

Developing an effective strategic heating/cooling plan: What key success factors?

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IRENA WEBINAR
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WHO ARE WE?

SUSTAINABLE ENERGY PLANNING RESEARCH GROUP AALBORG UNIVERSITY



AALBORG UNIVERSITY
DENMARK

- ~30 people (4 professors, 8 associate/assistant professors, PhDs, research assistants, etc.)

Focus areas:

- Smart Energy Systems
- Local/National/EU focus
- Strategic energy planning
- EnergyPLAN tool development
- International GIS mapping
- Public regulation, local implementation, ownership and market design



2050
Heat Roadmap Europe
A low-carbon heating and cooling strategy



Stratego | ENHANCED HEATING & COOLING PLANS

CEESA

sEnergies



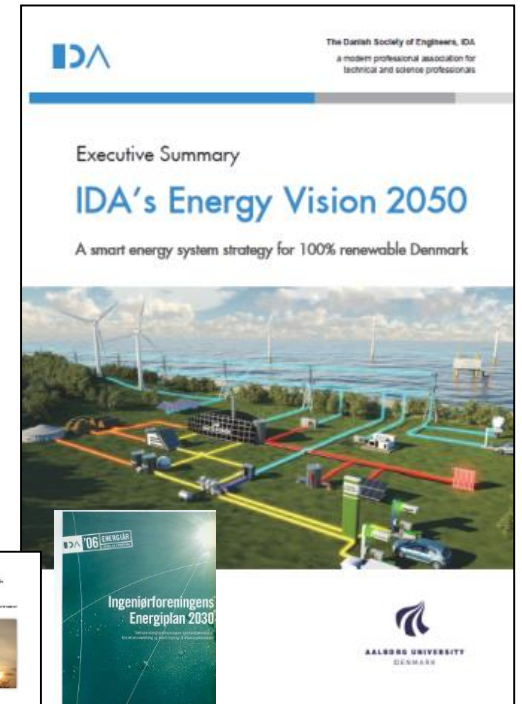
4DH
4th Generation District Heating
Technologies and Systems



re **INVEST**

<http://www.en.plan.aau.dk/research+groups/SEP>

Smart Energy Systems



Download rapport:
www.EnergyPLAN.eu/IDA

Energy Storage

Pump Hydro Storage 175 €/kWh

(Source: Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits. Electric Power Research Institute, 2010)

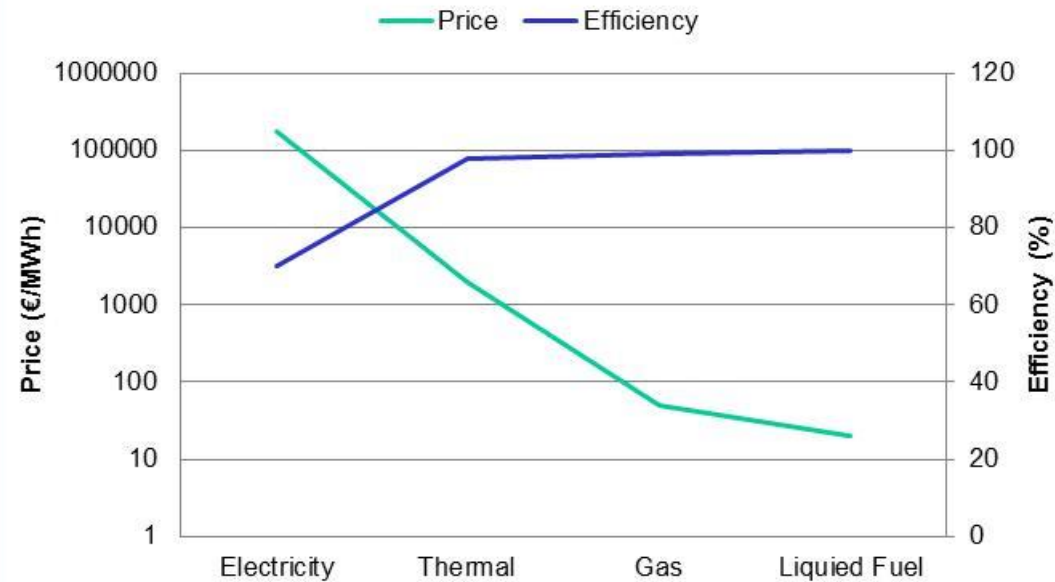


Thermal Storage 1-4 €/kWh

(Source: Danish Technology Catalogue, 2012)



Energy storage: Price and Efficiency



Oil Tank 0.02 €/kWh

(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)



Natural Gas Underground Storage 0.05 €/kWh

(Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)



Unit Investment Costs for Energy Storage

1. Thermal Cheaper at All Scales

Electricity



Thermal



Unit Investment Costs for Energy Storage

1. Thermal Cheaper at All Scales

Electricity



Thermal



€125/kWh



€1/kWh



€300/kWh

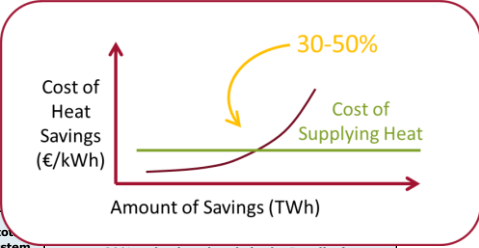
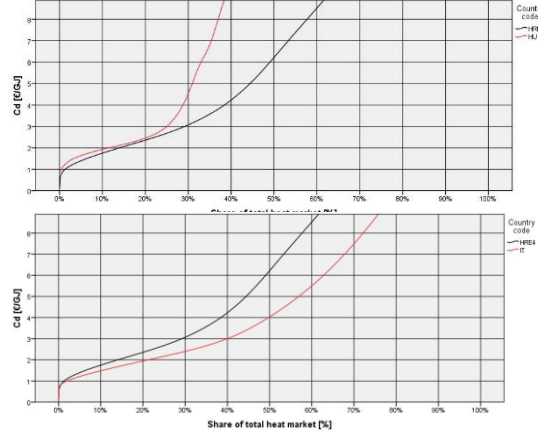
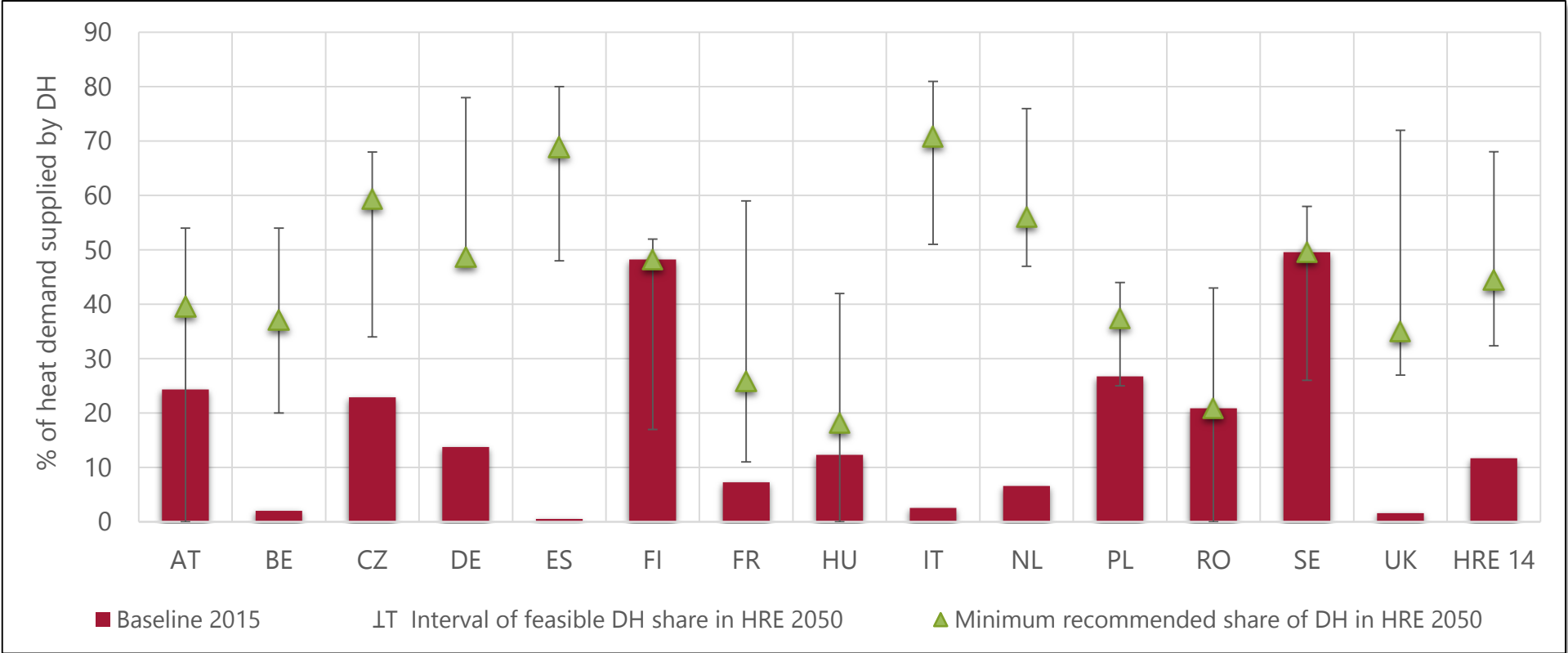
TESLA
POWERWALL

2. Bigger is Better i.e. Cheaper



€90/kWh

Recommended district heating levels in Europe



France: total energy system costs (MC/year)

a 30% reduction already in the Baseline

Percentage of market share covered by DH	0	5%	10%	15%	20%	25%
0%	175532	175582	175266	175452	175883	175978
5%	175219	175263	174932	175104	175529	175608
11%	174875	174898	174548	174699	175099	175162
18%	174566	174570	174197	174329	174706	174752
26%	174327	174317	173922	174037	174394	174418
34%	174197	174168	173752	173852	174191	174200
42%	174190	174142	173709	173789	174107	174101
51%	174400	174334	173878	173940	174240	174216
59%	175121	175038	174562	174604	174885	174844
68%	176559	176454	175961	175986	176246	176185
79%	185911	185790	185275	185282	185524	185443



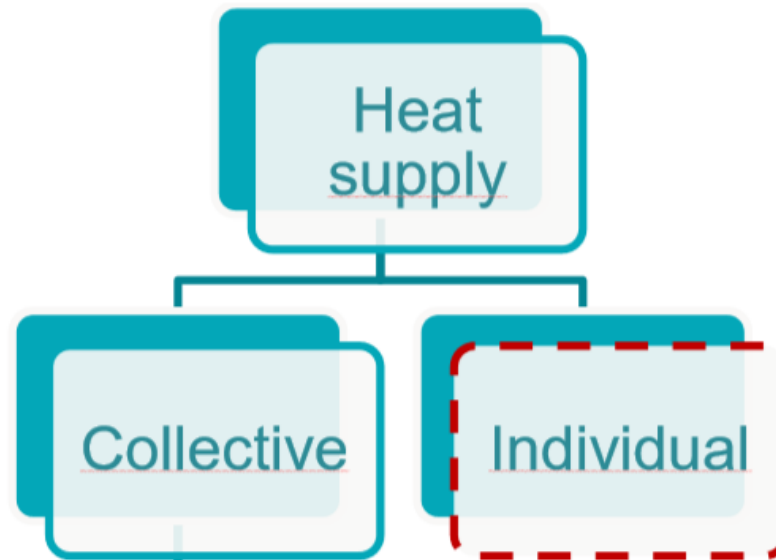
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.

Outline

- **Introduction**
- **Strategic heating and cooling planning:**
 - **Identifying and involving stakeholders**
 - **Constructing technical scenarios**
 - **Framework conditions, financing and business models**
- **Conclusions and summary**

Types of heating and cooling infrastructures

Strategic heating and cooling planning for collective large-scale infrastructures

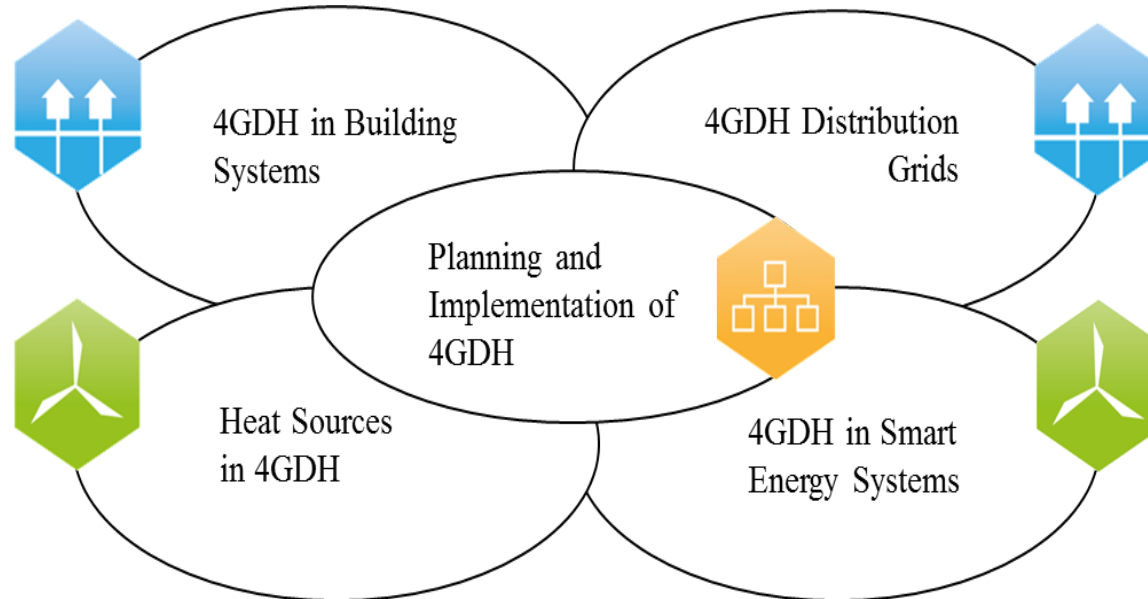
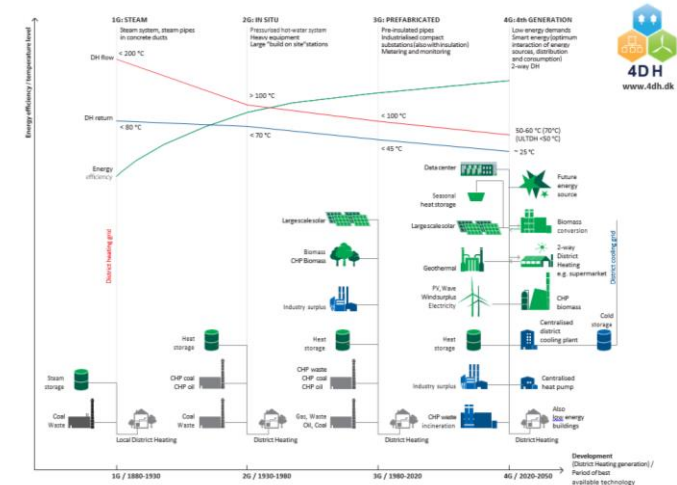


4th GENERATION DISTRICT HEATING AND COOLING

Heating is the largest end-use in Europe and many other countries

District heating and cooling allows access to many supply sources

Smart energy systems and sector coupling



Heating and cooling planning and governance

Heating and cooling are local demands

- Unlike electricity and gas, heating and cooling is situated locally
- Often overlooked in national energy policy

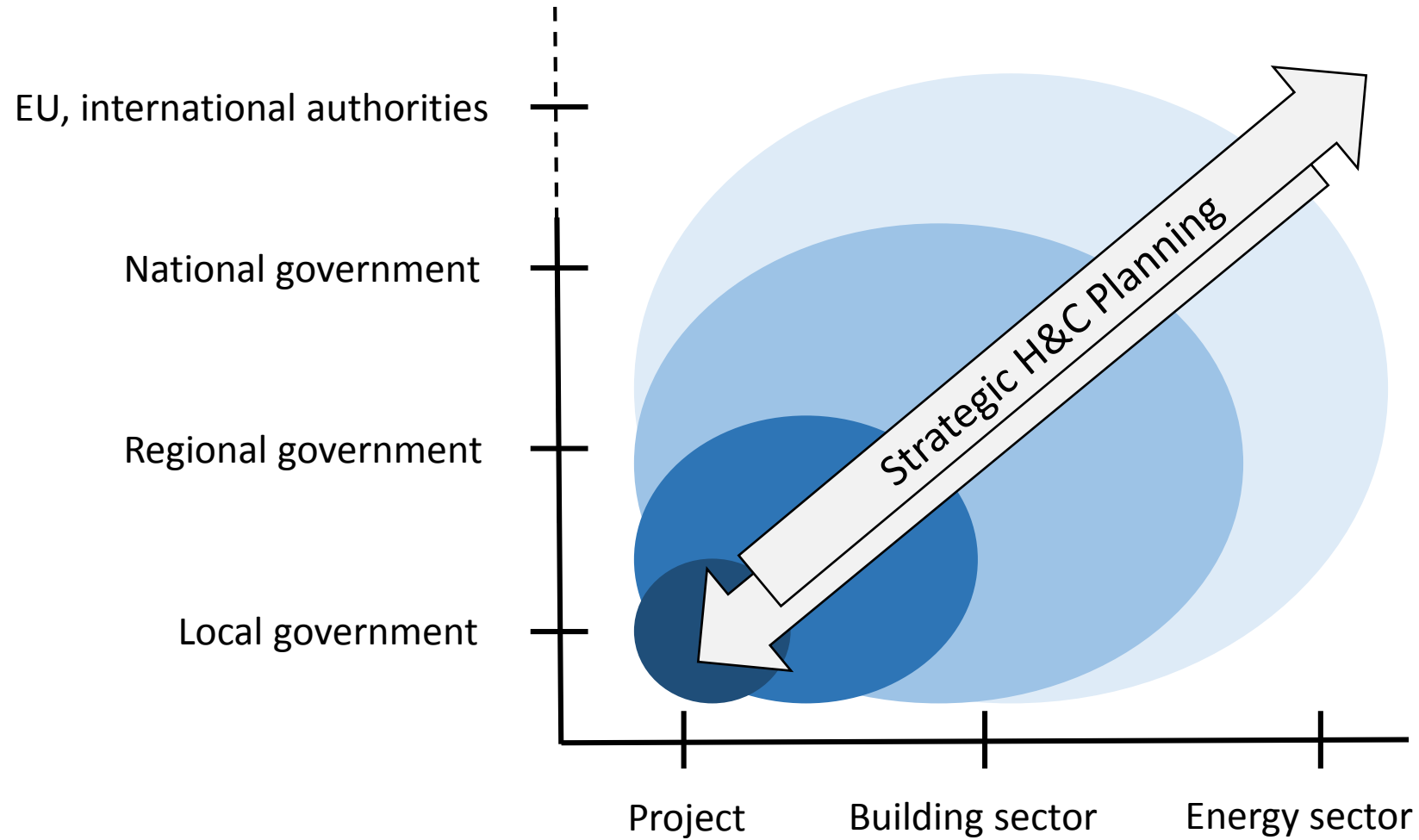
If not treated systematically in energy policy and governance:

- Significant sector coupling and synergies are missed
- Many renewable or efficient heating and cooling sources are not considered

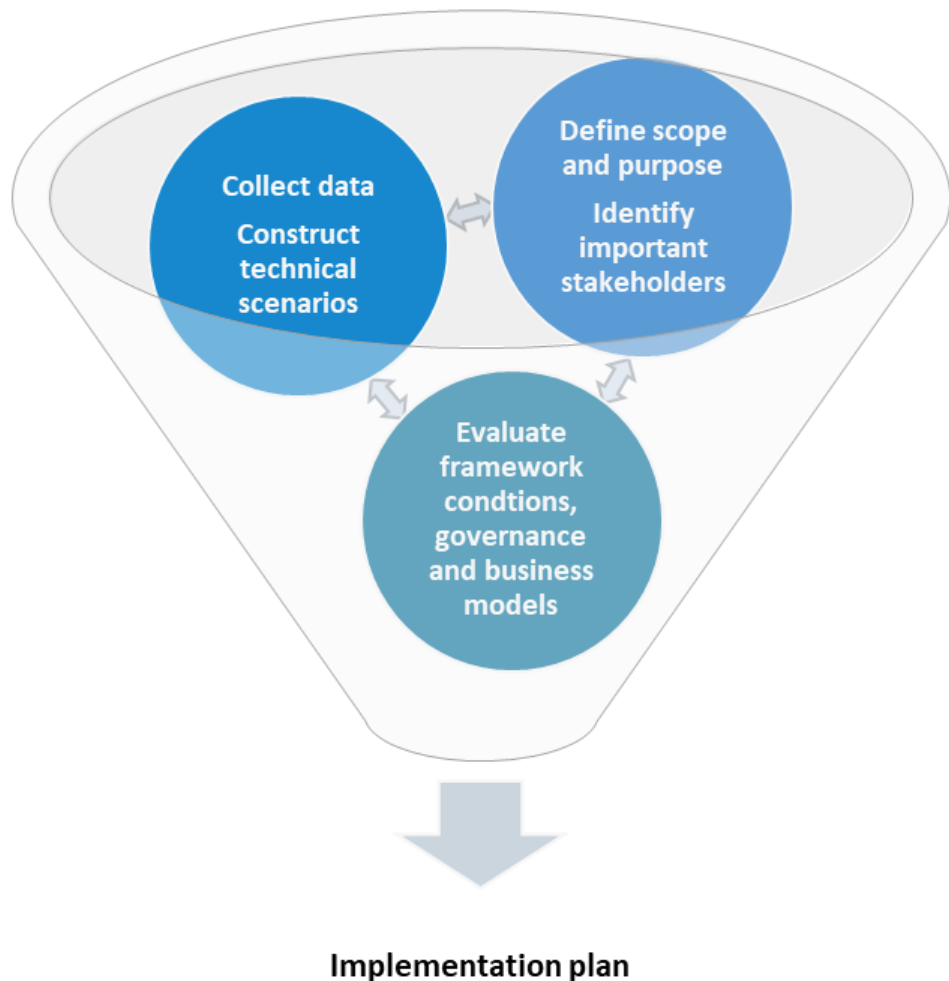
Strategic energy planning

- The purpose of Strategic Energy Planning is to **address issues** with current energy supply and to **formulate strategies** and plans for transitions.
- Strategic heating and cooling planning does differ from planning for other energy carriers due to the **local nature of heating and cooling** supply.
- **Interdisciplinary:** available resources, energy demands, technical potentials, current legislation, the organisation of the energy sector and the related actors, political drivers and barriers should be considered

The context of strategic heating and cooling planning



Key success factors in a Strategic Planning Process



Scope and purpose

- Identify main stakeholders
- Identify drivers for district H&C projects

Technical scenarios

- Measure energy demand
- Identify potential heat sources
- Balance savings and supply
- Establish scenarios

Evaluate Framework conditions and business models

- Ownership
- Financing
- Pricing
- Regulation

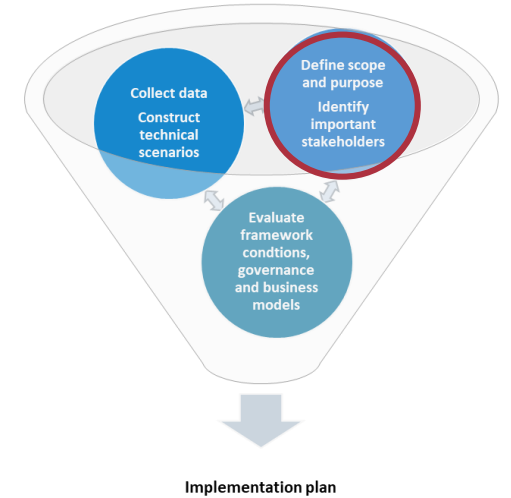
Scope, Purpose and Stakeholders in Strategic Heat Planning

Scope, Purpose and Stakeholders

- Important to identify drivers of the strategic energy planning process:
 - Climate change, energy security, pollution, energy poverty etc..
 - Multiple drivers are likely to exist: important to figure out which ones align

Identification and coordination of stakeholders

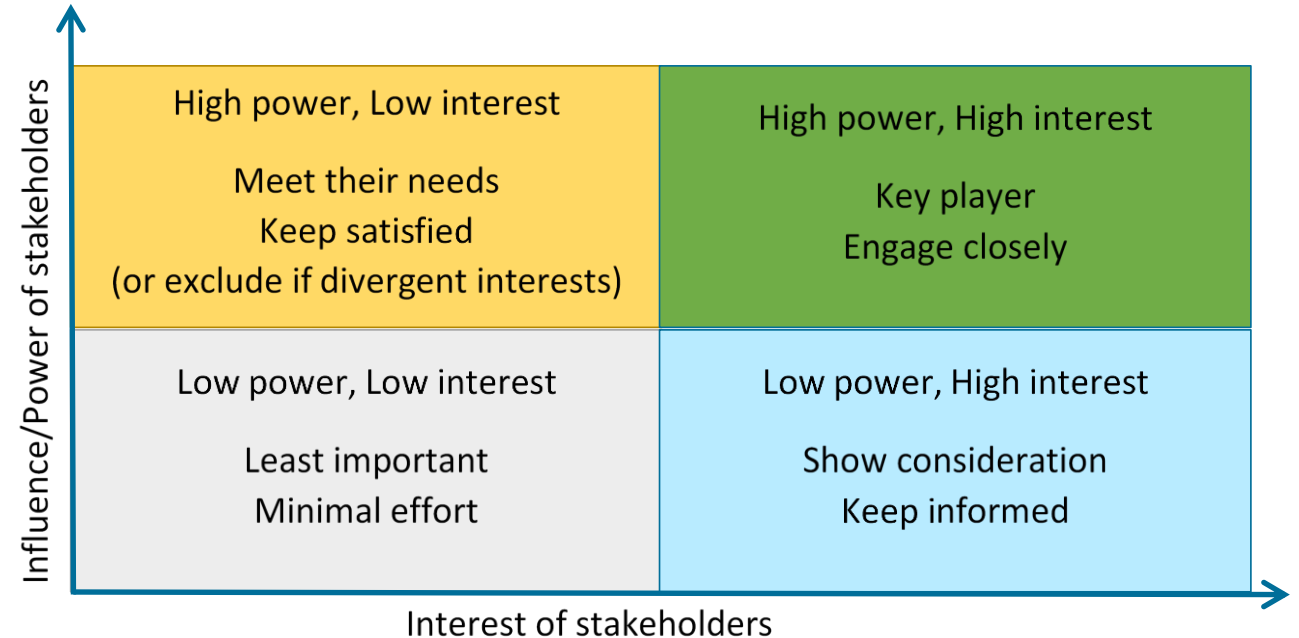
- *Who are* the main actors engaged in the process
 - Industry, high demand consumers, consumers with special needs
 - Already existing utilities: water, electricity, gas suppliers
- Identifying opportunities to involve stakeholders that can play a constructive role in realizing heat plans
- Identifying synergies and opportunities for cost-effective district energy systems



Scope, Purpose and Stakeholders in Strategic Heating and Cooling Planning

Some Stakeholders to Consider:

- National Authorities
- Local Authorities
- Utility Companies
- Investors
- Researcher / Academia
- Developers
- Technology developers: geothermal, solar thermal, PV, wind etc.
- Excess heat suppliers: industry
- Customers and Citizens
- Geothermal specific: Geological surveyors, drilling experts, geological knowledge of the underground



Scope, Purpose and Stakeholders in Strategic Heating and Cooling Planning

CASE EXAMPLE

Groß-Gerau (Germany), a successful stakeholder engagement strategy for utilizing geothermal energy

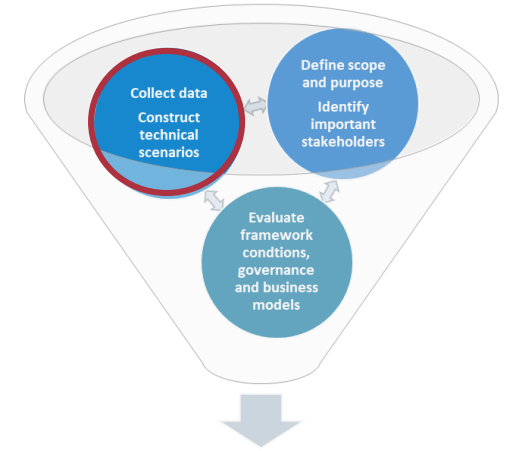
1. Social site characterisation
Gathering views, fears and expectations
2. Stakeholder dialogue
Involving stakeholders more closely, advisory group
3. Civil engagement
Engagement of the general public to resolve any issues and provide more information
4. Follow up survey
Survey after the project showed that most residents supported the project



Aerial view of the town Groß-Gerau near Frankfurt in Hessen, Germany. Image by Dietlinde B. DuPlessis from Shutterstock.

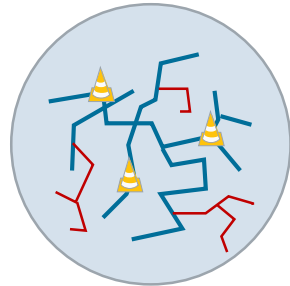
Scenario building

1. Quantify and locate H&C demand
2. Quantify and locate H&C resources
3. Quantify and assess energy-saving potentials
4. Establish scenarios for heat supply

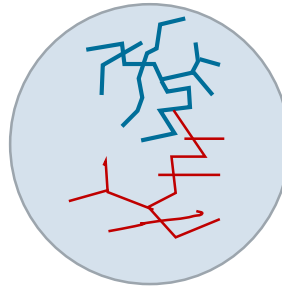


Implementation plan

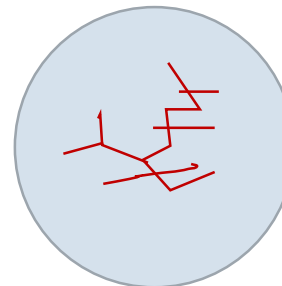
Renovation and expansion of existing district energy



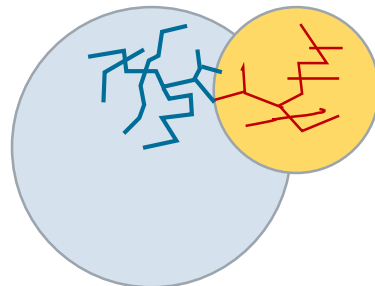
Connecting existing area to existing district energy



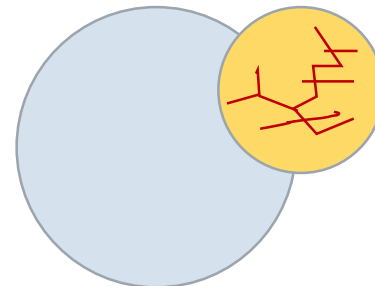
New district energy for an existing area



Connecting new development area to existing district heating



New district energy for new development area



Data availability

Reliable and good quality data is often lacking for heating and cooling demands

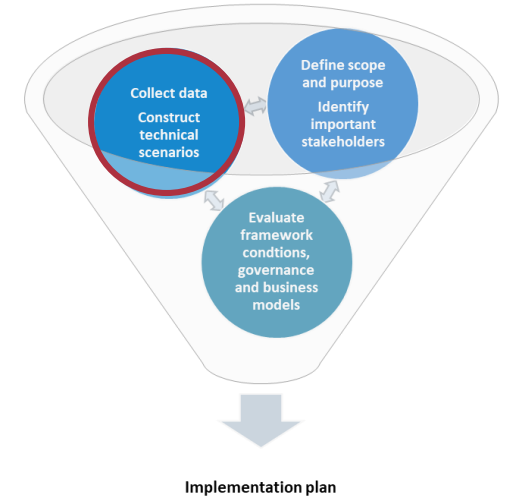
- Difficult to measure
- Disregarded in many places and countries

Metering and measuring:

- Consumption based billing can lower energy consumption
- Increase knowledge of quantity and location of energy demands
- Requires investments in metering equipment
- Important to share data – open access

Supply data

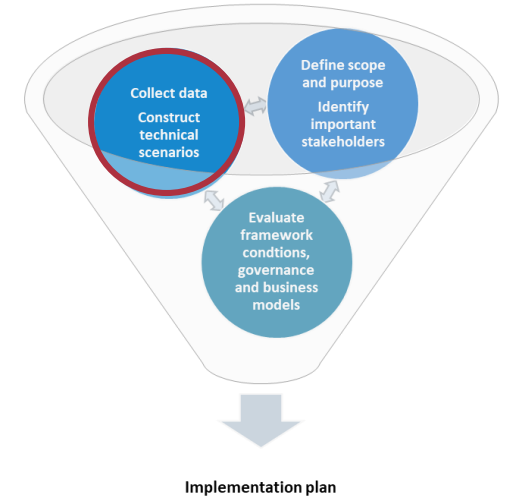
- What are the energy potentials available?
- Quantify different RE sources: wind, solar, geothermal, biomass



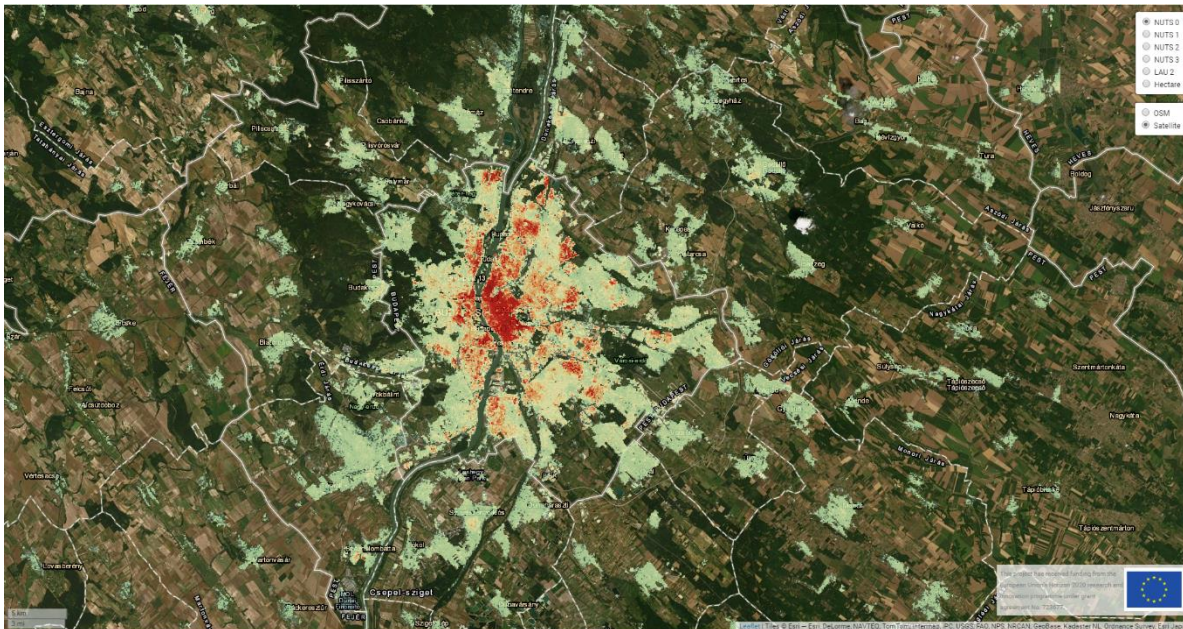
Scenario building for strategic H&C planning

1. Quantify and locate demands

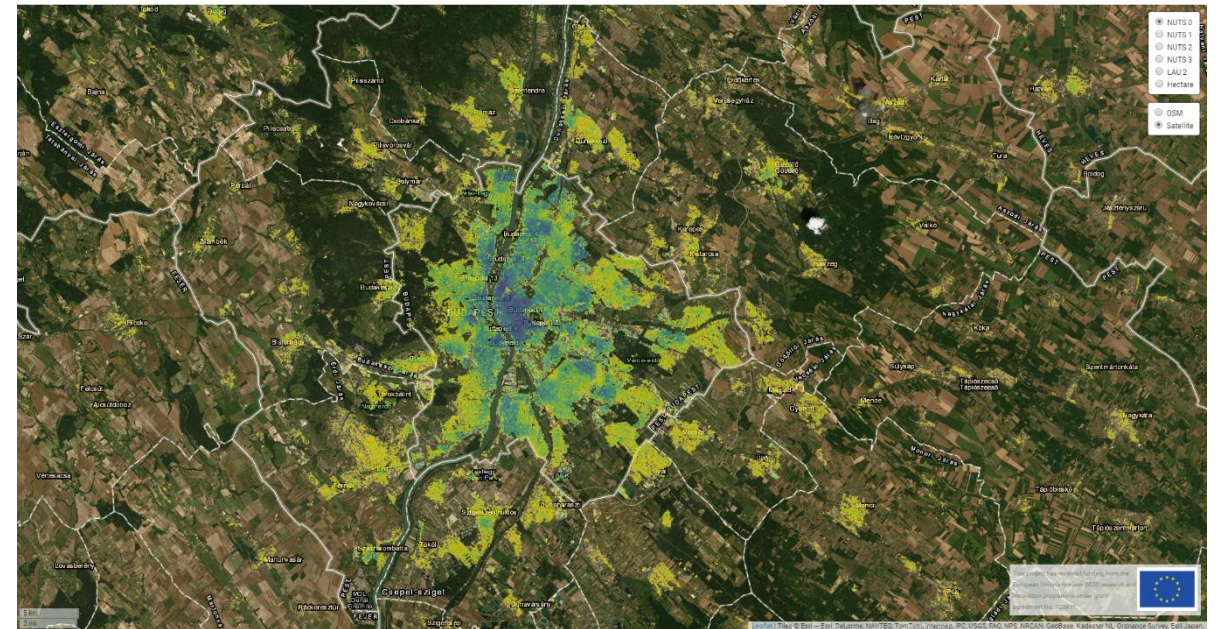
- **Measurements** of actual demands allow for actual knowledge of distribution of consumption.
- **Modelling** or estimating demands can be a way forward to provide inputs for decision making – see for example [Peta4](#) and [Hotmaps](#).



Heating demand Budapest



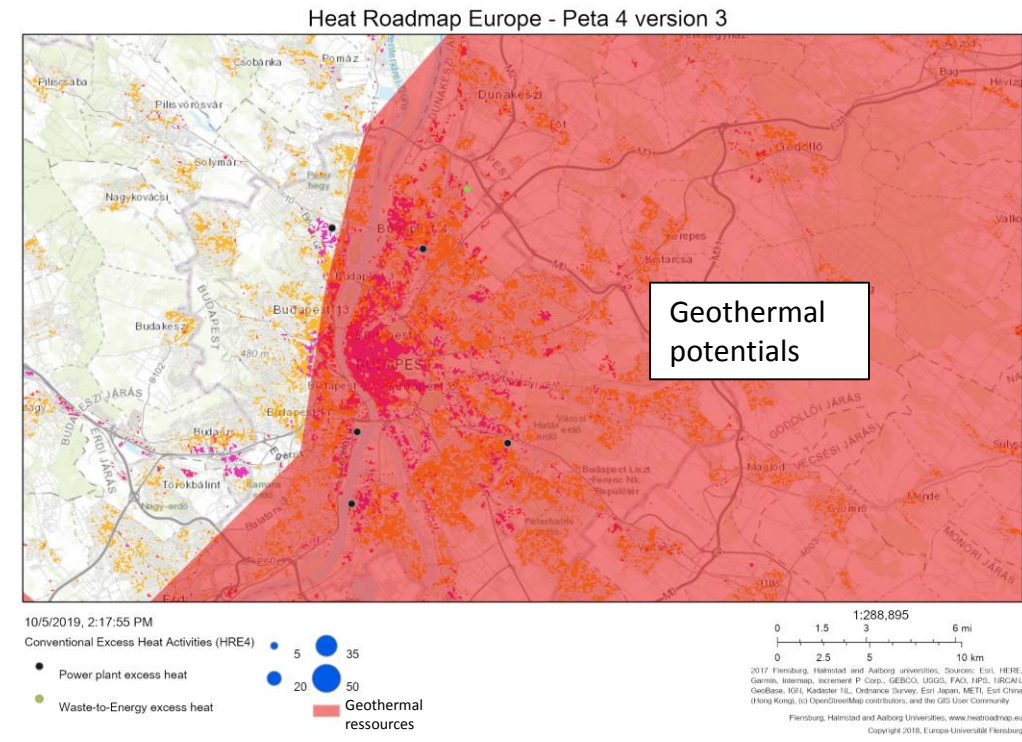
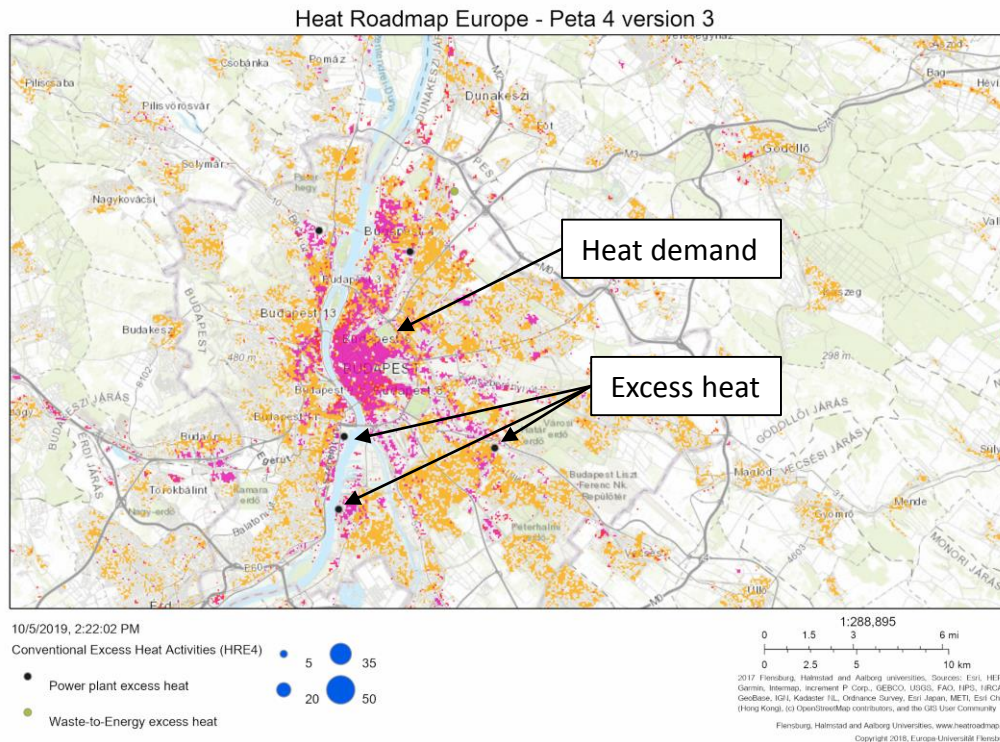
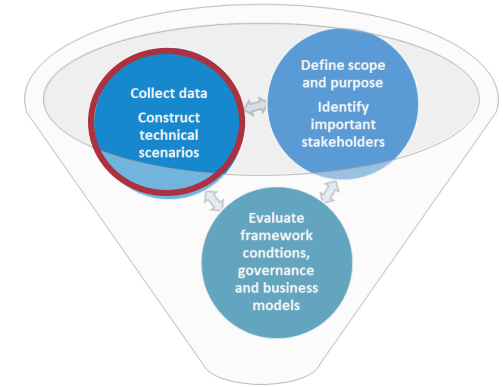
Cooling demand Budapest



Scenario building for strategic H&C planning

2. Quantify and locate H&C resources

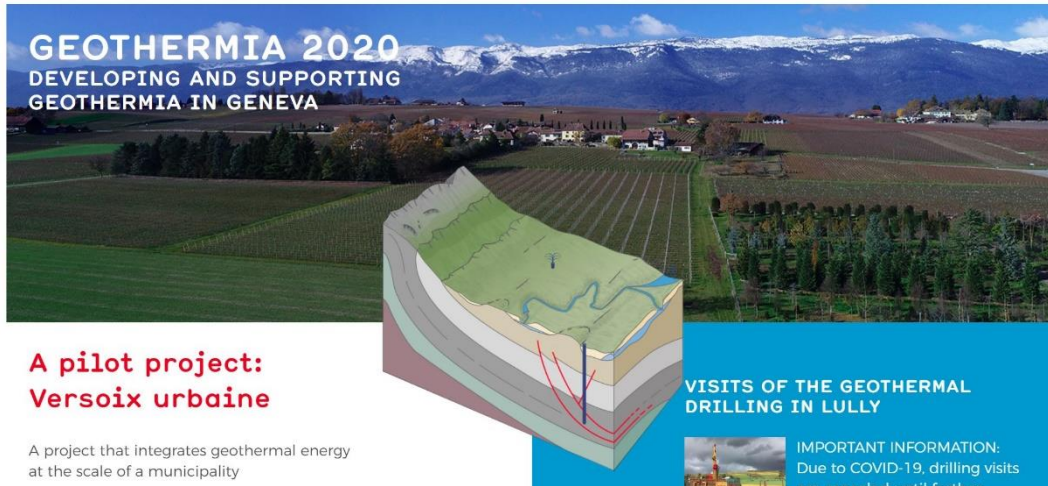
- Strategic heat sources are typically either excess heat or renewable sources
- Low district heating supply temperature enables the use of low temperature geothermal resources
- Strategic heat sources can thus be low-temperature decentralised renewable such as solar thermal, geothermal heat, or excess heat recovered from compressor machines



Geothermal resource mapping and assessment: examples of tools

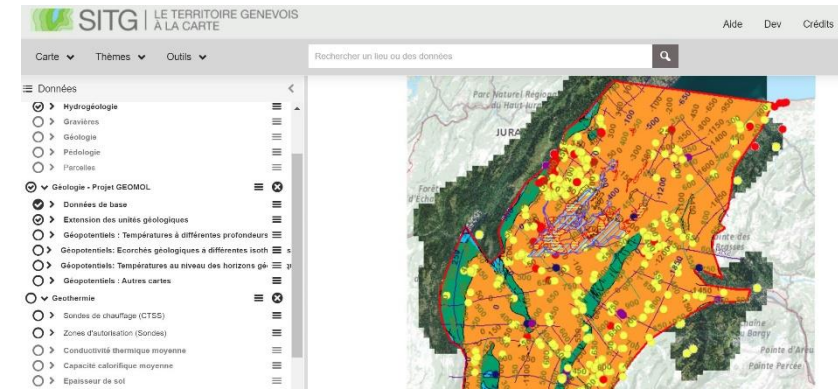
Database of wells drilled in Geneva

- Drilling companies required to register underground data obtained from the wells



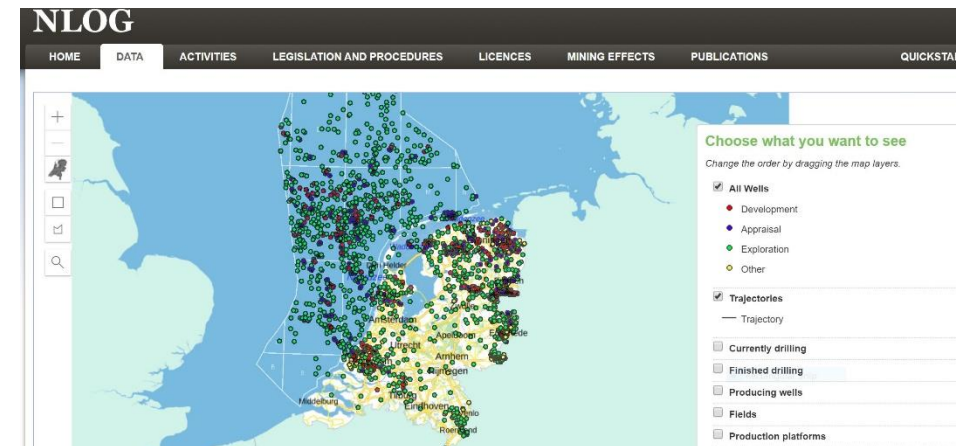
Public Geological Database, Netherlands.

- The Netherlands Oil & Gas (NLOG) portal holds subsurface data obtained under the mining permit.
- Data made publicly available 5 years after acquisition, hence significantly reducing resource risk for geothermal projects



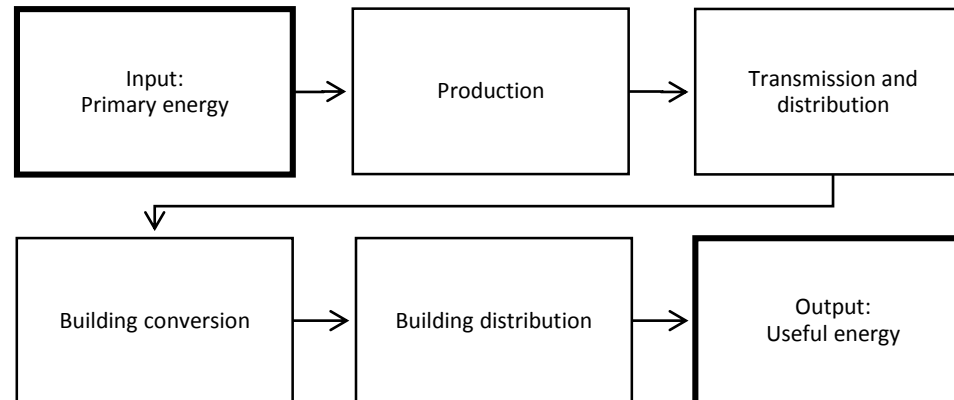
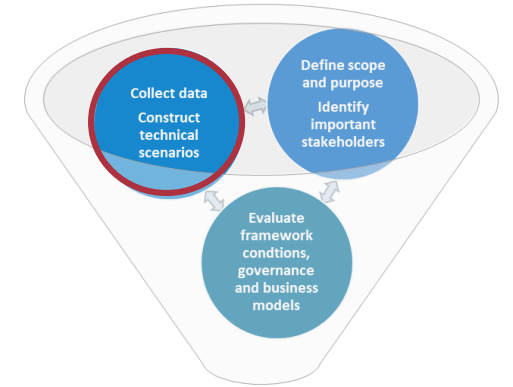
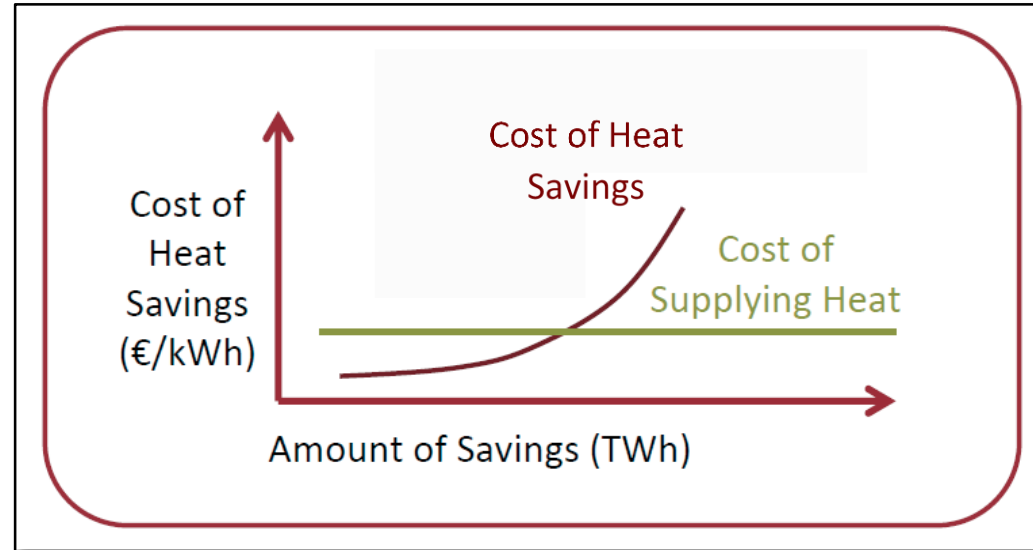
Evaluation of possible sources of RE and waste heat, Geneva

- Carried out under the umbrella of Geothermie 2020 project
- Aims to increase knowledge of subsurface by including newly acquired information e.g. results of exploration drilling
- Coordinate development of infrastructure e.g. DHC systems to utilise the geothermal resource



Scenario building for strategic H&C planning

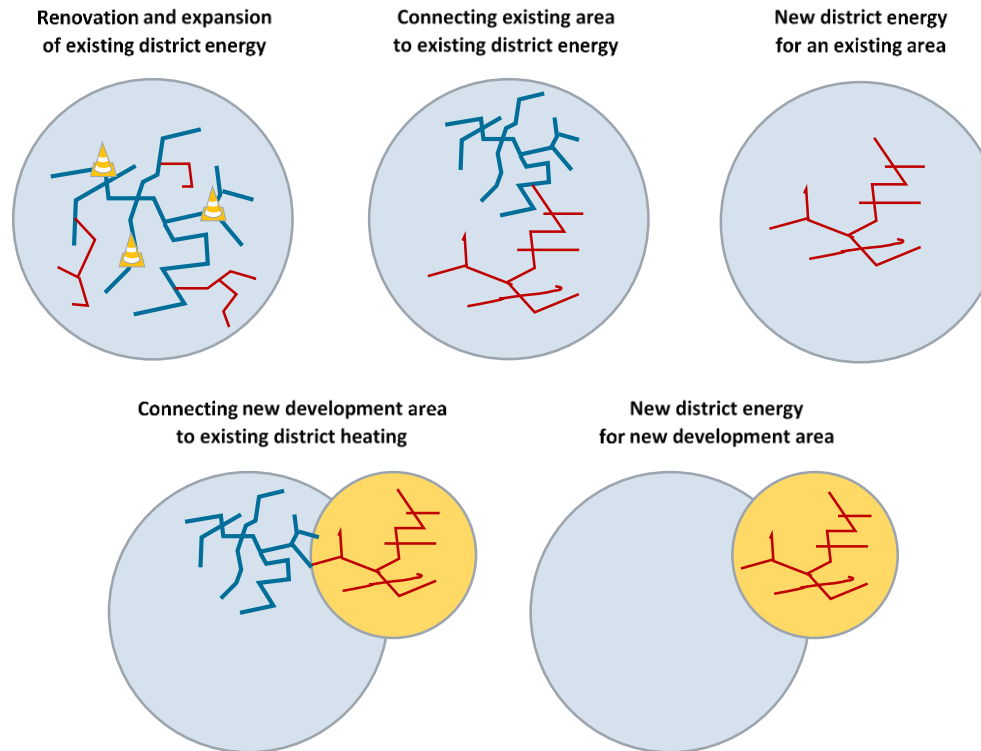
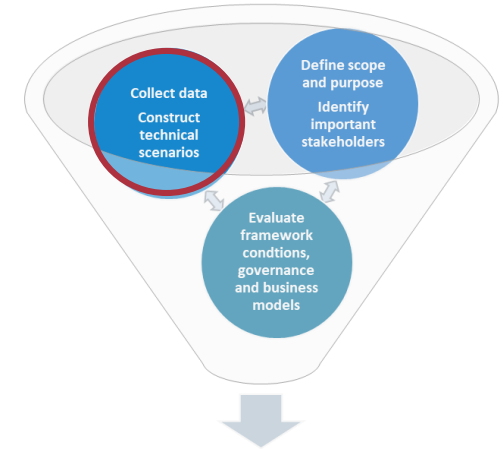
3. Quantify and assess energy-saving potentials



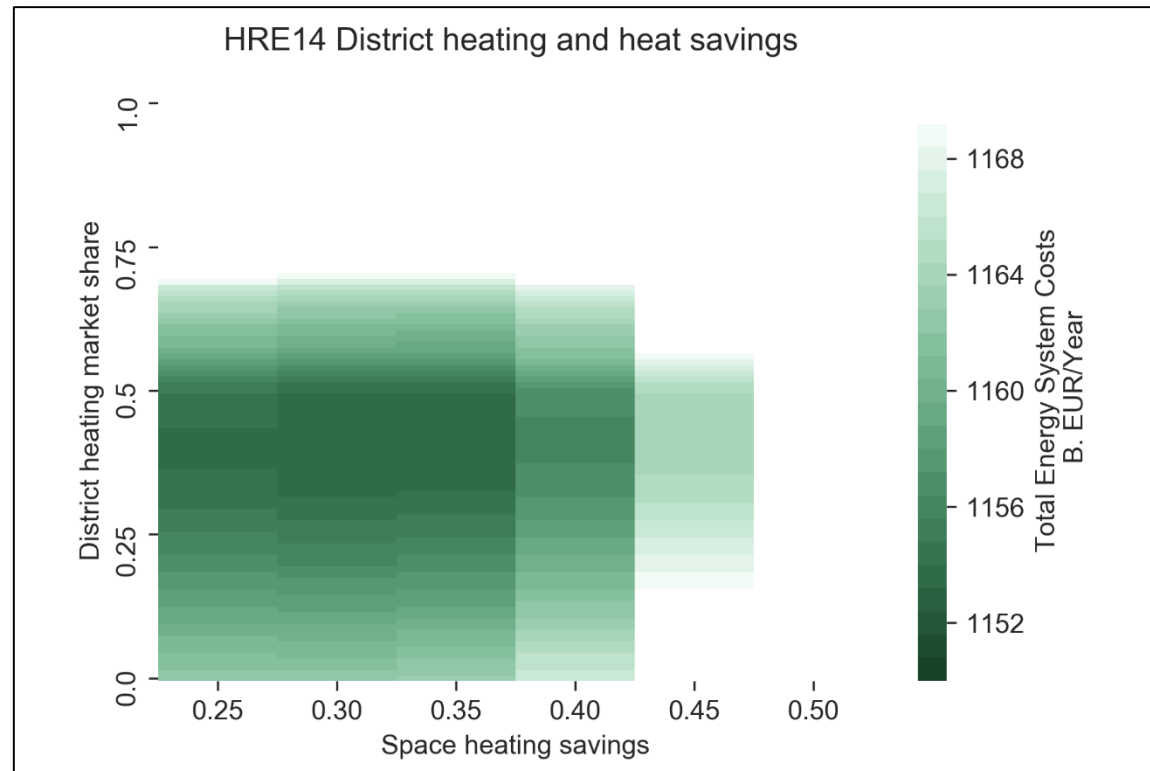
Scenario building for strategic H&C planning

4. Establish scenarios for H&C supply

- When establishing these scenarios, keep in mind the i) scope, ii) perspective and iii) timeframe of energy systems analysis
- Do not make them too detailed at first! Easy to get lost in technical or legal details. It is important to keep the process moving. Include the level of detail needed to make decisions and move further.



Heat Roadmap Europe 2050 scenario: The balance between space heat savings and district heating supply



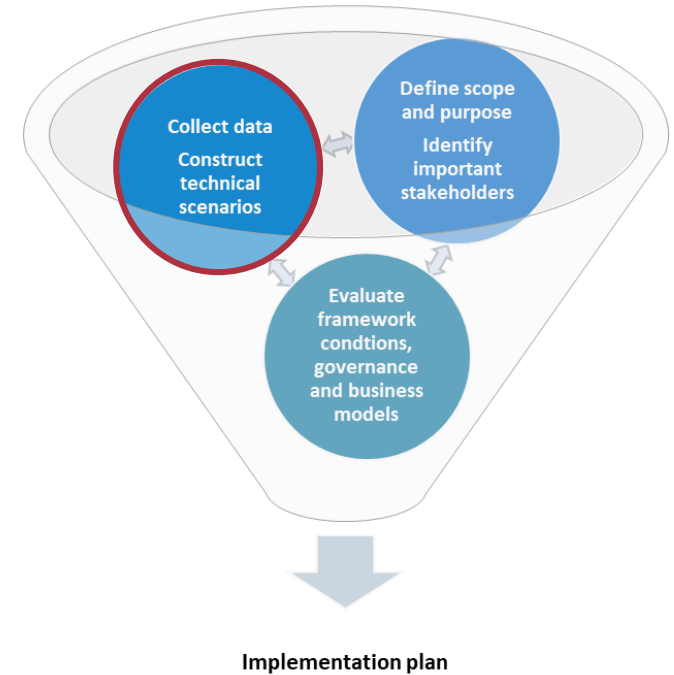
- We need both new supply and savings:**
Lowest total energy system costs with:
- ~30% heat savings
 - ~50% district heating

Towards a decarbonised heating and cooling sector in Europe:
Unlocking the potential of energy efficiency and district energy
<https://vbn.aau.dk/da/publications/towards-a-decarbonised-heating-and-cooling-sector-in-europe-unloc>

Scenario building for strategic H&C planning

Methodological points for scenario building:

- Energy system scope:
 - *Include entire energy system to identify synergies*
- Data is important:
 - *Good quality heating data is vital*
- Timeframe:
 - *Ensure that scenarios are in line with long-term targets*
- Differentiate between socio-economic and business economic prices:
 - *Taxation, subsidies, externalities etc. influence the result. Use costs that are relevant to society and not supporting status quo.*
- Important to remember that strategic heat planning is not business as usual



Enabling Framework Conditions, Financing and Business Models

Ownership structure

Interests and monopoly
Who owns the distribution infrastructure?

Pricing

What heat pricing mechanisms are being used?

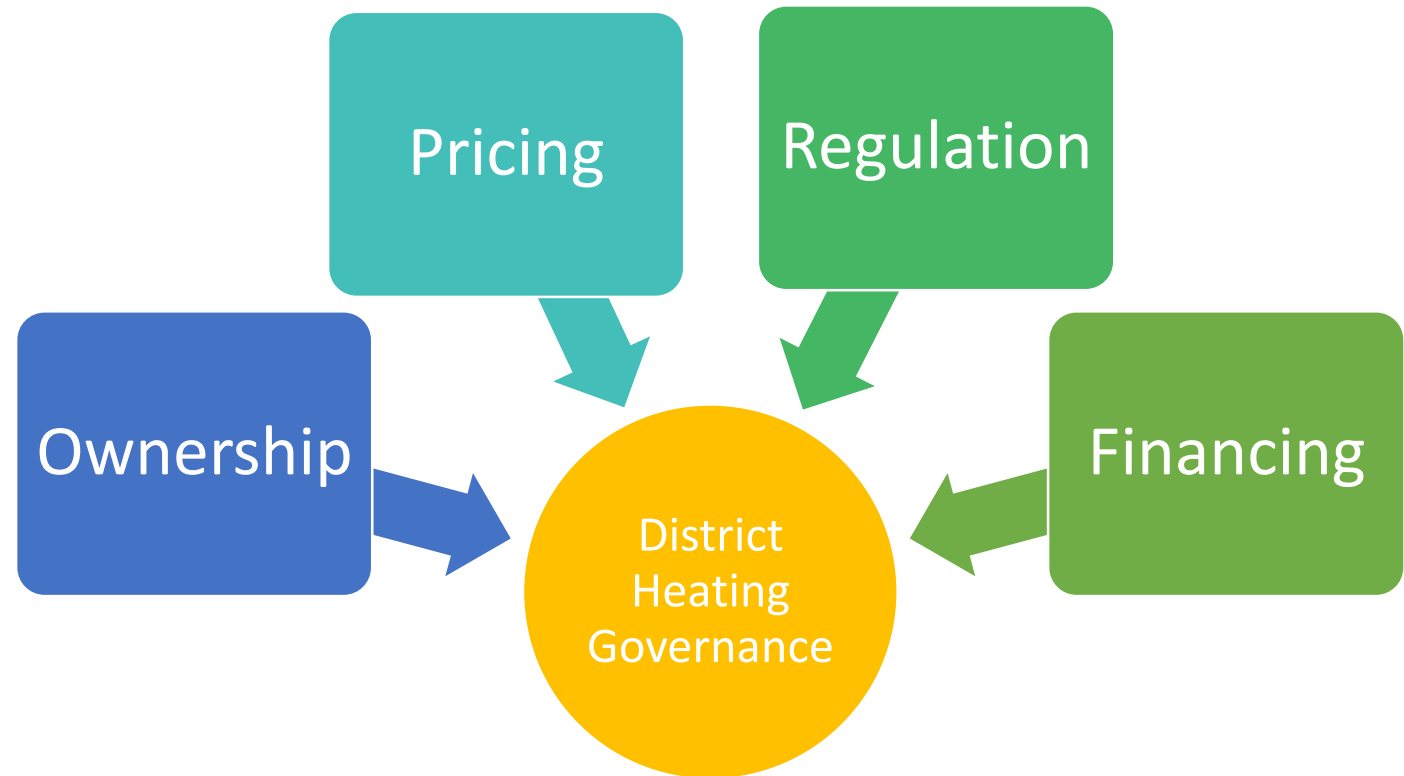
Regulation

Is there specific district heating regulation?

Financing

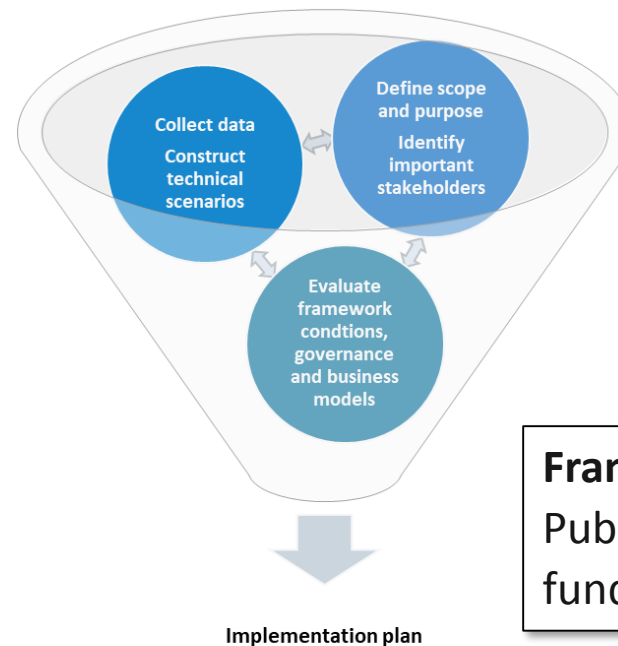
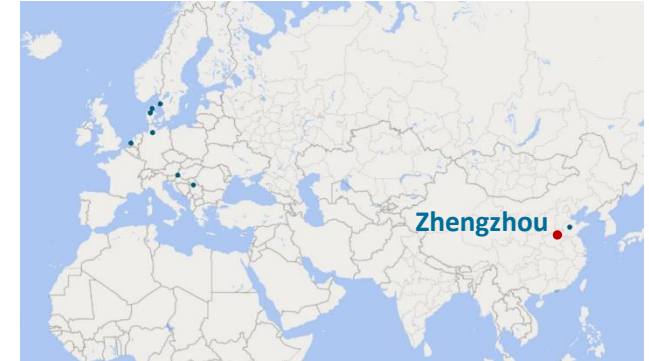
Is it possible to ensure a long timeframe for the return on investment?

Topic of upcoming webinar May 25th



Scope, Purpose and Stakeholders in Strategic H&C Planning

Case study: Zhengzhou Municipality included urban planners, architects, construction contractor, future building owners (mainly financial companies), distributor company and the heat supplier (water treatment factory) for planning new district heating systems



Technical scenarios:

- Interaction with buildings to achieve energy savings
- Use the wastewater heat

Scope and purpose:

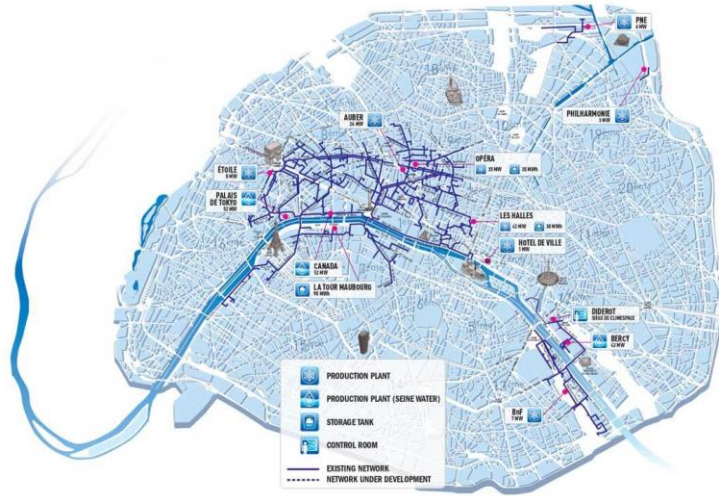
1. Replace all coal-fired energy production
2. Increase energy efficiency in buildings by 15%
3. Reduce air pollution levels

Framework and financing:

Public endowment fund – to recirculate funds for new district heating investments

District Cooling Systems

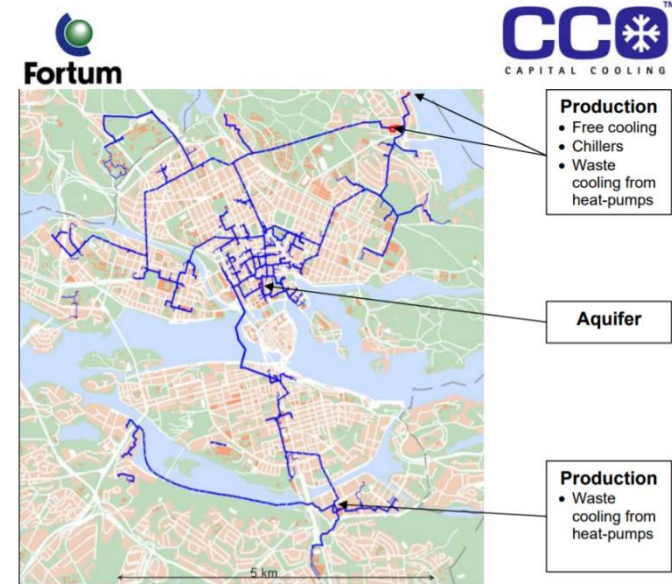
Paris CLIMESPACE



- 486 GWh cooling energy supplied
- 79 km of network

<https://www.climespace.fr/en/climespace-the-european-leader-of-District-Cooling-and-cold-distribution>

Stockholm district cooling

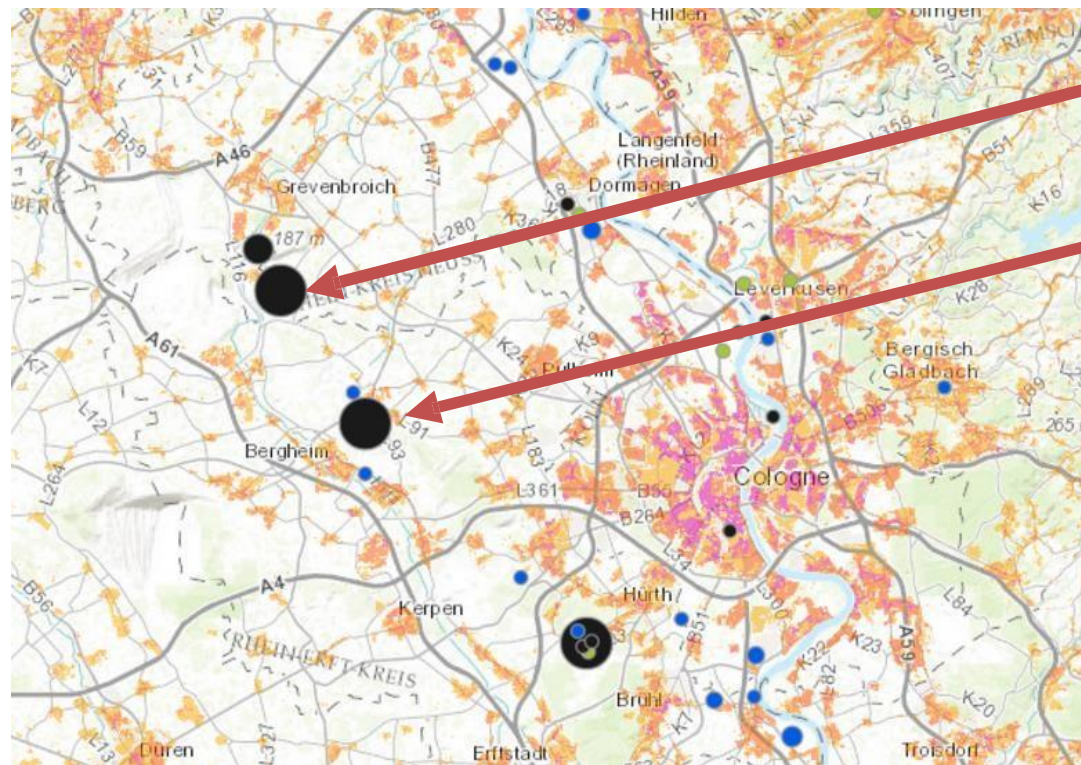


- ~500 GWh cooling energy supplied
- 76 km of network

https://www.iea-dhc.org/fileadmin/documents/DHC_CHP_Case_Studies/Showcases_District_Cooling_Stockholm.pdf

Pan-European Thermal Atlas: www.heatroadmap.eu

CASE STUDY: COLOGNE, GERMANY (1,000,000 PEOPLE)



Excess Heat
~180
PJ/Year

Excess Heat
~150 PJ/Year

District
Heat
production
in
Denmark

127 PJ/Year

Further Heating and Cooling Planning Resources

Open-access journal paper:

- N. Bertelsen and B.V. Mathiesen, 2020, *EU-28 Residential Heat Supply and Consumption: Historical Development and Status*, *Energies*. [link](#)

Heat Roadmap Europe studies: [link](#)

- Heat Roadmap Scenarios for 14 European countries: [link](#)
- Heating and cooling demands: [link](#)
- Interactive heat demand and resource map: [link](#)

HotMaps Research Project: [link](#)

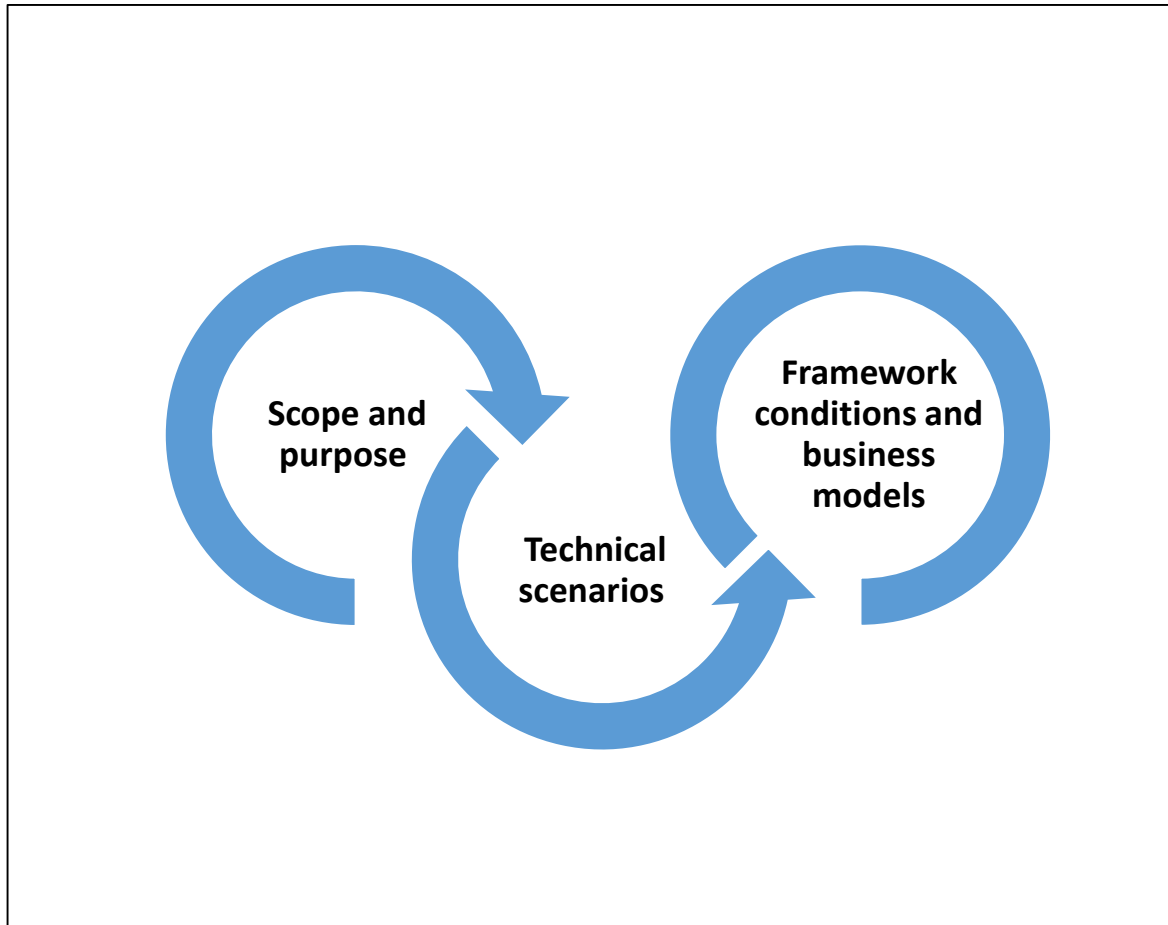
- HotMaps toolbox (still under development – more features to be added): [link](#)
- HotMaps report: Definition & Experiences of Strategic Heat Planning: [link](#)
- HotMaps report: Guidance for the comprehensive assessment of efficient heating and cooling: [link](#)
- HOW TO FINANCE GEOTHERMAL DISTRICT HEATING? SEMINAR, BRUSSELS 13 DECEMBER: [link](#)
- WEBINAR: HEATING AND COOLING PLANNING MADE EASIER: [link](#)

Other heat planning research projects:

- THERMOS – district heating network planning tool: [link](#)
- ReUseHeat – exploiting urban excess heat: [link](#)
- KeepWarm – Renewing district heating: [link](#)
- IRENA & AAU – Guidebook: Facilitating the integration of low-temperature renewable energy in district heating and cooling – *Soon published*
- Report: Towards a decarbonised heating and cooling sector in Europe: Unlocking the potential of energy efficiency and district energy: [link](#)

Strategic H&C planning and the integration of low-temperature renewable energy sources in DHC

Strategic H&C Planning is an iterative, multidisciplinary and continuous process



Key Success Factors:

Scope and purpose

- Identify main stakeholders
- Identify drivers for district heating projects
- Involve and engage!

Technical scenarios

- Measure heat demand – good data sources
- Identify potential heat sources
- Balance heat savings and supply
- Establish scenarios

Evaluate Framework conditions and business models

- Ownership that allows to achieve high coverage
- Financing with a long time frame
- Pricing that is competitive
- Regulation that promotes large scale infrastructures

Thank you for your attention!

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 <https://twitter.com/nisbertelsen>



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