



United Nations Development Programme
Country: CHINA
PROJECT DOCUMENT¹

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

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

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

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

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

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

Brief Description

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

| | | | |
|-------------------------|-------------|----------------------------|----------------|
| Programme Period: | 4 year | Total resources required | USD 61,733,560 |
| Atlas Award ID: | 00086819 | Total allocated resources: | |
| Project ID: | 00094022 | • Regular | |
| PIMS # | 5349 | • Other: | |
| Start date: | Oct. 2015 | ○ GEF | USD 8,233,560 |
| End Date | Oct. 2019 | ○ Government | USD 15,033,300 |
| Management Arrangements | NEX | ○ In-kind | USD 2,566,700 |
| PAC Meeting Date | May 8, 2015 | ○ Other | USD 35,500,000 |
| | | ○ UNDP | USD 400,000 |

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

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List of Acronyms

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

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

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

1. SITUATION ANALYSIS

1.1. Context and Global Significance

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

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

Exhibit 1-1: China's Global Rank in Energy Consumption/Production and CO₂ Emissions⁴

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

**Exhibit 1-2: Air Pollution Data, 2013: Chinese Cities Ranked by PM 2.5 Level in µg per m³
Numbers are annual averages; national standard for annual average is <35 µg per m³⁵**

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

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

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

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

⁴ Source: EIA statistics

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

though indoor heating for buildings is also a major contributing factor in North China. According to analysis of data from China’s Ministry of Environmental Protection, PM 2.5 (small particulates considered an important indicator in terms of health impacts of air pollution) levels in many cities far exceed the standard of 35 µg per m³ set by the GoC in 2012 (see Exhibit 1-2).⁶ Reflecting the severity of the situation, in 2014, Chinese Premier Li Keqiang stated that China will “declare a war on air pollution.” Among the key targets in this “war” is managing vehicle emissions.

3. China’s transport sector plays a significant and growing role in China’s overall energy use. Experts indicate that the transport sector now accounts for 10 to 15 percent of China’s final energy consumption.⁷ They expect that share to rise to 30 percent as urbanization levels stabilize. Indeed, comparisons to transport’s share in the energy consumption mix of developed countries, such as the US (almost 40 percent) and Japan (around 25 percent), suggest an increasing role for transport in China’s growing energy consumption.
4. China is the second-largest consumer of oil in the world after the US and, as of 2014, became the world’s largest oil importer.⁸ Exhibit 1-3 below provides data on China’s oil consumption, production, and net imports. Net imports grew at a compound annual growth rate of about 10 percent between 2009 and 2013. About 60 percent of China’s oil consumption was used in the transport sector, which over time has been accounting for a growing share of overall oil use, while industry’s share has been diminishing. Increasing oil imports have raised GoC concerns about energy security. These concerns, along with air quality and GHG emissions issues, have stimulated great interest in alternative energy vehicles.

Exhibit 1-3: China’s Daily Oil Consumption, Production, and Imports, million barrels⁹

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

5. Indeed, forecasts indicate China’s oil consumption along with its dependency on oil imports will grow substantially over the next 20 years. According to one forecast, energy consumed for transport in China will almost double between 2015 and 2035. Along with it, oil imports will grow from roughly 6 million barrels per day in 2013 to 13 million barrels per day in 2035. If this occurs, China will at that time depend on imports for 75 percent of its oil consumption, as compared to 60 percent in 2013.¹⁰ It is clear that the transport sector is a major driver of these trends. MIIT has indicated that new vehicle sales account for 70 percent of growth in China’s annual gasoline and diesel consumption.¹¹
6. Comparisons of China’s motor vehicle fleet size (total number and type of motor vehicles on the road) to that of other countries is difficult due to differences in categorization. Yet, China’s fleet

⁶ The standard is currently applicable in some major cities, such as Beijing, and will be applied across all cities in 2016.

⁷ Hailin Wang, Xi Yang, and Xunmin Ou, “A Study on Future Energy Consumption and Carbon Emissions of China’s Transportation Sector,” in *Low Carbon Economy*, 2014.

⁸ Source: EIA.

⁹ Source: EIA International Energy Statistics

¹⁰ British Petroleum, *BP Energy Outlook 2035 – Country Insights: China* (2015)

¹¹ State Council Development Research Information Network, 2013, as quoted in Sabrina Howell et al “Leapfrogging or Stalling Out,” 2014, Faculty Research Paper Harvard JFK School of Government.

appears to be second only to the US in size and is growing rapidly. According to the Ministry of Public Security, in 2013 China had 154 million registered autos and a total of about 260 million registered vehicles, including 3-wheelers, motorcycles, buses, and large trucks. For comparison, according to the US Department of Transportation, there were about 254 million registered vehicles in the US in 2012, including about 233 million autos or light duty trucks. Rapid growth in China’s auto market has launched the nation to the top spot in annual auto sales, for which it first surpassed the US in 2009. Sales growth has been rapid, with an 18.1 percent compound annual growth rate (CAGR) between 2005 and 2012. While this is expected to slow during 2012 to 2020, with some slowing already apparent, growth will still be substantial (e.g. 6 percent) out to 2020.¹² Exhibit 1-4 provides data on annual auto sales in China.

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

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

Alternative Energy Vehicles

- The issues cited above, namely energy security, urban air pollution, and global warming, along with an interest in developing high value-add industry, has led the GoC to promote new energy vehicles (hybrid, plug-in hybrid, battery electric, and fuel cell vehicles) and other clean energy vehicles (namely, CNG, LNG, and LPG vehicles). In terms of developing a high value-add industry, the rationale is that NEVs are an area in which Chinese manufacturers have the potential to rise to prominence, as compared to internal combustion vehicles, in which it is hard to compete with entrenched global players. China began concerted R&D and demonstration work on new energy vehicles (NEVs) in the 1990s. In 2009, MOF and MOST launched a new demonstration and promotion program known as *Thousands of Vehicles Tens of Cities* (“Cities Program”) to promote NEVs on a larger scale. The program focuses on demonstration via public sector vehicles such as buses, taxis, and postal and sanitation vehicles. MOF and MOST began the program with 13 Tier I cities. In 2010, MIIT and NDRC joined the effort, adding seven Tier II cities and 5 Tier III cities for a total of 25 cities.¹⁴ In 2010, these 25 cities accounted for 18 percent of China’s population and 33 percent of its vehicle stock.¹⁵ In 2013, the group of 25 cities was expanded to include 40 “promotion regions”, including a total of 86 cities.
- As a result of the *Cities Program* and incentives for NEV promotion, a significant number of NEVs are in operation on China’s roads, though numbers are far below government targets. The total number of NEVs on the road in China is estimated to be 160,000 (as of end of the first half of 2014), with an annual growth rate in sales of around 100 percent (see Exhibit 1-5 for cumulative total on an annual basis). China targets to have five million NEVs on the road by 2020. Data shows China lagging in NEV auto sales to countries such as the US and Japan, though China leads the world in new NEV buses being deployed annually. China’s numbers of electric buses are ramping up rapidly.¹⁶ This phenomenon (relatively fast penetration of EVs in public buses, low penetration in consumer auto purchases) reflects the government-driven nature to date

¹² Accenture, *China’s Automotive Market*, 2013.

¹³ Op. cit., Accenture; Bloomberg.

¹⁴ In China, Tier I cities are the largest, most densely populated, such as Shanghai, Beijing, Guangzhou, Shenzhen, and Tianjin. Tier II cities are generally made up of provincial capitals and similarly developed cities, where incomes are somewhat lower than in Tier I cities. Tier III cities generally have a lower administrative rank than Tier II cities, are smaller, and have yet lower incomes.

¹⁵ Huiming Gong, Michael Q. Wang, and Hewu Wang, “New Energy Vehicles in China: Policies, Demonstrations and Progress,” in *Mitigation and Adaptation Strategy and Global Change*, Jan. 2012.

¹⁶ *South China Morning Post* on July 15, 2014 offered the following comparative data for NEV auto sales for 2013: US: 110,000, Japan: 50,000, and China: 17,600.

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

Exhibit 1-5: Cumulative Total of New Energy Vehicles on the Road in China¹⁷

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

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

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

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

Fuel Cell Vehicles

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

¹⁷ Tsinghua University *New Energy Vehicle Database*

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

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

11. To date, China's efforts in showcasing and testing FCVs have been on a non-continuous basis, driven by either events or a short-term testing approach. Of particular note, during the Beijing Olympics in 2008, three fuel cell buses and 20 fuel cell cars were demonstrated. Also noteworthy, during the six-month long Shanghai Expo in 2010, 196 FCVs were demonstrated, constituting the largest field trial of fuel cell vehicles in the world to date.¹⁹ In addition, a previous GEF funded project in China, *Demonstration for Fuel-Cell Bus Commercialization in China (Phase I and Phase II)*, sought to showcase the application of fuel cell bus technology in the public bus transport systems of Beijing and Shanghai.²⁰ Important lessons learned from this earlier project, particularly on the logistical and administrative requirements of the implementation of the demonstrations, are taken into account in design of the current project and discussed later in this document. While long-term use of the prior project's vehicles as intended was not achieved, field testing, including the aforementioned achievements at the Olympics and the Expo, was conducted and expanded the knowledge and experience base of Chinese experts and institutions working in the fuel cell vehicle field.
12. At present, a handful of Chinese manufacturers are gearing up to participate with fuel cell vehicles in opportunities presented by the *Cities Program*. Manufacturers with notable FCV programs include SAIC, Yutong, and Foton. Others are exploring launching such programs to serve interested customers (municipalities considering purchase of fuel cell buses). In some cases, manufacturers are supported by expert teams in academia. In particular, Tsinghua University and Tongji University are known for their work in fuel cell vehicles and ability to assist manufactures with the needed power train.
13. Given the track record of past efforts, FCV cost and durability issues, and the very limited number of FCVs manufactured to date in China, the general motivation behind this project warrants further explanation. Reviews of the previous GEF-funded project emphasize the technology's lack of maturity as a barrier to that project's success. Yet, a major change from the previous project is that, since that time, international advancement in fuel cell vehicles has reached a turning point providing strong motivation for this project. International efforts in setting up hydrogen refueling infrastructure have correspondingly begun to ramp up. Fuel cell autos for the first time in history have been released on a limited commercial basis, including Hyundai's Tucson in 2013, Toyota's Mirai in December 2014, and Honda's FCV, expected in 2015. In addition, Toyota in January 2015 announced it will make over 5,600 patents available through 2020 to interested car and part makers. Non-OEM manufacturers of fuel cell engines, such as Ballard and Hydrogenics, have also released high durability, commercial-grade products. Other countries, such as Japan, the US, Germany, and South Korea have launched ambitious fuel cell vehicle development programs and made marked progress in initiating ramp up of hydrogen infrastructure. Exhibit 1-7 below shows number of hydrogen refueling stations reported as already operational, as well as future targets, for these countries.

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

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

Exhibit 1-7: Hydrogen Refueling Stations Operational and Targeted, by Country²¹

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

14. Pursuit of FCV commercialization for China in this project is also motivated by the potential benefits of pursuing a diversified NEV strategy. As it is unclear what future technology developments will bring, China is interested in diversifying its risk and potential benefit by pursuing both EVs and FCVs; and this project will be a key link in such a diversification strategy. Looking at potential progress in cost reduction, the *IPCC Mitigation Report* has pointed out that by 2030, EVs will still be relatively costly without major breakthroughs. EVs have come a long way down the cost reduction learning curve. They are being sold in volume and have been for several years. While there will likely be some improvements in battery cost, there is much less room for reduction in EV costs than is the case with the costs of FCVs, which to date have only been developed in prototype quantities. In addition, FC stack costs include many immature components, such as MEA and catalyst. There is also a lot of room for cost improvements with these.
15. Indeed, credible studies have determined that the long-term high-volume cost of fuel cell vehicles will be lower than that of battery electric vehicles.²² Further reduction in battery cost is limited by physics/chemistry and the fact that batteries are already manufactured in high volumes (commercial batteries for computers, etc.). Elon Musk’s Giga-scale factory will reduce costs via economies of scale, but this reduction is not expected to surpass 20 percent. There have been several reports of major technological breakthroughs in batteries (via different chemistry) by universities, but none have been substantiated in commercial applications. In contrast, FCVs have the potential for cost reduction via: (1) technological advancements without the need for breakthroughs (because they are a less mature technology), (2) high volume manufacturing (i.e. economies of scale), and (3) development of a supply landscape. Economies of scale alone are expected to reduce cost/kW of the fuel cell stack by a factor of five or more.
16. Diversification that includes concerted efforts in both EVs and FCVs makes sense for China for additional reasons. EVs and FCVs have different strengths and weaknesses to consider. While FCVs present the current challenge of hydrogen availability, they also present several advantages over EVs. The first of these is range. Projected range of FCV buses (between refueling events) is in the 250 km range, as compared to the 100 km-plus range for EV buses. In addition, recharging of EVs can be a slow process, as compared to hydrogen refueling, which can occur quickly, just like gasoline refueling. For a busy bus to stop midday for a long recharging session can be problematic to operations.
17. Another issue with EVs is that of the battery wearing out. Particularly in the case of EV buses, where driving patterns mean that the battery will be drawn down to a relatively low level between recharging events, the lifetime of the battery may be much less than that of the vehicle. FC buses of the series hybrid type (which run off a battery recharged by the fuel cell rather than directly off the fuel cell) do have a battery, but it is never drawn down much, so battery replacement will not

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

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

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

18. Lastly, in the case of China, the vast majority of EV recharging uses electricity made from coal and thus is "high carbon." In contrast, the majority of hydrogen that will be used in the near-term for FCVs in China is likely to be by-product hydrogen and hydrogen produced from natural gas reforming. FCVs powered by a mix of these types of hydrogen have substantially smaller carbon footprints than EVs powered by coal-based electricity from the grid.
19. A further area of motivation for this project is the opportunity to leverage China's comparative advantages in combination with international advancements in fuel cell technology to drive the FCV industry further towards commercialization both in China and abroad. First, China, with the largest bus market and bus production capacity in the world, has great strengths in bus manufacturing generally. Its bus manufacturers have also developed strengths in EV buses. Thus, there is an opportunity to bring in international advanced fuel cell stack technology and integrate it with Chinese EV bus technology in series hybrid fuel cell buses.²³ Secondly, China is known for its manufacturing prowess and ability to reduce production costs. This may be of benefit to the fuel cell industry both in China and internationally if the cost of certain components of fuel cell vehicles can be reduced through China-based production.

FCV and Hydrogen Value Chains in China

20. Beyond the situation of China's FCV manufacturers (or potential FCV manufacturers), which has been touched on above, another important aspect of the context for this project is the current situation in China with regard to the FCV and hydrogen value chains. For the FCV value chain, the foremost issue is FCV components. For the hydrogen value chain, key issues are hydrogen production, hydrogen refueling stations, and equipment and parts for hydrogen refueling stations. The current situation of each of these areas is discussed briefly below.
21. **FCV Components:** China has domestic manufacturers of a number of key FCV components. Generally, however, there are not very many of these manufacturers in each key component area (often just one per area) and technological levels are usually substantially below global best levels. Exhibit 1-8 shows a rough cost break down of the FC system, of the FC Stack (a major component of the FC system), and the MEA (a major component of the FC Stack). Exhibit 1-9 incorporates the components of the stack and MEA into the overall FC system cost structure, so that it is more clear which items are major contributors. Finally, Exhibit 1-10 shows the status and availability of some key components from domestic manufacturers.

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

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

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

†Hydrogen Supply System Integration

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

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

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

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

22. **Hydrogen refueling stations:** China currently has two operating hydrogen refueling stations. One is located in Shanghai in Jiading District and is servicing a handful of SAIC FC autos at present. The other is in Northwest Beijing and is available for FC vehicles when they are tested. These two stations provide hydrogen only and no other fuels at present. During the Shanghai Expo, there was a second hydrogen refueling station (HRS) in Shanghai, but it was closed down after the Expo. There also previously was a station in Shenzhen that is no longer being used. One of the major challenges for setting up new HRSs in China is the scarcity and high cost of land in city centers. The GoC, however, is currently offering a subsidy of 4 million RMB for new HRSs that meet the minimum capacity requirement of being able to deliver 200 kg of hydrogen per day. Some localities are planning to provide additional subsidies to supplement the national one.
23. The equipment supply chain in China for hydrogen refueling stations is understandably in its infant stage. There is at least one Chinese company that can provide hydrogen refueling dispensers. Compressors at the two operational stations are imported, though the Shenzhen Station, when operational, used a domestic-made compressor from a company based in Beijing. It is believed the domestic compressor product is substantially behind international best levels in durability. Other key parts, such as key valves, pipes for hydrogen, and hydrogenation spears must be imported at high cost as no acceptable product exists in China.
24. **Hydrogen production:** Hydrogen production in certain areas of China, such as Shanghai, is considered to be at world class levels, with prices that are reasonable by world standards (e.g. US\$8/kg in Beijing). Locations with less industrial activity, however, face a challenge in procuring hydrogen and may need to pay significantly higher prices. Industrial by-product hydrogen is one of the most common forms of hydrogen that is becoming available on the commercial market in China. It has a very limited carbon footprint, making it an attractive transitional form of hydrogen for FCVs. Other methods of hydrogen production include natural gas reforming. When such hydrogen is used in FCVs, it has a similar carbon footprint to natural gas vehicles. Hydrogen is also available by electrolysis (use of electricity to make hydrogen and oxygen from water). If coal powered electricity is used to power electrolysis, the footprint is quite carbon heavy. While the majority of China's electricity is coal-powered, electrolysis presents the opportunity to use excess wind power or solar panels to generate hydrogen whose only carbon footprint is its transport to the refueling station. At present, however, there is no large-scale wind or solar based hydrogen production in China. China manufactures large-scale water electrolysis units, which can perform the electrolysis function. The quality is considered good and the price reasonable, with Chinese-made water electrolysis devices being exported to other countries, as well as being sold domestically. An alternative form of renewable energy based hydrogen production would be steam reforming of the natural gas from biogas or landfill methane. This method has not been used on a substantial scale in China to date, though there have been some small-scale experiments.

FCV and Hydrogen Value Chain Safety Issues

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

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

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

Exhibit 1-10: Hydrogen Safety Risks and Countermeasures

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

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

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

1.2. Barrier Analysis

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

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

31. **FCV Technology Barriers:** FCV cost, durability, and performance are key barriers to FCV commercialization in China and, despite great progress, worldwide. Due to the high cost of FC stacks, FCVs are not cost competitive compared to internal combustion engine (ICE) vehicles. The price of a locally made FCB in China, for example, is currently around USD 640,000, which is about seven times the price of a conventional diesel bus with similar configuration and performance. One of the key cost issues is economies of scale, with the cost of fuel cell stacks to be reduced by a factor of 5 once significant production capacity is reached.
32. As for durability and performance, substantial progress has been made in these areas internationally and within China. Internationally, fuel cell vehicles are now being sold on a limited commercial basis. Yet, in China, durability (measured in lifetime hours of operation over a specified test cycle), which for a fuel cell bus is around 2,000 hours, lags substantially behind international levels, which have reached 10,000 hours.
33. Cost, durability, and performance barriers, are, in turn, related to barriers with regard to FCV and FC components and with regard to the technical capacity of China's FCV manufacturers. Chinese FCV manufacturers lack access in many cases to best quality, world class components; and the cost of components is also high. Most China-made FCV and FC components, when available, are below international best achievement in durability and performance. Yet, Chinese FCV manufacturers are in many cases unable to get access to the foreign components they wish due either to lock-up agreements component suppliers have with other vehicle manufacturers or to IPR concerns of such suppliers. Localizing production of these components in China presents the potential for addressing both access and cost barriers, but local component manufacturers lack the know-how and scale to achieve needed quality at cost-competitive prices. Finally, quality issues of Chinese FCVs are also related to the limited capacity of Chinese FCV manufacturers. At present, they have only very limited experience with FCVs. Further, most rely on outside know-how (from top research groups at universities) to develop their power train.
34. **Hydrogen Infrastructure Barriers:** Lack of hydrogen refueling stations is a key barrier to the commercialization of FCVs; and lack of low-cost, low-carbon hydrogen is also a barrier to realizing the environmental potential represented by FCVs. Potential buyers of FCVs, whether they be public transport companies, delivery companies, government organizations, or consumers, will understandably be hesitant to purchase FCVs without sufficient locales at which they can refuel. Currently, China has only two hydrogen refueling stations that are available to those who wish to refuel. One is in Shanghai; and one is in Beijing. Lack of hydrogen refueling stations and lack of customers for those stations (FCVs) together present a classic "chicken and egg" challenge to the commercialization of FCVs not only in China, but worldwide.
35. Lack of availability of low-cost, low-carbon hydrogen presents both a basic challenge to FCV commercialization (hydrogen cost) and to that commercialization occurring in a way that honors the intention of FCV promotion as a means of "greening" the transport sector (hydrogen production "carbon content"). At present, the cost of hydrogen is considered relatively high as a transport fuel (though its competitiveness depends on the price of gasoline, which fluctuates widely). This is true even of hydrogen that is not produced by renewable energy. (Hydrogen produced by renewable energy tends to have even higher production costs.) Prices in Beijing in Jan. 2015 for hydrogen produced by natural gas reforming were USD 8 per kg, similar to international levels. There is a lack of information about the specific requirements for hydrogen used as a transport fuel, though such information may reveal opportunities for cutting costs. Yet, there is also a lack of methodologies to reduce costs by producing vehicle-specific hydrogen. Further, while large cities, such as Shanghai, have good hydrogen availability and prices similar to that of the world market, other locales without locally produced hydrogen, such as Foshan, face much higher prices.

36. While the availability of by-product hydrogen in China is attractive transitionally due to its relatively small carbon footprint current, more radical reductions in carbon emissions will require a shift to renewable energy based hydrogen production. Hydrogen produced from electrolysis powered by China's electricity grid (in which coal-fired power plants predominate) is very high carbon. Natural gas reforming has a substantially lower carbon footprint than hydrogen from grid-based electrolysis, but renewable-energy based hydrogen production is what really presents the greatest potential for a "green" hydrogen source. Hydrogen produced from wind or solar-based electrolysis will essentially have no carbon footprint, aside from that generated in transporting the hydrogen from place of production to the hydrogen refueling station. Hydrogen produced from biogas/landfill methane will also have quite a small carbon footprint. Yet, China has no experience with producing hydrogen from renewable energy on a substantial scale. Further, while recent progress in this area has been made internationally, there is a lack of knowledge of these international developments in China.
37. Significant barriers to the development of hydrogen refueling stations in China also exist. Key HRS issues include reliability of stations, financial viability of stations, and high costs of equipment and land to set up such stations. There is a lack of experience in the design and business models for such stations; and lack of knowledge of latest international developments in these areas. Given the situation of low numbers of FCVs on the road, a key challenge (despite the significant subsidy of US 640,000 per station) lies in developing a business model to make these stations economically viable in China. While some ideas have been proposed, such as addition of hydrogen refueling to existing gasoline stations or development of multi-fuel stations with options of hydrogen, CNG, LPG, etc., none have moved past the initial concept stage. Costs of imported equipment, such as compressors, high quality valves, hydrogenation spears, and hydrogen piping, keep overall costs of these stations high. Yet, at the same time, domestic counterpart products have not achieved the quality needed to ensure the reliability and safety desired. Further, there is a lack of data on Chinese operation of such stations from which to gather lessons learned to improve.
38. **Policy Barriers:** The pertinent support policy and regulatory frameworks for FCVs and hydrogen refueling stations in China are inadequate. The Government's rather unclear and vacillating policy signals to date have made it difficult for the local FCV industry and market to develop. Areas in which policy and regulatory frameworks are lacking include: development roadmap, standards and certification, approval processes (and knowledge level of relevant authorities), and incentive policies. While China has developed clear plans and targets for other areas requiring technology development and demonstration roll-out (notably EVs), for FCVs and hydrogen refueling stations, there is no such official plan. This impedes progress and reduces the confidence of localities and potential investors in pursuing FCV development.
39. As for standards and certification, while a significant standards base for both FCVs and hydrogen refueling stations exists, there are gaps. There is further a need to ensure Chinese standards are harmonized with international standards. There is also a need to develop a certification system. The absence of a complete standards and certification system creates challenges in both national-level and local level approval of FCVs, as discussed below.
40. To date and in the previous GEF FC bus project, approval of FCVs at both the national and local levels has been a major barrier. In the previous GEF project, at one point, government officials, due to their safety concerns, allowed the FC buses to be tested only with sandbags and not with human passengers. Further, all of China's FCV demonstrations to date, whether for the Olympics, the Shanghai Expo, etc., have been short-term. Approvals for using these vehicles have been issued only on a basis limited in space and time. After demonstration, the vehicles sit unused, though their lifetimes have not expired. A valuable opportunity to collect test data is lost. At the national level, the barrier is lack of streamlined approval processes at relevant agencies. Approval issued by relevant national-level authorities to the manufacturer for a certain model allows the

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

41. Finally, while there are significant incentive subsidies for both FCVs and HRSs at present, a barrier to more substantial progress is the lack of robustness and completeness of the incentive system. For both FCVs and HRSs, there is a lack of government commitment to maintain current subsidy levels for a strategic amount of time. Further, at present, incentive policies are quite narrowly focused on subsidies. There is a lack of more innovative incentive policies, such as preferred parking spaces or preferred lane usage for FCV drivers.
42. **Awareness and Information Barriers:** A key barrier to broader adoption of FCVs is lack of awareness about FCVs and lack of information about them, as well as lack of substantial proof on the roads in China to stimulate this awareness and information provision. Much of the general public is unaware of FCVs. Those that have heard of them are not clear on key aspects of FCVs. Further, there is fear and lack of understanding among the public about hydrogen-related safety issues. Policy makers, managers, and experts also lack the awareness and information needed to give them the confidence to develop plans for the use of FCVs in their locales. They will continue to be hesitant to pursue FCV plans in the absence of solid results of FCVs on the road in China. Further, these groups lack information on the latest progress and results internationally with FCVs. Finally, there is lack of a good, reliable information source within China to inform experts and investors on the FCV market and technological developments.
43. **Barriers in O&M and Financial Sector Capacity:** Human capacity barriers in O&M of FCVs and HRSs and in financing of FCV related manufacturing facilities and FCV sales also inhibit commercialization of FCVs. In the prior GEF FC bus project in China, lack of FCV O&M capabilities was found to be a major problem. O&M services were provided for imported buses by the manufacturers for a certain period of time, but once this time period was over, no one remained on site who could perform the needed O&M function. HRSs may face a similar problem in that suppliers from out of town provide O&M for a certain time period, but sustainability via capacity building of local persons is lacking.
44. As for the financial sector, at present there is little knowledge within this sector about FCVs and lack of capacity to evaluate FCV related investment opportunities. Both banks and equity investors, such as venture capital and private equity firms, lack the needed capacity to evaluate opportunities to support FCV or FCV component manufacture. Similarly, these groups also lack the capacity to evaluate opportunities to support hydrogen refueling stations or related value chain initiatives. Lastly, there is also an absence of financial institution programs to support consumer purchase of FCVs, such as a dedicated loan facility.

1.3. Stakeholder Analysis

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

46. **National-level government officials:** National-level government officials will be critical in adopting policies and plans to promote FCVs and in ensuring the success of this project. For the project, key organizations include the Ministry of Science and Technology (MOST), the implementing partner for the project. MOST promotes R&D and development of new industries in China. As IP, MOST will handle communication and coordination with MOF and UNDP, liaison with local governments, project activity management, and project financial management. MIIT has more recently joined MOST and MOF as a key player in driving NEV demonstration. At the same time, its role in approving new FCV models will be critical to commercialization efforts. For this project, MIIT will provide assistance in the identification and design of replication demos for FCVs, HRSs, and hydrogen refueling. It will also interact with the project in developing streamlined approval procedures for new FCV models.
47. **Local-level government officials:** Local-level government officials will be instrumental in taking the lead from the National Government to promote actual adoption of FCVs at the local level, initially through demonstration and replication plans. For this project, key entities will be local level government organizations driving the project demos: (1) Beijing Science and Technology Commission, (2) Shanghai Science and Technology Commission, (3) Zhengzhou Bureau of Science and Technology, and (4) Development and Reform Commission of Guangdong Province, along with Nanhai District Development and Reform Bureau. For the project, these local entities will coordinate implementation of FCV and HRS demos and drive the process forward. They and their counterparts in other cities will be responsible for developing plans to replicate project demos. Many other local government organizations will be involved in the demos in each city. Other important entities at the local level will be public security bureaus and transportation management bureaus, who will play an important role in approving and issuing license plates for individual vehicles. Their further education regarding FCVs and safety methods will be critical to the approval and thus success of the demos.
48. **FCV and component manufacturers:** FCV and component manufacturers (and potential such manufacturers) will be major beneficiaries of the project and primary drivers of its progress. Due to the high subsidies for domestic-produced FCVs, involved FCV manufacturers will most likely be domestic-based manufacturers, whether fully Chinese-owned or joint ventures. Key FCV manufacturers likely to be involved include: SAIC, Foton, and Yutong. Yet, the project will reach out to all interested vehicle manufacturers. As for component manufacturers, it is likely that both overseas entities (such as Ballard, Hydrogenics, etc.) and domestic entities will be involved through supplying components to demo vehicles. Current or potential domestic component manufacturers may also become beneficiaries of project technical assistance.
49. **HRS investors and operators:** HRS investors and operators, via fuel availability and provision, are critical to the development of the FCV industry in China. For the project, these parties will play the critical roles of providing hydrogen to project demo FCVs and providing data and lessons learned on HRS operation. HRS investors may include city governments, state-owned companies, or private sector companies.
50. **Hydrogen producers and potential producers of renewable energy based hydrogen:** Availability of hydrogen at a low price will be critical to FCV commercialization; and availability of renewable energy based hydrogen will be important to realizing the “green” potential of FCVs. Existing hydrogen producers will play an important role in the project by providing hydrogen to demo HRSs. Further, potential producers of renewable energy based hydrogen, by setting up hydrogen production facilities, will play an important role in demonstrating this important aspect of the future hydrogen value chain for FCVs. These potential producers may include current wind farms with excess power (state-owned or private) as well as investors in land-fill methane based projects.
51. **Experts on the auto industry, FCVs, and hydrogen:** Currently, experts are playing a key role in the development of the FCV industry in China. Some of the nation’s strongest capabilities for

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

52. **Public transport companies, delivery companies, and other institutional users of FCVs:** Institutional users of FCVs, particularly public transport companies and delivery companies, are also a key link in promoting the commercialization of FCVs. To date, public bus companies in China have adopted NEVs (mostly HEVs, PHEVs, and EVs) at a much higher rate within their overall purchases than other users. Further, given the visibility of public buses, the companies' adoption of FC buses will be important in building awareness of the technology. For the project, key public transport companies will be those in each of the four demo cities: Beijing Public Transportation Corporation, Shanghai Jiading Bus Company, Zhengzhou Public Transportation Company, and Nanhai Public Transportation Company. For the project, these organizations will have the role of ensuring selection of high visibility routes. They will also be responsible for ensuring smooth refueling and O&M of the buses. Their staff will thus need to master O&M practices. For replication of the demos, public transport entities in other cities will be similarly involved. Other companies of relevance to the project demonstrations include Shenzhou Taiyue, City 100, and Potevio, each of which will be responsible for ensuring high visibility routes, refueling, and O&M of their FC delivery vehicles. Another company of relevance to the demos will be the SAIC-invested car rental company that will operate a majority of the project's demo FCV autos.
53. **Consumers/general public:** Consumers represent the largest ultimate market for FCVs in China. The need to raise their awareness and understanding of FCVs is critical, as well as the need to inform them and alleviate their fears regarding hydrogen's safety issues. The project will engage consumers via its awareness raising activities, including opportunities to test drive FCV autos in Shanghai. Consumers will also play a critical role as they begin to purchase FCVs for personal use. (To date, there have been no consumer FCV purchases in China.)
54. **Financial Institutions:** Financial institutions will ultimately be important to the growth and expansion of the FCV industry. Eventually, they will be needed to finance FCV manufacturing expansion, manufacturing of components, manufacturing related to hydrogen production and hydrogen refueling, and establishment of HRSs. They will also be needed to stimulate consumer purchase of FCVs through special bank loan programs. At present, these institutions are not very aware of the FCV industry or the industry's potential. Key players that the project will need to build capacity in include banks and private equity/venture capital firms. The latter may fund some of the more risky investments in manufacturing and technology development, while the former may establish FCV loan programs and provide loans to manufacturers that is seen as relatively low risk.
55. **UNDP and GEF:** UNDP's and GEF's role in promoting FCVs in China has been ongoing since initiation of the FC Bus Project. For implementation of the current project, UNDP will provide ongoing guidance and backstopping for implementation. This will range from technical inputs and idea generation for achieving project targets to ensuring reporting and financial processes are in order. UNDP's role will be carried out by both the UNDP China Country Office as well as the UNDP Asia-Pacific Regional Coordinating Unit in Bangkok. Both of these entities have played an active role in the previous project as well as a critical role in development of the current project.

1.4. Baseline Analysis

56. The baseline scenario presents a situation in which actions are taken and money spent to demonstrate FCVs in each of the four cities of Beijing (5 buses and 5 delivery trucks), Shanghai (50 autos and 30 delivery vans), Zhengzhou (1 bus), and Foshan (1 bus). Yet, in this scenario, durability of vehicles is weak and demonstration periods are short and non-continuous. Demo vehicles do have new advanced features as compared to the previous generation of FCVs manufactured in China and are thus referred to as a “new generation”. But this progress is not enough to ensure high durability vehicles with continuous operation over multiple years. Different manufacturers refer to this new generation in the baseline scenario differently. As a group, for the purpose of this project, this new generation is indicated as “Generation B.”
57. Parameters reached with the buses, for example, will be at best: 6,000 hours lifetime operation, 650 hours between breakdowns, 25 percent cost reduction (projected for high volume production and as compared to 2015 values), 2,000 annual hours of operation, and 44,000 km driven per year. (See Annex VI, Exhibit VI-2 for best case parameters achieved in the baseline 2019 case for autos and delivery vehicles.) In the baseline scenario, public bus companies and other operators of vehicles do not gain the capacity to handle their own maintenance; and this causes problems in the smooth and continuous operation of the vehicles. In the end, due to unattractive durability and high costs of vehicles, as well as weak results in other areas, replication (by end of project in 2020 and out to 2025) is not achieved on a significant scale.
58. Other factors, in addition to the low technical capacity of vehicle manufacturers that contribute to this low durability, high cost, and low replication baseline scenario are related to FCV and FC components. In the baseline scenario, domestic components continue to lag international levels significantly (by 2020 and 2025), while China’s FCV manufacturers continue to have difficulties importing components or continue to find the price of imported components too high.
59. Hydrogen refueling stations in the baseline scenario continue to exhibit the same phenomena seen in previous efforts to promote FCVs in China. Some stations are opened for demonstrations, but later closed down when operation of demonstration vehicles is discontinued (often after only a short period of time). Only a few stations (perhaps one in Beijing and one in Shanghai) continue to be operated for the long term. The stations that have been set up continue to exhibit only a single “business model” (hydrogen only). Costs of stations remain high; and expensive equipment must be important due to reliability issues with domestic products.
60. In the baseline scenario, hydrogen used for demo FCVs continues to be a mix of industrial by-product based hydrogen, hydrogen produced from natural gas reforming, and hydrogen produced from coal-heavy grid-based electrolysis. No progress is made in reducing hydrogen costs; and costs remain high in some areas, such as Foshan, which lack the relevant industries. While some efforts are made at wind farms to produce hydrogen from wind power, China continues to lack renewable energy based hydrogen production on a significant scale due to high costs, lack of know-how, and lack of dissemination.
61. In the policy arena of the baseline scenario, policy and regulatory support for FCVs remains unstable and incomplete. While having its more general *New Energy Vehicle Plan*, China continues to lack a roadmap specific to FCVs; and this situation contributes to cities losing confidence that demonstration of FCVs is a promising effort. Lack of a complete standards and certification system, as well as lack of harmonization with international FCV standards in some cases, causes difficulties in gaining approval for vehicles. Local authorities continue to be concerned about safety hazards of FCVs and lack specific safety procedures to address these concerns. This in turn inhibits successful demonstration programs, which instead become limited in space and time, and result in vehicles being parked after short demonstration periods rather than utilized for their full lifetime.

62. In the baseline scenario, public awareness of FCVs remains very limited. Most are unclear what an FCV is and have very little interest or concept of ever owning one. FC autos continue to be unavailable in China to individual consumers, who would be unlikely to buy them if they were available.
63. In the baseline scenario, the financial sector also remains unaware and/or skeptical of opportunities to finance FCV-related activities. Some auto makers continue to finance limited R&D from their general funds, but no FCV-specific loans exist. Domestic FCV component manufacturers are unable to scale up and become competitive on a global level due to lack of funds. HRS development and related value chain development remains constricted due to lack of funds. Financing for individual purchase of FCVs, in the absence of both availability and demand for vehicles, as well as lack of financial sector interest, is also absent.
64. Estimates for carbon dioxide reductions for the FCV demos in the baseline scenario are given in Exhibit 1-11 and explained in more detail in Annex III. The estimates conclude that by 2020 (equivalent to end of project), the demo vehicles will have resulted in direct reduction of CO₂ emissions of 1,449 tons. Given the less than inspiring results outlined above, the demos are only replicated on a 1:1 ratio in the five years following the project, so that indirect additional emissions reductions are also 1,449 tons. For these calculations, it is assumed that all of the demo vehicles remain operational for 1.5 years (exceeding achievements with past vehicles, but below lifetime expectations given mileage driven in the one year). It is assumed that an average of 125 km per day is achieved for the buses six days per week and 75 km per day is achieved for the other vehicles, also operating six days per week. The emissions estimates assume a mix of natural gas based hydrogen production and grid-based electrolysis made hydrogen for Beijing and by-product hydrogen for the other cities (more details in Annex III). There is no renewable energy based hydrogen production of substantial scale in the baseline scenario.

Exhibit 1-11: Direct CO₂ Emission Reductions in the Baseline Scenario

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

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

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

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

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

2. STRATEGY

2.1. Project Rationale and Policy Conformity

Rationale

65. Project rationale considers: (1) the great potential benefits for reducing emissions from China's transport sector, (2) the strong potential for advancing FCVs towards commercialization given the current situation of the FCV industry and the climate in China, and (3) the need for the project's incremental contribution in moving China beyond the baseline scenario. As has been mentioned, China is the world's top producer and consumer of primary energy and top emitter of GHGs, surpassing in its emissions of CO₂ from the energy sector the second largest emitter, the US, by 60 percent. Further, the transport sector accounts for 10 to 15 percent of China's final energy consumption; and this share is expected to grow substantially. China's oil consumption and net oil imports continue to grow, with China having risen to the position of top net oil importing nation in 2014 and expected to get 75 percent of its oil supply from imports by 2035. Transport is the largest contributor to the growth in China's oil consumption; and China now surpasses all other nations in annual new car sales. Local air pollution in many Chinese cities far exceeds the government's targeted standards; and the transport sector is considered an increasingly important contributor to this problem. All of these factors clearly provide rationale for a clean vehicle project that will contribute to potentially major transformations in China's vehicle sector, reducing GHGs, reducing local air pollution (congruent with the GOC's "war on air pollution"), and reducing oil imports (and thereby increasing energy security).
66. A project in the NEV space further fits with China's strategy to be competitive in this sector and facilitates diversification of China's NEV options, which are currently focused only on the various types of EVs. In contrast to ICEVs, with their entrenched producers, NEVs are a new industry, which may allow Chinese entrants to become competitive. Further, while China has put most emphasis on EVs, diversification into FCVs has many benefits and should be considered vis-à-vis FCV strengths. These comparative advantages of FCVs include: (1) greater future cost reduction potential as compared to EVs, (2) longer range, (3) alleviation of need to replace battery, and (3) much lower GHG emissions in the short-run (as China's EVs use mostly coal-generated power for recharging).
67. The opportune timing for this project provides further rationale: Currently, the international FCV industry has made marked advances towards commercialization in terms of cost and durability. At the same time, China has created a more favorable policy environment for FCVs with substantial subsidies for vehicles and efforts to promote demonstrations in various cities.
68. Finally, despite the improved environment for FCVs, the baseline scenario presents results that fall far short of what is needed to achieve replication on substantial scale. Input from a project such as this one is needed to push FCV durability improvement and cost reduction to more substantial levels, ensure continuous operation of FCVs and HRSs, and provide other strategic support in areas such as renewable energy based hydrogen production, awareness, and policy. Without such support, past problems, such as limited operation followed by termination of use of vehicles long before their lifetime is expired, may occur. And, with limited improvements, stakeholders will continue to find FCVs lack attraction for them. This project has strong potential for leveraging incremental funds to create much better outcomes than in the baseline scenario.

Policy Conformity

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

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

70. The proposed project is in line with China's several plans on the development of climate technologies, such as that being developed under the WB/GEF project on *Technology Needs Assessment*²⁵. While the nation of China has yet to meet the technological standards of OECD countries, the Chinese Government continuously stresses the role of advanced technologies for both climate change mitigation and adaptation to meet its sustainable development goals in a timely manner and at a minimum cost that does not threaten economic development and poverty alleviation. Both the transfer of best available global technologies (in this case FCV and hydrogen production and distribution/dispensing) to China and the enhancement of the local science, technology, innovation capacity, and diffusion are necessary to make the most relevant and advanced technologies widely available for deployment. The project is also in line with the plans and recommendations set out in the country's national communications to the UNFCCC. The most recent national communications (i.e., *Second National Communications*) mention the vigorous development of new energy industries, focusing on, among others, the deployment of plug-in hybrid vehicles, electric-drive vehicles, and fuel cell vehicles.
71. This proposed project is also in line with the GEF Climate Change strategic objective to promote energy efficient, low-carbon transport and urban systems (CCM-4). As a sustainable energy technology advocator, GEF supports the implementation of FCVs (particularly fuel cell buses) in selected developing countries, like China. By supporting interventions to facilitate the widespread and sustainable application of FCVs in China's transport sector, GEF can help the developing countries acquire early experience and knowledge in the application and local manufacturing of this type of energy efficient and environment-friendly transport vehicle.

2.2. Country Ownership/ Country Eligibility

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

2.3. Country Drivenness

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

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

2.4. Design Principles and Strategic Considerations

74. The proposed project intends to facilitate the realization of the potential CO₂ emission reductions (aside from the reduction in the emission of other air pollutants) by removing the identified barriers that up until now have prevented China from realizing substantial GHG emission reductions that would contribute to the achievement of the country's climate change mitigation targets. The project will address current problems in the FCV industry in China via focus on the improvement of the efficiency and durability of the FC engine, FC stacks, and overall FCV operating performance, as well as improvements in the main support infrastructures – hydrogen production facilities and hydrogen refueling facilities. The proposed project will focus on removing a number of key barriers in China's FCV initiatives. A combination of “technology push” and “market pull” activities will be employed to enhance the overall performance levels of locally produced FCs and FCVs by facilitating/enabling the effective promotion and application of FCV production and application technologies and techniques, as well as that for hydrogen production and hydrogen refueling facilities.
75. Based on the barriers identified, project outcomes and outputs have been designed to contribute to the project's overall objective of facilitating the commercialization of FCVs in China. Outcomes and outputs have been arranged along topical components including: (1) FCVs, (2) Hydrogen and HRSs, (3) Policy, (4) Awareness and Information, and (5) Capacity Building. An overriding theme in project design strategy has been to emphasize tangible results with clear links towards commercialization. As such, efforts have been made to reduce studies that may not be read and instead focus on demonstration and active events, such as one-on-one technical assistance sessions or group workshops. Indeed, a demonstration strategy is adopted in many key areas of the project. Central to the project will be the FCV demonstrations, covering four cities and involving a total of 109 vehicles of four different types (buses, autos, delivery vans, and delivery trucks). The project will also demonstrate renewable energy based hydrogen production and HRSs with different business models. In the areas of FCV and HRS components, the project will demonstrate manufacturers that are able to improve quality and/or reduce costs. Like the FCV demos, these component manufacturer demos will contribute to improved durability and cost reduction of FCVs. Yet, they will do so on a different and longer timescale, as the improved components are unlikely to be available at the time the demo FCVs are manufactured. Finally, the project will also pilot innovative FCV and/or hydrogen refueling station incentive policies that are new to China.
76. The proposed project adopts several innovations, not pursued before with regard to FCV commercialization in China. With regard to the FCV manufacturers, the project will provide support in sourcing of FCV parts from international manufacturers. Further, the support of domestic component manufacturers is a new approach. This latter support will combine one-on-one technical assistance through the retaining of experts, as well as facilitation of international cooperation that may lead to joint ventures or other types of cooperation. This latter (facilitation) approach is also quite new to this type of project. The inclusion of interventions focusing on the major support infrastructures for the FCV market, which are the facilities for hydrogen production and hydrogen refueling, are among the innovations in this proposed project. And, within these areas, the support will include aspects new to China, such as renewable energy based hydrogen production on substantial scale and different business models (such as multi-fuel provision) at hydrogen refueling stations. In the awareness area, consumer testing of FCVs is a new approach, not conducted before in China, as will be a televised documentary shown on a major television network and a video of an experiment showing how hydrogen cylinders behave on impact. Exposure of the financial sector to FCV-related opportunities is also completely new to China. Finally, databases including *China HRS Reliability Database* and *China FCV Market and Technology Monitoring System* will be innovative in providing relevant information to stakeholders.

2.5. Alternative Scenario

77. In the alternative scenario, demo FCVs in Beijing (10 buses and 5 delivery trucks), Shanghai (8 buses, 51 autos, and 30 delivery vans), Zhengzhou (3 buses), and Foshan (2 buses) leapfrog beyond the durability, performance, and cost reduction parameters that would be achieved if there were no GEF project. Further, with strong durability, performance, and an enhanced plan for demonstration, the vehicles are operated on a continuous basis (six days per week) over their full lifetime, expected to be 3.2 years or more. Different vehicle manufacturers use different terminology to refer to this “leapfrog” generation of vehicles in the alternative scenario. For the purpose of this project, these vehicles are collectively referred to as “Generation C,” to indicate their substantial advancement beyond “Generation B,” which is the target generation in the baseline scenario.
78. Parameters reached with the buses, for example, will be 10,000 hours lifetime operation, (compared to a maximum of 6,000 hours in the baseline scenario), 1,000 hours between breakdowns (compared to a maximum of 650 in the baseline scenario), 50 percent cost reduction (projected for high volume production and as compared to 2015 values; compared to 25 percent reduction in baseline scenario), 3,400 annual hours of operation (compared to maximum of 2,000 hours in baseline scenario), and 78,000 km driven per year (compared to a maximum of 44,000 km in the baseline scenario). (See Annex VI, Exhibit VI-2 for parameters achieved for autos and delivery vehicles in the alternative scenario, “with GEF project,” as compared to best case parameters achieved in the baseline case.) In the alternative scenario, public bus companies and other operators of vehicles gain the capacity to handle their own maintenance, resulting in smooth and continuous operation of the vehicles. In the end, due to attractive durability and substantially reduced costs of vehicles, as well as positive results in other areas of the project, replication (by end of project in 2020 and out to 2025) is achieved on significant scale.
79. Other factors, beyond improved technical capacity of vehicle manufacturers that contribute to enhanced durability, lowered costs, and high levels of replication in the alternative scenario are related to progress with FCV and FC components. In the alternative scenario, China’s FCV manufacturers are able to procure internationally-produced components that were previously inaccessible to them. At the same time, domestic components that reach international best levels, while having lower prices become available (by 2020).
80. In the alternative scenario, the number of hydrogen refueling stations operating in China on an ongoing/permanent basis is increased substantially from its currently level of 2 stations to 10 or more. The set of stations exhibits new business models, such as dispensing of both hydrogen and gasoline, and thus have improved viability. Station costs are reduced by the availability of lower cost domestic equipment and parts that, by 2020, reach international best levels.
81. In the alternative scenario, methods for reducing costs of hydrogen produced for vehicles are identified; and renewable energy-based hydrogen becomes available on substantial and growing scale. Wind farms produce hydrogen with excess power and landfill methane sites are also used to produce hydrogen, with both types of entity having gained access to information on international best practice. Areas wishing to develop FCV demonstration programs where costs of hydrogen were previously high are able to develop plans for local hydrogen production at lower costs.
82. In the alternative scenario, policy also contributes strongly to replication of the project demos, along with substantial purchase of FCVs by consumers. China develops an *FCV Roadmap*, increasing the confidence of cities that demonstration of FCVs is a promising effort. Approval of vehicle models by the national government and issuance of license plates by local government organizations is streamlined, so that these occur in an expedited fashion. This is partially due to development of a complete standards and certification system, harmonized with international standards, and partially due to successful efforts in lobbying and educating relevant officials. In addition, specific safety procedures are developed for dealing with FCV accidents, further

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

83. In the alternative scenario, a substantial portion of the public becomes aware of FCVs and comes to understand basic concepts associated with these. They learn about FCVs through the media, including a documentary aired on a major television network. Their fears regarding hydrogen are allayed through the project's awareness work, including a video demonstrating the results of impact on hydrogen canisters. In Shanghai, consumers also have substantial opportunities to test drive FCVs. As a result of this awareness building, combined with attractive subsidies and other incentives, a substantial number of FCVs are sold to individual consumers by 2025.
84. In the alternative scenario, the financial sector becomes aware of and more interested in opportunities to finance FCV-related activities. Banks make loans to auto makers specifically targeted at expanding FCV production capacity. Private equity and venture capital firms also become interested in the industry and its value chain and provide equity for higher risk situations. As a result of the increased availability of financing, domestic FCV component manufacturers are able to scale up and become competitive on a global level. HRS development and related value chain development similarly is able to scale up due to the availability of financing. In addition, individual purchase of FCVs by consumers is increased by the availability of special FCV purchase financing programs provided by Chinese banks.
85. Estimates for carbon dioxide reductions from FCV demos in the alternative scenario are given in Exhibit 2-1. The estimates conclude that by 2020 (equivalent to end of project), the demo vehicles will have resulted in direct reduction of CO₂ emissions of 10,814 tons (compared to 1,449 in the baseline case). Given the inspiring demo results outlined above as well as the many other contributing factors facilitated by the project (e.g. availability of competitive domestic components, substantially enhanced policy, and increased awareness), the FCV demos are expected to be replicated on a 4:1 ratio by the end of the project, so that additional emissions reductions via FCVs (out to five years after end of project and indirect via the bottom up approach) are 43,256 tons CO₂. For these calculations, it is assumed that all of the demo vehicles remain operational for 3.2 years (far exceeding achievements with past vehicles, though a conservative estimate given expected improvements in vehicles). It is assumed that an average of 250 km per day is achieved for the buses six days per week and 150 km per day is achieved for the other vehicles, also operating six days per week. The emissions estimates assume half of the hydrogen used in the Beijing vehicles comes from one of the project's wind-based hydrogen production demos (replacing the share of grid-based electrolysis in the baseline scenario), while other sources of hydrogen remain the same as in the baseline case.
86. The project's renewable energy based hydrogen production demos, including three hydrogen production installations at wind farms and one at a landfill methane site, add substantially to direct emission reductions. Some of this renewable energy based hydrogen is used to power project FCVs, resulting in 824 tons of emission reductions (during the project's lifetime) that have already been included above in the calculation for alternative scenario FCV emission reduction. During the project lifetime and excluding the already-counted foregoing amount used in the demos FCVs, they add 5,922 tons CO₂ reductions. This amount is for renewable energy based hydrogen used for purposes other than the demo FCVs. It too provides emissions reductions by replacing hydrogen produced by higher carbon methods. If well maintained, the installations last an additional 18 years beyond end of project, adding an additional 60,716 tons direct CO₂ emission reductions post-project.

Exhibit 2-1: Direct CO₂ Emission Reductions in the Alternative Scenario

| City or cities | Vehicle Type (Generation C ²⁶) | No. of vehicles (C) | Gasoline/diesel emission factor (g CO ₂ /km) (D) | FCV alternative emission factor (g CO ₂ /km) (E) | Emission reduction factor (g CO ₂ /km) (D-E) = (F) | Km driven per year (G) | Years driven (H) | Emission reduction (tons CO ₂) (C*F*G*H * 10 ⁶) = (I) |
|--|--|---------------------|---|---|---|------------------------|------------------|---|
| Beijing* | Bus | 10 | 1,338 | 428 | 910 | 78,124 | 3.2 | 2,274.97 |
| | DV Truck | 5 | 821 | 263 | 558 | 46,876 | 3.2 | 418.51 |
| Shanghai, Zhengzhou, Foshan** | Bus | 13 | 1,338 | 290 | 1,048 | 78,124 | 3.2 | 3,405.96 |
| | Auto | 51 | 304 | 66 | 238 | 46,876 | 3.2 | 1,820.74 |
| | DV Van | 30 | 821 | 178 | 643 | 46,876 | 3.2 | 2,893.56 |
| Total | --- | 109 | --- | --- | --- | --- | --- | 10,814 tons |
| Direct incremental emission reductions: 10,814 tons (alternative) – 1,449 tons (baseline) = | | | | | | | | 9,365 tons |

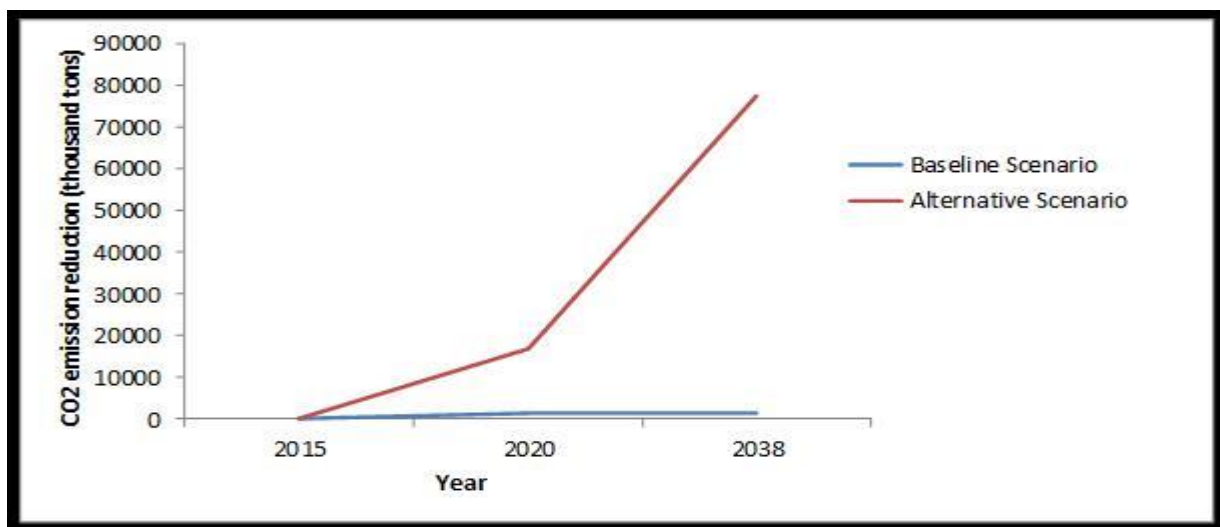
**Beijing’s baseline FCV hydrogen is assumed to be 50 percent natural gas-based (steam methane reforming) and 50 percent wind power based. The benefits of wind power based hydrogen have been incorporated into the emission factors for Beijing which, for example, are reduced in the case of buses from 766 g CO₂/km in the baseline scenario to 428 g CO₂/km in the alternative scenario.

**Baseline FCV hydrogen for the three other cities is assumed to be by-product hydrogen from coke oven gas, 80 percent of which would normally be unutilized and the other 20 percent of which would have been utilized for process heat. It is quite possible that these emission factors for some of these three other cities will be reduced further by use of hydrogen from the project’s demo land fill methane hydrogen generation or from its other demo wind powered hydrogen generation for their demo FCVs. Thus, the approach taken here is conservative; and total emission reductions realized in the alternative scenario may be even greater.

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

87. Exhibit 2-2 below compares direct emission reductions in the baseline and alternative scenarios, showing the cumulative direct emission reductions over time. It has data points at 2020, for direct emissions reductions achieved by end of project and at 2038, for total direct emissions reductions achieved both during and after project. It does not show the project indirect emission reductions from replications mentioned above. There are substantial and estimated to add an additional 117,420 tons CO₂ emission reductions to direct reductions of 15,287 tons by end of project for a total emission reduction by end of project of 132,707 tons CO₂. Neither does Exhibit 2-2 show the direct post-project emission reductions, defined as those reductions directly attributable to project activities, but associated with equipment put in place after end of project. For more information on these, see Annex III.

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



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

Project Goal and Objective

Goal: Reduced growth rate of GHG emissions from transport sector

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

Project Components, Outcomes, and Outputs

88. Component 1: Improvement of Local Fuel Cell (FC) and Fuel Cell Vehicle (FCV)

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

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

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

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

²⁷ Most currently depend on outside parties for this.

target; and (v) stack power density target. [*GEF support is required for the provision of technical assistance services by FCV expert(s).*]

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

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

91. Output 1A.2: Published and disseminated information on improved FCV design and production in China achieved via project.²⁸ This information will enable a wide group of stakeholders to gain insights on means of FCV durability/performance improvement and cost reduction and thus contribute to overall improvement in these areas key to FCV commercialization. (*Disseminated information on improved FCV design and manufacturing achieved via project*)

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

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

92. Output 1A.3: Multiple confirmed and implemented new sourcing agreements²⁹ between Chinese FCV manufacturers and international suppliers that are each verified to lower costs, increase durability, and/or raise performance from start of project benchmarks. Overcoming current

²⁸ Information will include baseline situation, project commercialization targets, steps to reach targets, results achieved, and lessons learned.

²⁹ This will include FC engine sourcing agreements with top OEM and/or non-OEM providers, if possible.

barriers to international sourcing of key parts, such agreements will enable enhanced durability and performance of China's FCVs. (*International sourcing agreements for China FCV industry*)

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

Activity 1A.3.2: Conduct of targeted individual assistance to selected FCV manufacturers in achieving new advantageous sourcing agreements for FCV-related components from international suppliers. The technical assistance will take into consideration sourcing challenges determined in Activity 1A.3.1. FCV expert(s) will assist the China-based manufacturers in liaising with relevant international component suppliers and in negotiating of sourcing agreements. This work will be completed early enough in the project so that newly sourced components that achieve cost reductions, durability improvements, and/or performance improvements are available to be incorporated into demo vehicles manufactured for the project. Assistance will be provided to all FCV manufacturers that are considered to have high potential to meet project commercialization targets. The expert(s) selected for this activity will be those that are well-connected in the international FCV component community. This work will include, but not be limited to, outreach to international manufacturers (including auto OEM and non-auto OEM) for purchase of world class FC engines. If generally attractive terms are obtained, activity will also include support to Chinese manufacturers in negotiating details of FC engine sourcing agreements. More than one make of engine may be sought to enable comparison of results. Regardless of results of engine sourcing work, this activity will also emphasize support to China FCV manufacturers in the international sourcing of other components. Other priority areas in this regard include: hydrogen recirculation pump, compressor, MEA, and hydrogen valve with high quality seal. [*GEF support is required for the provision of the specific technical services to each selected local FCV manufacturer.*]

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

³⁰ To be carried out by a FCV expert familiar with international component manufacturers. Building on the FCV expert's own previous knowledge and contact base, the compendium will provide contact information, details on products offered, quality of supplier compared to others in the market, typical price points, etc.

obtained. For those organizations receiving training materials, information on impact of these materials on their activities will be sought. [*GEF support is for the technical services required in the design and conduct of the survey.*]

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

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

Activity 1A.4.2: Assistance to China-based FC catalyst manufacturer (Guiyanboye) to achieve improved processing and scale-up and thus be able to offer a lower cost catalyst source to FCV manufacturers, which are currently importing catalyst. Leveraging Guiyanboye's platinum trading and recycling platforms, a 20 to 30 percent cost advantage over international sources is targeted. The technical assistance will consist of: (a) assessment of current manufacturing process and quality of FC catalyst products and preparation of action plan to implement the recommendations resulting from the assessment; (b) one-on-one technical assistance to improve production and testing; (c) incremental support to Guiyanboye's purchase of single fuel cell test platform and provision of related training that will enable procurement of higher quality/enhanced feature equipment as compared to Guiyanboye's purchase in the baseline case; (d) incremental support to Guiyanboye's purchase of a pilot preparation platform (to facilitate move from laboratory to batch production) that will enable procurement of higher quality/enhanced feature equipment as compared to Guiyanboye's purchase in the baseline case; and (e) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of catalyst. Items (a) and (b) will be provided by expert in FC catalyst production. Along with other efforts, these will target performance improvement from current level of 0.6 mg Pt per cm² to international level of 0.3 mg Pt per cm², or even beyond (0.2 mg Pt per cm²). Item (e) will be provided by expert in international facilitation. [*GEF support is required for expert technical assistance in improving the testing and production of FC catalyst in the selected local FC catalyst manufacturer*]

³¹ Dongyue-provided co-financing of USD 3.2 million annually will support baseline cost of standard testing equipment purchase and cost of all other equipment purchase and scale-up.

(Guiyanboye), incremental features/quality of equipment for catalyst testing and manufacturing at Guiyanboye³², and facilitation of international cooperation between Guiyanboye and counterpart international catalyst manufacturer.]

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

Activity IA.4.4: Assistance to China-based bi-polar plate manufacturer to improve process and technology for coating and stamping (and for welding and sealing, if needed) thereby enabling provision of lower cost bi-polar plate to FC stack and FCV manufacturers. The target in stamping is the reduction of plate thickness from China's current level of 0.7 mm to international level of 0.4 mm, thus increasing power density to international level of 3.1 kW per L. Through improved technique for coating stainless steel, reduced corrosion is expected and, thus, extended lifetime. The bi-polar plate manufacturer to be supported will be either a stand-alone manufacturer based in Dalian or Shanghai (such as Shanghai Jiaotong Manufacturing Research Institute) or the FC stack manufacturer Dalian Sunrise (which produces bi-polar plates as one component of the FC stacks it produces). Technical assistance will consist of: (a) assessment of current manufacturing processes and product quality and development action plan to implement recommendations emerging from assessment; (b) one-on-one technical assistance to improve processing and technology; and (c) facilitation of joint venture or other cooperative relationship with international counterpart manufacturer of bi-polar plates. Items (a) and (b) will be provided by bi-polar plate expert, who has strong experience in coating and stamping. Item (c) will be provided by expert in international facilitation. [GEF support is required for the expert technical guidance services in improving bi-polar plate manufacturing, particularly the process and technology for coating and stamping, and for facilitation of international cooperation with counterpart international bi-polar plate manufacturer.]

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

³² This will be for the enhanced features/quality of the planned single fuel cell test platform and of the 0.5 to 1.0 kg scale pilot preparation platform that Guiyanboye intends to purchase and install. Once the production process is confirmed, the company will build a 2 to 5 ton per year FC catalyst production line.

manufacturing of FC stack and BOS and for facilitation of international cooperation with counterpart international FC stack manufacturer and, as needed, international FC stack component manufacturers.]

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

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

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

facilitation of international cooperation with counterpart international high voltage DC/DC converter manufacturer.]

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

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

94. Output 1B.1: Completed procurement and production of 109 demo FCVs, including 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks.³³ Based on project strategy, demo FCVs will represent major advance towards commercialization (increased durability, improved performance, and reduced cost) from baseline at start of project and also “leapfrog” beyond the generation of vehicle intended in the baseline scenario. That is, while “Generation B” (an advancement from the situation in 2010 at the time of the Shanghai World Expo FCV demonstration) was targeted in the baseline scenario, in the alternative scenario incremental improvements taking all vehicles to “Generation C” will be achieved. These improvements will address many aspects of the FCVs including, in particular, the engine, the design, integration, and other components besides the engine.³⁴ Properly carried out procurement will ensure that vehicles meet enhanced technical standards to achieve alternative scenario targets. (*Procurement and production of demo vehicles*)

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

Activity 1B.1.2: Production and purchase of 23 demo FC buses, 51 demo FC autos, 30 demo FC delivery vans, and 5 demo delivery trucks according to the specifications of the RFPs (Activity 1B 1.1). It is likely that at inception, other cities will join the demo, with an expansion of the total number of vehicles. In particular, it is likely that Yancheng City and Changshu City (both in Jiangsu Province) , as well as other interested cities, will join with the addition of eight FC buses to the original 23. FCV numbers designated for the cities may change and will be determined during project inception based on cities’ interests and their commitment to co-financing. This activity will be carried out by selected vehicle manufacturers and organizations purchasing the

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

³⁴ Project activities associated with Outcome 1A will enable achievement of “Generation C” targets. Such activities include (a) one-on-one technical support for FCV manufacturers, (b) group capacity development for FCV manufacturers, and (c) international sourcing support for FCV manufacturers.

vehicles. [GEF support is required to achieve “leapfrogging” of vehicle generation from “Generation B” in the baseline scenario to “Generation C” in the alternative scenario. Based on provision of incremental GEF funding to be spread across the purchase of all vehicles, stakeholders have agreed to be bound by higher level requirements (“Generation C”) for all vehicles in the areas of durability, performance, and cost reduction and to expand the number of FC buses from seven to 23, allowing for greater testing and for inter-comparison of results of buses with different engine types. GEF incremental financing will be USD 5.12 million which represents 31 percent of costs for all 109 vehicles (USD 16.69 million), when estimated with cost reductions targeted in the alternative scenario. Co-financing will cover the other 69 percent of vehicle costs.]

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

Activity 1B.2.1: Preparation and building consensus to achieve approval of each of 4 plans for the operation of demo vehicles: (a) *Shanghai Plan*, (b) *Beijing Plan*, (c) *Zhengzhou Plan*, and (d) *Foshan Plan*. Plans will be approved both at the project/national and municipal levels. *Each city’s plan* will include bus route selection that will achieve both high visibility and desirable testing situation for the buses (8 buses in Shanghai, 10 in Beijing, 3 in Zhengzhou, and 2 in Foshan). *Shanghai Plan* will select uses of the 51 FC autos that will ensure high visibility and good testing situation for the cars. Similarly, the *Shanghai Plan* and *Beijing Plan* will select uses and routes of delivery vehicles (30 vans in Shanghai and 5 trucks in Beijing) that will achieve high visibility and good testing situation for these. *Each city’s plan* will include for all vehicles detailed designation of how the painting of the vehicle exterior and signage in vehicle interior will raise rider and other viewer awareness of FCVs and the fact that the vehicle itself is an FCV. The *Shanghai Plan* will also designate a certain number of sites and days (around 200 days per year over three years during project period) for consumer test driving of the FCV autos. *Each city’s plan* will also specify how required approvals will be obtained, how refueling will occur, and how maintenance of vehicles will be carried out. In general, plans will call for maintenance to be carried out by the operating organizations, so that they can learn and understand their vehicles, working side-by-side with resident engineer from manufacturer, who will then be able to provide feedback on results to his/her organization. In addition to repairs, scheduled maintenance will be carried out periodically at pre-defined intervals. Preliminary features of the plans are included in Exhibits VI-5 and VI-6 of Annex VI, which provides descriptions of the vehicle demos. Finally, *each city’s plan* will emphasize continuous operation of the vehicles both during the project period and for the rest of the vehicles’ lifetimes beyond project close. Arrangements for use of the vehicles after project close will be clearly designated and in most cases similar to uses before project close. *Each city’s plan* will be prepared by the relevant local government and the FCV experts that support them. [GEF support is required for the technical assistance for the improved FCV demo plans in each demo city, specifically for added requirements such as: special measures to demonstrate durability and performance of FCVs that “leapfrog” over the generation of FCVs that were originally planned as part of the baseline FCV program of each city; requirement of FCV promotion on the interior and exterior of vehicles; requirement of high visibility routes and uses; and requirement of continuous operation.]

³⁵ See footnote to first sentence of Output 1B.1 for specific demo plans by city or district.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Activity 2A.1.2.2: Organization and conduct of international study tour to Germany for site visits and international exchange on renewable energy-based hydrogen production ("P to G," power-to-gas) and distribution of hydrogen via natural gas networks. Planning, itinerary, and interpretation will be handled via this project activity and provided to individuals from Chinese organizations investing in or interested in investing in renewable energy based hydrogen production. Special efforts will be made to include as many women technical experts as possible. [GEF support is required for the technical and logistical services needed in the planning, organization, conduct and evaluation of the study tour, including services of counterpart entities in Germany³⁶.]

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

101. Output 2A.2: Expanded knowledge-base on reducing production costs of transport hydrogen and establishing local hydrogen production facilities, including database of information on all

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

aspects and applicable processes of hydrogen production (both non-renewable energy and renewable energy based). The expanded knowledge base will contribute to the reduction of costs in both non-renewable energy and renewable energy based hydrogen production. *(Information base on hydrogen production.)*

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

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

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

Activity 2A.2.4: Preparation of database of information on all aspects and applicable processes of hydrogen production (both non-renewable energy and renewable energy based). Database will include the three studies produced via Output 2A.2's other activities, as well as other relevant materials. This activity will involve cooperation with china-hydrogen.org to house and disseminate the database and continue upkeep after project close. *[GEF support is required for database preparation, including collection of information on all applicable processes for hydrogen production.]*

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

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

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

technical services needed in improving the reliability and performance of onsite RE-based (wind/PV) hydrogen production facility at the hydrogen refueling station.]

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

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

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

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

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

Activity 2A.3.2.2: Organization and conduct of international study tour to visit hydrogen refueling stations and discuss strategies with international counterparts. This project activity will include the conduct of planning and liaison, provision of itinerary, and provision of interpretation during visit. Current and potential investors in hydrogen refueling stations will be invited to attend the study tour. Special efforts will also be made to include as many women as possible. [GEF support is required for the technical and logistical services needed in the planning, organization, conduct, and evaluation of the study tour, including services of counterpart entity in Germany³⁷.]

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

Activity 2A.3.2.4: Design and conduct surveys of individuals that participated in: (a) group training for renewable-energy based hydrogen production; and (b) group training for HRS establishment. This is for the purpose of verifying relevant project indicators associated with Outputs 2A.3.1 and 2A.3.2. The surveys will each gather information on whether individuals are applying what they've learned through the training, and will be conducted towards the EOP. [GEF support is for the technical services required in the design and conduct of the survey.]

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

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

Activity 2B.1.1: Planning, construction, and operation of four renewable energy based hydrogen production facilities including wind energy-based and landfill-methane based. Activity will include securing of financing, any permitting necessary, procurement and installation of equipment, and testing and commissioning. Work will incorporate recommendations from technical assistance of Activity 2A.1.1.1 and Activity 2A.1.1.2.³⁸ [GEF support is not required; all expenses covered by co-financing.]

Activity 2B.1.2: Design and initiation of plan for replication and scale-up of renewable energy based hydrogen production demos at other sites. Replication plan will incorporate liaison with

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

³⁸ Monitoring, evaluation, reporting and dissemination of these four renewable energy based hydrogen production demos will be carried out under Activities 2.B.3.1, 2B.3.4, and 3B.3.5.

other potential renewable energy based hydrogen producers, including those attending capacity building workshops and study tour under Activity 2A.1.2.1 and 2A.1.2.2. [*GEF support is required for expert input into replication plan.*]

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

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

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

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

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

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

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

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

Activity 2B.3.3: Conduct of annual survey on the public's perception of hydrogen production and hydrogen refueling stations and reporting of findings. The survey will seek to see if the public continues to have safety concerns about hydrogen infrastructure and whether this has lessened via the awareness building activities of Outcome 4.⁴⁰ If any cities in which new HRSs will be built do not have a standard consultative process with nearby residents regarding new installations, survey in its first year will serve to initiate such a process in such cities. [GEF support is required for the technical assistance in the design, conduct, and analysis of the public perception survey.]

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

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

107. **Component 3: Policy and Regulatory Frameworks for the Application and Commercialization of FCVs:** This component focuses on achieving policy and regulatory frameworks that will facilitate the commercialization of FCVs in China. Key barriers to be addressed include: absence of a national *FCV Roadmap*, incompleteness of standards and certification systems (and lack of harmonization with international standards in some cases),

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

difficulties in obtaining national-level approval for new models of FCVs and in obtaining license plates from local authorities that allow permanent operation of each individual FCV, lack of stability in incentive policies, and lack of broader approaches (beyond subsidies only) in incentivizing FCVs and HRSs. The component will address both national-level and local-level policy, regulation, and implementation and will include the conducting of pilots of incentive policies that are new to China. The expected outcomes from the activities that will be carried out under this component are: (1) effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs; and (2) adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations.

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

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

Activity 3A.1.1: Preparation of draft *China FCV and Hydrogen Refueling Roadmap* covering the areas of: (1) FCV cost reduction, durability improvement, and performance enhancement; (2) increased availability of key FCV parts at lower prices locally and/or through improved international sourcing; (3) reduced cost, increased volume, and improved reliability of hydrogen production in China, particularly of hydrogen produced via renewable energy; (4) establishment of hydrogen refueling stations; (5) availability of cost effective/reliable equipment and services for hydrogen refueling station establishment (including compressors and hydrogen refueling dispensers); (6) availability of qualified O&M personnel for FCVs and hydrogen refueling stations; and (7) availability of financing for FCV manufacture and associated value chain, for hydrogen refueling stations and associated value chain, and for FCV purchase. The roadmap will indicate targets in each of these areas and the steps that will be taken to reach them. Functionally, the roadmap will cover the areas of policy, government funding/investment, and investment by businesses. In preparing the roadmap, the expert team retained for this task will review the roadmaps/strategies of other countries as well as take the special situation of China into consideration. [*GEF support is needed for the required technical services in the drafting of the Roadmap.*]

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

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

109. Output 3A.2: Newly approved and enforced internationally compatible FCV, hydrogen station, hydrogen fuel transport, and associated parts standards, testing/measurement methods, and certification, filling the gap in terms of standards/testing/certification not yet in place. A

complete and robust system of standards and certification will increase confidence of approval bodies, thus leading to smoother adoption of FCVs. (*Standards, testing, and certification for FCVs, hydrogen stations, hydrogen transport, and associated parts*)

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

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

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

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

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

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

Activity 3A.3.1: Conduct of advocacy and lobbying meetings and other forms of education for relevant national-level authorities and local officials to achieve: (i) expedited approval (*gongao*)

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

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

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

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

Activity 3A.4.1: Preparation of proposed extension and improvements to current incentive policy for FCV purchase. A primary aim is to extend the duration over which the current national FCV subsidy will be applied to the period between 2016 and 2020.⁴³ Improvements or refinements in the national policy will also be recommended. These will reflect increases in the number and types of FCVs available in China. Meetings will be held with policy makers and/or briefs will be prepared for them, promoting adoption of the extension and other measures. In addition to national-level policy, certain local-level policies encourage new energy vehicles (without differentiation between electric vehicles and FCVs). This activity will also include initiatives to extend (for FCVs, in particular) local preferential new energy vehicle policies (such as free vehicle plates issuance in Shanghai and sped up position in the queue for auto purchase in Beijing) or to even enhance these for FCVs, in particular. [GEF support is required for the technical assistance needed in the design and lobbying for enhanced incentive policies.]

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

Activity 3A.5.1: Preparation of proposed extension and improvements to current national incentive policy for establishment of hydrogen refueling stations. A primary aim is to extend the

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

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

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

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

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

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

Activity 3B.1.2: Design of and reaching of consensus on policy pilots. Based on ideas vetted in Activity 3B.1.1, design will first involve liaison with local government and reaching of consensus on location(s) for policy pilots and on the nature of those pilots. Detailed design of policy pilots will then be carried out. There will be at least two local policy pilots. *[GEF support is required for the technical and logistical services needed in the design and implementation mechanisms for policy pilots.]*

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

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

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

implementation of the monitoring plan, as well as in the documentation, publication and dissemination of the results and recommendations from the policy pilots.]

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

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

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

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

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

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

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

Activity 4.1.4: Design, production and airing of a documentary on FCVs on TV in China. The documentary will feature the project demos as well as FCV developments around the world. It will discuss the future prospects of the hydrogen economy. It will also provide information

regarding the safety of FCVs and hydrogen. The services of an experienced producer will be engaged to prepare the documentary and target getting it aired on a major program in China, such as *Discovery (探索)*. [GEF support is required for the technical and logistical services needed in the design and production of the FCV film documentary, as well as to ensure airing on prime time, if possible.]

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

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

Activity 4.2.1: Conduct of annual workshops for city officials from the demo cities and from other cities that may have the potential for adopting their own FCV and hydrogen refueling programs.⁴⁴ The workshops will present findings and lessons learned from operation of the demo FCVs, hydrogen production installations, and hydrogen refueling stations, as well as results of the policy pilots. Findings will include results from monitoring activities under Outcomes 1B, 2B and 3B. Presenters will include pertinent information to help existing demo cities improve their programs and to help other cities with an interest in pursuing FCV programs design their plans. [GEF support is required for the technical and logistical services needed in the design, organization, conduct, and evaluation of the workshops.]

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

Activity 4.2.3: Annual international forums and international study tour on FCVs and hydrogen infrastructure. The purpose of these is to conduct technical and information exchange among counterparts and to strengthen understanding and acceptance of government policy makers on the development of fuel cell vehicles at home and abroad. Special efforts will also be made to include as many women as possible. The international forums will be conferences based in China, whereas the study tours will aim to educate policy makers on FCV related initiatives in other countries. [GEF support is required for the technical and logistical services needed in the organization and conduct of international forums and study tour, including with regard to the

⁴⁴ Cities like Dalian, Changshu, Guangzhou, Shenzhen, and Wuhan are known as key cities for demonstrations. Many other cities will also be of interest, including a number that, at time or project design, are seriously considering an FCV demo program. At least one or two persons from each interested city will be encouraged to attend the project's annual workshops for cities.

study tour travel for four policy makers and one PMO staff member Organizations of other participating individuals will pay for their travel. Study tour expenses will also cover costs of services provided by counterpart entities in the country or countries visited.]

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

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

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

Activity 4.3.1: Development, operation and maintenance of an online database and monitoring system on China's FCV manufacturing and market, as well as new FCV technological developments and applications worldwide. The system will be known as China FCV Market and Technology Monitoring System. The services of a firm or non-profit organization will be retained to design and update this database and monitoring system. One candidate is Shanghai New Energy Vehicle Public Data Collection and Monitoring Research Center, which is currently maintaining a monitoring system of alternative energy vehicles in Shanghai. The monitoring work will require monthly contact with China's FCV manufacturers and distributors as well as with its registration bodies to determine technological developments, the number of new FCVs sold, and the total number of FCVs on the road in China. The contractor will also monitor a number of key information sources on developments in FCVs and hydrogen infrastructure internationally, providing links and summary translations of key articles. The contractor will further provide assessment of which technologies and other developments internationally are applicable and economically viable for China. As a part of this activity, a plan will be developed to sustain updating of the online FCV database and monitoring system after project close. [GEF support is required for the technical and logistical services needed in the design, development, operationalization, and maintenance of the online database and monitoring system.]

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

- 119. Component 5: FCV Technology Capacity Development Program:** This component will build human capacity in the areas of O&M for FCVs and HRSs and of financing of the FCV sector. The key barriers that will be addressed include: lack of capacity for O&M of FCVs (a substantial problem in the past that led to discontinuation of FCV operation), lack of capacity

for O&M of HRSs (an anticipated problem as the number of HRSs increases), lack of awareness of the financial sector of FCV-related financing opportunities, and lack of capacity of the financial sector to assess such opportunities. The expected outcomes that will be generated from the activities undertaken as a part of this component are: (1) increased technical capacity for O&M of FCVs and hydrogen refueling stations; and (2) increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/commercial purchase of FCVs.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.7. Key Indicators and Risks

Key Indicators

123. Key indicators for project success are listed below:

| Indicator | Target Value |
|--|---|
| Project Goal-level | |
| • Cumulative amount of GHG emissions from China’s transport sector reduced by end of project (EOP), tons CO ₂ eq | • 132,707 tons |
| Project Objective-level | |
| • Number of local transport vehicle manufacturers producing FCVs by EOP | • 10 |
| • Cumulative investment in local FCV manufacturing by EOP, USD Million | • \$10 million |
| • Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations by EOP | • 1,000 |
| Project Outcome-level | |
| <i>FCV-related technical assistance:</i> | |
| • Average lifetime hours of operation of newly produced Chinese FCVs by EOP | • 10,000 (bus) • 6,000 (car) • 6,000 (DV) |
| • Average high volume unit cost ⁴⁵ of newly produced Chinese FCVs at EOP, USD | • \$190,000 (bus) • \$36,000 (car) • \$120,000 (DV) |
| <i>FCV demos:</i> | |
| • Annual FCV sales in China by EOP, units | • 1,500 |
| • Average annual growth rate of unit FCV sales in China by EOP, % | • 100% |
| <i>Hydrogen and HRS related technical assistance:</i> | |
| • Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China | • 5 models • 3 RE-based H2 stations |
| <i>Hydrogen production and HRS demos:</i> | |
| • Annual hydrogen production (MT) and number of refueling stations in China of substantial scale | • 1000 MT • 15 |
| <i>Policy – national level:</i> | |
| Number of FCV manufacturing companies that are compliant to newly issued and enforced FCV product standards | • 10 |
| <i>Policy – local level policy pilots:</i> | |
| • Number of cities in which policies new to China promote FCV purchase | • 6 |

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

| | |
|--|-----------------|
| and/or investment in hydrogen stations are implemented | |
| <i>Awareness and Information:</i> | |
| Number of local governments that are aware and have adopted FCVs in their public transport systems | • 10 |
| Number of private vehicle owners that own and use a FCV | • 480 – 3,360 |
| <i>Capacity building for O&M of FCVs and HRSs:</i> | |
| • Number of individuals capable of satisfactorily operating and maintaining FCVs in China by EOP | • >500 |
| • Number of individuals capable of satisfactorily operating and maintaining hydrogen refueling stations in China by EOP | • >100 |
| <i>Capacity building for financial sector:</i> | |
| • Cumulative investment by financial sector in FCV and FCV value chain manufacturing and HRS and HRS value chain by EOP, USD Million | • \$100 million |

Risks

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

Exhibit 2-3: Key Project Risks

| Risk | Level of Risk | Mitigating Actions |
|---|---------------|---|
| 1. FCV operation demonstration activities will encounter the same implementation problems encountered in the FCB Demonstration Project (Phases I & II) | Low | The demonstrations have been designed to address all the necessary permits and requirements from the city authorities. This work to comply with pre-requisites will be accorded sufficient time to ensure smooth and seamless transition to the actual demonstration activities. |
| 2. Local transport vehicle manufacturers as well as other stakeholders in the local and central governments may have conflicting objectives about FCVs, preventing the effective coordination of their participation and support of the project | Low | The project implementing partner has closely coordinated the project design with the project partners putting to good use its experience implementing UNDP-GEF projects. Moreover, apart from establishing an effective project team that will be comprised of competent local and international experts in transport systems and technologies, project proponents will also make use of their good working relationship with the transport vehicle industry developed in the previous UNDP-GEF FCB demonstration project. |
| 3. The private sector will not be interested in investing in AEVs, in general, and in FCVs, in particular | Medium | The project design includes information dissemination and promotion to ensure end-users' better understanding about the use and benefits of using FCVs. The project also includes interventions aimed towards improving the local technical capacity to manufacture FCVs that are at least at par with international FCV standards, as well as other interventions that will help influence the production of cost-affordable but high quality FCVs that are expected to encourage private sector-led transport systems using FCVs. |
| 4. Transport vehicle manufacturers may favor electric vehicles rather than FCVs. | Medium | The project will build capacity of transport vehicle manufacturers, so that they are more confident about FCV production and view it as complementary to their EV work. The project will further support the GoC to develop an FCV and HRS Roadmap that will delineate the role of FCVs within the larger NEV landscape. |
| 5. Recommended policies may not be approved by the relevant | Low | The project will include the piloting of the application of the support policies for FCVs to gauge the effectiveness of said |

| | | |
|---|--------|--|
| authorities, or may be approved but not effectively enforced. | | policies. That will help guide the relevant government authorities in the finalization, approval, and effective enforcement of such policies. |
| 6. The level of co-financing amount may not support the project implementation promptly and sufficiently. | Low | Substantial co-financing commitment has been obtained. During project implementation, the project team will closely monitor and ensure co-financing is available by project partners and co-financers promptly and at least as per their respective committed amounts. |
| 7. The pace of investments for the FCV support infrastructure may not be in sync with the growth of the FCV market | Medium | The project includes activities to expand the number of HRSs and improve their viability. It further includes activities to lower the cost of hydrogen production and launch availability of renewable energy based hydrogen. |
| 8. Sustaining the outcomes and benefits of GEF investment in the activities implemented will not be fully achieved. | Medium | The project includes activities for the development of a sustainable follow-up plan for the replication of the FCV transport systems in other cities and expansion in existing demonstration cities. Implementation of the plan will be supported (financed) by the local governments. Officials from other cities will be key participants in annual workshops to disseminate results to date of the project's demos. |

2.8. Cost Effectiveness

Incremental Results and Leverage of Co-financing via GEF Inputs

125. The project, with about USD 8.2 million in GEF funding, will leverage at least 53.5 million in co-financing, and likely much more. Yet, this incremental funding from GEF, as evidenced by comparing the baseline and alternative scenarios will make a critical difference in the advancement towards commercialization of FCVs in China. The “leapfrog” in technical level and cost reduction achieved via the project along with other interventions will result in FCVs that are much more attractive for replication and that are demonstrated on an ongoing, continuous basis over a period of over three years. In the alternative scenario, at least four times replication of the project's 109 demo vehicles via new demos in other cities and scale-up in existing demo cities is expected, as compared to only one time replication in the baseline case. Similar differentiating results between the alternative and baseline scenario are seen in the areas of HRSs (more stations in continuous operation and demonstration of different business models in the alternative scenario) and hydrogen production (demonstration of renewable energy based hydrogen production in the alternative scenario), though these activities will be co-financed to a substantially greater extent than even the demo FCVs.
126. The wider impact of the project will be substantial. As it brings about the removal of the current barriers to the widespread production and application of FCVs, the start of the commercialization phase of FCVs will be realized even before 2020. The GEF's intervention through this proposed project will help spur interest among the local automotive manufacturers to carry out FCV R&D activities on their own or in collaboration with either or both local and foreign manufacturers. The current government funding in the current 12th Five Year Plan focuses also on R&D to advance domestic fuel cell technology. This project can help in further encouraging the manufacturers to avail of such assistance from the government. Furthermore, this GEF project will also supplement and assist the GOC's achievement of its NEVIDP targets and enable the realization of an alternative scenario wherein the future vehicle population in major Chinese cities includes FCVs that are not just funded by some government-subsidized environment improvement or transport pollution control programs, but also private-owned FCVs and commercially operated FCV fleets. With the facilitated market transformation from using traditional ICEVs to using AEVs (particularly FCVs), significant energy savings and energy cost savings from the transport sector will be realized, as will be the co-benefit of reduced negative environmental quality impacts.

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

Global Environmental Benefits

128. The major direct CO₂ emission reductions that are attributable to the project will come from the FCV operation demonstrations that will be carried out in the planned demonstration cities of Beijing, Shanghai, Zhengzhou and Foshan. There are also expected direct CO₂ emission reductions from other FCV application replications that will occur prior to close of the GEF project. Potential CO₂ emission reductions will further be realized from the improved renewable energy-based hydrogen production technologies that will be showcased under the project. All of these, at various levels, will be facilitated through the barrier removal activities and other capacity building and technical assistance activities that will be implemented. A major co-benefit from the project is the reduction of air pollution from cities where FCVs will be used.
129. With regard to the impact of replication on emissions abatement, this measure of the project's cost effectiveness (i.e., UAC) will be tracked using a monitoring and evaluation system that will be developed during the project. The UAC figure will be regularly re-evaluated and updated during the project implementation, particularly in quantifying the potential energy savings from projected replications, and in coming up with the CO₂ emission reduction estimates.

2.9. Sustainability and Replicability

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

131. Sustainability of results will also benefit from the Chinese government's policy and long-term development plan for FCVs. The demand for mobility by people, the necessity of transport for socio-economic development, and the current efforts of the government (central and local) to develop and support, and the need to address current transport-based air pollution are the major drivers for the sustained development efforts towards the commercialization of AEVs, in general, and FCVs, in particular. To ensure avoidance of the recurrence of the barriers and the continuance of the enabling environments that will be created and/or facilitated by the project, appropriate sustainable follow-up actions will be planned as part of the project activities. Such action plans will be implemented after the project as per the institutional arrangements that will be developed for such purpose.
132. In terms of potential for scaling up, the project will initially focus on four of the 86 cities in 40 promotional regions that have been identified by the GOC for demonstration of AEVs. The four cities will serve as the demonstration sites for the development and application of the interventions intended for the removal of barriers to FCV commercialization that will be carried out under the project. Several of the project interventions can be replicated in the other 82 cities, as well as in other regions of the country where the citizens and/or local governments are keen about the application of FCV technologies for private transport and public transport, or where interest and potential for local FCV manufacturing is present. The policies and implementing rules and regulations that will be developed under the project and adopted in the four cities can be replicated to further enhance the efforts to promote the utilization of FCVs and other environment friendly transport systems. Also, the planned demonstrations can be scaled up to involve more local transport vehicle manufacturers and transport vehicle distributors and retailers in the promotion efforts.

3. PROJECT FRAMEWORK

3.1 Project Results Framework

| This project will contribute to achieving the following Country Program Outcome as defined in CPAP or CPD: Policy and capacity barriers for the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed | | | | | |
|--|---|-------------|--|---|--|
| Country Program Outcome Indicators: Low carbon and other environmentally sustainable strategies and technologies are adopted widely to meet China's commitments and compliance with Multilateral Environmental Agreements | | | | | |
| Primary applicable Key Environment and Sustainable Development Key Result Area: 1. Mainstreaming environment and energy | | | | | |
| Applicable GEF Strategic Objective and Program: Climate Change Mitigation: Promote energy efficient low-carbon transport and urban systems | | | | | |
| Applicable GEF Expected Outcomes: Sustainable transport and urban policy and regulatory frameworks adopted and implemented. Increased investment in less-GHG intensive transport and urban systems. | | | | | |
| Applicable GEF Outcome Indicators: Cities adopting in low-carbon programs; Investment mobilized | | | | | |
| Strategy | Objectively Verifiable Indicators | | | Source of Verification | Critical Assumptions |
| | Description | Baseline | EOP Targets | | |
| Goal: Reduced growth of GHG emissions from transport sector | Cumulative tons of GHG emissions from China's transport sector reduced from FCV applications by end of project (EOP), tons | 0 | 132,707 tons CO ₂ ⁴⁶ | GHG emissions reduction estimates based on demo and pilot monitoring reports, Project's FCV Market and Technology Monitoring System | -The source of hydrogen used for project vehicles and subsequent FCVs in China is sustainable, low, or renewable (a) |
| Objective⁴⁷: Facilitation of the commercial production and application of fuel cell vehicles in China | Number of local transport vehicle manufacturers producing FCVs | 4 | 10 | Project survey of AEV manufacturers in China | -National subsidies continue at level that makes FCVs affordable to buyers (b) |
| | Cumulative investment in local FCV manufacturing, US\$ million | \$1 million | \$10 million | Project survey of AEV manufacturers | |
| | Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations | 1,000 | 10,000 | Project survey | |
| Outcome 1A : Markedly reduced | Average annual operating hours of newly | 670 (bus) | 3,300 (bus) | Project survey of FCV | |

⁴⁶ The indicated emission reduction (ER) is a target by end of project (EOP). This differs from the GHG ER calculations presented in Annex 2, which are the expected ERs during the lifetime of FCVs and hydrogen production equipment involved, some of which operate beyond EOP. The above targeted emission reductions of 132,707 tons CO₂ by EOP are a combination of direct incremental net ERs (for 109 FCVs and 4 renewable energy based hydrogen production units) and indirect ERs (assuming total vehicles by EOP are 4,000 including original 109 and assuming an additional 12 renewable energy based hydrogen production units by EOP). The estimated direct incremental net ERs total of 15,287 tons, is comprised of 9,365 tons that are derived from the operation of the 109 FCVs for 3.2 years (with baseline scenario subtracted out) and 5,922 tons are due to the four renewable energy based hydrogen production facilities operating for two year. This expected before EOP (with double counting for the portion of hydrogen used in the demo FCVs subtracted out). The indirect ERs by EOP total 117,420 tons. About 108,537 tons are due to additional FCVs (891 of which come online by start of year 3 and another 1500 of which come online by start of year 4) and 8,883 tons are due to an additional 12 renewable energy based hydrogen production facilities (which come online by start of year four).

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

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

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

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

3.2. Total Budget and Work Plan

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

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

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

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

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

Summary of Funds:⁴⁹

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

Budget Notes:

Outcome 1

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

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

3. Total of USD 144,650 in travel for Outcome 1A consists of per diems, international airfare, and domestic airfare. Per diems cover 421 days of travel in China. The large number of travel days is due largely to the intensive and extended nature of one-on-one TA for FCV manufacturers and component manufacturers. A per diem rate of US\$250 is assumed for shorter trips. For longer visits (particularly for the one-on-one assistance to component manufacturers) per diem of USD 150 is assumed based on local assistance in securing preferential rates for long visits. For airfare, 37 international roundtrips of roughly USD 1,600 each are assumed, as well as 61 legs of domestic travel at roughly USD 200 each;

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

4. Total of USD 22,500 for FCV manufacturer workshops (on at least 4 occasions; includes written materials) consists of 20 NC days at a rate of USD 200 per day, 10 days of travel with per diems USD 250, domestic flights (20 legs, at average cost of USD 200 per leg) and conference rent (6 days at USD 2000 per day);
5. Printing costs of USD 9,000 for Outcome 1A consist of the printing of 750 copies of the year 2 project FCV manufacturing progress report and 750 copies of the year 4 project FCV manufacturing progress report at unit cost of USD 2 and the printing of 1500 copies of materials for each of the FCV manufacturer workshops at unit cost of USD 4;
6. Contractual services of USD 10,000 for Outcome 1A consist of three small subcontracts, two for USD 3,000 and one for USD 4,000. The three small subcontracts are for surveys to measure indicators in the project results framework (PRF). The first will be for a survey of individuals attending the aforementioned FCV manufacturer workshops or obtaining related materials. The second will be for a survey of Chinese FCV manufacturers (one version for all such manufacturers and one for those receiving one-on-one training from the project). The third will be for a survey of the eight component manufacturers receiving one-on-one TA from the project. Each of these three subcontracts will have as its deliverables survey design, implementation, and results analysis. The main input for each will be person-days of local consultants;
7. Incremental support to China-based FC membrane manufacturer (USD 100,000) and catalyst manufacture (USD 100,000) to purchase equipment to achieve reduced cost and increased quality;
8. Miscellaneous communications costs (mail, telephone), transportation expenses, and exchange rate losses;

Outcome 1B

9. Total of USD 7,000 for international consultant (IC) services for Outcome 1B assumes a total of 10 IC days at a rate of USD 700 per day. These inputs are split among two activities, all of which are also supported by national consultants. The activities include: (1) preparation of RFPs for project FCV demo vehicles (5 days for ICs), (2) preparation of template on FCV manufacturing costs and analysis of results (5 days);
10. Total of USD 15,000 national consultant (NC) services for Outcome 1B assumes a total of 75 NC days at a rate of USD 200 per day. These inputs are split among three activities: (1) preparation of RFPs for project FCV demo vehicles (5 days for NCs), (2) analysis of demo results and recommendations for adjustments (40 days), (3) preparation of template on FCV manufacturing costs and analysis of results (30 days);
11. Printing costs of USD 20,000 for Outcome 1B consist of the printing of 2500 copies of the annual survey of public perception of FCVs (at USD 4 unit cost) and the printing of 2500 copies of the annual reports (that combine annual demo FCV operation report and public perception survey results and one-time report on FCV costs);
12. Contractual services of USD 178,000 for Outcome 1B consist of four subcontracts: (1) Design of FCV demo data collection system, collection of data, analysis (USD 70,000); (2) Annual survey of public perception of FCVs (USD 48,000); (3) Prep of template on FCV manufacturing costs and analysis of results (USD 30,000); (4) Annual reports on FCV demos (combining demo FCV operation and survey of public perception of this operation and one-time report on costs) (USD 30,000);
13. The total of USD 5.12 million in procurement of equipment for Outcome 1B represents 31 percent of the costs for all 109 FCV vehicles to be demonstrated as a part of the project. Total vehicle costs are estimated at USD 16.69 million, assuming cost reductions targeted in the alternative scenario are achieved. Co-financing will cover the other 69 percent of vehicle costs. This breakdown in cost-sharing between the GEF and domestic sources was achieved through negotiations. The negotiations resulted in agreement that the project will encompass more vehicles and vehicles meeting higher targets in durability, performance, and cost reduction than would have been achieved in China's baseline project. In addition to the 109 fuel cell vehicles considered here, there are likely to be a number of additions FCVs encompassed in the project activities (in cities such as Yancheng and Changsu, Jiangsu Province) that are 100 percent co-financed;
14. Miscellaneous communications costs (mail, telephone), transportation expenses, and exchange rate losses;

Outcome 2A

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

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

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

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

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

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

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

Outcome 2B

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

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

24. Printing costs of USD 15,000 for Outcome 2B consist of the printing of 2500 copies of the report on upfront costs for RE hydrogen demos and HRS demos (unit cost of USD 2) and the printing of 2500 copies of integrated annual report on results on both RE based hydrogen production and on HRSs (reports will include annual monitoring and public perception findings as well as integrating one-time up front cost studies);

25. Contractual services totaling USD 118,100 for Outcome 2B cover four sub-contracts for (1) Design of monitoring, monitoring, annual reporting, and related recommendations of RE-based hydrogen demos (USD 20,000); (2) Design of monitoring/HRS database, monitoring/annual reporting of HRS demos (USD 20,000); (3) Annual survey of public's perception of hydrogen (USD 20,100); (4) Design of template on upfront costs for RE hydrogen demos and HRS demos, collecting of data, analysis of findings, and reporting (USD 8,000);

Outcome 3A

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

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

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

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

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

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

Outcome 3B

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

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

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

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

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

Outcome 4

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

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

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

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

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

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

Outcome 5A

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

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

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

Outcome 5B

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

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

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

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

Project Management

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

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

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

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

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

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

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

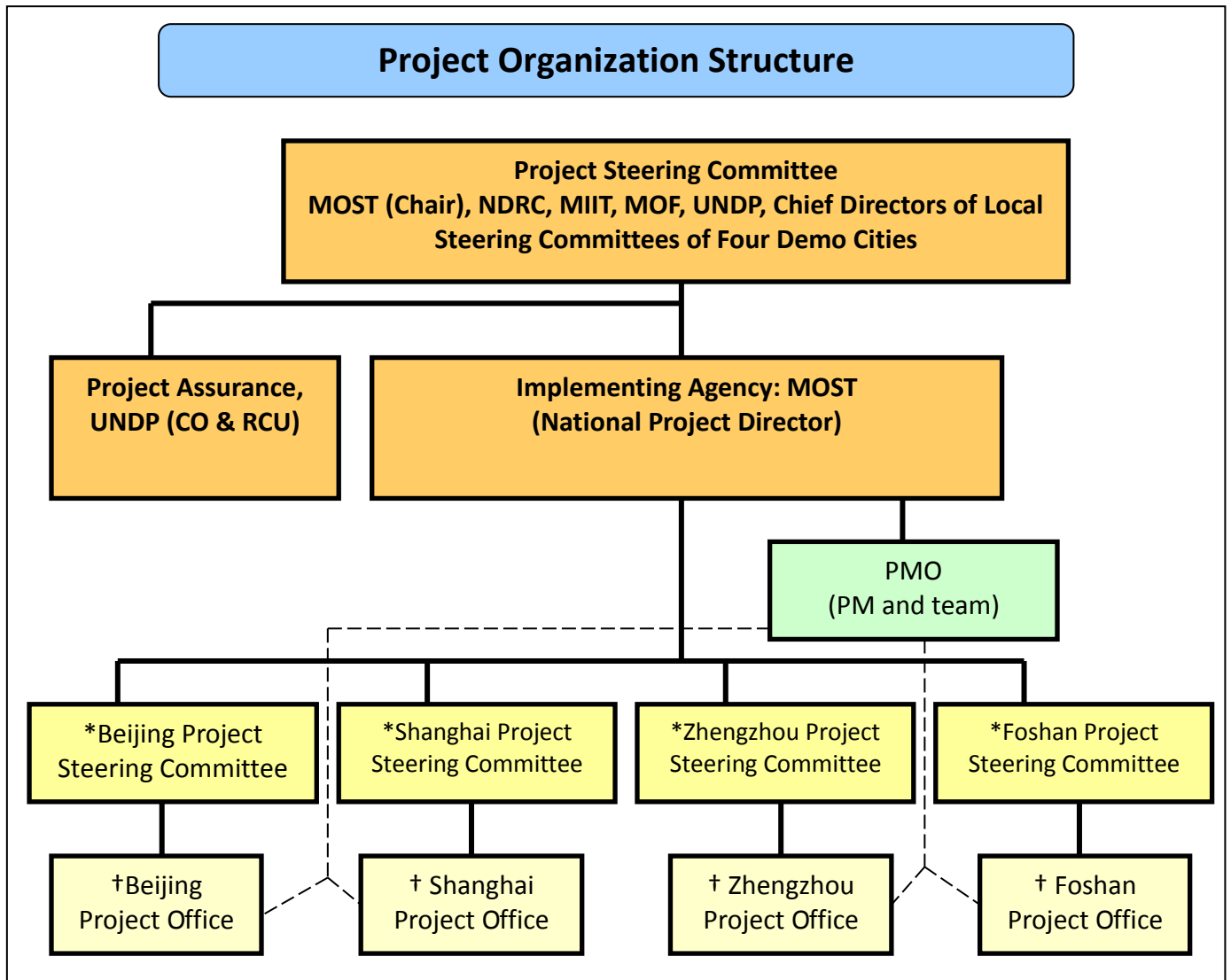
57. Total miscellaneous costs of USD 2,174 for project management are currently used mainly to balance the budget by a small amount and will be targeted at miscellaneous PMO costs;

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

4. MANAGEMENT ARRANGEMENTS

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

Exhibit 4-1: Project Management Arrangements



*Each city's project steering committee is led by a local chief director, with members from the committees, offices, or bureaus of: (1) technology, (2) industry, (3) transportation, and (4) vehicle demonstration.

†Each city's project office includes staff members responsible for: (1) operation of demonstration vehicles, (2) maintenance of demonstration vehicles, (3) operation and maintenance of hydrogen infrastructure, and (4) project management and coordination.

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

The project is nationally executed, in line with the Standard Basis Assistance Agreement between UNDP and the Government of China, and the Country Programme Action Plan (CPAP). UNDP China will, in addition to its normal oversight functions and upon the project needs, undertake the project's financial services as outlined in the agreed terms of references (Annex IX). In this regard, UNDP will create a separate unit (i.e. Financial Service Unit) to manage the project's financial services and this unit will act independently of UNDP China's normal oversight functions undertaken by UNDP China's Programme unit and all financial services actions will be undertaken following the authorization of the National Project Director or his/her assigned person/s. The financial services of the project will be done in accordance to UNDP Rules and Regulations for operations and financial management as outlined in the UNDP Programme and Operations Policies and Procedures. The financial services will in this regard follow the rules and procedures of Direct Execution and use the UNDP's internal setup for Direct Execution – including account management.

5. MONITORING FRAMEWORK AND EVALUATION

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

Project Start

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

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

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

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

Quarterly

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

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

Annually

140. Annual Project Review/Project Implementation Reports (APR/PIR): This key report is prepared to monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements. The APR/PIR includes, but is not limited to, reporting on the following:
- Progress made toward project objective and project outcomes - each with indicators, baseline data, and end-of-project targets (cumulative)
 - Project outputs delivered per project outcome (annual).
 - Lesson learned/good practice.
 - AWP and other expenditure reports
 - Risk and adaptive management
 - ATLAS QPR
 - Portfolio level indicators (i.e. GEF focal area tracking tools) are used by most focal areas on an annual basis as well.

Periodic Monitoring through Site Visits

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

Mid-term of Project Cycle

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

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

End of Project

144. An independent Final Evaluation will take place three months prior to the final Project Board meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.
145. The Terminal Evaluation should also provide recommendations for follow-up activities and requires a management response, which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC).
146. The relevant GEF Focal Area Tracking Tools will also be completed during the final evaluation.
147. During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met, and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

Learning and Knowledge Sharing

148. Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.
149. The project will identify and participate, as relevant and appropriate, in scientific, policy-based, and/or any other networks, which may be of benefit to project implementation through lessons learned. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects.
150. There will be a 2-way flow of information between this project and other projects of a similar focus.

Communications and Visibility Requirements

151. Full compliance is required with UNDP's Branding Guidelines. These can be accessed at <http://intra.undp.org/coa/branding.shtml>, and specific guidelines on UNDP logo use can be accessed at: <http://intra.undp.org/branding/useOfLogo.html>. Amongst other things, these guidelines describe when and how the UNDP logo needs to be used, as well as how the logos of donors to UNDP projects needs to be used. For the avoidance of any doubt, when logo use is required, the UNDP logo needs to be used alongside the GEF logo. The GEF logo is accessed at: http://www.thegef.org/gef/GEF_logo. The UNDP logo can be accessed at <http://intra.undp.org/coa/branding.shtml>.
152. Full compliance is also required with the GEF's Communication and Visibility Guidelines (the "GEF Guidelines"). The GEF Guidelines can be accessed at: http://www.thegef.org/gef/sites/thegef.org/files/documents/C.40.08_Branding_the_GEF%20final_0.pdf. Amongst other things, the GEF Guidelines describe when and how the GEF logo needs to be used in project publications, vehicles, supplies and other project equipment. The

GEF Guidelines also describe other GEF promotional requirements regarding press releases, press conferences, press visits, visits by Government officials, productions and other promotional items.

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

Audit Clause

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

155. M & E Work Plan and Budget

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

6. LEGAL CONTEXT

156. This document together with the CPAP signed by the Government and UNDP, which is incorporated by reference, constitute together a Project Document as referred to in the SBAA; and all CPAP provisions apply to this document.
157. Consistent with Article III of the Standard Basic Assistance Agreement, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner.
158. The implementing partner shall:
- a) Put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried out;
 - b) Assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.
159. UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.
160. The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list is accessed via <http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm>. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

Annex I. Risk Analysis

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

Exhibit I-1: China DevCom FCV Project Risk Log

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

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

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

Annex II. Agreements

Co-financing Letters are attached in a separate file.

Annex III. GHG Emission Reduction Estimates

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

1. First, direct GHG emission reductions due to the FCV demos in the baseline scenario are computed. These reductions are based on the reduced GHG emissions from using FCVs as compared to the use of the same type of vehicles that use internal combustion engines (ICEVs). The emissions from the latter are based on a typical gasoline-diesel consumption mix for ICEVs.
2. Second, direct GHG emission reductions due to the FCV demos in the alternative (project) scenario are computed. These are also computed based on comparison to the emissions from ICEVs based on a typical gasoline-diesel consumption mix.
3. Third, the difference between the alternative scenario direct emission reduction from the demo FCVs and the baseline scenario direct emission reduction from the demo FCVs is determined, to show the total direct emission reductions due to the project's demo FCVs ("incremental reductions"). A substantial gap between the two scenarios exists and may be attributed to the following reasons:
 - Alternative scenario FCVs are operated more hours of day and for more years than baseline scenario FCVs;
 - There are more vehicles in the alternative scenario case; and,
 - In the alternative scenario case, some of the hydrogen is renewable energy based.

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

4. Fourth, incremental emission reductions due to wind farm based hydrogen production are taken into account. Wind based hydrogen exists in the alternative scenario but not the baseline scenario. Some of the hydrogen is used to fuel FCVs, while the rest is used for other non-vehicular purposes. To avoid double counting in emission reductions, a correction is made in step six (to be discussed), so that the emission reductions due to wind power based hydrogen used in FCVs is not double counted.
5. Fifth, incremental emission reductions due to land-fill methane based hydrogen production are determined. At present it is assumed that this hydrogen is used for purposes other than FCVs, though in the long-term it is expected land-fill methane based hydrogen production in China will serve a growing FCV base.
6. Sixth, total direct incremental emissions reductions from both the demo FCVs and the renewable energy based hydrogen production efforts are computed. It is at this point that a correction is made to eliminate double counting of hydrogen that is used in FCVs.
7. Seventh, indirect emission reductions using both the bottom up and top down scenarios are estimated, thus providing a range for the project's potential indirect emission reductions.

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

Direct GHG Emission Reductions due to FCV Demos – Baseline Scenario

Exhibit III-1 shows emission factors and other parameters used to estimate GHG reductions in the baseline scenario (without the GEF project) for the total of 92 fuel cell vehicles that four Chinese cities (Beijing, Shanghai, Zhengzhou, and Foshan) collectively have planned for demonstration as part of their individual programs on new energy vehicles (NEVs). Each city has its own NEV program that includes alternative energy vehicles among which are FCVs. Considering only these four separate baseline FCV programs (i.e., without GEF incremental interventions), the demonstration FC vehicles are operated for a limited time of about one and a half years. Further, the total distance (kms) driven per year for each vehicle is on average about half of what will be expected in the alternative scenario, which will be facilitated by this proposed GEF project. Total emission reductions for the baseline scenario are 1,449 tons CO₂.

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

In order to compute emission reductions in the baseline scenario, we compare emission factors for a mix of gasoline and diesel ICE vehicles to emission factors for the baseline scenario FCVs. Subtracting the FCV emissions factor in each case from the gasoline/diesel emissions factor yields an “emissions reduction factor” used to compute total emissions reductions for each vehicle type. For the gasoline/diesel emission factors we use GEF TEEMP values of 304 grams CO₂ per vehicle km travelled for autos and 1,338 grams CO₂ per vehicle km travelled for buses. For delivery vehicles, we use an intermediary number, the average of the two foregoing emissions factors, 821 grams CO₂ per vehicle km travelled.

Because the Beijing vehicles will have different hydrogen source types than the vehicles from the other cities, we compute the Beijing FCV emission factors differently. In the baseline scenario, hydrogen for Beijing baseline FCVs will be provided by Capital Steel and be a mix of hydrogen produced from natural

gas (steam methane reforming, SMR) and hydrogen produced from electrolysis. It is assumed that this mix is 50-50 (half from each source) and that, in the baseline scenario, the electrolysis is powered by the electricity grid. (The latter will not be allowed in the alternative scenario due to high CO₂ emissions.) For the natural gas (SMR) FCV “well to wheel” emission factor, we use 162 g CO₂ per km for autos, based on an emission factor of about 260 g CO₂ per mile used by Joseck and coauthors (from US Department of Energy and Argonne National Labs, also in the US).⁵⁰ For the auto grid electricity FCV emission factor, we use the California Energy Commission’s estimate of 300 g CO₂ per mile to get 186 g CO₂ per km.⁵¹ Assuming a 50-50 mix and taking the average of the natural gas and grid electricity FCV emission factors yields an overall auto emissions factor of 174 g per km for the Beijing baseline scenario. Further, this is scaled up by a factor of 4.4 times for buses and 2.7 times for delivery trucks (based on the ratios of gasoline/diesel emission factors by vehicle type) to get a Beijing baseline FCB emission factor of 766 g CO₂ per km and a Beijing baseline FC delivery truck emissions factor of 470 g CO₂ per km.

Exhibit III-1: Direct CO₂ Emission Reductions in the Baseline Scenario

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

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

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

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

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

⁵⁰ Fred Joseck, Michael Wang, and Ye Wu, “Potential Energy and Greenhouse Gas Emission Effects of Hydrogen Production from Coke Over Gas in US Steel Mills,” *International Journal of Hydrogen Energy*, 2008, pages 1445-1454.

⁵¹ California Energy Commission as referenced by California Fuel Cell Partnership in *Well to Wheels: A Guide to Understanding Energy Efficiency and Greenhouse Gas Emissions*, updated September 2012.

⁵² Xue Deng, Hewu Wang, Hiyang Huang, and Minggao Ouyang, “Hydrogen Flow Chart in China,” *International Journal of Hydrogen Energy*, 2010.

emissions. In COG Scenario 2 (considering just the PSA system input and transport to HRS), Joseck et al come up with a well to wheel emission factor of roughly 50 g CO₂ per km. In their Scenario 3 (considering the PSA system input and addition of natural gas to replace lost process heat utilized), they come up with a well to wheel emission factor of roughly 130 g CO₂ per km. Based on the analysis of the situation that China currently utilizes only about 20 percent of its COG for fuel, these emission factors were taken to be at 80 percent and 20 percent respectively, to come up with an overall COG FCV emission factor of 66 gm CO₂ per km (=0.8*50 g/km + 0.2*130 g/km). This factor is scaled up 4.4 times for buses and 2.7 times for delivery vans to yield FCV emission factors of 290 g CO₂ per km and 178 g CO₂ per km, respectively, for those vehicle types.

Direct GHG Emission Reductions due to FCV Demos – Alternative Scenario

Exhibit III-2 shows CO₂ reductions in the alternative scenario for the 109 alternative scenario vehicles (16 GEF-financed and 93 co-financed⁵³). Total emission reductions in the alternative scenario are 10,814 tons CO₂ as compared to 1,449 tons CO₂ in the baseline scenario.⁵⁴ Three key factors result in the substantially higher reduction emissions in the alternative scenario. First and most importantly, due to focused technical assistance for achieving targets set by the project, assistance in achieving policy and long-term approvals for vehicle use, and assistance in designing enhanced plans for the demos, the vehicles operate for substantially longer hours per day (11 hours per day for buses instead of 5.5 hours and 6 hours per day for other vehicles instead of 3 hours) and are operated over a longer time period (3.2 years instead of 1.5 years). Secondly, there are more vehicles than in the baseline case, with the GEF funds supporting purchase of 16 FCBs, raising the number of buses from 7 to 23. In addition, existence of the UNDP-GEF project attracts Toyota to contribute one FC auto as well, raising the number of autos from 50 to 51. Thirdly, hydrogen produced from wind farms as facilitated by the project result in about half of the Beijing vehicles hydrogen supply being renewable energy based hydrogen, further increasing emission reductions. It is important to note, then, that incremental emission reductions are not only embodied in the buses purchased with GEF funds. The co-financed vehicles, which were to occur in the baseline case, benefit significantly from various forms of technical assistance and thus also operate more hours per day and over a longer period of time than in the baseline scenario.

In calculating emission reduction factors for the alternative scenario, the same emission factors for gasoline/diesel ICE vehicles as used in the baseline scenario were considered. For Beijing FCVs, assuming half of the hydrogen is provided by natural gas (steam methane reforming) and half of the hydrogen is provided by wind power based electrolysis, the new FCV emission factors are estimated by taking the average of the natural gas emission factor and the wind power based hydrogen emission factor for autos and then scaling it up by 4.4 times for buses and 2.7 times for delivery trucks. The auto natural gas hydrogen emission factor is the same as used above, 162 g CO₂ per km, based on Joseck et al. The FC automobile wind farm based hydrogen emissions factor is based on US Department of Energy well to wheel estimates, taking the average of 42 g CO₂ per mile (for 62-73 miles per gallon, 94 percent energy efficiency for hydrogen compression to 6,251 psig) and 63 g CO₂ per mile (for 42-48 miles per gallon, other parameters the same) and converting to g CO₂ per kilometer to get 32.6 g CO₂ per km for wind-based hydrogen fueled auto. Assuming half natural gas based hydrogen and half wind farm based

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

⁵⁴ Because Yancheng, Jiangsu Province, and several other cities have shown strong interest in joining the demonstration of this project, it is likely that the number of demo vehicles in the alternative scenario will substantially surpass 109 and that the direct GHG emission reductions will thus be larger than estimated here. Additional demo cities and vehicles will be officially incorporated into the project plan at inception and GHG direct emission reduction estimates (and direct incremental emission reduction estimates) will be revised accordingly. In the case of Yancheng, which is currently very likely to join the project demos, eight buses are expected, as is full provision of hydrogen by wind-based electrolysis. In the alternative scenario, this will add 2,389 tons (an additional 26%) to the direct incremental CO₂ emission reductions due to the project.

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

Exhibit III-2: Direct CO₂ Emission Reductions in the Alternative Scenario

| City or cities | Vehicle Type | No. of vehicles (C) | Gasoline/diesel emission factor (g CO ₂ /km) (D) | FCV baseline emission factor (g CO ₂ /km) (E) | Emission reduction factor (g CO ₂ /km) (D-E) = (F) | Km driven per year (G) | Years driven (H) | Emission reduction (tons CO ₂) (C*F*G*H*10 ⁶) = (I) |
|--|--------------|---------------------|---|--|---|------------------------|------------------|---|
| Beijing* | Bus | 10 | 1,338 | 428 | 910 | 78,124 | 3.2 | 2,274.97 |
| | DV Truck | 5 | 821 | 263 | 558 | 46,876 | 3.2 | 418.51 |
| Shanghai, Zhengzhou, Foshan** | Bus | 13 | 1,338 | 290 | 1,048 | 78,124 | 3.2 | 3,405.96 |
| | Auto | 51 | 304 | 66 | 238 | 46,876 | 3.2 | 1,820.74 |
| | DV Van | 30 | 821 | 178 | 643 | 46,876 | 3.2 | 2,893.56 |
| Total | --- | 109 | --- | --- | --- | --- | --- | 10,814 tons |
| Direct incremental emission reductions: 10,814 tons (alternative) – 1,449 tons (baseline) = | | | | | | | | 9,365 tons |

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

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

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

Incremental Direct Emission Reductions Due to Demo FCVs

Currently, it is anticipated the 109 demo FCVs can complete their full duration of driving during the lifetime of the project, so that total incremental FCV demo direct CO₂ emission reduction of the project will be equivalent to the lifetime incremental direct emission reductions of the FCV demos. In this case, that is, there will be no lifetime post-project incremental direct emission reductions due to the demo FCVs. This situation is expressed in the first equation below. It is quite, possible, however, that the lifetime of the FCVs will extend beyond the conservative 3.2 years (and associated kms per year) currently targeted, thus yielding greater emission reductions than in this conservative analysis. Further, it is expected that the FCV financing scheme will result in USD 50 million of FCV financing by EOP and that the financed vehicles will operate for about 3.2 years post project and have a similar vehicle mix to the project demos. USD 50 million is about three times the USD 16.650 million cost of the 109 demo vehicles. Thus, the financing scheme should purchase about three times the amount of demo vehicles (if a similar mix is assumed) and the lifetime direct post project emission reductions will be at least three times lifetime direct emission reductions, as expressed in the second equation below.

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

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

Direct GHG Emission Reductions due to Wind Farm based Hydrogen Production

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

The GHG emissions per kg of hydrogen produced by natural gas reforming and by-product (coke oven gas) are used as a comparison factor to estimate total emission reductions. A 50:50 mix of the two types of fossil-fuel based hydrogen production is assumed to be replaced. For natural gas reforming, an emission factor of 9 kg CO₂ per kg of hydrogen is assumed. This is a typical value found in the literature and, as mentioned, does not include transport to end use. Scaling the 66 g per km factor used for FC autos using by-product hydrogen in a similar way to the scaling suggested for the natural gas case (in both cases, 1 kg hydrogen per 100 kg auto travel distance is assumed), a CO₂ emissions factor of 3.67 kg CO₂ per kg hydrogen is arrived at. Thus, the average of these two fossil-fuel based hydrogen emission factors is 6.34 kg CO₂ per kg hydrogen. Emission reductions, based on this average factor, are computed below:

Lifetime Direct Emission Reductions (DER) = $3 \text{ wind farms} \times 133,304 \text{ kg/wind farm-year} \times 20 \text{ years} \times (6.34 \text{ kg CO}_2 \text{ per kg fossil fuel based hydrogen production}) = 50,709 \text{ tons CO}_2$

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

Direct GHG Emission Reductions due to Landfill Methane based Hydrogen Production

For the landfill methane based hydrogen production demonstration, the process is methane reforming ($\text{CH}_4 + 2\text{H}_2\text{O} = \text{CO}_2 + 4\text{H}_2$) and the CO₂ emissions from this process is about 5.5 kg of CO₂ per kg of hydrogen produced. The demo will be constructed at economic scale which is considered 1,000 to 2,000 Nm³ hydrogen per hour. Using a conversion factor of 1 Nm³ hydrogen = 0.08988 kg and assuming the demo scale is 1,500 Nm³ hydrogen per hour, the scale in kg of hydrogen produced is 135 kg per hour. Assuming 20 hour operation per day, annual output will be 985,500 kg of hydrogen. While we will use for comparison the fossil fuel hydrogen production CO₂ emission factor of 6.35 kg CO₂ per kg hydrogen as used above, it is noted that an additional important GHG emissions reduction benefit of landfill methane based hydrogen production is elimination of methane (CH₄) emissions from the landfill. Pound per pound, methane has 21 times the comparative impact that CO₂ does over a 100-year period. Emission reductions (considering only the CO₂ reduction benefit) are given below. It is assumed that the landfill methane hydrogen production equipment is up and running by the start of year three of the project and thus runs for two full years during the project lifetime. A 20 year lifetime of the land-fill methane hydrogen production equipment is assumed, so that the equipment continues to be used 18 years after end of project.

Lifetime Direct Emission Reductions (DER) = $1 \text{ landfill methane based hydrogen production site} \times 20 \text{ years} \times 985,500 \text{ kg of hydrogen per year} \times (6.35 \text{ kg CO}_2 \text{ per kg hydrogen} - 5.5 \text{ kg CO}_2 \text{ per kg hydrogen}) = 16,754 \text{ tons CO}_2$

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

Total Direct Incremental Emission Reductions

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

Total Incremental Lifetime Direct Emission Reductions (DER)
= FCV DER + wind farm H₂ production DER + land-fill methane H₂ production DER – double counting
= 9,365 tons + 50,709 tons + 16,754 tons - 824 tons⁵⁵ = 76,004 tons CO₂

Total Incremental Lifetime Direct Post Project Emission Reductions (DPPER)
= FCV DPPER + wind farm DPPER + land-fill methane DPPER – double counting
= 28,095 tons CO₂ + 0 - 824 tons*3⁵⁶ = 25,623 tons CO₂

Indirect Emission Reductions – Bottom Up

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

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

Indirect Emission Reduction for Bottom up Analysis for FCVs

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

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

$$= [(9,365 \text{ tons of CO}_2 - 824 \text{ tons CO}_2) + (28,095 \text{ tons of CO}_2 - 824 \text{ tons CO}_2 * 3)] * \text{replication factor of 4}$$

$$= (8,541 + 25,623) * 4 \text{ tons CO}_2 = 136,656 \text{ tons of CO}_2$$

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

Total Indirect Emissions Reduction – Bottom up Analysis
 $= 136,656 \text{ tons} + 202,365 \text{ tons} = 339,021 \text{ tons CO}_2$

Indirect Emission Reductions – Top Down

In the top-down analysis, we refer to Exhibit 1-5 in the main text which shows the cumulative total number of NEVs on the road in China for each of 2010, 2011, 2012, 2013, and first half of 2014. The vast majority of these FCVs are some form of electric vehicle, including hybrid. We assume that starting year one post-project (2020), fuel cell vehicles show a similar type of ramp up as EVs had shown, just delayed by ten years from the case of EVs and then forecast for further growth from 2025-2029, though somewhat less aggressive growth than in 2020-2024. To simplify computations, we also assume a mix of vehicle types similar to that of the 109 demo FCVs. Further we assume that the hydrogen mix is similar to that used for the 109 demo vehicles in the alternative scenario (and thus a mix of natural gas reforming based hydrogen, wind farm electrolysis based hydrogen, and by-product COG based hydrogen). Exhibit III-3 shows our computation for total emission reductions by FCVs in China from 2020 to 2029, which are estimated to be around 124 million tons CO₂. A causality factor of 50 percent is adopted, so that indirect top down FCV emission reductions are 62 million tons. The project is believed to have a relatively strong influence in future FCV adoption due to the policy pilots, the cost reductions in FCV components achieved via technical assistance and international cooperation assistance provided to China-based component manufacturers, and the initial very positive demonstration effect of the project FCV demos.

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

| Year | Cumulative number of FCVs on the road in China | Multiples of 109 represented by cumulative number [C] | Emission reductions for 109 vehicles over period of 1 year (CO ₂ tons) [D] | CO ₂ emission reductions (tons) [C] x [D] |
|---|--|---|---|--|
| 2020 | 15,000 | 137 | 3,379 | 462,923 |
| 2021 | 30,000 | 275 | 3,379 | 929,225 |
| 2022 | 60,000 | 550 | 3,379 | 1,858,450 |
| 2023 | 110,000 | 1,009 | 3,379 | 3,409,411 |
| 2024 | 210,000 | 1,927 | 3,379 | 6,511,333 |
| 2025 | 340,000 | 3,120 | 3,379 | 10,542,480 |
| 2026 | 500,000 | 4,587 | 3,379 | 15,499,473 |
| 2027 | 690,000 | 6,330 | 3,379 | 21,389,070 |
| 2028 | 900,000 | 8,257 | 3,379 | 27,900,403 |
| 2029 | 1,140,000 | 10,459 | 3,379 | 35,340,961 |
| Total emission reductions from FCVs in China in the ten years after project close | | | | 123,843,729 tons |
| Causality factor of 50% -> top down indirect emission reductions due to FCVs (E) | | | | 61,921,865 tons |

During this period in the top down approach, it is also projected that 240 MW total of wind based hydrogen production is adopted and that the causality factor is also 50 percent. Finally, about 40 land-fill methane based hydrogen facilities are projected to be set up on a similar scale to the project demo. The

total emission reductions yielded from all this renewable energy based hydrogen production is 632,880 tons CO₂, which with a causality factor of 50 percent suggest 316,440 tons of top-down indirect CO₂ emission reductions. While it is difficult to project that portion of this hydrogen production will be used for FCVs, it is envisioned that an increasing portion is indeed used in FCVs. In any event, as the value of top-down indirect CO₂ emission reductions from H₂ production is less than one percent of that estimated for FCV based emission reductions, it is assumed that all of hydrogen production ERs are double counted and thus can be ignored.

The total top down analysis (TDA) emission reductions are the sum of the top down indirect FCV emissions reductions and the top down indirect renewable energy based hydrogen production emission reductions. This total is 62,238,305 million tons CO₂.

Thus, the range for anticipated indirect emission reductions is from 339,021 tons CO₂ (bottom up analysis) to 62,238,305 tons CO₂ (top down analysis). This is the range of indirect emission reductions attributable to the project. The range is quite large due to uncertainty of the timing of the tipping point when FCVs will take off at a rate similar to EVs in China.

Annex IV. Annual Targets

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

| Strategy | Indicator | Baseline | Year 1 Target | Year 2 Target | Year 3 Target | Year 4 (EOP) Target |
|---|--|------------------------------------|------------------------------------|--|--|--|
| Goal: Reduced growth of GHG emissions from transport sector | Cumulative tons of GHG emissions from China's transport sector reduced by end of project (EOP) | 0 | 0 | 3,121 tons | 38,669 tons | 132,707 tons |
| Objective⁵⁷: Facilitation of the commercial production and application of fuel cell vehicles in China | Number of local transport vehicle manufacturers producing FCVs by EOP | 4 | 4 | 6 | 8 | 10 |
| | Cumulative investment in local FCV manufacturing by EOP, US\$ million | \$1 million | \$2 million | \$4 million | \$7 million | \$10 million |
| | Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations by EOP | 1,000 | 3,000 | 5,000 | 7,500 | 10,000 |
| Outcome 1A : Markedly reduced costs and improved performance and durability of FCVs in China | Average annual operating hours of newly produced Chinese FCVs by EOP, hours | 670 (bus) 670 (car) 670 (DV) | 670 (bus) 670 (car) 670 (DV) | 3,300 (bus) 2,100 (car) 2,100 (DV) | 3,300 (bus) 2,100 (car) 2,100 (DV) | 3,300 (bus) 2,100 (car) 2,100 (DV) |
| | Reduction in high volume unit cost ⁵⁸ of newly produced Chinese FCVs at EOP, % | 0% (bus) 0% (car) 0% (DV) | 0% (bus) 0% (car) 0% (DV) | 50% (bus) 40% (car) 50% (DV) | 50% (bus) 40% (car) 50% (DV) | 50% (bus) 40% (car) 50% (DV) |
| Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China | Annual FCV sales China by EOP (units sold) | 0 | 109-200 | 175-1,000 | 300-3,500 | 400 – 7,000 |
| | Average annual growth rate of FCV sales in China by EOP (% growth in units sold as compared to previous year) | 0% | >100% | 100% | 100% | 100% |
| Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations | Number of distinct business models used at hydrogen refueling stations (e.g. standard, hydrogen production on-site, dual gasoline-hydrogen station, etc.) in China | 1 | 1 | 4 | 4 | 5 |
| Outcome 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen | Number of hydrogen production units and refueling stations in China of substantial scale: | | | | | |
| | <ul style="list-style-type: none"> Annual H2 production, MT No. of H2 refueling stations | 0 2 | 0 4 | 500 8 | 750 12 | 1,000 15 |
| Outcome 3A: Effective | Number of FCV manufacturing companies that | 0 | 0 (N/A – | 4 | 7 | 10 |

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

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

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

Annex V: Terms of Reference

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

V.1: PMO and PMO Technical Advisor TORs

1. PMO Project Manager

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

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

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

Deliverables

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

Required Qualifications

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

2. PMO Monitoring and Evaluation Officer

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

Required Tasks:

- Updating of project indicators

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

Deliverables

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

Required Qualifications

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

3. PMO Communications and Dissemination Officer

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

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

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

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

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

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

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

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

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

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

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

Required Tasks

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

Deliverables

- Written training curriculum

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

Required Qualifications

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

3. Expert in International Sourcing of FCV Parts

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

Required Tasks

- Conduct comprehensive assessment of sourcing challenges faced by Chinese FCV manufacturers through consultations with these manufacturers and relevant experts in China. Through consultations, expert will determine how each major FCV component is currently sourced, whether it is up to international standard, and how prices compare to internationally competitive prices.
- Evaluate various feasible international sources of FCV components based on findings from aforementioned assessment.
- Prepare comprehensive compendium of recommended component suppliers in international market. Compendium to be shared with all interested vehicle manufacturers in China.
- Conduct targeted individual technical assistance to selected FCV manufacturers in achieving new advantageous sourcing agreements for FCV-related components from international suppliers. Taking into consideration identified sourcing challenges, assist the China-based FCV manufacturers in liaising with relevant international component suppliers and in negotiating of sourcing agreements.
 - This work will be completed early enough in the project so that newly sourced components that achieve cost reductions, durability improvements, and/or performance improvements are available to be incorporated into demo vehicles manufactured for the project. Assistance will be provided to all FCV manufacturers that are considered to have high potential to meet project commercialization targets.
 - This work will include, but not be limited to, outreach to international manufacturers (including auto OEM and non-auto OEM) for purchase of world class FC engines. If generally attractive terms are obtained, activity will also include support to Chinese manufacturers in negotiating details of FC engine sourcing agreements. More than one make of engine may be sought to enable comparison of results.
 - Other priority areas to be covered include: hydrogen recirculation pump, compressor, MEA, and hydrogen valve with high quality seal.

Deliverables

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

Required Qualifications

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

4. Expert in Design and Analysis of FCV Demonstration

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

5. TOR for FCV O&M Training Expert

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

Required Tasks

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

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

Deliverables

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

Required Qualifications

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

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

1. TOR for International FC Membrane Expert

International FC membrane expert will assist China-based FC membrane manufacturer (Shandong Dongyue) to achieve reduced cost and increased quality (manifested in increased durability, reduced thickness, and improved hydrogen cross-over, performance, and manufacturing quality). Reduced cost will be sought in part by targeting scale up of production/demand from current 200,000 m² per year to 1 million m² year to further leverage Dongyue's vertical integration (from mine to membrane) cost advantage. The technical assistance will complement Dongyue's 2014 investment of 50 million RMB (8 million USD) in pilot production equipment and its planned annual 20 million RMB (3.2 million USD) additional investment in FC membrane production and testing, targeting expanded production and increased product stability and consistency.

Required Tasks

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

Deliverables

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

Required Qualifications

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

2. TOR for Expert in Facilitating International Cooperation

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

Required Tasks:

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

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

Deliverables:

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

Required Qualifications:

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

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

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

Required Tasks

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

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

Deliverables

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

Required qualifications

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

4. TOR for International FC Catalyst Expert

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

Required Tasks

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

Deliverables

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

Required Qualifications

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

5. TOR for International MEA Expert

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

Required Tasks:

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

Deliverables:

- Memo on assessment of current production processes and MEA quality
- Written action plan, with strong attention to reducing discard rate
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications

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

6. TOR for International Bipolar Plate Expert

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

Required Tasks:

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

Deliverables:

- Memo on assessment of current production processes and bipolar plate quality
- Written action plan based on assessment
- Memo on improvements adopted and quality improvements and cost reductions achieved thereby

Required Qualifications

- Recognized international expert in bipolar plate manufacture
- Particular expertise in coating and stamping
- Experience working at known top international provider (past or present) of FC bipolar plates preferred

- Strong communication skills
- High level of integrity

7. TOR for International FC Stack Expert

International FC Stack Expert will provide assistance to China-based FC stack manufacturer Dalian Sunrise to optimize stack and balance of system (BOS) and thereby reduce cost to FCV manufacturers for globally competitive FC stack. Targets include: (i) increasing stack maximum efficiency from current level of 60 percent to 65 percent, (ii) increasing stack lifetime at specified test cycle from current level to 10,000 hours, and (iii) increasing performance from 1.0A@0.65V to 1.5A@0.65V.

Required Tasks:

- Assess current manufacturing processes, components, and quality of FC stack manufacture
- Develop action plan based on recommendations emerging from assessment
- Provide one-on-one technical assistance to optimize stack and balance of system
- Assist with sourcing as needed

Deliverables:

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

Required Qualifications

- Recognized international expert in FC stacks
- Special expertise in stack and BOS optimization
- Experience working at known top international provider (past or present) of FC stacks
- Strong communication skills
- High level of integrity

8. TOR for International FCV Air Compressor Expert

International FCV Air Compressor Expert will provide assistance to China-based FCV air compressor manufacturer Foshan Guangshun to improve quality control processes, technology, and sourcing of compressor parts, thereby reducing cost to FCV manufacturers for globally competitive FCV air compressor. Improvements will include those in the areas of air bedding and better high speed motors. Targets will be to increase power density and durability (lifetime) to internationally competitive levels.

Required Tasks:

- Assess current manufacturing processes of, quality of, and sourcing of parts for the FCV air compressor. This will include assessment as to which compressor technology (conventional compressor or other) will be most strategic in terms of cost and durability potential.
- Develop action plan based on recommendations emerging from the assessment
- Provide one-on-one technical assistance

Deliverables:

- Memo on assessment of current production processes, quality, and sourcing of FCV air compressor manufacturer Guangshun
- Written action plan based on assessment
- Memo on measures adopted and quality improvements and cost reductions achieved thereby

Required Qualifications

- Recognized international expert in FCV air compressors
- Experience working at known top international provider (past or present) of FCV Air Compressors, such as Eaton
- Strong communication skills

- High level of integrity

9. TOR for International FCV Hydrogen Recirculation Pump Expert

International FCV Hydrogen Recirculation Pump Expert will provide assistance in identifying China-based potential manufacturer of hydrogen recirculation pump and in design/engineering of production/processing facilities and launch of production. Domestic production of hydrogen recirculation pump (currently unavailable) will be targeted to lower costs and other difficulties faced by Chinese FCV manufacturers in sourcing this component.

Required Tasks:

- Identify and vet China-based manufacturers currently interested in production of hydrogen recirculation pump, resulting in selection of one manufacturer
- Assess of needs of selected manufacturer in launching production of quality hydrogen recirculation pump
- Develop action plan to implement recommendations emerging from assessment
- Provide one-on-one technical assistance to enable selected manufacturer to design and set up manufacturing line and ensure quality product

Deliverables:

- Memo on shortlisted potential hydrogen recirculation pump manufacturers in China and explanation of strengths
- Written assessment and action plan
- Memo on launching of production and on measures adopted to ensure quality and cost reduction

Required Qualifications

- Recognized international expert in FCV hydrogen recirculation pump
- Experience working at known top international provider (past or present) of FCV hydrogen recirculation pumps preferred
- Strong communication skills
- High level of integrity

10. TOR for International FCV High Voltage DC/DC Converter Expert

International FCV High Voltage DC/DC Converter Expert will provide assistance identifying China-based existing or potential manufacturer of FCV high voltage DC/DC converter and assistance in design/engineering or improvement of production/processing facilities. Domestic production of FCV high voltage DC/DC converter will be targeted to lower costs and alleviate other difficulties faced by Chinese FCV manufacturers in sourcing this component.

Required Tasks:

- Identify and vet China-based manufacturers currently interested in production of or currently producing FCV high voltage DC/DC converter, resulting in selection of one manufacturer
- Assess needs of selected manufacturer in launching production of quality FCV high voltage DC/DC converter
- Develop action plan to implement recommendations emerging from assessment
- Provide one-on-one technical assistance to enable selected manufacturer to design and set up (or improve) manufacturing line and ensure quality product

Deliverables:

- Memo on shortlisted potential or existing FCV high voltage DC/DC converter manufacturers in China and explanation of strengths
- Written assessment and action plan
- Memo on launching of (or improving) production and on measures adopted to ensure quality and cost reduction

Required Qualifications

- Recognized international expert in FCV high voltage DC/DC converter
- Experience working at known top international provider (past or present) of FCV high voltage DC/DC converters preferred
- Strong communication skills
- High level of integrity

V.4: TORS for Consultants to Support Hydrogen Production and Hydrogen Refueling Stations, including Demos and HRS O&M

1. TOR for Expert in Wind Power Based Hydrogen Production

Expert will provide one-on-one technical assistance for investors in and managers of wind power based hydrogen production facilities on wind farms in China hoping to utilize excess power. Technical assistance will enable investors and managers to incorporate international best practice into their efforts thus improving the viability and reducing the cost of wind power based hydrogen production in China. In doing this work, expert will work with Project Technical Advisor on Hydrogen.

Required Tasks

- Provision of technical assistance to three wind farms planning to produce hydrogen from excess wind power. Assistance will be focused on improving reliability and reducing costs. It will include:
 - Site visits
 - Follow-up conference calls
 - Sourcing support if needed
 - Guidance on safety issues

Deliverables

- Memo on initial assessment of needs of three wind farms planning to produce hydrogen from excess wind power
- Written action plan
- Memo reporting key measures taken based on technical assistance and improvements achieved

Required Qualifications

- Recognized expert in wind energy-based hydrogen production
- Five years of experience related to wind energy-based hydrogen production
- Technical knowledge related to improving reliability and reducing costs of wind energy-based hydrogen production systems
- High level of integrity
- Good communication skills

2. TOR for Expert in Landfill Methane Based Hydrogen Production

Expert will provide one-on-one technical assistance for investor in and managers of landfill methane based hydrogen production facilities at a landfill in China. Technical assistance will enable investor and managers to incorporate international best practice into their efforts thus improving the viability and reducing the cost of landfill methane based hydrogen production in China. In doing this work, expert will work with Project Technical Advisor on Hydrogen.

Required Tasks

- Provision of technical assistance to land fill site planning to produce hydrogen from land fill methane. Assistance will be focused on improving reliability and reducing costs. It will include:
 - Site visits
 - Follow-up conference calls

- Sourcing support if needed
- Guidance on safety issues

Deliverables

- Memo on initial assessment of needs of landfill methane project planning to produce hydrogen directly from landfill methane
- Written action plan
- Memo reporting key measures taken based on technical assistance and improvements achieved

Required Qualifications

- Recognized expert in landfill methane based hydrogen production
- Five years of experience related to landfill methane based hydrogen production
- Technical knowledge related to improving reliability and reducing costs of landfill methane based hydrogen production systems
- High level of integrity
- Good communication skills

3. TOR for Expert in Renewable Energy Based Hydrogen Production

Working with Project Technical Advisor on Hydrogen, expert will develop and implement group capacity building through workshops and an international study tour on renewable energy based hydrogen production. Group capacity building will bring knowledge of international best practice in renewable energy based hydrogen production to a large group of beneficiaries, thus stimulating further investment in this area as well as improved technical levels and cost reduction.

Required Tasks

- Design workshop training curriculum (see next item for content)
- Conduct series of at least two workshops to address needs of China’s potential renewable energy based hydrogen producers. Training will emphasize means of reducing costs and raising reliability of renewable energy based hydrogen production systems, as well as safety issues. The workshops will cover:
 - Opportunities in wind farm based hydrogen production
 - Solar PV-based hydrogen production
 - Landfill methane based hydrogen production.
- Provide written training materials based on workshop content
- Identify priority organizations/sites to visit on study tour to Germany to study renewable energy based hydrogen production (“power-to-gas”) and injection of hydrogen into natural gas network.

Deliverables

- Curriculum for at least two workshops on renewable energy based hydrogen production
- Written training material based on content of at least two workshops
- Recommended itinerary/target organizations and site visits for study tour to Germany

Required Qualifications

- Recognized expert in renewable energy based hydrogen production
- Broad knowledge of renewable energy based hydrogen production and worldwide projects in this area, covering wind, solar PV, and biogas/landfill methane based hydrogen production
- Skill in preparing training materials and presentations
- Strong communication skills
- Strong international network, particularly in Germany, of renewable energy based hydrogen production sector
- Strong technical knowledge in improving reliability and reducing costs of renewable energy based hydrogen production

4. TOR for Expert in HRSs and Hydrogen Production

Expert knowledgeable about China and fluent in Chinese will work closely with Project Technical Advisor on Hydrogen to carry out a number of project activities, many but not all of which are related to monitoring and reporting on hydrogen production demos and HRS demos.

Required Tasks

- Conduct study for Nanhai District, Foshan City on local establishment of hydrogen production to supply an expanding fleet of fuel cell vehicles and other applications. The study will compare the pros and cons of options for local hydrogen production, including industrial byproduct, industrial (non by-product), and renewable energy-based. It will look at ways of reducing the relatively high price of hydrogen in Foshan.
- Conduct a comparative economic analysis (including investment, operation, maintenance, etc.) of different hydrogen production models, including natural gas reforming, industrial by-product, other industrial, renewable energy based power (wind, PV, etc.), and biogas/landfill methane based.
- Prepare database of information on all aspects and applicable processes of hydrogen production (both nonrenewable energy and renewable energy based). Database will include study conducted for Foshan on hydrogen production options, study conducted on comparative economic analysis of different hydrogen production models, and study (conducted by another consultant) on increasing the energy efficiency of hydrogen produced via industrial by-product methods, as well as other relevant materials. This activity may cooperate with chinahydrogen.org or other relevant partner to disseminate the database.
- Design and initiate plan for replication and scale up of renewable energy based hydrogen production demos at other sites. Replication plan will incorporate liaison with other potential renewable energy based hydrogen manufacturers, including those attending capacity building workshops and study tour under other project activities.
- Conduct monitoring, annual reporting, and dissemination of results of renewable energy-based hydrogen production, as well as making of recommendations based on findings. This activity will cover the three demo wind energy-based hydrogen production sites and the one landfill methane based hydrogen production site.
- Design of data collection plan and conduct data collection/monitoring for operational phase of demo hydrogen refueling stations. Task will include preparation and dissemination of annual reports on findings. Separate subsections in these reports will be prepared on each of (1) standard stations (Zhengzhou, Foshan, and second Beijing station), (2) onsite renewable energy based hydrogen production, (3) addition of hydrogen to gasoline stations (if possible), and (4) addition of electric vehicle recharging to hydrogen refueling station (Shanghai's Anting station) to provide insights on these different models. Monitoring plan will include both financial and technical parameters. The technical parameters will serve as the basis of *China Hydrogen Refueling Station (HRS) Reliability Database*, modeled on international best practice. In addition to periodic recording of parameters, the monitoring plan will accommodate the recording of special issues or problems that may arise. The monitoring plan will be centrally designed, so that collected information can be compared across refueling stations. The *China HRS Reliability Database* may also be integrated with international efforts in HRS reliability data sharing.
- Collect information from hydrogen production demo investors and hydrogen refueling demo investors on upfront investment costs using the designed data collection template, and report findings from the data collection process. Task will including designing of templates for collection of needed parameters, conducting of any needed analysis, and preparation of a report on findings.
- Integrate reports prepared under aforementioned tasks (annual reports on hydrogen production demos, annual reports on HRS demos, and onetime report on costs of hydrogen production demos and HRS demos), as well as survey of the public (conducted by separate organization) on perception towards hydrogen production and HRSs. Final products will be annual consolidated monitoring reports of hydrogen production demos and hydrogen refueling station demos that also include findings from onetime report on investment costs of these demos. Thus, the annual reports

will cover both renewable energy based hydrogen production and hydrogen refueling stations of several types. Further, they will include technical and financial data related to operation, data from surveys of public perception of these installations, and onetime data on investment. Findings should be presented in clear and attractive documents that will be widely disseminated by PMO to government officials, industry, investors, and relevant researchers/academics.

Deliverables

- Study with recommendations to Nanhai District on options for local hydrogen production
- Written report on comparative economic analysis of different hydrogen production models
- Database of information on all aspects and applicable processes of hydrogen production (both nonrenewable energy and renewable energy based)
- Written replication plan for renewable energy based hydrogen production in China
- Annual reports on results of renewable energy based hydrogen production demos
- Annual reports on results of HRS demos
- Onetime report on costs of renewable energy based hydrogen production demos and HRS demos
- *China Hydrogen Refueling Station (HRS) Reliability Database*
- Integrated annual reports including several of the above items (results of renewable energy based hydrogen production demos, results of HRSs, and onetime cost reports), as well as annual survey of public perception on hydrogen production and HRSs

Required Qualifications

- Ten years of experience in the hydrogen and hydrogen refueling fields
- Strong technical knowledge of hydrogen and use of hydrogen for FCVs
- Very strong writing skills and track record of writing reports that are clear to experts and non-experts alike
- Strong skills in developing monitoring plans
- Fluent in Mandarin; fluent in English

5. TOR for Expert in Energy Efficiency of Hydrogen Production via Industrial By-Product Methods

Required Tasks

- Conduct a study on increasing the energy efficiency of hydrogen produced via industrial by-product methods. Study will look at the main industrial by-product methods being used in China or likely to be used in China in the future and will propose methods of reducing use of fossil fuels in producing hydrogen from industrial by-products. Study will also assess baseline and potentially reduced GHG emissions associated with the different industrial by-product methods.

Deliverables

- Written report on findings on increasing the energy efficiency of hydrogen produced via main industrial by-product methods, including associated GHG emissions.

Required Qualifications

- Ten or more years of experience conducting research or actively involved in the business of hydrogen production or purification
- Knowledgeable about main methods of producing hydrogen from industrial by-products
- Expertise in energy efficiency and knowledge of methods of computing GHG emissions
- Strong research and analysis skills
- Strong writing skills

6. TOR for Expert in HRSs

Working with Project Technical Advisor for Hydrogen, expert will provide one-on-one technical assistance for investors in and managers of project demo hydrogen refueling stations One-on-one

technical assistance will contribute to increased viability and lowered cost of hydrogen refueling stations, via approaches such as improved business models.

Required Tasks

- Conduct of individual technical assistance to proposed Foshan hydrogen refueling station in developing a business plan for commercially viable operation. The plan may include multi-fuel strategy (e.g. hydrogen, petroleum, CNG, etc.).
- Assist in conducting outreach to gasoline stations that may be interested in adding hydrogen refueling. Outreach will include identification of promising candidates and presentation to them of details of the opportunity.
- Conduct of technical assistance to two existing gasoline stations (one in Shanghai and one in Beijing) that are intending to include hydrogen refueling as part of their transport fuel retail services. Technical assistance will include guidance in design, permitting, equipment procurement, installation of equipment, testing, and commissioning.

Deliverables

- Business plan for Foshan station
- Business plan for combined hydrogen and gasoline stations, one in Shanghai and one in Beijing

Required Qualifications

- Recognized expertise in HRSs/ hydrogen refueling
- Five years of experience successfully running or developing hydrogen refueling stations
- Knowledge of business models for HRSs
- Technical knowledge and knowledge of sourcing for HRSs
- High level of integrity

7. TOR for Expert in onsite Renewable Energy Based Hydrogen Production at HRSs

Required Tasks

Conduct individual technical assistance to one hydrogen refueling station to improve reliability and output of its onsite wind-PV-based hydrogen production. Efforts will focus on reducing costs and increasing proportion of the station's hydrogen that is supplied via hybrid renewable energy system, so that it reaches targeted level of 50 percent.

Deliverables

- Action plan to improve a station's renewable energy based hydrogen production
- Report on improvements in a station's renewable energy based hydrogen production

Required Qualifications

- Known expert in onsite renewable energy based hydrogen production at HRSs
- Technical knowhow in improving reliability of renewable energy based hydrogen production at HRSs
- Track record of successfully working with renewable energy based hydrogen production systems
- General knowledge of other HRS issues

8. TOR for Expert in HRS Air Compressor Manufacture

The expert will provide technical assistance to increase reliability and reduce cost of product of domestic compressor manufacturer supplying China's hydrogen refueling stations. The likely candidate is Beijing Tiangao, which supplied the Shenzhen hydrogen refueling station. The support will include increasing reliability, control of production, and sourcing of parts.

Required Tasks

- Assess current situation of target China-based HRS air compressor manufacturer
- Develop action plan based on findings of assessment

- Provide one-on-one technical coaching to improve reliability and reduce cost of domestic HRS compressor

Deliverables

- Written action plan
- Memo outlining improvements achieved via one-on-one technical coaching

Required Qualifications

- Recognized international expert in HRS air compressor manufacture
- Experience working at top international provider of HRS air compressors preferred
- Demonstrated knowledge on means of improving reliability and reducing costs of HRS air compressors
- Strong communication skills
- High level of integrity

9. TOR for Expert in HRS Hydrogen Refueling Dispenser

The expert will provide technical assistance to lower cost and increase reliability of product of domestic hydrogen refueling dispenser manufacturer supplying China's hydrogen refueling stations. The likely candidate is Sunwise, based in Shanghai. The support will address two areas: sourcing and assistance in adjusting technical methodology.

Required Tasks

- Assess current situation of target China-based HRS hydrogen refueling dispenser manufacturer
- Develop action plan based on findings of assessment
- Provide one-on-one technical coaching to adjust technical methodology
- Provide advice on sourcing

Deliverables

- Written action plan
- Memo outlining improvements achieved via one-on-one technical coaching

Required Qualifications

- Recognized international expert in HRS hydrogen refueling dispenser manufacture
- Experience working at top international provider of HRS hydrogen refueling dispenser preferred
- Demonstrated knowledge on means of improving reliability and reducing costs of HRS hydrogen refueling dispenser
- Strong communication skills
- High level of integrity

10. TOR for Expert in HRSs and HRS Equipment

Working with Project Technical Advisor on Hydrogen, expert will develop and implement group capacity building through workshops and an international study tour on HRSs and associated equipment and service providers. Group capacity building will bring knowledge of international best practice in HRSs and HRS equipment to a large group of beneficiaries, thus stimulating further investment in this area, as well as improved technical levels and cost reduction.

Required Tasks

- Design workshop training curriculum (see next item for content)
- Conduct series of workshops to address the needs of the local hydrogen refueling industry in achieving lower investment costs, high safety performance, better reliability, and viable financial performance. Topics covered in workshops will include, but not be limited to:
 - global and Chinese situation of hydrogen refueling station establishment, operation, policy, and market

- design of hydrogen refueling stations
- sourcing of parts for hydrogen refueling stations (and potential alternatives to high cost imports, such as key valves, hydrogenation spears, and hydrogen pipes)
- compression and cooling equipment for hydrogen refueling station
- water electrolysis unit for onsite and offsite production of hydrogen using renewable energy
- hydrogen refueling dispensers
- financially viable business models for hydrogen refueling stations, such as multi-fuel offerings (e.g. hydrogen, gasoline, and CNG)
- safety issues
- Provide written training materials based on workshop content
- Identify priority organizations/sites to visit on international study tour to visit hydrogen refueling stations and discuss strategies with international counterparts

Deliverables

- Curriculum for series of workshops for HRS investors, potential HRS investors, equipment manufacturers for HRSSs, and service providers for HRSSs
- Written training material based on content of series of workshops for HRS investors, potential HRS investors, equipment manufacturers for HRSSs, and service providers for HRSSs
- Recommended itinerary/target organizations and site visits for international study tour for HRS investors, potential HRS investors, equipment manufacturers for HRSSs, and service providers for HRSSs

Required Qualifications

- Recognized expert in HRSSs and HRS equipment and service provision
- Broad knowledge of HRS sector including technical aspects, business models, equipment, etc.
- Skill in preparing training materials and presentations
- Strong communication skills
- Strong international network in HRS sector, including both stations and equipment providers
- Strong technical knowledge in improving reliability and reducing costs of HRSSs

5. TOR for HRS O&M Training Expert

The purpose of this consultancy will be to develop a qualified contingent of persons to operate and maintain HRSSs in each of the four demo cities as well as in other cities in which replication is taking place. This qualified contingent of persons will ensure sustainability of project demos.

Required Tasks

- Conduct of onsite training in each of the demo cities of staff responsible for the operation and maintenance of hydrogen refueling stations. This training will supplement training provided by equipment suppliers/general contractors and will put a strong emphasis on safety issues. (It is expected that equipment manufacturers or general contractors building the stations will provide the bulk of O&M training needed and also that major repairs will be handled by equipment manufacturers. Stations like Shanghai's Anting Station, which has extensive experience in hydrogen refueling station O&M, will not need training.)
- Based on identified needs during visits, provide trainees with written materials on O&M of hydrogen refueling stations.
- Design and implement post-training assessment of qualification of trainees to operate and maintain HRSSs.

Deliverables

- Memo on needs determined during onsite training
- Written materials on HRS O&M
- Assessment test
- Analyzed results of assessment test

Required Qualifications

- Ten or more years of experience in HRS operation and maintenance
- Track record in training others in HRS operation and maintenance
- Experience with top HRS equipment manufacturer or owner preferred
- Strong presentation and writing skills

V.5: TORs for Consultants in Policy Area

1. TOR for China and Local FCV Roadmap Expert

One or more experts may be recruited for these tasks.

Required Tasks

- Prepare draft *China FCV and Hydrogen Refueling Roadmap* covering the areas of: (1) FCV cost reduction, durability improvement, and performance enhancement; (2) increased availability of key FCV parts at lower prices locally and/or through improved international sourcing; (3) reduced cost, increased volume, and improved reliability of hydrogen production in China, particularly of hydrogen produced via renewable energy; (4) establishment of hydrogen refueling stations; (5) availability of cost effective/reliable equipment and services for hydrogen refueling station establishment (including compressors and hydrogen refueling dispensers); (6) availability of qualified O&M personnel for FCVs and hydrogen refueling stations; and (7) availability of financing for FCV manufacture and associated value chain, for hydrogen refueling stations and associated value chain, and for FCV purchase. The roadmap will indicate targets in each of these areas and the steps that will be taken to reach them. Functionally, the roadmap will cover the areas of policy, government funding/investment, and investment by businesses. In preparing the roadmap, the expert will review the roadmaps/strategies of other countries as well as take the special situation of China into consideration.
- Provide presentation on draft national roadmap at national workshop on *China FCV and Hydrogen Refueling Roadmap*
- In conjunction with local governments, draft local level *FCV and Hydrogen Refueling Roadmap* (as counterpart to the national *Roadmap*) for at least four cities. Participate in local meetings to build consensus on these roadmap. The local roadmaps will take their lead from and build upon the national *Roadmap* in their content.

Deliverables

- Draft national *FCV and Hydrogen Refueling Roadmap*
- Presentation for national workshop on national *FCV and Hydrogen Refueling Roadmap*
- Drafts of at least four local level FCV and hydrogen refueling roadmaps

Required Qualifications

- Proven track recording in designing policy, roadmaps, etc. for China's auto sector
- Strong experience in promoting NEVs in China via policy measures
- Ten or more years of experience advising Chinese Government on industrial policy
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

2. TOR for China FCV and HRS Standards, Certification, and Safety Expert

One or more experts may be recruited for these tasks.

Required Tasks:

- Identify priority gaps in China's existing standards for FCVs, hydrogen stations, and hydrogen production/transport, as well as priority areas in which harmonization with international standards may be increased. Review existing Chinese standards, as well as international counterpart

standards, to identify gaps. Propose areas for revision to the relevant committees responsible for designing standards in each area.

- Develop and promote approval of testing and certification system for FCV vehicles, hydrogen refueling stations, and products supporting the FCV industry, such as hydrogen cylinders. Review certification testing and certification needs in relevant areas, as well as international experience in these areas. Based on findings, design testing and certification system.
- Develop and promote adoption and enforcement of standard safety and fire protection regulations and procedures for FCVs and hydrogen infrastructure. Identify needs with regard to safety and fire protection and also review international experience as a part of this process. Based on findings, design recommendations for relevant government regulatory departments.

Deliverables

- Written memo reporting gaps in China's existing standards for FCVs, HRSs, and hydrogen production transport and proposing areas for revision to the relevant committees responsible for designing standards in each area.
- Draft testing and certification system for FCVs, HRS, and products supporting the FCV industry.
- Draft standard safety and fire protection regulations and procedures for FCVs and hydrogen infrastructure.

Required Qualifications

- Proven track recording in designing technical standards for China, particularly in auto and hydrogen related sectors
- Strong experience related to NEV standards, testing and certification
- Strong familiarity with international standards for FCVs and HRSs
- Ten or more years of experience advising Chinese Government on standards, testing, and certification
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

3. TOR for China FCV Registration and Approval Expert

One or more experts may be recruited for these tasks.

Required Tasks:

- Conduct of advocacy and lobbying meetings and other forms of education for central government and local officials to achieve: (i) expedited approval (*gongao*) by FCV manufacturers for production of FCV vehicles (by central government) (note: In some cases, as it will take time for standards and certification system to be improved, project will need to seek "exceptions" from central government to expedite approval process.); (ii) expedited issuance of long-term license plates to FCV operators for individual vehicles (by local officials); and (iii) expedited approval of hydrogen refueling stations (by local officials). Design and recommend processes and implementing rules and regulations (IRR) to expedite each of these approval/issuance processes. Meetings with Central Government will occur in Beijing. Meetings with relevant local officials will occur, at minimum, in the project's main demo cities (Shanghai, Beijing, Zhengzhou, and Nanhai/Foshan). In addition to Central Government, key target organizations will include the local public security bureau (*gonganju*), local transportation management bureau (*jiaoguanju*), and others, as necessary.
- Design content of a seminar on fire safety of FCVs, hydrogen production, hydrogen fuel transport, and hydrogen refueling station with participation of relevant officials, experts, and companies. Content of seminar to be designed based on identified issues and international experience. Targeted invitees will be national and local officials whose purview includes approval and/or management of motor vehicles and hydrogen infrastructure. Make relevant presentations during seminar.

Deliverables

- Preparation of action plan for advocacy and lobbying meetings with central government and relevant local officials
- Preparation of memos and other educational materials for central government and relevant local officials
- Written design of fire safety seminar content
- Presentation materials for fire safety seminar

Required Qualifications

- Proven track recording in lobbying and advocacy work targeting Chinese policy makers with regard to vehicle acceptance and registration
- Strong experience related to NEV registration and licensing
- Ten or more years of advocacy and lobbying work with national and local governments in China
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

4. TOR for China FCV and HRS Incentive Policy Expert

One or more experts may be recruited for these tasks.

Required Tasks:

- Prepare proposed extension and improvements to current incentive policy for FCV purchase. A primary aim is to extend the duration over which the current national FCV subsidy will be applied to the period between 2016 and 2020. Recommend improvements or refinements in the national policy. These will reflect increases in the number and types of FCVs available in China. Hold meetings with policy makers and prepare briefs for them, promoting adoption of the extension and other measures. In addition to national level policy, certain local level policies encourage new energy vehicles (without differentiation between electric vehicles and FCVs). This task will also entail design of recommendations to extend (for FCVs, in particular) local preferential new energy vehicle policies (such as free vehicle plates issuance in Shanghai and sped up position in the queue for auto purchase in Beijing) or to even enhance these for FCVs, in particular.
- Prepare proposed extension and improvements to current national incentive policy for establishment of hydrogen refueling stations. A primary aim will be to extend the duration over which the current hydrogen station subsidies will be applied to continue at the same level. Recommend improvements/ refinements in the policy. Hold meetings with policy makers and prepare briefs for them, promoting adoption of the extension and other measures. Prepare recommendations for extension and enhancement of local level incentive policies for hydrogen refueling stations.
- Develop ideas for novel FCV and hydrogen station incentive policies for discussion among experts and local policy makers. Review incentive policies used elsewhere in the world (such as in the California Fuel Cell Partnership), but not yet in China. Preliminary ideas include: access to priority lanes for FCVs, preferential or free parking spaces for FCVs, and standards and incentive policy for four-in-one, three-in-one, or two-in-one refueling stations (stations that include hydrogen fuel and other types of refueling on the same premises). Discuss ideas with local governments who are active in the FCV field and particularly the four cities that are the demo locations for the project's FCVs.
- Design and participate in meetings to reach consensus on at least two different types of policy pilots. Based on ideas vetted in above task, design will first involve liaison with local government and reaching of consensus on location(s) for policy pilots and on the nature of those pilots. Detailed design of policy pilots will then be carried out. There will be at least two local policy pilots.
- Design and implement plan to monitor results of the two or more local level policy pilots. The monitoring plan will assess the effectiveness of outreach to potential buyers/ investors and seek to

understand how influential preferential policies were in impacting their FCV/HRS related behavior. It will further assess the numbers of stakeholders influenced by the relevant pilot policy.

Deliverables

- Memo/ policy brief on proposed extension and improvement to national FCV incentive policy
- Memo/policy brief on proposed extension and improvement to national HRS incentive policy
- Memo/policy brief on recommendations with regard to existing local level FCV and HRS incentive policies
- Memo on novel potential FCV and HRS incentive policies that may be pursued in China. (Memo will reference such policies pursued elsewhere in the world.)
- Draft of two novel local level incentive policies for FCVs and/or HRSs
- Report on result of monitoring of implementation of two or more novel local level incentive policies for FCVs and/or HRSs.

Required Qualifications

- Proven track recording in designing policies, especially incentive policies
- Proven track record in drafting policies and briefs for policy makers
- Strong experience related to China's NEV sector
- Ten or more years of advocacy with and policy design for national and local governments in China
- Very strong writing skills
- Native speaker of Mandarin
- High level of integrity

V.6: TORs for Consultants in Awareness and Knowledge Dissemination Area

1. TOR for Communications and Media Consultant

The communications and media consultant will work closely with the PMO Communications Officer in carrying out the following tasks.

Required Tasks

- Conduct media campaign targeting the press in the four demo cities as well as nationally. Media campaign will both highlight the commercialization progress represented by the demos and provide information regarding the safety of FCVs and hydrogen. Print, online, and broadcast media will all be targeted.
- Preparation leaflets/brief brochures on the characteristics and benefits of FCVs to be displayed in FCBs, at FCV auto test ride locations in Shanghai, and at relevant booths at public events. Brochures will discuss environmental benefits and consumer benefits, as well as provide information regarding the safety of FCVs and hydrogen. Design dissemination strategy for leaflets.
- Provide advice on building and updating of project website and contribute to monthly project newsletter. Project progress and FCV and hydrogen refueling station operation results will be updated periodically on the website. Database of information on hydrogen production processes prepared through another project activity will also be made available through the project website, along with links to partner organization in hydrogen production dissemination.

Deliverables

- Memo on strategy for media campaign
- Leaflets/brochures on FCVs
- Articles contributed to monthly project newsletter

Required Qualifications

- Five or more years of experience in communications and media outreach

- Excellent writing skills in Chinese; native speaker of Mandarin
- Proven skills in design of written materials
- Track record in successfully getting write-ups/ airtime in the media
- High level of integrity

2. TOR for Documentary Sub-contractor

The documentary sub-contractor will work closely with the PMO Communications Officer in carrying out the following tasks.

Required Tasks

- Design, produce, and secure airing of a documentary on FCVs on TV in China. The documentary will feature the project demos as well as FCV developments around the world. It will discuss the future prospects of the hydrogen economy. It will also provide information regarding the safety of FCVs and hydrogen.
- Design and produce video material to counter myths regarding the safety of hydrogen. The video will be presented as an experiment, but in a fun and attractive way. It will be uploaded to the internet and the link will be provided in materials generated by other activities under the project's Awareness and Information Dissemination Component, as well as being promoted through other avenues. The project will target participation in well know science documentary programs produced and aired on cable TV.

Deliverables

- Documentary on FCVs to be aired on TV in China
- Video material countering myths regarding the safety of hydrogen

Required Qualifications

- Sub-contractor led by experienced producer that has good links with TV stations
- Team lead has ten or more years of experience in documentary production
- Sub-contractor has track record of quality documentaries aired on prime time
- Sub-contractor has enthusiasm for environment-related topics
- High level of integrity

3. FCV and HRS Demo Replication Consultant

The FCV and HRS Demo Replication Consultant will work closely with the Project CTA and Project Advisor on Hydrogen to carry out the following tasks:

Required Tasks

- Based on consultation with relevant national and city officials, design a sustainable follow-up plan to replicate the project FCV and HRS demos in other cities and scale it up in participating cities. Plan will include strategies for procurement of high performance vehicles and for effective operation and monitoring of the demos. Plan will be designed in second half of project, once sufficient data and lessons learned from demos has been obtained.
- Present above designed replication plan at annual workshop for city officials and in smaller meetings with officials from cities prioritized for replication.

Deliverables

- Written replication plan for FCV and HRS demos in other cities and for scale up in participating cities
- Presentation materials on replication plan

Required Qualifications

- Over ten years of experience with FCVs and other NEVs
- Track record of quality participation in designing demonstration programs

- Technical expertise in FCVs and HRSs
- Experience advising local governments in China
- Native speaker of Chinese

4. Expert on International Exchange on FCVs and HRSs

The Expert on International Exchange on FCVs and HRSs will work closely with the Project CTA and Project Advisor on Hydrogen to carry out the following tasks. The purpose of this work will be to conduct technical and information exchange among counterparts and to strengthen understanding and acceptance of government policy makers on the development of fuel cell vehicles at home and abroad.

Required Tasks

- Design of international forums on FCVs and hydrogen infrastructure. Identification of key topics to be covered and key speakers to be invited.
- Design of international study tour on FCVs and hydrogen infrastructure

Deliverables

- Agenda for international forums on FCVs and hydrogen infrastructure
- Itinerary for international study tour on FCVs and hydrogen infrastructure

Required Qualifications

- Ten years of experience in international liaison
- Strong knowledge of international players in FCVs and HRSs
- Track record in designing workshops and international forums
- Track record in designing study tours/delegations
- Fluent in English and Mandarin

5. Expert on Monitoring System for NEVs

The Expert on Monitoring Systems for NEVs will work closely with the Project CTA to carry out the following tasks.

Required Tasks

- Development, operation, and maintenance of an online database and monitoring system on China's FCV manufacturing and market, as well as new technological developments and applications worldwide. The system will be known as *China FCV Market and Technology Monitoring System*. The monitoring work will require monthly contact with China's FCV manufacturers and distributors as well as with its registration bodies to determine technological developments, the number of new FCVs sold, and the total number of FCVs on the road in China. The contractor will also monitor a number of key information sources on developments in FCVs and hydrogen infrastructure internationally, providing links and summary translations of key articles.
- Preparation of a plan to sustain updating of the online FCV database and monitoring system after project close.

Deliverables

- *China FCV Market and Technology Monitoring System*

Required Qualifications

- Three years of experience in monitoring NEVs in China
- Expertise in developing databases and monitoring systems
- Fluency in Chinese and English
- Proven expertise in auto industry
- Ability to develop good rapport with FCV manufacturers
- High level of integrity

V.7: TORs for Consultants to Build Capacity in Financial Sector

1. TOR for Consultant on Financing of FCV Manufacturing and Value Chain and HRSs and Value Chain

The purpose of this work will be to stimulate FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling associated value chain projects that are or will be financed by financial institutions/financial sector companies. Financing of FCV-related projects by financial institutions will expedite commercialization of the sector. Successful initial financings will lead to increased interest among the financial sector and to further such financings.

Required Tasks

- Design and hold FCV manufacturing, FCV component manufacturing, hydrogen refueling station, and hydrogen refueling value chain financing workshop. The workshop will educate financial sector on current and projected future situation of the FCV and FCV component industries and of hydrogen infrastructure industries. It will be attended both by the financial sector and by FCV and FCV component manufacturers and hydrogen infrastructure related companies wishing to attract investment. It will set up mechanisms, such as matchmaking sessions, to connect investors with projects. Financial sector organizations targeted to attend will include venture capital and private equity firms, as well as banks, which routinely provide loans to China's major vehicle manufacturers, but not for FCV manufacturing in particular.
- Deliver presentations at financing workshop
- Facilitate meetings between banks, venture capital/private equity firms, etc. and individual FCV manufacturers, FCV component manufacturers, and hydrogen refueling or associated value chain businesses seeking debt or equity financing. This task will involve identification of appropriate interested parties on both sides (both financial institutions and those in the FCV or HRS industry seeking capital). It will also involve facilitating communications and meetings between relevant parties with the purpose of securing financing for the latter group.

Deliverables

- Financing workshop agenda
- Presentations for financing workshop
- Memos on achievements resulting from meetings facilitated

Required Qualifications

- Expertise in financial and business aspects of vehicle and vehicle parts manufacturing industry
- Five years of experience in NEV sector
- Experience designing workshops and giving presentations
- Proven track record in facilitating business meetings, negotiations, and deals

2. TOR for Consultant on FCV Purchase Financing Scheme

The purpose of this work will be to achieve an established and operational FCV purchase financing scheme in selected banks/FIs. Financing schemes will enable expanded purchase of FCVs by consumers and other entities. Successful schemes will also further stimulate interest of the financial sector and lead to more such schemes.

Required Tasks

- Design feasible financing scheme for consumer purchase of FCVs in China. Task will include review of existing auto financing schemes in China as well as incentive-oriented bank loan schemes for other products/investments available in China or other countries.
- Hold meetings with select financial institutions to explain, discuss, and promote the scheme, achieving adoption of scheme by at least one institution.

Deliverables

- Memo on designed financing scheme for consumer purchase of FCVs in China
- List of target institutions to which scheme will be promoted
- Memo on feedback from financial institutions on scheme

Required Qualifications

- Expertise in financial and business aspects of consumer vehicle financing programs
- Experience with and/or exposure to NEV sector
- Experience designing consumer loan programs
- Strong knowledge of and familiarity with Chinese banking sector
- Native speaker of Mandarin

V.9: TORs for Various Surveys Related to Project Outcomes and/or Project Monitoring

1. TOR for Social Science Survey Expert

In consultation with the Project's M&E Officer, the Social Science Survey Expert will field a number of surveys to support project monitoring as well as to conduct activities under some of the project's outcomes. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, conduct, and analyze results of annual survey of public perception of FCVs. Survey will cover various segments of the public including in each city, as relevant, those who have ridden or seen FCV buses, those who have seen and/or test driven FCV cars, and those who have seen FCV delivery vans or trucks. In particular, the survey will probe consumer concerns about hydrogen as a fuel, understanding of environmental benefits of FCVs, general attraction to the FCV concept, and general understanding of FCVs.
- Design, conduct, and analyze results of annual survey on the public's perception of hydrogen production and hydrogen refueling stations and report findings. The survey will seek to see if the public continues to have safety concerns about hydrogen infrastructure and whether this has lessened via the awareness building activities of Outcome 4. The surveys will be conducted in the neighborhoods of HRSs and hydrogen production facilities. If any cities in which new HRSs will be built do not have a standard consultative process with nearby residents regarding new installations, survey in its first year will serve to initiate such a process in cities.
- Design, conduct, and analyze results of a survey of individuals (as distinct from companies) attending group training on FCV manufacture and/or receiving training materials through the project. Survey will gather information on whether training has impacted the work of these individuals.
- Design, conduct, and analyze results of a survey of individuals attending group training for renewable energy-based hydrogen production and of a survey of individuals attending group training for HRS establishment. Surveys will each gather information on whether individuals are applying what they've learned through the training.
- Design, conduct, and analyze results of broad survey of individuals, officials, and organizations that purchase/use vehicles regarding their awareness and perception of FCVs. This survey will be conducted both at beginning of project and end of project.
- Design, conduct, and analyze results of survey of individuals exposed to project advocacy program to determine how this exposure has changed their views of FCVs.
- Design, conduct, and analyze results of survey of cities to determine how many have developed their own local *Hydrogen Refueling Roadmap*. Survey will also gather information on how many cities have their own local incentive policy for FCVs and/or HRSs and whether these are traditional type incentive policies or policies new to China.

Deliverables

- Template for survey on public perception of FCVs; results of survey
- Template for survey on public perception of HRSs/hydrogen production (by people living in the neighborhood of these); results of survey
- Template for survey of those attending group training on FCV manufacture or receiving training materials on this; results of survey
- Template for survey of those attending group training on renewable energy based hydrogen production; results of survey
- Template for survey of those attending group training on HRSs; results of survey
- Template for broad survey of vehicle purchasers and users; results from survey fielded at beginning of project; results from survey fielded at end of project.
- Template for survey of individuals exposed to project advocacy program; results of survey
- Template for survey of cities on FCV and HRS policies; results of survey

Required Qualifications

- Ten years or more experience in designing, fielding, and analyzing studies
- Proven track record of effective survey design and fielding
- Proven track record of high quality write-ups of survey findings
- High level of integrity

2. TOR FCV Manufacturer, FCV Component Manufacturer, Hydrogen Producer, and HRS Survey Expert

In consultation with the Project's CTA, Project's Technical Advisor on Hydrogen, and Project's M&E Officer, the FCV Manufacturer, FCV Component Manufacturer, Hydrogen Producer, and HRS Survey Expert will conduct surveys of FCV manufacturers, FCV component manufacturers, hydrogen producers, and HRSs. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, field and analyze results of survey of China's FCV manufacturers to obtain information needed for project monitoring indicators. There will be a standard version of the survey for all FCV manufacturers and an expanded version for those that have received one-on-one technical assistance, or accessed training materials. Targeted information for the standard version will be: number of companies producing FCVs, number of new FCV production lines, cumulative investment in FCV manufacturing, and lifetime hours of operation of FCVs, and actual cost and projected cost at high volume for FCVs. For those FCV manufacturers obtaining project one-on-one assistance, information on mean time between failure, lifetime mileage, cruising range, and fuel cell stack power density will also be obtained. For those obtaining sourcing assistance, information on newly signed sourcing agreements and total value of these agreements will be obtained. For those organizations receiving training materials, information on impact of these on their activities will be sought.
- Design, field, and analyze results of a survey of the eight FCV component and FC component manufacturers assisted by the project. Survey will gather information on FCV/FC components newly sourced in China as a result of project. It will also gather information on cost reduction achieved by each manufacturer and durability/performance improvement achieved.
- Design, field, and analyze results of a survey of FCV manufacturers and their products. The purpose will be to determine how many are compliant with new standards.
- Design, field, and analyze a survey of individual experts utilizing the project's *China FCV Market and Technology Monitoring System*. Survey will gather information on whether the technical updates of the system have been useful to the experts.
- Design, field, and conduct survey of China's renewable energy based hydrogen producers. Standard survey of all producers will gather information on cost and price of hydrogen produced from renewable energy, annual and cumulative hydrogen production from wind farms and landfill

methane, respectively, cumulative investment in renewable energy based hydrogen production, and total number of sites producing renewable energy based hydrogen.

- Design, field, and conduct survey of China's HRSs. Standard survey will gather information on the number and type of different business or operation models being used at China's hydrogen refueling stations, the cost of setting up HRSs (and associated scale), the total number of HRSs in China, and the cumulative hydrogen distributed through HRSs. For those stations participating in the project's one-on-one technical assistance, information will be gathered on whether and how the assistance impacted the station's strategy or operation.

Deliverables

- Template for survey of China's FCV manufacturers; results of survey, and required indicator values for Project Result Framework
- Template for survey of eight FCV component and FC component manufacturers and for gathering of information on FCV/FC components newly sourced in China; results of survey
- Template for survey of FCV manufacturers and product compliance; results of survey
- Template for survey of experts regarding project's *China FCV Market and Technology Monitoring System*; results of survey
- Template for survey of China's renewable energy based hydrogen producers; results of survey
- Template for survey of China's HRSs; results of survey

Required Qualifications

- Track record in conducting surveys of industry
- Track record of high quality presentation of survey results
- Technical/science background; ability to understand technical concepts and incorporate into survey
- Five years of experience in industry-related survey work

3. TOR for Financial Sector Survey Expert

In consultation with the Project's M&E Officer, the Financial Sector Survey Expert will conduct surveys of financial sector entities involved in the FCV and hydrogen refueling sectors. The expert will handle design and fielding of surveys, as well as analysis and presentation of results.

Required Tasks

- Design, conduct, and analyze results of survey of financial sector entities involved in financing of FCV manufacturing, FCV value chain financing, HRS value chain financing, and/or financing of FCV purchase. Survey will gather information on total investment by financial sector in FCV and FCV value chain manufacturing and hydrogen stations and their value chain. It will also gather information on cumulative financing by financial sector of FCV purchase. It will further determine the number of financial institutions that are financing each of the aforementioned types of activities. Lastly it will determine the number of FCVs purchased through dedicated bank financial schemes.

Deliverables

- Template for survey of China's financial sector entities involved in FCV-related or hydrogen-related financing; results of survey

Required Qualifications

- Track record in conducting surveys of financial sector
- Track record of high quality presentation of survey results
- Financial sector and science/technical background; ability to understand financial and technical concepts and incorporate into survey
- Five years of experience in financial sector related survey work

Annex VI. Details of Demonstrations

This annex provides details on the project demonstrations. The project includes demonstrations in the following five areas. Each is discussed in turn below.

- 109 fuel cell vehicles (FCVs), comprised of 23 FC buses, 51 FC autos, 30 FC delivery vans, and 5 FC delivery trucks.
- Between 4 and 7 hydrogen refueling stations that are new or demonstrate a new business model
- 4 renewable energy based hydrogen producers of significant scale
- 2 FCV related local-level policy pilots that demonstrate policies new to China
- 8 domestic manufacturers of key FCV components that will improve their product and/or decrease costs, thus providing world class FCV components to domestic manufacturers (and possibly the world) at a price lower than previously available; and 2 domestic manufacturers of HRS equipment that will achieve world-class quality at prices lower than previously available

The FC vehicle and hydrogen refueling station demonstrations will be highly integrated in that most of the refueling stations will be in the same cities as the demo FCVs and be used for refueling those vehicles. Other demo areas share the same objective (facilitation of the commercialization of FCVs in China), though may have a different angle and/or approach. For example, the renewable energy based hydrogen production demos will have locations based on resource and partner availability, but will contribute to efforts to “de-carbonize” China’s hydrogen supply. To the extent possible, these demos will provide hydrogen directly to the project’s demo FCVs, such as in the case of Beijing and an expected additional demo city Yancheng, but in some cases due to geographic issues, it may not be possible. The two local-level policy pilots will most likely be located in some of the same cities as the project’s demo vehicles and will aim to stimulate increased purchase of FCVs and/or investment in hydrogen refueling stations. The demonstration of domestic component manufacturers will have a similar aim as technical/cost targets for the FCV demos (and HRSs), but on a longer time scale. That is, while the component manufacturer demos should contribute in the longer term to achieving world class durability and performance for lower cost, new components from these efforts will not be available at the time of demo vehicle manufacture (or demo HRS establishment).

1. Fuel Cell Vehicle Demonstrations

Purpose and Differentiating Features: The purpose of the FCV demonstrations will be two-pronged. First, the demonstrations will push progress towards commercialization (both in raising technical levels and lowering costs) to a level beyond that which would be achieved in the baseline scenario. That is, with the UNDP-GEF project, the demos will “leap-frog” over a generation of FCVs in terms cost reduction and durability and performance improvement. That is, if in the baseline scenario China’s FCVs would have advanced from “Generation A” (generation at time of Shanghai World Expo in 2010) to “Generation B,” in the alternative scenario with the project, they “leapfrog” over Generation B to reach “Generation C.” This will be achieved with targeted technical assistance to Chinese FCV manufacturers, as well as assistance in international sourcing of components. In the case of FC buses, in particular, an effort will be made to leverage China’s strengths and cost advantage in bus making with recent breakthroughs towards FCV commercialization internationally, by sourcing foreign FC engines for Chinese built FC buses. Yet, autos and delivery vehicles will also “leapfrog” over the generation targeted in the baseline scenario through improvements in technology and sourcing.

Second, the demos will present a critical mass of FCVs demonstrated on a long-term/continuous basis. This will both markedly increase the exposure of government officials (both national and local), industry, the financial sector, and the public to the reality and benefits of FCVs *and* provide a substantial dataset of results for analysis. The demonstration of FCVs on a long-term/continuous basis is something that has not occurred before in China. Previous FCV demo efforts have been temporary

and event driven (e.g., with permission to operate only during the Olympics or Shanghai Expo) or considered experimental (e.g. buses driven with sand bags rather than real passengers).

Technical and cost targets: The project will aim to achieve “leapfrog-scale” progress towards commercialization of China’s FCVs in the demo vehicles via combination of targeted one-on-one technical assistance to China’s FCV manufacturers, group training sessions, and assistance to Chinese FCV manufacturers in overcoming barriers to international sourcing. That is, the generation of vehicles targeted in the baseline scenario (“Generation B”) will be surpassed for a higher level of durability, performance, and cost reduction (“Generation C”) Exhibit VI-1 below shows project technical and cost targets for FC buses. Exhibit VI-2 summarizes targets for other demo vehicles.

Exhibit VI-1: Demo FC Bus Technical and Cost Targets

| Parameter (FC Bus) | 2015 | 2019 – no GEF support | 2019 – with GEF support |
|---|---------------|-----------------------|-------------------------|
| Lifetime hours operation | 2,000 hours | 6,000 hours | 10,000 hours |
| Mean time between breakdown | 300 hours | 650 hours | 1,000 hours |
| Projected cost reduction at high volume ⁵⁹ | 0% (baseline) | 25% | 50% |
| Projected unit cost at high volume ⁶⁰ | USD 380,000 | USD 285,000 | USD 190,000 |
| Actual unit cost | USD 640,000 | USD 480,000 | USD 320,000 |
| Annual operating hours | 670 hours | 2,000 hours | 3,400 hours |
| Annual distance driven | NA | 44,000 km | 78,000 km |
| Daily distance driven | NA | NA | 250 km |

Exhibit VI-2: Technical and Cost Targets for other Demo FCVs

| Vehicle | Scenario | Lifetime hours operation | Time between breakdown | Annual operating hours | Projected cost reduction at high volume ⁶¹ |
|----------------|----------------------|--------------------------|------------------------|------------------------|---|
| Automobile | 2015 | 2,000 hours | 300 hours | 402 hours | 0% (baseline) |
| | 2019 w/o GEF project | 4,000 hours | 650 hours | 1,200 hours | 25% |
| | 2019 w/ GEF project | 6,000 hours | 1,000 hours | 2,100 hours | 40% |
| Delivery truck | 2015 | 2,000 hours | 300 hours | 670 hours | 0% (baseline) |
| | 2019 w/o GEF project | 4,000 hours | 650 hours | 1,200 hours | 25% |
| | 2019 w/ GEF project | 6,000 hours | 1,000 hours | 2,100 hours | 50% |
| Delivery van | 2015 | 2,000 hours | 300 hours | 402 hours | 0% (baseline) |
| | 2019 w/o GEF project | 4,000 hours | 650 hours | 1,200 hours | 25% |
| | 2019 w/ GEF project | 6,000 hours | 1,000 hours | 2,100 hours | 50% |

Overall plans – vehicle types, numbers, and financing: Exhibit VI-3 below shows the breakdown of numbers of vehicles to be demonstrated among the four vehicle types that will be demonstrated: 23 FC buses, 51 FC autos, 30 FC delivery vans, and 5 FC delivery trucks. The rationale behind the selected numbers of vehicles is to have a critical mass to create robust data and experience sets, as well as create sufficient visibility in the selected cities.

Plans for each city: Exhibit VI-4 shows the breakdown of vehicles by city. The plans for each city are discussed in turn below, with further detail provided in Exhibit VI-5. Exhibit VI-6 provides preliminary plans for vehicle usage patterns.

⁵⁹ High volume projection at 500 units for buses.

⁶⁰ High volume projection at 500 units for buses.

⁶¹ High volume projection at 5,000 units for cars, delivery trucks, and delivery vans.

Exhibit VI-3: Breakdown of Demonstration Vehicle Type⁶²

| Vehicle Type | Total |
|---------------------|--------------|
| Buses | 23 |
| Cars | 51 |
| Delivery Van | 30 |
| Delivery Truck | 5 |
| Total | 109 |

Exhibit VI-4: Breakdown of Demonstration Vehicles by Type and City

| City | Bus | Car | Delivery Van | Delivery Truck | Total |
|--------------|------------|------------|---------------------|-----------------------|--------------|
| Shanghai | 8 | 51 | 30 | 0 | 89 |
| Beijing | 10 | 0 | 0 | 5 | 15 |
| Zhengzhou | 3 | 0 | 0 | 0 | 3 |
| Foshan | 2 | 0 | 0 | 0 | 2 |
| Total | 23 | 51 | 30 | 5 | 109 |

Shanghai: Shanghai will have 89 demo vehicles, comprised of 8 buses, 51 autos, and 30 delivery vans. These will be financed by a combination of support from MOST, other relevant national-level agencies, Shanghai Municipal Government, and the GEF. Based on agreement achieved via provision of GEF funding, all vehicles will be required to reach a much higher level of durability, performance, and cost reduction than had been targeted in the baseline scenario. The new generation demo FVBs will be used as public buses on short-distance routes in urban areas of Jiading District. Of the new generation FC autos, 50 will be manufactured by SAIC and one is expected to be provided by Toyota. Most of the SAIC autos will be used by a vehicle rental company of which SAIC has part ownership, while a few will be available for consumer test driving (around 200 days per year for three years during project period). The new generation FC delivery vans will be manufactured by Potevio New Energy and will be used for postal delivery within the city.

Beijing: Beijing will have 15 demo vehicles, including 10 buses and 5 delivery trucks. All buses will be used as public buses on short-distance routes in urban areas in the northwest of Beijing. Delivery trucks will be used for delivery within the city.

Zhengzhou: Zhengzhou, capital of Henan Province, will have 3 demo vehicles, all FC buses. All buses will be used as public buses on short-distance routes in urban areas of Zhengzhou.

Foshan: Nanhai, which is a district of Foshan City in Guangdong Province, will have 2 demo vehicles, both FC buses. The two Foshan FC buses will be used for mid-distance public transport from Foshan City center to an outlying tourist area.

Plans among the cities and vehicle types will share some important commonalities. For all vehicles, emphasis will be on ensuring high visibility routes suitable for collecting data on vehicle performance. Further, vehicle exteriors will include visible indication of the fuel cell status of the vehicle, so that viewers and riders are aware of this. Further, where relevant (such as in public buses) interior signage (and possibly brochures) will promote the FCV concept. Finally, continuous operation (with only one day off per week if needed) of all vehicles will be emphasized, as will continued operation after project close for those vehicles with remaining lifetime. A monitoring plan prepared by experts will ensure that necessary data for analysis is gathered from all vehicles.

⁶² Because Yancheng and other potential cities have recently shown strong interest in participating in the demo aspects of this project, FCV numbers designated for the cities may change and will be determined during project inception based on cities' interests and their commitment to co-financing.

Exhibit VI-5: Basic Information on Each City’s Demo Plans

| Vehicles (number) | Use | Part of town/visibility | Ownership after procurement; responsible for refueling costs | Party Handling Maintenance |
|---------------------------------------|---|--|---|---|
| Shanghai bus (8) | Short-distance public transport | Jiading District – known for auto industry | Jiading Public Transportation Co. | Jiading Public Transportation Co. with manufacturer assistance |
| Shanghai car (50)⁶³ | 47 Rental cars and 3 for consumer test driving (around 200 days per year) | 47 all over city (the rest for test driving at 3 different sites in Jiading) | Rental company (part-owned by SAIC) | Rental company with SAIC assistance |
| Shanghai delivery van (30) | Mail delivery sub-contracted from China Post | All over city | Potevio | Potevio (which will be both manufacturer and end user) |
| Beijing bus (5) | Short-distance public transport | North Beijing-Haidian District – high tech part of city | Beijing Public Transportation Co. | Beijing Public Transportation Co. and manufacturer(s) |
| Beijing delivery truck (5) | Delivery within city | All over city | City 100 and Shenzhou Taiyue | City 100 and Taiyue with assistance from Foton |
| Zhengzhou bus (3) | Short-distance public transport (route 600 or route 319) | Within Zhengzhou City | Zhengzhou Public Transportation Co. | Zhengzhou Public Transportation Co. with assistance from Yutong/manufacturer(s) |
| Foshan bus (2) | Mid-distance public transport | From district center to outlying area, which has tourism | Nanhai Public Transportation Co. | Nanhai Public Transportation Co. with assistance from manufacturer(s) |

Exhibit VI-6: Preliminary Plans for Demo Usage Patterns

| Type of vehicle | Hours per day | Km per day | Days per week | Total years in use (lifetime) | Total km (lifetime) |
|------------------------|----------------------|-------------------|----------------------|--------------------------------------|----------------------------|
| Buses | 11 hours/day | 250 km | 6 days/week | 3.2 years | 250,000 km |
| Autos | 6 hours/day | 150 km | 6 days/week | 3.2 years | 150,000 km |
| Delivery Vans | 6 hours/day | 150 km | 6 days/week | 3.2 years | 150,000 km |
| Delivery Trucks | 6 hours/day | 150 km | 6 days/week | 3.2 years | 150,000 km |

Assumptions: Implementation of the above-described FC demo plan hinges on a couple of critical assumptions. First it is assumed that national government subsidies for domestically manufactured FCVs will continue through purchase date of the demo vehicles, substantially lowering costs so that the targeted number of vehicles can be purchased with the allocated funds. The second assumption is that approval for long-term use of these vehicles can be obtained from both relevant national level authorities (which authorize production of various models) and local authorities (which issue vehicles license plates). The project has activities targeted at ensuring both of these two assumptions hold.

Baseline and target values for energy savings and GHG reductions: Please see Annex III for estimated energy savings and GHG reductions directly associated with the above demo vehicles.

⁶³ This includes plan for the 50 cars manufactured by SAIC, but not the Toyota car, plans for which are still under discussion.

Parties involved: At the local level, each of the four cities has set up a project steering committee, whose members are local government officials, to lead local management of the demo vehicles (and associated hydrogen refueling stations). Working level staff at the local level comprise a local PMO to support the local steering committee. Other involved parties will be the vehicle owners/operators. The owners/operators will be responsible for routine maintenance, though they will have manufacturer support in this area. National FCV and hydrogen refueling experts will support local efforts; and the central-level PMO will serve to coordinate and backstop demo efforts.

2. Hydrogen Refueling Station Demonstrations

Purpose and differentiating features: The project will have at least 4 and possibly up to 7 demonstration hydrogen refueling stations (HRSs), with the minimum of 4 being represented by one station in each of the 4 cities in which vehicles will also be demonstrated. The demos will each be either a new HRS (3 to 6 of them) or an existing HRS (1 of them) with new aspect added to its business model. The building, equipment, and installation for all of these HRSs will be funded by local entities. GEF funds will be used to support related incremental activities, such as developing new business or operational models, trouble-shooting problems, capacity building for O&M, and developing a *China Hydrogen Refueling Station (HRS) Reliability Database* and other monitoring processes to assess results and develop lessons learned.

The demo HRSs will have three important demonstration aspects compared to past efforts. First, an important demonstration aspect of the HRSs will be their continuous and ongoing (beyond project close) operation. China has had a small handful of hydrogen refueling stations in the past, but none have operated continuously since initiation due to the previously sporadic nature of FCV demos. At present, there are just two stations that are operational. One is in Shanghai has recently resumed almost daily operation to serve a small group of SAIC FC autos. The other is in Beijing and operates sporadically to serve test FCVs.

The second important aspect of the HRS demonstrations is that they will enable achievement of a “critical mass” of stations to provide monitoring data for analysis, lessons learned, and associated achievement of targets. Including an existing station in Beijing that will not be counted as a demo, the project HRS demos will result in a total of at least 5 and possibly up to 8 continuously operated HRSs in China. Targets for these stations will be reliability (to reduce down days per year to as few as possible), reduction in accidents (maximizing periods between incidents), and reduction in capital costs to build the stations.

The third demonstration aspect of the project HRSs will be to introduce new business or operational models for hydrogen refueling stations in China. Targeted models to be demonstrated include: addition of EV charging to HRS, on-site generation of hydrogen via renewable energy, possibly addition of hydrogen to existing gasoline station, and possibly other multi-fuel offerings for new stations (e.g. hydrogen and CNG).

Plans for Individual Stations: The plans of each relevant city with regard to project demo HRSs are discussed below and summarized in Exhibit VI-7.

Exhibit VI-7: Plans for Project Demo HRSs and Existing HRSs

| City | New or existing | New business model or approach | Incremental project activities | Project demo? / Status |
|------------------------|-------------------------------|--|---|---|
| Shanghai | Existing in Jiading | Will add EV recharging to existing HRS | Monitoring/ reporting results | Project demo; plans confirmed |
| Shanghai ⁶⁴ | Possibly, new or existing one | Hydrogen added to new or existing gasoline station | Outreach to potential gas stations; business plan; O&M capacity building; | Potential project demo: candidate gasoline station to be identified |
| Beijing | Existing in Northwest Beijing | Will be expanded to accommodate more vehicles, but no new approach | Monitor/report results | Not a project demo |
| Beijing | New in SE Beijing | NA (standard station planned) | O&M capacity building; monitor/ report results | Project demo; plans confirmed |
| Beijing | Possibly, new or existing one | Hydrogen added to new or existing gasoline station | Outreach to potential gas stations; business plan; O&M capacity building; | Potential project demo: candidate gasoline station to be identified |
| Zhengzhou | New | PV-powered water electrolysis unit onsite will supply small portion of hydrogen | O&M capacity building; monitor/report results | Project demo; under construction |
| Foshan | New | Business model not yet confirmed (possibly multi-fuel provision) | Business plan; O&M capacity building; monitor/ report results | Project demo; planning stage |
| Other interested city | New | Wind-PV hybrid powered water electrolysis unit on-site targeted to supply one-half of hydrogen | Trouble-shooting wind-PV system; O&M capacity building; monitor/ report results | Potential project demo; under construction |

Shanghai: Shanghai has an existing hydrogen refueling station in Jiading District’s Anting (“Anting Station”). Shanghai’s project HRS demo will be achieved through a new addition to Anting. A second demo HRS in Shanghai is also targeted, in this case a gasoline station that adds hydrogen refueling capabilities. The Anting Station has been in existence for seven or eight years and is now providing refueling for several SAIC FC autos. Anting will become one of the project demos via co-financed addition of EV recharging capabilities to current hydrogen refueling capabilities. A solar panel will generate a small portion of the electricity used for recharging. With the new additions, Anting will become the first station in China to provide both hydrogen refueling and EV recharging on the same premises. The project will provide monitoring and reporting on the performance of Anting Station, including the EV recharging. There will be no provision of HRS O&M capacity building to Anting, as its owners and staff are already well versed in this area.

Hydrogen addition to existing gasoline stations is an important strategy for expanding hydrogen refueling infrastructure. As most central locations in Shanghai already have the required number of gasoline stations and land costs are a barrier to new HRSs, adding hydrogen to an existing station is the preferred strategy. The project will conduct outreach to owners of existing gasoline stations and business plan support for the addition of hydrogen once a candidate station in Shanghai is identified.

Beijing: Beijing at present has an existing hydrogen refueling station (not considered a project demo); and a second one (considered a project demo) is being set up. The project will further aim to establish a second project HRS demo in Beijing, in this case a gasoline station that adds hydrogen refueling

⁶⁴ Using existing hydrogen stations presents special challenges, including lack of standards and lack of space in Beijing and Shanghai.

capabilities. The existing station is in Yongfeng, which is in the northwest part of Beijing. Currently, with investment support from the Beijing Municipal Government, it is undergoing updating of its equipment and expansion so that it will be able to meet the needs of the ten project demo public buses and the five project demo delivery vans. Beijing's second HRS is being set up in an area in the Southeast corner of Beijing. Finally, as in the case of Shanghai, the project will conduct outreach to owners of existing gasoline stations and provide business plan support for the addition of hydrogen once a candidate station in Beijing is identified. The project will provide monitoring and reporting support to all Beijing stations and O&M capacity building support to new Beijing stations.

Zhengzhou: In Zhengzhou, Yutong Bus Company is currently building a hydrogen refueling station, which will be a project demo. Onsite, the station will include PV panels and a water electrolysis unit that will produce from water and sunlight a small portion of the hydrogen utilized by the station. The project will provide monitoring and reporting support and O&M capacity building support to the Zhengzhou HRS.

Foshan: A new HRS will be built in Nanhai, which will be a project demo. Land has already been secured, but final decisions on the business model have not yet been made. The project will provide business plan support for a possibly multi-fuel station. It will also provide monitoring and reporting support, as well as O&M capacity building.

Other interested cities: A new HRS that has a substantial wind-PV hybrid system powering a water electrolysis unit to produce hydrogen onsite will be built. This HRS will be a potential project demo. The wind-PV-powered water electrolysis system is targeted to provide 50 percent of the hydrogen used on-site, though there will be challenges in attaining this figure. The project will provide troubleshooting support to the wind-PV-water electrolysis system and also provide monitoring and reporting and O&M capacity building.

Assumptions: Implementation of the above-described HRS demo plan hinges on a couple of critical assumptions. First it is assumed that national government subsidies for hydrogen refueling stations (currently at the level of 4 million RMB for stations that are designed to provide 200 kg or more of hydrogen per day to FCVs) will continue through the time of station establishment. The second assumption is that approval for new stations from local authorities will be timely. The project has activities targeted at ensuring both of these two assumptions hold.

Parties involved: There will be several parties involved in the hydrogen refueling station demos. These include local governments and companies (to date, largely state-owned) that invest in building the stations. Specialized organization designing and building the stations, as well as key equipment suppliers, are also important parties. They are likely to provide O&M training to the stations, so that project O&M capacity building will be supplementary to this base of vendor-supplied training. Through the project, experts will also be involved in the HRS demos. They will design the *China Hydrogen Refueling Station (HRS) Reliability Database* and other monitoring schemes and conduct analysis and reporting. They will provide outreach and business plan support to demos and potential demos. Further, they will provide O&M capacity building to demos.

Hydrogen source: Exhibit VI-8 shows the main source(s) of hydrogen anticipated for the demo HRSs in each city.

Exhibit VI-8: Main Source of Hydrogen Anticipated for Project Refueling Stations

| Beijing | Shanghai | Zhengzhou | Foshan |
|---|---|--|--|
| (1) Capital Steel’s natural gas reforming (currently 50 RMB per kg) and, later (2) Zhangbei Wind farm’s wind power based hydrogen. | Shanghai coking factory: industrial by-product hydrogen | Hydrogen production to take place at Yutong Company: Method of production will be H2 recovery from industrial H2-laden gas streams. Also, small portion of hydrogen will be produced onsite with PV-powered electrolysis of water. | Hydrogen source still to be confirmed. |
| Other interested cities | | | |
| Up to 50% of hydrogen will be provided onsite by wind-PV hybrid powered electrolysis of water; source of the rest to be determined. | | | |

3. Renewable Energy Based Hydrogen Production Demonstrations

Purpose: The purpose of the project’s renewable energy based hydrogen production demos will be to promote and build technical capacity in a new area of hydrogen production that has the potential of “de-carbonizing” the fuel source and thus fulfilling the future FCV promise of zero carbon emissions. At present, hydrogen production through industrial by-product or natural gas reforming is relatively advanced in some areas of China. Yet, there is little experience with renewable energy based hydrogen production of substantial scale. Indeed, worldwide one criticism of FCVs is they have not yet fulfilled their promise of zero emissions due to use of carbon-based methods of hydrogen production. The renewable energy based hydrogen production demos of the project will demonstrate hydrogen production of substantial scale. In some cases the renewable energy based hydrogen production will directly supply project demo HRSs and thus project demo FCVs, though in others this may not be the case in the short term. The hydrogen production demos, however, will set the stage for replication and thus greater availability of renewable energy based hydrogen production. In a sense, then, they will lay the path for de-carbonizing China’s hydrogen production just as the use of FCVs begins to grow.

Type of demos and demo partners: The project targets four renewable energy based hydrogen production demos of substantial scale. These will be wind-farm based hydrogen production and land fill methane based hydrogen production. Wind farm based hydrogen production on substantial scale is new to China. China Energy Conservation and Environmental Protection Corporation (CECEP) at its Zhangbei Windfarm (in Hebei Province north of Beijing) will be the first wind farm to pursue this and the first of the project’s renewable energy based hydrogen production demos. CECEP and others are interested in hydrogen production as a way to capitalize on excess wind power not being fed into the power grid. In addition to CECEP, a wind farm based hydrogen production facility will be set up at a wind farm near Yancheng, Jiangsu Province. Work will also be done to establish other wind farm partners among interested parties for an additional demonstration. While biogas-based hydrogen production has been carried out on a test scale in China, no large scale biogas systems like landfill methane based hydrogen production has occurred. The project will seek out an appropriate partner for a demonstration in this area.

Financing and incremental activities: Equipment and installation for the renewable energy based hydrogen production demonstrations will be co-financed, while incremental activities will support technical capacity building and promotion of the renewable energy based hydrogen production opportunity. Already, through its *863 Program*, the Government of China is providing some support for wind farm based hydrogen production, including for the first of the project hydrogen production demos at Zhangbei Wind Farm in Hebei Province. The project will first of all conduct outreach to additional potential demo candidates. Then, project activities will include one-on-one technical assistance to each of the three demo wind farm partners and to the one demo landfill methane partner. This assistance will be focused on achieving lowest possible costs and highest possible reliability. International experience will be emphasized in group workshops as well as a study tour to Germany to

learn about that country's work to date in "P to G" (power to hydrogen gas) and injection of hydrogen gas into the natural gas network.

4. Local-level Policy Pilots

Purpose of the policy pilots: The project will have two local-level policy pilots. The policies will incentivize FCV purchase and/or investing in hydrogen refueling stations. So far, China has developed subsidy-based incentive policies at the national level for FCV purchase and for the establishment of hydrogen refueling stations. At the national level, no other incentive policies for such vehicles/stations exist. In a few localities, new energy vehicles (NEVs, including both EVs and FCVs), are eligible for lower fees or avoidance of what can be a long queue in vehicle purchase. The aim of the policy pilots is to broaden the base of experience with incentive policies in China by introducing novel incentive policies that have not been used before in China.

The policy pilots will not have an impact on the direct CO₂ emission reductions of the project, as these demo FCVs and hydrogen production demos will likely be launched prior to the policy pilots. Instead, the policy pilots are expected to play a positive role in stimulating replication and thus indirect CO₂ emission reductions. The project will monitor the policy pilots to ascertain the number of replication vehicles and HRSs directly stimulated by them. In general, given the importance of this policy, it is considered that policy pilots and other policy work will be critical in working synergistically with other aspects of the project to stimulate replication. In this regard, policy's role may be preliminarily estimated to be 30 percent, while: technical assistance to the component/equipment manufacturers will play a 30 percent role, the FCV demos and associated technical assistance to the vehicle manufacturers will play a 20 percent role, and other factors will play the remaining 20 percent role.

Location and nature of the policy pilots: The project as a part of its activities will determine the nature and location of its two policy pilots. In scoping for concepts, international experience and particularly the *California FCV Project*, will be reviewed. Preliminary ideas include free or preferred parking spaces for FCVs and the right to use special lanes with less traffic. Locations for the policy pilots will likely be in some of the four cities in which the project's demo vehicles will be demonstrated. Shanghai and Beijing, given the greater scale of their FCV efforts, may be the most likely candidates.

5. Improved/Cost-Reduced Component Manufacturing Demonstrations

Purpose and nature of component manufacturer pilots: Reducing costs and improving reliability and performance of China-based production of components represents a critical medium-term path towards FCV commercialization. As such, the project will have 8 demonstrations of China-based FCV component manufacturers (each representing a different component) that progress to a level at which they are able to provide world-class FCV components at lower than start-of-project global prices. The main incremental activities of the project in this regard will be provision of both one-on-one technical assistance and facilitation of international cooperation to each of the demos. Because the vehicle demos are expected to be launched early in the second year of this four year project, the demo vehicles will not benefit directly from the component manufacturing demos. Yet, the latter are expected to make a critical contribution to medium-term progress towards FCV commercialization in China and possibly the world. They will do this by facilitating achievement of globally competitive component durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels.

In addition to the eight FCV component manufacturer demos, there will also be two hydrogen refueling station equipment manufacturer demos. These will be discussed, in turn, after details are presented on the FCV component manufacturer demos.

Given the timeline of the project, these FCV component manufacturer and HRS equipment manufacturer demos will not play a role in the project’s direct emission reduction to be achieved by the 109 FCV demos and four hydrogen production installations. Instead, they will contribute to indirect emission reductions that will be realized by replication. By end of project, these demos should result in lower costs for components and in this way play a key role in stimulating replication. Different aspects of the project will together contribute synergistically to create indirect emission reductions. Preliminarily, we estimate that technical assistance to the component/equipment manufacturers will play a 30 percent role in indirect emission reductions, the demos and associated technical assistance to FCV manufacturers will play a 20 percent role, policy pilots and other policy work will play a 30 percent role, and other factors will play the remaining 20 percent role.

Selection of FCV component manufacturer demos – component type: The project formulation team selected type of demo FCV component manufacturers based on a combination of factors, key among which were: role in FCV overall cost structure, potential for improvement, and existence of a candidate company or companies taking or planning to take action-oriented steps towards serving/better serving the FCV sector.

To assess the role of various components in overall costs, cost structure estimates were collected from FCV experts. A representative example of cost structures provided by experts is given in Exhibits VI-9 and VI-10 below. The first (left-most) column in Exhibit VI-9 shows the cost structure of the overall “FC System,” consisting of the fuel cell stack (engine), which accounts for 49% of costs, and various balance of system components, such as hydrogen tank. The middle column shows the cost structure of the fuel cell stack (or “engine”) alone, for which the MEA makes up 47%. Finally, the right column shows a breakdown of MEA component costs. Exhibit VI-10 combines the three columns of Exhibit VI-9, thus incorporating stack and MEA individual components into the overall picture of the larger fuel cell system cost structure.

Exhibit VI-9: Cost Structure of FC System, FC Stack, and MEA

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

†Hydrogen Supply System Integration

Exhibit VI-10: Overall Cost Structure of FC System, incorporating Stack and MEA Components

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

Specific FCV component manufacturer demonstrations: Details of each of the eight China-based FCV component manufacturer demos are given below. The demos are summarized in Exhibit VI-11.

Membrane: The project's demo membrane manufacturer will be China's top FC membrane manufacturer, Dongyue (located in Shandong Province). In this demo, Dongyue will be assisted to achieve reduced cost and increased quality, which are still needed despite this component already being domestically sourced from Dongyue by China's FCV manufacturers. Quality needs are: increased durability and reduced thickness, as well as improved: hydrogen cross-over, performance, and manufacturing quality. Dongyue possesses cost advantage in that it is vertically integrated, owning its own mines for membrane raw materials. Scale up from its current annual capacity of 200,000 m² per year to 1 million m² per year is expected to yield strong cost improvements. Planning/assessment and one-on-one TA and facilitation of joint venture or other international cooperation will be provided. One-on-one TA will be provided by a membrane testing and production expert, preferably with experience from a top international manufacturer of membranes. The facilitation with potential FCV clients internationally as a way of achieving enough demand for the scale-up targeted will also be carried out. Dongyue in 2014 invested 50 million RMB (8 million USD) in pilot production equipment and plans to continue to invest an additional 20 million RMB annually (3.2 million USD) in membrane testing and production. Incremental funds will be provided for the incorporation of enhanced features/higher quality of selected membrane quality testing/assessment equipment Dongyue is planning to purchase.

Catalyst: Chinese FCV manufacturers are currently importing catalyst. The project demo catalyst manufacturer will be Guiyanboye (based in Yunnan Province), which needs to achieve improved processing and scale-up in order to offer a lower cost catalyst to FCV manufacturers. A cost advantage of 20 to 30 percent, leveraging Guiyanboye's platinum trading and recycling platforms, is sought. Target performance improvements include reduction of indicator from 0.6 mg Pt per cm² to 0.3 mg Pt per cm², or even beyond to 0.2 mg Pt per cm² through the optimization of MEA structure and manufacturing. Incremental assistance from the project will include assessment/action plan and one-on-one technical assistance in production and testing. It will also include incremental funds for enhanced features/higher quality of single fuel cell test platform (and provision of related training) that Guiyanboye plans to purchase, incremental funds for enhanced features/higher quality of pilot preparation platform (to facilitate the move from laboratory to batch production) that Guiyanboye plans to purchase, and facilitation of joint venture or other international cooperation. Once basic

methodology is proven, Guiyanboye plans to scale up by building a 2 to 5 ton per year FC catalyst production line.

Exhibit VI-11: Project FCV Component Manufacturer Demos

| Component | Current Procurement | Selected Demo Manufacturer or Candidate | Key Needs | Incremental Activities |
|-----------------------------|---------------------|--|---|--|
| Membrane | China | Dongyue (Shandong) – top Chinese FC membrane provider; cost advantage via owning its own mines | Increase durability, reduce thickness; improve hydrogen cross-over, performance, and manufacturing quality. Scale up production to lower cost. | TA, facilitate international cooperation, equipment purchase |
| Catalyst | Imported | Guiyanboye (Yunnan) | Improved testing and processing; scale-up of production. Reduce indicator from 0.6 mg Pt/cm ² to 0.3 or 0.2 mg Pt/cm ² through the optimization of MEA structure and manufacturing. | TA, facilitate international cooperation, equipment purchase |
| MEA | China | Wuhan-based co. or Sunrise (Dalian) | Reduce discard rate from 20% to 2% | TA, facilitate international cooperation |
| Bi-polar plates | China | Shanghai or Dalian-based co., maybe Sunrise | Improve coating and stamping, thereby decreasing corrosion and reducing thickness from 0.7 mm to 0.4 mm | TA, facilitate international cooperation |
| FC stack | China | Sunrise (Dalian) | Increase stack maximum efficiency from current 60% to 65%; increase lifetime at specified test cycle from current level to 10,000 hours | TA, facilitate international cooperation |
| Compressor (for FCV) | China/ imported | Guangshun (Foshan) | Improve quality control, technology, and supply chain. (Include air bedding and better high speed motors in this work.) | TA, facilitate international cooperation |
| Hydrogen recirculation pump | Imported | Project to search for candidates | Launching of domestic manufacture, lowering costs and alleviating other obstacles faced by FCV manufacturers | Identify prospects, TA, facilitate international cooperation |
| HV DC-DC converter | China | Project to search for candidates | Lowering costs and alleviating other obstacles faced by FCV manufacturers | Identify prospects, TA, facilitate international cooperation |

MEA: The project demo MEA manufacturer will be either a stand-alone MEA manufacturer based in Wuhan or Dalian Sunrise (which produces MEA as one component of the FC stack it produces). Final selection will occur during project inception. Assistance will consist of assessment/action plan, one-on-one technical assistance to improve processing, and facilitation of joint venture or other cooperative relationship with international counterpart.

Bi-polar plate: The project demo bi-polar plate manufacturer will either be a stand-alone bi-polar plate manufacturer based in Dalian or Shanghai or FC stack manufacturer Dalian Sunrise, which produces bi-polar plates as a component for its FC stacks. The manufacturer will be selected during project inception. The key issue will be to improve the process and technology for coating and stamping. Improved stamping will facilitate decreasing width of the plates from 0.7 mm to 0.4 mm. Improved coating is required to reduce corrosion. Incremental activities will include assessment/action plan, one-on-one TA, and facilitation of international cooperation.

FC stack: The project demo FC stack (engine) manufacturer will be Dalian Sunrise, which is believed to be the best manufacturer of its type in China. Targets for the demo will include increasing stack maximum efficiency from its current level of 60 percent to 65 percent, increasing stack lifetime at specified test cycle from current level to 10,000 hours, and increasing performance from 1.0A@0.65V to 1.5A@0.65V. Incremental assistance will include assessment/action plan, one-on-one technical assistance, and facilitation for international cooperation.

Compressor (for FCV): Foshan Guangshun will be the project’s demo FCV compressor manufacturer. The purpose of the demo will be to improve quality control processes, technology, and supply chain. Areas of improvement will include air bedding and better high speed motors. Incremental activities will include assessment/action plan, one-on-one technical assistance, and facilitation of international cooperation.

Hydrogen recirculation pump: At present there are no China-based producers of hydrogen recirculation pumps in China. Yet, there are there are a number of interested and potentially qualified candidates. Thus, the project’s first incremental sub-activity in this area will be to identify an interested, capable, and proactive manufacturer to assist in launching domestic production of the hydrogen recirculation pump. The aim of the demo will be to lower costs and reduce other difficulties faced by Chinese FCV manufacturers in sourcing this component. Other sub-activities will include one-on-one technical assistance and, facilitation of international cooperation.

High voltage DC/DC converter: This demo will be targeted to lower costs and other difficulties currently faced by Chinese FCV manufacturers in sourcing high voltage DC/DC converters. The first incremental sub-activity will be to identify a current or potential manufacturer with qualifications and interest in achieving needed improvements. Other sub-activities will include assessment/action plan, one-on-one technical assistance, and, facilitation of international cooperation.

Specific HRS equipment manufacturer demonstrations: As with the FCV component manufacturer demos, the HRS equipment manufacturer demos are intended to facilitate achievement of globally competitive component durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels. Details of the two China-based HRS component manufacturer demos are given below. The demos are also summarized in Exhibit VI-12.

Exhibit VI-12: Project HRS Component Manufacturer Demos

| Component | Current procurement | Selected demo manufacturer or candidate | Key needs | Incremental activities |
|------------------------------|----------------------------|---|--|---|
| Compressor for HRS | Imported/ domestic | To be determined: likely candidate Beijing Tiangao | Improve reliability, control of production, sourcing of parts | Technical assistance, facilitation of international cooperation |
| Hydrogen refueling dispenser | Domestic | To be determined; likely candidate Shanghai Sunwise | Sourcing, adjusting technical methodology, support for international cooperation | Technical assistance, facilitation of international cooperation |

Compressor for HRS: At present, China-based compressors supplied to HRSs lack the reliability of their international counterparts and often break down. Yet, imported HRS compressors are expensive. Currently, Shanghai's Anting Station and Beijing's HRS are using imported compressors. A station in Shenzhen (not currently operational) has used a domestic compressor supplied by Beijing Tiangao. Yet, operation of the station has not been continuous enough to get detailed data on performance. While the demo manufacturer has not yet been selected, Beijing Tiangao, as the only China-based company having supplied compressors to HRSs, is a likely candidate. The selected demo manufacturer will be confirmed during project inception. Assistance will target increasing reliability, control of production, and sourcing of parts. Facilitation of international cooperation will also be provided.

Hydrogen refueling dispenser: The demo hydrogen refueling dispenser manufacturer will likely be Shanghai Sunwise, though this will be confirmed during project inception. Incremental support will include assistance in sourcing, assistance in adjusting technical methodology, and liaison support for potential cooperation with international manufacturer.

Annex VII: Service Agreement between Country Office and Implementing Partner

STANDARD LETTER OF AGREEMENT BETWEEN UNDP AND THE MINISTRY OF SCIENCE AND TECHNOLOGY FOR THE PROVISION OF SUPPORT SERVICES

1. Reference is made to consultations between officials of the *Ministry of Science and Technology* (hereinafter referred to as “MOST”) and officials of UNDP with respect to the provision of support services by the UNDP country office for the project. UNDP and MOST hereby agree that the UNDP country office may provide such support services at the request of MOST through its institution designated in the relevant project support document or project document, as described below.
2. The UNDP country office may provide support services for assistance with reporting requirements and direct payment. In providing such support services, the UNDP country office shall ensure that the capacity of MOST-designated institution is strengthened to enable it to carry out such activities directly. The costs incurred by the UNDP country office in providing such support services shall be recovered from the administrative budget of the office.
3. The UNDP country office may provide, at the request of MOST or its designated institutions, the following support services for the activities of the project:
 - (a) Identification and/or recruitment of project and program personnel;
 - (b) Procurement of goods and services; and
 - (c) Other project related actions as needed and requested in addition to the country office’s project oversight support covered under the GEF implementing Agency fee.
4. The procurement of goods and services and the recruitment of project personnel by the UNDP country office shall be in accordance with the UNDP regulations, rules, policies and procedures. Support services described in paragraph 3 above shall be detailed in an annex to the project support document or project document, in the form provided in the Attachment hereto. If the requirements for support services by the country office change during the life of a project, the annex to the project support document is revised with the mutual agreement of the UNDP Country Director and the designated institution.
5. The relevant provisions of the Standard Basic Assistance Agreement between the Government of China and the United Nations Development Programme in China signed on January 29 1979 (the “SBAA”), including the provisions on liability and privileges and immunities, shall apply to the provision of such support services. The Government shall retain overall responsibility for the nationally managed program or project through its designated institution. The responsibility of the UNDP country office for the provision of the support services described herein shall be limited to the provision of such support services detailed in the annex to the project support document or project document.
6. Any claim or dispute arising under or in connection with the provision of support services by the UNDP country office in accordance with this letter shall be handled pursuant to the relevant provisions of the SBAA and the project support document or project document.
7. The manner and method of cost-recovery by the UNDP country office in providing the support services described in paragraph 3 above shall be specified in the annex to the project support document.

8. The UNDP country office shall submit progress reports on the support services provided and shall report on the costs reimbursed in providing such services, as may be required.
9. Any modification of the present arrangements shall be effected by mutual written agreement of the parties hereto.
10. If you are in agreement with the provisions set forth above, please sign and return to this office three signed copies of this letter. Upon your signature, this letter shall constitute an agreement between the MOST and UNDP on the terms and conditions for the provision of support services by the UNDP country office for the project.

 Patrick Haverman
 Deputy Country Director
 United Nations Development Programme

 Ministry of Science and Technology

[Date]

[Date]

Attachment

DESCRIPTION OF UNDP COUNTRY OFFICE SUPPORT SERVICES

1. Reference is made to consultations between MINISTRY OF SCIENCE AND TECHNOLOGY, the institution designated by the Government of China and officials of UNDP with respect to the provision of support services by the UNDP country office for the nationally managed project *China DevCom FCV: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (PIMS#: 5349)*.
2. In accordance with the provisions of the letter of agreement signed on *[insert date of agreement]* and the project document, the UNDP country office shall provide support services for the project as described below.
3. Support services to be provided:

| Support services (insert description) | Schedule for the provision of the support services | Cost to UNDP of providing such support services (where appropriate) | Amount and method of reimbursement of UNDP (where appropriate) |
|--|--|---|--|
| 1. Recruiting two international and two national specialists | To be recruited as per AWP. | As per UPL, the service fee is US\$ 5,265.6. | ATLAS billing -Estimated amount: US\$ 5,265.6. |
| Estimated total | | | US\$5,265.6 (estimated) |

4. Description of functions and responsibilities of the parties involved:
5. Description of functions and responsibilities of the parties involved is as per the project document. UNDP country office will provide the services as stated above upon the request of the Ministry of Science and Technology. The reimbursement of the UNDP support cost will be recorded as per transactions based on the established UNDP financial regulations and rules.

Annex VIII. Social and Environmental Screening

Project Information

| Project Information | |
|-------------------------------------|---|
| 1. Project Title | Accelerating the Development and Commercialization of Fuel Cell Vehicles in China |
| 2. Project Number | PIMS 5349 |
| 3. Location (Global/Region/Country) | China |

Part A. Integrating Overarching Principles to Strengthen Social and Environmental Sustainability

| QUESTION 1: How Does the Project Integrate the Overarching Principles in order to Strengthen Social and Environmental Sustainability? |
|--|
| <i>Briefly describe in the space below how the Project mainstreams the human-rights based approach</i> |
| The project does not have any activities specifically focused on mainstreaming the human rights based approach. It will, however, in general terms ensure it follows the human rights based approach, despite one identified risk, as explained below. |
| <i>Briefly describe in the space below how the Project is likely to improve gender equality and women's empowerment</i> |
| The project does not have any activities specifically focused on mainstreaming gender equality and women's empowerment. As such, it is not likely to improve these areas in a general way. Yet, efforts will be taken to promote gender equality and women's empowerment where possible and as follows: Throughout all its activities, the project will aim to include as many women as possible, both as recipients of various forms of technical assistance and as consultants retained by the project. In particular, six major project activities (group capacity building for FCV manufacturers, group capacity building for potential renewable energy based hydrogen producers, group capacity building for hydrogen refueling stations (HRSs), and three study tours, one for each of the aforementioned groups) include in their design efforts to include as many women as possible. |
| <i>Briefly describe in the space below how the Project mainstreams environmental sustainability</i> |
| This project's objective "facilitating the development and commercialization of FCVs" is motivated primarily by the potential of wide-scale FCV adoption to reduce greenhouse gas emissions and improve local air quality. In the scenario with the GEF project, demonstrated FCVs leapfrog beyond the durability, performance, and cost reduction parameters that would be achieved if there were no GEF project; and, as a result, FCVs become more attractive to end users. Further, international sourcing of FCV components and domestic production of such components are both improved, leading to further improvements in durability and reduction in price over the no-project scenario. With the GEF project, renewable energy based hydrogen production of substantial scale is introduced into China as are hydrogen refueling stations with varied business models. Policy promoting FCVs is enhanced as is awareness of FCVs. Human capacity in O&M (for vehicles and stations) is enhanced, as is capacity in the financial sector as relates to FCVs. Direct CO ₂ emission reductions are 15,172 tons as compared to 1,329 tons in the no-project case. Indirect "bottom up" emission reductions in the GEF project scenario (assuming ten times replication of the FCV demos) are 151,724 tons as compared to 1,329 tons (assuming one time replication) in the no-project case. |

Part B. Identifying and Managing Social and Environmental Risks

| QUESTION 2: What are the Potential Social and Environmental Risks? <i>Note: Describe briefly potential social and environmental risks identified in Attachment 1 – Risk Screening Checklist (based on any “Yes” responses). If no risks have been identified in Attachment 1 then note “No Risks Identified” and skip to Question 4 and Select “Low Risk”. Questions 5 and 6 not required for Low Risk Projects.</i> | QUESTION 3: What is the level of significance of the potential social and environmental risks? <i>Note: Respond to Questions 4 and 5 below before proceeding to Question 6</i> | | | QUESTION 6: What social and environmental assessment and management measures have been conducted and/or are required to address potential risks (for Risks with Moderate and High Significance)? |
|--|--|---|---|--|
| Risk Description | Impact and Probability (1-5) | Significance (Low, Moderate, High) | Comments | Description of assessment and management measures as reflected in the Project design. If ESIA or SESA is required note that the assessment should consider all potential impacts and risks. |
| Risk 1 (Principle 1-4): There is a possibility that residents of certain neighborhoods will not be included in decisions to site hydrogen refueling stations in those neighborhoods. Some cities, such as Shanghai, have regulations requiring public consultation before building certain facilities, such as refueling stations, but other cities may not have such a process. | I = 3 P = 3 | Moderate | | Project plans annual survey of public perception of hydrogen refueling stations in the neighborhood of the HRS demos. For cities that lack standard consultative process, first annual survey will serve to initiate consultation process. Stakeholder engagement via annual neighborhood surveys is included in Outcome 2B, which demonstrates, among other things, hydrogen refueling stations. The specific activity through which the survey is conducted is Activity 2.B3.3. |
| Risk 2 (Principle 2-2): There is a possibility that the project will unintentionally reproduce discrimination against women based on gender, particularly with regard to participation in some project activities. While women are well-represented in the workplace in China, they may face a “glass ceiling” and as such may not be accorded equal opportunities for involvement in special activities, such as workshops and international study tours. | I = 3 P = 3 | Moderate | The reason a probability of 3 “moderately likely” is given is that it will generally be the beneficiary work unit rather than the project itself that makes the decision as to who will be involved in project activities. Beneficiary work units may have a bias towards involving men in project activities over women. The impact is also rated 3 (“moderate”). With fewer women involved in project activities than might | Throughout all its activities, the project will aim to include as many women as possible, both as recipients of various forms of technical assistance and as consultants retained by the project. In particular, six major project activities (group capacity building for FCV manufacturers, group capacity building for potential renewable energy based hydrogen producers, group capacity building for hydrogen refueling stations (HRSs), and three study tours, one for each of the aforementioned groups) include written into their design that an effort to include as many women as possible will be made. |

| | | | | |
|---|----------------|-----|--|---|
| | | | be, the potential for them to be significantly involved in the FCV sector is further reduced. | |
| Risk 3 (Principle 3, Standard 3-3.1): It is possible that elements of project operation will lead to potential safety risks to the community, as relates to the production, transport, and refueling of hydrogen, as well as its use in vehicles. For FCVs the main risk relates to hydrogen leaks (due to part failure or rupture due to impact), which could lead to fire or explosion. For hydrogen refueling stations, the main risk relates to hydrogen leaks (due to part failure or misuse), which could lead to fire or explosion. For hydrogen production, the main risk is that hydrogen leak (due to part failure) could lead to fire or explosion. (If wind farms are used to produce hydrogen, they don't create any risk on the wind farm side of things.) As for hydrogen transport (from producer to station), the main risk is hydrogen leak at tanker truck (due to part failure, accident) that could lead to fire or explosion. | I = 2 P = 2 | Low | While safety issues are acknowledged and deserve careful attention, there is in a sense also a certain level of myth in regard to hydrogen safety issues. Hydrogen has some substantial advantages that limit the impact of any incident: It is so light that it immediately evaporates upwards and disappears. It is also non-poisonous, so that there is no contamination or health impact to affected people or environment (except fire/explosion). Finally, because hydrogen is so light, any fire will be gone quickly (much faster than a gasoline/natural gas fire). ⁶⁵ | Safety issues will receive prominent position in one-on-one and group technical assistance for FCV manufacturers and renewable energy based hydrogen production, as well as in group technical assistance for hydrogen refueling stations. Their coverage is specifically indicated in the text of the project design. Standards and testing work will further reinforce safety aspects. Finally, the project design also calls for the holding of a fire safety seminar covering all aspects of the FCV value chain (including hydrogen infrastructure). Specific countermeasures taken for each sub-area of risk and that will be adopted in the aforementioned activities include the following: (1) FCV risk: countermeasures in vehicle and component design (special hoses, valves, position of tank in vehicle), hydrogen sensors, and shutoff-valves; (2) hydrogen refueling station risk: station design, safety/shutoff mechanisms, control of station, and location of pump and equipment; (3) hydrogen production risk: design, shutoff mechanisms, and operator training; (4) hydrogen transport risk: tanker and component design, safety/shutoff mechanisms, and operator training. |
| Risk 4 (Principle 3, Standard 3-3.2): It is possible that elements of project operation will lead to potential occupational safety risks as relates to the production, transport, and refueling of hydrogen, as well as its use in vehicles. The specific risks for each of these areas is the same as outlined above under Risk 3. | I = 2 P = 2 | Low | | Same management measures as described in cell directly above (for Risk3). |
| QUESTION 4: What is the overall Project risk categorization? | | | | |
| Select one (see SESP for guidance) | | | Comments | |
| <i>Low Risk</i> | | | <input type="checkbox"/> | |
| <i>Moderate Risk</i> | | | <input checked="" type="checkbox"/> | Of four risks, two are rated "moderate;" Two rated "low." |
| <i>High Risk</i> | | | <input type="checkbox"/> | |

⁶⁵ Additional background on hydrogen safety issues is provided at the end of Section 1.1 (Context and Global Significance).

| QUESTION 5: Based on the identified risks and risk categorization, what requirements of the SES are relevant? | | |
|--|-------------------------------------|--|
| Check all that apply | | Comments |
| <i>Principle 1: Human Rights</i> | <input checked="" type="checkbox"/> | Risk 1 relates to human rights – the right to be involved in decisions that impact one’s community |
| <i>Principle 2: Gender Equality and Women’s Empowerment</i> | <input checked="" type="checkbox"/> | Risk 2 relates to gender equity and women’s empowerment – the principle that women should be treated equally and have equal opportunity (in this case equal opportunity for participation in the project and related career advancement or business opportunity) |
| <i>1. Biodiversity Conservation and Natural Resource Management</i> | <input type="checkbox"/> | |
| <i>2. Climate Change Mitigation and Adaptation</i> | <input type="checkbox"/> | |
| <i>3. Community Health, Safety and Working Conditions</i> | <input checked="" type="checkbox"/> | Risks 3 and 4 relate to safety of the community and employees with regard to hydrogen production, transport, refueling, and use in vehicles. |
| <i>4. Cultural Heritage</i> | <input type="checkbox"/> | |
| <i>5. Displacement and Resettlement</i> | <input type="checkbox"/> | |
| <i>6. Indigenous Peoples</i> | <input type="checkbox"/> | |
| <i>7. Pollution Prevention and Resource Efficiency</i> | <input type="checkbox"/> | |

Final Sign Off

| <i>Signature</i> | <i>Date</i> | <i>Description</i> |
|------------------|-------------|---|
| QA Assessor | | UNDP staff member responsible for the Project, typically a UNDP Programme Officer. Final signature confirms they have “checked” to ensure that the SESP is adequately conducted. |
| QA Approver | | UNDP senior manager, typically the UNDP Deputy Country Director (DCD), Country Director (CD), Deputy Resident Representative (DRR), or Resident Representative (RR). The QA Approver cannot also be the QA Assessor. Final signature confirms they have “cleared” the SESP prior to submittal to the PAC. |
| PAC Chair | | UNDP chair of the PAC. In some cases PAC Chair may also be the QA Approver. Final signature confirms that the SESP was considered as part of the project appraisal and considered in recommendations of the PAC. |

SESP Attachment 1. Social and Environmental Risk Screening Checklist

| Checklist Potential Social and Environmental Risks | |
|---|------------------------|
| Principles 1: Human Rights | Answer (Yes/No) |
| 1. Could the Project lead to adverse impacts on enjoyment of the human rights (civil, political, economic, social or cultural) of the affected population and particularly of marginalized groups? | No |
| 2. Is there a likelihood that the Project would have inequitable or discriminatory adverse impacts on affected populations, particularly people living in poverty or marginalized or excluded individuals or groups? ⁶⁶ | No |
| 3. Could the Project potentially restrict availability, quality of and access to resources or basic services, in particular to marginalized individuals or groups? | No |
| 4. Is there a likelihood that the Project would exclude any potentially affected stakeholders, in particular marginalized groups, from fully participating in decisions that may affect them? | Yes |
| 5. Is there a risk that duty-bearers do not have the capacity to meet their obligations in the Project? | No |
| 6. Is there a risk that rights-holders do not have the capacity to claim their rights? | No |
| 7. Have local communities or individuals, given the opportunity, raised human rights concerns regarding the Project during the stakeholder engagement process? | No |
| 8. Is there a risk that the Project would exacerbate conflicts among and/or the risk of violence to project-affected communities and individuals? | No |
| Principle 2: Gender Equality and Women's Empowerment | |
| 1. Is there a likelihood that the proposed Project would have adverse impacts on gender equality and/or the situation of women and girls? | No |
| 2. Would the Project potentially reproduce discriminations against women based on gender, especially regarding participation in design and implementation or access to opportunities and benefits? | Yes |
| 3. Have women's groups/leaders raised gender equality concerns regarding the Project during the stakeholder engagement process and has this been included in the overall Project proposal and in the risk assessment? | No |
| 4. Would the Project potentially limit women's ability to use, develop and protect natural resources, taking into account different roles and positions of women and men in accessing environmental goods and services? <i>For example, activities that could lead to natural resources degradation or depletion in communities who depend on these resources for their livelihoods and well being</i> | No |
| Principle 3: Environmental Sustainability: Screening questions regarding environmental risks are encompassed by the specific Standard-related questions below | |
| Standard 1: Biodiversity Conservation and Sustainable Natural Resource Management | |
| 1.1 Would the Project potentially cause adverse impacts to habitats (e.g. modified, natural, and critical habitats) and/or ecosystems and ecosystem services? <i>For example, through habitat loss, conversion or degradation, fragmentation, hydrological changes</i> | No |
| 1.2 Are any Project activities proposed within or adjacent to critical habitats and/or environmentally sensitive areas, including legally protected areas (e.g. nature reserve, national park), areas proposed for protection, or recognized as such by authoritative sources and/or indigenous peoples or local communities? | No |
| 1.3 Does the Project involve changes to the use of lands and resources that may have adverse impacts on habitats, ecosystems, and/or livelihoods? (Note: if restrictions and/or limitations of access to lands would apply, refer to Standard 5) | No |
| 1.4 Would Project activities pose risks to endangered species? | No |
| 1.5 Would the Project pose a risk of introducing invasive alien species? | No |
| 1.6 Does the Project involve harvesting of natural forests, plantation development, or reforestation? | No |
| 1.7 Does the Project involve the production and/or harvesting of fish populations or other aquatic species? | No |
| 1.8 Does the Project involve significant extraction, diversion or containment of surface or ground water? <i>For example, construction of dams, reservoirs, river basin developments, groundwater extraction</i> | No |
| 1.9 Does the Project involve utilization of genetic resources? (e.g. collection and/or harvesting, commercial development) | No |
| 1.10 Would the Project generate potential adverse trans-boundary or global environmental concerns? | No |
| 1.11 Would the Project result in secondary or consequential development activities which could lead to adverse social and environmental effects, or would it generate cumulative impacts with other known existing or planned activities in the area? <i>For example, a new road through forested lands will generate direct environmental and social impacts (e.g.</i> | No |

⁶⁶ Prohibited grounds of discrimination include race, ethnicity, gender, age, language, disability, sexual orientation, religion, political or other opinion, national or social or geographical origin, property, birth or other status including as an indigenous person or as a member of a minority. References to "women and men" or similar is understood to include women and men, boys and girls, and other groups discriminated against based on their gender identities, such as transgender people and transsexuals.

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| <i>felling of trees, earthworks, potential relocation of inhabitants). The new road may also facilitate encroachment on lands by illegal settlers or generate unplanned commercial development along the route, potentially in sensitive areas. These are indirect, secondary, or induced impacts that need to be considered. Also, if similar developments in the same forested area are planned, then cumulative impacts of multiple activities (even if not part of the same Project) need to be considered.</i> | |
| Standard 2: Climate Change Mitigation and Adaptation | |
| 2.1 Will the proposed Project result in significant ⁶⁷ greenhouse gas emissions or may exacerbate climate change? | No |
| 2.2 Would the potential outcomes of the Project be sensitive or vulnerable to potential impacts of climate change? | No |
| 2.3 Is the proposed Project likely to directly or indirectly increase social and environmental vulnerability to climate change now or in the future (also known as maladaptive practices)? <i>For example, changes to land use planning may encourage further development of floodplains, potentially increasing the population's vulnerability to climate change, specifically flooding</i> | No |
| Standard 3: Community Health, Safety and Working Conditions | |
| 3.1 Would elements of Project construction, operation, or decommissioning pose potential safety risks to local communities? | Yes |
| 3.2 Would the Project pose potential risks to community health and safety due to the transport, storage, and use and/or disposal of hazardous or dangerous materials (e.g. explosives, fuel and other chemicals during construction and operation)? | Yes |
| 3.3 Does the Project involve large-scale infrastructure development (e.g. dams, roads, buildings)? | No |
| 3.4 Would failure of structural elements of the Project pose risks to communities? (e.g. collapse of buildings or infrastructure) | No |
| 3.5 Would the proposed Project be susceptible to or lead to increased vulnerability to earthquakes, subsidence, landslides, and erosion, flooding or extreme climatic conditions? | No |
| 3.6 Would the Project result in potential increased health risks (e.g. from water-borne or other vector-borne diseases or communicable infections such as HIV/AIDS)? | No |
| 3.7 Does the Project pose potential risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during Project construction, operation, or decommissioning? | Yes |
| 3.8 Does the Project involve support for employment or livelihoods that may fail to comply with national and international labor standards (i.e. principles and standards of ILO fundamental conventions)? | No |
| 3.9 Does the Project engage security personnel that may pose a potential risk to health and safety of communities and/or individuals (e.g. due to a lack of adequate training or accountability)? | No |
| Standard 4: Cultural Heritage | |
| 4.1 Will the proposed Project result in interventions that would potentially adversely impact sites, structures, or objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture (e.g. knowledge, innovations, practices)? (Note: Projects intended to protect and conserve Cultural Heritage may also have inadvertent adverse impacts) | No |
| 4.2 Does the Project propose utilizing tangible and/or intangible forms of cultural heritage for commercial or other purposes? | No |
| Standard 5: Displacement and Resettlement | |
| 5.1 Would the Project potentially involve temporary or permanent and full or partial physical displacement? | No |
| 5.2 Would the Project possibly result in economic displacement (e.g. loss of assets or access to resources due to land acquisition or access restrictions – even in the absence of physical relocation)? | No |
| 5.3 Is there a risk that the Project would lead to forced evictions? ⁶⁸ | No |
| 5.4 Would the proposed Project possibly affect land tenure arrangements and/or community based property rights/customary rights to land, territories and/or resources? | No |
| Standard 6: Indigenous Peoples | |
| 6.1 Are indigenous peoples present in the Project area (including Project area of influence)? | No |
| 6.2 Is it likely that the Project or portions of the Project will be located on lands and territories claimed by indigenous peoples? | No |
| 6.3 Would the proposed Project potentially affect the human rights, lands, natural resources, territories, and traditional livelihoods of indigenous peoples (regardless of whether indigenous peoples possess the legal titles to such areas, whether the Project is located within or outside of the lands and territories inhabited by the affected peoples, or whether the indigenous peoples are recognized as indigenous peoples by the country in question)? <i>If the answer to the screening question 6.3 is "yes" the potential risk impacts are considered potentially severe and/or critical and the Project would be categorized as either Moderate or High Risk.</i> | No |

⁶⁷ In regards to CO₂, 'significant emissions' corresponds generally to more than 25,000 tons per year (from both direct and indirect sources). [The Guidance Note on Climate Change Mitigation and Adaptation provides additional information on GHG emissions.]

⁶⁸ Forced evictions include acts and/or omissions involving the coerced or involuntary displacement of individuals, groups, or communities from homes and/or lands and common property resources that were occupied or depended upon, thus eliminating the ability of an individual, group, or community to reside or work in a particular dwelling, residence, or location without the provision of, and access to, appropriate forms of legal or other protections.

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| 6.4 | Has there been an absence of culturally appropriate consultations carried out with the objective of achieving FPIC on matters that may affect the rights and interests, lands, resources, territories and traditional livelihoods of the indigenous peoples concerned? | No |
| 6.5 | Does the proposed Project involve the utilization and/or commercial development of natural resources on lands and territories claimed by indigenous peoples? | No |
| 6.6 | Is there a potential for forced eviction or the whole or partial physical or economic displacement of indigenous peoples, including through access restrictions to lands, territories, and resources? | No |
| 6.7 | Would the Project adversely affect the development priorities of indigenous peoples as defined by them? | No |
| 6.8 | Would the Project potentially affect the physical and cultural survival of indigenous peoples? | No |
| 6.9 | Would the Project potentially affect the Cultural Heritage of indigenous peoples, including through the commercialization or use of their traditional knowledge and practices? | No |
| Standard 7: Pollution Prevention and Resource Efficiency | | |
| 7.1 | Would the Project potentially result in the release of pollutants to the environment due to routine or non-routine circumstances with the potential for adverse local, regional, and/or trans-boundary impacts? | No |
| 7.2 | Would the proposed Project potentially result in the generation of waste (both hazardous and non-hazardous)? | No |
| 7.3 | Will the proposed Project potentially involve the manufacture, trade, release, and/or use of hazardous chemicals and/or materials? Does the Project propose use of chemicals or materials subject to international bans or phase-outs? <i>For example, DDT, PCBs and other chemicals listed in international conventions such as the Stockholm Conventions on Persistent Organic Pollutants or the Montreal Protocol</i> | No |
| 7.4 | Will the proposed Project involve the application of pesticides that may have a negative effect on the environment or human health? | No |
| 7.5 | Does the Project include activities that require significant consumption of raw materials, energy, and/or water? | No |

Annex IX. Letter of Agreement on Project Financial Service Support between Ministry of Science and Technology and United Nations Development Programme

附录9 项目财务服务协议书

In accordance with the UNDP Rules and Regulations, GEF Project Management Guidelines (issued by Ministry of Finance [2007] 45) and relevant Chinese laws, regulations and policies, Ministry of Science and Technology (MoST) (hereinafter referred to as “Party A”) and United Nations Development Programme (UNDP) (hereinafter referred to as “Party B”) will enter into an agreement on project financial services support regarding “Accelerating the Development and Commercialization of Fuel Cell Vehicles in China” (hereinafter referred to as the “FCV Project”), following a consultation with Ministry of Finance, the GEF Focal Point.

Party A and Party B hereby agree that UNDP country office may provide such support services in accordance with the FCV Project Document (the ProDoc) and at the request of Party A through establishment of an independent Finance Management Unit (FMU). The FMU consists of two staff, with one is for finance and the other one for procurement. Party B will be responsible for recruitment and contract of the two staff, who will take the responsibilities of related project management tasks esp. the finance management support, following the authorization of National Project Director (NPD). Salary of the two staff and related office cost will be covered by FCV Project.

Description of functions and responsibilities of the parties involved are as follows:

依据联合国开发计划署有关规定、《全球环境基金赠款项目管理办法》（财际[2007]45号），以及中国相关的法律和政策，经与全球环境基金事务统一管理部门财政部沟通协商，科技部（以下简称“甲方”）和联合国开发计划署（以下简称“乙方”）达成“促进中国燃料电池汽车商业化发展”项目（以下简称“项目”）财务管理服务协议。

甲乙双方同意，根据项目文件和甲方的要求，联合国开发计划署驻华代表处将成立单独的财务管理工作组承担项目的财务管理工作。财务管理工作组由财务和采购各一人组成，人员聘用程序和合同签署由乙方负责。该财务管理小组成员经项目主任授权后，主要承担项目财务等相关工作，人员薪酬及办公等相关费用从项目经费中支付。

具体职责描述如下：

I. Financial management

1.1 Responsibility of Party A

1.1.1 Party A shall submit a multi-year work plan to Party B within 20 working days before the start of the FCV project. Besides, Party A shall submit a revised two year work plan to Party B within 20 working days after the finalization of Combined Delivery Report (CDR) every year.

1.1.2 Party A shall prepare annual budget revisions, regular budget revisions and final budget revisions. Annual budget revisions should be done according to final CDR of previous years and the revised annual work plan of the current year at the beginning of every year; regular budget revisions should be done upon actual needs of the FCV project; final budget revisions should be done according to actual delivery of previous years prior to the financial closure of the FCV project.

1.1.3 All the financial management documentation, direct payment authorization letters and payment requests should be signed by the NPD of Party A.

1.1.4 Party A shall officially notify Party B any changes in the National Project Director.

1.2 Responsibility of Party B

1.2.1 Party B is responsible for making payments according to Party A's authorization and keeping the FCV Project's financial records. Party B shall provide financial report of the previous quarter to Party A at the first month of each quarter.

1.2.2 When Party B receives the work plan signed by National Project Director of Party A, Party B shall record it into system and then print out annual work plan in the Atlas system and send back to Party A for review, approval and signature.

1.2.3 According to financial regulations of UNDP, Party B is responsible for the following budget revisions and shall provide all the generated documents in the Atlas system to Party A:

- ✓ Annual budget revisions;
- ✓ Regular budget revisions;
- ✓ Final budget revision.

I. 财务管理

1.1 甲方责任

1.1.1 甲方在项目启动前 20 个工作日内，向乙方提交项目周期内的分年度工作计划。此外，甲方应在上一年度财务支出报告完成后的 20 个工作日内，向乙方提交修改过的上一年度工作计划和本年度工作计划。

1.1.2 甲方编制预算包括年度预算、常规预算、最终预算。年度预算修改在每年年初根据上一年度财务支出报告和本年度工作计划修改；常规预算修改根据实际支出情况修改；最终预算修改将根据历年实际支出，并在项目关账前修改。

1.1.3 所有财务管理文件、直接支付授权书和付款申请应由项目主任签署。

1.1.4 如项目主任发生人员变更，甲方需书面通知乙方。

1.2 乙方责任

1.2.1 乙方根据甲方授权，进行付款并保留项目的财务记录。乙方应在每季度的第一个月内，向甲方提交上一季度财务报告。

1.2.2 乙方收到由项目主任签署的年度工作计划后，应将其录入到财务管理系统后生成、打印，并返给甲方，由项目主任审核、批准和签署。

1.2.3 按照乙方的财务规定，乙方向甲方提供系统生成的预算修改文件，包括年度预算修改、常规预算修改、最终预算修改。

II. Project management

2.1 Consultants Employment

2.1.1 Responsibility of Party A

2.1.1.1 Prepare job description (including the estimated budget and duration of the contract) and technical description.

2.1.1.2 Select candidates according to UNDP procurement guidelines.

2.1.1.3 Negotiate with the signatory about the technical part and the financial part of contract (Except in the case of mid-term and final-term evaluation consultants)

2.1.1.4 Sign the contract of the selected consultants (Except in the case of mid-term and final-term evaluation consultants).

2.1.1.5 Authorize Party B to sign the contracts of mid-term and final-term evaluation consultants.

2.1.1.6 Arrange domestic travel of consultants who have signed contracts with Party A and/or Party B.

2.1.2 Responsibility of Party B

2.1.2.1 Assist Party A to provide a list of candidate consultants.

2.1.2.2 Procurement of mid-term and final-term evaluation consultants.

2.1.2.3 For the mid-term and final-term evaluation consultants, Party B shall negotiate with the signatory about job descriptions and the financial part of contract.

2.1.2.4 To prepare and sign consultant contracts upon the authorization of Party A for the mid-term and final-term evaluation consultants.

2.1.2.5 Arrange international and domestic travel for the mid-term and final-term evaluation consultants upon the authorization of Party A according to the requirement of project.

2.1.2.6 Make the direct payment to the consultants upon the request of Party A with all of the relevant supporting documents including contracts, TORs, timesheet, certification of payment and payment request.

II. 项目管理

2.1 专家聘用

2.1.1 甲方责任

2.1.1.1 准备包括预算和合同期限在内的职位描述和任务描述。

2.1.1.2 按照乙方专家聘用程序，确定聘任专家人选。

2.1.1.3 与聘任专家协商合同任务、合同财务条款等内容（不包括聘用中期及终期项目评估专家）。

2.1.1.4 与专家签订合同（不包括聘用中期及终期项目评估专家）。

2.1.1.5 授权乙方与中期及终期评估专家签订合同。

2.1.1.6 根据项目需求，为与甲方签约专家或乙方签约的中期和终期评估专家，安排国内出差事宜。

2.1.2 乙方责任

2.1.2.1 协助甲方提供专家候选人人选。

2.1.2.2 聘用中期及终期项目评估专家。

2.1.2.3 与聘任的中期及终期评估专家协商合同任务、合同财务条款等内容。

2.1.2.4 乙方与中期及终期评估专家签订合同。

2.1.2.5 根据项目需求，经甲方授权，为中期及终期评估专家安排国际及国内出差事宜。

2.1.2.6 乙方依据合同、任务书、工作进度、付款申请和付款确认书等在内的所有证明文件，按甲方要求向专家直接付款。

2.2 Trainings/Seminars/Research/Study tours abroad

2.2.1 Responsibility of Party A

2.2.1.1 Draw up agenda of trainings/seminars/research/study tours abroad. Make, review and approve the budget. All of the related cost should be paid in accordance with the documentations issued by Ministry of Finance including but not limited to “Conference Fee Management Guidelines for Central Government Organizations” ([2016]214), “Travel Cost Management Guidelines for Central Government Organizations” ([2013]531), “Notice on Adjustment of Travel and Accommodation Standards for Central Government Organizations” ([2015]497) and “Financial Management Practices for Temporary Business Trips for Central Government Organizations” ([2013]516).

2.2.2 Responsibility of Party B

2.2.2.1 Review and make the direct payment to the contractors on the authorization of Party A.

2.2 培训/会议/调研/境外考察

2.2.1 甲方责任

2.2.1.1 制定培训、会议、调研、境外考察等方案和预算。相关标准依据财政部《中央和国家机关会议费管理办法》（财行[2016]214号）、《中央和国家机关差旅费管理办法》（财行[2013]531号）、《关于调整中央和国家机关差旅住宿费标准等有关问题的通知》（财行[2015]497号）、《因公临时出国经费管理办法》（财行[2013]516号）等文件执行。

2.2.2 乙方责任

2.2.2.1 在甲方授权下，乙方审核并支付相关费用。

2.3 Subcontracts and Equipment Procurement in General Terms

Subcontracts and equipment procurement contracts listed in present agreement are only restricted to the related contracts listed in the project document of the FCV project.

2.3.1 Responsibility of Party A

2.3.1.1 According to the UNDP rules and regulations and actual needs of the FCV Project, if Party A requires Party B to do procurement of equipment or subcontracts, Party A shall provide the equipment procurement request or sub-contracts' TOR to Party B. Party B will act in accordance with UNDP procurement procedures. Meanwhile, Party A shall assist Party B in provision of necessary technical documentations and technical support.

2.3.1.2 According to actual needs of the FCV Project, if Party A needs to do procurement by itself, it should be done in accordance with Law of People's Republic of China on Bid Invitation and Bidding and other related laws and regulations. All of the related cost will be covered by the Project.

2.3.1.3 Party A shall prepare and sign the contract in line with the TOR and the bidding evaluation reports.

2.3.1.4 Since the equipment will be handed over to the Chinese government after the FCV Project is completed, Party A shall prepare and update an equipment list and serial number for all the non-expendable-equipment and provide a copy to Party B in the beginning of each year.

2.3.2 Responsibility of Party B

2.3.2.1 Party B is responsible for publication of bidding notice and bidding results at websites upon the request of Party A according to the UNDP procedures and regulations.

2.3.2.2 After the signing of the contract, Party B shall assist Party A manage the contracts, and pay the contractors according to the payment terms upon invoice issued from the contractors and the request from Party A.

2.3.2.3 If the procurement is from abroad, Party B is responsible for the signing of the contracts with suppliers and will assist the process for obtaining import license, tax-free certificate and customs clearance, etc., if there is a need. The end user shall pay all fees directly to the relevant government departments.

2.3.2.4 Party B shall submit the non-expendable-equipment handover documents to Party A after the end of the project.

2.3 分包合同和设备采购的一般性条款

关于分包合同和设备采购的一般性条款仅限于项目文件所列的相关活动内容。

2.3.1 甲方责任

2.3.1.1 根据联合国开发计划署有关程序、规定和项目需求，如需委托乙方进行设备采购或招标，甲方应向乙方提供设备采购申请或采购任务书，乙方按联合国开发计划署的程序进行采购。同时，协助乙方提供项目所需要的技术文件和技术支持。

2.3.1.2 根据项目需求，甲方自行采购时，依据《中华人民共和国招标投标法》等进行。相关费用由项目经费支付。

2.3.1.3 根据采购任务书、评标结果等文件，甲方起草合同并与中标方签署合同。

2.3.1.4 由于项目结束后乙方将向中国政府移交设备所有权，甲方应在每年年初向乙方提供最新的非消耗性设备清单及序列号。

2.3.2 乙方责任

2.3.2.1 根据甲方要求，乙方按照联合国开发计划署有关程序和规定，在乙方网站公布招标公告和招标结果。

2.3.2.2 合同签订后，根据甲方要求，乙方协助甲方管理合同。依据付款条件，在中标方出具发票后，乙方向中标方支付合同款项。

2.3.2.3 如果设备是从国外采购，乙方负责与供应商签订合同并根据需要协助办理进口许可证、免税证明书及报关等事宜。上述相关费用需由最终用户承担。

2.3.2.4 项目结束后，乙方应向甲方提交非消耗性设备移交文件。

III. Support to Monitoring and Evaluation

According to UNDP rules and regulations "GEF Project Management Guidelines" (issued by Ministry of Finance [2007]45), Party B shall keep accurate and up-to-date records and documents in respect of all expenditures incurred with the funds made available under the project to ensure that all expenditures are in conformity with the provisions of the Project Work Plan and Project Budgets.

For each disbursement, proper supporting documentation shall be maintained, including original invoices, bills, and receipts pertinent to the transaction. Party B shall keep the records of all the financial reports (including budget revisions, CDR and etc.) for the sake of internal and independent audits carried out by National Audit Office and other qualified audit firms.

Any dispute, controversy or claim arising out of or relating to the understanding and implementation of the present agreement shall be settled through friendly negotiations.

This agreement is written in both Chinese and English languages while both the Chinese and English versions have an equal legality. In case of discrepancy between the two versions, the English version prevails. Produced in just 2 copies, each Party has one copy signed by both parties.

The terms of the present agreement shall commence on the date when the FCV project is launched and terminate when it ends.

III. 监督评估的相关协助工作

根据联合国开发计划署有关规定、财政部《全球环境基金赠款项目管理办法》（财际[2007]45号）等，乙方应确保所有支出均符合项目工作计划和项目预算，并保证项目资金所有支出记录和文件的准确性及时效性。

对于每一笔支出，乙方应保留包括原始发票、账单和交易相关收据在内的文件证明。同时乙方应保存包括预算修订、财务支出报告等在内的所有财务报告。

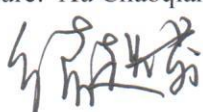
乙方接受国家审计署或其他有资质的会计师事务所进行内部和独立审计。

其他未尽事宜，由甲乙双方本着友好协商的原则商定。

本合同中英文文字具有同等效力。自签署之日起生效，项目结束后终止。

For MoST (科技部):

Signature: Xu Chaoqian

签名: 

Title: Deputy Director General

职务: 副司长

Date: July 6, 2016

日期: 2016年7月6日

For UNDP (联合国开发计划署):

Signature: Patrick Haverman

签名: 

Title: Deputy Country Director

职务: 副国别主任

Date: July 6, 2016

日期: 2016年7月6日

SIGNATURE PAGE

Country: China

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

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

CPAP Output (s)/Indicator (s): Policy and capacity barriers to the sustained and widespread adoption of low carbon and other environmentally sustainable strategies and technologies removed

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

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

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

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

Agreed by (Government):

15/ 8 / 2016
NAME _____ SIGNATURE _____
Date/Month/Year

Agreed by (Executing Entity/Implementing Partner):

NAME _____ SIGNATURE _____
Date/Month/Year

Agreed by (UNDP):

AKI VERES
NAME _____ SIGNATURE _____
Date/Month/Year
Country Director
14/7 / 2016