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Support mechanisms for biomethane production and supply

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Abstract

Biomethane can be produced from biogas by upgrading it to the quality of natural gas. This way it is possible to obtain a renewable substitute for the natural gas which may be injected into the natural gas grid and used in the existing technologies without need for replacement. Biogas, after purification, can be diverted from distributed biogas-fired power plants which often are relatively inefficient due to lack of sufficient heat loads to large district heating systems with efficient cogeneration possibilities. The research question of this study was: what is the level of support required for the production of biomethane in order to put it in price parity with natural gas, and how should a support policy for biomethane supply chain be designed to make it sustainable over time? The methodology used was system dynamics modeling with data obtained from public authorities, biogas industry and scientific publications. The studied time horizon is 2017–2030 and the model is tested for the case of Latvia. The novelty of the approach is more detailed modeling of support policy by including issue of support allowances and physical construction of biomethane production capacities. The aim of the model is to provide policy makers with the tool which allows organizing support in a well-controlled manner over a sufficiently long time period considering economic and technical constraints. The results show that the average level of support required for biomethane as a feed-in-premium payment on top of the unit production costs is circa 68 EUR/MWh under the most favorable scenario. The analysis suggests that the period of support should be extended from the present 10 years to 15 years or more to decrease the required average feed-in-premium payment.

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Keywords: biomethane; renewable energy support mechanism; system dynamics

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1. Introduction

Given the current market price of natural gas and biomethane production costs, as it was stated in the study made before [1], the biomethane production should be supported to compete with fossil fuel sales prices and the FIP (i.e. market-oriented tariff with a premium payment on top of the natural gas market price) support policy seems to provide a controllable and stable growth of biomethane production over time. Besides, introduction of the FIP support mechanism is in line with the EC guidelines where EU member states are encouraged to introduce support incentives developed according to the market-based principles [2]. Interest on the possibility of biomethane production and injection into a natural gas grid is of increasing interest to policy makers, as well as representatives of the gas industry in the UK, Netherlands, Germany and other European countries. In Austria, 11 biomethane plants are operating (8 of them are connected to the natural gas network), in Denmark – 3 (1 of them injects biomethane into the grid), in Finland – 5 (2), France – 4 (2), in Germany – 154 (118), Luxembourg – 3 (3), Sweden – 54 (11), Switzerland – 17 (15), the Netherlands – 23 (19), UK – 50 (50) [3–6]. Latvia also has a well-developed natural gas infrastructure which could be used for transportation of biomethane to end users. Since biomethane energy unit production costs cannot compete with natural gas unit price, countries are using a variety of support mechanisms. Mostly support is provided via feed-in tariffs (FIT), investment subsidies, quota systems or tax relief. In Sweden, biogas is used mainly in the transport sector, and in this respect the country is the leader in Europe [7]. Sweden has introduced different investment programmes for municipalities and farms, and support mechanisms are with a focus on vehicle fuel applications [3, 8]. Since 1930, Germany has been able to introduce favorable conditions and achieve rapid development of the biomethane production and grid injection sector [9]. It was achieved through different support mechanisms, such as sharing of investment costs for grid connections, facilitated biomethane transport, re-financing programmes, tax reductions and FIT plus bonuses if biogas is upgraded [3]. In Germany, technology specific FIT is guaranteed for 20 years [10] and time allowed to realize gas grid access is set to 18 months [11]. While in the Netherlands the scheme provides 12 year long support and the producer has to bear all costs associated with the connection to the grid [3, 7, 12].

The German biomethane market was modeled and analyzed with a system dynamics (SD) [13–15] approach by implementing varying FIT price mechanism and emission trading scheme [16]. Authors of this research admit the absence of a system dynamics model that analyzes the effects of energy and climate policies to the sectors of power, heat and mobility integrated into single model [16]. For their part Dutch researchers analyzed biomethane production and effectiveness of the support mechanism under uncertainty by applying the SD approach [17]. The model of this study investigates interaction between such factors as demand and capacity installation, as well as resource availability, and it also studies several financial and technical uncertainties, as well as behavioral uncertainties of producers and consumers. The goal of this study was to model a structure of biomethane support policy in more detail, i.e. by considering two parallel flows – allocation of permits for receiving the support and actual commissioning and de-commissioning of the production capacities.

2. Methods

The aim of the study was to develop a system dynamics model which facilitates design of stable biomethane production and supply support policy, and test the model for Latvia's case by defining the most appropriate support mechanism for biomethane production and supply. Since interdisciplinary SD [13–15] approach, as a tool for energy systems conceptualizing, is the recognized approach to address various energy policy issues both worldwide [16–22] and in Latvia [23–26] (as it was described previously [1]), it was also used to create a basis for the support mechanism and analyze different scenarios in this study. The SD model was developed using the Powersim Studio 8 software platform, and the simulation period was selected to be 2017–2030. Fig. 1 shows the main elements and the feedback loops which explain structure of the biomethane support system. On the basis of this structure, a SD model is constructed to develop a biomethane supply support mechanism (Fig. 2).

There are four main stocks with the respective flows in the SD model (Fig. 1 and Fig. 2) – (1) permits granted (affected by three flows – granting and cancellation rate of permits, as well as the flow of annual permits leading to investment); (2) capacity under construction, as well as (3) capacity in operation with and (4) without subsidies (i.e. capacities which continue production after end of the support period) affected by the capacity order rate, commissioning and de-commissioning rates, suspension of subsidies and production without subsidies.