IRENA
International Renewable Energy Agency

RENEWABLE ENERGY POLICIES FOR CITIES

EXPERIENCES IN CHINA, UGANDA AND COSTA RICA

SUMMARY for policy makers

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

IRENA
International Renewable Energy Agency

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About IRENA

The International Renewable Energy Agency (IRENA) serves as the principal platform for international co-operation, a centre of excellence, a repository of policy, technology, resource and financial knowledge, and a driver of action on the ground to advance the transformation of the global energy system. An intergovernmental organisation established in 2011, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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For further information or to provide feedback: publications@irena.org

Available for download: **www.irena.org/publications**

IRENA Headquarters

Masdar City

P.O. Box 236, Abu Dhabi, United Arab Emirates

www.irena.org

ABOUT THIS STUDY

Cities are critical to the global energy transition. Their massive energy demands alone make them central to the transition, and they play a major role in their national economies. City planners and administrators do well in gaining the knowledge and skills they need to integrate renewable energy technologies into urban planning and regulations. The efficiency and electrification of buildings and transport are key here too.

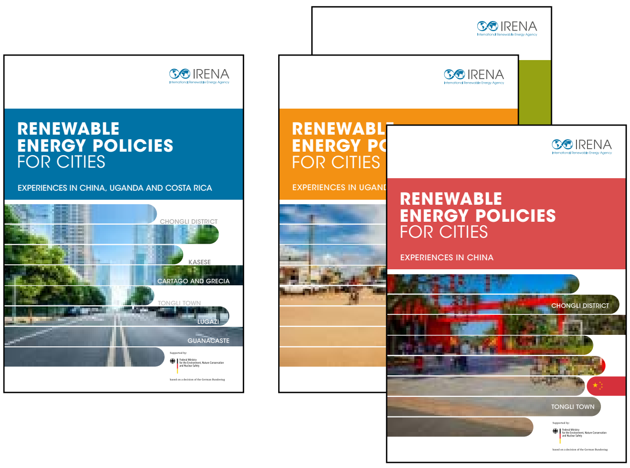
To date, the most visible energy transitions are occurring in large cities, which are gobbling up most of the attention when people study urban trends. With their larger revenue base, big cities have the regulatory frameworks and infrastructure to scale up renewables and meet emission reduction targets.

Small and medium-sized cities (holding fewer than 1 million inhabitants) often lack the requisite access to financing and policy support to advance in this direction. They are less visible than megacities, even though they are home to some 2.4 billion people, or 59% of the world's urban population (UN-Habitat, 2018), and are growing faster than any other urban category (UN-Habitat, 2020).

This study fills a knowledge gap regarding the deployment of renewable energy in medium-sized cities, focusing on the challenges and successes to date. The first chapter provides some general background on urban renewable energy initiatives around the world. Each city has its own set of opportunities and obstacles. Regardless of setting, however, openness to best practices is vital. Chapters 2–4 present case studies of six medium-sized cities from three very different countries: **Chongli District** and **Tongli Town (China)**; **Kasese** and **Lugazi (Uganda)**; and, **Cartago** and **Grecia**, and **Guanacaste (Costa Rica)**. These cities were chosen for study either because they have effective policies in place or they have untapped renewable energy resources that could contribute to their sustainable development. They also illustrate deployment strategies for renewable energy across vastly different socio-economic and institutional contexts.[1]

The findings of this study[2] should, it is hoped, support other countries as they implement their Nationally Determined Contributions (NDCs), empowering other cities to take on sustainable energy solutions and, so, reduce greenhouse gas emissions.

Each case study outlines the national-level policies framing renewable energy deployment at the local level. The case study then offers a summary of key lessons learnt and considerations for taking solutions to scale. They also synthesise key takeaways for policy makers – both at the local and national levels – so cities are encouraged in their endeavours to help form a more sustainable energy future.



1 Where the case studies make reference to monetary values, these are expressed in the national currency of the country in question and, with the help of applicable exchange rates, are also stated in US dollars (USD).

2 The study is based on desk research and interviews in the case study countries conducted in 2018 and 2019.

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Shenzen, China

ABBREVIATIONS

ASOMOVE	Costa Rican Association of Electric Mobility (Asociación Costarricense de Movilidad Eléctrica)
CBOs	community-based organisations
CDI	Champion District Initiative [Uganda]
CIRCODU	Centre for Integrated Research and Community Development Uganda
CNFL	National Company of Power and Electricity (Compañía Nacional de Fuerza y Luz) [Costa Rica]
CNY	Chinese yuan [currency]
CO_2	carbon dioxide
DDP	District Development Plan [Uganda]
DECC	Department of Energy and Climate Change [UK]
DFID	Department for International Development [UK]
EFA	Eco-Fuel Africa [Uganda]
e-mobility	electric-mobility
EPSRC	Engineering and Physical Sciences Research Council [UK]
ESPH	Heredia Public Services Company (Empresa de Servicios Públicos de Heredia) [Costa Rica]
EV	electric vehicle
FIPs	feed-in premiums
FITs	feed-in tariffs
GAM	Grand Metropolitan Area [Costa Rica]
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt
GWh	gigawatt-hours
ICE	Costa Rican Electricity Institute (Instituto Costarricense de Electricidad)
IFAM	Municipal Advisory Institute (Instituto de Fomento y Asesoría Municipal) [Costa Rica]
IEA	International Energy Agency
INS	National Insurance Institute (Instituto Nacional de Seguros) [Costa Rica]
JASEC	Cartago Electric Service Administrative Board (Junta Administrativa del Servicio Eléctrico de Cartago) [Costa Rica]
KAIST	Korea Advanced Institute Science and Technology
KDRES	Kasese District Renewable Energy Strategy [Uganda]
kg	kilogramme
km	kilometre
km^2	square kilometre
KRW	Republic of Korea won [currency]
kW	kilowatt
kWh	kilowatt-hours
m^2	square metre
MEMD	Ministry of Energy and Mineral Development [Uganda]
MoHURD	Ministry of Housing and Urban-Rural Development [China]
MOU	Memorandum of Understanding
MW	megawatt
NDC	Nationally Determined Contribution
NDRC	National Development and Reform Commission [China]
NEA	National Energy Administration [China]
NGO	non-governmental organisation

PM	particulate matter
PV	photovoltaic
RE	renewable energy
REA	Rural Electrification Agency [Uganda]
RETs	renewable energy technologies
SACCOs	Savings and Credit-Cooperative Organisations [Uganda]
SAMSET	Supporting African Municipalities in Sustainable Energy Transitions
SE4All	Sustainable Energy for All
SGCC	State Grid Corporation of China
SOPEC	Southeast Ohio Public Energy Council [United States]
SWH	solar water heating
tce	tonnes of coal equivalent
UECCC	Uganda Energy Credit Capitalisation Company
UGX	Uganda shilling [currency]
UIA	Uganda Investment Authority
UN	United Nations
UNBS	Uganda National Bureau of Standards
UNESCO	United Nations Educational Scientific and Cultural Organisation
UNGL	National Union of Local Governments (Unión Nacional de Gobiernos Locales) [Costa Rica]
UNREEEA	Uganda National Renewable Energy and Energy Efficiency Alliance
USD	US dollar [currency]
USMID	Uganda Support to Municipal Infrastructure Development Programme
WWF	World Wide Fund for Nature


Reykjavik, Iceland

1. RENEWABLE ENERGY AND CITIES

Urban areas across the world are home to an ever-increasing share of the world's population. As of 2018, cities were home to 55% of the world's population, up from just 30% in 1950. By 2050, the United Nations expects that 68% of the world's population will reside in cities (UNDESA, 2018). Growth is driven both by an increase in the number of people already residing in cities and by the continued movement of people from rural areas into cities. The United Nations (UN) projects that the fastest growth will occur in low- and lower-middle-income countries in Asia and Africa.

Cities are where much of the world's economic activity is concentrated, accounting for more than 80% of global gross domestic product (GDP). Energy is the lifeblood of cities, powering transport, industrial production, commerce, building construction, public works, lighting, air conditioning and countless other human activities. Cities are engines of the economy, using about 75% of global primary energy. They have a major role to play in advancing and shaping the energy transition.

Because much of current urban energy supply is fossil fuel–based, cities are major contributors to air pollutants and greenhouse gas (GHG) emissions. Urban areas directly contribute 50-60% to global greenhouse gas emissions, a figure that rises to 80% if indirect emissions are included (UN Habitat, 2019). At the same time, cities suffer from severe air pollution; according to WHO data, 98% of cities in low- and middle- income countries with more than 100 000 inhabitants fail to meet WHO air quality guidelines (WHO, 2016).

55% of the total population are in cities

70% of global energy related GHG emissions come from cities

75% of global primary energy is consumed in urban areas.

Much of the challenge of sustainable development, in its economic, social and environmental dimensions, relates to how cities are governed and urban growth managed. As sea levels rise and storms, floods, droughts, and heat waves begin to proliferate, climate change poses a severe test of cities' economic vitality and even habitability. Hundreds of millions of urban residents will become more vulnerable to sustained, extreme heat, which will in turn increase air conditioning in higher-income countries. Anticipated declines in freshwater availability deeply affects the prospects of cities, along with declines in major crop yields and coastal flooding (and related loss of power supplies) as sea levels rise (C40 Cities, GCMCE, UCCRN, and Acclimatise, 2018). Mitigation and adaptation efforts will require growing material and financial resources.

As cities and their populations continue to grow, urban areas will need to integrate renewable energy technologies to mitigate climate change and achieve their NDC goals. IRENA analysis has shown that renewable energy deployment measures are often developed as part of national policies rather than at the city level. Yet because modern renewable energy sources, like solar rooftop arrays, are modular, new opportunities are opening up for cities. Local governments must therefore find renewable energy solutions that suit their circumstances and needs, while ensuring their integration in planning processes in line with local cross-sectoral policies and regulations.

When municipalities are given the necessary policy mandates, cities can become vital policy laboratories where mayors, city councils, community groups, and other actors experiment with approaches and policies making energy use more sustainable in buildings, transport, industry, and the residential sector.

BOX 1.1 WHAT IS A CITY?

Broadly defined, a city or urban area is a densely settled place with administratively defined boundaries where inhabitants live on a permanent basis and the bulk of economic activity takes place outside primary sectors like agriculture or resource extraction.

With this generic definition, the term "city" can be applied to an array of urban settlements that share attributes but are also marked by tremendous differences. One of them concerns size of a city's population and its density, and its effective territory, including surrounding rural areas that fall under a city's municipal authority. Jurisdictions and administrative units differ from country to country, leading to discrepancies when speaking about a "city" as an urban conglomerate, a "city proper", or the geographic or administrative unit that extends beyond purely urban areas, for example. The vast demographic differences between countries such as China and Uganda, as seen in this report, exemplify these disparate meanings.

Conversely, a large contiguous urban area may be subdivided into multiple towns or districts, a situation that complicates effective urban governance. Thus, the city as a governance unit can be dramatically different from the larger metropolitan area surrounding it. This circumstance can translate into vastly different administrative setups for urban governance, as illustrated by the cases of China and Costa Rica in this report. The particular context of cities may help explain why much of existing literature focuses on large and "mega" cities, rather than on secondary and medium-size cities, a gap this report aims to help bridge.

Urban areas can be small, medium, large, or massive, or 'megacities'. But there are no agreed thresholds. In part this reflects the fact that many cities are continuously growing and thus defy static definitional boundaries. In addition, each country has its own approach to how it classifies cities. The first, analytical section of this report draws on initiatives and experiences of cities small and large around the world, but the case-study cities were selected from the ranks of "medium-size" urban areas (defined for the purpose of this study as anywhere from 30 000 to 1 million inhabitants).

As this report notes in the context of the case studies it presents, urban governance systems vary significantly. Political mandates, regulatory and revenue-generating authority of a given municipality diverge among cities of comparable size, and these strongly affect the degree to which medium-size or secondary cities can become agents of change within a country's energy transition. Cities can be renewable energy pioneers, but urban decision-making in support of the energy transition often depends strongly on the overall governance hierarchies in each country and thus on effective collaboration with national-level authorities.

Source: López Moreno (2017).

THE SIGNIFICANCE OF CITIES IN DEPLOYING RENEWABLE ENERGY

Cities can be important agents driving local renewable energy deployment through measures and initiatives that complement policy at the national level. IRENA's report on *Renewable Energy in Cities* (IRENA, 2016) characterised cities as important actors in several dimensions: they can and must act as planners, regulators, owners of municipal infrastructure, procurers and distributors of energy services, direct consumers of energy, aggregators of demand, advocates and facilitators, and financiers of renewable energy projects. In what follows, the multiple ways in which cities can promote the use of renewable energy are explored (see Figure 1.1); for each category, a text box offers a specific example.

Figure 1.1 Roles of municipal governments in the energy transition

Source: IRENA urban policy analysis (based on IRENA 2016).

CITIES' ROLES IN ENERGY GENERATION AND PROCUREMENT

Municipal energy generation and procurement are fundamental functions. In many countries, the statutory authority for urban electricity supply lies with national energy utilities and regulatory authorities. Public ownership can be an effective lever for driving local energy transitions and for channelling funding to renewables. But the degree to which cities own their municipal generating facilities varies substantially among countries; privatisation moves in previous decades have limited the extent of public control in many places.

Germany is one country where local public utilities, as well as citizens' energy co operatives, play a big role in electricity generation and distribution, in some cases after grassroots campaigns to remunicipalise energy assets. In the United States, as of 2013, more than 2 000 communities, with about 14% of the country's population, got their electricity from city-owned utilities (IRENA, 2016). In a number of countries, municipalities are setting up new companies to generate renewable power from local resources, such as in the United Kingdom, where new public companies and community-owned enterprises have been set up in Aberdeen, Bristol, Nottingham and Woking (Cumbers, 2016). Cape Town, South Africa, offers another example (see Box 1.2).

BOX 1.2 MUNICIPAL EFFORTS TO PROMOTE RENEWABLE ENERGY IN CAPE TOWN

Cape Town, South Africa, has undertaken a number of initiatives and infrastructure projects aimed at reducing city-wide electricity consumption (through more efficient buildings, transport and street lighting as well as metering and monitoring measures) and at increasing renewable energy capacity to reduce heavy dependence on coal-generated power. As with other cities in this country, concerns about reliable supply (load shedding), rising electricity prices and greater awareness of the promise of renewable energy technologies have been key drivers of action.

Cape Town has installed rooftop solar photovoltaic systems on several municipal buildings and facilities and maintains four micro-hydro generation turbines at water treatment plants that meet 5% of the total electricity used for municipal operations. Cape Town is also one of South Africa's 18 municipalities that have begun to install small-scale distributed energy projects in the residential, commercial and industrial sectors. Some 274 projects, with a peak generation capacity of 247 kilowatts, were approved in early 2018, and more than 2 megawatts of additional capacity were in the planning pipeline (ICLEI and IRENA, 2018).

Cape Town, South Africa

Expanding the use of district energy systems

Many cities have authority over the generation and distribution of heating and cooling energy (IRENA, 2016). District energy systems have clear benefits. But there is room to expand. To date these systems account for only about a tenth of total commercial and residential sector heating demand (IRENA, 2016). Business and policy models vary, depending on local conditions and priorities, ranging from full public ownership to public-private partnerships, to private ownership. The public model allows cities to control tariffs and thus to guard against energy poverty among residents. Box 1.3 offers various examples.

Installing solar street lighting

Cities and municipalities can be important agents for solar PV, pushing for modernised streetlights and solar rooftops. Streetlights account for a major share of urban energy use. Worldwide, lighting accounts for around 20% of all electricity used (Rondolat, n.d.), with public lighting consuming as much as 40% of a city's energy budget (IRENA, 2016). Solar lights with LED bulbs offer energy and cost savings of 50% or more and, with life spans of up to 20 years, they are more durable than conventional lights. They offer additional benefits when they are networked and connected with a smart grid, net metering, and demand response policies. The potential is huge: only about 10% of the approximately 300 million streetlights globally are LEDs, and only 1% are networked (Rondolat, n.d.).

BOX 1.3 DISTRICT HEATING AND COOLING PIONEERS

Several cities are building or expanding district energy systems. **Växjö**, Sweden, is a pioneer in using biomass and co-generation for district heating purposes (Agar and Renner, 2016). Another leader is Iceland's capital, **Reykjavik**, where some 95% of residences are connected to a geothermal-based district heating network (IRENA, 2016). Industrial waste heat is being recycled in various European cities (IRENA, 2016). European cities lead the move towards solar district heating systems (which numbered about 340 worldwide as of 2018), but such systems are beginning to spread to other regions, such as **Bishkek**, Kyrgyzstan, which inaugurated a solar system in 2017 (REN21, 2018). Modern district heating systems and efficient buildings that enable the utilisation of low-temperature renewables (such as geothermal heat) have paved the way for a greater recourse to low-enthalpy resources, including from abandoned mines and through heat pumps.

REGULATION AND URBAN PLANNING

Rooftop solar PV is a dynamic and cost-effective technology (IRENA, 2017) whose adoption can be boosted through regulatory requirements, in particular building codes, or through incentives to building owners. Systematic deployment can have a huge impact, as buildings are among the most voracious users of energy and are a factor in greenhouse gas emissions (UNEP, 2018). For cities, wielding regulatory measures to deploy rooftop solar can be a win-win policy. It matches local and national efforts to boost energy efficiency while benefiting both governments and local consumers. Box 1.4 offers some examples of such policies.

Adopting net metering

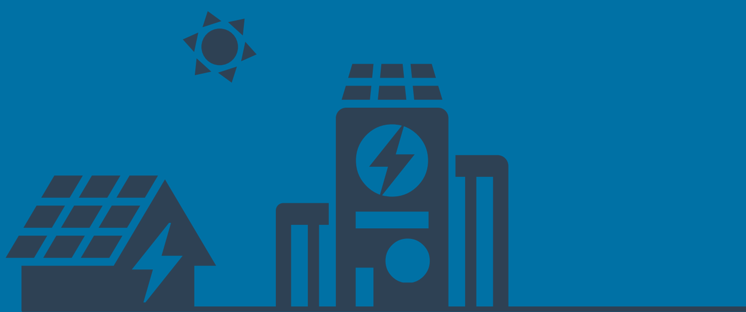
Through net metering, local or national authorities can encourage solar PV deployment, allowing households or businesses who generate their own electricity to feed any surplus back to the grid, thus turning them from consumers into "prosumers". They can either receive a credit against future consumption or remuneration at a specified rate (IRENA, 2016). In some countries, the policy lead on net metering lies with national-level authorities; but where national governments have not already acted, municipal authorities may be able to introduce regulations in accordance with their function as local electricity regulators (Box 1.5).

BOX 1.4 ROOFTOP SOLAR PV IN CITIES

Chinese cities have been at the forefront of solar rooftop installations. The city of Dezhou, in Shandong Province (northwest China), launched its "Million Roof Project" in 2008, requiring that all new residential buildings be equipped with solar water heaters. Solar thermal or solar PV technology is integrated in 95% of new buildings in the city (ICLEI and IRENA, 2013a).

Elsewhere in Asia, Tokyo plans to install 1 gigawatt (GW) of rooftop systems by 2024, including 22 megawatts (MW) on publicly owned buildings and facilities. The city has created Japan's first solar map, the "Tokyo Solar Register", which calculates suitable solar photovoltaic (PV) system size (kilowatt, kW) and potential electricity generation (kilowatt-hour, kWh) by assessing solar insolation, rooftop space, roof tilt and shading for each home or building in the city (Movellan, 2015). Seoul in the Republic of Korea also has a PV capacity goal of 1 GW by 2022. The "Solar City Seoul" plan is set to invest KRW 1.7 trillion (USD 1.56 billion). In addition to increasing the number of miniature solar generators on household rooftops and verandas to as many as 1 million, Seoul will also install PV panels at major buildings and parks, designating a number of areas around the city as solar energy landmarks or solar energy special districts (Renewables Now, 2017; Lennon, 2017).

San Francisco, California, became the first major US city in April 2016 to require all new buildings to install rooftop solar PV (IRENA, 2016). The city administration also has a goal of installing 100 MW of solar power on public buildings and spurring the installation of 250 MW on private buildings by 2025 (Patel, 2016), though stringent safety and permitting rules have slowed progress (Maloney, 2018). To deal with the variability of solar power, New York City is the first city in the United States to adopt a citywide target of 100 megawatt-hours by 2020 for energy storage.



BOX 1.5 NET METERING ACROSS THE WORLD

Net metering has been introduced worldwide in a number of cities. In the United Arab Emirates, the Shams Dubai programme adopted by the Dubai Electricity and Water Authority led to an installation of 30–40 megawatts (MW) of solar capacity on the premises of the Dubai Ports Authority (IRENA, 2019).

In India's capital, New Delhi, net metering was introduced in 2014. Homeowners can either own a solar power system or lease it on a monthly basis from project developers (Times of India, 2017).

In India's state of Karnataka, Bangalore is struggling to meet its energy needs. Demand is rising just as droughts diminish hydropower generation. After the city introduced its net-metering programme in 2014, deployment of rooftop solar panels by residents, business owners, schools and other public institutions surged. Solar capacity connected to the grid of the city utility BESCOM expanded in 2016, vaulting from 5.6 MW (Martin and Ryor, 2016) to 98 MW in the fall of 2018 (New Indian Express, 2018).

Bangalore, India

Promulgating solar thermal ordinances

Municipal ordinances establish minimum requirements for renewable energy use, including solar energy, biomass, and air- or ground-sourced heat pumps. Such measures tend to be required in new buildings and major building renovations. In several cases, municipal requirements are more ambitious than national ones; in this way, cities may function as pioneers, elevating national standards over time. Solar thermal ordinances exemplify such measures—municipal regulations that stipulate that solar energy provide a minimum share of heating demand. Over the past decade or so, solar ordinances have become a common tool across countries worldwide to promote solar thermal technology (ESTIF, 2018) (see also Box 1.6). Integrating solar water heaters into social housing programmes helps to ensure that low-income households benefit from renewables as well.

Adopting measures to decarbonise transport

Accounting for a third of total final energy consumption worldwide, the transport sector is one of the largest energy users in the urban environment, making it an important, yet often neglected target of renewables-focused policy. Energy demand in the transport sector is growing fast, and a major share of urban transport energy use remains in the form of gasoline and diesel fuels, as well as power generated from coal.

Urban transport-related policy making can tap into various measures that support cleaner fuels, electrification, a better modal mix and fewer motorised transport vehicles. Often driven by air pollution concerns, cities around the world are seeking to reduce the number of cars on urban streets, promote car-sharing, close certain roads entirely (or for high-emission vehicles) and promote pedestrian-friendly and bike sharing policies.

BOX 1.6 SOLAR THERMAL ORDINANCES IN PRACTICE

China is home to about 70% of global installed solar water heating (SWH) capacity. More than 80 cities in China having adopted favourable policies for installing such systems, often including mandatory installation in new buildings. The city of Rizhao, in Shandong Province, has promoted SWH in residential buildings for the past 20 years through regulations, subsidies and information campaigns for residents. Today, virtually all city centre households use it. The Shandong provincial government helped finance solar research and development, resulting in competitive pricing of SWH systems compared to electric heaters (IRENA, 2016; REN21, ISEP and ICLEI, 2011).

In 2000, Barcelona, Spain, became the first European city to pass a solar thermal ordinance. It requires that solar thermal energy cover 60% of running hot water needs in new, renovated or repurposed buildings – both private and publicly owned. To ensure public awareness and acceptance, a "Solar Reflection Days" initiative showcased state-of-the-art systems. "Taula Solar" was set up to promote stakeholder discussion. More than 70 other Spanish cities have replicated Barcelona's ordinance; in 2006, a requirement to install solar thermal systems became part of Spain's national Technical Building Code (ICLEI, 2014).

In Brazil, São Paulo's 2007 solar ordinance mandates that solar technology cover at least 40% of the energy used for water heating in all new buildings. Public consultations were a key element in drafting the ordinance. Product certification efforts were critical to avoid the use of low-quality equipment that could have damaged public acceptance (ICLEI and IRENA, 2013b; ABRAVA, 2015). The ordinance inspired similar measures in cities across Brazil; the country is a global leader in deploying solar water heaters (Weiss and Spörk-Dür, 2018).

Barcelona, Spain

Although such policies do not directly concern renewable energy use, they create the context within which cleaner fuels and electricity become central to civic and policy conversations. Relevant policies undertaken at city-level include congestion pricing; vehicle quotas through auctions or lottery systems; license plate restrictions; low-emission zones; parking restrictions; and car-free streets (McKerracher, 2018; SLoCaT, 2018; Hidalgo, 2014; Renner, 2016; Reuters, 2015).

More cities are pushing for reducing and eventually ending the use of vehicles with internal combustion engines. For example, Athens, Madrid, and Mexico City have decided to ban petrol and diesel-powered cars by 2025, and Paris will do so by 2030 (REN21, 2018). As of late 2018, 26 cities[3] around the world had signed the C40 "fossil-fuel-free streets declaration" (Box 1.7), which among other things commits to transition away from vehicles running on fossil fuels (C40 Cities, n.d.). These policies create the context within which cleaner transport energy, whether in the form of biofuels or renewable energy–based electricity, will play an increasing role.

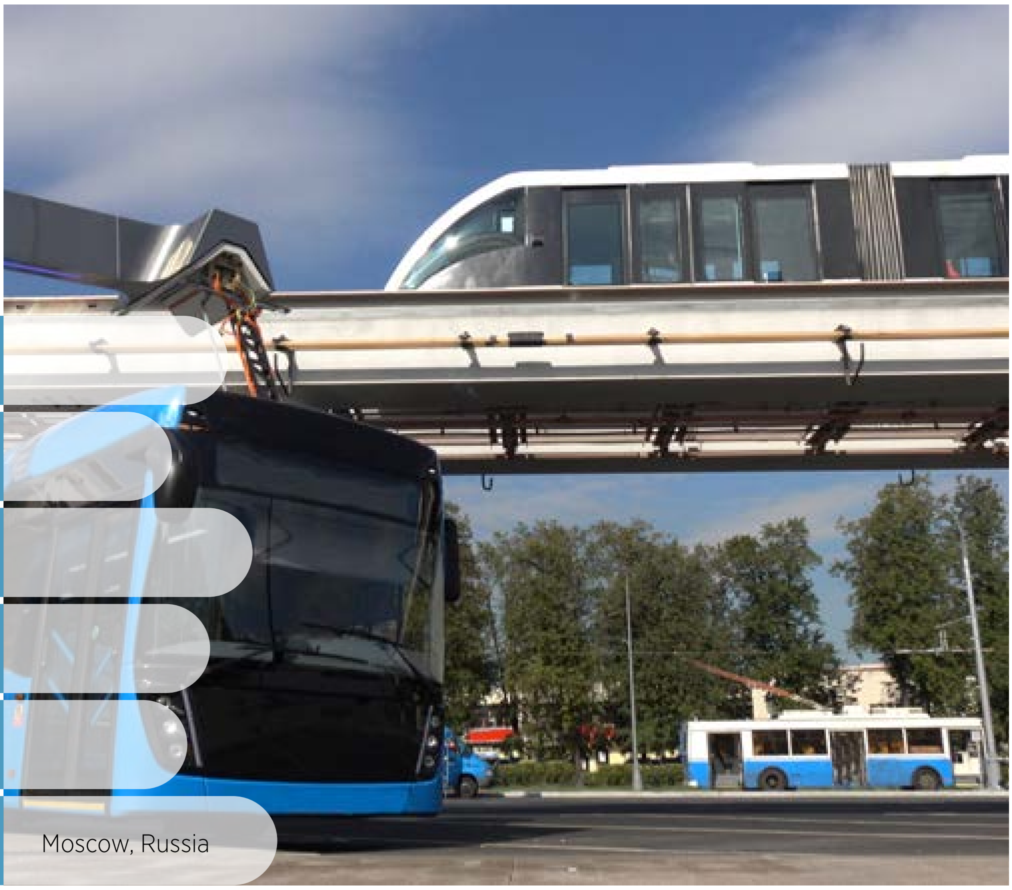
3 Among the signatories are a number of cities with fewer than 1 million inhabitants: Copenhagen, Cape Town, Heidelberg (Germany), Oslo, Rotterdam, Vancouver, Honolulu, Oxford, Manchester, Santa Monica, and West Hollywood.

BOX 1.7 C40 FOSSIL FUEL–FREE STREETS DECLARATION

Participating cities pledge to procure only zero-emission buses from 2025 and to ensure that a major area of the city is a zero-emission zone by 2030. To meet this commitment, a range of measures will be taken (and progress will be reported on a bi-annual basis):

- Increasing the rates of walking, cycling and the use of public and shared transport that is accessible to all citizens.
- Reducing the number of polluting vehicles on the streets and transition away from vehicles powered by fossil fuels.
- Procuring zero-emission vehicles for city fleets as quickly as possible.
- Collaborating with suppliers, fleet operators and businesses to accelerate the shift to zero emissions vehicles and reduce vehicle miles.

Source: C40 Cities, 2018.



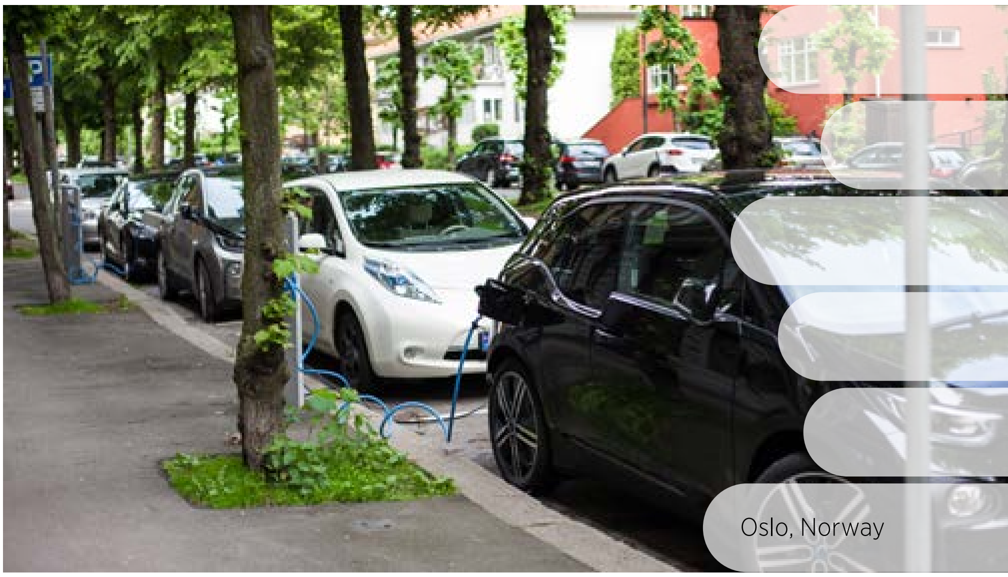
Moscow, Russia

Promoting renewable energy-based e-mobility

Efforts to reduce reliance on internal combustion engines are often paired with targets, mandates, and incentives to support the electrification of municipal bus fleets, taxis and private vehicles. Measures include subsidies, fleet procurement and conversion decisions, charging infrastructure, and other efforts and are becoming critical objectives for a growing number of cities. The life-cycle emissions of EVs compares favourably to internal combustion vehicles (ICCT, 2018), even in countries like China, where power generation is still dominated by coal (Energy Foundation China, 2018).

Policies that favour passenger car electrification are being formulated at national and local levels. Support measures include public procurement and investment plans that help to create and stimulate an EV market. Various financial incentives reduce EV costs, including purchase subsidies, tax exemptions and differentiated taxes that penalise polluting or inefficient vehicles and favour better-performing ones. Additionally, regulations such as fuel-economy and fuel-quality standards and zero-emission vehicle mandates can play an important role. Moreover, creating a sufficiently dense network of charging stations is an essential part of an EV strategy. Cities can directly invest in building such an infrastructure and issue deployment targets, issue regulations that standardise hardware and software, and take measures to encourage privately owned charging stations through building codes and zoning regulations (IRENA, 2016).

Electrification efforts also extend to municipal bus fleets, which typically run on highly polluting diesel fuel. According to ICCT (2012), the world's total bus fleet is projected to grow from 16 million vehicles in 2010 to 20 million by 2030. Among the barriers to widespread adoption of electric buses are higher upfront costs (although total lifecycle costs may be not much high higher than those for diesel models); battery replacement costs (at almost half the vehicle price); and the need for a charging infrastructure (Lu *et al.*, 2018). Altogether, more than 300 cities worldwide now have at least some battery-powered electric or hybrid buses (SLoCaT, 2018), with China accounting for the vast majority of the global fleet. This development has been supported at the central government level by generous subsidies for vehicle purchases and charging infrastructure, matched by reduced subsidies for diesel fuel. Shenzhen has been a leader in switching its bus fleet to electric vehicles (Box 1.8).



Oslo, Norway

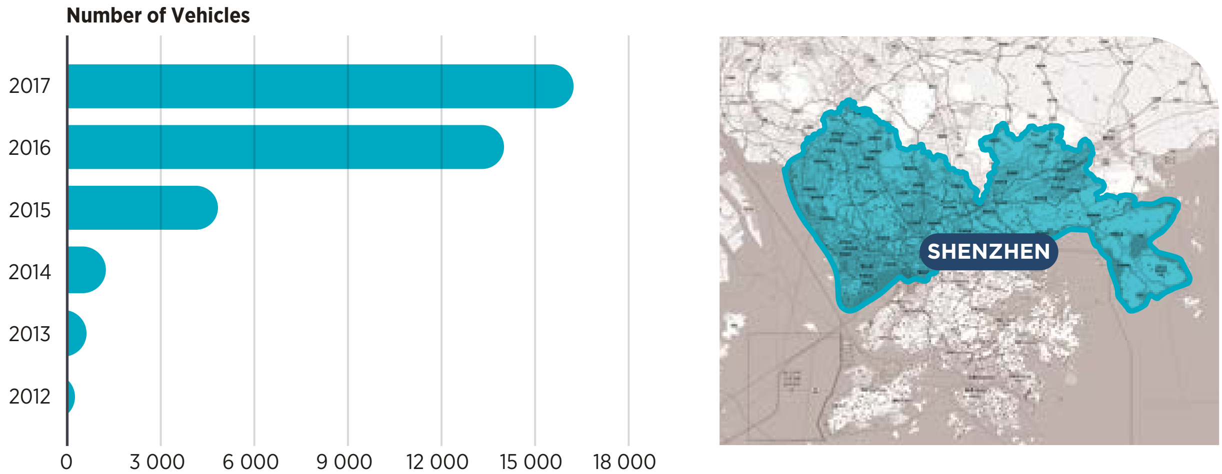
BOX 1.8 PIONEERING ELECTRIC BUS USE IN SHENZHEN

In 2009, China launched the piloting programme for "new energy vehicles (新能源汽车), starting from 25 cities and expanded to hundreds of cities and the whole country. Chosen to be the first "new vehicle" pilot city, Shenzhen had by the end of 2017 completely switched its bus fleet to electric (see Figure 1.2). This makes Shenzhen the world's first city whose entire bus fleet is electrified. With financial support from the central government, Shenzhen has provided substantial subsidies for buses and charging facilities, totalling RMB 3.3 billion (USD 490 million) in 2017 alone (Dixon, 2017).

E-buses deployed in Shenzhen consume 73% less energy than diesel buses and emit 48% less carbon (67 kilogrammes of carbon dioxide per 100 kilometres, compared to 130 kg for diesel vehicles). During 2017, the fleet's carbon dioxide emissions were cut by 1.35 million tonnes. Pollutants such as nitrogen oxides, hydrocarbons and particulate matter are also down (ITDP, 2018). According to the Shenzhen Municipal Transportation Commission, the resulting energy savings amount to 366 000 tons of coal saved annually, substituted by 345 000 tons of alternative fuel (Dixon, 2017). As China reduces its heavy reliance on coal power plants, the advantages of e-buses will further widen.

Leasing rather than buying buses from manufacturers[4] has allowed bus operators in Shenzhen to lower upfront costs and thus the need for debt financing. Manufacturers are providing lifetime warranties for vehicles and batteries, limiting risks to operators. Because e-buses tend to have shorter driving ranges per charge,[5] more of them are needed than is the case for a diesel powered fleet, translating into greater procurement costs. Shenzhen managed to avoid most of these extra costs by co-ordinating charging and operation schedules; e-buses are charged overnight and recharged at terminals during off-peak hours (Lu, Xue and Zhou, 2018). Shenzhen has 510 bus charging stations with a total of 8 000 charging points, so that half the fleet can be charged at once (Dixon, 2017).

Figure 1.2 Electric bus adoption in Shenzhen, China



Source: Lu, Xue and Zhou, 2018. © OpenStreetMap contributors

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4 Shenzhen is home to the car and bus manufacturer BYD, the world leader in e-bus production. Promoting local industry, Shenzhen has awarded nominally competitive tenders for e-buses to BYD. However, in February 2018 the central government reformed EV subsidies, prohibiting local authorities to discriminate against non-local vehicle manufacturers (OECD/IEA, 2018).

5 But performance is improving; the average daily mileage of e-buses in Shenzhen increased 41% between 2012 and 2016 (ITDP, 2018).

Adopting biofuel blending mandates and biomethane use

Switching from internal combustion engines to electric models will take time. A number of governments around the world are pursuing renewable energy deployment policies — specifically, biofuels blending mandates — in an effort to decrease the carbon footprint of internal combustion engines (REN21, 2018). To date, national or subnational governments in at least 70 countries have enacted biofuel blending mandates, though only seven aim for shares higher than 10% (SLoCaT, 2018). In most cases, biofuel blending mandates are adopted at the national level, though some cities have their own initiatives. For example, Curitiba in Brazil is implementing a 100% biodiesel mandate for its municipal bus fleet, as part of its Biocidade programme (IRENA, 2015). Vancouver hopes by the end of 2019 to convert its fleet of 577 diesel-powered vehicles (buses, fire engines, garbage trucks, etc.) to biodiesel made from organic wastes like fats and used vegetable oils, and to cut emissions in half compared with 2007 (Cruickshank, 2018).

THE ROLE OF CITIES IN TARGET SETTING, ENGAGEMENT AND CAPACITY BUILDING

Cities can champion local renewable energy deployment through municipal policy and awareness-raising programmes (as outlined in several case studies in Chapters 2–4). Progress will likely be greatest if local citizens play an active role in formulating and implementing municipal policies, and if policy makers ensure that all urban residents benefit from the move to renewable energy. The social equity dimension is thus crucial.

Around the world, community energy approaches are becoming a popular solution for meeting local energy supply needs. Amongst other definitions, "community energy" can be defined as a combination of at least two of the following elements (IRENA Coalition for Action, 2018):

- Local stakeholders own the majority or all of a renewable energy project.
- Voting control rests with a community-based organisation.
- Most of the social and economic benefits are distributed locally.

Such projects may be initiated and directed by municipalities, even as co-operative structures allow urban residents to participate in decision making, directly and actively. Citizens must thus acquire the knowledge and capacity needed to take part in energy decision making (Roberts, Bodman and Rybski, 2014). National and local governments can also help develop alternative business models to encourage financial institutions to dispense loans (IRENA Coalition for Action, 2018). One recent example of community energy is in Athens, Ohio (United States) (see Box 1.9).

BOX 1.9 COMMUNITY CHOICE IN ATHENS, OHIO (UNITED STATES)

Residents of Athens, Ohio, have access to a community choice programme, the Southeast Ohio Public Energy Council (SOPEC). The city's 2017 Sustainability Action Plan includes a goal of reducing municipal energy use by 20% by 2020. UpGrade Ohio (which used to be a part of SOPEC) launched the Solar ACCESS programme to help bring solar electricity to low- and moderate-income households. The programme was entered into the US Department of Energy's "Solar in Your Community Challenge". Construction to install rooftop solar panels at a public secondary school was scheduled to start in August 2018.

Further, in May 2018, Athens residents approved a ballot initiative in favour of a small carbon fee per kilowatt-hour. The fee will be routed through the community choice programme (and translate into a USD 1.60 to USD 1.80 monthly cost per household, though residents are allowed to opt out). The revenues will be used to purchase solar panels for public buildings in the city. Community choice aggregation is seen in Athens as a way to help local utility dollars stay local (Farrell, 2018).

Many bottom-up grassroots efforts feature the active involvement of local residents and community groups, including co-operatives, non-profit associations, community trusts and others that support renewable deployment in urban spaces. For instance, in the favela of Morro de Santa Marta, Rio de Janeiro, Brazil, solar panels were installed at day-care centres, schools and along alleys and courtyards by Insolar, a local social enterprise. The panels reduce energy costs of the 4 000 residents and provide relief from frequent power outages.

Santa Marta, Rio de Janeiro, Brazil

MOVING FORWARD

This lead chapter has laid out the key circumstances, drivers and motivations that shape the ways cities can act to promote the use of renewable energy in areas under their jurisdiction. It has also offered a brief overview of some of the initiatives and measures taken in pursuit of energy transition objectives, drawing on examples of cities small and large around the world.

However, to understand both the possibilities and the constraints (and the real-world ability to scale up efforts and replicate them elsewhere), it is important to examine specific circumstances. The bulk of this report is focused on city case studies in three diverse countries, China, Uganda, and Costa Rica. The cities chosen for the case studies vary somewhat in size. But they are all medium-sized cities, defined as ranging in population from 30 000 to 1 million inhabitants. As such, the focus of this report varies from that of other assessments, which often concentrate on large and internationally known cities.

Geographically and culturally diverse, China (Asia), Uganda (Africa), and Costa Rica (Latin America) are divergent not only in their territorial expanse and population size, but also in their economies and governance systems. The point of this report is not to find commonalities amid such diversity, but to discern the manifold real-world challenges faced by divergent cities and to examine what they can (or cannot) do about them.

By increasing their reliance on renewables Chinese cities can address pervasive air pollution caused by the country's heavy use of coal. By way of contrast, cities in Uganda are mainly concerned with deploying renewables to improve energy access. Because Costa Rica's power sector is already largely based on renewables (hydropower), the policy discourse there has identified the electrification of the transport sector as the area with the highest potential, nationally and locally, to reduce the use of fossil fuels and associated GHG emissions.

With a population of 1.4 billion, China's size is such that many of its more than 600 prefecture- and county-level cities each have a million residents or more. To remain within the range of population size chosen for this report, the case studies focus on specific districts within larger cities: Chongli District of Zhangjiakou and Tongli Town of Suzhou (see Chapter 2).

With a rapidly growing population of about 46 million and a territory of roughly 241 000 square kilometres (km^2), demographically and spatially Uganda sits between Costa Rica and China. Despite an ongoing national political dialogue on decentralising and devolving government authority in certain policy areas, local capacities and competencies in energy matters are still limited. They depend on the relevance of a given region to the national energy supply, *e.g.*, regions with large power plants have slightly more authority and influence in national energy politics. The Uganda case studies focus on the cities of Kasese and Lugazi (see Chapter 3).

With a population of just 5 million and territory of about 51 000 km^2, Costa Rica is the smallest of the three countries covered in this report. Highly urbanised, Costa Rica has some 77% of its population living in cities. Its small size allows it to have surprisingly centralised political decision-making structures. At the same time, administrative units at the city level are deeply fragmented, circumstances that severely restrict the ability of cities to make autonomous decisions and limit the incentive local policy makers have to take independent action to promote renewable energy projects. Reflecting these circumstances, the Costa Rica case study discusses municipal engagement in carbon-neutrality efforts in the context of its ambitious national decarbonisation plan, with initiatives taken by Cartago, Grecia and Guanacaste as examples (see Chapter 4).

Each of the chapters presenting the country case studies begins with a sketch of the national context and is followed by a discussion of the initiatives and experiences of select cities. They each conclude with a set of lessons learnt. The report wraps up with some broader conclusions.

Country Case

- National Context
- Initiatives and Experiences
- Lessons learnt

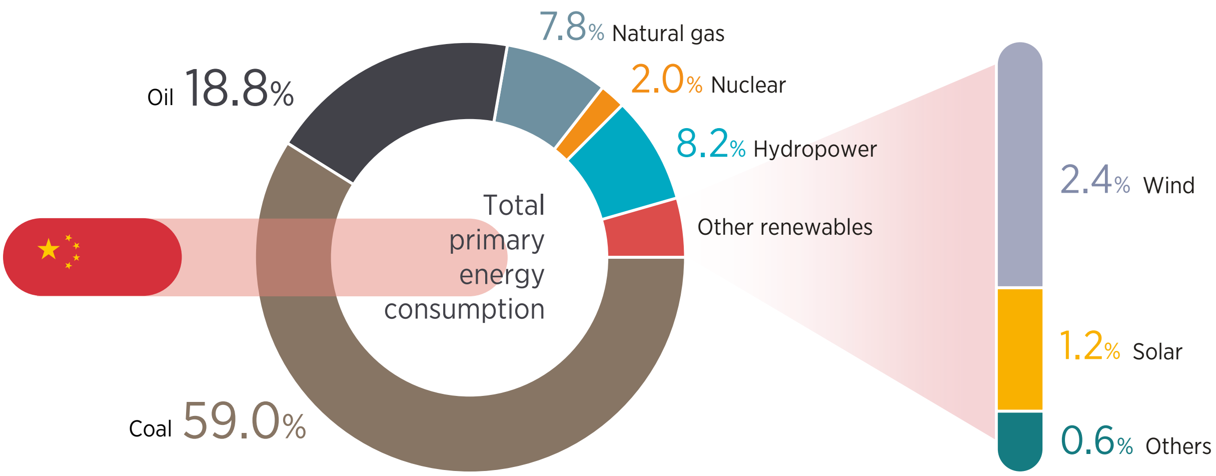
2. **CHINESE CITIES:** CHONGLI DISTRICT AND TONGLI TOWN

NATIONAL CONTEXT IN CHINA

China is the world's most populous country, with about 1.4 billion people. Rapid economic growth and large-scale industrialisation have made China the world's largest energy consumer, accounting for around one-quarter of global primary energy demand in 2018. China is the largest producer and consumer of coal and the largest emitter of carbon dioxide (IEA, 2019a). It relies heavily on energy imports, accounting for more than 70% of oil use and 43% of natural gas in 2018 (CREEI, 2019).

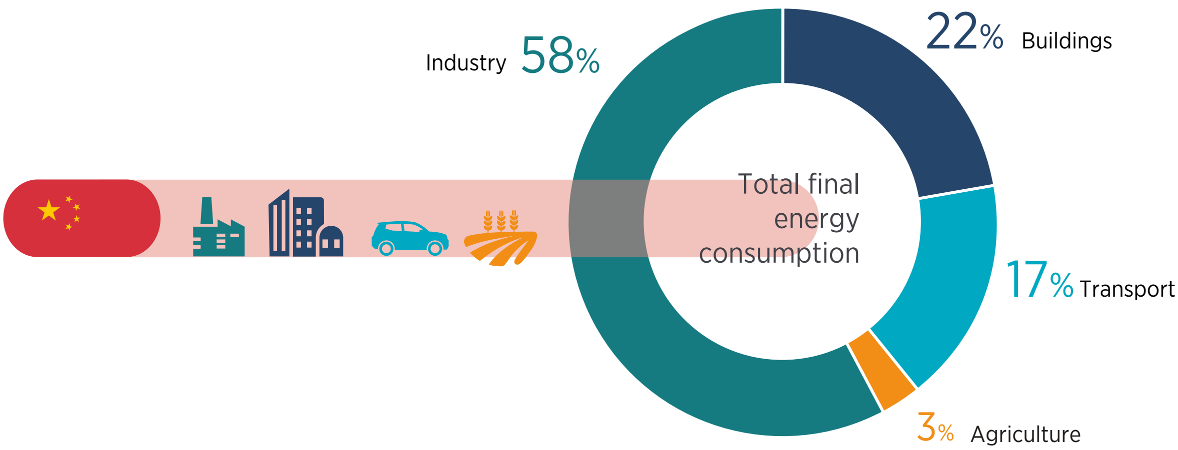
Notwithstanding the still-limited share of renewable energy in the country's primary energy mix (Figure 2.1), China is a major market for and producer of renewable energy technology. Renewable energy represented 38% of China's installed power generation capacity in 2018 (Figure 2.2) and 27% of its power generation (NEA, 2019). China now has 29% of the world's installed renewable energy capacity, leading in hydropower, wind and solar PV, as well as the second-largest bioenergy capacity worldwide (IRENA, 2020). China also accounts for 70% of the world's deployment of solar water heaters, 99% of electric buses, and 45% of all electric vehicles stock (IEA, 2019c, 2019d).

Figure 2.1 Share of total primary energy consumption in China, by fuel, 2018



Source: CEPPEI, 2019.

Figure 2.2 Share of total final energy consumption in China, by sector, 2017



Source: Wang Qingyi, 2019

Increasing urbanisation, rising living standards, and the growth of megacities translate into ever-increasing urban energy demand. Including urban-based industries, cities are estimated already to account for more than 60% of China's total energy consumption, a percentage expected to rise further (Wang, 2018). In 2018 alone, urban growth added more than 17 million new residents, around 2 billion m^2 of building space and more than 22 million vehicles (National Bureau of Statistics, 2020; Jiang et al., 2018).

Urban residents also bear the brunt of the adverse health effects caused by air pollution. Nearly half of the locations in the WHO's list of the 100 most polluted cities (measuring particulate matter pollution) in 2019 were in China. Coal burning used to be a major source of China's air pollution, but its contribution has receded since 2012 (NRDC, 2014). The share of vehicle emissions ranges from as low as 10% in smaller urban areas to much higher shares in some large cities like Shenzhen (52%) Beijing (45%) and Shanghai (29%) (MEE, 2018).

Given China's massive population, many of its cities are gigantic by global comparison. This report focuses on replicable, scalable experiences at smaller urban scales, exploring the cases of Chongli District (which is part of Zhangjiakou City in Hebei Province) and Tongli Town (part of Suzhou City in Jiangsu Province). Box 2.1, below, explains China's city level designations and governance structures as background to the analysis that follows.

BOX 2.1 ADMINISTRATIVE UNITS IN CHINA: PROVINCE, CITY, DISTRICT AND COUNTY

Subnational jurisdictions in China differ from typical structures in Europe; a city or district, for instance, may include both urban and rural areas, including villages, that are administratively part of a city and fall under municipal governance. Clearly classifying medium-sized cities based on only the size of their urban population is thus intrinsically difficult.

The population of a Chinese city can range from several thousand to more than 30 million. More than 91 Chinese cities have populations of more than 1 million, and 15 are home to more than 5 million. A medium-sized city in China would normally have between 500 000 and 1 million urban inhabitants (State Council, 2014). The administrative level most comparable with a medium-sized European city is in many cases a town or district of a prefecture city (Li Tie, 2019).

China divides subnational governance into four levels of administration: provincial, prefectural, county and township. As Figure 2.3 indicates, there are 34 provincial level administrations. These include provinces, autonomous regions, directly administered municipalities and special administrative regions. Many of them are subdivided. Prefectural level cities are in turn divided into districts, county-level cities or counties. Most cities are either prefecture or county level. A large share of county-level cities' GDP comes from secondary and tertiary sectors and urban residents, while counties focus more on rural development and agriculture.

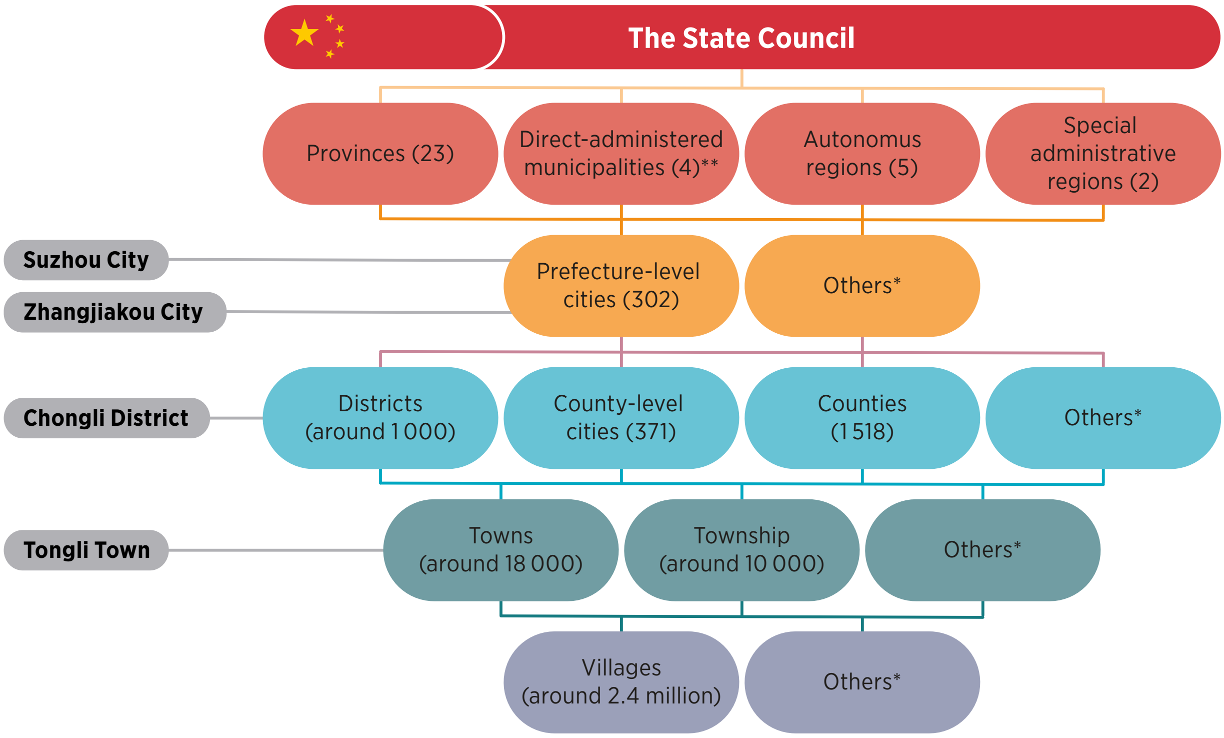
The various levels of administration are not necessarily hierarchical in terms of their decision making power.

Currently, China has 673 cities, excluding four provincial-level municipalities under the direct administration of the central government – namely Beijing, Shanghai, Tianjin and Chongqing City – 302 prefecture-level cities and 371 county-level cities (see Figure 2.3) (MoHURD, 2020). Provinces are usually the administrative layer above municipalities.

For instance, Suzhou City is a prefecture-level city under the administration of Jiangsu Province and is divided into six districts, the administrative level under prefecture-level cities, and four county-level cities. Tongli Town is in one of Suzhou's districts.

Suzhou City, Industrial Park

Figure 2.3 Administrative layers of the Chinese government



Source: MoHURD, 2018, 2020; National Bureau of Statistics, 2020.

Notes: *Including some administrations at the same level.
** The four cities directly under the central government are Beijing, Shanghai, Tianjin and Chongqing.
Figures on prefecture-level cities, county-level cities, counties and districts are as of 2018. Other figures are as of 2016.

CASE STUDY 1: CHONGLI DISTRICT

Chongli District is one of the six districts of Zhangjiakou city in Hebei Province (Figure 2.4). This district is 50 km from downtown of Zhangjiakou and has a population of 126 000 (2015 data) (Chongli District Government, 2016). Owing to its geographic location in mountainous territory, Chongli has a cold climate, with average temperatures of -12 Celsius degrees and five months of snow cover during the year (Qingzhe et al., 2017). This makes space heating an important component of the district's energy demand.

Zhangjiakou Municipality has adopted a number of enabling policies in support of renewables, and these are discussed below, together with renewable energy targets for Chongli. There are two key drivers of the renewable energy strategy in Zhangjiakou and Chongli District. One is the decision to have Zhangjiakou co-host (with Beijing) the 2022 Winter Olympics. The other is the designation in 2015 of Zhangjiakou as a National Renewable Energy Pilot City.

The Winter Olympics and the National Pilot City status bring new economic opportunities to the district, among which tourism (skiing and related activities) feature prominently (Chongli District Government, 2018). The local GDP has risen since 2017, and the improved local economy allowed Chongli District to be removed from the National Poverty Counties list in May 2019 (Hebei Provincial Government, 2019b). National-level policies are significant in shaping action at the local level, and this section also explores their importance for Chongli.

Figure 2.4 Chongli District in China

Source: © OpenStreetMap contributors | For visual purposes, maps are on different scales.

Disclaimer: Boundaries and names shown on this map do not imply any formal endorsement or acceptance by IRENA.

THE ROLE OF HEBEI PROVINCIAL GOVERNMENT

The Hebei provincial government is the upper level administration of Zhangjiakou City and plays proactive roles in provincial level targets, strategies and planning. These in turn enable city-level renewable policies and actions. The Hebei provincial government also plays a vital role in engaging the national government, regional-level authorities and grid companies, as well as pricing electricity and providing financial support for pilot projects in its jurisdiction.

THE ROLES OF ZHANGJIAKOU MUNICIPALITY

Target setter and regulator

Zhangjiakou Municipality is the main body developing city-level plans (which include Chongli District), implementing related local policies, and facilitating communication between all related stakeholders and co-ordinating platforms (for more on these platforms, see Box 2.2).

Under its 2015 pilot plan, Zhangjiakou City committed to raising the share of renewables in terms both of capacity and the percentage of final energy consumption. Renewables are to supply 55% of electricity by 2020 and 80% by 2030; 40% of all residential building energy needs, 50% of public buildings and 100% of public transport energy needs by 2020; and 100% of residential public building energy needs by 2030 (NDRC and NEA, 2015). Renewables-based electricity generation capacity is to reach 20 GW by 2020 and 50 GW by 2030 (NDRC and NEA, 2015). As for consumption, Zhangjiakou City aimed for a 35% renewable share in total final energy consumption by 2020, and 50% by 2030. It also aims to achieve 100% renewables in total energy consumption of public buildings and urban households by 2030, across all districts. These renewable targets are ambitious in China, which has a national target of 28% for renewables' share of electricity by 2020.

This affects all end uses. In heating, Zhangjiakou's target to phase out all coal-burning boilers, except cogeneration projects, by the end of 2020 has increased pressure on the company providing heating energy as well as industries consuming energy for heating. In transport, the city further established a target of 100% renewable energy–based urban public transport, supported by newly released strategy and policies to promote local renewable energy–based hydrogen industries and the manufacturing and deployment of hydrogen fuel cell vehicles in 2019.

Hebei Province

BOX 2.2 THE FOUR-PARTY CO-ORDINATION PLATFORM OF ZHANGJIAKOU CITY

Renewable energy developers in Chongli District mainly build and operate wind and solar power plants, so they form the backbone of efforts on the ground to promote local economic development and achieve ambitious renewable energy goals. The companies are a mix of large national renewable energy firms and developers controlled by the provincial government, for example, joint ventures between leading developers and local investors. Following project approval by the provincial government, the developers sign a power purchase agreement with the national grid company and establish eligibility for feed-in tariffs (FiTs), to ensure grid connection.

Given the wide curtailment of wind and solar generation in this region due to excess capacity, project operators have been involved in a four-party co-ordination platform to sell more electricity generation (out of the national guaranteed generation hours) at a lower price. The platform was initiated in 2018, with the aim of promoting wind electricity for heating in Zhangjiakou City, as well as reducing curtailment and utilising more renewables potential. The platform involves Zhangjiakou Municipality, the grid company, wind and solar power plant operators and heating companies as the electricity consumers. The platform facilitates the trading of wind and solar electricity between heating companies and power plants via the regional grid. The four parties facilitate monthly electricity trading.

The regional branch company of the state-owned grid company is responsible for establishing the trading rules, electricity connection, and operation and recording of the trading. Each month, Zhangjiakou Municipality aggregates demand from heating companies and other consuming companies and industries. Wind and solar power plants subscribe to the aggregated electricity needs with offered prices. Heating companies and other electricity consuming companies and industries will pay the subscribed power plants through the grid company in trading prices. Trading electricity on this platform, with a tariff lower than one-third of the normal electricity tariff, could also reduce the operation cost of heating companies. Solar and wind power plants could sell more electricity, at a lower tariff, outside of guaranteed hours.

Although trading on this platform is voluntary, pressure from the national policy (especially the planned phaseout of coal-fired boilers) and the prospect of lower heat energy costs are incentives for the producers and consumer companies to participate.

In 2017, 52 solar and wind power plants participated in the platform. During the winter of 2018, around 425 heating companies and 4 226 distributed heating consumers traded more than 235 gigawatt-hours (GWh) of renewables electricity on the platform. As of 2019, the platform organised 12 trades with a total of 700 GWh of trading electricity (Zhangjiakou Municipality, 2020; Hebei Provincial Government, 2019a).

Zhangjiakou City

Financier and operator

Renewable energy electricity projects, including onshore wind, solar PV and municipal waste generation, are already economical for generators receiving national FiTs, as well as for the distributed generation and household generators under provincial and city-level FiP policies. The business case for renewable energy–sourced electricity used for space heating, on the other hand, still needs to be demonstrated. In Zhangjiakou City, the municipality and grid companies plan to invest hundreds of millions of dollars to improve local energy infrastructure, including district heating stations and a distributed system, as well as electricity transmission and distribution networks. Zhangjiakou provides subsidies to cover 85% of electric heating equipment of a heating company using wind power, capping the electricity price at CNY 0.15/kilowatt-hour (kWh), or USD 0.0218/kWh) for heating companies on the four-party co-ordination platform. Zhangjiakou had deployed 194 hydrogen fuel cell buses for public transport by the end of 2019, with funding from both the central and its own municipal government budget (Zhangjiakou Municipality, 2020).

THE ROLES OF CHONGLI DISTRICT

Target setter and planner

The district government defines its own renewable energy strategy and targets. It has little in the way of independent policy making authority, however, especially when it comes to fiscal and financial aspects. Therefore, collaboration with upper-level governmental authorities, including Zhangjiakou Municipality and the Hebei provincial government, with the aim to support comprehensive planning in Zhangjiakou City is key. The district government does have roles in district planning as well as managing and facilitating the implementation of projects locally, in collaboration with Zhangjiakou Municipality, the grid company and other key stakeholders.

Renewable energy targets for electricity, heating and transport in Chongli are included in the Renewable Energy Demonstration Plan of Zhangjiakou City, which was announced by the State Council of China and released by Zhangjikou Municipality with support from the provincial government. The plan establishes targets for reaching a very high share of renewables for Chongli District, in the context of planning to host the Winter Olympics (as discussed further below in Box 2.4). According to the Low-Carbon Olympics Plan, electricity will be supplied mainly from renewables within Chongli District and some wind or solar electricity will be sourced from nearby counties in the Zhangjiakou City area. Solar thermal energy will provide heating for all buildings in the Special Zone for the Winter Olympics. The plan is to build four to six solar district heating stations, each providing heat energy for 10 000 m^2 of floor space (NDRC and NEA, 2015).

Targets also include 100% electric heating in urban areas of Chongli District by 2021, 70% for suburbs and 40% for rural areas (NDRC and NEA, 2015; see Box 2.3, below). Renewably sourced electricity was to cover the heating needs of 3 million m^2 of existing buildings and 0.6 million m^2 of new buildings in 2020. Altogether, this was expected to add 360 million kWh of new electricity consumption in Chongli District.

The targets are supported by differentiated technology solutions. Renewable energy combined with district heating networks will provide heat for urban areas and the Olympic village. Distributed heating solutions will be applied mainly in rural households. However, given

BOX 2.3 DEPLOYMENT OF RENEWABLE ENERGY HEATING SOLUTIONS IN CHONGLI

The electrification of heating is a core element of transitioning from coal towards clean energy in China and Chongli. At the national level, NDRC and nine other ministries in 2017 joined hands to create policies aimed at substituting coal-fired boilers with electric boilers. Heat pumps as well as gas fired boilers and other renewables-based options, including biomass and geothermal. Chongli has set a target of replacing all coal-fired heating with the help of electric solutions and wind power. The electricity used for this purpose reflects the mix of energy sources of the regional grid; meanwhile, the provincial government, in collaboration with the grid operator, seeks to raise the share of wind power.[6]

The share of heating in total energy consumption is expected to increase significantly. Local power generation capacity requirements are estimated to rise ninefold from 2019 to 2022 due to the rising needs for electric heating. Chongli will need to source additional supplies of renewable energy as existing local capacity will eventually fall short of electricity needs for heating. As of 2018, Chongli District had planned an additional 608 MW of renewable electricity generation capacity for heating purposes (Zhangjiakou Municipality, 2018). The most likely option would be to utilise clean electricity from nearby areas within Zhangjiakou City.


Zhangjiakou City

5 Chongli District's existing district heating system was built and operated by a privately owned company on the basis of a 2010 franchise agreement. The district system provides space heating for 4.5 million m2 of building floor area, supported by seven 46 MW boilers, and 39 km of district heating network through 38 heating exchange stations.

the available assessment, the use of bioenergy and geothermal as heating sources in this district is limited. Renewables based electric heating could address the curtailment of renewable power as well as provide cleaner heating.

Financier and operator

Meanwhile, Chongli District committed to all energy consumption of municipal owned buildings being sourced from renewables. This target includes government office buildings, hospitals, schools, parks, squares and public spaces (NDRC and NEA, 2015). Renewables will provide both heating and power for the buildings' operation. It is estimated that the electricity will be procured from wind electricity generated by power plants in Zhangjiakou City through a regional pilot market platform initiated by the NEA, the grid company and the provincial government.

BOX 2.4 INVESTMENT IN RENEWABLES-BASED PROJECTS RELATED TO THE WINTER OLYMPICS

Fulfilling Chongli's goal of 100% renewable energy for the Winter Olympics entails large-scale investment – in construction and operations of new power generation plants, grid networks; in upgrading infrastructure, improving heating networks and appliances in addition to power supply and charging stations for electric vehicles and hydrogen cell vehicles. It will also require money for subsidies supporting operations and maintenance of renewable generation, heating and transport.

Estimation of project costs is mainly associated with the comprehensive energy supply planning for the Green Olympic Zone and Low-carbon Chongli District planned by Zhangjiakou Municipality. Of the total required investment for renewables generation, transmission and distribution as well as consumption, 11% will be used for the Olympic zone, 9% for electric heating projects, 2% for electric vehicles charging stations, 1% for an energy transaction data service platform and 45% for grid upgrading and improvement. The remaining 32% of the investment will be supporting energy efficiency in the building, industry and transport sectors (IRENA, 2018a).

Financial support from the central government of China will cover most of the investment for public facilities and public buildings, as well as most of the construction and infrastructure required for the Winter Olympics. The private sector and other stakeholders are also involved in renewable projects in heating and transport sectors. Given data constraints, it is difficult to estimate private investment. However, the private-owned heating company and some renewable power plants with private investors have invested in the procurement of boilers and the construction of plants.

CASE STUDY 2: TONGLI TOWN

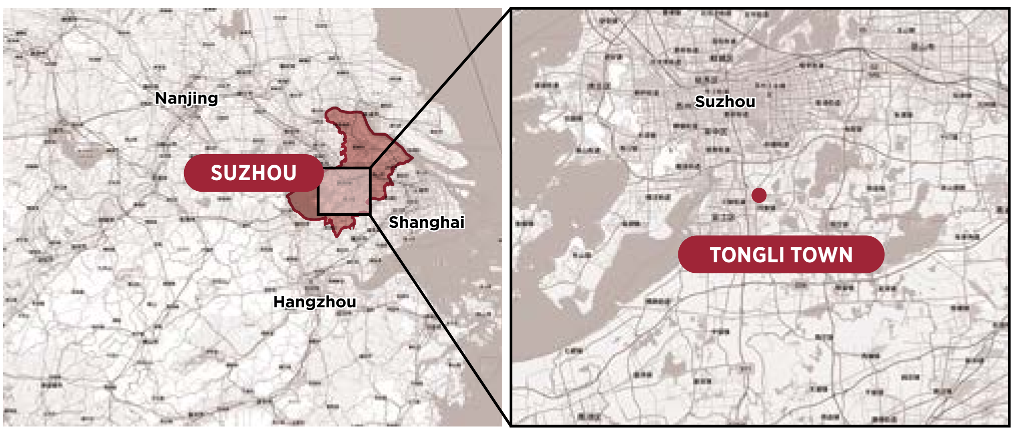
Tongli town, part of the Wujiang District of Suzhou City, Jiangsu Province, has more than a thousand years of history. Located on the eastern shore of Taihu Lake, 18 km from the city centre of Suzhou and 80 km from Shanghai, Tongli covers an area of 98.03 km^2 with a population of 67 900 spreading across five neighbourhoods and eleven villages (Figure 2.6). The historic core of Tongli Town stretches over an area of 2.4 km^2, in which a tiny area is the city core (Suzhou Municipality, 2018a).

Tongli Town is certified as a World Heritage site by the United Nation Educational Scientific and Cultural Organisation (UNESCO) as well as the protected historical heritage by Jiangsu provincial government. Tourism is therefore a mainstay of the local economy. Tongli Town ranks among the top ten popular tourist destinations in China, receiving more than 5 million visitors annually since 2011. However, the heritage certification has translated into a restrictive policy for buildings, decorations and reconstruction. The surge in visitors has brought spikes in energy consumption[7] as well more risks to the ancient buildings in the city core.

Given Tongli's small population and its lack of energy-intensive manufacturing industries, the town's energy demand is comparatively small. However, power demand may rise as transport and other activities are electrified. Local government has recognised the major challenge of reconciling the growth of tourism in Tongli with the parallel goal of increasing the use of clean energy in Tongli. Major energy consumers in Tongli City are households and the tourism industry including restaurants, hotels and transport for tourists. Existing infrastructure is a major local challenge, as open fires continue to be used for cooking and heating in the densely populated town, while increasing electricity consumption also raises the risk of overloaded old wires.

7 Since 2014, the flow of tourists to Tongli Town has increased by more than 30% every year, driving growth in energy consumption to the tune of 7.4% annually, according to local authorities.

Figure 2.5 Tongli Town



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Disclaimer: Boundaries and names shown on this map do not imply any formal endorsement or acceptance by IRENA.

Given the Lack of space and restrictive building protection policies limit the exploitation of renewable resources in Tongli Town's ancient core. But the outlying areas have the potential to deploy various technologies including solar PV, solar thermal, heat pumps (ground-source and sewage source), as well as biogas from sewage.

Tongli Town, along with Suzhou City and its wider region registers average solar radiation of about 1 279 kWh/m^2 per year and 3.5 kWh/m^2 per day. Based on the assumption of an average living area in Tongli of around 50 m^2 per capita housing area and 25% of total rooftop area utilisation, the estimated available rooftop area for solar PV could reach 300 000 m^2. This would translate into around 30 MW of potential capacity for solar PV rooftop in buildings, which is more than 100 times of the installed solar panels in Chongli District (Jiao Xiaolong, 2017).

Tongli has a rich potential of distributed solar PV generation. The estimated area available for integrated solar PV solutions is 90 km^2, mainly on farmlands and fishponds outside of the ancient town. Installing solar panels on fishponds is one of the solutions for cities in Yangtze delta region where there is limited land for the installation of solar panels on the unutilised land but abundant fishponds and farmlands on which the solar panel could be built to generate renewables electricity as well as to shelter sunlight for the shade-requiring plants and fishes. The potential solar thermal for water heating could meet hot water needs for more than 5 000 households.

Suzhou

THE ROLE OF JIANGSU PROVINCIAL GOVERNMENT

The Energy Division of the Jiangsu provincial government is responsible for all energy-related policy making, implementation and strategies in the province, and guides all energy-related work of municipalities in this province. In collaboration with NEA, the Energy Division provides support for Tongli's ambitious renewable energy targets as well as expertise and knowledge. It also facilitates necessary support in strategies, power market co-ordination and other necessary guidance to ease the involvement of NEA and other national institutions.

ROLES OF SUZHOU CITY

Suzhou City, acting through Suzhou Municipality, is responsible for setting, facilitating and financing energy policy, including renewables deployment, throughout its jurisdiction. This includes Tongli, which is under the administration of Suzhou City. All targets, strategies, action plans and local financial supports for renewables in Tongli are released by Suzhou City in collaboration with the Jiangsu provincial government.

Target setter and planner

Suzhou is the main planning body for renewables deployment, as Tongli Town cannot issue such plans itself and all actions taken locally require the city's approval. Suzhou adopted a 2020 target of 55% of total electricity consumption coming from clean energy sources, which in practical terms has come from hydro plants in southwest China. Hydroelectricity is equivalent to a 30% renewable share in total final energy consumption by 2020 (see Tables 2.1 and 2.2) (Suzhou Municipality, 2018b). Further, Suzhou plans to deploy some 310 MW of local renewable electricity capacity, of which 250 MW would be solar PV, 10 MW onshore wind and 50 MW biomass power. For heating and cooling, the city established a target of 85 000 m^2 of solar water heater collector area, and 150 000 m^2 of building floor area using geothermal, groundwater and sewage-sourced heat pumps. For transport, the target is to build enough charging stations to serve a fleet of 50 000 EVs.

Table 2.1 Targets for renewables' share of energy consumption in Suzhou City, Tongli Town and town centre, by 2020

	RE in total energy consumption	Electricity in TFEC	RE in electricity consumption	RE in the building sector	Deployed electric vehicles
Suzhou City	–	30%	55% derived from hydro	–	5 000
Tongli Town	around 20%	–	–	–	–
Historic centre of Tongli Town	near 100%	near 100%	near 100%	near 100%	–

Table 2.2 Targets for renewable deployment, by technology, in Suzhou City, and Tongli Town, by 2020

	Solar PV generation	Onshore wind generation	Biomass generation	Solar water heaters *	Biogas output	Geothermal**
Suzhou City	250 MW	10 MW	50 MW	85 000 m^2	250 000 m^3	15 000 m^2
Tongli Town	121.6 MW	–	–	–	–	1.9 MW

Source: NEA, 2016; IRENA, 2018a.

Note: * By area of collectors; ** Includes groundwater- and sewage-sourced heat pumps, by heated building floor areas.

Other targets include reducing per capita energy consumption by 11% and building energy intensity by 10% and limiting government-owned institutions' energy consumption to 210 000 tons of coal equivalent (tce) (Suzhou Municipality, 2017a). Achieving these targets in Suzhou would not only drive the sustainable transition of this city but also provide a model for other industry-intensive cities to follow. Renewable energy policies, along with energy efficiency measures, support Suzhou's climate pledges and renewable energy targets.

Regulator

Like dozens of other Chinese cities, Suzhou decided to ban coal burning due to air quality concerns in all its districts and towns in early 2017. Suzhou even went one step further to ban all heavy polluting fuels, including oil products. The construction of new boilers using such fuels is prohibited, while most existing boilers were to be phased out and replaced by cleaner fuel-burning technologies by the end of 2019 (Suzhou Municipality, 2017b). Selling these fuels is also outlawed. Cleaner fuels are defined as natural gas, liquid natural gas (LNG), electricity and renewables.

Several renewables-based solutions and energy efficiency measures have been identified for deployment in Tongli Town. These include:

- Securing the town's energy supply through the utilisation of derived hydropower, local megawatt-scale solar PV plants and natural-gas-sourced trigeneration;
- Deploying more local distributed renewables, including groundwater-sourced heat pumps (for heating and cooling) and distributed solar PV generation in collaboration with mini-grids;
- Improving power infrastructure in the historic town centre, including the grid network, electricity distribution and local energy storage capacity;
- Setting up energy efficiency measures in the building sector and green transport;
- Supporting renewables-related technology innovation and companies that provide relevant solutions.

Financier and awareness-raiser

Apart from the FiT defined by NEA, Suzhou Municipality subsidises distributed solar PV generation. In all districts and towns of Suzhou, households, businesses and industries investing in distributed solar PV projects are eligible for a FiP, set at CNY 0.05/kWh (around USD 0.007/kWh), on top of NEA's FiT. Moreover, the distributed solar PV projects not eligible for FiTs have the chance of receiving financial support from Suzhou Municipality at CNY 0.37/kWh (around USD 0.053/kWh), a rate nearly two-thirds that of the national FiT level. These rates are initially guaranteed for a three year period.

Suzhou Municipality also provides financial incentives for renewable energy plant developers and technology innovation companies. Both state-owned and private companies are allowed to develop, own and operate power plants and sell electricity to the sub-branch of the state-owned grid company. According to a recently released policy in Suzhou, companies that have developed and are operating more than 10 MW of new renewables-based power plants in 2018 are eligible to receive financial support from Suzhou Municipality in addition to FiTs. The support is based on installed capacity, about CNY 0.1/watt (around USD 0.015/watt) and up to around USD 300 000 per company (Suzhou Municipality, 2018d).

ROLES OF TONGLI TOWN

The town government of Tongli is the main body responsible for defining strategy, setting targets, as well as implementing development plans and related policies in collaboration with Suzhou Municipality. Tongli Town is part of one district (of the total six districts and four county level cities) under Suzhou City, and therefore two administrative layers below the Suzhou municipal government.

Target setter and planner

With higher-level political support, Tongli Town's government released its *Development Plan for a New Energy Tongli Town* in 2016, which is different from Suzhou's development plan. It aims to deploy renewable energy, mainly from hydro-sourced electricity derived from western China, as well as some distributed solar PV and wind demonstration projects and electric buses, and become a national front runner in sustainable development (Suzhou Municipality, 2018c).

The plan set 2020 targets for the historic town centre (100% share of new energy in total final energy consumption) and for Tongli Town as a whole (a 20% share) (NEA, 2016). Approaches to the two targets are slightly different. For the town centre, the focus is on electrifying the buildings; replacing all primary energy (coal, petroleum, diesel, biomass and other) used in cooking, heating and cooling with electric appliances powered by derived hydroelectricity; and deploying a fast-charging EV station, 4 electric bus-charging stations and 60 regular EV charging stops.

Tongli

The larger area of Tongli Town, by way of contrast, aims to draw half of its renewables from local sources and the other half from hydropower derived from western China. According to the local government, the local renewable energy potential includes 121.6 MW of distributed solar PV, 1.9 MW of water-sourced heat pumps for heating and cooling as well as biomass consumption (around 4 400 tons of coal equivalent).

Tongli Town has already achieved some of its targets for renewable energy. The 2020 targets for both the larger Tongli Town and its historic town centre were achieved in 2018. Thus, Tongli Town achieved its target of 20% new energy use. The town's full electrification, and a planned move away from traditional fuel in the transport sector, requires further support. The benefits are both financial and social. For instance, a restaurant in the town centre used about 20 kWh in its kitchen after electrification, indicating a USD 2.5 daily bill, which is much lower than the USD 8[8] paid for the use of natural gas, petroleum and coal before the installation of electric cookstoves. Social benefits include less air pollution and reduced fire hazard for kitchen workers.

Enabling factors include the availability of derived hydro-sourced electricity as well as the absence of heavy industries for which the electrification of heating could be much more challenging. Moreover, Tongli's success has benefited from collaboration with others; to achieve the targets for the entire town, Tongli's development plan was combined with that designed for part of the Wujiang District, another area in Suzhou City. Wujiang has more industries, so the combined plan expects to utilise the local renewable industries of Wujiang District to provide tailored plans and solutions for Tongli's deployment of renewables.

Financier and awareness builder

The development plan also outlines actions and demonstration projects to support the targets. These include the electrification of heat uses in households and restaurants, an energy service centre hosted by the utility running the grid, and a demonstration project in the buildings sector.

Suzhou

8 Based on the estimation of its previous monthly consumption: USD 150 for petrol, USD 70 for LNG and USD 30 for coal.

Tongli Town's pilot electrification project has expanded from a focus on dozens of restaurants and hotels in the historic town centre to more districts of Suzhou City, which has replaced the traditional gas-fired oil or coal-fired cookstoves with electric cookstoves in more than 150 restaurants and hotels by 2019 (SGCC, 2020; Zhang Cong, 2020). The local branch company of SGCC has taken actions to improve the grid network and capacity, thus enhancing service access and quality. Since 2016, all low-voltage grid networks in the historic town centre have been upgraded to meet the energy needs of restaurants and hotels without fire hazards from inadequate grid networks and distribution lines. While Tongli's electricity mix is still not 100% renewables based, the share of renewables in the grid is planned to increase.

In addition, the town's several demonstration projects include an international energy transition forum co-hosted by NEA, Jiangsu provincial government and IRENA (see Box 2.5).

It is difficult to estimate the total investment thus far. Suzhou Municipality and Tongli Town invested in most of the demonstration and pilot projects, in collaboration with SGCC and the Jiangsu provincial government, while the FiTs and additional incentives for technology development come from NEA and other related ministries. The procurement and operational costs of electric cookstoves and water heaters were borne by households and businesses.

BOX 2.5 DEMONSTRATION PROJECTS IN TONGLI TOWN: SGCC'S ENERGY SERVICE CENTRE AND A PERMANENT VENUE FOR AN INTERNATIONAL ENERGY TRANSITION FORUM

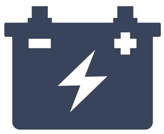
The State Grid Corporation China (SGCC), the country's largest state-owned grid company, has collaborated with Suzhou Municipality to build a comprehensive energy service centre in Tongli Town. The service centre is the office building of the SGCC branch company, on the north side of the historic part of town, and demonstrates renewable technologies deployed in Tongli, including small-scale solar PV, low-speed wind generation and a groundwater-sourced heat pump, among others (SGCC, 2018). New technologies like photothermal power generation and liquefied air storage have also been deployed for heating and cooling (Feng, 2019). SGCC also set up a self-use EV charging station, a wireless charging road and a passive building.

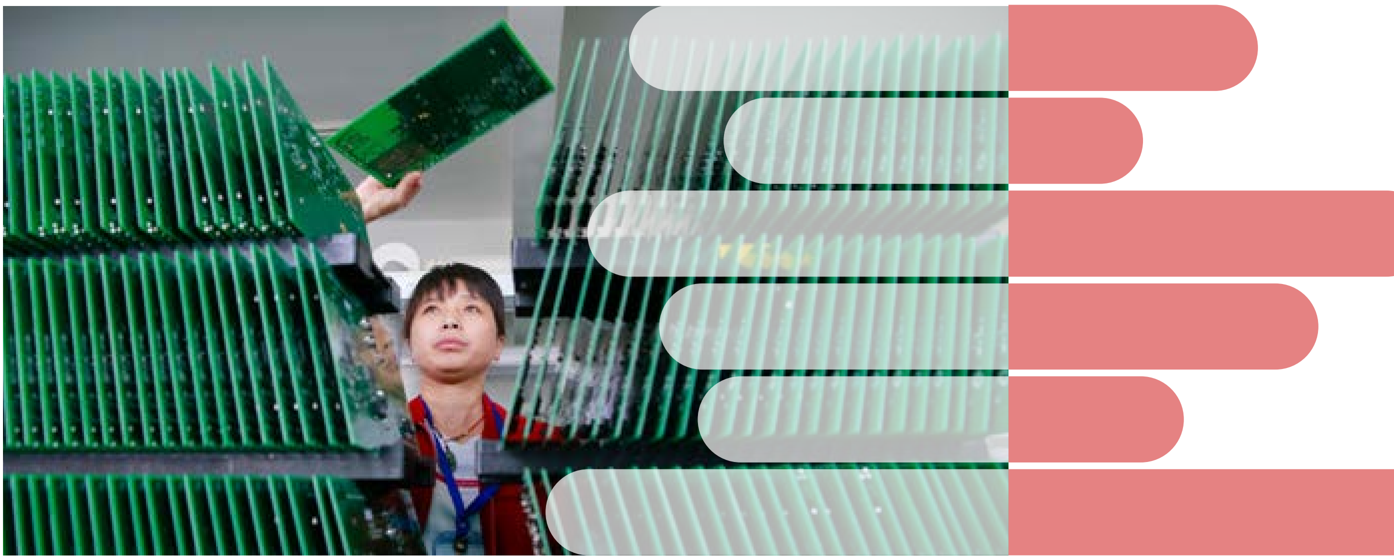
In collaboration with Suzhou Municipality, Tongli is also building a permanent venue for the International Forum on Energy Transition, which was co-hosted by the NEA, Jiangsu provincial government and IRENA in 2016 and 2018 (Suzhou Municipality, 2016).

THE ROLE OF SUZHOU-BASED RENEWABLES MANUFACTURERS

Renewable energy-based manufacturers play a role in the deployment of renewables locally. As one of China's most industrialised cities, Suzhou City is seeking to shift its conventional manufacturing industries to renewables and other strategic emerging industries. Solar PV manufacturing is a key industry asset. The city is also home to more than 70 manufacturers covering the entire supply chain, especially battery storage and PV panels and modules. Their numbers include two of the world's leading solar PV manufacturers of module products and supply. Related industry branches manufacture EVs and batteries.

This industrial cluster suggests high local political awareness of available RETs, and a local government highly motivated to promote renewable energy products. Under China's taxation system, tax receipts from local companies account for a sizable portion of municipal government revenues, providing municipalities with incentives to promote local industries. Many municipalities promote renewables projects, such as in solar and wind generation, heat pumps and electric vehicles. This includes support of local industries to procure solutions and products from local manufacturers that contribute to the local economy and jobs. The availability of renewable energy products manufactured locally also adds to their cost advantage, which in turn supports the local government's interest in promoting these technologies. This is a win-win situation for both sides, and renewable energy deployment in Tongli clearly benefits from this.





LESSONS LEARNT

Electrification strategies support scaleup of renewable energy and improve the urban environment

Chongli and Zhangjiakou as a whole benefit from the availability of large-scale renewable energy projects, in particular wind and solar PV. This level of already existing deployment provides a solid base for more ambitious targets than would be possible in cities where renewable energy has yet to begin to feed into the local energy system.

Electrification strategies can support the scaleup of renewable energy. Cities, towns and districts can be important laboratories demonstrating the feasibility of policies supporting electrification nationwide. Redundant wind power capacity for heating addresses both the problems of wind curtailment and coal burning for heating. Overcoming challenges such as unclear trading rules and limited motivation for power plants to participate in local electricity trading will be critical. Greater flexibility in the electricity pricing system can support this objective.

Tongli Town's tourism industry also benefits from the electrification of end-use sectors. With more tourists visiting every year, Tongli demonstrates that the pursuit of innovative energy solutions not only saves money but also increases the safety and security of its residents and visitors, and significantly improves the quality of tourists' experience through better air quality and less environmental pollution.

Access to financial resources is critical for rapid, effective action

Chinese cities clearly benefit from the availability of financial resources targeting renewable energy deployment. Tongli Town receives financial support from its upper-level administration, the Suzhou municipal government, which has one of the largest government revenue streams of all of China's cities. Given the high upfront investment and long payback for grid networks and related infrastructure, Tongli's example is most replicable in developed cities similar to Suzhou. Cities and towns with limited financial capacity or low shares of renewables in the grid may find it difficult to emulate this example. Zhangjiakou City is not as rich as Suzhou, but its Chongli District received financial support from the national government in the context of the Winter Olympic Games.

Distributed renewable energy technologies are becoming more important

Tongli Town's example also reveals that distributed renewables could play a much more significant role in cities. Distributed renewables such as solar PV generation systems could be deployed outside highly populated urban centres, and heat pump solutions combined with urban sewage systems and district heating and cooling networks could reduce the need for urban-centric deployment. Tongli's case, on the other hand, could suit many small towns with relatively low-storey buildings that could realistically be supplied through their limited rooftop space.

Manufacturing industries benefit renewables deployment

Tongli exemplifies the mutually beneficial relationship between local governments and local manufacturing industries in the deployment of RETs. Many Chinese cities and towns have local manufacturing industries for solar PV panels and other parts of the RET value chain. This clustering of industrial production and innovation with cities willing to support innovative industries through deployment policies benefits both local industries and cities themselves through shortened supply chains and lower costs.

Showcase events increase visibility

Showcase events can rally policy making, as in the case of the Winter Olympics in China. Chongli District and Zhangjiakou Municipality have linked local renewables development targets with the hosting of the Winter Olympics in Chongli, thus focusing political attention and financial support on renewable energy projects.

Cross-governmental collaboration counts

One of the replicable success factors in Chongli's ability to raise the share of renewables in end use sectors is its collaboration with upper government levels, including the municipal government of Zhangjiakou and the Hebei provincial government. The provincial government has played a pivotal role in this context by releasing most of the policies for renewables deployment as well as providing subsidies and facilitating an electricity trading platform that is key for Chongli to fulfil its 100% renewable energy heating target by 2022.

Direct policies released by Suzhou municipality include the setting of renewable energy targets, the ban of heavy polluting fuels, subsidies for EVs and the demonstration of buildings integrating distributed solar panels. These are replicable policy instruments at the city and town level, supporting the deployment of renewable energy across various sectors. The collaboration with Jiangsu provincial government and NEA also supports the scaling up of distributed renewables generation and the electrification of the heating and cooling and transport sectors at the regional and national level.

3. UGANDAN CITIES: KASESE AND LUGAZI

NATIONAL CONTEXT IN UGANDA

Uganda is a young and fast-growing country. Socio-economic conditions and pressures arising from demographic trends and rising urbanisation are shaping the demands placed on the country's energy sector. This unfolds against the backdrop of limited access to modern energy services such as electricity and clean cooking fuels. Sustained population growth exerts a lot of pressure on cities. Towns and cities provide better access to services such as health, education, and jobs, all of which attracts people. Uganda's expected demographic changes and rapid urban growth will require co-ordinated government intervention in order to create new urban habitats that are safe, healthy and productive (UN Habitat, 2010).

Uganda has a rich but underexploited renewable energy endowment, including hydropower, modern biomass, geothermal, wind and solar energy. Modern renewable energy has a potentially important role to play in bridging Uganda's parallel needs to facilitate long-term growth and sustainable urban development. Developing renewable energy as part of local urban planning can help support a young, innovative industry with the potential to create jobs and contribute to wider sustainable development goals, while providing safe, clean energy to households and businesses and building productive and sustainable urban living spaces through a more efficient use of energy and natural resources (GOU/NCEP, 2016).

In recent years, the Ugandan government has promoted solar energy through tax breaks and consumer subsidies, as well as rural electrification projects. More than 200 companies, including foreign investors, are active in the Ugandan PV and solar thermal field (Environmental Alert, 2018) and this represents an opportunity to increasingly utilise solar technology in cities as well. At present, IRENA data suggest that at least 3% of Uganda's population benefits from Tier 1 energy access,[9] either through solar home systems or connection to a solar mini-grid (IRENA, 2018b); and more than 6% of the population use small-scale solar systems for basic energy services such as solar lighting (Ibid).

Cities are becoming more important in the deployment of renewable energy in Uganda, functioning not only as centres of demand growth but also as focal points for modern industries and research. As is true for urban areas in other countries, Ugandan cities are regulators, planners, service delivery vehicles and facilitators of development (Ndibwami and Drazu, eds. 2018). These roles have in principle been strengthened through the devolution of political powers during the 1990s, though their day-to-day capability to act varies significantly.

9 The Multi-Tier Measurement of household access to electricity classifies access to electricity into tiers based on the six attributes of electricity supply. As electricity supply improves, an increasing number of electricity services become possible. Tier 1 applies where a household has access to task lighting and phone charging (or radio). See IRENA (2013).

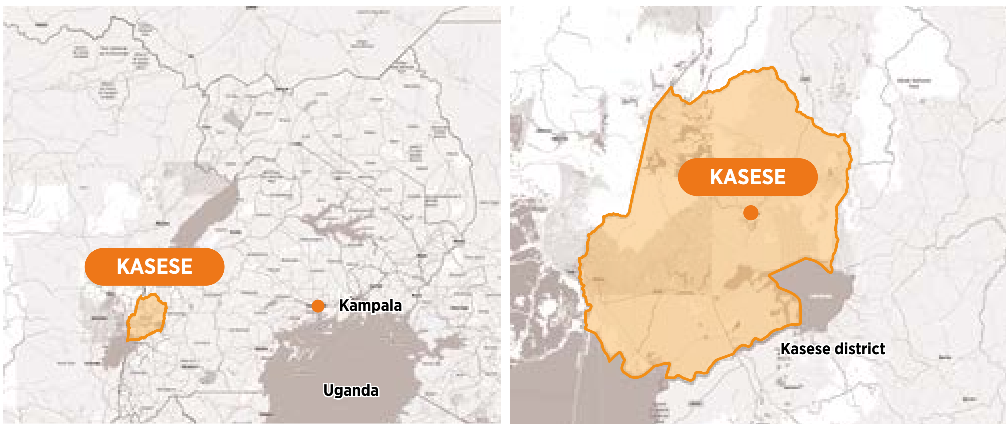
CASE STUDY 3: KASESE

Kasese is a largely urban settlement in southwestern Uganda. With a population estimated at about 130 000 people that includes surrounding rural and semirural areas, governed by Kasese Municipality, Kasese is the biggest urban centre in the Kasese District (Figure 3.1) and the tenth most populated town in Uganda. Historically a trade hub bordering on the eastern districts of the Democratic Republic of Congo, Kasese is also a tourism gateway to the popular Queen Elizabeth National Park and Rwenzori National Park (KDLG, 2013).

Like other parts of Uganda, Kasese suffers from a persistent gap in access to electricity and other types of modern energy. Over half its households have no electricity, compared with estimated nationwide urban electricity access rates of around 60% (SE4ALL, n.d.). Traditional biomass in the form of firewood and charcoal provides a large share of Kasese's non-transport energy needs among households and commercial establishments (McCall *et al.*, 2017; see Figure 3.2). The heavy use of charcoal in particular entails major environmental impediments, in addition to deforestation caused by intense use of fuelwood (Ndibwami and Drazu, 2018).

Both the district government and the municipality of Kasese have been active proponents of local renewable energy deployment in Uganda. Renewable energy is part of the local governance focus on sustainable development, where access to modern energy is seen as vital for progress in health, education and anti-poverty work (KDLG, 2013). International initiatives combined with local stakeholder engagement have carried renewable energy into policy making in Kasese. Key initiatives are explored below in more detail.

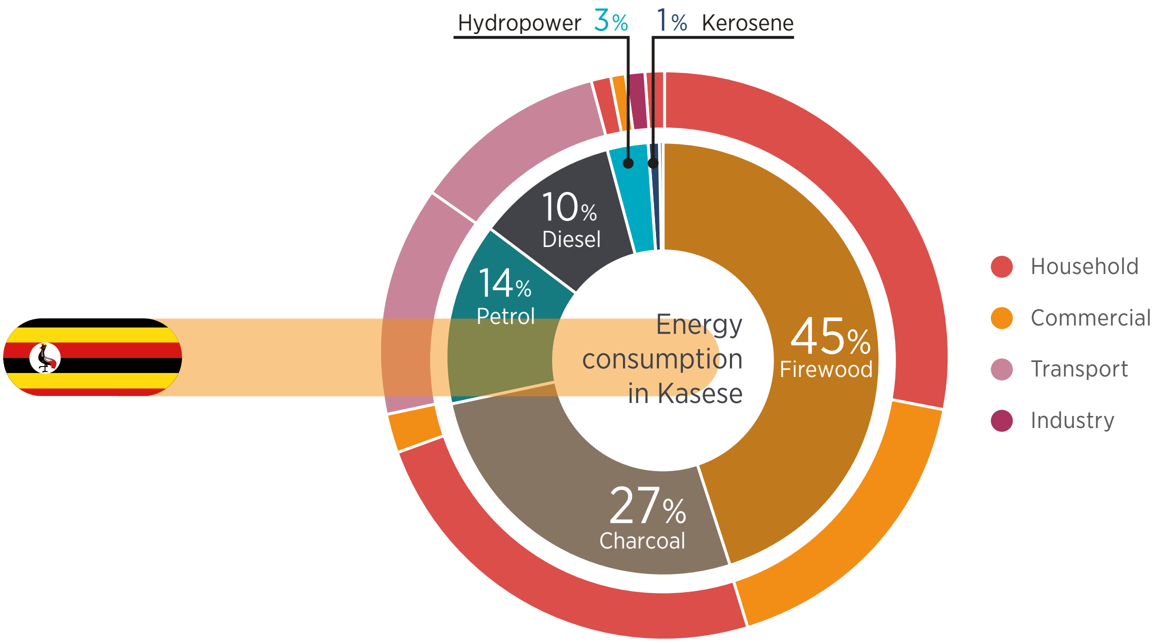
Figure 3.1 Kasese City, 2018



Source: © OpenStreetMap contributors | For visual purposes, maps are on different scales.

Disclaimer: Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

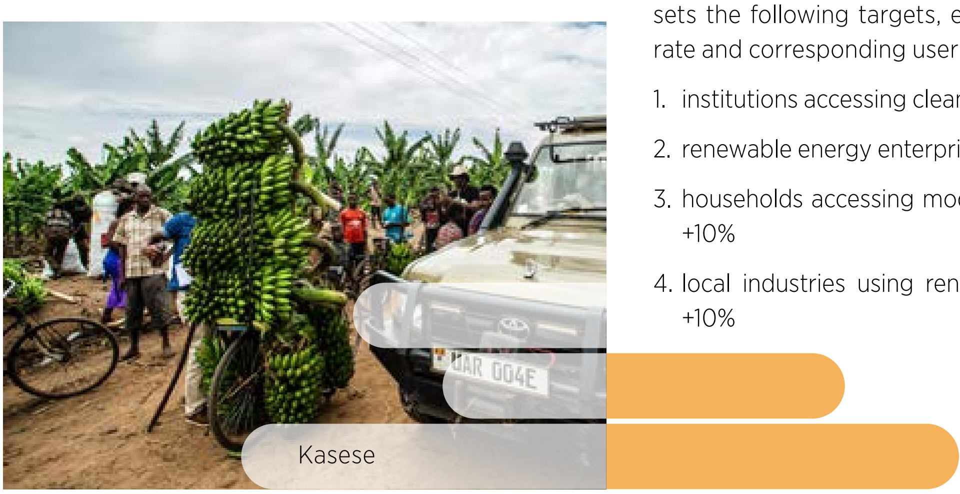
Figure 3.2 Energy consumption in Kasese, by source and sector, 2018



Source: Ndibwami and Drazu, 2018.

THE ROLES OF KASESE DISTRICT

Kasese's district-level government has been instrumental in renewable energy deployment throughout its territory, implementing the Kasese District Renewable Energy Strategy; working with national stakeholders on the regulatory frameworks; and promoting renewable energy district-wide through awareness campaigns and high-level support. The district government cooperates with international partners such as the WWF.



Target setter and planner

In 2012 the Kasese District Council launched the Kasese District Renewable Energy Strategy (KDRES 2013 2020), a 100% renewables programme that brings clean energy services to all local households by 2020 (KDLG, 2013). The programme aims to integrate renewable energy access into all government-funded projects and institutions, including schools, health centres, markets and other public infrastructure. The strategy specifically sets the following targets, expressed in annual growth rate and corresponding user:

1. institutions accessing clean renewable energy: +20%
2. renewable energy enterprises in the district: +20%
3. households accessing modern renewable technology: +10%
4. local industries using renewable energy technology: +10%

The strategy emerged out of the multi-partner Clean Energy Champion District Initiative (CDI) (see Box 3.2), funded by the World Wide Fund for Nature (WWF) through the District Energy Access Programme and now implemented by both the Kasese district local government and Kasese City. The strategy highlights wider socio-economic objectives, aiming for "a socio-economically empowered community accessing and utilising renewable energy technologies in place" (KDLG, 2013).

Despite the special focus on the rural poor, all residents of Kasese District are potential beneficiaries of the district's renewable energy strategy and the CDI. The city has (1) actively lobbied relevant government agencies to abolish or reduce taxes on renewable energy technologies and equipment so that the uptake of renewable energy can be increased; and (2) adopted the district's energy strategy to serve as a guide for its own transition trajectory (Ndibwami and Drazu, 2018).

BOX 3.1 THE CHAMPION DISTRICT INITIATIVE (CDI), 2012–2016

The Champion District Initiative (CDI) was a district-led, demand-driven and multi-stakeholder initiative that promoted renewable energy access at the district level in Uganda. It was implemented between 2012 and 2016 by the World Wide Fund for Nature's Uganda Country Office (WWF-UCO), with technical support from other WWF country offices (WWF-UCO, 2017).

Kasese was selected in 2013 as the initiative's first Clean Energy Champion District. The CDI's ultimate objective was not only to increase access to renewable energy services for cooking and lighting but also to demonstrate solutions that harness renewable energy, increasing efficiency and enabling access to modern energy services for all (WWF-UCO, 2017).

The project included support from a coalition of international development organisations, including Access2innovation, WWF Nordic, WWF China, WWF Global Climate and Energy Initiative and WWF Uganda.

The CDI has made noteworthy progress in meeting its targets to demonstrate the viability of replicable renewable energy access projects. For instance, a 5 kilowatt mini-grid piloted in 2014 under the CDI was developed in the Kayanzi fishing village (see photos) (Nygaard *et al.*, 2018; WWF, 2018), to provide electrical power to households and businesses, mainly for lighting (Pedersen, 2016). WWF-UCO, with funding from the European Union and the Rural Electrification Agency, has also been developing six mini-grids in Kasese and the neighbouring Rubirizi districts to supply electricity to 900 households and 2 000 businesses (WWF, 2018).

Solar mini-grid installed in the village of Kayanzi

BOX 3.2 EXPLAINING SACCOs AND CBOs

Uganda has seen the development of various community-focused organisations that cater to the specific needs of low-income communities.

Uganda's **savings and credit co-operatives (SACCOs)** are financial community-level organisations that provide micro-finance solutions for a variety of local goods and services. SACCOs offer savings opportunities for their members and channel savings into loans that in turn allow micro-level lending. SACCOs are member-driven organisations, where members agree to save their money together and offer loans to one another at reasonable rates of interest. Interest is charged on loans, to cover the interest cost on savings and the cost of administration.

Community-based organisations (CBOs) are non-profit associations that work at local levels to improve the life of residents in all spheres, including health care, environmental health, education and energy.

THE ROLES OF KASESE MUNICIPALITY

Target setter and planner

Kasese Municipality has been an active proponent of renewable energy. Using district-level and international initiatives such as SAMSET as a vehicle, it has promoted renewable energy through its own strategy and self-funded initiatives. The municipality has also been instrumental in providing training in the installation, maintenance and distribution of renewable energy technologies; and fostering partnerships between international NGOs such as the WWF and local entrepreneurial businesses (Mukobi, 2015).

Following Kasese District Renewable Energy Plan, Kasese Municipality subsequently launched its own sustainable energy strategy in 2017 (Ndibwami and Drazu, 2017). The strategy is an outcome of the **SAMSET project** that ended earlier in the decade (see Box 3.3). Kasese's sustainable energy strategy aims to support the municipality's vision of becoming "a well-planned, clean, green and poverty free municipality by 2025", specifically by promoting renewable energy and energy efficiency through direct policy and communication (KDLG, 2013).

The development of the municipal sustainable energy strategy was premised on the availability of various alternative sources, notably solar and hydro, the strong political

BOX 3.3 SUPPORTING AFRICAN MUNICIPALITIES IN SUSTAINABLE ENERGY TRANSITIONS (SAMSET)

In operation from October 2013 to September 2017, SAMSET was funded by the United Kingdom through the Engineering and Physical Sciences Research Council (EPSRC), the Department for International Development (DFID) and the former Department of Energy and Climate Change (DECC). Its objective was to develop a knowledge exchange framework for supporting local and national bodies involved in municipal energy planning in the effective transition to sustainable energy use in urban areas. At the core of the SAMSET project was the promotion of responsible use of and access to clean energy, empowering local communities to thrive on their own (Ndibwami and Drazu, 2017).

In addition to Kasese City, SAMSET involved five other cities in three African countries: Ghana, Uganda and South Africa. Through engagement with universities,[11] businesses and non-governmental organisations, the SAMSET project helped Kasese fill various data gaps in the energy sector; conducted capacity building through various continuous professional development courses; encouraged international exchange visits by Kasese City staff and expanded the municipality's network of contacts both locally and internationally (Ndibwami and Drazu, 2018). The project also resulted in the development of several reports, including reports on existing and projected energy uses and sources, policy case studies, technical briefs and guidelines for implementation of renewable energy across the city.

11 University College London (UCL) administered the programme on behalf of Sustainable Energy Africa (SEA) – Scientific Lead, Uganda Martyrs University, University of Ghana, University of Cape Town, University of Sheffield and Gamos Limited. Project details can be found at http://samsetproject.net/.

will of municipal council leaders and subsequently the support of the mother district, Kasese (Ndibwami and Drazu, 2017). It is hoped that with the strategy's implementation, Kasese City will have not only the tools but also the capacity (the network and a model structure) to position itself as a champion for urban sustainable energy transition in western Uganda (Ndibwami and Drazu, 2017).

The Kasese Municipal Council established a one-stop centre that brings together the government, the private sector, and civil society organisations to showcase opportunities/services that they offer to boost renewable energy financing to local communities. This initiative has attracted banking institutions, the Uganda Revenue Authority, the Micro Finance Support Centre and SACCOs. In addition, Kasese municipality allocated 20 acres of land for interested investors in solar plants (Environmental Alert, 2018), and provided training in the installation, maintenance and distribution of RETs.

Aiming to increase access to solar energy among both residents and small businesses, Kasese municipality has also participated in the Solar Loan Programme run by the Uganda Energy Credit Capitalisation Company (UECCC). UECCC is a government agency put in place to facilitate investments and provide credit support for renewable energy projects in Uganda (UECCC, 2016). With a particular focus on enabling private-sector participation, the company's main objective is to provide financial, technical and other support for renewable energy development in Uganda.

UECCC also runs a credit support facility that finances energy products and/or programmes. In Kasese City and the surrounding districts of Hoima and Kabarole, UECCC has established linkages with grassroots financial institutions such as SACCOs and other micro-finance institutions, in order to extend solar loans to households and commercial enterprises. UECCC's credit support facility encompasses three components:

- **A solar loan product,** available to micro-finance institutions, institutions that accept micro-finance deposits, commercial banks and credit institutions primarily engaged in micro-lending licensed by the Bank of Uganda (UECCC, 2016). The facility is a short-term loan that facilitates the acquisition and installation of SHSs by households and businesses and seeks to overcome the barrier of high upfront costs (Ibid). The value of loans ranges from UGX 100 000 (USD 27), roughly equivalent to a small multi-function solar home lighting system, up to a maximum of UGX 20 million (USD 5 440), which could fund one integrated solar streetlight and a solar water heater. Features of two loan types offered through the financing facility are provided in Table 3.1.
- **A power connection loan programme.** The Government of Uganda's Free Electricity Connection Policy/ Programme has set an annual target of 300 000 grid connections. Because of the progress made in extending and deploying renewable energy in the city, Kasese City was the launching pad for the programme on 14 August 2018. Through its Connection Loan Programme, UECCC has extended financing to households and commercial enterprises in the city, helping to overcome the problem of upfront costs and also subsidising connection costs under the condition that households take charge of their own wiring.[12]
- **A solar vendors' working capital facility.** This facility targets solar companies selling solar systems on pay-as-you-go, pay plan and cash business models in Kasese. Working capital loans support the purchase and import financing of SHSs, including taxes, import duties, transport costs and clearing (Von Hülsen, Koch and Huth, 2016).

12 The distribution infrastructure alone is not sufficient in promoting electrification. One key factor in the electrification equation is the high cost charged by distribution companies to connect a customer, as well as the cost for house wiring. The minimum wiring costs for a small house are estimated at about USD 90 (about UGX 333 498). These expenditures are well beyond the average monthly income of a household, which is less than USD 50 (about UGX 185 276) (Monitor, 2018).

Table 3.1 Features of solar loans offered by Uganda's credit support facility based on two examples

	Cente Solar Loan (Centenary Bank)	POSTBANK Solar Loans (POSTBANK)
Features	• Loan amounts from UGX 100 000 to UGX 20 million for a period of 6–24 months, for up to 70% of the purchase/installation price • Loan application processing within 48 hours • Regular and flexible repayment plans based on borrower's cash flow • Government subsidy for clients located 100 metres or farther from the grid	• No loan amount restriction • Fast loan processing • Flexible repayment period of up to 36 months • No penalty charged on early payments • Individuals will only pay up to 70% of the cost of the solar system; 30% subsidy by the Rural Electrification Agency (REA) • Guarantee on the system (batteries and panels)
Loan requirements	• Proof of regular income • Secured with a combination of securities: moveable, immoveable and guarantors	• Proof of regular income • Cash deposit of 20% of the cost of the loan

Source: Authors' compilation based on original bank documents.

Note: Centenary Bank has partnered with Kasese City and several NGOs in the municipality to provide loans for renewable energy, especially solar and cook stoves, by contributing 50% of the loan pool from UECCC towards acquisition of solar systems and working capital for companies. It also provides a specific loan facility, Cente Solar, to finance standalone solar systems. Dedicated bank staff manage the bank's relationship with UECCC and the REA.

Renewable energy deployment has been supported by national-level stakeholders, particularly in regulatory issues, over which in some cases neither the Kasese Municipality nor the Kasese District governments have authority. While the national regulatory framework for renewables does not in itself target urban development per se, it is an important element of the policy framework under which municipalities operate. The national level has also been instrumental in facilitating the development of financial channels by collecting and providing data and forging of partnerships with international NGOs. Ugandan municipalities have no mandate or capacity in these areas, so effective action at the national level both complements and drives action at the local level.

In addition to political stakeholders, renewable energy deployment in Kasese has benefited from a range of local, district-level and national stakeholders, including CBOs, national and local banks, SACCOs, local cultural institutions and the media.

THE ROLE OF INTERNATIONAL PARTNERS AND NGOS

International partners have been vital to renewable energy deployment in Kasese. Usually funded as part of wider initiatives in sustainable energy and development, renewable energy has benefited from numerous plans and programmes designed, partly implemented and often financed by international partner organisations. Key examples include the CDI and SAMSET initiatives (see above), but also more modest schemes, for instance, CSOs' sub grants that fund instalment payment plans for solar systems (a WWF project).

National NGOs have also played an important part in providing training and financing for schemes to support renewable energy deployment. Examples include the provision of affordable payment options through instalment payment schemes for solar PV panels and improved cookstoves, green business creation, training young people and women and providing minimal start-up capital support for locally produced briquettes, improved cookstoves and tree nurseries. Both of these initiatives were funded by Kasese's Conservation and Development Agency, a local NGO (Ndibwami and Drazu, 2018).

THE ROLE OF NATIONAL RESEARCH INSTITUTIONS

In addition to the above, Kasese's renewable energy plans (most of them at the district level) have benefited from the work of national research institutions on collecting data and providing analysis. Key institutions include the Centre for Research in Energy and Energy Conservation, Centre for Integrated Research and Community Development Uganda and Uganda National Renewable Energy and Energy Efficiency Alliance (Ndibwami and Drazu, 2018). The output of the SAMSET initiative, including Kasese's first Municipal State of Energy Report in 2017, was produced at the Uganda Martyrs University. These institutions fill the gap left by the capacity shortages that local governments are struggling with across Uganda.

CASE STUDY 4: LUGAZI

Located approximately 50 km east of Kampala, Lugazi is the second-largest urban area in Buikwe District, with an estimated population of 126 100 people (UBoS, 2018) (see Figure 3.3). The local economy has historically been dominated by the sugar industry. Only around 37% of households in Lugazi have access to electricity (Mukwaya, 2019). Some 1 100 households (4% of Lugazi's total) use solar home systems and a small number of solar panels has been fitted on roofs of local hospitals, but all in all solar energy remains largely underexploited.

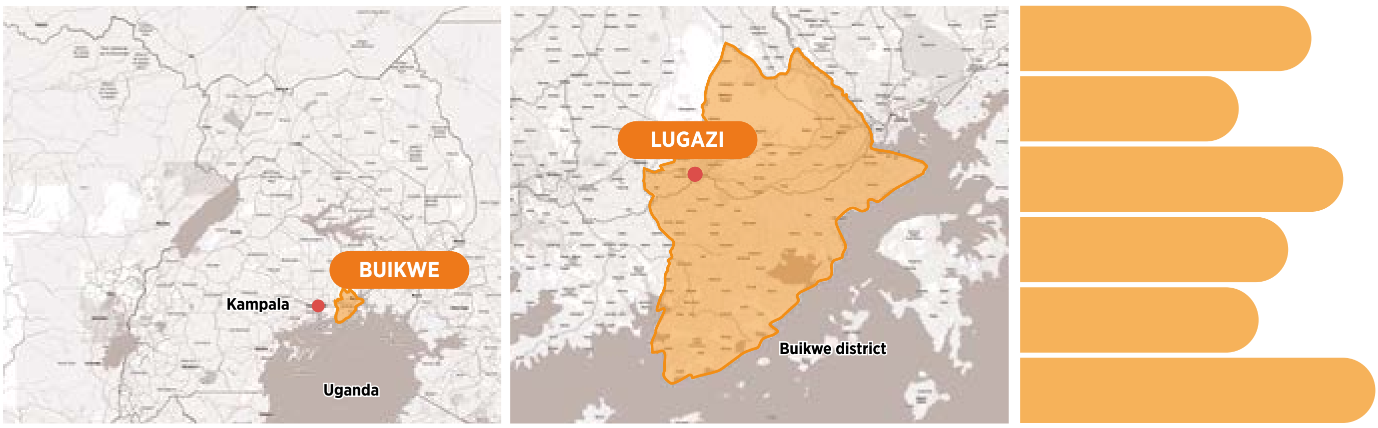
THE ROLES OF BUIKWE DISTRICT GOVERNMENT

Target setter and financier

With support by Lugazi municipality, renewable energy deployment in Lugazi has so far been largely driven by the Buikwe district government's Local District Development Plan. Buikwe District formulated a **District Development Plan (DDP)** in 2015 for the period 2015–2020, with the ultimate objective to improve the quality of life of people, promote sustainable enterprise and achieve a more equitable utilisation of resources (BDLG, 2015). Relevant to the promotion of renewable energy, the development plan provides funds for infrastructure development across the district of approximately UGX 55 000 000 (approximately USD 20 000 in 2015[13]), including for the provision of streetlights for all urban authorities in Buikwe District including Lugazi (see Box 3.4). The plan also aims to promote the use of alternative sources of energy such as solar PV and biogas by 60% of the district's rural population, and to support the acquisition of solar-powered irrigation systems for small-holder farmers.

13 Currency conversion as of 1 January 2015. The Ugandan shilling fluctuates considerably in value relative to the US dollar, affecting the value of foreign development aid and loans depending on the time of disbursement.

Figure 3.3 Lugazi Municipality, 2018



Source: © OpenStreetMap contributors | For visual purposes, maps are on different scales.

Disclaimer: Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

Financier and operator

Another area of direct engagement by Buikwe District is through the installation of solar streetlighting. Solar street lighting has a cost-saving potential while contributing significantly to public safety and an improved business environment (see Box 3.4). The district government has been working with the four urban councils, including Lugazi, on an initiative to install solar streetlights. A study to map the lighting needs of all urban councils across the district by the local government in partnership with a private firm resulted in the 2016–17 Solar Street Lighting Project in Lugazi City, the first of its kind in the municipality.

Twenty-two streetlights were installed with local funds mobilised locally. With solar street lighting, trade in goods and services increased in Lugazi because small businesses and retail activities were now possible after sunset.

Although the installation of streetlights is in its early stages, the district council continues to evaluate the potential to scale up the project to service all areas in Lugazi and in other urban councils (MoFPED, 2018). The Buikwe District government puts the number of streetlights still needed to cover basic needs in Lugazi municipality at 294, of a total of 958 needed across the district (BDLG, 2016).

BOX 3.4 SOLAR STREET LIGHTING IN UGANDA

A 2019 study of solar streetlights installed in Kampala and Jinja found that such lights offer considerable local benefits to the community and businesses. They create safer streets and allow small businesses to stay open for an extra five hours per day. This is particularly important for low-income groups who can now make more money in the day.

The cities themselves save considerable costs compared with conventional lighting systems. The average cost is around USD 1600 per solar streetlight pole, with almost no operating costs, compared to USD 2150 for a conventional streetlight pole, which additionally incurs large electricity bills and higher maintenance costs because their bulbs need to be replaced more frequently.

The study concludes that

> In Jinja, solar street lighting could pay for itself through the money saved on electricity bills and generated from advertising space on poles, with the extra street lighting stimulating economic activity in more parts of the city. In Kampala, this could be particularly significant.
>
> (...) Strengthening the night-time economy in cities by providing safe spaces for workers and street lighting could therefore provide substantial benefits to national governments by stimulating inclusive national economic growth. (...)

Solar-powered street lighting could also be adopted by other urban centres across Uganda as a partial solution to the high electricity costs and low revenue collection that has hampered local governments and the country's decentralisation agenda.

Moreover, the authors find that it would be at least UGX 224 billion (approximately USD 60 million) cheaper to install solar streetlights rather than conventional ones in urban areas in Uganda; and that some 14 000 more jobs could be created nationwide thanks to extended trading hours. This makes solar street lighting a high-potential investment for urban centres in Uganda that would benefit from strengthened policy focus and financing.

Source: Gillard *et al.*, 2019

Lugazi receives funding through the World Bank's Uganda Support to Municipal Infrastructure Development Programme (USMID). This is a countrywide programme that strengthens institutional performance and improves service delivery in urban centres, including road construction and street lighting (see photo). Channelled through the Ministry of Lands, Housing and Urban Development, Lugazi Municipality has been awarded UGX 2.6 billion (approximately USD 685 000) for five years, with payment contingent on annual performance requirements (Kissa, 2019).

THE ROLE OF NATIONAL-LEVEL STAKEHOLDERS

As is the case in Kasese, national institutions play an important role in shaping local energy supply and market structures in Lugazi. National policy frameworks, strategies, projects and programmes shape the deployment of modern renewable energy, and central government financial allocations determine district and municipal finances in the absence of local government capacity. National planning also sets out policy objectives and priorities, offering local governments an opportunity to utilise national targets in local discourse for the purpose of policy making and awareness creation. Renewable energy deployment in Lugazi benefits indirectly from national-level support of national institutions and the private sector such as the Uganda National Renewable Energy and Energy Efficiency Alliance, Renewable Energy Association (solar, biomass, etc.) and Uganda Solar Energy Association. Lugazi's ability to benefit from World Bank funding for sustainable infrastructure projects (USMID) was also determined by national actors, specifically the Ministry of Lands, Housing and Urban Development, which allocates the development funding for districts and municipalities allocated.

In order to make solar equipment more affordable, the Ugandan government has exempted it from value added taxes (VATs) and abolished import duties under the East African Community framework.[14] Through the Rural Electrification Agency, the government recently announced a 45% subsidy, promoted through micro-finance institutions, and NGOs that provide cash payouts to those who install the solar systems and lend money that is paid back in instalments (Kulabako, 2013).

Promotional campaigns of the Ministry of Energy and Mineral Development (MEMD) include an annual energy week and a sustainable energy campaign that aims at promoting demand side management through renewable energy and energy-efficient technologies and practices. The campaign encourages district local governments and urban councils to set up renewable energy policy frameworks to increase the uptake of renewable energy.

THE ROLE OF COMMERCIAL COMPANIES

In the absence of significant policy initiatives in Lugazi, commercial companies have become vital in promoting renewable energy solutions. Facing a local market in its infancy, many of these companies are assuming multiple parallel roles, informing customers about their renewable energy products and financing options and answering questions on product delivery, installation and maintenance.

Recognising that their customers are hard to reach and expensive to serve (subject to disruptions because of their unstable incomes), several solar companies have also taken steps to de-risk solar adoption for businesses and institutions, including through affordable payment plans and flexible credit options. Sunlabob, for example, has been working to electrify 64 schools throughout rural areas of Uganda and has expanded its Solar Lantern Rental System operations into Buikwe District and Lugazi Municipality. Its efforts include training Ugandan technicians.

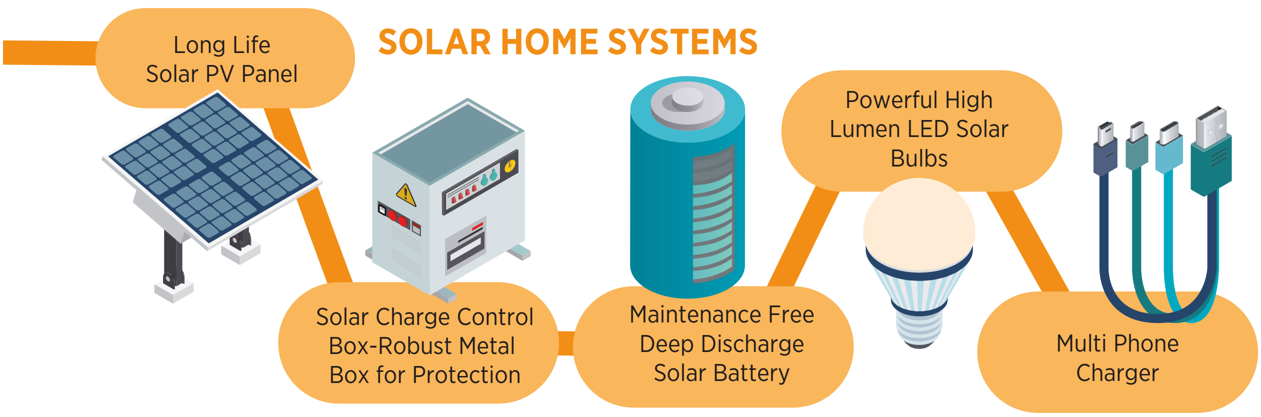
14 Uganda exempts some solar equipment from import duty and VAT, specifically the supply of photo-sensitive semi conductor devices, including PV devices, whether or not assembled in modules or made into panels; light emitting diodes; solar water heaters, solar refrigerators and solar cookers; and solar power generation (UIA, n.d.; URA, 2017). Specialised equipment and accessories for the development of solar and wind energy including accessories, spare parts, deep cycle batteries which use and/or store solar power and plastic bag biogas digesters are also exempt from import duties and taxes under the fifth schedule of the East African Community Customs Management Act. This also includes penstock pipes for use in hydropower projects (UIA, n.d.; URA, 2017).

Several small and medium-sized solar companies, such as Fenix International, SolarNow, Village Power Uganda, M-KOPA Solar, Jyoty Solar Power and Solar Energy Systems Limited design, sell and install solar products (see Figure 3.4) and provide credit schemes specifically designed for SMEs (Kulabako, 2013). While their motivation is commercial, they contribute to local market creation and therefore to the bottom-up deployment of renewable energy solutions.

A particularly successful model promoting standalone solar home systems (in Lugazi and elsewhere throughout East Africa) is a pay-as-you-go (PAYG) financing scheme offered by companies that sell and install PV kits. Customers typically pay in instalments by using mobile phone payment platforms that allow companies to diagnose devices and offer real-time customer support remotely (M-KOPA, 2015). Lugazi City and the Buikwe District local government have expressed interest in gathering energy spending data from key solar companies, to better understand energy consumption patterns and consequently generate realistic development plans based on what municipal residents and customers can afford. A UN Capital Development Fund (UNCDF) study (2019) shows that by 2016, the active number of PAYG customers in Buikwe District stood at about 1 000–2 000, a number that increased by 2018 by about 3 000.

An altogether different project is being conducted by Eco-Fuel Africa (EFA), a Lugazi-based social enterprise. EFA trains low-income farmers, with a focus on women, to turn farm and municipal waste into briquettes and biochar fertiliser and to distribute briquettes to final customers (see Box 3.5). EFA was launched in 2010, having been able to raise some grant capital from organisations like the Energy and Environment Partnership Trust Fund (EEP Africa), the United States Agency for International Development and the Swedish International Development Cooperation Agency (Theron, 2016). It seeks to create a scalable model that addresses deforestation and air pollution. Beyond the direct benefits of the project, a portion of its income is donated to tree-planting initiatives to restore destroyed forests. EFA illustrates that city-based projects need not only focus on urban spaces but can also synergise business ideas that help surrounding areas as well.

Figure 3.4 Examples of solar products for sale in Uganda



Source: Village Power Africa, n.d.

BOX 3.5 7 ECO-FUEL AFRICA (EFA)

Eco-Fuel Africa (EFA) trains marginalised farmers to convert locally sourced farm and municipal waste into clean-cooking fuel briquettes and a product called 'char' using simple, locally made kilns (Clean Cooking Alliance, n.d.). For this purpose, EFA invented a simple technology, which can be used by impoverished communities without access to extensive equipment to convert farm and municipal waste into briquettes and biochar fertilisers. The briquettes, known as "green charcoal", are a carbon neutral cooking fuel made from renewable biomass made with sugarcane waste and husks from coffee and rice production (Gebrezgabher and Niwagaba, 2018). The briquettes function like fuelwood, but they burn longer, are smokeless and cost 20 percent less.

EFA selects its chain actors through partnerships with local community groups, in particular women's groups. At the end of the training, EFA builds a kiosk for each of the women, which they use as a retail shop to sell EFA's green charcoal in their own communities (Gebrezgabher and Niwagaba, 2018; Theron, 2016). The women are further trained in basic bookkeeping, marketing and customer service. They then receive, on a lease basis, the initial machinery needed to launch a briquette micro-factory in their village. Each micro-franchisee can make enough fuel briquettes to meet the energy needs of at least 250 local households. The micro-franchisees sell all the briquettes to EFA, which are packaged and sold to its network of women retailers (Theron, 2016).

Lugazi

LESSONS LEARNT

Renewable energy deployment benefits energy access and many other development goals

Lack of access to electricity in Uganda is not only a rural problem, but also an urban one, experienced by many urban residents, businesses, schools and medical centres. One of the overarching conclusions that can be drawn from these two Ugandan case studies is that renewable energy deployment benefits local communities in multiple ways, pushing progress across a range of socio-economic development goals (see Figure 3.5).

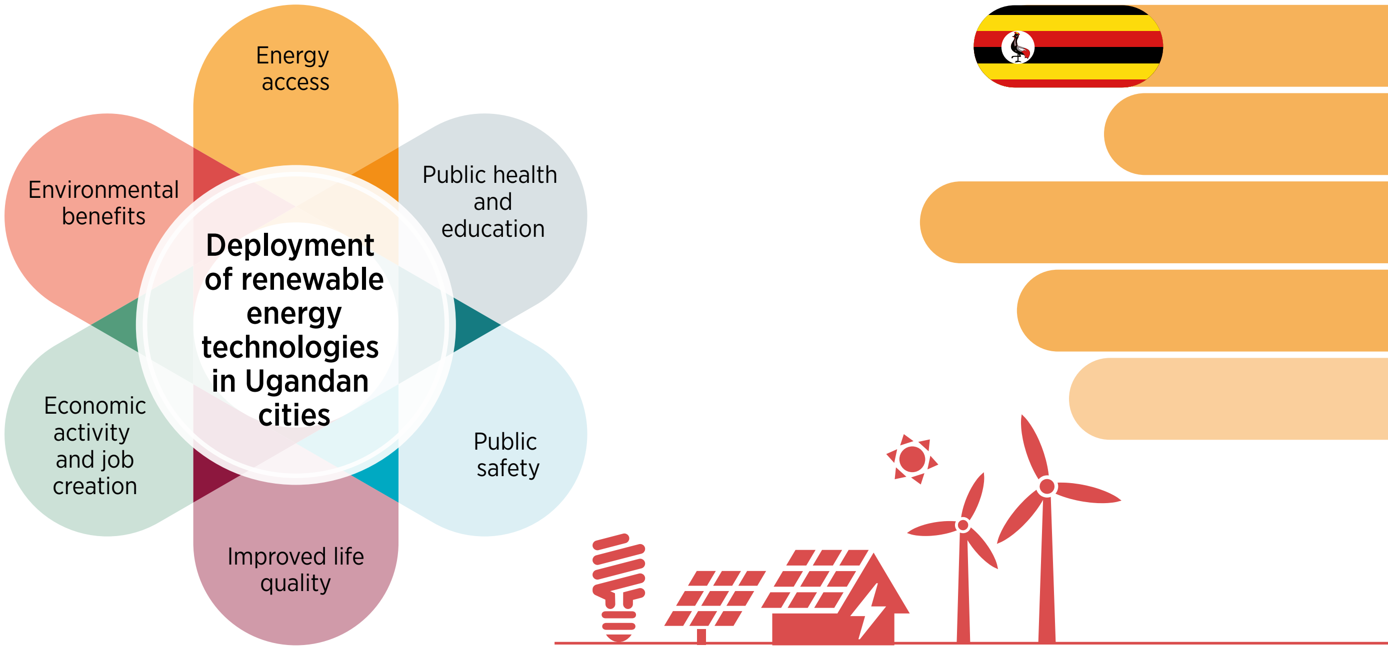
The installation of a few solar panels at Lugazi's public hospital, with a comparably modest investment, provides backup power for lights in operating rooms and for technical equipment, including that used to analyse critical biomedical samples like blood. Solar PV systems are also used to refrigerate medications and vaccines. Solar panels at Kasese District's Hamukungu Health Centre II power a refrigerator to store vaccines for a local vaccination programme. Clean, modern renewable energy, in particular, solar home kits, also reduce the negative health effects of indoor use of traditional biomass and fuels such as kerosene.

Solar lighting allows children to study at home after dark and reduces the time women and children spend collecting fuelwood at the expense of education and paid work. Solar home kits also offer vast improvements to quality of life in these remote regions by powering TVs, radios, and mobile phones. Improved access to telecommunication also benefits local businesses, while solar-powered street lighting helps increase business hours for street sellers. Finally, access to modern renewable energy helps reduce the impact of illegal logging for fuelwood and charcoal, helping protect the local environment.

Deploying renewables in Ugandan cities still face major challenges

Despite the obvious benefits of renewable energy, Ugandan cities face significant challenges in local deployment. Institutional constraints, including limits of political mandates, administrative capacity and local expertise, municipal finances all present obstacles to effective policy action; costs and inadequate information; operation and maintenance challenges and vandalism are additional challenges. This is why, in the absence of

Figure 3.5 Renewable energy benefits in Ugandan cities



Source: IRENA urban policy analysis.

either central state action, or/and international finance and capacity building, Ugandan cities struggle to reach the level of progress that they would clearly benefit from. Experience from Uganda with central state policy also underlines that relying on national policies alone is not enough to deploy renewable energy anywhere near its localised potential, be it in the countryside or, as shown here, in urban areas.

Deploying and scaling up projects will require much more action

Overcoming intrinsic obstacles to city-level renewable energy deployment requires action across the political spectrum, and by a range of social and business actors. A positive national enabling framework that supports and encourages local governments – both at district and municipal levels – to engage in positive change is essential in deploying renewable energy beyond key cities. Both Kasese and Lugazi have fundamentally benefited from initiatives targeting sustainable energy at the district level in particular, illustrating the importance of strengthening local governance through mandates and finances. Local stakeholder engagement and capacity building are both critical in further broadening the basis for deployment, beyond demonstration projects and internationally funded initiatives.

Adequate financial resources for district and municipal governments are prerequisites for effective action. Even though renewables offer cost savings in the medium and long runs, the substantial upfront costs often surpass what funds are available to municipalities and districts. Solar street lighting is a key example where scaling up city-level action across Uganda could produce major economic benefits. Currently, such initiatives are almost without exception tied to third-party financing, such as the World Bank's USMID initiative. Empowering Ugandan cities beyond development finance to engage in critical public procurement of clean energy will require structural improvements to municipal and district funding, as well as local capacity building and training in project delivery and financial management. Foreign partnerships can in turn drive progress not only through financing, but also by helping build local capacity, as demonstrated in the case of Kasese.

4. COSTA RICAN CITIES: CENTRALISATION AND PROMOTION OF E-MOBILITY

NATIONAL CONTEXT IN COSTA RICA

With a population of 5 million as of 2018 and territory of about 51 000 km^2, Costa Rica is the smallest of the three countries examined in this series. A highly urbanised country with some 77% of the population living in cities (Presidencia de la República, 2019a). Costa Rica has one of the highest electrification rates in Latin America going from 47% grid coverage in 1970 to virtually universal access today.

Costa Rica is well known for its high share of power generation sourced from renewable sources – 98.5% as of 2019 – based on hydro, wind and geothermal projects. This stands out internationally and in Latin America. In 2019 the Government passed a national plan to make Costa Rica one of the world's first fully decarbonised economies to reach net-zero carbon neutrality by 2050 as established in the Paris Agreement on climate change.

The already high share of renewable energy in Costa Rica's power sector implies that debates around deployment differ from countries where renewables contribute a minor portion of national electricity supply. Instead, key national challenges include the need to balance demand and supply so the overall mix of power sources can respond to variable hydropower generation. There are also questions relating to the role played by the public and private sectors and the degree to which electricity generation should be based on centralised and decentralised sources. Electrification of the transport sector, pursued in order to meet GHG emission reduction goals, will inject a new dynamic into the power sector.

The dominance of fossil fuels in transport

While Costa Rica is exceptional in terms of electricity generation based on renewable sources, its end-use sectors are, like those of most other countries, heavily reliant on fossil fuels, particularly oil for transport. Oil represents nearly 70% of energy consumption and is therefore the primary source of carbon emissions given its growing use in passenger and freight transport (Presidencia de La República, 2019b). The carbon dioxide (CO_2) emissions generated by the combustion of gasoline and diesel grew 43% between 2002 and 2012.

Instead of attempting to substitute imports with domestic supplies, a strong consensus has developed in favour of a moratorium on domestic oil exploration and exploitation. As maintained by five successive presidents from three different political parties since 2002, the Alvarado administration recently extended the moratorium to 2050, and a bill in Congress (Expediente No. 20.641) would make this ban permanent (Poder Ejecutivo, 2017).[15] An opinion poll by the State of the Nation, an independent academic entity, showed active citizen backing for the ban on oil drilling (Estado de la Nación, 2017).

15 The official name of the bill is "Ley para avanzar en la eliminación del uso de combustibles fósiles en Costa Rica y declarar el territorio nacional libre de exploración y explotación de petróleo y gas". The proposal aims to terminate the previous law on hydrocarbons (Number 7399, from 1994). The official text is available at: https://www.imprentanacional.go.cr/pub/2018/06/29/ALCA125_29_06_2018.pdf.

For years the energy and transport debates have taken place on separate tracks, but the National Energy Plan 2015–2030 set joint goals for the first time to decrease dependence on oil by calling for cleaner forms of transport and fuels. In 2018 a law to promote zero emission e-mobility was passed. In October 2019, the government presented a set of adjustments in the National Energy Plan to 2030 to accelerate the implementation of actions to decarbonise the economy, in alignment with the National Decarbonisation Plan to 2050.

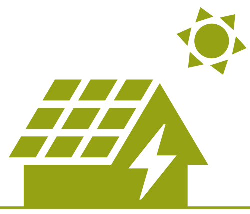
The role of cities in Costa Rica's renewable energy drive

Costa Rica's small size allows it to have a governance structure that is characterised by a high degree of centralisation in political decision-making structures. Administrative units, at the city level, are marked by deep fragmentation. This circumstance severely restricts cities in their ability to make autonomous policy decisions. Costa Rica´s highly centralised model leaves cities with close to no role in generation projects or energy-relevant sectors such as public transport.[16] Their main function is often limited to administrative tasks such as granting permits associated with energy projects. Yet lively debates are ongoing about the need to strengthen the role of cities and municipalities, to decentralise decision-making processes and bring in new stakeholders.

Calls for greater stakeholder engagement in energy policy have emanated from the Ministry of Environment and Energy. In 2015, for the first time, they asked for feedback in preparation for the National Energy Plan 2015–2030 – mostly concerning NGOs, the business sector, political parties and other government ministries. No municipality participated in this process.[17] In October 2019, the ministry shared a draft version of proposed changes with various stakeholders. Municipalities were not formally excluded but in practice they are not engaged in these debates.

In other countries where cities engage actively in energy governance, local authorities make decisions about net metering, community-organised energy projects, provide feedback to national policy makers and propose ordinances. The overarching goal tends to be to promote renewable energy. Because the share of renewables in power generation is nearly 100%, municipalities have not been tasked with roles seen as routine in other countries – for example, setting up renewable energy targets, regulations to promote renewable energy use, fees and taxes as incentives for greater renewable energy or engaging in citizen campaigns to encourage citizen use of renewable energy.

While ICE has no history of external stakeholder engagement in electricity sector planning and policy design, its national expansion plan for 2018–2034) offers a vision of a globalised society that is responsible, inclusive and sustainable, with smart cities discussed as a global trend. Municipalities are listed among the critical counterparts for ICE, along with banks, academia and manufacturers. While working with local governments does not feature in the strategy, this leaves hope for scope to revisit the role of local governing institutions in the future.



16 Cities do have a role when it comes to roads and related infrastructure up to a certain level. Therefore, they have a role when it comes to bike lanes, shared bike systems (one is being tested by the Municipality of Cartago) and exclusive lines for buses. When it comes to vehicles, all decisions are centralised by the national government.

17 The list of participants in the 2015 energy dialogue process are available in Gobierno de La República (2015: 135 – 139).

Costa Rica's decarbonisation plan and its impact on municipalities

Costa Rica is one of the first developing countries to establish an official target to fully decarbonise the economy by 2050 and to publish an official plan for each sector of the economy.[18] Led by the Ministry of Environment and Energy, the National Decarbonisation Plan 2018–2050 envisions three implementation periods (2018–2022, 2023–30 and 2031–2050). It aims to send a signal to the private sector, the public and municipalities by identifying transformation routes for each sector, including areas of work that could open opportunities for city-level action. The actions are presented in ten sectoral focus areas for the next three decades and organised in four clusters:[19]

Because Costa Rica has already effectively decarbonised its power generation, tackling its oil dependence is essential – a challenge mostly centred on the transport nexus. Table 4.1 discusses three focus areas in the National Decarbonisation Plan with direct relevance to transport and sustainable mobility.

Cluster 1. **Transport and sustainable mobility has three sectoral focus areas:**

- Collective transport,
- Fleets and passenger cars, and
- Freight.

Cluster 2. **Energy, green buildings and industry also has three sectoral focus areas:**

- Power sector,
- Buildings and
- Industry.

Cluster 3. **Integrated waste management has one sectoral focus area:**

- Waste management.

Cluster 4. **Agriculture, land-use change and nature-based solutions has, like clusters 1 and 2, three sectoral focus areas:**

- Agriculture,
- Livestock and
- Biodiversity.


Corcovado National park

18 In addition to the Decarbonisation Plan to 2050, Costa Rica's NDC under the Paris Agreement is to reduce GHG emissions by 30% between 2015 and 2030. In response to the Intergovernmental Panel on Climate Change (www.ipcc.ch/sr15/) Special Report on 1.5°C, the government is working on a revised NDC to make it compatible with a 1.5°C target. It will require deeper carbon emission reductions to 2050 and will be revisited in 2030.

19 The plan also establishes eight cross-cutting areas, for example, a green fiscal reform, digitalisation and equitable transition strategies for workers. These reforms are needed to achieve a zero-emissions society.

Table 4.1 Cluster 1: Transport and sustainable mobility in the National Decarbonisation Plan

Three focus areas (out of 10)	Transformational vision to 2050	Examples of mid-term goals
Collective mobility Development of a mobility system based on safe, efficient and renewable energy in public transport, and active and shared mobility schemes.	The public transport system (buses, taxis, rapid transit) will operate in an integrated manner, replacing the private car as the first mobility option for the population. By 2050, 100% of the buses and taxis will be zero emissions.	By 2035, 70% of buses and taxis will be zero emissions and passenger trains will be 100% electric. An increase of at least 10% in trips in non-motorised modes within the main urban areas of the Great Metropolitan Area (GAM).
Light-duty and passenger vehicles Transformation of the light-duty vehicle fleet to a zero emissions one, using energy that is renewable and not of fossil origin.	60% of the fleet of light private vehicles will have zero emissions, with a higher percentage for those in commercial and governmental use. 100% of sales of light vehicles will generate zero emissions by 2050, at the latest.	In 2035, 25% of the fleet will be electric.
Freight transport Promotion of freight transport that adopts modalities, technologies and energy sources that emit zero or the lowest possible emissions.	At least half of cargo transport will be highly efficient and will have reduced emissions by 20% compared to 2018 emissions.	By 2022 the country will have public data on carbon emissions (and certain pollutants) of the cargo truck fleet, and pilot projects will be carried out to increase the efficiency of trucks through an intelligent logistics approach.

Source: Presidencia de La República, 2019a.

E-mobility hence becomes a central pillar of the decarbonisation vision. Costa Rica is a natural candidate for e-mobility for several reasons (Utgard, 2017) (see Figure 4.1). Nearly 99% of electricity comes from renewable sources, and the country has spare power supply. Since most private houses and other buildings have garages, most EV charging can happen there, limiting the need for street charging infrastructure principally for longer trips and for tourist services. And Costa Rica is a small country, where the average driving distance is 35 km per day. This means that even electric cars with limited range can easily be used for everyday driving needs in urban areas, where most Costa Ricans live. Finally, the country's average temperature is 24.7°C, an optimal operating temperature for EVs.

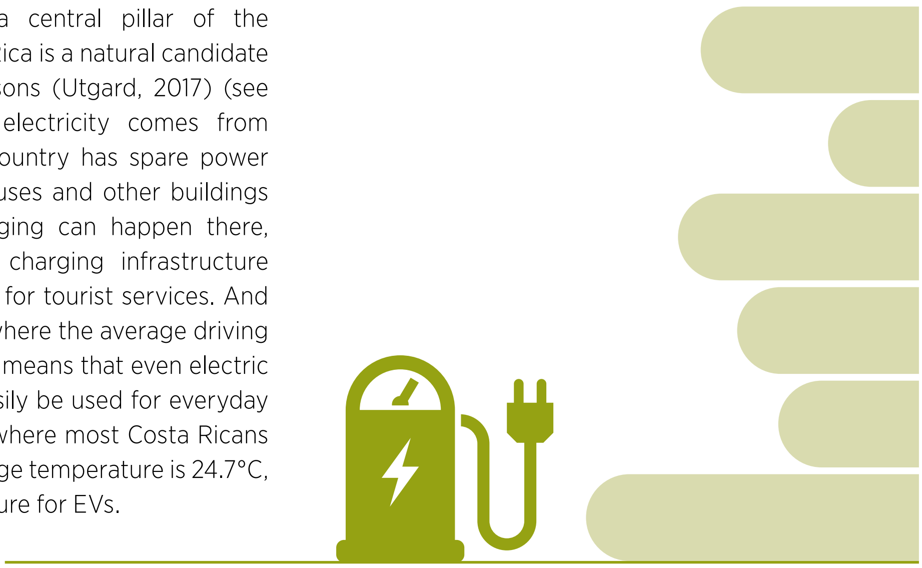
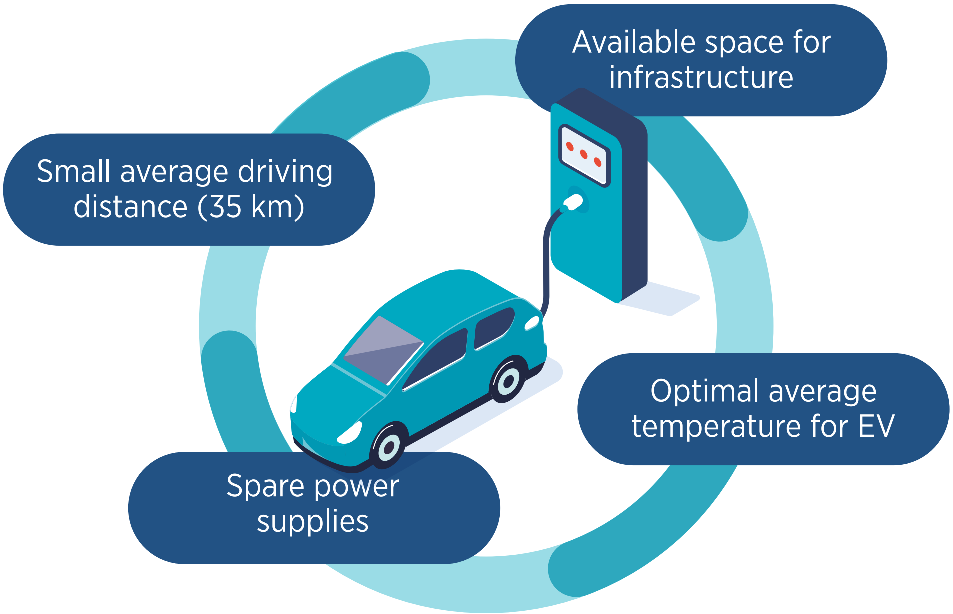


Figure 4.1 Enabling factors for e-mobility



Source: IRENA urban policy analysis.

Table 4.2 Efforts to promote electric vehicles

Public utility EV fleets	ICE acquired 100 electric cars for its fleet together with 110 EV chargers, the largest purchase of institutional fleet EVs in Latin America (Estrategia y Negocio, 2018). Other public entities planned follow suit in 2020 (Blanco, 2020).
Postal zero-emission deliveries	The postal service aims to electrify its fleet of 348 motorbikes by 2023, with an intermediate goal of 70 by 2020 (Presidencia de la República, 2019b).
Electric motorbikes for the police and security companies	The national police force plans to electrify its fleet; a first phase began in October 2019 with ten electric motorcycles (Arce J. M., 2019). One of the leading security companies in the country has electrified half of its fleet and aims to electrify the entire fleet in the future (Marin, 2019).
National insurance company's EV discount	The national insurance company (Instituto Nacional de Seguros, INS) offers a 15% discount on insurance of all EVs (Grupo INS, 2019).
Executive order #41426 to give incentives to second-hand EVs	To complement the *Electric Mobility Law 9518* (focused on new EVs), this decree authorises discounts for second-hand EVs (certain taxes are waived) that are not older than five years and do not exceed USD 30 000 in cost (Presidencia de la República, 2018c).
Banks credit line for electric taxis, e-buses and private electric cars	Three state-owned banks (Banco Popular, Banco National and Banco de Costa Rica) will provide special credit lines for EVs, electric taxis and electric buses that include favourable interest rates and some discounts (Presidencia de la República, 2019b).

Costa Rica has gained awareness of the limits of a highly centralised governance structure. The need to actively engage municipalities in the design of cities of the future has entered the public debate. In concrete, this is observed in the debates about the vision of a "bioeconomy, green growth, inclusion and improvements in the citizens' quality of life" as stated in the Decarbonization Plan (Presidencia de la República, 2019a).

The plan sent a new signal to municipalities. This is because sustainable urbanisation is key to decarbonisation, and the plan's implementation will require a stronger role for cities and local governments. In particular, the 2050 vision for focus area 1 (public mobility) embraces the goal of "compact cities in the main urban areas of the GAM [Greater Metropolitan Area] and a 10% increase of non-motorised mobility in secondary cities) (Presidencia de La República, 2019a).

While the central government has primary responsibilities under the plan and is required by law to make transport-related decisions, the plan sets two goals for municipalities for the 2018–22 period: First, at least three municipalities are to adopt a "transit-oriented development" vision in their planning and management practices, and, second, sixteen municipalities must join the "Carbon Neutrality Program 2.0," designed for companies opened up for municipality participation. This program will be addressed in a section below.

Cartago

In terms of governmental activities during the current administration (2018–22), the focus will be on integrating the decarbonisation imperative into urban planning tools and manuals for municipalities, promoting compact-city models with programmes and incentives for compact-city decisions. A strong emphasis is placed on improving active mobility modalities such as bicycling and walking. There are also new restrictions on cars beyond San José and stricter parking rules. The government commits to include municipalities in decisions concerning bike paths and electric mobility.

CITIES' ENGAGEMENT IN CARBON-NEUTRALITY

In the context of Costa Rica's NDC in response to the Paris climate accord, the Ministry of Environment and Energy has engaged municipalities in the National Program Carbon Neutrality 2.0 by developing a specific programme for municipalities ("Programa País Carbono Neutral Cantonal") (Presidencia de la República, 2017).

The country had set the goal of 16 municipalities measuring their GHG emissions by 2022. Initially, a pilot phase was established for five municipalities and two districts.[20] Between 2018 and 2019, 15 additional municipalities joined the programme.[21] The 22 municipalities participating represent 38% of the Costa Rican territory and 43% of the population (Elpais.Cr, 2019).

Cities played a significant role in developing this programme to track their carbon footprint (Bermudez 2019). Costa Rica´s largest city, San José, found that transport accounts for 55% of its total carbon emissions (Rodríguez, 2019). Transport is also a significant source of carbon emissions in smaller cities (Salazar, 2018); much of this impact stems from vehicles that merely pass through a particular *cantone*, adding to air pollution and congestion but not contributing to the local economy.

IFAM participated in the preparatory consultations for this programme. It is undergoing internal changes designed to better support municipalities in tackling climate change issues, including e-mobility, and has helped link municipalities to international initiatives. This is happening as the Ministry of Environment and Energy's climate change directorate also seeks to engage cities and municipalities in the national decarbonisation plan.

20 Belén, La Unión, Desamparados, Golfito, San José, Monteverde District and Puntarenas District.

21 San Carlos, Cartago, Pérez Zeledón, Pococí, Goicoechea, San Ramón, Santa Cruz, Nicoya, Montes de Oca, Oreamuno, Osa, Quepos, Cañas, Parrita and Zarcero.

CASE STUDY 5: MUNICIPAL ENGAGEMENT IN ELECTRIC MOBILITY IN CARTAGO AND GRECIA

Municipalities could play a more active role in stimulating e-mobility choices, beyond granting permits. Two Costa Rican cities, Cartago and Grecia, have become e-mobility pioneers, and both report broad public acceptance (ASOMOVE, n.d.).

The municipality of Cartago developed a co-operation agreement on e-mobility with JASEC, the Cartago Board of Public Services. In 2019, the municipality initiated the first phase of "Cartago Green Transport", promoting the decarbonisation of transport and educating citizens about the importance of lowering carbon emissions (Calderon, 2019). The strategy involves the following elements:

- **Free EV charging stations:** By working with JASEC and private sector companies, four semi-fast charging stations were installed in the main mall, the JASEC headquarters and two public spaces.
- **EV fleet:** The municipality plans to substitute its internal combustion cars with EVs.
- **Electric bikes:** The municipality acquired 25 electric bicycles for free public use at the train station, the main university and the technical college. Cartago is the only city where a bike path has operated since 2016 and 100 bikes are already available for public use (ASOMOVE, n.d.).
- **Fast chargers:** The installation of fast chargers in collaboration with JASEC started with two units in December 2019, as part of an approved plan government plan specifying locations for fast-charging infrastructure (Municipalidad de Cartago, 2019).

Grecia is home to about 80 000 people in the province of Alajuela, Costa Rica's second-largest province, and the capital city has a population of about 38 000. A campaign to brand the city as "Grecia: We Are Progress," whose mission statement is to make Grecia "a model city and a county of opportunities, under a sustainable and inclusive development approach. With vibrant and progressive people, with participatory citizenship, linked and proud of their identity" (Municipalidad de Grecia, 2019).

The campaign seeks to attract investments and tourism and promote a healthy environment and the use of smart technologies. In 2017, the municipality signed a memorandum of understanding (MOU) with the Korea Advanced Institute of Science and Technology (KAIST) to collaborate on intelligent lighting and EV charging, among other initiatives (Municipalidad de Grecia, 2018). This is the first municipality in the country to install smart parking meters (Municipalidad de Grecia, 2020) as a result of an MOU with ESPH, the municipal company of Heredia, Costa Rica.

The municipality is now taking initial steps to promote e-mobility, including the installation of chargers, acquisition of electric motorbikes for parking meter inspectors and free parking for electric vehicles as suggested by the Electric Mobility Law of 2018.

Grecia

CASE STUDY 6: GUANACASTE AS A DECARBONISATION HUB

Guanacaste is considered Costa Rica's "capital of renewable energy" and sets a precedent for towns outside the GAM. Since the 1990s, Guanacaste generates nearly 40% of Costa Rican electricity and is home to 27 plants with 978 MW of installed capacity. The Arenal, Dengo and Sandillal plants – known as the "Ardesa" complex – form the core of the Costa Rican electric system (Grupo ICE, 2018). The electricity produced in Guanacaste comes from a mix of ICE Group plants, private-sector projects and Coopeguanacaste, the local, independent electrification co-operative.

Guanacaste has hosted several trailblazing projects in the fields of wind, solar and geothermal. The first-ever wind power plant in all of Latin America was set up in the area in 1996. Today, the Guanacaste Province is also home to 16 of Costa Rica's 18 wind power plants. In 2019, the wind parks accounted for more than 11.5% of the country's electricity mix, becoming the second source of production behind hydropower. It is important to mention that as the wind resource is concentrated mostly in Guanacaste, the transmission capacity needs to be increased to distribute the electricity across the country (Teske, Morris and Nagrath, 2020). Similarly, the first PV electricity generation plant in Central America, Solar Miravalles, was installed in Guanacaste in 2012. While biomass barely plays a role in Costa Rica's matrix, two out of the four existing plants are located in Guanacaste: the Taboga and El Viejo sugar mills have been feeding electricity into the national system since the mid-1990s (Taboga, n.d.; FAO, n.d.; Azucarera El Viejo, n.d.).

Cariari

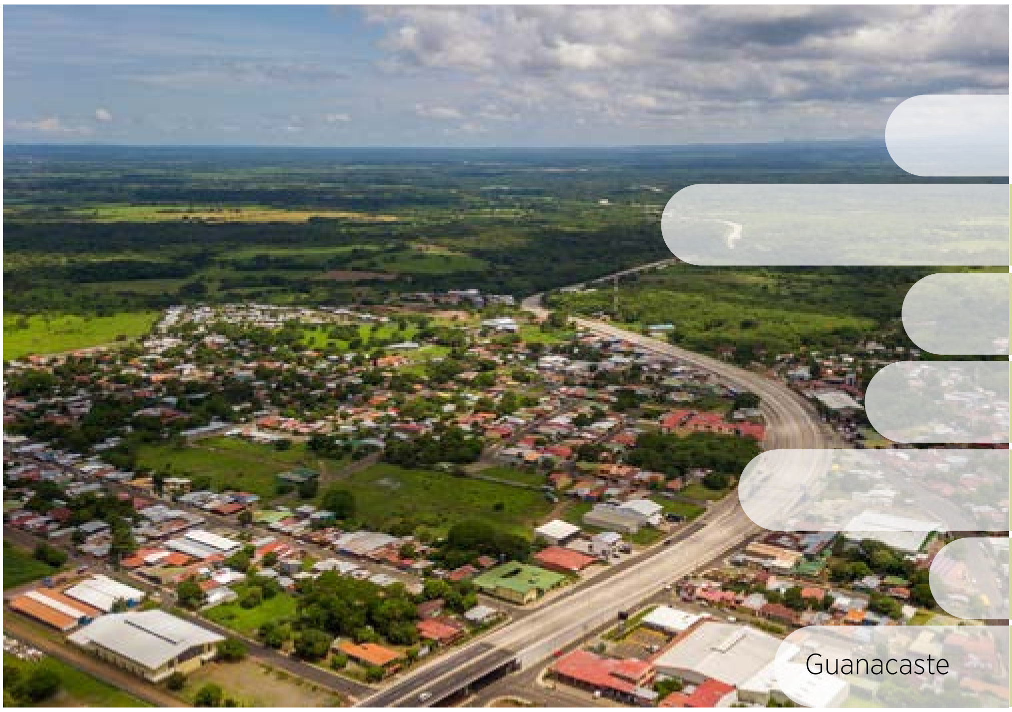
The integration of geothermal and wind has played an essential role in diversifying the electricity matrix. After more than 20 years of studies in Bagaces County, the 55 MW Miravalles I Geothermal Plant was inaugurated. Hand-in-hand with this resource, ICE decided to convert grasslands into secondary forests. Next to the second geothermal field of the country – Las Pailas – today 1 869 hectares of forest are protected and recovered, and species of flora and fauna that had almost vanished amidst livestock and timber are reappearing.

Guanacaste has many solar projects. Coopeguanacaste[22] developed and operated Costa Rica´s largest solar park – Parque Solar Juanilama with 5 GW – which powers 2 100 homes. Occupying 5 hectares and featuring 15 456 PV panels, it generates 9 GWh per year. The project was launched in September 2017 with USD 8.6 million from a private-sector fund, MSEF, resulting from a bilateral agreement between Japan and Costa Rica (Coopeguanacaste R.L., 2019).

22 Coopeguanacaste R.L. provides electric and commercial services to a large area of the Guanacaste Province.

In January 2018 Coopeguanacaste installed the first EV charger in the province to attract EV users to this popular tourist destination (Coopeguanacaste R.L., 2018). Other chargers have since been installed. The co-operative sells electricity and wants to develop new business opportunities around e-mobility. These first chargers signal the co-operative's effort to provide charging services outside the GAM. The ICE Group has also installed fast chargers in this province. Both electricity companies aim to encourage consumers to consider switching to electric options and to signal the emergence of an electric market in Guanacaste. In August 2019, the ICE Group installed the first fast charger outside the GAM at a popular restaurant in Limonal, Guanacaste.

Guanacaste is also at the forefront of Costa Rican forays into developing hydrogen as an alternative transport fuel. An alliance to establish a hydrogen economy grew out of initial efforts by a private firm, Ad Astra Rocket Company (based in Liberia, the main city in Guanacaste), to launch local fleets of hydrogen buses and cars in co-operation with Purdy Motor (Toyota), Relaxury and Las Catalinas. Guanacaste is currently the only place in Latin America where hydrogen cars are being tested (Castro, 2019). Unlike many other hydrogen projects around the world that use natural gas, this initiative relies on renewable energy sources. Ad Astra is also involved in efforts to develop hydrogen refuelling infrastructure in Liberia, with support from the Toyota Mobility Foundation and the Innovation Laboratory of the Inter-American Development Bank (IDB Lab), respectively.[23]



23 This laboratory supports early-stage ventures that can improve the lives of populations vulnerable to economic, social or environmental challenges.

LESSONS LEARNT

Costa Rica has several defining attributes that set it apart from other locations. These include a large percentage of renewable energy sources in power generation and a highly centralised governance structure for both energy and transport. Cities do not make energy and transport decisions, but rather play a marginal role in local decision making and implementation, from power production to the operation of electric bus fleets.

As cities become central protagonists of the efforts to promote sustainable urban practices and liveable cities in many parts of the world, municipalities in Costa Rica, too, may become more interested in taking part in their country's ongoing energy transformation. In many ways, this is also about better urban governance and local choice. Although it is unlikely that cities will be running energy projects themselves, the demand for more decentralised energy systems, and in particular for solar energy solutions, is hardly going to end. Capacity building as part of the GHG inventories under Costa Rica's Carbon Neutrality Programme could be a first step towards empowering Costa Rican cities in developing their own mitigation strategies and playing a more relevant role in the decarbonisation process.

Governance adjustments are more likely in the realm of public transport. As other Latin American cities like Medellin and Cali in Colombia, Panama City in Panama and Santiago in Chile advance with their e-mobility projects – in particular, electric buses – the contrast with Costa Rica (*i.e.*, with its lack of municipal transport authorities) becomes clearer. One possible step forward is to develop the role cities play in waste and building management, including through local policies designed to boost energy efficiency and distributed generation, both pillars of the national decarbonisation plan.

For now, encounters with city representatives elsewhere in the region are informal. Indeed, Costa Rican local governments would benefit from developing sister-city approaches or co-operation agreements that are pursuing similar tasks. The Decarbonisation Plan to 2050 offers a concrete opportunity to rethink the role of cities and make proposals for engaging cities in the implementation of actions in the short, medium and long terms.

Solving the energy-transport conundrum in Costa Rica will require rethinking the role of urban planning and the greening of cities. The current level of centralisation may present a barrier to the successful implementation of the National Decarbonisation Plan. The transformation of public transport holds great promise because of the high cost of the current model.

The integration of e-mobility – given the country's large share of renewable electricity – interfaces with the economic importance of eco-tourism to Costa Rica. There is a need to offer new experiences and value propositions, and zero-emissions tourist experiences open a new space for decentralised, in situ projects where municipalities can engage and perhaps even propose their own projects.

Having a formal, economy-wide decarbonisation plan sent a powerful signal to companies and municipalities. Today the question is how to engage non-state actors and local governments. The current country's administration has prioritised decarbonisation as one of the top pillars of the development strategy, realising that the involvement of the private sector, municipalities and citizens is essential. In parallel, a new ecosystem of stakeholders is emerging around sustainable mobility, cities and climate action.

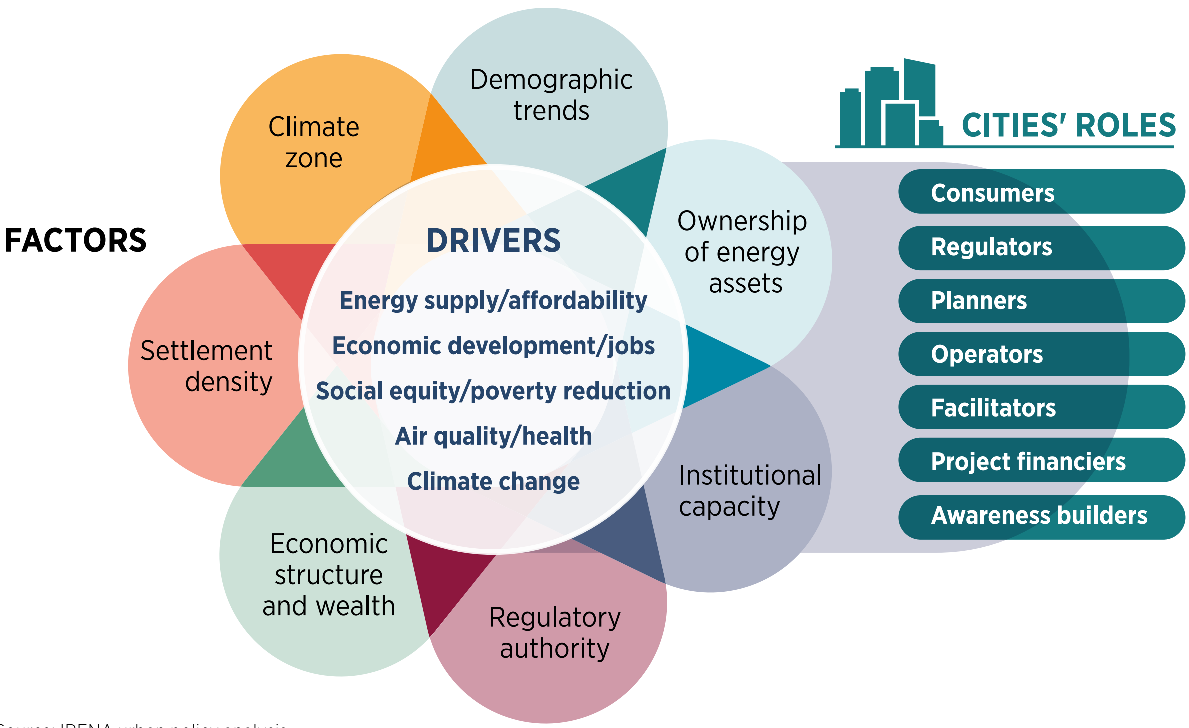
Collaboration with a diverse set of actors is key to success, the Guanacaste "renewable energy" hub – featuring renewables, e-mobility and a hydrogen ecosystem – confirms how critical multi-stakeholder engagement is in pioneering initiatives. In a country where energy and transport decisions are centralised in San José, the Guanacaste developments might pave the way for new modes of attaining renewable energy and clean transport goals in Costa Rica and beyond.

Promoting international best practices among municipalities will be essential: because local governments are weak, learning from other countries and cities will encourage them to avoid mistakes and to learn from successful policies. New initiatives, such as how to promote e-mobility at the municipal level or how to measure emissions, are helping municipalities gain insights into how to manage these emerging agendas.

5. WRAP-UP

Cities are promoting the use of renewable energy even as a complex set of circumstances determines their energy needs and their capacity to act. Diverse factors shape the many roles that cities can fulfil, and diverse factors, likewise, inform the policies actually formulated in pursuit of renewables for electricity, heating and cooling, and transport (see Figure 5.1).

Figure 5.1 Factors and drivers motivating municipal energy policies and shaping cities' roles in the energy transition



Source: IRENA urban policy analysis

Costa Rica

While the particular mix of **drivers and motivations** regarding the energy transition varies from city to city, a secure and affordable energy supply is an objective held in common by all cities. Other drivers include economic development (job creation); social equity (including better energy access and less energy poverty); and air quality and health as vital components of urban quality of life while addressing climate change impacts.

But the needs and capacities of cities are far from uniform. Strategies to promote renewables need to be tailored to each city's specific conditions. These conditions determine whether overall energy demand is growing or falling; they also shape the ability of cities to act.

Some of these **factors** are fixed and therefore impossible to alter. A given city's climate zone shapes its heating and cooling needs, and the zone cannot be changed). Other factors, such as settlement density and the built infrastructure can be altered only over time. Demographic and socio-economic profiles are more dynamic and malleable factors, but cities with rapidly growing populations face greater challenges than those with stable populations, and wealthier cities have greater leeway to act than poorer ones.

Another set of factors concern the institutional capacity and authority of cities to act. Regulatory authority, vis-à-vis national and/or provincial governments varies tremendously. Some cities may have limited powers to generate their own revenue streams or to decide how to spend them. Furthermore, cities may not have the full technical know-how they require. In general, cities that own their own power-generating assets have far more direct influence on energy policy than those that do not.

These background factors and drivers interact and influence one another. Together, they determine the specific **roles** cities can play in the energy transition, whether it be as regulators, planners and operators, energy consumers, project facilitators and financiers, or as facilitators of raised public awareness. These different roles require different policy toolboxes. They are driven by energy and climate ambition, by local institutions' capacity to act, by interactions between energy and other sectors of the local economy and by alliances among different local or non-local actors.

This means that any analysis of cities' renewable energy policies needs to assess not only the local resource endowment (and the technical feasibility or financial viability of projects) but also a range of socio-economic and political factors, including which key actors and stakeholders set the stage for policy making.

The city case studies from three countries featured in this report provide in-depth assessments of specific conditions and circumstances. They indicate that both national and local factors are of crucial importance, both in terms of the challenges and opportunities faced by municipal-level decision makers. Governmental structures in all three countries are quite different from each other, with unique features.

The huge scale of Chinese cities stands out. Costa Rica is tiny by comparison. Still, size notwithstanding, both China and in Costa Rica feature strong centralised governance patterns; in Costa Rica, local administrations are limited in what they can do. Whereas Chinese cities are powered largely by coal, an unsustainable energy source, Costa Rican cities already rely on a renewable source – hydropower – for their electricity needs. Their challenge is to effect an energy transition in the end-use sector of transport. In Uganda, the cities are far more concerned with improving energy access.

Lessons learnt and best practices are worth sharing among cities, domestically and internationally. Indeed, more cities are collaborating with other like-minded cities, and with public and private actors, in peer-to-peer networks devoted to energy and climate objectives. They share information and insights, exchange suitable policies, pool technical capacities and broadly compare notes on lessons learnt.

While a range of policies in support of renewable energy is relevant to cities, it is clear that there is no simple one-size-fits-all approach. 'Replicability' is a familiar term in policy analyses, but real-world replicability has practical limitations owing to the variable conditions and circumstances of cities worldwide.

It is important for cities to ensure that collaboration with national governments is effective and also involves proactive engagement with local residents, community groups and businesses. The mix of local drivers and factors and the way in which various urban stakeholders are being involved shape the roles cities can realistically fulfil. Ambitious policy is critical (as is the local capacity to act). Also critical: a strong understanding of how energy interacts with other sectors of the urban economy.

China

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