



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

Project Name	Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation		
Project Number	52249-003		
Country / Economy	China, People's Republic of		
Project Status	Closed		
Project Type / Modality of Assistance	Technical Assistance		
Source of Funding / Amount	TA 9670-PRC: Developing a Climate-friendly Cooling Sector through Market and Financing Innovation		
	Technical Assistance Special Fund		US\$ 500,000.00
Strategic Agendas	Environmentally sustainable growth Inclusive economic growth		
Drivers of Change	Governance and capacity development Knowledge solutions Private sector development		
Sector / Subsector	Energy / Energy efficiency and conservation		
Gender	No gender elements		
Description	The knowledge and support technical assistance will design a climate-friendly, energy-efficient cooling initiative in Ningbo to simultaneously reduce greenhouse gas emissions and improve energy efficiency in multiple sectors related to refrigeration and/or cooling.		
Project Rationale and Linkage to Country/Regional Strategy	<p>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 (CO2) and, with an annual growth rate of 10%, are the fastest growing greenhouse gases (GHG). 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. 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 CO2 emissions caused by cooling energy consumption have contributed nearly 10% of global CO2 emissions. 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 generation of 22 Three Gorges Dams. 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. The energy efficiency of these legacy systems can be greatly improved. 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.</p>		
Impact	Climate change mitigated and air quality and public health in Ningbo improved		
Project Outcome			
Description of Outcome	A climate-friendly and energy-efficient cooling initiative in Ningbo adopted		

Progress Toward Outcome	<p>The midterm TA review mission was held virtually on 25 July 2020. Two rounds of survey was conducted targeting institutional customers in industrial, commercial, and public sectors in Ningbo that operate cooling/refrigeration equipment, with the purpose of gaining a better knowledge about the city's cooling equipment/systems in order to create a database of viable retrofit projects, and understanding customer willingness to participate in a city-wide cooling improvement program. The survey targeted a wide variety of electricity users in Ningbo in multiple sectors, ranging from manufacturing, food processing, cold storage, ice-making facilities, dairy factories, auto parts stores, super-market, shopping malls, restaurants, sport complex, hotels, conference centers, libraries, hospitals, amusement park, vocational college, universities, government facilities, transportation hub, and banks. A standardized survey questionnaire was created by the TA consultants. It has, so far, received responses from 351 institutional customers (207 customers in the first round and 144 in the 2nd round). The first round of survey found that many facilities are still using old and inefficient cooling equipment, with a number of systems being over 15-20 years old. Most facilities have neither robust maintenance procedures nor a service agreement that allows a third-party provider to offer routine maintenance services to keep the equipment in optimal operation condition. Facilities surveyed also indicated that they are not willing to pursue a retrofit/early replacement project if the investment payback exceeds 3 years or if the interest rate of financing is higher than 5% (as a comparison, typical interest rates for commercial loans in China are now 8-10%, or even higher). Most facilities are small- and medium-sized enterprises that have low creditworthiness and high default concern for investors. The TA has also thoroughly studied the initial survey data and selected five facilities from the surveyed customers for conducting a comprehensive energy use diagnostics to (i) examine the cooling equipment against the survey information for verification, (ii) gain a better understanding about the operation of cooling equipment in these facilities, and (iii) identify improvement opportunities for the equipment. The TA also reviewed key international agreements on promoting cooling efficiency and GHG reduction including Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer, and the Kigali Amendment to the Montreal Protocol as well as China's implementation of these international agreements and evaluated best practices in developing enabling policies and programs in promoting cooling efficiency and GHG reductions and encouraging use of low global warming potential (GWP) refrigerants in specific countries including EU, the U.S. (particularly California), Australia, Japan, South Korea. The TA also covered the review of standards and labeling frameworks of six countries including Australia, EU, Japan, the Republic of Korea, United States, and the PRC. The TA also gathered information related to financing green energy projects globally that includes sources of financing and effective financing mechanisms, which aims at providing valuable insights for developing effective financing mechanisms for a largescale green cooling deployment in Ningbo. The final review mission was conducted on 28-29 July and the consultant team presented their research/survey results and findings.</p>
Implementation Progress	
Description of Project Outputs	<p>Current national policies on energy efficiency improvement and reduction of GHG emissions in the cooling sector assessed</p> <p>Advanced refrigeration and/or cooling technologies and applications identified</p> <p>Viable business models and innovative financing mechanisms for the cooling initiative in Ningbo developed</p> <p>An "internet+ cooling" prototype to promote optimal resource utilization designed</p>
Status of Implementation Progress (Outputs, Activities, and Issues)	<p>Advanced refrigeration and/or cooling technologies and applications identified. The TA study focused on the following areas: (i) cooling industry development status in the PRC, (ii) national energy efficiency standards of cooling equipment, (iii) market position of green and efficient cooling products, (iv) market potential of green and efficient cooling products, (v) green and efficient cooling/refrigeration technologies, and (vi) challenges and development prospects of green and efficient technologies. The study estimated that PRC's electricity consumption for refrigeration/cooling accounted for 20% to 25% of the country's total electricity consumption of 7,225 billion kWh in 2019. Of which, power use of household refrigeration and air-conditioning equipment accounted for about 35% of the total, while industrial and commercial refrigeration and air-conditioning equipment accounted for about 65%. In the review of the efficiency level of refrigeration and air-conditioning products, the TA revealed that there is great potential for high-efficiency products in the PRC market. Promotion of high-efficiency refrigeration and AC equipment in the commercial sector is better than the residential sector. In the review of national standards governing the energy efficiency performance of the refrigeration and air-conditioning products, the TA revealed that energy efficiency standards related to cooling equipment have improved significantly in the past few years. The TA also analyzed the gap in the in cooling energy efficiency standards between PRC and developed countries. The energy efficiency indicators of some high-efficiency domestic products have reached the advanced level of developed countries. For example, for household air conditioners, the energy efficiency rating of China's new national standard is compared with the current energy efficiency indicators of developed countries, with the new national standard of level-1 is higher than the energy efficiency requirements of Japanese "top-runner" and the U.S. Energy Star. However, there is still a significant gap between the energy efficiency standards of some Chinese products and the advanced level of developed countries, such as chillers, unitary air conditioners and other products. The TA examined the collaborative use of renewable energy resources (mainly photovoltaics or PV) and other technologies such as energy storage (both electric and thermal) and cool roof in cooling sector to capture greater economic values and enhanced social benefits. Collaborative use of renewable energy and other technologies has great significance for Ningbo as fossil fuels account for 97% of the city's energy mix. The TA evaluated the adoption of cool roof, roof-top PV, battery storage, and ice thermal energy storage in three building types: refrigeration warehouses, supermarkets, and office buildings. The analysis of collaborative use of renewable energy and other resources reached the following conclusions:</p> <ul style="list-style-type: none"> Three cooling load profiles studied show that Ningbo has great potential in collaborative using of renewable energy resources. All scenarios show that roof-top PV helps reduce the purchase of electricity from the grid and thus bring significant benefits to facilities. The benefit is particularly greater in businesses with large electricity/cooling load demand. If excess PV power can be sold to the grid, the benefit is further enhanced. Use of roof-top PV in Ningbo is economical, feasible and environmentally friendly. Collaborative use of cool roof and ice thermal storage with refrigeration and cooling systems can reduce the size/capacity of electric refrigeration unit. Although use of batteries or ice storage add costs to PV system, they can store electricity during low electricity prices and when PV have excess output, and release electricity when PV output are insufficient or when electric price is high. Therefore, combined use of PV and energy storage reduces both investment and operation costs while minimizing PV power curtailment. The ice storage is not as good as electric storage in terms of cost-effectiveness, but other thermal storage technologies such as phase change materials could provide more economical thermal energy storage solutions. Compared with other scenarios studied, PV + battery storage creates the largest reduction of CO2 and lowest total cost. Viable business models and innovative financing mechanisms for the cooling initiative in Ningbo developed. The TA has developed an evaluation method and associated assessment tool that help assess cost-effectiveness of different green cooling measures and determine financing feasibility of investing in different measures. The method is used to measure bankability of green cooling projects and makes an investment decision based on three optimization indicators: (i) The most efficient investment with largest NPV per unit of investment, (ii) the greatest total NPV, and (iii) largest emission reductions. The method of assessing a green cooling project's financing feasibility in a comprehensive manner considers several affecting factors that could potentially affect the bankability of green cooling projects. Factors assessed include the timing of the investment, level of government incentives, interest rates variation in a result-based lending, type of entities who carry out the project itself, an ESCO, or a leasing company, and contracting models used in delivering green cooling projects. The key considerations in assessing these factors include (i) timing of investment, (ii) government incentive, (iii) interest variation, (iv) project delivery entities, and (v) contracting models for delivering green cooling projects. An "internet+ cooling" prototype to promote optimal resource utilization was designed. The TA includes identifying digital solutions and design of a digitization infrastructure in developing a climate-friendly, energy efficient, and smart cooling sector in Ningbo that is linked to the New Infrastructure Building initiative of the PRC which focuses on information infrastructure, innovation infrastructure, and converging infrastructure. The TA has also identified steps to be taken for digital transformation to take place in the cooling sector, which include (i) complete digitization of energy data and cooling equipment operations (smart ready), (ii) building core software and algorithm ability of smart cooling (platform building and enabling), and (iii) creating new business models and building an effective cooling system (services innovation).
Geographical Location	Ningbo
Summary of Environmental and Social Aspects	
Environmental Aspects	
Involuntary Resettlement	
Indigenous Peoples	
Stakeholder Communication, Participation, and Consultation	
During Project Design	
During Project Implementation	ADB is working closely with Ningbo Municipal Government, Ningbo Development and Reform Commission and other potential stakeholders. The TA midterm review mission was held virtually on 25 July 2020 and final TA review in July 2021. All TA activities were completed in August 2021, as scheduled.
Business Opportunities	
Consulting Services	ADB will engage the consultants following its Procurement Policy (2017, as amended from time to time) and its associated project administration instructions and/or staff instructions.

Responsible ADB Officer	Zhou, Yun
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Timetable	
Concept Clearance	27 Nov 2018
Fact Finding	19 Nov 2018 to 19 Nov 2018
MRM	-
Approval	07 Dec 2018
Last Review Mission	-
Last PDS Update	28 Sep 2021

TA 9670-PRC

Milestones					
Approval	Signing Date	Effectivity Date	Closing		
			Original	Revised	Actual
07 Dec 2018	29 Dec 2018	29 Dec 2018	31 Dec 2020	31 Aug 2021	25 Oct 2021

Financing Plan/TA Utilization						Cumulative Disbursements		
ADB	Cofinancing	Counterpart				Total	Date	Amount
		Gov	Beneficiaries	Project Sponsor	Others			
500,000.00	0.00	0.00	0.00	0.00	0.00	500,000.00	17 Jun 2022	452,916.04

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