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IMPLEMENTATION COMPLETION AND RESULTS REPORT

ON THE

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
LOAN (IBRD-8233-CN) IN THE AMOUNT OF US$100,000,000

AND

GLOBAL ENVIRONMENT FACILITY
GRANT (TF-14205-CN) IN THE AMOUNT OF US$4,345,000

TO THE

PEOPLE'S REPUBLIC OF CHINA

FOR THE

GREEN ENERGY FOR LOW-CARBON CITY IN SHANGHAI PROJECT

July 12, 2019

Energy & Extractives Global Practice
East Asia And Pacific Region

CURRENCY EQUIVALENTS
Exchange Rate Effective April 1, 2019

1 United Stated Dollar ($) = 6.712 Chinese Yuan (¥)

China Fiscal Year: January 1 – December 31
World Bank Group Fiscal Year: July 1 – June 30

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ABBREVIATIONS AND ACRONYMS

BOS	Bank of Shanghai
CO_2e	carbon dioxide equivalent
CPS	Country Partnership Strategy
DG	distributed generation
EA	Environmental Assessment
EE	energy efficiency
EIRR	economic internal rate(s) of return
ESCO	energy service companies
ETS	emission trading scheme(s)
FIRR	financial internal rate(s) of return
FM	financial management
FY	fiscal year
FYP	Five-Year Plan
GDP	gross domestic product
GEF	Global Environment Facility
GEO	Global Environmental Objective
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
IBRD	International Bank for Reconstruction and Development
ICR	Implementation Completion and Results Report
ICT	information and communication technology
IR	Intermediate Results
ISR	Implementation Status and Results Report
MAC	marginal abatement cost
M&E	monitoring and evaluation
MTR	Mid-Term Review
NMT	non-motorized transport
NZE	near-zero emissions
NO_x	nitrous oxides
PAD	Project Appraisal Document
PDO	Project Development Objective
PFI	Participating Financial Institution
PMO	Project Management Office
PV	photovoltaics
RE	Renewable Energy
SME	small and medium enterprise
SO_2	sulphur dioxide
SPDB	Shanghai Pudong Development Bank
TA	Technical Assistance
TSP	total suspended particulates
UNFCCC	United Nations Framework Convention on Climate Change

UNITS OF MEASURE

$	United Stated Dollar
¥	Chinese Yuan
g	gram
k	kilo (1,000)
J	Joule
M	mega (1,000,000)
m	million (following a currency unit)
m^2	square meter
Wh	Watt-hour
t	metric ton (1,000 kilograms)
tce	metric tons of coal equivalent (29.39 gigajoules)
W	Watt (Joule/second)
Wp	Watt peak

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DATA SHEET

BASIC INFORMATION

Product Information

Project ID	Project Name
P127035	Green Energy Schemes for Low-carbon City in Shanghai, China
Country	**Financing Instrument**
China	Investment Project Financing
Original EA Category	**Revised EA Category**
Financial Intermediary Assessment (F)	Financial Intermediary Assessment (F)

Related Projects

Relationship	Project	Approval	Product Line
Supplement	P127034-Green Energy Schemes for Low-carbon City in Shanghai	20-Mar-2013	Global Environment Project

Organizations

Borrower	Implementing Agency
Government of the People's Republic of China	Changning District Government (Shanghai), Shanghai Pudong Development Bank, Bank of Shanghai

Project Development Objective (PDO)

Original PDO

The project development objectives are to pilot green energy schemes and scale up low-carbon investments in buildings in Shanghai, with a focus on Changning district.

PDO as stated in the legal agreement

The objectives of the Project are to pilot green energy schemes and scale up low-carbon investments in buildings in Shanghai, with a focus on Changning District, and the higher-level global environmental objective of the Project is support Shanghai Municipality'slow-carbon city development by promoting green energy schemes, with a focus on Changning District.

FINANCING

	Original Amount (US$)	Revised Amount (US$)	Actual Disbursed (US$)
World Bank Financing			
P127035 IBRD-82330	100,000,000	100,000,000	100,000,000
P127034 TF-14205	4,345,000	4,345,000	4,345,000
Total	**104,345,000**	**104,345,000**	**104,345,000**
Non-World Bank Financing			
Borrower/Recipient	151,655,000	151,655,000	222,255,000
Total	**151,655,000**	**151,655,000**	**222,255,000**
Total Project Cost	**256,000,000**	**256,000,000**	**326,600,000**

KEY DATES

Project	Approval	Effectiveness	MTR Review	Original Closing	Actual Closing
P127035	20-Mar-2013	06-Sep-2013	17-May-2016	31-Dec-2018	31-Dec-2018

RESTRUCTURING AND/OR ADDITIONAL FINANCING

Date(s)	Amount Disbursed (US$M)	Key Revisions
23-Jul-2018	99.75	Reallocation between Disbursement Categories

KEY RATINGS

Outcome	Bank Performance	M&E Quality
Satisfactory	Satisfactory	Modest

RATINGS OF PROJECT PERFORMANCE IN ISRs

No.	Date ISR Archived	DO Rating	IP Rating	Actual Disbursements (US$M)
01	23-Jun-2013	Satisfactory	Satisfactory	0
02	21-Dec-2013	Satisfactory	Satisfactory	0
03	24-Jun-2014	Satisfactory	Moderately Satisfactory	0
04	30-Aug-2014	Satisfactory	Moderately Satisfactory	0
05	20-Mar-2015	Satisfactory	Moderately Satisfactory	1.36
06	17-Dec-2015	Moderately Satisfactory	Moderately Unsatisfactory	3.32
07	30-Jun-2016	Moderately Unsatisfactory	Moderately Unsatisfactory	20.77
08	20-Dec-2016	Moderately Satisfactory	Moderately Satisfactory	40.43
09	23-Jun-2017	Moderately Satisfactory	Moderately Satisfactory	65.50
10	30-Dec-2017	Moderately Satisfactory	Moderately Satisfactory	65.50
11	29-Jun-2018	Satisfactory	Satisfactory	99.75

SECTORS AND THEMES

Sectors

Major Sector/Sector	(%)
Energy and Extractives	**100**
Other Energy and Extractives	100

Themes

Major Theme/ Theme (Level 2)/ Theme (Level 3)	(%)
Urban and Rural Development	**30**
Urban Development	30
Urban Infrastructure and Service Delivery	30

Environment and Natural Resource Management	**70**
Climate change	60
Mitigation	60
Environmental policies and institutions	10

ADM STAFF

Role	At Approval	At ICR
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I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

A. CONTEXT AT APPRAISAL

Context

1. **The Green Energy for Low-Carbon City in Shanghai Project was appraised from September 2012 to January 2013.[1] At that time, the Government of China was pursuing broad efforts to reduce air pollution, mitigation climate change, and increase energy security.** Recognizing the threats posed by unabated consumption of fossil fuels, especially coal, the Government set targets to limit emissions of carbon dioxide and other pollutants as part of national development plans. Specifically, the Government had committed to reduce the carbon intensity of its economy[2] by 40 to 45 percent by 2020 compared to 2005 levels. Energy efficiency (EE) and renewable energy (RE) were expected to contribute significantly to this. Higher-level targets included to cut the energy intensity of the economy by 16% over the 12th Five-Year Plan (FYP) period of 2011 to 2015, and to increase the share of non-fossil fuels in primary energy from 8 to 15% from 2011 to 2020.

2. **Cities were at the core of the Government's climate action plan.** Cities accounted for 85 percent of China's commercial energy use, and their importance was set to increase with rapid urbanization underway. It was estimated that over the coming two decades energy demand and related carbon emissions from buildings and appliances would triple and those of transport would more than quadruple as the vehicle fleet would increase ten-fold. The speed and scale of urbanization provided an unprecedented opportunity to invest in clean energy technologies to contain emissions related to energy supply and consumption. Introducing efficient low-carbon technologies into new urban infrastructure today would avoid locking cities into a high-carbon growth path for decades to come. China's *12th FYP for Energy Conservation and Emissions Reduction*, issued in August 2012, set several targets to promote low carbon development in the building sector: increase the implementation rate of new green building standards by 14% and reduce the per capita energy consumption of public buildings by 15% by 2015 compared to 2010 levels.

3. **Shanghai Municipal Government and Changning District Government were committed to low-carbon city development.** In Shanghai, consumption-related GHG emissions per person were relatively high by national and international standards. Priorities under Shanghai's *12th FYP for Energy Conservation and Climate Change,* issued in March 2012, included to strengthen energy-saving monitoring and management systems; accelerate the development of energy saving and low carbon transportation; and promote low-carbon buildings. Shanghai was also to be one of the first of five cities and two provinces in China to pilot carbon emissions trading schemes (ETS). Changning District, a well-established commercial and residential urban area in Shanghai's inner west, had a population around 600,000. With relatively little industry compared to some of Shanghai's 15 other districts, buildings were estimated to contribute as much as 90% of total final energy consumption in Changning.

4. **Changning saw green growth as a way to become competitive and was willing to pilot bold policies and incentives not yet implemented at municipal or national level.** In 2007, Changning had established the first online platform to monitor energy use for public buildings in Shanghai. This became a model for replication in all other districts as mandated by the Shanghai Municipal Government in 2012. Expanded coverage was expected to address performance risk by allowing the monitoring and verification of consumer behavior and management of building energy systems. The municipal and district governments had also dedicated funds for energy conservation and emissions reduction activities

[1] The title as given is from the Loan Agreement and Project Appraisal Document (PAD). In some documents it is given as: 'Green Energy Schemes for Low-Carbon City in Shanghai'. The title in Chinese project documents (上海绿色能源建设低碳城区项目) translates to 'Shanghai Green Energy Construction Low-Carbon City District Project'.

[2] Carbon intensity means greenhouse gas (GHG) emissions per unit of gross domestic product (GDP).

to achieve various targets including in the building sector. In January 2013, Changning District Government issued "Low-Carbon Development Special Funds Management Measures" to provide subsidy incentives for building retrofits. See Annex 4 for further details of relevant municipal and district policies.

5. **Shanghai and Changning sought to benefit from international knowledge and best practice to accelerate and enhance the quality of their low-carbon urban development initiatives.** To this end the Municipal and District Governments together requested a concessional loan from the International Bank for Reconstruction and Development (IBRD) to finance low-carbon investments in buildings and a Global Environment Facility (GEF) grant for technical assistance and capacity building. The resulting project was to be an important and integral part of Changning's emission reduction program.

6. **From the outset, the municipal and district governments sought to lower their carbon intensity through an innovative, holistic, multi-sector approach.** In early 2012, ahead of project design, Changning District Government had commissioned a local energy conservation institution to identify available emissions reduction options in the Hongqiao Demonstration Zone as a representative part of the District. Some 58 interventions were evaluated in the areas of buildings and transport including technologies, behavior change, and training. Whereas land-use planning is also key to low-carbon urban development in general, this was less relevant to Changning since it was already fully urbanized. The analysis provided data to develop marginal abatement cost (MAC) curves, and to prioritize interventions based on abatement potential, cost, and ease of implementation. Alternative abatement scenarios were developed including a Baseline Scenario equivalent to existing 12th FYP targets, and a Stretch Scenario of greater ambition implementing more of the identified measures. Use of these analytic techniques to define priority interventions was considered novel in China at the time and provided the foundation for project design.

7. **A key conclusion of analysis at appraisal was that most emission reduction potential in Changning was in building retrofits, though these faced distinct barriers.** Building retrofits, especially of commercial buildings, would contribute more than half of the estimated potential reduction of emission in Changning. Smaller shares of abatement potential would come from new power sources, new building measures, and transport. Retrofitting buildings would have wide replication potential in China, but the single largest barrier was that owners were reluctant to invest in EE measures. The reluctance stemmed from several factors: (a) energy costs were a small share of building operating costs; (b) building retrofit investments usually had long payback periods; (c) building retrofits may disrupt building users and thus lead to foregone rent; and (d) building managers and users faced split incentives. For example, a building manager or owner have little direct incentive to invest in EE measures when they can simply pass on the costs of energy consumed to tenants who pay the bills. In addition, the benefits of energy efficient buildings for users may not be reflected in rent levels due to unequal information, further complicated by the fact that many buildings have multiple owners. Policy barriers included the lack of any energy efficiency requirements for existing buildings, as building code requirements applied only to new buildings. In addition, a shortcoming of China's building code was that it was not directly linked to energy savings or emissions reduction targets. Prevalent business models were not good at bundling small projects together to reduce transaction costs. In addition, uncertainties of building user behavior and energy management systems created a performance risk, and most service companies specialized in EE measures had weak balance sheets. These factors made it difficult for project developers to access finance for building EE projects.

Theory of Change (Results Chain)

8. **The project involved grants and loans to support the piloting of green energy schemes and scale-up of low-carbon investments in buildings with a view to reducing greenhouse gas emissions.** The concepts of 'green energy schemes' and 'pilots', while not expressly defined in project documents, can be understood from the description of activities and outcomes in the PAD. On this basis, green energy scheme refers to a policy, financing mechanism, business model, technology application, or infrastructure program leading to reduced energy consumption and reduced use of

high-carbon energy. Piloting is understood as an initial, small-scale version of an activity to test or refine its features ahead of potential full-scale implementation. In general terms, pilot activities may thus help to demonstrate the viability of a scheme, provide insights to inform decisions on whether or how to proceed with a scheme in some form, and remove barriers to scale-up.

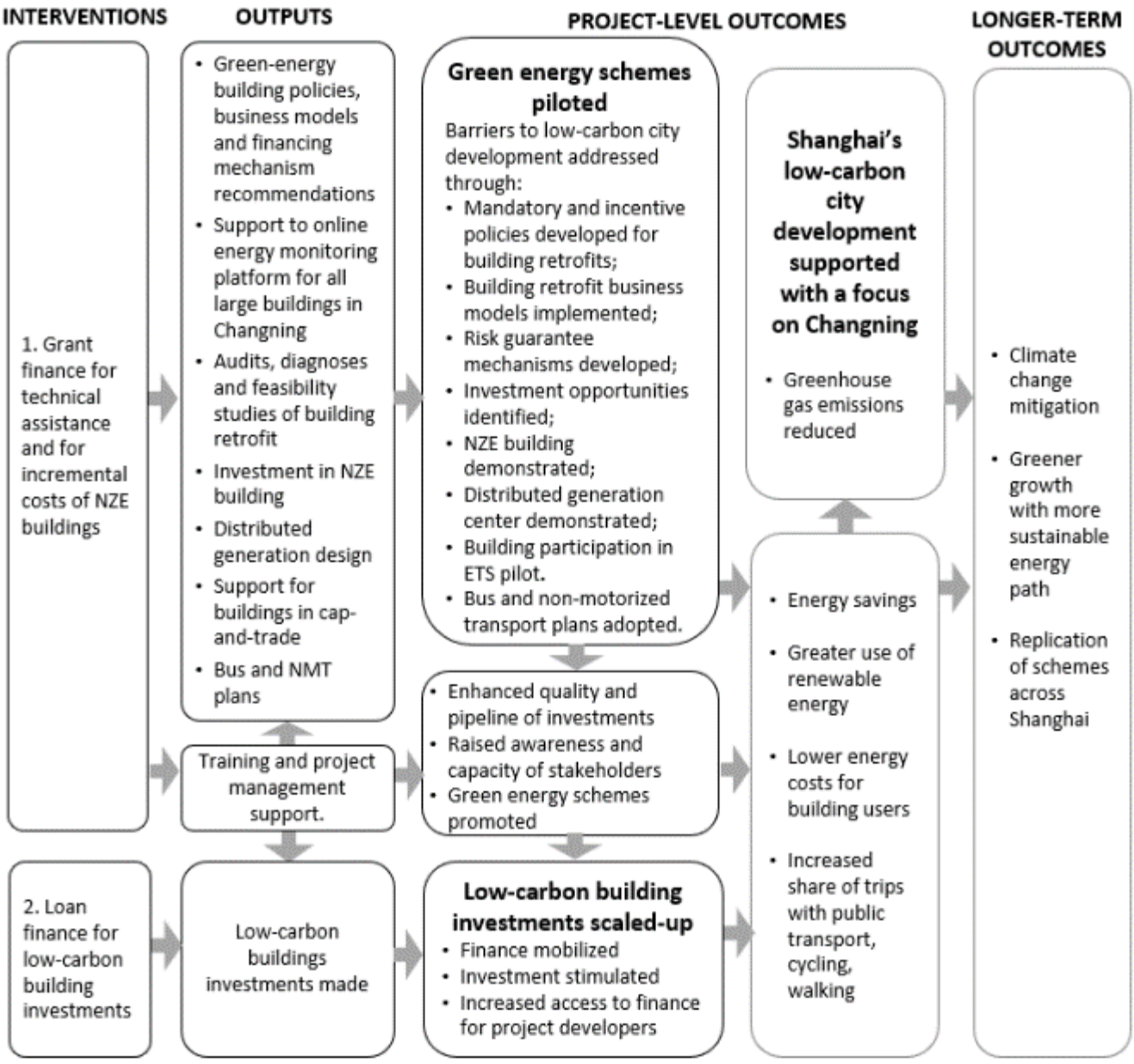
9. **The project's focus on Changning District entailed a focus on building retrofits.** Informed by the prior analysis mentioned above, the bulk of activities would be in the building sector especially on retrofits. It was estimated that 93% of total project costs and 95% of emissions reduction would be associated with building retrofits (PAD page 75). The expected range of demand-side building EE technologies would span lighting, heating, ventilation, and air conditioning (HVAC), insulation, envelope, and energy management systems. The 'pilot' character of schemes for building EE would come from innovative policies to benchmark performance and mandate retrofit of inefficient buildings, business models to bundle many small projects, and a risk guarantee mechanism to facilitate financing. Data to inform the design and implementation of such policies and mechanisms would be provided by audits and feasibility studies but moreover by advancement in functions of an online monitoring platform. Support for a new near-zero emission (NZE) building would demonstrate its technical and commercial feasibility and drive down costs through the technology learning curve. A technical study as part of project preparation demonstrated that lighting and HVAC-related emissions of only 12 kilograms CO_2/year/m^2 was possible compared to over 100 kg CO2/year/m^2 for a typical commercial building in Shanghai. If successful, the government and developers were expected to replicate an NZE building with their own funds. The project would also support the participation of buildings in Changning in Shanghai's forthcoming ETS, which was itself a policy pilot to inform a future nation-wide ETS.

10. **Reducing building demand for energy would be complemented by low-carbon energy supply and transport interventions.** Distributed generation (DG) activities would include on-site production of electric, thermal and other types of power from solar and from natural gas. Grid-connected distributed electricity generation was still fairly novel in China at the time, as was the use of natural gas for combined power outputs of power, heating, cooling, and compressed air in a non-industrial distributed application. Transport-related activities would study the feasibility of new ways to promote buses and non-motorized transport (NMT)—walking and cycling—through improved infrastructure systems such as lane design and bus routes, resulting in increased share of trips without cars.

11. **Grant-financed activities were designed to directly and indirectly facilitate low-carbon investments and associated outcomes.** Grants would be administered by a Project Management Office (PMO) in the Changning District Government for: technical assistance to pilot green energy schemes; sub-grants for incremental costs of NZE buildings; training to build the capacity of stakeholders; and support for program management. In parallel, an IBRD loan would leverage co-financing from two participating financial intermediaries (PFIs), the Shanghai Pudong Development Bank (SPDB) and Bank of Shanghai (BOS). Each would finance investments in building EE and low-carbon distributed energy resources, matching the amount of a respective IBRD loan allocation for low-carbon investments, and competing between the two of them for a remaining share of IBRD loan based on whichever PFI got contracts in place first. As private commercial banks, the PFI's on-lending rates would be based on market conditions to provide a reasonable profit margin. Financial intermediaries were considered better placed than the government to manage investments given their potential to sustain access to finance through new business lines. The links between grant- and loan-financed activities, outputs, and outcomes are illustrated in Figure 1. In particular, grant-financed activities would: (a) support policies to overcome barriers and increase market demand and uptake of the IBRD loan; (b) support pre-investment studies and due diligence review for loan-financed investments; (c) build capacity of various stakeholders, particularly the participating banks and the government officials, to facilitate project implementation; (d) facilitate measurement and verification of energy savings achieved through the investments; and (e) ensure sustainability and replication of the low-carbon investments and other green energy schemes to a large scale. One result would be that project developers have increased access to

finance for building EE. All project activities would be coordinated by two interagency committees, one at municipal level with responsibility including to promote scheme replication, and one at district level.

Figure 1: Results Chain



Source: ICR authors based on PAD. NZE = near zero-emissions. ETS = emissions trading scheme. NMT = non-motorized transport.

12. **Piloting schemes and scaling-up investments focused on the best abatement opportunities in Changning would help to decouple GHG emissions from local economic growth.** Reducing total energy demand from buildings and increasing use of distributed low-carbon energy would reduce the need to supply grid electricity, which in China comes mostly from coal-fired power plants. As such, less grid electricity would need to be generated compared to what would be expected under a counterfactual scenario without the project. This, and low-carbon transport in place of fossil fuel-

powered vehicles, would contribute to reduced GHG emissions. By targeting interventions in the building sector with the largest mitigation potential in Changning, aided by online monitoring of all major buildings in the District, project activities should have an observable impact on Changning's energy-related GHG emissions. Concurrent benefits of lower energy costs for businesses would support continued economic growth.

13. **Schemes promoted in Changning could be replicated across Shanghai.** This would occur with knowledge sharing among municipal-level government, finance and building-sector stakeholders through capacity building, dissemination activities, and the functions of coordination committee. As a higher-level impact, it was estimated that replicating outcomes from Changning to Shanghai could result in cumulative energy savings of 21.4 million metric tons of coal equivalent (tce) and 46.3 million t CO_2 over the assumed 20-year lifetime of investments (PAD page 75). Reducing emissions in this way would contribute to China's broader agenda of low-carbon city development, green growth, and addressing climate change.

14. **The project design rested on some key assumptions.** These include that: (a) analysis and accompanying institutional arrangements would ensure that pilot low-carbon city schemes were both technically and politically feasible; (b) Changning Government would commit to mechanisms recommended by project-financed studies; (c) the participating financial intermediaries, supported by new mechanisms, would be able to overcome long-standing barriers to improving building EE in particular the reluctance of building owners to retrofit; and (d) impacts would be observable within the project implementation period.

Project Development Objectives (PDOs)

15. The Loan Agreement states that "the objectives of the Project are to pilot green energy schemes and scale up low-carbon investments in buildings in Shanghai, with a focus on Changning District, and the higher-level global environmental objective of the Project is to support Shanghai Municipality's low-carbon city development by promoting green energy schemes, with a focus on Changning District." The project development objectives (PDOs) and global environment objective (GEO) were similarly stated in the PAD, though in the PAD the GEO was listed first.

Key Expected Outcomes and Outcome Indicators

16. **Assessment of outcomes is organized in terms of two PDOs and the GEO.** The two PDOs are: (a) pilot green energy schemes; and (b) scale up low-carbon investments in buildings. The GEO—supporting Shanghai's low carbon-city development—is included in the assessment as it forms part of the Loan Agreement's statement of objectives. All three objectives pertain to Shanghai with a focus on Changning District. The focus on Changning implies a focus on building retrofits as the leading measure identified for reducing emissions in Changning. This focus is interpreted qualitatively rather than quantitatively. The results framework provides flexibility as to whether the pilot schemes and low-carbon investments occur in Changning and whether they involve building retrofits versus other types of investments. For each PDO and the GEO, the corresponding outcomes and associated indicators are listed in Table 1 and summarized below. The project was conceived as an integrated part of the overall low carbon program implemented by Changning District, so it is important to consider the outcomes as a set. According to legal agreements, progress toward objectives was to be assessed using indicators in the Operation Manual and Implementation Plan dated September 12, 2012. Indicators in the Implementation Plan are similar in intent and coverage to the PAD Results Framework. See Annex 1 for the complete list and comparison of all indicators. The PAD Results Framework was used for reporting by the PMO and Bank team throughout implementation, and is used here for assessment as it best reflects the achievement of objectives.

17. **For PDO 'A', the outcome of '*pilot of green energy schemes*' contributes to other outcomes and is reflected more directly by Intermediate Results (IR) Indicators.** There is no specific overall indicator for pilot schemes. IR Indicators 1, 3, 4, 5, and 6 correspond to five types of green energy scheme to be piloted under the project, namely: innovative

policies; NZE building; innovative financing mechanisms; distributed generation center; and NMT. Building retrofits are the focus of the innovative policies and financing mechanisms indicators. Taken together, the five IR Indicators can be used to assess the extent of green energy schemes piloted as the outcome of PDO 'A'. For each of the relevant IR indicators, the end target value is "completed". Completion of innovative policies would mean that study recommendations were adopted and a policy issued by the District Government with implementation support from the Project. Completion of a demonstration NZE building, DG center, and NMT system intuitively involve physical works. The ETS can be considered as an additional pilot scheme as presented in Loan Agreement activity description. The Implementation Plan included an indicator for completion of an ETS study by the end of 2013.

18. **For PDO 'B', the outcome of '*scale-up of low-carbon building investments*' is reflected in IR Indicator 7 and PDO Indicators 2 and 3**. IR Indicator 7 measures the scale of low-carbon investments, with an end target of $246 million. The target value is equivalent to the estimated cost of subprojects that would receive loan support under Component 2. As such it does not necessarily count the contribution of subprojects that would receive only grant-support under Component 1, which could also be considered investments in low-carbon buildings. All project investments were expected to reduce emissions by reducing total energy consumption and by deploying low-carbon distributed energy generation systems to replace demand for grid electricity relative to a scenario without the project. Distributed generation occurs as part of the built environment so such investments are also considered a type of low-carbon investment in buildings, consistent with the wording of PDO 'B'. PDO indicator 2 indicates the annual energy savings supported by the investment under the project with an end target value of 76,000 tce, based on an assumed average ¥20,000 investment cost per tce annual energy savings. This indicator includes avoided consumption of grid electricity resulting from distributed generation as a gross saving. PDO Indicator 3 measures the associated scale of CO_2 emissions reduced. Its target value of 165,000 t CO_2 was based on an assumed rate of 2.166 t CO_2 emissions reduction per tce annual energy savings, using emissions factors for Shanghai. The target value for PDO Indicator 3 is equivalent to 77% of the emissions reduction by mid-2018 under a Stretch Scenario for Changning District versus the Baseline Scenario.

19. **For the GEO, the outcome of *'support to Shanghai's low-carbon city development'* is assessed as a higher-level outcome.** This is understood as meaning an impact of project activities that is less direct or longer-term. The PAD Results Framework denotes a specific GEO indicator with an end target value to be achieved nevertheless by mid-2018. Whereas the emissions reductions target of PDO Indicator 3 was equivalent to covering all buildings in Changning, the logic implied by the GEO Indicator is that project investments and schemes would have a measurable impact on the carbon intensity of Changning's economy. In this way, the GEO indicator integrates PDO 'A' and 'B' to demonstrate the achievement of Changning's low-carbon program. The GEO Indicator target was for the carbon intensity of Changning's economy to reach 77.4% of its 2010 level. This target is more conservative than the 73.5% value under the Baseline Scenario analyzed at appraisal and the 65% value under the Stretch Scenario.[3] The means of achieving the GEO is specified as promotion of green energy schemes. Promotional activities are not measured in the Results Framework but are implicitly part of the Component 1 design.

[3] The GEO Indicator target is based on the 12 FYP target of 17% carbon intensity reduction from 2010 to 2015, plus a nominal 13% reduction from 2015 to 2020 or 6.7% from 2015 to mid-2018 (i.e. 2.68 percent points/year in terms of 2015 levels). According to the analysis at appraisal, Changning's carbon intensity expressed as a share of the level in 2010 could fall by mid-2018 to 73.5% under a Baseline Scenario consistent with 12th FYP targets (83% in 2015 extended to 64% in 2020 at a rate of 3.8 points/year in terms of 2010 levels), and to 65.0% under a Stretch Scenario (77% in 2015 and 57% in 2020 at a rate of 4 points/year). The difference between baseline and Stretch scenario would be 197,500 tons CO_2 emission reduction at mid-2018. See the PAD pages 22 and 50-52 for details of the analysis and target methodology.

Table 1: Key expected outcomes and outcome indicators

Outcome	Relevant outcome indicators from the Results Framework	Remarks
PDO 'A': Pilot of green energy schemes	• IR Indicator 1: 'Innovative policies piloted under the Project in relation to green-energy retrofitting of buildings'. Target: Completed by fiscal year (FY) 2016. • IR Indicator 3: 'At least one near zero-emission building piloted under the Project'. Target: Completed by FY2018. • IR Indicator 4: 'Innovative financing mechanisms developed under the Project for green-energy retrofitting of buildings'. Target: Completed by FY2016. • IR Indicator 5: 'At least one distributed generation center built under the Project'. Target: Completed by FY2018. • IR Indicator 6: 'Non-motorized transport system piloted under the Project'. Target: Completed by FY2017.	There is no overall indicator for PDO 'A'. Instead, IR Indicators 1, 3, 4, 5 and 6 are taken together as indicating the extent of green energy schemes piloted.
PDO 'B': Scale-up of low carbon investments in buildings	• IR Indicator 7: 'Low-carbon investments supported under the Project'. Baseline: zero. End target: $246 million by FY2018. • PDO Indicator 2: 'Annual energy savings supported by the investments under the project'. Baseline: zero. End target value: 76,000 Tons of coal equivalent. • PDO Indicator 3: 'Annual carbon dioxide emission reduction supported by the investments under the Project'. Baseline: zero. End target value: 165,000 tons CO_2.[4]	93% of accounted project costs and 95% of CO_2 reductions were expected from retrofits.
GEO: Support of Shanghai's low carbon city development by promoting green energy schemes	GEO Indicator: 'Accumulated carbon intensity per unit of GDP in Changning District'.[5] Measured as a percentage of the value in 2010. Baseline value of 100 percent. End target value of 77.4% to be achieved by mid-2018.	End-target value is conservative relative to the baseline scenario.

Components

20. The project comprised two components per the Loan Agreement and PAD, as described below. Total costs were estimated at $256 million. Actual costs were $369.89 million.[6] For a breakdown of costs by sub-component, see Annex 3.

21. **Component 1: TA and Incremental Support for NZE Buildings.** Component 1 was estimated to cost a total of $10 million including the GEF grant of $4,345,000 and the remainder from the Changning District Government and project developers for green energy buildings. The actual cost was $37.57 million including the $4,345,000 GEF Grant, District Government grants equivalent to $13.83 million, and the remaining $19.39 million from project developers.[7] The component would comprise four sub-components as follows.

22. **Sub-component 1.1 Green energy buildings.** This would involve: (i) provision of TA to and capacity building of Changning District for implementation of energy efficiency and renewable energy technologies in existing buildings and covering part of the incremental cost of a new pilot near zero-emission building; and (ii) demonstration of at least one

[4] The PDO Indicator 3 unit of measure is sometimes given, incorrectly, as tons of coal equivalent (e.g. PAD page 20).

[5] The GEO indicator, also called PDO Indicator 1 in the PAD, is understood as 'carbon intensity of the economy in Changning District'. The denominator 'per unit of GDP' is already embodied in the concept of 'carbon intensity' defined as energy consumption-related CO_2 emissions per unit of GDP. This indicator includes all major sources of energy consumption, including from transport.

[6] Actual values in US dollars are converted from Chinese Yuan using the exchange rate of 6.5795 ¥/$ per project cost accounting in Annex 3.

[7] The actual contribution of project developers is derived from Component 1 subproject costs less government subsidies as listed in Annex 5.

NZE building in Changning District. More specifically, the sub-component funds would be used to: (i) develop performance-based building energy efficiency benchmarks in kWh/m^2 for additional types of buildings and mandatory policies; (ii) recommend business models and financing mechanisms; (iii) undertake energy audits, diagnostic and feasibility studies for comprehensive building retrofit to achieve deep emission reductions; and (iv) support the online energy monitoring platform for measurement and verification of energy savings.

23. **Sub-component 1.2 Low-carbon energy supply.** This sub-component was to involve: (i) technical design of a pilot distributed generation center in Changning District using RE and/or natural gas; and (ii) TA to design and implement pilot participation of buildings under the city's cap-and-trade scheme including through purchase of 'green electricity'.

24. **Sub-component 1.3 Green mobility**. This sub-component was to involve TA for: (i) plans to improve 'last mile' connectivity between subways stations and commercial buildings; and (ii) designs to facilitate NMT infrastructure and services such as integrated optimization of bike lanes, walkways, traffic signals, etc.

25. **Sub-component 1.4 Capacity building and project management support:** This sub-component would involve: (i) support for due diligence reviews and promotion of low-carbon investments; (ii) capacity building of key stakeholders, particularly the participating banks, government officials, and project developers; and (iii) program management costs, donor coordination activities, and administration including fiduciary duties.

26. **Component 2: Low-carbon Investments.** The estimated cost of this sub-component was $246 million including $100 million IBRD loan on-lent to two private banks, the Shanghai Pudong Development Bank (SPDB) and Bank of Shanghai (BOS), matched by their own debt financing of $50 million each, plus a total of $46 million in equity from project developers. The actual cost was $332 million including the full IBRD loan and greater-than-expected counterpart financing equivalent to $116.93 million from the participating banks and $115.40 million from project developers. At appraisal, the majority of investments ($231 million) were intended to be made in green-energy retrofitting of buildings (Sub-component 2.1). These would involve EE improvements in commercial and government buildings such as lighting, HVAC systems, energy management systems, envelope insulation measures, and DG from solar and from natural gas for electric power, cooling, and heating services to buildings. In addition, a portion of the IBRD loan proceeds ($15 million) would be used for low-carbon technologies in new green-energy buildings beyond the requirements of the municipal building code (Sub-component 2.2). According to the PAD and Operational Manual at appraisal, the project would finance only the incremental costs for new building measures, to be calculated through computer modeling. In implementation, Component 2 costs included equivalent to approximately $46 million for building EE retrofits (some with small-scale DG), $143 million for large-scale DG on site at existing buildings, and $126 in new building EE measures.[8] The latter amount includes total costs of approved high-efficiency technologies in new buildings, which is estimated to be $68.8 million more than their incremental cost as compared with traditional low-efficiency measures.

B. SIGNIFICANT CHANGES DURING IMPLEMENTATION (IF APPLICABLE)

Revised PDOs and Outcome Targets

27. The PDOs and targets, PDO Indicators, and components remained unchanged during implementation.

Revised PDO Indicators

28. The PDO Indicators remained unchanged during implementation.

[8] Actual costs of retrofits, DG and new buildings, from the data in Annex 5, sum to $315 million at the exchange rate of 6.5795 ¥/$. The given total component cost of $332 million is higher due to adjustments made after auditing and use of different exchange rates.

Revised Components

29. The components remained unchanged during implementation other the adjustments to subcomponent activities as described below.

Other Changes

30. **Some activities and eligible costs were adjusted during implementation.** The technical criteria for Sub-Component 2 in the Operation Manual were amended at mid-term review to allow financing of the total cost of approved high-efficiency technologies for new buildings, rather than the incremental cost as compared to traditional low-efficiency measures. Meanwhile, a new subcomponent activity was added: design of pilot low-carbon community plans for a block of buildings and a neighborhood in Changning District. The following activities were dropped: support to pilot building participation in ETS; and planning schemes to improve connectivity between metro stations and commercial buildings. The latter was one of two transport-related activities, and the other NMT activity remained unchanged. Technical design of a pilot DG center in Changning District received complementary funding by the Energy Foundation as another development partner of the District Government. Equivalent work was supported for investment subprojects under Component 2. These changes did not require project restructuring other than a reallocation of funds as described below.

31. **Reallocation of Funds.** The project was restructured in June 2018 upon the Government's request for the purpose of reallocating amounts between grant disbursement categories for Component 1, as shown in Table 2.

Table 2: Reallocation amounts between grant disbursement categories following a Level Two restructuring

	Original Expenditure Category	Original Allocation	Revised Allocation	Change	Revised as share of original
1.	Goods, non-consulting services, consultants' services (including for audits), and training	$2,745,000	$3,692,000	+ $947,000	135%
2.	Green energy building sub-grants	$1,500,000	$600,000	- $900,000	40%
3.	Operating costs	$100,000	$53,000	- $47,000	53%
	TOTAL	$4,345,000	$4,345,000	$0	100%

Rationale for Changes and Their Implication on the Original Theory of Change

32. **The above changes to grant category allocation and pilot energy scheme subcomponents reflected evolving circumstances.** The changes did not have any significant implication on the overall theory of change or the overall achievement of the objectives.

- Activities for ETS participation proved to have limited demand as the number of buildings participating in Shanghai's pilot ETS dropped during the implementation period. This was due to: lack of benefits compared to the perceived costs; uncertainty in context of the emerging national ETS that would initially focus on the power sector rather than buildings; and oversupply of offsets under the China Certified Emissions Reduction program relative to demand; and indications that a renewable energy purchase obligation would be developed by the central government, superseding Shanghai's green electricity scheme. Under parallel operations of the Partnership for Market Readiness and China RE Scale-Up Program the World Bank remained engaged with national and subnational government authorities on ETS design and renewable energy quota scheme design.

- The need to improve connectivity between metro stations and commercial buildings was met early on during the Project implementation period by the advent of multiple popular bicycle-sharing schemes offered at cheap rates by private companies.
- Meanwhile, substantial cost savings were realized for both the pilot NZE building and for operational costs. This provided a rationale for reallocation of grant disbursement category amounts, and the savings provided an opportunity for the Project to use the Grant funds more effectively and expand the impacts of the Project. The savings were used to support new low-carbon community activities.
- Modelling to calculate incremental costs of new energy efficiency measures in new buildings case by case proved difficult due to the skills, data and time required. Financing for the total cost of approved high-efficiency specific technologies in new buildings was allowed after the mid-term review as a practical refinement of the technical eligibility criterion for Sub-Component 2.

II. OUTCOME

A. RELEVANCE OF PDOs

Assessment of Relevance of PDOs and Rating

Rating: *High*

33. **The PDOs were and have remained relevant to priorities and goals of the Government of China at all relevant levels, the World Bank Group, and the Global Environment Facility.** Improving energy efficiency of buildings and scaling-up renewable energy contribute to high-level priorities air pollution reduction, climate change mitigation, and energy security. These priorities are identified in the 12th FYPs for the period 2011 to 2015 and subsequent 13th FYPs for 2016 to 2020. The 12th and 13th FYPs set targets to reduce energy intensity and carbon intensity at national, municipal and district levels. Under China's 13th FYP program for energy efficiency and emissions reduction (PRC 2017), key targets for the building sector include, for example, increasing the implementation rate of new green building standards by 30% and reducing the per capita energy consumption of public institutions by 11% by 2020 compared to 2015 levels. Low-carbon city development in Changning and its replication and municipal level and beyond would contribute to meeting these targets. Carbon intensity reduction is consistent with China's 2013 National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) and its later nationally-determined contribution to the UNFCCC Paris Agreement made in 2015, as well as United Nations Sustainable Development Goal 7 to ensure access to affordable, reliable, sustainable and modern energy for all, also adopted in 2015.

34. **The PDOs are fully consistent with the World Bank Group Country Partnership Strategy (CPS) FY2013-2016 for China.** The CPS supported 'greener growth, in particular, 'shifting to a sustainable energy path'. These priorities were reaffirmed in the CPS Performance and Learning Review discussed by the World Bank Board in February 2016. The PDO remained relevant for the World Bank Group's corporate commitment to increasing energy efficiency and renewable energy lending and addressing climate change.

B. ACHIEVEMENT OF PDOs (EFFICACY)

Assessment of Achievement of Each Objective/Outcome

Rating: *Substantial.*

35. **The project fully achieved its objectives, notwithstanding minor shortcomings, and the results are attributable to the project.** Outcomes are assessed in terms of the two PDOs, namely: (a) pilot of green energy schemes; and (b) scale-

up of low-carbon investments in buildings; as well as the higher-level GEO to support low-carbon city development, pertaining to Shanghai with a focus on Changning District. The assessment refers to relevant indicators from the Results Framework for each objective and outcome, noting the relationships identified in Table 1 above, as well as additional evidence of expected outcomes described as follows and summarized in Table 3 below.

Project objective 'A': Pilot of green energy schemes

36. **The project achieved significant results in pilot green energy schemes.** For four of the five relevant indicators, targets were fully achieved with high attribution to the Project, namely: 1 (innovative policy on retrofitting) albeit later than intended; 3 (near-zero emissions building); 5 (distributed generation center); and 6 (non-motorized transport). The result under IR Indicator 4 (innovating financing mechanism) was not achieved. Additional green energy schemes were piloted beyond the results framework, including to improve the online energy monitoring platform. Each of these points is elaborated below.

37. **Changning District Government issued two relevant policies in 2018.** The first was "Low-Carbon Development Special Funds Management Measures" issued in June 2018 to update the previous 2013 version. This was prepared by the PMO and included incentives for new NZE buildings and for demand response. The update drew on experience gained from implementation of the 2013 version during the project implementation period. The second policy was "Public Building Energy Efficiency Benchmarking Management Measures", issued in October 2018, building on recommendations of a project-supported study completed in 2017. The latter is considered a breakthrough as it is the first "mandatory policy" for public building energy performance benchmarking in Shanghai. However, the relatively late adoption of the policies meant that their impact on building performance and investments could not be observed at project closing.

38. **As a pilot scheme in its own right, the Project greatly improved the online building energy platform's functions to assess, manage, monitor and verify energy performance and efficiency opportunities.** Improving the quality of the platform was a key component of the project design, and the platform has demonstrated the power of advanced monitoring systems to reveal savings opportunities for participating buildings and for the sector at large. For the 187 participating buildings in Changning, covering 9 km^2 the platform reveals opportunities for managers to optimize system operation and maintenance, and to verify the effect of measures taken from day to day and year to year. For the District Government, the platform allowed policymakers and regulators to monitor and verify energy performance of buildings for participation in Changning's innovative subsidy and benchmarking programs. Changning was the first jurisdiction to establish such a platform and similar platforms were since established in most of districts of Shanghai and in Shanghai at municipal level, all based on the Changning model. Policies issued by the Shanghai and Changning governments in 2018 refine the administration of energy monitoring systems including for benchmarking purposes (see Annex 4).

39. **A new financial mechanism was not developed as intended.** The PAD identified guarantees as a proposed mechanism to mitigate risks of lending to small and medium enterprises (SMEs). Despite interest in guarantees from SPDB and BOS, the District Government was unwilling to offer guarantees having experienced a developer default in 2013 unrelated to the Project. The PFIs retained their existing ranges of products rather than developing any new instrument. Nevertheless, SPDB and BOS successfully implemented a systematic approach to originate loans involving a three-level hierarchy of headquarters, branches, and retail outlets. They also decreased the technical uncertainties associated with loans for building retrofits through the TA and capacity building for sub-borrowers. Together these increased access to financing and bankable projects.

40. **Demonstration of a NZE building retrofit surpassed expectations.** The NZE building was successful given: (a) a clear target oriented (25 kg CO_2/m^2) across the full cycle of the NZE building pilots; (b) full cycle project management and monitoring across building design, construction and operation; and (c) dissemination to expand the beneficiaries. The Project pioneered holistic processes to design, construct and operate the retrofit of Hongqiao State Guest Hotel Building

9 to near-zero emissions standard winning the acclaim of national and international governments and private sector bodies. The approach has been replicated for a new building at 191 Neijiang Road Yangpu District Shanghai with even better performance (10 kWh/year/m^2 compared to Shanghai building average range of 70-165 kWh/year/m^2), and at much lower cost.

41. **The Project also exceeded expectations with respect to innovative distributed energy resources systems and low-carbon community planning.** The Project provided financial support to distributed combined heat and power generation systems in three subprojects and to distributed PV in five other subprojects. The Project also supported the design of smart distributed energy resource systems for one complex, and comprehensive low-carbon community schemes for two locations, all involving distributed PV. The low-carbon community planning can be considered a further pilot green energy scheme successfully supported by the Project, and not measured by the Results Framework. The community planning involves a comprehensive set of indicators covering all aspects of community resource consumption along with benchmarks to prioritize actions.

42. **The Project financed design of three non-motorized transport areas which are being implemented as part of an overall plan for Changning district.** While the focus of the project is to support buildings, the project also supported low-carbon transport as another type of pilot green energy scheme. In these areas, the purpose of different roads has been clarified to optimize and balance diverse uses, and the design of intersections, traffic signal timing, road features, and sidewalks have also been improved to prioritize pedestrians and cyclists in an integrated manner. Studies available at completion predict predicted improvements by indicators such as fuel consumption, waiting times, and share of non-motorized trips. The plans were at more or less advanced stages of implementation at project closing.

Project objective 'B': Scale-up of low-carbon investments in buildings

43. **The Project scaled-up low-carbon investments in buildings beyond target values.** The scale of investments per IR Indicator 7 is evaluated first by counting subprojects that received loan-support under Component 2, consistent with the basis for setting the target at appraisal. Under Component 2, the IBRD loan was fully disbursed and combined with loan financing from the PFIs and equity from project developers to total investment equivalent to $332.2 million for 41 low-carbon building sub-projects.[9] Eight of these were retrofits that also received Changning District Government subsidies equivalent to around $2.1 million. The amount invested, excluding subsidies, exceeds the $246 million target value by 35%. As previously noted, the $332.2 million includes new building energy efficiency measures with an estimated $68.8 million of costs beyond the incremental cost as compared with traditional low-efficiency measures. If counting only $263.5 million equivalent to only incremental costs as expected at appraisal at given exchange rates, the investment target would be 7 percent above the IR Indicator 7 target and thus can still be considered as met. Moreover, under Component 1, another 26 subprojects received Changning District Government subsidies equivalent to $7.15 million, leveraging $19.39 million of co-financing from project developers. See Annex 5 for a list of all subprojects.

44. **The total of 67 subprojects are now annually saving energy equivalent to over 78,083 tons of coal, with an associated 189,946 tons less CO_2 emitted, compared to what was expected without the Project.** These energy savings and emissions reductions exceed project end target values respectively by 3 and 15 percent. If more narrowly counting only investments under Component 2, the annual emissions reductions of 164,444 t CO_2e would be equivalent to 99.7% of the end target value. The 67 total subprojects are diverse in type and scale. They cover 5.87 million m^2 of floor area and involve a combination of measures ranging from improved new and existing building lighting, HVAC systems, insulation, and energy management systems, and low-carbon distributed generation systems. The ten largest subprojects account for 82% of Component 2 investments and 70% of emissions reductions. The largest is the ¥580 million Disney International Tourism and Resort Zone Energy Station Subproject, which accounts for one-third of emissions reductions. Retrofits

[9] Values shown in US dollars are converted from Chinese Yuan using the exchange rate of 6.5571 ¥/$ per component cost accounting in Annex 3.

contributed a lesser share of emissions reductions than was intended due to the lack of a mandatory policy and other factors as discussed further below. Yet retrofit subprojects taken together contributed one-third of total emissions reductions, and they were the most ubiquitous of all subproject types occurring in 12 different districts across Shanghai. Three quarters of emissions reductions from retrofit subprojects were from projects in Changning. New building EE subprojects contributed 22% of emissions reductions, and covered 7 districts.

45. **The outcomes are highly attributable to the Project on account of the highly detailed monitoring and evaluation (M&E) undertaken for each individual subproject.** Whereas the targets were based on project-wide assumptions, the estimated actual values are robust as they are based on detailed analyses of the individual measures and circumstances of each subproject.

Achievement of Global Environment Objective (GEO)

46. **The Project achieved the GEO to support Shanghai's low-carbon city development by promoting green energy schemes, with a focus on Changning District.** Achievement of the GEO is partly assessed by the GEO Indicator and moreover by additional information.

47. **The GEO Indicator of carbon intensity of Changning's economy was achieved with modest attribution to the Project.** The indicator refers to GHG emissions associated with final energy consumption per unit of GDP in the District. The value at completion in 2018 was 69% of the 2010 value, surpassing the target value of 77.4% by over six percentage points. This indicator should be interpreted with caution as the target value is conservative compared to the baseline scenario consistent with the 12th FYP and subsequent 13th FYP. In March 2017, under Shanghai's 13th FYP for energy conservation and combating climate change, Changning took on a target to reduce carbon intensity by 15% from 2016-2020, two percentage points more ambitious than the 13% target assumed at appraisal for the same time period. Progress as of 2018 is considered to be on track with the latter target. The increase in ambition of Changning's target, as compared to appraisal, is a positive development. The PMO contributed to policy deliberations of the district and municipal government authorities to inform the 13th FYP targets. However, as such targets are ultimately a higher-level political decision, the value of the 13th FYP target itself is not taken as directly attributable to the project.

48. **The project reduced carbon emissions in Changning District through the investments in building energy efficiency and clean energy generation.** The 189,946 t CO_2 annual emissions reductions from all subprojects at end 2018 is equivalent to 96% of the 197,500 t CO_2e reduction forecast to be possible for Changning under a Stretch Scenario compared to a Baseline Scenario at mid-2018. However, the two values cannot be directly compared as only 24% (45,435 t CO_2/year) of total accounted emissions reductions were from subprojects in Changning. Nevertheless, project-supported buildings at the end of 2017 covered around 45% of the 4.0 million m^2 floor area in Changning District, and buildings contribute to the majority of carbon emissions accounted at the district level. Data is unavailable to more precisely compare the target and completion value and attribute the result to the Project, such as to account for variation between forecast and actual energy mix, emissions factors, and economic growth in Changning and Shanghai, which are factors beyond the control of the Project. Absolute emissions and GDP data are not available at district level due to political sensitivities.

49. **The investments themselves constitute a variety of green energy schemes, several of which include pilot characteristics within and beyond Changning District.** Subprojects cover almost all of Shanghai's 16 districts. For example, the Shanghai Disneyland International Tourism and Resorts Zone Distributed Energy Station Subproject, covering 3.9 million m^2 in Shanghai's New Pudong District, is notable for several innovations. It uses natural gas for cooling, heating, electricity, hot water and compressed air with a system efficiency of 83%. This single subproject accounted for 32% (62,900 t CO_2) of total annual emissions reductions measured under the Project.

50. **Changning's pilot green energy schemes have been promoted locally, nationally and internationally.** Between September 2013 and December 2018, the evolving experience, successes, and lessons of Changning's green energy scheme were showcased at some 18 high-level meetings, workshops, conferences, and conventions in various locations. Eight events were in Shanghai, nine in other parts of China (Beijing, Hebei, Shenzhen), and one in Denmark for the international C40 Cities Climate Leadership Group. The NZE demonstration building at Hongqiao State Guest Hotel has attracted the attention of Chinese leaders and dignitaries including the Prime Minister of Norway. Interest from project developers has led to the replication of the NZE design at another location in Shanghai. Overall, the various green energy schemes successfully piloted under the Project have high potential for further replication in other areas of China.

Table 3: Achievement of each objective and outcome

Outcome	Outcome Indicator	Target value	Actual value at completion
PDO 'A': Pilot of green energy schemes	IR Indicator 1: Innovative policies piloted under the Project in relation to green-energy retrofitting of buildings.	Completed by FY2016.	Completed in 2018. High attribution to the Project.
	IR Indicator 3: At least one near zero-emission building piloted under the Project.	Completed by FY2018.	Achieved in 2017. High attribution to the Project.
	IR Indicator 4: Innovative financing mechanisms developed under the Project for green-energy retrofitting of buildings.	Completed by FY2016.	Not achieved. Substantial attribution to the Project.
	IR Indicator 5: At least one distributed generation center built under the Project.	Completed by FY2018.	Achieved. High attribution to the Project.
	IR Indicator 6: Non-motorized transport system piloted under the Project.	Completed by FY2017.	Achieved. High attribution to the Project.
	Advanced functions of online energy monitoring platform demonstrated under the Project.	Not applicable (outside Results Framework).	Achieved with high attribution to the Project.
	Design of pilot low-carbon community plans for a block of buildings and neighborhood in Changning.	Not applicable (outside Results Framework).	Achieved with high attribution to the Project.
PDO 'B': Scale-up of low carbon investments in buildings	IR Indicator 7: Low-carbon investments supported under the Project.	$246 million by FY2017.	$332.2 million. Surpassed with high attribution to the Project.
	PDO Indicator 2: Annual energy savings supported by the investments under the Project.	76,000 tce.	78,083 tce. Surpassed with high attribution to the Project.
	PDO Indicator 3: Annual carbon dioxide emission reduction supported by the investments under the Project.	165,000 tons CO_2.	189,946 tons CO_2. Surpassed with high attribution to the Project.
GEO: Support of Shanghai's low carbon city development	GEO Indicator: Carbon intensity of Changning District.	77.4% of 2010 level to be achieved by mid-2018.	69%. Achieved with modest attribution to the Project.
	Green energy schemes promoted with a focus on Changning.	Not applicable (outside Results Framework).	Achieved. High attribution to the Project.

Justification of Overall Efficacy Rating

51. A rating of substantial overall efficacy is justified on the basis that the Project almost fully achieved its objectives to pilot green energy schemes and scale-up low carbon investments in buildings as well as to support low-carbon city development by promoting green energy schemes in Shanghai with a focus on Changning District.

C. EFFICIENCY

Assessment of Efficiency and Rating

Rating: *Substantial*

Economic and financial analysis at appraisal

52. In 2012, the Changning District Government analyzed and compared different abatement options based on costs, abatement potential and ease of implementation for both 2015 and 2020. The analyses concluded that the total carbon emission in Changning district could be further reduced by 197,500 t CO_2/year by mid-2018 if mitigation measures were conducted beyond national governments' targets as of 2012.

53. Cost-benefit analyses of five types of building subprojects indicated economic internal rates of return (EIRR) ranging from 12.4 to 33.9 percent based on specific social values of reduced total suspended particulates (TSP), sulphur dioxide (SO_2), nitrous oxides (NO_x) and CO_2. The same five subprojects would have financial internal rates of return (FIRR) of 10.1 to 31.9 percent with payback periods from 2.6 to 6.7 years excluding government subsidies. Including government subsidies, the FIRR would be 14.4 to 38.3 percent, and the longest payback period was reduced to 4.8 years, within the five-year period considered to be attractive for investors. The Operations Manual set an eligibility criterion that based on the simple static energy saving investment payback period formula, all qualified existing building energy-saving retrofit projects must ensure that the cash flow generated by the project energy saving can repay the project investment cost within 12 years. The target values for PDO Indicator 2 and 3 reflected assumptions about the investment cost per unit of annual energy savings and associated emissions reduction, as previously noted (20,000 ¥/tce and 2.166 t CO_2e/tce).

Project efficiency at completion

54. The total volume of emissions reduction from project activities at completion is slightly less than the 197,500 t CO_2e that was forecast at appraisal to be possible under the Stretch Scenario of comprehensive measures in Changning versus the Baseline Scenario. However, the outcome cannot be directly compared with the macro-level appraisal estimates for Changning as most emissions reductions (76%) occurred outside Changning.

55. At completion, the economic and financial costs and benefits were analyzed for 29 different types of abatement technologies deployed in 67 building subprojects, resulting in detailed data on 287 building-technology interventions and an updated MAC curve. Most technology measures were more cost effective than expected at appraisal, though efficient enclosure structures remain expensive as expected at appraisal. For the 63 building subprojects besides the four demonstration buildings, the overall weighted average EIRR is 17.6%, which is within the range expected at appraisal. This, and the EIRR of the vast majority of subprojects, exceed the benchmark of 12% used at appraisal and the 10.6% social discount rate benchmark based on World Bank guidelines applied to China. As such the project can be considered to be economically justified at completion. The weighted average EIRR of the four demonstration low-carbon buildings was 5.1%. Emissions reductions were achieved at a rate of 2.43 t CO_2 per tce energy savings, 12% more efficient than anticipated at appraisal. The economic efficiency indicators underestimate benefits as they do not fully quantify various positive externalities including the demonstration effect. For the 63 building subprojects, the weighted average FIRR from the project developer perspective including government subsidy is 13.9%, and the simple payback period is 5.7 years. PDO Indicator 2 was achieved at an average investment cost of 28,760 ¥/tce annual energy savings, which is 44% more than assumed at appraisal. These values appear slightly worse than the range of values expected at appraisal however net benefits are underestimated due to accounting the total cost of new EE building measures financed without accounting for the direct benefits of the services (e.g. lighting) provided in the new building. Accounting only the incremental costs of new EE building measures compared to

traditional low-efficiency measures would improve the performance values to be comparable to appraisal. All retrofit projects had payback periods within the 12-year criterion agreed at appraisal. See Annex 6 for details.

Table 4: Key economic and financial indicators at appraisal and at completion

Indicator	Unit	Appraisal: 5 subprojects range	Completion: 63 investment subprojects	
			Weighted average	Range
EIRR	%	**12.4 to 33.9**	**17.6**	**6.6 to 63.7**
FIRR (with subsidies)	%	**14.4 to 38.3**	**13.9**	**3.2 to 53.6**
Payback period (with subsidies)	years	**2.1 to 4.8**	**5.7**	**1.7 to 13.8**

56. Project implementation was generally efficient. Delays during initial years were mostly remedied to effectively complete both components on time without need for extension, though innovative policies were issued two years later than expected.

D. JUSTIFICATION OF OVERALL OUTCOME RATING

57. **The overall outcome is rated satisfactory.** The satisfactory rating is justified based on high relevance, substantial efficacy, and substantial efficiency as describe above.

E. OTHER OUTCOMES AND IMPACTS (IF ANY)

Gender

58. While the Project did not specifically focus on gender issues, it can be considered to have benefited all genders proportionate to their prevalence in the general population of beneficiaries, including both the businesses involved in financing and implementing building investments and the users of those buildings. During consultation with the beneficiaries, surveys and interviews were designed to ensure that women were given equal opportunities. SPDB and BOS guided their staff not to discriminate against women-owned companies as eligible sub-borrowers. Further information on gender outcomes or impacts through implementation was not available for assessment at closing.

Institutional Strengthening

59. The project provided TA and capacity building support on policies, financing mechanisms, business models of key abatement options including green energy buildings, clean energy supply, and green transport to support Changning district to achieve its carbon intensity reduction target. More specifically, key project outputs helped to develop institutions in the following respects.

- Studies on a holistic process for building construction and management constituted a fundamentally new way for project developers to design, construct, and operate buildings (both retrofits and new buildings) with low-carbon outcomes. The process required iterative collaboration among building stakeholders, which was facilitated by the Project Management Office. As a result of the success of the first application of this process to Hongqiao State Guest Hotel Building 9, the PMO have become champions of the approach and are replicating it for a second building, as well as widely disseminating findings in national and international forums.

- The online building energy monitoring platform pioneered by Changning and improved under the Project though optimization studies has informed new policies in Changning District. In being replicated across Shanghai, it has proved to be an innovative mechanism for building sector management. An outstanding example of how the platform is applied is in Shanghai's Huangpu District. Huangpu District's distribution grid has insufficient capacity

to fully supply peak demand on hot summer days, and the grid is difficult to upgrade due to land constraints. As a solution, the online building energy monitoring platform allows the government-contracted service company to identify opportunities for large buildings to voluntarily reduce demand for certain hours on request from the State Grid Corporation of China. Building users are not affected as the measures are marginal but in aggregate they serve to balance supply and demand at the limits of the system. The buildings also benefit by receiving compensation in their next bill. This solution represents a new model of institutional roles for the local government, grid company and service company, with significant potential for replication elsewhere in China.

Mobilizing Private Sector Financing

60. The IBRD loan ($100 million) was on-lent by the Government to SPDB and BOS, which in turn on-lent the funds to the eligible energy service companies. The PFIs matched the amounts of their respective Bank loan allocations for low-carbon investments. Also, the sub-project beneficiaries contributed equity investments of around 18% of Component 2 subproject costs. The IBRD leverage ratio at closing was 3.3:1, which compares favorably to the value of 2.5:1 expected at appraisal. The Government subsidizes leveraged private financing at a ratio of 2.7:1.

Poverty Reduction and Shared Prosperity

61. **Poverty Reduction and Shared Prosperity.** The benefits of energy efficiency are multiple and go well beyond enhancing economic and social development, reducing pollutant emissions and improving environmental sustainability and strengthening energy security. These benefits include improved comfort and health of occupants of industrial, commercial, and residential buildings.

Other Unintended Outcomes and Impacts

62. **Other Unintended Outcomes and Impacts.** Low-carbon buildings benefit the grid company by allowing deferral of investments in distribution infrastructure upgrade. However, they also involve a cost of foregone revenue from energy sales. Notwithstanding reduced energy intensity of economic growth, the overall growth trajectory of energy demand in Shanghai is such that the grid company can be considered well-placed to cope with the marginal impact.

III. KEY FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOME

A. KEY FACTORS DURING PREPARATION

63. **The Project preparation team prepared the Project design with sound background analysis and comprehensive assessment of the Government's commitment.** The Bank team closely coordinated with other ongoing and planned low-carbon initiatives and building energy efficiency programs, both at the national and municipal levels in China. The Project design was built on lessons drawn from international and Chinese experience of low-carbon cities and building EE and RE programs. Three upstream analytical and advisory activities provided solid foundation for the design including: (i) GHG MAC curves and scenarios; (ii) performance-based energy efficiency benchmarks and policies for building retrofit; and (iii) incremental costs of low-emission and NZE new buildings. Analysis of abatement cost curves provided a new paradigm for the district and municipal government to promote low-carbon city development in a systematic, evidence-based and strategic manner, in contrast to the more ad hoc approach that previously prevailed.

64. **The Project design benefitted from successful financial intermediary experiences**. These included (a) the China Energy Efficiency Financing Program, under which three participating banks on-lent Bank loans to sub-borrowers for industrial and building EE projects; (b) the Second Phase of China RE Scale-Up Program supported RE policies and piloted RE applications in cities, particularly tackling the issue of grid connection for rooftop PV; (c) establishing a methodology and system to monitor and verify EE in China; and (d) Partnership for Market Readiness assisted in designing, piloting, and eventually implementing a carbon cap and trade scheme as Shanghai was to pilot; and (e) the GEF-financed Heat Reform and Building EE Project focused on new residential building codes in northern China. The Bank team worked closely with the International Finance Corporation team to explore potential joint investment programs by undertaking joint due diligence review of local banks and potential joint studies on green building benchmarking tools and business models for building retrofit during project preparation and implementation.

65. **The Bank's preparation team also took into account key lessons from other operations.** This included a study on 'lessons learned from financing instruments for energy efficiency and renewable energy' and global experience. Findings were incorporated into the Project design. In particular:

a. GHG MAC curves and scenarios are a useful analytical tool to set low-carbon targets for cities and define an investment program to achieve emissions reduction target. Whereas the low-carbon city concept in China was not previously clearly defined, and goals and investments programs were usually determined without analytical underpinning, this Project provided a quantitative evidence base to prioritize measures.

b. A credit line, together with TA, is effective in increasing the capacity, interest, and confidence of participating banks in mainstreaming new types of low-carbon business with learning by doing. This built on the success of the China Energy Efficiency Financing Program.

66. **During project preparation, the Bank task team identified critical risks and mitigation measures**. Implementation risks were considered substantial because of the innovative nature of the initiative. The Project success hinged on financial viability of each subproject investment and the credit risk of sub-borrowers, which were expected to include energy service companies (ESCOs) as well as property developers and building owners. Financial viability of subprojects was mitigated by the district Government's decree, issued in January 2013, to offer additional financial incentives for building retrofit. The Government also provided evidence of budget allocation to support such policies. To address sub-borrower risk, PFIs were chosen based on their experience in building EE and financing of ESCOs, and comparative advantage to screen and manage risks. Both PFIs already had in place the possibility of using energy savings as collaterals, which is essential for financing ESCOs. The risk mitigation measures built into Project design were monitored and sufficient support was provided during implementation with GEF Grant support.

B. KEY FACTORS DURING IMPLEMENTATION

67. Key factors during implementation, which occurred from July 2013 to December 2018, include the following.

68. **Grant and loan implementation was slow in early years due to various constraints**. Implementation of the GEF-financed component was constrained initially due to the limited number and capacity of PMO staff. Lending also experienced delays for the first two to three years, leading to moderately unsatisfactory ratings for the Project. Apart from the general barriers identified at appraisal, namely uncertainty on returns, high transaction costs, lack of mandatory policies and aggregating business models, the slow disbursement of loans can be attributed to the following factors. First, the project intentionally limited the geographical scope initially to only Changning District in order to encourage take-up within the district before considering other parts of Shanghai. The Operations Manual as approved at appraisal deferred a decision on whether to expand to other districts in Shanghai a possible change to consider around mid-term review. Changning's policy to subsidize low-carbon city activities, issued in 2013, had some

effect but was not complemented by a mandatory policy to provide a sufficiently strong incentive to unlock potential investments, as discussed further below. Second, the requirement for new buildings to used sophisticated modeling to estimated incremental costs of energy efficiency measures required relatively great use of time, data and skills to be completed. Third, environment review of subprojects was taking longer than expected with multiple levels of processing, resulting in delays of approvals.

69. **Key constraints were successfully addressed during project implementation, resulting in significant scale-up of activities.** Initial PMO staffing constraints were addressed early on when the PMO hired additional staff and developed a robust disbursement plan for GEF grants. The PMO also outsourced some activities including accounting and financial reporting to ensure that finances were managed by professional and qualified personnel. Grant subcomponent activities were also adjusted during implementation as described in Section I.B above. For the lending component, the following changes were agreed around 2015 and 2016 to enable greater disbursement. First, the geographical area of subprojects was expanded from initial focus strictly on Changning District to also include other districts of Shanghai Municipality, as anticipated in the Operations Manual. Second, the approach of modeling new buildings' incremental costs was supplemented with an option to use a positive list of pre-approved technical measures. This simpler alternative method expanded the eligible costs of measures in new buildings. Third, the project management was streamlined in terms of environmental review of investment subprojects.

70. **While government subsidies served to incentivize building retrofits, accompanying policies focused on benchmarking for the near-term rather than making retrofitting mandatory.** At appraisal it was contemplated that retrofitting would become mandatory in Changning for buildings that did not meet certain benchmark requirements. Any such mandatory policy would depend on benchmarks being in place. It proved difficult for Changning District to issue a proposed benchmarking policy early on out of concern that public disclosure of data for high energy consumption buildings could face resistance from stakeholders. For example, a low energy efficiency rating could prompt potential tenants to taken their business to buildings elsewhere. In response, the Government opted for a step-by-step approach by allowing a period of time for buildings to first report and reflect on their data with the opportunity to improve before eventually disclosing benchmark findings for individual buildings. Following relevant consultations, and building on Shanghai's public building energy management measures issued in June 2018, Changning issued its policy on benchmarking in October 2018, as detailed in Annex 4. The first public reports in Changning would occur only in 2020, so the impact of benchmarking as an incentive to retrofit could not emerge within the project implementation period. In the meantime, further to initial subsidies introduced in 2013, and complementing municipal-subsidies introduced in 2016, Changning added further performance-based subsidies in 2018. These subsidies served the purpose of spurring certain projects including those with demonstration value, but the amount of subsidies could not have been expected to compensate for the lack of a mandatory policy. In this context, the amount of investments in retrofitting remained less than anticipated at appraisal.

71. **Despite greater returns on retrofitting projects, financing proved to be more easily secured for new EE buildings.** The shortfall in quantity of EE retrofit subprojects was offset by the large scale of 13 new EE buildings and four investments in DG subprojects. The average investments size for the latter two types of projects was much larger than the for building retrofits (see Table 6-2 in Annex 6). For both financiers and borrowers, securing loans for EE measures in new buildings compared to retrofits had the advantage that most building developers were already in discussion with banks to access finance for the new building anyway, and thus did not necessarily require a special type of financial product. Whereas there was an intention to establish guarantees for retrofit projects which depended on the certainty of performance of EE measures, the District Government was unwilling to offer guarantees having experienced a developer default in 2013 unrelated to the Project. An alternative provider for guarantees was not forthcoming.

72. **Project coordination across government agencies was effective without the need for formal project-specific committees.** Two committees were formally established: (a) Project Steering Committee to coordinate GEF-financed activities and replicate policies at the municipal level; and (b) Project Executive Committee to coordinate district government agencies and supervise day-to-day project implementation. In practice, the committees remained inactive and ordinary mechanisms for communication and coordination among agencies were used as needed. For example, the District Government participated in regular discussions with the Municipal Finance Bureau, Development and Reform Commission, and other bodies, on policy development during the implementation period such as the 13th FYP. Municipal officials and leaders also participated in activities to share findings of the green energy schemes in Changning. The PMO enjoyed strong support from local government leaders which allowed it to be sustained as the Changning District Government's Urban Regeneration and Low-Carbon Project Management Center with ongoing programs independent of this Project. The low turnover of working-level staff in the PMO was vital for carrying through ideas from beginning to end and fostering productive relationships with many stakeholders.

73. **Technical assistance and institutional strengthening activities were critical for building the capacity and appetite of both PFIs to continue lending for low-carbon investments beyond the project.** With the cooperation of the PMO and guidance of technical experts, the capacities of PFI staff was built to better understand and contribute to development of the market for building EE. Technical assistance also improved their capacity to manage technical and safeguards issues. The PMO played a key role in facilitating communication among PFIs, ESCOs and other stakeholders to identify and follow through on new subprojects. Transaction cost was reduced through the PFIs' institution-wide approach to originating and managing loans, with the leadership of headquarters and systematic participation of branches and retail outlets, as well as through training for their staff and for project developers. In addition, each PFI established internal incentives for staff to encourage business development in low-carbon loans.

IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

A. QUALITY OF MONITORING AND EVALUATION (M&E)

M&E Design

74. The M&E framework design is assessed against each objective as below.

75. **For PDO 'A' of piloting green energy schemes, the results framework captures outputs of individual schemes but lacks a specific PDO indicator.** The pilot schemes are expected to contribute to results measured in the PDO Indicators and GEO Indicator but the contribution is only partial. Pilot schemes are reflected rather by IR indicators 1, 3, 4, 5, and 6. The indicators for innovative policies and financing mechanisms for green-energy retrofitting did not predefine the details of such mechanisms as these were still to be determined. This provided flexibility for details of green energy schemes to evolve over time. If adopted, implemented, and scaled-up sufficiently early before project completion, the pilot schemes could contribute indirectly to the outcome at completion as measured by GEO Indicator, and to PDO Indicators 2 and 3 on energy savings and emissions reductions from investments in low-carbon buildings. This logic was positively reflected in the fact that IR Indicator 1 (policies) and 3 (financing mechanisms) were expected to be completed by FY2016. The indicator on financing mechanism could have benefited from an operational definition of its end target value of being "completed". IR Indicator 2 was 'Online energy monitoring platform established under the Project' measured in terms of number of buildings with a baseline of 100 in July 2013 and end target value of 160 by FY2016. This indicator is not used for assessing PDO 'A' for several reasons. First, the platform was already established prior to the Project. Second, increasing the platform's coverage was required by Shanghai's 2012 policy. Third, the PMO's work to expand coverage in line with this policy constitutes scaling-up implementation

rather than a pilot. Nevertheless, improvement of the online energy monitoring platform was a key component of the project design. However, this outcome was not measured in the Results Framework.

76. **The flexibility of the Results Framework indicators for PDO 'B' allowed the development impact of all low-carbon subproject investments to be accounted in an integrated manner**. Energy savings and emissions reduction are not explicitly mentioned as outcomes in the PDO statement. Their measurement per PDO Indicators 2 and 3 is nevertheless meaningful. Energy savings is a key impact of low-carbon investments, and it is also a means for low-carbon city development and for emissions reduction. The scale of investments, as described in the PDO, was measured by IR Indicator 7, with a target value equivalent to the estimated cost of Component 2. This implied that only subprojects supported by project loans would count toward IR Indicator 7. Subprojects supported by grants could nevertheless also be counted as investments. While most investments were expected to be building retrofits, the results framework left room for variation in the share of investments in retrofitting versus new buildings, and the share expected to occur in Changning. While NMT as a pilot scheme was covered by IR Indicator 6, low-carbon transport was not the focus of investment activities and therefore was not covered by PDO Indicators 2 and 3 and IR Indicator 7.

77. **The GEO of supporting Shanghai's low-carbon city development is partly measured in the results framework.** As described in the PAD, the GEO was to be measured with a dedicated indicator – the carbon intensity of Changning's economy. This integrates outcomes from all activities in Changning including energy consumption from buildings and from transport. It is only to be expected that Changning's carbon intensity, as a higher-level outcome, could be affected by factors beyond the control of the Project and that the impacts of project activities may not be fully observable by the closing date. This makes supplementary evidence important to consider as well. The GEO statement specifies the means of achieving the outcome as 'promoting' green energy schemes with a focus on Changning. The PAD (page 75) elaborates that project success is expected to lead to replication throughout Shanghai of policies, business models, and financing mechanisms piloted under the project. In this respect, the Results Framework could have been strengthened by an indicator at the level of Shanghai such as on the promotion and replication of schemes or on key stakeholders' perceptions of the project's contributions. It can also be noted that while stakeholder feedback was not part of the Results Framework, the PAD suggested that surveys and interviews would be conducted with beneficiaries ensuring equal opportunities for women.

M&E Implementation

78. **M&E data were mostly collected and analyzed in a methodologically sound manner.** The PMO, with inputs from the PFIs, was responsible for the overall M&E system and furnished progress reports on project implementation. The high level of detail in M&E of building subprojects allowed the PMO and Bank team to track the focus on Changning and on retrofits. However, shortcomings in the M&E design, as described above, were not addressed during implementation. In project reports, IR Indicator 7 as well as PDO Indicators 2 and 3 were interpreted to include the contribution of subprojects financed with grants under Component 1, rather than only subprojects financed with loans under Component 2. At mid-term review, the PMO reviewed the project indicators based on the information of existing subprojects, and confirmed that key assumptions at appraisal were still valid and on this basis it was decided that the PDO-level indicators would not be changed. The GEO Indicator could have been updated to reflect the increased ambition of Changning's carbon intensity reduction target for the 13th FYP period, issued in 2017. While no formal survey was conducted, informal consultations with beneficiaries provided positive feedback about the Project.

79. **The online building energy monitoring platform was an integral part of the Project's M&E and improved significantly during implementation with Project support.** Participation in the platform was expected for all large buildings as a matter of District Government policy. One feature of the platform's implementation it that participation was not strictly compulsory. A few buildings were able to opt out on the basis that they did not want to have their

building energy data disclosed for commercial reasons. The small number of buildings that opted not to participate did not affect the overall value of the platform. The District Government also took steps to ensure the security of data collected from participating buildings.

80. **An impressive feature of the M&E system is that investment subproject were appraised at the level of each individual building, covering all 67 buildings supported by the Project in great detail.** Calculation of incremental costs of building investments was integral to determining the level of project financing, and was originally intended to be based on modelling for new buildings. In practice such modelling proved to be excessively difficult due to the significant time, data, and expertise required. In response, an alternative practical approach was introduced mid-way to allow predefined technologies, and the full cost of such technologies was deemed to eligible. In several cases, however, the full cost of such technologies exceeds their incremental cost. As such, the measure of finance mobilized for new buildings with predefined measures also somewhat exceeds the incremental costs. Calculation of incremental investment costs for the purpose of economic evaluation was done by the PMO *ex post*.

81. **The occasional moderately satisfactory rating for M&E during implementation concerned delays in timely progress reports from the implementing agencies.** The district government did not have access to the real-time information on all project-supported buildings outside of Changning. Access to data on building investments therefore depended on the PFIs, which did not always submit reports on time. Timeliness of reporting did improve, however, during implementation.

M&E Utilization

82. **M&E data on performance and results progress were used to inform project management and related decisions.** Several reports, including annual and semi-annual progress reports, and monthly fiscal reports for the GEF grant were used to monitor the Project's outcome and results indicators. The arrangement of data being collected by both PFIs and the PMO helped to create shared ownership of the project by all three implementing agencies. The proactive management approach of PMO staff allowed decisions to be made as needed through informal consultations without relying on the formal interagency committees. The main way in which M&E data were used to informed implementation was in relation to disbursement of the grant and loan proceeds. Closely monitored rates of disbursement shaped decisions such as to modify the criteria and process of subproject selection as already described. Online monitoring platform data, with the improved functionality, facilitated the identification of unusual patterns in building energy consumption from month to month that would require corrective action in operations or maintenance. Moreover, it informed the design of subsidy and benchmarking policies that were issued in 2018.

Justification of Overall Rating of Quality of M&E

83. **The overall quality of M&E is rated Modest.** The design, implementation and use of M&E was adequate to assess achievement of PDO 'B' and provided useful flexibilities, though shortcomings made it somewhat difficult to assess achievement of PDO 'A' and the GEO and test the links in the results chain. The PDO Indicators and GEO Indicator do not completely correspond to each objective, but rather reflect certain impacts expected to result from achieving the objectives. In particular, the PDOs describe outcomes that are under the Results Framework appear as intermediate results. M&E could thus have benefited from more definitive indicators of PDO 'A' of piloting green energy schemes and the GEO of supporting Shanghai's low-carbon city development. In addition, indicators could have been added to capture additional intermediary outcomes of project activities such as improvement of the online energy monitoring platform. Despite these shortcomings, relevant information beyond the Results Framework was made available in progress reports and at completion to assess the project's performance. The M&E reports were prepared mostly on time to keep track of Project status at a given time.

B. ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

84. **Overall safeguards implementation performance is considered Satisfactory**. The Project was assigned Category "FI" as project that involve a financial intermediary. The Environmental Assessment (OP4.01) was triggered because of the nature of activities which included small-scale sub-projects. The Project nevertheless had limited social impacts. An Environmental and Social Management Framework was prepared as specific investments were to be identified only during implementation. The PMO and the PFIs worked together to screen environmental impacts, prepared sub-project technical and environmental documents, and supervised implementation as required. An environmental management consultant was engaged throughout implementation period to provide safeguards training, and advice on environmental assessment process and compliance. While no land acquisition was involved, land use certificates were provided for all existing commercial buildings. For new commercial buildings, developers obtained clean land areas for development, and copies of land use certificates or land lease sale contracts were provided as part of the evaluation package. In Shanghai, the land acquisition and resettlement were often carried out by local district governments before being sold to potential developers.

85. **Fiduciary Compliance:** The Project complied with all fiduciary covenants. Internal control arrangements were put in place, and adequate financial management (FM), procurement, and disbursement systems were maintained.

86. **Financial Management.** Due to the specific feature of Project activities which utilized financial intermediary to implement activities, the PMO's responsibility on FM issues focused mainly on the GEF grant. The Bank's supervision mission and annual Project audits did not note any significant problems or internal control weaknesses. The PMC's staff became familiar with the Bank's requirements and FM activities improved further during implementation. The FM Manual was prepared and included necessary internal control guidelines. The internal controls of the Project worked as intended. All key FM project staff attended training workshops to fully understand the approved FM Manual. The interim unaudited financial reports were generally submitted on a timely basis and all external audit reports were submitted before the due date. The final audit was carried out by an internationally affiliated firm, in full compliance with the international standards. The auditors expressed 'unqualified audit opinion' on the financial statements of the recent years, which indicated financial statements gave a true and fair view on the financial state of the Project. The borrower's completion report referred to 70 subprojects. After closing, three subprojects were excluded as a result of audit findings, leaving a total of 67 subprojects.

87. **Procurement.** Procurement under the loan component was undertaken by respective private enterprise beneficiaries in accordance with the well-established private sector procurement methods and commercial practices. The GEF grant funded activities on the other hand were implemented by PMO which followed the World Bank's procurement policies and procedures. In light of small value goods or contracts, simple procurement method was utilized including request for quotations, or consultant qualification based section. The procurement adequately met the World Bank's requirements to ensure that funds were used for the intended purposes.

C. BANK PERFORMANCE

Quality at Entry

88. The World Bank team at identification focused on gaps and opportunities for interventions in China's energy sector to achieve Changning's ambitious energy-saving targets. During Project preparation, the team considered adequacy of project design and all major relevant aspects such as technical, financial, economic, institutional, and procurement. Major risk factors and lessons learned from earlier projects were also considered and incorporated into the design. The Project was well grounded in the realities of China, its problems in the energy sector, and was focused on designing novel and efficient ways to achieve China's carbon intensity reduction targets. An experienced and committed task team was constituted to provide technical support for preparation. This was critically important, given

that implementation of climate change mitigation interventions in any country is complex and challenging. Shortcomings associated with the M&E framework as previously described also constitute a shortcoming of quality at entry.

Quality of Supervision

89. The World Bank team included the Task Team Leader, technical experts, environmental, social, FM and procurement specialists, and consultants. The Project was subject to implementation supervision missions approximately every six months that monitored progress and provided extensive support. Missions included review of safeguard documentation and field visits. The team consistently and closely engaged the PMO and PFIs, and met periodically with the higher-level Municipal Finance Bureau and Municipal Development and Reform Commission. The task team collected relevant data on a regular basis and updated current progress against the baseline. The progress was recorded in 11 Implementation Status and Results Reports (ISRs) and seven Aides-Mémoire which were generally very detailed. ISRs were candid and targeted to outline important events, and highlighted issues for World Bank management attention. The Task Team responded appropriately and on time to all Government's requests. The World Bank team's support resulted in timely adjustments including project restructuring and funds reallocation. The Task Team also provided extensive sector expertise, including high-value technical guidance through EE experts that were considered indispensable to the success of the Project.

Justification of Overall Rating of Bank Performance

90. Based on no more than moderate shortcomings at both Quality at Entry and Quality of Supervision, the overall rating of the World Bank Performance is considered **Satisfactory.**

D. RISK TO DEVELOPMENT OUTCOME

91. **The risk to development outcome is rated as moderate.** The green energy schemes piloted have already demonstrated value. They will provide value in future as long as their implementation continues, and associated lessons and knowledge are disseminated for replication or to inform alternative approaches. Under the benchmarking policy issued in 2018, the first public disclosure will occur in 2020. The risk that the policy may not be fully implemented is mitigated by the support it receives from the District Government. The subsidy policy issued in 2018 is effective until 2020 and is expected to reviewed in future to accommodate evolving circumstances. The NZE demonstration buildings, along with the low-carbon building investments, have been designed to last for decades to come. There is a risk that these buildings could be operated below the designed efficiency based on patterns of user behavior or building management. However, this risk has been mitigated by the close involvement of building managers in the activities and the expected ongoing use of advanced information and communication technology (ICT) systems to provide alerts of any anomalies that building managers can address. In Shanghai, the market for ICT in energy management is sufficiently large that ESCOs are competing for business.

92. **Further scale-up of low-carbon building investments depends on various factors.** Investments and willingness to undertake costly retrofits may be impacted by a more general economic slowdown that is underway in China at present. The impact of such a slowdown could be mitigated by stimulus measures to further incentivize low-carbon building investments as a green growth tactic. At appraisal, it was foreseen that the PFIs would use repayments of Project sub-loans to reinvest in further low-carbon activities. While neither bank has a specific policy to this end, the stream of revenue from Project sub-loan repayments is smaller than the volume of total low-carbon investments that SPDB and BOS both intend to make in coming years under market trends and government strategy. In addition, SPDB has adopted progressive internal corporate targets to increase low-carbon investments each year. The PFIs are well-

placed to continue growing the market for low-carbon building investments in line with the direction of Government strategy and policy.

93. **The PMO has been established not just as a short-term project office but as an ongoing unit responsible for long-term government programs.** It receives general budget funding from the District Government. It remains available to provide technical advice to projects financed by SPDB and BOS or by other local banks. While the PMO itself may change, the District Government's commitment to low-carbon development is stable and likely to only grow stronger in line with national and municipal-level strategy and policy.

V. LESSONS AND RECOMMENDATIONS

94. The Project offers key lessons and recommendations applicable for similar projects within and beyond China, as follows.

95. **Government institutions can and should play a critical role to share knowledge and coordinate interventions to unlock innovative win-win opportunities for low-carbon city development.** The PMO served this role in the Project as designed and implemented. It acted as a professional management agency that forged links between building managers, project developers, financiers, energy service companies, and policymakers. The pilot schemes led by the PMO acted as a test bed for operations that succeeded by reducing information asymmetries among stakeholders. This allowed policies and programs to evolve over time and create public-private partnerships. For buildings specifically, the Project demonstrated that a holistic approach to design, construction and operation of both new and retrofit projects can achieve innovative, replicable results for near-zero emissions. To facilitate this, a project management office needs high-level support from government leaders and long-term retention of competent staff to carry though ideas and relationships from beginning to end, as occurred in Changning. Other important factors include well-targeted grants or subsidies and technical assistance activities, as well as the intensive involvement of leading experts to push the frontier in partnership with commercial developers.

96. **Access to good quality building energy data is fundamental to reveal efficiency opportunities and is useful to inform related government policy.** Data access can be facilitated by building submeters connected to a secure online data platform, as pioneered in Changning for government and commercial buildings through a contracted technology service provider. Such data can identify savings opportunities for individual buildings, and when aggregated and analyzed for a large number of buildings can demonstrate the usefulness of such systems for the sector at large. Representative data for an entire district or municipality can enable more precise targeting of subsidies to support innovative interventions and the formulation of benchmarking policies. Government data collection and benchmarking programs need to consider commercial confidentiality and privacy, voluntary participation or a range of ways to fulfil data requests.

97. **Some benefits and costs of building energy interventions are difficult to estimate but nevertheless important to consider in formulating policy and scaling-up investments.** This relates to several aspects which have been learnt in context of the project's economic and financial analyses.

- First, the rehabilitation of existing buildings was more challenging than expected. All existing buildings that rehabilitated under the project were commercial buildings, it is more complicated for residential buildings due to the complexity of owners. It could be an area that public funding can play roles in future, and identifying viable business models is critical. The following factors are considered critical for the rehabilitation of existing buildings: (a) government commitment to achieve low carbon target; (b) engagement with PFIs; and (c) involvement of technical experts (e.g. ESCOs). Knowledge gap exists in the banking sector to provide their funds,

and the project has tried to minimize this gap. More engagement with the central government agencies and national institutes could be useful to expand the impact of the project.

- Second, energy efficiency measures can benefit building users in terms of increased comfort and usability of available floor space. Energy conservation and distributed generation can also benefit utilities by deferring the need to update distribution infrastructure, albeit at the cost of foregone sales revenue. Such broader impacts need to be considered to fully evaluate the opportunities and challenges of scaling-up low-carbon building investments.

- Third, incremental costs of energy efficiency measures can be burdensome to calculate for new buildings. Modelling is possible but involves significant transaction costs in terms of the skill, data, and time required, so may be unreasonable to expect for a large volume of investment loan appraisals. A positive list of specific technologies is a practical alternative, but needs to be accompanied by general estimates of incremental cost if economic or financial returns are to be evaluated.

- Fourth, public benchmarking and ETS schemes can each be difficult to pilot at district level due to the relatively small number of participants and concerns about competitiveness. This adds to general challenges associated with the participation of buildings in cap-and-trade schemes—complex ownership structures, low energy costs as a share of building operating expenses, and high transaction costs for individual buildings to participate. Policymakers need to consider ways to aggregate opportunities for buildings to participate in such schemes at a higher level and address related concerns.

ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

A. RESULTS INDICATORS

A.1 PDO Indicators

Objective/Outcome: GEO: Support Shanghai's low-carbon city development by promoting green energy schemes in Changning

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Accumulated carbon intensity per unit of GDP in Changning District (Percentage).	Percentage	100.00 31-Dec-2010	77.40 29-Jun-2018		69.00 31-Dec-2018

Comments (achievements against targets):

Achieved with modest attribution to the project. The value at completion surpasses the target value by over six percentage points. While the target value is considered conservative and the actual value is influenced by factors beyond the project's control, the project successfully reduced carbon emissions through investments in building energy efficiency covering around 45 percent of floor area in Changning District. Moreover, the project's green energy schemes have been promoted through eight events in Shanghai and have attracted high-level attention from local, national and international leaders and dignitaries, with high potential for replication.

Note: PDO 'A' (green energy schemes piloted) has no specific overall indicator in the Results Framework. Rather, green energy schemes as measured by Intermediate Results Indicators 1, 3, 4, 5, and 6 together contribute to the higher-level GEO Indicator and can also be counted toward project-level outcomes of PDO 'B'.

Objective/Outcome: PDO 'B': Scale-up low-carbon investments in buildings in Shanghai with a focus on Changning District

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Annual energy savings supported by the investments under the project (Tons of coal equivalent)	Tones/year	0.00 01-Jul-2013	76000.00 29-Jun-2018		78083.00 31-Dec-2018

Comments (achievements against targets):

Energy savings as measured by PDO Indicator 2 are surpassed with high attribution to the Project. The achievement rate is 103%. Of total energy savings accounted, 33% are from building retrofits, and 24% occurred in Changning District.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Annual CO2 emission reduction supported by the investments under the project (Tons of coal equivalent)	Tones/year	0.00 01-Jul-2013	165000.00 29-Jun-2018		189946.00 31-Dec-2018

Comments (achievements against targets):

Surpassed with high attribution to the project. The achievement rate is 115%. The value at completion is derived from detailed analyses of individual measures and circumstances of each subproject compared to the expected scenario without the project. Note the unit of measure for both target and actual values is tons of carbon dioxide (not tons of coal equivalent).

A.2 Intermediate Results Indicators

Component: Component 1: Technical Assistance and Incremental Support for Near-Zero Emission Buildings

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Innovative policies piloted under the Project in relation to green-energy retrofitting of buildings	Text	none 01-Jul-2013	Completed 30-Jun-2016		Completed 31-Oct-2018

Comments (achievements against targets):
Achieved after delay with high attribution to the Project. Changning District Government in June 2018 issued “Low-Carbon Development Special Funds Management Measures” prepared by the PMO including tiered performance-based incentives for low-emissions buildings, and in October 2018 issued “Public Building Energy Efficiency Benchmarking Management Measures” building on recommendations of a Project-supported study completed in 2017.

Indicator Name	Unit of	Baseline	Original Target	Formally Revised	Actual Achieved at

	Measure			Target	Completion
Online energy monitoring platform established under the Project	Number	100.00 01-Jul-2013	160.00 30-Jun-2016		187.00 31-Dec-2018

Comments (achievements against targets):
Surpassed with modest attribution to the Project. The PMO led work to expand coverage according to Government policy that was in place prior to the Project. The achievement rate of 117% is due to a higher than anticipated number of buildings that meet the thresholds for participation in the platform. Meanwhile, the Project significantly improved the platform's capabilities and functions to assess, manage, monitor and verify energy performance and efficiency opportunities as a pilot scheme in its own right, and as a foundation for other measures.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
At least one (1) near zero-emission building piloted under the Project	Text	NA 01-Jul-2013	Completed 29-Jun-2018		Completed 31-Dec-2018

Comments (achievements against targets):
Achieved with high attribution to the Project. The Project supported the retrofit of Hongqiao State Guest Hotel Building 9 to near-zero emissions standard through a comprehensive management approach winning the acclaim of national and international governments and private sector bodies. The approach has been replicated for a new building at 191 Neijang Road, Yangpu District, Shanghai.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Innovative financing mechanisms developed under the Project for green-energy retrofitting of buildings	Text	NA 01-Jul-2013	Completed 30-Jun-2016		Not completed 31-Dec-2018

Comments (achievements against targets):

Not achieved. Substantial attribution to the Project. Guarantee mechanisms to mitigate risks of lending to SME were not developed as intended. The two Participating Financial Intermediaries nevertheless developed a corporate-wide approach to originate and decrease the risk of loans for building retrofits facilitated by technical assistance and capacity building for sub-borrowers. This increased access to financing and bankable projects as demonstrated by IR Indicator 7.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
At least one (1) distributed generation center built under the Project	Text	none 01-Jul-2013	Completed 29-Jun-2018		Completed 31-Dec-2018

Comments (achievements against targets):

Achieved with high attribution to the Project. The Project provided financial support to distributed combined heat and power generation systems in two subprojects and to distributed PV in five subprojects. In addition, the Project has supported the design of smart distributed energy resource systems for one complex, and comprehensive low-carbon community schemes for two locations, all involving distributed PV.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Non-motorized transport system piloted under the Project	Text	none 01-Jul-2013	Completed 30-Jun-2017		Completed 31-Dec-2018

Comments (achievements against targets):
Achieved with high attribution to the Project. The Project financed design of three non-motorized transport areas which have begun implementation as part of an overall plan for Changning district. The Project also financed an integrated low-carbon urban renewal plan for one site.

Component: Component 2: Low-carbon Investments

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Low-carbon investments supported by the Project	Amount(USD)	0.00 01-Jul-2013	246000000.00 29-Jun-2018		332190136.00 31-Dec-2018

Comments (achievements against targets):
The achievement rate is 135%. The Bank loan was fully disbursed for 41 low-carbon building investments with greater than expected co-financing from the local banks and project developers, of which 8 also received subsidies from the Changning District Government. In addition,

26 other low-carbon buildings received Changning District Government grant support under Component 1 to leverage $19.4 million of co-financing from project developers.

B. KEY OUTPUTS BY COMPONENT

PDO 'A': **Pilot green energy schemes in Shanghai, with a focus on Changning district.**	
Outcome Indicators	The outcome of green energy schemes piloted has no specific overall indicator. It is indicated by Intermediate Results Indicators 1, 3, 4, 5, and 6, as described below. The results also contribute to PDO 2 and the higher-level GEO as described further below.
Intermediate Results Indicators	1. Innovative policies piloted under the Project in relation to green-energy retrofitting of buildings 3. At least one near-zero emission building piloted under the Project 4. Innovative financing mechanisms developed under the Project for green-energy retrofitting of buildings 5. At least one distributed generation center built under the Project 6. Non-motorized transport system piloted under the Project
Key Outputs by Component[10]	**Component 1: TA and Incremental Support for Near Zero-Emission Buildings** <u>1.1: Green energy buildings</u> • *Building energy policy studies:* Public building energy baseline[1]; Public building energy saving policy reform[2]; Measures to support building energy benchmark publicity[30]; Methods to popularize building retrofit energy savings achievements[41]. • *Building energy monitoring platform improvement:* Top-level design optimization plan[18]; Software optimization[26, 44]. • *Building energy efficiency implementation activities:* Near-zero emissions building materials consulting[50]; Study and management of holistic process for new public building construction[29]; Study on public building energy commissioning and management model[28]. • *Financing mechanism.* Study on financial mechanism innovation[40]. • *Building energy technical assessments:* Study on building retrofit energy savings evaluation method[3]; Study on tools to standardize building energy audit and retrofit plans[27]; Asset appraisal tools[49]. <u>1.2: Low-carbon energy supply and low-carbon communities</u> • *Smart distributed energy resources:* Network construction planning study for Hongqiao Airport Economic Demonstration Zone[42]. • *Green electricity scheme:* Carbon trading mechanism pilot system low-carbon practice project[6]. • *Low-carbon community planning:* Urban renewable scheme for Wuyi Road[46]; Construction scheme study[47]. <u>1.3: Green mobility</u> • *Non-motorized transport planning:* Road layout and design scheme for Changning Hongqiao Area[7]; Proposal for Changning District[39]; Proposal for Changing District East Area[52].

[10] Outputs are arranged by the themes of activities as implemented. In some cases these differ from the design at appraisal. Numbers in square brackets (e.g. [1]) refer to the output's corresponding serial number(s) per the table of GEF-funded contracts in the PMO progress report.

	1.4: Capacity building and project management support • Due diligence review, trainings for participating banks and project developments, knowledge management and outreach including international study tours[4-5, 8-17, 19-25, 31-38, 51]. Training on environment and social management was delivered to a total of 257 individuals over 38 sessions between October 2013 and June 2018. This sub-component also contributes to achievement of PDO 2 as described below.
PDO 'B': **Scale-up low-carbon investments in buildings in Shanghai, with a focus on Changning district.**	
Outcome Indicators	2. Annual energy savings supported by the investments under the Project. 3. Annual carbon dioxide emission reduction supported by investments under the Project. These outcomes also contribute to the higher-level GEO as described further below.
Intermediate Results Indicators	7. Low-carbon investments supported under the Project
Key Outputs by Component	**Component 2: Low-carbon investments** • *Green-energy retrofitting of buildings*: Energy efficiency and low-carbon energy supply measures in existing buildings. Efficiency improvements including lighting, HVAC, energy management systems, and insulation. Energy supply sources included PV and gas. • *New green-energy buildings*: Energy efficiency measures for new buildings. Sub-component 1.4: Capacity building and project management support, as described above, also contributes to PDO 2.
GEO: **Support Shanghai's low-carbon city development by promoting green energy schemes, with a focus on Changning District.**	
Outcome Indicators	1. Accumulated carbon intensity per unit of gross domestic product in Changning District (percentage)
Intermediate Results Indicators	Intermediate results for PDO 1 and PDO 2, as described above, contribute to the GEO.
Key Outputs by Component	Component outputs for PDO 1 and PDO 2, as described above, contribute to the GEO.

C. INDICATORS FROM OPERATION MANUAL

The following is a verbatim excerpt of the Green Energy Schemes for Low-Carbon City in Shanghai, China: Project Implementation Plan (dated September 2012). *Remarks on results and the relationship of indicators in the Plan to the PAD Results Framework Shaded text have been added to the right-hand side of Table 3-1 and to the bullet points of indicators further below.*

Key project performance indicators by which the success of the project will be measured include the following in the Table 3-1:

Table 3-1 Key project performance indicators

Deadline	**Indicators**	***Remarks for ICR***
Before the end of 2013	Completion of the "Study on Changning District public Buildings Energy over Baselines. Development of energy consumption baselines for office buildings, hotels, and shopping centers. Recommendations on building energy efficiency technologies.	*A study "Public building energy baseline" was completed in 2015. It informed dialogue between the district and municipality. See also IR Indicator 1 (innovative policies) for discussion of benchmark policies.*
	Competition of studies on Management Method of Subsidies for Public Building Retrofitting and Proposal for Retrofitting Public Buildings. Management regulations will be issued by the Changning District government.	*Changning Government issued Low Carbon Development Special Funds Management Measures in January 2013, during project preparation. See IR Indicator 1 (innovative policies) for discussion of the update to these measures issued in 2018.*
	Completion of Extended and Improved Building Energy Consumption Monitoring Platform. The platform will be used for energy efficiency measurement and assessment, project management and carbon footprint functions.	*This corresponds to IR Indicator 2 (online platform). The platform underwent three upgrades based on project-supported activities from 2016 to 2018.*
	Recommendations and implementation support of technologies, policies, and institutional arrangements to retrofit existing buildings to improve energy efficiency in Changning district.	*This corresponds to IR Indicator 1 (innovative policies). Relevant studies completed include "Building retrofit energy savings evaluation method" (2015), Study on tools to standardize building energy audit and retrofit plans" (2017); and "Methods to popularize building retrofit energy savings achievements" (2018).*
	Recommendations and implementation support of technologies, policies, and financing mechanisms (EE, RE, and integration of intelligent two-way meters) for near zero emission buildings in Changning district with higher energy efficiency standard than average in Shanghai.	*The study "Near-zero emissions building materials consulting" was completed in 2018. See also IR Indicator 3.*
	Study on incentives for higher standard energy saving buildings, to encourage over 70% energy saving of new commercial buildings.	*Study on "Public building energy saving policy reform" was completed in 2015. See also IR Indicator 1 (innovative policies).*

Deadline	Indicators	***Remarks for ICR***
	Preparation of proposals for distributed energy mix and smart meters for district center hospitals.	*A design for distributed energy and smart meters was prepared with funds outside the Project. See discussion under IR Indicator 4 (distributed generation) for related results.*
	Study on green power and carbon trade schemes to reduce district GHG emission.	*Completed in 2015.*
	Electric vehicles (buses) feasibility studies, if possible, piloted to connect between metro to buildings at Changning District. Pilot evaluation completed.	*Not carried out.*
	Layout and Design of Slow Mode Road in Hongqiao Region in Changning District	*This corresponds to IR Indicator 6 (non-motorized transport systems). Three studies were completed from 2015 to 2018.*
By the end of 2015	Completion of at least 50 retrofitting energy efficiency integrated building.	*Changning supported 31 building EE retrofits from 2013 to 2018 including the NZE Hongqiao Guest House Building 9.*
	Completion of a near-zero emission building.	*This corresponds to IR Indicator 3 (NZE demonstration). NZE Hongqiao Guest House Building 9 completed in August 2017.*
	Completion of a new higher standard energy saving building	*Changning supported 3 new buildings to high standard.*
	Several training workshops organized by the PMO on project and policies for building owners, estate management companies, and every saving service providers.	*Training on environment and social management was delivered to a total of 257 individuals over 38 sessions between October 2013 and June 2018.*

The GEF grant to support the effort of Changning district to improve energy efficiency and increase use of renewable energy, with the following success indicators:

	Remark for ICR
• Pilot of retrofitting energy efficiency buildings;	*Changning supported 31 building EE retrofits from 2013 to 2018 (including the NZE Hongqiao Guest House Building 9). Energy retrofitting of buildings is not in itself a 'pilot' scheme so is not relevant for assessing PDO 'A'.*
• Pilot of innovative financing mechanisms for retrofitting existing buildings. The energy saving monitoring platform shall cover 160 building in the Changning District;	*This corresponds to IR Indicator 4 (innovative financing) and IR Indicator 2 (online platform).*
• Pilot of one near zero emission building;	*This corresponds to IR Indicator 3.*
• Pilot at least one distributed energy mix system; and	*This corresponds to IR Indicator 5.*

- Pilot of slow mode transport in the Changning District.

This corresponds to IR Indicator 6.

The above studies and policy development on energy efficiency building incentives, measurement and monitoring, market development and insurance, renewable energy and green transport, as well as proposal preparation and soft system development, will contribute to the District green building and other low carbon projects. The GEF grant will be used to bring additional investment of 246 million Yuan, reduced fuel use of 76000 tons, and reduced emission of 165000 tons. Overall the project will provide replication potential of low-carbon development for Shanghai and its prefectures.

Remark for ICR

The quantitative targets are taken as corresponding to IR Indicator 7 (scale of low-carbon investments), PDO Indicator 2 (energy savings) and PDO Indicator 3 (emissions reductions).

ANNEX 2. BANK LENDING AND IMPLEMENTATION SUPERVISION

A. TASK TEAM MEMBERS

Name	Role
PREPARATION	
Xiaodong Wang	Task Team Leader
Ximing Peng	Co-Task Team Leader
Yabei Zhang	Energy Economist
Feng Liu	Senior Energy Specialist
Xiaowei Guo	Senior Procurement Specialist
Yi Dong	Senior Financial Management Specialist
James Seward	Lead Financial Sector Specialist
Holly Krambeck	Transport Economist
Sameena Dost	Senior Counsel
Ning Yang	Environmental Specialist
Yi Yang	Transport Specialist
Kun Cao	Team Assistant
Dan Xie	Program Assistant
Cristina Hernandez	Program Assistant
Noureddine Berrah	Energy Advisor
James Lacey	Financial Sector Consultant
Dilip Limaye	Energy Efficiency Consultant
Bernard Baratz	Environmental Safeguards
Youxuan Zhu	Social Specialist

Name	Role
SUPERVISION & ICR	
Ximing Peng	Task Team Leader
Alan David Lee	ICR Task Team Leader
Sathyanadhan Achath	ICR Contributing Author
Bernard Baratz	Environmental Safeguards
Noureddine Berrah	Energy Advisor
Subhash Dhingra	Procurement Advisor
Yi Dong	Financial Management Specialist
Na Han	Program Assistant
Cristina Hernandez	Program Assistant
Zeyu Hu	Research Assistant
James Lacey	Financial Sector Consultant
Dilip Limaye	Energy Efficiency Consultant
Yunlong Liu	Procurement Specialist
Rachel Chikiu Mok	Analyst, ICR Contributing Author
Qingpeng Wei	Building Energy Expert
Ning Yang	Environmental Specialist
Yang Yi	Transport Specialist
Shanshan Ye	Program Assistant
Youxuan Zhu	Social Specialist

A. STAFF TIME AND COST

Stage of Project Cycle	Staff Time and Cost	
	No. of staff weeks	US$ (including travel and consultant costs)
Preparation		
FY12	11.085	176,275.62
FY13	12.889	113,051.18
Total	**23.97**	**289,326.80**
Supervision/ICR		
FY14	9.140	42,032.21
FY15	6.143	33,798.62
FY16	10.815	64,039.12
FY17	9.842	40,620.35
FY18	10.844	69,641.87
FY19	17.316	130,247.26
Total	**64.10**	**380,379.43**

ANNEX 3. PROJECT COST BY COMPONENT

Component and source of financing	Estimate at Approval ($m)	Actual at Closing ($m)[11]	Closing as share of Approval
1. Technical Assistance and Near Zero-Emission Building	**10.000**	**37.570**	**376%**
GEF	4.345	4.345	100%
Changning District Government[12]	5.655	13.833	588%
Project developers		19.392	
1.1 Green energy building	**6.660**	**30.733**	**461%**
GEF	2.660	2.138	80%
Changning District Government[12]	4.000	9.203	715%
Project developers		19.392	
1.2 Low-carbon energy supply[13]: GEF	**0.400**	**0.644**	**161%**
1.3 Green mobility	**0.900**	**0.411**	**46%**
GEF	0.300	0.411	137%
Changning District Government	0.600	-	0%
1.4 Capacity building and project management support	**2.040**	**5.782**	**283%**
GEF	0.985	1.153	117%
Changning District Government	1.055	4.630	439%
2. Low-Carbon Investments[14]	**246.00**	**332.19**	**135%**
IBRD	100.00	100.00	100%
Shanghai Pudong Development Bank	50.00	70.25	141%
Bank of Shanghai	50.00	46.68	93%
Project Developers	46.00	115.39	251%
2.1 Green energy retrofit	**231.00**	**91.52**	**40%**
IBRD	85.00	47.12	55%
Shanghai Pudong Development Bank	50.00	1.97	4%
Bank of Shanghai	50.00	0.30	1%
Project Developers	46.00	42.13	92%
2.2 New green-energy buildings	**15.00**	**240.67**	**1,604%**
IBRD	15.00	52.85	352%
Shanghai Pudong Development Bank	-	68.25	n.a.
Bank of Shanghai	-	46.36	n.a.
Project Developers	-	73.21	n.a.
Total	**256.00**	**369.75**	**144%**

[11] US dollar equivalent of actual amounts at closing use an exchange rate of 6.5795 ¥/$, which reflects full disbursement of the GEF Grant.

[12] Estimates at appraisal did not dissagregate between District Government and project developers for Component 1.1. The actual contribution of project developers is derived from Component 1 subproject investment costs less government subsidies per Annex 5.

[13] Component 1.2 actual costs includes low-carbon community activities additional to the original sub-component design at appraisal.

[14] Component 2 actual costs are shown here according to data provided by the PMO in terms of retrofit and new buildings. Large-scale DG activities at existing buildings are taken as included under Component 2.2. See Annex 6 for disaggregation of DG from retrofit and new buildings. Component 2 investment subprojects also included $2.1 million of subsidies from the District Government.

ANNEX 4. KEY POLICIES ON LOW-CARBON BUILDINGS IN CHANGNING AND SHANGHAI

This annex summarizes specific policies and management systems established at the municipal and district levels to contribute to China's 12th and 13th FYP targets.

a) Shanghai Municipality "12th Five-Year Plan for Energy Conservation and Climate Change" issued March 2012.

Shanghai's target was to reduce carbon intensity by 19% and energy intensity by 18% while Changning was to reduce energy intensity by 17%, by 2015 compared to 2005 levels. Both Shanghai and Changning governments also aimed to cap total annual energy consumption by 2015. Changning's target to limit energy consumption to 950,000 tons of coal equivalent (tce) would be equivalent to cutting annual growth of energy consumption by half compared to levels in 2012.

b) Shanghai Municipality "Accelerating the implementation of the construction of energy consumption monitoring system for public buildings", issued May 2012

The objective of this policy is to enhance the energy-saving management of public buildings by building 17 Energy Monitoring District Sub-Platforms and 1 Municipal Office Building Energy Consumption Sub-Platform. The municipal sub-platform will include information on energy consumption statistics, benchmarking analysis, industry monitoring of official buildings and large public buildings in Shanghai, among other things. It is responsible for providing the Municipal Development and Reform Commission and the Municipal Construction and Transportation Commission with the monitoring and analysis data of the performance of buildings in various fields of the city. The 17 district sub-platforms will have functions such as energy consumption statistics, energy efficiency assessment and monitoring for public buildings in the district departments. It is responsible for providing the monitoring and analysis data of the performance of buildings at the district level to the Energy Conservation Office and other relevant district authorities. Each district may expand the scope of their sub-platform according to their respective needs. It was envisioned that by 2014, the energy consumption monitoring systems would fully cover Shanghai's official buildings and large public buildings.

c) Changning District "Low Carbon Development Special Funds Management Measures" issued January 2013

Effective to January 2018, subsidies will be provided for the following types of activities.

Existing buildings:

- Subsidy of 1000 ¥/tce annual saving or 450 ¥/t CO_2 equivalent annual emissions reduction will be provided for building retrofit projects that save at least 50 tce/year.
- Subsidy of ¥20,000 to ¥250,000 for demonstrative projects that provide innovative equipment or EE systems.
- 30% compensation is provided to the actual rent loss for renovation project that experience 6 or more months of interruption to their normal business operation. However, total subsidy for each project should not exceed ¥1 million.

- Subsidy that covers 50% of the total contract fee will be provided for reconstruction plans for projects that are in the proposed transformation list. Total subsidy for each project should not exceed ¥70,000 for each project.

New buildings: New construction projects with energy-saving standard at least 70% compared to the 1980s baseline, should be given the subsidy of 100 ¥/m^2. Specifically, the area of residential building should be more than 20,000 m^2, and public buildings should be more than 10,000 m^2. For residential and public buildings, the total subsidy for each project should not exceed ¥4 million or ¥3 million respectively.

Low carbon transport project: Subsidy provided to low carbon transport projects, such as electric vehicles, slow traffic system construction etc., should not exceed ¥5 million individually.

Distributed energy supply and renewable energy project: These projects are given 20% subsidy based on the actual investment amount, but total subsidy for each project should not exceed ¥3 million. The total energy construction for renewable energy should be more than 100 tce.

Others: The projects with annual energy savings exceeding 50 tce, should receive a subsidy of 1,000 ¥/tce, or equivalent to 450 ¥/t CO_2.

d) Shanghai Municipality "Specials Support Measures for Building Energy Saving and Green Building Demonstration Projects" issued 2016

Municipal special funds for energy conservation and emission reduction are used to support the following types of energy saving and green building demonstration projects.

- For Green Building demonstration projects: "two-star" green building projects receive 50 ¥/m^2, and "three-star" green building projects receive subsidy of 100 ¥/m^2.[15]
- Projects that meet "integrated assembly standards"[16] receive a subsidy of 100 ¥/m^2.
- For existing buildings: Residential buildings receive 50 ¥/m^2. Public buildings that decrease energy consumption in the building area by 20% or more receive a subsidy of 25 ¥/m^2. Public buildings that decrease energy consumption in the building area by 15% to 20% receive subsidy of 15 ¥/m^2.
- Existing building exterior window or external shading energy-saving transformation demonstration project receive a subsidy of 150 ¥/m^2. Simultaneous implementation of building exterior window and external shading energy-saving transformation projects receive a subsidy of 250 ¥/m^2.
- Demonstration projects that integrate solar energy into buildings receive a subsidy of 45 ¥/m^2, and demonstration projects that integrate geothermal energy into buildings receive a subsidy of 55 ¥/m^2.
- Buildings with roof gardens receive a subsidy of 200 ¥/m^2; combination roof greening area receive a subsidy of 100 ¥/m^2; and lawn roof greening receive a subsidy of 50 ¥/m^2; general wall greening receive a subsidy of 30 ¥/m^2; and special wall greening receive a subsidy of 200 ¥/m^2.

[15] The two start and three star ratings refer to China's voluntary Green Building Design Label Rating established in 2007. Three stars is the highest rating. The ratings involve six criteria: landuse and outdoor environment; energy efficiency; water efficiency; resource efficiency; indoor environment; and operational management. For more information see Khanna & others (2014.

[16] The original term in Chinese is 符合装配整体式建筑.

The policy notes that a single integrated assembly standard demonstration project has a maximum subsidy of ¥10 million, and other demonstration projects receive a maximum of ¥6 million. This policy has no provision for an end date of effectiveness.

e) Shanghai Municipality "13th Five-Year Plan for Energy Conservation and Climate Change" issued March 2017

This set targets to ensure that public buildings would meet "two-star" and above standards. It would also popularize and apply high-performance energy-saving doors and windows; and promote specific low carbon technologies for existing buildings, such as efficient air conditioning, and energy-saving lighting products. It also sets target for reducing energy intensity and carbon intensity for the municipality and for each of the 16 districts. For Shanghai overall, the target is to reduce energy intensity by 17% and carbon intensity by 20.5% by 2020 as compared to 2015 levels. For Changning and for six other districts the target is to reduce energy intensity and carbon intensity both by 15%. The remaining 9 districts have targets of between 16% and 18% reduction. In additional, all districts have a target of not allowing energy consumption to increase by more than 2% per year.

f) Changning District "Low-Carbon Development Special Funds Management Measures" issued May 2018

The measures establish a series of special funds to support projects that contribute to the energy saving and emission reduction targets of the 13th FYPs. The following types of projects are supported by the fund.

- For existing buildings that meet the requirements for energy-saving renovation: if the energy consumption per unit of building area reduces by 20% or more, the subsidy will be 25 ¥/m^2. For buildings that reduce the energy consumption per unit of building area by 15% to 20%, the subsidy is 15 ¥/m^2. The total subsidy amount for a single project should not exceed ¥2.5 million.
- Existing public buildings that adopt a new mode of energy-saving management (e.g. energy storage) can be subsidized by 10% or more per square meter. The subsidy for a single project does not exceed ¥1 million.
- For new buildings that emit no more than 25 kg CO_2/year/m^2 and have a single building area of 4,000 m^2 and above, subsidies are granted in accordance with 50% of the incremental cost of the new building EE standard in Shanghai. The subsidy per unit of construction area shall not exceed 600 ¥/m^2 and the subsidy amount for a single project shall not exceed ¥5 million.
- Low carbon demonstration projects that won the honorary title of "Shanghai Green Renewal Project" receive a subsidy of ¥250,000 for first-class honor, ¥200,000 for second-class honor and ¥150,000 for third-class honor. Buildings that participate in grid demand-response management schemes agreed with relevant authority to receive a subsidy of 6 ¥/kWh.

g) Shanghai Municipal Government "Public Buildings and Large Public Buildings Energy Monitoring System Management Measures" issued June 2018

From June 2018 to June 2023, Shanghai's Ministry of Housing and Urban-Rural Development together with the Development and Reform Commission will be responsible for establishing and managing an

Energy Monitoring System for large public buildings. Every district within Shanghai will be responsible for establishing its energy monitoring system for official public buildings and large public buildings in accordance with these rules and guidance. New buildings that have a floor area of 10,000 m^2 and above, as well as new public buildings that have a floor area of 20,000 m^2 and above, or existing government official buildings that are undergoing retrofitting should establish their own energy monitoring systems. The energy monitoring systems at each level should regularly provide reports to analyze the energy consumption of buildings. Shanghai's Ministry of Housing and Urban-Rural Development together with the Development and Reform Commission will analyze the status of buildings' energy management every year and will publish the results on an annual basis.

h) Changning District Public "Buildings Energy Efficiency Management Measures" issued October 2018

Changning seeks to establish a District Low Carbon Project Center to pilot work on EE benchmarking for public buildings. Building owners are required to provide basic information on the energy consumption of their buildings. A third-party organization will work with the District's energy supply enterprise or the District Bureau of Statistics to review the completeness and accuracy of data. The energy monitoring platform will include data from large buildings with a single building area of 20,000 m^2 or above; office buildings with a building area of 10,000 m^2 or above; and public buildings with energy consumption of more than 500 tce/year. The energy efficiency data of different buildings will be collected to form benchmarking values in accordance with national guidelines. Threshold values will be calculated, and buildings will be divided into three levels according to their energy efficiency standards: "advanced", "standard" and "below standard". The District Low Carbon Center will urge building owners to promote energy conservation for buildings that fail to meet the standards for two consecutive years.

The EE benchmarking work will be carried out once a year. In the first quarter of each year, the District Low Carbon Center will determine the participation of public buildings in this benchmarking exercise after reviewing the annual work plan for EE of public buildings. The District Low Carbon Center will compile and publish annual analysis report on EE benchmarking of public buildings in Changning. This report will be submitted to the District Development and Reform Commission's Energy Conservation Office, the District Construction and Transportation Commissions, the District Commercial Committee and the District Housing Management Bureau.

The policy effectiveness period is until December 2020.

ANNEX 5. LOW-CARBON BUILDING SUBPROJECTS

Table 5-1: List of 67 low-carbon building subprojects supported under the Project

Note: Table is sorted by emissions reduction from large to small. Shaded rows denote Component 1 subprojects. Investment data are estimates subject to adjustment pending audit. "Ref." = PMO database reference number. "New" = new building. "Gov." = Changning District Government grant.

Subproject building name	Ref.	District	Building type	Activity type	Floor area (m^2)	Investment (¥m)	Financier		Energy savings (tce/year)	Emissions reduction (tCO_2/year)
							Bank	Gov. (¥m)		
Disneyland International Tourism and Resorts Zone Energy Station 迪士尼乐园国际旅游度假区能源站	7	New Pudong	Tourism	DG	19,748	580.00	SPD	-	18,074	62,900
Shanghai Qingpu Industrial Park 青浦工业园区	6	Qingpu	Industrial	DG	462,000	190.00	SPD	-	7,225	15,599
Changfeng Sector No. 10 South Block Project 长风板块10号南地块项目	41	Putuo	Office	EE new	356,949	305.04	BOS	-	4,993	10,780
Hongxiao Airport Terminal 1 虹桥机场T1航站楼	8	Changning	Airport	EE retrofit	126,000	130.58	SPD	-	4,875	10,237
Network Audio-Visual Industry Base 网络视听产业基地	14	Minhang	Industrial	EE new	223,126	66.66	SPD	-	4,195	9,058
Shanghai Sky Mall 上海仲盛世界商城	4	Minhang	Shopping mall	EE retrofit	287,124	23.71	SPD	-	3,037	6,298
Qiantan Plot 24-01 30-01 前滩24-01 30-01 地块	20	New Pudong	Other commercial	EE new	126,865	164.25	SPD	-	2,556	5,520
Shanghai Tower Energy Station 上海中心大厦能源站	9	New Pudong	Multi-purpose	DG	576,000	36.85	SPD	-	1,407	4,812
Junhua Financial Plaza 上海君康金融广场	40	New Pudong	Other commercial	EE new	105,798	123.86	BOS	-	2,014	4,348
Xinjiangwancheng F3 Area Office Building 新江湾城F3地块办公楼	19	Yangpu	Office	EE new	276,366	39.06	SPD	-	1,377	2,973

Subproject building name	Ref.	District	Building type	Activity type	Floor area (m^2)	Investment (¥m)	Financier		Energy savings (tce/year)	Emissions reduction (tCO_2/year)
							Bank	Gov. (¥m)		
Hongqiao Jin Jiang Hotel Shanghai 虹桥喜来登上海太平洋大饭店	54	Changning	Hotel	EE retrofit	68,133	11.55		2.50	1,139	2,966
Nan Zheng Buildiung 上海南证大厦	11	Huangpu	Other commercial	EE retrofit	110,715	11.85	SPD	-	1,109	2,578
Renaissance Shanghai Yangtze Hotel 上海扬子江万丽大酒店	49	Changning	Hotel	EE retrofit	60,605	14.09		2.50	1,236	2,480
Shanghai Mart 上海世贸商城	48	Changning	Other commercial	EE retrofit	282,140	18.94		2.50	1,013	2,475
Shanghai Lingang Industry Area I临港	5	New Pudong	Industrial	DG	40,000	24.58	SPD	-	1,039	2,243
Huamin Empire Plaza 华敏翰尊国际大厦	30	Changning	Office	EE retrofit	144,241	11.75	BOS	2.50	940	2,029
Longemont Shanghai Hotel 上海龙之梦大酒店	23	Changning	Other commercial	EE retrofit	110,600	22.46	BOS	2.50	1,618	1,945
Hongqiao State Guest Hotel 虹桥迎宾馆	55	Changning	Hotel	EE retrofit	65,930	11.61		2.50	985	1,911
Far East International Plaza 远东国际大厦	24	Changning	Office	EE retrofit	103,355	10.82	BOS	2.20	844	1,822
Gubei International Fortune Center Phase II 古北国际财富中心二期	52	Changning	Office	EE retrofit	101,800	4.81		0.72	795	1,717
Shanghai International Trade Center 上海国际贸易中心	56	Changning	Office	EE retrofit	92,518	11.37		2.35	792	1,670
Maxdo Centre 上海万都中心大厦	62	Changning	Office	EE retrofit	117,561	5.69		1.42	718	1,659
Huada Semiconductors Headquarters 华大半导体总部	16	Minhang	Office	EE new	91,394	45.74	SPD	-	744	1,606
Songjiang District Central Hospital 松江区中心医院	25	Songjiang	Hospital	EE retrofit	50,587	4.28	BOS	-	781	1,588
Huayu Building 华姿奔腾大厦	10	Baoshan	Other commercial	EE new	102,000	44.66	SPD	-	708	1,529

Subproject building name	Ref.	District	Building type	Activity type	Floor area (m^2)	Investment (¥m)	Financier		Energy savings (tce/year)	Emissions reduction (tCO_2/year)
							Bank	Gov. (¥m)		
Radisson Blu Hotel Shanghai 上海兴国丽笙大酒店	60	Changning	Hotel	EE retrofit	59,643	9.39		2.34	755	1,516
Ruijin Hospital, Outpatient Building 上海瑞金医院门诊医技楼	29	Huangpu	Hospital	EE retrofit	73,271	8.10	BOS	-	990	1,449
Zhaofeng World Trade Center 兆丰世贸大厦	44	Changning	Office	EE retrofit	48,838	6.32		0.51	649	1,398
Zhanzhuang Business District 16A01A North Block 莘庄商务区16A01A北块	34	Minhang	Other commercial	EE new	80,366	49.92	BOS	-	643	1,388
Shanghai Yitai Building 上海协泰大厦	22	Changning	Office	EE retrofit	31,803	7.80	BOS	1.96	606	1,309
Hongqiao Business District North Zone No. 8 虹桥商务区北片区08号地块	18	Minhang	Office	EE new	74,508	35.70	SPD	-	560	1,209
340 Wujiaochang Town 五角场镇340街坊	13	Huangpu	Office	EE new	89,109	19.27	SPD	-	501	1,083
Millennium Hongqiao Hotel Shanghai 上海千禧海鸥大酒店	2	Changning	Hotel	EE retrofit	44,798	6.66	SPD	1.64	809	1,081
Zhanzhuang Business District Lot 19A-03A 莘庄商务区19A-03A地块	37	Minhang	Other commercial	EE new	62,728	24.54	BOS	-	420	906
Crowne Plaza Shanghai Xiayang Lake 夏阳湖宾馆	36	Qingpu	Hotel	EE retrofit	45,000	4.15	BOS	-	440	869
Minghu Research Center Building ABC 明沪科研大楼ABC楼	68	Changning	Office	EE new: high standard	108,445	13.70		3.00	384	825
Rehabilitation Institute No. 2 第二康复院	35	Yangpu	Hospital	EE retrofit	27,682	2.88	BOS	-	381	823
Shanghai International Medical Centeral - Technology Center 上海新虹桥国际医学中心医技中心	15	Minhang	Hospital	EE new	89,137	17.44	SPD	-	368	795
Shanghai Municipal Building 上海市政大厦	27	Huangpu	Office	EE retrofit	73,766	7.41	BOS	-	501	792
Gubei Tower Phase 1 古北财富一期	66	Changning	Office	EE retrofit	38,881	3.21		0.36	333	720

Subproject building name	Ref.	District	Building type	Activity type	Floor area (m^2)	Investment (¥m)	Financier		Energy savings (tce/year)	Emissions reduction (tCO_2/year)
							Bank	Gov. (¥m)		
Chemical Park Lighting Renovation 化工园区灯改造	32	Fengxian	Industrial	EE retrofit	20,000	2.40	BOS	-	302	653
East Century Building 东方世纪大厦	53	Changning	Other commercial	EE retrofit	26,884	5.10		1.06	302	651
HSBC Building, the Bund 外滩浦发大厦	26	Huangpu	Other commercial	EE retrofit	28,000	4.97	BOS	-	292	631
Hongqiao Silver City Building 虹桥银城大厦	21	Changning	Office	EE retrofit	30,840	7.20	BOS	1.12	281	607
Changfeng Tower 长峰中心大厦	47	Changning	Office	EE retrofit	53,990	4.58		1.74	285	599
Jianguo Hotel 建国宾馆	33	Xuhui	Hotel	EE retrofit	43,000	10.09	BOS	-	478	539
Sheng Gao International Building 盛高国际大厦	57	Changning	Office	EE retrofit	41,759	4.41		0.72	247	533
Changning Police Station 长宁公安分局	50	Changning	Office	EE retrofit	25,659	3.55		2.34	246	528
Wenguang Tower 文广大厦	58	Changning	Other commercial	EE retrofit	42,229	5.30		1.39	279	525
Oasis Tower 上海绿洲大厦	46	Changning	Hotel	EE retrofit	22,000	4.68		0.36	233	493
Shanghai Luodian Middle School 上海罗店中学	39	Baoshan	School	EE retrofit + DG	6,300	3.80	BOS	-	224	483
District Government Building 区政府大楼	65	Changning	Office	EE retrofit	49,118	4.34		4.34	221	478
Shanghai Shen Ya Financial Building 上海申亚金融大厦	1	Changning	Office	EE retrofit	23,697	4.41	SPD	1.04	221	477
Mercure Shanghai Royalton 上海虹桥美仑美居酒店	61	Changning	Hotel	EE retrofit	22,779	2.46		0.57	209	450
XingHua Hotel 兴华宾馆	3	Changning	Hotel	EE retrofit	20,700	3.70	SPD	0.92	199	426
Youth Center 青少年中心	31	Jing'an	Other commercial	EE retrofit	60,000	4.12	BOS	-	200	423
Xiada Tower 鑫达大厦	63	Changning	Office	EE retrofit	34,267	5.76		1.44	238	406

Subproject building name	Ref.	District	Building type	Activity type	Floor area (m^2)	Investment (¥m)	Financier		Energy savings (tce/year)	Emissions reduction (tCO_2/year)
							Bank	Gov. (¥m)		
New Hongqiao Tower 新虹桥大厦	59	Changning	Office	EE retrofit	27,119	3.13		0.75	172	370
Kaqi Tower 嘉麒大厦	45	Changning	Office	EE retrofit	24,911	2.06		0.52	144	311
Qianyuan Science and Technology Park 舜元科创园	69	Changning	Office	EE new: high standard	32,507	4.50		3.00	131	284
Pacific Hotel 上海金门大酒店	28	Huangpu	Hotel	EE retrofit	17,677	3.08	BOS	-	199	244
Shanghai Yuchu Industrial Co., Ltd. 上海昊初实业有限公司	38	Jinshan	Industrial	EE retrofit + DG	63,000	2.99	BOS	-	103	223
Changning Library 长宁图书馆	64	Changning	Office	EE retrofit	16,932	3.02		1.77	100	217
Minghu Research Center Building D 明沪科研大楼D楼	67	Changning	Office	EE new high standard	25,903	3.62		3.00	98	213
Hongqiao State Guest Hotel Building 9 虹桥迎宾馆9号楼	70	Changning	Hotel	EE retrofit: NZE + DG	3,064	7.39		3.36	49	106
Lai Bao Plaza 丽宝广场	17	Minhang	Other commercial	EE new	55,284	3.18	SPD	-	44	96
Golden Bell Plaza 金钟广场	12	Huangpu	Other commercial	EE retrofit	4,500	1.12	SPD	-	33	72
Total, Component 1 subprojects					**1,493,614**	**174.59**	n.a.	**47.04**	**11,752**	**25,502**
Total, Component 2 subprojects					**4,378,034**	**2,071.07**	n.a.	**13.87**	**66,331**	**164,444**
GRAND TOTAL					**5,871,648**	**2,245.66**	n.a.	**60.92**	**78,083**	**189,946**

Table 5-2: Distributed Generated Subproject details

Note: PV = photovoltaic. ICE = internal combustion engine. kWp = kilowatt peak. MWh = megawatt-hour. GJ = gigajoule.

Subproject name	Ref.	Installed Capacity	Electrical output (MWh/year)	Heating output (GJ/year)	Cooling output (GJ/year)	Compressed air output (10^6 m^3/year)
Disneyland International Tourism and Resorts Zone Energy Station	7	• Eight 4.035 MW gas-fired ICE • Eight 3.49MW lithium bromide chiller • Two 3.0MW centrifugal chillers • One 6.3MW centrifugal chiller • Three 8.4MW hot water boilers	144,626	234,000	591,000	58.6
Shanghai Tower Energy Station	9	• Two 1.165MW gas-fired ICE • Two 1.047MW lithium bromide chiller	12,370	16,651	31,729	-
Shanghai Qingpu Industrial Park	6	20,000 kWp PV	21,696	-	-	-
Shanghai Lingang Industry Area	5	3,000 kWp PV	3,120	-	-	-
Shanghai Luodian Middle School	39	700 kWp PV	710	-	-	-
Shanghai Yuchu Industrial Co., Ltd.	38	350 kWp PV	340	-	-	-
Hongqiao State Guest Hotel Building 9	70	51 kWp PV	35	-	-	-
TOTAL		• 24.10 MWp PV • 34.61 MW gas-fired ICE • 27.92 MW lithium bromide chiller • 12.3 MW centrifugal chiller • 25.2 MW hot water boiler	**182,897**	**250,651**	**622,729**	**58.6**

ANNEX 6. EFFICIENCY ANALYSIS

Economic and financial analysis at appraisal

During project preparation, economic analysis was carried out to identify, distinguish and prioritize a large set of potential low-carbon activities for Changning District. A second level of cost-benefit analysis for five representative subprojects found that they would be economically viable, and would be financially viable with modest government subsidies.

At the Changning level, analysis was conducted in three steps. First, Hongqiao Demonstration Zone, as a representative area of Changning District, was comprehensively surveyed to identify the levelized cost and carbon reduction potential of diverse mitigation options. This provided the data for a marginal abatement cost (MAC) curve. The analysis distinguished three categories of intervention: 'do it now' for low-cost technologies ready to be applied at full scale; 'start now, then accelerate' for low-cost technologies still in the process of becoming standardized such that small-scale implementation had strategic value; and 'develop now, capture over time' for technologies that have high costs or are otherwise difficult to implement. Second, three alternative abatement scenarios were analyzed for the zone to examine their aggregate carbon reduction potential through to 2020. The three scenarios were: "Frozen Technology Scenario" assuming frozen penetration of existing technologies and no adoption of new technologies; "Baseline Scenario" assuming sustainable technology development across all sectors to achieve the national government's target; and "Stretch Scenario" assuming maximum technical potential under constraints of technology applicability and maturity. Finally, the results in Hongqiao demonstration zone were extrapolated to all of Changning District.

The analyses concluded that mitigation measures in Changning per the Stretch Scenario could reduce greenhouse gas emissions by 197,500 tons CO_2e in mid-2018 as compared to the Baseline Scenario. This would be equivalent to reducing the carbon intensity of Changning's economy by 30.2 percent below the 2010 level.[17] Building retrofits would contribute more than half of this reduction, around a quarter would come from purchase of green power[18] and distribution generation, and the remaining 15% or so from new buildings, transport, and training and behavior change. Around half of abatement potential had a negative levelized cost of carbon abatement, meaning that such activities could be profitable without valuing carbon. The values ranged from about -2,000 ¥/(tCO_2e/year) to more than 10,000 ¥/(tCO_2e/year).

For the activity-level cost-benefit analysis, five types of subprojects covered typical buildings to be financed under the project in Changning district – a hotel, an office building, a hospital, a mixed-use commercial building, and a mixed-use building with a hotel, restaurants and offices. The key assumptions for this analysis are listed in Table 6-1 below. The economic costs include investment costs and additional operation and maintenance costs. All cost excludes taxes and duties and financing costs. The primary economic benefits include energy saving (mainly electricity and diesel) and associated environmental benefits from the reduction of energy consumption (i.e. reduced CO_2, SO_2 and particulate emissions). The analysis showed that the EIRR for the representative subprojects would range from 12.4% to 33.9%, exceeding the 12% economic discount rate that

[17] This value if based on constant rate (2.4 points/year or 20.2 kt CO2/year) between 2015 and 2020, per the economic analysis extrapolated from Hongqiao.

[18] 'Green power' meant that end users voluntarily purchase certificates to guarantee that power is generated from renewable sources at a certain quantity (and in a certain time frame and geographical area) so as to offset some or all of the grid electricity they consume, which in China comes mostly from non-renewable sources.

was applied to Bank projects in China at the time of appraisal. Economic net present value (NPV) was provided for one sample subproject, a hospital, with a value of ¥3.5 million for base year 2013.

Financial analysis was also carried out for five typical subprojects in two scenarios, with and without subsidies. The results showed that the FIRR for the five sub-projects without government subsidies would range from 10.1% to 31.9% and the payback periods from 2.6 to 6.7 years, beyond the normal range of 3-5 years that are attractive for investors. However, with government subsidy considered, the FIRRs increased to a range of 14.4% to 38.3%, and the payback periods of all five subprojects were less than 5 years, ranging from 2.1 to 4.8 years.

The analyses at appraisal did not consider benefits and costs to the grid company of deferred distribution infrastructure upgrade and foregone revenue resulting from reduced building demand for grid electricity. It also did not include sensitivity analysis.

Economic and Financial Analysis at completion

At completion, the economic and financial costs and benefits were analyzed for 29 different types of abatement technologies deployed in 67 building subprojects, resulting in detailed data on 287 building-technology interventions. Sensitivity analysis was also carried out. The analysis focuses mainly on the 63 investment subprojects besides the four demonstration buildings, comprising the 22 supported by subsidies under Component 1 and 41 subprojects that received loans under Component 2. The results confirm both the economic viability and financial viability of the project as a whole, and of most if not every single subproject by various measures. Key parameters are presented in Table 6-1 below and the main results in Table 6-2. Assumptions in addition to those listed in Table 6-1 are otherwise the same as appraisal (e.g. excludes tax).

Table 6-1: Parameters for economic and financial analysis at appraisal and completion

Item	Unit	Appraisal	Completion
Assumptions			
Energy price, electricity	¥/kWh	0.820 [19]	0.955
Energy price, diesel	¥/ton	7,200	6000
Energy price, natural gas	¥/m^3	2.04	4.333
Carbon emission factor, electricity	g CO_2/Wh	0.719	0.719
Carbon emission factor, diesel	g CO_2/g	3.160	3.0997
Carbon emission factor, natural gas	kg CO_2/m^3	2.130	2.117
Social value of carbon emissions reduction	$/(t CO_2/year)	$20	$33 in 2013 increasing to $63 in 2040 at 2017 prices
Social value, Total Suspended Particulates	¥/(t/year)	51,328	51,328
Social value, sulfur dioxide	¥/(t SO_2/year)	3,353	3,353
Social value, nitrous oxides	¥/(t NO_x/year)	2,382	2,382
Exchange rate	¥/$	6.22	6.7

[19] The PAD gives this, incorrectly, as 820 ¥/kWh.

Table 6-2: Results for economic and financial analysis at appraisal and completion

		Appraisal	Completion				
			63 investment subprojects				4 demonstration subprojects (1 NZE retrofit with small DG; 3 high-standard EE new buildings)
		5 EE retrofit subprojects (of which 2 with small DG)	46 EE retrofit (of which 2 with small DG)	13 EE new buildings*	4 large DG	63 investment subprojects	
Floor area per subproject, average	m^2	n.e.	61,137	133,356	274,437	87,637	42,480
Investment per subproject, average	¥ million	(22.3 to 5.0)	9.64	72.26 [37.44]*	207.86	33.52 (1.12 to 580.00)	7.30
Effective lifetime, weighted average (range)	years	(4 to 25)	n.e.	n.e.	n.e.	21.5 (8 to 25)	n.e.
Subsidy per subproject, average (range)	¥ million	5.84 for one project	1.67	n.a.	n.a.	1.79 (0.36 to 60.92) for 34 subprojects	3.09
Energy savings per subproject, average (range)	tce/y	(153 to 707)	651	1,471	6,936	1,165 (33 to 18,074)	166
Carbon reductions per subproject, average (range)	t CO_2/y	(331 to 1,925)	1,314	3,176	21,839	2,835 (72 to 62,900)	357
Economic value including CO_2 benefit and local pollutants							
Economic IRR, weighted average (range)	%	12.4 to 33.9	23.1	12.9 [22.5]*	17.0	17.6 (6.6 to 63.7)	5.1
Economic NPV with base year 2013 at 12% social discount rate	$ million	0.56 for one project	n.e.	n.e.	n.e.	Sum: 122.85 Average: 1.95 (-46.84 to 53.46)	n.e.
Financial value from project developer perspective including tax							
Financial IRR including subsidy	%	14.4 to 38.3	n.e.	n.a.	n.a.	13.9 (3.2 to 53.6)	n.e.
Financial IRR excluding subsidy	%	10.1 to 31.9	n.e.	n.e.	n.e.	13.4 (3.2 to 52.7)	n.e.
Static payback period incl. subsidy	years	2.6 to 6.7	n.e.	n.a.	n.a.	5.7 (1.7 to 13.8)	n.e.
Static payback period excl. subsidy	years	2.1 to 4.8	n.e.	n.e.	n.e.	5.6 (1.9 to 13.8)	n.e.

Note: "EE" = energy efficiency; "DG" = distributed generation; "NZE" = near-zero emissions. "n.e." = not estimated; "n.a." = not applicable.
* Actual investments for new building EE included the total costs of EE measures. Estimated incremental cost compared to low-efficiency counterfactual is shown in square brackets.

Costs. For the 63 subprojects excluding four demonstration sites, the average investment cost of subproject was ¥33.5 million ranging from around ¥1 million for a small commercial building up to ¥580 million for the Disney International Tourism and Resort Zone Energy Station Distributed Generation subproject. The average cost of new building EE technologies was ¥72.26 million, which includes total cost of measures approved according to the Operations Manual as revised at the mid-term review. If including only the incremental cost relative to low-efficiency counterfactual technologies, the average investment cost of new EE buildings would decrease to ¥37.44 million. Taken as a group, the incremental cost of new building EE technologies relative to low-efficiency counterfactual technologies was on average 51.8% of the total cost of new building EE technologies. Table 6-3 shows the investment breakdown per technology an per subproject for new EE buildings.

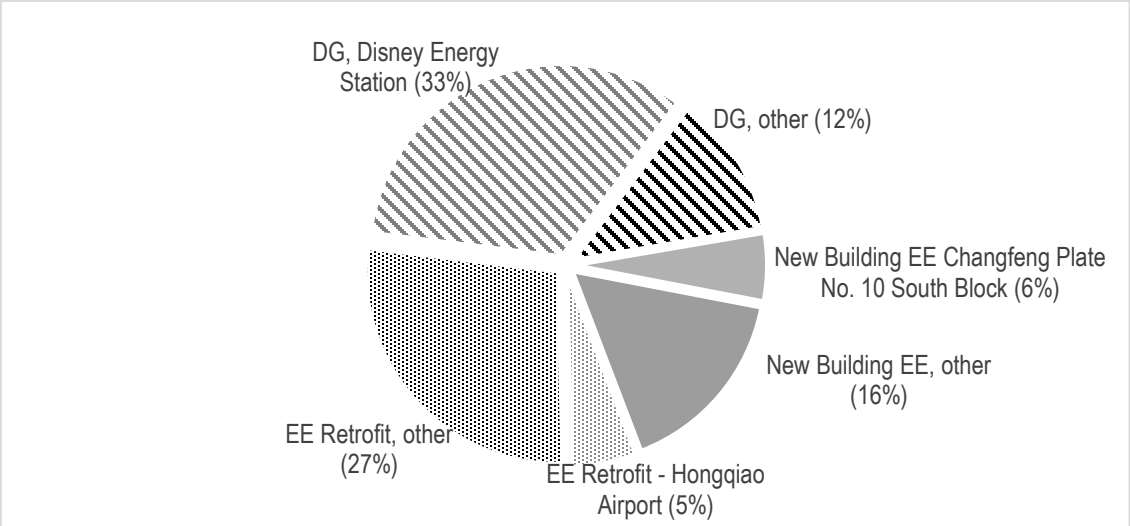
Table 6-3: Incremental investment cost breakdown by new building EE technology and by subproject

New EE Buildings by Technology and Building	Ref.	Total cost financed (¥m)	Incremental cost compared to traditional low-efficiency design (¥m)	Incremental cost as share of total (%)	FIRR (%) on total cost
Total		**939.32**	**486.74**	**51.8%**	n.e.
By technology					
Air Conditioning System Renovation Measures		49.92	10.55	21.1%	n.e.
Exterior Window Renovation		20.93	7.63	36.4%	n.e.
Glass Curtainwall		597.45	267.85	44.8%	n.e.
Transformer		15.12	7.28	48.2%	n.e.
Roof Greening		7.87	4.19	53.2%	n.e.
External Wall Insulation		131.30	76.76	58.5%	n.e.
Roof Insulation		28.18	23.94	85.0%	n.e.
LED Lights		1.69	1.69	100.0%	n.e.
Air Source Heat Pump		66.66	66.66	100.0%	n.e.
Solar Water Heating System		1.30	1.30	100.0%	n.e.
Chiller		18.90	18.90	100.0%	n.e.
By sub-project					
Huayu Building	10	44.66	29.05	65.1	5.21
Qiantan 24-01 30-01 Plot	20	164.25	85.04	51.8	6.99
Hongqiao Business District North Zone No. 8	18	35.70	18.40	51.5	7.13
Shanghai International Medical Technology Center	15	17.44	9.87	56.6	7.29
Huada Semiconductors Headquaters	16	45.74	23.07	50.4	7.72
Lai Bao Plaza	17	3.18	1.08	33.9	8.76
340 Wujiaochang Town	13	19.27	11.13	57.8	8.82

New EE Buildings by Technology and Building	Ref.	Total cost financed (¥m)	Incremental cost compared to traditional low-efficiency design (¥m)	Incremental cost as share of total (%)	FIRR (%) on total cost
Changfeng Plate No. 10 South Block Project	41	305.04	138.67	45.5	9.08
Junhua Financial Plaza	40	123.86	53.37	43.1	9.61
Xinjiangwancheng F3 Area Office Building	19	39.06	30.00	76.8	10.68
19A-03A Lot of Zhanzhuang Business District	37	24.54	9.85	40.1	11.05
Network Audio-Visual Industry Base	14	66.66	66.66	100.0	15.73
Zhanzhuang Business District 16A01A North Block	34	49.92	10.55	21.1	16.21

Benefits. The main benefits were energy savings and emissions reductions. The Disney subproject accounted for almost a third of project results across all 67 subprojects, making distributed generation the most significant contributer to total emissions reductions at 45% (Figure 6-1). EE retrofitting contributed 33% of all emissions reductions and new buildings the remaining 22%. The largest emissions reduction of any EE retrofit and new EE building subproject were respectively the Hongqiao Airport Terminal 1 and Changfeng Plate No. 10 South Block Project, which each accounted for 5% of total emissions reductions. Overall, the volume of emissions reduction achieved from all building subprojects was 189,946 t CO_2/year as of 2018. This is 96% of the 197,500 t CO_2/year reduction forecast to be possible for Changning under a Stretch Scenario compared to the Baseline Scenario by mid-2018. However, the outcome cannot be directly compared with the macro-level appraisal estimates for Changning as most emissions reductions (76%) occurred outside Changning.

Figure 6-1: Share of emissions reductions (tCO_2/year) from 63 subprojects by activity type and largest subproject of each activity type



Efficiency indicators. For the 63 investment subprojects, the overall weighted average EIRR is 17.6%, ranging from 12.9% for new EE buildings (including the total cost financed for new EE buildings) to 23.1% for building retrofits. These EIRR values well exceed the 10.6% social discount rate benchmark relevant to projects in China according to current World Bank guidelines[20] as well as the more conservative EIRR benchmark of 12% used at appraisal. The 1 NZE building and three high-performance buildings have relatively low returns with a weighted average EIRR of 5.1%. They comprised only 1% of total costs so their inclusion in the project would not affect the overall project-level EIRR. The economic net present value (NPV) of the 63 subprojects is $122.85 million, ranging from negative $46.84 million to positive $53.46 million using the conservative discount rate of 12%. In terms of financial indicators, including government subsidies, the FIRR of the 63 investment subprojects is 13.9%, and the static payback period is 5.7 years. While the weighted average financial indicator values show slight underperformance compared to the range expected at appraisal for the 63 subprojects as a set, all retrofit projects had payback periods within the 12-year criterion agreed at appraisal.

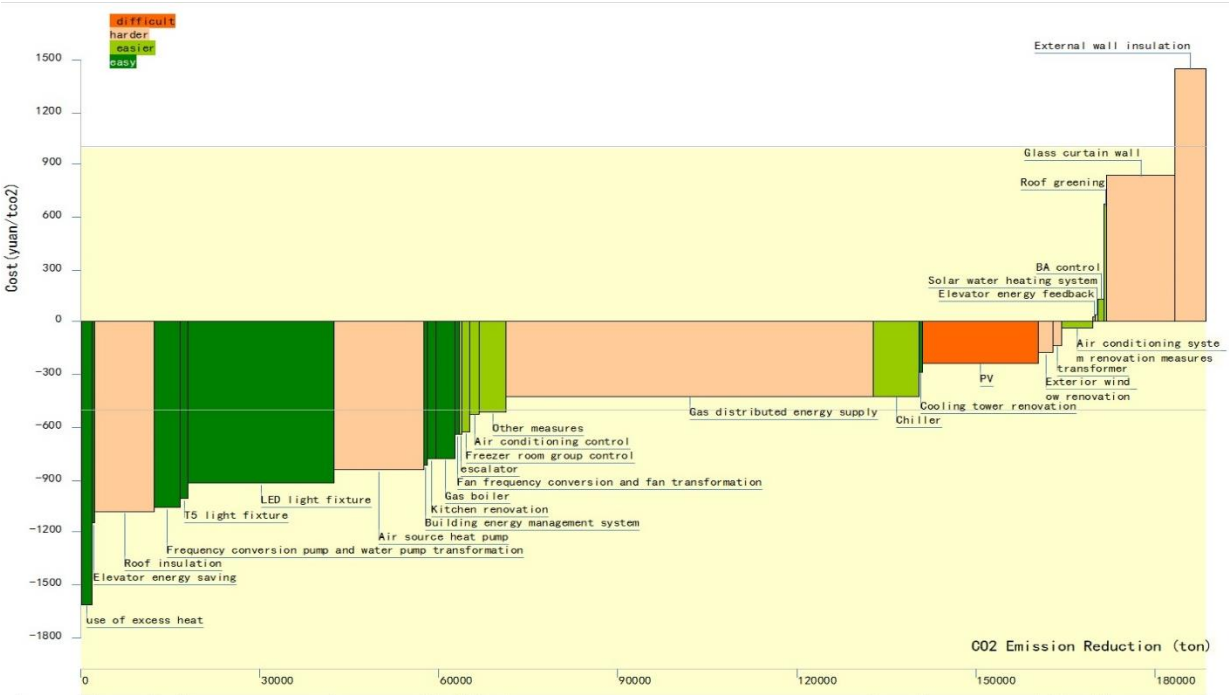
Caveats and remarks. Both the economic and financial performance of new EE building subprojects and thus the whole portfolio are understated for multiple reasons. First, the total financed costs of the new EE building measures are accounted, without accounting for the benefit of services (e.g. lighting) that they direct provide for the owner and user of the new buildings. Sensitivity analysis of the economic and financial indicators found that the two factors – the cost of investment, and the amount of energy savings – have roughly equal importance. A positive or negative variation of 10% in either factor would each impact EIRR by around 2.0 percentage points and would impact FIRR by 1.7 points. By extension, accounting for only the incremental cost of new building EE technologies relative to low-efficiency counterfactual technologies would increase the EIRR of new building EE subprojects from 12.9% to 22.5%, as shown in Table 6-2. Second, the analysis uses a low value of carbon pricing under the World Bank guidelines. The high value of carbon pricing under the same guidelines would significantly increase the economic benefits. Third, social values of local pollution reduction are used in the same nominal terms from 2013, whereas they could be increased to reflect inflation and economic growth. Fourth, the analysis excludes benefits of measures for new buildings and retrofits such as greater comfort and usability of space. Fifth, the support for demonstration projects provide unquantified benefits of generation experience and innovations that lead to declining costs over time as learn lessons learned are applied to replication across China. Meanwhile, as at appraisal, the analysis at completion did not consider benefits or costs to the grid company of deferred distribution infrastructure upgrade and foregone revenue resulting from reduced building demand for grid electricity. However, the overall growth trajectory of energy demand in Shanghai is such that the grid company can be considered well-placed to cope with the marginal impact.

The efficiency of subprojects varies widely depending on the type of subproject activity and the combination of technologies involved. Figure 6-2 shows the MAC curve of the 29 technologies, which can also be grouped in seven categories per Table 6-5. Some technologies such as light-emitting diodes (LEDs) are highly profitable and have benefited from cost reductions in recent years. Enclosure structure technologies such as external

[20] The *2016 Guidance Note: Discounting Costs and Benefits in Economic Analysis of World Bank Projects* to use a benchmark social discount rate equivalent to double the average growth in GDP per capita over the project's economic lifetime. The economic lifetime of the 70 subprojects varies from 8 to 25 years, with as a weighted average of 21.5 years. Growth in GDP per capita in China has decreased from 6.6% in 2015 when most investments began to 6.7% in 2018 at completion, and is forecast to reach 3.7% in 2037 according to World Bank staff estimates. This gives an average value of 5.3% over the period 2013 to 2037, implying a social discount rate of 10.6%.

wall insulation remain relatively expensive largely due to site-specific characteristics that make mass deployment challenging, ahead of standardization. This is consistent with expectations at appraisal.

Figure 6-2: Marginal abatement cost curve for 29 low-carbon building technologies as implemented



Source: Changning Low-Carbon City Project Management Office

Table 6-5 – Efficiency indicators for 29 retrofit and new building technology measures by type

Category	Investment (¥m)	Economic Net Present Value	Static Payback Period (year)	FIRR (%)	EIRR (%)
HVAC and hot water Supply systems	372.16	116.20	5.35	17.27	21.22
Power supply and lighting	72.78	112.91	1.97	48.60	60.77
Power and other equipment	26.81	12.01	3.93	22.05	29.05
Applications of renewable energy	824.79	25.74	6.83	12.54	16.65
Monitoring and control systems	8.88	0.75	4.58	14.38	21.41
Management measures	0.21	0.48	1.53	64.23	78.80
Enclosure Structure	458.24	-163.20	12.18	6.51	9.27

Implementation efficiency. The implementation efficiency is considered substantial based on the fact the bulk of planned activities were effectively completed on time. The Project experienced some delays during its initial years of implementation and activities were adjusted as previously described. Following mid-term adjustments, the Project had achieved full disbursement of loan and grant proceeds by the end of the implementation period with no need for extension of the closing date. Innovative policies were issued two years later than expected.

ANNEX 7. BORROWER, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

The following is the verbatim Abstract of the Green Energy Project for Low-Carbon City in Shanghai Project Summary and Extraction Final Report *dated December 2018, provided by the PMO. Subsequent to this report, some results data were updated in consultation with the PMO.*

In order to explore the path for low-carbon construction of existing mega cities that have been completed, the Government of China (GoC), the World Bank (WB) and the Global Environment Facility (GEF) jointly implemented the low-carbon city development and investment project. The project takes Changning District, Shanghai as its core implementation area and aims to drive the transformation and development of Shanghai into a low-carbon city and provide good demonstration and guidance for further reducing the carbon emissions and realizing the carbon intensity reduction targets in Shanghai and even across China. The project measures include developing green buildings, promoting green transportation, improving the energy structure (supply of low-carbon energy), optimizing systems and mechanisms, formulating incentive policies, making more investment, etc.

Thanks to WB's international vision and global experience as well as the great support and guidance from the Development and Reform Commission and the Financial Bureau of Shanghai Municipality, Changning District established the professional management organization for low-carbon city construction projects—Urban Regeneration and Low-carbon Project Management Center at the government level. The Center is responsible for overall coordination among financial institutions, universities, research institutions, service companies and other parties, and has achieved fruitful results in such fields as green finance, energy-saving renovation of existing buildings, energy consumption supervision platforms for near-zero carbon emission buildings and public buildings, green transportation, low-carbon communities. By the end of 2018, the project's objectives including the extent of support and energy saving and emission reductions have been achieved beyond expectation. This is evidenced by: (i) The low-carbon investment supported by the project has reached USD369million accumulatively; (ii) The energy savings generating from project investment have reached 83,655tons of standard coal; and (iii) The CO_2 emission reductions have reached 202,282 tons of CO_2.

While achieving fruitful project results, Changning District has also formed innovative experience and practices that can be replicated and promoted to other projects for reference, in terms of the innovation and amplification effect of green finance mechanisms, scaled investment in renovation of existing buildings and cross-system management mechanisms, breakthroughs and market-oriented promotion of near-zero carbon emission building modes, demonstration and guidance of energy consumption supervision platforms, planning and demonstration of green NMT networks, the indicator system of low-carbon communities and low-carbon regeneration practices of communities, supply of distributed energy and energy Internet exploration, etc. These experience and practices demonstrate the proactive technology paths and management mechanisms for low-carbon city construction of Shanghai and China, asnd guarantee the sustainable development of low-carbon city construction.

ANNEX 8. REFERENCES

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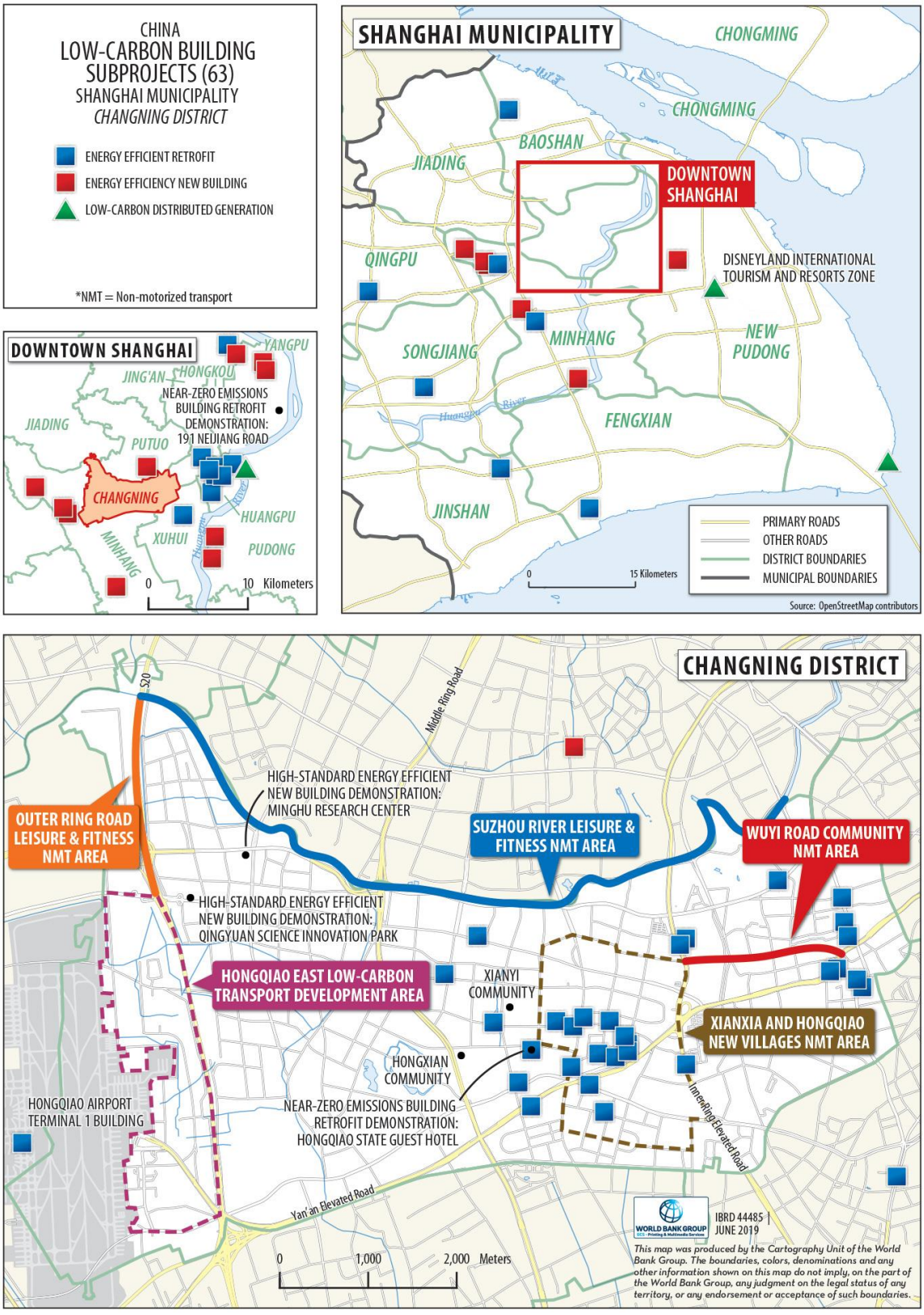
ANNEX 9. MAP


CHINA
LOW-CARBON BUILDING SUBPROJECTS (63)
SHANGHAI MUNICIPALITY
CHANGNING DISTRICT
ENERGY EFFICIENT RETROFIT
ENERGY EFFICIENCY NEW BUILDING
LOW-CARBON DISTRIBUTED GENERATION
*NMT = Non-motorized transport
SHANGHAI MUNICIPALITY
CHONGMING
BAOSHAN
JIADING
DOWNTOWN SHANGHAI
QINGPU
DISNEYLAND INTERNATIONAL TOURISM AND RESORTS ZONE
MINHANG
NEW PUDONG
SONGJIANG
FENGXIAN
JINSHAN
PRIMARY ROADS
OTHER ROADS
DISTRICT BOUNDARIES
MUNICIPAL BOUNDARIES
0 15 Kilometers
Source: OpenStreetMap contributors
DOWNTOWN SHANGHAI
YANGPU
HONGKOU
JING'AN
NEAR-ZERO EMISSIONS BUILDING RETROFIT DEMONSTRATION: 191 NEIJIANG ROAD
JIADING
PUTUO
CHANGNING
HUANGPU
XUHUI
PUDONG
MINHANG
0 10 Kilometers
CHANGNING DISTRICT
S20
Middle Ring Road
HIGH-STANDARD ENERGY EFFICIENT NEW BUILDING DEMONSTRATION: MINGHU RESEARCH CENTER
OUTER RING ROAD LEISURE & FITNESS NMT AREA
SUZHOU RIVER LEISURE & FITNESS NMT AREA
WUYI ROAD COMMUNITY NMT AREA
HIGH-STANDARD ENERGY EFFICIENT NEW BUILDING DEMONSTRATION: QINGYUAN SCIENCE INNOVATION PARK
HONGQIAO EAST LOW-CARBON TRANSPORT DEVELOPMENT AREA
XIANYI COMMUNITY
XIANXIA AND HONGQIAO NEW VILLAGES NMT AREA
HONGXIAN COMMUNITY
HONGQIAO AIRPORT TERMINAL 1 BUILDING
NEAR-ZERO EMISSIONS BUILDING RETROFIT DEMONSTRATION: HONGQIAO STATE GUEST HOTEL
Inner Ring Elevated Road
Yan'an Elevated Road
0 1,000 2,000 Meters
IBRD 44485 | JUNE 2019
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