In addition to pursuing infrastructure improvements, some cities are striving to match the generating profile and other characteristics of the contracted supply against their demand profiles. For example, in 2020 Sydney (Australia) achieved its goal of meeting 100% of municipal electricity demand (buildings, facilities and streetlights)[i] with renewables via PPAs from solar and wind projects in New South Wales.[257] The PPA criteria included local supply to minimise transmission losses, and high load matching[ii] (80%) for economic and system efficiencies.[258] The city also is pursuing solar PV on municipal buildings and battery storage to improve the reliability and resilience of the distribution network.[259]

London (UK) offers an example of how storage can be used to time-shift system demand to match the available renewable supply. In a pilot project, battery storage is being deployed at some London homes to allow residential consumers to purchase excess electricity during off-peak periods (and thus at lower cost), which they can then store for later use during times of peak demand. This approach provides both load matching and grid management benefits, while potentially reducing the cost of supply.[260]

Many cities, especially in developing countries, struggle with insufficient distribution infrastructure. In these cases, renewable energy projects will require investment in local infrastructure. Building mini- and micro-grids can facilitate the deployment of reliable and relatively affordable renewable energy in locations with limited electricity access or where the main grid is frail and overburdened.[261]


Sweden

DIRECT THERMAL ENERGY DISTRIBUTION

District energy networks are present in the urban areas of more than 30 countries worldwide, with an estimated 80,000 systems in total (including more than 6,000 each in the United States and Europe).[262] In China, district energy networks provide heating to over 5.7 million m^2 of floor space.[263] The vast majority of these district networks worldwide are used for heating.[264]

During 2019 and 2020, several cities expanded their district energy infrastructure or commissioned new systems. Often, this activity was driven by the desire for an efficient, stable and reliable heat supply with low heat loss; for cost-effective cooling of large residential and office buildings; and for more options to integrate multiple renewable energy sources.[265]

In 2020, the first **district heating** network in Scotland (UK) using large-scale water-source heat pumps entered into operation in Clydbank to serve municipal, commercial and residential buildings, taking advantage of Scotland's nearly 100% renewable electricity mix.[266] The municipal government in Leeds (UK) plans to invest GBP 24 million (USD 31.5 million) in six new district heating networks (relying on biomass or heat pumps), following the success of the city's first such network, which was expected to provide waste-derived heat to some 2,000 homes by the end of 2020.[267] Montauban (France) is installing a district heating network using residual waste to heat 4,200 homes, with completion scheduled for 2023.[268]

Although less widespread, **district cooling** networks have operated for years in many European cities, particularly in Denmark (Aalborg, Aarhus, Copenhagen, Høje Taastrup) and Sweden (Gothenburg, Helsingborg, Linköping) but also in France (Bordeaux, Paris) and Germany (Berlin, Hamburg).[269] Elsewhere, district cooling networks are present in Canada (Toronto), Japan (Osaka, Tokyo, Yokahama), Kuwait, the United Arab Emirates and the United States (Boston, Chicago, New York).[270]


Berlin, Germany

3

i Sydney's municipal electricity demand represents 115 buildings, 75 parks, 5 swimming pools and 23,000 streetlights.

ii In this instance, the load matching was achieved by skewing the PPAs towards wind power over solar because the generating profile of wind power better matches the predominantly night-time demand of the city government (i.e., street lighting).

Several city governments, especially in Asia, plan to add new district cooling infrastructure, although it is uncertain whether these systems will incorporate renewables. Bangkok (Thailand) is developing a district system, expected to be operational in late 2022, to serve the cooling needs of several office, retail and residential properties.[271] Amaravati (India) signed a concession to develop a district cooling system slated for operation in 2021.[272] Singapore announced plans for a district cooling network for the Punggol Digital District, and new district cooling systems also were commissioned in Cyberjaya (Malaysia), Gujarat City (India) and Manila (Philippines), among others.[273]

A few cities in Scandinavia have developed **integrated district heating and cooling systems**. Copenhagen (Denmark) has a district heating capacity of 3,000 MW and a cooling capacity of 50 MW; the network is connected to a waste-to-energy combined heat and power plant and supplies the city itself as well as 24 surrounding municipalities.[274] In Stockholm (Sweden), the district energy network, co-owned by the city and a private company, has a 3,600 MW heating and 220 MW cooling capacity, supplying six municipalities.[275] Since Stockholm's last coal-fired plant closed in early 2020, heat supply has been based on biofuel and municipal waste, with plans to use 100% renewable fuels by 2022.[276]

EV CHARGING NETWORKS

Widespread roll-out of EV charging infrastructure is key to the continued growth of electric vehicles and plays an important role in increasing the use of renewable energy in the urban transport sector.[277] Of the estimated 7.3 million EV chargers[i] worldwide in 2019, most were concentrated in urban areas of China.[278] Although the vast majority of chargers are not linked to renewable electricity, several municipal governments as well as private actors in cities in Australia, Europe, the United States and Latin America have made an explicit connection between EV charging and renewables.[279]

As of 2019, Adelaide (Australia) had installed 49 EV fast-charging points, which the city planned to run on 100% renewable electricity.[280] Chargefox, Australia's largest EV charging network, opened the country's first ultra-rapid charging station, delivering 100% renewable electricity in the city of Keith.[281] In Europe, Oslo (Norway) and Stockholm (Sweden) are among the leaders in the number of EV chargers per person, and their charging stations benefit from the high shares of renewables in the national electricity mixes (→ *see Table 2*).[282] Since 2019, Oslo's municipal government has worked with private companies to deploy wireless-charging infrastructure for the city's growing electric taxi fleet.[283]

i Of these, around 90% were private, light-duty vehicle slow chargers.

Table 2. Number of Public Electric Vehicle Charging Stations and Renewable Energy Uptake in Selected EV Capitals, 2019

City (State, Country)	No. of public chargers per million population	Share of renewables in city's electricity mix*
Asia		
Shenzhen (China)	4,800	
Beijing (China)	1,920	28%
Shanghai (China)	1,690	
Europe		
Oslo (Norway)	3,000	98%
Amsterdam (Netherlands)	2,750	18%
Stockholm (Sweden)	717	69%*
London (UK)	405	37%
Paris (France)	307	22%
North America		
San Jose (California, US)	1,200	48%*
Los Angeles (California, US)	590	32%*

Charging stations

in several EV capital cities benefit from high shares of renewables in the national electricity mixes.

Note: EV charger data were reported by ICCT in late 2019 and 2020. *Renewable electricity data for Los Angeles, San Jose and Stockholm are from 2018. All other city renewable electricity shares refer to national-level data from 2019.

Source: See endnote 282 for this chapter.

New York City (US) added 50 solar-powered EV charging stations in 2018.[284] In Latin America, renewable-powered charging infrastructure was being developed in 2019 and 2020 in Santiago (Chile) and across São Paulo state (Brazil), among others.[285] In addition, "smart charging"[i] solutions have been deployed and tested in some cities, mostly in Europe, including Amsterdam, Arnhem and Utrecht (all Netherlands) and Cranfield (UK).[286] In Tokyo (Japan), a partnership among utilities, automakers and other stakeholders is testing bi-directional EV charging stations.[287]

FUEL DISTRIBUTION

Much of the renewable fuel used in transport, including biofuels and hydrogen, is still produced outside of city limits. As a result, providing sufficient distribution and refuelling infrastructure in cities is key to enabling citizens to access alternatives to fossil fuels (which rely on established distribution networks and widely available petrol filling stations).[288]

Biofuel blends typically are transported from refineries to distribution terminals and sold at existing petrol filling stations.[289] In 2019, nearly 250 stations in Shanghai (China) were selling B5 biodiesel.[290] That same year, a new terminal for biodiesel storage and blending opened in Antwerp (Belgium).[291] In 2020, the US company Eco-Energy entered the final stage of construction of its ethanol distribution facility in Phoenix (Arizona, US).[292]

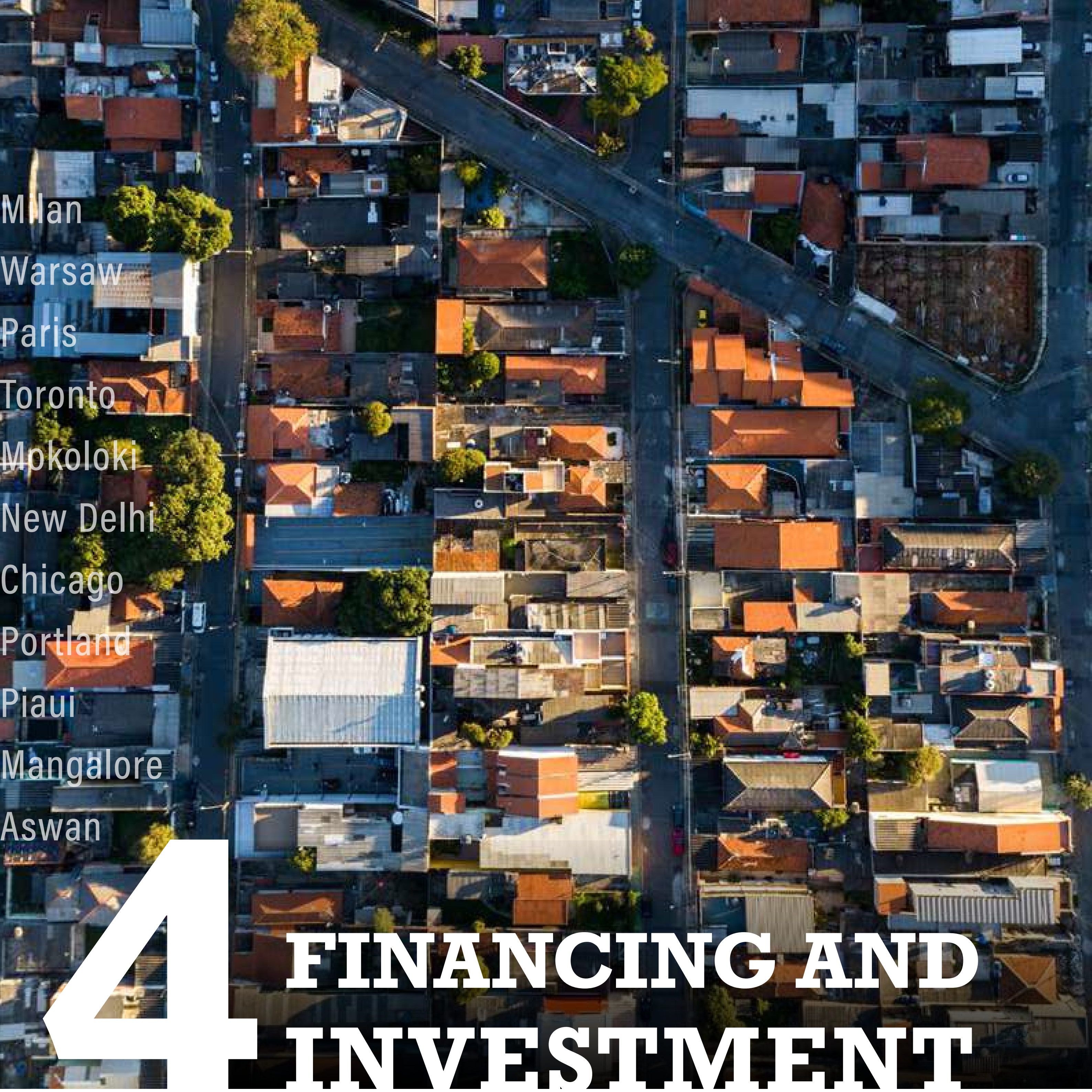
Hydrogen generally is distributed by pipeline, high-pressure tube trailers and liquefied hydrogen tankers. The costs associated with hydrogen distribution and delivery infrastructure depend on whether the fuel is produced centrally at large industrial sites (high distribution costs) or at the point of end-use such as in fuelling stations in cities (low distribution costs).[293]

The number of hydrogen refuelling stations remains low but has continued to increase. By the end of 2019, some 470 such stations[ii] were in operation worldwide, up more than 20% from the previous year.[294] Most hydrogen refuelling stations are publicly available and located in cities, although only an estimated 24% of the stations globally provide renewable hydrogen.[295] Shell's hydrogen refuelling stations in Beaconsfield and Cobham (both UK) supply hydrogen produced on-site using electricity from renewable sources.[296] The first hydrogen filling station for passenger trains in Bremervörde (Germany) was scheduled to begin construction in late 2020, with the hydrogen to be produced on-site using renewable electricity.[297]

i See Glossary for definition.

ii Since virtually all hydrogen is still produced from fossil fuels, most of the hydrogen available in these stations is fossil fuel-based hydrogen.


Frankfurt, Germany



Milan
Warsaw
Paris
Toronto
Mokoloki
New Delhi
Chicago
Portland
Piaui
Mangalore
Aswan

4 FINANCING AND INVESTMENT IN CITIES

Palmas
North Lombok Regency

FINANCING AND INVESTMENT IN CITIES

Global investment in new renewable energy capacity, including power and fuels (but not including hydropower projects larger than 50 MW) totalled USD 282.2 billion in 2019, up 1% over 2018.[1] In the first half of 2020, global investment in new renewable energy capacity rose 5% relative to the first half of 2019, suggesting sustained growth despite the COVID-19 pandemic.[2] Some of this investment occurred in city-related projects – by municipal governments as well as other residential, commercial and industrial actors within cities – but the exact amount is unknown. Although data are becoming more available, no comprehensive dataset on renewable energy investment in cities by sector exists.

This chapter explores financing and investment in cities, including the provision of funding for renewable energy projects and the process of investing in projects to turn a profit. The discussion examines common financing mechanisms applied by cities worldwide and how these mechanisms are being used to support renewables across the world's regions. The chapter concludes with an overview of the challenges that cities face in investment and finance of renewable energy projects.

Each city operates within a distinctive framework that affects the amount and type of renewable energy financing and investment available. Variables include the policies and regulations that govern city actions, the nature of relationships with higher levels of governments, partnerships with the private sector, ownership rights of the electric grid, etc.

Municipal governments are responsible for only a small share of the total financing that occurs within a city; in contrast, private individuals and companies account for far more of the investment in city-related projects – whether in the energy, buildings, commercial or industrial sectors – and have their own priorities, planning horizons and funding constraints. The total finance package allocated to renewables therefore results from many different players, regulations, institutions and financing mechanisms and is specific to every city.

Barbados

BOX 1. Global and Urban Climate Finance Flows

Global climate finance flows reached an estimated USD 608-622 billion in 2019, up 6-8% from the 2017/18 averages of USD 574 billion annually. Climate flows, which crossed the USD half-trillion mark for the first time in 2017, were highly concentrated on mitigation efforts (representing 93% of total flows in 2019). By sector, renewable energy generation accounted for the largest share of the flows tracked, largely due to more investments originating in China (particularly solar, wind and hydropower investments) and the United States (with an increased volume of investments in solar PV and onshore wind). The second largest investment during 2017/2018 was in sustainable transport (around USD 140 billion annually, making it the fastest-growing sector for climate finance), followed by investment in energy efficiency (around USD 33 billion annually).

Cities face major capacity constraints in financing climate change mitigation and adaptation projects. First, the public sector, notably city governments, often has budget capacity limitations and low rates of creditworthiness, which hinders private investment or any major borrowing scheme. Also, many long-term climate-smart infrastructure investments need highly technical capacity to pull together investor-ready bankable projects with sufficient size and quality to increase climate finance flows. Many countries forbid their local governments from issuing any kind of debt, including municipal bonds. Also, many private investors lack experience working with sustainable urban infrastructure, which often impedes investments.

Because cities are key players in achieving the Paris Agreement, investments must be scaled to promote the shift to the low-carbon, climate-resilient infrastructure that is needed to face the climate emergency. However, while there is a clear picture of global climate finance flows, information on **urban climate finance**[i] flows is lacking. By producing clear data, measuring progress, and understanding gaps and opportunities, city governments can have a better picture of the sources of finance, the financial instruments employed, and the policies that can more effectively drive investment, leading to improved policy planning in cities.

Source: See endnote 5 for this chapter.


Sanxia Dam, Yangtze River, China


New Bedford, United States

i For further information on financing of city-level climate action, see the Cities Climate Finance Leadership Alliance, www.citiesclimatefinance.org, and its forthcoming report, *State of Cities Climate Finance 2021*.

Financing for renewables also must be tailored to meet the unique characteristics of each end-use sector: power, heating and cooling, and transport. In the power sector, municipal governments and other urban actors generally target renewable energy projects in two main categories: small-scale, on-site generating capacity (for example, rooftop solar PV on single buildings or on somewhat larger areas such as parking or waste sites), and larger-scale projects (for example, solar PV or wind farms) that often are located outside of geographical city limits.

In the heating and cooling sector, cities often target district heating networks. Different ownership models for these networks affect the allocation of financing and include, for example, municipal ownership, long-term concession agreements with private operators and "unbundled" networks with private ownership. The networks can be fed by large-scale heat pumps[i], municipal waste incineration, biomass boilers, industrial waste recovery, solar thermal and geothermal energy, although the share of renewables across these options can vary.[3]

In the transport sector, cities working towards climate mitigation goals typically target projects related to mass public transit and zero-emission vehicles (including electric vehicles), which enables renewable electricity to replace fossil fuels in some transport applications (particularly through smart charging[ii]).[4]

Each city operates within a **distinctive framework** that affects the amount and type of renewable energy financing and investment available.

FINANCING MECHANISMS

Municipal governments and other urban actors that aim to increase the share of renewables in their power, heating and cooling, and transport sectors have many options for financing such projects.

These options can be grouped into three general categories:

- the actors may have their own capital or assets available for funding renewable energy projects;
- if they do not have their own capital available, they may be able to raise funds through bonds, or make use of funds provided by other levels of government or external actors (such as local or domestic banks and development banks); and
- they may be able to leverage external funds for renewable energy projects by participating in arrangements such as public-private partnerships or power purchase agreements.

In addition, cities have relied on climate finance from private and public sources, some of which has included funding for renewables (→ *see Box 1*).[5]

USING OWN AVAILABLE CAPITAL OR ASSETS

In the first category, actors may have their own financing available or may be able to generate the necessary capital to develop renewable energy projects (→ *see City Snapshot: Palmas*).[6] Some municipal governments fund renewable energy projects based on fees and returns from the project itself. To generate capital, one option is to sell or lease land or assets.[7] For example, land value capture can be used to help finance new infrastructure projects by harvesting a portion of the increase in value of nearby property caused by the investment. Land value capture has been used in some cities to finance electric transport and new metro and rail investments.[8] Municipal governments, alongside other actors, also may indirectly support renewable energy by divesting from fossil fuels and reinvesting in renewable energy companies (→ *see Box 2*).[9]

Warsaw, Poland

i Although heat pumps are not renewable energy technologies in themselves, they may be viewed as enabling technologies because they can be powered by renewable electricity.

ii See Glossary for definition.

PALMAS

BRAZIL

Land area (km²)

100.6

Population size (2020)

306,000

Palmas City, the capital of the state of Tocantins in north-central Brazil, aims to generate 100% of its electricity from solar power by 2022 and to have 100% of its local electricity energy supply based on solar energy by 2035 (foregoing the use of hydropower from the regional grid). Hydroelectric dams located on the Tocantins River account for nearly 97% of the electricity consumed in the city, in addition to providing power elsewhere in the country. However, electricity bills in Palmas are among the highest in Brazil, and growing uncertainties about hydropower's stability and climate and environmental risks have heightened interest in exploring the local solar resource.

The Palmas Solar project, established in 2015, provides tax incentives for companies and households to install solar PV panels and to feed surplus generation to the electricity grid. The benefits include reducing the city's dependence on hydropower and non-renewable energy sources, improving air quality and reducing greenhouse gas emissions. The main drivers for reducing hydropower are rising energy bills and the environmental risks of this generation source.

At first, the project focused on solar PV installations only in new buildings, but it has since extended city-wide. Users are encouraged to install solar panels in exchange for a discount of up to 80% on two municipal taxes – the Property and Urban Land Tax and the Real Estate Transfer Tax – for a period of five years. The costs for private users are drastically reduced, as the solar power they generate is fed into the grid and discounted from their energy bills. The local utilities maintain the distribution infrastructure, for which users pay a minimal equipment cost.

For Palmas, the tax incentives did not affect public revenue because the project was launched right after a tax increase, foreseeing that a share of municipal revenue would be allocated to this project. Three private banks, Banco da Amazônia, Banco do Nordeste and Banco do Brasil, have helped finance any remaining costs. The programme has led to the creation of a solar PV market with more than 20 local enterprises selling and installing imported or locally manufactured solar panels. As of October 2020, the city had granted discounts totalling BRL 415,785 (around USD 103,000) and supported 3.8 MW of installed decentralised generation capacity under the Palmas Solar programme.

In parallel, Palmas implemented the Parque Solar project. During phase 1 of the project in 2018, the government-owned bank Caixa Econômica Federal provided financing to install solar panels on public schools, saving the municipality an estimated BRL 5,000 (USD 1,240) per month. Phase 2 involves building a 5 MW solar farm to power all municipal buildings with solar energy, although funding is yet to be secured.

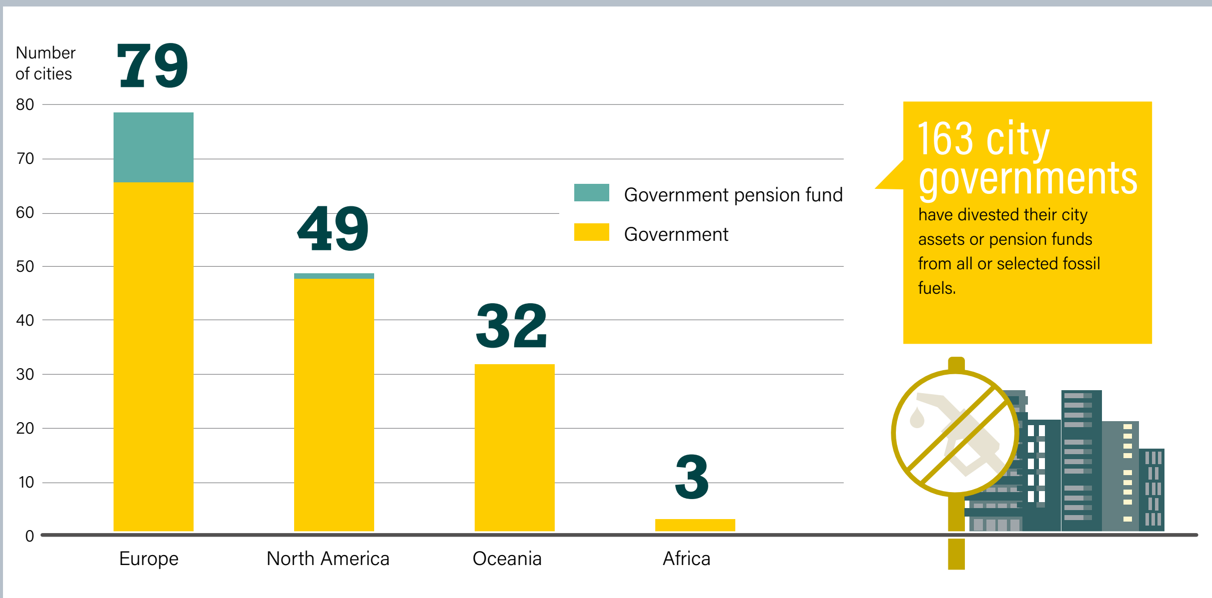
Source: See endnote 6 for this chapter.

BOX 2. Divestment of Municipal Public Funds from Fossil Fuels

By 2020, more than 1,300 institutions with around USD 14 trillion in investment value had sold off their financial interests in fossil fuel companies. Although the institutions undertaking this divestment are diverse, two entities critical to this movement at the city level are government bodies and their pension funds. The C40 Cities network, launched in 2018 in close co-operation with London (UK) and New York City (US), the C40 Divest/Invest Forum, an initiative that helps guide cities interested in divesting their pension funds and investing in climate-friendly solutions (14 cities signed up to the Divest declaration). Funds divested from fossil fuel companies are not necessarily reinvested in companies associated with renewable energy, however.

Numerous cities worldwide have taken strong action to divest their city assets or pension funds and, in some cases, to increase the investment in sustainable infrastructure (→ *see Figure 16*). For example, in 2020, as part of their COVID-19 recovery plans, 12 cities (Berlin, Bristol, Cape Town, Durban, London, Los Angeles, Milan, New Orleans, New York, Oslo, Pittsburgh and Vancouver) pledged to divest from fossil fuel companies and advocate for greater sustainable investment within the C40 framework.

Figure 16. Number of Cities with Fossil Fuel Divestments, by Region and Divestment Scope, 2020



Source: See endnote 9 for this chapter.


Berlin, Germany

RAISING FUNDS FROM EXTERNAL SOURCES

If an actor is unable to draw from its own funds or assets, a number of options are available from other levels of government or external sources to address a given shortage of capital. Cities that are eligible to generate debt may choose to issue municipal green or climate bonds to support renewable energy projects.[10] Municipal actors also can apply for grants, subsidies and loans from national governments and international entities, such as the EU, multilateral and bilateral financial institutions, and multilateral development banks. On average, direct budgetary contributions from national governments supply 40% of urban infrastructure finance for transport, water, energy and other projects in developed countries and 60-65% in emerging and developing countries.[11]

Two common approaches for raising funds from external sources – issuing municipal or green bonds, and acquiring funds through development finance – are discussed in the following sub-sections. Another more novel approach is crowdfunding, or raising money from a relatively large number of people in small, individual amounts, generally via the Internet and social media. Crowdfunding is a growing option for both public and private projects and has been used in Africa (especially for small, off-grid projects), Asia, Australia, Europe and North America.[12]

MUNICIPAL AND GREEN BONDS

Since they were first used in the early 19th century, municipal bonds have become one of the most widely applied instruments for municipal finance, helping to fund trillions of dollars of urban infrastructure projects.[13] Bonds tend to provide more attractive conditions for financing long-term infrastructure projects than do traditional bank loans, and many municipalities (particularly larger cities) consider municipal bonds to be the best tool to meet their financing needs.[14] However, in some countries, particularly in developing or emerging economies, national legislation that limits borrowing power may restrict cities from using bonds (→ *see Challenges section*).

Although municipal bonds traditionally have been used to fund major infrastructure or other projects, they also have provided funding for renewable energy projects (especially solar PV) in cities around the world (→ *see Table 3 and Sidebar 6*).[15] The two main types of municipal bonds are general obligation bonds and revenue bonds. General obligation bonds are loans that can be repaid through a variety of tax and income sources available to the municipality; they rely first and foremost on the creditworthiness of the issuing municipality, not on the financial return or attractiveness of the project.[16] In the case of revenue bonds, repayment of the loan is backed by a specific revenue stream, such as electricity sales generated by a renewable energy project, or power tariffs collected by the municipal utility.

Cities worldwide

have been using municipal bonds to fund renewable energy projects since 2013.

Table 3. Value of Municipal Bonds to Finance Renewable Energy Installations in Cities Worldwide, 2013-2019

City (State, Country)	2013	2014	2015	2016	2017	2018	2019	Total
	In USD million							
Africa								
Johannesburg, South Africa	–	136.4	–	–	–	–	–	**136.4**
Asia								
Tokyo Metropolitan Government, Japan	–	–	–	–	88.2	88.4	91.8	**268.5**
Europe								
Paris, France	–	–	319.8	–	–	–	–	**319.8**
Gothenburg, Sweden	78.8	27.0	126.6	120.3	138.3	165.6	393.1	**1,293.8**
Lund, Sweden	–	–	–	–	85.2	66.1	–	**151.2**
Malmö, Sweden	–	–	–	–	153.2	110.5	128.2	**392.0**
Nacka Kommun, Sweden	–	–	–	–	–	57.4	–	**57.4**
Norrköping, Sweden	–	–	–	68.3	–	–	–	**68.3**
Örebro Kommun, Sweden	–	103.8	–	58.0	59.2	55.0	155.2	**431.1**
Östersund Municipality, Sweden	–	–	–	–	95.6	–	85.2	**180.8**
Västerås, Sweden	–	–	–	81.2	–	–	–	**81.2**
Vellinge Municipality, Sweden	–	–	–	–	–	41.2	20.4	**61.6**
North America								
Toronto, Canada	–	–	–	–	–	–	150.7	**150.7**
Auburn, New York, United States	–	–	8.7	–	–	–	–	**8.7**
Honolulu (City and County), Hawaii, United States	–	–	–	143.8	–	–	–	**143.8**
Otis, Massachusetts, United States	–	–	6.2	–	–	–	–	**6.2**
Richland, Washington, United States	–	–	–	–	–	–	3.1	**3.1**
San Francisco (City and County), California. United States	–	–	–	–	–	–	247.8	**247.8**
Spokane, Washington, United States	–	181.2	–	–	–	–	–	**181.2**

Note: Table includes only city (and in some cases, county) governments that have used bonds to finance renewable energy projects. Within city boundaries, other entities such as banks, utilities and school districts also have used bonds for such projects.

Source: See endnote 15 for this chapter.

SIDEBAR 6. Distributed Solar PV to Empower Cities in Developing Countries

Grid-tied distributed solar PV is changing electric power systems worldwide, alongside other consumer-level, distributed technologies such as batteries. Installed on rooftops, as canopies above car parks, or floating on industrial ponds, solar cells can even be integrated into building materials such as glass and tiles, as well as into the surfaces of sidewalks and highways. The installed capacity of commercial and residential solar PV surged from just a few megawatts in 2000 to 259 GW in 2019. Since distributed solar PV energy is consumed close to where it is generated, it can provide affordable and resilient electricity service for consumers, help grid operators reduce energy losses and grid congestion, and defer or avoid expensive grid upgrades, among other benefits.

Distributed solar PV offers distinct solutions or use cases. Often such systems are used to reduce customer energy bills and to provide a least-cost back-up solution for consumers who otherwise rely on costly diesel generators to make up for unreliable or insufficient grid electricity. Governments that subsidise diesel fuel can incentivise the use of distributed solar PV as part of a subsidy reform strategy. In islands and similar settings, distributed solar PV can be a least-cost generation option due to the absence of land for ground-mounted power stations. In cities where the power grid lacks sufficient capacity to transmit and distribute bulk power to consumers, the utility or third-party provider may be able to deploy distributed solar PV, perhaps with batteries, as a fast, modular, cost-effective alternative to investing in traditional grid upgrades.

For low-income consumers, distributed solar PV can provide community social support to make electricity more affordable while also addressing fiscally responsible social inclusion. Many low-income consumers have a volumetric tariff rate below operating costs ("social tariff") and live in housing unsuitable for individual distributed solar PV deployment, and/or they lack access to finance to cover the upfront costs of distributed systems. City as well as national governments can install community-level distributed solar PV to serve subscribed consumers and mitigate the financial burden of social tariffs and/or to reduce chronic financial losses for retailers of grid electricity. The government also can deploy distributed solar PV to reduce the arrears of public institutions that are unable to pay their electricity bills.

Viable business models are crucial to support the deployment of distributed solar PV. Broadly, three generations of distributed solar PV business models have evolved over time: 1) direct deployment of distributed systems by individual consumers (first generation); 2) reliance on third-party providers who aggregate projects and facilitate some part of the design, installation and financing (second generation); and 3) engaging utilities to help drive deployment (third generation). Different models may be available simultaneously in cities: some users can buy the distributed solar PV systems from installers for self-consumption, while utilities can integrate distributed solar PV in their business by partnering with third-party companies to actively engage in deployment and share the value of increasing consumers' access to low-cost financing.

New financing models open up win-win opportunities for the stakeholders involved. For instance, the issuance of "solar bonds" by governments can potentially increase the availability of debt for distributed solar PV projects and lowers its costs. In India, a municipal entity aggregates projects for third-party distributed PV developers and enables them to overcome barriers to accessing debt capital markets. Solar bonds in India are expected to lower costs by up to 12%, and the funds are disbursed via a public-private partnership. Such public financing, especially at early stages of distributed solar PV market development, can help attract large-scale private sector participation, and can then be phased out over time in favour of a deepening commercial financing pool as the market becomes self-sustaining. In addition to direct and indirect financing, the public sector support may take the form of: a legal, policy and regulatory framework; planning, technical and operational capacity; government-sponsored guarantees; and investment in enabling infrastructure such as smart grids.

Financing also can be offered from third parties to creditworthy customers, such as renewable energy service companies, in the form of: a solar lease; a fixed monthly fee for a predetermined period with the option of buying the system at the end of the lease; and PPAs, with a fixed kilowatt-hour fee normally lower than that from the incumbent utility. Aggregating small projects can help attract more attention from investors and reduce transaction costs.

Douala, Cameroon

Urban settings, where there is higher potential for distributed PV projects, can be particularly effective in aggregating small projects. Users themselves also can collectively finance small-scale distributed PV projects via crowdfunding. Both Argentina and Mexico have online platforms where users can invest in distributed solar PV projects or access cheaper financing for installing a distributed system.

In India, New Delhi's largest distribution company, BSES Radjhani, with 2.3 million customers, is leading community distributed solar PV by aggregating projects and leasing or selling systems to customers. Multiple distributed systems are connected to the grid at a single metering point, with consumption costs and production benefits (such as lower electricity bills) shared among all households in the community. The involvement of distribution companies and community-level intermediaries assures both households and investors that the programme is viable. Intermediaries help ease the complicated application processes and contracting of distributed solar PV vendors. Once installation costs are paid off in full, ownership is transferred to the customers.

Nigeria is exploring the viability of microgrids or mini-grids for communities underserved by distribution companies. Microgrids up to 1 MW in size, for example, can improve service reliability compared to existing grid service while leveraging existing distribution infrastructure to achieve lower system cost than isolated mini-grids. Four business models have been identified, each led by a different actor: 1) a private operator, who would engage the distribution company and community; 2) a special purpose vehicle (SPV) formed by a distribution company's investors, for example, with certain functions subcontracted to an operator; 3) a co-operative formed by the community; and 4) a collaborative SPV where ownership and operation functions are shared among the operator, community co-operative and distribution company investors. Nigeria's first commercial "undergrid mini-grid" is under development in Mokoloki in Ogun State, with the first tripartite contract in which the mini-grid operator will pay a distribution usage fee to the distribution company.

Source: See endnote 15 for this chapter.

Ogun State, Nigeria

New Delhi, India

New Delhi, India

In recent years, green bonds or climate bonds have emerged as an alternative financial instrument to enable national and municipal governments, as well as companies, to tap into financing. Green bonds differ from normal bonds in that the proceeds are earmarked for qualifying investments in renewable technologies or in various forms of climate adaptation and mitigation.[17] Binding definitions regarding which projects qualify for green bonds are typically applied on a voluntary basis, although more uniform taxonomies have been developed, for example by the EU or Climate Bonds Iniative.[18]

Green bonds give investors greater visibility over the actual use of funds than traditional bonds.

With green bonds, investors (typically institutional investors, often with an environmental, social and governance (ESG) mandate or environmental interest) obtain a certain interest rate over a stipulated period of time, and the funds must be used for the specific purposes for which the bond was issued. This provides investors with greater visibility over the actual use of the funds than is the case for traditional bonds. Gothenburg (Sweden) was the first city to issue a green bond in 2013.[19] In 2019, the United States and China led in the total value of green bonds issued and in the number of issuers.[20]

DEVELOPMENT FINANCE

In many cases, dedicated funds from development finance institutions (also known as development banks) have supported renewable energy projects in cities. Municipal governments can receive these funds, which often require close co-operation across a range of stakeholders (including national governments) and a long-term commitment to renewables.[21] Development banks frequently partner with local banks to provide the catalytic finance required to unlock investments in renewable energy assets, including capital-intensive projects such as district heating networks. Such institutions step in where local commercial banks are either unwilling or unable to provide the financing required, offering long-term financing. Around 75% of finance for climate mitigation or adaptation activities in cities from development finance institutions comes at commercial rates, but concessional finance (for example, below-market rates) is also an option.[22] For decades, loans from development banks have been accompanied by safeguard policies on environmental and social impacts.[23]

Development banks also provided financing for renewable energy generation projects within in cities.[24] In one recent example, in 2019, the Green Climate Fund made available EUR 87 million (USD 107 million) to cities in nine countries (Albania, Armenia, Georgia, Jordan, Moldova, Mongolia, North Macedonia, Serbia and Tunisia) through the European Bank for Reconstruction and Development's (EBRD) Green Cities Program.[25] The programme provides grants and concessional funds for renewable energy projects along with projects in the areas of water, air and waste management.

LEVERAGING EXTERNAL FUNDS

In the final category of financing, actors may be able to leverage funds from external parties for a given renewable project. Three notable approaches for doing this are: mobilising private finance through public-private partnerships; borrowing through green banks; and signing power purchase agreements to encourage private finance.

PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships (PPPs) provide an alternative means of financing for municipal governments that lack the funds to develop renewable energy or infrastructure projects when there is no guarantee that the private sector will invest.[26] Such projects typically are funded by means of government finance, private/corporate finance or project finance in which loans are secured for a specific partnership.[27] A blend of finance in PPPs is also possible: for example, if the private sector raises financing, it may be easier or more sensible for the government to take on some aspects or risks of the project.[28]

In the PPP model, local governments may leverage private investment to expand projects (→ *see City Snapshot: North Lombok*).[29] Such arrangements enable municipalities to access financing and technical expertise and to benefit from operational efficiency, while shifting performance and technology risks to the private sector.[30] On the down side, PPPs may have comparatively high transaction costs and may be complicated by differing timelines in the private and public sectors (with the latter heavily influenced by elections).[31] PPP arrangements vary across countries, sectors and projects and may take the form of build-operate-transfer, design-build-operate and lease-develop-operate.[32] Most PPPs supporting renewables are in the power sector, although examples exist of PPPs for renewable heat, such as in the village of Rittershofen (France), where a PPP helped support a geothermal project to supply process heat to a local biorefinery.[33]

Although PPPs are used worldwide, historically they have been more frequent in developing countries.[34] Data on private participation in infrastructure (PPI, which also may encompass agreements that are not necessarily PPPs) gives a rough indication of PPP use worldwide. In low- and middle-income countries, PPI investments are dominated by the transport sector (mainly road and railway projects), which attracted USD 47.8 billion across 123 projects in 2019.[35] By comparison, the energy sector received USD 40.1 billion across 169 projects, of which 136 were renewable energy projects, mainly solar PV and wind power.[36]

Wadi Rum Village, Jordan

NORTH LOMBOK REGENCY

INDONESIA

Land area (km²)
776.3

Population size
200,000

North Lombok is the youngest regency (municipality) in the Indonesian province of West Nusa Tenggara, located on Lombok Island. Energy demand in West Nusa Tenggara totalled more than 1,950 GWh in 2019 and was growing by 5.9% annually. With increased economic development in the region, energy demand is expected to continue to grow rapidly to 2030.

To reduce greenhouse gas emissions in the city and to support the provincial target to generate 35% of electricity from renewable sources by 2025, the local government has set ambitious goals to deploy renewables in a cost-efficient and sustainable manner. North Lombok has rich potential for cheap biomass residues and opportunities to harness wind and solar energy. Out of 8.97 MW of operating power plant capacity in North Lombok, 8.82 MW is derived from renewables, primarily micro-hydropower (the 7 MW Segara and 1 MW Santong plants) and solar energy in Gili Islands.

To support local communities, the North Lombok government developed a Cost-sharing Financing Scheme for Household-scale Biogas to simultaneously reduce dependence on traditional biomass and cut greenhouse gas emissions in the residential sector. Although this scheme was originally an initiative of the provincial government, the North Lombok government has taken measures to adopt it in the city region. The cost is shared between the local government and Hivos / Yayasan Rumah Energi, along with the household users of the biogas, who pay a small amount to ensure citizen participation and ownership.

As of 2020, some 1,152 household-scale biogas units using organic waste had been installed in the North Lombok region through this scheme. The cost of one unit of biogas is IDR 13 million (USD 933), and the local government shares this amount by contributing IDR 4-5 million (roughly USD 290-360) per unit (30-40%). To support the technical portion of the project, Hivos / Yayasan Rumah Energi provide high-quality biogas digesters to the users as well as three years of after-sales service for civil buildings and one year for pipe and stove installations.

Source: See endnote 29 for this chapter.

GREEN BANKS

Green banks offer another option for leveraging funds for renewable energy projects, in a PPP of sorts. Green banks function as banks only in terms of being financial intermediaries – they do not fall under traditional banking regulations, and are typically set up as a public financing authority that leverages limited public funds to attract additional private capital for renewable and other related technologies.[37] However, just like a traditional bank, green banks conduct their own financial assessments and lend funds to qualifying projects. The initial cash infusion to create the green bank can be raised in a range of ways, including through the issuance of bonds, surcharges on local utility bills (particularly in cities with their own municipal utility), direct government allocation of funds, and revenues from dedicated taxes, such as on carbon.

As of May 2020, there were 21 established green banks worldwide, with the majority (14) in the United States and others in Australia, Japan, Malaysia, South Africa, Switzerland, the United Arab Emirates and the United Kingdom.[38] They include green banks in the US cities of Washington, D.C. (D.C. Green Bank) and New York City (New York City Energy Efficiency Corporation).[39]

POWER PURCHASE AGREEMENTS

A final option commonly used to mobilise private sector financing is power purchase agreements (PPAs), which are a useful tool for both municipal governments and corporations.[40] PPAs are long-term contracts in which a buyer agrees to purchase the energy generated by a renewable energy project for a fixed price during the contract's tenure.[41] A PPA typically specifies at least three factors: the volume, price and contract length for the electricity or heat that will be sold.[42] Although PPAs are usually associated with renewable electricity, they also can be used for heat supply to industry, agrifood and space heating.

Under most PPAs, the developer is responsible for financing, building and operating the renewable energy project.[43] City governments may initiate projects, for example by committing to buy electricity from a dedicated wind farm or solar PV plant. This essentially guarantees a steady income to the project developer, helping to incentivise the project and to enable the developer to secure financing. In this framework, PPAs are a way for cities to leverage private finance for a renewable energy project (→ *see also Markets and Infrastructure chapter*).

In some jurisdictions, cities wishing to pursue a PPA are limited by existing regulations that cover retail choice and electricity franchises. In markets that allow retail choice with favourable franchising, municipal actors typically can pursue PPAs, whereas in markets that do not allow retail choice they may be prohibited from purchasing electricity from any entity besides the existing utility.[44] In the latter case, a city still may have the opportunity to create a virtual PPA, in which the renewable electricity generated by the project is bought and sold into a power market that may or may not be the same as the customers.[45]

City governments have two main options for participating in a renewable energy PPA: they can sign a municipal PPA themselves, or they can work with other local institutions to arrange a joint-collective PPA.[46] The latter is particularly attractive for cities whose electricity demand is too small to make a bilateral PPA possible. Bilateral PPAs have been used most widely in the United States but also in Australia and South Africa.[47] Collective PPAs for renewable energy have been initiated in Melbourne (Australia) and in 20 US cities, including Boston (Massachusetts), Chicago (Illinois), Houston (Texas) and Portland (Oregon).[48]

Australia

INVESTMENT AND FINANCING IN CITIES BY REGION

In the 533 cities that self-reported to the CDP-ICLEI Unified Reporting System in 2019, a combined 171 renewable energy projects were in the pipeline with total project costs of USD 31.2 billion.[49] In addition, between 2015 and 2019, municipal governments identified USD 7 billion in finance and investment needs for energy infrastructure through ICLEI's Transformative Actions Program.[50] Generally, cities use distinctive approaches to finance renewable energy projects, depending on their government structure, development status and cultural norms. The following sub-sections explore the varying financing mechanisms used for renewable energy in cities across different world regions.

Tokyo, Japan

Valenzuela City, Philippines

ASIA

China and India account for most of the renewable energy investment in Asia (see later discussion). Outside of these countries, the non-OECD Asia-Pacific region accounted for USD 15.2 billion of renewable energy investment in 2019, up 17% from 2018 due largely to investment in offshore wind power in Chinese Taipei.[51] Diverse financial mechanisms have been used across the region, although data are limited. In Cambodia, dedicated funds from the Asian Development Bank have supported a number of PPPs for solar PV plants, including a 10 MW project in Bavet City and two 60 MW plants in the Krakor and Tek Phos districts.[52] In the Philippines, the private sector has been active in financing solar PV plants in San Carlos City and in cities in Cebu.[53]

In Japan, renewable energy investment totalled USD 16.5 billion in 2019, down 10% from 2018.[54] This drop reflected grid and land constraints that continued to hold back solar PV developer activity and auction bidding in the country.[55] Japan's cities, towns and villages lie under the jurisdiction of 47 prefectural local government areas, and it is common for renewable energy projects to be funded privately by individual companies or by a consortium of companies.[56] Prefectural governments occasionally use their own revenue to subsidise projects, at times with co-funding from the national government. For example, the Ministry of the Environment's Local Decarbonization Investment Promotion Fund provides capital contributions and loans for local renewable energy projects.[57]

Projects in Japan also rely on public or green bonds.[58] In the town of Shikaoi-cho (Hokkaido) in 2004, a biogas power plant that provides electricity and heat for greenhouses and fish farming and fuel gas for vehicles was financed mainly by a national subsidy (80%), with the remainder supplied via a public bond issued by the town.[59] The Tokyo Metropolitan Government used green bonds to finance building retrofits that included renewable energy technologies, and the city of Tsuru issued JPY 17 million (USD 164,640) in public bonds to build a 20 kW hydropower station in 2005 that supplies electricity to the city hall.[60]

Prefectural governments in Japan use PPPs (in different forms) to push developers to invest in renewables. A recent and innovative trend is for Japanese local governments to either invest in local energy companies or establish their own local energy companies, in part to ensure the incorporation of renewables in the energy mix and to aid in the circulation of related finance.[61] For example, the city of Kitakyushu provided funds to establish its own local energy company together with the private sector and is planning a 5,000 kW waste-to-energy plant and a 10 MW offshore wind power plant.[62]

Diverse financial mechanisms have been used across Asia, although data are limited.

4

CHINA

China has dominated global investment in renewable energy capacity since 2012.[63] In 2019, however, renewable energy investment in the country fell 8%, to USD 83.4 billion, following a slowdown in the solar PV market after the central government suspended the feed-in tariff for solar PV in 2018.[64]

In contrast to the bottom-up approach used in many Western countries to drive renewable energy development, projects in Chinese cities frequently are driven by policies and targets set by the central government, which officials at lower levels of jurisdiction then are required to implement.[65] The central and provincial governments often provide loans, grants and subsidies to finance project development, although finance for renewables also may originate from bank loans, venture capital, public and private funds, and bonds.[66]

Governments at the county and township levels often act as co-ordinators, linking financing with technological expertise in a PPP of sorts.[67] In Shanghai, the municipal government facilitated a partnership with Shanghai Electric in 2007 to expand offshore wind power capacity near the city.[68] Since then, other Chinese cities (for example, in Shandong and Guangdong provinces) have partnered with Shanghai Electric to build more offshore wind power projects.[69] The Nanjing municipal government joined with two private investors (Nanjing Fengsheng Industry Holding Group and Fengsheng New Energy Technology Consortium) to build a large-scale heat pump project sourced by river water.[70]

To reduce project costs by shifting away from renewable power plants located far from load centres, a number of Chinese cities (such as Beijing, Guangzhou, Shanghai and Shenzhen) have implemented small-scale wind power pilot projects closer to city boundaries.[71] Developers or private investors have funded most of these projects, supported by PPAs signed by utilities or grid companies to ensure that the electricity is sold at a specified price.[72]

Green bonds have been used to facilitate renewable energy investment in China. Between 2016 and late 2019, USD 17.5 billion in green bonds had been issued at the local level, most of them by provincial governments, although examples exist at the county and township levels as well.[73] Most of the green bonds issued locally were for low-carbon transport (such as local mass transit systems) or water infrastructure.[74] However, in 2020 Datang Henan Power Generation Co., Ltd issued a USD 144 million green bond to finance 14 offshore wind power projects.[75]

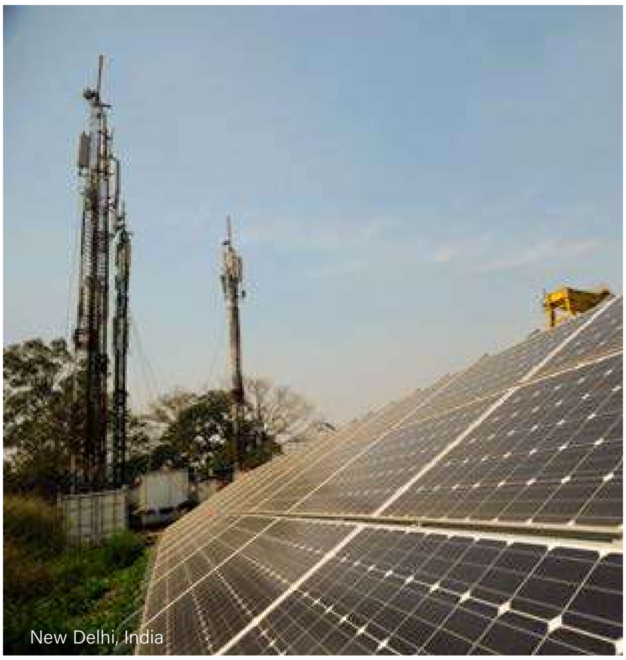
Some Chinese cities (such as Zhangjiakou) have been pro-active in developing and investing in hydrogen for transport, especially for buses.[76] In a few cases, the emphasis has been on hydrogen produced with renewable electricity. In 2019, the state-owned Hebei Renewables Construction and Investment Company completed the Zhangjiakou Guyuan wind power hydrogen generation project, with an investment of CNY 2 billion (USD 306.4 million).[77] Meanwhile, Shanghai and Shenzhen have been involved in China's push for electric vehicle infrastructure: in 2020, Shanghai completed a pilot programme that will allow utilities to co-ordinate EV charging with the availability of renewables.[78]

INDIA

Investment in renewable energy capacity in India fell 14% in 2019, to USD 9.3 billion.[79] Financing for renewables in Indian cities originates from three main sources: national and state-level schemes (such as the 100 Smart Cities Mission), which have increased in scale and number over time; international financing agencies and development banks, with many of these projects being small and experimental; and local private capital, for which very little information is available.[80] Although municipal bonds have been used to a limited extent for infrastructure projects in India, they have not been adopted for renewable energy projects to date.[81]

Historically, Indian cities have not been at the forefront of financing renewables, in large part because energy governance in the country remains constitutionally with the central and state governments.[82] In 2015, however, the government launched the 100 Smart Cities Mission, creating a new vision for the role of cities in renewable energy projects.[83] Subsequently, around 100 cities in India created plans for investing in energy distribution and supply, including solar PV, waste-to-energy and wind energy (to a limited extent), as well as electric mobility.

Of the first 60 approved proposals, around 10% of the budget – a total of INR 13,161 crore (USD 1.8 billion) – was for such energy projects, with the remainder directed towards other infrastructure projects such as water, buildings, transport and waste management.[84] The cities allocating the most of their proposed budgets to solar PV were New Delhi (INR 535 crore or USD 73 million), Mangalore (INR 311.85 crore or USD 42.5 million) and Vishakapatnam (INR 305.83 crore or USD 41.7 million), whereas the cities allocating the most to waste-to-energy were Jaipur (INR 200 crore or USD 27.3 million), followed by Kalyan and Surat.[85] The cities allocating the most to e-mobility were Chandigarh (INR 163.15 crore or USD 22.3 million), followed by Pune and Dharamshala.[86]


New Delhi, India

AFRICA AND THE MIDDLE EAST

Investment in renewable energy capacity in Africa and the Middle East fell 8% in 2019 to USD 15.2 billion, down from a record USD 16.5 billion invested in 2018.[87] Most of this investment was in the United Arab Emirates, followed by South Africa and Kenya.[88]

Development finance is important for renewable energy projects across the region, and many funds are available, some of which are applied in city settings.[89] One notable effort is the USD 4 billion solar PV park (comprising multiple smaller projects) outside of Aswan (Egypt), which is being financed by several international development banks on land donated by the Egyptian government, and is supported by a 25-year PPA with the local electricity transmission company.[90]

In 2020, the German development bank KfW announced a EUR 9.6 million (USD 11.8 million) grant for Kigali (Rwanda) to develop a "green city" project powered by solar PV, which also will be financed by the Rwandan government and the Green Climate Fund.[91] In addition, KfW provided USD 25 million to finance two solar PV plants in the Ghanaian cities of Kaleo and Lawra.[92] In the United Arab Emirates, loans from international banks were key for the USD 4.33 billion concentrating solar thermal power (CSP) and solar PV project south of Dubai, which dominated investment in the region in 2019.[93]

Cities in Africa and the Middle East also have relied on PPPs. Since 2011, South Africa's Renewable Energy Independent Power Producer Programme (REIPPP) has helped independent power producers design, develop and operate biomass, landfill gas, hydropower, solar PV, CSP and onshore wind power plants across the country, many of them in or near cities.[94] Private investors have readily supported the projects, since the government mitigated project risks through a transparent procurement process.[95]

In Kenya, a tender was issued in 2020 for a build-own-operate-transfer PPP to support a new 140 MW geothermal power plant, from which Kenya Power and Lighting Company (KPLC) will buy electricity under a 25-year PPA to supply local businesses, the city of Naivasha and several surrounding towns.[96] In Qatar, an 800 MW solar PV farm near the village of Al Kharsaah reached financial close in 2020, supported by a build-own-operate-transfer PPP and USD 330 million in loans from international banks.[97]

Comparatively few African cities have used green bonds to support renewable energy projects. Notably, Johannesburg (South Africa) issued a USD 143 million green bond to fund projects across a range of sectors including new dual-fuel buses and the conversion of 30 buses to biogas.[98] Although some larger players in the Middle East have issued green bonds (such as the Egyptian government and Qatar National Bank), cities in that region have not yet used this mechanism for renewable energy projects.[99]

Development finance is important for renewable energy projects in cities across Africa.

LATIN AMERICA

Investment in renewable energy capacity across Latin America has grown markedly, up 43% in 2019 to a record USD 18.5 billion.[100] Four countries dominated this investment: Brazil (up 74% to USD 6.5 billion), Chile (up 302% to USD 4.9 billion), Mexico (up 17% to USD 4.3 billion) and Argentina (down 18% to USD 2.0 billion).[101] PPPs, PPAs and development finance provide key support for projects in cities across the region.[102]

PPPs have been used widely in Latin America to finance transport-related projects as well as distributed generation. In 2019, Mexico used the PPP model to attract USD 2.1 billion for 15 solar PV projects, and in Santiago (Chile) a PPP was established to install 104 EV charging points of 22 kW each (which eventually will use renewable electricity) at a total cost of USD 2.5 million.[103] The state government of Piaui (Brazil) opened bidding in 2020 for a USD 32 million PPP to build eight solar PV plants of 5 MW each in six municipalities (Caraúbas do Piauí, Miguel Alves, Piracuruca, Jose de Freitas, Cabeceiras do Piauí and Canto do Buriti) as a way to meet the power demand of all state-owned buildings.[104] Also in Brazil, São Paulo initiated a PPP for a USD 32.6 million investment in solar PV to supply the city's health department, and Curitiba partnered with the local utility to jointly finance (51%/49%) a 5 MW solar-biomass project that will supply 43% of the municipal building's electricity needs.[105]

The public and private sectors have used PPAs to establish large-scale wind power and solar PV projects as well, both within and outside cities.[106] Private companies often are driven by a desire to meet sustainability goals. For example, in Mexico the beer producer Grupo Modelo signed a PPA for the construction of a 220 MW wind farm that will supply electricity for the company's brewery.[107]

National banks increasingly have helped finance renewables in the region.[108] The Development Bank of Colombia (Bancoldex) offers a green credit line totalling USD 14.4 million to finance renewable energy and energy efficiency projects in cities across the country.[109] In São Paulo (Brazil), the state's Bureau of Energy and Mining and the São Paulo Development Agency (Desenvolve SP) provide long-term, low-interest loans for small-scale renewable energy projects including solar PV, wind, and small hydropower plants, as well as equipment for biogas plants.[110] International agencies that finance distributed generation usually co-ordinate through partnerships with national and regional banks.[111]

Some innovative instruments have been used to provide finance for smaller-scale projects, especially for solar PV. This includes crowdfunding in Argentina and Mexico and the use of energy service companies (ESCOs) in Brazil, Chile and Colombia.[112] Municipal bonds and green bonds have not been used to the extent seen in some other world regions, although examples exist.[113] Mexico City (Mexico) issued Latin America's first municipal green bond in 2016 with a focus on mobility, energy efficiency, water infrastructure and management projects.[114]

EUROPE

Financing for renewables in cities across Europe is diverse. Cities provide their own funds, rely on national or EU funds and use PPPs or green bonds.

Investment in renewable energy capacity in Europe fell 7% in 2019, to USD 54.6 billion, with large variations across countries and technologies.[115] Most of the investment occurred in Spain (an increase to USD 8.4 billion), the Netherlands (an increase to USD 5.5 billion) and the United Kingdom (a decrease to USD 5.4 billion).[116] In Germany, local governments have relied mainly on their own funds to finance infrastructure projects, with contributions from the national and state governments and other purpose-tied investment allocations.[117] Only around 20% of finance for municipal infrastructure in the country has come from borrowed funds, mostly bank loans.[118]

Nonetheless, the use of green bonds is rising across Europe, with notable increases in 2019 in France (up 113% to USD 30.1 billion), Germany (up 144% to USD 18.7 billion) and the Netherlands (up 105% to 15.1 billion).[119] Although national governments account for the majority of government green bond issuance in Europe, several local governments and cities have issued a steady stream of bonds – including the Canton of Geneva (Switzerland), Gothenburg and Stockholm's Lans Landsting (Sweden), Ile-de-France (France) and Oslo (Norway).[120]

In Europe, both the aggregate value of PPP transactions that reached financial close in 2019 and the average transaction size decreased in 2019.[121] Although the transport sector dominated these transactions, PPPs also have been used for renewable electricity and heat. Ljubljana (Slovenia) announced a renovation project in 2020 that uses a tested PPP model with a consortium of companies to renovate sports centres, schools and a concert hall with energy efficiency and renewable energy solutions; the city will use the energy savings to repay project costs.[122] The Serbian cities of Niš and Pirot used PPPs to replace heating oil boilers with biomass boilers in schools.[123]

The EU provides funding (in the form of grants, equity, loans, guarantees or other) for urban renewable energy projects through various programmes, including the Connecting Europe Facility, EU Integrated Territorial Investments, European Local Energy Assistance, Horizon 2020 SC3 Energy, the Innovation Fund, the LIFE Programme, URBACT and Urban Innovative Actions.[124] Among recent examples of such support in the heating sector, Riga (Latvia) attracted EU co-financing to implement a 50 MW boiler house and biomass-fired water boilers of 4 MW each.[125] The EBRD provided Banja Luka (Bosnia and Herzegovina) with a loan of EUR 8.3 million (USD 10.2 million) to build a 49 MW district heating boiler plant fired by wood biomass.[126] Pancevo (Serbia) received a loan from the EBRD and KfW to construct a solar thermal field in 2017 as part of a solar district heating project.[127]

OCEANIA

Investment in renewable energy projects in Australia has increased in recent years, although it fell slightly in 2019 to around AUD 7 billion (USD 5.4 billion), down from AUD 8.5 billion (USD 6.5 billion) in 2018.[128] Most of the investment was in the private sector, supplied by domestic banks, but overseas financing has played an increasing role. Households have driven small-scale investment in renewables as well, with more than 25% of Australian homes now fitted with rooftop solar PV, many of them in cities.[129] Around 10% of the country's rooftop solar installations have been financed via short-term credit.[130]

PPAs also are being used in Australia. Historically, developers entered into PPAs with electricity retailers, but corporate PPAs are on the rise, and in some cases municipal governments have joined the ranks. To reach its goal of powering its street-lights, pools, sports fields, depots and other buildings with 100% renewables – which it did in 2020 – Sydney (Australia) signed an AUD 60 million (USD 46 million) PPA for electricity supplied mainly from a 270 MW wind farm and a 120 MW solar PV farm (plus a 3 MW community solar project) in New South Wales.[131] In Melbourne, 14 public and private institutions including the city, banks, universities and local councils signed a collective PPA in 2017 to enable the construction of an 80 MW wind farm in western Victoria state.[132]

In the Solomon Islands, the country's first ever PPP was signed in 2019 for more than USD 200 million for a 15 MW hydropower project 20 kilometres south-west of the capital city of Honiara.[133] Although the original plan considered only private sector financing, the final package also included dedicated funds from the World Bank, the Green Climate Fund, the Asian Development Bank and others.[134]

NORTH AMERICA

In the United States, a leading country in investment in renewable energy capacity, investment grew 28% in 2019 to USD 55.5 billion.[135] Since 2015, a majority of renewable electricity capacity transactions announced by cities have been supported by PPAs (mostly for capacity located outside of city limits).[136] This capacity is financed mainly by private rather than public entities, as private entities have the requisite tax liability to take advantage of national and state-level tax incentives. US cities are addressing this by partnering with private companies and by signing PPAs with private developers.[137]

US cities signed PPAs for a total of 2,625 MW of renewable power capacity in 2019, up from 2,056 MW in 2018.[138] Cincinnati (Ohio) signed a PPA in which the city agreed to purchase the electricity from a 100 MW solar PV farm some 64 kilometres east of the city to fulfil its renewable energy goals.[139] The PPA model also has been used in Canada: for example, in 2020 the Royal Bank of Canada signed a PPA for two utility-scale solar PV farms in Alberta totalling 39 MW.[140]