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# ***DISTRICT HEATING AS A SOURCE OF FLEXIBILITY IN THE NORDIC ELECTRICITY MARKET***

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## **Overview**

The present share of variable renewable energy (VRE) generation such as wind power and solar photo voltaic is relative high in many of the Nordic countries. E.g. wind power generated 42% of the annual electricity consumption in Denmark in 2015. The share of VRE is expected to increase in the years to come in order to reach the ambitious renewable energy deployment targets in the Nordic and Baltic countries. Transformation to an energy system increasingly based on VRE will escalate the requirement for flexible operation of the entire energy system, including improved integration among energy sectors. District heating (DH) is an important sector in the Nordic energy system and has a large potential for increased flexible operation in relation to the future electricity system. This potential is only partly exploited today. One reason for this is the differences in regulatory framework conditions for DH compared to the electricity market, e.g. different energy taxes, which may hinder the potential benefits from systems integration and lower the realisable potentials.

Despite different national traditions and different technology mixes, the Nordic electricity market is today integrated and regulated by the same EU-defined rules. The situation is completely different for DH. DH is still a locally operated sector, applying different technology mixes and regulated differently by a combination of national and municipal defined rules. To identify drivers and barriers for flexible integration between DH and electricity in the Nordic and Baltic countries, we survey the regulatory framework conditions in Denmark, Estonia, Finland, Latvia, Lithuania Norway and Sweden. The results are evaluated in a comparative manner with regard to their efficiency of ensuring flexibility between DH and electricity. The study is expected to have particular significance for regulators, in regard of alignment between regulation and energy policy goals and needs.

## **Methods**

CHP is presently the technology that offers the best flexibility potential between district heating and the electricity market. In this paper we discuss to which extent this potential is exploited in the Nordic and Baltic countries and if not, which are the explanations/regulatory barriers. Further we look at the future for CHP in the six countries to see whether the potential is threatened or not. Finally, we discuss the prospects of the power-to-heat technologies (large scale heat pumps and electric boilers) for the future DH system and for flexibility. Such technologies are not much used to day but are particularly interesting in a future situation with large amounts of VRE occasionally creating large surpluses of power. Thus power-to-heat technologies can deliver a potential large amount of flexibility if the regulatory barriers do not hinder the future deployment of these technologies.

We have conducted national surveys of regulation frameworks for DH to add flexibility to the electricity sector through review and consultation with key stakeholders. These surveys are used in a comparative analysis in order to identify differences, drives, and barriers in the Nordic and Baltic countries.

## **Results**

Our survey results show that regulation of DH towards integration with the electricity sector has historically been an issue for the heat production-side. We reveal that the choice of technologies for heat generation is mainly driven by outdated policies and tax conditions that create barriers for additional flexibility in the overall energy system. Also energy policy to increase renewable technologies can sometimes as an unintended consequence decrease the flexibility potential offered by DH (see below). CHP is at present generally encouraged by energy policy not because of flexibility but to increase energy efficiency and security of supply. In Denmark, Finland and Sweden investments in water tanks have provided CHP-plant with good opportunities for adapting their production to the power market. There have been strong economic incentives for these investments, which in addition have been encouraged by energy policy. E.g. CHP has since long been encouraged in Denmark by legal means. In Sweden there are some tax incentives for CHP. In the three Baltic countries there is much CHP but the flexibility potential has only been exploited to a very limited extent.

Furthermore, our survey results indicate a potential stagnation in the integration between DH and electricity, due to the current trend of preference for investment in (biomass-based) heat-only boilers and, in some cases, low

income for combined heat and power (CHP) units. The promotion of renewable energy that is taking place in all countries by different policy means such as reduced taxes on biomass, subsidies and restrictions on fossil fuels can have dubious effects on CHP as can be seen in Denmark. It can encourage the choice of biomass boilers instead of gas-fired CHP and thus reduce the flexibility potential. The barriers here are both political (a problematic tax system) and technological as small scale CHP using solid biomass is not economic today.

Power-to-heat technologies that have a large future flexibility potential also face large barriers today mainly due to energy policy. The main cost drivers for these technologies are the energy taxes that with the present level are prohibitive for investing in large heat pumps or electric boilers.

As expected, results among countries vary, but a common result is that operation on the power markets provides the best signal to DH for flexible operation. This may not be a sufficient incentive, since the gains of operating flexible on the power market has not brought sufficient business-economic incentive in all cases, to establish flexible equipment and operational procedures. Improving the business case for investment and operation towards increased flexibility, can take place through levelling the playing field of economic regulation between particularly biomass and electricity, initially through production independent subsidies to decrease investment risk.

## Conclusions

A geographically wide distribution of CHP-plants has made and can continue to make a significant contribution to the flexibility of the energy system, although the benefits from this technology may vary considerably between countries and regions. Other technologies providing good perspectives for increased integration, also in areas where CHP is not so obvious, are electric boilers and heat pumps. However, under the present conditions they face a number of regulatory barriers.

It can be concluded that unless technology costs or market conditions will change to provide sufficient incentive, there is a need for coordinated regulatory measures, in order to maintain and increase the flexible integration of DH and electricity. Specifically, when making new investments, DH-producers have incentives to choose heat-only solutions such as biomass-based boilers, thus implying an increasing decoupling of DH from the electricity system and therefore limit the flexible potentials.

Part of such development is unavoidable - large power plants becoming uneconomic due to increasing wind production causing many hours with low spot market prices. Part of it can be avoided by political action adapting the energy tax system to present day's needs. The adaption of the system of energy taxes to the conditions and political priorities of today is mandatory to enhance the flexibility potential offered by DH but politically very hard to achieve.

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