An innovative model-based approach to CO_2 marginal abatement cost (MAC) curves*

Fabian A Kęsicki

UCL Energy Institute, University College London, 14 Upper Woburn Place, LONDON, WC1H 0HY
Tel. +44 (0)20 3108 5973, fabian.kesicki.09@ucl.a.cuk

1. Introduction

Policy makers in the UK as in many countries around the world are confronted with the task of how to reduce carbon emissions in a cost-efficient way. For this purpose, marginal abatement cost (MAC) curves have been frequently used to illustrate the economics of climate change mitigation and have contributed to decision making in the context of climate policy. So far decision makers have generally relied on expert-based MAC curves, which assess the abatement cost and the abatement potential of each measure individually. A disadvantage of the use of such cost curves is that they are not able to capture behavioural, technological, economic and intertemporal interactions.

In order to overcome these shortcomings, a new approach to deriving MAC curves is demonstrated, through the combination of an integrated energy system model (UK MARKAL) and index decomposition analysis. This allows the generation of a consistent carbon abatement cost curve with a high degree of technological detail, as well as incorporating behavioural aspects.

2. Existing Approaches

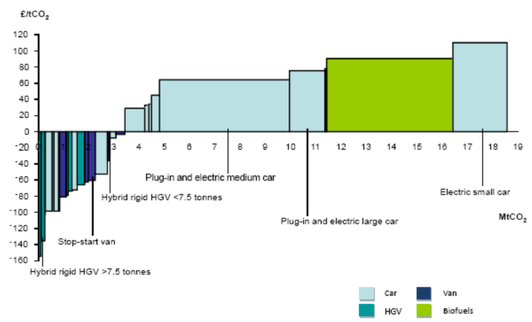
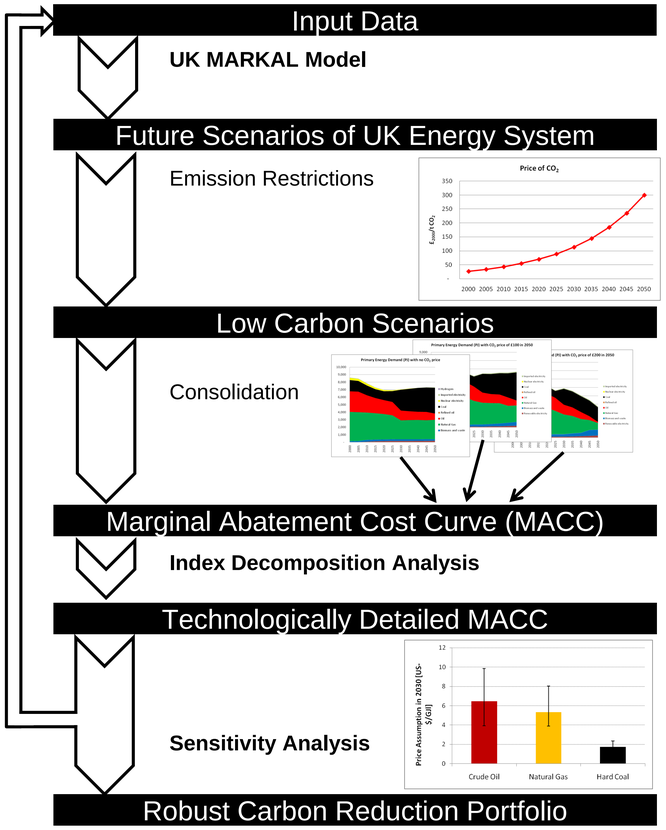


Fig.1: MAC curve for the UK transport sector in 2020 (CCC, 2008)

The most common approach to generate MAC curves relies on expert information for individual abatement measures, which are then ranked according to their marginal abatement cost. In the UK, the Committee of Climate Change (CCC), an independent body set up to advise the UK government on reducing greenhouse gas emissions, has commissioned such MAC curves for different sectors of the energy system, such as industry, buildings and transport (Fig. 1). These curves have underpinned the CCC's recommendations to Parliament.

The main strength of such curves is that they are easy to understand for policy makers and that marginal costs and abatement potentials can be unambiguously assigned to mitigation options. Since this is not a systems approach, it is not possible to take into account interdependencies and interactions within the energy system; although the implementation of one mitigation measure will have an effect on other mitigation measures across the whole energy system. Furthermore, changes in demand, provoked by price changes, and intertemporal interactions cannot be considered. This type of curve is also susceptible to inconsistent baseline assumptions, double counting and allows only a limited analysis of the significant uncertainties involved in abatement costs and potentials.

3. Method



4. Results for the UK Transport Sector in 2030: low fossil fuel prices (left), high fossil fuel prices (right)

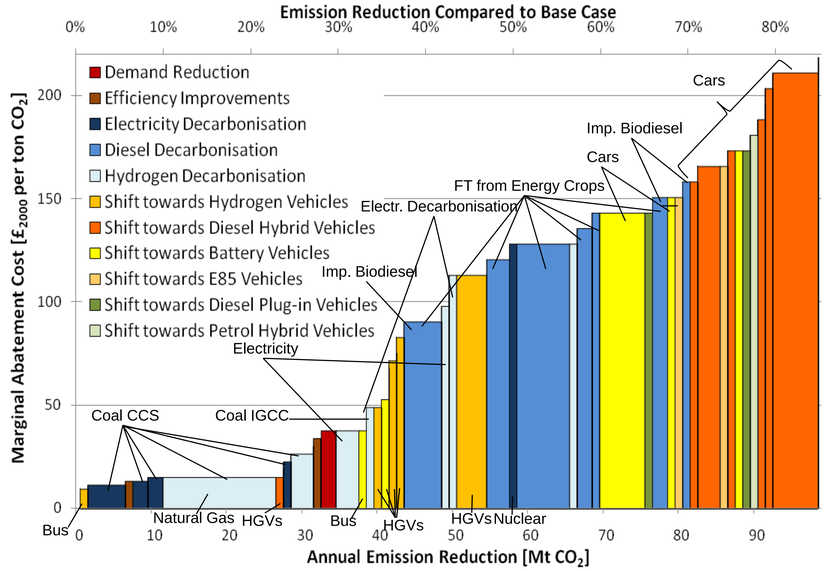


Fig.2: MAC curve for the UK transport sector in 2030 (low fossil fuel price scenario)

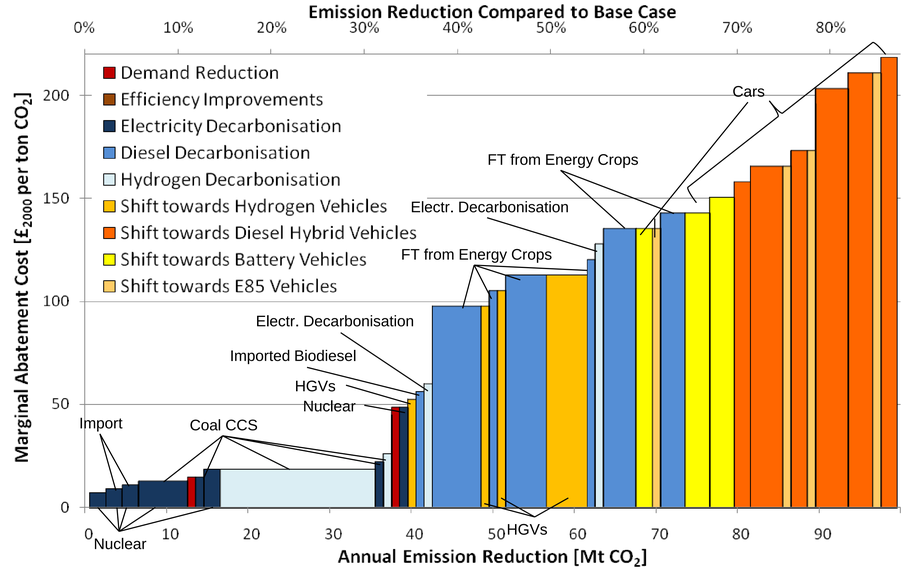


Fig.3: MAC curve for the UK transport sector in 2030 (high fossil fuel price scenario)

5. Conclusions

Decomposition analysis applied to the results of energy system models can be a powerful tool to derive technologically detailed MAC curves. As shown for the UK transport sector, interesting and consistent results can be generated. With this new approach it is possible to avoid inconsistencies in the base case assumptions and to reflect intertemporal as well as technological and behavioural interactions in the energy system.

Nevertheless, it has to be taken into account that these MAC curves are not able to capture some micro-economic and macro-economic interactions, nor the cost influence of ancillary benefits and are dependent on the input assumptions of the energy system model.

Therefore, it will be important to continue the variation of important input assumptions to point out how abatement measures interact and how robust the abatement curve is. To sum up, the results represent an improved and suitable basis for robust decision making in long-term climate policy, while further research remains to be undertaken.

*The support of a German Academic Exchange Service (DAAD) scholarship is gratefully acknowledged.