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What is the impact of the policy framework on the future of district heating in Eastern European countries? The case of Brasov

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A B S T R A C T

District heating in general is seen as an important opportunity to decarbonise the heating sector especially in urban areas and therefore important to reach European and global climate goals. In this case study we analyse possible future scenarios for the city of Brasov, Romania. Like in many other cities in Eastern Europe a district heating system exists in the city, however, facing severe challenges like old and inefficient infrastructure and loss of consumers due to unreliability of supply over the last decades. This work assesses the impact of different policies on the feasibility of renewable and efficient heating under various conditions and suggests favourable policy frameworks to ensure an economically and ecologically viable future heating system for the city.

1. Introduction

Decarbonising the heating sector is essential to reach the climate goals agreed on at COP 21 in 2015. In this context, district heating (DH) is an important decarbonisation option especially in urban areas, where it is often the only possible option to integrate large shares of renewable and/or excess heat into the heating sector [1–3]. In many Eastern European cities DH systems exist, however, at the moment not providing efficient and renewable heat supply. These systems typically were installed in the communist era, without relevant re-investments since that time. They often still have installed old supply technologies and are based on fossil fuels. High losses due to overdimensioned and old infrastructure and outdated technology make these DH systems economically unfeasible and lead to unreliable supply. At the same time in many areas where DH networks were placed also a gas grid was placed. This led to disconnection of many customers, further increasing the inefficiency of these systems [3–6].

The aim of this work was to a) identify technical solutions for increasing the efficiency and the share of renewable energy in the heating systems of the city of Brasov at minimal costs, and b) assess the effect of various policies to enforce the use of renewable energy in the heating system. Based on the results for the city of Brasov conclusions should be drawn also for other Eastern European countries in similar situations.

2. Method

The assessment performed in this paper is based on the case study of the municipality of Brasov with around 275 thousand inhabitants and 1760 inhabitants per km^2 on average. The city is located in the centre of Romania with 3413 heating degree days. The existing DH system is supplied by heat from an external producer in combined heat and power (CHP) engines as well as heat only boilers all fuelled with natural gas, and in the distribution system currently more than half of the inserted heat is lost before reaching the consumers.

2.1. Modelling framework

The modelling framework to analyse the defined research question combines different tools and approaches: (1) The existing DH system and possible alternative supply portfolios for the future of the DH system until 2030 were modelled in energyPRO [7] to calculate the DH generation costs, CO_2 emissions and fuel use and also to obtain the sensitivity of the costs to disconnection or additional customers based on optimal dispatch of the supply portfolio. (2) The costs and potentials for decreasing thermal losses

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through the building envelope in existing buildings (heat savings) of the city until 2030 were calculated, hereby distinguishing ten typical building types with three different construction periods[1] and eight renovation levels for each of these buildings with the Invert/EE-Lab model [8,9]. (3) Costs for the supply of heat with five different individual heating technologies were calculated for the same building types, construction periods and renovation levels. (4) The municipality was divided into four different types of areas according to resulting costs of connecting buildings to the existing DH system: a) The so-called "DH area" is the area of the currently existing distribution network including the zone of 50 m distance to this network. In this area it is assumed that additional buildings can be connected to DH without further expansion of network but by investing only in connecting pipes and heat exchangers. b) The so called "next-to-DH area" is the area within 1000 m of the current transport network that is not within the "DH area". In this area it is assumed that further buildings can be connected by investing in an additional distribution network plus connecting pipes and heat exchangers. c) The "individual area" is defined as the area outside the "next-to-DH areas" that is not sharing a border with the existing DH area. For buildings located in these areas, it is necessary to invest in transmission pipes, distribution pipes, connecting pipes and heat exchangers to be able to connect to DH. d) Scattered buildings, which are spread across the municipality and not close enough to other buildings, are not considered to be possibly connected to the DH system. (5) For all building classes and all areas within the municipality the cheapest combination of heat savings and heat supply was calculated for different technical scenarios and policy settings. For all combinations of technical scenarios and policy settings total system costs, total CO_2 emissions, energy demand for space heating and hot water preparation, share of renewable energy and share of DH were calculated. The total system costs hereby include the investment costs in supply technologies, DH network infrastructure and heat saving measures, the operation and maintenance costs for supply technologies and the DH network as well as the fuel costs. Used investment and energy costs are stated in the Annex of this paper.

2.2. Technical scenarios

Two technical scenarios of the future DH system were considered in the analysis: the reference scenario represents the continuation of the current DH system where heat is mainly purchased from an external heat producer and also in own natural gas heat only boilers, however, re-investments into the existing network infrastructure are included to reduce the currently high network losses to 20%. The alternative scenario additionally includes investments into renewable heat supply options for the DH system including a 0.5 MW biomass boiler, a 3 MW_{el} heat pump and 2000 m^2 of solar thermal collectors.

2.3. Policy settings

Table 1 describes the status quo, the assessed standalone policies and the combination of these policies in the policy package. All of them had been discussed with local and national stakeholders from Brasov and Romania and were considered as interesting to analyse. In a first step each policy was assessed as a standalone policy for both technical scenarios ("Reference" & "Alternative"). In a second step it was assumed that all investments into the DH system are made by a public service following a long term investment horizon without additional profit and therefore assuring the "Long Term Loan" policy. Under this condition again the combination with all other policies was investigated ("Public Reference" & "Public Alternative"). As last step the effect of a "Policy Package" including the most promising policies was assessed.

3. Results

Fig. 1 shows the least cost combination of heat savings and heat supply for the different technical scenarios and policy settings compared with the status quo. It can be seen that a reduction of the total heat demand of around 250 GWh (18%) can be achieved in all scenarios. This demand reduction results mostly from the cost-effective heat savings in buildings until 2030 and not from the assessed policies, which do not directly target a heat demand reduction.

Without any policy, the DH system would only have a share of 1.5% of the overall heat demand in both the reference and the alternative scenario assuming that all consumers apply the cost optimal combination of heat savings and heating supply for their building. According to this assumption most detached single family houses would switch to air source heat pumps after renovation resulting in almost 16% of the demand supplied by this technology. Other single family houses and row houses would switch to individual biomass boilers as the cheapest option after renovation, resulting in more than 9% of the heat demand supplied by biomass. Restrictions like the availability of biomass or consumer preferences are not reflected in the modelling framework but probably would inhibit the expansion of biomass resulting in more natural gas boilers.

Comparing the different standalone policies for the two technical scenarios it can be seen that most of the assessed policies alone do not affect the results regarding the cheapest heat supply combination. Only a high CO_2 tax on fossil fuels of 130 €/t would increase the cost for natural gas to an extent so that individual heat pumps become cost effective in more buildings and that DH would become competitive for most of the larger buildings within the "DH area", where no additional network has to be built. As another policy, the regulatory measure of forbidding natural gas boilers in designated "DH areas" would also enforce most of the buildings within this area to switch to DH leading to a DH share of almost 18%.

In the "Public Alternative" setting, where long term loans by a public service are available to finance investments in DH, higher RES and DH shares can be achieved with not too strong additional policies like an additional CO_2 tax of 31.5 EUR/t or investment subsidies for RES in DH. Alternatively banning natural gas from the DH area allows reaching similar shares.

The "Policy Package" setting allows reaching the highest share of RES for heating without very high CO_2 taxes and without the strong regulative measure of forbidding natural gas within the "DH area". Therefore combining different policies lead to similar shares of RES and DH without overstressing single measures.

The results show that from a climate policy point of view it only makes sense to force increased shares of DH when the DH system is transformed to include higher shares of RES ("Alternative" & "Public Alternative"). When DH is forced in by zoning and the prohibition of gas but the DH system stays with the fossil reference supply there is no positive effect on the CO_2 emissions.

4. Discussion

Although the proposed approach is not capable to fully reflect the real behaviour of all actors, and certain barriers like comfort or consumer preferences couldn't be integrated in the modelling

[1] Buildings of a certain type with a certain construction period are further on called building of a certain building class.

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