

Smart city heating and cooling in Europe

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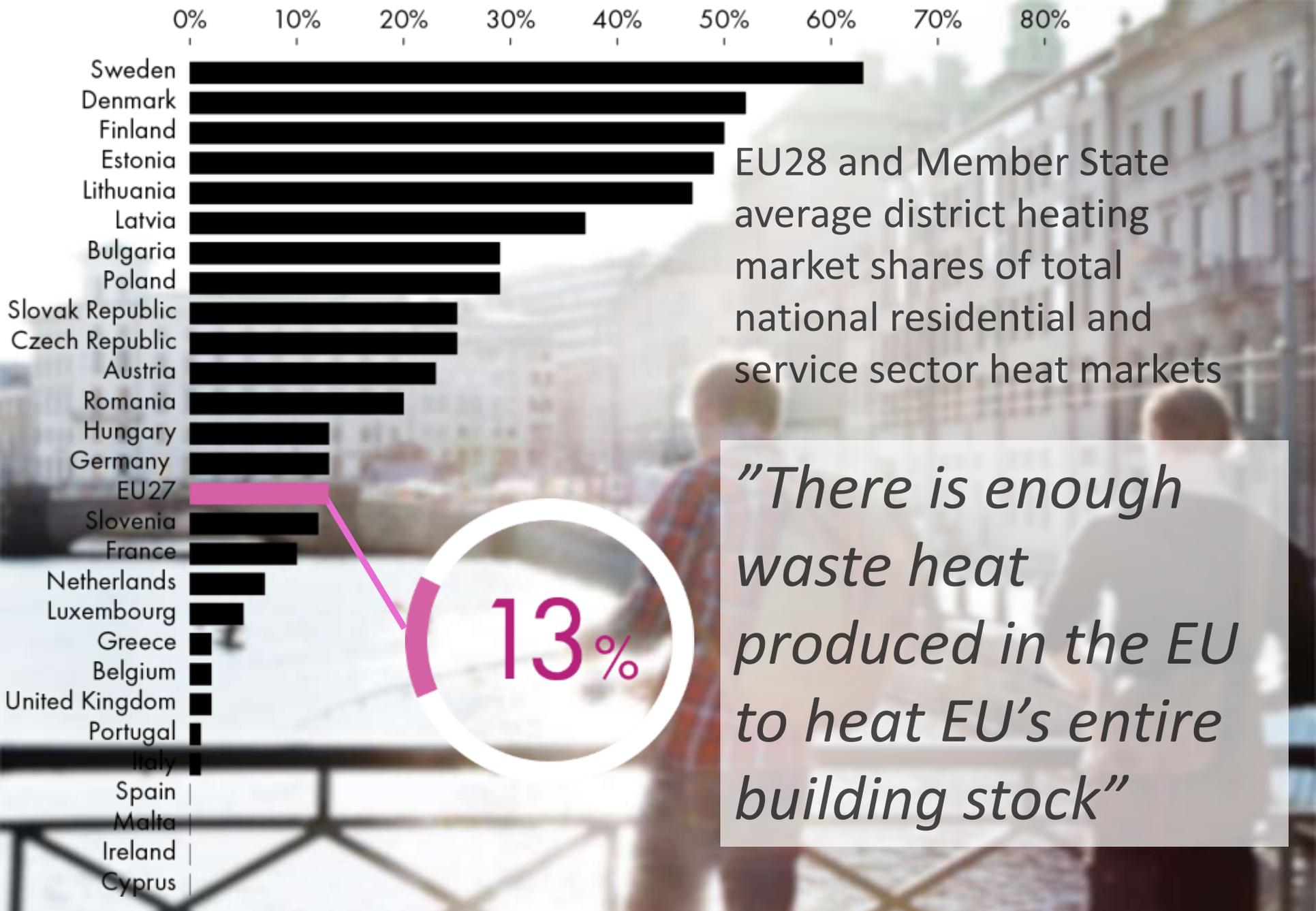




EU28 and Member State average district heating market shares of total national residential and service sector heat markets

There is enough waste heat produced in the EU to heat EU's entire building stock





GOTHENBURG (lead partner)

LONDON

COLOGNE

GENOA

ROTTERDAM

20
PARTNERS

4
YEARS



Demonstrators



CELSIUS
toolbox



Study
visits



CELSIUS
expert group



Existing demonstrators

London

- Small DH phase 1 – active network management and demand response

Rotterdam

- Vertical City (160 000m² /apartments /offices/hotel)
- District cooling with river water
- Waste heat capture – industry, waste incineration
- Rotterdam Datacenter

Cologne

- Local heat sources
- Heating residential areas with biogas
- KlimatKreis-Köln: energy efficiency initiative

Gothenburg

- Integration of other municipality networks
- Waste heat capture from industry
- Waste heat capture from waste incineration
- Biofuel in DH
- District cooling from river water
- Absorption cooling
- Solar cells to DH
- Climate agreements
- Total production and distribution system



New demonstrators

London

- Bunhill Phase 2: Heating system extension, thermal store, waste heat from underground

Rotterdam

- Heat hub: 300 MWh/ 50 MW
- IT solutions

Cologne

- DH from sewage (schools)
- Smart IT solutions to customers

Genua

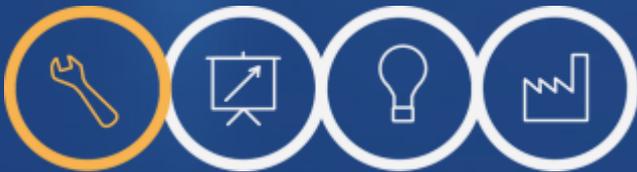
- Energy recovery from gas distribution network – turbo expander

Gothenburg

- Short-term storage in buildings
- DH to white goods
- DH to ferry in harbour
- DC from riverwater



CELSIUS Toolbox – an online wiki



Main Page

Welcome to the CELSIUS Toolbox! - A district heating and cooling resource

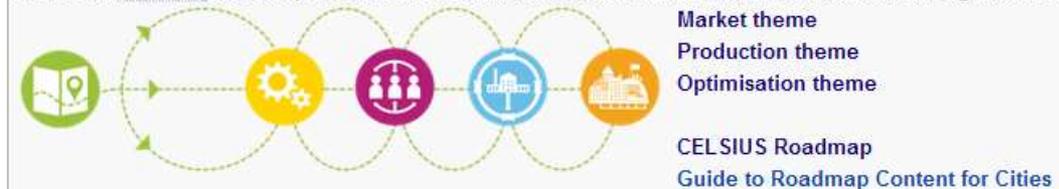
The CELSIUS Toolbox strives to be a source of knowledge and inspiration for cities interested in developing district heating and cooling solutions. It addresses cities which are just beginning to implement small-scale district heating and cooling networks as well as cities with large established systems endeavoring for even smarter and more efficient solutions.

The CELSIUS Toolbox consists of five elements. To navigate the CELSIUS Toolbox, choose one of four options:

1. Go directly to the element of your interest

CELSIUS Roadmap	Technical Toolbox	Social Toolbox	Demonstrators	CELSIUS Cities
- a holistic perspective when developing DHC systems	- technical information on developing DHC systems	- social and economic aspects of DHC development	- new and existing CELSIUS demonstration projects	- CELSIUS Cities and CELSIUS member Cities

2. Use the CELSIUS Roadmap that connects the information from the other four elements through three themes



3. Go to Categories to which all articles are linked

4. Watch a CELSIUS webinar, workshop or other video recording

Imagine an intelligent, competitive and liveable city. Imagine a resource-efficient city with smart heating and cooling. This is your city – a CELSIUS city! [More about the CELSIUS vision.](#)

As one of the possibilities to work toward the EU energy efficiency goals, CELSIUS is a demonstration and information transfer project with focus on smart heating and cooling solutions. [More about CELSIUS.](#)

- Main page
- [CELSIUS Roadmap](#)
- [Technical Toolbox](#)
- [Social Toolbox](#)
- [Demonstrators](#)
- [CELSIUS Cities](#)
- [Categories](#)
- [CELSIUS videos](#)
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CELSIUS Roadmap

Celsius Roadmap



The **CELSIUS Roadmap** presents a holistic view to sustainably developing district heating and cooling systems. The road map breaks down into three themes - **Creating the market**, **Production** and **Optimisation** - which connect the information in the **CELSIUS Toolbox**. To find information in the toolbox related to each theme, click on the links here in the text above.

To find more information about each theme, click on the links below. For more information about the **CELSIUS Roadmap** see the **Guide to Roadmap Content for Cities**.

Content [\[edit\]](#)

Creating the market [\[edit\]](#)

- Network infrastructure development
 - Masterplanning
 - Why heat mapping - A GLA perspective
 - Heat mapping as a planning tool
 - DH infrastructure development
 - DC infrastructure development
 - New applications of DHC
- New business models for end-users
 - Business models for district energy

Production [\[edit\]](#)

- Renewable sources: primary energy
 - Biomass
 - Solar
 - Geothermal
- Waste energy recovery
 - Waste heat from industry
 - Waste incineration
 - Waste heat from urban infrastructure
 - Energy infrastructure: gas grids and turbo expanders
 - Cooling from excess energy

Optimisation [\[edit\]](#)

- End user management
 - Energy services to the end-user
- Production optimisation
 - Supply chain and production optimisation
- Distribution optimisation
 - Heat distribution monitoring and supervision
- System optimisation
 - Connecting municipalities
 - Utility side storage
 - Integration with the electricity grid
 - Lowering grid temperatures



A holistic and overarching guide to planning, developing and optimising a sustainable district heating and cooling network.

Organized in 3 themes that serve as guiding lines to the articles in the other elements

CELSIUS
Roadmap
Theme



Market

CELSIUS
Roadmap
Theme



Production

CELSIUS
Roadmap
Theme



Optimisation



CELSIUS Toolbox

Technical Toolbox



The **Technical Toolbox** is a set of tools which provide knowledge and experience in *technical aspects of district heating and cooling solutions* and development. You will find descriptions of best available technologies, methodologies for energy mapping, tools for optimisation, inspirational examples and more.

Browse the list below to learn about topics of interest to you and your city. From each article you will find links to more in-depth information, to demonstrators and case studies of the technology and to related topics. You can also use the CELSIUS Roadmap for guidance to tools which are relevant in your unique situation.

Content [\[edit\]](#)

Energy demand [\[edit\]](#)

- Energy Potential Mapping (demand)
- Heat demand forecasting techniques
 - Forecasting example based on numerical regression
- Heating and cooling in buildings
 - End user Management concept
 - End user dialogue concept
 - End User Side Optimisation
- Heat driven white goods
 - Heating water circuit (HWC)-connected white goods
 - Domestic hot water (DHW)-connected white goods
- District heating to ships in harbour



Supply of renewable and waste energy [\[edit\]](#)

- Energy Potential Mapping (supply)
- Biofuel CHP
- Solar heating technology
- Geothermal heat

Knowledge and experience in technical aspects of DHC solutions, including technologies, methodologies, tools and examples

- Energy demand
- Supply of renewable and waste energy
- System integration
- Storage and peak shaving



Social Toolbox

Social Toolbox



The **Social Toolbox** is a set of tools intended to provide knowledge, experience and examples from other cities in *socio-economic aspects of district heating and cooling development*.

Use the Celsius Roadmap to find out which tools are most relevant to your unique situation, or browse the list below.

Content [\[edit\]](#)

End user engagement [\[edit\]](#)

- End user
- End user participation
- The spectrum of end user engagement
- End user participation methods
- End user service agreements (SA), price dialogues and consumer charters
- End user engagement checklists: questions and impediments

Business models and funding [\[edit\]](#)

- Governance and ownership of business models
- Business opportunities, job creation and macro benefits
- Investment and capital funding

Regulations and policy frameworks [\[edit\]](#)

- Legal framework summary
- Identified legal/policy barriers
- Best practice policy frameworks
- City strategies
- Policy recommendations

Case Studies and methodology (social) [\[edit\]](#)

- Islington case study
- Rotterdam case study

Knowledge and experience in socio-economic and political aspects of DHC development, including inspiring business models & case studies

- End-user engagement
- Business models and funding
- Regulations and policy frameworks
- Case studies & methodology



Demonstrators

Celsius demonstrators



Here you can find inspirational examples of district heating and cooling solutions in the CELSIUS partner cities.

Read about their experiences and find links to related information in the toolbox.

Content [\[edit\]](#)

System integration [\[edit\]](#)

- Total production and distribution system in Gothenburg
- Integration with other municipalities in Gothenburg
- Solar heat to DH system in Gothenburg
- The Heat Hub in Rotterdam
- Vertical City in Rotterdam

Sustainable production [\[edit\]](#)

- Waste heat recovery from sewage water in Cologne
- Cooling from river water in Gothenburg
- Absorption cooling in Gothenburg
- Biofuel CHP in Gothenburg
- Sustainable production Vertical City - Biofuel CHP in Rotterdam
- Recovery of heat from waste incineration in Gothenburg
- Waste energy recovery from gas distribution in Genoa
- Capture of waste heat sources in Islington
- Sustainable production Vertical city - Cooling by river water in Rotterdam

Storage [\[edit\]](#)

- Aquifer thermal energy storage for cooling and heating in Maastoren, Rotterdam
- Buildings for short-term storage in Gothenburg
- Short-term thermal storage
- The Heat Hub in Rotterdam

Examples of district and cooling solutions implemented in the CELSIUS partner cities including lessons learned and replicability matrixes

- System integration
- Sustainable production
- Storage
- End-user
- Infrastructure



CELSIUS Cities

CELSIUS Cities



The **CELSIUS Cities** are made up of the **CELSIUS Partner Cities** - initiators of the CELSIUS project - and **New CELSIUS Cities - member cities** who have joined the CELSIUS platform, of knowledge and networking, with focus on smart district heating and cooling solutions.

One of the goals with CELSIUS is to recruit 50 member cities by 2017. On 15 March, 2016, there were 48 New CELSIUS Cities.

Content [\[edit\]](#)

CELSIUS Partner Cities [\[edit\]](#)

- [Gothenburg](#)
- [Cologne](#)
- [Islington/London](#)
- [Rotterdam](#)
- [Genoa](#)



New CELSIUS Cities [\[edit\]](#)

- | | | | | |
|--|--|--|---|---|
| <ul style="list-style-type: none">• Enfield• San Sebastián• Gdynia• Copenhagen• Antwerp• Riga• Stoke-on-Trent• Helsingborg• Zaanstad• Greenwich | <ul style="list-style-type: none">• Tilburg• Ghent• Granollers• Leiden• Birmingham• Guidonia Montecelio• Reggio Emilia• Cagliari• Bergamo• Manisa | <ul style="list-style-type: none">• Westland• Bristol• Haringey• Exeter• Bolzano• Torino• Lyon• Lund• Manchester• Leeds | <ul style="list-style-type: none">• Groningen• Chemnitz• Turku• Valladolid• Merton• Issy-les-Moulineaux• Düsseldorf• Parkstad Limburg• Limoges• Pijnacker-Nootdorp | <ul style="list-style-type: none">• Frankfurt am Main• Bydgoszcz• Bonn• Delft• Lille• Leipzig• Aberdeen• Ljubljana• • |
|--|--|--|---|---|

The stories and experiences of the CELSIUS partner cities and the CELSIUS member cities as they plan, develop and optimize their DHC networks



Locations of CELSIUS partner cities and CELSIUS member cities

48 Cities

13 Countries





Waste heat capture and utilization

SUSTAINABLE PRODUCTION

Residual heat from the London Underground mid-tunnel ventilation shaft is used for the district heating system



1.9 MWe gas
CHP unit with
115m³ thermal
store

1.5km heat
network
trenching

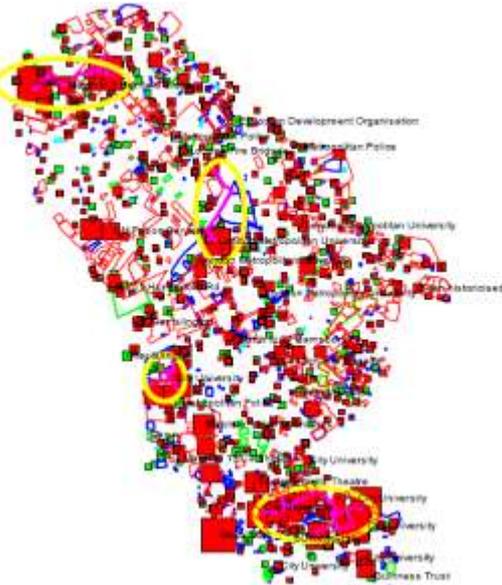


Waste heat capture and utilization

SUSTAINABLE PRODUCTION

Planning Policy – Core Strategy (2011):

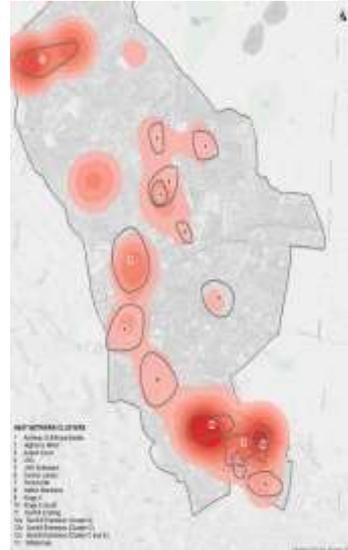
to promote and develop decentralised energy (DE) networks



2008



2009



2014



Capturing Heat and thermal storage:

Mid tunnel ventilation shaft on the Northern Line

District Heat network extension:

1km extension to Bunhill 1 DH; connecting 1,000+ homes, school, community centre



Waste heat capture and utilization

SUSTAINABLE PRODUCTION

Residual heat from the London Underground mid-tunnel ventilation shaft is used for the district heating system





Waste heat capture and utilization

SUSTAINABLE PRODUCTION

Residual heat from the London Underground mid-tunnel ventilation shaft is used for the district heating system



Containerised:

- 1MWth Air source heat pump
- 2x 230kWe gas-fired CHP engines
- 5x7.5m coil heat exchanger
- 70m³ thermal store





Waste heat capture and utilization

SUSTAINABLE PRODUCTION

Residual heat from the London Underground mid-tunnel ventilation shaft is used for the district heating system

Number of steps down 155





Heat hub storage

STORAGE

This structure is located in a strategic location to increase the effectiveness of the waste heat transportation and buffering capacity

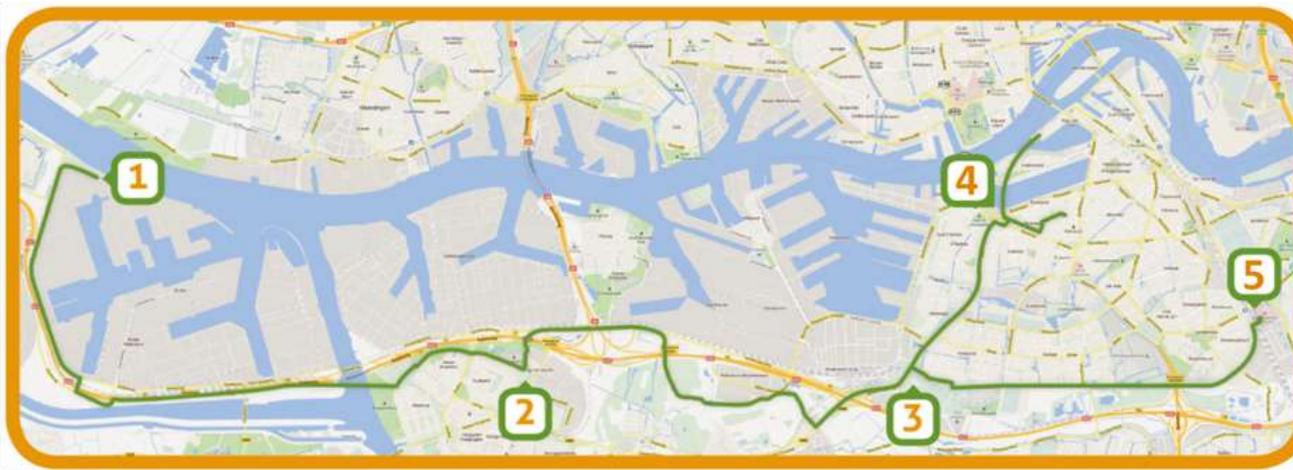


System overview

Heat hub storage

STORAGE

This structure is located in a strategic location to increase the effectiveness of the waste heat transportation and buffering capacity



1



Waste incinerator and energy plant at Rozenburg

2



Booster station Hoogvliet

3



Booster station Groene Kruisweg

4



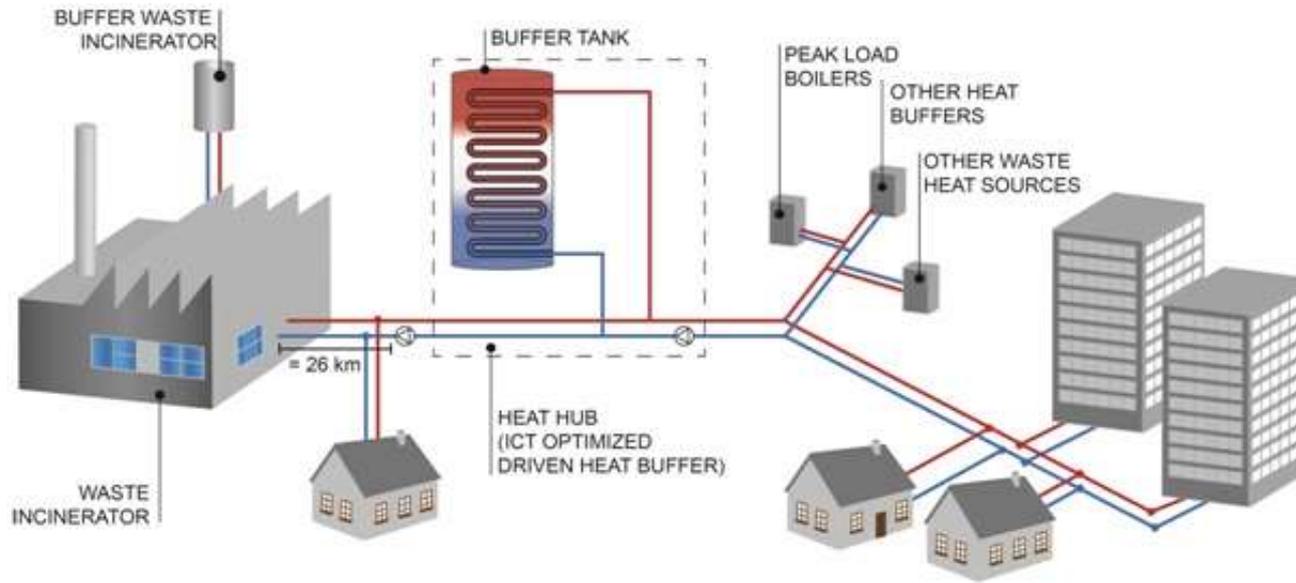
Heat hub Brielselaan

5



Heat station Maasstad Hospital

System overview



Heat hub storage

STORAGE

This structure is located in a strategic location to increase the effectiveness of the waste heat transportation and buffering capacity



Operational since Q4 2013, - contains three parts

1. The heat hub acts as a distribution station and it **connects the existing district heating** systems in the south and north of Rotterdam.
2. The heat hub has a well-insulated buffering tank. The capacity of the buffer is **185MWh** and the discharge capacity is **30MWth**.

By placing the tank in the **middle of the distribution network**, the buffered heat is closer to the end-consumer. There is also a positive effect on the local air quality because there are less gas-fired boilers needed for peak load.

3. For better forecasting and heat balancing, a **smart ICT-system** is developed.

The Smart ICT tool **optimizes** heat demand forecasting and the use of heat sources and other assets **on an economical and ecological basis**.

Heat hub storage

STORAGE

This structure is located in a strategic location to increase the effectiveness of the waste heat transportation and buffering capacity



It looks great too!



Heat hub storage

STORAGE

This structure is located in a strategic location to increase the effectiveness of the waste heat transportation and buffering capacity





Industrial waste heat recovery

SUSTAINABLE PRODUCTION

Nearly 80% of the DH in Gothenburg is based on waste heat from industries, heat that would otherwise be released into the air or water bodies





District heating to white goods

END-USERS

Dish washers, washing machines and dryers use the DH instead of electricity for the heating demands of the machines, reducing the electricity consumption by 70-80%





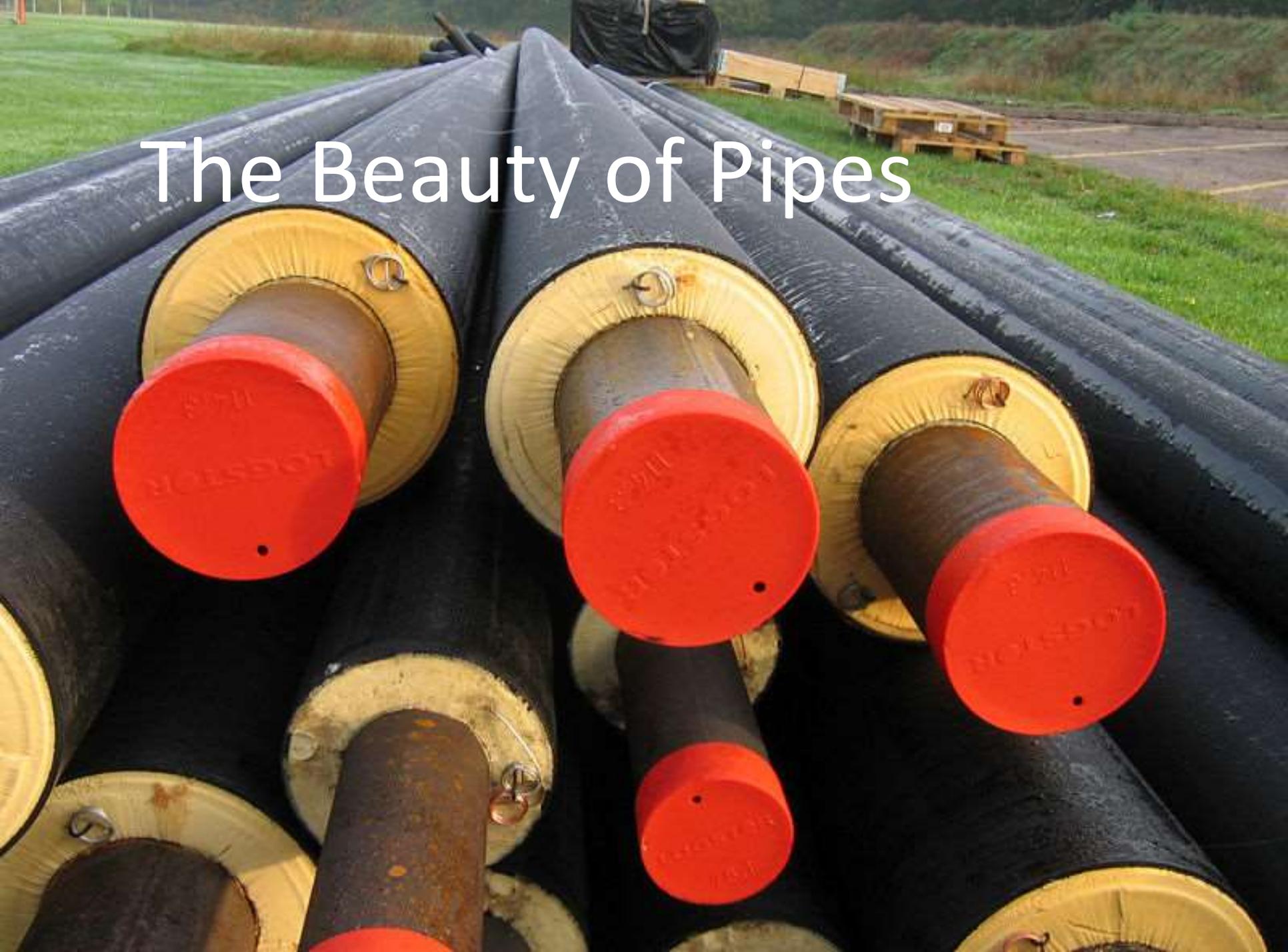
District heating for ships in harbour

END-USERS

For the first time a ship in regular service is being connected to the DH network instead of burning bunker oils while in the harbour



The Beauty of Pipes



Thank you

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