



SMART URBAN ENERGY SYSTEMS

Summary of the Final Report

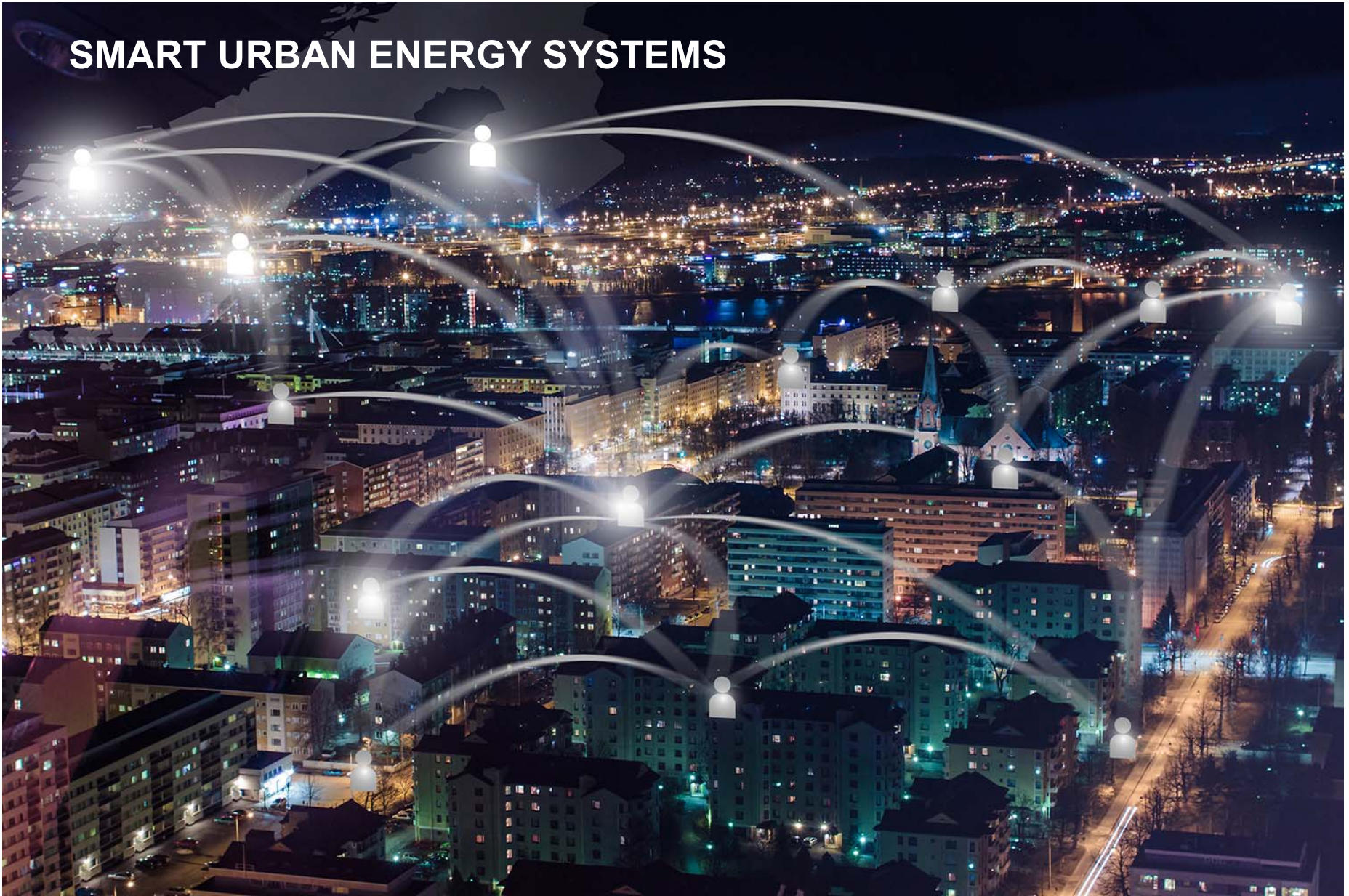


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SMART URBAN ENERGY SYSTEMS



BACKGROUND AND OBJECTIVES

This study presents how urban energy systems can contribute to the flexible energy system of the future

- In the future, different forms of energy, production technologies, distributed generation and demand response should be optimally combined enabling the flexible and cost efficient transition towards emission-free energy systems.
 - Especially the urban energy systems have a significant role in the development as the energy networks in cities enable energy distribution and utilization of storages based on the needs of both consumption and production.
- This study addresses urban energy systems especially from the perspective of district heating and cooling and seeks to identify how the utilization and smart control of these systems could support the whole energy system to meet the future requirements and challenges.
- In addition, one objective of the study is to supplement and support Finnish Smart Grid working group's (nominated by the Ministry of Economic Affairs and Employment) work by offering the perspective of heating networks to the discussions.

RECENT AND FUTURE DEVELOPMENT OF ENERGY SYSTEMS

The increase in intermittent electricity generation and decrease in flexible generation increases the need for flexibility in energy system

- Increasing amount of intermittent and inflexible generation, especially wind power, is one of the challenges for the Nordic energy systems
 - It is estimated that the amount of wind power would double during the 2020s
- Flexible condensing power has already retired to large extent from Finland due to low electricity market prices.
- In addition, several reinvestments for existing CHP plants have been for new heat-only boilers instead of new CHP.
 - This has caused additional challenges for the sufficiency of flexible capacity as well as for peak-load capacity.

SMART URBAN ENERGY SYSTEMS – VISION

“Smart energy systems for cities provides cost-efficient flexibility in transition towards carbon-neutral energy system enabling the customers to choose energy services according to their own preferences easily”

- The vision of smart energy systems until 2030 created during the study focuses especially on the opportunities to utilize district heating and cooling systems to offer flexibility and to increase the integration between different energy systems.



INTEGRATION OF DISTRICT HEATING AND ELECTRICITY SYSTEMS

Production of heat can be easily adjusted based on prevailing market conditions

- District heating systems offer sources of flexibility for the energy system in several ways:
 - During high electricity prices the district heating is produced in CHP plants
 - During low electricity prices heat is produced by heat-only boilers without generation of electricity or with heat pumps by utilizing the cheap electricity prices.
 - This existing source of flexibility is enhanced by district heating storages located usually near CHP plants.
- In addition, CHP production offers additional capacity to the electricity markets especially during periods of peak-demand
 - CHP has a significant impact on sufficiency of capacity.
- CHP can also participate in within hour power balance management through balancing markets.

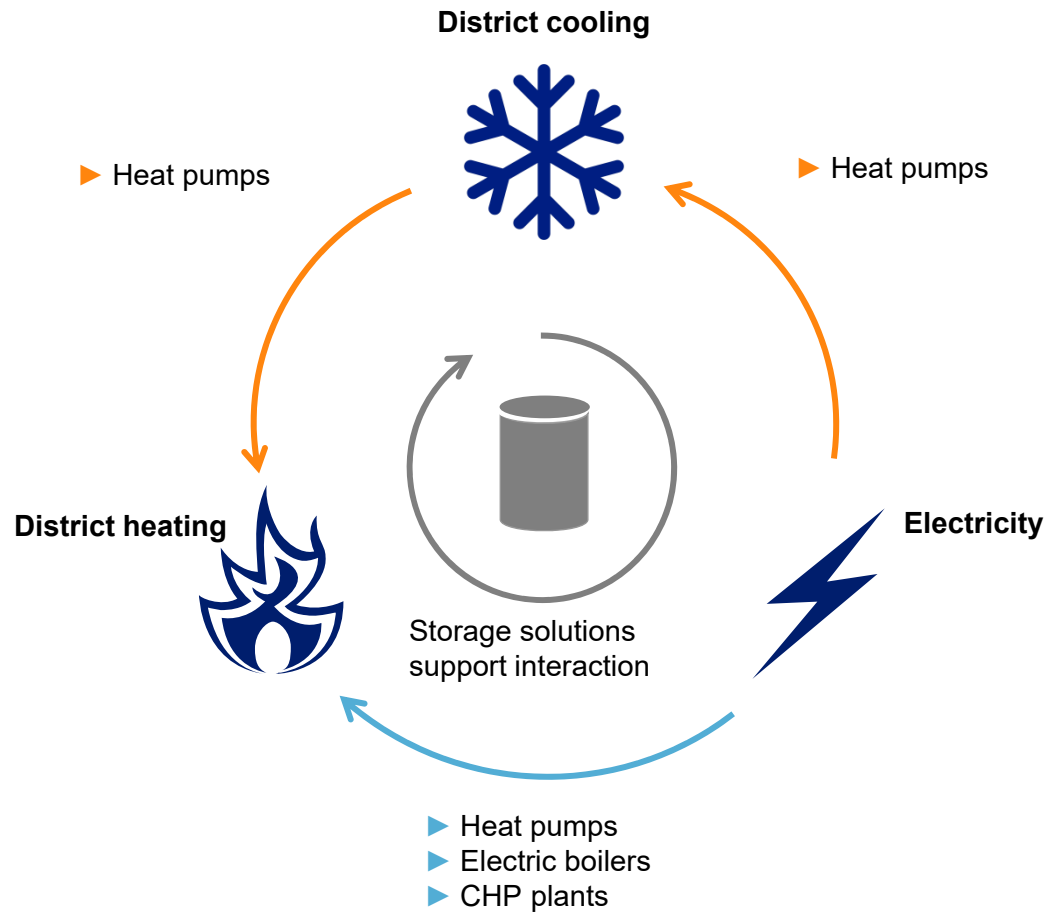
INCREASING THE INTEGRATION BETWEEN ENERGY SYSTEMS

District heating networks will allow fast and flexible deployment of electric boilers, should the electricity price decrease significantly in the future

- The study addressed also possibilities to increase the integration between district heating and electricity systems by utilizing electric boilers. Currently it is not profitable due to the tax treatment of district heating companies.
- According to the simulations conducted in the study, the heat production with electric boilers would become profitable in district heating networks utilizing fossil fuels, if the taxation of electricity used in electric boilers was lowered or removed.
 - Electric boilers would still not be profitable in district heating networks, which use biofuels.
- In order to utilize electric boilers on a large scale, the electricity prices should be close to zero for relatively long periods of time.
 - Curtailment in renewable electricity generation (mainly wind and hydro) could be avoided by increasing the electricity consumption with electric boilers and converting surplus electricity to heat.
 - Even though the probability for large amounts of near-zero electricity prices in Finland remains low in 2020, the district heating network would enable quick deployment of electric boilers in case the electricity prices decrease significantly.

INTERACTION BETWEEN DIFFERENT ENERGY FORMS

Energy storing capability of district heating networks enhances the optimal interaction between different energy forms

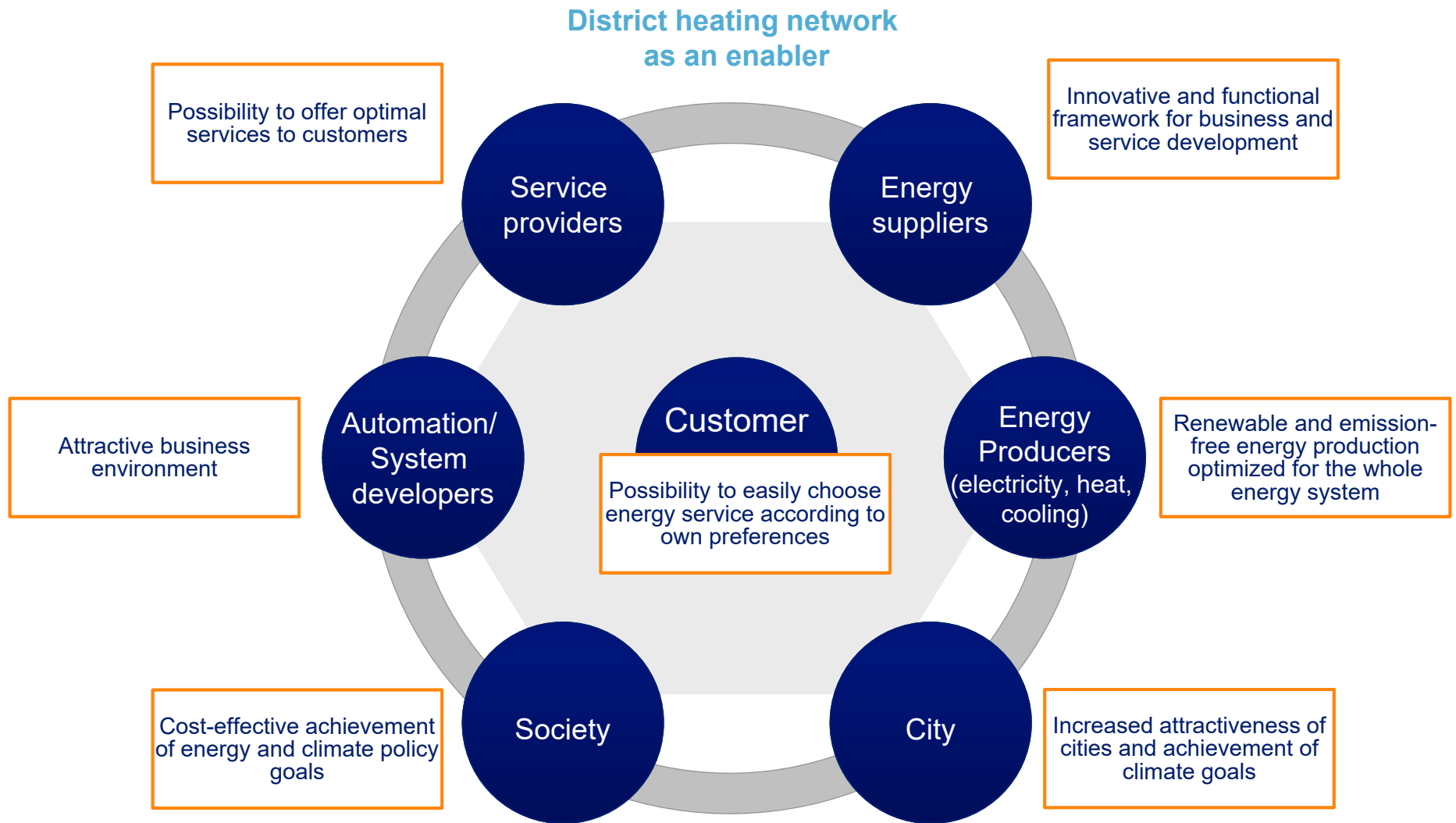


CUSTOMERS' ROLE IN FUTURE ENERGY SYSTEMS

Customers' expectations should be met and their own production utilized for better interaction of market participants

- In addition to increasing the integration and interactions between energy systems, vision of smart energy systems brings the customers' role and diverse service offering into focus
- Also in terms of heating solutions customers expect to be able to choose energy solutions and services individually and effortlessly and based on their own values.
 - One of the key conclusions is that district heating companies should be more active in offering comprehensive services including optimization of living conditions, such as room temperature and humidity, and alternative energy solutions.
- Smart energy control systems and service platforms enable better utilization of, e.g., customers' own energy production and demand-side response, which can support the whole energy system.
 - In case of district heating, this allows improved utilization of existing production capacity which decreases the emissions
 - Optimization of customers' own production together with the production of district heating company has the largest potential in DH networks where natural gas is used

STAKEHOLDERS OF SMART URBAN ENERGY SOLUTIONS

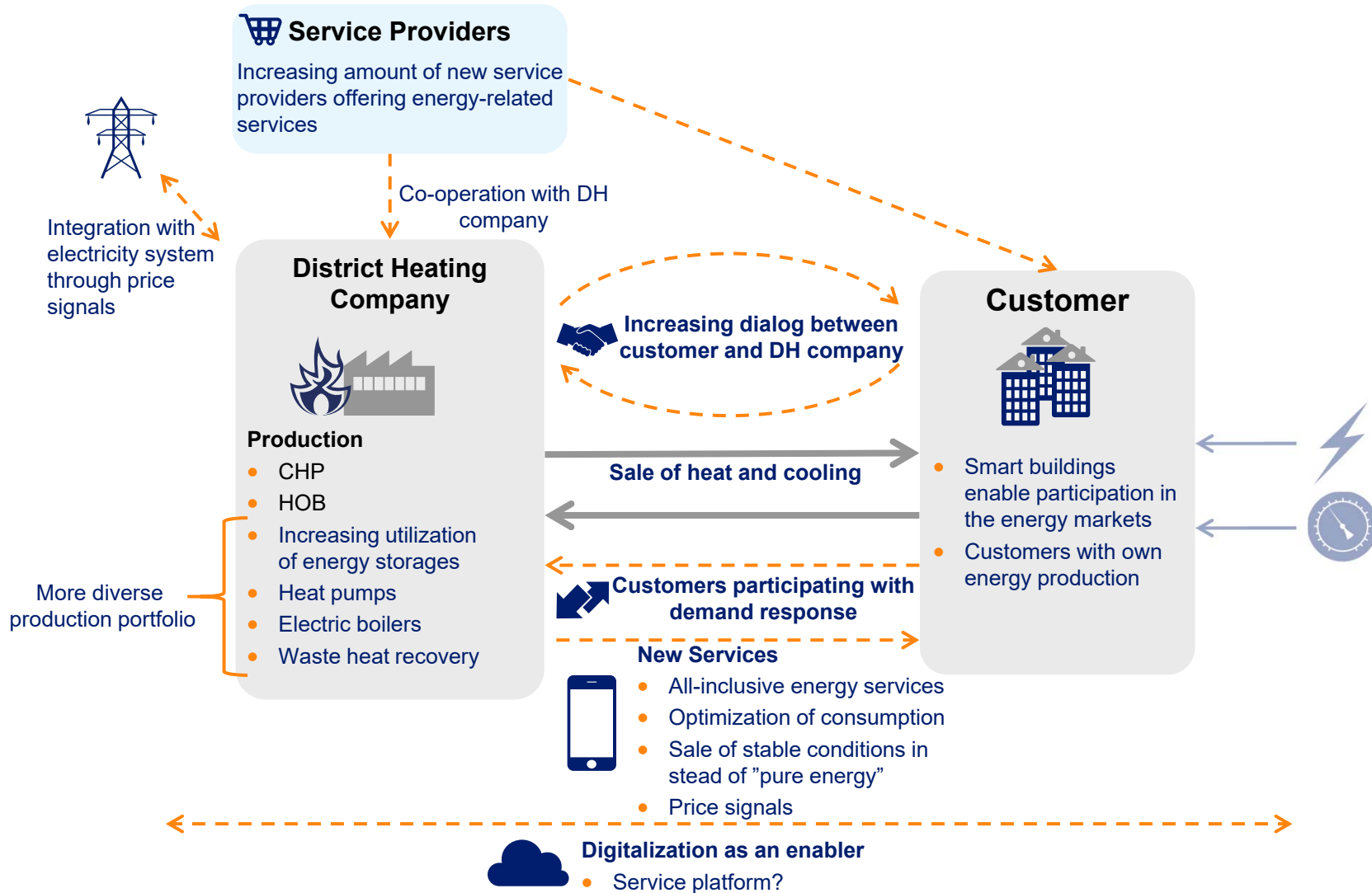


REQUIREMENTS FOR INFORMATION EXCHANGE

Service platforms can be developed as market-based and with small agile steps

- If implemented on large-scale, the more active involvement of customers and the development of partnerships between district heating companies and other service providers sets new requirements for information collection, exchange and storages relating to energy production and consumption.
- In order to implement new service models cost-efficiently, it might be that some kind of harmonization of information exchange is required.
 - It is possible to develop different kind of service platforms for heat sector to meet these requirements.
 - These service platforms can be developed, e.g., as subsystems by different market participants and service providers, in which case these systems can be developed with small agile steps.

SMART URBAN ENERGY SYSTEM





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