United Nations Development Programme

Government of China

Terminal Evaluation of UNDP/GEF/MOST Project: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China – (DevCom FCV Project)

(GEF Project ID: 5728; UNDP PIMS ID: 5349)

Final Report

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TABLE OF CONTENTS

Page

SYNOPSIS

Title of UNDP supported GEF financed project: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (FCV Project)

UNDP Project ID: PIMS 5349

GEF Project ID: 5728

Evaluation time frame: August 2016 to June 2021

CEO endorsement date: 3 March 2016

Project implementation start date: 16 August 2016

Project end date: 16 August 2021

Date of evaluation report: 18 July 2021

Region and Countries included in the project: China

GEF Focal Area Objective: Climate Change Mitigation Focal Area Strategic Objective CC1 (for GEF-6): "Promote timely development, demonstration and financing of low carbon technologies and mitigation options"

Implementing partner and other strategic partners:
Executing Entity/Implementing partner: Ministry of Science and Technology (MOST), People's Republic of China

Terminal Evaluation team members: Mr. Roland Wong, International Consultant
Prof. Qiu Bin, National Consultant

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EXECUTIVE SUMMARY

This Termination Evaluation (TE) report assesses the design and formulation, implementation, results (at goal, objective, outcome, outputs levels), targets (against the indicators in the Project Result Framework on p. 54 of the ProDoc, hereinafter referred to as the PRF), GEF additionality, catalytic effect, and progress to impact of the "Accelerating the Development and Commercialization of Fuel Cell Vehicles in China" Project (hereinafter referred to as the DevCom FCV Project or the Project). It also evaluates the Project's relevance, effectiveness, efficiency, sustainability, country ownership, gender equality, and cross cutting issues.

The Project received the CEO endorsement on 03 March 2016. The project inception workshop was held on 31 August 2016 and the project implementation commenced in August 2016. As of the MTR report, had completed 3 years of implementation. As per the Mid-Term Evaluation recommendations, the Project applied for a 12-month no-cost extension in 2020, which was granted by the GEF. The end date of the project has been extended to 16 August 2021.

The duration of the TE assessment is from the project's inception in August 2016 till April 2021, while also providing estimations on the emission reduction results by the End of the Project (EOP). The TE and this report follow the *Guidance for Conducting Terminal Evaluations of UNDP-Supported, GEF-Financed Projects*, copyrighted by UNDP in 2020.

Project Summary Table

Project Title:	*Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (FCV Project)*			
GEF Project ID:	5586		*at endorsement (Million US$)*	*at completion (Million US$)*
UNDP Project ID:	5232	GEF financing:	8.234	7.810[1]
Country:	China	IA/EA own:	0.400	0.400
Region:	Asia and the Pacific	Government:	17.600	114.467
Focal Area:	Climate Change	Other:	35.500	273.897
FA Objectives, (OP/SP):	CCM2 for GEF 5: Promote market transformation for energy efficiency in industry and the building sector	Total co-financing:	53.500	388.764
Executing Agency:	Ministry of Science and Technology (MOST)	Total Project Cost:	61.734	396.998
Other Partners involved:		ProDoc Signature (date project began):		16 August 2016
		(Operational) Closing Date:	Proposed: 16 August 2020	Actual: 16 August 2021

Project Description

The DevCom FCV Project was designed to overcome barriers to the fuel cell vehicle (FCV) industry in China:

[1] Up to 30 April 2021

- Fuel cell vehicle (FCV) technology barriers: high cost, and low durability and performance of FCVs;
- Hydrogen infrastructure barriers: lack of hydrogen refueling stations (HRS), and low availability of low-cost low-carbon hydrogen;
- Policy and regulatory barriers: lack of a robust national FCV development roadmap, non-existent FCV standards and certification processes, slow approval processes, lack of knowledge level of authorities, and unclear incentive policies;
- Awareness and information barriers: lack of information and public awareness of FCVs – their availability, financial incentives, technological developments, reliability, durability, safety, and their economic and environmental benefits.
- Barriers in operation and maintenance of FCVs, and capacity of the financial sector: human capacity is low for operation and maintenance (O&M) of FCVs and HRSs, and in financing of FCV related manufacturing facilities and FCV sales.

The goal of the DevCom FCV Project was the "reduction of GHG emissions in China's transport sector" or 132,707 tons of CO_2 by the end of the project (EOP) through the development and commercialization of FCVs in China. The FCV's objective of the DevCom FCV Project was "to facilitate commercialization and application of FCVs in China" to be achieved 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 consisted of components covering the areas of:

- Component 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);
- Component 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);
- Component 3: Policy (covering national FCV Roadmap, standards, and certification, expedited approval processes, and stabilized and expanded incentive policies, including two policy pilots);
- Component 4: Awareness and information dissemination (addressing the general public, government officials, etc. and ensuring replication);
- Component 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).

By overcoming these barriers, the Project was expecting to achieve the following outcomes by EOP:

- Reduction in costs and improvement in performance and durability of FCVs in China (Outcome 1A);
- Procurement/purchase and demonstration/use of FCVs by local governments, organizations, and individuals (Outcome 1B);
- Reduction in cost and improvement in viability of hydrogen production and HRS (Outcome 2A);
- Increased number of transport hydrogen producers and HRS, including renewable energy-based (RE-based) HRS (Outcome 2B);
- Implementation of policies and regulatory frameworks supporting the application and commercialization of FCVs (Outcome 3A);

- Local/national adoption of policies for promoting procurement of FCVs and investment in HRS (Outcome 3B);
- Enhanced acceptance of FCV for public and private use by increased awareness (Outcome 4);
- Increased technical capacity for operations and maintenance of FCV and HRS (Outcome 5A);
- Increased technical capacity of financial sector for investing in FCV production and HRS and its supply chain and supporting FCV sales (Outcome 5B).

The approach of the DevCom FCV Project was to build capacities in the FCV industry in China for improving FCV technological development and commercialization, facilitate international cooperation for relevant technology transfer, and support the development a favorable policy and regulatory environment for FCV adoption and establishment of a robust hydrogen infrastructure. The Project was originally designed to work closely with 4 cities in China to demonstrate 109 FCVs to enhance the understanding of FCV operations, maintenance, durability, reliability, and costs, and to influence local governments through this information to implement appropriate policies and programs to support the uptake of FCVs. The Project has actually worked with 6 cities to demonstrate more than its target of 109 FCVs.

The Project is funded by the GEF with co-financing from the Implementation Partner (IP), namely the Ministry of Science and Technology (MOST) of the Government of China. The Project is being implemented by UNDP China, and the executing agency is China Automotive Technology and Research Centre (CATARC). Daily management of the Project activities is administered by the Project Management Office (PMO) at CATARC and the local project management units (PMUs) in the Project demo cities.

The Project involves a wide range of stakeholders from the FCV manufacturing industry, including the leading companies in China that are producing FCVs, FCV research organizations, and experts. These stakeholders have made substantive contributions towards achieving the Project activities and outputs.

The implementation of the Project is being managed by the PMO as per UNDP-GEF guidelines. The management arrangement and the annual work plans for 2017, 2018, 2019, 2020 and 2021 have been reviewed and approved by the PSC. The monitoring and evaluation activities are being implemented according to the Project Document (Prodoc) and UNDP-GEF requirements. The communication and coordination between MOST, PMO and UNDP Country Office and UNDP Regional Technical Advisor appears to be effective.

Project Results

Actual outcomes of the DevCom FCV Project are summarized on Table A in comparison with intended outcomes.

Table A: Comparison of Intended Project Outcomes from the ProDoc to Actual Outcomes

Measure	Rating	Achievement Description
Project Strategy	N/A	The Project is designed to reduce GHG emissions in the transport sector in China by supporting the enhanced production and widespread application of FCVs and the development of low-carbon HRS for reliable and environmentally friendly hydrogen supply. The Project design is robust, has SMART results framework, a participative multi-stakeholder approach, and is well aligned with local, national, and global priorities.

Measure	Rating	Achievement Description
Progress towards results	Goal and Objective Achievement Rating S	The Evaluators have seen evidence that the Project has achieved its goal and objectives. It has achieved 230,261 tonnes CO_{2eq} against its target of 132,707 tonnes CO_{2eq} for its goal of GHG emissions reductions, and its objective-level EOP targets for the number of local FCV manufacturers producing FCV with 16 (against a target of 10), cumulative investment in local FCV manufacturing of US$2.2 billion (against a target of US$ 10 million), and number of persons employed in the FCV industry and hydrogen re-fueling stations at 12,000 (against a target of 10,000).
	Component 1 rating (Improvement of local fuel cell and FCV production and application) S	The Project has enhanced the number of operating hours of FCV vehicles through completing Project activities for providing technical assistance to FCV companies, as well as enhancing the demonstrations of FCVs. In addition, Project has met it targets for annual number of FC buses and FC delivery vehicles sold and annual growth in FCV sales but did not meet the target for the annual number of FC cars sold.
	Component 2 rating (Improvement of hydrogen production and refueling system) S	The Project has achieved the EOP target for the number of distinct business models used at HRS of 6, the target for the quantity of annual hydrogen production from renewable energy of 1,200 MT of hydrogen, and the establishment of 171 new HRS in all cities, including demonstration cities. The Project is accounting for RE-based hydrogen.
	Component 3 rating (Policy and regulatory frameworks for the application and commercialization of FCVs) HS	The Project has done well in influencing the development of the FCV industry, through the support of partner cities and companies, and in influencing cities to implement policies for promoting FCVs and HRS. The Project has achieved the EOP targets for this component: (a) 13 FCV manufacturing companies complying to new FCV product standards (against a target of 10), and (b) 37 cities and 3 autonomous regions implementing policies to support FCV and HRS (against a target of 6 cities).
	Component 4 rating (Enhancement of information dissemination and awareness about FCV transport systems) S	The Project has achieved the EOP targets of 45 local governments that are aware and have adopted FCVs in their public transport systems (against a target of 10). The Project has also influenced a private company to operate 2,933 FCVs and renting them to other companies or individuals (against a target of 480 to 3,360).
	Component 5 rating (FCV technology capacity development program) S	The Project has achieved its EOP targets for the (a) 4,758 individuals capable of satisfactorily operating and maintaining FCVs (against a target of >500); and (b) 216 individuals capable of satisfactorily operating and maintaining HRS (against a target of >100). The Project also has met its EOP target for the cumulative investment by the financial sector in FCV and FCV value chain manufacturing and in hydrogen stations and their value chain of over US$2.2 billion (against a target of US$100 million). The Project has also delivered well on capacity development.

Measure	Rating	Achievement Description
Progress Implementation and Adaptive Management	S	The Project's management arrangements, work planning, financing, and co-financing, are sound; stakeholder engagement and partnerships are good; and the Project-level monitoring and evaluation, reporting, and communications are efficient and effective towards Project implementation and adaptive management.
Sustainability	L	The Project has enough funds to sustain the Project implementation activities, and there are no new economic, social, political, and technological barriers that can prevent the sustainability and scaling up of FCVs and HRSs in China.

With regards to the Project-level goal, at least 230,261 tonnes of CO_2 has been reduced from the transportation system in China. The actual number will be higher since there are also fuel cell trams deployed and a small number of vehicles (approximately 1000) not yet connected to the National NEV data monitoring system. Nonetheless, this exceeded its EOP target for the goal of GHG emissions reductions.

Conclusions

The Project has had successes in the demonstration cities of Beijing, Shanghai, Zhengzhou, Yancheng, Foshan, Zhangjiakou and Changshu. The progress of hydrogen and fuel cell industrial development has been significant in the 7 demonstration cities. The Project has been a key factor in breaking through commercial applications of FCVs by carrying out commercial FCV operations in multiple cities, using multiple models and applying FCV operations in multiple climate environments and various commercial operation modes. This includes 16 FCV enterprises and over 150 hydrogen fuel cell enterprises, forming a relatively complete hydrogen FCV industry chain, employing over 12,000 people in 6 demonstration cities, one third of them women.

The DevCom FCV Project's design and strategy, goal and objective, global and national alignment, and progress results framework are based on a clear analysis of the social, economic, political, and technological contexts of the FCV industry in China and internationally. The originally designed outcomes, output, and activities were appropriate for addressing the identified barriers. The Project's indicators and quantitative targets are specific, measurable, achievable, realistic, and time bound. The methodology to calculate the GHG emissions reductions and the Project results framework (PRF) were clear and coherent towards measuring Project progress. Most importantly, the Project was being implemented effectively by MOST and the national and local PMOs. This has fostered strong local ownership that is marked by strong multi-stakeholder partnerships and the active participation of local governments, FCV and HRS industry representatives, technology development organizations, research institutes, and experts.

The Project has achieved the target for its goal of GHG emissions reductions and its EOP targets:

- Reduction in costs (56% and 58% reduction in the price of demo vehicles and FCBs respectively) and improvement in performance and durability of FCVs in China (Outcome 1A);
- Procurement, purchase, demonstration and use of FCVs by local governments, organizations, and individuals. These FCVs were all demonstrated with the support of the municipal governments, local manufacturers, and the Ministry of Science and Technology (Outcome 1B);

- Reduction in cost (from approximately RMB 70/kg to less than RMB 35/kg) and improvement in viability of hydrogen production and HRS (Outcome 2A);
- Increased number of transport hydrogen producers and HRS, including renewable energy-based (RE-based) HRS especially in Zhangjiakou where there is a wind energy source for the 4 HRSs (Outcome 2B);
- Implementation of policies and regulatory frameworks supporting the application and commercialization of FCVs (Outcome 3A);
- Local/national adoption of policies for promoting procurement of FCVs and investment in HRS (Outcome 3B);
- Enhanced acceptance of FCV for public and private use by increased awareness to over 13,000 FCV and HRS personnel (Outcome 4);
- Increased technical capacity for operations and maintenance of FCV and HRS (Outcome 5A);
- Increased technical capacity of financial sector for investing in FCV production and HRS and its supply chain and supporting FCV sales including US$170.59 million in investments in the FCV and HRS value chain (Outcome 5B).

In summary, the Project has also showed great progress to impact, accelerating the mainstreaming of FCVs and achieving an expected reduction in transport-related GHG emission reductions in demonstration cities and other cities in China. This has been achieved through demonstrations of improved reliability and performance of FCVs and fuel cells, promotion of policy breakthroughs in the demonstration cities and the whole country, and remarkable results in information dissemination and sharing.

Recommendations and Lessons Learned

Recommendation 1 (to UNDP and MOST): The GEF should continue to support decarbonization of transport in China through FCVs and hydrogen-based solutions. This recommendation is made in consideration of the interest expressed by the demo cities during the TE mission, the need to mainstream FCVs in most Chinese cities, and the critical role that hydrogen and fuel cells potentially play in mitigating the adverse impact of climate change. See Para 163 for further details.

Recommendation 2 (to MOST, UNDP and GEF): Further support the scaling up of renewable energy hydrogen production through a GEF-funded project that provides more focus on diversified renewable based hydrogen production pathways, storage, transport as well as sector coupling i.e., steel production, heat/cooling and power supply. See Para 164 for further details.

Recommendation 3 (to UNDP and MOST): Strengthen the system of cultivating technical talent for fuel cell and hydrogen energy value chains. See Para 165 for further details.

Recommmendation 4 (to MOST): Strengthen policy support and sustainability for hydrogen and FCVs. See Para 166 for further details.

Best practice 1: Hydrogen Refueling Station Development of Foshan City. In response to the mentioned challenges, the People's Government of Foshan and Nanhai District made substantial efforts in accelerating the deployment of hydrogen refueling stations by being a forerunner of HRS construction guidelines and relevant policies. See Paras 167 to 170 for further details.

<u>Best practice 2: Successful Outcomes at City and National Levels</u>. Given its scale and importance, the HRS deployment in Foshan serves as a successful blueprint for China, as the Project sought to bring additional Chinese cities onboard. See Para 171 for further details.

Evaluation Ratings[2]

1. Monitoring and Evaluation	***Rating***	**2. IA & EA Execution**	***Rating***
M&E design at entry	5	Quality of Implementation Agency - UNDP	5
M&E Plan Implementation	5	Quality of Execution - Executing Entity (MOST)	5
Overall quality of M&E	5	Overall quality of Implementation / Execution	5
3. Assessment of Outcomes	**Rating**	**4. Sustainability[3]**	**Rating**
Relevance[4]	2	Financial resources	4
Effectiveness	5	Socio-political	4
Efficiency	5	Institutional framework and governance	4
Overall Project Outcome Rating	5	Environmental	3
		Overall likelihood of sustainability	3

[2] Evaluation rating indices (except sustainability – see Footnote 2, and relevance – see Footnote 3): 6=*Highly Satisfactory (HS)*: The project has no shortcomings in the achievement of its objectives; 5=*Satisfactory (S)*: The project has minor shortcomings in the achievement of its objectives; 4=*Moderately Satisfactory (MS)*: The project has moderate shortcomings in the achievement of its objectives; 3=*Moderately Unsatisfactory (MU):* The project has significant shortcomings in the achievement of its objectives; 2=*Unsatisfactory (U)* The project has major shortcomings in the achievement of its objectives; 1=*Highly Unsatisfactory (HU):* The project has severe shortcomings in the achievement of its objectives.

[3] Sustainability Dimension Indices: *4 = Likely (L):* negligible risks to sustainability; *3 = Moderately Likely (ML):* moderate risks to sustainability; *2 = Moderately Unlikely (MU):* significant risks to sustainability; and *1 = Unlikely (U):* severe risks to sustainability. *Overall rating is equivalent to the lowest sustainability ranking score of the 4 dimensions.*

[4] Relevance is evaluated as follows: 2 = Relevant (R); 1 = Not relevant (NR)

ABBREVIATIONS

Acronym	Meaning
AEV	Alternative energy vehicle: In China includes NEVs and alternative fuel vehicles, namely CNG, LNG, and LPG vehicles
APR-PIR	Annual Project Report - Project Implementation Review
ATLAS	UNDP financial management system
AWP	Annual Work Plan
BEV	Battery electric vehicle
BTOR	Back to Office Report
CAGR	Compound annual growth rate
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.
DV	Demo vehicle
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
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
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

Acronym	Meaning
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.
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
PRF	Project Results Framework
PSC	Project Steering Committee
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. INTRODUCTION

1. This report summarizes the findings, analyses and recommendations of the Terminal Evaluation Mission conducted during the 23 March to June 2021 period for the UNDP-supported GEF-financed Project entitled: "**Accelerating the Development and Commercialization of Fuel Cell Vehicles in China**" (hereby referred to as the DevCom FCV Project, FCV Project, FCV or the Project) that received a US$ 8,233,560 grant from the Global Environmental Facility (GEF). The Project goal was to "reduce growth of GHG emissions from transport sector". The Project objective was to "facilitate the commercial production and application of fuel cell vehicles in China".

1.1 Purpose of the Evaluation

2. This Terminal Evaluation (TE) for the FCV Project is to *evaluate the progress towards the attainment of global environmental objectives, project objectives and outcomes, capture lessons learned and suggest recommendations on major improvements.* The TE is to serve as an agent of change and play a critical role in supporting accountability. As such, the TE will serve to:

- promote accountability and transparency, and to assess and disclose levels of project accomplishments;
- synthesize lessons that may help improve the selection, design, and implementation of future GEF activities on climate change mitigation;
- provide feedback on issues that are recurrent across the portfolio and need attention, and on improvements regarding previously identified issues; and
- contribute to the GEF Evaluation Office databases for aggregation, analysis and reporting on effectiveness of GEF operations in achieving global environmental benefits and on the quality of monitoring and evaluation across the GEF system.

3. Outputs from this TE will provide an outlook and guidance in charting future directions on sustaining current efforts by UNDP, the Government of China, their donor partners, and the private sector, to sustain the momentum built by the Project to mainstream FC vehicles and hydrogen fuel and with the goal of reducing GHG emissions.

1.2 Scope and Methodology

4. The scope of the TE for the FCV Project was to include all activities funded by GEF and activities from parallel co-financing. The Terms of Reference (ToRs) for the TE are contained in Appendix A. Key issues addressed on this TE include:

- The extent to which the Project impacted the performance and durability of FCVs;
- The extent to which the Project is responsible for the reduction in costs in hydrogen production and operation of hydrogen refueling stations;
- The effectiveness of policies and regulatory frameworks in supporting the application and commercialization of FCVs;
- The effectiveness of activities related to improving technical capacity for operation and maintenance of FCVs and hydrogen re-fueling stations (HRSs);
- The effectiveness of technical capacity to financial sector for investing in FCV production and improving the supply chain of HRSs.

5. Outputs from this TE will provide an outlook and guidance in charting future directions on sustaining current efforts by UNDP and the Government of China on strengthening the legal and regulatory framework, and awareness raising for FCV and HRS promotion.

6. The methodology adopted for this evaluation includes:

- Review of all project documentation (i.e. APR/PIRs, meeting minutes of Project Board or multipartite meetings, MTR) and pertinent background information;
- Review of the project activity reports, including the reports about the results of the co-financed activities and the reports produced from the performance of sub-contracted activities, including evidentiary documents that were used as reference or source for measuring the level of achievement of the indicators for the project goal, objective and for each project outcomes.
- Interviews with key project personnel including the current Project Managers, technical advisors, and Project developers;
- Interviews with relevant stakeholders including participating government agencies, engineering professionals and academic institutions; and
- Field visits to selected Project sites and interviews with beneficiaries.

A detailed itinerary of the Mission is shown in Appendix B. A full list of people interviewed, and documents reviewed are given in Appendix C and Appendix D respectively. The Evaluation Mission for the UNDP-GEF project was comprised of one lead international expert and one national expert.

7. The Project was evaluated for overall results in the context of:

- *Relevance* - the extent to which the outcome is suited to local and national development priorities and organizational policies, including changes over time;
- *Effectiveness* - the extent to which an objective was achieved or how likely it is to be achieved;
- *Efficiency* - extent to which results were delivered with the least costly resources possible; and
- *Sustainability* - The likely ability of an intervention to continue to deliver benefits for an extended period after completion.

The conclusions are drawn from the information from relevance, effectiveness, efficiency and sustainability ratings.

8. All possible efforts have been made to minimize the limitations of this independent evaluation. During the 9 days spent in the field by the National Evaluator, meetings were setup to collect and triangulate as much information as possible, and visits were made to Beijing, Shanghai, Zhengzhou, Foshan, Yancheng and Zhangjiakou. Notwithstanding, follow-up interviews, Skype conversations and e-mails were utilized by both the International and National Evaluator after the TE mission to fill in information gaps.

1.3 Structure of the Evaluation

9. This evaluation report is presented as follows:

- An overview of Project activities from commencement of operations in August 2016 to the present activities of the FCV Project;

- A review of all relevant sources of information including documents prepared during the preparation phase (i.e. PIF, UNDP Social and Environmental Screening Procedure/SESP), the Project Document, project reports including annual PIRs, Mid-Term Evaluation (MTR) report, and any other materials that the team considers useful for this evidence-based evaluation;
- A participatory and consultative approach to ensure close engagement with the Project Team, government counterparts, implementing partners, the UNDP Country Office, the Regional Technical Advisors, direct beneficiaries, and other stakeholders. Stakeholder involvement includes interviews with stakeholders who have project responsibilities. Additionally, the national evaluator conducted field missions to the Project's demo cities such as Beijing, Shanghai, Zhengzhou, Yancheng, Foshan, Zhangjiakou;
- An assessment of Project results on the basis of evaluation criteria (including relevance, effectiveness, efficiency, and sustainability criteria); and
- Drawing up conclusions, recommendations, and lessons learned.

10. This evaluation report is designed to meet GEF's "Guidelines for Conducting Terminal Evaluations of UNDP-Supported, GEF Financed Projects" of 2020: http://web.undp.org/evaluation/guideline/documents/GEF/TE_GuidanceforUNDP-supportedGEF-financedProjects.pdf

1.4 Data collection and analysis

11. Data and information for this TE was sourced from:

- Review of Project documentation notably the final country reports from the UNDP China office. This was important in establishing information pertaining to the country's efforts in implementing the Project. This was done primarily at the Evaluator's home base. A full listing of data and information sources is provided in Appendix C;
- Interviews conducted by the International and National Evaluators with key Project personnel on the Project Management Office (PMO) concerning the general implementation of the Project. These were generally done by Zoom;
- Interviews conducted by the National Evaluator with representatives from the demonstration cities and their efforts towards commercialization of FCVs. These were in-person meetings where the National Evaluator got to travel to these cities.

12. The information required for data analysis was mainly derived from qualitative and desk research. Firstly, semi-structured interviews with Project officers and various stakeholders involved in the Project (including representatives of PMO, UNDP, MOST, and sub-contractors) have served to complete the fact-finding regarding the evaluation.

13. Secondly, collected data from desk research was analyzed against the evaluation matrix. For example, cumulative operating mileage of FCVs was retrieved from *the National Monitoring and Management Center for New Energy Vehicles*. Given that the Center has not yet accessed the data of all operating FCVs, this data is slightly lower than the actual value, but still reflects the effectiveness of the Project. In addition, the Terminal Evaluation extracts the relevant data from the annual and monthly reports of the Hydrogen Fuel Cell Vehicle Industry Association, and *the New Energy Vehicle Database* at Tsinghua University.

14. The information collected was analyzed by the Evaluation team for the progress towards targets and GHG emission reductions. The full list of persons interviewed is provided in Appendix B.

1.5 Ethics

15. This Terminal Evaluation has been undertaken as an independent, impartial and rigorous process, with personal and professional integrity and is conducted in accordance with the principles outlined in the UNEG Ethical Guidelines for Evaluations, and the UNDP GEF M&E policies, specifically the August 2020 UNDP "Guidance for Conducting Terminal Evaluations of UNDP-supported, GEF-financed Projects".

1.6 Limitations

16. There are limitations to this TE process, mainly due to the COVID-19 pandemic and the inability of the International Evaluator to travel to the PMO and the demonstration cities to conduct face-to-face meetings. This task was instead undertaken by the National Evaluator. The information collected by the National Evaluator was then passed onto the International Evaluator. However, the International Evaluator was not able to take the opportunity to get to know the stakeholders better. Actual visits to the offices of the stakeholders and the PMO by the International Evaluator are usually an opportunity for the stakeholders and the PMO to make a 2-3 hour presentation followed by question-and-answer period. This has many intangible benefits including the collection of information not documented. With the virtual visits on Zoom, the opportunity to make these 2-3 hour presentations and conduct a question-and-answer period is limited. By this limitation to the International Evaluator, he has limited exposure to the stakeholder teams, and as such, the Terminal Evaluation to a large extent is dependent on the information passed on by the National Evaluator and the documentation from progress reports, PIRs and other reports. This also limits the Terminal Evaluation in terms of findings.

2. PROJECT DESCRIPTION AND DEVELOPMENT CONTEXT

2.1 Project start and duration

17. The DevCom FCV Project commenced as of 16 August 2016. The Project has been implemented up to the time of writing of this report (as of June 2021). The Project is scheduled to close as of 16 August 2021. During this period, the Project was expected to facilitate the establishment of 15 HRS with a total hydrogen production of 1,000 metric tons, facilitate US$10 million of cumulative investment in domestic FCV manufacturing and US$100 million cumulative investment by the financial sector in FCV manufacturing and HRS and their value chains, and influence six cities to institute policies to promote FCVs and HRSs (as well as 10 domestic manufacturers of FCV that are compliant to newly issued FCV). This was expected to lead to FCV sales of up to 7,000 units and private ownership of up to 3,360 FCVs annually.

2.2 Development context

18. China is the leading global emitter of GHG emissions. At the time of the design of the DevCom FCV Project in 2015, the transport sector in China accounted for 10-15% of China's total energy consumption and the largest share of China's oil consumption. China is also the global leader in automobile sales; however, the sales of FCVs remains low due to technological, economic, and policy-related reasons. Enhancing the development and commercialization of FCVs can provide a range of sustainable development co-benefits in China, such as reducing air pollution and GHG emissions, improving urban living environments, providing green jobs, and transitioning the Chinese economy towards greater sustainability.

19. Research and development (R&D) of fuel cell vehicles in China began in 2001 under the National 10th Five-Year Plan (2001-2005). China's project on fuel cell technology application in transport began with a fuel cell bus (FCB) demonstration in cooperation between the MOST and the UNDP-GEF. The first phase of project was approved in 1999 and finished in 2007. The first phase of the UNDP-GEF FCB Project was carried out in Beijing from June 2006 to October 2007, with a total of 3 Mercedes-Benz 12 m Citaro FCBs. A dedicated HRS was set up and operated solely for fueling the demo FCBs.

20. The second phase of the FCB Project was carried out from August 2008 to January 2012 in Beijing and Shanghai. The demonstration in Beijing deployed three 12-meter hybrid FCBs jointly developed by Tsinghua University and Foton AUV Bus. The demonstration in Shanghai purchased six 12m hybrid FCBs from SAIC Motor Group. A dedicated HRS in Shanghai was also established and operated for fueling the demo FCBs.

21. The DevCom FCV Project covered not only FCBs but other fuel cell vehicles (FCVs) such as FC cars and FC utility vehicles (e.g., delivery vans). It was launched in September 2015 with more than 100 FCVs being planned for commercial demonstration operations in 4 demonstration cities: Beijing, Shanghai, Zhengzhou, and Foshan. The DevCom FCV Project was designed based on a comprehensive barrier analysis and the outcomes are strategically focused on: enhancing the technical capacity of the FCV industry to improve FCV performance and reduce manufacturing and operational costs; developing a robust enabling environment of standards, policies, regulations and incentives to support FCV use and HRS establishment; developing a reliable and affordable hydrogen supply infrastructure; building public awareness of the affordability, performance and safety of FCVs and HRS; and supporting

human resource development for enhancing FCV operations and investment. The Project drew on the participation of committed stakeholders: participating demonstration cities, leading FCV manufacturing companies, expert organizations in FCV and HRS design and technological development, and leading national research institutes and universities in China

2.3 Problems that DevCom FCV Project sought to address

22. The commercialization of the local manufacturing and widespread application of FCVs were among the aims of the GoC regarding the promotion of new energy vehicles, under the New Energy Vehicle Industry Development Plan (2012-2020). However, there were fundamental barriers to be removed, and the DevCom FCV Project was designed to remove such barriers, which includes:

- FCV technology barriers: the high cost, low durability, and an unreliable performance of FCVs are the primary impediments to FCV commercialization in China;
- Hydrogen infrastructure barriers: the lack of HRS and low-cost low-carbon hydrogen for commercializing FCVs in China[5];.
- Policy barriers: there is a lack of clear and robust support policy and regulatory frameworks for FCVs and HRS in China[6], inhibiting local governments and potential investors from investing in FCV development, commercialization, and application;
- Awareness and information barriers: there is a lack of public awareness about the availability and safety of FCVs, FCV market and technological development, and the social, economic, and environmental benefits of FCVs in comparison to other forms of motorized transport;
- Barriers in operations and maintenance and financial sector capacity: there is a lack of appropriately trained personnel for efficient operations and maintenance of FCVs and HRSs, and in financing of FCV related manufacturing facilities and FCV sales[7].

23. The DevCom FCV Project was focused on overcoming these barriers through its activities and several capacity building activities for the FCV industry and local governments. These activities were to overcome the barriers, particularly those related to policy and regulatory support for FCVs and HRSs, design and implementation of a low-carbon low-cost hydrogen supply infrastructure, and further enhancement of the durability and performance of FCVs in China.

2.4 Immediate and development goal and objectives of DevCom FCV Project

24. The goal of the DevCom FCV project is “the reduction of GHG emissions in China’s transport sector”. The objective of the Project is “to facilitate the technological enhancement and commercialization of FCVs in China”. The Project has been consistent with China’s national energy strategy and planning in the National 12th Five-Year Plan (2011 to 2015) and 13th Five-Year plan (2016-2020), and with China’s National Medium and Long-Term Science and Technology Development Plan (2006 – 2020).

[5] At the time of the Project design, China had only two HRS: one in Shanghai and one in Beijing. There was also a lack of information and awareness on HRS design, establishment, financial viability, safety, and experience in operating HRS. In addition, the prices of hydrogen vary from city to city and most of the hydrogen is produced from fossil or industrial sources

[6] Lack of policy support and regulatory frameworks particularly in standards and certification, approval processes, financial incentives, and a national road map for FCV and HRS development

[7] Personnel in the financial sector lack the appropriate technical and financial knowledge for supporting FCV related investment. Banks and equity investors, such as venture capital and private equity firms, also lack the needed capacity to evaluate opportunities to support FCV component manufacturing, FCV sales and procurement, and the establishment of HRS and hydrogen supply infrastructure.

2.5 Theory of Change

25. No theory of change (ToC) was done for this Project. However, the Project Results Framework (PRF) in Appendix F, contains a number of indicators and targets that embodies the ToC that the Project is supposed to bring about. Examples include:

- GHG emission reductions in quantities to cause impacts;
- Number of local transport vehicle manufacturers producing FCVs in quantities to cause a significant shift to FCVs;
- Annual FCV sales in China;
- Number of hydrogen re-fueling stations in China;
- Number of cities where new policies to China promote FCV purchase and investment in hydrogen stations;
- Number of local governments that are aware and have adopted FCVs in their public transport systems;
- Number of individuals capable of satisfactorily operating and maintaining FCVs in China;
- Number of individuals capable of satisfactorily operating and maintaining hydrogen refueling stations in China. The indicators for the DevCom FCV Project goal, objective and each project outcome, and their corresponding target values can be found in the PRF contained in Appendix F.

With the Project achieving its goal and objective, the Theory of Change embodied in the PRF appears to be rational.

2.6 Expected Results

26. The Project was expected to achieve the following outcomes by EOP:

- Reduction in costs and improvement in performance and durability of FCVs in China.
- Procurement/purchase and demonstration/use of FCVs by local governments, organizations, and individuals.
- Reduction in cost and improvement in viability of hydrogen production and HRS.
- Increased number of transport hydrogen producers and HRS, including renewable energy-based (RE-based) HRS.
- Implementation of policies and regulatory frameworks supporting the application and commercialization of FCVs.
- Local/national adoption of policies for promoting procurement of FCVs and investment in HRS.
- Enhanced acceptance of FCV for public and private use by increased awareness.
- Increased technical capacity for operations and maintenance of FCV and HRS.
- Increased technical capacity of financial sector for investing in FCV production and HRS and its supply chain and supporting FCV sales

2.7 Total resources required by Project

27. Total resources required by the DevCom FCV Project are shown on Table 1.

Table 1: Total Resources Planned by DevCom FCV Project

Project Fund Sources		
Total Budget: $61,733,560 Project Period: 2016-2021		
Source	**Amount($)**	**Main Applications**
GEF	8,233,560	FC Vehicle acquisition, technical assistance, subcontracting of subjects, international experts, travel, etc..
UNDP in-kind	400,000	Service support, staff costs ；
Local Government in-kind (Beijing, Shanghai, Zhengzhou, Foshan)	17,600,000	FC Vehicle acquisition, infrastructure construction, operation and maintenance, project management
Enterprise Support	35,500,000	Technological upgrading, production line construction, vehicle production, etc..

2.8 Main stakeholders and key partners

28. Main stakeholders that are of interest to the Evaluation includes:

- National Government officials: National-level government officials are critical in adopting policies and plans to promote FCVs and in ensuring the success of this project. For the Project, key organizations included the Ministry of Science and Technology (MoST), the implementing partner for the project. MoST promotes R&D and development of new industries in China.;
- Local-level government officials: Local-level government officials are 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 were to 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;
- FCV and component manufacturers: FCV and component manufacturers (are the major beneficiaries of the Project and primary drivers of its progress. Due to the high subsidies for domestic-produced FCVs, involved FCV manufacturers are most likely the 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;
- 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 play the critical roles of providing hydrogen to Project demo FCVs and providing data and lessons learned on HRS operation. HRS investors were to include city governments, state-owned companies, or private sector companies;
- Hydrogen producers and potential producers of renewable energy-based hydrogen: Availability of hydrogen at a low price is critical to FCV commercialization, and availability of renewable energy based hydrogen is important to realizing the “green” potential of FCVs. Existing hydrogen producers play an important role in the Project by providing hydrogen to demo HRSs. Furthermore, potential producers of renewable energy based hydrogen, by setting up hydrogen production facilities, play an important role in demonstrating this important aspect of the future hydrogen value chain for FCVs;
- 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 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: 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;

- 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;
- Financial Institutions: Financial institutions were 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

Stakeholder partnerships on the DevCom FCV Project are further discussed in Section 3.1.4 (Para 44) and Section 3.2.2 (Paras 60 to **错误!未找到引用源。**).

3. FINDINGS

3.1 Project Design and Formulation

29. The DevCom FCV Project rationale considers the significant potential benefits for reducing emissions from China's transport sector, the strong potential for advancing FCVs towards commercialization given the current situation of the FCV industry, and the need for the Project's incremental contribution in moving China beyond the baseline scenario. As the world's top producer and consumer of primary energy and top emitter of GHGs, China needs assistance to reduce its emissions from the transport sector which accounted for 10 to 15% of the final energy consumption when this Project was designed in 2015.

30. Transport is the largest contributor to the growth in China's oil consumption. Furthermore, China now surpasses all other nations in annual new car sales leading to local air pollution in many Chinese cities that far exceeds the government's targeted standards. All of these factors clearly provide rationale for a clean vehicle project that was to contribute to potentially major transformations in China's vehicle sector, reducing GHGs, reducing local air pollution, and reducing oil imports thereby increasing energy security.

31. Design of the DevCom FCV Project was done through extensive stakeholder consultations held in conjunction with the PRF exercise and to obtain FCV manufacturer and other stakeholder input regarding Project-related issues, concerns, and barriers regarding development and commercialization of FCVs. The consultations were also the basis for the formulation of Project implementation and management arrangements proposed under the DevCom FCV Project.

32. The DevCom FCV Project was designed to facilitate the realization of the potential CO_2 emission reductions by removing the identified barriers that have prevented China from realizing substantial GHG emission reductions that would contribute to China's climate change mitigation targets. The Project was to address current problems in the FCV industry in China through a focus on the improvement of the efficiency and durability of the FC engine, FC stacks, and overall FCV operating performance, as well as improvements to the hydrogen production and refueling facilities.

33. The Project was also to focus on removing a number of key barriers in China's FCV initiatives, using a combination of "technology push" and "market pull" activities to enhance the overall performance levels of locally produced FCs and FCVs and hydrogen production and hydrogen refueling facilities. Project outcomes and outputs have been designed to contribute to DevCom FCV's overall objective of facilitating the commercialization of FCVs in China. The Project is laid out as outcomes and outputs into topical components: (1) FCVs, (2) Hydrogen and HRSs, (3) Policy, (4) Awareness and Information, and (5) Capacity Building.

34. In more detail, the topical components of the DevCom FCV Project are as follows:

- Component 1 – Improvement of local FC and FCV production and application:
  - Outcome 1A: Markedly reduced costs and improved performance and durability of FCVs in China:
  - Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China:
- Component 2 – Improvement of hydrogen production and refueling system:

  - Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations;
  - 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:
- Component 3 – Policy and regulatory frameworks for the commercialization and application of FCVs:
  - Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs:
  - Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations:
- 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:
- Component 5 – FCV technology capacity development program:
  - Outcome 5A: Increased technical capacity for operations and maintenance of FCVs and HRS;
  - 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

35. The DevCom FCV Project has been comprehensively designed and was well accepted by the FCV industry. The Project strategy has been developed on a sound analysis of the FCV industry's status and trends; the technological, policy-related, regulatory, informational, and financial barriers to the industry's enhancement and application of FCVs; the demonstrations and capacity building activities that could enhance the production and application of FCVs and the development and cost-reduction of HRS; and a comprehensive set of activities, targets, indicators, outputs, and outcomes that encompass the range of interventions needed and tracked for enhancing the FCV industry and its related hydrogen supply chain. The interventions had a clear focus on building industry capacities, supporting innovation and adoption of advanced technologies, and creating and sustaining an enabling environment through the development of standards, regulations, policies, and fiscal incentives, as well as increasing public awareness, acceptance, and use of FCVs.

36. At the core of the Project were demonstrations of FCVs and HRS in participating cities, partnerships to document and disseminate the performance results from the demonstrations, and the systematic scaling-up and replication of the demonstrations from the initial four cities to more cities and involving more FCV stakeholders in China. This was combined with strategic support to the local governments and FCV industry in building technical capacities. This was done through:

- international visits and cooperation with international companies and experts on FCV and HRS technologies and best practices;
- conducting FCV and HRS trainings for personnel;
- developing and implementing FCV and HRS standards and certification processes; and
- creating databases such as the China's "HRS Reliability Database and China FCV Market and Technology Monitoring System" to ensure the sustainability of the Project's outcomes.

3.1.1 Analysis of Project Results Framework for DevCom FCV

37. The Project was designed based on a PRF (log frame) that includes SMART indicators[8] for the Project goal and objective and for each Project outcome, and with the corresponding target values. These indicators and their targets are listed in the PRF shown in Appendix F.

38. The only issue with the PRF is the indicator for "Outcome 4: Number of private vehicle owners that own and use a FCV by EOP" which the Project should not consider reporting (as recommended by the MTR). The current regulations in China do not support long-term registrations of private individually owned FCVs, deterring private ownership. Although Output 3A.3 specifically addresses this regulatory gap, it is unlikely that the regulations will change before the EOP. Private companies (such as Anting Shanghai International Automobile City, an independent legal entity) are operating these passenger vehicles and renting them to other companies or individuals, making it even more difficult to rapidly achieve the EOP target of 480-3360 private vehicle owners that own and use an FCV.

3.1.2 Risks and Assumptions

39. Project risks are covered in Annex A of the ProDoc. Eight risks were identified[9] that were within, to a certain extent, under control of DevCom FCV activities. More importantly, the assumptions in the PRF are linked to the risks identified in Annex A of the ProDoc. The ProDoc clearly states that the assumptions in the PRF are conditions critical to the achievement of the Project outcomes and objective, which if worded negatively, would constitute a Project implementation risk. The risks in Exhibit I-1 of the ProDoc are internal risks identified that are within the control of the Project. In summary, risks and assumptions identified in the ProDoc are reasonably laid out in a useful manner for Project implementers.

40. Project assumptions are covered in Section 3.1 of the ProDoc, pgs. 54-56. The assumptions are reasonable considering the source of hydrogen is reasonable in terms of cost, be it renewable resources or low cost in terms of production. In addition, assumptions also include national subsidies continue to make FCVs affordable to buyers, and fear of safety issues being allayed.

3.1.3 Lessons from Other Relevant Projects Incorporated into FCV Project Design

41. Lessons from other relevant projects incorporated into DevCom FCV Project design includes the 196 FCVs demonstrated during the 6-month long Shanghai Expo in 2010, constituting the largest field trial of FCVs in the world to that point in time. 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. 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 DevCom FCV Project.

42. The Project team drew also from the experience of the Knowhy Programme carried out by the European Commission on nurturing front line technicians and mechanists to support the talent demand of the industry.

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8 Specific, measurable, achievable, relevant, timebound

9 Exhibit I-1, pg. 72 of the ProDoc

43. Finally, the Project procured consultancy services aimed at providing technical assistance as in specific training modules that feature automotive and material handling sector, hydrogen and handling, micro fuel cells, CHP and microCHP, and fuel cells-based generators. The training modules were to facilitate the deployment of the technologies expected to enter the market within the time frame 2014-2020. Job opportunities for technicians and workers were expected to arise for fuel cells and hydrogen applications. The FC&H2 consortium who were the intended consultants included very experienced partners such as Delft University of Technology (coordinator organization), Instituto Superior Tecnico, FAST, Munich Technical University, Fundación para el desarollo de las nuevas tecnologias del hidrogeno en Aragon, Environment Park, the University of Birmingham and McPhy Energy, all of them with own premises, labs and even demonstration facilities of their own.

3.1.4 Planned Stakeholder Participation

44. A wide range of stakeholders was relevant to overcoming the aforementioned barriers to be involved on this Project. The stakeholder participation included 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, public transport companies, delivery companies, consumers and the 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.

- *National-level government officials*: National-level government officials were to 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. MOST promotes R&D and development of new industries in China. As IP, MOST handled 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 was critical to commercialization efforts. For this Project, MIIT was to provide assistance in the identification and design of replication demos for FCVs, HRSs, and hydrogen refueling;
- *Local-level government officials*: Local-level government officials were to 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 were to 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. These local entities were to coordinate implementation of FCV and HRS demos and drive the process forward and be responsible for developing plans to replicate project demos;
- *FCV and component manufacturers*: FCV and component manufacturers (and potential sub-manufacturers) were to be major Project beneficiaries and primary drivers of its progress. Due to the high subsidies for domestic-produced FCVs, involved FCV manufacturers were most likely be domestic-based manufacturers, whether fully Chinese-owned or joint ventures such as SAIC, Foton, and Yutong. Yet, the Project was to reach out to all interested component vehicle manufacturers, both domestic and overseas entities such as Ballard and Hydrogenics;

- *HRS investors and operators*: HRS investors and operators were to play the critical roles of providing hydrogen to Project demo FCVs and providing data and lessons learned on HRS operation. HRS investors were to include city governments, state-owned companies, or private sector companies;
- *Hydrogen producers and potential producers of renewable energy-based hydrogen*: Availability of hydrogen at a low price was thought to be critical to FCV commercialization; and availability of renewable energy-based hydrogen was to be important to realizing the "green" potential of FCVs. Existing hydrogen producers and potential producers of renewable energy-based hydrogen, by setting up hydrogen production facilities, were to play an important role in demonstrating this important aspect of the future hydrogen value chain for FCVs;
- *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 were to play an important role in designing and carrying out monitoring efforts (and analysis of collected data) with key institutions being Tsinghua University and Tongji University. Society of Automotive Engineers of China was important in advising the government on policy and playing a policy promotion role on the Project. The China Automotive Technology and Research Center plays a key role in housing the PMO;
- *Public transport companies, delivery companies, and other institutional users 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 was to be important in building awareness of the technology (i.e. Beijing Public Transportation Corporation, Shanghai Jiading Bus Company, Zhengzhou Public Transportation Company, and Nanhai Public Transportation Company). These organizations have the role of ensuring selection of high visibility routes, and also be responsible for ensuring smooth refueling and O&M of the buses.;
- *Consumers/general public*: Consumers who represent the largest ultimate market for FCVs in China, needed to have their awareness and understanding of FCVs raised, as well as the need to inform them and alleviate their fears regarding hydrogen's safety issues. The Project was to engage consumers via its awareness raising activities, including opportunities to test drive FCV autos in Shanghai;
- *Financial Institutions*: Financial institutions were needed to finance FCV manufacturing expansion (i.e. manufacturing of components, manufacturing related to hydrogen production and hydrogen refueling, and establishment of HRSs) and also to stimulate consumer purchase of FCVs through special bank loan programs. At the time of Inception, these banks and private equity/venture capital firms were not very aware of the FCV industry or the industry's potential; and
- *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 was to 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 was to 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.

In summary, the planned level of stakeholder involvement is **highly satisfactory** in consideration of wide range of stakeholders required for successful deployment FCV technologies and measures. While reaching out to this number of stakeholders is ambitious, the involvement of all these listed stakeholders seems well justified.

3.1.5 Linkages between DevCom FCV and other interventions in the sector

45. The DevCom FCV Project couples very well with the national and local government priorities. For example, it has laid a solid foundation for China's pollution control of diesel delivery trucks. In the *Action Plan for Pollution Control of Diesel Delivery Trucks*, MEE, NRDC MIIT and 8 other line ministries institutions encouraged local authorities to carry out demonstration operations of fuel cell delivery trucks and build hydrogen refueling stations, which required the industrial progress catalyzed by the Project.

46. In the State Council's Report on the Work of Government 2019, emphasis has been given to maintain stable FCV procurement by continuing preferential policies on the purchase of new-energy vehicles and facilitate the building of EV charging and hydrogen refueling facilities. This Project was designed and implemented with a strong focus on scaling up hydrogen refueling infrastructures, the governance of planning, designing, approving, constructing, testing, and launching such infrastructure, and the capacity building for operations and maintenance.

47. Due to the industrial development that it catalyzed, the Government continued to provide financial support subsidies for the upscaling and operations of EV charging and hydrogen refueling infrastructures. In 2020, the Government drew from its experience and lessons learnt from subsidizing BEVs and adjusted the previous subsidy for the purchase of FCVs for selected demo cities. Many local governments also "match" the national subsidies to different degrees such as Guangdong, Wuhan, Hainan, Shandong, Tianjin, Henan, Foshan, and Dalian.

48. The Project team formulated recommended policies building on the lessons learnt from at various conferences and through different policy advisory channels and informal dialogues, on the need to categorize hydrogen as energy as well as the importance of renewable-based hydrogen production. In the *Energy Statistics Report System* published in November 2019, the National Bureau of Statistics required that hydrogen, together with coal, natural gas, crude oil, electricity, and biofuels, are included in the energy statistics for 2020. The *National Energy Administration Announcement No.3 of 2019* invited research focused on *Coordinated Development Path of Hydrogen and Renewable Energy*, *Development Strategy of Hydrogen Energy Industry*, and *Medium and Long-term Development Trends of New-Energy Vehicle Charging and Hydrogen Refuelling Infrastructure*. Thus, strong synergies and complementary linkages can be found between the DevCom FCV Project and other interventions by the national and local governments.

3.1.6 Gender responsiveness of Project design

49. The DevCom FCV Project is under the 5th funding phase of the GEF (i.e., GEF-5). Due to that, it does not have any activities specifically focused on mainstreaming gender equality and women's empowerment. As such, efforts to promote gender equality and women's empowerment aimed 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. There were 6 major Project activities to maximize women's involvement: group capacity building for FCV manufacturers, group capacity

building for potential renewable energy-based hydrogen producers, group capacity building for hydrogen refueling stations, and 3 study tours (one for each of the aforementioned groups).

3.1.7 Society and Environmental Safeguards

50. The DevCom FCV Project identified 4 potential social and environmental risks:

- possibility that residents of certain neighborhoods will not be included in decisions to site hydrogen refueling stations in those neighborhoods;
- possibility that the Project will unintentionally reproduce discrimination against women based on gender, particularly with regard to participation in some project activities;
- 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; and
- 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.

51. With regards to how the Project would mainstream environmental sustainability in the Social and Environmental Screening in Annex VIII in the ProDoc, demonstrated FCVs leapfrog durability, performance, and cost reduction parameters, making FCVs more attractive to end users. Furthermore, 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, the Social and Environmental Screening in the ProDoc states that renewable energy-based hydrogen production of substantial scale can be introduced into China as with hydrogen refueling stations with varied business models. With enhanced FCVs policies, human capacity for FCV O&M is then enhanced as is capacity in the financial sector as relates to FCVs. Direct CO2 emission reductions of 15,172 tons can then be generated.

3.2 Project Implementation

52. The following is a compilation of critical path events and issues of DevCom FCV Project implementation in chronological order:

- The ProDoc was signed on 16 August 2016;
- The Project Inception workshop was held August 2016;
- Start of media campaign during August 2016 targeting the press in 4 demo cities as well as nationally;
- Design of data collection plans and collection and analysis of data on operation of demo FCVs starting in December 2016;
- International study tour to Germany for site visits and international exchange on renewable energy-based hydrogen production during 2Q 2017;
- Design of China's HRSs commenced March 2017;
- Building and updating of project website starting March 2017;
- Design, production and airing in July 2017 of a documentary on FCVs on TV in China and video material to counter myths regarding the safety of hydrogen;
- Start of group training program on FCV operations and maintenance on March 2018;

- Meetings starting June 2019 between banks, venture capital/private equity firms and individual FCV manufacturers, FCV component manufacturers, and hydrogen refueling businesses seeking debt or equity financing, and design of feasible financing scheme for consumer and other end user purchase of FCVs in China;
- Assistance to China-based FC component manufacturers mainly commencing November 2019;
- Broad survey in July 2020 of individuals, officials, and organizations that purchase vehicles regarding their awareness and perception of FCVs as well as public's perception of hydrogen production and hydrogen refueling stations.

3.2.1 Adaptive Management

53. Adaptive management is discussed in GEF terminal evaluations to gauge Project performance in its ability to adapt to changing regulatory and environmental conditions, common occurrences that afflict many GEF projects. Without adaptive management, GEF investments would not be effective in achieving their intended outcomes, outputs, and targets. Several examples are available of adaptive management on the FCV Project to adapt to the numerous changing circumstances to ensure effective implementation of the Project during its 5-year duration.

54. The management arrangements for the DevCom FCV Project are shown on Figure 1. The Project Steering Committee was to be responsible for major decisions and monitoring project progress. The implementing partner, MOST, directed overall implementation of the Project and delegated day-to-day coordination work to the national level. PMO and UNDP, both through its CO and its Asia-Pacific RCU, provided Project assurance and backstopping. A local Project steering committee in each city directed that city's demo activities. Reporting to each local Project steering committee was done by a local Project management office carrying out day-to-day implementation.

55. The PMO has been efficient in managing the implementation of the Project and responsive to stakeholders and proactive in seeking their expert inputs through commissioned sub-contracts to achieve intended outcomes. There is a close coordination between the MOST and the PMO, and a positive collaboration among the MOST, PMO, and UNDP for the Project's execution and alignment to the developing national policy and industry scenario. The UNDP has provided timely advice on Project implementation, monitoring, and reporting. The participating cities, FCV industry companies, and sub-contractors are appreciative of the PMO's Project management and of UNDP's coordination and facilitation, and these stakeholders have been able to participate in and contribute meaningfully to Project implementation.

56. The initial strategy of the Project was demonstrating 109 FCVs across 4 demo cities for which the PMO quickly found it was not possible to meet the Project goal of 132,707 tons CO_2 of GHG emissions from the transport sector by the EOP. The reason was that local FCV operation companies could not ensure 109 FCVs remain on the road for more than 10 hours per day in 3.2 years without repair and maintenance. To achieve the Project goal, UNDP and the PMO adaptively managed to work closely with each of the demo cities in two ways: firstly, to expand the number of demonstration cities by the EOP (3 cities: Yancheng, Zhangjiakou and Changshu joined the Project; secondly, to expand the number of demonstration FCVs in each city). By the end of April 2021, there were more than 3,200 FCVs in 7 demonstration cities, sufficient to ensure the Project achieving its goal.

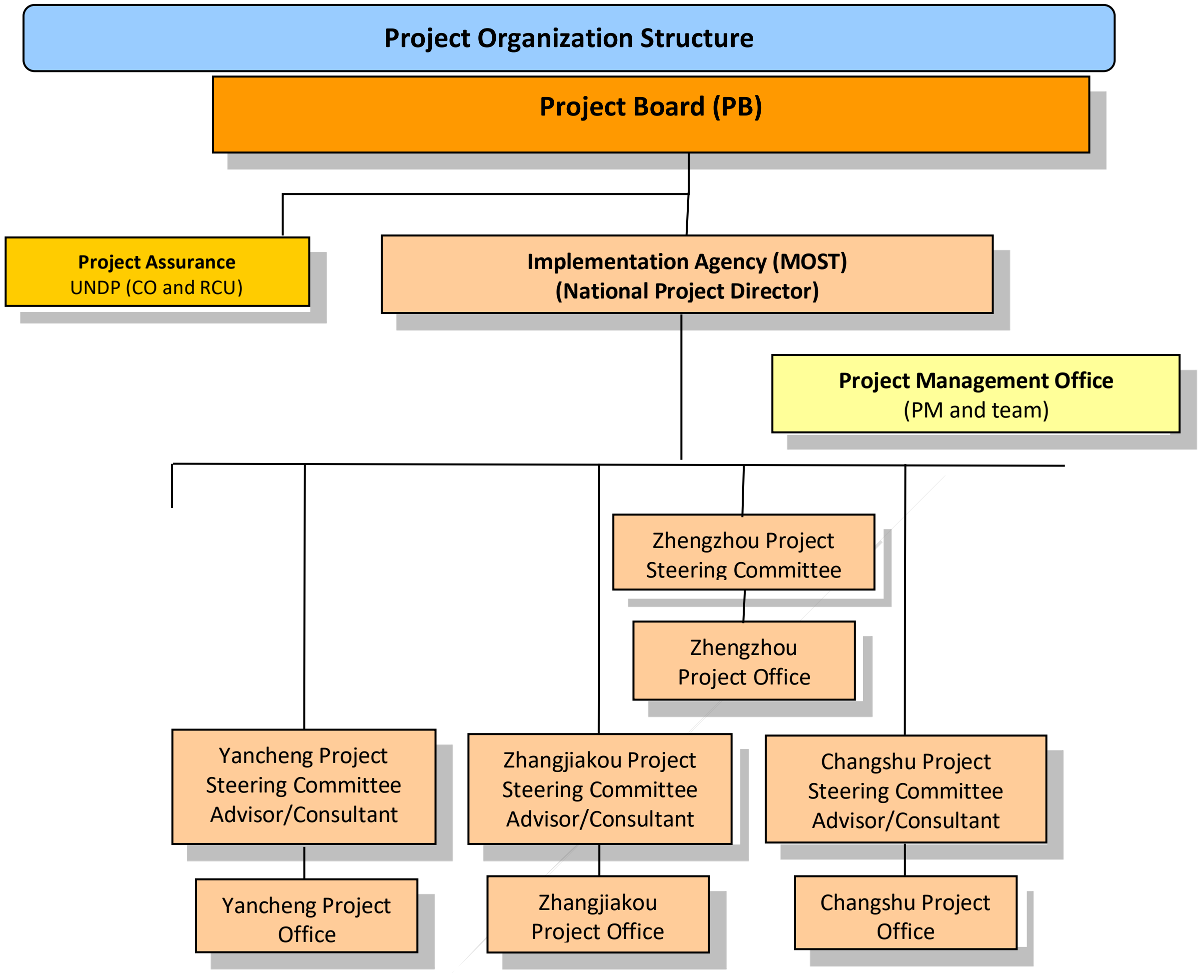
57. At the commencement of the Project, there was no planning and approval policy for the construction of HRS. In addition, land use and location of the HRS hindered the HRS investors which brought

problems to the construction and operation of HRS. The PMO and UNDP adaptively managed to communicate and collaborate with stakeholders of demonstration cities to remove these barriers. Foshan and Shanghai were the first two cities to issue related policies and guidelines; other demo cities were referred to the experiences of Foshan and Shanghai to form its own approval process.

58. Another problem was to achieve Outcome 2B: 1000 MT of RE-based hydrogen production per year, given that renewable energy was difficult obtain in each of the 4 initial demonstration cities (Beijing, Shanghai, Zhengzhou, and Foshan). To meet the target by the EOP, the PMO and UNDP adaptively managed to communicate with the governments of Zhangjiakou and brought Zhangjiakou into the demonstration cities of Project. The Project first identified Zhangjiakou as a promising demonstration city for its abundant renewable energy sources, especially its wind supply. Additionally, with the opportunities of hosting 2022 Winter Olympics, the city aimed to take advantage of renewable energy technologies.

59. In summary, the DevCom FCV Project has been adaptively managed to the benefit of the Project and in meeting its goal and objective.

Figure 1: Management Arrangements for the UNDP-GEF Project: Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (FCV Project)



3.2.2 Actual Stakeholder Participation Partnership Arrangements

60. The Project's progress is reliant on the active participation and contribution of its stakeholders, namely the participating demonstration cities, FCV industry companies, research organizations, experts, and sub-contractors. The PMO, with the guidance of UNDP, has effectively led the stakeholder engagement and effectively leveraged the contributions of a wide range of stakeholders for achieving the Project's intended outcomes. A list of actual stakeholders who have participated on the Project is on Annex H.

3.2.3 Project Finance

61. The FCV Project had a GEF budget of US$8,233,560 that was disbursed over a 5-year duration, managed by the PMO under the direction of a Project Steering Committee headed by MOST. Table 2 depicts disbursement levels up to 30 April 2021, 3.5 months prior to the terminal date of the FCV Project of 16 August 2021, revealing the following:

- Project finances are sound with appropriate financial controls including reporting and planning, that allow the PMO to make informed decisions regarding the budget and allow for timely flow of funds;

- The spending rate against intended expenditures was 55% in 2016, 77% in 2017, 110% in 2018, 118% in 2019, and 141% in 2020;
- Expenditures were mainly equipment procurement followed by contractual services. Table 3 depicts the expenditures by ATLAS code;
- The Bangkok Regional Hub was involved with detailed information if there were any deviations before releasing the ASL (authorized spending limit) for that particular year;
- Most of the funds were spent on consultants and workshops. Table 3 shows how the funds were spent;
- Government audits were carried out by the UNDP China Office.

62. Planned Project co-financing in the ProDoc was estimated to be US$ 53.5 million. Actual co-financing realized from the FCV Project was US$53.5 million or 100% of the target. This level of co-financing on the FCV Project is reflective of the investments leveraged by the Project through FCV activities. Each of the demonstration cities allocated their fair share of funds to promote and mainstream hydrogen fuels and FCVs. Table 4 provides details of FCV Project co-financing. Table 5 provides co-financing details. The co-financing for each demo city includes all financing including private sector financing by the industry itself.

63. In conclusion, the cost effectiveness of the FCV Project has been **satisfactory** in consideration of the Project meeting its intended targets.

3.2.4 M&E Design at Entry and Implementation

64. The Project follows the standard monitoring and evaluation design procedures adopted by full-sized GEF projects. The M&E design was deemed **satisfactory**.

Table 2: GEF Project Budget and Expenditures for China DevCom FCV Project (in USD as of 30 April 2021)

FCV Components	Budget (from Inception Report)	2016[22]	2017	2018	2019	2020	2021[23]	Total Disbursed	Total to be expended by 16 August 2021	Total remaining
OUTCOME 1A: Markedly reduced costs and improved performance of FCVs	954,950							-		954,950
OUTCOME 1B: FCVs deployed in continuous operation by cities, organizations, and individuals	5,426,250	245,298	2,093,718	3,152,324	519,056	174,155	-	6,184,551		(758,301)
OUTCOME 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	272,200							-		272,200
OUTCOME 2B: Increased number of transport hydrogen producers and of hydrogen refueling stations on the ground	146,500	7,922	132,486	214,621	30,940	30,875	-	416,844		(270,344)
OUTCOME 3A: Effective enforcement of policies and regulatory frameworks	400,250	79,600	55,668	89,700	2,590	110,105	-	337,663		62,587
OUTCOME 3B: Adoption of new policies that promote FCV purchase and investment in hydrogen refueling stations	116,700							-		116,700
OUTCOME 4: Enhanced acceptance of FCVs for both public and private uses	309,840	77,761	46,893	69,831	144,867	-	-	339,352		(29,512)
OUTCOME 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	169,200	-	-	-	2,475	164,163	8,460	175,098		(5,898)
OUTCOME 5B: Increased interest and technical capacity of financial sector	45,600							-		45,600
Project Management	392,070	9,500	70,742	102,103	64,729	105,138	4,213	356,425		35,645
Total (Actual)	**8,233,560**	**420,081**	**2,399,507**	**3,628,579**	**764,657**	**584,436**	**12,673**	**7,809,933**	**-**	**423,627**
Total (Cumulative Actual)		420,081	2,819,588	6,448,167	7,212,824	7,797,260	7,809,933			
Annual Planned Disbursement (from ProDoc)[24]	8,233,560	769,066	3,110,432	3,288,934	650,656	414,472				
% Expended of Planned Disbursement		**55%**	**77%**	**110%**	**118%**	**141%**				

[22]Commencing 16 August 2016, the date the Project Document signed by the Government of China
[23]Up to 31 May 2021
[24] Year 1 in ProDoc was prorated to the 16 August 2016-December 2016 when the Project was being implemented

Table 3: Expenditures by ATLAS Code (as of 30 June 2021)

ATLAS Code	Expenditure Description	US$
71200	International Consultants	25,590.46
71300	Local Consultants	32,632.27
71500	UNV	35,412.78
71600	Travel	191,069.06
72100	Contractual Services	1,816,675.91
72200	Equipment	4,666,697.56
74200	Audio Visual & Print Prod Costs	30,883.74
74500	Miscellaneous Expenses	300,802.71
75700	Training, Workshops and Confer	732,241.77
	Total:	**7,832,006.26**

Table 4: Co-Financing for DevCom FCV Project (as of 31 May 2021)

Co-financing (type/source)	UNDP own financing (million USD)		Government (million USD)		Partner Agency (million USD)		Private Sector (million USD)		Total (million USD)	
	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
Grants	0.400	0.400	15.033	85.638			10.167	23.735	25.600	109.773
Loans/Concessions										
• In-kind support			2.567	28.829			25.333	250.162	27.900	278.991
• Other										
Totals	**0.400**	**0.400**	**17.600**	**114.467**			**35.500**	**273.897**	**53.500**	**388.764**

Table 5: Summary of Co-Financing for DevCom FCV Project (as of 31 May 2021)

Sources of Co-financing	Type of Co-financing	Investment Mobilized
Government	Grants	85.638
	In-kind support	28.829
Private Sector	Grants	23.735
	In-kind support	250.162
Total Co-Financing:		388.364

65. The PRF was used effectively as a management tool towards monitoring implementation progress. The PRF and the annual work plans were two of the primary tools for monitoring the Project's progress and results. The institutional arrangement for the Project's monitoring and evaluation was formalized in the inception workshop. The PMO conducted the daily Project monitoring and evaluation with its expert team and the subcontractors, and the financial audit of the Project's implementation progress was conducted by an independent auditor proposed by UNDP.

66. The PMO prepared the annual work plan with detailed monitoring and evaluation indicators and targets, and the targets were represented in the terms of reference of sub-contractors. The PMO supervised and monitored the progress of activities and assessed the quality of implementation through progress report reviews and on-site field visits. The work plans, budgets, quarterly progress reports, and APR were prepared by the PMO and submitted to PSC and UNDP for review and approval.

67. M&E design at entry was rated as **satisfactory**. Implementation of the M&E plan was *rated as **satisfactory***. Ratings according to the GEF Monitoring and Evaluation system[25] are as follows:

- *M&E design at entry - 5;*
- *M&E plan implementation - 5;*
- *Overall quality of M&E - 5.*

3.2.5 Performance of Implementing and Executing Entities

68. The MOST and PMO have been efficient in managing the execution of the Project. They have been responsive to stakeholders and proactive in seeking their expert inputs through commissioned sub-contracts for achieving the Project's outcomes.

69. While there is coordination between the MOST and the PMO, there is positive collaboration between the MOST, PMO, and UNDP for the Project's execution and alignment to developing national policy and industrial development. UNDP has provided timely advice on Project implementation, monitoring, and reporting. The participating cities, FCV industry companies, and sub-contractors have been able to participate in and contribute meaningfully to Project implementation due in large part to PMO's Project management and UNDP's coordination and facilitation.

70. The performance of implementing and executing entities can be summarized as follows:

- *Implementing Partners (MOST)* – 5;
- *Implementing Entity (UNDP)* – 5;
- *Overall quality of implementation/execution (UNDP/MOST)* – 5.

[25] 6 = HS or Highly Satisfactory: There were no shortcomings;
5 = S or Satisfactory: There were minor shortcomings,
4 = MS or Moderately Satisfactory: There were moderate shortcomings;
3 = MU or Moderately Unsatisfactory: There were significant shortcomings;
2 = U or Unsatisfactory: There were major shortcomings;
1 = HU or Highly Unsatisfactory
U/A = Unable to assess
N/A = Not applicable.

3.3 Project Results and Impacts

71. This section provides an overview of the overall results of the FCV Project and assessment of the relevance, effectiveness and efficiency, country ownership, mainstreaming, sustainability, and impact of the FCV Project. In addition, evaluation ratings for overall results, effectiveness, efficiency, and sustainability are also provided against the August 2016 PRF (as provided in Appendix F)[26]. For Tables 6, a summary of the achievements of FCV Project at the Project Goal and Objective level, and component levels with evaluation ratings are provided. The "status of target achieved" is color-coded as per the following color-coding scheme:

Green: Completed, indicator shows successful achievements	Yellow: Indicator shows expected completion by the EOP	Red: Indicator shows poor achievement – unlikely to be completed by project closure

3.3.1 Progress towards goal and objectives

72. The Project has easily reached its GHG emissions reduction goal of 132,707 tons of CO_2, reaching 230,261 tonnes CO_2 through deployment of 6,407 FCV by private companies, operating and renting them to other companies or individuals. Moreover, there has been substantial investments by the financial sector to invest in value chain manufacturing and hydrogen refueling stations with renewable energy sources, leading to more FCVs on the road in the 6 demonstration cities. Table 7 summarizes the GHG emission reduction calculation for the Project.

73. In terms of objective level targets, cumulative emission reductions from demonstration cities, obtained from the National Monitoring and Management Center for New Energy Vehicles was 230,261 tonnes CO_{2eq}. This was based on:

- the emission reductions for the number of vehicles driven during the demonstrations in the cities, the kilometers traveled during the demonstrations, and the hydrogen coefficients defining the hydrogen fuel's tonnes of CO_{2eq} reduced per kilometer (which would factor in the CO_{2eq} required to produce the hydrogen);
- the hydrogen coefficients were obtained from hydrogen subcontractors who, when defining of an emission reduction factor, take 2 factors that are significant: 1) source of hydrogen; 2) vehicle type. Further details of the hydrogen coefficients are provided in Para 74;
- the credit to emission reductions based on renewable energy generated in Zhangjiakou that is being used to generate hydrogen fuels for FCVs in that city.

74. The hydrogen coefficients were defined as follows: the vehicle type defines the volume of fuel (hydrogen and petrol/diesel) consumption, which in turn affects the incremental unit emissions reduction achieved. According to the lifecycle assessment method of CATARC, the CO_2 emissions of hydrogen production methods of passenger cars, buses and trucks were calculated using [a] natural gas steam conversion hydrogen production, [b] electrolytic water hydrogen production (power grid), [c] coke oven gas conversion hydrogen production, [d] chlor-alkali by-product gas hydrogen production, and [e] water electrolysis hydrogen production (from wind power). The emissions factor of these 5 hydrogen production methods for passenger cars were 103.4, 286, 23, 14.6 and 6 g CO_2/km

[26] Evaluation ratings are on a scale of 1 to 6 as defined in Footnote 25.

Table 6: Project-level achievements against DevCom FCV Project targets

Project Strategy	Performance Indicator	Baseline	Target	Status of Target Achieved	Evaluation Comments	Rating [27]
Project 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	132,707 tons CO_2[28]	Approximately 230,261 tons CO_2 achieved	See Para 72 to 74	6
Objective: Facilitation of the commercial production and application of fuel cell vehicles in China	Number of local transport vehicle manufacturers producing FCVs by EOP	4	10	16	See Para 0	6
	Cumulative investment in local FCV manufacturing by EOP, US$ million	$1 million	$10 million	US$2.2 billion		
	Number of persons gainfully employed in new FCV, FC, and FCV component manufacturing firms and hydrogen re-fueling stations	1,000	10,000	>12,000		
Overall Rating – Project-Level Targets						**6**
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)	3,300 (bus) 2,100 (car) 2,100 (DV)	>3,300 buses completed >2,100 cars completed >2,100 DVs completed	See Paras 77 to 89	5
	Reduction in high volume unit cost[29] of newly produced Chinese FCVs at EOP, %	0% (bus) 0% (car) 0% (DV)	50% (bus) 40% (car) 50% (DV)	*>50% for buses* *>40% for cars* *>50% for DVs*		5
Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China	Annual FCV sales in China by EOP (units sold)	0	400-7,000	*7,505*[30]		5
Overall Rating – Component 1						**5**

[27] Ibid 25

[28] Emission reductions of 132,707 tons CO_2 by EOP are a combination of direct incremental net ERs (for 109 FCVs and 4 renewable energy-based hydrogen production units) and indirect ERs (assuming total vehicles by EOP are 4,000 including original 109 and assuming an additional 12 renewable energy-based hydrogen production units by EOP). Direct incremental net ERs total 15,287 tons, of which 9,365 tons are due to the 109 FCVs operating for 3.2 years (with baseline scenario subtracted out) and 5,922 tons are due to the 4 renewable energy- based hydrogen production facilities operating for two years before EOP (with double counting for the portion of hydrogen used in the demo FCVs subtracted out). Indirect ERs by EOP total 117,420 tons, of which 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 4).

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

[30] *2015: 10 FCVs; 2016: 629 FCVs; 2017: 1,275 FCVs; 2018: 1,527 FCVs; 2019: 2,737 FCVs; 2020: 1,177 FCVs; 2021 Jan to Mar: 150 FCVs.*

Project Strategy	Performance Indicator	Baseline	Target	Status of Target Achieved	Evaluation Comments	Rating [27]
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	5	*6*	See Para 99	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	Annual production of hydrogen from autonomous renewable energy in China at EOP, metric tons	0	1,000	*1,200 MT of hydrogen were produced in 2019 for China's transportation sector.*	See Paras 91 to 104	5
	Number of hydrogen refueling stations in China at EOP	2	15	*171 hydrogen refueling stations have been built*		6
Overall Rating – Component 2						**5**
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 by EOP	0	10	*43 These FCV manufacturers have obtained license issued by the Ministry of Industry and Information Technology (MIIT)*		6
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	6	*24 local governments and 43 cities*	See Paras 107 to 115	6
Overall Rating – Component 3						**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	10	45	See Paras 117 to 127	6
	Number of private vehicle owners that own and use a FCV by EOP	0	480 – 3,360	2,933		5
Overall Rating – Component 4						**5**
Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	Number of individuals capable of satisfactorily operating and maintaining FCVs in China by EOP	20	>500	4,758	See Paras 130 to 137	5
	Number of individuals capable of satisfactorily operating and maintaining hydrogen refueling stations in China by EOP	5	>100	*216*		5
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	100	*US$ 2.20 billion of investment in FCV and HRS value chain has been made by financial sector*	See Para 138138	6
Overall Rating – Component 5						**5**

Table 7: GHG reduction summary[19]

City[20]	Vehicles	# of vehicles	Total km travelled	Hydrogen Coefficient (tCO_{2eq} reduced per km)[21]	Cumulative emission reductions (tCO_{2eq})
Beijing	Bus	205	5,768,473	640	3,692
	Delivery Vehicles	165	1,919,421	331	635
	Total	**370**	**7,687,894**		**4,327**
Shanghai	Mini Bus (FCV80, SH6612A4FCEV)	347	1,432,917	733	1,050
	Delivery Vehicles	1,018	14,516,609	733	10,641
	Bus	8	448,737	1,191	534
	Total	**1,373**	**16,398,262**		**12,225**
Zhengzhou	Bus	223	11,742,371	1,191	13,985
	Total	**223**	**11,742,371**		**13,985**
Yancheng	Bus	10	386,751	1,202	465
	Total	**10**	**386,751**		**465**
Foshan	Bus	1,009	19,501,702	1,191	23,227
	Mini Bus (FCV80, SH6612A4FCEV)	3	52,634	733	39
	Delivery Vehicles	451	11,624,684	733	8,521
	Total	**1,463**	**31,179,021**		**31,786**
Zhangjiakou	Bus	224	13,656,988	1,202	16,416
	Total	**224**	**13,656,988**		**16,416**
Other	Bus	1,192	34,398,726	1,202	41,347
	Delivery Vehicles	1,552	23,137,987	741	17,145
	Total	**2,744**	**57,536,712**		**58,493**
Total ER vehicles		**6,407**	**138,587,999**		**137,697**
RE facility	**Hydrogen production (kg)/day**	**Operating days/year**	**Number of years**	**kg CO2 per kg fossil fuel based hydrogen**	**Total reduction of CO2 eq (tonnes)**
Hypower Zhangjiakou	4,000	365	10	6.34	92,564
Total emission reductions from DevCom Project					**230,261**

[19] Data is directly retrieved from National Monitoring and Management Center for New Energy Vehicles
[20] The demonstration city of Changshu only has one demonstration FC car (Toyota Mirai) with no FC buses in operation. Operational data is not available.
[21] This is based on coefficients from hydrogen vendors based in China.

respectively. For buses, they were 672.1, 1859, 149.5, 94.9 and 39 gCO_2/km respectively. For delivery trucks, they were 491.15, 1358.5, 109.25, 69.35 and 28.5 gCO_2/km, respectively.

75. The Project has 42 FCV enterprises in China as reported by the Notices of Road Motor Vehicle Manufacturers and Products released by Ministry of Industry and Information Technology (MIIT). An estimated 16 of these are OEMs, 12 out which are Project partners. With the cumulative investment in local FCV manufacturing being US$2.2 billion, over 12,000 people have been successfully employed in FCV and HRS related firms, among which there are 10,652 male employees and 4,566 female employees.

3.3.2 Component 1: Improvement of Local Fuel Cell (FC) and Fuel Cell Vehicle (FCV) Production and Application

76. To achieve Component 1's outcomes, focus was to be provided on building the capacities of Chinese FCV manufacturers in demonstration cities and facilitating their international access to advanced FCV technologies and high-quality components to reduce manufacturing costs and improve durability and performance. Pilot demonstrations and assistance to component manufacturers was provided, demonstrating the operations of FCVs (FCBs, cars, delivery vans, and delivery trucks) through partnership with 6 cities in China and generation of real data on continuous operation of FCVs, as reported by CATARC and the Hydrogen Fuel Cell Vehicle Industry Association. This led to the desired outcomes:

- Outcome 1A: Markedly reduced costs and improved performance and durability of FCVs in China;
- Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China.

77. *Beijing*: By April 2021, a total of 410 FCVs were in operation including 5 buses, 260 group buses and 145 logistics vehicles. The total operation mileage was 6,985,400 km including 553,600 km of public buses, 4,941,900 km of group buses and 1,489,900 km of logistics vehicles. Through the demonstration, FCVs were found to have certain advantages compared with pure electric vehicles such as output power, driving range, fuel filling efficiency and other aspects which are conducive to the continuous and efficient operation of vehicles.

78. Beijing has gradually built a relatively complete hydrogen energy industry chain. Beginning with scientific research at Tsinghua University, Beijing has built the capacity for large-scale promotion and the manufacture core components. The number of Beijing-based hydrogen-related enterprises and institutions has expanded to 67, covering the entire value chain. Cumulative investment in the Beijing industrial value chain totals RMB 57.9 billion, employing over 2,500 people. Details are contained in Paras I-1 to I-5.

79. *Shanghai*: Through the implementation of Phase I and Phase II of the FCB Project and this DevCom FCV Project, the technical level of FCVs has been significantly improved with rich experience having been accumulated in demonstration operations. The 1,483 FCVs demonstrated during the DevCom FCV Project have demonstrated advantages of output power, driving range, fuel filling efficiency and carbon emission over their Phase II models, which is conducive to sustained and efficient operation of vehicles.

80. With regards to assistance to component manufacturers, Shanghai has introduced world-leading technical resources of fuel cell components and carried out localized production and manufacturing. In 2018 and 2019, a large number of fuel cell related enterprises became established. This included 70 hydrogen energy and fuel cell industry chain related enterprises in Shanghai that were dealing with hydrogen production and supply, key parts (system, stack, membrane electrode, bipolar plate, catalyst), OEMs and vehicle operators. The power of fuel cell stacks produced by local enterprises in Shanghai has reached 150 kW. Durability of FCVs has increased from 2,000 hours to 10,000 hours, 12,000 hours and 10,000 hours for buses, service vehicles and passenger cars respectively.

81. Through implementation of UNDP DevCom FCV Project, the number of FCVs promoted and operated in Shanghai reached 1,373, with cumulative investment exceeding RMB 50 billion (with FCV sales increased with 31 in 2016, 570 in 2017, 363 in 2018, 403 in 2019 and 116 in 2020), with an average annual growth rate of 163%. Shanghai has a strong vehicle production capacity from a number of high-quality FCV stack, system and core parts enterprises, which has laid a solid foundation for the development of FCVs. Further details of Shanghai's assistance to component manufacturers can be found in Paras J-1 to J-9.

82. _Zhengzhou_: Fuel cell buses were demonstrated in Zhengzhou along Route No 727 growing from 3 vehicles in August 2018 to 223 vehicles in 2020. After more than 2 years of actual operation, Zhengzhou believed that FCVs were an important development direction of new energy vehicles, thus truly realizing "zero pollution and zero emission". Compared with the extra-long charging time of pure electric buses, FCV buses have shorter charging times as currently demonstrated on Route 727.

83. For the 223 FCVs operated in Zhengzhou under the DevCom FCV Project, the accumulated investment in the fuel cell industry chain exceeds RMB 750 million, employing 865 people. Yutong Bus completed the development of three generations of fuel cell buses, obtained the first fuel cell commercial vehicle qualification certification and product announcement in the industry in 2015, and realized small-batch demonstrations to promote FC buses in 2019. Further details of Zhengzhou's FCV industry are provided in Paras K-1 to K-5.

84. _Yancheng_: Ten fuel cell buses have been demonstrated and promoted in Yancheng during the DevCom FCV Project implementation, running for 27,322 hours in total, with a cumulative distance of more than 660,000 kilometers and a cumulative investment of over RMB 60 million. The Jiangsu Xingbang Energy Technology Co., Ltd. has been at the forefront of FCV development, with the company specializing in hydrogen fuel cell technologies. Details of the Project's support to Yancheng's FCV development can be found in Paras L-1 to L-4.

85. _Foshan_: Twenty-five demonstration bus routes have been established in Nanhai District through the demonstration project with 397 hydrogen buses and 427 logistics vehicles. Today, the number of FCVs in Nanhai District has increased to 1,463, and 9 hydrogen refueling stations have been built and operated with two hydrogen refueling stations under construction. Through demonstration, fuel cell buses were found to be advantageous in terms of output power, driving range, and fueling efficiency compared with pure electric buses. Numerous hydrogen enterprises in Foshan have been assisted by the Project. Further details are contained in Paras M-1 to M-3.

86. _Zhangjiakou_: Zhangjiakou had 304 FCV buses on demonstration over 10 bus routes. Through the demonstration project, fuel cell buses were seen to have advantages over battery electric buses in

terms of output power, driving range, and refueling efficiency. At present, there are 18 companies mainly involved with the FCV and hydrogen industry chain in Zhangjiakou. Zhangjiakou promoted FCV due to the green low-carbon sustainable transportation concept of the Winter Olympics, initially planned with 74 FCVs in operation and procurement an additional 100 FCVs. Further details are contained in Paras N-1 to N-5.

87. *Project-related activities*: To bring the cost down of FCVs manufactured in China, several workshops were held during September 2019, followed by two reports on the Annual Report on the Development of Automotive Hydrogen Industry in China. These reports formed the basis of technical assistance that has been provided to selected manufacturers through 1) the Project network, 2) the UNDP Hydrogen Industry Conference, and 3) the subcontract to the consortium led by Hinicio. Manufacturers taking in technical assistance from the Project included an effort to reduce prices in FC membranes, FC catalysts, membrane electrode assembly, bi-polar plates (to improve process and technology for coating and stamping and for welding and sealing, if needed), FC stacks (Dalian Sunrise to optimize stack and balance of system), and FCV air compressor (Foshan Guangshun to improve quality control processes, technology, and sourcing of compressor parts).

88. These firms were then surveyed for their intake of technical assistance during the Project in reducing costs of vital components of the FCVs. The SAE China survey "Service Institution to conduct Comparison Analysis and Evaluation on National FCV related Supply Chain Baseline and Capacity Building after Technical Assistance" had been completed with all the Chinese FCV manufacturers from 2016 to 2018. In 2019 and 2020, Hinicio also surveyed 5 FCV manufacturers from demo cities who received Project technical assistance. Results of the survey indicated that China's FCV manufacturers have achieved improvements in technology, management, and operation of demonstration FCVs. However, there were still challenges sourcing some components with the best compatibility and performance including air compressors, hydrogen circulation pumps, and bipolar plates materials

89. Using the unit price of an FCV from 2015, the baseline prices for FCVs as of 2017 were set:

- The price for DVs and FCBs has achieved a 56% and 58% reduction respectively;
- The price for FC cars has already reduced from US$80,645 to US$50,000, resulting in a 38% of reduction;
- The price reductions are attributable to the Project technical assistance, from making power improvements in the fuel cells and improvements in the driving range, to being able to manufacture FCVs and FCBs in large quantities, driving down the FCV prices on improved FCV models. This allows FCVs to be deployed in continuous operations in demonstration cities as well as other cities in China[22];
- China has clear plans to focus on developing fuel cell commercial vehicles in the short and medium term.

90. In conclusion, the results of Outcomes 1A and 1B can be rated as **satisfactory** in consideration that all barriers to widespread FCV deployment have been removed, and all outputs and targets with respect to demonstrations and FCV deployment and assistance to the FCV manufacturing sector have

[22] The status of the commercial FCV production in China by EOP is to carry on with production to the point where the FCVs are in other cities. It would be beneficial to track but there is an issue of access to relevant information. Vehicle purchase is done through procurement rather than selling with a tagged price. When the Project is not the entity that carries out the procurement, procurement prices are not public but can be obtained by specifically requesting them.

been met with a high degree of satisfaction amongst stakeholders. This includes delivery of the following outputs as a follow-up to Outcome 1A: Markedly reduced costs and improved performance and durability of FCVs in China:

- Output 1A.1.1: Completed individual technical assistance for China's vehicle manufacturers in the design and manufacture of FC vehicles;
- Output 1A.1.2: Completed group capacity development sessions for China's vehicle manufacturers in the design and manufacture of FCVs;
- Output 1A.2: Published and disseminated information on improved FCV design and production in China achieved via the Project;
- Output 1A.3: Multiple confirmed and implemented new sourcing agreements between Chinese FCV manufacturers and international suppliers that are each verified to lower costs, increase durability, and/or raise performance from start of project benchmarks;
- Output 1A.4: China-based FCV component manufacturers that achieve globally competitive durability and performance (previously unavailable in China) at significantly lower cost than pre-project global levels, and can provide quality components to domestic FCV manufacturers at a lower price than currently available, thus contributing to driving down the cost of FCVs;

There has also been delivery of the following outputs as a follow-up to Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China:

- Output 1B.1: Completed procurement and production of 109 demo FCVs, including 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks that meet enhanced technical standards;
- Output 1B.2: Approved plans in each demo city for increasing visibility and effectively testing operating performance of demo FCVs consisting of 23 buses, 51 cars, 30 delivery vans, and 5 delivery trucks, to maximize positive impacts in areas of awareness building and providing data for FCV operation analysis;
- Output 1B.3: Completed demonstration of FCV operation and application to continue operation after end of project (EOP);
- 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).

3.3.3 Component 2: Improvement of Hydrogen Production and Refueling System

91. To achieve Component 2's outcomes, focus was placed on improving hydrogen production and establishment of HRSs by reducing the cost and improving the viability of hydrogen production (especially RE-based hydrogen) and increasing the number of transport hydrogen producers and HRSs in China (including RE-based hydrogen). Studies, business plans, installation, and commissioning of the HRSs were provided, leading to the desired outcomes:

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

92. *Beijing*: As of April 2021, Beijing had a total of 6 HRSs completed. The total hydrogen refueling amount is 311.20 tons including 225.28 tons produced by electrolytic water, 42.96 tons by natural

gas, 25.78 tons by methanol decomposition, and 17.18 tons by chlor-alkali exhaust. The price of hydrogen has been reduced from more than RMB 70/kg to less than RMB 35/kg. There is an "Implementation Plan for Development of Hydrogen Energy Industry in Beijing City (2021-2025)" issued by Beijing Municipal Government for the development of hydrogen energy in the future. By 2023, 5 to 8 leading enterprises in the hydrogen energy industrial chain with international influence will be cultivated relying on the major demonstration projects of the Winter Olympics and Paralympics. Details are contained in Paras I-6 to I-10.

93. *Shanghai*: Currently, 9 HRSs have been built in Shanghai with hydrogen sourced mainly by industrial product hydrogen and hydrogen by natural gas reformation. The annual production capacity is 450,000 tons and the price of hydrogen has been reduced from more than RMB 70/kg to less than RMB 35/kg. However, due to its own geographical environment, renewable energy is scarce in Shanghai, and its potential renewable energy hydrogen production methods are to be mainly biomass hydrogen production, external transfer of hydropower and deep-sea wind power hydrogen production.

94. In future, 60 HRSs are planned. At present, most HRSs in Shanghai are operating at a loss. Currently, the profitable HRSs are mainly those located in the chemical area. The main profitable business is not from the hydrogen filling for fuel cell demonstration vehicles, but through the wholesale supply of hydrogen to the surrounding HRSs or hydrogen users. Financing of hydrogen energy investment in Shanghai is dominated by central enterprises (such as Sinopec, PetroChina and SPIC), who already have plans for an industrial chain of hydrogen filling stations. During the 14th Five-Year Plan period, the development of FCV industry in Shanghai will achieve the strategic goal of "100 stations, 100-billion scale and 10,000 vehicles" with 100 HRSs planned, installed and placed into operation to improve hydrogen energy infrastructure. Further details of Shanghai's HRS efforts are provided in Paras J-10 to J-18.

95. *Zhengzhou*: At present, Zhengzhou has put 1 hydrogen refueling station into operation and plans to build 30-40 in the future. The main hydrogen production methods in Henan Province include hydrogen production by petroleum, hydrogen production by coal, hydrogen production by chlor-alkali industry and hydrogen production by synthetic ammonia. The price of hydrogen has been reduced from more than RMB 70/kg to less than RMB 35/kg. Construction of hydrogen refueling stations is planned with the promotion of various hydrogen FCVs such as buses, logistics vehicles and passenger vehicles. Further details of Zhengzhou's efforts to build HRSs can be found in Paras K-6 to K-10.

96. *Yancheng*: Yancheng has the Chuangyong hydrogen refueling station. Two more HRSs are being constructed in Yancheng, the first being the hydrogen production and fueling integrated station and the second being fuel cell laboratory project at the New Energy Vehicle Industrial Park, both starting construction at the end of 2020. The Yangtze River Delta New Energy Vehicle Research Institute provided support in terms of technical scheme. Further details of Yancheng's HRS efforts can be found in Paras L-5 to L-10.

97. *Foshan*: The Project has promoted the development of hydrogen energy enterprises in Nanhai District. There have been 10 HRSs established in Nanhai District since 2017 with the price of hydrogen being reduced from RMB 70/kg to less than RMB 35/kg. To promote the further development of the fuel cell vehicle industry, Foshan Nanhai District Government plans to add 4,000 new fuel cell

vehicles and build 45 new hydrogen refueling stations by 2024, achieving an annual output of 68,600 tons/year of hydrogen. Further details are contained in Paras M-4 to M-9.

98. *Zhangjiakou*: In Zhangjiakou, there are 4 hydrogen refueling stations in operation: Chuangba Skid-mounted Station, Wangshan Hydrogen Production and Refueling Station, Hengpanliang Fixed Station and Weisanlu Oil, Hydrogen and Electricity Combined Station. There is also Hypower Zhangjoakou, a wind energy source for the 4 HRSs in Zhangjiakou. The installed capacity of renewable energy sources in Zhangjiakou at the end of 2020 reached 20 MW and will exceed 50 MW by 2030[23]. Multiple HRSs are also planned for completion before 2024. Further details are contained in Paras N-6 to N-10.

99. *Project-related activities*: In summary, there are 6 business models for hydrogen refueling:

- Model 1: Refueling station from water electrolysis (1 in Beijing in 2006);
- Model 2: Industrial by-product hydrogen stations (3 in Shanghai, Zhengzhou, and Foshan during FCB Phase II Project);
- Model 3: RE-based H_2 station (1 in Dalian in September 2016, 1 in Zhangjiakou already constructed);
- Model 4: 1 dual gasoline-hydrogen station is expected to be completed in Foshan by July 2019;
- Model 5: Hydrogen-electric station: 1 in Foshan, 1 in Jiashan of Zhejiang); and
- Model 6: Petro-hydrogen-electric hybrid station: 1 in Foshan.

100. HRS stations constructed with UNDP and CATARC placed significant efforts in advocating for renewable based hydrogen with demonstration cities. Four RE hydrogen production facilities were constructed with renewable energy-based hydrogen:

- one wind power project in Dalian (by Xinyuan Power, which is the Project's partner) has been successfully constructed in Oct 2016. The Xinyuan Dongli is the project's partner and the PMO has been in contact with it for knowledge sharing activities;
- two in Zhangjiakou, which is the Project's demo city: 1) The wind powered HRS in Guyuan (by the Hebei Construction & Investment Group Co., Ltd), which has been was put into operation in 2020; 2) large-scale wind-solar hybrid hydrogen production demonstration station in Chongli, which started construction in 2020;
- one in Shanxi: UNDP is also in close contact in Shanxi, promoting sustainable hydrogen economy development. On 25 September 2019, Changzhi of Shanxi Province commenced the construction of 200 MW PV power hydrogen production project, as well as the signing ceremony of phase II (500 MW) of this project.

101. During June 2019, a hydrogen development workshop was conducted during the Zhangjiakou launch, with focus on its renewable energy features, demand, and prospects. In June and July 2020, a 5-episode "Hydrogen Webinar Series" was jointly organized by Consulate General of the Kingdom of the Netherlands in Guangzhou and UNDP, to give an in-depth analysis into hydrogen sector by introducing policies, projects, and research ongoing in China and the Netherlands. The Project partner, Hypower, was invited to speak on the second webinar to address the current status of hydrogen production and green hydrogen production practice in Zhangjiakou.

[23] 50 MW includes 20 MW from wind power, 24 MW from solar PV and 6 MW from solar thermal power. Documented in: http://www.gov.cn/xinwen/2015-07/29/content_2905230.htm

102. During 26-28 October 2019, sub-forums of 2019 Hydrogen Industry Conference were conducted with topics on green hydrogen production. Around 52 enterprises who specialized in hydrogen production and refueling facilities participated in the conference and worked with national and international experts. On 17 June 2020, a second version of the "Hydrogen Webinar Series" hosted by the Netherlands Technology and Innovation Network and UNDP China, discussed green hydrogen production practices with a special focus on offshore wind energy hydrogen projects in the Netherlands. This provided insights for domestic wind farms who are planning to produce hydrogen with excess wind power. With the Project's support, the Foshan PMO invited national experts to carry out technical assistance and feasibility studies on land-fill methane-based hydrogen production.

103. Approximately 1,200 MT of hydrogen were produced in 2019 for China's transportation sector. All this activity has had data collected under a sub-contract commenced in 2016, "Analysis and Evaluation on National Refueling Station Operation" with Sinohytec. The PMO organized a review workshop and made recommendations for review of the completed report.

104. Other HRSs that were constructed and commissioned included:

- One HRS station integrating gasoline refueling facilities and hydrogen refueling facilities commissioned in Foshan instead of Shanghai and Beijing;
- In 2019, hybrid hydrogen and gasoline refueling stations have been successfully built in Guangdong, Zhejiang, and Shanghai;
- Two gasoline stations with the addition of HRS at West Shanghai and Anzhi in Shanghai commissioned by the Project's partner, Sinopec, and Air Liquide in November 2019; and
- 30 stations integrating gasoline refueling facilities and hydrogen refueling facilities for Beijing, Sinopec.

105. In conclusion, the results of Outcomes 2A and 2B can be rated as **satisfactory** in consideration that all barriers to HRS construction and operations has been removed, and all outputs and targets have been met with a high degree of satisfaction amongst stakeholders. The net result is the cost of hydrogen coming down considerably (from RMB 70 to RMB 35), and an increased number of transport hydrogen producers, and hydrogen refueling stations on the ground in China. While most of the hydrogen comes from industrial by-products, there are now some projects using renewable energy to produce hydrogen. Energy enterprises such as Sinopec and PetroChina are actively participating in the construction of hydrogen industry infrastructure. There has been delivery of outputs as a follow-up to Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations:

- Output 2A.1.1: Completed one-on-one technical assistance for investors in and managers of demo RE-based hydrogen production facilities, to incorporate international best practices to improve the viability and reducing the cost of RE-based hydrogen production in China;
- Output 2A.1.2: Completed group capacity development for prospective investors and managers of RE-based hydrogen production facilities, including publication and dissemination of capacity development materials with information on international best practices in RE-based hydrogen production, to stimulate investment, improve technical levels, and reduce costs;
- Output 2A.2: Expanded knowledge base on reducing production costs of transport hydrogen and establishing local hydrogen production facilities, including information on all aspects and applicable processes of hydrogen production.

- Output 2A.3.1: Completed one-on-one technical assistance for investors and managers of project demo HRS and manufacturers providing equipment to such stations, to increase the viability and lower the cost of HRS through improved business models and local availability of quality equipment;
- Output 2A.3.2: Completed group capacity development for prospective investors in HRS, manufacturers providing equipment to such stations, and relevant service providers, including publication and dissemination of capacity development materials

There has also been delivery of outputs as a follow-up to "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":

- Output 2B.1: At least four completed demonstrations of the application of reliable and cost-effective RE-based hydrogen production, including wind based and landfill methane based, and plan for replication of demos;
- 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, to provide important data and analysis of HRS operation in China;
- Output 2B.3: Clearly documented and disseminated results on operation and public perception of HRS and hydrogen production units (annual reports), investment costs (one-time reports), and revenue and operational costs (annual reports), to enhance the future design and operation of HRSs in China

3.3.4 Component 3: Policy and Regulatory Frameworks for the Application and Commercialization of FCVs

106. To achieve Component 3's outcomes, focus has been placed on achieving policy and regulatory frameworks to facilitate the commercialization of FCVs in China, and to overcome these barriers: (a) absence of a national FCV Roadmap, (b) incomplete standards and certification systems, (c) lack of harmonization with international standards, (d) unstable incentives and policies, (e) lack of broad approaches in incentivizing FCVs and HRSs, and (f) difficulties in obtaining national-level approvals for new FCV models and obtaining permanent (renewable) license plates for private operation of FCVs. Filling in of policy gaps, approved policies and standards, and regulations and standards to be approved comprise the technical assistance provided by the Project to this Component leading to the desired outcomes:

- Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs:
- Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations:

107. *Beijing*: Beijing has issued 18 local policies dealing with various FCV and HRS issues, and 33 National Standards (with the participation of Beijing) since the commencement of the DevCom FCV Project. These policies had the effect of strengthening the FCV industry and HRS investment. Further details are contained in Para I-11.

108. *Shanghai*: China has issued 31 national policies and Shanghai has issued 14 local policies. These policies are listed in Tables J-3 and J-4. Two 2 local standards (as shown on Table J-5) have been

formulated and promulgated in Shanghai to achieve the developmental goal of FCV industry in Shanghai, accelerate commercial application, create friendly domestic technical and political environments for the industrialization of FCVs, and mobilize the participation of enterprises.

109. The Shanghai Municipal Government still actively promotes the development of the FCV industry, providing policy and standard support for industrial chain innovation, key technical breakthroughs, innovative product development, and advanced infrastructure deployment. The fuel cell-related policies and standards to be approved in Shanghai in the near future are listed in Table J-6.

110. *Zhengzhou*: Zhengzhou Municipal People's Government and the People's Government of Henan Province have issued a number of related schemes, policies and plans in recent years to strengthen the FCV and HRS industry and to operationalize more FCV deployment. More details are contained in Paras K-11 to K-13, Tables K-1 to K-3.

111. *Yancheng*: During the Project implementation, Yancheng Municipal People's Government issued 4 policies to support the development of fuel cell industry as shown in Table L-3.

112. *Foshan*: Foshan issued 14 local policies during the implementation of DevCom FCV Project. The "Measures for Supporting the Development of New Energy Vehicle Industry in Nanhai District, Foshan City" were the first support measures nationwide for the construction and operation of hydrogen refueling stations. Further details are contained in Paras M-10 to M-12.

113. *Zhangjiakou*: Zhangjiakou have issued multiple policies on industrial development of FCVs and hydrogen development. Further details are provided inn Para N-11.

114. *Project-related activities*: The Governments of all 6 existing demo cities have endorsed their respective FCV and HRS development roadmaps, plans and policies regarding FCV and HRS value chains. The DevCom FCV project was a catalyst for the issuing of such documents. The persons involved in drafting the roadmaps and plans were all involved on Project activities since Phase I, particularly with the wide outreach since 2016. Furthermore, FCV development has become an innovative strategy for many provinces, 37 cities and 4 autonomous regions in China:

- Henan Province: Xinxiang;
- Hebei Province: Qinhuangdao, Handan;
- Guangdong Province: Guangzhou, Yunfu, Maoming, Shenzhen, Jiangmen, Dongguan;
- Jiangsu Province: Rugao, Nanjing, Zhangjiagang, Zhenjiang, Suzhou;
- Hubei Province: Wuhan;
- Shandong Province: Weifang, Qingdao, Jining, Jinan;
- Zhejiang Province: Ningbo, Jiaxing;
- Sichuan Province: Chengdu;
- Anhui Province: Tongling, Liu'an;
- Fujian Province: Fuzhou;
- Shanxi Province: Jinzhong, Datong;
- Demonstration cities: Beijing, Shanghai, Zhengzhou, Yancheng, Foshan, Zhangjiakou, Changshu;
- Municipalities: Tianjin, Chongqing;
- Guangxi Zhuang Autonomous Region: Laibin;
- Ningxia Hui Autonomous Region;
- Inner Mongolia Autonomous Region;

- Xinjiang Uyghur Autonomous Region.

115. All potential cities developing FCVs and policies have been influenced or have benefited from the efforts of the Project. For instance, many cities in China have approached UNDP as well as PMOs, and visiting demo cities to learn the Project experience in promoting FCV commercialization and hydrogen industry development. These cities are demonstrating great interest in developing similar projects in their own cities with the cities even wanting to participate as one of the Project's demo cities. The policies in different cities are largely influenced by other cities, especially the Project's demo cities which are more attractive to enterprises and more competitive in developing FCVs. There are 43 FCV manufacturers who have obtained licenses issued by the Ministry of Industry and Information Technology (MIIT) and who are beneficiaries of this policy.

116. In conclusion, the results of Outcome 3 can be rated **satisfactory** with the Project achieving its intended targets of 43 FCV manufacturers having obtained licenses issued by MIIT, and 24 local governments and 43 cities where policies promote FCV purchase or investment in hydrogen stations. This provides strong indications of the impact of new FCV and HRS policies to demonstration cities and other cities in China. There has been delivery of outputs as a follow-up to Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs:

- Output 3A.1: Approved and implemented national China FCV and Hydrogen Refueling Roadmap and local counterpart roadmaps, to increase confidence and interest of cities and investors to adopt FCV at a more rapid pace in China;
- Output 3A.2: Newly approved and enforced internationally compatible FCV, hydrogen station, hydrogen fuel transport, and associated parts standards, testing/measurement methods, and certification, to increase the confidence of approval bodies and lead to smoother adoption of FCVs;
- 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;
- Output 3A.4: Approved updated and enhanced incentive policy for FCV purchase, to increase the confidence of cities in implementing FCV demos, and of consumers in purchasing of FCVs for individual use;
- Output 3A.5: Approved updated and enhanced incentive policy for HRS establishment, to accelerate investments in new stations and increase FCV user confidence in ability to refuel their vehicles.

There has also been delivery of outputs as a follow-up to "Outcome 3B: Adoption (at local or national level) of policies new to China that promote FCV purchase and investment in hydrogen refueling stations":

- Output 3B.1: Designed and agreed upon local-level FCV and HRS incentive policy pilots (at least two in total) that are novel in China, but may have been implemented elsewhere in world, to incentivize FCV purchase and investment in HRSs;
- Output 3B.2: Successfully implemented local-level policy pilots (as designed in 3B.1) with monitoring, annual documentation, and dissemination of results to facilitate the replication of these pilots in other locations in China and stimulate the purchase of FCVs and/or investment in HRS.

3.3.5 Component 4: Enhancement of Information Dissemination and Awareness about FCV Transport Systems

117. To achieve Component 4's outcome, focus was placed on enhancing awareness on FCVs by disseminating information to public, national-level and local-level officials; companies that are end users of FCVs; FCV experts; FCV manufacturers; and other relevant stakeholders. This was expected to increase their confidence in pursuing and effectively implementing demonstration programs. Assistance was provided to conducting these capacity building awareness-raising programs and monitoring their effectiveness. These activities would lead to the desired outcomes of Outcome 4, "enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness".

118. *Beijing*: The number of people trained on the Project was 4,905. Currently, there are 403 people trained to operate and maintain FCVs and 44 people who were trained to able to operate and maintain HRSs in Beijing. The demonstration operation also trained high-end talents in the field of fuel cells. Details can be found in Paras I-12 to I-13.

119. *Shanghai*: An estimated 3,000 people were trained to operate and maintain FCVs and about 45 people able to operate and maintain HRSs in Shanghai. Training and education have been carried out for practitioners, including a total of 6 professional training activities for FCV practitioners of fuel cell passenger cars and commuter vehicles, and the "FCV Practitioner Training Manual" formulated to cover standards such as work procedures, operation manuals, and precautions for drivers and maintenance personnel. Training activities related to FCVs are found in Para J-22.

120. On the financial sector side, several seminars were conducted in Shanghai such as the "Thirteenth Five-Year" Development Plan for National Strategic Emerging Industry that includes the FCV industry and clarifies enhancing financial and taxation support and innovating fiscal and taxation policies. A complete listing of seminars and events is listed on Para J-23.

121. *Zhengzhou*: There were 40 people trained to operate and maintain fuel cell electric vehicles in Zhengzhou and 17 staff trained to operate and maintain hydrogen fueling stations, thus ensuring the orderly development of demonstration operation of hydrogen fueling stations and fuel cell electric vehicles. Details are contained in Paras K-14 to K-16.

122. *Yancheng*: Over 200 people were trained on Yancheng for fuel cell buses and hydrogen refueling stations hydrogen fueling infrastructure enterprises. This included Yancheng key component enterprises and OEMs who have formulated relevant training contents for the maintenance of FCV and hydrogen refueling stations. Details of the training can be found on Paras L-13 to L-14.

123. *Foshan*: Nanhai District People's Government has conducted training for nearly for 1,000 skilled personnel and training of nearly 50 personnel in hydrogen refueling station. It has promoted Guangdong Polytechnic of Environmental Protection Engineering, Foshan Technician College, Guangdong Polytechnic Institute and other vocational colleges to set up fuel cell vehicle-related training courses. Meanwhile, the UNDP Hydrogen Economy Institute has been setup to cooperate and promote the construction of Hydrogen Economy Vocational College to build a platform for personnel and skills training in the hydrogen energy industry. Further details are contained in Paras M-13 to M-15.

124. *__Zhangjiakou__*: Zhangjiakou carried out training for 3,874 persons with 98 training activities online and offline. Training course materials were formulated, covering the technologies, management and production related to FCVs and hydrogen productions hydrogen and electricity safety, assembly process, maintenance process, and fault diagnosis treatment. In the meantime, UNDP has provided services for the Project team concerning the FCVs and HRSs. International experts offered potential solutions for the Project teams such as international solutions for bipolar plates, and potential international suppliers for bipolar plates and air compressors. Details of training are contained in Paras N-12 to N-16.

125. *__Project-related activities__*. Media campaigns in 2019 were abundant where UNDP and the PMO were occupied campaigning for activities in all demonstration cities including:

- launch ceremonies of the FCVs;
- interviews with various media agencies;
- media tour organized in early November 2018, which covered 4 cities including Beijing, Shanghai, Foshan, and Zhangjiakou;
- media interviews with Project partners and staff.

126. CATARC designed and launched the Project website, which has been updated periodically. CATARC has also released 36 editions of newsletters on fuel cell from January 2017 to December 2019. UNDP has also developed a brief on hydrogen and fuel cell economy which had been shared on the UNDP website.

127. This facilitated the addition of the 13 demonstration cities. Rugao and Xinbin also purchased FCVs for public operation. Wuhan, Chengdu and Datong have officially started using hydrogen fuel cell buses in the public transportation system. A part of the awareness raising campaign were brochures on the characteristics and benefits of FCVs prepared, produced, and disseminated to the general public and professionals in the industry. Video clips were also produced in English and Chinese.

128. In conclusion, the results of Outcome 4 can be rated **satisfactory** with the Project removing all barriers to widespread awareness raising, and achieving all intended targets, notably the 19 local governments that have adopted FCVs in their public transit systems, over and above the original 6 demonstration cities. This is a strong indicator of the success of the awareness raising efforts by the Project. There has been delivery of outputs as a follow-up to ‘‘Outcome 4: Enhanced acceptance of FCVs for both public and private uses via increased knowledge and awareness”:

- Output 4.1: Completed FCV public advocacy program in at least four cities to alleviate public's safety concerns regarding hydrogen and encourage consumers to purchase FCVs;
- Output 4.2: Completed knowledge and awareness program for policy makers (national and local), managers, and experts, and associated plans adopted for replicating FCV demos in additional cities and scaling-up existing demos;
- Output 4.3: Established China FCV Market and Technology Monitoring System that provides up-to-date information on FCV manufacturing and market in China, FCV technological developments and applications, and assessment of FCV technologies that are applicable and economically viable in China.

3.3.6 Component 5: FCV Technology Capacity Development Program

129. To achieve Component 5's outcomes, focus was placed on building human capacity in the areas of operation and maintenance of FCVs and HRSs and of financing of the FCV sector. Assistance provided by the Project included provision of a "station and vehicle integrated platform", and financial investment projects leading to the desired outcomes:

- Outcome 5A: Increased technical capacity for operations and maintenance of FCVs and HRS;
- 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.

130. ***Beijing***: Beijing Institute of Technology New Energy Information Co., Ltd built a national demonstration operation platform for FCVs. The platform provides comprehensive business data services based on FCV supervision and can provide proprietary business data intelligent transmission channels and data value-added services for different application systems. There are future of capacity building programs in Beijing, details contained in Paras I-14 to I-17.

131. ***Shanghai***: Shanghai has established a public data platform for HRSs and FCVs in Shanghai, namely the "station and vehicle integrated platform". HRS companies and vehicle manufacturers upload the status of HRS equipment and the operating status of FCVs respectively, to perform remote real-time monitoring and safety warnings on temperature, braking, fuel cell systems. Relevant companies are required to deal with risks within the certain time limit. The entire platform has uploading function of corporate and model information, monitoring function of vehicle dynamic data, and visual display function of vehicle data. With the loading of vehicle information, and access to real-time vehicle data, visualization of the vehicle's operation data can be realized. Details of this platform can be viewed on Paras J-24 to J-34.

132. Shanghai has also established the "Shanghai AI NEV Innovative Platform Co., Ltd.", established in 2020 with an investment of over RMB 600 million to promote the research & development, transform common vehicles into new energy technologies, and create a new level for the development for smart vehicle technologies. Details can be viewed in Paras J-35 to J-36.

133. ***Zhengzhou***: Yutong Bus Company has set up a "New Energy Monitoring System" platform for Zhengzhou through the implementation of the Project consisting of vehicle monitoring, query for various fault details reported by vehicles, and query the energy consumption and mileage statistics of vehicles. In terms of investment into research and development of FCVs, Yutong Bus has taken the lead in the domestic bus industry in Zhengzhou, providing a solid foundation for the research and development of fuel cell bus technology and personnel training. At present, Yutong has invested RMB 250 million in more than 200 sets of test equipment with Yutong continuing investments in the future. Details of this are found in Paras K-17 to K-19.

134. ***Yancheng***: Ten fuel cell buses in Yancheng have been connected to the national FCV demonstration operation platform to track demonstration operation mileage, operation duration, operation track, fault alarms. This platform provided strong data and technical support in improving the durability and performance and reducing cost of FCV, thus laying a solid technical foundation and data support for the large-scale promotion of FCV and the promotion of the commercialized development of FCV in China. Details can be found on Paras L-15 to L-17.

135. *Foshan*: The first joint commercial platform for FCVs and hydrogen energy stations is the one in Nanhai District. Through the data supervision, analysis and assessment of the operation process of core components, the Nanhai Demonstration Project, the common technical problems of FCVs and HRS enterprises can be resolved, thereby promoting the continuous improvement of FCVs and HRSs in Nanhai District. In addition, there are investment plans for an industrialization base for fuel cell membrane electrodes and PEM electrolysis of water and 15 production lines and air-cooled fuel cell. Further detailed are contained in Paras M-16 to M-20.

136. *Zhangjiakou*: The Zhangjiakou FCV monitoring platform has been installed for data collection and analysis for the entire Zhangjiakou industrial chain of FCVs and HRSs to meet real-time demands of governments and industrial participants for FCV and HRS data. Furthermore, there are initiatives with respect to the future of FCVs and HRSs in Zhangjiakou. Details are contained in Paras N-17 to N-18.

137. *Project-related activities*. A sub-contract, "Service Institution to Develop China's FCV Operation, Technology and Market Monitoring System" was completed in 2020 on development of an O&M online database and monitoring system for China's FCV manufacturing and market. This subcontract also includes the research on a FCV Market and Technology Monitoring System. These monitoring systems found that SAIC has manufactured 20 FC passenger vehicles which are sold to Anting Shanghai International automobile city. This private company is operating these passenger vehicles and renting them to other companies or individuals. There are no private individual buyers of FCV as private individually owned FCV vehicles presently cannot be registered in China.

138. Of the US$2.2 billion investment in the FCV and HRS value chain, there were 210 investments, acquisitions, and projects in 2019, related to the FCV and HRS value chain. US$170.59 million of investments (US$120.37 million for FCBs, FC cars and FCVs; US$50.22 million for HRS) has been made directly under Project co-financing. Additionally, there are 33 publicly registered companies in China for investments including SAIC Motor Corporation Limited, a producer of FCVs and SinoHytec, a producer of FC power system and hydrogen stations in Beijing. There are 41 automakers that had set up FCV assembly lines in China. While the exact cumulative investment by their shareholders is unknown, over US$200 million of investment has been channeled to FC stack and FCV manufacturing in China as a whole.

139. In conclusion, the results of Outcome 5 can be rated **satisfactory** with the Project achieving its intended targets, namely increasing technical capacity for O&M platforms for FCVs and HRSs, and to the financial sector for investing in the FCV and HRS value chains that support consumer and commercial purchases of FCV and HRS-related products. There has been delivery of outputs as a follow-up to Outcome 5A: Increased technical capacity for operations and maintenance of FCVs and HRS:

- Output 5A.1: Qualified contingent of persons to operate and maintain FCVs and HRS in each of the four demo cities and in other cities where replication is ongoing and where. MOST will be the government entity qualifying the trained personnel.

There has also been delivery of outputs as a follow-up to "Outcome 5B: Increased interest and technical capacity of financial sector in investing in FCV manufacturing and value chain, investing in hydrogen stations and value chain, and supporting consumer/commercial purchase of FCVs":

- Output 5B.1: FCV manufacturing, FCV component manufacturing, HRS, and hydrogen refueling associated value chain projects that are or will be financed by financial institutions and financial sector companies;
- Output 5B.2: Established and operational FCV purchase financing scheme in selected banks/FIs, to enable expanded purchase of FCVs by consumers and other entities.

3.3.7 Relevance

140. The FCV Project is **relevant** to the development priorities of pollution and emissions control in China, coupled very well with the national and local government priorities. In the State Council's Report on the Work of Government 2019, emphasis was given to maintain stable automobile manufacture by continuing preferential policies on the purchase of new-energy vehicles and to facilitate the building of EV charging and hydrogen refueling facilities. The Project was designed and implemented with a strong focus on scaling up hydrogen refueling infrastructures, the governance of planning, designing, approving, constructing, testing, and launching such infrastructure, as well as the capacity building for operations and maintenance.

141. Notwithstanding the industrial development it catalyzed, and the know-how built in the Project demo cities when the subsidies were suspended for BEV purchase, the GoC continued to provide financial support subsidies for the upscaling and operations of EV charging and hydrogen refueling infrastructure. In 2020, the GoC drew from its rich experience and lessons learnt from subsidizing bus EVs, and subsidizing BEVs, adjusted the previous subsidy for the purchase of FCVs for selected demo cities or regions. Many local governments also "match" the national subsidies to different degrees. Such subsidies are available for several regions such as Guangdong, Wuhan, Hainan, Shandong, Tianjin, Henan, Foshan, and Dalian.

142. The building on the lessons learnt from the Project and the Project team's policy lobbying at various conferences, different policy advisory channels and informal dialogues on the need of categorizing hydrogen as energy and a renewable energy production, the National Bureau of Statistics required that hydrogen, together with coal, natural gas, crude oil, electricity and biofuels, be included in the energy statistics for 2020. Additionally, the "National Energy Administration Announcement No.3" of 2019 invited research focused on "Coordinated Development Path of Hydrogen and Renewable Energy, Development Strategy of Hydrogen Energy Industry, and Medium and Long-term Development Trends of New-Energy Vehicle Charging and Hydrogen Refuelling Infrastructure". These were built on lessons learnt from the Project, the Project team's policy lobbying at various conferences, different policy advisory channels, and informal dialogue on the need to categorize hydrogen as energy and a renewable energy resource.

143. Thus, it can be concluded that the DevCom FCV Project is strongly **relevant** to the development priorities in China.

3.3.8 Effectiveness

144. The effectiveness of the FCV Project has been **satisfactory** in consideration of:

- the substantial progress made in removing FCV technology barriers (such as FCV cost, durability, and performance) and barriers to the technical capacity of China's FCV manufacturers. This has led to the cumulative sale of 7,505 FCVs in China as of 2021, 1st Q[24];
- the high rate of investment and adoption of hydrogen production facilities and HRSs that has brought down the cost of hydrogen to around RMB 35/kg;
- the high rate of satisfaction amongst participants at seminars and workshops on the usefulness of these seminars towards understanding fuel cell vehicle, fuel cell supply chain, hydrogen infrastructure and international best practices of policy innovations;
- the high rate of satisfaction amongst Project partners on the support provided by UNDP, MOST and the PMO (CATARC) on policy innovations, expertise and know how support and management efficiency;
- the adoption by all demo cities of a demonstration operation platform to enable HRS companies and vehicle manufacturers upload the status of HRS equipment and the operating status of FCVs respectively, to perform remote real-time monitoring and safety warnings on temperature, braking, fuel cell systems;
- the high relevance of policy implications formulated by the Project which enacted policy and financial incentives flourishing across different cities and regions in China.

3.3.9 Efficiency

145. The efficiency of the FCV Project has been rated as **satisfactory** in consideration of:

- the financial, human and time resources spent in the high volume of FCV deployment (which was 2888% more than the EOP target) in the demo cities and the high number of hydrogen infrastructure established in the demo cities and across China;
- the Project playing important roles as the host, supporting agencies or cooperation partners at nationally and internationally important conferences, emphasizing the high exposure on communications and advocacy;
- the Project being implemented within 5 years instead of the design of 4 years;
- the unit abatement cost of US$35.76/tonnes CO_{2eq} reduced (based on 230,261 tonnes CO_{2eq} reduced at US$ 8,233,560).

3.3.10 Overall Project Outcome

146. The Evaluators confirm the existence of evidence that the Project has achieved its outcomes. Specific achievements have been verified from reports provided by the demonstration cities and the discussions during the TE mission in Beijing, Shanghai, Zhengzhou, Yancheng, Foshan and Zhangjiakou China by May 2021.

147. By carrying out FCV demonstration operations, the Project has broken through the key technical bottlenecks of FCV commercialization and put forward national and local fuel cell industry development paths and policy recommendations. In addition, several key FCV and hydrogen energy infrastructure-related enterprises emerged. Among them, 16 FCV enterprises, and over 150 hydrogen and fuel cell key enterprises have formed a complete hydrogen FCV industrial value chain.

[24] All information sourced from CATARC intelligence.

148. Moreover, the Project has promoted a significant increase in FCV deployment, creating more than 12,000 jobs in 6 demonstration cities of which 33.13% are women. The Project also catalyzed a total of USD 2.20 billion (RMB 14.13 billion) of investment attracted to the fuel cell and hydrogen infrastructure-related industries. Beyond the 7 demonstration cities, the Project had a great catalytic effect across China: it influenced 18 local governments and 36 cities to develop or adopt policies for supporting the FCV industry and conducting demonstrations of FCVs for public transport. As of 31 March 2021, there have been 7,843 FCVs produced in China. Table 7 is a summary of the completion status of all Project outcomes.

Table 7: Completion status of all DevCom FCV Project outcomes

Components	Expected Outcomes	Completion Status
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;	The lifetime of the fuel cell stack system is increased from 2,000 hours to 12,999 hours, and the cost is reduced by more than 50%, achieving markedly reduced costs and improved performance and durability of FCVs in China.
	Outcome 1B: FCVs deployed in continuous operation by cities, organizations, and individuals in China;	FCVs are used on a large scale in 37 cities in China, with users including bus and private enterprises.
2. Improvement of Hydrogen Production and Refueling System	Outcome 2A: Reduced cost and improved viability of hydrogen production and HRSs;	The minimum price of hydrogen is reduced from more than RMB 70/kg to less than RMB 35/kg; the number of domestic hydrogen-related enterprises has increased significantly, basically formed a hydrogen energy infrastructure supply chain.
	Outcome 2B: Increased number of transport hydrogen producers and of HRSs on the ground in China, including some (both producers and stations) using autonomous renewable energy to produce hydrogen	Currently, the number of HRSs in the demonstration cities has increased from 2 to 31, with a total of 133 HRSs nationwide (up to April 2021).
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	The Project has led to the establishment of several technology and experience exchange platforms, raised public awareness and acceptance of FCVs, and increased the financial industry's attention to the FCV/hydrogen fuel cell industry with investment amounts increasing year by year.
5. FCV Technology Capacity Development Program	Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	By April 2021, the number of FCV and HRS operation staff in the demonstration cities will reach over 4,700 and 200 respectively, effectively guaranteeing the smooth operation of demonstration FCVs.

Components	Expected Outcomes	Completion Status
	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	During the Project period, the 6 demonstration cities invested a total of US$ 2.2 billion (or RMB 14.13 billion) in fuel cell and hydrogen infrastructure-related industries.

3.3.11 Sustainability of Project Outcomes

149. In assessing sustainability of the FCV Project, the evaluators asked "how likely will the Project outcomes be sustained beyond Project termination?" Sustainability of these objectives was evaluated in the dimensions of financial resources, socio-political risks, institutional framework and governance, and environmental factors, using a simple ranking scheme:

- *4 = Likely (L):* negligible risks to sustainability;
- *3 = Moderately Likely (ML):* moderate risks to sustainability;
- *2 = Moderately Unlikely (MU):* significant risks to sustainability; and
- *1 = Unlikely (U):* severe risks to sustainability; and
- *U/A = unable to assess*.

Overall rating is equivalent to the lowest sustainability ranking score of the 4 dimensions. This is summarized on Table 8.

150. *The overall FCV Project sustainability rating is likely (L)*. This is primarily due to the Project's GHG emissions from hydrogen generation. While there is an overall reduction of GHG emissions from FCVs, renewable energy sources from hydrogen generation are needed to enhance GHG emission reductions from FCVs. Otherwise, the following aspects of the Project also contribute to the sustainability:

- *Having fiscal resources to demonstrate FCV and HRS technologies that will support the adoption of FCV technologies to reduce costs and improve durability and performance*. This also facilitates learning and sharing across local governments and the FCV industry in China to implement best practices and promote investments in the FCV and HRS industry;
- *MOST being interested in replicating and scaling-up the outcomes of the Project, as it supports the FCV industry and contributes to national development objectives*;
- *Building local capacities through training representatives from the FCV industry, local governments and other key stakeholders*. This assists in strengthening the understanding and adoption of FCVs and HRSs and building domestic manpower for efficient operations and maintenance of FCVs and HRSs. This local training combined with international FCV and hydrogen economy conferences and symposiums in China, helps sustain the exchange of ideas, solutions, and best practices on FCVs and HRSs;

Table 8: Assessment of Sustainability of Outcomes

Actual Outcomes (as of 30 April 2021)	Assessment of Sustainability	Dimensions of Sustainability
Actual Outcomes 1A and 1B: Project has enhanced the number of operating hours of FCV vehicles through completing Project activities for providing technical assistance to FCV companies, as well as enhancing the demonstrations of FCVs. In addition, Project has met it targets for annual number of FC buses and FC delivery vehicles sold and annual growth in FCV sales but did not meet the target for the annual growth rate of FCV sales due to current regulations.	• *Financial Resources:* Financing available for activities; • *Socio-Political Risks:* No risk to the users of FCVs; • *Institutional Framework and Governance*: There are no issues with respect to the use of the FCVs even though there is no private ownership of FCVs allowed in China. There is a company that rents FCVs to private citizens; • *Environmental Factors:* There are GHG emissions from hydrogen generation. While there is an overall reduction of GHG emissions from FCVs, renewable energy sources from hydrogen generation are needed to enhance GHG emission reductions from FCVs this outcome. ***Overall Rating***	4 4 4 3 **3**
Actual Outcomes 2A and 2B: Project has achieved the EOP target for the number of distinct business models used at HRS of 6, the target for the quantity of annual hydrogen production of 1,200 MT of hydrogen, and the establishment of 171 new HRS in demonstration cities.	• *Financial Resources:* There are no issues with financing of HRS ; • *Socio-Political Risks:* There are no socio-political risks to HRS deployment; • *Institutional Framework and Governance:* Governments, local and national, are encouraging their construction; • *Environmental Factors:* There are GHG emissions from hydrogen generation. While there is an overall reduction of GHG emissions from hydrogen generation, hydrogen generation using renewable energy sources is needed to enhance GHG emission reductions from hydrogen generation and FCVs ***Overall Rating***	4 4 4 3 **3**
Actual Outcomes 3A and 3B: The Project has done well in influencing the development of the FCV industry, through the support of partner cities and companies, and in influencing cities to implement policies for promoting FCVs and HRS. The Project has achieved the EOP targets for this component: (a) number of FCV manufacturing companies complying to new FCV product standards, and (b) number of cities implementing policies to support FCV and HRS	• *Financial Resources:* Financing is not an issue; • *Socio-Political Risks:* No risks with the beneficiaries of the policies; • *Institutional Framework and Governance:* No risks as the policies encourage promotion of FCVs and HRSs; • *Environmental Factors:* No environmental risks. ***Overall Rating***	4 4 4 **4** **4**
Actual Outcome 4: The Project has achieved the EOP targets of number of local governments that are aware and have adopted FCVs in their public transport systems. There are 45 local	• *Financial Resources*: No financial risks; • *Socio-Political Risks*: No socio-political risks due to positive messaging being conducted by governments;	4 4

Table 8: Assessment of Sustainability of Outcomes

Actual Outcomes (as of 30 April 2021)	Assessment of Sustainability	Dimensions of Sustainability
governments committed to adopting FCVs, and the Project has influenced a private company to operate 2,933 FCVs and renting them to other companies or individuals	• *Institutional Framework and Governance:* No risks from institutional framework and governance; • *Environmental Factors:* No environmental risks. ***Overall Rating***	4 4 **4**
Actual Outcome 5A and 5B: The Project has achieved its EOP targets for the (a) number of individuals capable of satisfactorily operating and maintaining FCVs (4,758); and (b) number of individuals capable of satisfactorily operating and maintaining HRS (216). The Project has met its EOP target for the cumulative investment by the financial sector in FCV and FCV value chain manufacturing and in hydrogen stations and their value chain of over US$200 million. The Project has also delivered well on capacity development.	• *Financial Resources*: No financial risks; • *Socio-Political Risks*: More than 4,000 people trained. No socio-political risks; • *Institutional Framework and Governance:* No resistance from government in attempting build capacity for operation and maintenance personnel for FCV and HRS, and for the financial sector; • *Environmental Factors:* No environmental risks. ***Overall Rating***	4 4 4 4 **4**
	Overall Rating of Project Sustainability:	**3**

- *Commitment of the participating cities to demonstrate and promote the application of FCVs and the commercial operation of HRS*. The cities have implemented policies for supporting FCVs and HRS, and made financial commitments for the procurement of FCVs, establishment of HRS, and supporting their local industry for producing, improving, and applying FCV and HRS solutions;
- *Support from local and national governments to develop policies, standards, regulations, and incentives for FCVs and HRS*. This could then be developed into a national roadmap and appropriate recommendations for policies and regulations, approval processes, and incentives to support the production and application of FCVs and HRS.

3.3.12 Country Ownership

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

3.3.13 Gender equality and women's empowerment

152. The gender impacts of the FCV Project are related to:

- contributing to closing gender gaps in access to and control over resources;
- Project management in the PMOs being gender-inclusive. Many of the consultants and technicians are women. Although not specifically targeting women or girls as key stakeholders or direct beneficiaries, the Project creates many employment opportunities including the positions of bus attendants, whose are predominantly women. Capacity building is provided to enhance their competency for the job and empower them through increased financial and social status;
- endeavors on building a more gender-inclusive FCV manufacturing, operations, and maintenance system. The Project is impacting a wider beneficiary group, increasing citizen's environmental awareness and more active participation in building a greener future.

3.3.14 Cross cutting issues

153. One of the most important cross cutting issue would be the future of work and talent development for a just transition to a low carbon future. Before the Project's intervention, there were relatively few persons with the training, skills, or background to be able to properly identify, evaluate, trade off, and deal with the myriad of technical and economic parameters characteristic of complex energy technologies. A core of specially selected people supported and nurtured under this Project has been essential.

3.3.15 GEF additionality

154. The issue of GEF additionality is quite clear on the DevCom FCV Project. With GEF funds, there was:

- additional activity regarding FCV technological improvement that effectively removed technical barriers to improving FCV performance;
- additional activity regarding hydrogen production and hydrogen re-fueling stations that effectively removed technical barriers to lowering the cost of hydrogen fuels;

- quicker policies and awareness information dissemination that effectively removed awareness barriers;
- capacity building amongst all stakeholders concerned with FCVs, hydrogen re-fueling stations, O&M and financial sector's ability to assess investments and loans in FCV-related areas, effectively removing barriers related to the capacities of O&M personnel and the financial sector in terms of providing financing for FCV and HRS value chains.

3.3.16 Catalytic/Replication Effect

155. The catalytic and replication effect has been significant, most of it attributable to the DevCom Project. Not only has there been growth in 4 industrial clusters (Beijing-Tianjin-Hebei, Yantze River Delta, Pearl River Delta and Central China) in China (3 of which are driven by the Project's 6 demonstration cities), it has also catalyzed a total of US$ 2.20 billion (RMB 14.13 billion) of investment to the fuel cell and hydrogen infrastructure-related industries. The Project also influenced local governments of 18 provinces and 36 cities to develop or adopt policies for supporting the FCV industry and conducting demonstrations of FCVs for public transport. As of 31 March 2021, there have been 7,843 FCVs produced in China.

3.3.17 Progress to impact

156. The progress to impacts of the FCV Project are related to:

- the Project having exceeded its targets for annual number of FC buses and FC delivery vehicles sold and annual growth in FCV sales, thereby mainstreaming FCVs as a transport mode. Though it is difficult to project growth of FCVs due to the procurement process by different cities, SAE a projects that the number of FCVs in China will reach 1 million by 2030;
- the establishment of more than 171 new HRSs in demonstration cities and other cities, due to the DevCom Project demonstrations and popularizing hydrogen as a fuel. Plans are being made by Sinopec to procure 1,000 HRSs by 2025 and the China Hydrogen Alliance has already proposed 100 GW renewable hydrogen production capacity by 2030;
- the growing number of FCV manufacturing companies complying to new FCV product standards, and the growing number of cities implementing policies to support FCVs and HRSs;
- a growing number of local governments that are aware and have adopted FCVs in their public transport systems. The Project has also influenced a private company to operate 2,933 FCVs renting them to other companies or individuals; and
- a growing number of individuals capable of satisfactorily operating and maintaining 4,758 FCVs, satisfactorily operating and maintaining 171 HRSs, and for assessing and facilitating investment by the financial sector in FCV and FCV value chains of over US$2.2 billion.

4. CONCLUSIONS, RECOMMENDATIONS AND LESSONS

4.1 Main Findings

157. The Project has achieved its EOP targets due to the catalytic effect of the DevCom FCV Project demonstrations. This includes:

- improvement in performance and durability of FCVs in China from 2,000 hrs to 13,000 hrs, reduction in costs by more than 50%, achieving markedly reduced costs and improved performance and durability of FCVs in China (Outcome 1A);
- an estimated 7,843 FCVs produced in China as of 31 March 2021. FCVs are used on a large scale in 37 cities in China, with users including bus and private enterprises (Outcome 1B);
- reduction in cost of hydrogen is reduced from more than 70 yuan/kg to less than 35 yuan/kg improving the viability of hydrogen production and increasing the number of domestic hydrogen-related enterprises (Outcome 2A);
- increased number of HRSs has increased to a total of 171 HRSs nationwide, including a small number of renewable energy-based HRSs in the demonstration cities (Outcome 2B);
- implementation of policies and regulatory frameworks supporting the application and commercialization of FCVs in cities (Outcome 3A);
- local and national adoption of policies for promoting procurement of FCVs and investment in HRSs (Outcome 3B);
- enhanced acceptance of FCVs for public and private use through increased awareness (Outcome 4);
- number of FCV and HRS operation staff in the demonstration cities is over 4,700 and 200 respectively facilitating smooth operation of demonstration FCVs and HRSs (Outcome 5A);
- the 6 demonstration cities have invested a total of US$ 2.2 billion (RMB 14.13 billion) in fuel cell and hydrogen infrastructure-related industries (Outcome 5B).

158. In summary, the Project has also showed great progress to the impact of reduced GHG emissions from the transport sector by 230,261 tonnes CO_{2eq}. It has also been quite effective in substantially demonstrating improved reliability and performance of FCVs and fuel cells in demonstration cities, has promoted policy breakthroughs in the demonstration cities spreading throughout the country, and has achieved remarkable results in information dissemination and sharing.

4.2 Conclusions

159. The Project has had successes in the demonstration cities of Beijing, Shanghai, Zhengzhou, Yancheng, Foshan and Zhangjiakou. The progress of hydrogen and fuel cell industrial development has been significant in the 6 demonstration cities. The Project has been a key factor in breaking through commercial applications of FCVs by carrying out commercial FCV operations in multiple cities, using multiple models and applying FCV operations in multiple climate environments and various commercial operation modes. This includes 16 FCV enterprises, and over 150 hydrogen and fuel cell enterprises and 67 hydrogen infrastructure enterprises, forming a relatively complete hydrogen FCV industry chain, employing over 12,000 people in 6 demonstration cities, one third of them women.

160. The Project has had a clear impact on reducing GHG emissions from transport sector in China. With GoC aggressively promoting FCVs and HRSs on this Project, China has developed a new mode of clean

transport complete with a high value-added industry that promotes and manufactures FC buses, delivery vehicles and private vehicles. Moreover, FCVs have demonstrated significant advantages over battery operated EV's during implementation of the demonstrations in the 6 cities including shorter charging times. This type of information leverages China's comparative advantages with international advances in fuel-cell technology to drive the FCV and hydrogen industry further towards commercialization in China and abroad. This accounts for China having the largest bus market and bus production capacity in the world. In addition, China is known for its manufacturing prowess and ability to reduce production costs that will be of benefit to the FCVs manufactured in China.

161. Finally, the DevCom FCV Project has managed to scale-up demonstration FCVs and HRSs in 6 cities to the extent that the durability of the FCVs has become much stronger and demonstration periods are much longer and continuous. The Project has had a clear focus on implementing activities to build industry capacities and public awareness, and on establishing supportive policy and regulatory environments for the development and commercialization of FCVs and HRS. The Project has also achieved significant cost reductions and performance and reliability improvements for FCVs in China and increased the number of vehicle hydrogen production and HRS is in China with reduced costs. In short, the Project has created a business environment where the number of FCVs is growing to the extent that FCVs are being mainstreamed.

162. While the Project has achieved remarkable results, stakeholders still need to continue promoting FCVs and HRSs in other cities to further scale-up FCV usage in China. Fuel cell buses seem to be a logical choice for FCVs moving forward given the exposure FC buses would have on the general public. In addition, there is a need to source renewable energy for hydrogen production capabilities to truly reduce GHG emissions from the transport sector.

4.3 Recommendations

163. ***Recommendation 1 (to UNDP and MOST): The GEF should continue to support decarbonization of transport through FCVs in China.*** This recommendation is made in consideration of the interest expressed by the demo cities during the TE mission, the need to mainstream FCVs in most Chinese cities, and the critical role that hydrogen and fuel cells potentially play in mitigating the adverse impact of climate change. While GoC is likely able to promote FCVs in public transport and HRS construction in some of their plans, some of the aspects for GEF support includes:

- the application of fuel cells on urban service vehicles, industrial vehicles such as fork lifts, heavy duty trucks, waterway vessels, and trams. Involvement of private sector companies would be necessary;
- the promotion of FCVs in other cities in China. There are over 100 cities in China with over 1 million people, and over 360 cities with a population between 100,000 and 1.0 million. Mainstreaming FCVs will take an extraordinary effort; and
- the promotion of innovative solutions for hydrogen transportation and storage such as ammonia and methanol piped gaseous hydrogen transportation, blending hydrogen into natural gas networks, transport-curtailed electricity through the grid and produce hydrogen locally, and renewable energy production (see Action 2).

164. *Recommendation 2 (to MOST, UNDP and GEF): Support the demonstration and promotion of renewable energy hydrogen production through a GEF-supported project that provides more focus on the energy -related aspects of hydrogen production*. Through further decarbonizing the transport sector with the application of fuel cells on urban service vehicles, the project would support renewable-based hydrogen production as an integration into the grid, large-scale integration, and carbon pricing mechanism. Through continued support to the demonstration and promotion of FCVs in more models, fields, and scenarios, the project could fully exploit the potential of fuel cells in commercial vehicles, and support China to further explore the feasibility of developing hydrogen fuel cell passenger cars in UMIC countries and compare them with electric passenger car applications, providing lessons for other countries, such as Malaysia and Chile, to develop zero- and low-carbon transportation energy sector project that would support the transport sector and beyond. Through support for deeper exploration of the potential of renewable energy sector, the project would support the transport sector by:

- piloting different types of renewable based hydrogen production from biomass, wind and solar;
- decarbonizing the power system through coupling renewable energy to gas technologies, hydrogen storage and transport solutions such as pipelines and ammonia;
- shaping private sector investments towards cost reductions on renewable energy projects;
- integrating renewable energy into the grid;
- demonstrating a carbon pricing mechanism in demonstration cities; and
- developing and scaling-up of a set of replicable solutions for training first line technicians and workers in the hydrogen industry, from hydrogen production to end-user operations and maintenance support.

This type of project would s*upport* China's drive to further explore the feasibility of renewable energy for hydrogen fuel production for FCVs and further reduce the GHG emissions of the transport sector.

165. *Recommendation 3 (to UNDP and MOST): Strengthen the system of cultivating technical talent for fuel cell and hydrogen energy value chains*. Further strengthening of the talent pool will involve the vocational colleges that setup a unit to focus on hydrogen and FCVs in cooperation with a host city. For example, the Greater Bay Area Hydrogen Economy Vocational College cooperates with Foshan City on multiple levels for the domestic and international community, promoting the transformation of scientific research results related to hydrogen energy and FCVs, and meeting the demands of the FCV and HRS industry.

166. *Recommendation 4 (to MOST): Strengthen policy support and sustainability for hydrogen and FCVs*. This can be achieved by:

- building on the 2022 Winter Olympics for Beijing and Zhangjiakou, to cultivate more internationally renowned enterprises spearheading the FCV industry, to formulate an industrial cluster of key components and equipment manufacturers, to strengthen the exploration of business models and application scenarios for sustainable development, and to disseminate these experiences internationally, especially to developing countries;
- further exploring policies, regulations and business models for FCVs in the private sector, first locally and then nationally;
- supporting the FCV industry by means of enhancing macro policy incentives and relevant approval mechanisms;

- drawing from the experience of Shanghai and Foshan in changing the land category for new HRSs and coordinating and promoting the commercial operations of HRSs; and
- strengthening the government's organization and guidance functions and the optimal allocation of resources to promote the sustainable development of the renewable energy hydrogen production industry.

4.4 Lessons Learned

167. *Best practice 1:* ***Hydrogen Refueling Station Development of Foshan City***. In response to the mentioned challenges, the People's Government of Foshan and Nanhai District made substantial efforts in accelerating the deployment of hydrogen refueling stations by being a forerunner of HRS construction guidelines and relevant policies.

168. Since 2016, Foshan City took the lead in exploring the approval, construction, examination process. This was China's first comprehensive effort to formulate guidance for HRS construction and evaluation: a research project was carried out by Guangdong Foshan Yunfu Industrial Transfer Park and Tongji University to improve the evaluation system for design, construction, O&M of hydrogen refueling stations. The output of the research project was later compiled into a draft guideline for approval procedures at city level, disseminated by Foshan Bureau of Housing and Urban-Rural Development (the responsible department of HRS issues), to develop and implement a clear regulatory framework for approval, evaluation, and inspection.

169. The approval procedures for HRS were thus significantly fast-tracked. Procedures were processed in parallel with different departments. Local government stakeholders were involved to strengthen the safety monitoring of local hydrogen industry. Administrative approvals such as fire inspection, dispensing and operation permits were received from responsible departments such as the Bureau of Housing and Urban-Rural Development and the Bureau of Market Regulation.

170. Additionally, there was policy progress on HRS from 2018 in Nanhai District, covering subsidies for FCV, infrastructure, and hydrogen production. Two working groups were also established, a special task force of district government officials from 8 bureaus in charge of overall planning, coordination and provision of guidance on HRS construction; and an Expert Group comprised of the industry's leading specialists to provide technical and facilitation assistance on infrastructure strategies. In April 2018, Nanhai released "Measures to Promote the Construction and Operation of HRS and FCV" as the first-of-its-kind policy across China. It provided subsidies not only for HRS construction but also for HRS operation, as well as operating units to address the "chicken-egg problem" and remove the high-cost barriers.

171. *Best practice 2:* ***Successful Outcomes at City and National Levels***. Given its scale and importance, the HRS deployment in Foshan served as a successful blueprint for China, as the Project sought to bring additional Chinese cities onboard. From 2017, around 150 site visits have been conducted to Nanhai District from national and international groups to promote experience sharing and capacity development on HRS O&M. Foshan has contributed to 4 out of 6 HRS business models to make the refueling stations economically viable. In 2017, Ruihui refueling station in Danzao Town was established as China's first commercialized HRS. Zhangkeng, China's first oil-hydrogen hybrid station which combines hydrogen-filling and retail sales of conventional fuels, was built in cooperation with Sinopec. The Development Plan of Hydrogen Energy Industry of Nanhai District, released in March

2020, further emphasizes piggybacking on its existing gas stations to expand the hydrogen refuel network. The first batch of 4 commercial standardization refueling stations also marked the significant progress on HRS development. In 2020, there were 16 HRSs in Foshan. The Development Plan of Foshan Hydrogen Industry (2018-2030) announced that 43 and 57 refueling stations will be built by 2025 and 2030, respectively.

APPENDIX A – MISSION TERMS OF REFERENCE FOR DEVCOM FCV PROJECT TERMINAL EVALUATION

UNDP-GEF Terminal Evaluation International Consultant

Location :	CHINA
Application Deadline :	04-Mar-21 **(Midnight New York, USA)**
Additional Category :	Climate & Disaster Resilience
Type of Contract :	Individual Contract
Post Level :	International Consultant
Languages Required :	English
Starting Date : (date when the selected candidate is expected to start)	08-Mar-2021
Duration of Initial Contract :	20 working days (home based 13-15 working days + evaluation mission 5-7 working days)
Expected Duration of Assignment :	16 weeks

UNDP is committed to achieving workforce diversity in terms of gender, nationality, and culture. Individuals from minority groups, indigenous groups and persons with disabilities are equally encouraged to apply. All applications will be treated with the strictest confidence.

UNDP does not tolerate sexual exploitation and abuse, any kind of harassment, including sexual harassment, and discrimination. All selected candidates will, therefore, undergo rigorous reference and background checks.

Background

1. **Introduction**

In accordance with the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF)'s Monitoring and Evaluation (M&E) policies and procedures, all full-sized UNDP- supported GEF-financed projects are required to undergo a Terminal Evaluation (TE) towards the end of the project. This Terms of Reference (ToR) sets out the expectations for the TE of the project titled Accelerating the Development and Commercialization of Fuel Cell Vehicles in China (PIMS #5349) implemented through the Ministry of Science and Technology of People's Republic of China/UNDP China Office. The project started on the Project Document signature date (15 August 2016) and is in its 5th year of implementation plus a 12-month extension till end August 2021. The TE process must follow the guidance outlined in the document **'Guidance For Conducting Terminal Evaluations of UNDP-Supported, GEF-Financed Projects'.**

2. **Project Description**

The Accelerating the Development and Commercialization of Fuel Cell Vehicles in China Project aims 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).

3. **TE Purpose**

The TE report will assess the achievement of project results, realization of the project outcomes, and achievement of the project objective against what was expected to be achieved and draw lessons that not only improve the sustainability of benefits from this project, and aid in the overall enhancement of UNDP programming. The TE report promotes accountability and transparency and assesses the extent of project accomplishments.

4 Duties and Responsibilities

TE Approach & Methodology

The TE must provide evidence-based information that is credible, reliable and useful such as tangible outputs that the project is designed to deliver, as well as documents (e.g., reports, databases, etc.) for verifying and confirming the achievement of end-of-project targets, and for confirming the actual amounts of project funding (GEF and non-GEF) that were spent. The TE task force is comprised of 1 international and 1 national consultant, with the international consultant taking the lead in organizing the evaluation and drafting the report. The national consultant is expected to fully support the international consultant for completing the evaluation.

The TE team will review all relevant sources of information including documents prepared during the preparation phase (i.e. PIF, UNDP Social and Environmental Screening Procedure/SESP) the Project Document, project reports including annual PIRs, Mid-Term Evaluation (MTR) report, Project Appraisal Committee meeting minutes, project budget revisions, relevant lessons learned/reports, national strategic and legal documents, and any other materials that the team considers useful for this evidence-based evaluation. The TE team will review the baseline and midterm GEF focal area Core Indicators/Tracking Tools submitted to the GEF at the CEO endorsement and midterm stages and the terminal Core Indicators/Tracking Tools that must be completed before the TE field mission begins.

The TE team is expected to follow a participatory and consultative approach ensuring close engagement with the Project Team, government counterparts, Implementing Partners, the UNDP Country Office(s), the Regional Technical Advisors, direct beneficiaries, and other stakeholders.

Engagement of stakeholders is vital to a successful TE. Stakeholder involvement should include interviews with stakeholders who have project responsibilities, including but not limited to executing agencies, senior officials and task team/component leaders, key experts and consultants in the subject area, Project Board, project beneficiaries, academia, local government and CSOs, etc. Additionally, the TE team is expected to conduct field missions to the project demo cities such as Beijing, Shanghai, Zhengzhou, etc. including the following project sites i.e. bus operations companies, hydrogen refueling stations, vehicle OEMs etc.

The specific design and methodology for the TE should emerge from consultations between the TE team and the above-mentioned parties regarding what is appropriate and feasible for meeting the TE purpose and objectives and answering the evaluation questions, given limitations of budget, time and data. The TE team must, however, use gender-responsive methodologies and tools and ensure that gender equality and women's empowerment, as well as other cross-cutting issues and SDGs are incorporated into the TE report.

The final methodological approach including interview schedule, field visits and data to be used in the evaluation should be clearly outlined in the inception report and be fully discussed and agreed between UNDP, stakeholders

and the TE team. The methodologies of calculation needed for reporting against project indicators, if not specified clearly in the ProDoc, shall be determined jointly the UNDP Office(s), the IP, and expert(s) in this field.
The final TE report should describe the full TE approach taken and the rationale for the approach making explicit the underlying assumptions, challenges, strengths and weaknesses about the methods and approach of the evaluation.

Detailed Scope of the TE
The TE will assess project performance against expectations set out in the project's Logical Framework/Results Framework (see TOR Annex A). The TE will assess results according to the criteria outlined in the **Guidance for TEs of UNDP-supported GEF-financed Projects.**
The Findings section of the TE report will cover the topics listed below. A full outline of the TE report's content is provided in ToR Annex C. The asterisk "(*)" indicates criteria for which a rating is required.
Findings

Project Design/Formulation

- National priorities and country driven-ness
- Theory of Change, if applicable
- Gender equality and women's empowerment
- Social and Environmental Safeguards
- Analysis of Results Framework: project logic and strategy, indicators
- Assumptions and Risks
- Lessons from other relevant projects (e.g. same focal area) incorporated into project design
- Planned stakeholder participation
- Linkages between project and other interventions within the sector
- Management arrangements

Project Implementation

- Adaptive management (changes to the project design and project outputs during implementation)
- Actual stakeholder participation and partnership arrangements
- Project Finance and Co-finance
- Monitoring & Evaluation: design at entry (*), implementation (*), and overall assessment of M&E (*)
- Implementing Agency (UNDP) (*) and Executing Agency (*), overall project
- oversight/implementation and execution (*)
- Risk Management, including Social and Environmental Standards

Project Results

- Assess the achievement of outcomes against indicators by reporting on the level of progress for each objective and outcome indicator at the time of the TE and noting final achievements
- Relevance (*), Effectiveness (*), Efficiency (*) and overall project outcome (*)
- Sustainability: financial (*), socio-political (*), institutional framework and governance (*),
- environmental (*), overall likelihood of sustainability (*)
- Country ownership
- Gender equality and women's empowerment
- Cross-cutting issues (poverty alleviation, improved governance, climate change mitigation and
- adaptation, disaster prevention and recovery, human rights, capacity development, South-South
- cooperation, knowledge management, volunteerism, etc., as relevant)
- GEF Additionality
- Catalytic Role / Replication Effect
- Progress to impact

Main Findings, Conclusions, Recommendations and Lessons Learned

- The TE team will include a summary of the main findings of the TE report. Findings should be presented as statements of fact that are based on analysis of the data at the end of the TE mission.
- The section on conclusions will be written in light of the findings. Conclusions should be comprehensive and balanced statements that are well substantiated by evidence and logically connected to the TE findings. They should highlight the strengths, weaknesses, and results of the project, respond to key evaluation questions and provide insights into the identification of and/or solutions to important problems or issues pertinent to project beneficiaries, UNDP and the GEF, including issues in relation to gender equality and women's empowerment.
- Recommendations should provide concrete, practical, feasible and targeted recommendations directed to the intended users of the evaluation about what actions to take and decisions to make. The recommendations should be specifically supported by the evidence and linked to the findings and conclusions around key questions addressed by the evaluation. A recommendation table should be put in the report's executive summary. While it is not obligatory to give recommendations to each project output, the TE consultant/team is encouraged to identify and assess recommendations to the Project Team but should make no more than 15 recommendations in total.
- The TE report should also include lessons that can be taken from the evaluation, including best and worst practices in addressing issues relating to relevance, performance and success that can provide knowledge gained from the particular circumstance (programmatic and evaluation methods used, partnerships, financial leveraging, etc.) that are applicable to other GEF and UNDP interventions. When possible, the TE team should include examples of good practices in project design and implementation.
- It is important for the conclusions, recommendations and lessons learned of the TE report to include results related to gender equality and empowerment of women.

The TE report will include an Evaluation Ratings Table, as shown in the ToR Annex.

5. Competencies

Expected Outputs and Deliverables
The TE task force shall prepare and submit:

- **TE Inception Report**: TE team clarifies objectives and methods of the TE no later than 2 weeks before the TE mission. TE team submits the Inception Report to the Commissioning Unit and project management. Approximate due date: 13 Mar 2021
- **Presentation**: TE team presents initial findings to project management and the Commissioning Unit at the end of the TE mission. Approximate due date: 12 Apr 2021
- **Draft TE Report**: TE team submits full draft report with annexes within 3 weeks of the end of the TE mission. Approximate due date: 7 May 2021
- **Final TE Report* and Audit Trail**: TE team submits revised report, with Audit Trail detailing how all received comments have (and have not) been addressed in the final TE report, to the Commissioning Unit within 1 week of receiving UNDP comments on draft. Approximate due date: 15 May 2021

*The final TE report must be in English. If applicable, the Commissioning Unit may choose to arrange for a translation of the report into a language more widely shared by national stakeholders.
All final TE reports will be quality assessed by the UNDP Independent Evaluation Office (IEO). Details of the IEO's quality assessment of decentralized evaluations can be found in **Section 6 of the UNDP Evaluation Guidelines**.

TE Arrangements
The principal responsibility for managing this TE resides with the Commissioning Unit. The Commissioning Unit for this project's TE is *UNDP China.*
The Commissioning Unit will contract the consultants and ensure the timely provision of per diems and travel arrangements within the country for the TE team. The Project Team will be responsible for liaising with the TE team to provide all relevant documents, set up stakeholder interviews, and arrange field visits.

Duration of the Work

The total duration of the TE will be approximately 20 working days over a time period of 16 weeks starting 9 Mar 2021 and shall not exceed five months from when the TE team is hired. The tentative TE timeframe is as follows:

- 04 Mar 2021: Application closes
- 5 Mar 2021: Selection of TE Team
- 9 Mar 2021 (0.5 working day): Prep the TE Team (handover of project documents)
- 10-11 Mar 2021 (2 working days within the given period): Document review and preparing TE Inception Report
- 12-13 Mar 2021 (1 working day within the given period): Finalization and Validation of TE Inception Report
- 22 Mar - 12 Apr 2021 (5.5 working days within the given period): TE mission: stakeholder meetings, interviews, field visits; on the last day of the TE mission, a mission wrap-up meeting & presentation of initial findings should be conducted
- 13 Apr - 7 May 2021 (9 working days within the given period): Preparing draft TE report
- 7 May 2021: Circulation of draft TE report for comments
- 7 - 30 May 2021 (2 working days within the given period): Incorporation of comments on draft TE report into Audit Trail & finalization of TE report
- 10 May 2021: Preparation & Issue of Management Response by UNDP China
- 15 May 2021: (optional) Concluding Stakeholder Workshop; Expected date of full TE completion

As a mission in China is required for the TE and in light of the concurrent pandemic, candidates that will be already based in China with disease control measures (i.e. mandatory quarantine, nucleic test etc.) completed close to the mission date will have a strong advantage in the selection process. Please make sure to clarify the relevant information in your application and technical proposals.

The date start of contract is 9 **Mar 2021.**

Duty Station
All related travel expenses will be covered and will be reimbursed as per UNDP rules and regulations upon submission of an F-10 claim form and supporting documents.
The consultant's duty station/location for the contract duration is mainly home based with mission to Beijing and field visits to the pilot cities. Given that it may be impractical to conduct missions to all pilot cities (Beijing, Shanghai, Zhengzhou, Foshan, Yancheng, Zhangjiakou and Changshu), the TE task force and UNDP China shall jointly decide and select cities for the mission.

Travel:

- **A mission in China is required during the TE**; in light of the concurrent pandemic, **candidates who are currently based in China with pandemic control measures** (i.e. mandatory quarantine, nucleic test etc.) or have the quarantine requirements co**mpleted close to the mission date will be given an advantage in the selection process**. Please make sure to clarify the relevant information in your application and technical proposals.
- The Basic Security in the Field II and Advanced Security in the Field (BSAFE) courses must be successfully completed prior to commencement of travel;
- Consultants are responsible for ensuring they have vaccinations/inoculations when travelling to certain countries, as designated by the UN Medical Director.
- Consultants are required to comply with the UN security directives set forth under https://dss.un.org/dssweb/.NOTE: This is now consolidated in BSAFE.

6. Required Skills and Experience

The TE team will consist of two independent consultants that will conduct the TE - one team leader (with international experience and exposure to projects and evaluations in other regions) and one team expert from

China. The team leader will be mainly responsible for the overall design and writing of the TE report. The team expert will support the team leader in drafting the TE report, provide local industry insights, conduct research in Chinese, work with the Project Team in developing the TE itinerary, etc.

As requested in the *Guidance for Conducting Terminal Evaluations of UNDP-supported, GEF-financed Projects*, the evaluator(s) cannot have participated in the project preparation, formulation and/or implementation (including the writing of the project document), must not have conducted this project's Mid-Term Review and should not have a conflict of interest with the project's related activities.

The selection of consultants will be aimed at maximizing the overall "team" qualities in the following areas:

- Recent experience with result-based management evaluation methodologies (5%);
- Experience applying SMART indicators and reconstructing or validating baseline scenarios (5%);
- Competence in adaptive management, as applied to energy, decarbonization, especially in relation to the automotive industry; fuel cell related technology or commercialization expertise a strong asset (10%);
- Experience working with the GEF or GEF-evaluations (20%);
- Experience working in Asia, especially in China (5%);
- Work experience in relevant technical areas for at least 5 years (10%);
- Demonstrated understanding of issues related to gender sensitive evaluation and analysis (10%);
- Excellent communication skills (10%);
- Demonstrable analytical skills (10%);
- Project evaluation/review experiences within United Nations system will be considered an asset (10%);
- A Master's degree in engineering, environmental management, industrial development, or other closely related field (5%).

Evaluator Ethics:
The TE team will be held to the highest ethical standards and is required to sign a code of conduct upon acceptance of the assignment. This evaluation will be conducted in accordance with the principles outlined in the UNEG 'Ethical Guidelines for Evaluation'. The evaluator must safeguard the rights and confidentiality of information providers, interviewees, and stakeholders through measures to ensure compliance with legal and other relevant codes governing collection of data and reporting on data. The evaluator must also ensure security of collected information before and after the evaluation and protocols to ensure anonymity and confidentiality of sources of information where that is expected. The information knowledge and data gathered in the evaluation process must also be solely used for the evaluation and not for other uses without the express authorization of UNDP and partners.

7. Annexes to the TE ToR

- ToR Annex A: Project Logical/Results Framework
- ToR Annex B: Project Information Package to be reviewed by TE team
- ToR Annex C: Content of the TE report
- ToR Annex D: Evaluation Criteria Matrix template
- ToR Annex E: UNEG Code of Conduct for Evaluators
- ToR Annex F: TE Rating Scales and TE Ratings Table
- ToR Annex G: TE Report Clearance Form
- ToR Annex H: TE Audit Trail template

8. Content of the TE report

Title page

- Tile of UNDP-supported GEF-financed project
- UNDP PIMS ID and GEF ID
- TE timeframe and date of final TE report
- Region and countries included in the project

- GEF Focal Area/Strategic Program
- Executing Agency, Implementing partner and other project partners
- TE Team members

Acknowledgements
Table of Contents
Acronyms and Abbreviations

Executive Summary (3-4 pages)

- Project Information Table
- Project Description (brief)
- Evaluation Ratings Table
- Concise summary of findings, conclusions and lessons learned
- Recommendations summary table

1. Introduction (2-3 pages)
   - Purpose and objective of the TE
   - Scope
   - Methodology
   - Data Collection & Analysis
   - Ethics
   - Limitations to the evaluation
   - Structure of the TE report

2. Project Description (3-5 pages)
   - Project start and duration, including milestones
   - Development context: environmental, socio-economic, institutional, and policy factors relevant to the project objective and scope
   - Problems that the project sought to address: threats and barriers targeted
   - Immediate and development objectives of the project
   - Expected results
   - Main stakeholders: summary list
   - Theory of Change

3. Project Design/Formulation
   - Analysis of Results Framework: project logic and strategy, indicators
   - Assumptions and Risks
   - Lessons from other relevant projects (e.g. same focal area) incorporated into project design
   - Planned stakeholder participation
   - Linkages between project and other interventions within the sector

4. Project Implementation
   - Adaptive management (changes to the project design and project outputs during implementation)
   - Actual stakeholder participation and partnership arrangements
   - Project Finance and Co-finance
   - Monitoring & Evaluation: design at entry (*), implementation (*), and overall assessment of M&E (*)
   - UNDP implementation/oversight (*) and Implementing Partner execution (*), overall project implementation/execution (*), coordination, and operational issues
   - Project Results
   - Progress towards objective and expected outcomes (*)
   - Relevance (*)
   - Effectiveness (*)
   - Efficiency (*)

- Overall Outcome (*)
- Country ownership
- Gender
- Other Cross-cutting Issues
- Social and Environmental Standards
- Sustainability: financial (*), socio-economic (*), institutional framework and governance (*), environmental (*), and overall likelihood (*)
- Country Ownership
- Gender equality and women's empowerment
- Cross-cutting Issues
- GEF Additionality
- Catalytic Role / Replication Effect
- Progress to Impact

5. Main Findings, Conclusions, Recommendations & Lessons

- Main Findings
- Conclusions
- Recommendations
- Lessons Learned

Annexes

- TE ToR (excluding ToR annexes)
- TE Mission itinerary
- List of persons interviewed
- List of documents reviewed
- Summary of field visits
- Evaluation Question Matrix (evaluation criteria with key questions, indicators, sources of data, and methodology)
- Questionnaire used and summary of results
- Co-financing tables (if not include in body of report)
- TE Rating scales
- Signed Evaluation Consultant Agreement form
- Signed UNEG Code of Conduct form
- Signed TE Report Clearance form
- *Annexed in a separate file*: TE Audit Trail
- *Annexed in a separate file:* relevant terminal GEF/LDCF/SCCF Core Indicators or Tracking Tools, as applicable

APPENDIX B – MISSION ITINERARY (FOR MARCH-MAY 2021)

#	Activity	Stakeholder involved	Place
26 March 2021 (Friday)			
1	Initiation meeting with PMO	UNDP China	Zoom
29 March (Monday)			
2	Project briefing meeting with Prof. Qiu and PMO	UNDP China	Zoom
20 April 2021 (Tuesday)			
3	Meeting and tour of demo FCVs with Shanghai demo city group	Shanghai Municipality	Shanghai
21 April 2021 (Wednesday)			
4	Meeting and tour of demo FCVs with Yangcheng demo city group	Yangcheng Municipality	Yangcheng
22 April 2021 (Thursday)			
5	Meet with Yancheng Municipal Government	Yangcheng Municipality	Yangcheng
23 April 2021 (Friday)			
6	Meeting and tour of demo FCVs with Zhengzhou demo city group	Zhengzhou Municipality	Zhengzhou
25 April 2021 (Sunday)			
7	Meeting and tour of demo FCVs with Beijing demo city group	Beijing Municipality	Beijing
27-28 April (Tuesday-Wednesday)			
8	Meeting and tour of demo FCVs with Foshan demo city group	Foshan Municipality	Foshan
6-7 May 2021 (Thursday-Friday)			
9	Meeting and tour of demo FCVs with Zhangjiakou demo city group	Zhangjiakou Municipality	Zhangjiakou
22 June 2021 (Tuesday)			
10	Meeting with UNDP	UNDP China	Zoom

Total number of meetings conducted: 10

APPENDIX C – LIST OF PERSONS INTERVIEWED

City	Participants	Government/Company
Beijing	Shen Tong	Beijing Municipal science and technology Commission
	Chen Xingfu	Beijing Public Transport
	Sun Baohai	
	Wang Lei	Beiqi Foton Motor Co., Ltd.
	Huo Junqing	Zhangjiakou Public Transportation Group Co.,Ltd
	Yu Min	Beijing SinoHytec Co., Ltd.
	Lu Chun	
	Yuan Dian	
Shanghai	Zheng Guanghong	Shanghai Science and Technology Committee
	Wang Wei	
	Zhang Yingjie	Shanghai Municipal Transportation Committee
	Huang Zan	Shanghai New Energy Center for Technology Transfer and Industry Promotion
	Zhu Gang	
	Guan Qingping	Shanghai International Automobile City (Group) Co., Ltd
	Wang Xue	
	Wang Zhe	Tongji University
	Miao Wenquan	Shanghai AI NEV Innovative Platform Co., Ltd
	Ruan Weimin	Shanghai Sunwise New Energy Systems Co., Ltd
		Jiading Bus
		Shanghai Hydrogen Propulsion Technology Co., Ltd
		REFIRE Technology Co., Ltd
		Shanghai Sunwin Bus Corporation
Zhengzhou	Zhang Longhai	Zhengzhou Yutong Bus Co., Ltd.
	Hu Junjie	
	Li Jin	
	Jiang Shangfeng	
	Wang Yue	
	Cui Guobiao	
	Chen Guoqian	
	Gao Jingjing	
Yancheng	Zou Suyu	Yancheng Science and Technology Bureau
	Nie Ru	Yancheng Public Transport
	Fan Hao	Yancheng Chuangyong Hydrogenation Station Management Co., Ltd
	Wei Yuehui	Jiangsu Xingbang Energy Technology Co., Ltd
	Zhang Zhiwei	
	Zheng Diankun	
	Zhang Yongbo	
	Li Chaokai	
Foshan	Cai Hanquan	Nanhai District People's Government of Foshan City
	Cai Dequan	Nanhai District Development and Reform Bureau of Foshan City

City	Participants	Government/Company
	Liang zhurong	
	Yu Yong	Nanhai District Transportation Bureau of Foshan City
	Huang Wenbin	Nanhai District Bureau of housing, urban and rural construction and water conservation
	Ye Guobin	Foshan Nanhai District Government Service Data Management Bureau
	Chen Jian	Nanhai District market supervision and Administration Bureau of Foshan City
	Qiu Li	
	Zhu Hancai	Nanhai Emergency Management Bureau
	Zhou Ning	South China new energy automobile industry promotion center
	Deng Kailun	
	Mai Jiena	
	Ning Jianing	Foshan Nanhai Foshan Transport Group Co., Ltd
Zhangjiakou	Sun Dongfeng	Zhangjiakou Development and Reform commission
	Yin Xuguang	
	Huo Junqing	Zhangjiakou Public Transportation Group Co.,Ltd
	Zhang Chengbin	Zhangjiakou hydrogen and Renewable Energy Research Institute
	Zhao Hui	Zhangjiakou Haiboer New Energy Technology Co.,Ltd
	Wang Lu	Zhangjiakou Jiaotou Hydrogen Energy New Energy Technology Co., Ltd
	Lu Chunyan	Beijing SinoHytec Co., Ltd
	Yuan Dian	
	Zhang Yinjie	
	Wang Xun	SinoHytec Power Co., Ltd
	Lu Hongwu	

APPENDIX D – LIST OF DOCUMENTS REVIEWED

1. UNDP-GEF Project Document on "Accelerating the Development and Commercialization of Fuel Cell Vehicles in China";
2. UNDP-GEF Draft Inception Report on "Accelerating the Development and Commercialization of Fuel Cell Vehicles in China";
3. 2018, 2019 and 2020 PIRs;
4. Mid-Term Review Report for UNDP Supported GEF Financed Project on "Accelerating the Development and Commercialization of Fuel Cell Vehicles in China", June 2020;
5. GEF/UNDP/MoST "Accelerating the Development and Commercialization of Fuel Cell Vehicles in China" Project, Terminal Evaluation report by National Consultants, 2 June 2021;
6. "The interview and inspection Report on FCV demonstration city of Beijing" from National Evaluator, June 2021;
7. "The interview and inspection Report on FCV demonstration city of Shanghai" from National Evaluator, May 2021;
8. "The interview and inspection Report on FCV demonstration city of Zhengzhou" from National Evaluator, May 2021;
9. "The interview and inspection Report on FCV demonstration city of Yancheng" from National Evaluator, May 2021;
10. "The interview and inspection Report on FCV demonstration city of Foshan" from National Evaluator, May 2021;
11. "The interview and inspection Report on FCV demonstration city of Zhangjiakou" from National Evaluator, May 2021;
12. The ppt presentation for TE meeting by the demonstration city of Beijing.
13. The self-assessment report for TE meeting by the demonstration city of Beijing.
14. The ppt presentation for TE meeting by the demonstration city of Shanghai.
15. The self-assessment report for TE meeting by the demonstration city of Shanghai.
16. The ppt presentation for TE meeting by the demonstration city of Foshan.
17. The self-assessment report for TE meeting by the demonstration city of Foshan.
18. The ppt presentation for TE meeting by the demonstration city of Yancheng.

19. The self-assessment report for TE meeting by the demonstration city of Yancheng.

20. The ppt presentation for TE meeting by the demonstration city of Zhengzhou.

21. The self-assessment report for TE meeting by the demonstration city of Zhengzhou.

22. The ppt presentation for TE meeting by the demonstration city of Zhangjiakou.

23. The self-assessment report for TE meeting by the demonstration city of Zhangjiakou.

24. The list of cities adopting FCVs in their transport systems – retrieved from National Monitoring and Management Center for New Energy Vehicles

APPENDIX E – COMPLETED TRACKING TOOL

Figure E-1: Screenshot of Page 1 of DevCom FCV Project Tracking Tool

Tracking Tool for Climate Change Mitigation Projects
(For Terminal Evaluation)

Special Notes: reporting on lifetime emissions avoided

Lifetime direct GHG emissions avoided: Lifetime direct GHG emissions avoided are the emissions reductions attributable to the investments made **during the project's supervised implementation period**, totaled over the respective lifetime of the investments.

Lifetime direct post-project emissions avoided: Lifetime direct post-project emissions avoided are the emissions reductions attributable to the investments made outside the project's supervised implementation period, but supported by financial facilities put in place by the GEF project, totaled over the respective lifetime of the investments. These financial facilities will still be operational after the project ends, such as partial credit guarantee facilities, risk mitigation facilities, or revolving funds.

Lifetime indirect GHG emissions avoided (top-down and bottom-up): indirect emissions reductions are those attributable to the long-term outcomes of the GEF activities that remove barriers, such as capacity building, innovation, catalytic action for replication.

Please refer to the Manual for Calculating GHG Benefits of GEF Projects.

Manual for Energy Efficiency and Renewable Energy Projects

Manual for Transportation Projects

For LULUCF projects, the definitions of "lifetime direct and indirect" apply. Lifetime length is defined to be 20 years, unless a different number of years is deemed appropriate. For emission or removal factors (tonnes of CO2eq per hectare per year), use IPCC defaults or country specific factors.

General Data	Results at Terminal Evaluation	Notes
Project Title	**Promoting Energy Efficient Electric Motors in Chinese Industries (PREMCI)**	
GEF ID	5728	
Agency Project ID	5349	
Country	China	
Region	EAP	
GEF Agency	UNDP	
Date of Council/CEO Approval		Month DD, YYYY (e.g., May 12, 2010)
GEF Grant (US$)	8,233,560	
Date of submission of the tracking tool	September 24, 2021	Month DD, YYYY (e.g., May 12, 2010)
Is the project consistent with the priorities identified in National Communications, Technology Needs Assessment, or other Enabling Activities under the UNFCCC?	1	Yes = 1, No = 0
Is the project linked to carbon finance?	0	Yes = 1, No = 0
Cumulative cofinancing realized (US$)	388,764,000	
Cumulative additional resources mobilized (US$)	2,200,000,000	additional resources means beyond the cofinancing committed at CEO endorsement

Figure E-2: Screenshot of DevCom FCV Project Tracking Tool

Objective 1: Transfer of Innovative Technologies		
Please specify the type of enabling environment created for technology transfer through this project		
National innovation and technology transfer policy	1	Yes = 1, No = 0
Innovation and technology centre and network	1	Yes = 1, No = 0
Applied R&D support	1	Yes = 1, No = 0
South-South technology cooperation	1	Yes = 1, No = 0
North-South technology cooperation	1	Yes = 1, No = 0
Intellectual property rights (IPR)	0	Yes = 1, No = 0
Information dissemination	1	Yes = 1, No = 0
Institutional and technical capacity building	1	Yes = 1, No = 0
Other (please specify)	0	
Number of innovative technologies demonstrated or deployed	6	
Please specify three key technologies for demonstration or deployment		
Area of technology 1	Other	
Type of technology 1	Fuel cells	specify type of technology
Area of technology 2	Transport_Urban	
Type of technology 2	Fuel cell vehicles	specify type of technology
Area of technology 3	Other	
Type of technology 3		refuelling stations; renewable hydrogen; hydrogen storage
Status of technology demonstration/deployment	4	0: no suitable technologies are in place 1: technologies have been identified and assessed 2: technologies have been demonstrated on a pilot basis 3: technologies have been deployed 4: technologies have been diffused widely with investments 5: technologies have reached market potential
Lifetime direct GHG emissions avoided	137,697	tonnes CO2eq (see Special Notes above)
Lifetime direct post-project GHG emissions avoided		tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (bottom-up)		not applicable
Lifetime indirect GHG emissions avoided (top-down)		not applicable

Figure E-3: Screenshot of DevCom FCV Project Tracking Tool

Objective 3: Renewable Energy		
Please specify if the project includes any of the following areas		
Heat/thermal energy production	0	Yes = 1, No = 0
On-grid electricity production	0	Yes = 1, No = 0
Off-grid electricity production	1	this is used by the project, rather than constructed by it
Policy and regulatory framework	0	0: not an objective/component 1: no policy/regulation/strategy in place 2: policy/regulation/strategy discussed and proposed 3: policy/regulation/strategy proposed but not adopted 4: policy/regulation/strategy adopted but not enforced 5: policy/regulation/strategy enforced
Establishment of financial facilities (e.g., credit lines, risk guarantees, revolving funds)	0	0: not an objective/component 1: no facility in place 2: facilities discussed and proposed 3: facilities proposed but not operationalized/funded 4: facilities operationalized/funded but have no demand 5: facilities operationalized/funded and have sufficient demand
Capacity building	2	0: not an objective/component 1: no capacity built 2: information disseminated/awareness raised 3: training delivered 4: institutional/human capacity strengthened 5: institutional/human capacity utilized and sustained
Installed capacity per technology directly resulting from the project		
Wind		MW
Biomass		MW el (for electricity production)
Biomass		MW th (for thermal energy production)
Geothermal		MW el (for electricity production)
Geothermal		MW th (for thermal energy production)
Hydro		MW
Photovoltaic (solar lighting included)		MW
Solar thermal heat (heating, water, cooling, process)		MW th (for thermal energy production, 1m² = 0.7kW)
Solar thermal power		MW el (for electricity production)
Marine power (wave, tidal, marine current, osmotic, ocean thermal)		MW
Lifetime energy production per technology directly resulting from the project (IEA unit converter: http://www.iea.org/stats/unit.asp)		
Wind		MWh
Biomass		MWh el (for electricity production)
Biomass		MWh th (for thermal energy production)
Geothermal		MWh el (for electricity production)
Geothermal		MWh th (for thermal energy production)
Hydro		MWh
Photovoltaic (solar lighting included)		MWh
Solar thermal heat (heating, water, cooling, process)		MWh th (for thermal energy production)
Solar thermal power		MWh el (for electricity production)
Marine energy (wave, tidal, marine current, osmotic, ocean thermal)		MWh
Lifetime direct GHG emissions avoided	92,564	tonnes CO2eq (see Special Notes above)
Lifetime direct post-project GHG emissions avoided		tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (bottom-up)		tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (top-down)		tonnes CO2eq (see Special Notes above)

Figure E-4: Screenshot of DevCom FCV Project Tracking Tool

Objective 4: Transport and Urban Systems		
Please specify if the project targets any of the following areas		
Bus rapid transit	1	Yes = 1, No = 0
Other mass transit (e.g., light rail, heavy rail, water or other mass transit; excluding regular bus or minibus)		Yes = 1, No = 0
Logistics management	1	Yes = 1, No = 0
Transport efficiency (e.g., vehicle, fuel, network efficiency)	1	Yes = 1, No = 0
Non-motorized transport (NMT)		Yes = 1, No = 0
Travel demand management		Yes = 1, No = 0
Comprehensive transport initiatives (Involving the coordination of multiple strategies from different transportation sub-sectors)		Yes = 1, No = 0
Sustainable urban initiatives		Yes = 1, No = 0
Policy and regulatory framework	5	0: not an objective/component 1: no policy/regulation/strategy in place 2: policy/regulation/strategy discussed and proposed 3: policy/regulation/strategy proposed but not adopted 4: policy/regulation/strategy adopted but not enforced 5: policy/regulation/strategy enforced
Establishment of financial facilities (e.g., credit lines, risk guarantees, revolving funds)	5	0: not an objective/component 1: no facility in place 2: facilities discussed and proposed 3: facilities proposed but not operationalized/funded 4: facilities operationalized/funded but have no demand 5: facilities operationalized/funded and have sufficient demand
Capacity building	5	0: not an objective/component 1: no capacity built 2: information disseminated/awareness raised 3: training delivered 4: institutional/human capacity strengthened 5: institutional/human capacity utilized and sustained
Length of public rapid transit (PRT)		km
Length of non-motorized transport (NMT)		km
Number of lower GHG emission vehicles		
Number of people benefiting from the improved transport and urban systems		
Lifetime direct GHG emissions avoided	137,697	tonnes CO2eq (see Special Notes above)
Lifetime direct post-project GHG emissions avoided		tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (bottom-up)		tonnes CO2eq (see Special Notes above)
Lifetime indirect GHG emissions avoided (top-down)		tonnes CO2eq (see Special Notes above)

APPENDIX F – REVISED STRATEGIC RESULTS FRAMEWORK FOR DEVCOM FCV PROJECT (AUGUST 2016 DEVCOM INCEPTION REPORT)

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	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
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	132,707 tons CO_2[25]	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)
	% reduction in annual growth increment of GHG emission from China's transport sector represented by new FCVs put in service for the year by EOP	0	0.4%	Project estimates of annual GHG emission from China's transport sector based on make-up and km driven as indicated in *China Automotive Industry Yearbook*	-(a) as above -Target growth of conventional vehicles is at least maintained

[25] Emission reductions of 132,707 tons CO_2 by EOP are a combination of direct incremental net ERs (for 109 FCVs and 4 renewable energy based hydrogen production units) and indirect ERs (assuming total vehicles by EOP are 4,000 including original 109 and assuming an additional 12 renewable energy based hydrogen production units by EOP). Direct incremental net ERs total 15,287 tons, of which 9,365 tons are due to the 109 FCVs operating 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 years before EOP (with double counting for the portion of hydrogen used in the demo FCVs subtracted out). Indirect ERs by EOP total 117,420 tons, of which 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).

Strategy	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
Objective[26]: Facilitation of the commercial production and application of fuel cell vehicles in China	Number of local transport vehicle manufacturers producing FCVs by EOP	4	10	Project survey of AEV manufacturers in China	-National subsidies continue at level that makes FCVs affordable to buyers (b)
	Number of bus companies that have FCBs in their bus fleet by EOP	0	100	Project's *China FCV Market and Technology Monitoring System*	-(b) as above
	Cumulative number of FCVs operating in China by EOP	8	4,000	Project's *China FCV Market and Technology Monitoring System*	-(b) as above
	Average share of FCVs in the Chinese automotive market (measured by total annual sales) by EOP, %	0	0.005%	Project's *China FCV Market and Technology Monitoring System*; reports on annual auto sales in *China Automotive Industry Year Book* and *China Alternative Electrical Vehicle Yearbook*	-(b) as above
	Number of transport vehicle distributors selling locally made and imported FCVs by EOP	0	12	Project's *China FCV Market and Technology Monitoring System*	-(b) as above
	Number of installed FCV production lines in Chinese automotive industry by EOP	3	10	Project survey of AEV manufacturers	-(b) as above -financial sector supports expansion of manufacturing (c)
	Cumulative investment in local FCV manufacturing by EOP, US$ million	$1 million	$10 million	Project survey of AEV manufacturers	-(c), as above
	Number of persons gainfully employed in new FCV, FC and FCV components manufacturing firms, and hydrogen refueling stations by EOP	1,000	10,000	Project survey	

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

Strategy	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
	Percentage of women employed in FCV manufacturing and associated value and supply chain industries by EOP (%)	5%	50%	Project survey	
Outcome 1A : Markedly reduced costs and improved performance and durability of FCVs in China	Average annual operating hours of newly produced Chinese FCVs by EOP, hours	670 (bus) 670 (car) 670 (DV)	3,300 (bus) 2,100 (car) 2,100 (DV)	Project survey of FCV manufacturers	
	Average lifetime hours of operation of newly produced Chinese FCVs by EOP, hours	2,000 (bus) 2,000 (car) 2,000 (DV)	10,000(bus) 6,000 (car) 6,000 (DV)	Project survey of FCV manufacturers	
	Average high volume unit cost[27] of newly produced Chinese FCVs at EOP, US$	$380,000(bus) $60,000 (car) $200,000 (DV)	$190,000 (bus) $36,000 (car) $120,000 (DV)	Project survey of FCV manufacturers	
	Actual unit cost of newly produced Chinese FCVs at EOP, US$	$640,000 (bus) $150,000 (car) $250,000 (DV)	$320,000(bus) $80,000 (car) $150,000 (DV)	Project survey of FCV manufacturers	
	Reduction in high volume unit cost[28] of newly produced Chinese FCVs at EOP, %	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 in China by EOP (units sold) Average annual growth rate of FCV sales in China by EOP (% growth in units sold as compared to previous year)	0, 0%	1,500 100%	Project *China FCV Market and Technology Monitoring System* GOC Official statistics	-(b), as above -consumers' and government officials' concerns about FCV safety issues are allayed (d)
	Number of Chinese cities in which FCVs are deployed by EOP.	1	10	Project *China FCV Market and Technology Monitoring System*	-(b), as above -(d), as above

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

Strategy	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
Outcome 2A: Reduced cost and improved viability of hydrogen production and hydrogen refueling stations	Number of types of renewable energy used on substantial scale to produce hydrogen in China	0	3	Project monitoring report	
	Average unit price of hydrogen gas (delivered) produced from renewable energy in China by EOP, % of baseline year cost using constant RMB	100%	75%	Project survey of renewable energy based hydrogen producers and purchasers of hydrogen	-Raw material prices (e.g. natural gas) or other market factors do not drive up price in unexpected way (f)
	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	3-5	Survey of hydrogen refueling stations	
	Average cost of setting up hydrogen refueling station capable of 200 kg hydrogen delivery per day (not including land cost) by EOP, % of baseline year cost using constant RMB	100%	65%	Survey of hydrogen refueling stations	-Materials prices or other market factors do not drive up costs in unexpected way (g).
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 production of hydrogen from autonomous renewable energy in China at EOP, metric tons	0	1,000	Project survey of renewable energy based hydrogen producers	
	Cumulative investments in renewable energy based hydrogen production and/or refueling stations in Chinese cities by EOP, US$ million	$3 million	$20 million	Project activity report Project monitoring report Project *China FCV Market and Technology Monitoring System*	-State-owned sector, financial sector, and/or private sector willing to invest (h) -Central government subsidies remain at level that make stations viable (i)
	Number of renewable energy based hydrogen production units in China of substantial scale	0	8		
	Number of hydrogen refueling stations in China at EOP	2	15		-(h), as above -(i), as above

Strategy	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
	Annual amount of hydrogen delivered to FCVs via hydrogen refueling stations, tons	10	1,000 – 2,000		-(h), as above -(i), as above
Outcome 3A: Effective enforcement of policies and regulatory frameworks supporting the application and commercialization of FCVs	Number of operating FCV models that have achieved approval from relevant authorities by EOP	1	11	Project activity report Project monitoring report Vehicle model registration list from relevant authorities	
	Number of individual FCVs that have received approval and license plates for long-term operation at local level	5	1,000 – 7,000	Project *China FCV Market and Technology Monitoring System*	
	Number of FCV manufacturing companies that are compliant to newly issued and enforced FCV product standards by EOP	0	10	Market survey of local FCV manufacturers and their FCV products Project activity report Project monitoring report	-(b), as above
	Total incentive subsidies disbursed for FCV purchase and hydrogen station establishment in China by EOP, million RMB	0 (bus) 0 (car) 0 (van/truck) 0 (hydrogen station)	100M - 700M (bus) 96M – 672M (car) 96M – 672M (DV) 60M (hydrogen station)	Project *China FCV Market and Technology Monitoring System*	
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	6	Project monitoring report and project survey	-(j), as above
Outcome 4: Enhanced acceptance of FCVs for both public and private	Number of public and private vehicle users that are aware and interested in the application of FCVs by EOP	100,000	5 M	Conduct of research survey	-Fear of users re FCV safety issues is allayed (k) -(b), as above

Strategy	Indicator	Baseline	Targets	Source of Verification	Critical Assumptions
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	10	Conduct of research survey Project activity report Project monitoring report	-(b), as above -(k), as above
	Number of private vehicle owners that own and use a FCV by EOP	0	480 – 3,360		-(b), as above -(k), as above
	Number of other companies/service providers (such as postal service) that have adopted FCVs by EOP	0	10		-(b), as above -(k), as above
Outcome 5A: Increased technical capacity for O&M of FCVs and hydrogen refueling stations	Number of individuals capable of satisfactorily operating and maintaining FCVs in China by EOP	20	>500	Results of project post-training assessment	-Relevant work units willing to send key staff with required capabilities to trainings (l)
	Number of individuals capable of satisfactorily operating and maintaining hydrogen refueling stations in China by EOP	5	>100		-(l), as above
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	200	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 (m)
	Cumulative financing (in US$ million) provided by financial sector for purchase of FCVs by individuals, governments, or other entities by EOP.	0	50		-(b), as above -consumers' fears regarding safety of FCVs allayed (n)

APPENDIX G – ACTUAL STAKEHOLDER PARTICIPATION

Industry chain	Stakeholder
Key components (Fuel Cell Stack, Bipolar Plate, Membrane Electrode Assembly, Air Compressor, Proton Exchange Membrane, Catalyst, Carbon Paper, Hydrogen Circulation System, Electric Motor, Hydrogen Storage Systems)	REFIRE Technology Co., Ltd.
	H-RISE Technology Co., Ltd.
	Aerospace Hydrogen Energy (Shanghai) Technology Co., Ltd.
	Shanghai Ji Chong Hydrogen Energy Technology Co., Ltd.
	Shanghai Tangfeng Energy Technology Co., Ltd.
	Shanghai Maxim Fuel Cell Technology Co., Ltd.
	Shanghai Hydrogen Propulsion Technology Co., Ltd.
	Horizon Fuel Cell Technology Co., Ltd.
	Shanghai Jiening New Energy Technology Development Co., Ltd.
	Shanghai Guandi Hydrogen Energy Technology Co., Ltd.
	Shanghai Sunrise Power Co., Ltd.
	Shanghai Shenli Technology Co., Ltd.
	Shanghai Zhizhen New Energy Equipment Co., Ltd.
	Shanghai Fuel Cell Vehicle Power System Co., Ltd.
	Shanghai G-Power Technology Co., Ltd.
	Shanghai Green Hydrogen Technology Co., Ltd.
	Shanghai Yipu Technology Co., Ltd.
	Easyland Automotive Corporation
	Shanghai Qinglan New Energy Technology Co., Ltd.
	XecaTurbo(Shanghai) Technology Co., Ltd.
	Shanghai Electric Group Co., Ltd.
	Shanghai Ranrui New Energy Vehicle Technology Co., Ltd.
	Shanghai Tongcheng Energy Technology Co., Ltd.
	Wisedrive Technology Co., Ltd.
	Shanghai Liangcang Energy Technology Co., Ltd.
	Shanghai Jiping New Energy Technology Co., Ltd.
	Shanghai Hesen Electric Co., Ltd.
	Shanghai Yunliang New Energy Technology Co., Ltd.
	Shanghai Jiazi New Material Co., Ltd.
	Jiangsu Xingbang Energy Technology Co., Ltd
	Beijing SinoHytec Co., Ltd.
	State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.
	Hengdong Hydrogen Energy (Beijing) Technology Co., Ltd.
	Beijing Guohong Hydrogen Energy Technology Co., Ltd.
	Beijing Juxing Huatong Technology Co., Ltd.

Industry chain	Stakeholder
	Beijing Tomorrow Hydrogen Energy Technology Co., Ltd.
	Beijing Yingbo New Energy Co., Ltd.
	Edelman (Beijing) Hydrogen Energy Technology Co., Ltd.
	China Hydrogen Power (Beijing) Technology Co., Ltd.
	Beijing Jinneng Fuel Cell Co., Ltd.
	Beijing Puxing New Energy Technology Co., Ltd.
	Beijing Jichong Hydrogen Energy Technology Co., Ltd.
	Beijing Jiaqing New Energy Technology Co., Ltd.
	Beijing Qingpuchuang Energy Technology Co., Ltd.
	Beijing Xinyan Chuangneng Technology Co., Ltd.
	China Energy Engineering Group Hydrogen Energy Technology Co., Ltd.
	United Fuel Cell System Research and Development (Beijing) Co., Ltd.
	Antai Environmental Engineering Technology Co., Ltd.
	Beijing Sinohydro Green Energy Technology Co., Ltd.
	Wuli Hydrogen Creation (Beijing) Technology Co., Ltd.
	Beijing Qingdong Chuangneng New Material Co., Ltd.
	Beijing Huiyuan Hydrogen Energy Technology Co., Ltd.
	Sigatobo (Beijing) Technology Co., Ltd.
	Beijing Birken Energy Technology Co., Ltd.
	Hydrogen Energy Technology (Beijing) Co., Ltd
	Beijing Wenli Technology Co., Ltd.
	Lingchen Hydrogen Technology (Beijing) Co., Ltd. (formerly Binglun Haizhuo Hydrogen Technology Co., Ltd.)
	Beijing Air Aviation Technology Co., Ltd.
	Beijing Lantianda Automobile Clean Fuel Technology Co., Ltd.
	Science and Technology Qingke (Beijing) Technology Co., Ltd.
	Xinyida Membrance (Beijing) Technology Co., Ltd.
	Beijing Qingneng Xingtai Technology Co., Ltd.
	SinoHytec Power Technology Co., Ltd
	Zhangjiakou Himalaya Hydrogen Technology Co., Ltd
	Zhangjiakou Hydrogen Energy Technology Co., Ltd
	Zhangjiakou Jutong Technology Co., Ltd
	Henan engineering technology research center for fuel cell and hydrogen energy
	The Battery Research Institute of Henan
	Henan Key Lab. of Surface & Interface Science and Technology
	Zhengzhou jingyida Auto Parts Co., Ltd
	Pingyuan Filter Co., Ltd
	Henan Aerospace Industry Corporation

Industry chain	Stakeholder
	Guangdong Discoverty-Motors
	Cemt GD Co.,Ltd
	Telos Auto Power Systems Co.,Ltd
	Sunrise Power Co., Ltd.
	Guangdong Cleanest-Energy Hydrogen Energy Co.,Ltd
Hydrogen Production, Hydrogen Supply, Hydrogen Refueling Station	Air Products and Chemicals (China) Investment Co., Ltd.
	Shenergy (Group) Co., Ltd.
	Baowu Clean Energy Co., Ltd.
	Sinopec Hydrogen Energy (Shanghai) Co., Ltd.
	Shanghai Sunwise Energy Systems Co., Ltd.
	Shanghai Electric Power Company Limited
	Shanghai Hyfun Energy Technology Co., Ltd.
	Shanghai Xianli New Energy Technology Co., Ltd.
	Shanghai Fuel Cell Vehicle Powertrain Co., Ltd.
	Shanghai Pujiang Specialty Gases Co., Ltd.
	Linde Gas (Shanghai) Co., Ltd.
	Air Liquide (China) Holding Co., Ltd.
	Shanghai Baoqing Gases Industrial Co., Ltd.
	Hyfuture (Shanghai) Industrial Co., Ltd.
	Shanghai Huayi Group Corporation Limited
	Shanghai Chemical Industry Park Industrial Gases Co., Ltd.
	Shanghai Elite Energy Technology Co., Ltd.
	Jinqiao Wilmar Chlor-Alkali(Lianyungang) Co., Ltd.
	Yancheng chuangyong hydrogenation station management Service Co., Ltd
	China Petroleum & Chemical Corporation Beijing Yanshan Branch
	Beijing Huanyu Jinghui Jingcheng Gas Technology Co., Ltd.
	Air Huatong (Beijing) Hydrogen Energy Technology Co., Ltd.
	Beijing Hypor Hydrogen Energy Technology Co., Ltd.
	China National Petroleum Corporation Beijing Sales Branch
	Sinopec Sales Co., Ltd. Beijing Petroleum Branch
	Beijing Green Hydrogen Technology Development Co., Ltd.
	Beijing Shougang Gas Co., Ltd.
	Beijing Haidelisen Technology Co., Ltd.
	Beijing Aishengde Hydrogen Energy Technology Research Institute Co., Ltd.
	China Chemical Science and Technology Research Co., Ltd.
	Mingyang Smart Energy Group Co., Ltd.
	Beijing Zhongke Fuhai Cryogenic Technology Co., Ltd.

Industry chain	Stakeholder
	Beijing Haoyun Jinneng Technology Co., Ltd.
	CIMC Enric Holdings Co., Ltd.
	Qunyi Energy Co., Ltd.
	Beijing Sanying Hydrogen Energy Equipment Co., Ltd.
	Research Institute of Youyan Engineering Technology
	Zhangjiakou Honghua Clean Energy Technology Co., Ltd
	Hebei Hongmeng new energy Co., Ltd
	Chongli Xintian wind energy Co., Ltd
	Construction investment Yanshan (Guyuan) wind energy Co., Ltd
	Guohua (Chicheng) wind power Co., Ltd
	Zhangjiakou Jiaotou hydrogen energy new energy technology Co., Ltd
	Zhangjiakou investment shell new energy Co., Ltd
	Zhangjiakou hypower New Energy Technology Co., Ltd
	Zhongzhi Tiangong Co., Ltd
	Hebei Zhangjiakou Petroleum Branch of Sinopec Sales Co., Ltd
	National energy group hydrogen technology Co., Ltd
	Zhangjiakou PetroChina new energy Co., Ltd
	Zhengxing Technology Co., Ltd
	Weiqi chemical JiaoZuo Branch
	Henan Coal Chemical Industry Group Co.,Ltd
	Weiqi chemical JiYuan Branch
	Henan Fengli Petrochemical Co., Ltd
	Puyang Yongjin Chemical Co., Ltd
	Foshan Ruihui Energy Co.,Ltd
	GRANDBLUE ENVIRONMENT CO., LTD.
	Foshan New Energy CO., LTD. , China Petrochemical Corporation
Fuel Cell Vehicle	SAIC Motor Corporation Limited
	SAIC MAXUS Automotive Co., Ltd.
	SAIC Yuejin Automotive Co., Ltd.
	SAIC Hongyan Automotive Co., Ltd.
	Shanghai Sunwin Bus Co., Ltd.
	Shanghai Shenlong Bus Co., Ltd.
	Shanghai Wanxiang Automobile Co., Ltd.
	Nanjing Golden Dragon Bus Manufacturing Co., Ltd.
	Beiqi Foton Motor Co., Ltd.
	Beiqing Zhichuang (Beijing) New Energy Vehicle Technology Co., Ltd.
	Beijing New Energy Automobile Co., Ltd.

Industry chain	Stakeholder
	Beijing Zhongji New Energy Automobile Co., Ltd.
	Changan Automobile Co., Ltd.
	Zhengzhou Yutong Bus Co., Ltd
	Yunnan Wulong Automobile Co.,Ltd
	Xiamen Jinlong Automobile Group Co., Ltd
	Guangdong FDQC Automotive Co.,Ltd
	Zhongzhi New Energy Vehicle Co., Ltd
	Foshan Feichi Automobile Technology Co.,Ltd
Vehicle Operator	Shanghai E-drive Automotive Service Co., Ltd.
	Shanghai Sinotran New Energy Automobile Operation Co., Ltd.
	Shanghai Jiushuang New Energy Technology Co., Ltd.
	BESTPATH (Shanghai) IoT Technology Ltd.
	Deer Bus
	Wulabang Logistics Supply Chain (Shanghai) Co., Ltd.
	Shanghai Fengxian Bus Transportation Co., Ltd.
	Jiading Public Transport Co., Ltd.
	Shunxiang Car Passenger（Shanghai) Co., Ltd.
	Shanghai Duckbill Co., Ltd.
	Shanghai Zhidi Automobile Co., Ltd.
	Zhengzhou Yutong Bus Co., Ltd
	Beijing Shuimu Tongda Transportation Co., Ltd.
	Anke Jieneng Technology Development Group Co., Ltd.
	Xiaoshizi (Beijing) New Energy Vehicle Leasing Co., Ltd.
	Zhangjiakou Public Transport Group Co., Ltd
	Zheng Zhou Public Transport Group Co., Ltd
	FoGuang Transportation Group
	Guangdong Kenaz Green Car Serve Co.,Ltd
	Foshan Power Gathering New Energy Vehicle Co, Ltd
	QLQW Hydrogen Vehicle operation (foshan) Co.,Ltd
	Hydrogen-equipped Forward Vehicle operation (foshan) Co.,Ltd
Research Institute	Tongji University
	Jiaotong University
	Fudan University
	East China University of Science and Technology
	Shanghai Institute of Space Power-Sources
	Shanghai Institute of Ceramics，Chinese Academy of Sciences
	Shanghai Institute of Microsystem and Information Technology

Industry chain	Stakeholder
	Tsinghua University
Data Monitoring	Shanghai Motor Vehicle Inspection Certification & Tech Innovation Center Co., Ltd.
	Shanghai Electric Vehicle Public Data Collecting, Monitoring and Research Center
Service Platform/Industry Alliance	Shanghai AI NEV Innovative Platform Co., Ltd.
	Shanghai Fuel Cell Vehicle Demonstration and Application Innovation Alliance
	Yangtze River Delta Hydrogen Infrastructure Industry Alliance
	Baoshan Hydrogen Energy Industry Technology Innovation Alliance
	Shanghai Partnership of Fuel Cell Vehicle

APPENDIX H – BEIJING DEMONSTRATION CITY REPORT

I-1. Support to Beijing's FCV Industry

I-1 In 2003, Beijing participated in the Phase I of the DevCom Project with DaimlerChrysler conducting the demonstration on FCVs. On June 20, 2006, three Citaro fuel cell buses produced by DaimlerChrysler officially started passenger carrying demonstration operation. By October 2007, the Phase I demonstration operation project ended, and the vehicles ran more than 90,000 km safely. On July 11, 2008, three domestic fuel cell buses participating in the Phase II of the DevCom demonstration project were handed over at the Olympic Village. After full preparation, 3 domestic fuel cell buses officially started their one-year demonstration operation of carrying passengers on bus routes in Beijing on August 1, 2008, which is the first commercial demonstration operation of domestic fuel cell buses with the support of the Ministry of Science and Technology and the Beijing Municipal People's Government. The accumulative distance travelled by the vehicles reached 75,460 km with cumulative working time of 3,646 hours.

I-2 In 2016, Beijing began to participate in the DevCom FCV Project. By April 2021, a total of 410 FCVs were in operation including 5 buses, 260 group buses and 145 logistics vehicles. The total operation mileage was 6,985,400 km including 553,600 km of public buses, 4,941,900 km of group buses and 1,489,900 km of logistics vehicles. The total operation time is 235,467 hours including 27,344 hours of public buses with a demonstration cycle of 2.5 years (average annual running time of 10,938 hours), 180,578 hours of group buses with a demonstration cycle of 3.4 years (average annual running time of 53,111 hours) and 27,545 hours of logistics vehicles with a demonstration cycle of 2.3 years (average annual running time of 11,976 hours). The hydrogen refueling amount totaled 311.20 tons, including 225.28 tons produced by electrolytic water, 42.96 tons by natural gas, 25.78 tons by methanol decomposition, and 17.18 tons by chlor-alkali exhaust. It has carried 6,493,600 persons, including 692,200 by public buses and 5.801,400 by group vehicles.

I-3 Through demonstration project, fuel cell vehicles have certain advantages compared with pure electric vehicles such as output power, driving range, fuel filling efficiency and other aspects which are conducive to the continuous and efficient operation of vehicles. For example, pure electric buses may need a recharge after just one round trip, while fuel cell buses only need to add gaseous hydrogen once a day. In addition, fuel cell buses can ensure the internal heating demand during the operation in winter, which is well evaluated by passengers. In addition, commercial vehicles run on relatively fixed routes and have relatively low dependence on HRSs, which can support the daily operation of fuel cell commercial vehicles under the condition of relatively low density of HRSs, and effectively alleviate "hydrogenation anxiety".

I-4 Beijing has gradually built a relatively complete hydrogen energy industry chain. The scientific research at Tsinghua University was quickly transferred to the fuel cell engine products of Beijing SinoHytec and Foton vehicles. At the same time, Beijing has built the capacity for large-scale promotion, in terms of fuel cell engine system, mass production lines and test centers. At the same time, Beijing has developed capacities to manufacture core components. Beijing has made breakthroughs in air compressors, air bearings, gaseous hydrogen circulating pump, shaft seal, explosion prevention and motor suitable for hydrogen. gaseous hydrogen ejector, water pumps from small flow to large flow, humidifiers in membrane tube materials, gaseous hydrogen storage pressure developed from 35 MPa to 70 MPa, and the development of liquid hydrogen system. At present, there are 93 enterprises servicing the FCV industry chain in Beijing as shown in Table I-1.

Table I-1: Hydrogen Energy Enterprises in Beijing

S/N	Industrial chain link		Enterprise	Qty.
1	Fuel cell	Fuel cell engine system	Beijing SinoHytec Co., Ltd.	10
2			State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	
3			Hengdong Hydrogen Energy (Beijing) Technology Co., Ltd.	
4			Beijing Guohong Hydrogen Energy Technology Co., Ltd.	
5			Beijing Juxing Huatong Technology Co., Ltd.	
6			Beijing Tomorrow Hydrogen Energy Technology Co., Ltd.	
7			Beijing Yingbo New Energy Co., Ltd.	
8			Edelman (Beijing) Hydrogen Energy Technology Co., Ltd.	
9			China Hydrogen Power (Beijing) Technology Co., Ltd.	
10			Beijing Jinneng Fuel Cell Co., Ltd.	
11		Stack	Beijing SinoHytec Co., Ltd.	11
12			State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	
13			Beijing Guohong Hydrogen Energy Technology Co., Ltd.	
14			Beijing Puxing New Energy Technology Co., Ltd.	
15			Beijing Jichong Hydrogen Energy Technology Co., Ltd.	
16			Beijing Jiaqing New Energy Technology Co., Ltd.	
17			Beijing Qingpuchuang Energy Technology Co., Ltd.	
18			Beijing Xinyan Chuangneng Technology Co., Ltd.	
19			China Energy Engineering Group Hydrogen Energy Technology Co., Ltd.	
20			United Fuel Cell System Research and Development (Beijing) Co., Ltd.	
21			Antai Environmental Engineering Technology Co., Ltd.	
22		Bipolar plate	Beijing SinoHytec Co., Ltd.	10
23			Beijing Qingpuchuang Energy Technology Co., Ltd.	
24			Beijing Jichong Hydrogen Energy Technology Co., Ltd.	
25			Beijing Puxing New Energy Technology Co., Ltd.	
26			Beijing Guohong Hydrogen Energy Technology Co., Ltd.	
27			Beijing Jiaqing New Energy Technology Co., Ltd.	
28			State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	
29			China Energy Engineering Group Hydrogen Energy Technology Co., Ltd.	
30			Beijing Sinohydro Green Energy Technology Co., Ltd.	
31			Antai Environmental Engineering Technology Co., Ltd.	
32		Membrane electrode	Wuli Hydrogen Creation (Beijing) Technology Co., Ltd.	5
33			Beijing SinoHytec Co., Ltd.	
34			Beijing Qingdong Chuangneng New Material Co., Ltd.	
35			State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	
36			Antai Environmental Engineering Technology Co., Ltd.	
37		Air compressor	Beijing Huiyuan Hydrogen Energy Technology Co., Ltd.	5
38			Sigatobo (Beijing) Technology Co., Ltd.	
39			Beijing Birken Energy Technology Co., Ltd.	
40			Hydrogen Energy Technology (Beijing) Co., Ltd	
41			Beijing Wenli Technology Co., Ltd.	

S/N	Industrial chain link		Enterprise	Qty.
42		Gaseous hydrogen circulating pump	Lingchen Hydrogen Technology (Beijing) Co., Ltd. (formerly Binglun Haizhuo Hydrogen Technology Co., Ltd.)	4
43			Beijing Air Aviation Technology Co., Ltd.	
44			Beijing Lantianda Automobile Clean Fuel Technology Co., Ltd.	
45			Beijing Juxing Huatong Technology Co., Ltd.	
46		Proton exchange membrane	State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	3
47			Science and Technology Qingke (Beijing) Technology Co., Ltd.	
48			Xinyida Membrance (Beijing) Technology Co., Ltd.	
49		Catalyst	State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	4
50			Science and Technology Qingke (Beijing) Technology Co., Ltd.	
51			China Energy Engineering Group Hydrogen Energy Technology Co., Ltd.	
52			Beijing Qingneng Xingtai Technology Co., Ltd.	
53		Carbon paper	State Power Investment Corporation Hydrogen Energy Technology Development Co., Ltd.	2
54			Antai Environmental Engineering Technology Co., Ltd.	
55		On-board hydrogen system	Beijing Kotec Technology Co., Ltd.	6
56			Beijing Tianhai Industry Co., Ltd.	
57			Beijing Peruihua Hydrogen Energy Technology Co., Ltd.	
58			Beijing Birken Energy Technology Co., Ltd.	
59			Beijing Haidelisen Technology Co., Ltd.	
60			Beijing Anruike New Energy Technology Co., Ltd.	
61	OEM		Beiqi Foton Motor Co., Ltd.	5
62			Beiqing Zhichuang (Beijing) New Energy Vehicle Technology Co., Ltd.	
63			Beijing New Energy Automobile Co., Ltd.	
64			Beijing Zhongji New Energy Automobile Co., Ltd.	
65			Changan Automobile Co., Ltd.	
66	Production, storage, transportation and addition of gaseous hydrogen		China Petroleum & Chemical Corporation Beijing Yanshan Branch	25
67			Beijing Huanyu Jinghui Jingcheng Gas Technology Co., Ltd.	
68			Beijing Huanyu Jinghui Gas Chemical Transportation Co., Ltd.	
69			Air Huatong (Beijing) Hydrogen Energy Technology Co., Ltd.	
70			Beijing Hypor Hydrogen Energy Technology Co., Ltd.	
71			Beijing Hyper Energy Management Co., Ltd	
72			China National Petroleum Corporation Beijing Sales Branch	
73			Sinopec Sales Co., Ltd. Beijing Petroleum Branch	
74			Beijing Green Hydrogen Technology Development Co., Ltd.	
75			Beijing Shougang Gas Co., Ltd.	
76			Beijing Haidelisen Technology Co., Ltd.	
77			Beijing Aishengde Hydrogen Energy Technology Research Institute Co., Ltd.	
78			China Chemical Science and Technology Research Co., Ltd.	
79			Mingyang Smart Energy Group Co., Ltd.	
80			Beijing Zhongke Fuhai Cryogenic Technology Co., Ltd.	
81			Antai Environmental Engineering Technology Co., Ltd.	
82			Beijing Haoyun Jinneng Technology Co., Ltd.	
83			CIMC Enric Holdings Co., Ltd.	
84			Qunyi Energy Co., Ltd.	
85			Beijing Sanying Hydrogen Energy Equipment Co., Ltd.	

S/N	Industrial chain link	Enterprise	Qty.
86		Research Institute of Youyan Engineering Technology	
87		101 Institute of the Sixth Aerospace Academy	
88		Beijing Haidelisen Technology Co., Ltd.	
89		China Power International Co., Ltd.	
90		Beijing Peruihua Hydrogen Energy Technology Co., Ltd.	
91	Vehicle operation	Beijing Shuimu Tongda Transportation Co., Ltd.	3
92		Anke Jieneng Technology Development Group Co., Ltd.	
93		Xiaoshizi (Beijing) New Energy Vehicle Leasing Co., Ltd.	

I-5 The DevCom FCV Project has seen investment of Beijing FCV industry chain and hydrogen energy totaling RMB 5.787 billion. By the end of the Project, durability of domestic FCVs has increased from 2,000 hours to 10,000 hours for passenger buses, and from 2,000 hours to 6,000 hours for cars and logistics vehicles. For fuel cell system, rated power has increased from 30 kW to 120 kW, power density has increased from 100 W/kg to 700 W/kg, efficiency has increased from 45% to 60% and cold start ability has increased from -10℃ to -35℃. Fuel cell engine system has decreased from RMB 15,000/kW - RMB 20,000 /kW to about RMB 5,000/kW. For 9 m passenger buses, the price has decreased by 51% from RMB 1.7 million/bus to RMB 0.83 million/bus (same configuration without subsidy); for 8t logistic vehicles, the price has decreased by 50% from RMB 1.15 million/vehicle to RMB 0.58 million/vehicle (same configuration without subsidy). The operating cost of fuel cell group commuter bus is about RMB 6.30/km (excluding manual labor), whose gap with that of fuel bus (RMB 5.54/km) is within 15%.

I-2. Hydrogen refueling systems in Beijing

I-6 Through implementation of DevCom FCV Project, hydrogen industry chain in Beijing has been continuously improved. At present, a mature hydrogen supply network has been basically formed in Beijing. At the same time, Beijing will explore hydrogen production by renewable energy on the basis of "exploring a green and zero-carbon energy system" as an opportunity to demonstrate during the 2022 Beijing Winter Olympic Games.

I-7 As of April 2021, Beijing has a total of six HRSs completed or put into operation under the DevCom FCV Project as listed in Table I-2. The total hydrogen refueling amount is 311.20 tons, including 225.28 tons produced by electrolytic water, 42.96 tons by natural gas, 25.78 tons by methanol decomposition, and 17.18 tons by chlor-alkali exhaust. Beijing Yanqingyuan HRS had been completed in 2020, which is an integrated station for hydrogen production and refueling, mainly providing hydrogen refueling services for group buses and logistics vehicles. This project covers an area of 5,622 m^2, providing 35 MPa/70 MPa HRS with a daily hydrogen refueling capacity of over 1,000 kg (500kg per 12h for 35MPa and 70MPa stations, respectively). At present, it has 35 MPa refueling capacity, and is expected to achieve 70 MPa refueling capacity by September 2021. At the same time, a supporting hydrogen production station (hydrogen production from wind power electrolysis) is under construction, with an expected hydrogen production capacity of 500kg per day, which will meet part of the demands of the HRS.

I-8 Beijing is densely populated with in land issues for locating HRSs. If the HRS applies for commercial operation, it must apply for commercial land in construction. If the station is built on less expensive industrial land, the completed station can only be used for hydrogen refueling or experiment for fuel cell vehicles inside the operation system or is not open to commercial operation. Beijing started to explore a flexible construction model of gasoline and HRSs to resolve problems in land construction. At the same time, relevant enterprises are looking for appropriate land. Except for the HRSs that are completed or under construction, there are 15 independent HRSs filed or planned in Beijing.

Table I-2: Construction of HRSs in Beijing including planning and operation (as of April 2021)

S/N	Area	Name of HRS	Completion time	Current status	Supplying capacity (kg/d)	Major equipment supplier
1	Haidian	Yongfeng HRS	2006	Operation	1000	Hydrosys
2	Yanqing	Yanqing Park HRS (Phase I)	2020	Operation	500	Henan Yuqing
3	Fangshan	Huanyu Jinghui HRS (Doudian)	2019	Operation	500	PERIC Hydrogen
4	Fangshan	Huanyu Jinghui Skid-Mounted HRS	2019	Completed	500	PERIC Hydrogen
5	Daxing	HRS of Daxing Hydrogen Energy Demonstration Park	2021	Completed	4800	Air Liquide
6	Fengtai	Liquid HRS of Beijing Aerospace 101 Institute	2019	Completed	400	/
7	Changping	Futian Ouhui Skid-Mounted HRS	2020	Under construction	260	Hydrosys
8	Yanqing	No. 919 Bus Terminal HRS (Qingyuan Street HRS)	/	Filed	/	Censtar
9	Yanqing	Xingkang Gasoline and HRS	/	Filed	/	Censtar
10	Yanqing	Yanqing Park HRS (Phase II)	/	Planning	/	Air Liquide
11	Fangshan	Doudian HRS	/	Planning	1000	/
12	Daxing	Daxing International Airport HRS	/	Planning	/	/
13	Shunyi	Beijing Capital International Airport No. 1 HRS	/	Planning	/	/
14	Shunyi	Beijing Capital International Airport No. 2 HRS	/	Planning	/	/
15	Yanqing	Jinlong HRS	/	Planning	/	/
16	Yanqing	West Badaling HRS	/	Planning	/	/
17	Yanqing	East Badaling HRS	/	Planning	/	/
18	Yanqing	Jingfulong HRS	/	Planning	/	/
19	Yanqing	Changyan HRS	/	Planning	/	/
20	Yanqing	Taiping Jingzhang HRS	/	Planning	/	Censtar
21	Yanqing	Yanhua Xinglong HRS	/	Planning	/	Censtar
22	Yanqing	Songlixin HRS	/	Planning	/	Censtar
23	Fangshan	Sinopec Yanshan Skid-Mounted HRS	/	Planning	500	/
24	Changping	Wangfu Gasoline and HRS	/	Planning	/	/
25	Changping	Gasoline and HRS at the Intersection of Beijing-Tibet Expressway of North Sixth Ring	/	Planning	/	/

I-9 At present, there is limited space surrounding the gas stations within the 6th Ring Road in Beijing. According to Code for Design and Construction of Automobile Refueling Stations (GB50156-2012 (2014)), the safety distance between the refueling stations and the surrounding buildings shall range from 30 m to 100 m based on the volume of gas tank, making it more difficult to construct or expand gasoline and HRSs within the 6th Ring Road in Beijing. In response to this issue, Beijing Municipal Science & Technology Commission accelerated the overall layout planning of HRSs. In addition, Sinopec signed relevant strategic agreements with SinoHytec, to carry out comprehensive, in-depth cooperation in terms of combined construction of gasoline and HRSs.

I-10 There is an "Implementation Plan for Development of Hydrogen Energy Industry in Beijing City (2021-2025)" issued by Beijing Municipal Government for the development of hydrogen energy in the future:

- By 2023, 5 to 8 leading enterprises in the hydrogen energy industrial chain with international influence will be cultivated relying on the major demonstration projects of the Winter Olympics and Paralympics. The industry scale of hydrogen energy industrial chain in Beijing-Tianjin-Hebei Region will total over RMB 50 billion. Flexible construction models such as HRSs and combined gasoline and HRSs will be promoted, and will strive to complete 37 HRSs;
- By 2025, the foundation for large-scale promotion of hydrogen energy industry will be laid, the hydrogen energy industrial system and supporting infrastructure will be improved, and 10 to 15 leading enterprises in hydrogen energy industrial chain with international influence will be cultivated, to form an industrial cluster of key components and equipment manufacturing in hydrogen energy industry. Three to four world-class hydrogen energy industrial R&D and innovative platforms will be established. The Beijing-Tianjin-Hebei Region will achieve a total industrial scale of more than RMB 100 billion in hydrogen energy industrial chain. At the same time, it will explore a business model of HRS construction on a larger scale and strive to complete the 37 new HRSs.

I-3. Beijing local policies

I-11 Beijing has issued 18 local policies, and 33 National Standards (with the participation of Beijing) since the DevCom FCV Project. Details are on Tables I-3 and I-4. Table I-5 shows national standards still to be approved by Beijing.

Table I-3: Beijing Local Policies

S/N	Level	Policy name	Issued on	Issued by
1	Municipal level	Implementation Plan for Development of Beijing's Hydrogen Energy Industry (2021-2025) (Draft for Solicitation of Comments)	April 2021	Beijing Municipal Bureau of Economy and Information Technology
2	Municipal level	Development Plan of FCV Industry in Beijing (2020-2025)	September 2020	Beijing Municipal Bureau of Economy and Information Technology
3	Municipal level	Notice by Beijing Municipal Commission of Urban Management on Accelerating the Construction of HRS Project	September 2020	Beijing Municipal Commission of Urban Management
4	Municipal level	Notice by Beijing Municipal Commission of Urban Management on Issuing the Implementation Rules of Construction and Operation Subsidies for HRSs for Hydrogen FCVs in Beijing	November 2020	Beijing Municipal Commission of Urban Management

S/N	Level	Policy name	Issued on	Issued by
5	Municipal level	Financial Subsidy Policies for Promotion and Application of FCVs in Beijing	November 2020	Beijing Municipal Finance Bureau
6	Municipal level	Opinions on Supporting Technical Innovation of FCVs	November 2020	Beijing Municipal Science & Technology Commission
7	Municipal level	Action Plan for Promotion and Application of New Energy Smart Vehicles in Beijing (2018-2020)	December 2018	Beijing Municipal Science & Technology Commission
8	District level	Interim Measures of Promoting Development of Hydrogen Energy Industry in Daxing District	December 2020	The People's Government of Daxing District
9	District level	Interim Measures of Promoting Development of High-tech Industry in Daxing District	August 2020	The People's Government of Daxing District
10	District level	Implementation Opinions of Promoting Transfer and Transformation of Scientific and Technological Achievements in Daxing District	July 2019	The People's Government of Daxing District
11	District level	Opinions on Further Strengthening the Construction of Young Talent Group	December 2018	Daxing District Committee of CPC, Beijing Municipality
12	District level	Measures of Training and Supporting Outstanding Young Talents in Daxing District	December 2018	Daxing District Committee of CPC, Beijing Municipality
13	District level	Interim Measures of Promoting Development by Introducing High-tech Enterprises into Daxing District	December 2018	The People's Government of Daxing District
14	District level	Guiding Opinions on Promoting Industrial Development in Daxing District	April 2018	The People's Government of Daxing District
15	District level	Measures of Supporting Services and Introduction of Key Enterprises in Haidian District	June 2012	The People's Government of Haidian District
16	District level	Targeted Support Measures of Promoting Development of Major Industrial Projects in Shunyi District	December 2019	The People's Government of Shunyi District
17	District level	Supporting Measures of Promoting Development of Entering Enterprises in Shunyi District	August 2017	The People's Government of Shunyi District
18	District level	Management Measures of Science and Technology Innovation Fund in Beijing Economic-Technological Development Area	September 2019	Management Committee of Beijing Economic-Technological Development Area

Table I-4: Issued National Standards with participation of Beijing (2016-2021)

S/N	Standard name	Participating Units (Beijing Enterprises)	Issued on
1	GB/T 26779-2021 Fuel Cell Electric Vehicles - Refueling Receptacle	China Automotive Technology & Research Center Co., Ltd., Beijing SinoHytec Co., Ltd.	2021
2	GBT38914-2020 Evaluation Method for Lifetime of Proton Exchange Membrane Fuel Cell Stack in Vehicle Application	Tsinghua University, Innoreagen Power Technology Co., Ltd., Beijing SinoHytec Co., Ltd.	2020
3	GBT38954-2020 Hydrogen Fuel Cell Power System for Unmanned Aerial Vehicles	Innoreagen Power Technology Co., Ltd., Machinery Industry Beijing Electrotechnical Institute of Economic Research, SEARI, Beijing SinoHytec Co., Ltd.	2020
4	GB T 36288-2018 Fuel Cell Electric Vehicles-Safety Requirement of Fuel Cell Stack	Machinery Industry Beijing Electrotechnical Institute of Economic Research, Innoreagen Power Technology Co., Ltd., Beijing Qingpuchuang Energy Technology Co., Ltd.	2019
5	GB/T37562-2019 Technical Conditions for Pressurized Water Electrolysis System for Hydrogen Production	Beijing University of Chemical Technology, China National Institute of Standardization, Pudun (Beijing) Hydrogen Technical Co., Ltd.	2019
6	GB/T37563-2019 Safety Requirements for Pressurized Water Electrolysis System for Hydrogen Production	China National Institute of Standardization, Beijing University of Chemical Technology, Pudun (Beijing) Hydrogen Technical Co., Ltd.	2019
7	GB/T 36544-2018 Supply System for Proton Exchange Membrane Fuel Cells for Transformer Substations	Innoreagen Power Technology Co., Ltd.	2018
8	GB/T 37154-2018 Fuel Cell Electric Vehicles - Test Methods of Hydrogen Emission	China Automotive Technology and Research Center Co., Ltd.	2018
9	GB⁄T 37244-2018 Fuel Specification for Proton Exchange Membrane Fuel Cell Vehicles—Hydrogen	China National Institute of Standardization	2018
10	GB⁄T 34542.2-2018 Storage and Transportation Systems for Gaseous Hydrogen - Part 2: Test Methods for Evaluating Metallic Material Compatibility in Hydrogen Atmosphere	China National Institute of Standardization, Beijing Haidelisen Technology Co., Ltd., Institute of Metal Research, Chinese Academy of Sciences	2018
11	GB/T 34542.3-2018 Storage and Transportation Systems for Gaseous Hydrogen - Part 3: Test Methods for Determination of the Susceptibility	Beijing Haidelisen Technology Co., Ltd., China National Institute of Standardization	2018
12	GB/T 34425-2017 Fuel Cell Electric Vehicles - Hydrogen Refueling Nozzle	China Automotive Technology & Research Center Co., Ltd., Beijing SinoHytec Co., Ltd.	2017
13	GB/T 34542.1-2017 Storage and Transportation Systems for Gaseous Hydrogen - Part 1: General Requirements	China National Institute of Standardization, Beijing Haidelisen Technology Co., Ltd.	2017
14	GB/T 34544-2017 Safety Test Methods for Onboard Low Pressure Hydrogen Storage Devices for Small Fuel Cell Vehicles	China National Institute of Standardization, GRINM Group Corporation Limited, Beijing Haidelisen Technology Co., Ltd.	2017

S/N	Standard name	Participating Units (Beijing Enterprises)	Issued on
15	GB/T 34582-2017 Single Cell/Stack Performance Test Methods For Solid Oxide Fuel Cells (SOFC)	Tsinghua University	2017
16	GB/T 34583-2017 Safety Technical Requirements for Hydrogen Storage Devices used in Hydrogen Refueling Station	China National Institute of Standardization, Beijing Haidelisen Technology Co., Ltd.	2017
17	GB/T 34584-2017 Safety Technical Regulations for Hydrogen Refueling Station	China National Institute of Standardization, Tsinghua University, Beijing Haidelisen Technology Co., Ltd., Beijing SinoHytec Co., Ltd.	2017
18	GB/T 34593-2017 Test Methods of Hydrogen Emission for Fuel Cell Engine	China Automotive Technology & Research Center	2017
19	GB/T 34872-2017 Technical Requirements of Hydrogen Supply System for Proton Exchange Membrane Fuel Cells	Beijing SinoHytec Co., Ltd.	2017
20	GB/T 35178-2017 Fuel Cell Electric Vehicles - Hydrogen Consumption - Test Methods	China Automotive Technology & Research Center, Tsinghua University	2017
21	GB/T34537-2017 Hydrogen and Compressed Nature Gas (HCNG) Blended as Vehicle Fuel	Tsinghua University, China National Institute of Standardization, Beijing Tianhai Industry Co., Ltd., Beijing Huaqing Co., Ltd.	2017
22	GB/T34539-2017 Safety Requirements on Hydrogen-Oxygen Generator	Beijing Heyuan Tianli Technology Co., Ltd.	2017
23	GB/T 35544-2017 Fully-wrapped Carbon Fiber Reinforced Cylinders with an Aluminum Liner for the On-Board Storage of Compressed Hydrogen as a Fuel for Land Vehicles	Beijing Tianhai Industry Co., Ltd., Beijing Kotec Technology Co., Ltd., China National Institute of Standardization, Beijing Haidelisen Technology Co., Ltd.	2017
24	GB/T 23751.2-2017 Micro Fuel Cell Power Systems - Part 2: Performance Test Methods	Beijing Qunling Energy Technology Co., Ltd.	2017
25	GB/T 27748.1-2017 Stationary Fuel Cell Power System - Part 1: Safety	Tsinghua University	2017
26	GB/T 27748.3-2017 Stationary Fuel Cell Power System - Part 3: Installation	Beijing SinoHytec Co., Ltd.	2017
27	GB/T 27748.4-2017 Stationary Fuel Cell Power System - Part 4: Performance Test Methods for Small Fuel Cell Power Systems	Beijing Qunling Energy Technology Co., Ltd.	2017
28	GB/T 33978-2017 PEM Fuel Cell Module for Road Vehicle	Tsinghua University, Beijing SinoHytec Co., Ltd.	2017
29	GB/T 33979-2017 Test Method of Proton Exchange Membrane Fuel Cell System Properties at Sub-Zero	Tsinghua University, Beijing SinoHytec Co., Ltd.	2017

S/N	Standard name	Participating Units (Beijing Enterprises)	Issued on
30	GB/T 33983.2-2017 Direct Methanol Fuel Cell System - Part 2: Performance Test Method	Machinery Industry Beijing Electrotechnical Institute of Economic Research	2017
31	GB/T 34540-2017 Specification of Hydrogen Production by Methanol Reforming and Pressure Swing Adsorption	China National Institute of Standardization	2017
32	GB/Z 34541-2017 Safety Operation Management Regulation for Hydrogen Fueling Facilities Of Hydrogen Vehicles	Beijing SinoHytec Co., Ltd., Beijing Jiuantong Technology Co., Ltd.	2017
33	GB/T 33292-2016 Metal Hydride Hydrogen Storage System for Fuel Cells Backup Power	GRINM Group Corporation Limited, China National Institute of Standardization, Tsinghua University, Beijing Jiuantong Hydrogen Energy Technology Co., Ltd.	2016

Table I-5: Beijing Standards in Research and Demonstration

Standard	Standard name
National standard	Fuel Cell Electric Vehicles - Onboard Hydrogen Systems - Technical Conditions
National standard	Fuel Cell Electric Vehicles - Onboard Hydrogen Systems - Test Methods
National standard	Post-crash Safety Requirements for Fuel Cell Electric Vehicles
National standard	Communication Protocol for Refueling Receptacle of Fuel Cell Vehicles
National standard	Test Methods for Air Compressor of Fuel Cell Electric Vehicles
National standard	Specifications for Hydrogen Circulating Pump of Fuel Cell Electric Vehicles
National standard	Air Filters for Fuel Cell Electric Vehicles

I-4. Capacity building and awareness raising programs in Beijing

I-12 The number of people trained in the Project was 4,905 (see Table 7). Currently, there are 403 people trained to operate and maintain FCVs and 44 people who were trained to able to operate and maintain HRSs in Beijing. The demonstration operation has cultivated an experienced O&M team to provide for the rapid development of hydrogen energy industry. The management training consists of the consists of the design, development, products, testing, software, and the workers' training consists of the assembly, safety, driving. The demonstration operation also trained high-end talents in the field of fuel cells. For example, project members have been selected into the national "Ten Thousand Plan", the "Science and Technology Innovation and Entrepreneurship Talents" of the Ministry of Science and Technology, the "Capital Science and Technology Leading Talents" of Beijing Science and Technology Commission, Zhongguancun's "High-end Leading Talents" and Haidian Park's "Young Talents".

Table I-6: Number of people trained in the project

Total number	Female	Male	Management personnel trained (person-time)	Technical personnel trained (person-time)	Workers trained	Other
4905	1500	3405	1076	2922	907	/

I-13 During the demonstration period, the total investment of hydrogen energy and FCV industry chain in Beijing reached about RMB 5.787 billion, including R&D expenditure, fixed assets, production line investment, completing the transformation from laboratory pilot test and pilot test to initial scale. SinoHytec's listing on the science and technology innovation board has also broken through a new financing channel for hydrogen energy-related enterprises, encouraged the confidence of the industry, and indirectly promoted the attention and investment of the capital market for the fuel cell industry.

I-5. Training related to China FCV market and technology monitoring systems in Beijing

I-14 During the implementation of the DevCom FCV Project, the Beijing Institute of Technology New Energy Information Co, Ltd built a national demonstration operation platform for FCVs. The platform provides comprehensive business data services based on FCV supervision and can provide proprietary business data intelligent transmission channels and data value-added services for different application systems. This includes standardized conversion of data from vehicle enterprises and transmission to various application systems as well as the simultaneous transmission of data to national regulatory authorities.

I-15 Through communication, information, electronic control, network, positioning, GIS and other technologies, the platform aims to realize the information of safety monitoring and operation management of fuel cell, build an integrated operation management platform, strengthen the data collection, statistical analysis, tracking inspection of fuel cell operation, provide strong data support and technical support in improving the durability and performance and reducing the cost of fuel cell, lay a solid technical foundation and data support for the large-scale promotion of FCV, and the promotion of the commercialized development of FCV in China

I-16 By completing access of all new FCVs, including the import of vehicle-related registration information, license plates, regions and other information, the promotion and operation of vehicles in various regions, provinces and cities are comprehensively and intuitively monitored, providing important data support for vehicle enterprises, governments, financial institutions, etc. to understand FCV market in China. Through data collection, statistical analysis and in-depth mining of FCV operating mileage, operating time, fault alarm and type, the development of China's fuel vehicle technology level has been continuously developed to provide data support and technical support for FCV manufacturers and components manufacturers in improving their product performance, technical level and reducing cost.

I-17 The future of capacity building programs in Beijing for the FCV and HRS consists of the following:

- Daxing International Hydrogen Energy Demonstration Zone is next to Daxing International Airport, JD.COM "Asia No.1", Jingnan Logistics Base, and other important transportation hubs. The Daxing International Hydrogen Energy Demonstration Zone can enjoy Zhongguancun, national innovation policy, and the integrated "three-zone " policy of airport zone, free trade zone, and comprehensive bonded zone. Phase I of the demonstration zone plans on building a demonstration station with a daily hydrogen refueling capacity of 4.8 tons, the largest capacity in the world. At the same time, it will be transformed into a hydrogen energy science and technology experience exhibition hall integrating hydrogen energy achievements and enterprise products into a "Hydrogen Spring" theme science and technology park;
- The existing government investment funds will be fully utilized to attract and encourage qualified support the development of the hydrogen FCV industry. Beijing will further allocate resource to enhance market viability and stimulate the potential of the FCV; build bank-enterprise docking platform to encourage and guide financial institutions to increase financial support for key projects of enterprises in hydrogen FCV industry; support enterprises to finance good ventures, and support the listing and financing of enterprises such as OEMs, key components enterprises and other FCV related industry chain.

APPENDIX I – SHANGHAI DEMONSTRATION CITY REPORT

J-1. Pilot demonstrations and support to Shanghai's FCV component manufacturers

J-1 Shanghai is the industrial center of China, and the automobile industry is one of its pillar industries. SAIC Motor's automobile production and sales have topped the Chinese automobile market for many years. Shanghai has many internationally and domestically well-known universities and research institutes, which led to strong talent base. Since 2001, School of Automotive Studies of Tongji University has undertaken a series of national research and development projects on key technologies of fuel cell vehicles (FCVs), cooperated with relevant enterprises, scientific research institutions and SAIC Motor to jointly research and develop FCV-related technologies, and cultivated a number of fuel cell industry chain enterprises. Shanghai, as one of the earliest cities in China to participate in the construction of hydrogen energy and fuel cells, has participated in the Phases I, II and III demonstration projects of GEF/UNDP/MOST's "Promoting Commercial Development of China's Fuel Cell Electric Vehicles" Project since 2003, and carried out small-scale demonstration activities of FCVs during the 2008 Beijing Olympic Games and the 2010 Shanghai World Expo. Shanghai. The city has the foundation of developing hydrogen energy industry, and its industrial chain system is very complete including upstream hydrogen energy industry, midstream fuel cell key components enterprises, and downstream vehicle manufacturing enterprises. In addition, Shanghai has a number of vehicle operators with rich operation experience.

J-2 In 2003, Shanghai participated in UNDP/GEF Phase I Project and provided the supporting funds for the project, and Tongji University took the lead in carrying out the pre-research work of implementing FCV demonstration operation activities in Shanghai. During the 2008 Beijing Olympic Games, 20 Passat Fuel Cell Cars of Shanghai Volkswagen provided transportation services for the Olympic Games, with a total of 970 trips and a total driving distance of 73,000 kilometers. After the Olympic Games, 16 of the fuel cell cars continued to carry out demonstration operation in California for half a year. On 15 November 2007, UNDP/GEF Phase II Project was launched in Shanghai. In October 2008 with SAIC Motor provided 6 fuel cell buses that operated for 192,853 km and transported 106,040 passengers. In addition, these buses also participated in the transportation services of the Expo Park in 2010 during which the fuel cell buses had a hydrogen consumption of 10.1kg/100km, and the fuel cell system's service life was not more than 4,000 hr. To ensure the demonstration operation of the FCVs, Shanghai Anting Hydrogen Refueling Station was placed into service in 2007. The supplied hydrogen was mainly recovered, separated and purified from coke oven gas and other auxiliary hydrogen industrial tail gas which were transported to the HRS by tank trucks. Through the implementation of the above-mentioned series of projects, Shanghai has achieved functional results in the design and integration of FCVs and the construction and operation of HRSs.

J-3 Through the implementation of Phases I, II and III, the technical level of FCVs and HRSs has been greatly improved, and rich experience has been accumulated in demonstration operation. FCVs have certain advantages in terms of output power, driving range, fuel filling efficiency and carbon emission, which is conducive to sustained and efficient operation of vehicles.

J-4 With regards to assistance to component manufacturers, Shanghai has introduced world-leading technical resources of fuel cell components and carried out localized production and manufacturing. In 2018 and 2019, a large number of fuel cell related enterprises became established. At present, there are about 70 hydrogen energy and fuel cell industry chain related enterprises in Shanghai, with progress being made in key raw materials and the improved research capability. At present, the power of fuel cell stacks produced by local enterprises in Shanghai has reached 150 kW. In terms of durability of FCVs, the hours of buses, logistics vehicles and passenger cars have increased from 2,000 hours to 10,000 hours, 12,000 hours and 10,000 hours respectively. Shanghai Jieqing Technology Co., Ltd., Shanghai Qingchen New Energy Technology Co., Ltd., Shanghai Yunliang New Energy Technology Co., Ltd. and other enterprises have developed stacks with independent intellectual property rights, with mass power density exceeding 3 kW/L and quota power covering 60-150 kW; Shanghai Refire Energy Technology Co., Ltd. has realized the research and production of a full range of fuel cell systems in the range of 32 kW-110 kW.

Table J-1: Enterprises Related to FCV Industry Chain in Shanghai

Industrial chain	Major enterprises
Hydrogen production/supply	Shanghai Huayi, Baowu Clean Energy, Linde Gas, Air Liquide, Air Products and Chemicals, Shanghai Chemical Gas, Shanghai Baoqing Gas
Hydrogen refueling station (HRS)	Shanghai Yilan, Shanghai Qingfeng, Shanghai Jiaqing Industry, Sinopec Shanghai Branch and PetroChina Shanghai Branch
Key parts (system, stack, membrane electrode, bipolar plate, catalyst, proton exchange membrane, carbon paper, air compressor, hydrogen circulation system, hydrogen storage system, etc.)	Shanghai Jieqing, Shanghai Refire, Shanghai Shenli, Shanghai Panye, Shanghai Fuel Cell Vehicle Powertrain, Shanghai Jiening, Shanghai Qingneng, Shanghai Fuersai, Shanghai Xinyuan, Shanghai Shunhua, Shanghai Dajun, Shanghai Jingjin Electronics, Shanghai Electric Drive, Shanghai Tonghu Electric, Shanghai Qingchen, Aerospace Qingneng, Shanghai Jichong, Shanghai Tangfeng, Shanghai Yiqing, Shanghai Guandi, Shanghai Zhizhen, Fengqingqing, Qingqing, Shanghai Yipu, Yihejie
OEM	SAIC Motor, SAIC MAXUS, Shanghai Shenlong, Shanghai Sunwin, Shanghai Wanxiang
Vehicle operator	Qingche Shulu, Huanqiu Chexiang, Shanghai Yidong, Jiading Bus, Shunxiang Bus, Shanghai Post, Fengxian Bus, Fengxian Keyun, Shanghai Niuji

J-5 Through the implementation of the DevCom FCV Project, the number of FCVs promoted and operated in Shanghai has reached 1,483, accounting for about 22% of the whole country, and the cumulative investment has exceeded RMB 50 billion. The sales of FCVs increased year by year, with 31 in 2016, 570 in 2017, 363 in 2018, 403 in 2019 and 116 in 2020, totaling 1,483 vehicles, with an average annual growth rate of 163%.

J-6 The implementation of the UNDP/GEF DevCom FCV Project has improved the technical capability of Chinese FCV manufacturers and broadened the international procurement channels, thus enhancing the technical capability of FCV parts manufacturers. By the end of the project, the average annual running time of FCVs was 3,300 hours for buses and 2,100 hours for cars and logistics vehicles; the durability of domestic FCVs has increased from 2,000 hours to 10,000 hours for buses, and from 2,000 hours to 6,000 hours for cars and logistics vehicles; the actual production cost and scale production cost of a single domestic fuel cell bus are USD 380,000 and USD 190,000, respectively, while those of a single domestic fuel cell car are USD 60,000 and USD 36,000, respectively, and the scale production cost is reduced by 50% for buses and 40% for cars.

J-7 The fuel cell system of the fuel cell buses in the DevCom FCV Project adopts power balance control strategy, and its net output power is more than 60kW, which is higher than that in Phase II project. The durability of the buses has increased from 2,000 hrs to 10,000 hrs. In addition, the vehicles have been significantly improved in terms of vehicle weight and fuel economy compared with Phase II.

J-8 Shanghai has formed seven FCV manufacturers represented by SAIC Motor Corporation Limited (Passenger Car), SAIC MAXUS Automobile Co., Ltd. (Passenger Car, Minibus), Shanghai Shenlong Bus Co., Ltd. (Bus, Logistics Vehicle), Shanghai Sunwin Bus Corporation (Bus), Shanghai Wanxiang Automobile Manufacturing Co., Ltd. (Bus), SAIC Yuejin Automobile Co., Ltd. (Light Truck) and SAIC-IVECO Hongyan Commercial Vehicle Co., Ltd. (Heavy Truck). SAIC MRXUS launched China's first fuel cell passenger car, EUNIQ 7. The number of declared FCV models of FCV manufacturers in Shanghai that have been approved and announced has reached 44, which basically covers all vehicle models including passenger car, minibus, logistics vehicle, bus and heavy truck, and some of them have been mass-produced and demonstrated.

Table J-2: FCV Production in Shanghai

Vehicle model	Representative enterprises	Basic conditions
Passenger car	SAIC Motor	SAIC Roewe 950, the first fuel cell passenger car in China, takes the lead in adopting technologies such as metal plate stack and 70MPa high-pressure hydrogen storage system.
	SAIC MAXUS	SAIC MAXUS's EUNIQ7 MPV is the first fuel cell MPV in China, whose core performance indexes are benchmarked with Toyota's Mirai, and has obtained the announcement.
Bus	SAIC MAXUS	SAIC MAXUS's FCV80 is the first fuel cell minibus in China, which has been demonstrated in many places such as Shanghai and Fushun in the early stage and sold 407 vehicles nationwide.
	Shanghai Sunwin	Sunwin fuel cell buses won the bid for 6 fuel cell buses of UNDP-GEF DevCom FCV Project in the early stage, which have been put into operation at Jiading Bus No.114.
	Shanghai Wanxiang	It completed the development of power-balanced fuel cell city buses in 2019 and obtained the national announcement. It has the development and production capacity of full-range and full-meter section fuel cell buses.
Truck	SAIC Maxus, Shenlong Bus, etc.	Based on the linkage mode of "bus-station-scenario", Yuejin FC500 trucks (announcement obtained) and Shenlong fuel cell logistics vehicles, etc., have actively expanded the scenarios such as urban distribution field and port/dock short barge, and 810 vehicles have been sold nationwide.

J-9 Shanghai has strong vehicle production capacity. It has gathered a number of high-quality FCV stack, system and core parts enterprises, which has laid a solid foundation for the development of FCV model platform. At present, there are 8 FCV production lines in Shanghai: SAIC Roewe 950 passenger car production line, Maxus EUNIQ7 MPV production line, Maxus FCV80 minibus production line, SAIC Yuejin FC500 truck production line, Sunwin 12m/10.5m bus production line, Shenlong fuel cell bus/logistics vehicle production line, Wanxiang fuel cell bus production line and Hongyan fuel cell heavy truck production line.

J-2. Hydrogen refueling systems in Shanghai

J-10 The implementation of GEF/UNDP DevCom FCV Project has effectively promoted the continuous improvement of the automotive hydrogen industry chain in Shanghai, notably with renewable energy as a source of hydrogen fuel. At present, a mature and stable hydrogen supply network has been basically formed in Shanghai, which has a certain hydrogen supply and timeliness guarantee capability. However, renewable energy is scarce in Shanghai with its potential renewable energy hydrogen production methods being biomass hydrogen production, external transfer of hydropower and deep-sea wind power hydrogen production. At present, relevant government departments and enterprises in Shanghai are promoting the implementation of related projects. For example, Shanghai Laogang Domestic Waste Landfill is actively carrying out the project of biomass energy hydrogen production, and SPIC plans to transfer hydropower of western China to produce hydrogen by electrolyzing water during valley period of power consumption.

J-11 Currently, the hydrogen source in Shanghai is mainly industrial by-product hydrogen and hydrogen by natural gas reformation. The annual production capacity is 450,000 tons, and 9 HRSs have been built. In the future, 60 HRSs are planned to be built, and the HRSs will mainly be distributed in areas close to application scenarios to improve the convenience and economy of HRSs. During the project period, the cost of hydrogen in Shanghai is 60-70 RMB/kg (the cost of hydrogen from hydrogen plant to HRS is 35 RMB/kg, and the operating cost of HRS is about 35 RMB/kg), which the utilization rate of hydrogen transportation by tank trucks is only two-thirds, and there is still a board fee problem. Through technical improvement, equipment localization, pipeline transportation and scale-up measures, the future hydrogen cost in Shanghai is expected to drop to about 55 RMB/kg. At present, most HRSs in Shanghai are operating at a loss. Currently, the profitable HRSs are mainly those located in the chemical area. The main profitable business is not from the hydrogen filling for fuel cell demonstration vehicles, but through the wholesale supply of hydrogen to the surrounding HRSs or hydrogen users.

J-12 To accelerate the construction, approval and management of HRSs with the cooperation of Shanghai Market Development and Reform Commission, Shanghai Finance Department, Shanghai Commission of Economic and Information Technology, Shanghai Science and Technology Commission, Shanghai Planning and Resources Bureau, Shanghai Ecological Environment Bureau, Shanghai Transportation Commission, Shanghai Emergency Management Bureau and Shanghai Market Supervision Bureau, the Shanghai Housing and Urban-Rural Development Committee took the lead in drafting the "*Interim Measures for the Administration of Temporary Business License of Automobile HRS in Shanghai*", which was issued in 2019. It is applicable to the application, acceptance, examination and approval, certificate issuance and related supervision and management of the business license of automobile HRS within the administrative district of Shanghai. The measures define the centralized management of HRSs: that is, Shanghai plans to take the HRSs and hydrogen in Shanghai as part of the city gas management of vehicle fuel.

J-13 The process of building HRS by Shanghai enterprises is as follows: ① Go to the Development and Reform Commission or Administrative Committee of the District for project filing; ② Go to the regulatory department to apply for the construction land planning permission and construction project planning permission (planning and site selection opinions). If the enterprise has the public support from the local government, it can carry out the corresponding planning, site selection and construction work in advance according to the planning and site selection opinions; ③ Apply for an EIA review, civil air defense review, construction drawing review (including fire protection design review) and lightning protection device (meteorological department) to the corresponding ecological environment department, civil air defense department, housing construction department and meteorological department respectively; ④ Go to the Ministry of Housing and Urban-Rural Development for construction permit; ⑤ After the completion of the construction, a special project acceptance is organized by the relevant functional departments; ⑥ After the acceptance, the enterprise can apply for a temporary gas operation license (hydrogen for vehicles) to the Municipal Housing and Construction Committee, and then the operation can be carried out formally; ⑦ After eleven months, the enterprise shall apply to continue operation in the next year.

J-14 In addition, the *Measures for the Administration of Hydrogen Filling Stations in Shanghai* also brings forward detailed requirements for enterprise management personnel, enterprise safety management personnel, enterprise technical leaders, HRS sites, HRS staff, hydrogen gas sources, cylinder filling licenses, safety evaluation reports, and also explains the revocation, cancellation and change of enterprise business license, and the suspension, shutdown or closure of HRSs.

J-15 The implementation of the UNDP-GEF DevCom FCV Project coincides with the commercialization of China's FCV industry, when the enterprises and the market are developing rapidly, and the public's awareness of FCVs is greatly improved. However, there is an accompanying issue that support services such as technological development and industrial policies lag behind market development.

J-16 During the implementation of the project, the construction of HRS served as an essential link in the promotion and application of FCVs. Conversely, it is also regarded as one of the main bottlenecks that restrict the development of FCV industry. The bottleneck of the problem is the obstacle of the government management system. At present, hydrogen is a hazardous chemical, which is managed by the emergency management department according to the function, while the urban gas managed by the Housing Construction Committee only includes LPG, CNG and artificial gas. From the perspective of management planning and construction, the main difficulties in the construction of HRSs lies in unclear approval process and difficulty in site selection. Shanghai solves the problem mainly through the following ways:

- First, the municipal government held a special meeting to clarify the competent department for HRSs. In May 2019, the Shanghai Municipal Government held a special meeting to study the promotion of the development of hydrogen FCVs. It pointed out that the layout of HRSs should be moderately advanced and focused on making it clear that Shanghai Municipal Commission of Housing and Urban-Rural Development is responsible for the approval and management of the construction of HRSs. In addition, the meeting promulgated the municipal measures for the approval and management of the construction of HRSs. Before the promulgation of the measures, the Municipal Commission of Housing and Urban-Rural Development needed to take the lead in carrying out the work of "one station, one discussion".
- Second, make special plans, promote oil-hydrogen joint construction, and solve the difficulties in site selection of HRSs. The decrease of urban land supply, especially the scarcity of land supply in Shanghai, makes it difficult to obtain land for project construction and the land cost high. With the country vigorously promoting the application of new energy and gradually controlling oil and reducing coal, traditional gas stations will develop towards comprehensive energy supply stations. In July 2019, Jiading District took the lead in starting the layout and site selection planning of HRSs in Jiading District, focusing on the layout of oil-hydrogen combined stations. It is planned to build 18 HRSs by 2025, including 12 oil-hydrogen combined stations by Sinopec. At the end of 2019, Shanghai also launched a special layout plan for automotive HRSs,

planning to build 69 HRSs in the city, including 46 oil-hydrogen combined stations. Make full use of the existing gas station network, learn from Sinopec's construction mode of oil-hydrogen combined stations, and guide the traditional gas stations to develop towards integrated energy supply stations. Meanwhile, start the formulation of policies such as the Interim Measures for the Construction, Operation and Management of Automobile Hydrogen Filling Stations, strengthen the top-level design of HRS construction, establish a promotion coordination mechanism, clarify the division of labor, strengthen the guidance, and complete the site selection and construction promotion of HRSs on a yearly basis.

- Third, adhere to the "vehicle-station-scenario" linkage operation mode. During the demonstration period of the project, in order to meet the hydrogen filling demand of demonstration vehicles and solve the problem of shortage in HRS resources, combined with the market demand of vehicle landing operation, we actively encouraged vehicle operators and HRS construction and operation enterprises to join hands to explore new operation scenarios, expand the terminal market scope, develop stations synchronously, so as to quickly and effectively break the dilemma of shortage in HRSs, and achieve the phased objectives of the demonstration operation project.

J-17 At present, this set of management methods formed in Shanghai has been extended to other cities, such as Dezhou in Shandong Province.

J-18 In terms of future investments in HRS, the capital of hydrogen energy investment in Shanghai is dominated by central enterprises, such as Sinopec, PetroChina and SPIC, which have already accelerated the layout of hydrogen filling industry chain. After the hydrogen production project is completed, it will continue to promote the in-depth development of hydrogen energy and FCV industry. During the 14th Five-Year Plan period, the development of FCV industry in Shanghai will achieve the strategic goal of "100 stations, 100-billion scale and 10,000 vehicles": nearly 100 HRSs have been planned, more than 50 station will be completed and put into operation, and hydrogen energy infrastructure will be improved further; the output scale will be nearly RMB 100 billion and the scale of development will take the lead nationwide.

J-3. Shanghai local policy

J-19 According to statistics, China has issued 31 national policies and Shanghai has issued 14 local policies during the DevCom FCV Project implementation. Details are on Tables J-3 and J-4.

Table J-3: National Polices on Hydrogen Energy and Fuel Cell Electric Vehicle Industry

S/N	Time	Department	Policy name
1	2020.8	National Development and Reform Commission	Catalogue of Encouraged Industries in the Western Region (2020 Edition, Draft for Comment)
2	2020.6	National Energy Administration	Guide for 2020 Energy Soft Science Research Topic Selection of National Energy Administration
3	2020.6	National Energy Administration	Guiding Opinions on Energy Work in 2020
4	2020.6	General Office of the Ministry of Housing and Urban-Rural Development of the People's Republic of China	Technical Specifications for Hydrogen Fueling Stations (Draft for Comments on Partial Revised Provisions)
5	2020.5	Approved by the Third Session of the Thirteenth National People's Congress	Report on the Implementation of the National Economic and Social Development Plan in 2019 and the Draft of National Economic and Social Development Plan in 2020

S/N	Time	Department	Policy name
6	2020.5	Ministry of Finance	Letter on Soliciting Opinions on the Notice on Demonstration Promotion of Fuel Cell Electric Vehicles (Draft for Comment)
7	2020.4	Ministry of Finance	Notice on Improving the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles
8	2020.4	National Energy Administration	Energy Law of the People's Republic of China (Draft for Comment)
9	2020.3	Ministry of Science and Technology	Guidelines for Application of Key Special Projects of "Renewable Energy and Hydrogen Energy Technology" in 2020
10	2020.3	Ministry of Science and Technology	Guidelines for Application of Directional Projects of Key Special Projects of "Science and Technology Olympic Winter Games" in 2020
11	2020.3	National Development and Reform Commission, Ministry of Justice	Notice on Issuing the Opinions on Accelerating the Establishment of Green Production and Consumption Regulations and Policies System
12	2020.1	Ministry of Education, National Development and Reform Commission, National Energy Administration	Notice on Printing and Distributing the Action Plan for Discipline Development of Energy Storage Technology Specialty (2020-2024)
13	2019.12	National Energy Administration	Announcement of the Science and Technology Department of the National Energy Administration on the Public Solicitation of the Undertaking Units of Four Topics Such As Energy Technology and Equipment Innovation Supporting Energy Revolution and Green Development Research
14	2019.12	Ministry of Industry and Information Technology	New Energy Vehicle Industry Development Plan (2021-2035) (Draft for Comment)
15	2019.10	National Development and Reform Commission	Guideline Catalogue for Industrial Restructuring
16	2019.3	National Development and Reform Commission Ministry of Industry and Information Technology Ministry of Natural Resources Ministry of Ecology and Environment Ministry of Housing and Urban-Rural Development of the People's Republic of China People's Bank of China National Energy Administration	Guideline Catalogue for Green Industry (2019)
17	2019.3	Ministry of Finance	Notice on Further Improving the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles
18	2018.12	National Development and Reform Commission, National Energy Administration	Action Plan for Clean Energy Consumption (2018-2020)
19	2018.8	Ministry of Science and Technology	Guidelines for Application of 2018 Annual Project Application of the Key Special Project of National Key R&D Plan "Renewable Energy and Hydrogen Energy Technology"
20	2018.5	Ministry of Science and Technology	Notice on Publicizing the 2018 Project Arrangements of 10 Key Special Projects such as the National Key R&D Plan "New Energy Vehicles"
21	2017.11	National Development and Reform Commission, National Energy Administration	Notice on Printing and Distributing the Implementation Scheme for Solving the Problem of Abandoned Water, Wind and Light
22	2017.6	Ministry of Science and Technology, Ministry of Transport	Special Plan for Scientific and Technological Innovation in the Transportation Field during the "13th Five-Year Plan"
23	2017.4	Ministry of Industry and Information Technology,	Notice on Printing and Distributing the Medium-and Long-Term Development Plan of Automobile Industry

S/N	Time	Department	Policy name
		National Development and Reform Commission, Ministry of Science and Technology	
24	2016.12	National Development and Reform Commission, National Energy Administration	Revolution Strategy of Energy Production and Consumption (2016 ~ 2030)
25	2016.12	National Development and Reform Commission, National Energy Administration	The "13th Five-Year Plan" for Energy Development
26	2016.12	Ministry of Industry and Information Technology, Ministry of Finance, Ministry of Science and Technology and National Development and Reform Commission	New Energy Vehicle Promotion Subsidy Scheme and Product Technical Requirements
27	2016.11	State Council	Notice of the State Council on Printing and Distributing the Development Plan of National Strategic Emerging Industries during the "13th Five-Year Plan"
28	2016.6	National Development and Reform Commission, Ministry of Industry and Information Technology, National Energy Administration	Notice on Printing and Distributing the Implementation Plan of Made in China 2025 - Energy Equipment
29	2016.6	Ministry of Science and Technology	Notice on Publicizing the 2016 Project Arrangements of 10 Key Special Projects such as the National Key R&D Plan "New Energy Vehicles"
30	2016.5	State Council	Outline of National Innovation-Driven Development Strategy
31	2016.5	National Development and Reform Commission, National Energy Administration	Innovation Action Plan for Energy Technology Revolution Innovation (2016-2030) and Key Innovation Action Roadmap for Energy Technology Revolution

J-20 A total of 14 local policies (Table J-4) and 2 local standards (Table J-5) have been formulated and promulgated in Shanghai to achieve the developmental goal of FCV industry in Shanghai, accelerate commercial application, create friendly domestic technical and political environments for the industrialization of FCVs, mobilize the participation of enterprises and truly realize comprehensive support and encouragement in terms of policies and standards.

Table J-4: Shanghai Policies on Hydrogen Energy and Fuel Cell Electric Vehicle Industry

S/N	File title	File No.	Date of release
1	*Shanghai Fuel Cell Vehicle Development Plan*	HKH[2017] No. 23	September 2017
2	*Measures of Shanghai Municipality on Encouraging Purchase and Use of New Energy Vehicles*	HFBG[2018] No. 7	February 2018
3	*Financial Subsidy Scheme for Promotion and Application of Fuel Cell Vehicles in Shanghai*	HKG[2018] No. 2	May 2018
4	*Action Plan for Promoting New Infrastructure Construction in Shanghai (2020-2022)*	HF[2020] No. 27	April 2020
5	*Implementation Plan for Innovation and Development of Fuel Cell Vehicle Industry in Shanghai*	HJZZ[2020] No. 1007	November 2020
6	*Measures of Shanghai Municipality on Encouraging Purchase and Use of New Energy Vehicles*	HFBG[2021] No. 3	February 2021

7	*Implementation Plan for Accelerating Development of New Energy Automobile Industry in Shanghai (2021-2025)*	HFB[2021] No. 10	February 2021
8	*Opinions on Encouraging Development of Hydrogen Fuel Cell Vehicle Industry in Jiading District (Trial)*	JJ[2019] No. 13	July 2019
9	*"Three-year Action Plan for Building a "Future Space" of Intelligent-networked New Energy Vehicles in Fengxian District (2019-2021)*	HFFF[2019] No. 29	September 2019
10	*Several Measures on Further Improving Consumption Level and Releasing Consumption Potential in Jiading District*	JFG[2020] No. 4	April 2020
11	*Three-year Action Plan for Comprehensive Energy Construction in Lingang New Area of China (Shanghai) Pilot Free Trade Zone*	HZMGW[2020] No. 314	May 2020
12	*Action Plan for Promoting New Infrastructure Construction in Baoshan District (2020-2022)*	BF[2020] No. 94	July 2020
13	*Development Plan for Hydrogen Energy and Fuel Cell Industry in Qingpu District, Shanghai*	QJF[2020] No. 118	November 2020
14	*Implementation Measures for Supporting Hydrogen Industry Development and Stimulating "Green Hydrogen" Green Kinetic Energy in Qingpu District*	QFBF[2020] No. 56	November 2020

Table J-5: Relevant Local Standards for FCVs in Shanghai

S/N	Standard name	Standard No.	Standard status
1	*Technical Specification of Hydrogen Filling Stations for Fuel Cell Vehicles*	DGJ08-2055-2017	Published
2	*Public Data Acquisition Technical Specifications for Fuel Cell Vehicles and Hydrogen Filling Stations*	——	Opinion solicitation completed

J-21 With regards to regulations and standards still to be approved, the Shanghai Municipal Government actively promotes the development of the FCV industry and will provide policy and standard support for industrial chain innovation, key technical breakthrough, innovative product development, advanced infrastructure deployment and scenario applications. Table I-6 shows fuel cell-related policies and standards still to be approved in Shanghai in the near future.

Table J-6: Policies and standards still to be approved in Shanghai

S/N	Names of policies and standards to be introduced soon
1	Interim Measures of Shanghai Municipality on Construction and Operation Management of Automobile Hydrogen Filling Stations **(Policies)**
2	Special Planfor Layout of Hydrogen Filling Stations in Shanghai **(Policies)**
3	Special Support Measures for Construction and Development of Automobile Hydrogen Filling Stations in Shanghai **(Policies)**
4	Several Political Measures for Supporting Accelerated Development of FCVs in Shanghai **(Policies)**
5	Hydrogen FCV Industry Development Plan in Lingang New Area of Shanghai Pilot Free Trade Zone **(Policy)**
6	Public Data Acquisition Technical Specifications for Fuel Cell Vehicles and Hydrogen Filling Stations (DB31) **(Standards)**

J-4. Capacity building and awareness raising programs in Shanghai

Training related to FCV

J-22 At present, there are about 3,000 people able to operate and maintain FCVs and about 45 people able to operate and maintain HRSs in Shanghai. Training and education have been carried out for practitioners to improve working, service and innovation capabilities of hydrogen energy and FCV practitioners. This included a total of 6 professional training activities for FCV practitioners of fuel cell passenger cars and commuter vehicles, and the FCV Practitioner Training Manual has been formulated to cover such unified standards as work procedures, operation manuals, and precautions for drivers and maintenance personnel. Meanwhile, a pyramid-shaped training platform and education system have been established according to the characteristics of personnel at different levels. The system is divided into three parts: primary training, intermediate training and advanced training for practitioners, of which the training contents and scopes tend to be more profound. Meanwhile, over 100 relevant policy training events have been organized and carried out on the basis of the e-micro classroom brand.

Table J-7: Training Activities Related to FCVs

S/N	Training level	Time	Activity name	Main contents
1	Primary	December 2017	Kick-off Meeting for First Hydrogen FCV Training and Demonstration Operation	Professors of Tongji University and engineers of SAIC Motor explained developmental history and trends of FCVs, operational aspects of the passenger car Roewe 950, etc.
2		January 2018	Delivery Ceremony for Second Hydrogen FCV Training and Beijing Demonstration Operation	The engineers of SAIC's Foresight Technology Research Department trained the drivers and staff on operational details and precautions of Roewe 950 vehicles in the demonstration operation
3		March 2018	Kick-off Meeting for Third Hydrogen FCV Training and FCV80 Demonstration Operation	The engineers of SAIC Maxus explained working principle, operation and safe maintenance of FCV80 FCV commuter vehicles.
4	Intermediate	July 2018	Matching and energy control technologies of FCV power systems	Starting from the classification and topology of the FCV power system, the knowledge required for research and development of the FCV power system was systematically explained, and such key issues as modeling methods of power systems, design of energy management and control strategies and verification test of system schemes were explained and analyzed.
5		April 2019	Development and Testing of Key Components in Hydrogen Fuel Cell Stack	The development and testing of key components in hydrogen fuel cell stack were explained on the basis of engineering cases. Main contents included principles and structures of hydrogen fuel cell stack, main materials, low-temperature startup characteristics and strategies, performance degradation mechanism and mitigation strategies, hydrogen safety of on-board systems, etc.

S/N	Training level	Time	Activity name	Main contents
6	Advanced	May 2019	Hydrogen Energy Industry Chain and Key Technologies	A special training session was organized jointly with ChinaEV100 to interpret the characteristics of Chinese hydrogen energy development route, low-cost hydrogen production technology from renewable energy, high-efficiency hydrogen production technology and equipment from water electrolysis, development of fuel cell systems, and integration and testing technologies of fuel cell systems.

J-23 Financial training was also provided. With total investment in FCVs, HRSs and other industrial chain links exceeding RMB 5 billion in Shanghai, a series of programmes, plans and seminars were held. At the national level, the "Thirteenth Five-Year" Development Plan for National Strategic Emerging Industry included the FCV industry and clarified enhancing financial and taxation support and innovating fiscal and taxation policies. The “Financial Support Policies and Guidelines for Promotion and Application of New Energy Vehicles in 2016-2020” stated clearly that FCV subsidies will not decline before 2020. The “Implementation Plan for Innovation and Development of Fuel Cell Vehicle Industry in Shanghai” issued by Shanghai Municipality in November 2020 encourages banks, insurance companies, social capitals and other institutions to provide preferential loans, innovative financial products and other special services to innovative companies in the fuel cell industry chain. The “Opinions on Encouraging Development of Hydrogen Fuel Cell Vehicle Industry in Jiading District (Trial)” guides the establishment of a special fund for hydrogen FCVs and encourages various equity investment funds (such as Angel Fund, venture capital fund, equity investment fund and M&A fund), to establish a special hydrogen fuel cells fund for automobile industrial cluster. Financial institutions have also successively entered the FCV industry to provide financing services for enterprises and the government to purchase FCVs and support the expansion of the manufacturing industry. The application of Shanghai Refire Energy Group Co. Ltd. for listing on the Science and Technology Innovation Board has been accepted and its sponsor is CITIC Jiantou Securities, a well-known broker. It has proposed to raise total amount of RMB 2 billion to fund construction projects of fuel cell stack production lines and research and development projects of high-power fuel cell systems

J-5. Training related to China FCV market and technology monitoring systems in Shanghai

Shanghai New Energy Vehicle Data Platform

J-24 The Project provided a new energy vehicle data platform in Shanghai that was expanded to establish a public data platform for HRSs and hydrogen FCVs in Shanghai, namely the "station and vehicle integrated platform". The HRS companies and vehicle manufacturers upload the status of HRS equipment and the operating status of FCVs, respectively, to perform remote real-time monitoring and safety warnings on temperature, braking, fuel cell systems, and relevant companies are required to deal with risks within the certain time limit.

J-25 At present, the entire platform has realized uploading function of static corporate and model information, monitoring function of vehicle dynamic data, and visual display function of vehicle data. Main conditions are as follows:

- Upload of static vehicle information

- Dynamic data monitoring function: National standard data communication service function. The function of national standard data communication service includes management of enterprise TCP link, analysis of national standard protocol, storage of real-time vehicle data, triggering and recovery of alarm data, recording of operation log and real-time vehicle data log.
- Joint debugging function of enterprise platform. For the successful registration of enterprises and vehicle models, it is required to first apply for joint debugging of the platform. The joint debugging of the platform is to verify whether the enterprise platform correctly understands the access requirements of the data center, whether it meets the technical requirements of the national standard GBT32960.3-2016, and whether it has basic platform docking capabilities. Each enterprise must first go through joint debugging through the platform before it can carry out the subsequent work of connecting to real vehicles. The joint debugging of the platform should be completed once. The joint debugging of the platform is divided into four sub-processes: vehicle registration review, vehicle data testing, platform testing, and real-time information testing;
- Log viewing function. The log viewing function includes viewing original message log uploaded to the data center platform in real time when the enterprise is conducting joint debugging of the platform, and viewing the original byte and corresponding specific data value of each real-time information message of the vehicle, the safety log generated when data information is added, deleted or modified, and the audit log generated by the audit of car companies, models, and vehicles. In the real-time vehicle information page, it is possible to query the message list of the real-time vehicle data through the vin code and time period and view the original byte and corresponding specific data value of each message.

J-26 On the visualization page of the vehicle's operation data, the operating status of the vehicle and the HRS are displayed in two ways: maps and statistical charts. The display page in Figure J-8 shows overall situation of the access and real-time online status of hydrogen fuel vehicles and HRSs in the data center.

J-27 The display page in Figure J-9. 6 shows the specific operation of hydrogen FCVs, including online rate, average mileage, average driving time, average hydrogen filling volume, and annual average mileage ranking of single vehicles.

J-28 The display page in Figure J-10 shows the operating status of the HRS, including daily hydrogen filling volume, number of hydrogen filling times, alarm situation, and ranking of cumulative hydrogen filling volume of the HRS.

J-29 The display page in Figure J-11 shows the replay function of the trajectory of single vehicle.

J-30 For the future of capacity building programs, firstly, there is a need to continuously increase talent training and introduction. In combination with technical innovation, industrial development and demonstration application needs of hydrogen energy and FCVs in Shanghai, it is required to introduce and train a group of international-level strategic scientific and technological talents, scientific and technological leaders, young scientific and technological talents and high-level innovative teams. Special talent funds should be arranged in the FCV industry development fund, and high-level talent training models should be innovated to establish the connection between key talents and major scientific installations, major scientific research projects and major innovation platforms.

Figure J-8: Visualization Page of Hydrogen FCVs and HRSs

Figure J-9: Visualization Page of Hydrogen FCV's Operation Data

Figure J-10: Visualization Page of HRS's Operation Data

Figure J-11: Replay Page of Running Trajectory of Hydrogen FCVs

J-31 Colleges and universities in Shanghai are encouraged to strengthen the subject and discipline construction in the fields of hydrogen energy and fuel cell, so as to focus on the urgently-needed talents, accelerate talent training, integrate the resources of "two stations and one base" (mobile station, work station, innovative practice base) and "five technical innovation platforms" (Enterprise Engineering Research Center, Engineering Laboratory, Engineering Technology Research Center, Enterprise Technology Center, Industrial Metrology and Testing Center) and build a cooperative education mechanism for industry, university, research and application.

J-32 It is required to further strengthen profound cooperation with industry organizations, such as China Society of Automotive Engineers, China Association of Automobile Manufacturers, ChinaEV100 and China Hydrogen Energy and Fuel Cell Industry Innovation Strategic Alliance, actively carry out technical, talent and intellectual cooperation and exchanges, cooperate with the International Hydrogen Council, United Nations Development Programme (UNDP) and other international organizations, explore the establishment of international science and technology cooperation alliance, international science and technology cooperation base and international science and technology industry cooperation parks, and hold internationally influential summit forums and academic conferences to attract various global outstanding industrial talents so as to provide sustainable power for technical innovation, industrial development and demonstration application of hydrogen energy and FCVs in Shanghai.

J-33 Secondly, for the future of capacity building programs, a safety training system is required. The legal representatives, major directors, safety management personnel and special operating personnel of the enterprises are supervised and urged to participate in safety training in accordance with the law and only allowed to get to work after being awarded with the certificates. It is required to conscientiously perform the inspection and assessment of on-the-job training and education for employees and fulfill a three-level safety education system of enterprises, workshops and teams. The on-board information system should collect and store status parameters of the vehicle in real time and have such functions as real-time monitoring, warning, real-time data import or export, historical data query, log management, authorized user query and so forth to strengthen professional and safety knowledge training of hydrogen filling personnel, and clarify the maintenance and scrapping of fuel cell systems and on-board hydrogen systems, start-up, parking and storage, hydrogen filling, driving, accident handling plans and training of the vehicle.

J-34 Meanwhile, vocational training will be carried out next for maintenance personnel in the hydrogen energy and FCV industry in Shanghai. It is planned to provide FCV knowledge, disassembly/assembly and maintenance internship opportunities for various automotive vocational and technical schools, so that the students can serve the needs of FCV development faster and better after they are employed.

Shanghai Training related to China financial sector

J-35 The UNDP project has spurred the development of the hydrogen FCV industry in Shanghai, and the governmental and corporate capital investments have been increasing day by day. To promote the research & development and transformation of common technologies in the field of new energy vehicles and create a new level for the development of new energy vehicles and smart vehicle technologies, Shanghai AI NEV Innovative Platform Co., Ltd. was established in 2020 with the project investment of over RMB 600 million. In order to further strengthen the service function of the FCV industry, a FCV laboratory has been established under the formal investment of the platform.

J-36 Guided by technical breakthroughs of fuel cells and innovation and entrepreneurial needs of small and medium-sized enterprises, the platform will become a research & development service carrier supporting enterprise product innovation, a think tank for the government to serve industry innovation and planning, a builder and executor of a technical evaluation system and the "magnetite" for clustering of smart and new energy automobile industry.

APPENDIX J – ZHENGZHOU DEMONSTRATION CITY REPORT

K-1. Pilot demonstrations and support to Zhengzhou's FCV component manufacturers

K-1 Henan Province has a developed transportation hub network that has undertaken a huge amount of passenger and freight business at home and abroad, resulting in huge demand for long-distance intercity passenger transport and medium-long distance and medium and heavy-duty freight transport. FCVs have been viewed as having the potential for clean transportation in Henan Province for years. Clean utilization of FCVs can take advantage of the low cost of industrial by-gaseous hydrogen to meet the demand of FCVs in a short time, effectively drive the development of fuel cell vehicle industry, and promote the industrial transformation and upgrading of Henan Province.

K-2 The fuel cell bus of Zhengzhou was put into operation (Route No 727) with 23 vehicles (3 vehicles started to run in August 2018, and 23 vehicles in December 2018) running from Sigangliandong Avenue of Hanghai Road to Zijingshan with a single trip of 19.8 km and 10 trips per day. As of 16 April 2021, 23 fuel cell vehicles have been running for 2 years, with a cumulative mileage of over 2.82 million kilometers and an annual average hydrogen consumption of 7.05 kg/100km. A total of 280 failures occurred in the scheme of which fuel cells accounted for 43%, with an average demonstration mileage of 112,219 km in single vehicle and an average duration between break down of 6,011 km in single vehicle.

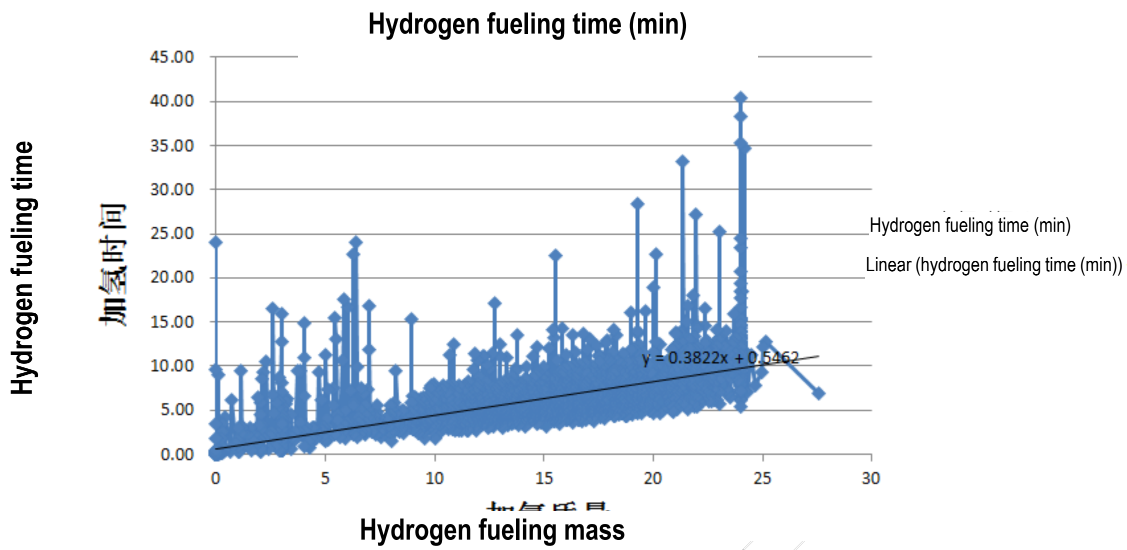
K-3 After more than 2 years of actual operation, Zhengzhou believed that FCVs were an important development direction of new energy vehicles, thus truly realizing "zero pollution and zero emission". Compared with the extra-long charging time of pure electric buses, hydrogen fuel cell buses have short charging time, with long driving range. Buses on Route 727 is currently in demonstration operation. As shown in Figure K-1, the statistical hydrogen fueling data of Bus 727 in demonstration operation for one year are mostly less than 10 minutes as a whole. By fitting the hydrogen refueling time with the hydrogen refueling value data, it can be seen that the hydrogen fueling time per unit mass (kg) of gaseous hydrogen is 0.38 minutes. At present, buses running in Route 727 are filled with hydrogen and have a driving range of more than 300 km. With the rising urbanization in Henan, the suburban ring bus lines are becoming increasingly complex, the demand of urban residents for indoor vehicle with long driving range is increasing year by year, and the advantages of fuel cell buses in driving range are gradually revealed.

K-4 With Henan Province having identified the weak areas in the whole industrial chain of FCVs through the implementation of the UNDP-GEF Project in Zhengzhou, it guided the implementation of advanced industrial projects and the upgrading of manufacturing industry by encouraging high-quality enterprises to settle down, introducing and cultivating FCV industrial platforms and policies:

- Encourage high-quality enterprises in the industrial chain to settle down: Support the introduction of major projects of direct investment in hydrogen fuel cell industry and related fields, and give awards for major investment promotion projects that actually have funds in place and meet relevant conditions[41];

[41] in accordance with the Notice of Henan Provincial Finance Department and Department of Commerce of Henan Province on Printing and Distributing the Measures for the Administration of Special Funds for Investment Promotion at Provincial Level in Henan Province (YCM [2018] No. 62) and the Supplementary Notice of Henan Provincial Finance Department and Department of Commerce of Henan Province on Printing and Distributing the Measures for the Administration of Special Funds for Investment

Figure K-1: Relationship between Hydrogen Fueling Mass and Hydrogenation Time



- Build a service platform for hydrogen powered vehicles and related industries and introduce and cultivate institutions: Support the introduction and cultivation of comprehensive and functional headquarters, public service platforms and industry institutions of hydrogen fuel cell electric vehicles and related industries, and give corresponding support to particularly important hydrogen energy headquarters, testing and certification centers and professional intermediaries according to the administration measures for administration of provincial special fund for investment promotion and relevant supplementary regulations[42].

K-5 For the 223 FCVs operated in Zhengzhou under the implementation of the UNDP-GEF Project, the accumulated investment in the fuel cell industry chain exceeds RMB 7.5 billion. Yutong Bus completed the development of three generations of fuel cell buses, obtained the first fuel cell commercial vehicle qualification certification and product announcement in the industry in 2015, and realized small-batch demonstration and promotion of fuel cell buses in 2019. As of April 2021, there are 10 fuel cell electric vehicle production lines in China, and Zhengzhou Yutong Bus has 1 fuel cell bus production line, with an average vehicle production beat of 36 minutes/unit, a daily production capacity of more than 13 vehicles (8 hours/day) and an annual production capacity of 3,250 vehicles/year (250 days/year). At present, the production and sales of 328 vehicles have been completed in Yutong Bus; the average annual running time of fuel cell electric vehicles is 3,565.4 hours for bus; in the durability of domestic fuel cells, the average life of Yutong Bus is 12,999.29 hours; the actual cost of domestic fuel cell buses has dropped from USD 630,000 in Phase II Project to USD 310,000 at present, and the production cost of buses has dropped by 51%. With the accumulation of operation experience and the optimization of power system control strategy, the reliability of fuel cell vehicles has increased the fault-free interval mileage by 44%.

Promotion at Provincial Level in Henan Province (YCM [2019] No. 124). (Responsible organizations: Department of Industry and Information Technology of Henan Province, Department of Commerce of Henan Province, Henan Provincial Finance Department, Henan Provincial Tax Service, State Taxation Administration, Henan Provincial Development and Reform Commission, and governments of demonstration cities)

[42] Responsible organizations: Department of Commerce of Henan Province, Administration for Market Regulation Henan Province, Henan Provincial Finance Department, Department of Industry and Information Technology of Henan Province.

K-2. Hydrogen Re-fueling systems in Zhengzhou

K-6 Henan Province, as an agricultural hub, enjoys large yield, wide distribution and many kinds of crops. Therefore, it was thought that many types of hydrogen production technologies by biomass gasification, such as thermochemical hydrogen production and biological hydrogen production, would be prevalent in Zhengzhou. However, progress of hydrogen production technology by biomass gasification has not yet taken off to provide a new way for the comprehensive utilization of province's various abundant biomass resources in the medium and long term.

K-7 At present, the main hydrogen production methods in Henan Province include hydrogen production by petroleum, hydrogen production by coal, hydrogen production by chlor-alkali industry and hydrogen production by synthetic ammonia. Zhengzhou Yutong Hydrogen Refuelling Station uses by-product hydrogen from chlor-alkali industry as its gaseous hydrogen source. At present, Zhengzhou has put 1 hydrogen refueling station into operation and plans to build 30-40 in the future. The construction of hydrogen refueling stations is planned with the promotion of various hydrogen FCVs such as buses, logistics vehicles and passenger vehicles. During the project period, the price of gaseous hydrogen in the hydrogen refueling station was 40 RMB/kg. With the development of technology, the final selling price of gaseous hydrogen was to be continuously reduced by providing a recovery system controlling vehicle residual gas, reducing the gaseous hydrogen procurement cost of hydrogen fueling station and improving the localization of equipment in hydrogen fueling station. Land investment cost was reduced by exploring the establishment of oil, gas and hydrogen refueling comprehensive stations.

K-8 With regards to installing and commissioning HRS in Zhengzhou, relevant HRS approval procedures were handled by Yutong Hydrogen Fueling Station include Construction Project Planning Permit, Proposal on Fire Protection Acceptance, Registration, Use and Inspection of Special Equipment, Gas Cylinder Filling Permit. However, in the early stage of planning and construction of Yutong Hydrogen Fueling Station, there were no regulations for relevant government departments to follow when handling the examination and approval procedures for hydrogen refueling stations due to the lack of management measures for hydrogen refueling stations in Zhengzhou City, resulting in extremely difficult to approval. Yutong conducted in-depth communication with relevant departments during this period. By drawing lessons from the examination and approval experience of other hydrogen refueling stations outside the province and the examination and approval mode of natural gas filling stations in Zhengzhou, Yutong Hydrogen Refuelling Station completed the last procedure "Gas Cylinder Filling Permit", on October 14, 2020.

K-9 Relevant departments of Zhengzhou City accumulated certain experience through the examination and approval of relevant procedures of Yutong Hydrogen Refuelling Station. Zhengzhou City Administration Bureau issued the Notice on Printing and Distributing the Interim Measures for the Examination and Approval and Management of Zhengzhou Hydrogen Fueling Station on 12 November 2020, achieving breakthrough of zero regulation of Zhengzhou Hydrogen Refuelling Station. However, the problem of site selection was not been completely resolved. Hydrogen refueling stations were allowed to be built within the Third Ring Zone of Zhengzhou City as required by laws and regulations. However, in fact, gaseous hydrogen is a hazardous chemical, and its transport vehicles cannot enter the Third Ring Zone, which leads to the fact that the area within the Third Ring Zone cannot be used as the site selection of hydrogen fueling stations for planning.

K-10 As for future investments in HRS in Zhengzhou, the Zhengzhou Hydrogen Fuel Cell Vehicle Industry Development Plan (2020-2025) was released on 9 November 2020, in which Zhengzhou plans to promote 1,000-1,800 hydrogen fuel cell electric vehicles (buses, logistics vehicles and passenger vehicles by 2022), and put into operation 15-20 hydrogen refueling stations, striving to achieve a cumulative output value of more than RMB 10 billion. By 2025, more than 3,000 hydrogen fuel cell vehicles such as buses, logistics vehicles and passenger vehicles will be promoted in the city, and 30-40 hydrogen refueling stations will be put into operation, striving to achieve a cumulative output value of more than RMB 30 billion.

K-3. Zhengzhou local policy

K-11 According to the statistics, China has issued 31 national policies and Henan Province and Zhengzhou City have issued 14 local policies during the DevCom FCV Project implementation. The national policies can be viewed on Table J-3. Zhengzhou Municipal People's Government and the People's Government of Henan Province have successively issued a number of related schemes, policies and plans in recent years, including *Zhengzhou Hydrogen Fuel Cell Electric Vehicle Industry Development Plan (2020-2025), Notice on Establishing the Leading Group of Zhengzhou Fuel Cell Electric Vehicle Demonstration Urban Agglomeration, Notice on Printing and Distributing Several Policies to Support the Development of Hydrogen Fuel Cell Electric Vehicle Industry in Zhengzhou, Notice on Printing and Distributing the Interim Measures for the Examination and Approval and Management of Zhengzhou Hydrogen Fueling Station* and other supporting policies, which reflects the sustained, steady and stay-up-to-date development strategy of Zhengzhou for the fuel cell electric vehicle industry. Zhengzhou Municipal People's Government and the People's Government of Henan Province have issued specific support policies and relevant information, as shown in Table K-1.

Table K-1: List of Relevant FCV Industrial Support Policies of Zhengzhou

S/N	Policy name	Document No.	Issuing date	Key contents
1	*Action Plan for Hydrogen Fuel Cell Electric Vehicle Industry Development in Henan Province*	YGXLZ [2020] No. 27	April 24, 2020	1. By 2023, there will be 5 automobile demonstration application cities, more than 60 demonstration bus and logistics lines, more than 3,000 hydrogen fuel cell electric vehicles, and 50 hydrogen fueling stations in demonstration cities. 2. By 2025, the scope of demonstration and application of hydrogen fuel cell electric vehicles in Henan Province will continue to expand, with more than 5,000 demonstration and application hydrogen fuel cell electric vehicles and more than 80 hydrogen fueling stations. The annual output value of hydrogen fuel cell electric vehicle related industries will exceed RMB 100 billion.
2	*Several Policies for Accelerating the Promotion and Application of New Energy Vehicles in Henan Province*	YZB [2019] No. 36	May 19, 2019	1. Expand the application scope of hydrogen fuel cell electric vehicle market. Relevant production enterprises in the province are encouraged to increase the promotion of hydrogen fuel cell electric vehicles and actively participate in the construction of demonstration operation projects of hydrogen fuel cell electric vehicles in China and Henan Province. Henan Provincial Finance Department will give a certain proportion of rewards according to the number of hydrogen fuel cell electric vehicles put into operation and the construction of supporting facilities. 2. Guarantee the construction land for supporting facilities. The construction land for newly-built centralized charging and replacing power stations, fuel cell hydrogen fueling stations and logistics distribution centers will be included in the scope of land for public facilities business outlets. Its use will be managed

S/N	Policy name	Document No.	Issuing date	Key contents
				according to the use determined by urban planning, and the land will be supplied by means of tendering, auction, listing or lease.
3	*Three-year Action Plan for the Development of New Energy and Networked Vehicles in Henan Province (2018-2020)*	YZB (2018) No. 46	August 6, 2018	By 2020, efforts will be made to introduce a number of new complete vehicle enterprises, The new energy vehicle production capacity in the whole province will reach 300,000 vehicles, driving the complete vehicle production capacity to exceed 2.5 million vehicles. The proportion of new networked cars will reach 50%, the local matching rate of auto parts will reach more than 60%, and the network of charging facilities in key areas will be basically improved. The intelligent networked automobile test demonstration zone starts operation, the formation of new industrial ecology is accelerated, and Zhengzhou RMB 500 billion-level automobile industrial cluster and several new energy automobile and parts industrial clusters with important influence in China will be built.
4	*Implementation Scheme for High Quality Development of Manufacturing Industry in Zhengzhou City in 2020*	ZZB [2020] No. 19	April 14, 2020	1. Accelerate the cultivation of emerging industries. Prepare and issue a development plan for strategic emerging industries of hydrogen fuel cell electric vehicles; 2. Expand the output of hydrogen powered vehicles, promote the construction of hydrogen fueling stations, and increase the demonstration operation lines of hydrogen fuel cell electric vehicles.
5	Three Documents, including Several Policies to Support the Development of Automobile Industry in Zhengzhou City	ZZ [2019] No. 19	August 19, 2019	1. For production enterprises listed in the category of fuel cell electric vehicles in the *Catalogue of Recommended Models for Promotion and Application of New Energy Vehicles* of the Ministry of Industry and Information Technology, research and development subsidies shall be given at 5% of sales revenue, with no more than RMB 10 million for a single enterprise; 2. Zhengzhou Finance Bureau will give subsidies at 50% of the equipment investment of hydrogen fueling stations from 2019 to 2020; 3. Differentiated traffic management measures will be implemented for new energy vehicles with special green license plates for new energy, the classified management system for road traffic of new energy logistics distribution vehicles will be improved, and convenience shall be provided for road traffic of qualified new energy logistics distribution vehicles.
6	*Action Plan for Zhengzhou Auto and Parts Industry Transformation and Upgrading (2017-2020)*	ZZB [2018] No. 40	March 28, 2018	1. Relying on Yutong Bus and other enterprises, it will be necessary to actively promote the research and development of high-efficiency auxiliary system components such as long-life and low-cost fuel cell stack, air system for fuel cell engine, gaseous hydrogen system and thermal management system, on-board hydrogen system and key equipment of hydrogen fueling stations, and cultivate the fuel cell electric vehicle industry chain; 2. Focus will be given on supporting Yutong Bus to carry out fuel cell bus demonstration operation and promote the research and development of fuel cell electric vehicles; 3. To promote the development of fuel cell electric vehicles and the demonstration operation of fuel cell buses, hydrogen fueling stations will be rationally distributed and constructed in Zhengzhou. By 2020, 5 hydrogen fueling stations are planned to be built.
7	Notice of Zhengzhou Industry and Information Technology Bureau,	ZGX (2020) No. 146	November 5, 2020	1. Strengthen the incubation and cultivation of high-quality enterprises. Enterprises that have been rated as "Global 500", "Top 500 Enterprises of China" and "Top 500 Private Enterprises of China" for the first time in hydrogen powered vehicles and

S/N	Policy name	Document No.	Issuing date	Key contents
	Zhengzhou Finance Bureau, Zhengzhou Bureau of Science and technology, Zhengzhou Municipal Development and Reform Commission and Zhengzhou City Administration Bureau on Printing and Distributing Several Policies to Support the Development of Hydrogen Fuel Cell Electric Vehicle Industry in Zhengzhou			related fields and have been recognized as headquarters enterprises will be given one-time awards of RMB 20 million, RMB 10 million and RMB 3 million respectively. A one-time award of RMB 200,000 will be given to enterprises that have won the title of "Little Giant" for the first time. (Provincial Policy) 2. Encourage merging and reorganization of enterprises. Where an enterprise successfully acquires well-known hydrogen powered vehicles and related industrial enterprises outside the province and obtains absolute holding power, there is no related relationship between the acquirer and the acquired party, and the actual capital contribution of the acquirer to the acquired enterprise reaches more than RMB 100 million (inclusive), the merger and acquisition procedures shall be completed and included in the consolidated statement, and the maximum reward of RMB 5 million will be given after the sales tax is realized. (Provincial Policy) 3. Support the manufacture of hydrogen fuel cells and key components. As for hydrogen fuel cells and manufacturers of equipment and key components for hydrogen production, hydrogen storage, hydrogen transportation and hydrogen fueling, a maximum reward of RMB 10 million will be given at 2% of the annual sales of related products (Provincial Policy). Where the annual sales revenue of hydrogen fuel cell parts enterprises exceeds RMB 200 million for the first time, a one-time reward of RMB 300,000 will be given, with a reward of RMB 200,000 given for every increase of RMB 50 million in annual sales revenue in the future. (Special Policy for Automobile) 4. Encourage local supporting support. Where complete hydrogen fuel cell vehicle and modified vehicle enterprises purchase non-holding (holding less than 25%) single parts manufacturing enterprises in the city, reaching a total of more than RMB 30 million, Zhengzhou Finance Bureau will subsidize RMB 100,000 for everyone percentage point increase based on the previous year, with a maximum subsidy of RMB 3 million. (Special Policy for Automobile)
8	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry Development in Henan Province on Establishing the Work Promotion Coordination Group of Henan Fuel Cell Electric Vehicle Demonstration Urban Agglomeration	YXNYQCLXB [2020] No. 10	November 6, 2020	Plan and coordinate the demonstration cities to carry out the research and development, demonstration application, infrastructure construction and other related work of fuel cell electric vehicle projects; guide the leading city to carry out the declaration of demonstration urban agglomeration, the promotion of demonstration application project, the evaluation of demonstration application and other important matters; align itself with the application for demonstration application funds and project evaluation of relevant national departments; establish a work promotion mechanism to ensure that all work is implemented; coordinate and solve other related matters among demonstration urban agglomerations.
9	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry	YXNYQCLXB [2020] No. 11	November 12, 2020	A promotion team shall be established at the provincial level to improve the organization and the rapid decision-making and accelerate the promotion mechanism to ensure the successful completion of the demonstration application task. The leading city shall establish a project promotion evaluation mechanism, and regularly organize progress evaluation and assessment. Each

S/N	Policy name	Document No.	Issuing date	Key contents
	Development in Henan Province on Printing and Distributing the Interim Measures for Evaluation and Reward of Demonstration Application of Fuel Cell Electric Vehicles in Zhengzhou Urban Agglomeration			demonstration city shall conduct self-examination every year, giving full play to the role of self-supervision and self-evaluation. Key indicators of demonstration and promotion shall be strict, and it is necessary to expand the application field of fuel cell electric vehicles and actively create a good industrial ecology.
10	*Notice of Zhengzhou City Administration Bureau on Printing and Distributing the Interim Measures for Examination and Approval and Management of Zhengzhou Hydrogen Fueling Station*	ZCG [2020] No. 421	November 12, 2020	In the absence of regulations on the examination and approval, construction and management of hydrogen fueling stations issued by the relevant national departments, the detailed rules for the construction, examination and approval, operation and management of hydrogen fueling stations are formulated based on the actual situation of Zhengzhou City and by drawing on the experience and practices of relevant regions.
11	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry Development in Henan Province on Printing and Distributing Several Policies to Promote the High-quality Development of Hydrogen Fuel Cell Electric Vehicle Industry in Henan Demonstration Urban Agglomeration	YXNYQCLXB [2020] No. 12	November 12, 2020	The R&D and purchase units in the province will be rewarded at 5% of the sales price, with the total reward amount no more than RMB 5 million; as for the first (set of) major technical equipment insured products recognized by the province, Henan Provincial Finance Department will give subsidies at the upper limit of 3% of the comprehensive insurance rate and 80% of the actual annual insurance premium.
12	Notice of the General Office of Zhengzhou Municipal People's Government on Establishing Zhengzhou Fuel Cell Electric Vehicle Industry Leading Group	ZZB [2020] No. 25	April 13, 2020	To further strengthen the organization and leadership and accelerate the industrialization development of fuel cell electric vehicles in Zhengzhou, Zhengzhou Municipal People's Government determines to set up a leading group for the fuel cell electric vehicle industry in Zhengzhou. The leading group is responsible for the planning and guidance, overall promotion, supervision and inspection of the development of the fuel cell electric vehicle industry. The leading group has an office, which is set up under the Zhengzhou Bureau of Industry and Information Technology. Comrade Fan Jianxun serves as the office director concurrently.
13	Development Plan of Zhengzhou Hydrogen Fuel Cell Electric Vehicle Industry	ZGX (2020) No. 145	November 9, 2020	By 2022, more than 1,000~1,800 hydrogen fuel cell electric vehicles such as buses, logistics vehicles and passenger vehicles will be promoted in the city, and 15~20 hydrogen fueling stations will be built and put into operation, striving to achieve a

S/N	Policy name	Document No.	Issuing date	Key contents
	(2020-2025)			cumulative output value of more than RMB 10 billion; By 2025, more than 3,000 hydrogen fuel cell electric vehicles such as buses, logistics vehicles and passenger vehicles will be promoted in the city, and 30-40 hydrogen fueling stations will be built and put into operation, striving to achieve a cumulative output value of more than RMB 30 billion.
14	Report of Zhengzhou Industry and Information Technology Bureau, Zhengzhou Finance Bureau, Zhengzhou Bureau of Science and technology, Zhengzhou Municipal Development and Reform Commission and Zhengzhou City Administration Bureau on Submitting the Implementation Scheme of Demonstration Application of Fuel Cell Electric Vehicles in Zhengzhou Urban Agglomeration	ZGX (2020) No. 147	November 9, 2020	As the leading city, Zhengzhou has formed a "1 + N+5" urban agglomeration in conjunction with the cities where advantageous enterprises outside the province are located and 5 cities in the province (Kaifeng, Luoyang, Anyang, Xinxiang and Jiaozuo) according to the spirit of the Notice on Demonstration Application of Fuel Cell Electric Vehicles (CJ [2020] No. 394) issued by five departments such as the Ministry of Finance and the Ministry of Industry and Information Technology. It has prepared the *Implementation Scheme for Demonstration Application of Fuel Cell Electric Vehicles in Zhengzhou Urban Agglomeration* and applied for demonstration and application of fuel cell electric vehicles.

K-12 Yutong Bus is the deputy director unit of the Bus Sub-technical Committee of the National Technical Committee of Auto Standardization and the member unit of the Electric Vehicle Sub-Committee of the National Technical Committee of Auto Standardization. More than 40 enterprise standards related to fuel cell buses have been formulated during the demonstration operation of UNDP-GEF Zhengzhou Project, covering design, research and development, experiments, testing and other contents to ensure the research and development and production of Yutong Fuel Cell Buses, as shown in Table K-2.

Table K-2: Relevant Standards of Yutong Bus Fuel Cell

S/N	Standard No.	Standard name
1	Q/ZK JS246	Fuel Cell Bus
2	Q/ZK JS321	Fuel Cell System for Electric Vehicle - Technical Conditions for Supply
3	Q/ZK JS4067	Aluminum Plate-fin Radiator for Main Heat Dissipation of Fuel Cell - Technical Conditions for Supply
4	Q/ZK JS4022	Intake and Exhaust Muffler for Fuel Cell - Technical Conditions for Supply
5	Q/ZK JS4024	Air Cleaner for Fuel Cell - Technical Conditions for Supply
6	Q/ZK JS319	Vehicle-mounted Hydrogen System - Technical Conditions for Supply
7	Q/ZK JS326	Compressed Gaseous Hydrogen - Technical Conditions for Supply
8	Q/ZK JS424	High Power DC/DC Converter for Vehicle - Technical Conditions for Supply
9	Q/ZK JS3993	Special Coolant for Fuel Cell - Technical Conditions for Supply

S/N	Standard No.	Standard name
10	Q/ZK JS105.21	Code for Design of New Energy Sources - Part 21: Fuel Cell Heat Dissipation System
11	Q/ZK JS105.23	Code for Design of New Energy Sources - Part 23: Fuel Cell System
12	Q/ZK JS105.24	Code for Design of New Energy Sources - Part 24: DC/DC Converter
13	Q/ZK JS105.25	Code for Design of New Energy Sources - Part 25: Code for Design of Vehicle-mounted Hydrogen System
14	Q/ZK JS105.28	Code for Design of New Energy Sources - Part 28: Matching of Fuel Cell Hybrid Power System
15	Q/ZK JS106	Installation Requirements for Vehicle-mounted Hydrogen System of Fuel Cell Bus
16	Q/ZK JS4127	Code for Creation and Design Selection of F1654 and F1662 Intake and Exhaust Muffler (Fuel Cell) Parts
17	Q/ZK JS4128	Code for Creation and Design Selection of F1664 Exhaust Tailpipe (Fuel Cell) Parts
18	Q/ZK JS4129	Code for Creation and Design Selection of F1666 Silicone Tube (Fuel Cell) Parts
19	Q/ZK JS4045	Code for Creation and Design Selection of Special Coolant Parts for Fuel Cell
20	Q/ZK JS4075	Code for Creation and Design Selection of Air Cleaner (Fuel Cell) Parts
21	Q/ZK JS4076	Code for Creation and Design Selection of Sensor (Fuel Cell) Parts
22	Q/ZK JS4077	Specification for Creation and Design Selection of F1653, F1655, F1663 and F1665 Fuel Cell Intake and Exhaust Bracket Parts
23	Q/ZK JS4092	Code for Creation and Design Selection of Silicone Tube Parts for Fuel Cell Air Intake
24	Q/ZK JS4046	Code for Creation and Design Selection of F1642 and F1643 Silicone Tube Parts for Fuel Cell Cooling
25	Q/ZK JS3696	Code for Creation and Design Selection of F1701 Fuel Cell Bracket Parts
26	Q/ZK JS3616	Code for Creation and Design Selection of F1681 Fuel Cell Electrical Accessory Assembly Parts
27	Q/ZK JS3636	Code for Creation and Design Selection of F1641 Fuel Cell Radiator Assembly Parts
28	Q/ZK JS1991	Code for Creation and Design Selection of F1601 Fuel Cell System Parts
29	Q/ZK JS4073	Code for Creation and Design Selection of F1672 Gaseous Hydrogen Pipeline Parts
30	Q/ZK JS4074	Code for Creation and Design Selection of F1673 Gaseous Hydrogen Pipeline Joint Parts
31	Q/ZK JS4048	Code for Creation and Design Selection of F1680 Low-voltage Electrical Accessories for Hydrogen System
32	Q/ZK JS4040	Code for Creation and Design Selection of Bracket Parts for F1674 Vehicle-mounted Hydrogen System
33	Q/ZK JS3576	Code for Creation and Design Selection of F1671 Gaseous Hydrogen Filling Panel Parts
34	Q/ZK JS1988	Code for Creation and Design Selection of F1661 Vehicle-mounted Hydrogen System Parts
35	Q/ZK JS4107	Test Method for Bench Performance of Fuel Cell System for Electric Vehicles
36	Q/ZK JS247	Test Method for Energy Consumption Rate and Driving Range of Fuel Cell Passenger Vehicle
37	Q/ZK JS4149	Test Method and Evaluation Code for Durability of Vehicle-mounted Hydrogen System
38	Q/ZK JS4117	Code for On-line Inspection of Hydrogen Leakage Sensor for Fuel Cell Vehicle
39	Q/ZK JS3105	Safety Code for Charging and Hydrogen Fueling of Electric Passenger Vehicle
40	Q/ZK JS3335	Safety Code for Charging and Hydrogen Fueling of Special Vehicle

K-13 Regulations and standards still to be approved by Zhengzhou are listed on Table K-3.

Table K-3: Policies and standards still to be approved in Zhengzhou

S/N	Policy name
1	Action Plan for Hydrogen Fuel Cell Electric Vehicle Industry Development in Henan Province
2	Several Policies for Accelerating the Promotion and Application of New Energy Vehicles in Henan Province
3	Development Plan for Xinxiang Hydrogen Energy and Fuel Cell Industry and Implementation Opinions on Xinxiang Hydrogen Energy and Fuel Cell Industry Development
4	Notice of Xinxiang Municipal People's Government Office on Establishing Xinxiang Hydrogen Energy and Fuel Cell Industry Development Headquarters
5	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry Development in Henan Province on Establishing the Work Promotion Coordination Group of Henan Fuel Cell Electric Vehicle Demonstration Urban Agglomeration
6	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry Development in Henan Province on Printing and Distributing the Interim Measures for Evaluation and Reward of Demonstration Application of Fuel Cell Electric Vehicles in Zhengzhou Urban Agglomeration
7	Notice of the Office of the Joint Conference on Energy Conservation and New Energy Vehicle Industry Development in Henan Province on Printing and Distributing Several Policies to Promote the High-quality Development of Hydrogen Fuel Cell Electric Vehicle Industry in Henan Demonstration Urban Agglomeration
8	Report of Zhengzhou Industry and Information Technology Bureau, Zhengzhou Finance Bureau, Zhengzhou Bureau of Science and technology, Zhengzhou Municipal Development and Reform Commission and Zhengzhou City Administration Bureau on Submitting the Implementation Scheme of Demonstration Application of Fuel Cell Electric Vehicles in Zhengzhou Urban Agglomeration
9	Notice on Establishing the Leading Group of Zhengzhou Fuel Cell Electric Vehicle Demonstration Urban Agglomeration

K-4. Capacity building and awareness raising programs in Zhengzhou

K-14 The demonstration project team completed the research, development and tendering of fuel cell buses from the second half of 2016 to the first half of 2018 and has carried out demonstration operation since the second half of 2018. The focus was team training for demonstration operation of fuel cell vehicles and training of hydrogen refueling stations. A total of 40 people were trained to operate and maintain fuel cell electric vehicles in Zhengzhou and 17 staff who can operate and maintain hydrogen fueling stations.

K-15 Training of demonstration operation team carried on for 2-6 months. Topics such as introduction, operation and maintenance of fuel cell buses, has improved the professional knowledge and technical support ability of the demonstration operation service team. Before a new vehicle is launched, operation and maintenance personnel and drivers are trained in the basic knowledge and operation skills of the vehicle. After the new vehicle is launched, the training work is subdivided into vehicle system cognition, practical driving, daily maintenance of maintenance personnel and other learning and training, with the specific training rules.

K-16 Training management of hydrogen fueling station was designed to enhance the awareness of safety production and environmental protection, prevent, control, eliminate and reduce the occurrence of various safety accidents, minimize the degree of accident hazards, guarantee the safety of life and property of hydrogen fueling stations and drivers and conductors, improve employees' safe operation and self-protection ability, ensure safety production and prevent environmental pollution. Relevant training management requirements have been formulated in combination with the actual situation of Yutong Hydrogen Fueling Station:

- Safety education is included in the annual training plan, and certain safety courses shall be arranged for various technical training and business training to ensure the personnel and facilities needed for safety production education and training;
- Safety production training is dominated by self-service training, in which various forms and multi-level ways can be taken to carry out extensive publicity and education of safety production laws and regulations, new knowledge and new technologies;
- Employee safety production training files are established to ensure that safety education is implemented to everyone;
- The supervision and inspection of safety education and training and employment with certificates shall be strengthened to ensure that the implementation of safety training system effectively improves employees' awareness of safety production and self-protection ability for safe operation;
- During the training process, it is necessary to sort out the training materials into the volume, keep the training records, track and check the training results in time, and rectify the training deficiencies. They shall be submitted to the Company for filing;
- Assessment requirements: All employees of the hydrogen fueling station shall fully grasp them and be able to use them flexibly at work and in emergency situations. Assessment shall be made on a regular basis, and the assessment results shall be submitted to the Equipment Safety Department of the Company for filing.

K-5. Zhengzhou training related to China FCV market and technology monitoring

K-17 Yutong Bus Company has set up a "New Energy Monitoring System" platform for Zhengzhou through the implementation of the Project, thus the following functions can be used on PC and mobile platform. It consists of vehicle monitoring (selection of vehicle to be queried through the vehicle information bar that includes current specific location, current speed, mileage and other information of the vehicle), query for various fault details reported by vehicles, and to query the energy consumption and mileage statistics of vehicles.

K-18 Key personnel and young talents from demonstration enterprises were to be included in the existing talent evaluation system of Henan Province in the field of hydrogen energy technology. Special plans were to be launched for the evaluation and identification of high-level talents, so as to effectively improve the attractiveness of industrial talents and the retention rate of introduced talents. The training of local technical talents was to be strengthened while introducing external R&D talents through universities, colleges and professional schools.

K-19 In terms of investment into research and development of FCVs, Yutong Bus has taken the lead in the domestic bus industry in Zhengzhou, providing a solid material foundation for the research and development of fuel cell bus technology and personnel training. At present, Yutong has invested RMB 250 million in more than 200 sets of test equipment with Yutong continuing investments in the future. In terms of the research and development of fuel cell technology, a 150 kW fuel cell system test platform, an air compressor test platform, a special DC/DC test platform for fuel cells, and a low-temperature environment bin have been installed. In terms of vehicle verification, a vehicle drum test bench has been built to test and verify the main performance of the FCV. A power system test bench was set up to carry out power system integration and complete vehicle control strategy development and calibration tests. In terms of motor and its control technology, Yutong was to establish a motor system test bench to carry out motor system performance test and electric drive system integration and matching test. Yutong was also to set up a vehicle-mounted energy system laboratory to test power battery system and fuel cell system and install an electrical accessory test platform with the functions and reliability verification capabilities of electric steering system, electric blast pump, DC/DC, electric air conditioning system, electric defrosting system, and electronic fans.

APPENDIX K – YANCHENG DEMONSTRATION CITY REPORT

L-1. Pilot demonstrations and support to Yancheng's FCV component manufacturers

L-1 Ten fuel cell buses have been demonstrated and promoted in Yancheng during the DevCom FCV Project implementation, running for 27,322 hours in total, with a cumulative distance of more than 660,000 kilometers and a cumulative investment of over RMB 60 million. The technology of fuel cell parts manufacturers has been significantly improved with 40 kW, 45 kW, 50 kW, 60k W fuel cell modules, 100 kW fuel cell engine testing platform and a 60kW fuel cell stack testing platform having been developed and placed onto the market for sale.

L-2 During the Project, the technology of FCV has been significantly improved, with the average duration between brake down of fuel cell buses exceeding 5,000 kilometers and the average life of fuel cell stacks exceeding 5,000 hours. Meanwhile, the Project has promoted the improvement of FCV industry in Yancheng as shown on Table K-1.

Table L-1: FCV Industry Chain in Yancheng

Industrial chain processes	Major enterprises
Hydrogen production/supply	Jinqiao Fengyi Chlor-Alkali (Lianyungang) Co., Ltd. and Jiangsu Dahe Chlor-Alkali Chemical Co., Ltd.
Hydrogen refueling station	Yancheng Chuangyong hydrogen refueling station Management Service Co., Ltd. and Xinao Gas Co., Ltd.
Key components	Jiangsu Xingbang Energy Technology Co., Ltd.
OEM	Jiangsu Aoxin New Energy Automobile Co., Ltd. and Yueda Group
Research platform	Yangtze River Delta New Energy Vehicle Research Institute
Vehicle operator	Yancheng Public Transportation General Company

L-3 In terms of assistance to component manufacturers, the Jiangsu Xingbang Energy Technology Co., Ltd. (founded in 2015) has been at the forefront of FCV development. The company specializes in hydrogen fuel cell technologies, in particular the research and development, production and sales of hydrogen fuel cell stack components, hydrogen fuel cell stacks, hydrogen fuel cell modules, hydrogen fuel cell stack test stations, hydrogen fuel cell module test stations, as well as hydrogen fuel cell system integration. Many activities such as technical support, report sharing, technical exchange, supplier meeting, have been organized under the Project, which provides necessary help for Jiangsu Xingbang and other enterprises. During implementation, R&D and production capacity of Jiangsu Xingbang improved, and 40 kW, 45 kW, 50 kW and 60 kW fuel cell modules, 100kW fuel cell engine testing platform and 60kW fuel cell stack testing platform have been developed.

L-4 During the project period, the total investment in FCV and its industrial chains, hydrogen refueling stations and their industrial chains exceeded RMB 60 million in Yancheng. FCV is a key area of new energy vehicles in Yancheng. Compared with pure electric buses, hydrogen fuel cell buses enjoy long mileage and short refueling time. With the technical improvement and commercialization of FCVs in Yancheng, the cost of FCV has been reduced.

L-2. Hydrogen refueling systems in Yancheng

L-5 The first hydrogen production and fueling integrated station and fuel cell laboratory project in Jiangsu Province started in Yancheng at the New Energy Vehicle Industrial Park at the end of 2020. The Yangtze River Delta New Energy Vehicle Research Institute provided support in terms of technical scheme. The HRS was designed by Dongfeng Design and Research Institute, covering an area of 3,400 square meters, with a total investment of RMB 12 million and 200 kg/day and 500 kg/day of the designed hydrogen production and fueling capacity respectively. It was put into operation at the end of the first quarter of 2021.

L-6 According to the project contractor, the HRS is the first hydrogen production and integrated refueling station in Jiangsu Province. A 1 MW roof photovoltaic microgrid was used to realize hydrogen production by water electrolysis in the station and effectively solve the problems of economy of "fuel hydrogen" and safety of hydrogen storage and transportation, providing technical experience for Yancheng to produce "green hydrogen" by large-scale application of renewable energy.

L-7 During the project implementation, one hydrogen refueling station (Chuangyong hydrogen refueling station) has been built and put into operation in Yancheng to ensure the smooth operation of fuel cell buses, with two hydrogenation stations under construction and one under planning (see Table L-2).

Table L-2: Hydrogen refueling stations in Yancheng

S/N	Name of hydrogen refueling station	Hydrogen refueling capacity (kg/d)	Progress
1	Chuangyong hydrogen refueling station	1,200	Operation
2	Jianbing hydrogen refueling station	500	Under construction
3	New Energy Vehicle Industrial Park hydrogen refueling station	500	Under construction
4	Yancheng Test Site hydrogen refueling station		Planning

L-8 To encourage the building of hydrogen refueling stations and promote the commercial operation of FCV, preferential treatment was given to newly-built hydrogen refueling stations in Yancheng according to the type of general commercial lands. Meanwhile, during the project implementation, an approval, supervision and acceptance process specification of hydrogen refueling stations has been developed in Yancheng from experiences of Shanghai, Foshan and other cities. The specific process is defined as follows:

- register with the Market Supervision Administration to obtain a business license;
- project approval at the National Development and Reform Commission;
- project planning in the planning bureau;
- environmental opinion review and project safety pre-evaluation (third-party intermediary agency);
- preliminary design (Designer);

- drawing review, fire control review (housing construction bureau)
- project construction and equipment installation;
- pressure vessel registration certificate (Market Supervision Administration);
- fire control acceptance (housing construction bureau);
- safety acceptance evaluation and environmental acceptance opinions (third-party intermediary agency);
- review of completion data and acceptance at the same time (housing construction bureau);
- handling of the gas cylinder filling license (Market Supervision Administration); and 13) Operation.

L-9 Total investment in HRS is over RMB 20 million. Both Yancheng Petroleum Company and China Energy Engineering Group Jiangsu Company plan to build a methanol gasoline and hydrogen production by methanol reforming/hydrogen refueling integrated station for Yancheng Test Site of China Automotive Technology and Research Center Co., Ltd. in Dafeng District.

L-10 Yancheng, with its 15,000 tons of waste hydrogen fuel and ample wind power and photovoltaic power generation, can provide clean conversion for hydrogen production by water electrolysis. It is possible to build Yancheng into a hydrogen energy FCV industrial base.

L-3. Yancheng local policy

L-11 During the project implementation, Yancheng Municipal People's Government issued 4 policies to support the development of fuel cell industry as shown in Table L-3

Table L-3: Yancheng's Policies on FCV

No.	Date	Sectors	Policy name
1	2019.5	Yancheng Bureau of Industry and Information Technology	Rules for the Implementation of Local Financial Subsidies for the Promotion and Application of New Energy Vehicles in Yancheng in 2018
2	2019.5	Yancheng Municipal People's Government	Yancheng Action Plan for Development Planning of Huaihe Ecological Economic Belt
3	2020.5	Yancheng Municipal Bureau of Finance and Yancheng Bureau of Industry and Information Technology	*Rules for the Implementation of Local Financial Subsidies for the Promotion and Application of New Energy Vehicles in Yancheng in 2019*
4	2021.3	Yancheng Municipal People's Government	Opinions on the Implementation of the "Year of Breakthrough in Scientific and Technological Innovation" in the City

L-12 As FCV is an emerging industry, un-sound policies and standards have been put in place, hindering its commercialization process. Relevant organizations in Yancheng have actively organized, planned and studied relevant industry standards, and participated in drafting the group standard, "Design

Code for Fuel Cell System Factories". The draft of this standard was issued on the official website of China Association of Automobile Manufactures in October 2020.

L-4. Capacity building and awareness raising programs in Yancheng

L-13 Over 200 people were trained on Yancheng for fuel cell buses and hydrogen refueling stations hydrogen fueling infrastructure enterprises. This included Yancheng key components enterprises and OEMs who have formulated relevant training contents for the maintenance of FCV and hydrogen refueling stations. Meanwhile, relevant personnel from Yancheng Yangtze River Delta New Energy Vehicle Research Institute have compiled the "Hydrogen Energy and Fuel Cell Electric Vehicles", which is one of the teaching manuals for automobiles in general higher education of new engineering and published by China Machine Press.

L-14 To ensure the demonstration operation of Yancheng fuel cell bus, Jiangsu Xingbang has conducted special fuel cell safety training for K11 bus drivers, who shall then work with qualification certificate to ensure that each driver has the safe operation ability of FCV and the emergency handling ability to deal with safety problems. Meanwhile, Xingbang has trained a professional fuel cell bus maintenance team to ensure the smooth operation of fuel cell buses. During the demonstration, the operation and maintenance system, safety specifications and emergency support scheme of the hydrogen refueling stations in Yancheng were verified with relevant staff trained in operation and maintenance and safety (see Table L-4).

Table L-4: Training in Yancheng

Total number of people	Female	Male	Management personnel trained	Technical personnel trained	Workers trained	Other
200	67	133	16	56	90	38

L-5. Yancheng training related to China FCV market and technology monitoring

L-15 Ten fuel cell buses in Yancheng have been connected to the national FCV demonstration operation platform to track demonstration operation mileage, operation duration, operation track, fault alarms. Through communication, information, electronic control, network, positioning, GIS and other technologies, the national platform was designed to realize the information-based, safety monitoring and operation management of FCV, build an integrated operation management platform, and strengthen the data collection, statistical analysis, tracking inspection of FCV operation. It provided strong data and technical support in improving the durability and performance and reducing cost of FCV, thus laying a solid technical foundation and data support for the large-scale promotion of FCV and the promotion of the commercialized development of FCV in China. The import of vehicle-related registration information, license plates, regions and other information, the promotion and operation of vehicles in various regions, provinces and cities are monitored in a comprehensive and intuitive manner, providing key data support for vehicle enterprises, governments, and financial institutions, to understand FCV market in China.

L-16 Both Yancheng Petroleum Company and China Energy Engineering Group Jiangsu Company plan to build a methanol gasoline and hydrogen production by methanol reforming/hydrogen refueling integrated station for Yancheng Test Site of China Automotive Technology and Research Center Co., Ltd. in Dafeng District, Yancheng City.

L-17 Human Resources Support - The training of local technical personnel and the coalition of colleges and enterprises are being strengthened by relying on many institutions of higher education and specialized institutes in Yancheng City, to encourage the establishment of technical courses and majors related to FCV and components and expand the scale of special technical personnel. A reasonable industrial employment guideline will be introduced for graduated professionals, so as to enhance the local counterpart employment rate of special talents, use emerging industries to drive the development of local universities and research institutes, and improve the regional scientific research and technical level.

APPENDIX L – FOSHAN DEMONSTRATION CITY REPORT

M-1. Support to Foshan's FCV Industry

M-1 Hydrogen energy industry in Foshan began its demonstrations as early as 2009 with the Guangdong Guangshun New Energy Technology Co. Ltd. in Nanhai District of Foshan City. The project was a fuel cell air compressor production demonstration. The DevCom FCV Project had a demonstration project to promote the large-scale development of fuel cell vehicles in public transportation and logistics scenarios. Twenty-five demonstration bus routes have been established in Nanhai District through the demonstration project, 397 hydrogen buses and 427 logistics vehicles in total. Today, the number of FCVs in Nanhai District has increased to 827, and 9 hydrogen refueling stations have been built and operated with two hydrogen refueling stations under construction. Through demonstration, it is found that fuel cell buses enjoy advantages in terms of output power, driving range, fueling efficiency, which is conducive to the continuous and efficient operation of vehicles compared with pure electric buses.

M-2 In terms of industrial operation, the cost of fuel cell system has been reduced from not less than RMB 10,000/kw at the initial stage of demonstration to RMB 5,000/kw at present, with reductions to RMB 2,000/kW expected in the future. As the main carrier of Refire technology in Foshan, Guangdong Discovery Motors Co., Ltd. has established Yunliang Fuel Cell (Guangdong) Co. Ltd. to be responsible for the research and development and production of stacks and membrane electrodes, with an annual production capacity of 5,000 stacks. The demonstration fuel cell system rated power of the 12 m fuel cell bus reached 92 kW with 5.42 kg/100km of hydrogen consumption. The demonstration fuel cell system rated power in the 8 t logistics vehicle reaches 35 kW with 2.92 kg/100km of hydrogen consumption.

M-3 Table M-1 shows new hydrogen enterprises in Foshan that were supported by the Project.

Table M-1: New Hydrogen Energy Enterprises in Nanhai District, Foshan City

S/N	Type of new hydrogen energy enterprise in Nanhai District	Name of new and introduced enterprise
1	Development, storage and transportation of hydrogen production and hydrogen production and fueling equipment	Guangdong Haidelisen Yiqing Technology Co., Ltd.
2		Guangdong Lianyue Gas Co., Ltd.
3		Foshan Tuling Green Hydrogen Technology Co., Ltd.
4		Foshan Yinchengwen Hydrogen Energy Technology Co., Ltd.
5		Grand Resource Co., Ltd.
6		Lvran (Foshan) Technology Co., Ltd.
7		Guangdong Qinglian New Energy Transportation Service Co., Ltd.
8		Guangdong Cawolo Health Technology Co., Ltd.
9	Fuel cell system, stack, core components, key materials	Foshan Panye Hydrogen Energy Technology Co., Ltd.
10		Guangdong Jiping New Energy Technology Co., Ltd.
11		Guangdong Qingneng New energy technology Co., Ltd.
12		Beili Huachuang (Foshan) New Energy Automobile Technology Co., Ltd.
13		Dalian Institute of Chemical Physics, Chinese Academy of Sciences
14		Foshan Chuangqu Electric Technology Co., Ltd.

S/N	Type of new hydrogen energy enterprise in Nanhai District	Name of new and introduced enterprise
15		Zhongke Rungu Smart Energy Technology (Foshan) Co., Ltd.
16		Yingfeiteng (Foshan) Hydrogen Energy Development Co., Ltd. (Tentative)
17		Guangdong Discovery Motors Co., Ltd.
18		Cemt GD Co.,Ltd
19		Yunliang Fuel Cell (Guangdong) Co., Ltd.
20	Complete vehicle R&D and manufacturing	Guangdong Hanhe Automobile Co., Ltd.
21		Guangdong Zhongyu Zhichuang Technology Co., Ltd.
22	Testing and equipment development enterprise	Guangdong LAN Hydrogen Technology Co., Ltd.
23	Standard setting	China Standard Promoting Science and Technology (Foshan) Co., Ltd.
24		China Standard Group Foshan Standardization Office
25		Foshan Green Development Innovation Research Institute
26	Vehicle promotion and operation enterprise	Foshan Juyuan Power New Energy Automobile Co., Ltd.,
27		Hydrogen Power Hydrogen For Automobile Operation (Foshan) Co., Ltd.
28		Hydrogen Forward Automobile Operation (Foshan) Co., Ltd.
29	Production and research platform	National and Local Joint Engineering Research Center for Self-lubricating Flow Power Machinery Technology
30		Foshan Xianhu Laboratory
31		Guangdong Wuhan University of Technology Hydrogen Energy Industry Technology Research Institute
32		South China Hydrogen Safety Promotion Center, Nanhai District, Foshan City
33		Hydrogen Energy and Clean Renewable Energy Technology Research Institute, Xi'an Jiaotong University
34	Personnel and skills training platform	Hydrogen Economy Vocational College
35	Supervision platform	Beijing Institute of Technology Xinyuan Information Technology Co., Ltd.
36		Guangdong Zhongqing Bochuang Industry Development Co., Ltd.
37		Xianhu Technology Co., Ltd.
38	Other productive service enterprises and institutions	Guangdong Qingyun Xingcui Data Co., Ltd.

M-2. Hydrogen Re-fueling systems in Foshan

M-4 The Project has promoted the development of hydrogen energy enterprises in Nanhai District. There are 10 HRSs to Nanhai District since 2017 including storage and transportation enterprises, 11 fuel cell system, stack, core component and key material enterprises, 2 OEM enterprises, one testing and equipment development enterprise, 3 standard-setting enterprises, 3 vehicle promotion and operation enterprises, 5 production and research platforms, one personnel and skills training platform, one supervision platform, and 3 other productive service enterprises and institutions, totaling 38 hydrogen energy enterprises.

M-5 By implementing the DevCom Project, the vehicle hydrogen industry chain in Foshan has been continuously improved, with hydrogen production potential in local and surrounding areas. Meanwhile, hydrogen production by renewable energy has been promoted by Hanlan (Foshan)

New Energy Operation Co., Ltd., which has put forward the proposal of "Hydrogen Production by Regional Food Waste Landfill Gas" with preliminary plans for hydrogen production by biogas. The integrated biogas purification and reforming process for gaseous hydrogen is expected to reach 4-7 tons per day.

M-6 With 395 hydrogen buses and 427 logistics vehicles being demonstrated, 10 hydrogen refueling stations have been built and operated, with two hydrogen refueling stations under construction. Table M-2 shows the refueling stations in Foshan.

Table M-2: Promotion of Hydrogen Refueling Stations in Nanhai District

S/N	Name	Category	Hydrogen fueling capacity (kg/day)	Year of completion	Current status	Investment (RMB '0,000)	Town and street
1	Ruihui Hydrogen Refueling Station	Fixed hydrogen refueling station	350	2017	Put into operation	1550	Danzao
2	Sinopec Xiqiao Zhanghang (Qinglong Oil-hydrogen Joint Combined Station	Fixed Oil-hydrogen Combined Station	500	2019	Put into operation	1500	Xiqiao
3	Songgang Hydrogen Refueling Station	Fixed hydrogen refueling station	1500	2019	Put into operation	3300	Shishan
4	Taoyuan Hydrogen Refueling Station	Fixed hydrogen refueling station	1500	2019	Put into operation	3000	Shishan
5	Dongfang International Machinery Factory Skid-mounted Station	Skid-mounted hydrogen refueling station	500	2019	Put into operation	800	Guicheng
6	Jiujiang Avenue Skid-mounted Station	Skid-mounted hydrogen refueling station	500	2019	Put into operation	800	Jiujiang
7	Government East Hydrogen Refueling Station	Fixed hydrogen refueling station	1500	2020	Completed, to be accepted	2600	Danzao
8	Funan N171 Oil-hydrogen Combined Station	Fixed oil-hydrogen combined station	500	2020	Completed, to be accepted	1500	Dali
9	Shishan Jiluo Oil-hydrogen Combined Station	Fixed oil-hydrogen combined station	500	2020	Completed, to be accepted	2000	Shishan
10	Ruihui (Expanded Hydrogen Refueling Station	) Fixed Hydrogen Refueling Station	650	2020	Completed, to be accepted	1300	Danzao
Total			**8000**			**18350**	

M-7 In the process of promoting the commercial development of hydrogen fuel cell vehicles in Foshan City, there was no relevant policy on the approval and access of hydrogen refueling stations. To resolve this problem, the first domestic approval, construction and acceptance process of the hydrogen refueling station was established in Nanhai District in 2015. The “Guidelines for Approval and Acceptance of Fixed Hydrogen Refuelling Stations in Nanhai District, Foshan City (Provisional) (Revised Edition)” and “Guidelines for Approval and Acceptance of Skid-mounted Hydrogen Refueling Stations in Nanhai District, Foshan City (Provisional) (Revised Edition)” were issued in

August 2020. At present, all hydrogen refueling stations are constructed in accordance with the relevant requirements of the Guidelines.

M-8 Following studies in January 2019, the Government of Nanhai District, Foshan released “Measures to Promote the Construction and Operation of HRS / Support the Operation of FCV”. In December 2019, the Economic and Technology Promotion Bureau of Gaoming District, Foshan has released Development Plan of Hydrogen Energy Industry in Gaoming District of Foshan City (2019 -2030). In March 2020, the NRDC of Nanhai District, Foshan has released “Development Plan of Hydrogen Energy Industry in Nanhai District of Foshan City (2020-2035)”. It pointed out that HRS must be jointly built with newly constructed or relocated gas stations.

M-9 To promote the further development of the fuel cell vehicle industry, Foshan Nanhai District Government plans to add 4,000 new fuel cell vehicles and built 45 new hydrogen refueling stations by 2024, achieving an annual output of 68,600 tons/year of high purity hydrogen. Table m-3 shows hydrogen supply targets for Foshan and Table M-4 shows development target of hydrogen refueling station and fuel cell vehicle quantity in Nanhai District.

Table M-3: Supply Target of Hydrogen Source in Nanhai District

Name of enterprise or project	Annual output of high purity hydrogen (tons/year)			
	2021	2022	2023	2024
Guangdong Lianyue	3500	23500	23500	23500
Zhuhai Changlian	20000	20000	20000	20000
Dongguan Grand Resource	3100	25000	25000	25000
Huate Gas	100	100	100	100
Total	26700	68600	68600	68600

Table M-4: Development Target of Hydrogen Refueling Station and Fuel Cell Vehicle Quantity in Nanhai District

Indicator	2021	2022	2023	2024	Accumulative
Hydrogen Refueling Station	5	10	10	20	45
Fuel cell vehicle	1000	1500	1000	500	4000

M-3. Foshan local policy

M-10 Foshan issued 14 local policies during the implementation of the DevCom FCV Project, as shown in Table M-5. The development plans and policies of hydrogen energy-related industries have been continuously improved since 2015. The “Measures for Supporting the Development of New Energy Vehicle Industry in Nanhai District, Foshan City” (referred to as "Support Measures"), were the first support measures nationwide for the construction and operation of hydrogen refueling stations. An industrial enhanced fund of RMB 5 billion has been set up to support the industrialization of major key technologies in hydrogen energy industry, forming a relatively perfect policy system and guiding the agglomeration and development of hydrogen energy industry elements, as shown in Table M-5.

Table M-5: Local Policies

S/N	Province/City	City/ District	Date	Policy name
1	Guangdong	Foshan	February 2021	*Foshan Nanhai District Gaseous Hydrogen Emergency Support Plan*
2	Guangdong	Foshan	March 2021	*Planning of Vehicle Hydrogen Refueling Station in Nanhai District (2021-2030)*
3	Guangdong	Foshan	January 3, 2020	*Development Plan of Hydrogen Energy Industry in Gaoming District, Foshan City (2019-2030)*
4	Guangdong	Foshan	February 24, 2020	*Development Plan of Hydrogen Energy Industry in Nanhai District, Foshan City (2020-2035)*
5	Guangdong	Foshan	May 6, 2020	*Notice on Printing and Distributing Measures (Revised) for Promoting the Construction and Operation of Hydrogen Refueling Stations and Supporting the Operation of Hydrogen Energy Vehicles in Nanhai District, Foshan City*
6	Guangdong	Foshan	June 9, 2020	*Measures for the Administration of Local Financial Subsidy Funds for the Promotion and Application of Fuel Cell Vehicles in Foshan (Draft for Public Comments)*
7	Guangdong	Foshan	August 2020	*Guidelines for Approval and Acceptance of Fixed Hydrogen Refueling Stations in Nanhai District, Foshan City (Provisional)* (Revised Edition)
8	Guangdong	Foshan	August 2020	*Guidelines for Approval and Acceptance of Skid-mounted Hydrogen Refueling Stations in Nanhai District, Foshan City (Provisional)* (Revised Edition)
9	Guangdong	Foshan	September 18, 2020	*Measures for the Administration of Municipal Financial Subsidy Funds for Fuel Cell Vehicles in Foshan City*
10	Guangdong	Chancheng District, Foshan City	February 2019	*Rules for the Implementation of Financial Subsidy Fund Management for the Promotion and Application of New Energy Buses and the Construction of Bus Charging Facilities in Chancheng District*
11	Guangdong	Foshan	November 2018	*Measures for the Administration of Financial Subsidy Funds for the Promotion and Application of New Energy Buses and Supporting Infrastructure Construction in Foshan City*
12	Guangdong	Foshan	December 2018	*Notice of the People's Government of Foshan on Printing and Distributing Development Plan of Hydrogen Energy Industry in Foshan (2018-2030)*
13	Guangdong	Nanhai District, Foshan City	April 12, 2018	*Measures for Promoting the Construction and Operation of Hydrogen Refueling Stations and Supporting the Operation of Hydrogen Energy Vehicles in Nanhai District, Foshan City (Provisional)*
14	Guangdong	Foshan	July 2017	*Measures for Supporting the Development of New Energy Vehicle Industry in Nanhai District, Foshan City*

M-11 In July 2020, the South China New Energy Automobile Industry Promotion Center in Nanhai District, Foshan City took the lead in publishing the first group standard for data collection of hydrogen refueling stations in China, "TCAB0064-2020 Technical Specification for Remote Service and Management Information System of Hydrogen Refuelling Stations", which provided standard reference for data collection and monitoring of hydrogen refueling stations. A technical seminar on "Group Standard for Operating Mileage with Hydrogen" was held in December 2020. With the background of launching the standard proposal, the group standard plan, the algorithm content, and the data analysis and summary of currently operating vehicles, focus was given on the full discussion and exchange of calculation methods for operating mileage with hydrogen consumed by hydrogen fuel cell vehicles, and the energy conversion mechanism and mileage calculation methods under different control strategies of fuel cell vehicles.

M-12 Nanhai District People's Government, Foshan City is formulating the “Implementation Plan for Promotion and Application of New Energy (Hydrogen Energy) public service and Logistics Vehicles in Nanhai District, Foshan City (2021-2024)” to support the demonstration and application of hydrogen energy vehicles such as public service and logistics, and encourage the use of hydrogen energy vehicles in newly added or updated municipal sanitation vehicles (including garbage transfer, spraying, sweeping and engineering emergency repair), municipal engineering vehicles (including muck transportation, concrete transportation and truck cranes), logistics handling, cargo loading and tow vehicles. At present, the first draft of the policy has been formed, the first stage of soliciting opinions has been completed, and is being revised and improved according to relevant opinions.

M-4. Capacity building and awareness raising programs in Foshan

M-13 Nanhai District People's Government has promoted Guangdong Polytechnic of Environmental Protection Engineering, Foshan Technician College, Guangdong Polytechnic Institute and other vocational colleges to set up fuel cell vehicle-related majors, training nearly for 1,000 skilled personnel and training of nearly 50 personnel in hydrogen refueling station. Meanwhile, the UNDP Hydrogen Economy Institute has been setup to cooperate and promote the construction of Hydrogen Economy Vocational College to build a platform for personnel and skills training in the hydrogen energy industry.

M-14 During the demonstration period, a total of RMB 982.12 million was invested in Foshan City in fuel cell vehicles their industrial chains, and hydrogen refueling stations. Meanwhile, Foshan City made full use of financial funds around hydrogen supply, construction and operation of hydrogen refueling stations and market promotion of FCVs to gradually established a commercial profit model. An estimated RMB 5.0 billion industrial fund and RMB 20 billion government investment fund pool were set up, and Foshan City participated in RMB 2 billion Enze fund led by Sinopec Capital, which supported a number of hydrogen energy projects such as Guangdong Discovery, Yunliang, Hanhe Automobile and Cemt GD.

M-15 Nanhai District also took advantages of Guangdong Polytechnic of Environmental Protection Engineering, South China Normal University Institute of Technology, Foshan University, Foshan Technician College, Nanhai Open University and other universities and vocational colleges to strengthen the training of hydrogen energy technicians and enhance the core competitiveness of the hydrogen energy industry setup with the UNDP Hydrogen Economy Vocational College. Innovation platforms were to be cultivated and developed to continuously improve innovation capabilities. At present, "Xianhu Hydrogen Valley" has introduced more than 50 hydrogen energy industry projects with a total investment of more than RMB 25 billion. More than 30 hydrogen energy enterprises have settled down one after another, gradually forming a complete hydrogen energy industry chain with domestic independent intellectual property rights.

M-5. Foshan training related to China FCV market and technology monitoring

M-16 The first joint commercial supervision platform for FCVs and hydrogen energy stations is the one in Nanhai District. Through the data supervision, analysis and assessment of the operation process of core components, the Nanhai Demonstration Project, the common technical problems of hydrogen energy vehicles and HRS enterprises can be resolved, thereby promoting the continuous improvement of FCVs and HRSs in Nanhai District. Combined with industrial policy, fuel cell system principle and actual operation experience of vehicles and stations, the calculation algorithm of hydrogen running mileage, actual hydrogen consumption, operation efficiency and other data is realized, which provides preparation data for policy monitoring, industrial analysis, operation management and other businesses.

M-17 The platform provides access to hydrogen vehicle data, hydrogen refueling station data, hydrogen safety data, manufacturing data and video images, and supports analysis and storage of various data specifications such as GBT-32960 and technical specifications for remote service and management of hydrogen refueling stations. It supports the collection of equipment data of the whole industrial chain from hydrogen production, hydrogen storage, hydrogen transportation, hydrogen fueling and hydrogen use. Third-party platform data access is supported. Currently, the development of platform function modules is being stepped up in terms of equipment safety, vehicle safety, personnel and site safety

M-18 The Hongji Chuangneng Fuel Cell High Performance Membrane Electrode Industrialization Project. plans to invest RMB 100 million to build an industrialization base for fuel cell membrane electrodes and PEM electrolysis of water. This will be to produce hydrogen membrane electrodes in "Xianhu Hydrogen Valley" in Danzao Town, Nanhai District. The Research and Development and Production Project of Panye Air-cooled Fuel Cell Stack plans to invest RMB 600 million in a total of 15 production lines and air-cooled fuel cell. Annual output will be 300 MW.

M-19 In 2019, the Measures for the Administration of Foshan Nanhai Industrial Enhanced Fund was promulgated, and an industrial enhanced fund with a total financial contribution of RMB 5 billion in Nanhai District was established. At present, it is promoting the industrialization of major key technologies in hydrogen energy industry.

M-20 Within the framework of the DevCom FCV Project, UNDP China has cooperated with Nanhai District Government of Foshan to establish the Hydrogen Economy Vocational College. This was done to further solve the shortage of professional and technical personnel in the field of hydrogen energy in China. The establishment of the Vocational College will fill the vacancy of front-line professional and technical personnel in the development of China's hydrogen energy industry.

APPENDIX M – ZHANGJIAKOU DEMONSTRATION CITY REPORT

N-1. Support to Zhangjiakou's FCV Industry

N-1 In recent years, Zhangjiakou City has been committed to implementing the development strategy of building a "hydrogen city" . The strategy was proposed from:

- the development strategy requesting that the Capital City (Beijing)'s Water Conservation Functional Zone and the Ecological and Environment Supporting Zone should be established in Zhangjiakou. This was to explore an approach for invigorating and strengthening the city based on economically less-developed areas;
- a development strategy which designates Zhangjiakou as a renewable energy demonstration zone which was approved in July 2015 by the State Council. It is also an effective means to complete the "Three Historical Tasks" (Preparation for the Beijing 2022 Winter Olympics; poverty alleviation; and building Capital City (Beijing)'s Water Conservation Functional Zone and Ecological and Environmental Supporting Zone) and "Two Priority Areas" (Preparing for the Beijing 2022 Winter Olympics; and local development) in Zhangjiakou;
- the development strategy being a main path to achieve "carbon dioxide emissions peak and carbon neutrality". Hydrogen will assist the carbon neutrality in terms of transportation, industry, energy and construction. In the Government Work Report this year, the new energy industry represented by hydrogen was to deepen the energy revolution.

N-2 During Project implementation, Zhangjiakou had 304 FCV buses on demonstration over 10 bus routes. Through the demonstration project, fuel cell buses enjoy certain advantages over battery electric buses in terms of output power, driving range, and refueling efficiency, which are conducive to the continuous and efficient operation of vehicles. For example, the battery electric buses may be recharged after a round trip in winter, but the fuel cell buses are only refueled with gaseous hydrogen once every day. This was highly praised by passengers. The normalized operation of fuel cell buses can be supported in the places with relatively low density of hydrogen refueling stations which will effectively mitigate the "anxiety for hydrogen refueling".

N-3 Through the demonstration projects, relatively complete hydrogen industry chain has been gradually built in Zhangjiakou based on abundant renewable energy sources. Several enterprises are engaged in FCVs and hydrogen production. At present, there are 18 companies mainly involved with the FCV and hydrogen industry chain in Zhangjiakou. Table N-1 shows the enterprises in the industry chain, which specialize in fields such as proton exchange membranes, air compressors, gaseous hydrogen circulating pumps and hydrogen system, and which are complementary to each other thus promoting the healthy development of local industry in Zhangjiakou.

N-4 Breakthroughs have been achieved in air compressor as air bearings. Shaft seals, anti-explosion motors and other technologies applicable to gaseous hydrogen circulating pumps have been achieved. Gaseous hydrogen ejectors can be used to substitute the gaseous hydrogen circulating pumps. As for water pumps, the volume production has been realized from small flow to large flow. As for humidifiers, breakthroughs have been made in membrane pipe materials, and the pilot plant test has been completed. For the on-board hydrogen system, the gaseous hydrogen storage pressure has grown from 35 MPa to 70 MPa (at the prototype stage) with the liquid hydrogen system having been developed.

Table N-1: Relevant Enterprises in Zhangjiakou

S/N	Industry chain link		Enterprise	Qty.
1	Fuel cell	Fuel cell engine system	SinoHytec Power Technology Co., Ltd.	2
			Zhangjiakou Himalaya Hydrogen Energy Technology Co., Ltd.	
2		Electric piles	Zhangjiakou Hydrogen Technology Co., Ltd.	3
3			Zhangjiakou Jutong Technology Co., Ltd.	
			Zhangjiakou Himalaya Hydrogen Energy Technology Co., Ltd.	
4		Bipolar plates	Zhangjiakou Himalaya Hydrogen Energy Technology Co., Ltd.	1
5		Membrane electrodes	Zhangjiakou Himalaya Hydrogen Energy Technology Co., Ltd.	1
6		Catalysts	Zhangjiakou Himalaya Hydrogen Energy Technology Co., Ltd.	1
7	Vehicle manufacturing		Zhangjiakou Hydrogen Fuel Industry Base of FOTON Automobile Co., Ltd.	1
8	Gaseous hydrogen production, storage, transportation and refueling		Zhangjiakou Honghua Clean Energy Technology Co., Ltd.	12
9			Hebei Hongmeng New Energy Co., Ltd.	
10			Chongli Xintian Wind Energy Co., Ltd.	
11			Hebei Construction & Investment Yanshan (Guyuan) Wind Power Co., Ltd.	
12			Guohua (Chicheng) Wind Power Co., Ltd.	
			Zhangjiakou Transportation Construction Investment Shell New Energy Co., Ltd.	
13			Zhangjiakou Transportation Construction Investment Hydrogen New Energy Technology Co., Ltd.	
14			Zhangjiakou Haiboer New Energy Technology Co., Ltd.	
15			Zhongzhi Tiangong Co., Ltd.	
16			Hebei Zhangjiakou Petroleum Branch of Sinopec Sales Co., Ltd.	
17			CHN Energy Group Hydrogen Technology Co., Ltd.	
19			Zhangjiakou Zhongyou New Energy Co., Ltd.	
20	Vehicle operation		Zhangjiakou Public Transportation Group Co., Ltd.	1

N-5 With technical progress from 2017 to present, total cost has decreased from RMB 15,000/kW-RMB 20,000/kW to RMB 5,000/kW. The cost of 9 m passenger car is reduced from RMB 1.7 million/vehicle to RMB 830,000/vehicle. Performance and quality of fuel cell engine system are improved, and their adaptation and durability in cold areas are verified, favorably leaning towards larger-scale promotion. The fuel cell system (the core component) has the rated power, power density, efficiency and cold start capability respectively increased from 30kW to 120kW, from 100 W/kg to 700 W/kg, from 45% to 60%, and from -10℃ to -35℃. Application scenarios of fuel cell vehicles have been broadened, such as highway passenger vehicles (equipped with 70 MPa hydrogen system) and 35t/49t heavy trucks (equipped with liquid hydrogen system).

N-2. Hydrogen Re-fueling systems in Zhangjiakou

N-6 The Zhangjiakou Municipal Government has focused on renewable energy development for the hydrogen industry, consisting of a 3-year action plan for hydrogen construction in Zhangjiakou, and "Ten Measures to Support the Development of Hydrogen Industry in Zhangjiakou". The "Layout Planning of Hydrogen Refueling Stations in Main Urban Areas of Zhangjiakou City (2019-2035)" and the "Construction Implementation Plan for Zhangjiakou Hydrogen Guarantee Supply System Phase I Project" have been issued, taking the opportunities to demonstrate green hydrogen for FCVs during the 2022 Olympic Winter Games.

N-7 The installed capacity of renewable energy sources in Zhangjiakou at the end of 2020 reached 20.03 million kW and will exceed 50 million kW by 2030. Presently, the "Hydrogen Production Phase I Project of Zhangjiakou Haiboer from Renewable Energy Sources" has been put into production (4 t/day), and the commissioning for the "Guyuan Wind Power Hydrogen Production Comprehensive Utilization Demonstration Phase I Project of Hebei Construction & Investment, has been completed (1.7 t/day).

N-8 In Zhangjiakou, there are 4 hydrogen refueling stations in operation: Chuangba Skid-mounted Station, Wangshan Hydrogen Production and Refueling Station, Hengpanliang Fixed Station and Weisanlu Oil, Hydrogen and Electricity Combined Station. Multiple HRSs are planned for completion before 2024. Table N-2 shows the planning of HRSs in Zhangjiakou during the "14th Five-Year Plan".

N-9 Under the support of the state and Zhangjiakou Municipal People's Government, the relevant enterprises have actively participated in hydrogen projects. At present, the Hydrogen Production Phase I Project of Zhangjiakou Haiboer from Renewable Energy Sources has been put into production (4 t/day), and the commissioning for the Guyuan Wind Power Hydrogen Production Comprehensive Utilization Demonstration Phase I Project of Hebei Construction & Investment has been completed (1.7 t/day). Enterprises such as Air Chemical Products (China) Investment Co., Ltd., Shell (China) Co., Ltd., CHN Energy, and CIIC Chemicals, are introduced for local hydrogen production projects.

N-10 Meanwhile, the present cost of hydrogen production by renewable energy, electrolyzed water, is up to RMB 30/kg, on a par with the current industrial by-product hydrogen. According to the "Implementation Plan of Fuel Cell Vehicle Demonstration Application in Zhangjiakou (2021-2024)" jointly issued by Zhangjiakou Municipal Development and Reform Commission, Zhangjiakou Finance Bureau, Zhangjiakou Bureau of Industry and Information Technology, Zhangjiakou Science and Technology Bureau, and Zhangjiakou Energy Bureau in April 2021, the cost of hydrogen production by renewable energy, electrolyzed water, will be reduced from RMB 30/kg to RMB 14/kg within four years by policy support and technological upgrade.

Table N-2: Planning of Hydrogen Refueling Stations in Zhangjiakou

S/N	Station name	Hydrogen refueling capability (kg/d)	Region	Construction entity	Progress
1	Chuangba Huatong Station	1500	Qiaodong District	Zhangjiakou Transportation Construction Investment Group	Operation
2	Dongwangshan	1500	Qiaodong District	Haiboer	Operation
3	Weisanlu Station	1000	Economic Development Zone	Zhangjiakou Transportation Construction Investment Group	Built
4	Qipanliang	1000	Chongli District	Zhangjiakou Transportation Construction Investment Group	Built
5	Shenjiatun	1000	Economic Development Zone	Zhongyou Jinhong	Planning
6	Xishan Industrial Park	1000	Wanquan District	CHN Energy Group	Planning
7	Weiyi East Gas and Hydrogen Combined Station	1000	Economic Development Zone	Zhongyou Jinhong	Planning
8	Beiwapenyao Oil and Hydrogen Combined Station	1000	Qiaoxi District	Constructed by Hebei Construction & Investment and Sinopec together	Planning
9	Wangjiazhai Oil and Hydrogen Combined Station	1000	Qiaodong District	Constructed by Hebei Construction & Investment and Sinopec together	Planning
10	Chongli South	1000	Chongli District	Constructed by Hebei Construction & Investment and Sinopec together	Planning
11	Chongli North	1000	Chongli District	Zhangjiakou Transportation Construction Investment Group	Planning
12	Nanhuan	1000	Economic Development Zone	Constructed by Hebei Construction & Investment and Sinopec together	Planning
13	Dongshan Industrial Park Station	1000	Economic Development Zone	Zhangjiakou Transportation Construction Investment Group	Planning
14	Sijietun Station	1000	Economic Development Zone	Zhangjiakou Transportation Construction Investment Group	Planning
15	Chongli South Skid-mounted Station	500	Chongli District	Constructed by Hebei Construction & Investment and Sinopec together	Planning
16	Skid-mounted Station in Qipanliang Service Zone	500	Chongli District	Zhangjiakou Transportation Construction Investment Group	Planning

N-3. Zhangjiakou local policy

N-11 Zhangjiakou has successively issued multiple policies on industrial development of FCVs and hydrogen development. Table N-3 shows these policies. Currently, Zhangjiakou is studying and formulating the "Rules for Acceptance of Hydrogen Refueling Station in Zhangjiakou".

Table N-3: Fuel Cell-related Policies Issued by Zhangjiakou

S/N	Level	Policy name	Issued on	Issued by	Supporting fields
1	National level	*Development Plan of Renewable Energy Demonstration Zone in Zhangjiakou, Hebei Province*	July 2015	National Development and Reform Commission	Whole industry
2	Municipal level	*Hydrogen Construction Plan of Zhangjiakou (2019-2035)*	June 2019	Zhangjiakou Municipal People's Government	Whole industry
3	Municipal level	*Three-year Action Plan for Hydrogen Construction in Zhangjiakou (2019-2021)*	June 2019	Zhangjiakou Municipal People's Government	Whole industry
4	Municipal level	*Ten Measures to Support the Development of Hydrogen Industry in Zhangjiakou*	June 2019	Zhangjiakou Municipal People's Government	Whole industry
5	Municipal level	*Implementation Opinions on the Approval and Filing of Investment Projects of Hydrogen Refueling and Hydrogen Production Enterprises in Zhangjiakou*	June 2019	Zhangjiakou Municipal People's Government	Hydrogen
6	Municipal level	*Notice of Zhangjiakou Municipal People's Government on the Establishment of Zhangjiakou Municipal Hydrogen Industry Development Leading Group*	July 2019	Zhangjiakou Municipal People's Government	Whole industry
7	Municipal level	*Notice of Zhangjiakou Municipal People's Government Office on Work Ledgers of Hydrogen Industry Development Practically*	November 2019	Zhangjiakou Municipal People's Government	Whole industry
8	Municipal level	*Construction Implementation Plan for Zhangjiakou Hydrogen Guarantee Supply System Phase I Project*	February 2020	Zhangjiakou Municipal People's Government	Hydrogen
9	Municipal level	*Measures for the Safety Supervision and Management of the Hydrogen Industry in Zhangjiakou*	March 2020	Zhangjiakou Municipal People's Government	Whole industry
10	Municipal level	*Supplementary Notice on the Implementation Opinions on the Approval and Filing of Investment Projects of Hydrogen Refueling and Hydrogen Production Enterprises in Zhangjiakou*	April 2020	Zhangjiakou Municipal People's Government	Hydrogen
11	Municipal level	*Layout Planning of Hydrogen Refueling Stations in Main Urban Areas of Zhangjiakou City (2019-2035)*	May 2020	Zhangjiakou Municipal People's Government	Hydrogen
12	Municipal level	*Measures for the Administration of Hydrogen Refueling Stations in Zhangjiakou (Trial)*	July 2020	Zhangjiakou Municipal People's Government	Hydrogen
13	Municipal level	*Implementation Plan of Fuel Cell Vehicle Demonstration Application in Zhangjiakou (2021-2024)*	April 2021	Zhangjiakou Municipal People's Government	Whole industry

N-4. Capacity building and awareness raising programs in Zhangjiakou

N-12 During the demonstration project, the Project have carried out 98 training activities online and offline, and cumulatively trained 3,874 persons. Training course materials were formulated, covering the technologies, management and production related to FCVs and hydrogen productions hydrogen and electricity safety, assembly process, maintenance process, and fault diagnosis treatment.

N-13 In the meantime, United Nations Development Program (UNDP) has provided services for the Project team concerning the FCVs and HRSs. International experts have offered potential solutions such as international solutions for bipolar plates, and potential international suppliers for bipolar plates and air compressors for the Project team.

N-14 Drivers, operators and maintainers have been trained on the Project including the basics of the FCVs, the driving or operation and maintenance precautions, and the meaning of instrument instructions to ensure that drivers, operators and maintainers will accurately and safely use or maintain the fuel cell vehicles.

N-15 When implementing the Project, training documents such as the “User Manual, Work Specification, Safety Management Manual, and Training Courseware” have been prepared. Table N-4 shows the training persons and the management training of the Project. Figure N-1 shows evidence of on-site training that includes worker training, assembly, safety and driving.

N-16 During the demonstration, approximately RMB 1.572 billion has been invested totally in the FCV and the HRS industrial chain of Zhangjiakou. The demonstration project sets up a benchmark for the industry, enhancing the growth confidence. Excellent performance of SinoHytec Power has significantly supported the listing of its parent company, Beijing SinoHytec Co., Ltd, establishing a new financing channel, which has directly increased the investments in FCV and HRS related enterprises.

Table N-4: Training Persons-time of Project

Total persons	Female	Male	Managers trained (person)	Technicians trained (person)	Workers trained	Others
3,874	1,360	2,514	750	1,200	1,924	-

Figure N-1: On-site Training for Fuel Cell Vehicles

N-5. Zhangjiakou training related to China FCV market and technology monitoring

N-17 The Zhangjiakou fuel cell vehicle monitoring platform has been installed for data collection and analysis for the entire Zhangjiakou industrial chain of FCVs and HRSs to meet real-time demands of governments and industrial participants for FCV and HRS data. At present, the machine room of this platform has been built with hardware construction and software platform construction completed. It has been connected to all the fuel cell buses and is now accessing data of HRSs and hydrogen production plants.

N-18 There are 2 initiatives worth mentioning with respect to the future of FCVs and HRSs in Zhangjiakou:

- Hebei Hydrogen Energy Industry Innovation Center was planning the construction and installation of a central R&D building, ALK/PEM production lines, SOEC laboratory and small test lines, a national hydrogen product testing center, and an optical storage and hydrogen charging demonstration projects;

- Zhangjiakou Public Transportation Group is setting up a training base to disseminate demonstration operational knowledge of FCVs and HRSs.

APPENDIX N - EVALUATION CONSULTANT AGREEMENT FORM

Evaluators:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded.
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence and must ensure that sensitive information cannot be traced to its source. Evaluators are not expected to evaluate individuals and must balance an evaluation of management functions with this general principle.
4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.
6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study imitations, findings, and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

Evaluation Consultant Agreement Form[43]

Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: __Roland Wong____

Name of Consultancy Organization (where relevant)**:** ________________________

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at *Surrey, BC, Canada* on *28 September 2021*

[43]www.unevaluation.org/unegcodeofconduct

Evaluators:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded.
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
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7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

Evaluation Consultant Agreement Form[44]

Agreement to abide by the Code of Conduct for Evaluation in the UN System

Name of Consultant: __Prof. Qiu Bin____

Name of Consultancy Organization (where relevant)**:** ________________________

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at *Beijing, China* on *28 September 2021*

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