FINANCING CLIMATE-FRIENDLY COOLING AT CITY SCALE

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ABSTRACT

Cooling has had a significant impact on global climate change. It is important to respond promptly and effectively to the climate challenges posed by the growing global demand for air-conditioning and refrigeration to achieve the Paris Agreement objectives and the mid-century carbon-neutral goals. Improving the energy efficiency of refrigeration and cooling equipment to reduce their energy consumption, lessening the burden of cooling on power systems (especially during periods of peak demand), and using climate-friendly refrigerants are all necessary means of mitigating the climate impact of the growing demand for cooling in developing countries. The lack of accessible and affordable financing, coupled with limited project scale to attract investment, is among the most critical obstacles to the effective deployment of climate-friendly cooling solutions in Asian developing countries. Promoting climate-friendly cooling solutions at city scale by bringing together green cooling project opportunities in multiple sectors across the city will achieve sufficient scale to attract investors and reduce greenhouse gas emissions due to cooling. The financing of large-scale deployment of green cooling solutions faces many obstacles requiring a comprehensive solution. This working paper presents an integrated model for financing city-scale green cooling initiatives by drawing on various international financing tools that will help remove the obstacles, and on diversified business models that will increase the return on cooling projects.

Keywords: climate-friendly cooling, refrigeration and air-conditioning, cities, greenhouse gas emissions, mitigation, financing, business models

JEL Classification: Q4, Q5

ABBREVIATIONS

ABS	–	asset-backed securities
ADB	–	Asian Development Bank
CaaS	–	cooling as a service
CO_2	–	carbon dioxide
EERF	–	Energy Efficiency Revolving Fund (Thailand)
ESA	–	Energy Saving Agreement
ESCO	–	energy service company
GHG	–	greenhouse gas
HFC	–	hydrofluorocarbon
MEPS	–	Minimum Energy Performance Standard
PACE	–	property assessed clean energy
PRC	–	People's Republic of China
SMEs	–	small and medium-sized enterprises
SPV	–	special purpose vehicle
UNEP	–	United Nations Environment Programme

I. IMPACT OF AIR-CONDITIONING AND REFRIGERATION ON CLIMATE CHANGE

The significant impact of cooling on global climate change is due to three main causes: (i) the use of hydrofluorocarbons (HFCs) as a refrigerant substitute, (ii) the enormous amount of greenhouse gas (GHG) emissions from fossil fuel-powered refrigeration and air-conditioning systems worldwide, and (iii) the high peak electricity demand due to many cooling systems running at the same time.

First used as refrigerant substitutes for refrigeration and air-conditioning, HFCs have several thousand times the global warming potential of carbon dioxide (CO_2), and their emissions are increasing at a rate of 10%–15% per year (Velders et al. 2012). This is the fastest increase of all types of GHGs. Due to the destructive effect of HFCs on the global climate, 197 nations reached a legally binding accord to phase out HFCs, incorporated as an amendment to the Montreal Protocol in October 2016 in Kigali, Rwanda. The United Nations Environment Programme (UNEP) estimates that reducing HFC emissions under the Kigali Amendment is expected to prevent a global temperature increase of 0.5°C at the end of this century (UNEP 2016).

Second, the enormous demand for cooling from refrigeration and air-conditioning systems causes a large amount of GHG emissions when these systems are powered from fossil fuel-generated electricity. Clean Cooling Collaborative[1] (2021) estimates that air conditioners and electric fans consume 20% of the electricity used in buildings around the world, that their use is expanding more rapidly than that of any other building appliances, and that global energy demand for cooling is expected to triple by 2050. It has been estimated that CO_2 emissions, caused by meeting global cooling electricity demand, have contributed nearly 10% of the world's total CO_2 emissions (Henley 2015). Reducing cooling electricity consumption could therefore lead to significant GHG emission reduction. For example, the Green Cooling Action Plan of the People's Republic of China (PRC) puts forward cooling energy efficiency improvement targets, including a 25% improvement in the energy efficiency of refrigeration and air-conditioning systems and a 40% increase in the market share of green and high-efficiency cooling products by 2030 (National Development and Reform Commission 2019). A study on the GHG emission reduction potential of 29 refrigeration and air-conditioning products in five key user sectors showed that, compared with the business-as-usual scenario that reflects the current cooling energy efficiency and related policies, the achievement of the Green Cooling Action Plan targets will cumulatively save 2,261.8 billion kilowatt-hours of electricity and reduce CO_2-equivalent GHG emissions by more than 1.1 billion tons by 2030 (Cheng et al. 2020).[2]

Third, peak demand occurs when many pieces of electrical equipment are operating at the same time, so the demand for electricity is at its highest. This will often place a huge burden on the power system. To avoid the strain, the power system is equipped with extra generators to meet the higher demand during the short peak hours. Typically, 10% of a power system's installed capacity is equipped to handle the peak loads, which only occur for tens of hours in a year (Feldman, Tanner, and Rose 2015). The electricity generator used to handle the peak load–called a "peaker" —is often the fossil fuel unit with the lowest efficiency and the highest fuel cost.[3] This mismatch between power supply and demand, and the inefficient power generation used to meet the peak demand, leads to higher CO_2 emissions. The cooling load is one of the largest electricity loads during the peak demand, accounting for a large proportion of the demand for peaking units that emit GHGs.

1 The Clean Cooling Collaborative is a philanthropic initiative of the ClimateWorks Foundation that is working to create a future with efficient, climate-friendly cooling for all.

2 The five key user sectors include industrial and commercial refrigeration, industrial and commercial air-conditioning, household appliances, data centers, and vehicle air-conditioning.

3 A "peaker" is the last generator set to be dispatched by the grid operator to provide electricity during periods of peak demand.

Improving the energy efficiency of refrigeration and cooling equipment to reduce their energy consumption, reducing the burden of the cooling load on the power system (especially during periods of peak demand), and using climate-friendly refrigerants are all necessary means of reducing the negative impacts of cooling on climate change. Although countries in Asia have already done a lot to mitigate the impact of climate change on the industry, commerce, and residential sectors, there is still untapped potential for reducing GHG emissions from refrigeration and cooling equipment.

Financing is a key means of deploying of green cooling solutions, but it faces many obstacles, and overcoming those obstacles will require comprehensive solutions. This paper presents strategies for financing green cooling deployment at scale, drawing on international experience. The remainder of the paper is organized as follows: Section 2 presents cases in selected countries of policies and standards promoting green cooling, Section 3 introduces a concept for large-scale deployment of green cooling technologies across sectors in cities, Section 4 introduces a range of financing mechanisms that have been employed internationally and could be applied to the financing of green cooling deployment, Section 5 presents diversified business models that could increase the return on cooling projects, Section 6 discusses strategies for minimizing the potential risks associated with green cooling investment, and Section 7 introduces an integrated model for financing city-scale green cooling deployments.

II. POLICIES AND STANDARDS FOR PROMOTING GREEN COOLING

Policies and standards focusing on energy efficiency involve effective measures to reduce GHG emissions from the refrigeration and cooling industries. The experiences of countries around the world, including those in Asia, in adopting policies and standards to improve cooling efficiency could benefit Asian Development Bank (ADB) developing member countries.

For example, the People's Republic of China (PRC) revised its Minimum Energy Performance Standard (MEPS) for indoor air conditioners in 2020. Since the PRC is the largest manufacturer of indoor air conditioners in the world, raising its MEPS will help reduce cooling energy consumption and the associated impact on climate change. According to the China National Institute of Standardization, the newly adopted MEPS will lead to an increase in the energy efficiency of indoor air conditioners by around 14%. If the standard is fully implemented, approximately 45% of the PRC's room air-conditioner models produced before this revised standard will be withdrawn from the market.

Countries outside Asia are working to reduce cooling energy consumption through policies and standards, including the United States (US) and the member countries of the European Union (EU).

In the US, the Government of California first established energy efficiency standards for appliances in 1977. Continuous updates over the years have made California's standards among the most stringent in the world. Centralized and noncentralized air-conditioner and refrigeration products are regulated by these standards. For a product to be offered for sale in California, the manufacturer must first test it in a state government-approved laboratory and obtain third-party certification. Once a product is certified, the manufacturer must submit its documents and data to the state regulator, the California Energy Commission, for upload onto the agency's online Modernized Appliance Efficiency Database System (California Energy Commission n.d.).

The European Commission launched the EU Heating and Cooling Strategy in 2016 to incorporate efficient heating and cooling into the EU energy policy framework (European Commission n.d.).

Australia, the EU, Japan, the PRC, the Republic of Korea, and the US all have energy efficiency labeling systems for cooling equipment such as air conditioners. For example, the PRC began developing a mandatory energy labeling scheme in 2005 and updated it in 2020. The labeling program uses the seasonal energy efficiency ratio and annual performance factor as indicators of energy efficiency. The labels show five efficiency levels, the first being the most efficient and the fifth the least efficient, and they include other information, such as the rated cooling capacity and electricity consumption during high-demand seasons (ADB 2021).

Local governments have also implemented effective building codes to reduce the need for cooling. For example, a building energy code enacted in 2020 by the California Energy Commission, the first of its kind in the US, requires builders to meet energy efficiency standards by using energy-efficient attics, walls, windows, and doors, as well as better insulation, so that new homes will require minimal heating and cooling to remain comfortable. At the same time, the new code requires that all new single-family homes and low-rise apartment buildings install solar panels or use community solar electricity supplies. Only houses that are unsuitable for photovoltaic panels, such as those shaded by trees or large structures, are exempt. The code also encourages builders to install energy storage devices, such as home batteries or flexible electric water heaters. Finally, the code covers not only new residential buildings, but also nonresidential buildings (Delforge 2018).

III. CITY-SCALE GREEN COOLING DEPLOYMENT

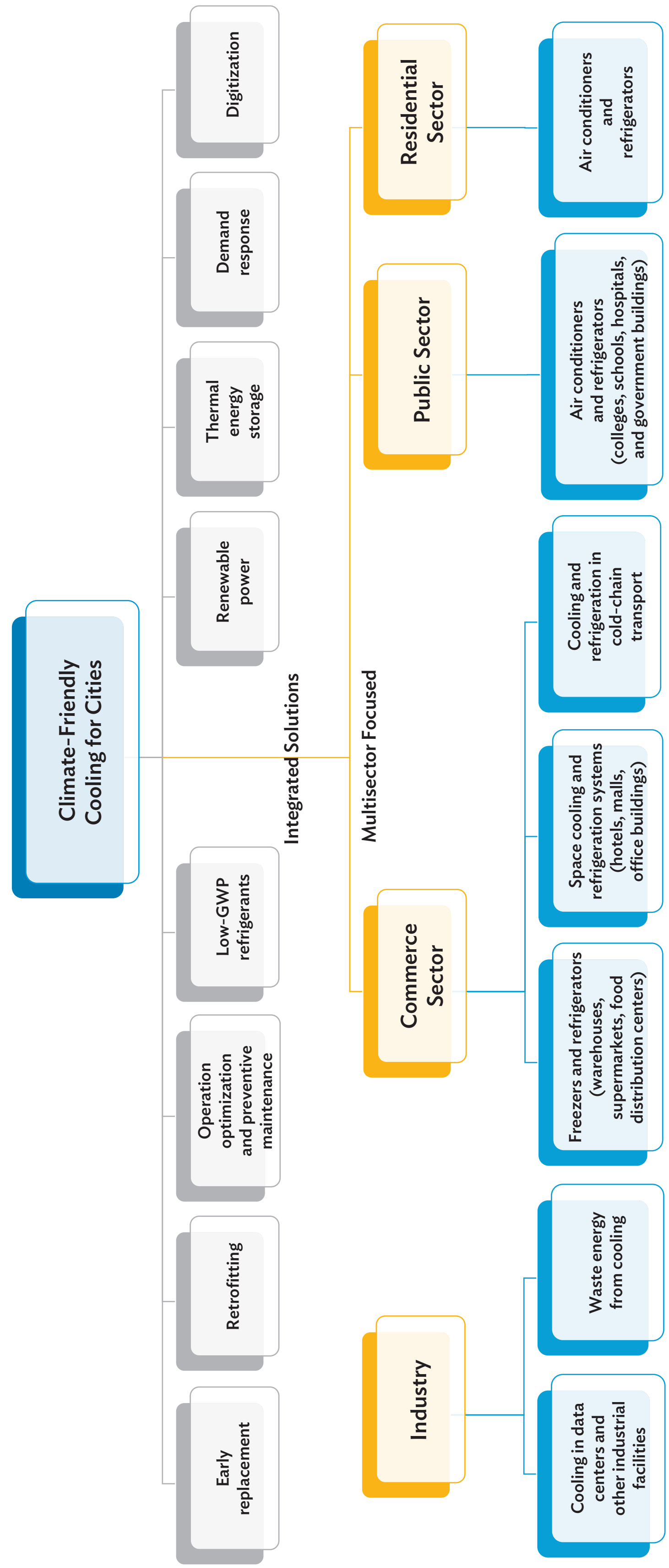
The lack of accessible and affordable financing is one of the obstacles to using energy-efficient cooling systems. In many countries, customers prioritize less-efficient solutions for refrigeration and cooling systems. In addition, cooling improvement projects are generally small and scattered, and they tend to focus on a single technology, making them difficult to scale. This lack of economies of scale makes it difficult to attract investment and increases the cost of financing because lenders have to deal with many small projects.

Implementation of climate-friendly cooling deployment programs at city scale is an innovative model that will replace the traditional implementation model. A city has multiple sectors that require refrigeration and cooling—industry, commerce, residential, public institutions, and transportation and logistics. Services are needed in facilities such as cold storage warehouses, food and medicine distribution centers, food services, supermarkets, shopping malls, hotels, office buildings, data centers, hospitals, universities, schools, government buildings, residential buildings, industrial facilities, and logistics and transportation. Bringing together project opportunities for green cooling in these sectors would help achieve an investment scale large enough to attract investors, thereby reducing both project development and financing transaction costs.

A city-scale green cooling deployment not only targets all related sectors in a city, but also adopts an integrated solution that brings together diverse measures aimed at mitigating the climate impact of cooling. These green measures include, but are not limited to, early retirement of inefficient cooling equipment, energy-saving retrofits of existing cooling systems, optimized operation and preventive maintenance of cooling units, use of refrigerants with low global warming potential, installation of distributed renewable energy generation systems, adoption of thermal energy storage technologies, promotion of demand–response behavior changes, and the advancement of digitalization.

Focusing on the deployment of integrated green cooling solutions in various sectors throughout a city will scale up implementation and maximize the effect of GHG emission reduction. Figure 1 illustrates the framework for city-scale climate-friendly cooling deployment.

Figure 1: City-Scale Climate-Friendly Cooling Deployment Framework



GWP = global warming potential.

Source: Asian Development Bank (ADB). 2021. *Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation.* Technical assistance consultant's report. Manila. 52249-003: Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation (adb.org).

Although there are diversified green cooling solutions on the market and cities have a great potential for implementing these solutions, there are obstacles that hinder them from taking aggressive actions in the large-scale deployment of these solutions. ADB supported the innovative mechanisms of Ningbo city in the PRC in financing large-scale green cooling deployments by conducting two rounds of customer surveys. The surveys targeted institutional customers in the industry, commerce, and public sectors of Ningbo that use refrigeration and cooling equipment. The survey results show that Ningbo faces many obstacles in financing a city-scale green cooling program (Shen et al. 2021). A brief description of these obstacles is presented in Table 1. Many of these barriers are not unique to Ningbo, but are instead shared by many cities in Asian developing countries (International Energy Agency 2014).

Table 1: Obstacles to Scaling Green Cooling Solutions

Barriers	Faced by	Description
High up-front investment	Equipment buyers	• Due to the high up-front investment required, owners of cooling equipment are reluctant to pursue green cooling solutions. • Equipment buyers focus on equipment cost, rather than on the life-cycle energy cost savings, and they only buy when extremely necessary.
High borrowing cost	Equipment buyers	• Equipment buyers are usually small and medium-sized enterprises (SMEs). As they do not have much collateral, they are seen as higher credit risks, and thus face higher borrowing costs. • Their status as high credit risks prevents SME buyers from accessing affordable financing.
Financiers' lack of confidence in green cooling investments	Financiers	• Financiers are reluctant to invest because they have limited information about green cooling solutions. • Financiers lack confidence in green cooling investments, given the technology- and performance-related risks due to the lack of accurate information on real-time energy use and verified energy savings. • The lack of timely and credible information on the borrower's operation prevents the detection of potential problems, and this contributes to financiers' worries about the risk of default.
Lack of diversified financing options	Both equipment buyers and financiers	• Buyers of cooling equipment lack diversified financing sources, so they rely heavily on their own funds or on traditional borrowing methods that use fixed assets as collateral. • Financiers offer limited financing options. For example, most financing consists of traditional loans that require collateral.
Inability to access energy-saving opportunities	Equipment buyers, financers, equipment manufacturers, and energy service companies	• Lenders and borrowers favor projects with short payback periods, rather than projects with longer payback periods (due to higher up-front capital investment), but greater energy-saving potential. • The users of cooling equipment often do not understand how their equipment can operate optimally, so they do not know how to maximize their energy savings through optimal operations. • Equipment manufacturers and energy service companies that limit themselves to one-time sales and installations lack business opportunities of managing equipment performance.

Continued on next page

Table 1: continued

Barriers	Faced by	Description
Lack of scalability of green cooling deployment	City governments and market participants	• As green cooling projects tend to be scattered, it is difficult to achieve economies of scale, and thus hard to attract investors. • There are no bodies responsible for organizing, coordinating, and bundling many green cooling projects. • Due to the lack of implementing bodies, implementation decision-making is decentralized, resulting in low implementation efficiency and high implementation costs.
Lack of information and trust	Market participants and city governments	• The lack of information and trust among market participants makes it difficult to obtain the resources required for implementing green cooling projects. • Equipment buyers lack access to reliable information on equipment suppliers and service providers. • Financiers face difficulties in accessing quality borrowers and bankable projects. • Energy service companies and equipment manufacturers face high project development costs due to the lack of information on potential projects. • Since municipal authorities are incapable of tracking equipment energy consumption, they cannot establish incentives for achieving green cooling goals or the effective implementation of energy efficiency policies.
Lack of liquidity in financing of energy efficiency projects	Financiers	• Green cooling finance lacks liquidity, which makes it a less attractive investment.
Split incentives	Equipment buyers	• When the owner and user of a cooling facility are not the same party, neither has the motivation to make changes in the facility. As a result, the facility's energy performance could remain inefficient. • The owner of a facility will not directly benefit from improved energy efficiency of the facility because he or she does not use the facility, so the owner has no incentive to invest in more efficient equipment. • There is no incentive for the user to retrofit the facility because he or she does not own the facility, and so would not benefit from adding value to it.

Source: Asian Development Bank (ADB). 2021. *Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation.* Technical assistance consultant's report. Manila. 52249-003: Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation (adb.org).

The large-scale deployment of green cooling solutions and the financing of that deployment will require effective handling of these obstacles. Adopting a range of financing mechanisms, business models, and risk mitigation tools can help developing countries in Asia overcome these barriers. These mechanisms and tools are discussed in the following sections.

IV. FINANCING MECHANISMS

Access to affordable financing plays a key role in accelerating the adoption of green cooling solutions in Asian developing economies. The lack of diversified financing instruments is one of the obstacles hindering the efforts. Various energy efficiency financing mechanisms have been adopted internationally, which can be applied to the financing of green cooling deployment. This section summarizes energy efficiency financing methods that have emerged in different countries.

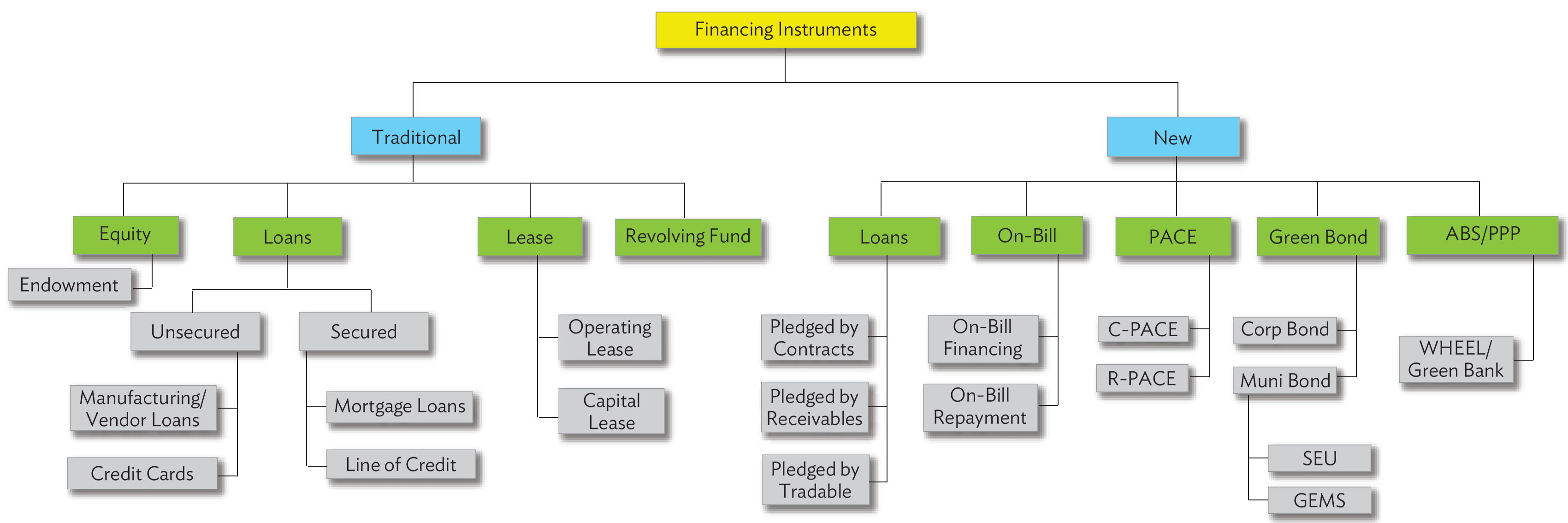
These mechanisms include both traditional and new financing instruments. Traditional mechanisms refer to the more common financing models, such as self-funding; traditional loans (i.e., unsecured loans such as manufacturing or supplier loans and credit cards, and secured loans such as mortgages and credit lines); lease financing; and revolving funds. New financing mechanisms are emerging models with innovative features, which include, but are not limited to, loans secured by revenue-generating project contracts, accounts receivable, and tradable permits; on-bill financing, energy efficiency bonds; property assessed clean energy (PACE) financing; and asset securitization. Figure 2 shows the classifications of different types of energy efficiency financing instruments.

The following paragraphs explain some of these financing mechanisms. Traditional financing mechanisms are easy to accept because they have been widely used for a long time. The adoption of new financing mechanisms, however, faces more challenges due to novelty. Innovative financing mechanisms can broaden the financing instruments of Asian developing countries and overcome the shortcomings of traditional financing methods. But the potential of these new mechanisms depends on the market structure, policy environment, and financing practices of these countries. Each country should explore how to transform these mechanisms in its country according to its own unique situation.

A **green revolving fund** is a repayable investment facility whereby a capital pool is earmarked for energy efficiency projects at a very low or no cost. The repayments or proceeds of the first investments are returned to the capital pool and reinvested in additional eligible projects. The Government of Thailand's Energy Efficiency Revolving Fund (EERF) is a good example of this investment vehicle. The EERF began operations in 2003 as part of Thailand's National Energy Conservation Program. It provides low-interest loans to 11 commercial banks, which then finance energy efficiency projects. The loan term can be up to 7 years, with a negotiable interest of up to 4%. Loan size is up to 100% of the project cost, but not more than 50 million baht (approximately $1.4 million) per project (Grüning et al. 2012). The EERF had funded a total of 294 projects by February 2012. The initial capital for the fund came entirely from the Thai government's allocation from its petroleum tax revenue. The EERF has had five funding phases, with a total financing of $235 million (Grüning et al. 2012).

On-bill financing is a new financing option that allows customers to pay for energy efficiency measures over time via surcharges on their utility bills. The customer's monthly payment covers the actual energy costs plus the monthly payment of the loan. The loan payment is offset by the cost savings achieved through energy efficiency retrofits, making the customer's monthly payment equal to or lower than the energy payments before the implementation of the project; in this way, customers can achieve efficiency upgrades cost free. This financing option includes two types. One of them works on a tariff basis, linking a loan to an energy meter, rather than to a customer. When the customer moves, the loan continues to be repaid by the new customer. This model allows the loan repayment period to remain flexible. The other type is a customer loan model called "**on-bill repayment**," in which the loan is linked directly to a customer. A disadvantage of linking the loan to a customer instead of a meter is that the loan must be paid off when the customer moves out, and this reduces the flexibility of the loan-repayment period.

Figure 2: Schematic Diagram of the Structure of Energy Efficiency Financing Instruments



ABS = asset-backed securities, C-PACE = commercial property assessed clean energy, GEMS = Green Energy Market Securitization (program), PACE = property assessed clean energy, PPP = public–private partnership, R-PACE = residential property assessed clean energy, SEU = Sustainable Energy Utility, WHEEL = Warehouse for Energy Efficiency Loans.

Source: Adapted from Leventis et al. 2016.

On-bill financing has several advantages. First, customers can pay up-front energy improvement expenses and start saving energy immediately. Second, it reduces the financing risks due to the relationship between the utility company and its customers. Lenders can use a customer's bill payment history to underwrite upgrades. If customers default on their bills, they will face service interruptions from the utility company. For example, the default rate of bill financing projects in the US is under 3%, which is lower than the default rates of loan projects elsewhere (National Conference on State Legislatures 2015). In addition, on-bill financing brings tax benefits because loan payments are regarded as operating expenses that can offset taxable income. Further, the financing is carried out in the form of utility payments, rather than direct debt payments, thereby reducing customer debt on the balance sheet. Examples of on-bill financing include utility demand-side management programs in the US (US Department of Energy n.d.).

Lease financing is a tool in which the lessor, who owns the equipment (e.g., the equipment manufacturer or energy service provider), signs an agreement with the lessee (e.g., the cooling facility user) to allow the latter to use the equipment and pay for the lease on a regular basis. At the end of the contract, the asset is returned to the lessor, or the lessee may choose to renew the lease agreement or pay the residual value to the lessor to own the asset outright.

Lease financing has three major advantages. First, compared with traditional loans, lease financing procedures and documentation are simplified, enabling the lessee to obtain equipment faster and at a lower cost. Second, lease financing reduces investment risk for the lessor, because if the lessee defaults on payment, the lessor can take back the leased equipment. Third, the lessee has the opportunity to use the latest technology, avoiding the risk of technology obsolescence (Account Learning n.d.). Lease financing also has certain disadvantages. First, the lessee cannot freely modify the leased equipment. Second, once the lease is signed, it cannot be canceled unless a very high price is paid. If the equipment is not suitable, the lessee will suffer losses. Third, lease financing can be costlier than debt financing, depending on how the contract is structured (Account Learning n.d.). Türkiye's Commercializing Sustainable Energy Finance Program is an example of green lease financing (World Bank n.d.).

Property assessed financing is a new type of green financing in which local authorities issue tax-exempt municipal bonds to raise funds for property owners to carry out energy efficiency retrofits or install renewable energy systems. Under property assessed financing, which can apply to both the commerce and residential sectors, the loans are attached to the property, rather than to individuals, and are repaid through the annual property tax within a specified period (usually 15 or 20 years).

This mechanism allows owners to make an up-front investment and start saving immediately. The loan is treated as a tax liability, rather than as a debt, thus allowing the borrowing costs to be reduced through tax-free municipal bond financing. Greater savings materialize for retrofits with longer payback periods, since property assessed financing is repaid over a much longer time span. The property assessed clean energy (PACE) program in the US is an example of property assessed financing (PACENation n.d.).

Pledge financing is a new type of loan in which borrowers can obtain loans by pledging soft assets such as profitable energy service contracts, accounts receivable, inventory, and tradable emission allowances as collateral. This option provides more financing opportunities for customers with low fixed assets, such as small and medium-sized enterprises (SMEs). If the borrower defaults on the loan, the lender may take possession of the pledged assets. An example of pledge financing can be found in the PRC. Since the creation of carbon trading markets, loan programs using carbon emission allowances as pledged assets have become a trend in the PRC (Jiang 2021).

Green bonds use debt capital markets to fund climate and environmental pollution mitigation projects. These tax-exempt municipal bonds, coupled with the government's excellent credit rating, greatly reduce the financing costs of government green bonds. There are several examples of green bonds, such as "use of proceeds" revenue bonds, project bonds, and securitized bonds. Energy-saving and GHG-mitigation projects can be implemented by government-affiliated implementation agencies or government tenders to establish specialized implementation bodies. A good example is the state of Delaware in the US, where the state government bids to run a sustainable energy utility that is responsible for issuing green bonds and organizing project implementation (Energize Delaware 2019).

Securitized energy efficiency finance involves asset-backed securities (ABS); specifically, a pool of energy efficiency loans is packaged together and converted into securities that can be sold to ABS investors. ABS allows originators to move these assets off their balance sheets by selling the assets to other investors and use the proceeds to make new loans. This provides the great liquidity that attracts more investors. Besides the liquidity that attracts investors, another advantage of ABS is its flexibility. Energy efficiency loan securitization enables the investors to spread risk by purchasing a small portion of many loans rather than large pieces of a few loans.

It also allows investors to choose which tranche of the loan they wish to acquire based on their risk- and-return trade-off considerations. More senior tranches usually provide investors with lower returns, while mezzanine and subordinate tranches provide higher returns, but also carry greater risks, as they have to bear the initial loss of the underlying assets once the borrower defaults. This approach, based on risk-return considerations, helps to establish public–private partnerships in green financing: when private sector investors are not willing to invest in a riskier tranche of a loan, public capital can provide that part of capital without having to cover the entire project.

The liquidity, flexibility, and diversification offered by energy efficiency loan securitization help reduce the cost of capital. The Warehouse for Energy Efficiency Loans is a good example of securitized energy efficiency finance. It originated in the US, but research shows that it has application prospects in Brazil, the EU, India, the PRC, and the United Kingdom (Bellis 2017).

V. CONTRACT AND BUSINESS MODELS

The profitability of a green cooling project depends on the return on its investment. The choice of different business models and project contract schemes will have an important effect on the return on investment of the project. This section examines a variety of business models and energy service contracts that have been utilized to improve energy use in the industry, commerce, public, and residential sectors in different countries. These models can be applied to the city-scale deployment of green cooling solutions. The following paragraphs summarize some major business models and contract arrangements for implementing energy efficiency projects.

The **shared savings contract** is a traditional energy efficiency performance contract model, in which the energy service company (ESCO) and the customer sign an energy efficiency service contract for a specific period. During this period, the customer and the ESCO agree to share, based on an agreed percentage split, the benefits of the cost savings from the energy efficiency measures minus the debt payments. In this model, the ESCO is usually responsible for financing the project, either from its own funds or through third-party financing. A disadvantage of this model is that the ESCOs bear the financial risks in addition to the performance risks, which is a huge burden that limits their ability to invest in more projects. Another problem is that the customers have an incentive to claim insufficient energy savings in order to reduce the benefits they should pay to the ESCO (Evans et al. 2015).

The **guaranteed savings contract** is an energy efficiency performance contract under which the customer is responsible for project financing, and the ESCO guarantees the energy savings. This model protects the customer from any project risks; instead, the customer only takes on the financing risks. If the cost savings are not enough to cover the customer's debt payment, the ESCO must fix the problem or pay the difference to the customer. One problem with this model is that the ESCO tends to avoid committing to uncertain projects because of the performance risks, thereby missing opportunities to tap into greater energy saving potential (Evans et al. 2015).

The **Energy Saving Agreement (ESA)** is a savings-as-a-service model in which the ESA provider covers all the costs of developing and operating energy-saving projects. It pays a customer's energy bill and, in turn, bills the customer for the energy saved as a service ("negawatts") with a service charge per unit of energy saved that is set below the customer's baseline utility charges. This model is gaining momentum in several countries.

The ESA model shifts the responsibility for equipment operation management from the customer to the service provider. In this model, ESA providers have a strong incentive to achieve high energy efficiency to maximize energy savings, thus generating substantial energy-saving opportunities. Despite the benefits of ESAs, however, there are also some problems. In this model, ESA providers incur substantial up-front costs and take on performance risks. As a result, the financing costs are often higher than other low-interest debts. ESA providers may charge customers higher fees for their services to hedge these costs, leading to lower returns for the customers (Nadel 2019).

Cooling as a Service (CaaS) is an energy-saving agreement under which customers pay for cooling services instead of paying for the purchase and operation of their own cooling equipment. CaaS providers (e.g., equipment manufacturers or specialized service companies) install and maintain the cooling equipment and pay the cost of the energy used by their customers. They recoup the costs and earn revenue by charging the customers for their cooling services on a regular basis. The regular charges are based on the price per unit of the refrigeration or cooling service provided. CaaS providers have a strong motivation to improve energy efficiency and to achieve an optimal operation of their cooling systems to maximize energy savings for greater earnings. The CaaS model shifts the responsibility of equipment operation management from the customer to the service provider, thereby eliminating the customer's concerns about shouldering these responsibilities.

Value-stacking service is a new business model that has been adopted in some countries, such as the PRC and the US. In this model, project developers (e.g., ESCOs) integrate diverse green solutions—such as efficiency improvement, distributed photovoltaic power generation, energy storage, and customer load response—and optimize their use to maximize the value of the bundled services. This model can help customers achieve greater savings and earn income (Shen, Kahrl, and Satchwell 2021).

Performance monitoring and management service contract enables the customers to own and operate their own cooling systems, and the manufacturers or professional service companies maintain the systems. The service providers install sensors and other online monitoring systems, and provide performance optimization, malfunction diagnoses, preventive services, and recurring maintenance. Service fees are charged to customers on a regular basis, based on the frequency and technical complexity of the services provided.

The **sharing economy** is a new business model based on the concept of the shared economy, which has been applied in many industries. Refrigeration warehouses and cold chain transportation companies have a lot of service space and capacity, but the utilization, turnover, and occupancy rates of their facilities are not always optimal, and this results in a lot of waste. A sharing economy model for the refrigeration and cooling business would enable the sharing of underutilized space and equipment. If the distribution of these resources were to be well coordinated throughout a city, they would be used in a rational and optimal manner, thereby helping companies reduce the waste of cooling capacity and corresponding energy use, improve resource utilization efficiency, cut costs, and increase revenue.

VI. INVESTMENT DE-RISKING STRATEGIES

Investment in green cooling deployment faces multiple risks, including property risk for cooling systems, performance risk for green cooling measures, and credit risk for borrowers. Further, these risks may affect loan payments and result in bad debts, which is a default risk. Cooling systems are characterized by a concentration of property values. Due to the nature of their operation, basic property risk events such as fires, explosions, equipment failures, and severe weather conditions may have a significant impact on cooling systems and their associated physical infrastructure. In addition to damaging or destroying tangible property, property risk events may also cause economic losses due to operation interruption. These property risks pose challenges for the adoption of new business models such as CaaS.

For the implementation of green cooling projects and for the ESCO undertaking the projects, it is also a challenge to assure the cooling system owners and their creditors that the implementation of the new measures will produce the expected energy savings. Due to the complexity of the new measures and the uncertainty of the verification of their energy savings, financial institutions generally regard such projects as risky in terms of performance. Furthermore, as many equipment owners are SMEs, which usually do not have strong asset collateral, the resulting credit risk is a severe challenge for financial institutions. Mitigating potential risks—property risks, project performance risks, borrower credit risks, and payment default risks—is the key to increasing investment in green cooling deployment. Several possible de-risking strategies are discussed as follows:

A. Guarantee

The guarantee is a finance de-risking mechanism that addresses the lack of creditworthiness of customers requiring funding. These customers usually lack strong collateral or have limited financial resources, so financial institutions are unwilling to provide them with funding. A guarantee is a contractual arrangement among the lender, the borrower, and a third-party guarantor. Essentially, the guarantor promises to assume borrower's debt liability should the borrower be unable to keep up on its payments to the creditor. Because the guarantee means that the lender is taking on less risk when issuing the loan, it can result in a reduction of the loan's risk premium, and thereby reduce the customer's borrowing cost. Guaranteed financing can help solve the problem of financing accessibility and affordability faced by customers, especially SMEs that would otherwise not be eligible for loans.

B. Insurance

Insurance products, such as property insurance, business income loss insurance, and asset performance insurance are designed to provide value protection for events with a small probability of occurrence, rather than for events with a higher probability. Energy efficiency insurance is a new type of asset performance insurance aimed at underwriting the implementation effects of energy-saving measures. If the effects of energy-saving projects are less than expected, energy efficiency service providers will receive compensation from third-party insurance companies. Examples of energy performance insurance include energy savings insurance programs in Colombia, El Salvador, and Mexico (Basel Agency for Sustainable Energy 2020 and Global Infrastructure Hub 2021).

Energy efficiency insurance can help reduce financing costs in a variety of ways. First, ensuring asset performance is an effective means of reducing the risk of default because in many energy retrofit projects, loan payments are offset by the cost savings achieved through energy efficiency measures. Second, performance insurance reduces the technical uncertainty and performance risk of energy efficiency projects that lenders are generally concerned about, allowing them to focus on the credit risks that they are more familiar with. Another advantage of energy efficiency insurance is that cooperating with an insurance company with a high credit rating can transfer risk and bring credit enhancement to the insured, as the insurance coverage is supported by the credit rating of the insurance company, rather than by the credit rating of the insured (Jones and Tine 2014). Credit enhancement can help reduce interest rates and financing costs.

C. Insurance versus Guarantee

Insurance and guarantees are both tools to provide buffers and avoid financing risks in response to events that would trigger the coverage. Although they both provide protection for the green-project financing, the two mechanisms differ from each other. A guarantee is a legal contract. When the debtor fails to fulfill its financial obligations or is insolvent, the guarantor must repay the debt to the financial institutions. When the guarantor assumes financial responsibility, it is obligated to compensate the loan losses partially or fully. This liability covers all risks that lead to the failure to repay the debt.

Insurance promises to compensate losses when the insured assets cannot be operated normally. The coverage depends on the nature of the insured event (usually property, third-party liability, and asset performance), and on the value of the policy purchased. The calculation of the policy is based on the underwriting and possible losses. Risks that are considered predictable in nature, such as credit and default risks, are risks that insurance companies generally do not accept. Both guarantees and insurance policies require personnel with experience and expertise to conduct prudent risk identification and assessment, based on established workflows, to understand the factors affecting risks and to determine the key characteristics of specific risk exposures. The two mechanisms also rely on the use of risk-sharing mechanisms, such as re-guarantees and reinsurance, to further transfer risks.

D. Hybrid Approach

Neither insurance nor a guarantee alone can cover all the risks in a cost-effective manner. A hybrid approach that combines insurance and guarantees, and makes full use of the different characteristics of both, can benefit from their complementary strengths. Insurance will help to transfer insurable risks and greatly reduce the total risk borne by the guarantee company. The hybrid approach will allow certain risks to be transferred, while covering a wider range of risks than would be possible with a single mechanism, thereby reducing the risk premium of financing and lowering the financing cost for customers. Table 2 provides a comparison of the risks covered by a guarantee, insurance, and a combination of the two.

Table 2: Comparison of Insurance and Guarantee Coverage

	Uninsurable Risks		Insurable Risks					Characteristics Comparsion		
Mechanism	**Policy Risk**	**Default Risk to Lender**	**Property Risk**	**Loss of Income and Profit**	**Equipment Breakdown Risk**	**Third-Party Liability**	**Asset Performance (Technology Risk)**	**Cost**	**Credit Enhancement**	**Risk Sharing**
Guarantee	Yes	Yes: subject to total loan	No	No	No	No	No	3%–5% or higher	Yes: guarantor's credit rating	Re-guarantee
Insurance	No	No	Yes	Yes	Yes	Yes	Yes	Around 1% or less	Yes: insurer's credit rating	Reinsurance
Hybrid	Yes	Yes:subject to total loan	Yes-can cover project value (higher than the loan value)					Overall cost reduction	Double credit enhancement	Risk sharing between guarantee company and insurer, expanded coverage scope, reduced overall cost

Source: Asian Development Bank (ADB). 2021. *Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation.* Technical assistance consultant's report. Manila. 52249-003: Developing a Climate- Friendly Cooling Sector through Market and Financing Innovation (adb.org)..

VII. AN INNOVATIVE MODEL FOR FINANCING CITY-SCALE GREEN COOLING DEPLOYMENT

Cities are ideal places to implement green solutions on a large enough scale to attract investors, as they can offer opportunities in various sectors simultaneously, including the industry, commerce, public, and residential sectors. However, carrying out city-scale green solutions in a way that differs from the traditional implementation of single projects will require an integrated model with innovations in financing and project implementation.

This paper recommends an integrated model that can be considered by cities in ADB's developing member countries for launching green city-scale cooling deployment programs. This recommended model draws on international financing mechanisms, business models, and investment de-risking strategies introduced in the previous sections. The design of the model reflects the goal to be achieved, which is to solve the obstacles to the large-scale deployment of green cooling solutions discussed in Section 3. Figure 3 shows a schematic diagram of the integrated model.

As discussed in Section 3, green cooling deployment at city scale faces many challenges, including small investment scale, fragmented projects, no effective implementation systems for integration and coordination, and so on. Scaling up clean cooling financing and deployment at scale requires consideration of actions to remove these barriers. The proposed integrated financing model aims to expand the scale of investment, establish an effective implementation system, and at the same time drive the realization of climate benefits through financing. The model contains three main means to achieve these goals: (i) removing financing barriers by increasing the scale of financing, unlocking private capital, lowering financing costs, and reducing investment risks; (ii) enhancing the climate benefits of financing; and (iii) enabling large-scale implementation. Each area is discussed as follows:

A. Expanding the Scale of Financing

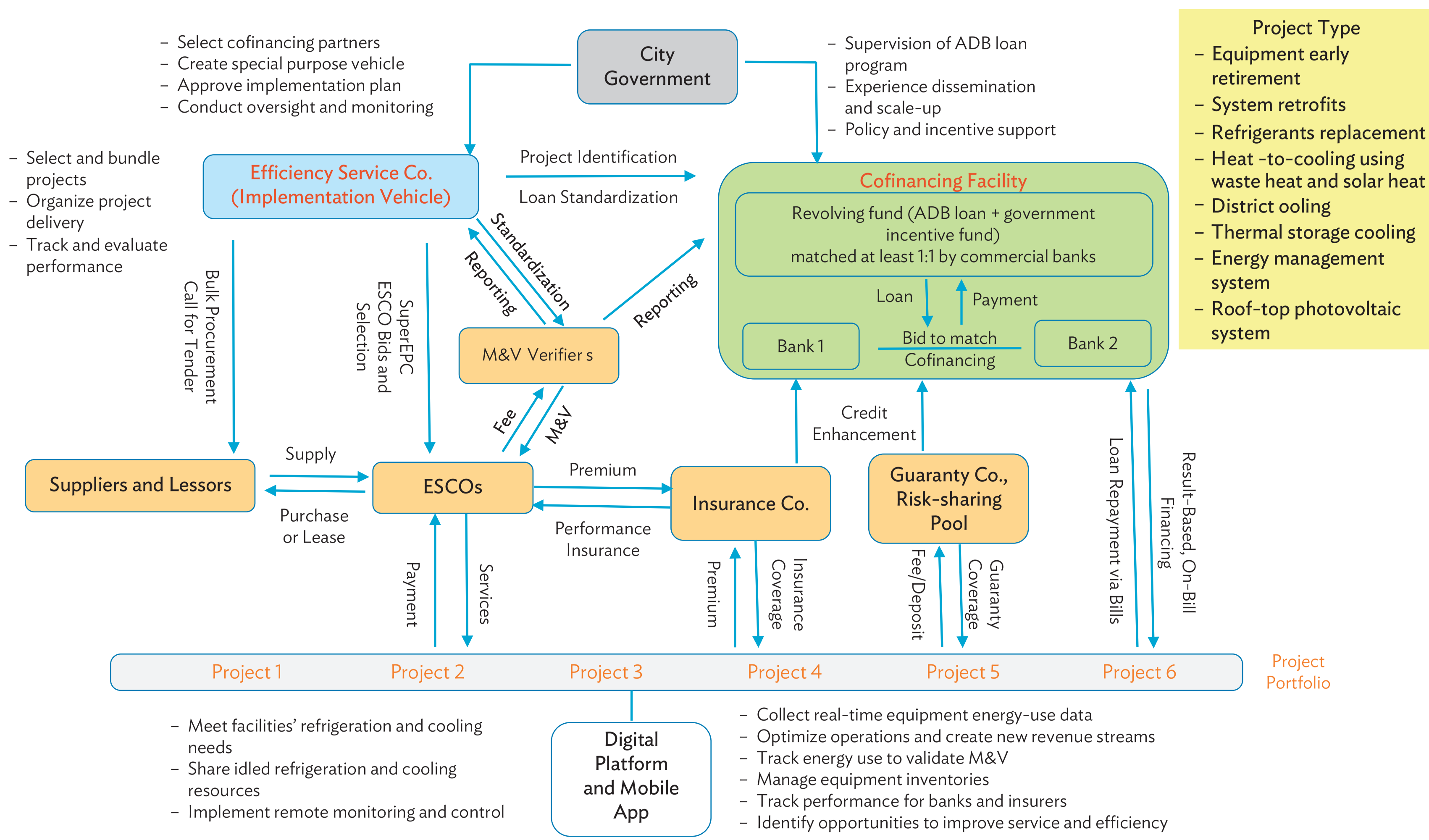
In the proposed model, the cities establish cofinancing programs, which can be carried out through a partnership that includes the municipal government, a multilateral development bank, and the private sector. The partnership uses the multilateral development bank's preferential sovereign loans and the government's energy-saving incentive funds as leverage to drive cofinancing by commercial capital. This will unlock massive private investment. Cofinancing uses the preferential interest rates of public funds and sovereign loans to neutralize the higher commercial interest rates of partner banks, to reduce the borrowing costs for customers, especially SMEs.

The cofinancing scheme will create a green cooling revolving fund that returns the initial capital repayment to the capital pool, and reinvests it in other eligible projects. In addition, in the recommended model, insurance and guarantees play an important role in reducing the risk of green cooling investment. The model promotes the use of insurance and guarantee bundles to allow certain risks to be transferred, while covering a wider range of risks that could not otherwise be covered by a single mechanism, thereby reducing the risk premium of financing, and lowering the financing cost for customers.

B. Enhancing the Climate Benefits of Financing

The proposed model promotes the adoption of result-oriented financing to incentivize projects that are more effective in mitigating climate change. Variable interest rates, flexible terms, and reward points can be used based on the project's contribution toward improving energy efficiency and reducing GHG

Figure 3: Schematic Diagram of the Integrated Implementation Model



ADB = Asian Development Bank, Co. = company, EPC = energy performance contracting, ESCO = energy service company, M&V = measurement and verification.

Source: Asian Development Bank (ADB). 2021. *Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation.* Technical assistance consultant's report. Manila. 52249-003: Developing a Climate-Friendly Cooling Sector through Market and Financing Innovation (adb.org).

emissions. This method of linking to climate benefits would ensure that financing becomes the driving force for climate-friendly cooling.

C. Enabling Large-Scale Implementation

The recommended model promotes the creation of a special purpose vehicle (SPV) type of green cooling service company to aggregate many individual projects and develop bulk procurement programs in the relevant city. The purpose is to enable large-scale green cooling deployment, which would not only achieve an attractive scale for investors, but would also reduce the total transaction costs through standardized implementation. The SPV would be responsible for all tasks related to deployment, including the development of the project portfolio, acquisition, and management of financing, ESCO selection, contract placement, bulk equipment procurement, loan payment management, and project result tracking and verification.

The SPV would adopt diversified contract models to achieve optimal efficiency, such as CaaS, operating and maintenance contracts, as well as equipment leasing contracts. In addition, the SPV would build a digital platform to connect isolated information nodes to form a flow of information on the city's refrigeration businesses, thereby enabling the sharing of underutilized refrigeration and cooling resources throughout the city.

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Financing Climate-Friendly Cooling at City Scale

Refrigeration and air-conditioning are major contributors to climate change, and demand for them is growing. Crucial obstacles to climate-friendly cooling solutions in developing countries in Asia are the lack of accessible and affordable financing and insufficient project scale. This paper discusses a variety of financing instruments and business models and presents an integrated model for financing city-scale green cooling. This model could help rollout green cooling solutions at a scale large enough to attract investors and to reduce transaction costs through standardized implementation.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members —49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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