ARE CLIMATE CONSTRAINTS GOING TO HAVE AN IMPACT ON TRANSPORT INFRASTRUCTURE?

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ABSTRACT

Today, numerous works conclude that transport seems to be completely coupled to economic and export/import growth. Therefore, as a direct consequence of economic development, transport sits today as one of the major final energy consumers and as one of the most important sources of carbon dioxide (CO_2) emissions. Consequently, this situation of continuous increase in transport clearly poses an environmental problem, especially in the current situation where even though fuel prices have gone up, fuel consumption has stayed high because bigger cars are being bought. Thus, modal shifts towards public transport have been accompanied by reductions in average distances being travelled by cars but with higher consumptions.

In this state of matters, a number of exploratory long term transport scenarios have been developed using the TILT (Transport Issues in the Long Term) model. These scenarios are focused on the French economy in order to offer insight on relationships existing between new technologies, market trends, public policy and infrastructure investments. This paper explores how a continued market trend in the vehicle sector is not viable in the long-term future if observed through infrastructure investment needs.

Keywords: Greenhouse gas, long term, scenario, transport, sustainable development.

1. INTRODUCTION

Currently, transport activities in France are at the origin of 25% of the county's total energy consumption and are responsible for, at least, 30% of its carbon dioxide emissions. In essence, 80% of these emissions come from road transport. As this situation is viewed as unsustainable, French authorities have fixed themselves a 75% reduction objective from the 2000 level to be attained by 2050. This objective will serve as the work base to the effects of this paper, in which we will analyze what a continued trend in car markets implies on infrastructure needs for 3 scenarios proposed by the LET-ENERDATA group in 2008.

The reduction of CO_2 emissions implies not only the need for new technologies and their widespread use but also an increased match in current technology supply and consumer demand through the use of incentive economic instruments. Thus, this reduction objective implies the need to set up a certain number of public policies ranging from inciting technological progress, to tolls, to intermodal development or even rationing (tradable emission permits). Currently, an increasing number of countries have set up different types of programs to try to influence the private vehicle market in order to renew vehicle fleets and to curb emissions from this sector, but are these programs viable in the long term?

Although vehicle demand management programs have had a lot of success, studies like those of F. CUENOT show that if average weight on new cars in Europe had stayed constant from 1995 to 2005, the 2008 target of 1998s voluntary agreement would have been met and new regulation aiming at better averages in CO_2 emissions would probably have been unnecessary. Furthermore, F. CUENOT shows that if, in the following years, vehicle weights do not increase, new CO_2 reduction objectives might be attained by 2015 through a combination of strategies referring to car weight and motor technology.

In the French case, a "GHE bonus-malus" program started in 2008 based on malus payments or bonus rebates for new cars. These bonus/malus are calculated according to fiscal power units based on the car's maximum power and its CO2 emissions. This program has been quite successful and although, two years might be a short time span to get to any firm conclusion, we find it interesting to observe (table 1) that growth in total car sales in France has been fairly stable but skewed.

The number of fiscal power units is calculated through the following formula: $\left(\frac{P}{40}\right)^{1.6} + \left(\frac{U}{45}\right)$ where, P is equal to the maximum power in kilowatts and U is equal to the amount of CO2 emitted in grams per kilometer.

As we can see in table 1, when we look at sales according to fiscal power units, we can notice that the bonus/malus program combined to increasing fuel prices has resulted in a decrease in sales for mid-sized cars as sales for smaller and bigger cars have both gone up.

Moreover, the slowdown on mid-sized vehicles has not been translated in a reduction in total car sales or total vehicles and thus, has not been a key element in fuel consumption reductions. Rather, total fuel consumption has gone down because of increased sales for smaller cars and, additionally, a drop in average fuel consumption by larger cars.

This translates into the fact that, even though fuel prices have gone up and consumption averages have gone down, total fuel consumption has stayed relatively high because bigger cars with relatively "affordable" -in relation with the car's final price tag- malus payments have gone from an 11% market share to 21%.

TABLE 1 Car fleet evolution

	AGR 1998-2008	AAGR 1998-2008	% of fleet in 1998	% of fleet in 2008
Total car fleet	16%	1,5%	-	-
New 4 FPU cars	65%	5,1%	15%	23%
New 5 FPU cars	-1%	-0,1%	28%	26%
New 6 FPU cars	-9%	-1,0%	28%	24%
New 7 FPU cars	-64%	-9,7%	19%	7%
New 8 FPU cars	290%	14,6%	3%	10%
New 9 FPU cars	42%	3,6%	3%	4%
New 10 to 12 FPU cars	10%	0,9%	4%	4%
New 13 to 16 FPU cars	66%	5,2%	1%	2%
New 17 FPU or more cars	187%	11,1%	0%	1%
Total new cars	6%	0,5%	-	-
Average fuel prices	55%	4,5%	-	-
Average fuel consumption liters per 100 km	-10%	-1,1%	-	-
Average distance per car per year (in km)	-9%	-0,9%	-	-
Total fuel consumption for cars (millions of m^3)	-5%	-0,5%	-	-
GPKM in private cars	6%	0,6%	-	-
GPKM in buses	14%	1,4%	-	-
GPKM rail	32%	2,8%	-	-

Data sources: Les comptes des Transports, Fichier central des automobiles (FCA) and Ministère de l'Écologie, de l'Energie, du Développement durable et de la Mer. Data available on 03/2010 showed results only until 2008

GPKM= Billions of passenger-kilometers
FPU=Fiscal Power Units (which are calculated on the basis of the cars max. power and CO2 emissions).

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In this setting, reductions in average travel distances by cars and modal shifts towards public transport can be largely explained by growing fuel prices, which are not entirely under the control of a determined public policy but rather fluctuations on international markets.

This means that we resume the situation in three effects:

- fuel prices and the "GHE bonus-malus" scheme have had little or no impact on total car demand
- fuel prices and the "GHE bonus-malus" have had ad unconvincing impact on reductions stemming from vehicle size effects

- fuel prices have had an important impact on vehicular use and a shift towards public transport.

Furthermore, this implies that the cost of personal vehicle use has increased and that economic policies aiming at influencing vehicle size -and not vehicle demand/use- have resulted in:

- a decrease in car use -with lower consumption averages-

and

- a slow shift towards public transport.

Consequently, this situation has a direct impact on infrastructure use and spatial demand. Stemming from this reasoning, we may ask ourselves if strategies looking to incite people to buy more fuel efficient cars are viable -in the long run- from an infrastructure point of view especially if we compare it to green-modes scenarios or even decoupling scenarios.

In this state of matters, a number of sustainable transport scenarios have been developed, essentially focused on the French economy in order to offer insight on relationships existing between new technologies, market trends, public policy and infrastructure investments. This paper has two aims: Firstly, we explore how a continued market trend in the vehicle market is not viable in the long-term future from an infrastructure point of view. Secondly, we offer insight on how changes in behavior can offer more viable solutions.

2. BAU SCENARIO OVERVIEW & CAR MARKET TRENDS

In light of the environmental situation, it is, more than ever, necessary to shed some light on the important role played by transport activities in greenhouse gas emissions. It is equally important to develop environmental policies for reducing CO_2 emissions and to be able to model them correctly whilst assessing the effects of the different technological, institutional, regulatory and economic options available. The TILT model is a flexible tool that does just that.

The basis of the TILT approach lies on the proposition that a Speed/GDP elasticity implies different modal split possibilities. This is based on the growing importance of higher speeds as affluence and freight value grow (SCHAFER, A., Victor, D.G., 2000). Moreover, the modal split in transport is directly linked to the idea that modal speed; transport times, transport management and household/firm locations determine modal shares. In this manner, transport modal saturation rhythms can be varied -in the model- through public policies affecting location and the speed/GDP elasticity -which has proved to be fairly stable over time and very similar from one country to another (LET-ENERDATA, 2008).

Furthermore, in order to have a more precise view of the effects of public policies on each scenario, TILT has a microeconomic substructure that allows further analysis of demand determinants behind each scenario's modal split.

These results coupled with the model's structure make TILT a powerful tool for building and exploring scenarios. The utility of the TILT model lays not only in its capacity to be flexible concerning political transport measures, changes in demography, behavioral differences as well as changes in transport structure and cost but also in its capacity to integrate new technologies' influence according to their year of entrance on the market and their ability to penetrate it. Furthermore, on the basis of its modeling structure, TILT is able to deliver a clear assessment of public policy sensitivity and infrastructure needs.

The TILT model was used to develop three scenarios and to quantify the effects of climate oriented policies on the problem posed by the massive emission of carbon dioxide by transport activities. The inherent logic in building these technico-organizational scenarios is linked to the idea of growing constraints –ranging from promoting new motor technologies to public policies aiming at decoupling transport activities and GDP-. This underlying principle enables us to present three different scenarios that allow a quick comprehension of what can be obtained through policy mixes.

In short, the three scenarios built by LET&ENERDATA are organized following and incremental constraint on "high carbon footprint behaviors". The main characteristics of the BAU scenario are as follows:

Pegasus - promoting strict tech standards

Pegasus is a BAU (Business As Usual) scenario where the Speed/GDP elasticity of 0.33 for passengers and 0.6 for freight are maintained, and transport times are stable (1 hour per person per day). Pegasus lets us appreciate:

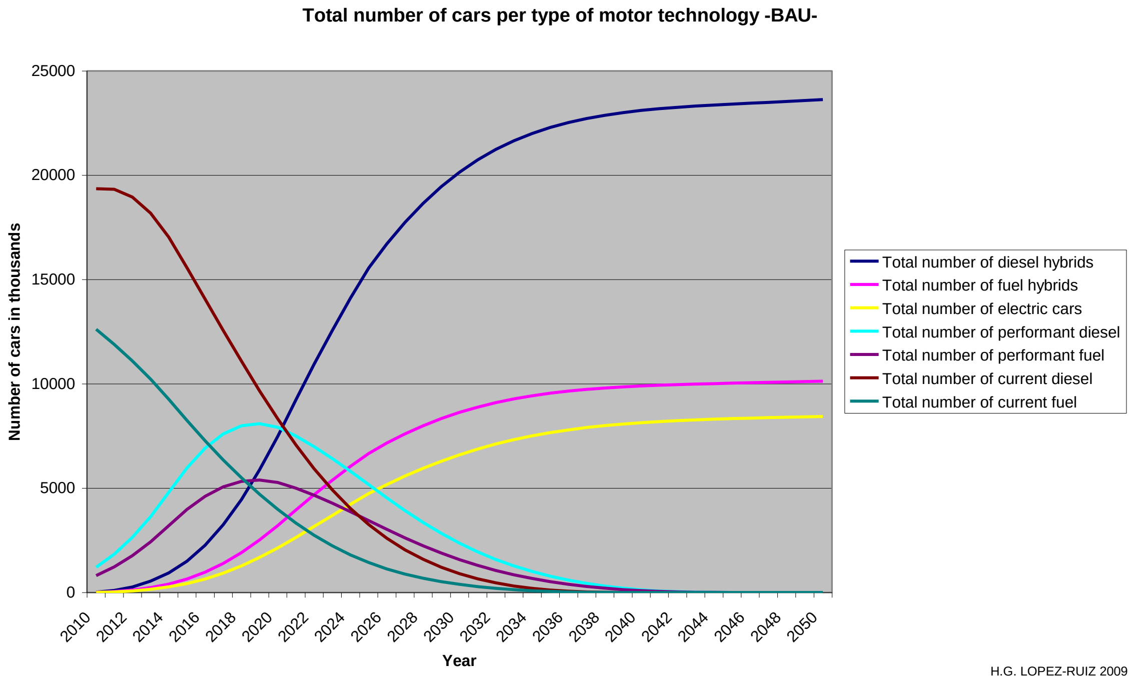
- Transport traffic in a situation where there is no major public policy affecting behavior and/or the system's regular performance (continued infrastructure investments and optimization)
- The effects of new motorization technologies on total CO_2 emissions

In this manner Pegasus lets us evaluate the contribution of strict and realistic technology standards that –according to our calculations- would lead to half of the reductions of the CO_2 emissions target.

In this sense, we can quickly asses that a BAU case scenario (like Pegasus) implies vehicular needs that are numbered at over 42 million vehicles.

As we can see in figure 1, if we suppose that hybrid vehicles go into the market in 2010 and electric vehicles are marketed by 2015, the modeled vehicle fleet would be mainly composed by hybrid vehicles by 2040. New technologies in the Pegasus scenario would translate into a 50% reduction in CO_2 emissions.

FIGURE 1 Total number of cars per type of motor technology



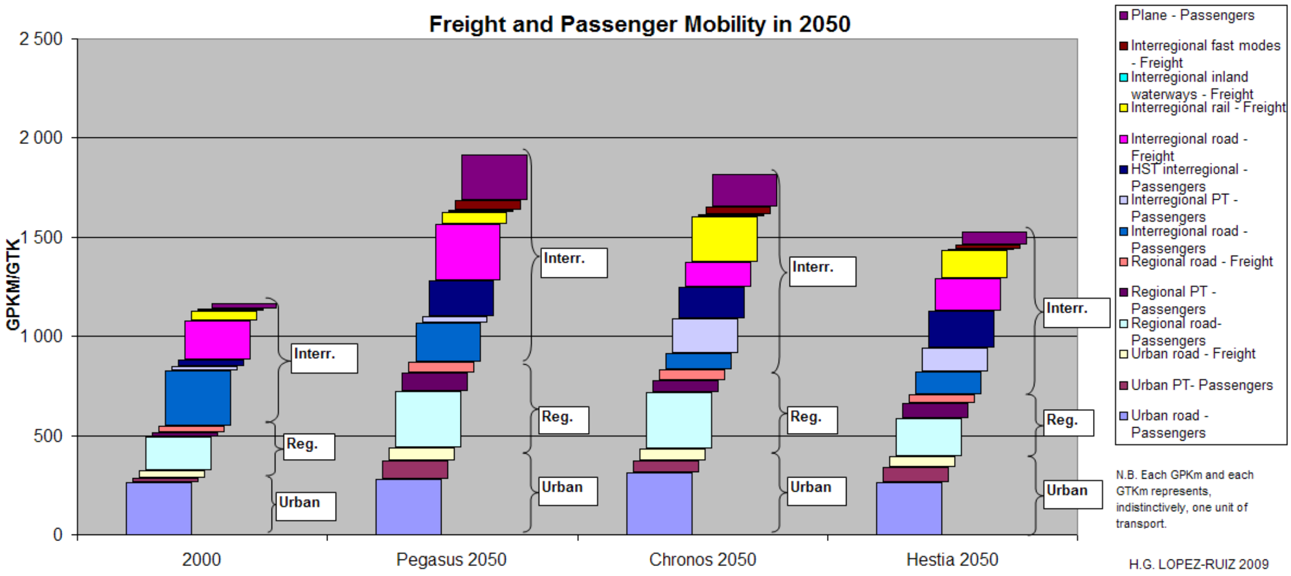
If we take a more detailed look into the Pegaus scenario, we see that it is a scenario based on an inelastic market structure largely dependent on private vehicles. In this scenario, modal split is explained by the fact that a rise in oil prices translates into behavior changes that are determined by a sharp increase in private vehicle cost accompanied by a comparatively more interesting transport offer in public transport. Even though private vehicle costs go up, mobility in Pegasus is very dependent on road transport and, thus, dependent on road infrastructures.

In this manner, if we suppose that market trends in cars continue to follow current practices, it is more than likely that spatial demand for car use –thus infrastructure needs- will grow accordingly. In order to carry out this assessment, we calculated what investments would be needed for infrastructure in a BAU scenario (which will be compared to other scenarios at the end of the paper). In sum, spending on infrastructure would remain at a 1,4% of GDP level (which is roughly the same as today) with most of it going to road infrastructures. The dilemma behind this is linked to the fact that it might be a loss of money to keep on spending money in road infrastructure when it can be spent on something else.

3. EXPLORING ALTERNATIVE SCENARIOS

Accordingly, the Chronos and Hestia scenarios from the LET-ENERDATA report offer a great basis for exploring how sustainable scenarios would shape future investment needs in the transport sector. In the original report, these scenarios are presented as different possibilities to attain important GHG reductions through multimodality and/or decoupling from GDP. On a macroeconomic level, all scenarios have the same hypothesis; the differences between each scenario are linked to the transport structure where: speed/GDP elasticity, modal speeds and transport times differ accordingly to public policy aims. The results for each scenario were obtained through a mix of different policies aiming at sensible changes in transport behavior and new motor technologies. Each of these scenarios implies different characteristics and thus different types of results that are tightly linked to modal shares and demographic dynamics.

FIGURE 2 Freight and Passenger Mobility in 2050



Chronos - promoting green multimodality

In this scenario, market oriented policies constrain the use of high carbon footprint modes leading to an increase in slower transport modes that have a smaller carbon footprint. In Chronos, the 75% reduction objective is nearly attained by favoring greener modes through an increase in transport costs according to their speed and associated emissions. As a result, Chronos shows a change in behavior patterns where the main effects are:

- A trade-off between the system's need for speed (coupled to growth)
- An increase in transport times in order to be able to take full advantage of all modes

Chronos implies a speed/GDP elasticity equal to zero, which translates into an increase in transport times (roughly 1 hour and 20 minutes per person per day) because transport distances are still supposed to be coupled to growth. Thus

Chronos is a scenario based on market oriented public policies in an infrastructure intensive situation (because transport distances and public transport traffic increase sharply).

In this manner, Chronos lets us appreciate:

- The limits of a continuous increase in transport distances linked to financial constraints on the infrastructure investments required to ensure a steady growth in transport distances.
- That a mix of technology and policy can get us to the wished reduction target.

Hestia - promoting decoupling

The main issue in this scenario is a trade-off between an elevated transport cost and transport distance. Indeed, transport costs (both in time and in money) are considered higher than in Chronos. This results in economic agents choosing to modify their localization and concentrate on proximity strategies.

In this manner, Hestia leads the way to the 75% reduction objective through market mechanisms, regulation and spatial planning. This imposes new trade-offs between localization and transport distances. Thus, Hestia also implies a Speed/GDP elasticity equal to zero but, since transport distances increase less rapidly than in Pegasus and Chronos, transport times are reestablished around one hour per person per day. This new equilibrium based on proximity gives the system a better opportunity for the implementation of « low range 0 emissions technologies ».

TABLE 2 Investment Needs

Billions of €	Mode	2050 Pegasus	Per annum	% of GDP	2050 Chronos	Per annum	% of GDP	2050 Hestia	Per annum	% of GDP	Year 2007	% of GDP
Investments	Road	1043	21	0,7%	384	8	0,3%	140	3	0,1%	12	0,9%
	Rail	747	15	0,5%	1529	31	1,1%	992	20	0,7%	2	0,2%
	Public Trn.	137	3	0,1%	74	1	0,1%	77	2	0,1%	2	0,2%
	Others	-	-	-	-	-	-	-	-	-	1	-
	Total	1927	39	1,4%	1987	40	1,4%	1209	24	0,9%	18	1,4%

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Note: - means not applicable - All values are presented in year 2000 euros

As we can see in table 2, these two scenarios let us appreciate a situation where mobility increases from the 2000 level but where infrastructure needs are not as overwhelming as in the two previous scenarios. In sum, Hestia gives us a clear view of how the allocation of funds in planning for CO2 reductions will be crucial. Indeed, the value of CO2 reductions per euro invested, in a BAU scenario, is double than that of the multimodality or the decoupling scenario. What is more, the only explanation for this result is the way public money is invested in different types of infrastructures.

4. CLOSING REMARKS

On the basis of the three LET-ENERDATA scenarios, different ways of attaining planned CO_2 reductions were analyzed and discussed. In sum, realistic technological hypothesis show that a 50% reduction in emissions is a clear possibility and that going further based on new technologies would require very big advances in zero emission vehicles.

Nevertheless, in the absence of these new technologies, the remaining reductions in emissions are possible through different types of policy mixes that come down to:

- Encouraging important modal shifts that would translate into a decrease in total average speed which would in turn make transport times go up.
- Encouraging modal shift accompanied by a decoupling of transport distances. Consecutively, this would help to maintain stable transport times.

In this setting, this paper offered a complete view of current developments concerning organizational solutions that could lead to a reduction in oil consumption and emissions through important changes in the transport structure and behavior patterns and proposes a quantitative analysis of investment needs for different policy mixes.

On this basis, this paper gives insight on how strategies aiming at modifying market trends have had little or no impact on vehicle size but have had a positive impact on average fuel consumption. This in turn has heightened the pressure put on infrastructure demand and will continue to do so in the future. Thus, although policies looking to curb fuel consumption by targeting market trends are getting positive results, they are shortsighted strategies that pose question as to their viability in terms of long-term infrastructure demand linked to car use.

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