RESIDENTIAL ENERGY EFFICIENCY IN TIMES – ANALYSIS OF MODELLING APPROACHES AND IMPACTS ON ENERGY POLICY

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Overview

The TIMES energy system model has been used for informing energy and climate change policies in several countries and regions around the world. The type and scope of the studies varies, but many works consider (at least briefly) energy efficiency in their findings. However, very few include explicit energy efficiency scenarios and/or direct analysis of energy efficiency improvements.

Certainly, many TIMES studies mention energy efficiency as part of the strategies to achieve other outcomes (e.g. decarbonisation scenarios), but without explicitly measuring it in model runs. From the studies that measure energy efficiency improvements (involving technological change, not behavioral change), most cases report them as a sub product of other type of scenarios, such as emission reduction, renewable energy penetration or technology adoption cases. Lastly, few studies consider explicit energy efficiency scenarios, in some cases in combination with other type of scenarios such as emission reduction targets. Moreover, these studies have shown significant differences on the modelling approach and it has been recognised in (Blesl et al., 2007) and (Rosnes et al., 2017) that the model used and the approach taken considerably affect the results, potentially affecting policy decisions as well. Nonetheless, a direct comparison between energy efficiency modelling approaches in TIMES has not been developed yet. The work developed in this paper aims to provide insight on this issue, analysing the implications of different energy efficiency modelling approaches in TIMES, and discussing best practices on informing energy efficiency policy.

Methods

Many TIMES-related studies propose energy efficiency scenarios in their analyses. However, these scenarios consider different modelling approaches. In this paper, three types of residential energy efficiency scenarios are analysed using the UK TIMES model, all of them with the objective of reducing 20% of energy consumption on residential heating. The analysed scenarios are:

1. **Input energy constraints**. That is, reducing the amount of input fuels to achieve the same energy service output. A similar approach as implemented in (Blesl et al., 2007) and (Fais et al., 2016).
2. **Demand changes**, as implemented in (Shi et al., 2016), which involves a reduction in the energy service demand (exogenous variable), produced by the assumption of changes on consumer behaviour or technological progress.
3. **Technology adoption constraints**, as implemented in (Rosnes et al., 2017), forcing the implementation of more energy conservation measures to reduce input fuel requirements.

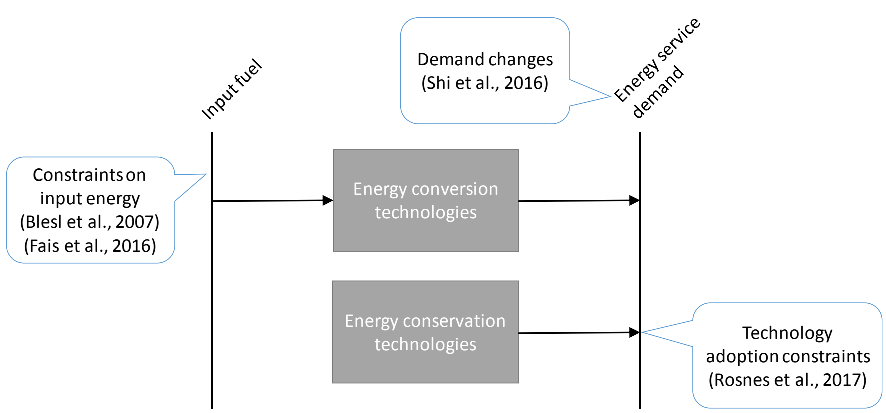

Figure 1. Diagram of energy efficiency modelling scenarios in TIMES.

Figure 1 shows a diagram on how energy service demand is met in TIMES, and how the proposed scenarios have been applied. The results of the different scenarios are compared between them and with a base case where no energy efficiency is implemented. Also, the impact of the modelling approach is analysed in terms of costs, energy savings and technology mix.

Results

Preliminary results show that these energy efficiency scenarios, which are in theory equivalent, produced different results, suggesting that the modelling approach taken can significantly impact the outcomes of the model. For example, Figure 2 shows the residential energy consumption of two energy efficiency scenarios, and how do they relate to the base case. It can be noted that the consumption patterns can change significantly between cases, especially for gas (blue lines in Figure 2).

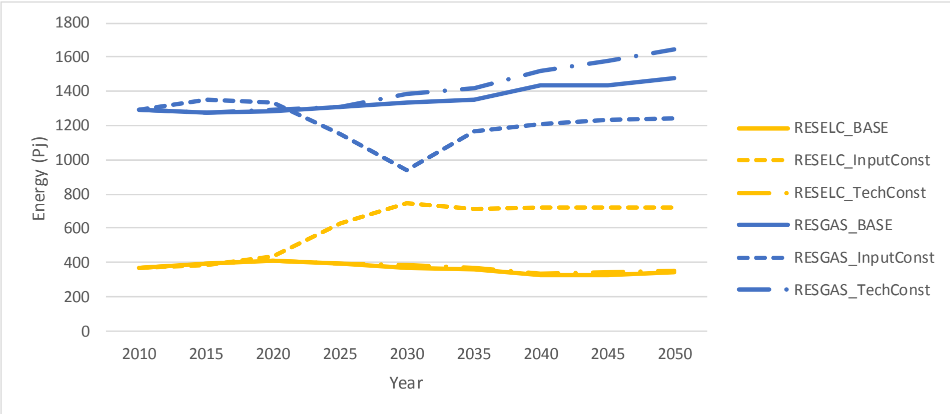

Figure 2. Comparison of electricity and gas consumption in the residential sector for different energy efficiency scenarios.

Additionally, not all energy efficiency scenarios performed as expected. For instance, in the technology adoption case, other user constraints (which are common to all the analysed scenarios) limited the amount of conservation technologies available, so the expected energy savings were lower than in other cases. This is something to take into account while designing energy efficiency policies.

Conclusions

Even though only three TIMES modelling approaches for energy efficiency were considered, the study proposed in this paper provides some insight on the implications on model outcomes of modelling different types of residential energy efficiency gains, and how can they affect policy decisions. Also, model outcomes may help policymakers in "picking winners" as some of the modelling approaches might suggest that greater gains may result from favouring one approach over another. Therefore, the outcomes obtained show the importance of not solely relying on a particular scenario or model for policy analysis, as this might lead to partial views or suboptimal solutions.

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