Global District Energy in Cities Initiative

ENERGY MAPPING AND MASTERPLANNING
DATA COLLECTION & ENERGY MAPPING

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DISTRICT ENERGY IN CITIES
A GLOBAL INITIATIVE TO UNLOCK THE POTENTIAL OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

UN Environment
• Development of district heating projects from "Green Field" stage;

• **District Energy** and City level **Energy Mapping**. Encouraging Customers and Technologies for Energy Efficiency
DEVELOPMENT OF DISTRICT HEATING PROJECTS IN DEVELOPING COUNTRIES

DEVELOPMENT OF DISTRICT HEATING PROJECTS FROM "GREEN FIELD" STAGE
• Why District Heating?
• Methodology and principles for District Energy development in "Green Field" areas. Temuco city case;
• Technical - Economical results;
• Tomorrows Temuco has been invented today: Temuco city after District Heating implementation;
WHY DISTRICT HEATING?

- The effects of **Air pollution** on **human health** have been well researched within internationally;
- The **Great Smog of London** of 5-9th December 1952, was a severe air-pollution event, reducing visibility and even penetrating indoor areas, caused **10’000 people die** and >100’000 were made ill;
- **Temuco** has the **third-worst** air quality in Chile. It is estimated that **93%** of the particulate matter in the winter months is caused by burning firewood in woodstoves in single homes;
- Inefficient burning of firewood produces contaminants such as **formaldehyde, methane, black carbon** which cause **effects on health**. In Temuco the current high levels of air pollution cause between **400-500 premature deaths** per year;
WHY DISTRICT HEATING?

- **District energy systems** are networks of underground insulated pipes that pump hot or cold water to multiple buildings in a district, neighbourhood or city.

- Such systems create synergies between the production and supply of heating, cooling, domestic hot water and electricity, and can be integrated with municipal systems such as power, sanitation, sewage treatment, transport and waste.

- This enables integrated energy grids that fuel low-carbon, energy efficient heating and cooling, and maximize local renewable resources.
District energy systems are increasingly climate resilient and low-carbon, allowing:

- up to **50 per cent** less **primary energy consumption** for heating and cooling;
- the recovery and distribution of **surplus and low-grade heat** and cold to end-users (e.g. waste heat from industry, power stations, waste incinerators and sewage treatment or cooling from water bodies and even LNG terminals);
- the **storage of large amounts of energy** at low cost – for example, solar heat for use during winter or conversion of surplus renewable power into heating or cooling for use during peak thermal demand;
- the integration and balancing of large shares of **variable renewable power** on electricity grids through thermal storage, cogeneration and heat pumps;
- a **fast and cost-effective transition** to sustainable refrigerants compliant with the Kigali Amendment to the Montreal Protocol.
- These benefits make district energy a key measure for cities/countries that aim to achieve **100% renewable** energy or carbon neutral targets. Compared with competitive technologies, district energy is frequently more cost effective – by up to 50 per cent – than individual buildings producing their own heating or cooling when there is sufficient energy demand density in a neighbourhood.
METHODOLOGY AND PRINCIPLES FOR DISTRICT ENERGY DEVELOPMENT IN "GREEN FIELD" AREAS

• There are no Methodologies for District Heating rehabilitation as there is no District Heating before;

• The Bottom-Up approach has been used:
  • Identified the typical housing in Temuco;
  • Calculated energy demand for heating and hot water;
METHODOLOGY AND PRINCIPLES FOR DISTRICT ENERGY DEVELOPMENT IN "GREEN FIELD" AREAS

- Designed District Heating Network:
METHODOLOGY AND PRINCIPLES FOR DISTRICT ENERGY DEVELOPMENT IN "GREEN FIELD" AREAS

- Designed **Power Plants**: for the base load Biofuel and for the peak load Gas.
- Analysed optimal proportion between Biofuel-Gas power distribution;
- Identified principal areas for power generation in a city;
EXAMPLE OF POTENTIAL PILOT PROJECT TECHNICAL - ECONOMICAL ASSESSMENT

- Designed 4th Generation Low temperature District Heating;
- Total installed capacity - 10-12 MW;
- Investments:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Thousand Eur*</th>
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<tbody>
<tr>
<td>1</td>
<td>Total CAPEX</td>
<td>11'000</td>
</tr>
<tr>
<td>2</td>
<td>Power Generation</td>
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<tr>
<td>3</td>
<td>District Heating Network</td>
<td>1'100</td>
</tr>
<tr>
<td>4</td>
<td>Heat Substations</td>
<td>900</td>
</tr>
<tr>
<td>5</td>
<td>Building Internal heating systems</td>
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<table>
<thead>
<tr>
<th>No.</th>
<th>Fuel diversification</th>
<th>Interest rate, %</th>
<th>Eur/kWh*</th>
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<tbody>
<tr>
<td>1</td>
<td>Wood Pellets/Gas (67/33)</td>
<td>6%</td>
<td>0,099</td>
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</table>
EXAMPLE OF POTENTIAL PILOT PROJECT TECHNICAL - ECONOMICAL ASSESSMENT

- One family building customer average annual payments after District Heating implementation:

<table>
<thead>
<tr>
<th>No.</th>
<th>One family building area, m²</th>
<th>District Heating, CLP/year*</th>
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<tbody>
<tr>
<td>1</td>
<td>70 m²</td>
<td>700</td>
</tr>
<tr>
<td>2</td>
<td>100 m²</td>
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<tr>
<td>3</td>
<td>120 m²</td>
<td>1'200</td>
</tr>
<tr>
<td>4</td>
<td>140 m²</td>
<td>1'400</td>
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DISTRICT ENERGY AND CITY LEVEL ENERGY MAPPING.
ENCOURAGING CUSTOMERS AND TECHNOLOGIES FOR
ENERGY EFFICIENCY
• **Local Governments** often need more detailed information on the current and future geographical distribution of energy use at the neighbourhood and building levels, as well as on local heat and energy assets and distribution structures.

• This can be achieved through an **Energy Mapping** process that analyses the local conditions, such as sources of **excess heat**, **renewable** heat assets (geothermal and solar), and concentrations of **heat or cooling demand**.

• Taking into account the principles of **Energy Mapping** and some specifics of every country and city, the **Energy Mapping** methodology has been developed and adopted for Cities;

• For the evaluation of actual energy consumption performance the separate evaluation criterion showing actual consumption of a building and being comparable between others has been developed (**Energy Performance Class for District Heating Customers (EPClass)**);
Energy maps for district energy can contain, among other variables, data on:

- **Existing and projected energy** consumption by sector, fuel source or neighbourhood; the resulting emissions and pollution and an understanding of the load profile;
- Present and future **building density** and **type** (residential, commercial, etc.);
- Sources of surplus or **industrial heat** supply;
- **Large energy consumers** and buildings with potential excess heating or cooling capacity (e.g., buildings for events such as a stadium or arena);
- Current networks and potential **network routes**;
- Potential **anchor loads** and their energy consumption;
- **Barriers and opportunities** particular to the location related to local energy sources, distribution, transport, land use, development density and character;
- **Socio-economic** indicators to identify fuel-poor areas that could benefit.
• **Individual metering** and **Demand Side Management** encourage final customers to use more efficient and less energy.

• But to identify that for every consumer should be defined **Standardized Energy Consumption** (eliminated influence of inside/outside temperatures, number of heating days, heating area, etc.):
To **compare different buildings**, various influencing factors must be eliminated:

- Areas;
- Hot water consumption;
- Number of days;
- Outside temperature;
- Wind speed ???
- Outside air humidity ???
- Other ???
• A **special methodology** is developed for **Energy Mapping** in Vilnius City case.

• This methodology **eliminates all different factors**: climatic factors as outside air temperature, number of heating days, heated area, amount of consumed hot water and etc.

• The **Actual Energy Consumption Performance indicator** shows standardized energy consumption amount per 1 day per 1 m² of building to increase inside air temperature by 1 °C, so different buildings can be compared between.
- **GRID** refers to a something resembling a framework of crisscrossed parallel bars, as in rigidity or organization (the city's streets form a grid)
• Vilnius City case
BIG DATA STATISTICAL ANALYSIS OF ACTUAL ENERGY PERFORMANCE CLASS FOR GIS APPLICATION
BIG DATA STATISTICAL ANALYSIS OF ACTUAL ENERGY PERFORMANCE CLASS FOR GIS APPLICATION
<table>
<thead>
<tr>
<th>EP Class</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>Zero energy consumption building</td>
</tr>
<tr>
<td>1</td>
<td>Low energy consumption</td>
</tr>
<tr>
<td>2</td>
<td>Low energy consumption</td>
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<td>3</td>
<td>Low energy consumption</td>
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<td>4</td>
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<tr>
<td>14</td>
<td>High energy consumption</td>
</tr>
<tr>
<td>15</td>
<td>High energy consumption</td>
</tr>
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**EXAMPLE OF ACTUAL ENERGY PERFORMANCE CLASS FOR DISTRICT HEATING CUSTOMERS**
Big Data and Statistical analysis shows that customers with **individual heat metering** by HCA use **25% less energy for space heating**.
By the help of Big Data and Statistical analysis customer from Old Town (buildings before 1960) can find does his building **consumption is bigger comparing to Vilnius City** because he lives in Old Town or his energy **consumption is too big even for Old Town.**
ADVANTAGES OF ENERGY MAPPING AND ENERGY PERFORMANCE CLASS

• **Analytical tools** in Energy Map **encourage customers** for Efficient Energy use.
• Showcases of **Refurbished** buildings.
• **Strategic** City Energy development **plan**.
Old Town view - energy consumption is very different
New constructed VS Typical Soviet period construction building
Insulated VS non insulated buildings:
ADVANTAGES OF ENERGY MAPPING AND ENERGY PERFORMANCE CLASS

• **Energy Consumption Efficiency** of all different buildings (Final Customers) can be compared between – from smallest to the largest;

• It encourages **Customers to take an active role in Energy Management**;

• As for better Energy Management engineering systems should be upgraded, it will stipulate the **technical progress and upgrade of HVAC systems inside buildings** - from thermostatic valves, balancing valves, heat substations to the heat and hot water metering for a whole building and individual metering for every final customer (flat), switching from square meters based billing to meter based billing, also it can be useful to Manage and balance District Heating Network grid more efficiently, take a decisions on a DH Network pipes replacement.
TRANSFERRING KNOWLEDGE OF APPLYING DIGITAL DATA ON A GIS PLATFORM LAYERS

Belgrade case:

- Energy Map for **Belgrade** area has been created.
- Based on a data the **layers on a GIS platform** have been created:
  - District heating **pipe network** and related data;
  - **Energy Performance** of Final Customers (in Colours and Numbers);
Welcome! Please log in.

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Username

Password

Change Password

Login
NEXT GENERATION ENERGY MAPPING

- **Photogrammetry** can help city buildings transfer into 3D shapes
NEXT GENERATION 3D ENERGY MAPPING

• Panevezys city map digital transfer into 3D
The **major barriers** for application of GIS and Big data methods in energy transition projects

- The application of GIS and BIG data methods usually is very important for the strategic city planning what is the role of local **governments/municipalities**. But the local governments usually do not have the **capacities and workforce** to do this, they may not have a **budget** for this activity (the budget for the city sometimes is politically sensitive), some quite small municipalities do not use and **don’t have a licence for the GIS**.

- The **private sector** (for example having a concession of District Heating Systems for 30 years in a city or etc.) may have a required experience and capacities but this activity may **be not direct profit orientated**, so the private sector may **lack a motivation** to work on this.
Legal and organizational practices to mitigate or remove the existing barriers

• There are no any specific restrictions from the legislation side, so no so many legal barriers.

• Legal framework improvements can be used to facilitate faster projects implementation (create city strategy including GIS and BIG data in the activity and etc.). The optimal solution would be to engage the public and private sector to have common goals leading to a certain implementation project. In energy transition process these applications should be very well orientated to the final consumer level - well disseminated and open source.
The role institutions and utilities play nowadays in creation and share of geo-spatial and Big data

• The utility companies are the main workforce and competence centres and institutions are like platforms for the realisation and dissemination publically.
The balance between Open access and Personal data protection policies with regards to energy-related data

- The personal data are the data of certain final customer as his name, address or amount of consumed data.
- The GIS and BIG Data can be presented in such way that this information would not be necessary presented. In a Vilnius City case this issue has facilitated to develop special actual energy consumption methodology and final results are special normalised indices for the buildings (not final consumer), so no personal data presented. We do not have to go to the final consumer/apartment level data, as the main criterion is a building. Inside building, every consumer can increase/decrease heat consumption according to his needs by the help of thermostatic valves/automatics and to see impact on the heat meter. If no apartment level heat meters installed, also there is no necessity to go to apartment level private data. Also we can go deeper to the data of every room but there is no necessity for that.