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Competiton, Cooperation and Innovation for Sustainable Growth
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Three scenarios for a Second Automobile Revolution

The riskiest is not the more improbable

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Since 2008, the conditions for a real transition to all cleaner vehicles are fulfilling, after several failures throughout the 20th century. According the experience of the first automobile revolution, such as it is restored by the historical literature, four conditions seem to be necessary for a new automobile revolution: the crisis of the previous transport system, the emergence of various alternative solutions notably thanks to innovations coming from other industrial sectors, the formation of a coalition of economic, social, cultural, politic forces to make prevail one of the solutions in spite of its uncertainties, macro-economic decisions and public policies to allow a broad diffusion ¹.

The first condition is already fulfilled. The petrol car transport system is in structural crisis: high probability of a durable increase of oil prices, due to the enormous needs for the large emerging countries and to the growing difficulties and costs to find new resources, due also to the sudden geopolitical transformations and to the speculation (Figure 1); reduction of available petrol and gas resources per world resident from 2011, reduction of sure resources from 2015 and of possible resources from 2025 (Figure 2); impossibility for China and India to pursue a strong growth with petrol energies (Figure 3); and finally the accentuation of traditional problems of petrol cars (rise of the use costs, fall of use value because of congestion, pollution, growing costs of the externalities, accidents etc., growing gap of individual automobile transport productivity with the other activities, tendencies to profitability drop of auto industry, etc.).

¹ This communication is an adapted, improved and actualized version of Freyssenet M., **A Second Automobile Revolution? Firms Strategies and Public Policies**, in Jullien B. (ed.), Proceedings of the 18th International GERPISA colloquium, « The Greening of the Global Auto Industry in a Period of Crisis », 9-11 June 2010, Berlin, Digital publications, <http://leblog.gerpisa.org>, 2010; freyssenet.com, 2010, 160 Ko, ISSN 7116-0941. Freyssenet M., **Three scenarios for a Second Automobile Revolution. The riskiest is not the more improbable**, 2011 MMRC-Hosei RIIM-IMVP World Auto Industry Forum: “Changes and Challenges of the Global Automobile Industry: Competiton, Cooperation and Innovation for Sustainable Growth”, Hosei University, Tokyo, 4 march 2011. Digital publication, freyssenet.com, 2011, 700 Ko, ISSN 7116-0941.

The second condition is probably also fulfilling. Some innovations, realized by the food, chemical, electric, electrochemical, electronic and computer industries, allow to solve many problems that had prevented until now the rise of alternative solutions in the car industry: agro-fuels, cleaner gas, electronic control system, batteries of which the performances are multiplied by two, alternative sources of electricity, etc.

The third condition, the formation of coalitions for one of the solutions is in progress. The fourth condition, the macro-economic decisions and the public policies for a broad diffusion of a chosen standard, could have to be fulfilled after.

Since 2009, we attend an astonishing effervescence, a boiling of initiatives for alternatives solutions in the automobile industry and in related sectors. There is also a rise of initiatives taken by Public Authorities, enterprise with car fleet, scientific and technical centres, citizen groups, media, etc. After the isolated launchings of hybrid or electric cars during the eighties and the nineties, their number explodes from 2009 (Figure 4). Each week, a new alternative car is announced for the next years or a prototype is presented (Figure 5). In few years, many start-ups have been created in numerous countries. The newcomer carmakers, especially Chinese, launched or are preparing the launching of electric cars (Figure 6). It is the same by providers, assemblers, rental cars companies, two wheels makers, without licence car producers, net economy companies, etc (Figure 7). Many States or local authorities have adopted ecomobility, even electromobility plans. Some of them support their national champion car producer company in order to help it to become leader. The partnerships between manufacturers, start-ups, equipment suppliers, alternative energies providers, manufacturers of batteries, territorial authorities, universities, research centres and States are multiplying. Research and development groupings of manufacturers were created. Different concurrent standards for electric charging were elaborated. Many experiments and tests of new systems of mobility are in progress. Some companies and institutions with car fleet and some municipalities undertook to buy plug-in hybrid or electric cars.

But neither the States, nor the manufacturers have had initially the same vision of how to carry out the transition towards cleaner cars. The confrontation of these visions and the first decisions seems to lead the actors to be less affirmative, even to change now their previous orientations. The positions are moving. So for the moment, the elaborated classifications can only be indicative and provisional. This uncertainty is the sign of the battle in progress for the leadership to impose a new standard.

So, although their preference for a type or for a mix of energies are not definitive, the countries can be classified in six groups (Figure 8). The countries that make up the first group, as for example the countries of the Middle East or Mexico, privilege the oil, with improved environmental performances, because of its probable durable lower price for them. The second group, oriented towards the agro fuels, has Brazil as leader and main provider, because of its agro resources, of its know-how in this matter, of the potential extent of its market and of its commercial relations in strong growth. The third group of countries gave the priority to gas. It includes notably Russia, being given its reserves and its weight growing in the provisioning of many European countries and also of the potential extent of its automobile market. The fourth group chooses a mix oil-electricity supporting the plug-in car, in particular because of the frequency and the importance of the long displacements, because of the preference for the powerful cars and because of the absence of an energy specialization, as Canada and USA, even if the current US administration seems more interested by the full electric car. The fifth group prefers the full electric car, because of the nuclear or ecological origin of its electricity, because of the frequency and the importance of the short and average displacements, or because of the political will to have quickly a competitive national auto industry. For these different reasons, this option is adopted by West European countries

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excluded Germany and Italy, by China and India, by many little countries and many Islands. Finally the sixth group is made up by the countries that refuse to choose in the place of the carmakers and the households and that only lay down successive objectives of pollution reduction to reach. Until now, it was the case of Germany, European Union, Japan. But we can note some evolutions.

All carmakers continue to improve the environmental performances of their oil internal combustion engine. But they are divided concerning the new powertrains, as the countries concerning alternative energies (Figure 9). Until recently, Fiat, Volvo and it seems the Russian carmakers privileged the less polluting fuel: agrofuels and natural gas. The second group, including until recently Toyota, Honda, Porsche, consider the hybrid engine as the best solution for the current period and the plug-in car as a perspective for next period. Some of these carmakers seem evolve to the third group. The third group that was composed of PSA, Volkswagen, Ford, Daimler, BMW and may be Hyundai, choose to offer progressively all types of engine. But Daimler and BMW seem to want to accelerate the transition towards the electric vehicle. The two last groups jump the stage of hybrid car. The fourth group concentrate its investments on the plug-in car versus electric car, as General Motors, Mitsubishi and BYD. The fifth group takes the bet of immediate passage to electric vehicle, as Renault-Nissan, Chrysler, many Chinese and Indian newcomers, some providers or other companies related to car industry, nearly all start-ups.

From these different orientations, three possible scenarios are taking shape: the scenario of diversity, the scenario of progressiveness and the scenario of rupture

1. The scenario of the diversity

The scenario of diversity could be the scenario in which the six groups of countries could be able to impose the source of energy or the mix of energies of which they dispose naturally or commercially in the best conditions. The carmakers could be obliged either to specialize in some types of motorization or to offer all types of engine.

This scenario seems already moving. The countries support generally the kind of motorization that is the most favourable for them, as Brazil for the agro fuels, Russia and Italy for natural gas, countries of Middle East, Mexico for petrol, Japan, Germany for a mix, France for electricity. Some carmakers have or are preparing a specialized offer, others think to be able to produce all types of powertrain and to be able to sell them according to the countries or even according to the use or according to the customers. For example, Fiat had until now selected the agro-fuels and the natural gas, taking into account its South American and Eastern-European anchoring. But its merger with Chrysler could change this incipient specialization.

The diversity of powertrain could be supported particularly by the countries and by the carmakers of which the selection is not the selection of the majority, by the producers and providers concerned (agro business, petrol and gas producers), but also by some citizen and politic movements and by local media.

The first condition of possibility of the diversity scenario is the presence of at least one country with a large expanding automobile market and with a geopolitical power in each group of countries. It is currently the case. The second condition is an acceptable gap of price of different energies and of alternative cars between the countries. It will be probably more difficult to fulfil. The third condition is the tolerability of a largest heterogeneization of the world automobile market for the main carmakers. The problem for them is the cost of the diversity. To develop, to produce, to improve all the types of engines and to be able to sell

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them everywhere require considerable means. The economies of scale would strongly decrease. The automobile producers, privileging the volume and the limited diversity as sources of profit, would be affected. For this reason, some of them are convinced that it will be necessary to grow again by mergers or by acquisitions, or to multiply again the co-operations, as Volkswagen and PSA do. Could that ways be sufficient? Is it possible to imagine the emergence of regional manufacturers or manufacturers specialized only in some types of engine?

If the scenario of diversity prevails, the consequences will be therefore a higher heterogeneization of the world automobile market, the complexification of the platforms, the necessity of more R&D investments, difficulties for carmakers pursuing the “volume and diversity” strategy and the “permanent reduction of costs” strategy, the formation of an oligopoly of motor specialized carmakers in each group of countries or of all engines automobile companies in the world. There could be meanwhile some local opportunities for newcomers. The States could keep or recover a capacity of control on the manufacturers and on the car market trough their energy policy.

2. The scenario of the progressiveness

The scenario of progressiveness is the scenario of the progressive transition from the petrol vehicles to agro fuels or natural gas vehicles, then to the hybrid vehicles, then to the plug-in hybrids, then to the electric cars with batteries, finally to electric automobiles with fuel cells. Many people consider that this scenario is the only reasonable and realistic scenario, as one can read in many articles and newspapers. It seems reasonable, because the successive motorizations could be adopted as their technical improvement and as the amortization of investments. It seems realistic, because in any event the world car fleet could not be renewed at a stretch, and because the inversion of the proportions of the various motorizations will be necessarily progressive.

The scenario of the progressive transition was the scenario privileged until recently by the German manufacturers, and also by Ford, PSA, Toyota, Honda and Hyundai. According to them, the market of the electric car was very limited in short term. Taking in account this scenario, the German government, the European Union, the Japanese government had adopted “technological neutrality”. For them, the governments must decide only objectives of fuel consumption and gas pollution reduction, the manufacturers have to propose the solutions that they consider the best, and finally the markets will choose.

But since few months, the speeches and the acts of the German car manufacturers and also of PSA and Hyundai are changing. Volkswagen has announced the launching of a plug-in hybrid and a full electric Golf for 2013 (two thousand thirteen) and an electric taxicab named Milan. Daimler has tied partnerships with the American start-up Tesla, with the Chinese newcomer BYD and with Renault-Nissan. BMW is going to create a new brand and a range of plug-in and electric vehicles, with to begin two models that will be launched in 2013. Porsche has just announced a plug-in hybrid version of its five models between now and 2015. PSA launched in October 2010 (two thousand ten) clones of the i-Miev electric car of Mitsubishi, its new ally, and the electric versions of its two small commercial vehicles. It is preparing two other electric models. So the position of the German government and the European Union also evolved, recognizing the importance of the electro mobility and the need to set up a network to recharge the batteries, to standardize the plugs and to install an electronic billing system. Hyundai has just launched a city car, the electric i10, produced in India. Toyota and Honda seem to conserve the same position. Honda has even reaffirmed

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recently that it does not believe in the success of electric car, preferring to continue its search for fuel cells, the only radical innovation for it. The Japanese carmakers are preparing however standards for recharge plugs, and they would like that the other countries adopt these standards.

The current hesitations of initial supporters of the scenario of progressiveness come paradoxically from the difficult conditions necessary for the success of this scenario. It implies indeed that the oil prices will not increase too quickly, that the climatic urgency and the pressure of the governments and of the ecologists will not be too strong, that the performances of the batteries will progress slowly, that the growth of the large emerging countries slows down clearly, that historical carmakers domination will continue to be geopolitically acceptable, finally it implies also not to fear to be exceeded technologically by electric carmakers and to be sure to be able to fill its delay quickly.

What are the chances of the scenario of progressiveness to be carried out? An economic and social crisis in the main emerging countries can occur. In this case, the price of oil could increase more slowly. It is not sure that the performances of the batteries will be significantly improved from now to five years. The will of certain important States to contribute to the creation of the market of the electric vehicles is not durably ensured. Eventually, the main historical carmakers could make up for its lost time and, thank to their financial means, they could precede the innovating firms by correcting their errors.

If si scenario prevails, the consequences will be the continuation of historical carmakers domination. The pollution will less increase, but it will not decrease. All profit strategies developed by the current carmakers will remain viable. The newcomers will have much more difficulties to survive. The value chain and the workforce could evolve in a controlled way.

3. The scenario of the rupture

The scenario of the rupture consists in passing directly to the electric vehicle with or without small auxiliary Internal Combustion Engine, and in offering, from the start, a range of models meeting the principal needs for the drivers who cover only short or average distances, like the home-work displacements, the intra-urban area displacements or the displacements carried out by the company cars fleets. This scenario also consists in setting up, simultaneously with the launching of the first electric vehicles, the infrastructures of electric charging or of exchange of batteries in the concerned areas. Important investments in R & D would be devoted to prepare a second generation of batteries definitely more powerful and to conceive a new automobile architecture by exploiting the many potentialities offered by the electric vehicle.

The supporters of this scenario are currently the West European countries, except Germany, Italy and Sweden, little countries as Israel, many Islands, and also China, India, USA and Canada, many local authorities, car rental companies, companies with important cars fleet, households owning a car dedicated exclusively for short or average displacements, Renault-Nissan Alliance, Mitsubishi, General Motors, many Chinese and Indian carmakers, small assemblers, some sport cars producers, almost all start-ups, some providers of electricity, batteries, electronic devices, electric engines, telematic equipments, car sharing, many active specialized media, some scientific and technical centres, some ecologist movements, some Churches, etc. These actors are creating federations to make lobbying and are tying many partnerships between them. The start-ups occupy niches market: city-car, small utilities, sporting cars. They sell their know-how to historical manufacturers that took delay in this field, or tie partnerships with them like Tesla with Daimler and Toyota, or even

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they sell themselves, as recently Reva to Mahindra. Some other actors dream to become carmakers as Bolloré-Pininfarina, Heuliez, etc...

The conditions of possibility of the rupture scenario are the availability of electricity everywhere at low price, the rapid increase of oil prices or climatic and food urgency, the existence of a temporary public financial aid to leave the vicious circle: high price / weak demand and to setting up the electricity charging infrastructures. The fear to see the Chinese and Indian car producers to jump the stage of Internal Combustion Engine and to become hard competitors could accelerate the adoption of rupture scenario by more historical carmakers.

Although this scenario is the riskiest, it seems to have many chances to succeed. The electricity is now available everywhere and it can be produced more and more locally. The electric infrastructure exists, including in the developing countries, especially in their urban areas. The decentralized solar and wind production of electricity will offer many possibilities to be provided practically everywhere in the future.

The absence of a generalized electrical grid was indeed the fundamental reason of the defeat of the electric vehicle at the beginning of the last century vis-à-vis the gasoline car.

When the car manufacturers, the Armies, and finally also the States, quickly preferred the petrol solution during the first automobile revolution, it was the solution technically most complicated, most dubious, most expensive, most polluting, most uncomfortable, most criticized, most dangerous and least powerful in certain roads or urban configurations. In spite of its uncertainties and of its disadvantages, the internal combustion engine of gasoline was preferred, because oil was the only energy source easily storable, relatively compact, immediately transportable and distributable on all territories at an acceptable price by many private companies, subject to its provisioning from the producing countries is sure. It is thus not the weight, the dimensions and the autonomy of the batteries, which penalized the electric car solution in the past. These problems were reasonably soluble. They could be effectively solved early, if one had devoted as many financial means than those that were devoted to solve the much more complicated problems of the internal combustion engine vehicle. The electronic industry now has invented new type of batteries, because it was crucial for itself to increase strongly their autonomy. What really penalized the electric car, it was the absence of electrical grids in all territories. And effectively, the installation and the generalization of coordinated electric grids in the industrialised countries required a long time efforts, and it was fulfilled only more than sixty years later. The availability of the appropriate energy is the key point.

The second reason favourable to the scenario of rupture is that the structural and conjuncture conditions of a rapid increase of oil prices are currently fulfilled.

The third reason is that China and India are obliged to privilege the EV and they have interest to do that. Neither China, nor India will be able to continue their « automobilisation » only with the petrol engine, included hybrid. On other hand, they have the means to become electric car producers and exporters and to precede the historical car countries and car manufacturers. The last declarations and the adopted plans, in particular by China, do not make mystery of the will to reach that point. The electric car is an historical opportunity for these countries and for its newcomer carmakers.

Other new actors: the manufacturers of batteries, the manufacturers of tires, the suppliers of electronic equipments, even the car rental companies, etc have also interest with this scenario, not only to develop their business, but also to eventually take the control of the value of the new car chain, and even to become themselves carmakers, etc. At last, a growing number of States and Armies could prefer the electric solution, if their financial and strategic dependence with oil became unbearable and dangerous.

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Some important territorial authorities and countries want to quickly reduce pollution and the dependence to oil for financial and geopolitical reasons. They are ready to create the infrastructural and the financial conditions for the takeoff of the electric vehicles. Thus, a possibility exists to leave effectively the vicious circle "high price / weak demand".

The mass production of batteries, the reduction of number of parts and the possibility of a real modularization of the EV will make decrease the price of the car. EV is much more easy and less expensive to conceive and to produce.

The technical problems of electric vehicle are much less important than the problems of the petrol automobile at its appearance and during several decades. The important financial and scientific means used in many countries by many actors with the aim to double the performance of batteries in the next years should make it possible to achieve this goal.

The electric vehicle allows a completely new car architecture, specially using « engine wheels ». A such architectural change is able to respond better to the constraints of the urban mobility and to the expectations of many people, and above all, to relaunch the profit and the competition in the car sector. A new profit strategy could be even invented, making compatible volume and conceptual innovation profit sources.

If the scenario of rupture prevails, the future of car industry will be played in China and India and with new world Chinese and Indian carmakers. Car value chain will be completely reconfigured. A new geography, economy and sociology of car industry will emerge.

But it is necessary to remain that the full electric car can be the best or the worst of the solutions from point of view of pollution and climatic warming, according to the origin of electricity, as we can see on this diagram (Figure 10). The supporters of the electric scenario think that the electrical production starting from fossil energies will necessarily regress. The congestion problem will not be resolved with EV, even eventually be amplified. But the EV offers better possibilities of car sharing development.

Conclusion

The quivering observed towards the alternative motorizations could be the start of at least three scenarios. The consequences of these three scenarios on the geography, the structure, the economy and the sociology of the world car industry are completely different. In the first scenario, each car producer will be able to find its regional niche. In the second, only most powerful carmakers will survive. In the third, the newcomers and the innovating enterprises will have the possibility of engage a rapid « Second Automobile Revolution ». The winning scenario will prevail, after confused and nevertheless rough fights, not because of its technical superiority or of its best environmental performances, but initially because of energy geopolitics and of firm profit strategies. For these reasons, the third scenario, the scenario of electric vehicle, that appears today most random, could impose in the next years, as the improbable petrol car scenario imposed one century ago.

Figure 1

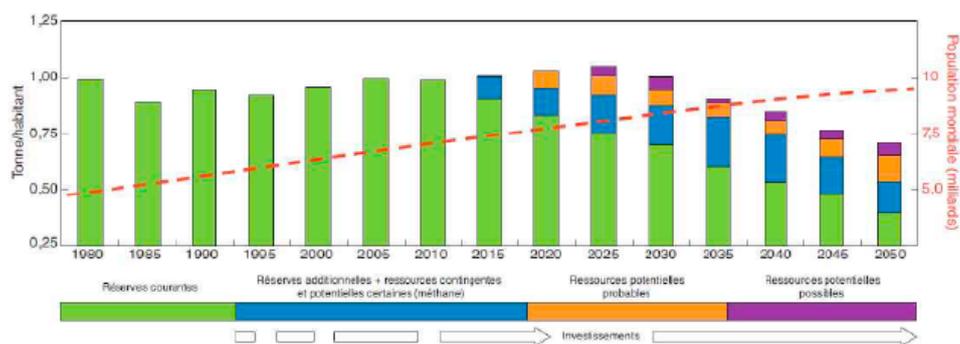


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Figure 2

Declining oil and gas stocks by world resident

disponibilité moyenne en pétrole +gaz par habitant sur la planète :
projection jusqu'en 2050



source : IFP, Entretiens Panorama 2010 (Y. Mathieu)

*il est indispensable d'augmenter le rendement des
motorisations et de diversifier progressivement les sources d'énergie*

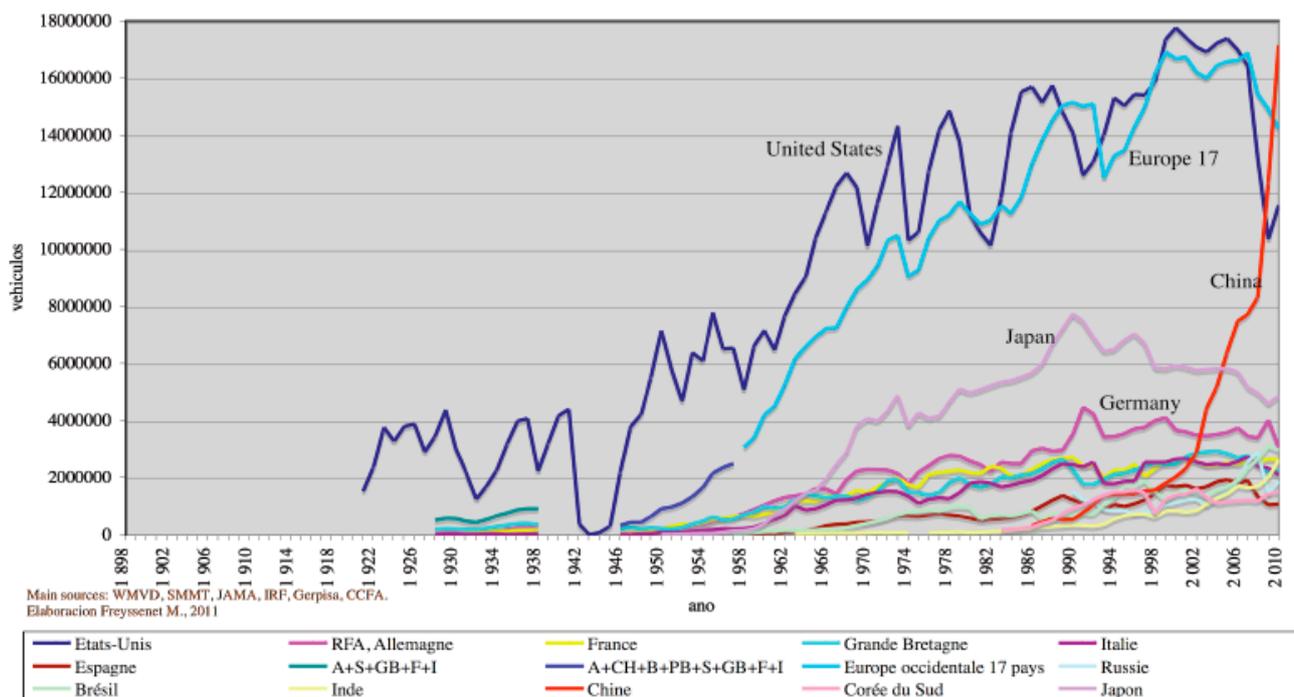
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Entretiens Unitaire Pénne – Table ronde – l'Innovar 15/04/2010



Figure 3

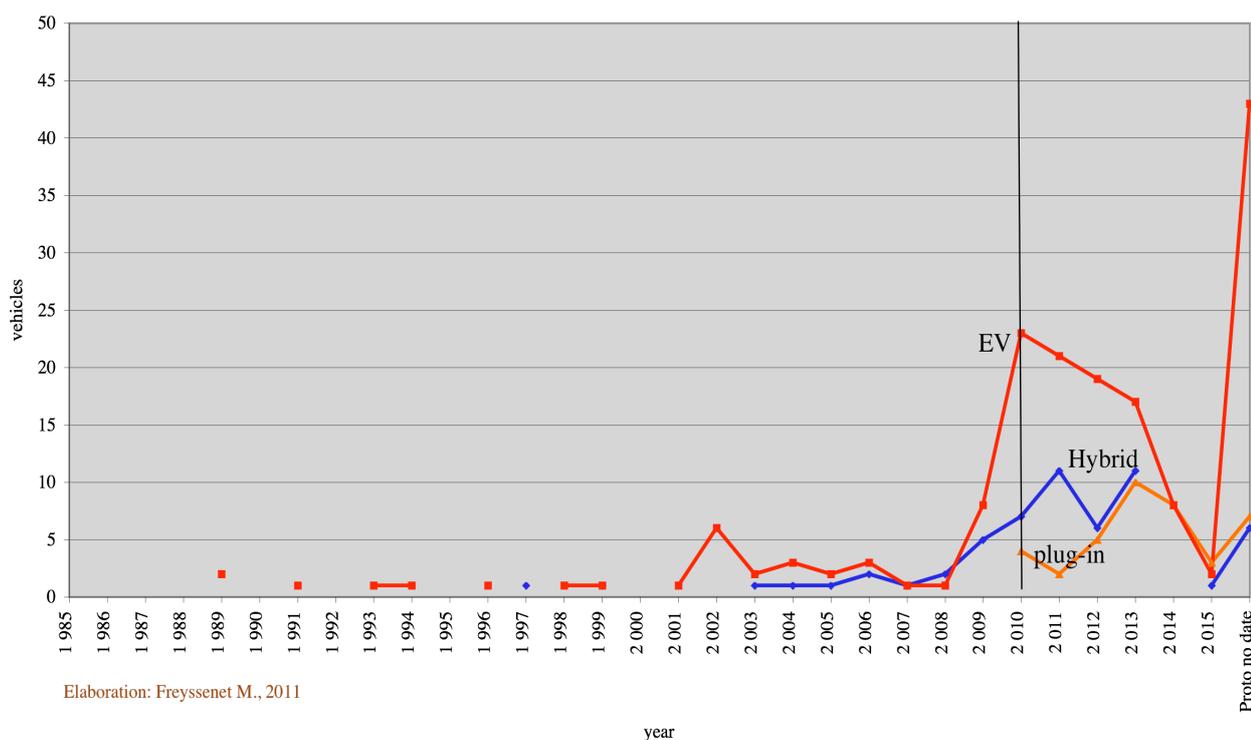
Main automobile markets, 1898-2010



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Figure 4

Number of commercial launchings of hybrid, plug-in and electric vehicles
by year in the World, effective and announced, 1985-2015
and prototypes without date
(non exhaustive census, march 2011)



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Figure 5

Number of alternative automobiles
(on sale, under development, prototypes no date)
in the world by OEM, newcomers and start-ups
(non exhaustive census, march 2011)

	Hybrid automobile	Plug-in automobile	Electric automobile
on sale 2011	26	6	44
under development	18	26	46
prototypes no date	6	7	43

Figure 6

Number of launched alternative automobiles
(effective in past and now, and announced)
in the world by OEM, Chinese and Indian carmakers and start-ups/others
(non exhaustive census, march 2011)

	Hybrid automobile	Plug-in automobile	Electric automobile
Historical carmakers	57	33	77
Chinese, Indian carmakers		3	18
Start-ups and others		3	66

Figure 7

A first list of electric vehicles start-ups and newcomers in some countries
(non exhaustive census, march 2011)

	Start-ups	suppliers	newcomers	others
USA	Azure Dynamic, ELV, E-Z-GO, Fisker, Phoenix, Segway, Tesla, Think, Zap	Johnson Control		Balqon Corp, GEM, Google, Miles Electric, Toro
Canada	Nemo	Magna		
France	Eco&Mobility, Eon-Motors, Electric-Car, Fiorconcept, Goupil, Volteis	Bolloré, SVE Dassault, Michelin		Aixam, Andruet, FAM, Heuliez, Innovep, Ligier-Matra, Soffimat, Venturi
Germany	E-Wolf, Innovative, Ruf, Streetcooter			
Italy	Micro-Vett, K-Way Motus			Alke, Biro, Effedi, Piaggio, Pininfarina, Tazzari,
Spain	Afaipada, Comarth			
Switzerland	Protoscar, Rinspeed			
Denmark				Protanium
United Kingdom	Lightning, Murray, Nice Car, Smith Electric, Stevens Vehicles,	GKN		Lotus, Modec
Suède	EV adapt, Koenigsegg			
Russia	E-avtö			
Japan	SIM-Drive			
India	Reva		Tata, Mahindra	
China	Eagle, MyCar (Hong Kong), Yulon (Taiwan)		BAIC, BYD, Chana, Chery, Dongfeng, FAW, Geely, JAC, Lifan, Zotye	

Figure 8

Some national energies preferences
for cleaner cars ...until recently (march 2011)...

Less polluting petrol	Agro-fuel	Natural gas	Plug-in hybrid	electric	Objectives of pollution reduction
Midle East Mexico	Brazil Sweden	Russia Italy	USA Canada	China, India, Korea, UK, France, Spain, Portugal, many little countries, many Islands	Japan Germany European Union

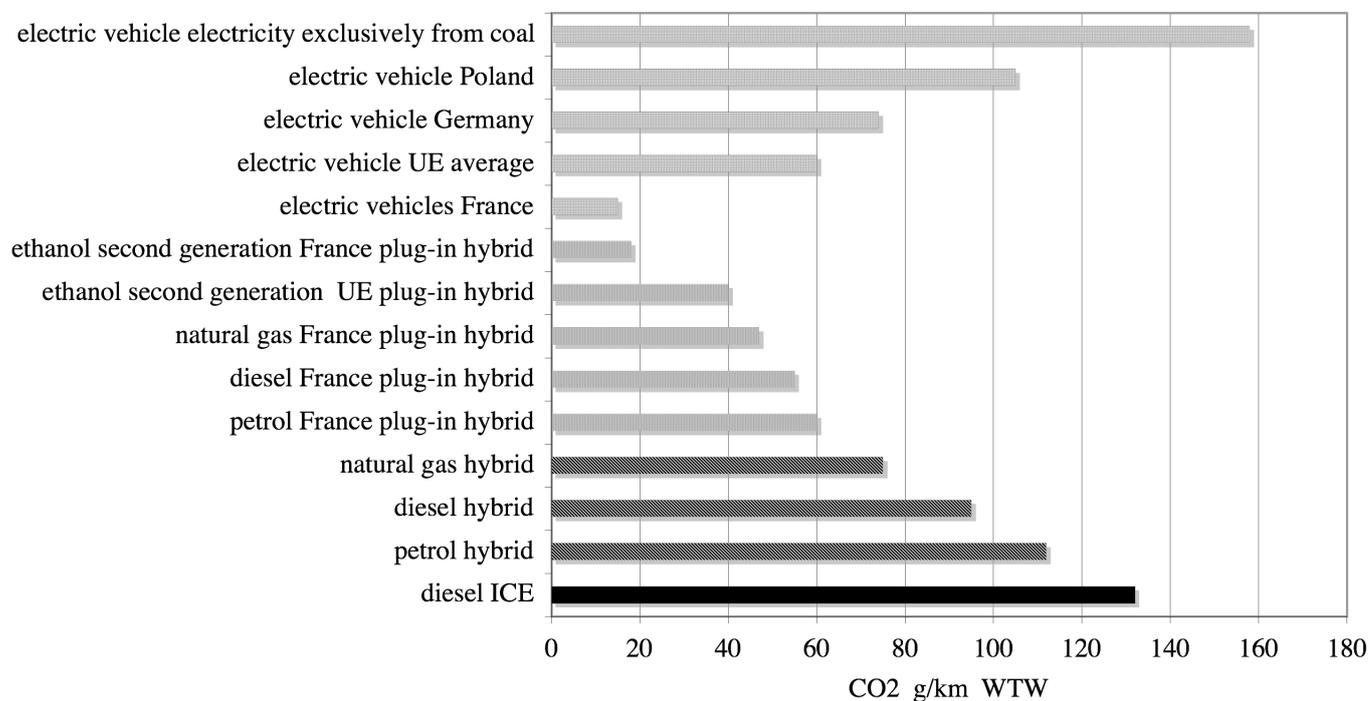
Figure 9

(changing!) cleaner automobile strategies:
 priority to...
 (march 2011)

less polluting fuels: gas, agrofuel	hybrid versus plug-in hybrid	hybrid versus all types	plug-in hybrid versus electric	electric
Fiat Volvo Russian carmakers	Toyota Honda Porsche	PSA Volkswagen Daimler BMW Ford Hyundai	GM Mitsubishi BYD	Renault-Nissan, Chrysler, many Chinese and Indian carmakers, nearly all start- ups and others

Figure 10

**"Well to wheel" CO2 emission,
according to the type of engine, the energy and the country**



Source: French Institute of Petroleum, 2009