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Upgraded biogas for transport in Sweden – effects of policy instruments on production, infrastructure deployment and vehicle sales

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ABSTRACT

Sweden is a leading country in the development of upgraded biogas for use in the transport sector. The introduction of a new vehicle fuel is complex when the production, infrastructure, and vehicle fleet must be developed simultaneously. The aim of this article is to present and analyse the development of upgraded biogas in the Swedish transport sector in relation to policy instruments and the availability of a natural gas grid. Plausible implications for the future development of the biogas system are also analysed.

The development of upgraded biogas in Sweden's transport sector is heavily influenced in several ways by domestic policy instruments. Investment support schemes and exemptions from energy and carbon dioxide taxes have been key instruments in initiating the construction of new biogas production facilities and infrastructure. The study of the biogas development in relation to the natural gas grid presented in this article indicates that it may not be necessary to construct a comprehensive network of pipelines for methane (natural gas) to develop the market – at least not initially. In Sweden and elsewhere the biogas volumes will still be quite small in the near future and it is possible to achieve biogas development without an available methane gas grid.

Public procurement, investment schemes and reduced fringe benefit tax have likely been important policy instruments in the introduction of biogas vehicles, whereas the support for private biogas cars has been short-sighted in some ways, and not sufficient to achieve a competitive cost of ownership for biogas cars in relation to diesel cars.

The future strategy for biogas should be based on a realistic potential for using biogas in the transport sector; this would determine whether further market expansion is necessary or if incentives should be focused on development of the production side to cover the current demand for vehicle gas.

The development of biogas production likely depends on continued tax exemptions, which are currently available only until the end of 2015; it is uncertain whether they will remain in place. If biogas should be promoted further among private car owners, more visible incentives for private cars are needed together with incentives for expanding the fuelling infrastructure network.

1. Introduction

Biogas is a waste-based renewable fuel that can be used in the transport sector and Sweden is among the most progressive countries in this field. In Sweden, anaerobic digestion has been used in wastewater treatment plants since around 1950, while the use of upgraded biogas in the transport sector started during the 1990s. Biogas, a mixture of methane and carbon dioxide (CO_2), is produced when organic matter is degraded in an anaerobic digestion process. The gas may be upgraded to 95–99% methane (Swedish standard) (Persson et al., 2006), to enable use in vehicles and/or injection into the natural gas grid. Methane for vehicles is commonly referred to as compressed natural gas or compressed biogas, but in this article the term vehicle gas is used (direct translation from the Swedish term), because it describes the

Abbreviations: CBG, Compressed biogas; LBG, Liquefied biogas; LNG, Liquefied natural gas; LIP, Local Investment Programme; KLIMP, Climate Investment Programme.

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Swedish conditions better. It refers to a gas mixture (mainly consisting of methane of fossil or renewable origin) that is used for methane-fuelled vehicles.

The biogas system has several environmental and societal benefits: organic waste is converted to a high-quality renewable fuel, valuable plant nutrition in the waste is recycled and methane emissions from untreated waste are avoided. All these benefits can reduce greenhouse gas emissions, either by replacing fossil fuel based alternatives or by reducing direct emissions from waste. Biogas is put forward in several frameworks for environmental sustainability, such as the EU directive on promotion of energy from renewable resources (European Commission, 2009), the 16 quality goals for more environmentally sustainable development set by the Swedish parliament (Environmental Protection Agency, 2015), and the Swedish government's vision of a fossil fuel-independent vehicle fleet by 2030 (Ministry of Enterprise, Energy and Communications, 2013).

In 2013, primary biogas production in the EU amounted to 156 TWh, of which Germany accounted for about half and Italy and the UK also had significant shares, about 14% each (EurObserv'ER, 2014). Combined heat and power production is the main use for biogas all over Europe, and in many countries, for example, Germany, Italy and France, biogas production is driven by feed-in tariffs (EurObserv'ER, 2014). Statistics for upgraded biogas used in vehicles in Europe are difficult to find, but Sweden is known to be one of the leading countries for upgraded biogas (EurObserv'ER, 2014) and is among the European countries with the strongest focus on biogas for transport.

Biogas is a suitable fuel for heat and power production, and heat production has been the traditional application also in Sweden. However, a variety of other renewable energy sources can be used for this, whereas the options for producing renewable transport fuels seems more limited, at least in terms of economy. It may, therefore, seem reasonable to upgrade the biogas for use in the transport sector, as methane is a suitable fuel for all types of road transports and already is used for that in many countries. In this way, fossil transport fuels can be substituted with a renewable fuel that is already to some extent available in society. Furthermore, biogas can be sold at a higher price in the transport sector compared to the energy utility sector.

According to Browne et al. (2012) the most significant barriers to alternative fuels and vehicles are as follows: availability of fuels and vehicles, feedstock availability, and infrastructural challenges, as well as lock-in and path dependence. Moreover, Browne et al. consider several financial barriers to be quite significant, including fuel and vehicle cost. Specifically for natural gas, which is more widely used than biogas in transport applications, Steenberghen and López (2008) stressed the importance of financial barriers, such as higher vehicle retail prices (also reported by Lantz et al. (2007) as a significant user barrier for biogas cars) and a significant cost for implementing widespread refuelling infrastructure. Such infrastructure is significantly more expensive than that for liquid fuels, and lack of infrastructure has proven to be a major obstacle for transportation fuels, which is emphasized in the EU Directive on infrastructure for alternative fuels (European Commission, 2014). This obstacle was one reason why biodiesel could be introduced faster than methane in the German transport sector (Schulte et al., 2004). For biogas, there are also financial barriers on the production side.

In biogas production from municipal and industrial waste in Germany, high costs have been reported for feedstock handling and production facilities (Poeschl et al., 2010). In Sweden, the development and construction of biogas plants that can handle unconventional types of feedstock, e.g. agricultural waste, have been associated with high costs (Lantz et al., 2007). Uusitalo et al. (2015) studied limiting factors for the use of biomethane in the transport sector in Finland. They found that the main limiting factors were limited access to distribution infrastructure and uncertainties regarding the economic conditions for agricultural biomass producers and vehicle owners. Fallde and Eklund (2014) studied the biogas development in a Swedish city, and concluded that while highly influenced by national support and pressure, the development was primarily driven by local actors. Olsson and Fallde (2014) report that the development of biogas in Sweden has been successfully driven by issues regarding environment and waste management, but that a large part of the potential for biogas production remains unutilised. Furthermore, they point out that to increase biogas production, it is essential to address the plurality of the biogas system and apply local and sectorial measures, in particular policies in waste management. Börjesson and Ahlgren (2012) investigated cost-effective infrastructure options for biogas through the modelling of a regional energy system. They found that relatively low subsidies could increase techno-economic biogas production potential significantly, as would developed distribution possibilities for biogas. Goulding et al. (2014) recommended the following policy instruments and measures for introducing methane in the Irish transport sector: introduce biogas in the captive fleet, facilitate injection in the natural gas grid, introduce investment grants for infrastructure, and establish a feed-in tariff for biogas. In the Netherlands, Eker and van Daalen (2015) evaluated the effectiveness of subsidization of biomethane production. They found that subsidization is crucial for this development and that it should be provided for a long time period at a relatively low subsidy level to reach the objectives of maximizing biogas production and emission reduction in a cost effective way.

In relation to available studies on biogas, this article focuses on Sweden and specifically the development of biogas in the Swedish transport sector and the unique combination of national policy instruments that have been applied. It focuses mainly on economic and, to some extent, procurement instruments. The motivation for this is that these two types of instruments probably have been the most important ones for the introduction of biogas in the transport sector. Experiences of barriers and policy instruments for other fuels in other areas of Europe will be part of the framework for analysing biogas development in Sweden.

The aim of this article is to present and analyse the development of upgraded biogas in the Swedish transport sector in relation to policy instruments and the availability of a natural gas grid. The information is used to explore some factors of importance for continued expansion of the biogas in the transportation sector. The following questions will be asked in the analysis:

- How have Swedish policy instruments, mainly financial instruments, affected the use of biogas in the Swedish transport sector?
- What influence has the available natural gas grid had on the development, and is this grid a prerequisite for developing production and use of biogas?
- If continued expansion of the sector of upgraded biogas for transport is desired, what changes may be needed in the policy instruments?

Section 3 describes the development of biogas in Sweden as well as general policy instruments directed at transport fuels and the policy instruments directed at biogas in Sweden. In Section 4, the impact of the policy instruments on each part of the fuel chain is described and analysed, and finally the overall effects and policy implications are discussed in Section 5.

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