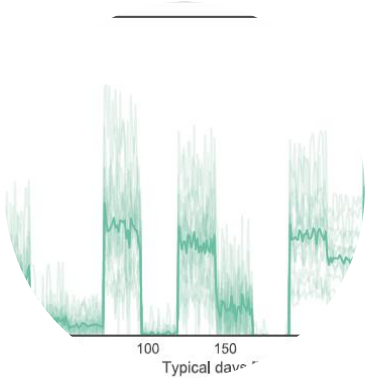
# Integration of Renewable Energy for Thermal Use in Cities

*--- Technology, project development and case studies*



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IRENA Innovation and Technology

Bonn, 26 May 2020

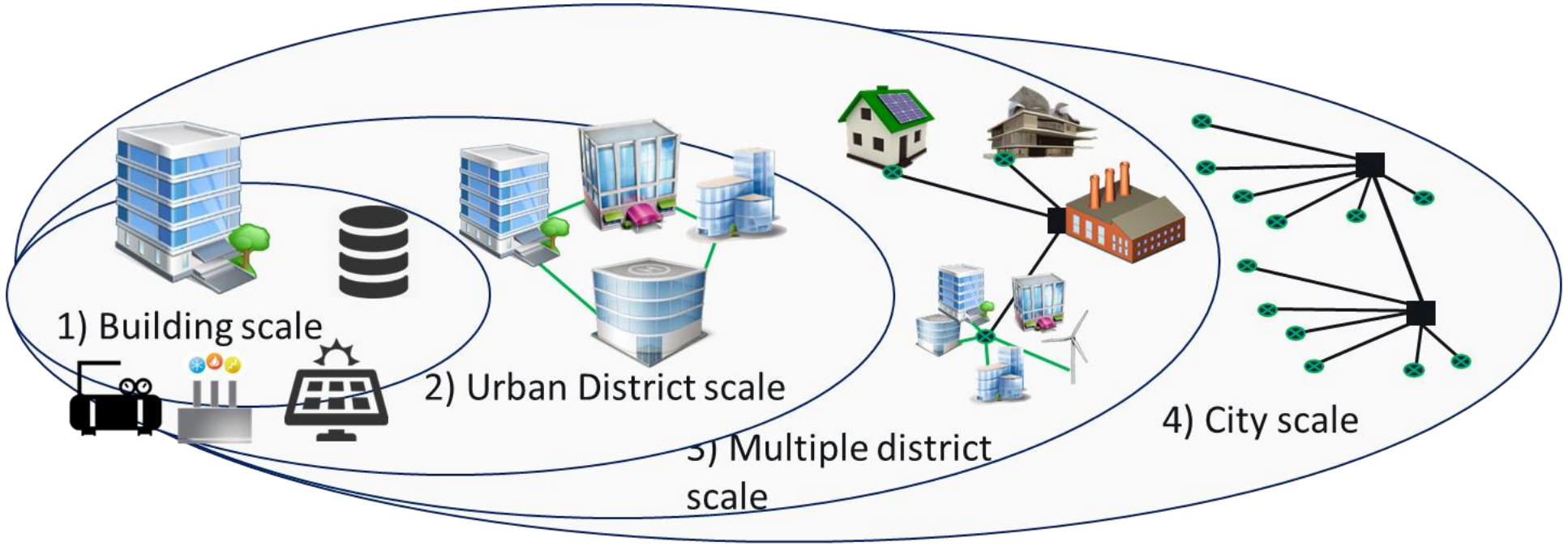
# Urban Energy Systems and Renewables

## What does urban energy system mean?

- Networked infrastructure with spatiotemporal and socio-technical dimensions
- Scalable and trade-off options
- Vulnerable

## RE accounts for 20% of the urban energy consumption:

- 1/3 for transport
- 2/3 for buildings

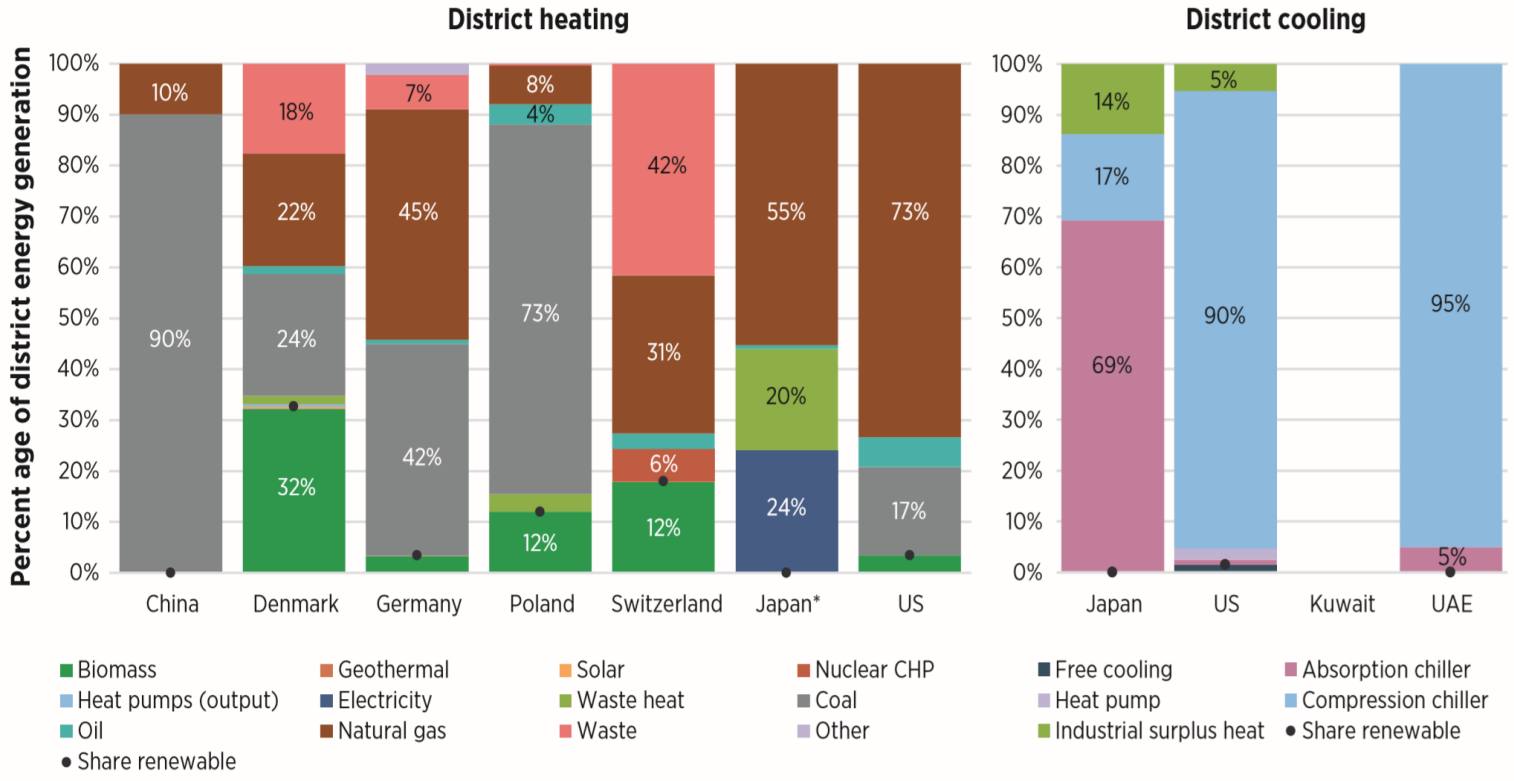



Marquant, J. F., Evins, R., Bollinger, L. A., & Carmeliet, J. (2017). A holarchic approach for multi-scale distributed energy system optimisation. *Applied energy*, *208*, 935-953.

# Urban Renewable Energy Thermal Technologies

## For both DHC and building levels

- Solar thermal applications (Flat-plate glazed, evacuated-tube collectors and concentrating solar energy for heating)
- Direct utilization of geothermal energy
- Heat pumps (different heat sinks, small and large-scales)
- Bioenergy and waste-to-Energy (co-gen)
- Surplus RE electricity for heating through sector coupling



# Technical Guidelines for Heating and Cooling systems

## For whom?

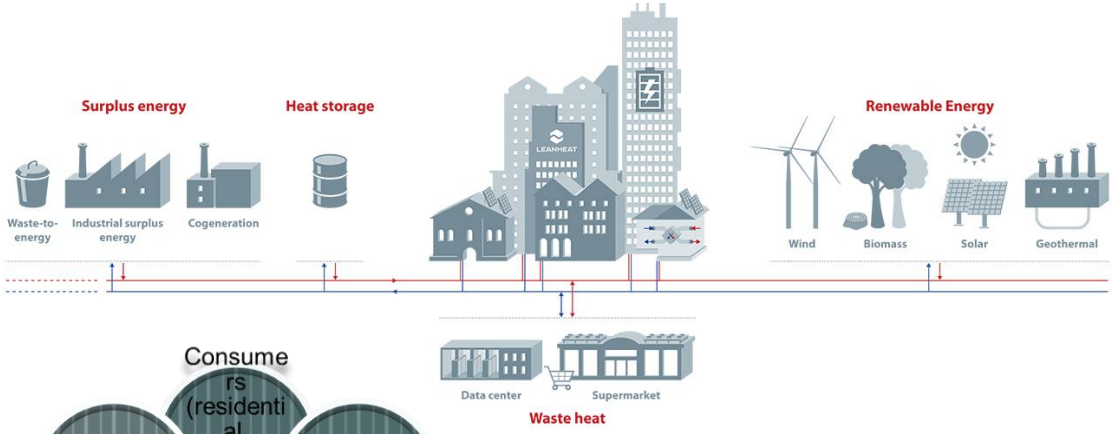
- Support the development of renewable energy heating and cooling solutions for residential, industrial and commercial end-users

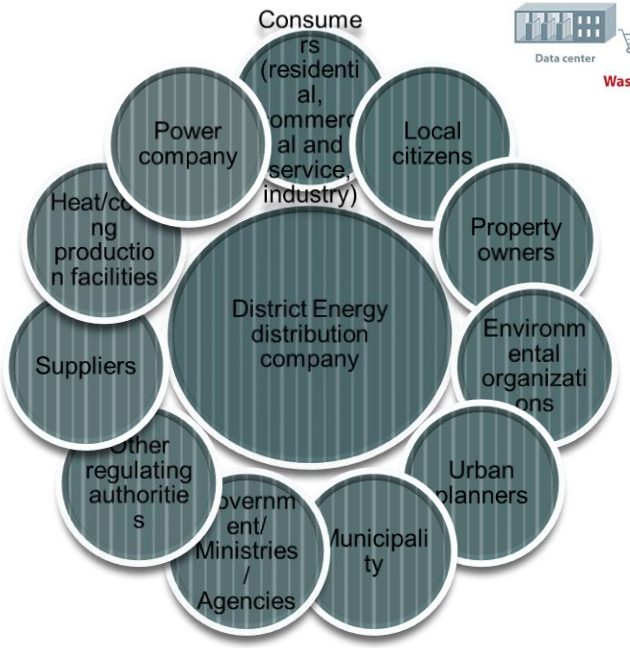
## How can it help?

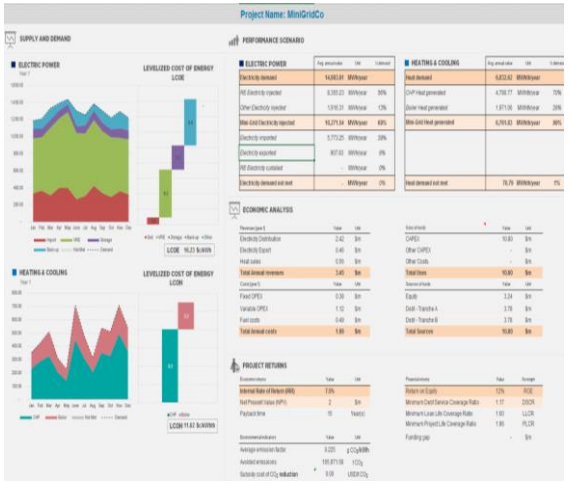
- Provide technical guidelines to RET project development for thermal use (small-medium sizes): supply volume, time of day, resource efficiency to match user requirements

## What are covered?

- Low-temp thermal networks (Heating and cooling)
- RETs: solar thermal, biomass (cogeneration), biogas, geothermal and heat pumps combined with storage technologies
- Other key factors for RETth project development

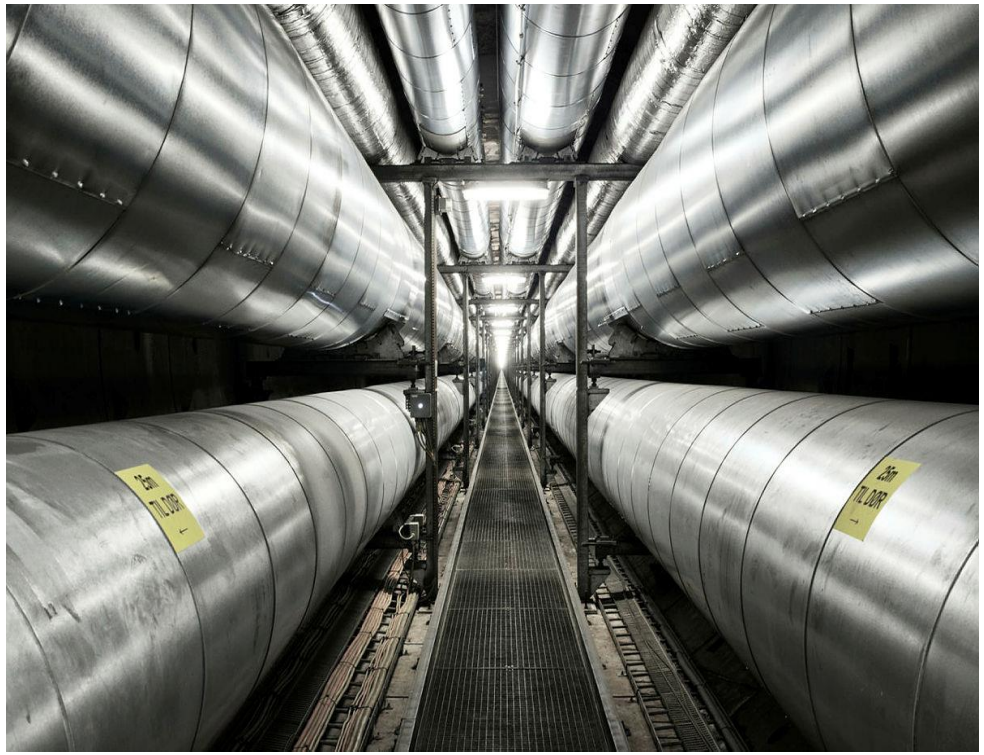


Focus on bankable project alternatives for each configuration and load requirement with practical details such as energy audit, process integration, technology selection, technical design, cost estimation or financial modelling.

# Success factors for REth project development



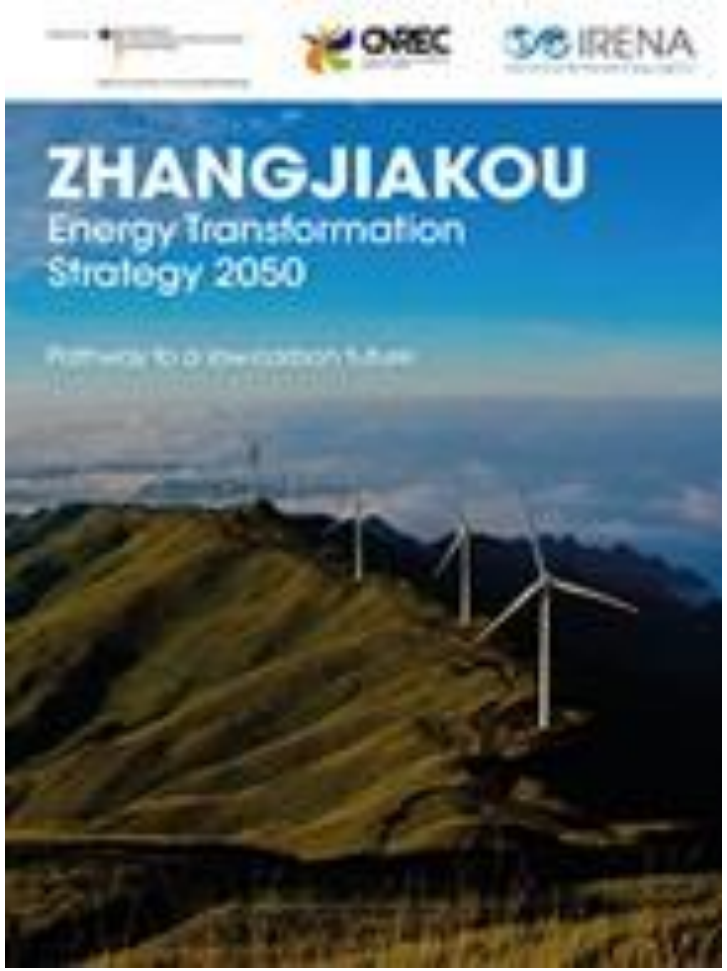
*District heating tunnel under the Copenhagen Harbour*
*Two sets of forward and return pipes*

## Key takeaways

- Provide proven and credible RE solutions for district energy systems
- Identify, assess, district energy risks early in the planning
- Enhance capacity and knowledge on the ground
- Inform city-level decision makers towards RE Heating and Cooling benefits
- Strengthen institutional mechanisms across similar cities
- Facilitate access to predictable and sustained climate financing
- Measure, evaluate and share results

# Case study: China

# Zhangjiakou Energy Transformation Strategy 2050

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*Report available at:*
*https://irena.org/publications/2019/Nov/Zhangjiakou-Energy-Transformation-Strategy-2050*

# City Profile

***IRENA's joint study with Zhangjiakou Municipal Government and China National Renewable Energy Center***

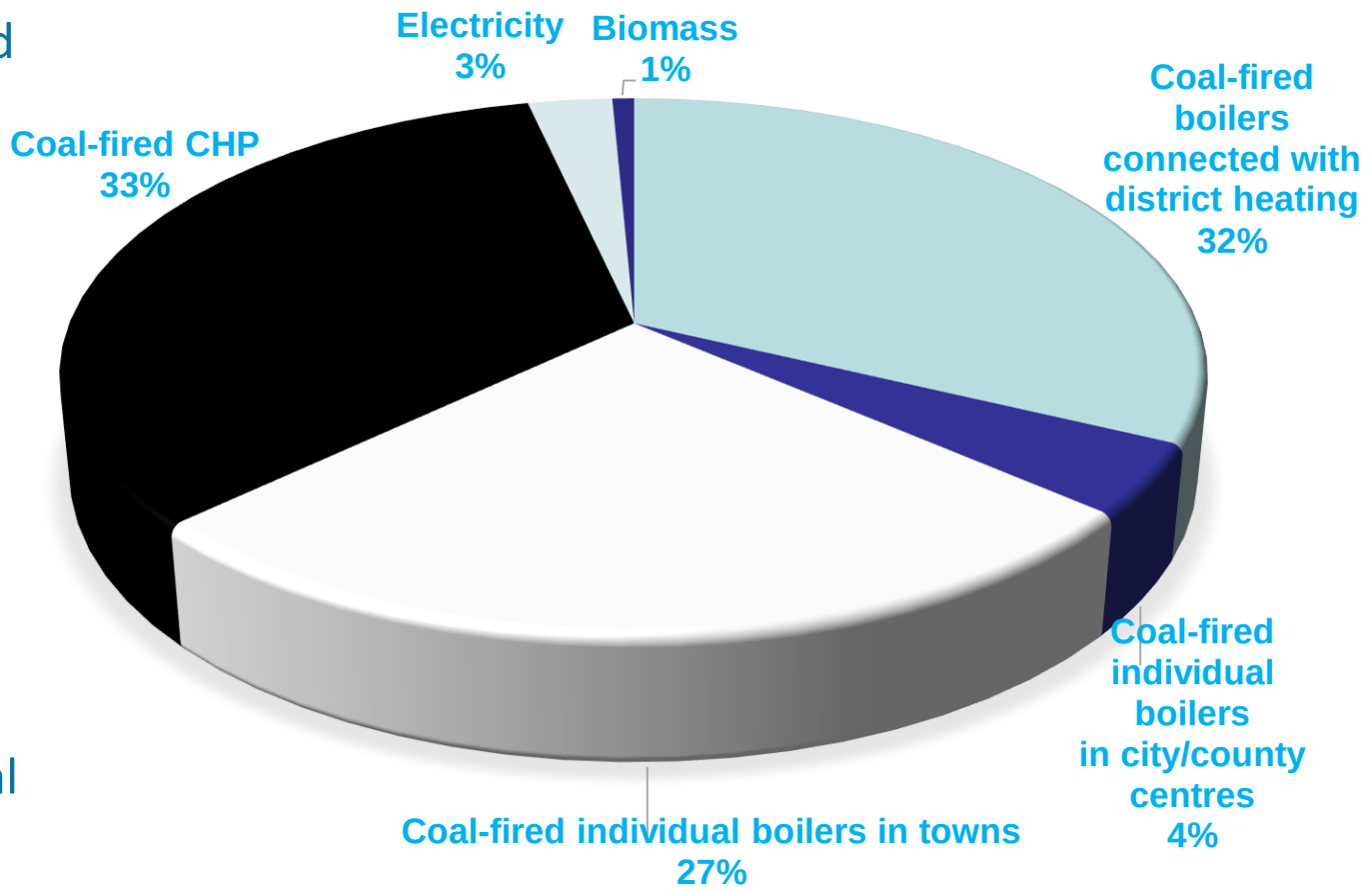
- The National Renewable Energy Demonstration Zone approved by the State Council of China – the first-of-this kind
- Low-carbon Winter Olympic 2022;
- Provision of low-carbon green energy to Jing-Jin-Ji region, particularly Beijing.
- 5-month long heating period for 4.4 million inhabitants

# District Heating: transformation in progress

IRENA
International Renewable Energy Agency

***Current heating demand and supply***

- 150 million m2 of floor area in the city required space heating services
- 32% is covered by DH systems through 3 453 km networks, including 1 092 km of the main network and 2 361 km of pipelines connecting the main network to buildings.
- 33% by heating systems in building complexes(1 117 coal-fired boilers with capacity <35 tonnes of steam/hour and 63 boilers with capacity above this size)
- 95% of space heating services were met by coal

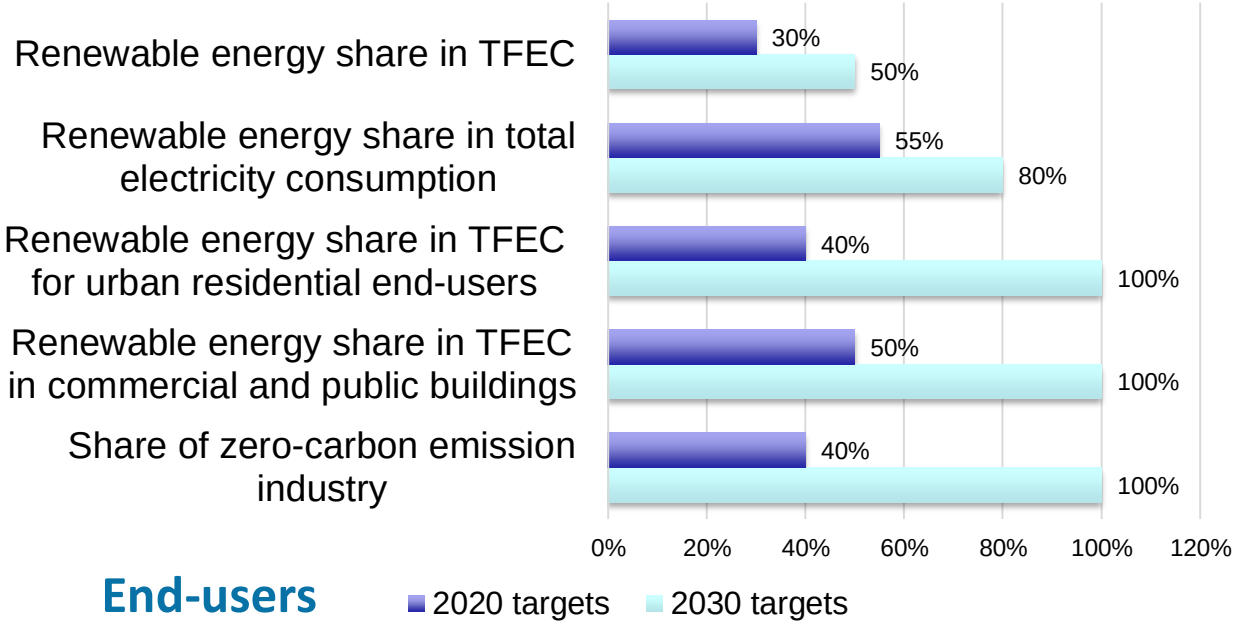


# District Heating: transformation in progress

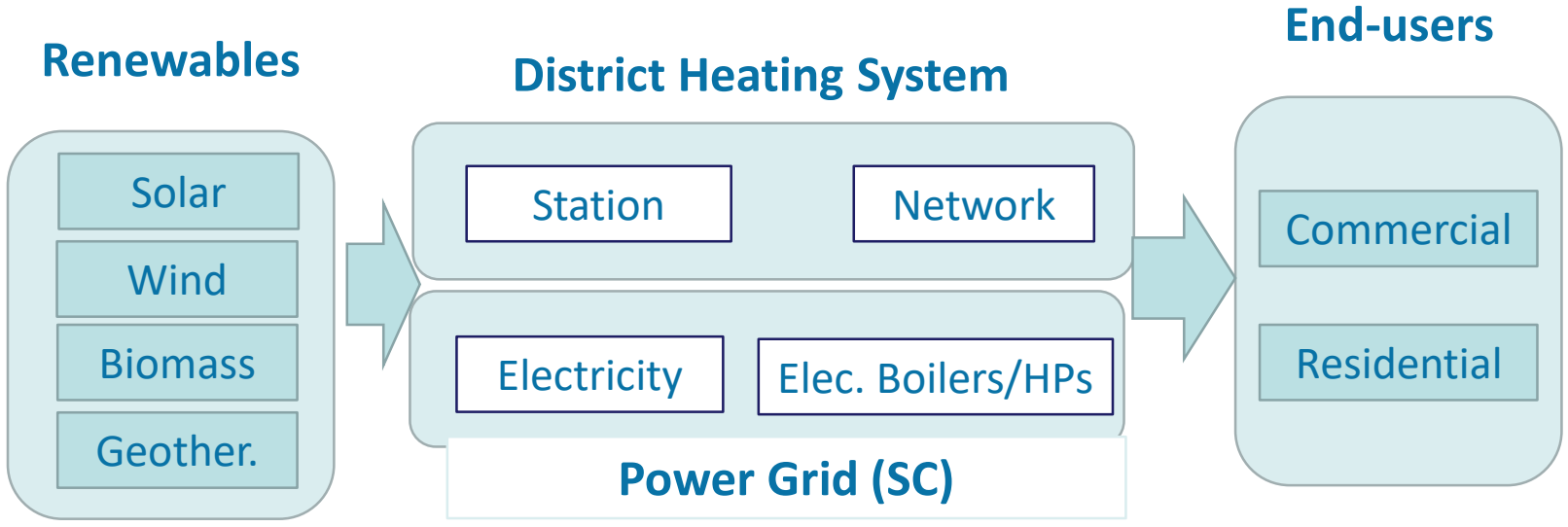
IRENA
International Renewable Energy Agency

## *Conventional (coal CHP) to RE heating solutions* ⟹ *Policy objectives for transformation of heating sector*

- District heating with renewables as a measure for phaseout of coal use
- Concentrating solar thermal (tower) with seasonable energy storage for building complex
- Scale up the biomass and geothermal for heating
- Surplus renewable electricity for heating through DH and thermal energy storage




### *Transformation*




# Parabolic Trough Collector System for Industrial Steam Production in Limassol, Cyprus

Contributed by Prof. Soteris Kalogirou (soteris.kalogirou@cut.ac.cy)

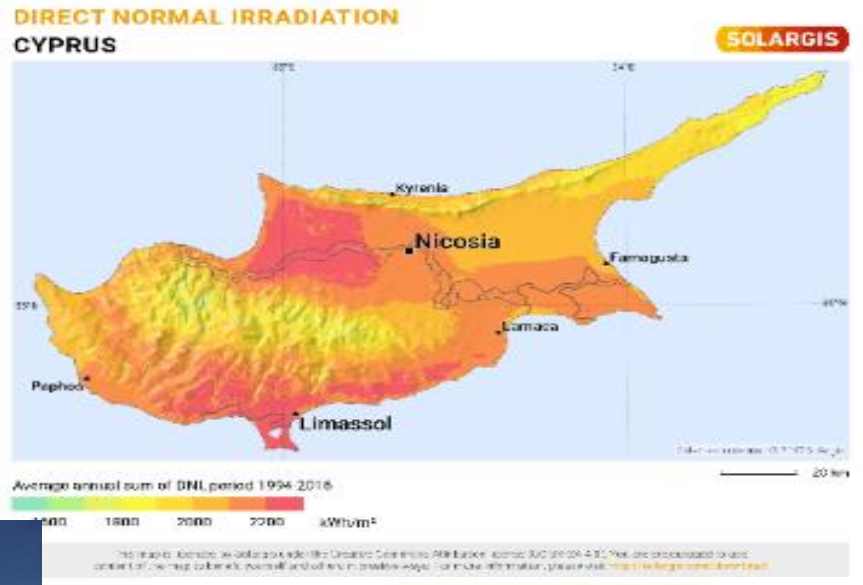
Department Chair, Department of Mechanical Engineering and Materials Science and Engineering, Cyprus University of Technology

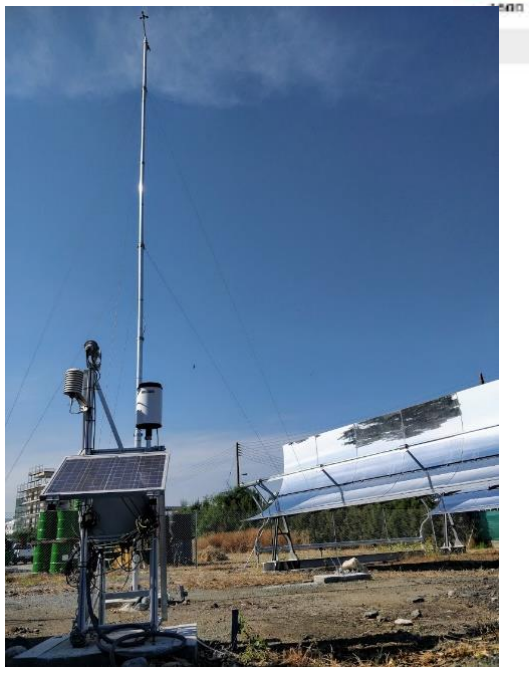
# Juice Production in Cyprus with Solar Energy

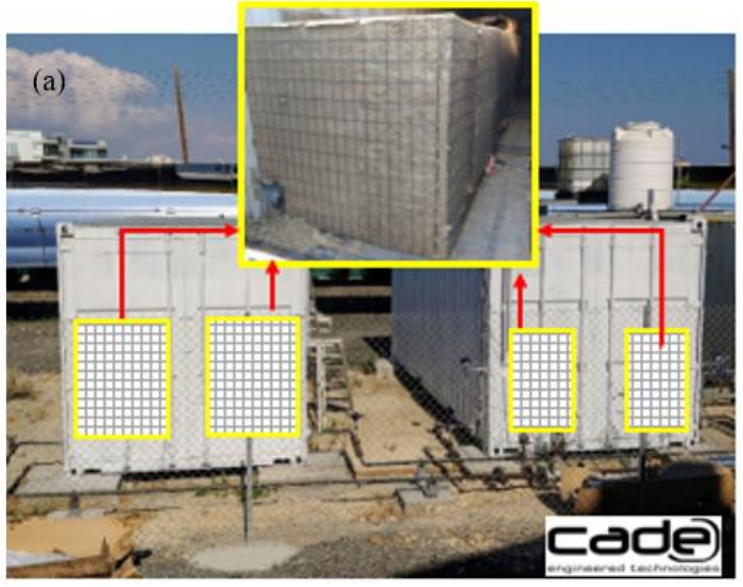
IRENA
International Renewable Energy Agency

***The case profile:***

- Direct normal irradiance (DNI) resources of up to 2200 kWh/(m2a)
- The industrial sector is ranked as the 2nd largest fossil fuel consumer
- Innovative application of parabolic trough collector (PTC) technology to produce heat in one of the biggest soft and drinks industries, called KEAN, located in Limassol
- Concrete thermal energy storage (CTES) with advanced composition of concrete is applied to meet the heat demand in winters



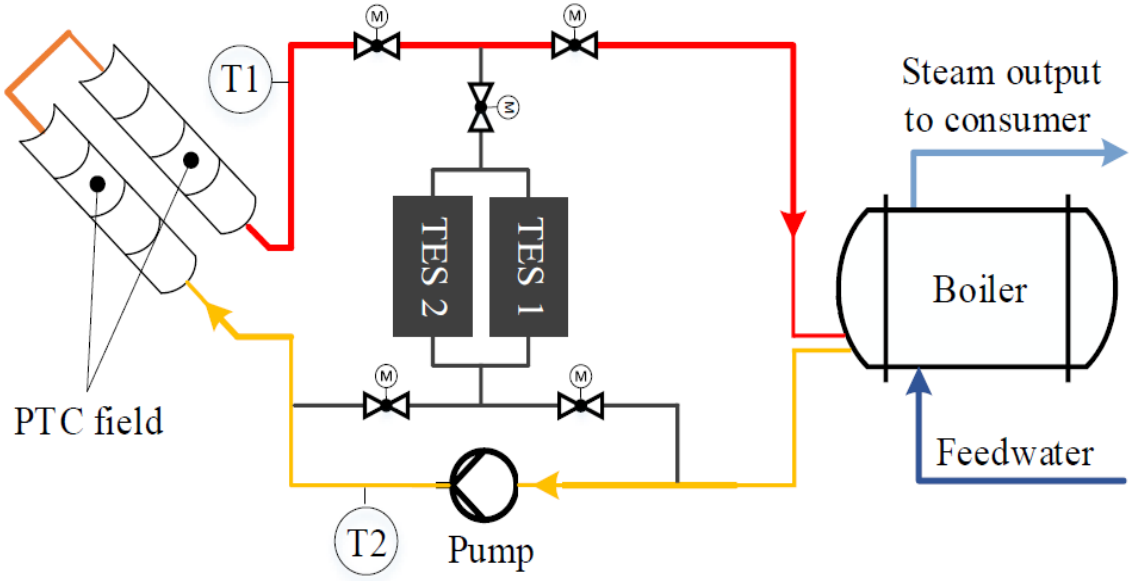





# The PTC with CTES system

### *The system configuration and capacity*

- 8 PTC (CF100) connected in 2 parallel rows of 4, with an aperture of 3 m and a length of 12 m
- Nominal thermal capacity: 125 kWth.
- PTCs employ a highly efficient receiver tube for operation at temperatures up to 425 C.
- CTES performance: operation temp up to 400 C




### *System operation performance*

- Advanced processor to control all the operation modes and strategies to make the system dispatchable and autonomous
- After a year of operation, the system responds perfectly to the Strategies and Modes and supply the required amount of steam to the factory when is needed even at times when there is no solar radiation.

# Thank You!

This presentation is based on the following three reports:

- *Zhangjiakou Energy Transformation Strategy 2050*
  https://irena.org/publications/2019/Nov/Zhangjiakou-Energy-Transformation-Strategy-2050
- *Energy Solutions for Cities of the Future: Technical guidelines for the development of bankable renewable energy heating and cooling projects* (to be published in 2020)
- *Rise of Renewables in Cities: Opportunities, Technologies and Urban Energy System Planning* (to be published in 2020)

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