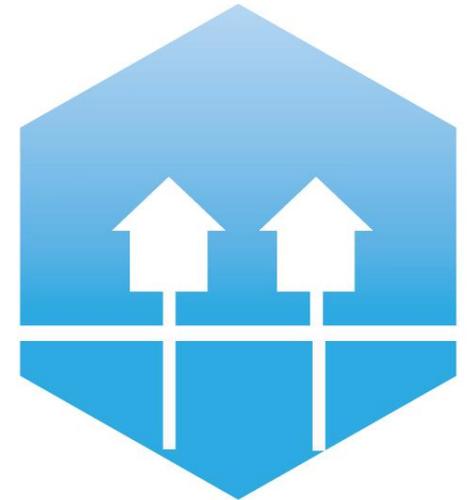
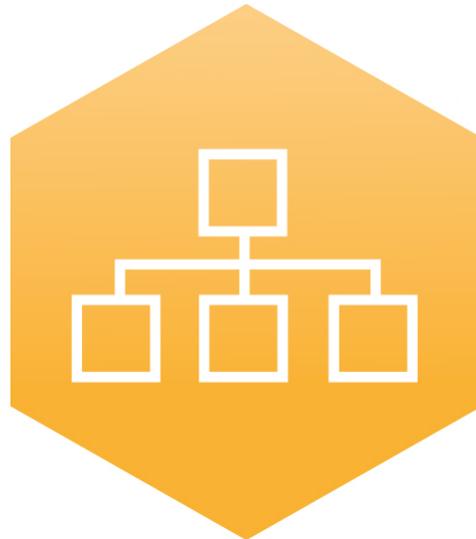


International Conference on Smart Energy Systems and 4th Generation District Heating  
Copenhagen, 25-26 August 2015

# District Energy in Cities: Unlocking the potential of Energy Efficiency and Renewable Energy



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**AALBORG UNIVERSITY**  
DENMARK



SUSTAINABLE  
ENERGY FOR ALL

# 4DH

**4th Generation District Heating  
Technologies and Systems**

# Copenhagen Centre on Energy Efficiency



# Sustainable Energy for All



## One Goal:

**Achieving Sustainable Energy for All by 2030**

## Three Objectives:



ENSURING  
*universal access*  
TO MODERN ENERGY  
SERVICES.



DOUBLING THE GLOBAL  
RATE OF IMPROVEMENT IN  
*energy  
efficiency.*



DOUBLING THE SHARE OF  
*renewable energy*  
IN THE GLOBAL  
ENERGY MIX.

# Global Energy Efficiency Accelerator Platform



The **Accelerator Platform** was established to support specific sector-based energy efficiency accelerators

## Transport and Motor Fuel Efficiency

Improve the fuel economy capacity of the global car fleet



## Lighting

Global market transformation to efficient lighting



## Appliances & Equipment

Global market transformation to efficient appliances & equipment



## Building Efficiency

Promote sustainable building policies & practices worldwide



## District Energy

Support national & municipal governments to develop or scale-up district energy systems



## Industrial Energy Efficiency

Implementing Energy Management Systems, technologies & practices



## Power Sector

Improving the efficiency of generation, transmission, distribution & end-use



## Finance

Accelerating investment in energy efficiency



# Launch of the Global District Energy in Cities Initiative



- **INCREASE** awareness on the potential of district energy and its role in achieving multiple benefits, showcase good practices and successful efforts globally;
- **PROMOTE** and strengthen local and national policies and enabling environments, including by identifying and overcoming barriers, enhancing capacity, and mobilizing support;
- **ENCOURAGE** the participation of private sector operators and investors to take a lead role in the shift towards modern district energy systems.



 **GLOBAL ENERGY EFFICIENCY  
ACCELERATOR PLATFORM**

# Partners and supporters of the Initiative



**DISTRICT  
ENERGY  
IN CITIES**

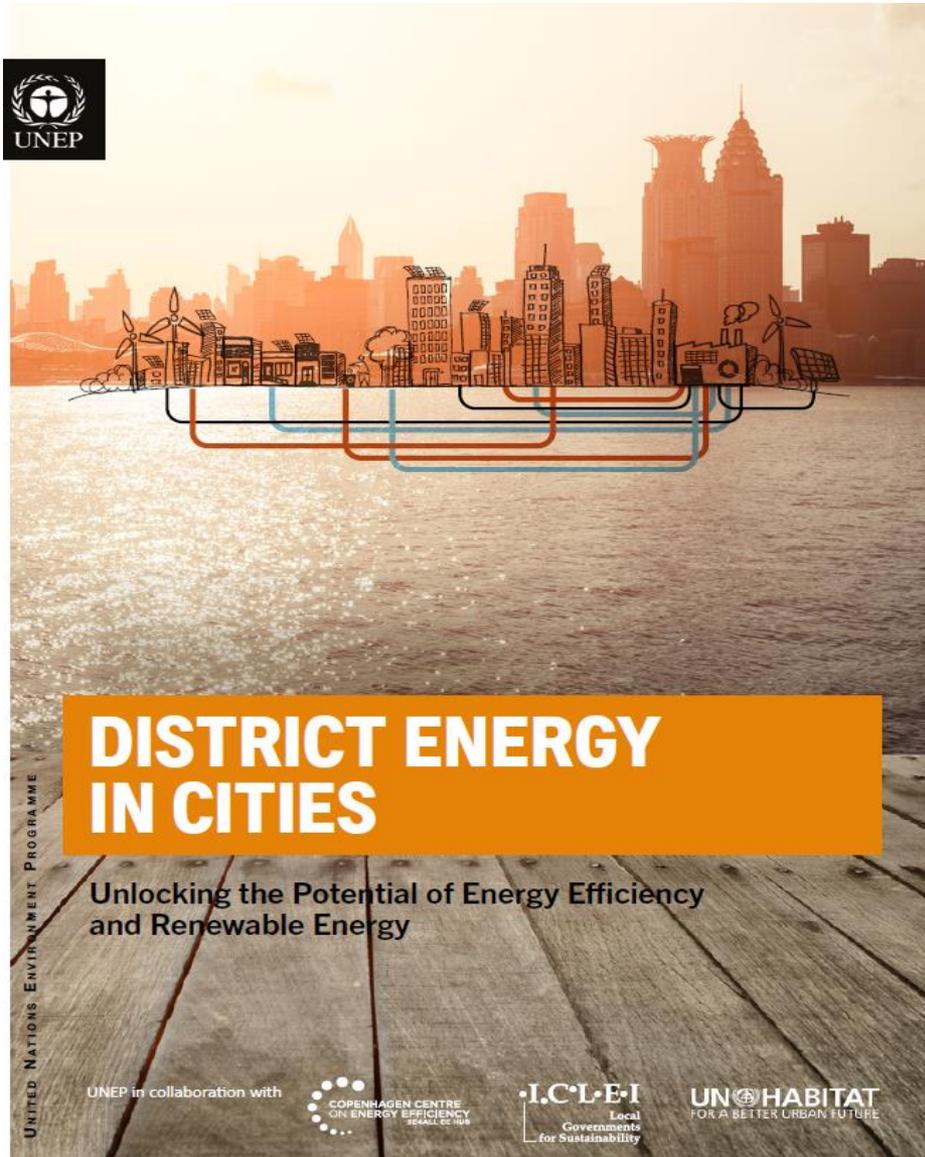


# Launch of Publication: An Address from Achim Steiner



**4DH**

4th Generation District Heating Technologies and Systems



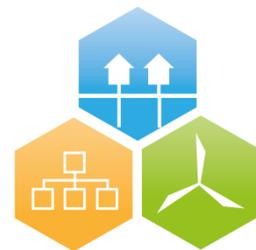
*“In launching this report we want to draw the attention of the world’s decision makers, mayors and leaders at the community level to the importance of district energy systems.”*

Achim Steiner, UN Environment Programme Executive Director. Launch of the District Energy in Cities Report

- Paris, 25 February 2015

# 45

## CITIES AROUND THE WORLD



### 4DH

4th Generation District Heating  
Technologies and Systems

BOX 1.1

The 45 champion cities for district energy use



An analysis of **45 cities** leading on district energy, covering policy, technology and finance/business models applications, and highlighting the steps needed for successful planning and implementation.

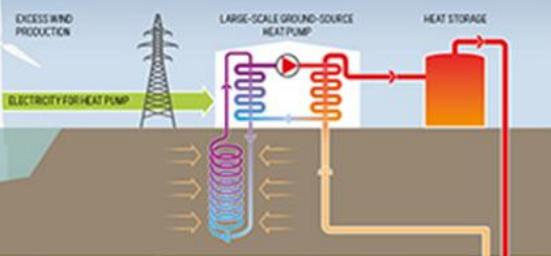
[www.unep.org/energy/des](http://www.unep.org/energy/des)

# Many Technical Options to Consider



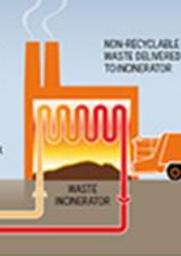
## CONNECTING RENEWABLE ELECTRICITY GENERATION

Excess variable electricity production, such as wind generation, can be utilized and stored using district energy, providing valuable demand response for the power system. This electricity can power large-scale heat pumps, which capture low-grade heat (such as from underground) to produce hot water to be stored as heat or fed directly into a district heating network. Similarly, high-efficiency electric chillers could provide demand response and store surplus cold water as cold to be used in district cooling. Through such means, district energy can enable higher shares of renewable energy in power systems.



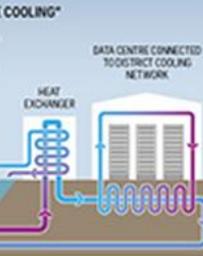
## WASTE INCINERATION

Instead of sending non-recyclable municipal solid waste to landfills, cities can incinerate it. The waste heats water into steam, and this heat is transferred into the district heating system. Some larger waste incinerators also have a steam turbine to produce electricity and heat. The exhaust fumes of the incinerator must be controlled so as not to contribute to local air pollution.



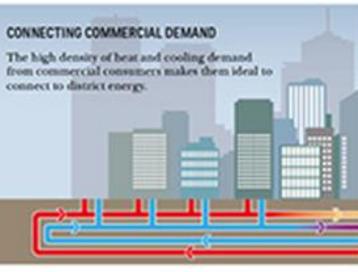
## CONNECTING SOURCES OF "FREE COOLING"

Many cities have renewable sources of low-temperature water that can be used to provide district cooling. The cooling is extracted from sea, river, lake or aquifer water using a heat exchanger. District cooling networks can meet the demands of data centres, which normally require huge amounts of electricity to stay cold.



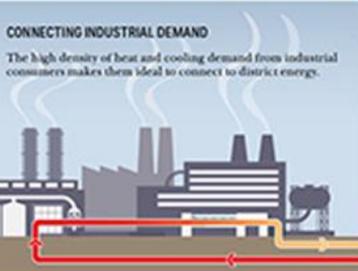
## CONNECTING COMMERCIAL DEMAND

The high density of heat and cooling demand from commercial consumers makes them ideal to connect to district energy.



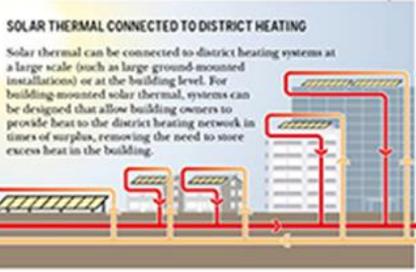
## CONNECTING INDUSTRIAL DEMAND

The high density of heat and cooling demand from industrial consumers makes them ideal to connect to district energy.



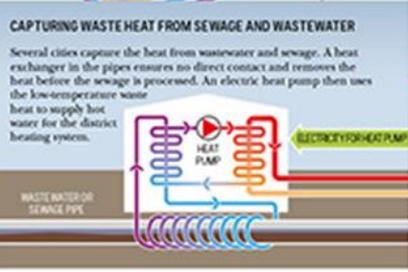
## SOLAR THERMAL CONNECTED TO DISTRICT HEATING

Solar thermal can be connected to district heating systems at a large scale (such as large ground-mounted installations) or at the building level. For building-mounted solar thermal, systems can be designed that allow building owners to provide heat to the district heating network in times of surplus, removing the need to store excess heat in the building.



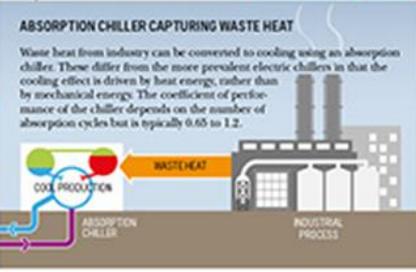
## CAPTURING WASTE HEAT FROM SEWAGE AND WASTEWATER

Several cities capture the heat from wastewater and sewage. A heat exchanger in the pipes ensures no direct contact and removes the heat before the sewage is processed. An electric heat pump then uses the low-temperature waste heat to supply hot water for the district heating system.



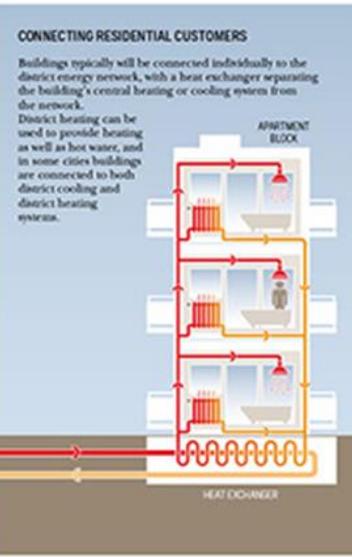
## ABSORPTION CHILLER CAPTURING WASTE HEAT

Waste heat from industry can be converted to cooling using an absorption chiller. These differ from the more prevalent electric chillers in that the cooling effect is driven by heat energy, rather than by mechanical energy. The coefficient of performance of the chiller depends on the number of absorption cycles but is typically 0.65 to 1.2.



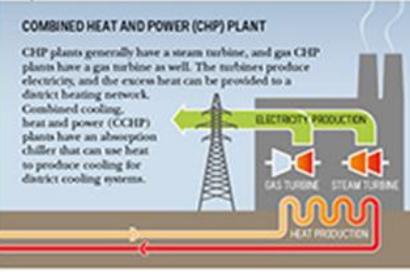
## CONNECTING RESIDENTIAL CUSTOMERS

Buildings typically will be connected individually to the district energy network, with a heat exchanger separating the building's central heating or cooling system from the network. District heating can be used to provide heating as well as hot water, and in some cities buildings are connected to both district cooling and district heating systems.



## COMBINED HEAT AND POWER (CHP) PLANT

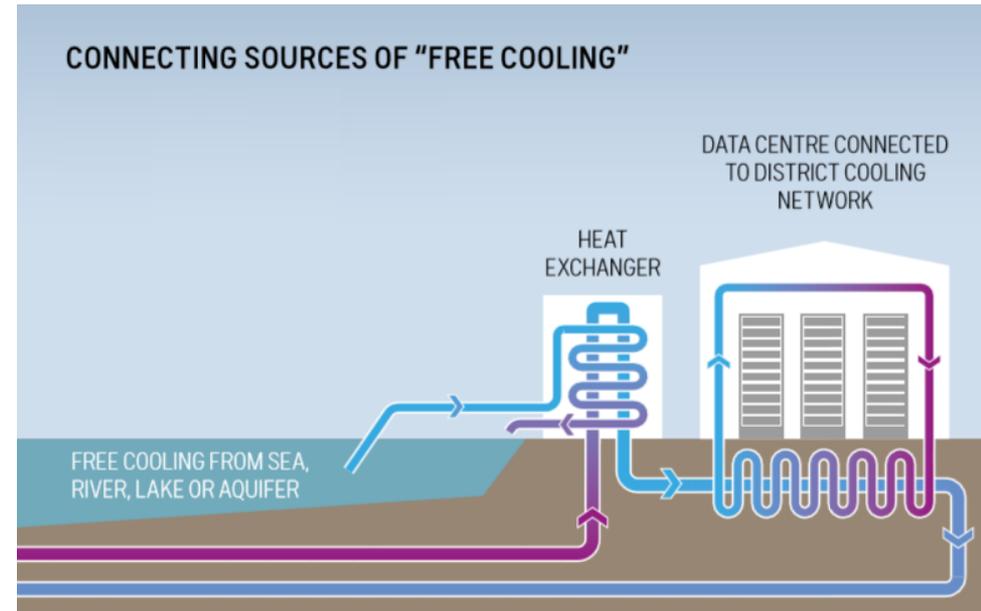
CHP plants generally have a steam turbine, and gas CHP plants have a gas turbine as well. The turbines produce electricity, and the excess heat can be provided to a district heating network. Combined cooling, heat and power (CCHP) plants have an absorption chiller that can use heat to produce cooling for district cooling systems.



# District energy is the only way to use large scale renewable heat and cool sources



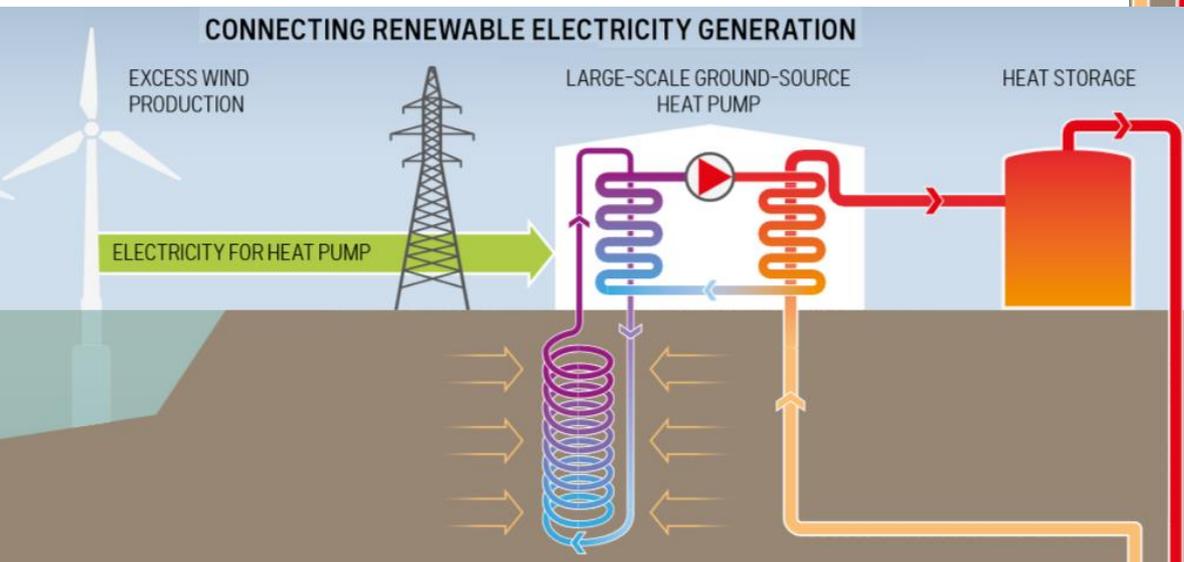
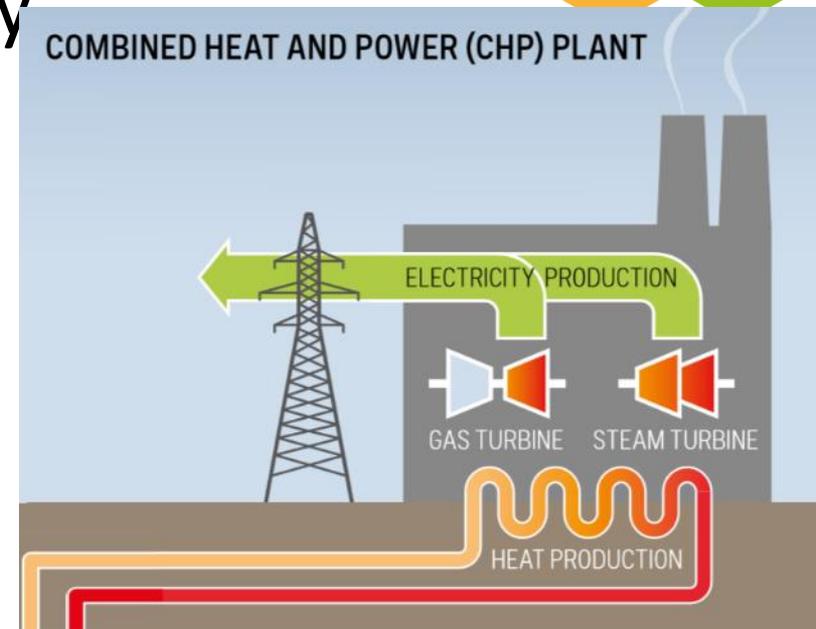
- District cooling and heating networks enable the connection of renewable heat or cool that cannot otherwise be used on an individual building level for example:
  - waste heat from industry, power plants, waste incinerators, metro systems or data centres;
  - geothermal;
  - large scale biomass;
  - large scale heat pumps;
  - free cool from rivers, lakes, seas and aquifers;
  - large scale solar thermal; and
  - sewage and wastewater heat.
- By connecting heat or cool storage district energy networks can maximise the use of these renewable resources



# District energy provides important electricity balancing services enabling higher shares of renewable electricity



- The combination of CHP or CCHP and heat/cool storage can allow district energy networks to balance renewables such as wind and PV on the electricity network.
- This is how Denmark is reaching such high shares of wind and Germany such high levels of solar PV.



# Key Findings: The importance of local governments



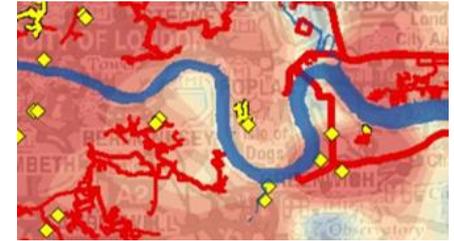
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**Strategy and  
Targets**

**Integrated energy planning  
and mapping**



**Local governments**



**Facilitating  
Finance**

**Consumers and  
Providers**



# Key Findings: Multiple Benefits and Policy Objectives



**Energy Efficiency  
and Access**

**Local and Renewable  
Sources**



Meet Tomorrow's Energy Needs  
by  
Leapfrogging to Modern District  
Energy Systems Today!



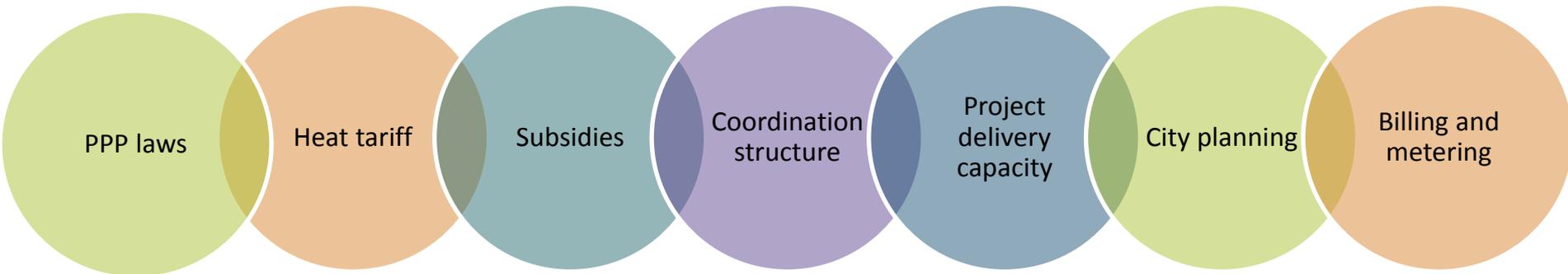
**GHG Mitigation  
Improved Air Quality**

**Green Economy  
Resilience**



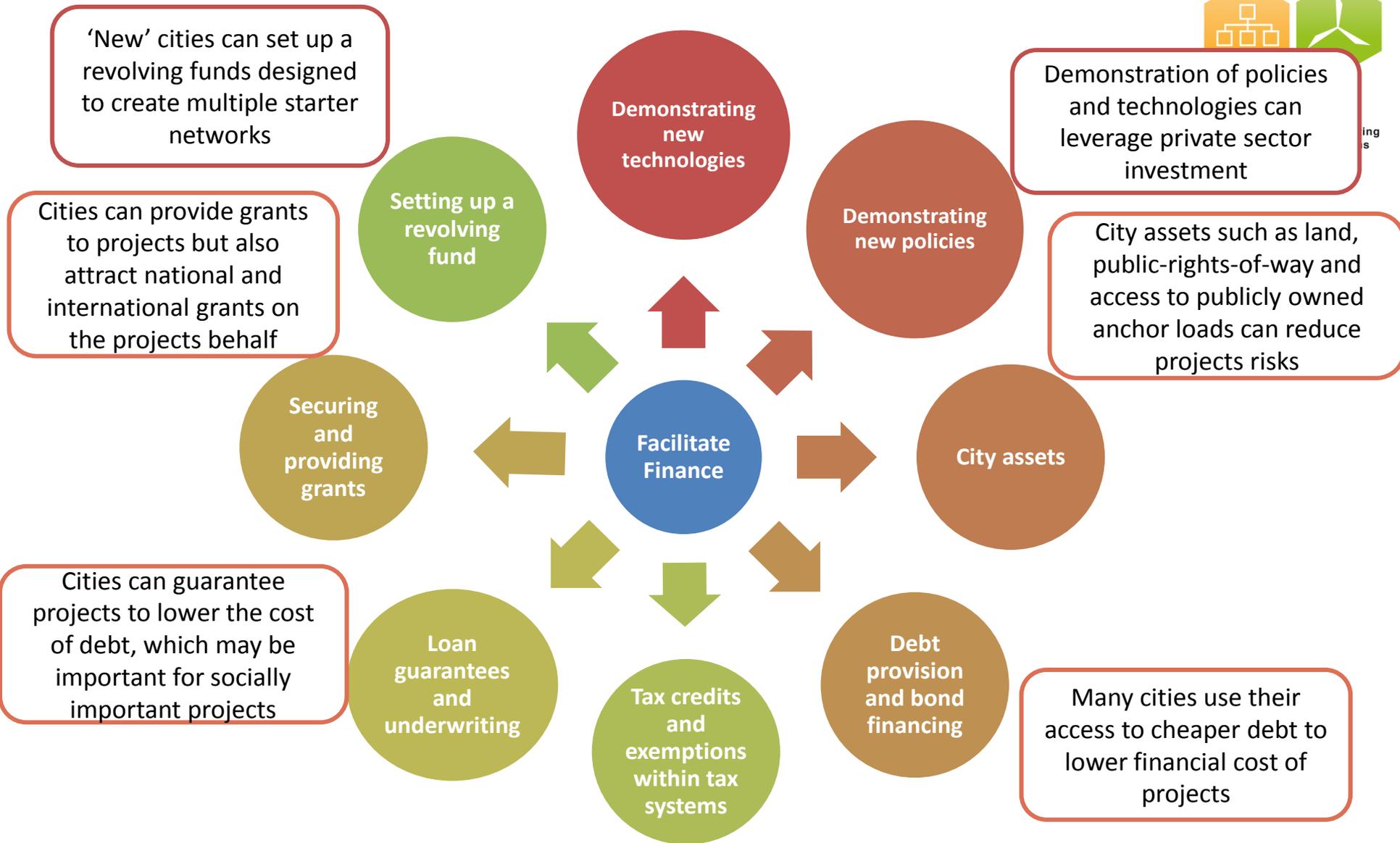
# Key Findings: Piloting Policies

- Coordination between national and local government is key to ensuring replicable projects.
- Support from national governments is key.
- Pilot projects can provide lessons for national policy and local lessons for replication in cities.





# Local Governments can Facilitate Finance

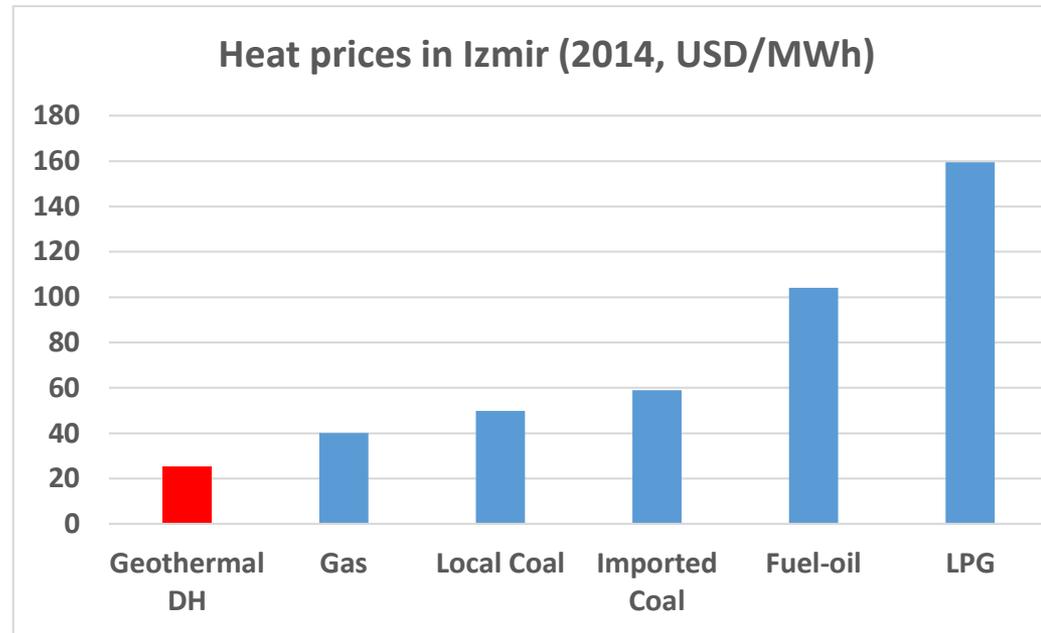


# Izmir, Turkey has developed large scale district heating system based on geothermal



## Izmir Geothermal Company

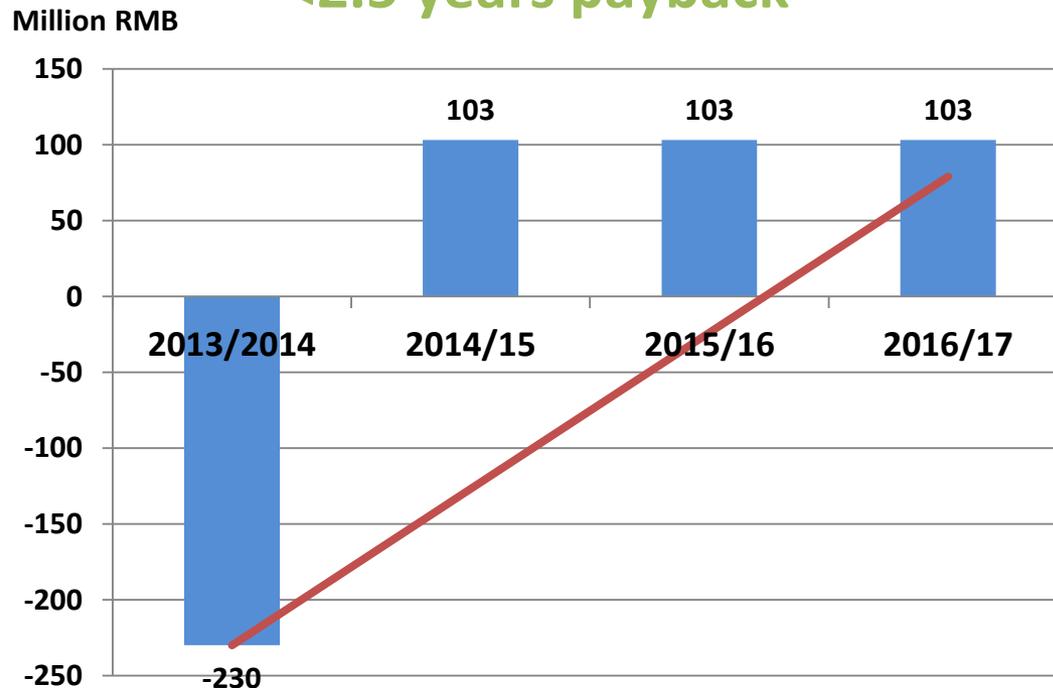
- 3.3 million square metres connected, 4,400 buildings
- Heat demand approximately 46kWh/msq/year
- Uses 100% Geothermal through 20 geothermal wells with power of 160MW
- Geothermal has a 67% load factor
- System prevents 68,000 t CO<sub>2</sub> emissions (compared with natural gas)
- Out of heating season, hot water is still provided.
- The city is now looking to produce power from the geothermal resource outside of the heating season.
- Very low heat prices.



# Anshan, China: Investing in waste heat



<2.5 years payback



220 MW available surplus heat (1<sup>st</sup> phase)

Yearly energy saving	830,000 MWh
Coal savings	173,000 tons
CO <sub>2</sub> emission savings	290,000 tons
Yearly savings	103 million RMB (15 million euros)
Investment	200-230 million RMB (30 – 35 million euros)

# Paris ownership structure and control



- City of Paris owns the network
- Production facilities mostly owned by CPCU except 3 waste-to-energy plants
- CPCU does all maintenance, investment and customer interactions.
- 4 of 10 directors on CPCU's Board of Directors nominated by City of Paris.
- Concession contract specifies maximum heat tariff indexed by percentage of renewable energy sources used to encourage renewables.
- City of Paris can control the production mix of heat and target higher renewable shares.

Today district heating is nearly **50% renewable** and supplies equivalent of 500,000 households including 100% of hospitals, **50% of social housings**, and 50% of public buildings.

# Paris: Local government impact



## Planner and Regulator

### Urban Development Zones

Will develop mandatory connection once more than 50% renewable (2015)

Strategy and targets: 60% renewable by 2020.

## Facilitator of Finance

Enables cheap loans for CPCU

Direct loans.

**Sometimes pays for extending the network inside the new zone**

Pools investment with other municipalities

## Provider and Consumer

**Anchor loads (public buildings, hospitals, social housing).**

Network runs through parts of the metro system

Direct ownership of network in the city.

**Sets maximum heat tariffs and sets a special low tariff for social housing**

## Coordinator and Advocate

Coordinate with other cities to interconnect networks and jointly develop heat production facilities.

**Coordination across:** Waste collection, metro, tram and road development, building efficiency programmes, new building developers

# Key steps in developing a district energy system



- Ten key steps that cities can take to support the development of district energy systems
- These steps can be taken individually or packaged to meet specific city conditions and needs.
- Depending on city type some steps may have already been completed

<b>1.</b>	<b>ASSESS</b> existing energy and climate policy objectives, strategies and targets, and identify catalysts
<b>2.</b>	<b>STRENGTHEN</b> or develop the institutional multi-stakeholder coordination framework
<b>3.</b>	<b>INTEGRATE</b> district energy into national and/or local energy strategy and planning
<b>4.</b>	<b>MAP</b> local energy demand and evaluate local energy resources
<b>5.</b>	<b>DETERMINE</b> relevant policy design considerations
<b>6.</b>	<b>CARRY OUT</b> project pre-feasibility and viability
<b>7.</b>	<b>DEVELOP</b> business plan
<b>8.</b>	<b>ANALYSE</b> procurement options
<b>9.</b>	<b>FACILITATE</b> finance
<b>10.</b>	<b>SET</b> measurable, reportable and verifiable project indicators



# Realising the Initiative's full potential

## Business as Usual

- New cities without heat/cool planning
- Abandoned refurbishment systems
- European best practice not shifting abroad
- DHC mostly confined to Nordics and EU

## Funded Initiative Activities

- 3 pilot cities in India, China and Eastern Europe
- State/Provincial replication
- Global training and decision tools for local governments
- City-twinning

- Initial funding of Initiative
- In-kind support from existing partners

## Potential Initiative Activities

- Multiple pilot cities builds to national momentum and replication
- New markets emerge for best practices transfer
- DES becomes status-quo in new city design
- Energy transition

- More funds to Initiative
- Universities, cities and private sector contribute expertise

# 'City Energy Efficiency Support Office'



- Proposal to consider the establishment of a 'City Energy Efficiency Support Office'.
- Danfoss Foundation providing funding.
- Will be linked to the CLEAN business network and focus on the District Energy Accelerator.
- Opportunities exist for other donors and partners.
- Initially, 3 District Energy experts would be recruited to provide technical support to cities initiating or expanding District Energy.
- Office activities could be expanded to in the future e.g. building efficiency

# Thank you



For more information on the **Global District Energy in Cities Initiative**, to join the Initiative and to become a partner, please visit the website or contact:

- Ms. Djaheezah SUBRATTY, Head, Policy Unit, Energy, Climate and Technology Branch, UNEP, [djaheezah.subratty@unep.org](mailto:djaheezah.subratty@unep.org)
- Ms. Lily RIAHI, Advisor on Sustainable Energy in Cities, Policy Unit, Energy, Climate, and Technology Branch, UNEP [lily.riahi@unep.org](mailto:lily.riahi@unep.org)

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Combining Building Efficiency and District Energy for More Sustainable Cities: A Sustainable Energy for All webinar  
10:00-11:30 Tuesday, 1 September 2015  
[www.energyefficiencycentre.org/](http://www.energyefficiencycentre.org/)

