A GIS-BASED ASSESSMENT OF THE DISTRICT HEATING POTENTIAL IN EUROPE

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Introduction

The efficiency of the fuel use in thermal power stations can be increased by using the excess heat for purposes of district heating (DH) or industrial processes. Given the possible energy savings, the share of combined heat and power (CHP) generation in Europe's electricity supply is expected to rise in the future [1]. According to the International Energy Agency, CHP can also contribute substantially to the balancing of the intermittent generation of renewable energies [2].

This paper presents an assessment of the possible role of DH in Europe until the year 2030. It is based on a newly developed method that allows for the quantification of the country-specific DH potentials for different heat demand levels. The analysis is performed in three steps: (1) an estimation of the overall demand for useful heat in the residential and commercial sector, (2) a consideration of its spatial distribution and (3) an evaluation of the suitability to supply it with DH.

Data and Methodology

The technological and economic potential for DH use in a specific location is primarily defined by the overall heat demand and its distribution. Heat demand is associated to all residential and commercial buildings and influenced by many factors such as population density, outside temperature and building type. Here, it is assumed that only the heat demand in the residential and commercial sector is covered by DH systems – industrial heat demand is thus not included. Furthermore, only the heat demand for space heating and hot water is considered, excluding process heat.

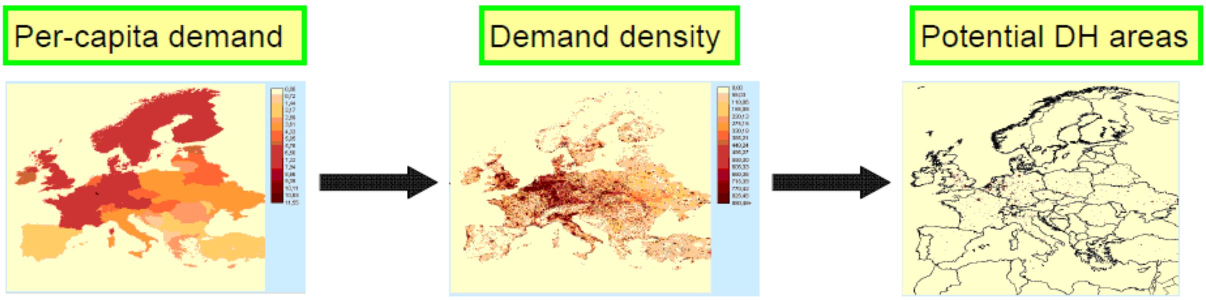

Figure 1: Schematic view of the procedure of the estimation of district heating potentials.

The analysis of the DH potential is conducted in a spatially explicit top-down approach. Using GIS data, the overall heat demand of a country – extracted from national energy balances and scenarios – is distributed according to the population and land use (see scheme in Figure 1). In doing so, the impact of temperature differences within countries is considered, as well as the relatively lower specific demands in densely populated areas. Due to the high capital cost of the distribution network, the heat demand density is the crucial parameter for the economic viability of DH systems. The areas suitable for DH are thus defined by the application of a minimum heat demand density threshold. As no universally valid lower limit can be defined, a sensitivity analysis is conducted by considering different threshold values.

A significant share of the specific costs of district heat arises from the investment in the pipe network. Specific distribution costs can be calculated as the ratio of the overall investment costs and the heat sold. Whereas the amount of heat can be easily obtained from the demand density in the respective area, the determination of investment costs is much more complex. Given that for this study no information on the building structure of settlements and country-specific installation costs was available, a simplified method for the rating of heat demand agglomerations is used. It is based on the experience that installation costs are generally higher in densely populated areas [3].

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In order to not only estimate the potential for DH but also the primary energy input and electricity output of the corresponding heat generation technologies, a closer look on the supply side is necessary. Thus, a CHP unit and a peak boiler are attributed to each agglomeration. The size and technical characteristics of both units are defined by the total heat demand and the base load share of the agglomeration.

Results and Conclusion

The analysis reveals that potentials for an extension of DH exist in most European countries. Their extent depends on a variety of factors such as the current use of DH, the per capita heat demand and the demand density threshold applied (see Figure 2, left). The countries with the greatest potentials in absolute numbers are Germany, France, Belgium, the Netherlands and the United Kingdom. Given their high degree of urbanization, DH could supply up to almost 50 % of the demand for useful energy for space heating and hot water generation in those countries. With regard to more radical energy efficiency policies in the building sector it is shown that even for a heat demand reduction rate of 2 % per year, a significant potential for DH remains.

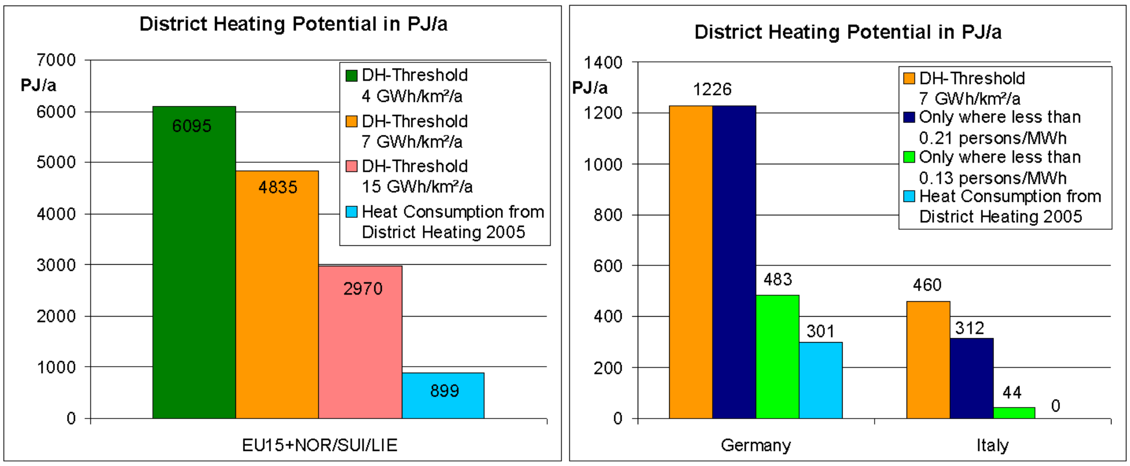

Figure 2: DH Potentials in the EU15, Norway, Switzerland and Liechtenstein for different demand density thresholds and in comparison to the current DH use (left).
Potential in Germany and Italy considering different maximum population numbers per heat unit (right).

With the method used, also in southern Europe significant DH potentials are identified. In contrast to central Europe, they are however almost only found in major cities with sufficiently high population densities. Whether their exploitation is economically feasible does strongly depend on the installation costs for the DH network. Excluding the potentials found in areas with low per capita heat demand and high population density, only a small share of the original value remains (see Figure 2, right). For some countries in northern and eastern Europe, the potentials found are smaller than the heat currently supplied from DH, according to the statistics. The reasons for this discrepancy are identified and related to the characteristics of the method and uncertainty in the input data.

Considering the vast potentials for DH identified in this paper, an extension of the CHP use in Europe appears feasible. The specific advantages of efficiency and flexibility – especially provided by the additional installation of thermal storages – give CHP an important role in Europe's future energy system.

References

[1] European Commission Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG: *EU Energy trends to 2030 – 2009 Update*; Publications Office of the European Union, Luxembourg, 2010, ISBN 978-92-79-16191-9.
[2] IEA: Cogeneration and Renewables - Solutions for a low-carbon energy future; OECD/ IEA, 2011, http://www.iea.org/papers/2011/CHP_Renewables.pdf (accessed 11.01.2012).
[3] Persson, Werner: *Heat distribution and the future competitiveness of district heating;* Applied Energy, 88, 568–576, 2011.