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Overview of the policy toolbox for low-carbon road mobility in the European Union

Claire Papaix[1], Bénédicte Meurisse[2]

The transition to sustainable transport, which necessarily implies low-carbon transport, will require a major structural shift in both passenger and freight transport systems. Indeed, rapidly increasing traffic and a high dependency on fossil fuels have made transport a crucial but also a challenging issue with regard to the action required to fight climate change. Indeed, CO_2 emissions from transport have been sharply increasing over the last decades contrary to the observed trends in the other industrial sectors. Since road represents most of carbon emissions we choose to focus in this report solely on the levers for reducing emissions from road mobility systems.

When it comes to the means to steer low-carbon road mobility, most of transport's carbon emissions are not directly covered by "first best" (CO_2-oriented) economic instruments, such as fossil fuel taxation, or very heterogeneously in Europe when it is the case. Therefore, we propose in this report a French and European review of such "first best" and "second best" (not directly CO_2-oriented) policy-tools for rolling out low-carbon transport systems. In particular, command-and-control levers, economic instruments, collaborative initiatives and information and communication policies – applying both to the demand and the supply side of road transportation will be thoroughly analyzed here.

Beyond the proposed framing and efficiency appraisal of the policy-tools, one of the key outcomes of this report is that such regulation package for reducing carbon in transport emissions may be recognized as opportunities for innovation and growth rather than constraints if consistently anticipated and time-wisely influenced by all the actors.

Keywords: Low-carbon mobility, road transport, policy-tools.

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1. PhD student in Economics at the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR) and Climate Economics Chair. claire.papaix@ifsttar.fr

2. PhD student in Economics, Economix and Climate Economics Chair. benedicte.meurisse@chaireeconomieduclimat.org

Climate Economics Chair
Paris-Dauphine University
CDC Climat

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Introduction

The broad range of policy-instruments dealing with road transport's greenhouse gases (GHG) emissions in France and in the European Union (EU) makes possible different relevant classifications. We have chosen in this report a classification of the tools based on the form of action taken by the instrument (e.g. its binding/non-binding feature) as follow: 1. regulatory constraints (see "command-and-control levers"), 2. price-incentives (see "economic instruments"), 3. collaborative tools (see "collaborative initiatives"), and 4. informative policy (see "communication and diffusion"). Each category of the decision maker toolbox can then either play on the demand-side or on the supply-side of the low-carbon mobility system's stakeholders. Correspondingly, we can also classify these instruments according to their target groups, namely: 1. road users (see e.g. speed limit measures, LEZs, HOV lanes, parking access management, pricing schemes related to vehicle purchase, ownership or use, fuel pricing, road user charging, parking fees, energy consumption and CO_2 emissions labeling for new passenger cars), 2. industrial actors (see e.g. CO_2 emissions standards, obligation of a minimum content of biofuels in fuels and tyre labeling), 3. transport professionals (see e.g. the binding information reporting on CO_2 emissions from transport services or eco-driving training) and 4. public authorities (see e.g. norms on publicly accessible charging infrastructures).

Eventually, a noteworthy attention should also be paid to the name of the instrument under consideration. For example, the Eco-tax for heavy goods vehicles in France is totally inspired by the "Lkw-Maut" in Germany which is a toll on major roads. Their different names might (wrongly) suggest they have different scopes and purposes, but thereby these two instruments are each made more or less acceptable to society.
Another confirmation of this hypothesis that "the branding of the charges matters" (Börjesson and al., 2012) was the way in the Stockholm congestion charge trial in 2006 was presented. The system was initially marketed to be aligned with the stated purpose of the charges and with the generally shared environmental preferences among the population. Indeed, the label "environmental charge" emphasized the targeted positive effects on air quality and was thus well-received by the public.

Rapidly increasing traffic and a high dependency on fossil fuels have made transport a crucial issue with regard to the action required to fight climate change (Michelin and CEC, 2011). Indeed, climate action in transport activities is particularly challenging, since they represent 30% of the total CO_2 emissions in the European Union, 38% in France in 2009 (European Commission, 2012a) and levels have increased relentlessly since 1990 (by 26% between 1990 and 2007; European Environment Agency, 2010), whereas CO_2 emissions in other industrial sectors have decreased (by 15%) over the same period.

This is one of the reasons why we mainly concentrate in this report on the carbon emissions related to transport activities rather than paying a wider attention to air pollution when dealing with the environmental impacts of the sector. In fact, even though many cities are still struggling to meet EU legislation regarding concentration limits, observed trends in air pollutants have been downward since 1990 (NOx were reduced between 1990 and 2009 by 25%, PM2.5 by 27%, SOx by 37%, CO by 75% and NMVOCs by 77% (EEA, 2012)) despite the great expansion of activity. In addition, considering both air pollutant fighting measures (e.g. EURO standards) and CO2 emissions regulating tools at once makes economic instruments analysis more complex, since the former can run against the efficiency of the latter (example of the particulate filter).

Therefore, in its publication "A roadmap for moving to a competitive low carbon economy in 2050" (European Commission, 2011a), the European Commission has set an objective by 2030 to reduce transport GHG emissions to 20% below their 2008 level, and has called for a 60% cut by 2050 compared to 1990's levels. The European Commission also pledges in its White Paper (European Commission, 2011b) to halve the use of conventionally fuelled cars in urban transport by 2030 and to phase them out in cities by 2050. The targets for other categories are to achieve a 40% level of CO_2-low aviation fuels by 2050 and to decrease CO_2 emissions from ships by 40%. Similarly in France, the French Climate Plan launched in 2009 (MEDDTL, 2011) sets the objective set in the Grenelle I Act (JORF, 2009a): by 2020 to cut by transport GHG emissions by 20% i.e. to return to 1990's levels within this period.

To achieve these goals and to reduce the carbon footprint of transport systems, several levers are called up in the French climate action plan:
a) the rationalization of the current road, air, rail and maritime transport systems, through a clear regulatory approach (i.e. binding norms, etc.), pricing (namely tax, subsidies, tax credits) or market-based (such as the inclusion of the transport sector (see Russo and Boutueil, 2011) in the policy tools of the European Emissions Trading Scheme (EU ETS)). The aim is to trigger technological changes and, in particular, to improve the energy-emissions performance of the new fleet;
b) the promotion of modal shift supporting low-carbon transport modes (notably rail and maritime), namely through the kilometer eco-tax applying to heavy-duty vehicles (as planned in the Grenelle I Act) for freight, the consolidation of public transit or the implementation of the projected Low Emissions Zones (LEZ) for passenger transport;
c) information and communication measures directed towards users (e.g. labeling), local communities and transport utilities (e.g. training programs for bus drivers, energy suppliers, etc.) and
d) structural governance, for instance through the strengthening of the link between inland transport organization and urban planning management.

However, when it comes to the methods for achieving low-carbon transportation, most transport GHG emissions are not directly covered by "first best" economic instruments, such as fossil fuel carbon taxation. Indeed, "taxing cars or kilometres" rather than the fuel is an indirect and imperfect way of taxing GHG emissions as these depend on how the car is used" (OECD, 2011). Some exceptions exist though and a few carbon tax schemes have been put in place in British Columbia, Denmark, Finland, Norway, Sweden, Switzerland and Ireland (OECD, 2012). Therefore, we propose in this report a French and European review of such "first best" and "second best" policy-tools for rolling out low-carbon mobility systems.

Furthermore, since road represents 72% of CO_2 emissions from transport activities in the EU-27, and 79% in France in 2009 (European Commission, 2012a), we choose to focus in this report solely on the levers for reducing emissions from road mobility systems. This work is not full-fledged and not all the measures for internalizing CO_2 emissions from road transport will be considered here, simply because of the great variety of such policy-tools in the EU.

Thus, we will identify some French and European policy-makers' commanding heights to make the low-carbon mobility pathway happen and, for this, we will proceed as follows: first we will explore the "command and control" levers (**part. I**), then the economic instruments (**part. II**), the collaborative initiatives (**part. III**) and finally information and communication policies (**part. IV**).

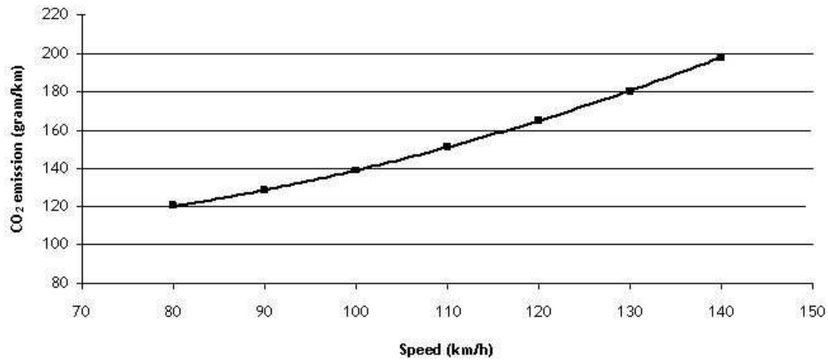
1. Command and control levers

1.1. Demand-side

1.1.1. Speed limits

Since on average, vehicles burn less fuel per kilometre at lower speeds (figure 1), tightening speed limits can reduce transport CO_2 emissions. For example, a CE Delft pilot study has estimated a 30% reduction of CO_2 emissions on highways (in the longer term) if speed limit is reduced from 130km/h (110km/h in wet-weather) to 80km/h (Otten and van Essen, 2010).

Figure 1: Relationship between vehicle speed (km/h) and CO_2 emissions (g/km) at constant speed



Source: Otten, M. & van Essen, H., 2010.

In most cases, speed regulation is used to improve road safety. Nevertheless, some European countries have already had recourse to speed limit in order to reduce air pollution. For example, it has been used in Barcelona (Spain) since December 2007, where the upper speed limit on highways and major roads (i.e. applying to a perimeter of about 80km) was reduced to 80km/h. The Polytechnic University has estimated that this speed limit measure achieved a saving of 93,400 tonnes of CO_2 (ADEME, 2009).

Correspondingly, speed moderation measures have been undertaken in French cities. Lille Métropole for instance has included in its Urban Mobility Plan of 2000 (LMCU, 2000) a charter for speed moderation (30km/h) in the wake of the air quality Act "Loi sur *l'Air et l'Utilisation Rationnelle de l'Energie* (LAURE)" of 1996.

1.1.2. Low Emission Zones

Low Emission Zones (LEZs) are areas or roads where the most polluting vehicles (classified according to the "Euro Standards") are restricted (i.e. banned from or charged for entering the zone). LEZs aim at reducing pollutant emissions by forcing drivers to: a) buy a lower emission vehicle; b) retrofit (incorporating a pollution abatement equipment like a diesel particulate filter, a cleaner engine, etc.); c) check for exemptions or d) change their journey. By doing so, these tools also contribute to the reduction CO_2 emissions.

Table 1 illustrates selected LEZs initiatives as implemented in three European countries in 2008: Germany (Umweltzone), UK (Low Emissions Zone) and Sweden (Miljözon).

Table 1: Description and estimation of costs and impacts of LEZs

	Germany	United Kingdom: London	Sweden
Vehicles banned	All petrol and diesel vehicles without catalytic converter (see emissions standards according to the color of the sticker in annex N°1)	Lorries and buses	Lorries more than 6 years old (excluding lorries less than 8 years old that respect EURO III)
LEZ area	39 cities	1,600km² (7M inhabitants)	Lund (5,7km²) Stockholm (40km²) Göteborg (30km²) Malmö (65km²)
Monitoring system	Sticker on the windshield	Surveillance camera	Visual inspection by Police

Cost		£ 17,4M (implementation & operating costs)	SEK 18,5M (implementation cost only)
Average fine	€40	£ 500-1,000	SEK 1,000
Revenues allocation		No specific uses	
Nox emissions	-14%	-2,7%	-10%
PM emissions	-25%	-19%	-40%
Car fleet			+21% diesel -48% gasoline -50% ethanol

Source : ADEME, 2009

LEZs do also exist in the following European countries: Netherlands (heavy goods vehicles forbidden), Norway (buses and heavy goods vehicles), Italy (all vehicles), Denmark (heavy goods vehicles), Czech Republic (vehicles over 3,5t), Austria (vehicles of more than 7,5t). Euro classes, motorization types and vehicles' maximum weight allowed/forbidden in the regulated zone vary according to the country and even between cities within a given country (ADEME, 2009).

Firstly introduced in the "Grenelle II Act" in 2010 (JORF, 2010), LEZs are currently experiencing difficulties in France. Their experimentations were authorized under the following conditions (MEDDE, 2013b):

- Only for municipalities or groups of municipalities of more than 100,000 inhabitants with a "Urban Transportation Plan" (PDU in French);
- Requirement of a preliminary impact study in consultation with stakeholders;
- Publication of the information required to evaluate the project every 12-months;
- An experimentation period of 3 years (4 and a half years in the case of an extension).

Yet, those French agglomeration communities which are eligible judge the scheme too strict and rather unfair for the owners of high-polluting cars. However, 182 LEZs exist in the EU in 2012 and should France continue to lag behind it could be exposed to heavy financial penalties. Indeed, considering the average level of particles concentration in French cities over the last years, the penalty imposed by the European Justice Court could reach about €100M by 2016 (Journal de l'environnement, 2012).

1.1.3. High-Occupancy Vehicles (HOV) lanes

A solution to reduce congestion (i.e. to reduce CO_2 emissions too) is to limit the number of cars circulating on the road. While people increasingly tend to drive alone, High-Occupancy Vehicles (HOV) lanes are intended to encourage drivers to share vehicles (carpooling) or to take public transport like buses, making their journeys using lanes reserved for High-Occupancy Vehicles.

HOV lanes benefit both to motorists and to the whole community (Ontario Ministry of Transportation, 2013) making journey times faster, reducing travel costs (since car-poolers can actually share the monetary cost and passengers can benefit from less stress caused by traffic congestion), increasing taxicabs and airport shuttles activities, encouraging Electric Vehicle purchase (EVs are sometimes authorized to take HOV lanes) and finally reducing GHG emissions.

Yet, in the USA where HOV lanes have been in existence since the 1990's, results show that the efficiency of the scheme has not reached any consensus, particularly because of the weakness of environmental impacts and due to the sizeable operating costs. Nevertheless, traffic conditions have improved and the complex pricing scheme didn't seem to be a barrier for drivers (CGDD, 2009).

In the EU, road priority access for HOV are generally limited to reserved lanes for buses, although in Norway electric cars are also allowed to use bus lanes (The Green Car, 2013).

1.1.4. Parking policies

- **Designing new parking conditions**

Degrading parking conditions in city-centres (i.e. by adjusting the number or the geographical location of new parking places, increasing the walking time to the final destination, etc.) and, conversely, enhancing peripheral parking capacity (near to public transit facilities) represent an efficient tool to deter car use and to promote modal shift within or at the borders of urban areas.

This has been investigated for the French city of Lille. The main conclusions of this empirical work (Hasiak et al., 2011) are that:

- Most research on modal choice modelling has difficulty identifying parking conditions as a key determinant of individuals' mode choice. Indeed, they only refer to "penalties" (e.g. difficulty of getting parked), "pegged to expert opinions on the basis of highly empirical field knowledge".
- Under the specification of indicators to qualify the difficulty of parking conditions (high, medium or low constraints) and considering the extension of parking constraints in the city of Lille in 2006, the authors show that, on average: if 60% of short journeys (<2 km) are made by car under the "low level of parking constraints" scenario, walking mode share gets predominant (64% of the journeys) in zones with the highest level of parking constraints.

- **Optimizing existing parking conditions**

Under the current parking supply conditions in cities, looking for a parking place represents about 30% of car traffic in town and is responsible for 20% of CO_2 emissions (Zenpark, 2013). In France, Zenpark aims at facilitating parking and reducing circulation and emissions. Several motorists can use the same parking space but at a different time of the day/week depending on their activities (residents mostly use parking spaces during the night and at weekends whereas commuters generally use them during the day) and by doing so they can reduce their parking costs. Zenpark is currently proposing services in Paris and Strasbourg.

Similarly, a new parking sign (see below) was introduced in January 2013, indicating "reserved parking for car-sharing" (Lievre ou tortue, 2013).

C1a + M4z

In addition, electric vehicles benefit from special parking facilities too, to the extent that they are assigned 10% of the car spaces (Decree N°2011-873, European Commission, 2011c).

1.2. Supply-side

1.2.1. Binding targets related to CO2 emissions

Emissions standards are difficult instruments to handle when it comes to diffuse emissions. One difficulty stems from the need to define normative levels for very varied sources: passenger cars, light-duty vehicles (LDV), trucks, etc. (de Perthuis and Jouvet, 2011).

1.2.1.1. The CO_2 emissions standards for new passenger cars

From an historical perspective, the European Commission started in 1995, proposing a target of 120 CO_2g/km to be achieved as an average across the EU by 2005-2010. Transport operators would have preferred an option at that time (1999) of a non-binding agreement to achieve 140 CO_2g/km by 2008, but they failed (in 2008 the EU-wide average was 150 CO_2g/km in 2008 on average in Europe). Therefore, the European Parliament (see the Regulation EC n°443/2009, European Commission, 2009a) approved the legally binding target of 130g CO_2/km to meet on average for the new fleet in Europe by

2015[1] (representing fuel consumption of approximately 5.6 litres per 100km for petrol cars and 5.0 litres per 100km for diesel cars) and the more stringent target of 95 CO_2g/km to be achieved by 2020 (see modalities and aspects of implementation in European Commission (2012b) and (2013)).

Individual manufacturers' targets are differentiated on the basis of the average weight of the cars produced during the year under consideration (table 2). For example, if a car manufacturer's vehicles are 100 kg heavier than the industry average by 2015, it will be granted an additional 4.57 CO_2g/km as its target (Transport & Environment, 2012). To some extent, regulation on CO_2 emissions takes the form of an average target for all cars sold, and does not consist of a fixed upper limit that may not to be breached by any car.

Table 2: Ranking of the percentage reduction in CO2 each car manufacturer now has to make in order to hit its 2015 EU CO2 target

Ranking		2011 Performance	Target 2015*	Reduction Required
1-	Peugeot Citroën	127.4	127.8	**-0.3%**
2-	Toyota	126.8	127.2	**-0.3%**
3-	Fiat	119.4	119.1	0.3%
4-	General Motors	135.4	131.2	3.2%
5-	Ford	132.2	127.0	4.0%
6-	Volkswagen	137.3	131.8	4.0%
7-	Renault	131.4	125.7	4.4%
8-	BMW	144.8	138.4	4.4%
9-	Volvo	151.4	144.2	4.7%
10-	Hyundai	134.2	126.9	5.5%
11-	Honda	144.9	135.2	6.6%
12-	Suzuki	131.6	119.5	9.2%
13-	Nissan	142.9	129.3	9.5%
14-	Daimler	153.5	138.3	9.9%
15-	Mazda	146.6	128.3	12.5%
	Average**	135.8	130.0	4.3%

*assuming the average weight of the company's new cars in 2015 will be the same in 2011
**average = average of all carmarkers

Source: Transport & Environment, 2012.

Individual manufacturers can also file for joint-compliance and "pool" ("on an open, transparent and non-discriminatory basis") with other manufacturers (the duration may not exceed five years, but may be renewed), in order to average their emissions over a larger pool of vehicles. This flexibility mechanism is called 'pooling'.

This regulation has been enforced gradually and through a system of fines. Indeed, the legally binding target of 130CO_2g/km to be reached by 2015 includes actually four different periods: a first one in which 65% of the compliance has to be done by 2012, a second in which 75% of the target has to be fulfilled by 2013, a third one in which 80% has to be completed by 2014 in order to be on track for 2015 (the fourth and last period). Between 2015 and 2018, penalties for missing the target are equal to 5€ for the first CO_2g/km in excess of 130CO_2g/km, to 15€ for the 2nd, to 25€ for the 3rd and to 95€ for the rest (Transport & Environment, 2012). From 2018, for each vehicle sold with CO_2emissions in excess of its target, the manufacturer will have to pay a fine of 95€ per exceeding CO_2g/km.

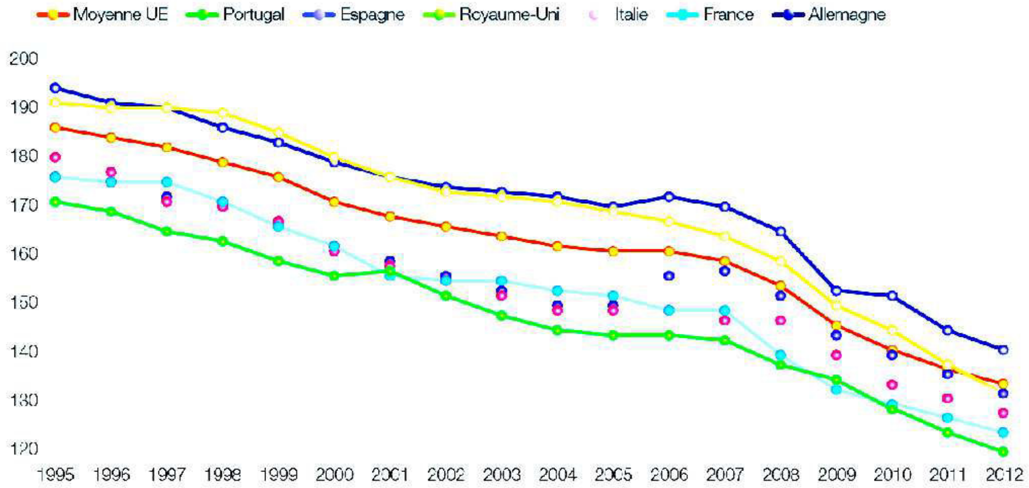
[1] with an additional 10g/km emission reduction due to complementary measures such as biofuels, driving behavior and environmentally friendly tiers

However, in spite of the existence of the fines scheme, CO_2 emissions would exceed the standards, due to the following loopholes (Transport & Environment, 2012):

- 'Eco-innovations' are being rewarded with credits (up to 7 CO_2g/km);
- Manufacturers who produce low-emitting vehicles (LEVs) are being rewarded with 'supercredits', which allow them to count each LEV as more than one car (1.3 more exactly). Consequently, this waters down the overall CO_2 reductions. Additionally, in February 2013, the « Verband der Automobilindustrie » has sent a request to the European Commission in order to increase this coefficient from 1,3 to 2 or 3 (CCFA, 2012a);
- Niche manufacturers (i.e. car manufacturers with between 10,000 and 300,000 sales in the EU, like the Japanese carmakers Mazda and Suzuki for example) should be allowed to benefit from an alternative target which is 25 % lower than their average specific emissions of CO_2 in 2007;
- Carmakers with less than 10,000 sales in the EU can negotiate their own target with the Commission.

In effect, CO2 emissions have decreased from 158 CO2g/km to 136 CO2g/km from 2007 to 2011 in the EU (figure 2), corresponding to a fuel consumption reduction of 0.9l per 100km (Transport & Environment, 2012).

Figure 2: Evolution of new car CO2 emissions in the EU over time



Source: Cetelem, 2013

CO_2 emissions standards do not seem to be ideal when reference is made to the "cheating" practices of car manufacturers in respect of CO_2 emissions test conditions. In fact, car manufacturers are "optimising" the way they put cars through official tests. Therefore, test results do not reflect real-life driving conditions and some emissions reductions (30% according to Ricardo, AEA & TNO, 2012) are due to such test manipulation rather than to genuine improvements. In addition, the report mentions a €135 annual extra cost due to a higher consumption of fuel[2]. Furthermore, emissions standards regulation appears to be too permissive, according to a T&E/Greenpeace study (Ricardo & AEA, 2012), which shows that a target of 60 CO_2g/km could actually be achieved through existing technologies by 2025, assuming a relevant mix of electric (24%), hybrid (24%) and conventionally-fuelled cars (52%). The potential additional costs for hitting this target of 60 CO_2g/km by 2025 could be around €2,370 per vehicle.

Correspondingly in France, we can note the objective set in the Grenelle I Act (JORF, 2009a) to bring down CO_2 emissions from the entire (existing plus new) car fleet to 120 CO_2g/km by 2020 (averaging 176 CO_2g/km in 2011, MEDDTL, 2011).

[2] Taking into account actual fuel price, for a 2010 car with 14,000km.

1.2.1.2. The CO2 emissions standards for light-duty vehicles

Light-Duty Vehicles (LDVs) along with motorcycles were exempted until 2011 from CO_2 emissions standards and from any forms of environmental registration taxation schemes, although they representing 19.4% of CO_2 emissions from road mobility in 2010 (CGDD, 2012).

Regulation EC n°510/2011 (European Commission, 2011c) has set in 2011 a binding target of 175 CO_2g/km applying to the new LDVs sold, which has to be achieved progressively from 2014 to 2017. Car manufacturers adapt their response according to their vehicles' dimensions. Indeed, targets vary depending on vehicle's authorized loaded weight (PTAC in French) in the following way (table 3):

Table 3: CO2 emissions/km objectives for light-duty vehicles from 2014 to 2017

Authorized loaded weight	CO_2 emissions (gr/km)
1,5t	156
2t	202
2,5t	249
3t	295
3,5t	342
Total	175

Source : Regulation EC n°510/2011 (European Commission, 2011c)

The French General Commission on Sustainable Development (CGDD in French) has estimated LDVs CO_2 emissions per kilometre, according to the vehicle's dimensions and fuel type in 2005 (table 4):

Table 4: CO2 emissions according to vehicle's dimensions and fuel type in 2005

Light-duty vehicle	CO_2 emissions (g/km) for light-duty vehicles in 2005		
Authorized loaded weight	**Diesel**	**Gasoline**	**Liquefied petroleum gas (LPG)**
<1.5t	181	191	130
1.5t<x<2.5t	202	220	158
2.6t<x<3.4t	277	288	267
3.5t	317	0	259
Total	229	203	164

Source: CGDD, 2011

Tables 3 and 4 show that LPG vehicles (i.e. 0.5% of the fleet) and diesel vehicles with an authorized loaded weight higher than 1.5t (i.e. 73% of the fleet) have already hit the 2017 binding target in 2005 (taking into account a medium weight for each authorized loaded weight class).

Looking to the future, the European Commission is considering setting a target of 147 CO_2g/km for LDVs to be met by 2020 (Regulation EC n°510/2011, European Commission, 2011c).

Other than in Europe and regarding Heavy Duty Vehicles (HDVs) this time, China is planning to strengthen by July 2014 its fuel consumption standard (in place since July 2012) in order to reduce CO_2 emissions from freight and to extend the regulation to new commercial trucks, dump trucks, tractors, coaches and buses with gross vehicle weight over 3,500 kg as well as tighten the fuel consumption limits (only for tractors, trucks and coach, and less stringently for models) by an average of 10.5% to 14.5% (ICCT, 2013). Under this regulation, the new fleet average HDV fuel consumption is expected to drop by about 11% by 2015, resulting in 5 - 6 million tons of annual oil saving.

1.2.2. Binding targets related to biofuels

As framed in the Renewable Energy Directive of 2003 (European Commission, 2003), “Member States should ensure that a minimum proportion of biofuels or other renewable fuels is placed on their markets and, to that effect, shall set national indicative targets”. For these targets, the EU Directive fixes the following references values:

- a minimum 2 % biofuels must be incorporated into the petrol and diesel transport fuels by 31 December 2005 (calculated on the basis of the energy content); and
- a minimum 5.75 % biofuels, by 31 December 2010.

After a first amendment of the Directive (European Commission, 2009b), the European Commission revised the Renewable Energy Directive again in 2012 (European Commission, 2012c) and provided more incentives to promote “advanced biofuels” (from waste or algae and including sustainability criteria) rather than “conventional biofuels” in the achievement of the target of a 10% share for renewable energy in the transport sector. As an indication, the share of renewable energy in transport in the EU in 2010 is of 4.7% and biofuels are the main contributor to this, with a 4.4% share. (Europa, 2013).

In 2005 the French biofuels plan in set the following minimum proportions of biofuels to be introduced into conventional fuels (table 5):

Table 5: Required percentage of biofuels in transport fuels according to the French biofuels plan

Year	2005	2006	2007	2008	2009	2010	2015
Minimum percentage of biofuels in fuels	1,20%	1,75%	3,50%	5,75%	6,25%	7,00%	10,00%

Source: Bordet et al, 2006

It should be noted that the French biofuels plan is more ambitious than the European policy. Indeed, French policy targets a 7% share of biofuels for 2010 against 5.75% at the EU level. Similarly, whereas the 10% incorporation target is scheduled for 2020 in the EU, it applies by 2015 in France.

In addition, fiscal instruments to support biofuels production (as included in the French biofuels plan) are (Cour des Comptes, 2012):

- a reduction of the domestic consumption tax. From 2005 to 2010, the reduction was €2,65 billion (i.e. €1,5 billion for biodiesel and €0,85 billion for bio-ethanol);
- a general tax on polluting activities (TGAP in French) for fuel producers and distributors who do not achieve the minimum percentage of biofuels in fuels. Note that they are not legally obliged to comply with the minimum percentage, but it is very disadvantageous, and the general tax on polluting activities encourages them to do so.

However, the French Court of Auditors has pointed out that consumers had borne a cost of €3 billion (from 2005 to 2010) due to biofuels policy development and the resultant higher levels of fuel consumption (caused by the relatively lower energy efficiency of biofuels) and higher pump price (Cour des Comptes, 2012a).

From a European point of view, the regulatory context for biofuels in Sweden is of particular interest. It is characterized by strong policy support, implemented at an early stage, with the main existing measures for encouraging the use of biofuels in the country being:

- Energy and carbon taxes exemptions for renewable fuels until 2013 (BEST, 2009). Yet, the ongoing consideration of the actual carbon content of biofuels from a life-cycle analysis (even though this is very difficult to calculate) (“Budget Bill for 2011”, see OECD, 2011) could lead to a reconsideration of these tax exemptions, or at least to adjust them depending on their real environmental impact, in order to better address the CO_2 externality;
- Vehicle tax reductions for bioethanol buses, leading to an annual tax of €23 against €2,600/annum for diesel buses (BEST, 2010);

- regulations regarding filling stations: operators selling over 1,000 m^3 petrol/diesel per year need to supply at least one type of renewable fuel;
- Investment subsidies (cf. local programs for investments in “green” projects).

Moreover, the overall structure of energy and CO_2 taxation was reviewed by the Government Commission on Green Taxation in 1997 in order to ensure consistency between all environmental fiscal measures.

However, experts claimed that developing biofuels in Sweden has been very costly, particularly with reference to the cost of such policy packages and to the underlying cost of “lock-in effects” related to this technology (OECD, 2011). The total cost for promoting the use of biofuels has been estimated at an average of €350 per ton of CO_2 avoided (OECD, 2011). However, Sweden bears only a very small part of the production cost, as it is mainly importing biofuels (80% of ethanol supply is imported, mostly from Brazil, incidentally offsetting in part local GHG emissions reductions[3]),

Furthermore, the “additionality” of biofuels subsidies is estimated to be very low. Indeed, 70% of the public support would have occurred anyway (OECD, 2011) and this is attributable to weak controlling measures and to very high administrative costs.

1.2.3. Binding targets related to EV charge plugs

At the European level, the Commission is proposing to Member States a package of mandatory targets on a minimum level of charging infrastructure (table 6) for clean fuels vehicles to roll-out by 2020, along with common EU standards for plug-in charging equipment. This could be a response to the following vicious circle (Europa, 2013):
- The price of electric vehicles is not competitive because there is not enough demand;
- Consumers don’t buy clean vehicles because they are expensive and the refueling stations do not yet exist.

Table 6: Minimum number of electric vehicle recharging points in each Member State

Member States	Existing charging points 2011	Proposed targets of publicly accessible infrastructures by 2020	Member States’ plans for number of electric vehicles for 2020
Austria	489	12,000	250,000
Belgium	188	21,000	
Bulgaria	1	7,000	
Cyprus	-	2,000	
Czech Republic	23	13,000	
Germany	1,397	150,000	1,000,000
Denmark	280	5,000	200,000
Estonia	2	1,000	
Greece	3	13,000	
Finland	1	7,000	
France	1,600	97,000	2,000,000
Hungary	7	7,000	
Ireland	640	2,000	350,000
Italy	1,350	125,000	130,000 (by 2015)
Lithuania	-	4,000	

[3] Besides, as fossil fuels are not taxed for the emissions generated by their production and transportation, this leads to an asymmetry in taxation between fuels.

Luxembourg	7	1,000	40,000
Latvia	1	2,000	
Malta	-	1,000	
Netherlands	1,700	32,000	200,000
Poland	27	46,000	
Portugal	1,350	12,000	200,000
Romania	1	10,000	
Spain	1,356	82,000	2,500,000
Slovakia	3	4,000	
Slovenia	80	3,000	14,000
Sweden	-	14,000	600,000
United Kingdom	703	122,000	1,550,000

Source: Europa, 2013

In addition, the European Commission announced in January 2013 that the "Type 2" plug will be the common standard for charging EVs in the EU (Euractiv, 2013). This decision is to the detriment of French vehicles and their charging infrastructures, the only ones in Europe to be compatible with Type 3 plug.

France has also started to develop infrastructures for electric vehicles. The French Grenelle II Act (JORF, 2010) requires every new building (with building permit application from January 2012) with parking units to have them connected to an electricity supply, whilst car parks at work places and all existing buildings with parking facilities will need to have such electricity connections by January 2015. In addition, the French Grenelle II Act establishes a right to equip a parking space with an electric charging port in co-ownership properties.

2. Economic instruments

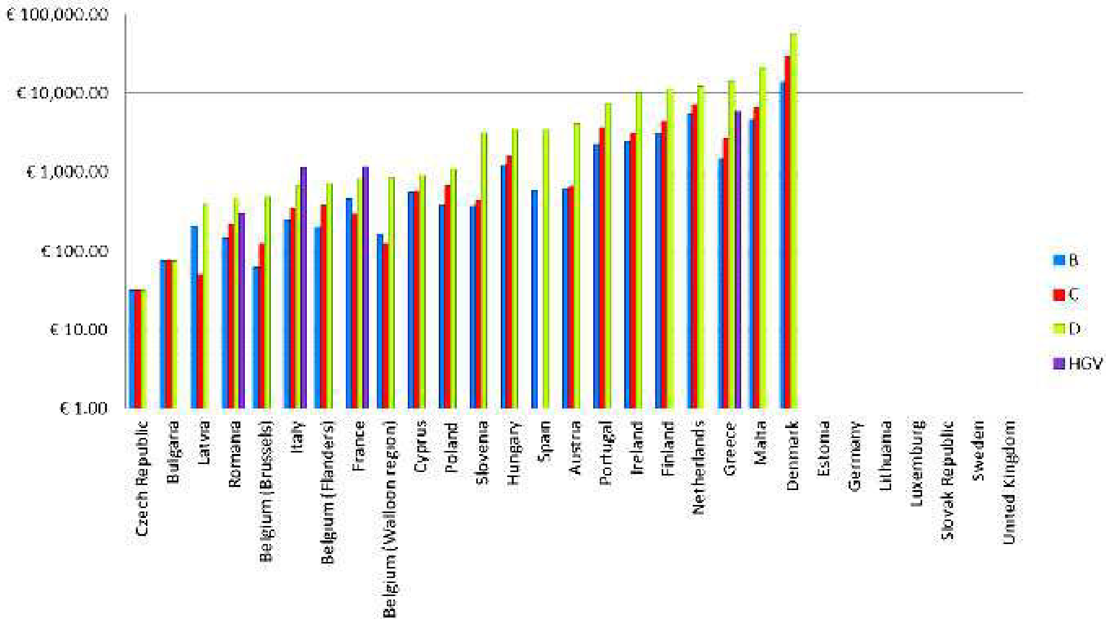
2.1. Demand-side

2.1.1. Automobile purchase pricing schemes

Registration taxes allow for the promotion or discouragement of certain vehicles types. Therefore, most EU countries (20 out of 27) have adopted registration tax schemes. Nevertheless, tax levels (figure 3) and criteria for calculating the tax rate (CO_2 emissions, EURO class, value of the vehicle, engine power, etc.) vary greatly between countries. For example, CO_2 emissions are largely included in the registration taxes calculation in nine countries (Austria, France, Latvia, Malta, the Netherlands, Portugal, Romania, Slovenia and Spain) and in the Flemish region of Belgium and constitute a minor parameter in four other countries (Cyprus, Denmark, Finland and Ireland) and in the Walloon region in Belgium. Note that France is one of the six countries in the EU to also apply registration tax on commercial freight vehicles (European Commission, 2012d).

Finally, annual revenues of registration tax range between €5.01M (Latvia), €2,005.00M (Netherlands) and €1,919.00M in France. (European Commission, 2012d). To set the example of the Netherlands, the car purchase tax was estimated to reduce 0.6–1 MtCO2 per year representing 2–3% of total transport carbon emissions (Harmsen et al., 2003). However, this estimate was based on a comparison of the average car size in the Netherlands compared to the average size in countries without purchase tax, thus potentially overestimating the effect on car size as there are likely to be other factors that also contribute to lower average car sizes. An econometric modeling study using data from 1995 to 2004 suggested that registration taxes in place in that period did not have an important impact on the CO2 emissions intensity of the new passenger car fleet over and above the effects of circulation and fuel taxes (Ryan et al., 2009)[4].

Figure 3: Comparison of registration taxes in EU Member States for selected vehicles (for 2012)



Source: European Commission, 2012d
Note: See Annex N°2 for description of vehicles B, C and D.

Registration taxes in the EU include in most cases a "bonus/malus" scheme and a "scrapping premium" scheme that are described more precisely below.

2.1.1.1. The ""Bonus/Malus scheme

The bonus/Malus or feebate is a "combination of a vehicle purchase tax/fee and a rebate/subsidy used to reward buyers that are more fuel efficient than the average vehicle in that class and penalize buyers of less efficient vehicles" (Brand et al, 2013). In France since 2012, a bonus of €7,000 is attributed to the purchase or leasing of new low-carbon vehicles emitting less than 20 CO_2g/km. Moreover, since 2012 a bonus of €4,000 is attributed to the purchase of an electric vehicle. Indeed, in accordance to the Decree n° 2007/1873 (JORF, 2007) and to the French General Tax Codes (JORF, 2013a), bonus (initiated in 2007) and malus (2008) amounts are each revised annually in order to reflect the Government's financial equilibrium (tables 7 and 8).

Table 7: Bonus over time in France

<table>
<tr><th>CO_2 emissions (g/km)</th><th>2008 & 2009</th><th>2010</th><th>2011</th><th>Until 31/07/12</th><th>Until 31/12/12</th><th>2013</th></tr>
<tr><td><20</td><td rowspan="3">5000</td><td rowspan="3">5000</td><td rowspan="3">5000</td><td rowspan="2">5000</td><td>7000</td><td>7000</td></tr>
<tr><td>20<x<50</td><td>5000</td><td>5000</td></tr>
<tr><td>50<x<60</td><td>3500</td><td>4500</td><td>4500</td></tr>
<tr><td>60<x<90</td><td rowspan="3">1000</td><td rowspan="2">1000</td><td>800</td><td>400</td><td>550</td><td>550</td></tr>
<tr><td>90<x<95</td><td rowspan="4">400</td><td rowspan="3">100</td><td rowspan="3">200</td><td rowspan="3">200</td></tr>
<tr><td>95<x<100</td><td rowspan="3">500</td></tr>
<tr><td>100<x<105</td><td rowspan="2">700</td></tr>
<tr><td>105<x<110</td><td>0</td><td>0</td><td>0</td></tr>
</table>

[4] In Brand et al, 2013

<table>
<tr><td>110<x<115</td><td rowspan="2"></td><td></td><td rowspan="4">0</td></tr>
<tr><td>115<x<120</td><td rowspan="2">100</td></tr>
<tr><td>120<x<125</td><td rowspan="2">200</td></tr>
<tr><td>125<x<130</td><td>0</td></tr>
</table>

Source: Authors from the French General Tax Codes

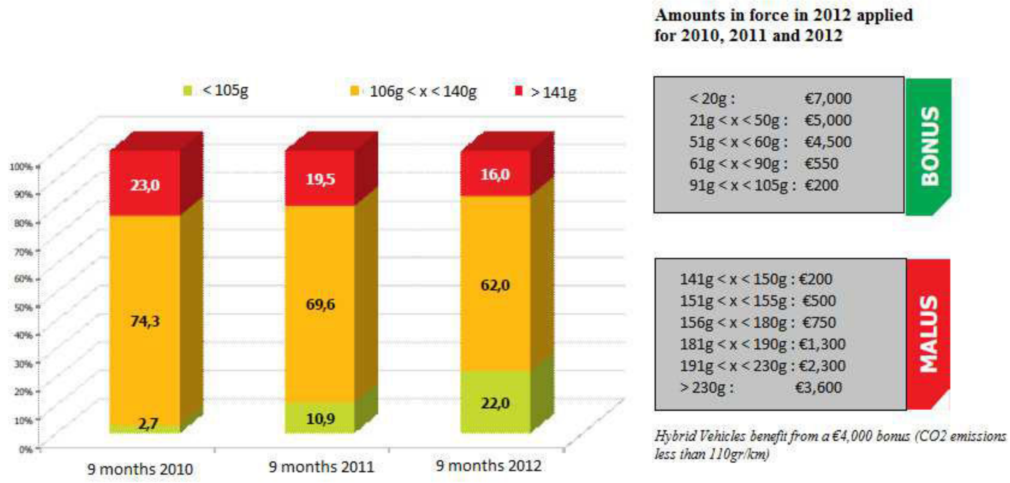
Table 8: Malus over time in France

<table>
<tr><th>CO_2 emissions (g/km)</th><th>2008 & 2009</th><th>2010</th><th>2011</th><th>Until 31/07/12</th><th>Until 31/12/12</th><th>2013</th></tr>
<tr><td><135</td><td rowspan="6">0</td><td rowspan="5">0</td><td rowspan="4">0</td><td rowspan="2">0</td><td rowspan="2">0</td><td>0</td></tr>
<tr><td>135<x<140</td><td>100</td></tr>
<tr><td>140<x<145</td><td rowspan="2">200</td><td rowspan="2">200</td><td>300</td></tr>
<tr><td>145<x<150</td><td>400</td></tr>
<tr><td>150<x<155</td><td>200</td><td>500</td><td>500</td><td>1000</td></tr>
<tr><td>155<x<160</td><td>200</td><td rowspan="7">750</td><td rowspan="5">750</td><td rowspan="5">750</td><td rowspan="4">1500</td></tr>
<tr><td>160<x<165</td><td>200</td><td rowspan="7">750</td></tr>
<tr><td>165<x<170</td><td rowspan="7">750</td></tr>
<tr><td>170<x<175</td></tr>
<tr><td>175<x<180</td><td>2000</td></tr>
<tr><td>180<x<185</td><td rowspan="2">1100</td><td rowspan="2">1300</td><td>2600</td></tr>
<tr><td>185<x<190</td><td>3000</td></tr>
<tr><td>190<x<195</td><td rowspan="4">1600</td><td rowspan="3">1600</td><td rowspan="3">2300</td><td rowspan="2">5000</td></tr>
<tr><td>195<x<200</td><td rowspan="4">1600</td></tr>
<tr><td>200<x<230</td><td rowspan="4">1600</td><td rowspan="5">6000</td></tr>
<tr><td>230<x<240</td><td rowspan="4">2600</td><td rowspan="4">3600</td></tr>
<tr><td>240<x<245</td><td rowspan="3">2600</td></tr>
<tr><td>245<x<250</td><td rowspan="2">2600</td></tr>
<tr><td>>250</td><td>2600</td></tr>
</table>

Source: Authors from the French General Tax Codes

Registrations per bonus/malus class in France have changed since 2010 in the following way (figure 4):

Figure 4: Registrations per bonus/malus class in France



Source: CCFA, 2012b

Note that preliminary results show that the average new light duty vehicle CO_2/km went from fourth lowest to the lowest (133 CO_{2g}/km in 2009) across the EU since the program started in 2007 (Brand et al, 2013). However, because of its success the tool has led to a financial loss of about €525M in 2009 and €490M in 2010, despite regulatory amendments having been made (MEDDTL, 2011).

The fact that effects of the bonus/malus scheme have largely overcome the initial economic forecasts could be explained by both the normative component (that is to say the psychological connotation of punishments and incentives, with the particular higher sensitiveness to losses when facing losses and gains of the same magnitude) which is often neglected and the role of the "information part" of such a feebate scheme – i.e. the underlying energy-label (Mueller and De Hann and al, 2009).

Other European countries have introduced a bonus/malus scheme too (table 9).

Table 9: European comparison of bonus/malus schemes

Country	Bonus/Malus
Austria	Bonus: €300 max for cars <120CO_2g/km; For alternative fuel vehicles and PHEVs*: extra bonus of €500 max (2008-2012) €5,000 rebate if the EV is charged with green electricity; €2,500 if charged with conventional electricity; Malus: €25 per CO_2g/km for cars >180CO2g/km.
Belgium	Bonus: 15% of the price (up to €4,540) for cars <105CO_2g/km and 3% of the price (up to €810) for cars [106;115]CO_2g/km; Eco-bonus in Wallonia of €600 for cars with a list price of maximum €30,000 and emitting less than 99CO_2g/km
Spain	Bonus from €2,000 to €7,000 for the purchase of EV, PHEV, fuel cell, NGV* and LPG* vehicles (2012). In Andalucia, the incentive is maximum 70% of the investment.

France	Bonus max of €5,000 for cars <50 CO_2g/km and for the purchase of EVs (i.e. up to 20% of the vehicle purchase price including VAT, increased with the cost of the battery if this is rented); bonus of €3500 for cars [50;60]CO_2g/km; €400 for cars [61;90]CO_2g/km; and of €100 for cars [91;105]CO_2g/km. (until 07/2012, see table 7 above for more accurate data); Bonus of €2000 for the purchase of PHEV <110gCO_2/km in 2011; Malus of €200 for cars [141;150] CO_2g/km; €500 for [151;155] CO_2g/km; €1100 for [181; 190] CO_2g/km; and €2,600 max for >231 CO_2g/km (until 07/2012, see table 8 above for more accurate data).
Italy	Bonus of €700 for cars <140CO_2g/km and diesel <130CO_2g/km in 2010 ; Bonus up to €5,000 (20 % of the price) for vehicles emitting <50 gCO_2/km in 2013 and 2014; and up to €3,500 (15 % of the price) in 2015;
Luxembourg	Bonus of €3,000 for EVs or cars <60 CO_2g/km (until 2011); Bonus of €750 for EURO 4 and EURO 5 gasoline vehicles and EURO 5 diesel vehicles for which CO_2g/km emissions are <120CO2g/km or <160CO2g/km + 6places or <160CO_2g/km + NGV or PHEV in 2010.
Netherlands	Bonus €6,400 max for PHEV in 2010 ; Malus of €125 per CO_2g/km >110 CO_2g/km (gasoline cars) and > 95 CO_2g/km (diesel cars).
Portugal	Bonus of €6,500 max for EVs acquisition applying to the first 5,000 EVs sold until the end of 2012. For other EV purchase, €5,000 rebate.
Sweden	Bonus of €1,000 (SEK10,000) for cars classified as "environment-friendly" (i.e. conventional cars < 120CO_2g/km, alternative fuels vehicles and EVs (between April 2007 and July 2009)
United Kingdom	Bonus of €6,000 (£5,000) max until 2015 (25% of the value of the vehicle) for OLEV* and ultra-low carbon vehicle (e.g. min. electric range of 70 miles for EVs and of 10 miles for PHEVs + emissions below 75CO_2g/km for PHEVs). Since 2012, the "Plug-in Van Grant" is of €9,500 (£8,000), i.e. 20% of the vehicle purchase price).

*PHEVs : Plug-in Hybrid Vehicles
*LPG : Liquefied Petroleum Gas
*NGV : Natural Gas for Vehicles
*OLEV : OnLine Electric Vehicle.

Sources: ACEA (2011), Avem (2012), Leurent (2011), PIPAME (2010), SEAI (2012), Viktoria Institute (2011)

2.1.1.2. The Scrapping premium scheme

The vehicle scrappage schemes constitute "a financial incentive for drivers of older vehicles to prematurely remove their vehicle off the road before the vehicle's lifespan is completed. Vehicle scrappage schemes therefore target older vehicles, which often have lower fuel efficiency and higher carbon emissions than newer vehicles. There are typically two broad categories of scrappage schemes: (1) Cash-for-Scrappage, which is a payment offered to consumers for their vehicle regardless of how the consumer replaces the scrapped vehicle, and (2) Cash-for-Replacement, which is a payment conditional upon the consumer replacing the scrapped vehicle with a specific type of vehicle, typically, but not necessarily, a new car" (Brand et al, 2013).

In France since January 2010 (and for orders before 31/12/10), the purchase or leasing of a new car[5] emitting less than 155 CO_2g/km has received a premium if accompanied by the scrapping of a vehicle over ten years old (Decree N°2009-1581, JORF, 2009b). The premium varies between €500 and €700 according to the dates of order and invoice (table 10). It should also be noted that the threshold of new

[5] The scrapping premium was also existing for vans, but the granted amounts didn't vary according to CO_2 emissions.

car's CO_2 emissions below which the scrapping premium applies has decreased from 160 CO_2g/km in 2008-2009 to 155 CO_2g/km in 2010, as has the amount of premium itself.

Table 10: Evolution of scrapping premium over time in France

CO_2 emissions	Date of order	Date of invoice	Amount of scrapping premium
< or = to 160g/km	Between 04/12/08 and 31/12/09	Before 31/03/10	1 000€
		Between 01/04/10 and 30/09/10	700€
		Between 01/10/10 and 31/03/11	500€
< or = to 155g/km	Between 01/01/10 and 30/06/10	Before 30/09/10	700€
		Between 01/10/10 and 31/03/11	500€
	Between 01/07/10 and 31/12/10	Before 31/03/11	500€

Source: Decree n°2009-1581 (JORF, 2009b)

According to Bernard Cambier, Sales Director for Renault France, orders of new vehicles have increased in line with the announcement of the end of the scrapping premium scheme. Indeed in December 2010, orders were 30% higher than their level in December 2009 (Le Monde, 2011). In addition, an empirical analysis of French households' vehicle ownership (from 1984 to 1998)[6] led by Yamamoto, T. and al (2004) demonstrates that the conditional probability of replacing a vehicle aged of 10 years and over gets 1.2 times higher when the scrapping premium scheme is in place (i.e. during the period 1994-1996 of reference here) than when it is not operating, and that the average vehicle's holding duration becomes 3.3 years shorter when the grant for scrapping it is available.

Brand et al. (2013) conclude that carbon savings from scrappage remain low in Europe and in the USA due to the fact that the schemes have been originally introduced to stimulate the car market rather than to meet any explicit environmental objectives.

Other European countries have introduced a scrapping premium scheme too, most of them from 2008 in line with the beginning of the economic downturn in the automobile industry (table 11):

Table 11: Scrapping premium schemes in EU

	Characteristics of the scrapped vehicle	Scrapping premium for the vehicle purchase
Austria	> 13years	€1,500 (until 31/12/2009) for new or used EURO 4 or 5 car purchase
Portugal	> 10 years	€1,000 to €1,250 (until 31/12/2009) for new car <140CO_2g/km purchase
Netherlands	> 9 years	€750 to €1,000 for new or used more environmental friendly car purchase, and respectively €1,000 to €1,750 for utility vehicle (from 2009 to the end of 2010)
Germany	> 9years	€2,500 for new or used EURO 4 car purchase (until 31/12/2009)
France	> 10 years	€1,000 for new car < 160 CO2g/km or utility vehicle purchase (until 31/12/2009) and for new car <155CO_2g/km purchase (until 31/12/2010)

[6] The authors used in this study the panel survey called Parc-Auto, which has been conducted by a French marketing firm, SOFRES, since 1976.

Italy	> 10 years	€1,500 for new EURO 4 or EURO 5 car, car < 140CO_2g/km (gasoline) and car < 130CO2g/km (diesel) purchase (from beginning of 2009 until 31/12/2009)
Spain	> 10 years (if new car purchase) > 12 years (if used car purchase)	€2,000 for new or used (until 5 years old) car <149CO_2g/km (from 18/05/2009 until 18/05/2010)
United Kingdom	>10 years	€2,225 for the purchase of a new car or utility vehicle (from May 2009 to March 2010)

Source: PIPAME, 2010

Following the success of the previous scrapping premium operations, some countries have renewed their schemes. In Spain, judging from the 75,000 new vehicles sold within a few months of the measure being implemented (between 01/10/12 and 10/01/13), the Spanish government has extended the duration and scope of its PIVE plan (a stimulus package for the automobile industry). Launched at the beginning of February 2013, the phase II of the PIVE plan covers now LDVs too and is expected to bring a total of about 150,000 new vehicles (cars and LDVs), saving on average 262,000 tons of CO_2 emissions per year (CCFA 2013).

2.1.1.3. VAT and income tax reduction

VAT reductions and income-tax credit schemes apply to the purchase of EVs in certain European countries:

- VAT reduction for EVs purchase :

Norway is the only country to exclude EVs purchase from VAT. In addition, Norway has Europe's highest rate of VAT, representing 25% of the retail price (Viktoria Institute, 2011), against an average of 15% to 25% across the EU (PIPAME, 2010).

- Income tax reduction :

Some European countries have implemented an income-tax credit scheme for EVs buyers, such as Belgium and Sweden. In Belgium electric passenger cars buyers receive a personal income tax reduction of 30% of the purchase price (to a maximum of €9,190). Similarly, in Sweden the purchase of company electric or hybrid vehicles reduces the income tax by 40% compared with the corresponding petrol or diesel cars' taxable value (with a maximum reduction of the taxable value of SEK 16,000 per year (ACEA, 2011)).

2.1.1.4. The "CO_2-tax" on the purchase of used polluting passenger cars

Under the French General Tax Code (JORF, 2013a) and since 1srt of June 2004, an additional « CO_2-tax » has been introduced and applies on the registration of used and polluting passenger cars. Tariffs are based on CO_2 emissions in the following way:

- 2€ per gram of CO_2 if emissions range from 200 CO_2g/km to 250 CO_2g/km;
- 4€ per gram of CO_2 if emissions exceed 250 CO_2g/km.

Besides, taxing registration of used cars is of particular interest in France judging from the car fleet structure: for each new car purchase each year, between two and three used vehicles are exchanged (CCFA, 2012).

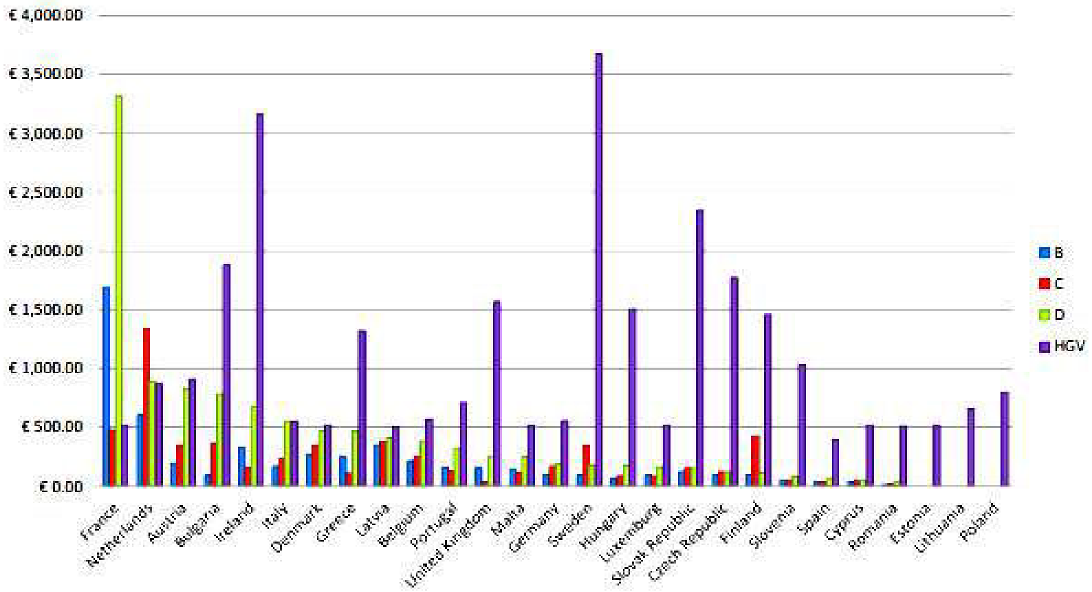
2.1.2. Automobile ownership fiscal schemes

The car ownership fiscal scheme or Vehicle Excise Duty (VED) corresponds to "an annual tax levied on vehicles in order to use public roads. Typically, the amount of charges levied are based on vehicle characteristics such as engine size, weight or power but are increasingly linked to specific environmental characteristics including CO_2 and other pollutant emissions" (Brand et al, 2013).

All the EU Member States apply one or more ownership tax(es) on road vehicles (figure 5) and in most countries, heavy-duty vehicles are subject to these ownership taxes. 12 out of 27 Member States (including France) use CO_2 emissions as criteria in tax calculation (European Commission, 2012d).

Annual revenues from ownership taxes vary between €3.50M (Estonia) and €8,500.00M (Germany), and are of €1,160.00M in France (European Commission, 2012d).

Figure 5: Comparison of ownership taxes in EU Member States for selected vehicles in 2012



Source: European Commission, 2012d
Note: See annex N°2 for description of vehicles B, C and D.

2.1.2.1. The annual tax for company vehicles

According to the French General Tax Code (JORF, 2013a), French companies have to pay an annual tax on their passenger vehicles which satisfy the following conditions:

- have been subject to community reception and came into operation from the 1rst June 2004,
- were registered in France,
- were not used by the company before 1st June 2006.

Tariffs vary according to CO_2 emissions in the following way (table 12):

Table 12: Annual tax for company vehicles depending on CO2 emissions

CO_2g/km	Tax per CO_2g (in €)	
	until 30/09/2011	**from 01/10/2011**
<50	2	0
50<x< 100	2	2
100<x<120	4	4
120<x<140	5	5,5
140<x<160	10	11,5
160<x<200	15	18
200<x<250	17	21,5
>250	19	27

Source: CGI

Exemptions exist and are related to professional activities (General Tax Code, JORF, 2013a): vehicles are excluded from the scheme if they are intended for sale (e.g. belonging to an automotive trader), for location (e.g. leasing company), for public transport (e.g. taxis), for driving lessons or for sport competitions. Exemptions can also be related to the energy use of the vehicles, and apply, for example, to natural gas, liquefied petroleum gas or E85 fuelled vehicles. Vehicles using alternatively premium fuels or liquefied petroleum gas are also partially exempt.

2.1.2.2. The annual tax for polluting vehicles

According to the French General Tax Code (JORF, 2013a), an annual €160-tax is applied to emitting passenger cars, which were first registered from 1rst January 2009. The tax is paid if CO_2 emissions exceed a threshold, which varies according to the date of the first registration, in the following way (table13):

Table 13: Threshold above which annual tax for pollutant vehicle is paid according to the date of the first registration

Year of first registration	CO_2 g/km
2009	250
2010	245
2011	245
2012 and after	190

Source: CGI

Exemptions exist if the vehicle owner holds a disability card, or, for example, if the vehicle is subject to the annual tax for company vehicles.

2.1.3. Automobile use pricing schemes

2.1.3.1. Fuel pricing

2.1.3.1.1. Fuel taxes in the EU

Fuel taxes are an important source of annual revenue for public budgets (for example, ranging from €99.48M in Malta to €35,738.28M in Germany). Revenues from fuel taxes in France are among the highest, representing €23,539.91M (European Commission, 2012d). Petrol and diesel tax rates vary greatly among the EU Member States (table 14).

Table 14: Total excise duties on transport fuels in some European countries in 2008 (in percentage of the retail price)

	Unleaded petrol	Diesel
Germany	46.7	42.0
Denmark	38.7	36.0
Finland	42.9	35.1
France	43.6	40.3
Italy	40.9	37.7
Norway	40.2	39.7
United-Kingdom	44.5	50.4
Sweden	40.6	38.9

Source: K. Schubert, 2009

In France, diesel and petrol taxes have historically been different (generally about €20 difference), and favor diesel use. After the Second World War, diesel was predominating used in freight transport activities (diesel being a by-product of the oil industry), and so to give a new impetus to the economy, the French Government decided to decrease the rate of diesel tax. This was also justified by diesel fuel being considered as less polluting than the other transport fuels (in terms of CO_2). This political decision has led to 83.5% of vehicles sold in France the beginning of 2012 being diesel fuelled. In comparison, Germany, also known for its strong support for diesel, had a share of 47% at that time (Huffington post, 2013).

However, this fiscal advantage for diesel is currently under discussion in France (Cour des Comptes, 2012b): Despite the power efficiency of diesel being between 20 and 40% higher than that of petrol, and with 15% less CO_2 emission than petrol, diesel produces much more nitrogen oxides, carbon monoxide and particulate matter (petrol produces almost none of these). In addition, funds raised through the increase of diesel tax would help the French government to finance the tax-credit for its competitiveness and employment scheme planned for 2016 (CICE in French).

2.1.3.1.2. Tax exemption for biofuels

Under the Directive 2003/96/EC (European Commission, 2003) on energy products and electricity taxation, the incorporation of biofuels in petrol or diesel oil benefit from tax reductions. The rates of tax relief (reduction in €/hectolitre) for 2013 are written in the table below (table 15):

Table 15: Reduction in €/hectolitre provided through 2013

	Diesel oil			Petrol	
€/hectolitre	**VOME biodiesel**	**Synthetic biodiesel**	**VOEE biodiesel**	**Ethanol**	**ETBE**
2004	33			37	**38**
2005	33			37	**38**
2006	25	25	30	33	**33**
2007	25	25	30	33	**33**
2008	22	22	27	27	**27**
2009	15	15	15	21	**21**
2010	11	11	11	18	**18**
2011	8	8	8	14	**14**
2012	8	8	8	14	**14**
2013	8	8	8	14	**14**

For ETBE (ethyl tert-butyl ether), only incorporated ethanol benefits from tax exemption
VOME: vegetable oil methyl esters
VOEE: vegetable oil ethyl esters

Source: Interactive EurObserv'ER Database, 2012

Tax exemptions for biofuels have been representing a growing cost for the government, from €260M in 2006 to €521M in 2009, to which should be added the over-consumption cost related to the lower energy content in biofuels (Interactive EurObserv'ER Database, 2012).

2.1.3.1.3. National carbon taxes

In 2009, supported by a favoring political background (one of the outcomes of the "Grenelle de l'environnement" in 2007)[7], the French Parliament proposed the implementation of a "climate-energy contribution" or CEC (OECD, 2012) applying to the sectors not included in the European cap-and-trade system for CO2 emissions quotas (EU ETS).

The carbon tax base covered the consumptions of fossil fuels (natural gas, coal, oil, domestic fuel oil, heavy fuel oil, petrol, and diesel oil) from:

- the residential and tertiary sectors (domestic emissions);
- heating and transportation demand (households' emissions).

The proposed tax rate was equal to €17/CO_2t, adjusted according to the CO_2 content of the fuel, with an annual revision. Indeed, even if the tax rate was initially supposed to follow a precise trajectory (as recommended by Commission Quinet (2009) to reflect the "social price of carbon emissions"), starting at €32/CO2t in 2010 (i.e. €0.07-0.08/l) and growing progressively to attain €100/CO2t in 2030, its rate was finally set at €17/CO2t in accordance with the expected medium-term price on the ETS market. This argument was in the wake of the "first best" theory, according to which the price of CO_2 should be unique. The expected revenues of the tax were of €4.5 billion (0, 2% GDP) on average.

This carbon tax project (as presented in the "Commission Rocard") was economically justified on the basis of their purpose being a pricing instrument (i.e. to restore the real price of goods and services that do not naturally include environmental costs i.e. negative externalities, market failures, etc.) and to the measure of its efficiency. Indeed, through this scheme, individuals are encouraged to change their behavior and reduce their energy consumption by paying less carbon tax and earning a financial compensation in return (independent of their energy consumption). Furthermore, this scheme was particularly appropriate for transport and heating emissions from the households sector, which are diffuse and therefore difficult to regulate through market mechanisms. Moreover, even if fiscal regulations do already exist for transport fuels (high excise duty called TICPE, greatly above the carbon price of reference) and for heating fuels, several sectors are exempted (e.g. kerosene in aviation) and CO_2 goals are not explicit.

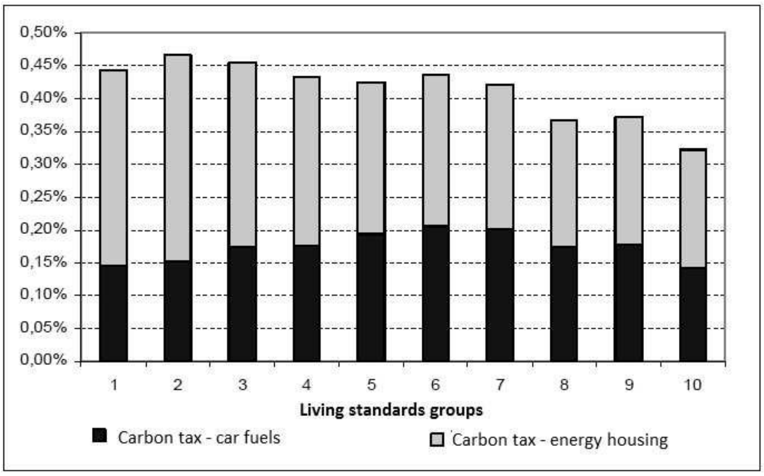
The CEC was also environmentally justified, helping the country to cut its emissions (particularly from transport and residential/tertiary sectors) and to be on track with its European and national commitments.

Regarding equity and acceptability issues, the carbon tax implementation was intended to be strictly compensated by the reduction of other taxes, to preserve industrial competitiveness (many sectors exempted[8]) and the purchasing power of households. Figure 6 shows the expected impacts on households' budgets, i.e. moderate effects but different (regressive) depending on living incomes.

[7] The carbon tax project was one commitment of the first "Grenelle de l'environnement" law, a broad-based environmental roundtable discussion initiated by the former President Nicolas Sarkozy in the summer of 2007 with stakeholders (firms, NGOs, administration, trade-unions,). During the presidential campaign, major candidates signed up a « green contract » proposed by Nicolas Hulot Foundation.

[8] Full exemption for sectors (industry and power production) covered by EU ETS; additional several exemptions (in line with EU Directive Energy Taxation) for energy intensive industry: thermal power stations, oil refinery, cement industry; process emissions of industry (decarbonation); air and marine transports; fishing; public road transports; electricity (not a CO_2 emitting energy); very reduced rate for agriculture and road freight transport,; and recycling of tax revenues from firms to finance removing existing tax on investment (« professional tax »).

Figure 6: Additional expenditures (from carbon tax) per living income



Source: OECD, 2012

Therefore it was planned that the overall revenues from households taxation would be given back to them under the form of either a) lump-sums (not correlated to the tax base) to the 25% poorest households, or b) tax credits on income, the so-called "chèques verts", seen as a reduction of a distortive tax, the labor cost and creating a "double dividend". The modalities of the tax credits were €46 per adult (double: €92 for a couple), with an extra €10 per person in the household, uplifted to €61 for households without access to public transport.

Despite these arguments and most probably because the rationale of the scheme was not entirely understood by the stakeholders (pointing out the already high TICPE, a natural rise in oil market prices, or equity and acceptability issues), the CEC wad rejected in 2010. Indeed, it was challenged by the constitutional principle of "equality in public taxation", since sectors under EU-ETS (40% of CO_2 emissions, 93% of non-industrial emissions) were exempted both from the tax and quotas (under "grandfathering" allocation at that time) whereas ETS sectors were subjected to the carbon tax, leading to an uneven fiscal treatment.

Several European Union Member States have also introduced carbon taxation. Finland (1990), Norway and Sweden (1991), Denmark (1992) and more recently Ireland (2010) have introduced national carbon taxes on fuels, with respective standard rates of €20, €43, €108, €13 and €15 per tonne of CO2 as of 1 Januay 2010 (Elbeze and de Perthuis, 2011).

2.1.3.2. Road user charge

2.1.3.2.1. Urban tolls

Urban tolling consists in making vehicle's drivers who enter the territorial limits of a geographical area pay for the cost of the congestion delays they impose on other drivers. The use of urban tolling avoids having to resort to road capacities investment, which creates induced traffic (i.e. Downs Thomson Paradox) and therefore other negative externalities. Different urban toll configurations exist (see box below).

Box: Urban tolls classification

Urban toll scheme may vary upon:

- the spatial configuration: cordon charging (e.g. Stockholm) or charging area (e.g. London);
- the tariff: which may depend upon the hour, the day, the duration, the mileage, the emissions class, or may include a rate base;
- the objective: fight against congestion (e.g. London), fight against pollution (e.g. Milan), infrastructure financing (e.g. Oslo), or a mix of these objectives (Stockholm);
- the revenue allocation: road infrastructures (e.g. Stockholm), sustainable mobility development (e.g. Milan), and so on.

In accordance with the French Grenelle II Act (JORF, 2010) and the General Tax Code (JORF, 2013a), urban toll experimentations are authorized in France under the following conditions:

- Subject to a 3-year experimentation period;
- Be reserved to areas with populations exceeding 300,000 inhabitants with a "Urban Transportation Plan" (PDU);
- Experimentation requests must be formulated by the urban transport organizing authority and must be made in order to limit car traffic and to counter local nuisances;
- A preliminary impact study must be carried out in consultation with stakeholders;
- Transport infrastructures must be developed to receive transferred and deviating traffic following the urban toll implementation;
- Information necessary to evaluate the project must be published for every 12-month experimentation period;
- Urban toll revenues must finance "Urban Transportation Plan" 's actions.

Abroad, the apparent success of both the London congestion charge in 2003 (table 16) and the Stockholm one in 2006/07 (table 16), has sparked the interest of other cities for implementing an urban road pricing, such as Milan in 2008 (table 16).

Table 16: Road pricing in practice

	Singapore	London	Stockholm	Milan
		Description		
Inception	1998	2003	2006/07	2008
Tolled area or infrastructure	Expressways, arterial roads and cordon charges for 3 restricted zones around CBD	Initially : 21km² area around city center, extended to west from Feb 2007 to Dec 2007	Cordon around 30km² inner city area	Restricted zone of 8km² in city center

Toll differentiation	**Differentiated** by six vehicles types **Exemptions** for police cars, ambulances, fire engines	**Exemptions** for blue badge holders, alternative fuel vehicles that meet strict emissions criteria, electrically propelled vehicles, vehicles with more than 9 seats, motor tricycles, recovery vehicles, breakdown vehicles **Discounts:** 90% for residents and 25% for fleets, various for monthly and annual payments	**Exemptions** for buses, taxis, emergency vehicles, electric and hybrid cars, traffic between Lidingö island and rest of county that speeds less than thirty minutes crossing the charging zone **No discount**	**Exemptions** for various vehicle categories, also clean conventional fuel vehicles and several types of alternative fuel vehicles **Discounts:** 50% rebate for 1rst entry, 40% rebate for 2nd fifty entries Residents can buy annual pass for 25 x cost of daily charge
Supplementary measures	Vehicle ownership taxes, fuel taxes, parking fees, road expansion, mass rapid rail, buses, taxis, park and ride, car cooperatives, signal timing	Increase in bus services, retiming of traffic signals	New bus lines, extension of existing bus, metro and rail service, new and improves park-and-ride facilities	New bus lanes, revised traffic directions and reduces illegal and on-street parking
		Impacts		
Traffic volumes		-34% cars, +22% taxis, -12% all vehicles	-22% across cordon, -16% within cordon	-12,3% in restricted zone, -3,6% outside
Travel time		-30% congestion delay	Congestion delays dropped 1/3 to ½ on arterials, lesser reductions inside cordon	
Speeds		+17% in restricted zone		+4% in restricted zone for private vehicles, +7,8% for buses
Accidents		-2% to -5% for personal injuries	-5% to -9% injuries, -3,6% accidents	-20,6%
Nox emissions		-12%	-8,5%	-14%
PM10 emissions		-12%	-13%	-19%
CO2 emissions		-19%	-14%	-15%

Public transport (person trips)	+30% within restricted zone during first 2 years	+4,5% across cordon	+7,3% surface PT, +9,2% exists in restricted zone
	Benefits and costs		
Gross benefits	$£_{2005}$ 230 M	SEK_{2006} 938 M	$€_{2008}$ 30,2M
Total Costs	$£_{2005}$ 163 M	SEK_{2006} 284 M	$€_{2008}$ 14,5M
Nets benefits	$£_{2005}$ 67 M	SEK_{2006} 654 M	$€_{2008}$ 15,7M

**In Milan the charge level ranges from € 2 to € 10 per day, depending on the Euro emission standard of the car. Based on the tickets sold we estimated the average charge level in 2008 at €4.40 per day. Corrected for inflation and PPP, a uniform price of € 4.48 per day is estimated.

*** In contrast to most of the other case studies, a cordon pricing scheme in which road users are charged when they enter and exit the charging zone is implemented in Stockholm. To make this charge comparable to the area charging schemes, we multiply the average charge for Stockholm by 2. Additionally, Stockholm uses three charge levels, for off-peak, shoulder and peak period respectively. Here we used an average charge level (of 28 SEK per vehicle per day).

Source: Anas, A. & Lindsey, R., 2011

2.1.3.2.2. Highway tolls

Highway toll are currently aimed at financing road investments. Motorists pay for using the infrastructure. For examples, France, Greece, Ireland, Italy, Poland, Portugal and Spain have a system in place that charges all road users on specific parts of the road network (European Commission, 2012d).

Yet, tolls are tending to be used as a means of promoting the circulation of low emission vehicles. For example, in October 2012, the French government announced preferential toll tariffs for EVs. However, one may doubt about the effectiveness of such a measure on electric vehicles since EVs' autonomy and speed are in most cases too low to enable their drivers to travel on highways anyway.

In addition, toll rates can depend upon GHG emissions. This is the case of the Lkw-Maut (DHL Freight, 2012) charging trucks above 12t on German highways (covering 12,800km) and primary roads network (perimeter of 1,100km)[9], depending on the distance and the vehicle's emissions class. In place since 2005, the German toll system in 2009 generated €600M in revenues, notably redistributed in the form of reductions in other vehicle taxes and investment supports to Environmental Enhanced Vehicles (EEVs). Originally made to reduce uncharged trips and to foster investments in cleaner high-duty vehicles (characterized by new EURO V or EURO VI vehicles acquisitions and by a reduced use of older vehicles, in particular for long-haul freight transport but much less for local traffic), the scheme was successful (Viktoria Institute, 2011). However, the resulting modal shift was almost non-existent and traffic diversion continued towards roads not subject to tolls.

More recently, in 2010 Slovakia established tolls on major roads (i.e. 2,031 kilometers of highways, express lanes and primary roads) for heavy goods vehicles (more than 3,5t) and buses (Assemblée Nationale, 2011).

The French "eco-tax for heavy goods vehicles" project, (inspired by the German Maut (above)) scheduled by the "Grenelle II Act" (JORF, 2010) to start on October 2013 is currently under discussion (MEDDE, 2013a). The « Eco-tax » aims at encouraging road hauliers to streamline their delivery rounds.

It consisted initially in:

- applying an additional tax on heavy goods vehicles (of more than 3.5t), regardless of the nationality (600,000 French and 200,000 foreign concerned vehicles[10]; Le Monde, 2013) circulating on the national road network (i.e. 15,000 km);
- making the eco-tax dependent upon vehicle category and EURO class with tariff ranging from 8 and 14 euro cents;
- trialing the "eco-tax" in Alsace from April 2013;
- rolling it out to all French departments from July 2013.

[9] Beyond national traffic, the key target of the Lkw Maut toll is foreign flows since they constitute about a third of total freight transport volumes in Germany (Viktoria Institute, 2011).

[10] Taking into account country of registration, not driver's nationality

The tax could bring around €1.2 billion per year (Le Monde, 2013).

2.1.3.3. Parking pricing

Parking pricing policies are effective in reducing transport externalities (i.e. congestion, insecurity and pollution), to deter car use and to increase the share of alternative modes (Ecorys, 2011).

2.1.3.3.1. Upward revision of parking tariff /extension of the tariffed area

Parking pricing management generally deals with an increase in parking tariffs and/or an extension of the priced area (either geographically or in terms of duration). Several case studies (Ecorys, 2011) showed that parking pricing measures result in a decrease of vehicle kilometres. The corresponding elasticity values indicate that a 10% increase of the parking charges can result in a reduction of vehicles kilometers of 1% to 3% (depending on the number of visitors and the type of policy).

In France, for example, the parking faring policy has been re-adjusted in the city of Lille, as framed in the Urban Mobility Plan (PDU) of 2000, in order to favor short and medium parking duration rather than long parking periods during the day. Variations have also been developed to address the particular needs of free parking for residents and to promote car-sharing.

More recently, in 2008, the City of Amsterdam adopted the Action Plan "Voorrang voor een Gezonde Stad (VGS)", aiming at improving air quality through a reduction of car-kilometres in the area. A 27% increase of parking charges resulted in a decrease in vehicle kilometres of 3.8%. Moreover, assuming that NO and PM emissions decreased by the same percentage as the number of vehicle kilometres, concentration decreased on average by 0.2 to 0.3 mg/m and by 0.0 to 0.1mg/m respectively (Ecorys, 2011).

2.1.3.3.2. Free parking for EVs

Most of the larger French urban areas have opted for free parking for electric vehicles. Parking (usually municipal) is free of charge for EVs in many other European countries, like Norway (Leurent, 2011), United Kingdom (Leurent, 2011), Denmark (Viktoria Institute, 2011) or Sweden (Viktoria Institute, 2011).

2.1.3.4. Free access to public transport

In France, about 20 municipalities are currently offering free access to public transport. In the early 2000s, Châteauroux was the first French municipality to implement free access to public transport (34 buses circulating between 7am and 8pm). Within 10 years, bus network capacity had increased by 42% and demand has reached 61 travels per year per inhabitant. As a comparison, in similar French municipalities with less than 100,000 inhabitants, the bus ridership generally is 38 travels per year per inhabitant (Le Monde, 2012).

Elsewhere in Europe, some countries are also experimenting with free public transportation. For example, in Tallin (Estonia) since January of 2013, residents holding the "green card" (which costs €2) can travel by tram or bus free of charge (Mobilité durable, 2013a).

2.2. Supply-side

2.2.1. Investment in R&D

As planned in the « Grand Emprunt », €750M, together with half the budget for the national R&D program for inland transport (PREDIT) was invested in R&D into vehicle electrification in France in 2009. ADEME launched two calls for projects in electro-mobility in 2008, one of €56.9M (11 projects selected) and one of €50M (35 projects financed). Another €750M was earmarked in 2009 under the policy programme "Investments for the Future" to finance new technologies in the e-mobility sector. In addition, €250M of subsidised loans were part of the « Pacte automobile » (2009) to foster the industrialization of carbon-free vehicles (Assemblée Nationale, 2010).

In the wake of the « Plan véhicules décarbonés », in 2009 Renault and PSA received €1.5 billion each in state aid to invest in R&D and to preserve employment and production in France (ERIEP, 2013).

Through this sizable financing support to the e-mobility sector, France is trying to catch up with the lead held by Asiatic countries, especially by targeting the fields of power electronics, charging batteries and fuel cells, rather than electric engine technology, which has already been acquired.

Similarly at the European level, the CIVITAS ("City-Vitality-Sustainability") initiative launched in 2002 aims to support cities which introduce ambitious transport policies or measures towards sustainable urban mobility. CIVITAS allows cities to learn from each other and facilitates exchanges of ideas, through a non-binding agreement called the "CIVITAS Declaration". Whereas 19 cities were participating in 2006, in 2013 there are 25 working together. Action plans involve the following items: clean fuels and cars, integrated charging strategies, access restrictions, soft measures, public passenger transport, urban goods transport, transport management, and car use reduction. The European Union is providing a €100M support and the total budget allocated to CIVITAS reaches €300M (ADEME, 2009).

2.2.2. Investment in infrastructures

Since road transport will largely take part in the future freight, probably with a 30% to 60% share depending on the scale of the modal shift towards other transportation solutions, investments in infrastructure for EVs and time-share car services cannot be ignored (de Perthuis and Jouvet, 2011), despite the inertia characterizing the transport infrastructures (Meurisse and Papaix, 2013).

Most of the public investments in sustainable mobility deal with charging stations for electric vehicles. For example, 900,000 private and 75,000 public charging stations are expected to be rolled out in France by 2015. Looking forward, 4 million private and 400,000 public charging stations are expected by 2020 (Assemblée Nationale, 2010) in order to hit the target of 2 million electric and hybrid vehicles circulating by 2020 (Nègre, 2011).

The French Government is currently (namely during the 2011-2015-period) contributing 50% towards the investment costs in the pilot cities, which have signed a charter in 2010 to develop demonstration projects related to electric charging infrastructure (Nègre, 2011). The SAVE (Seine Aval VE) project in the region of Yvelines (West of Paris), Autolib' in Paris or the car-sharing project in Nice are some examples of such experimentations.

Other European countries provide financial support to charging infrastructure. For example, in the United Kingdom, the Transport Ministry has just decided (February 2013) to allocate £37M (€42,6M) to finance new charging infrastructures for EV for households, roads and stations (CCFA 2012a).

Beyond infrastructures, public authorities have also invested in vehicles technology. This is the case of "On Line Electric Vehicles" (OLEV), launched by the Korea Advanced Institute of Technology. Vehicles are charged while running on reserved lanes with electricity produced from underground power strips, enabling a reduction of both batteries cost and charging infrastructure cost.

3. Collaborative initiative

3.1. Demand-side

A convention was signed in 2011 by 20 bodies for the public procurement of 100,000 EVs by 2015 (ERIEP, 2013). This collective initiative steered by the para-governmental enterprise La Poste (the French postal service), coordinated and promoted by UGAP (the French public buying department), aimed at creating a "club effect" for EVs demand in the market (Assemblée Nationale, 2010). In the beginning in 2011, the initiative involved the distribution of 23,000 EVs between La Poste (10,000), the

State and local communities (5,000) and companies (8,000). The bulk of the orders was initially made of first generation electric LDVs, i.e. conventional LDVs fitted with an electric engine rather than newly designed vehicles with their own electric engine.

3.2. Supply-side

3.2.1. Public-Private Partnerships (PPPs)

Whereas the public players (local authorities or public bodies and establishments) on the one hand and the private players (that are more and more diversified, e.g. Information and Communication Technologies actors) on the other are more and more numerous, the two are increasingly associated through Public-Private Partnerships (PPPs) (Meurisse and Papaix, 2013). PPPs procure public services and infrastructures by combining the skills and resources of both the public and private sectors. Risks are also shared between the two parties. Some examples of such PPPs can be found both in France and in foreign countries.

In 2011, the French capital has developed a car-sharing service named 'Autolib'. Autolib is also the name of the mixed syndicate who signed with Bolloré a public service delegation that aims at (Fournier, S., 2011):

- offering an "ecofriendly"' transport service,
- proposing an alternative transport solution,
- decreasing the use of the private cars,
- making this service accessible for everybody.

In return for the provision of the 500 surface stations and 200 underground car parks, the municipality received €16.8M. Simultaneously, Bolloré provided €50M and is in charge of the maintenance and insurance of the vehicles (La Gazette des Communes, 2011). 3,000 Bluecars are expected to be into circulation by 2013, representing a reduction in the private fleet of 22,500 vehicles and a reduction of 164,500,000 kilometers travelled by more polluting cars (Autolib, 2013).

Transport on demand (TOD) services can also be developed through a public-private partnerships. The community of municipalities of Ribeauvillé in France (Department of Haut Rhin) is currently (between January 2013 and June 2014) experimenting with a TOD service named Allo'Bus, at a tariff of €2 through a public service partnership with private operators. The cost of the project is €95,000. The operating deficit is financed equally between the General Council of Haut Rhin and the Community of municipalities (Mobilicites, 2013).

Another noteworthy example of public-private transport partnerships is the electric taxi service developed in Amsterdam. Developed by Hopper in partnership with the municipality of Amsterdam and the Ministry of Environment, since October 2012 citizens have had access to a new type of taxis based on electric scooters. One of the characteristics of this service is the €2.50 fixed tariff: the price does not depend on the distance travelled or the trip duration, and is no more expensive than a metro ticket in Amsterdam), thus encouraging people to choose taxis instead of private vehicles (Avem, 2012b).

3.2.2. Suppliers consortia

- Industrial partnerships :

Industrial partnerships aiming at developing low carbon mobility technologies are currently multiplying (see some examples in table 17 below).

Table 17: Selected examples of industrial consortia

Stakeholders	Objective	Other information
PSA & BMW BMW Peugeot Citroën Electrification (BPCE) dédiée	Develop hybrid and electric vehicles	€100M investment in R&D (Munich center)
Renault & Better Place	Launch of the Fluence ZE	Sign in 2011 Objective of 100,000 sales by 2016 in Denmark and Israel
Renault & Vinci	Develop parking for carpooling and quick charging stations	

Source : CCFA, 2011

 Joint venture :

Furthermore, Renault-Nissan aims to develop and produce charging batteries through a joint-venture with the Atomic Energy Commission (CEA) and the Stategic Invesment Fund (ISF) in different production sites around the world (Renault, 2013):

- in Flins (France) :100,000 to 350,000 units are expected to be produced with an investment cost for the first period averaging €600M;
- in Aveiro (Portugal): annual capacity production of 50,000 units from 2012;
- in Sunderland (UK): annual capacity production of 60,000 units and
- in Smyrna (USA): annual capacity production of 2000,000 units (only for Nissan vehicles).

 Innovation clusters :

Five major innovation clusters are dedicated to new car and transport solutions in France in 2012. Bringing together transport operators to deploy new systems and vehicles (Invest In France Agency, 2012), they are Mov'eo, Id4Car, Vehicles for the Future (focusing on advanced electric powertrain and hybrid techniques as well as recharge stations, while also opening up a unit dedicated to funding recharge infrastructures on public highways), Lyon Urban Truck and Bus and VEDECOM (Institute for Excellence in Low-Carbon Energies, specialized in the field of land transport and eco-mobility, set up in Satory).

4. Communication and diffusion

4.1. Demand-side

Mobility behavioral changes can be explained by shifting world geopolitics, shifting demographics and shifting mobility supply (Meurisse and Papaix, 2013). Besides, information is a powerful enabler of behavioural change.

4.1.1. The French Agency for Multimodal Information and Ticketing

The French Agency for Multimodal Information and Ticketing (AFIMB in French), operational since the beginning of 2011, is responsible for (MEDDTL, 2011):

- Promoting the interoperability of multimodal information and ticketing;
- Encouraging users' information services, dealing with all modes of transport;
- Networking multimodal information systems with voluntary local authorities.

4.1.2. The “Energy consumption and CO_2 emissions” label

From the 10th May 2006 (order of the 10th November 2005, JORF, 2005), car manufacturers have been obliged to inform customers on the fuel consumption and CO_2 emissions of new passenger cars, through an “Energy – CO_2” label. This informational tool aims at dissuading consumers from buying high pollution vehicles. Colour’s label varies depending on CO_2 emissions in the following way (figure 7):

Figure 7: Colour’s label depending on CO2 emissions

Such passenger cars labelling scheme has also been put in place in other European countries, namely: United Kingdom, Belgium, Denmark, Netherlands, France, Spain, Switzerland and is planned to be adopted in Portugal and Germany (De Hann et al, 2009).

This kind of label exists also for used cars in the UK. The Used Car Fuel Economy Label, launched in November 2009, gives information about model, CO_2 emissions and fuel consumption of used cars put up for sale. The Label has been developed by the Low Carbon Vehicle Partnership with support from the Retail Motor Industry Federation, Society of Motor Manufacturers and Traders and the British Government. It is a voluntary initiative, and car dealers are not obliged to take part (Which, 2009).

4.1.3. The EU Tyre Label

By November 2012 (and under Regulation EC N°1222/2009, European Commission, 2009c) all relevant new tyres sold in Europe must carry the EU Tyre label that aims to provide standardised information on fuel efficiency, wet grip and external rolling noise.

Experts suggest though that only tyres prototypes would satisfy criteria under letter A to date.

4.1.4. Information obligation on biofuel content in fuels

The Directive 2009/28/EC (European Commission 2009b) on the promotion of the use of energy from renewable sources states that “when the percentages of biofuels, blended in mineral oil derivatives, exceed 10 % by volume, Member States shall require this to be indicated at the sales points”.

The European Directive has been translated into the French Law of 12 January 2012 (JORF, 2012).

4.1.5. Eco-driving training

Eco-driving (i.e. smart driving, good maintenance of the vehicle, etc.) can lead to real CO_2 benefits, providing up to 50% of carbon emissions reductions, depending on the drivers. In Italy, the “Eco-drive” software used in 33,000 cars has enabled a decrease of 3,000 tons of CO_2 in one year. Correspondingly in Switzerland, 36,000 drivers were trained under the “Eco-driving” program and as a result 46,000 tons of CO_2 were reduced in 2007 (OICA, 2010).

Moreover in France, in order to raise drivers’ awareness of eco-driving, the French Climate Plan (MEDDTL, 2011) added some questions about eco-driving into the theoretical test on the rules of the road. In addition, eco-driving dimension had been integrated in the special educational programs on road safety. Furthermore, the French Government has set a 100% target for government officials to be trained in eco-driving (circular on the exemplary nature of government actions with regard to sustainable development (JORF, 2008).

4.2. Supply-side

4.2.1. Information obligation on CO2 emissions from transport services

With effect from 1st October 2013, the French Grenelle II Act (JORF, 2010) (Article L1431-3 of the transport Code, JORF, 2013b) has made it obligatory to report CO_2 emissions from transport services (MEDDE, 2012).

CO_2 certification in freight activity is more widely emerging in the EU in order to foster new fuel, engine, and powertrain technology options up-taking in commercial trucks and buses fleet (e.g. hybrid-electric, plug-in hybrid-electric, hybrid hydraulic-powered drivetrains, etc.). In this regards, the Working Party on Pollution and Energy (GRPE) is urging for a fairer and more transparent system of certification allowing a better integration of hybrid vehicles into emissions testing program (notably by developing pollution standards not only at the engine level that underrepresent g/kWh emissions of hybrid vehicles but by considering all emissions from a broader perspective). The GRPE aims to have the test procedure finalized and adopted by June 2014 (ICCT, 2012).

4.2.2. Eco-driving training

The French Climate Plan (MEDDTL, 2011) acted in favor of an eco-driving training program for professional drivers, followed-up by a continued training every five years.

Transport professionals themselves are also involved in "eco-driving" training programs. For example, Mobigreen launched by La Poste is a training company specialising in changes in drivers' behaviour. In addition, La Poste has also provided to 70,000 postal workers eco-driving training in 2012 (Mobilité durable, 2013b).

5. Summary table

Table 18: Summary table

Command and Control	Demand-side	**- Speed limit** **- Low Emission Zones** - High-Occupancy Vehicles lanes **(bus lanes only)** **- Parking access management**
	Supply-side	*Related to CO_2 emissions : **CO_2 emissions standards for new passenger cars and light-duty-vehicles** *Related to biofuels **:** **Minimum of biofuel content in fuels** *Related to EV charge plug : **Norms on publicly accessible infrastructures** **Obligation of EV charge plug in buildings**

Economic Instruments	Demand-side	* Automobile purchase pricing schemes : **Bonus-malus,** **Scrapping premium** VAT and income tax reduction **CO_2-tax for used pollutant passenger cars,** * Automobile ownership fiscal schemes : **Annual tax for company vehicles,** **Annual tax for pollutant vehicles** * Automobile use pricing schemes **Fuel pricing (Fuel tax, Tax exemption for biofuel,** Carbon tax) **Road user charge** (Urban toll**, Major roads and highways toll)** **Parking pricing** **Free access to public transport**
	Supply-side	**Investment in R&D** **Investment in infrastructures**
Collaborative initiative	Demand-side	**Public procurement**
	Supply-side	**Public Private Partnership** **Suppliers consortia (industrial partnership, joint venture, innovation clusters)**
Communication and Diffusion	Demand-side	**French Agency for Multimodal Information and Ticketing** **"Energy consumption and CO2 emissions" label for new passenger cars** Used car Fuel Economy Label **EU Tyre Label** **Information obligation on biofuel content in fuels** **Eco driving training (for automobilists)**
	Supply-side	**Information obligation on CO_2 emissions from transport services** **Eco-driving training (for transport professionals)**

In bold characters: In France

Source: Authors from Leurent, 2011

Conclusion

The transition to sustainable transport, which necessarily implies low carbon transport, will require a major structural shift in both passenger and freight transport systems. The capacity to anticipate and influence this shift will enable transport system operators to recognise constraints on carbon emissions as opportunities for innovation and growth.

According to the economic theory (Tinbergen, 1952), policy-makers should prefer one specific measure to achieve one particular goal. And yet, as has been highlighted in this report, several policy-tools (taxes, subsidies, etc.) can indirectly pursue the same objective (namely fight against climate change). The key would then be to achieve good coordination between the multi-lateral effects of such measures, in order to transform transportation systems and to actually ensure they move in the desired direction. The second caveat to this first assertion is that when one measure achieves its full efficiency (for example, when fossil fuel carbon taxation manages to dissuade or reduce conventional fuel consumption), it may run against the functioning of another policy-tool (for example, raising public funds through an energy tax). This is the well-known paradox of green taxes (Barde and Cournede, 2002).

Beyond insuring the overall consistency of the policy-toolbox for regulating transport emissions, transport and the other policies in the sector must evolve in a compatible way. Schematically, if public transport services are enhanced in city-centres, land rents and land prices increase, and poorer populations are forced to leave the centre to relocate to peripheral zones. There is then the tendency for the resulting "urban sprawl" effect to be contrary to land planning policies. Another consequence could then be the construction of housing in lightly populated zones where transport facilities are insufficiently developed (indeed, it appears to be a density threshold of 50-150 inhabitants/ha below which mass transportation systems are not economically feasible (Russo and Boutueil, 2011)), resulting in a mismatch between transport demand and infrastructure supply, thus encouraging car use.

Finally, it can be noted that the automotive industry is facing numerous structural challenges in which reducing CO_2 emissions from new cars sold is part of a wider strategy (ERIEP, 2013). Indeed, in the light of the economic downturn of 2008 the automotive industry is struggling with overcapacity, a saturated European market and increasing competition with firms in Brazil, India, and China. In this context, the emerging questions surrounding "green cars" and the new forms of mobility both embody an additional challenge for the industry (environmental concerns and the need for a transition to sustainable systems) but also a way-out from the other stakes by creating new strategic opportunities for innovation and growth.

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Annex 1: Stickers of low emissions vehicles in Germany

Emissions Standards	Group of quantity of pollutant emissions	Date of first registration (passenger cars)	Date of first registration (heavy goods vehicles)	Sticker
		Diesel		
< or = EURO I	1	Before 01-01-97	Before 01-10-96	X
EURO II or EURO I with SRHE	2	Between 01-01-97 and 31-12-00	Between 01-10-96 and 30-09-01	Red
EURO III or EURO II with SRHE	3	Between 01-01-01 and 31-12-05	Between 01-10-01 and 30-09-06	Yellow
EURO IV or EURO III with SRHE	4	After 01-01-06	After 01-10-06	Green
		Petrol/gas		
< or = EURO I (vehicles excluded from group 4)	1	Before 01-01-93	Before 01-01-93	X
< or = EURO I	4	After 01-01-93	After 01-01-93	Green

SHRE: Systems for reducing harmful emissions

Source: ADEME (2009)

Annex 2 : Selected passenger car types used for making comparisons

Category	Class B : small car	Class C : medium car	Class D : large car
Car model and type	Peugeot 207 1.4	Volkswagen Golf 1.6	Ford Mondeo 2.0
Fuel type	Gasoline	Diesel	Gasoline
CO2 emissions (g/km)	147	119	184
l/100km	6.34	4.49	7.93
Engine size (cc)	1,360	1,598	1999
Weight (kg)	1,214	1,314	1496
Euro Class	5	5	5
Purchase price in Belgium (incl VAT) (€)	12,283	22,115	35,820
Engine power (kW)	54	77	149
NOx (g/km)	0.06	0.18	0.06
PM (g/km)	0.005	0.005	0.005
Length (mm)	4,030	4,199	4,784

Source: European Commission (2012d)

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Contact us:
Chaire Economie du Climat - Palais Brongniart (4e étage)
28 Place de la Bourse, 75 002 Paris, France
Tel : +33 (0)1 73 01 93 42
Fax : +33 (0)1 73 01 93 28
Email : contact@chaireeconomieduclimat.org

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