Shift from oil fueled cars for future sustainable mobilities

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SHIFT FROM OIL FUELED CARS FOR A SUSTAINABLE MOBILITY IN FRANCE

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Overview

Mobility is an essential element of modern societies' functioning. It has successively been addressed over time as one input among others to economic growth, as a core societal aspiration and an enabler of well being or personal development, or today as a key end-use sector where the battle against climate change needs to be fought. While these three dimensions are still true, we focus here on the latter and on technical roadmaps to achieve the goal of a sustainable mobility. The problem can be simply stated as thus: we won't be able to satisfy growing demands for transportation services with current solutions without seriously harming the environment. But the answer is less straightforward. Using a bottom-up model of the French energy system we define the contribution to mitigation from the transport sector which depends on efforts in others, and identify leading technologies as well as transition ones. Especially mobility and vehicles fuel efficiency are differentiated between short and long distance travels and variations of the roadmap, depending on assumptions on technology acceptance, are discussed.

Methods

In order to tackle the central topic of this paper we use TIMES-FR, a bottom-up French model based on the Markal/Times approach [1], [2] [3]. Markal/Times models optimise energy systems in the long-term with explicit descriptions of the technologies used: they are based on an explicit formulation of the input-output relationships for each technology and minimise the total discounted cost over the chosen time horizon and for a given final services demands. It's a cost efficiency framework where investments levels, activities levels and total installed capacities are the main decision variables. .
Over a 50 years period (2000-2050), required demands for energy services including mobility- differentiated in short and long distance travels- have to be satisfied simultaneously with a strong constraint on CO2 emission levels i.e. a reduction by 50 to 75% of the emissions by 2050 compared to their 1990 level (except international transportation). The systemic approach used ensures consistency of the results across all end-use sectors. This methodology is used to propose a focus on personal vehicles in order to highlight the long term relationship between carbon constraints, technologies road map and cross sectors effects.

Results

Various scenarios were investigated reflecting different levels of acceptance of available transportation technologies. The results detail the impact of short and long distances needs on the technical choices and the evolution of marginal cost of each mobility demand. We have extracted hereafter the evolution of personal vehicles over the modelling horizon for two scenarios: figure 1 illustrates full acceptability; figure 2 excludes natural gas powered engines. The scenarios outline some key patterns in the evolution of the French transportation system when demand satisfaction is the main driving force:

- the vehicles number increase continuously over the modelling horizon to reach around 40 Millions;
- until 2020, conventional injection motorisation technologies are the preferred technologies;
- between 2020 and 2030, thanks to technological availability, the tighter carbon constraints induces a shift to either gas powered vehicles or conventional hybrid;
- from 2030 on, the trend is emphasized leading to the confirmation of previous technological choices. From gas to hybrid gas, and from hybrids to plug-in hybrids;
- pure biofuel vehicles remain marginal as they appear and disappear over a vehicle life time period;
- without support, pure electric vehicles based on the derivation of standard diesel or gasoline vehicles are not selected.

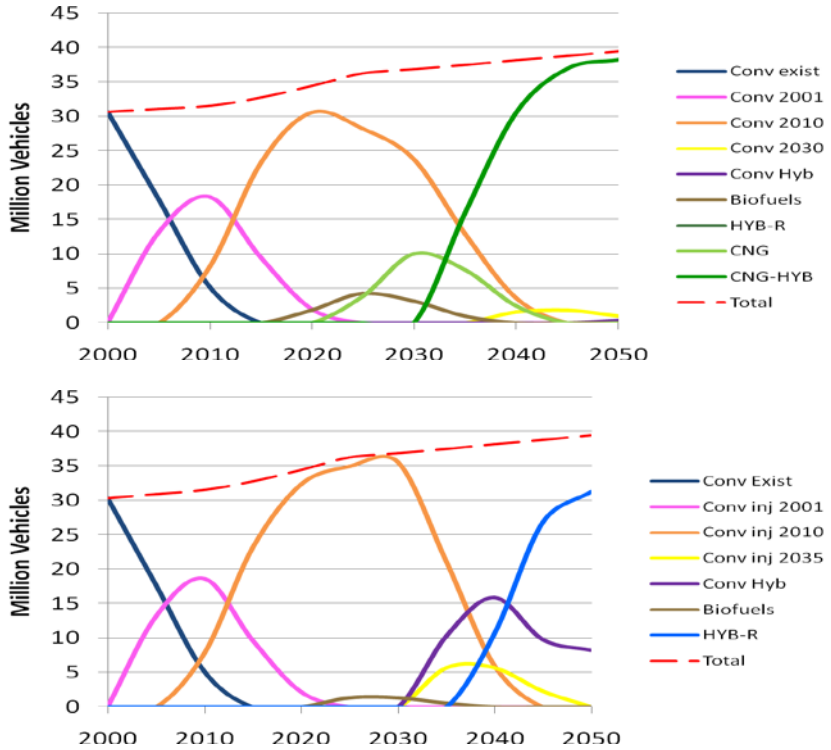

Fig1. Alternative evolutions of personal vehicle technologies

Conclusions

This paper provides insights on the necessary adjustment for technological availability in order to achieve sustainable mobility. Quantitative results on energy consumption show the appropriate substitutions between energy sources and sectors, and the factors influencing the merit order are highlighted.

The articulation of transition and dominant technology pointed out calls for more research efforts on global industrial strategies in the car manufacturing industry. For instance, the quick apparition of pure Biofuel (or non hybrid natural gas vehicle) only used as a transition in the French market, may reflect either a world-wide diffusion of the technologies with regard to local conditions, or the high pressure of the environmental constraint and the lack of mature alternative carbon-free technologies at that period. Selected road-maps through enforced R&D and investments could also enable a direct shift from conventional vehicles towards the more promising ones.

The history of innovations of course reminds us that good strategies, diffusion channels and distribution infrastructures are equally important for a commercial success. Yet technical-economic assessments as proposed here provide a valuable first step in order to validate technological landscapes in a prospective vision.

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