International Renewable Energy Agency

# RENEWABLE ENERGY POLICIES FOR CITIES

## EXPERIENCES IN CHINA

CHONGLI DISTRICT

TONGLI TOWN

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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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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# ABOUT THIS STUDY

With their great energy demands and their central role in national economies, cities are critical to the world's overall energy transition. City planners and administrators would therefore do well to acquire the knowledge and skills needed to integrate renewable energy technologies (in addition to efficiency and electrification of buildings and transport) into urban planning and regulations.

To date, most efforts towards energy transitions are taking place in large cities, and they are as a result garnering most of the attention when urban trends are studied. With their larger revenue base, big cities tend to have the regulatory frameworks and infrastructure necessary to scale up renewables and meet emission reduction targets.

Small and medium-sized cities (holding fewer than 1 million inhabitants) frequently lack the requisite access to financing and policy support to advance in this direction. They have far less visibility 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, in combination with the other studies published under the series "Renewable Energy Policies for Cities", 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. 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. Chapter 2 presents case studies of **Chongli District** and **Tongli Town**, in China. The case studies begin with a sketch of the national context and roles of cities. The discussion of relevant initiatives and experiences is followed by a set of lessons learnt. The report wraps up with some broader conclusions.

The findings of this study[1] should, it is hoped, support other countries as they implement their Nationally Determined Contributions, empowering cities to deploy sustainable energy approaches and solutions that can contribute to reductions in greenhouse gas emissions.

The case study outlines the national-level policies that frame renewable energy deployment at the local level and offers a summary of key lessons learnt and considerations for taking solutions to scale. They also synthesise key takeaway messages for policy makers – both at the local and national levels – to help empower cities in their endeavour to contribute to a more sustainable energy future.

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).

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

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# RENEWABLE ENERGY
# AND CITIES

Given that cities are dynamic agglomerations of people and their many activities, they are not easily defined (see Box 1). But it is beyond doubt that urban areas across the world are home to an ever-increasing share of the global population. As of 2018, cities were home to 55% of the total population, up from just 30% in 1950. By 2050, the United Nations (UN) expects that 68% of the world's population will reside in cities (UNDESA, 2018). This rapid 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, spurred by economic opportunities and higher living standards in urban areas. The 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 global energy transition away from polluting fuels and technologies.

Because much of current urban energy supply is fossil fuel-based, cities are major contributors of air pollutants and greenhouse gas (GHG) emissions. Cities are responsible for around 70% of global energy related GHG emissions and are therefore the main driver of climate change (UN-Habitat, 2019). At the same time, cities suffer from high rates of air pollution; according to the World Health Organization (WHO), 98% of cities with more than 100 000 inhabitants in low- and middle income countries do not meet WHO air quality guidelines (WHO, 2016).

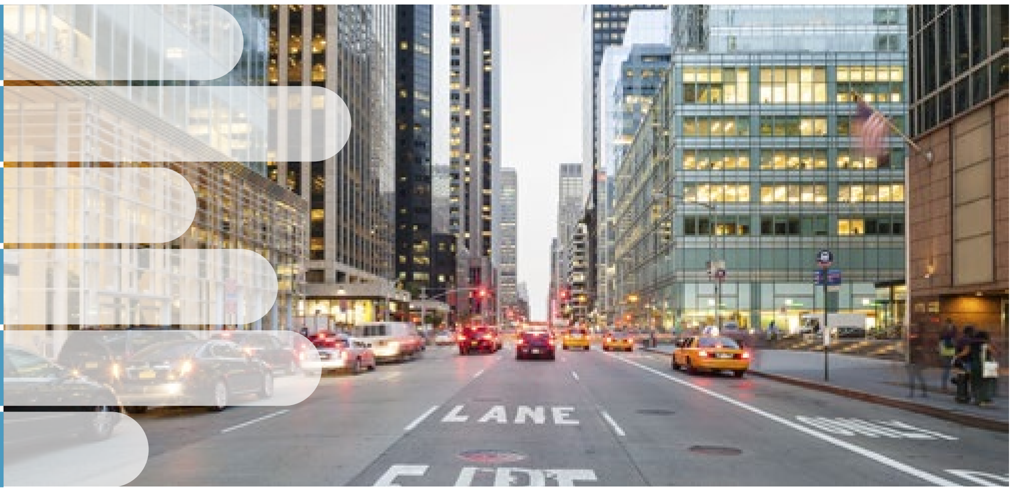
**55%** of the total population are in cities

**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 how urban growth is managed. Climate change poses tremendous challenges to cities' economic vitality and even habitability, due to sea-level rise and the increased intensity and frequency of weather events such as storms, flooding, droughts and heat waves. Hundreds of millions of urban residents will be increasingly vulnerable to sustained extreme heat, which will in turn drive increased use of air conditioning. Their lives will be deeply affected by less freshwater availability, lower major crop yields and more coastal flooding as sea levels rise (C40 Cities *et al.*, 2018). Interruptions in power supply because of these climatic changes are likely to be further escalated by greater demand for air conditioning, particularly in emerging economies where grids are still weak. Mitigation and adaptation efforts will require growing material and financial resources.

As urban populations continue to grow, cities will need to increase the integration of renewable energy technologies (RETs) into power grids and other energy distribution systems to mitigate the effects of climate change and achieve their Nationally Determined Contribution (NDC) targets. Analysis conducted by the International Renewable Energy Agency (IRENA) highlights that while renewable energy deployment measures in the power sector are often developed in the context of national policies, many measures relevant to the end uses of renewable energy, such as in the building and transport sectors, are made at the city level (IRENA, 2016; IRENA, 2017b; IRENA, IEA and REN21, 2018). National policies, meanwhile, shape local action. It is important to build the capacity of cities to identify renewable energy solutions that suit their particular circumstances and needs and to integrate these solutions in planning processes. The next step is to secure the requisite financing.



## **BOX 1** WHAT IS A CITY?

There are multiple definitions of what constitutes a city, owing to the dynamic realities of urban settlements and reflecting a variety of functional and administrative arrangements. Broadly speaking, 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 a very broad array of urban settlements that share some characteristics but may also be 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 in this context differ between countries, leading to significant discrepancies between what is being talked about with regards to a "city" – an urban conglomerate, a "city proper", a geographic or administrative unit that extends beyond purely urban areas for example.

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

Urban areas can be broadly grouped into small, medium, large, and 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. But there is also the reality that 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" populations (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 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).

## MOTIVATIONS AND DRIVERS OF MUNICIPAL ACTION ON ENERGY

Cities, can be important agents driving local renewable energy deployment through measures and initiatives that complement policy at the national level. Municipal energy policy is most directly concerned with securing adequate energy supply, which includes considerations of affordability and choices regarding suitable types of energy sources and carriers. How much energy is needed is influenced by decisions in sectors other than energy:

- Urban planning shapes cities in fundamental ways, strongly influencing the amount of energy (and to some extent even the type of energy) required for all types of urban activities.
- Cities with strong zoning laws and land-use controls can more readily affect settlement density and promote mixed-use development (limiting the segregation of residential, commercial and industrial activities). Such structural factors have decisive influence on energy needs. Individual motorised transportation is difficult to avoid in cities spread out over a large area. Similarly, cities with a preponderance of single-family houses require more energy – both for heating and cooling and for transport – than those where apartment buildings make up a large share of available housing.

Far-sighted urban policy will avoid structural path dependencies that lock in high energy demand, or, where they already exist, will seek to minimise and gradually overcome them.

Cities are often motivated to promote renewables by a number of factors beyond energy supply (see Figure 1). Critical considerations concern the cost and affordability of energy (including energy access and energy poverty issues); economic development objectives (including the ability to build local supply chains and to attract and retain a diversity of businesses) and employment generation.

Social equity considerations – reducing poverty and ensuring that poorer urban communities have access to clean energy solutions – are also central. Concerns about climate impacts are rising in importance, joining long-standing worries over the health impacts of air pollution from fossil fuel use, as well as the desire to ensure liveability and a high quality of life. Climate and air quality objectives add to the urgency of the energy transition. Yet even greater ambition – higher targets for renewables and shorter implementation timelines – may be needed to confront funding barriers.

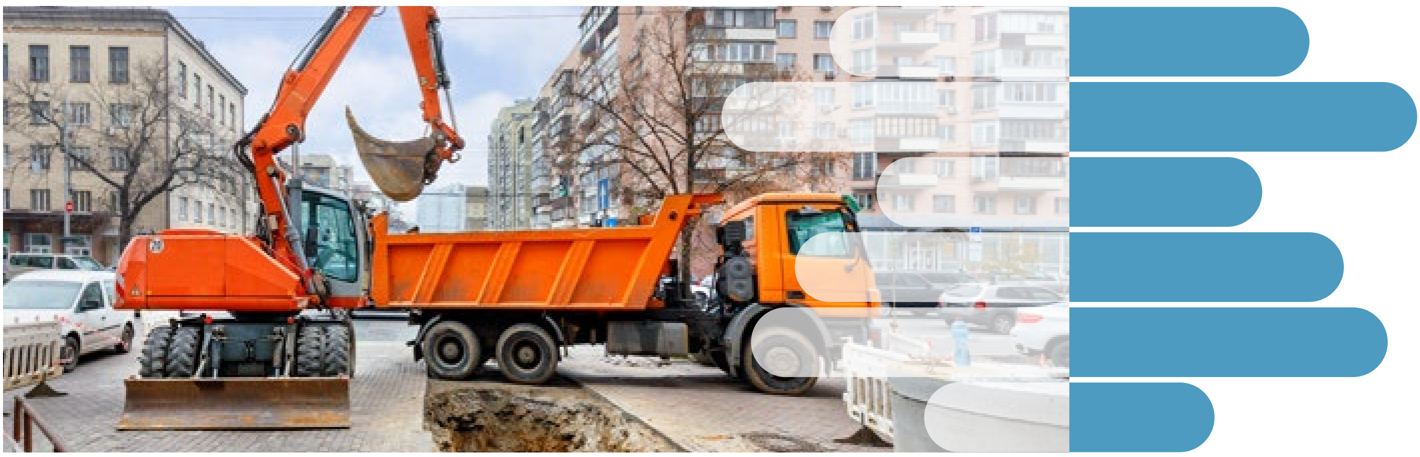
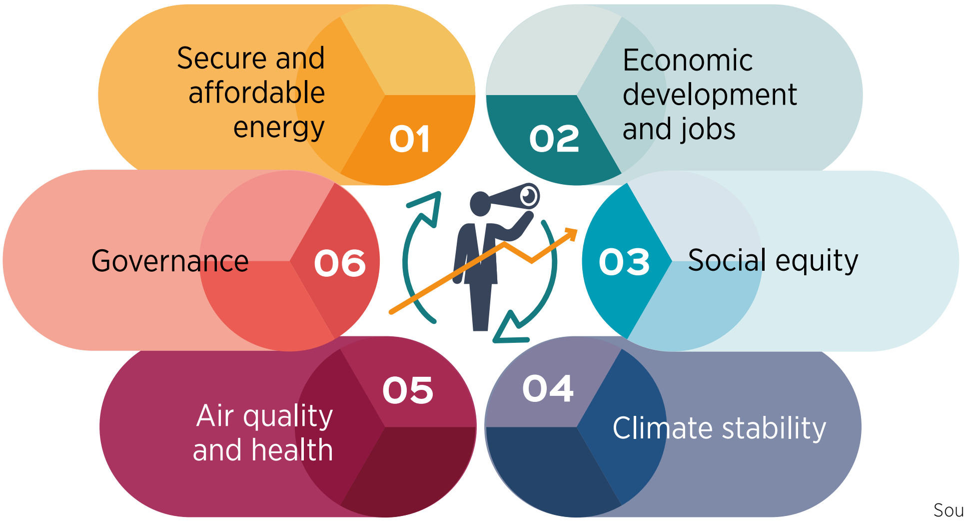


**Figure 1 Motivations and drivers of municipal decision making on energy**




Source: IRENA urban policy analysis.

Energy-related policy making is a complex process involving the diverse motivations of many stakeholders, from local community groups to the private sector. Progress not only requires the formulation of comprehensive plans, but also the resources and institutional capacity for successful implementation. Implementation requires vision, policy coherence and pragmatic co-ordination across various levels and layers of municipal governance.

In advancing the use of renewable energy, cities have multiple roles and responsibilities. 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.

These are highly diverse roles and responsibilities that entail a broad array of policy tools. In some cases, cities have the authority to take policy and regulatory action directly and on their own, whereas others may be able to act only in conjunction with authorities at the national and state/provincial levels or may only have indirect influence through persuasion and awareness-raising.

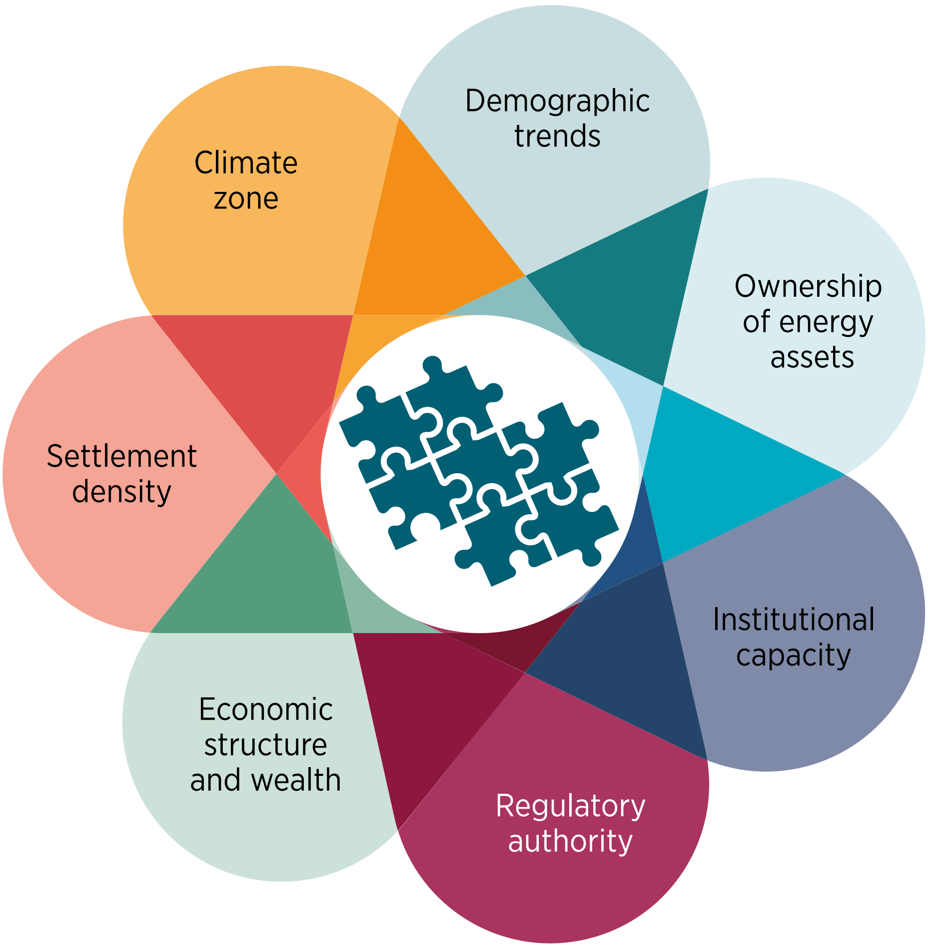
Local energy transition strategies are driven by multiple actors whose significance varies from city to city (and country to country), reflecting different administrative and policy making structures, as well as civic cultures. Mayors, city councils and municipal agencies are key actors in planning, issuing regulations and implementing policies and projects. Utilities and energy companies are other important actors; their roles and influence can vary considerably, depending on whether they are strictly local entities or operate on a larger (provincial, national or international) scale and whether they are under public or private ownership. Regulatory authority and financing needs can give regional and national governments a strong say in urban affairs.

The energy needs of the private sector – manufacturers, commercial businesses and service providers – shape a city's energy demand profile, along with household consumption. Community groups and other grassroots organisations may launch initiatives to urge faster or more ambitious action on the energy transition, but citizens may also express opposition to planned policies and projects. The presence of so many different stakeholders in the urban landscape makes for a dynamic situation.

## MUNICIPAL NEEDS AND CAPABILITIES

Although cities across the world face many similar challenges, their particular circumstances, needs and capacities to act – which are typically a product of their historically grown structures and reflect their various political cultures – can vary enormously. Cities' plans thus need to be tailored to their specific circumstances. Figure 2 provides an overview of the key factors – many of them interconnected – that shape cities' energy profiles.

**Figure 2 Factors shaping city energy profiles**




Source: IRENA urban policy analysis

- **Climate zone:** Individual cities' energy options are conditioned by an array of variables. Some, such as the particular climate zone in which a city is located (dictating heating and cooling demand profiles), are immutable – although advancing climate change triggers new challenges.

- **Demographic trends:** Cities with growing populations confront greater challenges than cities with more stable populations. This is especially the case in urban areas with large and rapidly expanding informal settlements, where energy access is limited or where residents suffer from energy poverty.

- **Settlement density:** Compact cities are able to build attractive public transportation networks, while sprawling megalopolises struggle to make them work and often remain reliant on energy-intensive passenger cars. The extent of mixed-use, transit oriented development influences the amount of energy required for routine human activities. In the building sector, the age, characteristics and condition of the building stock are of great importance to energy use.

- **Economic structure and wealth:** Cities' energy use profiles are shaped in fundamental ways by their economic structures. "Producer cities" with extensive materials processing and manufacturing industries, or those that function as significant trans shipment nodes for global trade, tend to have a large energy footprint. "Consumer cities", on the other hand, may have effectively outsourced polluting industrial activities and feature an extensive service sector. In general, wealthy, economically dynamic cities (*i.e.*, those where a diversified economy supports a major flow of tax revenues) are able to act in ways that poorer cities cannot.

- **Legal and budgetary authority:** Decision-making power over matters that affect urban areas does not always fully rest with municipal authorities. Statutory authority often lies with national energy utilities and national or state/provincial regulatory authorities.

- **Institutional capacity and expertise:** The ability of cities to act is shaped and constrained by the degree to which they either already have, or are able to build, adequate capacity (in terms of planning, implementation, budgetary resources and staffing) and access to required technical and professional expertise.

- **Regulatory power and asset ownership:** The role of private-sector energy providers varies from city to city, influencing the degree to which cities are able to exert control over energy generation in terms of ownership structures, investor preferences, operational authority or regulatory enforcement power. Cities typically do have substantial influence over factors that influence energy consumption, such as spatial planning, building efficiency, urban transport modes, settlement patterns and household consumption practices.

## THE SIGNIFICANCE OF CITIES IN DEPLOYING RENEWABLE ENERGY

IRENA's report on *Renewable Energy in Cities* (IRENA, 2016) identified several dimensions of cities' role in shaping adaptation and mitigation efforts, and as such in accelerating the deployment of renewable energy solutions as a key pillar of national sustainable energy targets.

Cities can be target setters, planners and regulators. They are often owners, and thus operators of municipal infrastructure. Cities are always direct consumers of energy and therefore aggregators of demand, and can be conveners and facilitators, and financiers of renewable energy projects. Finally, cities through their local governments can be important awareness builders, both through existing roles such as target setters and planners, and through their own voice through local media.

The following subsections explore several ways in which cities can promote the use of renewable energy (see Figure 3). They focus on three key sectors of the urban economy, namely, the energy sector itself (production and procurement of energy) and two key end-use sectors, buildings and transport. The discussion draws on selected examples of policy initiatives and experiences from cities around the world which are presented in short text boxes.

**Figure 3 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 significant role in electricity generation and distribution, in some cases after successful 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 entities to generate renewable power from local resources, such as in the United Kingdom, where 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 2).

### **BOX 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 greater efficiency in 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 is the case for other cities in this country, concerns about the reliability of supply (load shedding), rising electricity prices and increasing 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 microhydro generation turbines at water treatment plants that meet 5% of the total electricity used for municipal operations. Cape Town is also one of 18 municipalities in the country that have begun to facilitate small-scale distributed energy projects in the residential, commercial and industrial sectors. Some 274 projects, with a peak generation capacity of 247 kilowatts (kW), had been approved as of early 2018, and more than 2 megawatts (MW) of additional capacity were in the planning pipeline (ICLEI and IRENA, 2018).


Cape Town, South Africa

Even where they do not own energy-generating assets, municipalities can promote the adoption of renewable energy by exercising the purchasing power inherent in their roles as aggregators and regulators of energy demand. Green public procurement has become a widely used term, and the European Union has developed criteria and guidelines for it (European Commission, 2020). Municipal authorities may, for example, adopt clean energy guidelines governing their purchases of electricity, energy for heating and cooling, or transport fuels. By setting targets, adopting labelling schemes or requiring green certificates, cities can influence what kinds of energy sources private providers develop and offer to local households and businesses. In this manner, they may also shape companies' own purchasing decisions, as seen in the growing move towards corporate sourcing of renewable power (see Box 3).

## **BOX 3** CORPORATE SOURCING OF RENEWABLE ENERGY

Companies in the commercial and industrial sector account for roughly two-thirds of the world's end-use of electricity. An increasing number of these companies are committing to ambitious renewable electricity targets to power their own operations, driven amongst other by the steady decline in renewables costs as well as a growing demand for corporate sustainability among investors and consumers. Already in 2017, over 465 terawatt-hours (TWh) of renewable electricity were actively sourced by companies – comparable to the electricity consumption of France. Policies to support corporate sourcing have been introduced in over 70 countries, however, barriers in many markets are preventing companies from sourcing renewables and exercising their full purchasing power.

Cities can play an important role in ensuring that the growing corporate demand for renewables can be met and leveraged to accelerate investments in renewables. Cities can, for example, ensure that enabling frameworks are available to support corporate production of electricity for self-consumption; "green procurement" options should also be available. Cities with utility ownership can directly shape their energy offerings and may consider, *e.g.*, green premium products or tailored renewable energy contracts, such as green tariff programmes. These programmes enable companies to purchase renewable electricity from a specific asset through a longer-term utility contract similar to a corporate Power Purchase Agreement. In the United States, utilities in 13 states and the District of Columbia were offering green tariff programmes as of late 2017. Deals totalling more than 950 MW were contracted over the 2013-17 period through these programmes.

While there is a growing interest from the corporate sector to source renewables, there is still room for companies to strengthen their ambitions and accelerate decarbonisation of their operations. Through long-term renewable energy targets and energy transition plans, cities can encourage companies to further participate in the energy transition while fostering a greener and more resilient business environment, even attracting new economic development.

Source: IRENA, 2018d.

## Expanding the use of district energy systems

District energy is a technology option particularly suited to municipal procurement. Many cities have considerable authority over the generation and distribution of heating and cooling (IRENA, 2016). District energy systems could play a role as enabling infrastructure to achieve better efficiency for dense urban areas and offer opportunities to integrate low temperature renewables such as geothermal heat (IRENA, IEA and REN21, 2020).

Renewable energy at present supplies only 8% of district heat worldwide, a share that would need to rise to 77% in 2050 under an ambitious energy transition scenario (IRENA, 2020d). A few European countries have achieved shares of 50% or more (see Box 4). Globally, 417 solar district heating systems (with a combined capacity of 1.73 $GW_{th}$) were in place in 2019, up from 345 in 2018 (REN21, 2020).

Business and policy models vary, depending on local conditions and priorities, ranging from full public ownership to public private partnerships to private ownership, including models where the owners are also the consumers (IRENA, 2017b; IRENA, IEA and REN21, 2018). The public model allows cities to control tariffs and thus to guard against energy poverty among residents.

### **BOX 4** 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). The development of modern district heating systems and efficient buildings running at low temperatures has paved the way for a greater utilisation of low-enthalpy resources, including from abandoned mines and through heat pumps.

### Installing solar street lighting

Solar PV technology is another key technology suitable for municipal deployment and energy generation. Cities and municipalities can support the deployment of solar photovoltaic (PV) technology, for instance by modernising street lighting. Streetlights account for a significant 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-powered LED bulbs offer energy and cost savings of 50% or more and, with life spans of up to 20 years, are far more durable than conventional lights. They offer additional benefits if they are networked (rather than standalone installations) and combined with smart grid development, 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.).

## CITIES' ROLES IN REGULATION AND URBAN PLANNING

Cities can play a key role in promoting rooftop solar PV in urban spaces. Rooftop solar PV is a dynamic and increasingly cost-effective technology (IRENA, 2017b) whose adoption can be boosted significantly through regulatory requirements, in particular building codes, or through incentives to building owners. The impact of systematic deployment can be significant, as buildings are among the biggest users of energy and contribute substantially to greenhouse gas emissions (UNEP, 2018). For cities, encouraging the deployment of rooftop solar applications through regulatory measures can be a win-win policy that integrates well with parallel local and national efforts to increase energy efficiency. Urban policies in particular promise greater success if they address common barriers to the deployment of solar rooftop solutions (such as a large portion of tenants rather than owners in a building). Box 5 offers some examples of such policies.

### **BOX 5** EXAMPLES OF ROOFTOP SOLAR IN CITIES

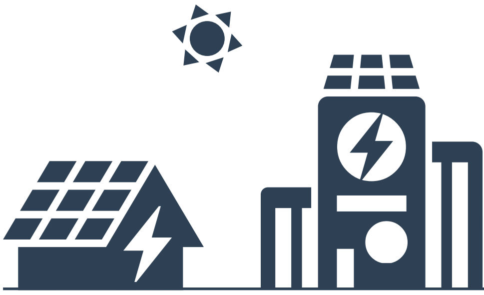
Chinese cities have been at the forefront of solar rooftop efforts. The city of **Dezhou**, in Shandong Province (northwest China), launched its "Million Roof Project" in 2008, requiring that all new residential buildings be equipped with solar water heaters. Solar thermal or solar PV technology is integrated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

Elsewhere in Asia, **Tokyo**, Japan, plans to install 1 gigawatt (GW) of rooftop systems by 2024, including 22 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 (kW) and potential electricity generation (kilowatt-hour, kWh) by assessing solar insolation, rooftop space, roof tilt and shading for each specific home or building (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). 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 (MWh) by 2020 for energy storage, though stringent safety and permitting rules have slowed progress (Maloney, 2018).

## Adopting net metering

Net metering is a billing mechanism that allows consumers who generate their own electricity (*e.g.*, through solar rooftop assemblies) to store that energy in the grid. Production in excess of the generator's own needs can be sent to the grid in exchange for credits, which can be used to pull power from the grid when demand exceeds generation (at night, for example).



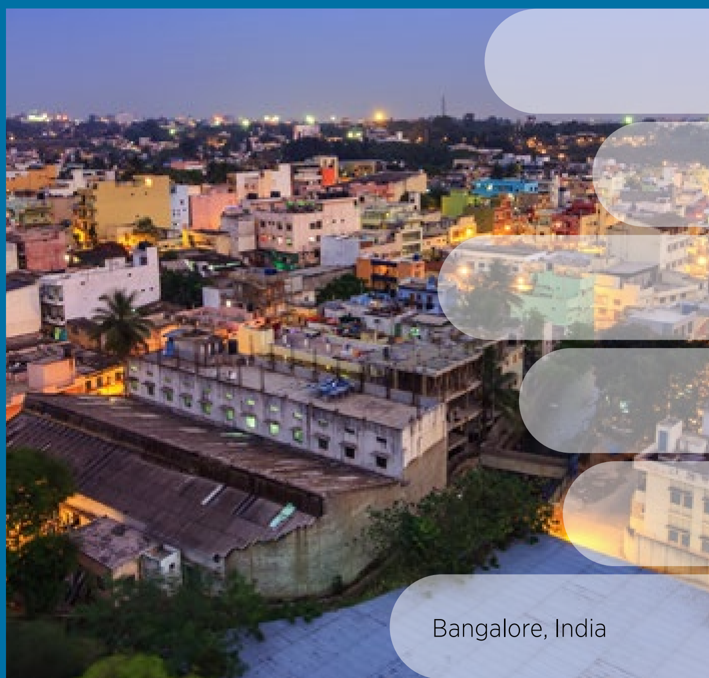
Through net metering, local or national authorities can encourage solar PV deployment, allowing households or businesses that generate their own electricity to feed any surplus back to the grid, thus turning them from consumers into "prosumers". They can either receive a credit against future consumption or remuneration at a specified rate (IRENA, 2016). In some countries, national-level authorities are responsible for net metering; however, where national regulators have not set up such regulations, municipal authorities may do so under their function as local electricity regulators. See Box 6 for examples.

### **BOX 6** NET METERING ACROSS THE WORLD

Net metering has been introduced in a number of cities across the world. In the United Arab Emirates, the Shams **Dubai** programme adopted by the Dubai Electricity and Water Authority led to an installation of 30–40 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 as demand rises while 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 expanded rapidly. Solar capacity connected to the grid of the city utility BESCOM expanded from 5.6 MW in 2016 (Martin and Ryor, 2016) to 98 MW in the fall of 2018 (New Indian Express, 2018).



Bangalore, India

## Promulgating solar thermal ordinances

Municipal ordinances may establish minimum requirements for the use of renewable energy, including solar energy, biomass, and air- or ground-sourced heat pumps. Such measures are typically required in new buildings and buildings that undergo major refurbishment. In several cases, municipal requirements are more ambitious than national ones; in this way, cities function as pioneers, helping to elevate national standards over time. Solar thermal ordinances are a key example of such measures; they are municipal regulations that stipulate that solar energy provide a specified minimum share of heating demand. Over the past decade or so, solar ordinances have become an increasingly common tool to promote the deployment of solar thermal technology across many countries worldwide (ESTIF, 2018) (see Box 7). Integrating solar water heaters into social housing programmes can also be an important way to ensure that low-income households can benefit from renewables as well.

### **BOX 7** 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 households in the city centre 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 60% of running hot water needs in all new, renovated or repurposed buildings – both private and publicly owned – be covered through solar thermal energy. 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

## Adopting measures to decarbonise transport

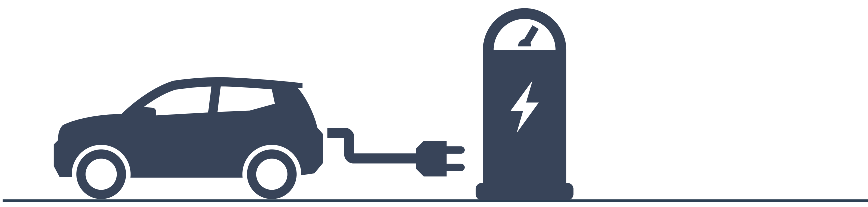
Accounting for one-third of total final energy consumption worldwide, the transport sector is one of the largest energy users in the urban environment, making it an important, yet often neglected target of renewables-focused policy. Energy demand in the transport sector is growing fast, and a significant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

Urban policy making that seeks to decarbonise the transport sector can tap into a broad array of measures aimed at supporting cleaner fuels, electrification, a better modal mix and reduced need for motorised transport. Often driven by air pollution concerns, cities around the world are increasingly trying to reduce the number of cars on urban streets, by encouraging passengers to shift to the most efficient or environmentally friendly mode(s) to improve trip efficiency. Such modes include, for example, non-motorised transport, public transport or carpools. Policies to support such shifts include the promotion of car sharing, closing certain roads entirely or for high-emission vehicles, and the creation of pedestrian walkways and bike-sharing systems (IRENA, IEA and REN21, 2018).

Although such policies do not directly concern renewable energy use, they create the context within which cleaner fuels and electricity assume growing significance. Relevant policies undertaken at the 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).

The use of renewable energy in transport offers numerous additional benefits, such as enhanced energy security, reduced transport-related carbon emissions and increased opportunities for sustainable economic growth and jobs (*e.g.*, there are more than 1.7 million jobs in the biofuels industry worldwide) (IRENA, 2017c). Depending on the renewable fuel, it may also improve local air quality.

A growing number of cities are pushing for reducing and eventually ending the use of vehicles with internal combustion engines in favour of electric vehicles (EVs) – an important though not exclusive avenue towards renewable energy's greater role in transport. For example, **Athens** in Greece, **Madrid** in Spain and **Mexico City** in Mexico have decided to ban petrol- and diesel powered cars by 2025, and **Paris** will do so by 2030 (UNFCC, 2016). More than 30 cities[2] around the world have signed the C40 Fossil Fuel Free Streets Declaration (see Box 8), which includes a commitment to transition away from vehicles running on fossil fuels (C40 Cities, n.d.). These policies create the context within which cleaner transportation energy, whether in the form of biofuels or renewable-energy-based electricity, will play an increasing role.



2 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 8 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 transitioning 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 emission vehicles and reduce vehicle miles.

Source: C40 Cities, n.d.

## Promoting renewable-energy-based e-mobility

The electrification of transport creates opportunities for greater integration of renewable electricity for trains, light rail, trams and two-, three- and four-wheeled EVs. Urban 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 including changes in subsidies, fleet procurement and conversion, and the provision of charging infrastructure are among the efforts being undertaken in a growing number of cities. The life-cycle emissions of EVs compare favourably with those of internal combustion vehicles (ICCT, 2018), even in countries like China, where power generation is still dominated by coal (Energy Foundation China, 2018).

Moscow, Russia

Policies that support the uptake of e-mobility need to be paired with renewable energy deployment to decarbonise the electricity sector. If efforts are made to raise the share of renewable energy in the electricity mix in parallel to electrification policies, the electrification of transport can become a stepping-stone to the more comprehensive use of renewable energy.

Policies in favour of passenger car electrification are being formulated at national and local levels in growing numbers of countries (IRENA, IEA and REN21, 2018). Support measures include public procurement and investment plans which help to create and stimulate an EV market. Various financial incentives to reduce EV costs include vehicle purchase subsidies, exemptions from applicable taxes 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. Creating a sufficiently dense network of charging stations is an essential part of an EV strategy. Cities can directly invest in building such infrastructure, issue deployment targets and regulations that standardise hardware and software and introduce measures to encourage privately owned charging stations through building codes and zoning regulations (IRENA, 2016). Integrated planning for e-mobility and renewable electricity production, transmission and distribution is crucial to link electrification to renewable energy deployment.

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 life-cycle costs may be not much higher than those for diesel models); battery replacement costs (which can represent almost half the vehicle price) and the need for an adequate charging infrastructure (Lu, Xue and Zhou, 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 (Bloomberg, 2019).

This development has been supported at the national government level by generous subsidies for vehicle purchases and charging infrastructure, in parallel with reduced subsidies for diesel fuel. Shenzhen has been a leader in switching its bus fleet to EVs (see Box 9).

Oslo, Norway

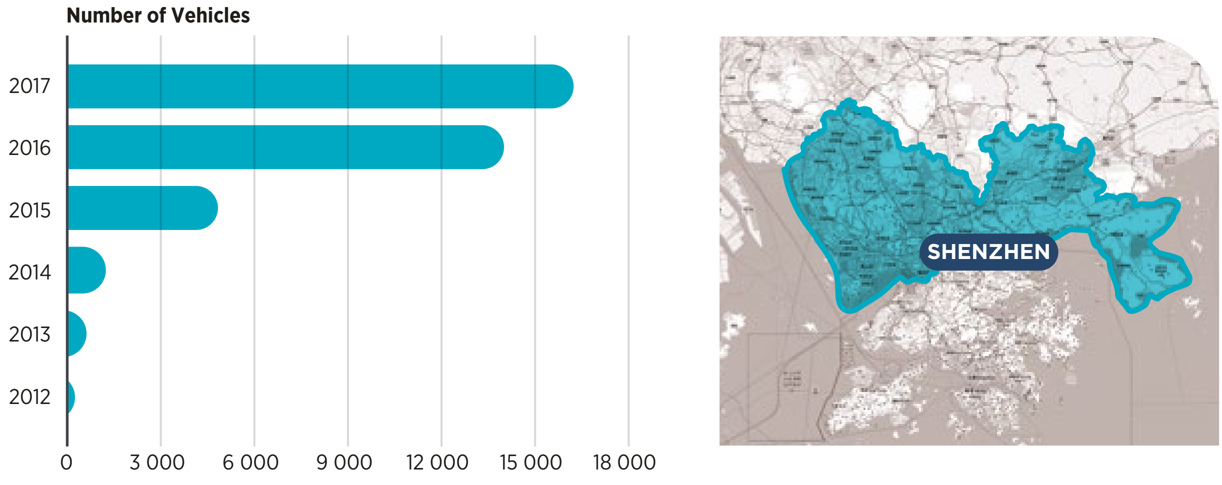
## BOX 9 PIONEERING ELECTRIC BUS USE IN SHENZHEN

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 4). 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[3] 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,[4] 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 4 Electric bus adoption in Shenzhen, China**




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

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

3 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).

4 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 – often through biofuel blending mandates, but also through fiscal incentives and public financing – in an effort to decrease the carbon footprint of internal combustion engines (REN21, 2018; IRENA, IEA and REN21, 2018).

National or subnational governments in at least 50 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**, British Columbia (Canada), hopes by the end of 2030 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 (Danigelis, 2018).

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

Cities can drive local renewable energy deployment by championing it through municipal policy and awareness-raising programmes. 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 an increasingly popular solution to local energy supply challenges. Amongst other, 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.
- The majority of 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 processes directly and actively. Citizens must thus acquire the knowledge and capacity needed to act as informed participants in energy decision making (Roberts, Bodman and Rybski, 2014). National and local governments can also contribute to the development of 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 10).

## **BOX 10** 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".

Further, in May 2018, Athens residents approved a ballot initiative in favour of a small carbon fee per kilowatt-hour (kWh). 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).

In 2019, close to 2 000 solar panels were installed at a nearby middle school, supplying 70% of its power needs and lowering its power costs (Beard, 2019).

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.

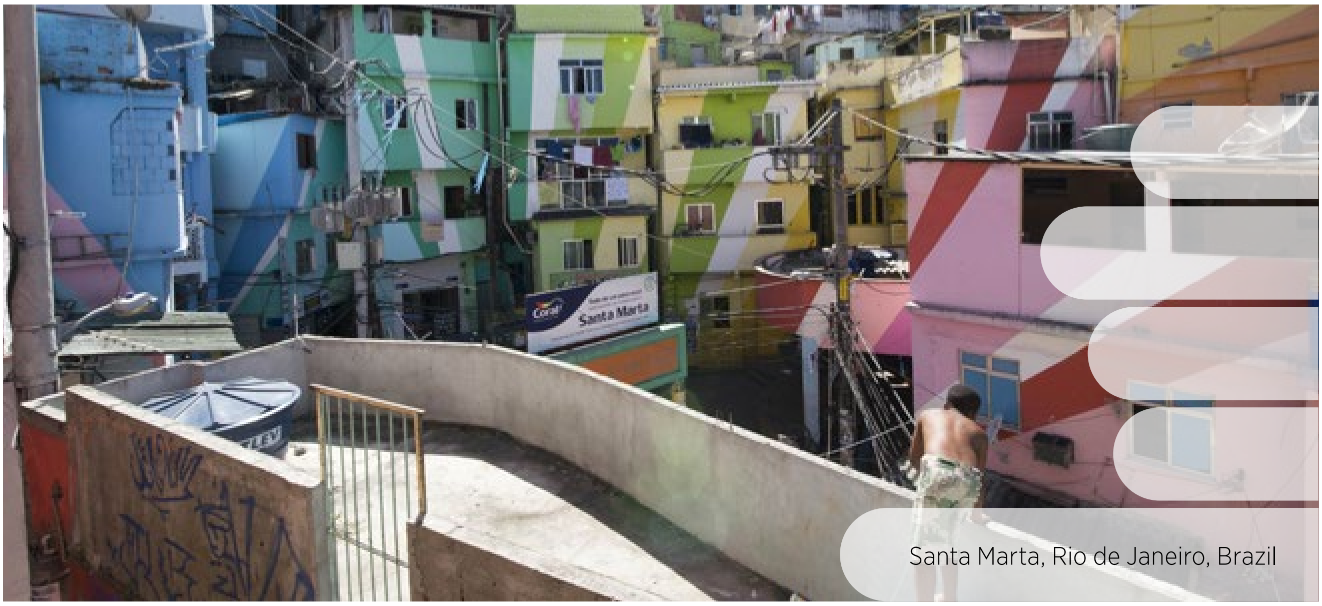
## STRUCTURE OF THIS REPORT

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 in the China context. The next chapter begins with a sketch of the national context and how it frames what Chinese cities can and cannot do. Its discussion of relevant initiatives and experiences is followed by a set of lessons learnt. The report wraps up with some broader conclusions.

Country Case

- National Context
- Initiatives and Experiences
- Lessons learnt




Santa Marta, Rio de Janeiro, Brazil

# **CHINESE CITIES:** CHONGLI DISTRICT AND TONGLI TOWN

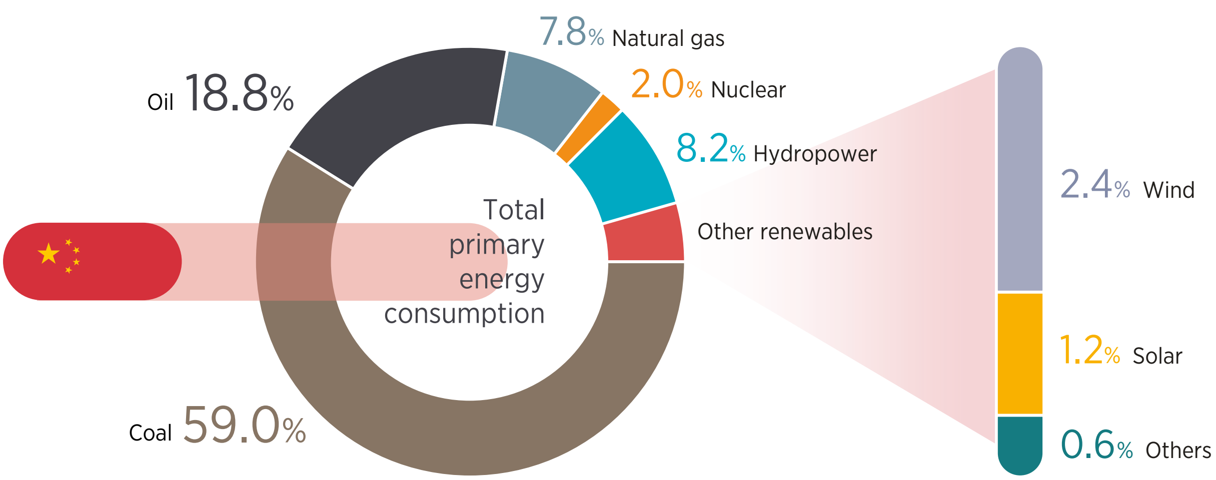
# NATIONAL CONTEXT

## BACKGROUND

China is the world's most populous country, with about 1.4 billion people. Rapid economic growth and large-scale industrialisation has 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, 2019e).

Although the share of renewable energy in the primary energy mix is still at around 12% (Figure 5), China is a major market for and producer of renewable energy technologies (RETs). In the power sector, clean energy has been accorded priority in an effort to reduce heavy reliance on coal and other fossil fuels.

**Figure 5 Share of total primary energy consumption in China, by fuel, 2018**




Source: CEPPEI, 2019.

China relies heavily on energy imports, which accounted for more than 70% of oil use and 43% of natural gas in 2018 (CREEI, 2019). Natural gas consumption rose 34% over just two years, from 2016 to 2018 (IEA, 2019a; NDRC, 2019, 2017).

While industries account for more than half of China's final energy use, their share fell by 10% between 2010 and 2017, whereas demand in the building (22%) and transport (17%) sectors has risen rapidly (Wang Qingyi, 2019) (see Figure 6). Increasing urbanisation along with higher living standards and the growth of megacities translate into ever-increasing urban energy demand.

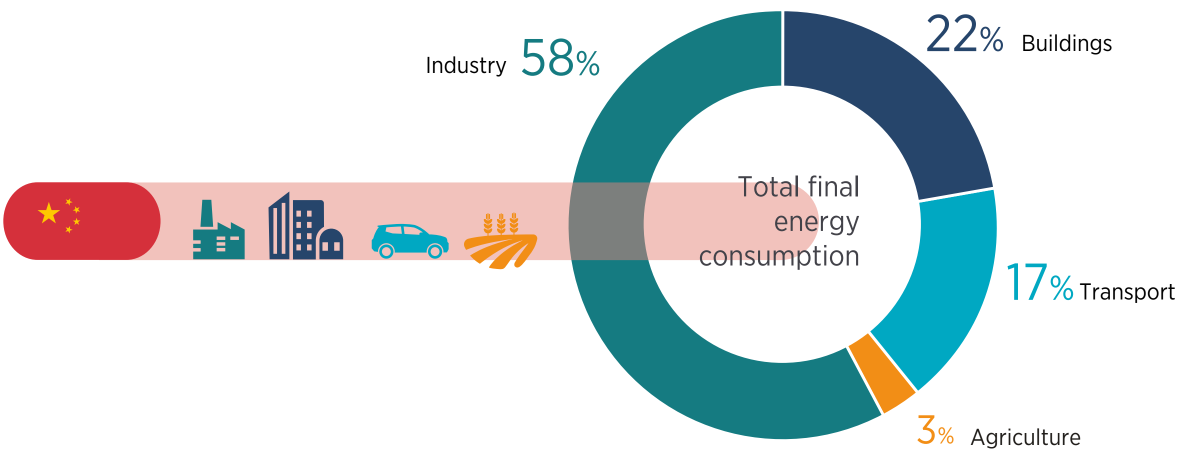
Including urban-based industries, cities are estimated to account for more than 60% of China's total energy consumption and this share is expected to rise further (SGCERI, 2018). In 2018 alone, urban growth added more than 17 million new urban residents, around 2 billion square metres ($m^2$) of building space and more than 22 million vehicles (National Bureau of Statistics, 2020; Jiang *et al.*, 2018).

Urban residents also bear much of the ill effects of high levels of 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 (IQ Air, 2020). Coal burning used to be a major source of China's air pollution, but its contribution has receded since 2012. The share of vehicle emissions ranges from as low as 10% in smaller urban areas to much greater shares in some large Chinese cities like Shenzhen (52%), Beijing (45%) and Shanghai (29%) (MEE, 2018). Ongoing efforts to replace coal fired heating in northern China have lowered the nation's average pollution levels, and Beijing's annual PM2.5[5], over the past several years. But 98% of Chinese cities still exceeded WHO's PM2.5 target (IQAir, 2020).

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 11 explains China's city level designations and governance structures as background to the analysis that follows.

5 Particulate matter.

**Figure 6 Share of total final energy consumption in China, by sector, 2017**




Source: Wang Qingyi, 2019

## BOX 11 ADMINISTRATIVE UNITS IN CHINA: PROVINCE, CITY, DISTRICT AND COUNTY

Subnational jurisdictions in China differ from typical structures in other parts of the world; 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 cities have urban 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 7 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 level 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.

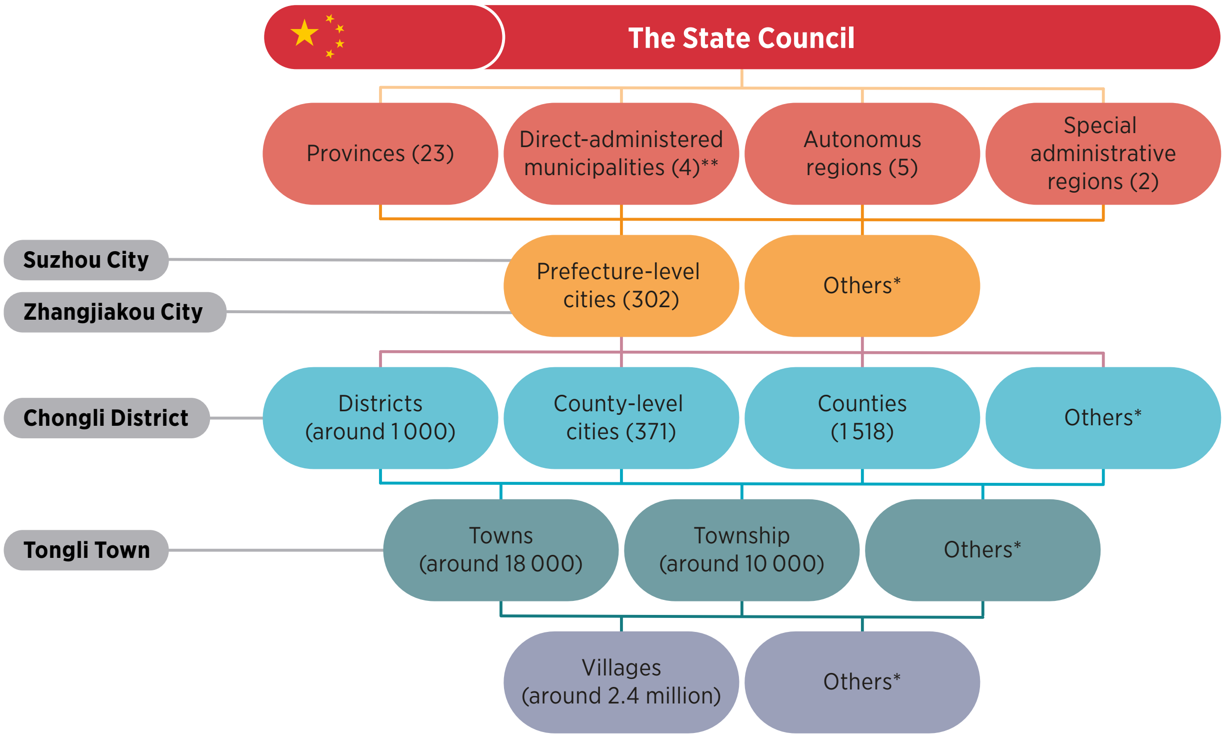
The various levels of administration are not necessarily hierarchical in terms of their decision making power.

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 7) (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 7 Administrative layers of the Chinese government**




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

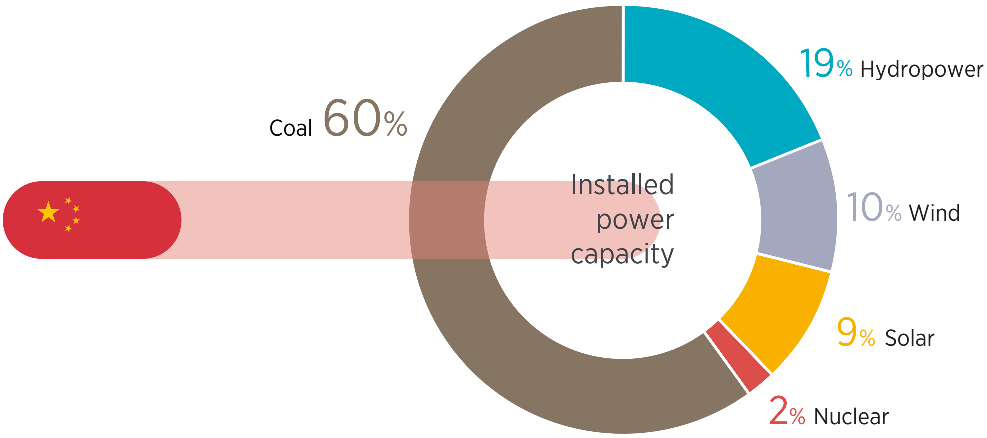
Notes: *Including some administrations at the same level.
** The four cities directly under the central government are Beijing, Shanghai, Tianjin and Chongqing.
Figures on prefecture-level cities, county-level cities, counties and districts are as of 2018. Other figures are as of 2016.

## RENEWABLE ENERGY DEVELOPMENT IN CHINA

Rising dependence on fossil fuel imports and growing concerns about carbon emissions and heavy air pollution are driving the government to adopt more ambitious renewable energy targets. Renewable energy represented 40% of China's installed power generation capacity in 2019 and 28% of its power generation (NEA, 2020). Figure 8 shows power capacity from different energy sources in 2018. 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, 2020b). China also accounts for 70% of the world's deployment of solar water heaters, 99% of electric buses and 45% of all EV stock (IEA, 2019c, 2019d; BNEF, 2018).

Hydropower continues to account for the largest share of all renewables in power generation capacity (46%), followed by onshore wind (26%) and solar PV (25%) (CEPPEI, 2019). Mounting environmental concerns regarding China's large-scale

**Figure 8 Installed power capacity in China, by source, 2018**

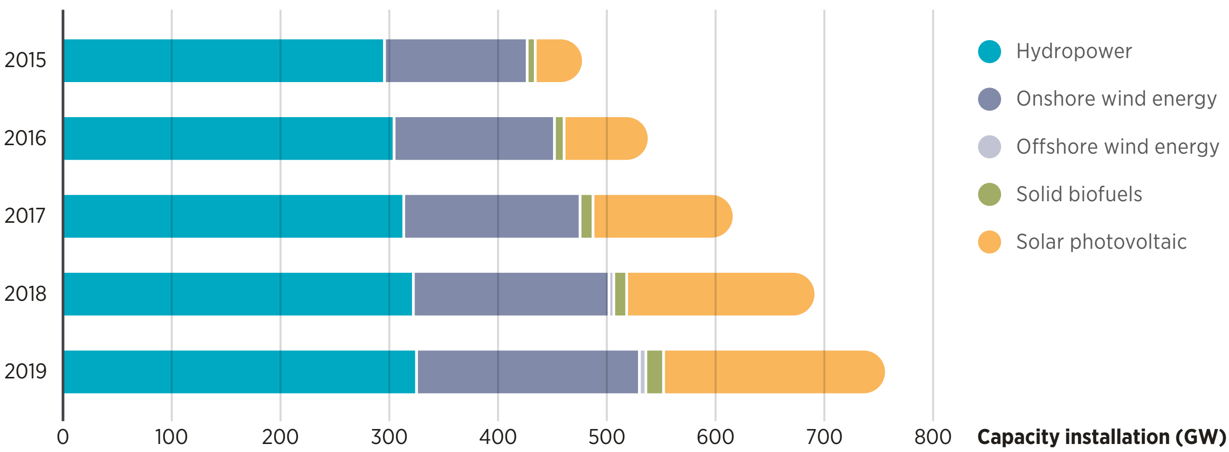



Source: CEPPEI, 2019.

hydropower have further boosted other RETs such as solar, wind and bioenergy as technologies of choice for new renewable energy projects (see Figure 9).

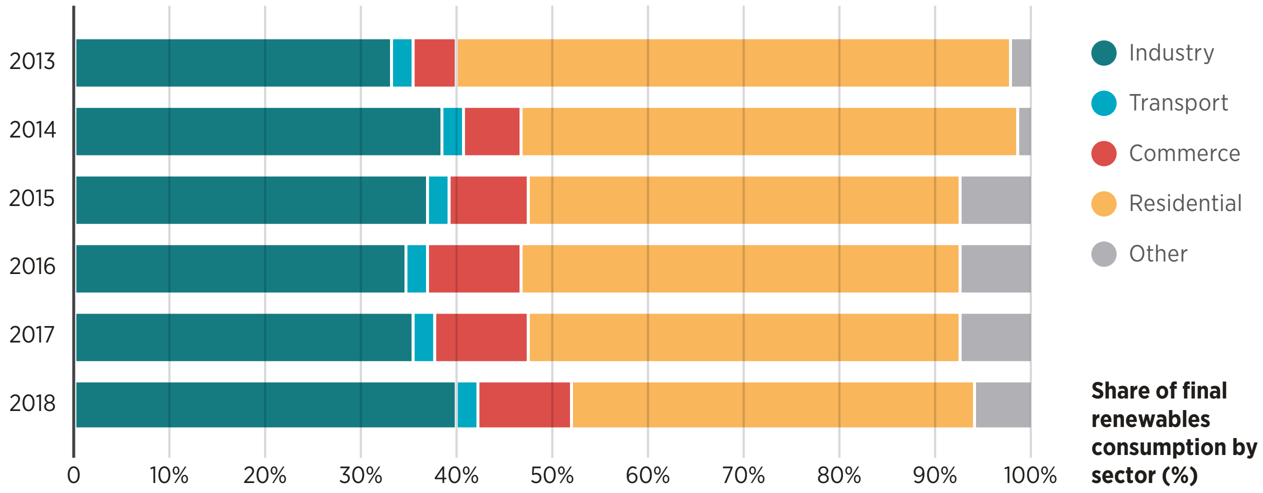
As for the consumption of renewables by sectors, China's residential and commercial buildings and industries consumed 91% of renewables in 2018 (including for power and for heating), while transport consumed only 2% of total renewables. The residential sector has taken on a bigger role due to the higher share of renewable energy used in electricity and in solar water heaters (see Figure 10).

**Figure 9 Cumulative renewable energy installations in China, 2015–2019**




Source: IRENA, 2020b.

**Figure 10 Share of renewable energy consumption in China, by sector, 2013–2018**




Source: IRENA, 2020c.

The expansion of renewable energy in China has been driven by strategic planning and various supportive policies, some of which are summarised below.

## China's Five-Year Plans

China's five-year plans (FYPs) constitute the government's fundamental policy instrument for target setting and strategy development and implementation. The FYPs set national targets for all renewable technologies as well as influence investment and research and development (R&D). The most recent $13^{th}$ FYP for 2016–2020 entails a target of 27% renewable energy in total electricity generation by 2020 and aims for 675 GW cumulative renewable electricity generation capacity by 2020, of which 50% is hydropower (excluding pumped storage), 31% wind power, 16% solar PV, 0.7% CSP and 2% from bioenergy (NDRC, 2016).

## Renewable Energy Development Fund

The Renewable Energy Development Fund plays a hefty role in renewables' development. The 2006 Renewable Energy Law set a fixed rate of CNY 0.001 (USD 0.00015) and gradually doubled it to CNY 0.019 (USD 0.0029) per kWh of electricity to finance the Renewable Energy Development Fund, which is the financial source of feed-in tariffs (FiTs), feed-in premiums (FiPs) and various subsidies to renewables (NPC, 2006). In 2018, close to half, or 44%, of funds went to wind projects, 37% to solar and 20% to bioenergy. Those are made available for R&D, industrial development, construction of renewable power plants, procurement and operation of renewable heating equipment and appliances.

But China's Renewable Energy Development Fund faced a cumulative shortfall of USD 32 billion (around CNY 230 billion) as of 2018 (Yuan Si, 2019). The finalisation of a renewable energy portfolio standard and green certificate policies announced by the National Energy Administration (NEA) are expected to mobilise alternative financial resources for renewables and prioritise auctions for onshore wind projects after 2020 (Hove and Watzel, 2018; NEA, 2019b). To support this change, more progress is needed in integrating policies and the power market.

## Feed-in tariffs (FiTs)

Since 2006, the National Energy Administration (NEA) has promulgated FiT policies applicable to onshore and offshore wind, solar PV, concentrating solar power (CSP) as well as biomass for electricity generation. As shown in Table 1, FiTs for onshore wind are determined according to natural resource classification standards that classify all regions in China into four types (Types 1 through 4), based on their renewable energy potential combined with the comparative plant construction costs. Type 1 has the greatest potential and lowest costs. Regions with greater renewable potential (and thus presumed lower cost) receive lower tariffs than regions with less potential. A similar classification applies to solar PV, which has three types of regions. Within this context, local governments are responsible for approving renewable generation. Over time, FiT rates have declined, in recognition of lower costs (NEA, 2019b).

## Feed-in premiums (FiPs)

FiPs are available for distributed solar PV renewable generation, including household-scale solar rooftop and self-consumed industrial and commercial projects. A number of cities with higher ambitions for renewables deployment as well as sufficient local financial capacity offer their own local FiPs for distributed solar PV generations. For instance, in 2015, Beijing Municipality announced an extra premium of CNY 0.3/kWh (USD 0.043/kWh) to distributed solar PV projects for a five-year period from 2015 to 2019. A few cities in the Yangtze Delta region released similar local FiP policies, which played an important role in making this the region with the most installations of distributed solar PV projects in China (WRI, 2018).

**Table 1 Feed-in tariffs and feed-in premiums, by type, 2020**

| Policies | Renewable energy technologies | Rates, in CNY | | | |
|---|---|---|---|---|---|
| | | Type 1 | Type 2 | Type 3 | Type 4 |
| *FiTs* | Onshore wind[6] | 0.29 | 0.34 | 0.38 | 0.47 |
| | Offshore wind (coastal) | n/a | n/a | n/a | 0.75[7] |
| | Offshore wind (intertidal) | n/a | n/a | n/a | 0.47 |
| | Solar photovoltaic (PV) (utility scale, commercial and industrial projects that 100% feed-in grid) | 0.4 | 0.45 | 0.55 | n/a |
| | Solar PV (poverty alleviation purpose) | 0.65 | 0.75 | 0.85 | n/a |
| | Concentrated solar power | 1.15 | | | |
| | Biomass (agro-forestry) | 0.75 | | | |
| | Municipal solid waste (waste incineration) | 0.65 | | | |
| *FiPs* | Distributed solar PV (self-consumption by industrial and commercial projects) | 0.1 | | | |
| | Distributed solar PV (residential) | 0.18 | | | |

Source: CNREC, 2019; NDRC, MoF and NEA, 2018.

Note: Rates highlighted in green are applicable to Chongli District. All rates are for the projects approved in 2020 according to the related policies released in 2019. The exchange rate is USD 1 = CNY 6.910, according to the yearly average rate in 2019.

6 The rate for distributed onshore wind to participate in market trading pilots is based on negotiation between sellers and consumers. FiTs are not applicable.

7 All offshore wind generation is in Type 4 areas.

## Subsidies to electric vehicles

Chinese national and local governments also provide subsidies for the procurement of EVs and related charging infrastructures. Different from the FiTs and FiPs, these subsidies draw not from the Renewable Energy Development Fund but from other, dedicated government budgets. A newly adjusted policy on subsidies for new energy vehicles was released by the Ministry of Finance, Ministry of Industry and Information Technology (MIIT), Ministry of Science and Technology and National Development and Reform Commission (NDRC). MIIT has a more proactive role to play in EV related policies, due to its relevance in cultivating the manufacturing industry.

During the 13th FYP from 2016 to 2020, some USD 62 billion was planned to be allocated for the procurement of new energy vehicles, including plug-in hybrid and EVs (MEE, 2018). Subsidies from national and subnational governments have also been used for infrastructure development related to EVs.

## Other policies

Given the curtailment of renewables, enabling and integrating policies were introduced to help build a smart grid system and begin a restructuring of the power market. In 2017, the curtailed renewable energy generation (100 TWh) was nearly equal to the total residential electricity consumption of the United Kingdom (NEA, 2018a, 2018b). In 2018, NDRC released a national action plan for accommodating clean energy and resolving the curtailment problem (NDRC, 2018). The main policy instruments focus not only on the targets and flexible operation of power plants but also encourage the deployment of electric heating technologies using renewable electricity to replace coal-fired heating in northern China (see Chongli case).

The implementation of these national and subnational policies leaves considerable space for local actions and complementing policies. Cities can and need to be more ambitious than national targets in their mandate to foster sustainable urban growth and address local environmental and social challenges, including air pollution and poverty, as well as reap benefits such as local employment generation and economic income. The Chongli District of Zhangjiakou City and Tongli Town of Suzhou City are among these pioneers.

Shenzhen, Electric Taxi

## CHINA'S ENERGY SECTORAL ORGANISATION AND THE ROLE OF CITIES

The governance of China's energy sector remains relatively state-centric, though oversees and co-ordinates energy sector and related industrial planning, including target setting (through its five-year plans), industrial strategy, standards, regulation and project approval. The NEA allocates targets to all provincial administrative divisions for the approval of utility-scale (*i.e.*, 6 MW and above) wind and solar installations, while distributed generation and household solar rooftops are managed by municipal governments. Beginning in 2015, provincial energy administrative departments were authorised to approve utility-scale projects. Distributed solar PV generation (up to 6 MW) for industrial and commercial self-consumption requires registration with the local government. Residential rooftop projects are easier to connect to the grid.

The NEA is also responsible for co-ordinating and managing the roles of various ministries in support of deploying renewables in power generation, heating and other end-use sectors. The relevant ministries are responsible for different technologies and strategic and cross-cutting issues, such as setting targets and regulating the respective market. For example, the NDRC, the NEA and the Ministry of Finance usually have a greater role in renewables planning and policies, while the project permitting for new capacity installation involves many other ministries, including the Ministry of Natural Resources and Ministry of Ecology and Environment (MEE), among others. The national 2017–2021 winter clean-heating plan in China was released by the NDRC, the NEA, MEE and the Ministry of Housing and Urban-Rural Development (MoHURD). MEE also has primary responsibility for climate change, which is related to renewables to some extent.

The NEA has been providing guidance to the renewable energy piloting projects and cities, including Zhangjiakou City. Further, in the context of the National Clean Heating Demonstration Cities, the NEA, in collaboration with the Ministry of Finance, MoHURD and MEE, facilitates CNY 500 million (USD 71 million) annually over a three year period to support the deployment of clean heating solutions and related infrastructure.

### Sectoral organisation in the electricity sector

Two publicly owned companies operate China's six regional electricity grids. They have important roles for renewables in terms of grid connection, smart grid and power market reform (NPC, 2006). NEA regulations require that transmission and connection lines for all new plants are approved by provincial (6 MW and above) or lower level municipal or county level authorities (less than 6 MW), with involvement from the two state grid giants (NEA, 2013). The branch grid companies in cities are also responsible for building all the infrastructure needed to enable plants' connections. Wind plants follow a similar procedure.

The State Grid Corporation of China (SGCC) is the only grid company for 26 out of the 34 provincial-level administrative divisions. The sub-branch company of SGCC in cities is the main stakeholder to provide grid connections for all utility-scale and distributed solar and wind power plants in both Chongli District and Tongli Town. It owns and operates the grid networks for both transmission and distribution of electricity to all consumers. In Chongli District, the SGCC branch company is indispensable for meeting the expected six-fold increase in local electricity consumption and for the transactions at the four-party co-ordination platform (see case study 1: Chongli District). It has been in the process of improving the grid and distribution networks in urban Chongli for the electrification of space heating (which would substitute coal burning) and also building more grid infrastructure in Chongli District, especially for the Winter Olympics sports venues. For Tongli Town, the SGCC, including the sub-branch company in Suzhou, has been actively engaged in promoting renewable energy, not only by making adjustments to grids to allow for more variable electricity to be fed into them, but also by using their own buildings in Tongli to exhibit innovative renewables technologies as well as raise to local residents' awareness of the potential of renewables (see Box 12 in one of the following subsections).

## Roles of different layers of government and non-governmental institutions

China's regulatory authority related to renewable energy spreads across different layers of the administrative system. The roles of provinces, cities and other actors such as research institutes and industry associations are briefly discussed below.

**Provinces.** The five-year plans and sectoral plans released by provincial governments include targets and plans in cities. The provincial governments follow the maximum yearly new capacity installation of both utility- and distributed-scale projects that are allocated by the NEA and eligible to receive FiT and premiums. Under the allocation, provincial governments decide the list of projects that can move forward. Meanwhile, the provincial governments decide the electricity tariffs, including the peak-valley tariffs which play a significant role in the electrification of heating activities. Provincial-level policies and development directives provide the framework for cities' work on renewables deployment.

**Cities.** National ministries and provinces have more roles in setting policy and mobilising fiscal revenues than cities, which usually follow upper-level authorities. But cities can be more ambitious and proactive when it comes to local target setting and policy making, providing additional subsidies and other financial support and adopting renewables-friendly land-use and zoning policies. Such measures, however, depend on local development strategies, renewables resources, financial revenues as well as support from national or provincial governments. For instance, Zhangjiakou City, with support from national governments and abundant wind capacity installation, announced China's first 100% renewable energy city target. Job creation and the cultivation of the renewables industry have been the incentives for local governments, who could benefit from GDP growth in the long term and tax revenues in the near term.

While the NEA regulates feed-in tariff (FiT) and fiscal policies, cities can offer extra financial support for innovative renewable projects covering not only power generation but also clean heating and EVs. In the past, this has resulted in many pioneering local policies including reductions or exemptions to land-use or property-related taxes for a specific period for solar PV producers, clean heating operators or EV manufacturers. Land-use policy is an important tool for local governments and could influence the cost of renewables generation.

**Research institutes and industrial associations.** These are widely involved in cities' actions for renewable energy, providing expertise and knowledge support. The Energy Research Institute (ERI) and the China National Renewable Energy Centre (CNREC) are the leading national energy research institutes under NDRC, conducting research and providing policy recommendations to ministries, provincial governments and cities on energy-related matters. Renewable energy industrial associations also fulfil a number of roles, including facilitating companies' engagement in renewables-related policy consultation, supporting local renewables demonstration projects as well as providing capacity building and information sharing for industrial development. For instance, the Chinese Renewable Energy Industries Association (CREIA) has been providing consultation work and reporting of industry development for China's renewable energy industry.

# CASE STUDY 1: CHONGLI DISTRICT

## BACKGROUND

Chongli District is one of the six districts of Zhangjiakou City in Hebei Province (see Figure 11). This district is 50 km from downtown Zhangjiakou and has a population of 105 000 (2016 data) (Zhangjiakou Municipality, 2017b). Reflecting the reduced role of agriculture (typical for designation as a county in China; see Box 11 for an explanation of administrative units and hierarchies) and the rising importance of industries and the tertiary sector (typical markers for a district), Chongli's status was changed to a district in 2016 but still directly reports to the Zhangjiakou Municipality. Owing to its geographic location in mountainous territory, Chongli has a cold climate, with average temperatures of –12°C 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.

With a per capita GDP of around USD 4 500 in 2018, Chongli is less affluent than Zhangjiakou City on average (around USD 5 200) or China as a whole (around USD 9 700) (Zhangjiakou Municipality, 2019a, 2018). The main reason is that Zhangjiakou City was defined as an ecological conservation area and therefore restricted from hosting heavily polluting industries. At the same time, Chongli has been transitioning from primary and secondary industries to services, mainly tourism. Some iron and gold mining companies have been shut down, and between 2014 and 2017 their output reduced by more than half, with local GDP dropping (Zhangjiakou Municipality, 2017a).

There are two drivers of the renewable energy strategy in the Zhangjiakou and Chongli districts. One is the decision to have Zhangjiakou co-host (with Beijing) the 2022 Winter Olympics (see Box 12). The other is the designation in 2015 of Zhangjiakou as a National Renewable Energy Pilot City. Zhangjiakou City aimed to deploy 20 GW of renewable capacity and generate 40 TWh electricity by 2020.It had achieved a total 15 GW of cumulative installed capacity as of December 2019 (Zhangjiakou Municipality, 2020). 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 improvement of the local economy allowed Chongli District to be removed from the National Poverty Counties list in May 2019 (Hebei Provincial Government, 2019b).

**Figure 11 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.

### BOX 12 CHONGLI DISTRICT AND THE 2022 WINTER OLYMPICS

By co-hosting the XXIV Winter Olympics in 2022, Zhangjiakou aims to achieve a low-carbon Olympic Games tied to the upscaling of renewable energy sources.

This objective offers Chongli District, which will host most of the Olympic skiing events, the opportunity to accelerate renewables in its own right. Plans are to use low-carbon energy sources to supply electricity to all the venues, residential buildings and transport systems in a special, 21.9 hectare zone (the Tai-zi-cheng village), to an Olympic square (1.2 hectares) as well as to local neighbourhoods (13.6 hectares), and to an area set aside for offices and operational facilities (7.1 hectares) (NDRC and NEA, 2015).

Chongli District also plans to expand this model to the entire district, in order to achieve 100% renewably generated electricity supply by 2022. All these targets and commitments were presented in Zhangjiakou City's National Renewable Energy Pilot City Programme, released in 2015.

Integrating renewables into development plans in preparation for the 2022 Winter Olympics is in process. Zhangjiakou Municipality and the Chongli District government have been collaborating with the special office for Winter Olympic preparation and co-ordination, with the aim of renewable energy providing 100% of the electricity and heating needed for the Winter Olympic venues and buildings.


## Energy supply and consumption

As is true throughout China, coal remains the dominant energy source. The total final energy consumption of Chongli was 163 195 tonnes of oil equivalent in 2016.[8] Primarily used for district heating and residential heating systems but also for industrial processes in the mining sector, coal burning accounted for 80% of total final energy consumption. Chongli's electricity mix (which accounts for about 19% of total energy demand), on the other hand, is already largely renewable energy based. The 1.1 GW of installed renewable capacity consists mainly of wind power with a small solar PV share. Chongli generates more electricity than it consumes itself and supplies other parts of Zhangjiakou City. Petroleum and diesel are mainly consumed by the transport sector, and at a much smaller scale than coal and electricity use. As of 2016, most vehicles on the roads had internal combustion engines; the number of electric buses remains small.

Installed renewable power capacity in Chongli District has reached 1.1 GW, including 1 116.75 MW wind power and 4.5 MW solar PV. Some more capacity for hydrogen production is to be built by 2020 (see Table 2). The 2020 targets foresee more than a doubling of capacity to 2.39 GW (including 1 GW wind and 1.39 GW solar). It is expected that electricity production by 2022 will reach 2.13 TWh, based on 2 300 hours of annual grid-connection hours for wind power and 1 500 hours for solar PV, which is much higher than Chongli's estimated total electricity consumption (IRENA, 2018a). It should be noted that the district, like the surrounding areas, taps into a regional grid that is fed by a mix of sources. Renewable capacity accounted for 60% of the regional grid as of 2019, the highest share of all of China's regional grids and more than the national average of 40% (NEA, 2020; SGCC, 2019).

Chongli District plans for a substantial increase in the share of renewable energy as part of its electricity mix. If it reaches planned renewable capacity additions in 2022 fossil fuel use could be reduced by 770 000 tonnes of coal equivalent per year, thus avoiding 2 million tonnes of $CO_2$ emissions, 20 000 tonnes of sulphur dioxide emissions and 3 300 tonnes of nitrogen oxide emissions (IRENA, 2018a). Without doubt, this would contribute significantly to the improvement of the region's air quality.

8 Given limitations on available data from the national government, some data on energy demand in Chongli District are derived from local government reporting as well as estimates made for this case study.

**Table 2 Installed and planned solar and onshore wind power generation in Chongli District, 2018**

| | Projects | Capacity (MW) | |
|---|---|---|---|
| **On-grid plants** | Qing-San-Ying wind power plant | 949.4 | Wind 1 116.8<br>Solar 4.5 |
| | Xi-Qiao-Liang wind power plant | 147.9 | |
| | Hong-Hua-Liang wind power plant | 9.8 | |
| | Wang-Shan-Ba wind power plant | 9.7 | |
| | Village-scale poverty alleviation solar power plants (15 * 300 kW) | 4.5 | |
| **Planned capacity** | Solar rooftop in Olympic special zone | 4.3 | Wind 149.5<br>Solar 504.3 |
| | Ma-Ni-Ba wind power plant | 49.5 | |
| | Wind power plants for hydrogen | 100 | |
| | Olympic corridor solar power plant | 500 | |

Source: Zhangjiakou Municipality, 2019b.

## Renewable energy potential in Chongli

Chongli has good solar PV and wind power potential. Chongli District is classified as a Type 2 Solar Resource Area as per national classification (see Table 2 further above), with average solar radiation hours of around 2 756 to 3 062 hours every year in Zhangjiakou. Solar radiation is around 1 500–1 700 kilowatt hours per square metre (kWh/m$^2$) per year, which is above China's average level (1 486.5 kWh/m$^2$ in 2018). Chongli also classifies as a Type 2 Wind Resource Area, with wind resources of about 200–500 kWh/m$^2$ at a height of 70 m. The wind speed in some areas can reach more than 6 meters/second (m/s) at 70 m height, and 7.2–9 m/s at 80 m height; this is above the national average, which was 5.5 m/s at 70 m height in 2018 (IRENA, 2018b).

Chongli has a relatively high rate of forest coverage, mainly on mountains, giving it potential to utilise substantial amounts of local forestry residue for biomass energy. The rate of forest coverage rose from 52% in 2015 to 67% in 2019 (Chongli District Government, 2020, 2016). However, published plans by Zhangjiakou Municipality do not include an assessment of this local biomass potential.

## DEPLOYING RENEWABLE ENERGY IN CHONGLI

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. This section also outlines the significance of national-level policies in the context of Chongli. The roles of a number of actors and stakeholders are essential to understanding policy making in Chongli District. Below, we discuss the importance of the Chongli district government, Hebei provincial government, Zhangjiakou Municipality, the local grid company and renewable energy companies operating locally.

### 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 key 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.


### Roles of Zhangjiakou Municipality

***Target setter and regulator***

Zhangjiakou Municipality is the main body developing city-level plans (which include Chongli District), implementing all related local policies, as well as facilitating communication between all related stakeholders and co-ordinating platforms (for more on these platforms, see Box 13).

Under its 2015 pilot plan, Zhangjiakou City committed to raising the share of renewables in terms of both capacity and 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 are very ambitious renewable targets for China, where the national target for renewables' share of electricity was 28% by 2020.

This affects all end uses. In heating, Zhangjiakou's target to phase out all coal burning boilers, except co-generation 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 a 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.

## BOX 13 THE FOUR-PARTY CO-ORDINATION PLATFORM OF ZHANGJIAKOU CITY

Renewable energy developers in Chongli District are mainly involved in the construction and operations of wind and solar power plants, and thus form the on the ground backbone of efforts 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 FiTs, to ensure grid connection.

Given the 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 phase-out 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 have planned significant investment of hundreds of millions of dollars for the improvement of 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, as well as caps 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).

## Roles of Chongli District

#### ***Target setter and planner***

The district government defines its own renewable energy strategy and targets. However, it has little in the way of independent policy making authority, 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 in Box 13). According to the Low-Carbon Olympics Plan, electricity will be supplied mainly from renewables within Chongli District and some wind and 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 14 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 the available assessment, the use of bioenergy and geothermal as heating sources in this district is limited.

## **BOX 14** 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.[9]

The share of heating in total energy consumption is expected to increase significantly. Local power generation capacity requirements are estimated to rise nine-fold 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.


9 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.

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 expected that the electricity will be from the procurement of wind electricity from power plants located in Zhangjiakou City through a regional piloting electricity market platform initiated by the NEA, the grid company and the provincial government.

## **BOX 15** 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 and infrastructure upgrading, improvement of heating networks and appliances, and power supply and charging stations for EVs and hydrogen cell vehicles. It will also require investments and financial support for operations and maintenance of renewable generation, heating and transportation.

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 is estimated to 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 transportation sectors. Given data constraints, it is difficult to estimate private investment. However, the privately 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

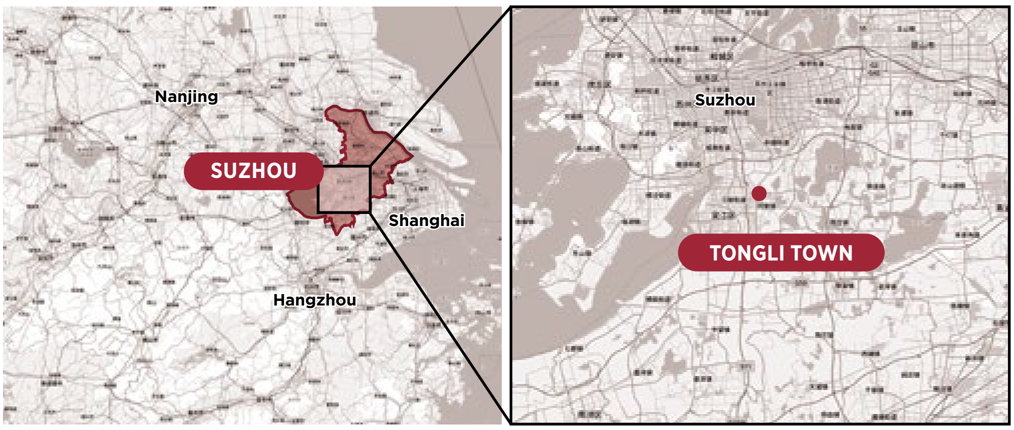
## BACKGROUND

Tongli Town, part of the Wujiang District of Suzhou City, Jiangsu Province, has a recorded history going back more than 1000 years. Situated among farmland, forests, rivers and lakes, the city was built during the Song dynasty. Located on the eastern shore of Taihu Lake, 18 km from the city centre of Suzhou and 80 km from Shanghai, Tongli covers a 98.03 $km^2$ area and has a population of 67900 spread across 5 neighbourhoods and 11 villages (see Figure 12). The historic centre of Tongli Town stretches over 2.4 $km^2$ – and the city core is just a tiny portion (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 a protected historical heritage site by the Jiangsu provincial government. Tourism is therefore a mainstay of the local economy. Tongli Town ranks among the top-ten tourist destinations in China, receiving more than 5 million visitors annually since 2011. Its status as a historical site has translated into restrictive policies on changes to buildings, decorations or reconstruction. The mounting number of visitors, meanwhile, has boosted energy consumption[10] and created more risks to buildings in the ancient town.

10 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 12 Tongli Town**




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

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Suzhou city

## Energy supply and consumption

Suzhou, of which Tongli Town is part, has the third-largest energy consumption out of the more than 300 prefecture-level cities in China. Suzhou's total final energy consumption was more than 85 million tce[11] or around 59 million tonnes of oil equivalent (toe) in 2017 (Lei *et al.*, 2019; Suzhou Municipality, 2018b). This is 20% higher than Beijing's energy demand (due to the great concentration of industries), even though the capital's population is more than double that of Suzhou (National Bureau of Statistics, 2020). Tongli itself, however, has a small population and no energy-intensive manufacturing industries, implying the town's energy demand is comparatively small, accounting for less than 1% of Suzhou's total electricity consumption. Power demand has been rising rapidly in recent years, however, and is projected to continue to boom (IRENA, 2018a). Renewable energy could help protect Tongli's integrity as a historical town while ensuring support for more tourism. So supporting sustainable and clean energy sources is a core challenge.

Tongli is supplied by Suzhou's municipal grid company covering all districts, counties and towns in Suzhou City. This implies Tongli's electricity mix is to some degree determined by Suzhou. The energy mix of Tongli Town is not clear due to limited available data. However, in 2019, a national energy newspaper reported that the renewable energy share in total final energy consumption reached 15%, mainly due to hydroelectricity, distributed solar PV and wind generation (Zhang Rongxin, 2019). Most of these renewable energy solutions, including groundwater-sourced heat pumps deployed in the district cooling system, are installed in the office buildings of the local grid company. So far, the installed distributed solar panel generation is about 477 kW and includes several 1–2 kW installations on household rooftops. The capacity of distributed wind generation reached 20 kW from four deployed 5 kW wind turbines (Feng, 2019).

Tongli Town has no local resources providing fossil fuel energy. All local energy supply is derived from other regions of China, including electricity, coal, oil and natural gas. Electricity is from hydropower plants in Sichuan Province transported to Suzhou. Natural gas comes from Sichuan Province and western China (natural gas is provided by one state-owned company in Jiangsu Province, its supply allocated by a higher-level administration). In 2015, Tongli's natural gas supply accounted for a small share of Suzhou's total supply. It is projected that the natural gas consumption of Tongli Town will keep increasing, which will require the expansion of existing natural gas networks and pipelines and other infrastructure.

The Suzhou City and Jiangsu provincial governments have adopted a series of policies to encourage the deployment of renewable energy, including targets, development plans, and subsidies, while planning the phaseout of fossil fuels. More than 1 GW of renewables capacity has been deployed, of which 300 MW is distributed solar rooftop and wind power. In Tongli, installed capacity amounts to around 500 kW. The fleet of electric vehicles (EVs) now surpasses 11 000 in Suzhou City; Tongli Town has built 60 EV charging stops and 6 charging stations for electric buses.

11 Tonne coal equivalent (tce) is the main unit in China's energy reporting system; 1 tce = 29 307.6 megajoule = 0.7 tonne oil equivalent (toe).

Tongli Town

## Local challenges

Local government has recognised the major challenge of reconciling the growth of tourism with the parallel goal of increasing the use of clean energy in Tongli. The major energy consumers in Tongli Town are households and the tourism industry, including restaurants, hotels and transportation for tourists. Around 70% of all buildings in the ancient town were built in the Ming and Qing dynasties, one thousand years ago. Most old buildings have brick and wood foundations vulnerable to fire hazards. 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. The widespread use of gas tanks, coal and oil products for cooking and water heating significantly adds to the local hazard of fire,[12] as does the amateur wiring connecting private homes and small businesses to the local grid.

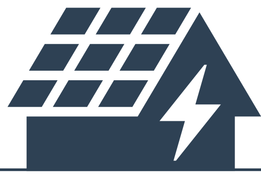
The local tourism industry has added to the strain on local infrastructure. Numerous new, small-scale merchants and shops have been opening in the tiny centre of the ancient town, increasing demand for electricity and other energy resources for lighting, transport and heating and cooling, burdening the electric transmission and distribution network. Existing distribution networks thus struggle to meet the growing energy needs of businesses. Safety concerns related to fuel use, old wires and an overloaded distribution network have been voiced by an increasing number of town managers, merchants and residents. Local government, in collaboration with the grid company, has noted that electrification could help to reduce the fire hazard from open fires.

## Renewable energy potential in Tongli

Tongli Town is classified as a solar energy Type 3 zone (see Box 16 and Table 3). Suzhou City and its environs register average solar radiation of about 1279 $kWh/m^2$ per year and 3.5 $kWh/m^2$ per day. The utilisable irradiation of Suzhou is about 1280 hours per year, below the average as a whole. Based on the assumption of an average living area in Tongli of around 50 $m^2$ per capita, and 25% of total rooftop area utilisation, the estimated available rooftop area for solar PV could reach 300 000 $m^2$.[13] This would translate into around 30 MW of potential capacity for rooftop solar PV installations, more than 60 times the installed solar panels in Tongli Town (Jiao, 2017).

Nonetheless, lack of space and restrictive building protection policies limit the exploitation of renewable resources in Tongli Town's historic centre. The estimated area available for integrated solar PV solutions is 90 $km^2$, mainly on farmlands and fishponds outside of the ancient town. With an assumed 1% deployment of solar PV, solar generation capacity could reach 90 MW, enough to meet all current local electricity needs. It is estimated that the payback period for distributed solar PV generation in this region is about five to ten years, depending on the technology, which becomes more efficient and affordable every year.

Outlying areas also have the potential to deploy various other technologies, including solar thermal, heat pumps (groundwater- and sewage-sourced) as well as biogas from sewage. According to the master development plan of Tongli 2011–2030, the city and surrounding areas will build three sewage-treatment plants. Heat pumps utilising heat from sewage in Tongli Town could be deployed at up to 21 MW of total capacity. This technology could meet heating and cooling needs for an area of around 2 $km^2$, roughly the size of the historic town centre (IRENA, 2018a).



12 In the historic centre of Tongli Town there are 4 500 households, 255 of which use coal and oil products for cooking and heating and cooling; the remaining 4 200 households use gas canisters for the same purpose (IRENA, 2018a).

13 Assumption is based on regional average and local experts' research (Jiao, 2017).

## DEPLOYING RENEWABLE ENERGY IN TONGLI

In accordance with China's policy framework for renewables, Tongli Town releases no policies on its own but implements those released by higher-level government departments, including the NEA, the Jiangsu provincial and Suzhou Municipality government (see Figure 13). Tongli's renewable energy deployment is hence the result of interwoven policies that include higher-level governments, as well as local initiatives.

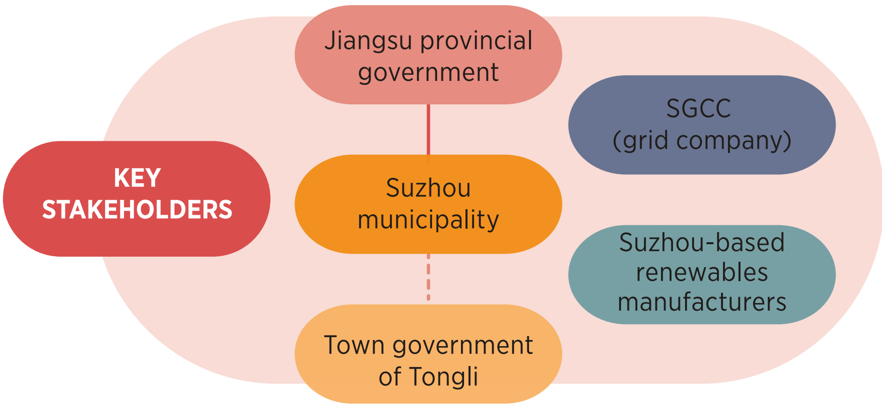

### The role of Jiangsu provincial government

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 the 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 the 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.

**Figure 13 Key stakeholders in Tongli Town's renewables policy**





Source: IRENA urban policy analysis

***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 means mostly hydro plants in southwest China. Hydroelectricity is equivalent to a 30% renewable share in total final energy consumption by 2020 (see Tables 3 and 4) (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 3 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 4 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%, 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 transportation;
- Supporting renewables-related technology innovation and companies that provide relevant solutions.

***Financier and awareness-raiser***

Apart from the FiT defined by the 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 the 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

In collaboration with Suzhou Municipality, the town government of Tongli is responsible for defining strategy, setting targets and implementing development plans and related policies.

### *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. It aims to deploy renewable energy, mainly from hydro electricity derived from western China, as well as some distributed solar PV and wind demonstration projects and electric buses (Suzhou Municipality, 2018c).

The plan set 2020 targets for both 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 historic town centre, the focus is on the electrification of 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 the deployment of a fast-charging EV station, 4 electric bus-charging stations and 60 regular EV charging stops.

The larger area of Tongli Town, on the other hand, 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 tce).

The 2020 renewable energy targets for both the larger Tongli Town and its historic town centre were achieved in 2018. 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 2.50 daily bill, which is much lower than the USD 8[14] 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 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 of part of the Wujiang District, another district under Suzhou City. As Wujiang has more industries, the combined plan provides opportunities to utilise local renewable industries to provide tailored plans and solutions for Tongli's deployment of renewables.

Suzhou

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

***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.

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, renewables' share in the grid is planned to increase.

In addition, the town's several demonstration projects include an international energy transition forum co-hosted by the NEA, Jiangsu provincial government and IRENA (see Box 16).

## BOX 16 DEMONSTRATION PROJECTS IN TONGLI TOWN: SGCC'S ENERGY SERVICE CENTRE AND A PERMANENT VENUE FOR AN INTERNATIONAL ENERGY TRANSITION FORUM

SGCC, the largest state-owned grid company in China, has collaborated with Suzhou Municipality to build a comprehensive energy service centre in Tongli Town. Located on the north side of the historic part of town, the service centre is the office building of the SGCC branch company in Suzhou and features a demonstration of renewable technologies deployed here.

Utilised renewables include small-scale solar PV, low-speed wind generation and a groundwater-sourced heat pump, among others (SGCC, 2018a). New technologies like solar thermal power generation and liquefied air storage have 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 construction.

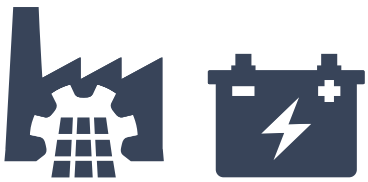
In collaboration with Suzhou Municipality, Tongli is also building a permanent venue for the International Forum on Energy Transition, which was cohosted by the NEA, Jiangsu provincial government and IRENA in 2016 and 2018 (Suzhou Municipality, 2016).

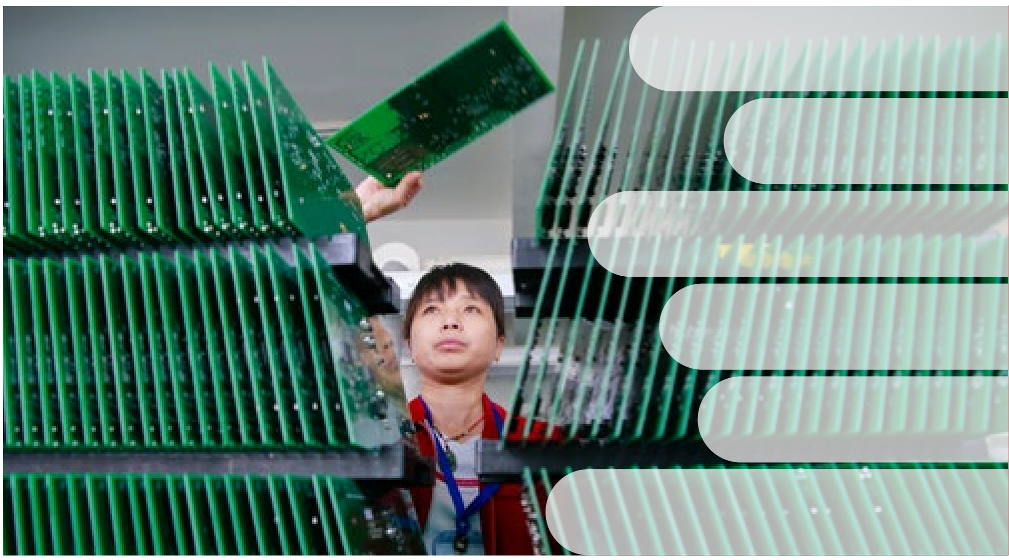
It is difficult to estimate the total investment thus far. Suzhou Municipality and Tongli Town invested in most of the demonstration and pilot projects, in collaboration with SGCC and the Jiangsu provincial government, while the FiTs and additional incentives for technology development come from the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

## The role of Suzhou-based renewables manufacturers

Renewable energy-based manufacturers play a role in the deployment of renewables locally. Suzhou City is one of the most industrialised cities and seeks to transition from conventional manufacturing industries to renewables and other strategic emerging industries. Solar PV manufacturing is a key industry asset. The city is 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 in module products and supply. Related industry branches manufacture EVs and batteries.

This industrial cluster implies that local political awareness of available RETs is high, as is the motivation of local government 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 AND CONSIDERATIONS FOR REPLICABILITY

Advancing towards ambitious renewable targets in Chinese cities requires collaboration across all levels of government to enable a change in energy policies that were originally designed for fossil fuels. It also requires the upgrade of grid infrastructure. More important, the transition of end-use sectors from fossil fuels to renewables not only offers financial and social benefits but also addresses key environmental challenges.

## Electrification strategies can support the scaling up of renewable energy and improve the urban environment

Chongli and Zhangjiakou as a whole benefit from the availability of renewable energy projects on a large scale, 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 scaling up of renewable energy. Cities, towns and districts can be important laboratories demonstrating the feasibility of policies supporting electrification nationwide. The utilisation of redundant wind power capacity for heating purposes offers a way to address 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 lessened environmental pollution.

## Access to financial resources is critical for rapid, proactive 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 that has one of the largest government revenue streams among Chinese 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 less wealthy than 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.

## Existing 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 together with cities willing to support innovative industries through deployment policies benefit both local industries and cities themselves through shortened supply chains and lower costs.

## Showcase events can help 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

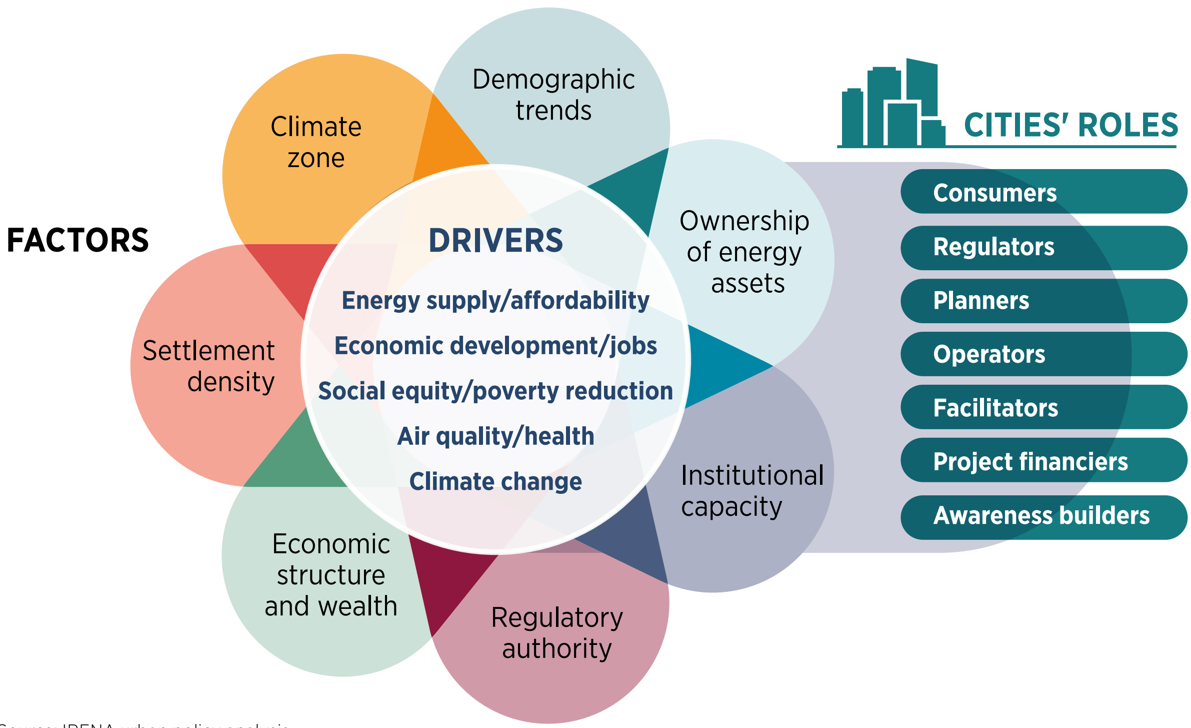
One of the replicable success factors in Chongli's ability to raise the share of renewables in end use sectors is its collaboration with upper government levels, including the municipal government of Zhangjiakou and the Hebei provincial government. The provincial government has played a pivotal role 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 setting renewable energy targets, banning highly polluting fuels, subsidising EVs and integrating distributed solar panels in buildings. These are replicable policy instruments at the city and town levels, supporting the deployment of renewable energy across various sectors. The collaboration with Jiangsu provincial government and the NEA also supports the scaleup of distributed renewables generation and the electrification of the heating and cooling and transport sectors at the regional and national levels.

# WRAP-UP

Political and administrative systems shape the extent to which cities are able to act autonomously, on energy policy and in other matters. In China, as in other countries, cities are promoting the use of renewable energy even as a complex set of circumstances determine their energy needs and their capacity to act. Diverse factors shape the many roles that cities can fulfil, and diverse drivers, likewise, inform the policies actually formulated in pursuit of renewables for electricity, heating and cooling, and transport (see Figure 14).

**Figure 14 Factors and drivers motivating municipal energy policies and shaping cities' roles in the energy transition**




Source: IRENA urban policy analysis

Tongli, China

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 improved energy access and reduced energy poverty); and air quality and health as vital components of a better urban quality of life and concerns about 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 cannot be changed, and it shapes a city's heating and cooling needs). 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 cities' institutional capacity and authority 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.

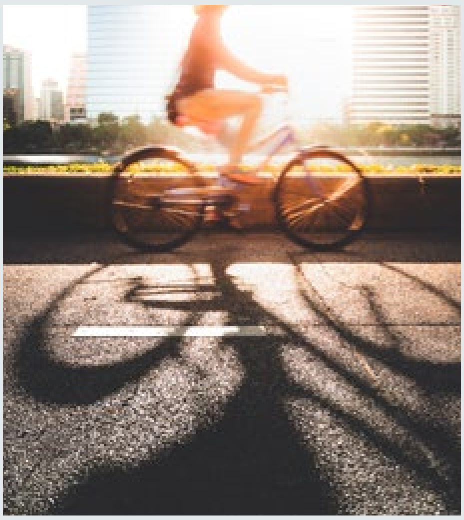
These background factors and drivers interact and influence one another. Together, they determine the specific **roles** cities can play in the energy transition, whether it be as regulators, planners and operators, energy consumers, project facilitators and financiers, or as facilitators of raised public 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.

Lessons learnt and best practices are worth sharing among cities, domestically and internationally. Indeed, many are collaborating with like-minded cities and 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.

A range of policies in support of renewable energy is relevant to cities, but 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. Just as critical is 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. Policy ambition 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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## ABBREVIATIONS

| | |
|---|---|
| **CNREC** | China National Renewable Energy Centre |
| **CNY** | Chinese yuan [currency] |
| **$CO_2$** | carbon dioxide |
| **CREIA** | Chinese Renewable Energy Industries Association |
| **e-mobility** | electric-mobility |
| **ERI** | Energy Research Institute [China] |
| **EV** | electric vehicle |
| **FIPs** | feed-in premiums |
| **FITs** | feed-in tariffs |
| **FYPs** | five-year plans [China] |
| **GDP** | gross domestic product |
| **GHG** | greenhouse gas |
| **GW** | gigawatt |
| **$GW_{th}$** | gigawatt thermal |
| **GWh** | gigawatt-hours |
| **IEA** | International Energy Agency |
| **kg** | kilogramme |
| **km** | kilometre |
| **$km^2$** | square kilometre |
| **KRW** | Republic of Korea won [currency] |
| **kW** | kilowatt |
| **kWh** | kilowatt-hours |
| **$m^2$** | square metre |
| **MEE** | Ministry of Ecology and Environment [China] |
| **MIIT** | Ministry of Industry and Information Technology [China] |
| **MoHURD** | Ministry of Housing and Urban-Rural Development [China] |
| **MW** | megawatt |
| **NDC** | Nationally Determined Contribution |
| **NDRC** | National Development and Reform Commission [China] |
| **NEA** | National Energy Administration [China] |
| **PM** | particulate matter |
| **PV** | photovoltaic |
| **R&D** | research and development |
| **RE** | renewable energy |
| **RETs** | renewable energy technologies |
| **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 |
| **toe** | tonnes of oil equivalent |
| **TWh** | terawatt-hours |
| **UN** | United Nations |
| **UNESCO** | United Nations Educational Scientific and Cultural Organisation |
| **USD** | US dollar [currency] |
| **WHO** | World Health Organization |

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