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Abstract

District heating in general is seen as an important technology to decarbonise the heating sector especially in urban areas and therefore important to reach the climate goals agreed on COP 21 meeting held in Paris. This case study is based on the city of Brasov facing severe challenges with their existing district heating system, like many other cities in Romania and Eastern Europe do. This work assesses the impact of different policies on the feasibility of district heating under these conditions and suggests favourable policy frameworks to ensure an economically and ecologically viable district heating system. The results show that with a mix of different policies district heating can be made attractive again in Eastern European Regions and contribute to a renewable heating sector.

Keywords: District heating; heat savings and supply; policy assessment; Eastern Europe; Romania

Highlights

- Decarbonisation of the heating sector to reach COP 21 goals
- Least cost combination of heat savings and heat supply by individual heating technologies or district heating
- Favourable policy framework for district heating in Eastern European Countries

1 Introduction

Decarbonising the heating sector is essential to reach the climate goals agreed on COP 21 meeting held in Paris and therefore district heating (DH) is seen as an important technology to decarbonise the heat sector especially in urban areas [1-3]. In many Eastern European cities DH-Systems are already in place. However, they face a number of challenges: These systems typically were installed in the communist era, without relevant re-investments since that time. Thus, they often still have installed old supply technology and are based on fossil fuels and therefore are not suitable to reach the desired level of decarbonisation. High losses due to overdimensioned infrastructure and outdated technology make many DH-Systems economically unfeasible and lead to unsecure supply. The association with communism and the lack of confidence ends up in further disconnection of customers. Many cities with a DH-System in Eastern Europe face these problems [3-6]. The aim of this work is to find economically and ecologically sound solutions for the heat supply under these difficult conditions and to identify how local and national policy frameworks can be improved to realise such solutions.

2 Method

The assessment performed in this paper is based on the case study of the municipality of Brasov, located in the centre of Romania, representative for different cities in Romania and Eastern Europe facing similar problems with their existing district heating system.

2.1 Modelling framework

The modelling framework to analyse the research question combines different tools: (1) As a first step, the existing district heating system and possible alternative supply portfolios for the future of the district heating system until 2030 were modelled in energyPRO [7] to obtain the district heating generation costs and related parameters and also to obtain the sensitivity of the costs to disconnection or additional customers. (2) As a second step, costs and potentials for decreasing thermal losses through the building envelope (heat savings) until 2030 were calculated for ten different building types with three different construction periods and for eight different renovation levels with the Invert/EE-Lab model [8,9]. (3) As a third step costs for supply of heat with five different individual heating technologies are calculated for the same building types. (4) In a fourth step the municipality was divided into four different types of areas according to the availability of a current district heating network or the feasibility and costs of expanding the network into adjacent areas. The so-called district heating area is the area within 50 m of the current distribution network. In this area it is assumed that additional buildings can be connected to district heating without further expansion of network but by investing only in connecting pipes and heat exchangers. The so called next-to-district heating area is the area within 1 000 m of the current transport network. In this area it is assumed that further buildings can be connected by additionally investing into the current distribution network. The individual area is defined as the area outside the next-to-DH areas and is not supplied by district heating and is not sharing a border

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with existing district heating 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 district heating. The expansion of district heating to scattered buildings which are spread across the municipality and are not close enough to other buildings is not considered to be an alternative. (5) As a last step, for all building classes and all areas within the municipality the cheapest combination of heat savings achieved with by the respective renovation level and heat supply with district heating or individual technologies is calculated. This is done for a reference scenario representing the continuation of the current district heating system and for a technical alternative scenario depicting a desirable future regarding the heat supply portfolio of the district heating system. Whereas in the reference scenario only investments into the network infrastructure are made to reduce the currently very high network losses, in the alternative scenario additionally investments into renewable heat supply technologies are foreseen. For both, the reference and for the alternative scenario different indicators like total system costs, total CO_2 emissions, share of renewables etc. are calculated for different individual and combined policies and their impact on these indicators is assessed.

2.2 Policies

Table 1 lists and describes the assessed policies and the policy package. All of them were discussed with local and national stakeholders from Brasov and Romania and were considered as interesting to investigate. In a first step each policy is assessed as a single policy for both the reference and the alternative scenario. In a second step it is assumed that all investments into the district heating 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 is investigated. And as a last step the effect of a policy package including the most promising policies is assessed.

Table 1 Assessed policies

Policy Name	Description
Long Term Loans	This policy instrument ensures low interest rates of 1.5% and long depreciation times of 40 years for investments made into district heating infrastructure.
CO2 Tax	This policy instrument reflects the implementation of a tax on CO2-Emissions caused by burning fossil fuels in individual heating technologies. Two different price levels are investigated: (1) The same CO_2 price per ton as it is expected in the EU Reference Scenario for 2030 for the CO_2-certificates market (31.5 €/t) and (2) a price level that is needed to reach an impact with CO_2 tax as a standalone policy.
DH connection Subsidy	This policy instrument supports the connection of buildings to the district heating network by covering the connection costs to the network.
RES DH Subsidy	This policy reflects investment subsidies of up to 45% of eligible costs for investments into renewable heating technologies in district heating systems. The maximum value for a project cannot exceed 15 Mio Euro.
Zoning / forbid Gas	This policy reflects the obligation of having a GIS based heat planning resulting in different zones for certain energy carriers to avoid double infrastructure and ensure a high connection to district heating by not allowing individual gas boilers within the designated district heating area.
Policy Package	The policy package includes long term loans for investments into district heating infrastructure together with subsidies for RES DH technologies and a CO_2 tax of 35 €/t.

3 Results

Figure 1 shows the results on the least cost combination of heat savings and heat supply for the different policy scenarios compared against 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 comes mostly from the achievable heat savings due to building refurbishment until 2030 and not from the assessed policies as they do not directly target the heat demand.

Without any policy, the currently inefficient district heating system would decrease its share to 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 technology 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 boiler as the cheapest option after renovation, resulting in more than 9% of the heating 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 up to this share resulting in more natural gas boilers.

Comparing the different single policies for the reference and for the alternative scenario 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 get cost effective in more buildings and that district heating would get competitive for most of the bigger buildings within the district heating area where no additional network has to be built. As another policy, the regulatory measure of forbidding natural gas boilers in designated district heating areas would also enforce most of the buildings within this area to switch to district heating leading to a district heating share of almost 18%.

In the Public Alternative scenario where long term loans by a public service are available to finance investments in district heating, better results regarding the supply structure can be reached with not too strong additional policies like an additional CO_2 Tax of 31.5 EUR/t or investment subsidies for RES technologies in district heating. Alternatively banning natural gas from the district heating area allows reaching similar shares. The "policy package scenario" allows reaching the highest share of renewables for heating without very high CO_2 taxes and without strong regulative measure of forbidding natural gas within the district heating area. Therefore combining different policies lead to good results without overstressing one single measure.

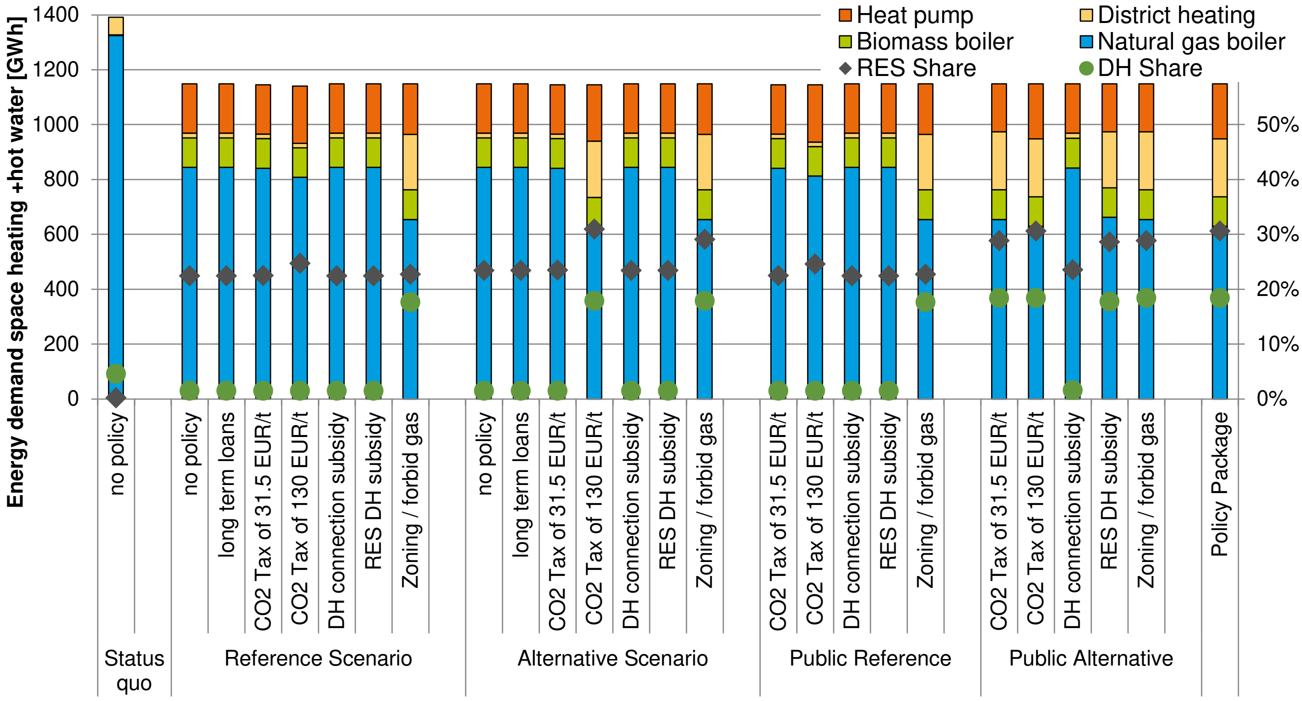

Figure 1 Results of the policies on energy demand for space heating and hot water, RES share and DH share in the status quo and in various scenarios up to 2030

Comparing the reference and the alternative scenarios, it can be stated that increasing the share of district heating only makes sense from a climate policy point of view when the district heating system is transformed into a renewable direction. When district heating is forced in by zoning and the prohibition of gas but the district heating system stays with the fossil reference supply system there is no positive climate mitigation impact.

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 framework, the impact of different policies on decisions based on a least-cost-approach could be assessed. The assessment showed that single policies are not enough to tackle all problems district heating networks in Eastern European Countries face. Rather it is necessary to combine different policies to ensure a modernization of these systems and to bring back confidence and the required consumers. On the one hand it is crucial to trigger new investments into the outdated network infrastructure and into renewable supply technologies and on the other hand it is essential for the feasibility of a district heating network to share the infrastructure costs amongst as many customers as possible. The former can be reached by guaranteeing a long term investment planning horizon and low rates of return by giving long term loans from a public fund to a private operating company or by guaranteeing an ownership structure that allows investment calculation under these conditions: This could be a public service or a consumer owned cooperative both operating without profit and following a long term planning horizon. And the latter can be either reached by making district heating economically more attractive compared to fossil technologies with connection subsidies or taxes on fossil fuels, or by a stronger planning approach in terms of strategic local and regional heat planning defining zones where certain supply technologies are preferred.

5 Conclusion

Many district heating systems in Eastern Europe face huge problems due to historic reasons and the lack of investments in the past decades leading to now inefficient and outdated networks. Identifying district heating as an important means to reduce CO_2 emissions especially in urban areas, policy frameworks should be adapted to enable economical end ecological feasible district heating systems.

With a modelling framework calculating the least cost combination of heat savings and supply with individual heating technologies or with district heating for 30 different building classes located in four different areas according to their location to an existing district heating network, the ability of different policies was assessed to generate favourable conditions for district heating.

Five different policy measures were assessed one at a time, as a combination of two policies and as a policy package including the most promising policies for a technological reference scenario and a technological alternative scenario. In the reference scenario it is assumed that the current supply situation is maintained and only investments into the network infrastructure are made whereas in the alternative scenario different renewable supply technologies will be integrated into the district heating system.

The assessment showed that single policies are hardly able to generate a favourable policy framework for economic and ecological efficient district heating but integrated policy packages have to be implemented. The policies should tackle different aspects: Guarantee a long term planning horizon, trigger new investments into the outdated network infrastructure and into renewable supply technologies, make district heating more attractive compared to fossil alternatives and generate enough customers to share the infrastructure costs.

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