



# Technical Assistance Report

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Project Number: 52249-003  
Knowledge and Support Technical Assistance (KSTA)  
December 2018

## People's Republic of China: Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation

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**Asian Development Bank**

## CURRENCY EQUIVALENTS

(as of 3 December 2018)

Currency unit	–	yuan (CNY)
CNY1.00	=	\$0.1437
\$1.00	=	CNY6.9590

## ABBREVIATIONS

ADB	–	Asian Development Bank
CO <sub>2</sub>	–	carbon dioxide
EPC	–	energy performance contracting
GHG	–	greenhouse gas
GWP	–	global warming potential
HFCs	–	hydrofluorocarbons
PRC	–	People's Republic of China
TA	–	technical assistance

## NOTE

In this report, "\$" refers to United States dollars.

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## KNOWLEDGE AND SUPPORT TECHNICAL ASSISTANCE AT A GLANCE

<b>1. Basic Data</b>		<b>Project Number:</b> 52249-003
<b>Project Name</b>	Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation	<b>Department/Division</b> EARD/EASI
<b>Nature of Activity Modality</b>	Policy Advice Regular	<b>Executing Agency</b> Ningbo Municipal Government
<b>Country</b>	China, People's Republic of	
<b>2. Sector</b>	<b>Subsector(s)</b>	<b>ADB Financing (\$ million)</b>
✓ Energy	Energy efficiency and conservation	0.50
		<b>Total</b> <u>0.50</u>
<b>3. Strategic Agenda</b>	<b>Subcomponents</b>	<b>Climate Change Information</b>
Inclusive economic growth (IEG)	Pillar 2: Access to economic opportunities, including jobs, made more inclusive	Climate Change impact on the Project Low
Environmentally sustainable growth (ESG)	Natural resources conservation Urban environmental improvement	
<b>4. Drivers of Change</b>	<b>Components</b>	<b>Gender Equity and Mainstreaming</b>
Governance and capacity development (GCD)	Institutional development	No gender elements (NGE) ✓
Knowledge solutions (KNS)	Application and use of new knowledge solutions in key operational areas	
Private sector development (PSD)	Promotion of private sector investment	
<b>5. Poverty and SDG Targeting</b>		<b>Location Impact</b>
Geographic Targeting	Yes	Urban High
Household Targeting	No	
SDG Targeting	Yes	
SDG Goals	SDG3, SDG8, SDG9, SDG11, SDG13	
<b>6. Risk Categorization</b>	Low	
<b>7. Safeguard Categorization</b>	Safeguard Policy Statement does not apply	
<b>8. Financing</b>		
<b>Modality and Sources</b>		<b>Amount (\$ million)</b>
<b>ADB</b>		<b>0.50</b>
Knowledge and Support technical assistance: Technical Assistance Special Fund		0.50
<b>Cofinancing</b>		<b>0.00</b>
None		0.00
<b>Counterpart</b>		<b>0.00</b>
None		0.00
<b>Total</b>		<b>0.50</b>
<b>Currency of ADB Financing: USD</b>		

## I. INTRODUCTION

1. The knowledge and support technical assistance (TA) will design a climate-friendly, energy-efficient cooling initiative in Ningbo to simultaneously reduce greenhouse gas (GHG) emissions and improve energy efficiency in multiple sectors related to refrigeration and/or cooling.<sup>1</sup>

2. The TA is fully aligned with the priority of the Asian Development Bank (ADB) country partnership strategy for the People's Republic of China (PRC), 2016–2020 on managing climate change and the environment to support the government's priorities in realizing an "ecological civilization".<sup>2</sup> The TA supports the strategic thrust of ADB's Strategy 2030 to mitigate climate change and promote environmental sustainability.<sup>3</sup>

## II. ISSUES

3. In the past 30 years, the implementation of the Montreal Protocol has resulted in the effective control of ozone layer depletion and the use of ozone-depleting substances. As a substitute for ozone-depleting substances, hydrofluorocarbons (HFCs) are being widely used as refrigerants for refrigeration and/or air conditioning systems. Although HFCs are believed to have a negligible impact on the ozone layer, they have global warming potential (GWP) several thousand times than that of carbon dioxide (CO<sub>2</sub>) and, with an annual growth rate of 10%, are the fastest growing GHGs.

4. Because of the destructive effect of HFCs on the global climate, a legally binding deal was reached to phase out HFCs in the Amendment to the Montreal Protocol during the 28th Meeting of the Parties to the Montreal Protocol in 2016.<sup>4</sup> The PRC is the world's largest user of HFCs, and the urgency of taking actions in addressing HFCs-induced climate change is prominent. In addition, operation of refrigeration and/or air conditioning systems also consumes enormous amounts of fossil fuel-powered electricity, and the large amount of fossil fuel consumption is also the main source of GHG emissions and air pollution. European research data shows that CO<sub>2</sub> emissions caused by cooling energy consumption have contributed nearly 10% of global CO<sub>2</sub> emissions.<sup>5</sup>

5. Although the PRC has made many efforts to improve energy efficiency in the industrial, commercial, and residential sectors, the potential for energy savings and GHGs reductions in the refrigeration and/or cooling sector is far from being tapped. According to the research supported by the Energy Foundation, increasing energy efficiency by 30% in residential and commercial air conditioners in the PRC by 2020 would result in energy savings equivalent to saving the power

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<sup>1</sup> The TA first appeared in the business opportunities section of ADB's website on 4 December 2018.

<sup>2</sup> An "ecological civilization" refers to achieving harmony between growth, people, and nature. It includes activities to mitigate ecological damage, relieve pressures on natural resources, and improve the balance between the environment and the economy. ADB. 2016. *Transforming Partnership: People's Republic of China and Asian Development Bank, 2016–2020*. Manila.

<sup>3</sup> ADB. 2018. *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*. Manila.

<sup>4</sup> United Nations Environment Programme. 2016. *The Kigali Amendment to the Montreal Protocol: another global commitment to stop climate change*. Nairobi. <https://www.unenvironment.org/news-and-stories/news/kigali-amendment-montreal-protocol-another-global-commitment-stop-climate>

<sup>5</sup> Jon Henley. 2015. *World Set to Use More Energy for Cooling than Heating*. New York. <https://www.theguardian.com/environment/2015/oct/26/cold-economy-cop21-global-warming-carbon-emissions>

generation of 22 Three Gorges Dams.<sup>6</sup> A survey by the Ningbo Development and Reform Commission on the refrigeration and/or cooling systems in Ningbo City's cold storage and/or refrigerated warehouses, food services, supermarkets, and hotels revealed that many refrigeration systems installed 20 to 30 years ago are still in operation.<sup>7</sup> The energy efficiency of these legacy systems can be greatly improved.

6. However, the lack of advanced technical solutions and effective financing mechanisms has made investors prioritize less-efficient solutions in the refrigeration and/or cooling systems in the PRC. The traditional way of doing small and isolated energy-saving projects makes it difficult to attract investment. Implementing a large-scale initiative could create opportunities for energy efficiency improvement in all sectors related to cooling from cold storage and/or refrigeration warehouses, food services, supermarkets, industrial production, and supply chain transportation to air conditioning in commercial, public, and residential buildings. As one of the most important energy production and manufacturing bases in the PRC, Ningbo—the country's largest port and a dynamic city of 7.6 million people—presents a unique opportunity to showcase advanced solutions and innovative financing mechanisms for climate-friendly refrigeration and/or cooling to demonstrate best practices for other cities.

### III. THE TECHNICAL ASSISTANCE

#### A. Impacts and Outcome

7. The TA is aligned with the following impacts: mitigated climate change and improved air quality and public health in Ningbo.<sup>8</sup> The TA will have the following outcome: a climate-friendly and energy-efficient cooling initiative in Ningbo adopted.<sup>9</sup>

#### B. Outputs, Methods, and Activities

8. **Output 1: Current national policies on energy efficiency improvement and reduction of GHG emissions in the cooling sector assessed.** The TA will assess (i) the adequacy of current national policies on energy efficiency improvement and reduction of GHG emissions in the cooling sector, and (ii) how these policies are implemented at the local level. The current energy efficiency and GHG emission standards for cooling equipment in the PRC will also be analyzed.

9. **Output 2: Advanced refrigeration and/or cooling technologies and applications identified.** A significant hurdle for greater cooling efficiency and cooling-related GHG emission reduction is the lack of application and access to advanced technologies. The TA will identify and assess a wide range of advanced technologies and relevant technical solutions in the PRC and other countries, including high-efficiency cooling systems, low to zero GHG emission refrigerants, natural refrigerants such as CO<sub>2</sub>, intelligent control and management technology for refrigeration and/or air-conditioning operations, comprehensive utilization of industrial waste heat for cooling,

<sup>6</sup> China National Institute of Standardization. 2018. *Improving Cooling Efficiency, Cutting GHG Emissions and Achieving Green Transition in Cooling Market—Launch of Kigali Cooling Efficiency China Program*. Beijing. [http://www.cnis.gov.cn/hzjl/dtxw/201803/t20180301\\_23898.shtml](http://www.cnis.gov.cn/hzjl/dtxw/201803/t20180301_23898.shtml)

<sup>7</sup> Ningbo Development and Reform Commission. 2018. *Ningbo Cooling and Refrigeration Equipment Survey*. Internal Report. Ningbo.

<sup>8</sup> Government of Ningbo Municipality. 2016. *Thirteenth Five-Year Plan for National Economic and Social Development of Ningbo Municipality, 2016–2020*. Ningbo. <http://www.ndrc.gov.cn/fzgggz/fzgh/ghwb/dfztgh/201607/P020160713600628829652.pdf>

<sup>9</sup> The design and monitoring framework is in Appendix 1.

solar thermal cooling using lithium bromide absorption refrigeration, as well as ice storage cooling systems and photovoltaic power generation installed on cold storage warehouses and supermarkets that reduce grid peak load and save electricity bills during peak hours.

10. **Output 3: Viable business models and innovative financing mechanisms for the cooling initiative in Ningbo developed.** The current energy performance contracting (EPC) model implemented in the PRC cannot play a major role in delivering energy savings and emission reductions in scale. Internationally, especially in the United States, a new model—SuperEPC—has become an important approach to energy savings.<sup>10</sup> The TA will assess the feasibility of employing the SuperEPC model for carrying out the city-scale initiative. The TA will also assess other innovative business models, including cooling as a service model,<sup>11</sup> contracting for a full-blown operation model,<sup>12</sup> and contracted maintenance services.<sup>13</sup> The TA will also identify key barriers as well as solutions regarding financing large-scale cooling efficiency deployment by assessing the feasibility and implementation strategies of different financing mechanisms, including (i) leveraging private investment for future public–private partnership in financing; (ii) results-based financing to explore the feasibility of adopting variable rates and terms based on the projects’ performance of energy savings and emission reductions; (iii) the Green Cooling Investment Fund that can be jointly established by governments, banks, fund management companies, energy service companies, other private investors, and other entities participating in the initiative; and (iv) asset-based securitization:<sup>14</sup> after the projects in the initiative establish a stable cash flow, the receivables generated by the private investment can be securitized.

11. **Output 4: An internet+ cooling prototype for optimal resource utilization designed.** The internet+ concept and the sharing economy provide several benefits such as optimizing the utilization of resources, avoiding waste, and reducing costs. For example, under-utilized refrigerated space in cold storage and supply chain transportation equipment can be shared by other facilities to optimize resources, save energy, and reduce emissions. The TA will apply the concept of internet+ and a sharing economy in the cooling sector and assess the feasibility of creating two types of an internet-enabled platform: (i) an application that enables the effective sharing of underutilized refrigeration and/or cooling resources, and (ii) an online equipment-tracking platform that gathers and analyzes real-time energy usage data from sensors installed in all retrofitted refrigeration and/or cooling equipment for identifying potential problems and spotting improvement opportunities.

### C. Cost and Financing

12. The TA is estimated to cost \$550,000, of which \$500,000 will be financed on a grant basis by ADB’s Technical Assistance Special Fund (TASF-other sources). Key expenditure items are listed in Appendix 2.

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<sup>10</sup> This model makes full use of emerging opportunities in different market segments and packages, several projects to form a single unified contract that encompasses multiple sectors, multiple energy sources, and diverse technologies.

<sup>11</sup> In this model, refrigeration and/or cooling equipment manufacturers will become service providers, while the industrial and/or commercial facilities purchase the refrigeration and/or cooling services from the service providers.

<sup>12</sup> This model enables customers to own their refrigeration and/or cooling systems and outsource the operations to a professional service provider to ensure an optimal operation to achieve energy efficiency and emission reduction targets and lower operating costs.

<sup>13</sup> Under this model, a customer owns and operates its own refrigeration systems but enters into a long-term tuning service contract with a professional service provider who will conduct performance and system checks regularly to keep equipment operating at optimum conditions.

<sup>14</sup> Asset-based securitization converts non-tradable financial assets into tradable capital market securities, increases investment liquidity; revitalizes investors’ financial assets; and attracts diversified investors, including institutional investors.

13. The Ningbo Municipal Government, through the Ningbo Development and Reform Commission, will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, information and documents relevant for the preparation of the TA, and other in-kind contributions.

#### D. Implementation Arrangements

14. ADB will administer the TA. The Sustainable Infrastructure Division of ADB's East Asia Department will select, administer, and supervise a consulting firm for the TA and evaluate the consulting firm's outputs.

15. The implementation arrangements are summarized in the table.

Implementation Arrangements			
Aspects	Arrangements		
Indicative implementation period	February 2019–December 2020		
Executing agency	Ningbo Municipal Government		
Consultants	To be selected and engaged by ADB		
	Package title	Selection method	Amount
	Consulting firm	QCBS (90:10)	\$451,200
Disbursement	The TA resources will be disbursed following ADB's <i>Technical Assistance Disbursement Handbook</i> (2010, as amended from time to time).		

ADB = Asian Development Bank, QCBS = quality- and cost-based selection, TA = technical assistance.  
Source: Asian Development Bank estimates.

16. **Consulting services.** ADB will engage consultants following its Procurement Policy (2017, as amended from time to time) and its associated project administration instructions and/or staff instructions.<sup>15</sup>

#### IV. THE PRESIDENT'S DECISION

17. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of \$500,000 on a grant basis to the Government of the People's Republic of China for Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation, and hereby reports this action to the Board.

<sup>15</sup> Terms of Reference for Consultants (accessible from the linked documents in Appendix 3).

## DESIGN AND MONITORING FRAMEWORK

<b>Impacts the TA is Aligned with</b>			
Climate change mitigated and air quality and public health in Ningbo improved (Thirteenth Five-Year Plan for National Economic and Social Development of Ningbo Municipality <sup>a</sup> )			
<b>Results Chain</b>	<b>Performance Indicators with Targets and Baselines</b>	<b>Data Sources and Reporting Mechanisms</b>	<b>Risks</b>
<p><b>Outcome</b> A climate-friendly and energy-efficient cooling initiative in Ningbo adopted</p>	<p>By 2021: The climate-friendly and energy-efficient cooling initiative approved by the Ningbo Development and Reform Commission (2017 baseline: NA)</p>	<p>ADB TA final report</p>	<p>Government's priority on climate change not sustained</p>
<p><b>Outputs</b></p> <p>1. Current national policies on energy efficiency improvement and reduction of GHG emissions in the cooling sector assessed</p> <p>2. Advanced refrigeration and/or cooling technologies and applications identified</p> <p>3. Viable business models and innovative financing mechanisms for the cooling initiative in Ningbo developed</p> <p>4. An "internet+ cooling" prototype to promote optimal resource utilization designed</p>	<p>By 2020:</p> <p>1a. Report on the assessment of major policy gaps affecting cooling-related energy efficiency prepared (2017 baseline: Not applicable)</p> <p>2a. Report on the assessment of current refrigeration and/or cooling technologies and applications in Ningbo prepared (2017 baseline: 0)</p> <p>2b. At least five advanced refrigeration and/or cooling technologies and applications identified (2017 baseline: 0)</p> <p>3a. At least two viable business models for deploying advanced cooling technologies identified (2017 baseline: 0)</p> <p>3b. At least three innovative financing mechanisms and risk mitigation strategies proposed (2017 baseline: 0)</p> <p>4a. Report on the feasibility of internet-enabled platforms prepared (2017 baseline: 0)</p> <p>4b. An "internet+ cooling" prototype implementation plan prepared (2017 baseline: 0)</p>	<p>1a. Midterm report prepared by the consulting firm</p> <p>2a.–b. Midterm report prepared by the consulting firm</p> <p>3a.–b. Final report prepared by the consulting firm</p> <p>4a.–b. Final report prepared by the consulting firm</p>	<p>Reluctance of refrigeration and/or cooling sectors to apply new technologies and business models</p> <p>Inadequate capacity of local counterpart</p>

<p><b>Key Activities with Milestones</b></p> <p><b>1. Current national policies on energy efficiency improvement and reduction of GHG emissions in the cooling sector assessed</b></p> <p>1.1 Analyze the current national policies in the PRC on energy efficiency improvement and reduction of GHG emissions in the cooling sector (Q1 2019–Q2 2019).</p> <p>1.2 Prepare a report on the assessment of major policy gaps affecting cooling-related energy efficiency (Q1 2019–Q2 2019).</p> <p><b>2. Advanced refrigeration and/or cooling technologies and applications identified</b></p> <p>2.1 Collect data on the refrigeration and/or cooling sector and relevant equipment and/or systems in Ningbo (Q2 2019–Q3 2019).</p> <p>2.2 Identify the major factors affecting energy use of these systems as well as the economic, environmental, and climate impacts of such energy use (Q2 2019–Q3 2019).</p> <p>2.3 Assess existing technology gaps in pursuing efficient and low-emission cooling in Ningbo (Q3 2019–Q4 2019).</p> <p>2.4 Identify cost-effective technologies and/or solutions related to efficient and low-emission cooling that enables achieving the dual goals of efficiency improvement and GHG emission reduction (Q3 2019–Q4 2019).</p> <p>2.5 Develop a guideline for the application of advanced refrigeration and/or cooling technologies in Ningbo (Q3 2019–Q4 2019).</p> <p>2.6 Prepare a comprehensive survey report in assessing the status of the refrigeration and/or cooling sector in Ningbo (Q4 2019).</p> <p><b>3. Viable business models and innovative financing mechanisms for the cooling initiative in Ningbo developed</b></p> <p>3.1 Study viable options for aggregating energy-savings and/or renewable energy projects (Q1 2020–Q2 2020).</p> <p>3.2 Assess the viability of developing a bulk procurement scheme for high efficiency and low GWP refrigeration and/or cooling equipment in Ningbo (Q1 2020–Q2 2020).</p> <p>3.3 Analyze the key barriers to finance climate-friendly refrigeration and/or cooling operations in Ningbo (Q1 2020–Q2 2020).</p> <p>3.4 Propose viable business models for the cooling initiative in Ningbo (Q3 2020–Q4 2020).</p> <p>3.5 Prepare a feasibility study report on designing and adopting innovative financing mechanisms and risks mitigation strategies for the Ningbo cooling initiative (Q3 2020–Q4 2020).</p> <p><b>4. An “internet+ cooling” prototype to promote optimal resource utilization designed</b></p> <p>4.1 Assess the feasibility of internet-enabled platforms for refrigeration and/or cooling operations in Ningbo (Q1 2020–Q2 2020).</p> <p>4.2 Develop an “internet+ cooling” implementation plan (Q3 2020–Q4 2020).</p>
<p><b>Inputs</b></p> <p>ADB: \$500,000 (TASF-other sources)</p> <p>Note: The government, through the Ningbo Development and Reform Commission, will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, information and documents relevant for the preparation of the TA, and other in-kind contributions.</p>
<p><b>Assumptions for Partner Financing</b></p> <p>Not applicable</p>

ADB = Asian Development Bank, GHG = greenhouse gas, GWP = global warming potential, PRC = People's Republic of China, TA = technical assistance, TASF = technical assistance special fund.

<sup>a</sup> Government of Ningbo Municipality. 2016. *Thirteenth Five-Year Plan for National Economic and Social Development of Ningbo Municipality, 2016–2020*. Ningbo.

<http://www.ndrc.gov.cn/fzgggz/fzgh/ghwb/dfztgh/201607/P020160713600628829652.pdf>

Source: Asian Development Bank.

**COST ESTIMATES AND FINANCING PLAN**  
(\$'000)

<b>Item</b>	<b>Amount</b>
<b>Asian Development Bank<sup>a</sup></b>	
1. Consultants	
a. Remuneration and per diem	
i. International consultants	225.05
ii. National consultants	166.90
b. International and local travel	49.25
2. Surveys <sup>b</sup>	10.00
3. Seminars, workshops, forum, and conferences <sup>c</sup>	15.00
4. Contingencies	33.80
<b>Total</b>	<b>500.00</b>

Note: The technical assistance (TA) is estimated to cost \$550,000, of which contributions from the Asian Development Bank are presented in the table above. The government, through the Ningbo Development and Reform Commission, will provide counterpart support in the form of counterpart staff, office accommodation, office supplies, information and documents relevant for the preparation of the TA, and other in-kind contributions. The value of the government contribution is estimated to account for 9% of the total TA cost.

<sup>a</sup> Financed by the Asian Development Bank's Technical Assistance Special Fund (TASF-other sources).

<sup>b</sup> A survey team will be engaged by the consulting firm to undertake the survey.

<sup>c</sup> Seminars, workshops, forums, and conferences under the TA will be administered by Asian Development Bank and conducted in Asian Development Bank member countries. Includes interpretation and translation costs.

Source: Asian Development Bank estimates.

**LIST OF LINKED DOCUMENTS**

<http://www.adb.org/Documents/LinkedDocs/?id=52249-003-TARreport>

1. Terms of Reference for Consultants