in the world that uses calcium carbide-based VCM production to produce polyvinyl chloride (PVC). The VCM/PVC sector consumes more than half of the total mercury supply in the country, accounting for 30% of world's total mercury consumption. Polyvinyl chloride (PVC) production increased from 11.3 to 16.3 million t between 2010 and 2014 in China, and production capacity continuously increasing from 20.4 million t in 2010 to 24.76 million t in 2013. The growth rate of PVC production has slowed down recently.

10. There are currently 89 PVC companies in China, 72 of which derive their VCM from CCP, 17 of which derive theirs from ethylene-based technology, and there are countless relevant enterprises up- and down-stream. The PVC production capacity in the 6 provinces of northwestern China, including Inner Mongolia, Xinjiang, Shaanxi, Qinghai, Ningxia and Gansu provinces, accounts for 45% of national total capacity, all of which are based on acetylene obtained either from calcium carbide or partial oxidation of natural gas. The PVC industry continues to develop the "coal - electricity - PVC" industrial chain as an integrated economic model.

11. The dominant position of the carbide-based VCM/PVC process is undeniable; nevertheless, China is encouraging the production of VCM by ethylene-based EDC (ethylene dichloride) processes. Ethylene-based processes account for about 16.7% of PVC production in China. These assets are mainly located in the eastern and coastal areas of China, such as Tianjin, Shandong, Jiangsu, Zhejiang, Shanghai and Guangdong provinces. PVC production capacity overall decreased 1.53 million t in the central, southern and east China in 2014 due to poor cost competitiveness of raw materials and integrated "coal - electricity - PVC" projects. The EDC process maximizes the use of chlorine through a process called the oxychlorination process (OC). Considering the potential for emission of dioxin from OC, this project will also address dioxin in line with the requirements of the Stockholm Convention.

B) PRODUCTION & USAGE OF MERCURY-CONTAINING CATALYST

12. There were 15 companies producing mercury-containing catalyst with a total output of about 10,000 t in China in 2010. In 2014, the number of companies and the production of mercury-containing catalyst increased to 22 and 16,800 t respectively. The companies are mainly located in Guizhou, Inner Mongolia, Ningxia, Xinjiang and Hebei provinces. Among them, the companies in Guizhou province accounted for 34.6% of national output.

13. Currently, high-mercury catalyst (HMC) containing about 10-12.5% mercuric chloride ($HgCl_2$) is still the mainstream technology in the VCM/PVC sector. This technology has grown in usage and has been very cost effective over the past decades because China's coal and limestone reserves are abundant but oil resources are scarce.

14. Low-mercury catalyst (LMC) containing 4%~6.5% $HgCl_2$ has been developed and promoted as an alternative to high-mercury catalyst (HMC) containing 12% $HgCl_2$ for the synthesis of VCM since 2010. This slows the high-speed growth of mercury consumption for PVC production to some degree. Mercury use decreased by 11.8% from

98.5 to 86.9 g Hg/t VCM. The use of HMC increased about 19% from 8,460 t in 2010 to 10,080 t in 2014 due to expansion of CCP VCM capacity. Use of LMC increased about 383% from 1,392 t to 6,720 t during the same period. However, there is still a large gap for meeting the relevant requirements of the Minamata Convention since the current share of VCM production by LMC has only increased from 13.8% to 40%, which will be elaborated in A1.2.3.

C) STATUS OF MERCURY WASTE IN PVC INDUSTRY

15. It is estimated that mercury-containing and mercury-contaminated waste is comprised of: 10,850 t of waste mercury catalyst, 3,600 t of waste activated carbon, 668 t of mercury contained slag, 97 t of waste sawdust, 100 million m3 waste acid and 17 million m3 waste alkali in 2010. Mercury material flow, mercury emission and sources of waste generation in acetylene-based VCM production is shown in Figure 1.

16. Most of the input mercury (60-90%) remains in spent catalyst and waste activated carbon according to the mercury material balance of VCM production. Thus, if annual mercury usage is about 800 t, then mercury remaining in waste catalyst and waste activated carbon is about 500-700 t.

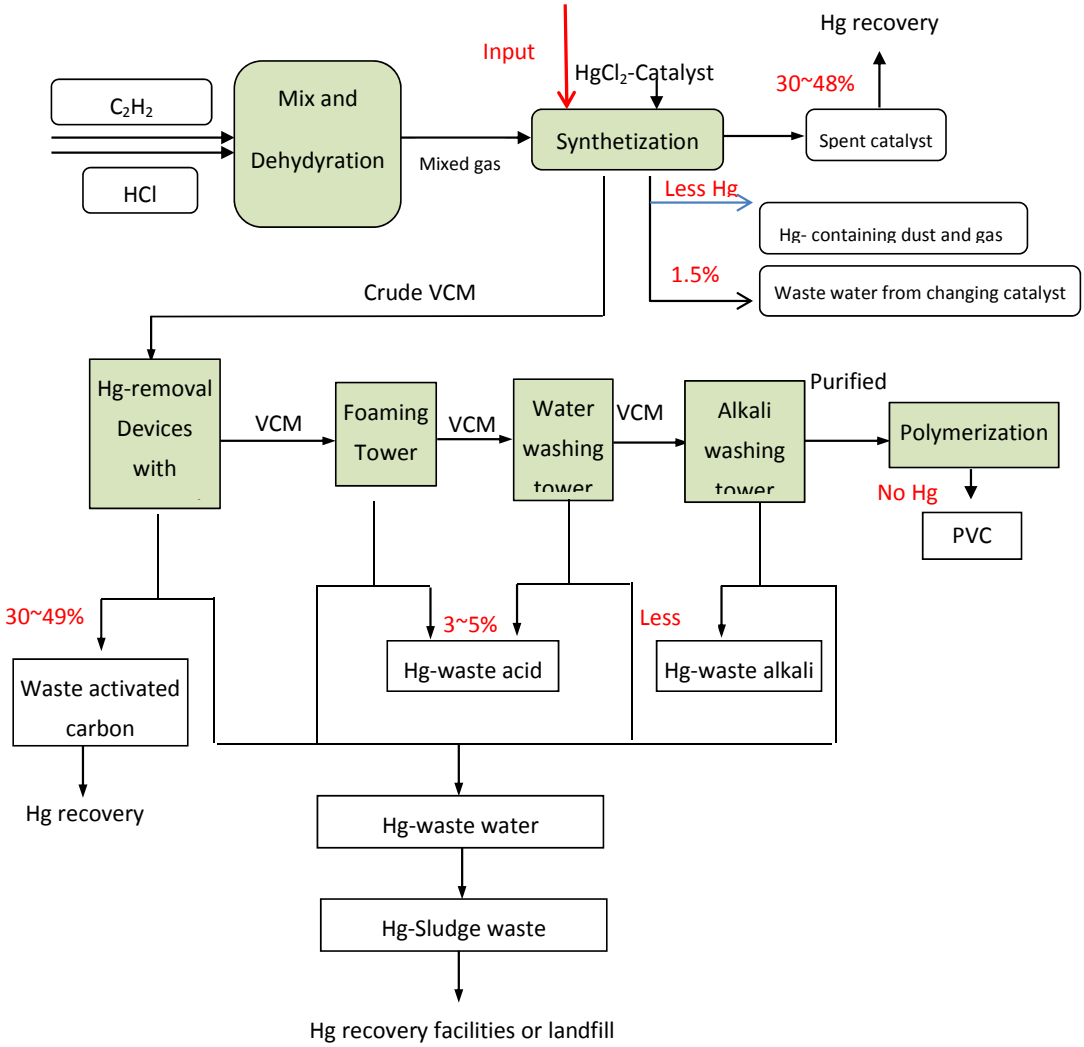

Figure 1 Mercury flow in the VCM sector, China (a CCP plant with a capacity of 300,000 t/a)

D) STATUS OF CONTAMINATED SITES IN PVC INDUSTRY

17. Mercury contamination in VCM and PVC operations mainly results from historical VCM production. Specific points of contamination include VCM manufacturing plants, warehouses containing either fresh or waste mercury catalyst, and associated sites contaminated by the improper disposal of mercury-containing waste water or solid waste. About 20 enterprises closed between 2010 and 2012. Those sites are potentially mercury-contaminated sites and the soil near the synthesis operations is potentially highly contaminated. Untreated mercury waste was dumped at some sites.

E) CURRENT STATUS OF NATIONAL LAWS AND REGULATIONS

18. China has enacted progressively stricter environmental policies and standards for the VCM industry over the past few years. Table 1 shows the regulations and policies related to VCM industry access, new plant construction, manufacturing processes and mercury catalyst products.

19. At present, China has regulatory requirements for CCP PVC production and its related industries in areas such as industrial structure, technology & equipment, cleaner production, environmental protection and pollution emissions.

20. In terms of industrial structure, CCP PVC industry is making more efforts in gradual reduction of consumption and release of mercury with measures such as phasing out high-mercury content catalysts (mercuric chloride content > 6.5%) and CCP PVC manufacturing facilities that employ high-mercury content catalysts, expanding the application of low-mercury content catalysts (mercuric chloride content at 4%~6.5%), encouraging research and development of mercury-containing catalyst with mercuric chloride content < 4% or mercury-free catalyst, and constraint of the construction of CCP PVC project with low production capacity.

21. The Chlor-Alkali (Caustic Soda, PVC) Industry Access Conditions specifies access conditions in areas such as industrial distribution, scale, technology and equipment, energy consumption, safety, health, environmental protection.

22. Cleaner Production Assessment Indicator System and Cleaner Production Standard for Caustic Soda/PVC Industry carries out 6 cleaner production technologies, which have made a good foundation for cleaner production in this field.

Table 1 Policies and regulations on mercury pollution management and control in PVC industry, China

No.	Policy	Policy development organization/time	Main contents
1	Chlor-Alkali (Caustic Soda, PVC) Industry Access Conditions	NDRC 2007	Chlor-Alkali (caustic soda, PVC) industry access conditions
2	The Catalogue for Guiding the Adjustment of Industrial Structure	NDRC 2011	Phasing out: Acetylene PVC production facilities employing high-level mercury catalyst (2015) Constraints: new CCP PVC construction project with initial scale <300,000 t/y and projects employing OC to manufacture PVC.
3	Catalogue for Guiding Phase-Out of Outdated Production Process, Equipment and Products of Some Industries	Ministry of Industry and Information Technology(MIIT) 2010	Phase out CCP PVC production facilities with annual capacity < 50,000 t that employ stockpiles to dispose of carbide slag.
4	Circular on Strengthening Prevention and Control of Mercury Pollution of CCP PVC and Relevant Industries	MEP No.(2011) 4	Specific requirements for new, revised and expanded projects employing CCP PVC.
5	Cleaner Production Assessment Indicator System for Caustic Soda/PVC Industry (Trial)	NDRC 2006	Indicators involving mercury: Total mercury in PVC production effluent among pollutant generation indicators; the baseline value is 2.0×10^{-5} kg/t PVC.

6	Program for Promotion of Cleaner Production in PVC Industry	MIIT No. (2010) 104	4 cleaner technologies for reducing consumption and release of mercury
7	Circular on Printed out and Distribution of Comprehensive Program on Prevention and Control of Mercury Pollution of CCP PVC Industry	MIIT No. (2010) 261	Make more efforts in application and extension of low-mercury and new catalysts; strengthen process control of mercury and minimize loss and release of mercury.
8	Cleaner Production Standard for Chlor-Alkali (PVC) Industry	MEP 2009	Three grades for cleaner production indicators.
9	Circular on Strengthening Prevention and Control of Mercury Pollution of CCP PVC and Relevant Industries	MEP No.(2011) 4	Present detailed arrangements for strengthening prevention and control of mercury pollution.
10	Circular on Joint Organization and Implementation of Action Plan for Reduction of Pollutants with High Risk	MIIT No.(2014)168	Mercury reduction cleaner production project: Comprehensively extend and employ low-mercury catalyst and mercury pollution control measures.
11	Catalogue for Guiding Phasing Out Outdated Production Process, Equipment and Products of Some Industries	MIIT 2010	Phasing out PVC products with some uses.
12	Circular on Adjustment of Export Rebate Rate of Some Goods and Additional Items in the Catalogue of Goods Banned in Processing Trade	Caishui No.[2006] 139	PVC export rebate rate has gone down from 13% to 11% since September of 2006.
13	Circular of State Tax Administration on Reducing Export Rebate Rate of Some Products	Ministry of Finance Caishui No.[2007]90	The export rebate rate of PVC was reduced again from 11% down to 5% in July of 2007.
14	Low-Level Mercury Catalyst for Vinyl Chloride Synthesis	China Petroleum and Chemical Industry Federation (CPCIF) HG/T4192-2011	The standard specifies the technical requirements, test method and rules, label, package, transport, storage and safety and so on for low-level mercury catalyst employed in vinyl chloride synthesis.
15	Measures on Making Public Low-Mercury Catalyst Manufacturing Enterprises	CPCIF and CCAIA 2014	Low-level mercury catalyst manufacturing enterprises meeting relevant requirements of Low-Level Mercury Catalyst for Vinyl Chloride Synthesis (HG/T4192-2011) should be made public once in every 6 months .

F) CURRENT STATUS OF NATIONAL ADMINISTRATIVE INSTITUTIONS

23. Many governmental departments at several levels are involved in the prevention and management of mercury pollution in VCM and mercuric chloride catalyst manufacturing sites. These include national, local and sector administrative departments as well as relevant institutions involving policy study, monitoring and assessment. The framework of the national management institutions of VCM sector is shown in Figure 2.

24. The national administrative departments including the Ministry of Environmental Protection（MEP), National Development and Reform Commission（NRDC), Ministry of Industry and Information Technology（MIIT), Ministry of Science and Technology, State Administration of Work Safety

25. As the competent environmental protection administrative department of the State Council, MEP is mainly responsible for developing and implementing plans, policies and standards for environmental protection; organizing the development of zoning of environmental function areas; supervising prevention and control of environmental pollution; coordinating and addressing key issues on environmental protection; as well as the

development and implementation of environmental policies, supervision on law enforcement and coordination of trans-administrative region environmental matters and so on. The administrative department in relation to prevention and control of the pollution of PVC industry is mainly the Department of Soil Environment Management and its main responsibilities include national supervision and management of prevention and control of soil, solid wastes, chemicals and heavy metals pollution; developing and organizing the implementation of relevant policies, plans, laws, administrative regulations, sector regulations, standards and norms; as well as domestic implementation of relevant international conventions. Therefore, MEP takes charge of unified supervision and management of the prevention and control of pollution in the whole process of production, use and recycling of PVC and mercury catalysts as well as implementation of the international conventions.

26. As the regulatory department for the macro economy, NDRC is in charge of comprehensive study and development of economic and social development policies, achievement of total balance and guiding the overall reform of the economic system. The NDRC departments mainly in charge of the management of PVC-related industries are the Department of Industrial Coordination and Department of Resource Conservation and Environment Protection. The main functions of the Department of Industrial Coordination are presenting the philosophy and policy measures that promote strategic adjustment of industrial structure and coordinated development of industry; organizing the development of the Catalogue for Guiding the Adjustment of Industrial Structure and comprehensive industrial policy; and enhancing the guidance of relevant industrial associations. The main functions of the Department of Resource Conservation and Environment Protection are studying and presenting policy recommendations on environmental protection; organizing the development of plans and policies that promote the development of the environmental protection industry and cleaner production; guiding the development of relevant standards; reviewing relevant key projects and demonstration projects, and organizing the extension and application of new products, technologies and equipment.

27. Ministry of Industry and Information Technology (MIIT) is a ministry of the State Council. The main duties of MIIT include developing and implementing industrial plans, policies and standards; promoting the development of key technology and equipment and other types of innovation. The MIIT departments primarily responsible for the management of PVC-related industries are the Department of Industrial Policy and Department of Energy Conservation and Comprehensive Use. The Department of Industrial Policy is mainly responsible for the development of industrial policies and supervising their implementation; presenting policy recommendations that will facilitate adjustment of industrial structure; developing and revising relevant text of the National Catalogue for Guiding the Adjustment of Industrial Structure; participating in review of investments; developing relevant industrial access conditions and organizing their implementation. The Department of Energy Conservation and Comprehensive Use is mainly responsible for development and implementation of policies on energy conservation and comprehensive use of resources as well as cleaner production in industries; participation in the development of the policies on cleaner production planning and pollution control policy; coordination of relevant key demonstration projects and extension and application of new products, technologies, equipment and materials.

28. As the key national administrative department on science and technology, the Ministry of Science and Technology (MST) is in charge of the macro strategy for development of science and technology as well as scientific guidelines, policies and regulations promoting economic and development. With respect to the PVC and mercuric catalyst industries, MST is responsible for basic research on mercury and applied research on alternative manufacturing technology and control technology; transformation and application of relevant scientific and technological achievements; and relevant activities on implementation of the international convention.

29. State Administration of Work Safety (SAWS) is in charge of comprehensive supervision and administration of work safety in the country. The SAWS department primarily responsible for the PVC and mercuric catalyst industries is No.3 Department of Safety Supervision. The main duties of the department are comprehensive supervision of work safety of hazardous chemicals; supervising the implementation of policies and regulations on safe production of hazardous chemicals; organizing the development of regulations, rules and standards for work safety; safety review and site identification of manufacturing enterprises of packaging materials and containers of hazardous chemicals; grant of hazardous chemical business license; registration and supervision on domestic hazardous chemicals as well as the development of the Measures on Work Safety License of Hazardous Chemicals Manufacturing and Operation Enterprises and its administration work.

30. The institutional setup of local administrative organizations is similar to that of national administrative organizations or local governments, including administrative organizations at province, city and county levels. The main duties of local administrative departments include implementation of national guidelines, policies, laws and regulations under the leadership of local government, and business leadership of the competent departments at higher level. Based on local needs, they develop local policies, regulations and plans and organize their implementation; investigate and punish infringements according to law; and implement local publicity, education and training activities.

31. Major industrial associations involving the PVC industry: in China, the industrial associations involving PVC and mercuric catalyst production mainly include China Petroleum and Chemical Industry Federation (CPCIF), the China Chlor-Alkali Industry Association (CCAIA), the China Chemical Industry Environmental Protection Association (CCIEPA) and the China Council for Industrial Environmental Protection (CCIEP).

32. At present, the policy study, monitoring and assessment institutions responsible for prevention and control of mercury pollution from the PVC industry are the Ministry of Environmental Protection Solid Waste and Chemicals Management Center (MEP SCC), MEP FECO, the Chinese Research Academy of Environmental Sciences (CRAES), National Research Center for Environmental Analysis and Measurement (CNEAC), The China Academy on Environmental Planning (CAEP), the China National Environmental Monitoring Center (CNEMC), The Chinese Society for Environmental Sciences (CSES), the State Environmental Protection Center for Mercury Pollution Prevention and Control(MPPC), and the local relevant technical support organizations.

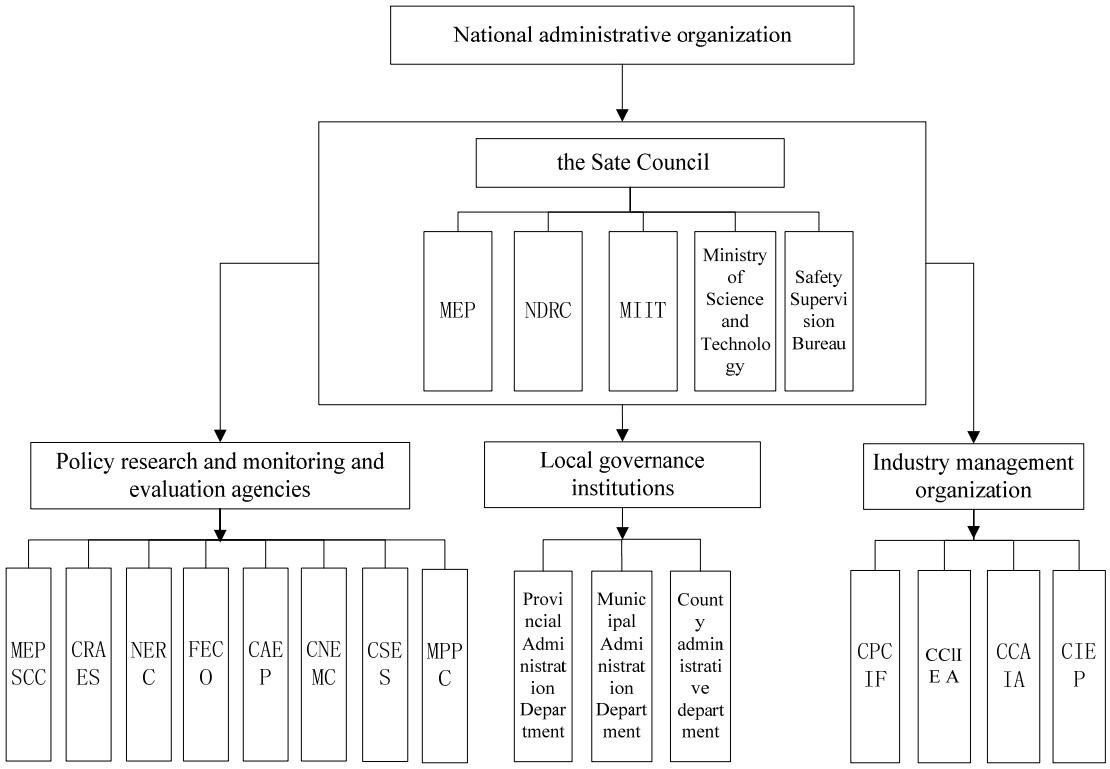

Figure 2 Framework of the national management institutions of VCM sector

G) RESEARCH AND DEVELOPMENT STATUS OF MERCURY-FREE PVC PRODUCTION TECHNOLOGIES

33. Mercury-free VCM production technologies are mainly divided into the oxychlorination/ethylene dichloride (EDC) method, the EDC/acetylene method and the non-mercury catalyzed acetylene synthesis method.

34. Ethylene and hydrogen chloride (HCl) are used as raw materials in OC. The ethylene is mainly obtained by cracking naphtha in the petrochemical industry or from coal-to-olefins processes. OC is a mature technology with

device capabilities well in excess of 100,000 t/y. Domestic EDC production enterprises applying the ethylene OC method reached 3,090,000 t/y in 2010. Potential for generation of dioxin-like by-products is a concern with this process, and the dioxin-like pollutant emissions from domestic ethylene OC facilities are estimated at 157.82 g TEQ via the Stockholm Toolkit Method.

35. The EDC/Acetylene method uses acetylene and ethylene dichloride in the presence of catalysts for recombination to generate VCM monomer ($C_2H_4Cl_2 + C_2H_2 \rightarrow 2C_2H_3Cl$). This technique avoids the 550-degree pyrolysis of EDC and the complex OC and thus has better energy efficiency, although it still uses acetylene, which is derived from high-energy calcium carbide. The technology was tried in a pilot operation at a scale of several thousand tons of VCM per year.

36. Mercury-free acetylene catalysis is similar to the traditional method although some facility modifications are required. Recently, China has increased funding for mercury-free catalyst research. There are also some foreign research institutes carrying out R&D and pilot research on mercury-free catalysts in cooperation with Chinese enterprises. The economic and management cost of using a precious metal catalyst may become the main factor restricting commercialization. Commonly-used catalysts could be divided into two categories: gas-liquid phase and solid phase methods. Specific research, development and applications are shown in Table 2.

37. Small-scale testing is based on laboratory experiment with grams of catalyst running less than thousand hours; Pilot-scale testing is based on the industrial side-line devices (Single tube reactor or multi-tubular reactor) using kgs of catalyst and running several thousands of hours; Industrial-scale testing is based on an industrial reactor utilizing tons of catalyst and running more than 8000 hours.

Table 2 Current status of research, development and application of mercury-free catalysts

Development direction	Country/Institute	Contents	Status
Non-mercury catalyst in the liquid phase for acetylene hydro chorination reaction. Progress is slow and domestic research has been suspended.	USA	Compounds of copper or cuprous dissolved in hydrochloric acid solution	Small-scale test; application for patent Nieuwland Julius A. Catalytic Process For The Preparation Of Vinyl Chloride US1812542, 1927-11-12. Carbide And Carbon Chem Corp. Preparation Of Vinyl Chloride. US1934324, 1931-04-10. Armin Jacobowsky, Process For Preparing Vinyl Chloride. US3113158, 1960-12-07. Thelen Gerhard, Bartels Harald, Droste Wilhelm, Deppe Herbert, Process For The Manufacture Of Vinyl Chloride By Reaction Of Acetylene With hydrogen chloride chloride, US4912271,1989-04-18.

			Strebelle Michel, Devos Andre, Catalytic hydrochlorination system and process for the manufacture of vinyl chloride from acetylene and hydrogen chloride in the presence of this catalytic system, US5254777, 1992-06-18.
	UK，G J Hutchings	Mixed solution of tributyl amine hydrochloride, isopropyl alcohol, dodecane and gold chloride	Small-scale test; application for patent Journal of Catalysis,1985, 96(1) Applied Catalysis, 1988(43) Gold Bull, 1996(29)
	Germany, Hills Co., Ltd	The reaction of acetylene and hydrogen chloride in aliphatic or cyclic aliphatic carboxylic acid amide is carried out by using a compound of palladium as catalyst.	Small-scale test; application for patent CN1037501, 1989-04-29.
	China Chengdu，Huien Fine Chemical, Yibin Tianyuan Co., Ltd	Palladium, platinum, rhodium compounds and cesium, bismuth, cerium and tin chloride as catalyst, in formic acid, N-methyl ketone, aliphatic ester in the hydrogen chloride reaction	Small-scale test; application for patent CN101514140, 2009-04-02
	Beijing Longzhida Co., Ltd	The use of gold, platinum, palladium, tin, copper or rhodium chloride as catalyst in the reaction of acetylene and hydrogen chloride in an ionic liquid	Small-scale test; application for patent CN101716528, 2009-10-30. CN101879464, 2010-05-28.
	Sichuan University, Yibin Tianyuan Co., Ltd	The reaction was carried out in organic amine solution with the catalyst of platinum chloride	Small-scale test; application for patent Sichuan Chemical, 2008, 11(6)
Non-mercury catalyst in the solid phase for acetylene hydroch1orination reaction; Precious metal (gold) on activated carbon catalyst has become an important research direction.	Britain; Aker Solutions (Being purchased by Johnson Matthey)	Precious Metal gold activated carbon-based catalyst	Small-scale test; Fixed bed reactor; application for patent
	Johnson Matthey	Precious Metal gold activated carbon-based catalyst	Small-scale test; Fixed bed reactor; application for patent
	Johnson Matthey; Xinjiang Tianye	Precious Metal gold activated carbon-based catalyst	Pilot test in 2011 running more than 10000 hours (cumulative); Fixed bed reactor in 2012 running 4800 hours; Did not reach the expected result, suspended
	East China University of Science and Technology, Tianjin	Precious Metal gold and copper activated carbon based catalyst	Small-scale, pilot and single tube reactor test; Fixed bed reactor, research from 2010 running for thousands

	Dagu Chemical		hours; Petroleum Processing And Petrochemicals Vol. 45, 2014 No.12
	Xinjiang Shihezi University, Xinjiang Tianye	Precious metal gold, cobalt, copper, lanthanum activated carbon based catalyst	Small-scale test; Fixed bed reactor; application for patent Journal Of Shihezi University (Natural Science), 2013,31(4) Journal Of Shihezi University (Natural Science), 2014, 32(6) Journal Of Shihezi University (Natural Science), 2015,33(1)
	Xinjiang University, Xinjiang Zhongtai	Precious metal palladium activated carbon based catalyst	Small-scale test; Fixed bed reactor Industry catalysis, 2015, 23(10) China Chlor-Alkali,2013, 15(8) Polyvinyl Chloride, 2015, 43(5) CN201110257696, 2012-02-22
	Xinjiang University, Xinjiang Zhongtai	Molecular sieve palladium catalyst	Small-scale test; Fixed bed reactor CN201110257697, 20l2-04-l8 Reaction Kinetics, Mechanisms and Catalysis, 2013, 110:187-194
	Nankai University, Xinjiang Tianye; Xinjiang Zhongtai	Precious metal gold iron or gold phosphorus activated carbon based catalyst, non noble metal nickel or molybdenum and barium carbon based catalyst	Small-scale and pilot test in 2014 running 10000 hours (cumulative); application for patent RSC Advances, 2012(2), 4814-4821. CN201310549110, 2014-02-05 RSC Advances, 2014(4),

			15877-15885 CN201110023357, 2011-07-20 CN201110023364, 2011-08-17 CN201110040371, 2011-08-17
	Tianjin University	Precious metal gold, molybdenum, copper activated carbon based catalyst	Small-scale test; Fixed bed reactor
	Tianjin University	Non precious metal copper based catalyst	Small-scale test; Fixed bed reactor; Effect is not as good as precious metal catalyst Journal of Molecular Catalysis (China), 2014, 28(3):259-267.
	Tsinghua University, Xinjiang Tianye	Non precious metal tin, bismuth, phosphorus activated carbon based catalyst	Small-scale test; fluidized bed reactor CN201010226793, 2011-01-05 Fuel Processing Technology, 2013,108:12-18
	Tsinghua University	Nitrogen doped nano activated carbon catalyst	Small-scale test; Fixed bed reactor
	Tsinghua University, Xinjiang Tianye	Precious Metal nano gold and copper activated carbon based catalyst	Small-scale and pilot test; Fixed bed reactor; application for patent
	Chengdu Institute of organic chemistry, Chinese Academy of Sciences	Non precious metal copper nickel based catalyst	Small-scale test in 2011 with running 50 hours; application for patent; China Journal of Synthetic Chemistry 2011, 19(5) 622-625
	Dalian Institute of Chemical Physics, Chinese Academy of Sciences	Nitrogen doped graphene-like catalyst	Small-scale test

A.1.2.2 Baseline Projects

38. In the 12th Five-Year Plan period, the Ministry of Industry and Information Technology and MEP have released policies on prevention and control of mercury pollution of CCP PVC and its related industries, set mercury reduction targets, promoted cleaner production technologies such as low-mercury catalyst and hydrochloric acid desorption, mandated a strict environmental management system, and taken measures in the whole process of CCP PVC production to strengthen prevention and control of mercury pollution.

39. From April 2011, China MEP has organized and carried out a national investigation and evaluation of mercury pollution emission sources, including 14 mercury-related industries. These include: primary mining (mercury

mining, processing and smelting), mercury-containing reagents, $HgCl_2$ catalyst, CCP VCM production, waste mercury catalyst recycling processing, mercury-containing zinc powder, coated paper, batteries, electric light sources utilizing solid mercury, thermometers, sphygmomanometers, lead, zinc and copper smelting. In August 2012, MEP carried out an investigation to determine the actual situation with respect to mercury emissions sources. The investigation and evaluation results reflect mercury pollution emission sources comprehensively and objectively, which will lay the foundation for the supervision and management of mercury pollution in the PVC industry, prescribed by this project.

40. In addition, the development and implementation of relevant standards have enhanced the management of enterprises. Mercuric chloride catalyst products shall comply with the Low-Level Mercury Catalyst for Chloroethylene Synthesis directive (HG/T 4192-2011). PVC resin products shall comply with Suspension Polyvinyl Chloride Resins of General Purpose directive (GB/T 5761-2006). The emissions of enterprises shall comply with the Integrated Emission Standard of Air Pollutants (GB 16297-1996). The wastewater discharge of CCP PVC manufacturing enterprises shall meet the Discharge Standard of Water Pollutants for Caustic Alkali and Polyvinyl Chloride Industry (GB 15581-1995). The wastewater discharge of mercuric chloride catalyst manufacturing enterprises shall meet the Integrated Wastewater Discharge Standard (GB 8978-1996).

41. The Chinese government offered great support for mercury-free catalyst development. In October 2010, the Ministry of Science and Technology invested about US$682,000 (RMB4.5 million) through the national '973 Program' to support research into the dichloroethane/acetylene method. In 2011, China Chemical Group invested about US$7.6 million (RMB50 million) in Dezhoushihua of Shandong Province to construct a relevant test platform and carry out an industrial experiment. The trial production with a capacity of hundreds of tons VCM per year was completed in April 2013 and a pilot experiment of 2,000 t/y was finished in 2014. The results passed technical evaluation by the China Petrochemical Association.

42. Research on non-mercury catalysts has been carried out in China since 2010. At present, research is mainly focused on the precious metal gold activated carbon-based catalyst. Gold has been a leading candidate for replacement of mercury since the 1980s. Although gold is far less volatile than mercury and is highly reactive and selective for hydrochlorination it is more expensive and less active than mercury catalyst.

43. Mercury/zeolite-based catalysts could provide a low mercury catalyst and no mercury release. But mercury zeolite-based catalysts have only been used in research and development and not commercialized. Non-mercury zeolite-based catalysts have also been researched by Chinese universities. Laboratory research results indicate that zeolite-based catalysts are not as effective as carbon-based catalysts.

44. Non-mercury catalyst has been researched at Xinjiang Tianye since 2009. Xinjiang Tianye has cooperated with many domestic and foreign research institutions and domestic universities on non-mercury catalyst research, including Johnson Matthey, Nankai University, Tsinghua University, Shihezi University, and the Dalian Institute of Chemical Physics.

45. "Sino-Norwegian Cooperative Project on Mercury Capacity Building for Reducing Mercury Pollution," a project funded by a grant from the government of Norway, involves characterizing the input and output of mercury in the VCM production industrial sector, and options to reduce the mercury usage therein.

A.1.3 The proposed alternative scenario, GEF focal area strategies, with a brief description of expected outcomes and components of the project

46. The main objective is to demonstrate mercury-free technology and promote BAT/BEPs to reduce mercury release and emission from existing VCM facilities. It will be a long process to switch from the low mercury carbide-based technologies to mercury free technologies due to their technological and economic challenges as well as complexity of the industry. With GEF intervention, mercury-free technology demonstrations, essential for China's mercury phase-out, will be carried out. This project mainly consists of 6 components:

47. **Component 1: Strengthen institutional, regulatory, and enforcement (IRE) capacity in VCM production in China**

48. This component will enhance the policy and regulatory framework for mercury management in the VCM sector. The policy and technical standard is basement of mercury reduction and emission and release control through phase-out of high-mercury catalyst and promotion of cleaner production. Capacity building is the key to effectively implement the regulations and technical standards.

49. With the efforts of the Chinese Government, a preliminary regulatory framework is in place, which provides a baseline for Minamata Convention implementation in China. However, further improvement is necessary to achieve the target. There are substantial needs for cleaner production, reduced mercury emission, industry access to advanced technology, and waste management in VCM plants. Existing mercury emission limits and standards do not match current processes and technologies. There are no strict standards and no specific emission limits from mercury point sources of CCP VCM enterprises. This project will develop or revise these policies and standards。

50. Effective linkage and integrated management are essential to achieve a life cycle mercury management system in the VCM sector. In order to improve capacity building this project will establish an inter-departmental coordination mechanism on mercury reduction in the VCM sector. In addition, new regulations will promote the demonstration and broad implementation of low mercury and mercury-free technologies, in a sustainable way. This project will improve local capacity in prevention, control, monitoring and supervision of mercury pollution via training.

51. **Outcome 1.** Institutional, regulatory, and enforcement capacity to fulfill obligations concerning VCM production sector under the Minamata Convention.

52. Strengthen the institutional, regulatory and enforcement (IRE) capacity of VCM in China so as to fulfill the obligations of the VCM manufacturing industry under the mercury convention. Main outputs include: 1) establishment of an interdepartmental coordination group on mercury reduction in the VCM sector, consisting of MEP, NDRC and MIIT; 2) 9 relevant policies and standards for prevention and control of mercury pollution of VCM industry and 9 policy recommendations submitted to relevant departments for approval; 3) National technical guidance for cleaner production audits in the VCM sector; 4) 3 nationwide investigations or inspections implemented with respect to phasing out high-mercury catalyst in the VCM production industry; 5) 400 environmental management officials or staff trained;6) the environmental management ability and law enforcement capacity strengthened for the MC implementation, especially local EPB where primary mercury mining is still being conducted and 7) a Pollutant Release and Transfer Register (PRTR) system developed.

53. Nine policies and standards will be developed, revised or released during the project implementation period. At first, a multi- ministry joint announcement will be issued to ban new primary mercury mining at the date of entry into force of the Minimata Convention and stop the existing primary mercury mining within fifteen years after that date. "Chlor-alkali industry standard conditions," which describes more stringent industry access conditions will be developed. The document will propose requirements on industrial layout, scale processes and equipment, resources and energy consumption, environmental protection, safety and occupational health, supervision and management. The ban on new mercury or mercury compounds as catalysts for vinyl chloride monomer production process will be considered and covered in this policy in accordance with Article 5 of the Minamata Convention.

54. With respect to environmental protection technology policy, "Mercury pollution control technology policy" and "the Caustic soda and PVC industry pollution control technology policy" for the VCM industry will be developed. "Mercury pollution control technology policy" will propose requirements for the use of mercury catalyst, mercury-containing waste water collection and treatment, mercury-containing waste acid treatment, and disposal of mercury-containing waste. It will also encourage the development of new technologies.

55. National low-mercury catalyst standards in the VCM sector and emission standards for the Chlor-alkali industry will be developed; National low-mercury catalyst standards will specify mercury concentration, sampling, measurement methods, inspection rules and signs, packaging, transportation, storage and security for catalyst.

56. With respect to waste management, the "National Hazardous Waste List" will be revised and "Feasible Technical Guide for Prevention and Control of the Pollution from Treatment and Disposal of Mercury-Containing Waste" will be developed. "Validation of the phasing out of high-mercury catalysts in the calcium carbide-based VCM production enterprises" will be developed to document the elimination of high mercury catalyst in companies.

Table 3 Policies and standards

NO.	Policies and standards	Proposing/issuing organization	Contents related with mercury
1	A multi- ministry joint announcement to ban primary mercury mining	MEP, MLR, NDRC, MIIT and other ministries	Ban on new primary mercury mining at the date of entry into force of the Minimata Convention and stop the existing primary mercury mining within fifteen years after that date.
2	Chlor-alkali industry standard conditions;	NDRC and MEP	Industry access and ban on new facilities using mercury or mercury compounds as catalysts for vinyl chloride monomer production process.
3	Development of the Mercury pollution control technology policy;	MEP	mercury pollution control technology
4	Development of the Caustic soda and PVC industry pollution control technology policy;	MEP	PVC industry pollution control technology
5	Development of national low-mercury catalyst standards in the VCM sector;	General Administration of quality supervision, inspection and quarantine，Standardization Administration	low-mercury catalyst standards
6	Development of emission standards in chlor-alkali industry;	MEP	emission standards
7	National Hazardous Waste List (mercury-containing waste from the VCM sector regarded as hazardous waste);	MEP	mercury-containing waste
8	Feasible Technical Guide for Prevention and Control of the Pollution from Treatment and Disposal of Mercury-Containing Waste	MEP	mercury-containing waste
9	Validation of the phasing out of high-mercury catalysts in the calcium carbide-based VCM production enterprises	MEP	the phasing out of high-mercury catalysts

57. The following 9 draft policies and standards will be finished during the project implementation period. The revised “Catalogue for Guiding the Adjustment of Industrial Structure” draft will call for a "phase-out mercury or mercury compounds as catalysts for vinyl chloride monomer production process step by step according to the development of mercury-free technologies." In environmental technology policy, recommendations will be made for carrying out cleaner production in the both the calcium-carbide-based VCM sector and the ethylene-based VCM sector. Technical guidance for the implementation of BAT/BEP in VCM manufacture, and recommendations for technical policy on mercury-contaminated sites will be finished. Full control of mercury use and emissions for VCM production enterprises and recommendations for implementing a PRTR demonstration in calcium-carbide-based VCM plant will also be put in place. Emission standards for the mercury recycling industry will be finished. Recommendations for economic policy with respect to development and application of mercury-free VCM production technologies will also be finished. The guideline on the environmental remediation of abandoned mercury mines and contaminated sites will be developed and proposed to enforce the mercury mining management.

Table 4 Policy recommendations

NO.	Policies and recommendations	Proposing/issuing organization	Contents related with mercury
1	Recommendation on revision of the Catalogue for Guiding the Adjustment of Industrial Structure	NDRC	Requires a "phase-out of mercury or mercury compounds as catalysts for vinyl chloride monomer production process according to the development of mercury-free technologies."
2	Recommendation on carrying out cleaner production in calcium-carbide-based VCM sectors;	MIIT	cleaner production
3	Recommendation on carrying out cleaner production in ethylene-based VCM sectors;	MIIT	cleaner production
4	Recommendation on the technical guidance of the implementation of BAT/BEP in VCM sectors;	MEP	BAT/BEP
5	Recommendation on the technical policy on mercury contaminated sites;	MEP	mercury contaminated sites
6	Recommendation on carrying out PRTR demonstration in calcium-carbide-based VCM sectors	MEP	Pollutant Release and Transfer Register
7	Recommendation on the emission standards in the mercury recycling sector;	MEP	emission standards
8	Recommendation on the economic policy to promote research, development and application of mercury-free VCM production technologies;	MEP	economic policy
9	Recommendation on the guideline on the environmental remediation of abandoned mercury mines and contaminated sites	MEP	mercury mining management

58. Main activities and outputs of component 1 include:

Output 1.1	**National regulatory policy and regulatory frameworks developed to reduce and eliminate mercury use in industrial VCM production, with focus on mandatory policy to ban the use of high-mercury catalyst;**
Activity 1.1.1	Establish an interdepartmental coordination mechanism on mercury reduction in the VCM sector and hold at least 5 coordination meetings to facilitate project implementation.
Activity 1.1.2	Issue 8 relevant regulations and policies and propose 8 policy recommendations to relevant departments for approval
Output 1.2	**National managerial capacity and enforcement capacity strengthened to coordinate and monitor the VCM production sector;**
Activity 1.2.1	Develop technical guidance on cleaner production audits in the VCM sector
Activity 1.2.2	Implement at least 3 nationwide investigations or inspections on the phase-out of high-mercury catalyst in VCM production
Activity 1.2.3	Organize national training courses for 400 environmental officials or staff on the Minamata Convention and mercury management

59. **Component 2:** Promote technology transfer and investment for the widespread application of BAT/BEP

60. China is still in the R&D and pilot development phase of mercury-free technologies, thus, full-scale demonstration of mercury-free technologies is risky. The high cost of infrastructure investment and uncertainty of success makes VCM enterprises unwilling to invest their own capital in such technologies. And yet for China to fully comply with the Convention, mercury-free methods will gradually have to become key technologies in the VCM production industry. This project will make full use of GEF funding to seed, catalyze and leverage capital ventures and thus encourage enterprises to carry out independent R&D and manufacturing demonstrations.

61. There are two key indicators in this Component. First, the 50% reduction in the relative amount of mercury use for per ton of PVC manufacturing by the year 2020 against 2010 use; second, an annual 360 t mercury use reduction when compared with the baseline in 2014. The strategy for reducing dioxin from oxychlorination processes is prevention of formation where feasible and reduction and elimination of emissions using BAT/BEP.

62. The full implementation of low-mercury catalyst based BAT/BEP is critical to achieving the Annex B requirement to reduce 50% mercury vs. reference year 2010 in per unit VCM production, The content of $HgCl_2$ in the high-mercury catalyst was about 12% in 2010; the low-mercury catalyst should contain less than 6.5% $HgCl_2$.. Moreover, catalyst consumption should decrease from 1.2 to 1.1 kg/t VCM production as a practice of BAT/BEP. When the effective replication and full application of low-mercury catalyst is achieved in 2020, the use of mercury per unit production should be about half of the level in 2010 (6.5%/12%×1.1/1.2 = 0.496). Moreover, production and use of super-low-mercury catalyst (<4%) will ensure the achievement of this target.

63. The quantitative target for mercury reduction is 360 t/y in this proposal. The baseline mercury use was about 1217 t in 2014 with VCM output of 14 million t. The estimated output of VCM is 17.5 million t in 2020 according to the trend of VCM production and sales in these years. When the catalyst consumption is set as 1.1 kg/t VCM and the $HgCl_2$ content is 6.0%, the mercury use is about 853 t (17,500,000×1.1/1000×6.0%×73.85% = 853 tons), and the reduction of mercury use is more than 360 t (1217 – 853 = 364 t). This target is more stringent than the target set in the MC and the $HgCl_2$ content should be lower than the national standard while the catalyst consumption should be 1.1 kg/t VCM with a high conversion ratio. Mercury control will become increasingly difficult under strict environmental management and only the mercury-free technology will be a feasible solution in the long term.

64. **Outcome** 2. Mercury emission and dioxin release reduced from VCM production through promotion of BAT/BEPs and if economical and technically feasible eliminate mercury

65. Communication and cooperation among PVC enterprises, research institutions, new technology holders, social investors and local governments through a public-private partnership (PPP) mechanism (Figure 3) for mercury reduction and minimization in the VCM sector is essential to carry out the demonstration and replication of technology promotion, cleaner production and BAT/BEP.

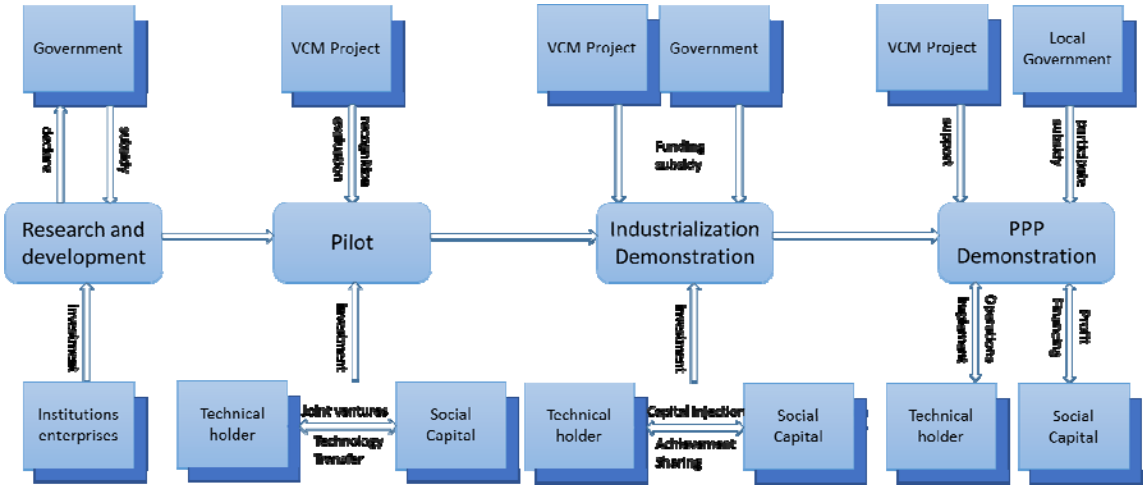

Figure 3 China mercury-free PVC demonstration of PPP-based business model

66. The demonstration enterprises and provinces will be selected based on market principles and in accordance with procurement rules of UNIDO and FECO to meet the following criteria:

- Demonstration provinces should have at least 2 VCM production companies whose production capacity is each more than 200,000 t/y with an average capacity utilization of more than 50% in the past 3 years;
- VCM plants for BAT/BEP Demonstration should each have a capacity no less than 400,000 t/y with an average capacity utilization of more than 80% in recent 3 years, and should have no administrative penalties for environmental violations.

- Candidate technologies for mercury-free demonstration in full-scale operation must be advanced and suitable for investment. Plants and technology suppliers to implement this scale-up must be willing to participate in mercury-free catalyst research and provide co-funding. The final selection will be made based on the evaluation of mercury-free VCM technologies.

67. An expert panel for mercury-free technology evaluation will be commissioned. The expert panel will be composed of international experts, national experts and key stakeholders. The mercury-free technology verification and evaluation criteria and technology guidance of mercury-free process validation will be formulated by this expert panel. The evaluation of this panel will be used as input for the activities under project component 1 and the selection of mercury-free technologies. Demonstration enterprises will be overseen by the expert panel.

68. The mercury-free VCM production demonstration enterprises will be selected in a fair, just and open manner according to evaluation criteria and technology guidance. Assessment of results achieved by previous research ventures will be also highly considered during the selection of demonstration enterprises. Mercury-free production facilities will be put in place to realize an industrial-scale demonstration operation with capacity of more than 10,000 t/y.

69. The technology routes of mercury emission reduction are shown in Figure 4 during VCM production with low-mercury catalyst. The five individual aspects of potential technology improvement are described in subsequent paragraphs. Other BAT/BEPs will also be identified during the process of a cleaner production audit.

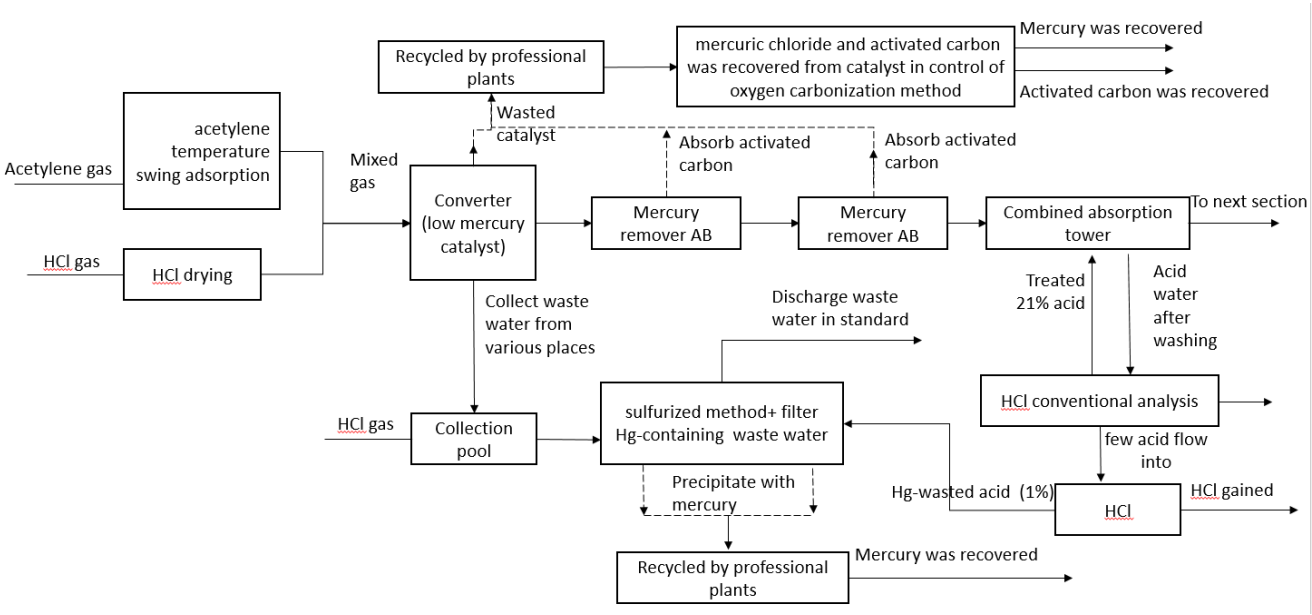

Figure 4 BAT/BEP to reduce mercury emission and release in low-mercury catalyst process

70. Feed gas dehydration technology: In general, water content in feed gas is high (600-800 ppm), which causes corrosion of the equipment and shortens the service life of converters down to 2.5-5 years. Moist catalyst tends to agglomerate, which leads to high mercury consumption. By the use of swing adsorption technology, water content in feed gas can be reduced below 100 ppm to ensure the efficient use of catalyst.

71. Catalyst exchange systems will be put in place using water-ring vacuum pumps to replace catalysts through the pressure differential between the catalyst tank and the converter. With this system the catalyst remains in the converter column tube in the tank. Particles in mercury-waste gas are separated by cyclone. In a further step, bag-type dust collectors remove additional catalyst particles from the air. These catalyst particles are discharged into waste catalyst barrels. The discharged gas from the water-ring vacuum pumps is introduced into waste gas washing devices and mercury is recovered for recycling by adding Na_2S during washing processes.

72. A high-efficiency mercury remover is placed at the converter exit. This system requires significant modifications to the structure of the mercury-remover and on the processing of the adsorbent by dipping the used activated

carbon in certain chemical agents. With this system in place, the efficiency of mercury-removal can reach more than 95%. The activated carbon in the 2-Level mercury remover must be replaced every three months.

73. The hydrochloric acid deep desorbed technology: The converter gas containing 4% ~ 10% HCl cannot be allowed to enter polymerization. HCl must be absorbed after the converter and the mercury-remover. However, the hydrochloric acid contains a large amount of mercury. Insertion of a high-efficiency combination of absorption tower processes can increase the HCl removal rate to more than 93%. In addition, pressure swing and extractive distillation assist to solve the problem of generating waste acid and to efficiently recover HCl gas.

74. Mercury-contaminated wastewater treatment technology: A mercury-water delivery pump moves the liquid into a pH adjustment pool, and pH is increased to 9 ~ 11. Then the water is analyzed for mercury content. Na_2S solution is added according to the Mercury concentration. After this, the solution is pumped into an activated carbon filter equipped with level 2 filtering (two filters in series).

75. Main equipment modification and technical investment: Increase converter capacity by 20% to maintain current throughput, install flowmeter for accurate control and improve feed gas dehydration. Each of the finally selected VCM plants will need one or more of these technological transformations according to their currently installed equipment and processes.

76. As it stands, private sectors are not willing to improve their environmental performance even though there are some policies and standards coming into effect and technologies available. An incentive program is essential to catalyze investment from private sectors to reduce and eliminate mercury emission and release. The incentive program will combine with existing main instruments including fiscal, monetary, tax, and insurance to allow the private sector to access the technologies and experience gained from demonstrations. At the same time, the proposed project will help private sectors identify more opportunities to get financial support from local government and central government after they achieved good environmental benefits, especially related with mercury.

77. Main activities and outputs of component 2 include：

Output 2.1	**Public-Private Partnership (PPP) established to promote R&D, venture capital investment and technology transfer;**
Activity 2.1.1	Design and develop a PPP mechanism in the VCM sector to promote industry venture capital investment and technology transfer
Activity 2.1.2	Organize 2 PPP-based venture capital investment and technology transfer promotion workshops
Output 2.2	**Environmental Technology Verification (ETV) methodology established to verify the performance of low-mercury and mercury-free alternatives by an expert panel;**
Activity 2.2.1	Hold expert panel meetings for alternative technology in VCM industry
Activity 2.2.2	Formulate a standard for evaluating mercury-free VCM production technologies;
Activity 2.2.3	Evaluate and verify at least 2 new mercury-free VCM production technologies;
Output 2.3	**Demonstration of low-mercury BAT/BEPs in 4 coal-based VCM companies and of mercury-free alternatives in a coal-based VCM company;**
Activity 2.3.1	Guide the cleaner production audits in the pilot VCM plants
Activity 2.3.2	Implement technology modification following BAT/BEP principles in 4 carbide or ethylene based VCM production plants for mercury or dioxin emission reduction as a means of demonstration;
Activity 2.3.3	Demonstrate a coal-based mercury-free VCM production line with a production capacity larger than 10,000 t/y, running stably;
Output 2.4	**Incentive program designed and implementation of major instruments (fiscal, monetary, venture capital, insurance etc.) to allow the private sector to access the technologies and experience gained from demonstrations;**
Activity 2.4.1	Design incentive program for low-mercury and mercury-free alternatives
Activity 2.4.2	Organize 2 promotion and communication workshops for low-mercury and mercury-free alternatives
Output 2.5	**Replication of BAT/BEPs and of feasible mercury-free alternatives in 15 coal-based VCM companies nationwide;**
Activity 2.5.1	Replicate cleaner production audits and BAT/BEP using low-mercury technologies in no less than 15 VCM plants
Activity 2.5.2	Conduct 2 supervisory inspections on the running of BAT/BEP in the VCM plant

78. **Component 3:** Promote the recovery of mercury from mercury-containing waste from VCM production

79. This component relates to recovery of mercury from mercury-containing waste in the demonstration provinces. About 74% of mercury from this process is left in spent catalysts and about 21% is in the activated carbon. About 4% of mercury is in waste acid and 1% of mercury is in waste alkali. The recovery of mercury from spent catalyst and waste activates carbon is key to promote the cycle of mercury in VCM sector and reduce reliance on primary mercury mining.

80. **Outcome 3. Promote the recovery of mercury from mercury-containing waste in VCM production process.**

81. In order to implement environmentally sound management of mercury wastes from VCM operations, it is important to know the types and the quantities of mercury wastes generated. The pollutant release and transfer registry is a good tool to know where mercury is generated and transferred. Its implementation in the mercury catalyst manufacturing, selected VCM producer and recycling plants would be helpful to document the mercury lifecycle.

82. Increase mercury recovery from mercury-containing wastes from VCM production. Main outputs include: PRTR implemented in all the mercury catalyst manufacturing and recycling plants to know the relevant mercury flow information and mercury-containing waste management situation; sampling, analysis and waste characterization of mercury-containing waste in the VCM sector; a national mercury waste inventory of the VCM industry established based on a combination of field research and questionnaire survey; establish a mercury accounting system in one pilot province; demonstrate a full-process environmentally sound management system for mercury-containing wastes generated in mercury catalyst manufacturing & recycling and VCM plants cleaner production audits and technology modification to ensure that a) 100% of spent catalyst and waste activated carbon containing mercury used in demonstration plants will be sent to the recycling plants; b) 90% of the mercury from waste mercury catalyst and waste activated carbon in the demonstration plants will be recovered and recycled c) 100% of the recycled mercury from demonstration plants will go back to VCM manufacture plants; d) 100% recycling plants will adopt PRTR system to monitor mercury flow from upstream to downstream; and e) the non-renewable mercury-containing waste will be disposed in an environmentally sound manner.

83. Main activities and outputs of component 3 include：

Output：3.1	**Development of a national inventory for high-mercury-containing waste;**
Activity 3.1.1	Compile a technical guidance on PRTR in the VCM sector;
Activity 3.1.2	Implement PRTR demonstration in all the mercury catalyst manufacturing and recycling plants;
Activity 3.1.3	Conduct PRTR and field investigation on mercury-containing waste in 15 VCM enterprises;
Activity 3.1.4	Compile a national inventory of mercury waste of the VCM industry based on a combination of field research and survey questionnaire.
Output：3.2	**Mercury recovery rate enhanced on mercury-containing waste nationwide;**
Activity 3.2.1	Demonstrate a whole process environmentally sound management system for mercury-containing wastes of the VCM sector by establishing a mercury accounting system in a pilot province;
Activity 3.2.2	Develop a technical guide for mercury recycling from waste catalyst and activated carbon
Activity 3.2.3	Develop a technical guide for safe disposal of and risk prevention from mercury-containing acid, wastewater treatment sludge and the residual produced from waste mercury catalyst and waste activated carbon after mercury recycling;
Activity 3.2.4	Hold training to improve capacity on the management of mercury wastes, treatment and disposal techniques for about 300 trainees
Activity 3.2.5	Conduct cleaner production audits and technology modification in 2 mercury catalyst recycling plants to promote mercury recovery from waste catalyst and activated carbon and safe disposal of the non-renewable mercury-containing waste;

84. **Component 4**: Contaminated site identification and risk reduction associated with VCM production

85. This component will develop an inventory of mercury-contaminated sites associated with VCM production and conduct a preliminary risk assessment (level and scope) on typical mercury-contaminated sites from VCM production. With a long history of mercury usage in VCM sector, mercury-contaminated sites become a potential risk to local environment and human health caused by bankruptcy, relocation and close of carbide-based VCM production plants. An inventory and preliminary risk assessment will be helpful to develop a national management strategy.

86. **Outcome 4. Appropriate strategies developed for identifying and assessing mercury-contaminated sites from VCM production**

87. The number of mercury-contaminated sites caused by VCM related production activities is not well known, therefore, establishing an inventory is an important baseline for any further work in this field. At least 2 sites will be selected for investigation and risk assessment, and measures to reduce risk will also be suggested.

88. The inventory of contaminated sites in VCM-related sectors and the preliminary risk assessment are the basis for characterization of mercury risk on the inventory of potential sites. China has had an overall framework for contaminated site investigation and risk assessment, but needs practical and professional guidance on specific contaminated sites, especially for remediation. This will be the basis for the further national strategy formulation on the environmentally sound management of mercury-contaminated sites in the carbide-based VCM sector.

89. Main activates and outputs of component 4:

Output 4.1	**Inventory of mercury contaminated sites developed from VCM production plants;**
Activity 4.1.1	Collect information on mercury-contaminated sites and develop principles for creating a priority list of mercury contaminated sites in VCM sectors;
Activity 4.1.2	Preliminary site investigation on the mercury-contaminated sites in VCM sector;
Activity 4.1.3	Compile a national inventory of mercury-contaminated sites in VCM sector;
Output 4.2	**Preliminary risk assessment (level and scope) on typical mercury-contaminated sites from VCM production;**
Activity 4.2.1	Conduct risks impact assessment in at least 2 mercury-contaminated sites of VCM sector
Activity 4.2.2	Prepare environmental risk management measures for the mercury-contaminated sites after RIA
Output 4.3	**Strategy proposal for the reduction of the health risk and environmental impact and remediation;**
Activity 4.3.1	Establish guidance on the guide values to start up risk assessment and take remediation actions for mercury-contaminated sites in the carbide based VCM sector;
Activity 4.3.2	Develop technical guidance on the remediation of mercury-contaminated sites in the carbide-based VCM sector;
Activity 4.3.3	Formulate a strategy on the environmentally sound management of mercury-contaminated sites in the carbide-based VCM sector.

90. **Component 5：** Information dissemination and awareness raising among stakeholders

91. Experience exchange and knowledge sharing is essential to involve relevant stakeholders in project activities and to raise awareness about environmental and social concerns of mercury usage during production. Therefore, a broad range of stakeholders directly or indirectly involved in VCM production will be actively invited to participate in training sessions to provide inputs to project design and implementation as well as follow up activities disseminating project results and lessons learned to the general public and internal audience.

92. **Outcome 5. Promotion of knowledge, experience and lesson sharing and environmental awareness raising among stakeholder groups**

93. The main outputs of this component focus on enhancing the participation of stakeholders in mercury pollution and control actions and to disseminate knowledge of mercury pollution and its negative effects on human health and the environment.

94. This will be achieved by providing training and workshops to a broad set of stakeholders, which focus on the dissemination of project results to at least 500 participants (female/male). The trainings will be documented by the minutes of meetings and training manuals prepared.

95. Awareness-raising activities are designed to fully utilize different media channels and to promote a wide range of public participation among more than 1 million people. Information exchange will also be ensured by the organization of at least two stakeholder meetings including the participation of NGO's and other relevant stakeholders. A serial of specific awareness-raising activities will be conducted focusing on stakeholders related with primary mercury mining to reduce the reliance on mercury from primary mining, including:

- Awareness raising activities on mercury risk will be carried out in local communities and schools, where primary mercury mining is still being conducted.
- Awareness raising activities on mercury risk and national action plan to implement the Minamata Convention will be conducted among local financial instituations, where primary mercury mining is still being conducted, thereby taking full account of the risks of national compliance when local finacial instituations issuing subsidies and loans to enterprises of primary mercury mining.

96. Main activities and outputs of component 5：

Output 5.1	**Training provided to disseminate project results (concerning component 1, 2 , 3);**
Activity 5.1.1	Organize trainings and awareness raising campaigns to improve information and experiences sharing
Activity 5.1.2	Hold at least 2 stakeholder workshops
Output 5.2	**Raise awareness among government, private and civil society stakeholder groups;**
Activity 5.2.1	Promote extensive public participation through internet, mass media that will cover more than 1 million people
Activity 5.2.2	Organize awareness-raising workshops or activities with NGO's participation

97. **Component 6**：Monitoring and Evaluation

98. This component will assess the results of project activities including lessons learned. Central to this will be the periodic monitoring of project indicators and the finalization of Mid-term and Terminal Evaluation during the implementation of project cycle. The project monitoring and evaluation framework will be established in accordance with UNIDO and GEF requirements including the tracking tools indicators.

99. Main activities and outputs of component 6：

Output 6.1	**Periodic monitoring and evaluation**
Activity 6.1.1	Design and implement the Monitoring and Evaluation framework in accordance with UNIDO and GEF requirements(inception workshop, annual project reports and disseminate report etc.);
Output 6.2	**Midterm and terminal evaluation report**
Activity 6.2.1	Conduct independent Mid-term review and terminal evaluation

A.1.4 incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, and co-financing;

100. The project objective is to reduce human health and environmental risk from mercury in response to the Minamata Convention. By conversion to low-mercury catalyst and mercury-free catalyst technology in VCM industrial production, GEF funds' intervention will help China to reduce mercury use per unit of product in VCM/PVC industry by 50% by the year 2020. With GEF funds support, VCM/PVC industry will pay more attention to convention performance and actively participate in related activities. GEF funds can help to mobilize all relevant resources (such as capital, land, labor and technology resources) and gradually achieve a phase out of mercury and control of mercury pollution through the use of alternative products.

101. China has enacted progressively stricter environmental policies and standards for the VCM industry over the past few years related to VCM industry access, new plant construction, manufacturing processes and mercury catalyst products. A number of governmental departments are involved in the prevention and management of mercury

pollution in VCM and mercuric chloride catalyst manufacturing sites including national, local and sector administrative departments. The project will further strengthen regulatory and institutional frameworks of the sector by the development of 8 relevant policies and standards issued for prevention and control of mercury pollution of VCM industry and 8 policy recommendations submitted to relevant departments for approval.

102. Mercury emission control and reduction of its use in VCM production in China is a difficult and long process requiring huge capital investment. The intervention and support of GEF will speed the process. Recently, China has increased funding for mercury-free catalyst research. GEF funding will be used as a seed fund to catalyze and leverage capital ventures and thus encourage enterprises to carry out independent R&D and manufacturing demonstration.

103. The demonstration of mercury-free technology and low-mercury BAT/BEP conversion in more than 15 VCM enterprises requires investment of US$67.68 million. GEF assistance of US$10.78 million is mainly used to support mercury-free technology verification and demonstration in order to achieve the priority goal of reduction of local, regional and global environmental risk from mercury catalyst use. The demonstrations and eventual replacement of high-mercury catalyst will require 15 enterprises to revise the heat transfer system of their converter, install a flow meter, build a new converter, and upgrade the raw material gas dehydration process, resulting in the need for investment.

104. Assistance of technology will help to improve the mercury regulatory framework and improve the system and technical ability. BAT/BEP transformation in VCM enterprises is mainly achieved through supporting funds. The co-financing funds from VCM plants are more than seven times the GEF investment for BAT/BEP conversion and mercury-free demonstration. Co-financing will provide major parts of the investment for mercury reduction, cleaner production, mercury recovery, and BAT/BEP implementation.

105. GEF funds help promote domestic co-financing and promote the mobilization of social resources. As shown in the co-financing table of Annex I, a significant amount of co-financing has been committed by various entities (see table C as a reference) which is even higher than the amount mentioned during PIF-stage. By far the largest portion of co-financing will support the demonstration and replication of mercury-free and low mercury alternatives in coal-based VCM companies (around US$ 67 million). Additional substantial co-financing is committed to the recovery of mercury from mercury-containing waste in VCM production processes (around US$ 14 million). The remaining amount of total co-financing contribution will support the implementation of various activities of the project dedicated to the development and update of policies and standards (component 1), identification and assessment of mercury contaminated sites (component 4), experience exchange and awareness raising (component 5) and monitoring evaluation of project results (component 6).

106. The Chinese government highly supports the implementation of the convention on mercury. The State Council appointed the Ministry of Environmental Protection as the leading ministry of China to be responsible for mercury convention negotiation and implementation. The FECO/MEP established a mercury working group to provide technical assistance, and is responsible for the routine coordination and management matters.

107. This GEF project will promote innovation on technology demonstration and application, government management and mercury elimination strategies. This will be a cost-effective approach to reduce the use and emission of mercury in VCM production. From an operational perspective, research and development and technology transfer of low-mercury catalyst and mercury-free catalyst know-how will help to improve the environmental performance of private sector enterprises and reduce mercury emissions and releases. From a management perspective, innovative incentive programs will encourage the application of new technologies to eliminate market barriers. National policy reforms to the private sector by increasing compliance with this specific regulatory and legal framework will facilitate the development of China's green industry. Those comprehensive strategies and measures will ensure the cost-effectiveness of this FSP.

A.1.5 global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF);

108. Because China’s VCM production accounts for approximately 30% of the total global mercury production and consumption, this project will significantly contribute to global efforts to reduce mercury production, use and emissions to the environment. By 2020, mercury use per ton of VCM production will be reduced by 50%

compared with referential year of 2010 through optimization of production. Research, development and application of mercury-free catalyst will be promoted. Without this project, mercury use would reach about 1520.8 t for production of 17.5 million t carbide-based VCM in 2020. With the project, that use would be halved to approximately 857.7 t of mercury use in 2020, resulting in reduction of about 360.5 t mercury usage in VCM industries from current levels. The project will also decrease significantly the risk to human health and the environment by implementing BAT/BEP to reduce unintentional mercury emissions. The project will also reduce 3 g I-TEQ dioxin/Furan emission to air and 4 g I-TEQ dioxin/furan release to residue depending on prevailing technology in the selected demonstration facility. Moreover, Ninety percent of the mercury remaining in spent catalyst and waste activated carbon will be recycled (about 500-700 t). Risk of mercury to human health and environment will be reduced by the promotion of new technologies in the private sector and awareness-raising among the general public. The lessons learned will be shared nationwide and internationally such as via UNIDO mercury initiatives.

109. This project will also promote technologies that bring synergistic benefits in controlling GHG emission such as liquid-phase catalysts. Because the liquid-phase catalytic reaction system does not use a solid carrier, it has more efficient heat transfer, avoids local overheating and reduces catalyst sublimation. This prolongs the service life of the catalyst, reduces consumption, and thus saves costs and resources.

A.1.6 Innovativeness, sustainability and potential for scaling up

A.1.6.1 Innovativeness

110. This project will be the first initiative to demonstrate low-mercury catalyst technologies and mercury-free alternatives in China and then will provide implementation of these environmentally preferable techniques nationwide. Taking into consideration the difficulties and technological state of mercury reduction in China's VCM production industry, the project has designed a systematic and staged mercury reduction solution. The first stage aims to realize the transition from using high-mercury to low-mercury catalyst, and to reduce mercury emission to the environment, thus meeting the first requirement of convention compliance. In the meantime, there will be focus on the demonstration and replication of mercury-free technology to facilitate the achievement of the ultimate goal - a complete phase-out of mercury in the whole VCM industry.

111. Capital mechanism innovation. This project makes fully use of the GEF funding as the seed fund to catalyze and leverage social venture capital investment, and to conduct feasibility studies on the incorporation of PPP as a mechanism for implementing mercury pollution prevention and control in the calcium carbide-based Chinese VCM industry, which will provide capital guarantee for the laboratory R&D, pilot, demonstration and ultimate commercialized applications of mercury free technologies.

112. The project adopts a whole-process mercury management approach for VCM production by establishing demonstration provinces wherein comprehensive control of mercuric chloride catalyst production, mercury catalyst use, mercury reduction technologies, mercury catalyst recycling technology and mercury contaminated site management in VCM industry will be implemented.

113. PPP is an innovative mechanism to leverage investment from private sectors to carry out the demonstration and replication of technology promotion, cleaner production and BAT/BEPs.

A.1.6.2 Sustainability

114. Capacity building. Various entities in the country ranging from government ministries and local governments, CSOs and private sectors will be strengthened by the project activities, which will provide a basis for the sustainable development of VCM sector to replicate experiences and BAT/BEPs gained from the project. Meanwhile, MEP and FECO will conduct a series of training programmes to improve technical capacity and awareness-raising of local stakeholders and the public, which will ensure the sustainability of the project.

115. Establishment of policies and a regulatory system. During the international mercury convention negotiation, China MEP reached out to the VCM industry to explain the importance placed by the Chinese government on mercury pollution prevention. After dialoging with industry, MEP developed guidance and issued a series of industrial

policies to establish a foundation for the promotion of mercury pollution prevention and control in VCM production. In addition, there will be continuous development and revision of mercury emission standards for the low-mercury catalyst VCM production process during the implementation of the project. Strengthening enforcement will help to ensure the sustainability of project results with the support of NDRE, MEP and MIIT and other relevant Ministries.

116. Establishment of technology research system. A group of technology research institutes in China has been created to promote mercury pollution prevention and control in the VCM production industry. At present, low-mercury catalyst and waste mercury catalyst recovery have been researched and developed, laying the technical foundation for mercury reduction in VCM production.

117. Demonstration of the feasibility of low-mercury technology. Based on the mercury pollution prevention and control technology demonstration, an advanced technology inventory will be assembled and promoted by the government. MEP will set up a special group to implement the national low-mercury industrial policy. Enterprises which refuse to implement this policy will be identified and penalized. Other punitive measures, such as fines and reduction in financial support, will be taken by local governments and financial institutions to guarantee the effective implementation of national policies.

118. Demonstration of the feasibility of mercury-free technology. Presently, many enterprises and research institutes are researching mercury-free catalyst. In China, both mercury-free processes and mercury-free catalysts are being developed. China's approval of preferred technologies will be informed by the requirements of the international environmental conventions. Economic feasibility and operability will also be considered so as to increase the likelihood of adoption by VCM producers.

119. Education of CCP-VCM companies. Through extensive publicity, VCM production enterprises will realize the importance of mercury reduction, become familiar with mercury pollution prevention and control technologies, and actively take part in mercury reduction activities, which will lay the public foundation for project implementation.

A.1.6.3 Potential For Scaling Up

120. Although there are many VCM production enterprises, they have relatively similar technology. The project will fully take into account factors including a strategic selection of pilot enterprises to conduct mercury reduction BAT/BEPs demonstration, and mercury-free technologies and process demonstration. In addition, the project will formulate standards for evaluating mercury-free VCM, which will give a clear direction for private sectors to select and invest for mercury-free technologies in future.

121. By carrying out demonstration of mercury emission reduction BAT/BEPs in the VCM production process, the project will promote the development and update of point source mercury emission regulatory standards for the whole industry, and give impetus to other relevant enterprises to independently replicate project demonstration results to meet the emission requirements.

122. A public-private partnership mechanism for mercury reduction and minimization in the VCM sector will be established. The PPP mechanism will take full advantage of public funds to leverage much more investments from private sectors to replicate achievements gained from demonstration projects by implementing fiscal, tax and insurance incentive.

A.2. Child Project? If this is a child project under a program, describe how the components contribute to the overall program impact.

N/A

A.3. Stakeholders. Identify key stakeholders and elaborate on how the key stakeholders engagement is incorporated in the preparation and implementation of the project. Do they include civil society organizations (yes ☒ /no☐)? and indigenous peoples (yes ☐ /no☒)? [8]

123. The stakeholders of the project include national and local administrative departments, industrial associations, technical support institutions, enterprises and the public.

124. National administrative departments mainly refer to FECO, MEP, NDRC, MIIT, as well as others.

125. The Foreign Economic Cooperation Office (FECO), part of the Ministry of Environmental Protection of China, is the project executing agency. FECO is responsible for coordinating the day-to-day management of the Minamata Convention implementation in China.

126. The activities carried out by MEP include:

- Lead the development of a national coordination mechanism at ministry level for VCM industry to implement the mercury convention;
- Lead the development or revision of the policies on prevention and control of pollution of VCM industry;
- Participate in the revision of the Catalogue for Adjustment of Industrial Structure and industrial access policy;
- Organize the enforcement of the phase-out of high-mercury catalysts in CCP VCM manufacturing enterprises.

127. The activities mainly carried out by NDRC is to lead the revision of relevant policies on the Catalogue for Adjustment of Industrial Structure.

128. The activities mainly carried out by MIIT include:

- Lead the development of a ministry-level national coordination mechanism for implementation of mercury convention for VCM industry;
- Lead the revision of the industrial access policy as the head organization;
- Participate in the enforcement of the phase-out of high-mercury catalysts in CCP VCM manufacturing industry.

129. Local administrative departments mainly refer to local administrative institutions at province, municipal and county levels corresponding to national administrative departments. Local administrative departments mainly carry out the following activities:

- Systematically monitor mercury release of typical enterprises of CCP VCM industry;
- Actively take part in relevant training on the control of mercury pollution and implementation of mercury convention;
- Actively support the completion of other relevant work of national administrative departments.

130. Industrial associations mainly include China Petroleum and Chemical Industry Federation, China Chlor-Alkali Industry Association, China Chemical Industry Environmental Protection Association, China Council for Industrial Environmental Protection, European Chlor and others. The industrial associations mainly carry out the following activities:

- Organize the demonstration of mercury-free technology and extension of low-level mercury technology in relevant enterprises;
- Help enterprises complete low-mercury technology and process reform and follow-up operation;
- Organize meetings on promoting venture investment and technology transfer in VCM industry;
- Organize meetings on promoting substitution and extension of low-level mercury & mercury-free

[8] *As per the GEF-6 Corporate Results Framework in the GEF Programming Directions and GEF-6 Gender Core Indicators in the Gender Equality Action Plan, provide information on these specific indicators on stakeholders (including civil society organization and indigenous peoples) and gender.*

technology in VCM industry;

- Study the incentive program for substitution and extension of low/no mercury technology in VCM industry;
- Study and develop PPP mode for promoting BAT/BEP in PVC industry;
- Conduct feasibility study on mercury-free VCM technology as well as its demonstration;
- Help to organize the environmental education and awareness-raising activities.

131. Technical supporting organizations include research institutes and enterprises in relation to VCM and mercury and mainly carry out the following activities:

- Develop and revise the policy of VCM industry on prevention and control of mercury pollution;
- Help national administrative departments check on the phase-out of high-level mercury catalysts;
- Study the incentive program on low/no mercury technology substitution and extension of VCM industry;
- Establish the National Inventory of mercury-containing waste of VCM industry;
- Conduct demonstration work on whole-process recycling and reuse of mercury-containing waste in VCM industry;
- Conduct whole-process cleaner production audit on recycling and treatment process of mercury-containing wastes and demonstration work on enhanced management of mercury wastes in VCM industry;
- Develop National Inventory of mercury contaminated sites of VCM industry;
- Organize relevant national training on the control of mercury pollution and implementation of the mercury convention;
- Organize the activities on publicizing project findings;
- Carry out publicity and training on relevant findings;
- Develop the technological verification platform for manufacturing of low-level/no mercury VCM;
- Study the standard for examination and assessment of mercury-free production technologies;
- Verify mercury-free VCM manufacturing technology.

132. Here, enterprises refer to CCP VCM manufacturing enterprises, mercuric chloride catalyst manufacturing enterprises as well as waste mercury catalyst recycling and disposal enterprises. These enterprises mainly carry out the following activities:

- 15 CCP VCM manufacturing enterprises complete low-mercury technology and process reform of VCM enterprises;
- Follow-up supervision on technical operation of the 15 CCP VCM manufacturing enterprises;
- Conduct demonstration on recycling and reuse of mercury-containing wastes in the whole process of VCM manufacture;
- Attend project findings extension and training activities on improvement of environmental awareness;
- Support administrative department to finish supervision monitoring and inspection.
- Actively take part in the activities of implementation of mercury convention;
- Attend meetings on findings of this project and on raising environmental awareness;
- Access knowledge about mercury pollution and its prevention through media such as internet, newspaper and TV;
- Support industrial associations and technical support institutions as they complete relevant work.

133. Main public participation is through mass media such as the internet, television and newspaper, so as to raise awareness of mercury pollution prevention and strengthen mercury-free product choices. NGOs and CSOs, such as Friends of Nature, All-China Environment Federation or China Environmental Protection Association will be invited in the inception workshops and encouraged to involve in the whole process of project implementation. A Stakeholder Consultation Plan has been developed to address the programmatic issues and environmental and social risk management associated with this project. The scheduled consultations are listed in Table 6.1 of the ESMP (Annex K).

134. The All-China Women's Federation, also known as the ACWF, is responsible for promoting government policies on women, and protecting women’s rights within the government. It will involve in this project for mainstreaming gender issues during implementation of the project.

A.4. Gender Equality and Women's Empowerment. Elaborate on how gender equality and women's empowerment issues are mainstreamed into the project implementation and monitoring, taking into account the differences, needs, roles and priorities of women and men. In addition, 1) did the project conduct a gender analysis during project preparation (yes ☒ /no☐)?; 2) did the project incorporate a gender responsive project results framework, including sex-disaggregated indicators (yes ☒ /no☐)?; and 3) what is the share of women and men direct beneficiaries (women 40%, men 60%)? [9]

135. Recognizing that the level of exposure to mercury and its related impacts on human health are determined by social and biological factors, women, children and men might be exposed to different kinds, levels and frequency of mercury, therefore, gender mainstreaming will be an integral part of this project.

136. Exposure to mercury is particularly dangerous for children as well as pregnant and breastfeeding women, since mercury is most harmful in the early stages of development. Scientists found that even small amounts of mercury can interfere with brain development. Therefore, gender mainstreaming will be an integral part of this project. Particularly in output 1.1, during integrating the prevention and control of mercury pollution of PVC industry, the project will consider gender and especially gender-related health issues. Additionally, awareness-raising materials will be prepared in output 5.2 targeted to children in kinder garden and women in their childbearing years, especially to those who live nearby mercury catalyst manufacturing companies and CCP-VCM manufacturing companies. Meanwhile, a specific topic on mercury exposure to women and children will be prioritized in training workshops for stakeholders in the same output.

137. The key to enhancing women's opportunities, and hence their position in the VCM sector is to provide them with access to know-how, technologies and credit. In output 3.2, a training session to upgrade women's technological capabilities in VCM production is at the heart of enabling women to advance in more rewarding positions. In this project, participation of women will be one of key indicator for the training of cleaner production audit in output 2.3. In addition, under the same component 2, a gender expert will be recruited as part of the Environmental and Social Management Planning team. The expert will ensure gender integration during demonstration and replication phase of this project and analyze in cooperation with specialized organizations in China on potential risks for affected communities, refine gender related indicators, guide planned consultations, provide inputs to mitigate health risks for woman and for potentially affected groups. For Output 4.3, the expert will contribute to the design of a strategy proposal for the reduction of health risk and environmental impact and remediation.

A.5. Risk. Elaborate on indicated risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, the proposed measures that address these risks at the time of project implementation.(table format acceptable):

[9] Same as footnote 8 above.

Risks*	Level	Mitigation measures
Key agencies and stakeholders might not attach sufficient importance and allocate sufficient resources to mercury supervision	Low	Focus on stakeholder awareness-raising as a priority.
NGOs and enterprises might not be willing to participate in outreach activities	Low	Raise public awareness and provide sufficient training
Mercury catalyst producers might not be willing to recycle the mercury and transfer to low-mercury catalyst production.	Low	A policy for extended mercury producer responsibility will be issued and enhanced monitoring will be implemented under the support of industry associates.
VCM producers might not be willing to cooperate and transfer to the low-mercury catalyst	Low	The low-mercury technology is technically ready to be adopted by the industry. Further policy support in the form of the phase-out of high-mercury catalyst production and use will be issued, combined with introduction of a proper price mechanism. An incentive program and PPP model will be established to promote R&D and technology transfer of low-mercury technology.
Delayed demonstration of mercury-free alternatives in VCM sector due to higher cost than expected and low efficiency.	Medium	A step-by-step strategy will be implemented from small to large scale to ensure the cost-effectiveness of the mercury-free alternatives in VCM sector through the transferring of international experience.
Climate change might affect the implementation of project activities	Low	Climate change scenarios will be taken into consideration for all selected facilities

*More details on environmental and social risks assessment and corresponding mitigation measure are elaborated in the Environmental and Social Management Plan (ESMP) attached as Annex G

A.6. Institutional Arrangement and Coordination. Describe the institutional arrangement for project implementation. Elaborate on the planned coordination with other relevant GEF-financed projects and other initiatives.

A.6.1 Project Institutional Arrangement for Project Implementation

138. Project management structure is shown in Figure 5

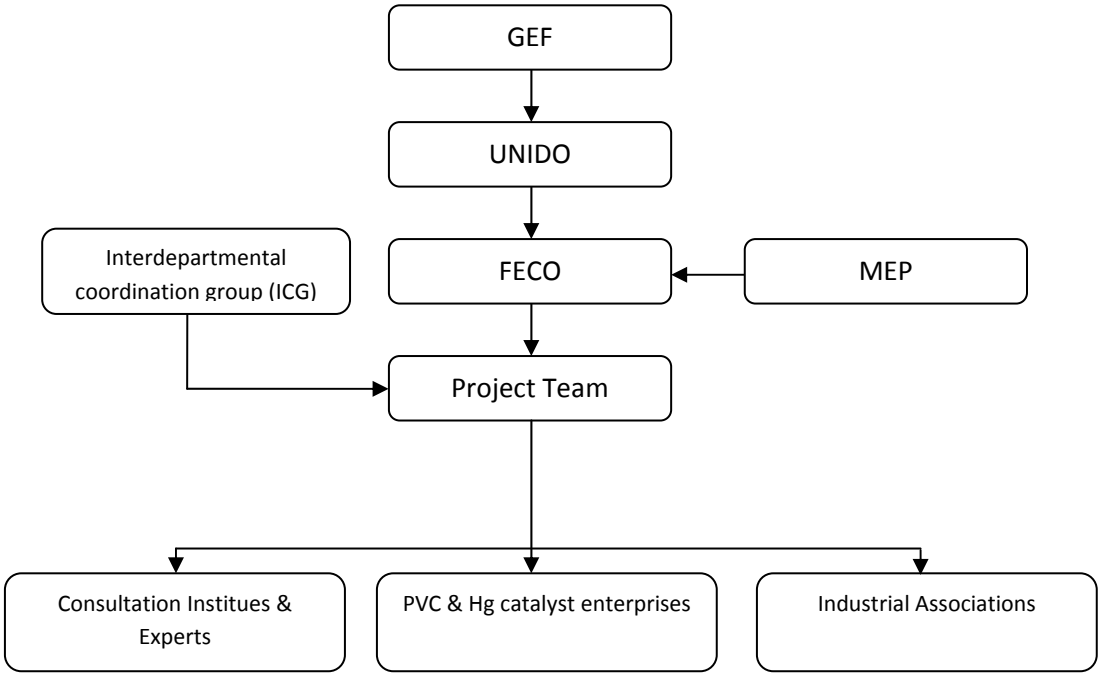

Figure 5 Project management structure

139. **The GEF** acts as financial mechanism for the Minamata Convention on Mercury and is the partnership for international cooperation for this project.

140. **UNIDO** is (i) the GEF Implementing Agency (IA) for the project and (ii) UNIDO will provide some administrative and technical execution support to the project, details see Annex H. A project manager will be appointed by UNIDO to supervise the project.

141. The Foreign Economic Cooperation Office (FECO), part of the Ministry of Environmental Protection of China, is the project executing agency. FECO is responsible for coordinating the day-to-day management of the Minamata Convention implementation in China. The FECO's responsibilities will include (i) assignment and supervision of project activities; (ii) recruitment of national consultants; (iii) coordination with stakeholders, donors, the IA, relevant national agencies and the private sector; (iv) preparation of terms of reference (TORs) for project activities; (v) project procurement in accordance with UNIDO procedures, (vi) organization and execution of project coordination stakeholder meetings, and (vii) review of project outputs.

142. MEP, as the competent environmental protection administrative department of the State Council, is mainly responsible for developing and implementing plans, policies and standards for environmental protection; organizing the development of zoning of environmental function areas; supervising prevention and control of environmental pollution; coordinating and addressing key issues on environmental protection; as well as the development and implementation of environmental policies, supervision on law enforcement and coordination of trans-administrative region environmental matters. The administrative department responsible for prevention and control of the pollution of VCM industry is mainly the Department of Soil Environment Management. Its main responsibilities include national supervision and management of prevention and control of soil, solid wastes, chemicals and heavy metals pollution; developing and organizing the implementation of relevant policies, plans, laws, administrative regulations, sector regulations, standards and norms; as well as domestic implementation of relevant international conventions. Therefore, MEP takes charge of unified supervision and management of the

prevention and control of pollution in whole process of production, use and recycling of VCM and mercury catalysts as well as implementation of the international conventions.

143. The project will establish an inter-departmental coordination group (ICG). The ICG will consist of MEP MIIT, NDRC, and any other relevant agency. The ICG will employ, on an ad-hoc basis, resources from related ministries or commissions in charge of development and reform, environment, health, construction, and industrial development to provide the project team with political guidance and inter-ministerial coordination support. The ICG's responsibilities include: (i) provision of technical support for international negotiations and policy studies on the Minamata Convention, (ii) provision of support for development and implementation of PVC-related policy and regulations, as well as coordination of key governmental stakeholders, (iii) mobilization of co-financing from bilateral, international, and national sources. The NSC will provide guidance to ensure the successful execution of the project, including regular monitoring and enforcement inspections. The ICG will ensure that any proposed changes or amendments to the project and/or to the annual work plan [AWP] and budgets are done in accordance with the approved project document, the GEF policy C.39/inf 3 and UNIDO rules and regulations.

144. **Consultation institutions and experts** are major technical supporters of the project, including relevant Chinese and international research organizations, companies and individual experts engaged in management and technologies for VCM and mercury pollution. Advisory institutions and experts will finish the compilation and revision of policy recommendations, development of the program on extension of low-mercury and demonstration of or non-mercury VCM technologies, development of relevant technical guidance as well as supervision and assessment of project findings.

145. **VCM and mercury catalyst related enterprises** are major targets of the project. They will carry out mercury-free demonstration in relation to mercury reduction and pilot of ESM of low-mercury BAT/BEP as well as mercury-containing wastes and contaminated sites. In 2014, there were 89 PVC enterprises in China, 72 of them utilized VCM produced via CCP. These manufacturing enterprises are mainly located in 6 provinces in northwestern part of China: Inner Mongolia, Xinjiang, Shaanxi, Qinghai, Ningxia and Gansu. There were 22 mercury catalyst manufacturers with total output of 16800 t. They were mainly concentrated on provinces and autonomous regions of Guizhou, Inner Mongolia, Ningxia, Xinjiang and Hebei.

146. **The industrial associations** involving PVC and mercuric catalyst production In China, mainly include China Petroleum and Chemical Industry Federation, China Chlor-Alkali Industry Association, China Environmental Protection Association of Chemical Industry and China Council for Industrial Environmental Protection. These associations will help implement relevant industrial policies, coordinate manufacturers and users of mercuric catalyst (VCM manufacturers); and facilitate technology transfer and facility retrofitting so as to meet project objectives. In addition, the China Petroleum and Chemical Industry Federation and the China Chlor-Alkali Industry Association will also help FECO coordinate and organize project activities by providing technical/poliocy advisory and services.

A.6.2 The planned coordination with other relevant GEF-financed projects and other initiatives.

147. Three GEF projects were approved during GEF5: Among them, the "Zinc Smelting Industry Mercury Emissions Reduction and Sound Chemicals Management Promotion Project", aims at reducing atmospheric mercury emissions and their impact on human health and environment by sound chemical management in the zinc smelting industry. Experiences gained and lessons learned from two demonstration projects of the Zinc smelting industry mercury emission reduction will be valuable for the VCM project implementation. The "Pilot Project of China Mercury Inventory Compilation" (2013-2014) enables local and national stakeholders to implement the proposed project and assist the Chinese government in the preparation of a sound national performance plan. The UNIDO/GEF MIA project (2014-2016) will assist China in fulfilling its obligations under the convention and China will make the sound management of chemicals a top priority of the national sustainable development agenda. This project will be fully coordinated with the focus of the work identified in MIA, where VCM production is the most important mercury-using production process. The FECO/MEP, as the execution agency for the three projects is moving forward as planned to ensure the expected outcomes achieved

148. One component of the Pilot Project on the Development of Mercury Inventory in China is to build the mercury inventory in the VCM industry in two demonstration provinces (Guizhou and Hunan) and a draft action plan to reduce mercury emission, which is closely related to this project. The mercury inventory in the VCM industry will help to know better of the current situation of the VCM industry in two demonstration provinces, and also increase China's capacity to control mercury pollution in that industry. Also VCM sector was identified as the priority mercury emission and source for intervention in the MIA project. Based on the results of MIA activities, technical and financial needs for successful mercury reductions in VCM sector will be assessed to support efficient implementation of Minamata Convention at the national level.

A.7 *Benefits.* Describe the socioeconomic benefits to be delivered by the project at the national and local levels. How do these benefits translate in supporting the achievement of global environment benefits (GEF Trust Fund) or adaptation benefits (LDCF/SCCF)?

149. The purpose of the VCM Project is to reduce risks to human health and impact to the environment from industrial production of Vinyl Chloride Monomer mainly through trial application of mercury-free alternatives in a coal-based VCM company and application of low-mercury catalyst and BAT/BEPs in 15 coal-based VCM companies nation-wide. Through these activities, the VCM Project can also reduce production costs of these enterprises and promote sustainable development of the PVC industry. In 2010, Chinese total consumption of mercury was 837 t for VCM production and mercury consumption per unit product is about 98.5 g/t. In 2014, Chinese total consumption of mercury was 1217 t for VCM production and mercury consumption per unit of product is about 86.9 g/t. After the implementation of the VCM Project, mercury-containing catalyst will be used to produce 17.5 million t VCM and mercury consumption will be 857.5 t, accounting for mercury consumption per unit product of 49 g/t. This will achieve about a 50% reduction of mercury use per unit of production by the year 2020 (reference year 2010). Mercury consumption will be reduced by 360.5 t compared to 2014. With high-mercury technology, 33.12 g mercuric chloride/t VCM would be released into hydrochloric acid and alkali liquid compared to 3.6 g mercuric chloride/t for low-mercury technology. Thus, release of mercury into waste liquid with low-mercury technology is only 10% of that in conventional high-mercury technology. The release of mercury into waste gas with low-mercury technology is also 10% of that in conventional high-mercury technology. Since mercury and its derivatives are highly toxic, these kinds of reduction in emissions are significant for the protection of environment and human health.

150. Replacement of high-mercury catalyst with low-mercury catalyst will also save about US$6.5 million per year. Thus, over 10 years, VCM production enterprises will save US$65 million. For the application of low-mercury BAT/BEPs, enterprises will upgrade their environmental pollution treatment process by installing highly-efficient mercury-removal devices, hydrochloric acid deep desorption technology, a catalyst pumping system, separated rain and sewage systems, and a sulfide precipitation process. The waste solids containing mercury will obviously be reduced. The reduction of mercury usage will result in less money spent on mercury pollution control and treatment. With the VCM Project, the generation of waste catalyst and waste activated carbon would be reduced by 347 t, which will save US$52.58 million in costs of recycling mercury from waste catalyst and activated carbon by distillation. The release of mercury into hydrochloric acid and alkali liquid using low-mercury technology will be 335 t less than that of high-mercury technology. This also results in money saving of US$30 million. In summary, the enhancement will save about US$82.58 million per year. Over a projected 10-year lifespan, the reduction of cost is US$825.8 million.

151. In the VCM Project, a nano-Au catalyst may be used as mercury-free alternative. Total catalyst life-cycle cost for nano-Au catalyst is about US$15/t VCM. For a 0.4 million t/y VCM synthesis plant with 100 reactors cooled by water, if high-mercury technology is changed into low-mercury technology, the cost for modification will be about US$3.75 million. However, if high-mercury technology is changed into mercury-free technology with nano-Au catalyst, the cost for modification is only US$1.50 million. Moreover, additional VCM capacity that could be produced is about 20,000~40,000 t/y. Also, catalytic acetylene-dichloroethane reforming technology may be used for mercury-free technology demonstration. For the demonstration of catalytic acetylene-dichloroethane reforming technology with output of 10,000 t/y VCM, the enterprises will save about US$15,200 compared to the high-mercury technology for the purchase of catalyst. Catalytic acetylene-dichloroethane reforming technology will require EDC that can be purchased in the market or produced from newly built production process. The price of EDC fluctuates in the market. If the market price is US$300/t, the cost of catalytic acetylene-dichloroethane reforming technology for 1 t VCM production is about US$75 less than calcium carbide based VCM production process. However, these data need be verified by pilot tests with higher output.

152. Through implementation of the low-mercury technology in this project, mercury discharge to the off-gas, liquid and solid waste generated per t of VCM will be controlled to less than 10% of the current level. The reduction of mercury release into environment will obviously decrease the economic impact of the hazard posed by mercury on environment and human health, which is inestimable.

153. The VCM Project can promote the sustainable development of the PVC industry and has no recognizable adverse effects on society. As there is much similarity between the low-mercury and high-mercury processes, workers who are responsible for high-mercury process can also operate low-mercury process after adequate training. Neither the construction nor operation of the VCM Project will result in obvious un-employment for the local community nor should it cause concern about hiring locals in the subproject area or for the enterprises producing mercury catalyst and VCM production industry. While no negative social impact from the project is foreseen, mitigation measures have been developed in table 3.1 of the ESMP. The project will provide VCM production enterprises with strong technical support and application experience, which will help them to reduce mercury production, use and emissions to the environment and conduct the activities to prevent mercury pollution. It also will help the Chinese PVC production enterprise to study foreign successful experience about cleaner production, and to improve its efficiency and competitiveness. All of these promote the sustainable development of the PVC production industry.

154. The project will not only green existing VCM industries on mercury emission control and reduction but also create new green industries during demonstrating and replicating mercury free technologies. New businesses and gender balanced jobs will be established accordingly depending on updated skills in order to implement new technologies and cleaner production processes.

A.8 *Knowledge Management.* Elaborate on the knowledge management approach for the project, including, if any, plans for the project to learn from other relevant projects and initiatives (e.g. participate in trainings, conferences, stakeholder exchanges, virtual networks, project twinning) and plans for the project to assess and document in a user-friendly form (e.g. lessons learned briefs, engaging websites, guidebooks based on experience) and share these experiences and expertise (e.g. participate in community of practices, organize seminars, trainings and conferences) with relevant stakeholders.

155. The project can share experiences gained from UNIDO/GEF MIA project. The MIA project has conducted campaigns and trainings to improve public awareness on mercury pollution, which will be a foundation for the proposed project to carry out further training in VCM sectors, especially focusing on VCM related industrial workers, local communities nearby the VCM manufacturing companies and consumers. In addition, an national wide inventory from MIA project will be a basis to conduct a VCM sector specific inventory during the project implementation.

156. UNIDO is actively coordinating with the Minamata Convention secretariat on technical consultation aspects of project implementation and will learn from their experience. Also the project involves demonstrations of BAT/BEPs and related policies in China, and the results will be shared with the public through awareness-raising campaigns, e.g. publications, presentations, gender and children-related publications. For governmental and industrial stakeholders the results will be summarized and distributed for replication. Lessons learned from introducing environmentally sound production patterns in the VCM sector and its integration into global commodity chains can be shared with other production sectors, regions and countries. The project related information published on UNIDO open data platforum and FECO website will be open to public

157. The experience gained from cleaner production audits and demonstration projects could also be shared with other developing countries through the Global Network for Resource Efficient and Cleaner Production (RECP net) of UNIDO. It aims at contributing to the effective and efficient development, application, adaptation, scaling up and mainstreaming of RECP concepts, methods, policies, practices and technologies in developing and transition economies, both at the regional and global level. It also targets at facilitating inter-regional and South-South cooperation with regards to RECP-relevant knowledge, experiences and technologies.

B. Description of the consistency of the project with:

B.1 *Consistency with National Priorities.* Describe the consistency of the project with national strategies and plans or reports and assessments under relevant conventions such as NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, etc.:

158. The project is highly consistent with the national strategies of environmental protection in China. In 2010, the Ministry of Industry and Information Technology issued "Cleaner Production Technologies in Calcium Carbide Process PVC Industry," which listed low-mercury catalyst, hydrochloric acid desorption technology and mercuric chloride sodium hydrosulfide processing technology as cleaner production technologies. In 2011, the State Council issued "State Council Notification on the Issuance of Industrial Transition and Upgrading Plan (2011-2015)," which defined the phasing out of high-mercury catalyst of the calcium carbide process in the VCM production. In 2011, the Development and Reform Commission issued the "Guiding Catalogue of Industrial Structure Adjustment (2011 version)," which listed high-mercury catalysts and facilities using high-mercury catalyst in VCM production as a technology to be eliminated. In 2012, the Ministry of Environmental Protection issued the "Catalogue of Environmental Protection Technology Encouraged by the Nation in 2012," and listed low-mercury catalyst technology as the preferred environmental protection technology. In 2013, the Ministry of Environmental Protection issued "The Twelfth Five-Year Plan on the Chemical Environmental Risk Prevention", which highlighted the promotion of low-mercury catalyst technologies in VCM industries and highly effective mercury recovery technologies as one of the main priority areas.

159. The Chinese government has made high efforts to control mercury pollution and signed the Minamata Convention on October 10, 2013. UNIDO/GEF MIA project will set China on the right path to fulfilling its obligation under the Minamata Convention and place sound chemicals management at the forefront of the national sustainable development agenda. The proposed project will be fully aligned with priorities identified in MIA, since VCM production is the most important manufacturing process in which mercury is used.

C. Describe the budgeted M&E plan:

160. Project monitoring and evaluation (M&E) will be conducted in accordance with established UNIDO and GEF procedures. The M&E activities are defined under project component 6 and the M&E budget is in the table below. Monitoring will be based on indicators defined within the project results framework and complemented by the annual work plans. The GEF tracking tool will also be used as monitoring and evaluation tool, and will be submitted three times during the duration of the project (CEO approval, mid-term and at project closure).

161. UNIDO as Implementing Agency will involve the GEF Operational Focal Point, national executing counterparts and project stakeholders at all stages of project monitoring and evaluation to ensure that evaluation results lead to improved project design and implementation.

162. In accordance with the Monitoring and Evaluation policy of the GEF and UNIDO, follow-up studies like Country portfolio evaluations and thematic evaluations can be initiated and conducted. All project partners and contractors are obliged to (i) make available studies, provide reports or other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities.

M&E Activity Categories	Reporting	Responsible Parties	GEF Grant Budget ($US)	Co-financing Budget ($US)	Time frame
Measurement of GEF Tracking Tool specific indicators	Mid-term Review and Terminal Evaluation Reports	FECO	30,000	180,000	At project mid-term and completion
Monitoring of project impact indicators (as per Log Frame)	Annual GEF PIR	FECO	90,000	540,000	Annually
Prepare Annual Project Reports	Annual project report (APR) and	FECO and UNIDO	100,000	600,000	Annually
Midterm review	Mid-term Review report	Independent evaluator, PM, UNIDO	40,000	240,000	At project mid-term

Independent terminal evaluation	Terminal evaluation report	Independent evaluator, PM, UNIDO EVQ	40,000	240,000	Project completion
Total indicative cost			300,000	1,800,000	

163. Day to day monitoring of project implementation progress will be the responsibility of the National Project Manager based on the project's Annual Work Plan and its indicators. The Project Team will inform UNIDO of any delays or difficulties faced during implementation so that the appropriate support or corrective measures can be adopted in a timely and remedial fashion.

164. The Project Manager, and the expert team will fine-tune the progress and performance/impact indicators for the project in consultation with the full project team at the Inception Workshop. Specific targets for the first-year implementation progress indicators together with their means of verification will be developed in this workshop. These will be used to assess whether implementation is proceeding at the intended pace and in the right direction and will form part of the Annual Work Plan.

165. UNIDO through meetings with project counterparts or as frequently as deemed necessary, but not less than semi-annually, will undertake periodic monitoring of the project implementation progress. This will allow parties to troubleshoot any problems pertaining to the project in a timely fashion to ensure the smooth implementation of project activities.

166. UNIDO and/or the UNIDO Country Office will conduct visits according to an agreed-upon schedule to be detailed in the project's Inception Report/Annual Work Plan to assess project progress. Other members of the Steering Committee may also accompany these visits. A Field Visit Report will be prepared by UNIDO and will be circulated to the project team and all Steering Committee members no less than one month after the visit.

167. A detailed schedule of project review meetings will be developed by the project management team in consultation with the project implementation partners and stakeholder representatives and incorporated in the Project Inception Report. The schedule will include: (i) tentative time frames for Tripartite Reviews and (ii) project related Monitoring and Evaluation activities.

168. A Project Inception Workshop (IW) will be conducted with the full project team, relevant government counterparts, co-financing partners, UNIDO and appropriate representatives from the UNIDO Country Office (CO), civil society NGOs and private sectors.

169. The objective of this Inception Workshop will be to assist the project team in understanding and assimilating the goals and objectives of the project, as well as to finalize the preparation of the project's first annual work plan on the basis of the project's logframe matrix. This work will include reviewing the logframe (indicators, means of verification, assumptions), imparting additional detail as needed, and completing an Annual Work Plan (AWP) for the first year of project implementation, including measurable performance indicators.

170. Additionally, the IW will: (i) introduce project staff to the UNIDO team, which will support the project during its implementation; (ii) delineate the roles, support services, and complementary responsibilities of UNIDO staff vis-à-vis the project team; (iii) provide a detailed overview of UNIDO reporting and Monitoring & Evaluation (M&E) requirements, with particular emphasis on Annual Project Implementation Reviews (PIRs), the Annual Project Report (APR), Tripartite Review (TPR) meetings, as well as mid-term and final evaluations. Equally, the IW will provide an opportunity to inform the project team on UNIDO project related budgetary planning, budget reviews and mandatory budget rephrasing.

171. Annual Monitoring will occur through Tripartite Review (TPR) meetings, which will take place at least once every year. UNIDO as the implementing agency, FECO as national executing agency and other national key stakeholders will attend the tripartite meeting. The first meeting will be held within twelve months of the start of

the full project implementation. The PMOs will prepare an Annual Project Report (APR) and submit it to UNIDO at least two weeks prior to the TPR for review and comments.

172. Prior obligations and prerequisites: GEF grant assistance will be provided subject to UNIDO being satisfied that obligations and pre-requisites listed below have been fulfilled or are likely to be fulfilled. When fulfillment of one or more of these prerequisites fails to materialize, UNIDO may, at its discretion, either suspend or terminate its assistance.

173. During project implementation, progress reports and PIR reports should be prepared as per monitoring plan of the project.

Project Reporting

174. A Project Inception Report (IR) will be prepared immediately following the IW. It will include a detailed First Year Annual Work Plan divided into quarterly timeframes, which detail the activities and progress indicators that will guide the implementation during the first year phase of the project. The Work Plan will include the dates of specific field visits, support missions from UNIDO and/or UNIDO consultants, as well as timeframes for meetings of the project's decision-making structures. The report will also include the detailed project budget for the first full year of implementation, prepared on the basis of the Annual Work Plan, and including any monitoring and evaluation requirements to effectively measure project performance during the targeted 12 month timeframe.

175. When finalized, the report will be circulated to project counterparts, who will be given a period of one calendar month in which to respond with comments or queries. Prior to this circulation of the IR, UNIDO will review the document.

176. The Annual Project Report (APR) is a UNIDO requirement and part of UNIDO central oversight, monitoring, and project management. It is a self-assessment report by project management to UNIDO, as well as a key input to the TPR. The APR will be prepared on an annual basis prior to the TPR to reflect the progress achieved in meeting the project's Annual Work Plan and assess performance of the project in contributing to the intended outcomes through outputs and partnership work.

177. The Project Implementation Review (PIR) is an annual monitoring process mandated by the GEF. It is an essential management and monitoring tool for project managers and offers the main vehicle for extracting lessons from ongoing projects. Once the project will be under implementation for a year, the project team shall complete the PIR. The PIR can be prepared any time during the year (July-June) and ideally immediately prior to the TPR. The PIR should then be discussed at the TPR so that the result would be a PIR that has been agreed upon by project staff, the national executing agency and UNIDO.

178. As and when called for by UNIDO, the project team will prepare Specific Thematic Reports, focusing on specific issues or areas of activity. The request for a Thematic Report will be provided to the project team in written form by UNIDO and will clearly state the issue or activities that need to be reported on. These reports will be used as a form of lessons learned exercise, specific oversight in key areas, or as troubleshooting exercises to evaluate and overcome obstacles and difficulties encountered.

179. During the last three months of the project, the project team will prepare the Project Terminal Report (PTR). This comprehensive report will summarize all activities, achievements and outputs of the project, lessons learned, objectives met (or not met), and structures and systems implemented. The PTR will be the definitive statement of the Project’s activities during its lifetime. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and reliability of the project’s activities.

Independent Evaluations

180. The project will be subjected to at least two independent external evaluations as follows:

181. **Mid-term Review.** A Mid-Term Review will be undertaken at the end of the second year of project implementation. The Mid-Term Review will measure progress made towards the achievement of outcomes and will identify corrections if needed. The Review will focus on the effectiveness, efficiency, and timeliness of project implementation; highlight issues requiring decisions and actions; and present initial lessons learned on project design, implementation and Environmental and Social Management Plan (ESMP) issues. Findings of this review will be incorporated as recommendations for enhanced implementation during the second half of the project's term. The organization, terms of reference (TOR's) and timing of the mid-term review will be decided after consultation between the parties to the project document. Participation of the technology evaluation expert group and civil society NGOs will be included. The review will also be used to assess target indicators as well as review and consider following two issues in order to probably assess project outcomes.

- The feasibility of replicating mercury free technologies at multiple facilities in the remainder of this project will be discussed by the expert panel, based upon relevant factors such as the preliminary results of demonstration projects, commercial availability and the cooperation of other companies;
- The 2020 mercury consumption goal is estimated to be 857.5 MT during the PPG stage. It will be updated based upon latest production trends and other relevant data;

182. **Terminal Evaluation.** An independent Final Evaluation will take place after the operational completion of the project implementation, and will focus on the same issues as the mid-term evaluation. The final evaluation will also review impact and sustainability of results, including the contribution to capacity development, the achievement of global environmental goals and ESMP issues. The Final Evaluation should also provide recommendations for follow-up activities. The Terms of Reference for this evaluation will be prepared by the UNIDO in accordance with the generic TORs developed by the GEF Evaluation Office.

PART III: CERTIFICATION BY GEF PARTNER AGENCY(IES)

A. GEF Agency(ies) certification

This request has been prepared in accordance with GEF policies[10] and procedures and meets the GEF criteria for CEO endorsement under GEF-6.

Agency Coordinator, Agency Name	Signature	Date (MM/dd/yyyy)	Project Contact Person	Telephone	Email Address
Philippe R. Scholtès, Managing Director, Programme Development and Technical Cooperation, UNIDO-GEF Focal Point		05/29/2017	Riccardo SAVIGLIANO Industrial Development Officer, PTC/ENV/ECR, Department of Enviornment	+43 01 26026 5082	r.savigliano @unido.org

[10] GEF policies encompass all managed trust funds, namely: GEFTF, LDCF, and SCCF

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

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
To reduce risks of mercury on human health and the environment from industrial production of Vinyl Chloride Monomer in China.	- Inclusion of Mercury pollution prevention by the VCM sector into the national environmental management system	- Lack of a national level environmental management on the mercury reduction for the VCM sector;	- Mercury pollution prevention of the VCM sector included into the national environmental management system;	- Texts of revised or new regulations, standards, policies and government documents - Documents for purchase of technical services and equipment - TORs for consulting services - Service contracts - Thematic study reports - M&E reports	- Necessary national, local and industry support is received - Barriers can be successfully removed with effective interventions from this project - Coal-based mercury-free VCM production technologies will be an economically viable option - The regulatory and policy framework established by the project will be
	- Establishment of a coordination mechanism on mercury reduction in VCM sector	- Lack of an interdepartmental coordination mechanism;	- An interdepartmental coordination mechanism on mercury reduction established in VCM sector;		
	- Installation of coal-based mercury-free VCM production lines	- Lack of demonstrations on coal-based mercury-free VCM production	- A coal-based mercury-free VCM production line installed or modified, with a VCM production capacity larger than 10,000 ton per year, running stably;		
	- Implementation of BAT/BEP in the VCM productions using the low-mercury catalyst process	- Lack of BAT/BEP experiences in the VCM sector	- BAT/BEP in the VCM sector demonstrated in 4 plants and replicated in more than 15 VCM plants;		
	- Mercury usage reduction in the VCM sector	- About 98.5 g Hg/t VCM production in 2010	- Mercury use reduced to 49 g (by 50%) in per unit VCM production - An annual 360 t mercury reduction achieved in the VCM sector by the year 2020 (reference year 2014).		

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
	- Mercury recycling in the VCM sector.	- Lack of effective management of waste mercury catalyst recycling	- 90% of mercury recovered from waste mercury catalyst and activated carbon in pilot areas, reducing the use of fresh mercury from primary mining production processes.		maintained and adequately resourced after the project's completion
OUTCOME 1: Institutional, regulatory, and enforcement capacity to fulfill obligations concerning VCM production sector under the Minamata Convention	- Enhanced institutional coordination - Development of technical guidance - Number of trainings and inspections conducted	- Lack of cross department exchange and capacities to apply cleaner production principles - Lack of effective regulations or policies to promote and enforce mercury reduction in the VCM sector.	- At least 5 coordinating meetings held to facilitate project implementation and continues coordination between departments - Training of 400 participants - National industrial development plans revised - 8 regulations developed or revised	- Coordination meeting reports - Training reports - Newly developed or revised regulations and policies	- Government agencies are open to cooperate - Endorsement of new or updated policies by national agencies
Output: 1.1 National regulatory policy and regulatory frameworks developed to reduce and eliminate mercury use in industrial VCM production, with focus on mandatory policy to ban the use of high-mercury catalyst	- Establishment of a coordination mechanism on mercury reduction in VCM sector	- Lack of an interdepartmental coordination mechanism;	- An interdepartmental coordination mechanism on mercury reduction established in VCM sector, consisting of MEP, NDRC and MIIT;	- Minutes and reports on the coordination mechanism and the coordinating meetings	- Key government agencies accept the coordination mechanism
	- Formulations or revisions of the regulations and policies in the VCM sector	- Lack of effective regulations or policies to promote mercury pollution prevention, mercury-free and low mercury VCM production technologies and target on mercury – containing waste	**National and industrial development plans** - Mercury pollution prevention in the VCM sector included into the national environmental management system; - Promotion of mercury-free and low-mercury VCM production technologies included into the industrial	- Reports on standards, guidelines, and specifications developed, proposed, and adopted	- Governments will endorse and adopt the required standards, guidelines and specifications according to the project timeline

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			development plan. **9 relevant regulations and policies developed or revised** - A multi- ministry joint announcement to ban primary mercury mining; - Chlor-alkali industry standard conditions; - Development of the mercury pollution control technology policy; - Development of the Caustic soda and PVC industry pollution control technology policy; - Development of national low-mercury catalyst standards in the VCM sector; - Development of emission standards in the chlor-alkali industry; - National Hazardous Waste List (mercury-containing waste from the VCM sector regarded as hazardous waste); - Feasible Technical Guide for Prevention and Control of the Pollution from Treatment and Disposal of Mercury-containing Waste; - Validation of the phase-out of high-mercury catalysts in the calcium-carbide-based VCM production enterprises **Policy recommendations**		

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			drafted on 9 regulations: - Recommendation on revision of the Catalogue for Adjustment of Industrial Structure and industrial access policy: high-mercury catalyst-based VCM production categorized into the phase-out group. - Recommendation on carrying out cleaner production in calcium-carbide-based VCM sectors; - Recommendation on carrying out cleaner production in ethylene-based VCM sectors; - Recommendation on the technical guidance of the implementation of BAT/BEP in VCM sectors; - Recommendation on implementing a PRTR demonstration in calcium-carbide-based VCM sectors - Recommendation on the technical policy on mercury-contaminated sites; - Recommendation on the emission standards in the mercury recycling sector; - Recommendation on the economic policy to promote research, development and application of mercury-free VCM production technologies;		

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			- Recommendation on the guideline on the environmental remediation of abandoned mercury mines and contaminated sites		
Output: 1.2 National managerial capacity and enforcement capacity strengthened to coordinate and monitor the VCM production sector	- Development of technical guidance on cleaner production in the VCM sector - Number of investigations or inspections related to the phase-out of high-mercury catalysts in the VCM production industry - Number of participators accepting training on the Minamata Convention and mercury management	- Lack of technical guidance on cleaner production in the VCM sector - Lack of investigations or inspections related to the phase-out of high-mercury catalysts - Lack of specific training for related personnel	- Technical guidance on cleaner production in the VCM sector developed - At least 3 nationwide investigation or inspections implemented on the phasing out of high-mercury catalysts in the PVC production industry - 400 environmental management officials or staff (female/male) trained.	- Reports on standards, guidelines, and specifications developed, proposed, and adopted - Investigation or inspection reports - Training minutes and reports	- Key government agencies accept and promulgate new guidelines - Key stakeholders can be effectively involved throughout the process
OUTCOME 2: Mercury emission and dioxin release reduced from VCM production through promotion of BAT/BEPs and if economically and technically feasible eliminate mercury	- Promotion workshops for venture capital investment held and incentive program designed - Verification of performance for low-mercury and mercury-free technologies - Replication of BAT/BEPs	- Lack of technology transfer and economic incentive programs to promote mercury-free and low-mercury technologies - Lack of experience and limited test results for technology verification and replication	- Promotion workshops held and incentive program designed - Tested mercury-free and low mercury technologies verified - Replication of technologies at 15 VCM production plants	- Minutes of workshops - Report on incentive program - Reports on test results - Reports on technology modification	- Key project stakeholders show strong commitment for technology transfer and verification - Selection of alternative technologies with proven

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
					test results and being economically feasible
Output 2.1 Public-Private Partnership (PPP) established to promote R&D, venture capital investment and technology transfer	- Number of promotion workshops held on venture capital investment and technology transfer through PPP mechanism	- Lack of sufficient capital and technology transfer in the PVC industry	- PPP mechanism in the VCM sector designed and developed to promote industry venture capital investment and technology transfer - 2 venture capital investment and technology transfer promotion workshops held through the PPP mechanism	- Minutes and reports on the PPP mechanism and the venture capital investment workshops;	- Key government agencies and stakeholders can be effectively involved throughout the process
Output 2.2 Environmental Technology Verification (ETV) methodology established to verify the performance of low-mercury and mercury-free alternatives by an expert panel	- Development of ETV expert panel to evaluate and verify the performance of low-mercury and mercury-free technologies - Number of the alternative VCM production technologies evaluated	- Lack of independent evaluation for mercury-free VCM production technologies - Lack of experiences on the ETV implementation for the VCM alternative technologies	- An expert panel established on mercury-free VCM production technologies, 5 meetings held to facilitate the ETV implementation; - A standard proposed for evaluating mercury-free VCM production technologies; - At least 2 new mercury-free VCM production technologies evaluated;	- Minutes on the ETV promotion meetings - Standards or guidelines proposed - Evaluation reports	- Key industrial stakeholders accept the standards or guidelines proposed
Output 2.3 Demonstration of low-mercury BAT/BEPs in 4 coal-based VCM companies and of mercury-free alternatives in a coal-based VCM company;	- Capacity demonstration of coal based low-mercury & mercury-free VCM production	- Lack of mature coal based low-mercury & mercury-free VCM technologies	- Cleaner production audits and technology modification following BAT/BEP principles implemented in 4 carbide or ethylene based VCM production plants for mercury or dioxin emission reduction as a means of demonstration; - A coal-based mercury-free VCM production line	- Reports on the cleaner production audits and technology modification - Service contracts signed - M&E reports	- Coal-based mercury-free VCM production technologies will be an economically viable option - Key industrial stakeholders

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			modified with a VCM production capacity larger than 10,000 t/y, running stably		are active on the technology modification
Output 2.4 Incentive program designed and implementation of major green instruments (fiscal, monetary, venture capital, insurance etc.) to allow the private sectors to access the technologies and experience gained from demonstrations	- Development of policy and economic incentive mechanism to promote mercury-free and low-mercury VCM production - Number of promotion workshops	- Lack of policy and economic incentive programs to promote mercury-free and low-mercury VCM production	- Incentive mechanism and program designed and developed using major green policy and economic instruments to promote mercury-free and low-mercury VCM production in the PVC sector; - 2 promotion workshops held	- Reports on the policies and program to promote green instruments - Minutes of the workshops	- Key government agencies and industrial owners accept the inception mechanism
Output 2.5 Replication of BAT/BEPs of feasible mercury-free alternatives in 15 coal-based VCM companies nationwide;	- Number of enterprises implementing BAT/BEPs in the VCM sector - Reduction of mercury use in the VCM sector	- Most of the VCM production enterprises process with high-mercury catalyst technologies -	- Cleaner production audits and BAT/BEP using low-mercury technologies implemented in more than 15 VCM plants - 2 supervisory inspections conducted on the running of BAT/BEP in the VCM production enterprises - Mercury use reduced by 50% per unit VCM production by 2020 - Annual 360 t mercury reduction achieved in the VCM sector by the year 2020 (reference year 2014).	- Reports on the cleaner production audits and technology modification - Service contracts signed - M&E reports	- Key PVC producers can be effectively involved throughout the process - No strong resistance from the industry on the promotion of low-mercury technologies
OUTCOME 3: Promote the recovery of mercury from mercury-containing waste in VCM	- Baseline situation of mercury waste investigated and mercury recovery rate enhanced	- Lack of technologies and experience for mercury recovery and limited data of waste amounts	- PRTR developed and established - National inventory established - Mercury waste management	- Report on PRTR - Inventory summary - Guidance	- Cooperation of stakeholders to access and analyze data

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
production process.			guidance developed and sound management of mercury containing waste demonstrated	developed - Cleaner production protocols	- Strong involvement and commitment of local governments and industries to ensure putting new standards into practice
3.1 Development of a national inventory for high-mercury containing waste	- A national inventory of mercury-containing waste in the VCM sector.	- Lack of mercury flow information and mercury-containing waste inventory in the VCM sector.	- Technical guidance on PRTR in the VCM sector. - PRTR implemented in all the mercury catalyst manufacturing and recycling plants to know the relevant mercury flow information and mercury-containing waste management situation. - PRTR and field research conducted in at least 15 VCM enterprises, characterization of the situation of mercury-containing waste generation from the CCP VCM process - Sampling, analysis and waste characterization of mercury-containing waste in the VCM sector. - A national mercury waste inventory of the PVC industry established based on a combination of field	- Reports on the guidelines developed - Reports on the PRTR implementation - Sampling and analysis reports - National mercury waste inventory developed	- Key industrial stakeholders will follow the guidelines proposed

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			research and questionnaire survey.		
3.2. Mercury recovery rate enhanced on mercury-containing waste nationwide;	- Recovery of 90% of the mercury from waste mercury catalyst and waste activated carbon.	- Lack of effective mercury management and properly guided mercury recovery practices.	- Whole process environmentally sound management of mercury-containing wastes demonstrated in the mercury catalyst manufacturing & recycling and VCM plants through mercury accounting system in a pilot province. - 100% of the recycled mercury from demonstration plants will go back to VCM manufacture plants; - Cleaner production audits and technology modification in 2 mercury catalyst recycling plants to ensure that 90% of the mercury from waste mercury catalyst and waste activated carbon is recycled, and the non-renewable mercury-containing waste is disposed of safely. - A technical guide developed on the mercury recycling from waste catalyst and active carbon. - A technical guide developed on the safe disposal and risk prevention from of the mercury-containing acid, wastewater treatment sludge and the residual produced from waste mercury catalyst	- Reports on the cleaner production audits and technology modification - Service contracts signed - Reports on the guidelines developed and proposed - Minutes on the training workshops	- Local government agencies and industrial stakeholders are active on the enforcement of mercury management

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
			and waste activated carbon after mercury recycling; - Mercury-containing waste management capabilities built and processing technology trainings carried out for PVC industry covering 300 people (female/male).		
OUTCOME 4: Appropriate strategies developed for identifying and assessing mercury contaminated sites from VCM production	- Investigation of mercury contaminated sites including risk assessment conducted and strategies for future management proposed	- Lack of knowledge about contaminated sites and experience on how to assess risks	- Develop inventory data for VCM related contaminated sites - Conduct preliminary risk assessment - Develop strategy proposal	- Report on Inventory development and risk assessment - Finalized strategy paper	- Key industrial stakeholders can be effectively involved throughout the process - Key industrial stakeholders accept the technical guidance proposed
4.1 Inventory of mercury-contaminated sites developed from VCM production plants;	- Establishment of the national contaminated-site inventory of the VCM industry.	- Lack of a national mercury-contaminated site inventory of the VCM industry	- A national mercury contaminated site inventory of the VCM industry established based on a combination of field research and questionnaire survey.	- National mercury contaminated site inventory developed	
4.2 Preliminary risk assessment (level and scope) on typical mercury-contaminated sites from VCM production	- Implementation of risk assessment of mercury contaminated sites.	- Lack of the experience on the risk assessment of mercury-contaminated sites in the VCM sector.	- Site investigation and risks impact assessment conducted in at least 2 mercury contaminated sites of VCM sector	- Reports on the site investigation and risk assessment	
4.3 Strategy proposal for the reduction of the health risk and environmental impact	- Development of technical guidelines for mercury pollution sites in the VCM industry. - Implementation of	- Lack of effective management of mercury-contaminated sites in the VCM sector.	- Guide values to start up risk assessment and take remediation actions proposed for mercury contaminated sites in the	- Reports on guidelines and strategies developed	

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
and remediation	trainings on mercury contaminated site management.		carbide based VCM sector. - Technical guidance developed on the remediation of mercury contaminated sites in the carbide based VCM sector; - A strategy formulated on the environmentally sound management of mercury contaminated sites in the carbide-based VCM sector.		
OUTCOME 5: Promotion of knowledge, experience and lesson sharing and environmental awareness raising among stakeholder groups	- Raised awareness among project stakeholders - Workshops conducted to disseminate project results	- Lack of relevant training and knowledge about mercury pollution and project milestones - Lack of broad stakeholder participation and consultation	- Trainings provided for around 500 participants (female/male) - Raised awareness of different stakeholder groups by holding of information sessions and publishing of project information on different channels	- Minutes and training report; references of published material	- NGOs and other stakeholders will be effectively involved in the workshops and activities
5.1 Training provided to disseminate project results (concerning component 1, 2 ,3)	- The promotion of project outcomes and organization of publicity activities.	- Lack of effective stakeholder participation in the mercury pollution control actions	- Training, workshops and other activities organized to exchange experience and knowledge gain from the project - NGOs and other stakeholders of the organizations participated in the project activities.	- Minutes on the training, workshops and other activities	
Output 5.2 Awareness raised among government, private and civil society stakeholder groups	- Number of stakeholders involved in the project activities.	- Lack of training and information dissemination on knowledge of mercury pollution and its negative effects on human	- Information exchange meeting or activities held for more than 2 times for stakeholders. - Improved environmental awareness among more than 500 participants	- Reports on the stakeholder involvement - Leaflets, new media and other mass media developed	

Outcomes & outputs	Indicators	Baseline	Targets	Sources of verification	Assumptions
		health and the environment	(female/male). - Leaflets, new media and other mass media prepared to share project information and to promote a wide range of public participation among more than 1 million people.		
OUTCOME 6: Monitoring and Evaluation	- Number and timely preparation of monitoring and evaluation reports		- Project reports verifying project performance (e.g. inspection reports, audit reports, Evaluation reports)	- Assessment reports and related documentation	
6.1 Periodic monitoring and evaluation	- Number of project start reports. - Number of annual implementation plans. - Number of annual reports. - Number of GEF-PIR reports. - Field trips. - Number of project financial audit reports.		- One project inception report. - Five annual implementation plans. - Five annual reports. - Five GEF-PIR reports. - Ten or more site inspection reports. - Five Project financial audit reports.	- Project inception report. - Annual implementation plans - Annual reports. - PIR reports - Site inspection reports. - Financial audit reports.	
6.2 Midterm and terminal evaluation report	- Mid-term review - Terminal evaluation		- Mid-term Review Report - Terminal Evaluation Report	- Mid-term Review and Terminal Evaluation Report	

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

Comments from Council, Convention Secretariat and STAP	Responses to Project Reviews
Looking specifically at the case of China, the STAP found significant work done in the country that does not seem to have been recognized in the PIF, which would be useful for future project development. The Royal Society of Chemistry has discussed the case of China in its 2013 Catalysis Series (Royal Society of Chemistry. 2013. Volume 13. "Environmental Catalysis over Gold-based materials". Eds George Avgouropoulos; Tatiana Tabakova), noting the preference for the coal-based, ethyne hydrochlorination process and use of mercury chloride catalysis, but also that ironically enough, the ethyne hydrochlorinaation process was one of the first reactions to show gold's huge potential as a catalyst, and that gold on carbon is now under investigation at industrial scale in China as a sound replacement to mercuric chloride. They further indicate that from a commercial perspective, Johnson Matthey is active in China, having already filed patents in China, along with other China-based organizations. Further investigation by the STAP found that since 2011, Johnson Matthey, partnered with JacobsEngineering Group out of the Netherlands and UNEP to carry out a joint multi-year private-public initiative that specifically focuses on commercializing an economically feasible, mercury free catalyst for the manufacture of vinyl chloride monomer (VCM) using China as the focal country for efforts. This so-called Jacobs / JM partnership area has also been informing the Minamata Convention, and baseline feasibility reports and the like are readily available online (see http://www.unep.org/chemicalsandwaste/Mercury/PrioritiesforAction /VinylChlorideMonomerProduction/tabid/4523/Default.aspx). Therefore, one has to question the thoroughness of baseline research undertaken for this PIF, since it claims to be the first effort towards finding non-mercury alternatives, and yet it would appear that there is so much evidence of serious investment and demonstration into mercury-free catalysis for VCM/PVC production, including the Foreign Economic Cooperation Office, Ministry of Environmental Protection of the People's Republic of China. In STAP's view, the project relies on very weak scientific support for researching alternatives to mercury in VCM production, while the scientific literature clearly indicates that there is significant previous work in this domain in China that the PIF does not acknowledge nor incorporate into the conceptualization of this initiative. STAP proposes therefore that UNIDO should reach out to Agencies such as UNEP (UNEP Mercury Partnership and the Science officer of the Convention Secretariat in particular) to first go over the feasibility of earlier work in this domain, and to establish which alternatives have been identified as the most viable for China. STAP's review of the literature would appear to indicate that alternatives such as gold catalysis are tested and viable, but a more rigorous discussion with partners, the	As the executing agency of the project, FECO/MEP is the leading agency in China for the Minamata convention intergovernmental negotiation and implementation. Before the PIF's preparation stage, FECO cooperated with UN organization and bilateral governments to carry out a joint private public initiative on R&D progress and feasibility study of mercury-free catalyst in China. The output report "Status and importance of R&D and pilot demonstration of mercury-free catalysts, 2011" prepared by FECO was recognized by the Secretariat of Minamata Convention and provided a solid base for the PIF preparation work. In this report, the precious metal catalyst developed by Sonning Common R & D Center of Johnson Matthey in the UK was reviewed.[…]*The experiments conducted by the Sonning Common R & D Center of Johnson Matthey in the UK show that, the mercury-free catalyst can produce the activity higher than that of the mercury catalyst. At present, the company has started cooperation with Chinese enterprises. In addition to the technical issues which call for further verification, the operating cost and economy of the company are also difficult to be determined* […]. At the same time the report highlighted that: […]*The oversea mercury-free catalyst researches in recent years have mainly focused on some precious metal salts, which are characterized in better reactivity but poor industrial application due to high cost.* It also mentioned that: […]*The enormous funding gap at each stage during the research and development of the mercury-free catalyst has also been an important factor restricting the research and development of the mercury-free catalyst to some extent.* These studies and other background investigations showed that mercury-free catalyst was not in a commercial running but only a pilot plant operation. In order to understand the application of various technologies in China more deeply, UNIDO and FECO are actively approaching Johnson Matthey, Jacobs Engineering Group and some other mercury-free catalyst suppliers. In November, 2015, the UNIDO team and FECO, national experts and representatives from the CCAIA, the Chinese Academy of Sciences and the Chinese University of Mining and Technology visited both Johnson Matthey company in Shanghai and the pilot plant in Xinjiang Tianye where the mentioned gold catalyst had being tested in 2011 and 2012. In the first single-tube reactor test, the gold catalyst had been in a stable operation for nearly 10000 h. While in the second

scientific community, the private sector, as well as the relevant Chinese Ministries could help significantly in fine tuning the design of the project, and ensure the most effective use of GEF resources based on recent advances in technology and lessons learned. Some additional points:- 1) The Tianjin University School of Chemical Engineering and the School of Chemistry and Chemical Engineering of Shihezi University in Xianjing, have also published significantly on cleaner production processes/non-mercury catalysts for the Chinese VCM/PVC industry. 2) The Xinjiang Tianye (Group) Co., Ltd, largest calcium carbide PVC manufacturer in China also appeared to be one of the local private sector partners involved in the UNEP PPP initiative. 3) Whilst some of the current risks laid out on pages 14-15 of the PIF will certainly be correct, the full scope of risks cannot be known without first ascertaining what risks may have been delimited, or what additional risks were identified, by previous work apparently not yet acknowledged	industry-scale reactor test in July 2012, the gold catalyst had lost its activity after 4800 h and the test had ceased because of the low acetylene conversion. Actually, there is still no a full-size gold-catalyzed commercial VCM production after that. During the discussion, the team was informed that although a patent was certified the gold based production is still facing big barriers. The cost of gold catalyst is comparatively high. Data indicates that if VCM sector in China completely converts to the gold catalyst about 20-60 tonne of gold will be consumed per year. This would lay great economic stress on the sector. There were also many researches on the precious metal catalyst conducted by universities and academic institutes in China. 1）Under the support of the National 863 project, Tianjin University has studied the catalyst system with precious metal Au as the active ingredient, and carried out the 720h lab scale experiment in the laboratory. Shihezi University has studied the Au ~ Co (III) /AC bimetallic catalyst, which shows higher anti-coking ability and high activity and stability. Currently, they are just doing the pilot testing with Xinjiang Tianye (Group) Co., Ltd. 2）Xinjiang Tianye (Group) have been doing research and pilot testing on gold catalysts together with Shihezi University, Tsinghua University, Nankai University and other institutions in these years. But it's a pity that there is no actual application of gold catalyst in a commercialized process in China till now. In addition, the regeneration of gold catalyst has never been operated in a calcium carbide PVC plant. Moreover, there are also many pilot tests on mercury-free catalyst carried out widely in other PVC manufactures, such as in the Zhongtai Chemical, Tianyuan Group and Tianjin Dagu Chemical under the support of domestic universities and research institutions. 3) Risk response measures have been developed. The technology evaluation and selection will be made by the expert panel consisting of international and domestic PVC experts. The process will be totally fair and transparent under the guidance of UINDO and GEF. In additional, a report on the background and strategic alternatives for VCM production in China was developed by the chief technical advisor who used to work for American Chemistry Council. The report was discussed with the project team, key national stakeholders and attached in Annex F after acceptance. On November 9, 2015, a kick off workshop was held in

	Beijing by UNIDO and FECO. More than 70 participants attended the workshop, including the representatives from MEP, MITT, Petrochemical Association, China Chemical Environmental Protection Association, China Council for Industrial Environmental Protection, China Chlor-Alkali Industry Association and other associations and relevant academic institutions and private sectors including Johnson Matthey. During the kick off workshop, the director of China Chlor-Alkali Industry Association introduced the progress of mercury pollution prevention and control in VCM production industry. The secretariat of the China Chemical Industry Environmental Protection Association elaborated the outlook of low-mercury, mercury free technologies application in China. The technology road map of the project was deeply discussed and accepted at the kick off meeting. During the PPG stage, further technical investigations and field visits were conducted by UNIDO and China Chlor-alkali Industry Association (CCAIA) which represents most of the main national industrial stakeholders. The results of this national assessment focused on the current status of research, development and application of mercury-free catalysts (briefly listed in table 2). R&D of mercury-free catalyst is connected with uncertainties: it requires a lot of investment, from the formula screening at laboratory, small scale test, pilot demonstration, commercial application and replication. Even the central government has financially supported R&D on mercury free technology. The design of this project provides a good opportunity for using GEF financial support as a seed fund to catalyze further research and demonstration and to foster the widely application of non-mercury technologies. As seen from co-financing commitments provided in Table C, a substantial investment will be leveraged from the government and a large number of private sector enterprises by GEF support. In this proposal, preliminary selection criteria for demonstration enterprises were developed. In order to lower risks associated with pilot tests, venture capital investment will be a key factor for the selection of mercury free technologies and demonstration enterprises. The selection of mercury free technologies and demonstration enterprises will be conducted by an expert panel composed international and national experts considering technical feasibility, economic viability and environmental friendliness to ensure it will be done in a fair, just and open manner for all potential technologies.
1. Germany 1.1 Component 1 refers to the institutional, regulatory and	1.1 Thanks for the comments from Germany. The institutional, regulatory and enforcement (IRE) capacity

enforcement (IRE) capacity in VCM (Vinyl Chloride Monomer) production. Germany suggests including IRE capacities for the recovery of mercury out of mercury containing wastes in order to enhance the efficiency of the Component 3 (Promotion of mercury recycling from VCM production).	was considered fully in the Component 1 and Component 3 to enhance the efficiency. In component 1, all the new policies "technical guidance of the implementation of BAT/BEP in VCM sectors", "Implementing a PRTR demonstration in calcium-carbide-based VCM sectors" and "emission standards in the mercury recycling sector" will enhance the IRE capacity in mercury waste recycling sectors. Moreover, 400 environmental management officials or staff will be trained on the knowledge and implementation of new regulations and policies. In addition, the contents of IRE capacity building for the recovery of mercury-containing waste have been included in the component 3. It was planned that mercury-containing waste management capabilities would be built and processing technology trainings carried out for PVC industry covering 300 people.
1.2. Further we would like to emphasize that the application of the Zeolite-based catalyst is suggested as a low mercury catalyst technology during VCM production. However, no information is provided if the technology has been successfully tested or not. Germany requests to clearly justify the suggestion of using the Zeolite-based catalyst as BAT/BEP with referring to onsite tested examples of the technology.	1.2 The zeolite-based low-mercury technology was studied and tested in China in 2009, when Shijiazhuang Kechuang Company launched a research project on the zeolite loaded HgCl2. There was no breakthrough in the mechanism study and process development, so the test was just in a laboratory stage and then stopped. In the same period, Xinjiang Tianye also conducted similar laboratory study and has been made a breakthrough in technology. Despite with a breakthrough, it does not have an associated continuing research and testing because of financial constrain. If this technology is identified as technical available through the technical evaluation and field application, we would include it as BAT/BEP alternative technology. If Germany related technologies and processes, project would like to be included in the BAT/BEP, and UNIDO will keep in contact and develop technical exchange with Germany on this issue.
2. US America The United States supports China's strong interest in addressing mercury use and emissions in this important sector. Overall, we think the proposed project has the potential to greatly improve environmental and human health since this project incorporates several elements to address key obstacles that often prevent sector-wide improvements. Since we would like the project to be as forward-leaning and effective as possible, we request that in addition to incorporating input from the STAP, that the UNIDO consider the following suggestions prior to GEF CEO endorsement: 2.1. Because of evolving private sector activities in China, we suggest that the project would benefit from more frequent evaluation of the potential for deployment of non-mercury catalysts throughout the course of the project, not just at the outset, and that mon-mercury catalysts should also be considered when mid-term and final project results are evaluated.	During the preparation stage, UNIDO facilitated a Chinese delegation (six members from the Ministry of Environmental Protection) to exchange information with the department of State, USA, the Department of Treasury and US EPA on 22nd September, 2016. UNIDO team and Chinese delegation briefed the progress and achievements of preparation work of project. In addition, UNIDO team and the Chinese delegation also presented the preparation work to representatives from the American Chemistry Council and the Vinyl Institute, USA. 2.1 Thanks for the comments from US America. The research and development of low-mercury and mercury-free technologies has been promoted by the Government and enterprises and big progress has been made since

	2010. All kinds of mercury-free and low-mercury technologies (including gold catalysts) will be evaluated by an expert panel in a fair, impartial and open process. The expert panel will be working throughout the project cycle, and tracking all of the low-mercury and mercury-free technologies concerned. First in the project start-up phase, the expert panel will carry out the first round of assessment, to determine the relevant technology to be used in the demonstration. Secondly, in the middle term of the project, the second round assessment will be carried out based on the initial results of the demonstration project and combined with the independent mid-term GEF evaluation. At the end of the demonstration, the third round assessment will be implemented based on the project outcomes and combined with the GEF final evaluation, to lay the foundation for large-scale promotion and sustainable application.
2.2. We believe that, for this project to be successful, baseline and mass balance measurements need to be conducted at typical Chinese VCM facilities to account for mercury inputs and outputs (air emissions and other mercury losses), which can be used to determine current emission levels. Similarly, it would be helpful if, as a part of this project, a life cycle assessment of the process from cradle to grave is conducted to establish an environmental footprint for the production of vinyl chloride monomer that can be used as a basis for measuring the success of the project and global environmental benefits of this proposed investment.	2.2 The mercury flow in a typical VCM plant was shown in the Figure 1 of PD. The actual material flow will be identified in the cleaner production audit through sampling and analysis to determine current emission levels and make out potential emission control measures. The concept of life cycle assessment has run through the design of PD, including the production, use, recovery of mercury catalyst and the recycling of mercury containing waste and management of mercury contaminated sites. The activity of mercury flow analysis was also specifically listed in the Component 3.
2.3. While we welcome the ambition to achieve a 50% reduction per ton of VCM production in 2020 in China, we recommend that measurements be conducted with low mercury catalysts that are expected to be available in China during the project implementation period to show that a 50% reduction can be achieved. Additionally, we would like to emphasize how critical it will be for all Chinese stakeholders to be engaged in this process for this project to be successful.	With the development of technologies, the catalyst with 6.5% $HgCl_2$ is already feasible and widely used in the VCM producers. Moreover the standards on the quality of mercury catalyst requires that the catalyst consumption be reduced from 1.2-1.3kg/t VCM to 1.1kg/t VCM and ensure the conversion rate and life span of the low-mercury catalyst when the content of $HgCl_2$ decreases from 12% to 6.5%. It could be found that the 50% reduction per ton of VCM production in 2020 in China could be achieved when the low-mercury catalyst is widely used according to the updated national standard. Moreover, the super-low-mercury catalyst (<4% $HgCl_2$) will be promoted in the demonstration and replicated in an incentive way. The Investigation and inspections on phase-out of high-mercury catalyst in the VCM production will be carried out during the project implementation to reduce the mercury usage in the VCM sectors. And an interdepartmental coordination mechanism will be setup to facilitate the involvement of relevant stakeholders.
2.4 While we are supportive of UNIDO encouraging "information	The experiences got from this FSP project, including

dissemination and awareness raising among stakeholders," we are concerned that this project component may not be the best use of GEF resources since China is the only country that utilizes calcium carbide based VCM production to produce PVC. Thus, the global environmental benefit of this project component is limited, and information will primarily be disseminated locally. However, the activities related to mercury emissions from the energy sources of the VCM production units, including coal-fired power plants, would be very useful to disseminate not just within China, but for the global community.	mercury-free technologies in VCM sector, mercury containing waste management, risk assessment and management strategy of mercury contaminated sites, and Minamata Convention implementation in the central and local areas can be valuable references for the mercury usage and emission control and MC implementation in the world. Especially, the life cycle mercury control and management technology in VCM sector will provide direct technical and management experiences for the mercury control in Chlor-alkali sectors. The success of China is of the global significance in the MC implementation.
2.5 Since this project is large and important, we highly recommend that international experts be invited to participate on an advisory panel or steering committee for this project. We would request this group evaluate at a minimum: baseline assessment and life cycle analysis of the VCM sector in China (as described in 2); technology verification (i.e., the ETV component of this project); and evaluation and monitoring.	Thanks for the comments. An expert panel will be established and consist of international and national VCM experts. The expert panel will carry out the Baseline assessment and life cycle analysis of the VCM sector in China (as described in 2); technology verification (i.e., the ETV component of this project); and evaluation and monitoring. In addition, the project will also invite technical experts, policy experts, and cleaner production audit experts to introduce international experience. As a GEF/UNIDO practice, the project will also employ independent international experts to conduct the mid-term and final evaluation.
2.6 We note that the co-financing list in Section C has a line labeled "unknown" for $6.6 Million. Are there further details about this unknown entity?	FECO has received the co-finance commitment letter from Inner Mongolia Wuhai chemical and industrial co. ltd, committing to the co-financing of 10 million dollars, which sufficiently satisfies the requirement of 6.6million dollars.
3. Canada	
3.1 The amount of GEF funding sought ($16.2M) seems high. Please provide more information and further justification to ascertain the value of each proposed activity, as well as the cost breakdown.	During the preparation stage, UNIDO facilitated a Chinese delegation (six members from the Ministry of Environmental Protection) to exchange information with representatives from Department of Environment and Climate Change, Canada on 26th September, 2016. During the mission, UNIDO team and Chinese delegation briefed the progress and achievements of preparation work of project. 3.1 VCM production is a capital intensive sector. In general, the construction investment of a 100,000 tons of calcium carbide VCM process is about US$ 80M. The BAT/BEP modification of a single enterprise investment is also as high as US$ 5-7M. This project covers policy and regulation development, capacity building, demonstration of 4 VCM plants, and promotion in 15 VCM plants, site management, mercury waste recycling and awareness raising and environmental education activities, the budget is US$116.4M, of which US$ 16.2M is from GEF grants and the leveraged co-

	financing is US$ 100.2M. The project shows very good cost-effectiveness and the detailed cost breakdown was given in Annex H.
3.2 It is unclear if a "demonstration" project should be used to minimize/reduce mercury use in the production of Vinyl Chloride Monomer (VCM), given this project would only benefit China, as it is the only country using a coal-based process with mercury catalysts to make VCM. As the project proposal notes, alternative petroleum-based processes that do not use mercury catalysts are already being used worldwide. In our view, the onus should be on China to switch to the low-mercury alternatives, and the 360 tonne estimated mercury reduction should not be dependent on this project. Please elaborate on the rationale for providing GEF funding for this project.	3.2 VCM is an important process in which mercury or mercury compounds are used and listed in Article 5 and Part 2 of ANNEX B of the Minamata Convention. The mercury reduction in China is of global importance on the Convention implementation and the mercury usage, emission and release control and reduction in this sector has effective global environmental benefit. In accordance with the requirements of the Convention (Article 13 and 14) and consensus of the parties, developed countries have an obligation to provide financial and technical assistant and help developing countries on the MC implementation. The mercury emission control and reduction of VCM production in China is a difficult and long term process with huge capital investment and the intervention and support of GEF will speed the process.
3.3. Given that China already received GEF funding to develop a mercury inventory (Pilot Project on the Development of a Mercury Inventory in China, implemented by UNEP- GEF Resources $1M), it is unclear why further mercury inventory work is needed under the current proposal. Please explain and justify. We note that many of the listed project outcomes (e.g., developing national regulatory policy, developing a national inventory on mercury waste, national inventory of contaminated sites, strategy for reduction of health risk, etc.) do not apply to a demonstration project and appear to relate to funding national programs . Given that the GEF does not fund national programs in countries, please revise the project outcomes to better align with GEF objectives.	3.3 The Pilot Project on the Development of a Mercury Inventory in China, implemented by UNEP- GEF focus on the mercury usage and emission inventory in VCM and coal fire power generation sectors. The inventory was mainly based on the UNEP emission factor methodology without actual monitoring activities, which provides a baseline of development of this FSP. While, the inventory in this project focuses on the mercury containing waste and mercury contaminated sites. The inventory of mercury containing waste is the basement of knowledge for mercury mass flow, promotion of mercury recycling and reduction of mercury emission. Please also see the detail in A6.2. Mercury is a global problem. Mercury pollution will harm the local ecological environment, and cause great damage to human health in the world. The regulatory policy and strategy for reduction of health risk is not only the issue of environmental management in China, but also the important measures of the MC implementation in China to achieve global environmental benefits. In addition, the development of policies and regulations and capacity building sets an important guarantee for FSP's sustainable performance, which is an important field of GEF with high priority.

ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS[11]

A. Provide detailed funding amount of the PPG activities financing status in the table below:

PPG Grant Approved at PIF:			
Project Preparation Activities Implemented	***GEF/LDCF/SCCF Amount ($)***		
	Budgeted Amount	***Amount Spent To date***	***Amount Committed***
1. National sub-contractors (FECO) for baseline data collection (-1.Gaps on existing laws, regulations and institutional capacity analyzed to fulfill MC obligations concerning VCM production sector; -2.Technology feasibility study, ETV methodology and PPT mechanism analyzed to promote R&D, venture capital investment and technology transfer; -3.Waste management and contaminated sites status and proposal developed and the contaminated sites associated with VCM production; -4. Public awareness raising and project dissemination plan prepared), recruitment of two national consultants (National Technical Advisor and ESMP expert including preliminary gender analysis), organization of inception and validation workshops, stakeholders consultations, demonstration projects selection and review	200,000	200,000	0
2. Two international consultants (a Chief Technical Advisor and a chemical and waste management expert)	32,000	26,021	5,979
3. International and local travel and international experience exchange to USA and Canada	58,000	58,000	0
4. Other costs	10,000	8,000	2,000
Total	300,000	292,021	7,979

[11] If at CEO Endorsement, the PPG activities have not been completed and there is a balance of unspent fund, Agencies can continue to undertake the activities up to one year of project start. No later than one year from start of project implementation, Agencies should report this table to the GEF Secretariat on the completion of PPG activities and the amount spent for the activities. Agencies should also report closing of PPG to Trustee in its Quarterly Report.

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

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

no respected reflows

ANNEX E: List of Abbreviations

VCM Vinyl Chloride Monomer

PVC Polyvinyl chloride

HMC High-mercury catalyst

LMC Low-mercury catalyst

EDC Ethylene dichloride

CCP The calcium carbide process

PPP Private Public Partnership

ETV Environmental Technology Verification

ODS Ozone-Depleting Substances

MEA Multilateral Environmental Agreements

ODP Ozone depletion potential

HCFC Hydrochlorofluorocarbons

MC The Minamata Convention

NDRC National Development and Reform Commission

MIIT Ministry of Industry and Information Technology

MEP The Ministry of Environmental Protection

CPCIF China Petroleum and Chemical Industry Federation

CCAIA China Chlor Alkali Industry Association

MEPSCC MEP's Solid Waste and Chemical Management Centre

CRAES Chinese Research Academy of Environmental Sciences

NERC National Research Center for Environmental Analysis and Measurement

FECO Foreign Economic Cooperation Office

CAEP Chinese Academy For Environmental Planning

CNEMC China National Environmental Monitoring Center

CSES Centre for Sustainable Environmental Sanitation

MPPC State Environmental Protection Engineering Center for Mercury Pollution Prevention and Control

CPCIF China Petroleum and Chemical Industry Federation

CC1EPA China Chemical Industry Environmental Protection Association

CIEP China Council for Industrial Environmental Protection

EIA Environmental Impact Assessment law

EPB Environmental Protection Bureaus

D/F Dioxin and furan

OC Oxychlorination

TEQ Toxic equivalency

PRTR Pollutant Release and Transfer Register

ICG Inter-departmental coordination group

APR Annual Project Report

PIR Project Implementation Review

IR Project Inception Report

TPR Tripartite Review

TOR Terms of Reference

PTR Project Terminal Report

ANNEX F: Work in PPG Stage and Solution

A) SUMMARY OF WORK IN PPG STAGE

183. According to the PIF, the GEF trust fund of this full size project will be mainly devoted to the demonstration of low-mercury and mercury-free VCM manufacturing technologies. Cleaner production audits and technology modification following BAT/BEP principles will be operated in 4 carbide- or ethylene-based VCM production plants for mercury or dioxin emission reduction as a means of demonstration. Moreover, a coal-based mercury-free VCM production line with capacity larger than 10,000 t/y will be put in place. After the demonstrations, reduced-mercury catalyst will be installed in at least 15 VCM plants in order to reduce mercury use per unit VCM production by 50% vs. reference year 2010 by 2020. An 360 t mercury reduction will be expected in the VCM sector by the end of this FSP, when compared with that in the year of 2014.

184. In the PPG stage, baseline research regarding the PVC industry status, capacity and enterprise distribution, industry management policy, mercury catalyst production and usage, mercury waste and control and the status of mercury contaminated sites were completed. The research on BAT/BEPs aiming to control mercury emission and release were carried out. The status of mercury-free catalyst and mercury-free technology was investigated and evaluated. The selection criteria for placing demonstration enterprises and the incentive mechanism based on public-private partnerships were designed. The low-mercury catalyst BAT/BEPs were identified and the mercury-free VCM production technology verification and demonstration plan was designed. The plan for sound management and technology demonstration for mercury waste and contaminated sites were also completed.

B) POLICY AND REGULATION STRENGTHENING PLAN

185. In the PPG stage, the gap analysis of relevant policies and regulation was conducted. In order to meet the requirements of the Minamanta Convention, eight policies and standards that will be developed/revised and issued during the project implementation period in the VCM sector include the followings:
    - National Hazardous Waste List (mercury-containing waste from the VCM sector regarded as hazardous waste);
    - Development of the Mercury pollution control technology policy;
    - Development of the Caustic soda and PVC industry pollution control technology policy;
    - Development of national low-mercury catalyst standards in the VCM sector;
    - Development of emission standards in chlor-alkali industry;
    - Development of the chlor-alkali industry standard conditions;;
    - Validation of the phasing out of high-mercury catalysts in the calcium carbide-based VCM production enterprises
    - Feasible Technical Guide for Prevention and Control of the Pollution from Treatment and Disposal of Mercury-Containing Waste

186. Policy recommendations will be drafted on 8 regulations, including:
    - Recommendation on revision of the Catalogue for Adjustment of Industrial Structure and industrial access policy: high-mercury catalyst based VCM production categorized into the phase-out group.
    - Recommendation on carrying out cleaner production in calcium-carbide-based VCM sectors;
    - Recommendation on carrying out cleaner production in ethylene-based VCM sectors;
    - Recommendation on the technical guidance of the implementation of BAT/BEP in VCM sectors;
    - Recommendation on the carrying out PRTR demonstration in calcium-carbide-based VCM sectors
    - Recommendation on the technical policy on mercury contaminated sites;
    - Recommendation on the emission standards in the mercury recycling sector;
    - Recommendation on the economic policy to promote research, development and application of mercury-free VCM production technologies;

C) BAT/BEP PROMOTION IN THE PVC PRODUCTION WITH LOW-MERCURY CATALYST

187. In the PPG stage, the BAT/BEPs to control mercury emission and release were identified with the support of national stakeholders. The full implementation of low-mercury catalyst is critical if mercury use is to be reduced by 50% vs. reference year 2010 in per unit VCM production. Work in PPG stage discovered that Chinese government and enterprises had invested significant funds and achieved positive progress in the production and application of low-mercury catalyst. The baseline and alternative scenarios of mercury use are listed in Table 3. About 10,080 t high-mercury catalyst will be phased out completely with the implementation of this FSP and an annual reduction of 360.5 t of mercury will be expected in the VCM sector by the year 2020 (reference year 2014). Nevertheless the problem of mercury emission during the use of low-mercury catalyst is still an unsolved difficulty for low-mercury enterprises. GEF funding will focus on supporting mercury emission reduction BAT/BEPs during the application process of low-mercury catalyst. The demonstration results will contribute to the formulation and development of national technical standards on mercury point source emission, and implementation of oversight and sound management of the use of low-mercury catalyst.

Table 3 The baseline and alternative scenarios of mercury use in VCM sector, China

Year	2010	2014	2020	Change
CCP-VCM（million t）	8.5	14.0	17.5	3.5
High-mercury catalyst use (t)	8697	10080	0	-10080
Low-mercury catalyst use (t)	1392	6720	17875	12155
Mercury use in per unit VCM production (g/t)	98.5	86.9	49.0	-37.9
Mercury use（t）	837	1217	857.5	-360.5

188. The BAT/BEPs demonstration and replication in the VCM production process will help put into place comprehensive pollution prevention and control process for mercury. Application of low-mercury catalyst will reduce the mercury consumption and mercury pollution from the source, the catalyst itself. With respect to other streams, mercury will be removed via deep desorption of hydrochloric acid is in order to reduce the stress in subsequent stages as part of the intermediate processing. Rain/sewage diversion will prevent mercury-containing wastewater and mercury gas from entering the environment. Mercury-containing wastewater will be centrally decontaminated as an end-of-process control. The BAT/BEP demonstration after the transformation of the application process of low-mercury catalyst will significantly reduce mercury emission to environmental media like air, water and soil during VCM production process.

189. The technology application routes of mercury emission reduction BAT/BEP of VCM production with low-mercury catalyst is shown as Figure 4. The five individual aspects of potential technology improvement are described in subsequent paragraphs. Other BAT/BEPs will also be identified during the process of a cleaner production audit.

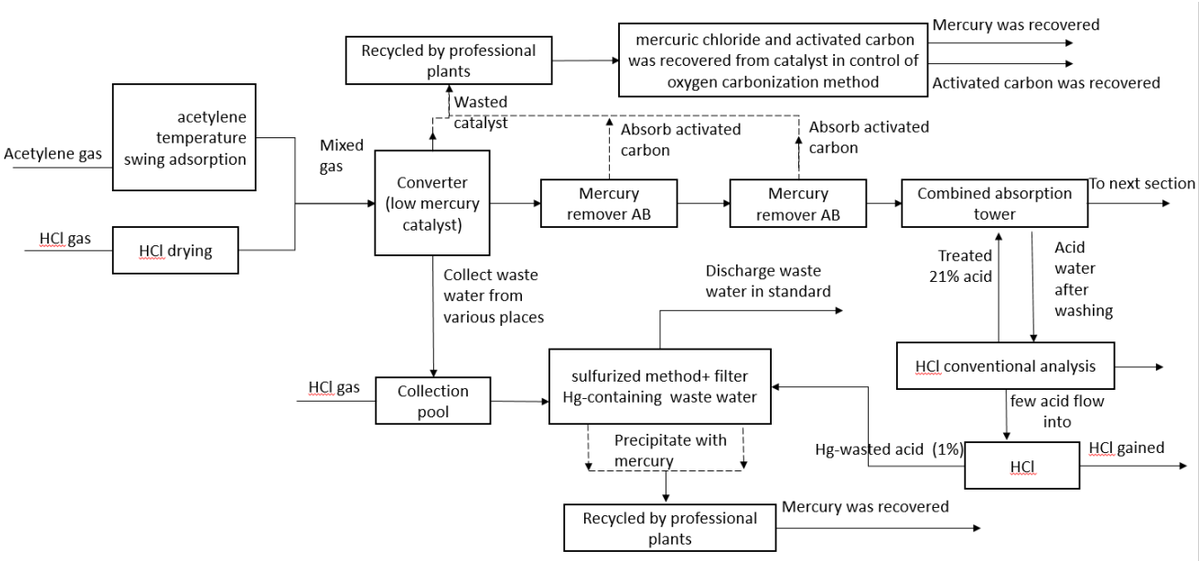

Figure 4 BAT/BEP to reduce mercury emission and release in low-mercury catalyst process

190. Feed gas dehydration technology: In general, water content in feed gas is high (600-800 ppm) which causes corrosion of the equipment and shortens the service life of converters down to 2.5-5 years. Moist catalyst tend to agglomeration to catalyst caking which leads to high-mercury consumption. By the use of swing adsorption technology, water content in feed gas can be reduced below 100 ppm to ensure the efficient use of catalyst devices.

191. Catalytic exchanging systems are using a water ring vacuum pumps to replace catalysts through the pressure difference formed between the catalytic tank and the converter. With this system the catalysts remains in the converter column tube situated in the tank. Mercury-waste gas is separated by cyclone separation. Catalyst particles and small dust particles are blown out. In a further step, bag-type dust remover further separates the catalyst particles from the air. These catalyst particles are discharged into waste catalyst barrels. The discharged gas from water ring vacuum pumps is introduced into waste gas washing devices and recycled through adding Na2S during washing processes.

192. A high efficiency mercury remover is placed at the rear of the converter exit. The system requires significant modifications on the structure of mercury-remover and on the processing of the adsorbent by dipping certain chemical agents in used activated carbon. With this system in place, the efficiency of mercury-removing can reach more than 95%. The activated carbon in the 2-Level mercury remover must be replaced every three months.

193. The hydrochloric acid deep desorbed technology: The converter gas containing 4%- 10% HCl cannot be allowed to enter polymerization. HCl must be absorbed after the converter and the mercury-remover. However, the hydrochloric acid contains a large amount of mercury. Insertion of a high-efficient combination of absorption tower processes can increase the HCl removal rate to more than 93%. In addition, pressure swing and extractive distillation assist to solve the problem of generating waste acid and to efficiently recover excessive HCl gas.

194. Mercury-contaminated wastewater treatment technology: A mercury-water delivery pump moves the liquid into a pH adjustment pool, and pH is increased to 9-11. Then the water is analyzed for mercury content. Na2S solution is added according to the Mercury concentration. After this, the solution is pumped into an activated carbon filter equipped with level 2 filtering (two filters in series process).

195. Main equipment modification and technical investment: Increase converter capacity by 20% to maintain current throughput, install flowmeter for accurate control and improve feed gas dehydration. Each of finally selected VCM plants will need one or more of these technological transformations according to their currently installed equipment and processes.

D) MERCURY-FREE TECHNOLOGY DEMONSTRATION PLAN IN VCM PRODUCTION

196. The PPG project identified bottlenecks in different scales of mercury-free technologies, such as R&D, pilot and demonstration, commercial application. Currently China is still in the R&D and pilot stage, thus making it difficult to move to the demonstration of mercury-free technologies. The high cost of infrastructure investment and uncertainty of success makes VCM enterprises unwilling to invest their own capital in such technologies. Yet with the advancement of China's convention compliance work, the mercury-free methods will gradually have to become the key technologies in VCM production industry. This project will make full use of GEF funding as a seed fund to catalyze and leverage capital ventures and thus encourage enterprises to carry out independent R&D and manufacturing demonstration.

197. The communication and cooperation of PVC enterprises, research institutions, new technology holders, social investors and local governments through a public-private partnership (PPP) mechanism (Figure 3) for mercury reduction and minimization in the VCM sector is essential to carry out the demonstration and replication of technology promotion, cleaner production and BAT/BEP.

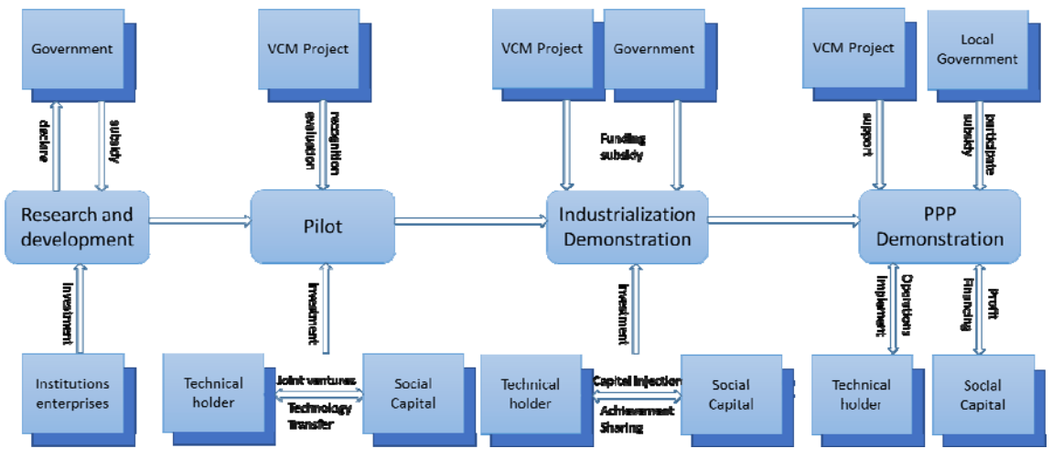

Figure 3 China mercury-free PVC demonstration of PPP-based business model

198. The demonstration enterprises and provinces will be selected based on market principles and in accordance with procurement rules of UNIDO and FECO and meet the following criteria:

- Demonstration provinces: they should have at least 2 VCM production companies whose production capacity is each more than 200,000 t/y with an average capacity utilization of more than 50% in the past 3 years;
- VCM plants for BAT/BEP Demonstration: they should each have a capacity no less than 400,000 t/y with an average capacity utilization of more than 80% in recent 3 years, and should have no administrative penalties for environmental violations.
- Candidate technologies for mercury-free demonstration in full-scale operation: Such technologies must be advanced and suitable for investment. Plants and technology suppliers implementing this scale-up must be willing to participate in mercury-free catalyst research and provide co-funding. The final selection will be made based on the evaluation of mercury-free VCM technologies by the expert panel.

199. An expert panel for mercury-free technology evaluation will be commissioned. The expert panel will be composed of international experts, national experts and key stakeholders. The mercury-free technology verification and evaluation criteria and mercury-free process validation evaluation technology guidance will be formulated by this expert panel. The evaluation of this panel will be used as input for the activities under project component 1 and the selection of mercury free technologies and demonstration enterprises will be conducted by the expert panel.

200. The mercury-free VCM production demonstration enterprises will be selected in a fair, just and open manner according to evaluation criteria and technology guidance. Assessment of results achieved by previous research ventures will be also highly considered during the selection of demonstration enterprises. Mercury-free production facilities will be implemented to realize an industrialized demonstration operation with capacity of higher than 10,000 t/y.

E) DEMONSTRATION OF REDUCING AND ELIMINATING DIOXINS FROM OXYCHLORINATION PROCESS

201. In the PPG stage, the strategy of reducing dioxin from OC was developed with the support of international consultant. In principle, there are two approaches to minimizing dioxin and furan (D/F) emissions from OC: 1) Prevention of formation and 2) Reduction and elimination of emissions. Virtually all prevention approaches depend on reducing the presence of aromatic precursors in the reaction mixture. As an example, some believe that use of pure oxygen for OC reduces the possibility of importing trace aromatics along with atmospheric air, especially if the OC plant is located near an industrial source of aromatics. HCl imported for recycle from other processes may also contain traces of aromatics. Reduction and elimination strategies involve isolation and destruction of contaminated process wastes called “heavy ends.”

202. The Stockholm Toolkit values are benchmark values derived from study of the global enterprise and can be used to provide a crude estimate of potential D/F emissions from facilities. However, because facilities vary, it is important to have a regular sampling regimen to determine what actual emissions are. Analysis for D/F is very expensive, particularly for sampling and analyzing combustor stack emissions. There are rigorous and very specific protocols for collecting samples and for analyzing the extremely small amounts of D/F collected.

203. The project will choose a pilot VCM plant whose CCP is expected to be modified to ethylene process. The OC process will be designed, constructed and operated according to the BAT/BEP guidelines on dioxin minimization during the technology modification. And the “heavy ends” of ethylene-based VCM will be burned in a BAT hazardous waste incinerator. When compared to the current D/F emission from an ethylene-based VCM process with similar capacity, a relative dioxin emission reduction of 3 g I-TEQ into the atmosphere and 4 g I-TEQ in the residue will be achieved as a means of demonstration.

F) ENVIRONMENTALLY SOUND MANAGEMENT OF MERCURY-CONTAINING WASTE

204. During the PPG stage, a preliminary investigation of mercury wastes generated from VCM production, mercury-catalyst production and mercury waste treatment and disposal was conducted. Based on that information, a management process for those wastes throughout their whole life cycle should be developed and implemented. The flowchart of conducting this study is presented in Figure 5.

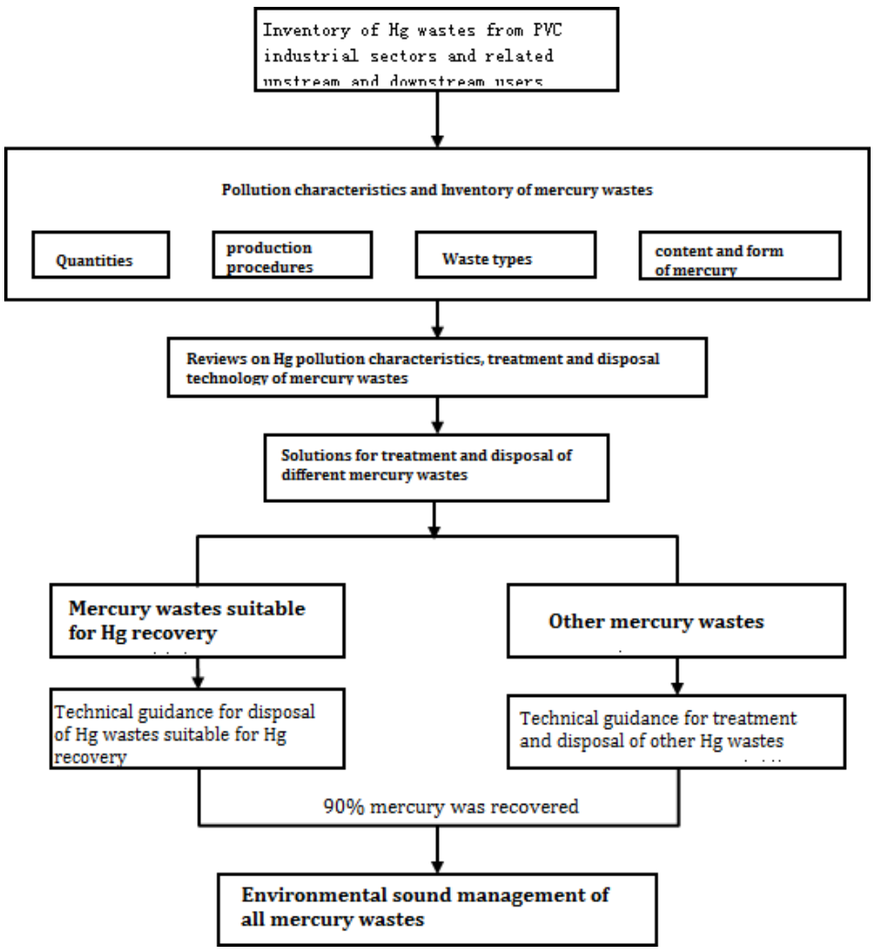

Figure 5 Environmentally sound management of mercury wastes from VCM production process

205. Between 60 and 90 percent of the initial mercury loading remains as mercury residual in the waste catalyst and activated carbon. This mercury will be recovered using thermal distillation and dry distillation with oxygen-control. As a result of the implementation of the project, companies that handle mercury will recover and potentially recycle 90% of the mercury currently lost to these wastes. This will be accomplished by introduction of cleaner production techniques in mercury recovery by the mercury waste disposal companies. This recovery will reduce risk from mercury pollution as well as the demand for primary mercury.

206. During implementation, the project team will develop technical guidance for treatment of mercury wastes that are suitable for mercury recovery. The project will enhance the implementation of a HW transfer receipt management system and strengthen the management of the whole life cycle including packaging, transportation, storage in the generator and disposer and packaging of recovered mercury. For those mercury wastes not suitable for mercury recovery, the project will evaluate other appropriate treatment and disposal solutions including landfill, solidification and stabilization, and other feasible technology. All mercury waste must be managed in an environmentally-sound fashion so as to reduce the risk from mercury emission and release during treatment and disposal.

G) ENVIRONMENTALLY SOUND MANAGEMENT OF MERCURY- CONTAMINATED SITES

207. The main tasks of environmentally sound management of mercury-contaminated sites includes: a national inventory of the sites in the VCM industry based on a combination of field research and survey

questionnaire as well as full site investigation and risk assessment conducted in at least 2 mercury-contaminated sites of the VCM sector. The output will be a strategy for the environmentally-sound management of all mercury-contaminated sites in the carbide-based VCM sector.

ANNEX G: LEGAL CONTEXT

208. The Government of the People's Republic of China agrees to apply to the present project, mutatis mutandis, the provisions of the Standard Basic Assistance Agreement between the United Nations Development Programme and the Government, signed on 29 June 1979 and entered into force on 24 June 1985