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German Energiewende and the heating market – Impact and limits of policy

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HIGHLIGHTS

- The residential heating market accounts for major share of carbon emissions.
- The disregard of the building stock weakens the impact of recent regulation.
- Current regulation preserves a heating market dominated by fossil fuels.
- A significant renewable share can be achieved through direct regulation.
- Alternative policy leads to emission reductions without major increases in costs.

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ABSTRACT

The German Energiewende envisages achieving a climate-neutral building stock in 2050 by means of two major pillars of regulation. First, residential buildings should consume 80% less primary energy and second; the remaining energy demand should be covered primarily with renewables. This paper simulates the future German heating market under different policy scenarios in order to evaluate the impact and limits of recent and conceivable policies. The investigation is based upon a dual model approach, linking a residential heating model to a discrete choice model. The major finding is that current regulations are not suitable for the achievement of governmental targets. Scenario calculations show that additional carbon emission reductions, triggered by the current regulatory regime, are falling short of expectations. In terms of economic efficiency, all calculated policy alternatives outperform the regulation currently in place. This allows to draw the conclusion that carbon emission reductions can be achieved without a major increase in cost. The model results highlight two policy implications. First, a rising mandatory share of renewables in the heating market is needed for target achievement and can be cost effectively. Second, renewable obligations for heating systems must include the existing building stock to achieve the postulated political targets.

1. Introduction

The German residential heating sector offers huge potential for energy and carbon reductions, constituting a central key for the modernisation of the energy supply and for the attainment of climate protection goals. It has been responsible for a rather stable 20% share of annual domestic CO_2 emissions in recent years (Federal Statistical Office, 2014). It further accounts for approximately 25% of the final energy consumption. There are two fundamental pillars of regulation to drive energy and carbon reduction. First, a lower energy demand of residential buildings and second, a higher number of renewable heating systems. Both of these pillars are addressed in the energy concept; the long-term energy strategy of the German Government (BMWi, 2010). The federal government acknowledges that the transformation of the residential heating sector is a key factor for the success of the Energiewende and postulates the long term target of a "climate-neutral building stock" for 2050. Virtually all heating market policy measures can be traced back to these two major pillars of regulation, a lower energy demand and a higher share of renewable energy (BMU, 2011). However, the formulated long-term target might be difficult to achieve, given the limited impact existing measures have had to date (Diefenbach and Born, 2007).

This paper analyses different scenarios for the transformation of the residential heating market and its decarbonisation. The aim

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of the study is to analyse the impacts and limits of recent and conceivable German residential heating market policies until 2050. The main research question is: will the enacted policy achieve the targets stated in the energy concept? As a corollary, further questions arise. What are conceivable alternative measures and how far do these alternatives contribute to the target achievement in terms of heating market structure, renewable heating energy and CO_2 emissions? How effective is the policy in economic terms?

To assess these questions, an integrated approach is chosen. A model of the building stock is used to calculate the future number and the energetic requirements of dwellings. These numbers and requirements subsequently have an influence on the economics of heating systems, the second part of the integrated model. The heating market development is yet not given, but calculated endogenously with the help of a nested logit approach to consider the process of individual decision making associated with residential heating systems. Five scenarios are considered to investigate the effects of heating market regulation.

The public interest and academic debate on the residential heating sector have led to a variety of approaches. Alternative scenarios, depicting a path towards a renewable heating market, have been calculated by Kirchner and Matthes (2009). Such scenarios show how a renewable heating market can be achieved and how it would contribute to the achievement of climate policy targets. However, they assume a given growth in renewable heating systems, which we do not find. Nevertheless, scenario calculations are of direct relevance for the design of the recent heating market policy in Germany. Early scenarios (Schlesinger et al., 2007) have been followed by scenario calculations for the German energy concept (Schlesinger et al., 2010). The policy measures retained in the energy concept, still pointing the way for German energy, are to a large extent based on the results of this study. They show the energy market future under a reference, and four target scenarios. Their heating market calculations show that under the policy framework of 2010, only limited demand and emission reductions of around 30% can be achieved until 2050, while alternative scenarios with the assumption of higher refurbishment rates lead to reductions of roughly 60%. The use of renewable energy for heating reaches 22% in the reference and not more than 37% in the alternative scenarios. Conclusions drawn recommend the tightening of building codes and subsidies for renewable heating systems as major measures. Such calculations are valuable as they enable the impact of regulation amendments to be assessed. However they do not consider the decision maker (houseowner or dweller) as the key player, who translates regulation into action. This study bridges this gap and focuses on the heating system decision as a consequence of given and conceivable policy. By investigating comparable questions, i.e. emissions and renewable shares, the present study therefore adds a critical component to the evaluation of policy.

Studies explicitly considering the decision making of houseowners or dwellers have been applied earlier but with a fairly different focus or approach. Schuler et al. (2000) find socio-economic characteristics of households to be essential for the impact of regulation, thus underlining the importance of the approach chosen in this study. By setting a methodical focus, Michelsen and Madlener (2012) present a detailed analysis of the influence of heating system specific attributes on the houseowners adoption decision. Based on their early findings, Michelsen and Madlener (2016) present another contribution that elaborates on the barriers in the adoption of renewable heating systems. Similar results are presented in Bauermann et al. (2014) using a discrete choice approach in a combined model with a limited heating system choice set. Such findings help the policy maker to understand, and align regulation. The reluctance to opt for a new, unknown heating system is a major barrier for decision makers that limits the impact of policy. Only by recognising such findings, policy can be adjusted and become more accurate. Just as the present study, Kranzl et al. (2013) make use of such effects to assess the impact and limits of policy on the heating market. Their integrated analysis for Austria, Lithuania and the United Kingdom until 2030 reveals that use obligations for renewable heating systems are most effective for growing market shares of renewable heating systems.

This study is the first integrated approach to apply such a method on the German heating market. Different heating market policy measures are investigated, taking into account both the development of the residential building sector and the choice process of decision makers in Germany. A major advantage of this approach is the consideration of two markets that are inevitably connected. But regardless of the conditions set by the built environment or regulation, it is the sum of individual heating system decisions that determine the future heating market and associated emissions. The consideration of the individual decision making for the impact of policy in Germany is the main advantage of the approach presented in this study, and represents a new approach and valuable contribution for the scientific debate.

The remainder is organized as follows. In order to set the scene, Section 2 elaborates on the heating market policy in Germany and illustrates the methodology behind the model. Results are presented in Section 3. Section 4 discusses and concludes.

2. Methods

In order to set the scene, this section provides a policy review of a European and national level and its consequences for the residential heating market. Based on that knowledge, the data and model setup are introduced.

2.1. Policy review

Beside the transformation of the electricity sector, energy efficiency in the residential heating market is another focal point of the Energiewende, and is crucial for its success. Recent energy policy in Germany has primarily focused on the electricity sector. While several laws were passed, the particularly important residential heating sector has so far only experienced minor legal modifications (Bürger et al., 2008). The reasons are as diverse as is the building sector itself. Heterogeneous ownership structures, principal-agent conflicts, property rights and politicians endeavoured not to burden voters prior to upcoming elections inhibit the realisation of the numerous announcements made in the energy concept (Schmid et al., 2012).

Regarding the household sector statistics, residential heating alone offers a substantial reduction potential. Fig. 1 shows the final energy demand per economic sector in 2011 and the distribution to energy applications within the household sector, which solely accounts for 28% of final energy consumption in Germany (BMWi, 2010).

The dominating role of heating for the household energy consumption implies that targeting only one single energy use, allows for major improvements in energy efficiency and CO_2 reductions. The two options to exploit these potentials are: first, a lower energy demand of the building sector and second; a higher number of efficient, renewable heating systems.

Policy makers have discussed several ways to address the two pillars including, proposals for legal amendments, tightening regulation on public buildings, a general tax deduction for energy-efficient refurbishments and a modernisation roadmap for buildings (BMU, 2011). However, besides repeated announcements and