Smart City - Good Practice

## Energy, Public services and infrastructures

District Heating Network & CHP

Rostock, Germany

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european post-carbon
cities of tomorrow

District Heating Network: 60% of households are connected and are ready for renewable energy in the future

The Rostock district heating network now supplies more than 60% of households with heat and hot water [1]. The main energy source is a combined heat and power (CHP) natural gas plant. Since 1994, the waste heat from a bituminous coal power plant is also used. Centrally produced and distributed energy from a district heating network is more efficient and less air-polluting than having single oil-fired furnaces in every household. In 2007, the City of Rostock released a regulation "Fernwärmesatzung", which states that every household has the obligation to connect to the heating network, unless other environmentally friendly heating systems were installed [2]. In 2014, Rostock decided on a climate protection masterplan to reduce its CO_2 emissions by 95%. This includes reaching very ambitious renewable energy targets by 2050. The energy sources for the district heating system will change to renewables as soon as the existing plants need to be replaced [3]. The district heating network is ready for renewable energy.

Country/ City Profile
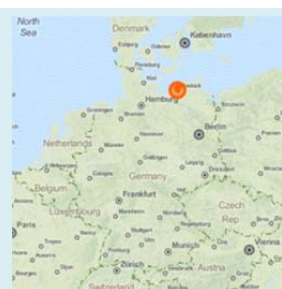
Source: © OpenStreetMap contributors

Country		City	
Population (2013)	80,889,505 [7]	Population (2013)	203,431 [5]
Land area (km²)	357,170 [7]	Land area (km²)	181 [5]
GDP per capita (2014, current international $, at purchasing power parity)	45,802 [8]	GDP per capita (2012, US$, at purchasing power parity)	34,410 [5]
Region	Central Europe	Region	Coastal (Baltic Sea)

City's physical geography	Location	✓ Rostock is a medium-sized city on the north-east coast of Germany (flooding risk, risk of sea level rising) ✓ The city is located in the state Mecklenburg Western-Pomerania within the geographical region of Northern Lowland. ✓ Rostock is situated on the Warnow river, which flows into the Baltic Sea in the northern quarter Warnemünde.
	Climate	✓ Maritime climate (average temperature: 8.4 C°) [5] ✓ The climate is temperate with significant rainfall throughout the year (507 mm/year annual rainfall) [5]

Initiating context

After the Unification of Germany in 1990, the City of Rostock underwent a major social, economic and environmental transition. Rostock shut down the very old and inefficient power plants and built an efficient combined heat and power natural gas-fired plant (CHP) in 1995, which now provides almost all of the city's electricity and feeds heat into the district heating network.

As a city with a Baltic Sea harbour, climate change and adaption is not a new issue; as changing climate conditions and extreme weather events have posed serious threats to Rostock, necessitating the city's response to address these issues. The next big transition will be to transform the city into one focused on climate mitigation and adaptation. In 2014, Rostock went through the process of developing and deciding on a master plan in which they list measures and monitoring tools to reduce the city's CO_2 emissions by 95% by 2050 and to raise energy efficiency by 50% compared to 1990 levels [3]. Further development and expansion of the district heating network and the stepwise change towards renewable sources are part of that master plan.

Project description

Since the district heating network resolution in 2007 [2], every household, except those using environmentally friendly alternative heating systems, is obliged to be connected to the network. This regulation supports the efficiency of the combined heat and power (CHP) natural gas-fired and the other plants. Prices for heat and hot water for the households are comparable to oil-fired central heating [1]. The district heating network is more than 384 km long [1] and is constantly expanding, e.g. Warnemünde in the north of Rostock was recently connected. The target is a connection rate of 80% of households by the year 2050 [3].

The main natural gas fired CHP plant will continue to operate until 2030. Beginning in 2025, renewable energy sources will take over the needed capacity to provide electricity and heating. There are still technological challenges to switch fully to renewable sources, but Rostock is already considering and facing this necessary transition process [3].

Implementation process

The district heating network of Rostock and the combined heat and power (CHP) plant are operated by the local energy provider Stadtwerke Rostock AG, which is economically closely connected with the City of Rostock. They are working closely together to achieve the targets of the climate protection master plan. The city established stakeholder networks (e.g. Energiebündnis Rostock) and institutionalised internal structures into the administration (Amt für Umweltschutz, Klimaschutzleitstelle) to support that transition process [3]. The homeowners are obliged to connect to the district heating network and are financing that process by paying for heating and hot water [2].

Projects implementation details [1,2,3,4]	
Process	The connection to the district heating network is an obligation for all households since the year 2007. The energy sources will change from natural gas, coal and other sources to renewable sources in the coming years.
Financing	The local energy provider established and operates the network and the CHP plant. The households pay for heat and water they consume. Costs for the heat and hot water are comparable to oil-fired centralheating.
Leadership	The city's energy provider (Stadtwerke Rostock AG) operates and expands the district heating network. The city decided on a master plan to reduce CO_2 emissions by 95% by 2050, expand the district heating network and change towards renewable sources.
Involved stakeholders	**Operators** ✓ City of Rostock (Bürgerschaft) (implementing agency) ✓ Local energy provider (Stadtwerke Rostock AG) (company, strongly economically connect to the city of Rostock) **Users** ✓ City residents (private households) ✓ Companies (using heat and hot water through the network).

Map of the district heating network, Rostock 2016
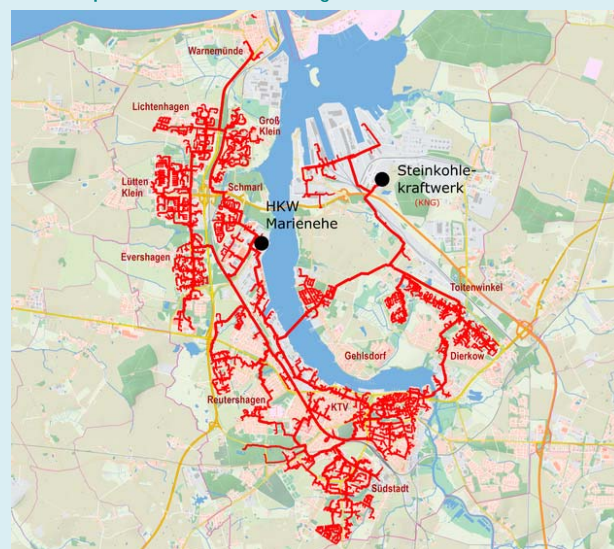
Source: [4]

Note: HKW = natural-gas fired CHP plant; Steinkohlekraftwerk = Bituminous coal fired CHP plant

Results

Within such a big network it is possible to replace thousands of individual oil, gas or electric heating systems in each household. The load management of heat demand and supply can be optimised. Rostock benefits from better air quality in residential zones because district heating is more efficient and the standards and regulations for air pollution are higher compared to household oil heating systems [1]. In 2007, Rostock consumed 631 GWh of heating energy via its district heating network. The network was able to increase its heat supply up to 729 GWh in 2013 [5]. The CO_2 emission intensity of the district heating network of Rostock is 0.136 kt CO_2/GWh while it is 0.300 kt CO_2/GWh for heating oil and natural gas [6]. The energy factor of the district heating network is 55% lower compared to oil and liquefied gas heating. In the year 2013, 120 kt less CO_2 emissions were produced compared to heating with oil and liquefied gas in every single building.

Project benefits (2007-2013) [5,6]

Year	Total energy used by district heating network Rostock (GWh)	Emission factor - district heating network Rostock (kt CO2/GWh)	Emission factor - heating oil and natural gas (kt CO2/GWh)	Emission reduction compared to heating oil and natural gas (kt CO2)	Emission reduction (in %)
2007	631			103	
2008	652			107	
2009	691		0.300 - oil systems	113	-55% - oil systems
2010	803	0.136	0.200 - natrual gas systems	132	-40% - natural gas systems
2011	676			111	
2012	716			117	
2013	729			120	

Rostock decided in its master plan to change the energy sources to renewables in the future. The energy source wood, for example, has an emission factor of 0.035 kt CO_2e/ GWh, if the wood is sustainably harvested and CO_2 emissions are assumed to equal 0, and could reduce CO_2 emissions by an additional 33% (total reduction of 88%) if integrated in fueling the district heating network [6].

Lessons learned

There are opportunities for other cities to build or enlarge district heating networks and transform their energy system towards renewables in the future. Cities may build on their existing networks to further develop and change their heating supply step by step towards renewable sources. The existence of a heating network makes it possible to change the heating source at once for all connected households and purchasers, rather than changing heating systems of households individually. This process is easier if the local energy provider works closely in cooperation with the municipality. The City of Rostock has a strategic climate protection master plan in place to facilitate this transition and works, through workshops and other recurring formats, closely together with all relevant stakeholders (local administration, citizens energy producers, etc.) to achieve this target in the future. The city authorities established different structures (institutional: "Klimaschutzleitstelle", communication activities, programmes, etc.) that support this long-term transition process towards efficient energy use and renewable sources. The city is actively working on the transition process, which will continue over the coming decades.

References

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[7]   World Bank: Data Germany: http://data.worldbank.org/country/germany

[8] World Bank: GDP per capita, PPP: http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD

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