Improvement of the environmental performance of the foam sector: Phase out and management of hexabromocyclododecane (HBCD) in China

Part I: Project Information

GEF ID
10163

Project Type
FSP

Type of Trust Fund
GET

CBIT/NGI
- ☐ CBIT
- ☐ NGI

Project Title
Improvement of the environmental performance of the foam sector: Phase out and management of hexabromocyclododecane (HBCD) in China

Countries
China

Agency(ies)

UNIDO

Other Executing Partner(s):
Foreign Environment Cooperation Center - Ministry of Ecology and Environment

Executing Partner Type
Government

GEF Focal Area
Chemicals and Waste

Taxonomy
Focal Areas, Type of Engagement, Stakeholders, Communications, Private Sector, Gender Equality, Chemicals and Waste, Waste Management, Hazardous Waste Management, Industrial Waste, Best Available Technology / Best Environmental Practices, Persistent Organic Pollutants, New Persistent Organic Pollutants, Sound Management of chemicals and waste, Green Chemistry, Disposal, Influencing models, Strengthen institutional capacity and decision-making, Demonstrate innovative approache, Transform policy and regulatory environments, SMEs, Civil Society, Academia, Awareness Raising, Public Campaigns, Strategic Communications, Consultation, Participation, Partnership, Information Dissemination, Gender results areas, Participation and leadership, Knowledge Generation and Exchange, Access to benefits and services, Capacity Development, Gender Mainstreaming, Gender-sensitive indicators, Sex-disaggregated indicators, Capacity, Knowledge and Research, Knowledge Generation, Workshop, Training, Knowledge Exchange, Field Visit, Conference, Innovation, Targeted Research, Climate Change, Climate Change Mitigation, Technology Transfer

Rio Markers
Climate Change Mitigation
Climate Change Mitigation 1

Climate Change Adaptation
Climate Change Adaptation 0

Submission Date
7/10/2020

Expected Implementation Start
10/1/2020

Expected Completion Date
9/30/2025

Duration

60In Months

Agency Fee($)

1,134,000.00

A. FOCAL/NON-FOCAL AREA ELEMENTS

Objectives/Programs	Focal Area Outcomes	Trust Fund	GEF Amount($)	Co-Fin Amount($)
CW-1-1	Strengthen the sound management of industrial chemicals and their waste through better control, and reduction and/or elimination	GET	12,600,000.00	97,940,000.00
		Total Project Cost($)	**12,600,000.00**	**97,940,000.00**

B. Project description summary

Project Objective

To improve the environmental performance of the foam sector in China through the phaseout, introduction of HBCD alternatives and environmentally-sound management of HBCD-containing EPS/XPS foams.

Project Component	Financing Type	Expected Outcomes	Expected Outputs	Trust Fund	GEF Project Financing($)	Confirmed Co-Financing($)
1. Policy and regulatory framework	Technical Assistance	Outcome 1.1 Policy and regulatory framework strengthened on the management and supervision of HBCD and HBCD-containing EPS/XPS polymer foam products in China	Output 1.1.1 National legislation, regulatory framework and technical specifications to ban the production, usage, import and export of HBCD used in EPS/XPS in China developed.	GET	1,260,000.00	2,150,000.00
			Output 1.1.2 Regulatory policies developed to reduce and eliminate the application of HBCD in EPS/XPS polymer foams, with focus on environmental quality standards and chemical limits of HBCD in EPS/XPS polymer foams and all potential HBCD users.			

Output 1.1.3: Framework for governmental alternative assessment established and flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated

Output 1.1.4 National managerial capacity, enforcement, supervision policies, monitoring methods of HBCD and HBCD-containing products strengthened to coordinate and monitor and establish problem-finding mechanism for the polymer foam production sector

2. Promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector	Investment	Outcome 2.1 Total ban on the production of HBCD in China Outcome 2.2 Prohibition of HBCD usage in the production of polymer foams or application of other alternatives through the promotion of BAT and BEP	Output 2.1.1 HBCD production lines closed down or converted to HBCD alternatives Output 2.2.1: Demonstration activities on at least 4 types of alternative materials for EPS/XPS foam manufacturing through technology transfer and research implemented Output 2.2.2 Replication activities on the best alternatives undertaken in at least 5 companies and outcomes promoted nation wide Output 2.2.3: Promotion of venture capital investment and technology transfer on switching to HBCD-alternatives established.	GET	6,330,000.00	81,000,000.00

3a. Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD	Technical Assistance	Outcome 3.1 ESM of HBCD-containing EPS/XPS foams implemented	Output 3.1.1 National inventory and data base on HBCD stocks and waste built and periodically updated. Output 3.1.2 HBCD waste identification and management methods on HBCD and HBCD-containing wastes disposal developed.	GET	100,000.00	420,000.00
3b. Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD	Investment	Outcome 3.1 ESM of HBCD-containing EPS/XPS foams implemented	Output 3.1.3 BAT/BEP demonstration of environmentally sound management and disposal of HBCD waste including assessment, comparison and demonstration of different treatment technologies, including volume reduction, HBCD extraction, HBCD decomposition, disposal, circular economy approach for bromine and EPS/XPS recovery	GET	3,380,000.00	9,860,000.00

4. Information dissemination, capacity building and knowledge management	Technical Assistance	4.1 Improved technical and regulatory capacity on the management of HBCD and HBCD-containing wastes 4.2 Knowledge management platform set up to contribute to regional/global actions on HBCD management.	Output 4.1.1 Technical trainings for various stakeholders (enterprises, government staff, technicians, researchers etc.) designed and implemented to strengthen capacity on HBCD and the EXPS/EPS foam sector, in general. Output 4.1.2. Awareness raising activities undertaken for various relevant stakeholders including the general public, NGOs, women and youth sector etc. Output 4.2.1 Establishment of a knowledge hub on HBCD and the XPS/EPS foam sector to disseminate lessons learned on a national, regional and global scale.	GET	630,000.00	1,230,000.00

5. Monitoring & Evaluation	Technical Assistance	Outcome 5.1 Effective monitoring and evaluation of project impact and sustainability implemented.	Output 5.1.1 Periodic monitoring implemented Output 5.1.2 Midterm review and terminal evaluation conducted	GET	300,000.00	1,080,000.00
				Sub Total ($)	**12,000,000.00**	**95,740,000.00**
Project Management Cost (PMC)						
				GET	600,000.00	2,200,000.00
				Sub Total($)	**600,000.00**	**2,200,000.00**
				Total Project Cost($)	**12,600,000.00**	**97,940,000.00**

C. Sources of Co-financing for the Project by name and by type

Sources of Co-financing	Name of Co-financier	Type of Co-financing	Investment Mobilized	Amount($)
Private Sector	Shandong Sunris New Material Co., Ltd.	In-kind	Recurrent expenditures	20,674,286.00
Private Sector	Shandong Sunris New Material Co., Ltd.	Equity	Investment mobilized	16,064,286.00
Private Sector	Shandong Dongxin New Material Technology Co., Ltd.	Equity	Investment mobilized	44,808,571.00
Private Sector	Shandong Dongxin New Material Technology Co., Ltd.	In-kind	Recurrent expenditures	905,714.00
Private Sector	Weifang Weiwei Chemical Co., Ltd.	Equity	Investment mobilized	5,000,000.00
Private Sector	Wuxi Xingda Paosu New Materials Co., Ltd	Equity	Investment mobilized	1,571,428.00
Private Sector	Wuxi Xingda Paosu New Materials Co., Ltd	In-kind	Recurrent expenditures	714,286.00
Private Sector	Shandong Lanhua Chemical Co., Ltd	In-kind	Recurrent expenditures	772,857.00
Private Sector	Shandong Lanhua Chemical Co., Ltd	Equity	Investment mobilized	512,857.00
Private Sector	Nanjing Feininger Energy Saving Technology Co., Ltd	In-kind	Recurrent expenditures	1,142,857.00
Private Sector	Nanjing Feininger Energy Saving Technology Co., Ltd	Equity	Investment mobilized	1,714,286.00
Private Sector	Qingdao Oukesi New Building Material Co., Ltd	In-kind	Recurrent expenditures	857,143.00
Private Sector	Qingdao Oukesi New Building Material Co., Ltd	Equity	Investment mobilized	571,429.00

Donor Agency	Bavaria State Ministry, Germany	Grant	Investment mobilized	200,000.00
GEF Agency	UNIDO	Grant	Investment mobilized	180,000.00
GEF Agency	UNIDO	In-kind	Recurrent expenditures	100,000.00
Recipient Country Government	Department of Ecology and Environment of Shandong Province	Grant	Investment mobilized	744,700.00
Recipient Country Government	Department of Ecology and Environment of Shandong Province	In-kind	Recurrent expenditures	1,405,300.00
			Total Co-Financing($)	**97,940,000.00**

Describe how any "Investment Mobilized" was identified

Investment mobilized was identified mainly from the commitment of the private sector. As the project mainly involves interventions to private sector facilities, a good baseline information identified possible partners. UNIDO, FECO and local DEEs engaged with HBCD and EPS/XPS producers from the onset of the project preparation. The private sector were then requested to provide an accounting of assets and investment possibilities that are directly relevant to the activities/interventions associated with the project.

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

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)
UNIDO	GET	China	Chemicals and Waste	POPs	12,600,000	1,134,000
				Total Grant Resources($)	**12,600,000.00**	**1,134,000.00**

E. Non Grant Instrument

NON-GRANT INSTRUMENT at CEO Endorsement

Includes Non grant instruments? **No**

Includes reflow to GEF? **No**

F. Project Preparation Grant (PPG)

PPG Required ☐

PPG Amount ($)

300,000

PPG Agency Fee ($)

27,000

Agency	Trust Fund	Country	Focal Area	Programming of Funds	Amount($)	Fee($)
UNIDO	GET	China	Chemicals and Waste	POPs	300,000	27,000
				Total Project Costs($)	**300,000.00**	**27,000.00**

Core Indicators

Indicator 6 Greenhouse Gas Emissions Mitigated

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO_2e (direct)	900000	1050000	0	0
Expected metric tons of CO_2e (indirect)	0	0	0	0

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

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

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

Total Target Benefit	(At PIF)	(At CEO Endorsement)	(Achieved at MTR)	(Achieved at TE)
Expected metric tons of CO_2e (direct)	900000	1,050,000		
Expected metric tons of CO_2e (indirect)				
Anticipated start year of accounting	2022	2022		
Duration of accounting	5	3		

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

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

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

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

Indicator 9 Reduction, disposal/destruction, phase out, elimination and avoidance of chemicals of global concern and their waste in the environment and in processes, materials and products (metric tons of toxic chemicals reduced)

Metric Tons (Expected at PIF)	Metric Tons (Expected at CEO Endorsement)	Metric Tons (Achieved at MTR)	Metric Tons (Achieved at TE)
18,097.00	54,880.00	0.00	0.00

Indicator 9.1 Solid and liquid Persistent Organic Pollutants (POPs) removed or disposed (POPs type)

POPs type	Metric Tons (Expected at PIF)	Metric Tons (Expected at CEO Endorsement)	Metric Tons (Achieved at MTR)	Metric Tons (Achieved at TE)
Hexabromocyclododecane (HBCDD)	18,000.00	54,300.00		

Indicator 9.2 Quantity of mercury reduced (metric tons)

Metric Tons (Expected at PIF)	Metric Tons (Expected at CEO Endorsement)	Metric Tons (Achieved at MTR)	Metric Tons (Achieved at TE)

Indicator 9.3 Hydrochloroflurocarbons (HCFC) Reduced/Phased out (metric tons)

Metric Tons (Expected at PIF)	Metric Tons (Expected at CEO Endorsement)	Metric Tons (Achieved at MTR)	Metric Tons (Achieved at TE)
97.00	580.00		

Indicator 9.4 Number of countries with legislation and policy implemented to control chemicals and waste (Use this sub-indicator in addition to one of the sub-indicators 9.1, 9.2 and 9.3 if applicable)

Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)
1	1		

Indicator 9.5 Number of low-chemical/non-chemical systems implemented, particularly in food production, manufacturing and cities (Use this sub-indicator in addition to one of the sub-indicators 9.1, 9.2 and 9.3 if applicable)

Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)

Indicator 9.6 Quantity of POPs/Mercury containing materials and products directly avoided

Metric Tons (Expected at PIF)	Metric Tons (Expected at CEO Endorsement)	Metric Tons (Achieved at MTR)	Metric Tons (Achieved at TE)
10,800.00	1,100.00		

Indicator 11 Number of direct beneficiaries disaggregated by gender as co-benefit of GEF investment

	Number (Expected at PIF)	Number (Expected at CEO Endorsement)	Number (Achieved at MTR)	Number (Achieved at TE)

Female	200	200		
Male	800	800		
Total	1000	1000	0	0

Part II. Project Justification

1a. Project Description

- **Changes in alignment with the project design with the original PIF**

The project structure presented in this document is consistent with that presented in the PIF. The project framework is essentially the same and is based on five (5) components: Component 1 deals with the strengthening of the policy and regulatory framework; Component 2 addresses the promotion of technology transfer and investment on the production of HBCD alternatives and application of the alternatives in the XPS/EPS foam sector; Component 3 focuses on the implementation of the ESM of XPS/EPS foam wastes containing HBCD; Component 4 addresses information dissemination, capacity building and knowledge management; and Component 5 is on monitoring and evaluation. Activities under all project components will be implemented in parallel, to the extent possible.

Due to the detailed assessment made during the PPG phase, however, some changes have been incorporated in the present document compared to the original PIF. Additional outputs were incorporated while other outputs were reworded and further elaborated. Output 2.1.2 of the PIF on the replication activities on the best alternatives was revised to demonstration activities on at least 4 types of alternative materials in the EPS/XPS foam manufacturing sector was introduced. The replication activities will involve both flame retardant producers and EPS/XPS enterprises. A redistribution of the cofinancing budget to reflect the activities supported by the co-financing received from stakeholders during the PPG was done.

An overview of the changes from the PIF structure versus the CEO endorsement is given in the table below:

PIF version	CEO endorsement version	Comments/Justifications
Output 2.2.1 Flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated was moved to Output 1.1.3 under Component 1: Policy and regulatory framework.	Output 1.1.3: Framework for governmental alternative assessment established and flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated.	During the PPG, it was known that China lacks an official evaluation/ specific assessment framework at the governmental level to evaluate alternatives for POPs like HBCD. This is significant to ensure that proposed alternatives pass set of criteria and proposes sustainable framework for new chemicals as alternatives.

Output 2.2.3 Private Public Partnership (PPP) to promote venture capital investment and technology transfer on switching to HBCD-alternatives established.	Output 2.2.3: Promotion of venture capital investment and technology transfer on switching to HBCD-alternatives established.	The statement of the Output was modified to be more flexible in the financing instruments. Private Public Partnership (PPP) is integrated as an activity under Output 2.2.3
Co-financing of USD 88,280,000 distributed across the different components	Secured co-financing of USD 97,940,000 redistributed across the different components	Co-financing distribution is revised in accordance to the secured co-financing. The current distribution in the CEO Endorsement document was based on the HBCD phase out plans of the participating companies, which was submitted to FECO/MEE as part of the published Request for Letter of Intent (RFOI). Most of the co-financing commitments of the private entities were shared between Components 2 and 3.

1a.a) Global environmental and/or adaptation problems, root causes and barriers that need to be addressed

1. Hexabromocyclododecane (HBCD) is a persistent organic pollutant which in May 2013 was listed in Annex A of the Stockholm Convention (SC) on Persistent Organic Pollutants (POPs) for its elimination. In November 2014, one year after notification, the amendment to add this substance entered into force for most countries party to the Convention and, therefore, these countries will have to prepare action plans to ban and/or restrict the uses/applications, productions, import, and export of HBCD as well as to eliminate stockpiles and obsolete HBCD.

2. HBCD (CAS Numbers 25637-99-4, 3194-55-6, 134237-50-6, 134237-51-7 and 134237-52-8) is a polybrominated cyclic alkane and a white crystalline powder. Commercial HBCD is mainly composed of three isomers, of which gamma-HBCD accounts for about 70-95%, while alpha and beta-HBCD range between 3-30%. It is mainly used as flame retardant to reduce the flammability of vehicles, buildings or articles during their service life, and plays a protective role in storage. Its primary application is in the manufacturing of extruded polystyrene and expanded polystyrene (XPS and EPS, respectively) boards, which are used for insulation purposes in the building industry. Other uses are in upholstered furniture, automobile interior textiles, car cushions and insulation blocks in trucks, packaging materials well as electric and electronic equipment.

3. The current production processes in the EPS and XPS foam industries have a number of impacts on the environment, including the emission of ozone depleting substances (ODS) like hydrochlorofluorocarbons (HCFCs) used as blowing agents, and the emission of the POP and flame retardant HBCD. HBCD has a strong potential to bioaccumulate and biomagnify. HBCD has a bio-concentration factors (BCF) in fathead minnow of 18100 and in rainbow trout of 13085 (Swedish Chemicals Agency 2008). It is persistent in the environment, and has a potential for long-range environmental transport. It is very toxic to aquatic organisms with a NOEC of 3.1 µg/l for Daphnia magna (Swedish Chemicals Agency 2008). Though information on the human toxicity of HBCD is, to a great extent lacking, vulnerable groups could be at risk, particularly because of the observed neuroendocrine and developmental toxicity of HBCD. HBCD has a strong potential to block the estrogen receptor indicating endocrine effects for females and have an even stronger effect to block the androgen receptor indicating endocrine effects for males (Hamers et al. 2006). Therefore particular care needs to be taken for female and male workers and at a lower risk level also for men and women in the general population. High human exposure to HBCD results from hot wire cutting of EPS/XPS in the construction sector (Zang et al. 2012) requiring the use of Personal Protective Equipment (PPE). Also, high human exposure can result from eggs from chickens picking EPS or XPS treated with HBCD as discovered in Germany and France (Hiebl and Vetter 2007; Jondreville et al. 2017)

4. The latest information available on the global production of HBCD, as presented by the Persistent Organic Pollutants Review Committee (POPRC) in its eighth meeting, indicates that the estimated total production in 2011 amounted to 31,000 metric tons, almost exclusively produced in China, Europe and the United States of America. Country-level information has been facilitated by these producers, indicating that China is the greatest consumer among developing countries.

5. Whereas the production and consumption of HBCD in developed countries is currently restricted (cases of Europe and the United States) or even banned (Japan, Norway), some developing countries have requested to extend its use in the XPS and EPS sectors until November 2021. This is in line with the exemption provided by decision SC-6/13 of the Stockholm Convention for these two sectors in particular.

6. There are several available alternatives to HBCD-based flame retardants in commercial use globally. The most known alternative is brominated styrene–butadiene styrene triblock copolymer (Br-SBS), which is styrene and butadiene copolymer bromide, a large polymeric brominated flame retardant (polymeric flame retardant PolyFR; CAS No 1195978–93–8) jointly developed by some overseas countries and largely used as a substitution for HBCD in the U.S, European countries, Japan and some western Asian countries. Tetrabromobisphenol A bis (2,3- dibromopropyl ether) and Tris (2,3- dibromopropyl) isocyanuric acid ester (TBC) also are two substitutes for HBCD. Due to the aromatic structure and the bromine, these alternatives have the potential to form brominated dioxins at end of life disposal in particular with non-BAT thermal treatment that is common practice in developing countries (Shaw et al. 2010). The UV degradation of brominated SBS resulted in the formation of brominated aromatic substances (Koch et al, 2017, 2019). In addition, they rely on the same chemical mechanism as HBCD to achieve flame retardant performance during fire / combustion, so they may also produce toxic substances in fire (Stec and Hull, 2011). Such considerations represent barriers for final users to take an optimal decision on the best alternative to be used in each case.

7. In the last decade, large amount of HBCD containing EPS/XPS have accumulated globally as insulation in buildings. Approx. 30,000 t of HBCD has been produced yearly and 90% of the HBCD produced has been used in EPS/XPS insulation. Considering that, in average, approximately 1% of HBCD is used in the EPS/XPS sector (0.7% in EPS and 0.8 to 3% in XPS (UNEP 2017a)) the yearly increase of HBCD containing EPS/XPS stockpile can be estimated to be about 2.7

million tonnes each year until 2013. Lower HBCD production volumes (approximately 18,000 t) was seen after 2013. Considering that HBCD-containing EPS/XPS was produced for more than 40 years, a total of approx. 40 to 70 million tonnes of HBCD- containing EPS/XPS has been produced in history with approx. 15 million metric tons of HBCD-containing EPS/XPS in China based on total HBCD production estimates (Li et al. 2016). The service life of EPS/XPS is 20 to 50 years (Posner et al. 2010; UNEP 2010) and therefore the largest share of these HBCD-treated EPS/XPS is still in use (Managaki et al. 2009; Li et al. 2016; EUMEPS 2018). XPS in current use contain chlorinated fluorinated carbons and hydrocarbon (CFC and HCFCs) which are used in former production process and is an important part of the ODS bank and has high GHG potential (GIZ 2018).

8. EPS/XPS foams containing HBCD, as with other plastic containing brominated flame retardants, pose challenges in recycling and energy recovery (UNEP 2017a,b; Lucas et al. 2017a,b). For polymers containing HBCD, recycling is prohibited by the Convention. Therefore, million tons of HBCD-containing EPS/XPS in China (and other countries) present a huge challenge for recycling and circular economy. These types of plastic and polymers often end up in the environment (and landfills) and may finally impact the oceans as marine litter. In Europe, less than 10% was recycled, ca. 58% was thermally recovered and 32% ended in landfills in 2017 (EUMEPS 2018). In China, as in most developing Asian countries, a large percentage is disposed or dumped (Li et al. 2016). A large share of the plastic and polymer wastes disposed in developing countries are released to the environment including marine litter plastic (Brooks 2018) negatively affecting marine biota and biodiversity (Gallo et al. 2018). Therefore, an improved management and/or the establishment of a management framework of plastic and polymer wastes in general and EPS/XPS wastes, in particular, is highly important to reduce the risk of further environmental pollution from this waste stream.

9. Activities for recycling or thermal recovery of EPS/XPS and other polystyrene have started in some developed countries (EUMEPS 2018; Mark et al. 2015; Vehlow et al. 2002; Styrenics Circular Solutions 2019). These activities mainly aim to recover the styrene or recover energy. In 2000, the bromine industry announced the recovery of bromine from BFR containing plastic/polymers in large scale (BSEF, 2000). Pilot plants were established and pilot tests were conducted to recover bromine from BFR polymers by thermal destruction and HBr recovery (Boerrigter et al., 2002; Vehlow et al., 2002). However, the recovery of bromine from BFRs such as HBCD in polymers has not been developed as a full scale operation yet. Also, the recovery of bromine from incineration via HBr (Vehlow et al. 2002) was considered but has not been realized as a full-scale process.

10. Releases of HBCD may occur during its manufacture and use in a variety of products accounting for its environment and health impacts. Releases occurring after disposal of these products in landfills or by incineration are also thought to be significant. Recycling of products containing HBCD is prohibited and need particular management approach to contribute to a more circular economy with appropriate separation and treatment technologies.

11. The need for proper phase out and management plans for HBCD is very much critical in China considering that HBCD is still produced and large volume of usage is seen in the EPS/XPS foam sector. The current project aims to improve the environmental performance of the foam sector in China through the phase out, introduction of HBCD alternatives and the sound management of HBCD-containing wastes.

1a.b) The baseline scenario and the associated baseline projects

12. In accordance with the provisions of paragraph 4 of Article 25 of the Stockholm Convention on Persistent Organic Pollutants, any amendment to Annex A, B or C shall enter into force only upon the deposit of its instrument of ratification, acceptance, approval or accession with respect thereto. In the case of China, on 2nd July, 2016, the twenty-first meeting of the twelfth session of the Standing Committee of the National People's Congress made the decision on ratifying the amendment to the Stockholm Convention on Persistent Organic Pollutants to list HBCD. On 26th December, 2016, the amendment came into force in China.

13. Parties may register for specific exemptions listed in Annex A or B pursuant to paragraph 3 of Article 4. These specific exemptions have a limited time frame and shall expire five (5) years after the date of entry into force of the Convention with respect to that particular chemical (paragraph 4 of Article 4), unless an earlier date is indicated in the Register by the Party or an extension is granted by the Conference of the Parties under paragraph 7 of Article 4. China has applied for the specific exemptions for five years on the production of HBCD for EPS/XPS and use of EPS/XPS foams containing HBCD in building insulation in accordance with the provisions of Part VII of the Annex A citing that it will take some time to transition from HBCD to alternatives in production and use.

Overview of HBCD production in China

14. HBCD has been put into the global market since the late 1960s. At that time, it was mainly produced in Europe, Japan and the United States. In the 1990s, a flame retardant chemical plant in Zhejiang Province in China began to produce HBCD but ceased production in 1998. Around 2000, some enterprises in Shandong and Jiangsu Provinces, having access to abundant bromine resources, began to produce HBCD. Since the 1990s, the cumulative production of HBCD in China has reached more than 200,000 metric tons and since 2009, the yearly production exceeded 10,000 t/year. (Figure 1).

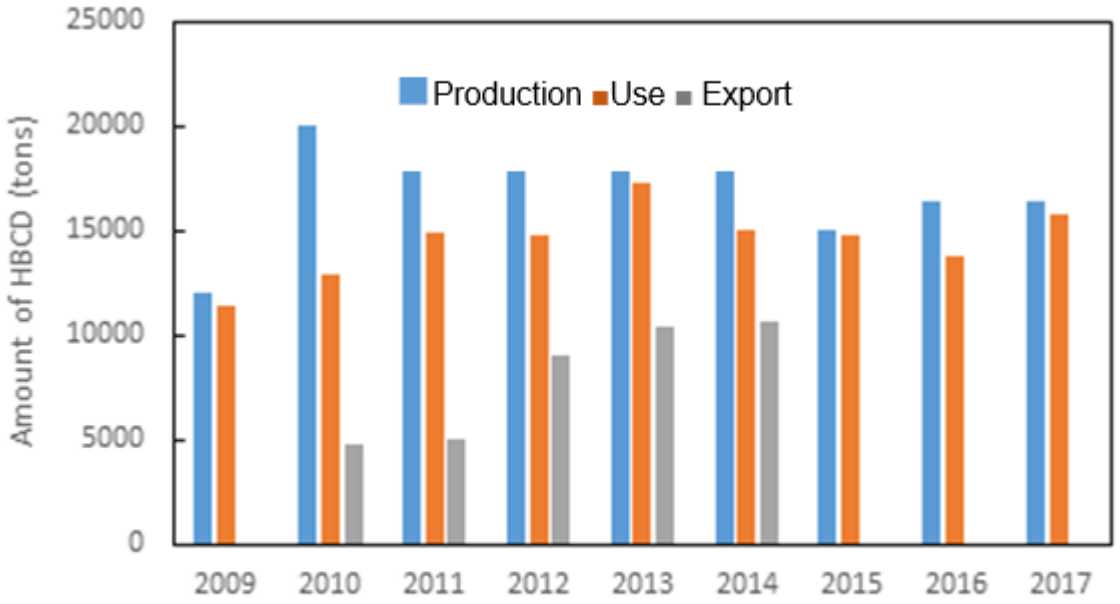

Figure 1. Production, use and export of HBCD in China

15. Since the establishment of more stringent anti-flammability standards for building materials in China, the country became the largest producer and consumer of HBCD globally. According to the statistics derived from the industry associations, in 2015-2017, the total output of HBCD in China was 52, 287 metric tons, and the total export volume was 9, 096.65 metric tons (Table 1). In 2017, the total output of HBCD in China was 17, 183 tons, of which 8120 tons were used for EPS manufacturing and 6621 tons were used for XPS, 14.21% of which were exported to other countries. The detailed information on HBCD production in recent years is listed in the Table 1 below.

Table 1. HBCD production capacity, output and export in 2015-2017 in China

Year	2015	2016	2017
Capacity (metric ton)	32000	34000	37000
Output (metric ton)	18157	16947	17183
Export volume (metric ton)	2855.8	3798.85	2442
For XPS (metric ton)	7772	5167	6621
For EPS (metric ton)	7529	7981	8120

16. In 2017, there were ten HBCD production enterprises in China. Nine enterprises were located in Weifang City, Shandong Province, the outputs of which accounted for about 80% - 90% of the national production from 2015 to 2017. One enterprise was located in Lianyungang City, Jiangsu Province. The biggest producers were the following:

Shandong X Co., Ltd. accounts for about 46% of the national production. Founded in 2009, the company is located in Yangkou chemical industry park, Shouguang City, Shandong Province, with a registered capital of 78 million RMB yuan, a total asset of 336.1 million RMB yuan, an area of 655 mu, and more than 400 employees. Relying on the advantages of local resources, the company is one of the earliest domestic enterprises engaged in the production of HBCD. Since the production line was put into operation in 2011, the company's production and sales of the HBCD have ranked first in the industry.

Shandong E Co., Ltd. is located in Houzhen Industrial Park, Shouguang City, Shandong Province with a total assets of 200 million yuan. There are more than 200 workers, including 40 technical personnel in the company. The company has a 5000 t/y HBCD production workshop, which will be replaced by the workshops of methyl octabromoether and brominated SBS proposed as the substitute of HBCD in the future. The removal of reaction kettle, distillation kettle, cooling tower, metering tank and other equipment in the original HBCD production workshop can be used for the production of substitutes. The waste generated in the demolition process will be treated in an environmentally sound manner.

Shandong S Co., Ltd. is located in Bohai Chemical Park, Shouguang City. It was established on June 12, 2007, with a registered capital of 10 million yuan and 70 employees. It is an enterprise that produces flame retardant HBCD. The company has a 3000 metric tons/a HBCD production plant, which is in good operation. The company has prepared to produce tetrabromobisphenol a-bis (2,3-dibromo (methyl) propyl) ether (hereinafter referred to as methyl octabromoether) as an alternative to HBCD, which is currently in the preliminary design stage.

Table 2 provides an overview of the production of the 3 major HBCD producers in Shandong province.

Table 2. The production of HBCD in the enterprises.

Item	Capacity in 2017/t	Capacity in 2018/t	Capacity in 2019/t	Output in 2017/t	Output in 2018/t	Output in 2019/t
X	9000	9000	9000	6568	6852	7381
E	5000	5000	5000	1747	2436	2473
S	4000	4000	4000	2580	2760	2840

Overview of EPS Production in China

17. China began to use insulation boards containing HBCD in the building industry, since the 1980s. Especially in recent years, a large number of insulation board containing HBCD has been used in the construction industry. During the years 2009-2017, the amount of HBCD used as flame retardant in external insulation materials was 111,900 metric tons resulting in approx. 11.8 million metric tons of treated EPS/XPS. Because the usage of began earlier, the cumulative use of HBCD in EPS products is greater than that of XPS products. Since 2010, China's HBCD output has been used only in the production of EPS and XPS. Figure 2 shows the usage of HBCD in the EPS and XPS industries.

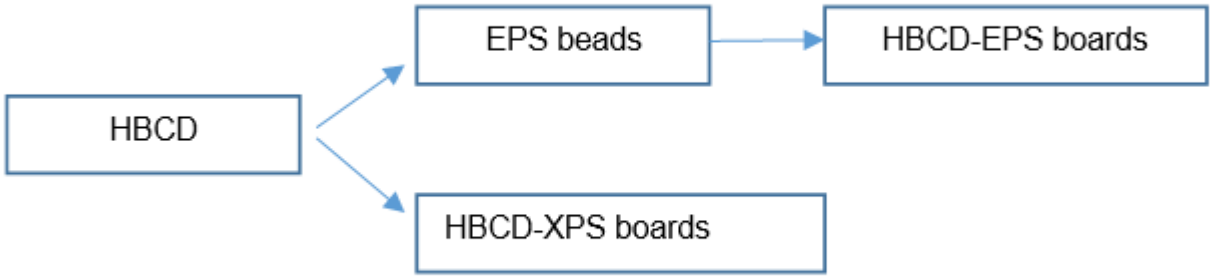

Figure 2. Circulation of HBCD in EPS and XPS industries

18. In the 1980s, China began to introduce EPS board production technology and applied it for building insulation. In recent years, more than 3000 Chinese enterprises manufacture EPS flame retardant insulation board, out of which around 100 are large-scale enterprises with an annual output of more than 5000 metric tons. China has become the world's largest producer and consumer of EPS insulation materials. These enterprises are mainly located in the North of China. Enterprises distribution expanded in Jiangsu Province, Zhejiang Province, Guangdong Province to Fujian Province, Shandong Province, Tianjin City, Hebei Province, Xinjiang, and other Provinces.

19. HBCD is largely used in EPS board products, although the EPS board manufacturers do not directly use flame retardant as raw materials. EPS boards are made from EPS beads after pre foaming, curing, molding and other processing. EPS beads are divided into flame-retarded and non-flame-retarded. Manufacturers can produce different types of products according to the needs of users. Thus, when HBCD is prohibited, EPS beads producers would be impacted if alternatives cannot meet their needs and consequently, EPS board manufacturers.

20 . EPS board is made from EPS beads. Styrene can be used to produce EPS beads, in which HBCD is added as flame retardant to produce EPS beads. According to the classification requirements of flame retardant materials, the proportion of HBCD added to grade B1 EPS flame retardant products is 0.8% - 1%; the proportion of HBCD added to grade B2 EPS flame retardant products is 0.6% - 0.8% and the proportion of HBCD added to grade B1 graphite EPS flame retardant products is about 1%.

21 . In 2017, there were about 21 EPS bead production enterprises in China (including all branches of large companies like Jianlong and Xingda), with a total capacity of 5.695 million metric tons, which are mainly located in Jiangsu, Shandong, Liaoning, Guangdong provinces and in Tianjin. Two of the major producers account for 51.36% of the total production, and the other 19 enterprises accounts for the rest. Because styrene is the main EPS raw material, these factories are close to the production sites of styrene or to the port, which is convenient for styrene transportation. In 2017, a total of 3.5764 million tons of EPS beads were produced in China, including 1.27 million tons of flame-retardant EPS beads, accounting for about 35.6% of the total. In 2017, EPS bead production enterprises used 8120 metric tons of HBCD. Table 3 and 4 shows the EPS beads production and capacity of a typical EPS beads producer in China,

respectively.

Table 3. EPS beads production in China in 2015-2017

Year	Flame retardant EPS beads, (t)	Non flame retardant EPS beads, (t)	Total(t)
2015	1,400,000	1,940,000	3,340,000
2016	1,280,000	2,185,000	3,465,000
2017	1,270,360	2,306,040	3,576,400

Table 4. Capacity of typical EPS beads producers in China

NO.	Location	Capacity/t	EPS beads output in 2017 (t)	EPS beads output in 2018 (t)	EPS beads output in 2019 (t)	HBCD consumption in 2017 (t)	HBCD consumption in 2018 (t)	HBCD consumption in 2019 (t)
1	Jiangyin	360000	160000	147000	169000	1080	910	1120
2	Wuxi	120000	86727	78621	101211	985	872	1121
3	Changzhou	120000	57671	38110	44533	330	139	153

Overview of XPS Production in China

22. The XPS foam industry in China started relatively late but the number of enterprises developed rapidly. Currently, there are around 700-1000 manufacturers of XPS board products in China with about 1500 XPS production lines and an annual production of nearly 800 thousand metric tons, out of which, 20% are flame-retarded boards. Most of the production enterprises are small- and medium-sized facilities, located mostly in Beijing, Tianjin, Hebei, Henan, Jiangsu and other regions. In addition, a considerable number of enterprises are manufacturers of a wide range of thermal insulation materials. Many enterprises produce both XPS and EPS products. Table 5 shows examples of typical XPS producers in China.

Table 5. Examples of typical XPS producers in China

NO.	Location	Capacity/t	XPS output in 2017/t	XPS output in 2018/t	XPS output in 2019/t	HBCD consumption in 2017/t	HBCD consumption in 2018/t	HBCD consumption in 2019/t
1	Guangzhou	5000	1774.70	3367.15	3180.87	35.49	67.34	63.62
2	Wuhu	6000	0	144.4	1871.02	0	2.74	37.42
3	Tangshan	5000	0	340.133	1293.17	0	11.84	40.1
4	Nanjing	9000	5250	5100	4980	307	337	326

23．HBCD is used in the XPS industry for either the direct manufacturing of XPS flame-retarded products, or for the manufacturing of XPS flame-retarded beads to be used for XPS products. Among them, the amount of HBCD added to the B1 level XPS board is generally 3-6%, whilst the amount of HBCD added to the B2 level is generally 1-3%. The amount of HBCD used in XPS sector was about 6000~8000 metric tons per year, which was almost equal to the HBCD consumption in the EPS sector in recent years.

24．In 2017, the total output of HBCD in China was 17, 183 metric tons, of which 8120 metric tons were used for EPS and 6621 metric tons were used for XPS production. Detailed information on recent HBCD production is reported in Table 6 below.

Table 6 The HBCD consumption in EPS and XPS in China 2015-2017

Year	2015	2016	2017
Capacity of HBCD (ton)	32000	34000	37000
Output of HBCD (metric tons)	18157	16947	17183
HBCD used in XPS (metric tons)	7772	5167	6621
HBCD used in EPS (metric ton)	7529	7981	8120

Overview of the HBCD releases and wastes in China and technology options

25. Most of the HBCD producers use semi-automated production line and only a small number of enterprises use advanced automated production lines. HBCD manufacturing in China is not in line with best available technology and best environmental practice. During the production processes of HBCD and EPS beads containing HBCD, some producers treat collected waste gas by alkali absorption, adsorption and oxidation in oxidation washing towers, membrane absorption, and activated carbon adsorption. Wastewater is treated by biological treatment or sewage treatment equipment processing after catalytic oxidation; waste residues containing HBCD are treated as hazardous solid waste and disposed through incineration.

26. In the production of HBCD chemicals and HBCD-containing EPS/XPS insulation board, the emissions of HBCD in the flue gas and waste water are 3.5 metric tons/y and 4.9 metric tons/y, respectively. In the life cycle of HBCD, waste gas, water and solid waste are likely to pollute the storage, production, and management sites. Large amount of dust containing HBCD pollutes the workshop and the surrounding environment. HBCD manufacturers, HBCD-containing insulation board production enterprises, and storage facilities may be considered contaminated sites (Li et al. 2012, Zhang et al. 2017).

27. During the production of HBCD chemicals and flame retardant insulation materials containing HBCD, a relatively small amount of solid wastes (treated as hazardous waste) is generated. However, the disposal of end-of-life insulation boards containing HBCD will become a hazardous waste issue in the coming years, China began to use insulation board containing HBCD in the building industry since the 1980s. In the period 2009-2017, around 111,900 metric tons of HBCD were used in external insulation materials. In total, more than 10 million metric tons of EPS/XPS containing HBCD are in use. While the release during usage is small, the management of end of life insulation board resulting from demolition or maintenance of building will become a major source of environmental emissions of HBCD and of EPS/XPS in the future (Li et al. 2016). The in-use HBCD-containing insulations in buildings are predicted to expire in 20 – 50 years, leading to vast HBCD-containing wastes problem. Construction and demolition waste (C&DW) accounts for 30% to 40% of the total amount of waste in China and C&DW is usually randomly dumped or disposed of in landfills. The average recycling rate of C&DW in China is only about 5% (Huang et al. 2018). It is expected that in 2035, China will produce more than ten thousand metric tons of HBCD construction waste per year increasing to more than 500,000 t/year later, which will need to be properly managed to mitigate impacts to human health and the environment.

28. For the recovery and recycling of EPS/XPS from HBCD-treated EPS/XPS a suggested approach is dissolving the HBCD containing EPS/XPS in specific solvents and separating the polystyrene from the HBCD (CreaCycle http://www.creacycle.de/en/projects/recycling-of-expanded-poly-styrene-eps/eps-circle.html). The process has been invented by Fraunhofer Institute and currently a full scale plant is constructed in The Netherlands including the aim to also recover bromine from the separated HBCD fraction to promote the circular economy approach for this waste (http://www.creacycle.de/en/projects/recycling-of-expanded-poly-styrene-eps/polystyrene-loop-2016.html).

29. The disposal of POPs-containing wastes through incineration and co-processing in cement kiln are also feasible technology options. The advantages of co-processing in cement kilns include high temperature, long retention time, alkaline environment, and it does not result in the generation of ashes, as all the residues are integrated into the clinker. Under high temperature condition (about 1500 ℃ or 1100 ℃ depending on feeding point) of cement kiln, the organic pollutants in waste are transformed into inorganic compounds. The use of incineration facilities has attracted attention for POPs disposal. In Germany, studies have demonstrated that HBCD containing EPS/XPS can be destroyed in a BAT waste incinerator without increasing emissions (Mark et al. 2015).

These technology options will be assessed to determine their suitability to address HBCD-containing waste streams.

Baseline Projects

30. 30. To meet its obligation to the Stockholm Convention, China has successfully established a number of government departments to implement the coordination with the support of “Building the capacity of the People's Republic of China to implement the Stockholm Convention on POPs and develop a National Implementation Plan” and “Strengthening Institutions, Regulations and Enforcement (SIRE) Capacities for Effective and Efficient Implementation of the National Implementation Plan in China”. Many administrative departments, including the Ministry of Ecology and Environment, the Ministry of Foreign Affairs, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Commerce, the Ministry of Science and Technology, the Ministry of Housing and Urban-Rural Development, the State Administration of Work Safety, the Ministry of Industry and Information Technology have formed an organic collaborative framework to ensure compliance to the Convention.

The following lists the baseline projects associated with the GEF project:

Component 1: Policy and regulatory framework

31 . On policy and regulatory framework, China has several laws and regulations relevant to HBCD including the following:

i) In 2014, HBCD was included in the "Key Environmental Management Hazardous Chemicals Inventory" released by the MEE. This inventory was effective until July 13, 2016

ii) In 2015, HBCD was included in the Catalogue of Hazardous Chemical,and the“Catalogue of Products with High Pollution and High Environmental Risk “. All processes of production, storage, use, transportation and operation shall be subject to safety supervision and management, and environmental management control in accordance with the requirements of the relevant management regulations and systems such as "Hazardous Chemicals Safety Management Regulations". Both catalogues have been updated in 2017 and the control measures on HBCD remained the same.

iii) On December 26, 2016, 11 ministries, including MEE, MFA and NDRC jointly released effective notice of the "Stockholm Convention on Persistent Organic Pollutants, New Amendments of Hexabromocyclododecane". Since December 26, 2016, the production, use, import and export of HBCD have been banned, except for the specific exempted uses for EPS and XPS in buildings.

iv) In 2017, HBCD has been included in the "List of Priority Control Chemicals (First Batch)".

v) According to the announcement, as of January 1, 2017, enterprises that import or export HBCD should apply to the MEE for the registration of the environmental management certificate for the import of toxic chemicals and the import and export environment for toxic chemicals Manage Release Notes. The import and export uses comply with the provisions of the Stockholm Convention, that is, for the production or use of EPS and XPS before the expiry date of the specific exemption registration (December 25, 2021).

vi) In December 2019, HBCD was listed in *List of Strictly Restricted Toxic Chemicals in China (2020)* issued by MEE, Ministry of Commerce and General Administration of Customs in response to its restrictions under the Stockholm Convention and the Rotterdam Convention . Before this, HBCD was also mentioned in the first *List of Strictly Restricted Toxic Chemicals in China (2018),* where the terms of HBCD restrictions remained the same as the version of 2020.

32．From the aspect of identification of the hazards of chemicals and management of hazardous chemicals, scientific and complete classification and labeling system helps with the effectiveness of risk assessment and information exchange, contributing to the effective risk management of chemicals. In "Environmental Labeling Products Technical Requirements of Voice Recorder (HJ 2510-2012)" and "Environmental Labeling Products Technical Requirements of Color TV (HJ2506-2011)", HBCD was added in the required environmental labeling of the products. As for XPS and EPS containing HBCD, however, no regulations are yet formulated in terms of labeling for presence of POPs.

33．The regulations and standards on building exterior insulation material indirectly affect the amount of HBCD in the insulation material. In September 2009, the Ministry of Public Security and the Ministry of Construction jointly issued the regulation: Civil Building External Wall Insulation System and External Decorative Fireproof Interim Provisions, in which exterior wall insulation materials in most of the civil buildings require class A and B1 and a few buildings can use class B2. The revised Code for Fire Prevention in Building Design (Draft) makes a similar requirement. According to the above criteria, the construction industry generally chooses class B1 insulation materials.

34．On June 8, 2013, in the "Legal Interpretation on the Handling of Criminal Cases of Environmental Pollution" of Supreme Court of the Judicial Committee, HBCD has been identified as "toxic substances". In 2013, HBCD was incorporated into the first part of the "high pollution, high environmental risk" products of Comprehensive Catalogue of Environmental Protection (2013 Edition) issued by the Ministry of Environmental Protection.

35．China is a central planning country where local governments would follow the national ban on HBCD and invest in personnel to enforce the supervision on HBCD producers and users. Shandong Province has expressed their willingness to participate in the project activities as demonstration province and as it hosts the major HBCD and EPS/XPS foam producers, the participation of the province is important. In their official proposal to the MEE, the local Department of Ecology and Environment (DEE) will formulate and improve the relevant policy standard system of HBCD in the province and implement the governmental supervision responsibilities supported by the local financing . The local DEE, however, indicated that it still lacks the technical capacity and knowledge necessary for assessing and managing HBCD which the project will address.

36．Considering the number and extent of regulations in China that are relevant to HBCD, China still lacks effective regulations, limits or policies to ban the production, usage, import and export of HBCD despite its large output of HBCD and HBCD containing products. There are still no specific requirements for the identification of POPs contained in insulation materials. Several policy gaps on environmental quality standards, chemical limits, monitoring methodologies and product labeling standards relevant to HBCD still need to be addressed. Pollutant discharge standards still do not include HBCD, thus related wastes are treated as general industrial wastes and there is no systematic monitoring and evaluation of HBCD from sources. More importantly, national managerial capacity, enforcement, supervision, and monitoring methods issues need to be strengthened. Harmonization of existing policies across different ministries also need to be undertaken. The project aims to address this gap.

Component 2: Promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector

37．At present, many developed countries, including European countries, have developed styrene and butadiene copolymer brominated SBS, tetrabromobisphenol A bis (2,3- dibromopropyl ether), and tris (2,3- dibromopropyl) isocyanuric acid ester as substitutes for HBCD. In terms of HBCD alternatives, China has started to investigate the use of brominated SBS in the production of EPS and XPS as alternative to HBCD. However, due to the small scale of production, the replacement cost was 15% ~ 25% higher than using HBCD. At the same time, Chinese manufacturers have carried out pilot production of the flame retardant tetrabromobisphenol A bis (2,3- dibromopropyl) ether. TBBPA is still in the development stage in China and not ready for industrial production. Manufacturing and processing facilities also need to make significant investment in new equipment in order to shift to the production of

alternative flame retardants. There are some commercially available alternatives (Aditya et al 2017) , for example thermosetting polystyrene foamed polymer, polypenyl insulation and polyurethane boards, for EPS/XPS insulation board. However, most of them are still at a relatively small scale production, command higher pricing and has a low market share. More importantly, their environmental risks need to be further evaluated.

38. Some HBCD manufacturers have initiated research and development on new HBCD alternatives and new insulation materials. While the main reason behind these iniatitives is the looming deadline on HBCD production and use, the demand of overseas market for HBCD-free products also required a switch to HBCD alternatives. However, the high cost of research and development, patent issues and small domestic market remain as major obstacles to the HBCD producers. Some EPS/ XPS manufacturers have taken measures to stop using HBCD, and they are willing to participate in the demonstration, training and awareness-raising activities initiated by the project through self-financing.

39 . The ongoing HCFC-22 phase out project maybe linked to the current project on assessing the use of HBCD alternatives in the XPS Sector. To meet its obligation to the Montreal Protocol. MEE/FECO, GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and UNIDO jointly developed the Sector Plan for Phase out of HCFCs in the XPS Foam Sector in China (Phase I and Phase II). The Sector Plan for Phase I was submitted to the 62nd ExCom Meeting in August 2010 and approved in July 2011 with grant fund of 50 million dollars. All targets set in the Phase I has been completed in 2015 with 25 phase-out contracts and a total of 9589.98 tons of HCFCs reduced. Also, in accordance with the phase-out activities under Phase I, technical standards were formulated, alternative technologies were developed and the Production Safety Whitepaper was revised.

40 . Phase II was approved at the 77th ExCom meeting with a grant fund of about US$112 Million to be released for HCFCs phase-out activities, TA activities and project management. As per the sector plan, HCFCs are expected to be completely phased out by 2026. In terms of enterprise renovation activities, this project has already signed phase-out contracts with 10 enterprises in 2016 and 2017 and phased out 4,296.796 tons HCFCs.

41 . From 2013, China began to gradually reduce the production and consumption of HCFCs. In 2020, the baseline level of HCFC -22 consumption will be reduced by 45%. By 2025, HCFCs will be completely eliminated in all sectors. The XPS foam industry is one of the main sectors of HCFC-22 consumption in China. In the first elimination phase, 25 enterprises in the XPS industry have applied for alternative projects and reduced about 10031 tons of HCFCs. The second elimination phase is in progress, and 17 enterprises have applied for the project.

42 . China has emphasized stricter enforcement of environmental law, and the punishment of illegal production or being listed in the "Red List" for future inspection is well known. This would force the enterprises to make the adaptive choices to HBCD alternatives. The project aims to assist HBCD producers to convert their production lines to HBCD alternatives and also support companies on the assessment of the alternatives produced. It also envisages the promotion of venture capital investment and technology transfer on switching to HBCD alternatives providing support on feasible green chemical solutions.

Component 3: Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD

43 . HBCD wastes from production facilities and construction wastes and demolition wastes (C&DW) containing HBCD will be major waste streams in the future (if not already is). As mentioned above, construction and demolition wastes (C&DW) account for 30% to 40% of the total amount of waste in China and this waste stream is usually randomly dumped or disposed in landfills. Due to the large scale use of flame-retarded insulation materials, the amount of HBCD in C&DW is significant. Research institutions in the country and the private sector have expressed commitment to collaborate with FECO-MEE in sharing knowledge and providing existing facilities to promote the demonstration of environmentally sound disposal of HBCD-containing waste streams.

44．Possible technology options for the management of HBCD-containing wastes exists in China. The country has already safely disposed POPs waste in particular POPs pesticide waste and Dioxin containing waste in cement kilns (Yan et al. 2014, 2018). Therefore, the disposal of HBCD-containing wastes through co-processing in cement kiln can be used as a potential technology option. In order to regulate co-processing technology in cement kilns, the government has issued "Technical specifications for environmental protection of collaborative treatment of solid waste by cement kilns (HJ662-2013)" and "Pollution control standard for collaborative treatment of solid waste by cement kilns (GB30485-2013)", etc. The specification clearly states that the disposal through co-processing in cement kiln can be used for the treatment of hazardous waste, domestic waste (including waste plastic, waste rubber, waste paper, waste tires, etc.), municipal and industrial sewage treatment sludge, animal and plant processing waste, contaminated soil, emergency waste and other solid wastes

This option should, however, be further assessed as there are no available study on the disposal of large volumes of bromine containing waste in cement kilns and on the effect on corrosion and the accumulation of sodium bromine and potassium bromine in the kiln.

45．Incineration facilities for municipal wastes are also present in a relatively good number in China. According to the "13th Five year plan for the construction of harmless treatment facilities for municipal solid waste", the total investment in the construction of treatment facilities for municipal solid waste is about 251.84 Billion Yuan. By 2020, the incineration capacity of municipal solid waste will account for more than 50% of the total treatment capacity. In order to control the pollution of MSW incineration, including the releases of dioxins and slags, the Government has issued the "Standard for pollution control of MSW incineration (GB 18485-2014)". Today, most of the pollution control measures adopted for MSW incineration in China have basically reached the standard. If policy permits, EPS and XPS wastes containing HBCD can be co-disposed in municipal solid waste incineration facilities but attention should be paid to avoid the generation of brominated dioxins.

46．In China, no attempt on the recovery of bromine from BFR containing polymers has been reported and considering that the country does not have a good source for bromine, bromine recovery from discarded HBCD-containing XPS/EPS foams could be explored similarly to the HBCD containing EPS/XPS project in the Netherlands (Tange et al. 2016: Schlummer et al. 2017). China has officially adopted the framework of circular economy in 2002 (Geng and Doberstein, 2008) and such large upcoming waste flow should be assessed for recovery of resources. In 2009, China's Circular Economy Promotion Law came into force to facilitate circular economy, resource efficiency and environmental protection. The Law aims to achieve sustainable development by raising resource utilization rate and increasing resource recovery in production, circulation, and consumption. However, as in other countries, there are still a range of challenges for circular economy and a recent study assessed the key causal barriers in China: the lack of regulatory pressures, the lack of environmental education and culture of environmental protection, and the lack of market pressures and demands (Zhang et al. 2019).

47．Currently, there are no identification standards or technical guidelines for the disposal of HBCD containing waste generated from either from manufacturing or dismantling buildings in China. The project aims to address these through proper inventory of HBCD stocks and wastes and identification and demonstration of environmentally-sound technologies for HBCD stocks and wastes.

Component 4. Information dissemination, capacity building and knowledge management

48．Several initiatives from various stakeholders comprise the baseline project for this component. In terms of awareness raising on POPs, China, in recent years, has carried out a number of large-scale promotional activities, through newspapers, television, the Internet, and other media to popularize the POPs hazards. In 2003, China set up a national leading group for the implementation of the plan, and in 2005 a national coordination group for the implementation was set up. In the past decade, public awareness on POPs issues has been further raised. However, the country has not yet carried out HBCD-related

information awareness-raising education; most stakeholders (including users, construction industry, demolition industry, and waste management sector) and the public have insufficient understanding of the problem and actions are needed. There is currently an overall lack of HBCD environmental awareness among HBCD producers, users and the public.

49. Research works have been undertaken by Chinese universities and researchers with regard to HBCD. Li and co-authors (2016) from Peking University conducted an initial material and substance flow analysis on EPS/XPS and concluded that a large stockpile of HBCD-containing EPS/XPS and related stocks and impacted buildings is present in China and needs urgently to be addressed to avoid further and future pollution. Currently, however, information on the disposal of insulation boards containing HBCD highlights that management of such wastes is not appropriate and that considerable release occurs at the end of life. It is expected that this pollution will increase with increasing HBCD containing EPS/XPS waste volumes in the future (Li et al., 2016). Furthermore, initial studies on HBCD environmental pollution around industrial sites have been conducted (Li et al. 2012, Zhang et al., 2017) and an overview of HBCDs in environmental media with focus on their potential risk and management has also been conducted (Cao et al., 2018). HBCD levels have been measured in human milk for the effectiveness evaluation for the Stockholm Convention (Huang et al., 2020; Lu et al., 2018). Research on the destruction of HBCD on lab scale studies using nanoscale zero-valent aluminum (Jiang et al., 2020), sodium persulfate(Yan et al., 2017) and mechanochemical treatment (Zhang et al., 2014) have been performed.

50. A socio-economic analysis (SEA) was also conducted by Peking University to the case of HBCD phase-out in China (Zhu et al. 2016). The study indicates that, under the possible scenarios of 10 years and 5 years, the economic costs of HBCD phase-out in China would be between 9.032 and 19.021 billion RMB (USD 1.4–2.8 billion). Although the total economic costs seem to be significant, it would only have a marginal impact on the house building industry with a likely cost increase of about 0.07‰–0.14‰. On the other hand, the HBCD phase-out may bring significant environmental and health benefits (Zhu et al. 2016).

51. The LfU Bayerisches Landesamt für Umwelt has provided baseline funding to the project through their ongoing project on setting up a POP Coordination Center for the Environment aims at strengthening the international cooperation regarding POPs issues between Bavaria and China with focus on HBCD and its replacement in the foam sector and HBCD wastes disposal. The main activities include exchange of experts on HBCD management and study visits and workshops. As per the project document, the involvement of Shandong stakeholders is envisaged.

52. China is a participating country in the regional project on "Ocean Plastic Turned into an Opportunity in Circular Economy – OPTOCE." funded by Norway (NORAD and SINTEF 2019). This is highly relevant to the present project as EPS/XPS is a part of the larger challenge of waste plastic and polymers pollution causing global marine littering. EPS/XPS can contribute a relevant share to marine litter (Danish Fisheries Agency and Ministry of Environment and food of Denmark 2019). Highly populated Asian countries with large shore lines have a high release of marine plastic litter (Lebreton et al. 2017). The current project aims to link its activities to the NORAD project and take advantage of its outputs and mutual benefits.

53. The common approach between the UNIDO ODS projects and the current project is highly relevant in terms of building knowledge generation. UNIDO builds on a strong and early program to support China in the implementation of the Stockholm Convention and is also working with China since the last two decades to implement sector plans for ODS control. Similarities between HBCD and ODS issues include: a large number of diverse stakeholders for which different types of incentives are required to influence phase-out; the continuing use of these chemicals subject to sanction from international markets; targeted beneficiaries of the project are private entities; and the phase-out involves conversion of chemical and/or production processes at enterprise level. Moreover, the counterpart is familiar with tools and approaches employed by ODS projects for transferring technology and financial assistance to private enterprises.

54. Considering the initiatives undertaken so far and even given the exemptions provided by the Stockholm Convention on the use of HBCD in the EPS and XPS sectors, there are, obviously, identified gaps in China to comply to the HBCD amendment. These gaps encompass laws and regulations, HBCD alternatives, product labeling, information on HBCD waste inventory and environmentally-sound technologies for HBCD wastes disposal. There is also a seemingly disharmonized information collection and sharing amongst relevant stakeholders. The current project aims to remove the barriers and addresse the gaps allowing China to address HBCD issue in the country.

1a.c) The proposed alternative scenario, with a brief description of expected outcomes and components of the project

55 . The aim of the current project is to improve the environmental performance of the foam sector in China through the phase-out, introduction of HBCD alternatives and environmentally-sound management of HBCD-containing EPS/XPS foams. With the assistance of the GEF, China plans to improve HBCD management policies, regulations and standards, prohibit new and expansion of enterprises producing/using HBCD, limit the production and use of HBCD, identify the EPS and XPS flame retardant products containing HBCD in the entire life cycle, develop and introduce alternative production technology of flame retardant insulation board without HBCD, encourage and support production of alternatives to HBCD and flame retardant insulation materials containing HBCD, strict control of emissions of HBCD, carry out survey of HBCD potential waste and contaminated sites, develop environmental sound technology of potential HBCD waste and contaminated sites, develop environment monitoring technology and carry out environmental monitoring activities, carry out environmental protection propaganda, raise public environmental awareness.

Theory of Change

56. The replacement of HBCD with non-POPs alternative will impact a whole industrial sector. It will not only bring wide environmental benefits, but will also represent an example and a source of information for the implementation of similar changes in the society. In this sense, the project will contribute to a broader objective of sustainable consumption and production. To phase out POPs and improve the environmental performance in the foam sector in China, the project is expected to take interventions that target the barriers and absence of effective measures in the following:

- Policy and regulatory framework to enforce the ban on HBCD and encourage the alternatives
- BAT/BEP demonstration activities of stopping HBCD production and conversion production of HBCD alternatives/alternative insulation materials, which are evaluated and then replicated in EPS/XPS
- EMS of HBCD containing EPS/XPS
- Proper training and knowledge sharing targeting various stakeholders.

A Theory of Change mapping is provided in Figure 3 below:

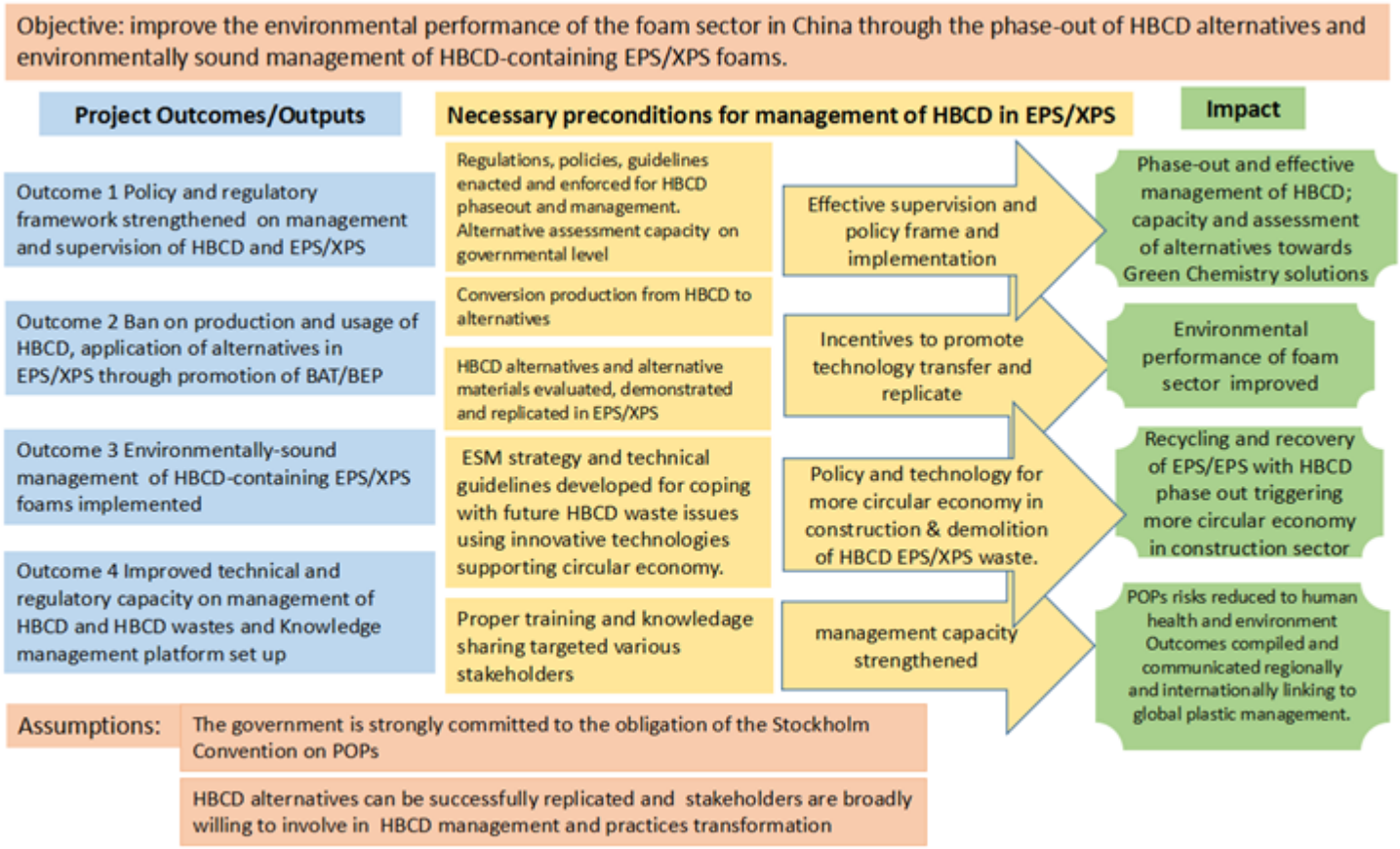

Figure 3: Overview on the project activities that can contribute to the Theory of Change

57. Each component of the project serves a different dimension of the project long-term goal, which seeks influences that resonates with the management concept of national government in chemicals and waste and also fulfills the gaps and applies lessons learned from previous projects.

- Component 1 facilitates the effective supervision and regulatory framework on POPs of governmental authorities inside and outside MEE and initiate a national assessment mechanism of alternatives.

- Component 2 encourages, by incentives and other promotion activities, the private sectors to urgently map out a solution to the health and environmental issue of the chemical of concern, helping them assess and avoid the adverse environmental and social impact of their current and future production activities on the community. The demonstration enterprises would practice Green Chemical solution that could lead the foam sector to more sustainable production.

- Component 3 is to improve design for deconstruction of buildings are of high importance for a better recycling and recovery rate from C&DW in future. The first basis for this is the information and education on deconstruction and demolition challenges and the need for better design of construction materials. This can lead to more sustainable construction of buildings already considering the end of life and deconstruction of buildings supporting a more circular economy.

• Component 4 is to improve the overall management capacity of various stakeholders under this project, which includes government, enterprises and academia that have direct influence in POPs management, raising the awareness of the general public who would possibly reflect their demand for more environmental-friendly products on the market. The project would bring comprehensive knowledge resources along the lifecycle management of POPs and compiled to feed into the knowledge platform for knowledge sharing on a national, regional and international level.

58. The assumptions in the TOC are: (i) The government is strongly committed to meeting its obligation of the Stockholm Convention on POPs and; (ii) HBCD alternatives can be successfully replicated and stakeholders are broadly willing to involve in effective HBCD management and implement transformation.

59. Through the various interventions, the project aims to produce POPs-free materials and support an improved sustainable material management contributing to circular economy and sound material-cycle society. Figure 4 summarizes the project framework:

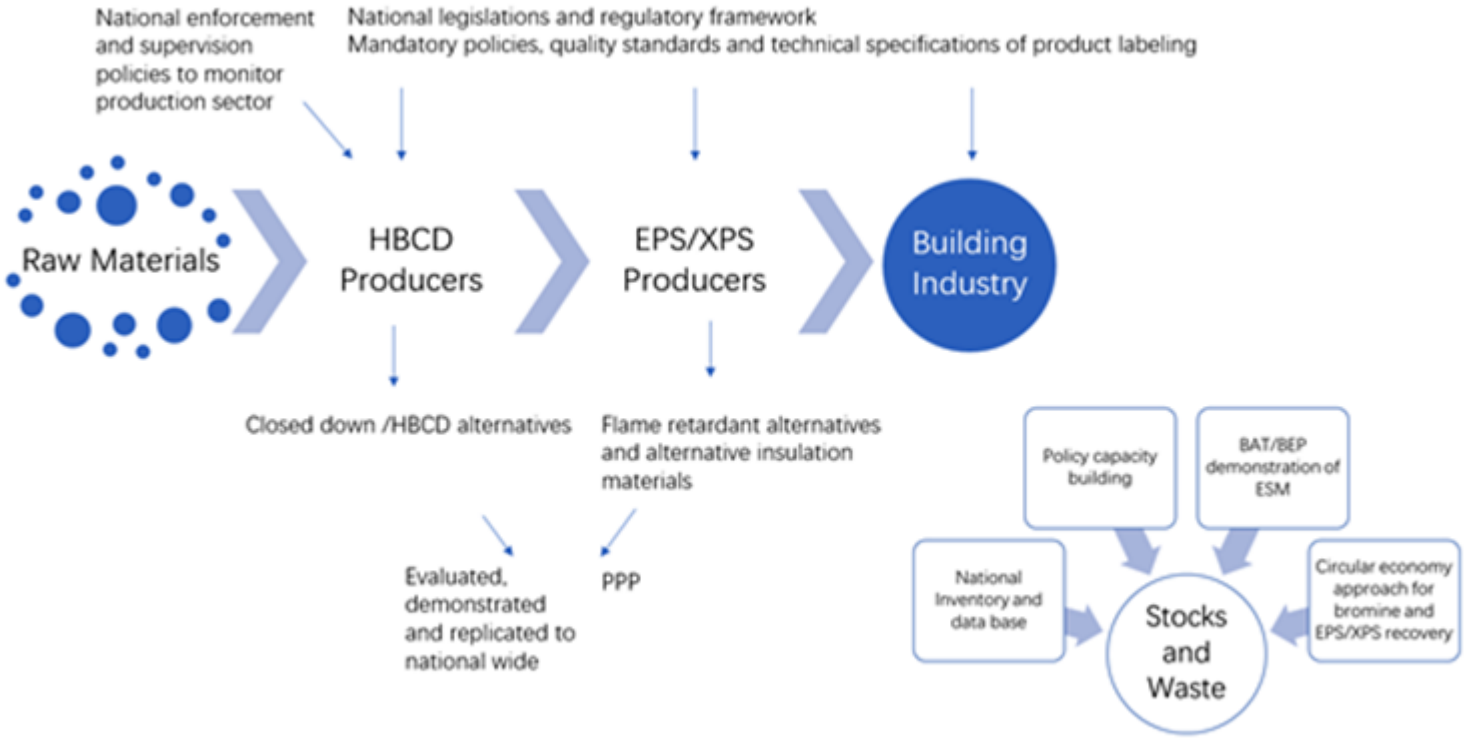

Figure 4. Schematic diagram of the project framework

The following provides the details of the project components:

Component 1. Policy and regulatory framework.

60. Component 1 is designed to improve and strengthen the policy and regulatory framework to stop the production and use of HBCD and develop a regulatory framework for the management of HBCD containing EPS and XPS wastes. It also intends to fill the gaps between the national legal framework and the Stockholm Convention requirements and effectively ensure the sustainability and replicability of the outcomes of the project. Component 1 focuses on the strengthening of policy and regulatory framework related to the management of HBCD and of EPS/XPS polymer foam products containing HBCD. Component 1 intends to provide targeted management support and technical assistance with the specific objective of addressing the main institutional barriers currently limiting the rapid and sustainable phaseout of HBCD and the use of the HBCD alternatives in the EPS and XPS sectors. It also aims to address legislative and regulatory gaps on the banning of the use, production, import, and export of HBCD. A description of the outcomes to be achieved under this component is reported below.

Outcome 1.1: Policy and regulatory framework strengthened on the management and supervision of HBCD and HBCD-containing EPS/XPS polymer foam products in China.

This Outcome aims at strengthening the policy and regulatory framework for the management and supervision of HBCD and EPS / XPS products in China. Through this component, the project will support the improvement of the current governance for an environmentally sound management of HBCD production and HBCD-containing products. The component will be led by the Ministry of Ecology and Environment in coordination with various relevant ministries and stakeholders. The project will also support the research of HBCD and related products and their substitute products. Technical capacity on laboratory testing will be also enhanced, to ensure that relevant authorities and the factory managers will be able to monitor and supervise the production of foam polymers.

The four outputs under this component envisage the development of a series of regulations and policies and are described with more details below:

Output 1.1.1 National legislation, regulatory framework and technical specifications to ban the production, usage, import and export of HBCD used in EPS/XPS in China developed.

This entails the drafting of a national legislation, regulatory framework and technical specifications to ban the production, usage, import and export of HBCD in China.

Output 1.1.2 Regulatory policies developed to reduce and eliminate the application of HBCD in EPS/XPS polymer foams, with focus on environmental quality standards and chemical limits of HBCD in EPS/XPS polymer foams and all potential HBCD users.

Under this output, national regulatory policies will be developed to eliminate the application of HBCD in EPS/XPS polymer foams. HBCD quality standards will be developed for HBCD-free EPS/XPS polymer foams.

Output 1.1.3 Framework for governmental alternative assessment established and flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated.

Currently, there is no established assessment framework of chemical alternatives in the MEE. The Department for Chemicals Management has only recently been established as an independent department. While some other countries have developed activities and capacity to assess HBCD alternatives, e.g., USEPA established alternatives assessment within the “Design for the Environment” framework and the alternative assessment initiatives of the European chemical

Agency ECHA. The activities under this output are envisaged to develop an evaluation framework and build capacity for alternatives assessment on governmental institution level. This output also will assess the alternatives to HBCD in the governmental level.

Output 1.1.4 National managerial capacity, enforcement, supervision policies, monitoring methods of HBCD and HBCD-containing products strengthened to coordinate and monitor and establish problem-finding mechanism for the polymer foam production sector.

According to the Stockholm Convention, each Party that has registered for the exemption pursuant to Article 4 for the production and use of HBCD for EPS/XPS in buildings shall take necessary measures to ensure that EPS/XPS containing HBCD can be easily identified by labeling or other means throughout its life cycle. This output focuses on the national capacity building in management, enforcement, and supervision of HBCD production and usage in compliance with Stockholm convention requirements. Capacity building on HBCD monitoring in production and consumption will be undertaken to evaluate and procure the proper monitoring equipment for the personnel in charge, prepare sample analysis report of HBCD containing products and produce monitoring reports. Managerial capacity, enforcement, supervision policies and monitoring methods for HBCD in demonstration province will also be strengthened.

Component 1 maybe summarized as follows:

Component 1 Policy and regulatory framework	
Outcome 1.1 Policy and regulatory framework strengthened on the management and supervision of HBCD and HBCD-containing EPS/XPS polymer foam products in China	
Output 1.1.1	National legislation, regulatory framework and technical specifications to ban the production, usage, import and export of HBCD used in EPS/XPS in China
Activity 1.1.1.1	Draft national legislation, regulatory framework and technical specifications to ban the production, usage, import and export of HBCD in China.
Output 1.1.2	Regulatory policies developed to reduce and eliminate the application of HBCD in EPS/XPS polymer foams, with focus on environmental quality standards and chemical limits of HBCD in EPS/XPS polymer foams and all potential HBCD users
Activity 1.1.2.1	Formulate regulatory environmental quality standards and chemical limits for regulation and supervision of HBCD.
Output 1.1.3	Framework for governmental alternative assessment established and flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated
Activity 1.1.3.1	Develop an evaluation framework for alternatives assessment on governmental institution level.
Activity 1.1.3.2	Undertake assessment of alternatives to HBCD to ensuring participation of relevant institution to build internal capacity
Output 1.1.4:	National managerial capacity, enforcement, supervision policies, monitoring methods of HBCD and HBCD-containing products strengthened to coordinate and monitor and establish problem-finding mechanism for the polymer foam production sector
Activity 1.1.4.1	Conduct national capacity building trainings for governmental authorities in management, enforcement, and supervision of HBCD production and usage
Activity 1.1.4.2	Conduct capacity building trainings for governmental authorities on HBCD monitoring in production and usage
Activity 1.1.4.3	Train enforcers on supervision policies and monitoring methods for HBCD in demonstration province

Component 2. Promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector.

61. Component 2 will implement the closure of HBCD production and the switch to non-POP alternatives. The component also supports the banning of the use of HBCD in EPS and XPS production and replacement with non-POP alternatives. Furthermore, it supports the implementation of BAT/BEP for the environmentally sound production and use of flame retardants in such a way which is not harmful for human health and the environment. Components 2 focuses on the promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector to ban the production of HBCD and use of HBCD in EPS/XPS. As mentioned above, this component will address the barriers related to the development of plans and demonstrations of alternatives to HBCD for the HBCD containing EPS/XPS sectors. This component will support the total banning of HBCD production in China, the prohibition of the HBCD usage in the production of polymer foams and the application of other alternatives through the promotion of BAT/BEP. BAT/BEP measures will be identified, implemented and demonstrated in the pilot enterprises. Several facilities visited during the PPG will be engaged during the implementation of these component.

Figure 5 One of the candidate facilities for Component 2 implementation

The following briefly describes the main elements of Component 2

Outcome 2.1 Total ban on the production of HBCD in China.

This Outcome aims at closing down HBCD production lines or convert them to production of HBCD alternatives within the 5-year exemption granted to China by the Stockholm Convention (until 2021). There are several available alternatives to HBCD-based flame retardants in commercial use globally. The most famous alternative is brominated SBS, which is styrene and butadiene copolymer bromide, a large polymeric brominated flame retardant jointly developed by some overseas countries and largely used as a substitution for HBCD in the U.S, European countries, Japan and some western Asian countries. Tetrabromobisphenol A bis (2,3- dibromopropyl ether) and Tris (2,3- dibromopropyl) isocyanuric acid ester (TBC) also are known to be substitutes for HBCD. Chinese HBCD producers have also implemented some initiatives in developing their own alternatives to HBCD.

Output 2.1.1 HBCD production lines closed down or converted to HBCD alternatives

This output envisages the demonstration, verification and evaluation of the closure of production lines of at least 2 HBCD producers. It includes the demonstration of the production of alternatives to HBCD for at least 2 manufacturers, the preparation of reports concerning production and sales of alternatives to HBCD alternatives, and the evaluation and verification of the new production lines for HBCD alternatives.

Outcome 2.2 Prohibition of HBCD usage in the production of polymer foams or application of other alternatives through the promotion of BAT/BEP.

The need to switch to HBCD alternatives requires a thorough analysis of the available options. This may be conducted in coordination with research institutes in China and in collaboration with international institutions already engaged in the research, pilot testing or technology transfer of HBCD alternatives. This outcome aims at assessing not only polymeric flame retardants but also other potential alternatives which are proposed by manufacturers or those under development. In addition, the project will put forward "Green Chemistry" solutions, where fire safety is considered not only in the foam but also the overall building structure. This outcome will be achieved through the implementation of three Outputs.

Output 2.2.1 Demonstration activities on at least 4 types of alternative materials for EPS/XPS foam manufacturing through technology transfer and research implemented:

As EPS/XPS manufacturing cannot make use of HBCD as flame retardants by December 2021, HBCD alternatives have to be adopted in EPS/XPS sectors. Six activities are envisaged for this output:

- Select and demonstrate the use of at least 1-2 alternative for HBCD used in 2 EPS in pilot plants;
- Verify and evaluate the EPS pilot production lines and products using HBCD alternatives;
- Select and demonstrate at least 1-2 alternatives in 2 pilot enterprises for HBCD used in XPS with research on co-benefits of HCFCs reduction;
- Verify and evaluate the pilot XPS production lines adopting HBCD alternatives, in which analysis reports of samples, BAT/BEP evaluation reports of XPS production lines using HBCD alternatives, and evaluation report of XPS containing HBCD alternatives will be developed;
- Evaluate the production of alternative insulation materials to EPS/XPS Concept for the assessment of the production of alternative insulation to EPS/XPS, and to develop assessment reports for the alternative productions. The candidate alternative materials to be assessed are eigid foam polyuretahne board, phenolic graphite insulation board, rock wool boards, glass wool, foam glass, foam ceramic, vacuum heat insulation boards and other substitute materials for EPS/XPS foams.

• Compile lessons learned and best practice of the substitution of HBCD in EPS and XPS production to educate the other EPS/XPS producers on the switch to alternatives and include the materials for the knowledge platform, which will draft case study report and case studies included in the knowledge platform.

Output 2.2.2 Replication activities on the best alternatives undertaken in at least 5 companies and outcomes promoted national wide.

This output envisages the replications of the best alternatives of HBCD in at least 5 companies, including at least 1 flame-retardant manufacturer, 2 EPS and 2 XPS manufacturer, and site visits carried out by relevant authorities to the companies producing alternatives. The replication results will be assessed and the report concerning the site visits by authorities will be prepared to further ensure the technological viability and commercial accessibility of the alternatives.

Output 2.2.3 Promotion of venture capital investment and technology transfer on switching to HBCD-alternatives established.

This output aims to establish public-private partnership or other financial mechanism to support the phase-out of HBCD in EPS/XPS production and to implement incentive programs or other promotions to support the replication of the demonstration experiences of substitution of HBCD to other EPS/XPS producers. Financial mechanisms envisaged are highly diverse but included bank loans, joint venture with foreign investors, foreign direct investment and domestic investment. It is aimed that these mechanisms be made accessible to the enterprises switching to HBCD alternatives.

The related activities under Component 2 are given below:

Component 2 Promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector	
Outcome 2.1	Total ban on the production of HBCD in China
Output 2.1.1	HBCD production lines closed down or converted to HBCD alternatives
Activity 2.1.1.1	Demonstrate closure of production lines of at least 2 HBCD producers and carry out ESM of wastes
Activity 2.1.1.2	Undertake verification and evaluation of the closure all HBCD production lines
Activity 2.1.1.3	Demonstrate and evaluate the production of HBCD alternatives in the pilot sites
Outcome 2.2	Prohibition of HBCD usage in the production of polymer foams or application of other alternatives through the promotion of BAT/BEP
Output 2.2.1	Demonstration activities on at least 4 types of alternative materials for EPS/XPS foam manufacturing through technology transfer and research implemented
Activity 2.2.1.1	Select and demonstrate the use of 1-2 HBCD alternatives in 2 EPS pilot plants

Activity 2.2.1.2	Select and demonstrate the use of 1-2 HBCD alternatives in 2 XPS pilot enterprises evaluating co-benefits of HCFC reduction
Activity 2.2.1.3 :	Carry out evaluation of the production of alternative insulation materials to EPS/XPS insulation boards
Activity 2.2.1.4:	Compile lessons learned and best practice of the substitution of HBCD in EPS and XPS production to educate the other EPS/XPS producers on the switch to alternatives and include the materials for the knowledge platform
Output 2.2.2	Replication activities on the best alternatives undertaken in at least 5 companies and outcomes promoted nation wide
Activity 2.2.2.1	Replicate the use of best HBCD alternatives in at least 5 companies
Output 2.2.3	Promotion of venture capital investment and technology transfer on switching to HBCD-alternatives established.
Activity 2.2.3.1	Establish public-private partnership or other financial mechanism to support the phase-out of HBCD in EPS/XPS production
Activity 2.2.3.2	Identify incentive programs or other promotions to support the replication of the demonstration experiences of substitution of HBCD to other EPS/XPS producers

Component 3: Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD

62.Component 3 will implement the environmentally sound management of HBCD wastes and HBCD-containing EPS/XPS through the demonstration of technologies aiming at support recycling and resource recovery, in compliance with a circular economy approach. The Component includes the development of a robust inventory and a material and substance flow analysis (Brunner and Rechberger 2016) for robust prediction of the generation of wastes in the long term, for appropriate planning of waste management infrastructures. Currently, there are limitations in terms of a strategic policy for treating HBCD-containing wastes and the identification of building waste containing EPS/XPS contaminated by HBCD. A huge amount of HBCD was used in insulation foams in the construction industry and insulation board wastes may become a major source contributing to the release of HBCD in the environment. Thus, it is important to develop standard methods for the identification of HBCD containing waste, as well as regulations on the disposal of these wastes.

Outcome 3.1 ESM of HBCD-containing EPS/XPS foams implemented.

This outcome aims to build and periodically update a national inventory and database on HBCD stocks and waste. It also proposes to develop HBCD waste identification methods/standards and regulation on the disposal of HBCD and HBCD-containing wastes. BAT/BEP measures for the environmentally sound management and disposal of HBCD wastes will be identified, implemented and demonstrated. This will also include the assessment, comparison and

demonstration of different treatment technologies that maybe applicable and economically-viable for the country wide disposal of HBCD wastes. The project also aims to assess the possibility of a circular economy approach for bromine recovery and EPS/XPS recovery and develop a pilot facility to undertake such activity. This outcome envisages the achievement of three Outputs.

Output 3.1.1 National inventory and data base on HBCD stocks and waste built and periodically updated.

Under this output, the inventory and database of HBCD stocks and waste generated by HBCD production and EPS and XPS sectors will be established. A demonstration on the inventory and database of EPS/XPS building materials containing HBCD in pilot provinces/cities will be conducted. Based on this demonstration, guidance for carrying out inventory and database of EPS/XPS building materials containing HBCD, including the analytical reports of samples, the methodology for the database, and database and inventory report in demonstration area will be developed

Output 3.1.2 HBCD waste identification and management methods on HBCD and HBCD-containing wastes disposal developed.

In order to achieve this goal, four activities will be carried out.

· Develop identification and regulatory strategies for HBCD containing waste in production and ESP/XPS sectors.

· Develop identification and managerial strategy of in-use HBCD in the construction industry and buildings demolition;.

· Develop technical guidelines for ESM of HBCD containing waste, and ESM guidelines of HBCD containing waste;

· Compile information on screening, classification and separation of HBCD containing waste and management methods for the knowledge management platform.

Output 3.1.3 BAT/BEP demonstration of environmentally sound management and disposal of HBCD waste including assessment, comparison and demonstration of different treatment technologies, including volume reduction, HBCD extraction, HBCD decomposition, disposal, circular economy approach for bromine and EPS/XPS recovery.

To achieve this output, the following activities will be carried out:

· Assessment and selection of technologies for ESM of HBCD-containing EPS/XPS waste considering circular economy and life cycle. In addition to thermal recovery (cement kiln and incinerator), this will include the assessment of chemical recycling, solvent based technologies (Gracia et al. 2009a,b) and in particular the recovery of polystyrene and bromine (Schlummer et al 2017). Also specific options of recycling of EPS recently published will be assessed (Siyal et al. 2013, Haeron et al. 2014).

· Demonstration and implementation at least 2 pilot projects for environmental sound management and disposal of HBCD-containing EPS/XPS waste. This will also assess the destruction options of CFC/HCFCs contained in XPS.

· Compilation of information and lessons learned on environmental sound management and disposal of HBCD-containing EPS/XPS waste for the knowledge management platform.

Component 3 is summarized as follows:

Component 3 Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD	
Outcome 3.1	ESM of HBCD-containing EPS/XPS foams implemented
Output 3.1.1	National inventory and data base on HBCD stocks and waste built and periodically updated
Activity 3.1.1.1	Establish the inventory and database of HBCD stocks and waste in HBCD production and EPS and XPS sectors.
Activity 3.1.1.2	Conduct inventory and create database of in-use HBCD in EPS/XPS building materials in pilot provinces/cities
Output 3.1.2	Develop HBCD waste identification and management methods on HBCD and HBCD-containing wastes disposal
Activity 3.1.2.1	Develop identification and regulatory strategy of HBCD containing waste in production and ESP/XPS sectors
Activity 3.1.2.2	Develop identification and management strategy of in-use HBCD in the construction industry and de-commissioning of buildings.
Activity 3.1.2.3	Develop technical guidelines for ESM of HBCD containing waste
Activity 3.1.2.4:	Compile information on screening, classification and separation of HBCD containing waste and management methods for the knowledge management platform
Output 3.1.3	BAT/BEP demonstration of environmentally sound management and disposal of HBCD waste including assessment, comparison and demonstration of different treatment technologies, including volume reduction, HBCD extraction, HBCD decomposition, disposal, circular economy approach for bromine and EPS/XPS recovery
Activity 3.1.3.1	Assess and select technologies for ESM of HBCD-containing EPS/XPS waste considering circular economy and life cycle
Activity 3.1.3.2	Implement at least 2 pilot projects for environmental sound management and disposal of HBCD-containing EPS/XPS waste
Activity 3.1.3.3	Compile information and lessons learned on environmental sound management and disposal of HBCD-containing EPS/XPS waste for the knowledge management platform

Component 4. Information dissemination, capacity building and knowledge management

63. Component 4 will gather all information achieved as a result of the pilot and demonstration activities, as well as the knowledge on the state of art on alternatives to HBCD and insulation materials and will arrange that information on a knowledge platform for national, regional and global dissemination. This component will also support the dissemination of experience and lessons learned from the pilot and demonstration activities to the entire sectors flame retardant and EPS/XPS insulation foam production to demonstrate alternatives to HBCD. It will develop and strengthen the technical capacity and skills of human resources of the production and supply chain in order to develop the necessary expertise for the replacement of HBCD in manufacturing and use, and for a better management of EPS/XPS containing HBCD at the end of their lifecycle. This component also will represent a bridge of the project with key aspects of circular economy in the construction and demolition sector in China. It will also bring examples related to the substitution of POPs and other hazardous chemicals with non-POP alternatives.

64. Component 4 aims to strengthen the information dissemination, capacity building and knowledge management on HBCD issues. Technical information on the management of HBCD, HBCD-containing products and waste will be disseminated through workshops held for various stakeholders including enterprises, government staff, researchers, etc. This Component ensures that relevant information will be effectively disseminated to a wide range of affected stakeholders for the commitment and acceptance of the government, EPS / XPS producers. This component will help China to develop a qualified base of professional experts in the field of HBCD management and will be beneficial in the phase out and disposal of HBCD and HBCD-containing foam wastes. The project will also contribute to the depository of information of the Stockholm Convention Secretariat on addressing HBCD issues and Convention obligations. This defines the design approach for the two Outcomes as described below.

Outcome 4.1 Improved technical and regulatory capacity on the management of HBCD and HBCD-containing wastes.

Technical and capacity building to address enforcement gaps for regulatory authorities and awareness raising activities for the public sector will be carried out under this outcome. to disseminate information on the adverse effects of POPs to human health and the environment and on HBCD and POPs in buildings, in particular. This would also allow collection of information useful for the building of the inventory and data base on HBCD in the country.

Output 4.1.1 Technical trainings for various stakeholders (enterprises, government staff, technicians, researchers etc.) designed and implemented to strengthen capacity on HBCD and the EXPS/EPS foam sector, in general.

Under this output, training sessions and technical capacity building activities targeting different stakeholders (government, private sectors, technicians, researchers) will be held. This will also include training for the Design for Deconstruction (DfD) (Kadiri et al 2017) in the building insulation sector and for policy makers. Around 4000 policy makers, technicians, researchers will be trained. Stakeholder specific training material for the HBCD/alternative BFR production sector, the EPS/XPS production sector and the waste management sector will be developed and made available. Training sessions of management and technical capacity building targeting females in direct contact with hazardous chemicals including HBCD will be also carried out.

Output 4.1.2. Awareness raising activities undertaken for various relevant stakeholders including the general public, NGOs, women and youth sector etc.

Development of stakeholder specific awareness raising materials and approach for the general public, women, NGOs and the youth sector on HBCD and other POPs in construction materials and alternatives will be conducted under this output. Awareness raising activities for general public, women, NGOs and the youth sector will form an integral part of the envisaged activities.

Outcome 4.2 Knowledge management platform set up to contribute to regional/global actions on HBCD management.

In Asia, China is one of the top countries producing excellent research work on POPs. Several institutes have also embarked on HBCD researches. Thus, it is envisaged that the outputs of the proposed project will contribute to the establishment of a knowledge hub on HBCD and the XPS/EPS foam sector to disseminate experiences and lessons learned on a national, regional and even, at a global scale. The knowledge hub will be set up in one of the leading universities/research institutes in China.In the preliminary stage of the project, FECO will be the owner of the knowledge hub and will seek for collaborating partners in the operation of the platform. The possible partners may be leading universities and research institutes in China, Belt and Road Initiative Green Coalition Big Data Platform, and/or Basel/Stockholm Convention Regional Center.

Output 4.2.1 Establishment of a knowledge hub on HBCD and the XPS/EPS foam sector to disseminate lessons learned on a national, regional and global scale.

This output aims for the establishment of a knowledge hub on HBCD and the XPS/EPS foam sector to disseminate lessons learned on a national, regional and global scale. Dissemination of lessons learned on HBCD management to national, regional and global stakeholders will be undertaken. The project will explore synergies for information dissemination with other projects in particular the regional project on "Ocean Plastic Turned into an Opportunity in Circular Economy – OPTOCE" from the Norwegian Government where China is one of 5 project countries and which has a regional multi-stakeholder forum for enabling awareness raising, south-south capacity building in the region (Norad and SINTEF 2019). Also, synergy options for regional input will be assessed for possible cooperation with the Stockholm/Basel regional Centers for Asia and the Pacific which is another option for regional communication and awareness raising of project results.

Component 4 comprises the following activities:

Component 4 Information dissemination, capacity building and knowledge management	
Outcome 4.1	Improved technical and regulatory capacity on the management of HBCD and HBCD-containing wastes
Output 4.1.1	Conduct technical and managerial trainings for various stakeholders (enterprises, government staff, technicians, researchers etc.) to strengthen capacity on HBCD and the EXPS/EPS foam sector, in general.
Activity 4.1.1.1	Conduct technical capacity building trainings targeting different stakeholders (government, private sectors, technicians, researchers), ensuring participation of women specifically those direct contact with hazardous chemicals including HBCD
Activity 4.1.1.2	Assess the social and economic impacts of gender-mainstreaming in foam sector
Output 4.1.2	Awareness raising activities undertaken for various relevant stakeholders including the general public, NGOs, women and youth sector etc.
Activity 4.1.2.1	Develop stakeholder specific awareness raising materials and approach for the general public, women, NGOs and the youth sector on HBCD and other POPs in construction materials and alternatives
Activity 4.1.2.2	Conduct awareness raising activities for public, women, NGOs and the youth sector.
Outcome 4.2	Knowledge management platform set up to contribute to regional/global actions on HBCD management.
Output 4.2.1	Establishment of a knowledge hub on HBCD and the XPS/EPS foam sector to disseminate lessons learned on a national, regional and global scale
Activity 4.2.1.1	Set up a knowledge management platform to contribute to regional/global actions on HBCD management
Activity 4.2.1.2	Establish partnerships for effective regional and international awareness raising and knowledge communication
Activity 4.2.1.3	Disseminate lessons learned on HBCD management to national, regional and global stakeholders

1a.d) Alignment with GEF Focal Area and/or Impact Program Strategies

65. The project is consistent with the GEF 7 strategy on Chemicals and Waste Program 1: Industrial Chemicals Program which aims at “Strengthening the sound management of industrial chemicals and their waste through better control, and reduction and/or elimination”. It addresses all three key issues of the program - A) Elimination of Chemicals/POPs that are used in processes and products: The aim of the current project is to improve the environmental performance of the foam sector in China through the phase-out of HBCD and introduction of HBCD alternatives; B) Management of the waste, or waste containing these chemicals: The project will develop regulations, strategies and technologies for the start of environmentally sound management of HBCD-containing EPS/XPS foams in China; C) Chemicals/POPs and POPs waste at the end of life: Demonstration activities on environmentally sound disposal of HBCD containing EPS/XPS will be implemented considering BAT/BEP and the waste hierarchy aiming for recycling and recovery towards a more circular economy of EPS/XPS and possibly bromine.

66. The project will prevent waste/products containing HBCD from entering material recovery supply chains. It supports the implementation of appropriate decision-making tools and regulatory approaches to stop the production and use of HBCD, to remove barriers to substitute HBCD in EPS/XPS sector and to establish the management of HBCD containing EPS/XPS and initiate circular economy. Notably, in GEF 7, more emphasis is placed in the reduction of POP chemicals with the support to the private sector “to adopt better technologies and practices aimed at becoming more environmentally sustainable, including eliminating POPs and mercury”, at the same time continuing to ensure that waste containing POPs are managed in an environmental sound manner. The project is fully compliant with this strategy, as it is addressed at phasing out the manufacture and use of HBCD, a POP substance, and at the same time will demonstrate environmentally sound technologies for the destruction of this chemical and for the recovery of bromine through the adoption of circular economy principles.

1a.e) Incremental/additional cost reasoning and expected contributions from the baseline, the GEF TF, LDCF, SCCF, CBIT and co-financing

67. The baseline projects presented above are, firstly, related to the government’s recent initiatives focused on the inventory of HBCD’s current consumption and, secondly, to the average annual investments undertaken by manufacturers to maintain the production lines optimized and operative. Despite the fact that research on appropriate alternatives to replace HBCD is considered as essential, none of the above-mentioned initiatives includes such researches due to its high specialization and international dimension. Therefore, the incremental costs in these initiatives are linked to the additional budget required to identify and assess the appropriate alternatives to HBCD and alternatives to EPS/XPS. Currently, there is no capacity on governmental level for alternative assessment comparable to the “Design for the Environment (DfE)” program of the USEPA or activities to the European Chemical Agency (ECHA) (Tickner et al. 2016, 2017). Without the project, academic institutions would have difficulty obtaining enough government support to develop an alternative assessment frame and there would not be comprehensive alternative assessment on governmental level for HBCD and for EPS/XPS in a timely manner.

68. The annual investments normally assumed by companies need to be increased in order to convert the production lines to use alternative flame retardants. This conversion relates to the installation of appropriate fire retardant feeding systems, where needed, and/or the adaptation of equipment and processes for obtaining production optimization with the new substance. The certification of products using such a substance is the last element to be considered in the incremental costs at industrial level. Regarding costs, both fixed and operating costs have to be considered when referring to the switch from one flame retardant to another. Fixed costs here relate to the cost of the development work, end-product certification, or equipment change. Manufacturing and processing facilities may need investment in new equipment in order to shift to alternative flame retardants. It also contains the cost of

research and development endeavors that may not succeed in finding an efficient flame retardant alternative. Without the GEF project, there would not be, in seek of sustainable manners, conducted demonstration projects partnered with government and academic institutions to implement BAT/BEP for reduced exposure and environmental release in brominated flame retardant producer industry and the EPS/XPS industry.

69. The current waste management situation of HBCD EPS/XPS in China largely result in dumping of these materials with associated releases of HBCD and of EPS/XPS into the environment (Li et al. 2016). The prediction is that this situation would continue for decades and only slowly improve (Li et al. 2016). Therefore, without the project there would still be a lack in identification and management of HBCD containing EPS/XPS thus probably no timely buffer strategy to face the enormous HBCD waste in the next decades. The project and funding of GEF will enable the country to initiate the ESM of EPS/XPS waste including BAT/BEP treatment by establishing and conducting demonstration projects for environmentally sound management of HBCD containing EPS/XPS towards recovery of EPS/XPS and possibly recovery bromine to promote circular economy.

70. A major component of the project is the information dissemination, capacity building and knowledge management. This component intends to develop a knowledge platform on HBCD substitution and phase out and HBCD in EPS/XPS alternatives and substitution and management of. This information is needed in all countries and regions since in all regions HBCD containing EPS/XPS has been used in the past in insulation in buildings against cold and heat. Without the project, there would not be comprehensive knowledge resources along the lifecycle of HBCD phase out and management developed and compiled to feed into the knowledge platform for knowledge sharing on a regional and international level.

71. The project components for which funding from the GEF is requested, are strictly linked to the incremental costs identified, and will contribute to both setting the basis for a correct selection and usage of alternatives to HBCD, and also facilitating and incentivizing an optimal shift to these alternatives by companies. In the project implementation process, the enterprises, including HBCD producers, EPS beads producers, EPS producers and XPS producers will provide co-financing to support the project implementation.

72. In addition to the co-financing provided by the enterprises, the Ministry of Ecology and Environment, Local Government and Local Environmental Protection Bureaus of demonstration region, Bavarian State Ministry, Germany etc. will also provide co-financing to support the project implementation. Table 7 below summarizes the contribution of the incremental cost to the baseline.

Table 7 Contribution of the incremental cost to the baseline

Baseline and incremental cost reasoning	Co-financing	Alternative Scenario	GEF Grant (USD)
Component 1: Policy and regulatory framework			
China has requested to extend use of HBCD in the XPS and EPS sectors until November 2021. However, China still lacks effective regulations, limits or policies to ban the production, usage, import and export of HBCD despite the large output of HBCD and HBCD co	The governmental co-financing of this project component is US $ 2,150,000. The local governments such as Shandong province will formulate and improve the relevant poli	The component is designed to improve and strengthen the policy and regulatory framework to stop the production and use of HBCD and develop a regulatory frame of managing HBCD containing EPS and XPS waste in order to fill the gaps between	1,260,000

ntaining products. Especially the local governments lack the capa city for assessing and managing HBCD. Although some information on al ternatives HBCD in EPS/XPS exis t, China is still lack of official eval uation of alternatives for HBCD. Without the project, academic ins titutions would have difficulty obt aining enough government suppo rt to develop an alternative asses sment frame and there would not be comprehensive alternative as sessment on governmental level for HBCD and for EPS/XPS in a ti mely manner	cy standard system and capacit y building of HBCD in the provin ce. The preparatory work of the pro ject is mainly carried out by the demonstration provinces throu gh self-financing.	the national legal framework a nd the Stockholm Convention r equirements and effectively en sure the sustainability and repli cability of the outcomes of the project; It develops and strengthen the technical capacity and skills of human resources of the produ ction and supply chain in order to develop the necessary exper tise for the substitution of HBC D in the production and use an d in the waste management of HBCD containing EPS/XPS and other waste for a sustainable management of this large POP s and polymer stockpile.	
Component 2. Promotion of technology transfer and investment on the production of HBCD alternatives and applica tion of alternatives to the XPS/EPS foam sector			
HBCD is still being produced in C hina. HBCD enterprises produce about 18000 metric tons HBCD p er year in 2017, which were used in the EPS and XPS enterprises a s the flame retardant to produce i nsulation materials for building in dustry. A few EPS/XPS producers have i nitiatives to stop using HBCD, but no financial mechanism in EPS/X PS sector to support the change to alternative flame retardants. No specific environmental, health and social assessment of the pro duction of alternatives to EPS/XP S insulation has been conducted by the companies or environment al ministries.	The government co-financing of the project component is US$8 1,000,000. Fully carry out the elimination a nd substitution of HBCD in the province, carry out the substitut ion demonstration and eliminati on in large enterprises in the HB CD fireproof EPS and XPS buildi ng board industries, Fully implement the best availa ble technologies and best envir onmental practices for HBCD pr oduction enterprises in the prov ince to stop production, change the line of production, clean up pollution and dispose of waste,	The component implements th e stop of HBCD production and the switch to better alternative s. The component also suppor ts the stop of use of HBCD in E PS and XPS production and ch ange to better alternatives. Fur thermore it supports the imple mentation of BAT/BEP for the environmentally sound product ion and use of flame retardant s for protection of humans and the environmental; This component will also supp ort the dissemination of experi ence and lesson learned from t he pilot and demonstration pro jects to the entire respective in dustrial sectors of alternative fl	6,330,000

Without the GEF project, there would not be, in seek of sustainable manners, conducted demonstration projects partnered with government and academic institutions to implement BAT/BEP for reduced exposure and environmental release in brominated flame retardant producer industry and the EPS/XPS industry.	and implement the environmental and social security guidelines, etc.; Implement the environmental and social security guidelines; The enterprises will participate in the phase out of HBCD, use of HBCD substitutes in EPS beads /XPS, reconstruct the EPS beads/XPS production line or build a new EPS beads/XPS production line, use HBCD substitutes as flame retardant, and produce EPS beads/XPS that meet the relevant national standards;	ame retardant production for HBCD and EPS/XPS insulation foam production.	
Component 3. Implementation of environmentally-sound management (ESM) of EPS/XPS foam wastes containing HBCD			
Releases of HBCD and EPS/XPS may occur during its manufacture and use but in particular in the end of life phase with related environment and health impacts. No specific standard for identification and regulation of HBCD containing waste in China. No national inventory and database on HBCD stocks and waste. No technical guideline for treating HBCD-containing waste in China. The ca. 10,000,000 t in-use HBCD containing EPS/XPS in buildings are predicted to be expired in the next 50 years, leading to vast HBCD waste problem. With the current unsustainable management of EPS/XPS waste and the predicted business as usual this would lead without the project to relevant release of HBCD and EPS/XPS from end of life (see Li et al. 2016).	The component is supported by a government co-financing of US$10,280,000. The stakeholders will promote the demonstration of substitution technologies in the construction material industry for the environmentally sound disposal of construction waste containing HBCD; Participate in the identification of EPS products containing HBCD. Identification for EPS products containing HBCD is to provide reference for the treatment and disposal of EPS after peeling off from buildings. The enterprises will participate	The component develop the environmentally sound management of HBCD waste and HBCD containing EPS/XPS with demonstration projects of technologies which aim to support recycling and resource recovery towards a more circular economy. The Component include the development of a robust inventory and a material and substance flow analysis for robust prediction of generated wastes the next decades for appropriate planning of waste management structures. This component also link the project to related major issues of circular economy in the const	3,480,000

Without the project there would s till be a lack in identification and management of HBCD containin g EPS/XPS thus probably no time ly buffer strategy to face the enor mous HBCD waste in the in next decades.	in the demonstration of environ mentally sound management of waste containing HBCD.	ruction and demolition sector, t he substitution of POPs and ot her hazardous chemicals and t he environmentally sound man agement of plastic and polyme rs in the end of life and a circul ar economy.	
Component 4. Information dissemination, capacity building and knowledge management.			
No training materials and training s for the HBCD/alternative BFR pr oduction sector, the EPS/XPS pro duction sector or ESM of waste a vailable in Chinese. No awareness raising materials o n HBCD and other POPs in insula tion and other construction mate rials Without the project no knowledg e management platform would b e developed to contribute to regi onal/global actions on HBCD ma nagement. Without the project there would n ot be comprehensive knowledge resources along the lifecycle of H BCD phase out and management developed and compiled to feed i nto the knowledge platform for k nowledge sharing on a regional a nd international level. The project will also incrementall y support training session and a wareness raising activities target ing different stakeholders includi ng mainstreaming gender equalit y.	The governmental co-financing for this component is US$1,23 0,000 The stakeholders will participat e in the training, awareness rais ing activities, which are mainly carried out by them through sel f-financing. Co-financing and in kind by ME E, FECO and the regional govern ments for the capacity building including facilities and rooms f or training. Also in kind contribu tions for preparing publications, attending conferences, organizi ng conference or workshops ar e included.	The component compiles all in formation of the pilot projects and demonstration projects as well as state of art knowledge on alternative to HBCD and alt ernatives insulation materials and the ESM of HBCD containi ng waste on a knowledge platf orm for national, regional and global dissemination. This component will also supp ort the overall capacity buildin g of HBCD and EPS/XPS indus tries, the waste management s ector, the public, NGOs and the research sector and related inf ormation and knowledge disse mination	630,000

1a.f) Global environmental benefits (GRFTF) and/or adaptation benefits (LDCF/SCCF)

73. The project seeks to phase out HBCD production and apply BAT/BEP for the key acceptable purposes for HBCD consumption in EPS and XPS, the specific exemptions of HBCD. This project is expected to generate multiple benefits for the global environment as it will not only lead to a reduction in HBCD production and consumption from the sectors, but envisages reduction of ODS and GHG (Greenhouse Gas) emissions as co-benefits.

74. The total phase out of HBCD production in China will result to direct global environmental benefits. By 2021, all HBCD production enterprises in China with a total output of 18,000 metric tons of HBCD will be phased out (based on the HBCD output of about 18, 000 metric tons in 2017). Since the amount or HBCD produced is assumed to be equivalent to the HBCD consumed by the EPS/XPS sectors, the HBCD reduction contributed by the EPS/XPS foam sector is equal to the amount of HBCD produced. In this regard, no double accounting of GEB is presented. Therefore, it is estimated that a total of 54,000 metric tons of HBCD will be phased out during the project lifetime after the ban in HBCD production is put in place. However, some HBCD producers in their Expressions of Interests have indicated that they will stop producing HBCD during the 4th quarter of 2021 which is estimated to contribute 300 tonnes of HBCD reduction in 2021, bringing the estimated HBCD avoided to 54,300 tons as contribution of the project. With a GEF grant of USD 6,330,000 for this component, this translates to a cost of USD 116.6 for 1 metric ton of HBCD avoided.

75. For HBCD wastes, about 5 metric tons of highly concentrated HBCD wastes (mainly the effluent and residues during HBCD production) and 95 metric tons of waste EPS and XPS boards will be disposed in an appropriate facility observing BAT/BEP measures. Furthermore, it is estimated that around 1,000 metric tons of HBCD wastes coming from dismantling of production lines and clean-up of production sites will be generated. Thus, a total of 1,100 metric tons of HBCD wastes will be disposed by the project. Currently, it is difficult to estimate the EPS/XPS wastes containing HBCD that can be generated from demolition of buildings. However, the project will endeavor to make an inventory of this category of HBCD waste.

Based on this the minimum GEB expected from the project is the following:

Table 8: HBCD reduction during the project lifetime

GEBs contributors	2020	2021	2022	2023	2024	subtotal
HBCD producers	0	300	18,000	18,000	18,000	**54,300**
HBCD wastes					1,100	1,100
HBCD reduction (core indicator)	**0**	**300**	**18,000**	**18,000**	**18,100**	**55,400**

Demonstration activities in the EPS/XPS Sector

76. While it is assumed that all HBCD produced is used by the EPS/XPS sector, the reduction in the demonstration facilities and the replication of the activities was also estimated. This reduction is not listed in the GEB as it would result in double accounting with HBCD phaseout. It would allow an appreciation of the magnitude of foam wastes that are avoided because of the project. Also, computation below aims to show the impact of the demonstration and replication activities in terms of using HBCD in products and the total amount of HBCD containing EPS/XPS product which is a far higher amount since the final EPS product contain only 0.8% HBCD and the final XPS product only 4% HBCD.

77. In this project, 2 EPS beads enterprises with individual annual capacity of 50,000 metric tons of EPS beads serve as demonstration companies for the production of HBCD-free EPS beads. The total reduction of HBCD containing EPS beads in these companies and related following EPS insulation foam products will be 300,000 metric tons in the 3 years where HBCD has stopped. Considering that the concentration of HBCD in EPS in these beads was 0.8%, these 300,000 metric tons EPS avoids the use of 2400 metric tons of HBCD within the project implementation period in these demonstration companies.

78. Based from the production capacity of the EPS foam sector, a total output of 1.27 million tons of HBCD-containing EPS beads was produced in China with the use of 8,120 metric tons of HBCD in this industry in 2017. Thus, 8120 metric tons of HBCD in total will be reduced annually for EPS beads production and 24,360 metric tons of HBCD avoidance in the 3 years were HBCD use will be stopped in the project implementation (2022, 2023 and 2024). Considering the use of 0.8% HBCD in EPS, the total avoided HBCD containing EPS in China during project implementation will be 3,045,000 metric tons by by the use of EPS foam with alternative flame retardants..

79. In this project, 2 XPS enterprises with a total annual capacity of 800 metric tons of XPS will produce the HBCD-free XPS after 2021. Therefore, the total estimated output of XPS is 2400 metric tons within the project duration after substitution. With the concentration of HBCD in XPS products around 4%, a total of 96 metric tons of HBCD will be reduced within the project implementation period.

80. In 2017, China's XPS board products manufacturing enterprises totaled about 1000 with an annual production of HBCD-containing XPS of about 160,000 metric tons, and around 6621 metric tons of HBCD was used. Thus, 6621 metric tons of HBCD in total will be avoided annually and 19,863 metric tons of HBCD will be avoided within the project implementation period, based on the HBCD consumption in the XPS sector in 2017. In total around 480,000 tonnes of XPS containing HBCD will be avoided within the project duration.

Thus, for the demonstration and for the contribution of the EPS/XPS sectors, the following are the estimated reduction/avoidance of HBCD-containing EPS and XPS foams:

Table 9: Estimated GEB contribution from the EPS/XPS Sectors*

GEBs contributors	2022	2023	2024	Subtotal
A. EPS/XPS products containing HBCD				
Demonstration EPS manufacturers: EPS products containing HBCD avoided (and HBCD)	100,000 (800)	100,000 (800)	100,000 (800)	300,000 (2400)
Contribution of the EPS Sector: EPS products containing HBCD avoided (and HBCD)	1,015,000 (8120)	1,015,000 (8120)	1,015,000 (8120)	3,045,000 (24360)
Demonstration XPS manufacturers. XPS products containing HBCD avoided (and HBCD)	800 (32)	800 (32)	800 (32)	2400 (96)
Contribution of the XPS sector: XPS products containing HBCD avoided (and HBCD)	160,000 (6621)	160,000 (6621)	160,000 (6621)	480,000 (19863)

** Note: Calculation is made after the total ban of HBCD production in December 2021 and only within the project lifetime*

CO_2 equivalent

81. For XPS enterpises, production using HBCD alternatives also means avoidance of HCFC consumption. For the two XPS demonstration facilities with a total combined annual capacity of 800 metric tons, given that XPS products contain about 12.1% HCFC-22, an estimated 290.4 metric tons of HCFC-22 is avoided. HCFC-22 has a global warming potential of 1810 (IPCC Fourth Assessment Report (AR4)). Therefore, the CO_2 equivalent avoided is 0.526 million metric tons. For the replication phase, two more XPS manufacturing facilities will be supported by the project. Thus, considering the same average combined output, a total of 580 metric tons of HCFC-22 and 1.05 million metric tons of CO_2 equivalent is avoided from these four facilities as a contribution of the project.

1a.g) Innovation, sustainability and potential for scaling up

Innovation

82. The project will promote the application of environmentally friendly alternatives through the promotion of BAT/BEP. As China is the biggest HBCD producer and consumer in the world and exports large amount of HBCD, the development of HBCD alternative/s will affect the flame retardant market and technologies worldwide. This represent a huge global innovation that would benefit the foam industry.

83. The project introduces alternatives to a persistent organic pollutant into approx. 4000 companies which by itself is innovative. The project further promotes alternative assessment similar to that which has been promoted by the Design for the Environment (DfE) program of the USEPA and the European Chemical Agency (ECHA). In China, no particular activity on alternative assessment is established by the authorities. Therefore, the current project will introduce an assessment framework that could benefit both the country and the region.

84. This project aims to develop at least 4 alternatives (chemicals or materials) to HBCD-containing EPS/XPS foams. The use of HBCD substitutes will promote the development of flame-retardant EPS beads, EPS and XPS foams, and improve the competitiveness of EPS / XPS products with other POPs-free materials in the market. Through the demonstration and evaluation of the demonstration results of HBCD substitutes in the EPS and XPS sector, the relevant experience and lessons can be replicated by other countries effectively in order to address similar issues. The alternative to XPS containing HBCD will also reduce the use of HCFC as blowing agent. Synergistic reduction could be achieved through the envisaged activities.

85. One important opportunity for innovation and sustainability is the improvement of the life cycle of EPS/XPS boards and insulation materials towards circular economy. As previously mentioned, construction and demolition waste (C&DW) accounts for 30% to 40% of the total amount of waste in China and the average recycling rate of C&DW in China is only about 5% (Huang et al. 2018). Circular economy thinking is considered and promoted by researchers in the construction sector in China as recently shown Huang and co-authors in their 2018 publication but it has not been put into practice yet. The project can contribute to the assessment and subsequently removal or reduction of barriers to a more circular economy approach (Huang et al. 2018; Zhang et al. 2019) and therefore contribute to a real change (Theory of Change).

86. Through the project, it is expected to enable and initiate a more circular economy approach for EPS/XPS insulation foam in construction, as well as recycling of related materials generated during demolition of insulation. This includes the assessment if recovery of polystyrene and (possibly) the recovery of bromine is feasible by solvent and precipitation technology. The improvement of circularity contributes to the paradigm of ecological civilization oriented development which is a major aim of China and might become also a model for others if appropriately developed (Hansen et al. 2018).

Sustainability

87. The legal framework and institutional and technical capacities developed by the project ensured sustainability of outcomes. Involving all key stakeholders in relevant project activities, including local participation from the beginning of project formulation and throughout its implementation, demonstrating the effectiveness of alternative to HBCD, supporting provincial and national capacity building, putting in place and demonstrating the phase out of HBCD, PPP-based management system, and public awareness raising safeguards the project objectives.

88. Multiple means and instruments will be adopted to regulate and promote HBCD phase-out and substitution. The case of phasing out of HBCD in production and industrial use including the compilation and assessment of alternatives will serve as a case study for phasing out of POPs and possibly other hazardous chemicals. The approach of phasing out production of hazardous chemicals and introducing better alternatives and assessment of alternatives is a change maker towards sustainable consumption and production and has been recognized as a relevant approach for chemical management (Tickner et al. 2016, 2017).

89. The project by making the case of informed substitution of POPs and establishing it as a case for bringing the approach of substitution and phasing out of POPs and problematic hazardous chemicals to a wider recognition of authorities, industrial stakeholders and the research community, as well as NGOs working on POPs and chemicals in China, can contribute to the broader objective of sustainable consumption and production and hence to a relevant and sustainable change (Theory of Change) (Zuzueta 2017). Also the involvement of the multiple stakeholders (government, industry science community and civil

society) in this substitution case will support that this approach gets a broad support can lead to a broader change and the further implementation of substitution of POPs and hazardous chemicals in future promoting sustainable consumption and production as stipulated by the Stockholm Convention POPs Phase out publication (SCRCAP 2014).

90. The low recycling rate for C&DW in China of only 5% (Huang et al. 2018) results partly from the way buildings are demolished and mainly, because buildings are not designed for deconstruction. Improved design for deconstruction of buildings are of high importance for a better recycling and recovery rate from C&DW in the future. The first basis for this is the information and education on deconstruction and demolition challenges and the need for better design of construction materials. Therefore, one element in the education and training component will be the education on Design for Deconstruction (DfD) (Kadiri et al. 2017) for the EPS/XPS sector and other building insulation material sector as well as for policy makers.

Potential for scaling up

91. The demonstration activities that will be implemented in the project will contribute greatly to the complete overhaul of the HBCD producing and consuming sector in China. Around 3000 EPS and 1000 XPS companies will benefit from the outputs of the demonstration activities. As China is the biggest HBCD and EPS/XPS producer and consumer in the world, relevant experience and lessons learned can also be shared to other developing countries for substituting HBCD in EPS/XPS production and for managing HBCD containing waste in an ESM.

92. The project further seeks to ensure replicability by including a specific component on promoting and disseminating project results and lessons learned to the rest of China. National, provincial, and local governmental organizations, institutes, and enterprises involved in this project will also help ensure the dissemination of relevant information. The public-private partnerships scheme that will be developed through the project will be used as mechanism to ensure the scale up of demonstration activities throughout the country. The role and commitment of partner industries and the private sector engaged in HBCD or foam manufacturing is also very critical in ensuring that the interventions maybe replicated and scaled-up to the whole HBCD sector in China.

93. Knowledge can be shared with other countries through the knowledge management platform, through Stockholm/Basel Convention Center for Asia and the Pacific or within the Belt and Road Initiative. Furthermore, a global outreach can be achieved by webinars or technical conferences in cooperation with interested regional centers or the Secretariat of the Basel, Rotterdam and Stockholm Convention (see Component 4). The lessons and project outputs will be shared to the UNEP BAT/BEP with the suggestion to assess relevant project outcomes for possible inclusion of these large scale substitution experience and waste management demonstration project in developing country. These may serve as case studies into the Stockholm Convention HBCD BAT/BEP guidance, which lacks full scale studies for EPS/XPS disposal in developing countries (UNEP 2017c).

1b. Project Map and Coordinates

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

There are 10 HBCD producers in China, of which 9 are located in Shandong province and 1 in Jiangsu Province. Figure below shows the location of HBCD producers where interventions will be implemented.

Figure 5. Location of HBCD enterprises where intervention will be implemented

(Left: Shandong Province, 9 enterprises; right: Jiangsu Province, 1 enterprise)

However, EPS beads, EPS and XPS enterprises that currently use HBCD are found all across the country because of its own low weight and difficulty in long-distance shipping. Therefore, locations of EPS beads, EPS and XPS manufacturers where intervention will be implemented are in various provinces. The enterprises are mainly located in the eastern and southern regions of China.

1c. Child Project?

If this is a child project under a program, describe how the components contribute to the overall program impact.

Not applicable.

2. Stakeholders

Select the stakeholders that have participated in consultations during the project identification phase:

Civil Society Organizations Yes

Indigenous Peoples and Local Communities

Private Sector Entities Yes

If none of the above,please explain why:

While the project envisages collaboration with civil society and private sector entities on its activities, the participation of indigenous people is not foreseen. Key project stakeholders have been engaged and consulted during the project development mainly on data validation, research activities and future engagement in the project. Relevant ministries have been met and consulted and close collaboration with local environmental departments, industrial associations and private HBCD/EPS/XPS sectors was undertaken.

Please provide the Stakeholder Engagement Plan or equivalent assessment.

The Stakeholders Engagement Plan is attached as Annex J.

In addition, provide a summary on how stakeholders will be consulted in project execution, the means and timing of engagement, how information will be disseminated, and an explanation of any resource requirements throughout the project/program cycle to ensure proper and meaningful stakeholder engagement.

The project involves a wide spectrum of stakeholders both vertically and horizontally distributed throughout China's administrative framework. While stakeholders in the environmental sector will undertake the principal responsibilities, a variety of stakeholders from the industry and other sectors will play an important role in the project. The Project will directly and indirectly engage with multiple stakeholders from various institutions including: Government, Industry, Finance, Academia, Civil Society and NGOs. Stakeholders will be engaged across the project duration, with broad stakeholder engagement being delivered under Component 4 focusing on "Information dissemination, capacity building and knowledge management". In addition, the project aims to promote gender equality. Therefore, it will, to the extent possible, ensure the equal representation of both women and men. This would also include the involvement of gender experts, gender-focal points of relevant stakeholders (including CSOs) that promote gender equality and women's empowerment ensuring that gender related targets are achieved. The Environmental and Social Safeguards Plan also reflects involvement not only of the demonstration enterprises but rather a wide spectrum of stakeholders.

The following table provides a snapshot of activities where stakeholders' engagement is envisaged:

Consultation	Purpose	Participants	Lead/Chair	Reporting	Schedule
Public consultation	Secure relevant feedback t	FECO, Policy Makers, PMO	FECO	In-person presentations,	Year 1-5, once a y

	o adjust policy formulation	s, policymakers from relev ant ministures in CICG, ind ustrial enterprises, industry association, universities, a nd research institutes, employees of participating industries		seminars, meeting minu tes, agendas, participan t list	ear
Training of national level	Secure relevant feedback and levels of interest for recruitment of trainers, participants	FECO,,local PMOs, industri al enterprises, industry ass ociation, universities, and r esearch institutes, employ ees of participating industr ies	FECO	In-person presentation s, seminars, meeting m inutes, agendas, partici pant lists, training pack s, toolkits, learning mat erials	Year 1-5, once a y ear
Training of local level	Secure relevant feedback and levels of interest for re cruitment of trainers, parti cipants	Local PMOs, industrial ent erprises, industry associati on, universities, and resear ch institutes, employees of participating industries	Local PMOs	In-person presentation s, seminars, meeting m inutes, agendas, partici pant lists, training pack s, toolkits, learning mat erials	Year 1-5, once a y ear
Public consultation & site visits to enterprises	Adjusting of mitigation me asures, if necessary; Impac t of replacing and updating activities; Comments and s uggestions; Effectiveness of mitigati on measures; Impacts and benefits of pr oject implementation; Comments and suggestion s	FECO, PMOs, Industrial Ent erprises, Industry Associati on, Universities, and Resea rch Institutes, Employees of participating industries	FECO	In-person presentations, meetings agendas. News, reports, photos. Site visit report. Materials/information p acks, checklists – hardc opies, PowerPoint slide s, USB sticks where app ropriate. Delivery of cas e studies/best practice s, technical manual dev eloped for sector. Focus groups/ interviews on le ssons learned.	Year 1-5, twice a y ear
Expert workshop, confere nces	Comments and suggestion s on impacts;	FECO, PMOs, Industrial Ent erprises, Industry Associati	FECO	In-person presentations, meetings, agendas. Ne	YEAR 1-5, twice a year

	public opinions; interest in partnerships collaborations to recruit/fund further industries/sectors interest in training	on, Universities, and Research Institutes, Employees of participating industries, Population living near participating industries		ws, reports, photos. Materials/information packs, Power Point slides, USB sticks where appropriate. Delivery of case studies/best practices.	
Addressing Community Concerns	Consultation, Grievance on Procedure	Working Group, Policy Makers, NGOs etc	FECO	News and reports, proceedings of the events, meetings minutes, grievance assessment, grievance complaint file, feedback mechanism , Project Communications Plan.	At least at Project beginning and whenever the Procedure is applied

Select what role civil society will play in the project:

Consulted only; Yes

Member of Advisory Body; Contractor;

Co-financier;

Member of project steering committee or equivalent decision-making body; No

Executor or co-executor;

Other (Please explain)

3. Gender Equality and Women's Empowerment

Provide the gender analysis or equivalent socio-economic assesment.

94. Gender and Development (GAD) considerations will be made an integral part of the project strategy in consideration of the Gender policies of the GEF, UNIDO and the Government of China. In line with the UNIDO guide on gender mainstreaming for environmental management projects and UNIDO gender mainstreaming tools, a detailed gender analysis of the HBCD management and phase-out in China has been conducted during the preparatory phase of the project to mainstream gender dimensions into the project elements. The complete Gender Analysis is provided in Annex K.

95. It has been noted that one of the key actions undertaken by the GEF relative to gender mainstreaming was to incorporate gender responsive approaches and indicators in all GEF projects. UNIDO, for its part, recognizes the significant positive impact on sustained economic growth and sustainable industrial development generated by gender equality and the empowerment of women. UNIDO adopted a policy on Gender Equality and the Empowerment of Women in 2009, which was further strengthened in 2019. As a consequence, the organization commits to engage all men and women equally in all of its organizational practices, policies, programmes and projects. In line with UNIDO's Gender Equality and Empowerment of Women Strategy 2020-2023, considerations for gender mainstreaming, gender equality, and women's empowerment in this project are as follows: i) ensuring women's access to resources and technologies that enhance their health and well-being, ii) recognizing women's role as key agents of environmental actions; iii) promoting women's engagement, leadership and decision-making; and iv) having a fair representation of women and men's distinct needs and priorities in the process. Gender dimensions are thus a prerequisite in the design, implementation, monitoring and evaluation of programs, projects and activities with tools and guidelines on mainstreaming gender in the whole gamut of project management.

96. Gender considerations are taken into account in the present project, since women and men might be exposed to different kinds and levels of POPs at different frequencies and there would be impacts on human health, due to social and biological factors. According to the study conducted in China, whose result corresponds with another study conducted in Canada, the level of hexabromocyclododecane (HBCD) in human serum from the HBCD production source region does not show statistically significant differences between genders. However, the rough estimation based on the published research and the 2014 Chinese Rural Migrant Workers Report issued by Chinese State Statistics Bureau shows that the number of male workers is more than twice of that of female workers in Chinese chemical plants. In this respect, it should be noted that male exposure may be more direct due to the handling of flame retardants in factories while female HBCD exposure is predominantly indirect through environment. Since HBCD is an endocrine disrupting chemical, the effects might differ between women and men and will be taken into account.

97. The concept of gender mainstreaming is a globally agreed strategy for achieving gender equality and women empowerment and it was defined by the United Nations Economic and Social Council in 1997 as "a strategy for making women's as well as men's concerns and experiences an integral dimension of policies and programmers in all political, economic and societal spheres' so that women and men benefit equally and inequality is not perpetuated".Gender mainstreaming is helpful to identify gaps in gender equality. Particularly it will be incorporated under the component above-described. In 2015, Chinese Women and Children Statistics issued by Chinese State Statistics Bureau indicates that female accounts for 42.6% of all the trained employees in 2014, which is greater than 38% in 2010, but it is still less than 50%. Thus, training sessions for company's personnel will consider this dimension, as well as others addressed to public institutions in order to influence future national policy.

98. This project will record gender ratio and set targets for women participation. The guidance sources for incorporating gender mainstreaming in the project are as follows: the UN System-wide Policy on Gender Equality and the Empowerment of Women, and the UNIDO's Policy on Gender Equality and the Empowerment of Women.

99. This gender analysis focused on the chemical production sector (with a special emphasis on HBCD, and EPS/XPS industries) of China and provided recommendations based on the data gathered on how gender maybe mainstreamed in the project. Gender indicators are also provided in the logical framework of the project. A midterm and final analysis on gender mainstreaming will be undertaken to monitor the results and to evaluate the achievements of the project on gender and development issues.

100. The production and trading of HBCD in China will be banned completely by the end of 2021 based on the Stockholm Convention. This project, the phase-out and management of hexabromocyclododecane (HBCD) in China, aims to work closely with companies involved in the production of HBCD and HBCD-related products (EPS and XPS) to better cope with the impacts of such legal and industrial action. From a GAD perspective, this project aims to raise awareness for HBCD, to continuously empower women economically and socially amid the management and phase-out of HBCD, to enlarge female participation in decision-making and management, and to encourage female participation in science, technology, engineering and mathematics (STEM) field and females' participation in paid labor in general. To address these aspects, this project proposes to include gender-responsive measures to promote gender equality and women's empowerment. Specifically, it incorporate elements including a) technical trainings for various stakeholders (as well as targeting females who are in direct contact with hazardous POPs, b) conducting assessment of the social and economic impacts of gender-mainstreaming in foam sector and the dissemination of the knowledge gained, c) awareness raising and knowledge building regarding HBCD and other POPs in construction materials (and their alternatives) for the general public (a subgroup of which consists of females and youth), and, d) dissemination of knowledge products on how to gender-mainstream the HBCD management, as generated during the project. For all of the trainings, workshops, and webinars held, efforts will be devoted to maximize female participation by setting the trainings at a more convenient day-time slot for females who are also caretakers to attend, and by setting a percentage for female attendants to be met.

101. Based the background analysis of the overall gender equality in China, as well as the field work research conducted in December 2019 in Shandong and Jiangsu Provinces, we obtained the baseline situation regarding gender-specific information in this sector, including, female participation in paid labour, in decision-making, and females' awareness of the hazards of POP on human body. As shown in the chart below, company managers in this sector generally have a low to medium gender awareness, with nearly half of their decision-makers being female. Generally, female employees have a very low level of health awareness regarding the biohazards of POPs (HBCD in this case); the representation of females in companies' workforce is also inadequate - female employees make up 37% percent of the total employees among the 16 companies surveyed. On the bright side, however, our interviews suggest that female employees working for these companies is the channel of their social and economic empowerment.

Table 10. Baseline gender-specific situation in Chinese HBCD and EPS/XPS Companies

Item Description	Content
Representations of female employees in the companies in general (i.e. the ratio of women among the total workforce)	37%
Gender awareness of the managers of the companies Low: not willing to hire females when compared with male candidates with similar backgrounds Medium: recognizing the advantages of having females as both employees and decision makers High: recognizing the necessity of ensuring gender parity in workplace, setting up schemes to actively promote such gender parity	Low in some, medium in others
Health awareness of female workers in the biohazards of POPs (HBCD in this case): Low (not familiar with females' vulnerabilities when exposed to POPs) - High (harms of POPs on reproduction health understood)	Vaguely understood the hazards and female vulnerability (e.g. would transfer from production line roles to office and administrative roles after getting married (planning for pregnancy), but have limited understandings of its biohazards otherwise.
Representations of female decision-makers in companies (i.e. ratio of female decision-makers among the total number of managerial positions)	33%
Scheme of ensuring the female to male ratio in the shortlist of candidates to be selected as 1) workshop managers, 2) middle to senior level leaders	None across all companies
Whether an women's representative or a women's association is in place in the companies	Yes in 2 companies; None in the rest
Whether organizations working with women to share their domestic tasks (help with care taking) and to promote their physical and psychological well-being are in place	Yes in some companies (e.g. Xurui has summer and winter camps for female employees' children during the school breaks)

102. The gender analysis conducted during the preparatory phase resulted in the following conclusions:

- (ii) Continuing with the aforementioned gender vision of labour, it is predominantly males (nearly always males) who are employed by HBCD and EPS/XPS companies to work as research and development engineers. This makes it highly important to incorporate measures in this project to ensure female researchers, engineers and technicians getting adequate trainings on HBCD.
  (iii) Very few of these female workers in the frontline production roles have some understandings of the biohazards of HBCD and POPs on human body, especially its potential harms on female health. The safety trainings they have received from their employers mainly focus on the safety of production, e.g. how to prevent and respond to situations of fires or explosions. This provides another entry point for gender mainstreaming through knowledge dissemination, which is expected to public and female workers' awareness in the harms of exposure to HBCD and POPs.

  (iv) In some cases, women are also hired by these companies as quality inspectors and laboratory technicians, and sometimes they also make it to managerial roles. These female employees tend to have a higher level of education, and a higher awareness of the hazards of HBCD exposure (and exposure to POPs in general). It is also those roles, however, as compared to frontline production workers, that may have a higher level of HBCD exposure. This again asks for better knowledge dissemination and training targeting female employees in this sector.

  (v) Within the HBCD and XPS/EPS industry, the overall gender equality situation varies from company to company. Some companies have a noticeable gender imbalance among frontline production workers, as well as an absence of female leaders in the management and decision-making of the companies. In contrast, some other companies, not only have they achieved a rather balanced gender ratio among employees, female participation in management and decision-making is on satisfactory level. Besides, welfare of women and mechanisms to ensure female employment by offering child-care sessions to parents free of charge are also in place. Successful experiences from these showcase examples can be summarised and disseminated through various knowledge dissemination channels devised by this project.

  (vi) Regarding female leadership in this sector, it is noteworthy that males take up the majority of the middle and top level of management. Among 17 companies surveyed, 4 of which have zero female leaders. There are also companies that achieve (nearly) 1:1 ratio between male and female leaders, which are the rare cases in this survey. Among the management level, the survey results also observe a distinct division of labor. Female leaders are normally in charge of finance, human resources, administration, (sometimes sales as well), and only a few female leaders made it to the director board. Through the field research, the researcher also observes that the promotion chances for female workers from frontline production roles to workshop managers are rather limited, and the same is for other promotion routes for females.

  104. In the implementation of the project, the following should be done in order to integrate gender dimension in the whole gamut of project management. These steps maybe distinct activities or maybe incorporated in the different activity components of the project with the gender indicators as provided in the project logical framework:

  Training and Skills:

  To offer professional training courses to female employees in these companies.

  To provide training in grassroot female entrepreneurships and relevant skills (such as e-commerce) for females who need to seek alternative employment.

  Knowledge, Information and their Dissemination:

  To organize workshops on basic knowledge of POPs for female employees (and company employees in general). Such workshops can be organized around the features of POPs as pollutants, and their impacts of POPs on human bodies as well as on the environment;

To offer training in gender awareness for main stakeholders (i.e. company personnel in charge of management and FECO team who design and implement this project), especially targeting companies with a low female representation.

For companies with exemplary projects to promote female employees' welfare, their experience and knowledge should be reviewed and disseminated.

Gender Parity in Workplace and in Decision Making:

To provide extra incentives for company to achieve gender parity in employment, and to enlarge female participation in decision-making and management, especially by targeting companies with a low level of female representation among their workforces and in managerial positions.

Does the project expect to include any gender-responsive measures to address gender gaps or promote gender equality and women empowerment?

Yes

Closing gender gaps in access to and control over natural resources;

Improving women's participation and decision making Yes

Generating socio-economic benefits or services or women Yes

Does the project's results framework or logical framework include gender-sensitive indicators?

Yes

4. Private sector engagement

Elaborate on the private sector's engagement in the project, if any.

103. The project will strongly involve and engage private sector entities in the manufacture of HBCD or are using HBCD in the production of XPS/EPS foams. A key component of the project is the "Promotion of technology transfer and investment on the production of HBCD alternatives and application of alternatives to the XPS/EPS foam sector" which will involve industries in designing and implementing technologies to achieve the objectives of the project. The private sector will also contribute a significant co-financing in the form of hard investments to the project and will ensure that the baseline is implemented. As mentioned, the project also envisages the implementation of demonstration and replication activities in the industrial facilities. The project will provide technical assistance in the closure of HBCD production lines, conduct demonstration of at least 4 types of alternative materials for EPS/XPS foam manufacturing, and carry out replication of the best alternatives in at least 5 companies.

104. During the PPG, a request of expression of interest (REOI) from private sector was published. FECO/MEE issued the REOIs in March 2020 and more than 10 enterprises expressed their willingness to participate in the project. The enterprises submitted the project screening application materials to FECO which highlighted their HBCD phaseout plans. Evaluation and screening of potential demonstration enterprises was conducted based on an agreed set of criteria. During the project implementation, FECO will issue a bid with Terms of Reference (TOR) agreed with UNIDO based on the work outline and requirements of the demonstration activities that needs to be undertaken and will invite those companies that expressed interests in participating in the project. Based from the proposals received, FECO and UNIDO will jointly determine the demonstration facilities and sign the contract (MOU) with the enterprises. The enterprises shall carry out the activities as per the TOR and complete the provisions of the contract. An assessment of the deliverables will be undertaken by FECO and UNIDO to ascertain the completeness of the contract delivery as per the agreed terms. Facilities for the replication phase will be engaged and will carry out production and/or use of the best alternatives based on the results of the demonstration phase.

Selection of HBCD enterprises

According to the preliminary survey, all the HBCD manufacturers in China are located in Shandong Province and Jiangsu Province, and the demonstration enterprises will be selected from these two provinces. The criteria for selection includes the following;

i) The HBCD demonstration enterprise is an independent legal entity with HBCD production line, which has produced HBCD after January 1, 2018;

ii) The enterprise shall eliminate the production of HBCD in advance or on schedule before December 25, 2021;

iii) The enterprise needs to have a degree of representations in the industry, with standardized operation, complete certificates and licenses, standardized environmental assessment, no record of major environmental violations, especially in line with emission standards, no major violations or environmental accidents;

iv) The enterprise is willing to participate in the elimination and management project activities of HBCD, provide supporting funds according to the project requirements, and issue a letter of interest willing to participate in the project.

105. Enterprises can participate in the following activities based on their management plan:

To participate in the closure of their HBCD production facilities: The enterprise shall close the HBCD production facilities in advance or as per deadline and use the production facilities for the production of other products; or dismantle the production facilities, and conduct the environmentally sound management to treat and dispose of the waste containing HBCD produced in the process of conversion, cleaning or dismantling of the HBCD production facilities.

To participate in the production of HBCD alternatives: The HBCD alternatives produced shall meet the requirements of the project. The company should formulate the production plan of the substitutes, prepare the relevant project approval and environmental impact assessment work, and conduct the environmentally sound management and disposal of the waste containing HBCD produced in the process of conversion, cleaning or demolition of HBCD production facilities.

Selection of EPS enterprises.

106. The criteria for the selection of EPS enterprises for the demonstration activity are the following:

i) The EPS beads or EPS foam production enterprises should be an independent legal entity which produce flame-retardant EPS beads or EPS products used in the construction industry that meet the relevant national standards. Enterprises shall eliminate the use of HBCD in advance or by the deadline on December 25, 2021.

ii) The enterprise has certain degree of representativeness in the industry, with standardized operation, complete certificates and licenses, standardized environmental assessment, no record of major environmental violations, especially in line with emission standards, no major violations or environmental accidents.

iii) The HBCD substitutes to be selected by the enterprise should meet the requirements of the project. A plan for adopting HBCD substitutes should formulated, or trial production of products with HBCD substitutes has been carried out. The corresponding material certificates should be provided.

iv) The enterprise is willing to participate in the elimination and management activities of HBCD, provide supporting funds according to the project requirements, and issue a letter of interest of its willingness to participate in the project.

107. Enterprises can participate in the following activities according to their management plans

i) Participate in the use of HBCD substitutes in EPS beads, reconstruct the EPS beads production line or build a new EPS beads production line, use HBCD substitutes as flame retardant, and produce EPS beads that meet the relevant national standards;

ii) Participate in the identification of EPS products containing HBCD. Identification for EPS products containing HBCD is to provide reference for the treatment and disposal of EPS after peeling off from buildings.

iii) Participate in the demonstration of ESM of waste containing HBCD

Figure 7 showing HBCD-containing EPS insulation boards

Selection of XPS enterprises.

108. The criteria for the selection of the XPS enterprise to participate in the project are as follow

i) The XPS production enterprise should be an independent legal entity, which produces flame-retardant XPS products that meet the relevant national standards used by the construction industry. The enterprise shall eliminate the use of HBCD in advance or before the deadline on December 25, 2021.

ii) The enterprise is representative of the industry, with standardized operation, complete certificates and licenses, standardized environmental assessment, no record of major environmental violations, especially in line with emission standards, no major violations or environmental accidents.

iii) The HBCD substitutes to be selected by the enterprise should meet the requirements of the project. A plan for adopting HBCD substitutes should been formulated, or trial production of products with HBCD substitutes has been carried out. The corresponding material certificates should be provided.

iv) The enterprise is willing to participate in the elimination and management project activities of HBCD, provide supporting funds according to the project requirements, and issue a letter of interest of its willingness to participate in the project.

109. Enterprises can participate in the following activities according to their own conditions:

i) Participate in the use of HBCD substitutes in XPS, transform the XPS production line or build a new XPS production line to use HBCD substitutes as flame retardant, and produce XPS materials that meet the relevant national standards;

ii) Participate in the identification of XPS materials containing HBCD. Identify the XPS materials containing HBCD in order to provide reference for the treatment and disposal of XPS after peeling off from the building;

iii) Participate in the demonstration of environmentally sound management of waste containing HBCD;

iv) Enterprises will be given priority if they have activities to carry out HCFC substitution.

110. The enterprise will cooperate with the local environmental protection department and FECO to ensure that the project implementation meets the requirements of the contract between FECO and the enterprise. FECO will require each enterprise to report on the performance of its contracts. The enterprise will provide materials for the monitoring and progress report of the project, which are submitted to the UNIDO and the GEF regularly.

5. Risks to Achieving Project Objectives

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):

111. The following table shows the envisaged project risks and the proposed mitigation measures:

Table 11: Risks versus Mitigation Measures

Risks	Level	Mitigation measures
Reluctance of companies to undertake a conversion to HBCD alternatives.	Medium	MEE has informed all HBCD producers and consumers of the deadline on the total ban of HBCD production. MEE and the local authorities will continue to keep communication with the companies to ensure progress in setting up the production lines for alternatives. The prospect of the technical assistance being provided by the project will lessen the risk. The close involvement of responsible ministries advising companies on the benefits of getting involved in conversion activities in light of future regulation will mitigate the risk.
Substitution by BEP options (Most environmentally sound solutions) might not be economically feasible for a large part of Chinese producers.	Medium	It is acknowledged that the switch to alternatives might not be economically feasible for a large part of the industries, especially for the small- and medium-sized EPS/XPS Foam producers. However, the project will support production of alternatives and demonstration of the best alternative materials by performing functionality tests in order to select technically qualified alternatives that will meet the quality requirements for concerned uses. These project activities will cover the part of the incremental costs associated with the R&D which could heavily burden most producers.
Lack of reasonable business case and commitment for a concrete purchase volume of HBCD foams	Medium	Both local and global markets dictates that products with non-HBCD alternatives are required. This would ensure that there is sufficient business case for the producers. Likewise, the government will ensure support to companies through certification of HBCD-free products.
Sharing information on handling critical materials can be limited due to fear of sanctions.	Low	The project has enjoyed the strong support and participation of the enterprises during the preparatory phase and baseline data and information have been provided. It is envisaged that this will

		have been provided. It is envisaged that this will continue during the project implementation. The project presented a very sound opportunity for incremental support incentivizing private sector participation thereby, mitigating this risk
Alternatives to HBCD and EPS/XPS using alternative FR not up to the required technical standards	Low	Most companies have long experience in producing brominated FR. Also, China has standards for flammability and appropriate testing methodologies are known. Therefore, this risk seems rather low.
Delay / difficulties in demonstration of the environmental sound management (ESM) of HBCD and HBCD waste	Low	The major activities for the waste management is scheduled in years 3, 4 and 5 of the project. However, assessment activities on the ESM of waste including lessons learned in other countries and selection and planning activities of technologies will be undertaken from the project onset.
Impact of climate change	Low	A major risk related to climate change is flooding of production areas. An assessment during the PPG showed that 90% of the participating companies are located in the northern part of the Yangtze River where the weather is generally dry with low associated flooding occurrences. Disasters such as extreme weather changes and flooding rarely occurs and the country is equipped with early warning and mitigation measures. These measures are explicitly reflected in the Environmental and Social Management Plan (ESMP) of the project found in Annex L.
Current pandemic, particularly COVID-19, can impact industrial production and the larger economy as experienced in recent months	Medium	The Chinese central government has taken effective measures against the Coronavirus (COVID-19), including financial rescue measures for private enterprises, especially small businesses, heavily affected by the pandemic. Furthermore, industrial production has already re-started in the country and local governments have issued guidelines on health measures to protect workers. Lessons learned from the management of other concerns of this nature (like SARS) will be useful.
Socio-economic risks, including manufacturers losing competitiveness on national and international market due to the cost of alternatives, reduced job and risk of closure of factories	Medium	Since, the production of HBCD will be phased out, the demands from EPS/XPS consumers will bring the market for alternative FRs. Almost all HBCD producers in China have conversion plans and therefore, job losses and closure of factories are not imminent.

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.

112. The project management structure is given in Figure 8 below.

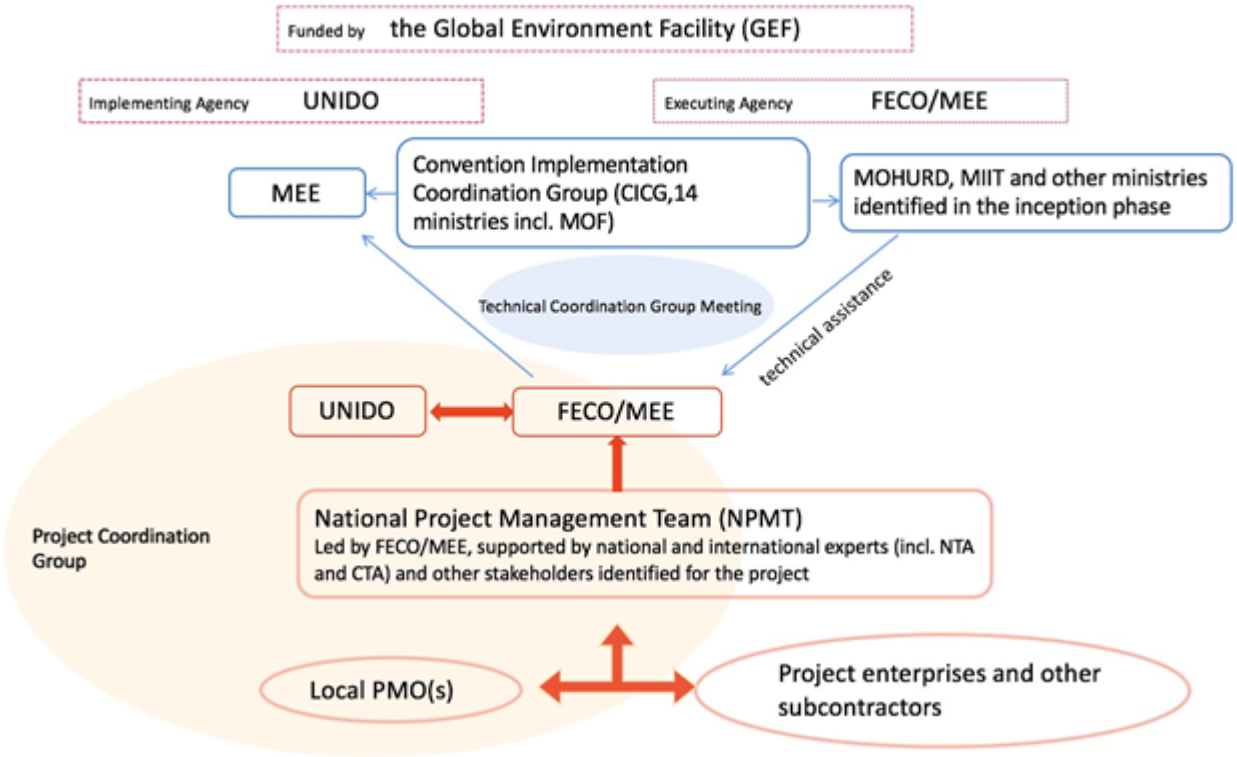

Figure 8. The Coordination Mechanism of the Project

112. UNIDO is the GEF Implementing Agency (IA) for the project. As the GEF IA, UNIDO will lead the process of project preparation and implementation. A project officer will be appointed in UNIDO HQ to oversee the implementation of the project and the UNIDO Country Office in China may also provide assistance in country level project monitoring. The Foreign Environmental Cooperation Center (FECO) under the Ministry of Ecology and Environment (MEE) will be the main executing partner in the project.

113. The project will report its progress to the Convention Implementation Coordination Group (CICG) of China as part of its coordination function on the activities related to the Stockholm Convention. China established the National NIP Development Leading Group in September 2003. This Group became the National Leading Group for Implementation of the POP Convention when China ratified the Convention on 13 August 2004, which was formally approved by State Council in April 2005 and renamed the National Technical Coordination Group (TCG) for Implementation of the Stockholm Convention, or Convention Implementation Coordination Group (CICG). The CICG will provide (i) review of significant policies related to POPs management and control, (ii) guidance and coordination for POPs management activities and Convention implementation. The CICG consists of the following 14 agencies including: (i) Ministry of Ecology and Environment (MEE); (ii) Ministry of Foreign Affairs (MOFA); (iii) National Development and Reform Commission (NDRC); (iv) Ministry of Finance (MOF), which is the GEF Focal Point in China; (v) Ministry of Commerce (MOCom); (vi) Ministry of Science and Technology (MOST); (vii) Ministry of Industry and Information Technology (MIIT); (viii) Ministry of Agriculture and Rural Affairs (MARA); (ix) National Health Commission (NHC); (x) Ministry of Housing and Urban-Rural Development (MOHURD); (xi) Ministry of Emergency Management (MEM); (xii) General Administration of Customs (GAC); (xiii) National Energy Administration (NEA) and; (xiv) State Administration of Market Supervision (SAMR)

114. A National Project Management Team (NPMT) will be set up in FECO/MEE and run the project on a day-to-day basis. The NPMT function will end when the final project terminal evaluation report, and other documentation required by the GEF and UNIDO, has been completed and submitted to UNIDO (including operational closure of the project). The NPMT's responsibilities will include (i) assignment and supervision of project activities; (ii) recruitment of national consultants; (iii) providing guidance to local PMOs; (iv) coordination with stakeholders, donors, the IA, relevant national agencies and the private sector; (v) preparation of terms of reference (TORs) for project activities, (vi) review of project progress reports submitted by the local PMOs, (vii) supervising project procurement and financial resources (viii) organizing and convening project coordination stakeholder meetings, and (ix) review of project outputs and other tasks as required by the project.

115. The NPMT will work under the guidance of the Convention Implementation Office (CIO) under the Ministry of Ecology and Environment (MEE). MEE is responsible for coordinating the day-to-day management of the Stockholm Convention implementation in China. The responsibilities include: (i) provision of technical support for international negotiations and policy studies on the Stockholm Convention, (ii) provision of support for development and implementation of POPs-related policy and regulations, as well as coordination of key governmental stakeholders, (iii) mobilization of co-financing from bilateral, international, and national sources, (iv) collecting data and information, compiling reports, organizing training activities, and publishing information. The CIO will provide guidance to ensure the successful implementation of the project.

116. The project will recruit an international Chief Technical Advisor (CTA), a National Technical Advisor (NTA), policy experts, waste management industry experts, chemists, monitoring & evaluation experts and other technical experts as required by the project. These experts will form a Project Expert Team (PET) to assist NPMT with the following activities:(i) Introduction of successful experiences gained from foreign countries; (ii) Management and coordination of all project activities; (iii) Provision of technical support for policy framework, institutional strengthening, demonstration activities, technology selection, market promotion, awareness raising and education, results and experience dissemination, project monitoring and evaluation, replication program development, and project management; (iv) Periodic project implementation progress appraisal; (v) Support for development of training materials; and (vi) Liaison for international symposia and field research.

117. The Project Coordination Group (PCG), comprising of FECO/MEE, UNIDO and representatives from the local authorities, is responsible for making, by consensus, management decisions when guidance is required by the NPMT. PCG 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 PCG will meet once a year or as needed. Other relevant

stakeholders maybe invited to the meeting based on the designed agenda. Work plan, budget, targets and indicators will be reviewed annually as part of the internal evaluation and planning processes undertaken by UNIDO and the NPMT. The project will also adhere to the Gender Indicators and Environmental and Social Management Plan (ESMP) as proposed in Annex K and L, respectively .

118. Local Project Management Offices (PMOs) will be set up to coordinate project activities in the project sites and at the levels. Their responsibilities will include (i) management of the provincial level activities; (ii) oversight of provincial implementation; (iii) dissemination of the experience emanating from demonstration sites; (iv) coordinating activities on HBCD alternatives production; (v) coordinating activities with the EPS/XPS sectors; and (vi) collecting information and preparing progress reports. Their specific responsibilities will be defined by the NPMT supported by the PET during the inception phase.

119. Private sector stakeholders, including HBCD and EPS/XPS producers, will be engaged mainly in the demonstration and technical capacity building activities and will provide the necessary co-financing support to the project activities.

120. The Midterm Review of the project will be under the responsibility of FECO, including recruitment of consultants, as the executing partner, in coordination with UNIDO while the final Independent Evaluation will be managed by UNIDO, in coordination with its Independent Evaluation Division. The allocated budget for the project evaluation is USD 130,000, of which USD 50,000 is budgeted for the Midterm review and USD 80,000 for the Final Evaluation. As the final evaluation falls under UNIDO's responsibility, the budget for this activity will be managed by UNIDO.

121. Full or partial ownership of equipment/assets purchased under the project may be transferred to national counterparts and/or project beneficiaries during the project implementation as deemed appropriate by the government counterpart in consultation with the UNIDO Project Manager.

Coordination with other GEF-financed projects and other initiatives

122. Currently, there are 19 completed and ongoing projects in the focal of areas of POPs and Chemicals and Wastes funded by the GEF in China, within which the proposed project will coordinate by integrating the experiences and lessons learned. The outputs and results from these projects will be made an integral framework of the proposed project with regard capacity building, regulatory measures and technical support.

123. The development of the original NIP and updated NIP provides a good institutional capacity for the preparation and implementation of the proposed project with the outcomes of the UNIDO-GEF project "Building the Capacity of the People's Republic of China to Implement the Stockholm Convention on POPs and Develop a National Implementation Plan" (GEF ID 1412) and the UNIDO-GEF project “China’s Compliance with the Stockholm Convention” (GEF ID 5624). In particular, the updated NIP has also developed a preliminary inventory of HBCD in China and identified prioritized action plans to reduce and eliminate the production and usage of HBCD, which are fully integrated in the current project.

124. Legally binding policies and relevant regulation formulated by the completed and ongoing projects funded by GEF provides a good baseline for the current project. HBCD was already strategically listed in the draft updated NIP by the UNIDO-GEF project “China’s Compliance with the Stockholm Convention” (GEF ID 5624), which will be finally sent to the State Council for approval. At the same time, HBCD was included in the “Catalogue of Hazardous Chemicals ” and the “List of Products with Heavy Pollution and High Environmental Risk”. Its production, storage, use, transportation and treatment should be managed by the "Regulations on the Safety Management of Dangerous Chemicals" and other related regulatory systems. In addition, since HBCD and PFOS are both new POPs with special exemptions that where they are still produced in China, experiences on World Bank-GEF Reduction and Phase-out of PFOS in Priority Sectors (GEF Project ID 9269) could be referred to for the industrial chemical regulatory management mechanism of HBCD.

125. The completed and ongoing projects funded by the GEF will also provide a good technical base for the implementation of the current project. For instance, the technology transfer center, which was established under the UNIDO/GEF projects "Strengthening institutions, regulations and enforcement capacities for effective and efficient implementation of the National Implementation Plan (NIP) in China" (GEF ID 3263), will continuously provide service for identifying and evaluating alternatives of HBCD in the XPS and EPS sector. The cement co-processing technology, which was successfully demonstrated and validated in the UNIDO/GEF “Environmentally Sound Management and Disposal of Obsolete POPs Pesticides and Other POPs Wastes” (GEF ID 2926), will be used as a potential technology for HBCD containing waste disposal. The incineration technology and facilities built by the World Bank project “PCB Management and Disposal Demonstration” (GEF ID 2360) can be another option for the disposal of HBCD containing wastes in the current project.

126. Coordination with the project "Enhancing environmental performance in the expanded and extruded polystyrene foam industries in Turkey" (GEF ID 10082) will be ensured. As the two projects share a common objective, knowledge exchange and sharing will ensure best use of resources and experiences. Knowledge sharing through different common platforms (common trainings, conferences, discussion/consultative groups, etc) and cross participation in capacity building and awareness raising will be promoted. The project also envisages coordination with other related initiatives, such as those related to the XPS sector under the framework of the Montreal Protocol for the Protection of the Ozone Layer and the "POPs- Coordination Center Environment" project funded by the Bavaria State Ministry of the Environment and Consumer Protection.

7. Consistency with National Priorities

Describe the consistency of the project with national strategies and plans or reports and assesments under relevant conventions from below:

NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.

127. The project responds to the objectives of the China's 13th Five Year Plan, which emphasizes a cleaner and greener economy, with a strong commitment to environmental management and protection, clean energy and emissions controls, ecological protection and security and the development of green industries. It will particularly support the Government of China's priority initiatives of enhanced hazardous waste pollution prevention and control, elimination of outdated industrial equipment and processes, and improved monitoring of industrial pollution sources.

128. The project design took advantage of the updating of the NIP to ensure the consistency with the strategy and action plan for HBCD phase out and substitution. The proposed project aims at large-scale reduction of HBCD in the production, consumption, and release from the relevant industrial sectors. Thus, it is highly responsive and contributes to the GEF-7 Chemicals and Wastes Strategy' s long term goal, which is to prevent the exposure of humans and the environment to harmful chemicals and waste of global importance, including POPs, mercury, and ozone depleting substances, through a significant reduction in the production, use, consumption, and emissions/releases of those chemicals and waste.

129. This project is also relevant to the following regarding Environmental policies and law:

(i) Law of The People's Republic of China on the Promotion of Cleaner Production (2012) and the Measures for Cleaner Production Audit (2016) regulate the cleaner production audit procedures and guide local and enterprises to carry out cleaner production audit. Article 19 : in the process of technological transformation, the enterprise shall take the following cleaner production measures, use non-toxic, harmless or low toxic and low harmful raw materials to replace the toxic and harmful raw materials. Article 24: construction and decoration materials must meet the national standards. It is prohibited to produce, sell and use construction and decoration materials with toxic and harmful substances exceeding the national standards.

(ii) Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution Environment aims to protect and improve the ecological environment, prevent and control the pollution of solid waste, protect public health, maintain ecological safety, promote the construction of ecological civilization, and promote sustainable economic and social development. The bill was revised for the second time at the 17th meeting of the Standing Committee of the Thirteenth National People's Congress on April 29, 2020. Article 5: The prevention and control of environmental pollution by solid wastes adheres to the principle of responsibility for pollution. Units and individuals that produce, collect, store, transport, utilize, and dispose of solid wastes shall take measures to prevent or reduce environmental pollution caused by solid wastes. The environmental pollution caused shall bear responsibility according to law. Article 41: Units that produce industrial solid wastes shall, before termination, take pollution prevention measures for the storage and disposal facilities and sites of industrial solid wastes, and properly dispose of unprocessed industrial solid wastes to prevent pollution surroundings. Article 77: The containers and packages of hazardous wastes, as well as the facilities and places for the collection, storage, transportation, utilization, and disposal of hazardous wastes shall be provided with hazardous waste identification marks in accordance with regulations.

(iii) Law of the People's Republic of China on the Promotion of Circular Economy carries out activities of reduction, reuse and resource utilization in the process of production, circulation and consumption, promotes the development of circular economy, improves the efficiency of resource utilization, protects and improves the environment, and realizes sustainable development, which came into force on January 1, 2009. On October 26, 2018, the Circular Economy Promotion Law of the people's Republic of China was amended. Article 18: it is prohibited to produce, import and sell the equipment, materials and products listed in the elimination list.

130. The project also addresses the Technical Guidelines For Green Building Materials Evaluation (Trial)” (JK [2015] No. 162), issued by the Ministry of Housing and Urban Rural Development and the Ministry of Industry and Information Technology, in which the relevant requirements for control items and scoring items were put forward. In the emission reduction index, the requirements of "No use of HCFC foaming agent and HBCD flame retardant" are especially put forward, which were the relevant requirements on HBCD in the technical documents of the construction industry.

8. Knowledge Management

Elaborate the "Knowledge Management Approach" for the project, including a budget, key deliverables and a timeline, and explain how it will contribute to the project's overall impact.

131. Knowledge management is a central piece in this initiative, which will be canalized through the establishment of a knowledge hub in China, whose major task will be to compile and assess information on the current use of HBCD-based flame retardants in the XPS and EPS sectors and on the existing alternatives. More possibly, the knowledge hub can be built upon existing institutions, which have already accumulated considerable amount of experience and expertise with previous focus on other POPs. These institutions can act as the leading organizers in the formation of such knowledge hub. Their academic nature will also serve to promote active exchange of knowledge with international researchers.

132. International organizations, including UNIDO, can also make unique contributions with its experience on the development and implementation of similar initiatives and programmes. Currently, UNIDO will also be implementing a GEF project (GEF 10082) on "Enhancing environmental performance in the expanded and extruded polystyrene foam industries in Turkey" where close coordination is to be undertaken, similar with future projects that maybe developed with relevant countries. Knowledge sharing through different common platforms (common trainings, conferences, discussion/consultative groups, etc) and cross participation in capacity building will be promoted. The project also foresees partnership with the Stockholm Convention Secretariat and the Basel and Stockholm Conventions Regional Centre in China ((BCRC-SCRC China), fully utilizing available resources including the clearinghouse mechanism for global and regional information dissemination. Conference papers and side events maybe organized during Conference of Parties to allow global information sharing.

133. A project website will be hosted by MEE - FECO where project updates and results will be shared. The project will organize international workshops and conferences to allow the presentation and sharing of project results. Technical reports, scientific papers, video materials, and relevant informative documents will be generated and shared containing relevant data and information on the project results. An active exchange of data and information among research institutions, administrations, and relevant stakeholders is beneficial for scientific research and the development of sound HBCD management strategy. A large repository can be constructed and attached to the planned website or knowledge hub to serve this purpose. This will ultimately allow a proper extraction of lessons learned and best practices that could be beneficial to other countries as well.

134. The partnership of UNIDO and FECO with the Bavaria Environment Agency is significant in the establishment of a knowledge sharing mechanism. As one of the outputs of the partnership, an online seminar on policy and waste management of HBCD-containing EPS/XPS with inputs from the German Environmental Ministry and German EPA will be conducted, inviting participants from target countries. Another seminar on alternatives to HBCD in EPS/XPS organized by UNIDO with speakers from the relevant private sectors/industry will be opened for a wider audience. The knowledge sharing, to be conducted online and physically (as appropriate), is foreseen to continue during project implementation.

135. A knowledge map (Figure 9) which shows who has what knowledge, where our knowledge resides, and how it is transferred or disseminated will allow people and organizations involved in the project to identify more easily the expertise and technology produced in the progress promoting the development and application of BAT/BEP.

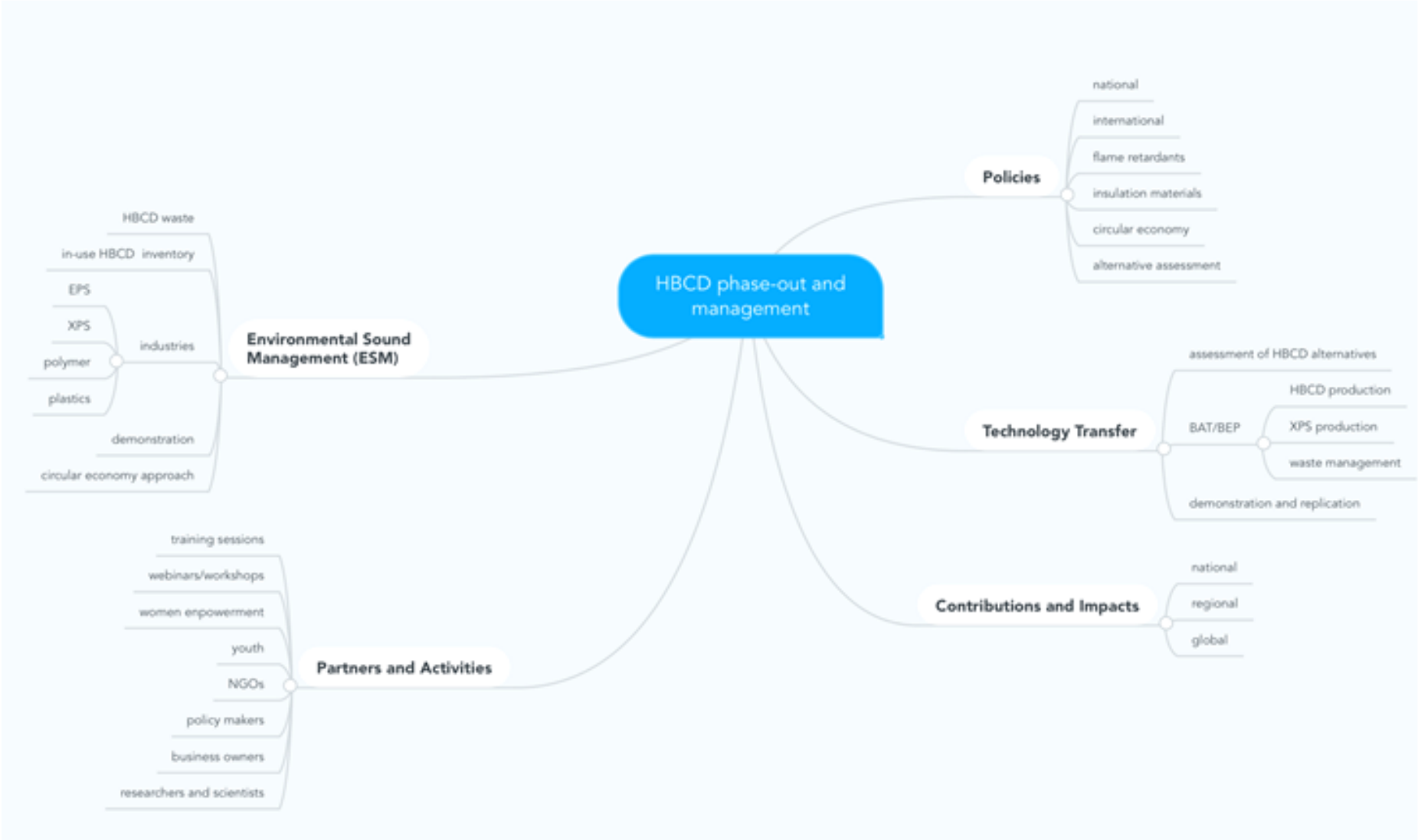

Figure 9 Knowledge map of the project

136. The center of the knowledge map is HBCD phase-out and management in China, which is the key goal of the project. To achieve this, the first knowledge category is the policies developed in the component 1. These include national and international policies on flame retardants, insulating materials, circular economy and alternative assessment. The second knowledge category is the technology transfer developed in the Components 2 and 3. Under technology transfer, there are three subcategories: assessment of HBCD alternatives, BAT/BEP, demonstration and replication, in which BAT/BEP is proposed for HBCD

production, EPS/XPS production and waste management. The third knowledge category is the Environmental Sound Management (ESM) developed under Component 3. HBCD waste, in-use HBCD inventory, industries, demonstration, circular economy approach are all included in this category. For ESM in the industries, EPS, XPS, polymer and plastics are classified as subcategories.

137. During the implementation of the project, several partners participate in a series of activities, which constitute the fourth category of knowledge map. These activities include training sessions, webinars, conferences and workshops, while the partners include relevant stakeholders - women, youth, NGOs, policy makers, business owners, researchers and scientists. The last category of the knowledge map is the contributions and impacts of the project which will be shared through the clearing house of the SC Secretariat and the BCRC-SCRC China, among other channels. Through the implementation of the project, the production, usage, export and import of HBCD will be banned by December 2021, and HBCD alternatives will be used in the EPS / XPS sectors delivering significant contributions and impacts on the environment, economy and the society, as a whole at the national, regional and even global levels.

9. Monitoring and Evaluation

Describe the budgeted M and E plan

138. An effective monitoring and evaluation process of project impact and sustainability will be designed and implemented, including setting a periodic review process to monitor the quality and the state of progress of the project. The main purpose of the M&E program will be to measure and document implementation progress towards outcomes and objectives according to verifiable indicators and related means of verification. Evaluation of performances will assist in monitoring effectiveness and results, identifying underperforming activities and suggesting remediating actions, monitoring project risks and flagging project risks early on, refining further work in order to ensure a coherent, coordinated and timely achievement of project objectives in accordance with the project results framework. At the same time, it will support the communication and coordination mechanism of the project network, the compilation of lesson learned from the project and the dissemination to the primary stakeholders as well as the international community of the knowledge and experience acquired during the project lifetime. Gender issues and environmental and social safeguards will be fully integrated in the monitoring and evaluation of the project.

The Monitoring and Evaluation (M&E) Work Plan and Estimated Associated Budget are presented below:

Table 12 Monitoring and evaluation budget

M&E activity	Responsible Parties	Indicative costs to be charged to the Project budget (USD)		Time frame
		GEF grant	Co-financing	
Design and implementation of M&E system	PMT in consultation with other project partners	0	20,000	Within the first six months
Monitoring indicators and project progress, including ESMP and gender	PMT,UNIDO, local and international consultants as needed	50,000	80,000	Regularly, with an annual review prior to the finalization of APR/PIR
Visits to demo sites to monitor progress and assess delivery of services	PMT, local and international consultants as needed	50,000	200,000	As required, minimum once a year.
Annual Project Reporting	PMT, local and international consultants as needed	0	50,000	Annually
Annual work-plans on planned project activities and outputs	PMT in consultation with other project partners	0	50,000	Annually, on the basis of APR/PIR outputs
Independent mid-term review (external) and project response	UNIDO, PCG, PMT, independent external evaluators.	50,000	80,000	Midpoint of project implementation
Independent final evaluation (external) and management response	UNIDO, PCG, PMT, independent external evaluators.	80,000	100,000	At least two months before end of project
Knowledge management (technical reports, lessons learned, dissemination activities, etc.)	PMT in consultation with other project partners	70,000	500,000	As appropriate
Total indicative cost		**300,000**	**1,080,000**	

139. According to the Monitoring and Evaluation policy of the GEF and UNIDO, follow-up studies including Country Portfolio Evaluations and Thematic Evaluations can be initiated and conducted. All project partners and contractors are obliged to (i) make available studies, reports and other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities.

140. The project results, based on the agreed logical framework, will be monitored annually and evaluated periodically during project implementation as part of the planning processes undertaken by the project team in accordance with established GEF and UNIDO monitoring and evaluation procedures. The evidence of outputs such as the number of participants in training activities, the release of reports and manuals, site visits at demonstration facilities, etc. will confirm the congruence of outcomes and objectives.

141. Day to day monitoring of project execution progress will be performed by the project team according to the work plan and identified indicators reported in the project's Annual Work Plan. The Project Team will inform UNIDO of any delays or difficulties faced during execution so that the appropriate support or corrective measures can be adopted in a timely manner. Periodic monitoring will be performed through site visits at the project demonstration facilities by UNIDO, the PMT and other members of the PCG wishing to join these visits. A field visit report will be prepared to ensure adherence to the agreed work plan.

142. Annual monitoring will be done through PCG meetings which will take place once a year with a UNIDO representative present. The PMT may also organize PCG meetings, as required. The first of such meetings will be held within 12 months of the start of full project implementation or as agreed during the Inception Meeting. The final evaluation will be performed at the end of project life and will consider the implementation of the project as a whole, paying attention to whether the project has achieved its stated objectives and contributed to the global environmental objective.

Reportorial Requirements

Regular reporting of the achievement of the project objectives and activities forms part of the monitoring and evaluation process. During project lifetime, the project team in conjunction with the PCG members and UNIDO will prepare and submit the following reports:

143. Inception Report (IR)

An Inception Workshop (IW) will be held within the first 3 months of project start. The IW will serve as the official launch of the project to and to provide relevant stakeholders and project partners of the overview of the project, the the first year Annual Work Plan (AWP) including appropriate indicators and related means of measuring performance. A detailed schedule of project review meetings and related M&E requirements and reporting activities, including the scheduling of the mid-term review and final evaluation, will also be developed during the IW. Subsequent meetings of the PCG will be planned and scheduled, too. The first PCG meeting should be held within the first 12 months following the IW. As an overall objective, the meeting will provide an opportunity to all partners to better understand and assimilate the goals and objectives of the project and take ownership of the project.

A Project Inception Report (IR) will be prepared at the beginning of project implementation and immediately following the Project Inception Workshop (IW). It will include: (i) a detailed Annual Work Plan (AWP) for the activities of the first year of the project; (ii) a fine-tuning of verifiable indicators and corresponding means of verification to effectively measure project performance during the targeted 12-month timeframe of the AWP; (iii) a detailed project budget for the first year of implementation, prepared on the basis of the AWP. The Inception Report has to be prepared by FECO and agreed with UNIDO.

144. Project Implementation Report (PIR)

The Project Implementation Report (PIR) is an annual management and monitoring process. It is an essential 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 annual PIR is the main tool used by the GEF for monitoring its portfolio and reviews financial status, procurement data, impact achievement and progress in implementation. Final PIR will be submitted to GEF as per standard procedures.

145. Project Terminal Report

During the last three months, the project management unit will prepare the Project Terminal Report (PTR), which will be the last PIR. It will be a comprehensive report summarizing the results achieved, areas where results may not have been achieved and lessons learned. The Project Terminal Report and the final evaluation (FE) report will form the final project documentation package to be discussed with the PCG during the Terminal Project Workshop.

The Terminal Project Workshop will be held in the last month of project implementation. The TPW will be aimed at assessing the implementation of the project as a whole and if it has achieved its stated objectives and contributed to the broader environmental objective. Particular focus will be given to lesson learned and opportunity for sustainability and replicability of the project's results.

The Project Terminal Report (PTR) will be the definitive statement of the Project's achievements. This comprehensive report will be the overall evaluation of the project and will summarize all activities, outputs and outcomes of the Project, objectives met (or not met), structures and systems implemented, etc., paying particular attention to whether the project has achieved its immediate objectives and contributed to the global environmental objective. It will also serve as a source of lessons learned and will lays out recommendations for follow-up activities that may need to be taken to ensure sustainability and replicability of the Project's activities. The project team will prepare the PTR during the last three months of the project lifetime. It shall be prepared in draft sufficiently in advance to allow review and technical clearance prior to the final PCG meeting.

146. Thematic Reports

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.

147. Technical Reports

Technical Reports are detailed, comprehensive documents covering specific areas of research within the framework of the overall project. The key areas where Technical Reports are expected to be prepared during the course of the Project will be individuated during annual PCG meetings. Technical Reports may also be prepared by external consultants and will be used as working documents for the Project implementation as well as to disseminate relevant information at local, national and international levels.

148. Project Publications

Project Publications in the form of articles in academic and peer-reviewed journals, multimedia publications, informational texts or other forms of distribution, will represent a method for a widely dissemination of relevant results and achievements of the Project. Publications can be based on Technical Reports, or may be summaries or compilations of a series of Technical Reports and other research. The project team will determine if Technical Reports merit formal publication, and will also (in consultation with UNIDO, the governments and other relevant stakeholder groups) plan and produce these Publications in a consistent and recognizable format. Publications setting out methodologies adopted in this project, achieved results and lessons learnt will be distributed to the industry, governments, Parties to the Convention. Any publication will observe UNIDO and GEF advocacy guidelines.

Independent Evaluations

149. Midterm Review

The mid-term review (MTR) will be undertaken at mid-term (between the second and third year of project implementation) by an independent consultant to review the progress of each project activity and assess effectiveness of implementation according to the project's indicators presented in the Project Results Framework. The Terms of Reference for this mid-term review will be prepared jointly by FECO and UNIDO.

The MTR will assess the effectiveness, efficacy and timeless of project execution, evaluate the effectiveness of the Partnership composition and of the interaction between partners, identify potential issues which could prevent optimal development of the project. This assessment will be extended to the administrative aspects and will also consider the provision of financial resources and co-financing provided by the project partners. The MTR findings could propose recommendations and remedial actions to be incorporated as improvement in the implementation strategy and execution for the remainder of the project's duration, if necessary. This review will also highlight initial technical achievements, achievement of GEBs and lessons learned derived from project implementation. The final MTR report will be reviewed by UNIDO and presented to the PCG.

150. Final Evaluation

The final evaluation (FE) is under the responsibility of UNIDO and will, ideally, begin three months before the completion of the project and after the end of the main planned project activities. This will allow the independent consultant to carry out the evaluation when major activities are already completed but with the project team still in charge. The final evaluation will focus on the same issues as the mid-term evaluation. However, since all the planned project activities set-out in the Project Results Framework will be completed at the start of the evaluation, a greater focus on identifying and extracting project impacts including the contribution in building local capacity, the achievement of global environmental goals, lesson learned, sustainability and replicability of project results will be reserved. This evaluation will be performed on the basis of the delivery of the project's results as initially planned, eventually as corrected after the mid-term evaluation, if any such correction took place. The FE will also provide recommendations on how to disseminate products and outputs of the project most efficiently within and outside the country. The Terms of Reference for this evaluation will be prepared by UNIDO in accordance with the generic TORs developed by its Independent Evaluation Division. The PMT and other stakeholders will be involved and consulted during the terminal evaluation process.

151. Legal Context

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.

10. Benefits

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

152. This project's socioeconomic benefits pertain multiple aspects, contributing to a) a more sustainable development of the flame retardants industry in China, b) the overall well-being of Chinese residents, as well as c) an improved gender equality situation within relevant companies and local community. On the national level, this project can first and foremost assist with the restructuring of the flame retardants industry. By working closely with existing HBCD and EPS/XPS manufacturing companies, this project will strongly incentivize and encourage existing companies to shift to produce and use HBCD alternative in their production. This contributes to a sustained ability to produce flame retardants within China, by companies that already have production lines and production abilities in place, minimizing the impacts of a complete HBCD phase-out on Chinese industries. Consequently, the industrial sectors such as HBCD, EPS and XPS and related construction industries will get sustained and potential development.

153. In addition to a sustained development of the flame retardants industry, this project can also contribute to the overall well-being of Chinese residents. By encouraging companies to produce POPs-free flame retardants, this project can help reduce significantly Chinese citizens' chances of HBCD exposure. Flame retardants such as EPS and XPS are widely used in office and residential buildings as insulation materials. By incentivizing existing companies in this business to produce HBCD-free insulation materials, this project also promotes the overall health and well-being of Chinese residents, due to the potential, chronological health hazards of HBCD on human's health. Besides, as an integral part of this project, activities aimed to raise awareness of the health hazards of HBCD and POPs in general will also better inform the general public about common knowledge of persistent organic pollutants, which in turn shapes their attitudes and consumption behaviors towards products that contain POPs.

154. On a local level, this project improves gender equality within companies and local communities. This project adopts the gender mainstreaming strategy to take into considerations of both men and women's experiences, concerns, and needs. Setting targets for improving female participation in training in this project, as well as the enlargement of female participation in decision making, this project contributes to an improved condition of gender equality within existing companies. Furthermore, working to keep existing companies in business is also to some extent a cause of welfare for local communities. This is because our field research shows that most female workers in existing HBCD and EPS/XPS companies are from relatively lower social standings and are more vulnerable towards changes in employment prospects, working for these companies is a means to socially empower them.

155. Seen together, this project supports the achievement of global environment benefits in the following ways. Globally, China is the largest HBCD producing country and one of the largest producing countries of EPS and XPS. This project will hence ensure a sustained supply of POPs-free flame retardants globally. Hence, this project not only helps contribute to the overall HBCD emission reduction in China, but also to a global POPs emission reduction. By working with existing companies that either produce HBCD alternatives (which make up the crucial raw materials of flame retardants) or use these alternatives in their production of EPS and XPS, this project also ensures the availability of adequate insulation materials for office and residential buildings that are free of POPs. Consequently, it helps to contribute to energy saving nationally and globally.

11. Environmental and Social Safeguard (ESS) Risks

Provide information on the identified environmental and social risks and potential impacts associated with the project/program based on your organization's ESS systems and procedures

Overall Project/Program Risk Classification*

PIF	CEO Endorsement/Approval	MTR	TE
	Medium/Moderate		

Measures to address identified risks and impacts

Elaborate on the types and risk classifications/ratings of any identified environmental and social risks and impacts (considering the GEF ESS Minimum Standards) and any measures undertaken as well as planned management measures to address these risks during implementation.

The identified risks and impacts of the projects and the management measures to address the risks are provided in detail in the attached Annex L Environmental and Social Management Plan (ESMP).

Supporting Documents

Upload available ESS supporting documents.

Title	Module	Submitted
ANNEX L (ESMP) CHINA HBCD	CEO Endorsement ESS	

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).

The project results framework is provided as Annex A in the attached documents.

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).

A. STAP comments at PIF on the December 2018 Work Program

Comments	Response
Component 3 on the implementation of environmentally-sound management of EPS/XPS. According to Para 42, BAT/BEP measures will be identified, implemented and demonstrated including assessing the possibility of a circular economy approach for bromine recovery and EPS/XPS recovery. STAP welcomes this idea and recommends that circular economy solutions should be prioritized. Research is showing the possibility of chemical recycling of EPS/XPS (for example: Schlummer et al. 2017: DOI:10.4172/2475-7675.1000131; Siyal et al., 2013: http://dx.doi.org/10.1155/2013/842435; Garcia et al. 2009: doi:10.1016/j.wasman.2009.01.001; Hearon et al., 2014: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4000729/; Garcia et al. 2009: DOI:10.1007/s10163-008-0210-8). STAP suggests that this research should be explored to identify possible BAT/BET for the project.	The project proponents have taken note of the STAP comment and has considered the recycling of EPS/XPS for circular economy and referenced to the suggested studies. Please refer to Paragraph 62 Output 3.1.3 which envisages circular economy approaches for BAT/BEP options. In Component 3 of the project, different practical technologies for bromine and EPS/XPS recovery will be assessed. A study visit to the PolyStyrene Loop plant currently under construction in the Netherlands is also planned.
STAP requests that the GEBs expected from the project should be clarified at the PPG stage. There are discrepancies between the numbers reported in the section on core indicators and Section 6 on global environmental benefits and/or adaptation benefits, i.e., para 53 -58. For example, while the quantity of POPs/mercury-containing materials and products directly avoided is stated as 10,800.00 metric tons in the core indicator section, para 45 in Section 6 indicates that 1.22 million metric tons are estimated to be avoided/reduced annually. There are similar issues in the estimated tons of HBCD, HCFC-22 and CO2eq to be avoided/reduced	The GEBs attained from the project have been clarified and recalculated the GEBs for the whole project duration. The calculation of the GEBs are presented in Section 6) Global environmental benefits. The estimation is made based on the direct contribution of the project during its lifetime. The project proponent also attempted to estimate the amount of HBCD-containing materials avoided from the EPS/XPS sector due to the phase out of HBCD. These were not reported in the core indicator to avoid double accounting of the GEB as it is presumed that the amount of HBCD produced is consumed by the foam producers.
STAP recommends that the estimated climate benefits be recalculated using the correct global warming potential (GWP) of HCFC-22.	The climate benefits have been recalculated with the correct global warming potential (GWP) of HCFC = 1810. Please see Paragraph 81 in Section 6 Global Environmental Benefits.

B. Council Members' comments (Germany) posted on April 2020

Germany welcomes this project, which aims to contribute to the phase out of HBCD and introduce alternatives to the chemical in the production of XPS/EPS foams. At the same time, Germany has the following comments that it suggests be addressed in the next phase of finalizing the project proposal:

Comments	Response
In the risk section of the proposal, Germany recommends to identify barriers to participation in project activities by Chinese chemical and foam producers, and devise associated measures to overcome these barriers. Potential barriers include: 1) Substitution by BEP options (most environmentally sound solutions) might not be economically feasible for a large part of Chinese producers. Awaiting bans to enter into force and/or choosing the most affordable substitute is the most likely solution for the major part of chemical factories; 2) Producers are willing to change their production processes only, if a reasonable business cases and commitments for concrete purchase volumes of HBCD free foams are available; 3) Enforcement of environmental laws in China is very strict and sanctions up to factory shutdowns or being 'red listed' for future inspections are known. Sharing information on handling critical materials can be limited due to fears of sanctions	The risk table has been updated to reflect the potentials risks, barriers identified by Germany and mitigation measures have also been proposed. It is acknowledged that the participation of HBCD producers and consumers are very important in the success of the project. Engagement of the HBCD and foam producers was done from the inception of the project and they have been fully consulted during the project development to raise their awareness and secure their commitment to the project objectives. These stakeholders also prominently figures in the Stakeholder Engagement Plan devised for the project as presented in Annex J on Stakeholders Engagement Plan. On the other hand, the private sector recognizes that the project presented a very sound opportunity for incremental support incentivizing their participation. Thus, it is envisaged that a good private sector involvement will be seen during the project implementation.
Germany would highly suggest to provide additional information on whether HBCD BAT/BEP alternatives represent the selection of the best alternatives available in Component 2, and not only 'less critical' alternatives, thus evading future contamination and health problems	This was addressed by including the establishment of an alternative assessment framework on governmental institution level and assess alternatives to HBCD in Component 1 and alternative materials for EPS/XPS in Component 2. A scientific assessment of alternatives that will not present future harm will be ensured. Please see elaborated activity in paragraph 60 Output 1.1.3 Framework for governmental alternative assessment established and flame retardant alternatives for HBCD and alternative insulation materials for HBCD-containing EPS/XPS foams evaluated.
Regarding component 4, Germany suggests including trainings and awareness building for Personal Protective Equipment (PPE) in the final proposal. Standard test methods for respiratory sensitization and test data are often not sufficiently available for alternative flame retardants	This was addressed in environmental and social management Plan (ESMP) according to Chinese law and regulations in regard with safety procedures and assessment. Enterprises shall abide by the national regulations in PPE to participate in the project. Please see Annex L on Environmental and Social Management Plan.

ANNEX C: Status of Utilization of Project Preparation Grant (PPG). (Provide detailed funding amount of the PPG activities financing status in the table below:

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

PPG Grant Approved at PIF: **USD 150,000**			
Project Preparation Activities Implemented	*GETF/LDCF/SCCF/CBIT Amount ($)*		
	Budgeted Amount	*Amount Spent To date*	*Amount Committed*
Meetings and workshops (inception meeting, focus group discussions, coordination meeting, consultative workshops, validation workshops)	30,000	9,791	20,209
Baseline data collection and analysis (visit to facilities, exchange visit, preliminary analysis and experts' mission)	170,000	114,910	55,090
Preparation of environmental and social management framework, stakeholder engagement plan and gender study	70,000	61,947	8,053
Development of the logical framework and project document	30,000	23,878	6,122
Total	**300,000**	**210,526**	**89,474**

If at CEO Endorsement, the PPG activities have not been completed and there is a balance of unspent fund, Agencies can continue to undertake exclusively preparation activities up to one year of CEO Endorsement/approval date. No later than one year from CEOendorsement/approval date, Agencies should 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/CBIT Trust Funds or to your Agency (and/or revolving fund that will be set up)

Not applicable.

ANNEX E: Project Map(s) and Coordinates

Please attach the geographical location of the project area, if possible.

The geographical location of the project areas is provided below. The project demonstration facilities are mainly located in Shandong and Jiangsu provinces.

ANNEX F: Project Budget Table

Please attach a project budget table.