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Integration of Renewables in District Heating and Cooling

--- Technical guidance for project development

--- Key challenges and solutions

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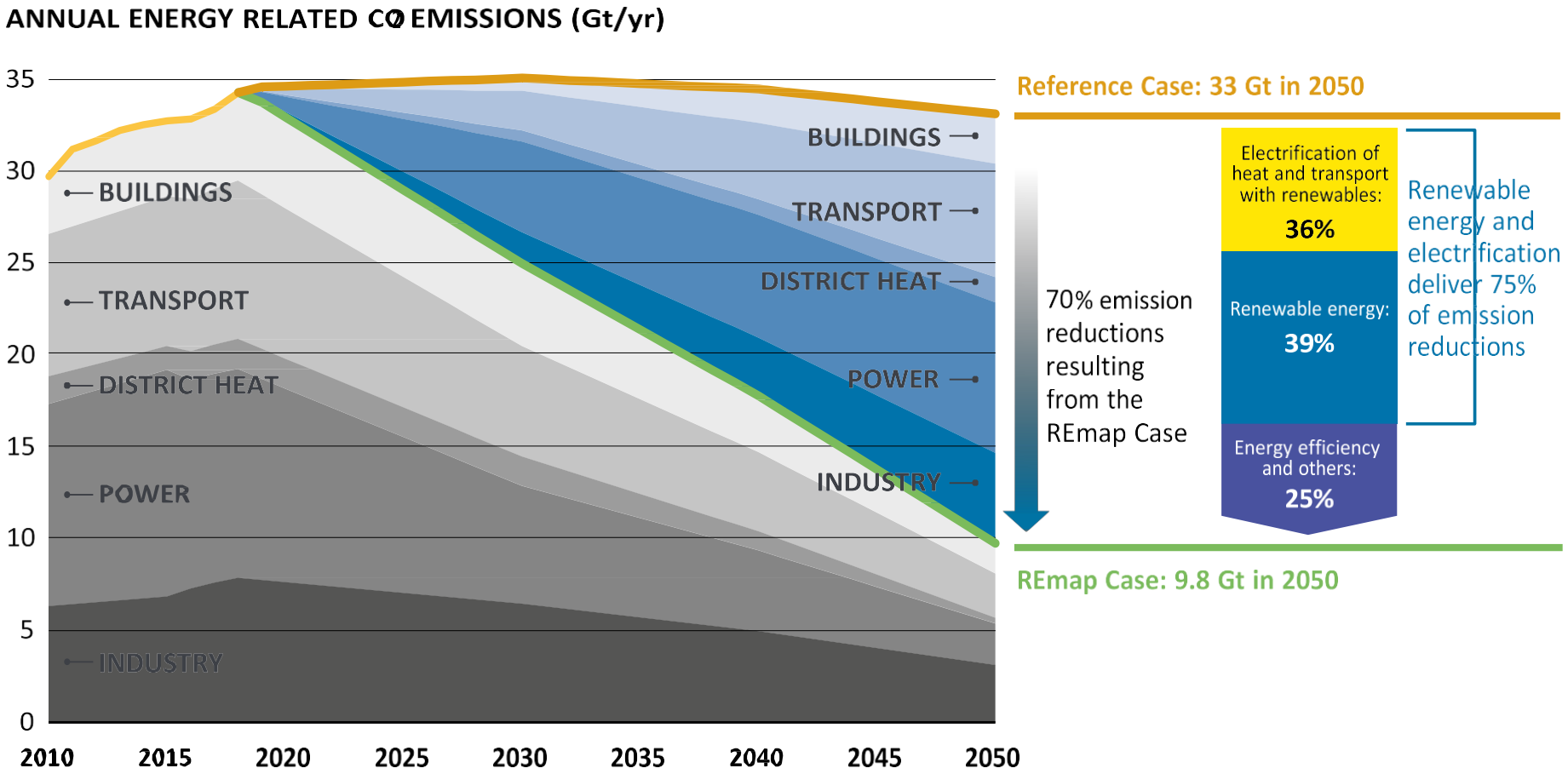
Context

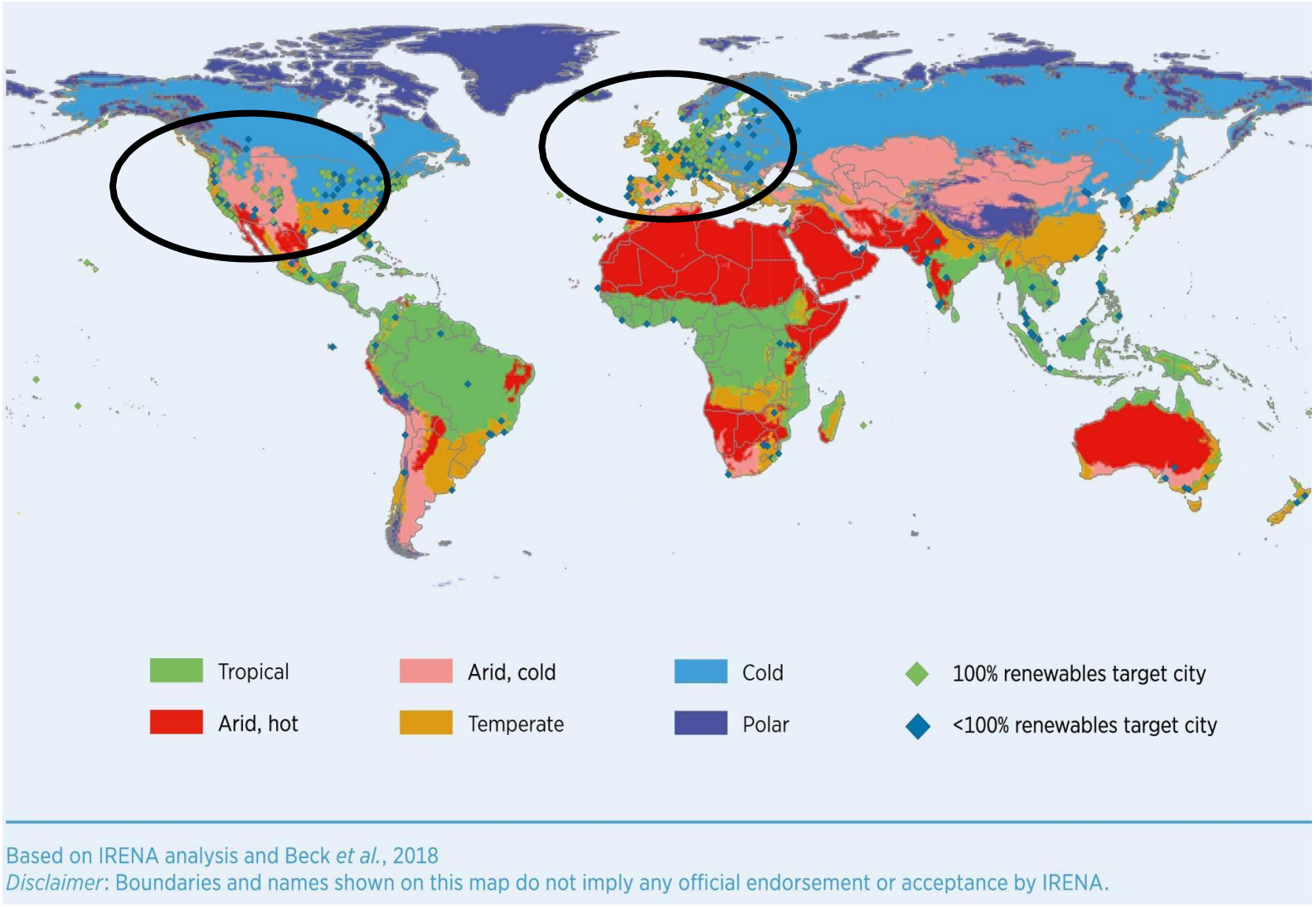
Cities is at the center of global energy decarbonisation

- From 2018-2050, **2.5 billion urban dwellers** will be added thus demanding additional energy services while energy-related carbon emissions must be significantly reduced.
- **How to meet the growing energy demand in** cities with low-carbon and sustainable energy sources?



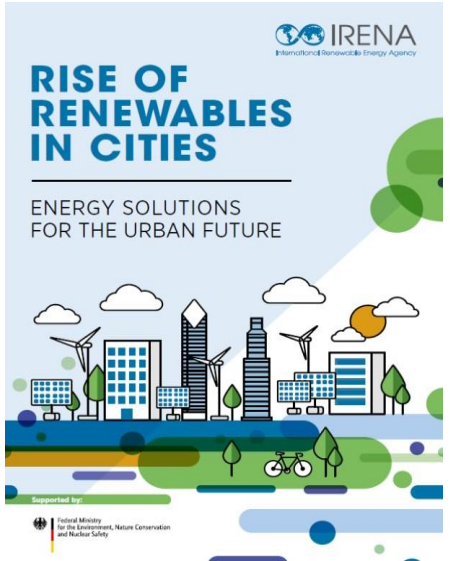
- The **potential** to substitute fossil fuels in the end-use sectors of **buildings, transport and industry**, as well as in district heating, account for the lion's share of the reductions

Global mapping of city-level renewable energy targets



Based on IRENA analysis and Beck *et al.*, 2018
Disclaimer: Boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA.

- 80% of the cities with targets are located in the **temperate or cold climate zones**
- Impact on energy demand – particularly **heating in winter**.
- Of the 980 targets, around 5% dedicated heating, while **55% covers heating** v.s. 40% for REe



https://www.irena.org/publications/2020/Oct/Rise-of-renewables-in-cities

Renewables for District heating and cooling systems

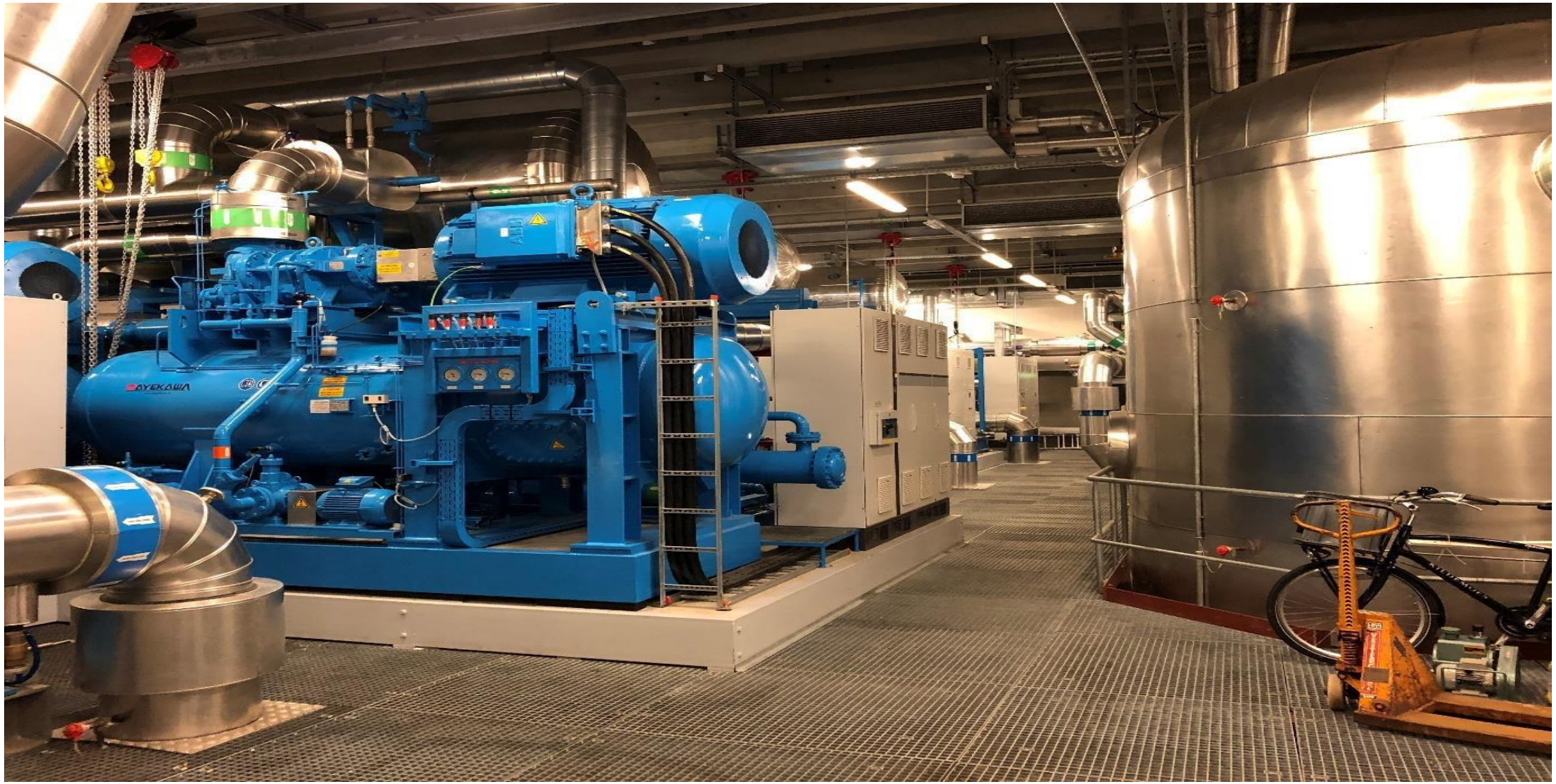
RE sources for DH:

- WtE;
- Biomass
- Direct use of geothermal energy
- Solar thermal
- Heat pumps/electric heater using surplus REe
- Waste heat

RE sources for DC:

- Free cooling sources air, seawater, water from a river, or groundwater to achieve higher efficiency
- Solar thermal for absorption chillers

Example for DC: free seawater cooling and compressor cooling



HOFOR’s DC Plant in Adelgade Copenhagen

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Technical Guidance for Development of Bankable Renewable Energy Heating and Cooling Projects

(9 stages in project development process)

Technical Guidelines for Heating and Cooling systems

For whom?

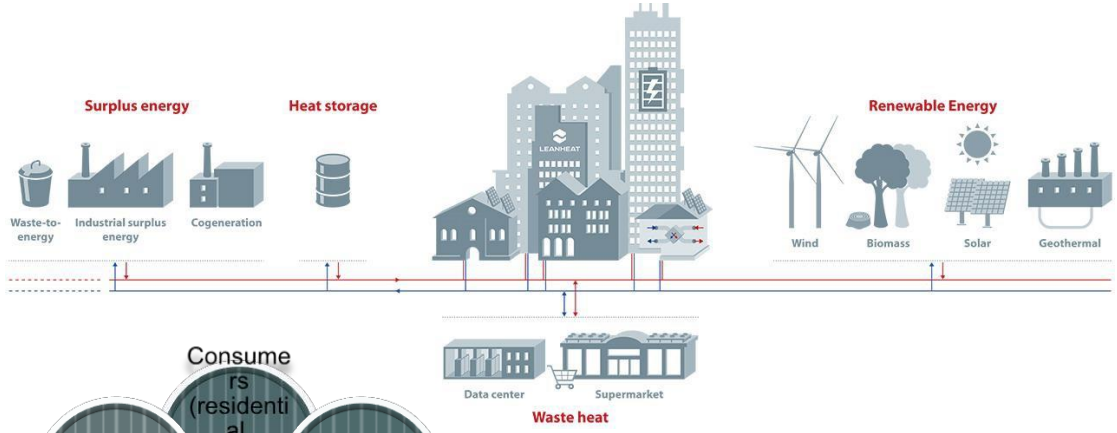
- Support the development of renewable energy heating and cooling solutions for residential, industrial and commercial end-users

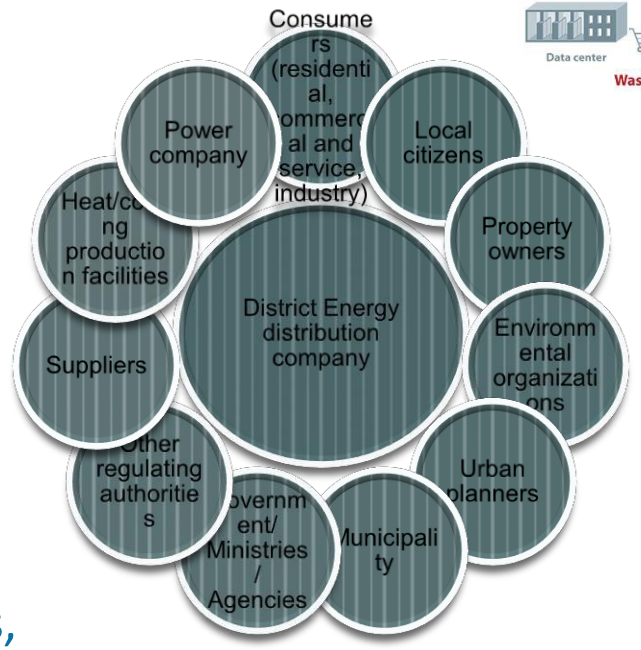
How can it help?

- 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.

Key elements in each stage

Identification

- Demand for H&C
- Surplus sources
- Scale and cost

Screening

- Create a short-list of DHC options (incl. RES)
- Feasibility study
- Risk: individual units

Assessment

- High-level CBA for different options
- Other factors

Selection

- Assess. meth & scoring matrix (tech & non-tech)
- Selection tool: Heat duration curve, Tech catalogue & Network Assessment

Pre-development

- Complete final design: detailed (engineering) feasibility study to permitting, financing, licenses, etc.

Development

- Contractors (EPC) scheduling, procurement, bankability and strategy.

Key elements in each stage (cont.)

Construction

- Project Master Plan
- Commissioning report
- Risk management
- Budget plan

Operation

- Definition of operating procedures and maintenance plan
- Production facility
- Network operation
- Consumers

Decommission

- Rarely shutdown of a network
- Need assess decommissioning v.s. refurbishment value
- Often upgrading and re-purposing

Success factors for RE project development

Key take-aways

- 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

Zhangjiakou Energy Transformation 2050: District heating

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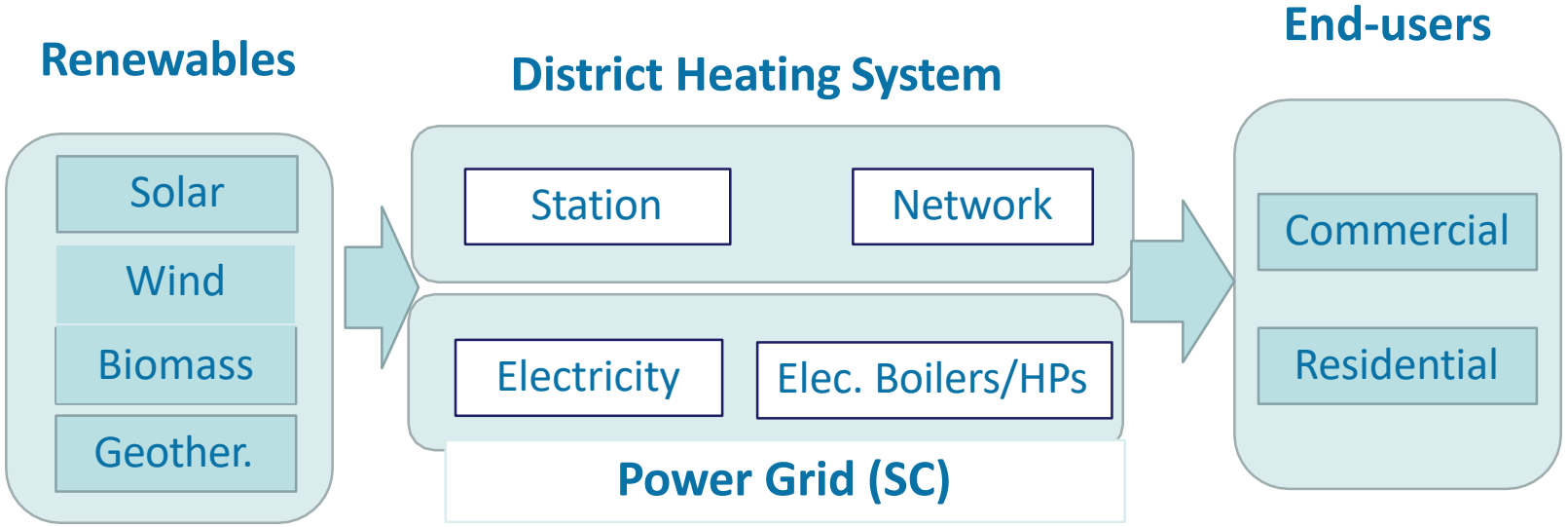
Conventional (coal CHP) to RE heating solutions ⟹ ***Policy objectives for transformation of heating sector***

- 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



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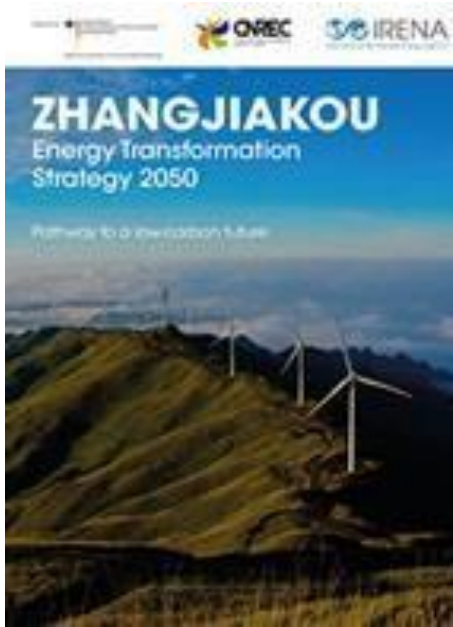

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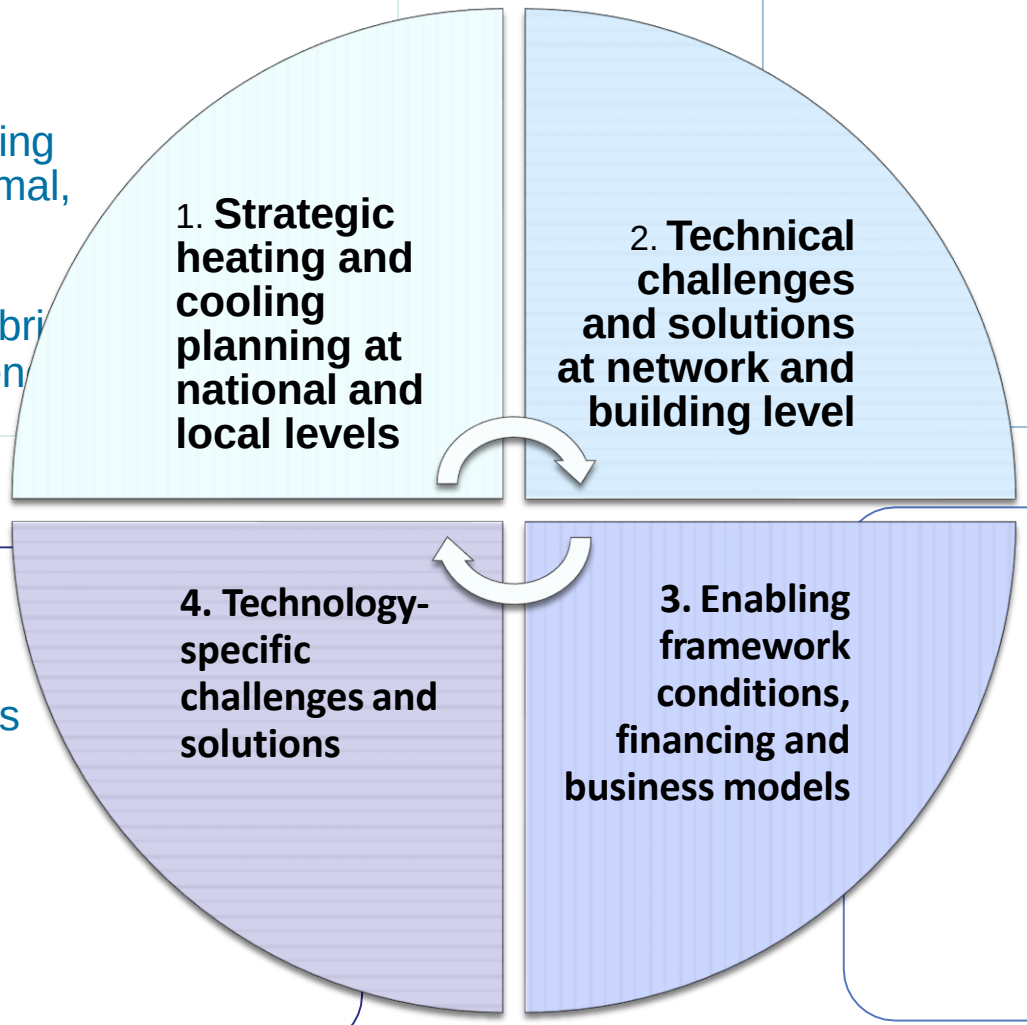
Key Solutions to the Challenges Identified

Enabling the integration of low-temp RE in DHC networks - Key focus areas

- Identification and coordination of stakeholders
- Assessing demand for heating and cooling
- Identifying and assessing geothermal, solar thermal, and other local heat sources
- Define optimum equilibri between energy efficien and supply



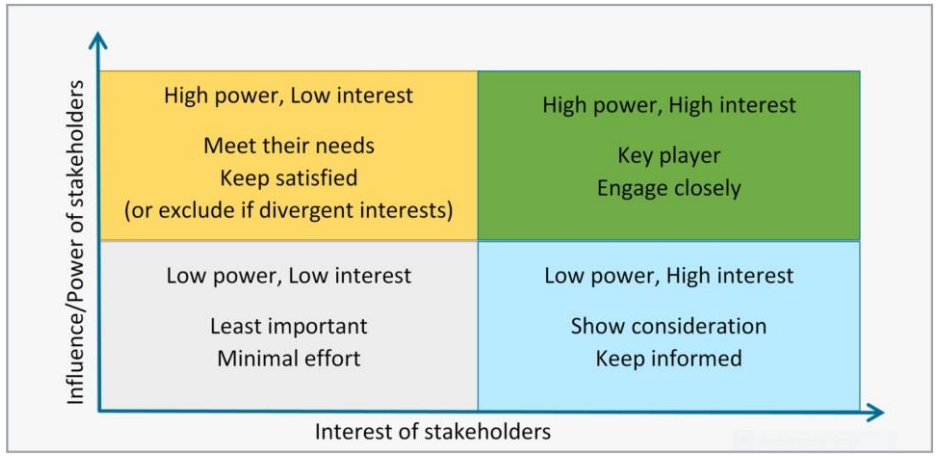
- Assess compatibility with existing network
- Assess compatibility with existing building systems
- Define and implement integrated building renovation strategies and modernisation/fuel switch

- Ownership structure
- Regulations
- Financing and risk mitigation

- Solar thermal solutions
- Geothermal solutions
- Project facilitation
- Training

Strategic heating and cooling planning

STAKEHOLDER ENGAGEMENT

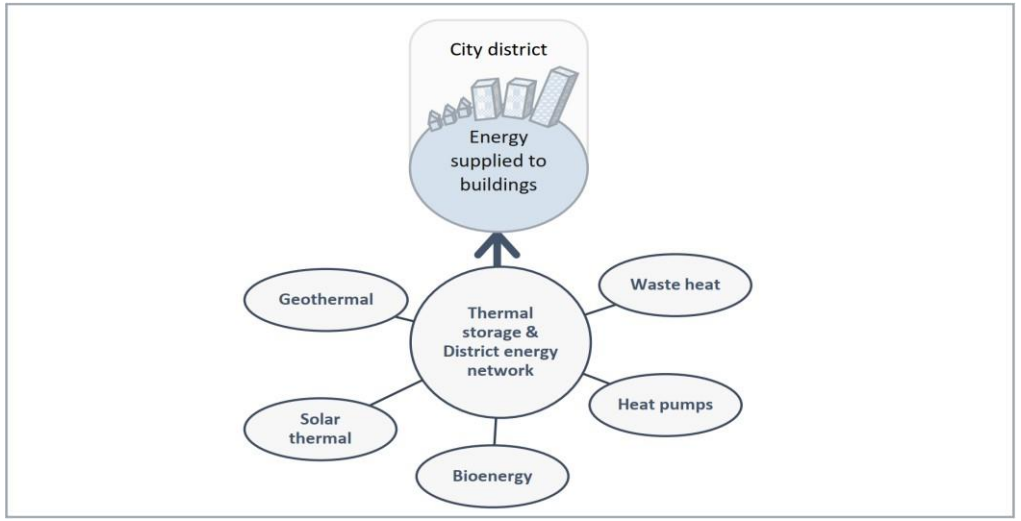


MAPPING HEATING AND COOLING DEMAND

- Measurements of actual demands allow for actual knowledge of consumption e.g. metering
- Bottom-up modelling of buildings' energy performance and consumption allows for estimated of expected heat demand e.g. portal of the territorial information system (SITG) – Switzerland
- Top-down modelling the spatial distribution of heat demands to identify priority areas e.g. heat demand atlases (PETA 4, hotmaps - Europe)

IDENTIFYING LOCAL HEAT RESOURCES

- Webmap viewer
  - Geothemal – GeoDH, Danube Region Geothermal Information Platform (DRGIP)
  - Solar - Photovoltaic Geographical Information System (PV GIS), IRENA's Global Atlas for renewable energy
  - Waste heat - Pan-European Thermal Atlas, ReUseHeat
- Best practice guide
- Database
  - Wells drilled in Geneva

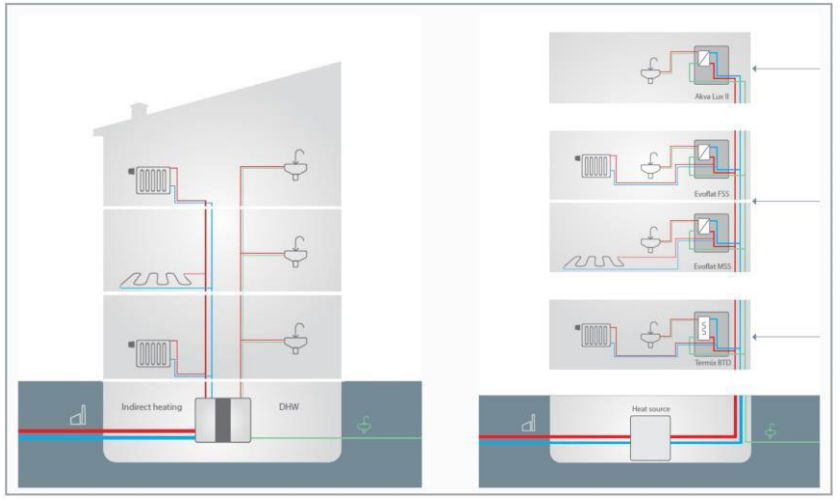


Compatibility of district energy infrastructure and RE technologies

NETWORK AND BUILDING LEVEL

Addressing the challenge of low supply temperature and high peak demand

- RETROFITTING
  - Building level: Building envelop, control equipment,
  - Domestic hot water preparation: boost temperature, water treatment
  - Network level: increase temperature drop at the building
- Human behaviour: preheating building, electronic control equipment



RENEWABLE ENERGY TECHNOLOGIES

- Geothermal
  - Reinjection for resource sustainability
  - Overcoming water chemistry challenges
- Solar thermal
  - Thermal storage- address supply and demand mismatch
  - Suitable location for solar thermal collectors in cities
- Waste heat
  - Boosting temperature of low quality resources
  - Thermal storage- address supply and demand mismatch

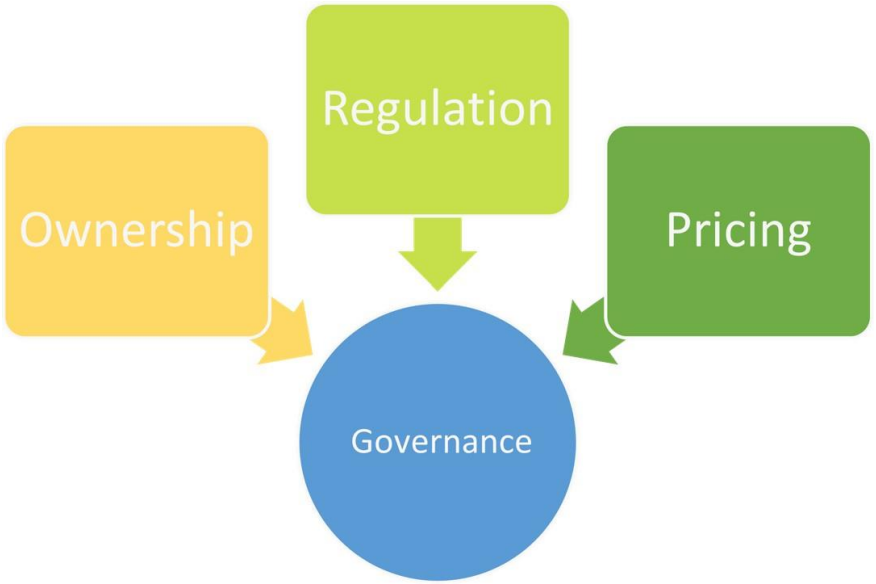
Enabling Regulatory conditions, business models and financing

OWNERSHIP MODELS

- Ownership of the district energy network and the heat production units facilitate meeting of societal goals
  - Public
  - Private
  - consumer

FINANCING

- High investment cost and long payback periods hence the need to address risks
  - Connection of high demand areas first
  - Government intervention (direct investment or incentives)
  - Financing programmes by development banks
  - Innovative financing schemes (ESCO, crowd funding)
  - Risk mitigation schemes



PRICING OF DHC SUPPLY

- Transparent pricing protects consumers from monopoly situations and enhances trust in DHC
  - True cost pricing
  - Price cap
  - No price regulation

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Thank You!