LONG-TERM SCENARIOS FOR AN ENERGY TRANSITION IN THE FRENCH TRANSPORTATION SECTOR UNDER MULTIPLE POLICY OBJECTIVES

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Overview

The energy transition (roughly speaking, away from fossil fuels) covers two main objectives – energy security and sustainability. The European debate for such a transition has not slowed down; the European Commission evokes ambitious climate targets for the 2050 horizon (with respect to a 1990 baseline) such as the division of the energy sector'emissions by 4 and the reduction of at least 60% of emissions in the transport sector. In France, recent policy consultations have led to the elaboration of many scenarios (Ademe, Ancre, Negatep, Negawatt) through the National Debate on Energy Transition (DNTE). Among these, the transport sector always raises particular attention. Indeed, ambitious global targets may not be reachable without strong actions in the transportation sector and more generally in the mobility's framework, even if it is well-known that abatement costs in transport are high (Proost et al. 2009, Van Dender, 2009). Moreover, and because transport relies almost exclusively on fossils fuels, thinking about futures leading to a more diversified and resilient transport sector is a crucial issue.

However, uncertainties surrounding potential evolutions of transport are numerous. They cover demand-side aspects (in the long-run, economic growth and the level of decoupling between growth and per capita mobility (Schäfer and Victor, 2000); in the medium run, the existence and the assessment of the rebound effect (Hymel, Small and Van Dender, 2008)), technological evolution (efficiencies and costs, Prud'homme & Koning, 2012), marginal damage cost associated to carbon emissions (Van Dender, 2009) and potential supply-side technology shifts (biofuels, electric or hydrogen vehicles). On the other hand, policy objectives obviously highlight co-benefits (Criqui and Mima, 2010 and Proost and Van Dender, 2012).

One drawback of existing studies is that they often explore a small part of possible futures through a simple set of scenarios. Synergies and antagonisms between the main dimensions are thus not explored in-depth. In this article, we aim at providing both a wider framework and a robust set of insights through a more extensive protocol of scenario analysis.

Methods

We rely on a long-term, linear programming, partial equilibrium model of the French energy-transport sector based on the TIMES-MARKAL paradigm. This model is used to conduct a systematic examination of potential futures of the transport sector under various (i) fuel diversification targets, (ii) GHG reduction targets, (iii) economic growth and mobility-growth decoupling scenarios and (iv) techno-economical evolutions of transport technologies. In that sense, uncertainty on possible futures is tackled through an extensive scenario analysis. For each of these four dimensions, two (and in some cases three) increasingly ambitious scenarios were built. Then, all combinations were tested (54 scenarios). This procedure allows to capture with consistency the co-benefits or antagonisms between policy objectives, as well as the role played by macroeconomic drivers and the relevance of technological progress.

Results

For each scenario, we first conduct an examination at the macroscopic level. We measure the additional energy system cost of reaching the given objectives, and identify the "ease" of reaching the various objectives through shadow prices. We notably identify how the level of demand impacts the implicit sectoral value of carbon. Then, we perform a "mesoscopic" analysis to investigate the contribution of carbon intensity, energy efficiency and demand-side reaction to the goal attainment. We show how, unless objectives are very stringent, some of these solutions are privileged. These considerations find their expression in the optimal technological trajectories (alternative fuels and mobility technologies). Simple statistical analysis across scenarios allow to better circumvent the potential of alternative pathways in the transport sector. For example, the complementarity and substitutability between biofuels and transport electrification are highlighted.

Conclusions

The extensive scenario exploration led in this research relies on the elaboration of assumptions about the most important dimensions in the transport sector, and their systematic cross-analysis. Rather than isolated sets of results, we aim at providing ranges to be interpreted in terms of risks and opportunities. This technique leads to the identification of key drivers and pathways for security- and sustainability-compliant transport systems.

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