



**ASIAN INFRASTRUCTURE
INVESTMENT BANK**

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**Project Document
of the Asian Infrastructure Investment Bank
Sovereign-backed Financing
People's Republic of China
Liaoning Green Smart Public Transport Demonstration Project**

Currency Equivalents

(As on July 26, 2021, People's Bank of China)

Currency Unit – Chinese Yuan (CNY)

CNY1.00 = USD0.1544

USD1.00 = CNY6.4763

Borrower's Fiscal year

January 1 – December 31

Abbreviations

ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
BEB	Battery Electric Buses
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
E&S	Environmental & Social
EIRR	Economic Internal Rate of Return
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESP	Environmental and Social Policy
ESS	Environment and Social Standards
etc.	Et cetera
EV	Electric Vehicle
FIRR	Financial Internal Rate of Return
FM	Financial Management
FSR	Feasibility Study Report
GRM	Grievance Redress Mechanism
IUFR	Interim Unaudited Financial Reports
LURCC	Liaoning Urban and Rural Construction and Renewal Project Management Company Ltd.
MDB	Multilateral Development Banks
MOF	Ministry of Finance
NO _x	Nitrogen Oxide
O&M	Operating and Maintenance
PIU	Project Implementation Unit
PMO	Project Management Office
PPM	Project-affected People's Mechanism
SO ₂	sulphur dioxide
WB	World Bank

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1. Summary Sheet

Project No.	000406
Project Name	Liaoning Green Smart Public Transport Demonstration Project
AIIB Member	People's Republic of China
Borrower	People's Republic of China
Project Implementing Entity	Liaoning Provincial Government
Sector	Transport
Sub-sector	Urban transport
Project Objective	To improve the quality and efficiency of public transport service and urban environment by replacing conventional fossil-fueled buses with battery electric buses (BEBs) and applying digital technology to public transport management systems in five small and medium cities of Liaoning Province.
Implementation Period	Start Date: December 2021 End Date: November 2025
Expected Loan Closing Date	May 2026
Cost and Financing Plan	Project cost: USD214.26 million <u>Financing Plan:</u> AIIB loan: USD 150 million Government: USD 42.41 million Bus companies: USD 21.85 million
Size and Terms of AIIB Loan	Euro 130 million (approximately USD150 million) ¹ , with a maturity of 25 years, including a grace period of 5 years, at AIIB's standard interest rate applicable to sovereign-backed variable-spread loans
Cofinancing (Size and Terms)	N/A
Environmental and Social Category	B
Risk (Low/Medium/High)	Medium
Conditions of Effectiveness	Signing of at least one subsidiary loan agreement between a city government and a bus company
Key Covenants/Conditions for Disbursement	<ul style="list-style-type: none"> The Project Implementing Entity shall ensure that the Project implementation comply with all measures and requirements set forth in the agreed Environmental and Social Impact Assessment (ESIA) accompanied with Environmental and Social Management Plan (ESMP).

¹ The Loan is requested to be in Euro. As of September 30, 2021, the exchange rate of Euro to USD was 1.157. However, the cost and financing plan in this report is still presented in USD to ensure consistency.

Retroactive Financing (Loan % and dates)	Up to 20% of the loan amount for the eligible expenses incurred no earlier than 12 months prior to the signing of the loan agreement.
Policy Waivers Requested	N/A
Policy Assurance	The Vice President, Policy and Strategy, confirms an overall assurance that the Bank is in compliance with the policies applicable to the Project.

President	Jin Liqun
Vice President, IO Region 2	Konstantin Limitovskiy
Director General, INF2	Supee Teravaninthorn
Manager, INF2	Gregory Liu
Team Leader	Hongliang Yang, Principal Investment Operations Specialist
Team Members	Chongwu Sun, Senior Environment Consultant Christopher Damandl, Senior Counsel Jingjing Zhao, Investment Operations Specialist Mengmeng He, Finance Associate Paul Lam, Strategy and Policy Officer – Digital Tech. Susrutha Goonasekera, Senior Social Development Specialist Suzanne Shaw, Infrastructure Sector Economist Yogesh Malla, Financial Management Specialist Yunlong Liu, Senior Procurement Specialist Siyang Wang, Project Assistant

2. Project Description

A. Project Overview

1. **Project Description.** On 22 September 2020 China officially announced at a meeting of the United Nations General Assembly that it will strive to peak carbon dioxide (CO₂) emissions by 2030 and achieve carbon neutrality by 2060. Various research proposals have subsequently been made by different institutions and experts for China to achieve its carbon reduction targets. These proposals are different in many aspects but there is a broad agreement that China must first generate most of its electricity from zero-emission sources, and then expand the use of clean electricity wherever possible, including electrifying its transportation systems.

2. Rapid economic growth and urbanization over last two decades have strained the delivery of public services and transportation systems in China. For instance, many cities in Liaoning Province have seen overcrowded roads, less efficient traffic management and deteriorated air quality. Given its direct health impacts, air quality has become a growing concern among urban residents. Tailpipe emissions from fossil-fueled engines are one of the major sources of harmful pollutants in urban areas, such as carbon monoxide (CO), nitrogen oxides (NO_x), and sulphur dioxide (SO₂). Like in many other places globally, diesel engines, which still make up majority of the bus fleets in Liaoning, have very high CO₂ and harmful pollutants emissions. In addition, a lack of integrated public transport management system leads to poorly managed bus timetables, long waiting time and overcrowding. These issues have altogether made public transport unattractive, resulting in lower ridership and inefficiency of bus operation.

3. There is an urgent need to identify sustainable, cost-effective transport options for small and medium sized cities. Electric vehicles, including electric buses (e-bus), are one of the most promising ways of reducing CO₂ emissions and improving air quality in urban areas. According to a recent study conducted in 16 cities in China, even if indirect emissions in the electricity generation process are included, e-buses still emit about 30-40 percent less CO₂ emissions than fossil-fuel units.² Given its obvious environmental merits, e-buses, including battery electric buses (BEBs) and electric trolley buses, have been widely promoted in Chinese cities in recent years. While large cities in general have more resources to replace fossil-fueled buses with BEBs, small and medium cities are often financially disadvantaged and have outdated bus fleets, which cannot meet public expectation for better environment and bus services. Therefore, financial assistances to small and medium cities to upgrade and electrify their public transport system should be considered.

4. With the proliferation of information technology and 5G communication technology, public transport management has evolved from traditional manual system into a more comprehensive and interactive platform in recent years. Smart public transport system³ applies a variety of innovative technologies to monitor, evaluate, and manage transportation

² Asian Development Bank (ADB), 2018 (November). Sustainable Transport Solutions: Low-Carbon Buses in the People's Republic of China. Indirect emissions or well-to-tank emissions are caused by fuel extraction, refinery and transport for fossil fuels and electricity production, as well as electricity transmission and distribution losses.

³ A synonym, i.e., intelligent public transport system, is also seen in literatures.

systems to enhance safety, efficiency, and convenience. Sensors and controllers can be imbedded into roads, vehicles, or any physical equipment in the public transportation systems, which can then be managed and controlled remotely. 5G communication can provide the real time information sharing among all parties of a public transport system, such as passengers, drivers, vehicles, and transportation management. Integration of technologies will make moving around a city via public transport more convenient, more cost-effective, and much safer. The concept of smart public transport system is still quickly evolving. In the long run, it has potential to transform the public transport system from passive service delivery to personalized service supply, and from fixed line service to flexible customized schedules.

5. The proposed Project will, above all, substitute modern BEBs for existing diesel-fueled or gas-fueled buses in five small and/or medium cities in Liaoning, including Fuxin City, Hu'ludao City, Jinzhou City, Panjin City, and Yingkou City (together Project cities). Since modern BEBs already include many digital applications, taking this opportunity, public transport management systems in the Project cities can be cost-effectively upgraded into smart digitalized platforms. Upon completion, the proposed Project will demonstrate that: (i) BEBs are viable options to zero-emission public transport systems in Liaoning; and (ii) smart public transport management system can enhance the efficiency of public transport and provide better services, thereby attracting more passengers to use public transport in the Project cities.

6. **Project Objective.** The proposed Project is to improve the quality and efficiency of public transport service and urban environment by replacing existing fossil-fueled buses with BEBs and applying digital technology to public transport management systems in five small and medium cities in Liaoning.

7. **Expected Results.** The Project results would be measured and monitored through the following indicators:

- Net CO₂ emissions reduced by 20,960 tons of CO₂ equivalent per year⁴.
- CO emissions reduced by 2,154 tons per year.
- NO_x emissions reduced by 200 tons per year.
- SO₂ emissions reduced by 89 tons per year.
- Particulate matter (e.g., PM₁₀, PM_{2.5}) reduced by 2.16 tons per year.
- Public transport punctuality ratio increased to 70% from 43%.
- Passenger satisfaction ratio increased to 88% from 76%.
- Bus real-time information sharing ratio increased to 100% from 71%.

8. **Expected Beneficiaries.** Upon completion, the proposed Project will help improve urban environments (i.e., better air quality, quieter living environment, and less congested traffic, etc.), enhance service quality of public transport, and improve passengers' riding experience. It is expected that 2.70 million residents in the five Project cities will benefit from the proposed Project. Also, compared to diesel-fueled vehicles, BEBs have lower operating and maintenance (O&M) costs. This will help improve the financial conditions of the five bus

⁴ Indirect carbon emissions in the electricity generation are deducted.

companies. Moreover, it is estimated that more than 1,000 skilled and non-skilled jobs will be created during the construction and operation periods.

B. Rationale

9. **Strategic fit for AIIB.** The proposed Project is aligned with three of the four cross-cutting thematic priorities of AIIB's Corporate Strategy, including green infrastructure, technology-enabled infrastructure, and private capital mobilization. It is also aligned with AIIB's three sector strategies (i) Transport Sector Strategy, in terms of ensuring economic and financial viability and promoting environmental and social sustainability of infrastructure; (ii) Sustainable Cities Strategy, in terms of enhancing urban mobility, improving basic infrastructure and city resilience; and (iii) Energy Sector Strategy, in terms of realizing energy efficiency potential. Given its carbon reduction impact, the proposed Project is eligible to be counted as climate financing.

10. **Value addition by AIIB.** The proposed Project will help Liaoning strengthen its understanding on green and climate financing in infrastructure. By applying AIIB's Policies and requirements, the Project has become more environmentally sustainable and socially inclusive. During project processing, AIIB project team helped project management office (PMO), bus companies and their consultants refine their methodologies for calculation of carbon emissions and other air pollutants, which will later help monitor and evaluate the Project results in the implementation stage. To promote inclusive access to Project benefits to all citizens, irrespective of age, gender, and disability, bus companies are requested to add specifications to increase bus accessibility when procuring BEBs, such as low floor and barrier free access board, for the elderly and disabled. This will ensure vulnerable groups are able to benefit from AIIB financed investments.

11. AIIB knowledge sharing helped the client enhance the Project's technical feasibility. This reflected in two aspects. Above all, bus companies are suggested to optimize the bus system configuration for types of BEBs, battery size, charging technology, and size of bus depot. Parameters (such as route distance, declined performance in summer using air conditioning and in winter using heating, battery capacity and reserve rates, and different charging modes) should be considered, together with BEB costs and time-of-use electricity prices. Also, bus companies were suggested to contact their local electricity supply companies to discuss electricity supply for the new charging facilities as early as possible, to avoid any potential issues, such as capacity constraint of local distribution network, which may come in the operation stage and preventing bus companies from achieving the designed objective. AIIB's suggestions have been well taken and executed in the Project preparation.

12. Last, but not the least, AIIB participation helps mobilize private capital through counterpart funding from two privately-owned bus companies in Fuxin and Hu'ludao.⁵ Without the Bank's financing, these two bus companies would not possibly conduct their respective subprojects immediately after the COVID-19 pandemic caused temporary financial distress in 2020, or simply selected cheaper gas-fueled buses to expand their service coverage. It is

⁵ The Project is aligned with the private capital mobilization thematic priority in terms of private indirect mobilization since private sector sponsors contribute equity investment of USD21.85 million to the Project.

reasonable to say that AIIB's financing support helps Liaoning Province close the Project's financing gap and makes the Project take off the ground sooner.

13. **Value addition to AIIB.** The proposed Project will be the Bank's first electric vehicle and smart public transport project. As modern information technologies are to be used, such as bus real-time reporting and real-time passenger information sharing, it will make public transport more efficient, safer, and more attractive to passengers. Through the proposed Project, the Bank can accumulate its institutional knowledge on how to electrify and digitalize public transport systems.

14. Partnering with the client and share experiences will also be a great demonstration to other stakeholders. The proposed Project is highly replicable in China and other member countries of AIIB. This will help AIIB build a conducive ecosystem for applications of new technologies in infrastructure. The proposed Project is a great example of utilizing new technologies, responding to the national new infrastructure investment plan⁶, which encourages the infusion of new technologies and transformation into traditional infrastructure. This has potential to open a new business field for the Bank in the years to come. Finally, the proposed Project will strengthen the Bank's green agenda in the fields of urban infrastructure and air quality improvement.

15. **Lessons learned from previous projects.** Lessons learned from the projects financed by AIIB and other multilateral development banks (MDBs) in China have been analyzed and incorporated in the Project design. Above all, for projects with multiple outputs or components, a centralized project management organization rather than a fragmented management structure would be more efficient for project implementation.⁷ Under the proposed Project, a PMO is designed to guide the five bus companies in Project preparation and implementation. Also, introducing bus real-time information sharing not only helps traffic demand management but also help redistribute passengers over time, reducing congestion and avoiding crowd.⁸ Under the proposed Project, real-time information sharing is included as an important objective indicator, which will be monitored and reported in the Results Monitoring Framework (Annex 1).

16. Moreover, installing large intelligent system applications without deploying adequately trained staff to maintain and operate the system limits the usefulness of the intelligent system in improving public transport and traffic management operation. An effective smart public transport application requires sustained capacity development.⁹ Under the proposed Project, one percent of the loan proceeds is allocated to provide technical support and capacity building to the five bus companies. In addition, choosing the most effective and cost-efficient BEBs is far more complex than choosing a diesel or gas bus. A mistake would result in buses

⁶ The "Report of the Work of the Government" delivered by Premier Li during the 2020 Two Sessions meeting emphasized the government's focus to accelerate New Infrastructure construction and development. New Infrastructure not only includes 7 key areas of new infrastructure like 5G, data centers, etc., it also highlights the importance of transformation of existing traditional infrastructure and infuse new technologies to improve their efficiency and productivity.

⁷ ADB, 2020. Shaanxi Green Intelligent Transport and Logistics Management Demonstration Project.

⁸ ADB, 2017. Shandong Spring City Green Modern Trolley Bus Demonstration Project; 2019, Guizhou Gui'an New District New Urbanization Smart Transport System Development Project.

⁹ World Bank, 2014. Heilongjiang Cold Weather Smart Public Transportation System Project.

with too small battery packs, and/or a larger number of BEBs than would have been required.¹⁰ Under the proposed Project, the five bus companies are suggested to optimize the system configuration with sufficient understanding on the complexity involved and related parameters. One BEB expert will be hired to review the BEB technical specifications prepared by the five bus companies before procurement starts.

17. Last, but not the least, project entities in China are technically strong in implementing project activities. Once they commit, results will be achieved in most cases. However, due to the language limitation, the clients often understood insufficiently MDBs' operational requirements and environmental and social policy during project processing and encountered implementation issues during project implementation. Taking this into consideration, the Project team provided a training on AIIB's policy requirements to the clients in the early stage of preparation, and confirmed project scope, cost estimate, and implementation arrangements step by step during the Project preparation.

C. Project Components

18. Key Project activities include:

- (i) procurement of approximately 1,285 BEBs.
- (ii) construction of approximately 286 new bus chargers.
- (iii) installation of smart public transport management systems and supporting software and equipment in the Project cities, which include smart operations and management platform, automated fare collection terminals, automatic vehicle location system, real-time driving assistance and safety systems, passenger information systems, depot management system, bus stop management system, control center upgrade, and data analytic and cloud infrastructure, etc.
- (iv) construction of the Liaodong Bay Intercity Bus Service Center in Panjin.
- (v) construction of the New Green Bus Maintenance Workshop in Fuxin.
- (vi) technical support and capacity building to the five bus companies on BEBs and smart public transport technology. A team of project management consultants will be engaged, covering technical, financial management, procurement, and environmental and social matters. The consultants will provide technical assistance to the bus companies and help PMO collect data, monitor progress, and verify the implementation results. Trainings will be provided to strengthen PMO's and bus companies' knowledge and understanding on the use of BEBs and smart public transport technology. Good practices and lessons learned during the Project implementation will also be summarized and shared with the wider audience.

D. Cost and Financing Plan

19. The Project's cost estimate is about USD214.26 million. Table 1 shows the Project's cost estimate and financing plan.

¹⁰ ADB, 2018. Sustainable Transport Solutions: Low-carbon Buses in the People's Republic of China.

Table 1. Project Cost Estimate and Financing Plan

Item	AIIB		Local Governments		Bus Company Investment		Total
	Amt.	%	Amt.	%	Amt.	%	
A. Base Costs							
1. Civil works			3.76	59	2.66	41	6.42
2. BEBs and related equipment	148.50	85	14.98	9	10.15	6	173.63
3. Land transfer expenses			4.57	100			4.57
4. Project management			4.24	66	2.22	34	6.46
5. E&S mitigation			0.34	89	0.04	11	0.38
6. Technical support and capacity building	1.5	100					1.50
B. Contingencies			6.34	66	3.30	34	9.64
C. Financing Charges During Construction			6.67	71	2.70	29	9.37
D. Working capital			1.51	66	0.78	34	2.29
Total (A+B+C)	150.00	70	42.41	20	21.85	10	214.26

20. The Government of the People's Republic of China (the Government) has requested a loan of Euro130 million (approximately USD150 million¹¹) from AIIB to help finance the Project. The loan is proposed to have a final maturity of 25-year term, including a grace period of 5 years, at AIIB's standard interest rate applicable to sovereign-backed variable-spread loans with the corresponding weighted average maturity.

21. AIIB loan will be made to the People's Republic of China, which will mainly be used to finance the expenditures related to procurement of BEBs and related equipment. The Government will on lend the loan proceeds to the People's Government of Liaoning Province (Liaoning Provincial Government) on the same terms and conditions as those of AIIB loan. Liaoning Provincial Government will make the loan proceeds available to the five cities and finally to bus companies following the established domestic procedures. Liaoning Provincial Government will make sure that counterpart funding is provided in a timely manner, including any additional funding required for any shortfalls in funds or cost overruns if any.

E. Implementation Arrangements

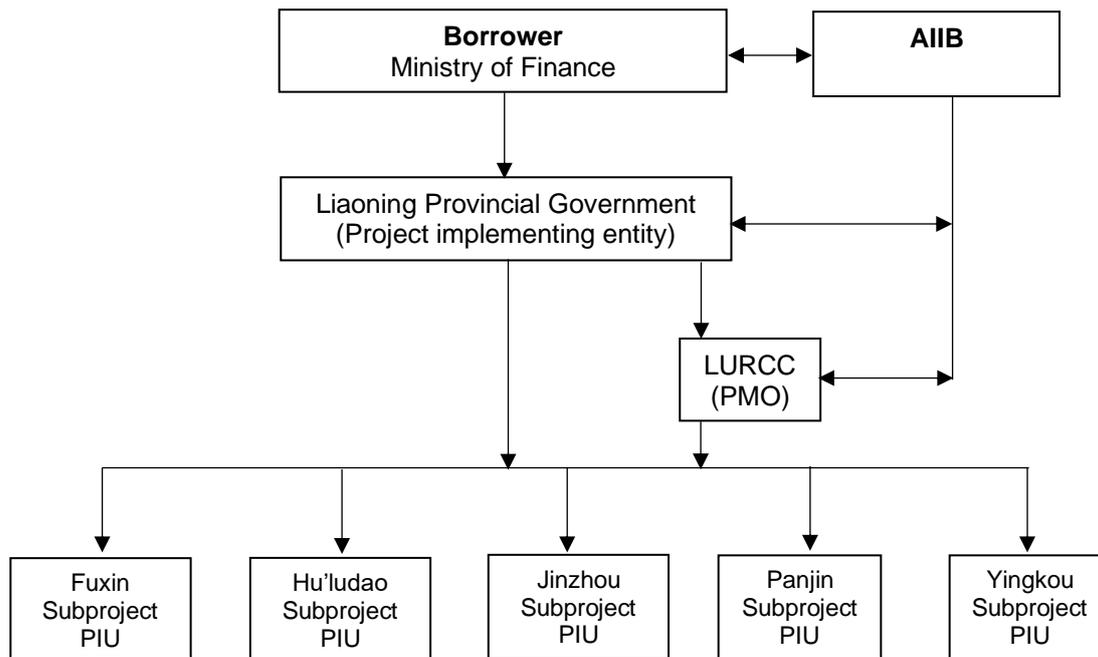
22. **Implementation period.** The Project will be implemented over a period of four years between December 1, 2021, and November 30, 2025.

23. **Implementation Management.** Liaoning Provincial Government will be the Project implementing entity, which has appointed Liaoning Provincial Development and Reform Commission (DRC) and Liaoning Provincial Department of Finance (DOF) to coordinate the Project preparation and implementation. The Liaoning Urban and Rural Construction and Renewal Project Management Company Ltd. (LURCC), a company owned by Liaoning Provincial Government, has been designated as the PMO and is responsible for the daily work of Project implementation. Liaoning Provincial Government shall ensure sufficient funding is

¹¹ As of September 30, 2021, the exchange rate of Euro to USD was 1.157. However, the cost and financing plan in this report is still presented in USD to ensure consistency.

provided to cover the operating costs of PMO during the Project implementation period. Each Project city has set up its subproject coordination group, which is led by a vice mayor of the city and staffed by professional personnel, responsible for the subproject preparation and implementation. The bus company in each Project city has set up a Project Implementation Unit (PIU) for daily works of subproject. The Project's management organization chart is in Figure 1.

Figure 1: Project Management Organization



24. **Procurement.** AIB's Procurement Policy (dated January 2016) and its associated Interim Operational Directive on Procurement Instructions for Recipients (PIR, dated June 2, 2016) shall apply to the procurement of all contracts funded in whole or in part by AIB loan under the Project. For purposes of the Project, the Project Implementing Entity and the PIUs are considered public entities. Therefore, the specific procurement provisions under Section II Procurement of Goods, Works and Services by Public Entities under PIR shall apply.

25. The PMO is responsible for all aspects of the procurement process with the support of five subproject PIUs. In addition, a professional procurement agent and a project management consulting company which are familiarized with projects financed by MDBs will be employed to assist in the procurement and implementation of the Project. A Project Delivery Strategy including a detailed procurement plan has been developed by the PMO and reviewed and accepted by AIB at appraisal stage, in which the contract packaging, procurement method and Bank review method, as well as specific procurement timelines are all have been finalized. In principle, the International Open Competitive Tendering will be the default approach together with using the AIB standard tendering documents. When National Competitive Tendering is used, the client's tender document and national procedures, subject to proper modifications to meet the conditions of National Competitive Tendering and comply with the

Core Procurement Principles of AIIB Procurement Policy, will be applied. The procurement of large value consulting services contracts will be carried out through International Open Competitive Selection and Quality & Cost-Based Selection procedures by using AIIB Standard Procurement Document: Request for Proposals for Consulting Services. Any contract wholly financed by the client's own budget will be conducted in accordance with the national procurement policies and procedures.

26. Advance Procurement and Retroactive Financing might be used, subject to the limit of 20 percent of the total amount of the loan and for expenditures incurred not earlier than 12 months prior to the signing date of the loan agreement. Any Project activities that are considered for retroactive financing will have to be implemented in accordance with the Bank's Procurement Policy and its social and environmental policies and requirements. According to the envisaged progress of the Project and processing timeline, procurement of BEBs might start before the loan signing date.

27. During the implementation, the Bank team will carry out the procurement oversight of all contracts to be funded by the loan through procurement prior review for large value and complex contracts, and post review for all other contracts on a regular basis. The client will establish a document record management system to keep all procurement related documents in its office for Bank's future review and auditing by the government authority.

28. **Financial Management (FM).** The PMO will be responsible for the overall Project financial management. The Project shall be implemented at the city level by five subproject PIUs, while PMO shall be responsible for overall coordination, management, and monitoring. PMO will prepare, consolidate, and submit on semi-annual basis the Interim Unaudited Financial Reports (IUFRs) within 45 days from the end of each such period. The audited consolidated Project financial statement for each year of Project implementation will be submitted within 6 months from the fiscal year-end.

29. **Monitoring and Evaluation.** A Project monitoring and evaluation system will be established, which will include all necessary indicators to monitor the progress of Project implementation, covering Project objectives and immediate Project outputs. All indicators will be regularly monitored and updated in the semi-annual Project progress report, which will be prepared by the PMO and be submitted to AIIB for review timely. Subproject PIUs in each city will be responsible for subproject monitoring data collection and preparation of their separate subproject implementation reports.

30. **AIIB's Implementation Support.** AIIB will conduct Project implementation support missions on a regular basis. In case of any compliance discrepancy identified during project implementation, a corrective plan will be developed and implemented.

3. Project Assessment

A. Technical

31. The proposed Project presents no significant technical risk. Technical due diligence was conducted based on: (i) Project Report and subprojects' Feasibility Study Reports (FSRs); (ii) other reports prepared by PMO and/or consultants engaged by PMO or subproject PIUs,

such as reports on energy savings and air emissions reduction;¹² (iii) discussions with engineers preparing the Project's reports and FSRs, and consultants engaged by PMO and subproject PIUs; and (v) project site visits conducted in April 2021 and July 2021. The Project Report and FSRs were prepared by specialized design institutes in public transportation and included considerations on the following advanced technologies: (i) development of electric bus (e-bus) technology, including analyses on the latest e-bus technology and manufacturers, detailed technical specifications of e-bus required with special consideration on the cold-weather operating environment; and (ii) e-bus operation supporting facility. Since e-buses require different operational supporting systems compared to traditional buses, adequate charging stations, power supply systems, in-service charging, bus inspection and maintenance facilities, and other necessary facilities are analyzed and to be constructed as required; (iii) intelligent e-bus scheduling and management system. Many latest technologies, such as vehicle positioning systems and passenger flow counting systems, will be adopted. Existing bus scheduling systems, IT systems used, and vehicle location systems in the Project cities will be upgraded; and (iv) e-bus management and O&M planning. The FSRs also include analyses on bus driver management system, e-bus daily check, parts and material supply, O&M facilities, and asset management.

32. The PMO has experience in managing projects financed by MDBs. Since late 1980s, it has managed 11 projects financed by the World Bank and ADB. The PMO is already on board and currently providing guidance to the five bus companies in project preparation. The PMO will be responsible for Project administration, procurement, implementation supervision and issue solving during the implementation stage. The five bus companies are responsible for the implementation of their respective subprojects, and e-bus operation management upon the completion of the Project. Similar Project implementation arrangements have been used before in Liaoning and proved to be effective.

B. Economic and Financial Analysis

33. **Project Costs and Benefits.** The Project is expected to provide economic benefits at various levels: bus companies, commuters, and the general urban population of the target cities. Main economic benefits include savings in vehicle operation costs, savings in travel time, reduction of local air pollution, reduction of greenhouse gas emissions, and reduction of bus-related accidents. With the exception of accident reduction, other economic benefits are quantified. Economic costs of the Project include capital costs related to the purchase of buses and associated smart transportation infrastructure, and electric vehicle and battery replacement costs; as the Project will result in a reduction of life cycle operation and maintenance (O&M) expenditures, these are not treated on the cost side, but under the benefits. All costs and benefits are calculated based on market prices and then converted to economic prices using shadow conversion factors.

34. **Economic Analysis.** The economic analysis indicates the Project is economically viable. At the overall Project level, the Economic Internal Rate of Return (EIRR) was estimated at 15.8 percent and Economic Net Present Value (ENPV) at CNY 419.4 million, based on a 9 percent social discount rate. At the individual city (subproject) level, the EIRR ranges from 10.8

¹² It is estimated that the Project will have energy savings of about 16,400 tons of standard coal equivalent per year.

percent to 19.0 percent, and the ENPV ranges from CNY 17.9 million to CNY 154.6 million. The EIRR exceeds the social discount rate, at both subproject and overall Project levels, and the Project demonstrates good economic viability.

35. A sensitivity analysis was conducted with respect to: (i) an increase of 10 percent in capital costs; (ii) a decrease of 10 percent in benefits; and (iii) a combined worst-case scenario. The ENPV remained above zero, and the EIRR above the 9 percent social discount rate at overall Project level, and in all cities for all individual scenarios, except for the Fuxin subproject in the combined worse-case scenario. Risk mitigation measures have been prepared to counter negative economic impacts of decreased revenues or increased costs in Fuxin, and the subproject will be monitored closely throughout its operation to ensure that costs and revenues remain under control so the subproject can operate in an economically viable and sustainable manner. Details of the economic analysis are presented in Annex 3.

36. **Financial Analysis.** Financial analysis indicates the Project is financially viable. Incremental financial costs and benefits brought by the Project to the five bus companies are analyzed, with taxes and duties applied accordingly. The Financial Internal Rate of Return (FIRR) for the Project is 8.64 percent, compared to the Project's real WACC of 2.22 percent. FIRR for five subprojects range from 5.54 to 11.67 percent, against subprojects' real WACC of 2.22 percent, suggesting that five subprojects are financially viable.

37. A sensitivity analysis was conducted to test the robustness of the Project in three adverse scenarios: (i) an increase of 10 percent in capital costs; (ii) an increase of 10 percent in O&M; (iii) a decrease of 10 percent in revenues. In all individual scenarios, the NPV remained greater than zero and the FIRR at or above the Project's WACC. All the five sub-projects will be monitored closely throughout its operation to ensure costs and revenues remain under control so the Project can operate in a financially viable and sustainable manner. Details of the financial analysis are presented in Annex 3.

38. **Financial Sustainability Analysis on Bus Companies.** Financial sustainability analyses on bus companies indicate that all five companies are expected to be financially sustainable over the period of 2021-2036. Although all five bus companies were adversely affected by COVID-19 in year 2020-2021 at varying degrees, they are expected to gradually recover from 2022 onwards. The Project will help bus companies improve financial performances, by reducing O&M costs, increasing ridership, and generating larger revenues.

C. Fiduciary and Governance

39. **Procurement.** Procurement assessment showed that the PMO has rich experience in working with MDBs and is familiar with MDBs' procurement policies and requirements. By end 2020, the PMO has completed and/or been implementing 11 projects funded by WB and ADB, with a total loan amount of \$1.498 billion. The PMO currently has 18 professional staffs, including one director in charge, one deputy director, seven senior engineers, and five engineers. Each PIU also has been assigned with procurement and contract management staff, as well as technical personnel to support the project implementation.

40. Since AIIB's Procurement Policy and procedures are substantially consistent with other MDBs, with establishment and strengthening of the client capacity, including using the

services of a professional tendering agent to support the procurement process, as well as a project management company to carry out PM supervision of project, the PMO will have adequate procurement capacity to implement the Project satisfactorily. Based on the procurement assessment conducted, the procurement risk of the Project is considered as Medium.

41. **Financial Management (FM).** The FM assessment focused mainly on institutional capacity, staffing, planning/budgeting, funds flow, accounting, internal controls/audit, reporting and external audits. PMO and one PIU (i.e., Panjin) have prior experiences in implementing projects financed by MDBs and are familiar with related FM requirements. PMO and PIUs have adequate finance/accounting staff, and the FM system is adequate to account and report on the project related activities. The Project Management Company hired by PMO shall include a FM specialist to provide additional support on overall FM functions such as consolidating financial reporting, preparing withdrawal applications, etc. Based on the FM assessment, FM capacity is considered adequate and FM risk as "Medium".

42. **Planning and Budgeting.** The Project will follow the existing planning and budgeting procedures of Liaoning provincial government. Subproject PIUs will prepare their annual plans based on their respective Procurement Plans and submit them to PMO, which will review and consolidate the Project's annual budget and financing plan.

43. **Funds Flow.** After the loan is signed between AIIB and the Borrower, the MOF will onlend the loan proceeds to the provincial government, which will onlend to cities and finally to the bus companies in the five Project cities following domestic procedures. The Liaoning DOF will open a Designated Account in agreed currency in a financial institution acceptable to AIIB. During the Project implementation, all the payment requests will be reviewed by PMO, Project City Finance Bureau, and Liaoning DOF sequentially.

44. **Accounting and Financial Reporting.** For Project accounting, each PIU shall establish a separate account. PIUs shall use financial accounting based on the Guidelines of MOF for MDBs-financed Project, which is based on accrual basis of accounting. PMO and PIUs will be responsible for maintaining Project accounts and custody of the supporting documents. PMO will prepare, consolidate and submit the Project financial report to AIIB. The financial progress of the Project will be reported on a semi-annual basis through IUFRRs to be submitted within 45 days from the end of each such period. The format and the content of IUFRRs has been shared and shall be agreed before implementation.

45. **Internal Control.** The existing internal control system of the Borrower can provide reliable and adequate controls over funds/transaction flow. Three state-owned bus companies (i.e., Jinzhou, Panjin, and Yingkou) have internal audit departments, which will carry out regular internal audits on Project activities, respectively. In case of the two privately-owned bus companies (i.e., Fuxin and Hu'ludao), the internal audits of the Project activities will be conducted by the internal audit of their parent company. The results of internal audits shall be included in the semi-annual reports to AIIB.

46. **External Audit.** The Project financial statements will be audited by the Liaoning Provincial Audit Office on an annual basis. The external audit report, which will include an audit opinion and management letter will be submitted to AIIB within six months after the end of each fiscal year.

47. **Disbursements.** Loan proceeds will be disbursed using the reimbursement, direct payment and advance methods. The direct payment will be used against payment of contracts

under prior review threshold. The Provincial DOF will open a Designated Account in agreed currency and in a financial institution acceptable to AIIB. The eligible project expenditures such as civil works, goods and consulting services will be subject to using Statement of Expenditure format. A Disbursement and Financial Information Letter will detail the authorized signatories, ceiling of DA, process of submitting claims and other terms and conditions of disbursements.

48. **Governance and Anti-corruption.** AIIB's Policy on Prohibited Practices (2016) has been explained to PMO and will be covered in the legal agreements for this financing. Implementation will be monitored regularly by AIIB. AIIB reserves the right to investigate—directly or indirectly through its agents—any alleged corrupt, fraudulent, collusive, or coercive practices related to the proposed Project and to take necessary measures to prevent and redress any issues in a timely manner, as appropriate.

D. Environmental and Social

49. **Environmental and Social Policy and Standards.** The Bank's Environmental and Social Policy (ESP), including the Environment and Social Standards (ESSs) and the Environmental and Social Exclusion List apply to this Project. ESS 1 (Environmental and Social Assessment and Management) is applicable to the environmental and social aspects of the Project. ESS 2 (Involuntary Resettlement) and ESS 3 (Indigenous Peoples) are not triggered, because (i) all Project activities are conducted on the lands owned by the government or bus companies, and (ii) there are no indigenous peoples in the Project areas.

50. **Categorization and Instruments.** The proposed Project has been screened and reviewed in accordance with the ESP and ESSs, and the Project has been assigned as Category B based on the following: (i) the general environmental and social impacts and risks of the Project are minor and localized, (ii) the impacts are expected to be reversible and temporary in nature, and (iii) the impacts can be effectively managed using practical and mature mitigation measures. The Environmental and Social Impact Assessment (ESIA) accompanied with Environmental and Social Management Plan (ESMP) has been prepared.

51. **Environmental Aspects.** The Project will reduce fossil fuel consumption and increase energy efficiency of public transport. Anticipated impacts will be site-specific and mainly limited to the construction stage for the service center and maintenance workshop and installation of chargers, such as dust, noise and construction waste. These impacts can be largely managed and controlled through properly designed site-specific mitigation measures and adequate implementation management during construction. The ESMP includes provisions related to occupational and community health and safety, air, noise and waste water pollution control, construction waste management, and the management of labor. The ESMP also sets out the institutional arrangements and respective responsibilities, monitoring and reporting, and capacity building for project implementation.

52. Disposal of replaced diesel-fueled or gas-fueled buses and used batteries will follow domestic policies and administrative decrees. Useful materials of the replaced buses, such as tires, plastics, and metals, will be collected and recycled by qualified recycling entities. For used batteries, domestic policies hold e-bus manufacturers responsible for the recycling and recovery of batteries. They must establish channels and/or service outlets to collect, store, and transfer used batteries to specialized recyclers, which are usually supported by battery makers. Manufacturers must also set up a system with traceability that will enable the

identification of owners of discarded batteries. Related mitigation measures and respective implementing and supervisory responsibilities are included in the ESMP.

53. **Climate Change Risks and Opportunities.** The proposed Project will reduce carbon emissions by replacing the fossil-fuel buses with BEBs. The Project has low climate change risks. BEBs have zero tailpipe emissions and will mitigate the negative impact from global climate change.

54. **Social Aspects.** The proposed Project is expected to generate largely positive social benefits to the overall population. The Project area of influence includes the urban areas and some suburbs of Fuxin, Hu'ludao, Jinzhou, Panjin, and Yingkou and covers a wide range of stakeholders including residents with differing levels of socio-economic status. As the civil works are minimal, and construction is to take place on available land, the construction period will remain short and, as a result, the impact on the surrounding residents' travel and local traffic is envisaged to be small.

55. **Gender and Disability Aspects.** The potential impacts of Project activities – both positive and negative - on women and the disabled in the community have been assessed. In consultation with relevant stakeholders, including the client and community members, measures such as focused skill training and staff awareness on gender equality have been identified to promote improved employment opportunities for women by the Project and each of the Project cities have committed to having a work force comprise at a minimum of 40 percent women. With respect to disability, the Project will finance barrier-free BEBs with wheelchair access and designated seats for the elderly.

56. **Occupational Health and Safety, Labor and Employment Conditions.** LURCC shall ensure adequate health and safety measures for the workers by including in the tendering documents clauses on how contractors will address health and safety requirements. LURCC will also ensure that civil works contractors comply with applicable labor laws and regulations and adopt and enforce codes of conduct (including guidelines for resolution of gender-based violence) for workers to mitigate possible risks related to labor. Taking cognizance of the situation at the time of mobilization, the contractors shall also take into consideration COVID-19 health and safety practices.

57. **Stakeholder Engagement, Consultation and Information Disclosure.** Consultations in various forms, including interviews with key stakeholders and meetings with communities, have been conducted during the ESIA preparation. This will continue during Project implementation, in accordance with national guidelines on restrictions imposed due to the COVID-19 pandemic. The English and Chinese versions of the ESIA, including executive summaries, have been posted on the websites of LURCC (<http://www.lnxmgl.com/html/xinwenzhongxin/2021/0730/75.html>) and AIIB (<https://www.aiib.org/en/projects/details/2021/proposed/China-Liaoning-Green-Smart-Public-Transport-Demonstration-Project.html>), with hard copies made available in the Project sites before construction starts.

58. **Project-level Grievance Redress Mechanism.** Existing Grievance Redress Mechanisms (GRM) in each Project city will be used for the Project, with some necessary upgrading and improvement to ensure proper coverage of concerned issues, such as those for construction activities. The GRM have been reviewed in accordance with the requirements

of the Bank's ESP. Locally appropriate public consultation and disclosure processes will be used to disseminate information about the GRM and the Project-affected People's Mechanism. Communities and individuals who believe that they are adversely affected by the Project will be able to submit complaints to the Project-level GRM for resolution. In addition to the above GRM for addressing complaints from the local community, commensurate mechanism will be made available at the contractor level for worker's grievance.

59. **Project-Affected People's Mechanism.** The Project-affected People's Mechanism has been established by the Bank to provide an opportunity for the independent and impartial review of submissions from Project-affected people who believe they have been or are likely to be adversely affected by the AIIB's failure to implement its ESP in situations when their concerns cannot be addressed satisfactorily through the Project-level GRM or the AIIB's management processes. Information about the Project-affected People's Mechanism, can be found at : <https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-the-project-affected-mechanism.html>.

E. Risks and Mitigation Measures

60. Summary of risks and mitigating measures are presented in Table 2.

Table 2: Summary of Risks and Mitigating Measures

Risk Description	Assessment (H/M/L)	Mitigation Measures
Economic and Financial		
Real ridership may be lower than projected figures, resulting in lower benefits and revenues.	Medium	Economic and financial analyses are conducted based on more conservative projections.
Governance: FM and Procurement		
Some bus companies being unfamiliar with AIIB's procurement policy and requirements, and coordination between PIUs and PMO may lead to implementation delays and potential procurement irregularities.	Medium	AIIB will provide continuous procurement training and guidance to PMO and the PIUs during procurement and contract management process. Also, all large value contracts will be subject to procurement prior reviewed by AIIB team. Moreover, regular field supervision mission and procurement post review will be conducted.
The delay or inadequate release of the counterpart funds. Some bus companies are unfamiliar with AIIB's requirements on FM	Medium	The PIUs need to assure that the counterpart fund is adequate and timely and PMO needs to monitor on regular basis. A FM consultant is planned to be engaged to provide support on

Risk Description	Assessment (H/M/L)	Mitigation Measures
related reporting and cause delays in the reporting process.		the overall FM functions such as consolidating financing reporting, preparing withdrawal application, etc.
Environment & Social		
E&S implementation of subprojects.	Medium	Adequate ES personnel to implement ESMP and conduct ES monitoring are provided by PMO and bus companies. AIIB will conduct regular supervision on ES performances.
Overall	Medium	

Annex 1: Results Monitoring Framework

Project Objective:	To improve the quality and efficiency of public transport service and urban environment by replacing conventional fossil-fuel buses with battery electric buses and applying digital technology to public transport management systems in five small and medium cities in Liaoning.									
Indicator Name	Unit of measure	Baseline 2019	Cumulative Target Values					End Target	Frequency	Responsibility
			2021	2022	2023	2024	2025			
Project Objective Indicators:										
1. CO ₂ emissions reduced per year ¹³	Tons	0	0	10,544	17,816	20,960	20,960	20,960	Annual	PMO
2. CO emissions reduced per year	Tons	0	0	1,193	1,848	2,154	2,154	2,154	Annual	PMO
3. NO _x emissions reduced per year	Tons	0	0	142	176	200	200	200	Annual	PMO
4. SO ₂ emissions reduced per year	Tons	0	0	71	80	89	89	89	Annual	PMO
5. PM reduced per year	Tons	0	0	1.74	1.93	2.16	2.16	2.16	Annual	PMO
6. Public transport punctuality increased	%	43	48	55	63	68	70	70	Annual	PMO/PIUs
7. Passenger satisfaction ratio increased	%	76	79	82	85	87	88	88	Annual	PMO/PIUs
8. Bus real-time information sharing ratio	%	71	75	94	98	100	100	100	Annual	PMO/PIUs
Intermediate Results Indicators:										
1. Electric buses procured and put in operation	No. of Vehicles	0	107	758	1098	1285	1285	1285	Semi-annual	PMO/PIUs
2. Electric chargers installed	No. of chargers	0	60	172	252	286	286	286	Semi-annual	PMO/PIUs

¹³ Indirect carbon emissions in the electricity generation process are deducted.

Annex 2: Detailed Project Description

A. Background

1. As the country's urbanization process continues, cities continue to expand and the demand for urban transportation system has become bigger and bigger. Even in small and medium-sized cities, more and more private cars start occupying urban roads and caused more and more traffic jams. People's Daily, the largest national newspaper, once launched a public discussion titled "How do we travel tomorrow". It was widely accepted that public transport, particularly buses, should be prioritized, given its advantages of speed, convenience, safety, high efficiency, low road occupation rate and low energy consumption. Modern electric buses are much more energy efficient than existing oil-fueled buses in operation, produce no tailpipe emissions, and are therefore well suited to the role of urban bus services.
2. According to the State Council's Guideline on Prioritizing the Development of Public Transport (Ministry of Transport, 2013[368]), cities with a population between 1.0 and 3.0 million should have more than 12 public transport vehicles per 10,000 people on average; cities with less than 1 million population should refer to this criterion and their local conditions to determine their local public transport development goals. In February 2019, the People's Government of Liaoning Province issued the Three-Year Action Plan (2018-2020) for Promoting Transport Structure Adjustment in Liaoning (Liaoning Government Office [2019] No. 6), which proposes to accelerate the deployment of new energy and clean energy vehicles, including the integration of construction of gas stations, charging stations and public chargers into urban infrastructure planning and construction, and provision of governmental support for land use and funds. On July 24, 2020, the Ministry of Transport and the National Development and Reform Commission issued the Action Plan for Creating Green Travel, which requires the proportion of new energy and clean energy buses among all buses in key areas such as the Beijing-Tianjin-Hebei region and surrounding areas should not be less than 60%.
3. Urban public transport in Liaoning has made considerable progress in recent years, but problems still exist, especially in some small and medium-sized cities. The main problems include:
 - (1) Poor bus conditions, high fuel consumption, high noise, and serious pollution.
 - (2) Uncomfortable riding experience.
 - (3) Excessive use of existing bus fleets and outdated facilities.
 - (4) Insufficient number of buses in operation.
4. The proposed Project will not only help address these problems, but also help in the following aspects.
 - (1) It will promote the use of new energy buses in Liaoning Province, and reduce the use of fossil-fuel buses, thereby reducing carbon emissions and other pollutions. It will have large energy-saving and environmental benefits.
 - (2) It will help improve the riding experience in the project cities and attract more people to use urban public transport, reducing road congestion and improving travel conditions.

(3) It will showcase the use of electric buses and help extend the market of electric vehicles in the selected cities. This will further promote the development of electric vehicles, particularly the manufacturing of parts and components of electric vehicles, battery and material industries. This will have a positive impact on the sustainable development of the national and provincial economy.

B. Project Activities

5. By substituting modern electric buses for diesel-fueled or gas-fueled buses and installing intelligent public transport management systems, the proposed Project will enhance urban transport systems, improve their operating efficiency, mitigate traffic congestion and improve local air quality and environment in the selected project cities such as Jinzhou, Yingkou, Fuxin, Panjin and Huludao (Figure A2.1).

6. Key project activities under each component include: (i) purchase of electric buses, (ii) construction of charging stations and installation of chargers, (iii) installation of smart public transport system and related software, and (iv) other related activities, e.g., installation of on-board intelligent equipment and bus-stop information sharing boards. Besides, a comprehensive public transport service center and an O&M workshop will be built in Panjin and Fuxin, respectively.

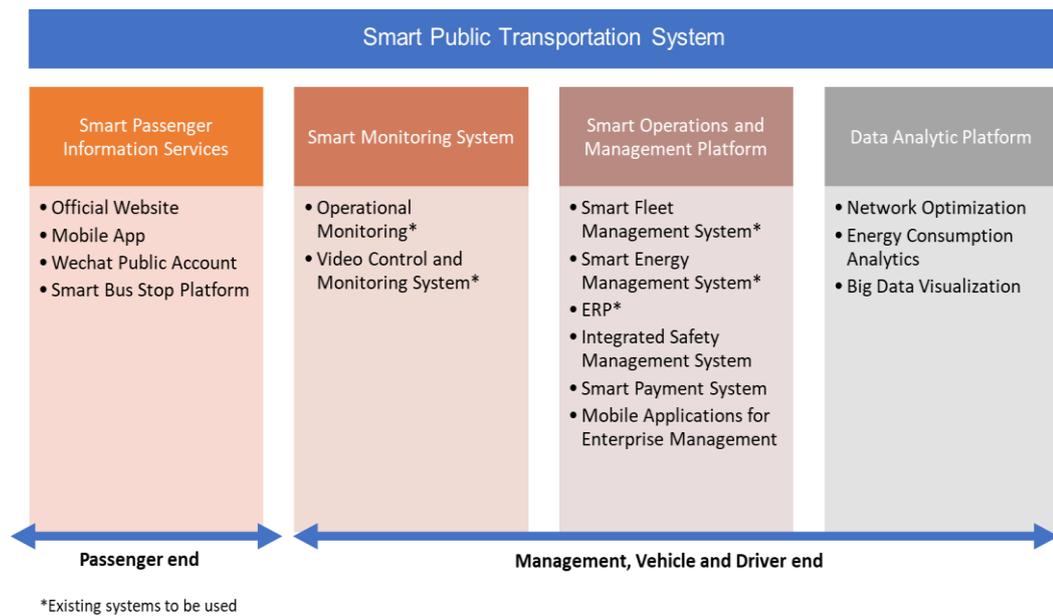
Figure A2.1: Geographic Location of the Project Cities in Liaoning



C. Application of Smart Public Transport Technology

7. The overall Smart Public Transportation System integrates all systems applied to vehicles/roadsides, corporate management, drivers, or passengers.

Figure A2.2: Smart Public Transportation System of the Project



8. These systems can be categorized into four main types: monitoring, operations and management, data analytic, and passenger service. It provides a centralized platform to help collate and visualize information, control, and respond to situations and inform decision-making at the control center.

- a) **Smart Passenger Information Service:** It provides a suite of services and applications that support passengers. It provides real-time bus information via mobile app, website, and in-station boards to enable passengers to plan their route and estimate waiting and arrival times.
- b) **Smart Monitoring System:** It provides operational monitoring of all vehicles, routes, passengers, and other key metrics. It utilizes GPS, GIS, GPRS, sensors, cameras, and other information to provide real-time information for control centers and management.
- c) **Smart O&M Platform:** It provides various digital systems and services to assist operational and business management. It includes a suite of sub-systems and applications which make managers, drivers, and other business functions work more effectively and efficiently. These include, but are not limited to, ERP systems, mobile applications.
- d) **Data Analytics Platform:** It collects, collates, manages, and utilizes data to generate insights that can be used to deliver better decisions for other systems or the business. The data analytics can be used to optimize networks, better manage energy consumption, and deploy drivers.

9. While Smart Public Transportation System will be implemented in all five cities, given the different existing systems and maturity, the actual compositions differ. Below is the summary of comparisons of system implementation in each city:

Table A2.1: Summary of Project Cities' Technology Selection

Project Cities	Fuxin and Huludao	Jinzhou	Panjin	Yingkou
i. Smart Operations and Management Platform	✓	✓	✓	
ii. ERP System				✓
iii. Depot Management System				✓
iv. Smart Vehicle System	✓	✓	✓	✓
v. Smart Bus Stops and Management		✓		
vi. Automated Fare Collection Service		✓		
vii. Control Center Upgrade	✓		✓	
viii. Data Centers and Cloud Infrastructure		✓		✓

Data Sources: Project Report and Subproject Feasibility Studies

10. Given different digital maturities between the five cities in this project, different components and approaches are used. Being the more developed among all, Jinzhou is developing more advanced digital applications and apply more sophisticated designs. Fuxin, Huludao, and Panjin are focusing on upgrading and optimizing the existing Smart Public Transportation Systems. Yingkou is slightly behind the development. Its focus remains to develop the digital foundation (such as the basic ERP systems, apps, and social media accounts).

D. Funds Flow Arrangement under the Project

11. After the loan is signed between AIIB and the Borrower, the MOF will onlend the loan proceeds to the provincial government, which will onlend to cities and finally to the bus companies in the five Project cities following domestic procedures. The Liaoning DOF will open a Designated Account in agreed currency in a financial institution acceptable to AIIB. During the Project implementation, all the payment requests will be reviewed by PMO, Project City Finance Bureau, and Liaoning DOF sequentially.

Annex 3: Economic and Financial Analysis

A. Economic Analysis

1. **Demand Analysis.** A public traffic volume survey was conducted, and a transportation demand analysis and forecasting model developed, to estimate bus transport demand in the Project cities at the start of Project operations, in 2025. Daily bus ridership estimates used in the economic and financial analyses are based on the results of the transport demand analysis and forecasting model, presented in the Feasibility Study Report (FSR) for the Project. Ridership estimates for the target cities in 2025 are summarized in Table A3.1.

Table A3.1: Daily Ridership Estimates in Project cities

City	Year 2025
Fuxin	406,000
Panjin	459,200
Yingkou	578,100
Huludao	504,000
Jinzhou	762,300

2. **Methodology.** A cost-benefit analysis was undertaken to assess the economic viability of the Project, based on a comparison between “with-” and “without-project” scenarios. The Economic Internal Rate of Return (EIRR) and Economic Net Present Value (ENPV) of the Project were estimated using discounted cash flow analysis of economic costs and benefits. A sensitivity analysis was performed to evaluate the impacts of: (i) increased capital costs; (ii) decreased benefits; and (iii) a worst-case scenario, combining the two previous scenarios.

3. **Key Assumptions.** The main assumptions used in the analysis are as follows:

- Demand: Ridership in each city is conservatively assumed to remain constant at the 2025 level.
- Domestic price numeraire: All Project inputs and outputs are valued at domestic market prices in national currency; traded goods are adjusted to domestic price level using the shadow exchange rate factor.
- Constant 2021 prices: All costs and benefits are represented in constant 2021 prices.
- Exchange rate: USD 1.0 = CNY 6.7.
- Shadow exchange rate factor: 1.023.
- Shadow wage rate factor (unskilled labor): 0.80.¹⁴
- Shadow wage rate factor (skilled labor): 1.00.
- Economic life of Project: 25 years (2022 to 2046).
- Economic life of battery electric buses (BEBs): 13 years. Buses are retired and replaced (and replacement costs accounted) in each city at the end of the buses' economic life.

¹⁴ National Development and Reform Committee and Ministry of Construction. 2006. Methods and Parameters for Economic Evaluation of Construction Projects, page 220.

- Economic life of batteries: 8 years. Batteries are replaced at the end of 8 years, as per current Chinese regulation.
- Project implementation period: 4 years (2021 to 2025).
- Residual value assumed to be zero at the end of the operation period (2046).
- During the project implementation period, benefits accrue in proportion to capacity realization in each city, based on the BEB acquisition forecast of the bus companies.
- Discount rate: 9 percent.

4. **Economic Costs.** Economic costs include capital costs of the Project, calculated from project cost estimates. The Project is expected to result in a net saving of operation and maintenance (O&M) costs, as such, O&M savings are included on the benefits side. Project capital costs include costs for the purchase of BEBs, implementation of smart systems for the management of the public transportation network, construction and installation of electric charging stations, and renovation of bus parking yards. Price contingencies, financial charges, taxes, and duties are excluded from the economic costs, and physical contingencies are included. Replacement costs for buses and batteries, which reach the end of their economic life during the analysis timeline, are included. Costs are converted to economic costs.

5. **Economic Benefits.** The Project benefits included in the quantitative analysis are: (i) savings in O&M costs, as explained above; (ii) avoidance of GHG and pollutant emissions; (iii) time saved by bus passengers.

Table A3.2: Economic Benefits of the Project (Year 2025) (CNY million)

Benefit Category	Fuxin	Panjin	Hu'ludao	Yingkou	Jinzhou	Total
O&M Savings	15.6	14.1	18.9	10.4	29.0	88.0
Avoided Emissions	2.1	0.9	2.6	0.6	3.0	9.1
Time Savings	11.8	42.6	16.7	33.3	29.0	133.4

6. O&M Savings arise from savings on fossil fuel expenditure. The O&M cost saving per sub-project is based on estimates provided by the bus companies. The estimates are based on the number and types of BEB to be implemented in each city, the number and types of fossil-fuel based buses (diesel, LNG, CNG) that will be replaced by the BEBs, and relative the O&M costs (fuel, labor and others) of each.

7. Avoided pollutant emissions include carbon dioxide (CO₂), carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen oxides (NO_x), particulate emissions (PM). Data on the quantities of pollutant emission reductions in each city were based on the FSR. The value of avoided CO₂ emissions in each city is: avoided CO₂ emissions in tons/year CO₂ * USD 36.30 (year 2016) increased at 2% per annum. The unit value of CO₂ is based on the global social cost of carbon, in 2016, reported by the Intergovernmental Panel on Climate Change (IPCC). This value is to be increased by 2% annually in real terms to allow for the potential of increasing marginal damage of global warming over time.¹⁵ The valuation of non-CO₂ pollutant

¹⁵ IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. [Link](#).

emissions is based on the PRC's Environmental Protection Taxation Law. The calculated quantity of each type of air pollutant avoided from the Project, is converted into an air pollution equivalent (kg-equivalent); the equivalency ratios of different emissions are: 16.7 kg per kg of CO; 0.95 kg per kg of SO₂; 0.95 kg per kg of NO_x; and 4 kg per kg of flue dust (i.e., PM). The environmental tax ranges between CNY 1.20 per kg-equivalent to CNY 12.00 per kg-equivalent.¹⁶ A value of CNY 7.00 per kg-equivalent is applied in the analysis. The economic benefit of an avoided pollutant is thus: kg pollutant avoided * equivalency ratio * 7 CNY/kg equivalent.

Table A3.3: Annual avoided emissions from Project (t/y)

Avoided Emissions	Fuxin	Panjin	Huludao	Yingkou	Jinzhou	Total
CO ₂	4,313	2,120	5,544	1,274	7,709	20,961
CO	383	425	441	280	624	2,154
SO ₂	33.2	0.56	38.6	0.44	16.6	89.3
NO _x	59.7	14.0	69.7	10.4	46.0	199.8
PM*	0.82	–	1.0	–	0.39	2.16

* In Panjin and Yingkou BEBs replace natural gas fueled buses, thus there are no PM reductions compared to the “without-project” scenario.

8. The implementation of a smart public transportation system, together with the establishment of dedicated bus lanes, as a result of the Project, will result in an average time savings of 2 minutes per passenger per day. The value of time saved per passenger per day, for each city, is estimated based on: 2 minutes, or 0.033 hours, of time saved per passenger per day (h/d/person), with time valued on the basis of local GDP per capita (CNY/y), over a working period of 2,000 h/y; the value of time is reduced using an efficiency factor of 0.5 to account for an expected lower-than-average earning bracket for a person taking public bus transport. The benefit of time gained per person per day is aggregated at city level by multiplying by the estimated working population of each city that takes bus transport (working population of the ridership). The annual benefit is derived from the daily benefit by multiplying by 250 workdays in the year (based on 5 days per week over 50 weeks of the year).

9. **Cost-Benefit Analysis.** The analysis indicates the Project is economically viable. At the overall Project level, the Economic Internal Rate of Return (EIRR) was estimated at 15.8 percent and Economic Net Present Value (ENPV) at CNY 419.4 million, based on a 9 percent social discount rate. At the individual city level, the EIRR ranges from 10.8 percent to 19.0 percent, and the ENPV ranges from CNY 17.9 million to CNY 154.6 million. The EIRR exceeds the social discount rate, at both city and Project levels, and the Project demonstrates good economic viability.

10. **Sensitivity Analysis.** A sensitivity analysis of the EIRR and ENPV was conducted to assess the impact of adverse changes in key variables: (i) an increase of 10 percent in capital costs; (ii) a decrease of 10 percent in benefits; and (iii) a combined worst-case scenario. The

¹⁶ Environmental protection agencies are authorized to determine the exact level of environmental tax applicable in their jurisdiction, within the prescribed range, by issuing local regulations or on a case-by-case basis. A mid-range value of 7.00 is chosen as a representative value for the purposes of the analysis.

ENPV remained greater than zero, and the EIRR at or above the 9 percent social discount rate in all individual scenarios, except for the Fuxin subproject in the combined worse-case scenario. Risk mitigation measures have been prepared to counter negative economic impacts of decreased revenues or increased costs in Fuxin, and the subproject will be monitored closely throughout its operation to ensure that costs and revenues remain under control and the Project can operate in an economically viable and sustainable manner.

*OFFICIAL USE ONLY

TableA3.4: Economic Analyses for the Project and All Five Sub-projects (CNY million)

Year	Fuxin					Panjin					Huludao							
	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit			
2021	0.0	0.0	0.0	0.0	0.0	32.1	4.2	0.3	12.8	-14.9	0.0	0.0	0.0	0.0	0.0			
2022	86.4	5.5	0.7	4.2	-76.0	233.9	11.3	0.7	34.1	-187.9	90.1	5.0	0.7	4.4	-80.1			
2023	81.1	12.3	1.6	9.3	-57.9	57.2	14.1	0.9	42.6	0.3	70.4	10.3	1.4	9.2	-49.5			
2024	51.5	15.6	2.1	11.8	-22.0	0.0	14.1	0.9	42.6	57.6	67.5	18.9	2.6	16.7	-29.4			
2025	0.0	15.6	2.1	11.8	29.5	0.0	14.1	0.9	42.6	57.6	0.0	18.9	2.6	16.7	38.2			
2026	0.0	15.6	2.1	11.8	29.5	0.0	14.1	0.9	42.6	57.6	0.0	18.9	2.6	16.7	38.2			
2027	0.0	15.6	2.2	11.8	29.5	0.0	14.1	0.9	42.6	57.6	0.0	18.9	2.7	16.7	38.2			
2028	0.0	15.6	2.2	11.8	29.6	0.0	14.1	0.9	42.6	57.6	0.0	18.9	2.7	16.7	38.2			
2029	0.0	15.6	2.2	11.8	29.6	0.0	14.1	1.0	42.6	57.6	0.0	18.9	2.7	16.7	38.3			
2030	0.0	15.6	2.2	11.8	29.6	81.3	14.1	1.0	42.6	-23.6	19.4	18.9	2.8	16.7	19.0			
2031	30.7	15.6	2.3	11.8	-1.0	0.0	14.1	1.0	42.6	57.7	17.1	18.9	2.8	16.7	21.2			
2032	0.0	15.6	2.3	11.8	29.7	0.0	14.1	1.0	42.6	57.7	14.6	18.9	2.8	16.7	23.8			
2033	0.0	15.6	2.3	11.8	29.7	0.0	14.1	1.0	42.6	57.7	0.0	18.9	2.9	16.7	38.4			
2034	56.0	15.6	2.3	11.8	-26.2	160.0	14.1	1.0	42.6	-102.3	58.4	18.9	2.9	16.7	-20.0			
2035	56.6	15.6	2.4	11.8	-26.8	16.4	14.1	1.0	42.6	41.3	56.7	18.9	2.9	16.7	-18.1			
2036	30.6	15.6	2.4	11.8	-0.8	0.0	14.1	1.1	42.6	57.7	50.6	18.9	3.0	16.7	-12.1			
2037	0.0	15.6	2.4	11.8	29.8	0.0	14.1	1.1	42.6	57.7	0.0	18.9	3.0	16.7	38.6			
2038	0.0	15.6	2.5	11.8	29.9	0.0	14.1	1.1	42.6	57.8	0.0	18.9	3.1	16.7	38.6			
2039	0.0	15.6	2.5	11.8	29.9	0.0	14.1	1.1	42.6	57.8	0.0	18.9	3.1	16.7	38.7			
2040	0.0	15.6	2.5	11.8	29.9	29.6	14.1	1.1	42.6	28.2	0.0	18.9	3.2	16.7	38.7			
2041	0.0	15.6	2.6	11.8	30.0	51.7	14.1	1.1	42.6	6.1	0.0	18.9	3.2	16.7	38.8			
2042	30.7	15.6	2.6	11.8	-0.7	0.0	14.1	1.1	42.6	57.8	19.4	18.9	3.2	16.7	19.4			
2043	0.0	15.6	2.6	11.8	30.0	0.0	14.1	1.2	42.6	57.8	17.1	18.9	3.3	16.7	21.7			
2044	0.0	15.6	2.7	11.8	30.1	0.0	14.1	1.2	42.6	57.9	14.6	18.9	3.3	16.7	24.3			
2045	0.0	15.6	2.7	11.8	30.1	0.0	14.1	1.2	42.6	57.9	0.0	18.9	3.4	16.7	38.9			
2046	0.0	15.6	2.7	11.8	30.1	0.0	14.1	1.2	42.6	57.9	0.0	18.9	3.4	16.7	39.0			
ENPV						17.9						154.6						57.6
EIRR						10.8%						19.0%						14.3%

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TableA3.4: Economic Analyses for the Project and All Five Sub-projects (CNY million) (continued)

Year	Yingkou					Jinzhou					OVERALL PROJECT				
	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit	Capital Cost	Savings in O&M	Avoided Emissions Cost	Value of Time Saved	Net Benefit
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.1	4.2	0.3	12.8	-14.9
2022	140.2	5.0	0.3	15.9	-119.0	170.7	21.0	2.1	21.0	-134.8	721.3	47.7	4.4	79.5	-597.8
2023	73.4	7.5	0.4	24.1	-41.4	92.6	29.0	2.9	29.0	-42.8	374.7	73.3	7.2	114.2	-191.2
2024	58.7	10.4	0.6	33.3	-14.4	9.0	29.0	2.9	29.0	40.8	186.6	88.0	9.0	133.4	32.6
2025	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.0	29.0	49.9	0.0	88.0	9.1	133.4	219.3
2026	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.0	29.0	49.9	0.0	88.0	9.3	133.4	219.5
2027	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.1	29.0	49.9	0.0	88.0	9.4	133.4	219.6
2028	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.1	29.0	50.0	0.0	88.0	9.5	133.4	219.7
2029	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.1	29.0	50.0	0.0	88.0	9.6	133.4	219.8
2030	26.8	10.4	0.6	33.3	17.5	47.6	29.0	3.2	29.0	2.5	175.0	88.0	9.8	133.4	44.9
2031	13.8	10.4	0.6	33.3	30.5	27.9	29.0	3.2	29.0	22.2	89.6	88.0	9.9	133.4	130.5
2032	15.5	10.4	0.6	33.3	28.8	0.0	29.0	3.3	29.0	50.2	30.0	88.0	10.0	133.4	190.2
2033	0.0	10.4	0.6	33.3	44.3	0.0	29.0	3.3	29.0	50.2	0.0	88.0	10.2	133.4	220.4
2034	85.8	10.4	0.6	33.3	-41.5	128.1	29.0	3.4	29.0	-77.8	488.3	88.0	10.3	133.4	-267.8
2035	41.7	10.4	0.6	33.3	2.6	84.3	29.0	3.5	29.0	-34.0	255.7	88.0	10.5	133.4	-35.0
2036	49.5	10.4	0.7	33.3	-5.2	0.0	29.0	3.5	29.0	50.4	130.8	88.0	10.6	133.4	90.0
2037	0.0	10.4	0.7	33.3	44.4	0.0	29.0	3.6	29.0	50.5	0.0	88.0	10.8	133.4	221.0
2038	0.0	10.4	0.7	33.3	44.4	0.0	29.0	3.6	29.0	50.5	0.0	88.0	10.9	133.4	221.1
2039	0.0	10.4	0.7	33.3	44.4	0.0	29.0	3.7	29.0	50.6	0.0	88.0	11.1	133.4	221.3
2040	0.0	10.4	0.7	33.3	44.4	0.0	29.0	3.7	29.0	50.6	29.6	88.0	11.2	133.4	191.9
2041	0.0	10.4	0.7	33.3	44.4	0.0	29.0	3.8	29.0	50.7	51.7	88.0	11.4	133.4	169.9
2042	26.8	10.4	0.7	33.3	17.6	47.6	29.0	3.9	29.0	3.2	124.4	88.0	11.6	133.4	97.3
2043	13.8	10.4	0.7	33.3	30.6	27.9	29.0	3.9	29.0	22.9	58.9	88.0	11.7	133.4	163.0
2044	15.5	10.4	0.7	33.3	28.9	0.0	29.0	4.0	29.0	50.9	30.0	88.0	11.9	133.4	192.1
2045	0.0	10.4	0.7	33.3	44.4	0.0	29.0	4.1	29.0	50.9	0.0	88.0	12.1	133.4	222.3
2046	0.0	10.4	0.8	33.3	44.4	0.0	29.0	4.1	29.0	51.0	0.0	88.0	12.3	133.4	222.5
ENPV	74.4					114.9					419.4				
EIRR	14.8%					18.5%					15.8%				

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Table A3.4: Sensitivity Analysis

Scenario	Fuxin		Panjin		Huludao		Yingkou		Jinzhou		Overall Project	
	ENPV	EIRR	ENPV	EIRR	ENPV	EIRR	ENPV	EIRR	ENPV	EIRR	ENPV	EIRR
Base case	17.9	10.8%	154.6	19.0%	57.6	14.3%	74.4	14.8%	114.9	18.5%	419.4	15.8%
Capital cost (+10%)	-5.4	8.6%	117.5	15.9%	32.5	11.8%	44.8	12.2%	82.4	15.2%	272.3	13.1%
Benefit (-10%)	-7.3	8.3%	102.0	15.6%	26.7	11.5%	37.3	11.9%	70.9	14.9%	230.3	12.8%
Combined Worst-Case	-32.2	6.3%	64.9	12.8%	1.6	9.1%	7.7	9.6%	38.4	11.9%	83.2	10.3%

B. Financial Analysis

11. **Methodology.** The financial analysis was conducted in 2020 constant prices for a Project period of 25 years. Only incremental financial costs and benefits brought by the Project to the five bus companies are considered, with taxes and duties applied accordingly.

12. **Financial Costs.** Financial costs of the Project include:

- **Project Costs:** initial capital expenses including civil works, procurement costs for BEBs and related equipment, land transfer expenses, project management costs, E&S mitigation costs, costs for technical support and capacity building, contingencies, financial charges during construction and initial working capital requirement.
- **Replacement Costs:** subsequent capital expenses including battery replacements, BEB replacement, and related refurbishments as needed and planned by the Bus Companies. In accordance with the Chinese regulations, BEBs will be retired and replaced after 13 years in operation, and batteries for BEBs will be recycled after 8 years in operation. and replaced. That is, over a reporting period of 25 years there will be a replacement of BEBs and two additional replacements of batteries. In reality, BEBs may have a technical life longer than 13 years, and batteries may be recycled and used as spare batteries for a large BEB fleets or pooled together for energy storage in distributed energy system. However, for calculation purpose, to be at the conservative side, the residual values of retired BEBs and batteries are assumed to be zero by default. Only when the batteries are replaced earlier than 8 years, some residual values are considered to make up the economic life of batteries of 8 years.
- **O&M costs:** Incremental O&M costs of the Project are calculated by the five bus companies according to their deployment plan for the new BEBs on existing and new routes. A detailed projection of O&M costs is conducted for the reporting period. Table 1 summarizes the number of buses to be procured and replaced.

Table A3.6: Number of BEBs per city

	City	Total number to be procured	Number of diesel buses replaced	Number of LNG buses replaced	Number of CNG buses replaced	New additions to the fleet
1	Fuxin	238	60	0	0	178
2	Panjin	294	0	195	0	99
3	Huludao	277	106	97	37	37
4	Yingkou	203	0	37	166	0
5	Jinzhou	273	55	0	151	67

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13. **Financial Benefits.** Financial benefits of the Project include:

- Incremental operating income, which is projected by the five bus companies in accordance with their deployment plans for the new BEBs, considering the increased number of BEBs, increased number of bus routes, expanded service area coverage, and increased passenger volume.
- Price of bus ticket. Price of bus ticket is under the regulation of local governments in Liaoning. Bus companies are allowed to adjust the ticket price following some defined procedures, for example, filing a request to the local authority, public hearing, etc. However, within a reporting period of 25 years, it is difficult to predict the size and frequency of price changes in the five Project cities, to simplify the discussion and be conservative, the bus ticket price is boldly assumed to remain at the current level.
- Incremental government subsidies associated with the Project, in which only recurring subsidies are estimated and included in the financial forecast. The subsidies will cover lost income from reduced/waived fares for elderly (above 60) passengers; an operational subsidy for new energy vehicles¹⁷.

14. **Weighted Average Cost of Capital (WACC).** WACC is calculated based on the financing structure and capital costs of different financing sources and adjusted for inflation, considering:

- AIIB loan: The AIIB loan is expected to have an average maturity of 12-15 years, which would correspond to a spread of 0.83 percent above LIBOR, at current rates. The US 30-year treasury average yield is used as an estimate of long-term LIBOR, which is 2.16 percent in 2021.¹⁸ Therefore, a rate of 3.0 percent is used to approximate the cost of AIIB loan over the life of the Project.
- The cost of government funding is 8 percent estimated by local government.

Table A3.7: Calculation of real weighted average cost of capital

	Amount USD million)	Weight	Nominal Rate Before Tax	Corporate Tax	Nominal Rate After Tax	Inflation Rate	Real Rate	Weighted Real Rate
AIIB Loan	150	70%	3.00%	25%	2.25%	1.50%	0.74%	0.52%
Government Fund	42.41	20%	8.00%	0%	8.00%	2.20%	5.68%	1.12%
Equity of Bus Co	21.86	10%	8.00%	0%	8.00%	2.20%	5.68%	0.58%
Total	214.27						WACC	2.22%

¹⁷ New energy vehicles refer to electric vehicles, hybrid vehicles and fuel cell vehicles.

¹⁸ Data source: [30 Year Treasury Rate - 39 Year Historical Chart | MacroTrends](#)

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TableA3.8: Financial Analyses for the Project and All Five Sub-projects (CNY million)

Year	Fuxin				Panjin				Huludao			
	Capital Cost	O&M Costs	Revenue	Net Cash Flow	Capital Cost	O&M Costs	Revenue	Net Cash Flow	Capital Cost	O&M Costs	Revenue	Net Cash Flow
2021	0.0	0.0	0.0	0.0	35.22	0.00	0.00	-35.22	0.0	0.0	0.0	0.0
2022	93.31	2.70	7.79	-88.23	256.25	4.88	46.89	-214.23	98.30	2.72	10.75	-90.27
2023	85.38	15.41	35.94	-64.85	62.67	6.15	44.49	-24.34	76.87	7.30	31.90	-52.27
2024	51.66	22.24	60.39	-13.50	0.00	6.15	48.35	42.20	73.69	10.29	42.50	-41.48
2025	0.00	23.65	64.36	40.71	0.00	6.15	48.69	42.54	0.00	10.26	43.19	32.93
2026	0.00	27.54	63.96	36.42	0.00	9.32	48.69	39.38	0.00	10.72	43.93	33.21
2027	0.00	31.48	63.89	32.41	0.00	9.32	48.69	39.38	0.00	11.79	47.06	35.27
2028	0.00	33.77	63.52	29.74	0.00	9.32	48.69	39.38	0.00	12.55	48.63	36.08
2029	0.00	34.83	63.52	28.69	0.00	11.13	48.69	37.56	0.00	14.69	48.52	33.83
2030	0.00	35.72	65.35	29.63	0.00	11.13	48.69	37.56	21.00	14.43	48.70	13.28
2031	33.31	27.58	64.34	3.45	88.20	11.13	48.69	-50.64	18.60	13.72	48.84	16.52
2032	0.00	27.13	63.48	36.36	0.00	13.03	48.69	35.66	15.80	14.53	51.25	20.92
2033	0.00	26.60	62.87	36.27	0.00	13.03	48.69	35.66	0.00	14.93	51.49	36.56
2034	60.75	28.58	62.87	-26.46	173.62	13.03	48.69	-137.96	63.41	15.44	51.73	-27.11
2035	61.39	34.38	65.68	-30.09	17.77	15.02	48.69	15.90	61.47	16.91	52.05	-26.33
2036	33.24	35.43	65.68	-2.99	0.00	15.02	48.69	33.67	54.90	17.47	52.37	-20.01
2037	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	0.00	17.47	52.37	34.89
2038	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	0.00	17.47	52.37	34.89
2039	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	0.00	17.47	52.37	34.89
2040	0.00	35.43	65.68	30.24	32.10	15.02	48.69	1.57	0.00	17.47	52.37	34.89
2041	0.00	35.43	65.68	30.24	56.10	15.02	48.69	-22.43	0.00	17.47	52.37	34.89
2042	33.31	35.43	65.68	-3.07	0.00	15.02	48.69	33.67	21.00	17.47	52.37	13.89
2043	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	18.60	17.47	52.37	16.29
2044	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	15.80	17.47	52.37	19.09
2045	0.00	35.43	65.68	30.24	0.00	15.02	48.69	33.67	0.00	17.47	52.37	34.89
2046	0.00	35.43	99.95	64.52	0.00	15.02	93.84	78.82	0.00	17.47	106.42	88.95
FNPV	218.2				104.8				207.4			
FIRR	11.67%				5.54%				10.14%			

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TableA3.8: Financial Analyses for the Project and All Five Sub-projects (CNY million) (continued)

Year	Yingkou				Jinzhou				Overall Project			
	Capital Cost	O&M Costs	Revenue	Net Cash Flow	Capital Cost	O&M Costs	Revenue	Net Cash Flow	Capital Cost	O&M Costs	Revenue	Net Cash Flow
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.22	0.00	0.00	-35.22
2022	152.78	-12.60	15.08	-125.09	181.29	5.56	15.61	-171.23	781.93	3.25	96.12	-689.06
2023	80.00	-11.54	20.07	-48.40	94.58	4.27	39.16	-59.69	399.50	21.60	171.56	-249.54
2024	63.94	-13.57	25.09	-25.27	3.56	8.03	48.21	36.62	192.84	33.14	224.53	-1.45
2025	0.00	-13.06	25.26	38.32	0.00	9.46	49.87	40.41	0.00	36.46	231.36	194.91
2026	0.00	-12.75	25.09	37.84	0.00	9.99	50.32	40.34	0.00	44.81	232.00	187.18
2027	0.00	-13.28	25.09	38.37	0.00	9.95	49.38	39.43	0.00	49.26	234.11	184.85
2028	0.00	-20.20	13.85	34.05	0.00	10.10	49.42	39.31	0.00	45.54	224.11	178.57
2029	0.00	-20.79	13.50	34.29	0.00	11.07	49.25	38.18	0.00	50.93	223.48	172.54
2030	29.10	-20.74	14.39	6.03	51.60	7.19	49.41	-9.38	101.70	47.73	226.54	77.11
2031	15.00	-20.74	14.70	20.44	30.30	7.57	49.70	11.83	185.41	39.25	226.26	1.60
2032	16.80	-17.34	14.13	14.67	0.00	12.88	49.84	36.96	32.60	50.23	227.40	144.57
2033	0.00	-17.19	14.28	31.47	0.00	13.32	49.89	36.57	0.00	50.69	227.22	176.53
2034	93.12	-17.05	14.23	-61.84	138.96	8.22	50.31	-96.88	529.86	48.22	227.83	-350.25
2035	45.30	-16.88	14.17	-14.25	91.51	8.66	50.60	-49.57	277.43	58.09	231.19	-104.33
2036	53.76	-21.75	14.12	-17.89	0.00	14.40	50.86	36.46	141.90	60.58	231.71	29.24
2037	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	0.00	59.79	231.65	171.85
2038	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	0.00	59.79	231.65	171.85
2039	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	0.00	59.79	231.65	171.85
2040	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	32.10	59.79	231.65	139.75
2041	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	56.10	59.79	231.65	115.75
2042	29.10	-21.75	14.12	6.77	51.60	8.09	50.79	-8.89	135.01	54.26	231.65	42.37
2043	15.00	-21.75	14.12	20.87	30.30	8.09	50.79	12.41	63.90	54.26	231.65	113.48
2044	16.80	-21.75	14.12	19.07	0.00	13.62	50.79	37.18	32.60	59.79	231.65	139.25
2045	0.00	-21.75	14.12	35.87	0.00	13.62	50.79	37.18	0.00	59.79	231.65	171.85
2046	0.00	-21.75	69.57	91.32	0.00	13.62	110.06	96.45	0.00	59.79	479.85	420.06
FNPV				178.9				186.5				878.6
FIRR				8.63%				8.52%				8.64%

15. **Results of Financial Analysis.** The analysis indicates the Project is financially viable. At the overall Project level, the FIRR was 8.64 percent, and the NPV was USD 878.6 million based on a WAC of 2.22 percent. At the individual city-level (sub-project level), the FIRR is at or above 5 percent. The IRR exceeds the WACC at both overall Project level and at the individual sub-project level, and the Project shows sound financial viability.

16. **Sensitivity Analysis.** Sensitivity analyses were conducted to test the robustness of the Project in three adverse scenarios: (i) an increase of 10 percent in CAPEX; (ii) an increase of 10 percent in O&M; and (iii) a decrease of 10 percent in revenues; In all individual scenarios, the NPV remained greater than zero and the IRR at or above the sub-project level WACC. The five sub-projects will be monitored closely throughout its operation to ensure costs and revenues remain under control so the project can operate in a financially viable and sustainable manner.

Table A3.9: Sensitivity Analysis

		Base Case	(i) Capital Costs +10%	(ii) Operating Cost +10%	(iii) Revenue -10%
Project	FNPV	878.6	631.4	790.6	455.5
	FIRR	8.64%	6.49%	8.07%	5.66%
Fuxin	FNPV	218.2	179.8	162.0	101.8
	FIRR	11.67%	9.43%	9.50%	6.91%
Panjin	FNPV	104.8	44.4	83.1	12.2
	FIRR	5.54%	3.52%	4.90%	2.62%
Huludao	FNPV	207.4	162.4	180.9	115.1
	FIRR	10.14%	7.98%	9.23%	6.80%
Yingkou	FNPV	178.9	127.4	144.3	144.2
	FIRR	8.63%	6.41%	7.45%	7.37%
Jinzhou	FNPV	186.5	130.4	166.8	92.1
	FIRR	8.52%	6.31%	7.91%	5.44%

C. Financial Sustainability Analysis for Bus Companies

17. **Fuxin Bus Company.** Due to the COVID-19 pandemic and the resulting decreased volume of passengers in 2020 and 2021, Fuxin Bus Company (privately owned) is currently in financial distress. The volume of passengers is expected to gradually return to normal from 2022 onwards. Hence, BEBs will enhance financial performance of Fuxin Bus Company, since (i) BEBs will reduce O&M costs compared to the “without-project” scenario; (ii) improved bus services will enhance ridership, which in turn will generate

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more turnovers. Fuxin Bus Company will have an improved financial situation and retain its financial sustainability during operation.

Table A3.10: Key indicators of Fuxin Bus Company

Item	2020 (Actual)	2021	2024	2031	2036
EBIT (CNY, million)	2.28	2.36	21.16	23.63	22.89
EBITDA (CNY, million)	16.83	20.19	59.98	64.84	58.43
Interest Coverage Ratio	0.33	0.39	1.97	2.71	3.07
L/A Ratio	101%	102%	95%	76%	62%
Debt Service Coverage Ratio	0.60	2.15	4.62	3.58	3.45

18. **Panjin Bus Company.** Panjin Bus Company is financially sustainable. Through the Project, the Bus Company will introduce BEBs, reducing its O&M costs and improving its profitability compared to the “without-project” scenario. Further, additional new BEBs will be deployed expanding the service coverage area and increasing ridership. Panjin Bus Company’s financial sustainability will increase significantly when the Project enters operation, from 2024 onwards.

Table A3.11: Key indicators of Panjin Bus Company

Item	2020 (Actual)	2021	2024	2031	2036
EBIT (CNY, million)	(14.22)	(11.47)	39.26	44.70	54.92
EBITDA (CNY, million)	15.04	17.79	73.18	80.99	91.54
Interest Coverage Ratio	(11.65)	(16.73)	5.28	7.75	14.07
L/A Ratio	77%	74%	73%	66%	60%
Debt Service Coverage Ratio	1.16	1.39	9.84	4.46	5.62

19. **Huludao Bus Company.** Huludao Bus company will introduce BEBs, saving O&M costs and increasing ridership through new bus routes. The Bus Company runs at considerable leverage, however financial forecasts indicate that the company will be able to service debt and repay interest when all BEBs are in operation, and thus be financially sustainable.

Table A3.12: Key indicators of Huludao Bus Company

Item	2020 (Actual)	2021	2024	2031	2036
EBIT (CNY, million)	0.92	0.34	(0.14)	11.90	8.01
EBITDA (CNY, million)	19.80	25.77	36.72	44.40	40.22
Interest Coverage Ratio	0.13	0.04	(0.03)	2.68	2.55
L/A Ratio	93%	93%	99%	92%	83%
Debt Service Coverage Ratio	1.56	1.41	3.82	3.23	3.29

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20. **Yingkou Bus Company.** Yingkou Bus Company is financially sustainable. Through the Project, Yingkou Bus Company will reduce O&M costs and improve its profitability compared to the “without-project” scenario. The financial forecast indicates that liability-to-asset ratio decreases, while the interest coverage ratio and debt-service coverage ratio (DSCR) increase, indicating an improved financial position as a result of the Project.

Table A3.13: Key indicators of Yingkou Bus Company

Item	2020 (Actual)	2021	2024	2031	2036
EBIT (CNY, million)	17.88	2.38	20.29	19.92	19.12
EBITDA (CNY, million)	54.22	37.99	72.85	65.75	64.28
Interest Coverage Ratio	1.97	0.29	1.82	3.11	4.26
L/A Ratio	84%	84%	72%	54%	44%
Debt Service Coverage Ratio	0.67	1.06	1.88	2.50	2.49

21. **Jinzhou Bus Company.** Jinzhou Bus company experienced reduced passenger numbers in 2020 due to COVID-19; passenger volume is expected to gradually increase from 2022 onwards. The reduction in O&M costs from BEBs and increased ridership from new routes will result in improved financial performance compared to the “without-project” scenario. Financial indicators indicate that Jinzhou Bus Company is financially sustainable.

Table A3.14: Key indicators of Jinzhou Bus Company

Item	2020 (Actual)	2021	2024	2031	2036
EBIT (CNY, million)	(43.82)	(25.53)	19.44	35.62	31.51
EBITDA (CNY, million)	(13.60)	13.32	61.56	79.43	78.51
Interest Coverage Ratio	(4.58)	(2.59)	2.24	6.55	8.25
L/A Ratio	82%	77%	60%	37%	26%
Debt Service Coverage Ratio	(0.20)	0.21	2.42	4.49	4.99

Annex 4: Member and Sector Context

A. Country context

1. After decades of high growth and poverty reduction, China has become an upper middle-income country with regional and global importance. Despite its great achievement of economic development and lifting over 800 million people out of poverty, China still faces complex challenges, including promoting high-quality and sustainable development and transitioning to a lower carbon growth model.

2. Chinese president Xi Jinping said at the United Nation's General Assembly in September 2020 that China would uphold the concept of building a community with a shared future for mankind and continue to make hard efforts to fully honor its obligation and adopt more effective policies and measures to achieve the goal set by "Paris Agreement", with CO2 emissions peaking by 2030 and carbon neutrality achieved by 2060. China's move will have a positive impact on tackling the global climate change.

3. The sector of transport and communication in China has seen steady growth, except for 2020 due to the COVID-19 pandemic. Growth rates of the transport and communication sector has been surpassing the overall GDP performance in year 2016 to 2019, according to China's National Bureau of Statistics. Though the COVID-19 pandemic seriously impacted the Chinese transport sector in 2020, its growth rate in 2020 was still positive as calculated in constant price. Also, a mild recovery was observed in the first quarter of 2021.

Table A4.1: GDP of China (by Sector) during 2016-2020

Year	Unit	2020	2019	2018	2017	2016
GDP	trillion, RMB	101.60	98.65	91.93	83.20	74.64
GDP per capita	RMB	72447	70581	66006	60014	54139
<i>GDP Growth Rate</i>	<i>%, constant price</i>	2.3	6.0	6.7	6.9	6.8
Primary Industry	trillion, RMB	7.78	7.05	6.47	6.21	6.01
Secondary Industry	trillion, RMB	38.43	38.07	36.48	33.16	29.54
Tertiary Industry	trillion, RMB	55.40	53.54	48.97	43.84	39.08
in which: Transport and Communication	trillion, RMB	4.16	4.25	4.03	3.71	3.30
<i>Transport and Communication Growth Rate</i>	<i>%, constant price</i>	0.5	6.5	8.3	9.6	6.9

Data Source: National Bureau of Statistics, PRC

4. **Energy Consumption and CO₂ Emission.** Alongside with rapid development, energy consumption and carbon emission in transport sector raised broad concern. In 2018, transport and communication sector of China recorded an energy consumption of 436.17 Mt Standard Coal Equivalent, which is 3.5% more than 2017 as per National Bureau of Statistics, PRC. And for carbon emission, IEA reported that China's transport sector emitted 925 Mt CO₂ in 2018, with a growth rate of 4.0%. Although decreasing growth rates of energy consumption

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and carbon emissions from transport sector were observed from statistics, showing some improvements, the trends are still upward. Thus, it is widely agreed that more efforts are required for improving energy efficiency also for decarbonizing the transport sector.

Table A4.2: Energy Consumption of China in 2015-2020

Year	Unit	2020	2019	2018	2017	2016	2015
Total Energy Consumption	Mt, Standard Coal Equivalent	4980	4870	4719	4558	4415	4341
<i>Total Consumption Growth Rate</i>	-	2.3%	3.2%	3.5%	3.2%	1.7%	1.3%
Transport and Communication Sector	Mt, Standard Coal Equivalent			436	421	399	385
<i>Sector Consumption Growth Rate</i>	-			3.5%	5.7%	3.6%	6.0%

Data Source: National Bureau of Statistics, PRC

Table A4.3: Carbon Emission of China by Sector in 2011-2018

Year	Unit	2018	2017	2016	2015	2014	2013	2012	2011
Total Carbon Emission	Mt CO2	9571	9288	9100	9136	9164	9236	8864	8613
<i>Growth rate of Total carbon emission</i>	-	3.0%	2.1%	-0.4%	-0.3%	-0.8%	4.2%	2.9%	9.4%
Transport	Mt CO2	925	889	851	834	777	748	692	628
<i>Growth rate of Transport sector emission</i>	-	4.0%	4.5%	2.0%	7.3%	3.9%	8.1%	10.2%	9.2%

Data Source: IEA

5. Urban public transport is developing to promote efficient and environment-friendly commuting. In 2012, the State Council of China released a Guideline on giving priority to the development of urban public transport with the aim to alleviate traffic congestion and reduce carbon emissions as well as local pollution in cities.¹⁹ As per the 2012 guideline, bus/economic bus (e-bus) will be developed as the backbone of future ground public transport system, while metro/subway can be developed in metropolitan areas where appropriate. After years of implementation, bus/e-bus fleet grew in scale, carrying 69.18 billion out of 127.92 billion passengers in 2019, more than 50% of urban passengers.

¹⁹ The state council of the People's Republic of China, Guideline on giving priority to the development of urban public transport, 5 Jan. 2012, http://www.gov.cn/zhengce/content/2013-01/05/content_3346.htm.

Table A4.4: Urban Passenger Transport by Type in 2016-2020

Year	Total Urban Passenger	by Bus/E-bus			by Metro		by Taxi	by Ferry
		Passenger	Milage	Passenger %	Passenger	Passenger %	Passenger	Passenger
	billion	billion	billion km	-	billion	-	billion	billion
2016	128.52	74.54	35.83	58.0%	16.15	12.6%	37.74	0.09
2017	127.22	72.29	35.52	56.8%	18.31	14.4%	36.54	0.08
2018	126.22	69.70	34.61	55.2%	21.28	16.9%	35.17	0.08
2019	127.92	69.18	35.41	54.1%	23.88	18.7%	34.79	0.07
2020	87.19	44.24	30.28	50.7%	17.59	20.2%	25.33	0.04

Data reorganized from: *Statistical Commniqué of Transport Sector Development 2016-2020*, Ministry of Transport, PRC.

Table A4.5: Urban Bus/E-Bus Fleet and Composition by Fuel Type in 2016-2020

Year	Bus/E-bus	Diesel	LNG	EV	Hybrid	Others
	thousands	%	%	%	%	%
2016	608.6	37.2	30.5	15.6	11.5	5.2
2017	651.2	28.7	27.9	26.3	13.2	3.9
2018	673.4	22.2	24.5	37.8	12.9	2.6
2019	693.3	17.4	21.5	46.8	12.3	2
2020	704.4	13.9	18.2	53.8	12.4	1.7

Data reorganized from: *Statistical Communique of Transport Sector Development 2016-2020*, Ministry of Transport, PRC.

B. Sector Context

6. **Urban public transportation needs to be made even greener.** Traditional fossil-fueled buses, particularly those with diesel engines, are one of the major sources of harmful pollutants in urban areas, such as CO₂, NO_x, SO₂ and CO. Electric vehicle (EV) has zero tailpipe emission, and even with fossil fuel-dominated grid, can reduce well-to-wheel GHG emissions by 30%-40%.²⁰ Therefore, the central government of PRC published a development plan in 2012, setting EV development as the top priority in the development of new energy vehicles.²¹ Since then, numerous supporting policies for public transportation and e-bus development have been issued by relevant ministries and municipal governments. To further promote the application of e-bus, the State Council of China stipulated that from 2021, new energy vehicles should account for at least 80% of the newly purchased buses in national

²⁰ ADB, *Sustainable Transport Solutions: Low-Carbon Buses in the People's Republic of China*, November 2018, <https://www.adb.org/sites/default/files/publication/468921/sustainable-transport-solutions-peoples-republic-china.pdf>.

²¹ The state council of the People's Republic of China, *Notice on energy-saving and new energy vehicle industry development plan (2012-2020)*., 28 Jun. 2012, http://www.gov.cn/zwgc/2012-07/09/content_2179032.htm.

ecological civilization experimental zones as well as key areas of air pollution prevention and control.²²

7. **E-buses have been widely applied in public transportation, but regional imbalance exists.** Since the adoption of promoting policies, the total number of e-buses in China has increased from 7,292 as of 2014 to 324,231 as of 2019, with an average annual growth rate of 114%. E-bus as a share of total type rose from 1.4% in 2014²³ to 53.8% in 2020²⁴. In 2019, e-buses accounted for 90.1% of newly purchased buses countrywide²⁵, which is higher than the level required by the central government. However, regional development is unbalanced. Application of e-buses mainly concentrated in mega and large cities, while medium and small cities lack essential funding to switch to e-buses. For example, as the end of 2020, among the total of 1,816 e-bus charging stations built in Liaoning province, 1,100 were in Dalian, the second largest city in the province²⁶. Without adequate funding, small and medium cities would have more difficulties in electrifying their bus fleets and meet the growing demand for better public transportation.

8. **Smart (or intelligent) Public Transportation Development is gaining momentum in China.** In 2012 and 2013, China's Ministry of Transport (MOT) launched two rounds of intelligent urban public transport demonstration projects in large cities. Examples of smart technologies that have been applied to public buses include: (i) positioning and video monitoring; (ii) end-to-end trip information sharing that facilitates pre-trip, wait, transfer and ride planning; (iii) customized mobile payment systems; (iv) intelligent scheduling and dispatching; (v) data analyses and visualization; (vi) Enterprise Resource Planning systems; (vii) bus line network optimization; and (viii) pilot autonomous driving e-buses. These pilot projects have achieved impressive results, and more demonstrations of intelligent public transport projects will be implemented in selected cities across the country.

9. Since 2015, MOT has been rolling out a national all-in-one (AIO) transport card interconnection, systematically mainstreaming intelligent urban public transport in China with the support of accompanying standards or guidelines. As of end-2020, more than 32,000 bus lines and 190 subway lines in 303 prefecture-level cities and 505 county-level in China are interconnected under the AIO transport card. More than 90 million AIO cards have been issued

²² General Office of the State Council of the People's Republic of China, Notice on energy-saving and new energy vehicle industry development plan (2021-2035), 20 Oct. 2020, http://www.gov.cn/zhengce/content/2020-11/02/content_5556716.htm.

²³ Ministry of Transport. *National Report on Urban Passenger Transport Development*. 2014 and 2019.

²⁴ Ministry of Transport, *Statistical Commnitiqué of Transport Sector Development 2016-2020*.

²⁵ China Academy of Transportation Sciences, China's Experience in Promoting and Applying New Energy Urban Buses, Oct. 2020.

²⁶ Liaoning department of transport, Report on the development of urban public transport in the whole province, Mar. 2021.

nationwide, and the number of cross-city public transport services has exceeded 500 million.²⁷

10. In Liaoning, all fourteen prefecture-level cities are connected to the national AIO transport card system. Passengers can query bus routes, stations and arrival information in real-time as well as pay for fares through mobile apps and payment platforms (e.g., UnionPay, WeChat pay) in all cities in Liaoning. For example, Dalian and Panjin have adopted digitized systems to dispatch bus information remotely. Anshan bus company has used an information management system which can track and manage operations, mileage statistics, vehicle maintenance, personnel and materials, thereby greatly reducing operation cost.

11. **Implementation of smart Public Transport System can be a good solution for developing countries.** Smart public transport system can improve the efficiency, safety, and cost-effectiveness of public transport. For developing countries with growing pressure on their existing infrastructure, smart public transport system can help making best use of road capacity while encouraging greater passenger usage, thus help reducing carbon emissions and relieving urban traffic congestion. Smart public transport system will continuously evolve by incorporating the cutting-edge technologies such as the Internet of Things and 5G communication, providing better public transport services with higher quality.

C. Battery Recycling Policies

12. In January 2016, the central government's ministries, including the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Environment Protection, the Ministry of Commerce, and the General Administration of Quality Supervision Inspection and Quarantine established the recycling policies for electric vehicle batteries. Since then, a series of administrative guidelines and decrees issued to hold electric vehicle manufacturers responsible for the recycling and recovery of batteries.

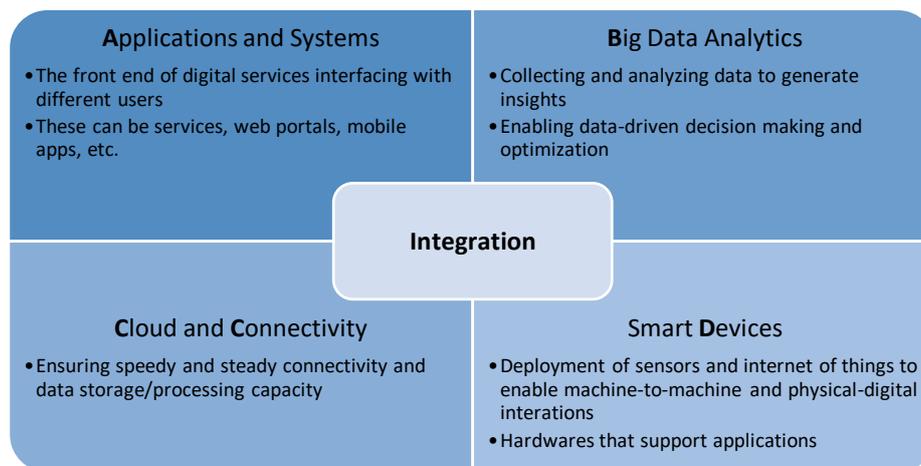
13. EV manufacturers are required to establish channels and/or service outlets to collect, store, and transfer old batteries to specialized recyclers, which are usually supported by battery makers. EV manufacturers must also set up a system with traceability that will enable the identification of owners of discarded batteries. In addition, the battery makers are encouraged to adopt standardized and easily dismantled product designs to help automate the recycling process.

²⁷ MOT: 303 cities have realized the all-in-on transport card interconnection), https://m.thepaper.cn/baijiahao_10743867.

Annex 5: Digital Technology and Smart Public Transport

1. Smart Public Transportation System development can be conceptualized as "ABCD-I," which consists of developing applications for businesses and users, optimizing data analytics, maintaining connectivity and cloud infrastructure, deploying smart devices, and integrating them in a single platform. This section aims to provide a detailed explanation of each component.

Figure A6.1: Four Key Components for Smart Public Transportation System



2. Systems and applications are the front ends of digital services interfacing with users who can be drivers, passengers, managers, and other stakeholders. Applications can be a web service portal or mobile app, etc. Smart Public Transport System is a comprehensive platform that integrates all applications and systems related to the service, from passengers to drivers and from vehicles to depots and bus stops. It also includes monitoring, data analytics, and other operational systems. It is typically provided as a "Software as a service" (SaaS), allowing users to connect to and use cloud-based web portals or apps over the Internet.

3. **Smart Passenger Information Services.** Passenger Information Service Application is one of the most essential digital components for the smart public transportation system. It provides real-time bus information via mobile app, website, and in-station boards. Route and bus stop information is also provided via on-board displays and announcements. The information provided to passengers typically includes GPS locations of the buses, the latest arrival time estimations, and other services such as lost and found. It can also be integrated with the payment systems to allow passengers to ride with contactless payments and enable other business models. Typical passenger information service mobile app today can achieve the following, but not limited to:

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- a. Digital ticketing - Secure mobile ticket purchase and delivery on iOS and Android. Purchase and gift tickets via debit/credit cards, Apple Pay, and Google Pay.
- b. Journey planning - A full-featured, scalable journey planning engine built on open architecture and open data.
- c. Timetables - Individually styled timetables for branded and regular routes can be filtered by direction and time, with all stops or just timing points.
- d. Real-time information - Real-time information from GPS, GIS, and other data sources, automatically blended with scheduled network data.
- e. Contextual disruptions - Synchronize operations and marketing with a central system to manage disruption information.
- f. Real-time vehicle tracking - Track buses with live vehicle tracking displayed en-route on maps and journey views.
- g. Destination marketing - Enable customer acquisition strategy and increase customer base through the event and attraction-based destination marketing through the passenger information service application.
- h. Smart Bus Stop and Management System: Integrated system to manage information bulletin boards, vending, advertisement, and other value-added services related to bus stops and terminals.

4. **Smart Monitoring System and Smart O&M Platform.** Smart applications and systems not only enable better customer services for passengers, but they can also be utilized for the vehicles, drivers, and management of the public transportation company. As part of the project, applications are also designed to improve the efficiency of operations and monitoring. It allows managers to plan drivers' duties, enable better customer management, and access crucial operational information.

- a. Mobile Applications: It allows employees and drivers to access information provided by other systems on the phones. The graphical illustration below shows the dashboard managers and employees can access on their phones to assist their management
- b. Automatic Vehicle Location System: Real-time visualization of vehicle location via fitted GPS enables the city to calculate an estimated arrival time and support bus operations from a central command center to adhere to a planned schedule.
- c. Automated Fare Collection Service: Quick and secure cashless payment via contactless cards or smartphone apps ensures greater convenience, passenger safety, and ridership visibility.
- d. Smart Fleet Management System and Network Optimization: Bus routes, schedules, dispatching optimized by analysis of bus travel performance and traffic volume. Allocate and optimize crew and overall bus operations by automating the

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- management of vehicles, electricity charging, inventory, personnel, and vehicle maintenance.
- e. Smart Energy Management Systems: Optimize charging, discharging, and maintenance of the battery. This will also be enabled by the data analytics platform.
 - f. Integrated Safety System (Driving assistance and Safety System): Systems supporting drivers on the road providing assistant driving on the road and provide safety precautions. The system can be further developed over time to incorporate semi/automated driving. It will utilize cameras as well as artificial intelligence to ensure the vehicle is operating safely. It also archives different safety cases for future analysis and optimization.
 - g. Enterprise Resources Planning (ERP) System: Provides capability to collect, store, manage and interpret data from business activities, which enables business management with a suite of integrated applications. ERP systems track business resources—cash, raw materials, production capacity—and the status of business commitments: orders, purchase orders, and payroll. The applications that make up the system share data across various departments that provide the data. ERP facilitates information flow between all business functions and manages connections to outside stakeholders. This is a mature technology and is commonly used in modern businesses.

Figure A6.2: Illustration of Enterprise planning, KPI, and Driver's Portal (From left to right)



图 4-21 公司管理端 APP 计划执行界面



图 4-21 公司管理端 APP 运营考核界面



图 4-22 司机端 APP 客流人次界面示意图

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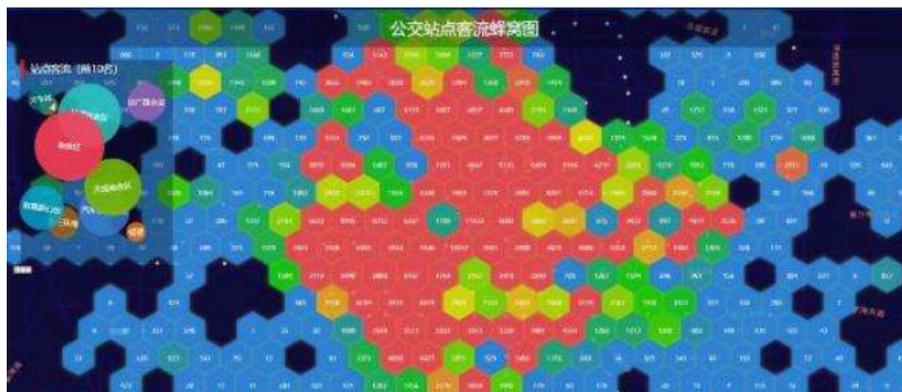
Figure A6.3: Illustration of Smart Bus Stop



5. **Data Analytics Platform.** The Data Analytics Platform consists of many functions, including data collection, data cleansing, database management, insight generations, algorithmic optimization, data visualization, etc. The platform will utilize all data from business operations, sensors, satellites, mapping, cameras, digital applications, etc. It will use advanced techniques, including machine learning and artificial intelligence, to generate useful insights that support better decision-making. There are a couple examples of applications.

- a. **Integrated Data Management.** All data received from different channels are central management and harmonized. One big data reservoir is created to ensure data interoperability and allowing speedy access to data for advanced analysis.
- b. **Network Optimization.** The data analytics platform will perform model-based analysis and simulation to identify key areas where traffic is higher and are more demanded. This can be updated every 30 minutes by utilizing passenger details, mapping, car sensors, surveys, and other information collected.
- c. **Smart Energy Management.** Energy consumptions can be visualized and support optimizations of the charging schedules, by utilizing data collected from the cars, GPS as well as mapping, details about the. It also allows better visualization of the emissions and provides other related information.

Figure A6.4: Heatmap of Passengers and Vehicles for network optimization



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6. **Digital Infrastructure is the foundation for the Smart Public Transportation System.** Proper connectivity and data center planning are pre-requisites for the system. Data centers are essential to allow all the systems to be hosted in the cloud, which enables access "anywhere, anytime, anyway." Networks and equipment are carefully designed and deployed to ensure reliable, fast, and safe connectivity (e.g., supporting high-speed ethernet, enable simultaneous connectivity of 1500 vehicle terminals, ability to process 200 million data entries with less than 1-second latency).

7. **Interoperability and integration are essential.** Given the variety of vendors and manufacturers for each device, system, and other equipment, interoperability and integration of them are critical. As the procurement of different components may happen during the different stages, a harmonized plan and system gateway will be essential to the successful deployment of the system. All components are required to pass the test of being able to communicate with each other and apply similar network protocols. Tests will also be conducted to ensure smooth operations before implementation.

Annex 6: Sovereign Credit Fact Sheet

A. Recent Economic Developments

1. China is an upper-middle-income country with income per capita of about USD10,400 and population of about 1.4 billion, as of 2019.²⁸ China has weathered the pandemic remarkably well. In 2020, economic growth remained positive as the country contained the virus outbreak, implemented an effective stimulus and reopened the economy ahead of others, benefiting from a booming export demand as other regions were still mired in the pandemic-related lockdowns, while global consumers switched consumption from services to manufactured goods. According to the National Bureau of Statistics (NBS), in Q1 2021, the economy grew by 18.3 percent, compared with Q1 2020, due to the base effect but also reflecting strong growth momentum.

2. Overall, China's economic growth has been trending down recently, declining from above 10 percent in 2010 to 6.0 percent in 2019.²⁹ This is related to the efforts to "rebalance" the economy more towards consumptions, which are showing some early results. On the demand side, before the pandemic, domestic consumption contributed 58 percent to the GDP growth, as of 2019, according to the NBS. However, in the aftermath of the COVID-19 crisis, private consumption recovery has been lagging, which has led to concerns about sluggish household income and insufficient incentives to consume. On the supply side, services accounted for more than a half of 2020 GDP, whereas manufacturing for about 38 percent.

3. Inflation in 2020 was stable, at 2.4 percent. Expansionary fiscal policy to support the economy through the pandemic and a carryover from the 2019 tax reforms led to a deterioration of the fiscal balance to a 11.4 percent of GDP deficit (IMF's definition), while public debt increased to 44.7 percent of GDP.³⁰

²⁸ Income classification and data from the World Bank.

²⁹ See the table for figures. This applies to all other numbers in the document if the source is not specified.

³⁰ Fiscal balance as measured by net lending/borrowing using IMF's definition, which is based on official statistics, but broadens the fiscal coverage to include all four independent components of China's fiscal accounts, namely: general public budget, government funds, Statement of Expenditure budget, and social security (see IMF Country Report No. 2021/006, for more details). On the other hand, according to the narrower official budgetary approach (which includes only general public revenue and expenditure, adjusted for transfers) the deficit was 3.7 percent of GDP. Public debt measured by the general budgetary debt (official definition).

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Selected Economic Indicators 1/	2017	2018	2019	2020	2021	2022
GDP growth 2/ 7/	6.9	6.7	6.0	2.3	8.4	5.6
Inflation 2/	1.6	2.1	2.9	2.4	1.2	1.9
Current account balance 2/	1.6	0.2	1.0	2.0	1.6	1.3
Fiscal balance 2/ 5/	-3.8	-4.7	-6.3	-11.4	-9.6	-8.7
Public debt 3/ 6/	36.2	36.5	38.1	44.7	47.2	49.5
External debt 3/	14.3	14.3	14.3	15.3	15.2	15.5
Gross official reserves (USD billions) 3/	3,236	3,168	3,223	3,579	3,842	4,127
Exchange rate (CNY/USD, end of period) 4/	6.53	6.86	6.98	6.52	6.38	..

Notes: 1/ in percent of GDP; except growth rates which are in percentage changes, average year-on-year; or as indicated otherwise; 2017-20 are actuals (or estimates), 2021-22 are projections, unless noted otherwise

2/ Source is IMF World Economic Outlook April 2021; 3/ Source is IMF Country Report No. 2021/006; 4/ Source is State Administration of Foreign Exchange, for 2021: as of June 2, 2021; 5/ General budgetary balance (IMF definition), measured by net lending/borrowing; 6/ General budgetary debt (official definition); 7/ Actuals for 2017-20 from National Bureau of Statistics database.

4. The current account has been broadly stable. It increased to a surplus of 1 percent of GDP in 2019 due to a decline in imports and a reduction in the primary income deficit. In 2020, current account surplus is likely to have increased further, to around 2 percent of GDP, due to lower commodity prices, the collapse in outbound tourism expenditure, and an unexpected surge of demand for Chinese exports, including pandemic-related goods.

5. Foreign direct investment into China reached record high levels in 2020, making China the biggest FDI destination in the world. Trade surplus combined with strong capital inflows led to a fast exchange rate appreciation. Since early 2020 the RMB has appreciated from around 7.0 to below 6.4 per USD, as of June 2021, which has raised some concerns among policy makers. International reserves have been broadly stable or growing. According to the IMF, reserves are estimated to cover about 16 months of imports, as of 2020, which is more than adequate.

B. Economic Outlook

6. According to IMF projections, China's GDP growth is expected to rebound to 8.4 percent in 2021. In the longer term, the GDP growth rate should continue the smooth and gradual downward trend, along the rebalancing policy. Meanwhile, the pandemic has also revealed risks in the economy, including lagging private consumption, rising financial vulnerabilities as debts have climbed up, and the still uncertain external environment.

7. Regarding external environment, there have been positive signs recently, including the signing of EU-China Comprehensive Agreement as well as the Regional Comprehensive Economic Partnership (ratification is pending). However, uncertainty remains about potential further escalation in trade and geo-political tensions that could lead to higher tariffs and supply chain disruptions. Continued technology decoupling could potentially add to risks.

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8. On the domestic side, there are concerns about increasing financial stability risks related to rising vulnerabilities in the nonfinancial corporate sector (e.g., a significantly increase in debt), the highly leveraged property sector, the likely deterioration of credit quality in the banking sector and about the delay of further progress on financial de-risking.

9. Risks to debt sustainability are relatively contained, as economic growth is robust while debt levels remain manageable. External debt is projected to remain stable in the medium term, at around 15 percent of GDP. As the budget deficit is expected to remain higher than before the pandemic, public debt may continue increasing gradually, to almost 50 percent of GDP in the near term.

10. However, off-budget public investment activities are a source of risk. According to IMF's "augmented" debt definition—that is, including debt of local government financing vehicles likely to be recognized, which amount to almost 40 percent of GDP— public debt in 2020 increased from 80.5 to 91.7 percent of GDP, and is expected to rise further to over 110 percent of GDP in 2025.³¹

11. Still, China's sovereign credit remains strong, at A+/A1 with a stable outlook. This is thanks to the large and diversified economy, positive growth prospects, high degree of government's control over the financial sector (and the economy in general), as well as to debts being almost entirely in the local currency, refinanced at low costs. China's future debt profile will depend on continued economic growth, implementation of fiscal consolidation measures and on the gradual reduction of off-budget activities.

³¹ See IMF Country Report No. 2021/006 for more discussion on the "augmented debt" and the related risks.