

Open District Heating for Data Centers

International Conference on
Heat Recovery from Data Centers

Kista, January 21. 2015

Erik Rylander, Fortum Värme

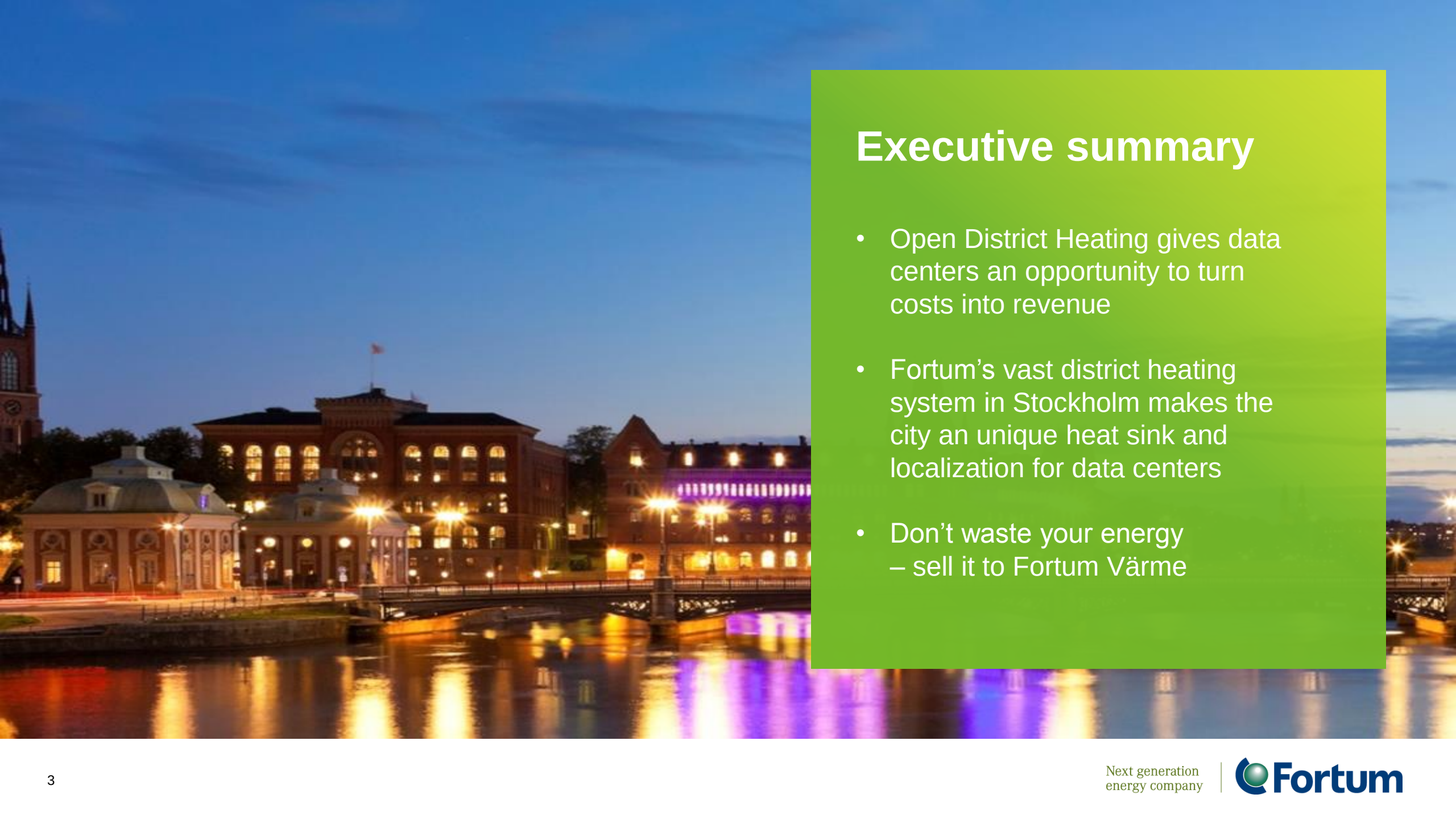
Next generation
energy company





Erik Rylander

Head of Open District Heating at Fortum Värme.



Executive summary

- Open District Heating gives data centers an opportunity to turn costs into revenue
- Fortum's vast district heating system in Stockholm makes the city an unique heat sink and localization for data centers
- Don't waste your energy – sell it to Fortum Värme



Open District Heating a novel market for recovered energy

- Fortum Värme has created a market place for recovered heat and production capacity
- We offer long-term transparent contracts and open prices for trade in excess heat and cooling
- Large as well as small companies and businesses can join the scheme

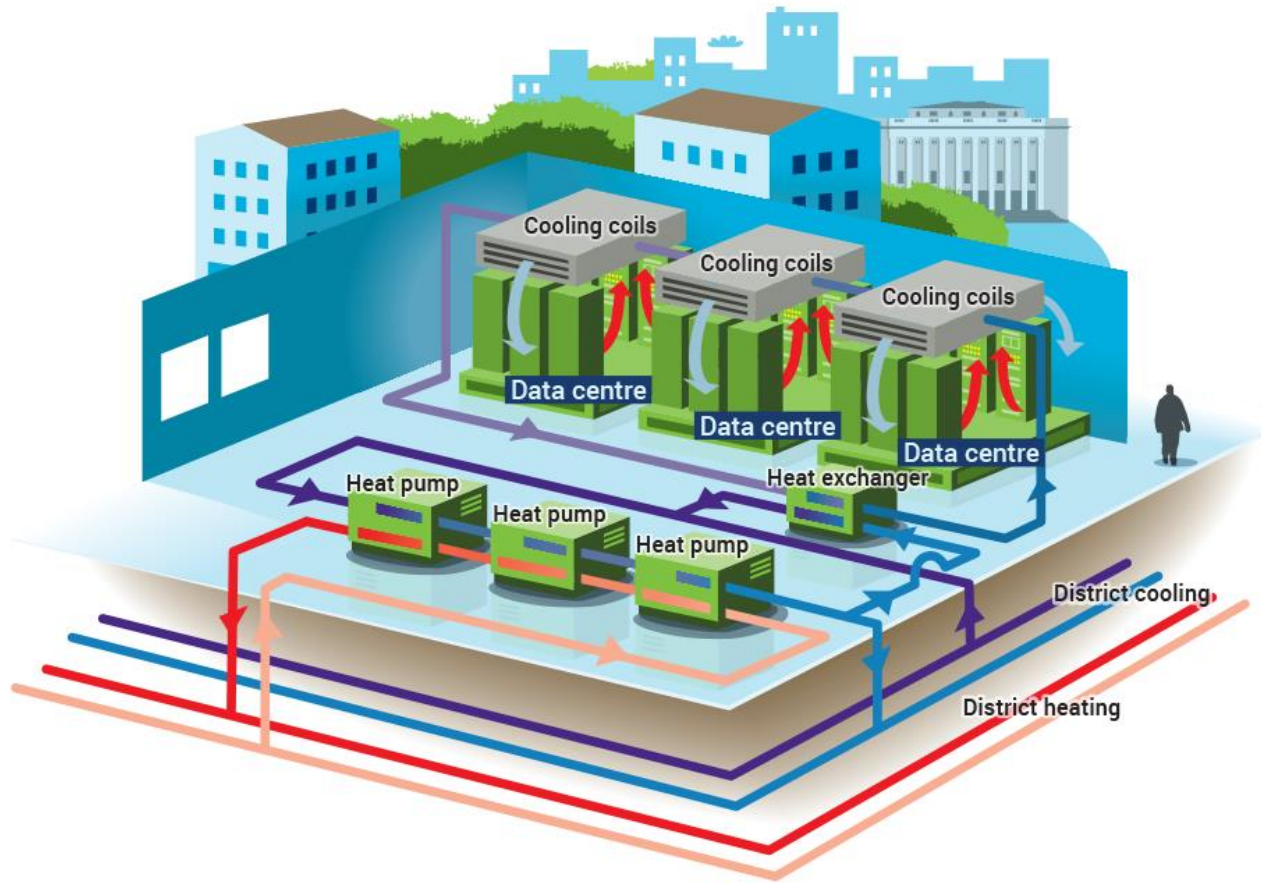


Open District Heating

a novel market for recovered energy

- Trade based on mutual gain
- Watchwords: Business, Scalability, Competition, Openness
- Together we build the next generation's urban energy system

Open District Heating for data centers in short



- Cool the data center with a heat pump
- Supply excess heat to the district heating network
- Supply surplus cooling capacity to the district cooling network
- Long term and transparent contracts, 10 + 5 years
- The data center invests in the heat pump
- Fortum Värme invests in the connection to the distribution system

Opportunities for data centres with Open District Heating

Cost efficient
solution for process
cooling

Improved utilization
of the data center's
cooling system

Create redundancy
in the cooling system for
increased reliability

Finance investment
in new energy efficient
technology

Heat recovery
forms part of sustain-
ability efforts

Open District Heating works

– Pilot projects with Bahnhof in Stockholm

Pionen (pROI 3y)

- Cooling load of ~400kW
- 2 heat pumps installed in series (available cooling capacity is ~800kW)
- Revenue from heat-sales surpassed £30000 in 4 months
- Heat is delivered to the District heating supply line at $>68^{\circ}\text{C}$

S:t Erik (pROI 3.5y)

- Cooling load of ~300kW
- One single heat pump installed (available cooling capacity is ~500kW)
- Heat is delivered either to District heating supply at $>68^{\circ}\text{C}$ or to District heating return at $\Delta 10^{\circ}\text{C}$

Thule (pROI 5y)

- Cooling load of ~1500kW
- 3 heat pumps installed in series
- Heat is delivered at variable temperature to the District heating supply and excess cooling to the District cooling supply

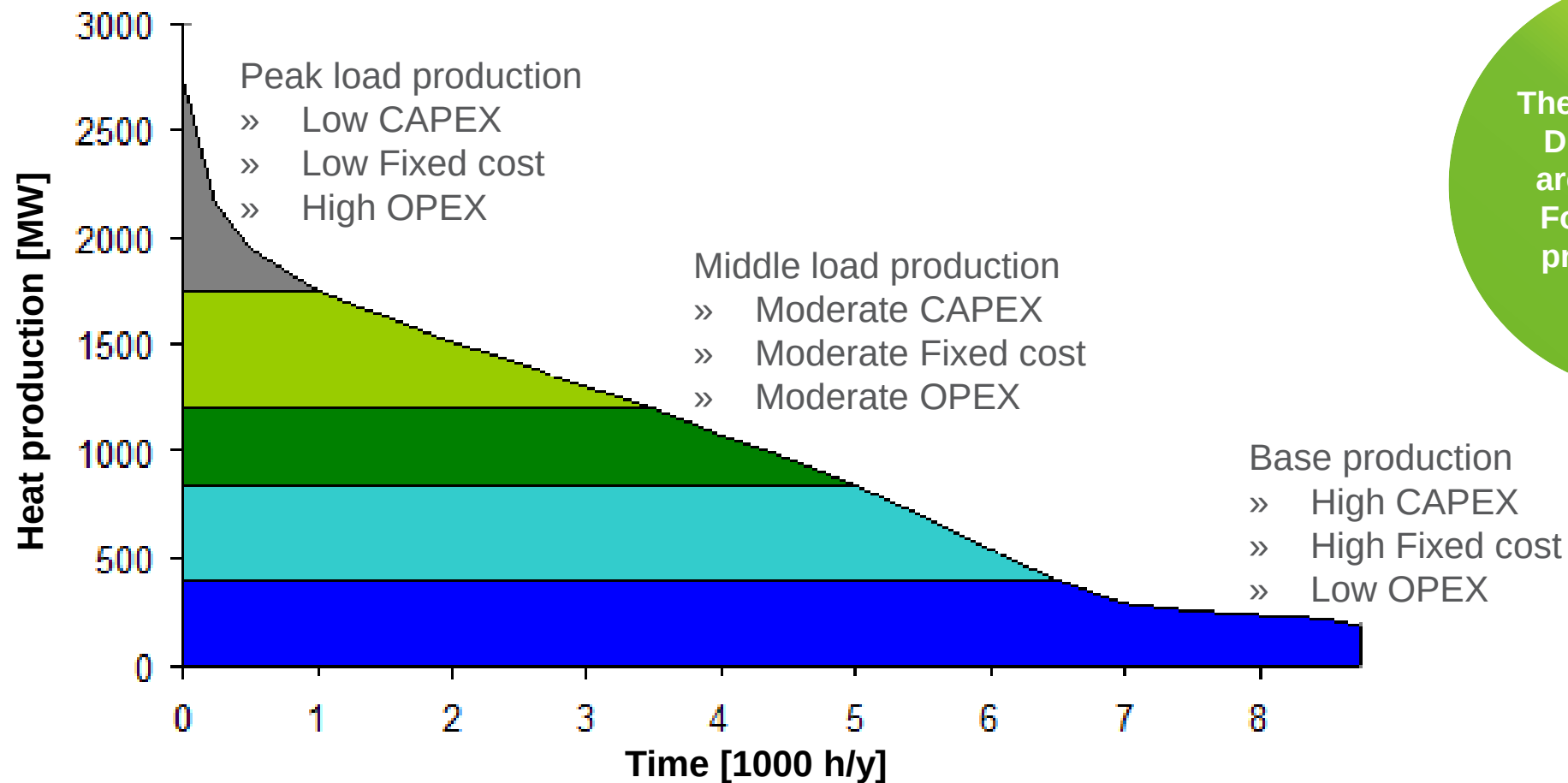


Fortum Värme's district heating and cooling systems in Stockholm



- » The city of Stockholm has a population of 900.000 and the greater metropolitan area a population of 2.2 million
- » Fortum has an annual district heating supply of 8.2 TWh (2013) and a peak load of 3.7 GW
- » Supply of district heating in the greater metropolitan area is 12 TWh p.a. corresponding to 70% of total demand
- » Fortum's district heating network comprises 2800 km of piping
- » Fortum's district cooling network comprises 250 km of piping
- » The business logic of locating a large data center is similar to the location of combined heat and power plants in urban areas

The cost of heat production varies with season



The prices of Open District Heating are set based on Fortum Värme's production cost

The four price models of Open District Heating 2015

ODH Spot and ODH Return

- Hourly price and temperature requirement for the next day published online at 4 PM.
- Option for supplier to deliver
- Compensation based on delivered energy
- Suitable for businesses with varying amount of excess heat

ODH Call and ODC Call

- Hourly call for production incl. price and temperature requirement for the next day published online at 4 PM
- Supplier obliged to deliver contracted output load upon call from Fortum
- Fixed annual compensation based on contracted output load, plus variable compensation for delivered energy.
- Suitable for businesses with constant surpluses of heat or cooling

Open District Heating Prices 2015: Expected Revenue (2020)

Price Model 1 MW Heating	South SEK	South Hours	North SEK	North Hours
ODH Call A	1 374 712	4 172	1 489 560	4 793
ODH Call B	1 433 822	4 492	1 738 996	7 386
ODH Call C	1 433 822	8 760	1 433 822	8 760
ODH Spot	1 553 004	8 760	1 922 381	8 760
ODH Return	629 972	8 760	826 743	8 760

Open District Heating Prices 2015: Compensation and Fees

Contract	ODH Spot	ODH Return	ODH Call	ODC Call
Annual capacity compensation	0 kr/kW	0 kr/kW	A: 603 kr/kW B: 962 kr/kW C: 1434 kr/kW	250 kr/kW
Predicted average energy price (2020):	N: 219 kr/MWh S: 177 kr/MWh	N: 94 kr/MWh S: 72 kr/MWh	A: 185 kr/MWh B: 105 kr/MWh C: 0 kr/MWh	247 kr/MWh
Predicted frequency of bids/calls (2020):	100%	100%	A: 55% N 48% S B: 84% N 51% S C: 100% N 100% S	<5%
Annual fee	550 kr/meter connection pipe	550 kr/meter connection pipe	550 kr/meter connection pipe	750 kr/meter connection pipe

Notes: All prices are real (in 2014 price level), in SEK, excluding VAT, Predicted average prices based on forecasted end user electricity price of 689 kr/MWh, Bids/Calls depends on geography of supplier. N (S) refers to delivery points in Northwest (South/Central).

Next generation
energy company



Open District Heating Prices 2015: Expected Revenue (2020)

Price Model 1 MW Heating	South SEK	South Hours	North SEK	North Hours
ODH Call A	1 374 712	4 172	1 489 560	4 793
ODH Call B	1 433 822	4 492	1 738 996	7 386
ODH Call C	1 433 822	8 760	1 433 822	8 760
ODH Spot	1 553 004	8 760	1 922 381	8 760
ODH Return	629 972	8 760	826 743	8 760

Notes: All prices are real (in 2014 price level), in SEK, excluding VAT, Predicted average prices based on forecasted end user electricity price of 689 kr/MWh, Bids/Calls depends on geography of supplier. N (S) refers to delivery points in Northwest (South/Central).

Next generation
energy company



Coming opportunities for data centers

Process Cooling as a service

- Purchase redundant cooling with heat recovery under long term contract
- Tailor made for data centers
- No investment needed
- To be launched in the spring 2015

Cool Village

- Data center location with redundant and green cooling and/or redundant and green power supply as optional services
- To be developed during 2015

Conclusions

- Open District Heating gives heat from data centers a significant value
- Open District Heating makes Stockholm a prime location for data centers
- Recovering heat from the cooling process with Open District Heating is profitable, sustainable and reliable.

Thank you!

Kista, January 21. 2015

Erik Rylander, Fortum Värme



Next generation
energy company

