Energy for road transport: a road map to 2050

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Context and motivation

The final target: to reduce transport CO_2 emissions by a factor 4 in 2050

- **Large discrepancies among experts on long term technology options regarding vehicles and motorization (Biofuels, electricity, H_2…)**
- **the goal of the study: a research road map for road transport power gathering experts from automobile industry, oil industry and research with the support of methodological consultant (EPRI)**

Key elements and road map process

- **The road map addressed a specific use of energy (not a single technology) and assessed various technological responses options to climate change challenge**
- **The road map process involved experts from automobile industry (Renault and PSA), oil industry (TOTAL) and research (IFP), Environment Business Association (EPE), ADEME with the support of methodological consultant (EPRI)**
- **Several meetings dedicated to “drivers” identification and shared “visions”(no economic scenario)**

Economic scenarios identify a large set of options (example WETO-H_2)

- A dedicated module representing the behaviour of the road passenger transport demand has been developed.
- With three categories of users:

- Urban (< 10.000 km/yr)
- Normal (~ 20.000 km/yr)
- Intensive (> 40.000 km/yr)

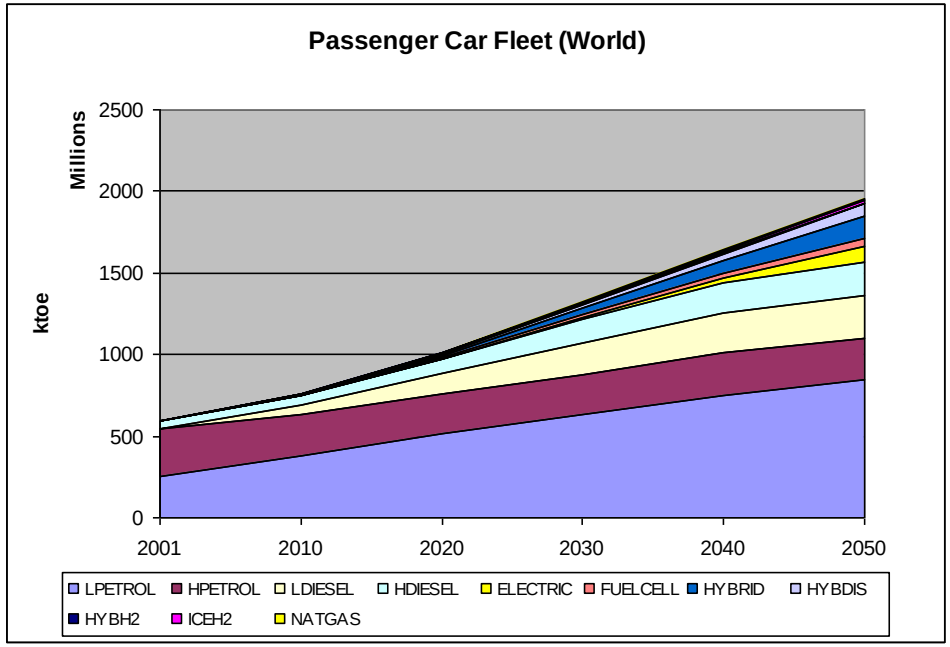
11 generic car technologies are represented:

- Light Gasoline
- Large Gasoline
- Light Diesel
- Large Diesel
- Electric vehicle Biomass Gasification
- Fuel cell H2-fuelled
- Hybrid-gasoline fuelled
- Hybrid-diesel fuelled
- Hybrid-Fuel cell H2 fuelled
- Internal Combustion Engine H2 fuelled
- Internal Combustion Engine Natural Gas-fuelled

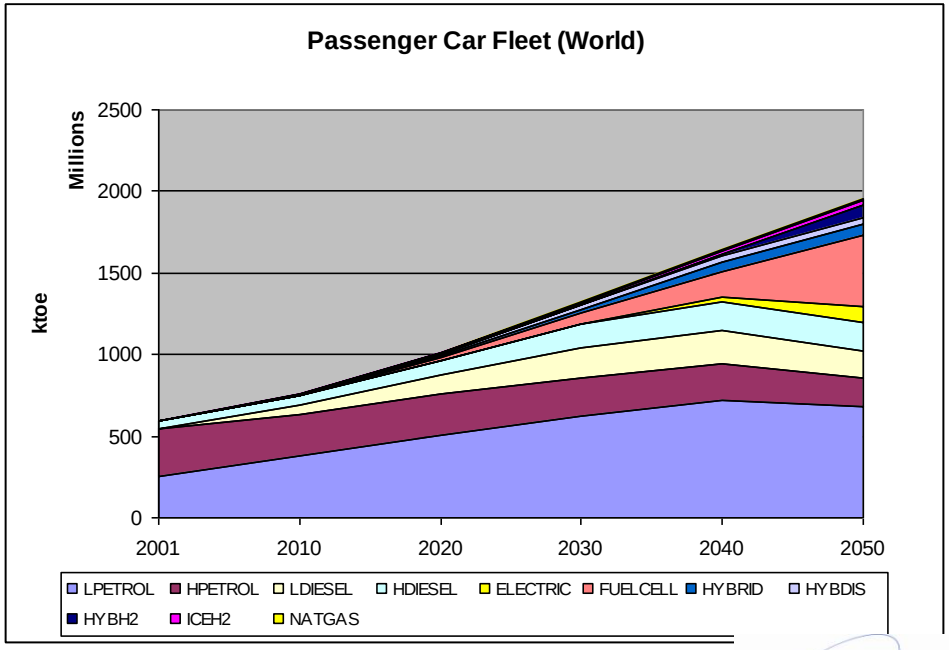
In scenarios more than 10 options are sharing the market : is it realistic ?

- **WETO : in 2050 cars are driven by oil, natural gas, electricity, hybrid, hydrogen + fuel cell, hydrogen ICE… No lock-in effect.**

Reference



H2 cases



Main drivers and key options

- Two main drivers:
  - **the value of CO_2**
  - **energy security**
- Two ways to solve the problem:
  - **to reduce the energy demand**
  - **to offer CO_2 free energies**

Biofuels (2nd generation) was not considered as a key option but as a partial contribution to all other options

The key technologies

- **technologies which could change the way to solve the problem**

- **4 key "technologies":**

To reduce the energy requirement

energy efficiency of the vehicle

new segmentation of the market

to offer alternative energy

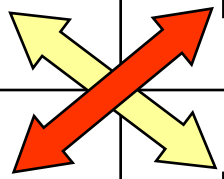
electricity storage

hydrogen and fuel cell

Biofuels and hybrids are useful but not key technologies

The main ways

	Reduction of Energy demand	Energy substitution
Step by step	business as usual: vehicle characteristics engine efficiency	biofuels (1st and 2nd generations hybrids
Breakthroughs	strong mass reduction new market of minicars	high energy capacity batteries fuel cells



Scenario 1 : energy efficiency

- **improvement of vehicle efficiency by 64%**
  mass reduction by 40%

Biofuels	40%
Oil+synthetic fuels	60%

Conventional flex fuel ICE
Mild hybrid vehicles

Scenario 2 : specific urban car

- **new market of min and micro cars for urban use (30%)**
- **improvement of vehicle efficiency by 33%**
  mass reduction by 20%

Electricity	50%
Biofuels	20%
Oil+synthetic fuels	30%

battery range ~ 200 km
New business models for urban mobility

Scenario 3 : hydrogen and fuel cell

- hydrogen and fuel cells become competitive
- improvement of vehicle efficiency by 8%

Fuel cell vehicles	60%-70%
Biofuels	20%
Oil+synthetic fuels	10%-20%

Hydrogen produced without CO_2 emissions
ICE flex fuel vehicles

Scenario 4 : electrical vehicle

- **vehicle range > 500km with batteries**

Electricity	80%
Biofuels + synthetic	20%

Electric battery + hybrid plug-in vehicles
Electricity is produced without CO_2 emissions

What consequences on Research and Development?

1 – key technologies have not a “linear effect” on the solution

2 – today, it is too early to select the ”winning technology”

3 – automotive industrial model is not compatible
with high diversity of products

there is a breaking-point (2015-2020

What consequences on Research and Development?

From now to the breaking point:

we need to work on all the challenging technologies

Power plant
best adaptation engine / synthetic fuels
hybridization
pure electric vehicles
fuel cells

Vehicle
mass reduction by redesigning the vehicle
active aerodynamics

New concepts dedicated urban vehicles

What about short and mid term developments?

- All the scenarios lead to electric vehicles by different ways:
  - strong lightening
  - mini cars
  - hydrogen and fuel cell
  - efficient batteries

- Other functions of the vehicle could take advantage of using electricity:
  - steering
  - braking
  - air conditioning

the vehicle of the future will be electric

What about short and mid term developments?

❖ **Power electricity** is a big challenge for car industry (R&D, manufacturing, sale, maintenance….)

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❖ **Power electricity** is a big challenge for car industry (R&D, manufacturing, sale, maintenance….)

❖ In order to get ready for the “break point”:

we need to do research

we need to start development and production of “electric vehicles”

What can be done?

- **Mild hybrid is the first step**
- **Plug-in hybrid could be the second**

The main problems to solve:

batteries	performances reliability cost
system	simplification (cost) reliability

What can be done?

❖ **electric vehicles with batteries**

problems are mainly coming from batteries

The way to succeed:

batteries are making progress

but no break through is expected for the time being

⇨ to adapt the vehicle to batteries

small and light

limited performances (speed, crash)

adapted business model

self-service urban car?

What road map for “electric vehicles”?

Electric vehicles with batteries	2010/2012
Plug-in hybrids	2012
Fuel cell vehicles (on-board reformer)	2015/2020
Fuel cell vehicles (on-board hydrogen)	2020+

Output : research priorities for ADEME in the field of road vehicles

- Increasing hybridization of vehicle from low hybridization (stop and start) to high hybridization (plug in).
- Optimization of conventional thermal motorization in association with hybridization (down sizing, efficiency, weight reduction…)
- Electricity storage on board
- Fuel cells and hydrogen, an option for longer term

Small urban car : which conditions for a market, competing with other transport modes ? New road map on urban mobility going on

Road map implementation and further steps

- **Economic modelization of scenarios (using POLES) in order to assess real impact on CO_2 emissions at world level of each option (on going work)**
- **Which conditions for urban small car market facing mobility demand in 2050: new « road map » going on dedicated to « urban mobility in large cities at 2050 »**
- **Present road map usefull for identification of «research demonstrators» to be implemented in the field of transport**

Thank you for your attention

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