RECHARGEABLE VEHICLES
INFRASTRUCTURE DEPLOYMENT POLICY:
FRENCH CASE

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power-trains to 2020/2030/2050:
A cross country assessment of early stages of implementation”

OECD, 30th November 2012
OUTLINE

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1- **Background**

   **a. French Energy landscape**

In 2011, the total primary energy consumption reaches the amount of 275 M toe (“tons of oil equivalent”) and the final energy consumption 168 M toe. In relationship with the existing and future transport energy demand, it will be reminded the main characteristics of French energy mix (figures from 2011 statistics):

- **Electricity production**: 569 TWh, mainly from *domestic and CO2-free* sources at 92 %: nuclear for 79%, Renewables for 13 %, the remaining 8% is from imported Fossil fuels. According to 2009/28/CE, part of renewable in electricity production is 16, 2 %.

- **Ratio of energetic independency: 53,5 %**: an ratio between domestic primary energy on total primary energy production, including nuclear, renewable and very small part of domestic fossil

- **Exportations of electricity are pretty large**: around 56 TWh in 2011, corresponding to 12 % of French production and earning a 2,5 B€ income.

- **Importations of fossils fuel (oil, gas and coal) for a near 64 B€ bill, accounted for 88% of the country’s trade deficit** and it represents 3.1% of GDP.

The share of Renewables in final consumption is around 13 % for a target of 23 % in 2020. According to figure 1, the main renewable sources are Hydraulic and Wind for 33 % (mainly for electricity production) and Biomass/Waste for 66 % (Heat, biofuels and electricity).

*Figure 1: Repartition of renewable in France in %*
**Zooming on electric production**, a typical consumption profile (Day 23rd November 2012) is described on figure 2 and figure 3 presents the CO2 emission profile during the same day.

This situation is typically from a normal and frequent working day, without large peak consumption due to very cold temperature for example.

**Figure 2**

![France Total electric production during 23 rd november 2012](image)

**Figure 3**

![Co2 Emissions (g/kWh) from french electricity production 23 rd november 2012](image)

What is noticeable is that the spread between minimum and maximum of power is about 20 GW (50 GW to 70 GW) far below maximum power capacity, secondly the CO2 emissions are rather low even during peak period. *That could indicate that for a large majority of days in the year, increasing for a few percents the maximum power (let’ say between 3 to 6 GW,*
could corresponds to 1 to 2 Million electric cars slow recharging), there will be no dramatic increase of CO2 emissions.

The power plants are relatively well geographically distributed along the national territory and the Transport and distribution system in France is a high quality and reliable grid, covering every cities, villages and remote area but there are two weak areas corresponding to a high unbalance between production and consumption: Brittany area and Provence region. These two regions are often called “electric peninsula” to stress out a weaker grid and higher risk of black out during winter time for example or when a local incident weaknesses the regional grid.

b. Main characteristics of individual transport system and mobility in France

General considerations on Mobility in France

France is a rather large country in Europe (550 000 Km2) with some non-or low-populated areas and a few very populated. More than 36 Millions of inhabitants are living in concentrated area, the main 50 urban areas above 200 000 inhabitants (Purple and red area on figure 4) but representing only 8 % of the territory. But 95 % of the French population (65 Million inhabitants) are “influenced” in their daily life by the nearest city.

Figure 4: French population density map (Inhabitants/Km2)
The share of road transportation both for passengers and goods is around 88% (727 billion km-passengers or near 400 Billion km-vehicles), despite some high level urban transport system in big cities and a high quality level of high speed train network (TGV) between main populated areas (Paris, Lyon, Marseille, Nantes, Lille, Strasbourg). Interesting for the future electric car systems is the share of road transportation along the nature of trip described in figure 5:

**Figure 5: repartition of road mileage according to type of road trip in France**

<table>
<thead>
<tr>
<th>Type</th>
<th>Trip Mileage (km)</th>
<th>% of total French road mileage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very short urban journey</td>
<td>1 to 10 km</td>
<td>9 %</td>
</tr>
<tr>
<td>Intermediate journey (leisure, visits, shopping...)</td>
<td>10 to 100 km</td>
<td>48 %</td>
</tr>
<tr>
<td>Commuting journey (Home /Work) &lt; 100 km</td>
<td>1 to 100 km</td>
<td>22 %</td>
</tr>
<tr>
<td>Long distance journey + long distance commuting</td>
<td>&gt;100 km</td>
<td>21 %</td>
</tr>
</tbody>
</table>

The total number of cars in France is about 31 Millions, and near 6 millions of utility cars, trucks, buses etc...

An important parameter for future business model for electric cars charging is also where and how the cars are parked (figure 6)

**Figure 6: repartition of car parking**

<table>
<thead>
<tr>
<th>Type of parking</th>
<th>Urban area in France</th>
<th>Paris (downtown)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private (house, building)</td>
<td>53 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Public parking lot</td>
<td>15 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Street parking</td>
<td>32 %</td>
<td>20 %</td>
</tr>
</tbody>
</table>

Paris inhabitants have a very low motorization ratio: only 42 % of population do have a car in Paris city, and 68 % in Paris urban area. The French mean value is 84 %.

Important figure to be noticed: there are 15 million of individual houses in France, 50 % are equipped with a private garage.
Energy and CO2/polluants emissions

The energy consumption in Transport sector is highly oil-dependant, more than 90%. The Green house gases emissions in transport sector represent 28 % of total French GHG emissions, on which half (14%) is due to individual cars.

The mean value of CO2 emissions dropped these last years to a 127,9 g CO2/km in 2011.

**Figure 7: mean CO2 emissions for a new car (gCO2/km) in France**

This dramatic decrease in new cars emissions is a combination of three factors:

- thanks to a positive/negative incentive (taxes on new cars according to their CO2 emission levels described for 2013 figure 8) promoting the lowest emissions cars
- linked with the former factor, a new tendency to down size the type of cars to more and more “Small” and “lower medium” cars is observed very clearly for a few years (For A, B, M1 market segments).
- the high ratio of diesel cars in France, now more than 70 % of new cars are diesel engine powered but more than 80 % of fuel consumption (and mileage too) in France is diesel. As specific consumption of a diesel car is 12 % less than a gasoline one, mean CO2 emissions are lower.
**Figure 8: 2013 premium/taxes system as a bonus/malus scheme for new cars according to CO2 emissions**

**Incentives**

<table>
<thead>
<tr>
<th>CO2 Level g/km</th>
<th>Hybrid cars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-20</td>
</tr>
<tr>
<td>Incentive</td>
<td>4000€</td>
</tr>
</tbody>
</table>

**NEUTRAL** Cars between 106 g/km and 135 g/km

**Taxes**

<table>
<thead>
<tr>
<th>CO2 Level g/km</th>
<th>136-140</th>
<th>141-145</th>
<th>146-150</th>
<th>151-155</th>
<th>156-175</th>
<th>176-180</th>
<th>181-185</th>
<th>186-190</th>
<th>191-200</th>
<th>&gt;200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxes</td>
<td>100€</td>
<td>300€</td>
<td>400€</td>
<td>1000€</td>
<td>1500€</td>
<td>2000€</td>
<td>2600€</td>
<td>3000€</td>
<td>5000€</td>
<td>6000€</td>
</tr>
</tbody>
</table>

The most important incentives are limited by the following rule: the premium is capped at 20% of the purchase price.

But in the same time intense utilization of diesel cars in urban areas leads to a high concentration of PM, particulate matters and NOx.

**Industry**

The transport sector represents in France around 5% of GNP and 5% of total employment. It is a highly strategic sector for French economy with a global turnover of more than 800 000 direct jobs and more than 1.5 Millions indirect jobs. Renault, Peugeot-Citroen are producing less than 2 Million of vehicles last year. Toyota and Smart are producing also in France cars, near 350 000 in 2011. Automobile industry is the first economic sector for patents portfolio.

But with economic crisis and over-sized capacity in Europe for car production, French car industry is facing one of the most hard and difficult challenges; some recent figures are rather alarming:

- dramatic decrease of jobs in this sector in France since the last ten years: 30% of jobs deleted! although French car manufacturers created a lot of job outside France and produces a large part now of their cars.
- market share decreasing, due a hard competition: French production decreased from 3,5 millions cars ten years ago to a 2,2 millions car per year today
- only 33% of cars sold in France are produced in France
With the recent announcement (last July) of Peugeot to shut down the Aulnay production plant, there is a big concern about car industry revitalization and it is now on the top level priority for the French government. Jobs creation in France, innovation, sustainable transport system are the key parameters for French policy support to Car industry.

c. **Main policy drivers and measures for a decarbonized transport system in France**

France Energy policy is completely integrated in European energy policy and Climate-Energy package. Energy law in 2005, then the three laws in 2008 to 2010, following the “Grenelle de l’environnement” (national debate in 2007 to 2009) determined the following mandatory objectives:

- 23 % of renewable in energy mix in 2020
- 20 % CO2 reduction in 2020
- 20 % increase in energy efficiency

For 2050 an ambitious target of 80 % Greenhouse gases reduction was fixed, with a 95 % reduction in transportation sector.

In automotive industry France succeed with Portugal to reach the target of 130 gCO2/km in 2010 (cf paragraph above) as it was foreseen by European legislation in 2015!

2- **Deployment of electric cars and infrastructure: state of the art and perspective**

   a. **General characteristics of French policy and main guidelines on electric cars and charging infrastructure:**

Deployment of electric cars and infrastructure could bring a partial but significant answer to the main issues:

- decarbonizing transport system by substituting a fossil fuel by low carbon french electricity with a double benefit: GHG reduction and reduction of oil bill (reducing commercial balance deficit)
- creating jobs and economic added value in France
- impulse a strong innovation effort in this old industry
- reducing pollution in cities, especially PM pollutants but it could be only achieved with a significant share of Zero emission vehicles. It will take two decades to reach this level.

The French governmental support is strongly linked to a production of car localized mainly in France and creating job and economic added value.

Specifically for electric cars (BEV and PHEV), the main measures are:
- **Incentives** are the main policy measure to accelerate market deployment
  - National level (described in paragraph above) a premium up to 7000€ for a electric car and 4000€ for an hybrid vehicle. The premium is capped at 20% of the purchase price.
  - A similar tax exemption for company vehicles is in place (ACEA 2012). Getting fleet owners to switch to EVs is important as it gives the opportunity for large scale tests of the technology and economies of scale for the producers. As such the company car tax exemption is important.
  - Sometimes with an additional incentive at regional or municipal level like in Strasbourg city up to end 2011.

- **Public procurements** with relatively high volume: at least 25% of public procurements for car in French administration must be electric or hybrids vehicles (only electric for an urban usage), and recommendation measures will be taken for local administration and public companies. In total French government has committed to buying 50000 EV (BEV, PHEV). As an example a public procurement for 15637 plus an additional 3074 electric cars (Kangoo ZE) was achieved last year by French postal, La Poste, for delivery and deployment from 2015.

- **Infrastructure:**
  - French law confirm the possibility for local authorities (municipalities, association of different cities) to deploy public electric infrastructures.
  - Mandatory obligation for new building and houses and new working place: pre-cabling installation for a future charge point installation.
  - Mandatory measure to facilitate charging point installation in existing building.

Coming soon in 2013 and 2014, additional measures should be taken and help EV:
- "ZAPA" area creation in pilot cities: priority area for a clean air, could mean interdiction of oldest vehicles in city center, and promote zero emission vehicles.

The main targets for electric vehicles and charge infrastructure are listed in figure 9&10:

**Figure 9: National targets for electric cars sales in France**

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of electric vehicles on French roads</td>
<td>450,000</td>
<td>2,000,000</td>
<td>4,500,000</td>
</tr>
</tbody>
</table>

*Source: MEDDTL 2009*
The Green book on accessible charging infrastructures, published by senator Louis Negre in April 2011 is the reference report and create a frame for all infrastructure deployment. The main conclusions and recommendations are:

- Normal charge (3 kVA) is highly recommended and must take the priority: due to the low cost (2 € for a complete charge), due to the fact that the car is not moving during 90% of time and is parking at home or at work at least during long period. At least 90% of energy needs will be assumed by this type of charge. It allows an optimized use of battery with mode 3, and combined with a smart grid has quite no impact on the grid peak.

- Accelerate (22 kVA) or fast (43 kVA) must be exceptional, expensive and just to answer the “anxiety range” or for more comfort. This is due to the high cost, high impact on electricity peak, impact on distribution grid (reinforcement) and in some specific conditions on Carbon content of peak electricity.

- 2 categories of connector recommended: existing domestic and type 3 for 3kVA
- for 22 kVA, possibility to deliver also 3 kVA
- both DC and AC for 43 kVA
- Interoperability is a critical point: communication and payment standards, allowing the roaming possibility for a customer, geolocalisation of charge points
- globally two charge point for a vehicle: one at home, one at work, plus public parking place. MEDDTL road map in 2009 assumed the same
- rules for determination of public charge point and estimation of costs are given, optimization rules to decrease investment costs are given
- business model not established for public charge point; impossible to be paid by the final customer only
- three best business models: DSP (Public Service delegation), PPP(private Public partnership), creation of a legal structure (gathering several local authorities) to finance, develop, operate public charge infrastructure.
- A global mobility service (like Autolib in Paris) has at least two advantages: scale factor, fusion between charge point parking place and mobility service itself (electric cars rent).

b. Electric cars

The total number of electric cars in France in November 2012 are around 13 000 to 15 000, including a 3000-4000 small vehicles or specific vehicles plus scooters or motorbike with sales of 184 in 2010, 2630 in 2011 and 5102 up to October 2012 (Figure 11, 12, 13). (Source Ademe www.ademe.fr, plus Yoann Nussbaumer, website www.automobile-propre.fr). CCFA gives 7858 cars sold up to 31/10/2012.

Figure 11: Electric cars sales 2010-2012

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VP</td>
<td>184</td>
<td>2670</td>
<td>5102</td>
<td>7950</td>
</tr>
<tr>
<td>VUL</td>
<td>796</td>
<td>1682</td>
<td>2756</td>
<td>5234</td>
</tr>
<tr>
<td>TOTAL</td>
<td>980</td>
<td>4352</td>
<td>7858</td>
<td>13190</td>
</tr>
</tbody>
</table>

Figure 12: Type of cars sold (2012)
c. Figures and deployment of infrastructure

The existing charge points are described in figure 14.

**Figure 14: Estimation of public charge points**

<table>
<thead>
<tr>
<th>Type</th>
<th>Installed CP 2012</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1 Non specific</td>
<td>8000</td>
<td>8000</td>
<td>50 000</td>
</tr>
<tr>
<td>Mode 2</td>
<td></td>
<td>50 000</td>
<td>100 000</td>
</tr>
<tr>
<td>Mode 3/Type 3</td>
<td>30 000</td>
<td>70 000</td>
<td>400 000</td>
</tr>
<tr>
<td>Mode 4/CHAdeMO</td>
<td>100</td>
<td>7500</td>
<td>10 000</td>
</tr>
<tr>
<td>Mode 4/Combo 2</td>
<td></td>
<td></td>
<td>10 000</td>
</tr>
<tr>
<td>MULTI STANDARDS</td>
<td>8000</td>
<td>15000</td>
<td>20000</td>
</tr>
</tbody>
</table>

**Figure 14 bis: Estimated private charging Point**

<table>
<thead>
<tr>
<th>Type</th>
<th>Installed CP 2012</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 3 domestic</td>
<td>0</td>
<td>150 000</td>
<td>1 000 000</td>
</tr>
<tr>
<td>Mode 3/Type 3</td>
<td>30 000</td>
<td>70 000</td>
<td>400 000</td>
</tr>
<tr>
<td>Mode 4/CHAdeMO</td>
<td>100</td>
<td>7500</td>
<td>20 000</td>
</tr>
</tbody>
</table>

Source: Governmental working group, MEDDTL and MRP, France 2012

Another source EURELECTRIC 2011 gives for existing connector Type 3 28 000 installed or commissioned, 50% private 50% publicly accessible.
Two programmes are devoted to support deployment, under the frame of “Investissement for the future”, funded by government:

- € 50 million is available for infrastructure development through the “Ville de demain” project run by the French environmental and energy agency (ADEME 2011). 50% of costs for normal and fast charge points and 30% of costs for rapid charge points are covered given that the points are made publicly available. In accordance with the governmental strategy, 13 pilot projects in towns across France have been done to test the deployment and use of charge points. Experience from the demonstration project in Strasbourg with EDF, Toyota and Strasbourg City indicates that charging happens during peak hours. The cars are plugged in when they arrive at work at 08:00 and when they get back home around 19:00, To get the full environmental benefit from EVs, charging patterns must change, smart meters must be installed or differential pricing must be implemented to incentivize charging during low load hours

- € 50 million under the same frame, and run also by French ADEME is available also through deployment experimentation to test technical, financial and societal conditions of such systems.

**COSTS ISSUES**

The cost of installing charge points has come down lately. In 2011 the costs were € 500 to € 3,700 for home, parking or work charging, € 7,800 for fast charge on highways and € 55,000 for rapid charging (MEDDTL 2011, p. 16).4 With the new cost per charging station, the break even price in €/kWh would be 3 times higher than the electricity cost. For a 3 kVA connections, depending on whether 2 or 12 charging spots are served from one charging station, costs can range from €4,000 to €9,000 per charging station (all costs taken into account) in 2011. There is additional costs for DSO (Distribution operator, which in France has to pay 40 % of the electricity installation). The economies of scale observed are significant and depend on the rate of proliferation of the charging spots (number of charging spots or parking places served by a given point of connection to the power grid).

**Who will be pay for that?**

For example, Green Book estimates if were the charging infrastructure costs to be borne totally by the end users, they would have to pay – for each “top-up” of 25 kWh – between €13 for a 3-kVA charging station at normal charge and €36 for a 43-kVA fast charging station, to which €2, being the cost of electricity, should be added. In total, the TCO, total cost of ownership for a medium ICE car is estimated to 22 000€ today. For the same type for vehicle but BEV, the TCO could be:

- 29 000 €, if charging is at home, including battery costs, 500€ for a home connector, plus some public charging sometimes
- 39 000€ if the main charge point is public (parking, street, fast charging)

The incentive could help to make profitable the first case (home) but never the second one.
When all these infrastructure costs are transferred to the end user, it becomes clear, at least during the initial years of the starting up of the market, that infrastructure costs partially hamper the competitiveness of rechargeable vehicles compared to ICE vehicles, and that it would be difficult to put the burden of financing the public infrastructure on the end user. These costs can be very significant (approximately €9,000 over 8 years) for users who park mainly in public areas (second case). This factor must be taken into consideration by the local authorities/municipalities in assessing the charging infrastructure and in prioritising the customer segments. In this respect, shared charging could prove to be a higher priority and economically more efficient to allow the market to reach critical mass than main charging in the public area, which would be developed in the second phase. In conclusion there is not a clear business case for public charge system.

- Probably, at least for the first 10 years, investment has to be taken by public authorities or public parking operators, or supermarkets for investment.
- As an example, on the scale of the 25 largest cities in France, this implies a cost flow (investments + operations) of some € 45 m in 2011 and € 300 m in 2014 for setting up the project. For example for a city like Rouen (500 000 inhabitants), it represents 3-4 millions in 2015.
- One of the most pragmatic solution will be to deploy progressively in the cities faster choosing the location. For public parking one way to compensate the extra costs of a few charging point could be to extend the duration of private contract to run a public service by one year for example. For super or hyper-market parking, such investment could be included in investment budget progressively.
- In a more global perspective, the total investment is estimated on figure 15.

**Figure 15: Total investment needed up to 2025 for electric infrastructure**
One major bottleneck in France could be the drastic reduction and cut in public budget, both at national level but also now at local level for the next 6 years.

**Standards and regulatory issues**

One issue is that Type 2 AC connector are not allowed in France according to French standards and regulations, at the contrary of others European countries. EURELECTRIC expressed its concerns about the absence of agreement. A standardized connector is expected in 2017.

**d. Synthetic Analysis of the French model/lessons learned/Conclusions**

The French model for electric car deployment is based on some specific aspects:

- electricity mix without CO2
- characteristic of small or medium vehicles
- priority to jobs creation and car industry revitalization
- national and global plan to help the market to start
- BUT implementation at local level
- **choice of normal charge priority and not fast charging**
- complementary publicly accessible infrastructure
- BUT no profitable business case
- public and local investment needed
- BUT difficulty to invest in economic crisis

Only one promising: “Autolib” model because it is not only a charge point service but a mobility service

Dilemma:: an electric car have to run a important mileage to become profitable but an electric car will run only on urban area

In any case the market is growing but slower than foreseen

**What about taxes lost when substituting gasoline by electricity ?**

Example Let’s take 1 million electric car running 13 000 km a year with an electricity consumption of 15 kWh/100 km.

In total 2 GWh are needed. These 2 GWH are decreasing the exportation balance by 5 %, loss for commercial balance of 125 M€

In the other hand, some gasoline consumption and CO2 emissions are avoided: around 0,8 Million t, leading to decrease the oil bill by 1 000 M€

So the net trade balance is dramatically improved, and CO2 emissions decrease also by around 3 %!

Positive externalities are net creation of jobs in the country.
But some taxes are lots by government:

Taxes are 0,66€ per liter on diesel; electricity is only VAT taxed (20%);

1 million electric vehicle lead to a net loss of around 500 M€.

If we add all incentives for cars and infrastructure, the total amount could be highly expensive for the public budget (national and local)

The global interest for the nation is obvious. Nevertheless it has a big impact on budget.

It is a sensitive point and a global economic approach taken into account all externalities has to be carry out to measures all the consequences of electric cars deployment at large scale.