

# Energy Solutions for Cities of the Future

A project by the International Renewable Energy Agency (IRENA) for the International Climate Initiative (IKI)

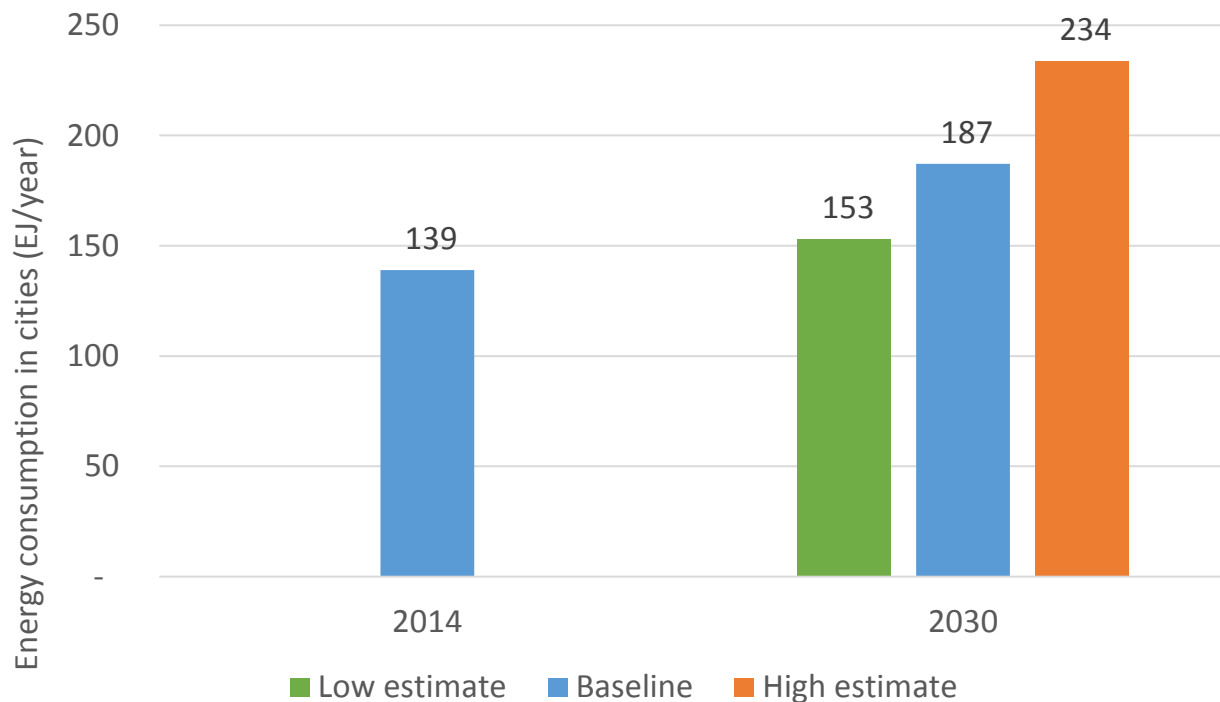
German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

**Urban Pathways – Delivering on the New Urban Agenda**  
Berlin, 16 October 2017



# Why are cities important for energy planning?

Energy use in buildings and for transport in cities, 2014 and 2030



Source: IRENA 2016.

## Issues of concern

- 60% of global primary energy demand from cities, to increase 35% by 2030
- 70% of global man-made CO<sub>2</sub> emissions from cities
- 90% of all urban areas are coastal
- > 90% of urban air pollution levels exceed WHO limits
- Vulnerabilities, especially in emerging economies: lacking infrastructure and planning capacity, and limited financial resources

# Cities are uniquely positioned to boost renewable energy locally





# IRENA-IKI Energy for Cities of the Future: Project overview

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## RATIONALE

## AND STAKEHOLDERS

Renewable energy deployment in cities empowers local and national policy-makers and other stakeholders, utilities, and investors to transform their energy system towards a high share of renewable energy, and thus contribute to achieving their national climate and development objectives.

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## GEOGRAPHIC SCOPE

China, Costa Rica, and Uganda

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## PROJECT SCOPE

Two city case studies per country, six in total, showing policies in place that could be used as **best practice**, or **untapped renewable energy potential** that can contribute to the cities' sustainable development

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## CITY SIZE

Medium-sized, with the population no less than 30,000 and not exceeding 1 million

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## PROJECT TIMELINE

July 2017 – July 2019

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# Project objectives

Knowledge on policy and regulatory frameworks and integrated planning for renewables



Capacity building at the municipal level

- Financing innovation
- Energy storage
- Grid integration
- Regulatory reform and public policy support
- Corporate commitment

Tools and information on technology solutions



Best practice and replicable solutions for renewables in cities



## Rationale for cities selection

Openness to adopt new or improved sustainable energy systems

Effective policies in place (“best practice”) OR untapped renewable energy potential

Replicability, scalability and affordability

High potential for growth of renewables

### Case studies

2 cities each from 3 countries:

China 

Costa Rica 

Uganda 



# Project components

## Output I: Case studies

- Policy instruments
- Best practice and business models
- Policy guidelines for replicability

## Output II: Demand side assessment and building stock assessment

- Analysis, tools and methodologies for renewable energy potential



## Output III: Technical work

- technical and economic indicators regarding the potential to use sector-coupling and the integration of renewable energy solutions at the city level, including for planning.

## Output IV: Solar city simulator

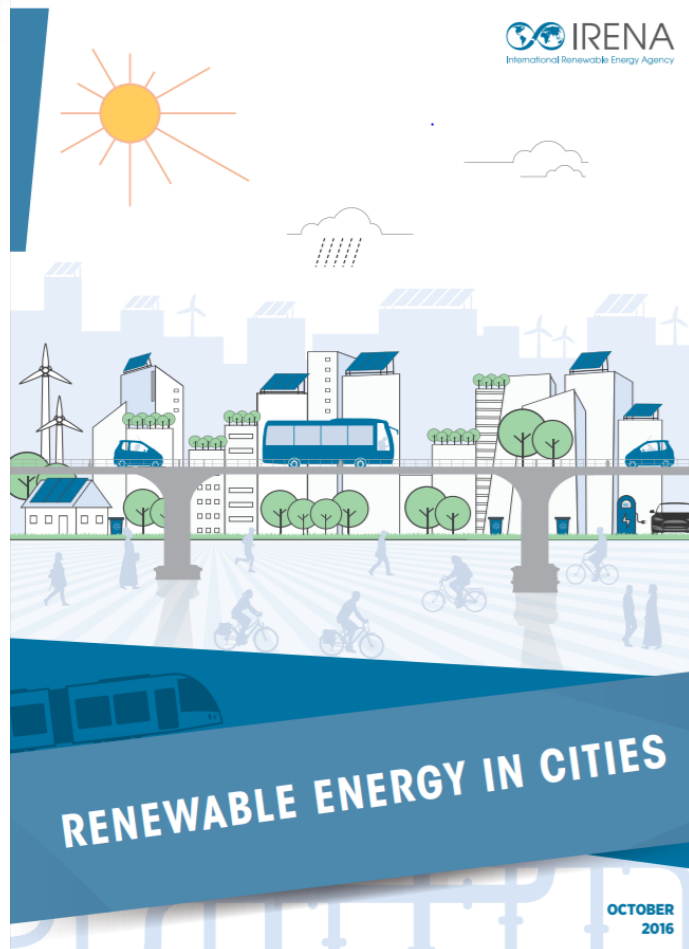
- Adapted for medium-sized cities
- Enabling cities worldwide to better evaluate resource potential for growing mid-sized cities and encouraging investment

## Output V: District heating and cooling

- Study on renewable energy applications for district heating and cooling in the urban setting

# IRENA's previous work on cities

IRENA (2016),  
**Renewable Energy in  
Cities**. Abu Dhabi:  
International  
Renewable Energy  
Agency. Available at  
[http://www.irena.org/DocumentDownloads/Publications/IRENA\\_Renewable\\_Energy\\_in\\_Cities\\_2016.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_Energy_in_Cities_2016.pdf)



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International Renewable Energy Agency

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**Renewable Energy Policy in Cities: Selected Case Studies**

IRENA, in collaboration with the International Council for Local Environmental Initiatives (ICLEI), has produced a series of case studies on cities where local governments have successfully adopted measures to promote renewable energy and sustainability.

No.	Title
1.	<a href="#">Dezhou, China</a> which has actively supported the establishment of renewable energy industries with the Dezhou Economic Development Zone for solar technology
2.	<a href="#">Chemnitz, Germany</a> where the local government enabled the formulation of strategies to use renewable sources and in 2008 developed the Integrated Climate Protection Programme (Integriertes Klimaschutzprogramm).
3.	<a href="#">Belo Horizonte, Brazil</a> which has reduced greenhouse gas (GHG) emission substantially and, since 2007, turning a closed landfill site into a waste-to-energy facility.
4.	<a href="#">Austin, US</a> where the GreenChoice Program active since 2001 has stimulated the initial demand for renewable-based electricity, facilitating municipal and community procurement of renewable

**Publications**

- Reports and papers
- Brochures
- IRENA Quarterly
  - Subscribe to the IRENA Quarterly
- REview for Parliamentarians
  - Subscribe to the IRENA's REview for Parliamentarians

**TOTAL**  
180

**Members**  
152

**States in accession**  
28

IRENA project  
website: **Renewable  
Energy Policy in  
Cities: Selected Case  
Studies**. Available at  
[http://www.irena.org/  
menu/index.aspx?  
mnu=Subcat&PriMen  
uID=36&CatID=141&  
SubcatID=286](http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=286)





**Thank you!**

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## Specific project focus

### Integration of renewable energy in planning

- Local renewable energy potentials
- Local planning capacity
- Support in achieving national climate and energy targets

### End-use sectors

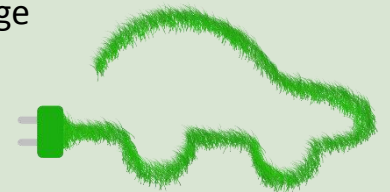
- End-use sector analysis
- Policy instruments
- Replicable business models

### Sector coupling

Power sector with growing renewables share electrifies end-uses

residential commercial industry

- District application for heating and cooling
- Electrified transport
- Integrated storage capacities
- Solar rooftop PV



## Country snapshot: China

- China is the world's most populous country with a fast-growing economy that has led it to be the largest energy consumer and producer in the world.
- China's rapid urbanization over the past thirty five years has boosted economic development and helped to raise the living standards of both urban and rural populations, but this process has also been characterized by intensive resource consumption and an emphasis on speed rather than quality of urbanization, which have negatively affected China's natural environment.
- Today, more than 50% of China's population lives in cities, Chinese cities are estimated to account for around 75% of total national energy consumption. The IEA estimates this proportion to rise to around 83% by 2050.
- Rapid urbanisation has been causing severe problems that are threatening the liveability of cities, and impedes sustainable human development in China. Serious problems include limited water, land and energy; poor quality air, water and sanitation. Severe air pollution in Chinese cities is of great concern as 1.6 million premature deaths per year are attributed to air pollution.
- Renewable energy technologies have experienced exponential growth during the past few years, and prospects for future growth are driving further cluster development.

**Renewable energy in combination with demand-side policies has high potential to reduce cities' carbon footprint.**



### China quick facts

Population, total	1,378,665,000
GDP per capita, PPP (constant 2011 international \$)	14,400
Urban population (% of total)	57%
Population growth (annual %)	+ 0.54%
Access to clean fuels and technologies for cooking (% of population)	57%
Access to electricity (% of population)	100%
Renewable energy consumption (% of total final energy consumption)	17%
Renewable electricity output (% of total electricity output)	23%

Source: World Development Indicators; latest available: 2016



## Country snapshot: Costa Rica

- Considered by many as an economic and environmental success story: among the lowest poverty rates in Latin America and a “green trademark”, including high-profile conservation and reforestation work
- But: poverty reduction has been stagnating and inequality has been rising; growing pressures on the use of resources and urbanization.
- The population of Costa Rica has increased 4.8 times in the past 50 years, confirming the urbanization process in the major cities of the country and the secondary cities.
- Urbanization has increased air and water pollution, with no long-term plan to protect the environment from these threats.
- San Jose the capital of Costa Rica, and three other mayor cities (Cartago, Heredia and Alajuela), have been presenting the negative symptoms of the large cities in matters of development, housing, urbanization, industry and commerce have grown uncontrolled and unregulated.
- Glaring gaps in infrastructure quality, from public transportation to waste treatment capabilities.
- Expanding certain RE technologies further also raises serious environmental concerns, e.g. in the case of the exploitation of more biomass and hydropower in protected areas



### Costa Rica quick facts

Population, total	4,857,274
GDP per capita, PPP (constant 2011 international \$)	15,402
Urban population (% of total)	78%
Population growth (annual %)	+1.02%
Access to clean fuels and technologies for cooking (% of population)	96%
Access to electricity (% of population)	99.7%
Renewable energy consumption (% of total final energy consumption)	38%
Renewable electricity output (% of total electricity output)	90%

Source: World Development Indicators; latest available: 2016

**Modern renewable energy could help Costa Rica decrease its urban centres' footprint, especially in transport.  
Precondition: holistic natural resource management.**

## Country snapshot: Uganda

- Young and fast growing country. About half (48.7 percent) of Uganda's population is younger than 15.
- Sustained population growth and the re-emergence of political peace have encouraged the rapid growth of cities, in particular Kampala, but also a number of secondary urban areas.
- Towns and cities provide better access to services such as health, education, and jobs. Rural-urban migration as a result of climate-induced rural problems such as droughts have been exacerbating the rate of urbanisation in Uganda, as in much of the rest of Africa.
- Local municipalities and secondary cities will play an increasingly important role in driving this agenda beyond the capital Kampala, which by itself will be unable to absorb the large numbers of people who will live in, and migrate to urban areas over the coming decades.

**Modern, renewable energy can help addressing parallel needs tied to long-term growth and sustainable urban development in Uganda.**



### Uganda quick facts

Population, total	4,1487,965
GDP per capita, PPP (constant 2011 international \$)	1,714
Urban population (% of total)	16%
Population growth (annual %)	+3.3%
Access to clean fuels and technologies for cooking (% of population)	2%
Access to electricity (% of population)	20%
Access to electricity, urban (% of urban population)	51%
Renewable energy consumption (% of total final energy consumption)	98%
Renewable electricity output (% of total electricity output)	79%

Source: World Development Indicators; latest available: 2016



# Facts about energy in cities



# Different demand development dynamics across countries

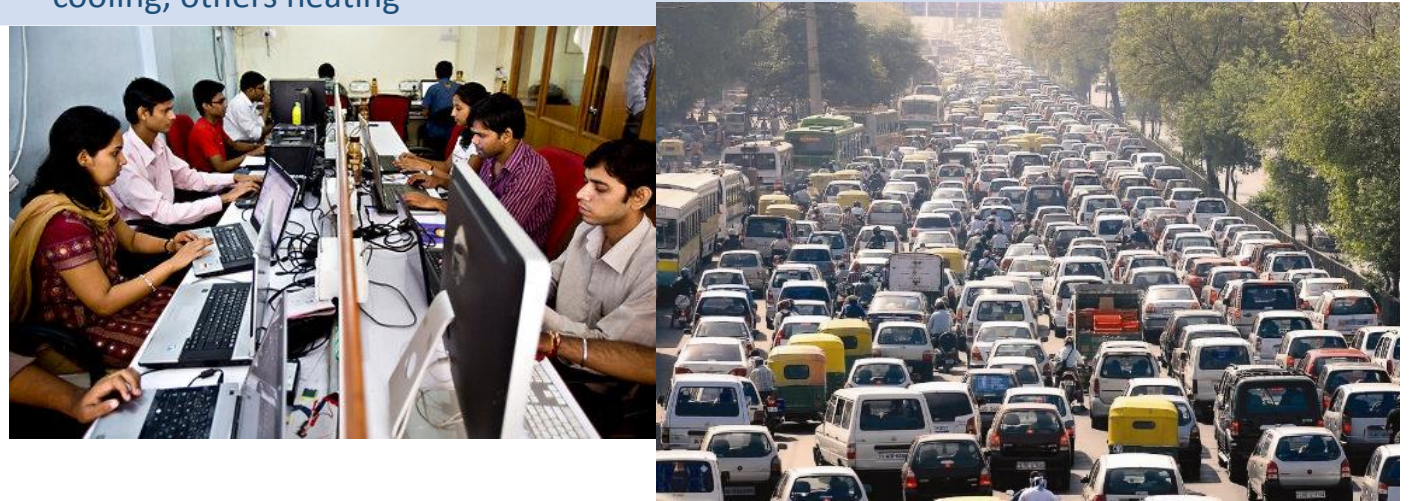
## Factors reducing energy demand in cities

- Limited new infrastructure development
- Existing public transport
- Limited population growth
- More efficient use of energy







## Factors boosting energy demand in cities

- Growing populations
- Rising disposable incomes and living standards
- Increased use of transport and vehicle ownership
- Young and in many cases rapidly growing infrastructure
- Climate – many of the fastest growing cities are in hot climates that require cooling; others heating



## Energy use patterns are set to change

Space and water heating	Transport	Electricity use	Cooling
			
<ul style="list-style-type: none"><li>• Close to <b>40% of current energy use</b> in cities</li><li>• Projected to <b>shrink to 31% by 2030</b> as many of the fastest growing cities are in hot climates</li></ul>	<ul style="list-style-type: none"><li>• <b>One third of energy use</b> in cities is currently for transport</li><li>• This proportion is <b>expected to grow, especially in emerging economies</b></li><li>• Half of all global passenger transport already takes place within cities</li></ul>	<ul style="list-style-type: none"><li>• <b>One quarter of cities' energy consumption</b> is in electricity use</li><li>• This proportion is expected to <b>increase by 50% by 2030</b>, mainly due to rising ownership of household appliances</li></ul>	<ul style="list-style-type: none"><li>• The share of cooling in cities' energy consumption globally <b>will remain low at 5% on average</b></li><li>• <b>Considerable climatic differences</b> between countries mean this share will vary widely between countries</li></ul>

# Renewable energy options in cities

## Buildings

Energy use	Technology	Resource
Heating	District heating	Waste to energy / bioenergy
		Geothermal
		Solar
	Decentralised boilers	Biomass
	Solar thermal heating	Solar
	Heat pumps	Renewable power
Cooling	District cooling	Water (sea)
		Water (river)
		Solar
	Solar cooling	Solar
Electricity (production)	Rooftop solar PV	Solar
	Building integrated solar PV	
Cooking	Electric cooking	Renewable power
	Modern cookstoves using bioenergy	Solid biomass
		Ethanol
		Biogas

## Transport

Energy use	Technology/Resource
Electric mobility	RE-powered electric public transport
	Electric vehicles
	Electric two- to three-wheelers
Bioenergy and hydrogen	Liquid biofuels
	Biomethane
	Hydrogen

## Sustainable Urban Energy Systems

Planning area	Technology/application
Demand side management	Vehicle-to-grid
	DSM for buildings / industry
Energy storage	Stationary battery storage
	Thermal storage
Grids and networks	Smart power grids
	Virtual power plants
	Smart district energy networks
Overarching city planning	Building design
	Landscape planning
	Urban agriculture
	Waste-to-energy
	Excess industrial heat



# Cities are uniquely positioned to boost renewable energy locally



## Key roles of cities: Target setting and planning

- Set **city-level RE targets** and formulate **sustainable energy strategies** to align various policy spheres and stakeholders behind common goals
- Establish **integrated urban planning processes** to promote RE, e.g. combining spatial and energy planning
- **Integrate renewables-based access solutions** into urban development strategies
- Foster **dedicated institutional capacity** to coordinate relevant stakeholders





## Key roles of cities: Operation and Control of Municipal Infrastructure

- **Develop and invest in** city-owned RE-based power plants, district energy networks and transportation infrastructure
- Directly **purchase RE power, heating/cooling from private producers**
- **Prescribe a share of RE to supply facilities and services owned and operated by cities**, e.g. through sustainable public procurement
- Steer the operation of **district heating/cooling networks, municipal solid waste management, and outdoor street lighting** to integrate higher shares of RE







## Key roles of cities: Norms and regulations

- ✓ Introduce **regulations based on the legal attributions of cities to promote RE** via, e.g. building codes, permitting procedures, solar ordinances, grid connection regulations, technical standards, public housing, local taxation, etc.
  - ✓ Enable households and businesses to purchase RE through **obligations on energy suppliers, or by aggregating their electricity demand**
- 



## Key roles of cities: Financing

- ✓ Facilitate **low-interest and long-term loans** for property owners, project developers and small-scale purchasers to invest in renewables
  - ✓ Provide **flexible financing solutions** for building owners and tenants to repay RE investments through their energy bills
  - ✓ **Leverage financial resources** through mechanisms to de-risk investment in certain RE technologies or projects;  
Issue municipal green bonds and create funds to support municipal RE investments
- 



## Key roles of cities: Advocacy and facilitation

- ✓ **Influence the behavioural choices of citizens by raising awareness** about the benefits of RE through public information and education campaigns, stakeholder consultations, demonstration projects, voluntary agreements, etc.
- ✓ **Disseminate relevant RE information** to individuals and companies such as potentials mapping, open data portals, etc.
- ✓ **Promote knowledge sharing** among various stakeholders, and strengthen local capacities and skills through dedicated training programmes on renewable energy