Klimaschonende Nahwärmeversorgung durch Abwasserwärmenutzung im Projekt Celsius, Standort Köln

Aldo Perez

City of Cologne

Coordination Center for Climate Protection
Department for Social Affairs,
Integration and the Environment

Stadt Köln

celsius smart cities

3. BMUB-Fachtagung Klimaschutz durch Abwärmenutzung,

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 314441.

Agenda

CELSIUS – Brief description

Cologne Demonstrators

KPIs

Wastewater Heat Potential

Lessons Learned

CELSIUS – Brief Description

- **EU Project with 4 Years of Experience**
- **10 New Demonstration Plants**
- **Waste Heat Recovery & more**

http://celsiuscity.eu/

Stadtentwässerungs-betriebe Köln, AöR

RheinEnergie

Stadt Köln

Technology Arts Sciences TH Köln

CELSIUS – Brief Description

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Main Page

Welcome to the CELSIUS Wiki

- a District Energy knowledge resource

You are welcome to contribute to the 312 articles presently here!

Introduction to District Energy
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Socio-Economic toolbox
Case Studies
CELSIUS Network

CELSIUS Cities

Map Satellite
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Belarus
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Greece
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Read more about the

CELSIUS Cities and the CELSIUS Network

The CELSIUS Vision

Imagine an intelligent, competitive and liveable city. Imagine a resource-efficient city with smart heating and cooling. This is your city – a CELSIUS city!

CELSIUS City has established an intelligent heating system covering virtually all the households and commercial buildings in the appropriate high density areas of the city and an energy efficient district cooling system for its commercial customers. These systems make use of a range of excess heat sources all created within the city during the course of an average operational day, for example from various industrial and datacentre activities, heat extracted from sewage and bio-based heating. CELSIUS City not only consumes much less fossil fuel generated energy than a traditional European city; but it also plays a fundamental role in supporting the resilience and security of the electricity network by effectively utilising existing network capacity for connecting new distributed generation and for providing grid balancing. This becomes more relevant via

The CELSIUS Wiki

The CELSIUS Wiki aims to be a source of knowledge and inspiration for cities interested in developing district energy (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 wiki is created within the EU project CELSIUS, sharing experiences and research from the project partners and it is continuously being developed in cooperation with the growing CELSIUS Network.

The CELSIUS Wiki consists of five main elements: **Introduction to District Energy** provides an overview and basic strategies for planning and developing a system. The Technical and Socio-Eonomic toolboxes contain more in-depth knowledge and tools; the **Technical Toolbox** about technologies and recent research from efficient supply to smart use and optimised system integration; the **Socio-Economic Toolbox** about end-user engagement, business models and policy. **Case Studies** share experiences and give inspirations from demonstrators included in the CELSIUS project and case studies throughout the **CELSIUS Network**.

If you are looking for a specific topic you can also use the search field in the upper right corner or use the Categories. All articles are tagged to at least one category and by following these at the bottom of each article related information can be found.

New articles

- VirtualKnob - OPTi
  Software developed as part of the OPTi project.
- CELSIUS Talk: Automatic Meter Reading
  Webinar on smart meters, what they are, how they may be used and the importance of standardisation.
- OPTi Substation tuning tool
  A proposed substation tuning tool produced by OPTi.
- PURIX
  A new CELSIUS City Supporter.
- Virtualization of DHC systems
  An overview of modelling for district heating and cooling systems.

Fig. 1 CELSIUS Wiki Internet Page [1]

Cologne Demonstrators

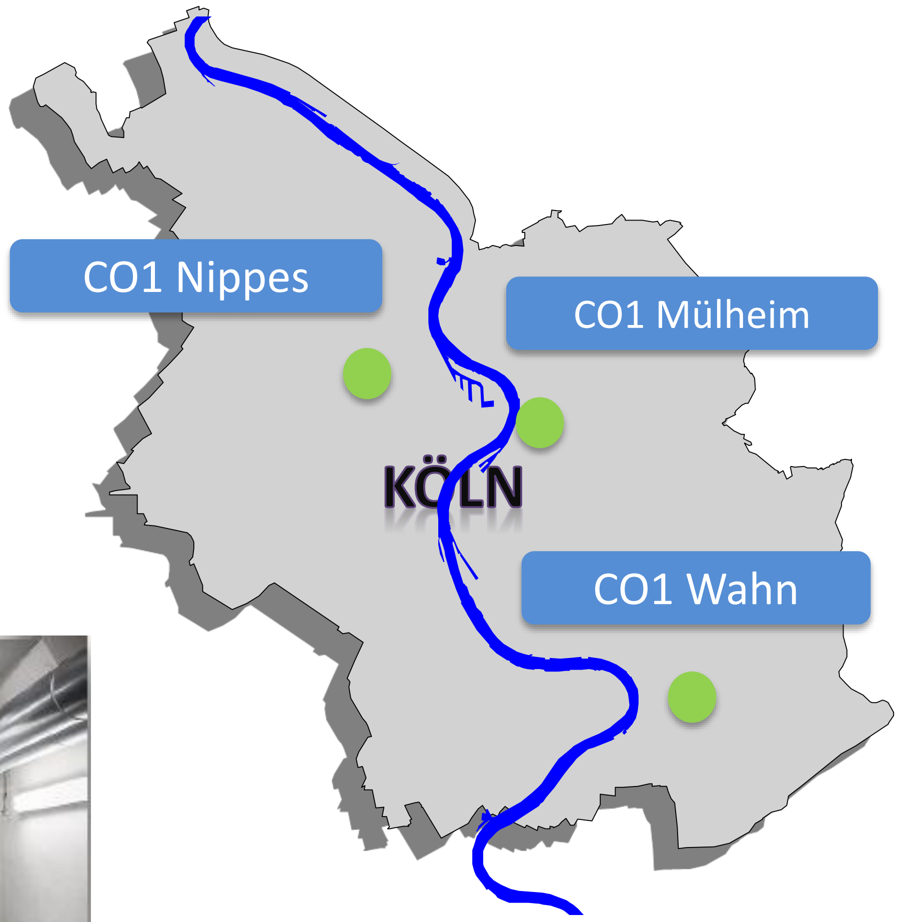

Fig. 4 Heat Exchanger Wahn @Rheinenergie

Fig. 5 Control Room Nippes @Rheinenergie

Fig.2 Cologne Demonstrator Plants [2]

Cologne Demonstrators

Requirements for wastewater heat recovery			
Parameter	**Size**		**Comments**
Dry weather flow rate (daily average) [l/s]	> 15 l/s		Mixed and dirty water sewage
Size of the channel [mm]	> DN 800		
Heat power [kW]	> 150	> 1000	Central heating system
Distance from the channel [m]	100-200	< 300	Dense house construction in the city
Heat source temperature	>12° C		
Supply temperature	40 °C	70 °C	COP >3, COP 5.6

Table 1. Requirements for wastewater heat recovery [3]

Cologne Demonstrators-Wahn

Figure 6: CO1 Wahn Layout [4]

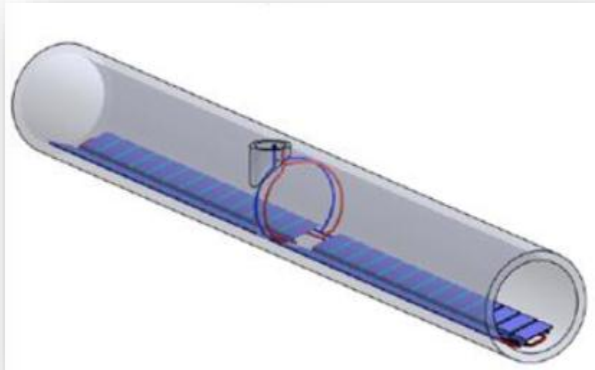

Figure 7: CO1 Drain heat exchanger in Wahn [3]

- **Heat exchanger long:** 40m
- **Water Temp.:** 10/22°C
- **Flow rate:** 220 l/s
- **Area Covered:** 22000 m2.

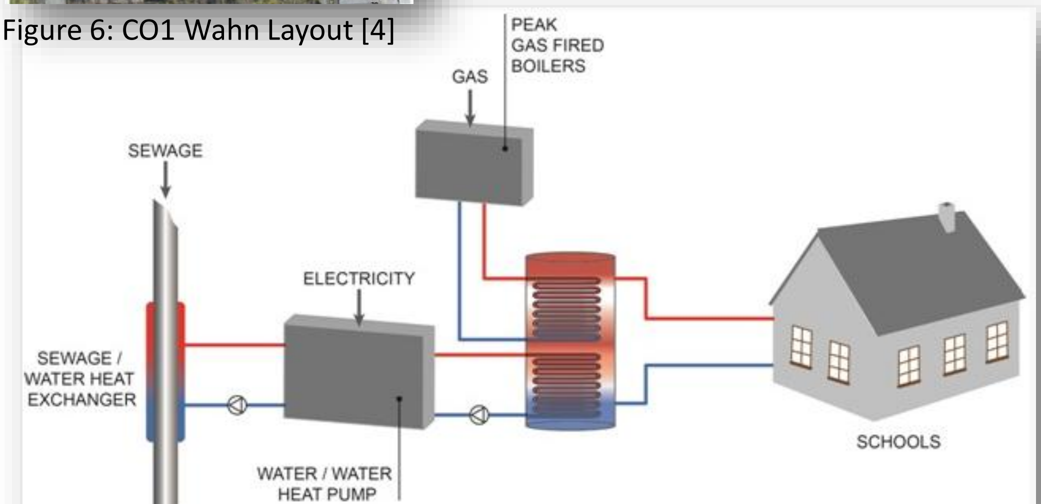

Figure 8: CO1 Wahn Layout [5]

- **Heat Demand:** 1220 MWh/year
- **Gas Boiler Heating Power:** 1MW
- **HP Heating Power:** 200 kW

Cologne Demonstrators-Mülheim

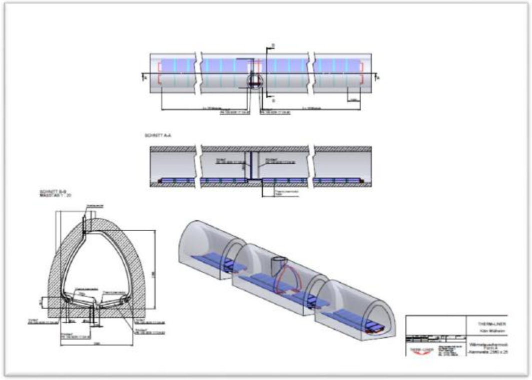

Figure 9: CO1 Mülheim heat exchanger [3]

Figure 10: CO1 heat exchanger replication [5]

engeneering drawing - Köln-Mülheim
© RheinEnergie AG, 2013

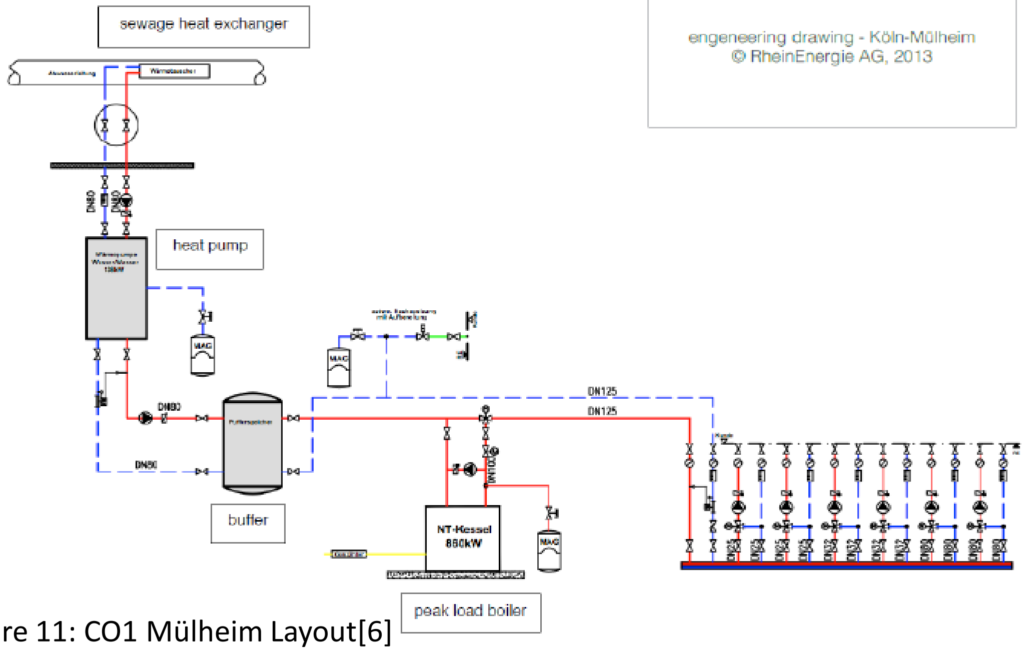

Figure 11: CO1 Mülheim Layout[6]

- **Buildings:** 1 School 1 Sport hall
- **Water Temp.:** 12/22°C
- **Flow rate:** 100 l/s
- **Area Covered:** 13000 m2.

- **Heat Demand:** 750 MWh/year
- **Gas Boiler Heating Power:** 860kW
- **HP Heating Power:** 150 kW

Cologne Demonstrators-Nippes

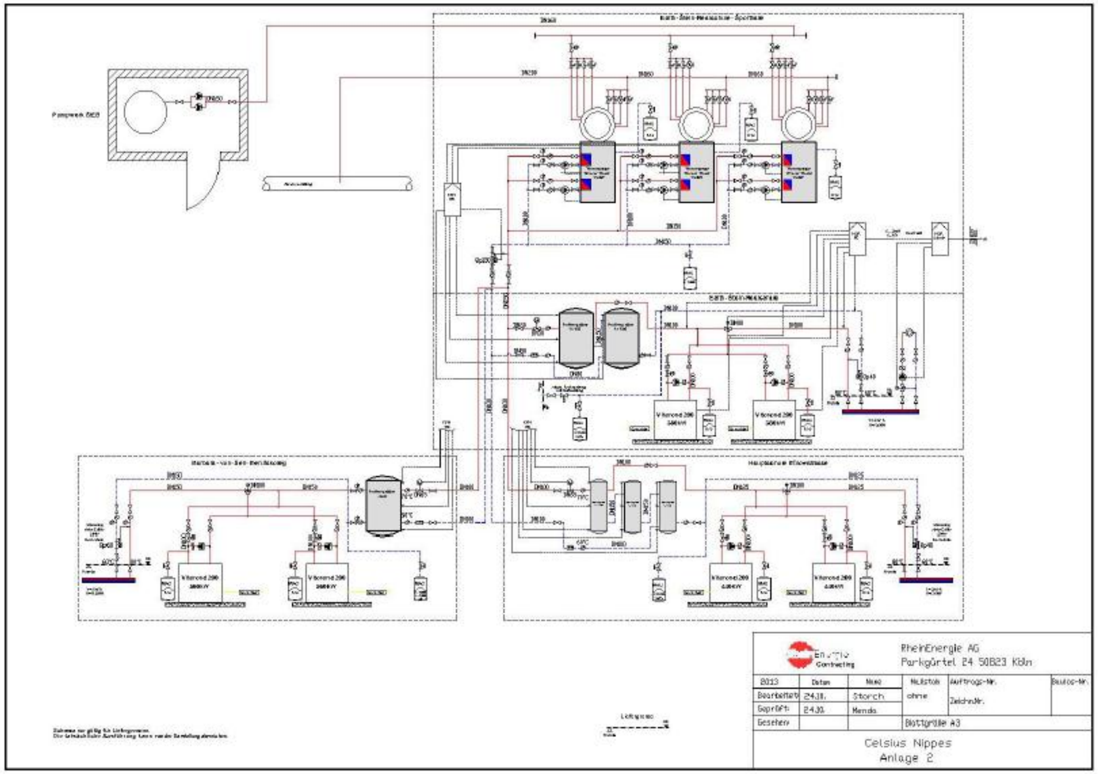

Fig. 12 CO1-Nippes Layout [3]

- **Buildings:** 3 Schools 1 Sport hall
- **Water Temp.:** 12/22°C
- **Flow rate:** 30 l/s
- **Area Covered:** 28000 m2.

- **Heat Demand:** 2130 MWh/year
- **Gas Boiler Heating Power:**
  760kW
  880 kW
  720 kW
- **HP Heating Power (x3):**
  150 kW

Key Performance Indicators

Energetic	Environmental	Economic	Social
Energy produced	CO_2 Emissions	Cost per kWh of saved PE	Surface Area m2
Energy Recovered	CO2 Savings	Cost per ton of saved CO_2	# Of residents clients benefitting from the project
Primary Energy saved	Emissions (SO_2,NOx,PM)		Reduction/increase of complaints
	Emissions savings (SO_2,NOx,PM)		

Key Performance Indicators

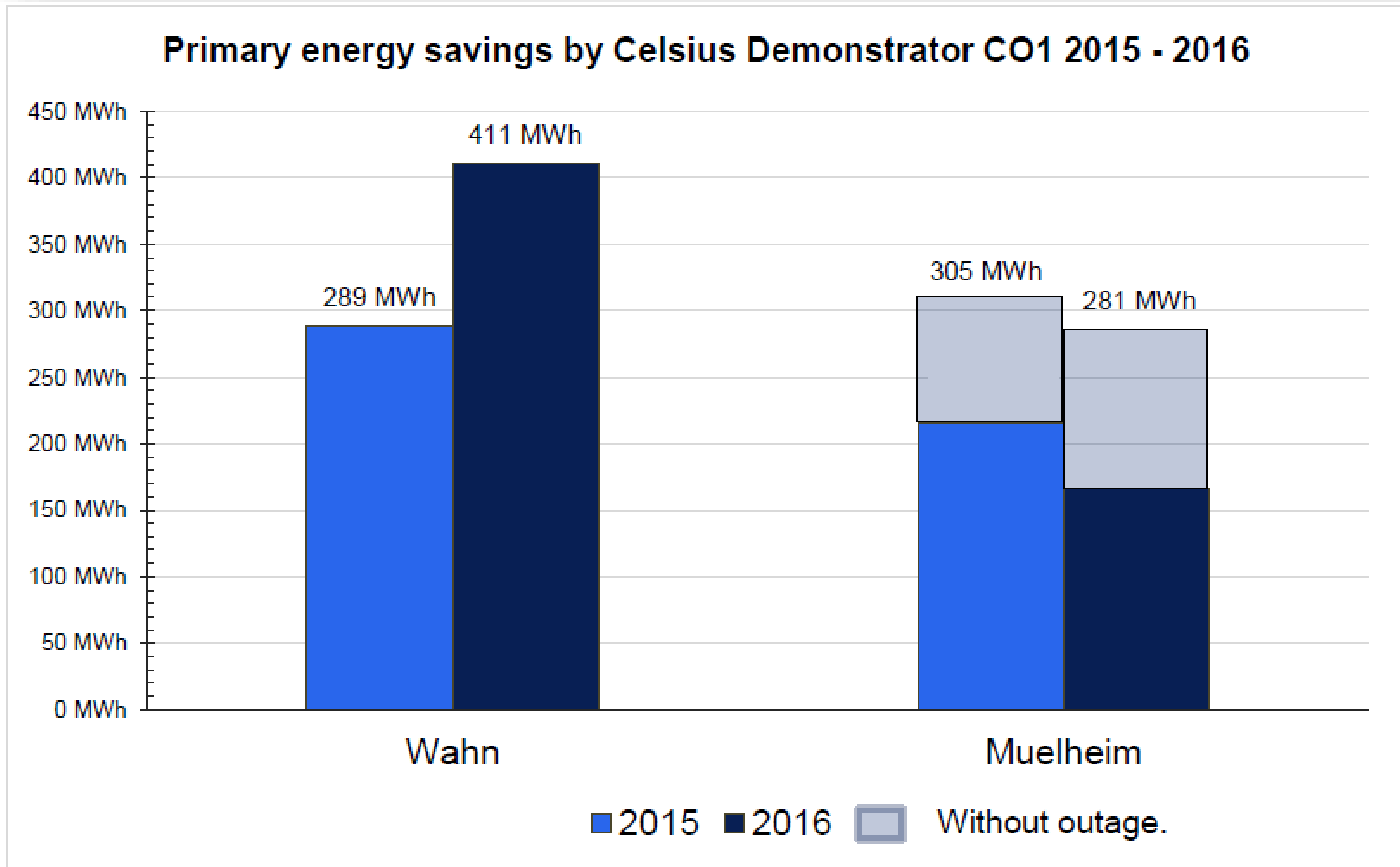

Fig. 13 Primary Energy Savings CO1-Wahn and Muelheim KPIs diagram 2015-2016 [3,6,7]

Key Performance Indicators

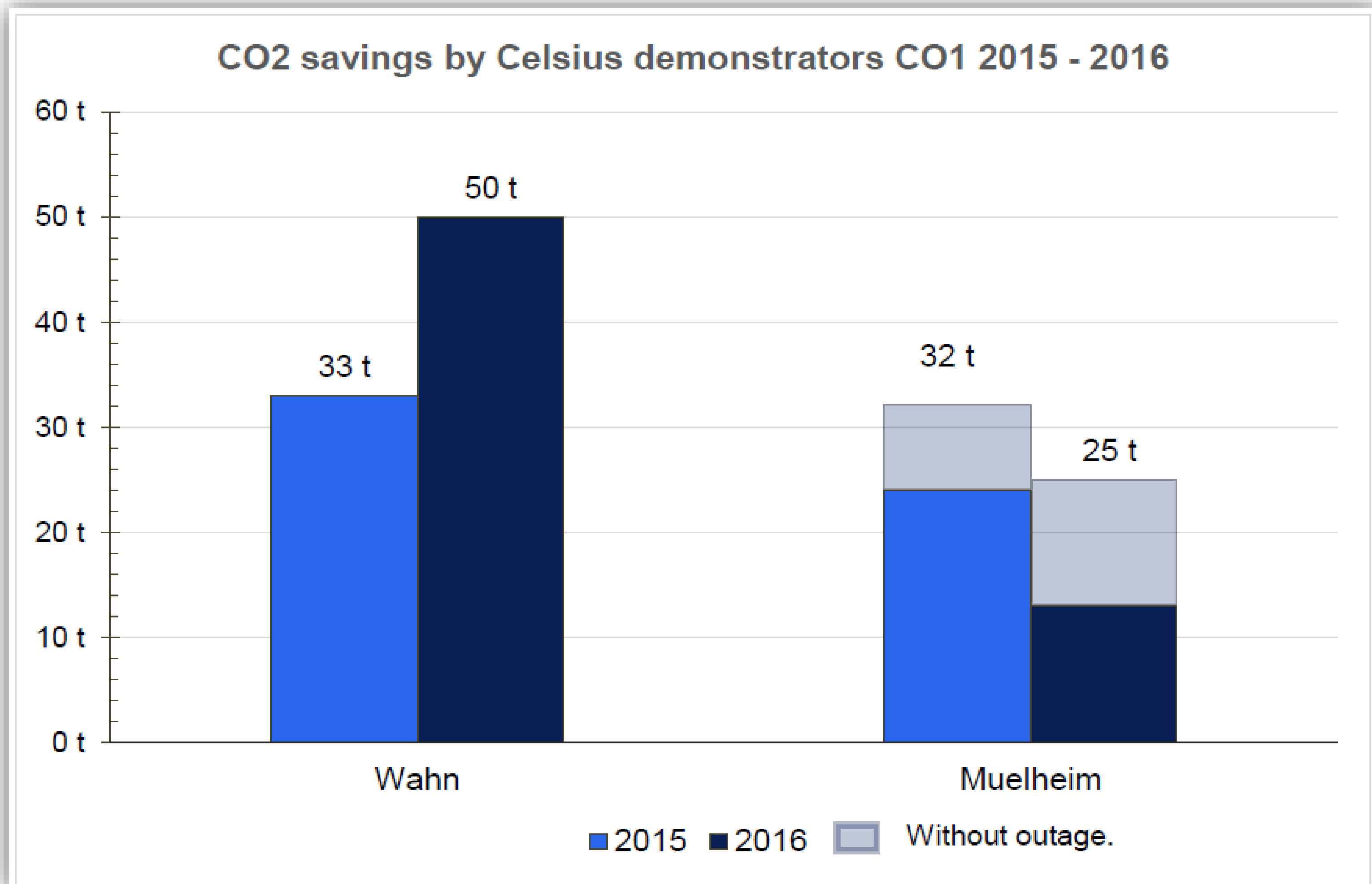

Fig. 14 CO2 Savings CO1-Wahn and Mülheim KPIs diagram 2015-2016 [3,6,7]

Key Performance Indicators

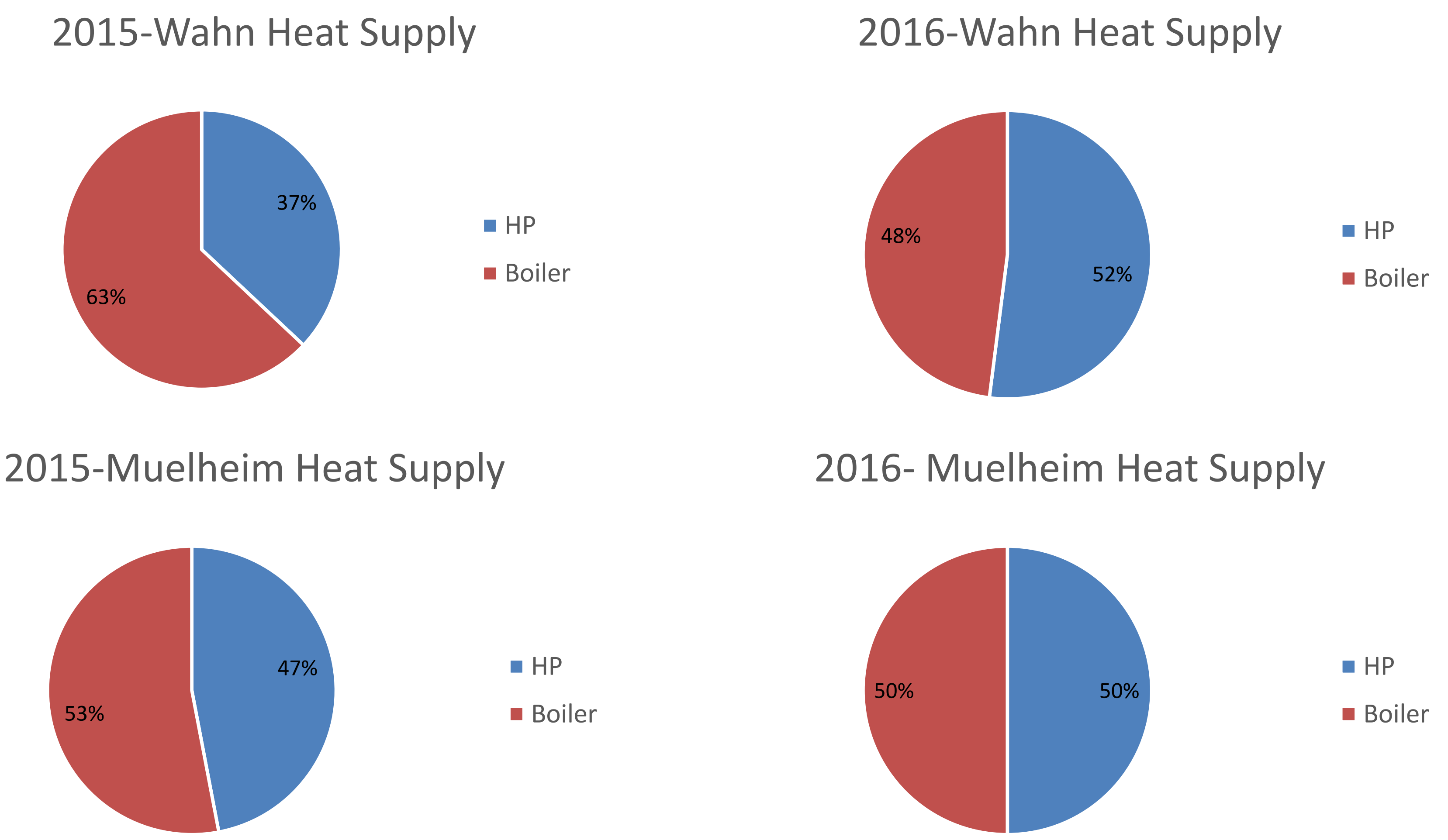

Fig. 15 Heat Supply Share CO1-Wahn and Muelheim 2015-2016 [6,7]

Wastewater Heat Potential

Fig.16Large-Scale Heat Pump [8]

Capacity of large-scale heat pumps (LSHP) in Europe = 1423MW *

Capacity of large-scale HP (sewage) in Europe = 742MW *

* According to Own Research

Wastewater Heat Potential

Fig.17 Wastewater Treatment Plants in Cologne [9]

Methodology based on 5 Cities:
Copenhaguen, Cologne, Hamburg, Gothenburg & Turku

Input Data for 135 Cities:
Population, heat sold, electricity and District heating energy mix, Investment costs, etc

Upload into personal server:
Wastewater heating potential App.

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Waste Water Heat Potential

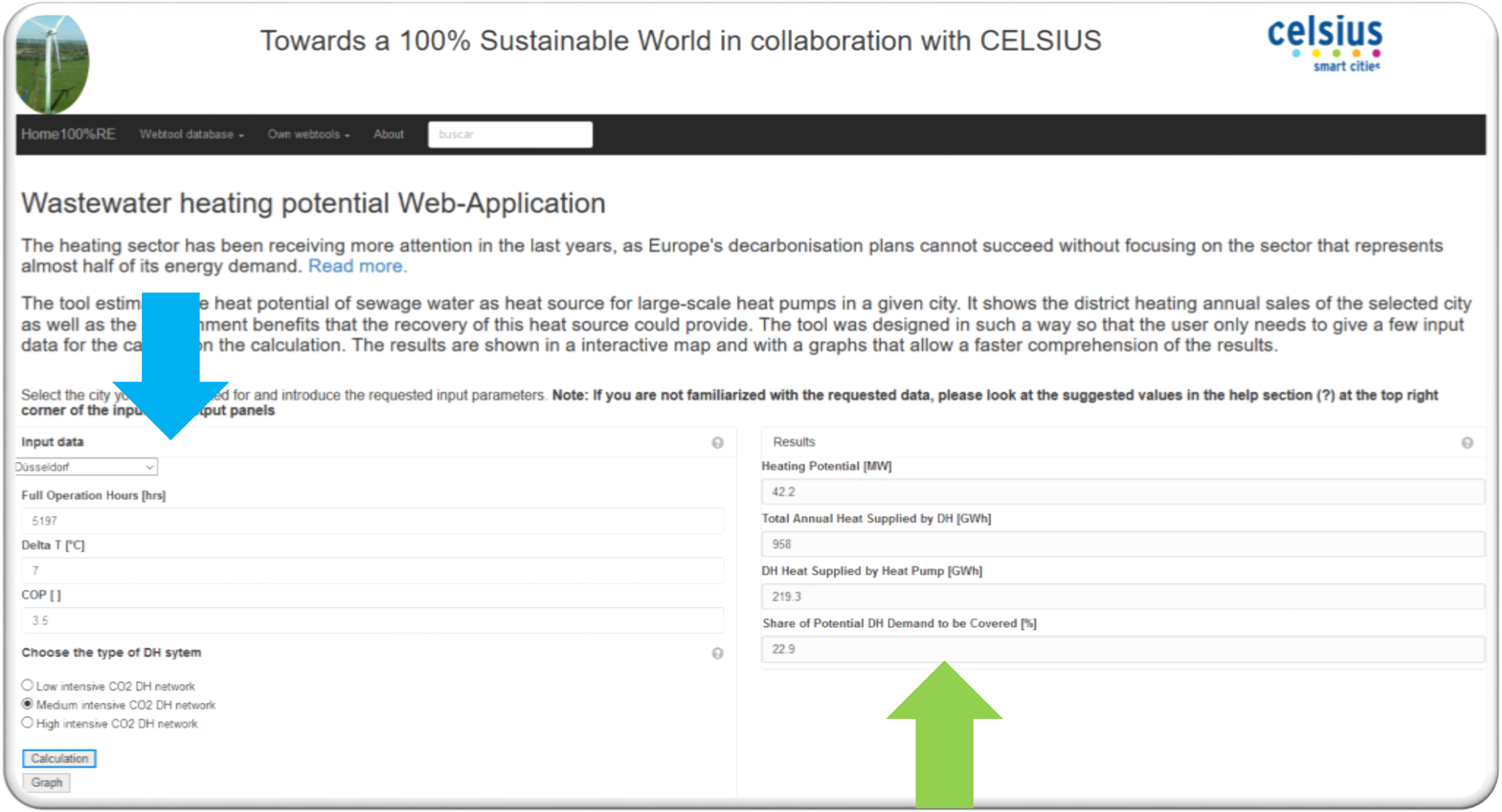

Fig. 18 Wastewater Heating Potential Web-Application Part 1 [10]

Wastewater Heat Potential

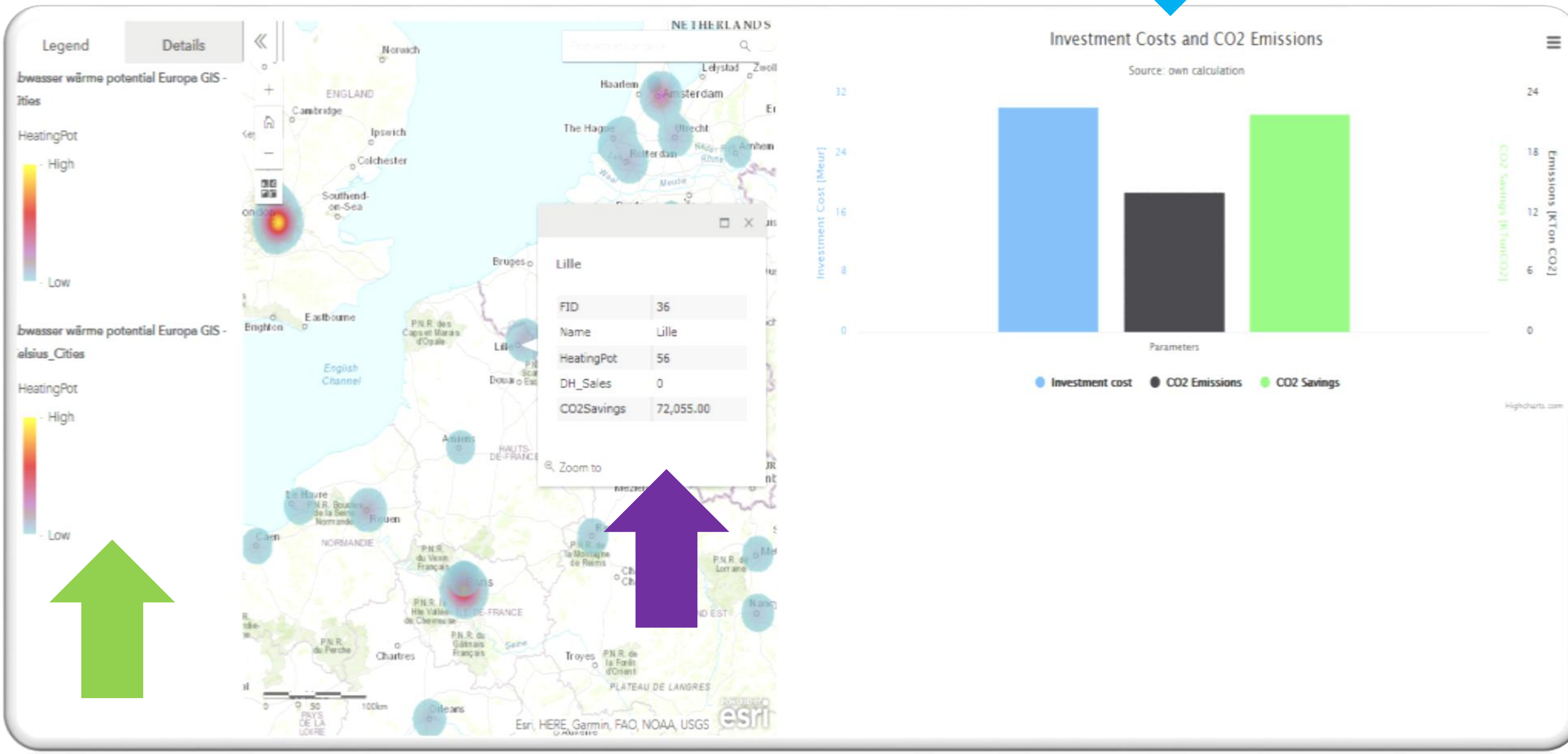

Fig. 7 Wastewater Heating Potential Web-Application Part 2 [10]

Lessons Learned

- **Prioritize objectives** to designe a good control system
- Establish a **good partnership** with stakeholders, lern from other experiences
- Look for **experieced companies**
- **Trust campaings** with clients
- Key **relationship-** City Gov. & drainage utility
- Involvement of local **specialist in WW**

Conclusions

- Significant **heat potential** for DH systems
- The use of wastewater makes sense from the **energy efficiency** and **environmental** point of view
- **Control system** is very important
- Define in a **smart** way the **objectives** of the plant
- We need the right **policies** to support heat pumps

Thank you for your attention!

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