IRENA
International Renewable Energy Agency

RENEWABLE ENERGY POLICIES FOR CITIES

EXPERIENCES IN COSTA RICA

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

Extracted from: IRENA (2021), *Renewable Energy Policies for Cities: Experiences in China, Uganda and Costa Rica*, International Renewable Energy Agency, Abu Dhabi.

ISBN: 978-92-9260-312-0

About IRENA

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

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IKI support

This project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

Acknowledgements

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Valuable external review was provided by María José Vasquez (IFAM), Roberto Quirós Balma (ICE) and Esteban Bermudez (UNEP/MOVE).

Valuable review and feedback were also provided by IRENA colleagues Fabian Barrera, José Torón, Paul Komor and Neil MacDonald.

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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. Chapter 2 presents case studies in the Costa Rican context, with highlights of **Cartago**, **Grecia** and **Guanacaste**.

Together with studies from the series regarding the experiences of selected cities in China and Uganda, they highlight the reality of cities that either have effective policies in place or they have untapped renewable energy resources that could contribute to their sustainable development. The experiences also illustrate deployment strategies for renewable energy across vastly different socio-economic and institutional contexts.

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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ABBREVIATIONS

ACESOLAR	Costa Rican Solar Energy Association (Asociación Costarricense de Energía Solar)
ACOPE	Costa Rican Association of Energy Producers (Asociación Costarricense de Productores de Energía)
ARESEP	Public Authority for the Regulation of Public Services (Autoridad Reguladora de Servicios Públicos) [Costa Rica]
ASOMOVE	Costa Rican Association of Electric Mobility (Asociación Costarricense de Movilidad Eléctrica)
BCIE	Central American Economic Integration Bank (Banco Centroamericano de Integración Económica)
CENCE	National Centre for Energy Control (Centro Nacional de Control de la Energía) [Costa Rica]
CNFL	National Company of Power and Electricity (Compañía Nacional de Fuerza y Luz) [Costa Rica]
CO_2	carbon dioxide
CONARE	National Council of Rectors (Consejo Nacional de Rectores) [Costa Rica]
CORCLIMA	Commission for Resilience to Climate Change (Comisión para la Resistencia al Cambio Climático) [Costa Rica]
CRUSA	Costa Rica–United States Foundation for Cooperation
e-mobility	electric-mobility
ESPH	Heredia Public Services Company (Empresa de Servicios Públicos de Heredia) [Costa Rica]
EV	electric vehicle
GAM	Grand Metropolitan Area [Costa Rica]
GDP	gross domestic product
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit [Germany]
GW	gigawatt
GW_{th}	gigawatt thermal
GWh	gigawatt-hours
ICE	Costa Rican Electricity Institute (Instituto Costarricense de Electricidad)
IFAM	Municipal Advisory Institute (Instituto de Fomento y Asesoría Municipal) [Costa Rica]
IEA	International Energy Agency
INCOFER	National Railroads Institute (Instituto Costarricense de Ferrocarriles) [Costa Rica]
INS	National Insurance Institute (Instituto Nacional de Seguros) [Costa Rica]
JASEC	Cartago Electric Service Administrative Board (Junta Administrativa del Servicio Eléctrico de Cartago) [Costa Rica]
KAIST	Korea Advanced Institute Science and Technology
kg	kilogramme
km	kilometre
km^2	square kilometre
KRW	Republic of Korea won [currency]
kW	kilowatt
kWh	kilowatt-hours
m^2	square metre
MIDEPLAN	Ministry of National Planning and Economic Policy (Ministerio de Planificación Nacional y Política Económica) [Costa Rica]
MINAE	Ministry of Environment, and Energy (Ministerio de Ambiente y Energía) [Costa Rica]

MIRENEM	Ministry of Natural Resources, Energy and Mining (Ministerio de Recursos Naturales, Energía y Minas) [Costa Rica]
MOU	Memorandum of Understanding
MW	megawatt
NDC	Nationally Determined Contribution
NGO	non-governmental organisation
PEN	State of the Nation Programme (Programa Estado de la Nación) [Costa Rica]
PV	photovoltaic
RE	renewable energy
RETs	renewable energy technologies
SEN	National Electricty System (Sistema Eléctrico Nacional) [Costa Rica]
SEPSE	Energy Planning Secretariat (Secretaría de Planificación del Subsector Energía) [Costa Rica]
SIEPAC	Central American Electrical Interconnection System (Sistema de Interconexión Eléctrica de América Central) [Costa Rica]
SOPEC	Southeast Ohio Public Energy Council [United States]
SWH	solar water heating
ToU	Time of Use
TWh	terawatt-hours
UN	United Nations
UNGL	National Union of Local Governments (Unión Nacional de Gobiernos Locales) [Costa Rica]
USD	US dollar [currency]
WHO	World Health Organization

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 Costa Rica. 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.

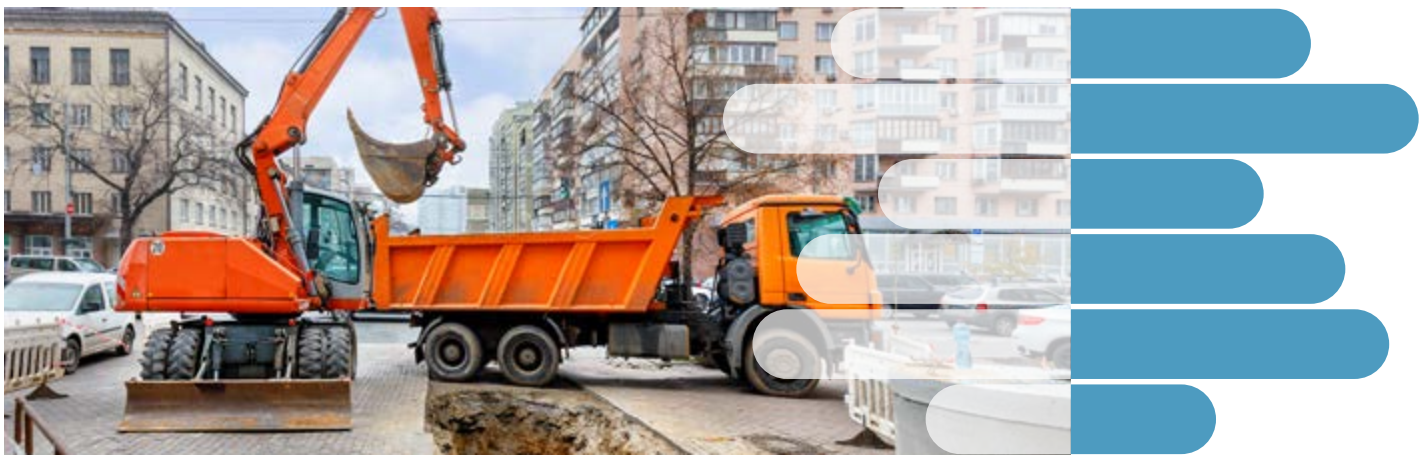
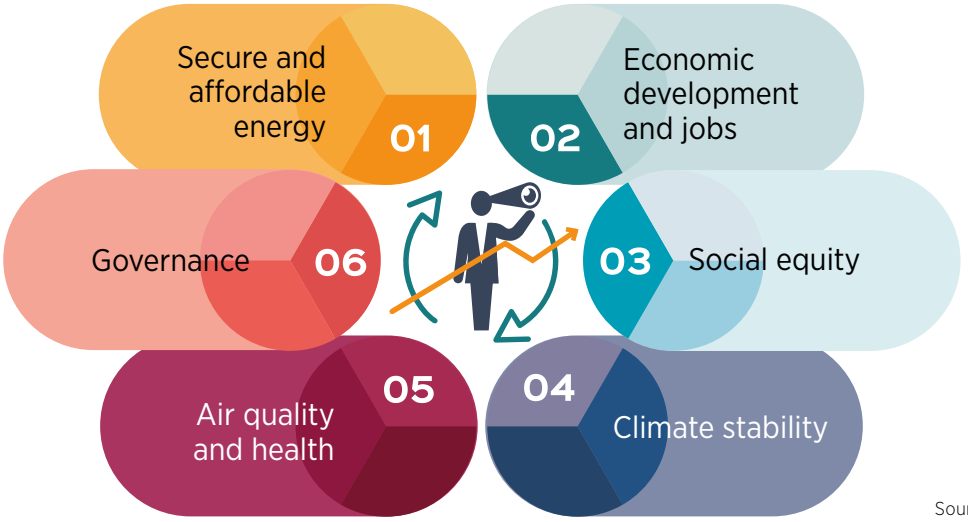


Figure 1 Motivations and drivers of municipal decision making on energy



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.

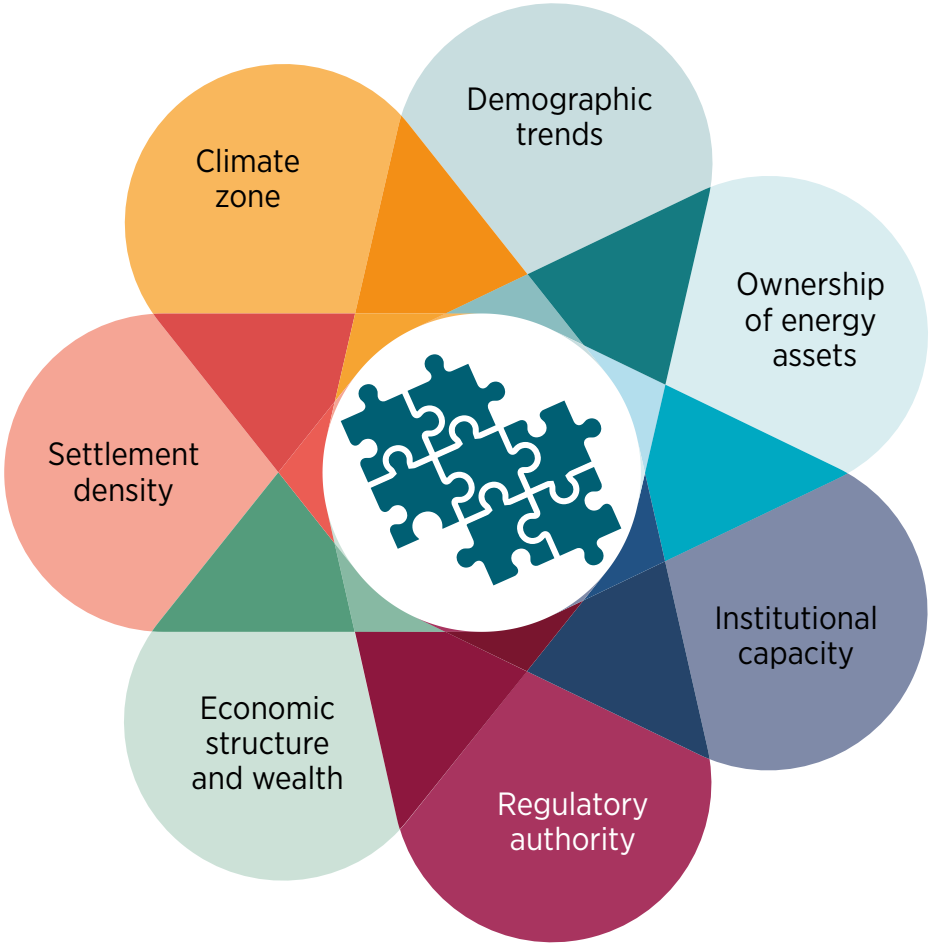
Local energy transition strategies are driven by multiple actors whose significance varies from city to city (and country to country), reflecting different administrative and policy making structures, as well as civic cultures. Mayors, city councils and municipal agencies are key actors in planning, 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

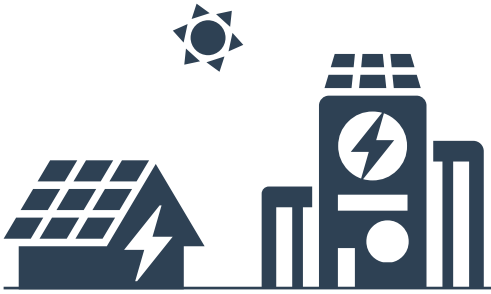
Chinese cities have been at the forefront of solar rooftop efforts. The city of **Dezhou**, in Shandong Province (northwest China), launched its "Million Roof Project" in 2008, requiring that all new residential buildings be equipped with solar water heaters. Solar thermal or solar PV technology is integrated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

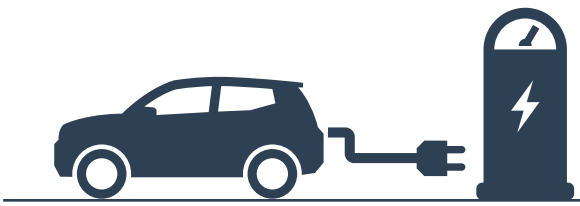
Accounting for one-third of total final energy consumption worldwide, the transport sector is one of the largest energy users in the urban environment, making it an important, yet often neglected target of renewables-focused policy. Energy demand in the transport sector is growing fast, and a significant 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 as in the case of Costa Rica.

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

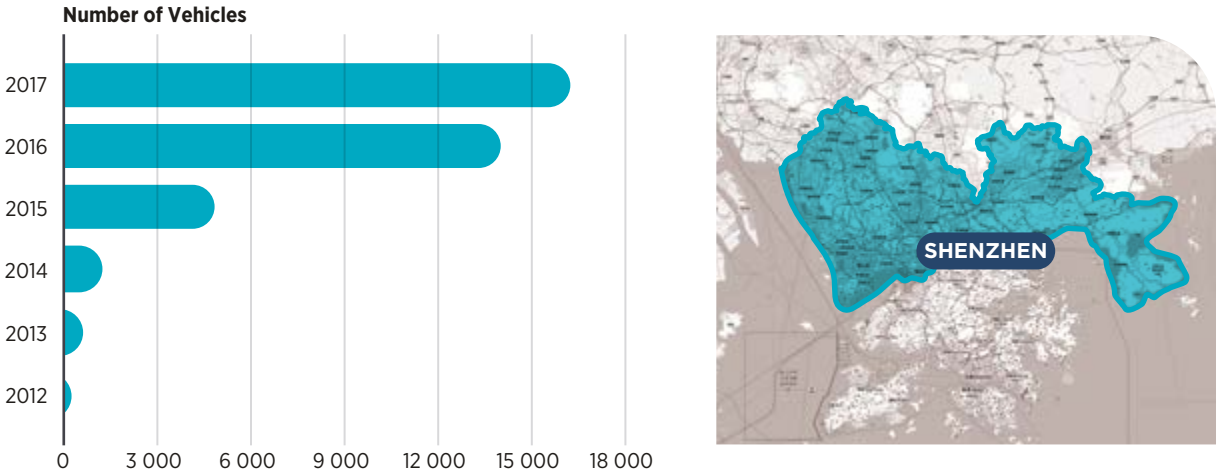
BOX 9 PIONEERING ELECTRIC BUS USE IN SHENZHEN

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

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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.

Santa Marta, Rio de Janeiro, Brazil

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 Costa Rican context. The next chapter begins with a sketch of the national context and how it frames what Costa Rican cities can and cannot do. In the final chapter, a discussion of relevant initiatives and experiences is followed by a set of lessons learnt and a wrap-up with some broader conclusions.

Country Case

National Context

Initiatives and Experiences

Lessons learnt

COSTA RICAN CITIES: CENTRALISATION AND PROMOTION OF E-MOBILITY

NATIONAL CONTEXT

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

Costa Rica is well known for its large share of power generation sourced from renewable sources – 98.5% as of 2019 – based on hydro, wind and geothermal projects. This stands out internationally and in Latin America, where only Uruguay and Paraguay have rates of over 90%. In 2019 the government passed a national plan to make Costa Rica one of the world's first fully decarbonised economies to reach net-zero carbon neutrality by 2050 as established in the Paris Agreement on climate change.

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

Costa Rica's small size allows a high degree of centralisation in political decision-making structures. This restricts cities' ability to make autonomous policy decisions.

This chapter will examine the roles played by both national and municipal actors. It also points out the need to empower municipalities in mobility and urban planning. The national decarbonisation plan offers a new opportunity for such empowerment as the central government recognises the importance of engaging municipalities in its implementation.

The urban and municipal context

Costa Rica has a population of only 5 million, equivalent to what in other countries is a mid-sized city run by a single municipality – for example, Bogotá's 7 million people. For this reason, the central government has traditionally made all the decisions concerning energy and transport policies. The municipal landscape, by contrast, is deeply fragmented, a feature that is increasingly seen as one of the main challenges to be tackled in order to achieve a sustainable urban future (Presidencia de La República, 2019a).

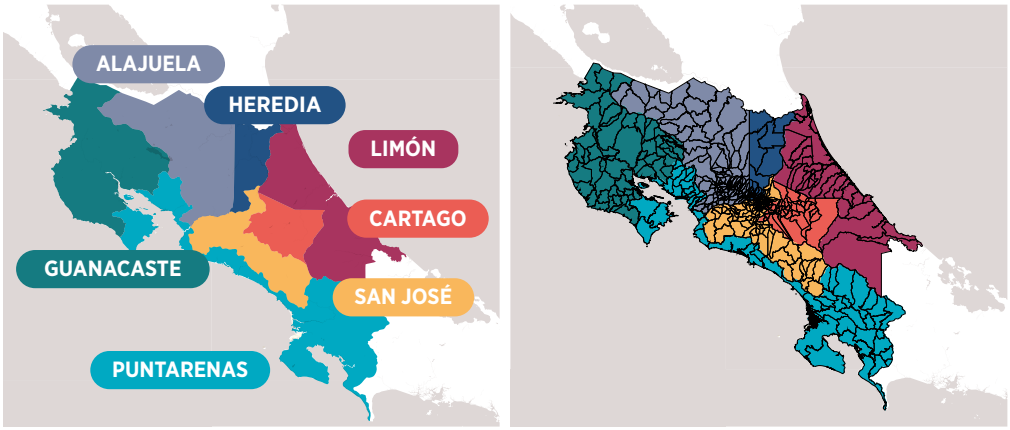
Costa Rica has seven provinces – Alajuela, Cartago, Guanacaste, Heredia, Limón, Puntarenas and San José, but no provincial governments as such. The country is split into 82 small municipalities (*cantones*, or counties)[5] (see Figure 5). For example, the Province of San José, where the capital is located, has 20 *cantones*. The capital is run by one municipality, and mayors oversee small slivers of the surrounding population, such as in the municipalities of Montes de Oca and Curridabat that are home to 55 000 and 32 000 people, respectively. The cantones are further subdivided into 484 districts, some with populations as small as 1 000 people.

Costa Rica's centralised governance structure mirrors the geographical concentration of the economy. The bulk of the population and economic activity is concentrated in the Grand Metropolitan Area (GAM), which represents just 4% of the country's surface area spread across the provinces of Alajuela, Heredia and Cartago (see Table 1). GAM is home to about 60% of Costa Rica's total population (some 2.8 million residents) and 65% of all companies, and accounts for 82% of commercial revenue nationwide (Presidencia de La República, 2019a; Arce, 2020).

Laws and provisions concerning municipalities are not always implemented. Since 1968 the country has had an urban development law in place that mandates municipalities to design and execute "regulatory plans", yet most of them are in breach of the law. Since 1971, Costa Rica has a law to support municipal development. The Municipal Advisory Institute (IFAM, Instituto de Fomento y Asesoría Municipal), was created as an independent entity that is part of the government. The president of IFAM, as well as the board, are political appointees. The role of IFAM is to advise the local governments operating in the 82 municipalities. In 1972, a National Union of Local Governments (UNGL, Unión Nacional de Gobiernos Locales) was launched to secure local governments' representation in various domestic fora. The UNGL board is made of political appointees proposed by the municipalities.

5 Costa Rica has also defined 24 indigenous territories administered by indigenous development associations.

Figure 5 Costa Rica's provinces, cantones and districts



Source: Guías Costa Rica, n.d.

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

Table 1 Costa Rican provinces and main cities

Province	Population size	Size (km²)	Population density (people per km²)	Main city	Population in the main city	Number of Cantones	Number of Districts
San José	1 404 242	4 965	282.8	San José	288 054	20	123
Alajuela	848 146	9 757	86.9	Alajuela	254 886	26	115
Cartago	490 903	3 124	157.1	Cartago	147 898	8	51
Heredia	433 677	2 656	163.2	Heredia	123 616	10	47
Puntarenas	410 929	11 265	36.5	Puntarenas	11 501	11	60
Limón	386 862	9 188	42.1	Limón	94 415	6	29
Guanacaste	326 677	10 140	32.2	Liberia	62 987	11	59

Source: INEC, 2011.

Note: San José, Alajuela, Cartago and Heredia are among the GAM provinces.

A new imperative for decentralisation

Costa Rica's centralised governance structure was designed at the end of the 1940s right before urbanisation took off, yet the municipal structures were not considered. This top-down model had many benefits – a stable welfare state, social progress in the form of a sound health-care system, free education and near-universal access to energy. But one of the downsides of this model is limited urban planning and severely restricted municipal decision making and expertise.

This paradox is openly discussed in the country. Today the imperative to rethink urban development has energised many stakeholders – ministries, independent public agencies, civil society and municipalities themselves. As sustainable-city initiatives gain momentum around the world, Costa Rica has seen the emergence of new initiatives engaging municipalities – instead of the traditional efforts centred around the Ministry of Environment, and Energy (MINAE). For example, an attempt to protect an important urban river that passes through four counties inside San José brought together the mayors from the relevant municipalities in 2018. The project would be overseen by each of the town councils, which would in turn be co-ordinating with the different institutions involved, including aqueducts and sewers administrations, the Ministry of Environment and Energy and the public or private hydroelectric plants (Gutiérrez, 2018). NGOs focused on urban development increasingly work with municipalities to build bottom-up strategies – for example, *Rutas Naturbanas* is an attempt to connect the city through pathways by the city rivers (see above).

In 2018, the central government formed a grand commission including the ministries of housing, economic planning, environment and energy; independent public institutions dealing with municipalities, such as IFAM; and several public service companies, including the power and water utilities as well as the National Emergency Commission.

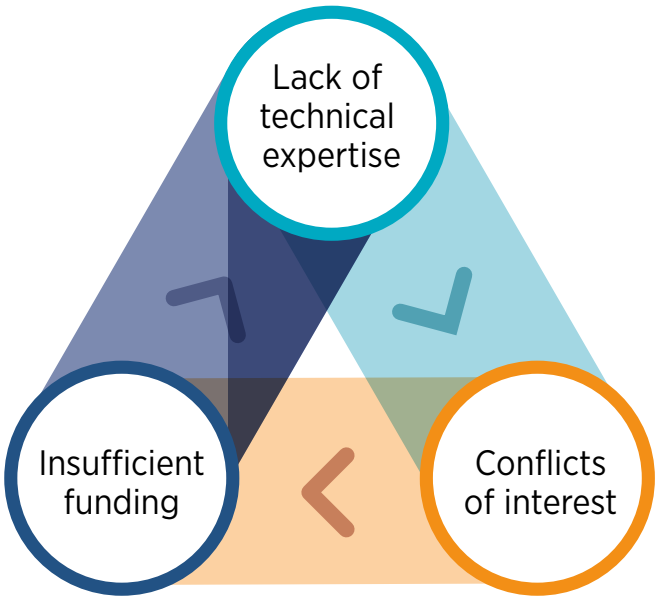
The Office of the First Lady[6] was given the presidential mandate to co-ordinate this commission with the purpose of passing a new urban development plan to 2030. A public consultation was launched in 2018 to seek feedback. The programme aims to reverse decades of delay in urban planning, particularly among municipalities. The commission highlighted both the breaches of urban development law dating back to 1968 and the low rate of execution by municipalities: only 31 out of 82 have published the mandatory "regulatory plans"[7] to deal with land use and environmental issues, and most of the existing plans are incomplete (see Box 11).

The breach of the law by so many municipalities for so many years explains, according to this commission, much of Costa Rica's weak urban track record. The commission also details the obstacles that municipalities encountered, including conflicts of interest, insufficient funding and lack of technical expertise (see Figure 6). Previous attempts to support municipalities to develop urban planning tools have failed. The core of the case for change is the need to work with municipalities to design and implement these missing regulatory plans that are mandated by law (Presidencia de la República, 2018a).

6 The Office of First Lady or First Gentleman in Costa Rica relies on private donations to cover the expenses of the office agenda. These funds support selected causes and foundations which traditionally focus on cultural, environmental and social issues.

7 The regulatory plans are instruments defined by the Urban Planning Law (Law Number 4240, 1968). They encompass development policy and plans for population distribution, land use, roads, public services, communal facilities, and construction, conservation and rehabilitation of urban areas (INVU, 2019).

Figure 6 Key challenges to municipal policy making



Source: IRENA urban policy analysis

BOX 11 MUNICIPALITIES AS A "MISSED OPPORTUNITY" TO ADVANCE DEVELOPMENT

As the central government faces fiscal constraints, there could be potential for strengthening local governments to make a palpable difference in human development.

A 2019 study by the State of the Nation (Programa Estado de la Nación, PEN)[8] identified two areas with potential to recalibrate the use of municipal social investments (in water infrastructure and waste management). There are better ways to manage these budgets so they can make a positive difference.

In addition, the analysis looked into the municipalities' legal mandates (for environmental management and land-use decisions) that could also make a difference if implemented with proper policy instruments.

The study confirms the lack of tools to carry out municipalities' environmental performance duties and points out that only 40 of the 82 municipalities have land-use plans; where plans exist, they are often incomplete. The election of new mayors in February 2020 was seen as a concrete opportunity to have a national debate about the future of local governments.

PEN developed a new online tool (at www.dcifra.cr), calling on citizens to "decipher their municipality" prior to the elections of 2 February 2020 and to increase the level of public scrutiny of poor performance over the years. Many mayors have been in power for decades; for example, the mayor of San José has been in office for 30 years.

Source: Estado de la Nación, 2019.

Dcifra TU CANTÓN

8 The State of the Nation Programme (PEN) is a think tank that belongs to the National Council of Rectors (CONARE, by its Spanish acronym), composed of Costa Rica's five public universities. PEN aims to conduct research and innovation for the promotion of sustainable human development, in its economic, political, environmental and social dimensions, by engaging with public and private organisations, as well as with international co-operation agencies. PEN also has the support of the Defender of the Citizens of the Oficina de la República (Office of the Republic).

San José

COSTA RICA'S ELECTRICITY SECTOR AND ENERGY INSTITUTIONS

The peculiarities of Costa Rica's governing structures accord high importance to national-level institutions even when it comes to city-level decision making and actions. It is therefore critical to understand the country's broad energy institutional framework and to identify key actors and stakeholders. This section also considers the mix of sources and other relevant attributes of the country's energy and electricity sectors.

The energy institutional framework

National-level authorities, the state-owned utility and regulators play central roles in energy policy:

- The **MINAE** governs Costa Rica's energy sector through the Vice Ministry of Energy, which is organised into technical divisions that manage energy issues and fuels for transport and industry.[9]
- The **Vice Ministry of Energy** drew up a national energy plan 2015–2030, currently under revision. MINAE's energy planning secretariat (Secretaría de Planificación del Subsector Energía, SEPSE) engages main stakeholders (discussed in the next section) such as the Costa Rican Electricity Institute (in Spanish, the Instituto Costarricense de Electricidad, or ICE), distribution companies, private generators, the national oil refinery and electrification co-operatives. In addition to SEPSE, an energy directorate focused on implementation became operational.
- The **Public Authority for the Regulation of Public Services (ARESEP)** sets the technical standards guiding electricity services and electricity tariffs and monitors the application of regulations.
- The **Costa Rican Electricity Institute, the state-owned utility known as ICE**, manage and operates the electricity sector and draws up 20-year plans for the electricity sector.

In contrast to many other countries, Costa Rica's highly centralised model leaves cities with close to no role in generation projects or energy-relevant sectors such as public transport.[10] Their main function is often limited to administrative tasks such as granting permits associated with energy projects. Lively debates are ongoing about the need to strengthen the role of cities and municipalities.

Key stakeholders in the electricity sector

ICE, Costa Rica's state-owned utility, controls generation, transmission and distribution grids through a vertically integrated, non-competitive regime (see Figure 7). New players seeking entry to the Costa Rican electricity value chain must have an enabling legal title or a public service concession.

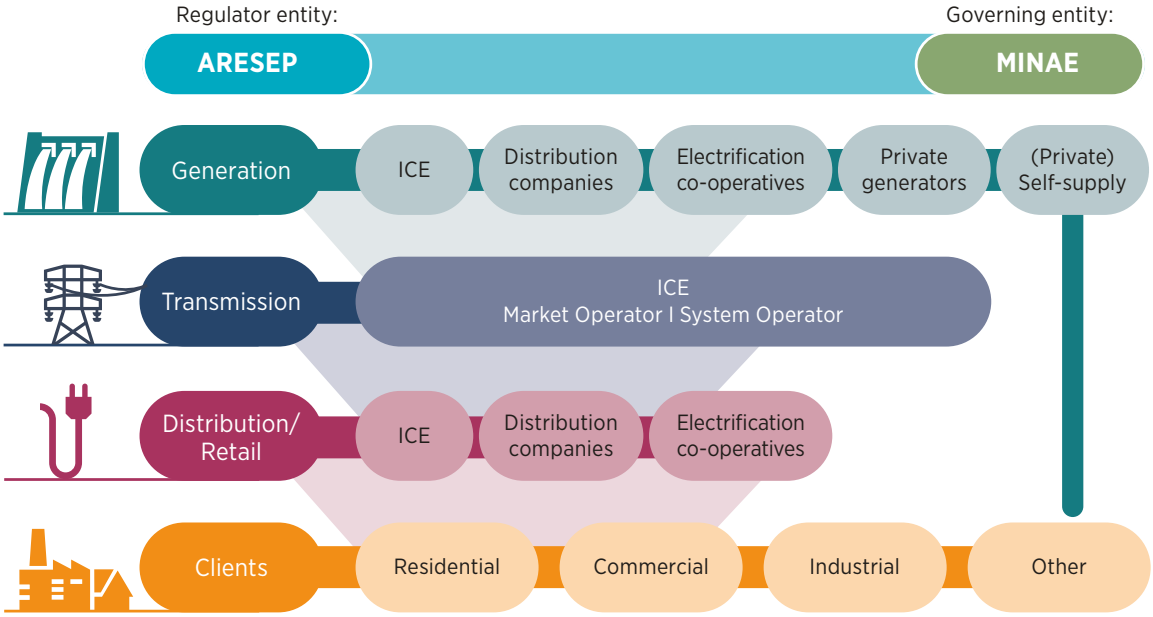
From generation to transmission and distribution, there are few major actors.

San José Province

9 Originally created as the Ministry of Natural Resources, Energy and Mining (MIRENEM) in 1988, this ministry has been reformed several times, most recently in 2013 when it became the Ministry of Environment and Energy (MINAE).

10 Cities have a say in bike lanes and shared transport systems (one is being tested by the municipality of Cartago) and exclusive lanes for buses. For personal vehicles, all decisions are taken by the national government.

Figure 7 Main stakeholders in Costa Rica's electricity system



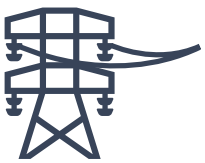
Source: Utgard and Forn, 2016.

Generation:

ICE owns most generation plants. Two distribution companies control the remaining plants, four rural electrification co-operatives grouped under conelectricas R.L., 37 private companies operating hydro plants, wind farms and solar[11] projects (grouped under the industry association, ACOPE) as well as individuals who self-generate their electricity. In general, ICE generates 70% of the country's electricity, while 20% comes from private generators.[12]

Transmission:

Only ICE can legally provide transmission services. ICE's National Centre for Energy Control (CENCE) is responsible for the operation of the transmission system, known as SEN, which is part of the Central American Electrical Interconnection System (SIEPAC) facilitating regional electricity exchanges.



11 ACESOLAR, the Costa Rican Solar Energy Association, was established in 2012 and brings together around 70 national and international companies including solar energy generation companies and technology providers. They have played an active role in promoting distributed energy solutions and modern regulation to boost Costa Rica's solar power generation.

12 Private generators can be subcontracted within the 30% cap that is established by the law. The two distribution companies operate plants reaching 10% of installed capacity.

Distribution:

ICE is again the primary distribution agency and controls nearly 80% of the market together with its subsidiary National Company of Power and Electricity[13] (CNFL, by its Spanish acronym). Two public service companies operate in Cartago (JASEC) and Heredia Public Services Company (ESPH), each with about 10% of the market. They operate independently of the municipalities.

Clients:

The largest electricity consumer in Costa Rica is the residential sector (38% of demand as of December 2017) followed by the commercial sector (36%) and industries (21%) (Grupo ICE, 2019). Others include churches and schools. The regulator sets the tariffs for ICE sales to the distribution companies, for sale by distribution companies to their clients and customers selling their electricity to the distribution companies (Grupo ICE, 2019).

Diversifying Costa Rica's electricity system

As of December 2017, Costa Rica's installed power-generating capacity was 3 530 MW, of which hydropower accounted for 66%, wind power for 11%, thermal plants for 16%, geothermal plants for 6%, with the remaining 1.2% from biomass and solar. Generation was 11 210 GWh, of which ICE produced 66%, private companies 24% and distribution companies 10% (Grupo ICE, 2019).

In 2019, Costa Rica reached more than 98% of clean production for the fifth consecutive year (Presidencia de La República, 2019a). This generation comes from five renewable energy sources: hydropower, geothermal, wind, biomass and solar (see Table 2).

Hydropower dominates the electricity supply in Costa Rica, but climate change (and increasing drought conditions) will likely reduce the reliability of hydropower generation. There is a growing awareness, for example, in the National Energy Plan of 2015, of Costa Rica's vulnerability to climate change and the link to hydropower production. Efforts have been underway to

13 Compañía Nacional de Fuerza y Luz S.A.

Table 2 Electricity generation in Costa Rica, June 2014–2018

		GWh	%
Renewable energy	Hydro	33 125	74.76
	Geothermal	5 289	11.94
	Wind	4 909	11.08
	Biomass	322	0.73
	Solar	12	0.03
Fossil fuel	Bunker fuel and diesel	653	1.47
Total		**44 309**	**100%**

Source: Grupo ICE, 2018a.

diversify the power matrix since the 1990s with a focus on wind and geothermal.

In 1996 Costa Rica inaugurated the first wind energy project in Latin America (Revista Summa, 2019). With 18 operational wind energy plants, Costa Rica reached over 400 MW in installed capacity in 2019 – compared with 66 MW ten years previous. Over 15% of annual production (1.8 GWh) came from wind, which is the highest percentage ever reached in Costa Rica (Revista Summa, 2019).

Geothermal energy contributes around 10% of electricity production. The addition of a new plant, Las Pailas II, operational since June 2019, lifted geothermal power capacity to 262 MW, the second largest in Latin America. Generation reached 132.7 GWh, the highest level since 2014 and equivalent to 13.3% of total electricity generated. The ICE attributes this development to its decision to rely more strongly on non-hydro renewable sources, driven by the experience in arid years such as 2014 and 2019 (Richter, 2019).[14]

Cachi, Cartago

The dominance of fossil fuels in transport

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

Relative to GDP, the weight of oil imports doubled between 2000 and 2010. However, instead of attempting to substitute imports with domestic supplies, a strong consensus has developed in favour of a moratorium on domestic oil exploration and exploitation. As maintained by five successive presidents from three different political parties since 2002, the Alvarado administration recently extended the moratorium to 2050, and a bill in Congress (Expediente No. 20.641) would make this ban permanent (Poder Ejecutivo, 2017).[15] An opinion poll by the State of the Nation, an independent academic entity, showed active citizen backing for the ban on oil drilling (Estado de la Nación, 2017).

For years the energy and transport debates have taken place on separate tracks, but the National Energy Plan 2015–2030 set joint goals for the first time to decrease dependence on oil by calling for cleaner forms of transport and fuels. In 2018 a law to promote zero-emission e-mobility was passed.

In October 2019, the government presented a set of adjustments in the National Energy Plan to 2030 to accelerate the implementation of actions to decarbonise the economy, in alignment with the National Decarbonisation Plan to 2050.

14 Most of the high-capacity reservoirs are located inside national parks. There is potential for low-enthalpy geothermal projects in other parts of the country, for example, Cartago or Golfito (Bermudez, 2019).

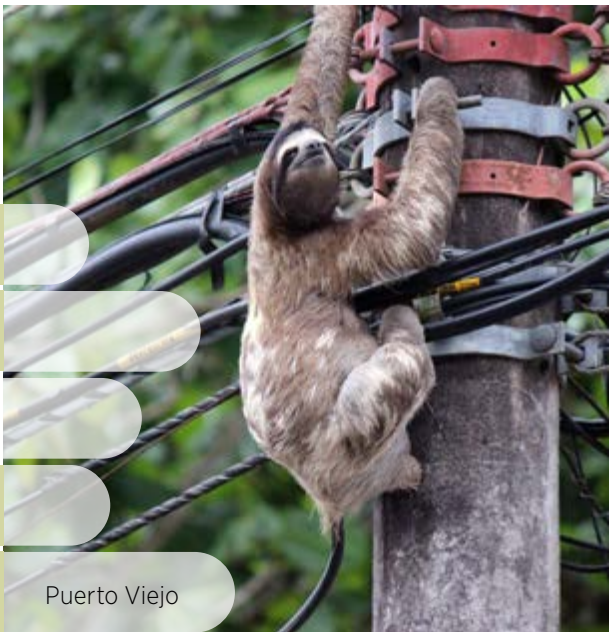
15 The official name of the bill is "Ley para avanzar en la eliminación del uso de combustibles fósiles en Costa Rica y declarar el territorio nacional libre de exploración y explotación de petróleo y gas". The proposal aims to terminate the previous law on hydrocarbons (Number 7399, from 1994). The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

EFFORTS TO ADDRESS NEW REALITIES

To diversify the country's energy mix requires both a change in the types of energy sources used and careful planning to avoid repeating missteps, as when erroneous projections of future electricity demand led to excess capacity. In this context, this section examines the relevant policy discussion and the work to draw up new rules for distributed generation. The section concludes with a discussion of Costa Rica's National Decarbonisation Plan.

Adjusting to weaker-than-expected demand growth

Costa Rica's annual electricity growth is 0.8%, according to 2017 data by the National Centre for Energy Control, CENCE (Lara, 2018a). This is much lower than the medium-growth projection of 4% and high-growth projection of 5.3% underpinning ICE's 20-year energy expansion plans (Lara, 2018b). Several factors help explain weaker than expected growth in demand: gains in energy efficiency across the economy, lower population growth and slower economic growth (Cañas, 2018).



Puerto Viejo

The resulting excess capacities have financial consequences for ICE and for public finances because lower-than-projected demand translates into lower revenues to pay for the expansion of capacity. ICE's total debt increased 41% in 2018 compared to 2013 (Lara, 2018c) and this had become a topic of public debate, especially since 2018, when fiscal reform debates came to dominate politics and experts called for cost-reduction measures and new taxes to avert an economic crisis. In December 2018, a budgetary reform was passed after years of failed attempts, and 2019 featured greater scrutiny of public debt.

Media scrutiny of ICE's performance has provided fresh impetus to debates of the pros and cons of liberalising the electricity market and of new ways to lower electricity tariffs. Thus far, municipalities have not been active in efforts to decentralise generation mostly driven by solar companies. ICE highlights the achievement of 100% renewable energy generation, the reliability of the system (for example, during natural disasters) and the access that over 99% of Costa Ricans have to energy. The private sector stresses the drag on competitiveness of high electricity prices and argues in favour of increased private-sector participation in power generation and a more diversified energy mix, including solar energy projects. It has been pointed out that the legal framework is unfriendly to new private-sector generation.

The subject of private electricity generation is controversial in Costa Rica. Past government efforts to privatise segments of the sector prompted protests that eventually forced the government to abandon its plans (Alfaro, 2017).

ICE is under pressure to reduce costs and create new revenue streams and is aware of the consequences of low demand growth. Excess capacity in the power sector means the need to review expansion plans. One consequence of this situation is the decision to cancel the 650 MW Diquís hydropower project, which would have been ICE's largest-ever (Lara, 2018a).[16] The project costs had escalated from USD 1.8 billion in 2010 to nearly USD 3.7 billion by 2015.

16 Diquís would have flooded indigenous territory. It faced opposition from several stakeholders, including local community members, ecotourism businesses and energy experts. One indigenous community member took the State to court in April 2019, asking the courts to reverse the 2008 executive order declaring Diquís a "project in the national interest". The Minister of Environment and Energy at that time stated publicly that he sided with the citizen's request – the national interest decree was unjustified, he argued – and declared in May 2018 that he too opposed the project (Lara, 2018b).

Expansion plans and engagement with municipalities

The 2019 edition of ICE's national expansion plan (2018–2034) reflects the Diquís cancellation and foresees no new capacity additions until 2026 but plans for additions of up to 653 MW by 2034 (Grupo ICE, 2019). Wind (280 MW) and geothermal (165 MW) are expected to contribute the most to this expansion, with additional hydro capacity limited to 47 MW, while increasing solar to 150 MW.

Other changes include the delay of a geothermal plant project in Guanacaste from 2024 to 2026, the closing of two old bunker-fuel plants (saving USD 5 million in operations) and a decision to halt any new investments in backup plants using fossil fuels (Lara, 2018c).

Costa Rica has no history of external stakeholder engagement in electricity sector planning and policy design, including local governments. This implies municipalities until today have limited decision making, and urban policies remain under the national authority.

ICE unveiled a new strategy in 2019 that is organised around five areas of work until 2023: (1) stabilisation and financial sustainability; (2) business evolution and customer experience; (3) operational efficiency, modernisation and digital transformation; (4) effectiveness of human talent; and (5) equity and sustainability. The framing vision is of a globalised society that is responsible, inclusive and sustainable. Smart cities are discussed as a global trend.

Modernisation entails the embrace of good governance practices such as accountability, transparency and fair treatment of stakeholders. Municipalities are, listed among the critical counterparts for ICE, along with banks, academia and manufacturers. While working with local governments does not feature in the strategy, this leaves hope for scope to revisit the role of local governing institutions in the future.

The national energy plan's stakeholder consultation

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

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

Tortuguero

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

New rules for distributed generation

Another opening for broader participation in power generation – and arguably policy formation – occurred in the context of distributed generation and solar projects. New regulations allow self-supply net metering in Costa Rica (La Gaceta Diario Oficial, 2015). Back in 2010, ICE had launched a pilot project to test self-supply distributed generation. The programme had a maximum capacity of 10 MW, and ICE clients could apply (366 users were accepted out of 416 applications) with 99.5% of the projects deploying solar PV but a single biomass power project making up 45% of the installed capacity (Utgard and Forn, 2016).

The pilot solar energy project was successful, but ICE terminated it in February 2015, stating that grid-connected distributed generation should be considered a public service. Ruling in June 2015 that self-supply was not a public service, the state attorney clarified the rules for two distributed generation categories. Under simple net metering for self-supply, up to 49% of monthly electricity generation can be fed into the grid without payment. Under complete net metering, electricity sold to the electricity company is considered a public service and permits are needed for grid connection.

The requirements for this second category are higher and more complex than for the first category. Setting a capacity limit of up to 49% for the monthly power generation, subject to payment, is still controversial as it arguably makes distributed generation less attractive for clients with high seasonality, for example, hotels. Costa Rica has a strong tourism sector, and some hotels have been exploring solar generation options. Thus far cities have not been active in these debates.

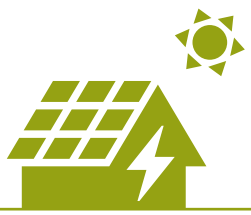
ICE has installed around 159 kW through rural electrification programmes that offer PV modules and direct current appliances to unserved clients in areas where extending the grid would be too expensive. Unlike municipalities, local entities were in these cases able to cater to themselves given that their customers need electricity in geographical areas that ICE does not reach.

Uncertainty remains, and efforts will be needed to avoid reducing distributed energy to one approach – for example, installing solar panels – without considering the wider spectrum of options such as demand management, energy efficiency and energy storage.[18]

One positive step would be to increase demand flexibility such as time of use (ToU) tariffs to incentivise large commercial and industrial energy consumers to reduce demand during peak hours. Thus far, one distribution company (CNFL) offers residential customers ToU tariffs. So far, the adoption of this voluntary scheme is marginal. Energy efficiency approaches are in place since 1994 and the National Energy Plan calls for stronger measures for end-use energy efficiency.

The main form of energy storage is large-scale hydropower dams connected at the transmission level. Fossil fuel–based power plants are the other backup for the electricity system. Most new buildings for offices and apartments have diesel generators to provide backup power for critical equipment in the event of power outages.

Once again, it is worth highlighting that municipalities are not yet part of this debate as they do not operate any power generation projects.



18 For an extensive discussion of distributed energy options in Costa Rica, see Utgard *et al.* (2016).

The National Decarbonisation Plan

Costa Rica is one of the first developing countries to establish an official target to fully decarbonise the economy by 2050 and to publish an official plan for each sector of the economy.[19]

Led by the Ministry of Environment and Energy, the National Decarbonisation Plan 2018–2050 envisions three implementation periods (2018–2022, 2023–30 and 2031–2050). It aims to send a signal to the private sector, the public and municipalities by identifying transformation routes for each sector, including areas of work that could open opportunities for city-level action. The actions are presented in ten sectoral focus areas for the next three decades and organised in four clusters:[20]

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

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

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

- Power sector,
- Buildings and
- Industry.

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

- Waste management.

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

- Agriculture,
- Livestock and
- Biodiversity.

Because three of the ten focus areas include clean transport, e-mobility is a central pillar of the decarbonisation vision.

In 2018, the decarbonisation of the economy became one of the three pillars of the National Development Plan, the official document guiding the central government. This plan tasks the Ministry of Economic Planning (MIDEPLAN 2018) to integrate decarbonisation into the activities of the line ministries.

Because Costa Rica has already effectively decarbonised its power generation, tackling its oil dependence is essential – a challenge mostly centred on the transport nexus. Table 3 discusses three focus areas in the National Decarbonisation Plan with direct relevance to transport and sustainable mobility.

The ministers of Environment and Energy, and Public Works and Transportation signed a transport sector agreement to reduce four megatons of CO_2 equivalent by 2050. This was announced the day the National Decarbonisation Plan was launched. The agreement's measures include public transport and active modes of transport such as biking and walking as well as cargo logistics (Cruse, 2019). Some municipalities are participating in the stakeholder engagement process surrounding this sectoral agreement.

Corcovado National park

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

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

Table 3 Cluster 1: Transport and sustainable mobility in the National Decarbonisation Plan

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

Source: Presidencia de La República, 2019a.

The decarbonisation plan and municipalities

Costa Rica has gained awareness of the limits of a highly centralised governance structure. The need to actively engage municipalities in the design of cities of the future has entered the public debate. This may be observed in the vision of a "bioeconomy, green growth, inclusion and improvements in the citizens' quality of life" as stated in the National Decarbonisation Plan (Presidencia de La República, 2019a: 1).

The plan sent a new signal to municipalities. Sustainable urbanisation is key to decarbonisation, and the plan's implementation will require a stronger role for cities and local governments. In particular, the 2050 vision for focus area 1 (public mobility) embraces the goal of "compact cities in the main urban areas of the GAM and a 10% increase of non-motorised mobility in secondary cities" (Presidencia de La República, 2019a:32).

While the central government has primary responsibilities under the plan and is required by law to make transport-related decisions, the plan sets two goals for municipalities for the 2018–2022 period. First, at least 3 municipalities are to adopt a "transit-oriented development" vision in their planning and management practices and, second, 16 municipalities must join the Carbon Neutrality Programme 2.0.

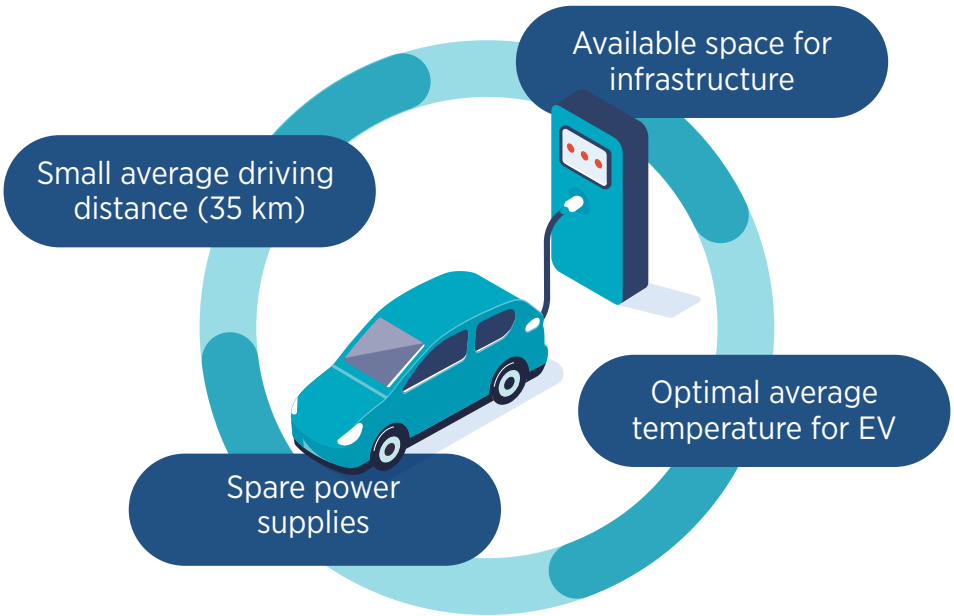
In terms of current administration activities (2018–2022), the focus will be on integrating the decarbonisation imperative into urban planning tools and manuals for municipalities and promoting compact city models by designing programmes and incentives for compact-city decisions. Enhancing infrastructure for bicycling and walking is a focus. There are also new restrictions on cars beyond San José and stricter parking rules. The government commits to include municipalities in decisions concerning bike paths and e-mobility.

ELECTRIC MOBILITY AS THE NEXT FRONTIER

While Costa Rica's decarbonisation plan raised the visibility of e-mobility both nationally and internationally, the initial impetus came in 2015, when Congressional representatives and civil society advocacy groups pushed for the decarbonisation of the transport sector in the context of the Paris Climate Agreement. Costa Rica is a natural candidate for e-mobility for several reasons (Utgard, 2017).

First, nearly 99% of electricity comes from renewable sources, and the country has spare power supply. Second, because most private houses and other buildings have garages (unlike European cities such as Amsterdam, the Netherlands, or Madrid, Spain), most EV charging can happen there, limiting the need for street charging infrastructure principally for longer trips and for tourist services. Third, Costa Rica is a small country, where the average driving distance is 35 km per day. This means that even electric cars with limited range can easily be used for everyday driving needs in the metropolitan area, where most Costa Ricans live. Finally, the country's average temperature is 24.7°C, an optimal operating temperature for EVs (see Figure 8).

Figure 8 Enabling factors for e-mobility




Cartago

Source: IRENA urban policy analysis.

This context is important because Costa Rica has seen the emergence of an ecosystem of e-mobility stakeholders from different sectors that successfully pushed for legislation in the previous legislature. At the end of 2017, the Congress voted in favour of providing incentives for zero-emission e-mobility as well as hydrogen technologies for use in cars, buses, motorbikes and e-bikes. When the Solís Administration (2014–2018) published Law 9518 in February 2018, Costa Rica became the first Latin American country to provide this type of incentive.

The main implication for municipalities is the call to provide free parking for EV drivers. They are not obliged to do so, but already one municipality has agreed to do so voluntarily (discussed later).

By February 2019, the National Plan for Electric Transport (Executive Order 41579) was published, setting up the basic rules for the deployment of EV infrastructure, and tax benefits for cars and spare parts. The plan also sets regulations to facilitate future manufacturing and assembly of EVs in Costa Rica (Lara, 2019). The main implication for municipalities is that they are encouraged to electrify fleets and to provide parking benefits for EVs.

The president appointed a commissioner for electric mobility – a technical expert from the ICE Group – to coordinate governmental activities around e-mobility, engage with the private sector and users and to liaise with municipalities.

Building on the Norwegian e-mobility example, the government unveiled a special "green plate" in February 2019 to make it easier to differentiate 100% electric cars from petrol and diesel cars and to facilitate the granting of benefits, for example, free parking and no driving restrictions.

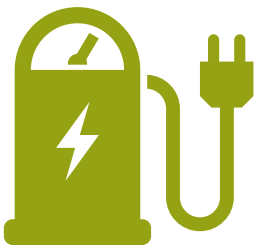
The current legislature (2018–2022) is exploring additional support measures, including extending EV incentives beyond the five years stated in the current law (Roque, 2019). Another proposed bill would put an end to the sales of internal combustion engine cars by 2025.

Progress on EV infrastructure

The Electric Mobility Law 9518, discussed above, obliges the state to deploy charging infrastructure by 2020 and to develop a standard for charging stations, among other implementing measures. ICE invests in and oversees the growth of a fast-charging infrastructure. At the beginning of 2020, more than 100 public chargers (known as "L2 chargers", of 7 kWh) were available across the country. The government planned to complete the first phase of a network of 34 chargers by July 2020 to satisfy basic long-distance needs (Presidencia de La República, 2019a).

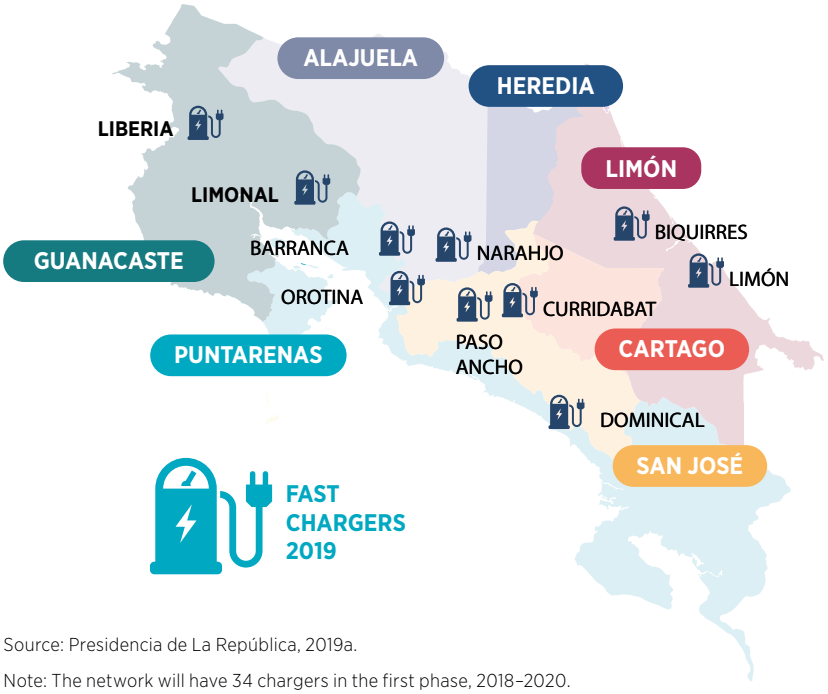
ICE considers itself the main provider of these services, arguing that the private sector would not be able to install fast-charging services and charge a fee to customers given the legal prohibition of private sales of electricity to consumers. Thus far, private companies have installed dozens of chargers, at business establishments such as shopping malls and car dealerships, intending to attract customers and polish their environmental credentials. They offer these services for free. The inauguration of new charging stations is often a public event.[21]

Other countries set the legal restriction to sell electricity as a private service. They found a compromise: the government and state-owned utility allowed the private sector to provide fast charging services and to charge a fee based on the time it takes to charge an EV (see Figure 9). But the electricity itself is provided for free so there is no breach of the law. This solution helps the private sector recover its investments in fast chargers, accelerates the deployment of infrastructure and encourages competition (several companies provide the services).



21 Local users of e-mobility have put together a public map with all the chargers (see www.conectaev.com).

Figure 9 The top ten fast chargers for EVs in 2019



Source: Presidencia de La República, 2019a.

Note: The network will have 34 chargers in the first phase, 2018–2020.

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

Stimulating demand for zero-emission e-mobility

Several initiatives aim to stimulate demand for e-mobility in the public and private sectors. Since 2017 civil society advocates have urged decision makers in both spheres to take action. Since then, four e-mobility festivals have helped to raise public awareness (Box 12). The first event was organised in collaboration with the municipality of San José. The ICE Group has also become a very active promoter of e-mobility through videos and educational activities and by collaborating with the Costa Rican Association of Electric Mobility (ASOMOVE).

Given that Costa Rica has an ageing fleet of buses and trains and faces severe road congestion,[22] the electrification of public transit has become an attractive proposition not only to meet decarbonisation objectives but also to modernise public transport and improve the quality of life.

The National Railroads Institute, INCOFER, has pledged to develop an electric train for the GAM (see Figure 10), but it should be noted that similar promises have failed to materialise throughout several administrations (Presidencia de la República, 2018b). The current proposal envisions a system that connects 4 provinces and 15 counties, covering a 72-km stretch. With the potential to move 200 000 persons daily, preliminary estimates suggest this train would cost around USD 1.3 billion. The Central American Economic Integration Bank (BCIE) has donated USD 1.3 million to conduct a feasibility study (Rodríguez, 2019).

The Decarbonisation Plan mandates a bidding process for the system by May 2022. In October 2019, a three-month virtual tour of the electric train was launched to educate the public about the attributes of the future electric train (Presidencia de la República, 2019b).

22 According to the State of the Nation, the cost of congestion in the GAM is about 3.8% of GDP per year (Arrieta, 2018).

Figure 10 The most ambitious e-mobility project in Costa Rica to date: Electric train system of the Greater Metropolitan Area of San José

Source: Presidencia de la República, 2018b.

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

Several initiatives are underway to promote electric buses. First, the government, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, Germany's development co-operation agency) and the Costa Rica–US Foundation (CRUSA) have developed an e-bus pilot project (Blanco, 2020)

A working group includes the Ministry of Environment and Energy, Ministry of Transportation, public service regulator, ICE Group, UN Environment Programme and Inter-American Development Bank (CRUSA, 2019). Second, the ICE Group and the Chinese bus manufacturer BYD started another project in October 2019 to test an electric bus at the campus of national universities (BYD, 2019). Third, a private-sector company is testing a fuel-cell electric bus in the province of Guanacaste (Ad Astra Rocket, 2018).

Cariari

In parallel, several technical assistance projects are being implemented to address capacity and knowledge gaps and provide instruments for decision making and scale-up of electric public transport.

An app-driven and privately run e-bicycle-sharing scheme, OMNIBicis, operates in the main metropolitan area with a current fleet of 400 bikes and a goal of 5 000 (Campos, 2019).

Promoting electric vehicles

Costa Rica has about 1.1 million cars, and the average fleet age is 16 years (Arrieta, 2018). While public transit is a priority, there are also efforts to promote the purchase of EVs by public institutions, companies and private users (see Table 4). The government estimates that an EV fleet would save about 75% in operational costs compared to petrol or diesel cars (Estrategia y Negocio, 2018).

Table 4 Efforts to promote electric vehicles

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

Tourism is a key economic activity in Costa Rica, and e-mobility represents an opportunity for boosting eco-tourism (Utgard, 2017). Several efforts are underway by EV advocates in civil society and the private sector (see Table 5). Integrating e-mobility fleets in this sector can help stimulate demand. Municipalities are not yet engaged in this opportunity, but the Monteverde Electric Route offers a pioneering example of a community-run initiative engaging the local government.

Most local governments in Costa Rica have been silent in the e-mobility debate. One reason is the lack of requisite technical expertise. In the absence of a legal mandate to manage transport, their teams have never developed expertise in this area. Yet there are several pioneering municipal efforts to learn from.

Table 5 Efforts to connect e-mobility with eco-tourism

Electric rent-a-car	In August 2019, a key rent-a-car company announced its first EV for rent and plans to electrify its fleets (Herrera, 2019). A Dutch tourist company planned a "Green Circle" EV driving tour of a dozen eco-lodges that meet the highest environmental standards in Costa Rica. About 20 EVs will be available for the tour, and the first units are already in operation (Smit, 2019).
Charging EVs at iconic destinations	The minister for environment and energy announced that the government would install 12 L2 chargers in national parks (Cerdas, 2019).
Hydrogen cars for eco-tourism	Toyota Costa Rica (Purdy Motors) and Ad Astra are partnering with premium car rental services to offer zero-emission driving in Guanacaste (Castro, 2019).
Electric shuttles for tourists	Nosara, a prime tourist destination, has commissioned a study of the benefits of replacing its fleet of motorbikes with electric buses (Presidencia de La República, 2019a).
Eco-tourism in Monteverde	CORCLIMA (Comisión para la Resistencia al Cambio Climático) launched an electric route for ecotourists in the Puntarenas Province, in collaboration with Costa Rica Limpia (Costa Rica Limpia, 2019).[23] It aims to inspire electric tours nationwide (Dvrgente, 2019).


Cariari

DECARBONISING CITIES

The growing recognition of limitations inherent in highly centralised governance (Presidencia de La República, 2018a) has triggered demands for change by citizen groups and others seeking improved and more sustainable mobility and, more broadly, better urban planning. The current gaps are well documented in the State of the Nation report, an independent annual assessment (see Box 12).

These expert discussions used to focus on the role of the central government, not that of local governments. But this is changing. As congestion and air pollution worsen, new

23 Monteverde, an iconic destination and arguably the first eco-tourist destination in the country (Van Dusen, 2019), is working with businesses and the local government, through the platform CORCLIMA, to engage over 50 small and medium enterprises – restaurants, hotels, lodges and tourist destinations – in the "the first EV friendly community" for tourist travel in Costa Rica. The town offers free charging to electric drivers and a digital map with information about EV-friendly companies and places to visit. The long-term goal is to signal to car rental companies that Costa Rica's eco-tourism industry requires a strong offering of electric car rentals (CORCLIMA, 2019) and to motivate other local communities and governments to follow suit.

BOX 12 THE IMPORTANCE OF ADVOCACY IN SCALING UP E-MOBILITY IN COSTA RICA

In addition to legislation, the promotion of e-mobility is a cultural challenge that involves addressing myths, resistance to change and scepticism. In Costa Rica, citizen groups have played an active role and could in the future combine forces with new stakeholders such as municipalities.

Among other things, citizen groups proposed the first pathway to e-mobility in Costa Rica. In 2017, the advocacy group Costa Rica Limpia modelled the required infrastructure to 2030 and provided answers to frequently asked questions and ideas about smart charging solutions, informing decision makers and stakeholders such as car companies; mobility, climate and energy experts; financial institutions and others. ASOMOVE was set up to accelerate the shift to zero-emission transport.

Costa Rica Limpia and ASOMOVE pioneered "electric mobility citizen festivals". The first festival took place at the municipality of San José. This annual event is sponsored by the private sector (through participants' fees) and features exhibits, test drives, talks and media engagement. About 5 000 people attend over two days. Special awards have been given to early adopters, for example, the first-ever electric taxi driver in Costa Rica. ASOMOVE has also created a platform for interaction among community members to stimulate demand and address prejudices against EV adoption (Rivera, 2019). In October 2019, ASOMOVE signed a memorandum of understanding (MOU) with the Solar Energy Association (ACESOLAR) to promote joint activities, advocacy, and consumer and media outreach.

The engagement of users and consumers is part of a broader pattern to influence society from a bottom-up perspective. Many of these efforts also aim to engage cities and local governments to help speed up change and send signals to the central government about the need to integrate cities and local governments in a fossil-free society.

Sources: ASOMOVE, n.d.; Costa Rica Limpia, n.d.; Utgard, 2017.

questions have emerged around the need to engage municipalities (at least those in the GAM) on urban planning issues, waste management, water and e-mobility.

The country will need to address the chicken-and-egg dynamic around governing competence: on the one hand, new powers are withheld from the municipalities because they are deemed ineffective (according to the Municipal Performance Index [24]), yet on the other hand, the more disconnected they are from planning their own future, the less they are able to build the skills and expertise needed to take charge and improve cities.

Some programmes seek to engage in climate debates and to develop municipal inventories to become familiar with the sources of their carbonisation.

Cartago

Municipal engagement in carbon neutrality

In the context of Costa Rica's NDC in response to the Paris Climate Agreement, the Ministry of Environment and Energy has engaged municipalities in the National Carbon Neutrality Programme 2.0 by developing a specific programme for them (Programa País Carbono Neutral Cantonal) (Presidencia de la República, 2017). The programme aims to contribute to Costa Rica's climate action agenda, through the development of GHG inventories at the municipal level, together with the implementation of a measurement, reporting and verification (MRV) system. Is also aims to identify main GHG emissions contributors in the municipalities, and to develop concrete mitigation actions in the identified sectors (Ministry of Environment and Energy, 2017).

The country had set the goal of 16 municipalities measuring their GHG emissions by 2022. Initially, a pilot phase was established for five municipalities and two districts.[25] Between 2018 and 2019, 15 additional municipalities joined the programme.[26] The 22 municipalities participating represent 38% of the Costa Rican territory and 43% of the population (Elpais.Cr, 2019).

24 According to the Municipal Performance Index of 2018, only 25 of 82 municipalities met performance indicators (Contraloría General de la República 2019). The most problematic areas are waste management, planning, internal controls, citizen participation and accountability. During 2018, municipalities set up plans to improve their performance – as requested by the evaluator – and 65 municipalities improved their indicators with respect to 2017. Ten municipalities, however, have shown no progress. The index highlights areas where progress has occurred, such as citizen engagement, and where no progress can be observed, such as public service user satisfaction. A new survey of municipal websites indicates that 77 of 82 fail to fulfil key transparency criteria (yet in terms of public participation and open data there have been some improvements) (Defensoría de los Habitantes, 2019).

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

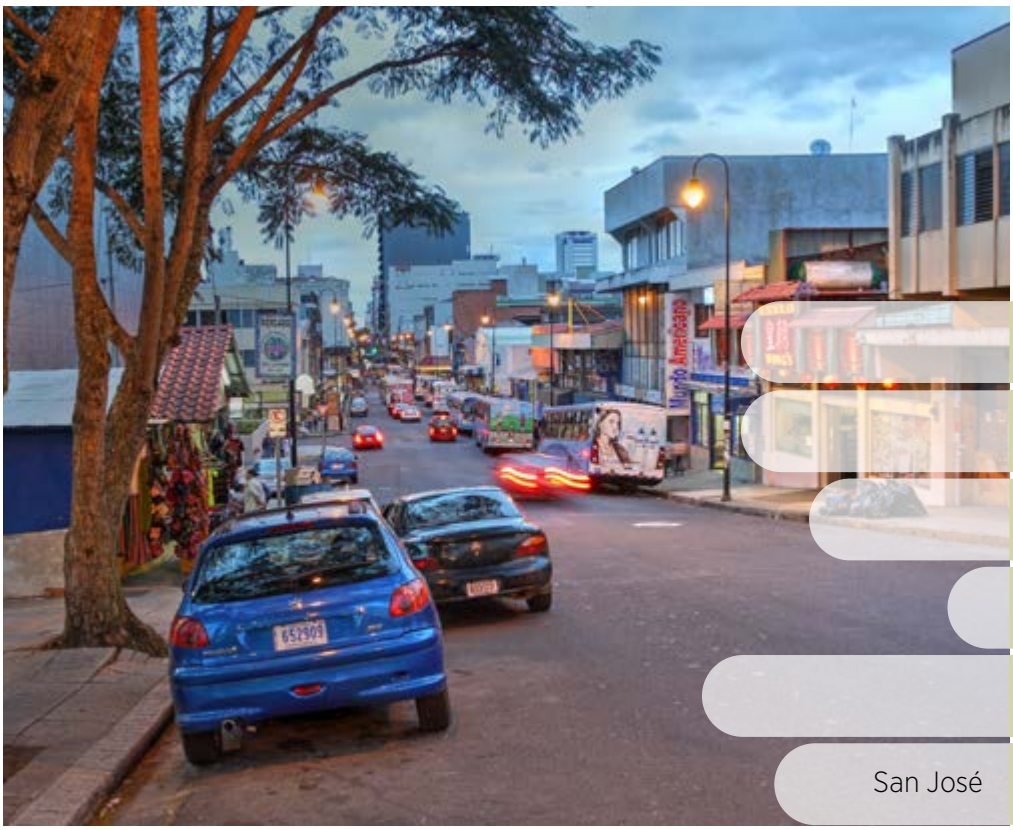
26 San Carlos, Cartago, Pérez Zeledón, Pococí, Goicoechea, San Ramón, Santa Cruz, Nicoya, Montes de Oca, Oreamuno, Osa, Quepos, Cañas, Parrita and Zarcero.

The programme was started to teach teams to develop GHG inventories. Cities had to compete to get support to design their inventory (Berlin, 2018). Once the results were analysed, the government launched a second contest, and 14 additional municipalities were selected (Rodríguez, 2019).

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

Between 2017 and 2019, 139 institutions participated in this programme, which has trained 1400 people and 300 city governments and districts to measure and mitigate the local carbon footprint (Elpais.Cr, 2019).

IFAM participated in the preparatory consultations for this programme. It is undergoing internal changes to better support municipalities in tackling climate change issues, including e-mobility, together with efforts to link municipalities to international initiatives (see Box 13). This is happening as the Ministry of Environment and Energy's climate change directorate also seeks to engage cities and municipalities in the national decarbonisation plan.



San José

BOX 13 IFAM'S NEW URBAN AGENDA

Together with the Ministry of Environment and Energy and the European Union delegation to Costa Rica, IFAM (the Municipal Advisory Institute) hosted the Global Covenant of Mayors for Climate and Energy in 2018. Thirteen municipalities joined the Latin American pact of this covenant to promote good practices. The IFAM president has highlighted the importance of investing in local development (Guerrero, 2018) and engaging municipalities in e-mobility education.

In August 2019, IFAM co-organised the first-ever workshop with ASOMOVE to train municipalities and share insights from international experience and lessons from the municipalities of Cartago and Grecia (Case 1). The institute is developing a how-to manual for municipalities on climate issues and will cover some basic e-mobility elements.

IFAM set up a national mobility event in December 2019 to showcase best practices. It is also working with the National Union of Local Governments (UNGL) on the MUEve project in collaboration with the Office of the First Lady. The project consists of a subregional plan for urban development oriented to transport that counts on the engagement of 15 municipalities. It proposes safety improvements at the cantonal level, complementary infrastructure near train stations (including sidewalks), public spaces, and pedestrian and bicycle paths. The European Union awarded USD 5.1 million in August 2019 to the Government of Costa Rica to support IFAM's technical dimension.

Source: IFAM.go.cr.

Case 1: Municipal engagement in e-mobility in Cartago and Grecia

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

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

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

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

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

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

Grecia

Case 2: Guanacaste as a "decarbonisation hub"

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

Guanacaste has hosted several trailblazing projects in the fields of wind, solar and geothermal. The first-ever wind power plant in all of Latin America was set up in the area in 1996. Today, the Guanacaste Province is also home to 16 of Costa Rica's 18 wind power plants. In 2019, the wind parks accounted for 11.5% of the country's electricity mix, becoming the second source of production behind hydropower. It is important to mention that as the wind resource is concentrated mostly in Guanacaste, the transmission capacity needs to be increased to distribute the electricity across the country (Teske, Morris and Nagrath, 2020).

Guanacaste

Similarly, the first PV electricity generation plant in Central America, Solar Miravalles, was installed in Guanacaste in 2012. While biomass barely plays a role in Costa Rica's matrix, two out of the four existing plants are located in Guanacaste: the Taboga and El Viejo sugar mills have been feeding electricity into the national system since the mid-1990s (Taboga, n.d.; FAO, n.d.; Azucarera El Viejo, n.d.).

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

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

In January 2018 Coopeguanacaste installed the first EV charger in the province to attract EV users to this popular tourist destination (Coopeguanacaste R.L., 2018). Other chargers have since been installed. The co-operative sells electricity and wants to develop new business opportunities around e-mobility. These first chargers signal the

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

co-operative's effort to provide charging services outside the GAM. The ICE Group has also installed fast chargers in this province. Both electricity companies aim to encourage consumers to consider switching to electric options and to signal the emergence of an electric market in Guanacaste. In August 2019, the ICE Group installed the first fast charger outside the GAM at a popular restaurant in Limonal, Guanacaste.

Guanacaste is also at the forefront of Costa Rican forays into developing hydrogen as an alternative transport fuel. An alliance to establish a hydrogen economy (see Box 14) grew out of initial efforts by a private firm, Ad Astra Rocket Company (based in Liberia, the main city in Guanacaste), to launch local fleets of hydrogen buses and cars, in co-operation with Purdy Motor (Toyota), Relaxury and Las Catalinas. Guanacaste is currently the only place in Latin America where hydrogen cars are being tested (Castro, 2019). Unlike many other hydrogen projects around the world that use natural gas, this initiative relies on renewable energy sources. Ad Astra is also involved in efforts to develop hydrogen refuelling infrastructure in Liberia, with support from the Toyota Mobility Foundation and the Innovation Laboratory of the Inter-American Development Bank (IDB Lab), respectively.[28]

BOX 14 AN ALLIANCE TO DEVELOP THE HYDROGEN ECONOMY IN COSTA RICA

An alliance to promote the hydrogen economy was launched in July 2019 (CRUSA, 2019) by Ad Astra, the Innovation Laboratory of the Inter-American Development Bank (IDB Lab) and the CRUSA. While this is not a project led by a city, it does establish a positive precedent for innovative, decentralised models that are not run from San José but create their own ecosystem of non-state actors. The alliance also involves companies like Purdy Motors, Linde, 21st Century Strategy, Electrotechnical Group, Matelpa, Siemens, Cummins and Relaxury. ICE joined the alliance in 2019.

This alliance seeks to develop a Costa Rican hydrogen ecosystem in support of decarbonisation efforts. It promotes the use of hydrogen as a clean energy vector in road transport (cars, cargo trucks, public transport and light industrial vehicles) and potential energy storage in the industrial, commercial and residential sectors. As a facilitator of the energy transition, it will seek high-level technical assistance to quantify the impacts and benefits of hydrogen in the country, as well as to develop proposals for regulatory frameworks that allow the development of the hydrogen market.

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

LESSONS EMERGING FROM COSTA RICA

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

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

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

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

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

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

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

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

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

Where cities don't have the mandate, their scope of action remains limited

Costa Rica's small size allows highly centralised decision-making structures that restrict the ability of cities to make autonomous policy decisions. The municipal landscape, by contrast, is deeply fragmented, which is increasingly being seen as one of the main obstacles to a sustainable urban future (Presidencia de La República, 2019a). Within these limitations, the municipalities of Cartago and Grecia have taken active measures, promoting green policies in the transport and tourism sectors, while the city of Guanacaste – considered Costa Rica's "capital of renewable energy" – has hosted several trailblazing projects in the fields of wind, solar and geothermal energy.

As cities worldwide become central protagonists in sustainability efforts, municipalities in Costa Rica, too, may become more proactive about their country's ongoing energy transformation. In many ways, sustainability is also about better urban governance and local choice. It is unlikely that Costa Rican cities will be running energy projects themselves. But capacity building as part of the GHG inventories established under Costa Rica's Carbon Neutrality Programme could be a first step towards empowering cities to develop their own mitigation strategies and play a more active role in the decarbonisation process.

Where the share of renewables in the electricity mix is already high, transport becomes the next frontier

Governance adjustments are more likely in the realm of public transport. As other Latin American cities (such as Medellin and Cali in Colombia, Panama City in Panama and Santiago in Chile) advance with electric buses and other electric-mobility (e-mobility) projects, the contrast with Costa Rica (*i.e.*, with its lack of municipal transport authorities) becomes clearer.

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

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

Collaboration is a key to success

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

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

Strengthening municipalities offers much potential for future action

Promoting international best practices among municipalities will be essential. Local governments are weak, but they learn from the experience of cities elsewhere, allowing them to avoid mistakes and benefit from lessons learnt. New initiatives, such as promoting e-mobility at the municipal level or measuring GHG emissions, provide critical insights for municipalities.

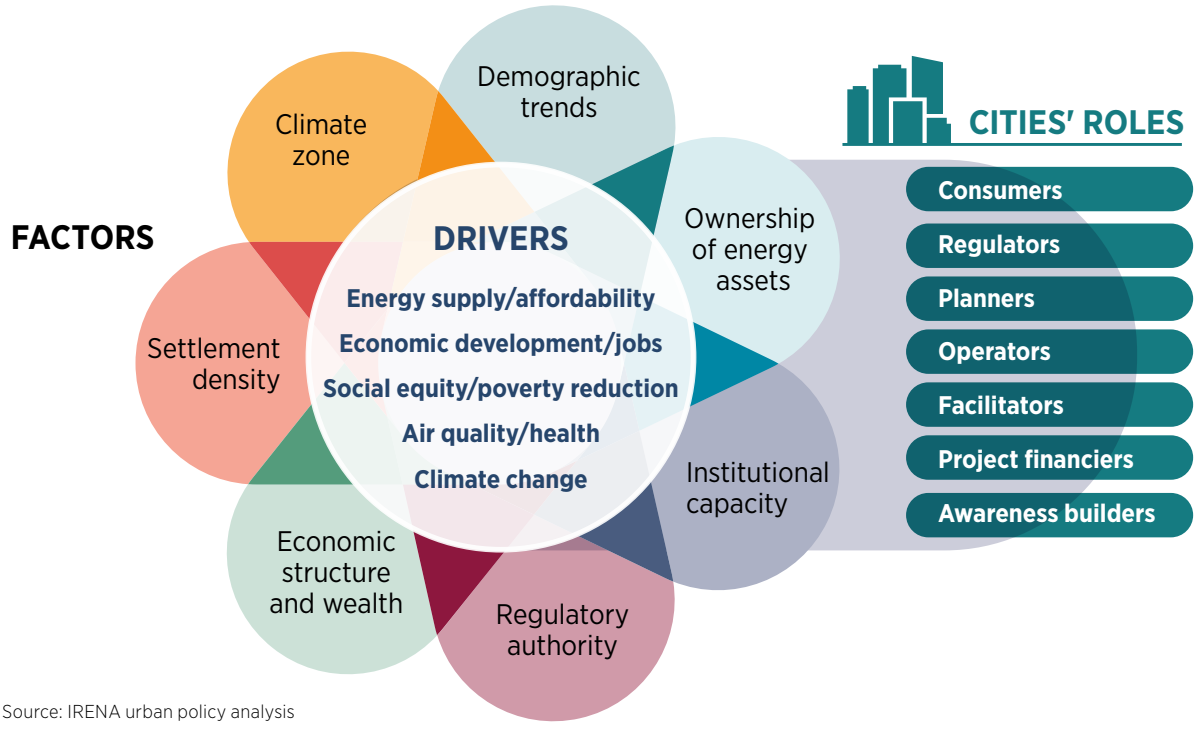
For now, encounters with representatives of cities elsewhere in the region are informal. Indeed, Costa Rican local governments could benefit from developing "sister city" approaches, or co-operation agreements with cities pursuing similar objectives. The Decarbonisation Plan to 2050 offers a concrete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

Puerto Limon

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 Costa Rica, 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 11).

Figure 11 Factors and drivers motivating municipal energy policies and shaping cities' roles in the energy transition



Source: IRENA urban policy analysis

Costa Rica

While the particular mix of **drivers and motivations** regarding the energy transition varies from city to city, a secure and affordable energy supply is an objective held in common by all cities. Other drivers include economic development (job creation); social equity (including 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

ANNEX (COSTA RICA)

The grid-connected power generation in Costa Rica comes mostly from the national utility ICE and its subsidiary (CNFL) and is supplemented by two distribution companies (ESPH in Heredia and JASEC in Cartago), four rural electrification co-operatives and some 37 private operators. Table 6 explains the attributes of these stakeholders. It is worth noting that this centralised structure has prevented cities from playing an active role in defining and engaging in energy decisions – and as mentioned earlier, municipalities often exhibit low levels of performance in traditional areas, such as urban planning.

Table 6 The main attributes of the energy stakeholders

ICE Group	**Costa Rican Electricity Institute, ICE** It was established in 1949 when a new Constitution was agreed and sought to make investments in economic and social development. Back then only 14% of Costa Ricans had access to electricity – compared to over 99% today. ICE aimed to tap into Costa Rica's own hydropower potential throughout a state-owned enterprise. In addition to operating in the electricity sector, the ICE Group provides telecommunications. The workforce for the entire group is around 13 500. In 2016, ICE delivered Central America's largest project, Reventazon, a USD 1.4 billion hydro plant of 305.5 MW installed in Limon, servicing 525 000 homes.
	The National Company of Power and Electricity, CNFL This operates as an ICE subsidiary with a focus on generating and distributing electricity in San Jose, Heredia, Alajuela and Cartago – known as the Great Metropolitan Area (GAM). This is the area where most economic activity takes place. CNFL covers around 1 000 km providing services to over 523 000 customers. Power generation in this area is minimal.
Other (province-based) public service companies	• Established in 1976, the **Heredia Public Services Company, ESPH**, its precursor was established in 1949 and by 1951 this municipal company was operating the first hydropower plant built by Costa Rican engineers. It provides electricity to 264 000 users as well as public lighting, telecommunications, sanitary sewer and potable water services. In July 2019, ESPH inaugurated a USD 120 million, 28 MW hydropower plant that service 36 000 homes. The plant is in Cuatro Bocas de Upala, Alajuela, (not in Heredia where the municipal company is based) and for the first time in the company's history, a woman will manage it (Elmundo.cr, 2019). • The second company is the **Cartago Board of Public Services, JASEC**, that generates and distributes electricity in that province since 1964. The main source is hydropower and it provides services to about 100 000 users.

Electrification co-operatives	• Electrification co-operatives in Costa Rica were set up nearly 50 years ago to increase access to electricity in rural areas. Today, access to energy is high throughout the country: 99.4% of the population has access to electricity. The four rural electrification co-operatives are: • Coopelesca R.L. • CoopeSantos R.L. • CoopeGuanacaste R.L. • CoopeAlfaroRuiz R.L. • They formed the **National Consortium of Electrification Cooperatives**, known as **Coneléctricas R.L.** to achieve stronger representation, generate electricity, acquire joint goods and services and promote technology transfer.
Private companies	• Thirty-seven private companies operate hydro plants, wind farms and solar projects – regulated under the Law 7200 mentioned earlier. • The **Association of Energy Producers of Costa Rica, ACOPE** Established in 1990, it brings together most private generation companies in Costa Rica, 26 members, to advance private-sector generation and promote renewable energy generation. • The **Costa Rican Solar Energy Association, ACESOLAR**, operating since 2012 and gathering around 70 national and international firms including solar energy generation companies and technology providers. They have played an active role in promoting distributed energy solutions and new regulations to boost Costa Rica's solar power generation. Since 2014 they organise the most significant annual solar energy fair in Central America.

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EXPERIENCES IN COSTA RICA

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

ISBN: 978-92-9260-312-0