



**DISTRICT ENERGY
IN CITIES
INITIATIVE**

E-TRAINING PROGRAM DISTRICT ENERGY DEVELOPMENT



MODULE 3. ENERGY MAPPING AND DATA COLLECTION TO IDENTIFY LONG-TERM OPPORTUNITIES FOR DES





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MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY LEARNING OUTCOMES

Objective: share insights on energy mapping in district energy (DE) projects.

By the end of this module, you will be able to:



Describe, understand and discuss the role of energy mapping in district energy planning;



Characterize main types of energy mappings in district energy development;



Recognise and be able to apply key steps in the development of energy mapping across various levels of detail;



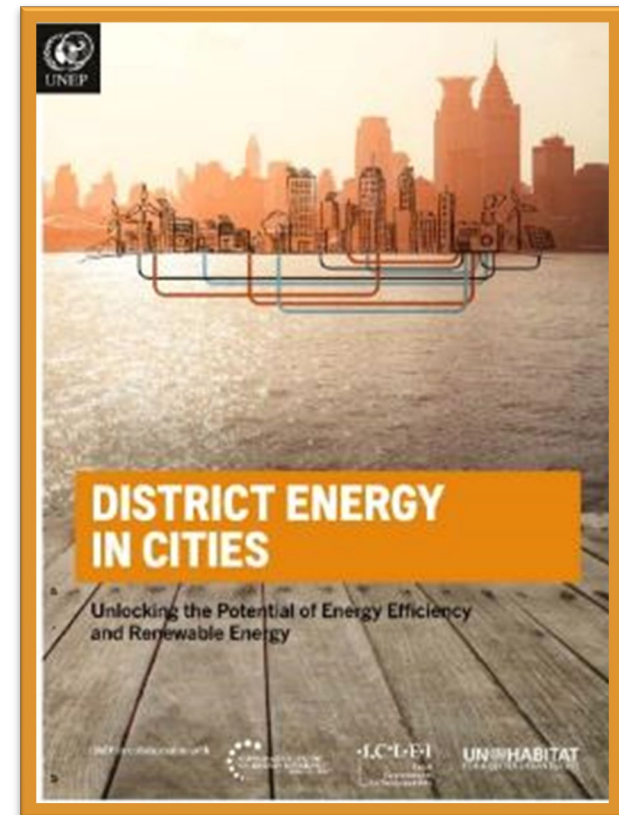
Become aware of best practices in district energy mapping;

MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

KEY STEPS IN DISTRICT ENERGY PLANNING

Key Steps in District Energy planning

1. **Assess** existing energy and climate policy objectives, strategies and targets and identify catalysts
2. **Strengthen** or develop the institutional multi-stakeholder coordination framework
3. **Integrate** district energy into national and/or local energy strategy and planning
4. **Map** local energy demand and evaluate local energy resources
5. Determine relevant **policy design** considerations
6. Carry out **project pre-feasibility** and viability
7. Develop **business plan**
8. Analyse **procurement options**
9. Facilitate **finance**
10. **Replicate**



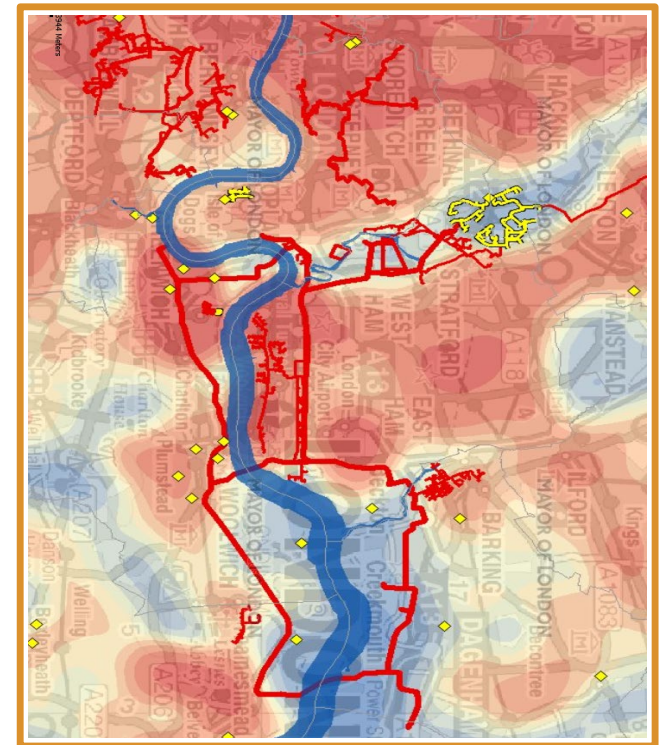
Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY ITS RELEVANCE

Why do mapping in DES?

- To **identify individual projects, properly expand and connect them in the future**, and link this expansion with other infrastructure development.
- It allows networks that **maximise waste heat recovery** and **targets high energy density areas** leading to more cost-effective solutions.
- Allows zones to be selected where the city can apply its **land-use authority**, and tailor specific incentives.
- Very important for developing **stakeholder engagement**.
- **Raises public awareness** as a visual tool



Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY ITS RELEVANCE

Why do mapping in DES?

Different project types should develop and maintain energy mapping for different reasons

New

- Demonstrate DE in the city and justify expenditure
- Identify initial starter networks and demonstration projects
- Boost confidence in the project and secure private sector investment

Consolidation

- Seek to maximise the connection of waste heat both low and high temperatures
- Identify potential distributed renewable production
- Optimise interconnection and potential for integration of a district cooling and a district heating network

Refurbishment

- Identify potential interconnection or transmission lines
- Understand losses in the network and identify stages or redevelopment
- Identify potential waste heat sources that could be connected
- Attract private sector investment by showcasing potential projects and the strength of data collection

Expansion

- Identify optimum interconnection and pooling of networks
- Identify renewable sources of innovative waste heat
- Attract private sector investment networks
- Identify optimal expansion of network



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

WHAT IS ENERGY MAPPING?



In District Energy ...

Energy mapping refers to the **visual representation** of energy and material flow distribution along the system, **related to its geographical location**



Source: District Energy in Cities Initiative



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

PURPOSE & BENEFITS

From an energy system perspective

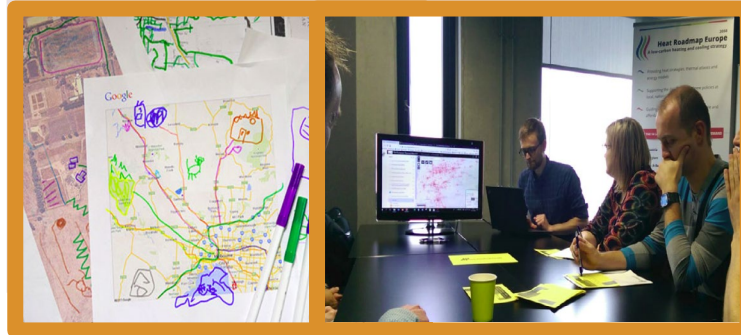
- Link locations, distances, heating and cooling demand needs spatially.
- Supports the development of long-term strategies at local and national level.
- Identify potential (new) pilot projects and/or interconnection of existing networks or retrofiting needs.



Source: Deltares, Unsplash

From a process perspective

- Visual tools are an easy way to present otherwise complex and abstract data to different audiences.
- Keep non-technical stakeholders on board.
- Enable stakeholder understanding and discussions.

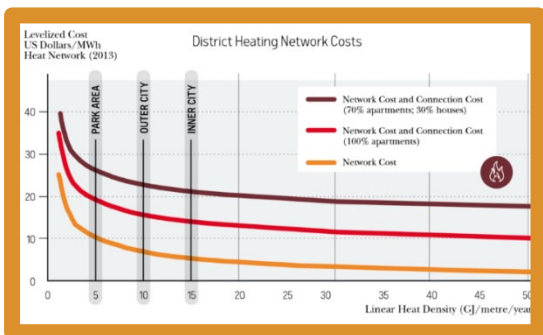


Source: Heat Roadmap Europe



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

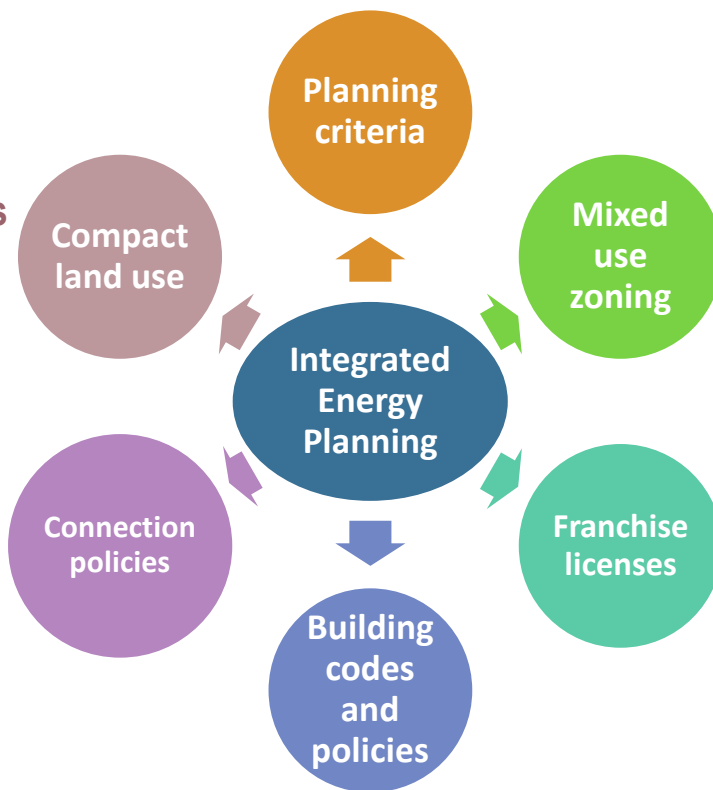
CHARACTERIZATION OF ENERGY MAPPING



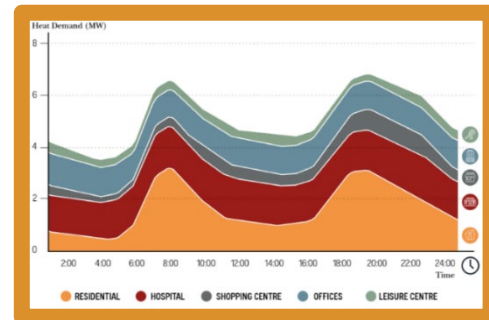
- Key to calculate network costs > *Energy mapping required*
- Zonal or city-wide mandatory connections
- Density bonus > *Energy mapping required*
- Connect (unless)
- Subsidies for connection

Source of both images: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy

Integrated Energy Planning



[Further details in Module 4!]

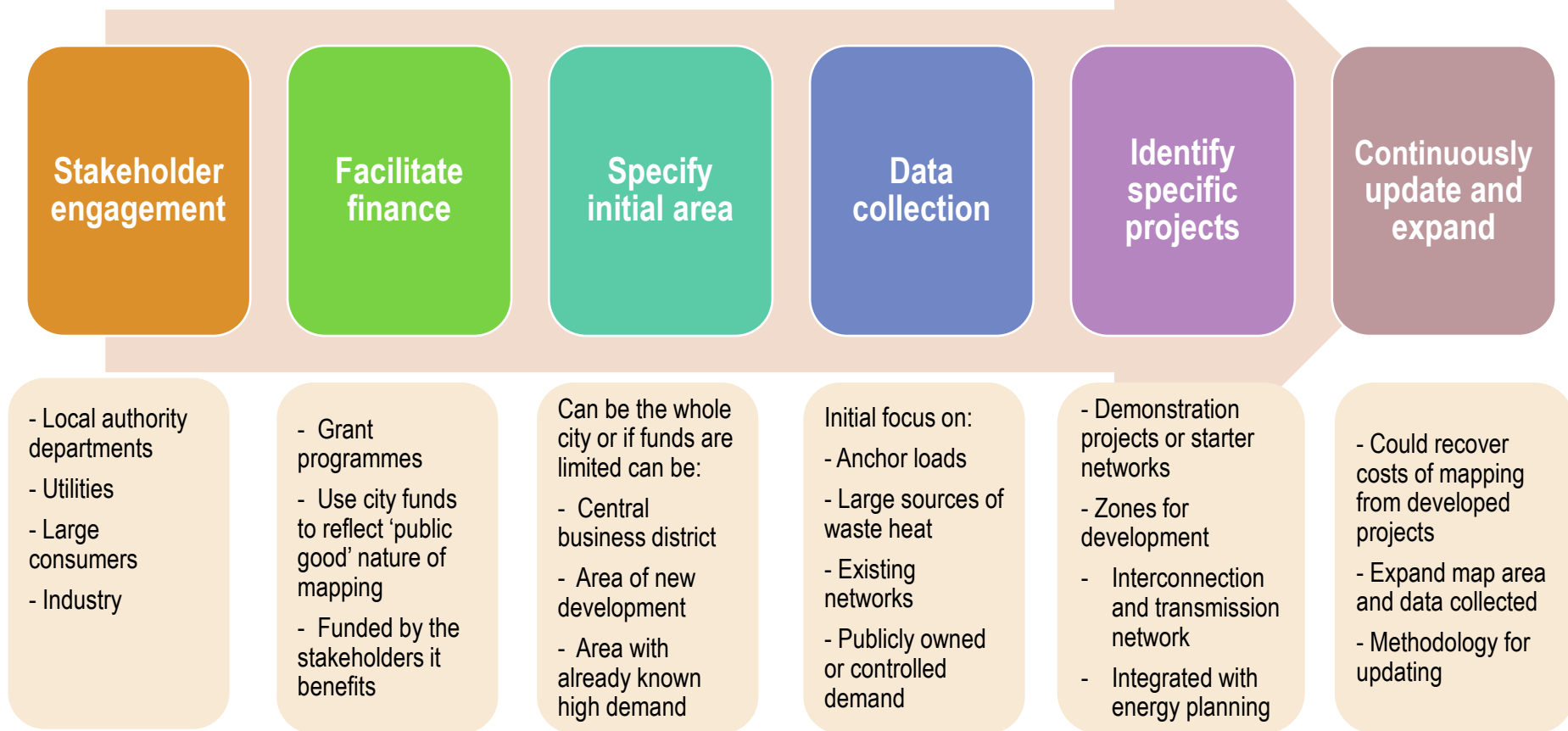


- Zoning
- New development policies > *Energy mapping required*
- Control development
- Mandate connection
- Regulate tariffs
- Protect consumers
- Competition to win franchise
- Building requirements and certification



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY CHARACTERIZATION OF ENERGY MAPPING

Process of developing Energy Mapping

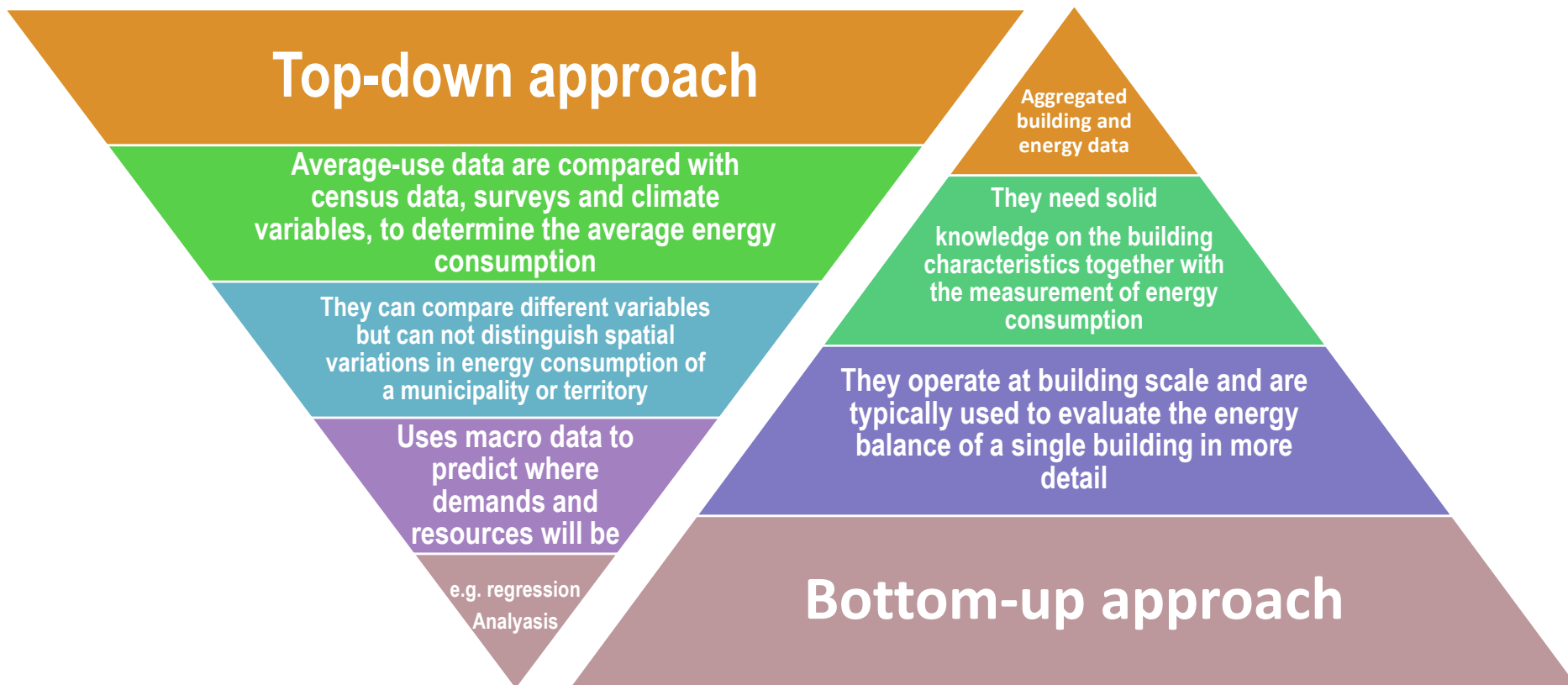




MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

CHARACTERIZATION OF ENERGY MAPPING

“Top-down” versus “Bottom-up” Energy Mapping





Types of Energy Mappings along District Energy Development Phases



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

CHARACTERIZATION OF ENERGY MAPPING

Use mapping strategically to achieve the right answers

1. Initial mapping

> Where should efforts focus on?

- Broad scope: national, regional and city scale
- High uncertainty, low data needs
- Relatively quick

*Average time required:
1-2 months approx.*

2. Mapping for detail

> Should a feasibility study be encouraged?

- Local scale (district)
- Higher level of certainty, but some assumptions
- Relatively time consuming

*Average time required:
1-3 months approx.*

3. Mapping for feasibility

> Can we financially /technically assure the feasibility of the project?

- Local scale (district)
- Highly specific scope
- High level of certainty
- Time consuming

*Average time required:
3-4 months approx.*

→ Increasing data and cost requirement →

→ Increasing certainty →

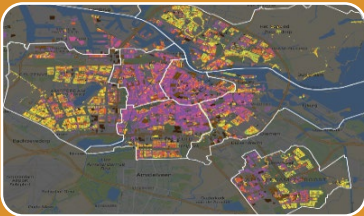
Source: Own elaboration



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

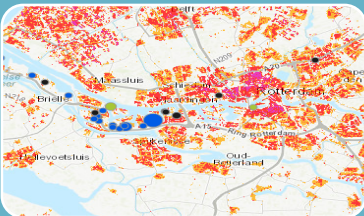
CHARACTERIZATION OF ENERGY MAPPING

What level of data is necessary for each type of mapping?



Available and high quality data – *Mapping for detail and mapping for feasibility*

- Readily available data to get a good overview of target areas and project pipelines
- Easy transition towards more detailed levels of feasibility
- Examples: countries with cadastres; cities with measured/managed DH systems



Estimated or modelled data – *Mapping for detail and mapping for feasibility*

- Not exact, but can provide a good representation of the spatial dimension and a good indicator of areas where more precised data could be useful
- Useful to understand priority areas, demand and resource density, develop potential project pipelines and discuss general planning approaches.



Little to no data – *Initial mapping*

- Knowledge can be generated based on stakeholder discussions and (informal) knowledge source
- Can be used to understand priority areas and data gaps
- Where to start: look at electricity or gas bills, contact building owners, the local utility

Source: Own elaboration



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY INITIAL MAPPING

Key aspects of Initial Mapping

- **Main objective: where you can do the further mapping**
 - Identification of high density areas
 - Identification of local sources for district energy
 - Building number and use
 - Energy demand
- **Main steps:**
 - Map relatively high heat/cool demand
 - Map potential local sources of energy
 - Mark potential needs of the city and future developments (e.g. urban development plans)
- **Data needed**
 - Population map (Census)
 - Map of economic activity (i.e. service buildings)
 - General knowledge on the conditions and needs in the area (can be local knowledge)



Source: (1) Heat Roadmap, sketches (2) Aiguasol, Informe de Avance nº1 Coyhaique



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY MAPPING FOR DETAIL

Key aspects of Mapping for Detail

- **Main objective: Viability + High potential options of DES**
 - Quantification of heat/cool demand
 - Quantification of heat/cool resources
 - Enabling factors for high potential options
- **Main steps:**
 - Map heat/cool demand per building/hub
 - Map local sources of energy for high potential options
 - Map urban planning and development
- **Data needed**
 - Estimated/available data on:
 - Demand
 - Local climate conditions
 - Building stock composition
 - Technology options and assumptions
 - Costs: energy, technologies, construction, staff salaries etc.
 - Urban plans and regulatory frameworks



Source: Ghodbunder Road, India. Carbon Trust



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY MAPPING FOR FEASIBILITY

Key steps in Mapping for Feasibility

1. Assessment of energy demand per building

- Building typologies & constructive characteristics
- Characterization of individual heating/cooling (HC) generation systems
- Simulation and calibration of energy consumption

Average, maximum & minimum figures: 1 Dec 2007 - 31 Jan 2008;
Tuesdays, Wednesdays & Thursdays only (excluding 25, 26, 27 Dec
2008; 1, 2 Jan 2008)

Time	Average kW	kW	Maximum Date	kW	Minimum Date
00:00	4,036.1	4,461.6	Wed, 30 Jan 2008	3,616.8	Wed, 19 Dec 2007
00:15	4,028.6	4,460.0	Wed, 30 Jan 2008	3,624.8	Wed, 19 Dec 2007
00:30	4,020.1	4,430.8	Wed, 5 Dec 2007	3,614.8	Thu, 24 Jan 2008
00:45	4,032.0	4,370.0	Wed, 30 Jan 2008	3,651.2	Thu, 24 Jan 2008
01:00	4,052.0	4,345.2	Thu, 11 Jan 2008	3,731.2	Thu, 24 Jan 2008
01:15	4,044.1	4,329.2	Thu, 11 Jan 2007	3,731.6	Thu, 24 Jan 2008
01:30	4,044.8	4,351.6	Wed, 30 Jan 2008	3,738.0	Tue, 18 Dec 2007
01:45	4,036.2	4,384.4	Wed, 30 Jan 2008	3,765.6	Thu, 24 Jan 2008
02:00	4,039.1	4,389.2	Wed, 30 Jan 2008	3,676.4	Thu, 24 Jan 2008
02:15	4,039.6	4,332.0	Wed, 30 Jan 2008	3,642.4	Thu, 24 Jan 2008
02:30	4,026.0	4,327.6	Wed, 30 Jan 2008	3,610.4	Thu, 24 Jan 2008
02:45	4,045.9	4,349.6	Wed, 30 Jan 2008	3,737.2	Thu, 24 Jan 2008

2. Visualization of energy demand in the city or region

- Collect all of the values for energy demand
- Geo-reference each of the calculations in the city



Both **available** and **estimated or modelled** data will be required

Source: District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

MAPPING FOR FEASIBILITY

1.a. Identification of building typologies & definition of constructive characteristics

- The data availability and sources will very much depend on the country or city
- Software: Excel-based

Data needs	Level of importance	Data source	If data is not available
Building typology	High	Census	Previous studies, site visits
Building use (residential, non-residential, mixed)	High	Census	Previous studies, site visits
Year of construction	High	Census	Books, reports, alternative database (e.g. SII 2018)
Constructed area (m2/building)	High	Census	Books, reports, alternative database (e.g. SII 2018)
Material: outer wall	High	Census	Books, reports, alternative database (e.g. SII 2018)
Material: roof and floor	High	Census	Books, reports, alternative database (e.g. SII 2018)
Material: insulation	High	-	Books, reports, alternative database (e.g. SII 2018)
Material: further characteristics on the constructive status of the building	Medium-high	-	Books, reports, alternative database (e.g. SII 2018)
Number of people living	Medium-low	-	Surveys
Geo-reference	High	Census	Previous studies, site visits

Source: Own elaboration



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY MAPPING FOR FEASIBILITY

1.b. Definition and characterization of heating or cooling generation systems

- The data availability and sources will very much depend on the country or city
- Software: Excel-based

Data needs	Level of importance	Data source	If data is not available
Type of heating and cooling systems in each building	High	Previous studies / existing databases	Surveys
% of use of each system per building	Medium	Previous studies / existing databases	Surveys
Energy demand per building or dwelling	High	Previous studies / Calculated based on above	-
Local emission factors of pollutants by energy source	High	Previous studies	Studies from other regions or cities
GHG emission factors by energy source	High	Previous studies	Studies from other regions or cities

Source: Own elaboration



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY MAPPING FOR FEASIBILITY

1.c. Simulation and calibration of demand and consumption models

- This data is mostly calculated based on the previous steps
- Softwares: EnergyPLAN (Open access), EnergyPlus, DesignBuilder v5.5, i.a.

Data needs	Level of importance	Data source	If data is not available
Building characteristics	High	Previous steps	Surveys, previous studies, etc.
Annual energy consumption	High	Previous steps	Surveys, previous studies, etc.
Weather conditions	High	National database or	Other databases (e.g. Meteonorm)

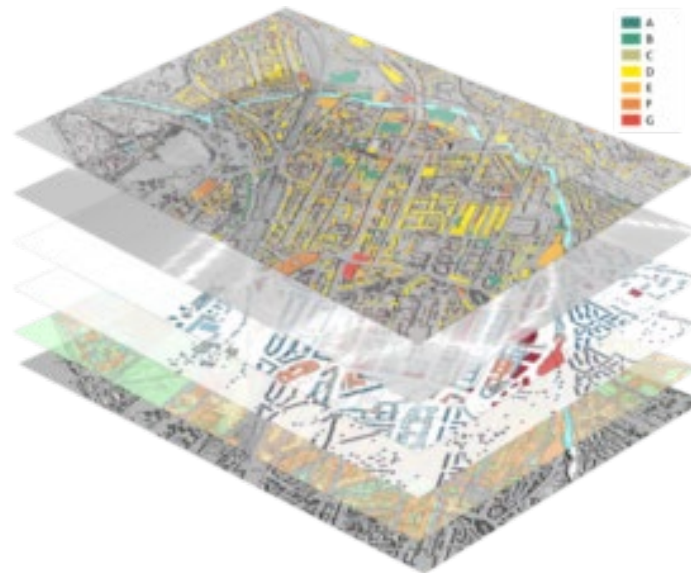
Source: Own elaboration



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY MAPPING FOR FEASIBILITY

2. Visualization of energy demand in the city or region

- Visualize the energy demand in the territory
- A software is typically used to cross the energy assessments with local weather data and georeferences
- Softwares: QGIS, gVSIG, GRASS GIS, SAGA GIS, i.a.



Source: ArchGIS



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CASE STUDIES

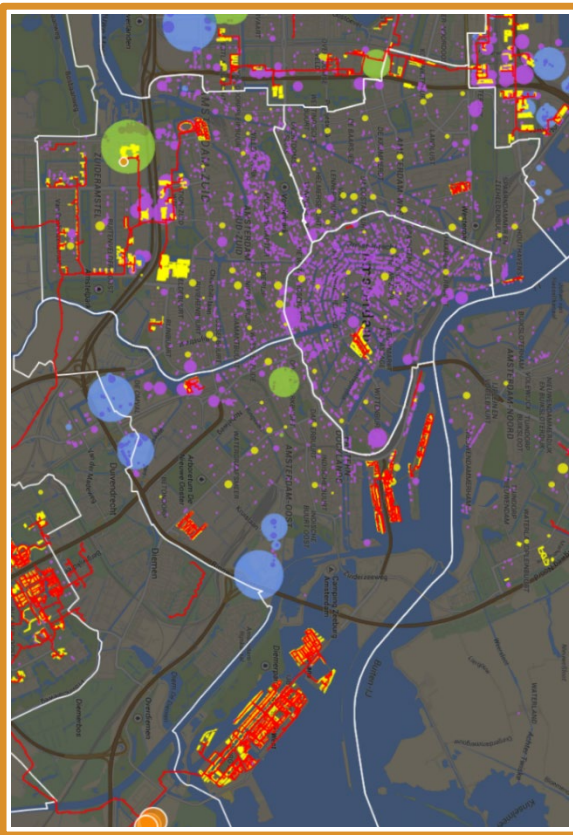


Amsterdam, Netherlands Source: Unsplash

MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

CASE STUDY: AMSTERDAM, NETHERLANDS

Initial mapping: What data can we get from master planning documents?



Source: Energy Atlas Amsterdam.
City of Amsterdam

- Infrastructures: roads, utilities (water/electricity/heating/gas/cooling), transportation etc.
- Buildings: type, built-up-area, floor area ratio (FAR),
- Future development plans
- GIS and/or AutoCAD and/or SketchUp, etc.

Initial mapping can act as a **tool** to **communicate** and **raise awareness**



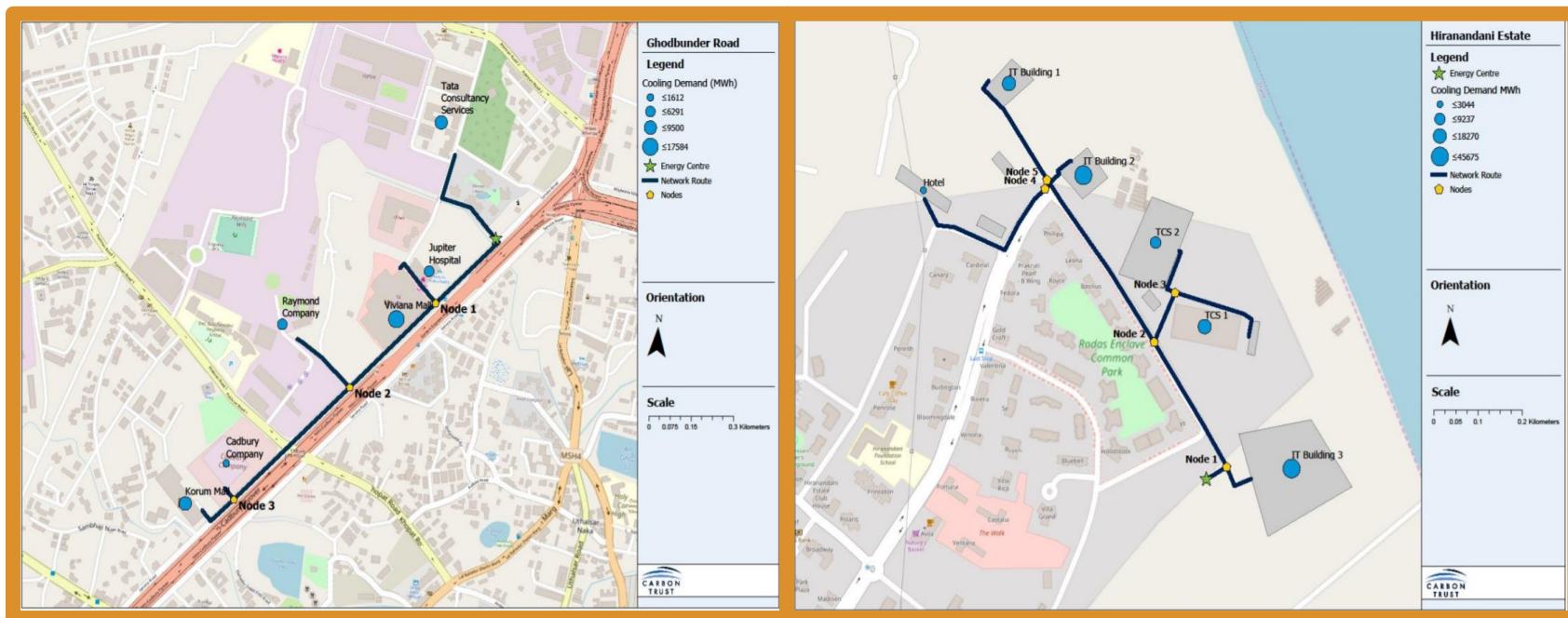
MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

CASE STUDY: THANE, INDIA

Mapping for detail

Characteristics:

- Neighbourhood/cluster project scope
- High level of certainty, but some assumptions
- Relatively time consuming



Source: Ghodbunder Road, India. Carbon Trust



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

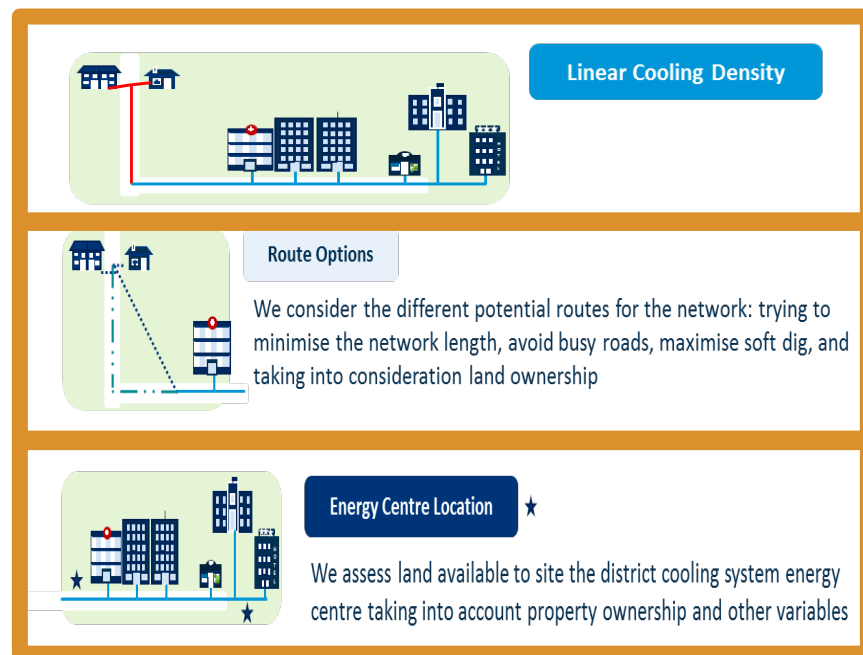
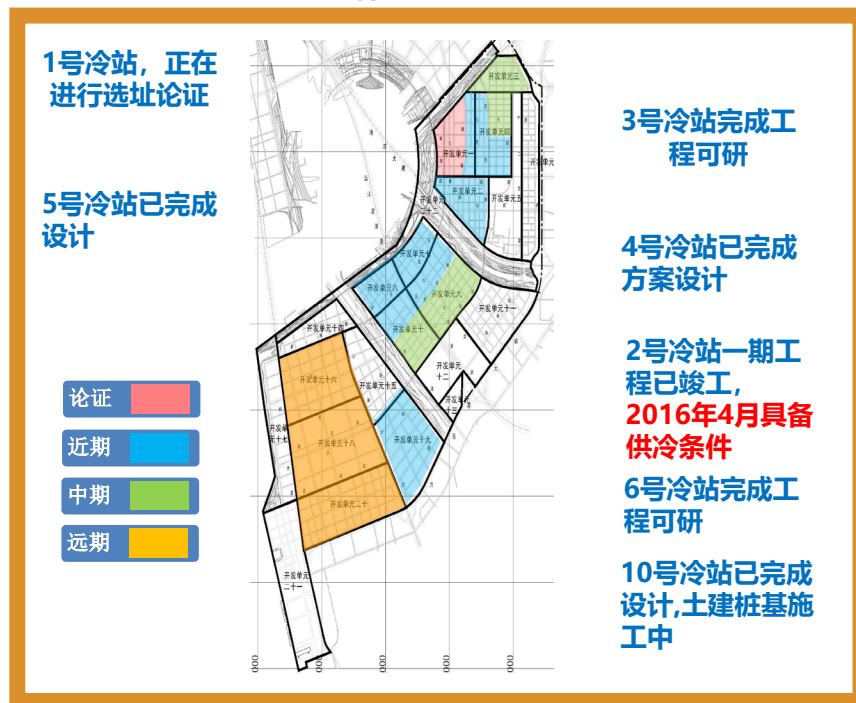
CASE STUDY: QIANHAI, CHINA

Mapping for feasibility

Characteristics

- Highly specified scope towards project design
- High level of certainty (+/-10%), minimal assumptions, feasibility level
- Highly time consuming

Shenzhen Qianhai Energy Investment Development:



Source: Shenzhen Qianhai Energy Investment



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

CASE STUDY: BELGRADE, SERBIA

Objectives of energy mapping exercise:

- Identify **energy consumption** of consumers
- Assess potential for **interconnection of networks**
- Analyse **fuel diversification options** and energy storage potential

Outcomes of energy mapping and energy performance class:

- **Energy consumption efficiency** of different buildings typologies can be compared
- **Systems components** will be upgraded to increase energy efficiency
- **Switch from building level metering to individual metering** for effective management



Source: Romanas Savickas



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY SYNTHESIS AND CONCLUSIONS

Strengths

- Visually understand heating and cooling demands.
- Visual tool to foster comprehension and communication among stakeholders
- Development of long-term energy strategies at local and national level
- Interlinks across various systems
- Identify the opportunities for development, extension, retrofitting and interconnection of existing networks
- Links to spatial and geographical elements with energy systems and flows
- Stimulate business investment and project development
- Identify long-term opportunities for district energy systems

Limitations

- Highly dependent on data availability
- Oftentimes data not available (e.g. data sensitive to privacy concerns)
- Lack of local expertise in conducting energy mappings



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY

KEY TAKEAWAYS

Some of the main aspects we have seen in this module are:

- **Energy mapping** is important to
 - Link heating and cooling demand needs, locations, distances, and calculate infrastructure costs and DES viability
 - Enable stakeholder discussions
 - Identify potential projects
 - Develop a city-wide district energy long term strategy
- Mapping approaches can be **bottom-up or top-down**
- There are **three main types of bottom-up energy mapping**, each of which has an increasing data, cost requirement and certainty, namely:
 - Initial mapping
 - Mapping for detail
 - Mapping for feasibility
- The **type and scope of mapping** can be defined by:
 - The purpose of the mapping
 - The phase of the project it is embedded in
 - If there is already DES in place or not
- **In practice, data availability and reliability can be an important limiting factor**
- The main drivers should be **sustainability and common welfare**



MODULE 3. ENERGY MAPPING IN DISTRICT ENERGY RECOMMENDATIONS

Some recommendations for energy mapping process:

- Use energy mapping as an effective tool to communicate the benefits and viability of DE to stakeholders and raise awareness among the general public
- Allocate funds required to carry out the energy mapping process from the city, grants or private investors
- While gathering the data for energy mapping, special focus should be on anchor loads, large sources of waste heat, existing networks and large publically owned demand
- Energy mapping can begin with initial mapping for a small pilot area and expand in detail and area covered when more funds are available and as DE systems prove their viability in the pilot areas



THANK YOU FOR COMPLETING THIS MODULE!

For more information about the initiative or this Training, please visit the following websites or contact:



www.districtenergyinitiative.org



unep.org



c2e2.unepdtu.org



E-TRAINING PROGRAM

DISTRICT ENERGY DEVELOPMENT

In the upcoming modules, you will learn about ...

Module 4

- Strategy development: Incorporating district energy into a local energy and low carbon systems

Module 5

- Carbon heating and cooling strategies

Module 6

- Business models for sound sustainable district energy systems