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POSSIBILITY OF REDUCING CO_2 EMISSIONS FOR EXAMPLE ELECTRIC VEHICLES

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Abstract

Development of road transport is now subjected to numerous constraints related to reachability exhaustive sources of liquid fuels and the associated increase in their prices. In addition, restrictions on emissions tend for quickly change the drives with an internal combustion powered petroleum products for electric cars in the near future. Compared to the conventional internal combustion engine, full electric cars driven on European roads appear as environmental winners for the next decades in terms of environmental protection. The article draws attention to the growing increase in CO_2 emissions over the years until 2050. Forecasts by 2050, it is estimated that environmentally friendly vehicles will probably reduce the CO2 emissions into the atmosphere comes from cars. The article shows that the speaking of electric vehicles in terms of ecology should take into account the emissivity of the vehicle together to produce a current, and not only the emission of the vehicle from tan to wheel. In the article dealt with directions of development electric sector model in the context of the year 2050. It presents three scenarios that involve the reduction of CO2 emissions, which directly translates into lower fuel consumption.

Keywords: *transport, electric vehicles, emission, fuel consumption, energy*

1. Introduction

By helping to diversify the fuel mix, EVs reduce dependence on petroleum and tap into a source of electricity that is often domestic and relatively inexpensive. Just as important, EVs have the potential to unlock innovation and create new advanced industries that spur job growth and enhance economic prosperity.

In the long-term, EVs are important to countries seeking to decarbonise the transport sector. Fig. 1 illustrates the key role of transport CO_2 reductions in the International Energy Agency's (IEA) "2DS" scenario (2°C Scenario), which describes a future energy system that would limit average global temperature increases to 2°C by 2050 [6]. In this scenario, the transport sector's potential share of overall CO_2 reductions would be 21% by 2050. In order to meet this share, three-fourths of all vehicle sales by 2050 would need to be plug-in electric of some type.

Electrified road transport has been around in some form for more than 100 years, although by the 1930s the petroleum-fuelled internal combustion engine (ICE) displaced its use by light-duty passenger cars almost entirely. EVs appeared on the market both in the early 1900s and briefly in the 1990s. In the last 10 years, the world has again considered vehicle electrification in light of increasing and volatile oil prices, deteriorating urban air quality, and climate change. This renewed interest represents a "third age" of electric vehicles, starting with the mass-market introduction of

EVs in 2010d.

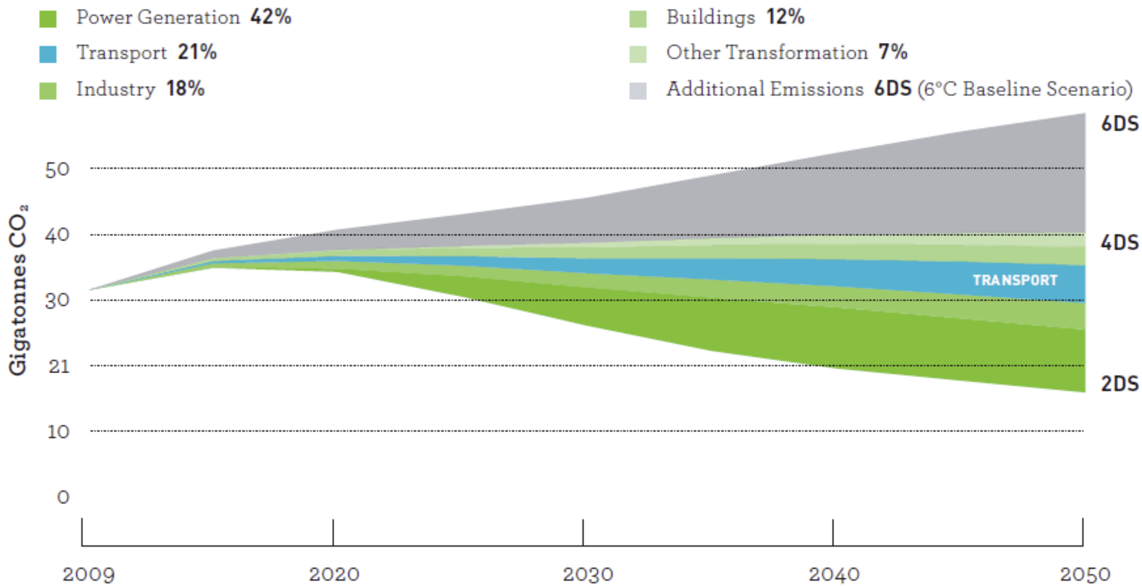

Fig. 1. Role of transport in CO_2 reduction (% = 2050 estimate)

The Energy Technology Perspectives (ETP) scenario sets an overall target of a 50% reduction in global energy-related CO_2 emissions by 2050 compared to 2005 levels. In the scenario, transport contributes to this overall reduction by cutting CO_2 emissions levels in 2050 to 30% below 2005 levels [1, 2]. This reduction is achieved in part by accomplishing an annual sale of approximately 50 million light-duty EVs and 50 million PHEVs per year by 2050, which is more than half of all LDV sales in that year. The EV/PHEV roadmap vision reflects the future EV/PHEV market targets set by the BLUE Map scenario. Achieving requires that EV/PHEV technologies for LDVs evolve rapidly over time, with very aggressive rates of market penetration once deployment begins (Fig. 2).

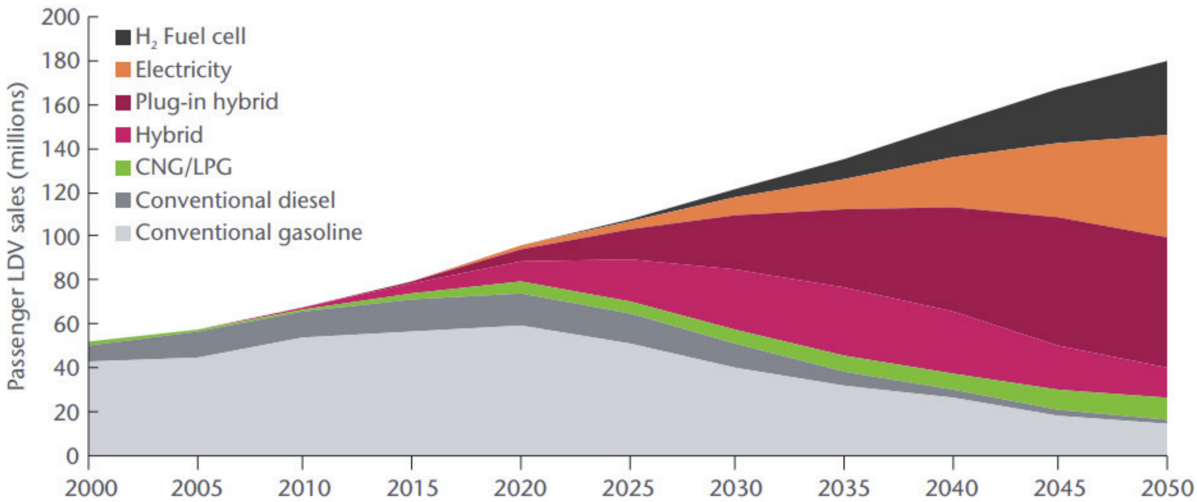

Fig. 2. Annual light-duty vehicle sales by technology type

PHEVs and EVs are expected to begin to penetrate the market soon after 2010, with EVs reaching sales of 2.5 million vehicles per year by 2020 and PHEVs reaching sales of nearly 5 million by 2020 (Fig. 3). By 2030, sales of EVs are projected to reach 9 million and PHEVs are projected to reach almost 25 million. After 2040, sales of PHEVs are expected to begin declining as EVs (and fuel cell vehicles) achieve even greater levels of market share. The ultimate target is to achieve 50 million sales of both types of vehicles annually by 2050.

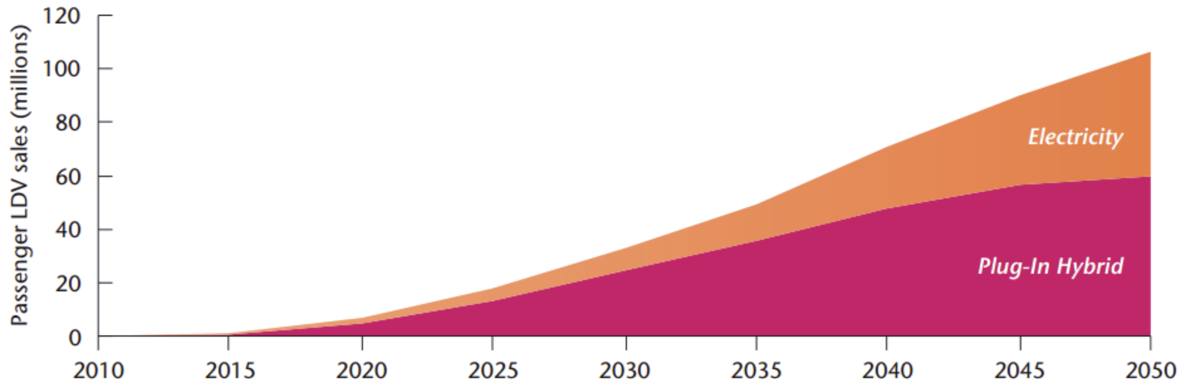

Fig. 3. Annual global EV and PHEV sales

2. Impacts on fuel use and CO_2 emissions in electric cars

In 2009, both the European Union (EU) and G8 leaders agreed that CO_2 emissions must be cut by 80% by 2050 if atmospheric CO_2 is to stabilise at 450 parts per million 15 – and global warming stay below the safe level of 2ºC. However, 80% decarbonisation overall by 2050 requires 95% decarbonisation of the road transport sector (Fig. 4).

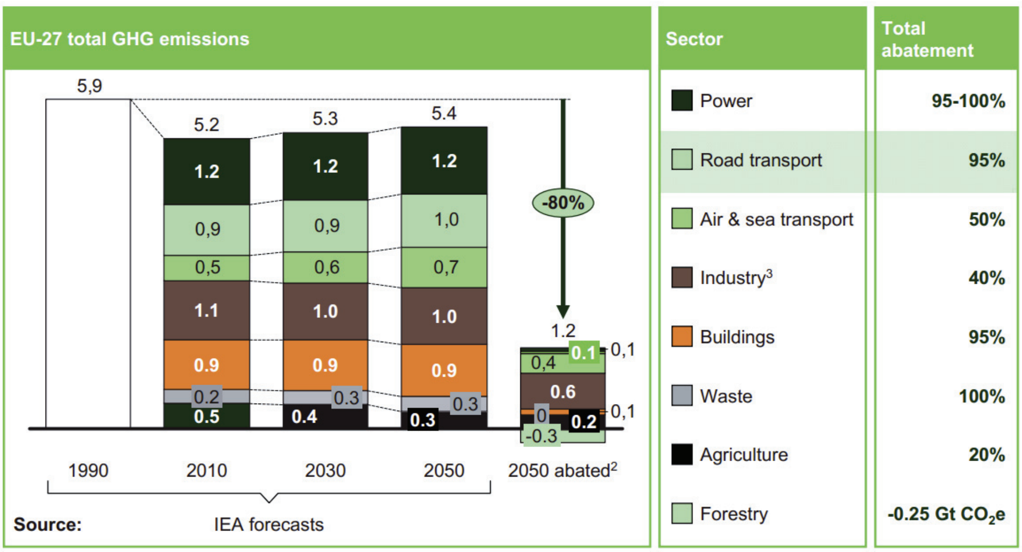

Fig. 4. Founded CO_2 reduction by 2050

Compared to the conventional internal combustion engine, full electric cars driven on European roads appear as environmental winners for the next decades. Automobile CO_2 emissions rate (in g per driven km), are usually evaluated tank-to-wheel. This method looks only at the CO_2 emissions produced through the vehicle fuel consumption i.e. it considers mainly the energy efficiency of the car. Contrary to conventional vehicles, electric vehicles present the advantage of emitting no CO_2 on a tank-to-wheel basis, as power is provided to the wheel without the internal combustion of fuel. Tank to wheel, a car can be considered as "zero emission vehicle" when it runs solely on electricity [4]. Electric cars, in particular full electric vehicles, also appear much more efficient than conventional vehicles. For the same distance, conventional cars need up to three times more energy than lithium-batteries electric cars. The CO_2 emissions of plug-in hybrids are more difficult to estimate. Indeed, there is a large range of PHEVs, the number of kilometres driven on electric mode can fluctuate (the longer the journey, the more the car will be driving on conventional fuels and the more it will pollute), the consumption – on electric mode – will probably be higher than for a full electric car (if only because the car is heavier), and it is not clear whether its conventional engine will be efficient. As it is almost impossible to define a small bracket in which to place Plug-in hybrids, most studies assessing new vehicles technologies contribution to CO_2 reduction efforts have mainly focused on pure electric vehicles as compared to conventional ones, assuming that plug-in hybrids technologies should score in between.

An electric car has neither tailpipe emission nor smell of unhealthy gases – but it would be too easy to think that emissions simply do not exist. In fact, they come from elsewhere: in the process of bringing that electrically charged vehicle to the road. A meaningful comparative assessment of CO_2 emissions from different types of cars has to include both emissions from the vehicle itself and emissions generated by the production and distribution of the fuel needed to drive this car, i.e. the carbon factor of the fuel (gasoline, diesel, biofuels or electricity). This full assessment is called a well to tank assessment. The entire methodology is called a well-to-wheel assessment.

In order to calculate the CO_2 emissions of an electric vehicle, its (electric) consumption (in Wh by km) has to be multiplied by the CO_2 gases emitted to produce the kWh of electricity consumed (the carbon factor of electricity in g/kWh). There is a variety of estimations for the EU carbon factor of electricity. Tables below show the CO_2 emissions of electric vehicles.

The first table displays the CO_2 emissions of electric cars samples (in different categories), for which consumption levels are already known. These approximate results reveal that full electric cars, with the current power structure of the EU27, will emit little CO_2 (from 58 to 70gCO_2/KWh). This represents only half of the current average conventional vehicle, and still less than binding fleet emissions levels set for 2020 [3]. However, despite being widely used to promote the electric vehicle as a green car, the results obtained in the two tables above should not be taken for granted. Several elements presented in the following parts challenge this conclusion. Firstly, averages distort the reality; secondly, the standardized test to evaluate vehicle fuel consumption is biased in favour of electric vehicles; moreover, if the CO_2 assessment is extended to the car production and recycling (i.e. a life cycle assessment), the electric vehicle slips a bit off its green podium.

Tab. 1. Emissions for selected Full Electric Vehicles

Vehicle	Consumption KWh/100km plant-to-wheel	Driving Range km	CO_2 emissions g/ CO_2 (based on EU electricity mix 410gCO2/KWh)	CO_2 emissions g/ CO_2 (if electricity is produced by a coal fired plant over 100g CO_2/km)
Reva-i (small urban car)	11	80	45	110
EV1	11	120	45	110
QUICC! (van)	39	100	175.5	390
Tesla Roadster (sport car)	34.4	220	141.04	344

The cost-effectiveness of (different types of) electric cars as a climate change mitigation instrument will depend on the cost of CO_2 itself. In twenty years, the price of CO_2 might offset the price of investing today in new technologies, as it should increase substantially. A study commissioned by DG environment estimates that for 2013 the cost of CO_2 is around 25€/t, while in 2050 it could increase to roughly 85€. The official scenario forecasting the impact of EU policies on CO_2 prices confirms this increase.

The estimates of EV and PHEV sales and use in this roadmap are based on achieving the data scenario's 2050 CO_2 reduction targets, which can only be met with the enactment of aggressive policies. CO_2 reductions also depend heavily on changes in electricity generation; data targets require the nearly full decarbonisation of electricity generation around the world by 2050. As shown in Fig. 4, the CO_2 intensity of electricity generation in the data scenario drops steadily over time until, by 2050, all regions have nearly decarbonised their electricity. This steady decrease is an important assumption; if the achievement of low CO_2 electricity generation around the world does not occur in the 2030 to 2050 timeframe, the CO_2 benefits of EVs and PHEVs will be much lower. The IEA is also developing roadmaps on electricity CO_2 intensity targets.

Tab. 2. The evolution of CO_2 tone prices for the EU

		2015	2020	2025	2030
Carbon	NSAT	33.8	42.7	45.6	48.5
value	NSAT-CDM	23.7	30.0	32.0	34.1
€/tCO_2	CES	31.0	39.2	41.9	44.5
RES	NSAT	35.1	44.5	47.5	50.5
value	NSAT-CDM	39.1	49.5	52.9	56.2
€/MWh	CES	35.4	44.8	47.8	50.8

For PHEVs, CO_2 reduction levels will depend on the proportion of miles driven using battery electricity from grid recharging in lieu of petroleum consumption from an ICE. While it will take time to understand the relationship between the PHEV driving range as a function of the battery capacity, it is likely even a modest battery power range (e.g. 40 km) will enable many drivers to cut.

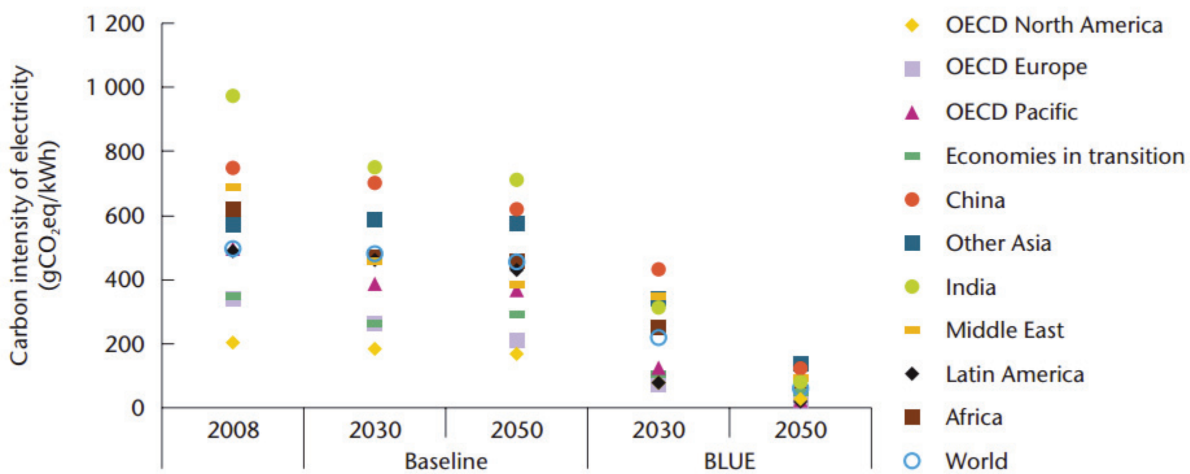

Fig. 5. Annual global EV and PHEV sales

3. Directions of development Electric Sector Model

Are developed detailed and comprehensive models of the electric and transportation sectors that simulated the evolution of both sectors over the 2010 to 2050 study timeframe. The researchers also developed a series of scenarios to assess the impact of PHEVs over a range of different possible futures depending on the evolution of the energy and transportation sectors.

To determine the GHG emissions from the electricity generated to charge PHEV batteries, EPRI developed a modelling framework that provides a detailed simulation of the electric sector. The EPRI framework integrates two sophisticated computer models. The first model, the Energy Information Agency's National Energy Modelling System (NEMS) covers the entire energy-economy system and calculates energy supply and demand nationwide. NEMS outputs-prices and electric loads-are the inputs to the second model, the EPRI National Electric System Simulation Integrated Evaluator (NESSIE). The NESSIE model represents the electricity sector from 2010 to 2050.

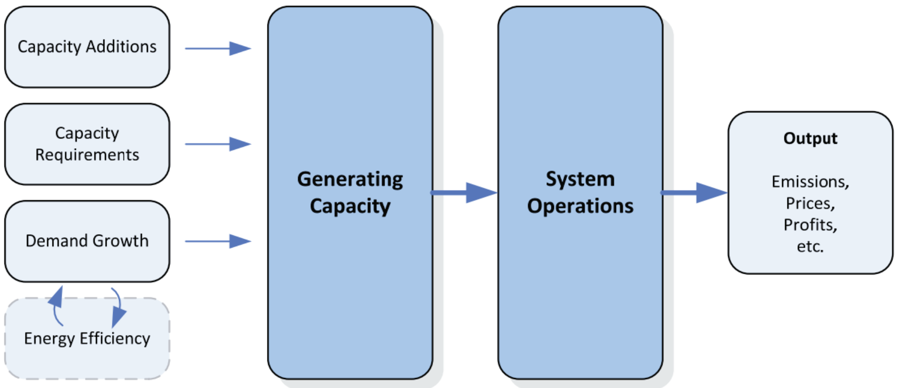

Fig. 6. Structure of Electric Sector Model

The model simulates decisions to add new capacity and to retire existing capacity. This component is extremely important for tracking the evolution of the generation capacity over time as it serves existing load and new load from PHEV charging. New generating capacity is generally lower in GHG (greenhouse gas) emissions than existing capacity. Capacity retirements increase the rate at which newer, lower emitting capacity is created. In addition, NESSIE simulates how technologies change over time, including gradual performance improvements for commercially available technologies such as combustion turbines or the emergence of advanced technologies such as Integrated Gasification Combined Cycle (IGCC) coal plants. Technology improvement is an important factor for reducing the GHG intensity of the future electric grid.

After simulating capacity additions and retirements, the model operates this capacity to meet electricity demand. Electric sector analysts call this a "production simulation" or "dispatch." The load varies across the year. Each generating technology has a bid price for energy that it offers to the market based on its variable cost of production [5]. The market selects the lowest possible bids. The price for all operating generators is set by the technology with the highest bid price that is operating at the time. This production simulation identifies the load served by every technology, cost of electricity, and emissions of SO_2, NOx, HC, and GHG.

The future of the electric sector may follow different paths, depending on the evolution of environmental policies, electricity demand, and available technologies. Rather than trying to develop a single consensus view, the team created three scenarios to span the impact of PHEVs over different possible futures.

The scenarios represent different levels of CO_2 intensity for the sector:

– high CO_2 intensity scenario: There is limited availability of higher efficiency and non-emitting generation technologies and a low cost associated with allowances to emit CO_2 and other GHGs in this scenario. Total annual electric sector GHG emissions increase by 25% from 2010 to 2050,
– medium CO_2 intensity scenario: Advanced renewable and non-emitting generation technologies, such as biomass and IGCC with carbon capture and storage, are available in this scenario. There is a moderate cost associated with allowances to emit CO_2 and other GHGs. Total annual electric sector emissions decline by 41% between 2010 and 2050,
– low CO_2 scenario: Carbon capture and storage retrofit technology for existing coal plants are available in this scenario. In addition, there is significantly slower load growth indicative of a nationwide adoption of energy efficiency, or other demand reduction, and a high cost to emit CO_2 and other GHGs. Total electric sector emissions decline by 85% in this scenario from 2010 to 2050.

Presented model was used to model each of the above scenarios and to output the detailed results. Each scenario used a different set of input data; and it was run through the entire model to produce the measures of interest. The following table shows the key differences among electric sector scenarios.

4. Conclusions

The electric car is making the front lines of newspapers where it is often presented as an innovative solution to the CO_2 emitted by the expansion of the transport sector. However, it appears that by 2020, Electric vehicles will barely contribute to CO_2 reductions in Europe, even if massively introduced. On the contrary, the optimization of conventional fuel power trains and the progressive hybridization of cars can, until then be a less costly and more efficient way of decreasing CO_2. Conventional engines will yet always have to burn fuel, whereas electric vehicles are not only potentially "zero emissions vehicles" but also offer interesting perspectives in terms of energy security as electricity can be produced variety of sources. By supporting its development now, Europe can thus secure the potential of a future mitigation tool.

The electric car will first need to overcome several bottlenecks: price, technological shortcomings and its interaction with European power grids. It will have to be introduced in a sustainable framework made of a greener power sector, electric interconnections, smart grids and smart meters. Either these complementary technologies are to be introduced at the same time, or we face the risk of locking electric vehicles into a non-sustainable CO_2 path.

The main concern behind the promotion of the electric vehicle until now has actually mainly been industrial: it is about saving jobs in Europe by maintaining the competitiveness of the car industry. In this respect, little has been done so far to ensure the sustainability of policies promoting this new technology. In the climate change race, the electric vehicle is currently not the best solution, nor is it the cheapest option. It can become an interesting long term potential, in particular as a third generation now emerge on the market, and policies should be tailored thereof.

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