ARTICLE IN PRESS

Utilities Policy xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Utilities Policy

journal homepage: www.elsevier.com/locate/jup

Policy incentives for flexible district heating in the Baltic countries

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ARTICLE INFO

Keywords:
District heating
Flexibility
Energy policy

ABSTRACT

This study analyzes the impacts of taxes, subsidies, and electricity transmission and distribution tariffs and heat storage on the operation and economic feasibility of district heating plants with different flexibility potentials in the Baltic countries. Under 2016 conditions, the lowest levelized cost of heat is achieved by a combination of wood chip boilers, electric boilers, and heat storage. Heat storage enables a higher utilization of least-cost technologies, resulting in greater cost efficiency for all considered scenarios. Current taxes and subsidies are found to have limited impact on the operation of combined heat and power plants and electric boilers.

1. Introduction

The renewable shares of 2014 total final energy consumption in Estonia, Latvia, and Lithuania were 25, 40 and 28%, respectively. These shares have increased steadily since the dissolution of the Soviet Union in 1991, when they were 3, 18, and 3% (The World Bank, 2017). The renewable share in Baltic district heating (DH[1]) systems is already significant: In 2015, biofuels represented 43, 37, and 59% of DH in Estonia, Latvia, and Lithuania, respectively, most of which was solid biomass (IEA, 2017). Heat-only boilers and combined heat and power (CHP) options, which use biomass as their only fuel source, are, therefore, currently common in the Baltic countries. In addition to biomass, the main fuels used in DH are natural gas and waste (Sneum et al., 2016). In 2015, the three Baltic countries managed a combined net export of more than four million tons of fuelwood (Eurostat, 2017), indicating strong potential for regional biomass development. The renewable share in the Baltic energy systems is expected to increase further, as energy and climate policy indicate a general future increase in renewable energy across the EU member states to achieve compliance with national action plans for the 20-20-20 targets (e.g., the Latvian Guidelines of Energy Development for 2016–2020 (Likumi, 2016)), and the proposed EU 2030 targets (European Commission, 2014). Assuming that a proportion of this increased share of renewable energy will stem from variable renewable energy (VRE) sources, such as wind power and solar photovoltaics, there may arise an increased need for a well-integrated and flexible energy system. The matter of security of supply and energy imports adds to this picture. The Baltic countries are largely dependent on imported fossil fuels (Roos et al., 2012). The Ignalina nuclear power plant in Lithuania accounted for 70% of the country's electricity production before it was shut down in 2009 (IEA, 2014a), and Lithuania's dependence on imported energy resources has increased remarkably since the closure, growing from 50 to 62% to approximately 80–82%, exceeding the EU average of 53–54% (Gaigalis et al., 2016). To decrease its dependency on imports, Lithuania has been prioritizing an increase in the renewable energy share (Lund et al., 2005).

Due to the increase in renewables and the possible following need for an integrated, flexible energy system, this study asks the following research question:

> How do policies, in the form of taxes and subsidies, incentivize investment in technologies which flexibly couple the DH and the electricity systems in the Baltic countries?

DH facilitates the interaction between electricity and heat production. In the Baltic context, this has been illustrated by Kuhi-Thalfeldt and Valtin (2009), who describe how VRE can be balanced by local small-scale CHP plants in Estonia. In Latvia, Bazbauers and Cimdina (2011) shows that it is possible to increase the share of renewable

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[1] Abbreviations: CHP: combined heat and power, DH: district heating, DSO: distribution system operator, EB: electric boiler, EE: Estonia, LCOH: levelized cost of heat, similar to the more commonly used term *levelized cost of electricity*, LV: Latvia, LT: Lithuania, NETP: Nordic Energy Technology Perspectives, O&M: operation and maintenance, P2H: power-to-heat, PSO: public service obligations, T&D: transmission and distribution, TSO: transmission system operator, VRE: variable renewable energy.

https://doi.org/10.1016/j.jup.2018.02.001
Received 14 June 2017; Received in revised form 31 January 2018; Accepted 1 February 2018

energy sources by combining the surplus electricity produced by wind power in heat pumps with heat storage. Mathiesen et al. (2015) termed such flexible coupling in the energy system *smart energy systems*. Other studies demonstrate that CHP and power-to-heat (P2H) technologies, such as electric boilers (EB), may support flexibility in smart energy systems (Blarke, 2012; IEA, 2014b; Lund, 2003; Lund et al., 2015). An important enabler of such system integration is heat storage, which allows a partial decoupling of heat production and heat demand; e.g., by allowing a CHP to generate electricity whenever the electricity price is high and store the excess produced heat (Colmenar-Santos et al., 2016). This coupling of heat generation and electricity is already practiced in CHPs in the Baltic countries. Storage capacity and P2H technologies, however, are currently virtually nonexistent in Baltic DH (Sneum et al., 2016).

DH constitutes more than 50% of households' energy demand for heating, and the CHP share is above 50% of the DH production in Latvia and Lithuania, as seen in Figs. 1 and 2. The potential to deploy DH as a flexibility provider in the Baltics is, thus, considerable.

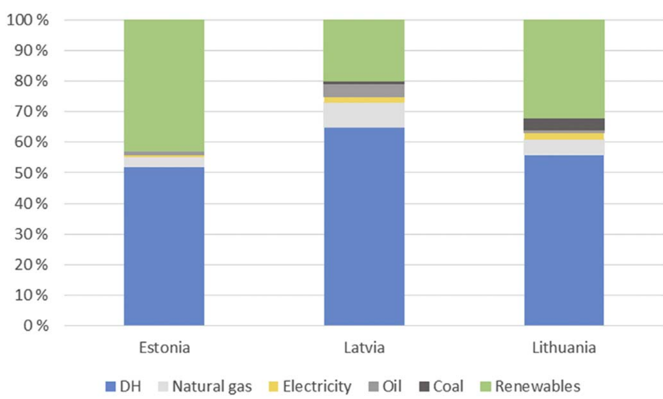

Fig. 1. Share of residential energy consumption for heating in the Baltic countries in 2013 (Euroheat and Power, 2015).

The present energy policies of the Baltic countries in terms of taxes and subsidies are not favorable for exploiting this potential. Feed-in-premiums promote CHP for the sake of security of supply and the use of domestic fuels. The electricity used for DH production is subject to the same tax rates as any other electricity consumption, reducing incentives for P2H deployment. The decision to invest in heat storage is entirely determined by market incentives (Sneum et al., 2016).

The objective of this paper is to investigate the feasibility of flexible DH technologies in a future electricity system comprised of a large share of VRE in the three Baltic countries, which assumes a greater need for flexibility options. We accomplish this by modelling different compositions of a DH system under current policies in terms of taxes and subsidies to find the resulting heat production costs. Furthermore, the impacts of electricity T&D tariffs and heat storage are explored. This approach shows if combinations of DH technologies and current policies produce both low heat costs and an opportunity for coupling DH with the electricity system.

Section 2 describes the methodology of the study, and Section 3 presents the results of the analyses. Section 4 concludes the study.

2. Methodology

This study analyzes the impacts of taxes and subsidies on investment incentives. Using the analysis tool energyPRO (EMD International A/S, 2018), we developed a model for DH plants with different degrees of coupling to the electricity system and, thus, different potentials for providing flexibility. The inputs and policies for the model plants are derived from the policy schemes for the different Baltic countries. By applying current economic conditions to the model plants, we test whether it is economically feasible to invest in flexible technologies in the Baltic countries. Earlier studies have addressed and modelled alternative policies for the operation of (Skytte et al., 2017) and investment in DH plants by taxation (Olsen and Munksgaard, 1998), using the capacity factor as a measure (Athawale and Felder, 2014). This study extends these methods by including storage, hourly variations, and long-term changes in fuel and electricity prices. The focus is on heat production costs, measured as the levelized cost of heat (LCOH).

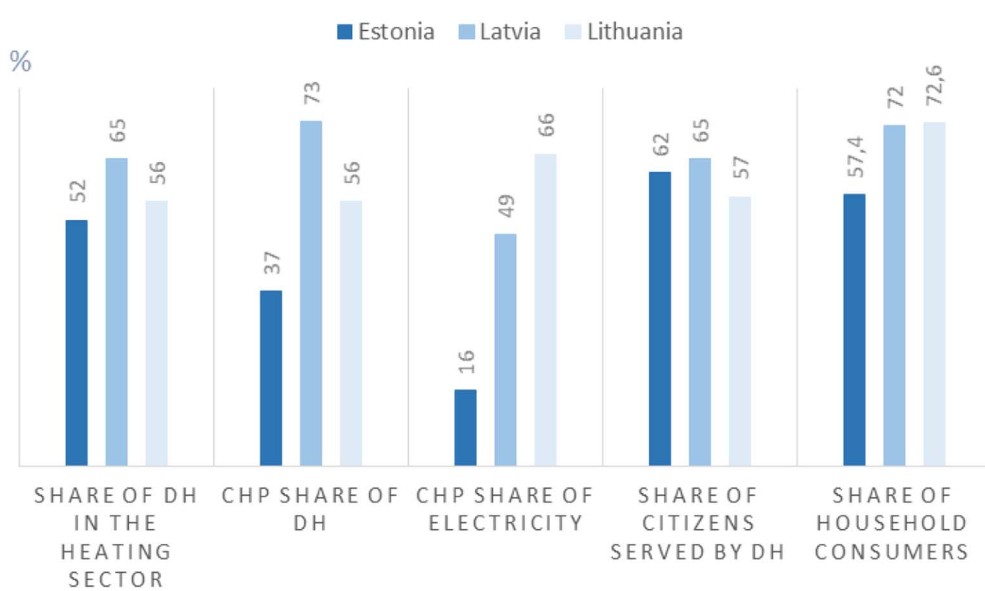

Fig. 2. Key figures in Baltic district heating shares in 2013 (Euroheat and Power, 2015).