PSA Insight

Foresight
Scenarios planning
& Modelization

First Part

I Complexity
- *Concept of complexity*
- *Complexity of the automotive system*

II PSA Prospective Approach
- *A systemic approach*
- *Scenario Planning*

III Quantitative Modelization
- *Modular approach*
- *A few cases and challenges*

I What's a complex system ?

Complex ≠ Complicated

- **3 levels of complexity**
  - **1. Simple**
  - **2. Complicated**
  - **3. Complex**

- **COMPLEX SYSTEM**
  - A complex system is compounded of various items which interact in non trivial dynamics (non linear effects, feedback loops …)

- **Simulation & Forecast**
  - If a system is CIR '*Computer Irréductible*' , one can perform simulations but it is impossible to simplify the system
  - Then what does it mean to 'comprehend' and to 'forecast' ?

Automotive is a complex system

The concept of complexity is central in the problematics of mobility

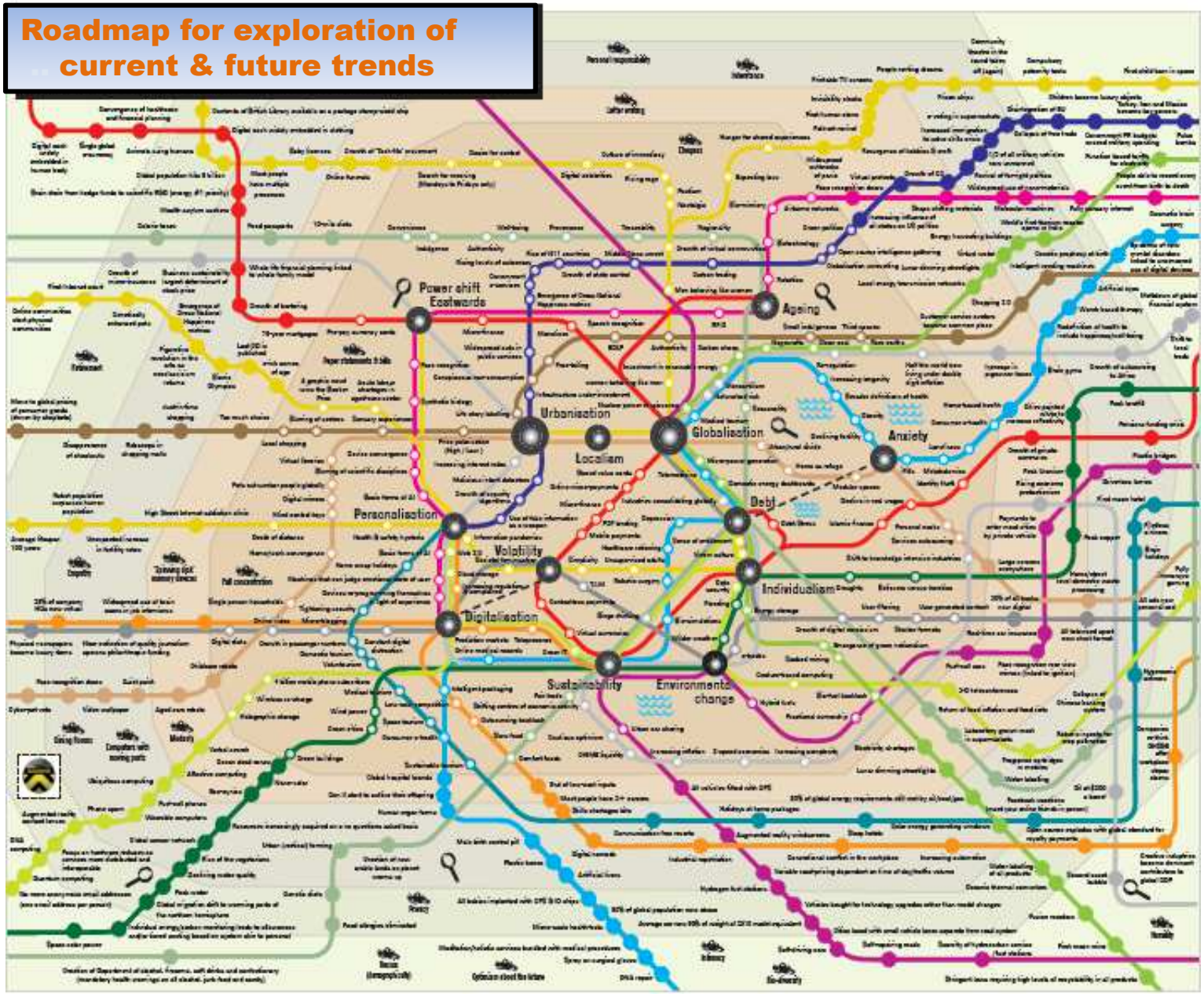
- **The 3 orders of system complexity**
  - i. First order : Object system complexity → 3 states
    - *random state (gas) , structured state (solid) , hybrid state(liquid)*
  - ii. Second order : Living system complexity
    - *system in strong interaction with its environment*
  - iii. Third order : Human system complexity
    - *idiosyncratic behavior*
    - *statistics & law of great numbers*

The automotive system is composed of various elements & factors in interaction

- ✓ a system too complex to be left only to economists and forecasters
- ✓ a system complex enough to stimulate the insight of prospectivists

COMPLEX©ITY MAP

Roadmap for exploration of current & future trends



Meta Variables
1 Society
2 Geo-pol
3 Energy
4 Techno
5 Health
6 Leisure
7 Economy
8 Finance
9 Climate
10 Food
11 Transport
12 Tourism
13 Home
14 ITT
15 Media
16 Business

Time Zones	Zone 1 2010-15	Zone 2 15-20	Zone 3 20-25	Zone 4 25-35	Zone 5 35-50

II Prospective standpoint

Scenarios

Prospective & Scenario Planning

*The goal of prospective is to enlight the firm's **strategy** on key orientations in a **complex** environment*

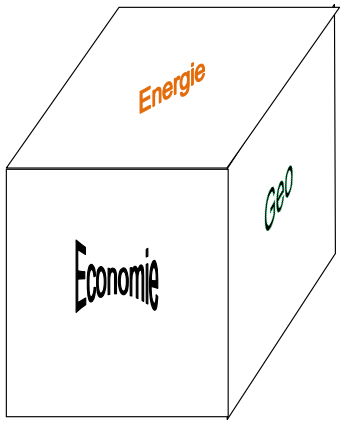
- ✓ **The Scenario Method has been implemented by the US experts of the Rand Corporation (*Herman Khan*) in the 50's**
- ✓ Shell is the first private company to use it in its 'business' activity in 1972
  - This tool induced Shell to forecast the risk of an oil Shock sooner than its competitors and to be better prepared to adapt to it
  - The method is based on the analysis of trends in interaction, and designed to build scenarios of the future, in order to be credible and coherent rather than normative

*- The **word scenario** was first used by Pierre Wack 'Shell head of planning' in order to describe the various ways the energy market could evolve in the future*

Building of Scenarios

PSA

Scenario Box on 3 axes



- ***Economy***
  - ***Energy***
    - ***Geo-policy***

Prospective Method

- **3 OBJECTIVES**
  1. Make projections in the long term in order to see emerging new trends
  2. Produce shared & stimulating visions in the context of an uncertain & dark future
  3. Objectivize & quantify these visions

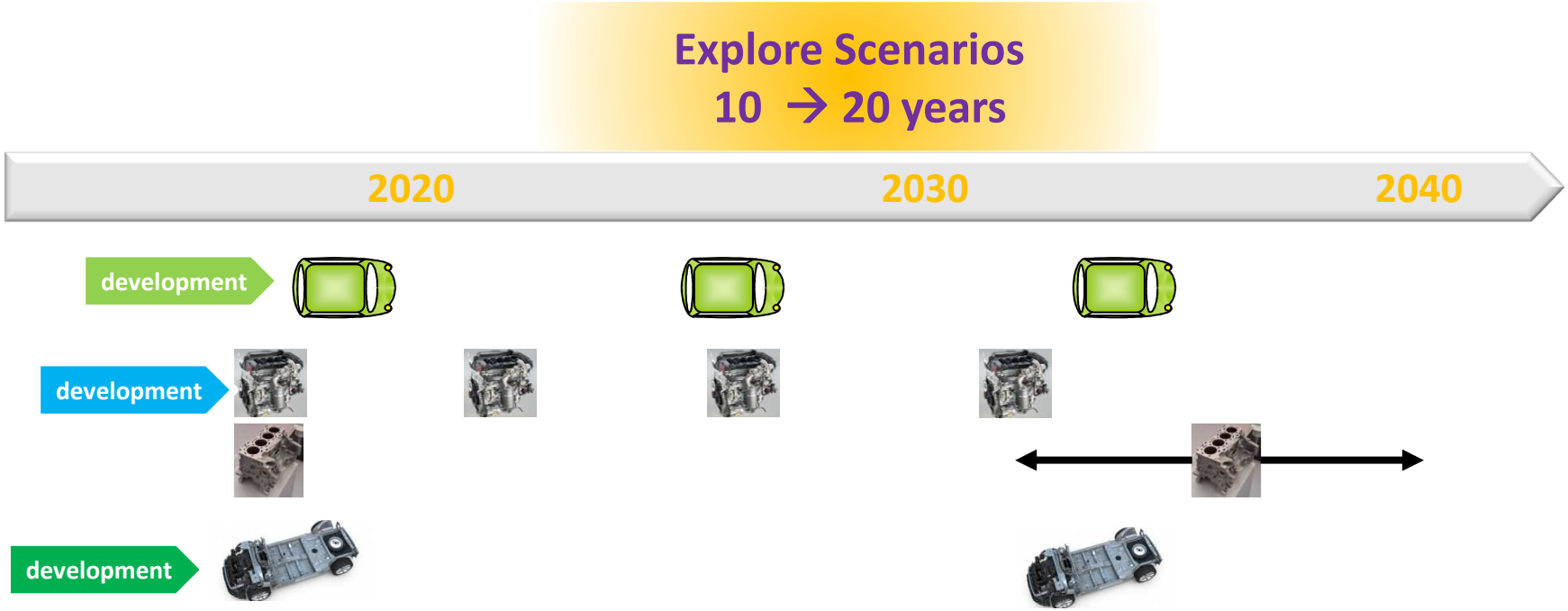
- **4 PILLARS**
  1. Prospective & Scenarios Planning
  2. Systemic & holistic approach in order to apprehend complexity
  3. Creative approach i.e. « capacity to modify the representations »
     - *To be creative is to look at things in a different way*
  4. Collaborative methods

Foresight and scenarios

- ✓ Future is uncertain but the prospective approach can help to scale the risks
  - Forecast → reference case for Business
  - Alternative scenario

Prospective scenario to contribute to risk assessment

- ✓ Automotive industry time characteristics :



A systemic Approach

Global Environment

General Context :

- Macro-economy / Demography
- Regulation
- Socio-cultural Trends

Ecosystem

Specific context:

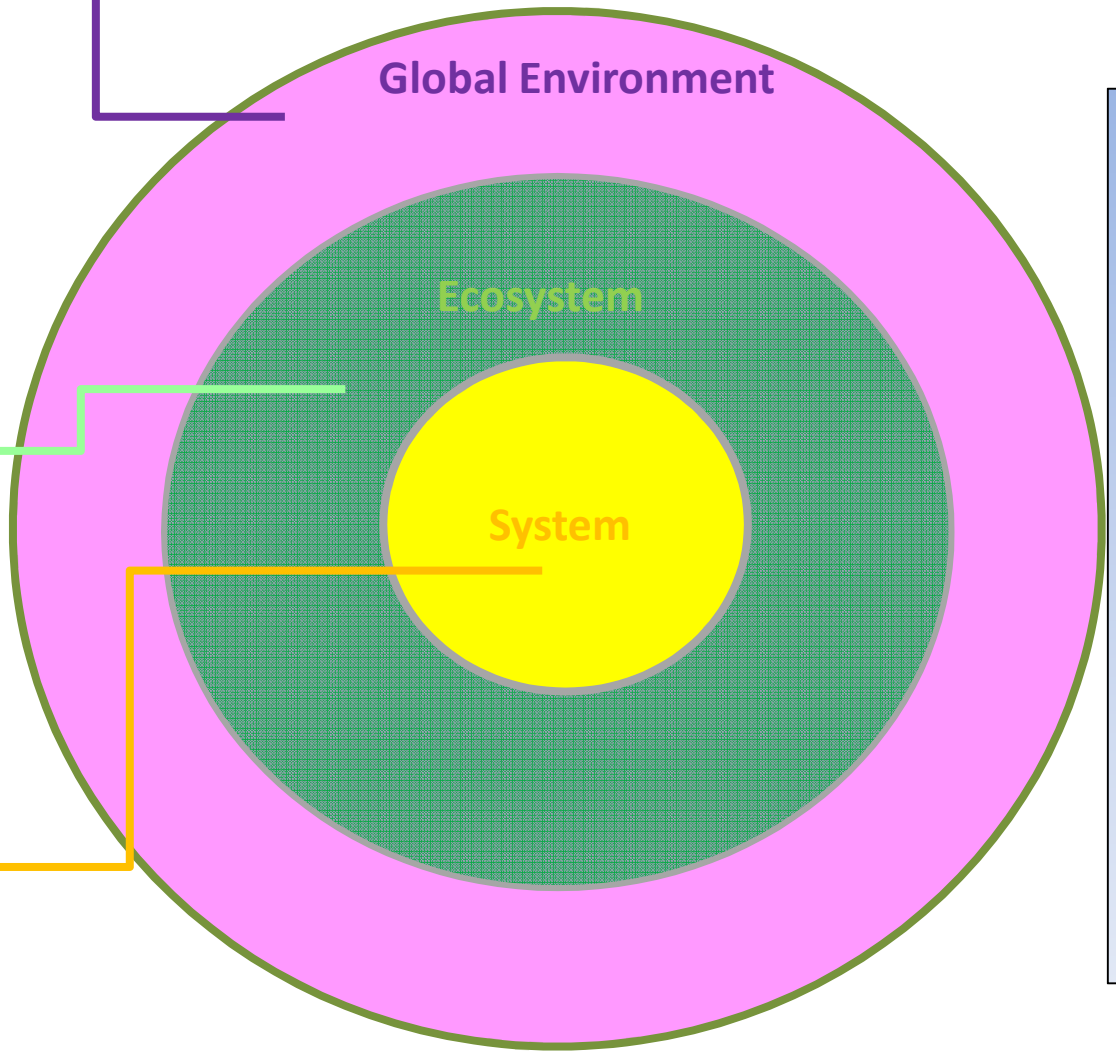
- New energy system
- New car techno

  weight, cx …
- New motorization

System

Market:

- Offer
- Demand



SYSTEMIC ANALYSIS

'Method of the 3 circles'

Methodology

Global Environment

General Context :

- Macro- Demo
- Regulation
- Socio-cultural

Ecosystem

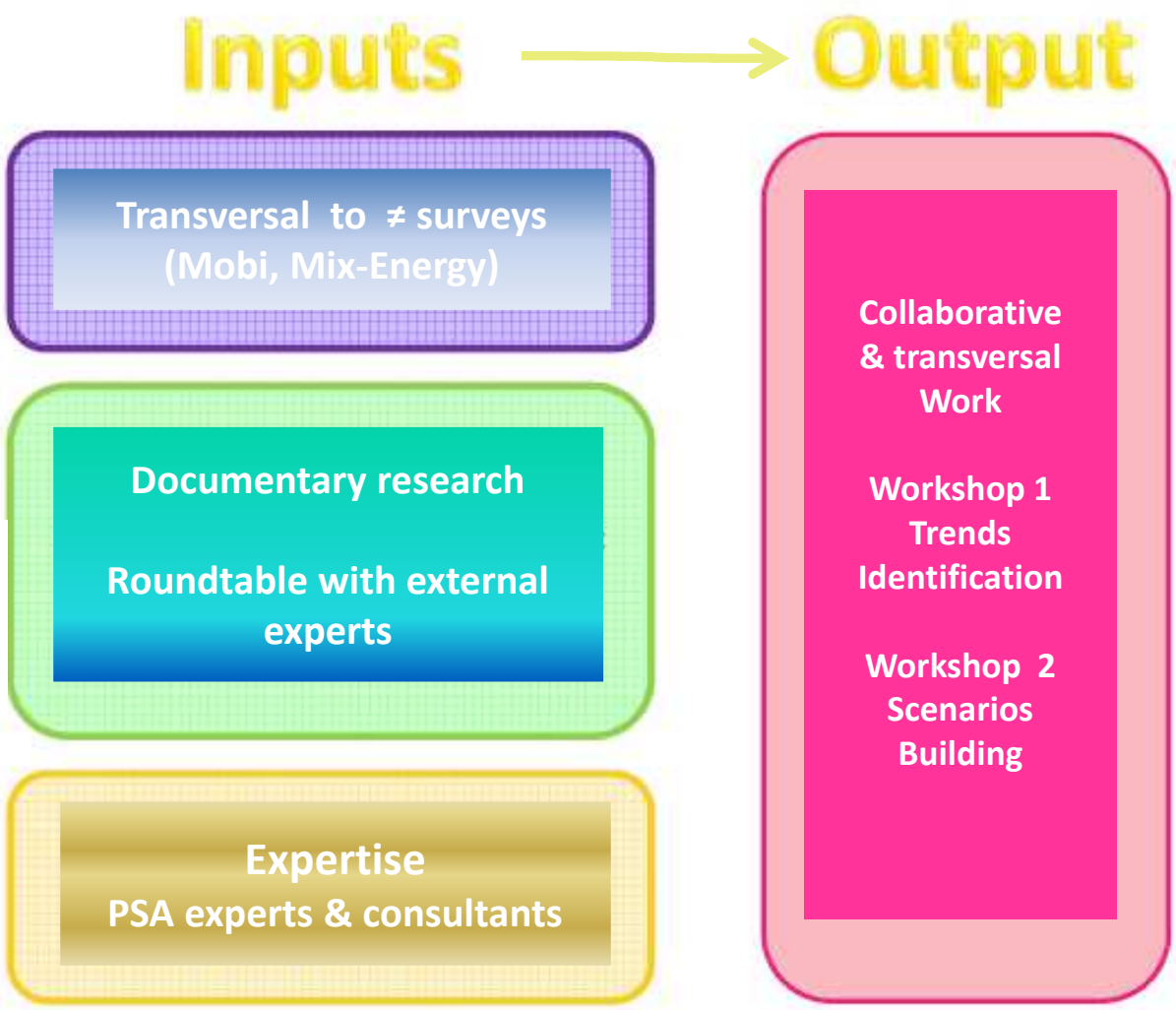
Specific context:

- New energy system
- New car techno
- New motorization

System

Market:

- Offer
- Demand



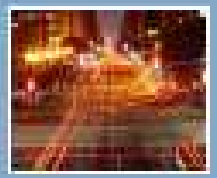
Step 1

Identification of trends

Macro Trends

Extension of environmental protection

Urbanization



Increasing demand for mobility

Matrix

Impact - variance

IMPACT

Trends
with large impact

on the system

= no variance

between scenarios

Trends
with potentially

large impact

= variance between scenarios

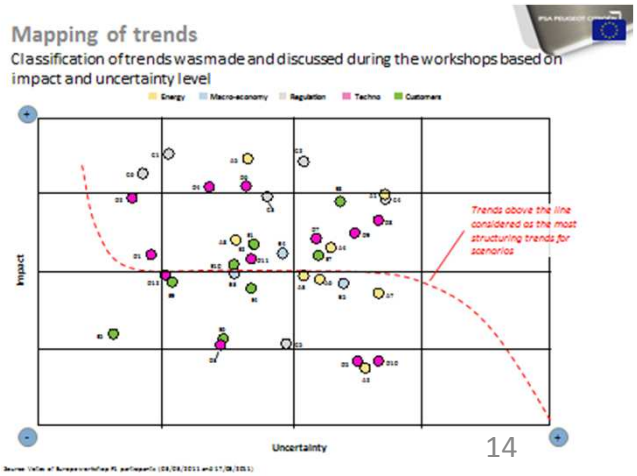
UNCERTAINTY

Secondary Trends

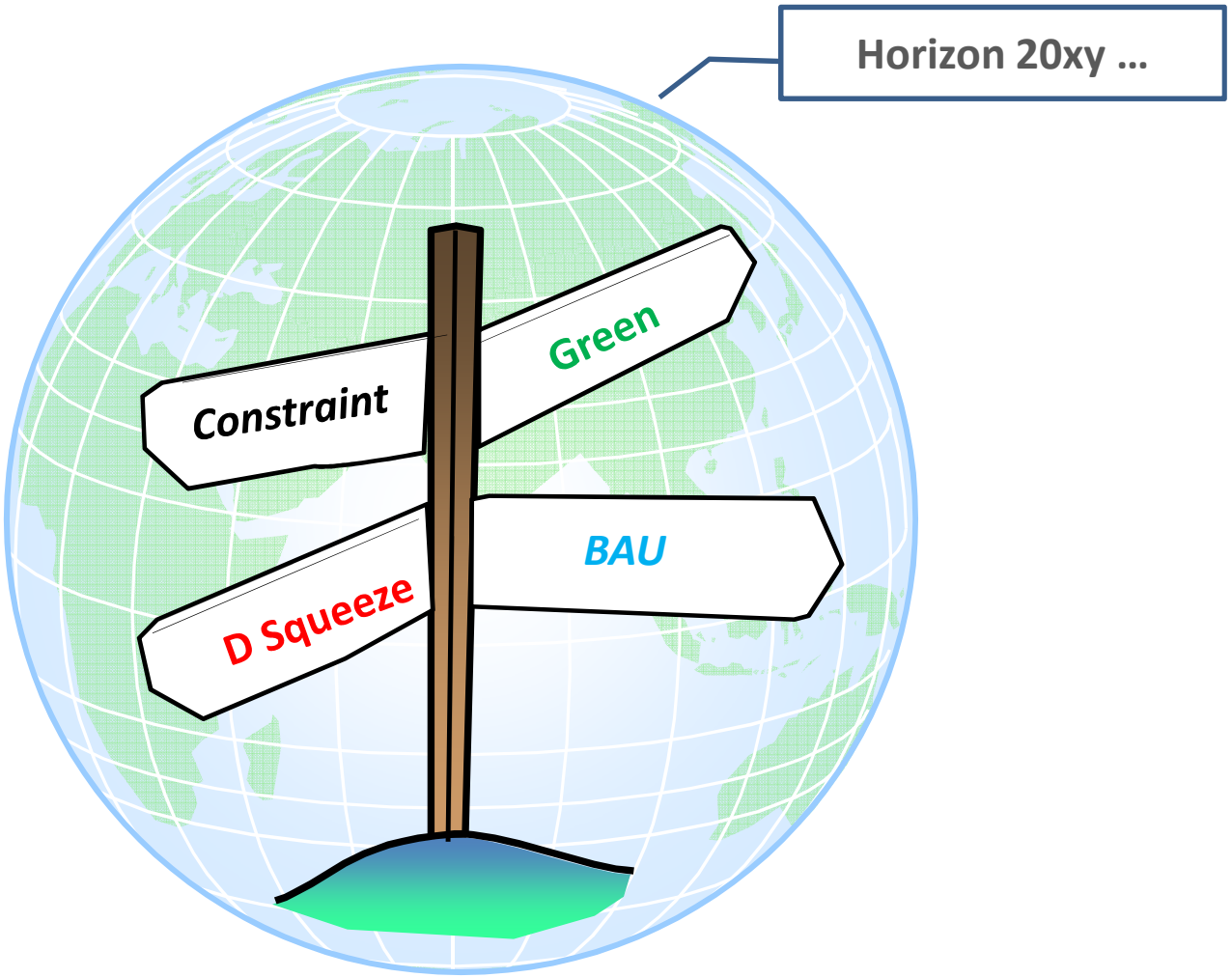
trends on 2 axes

Scenarios

2020-2030



Step 2
PSA Scenarios



PSA Alternative Scenarios

Contrasted Stories of the future

Constraints & Optimization

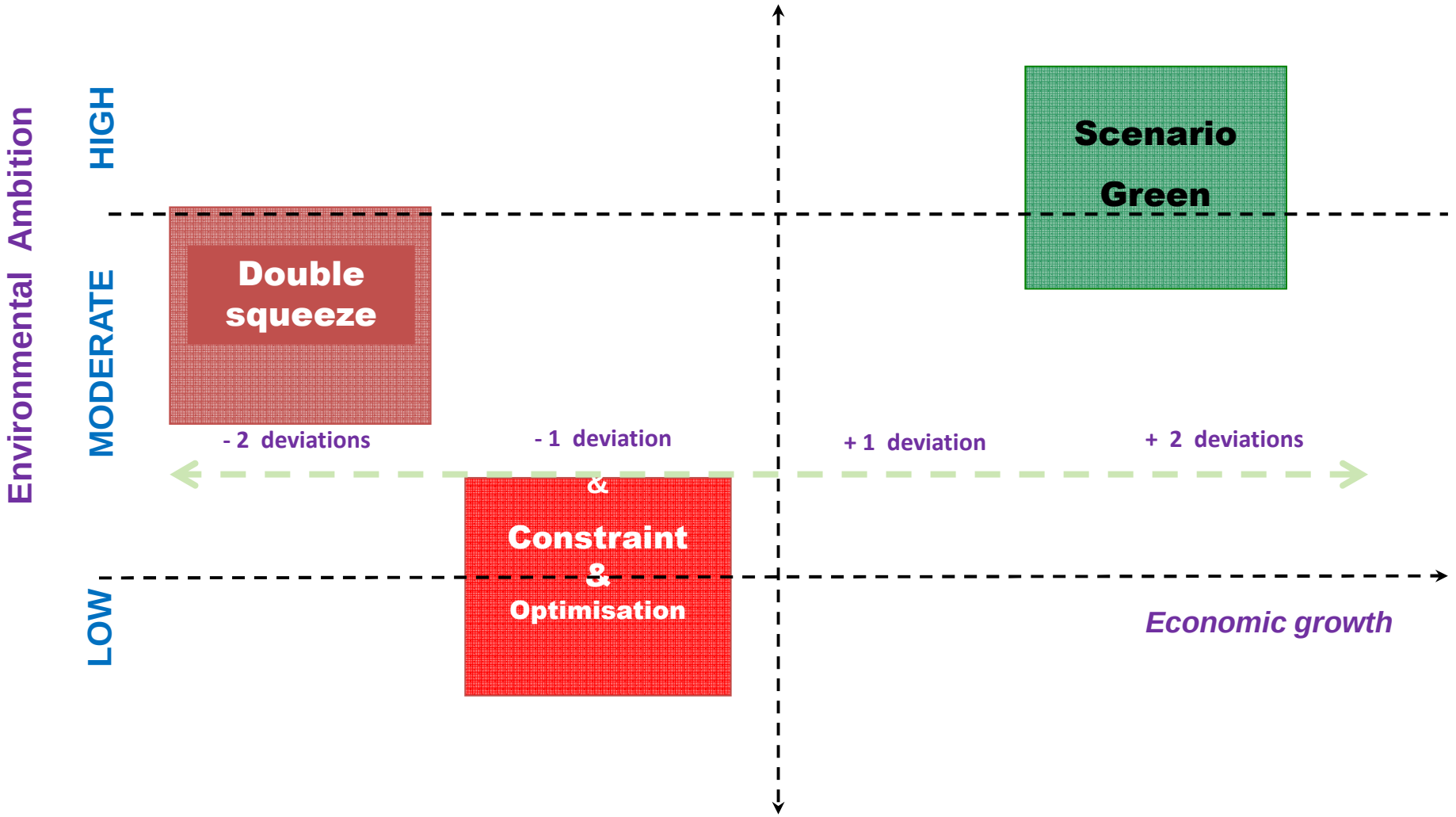
horizon 2020 - 2025

Double squeeze

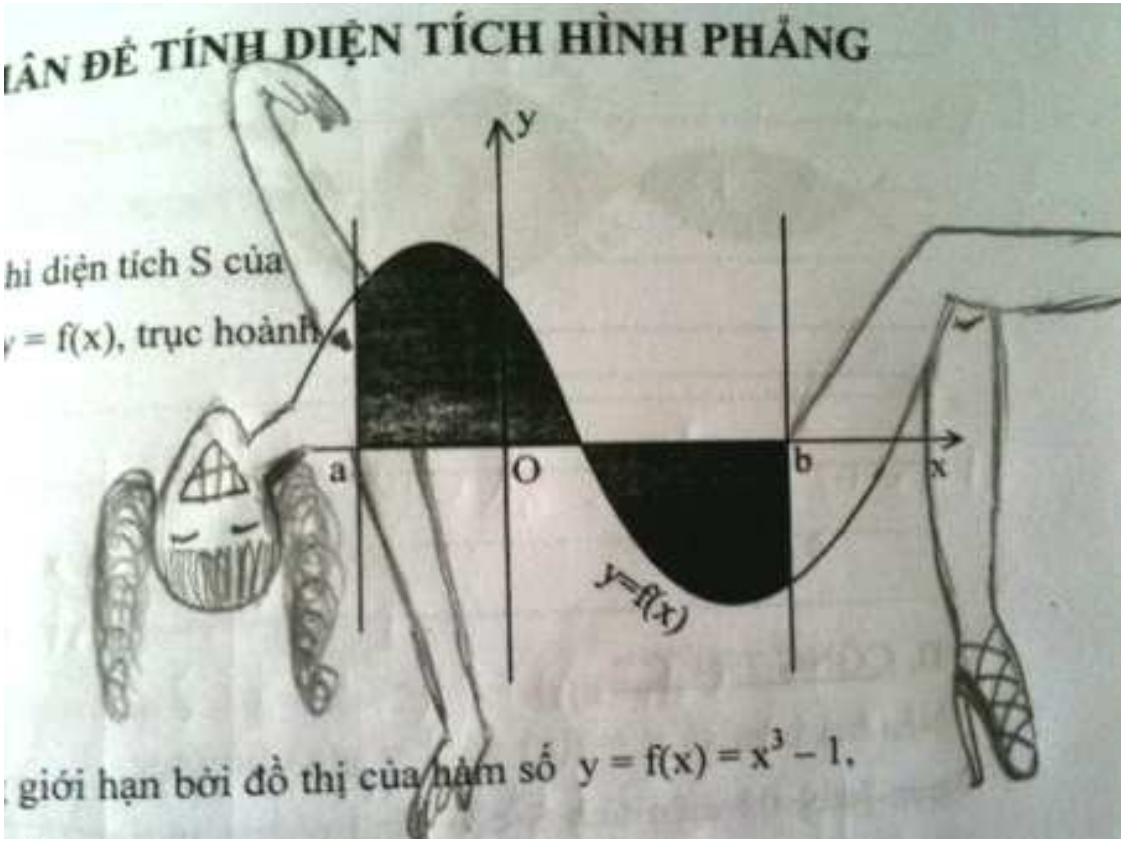
Green taxation

Scenarios projections

on 2 principal axes



III Modelization



Models

Modular Approach

- ✓ Depending on the kind of systems that are considered, we implement modules of quantitative modelization by our own expertise, or by external expertise or by a mix of both

- ✓ Examples of modelizations for the car market
  - Macro-economic models
  - Impact on the car market of the mix-energy ressources
  - Impact on the car market of the rate of urbanization

Macro-Eco Modelization

Quantify the future in the prospective frame

Type I **Méthode tendancielle classique**

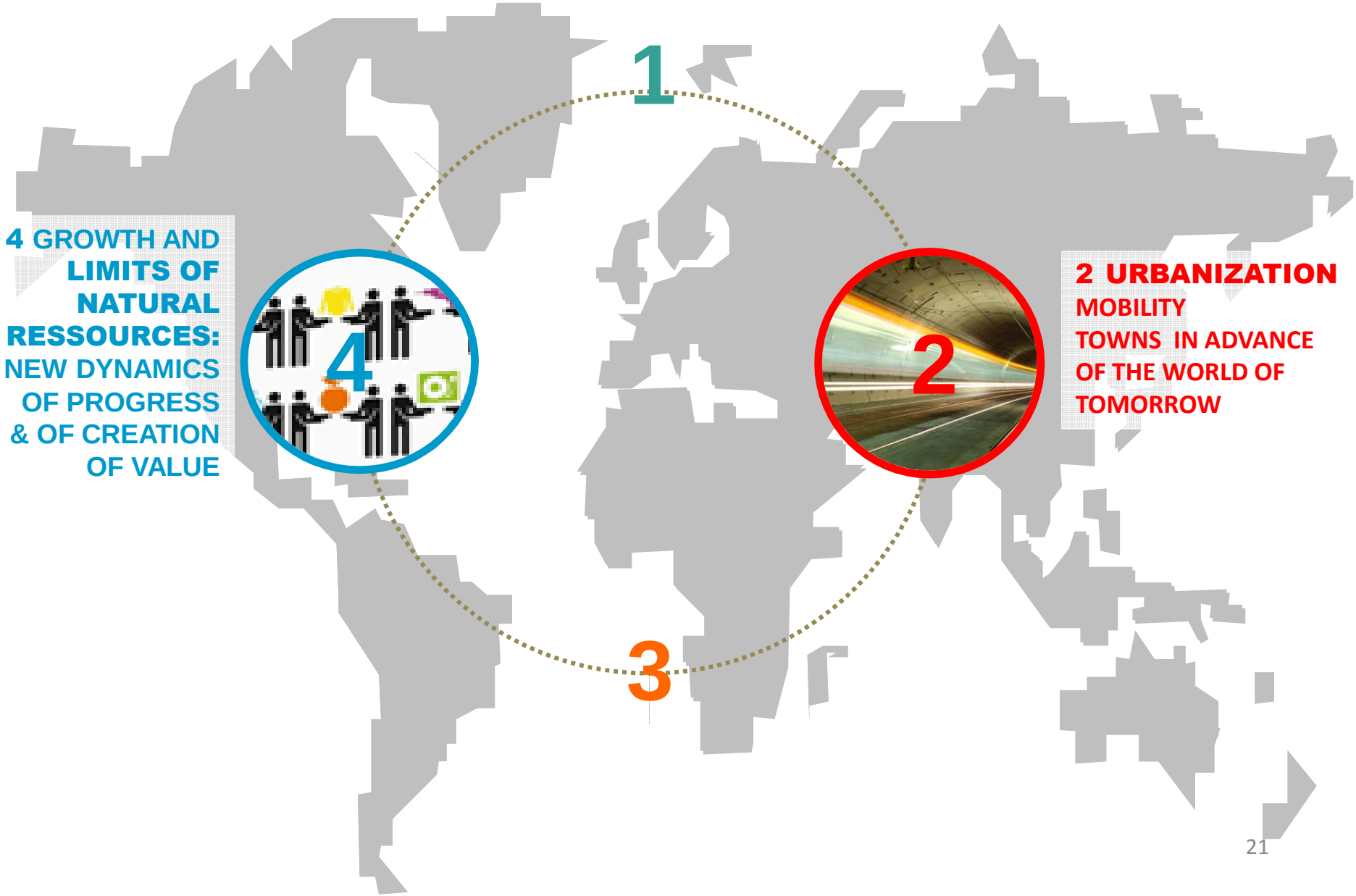
- on identifie les tendances et on prolonge les tendances
  - avec croissance potentielle LT = π (productivité) + δ (démographie)

Type II **Méthode différentielle alternative**

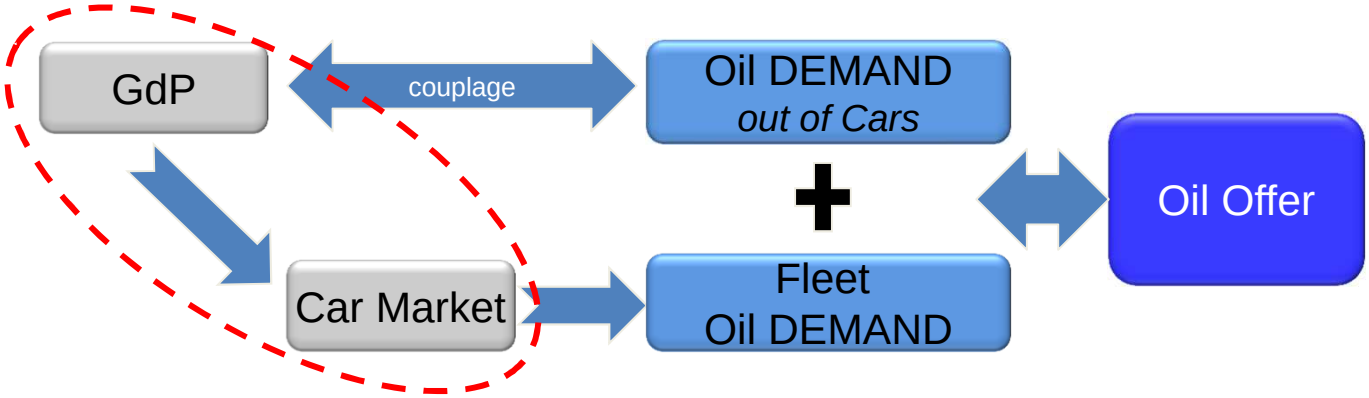
- on calibre les scénarios alternatifs en écart type / scénario de base
  - Scénarios réguliers à 1 écart $\sqrt{D}$ en + (optimiste) ou – (pessimiste)
  - Scénarios en rupture à 2 écarts en + (optimiste) ou – (pessimiste)
  - Loi de Bienaymé Tchebychev → 80% des scénarios se situent < 2 écarts types>

… et même 95% si la loi est normale …

TRANSFORMATION AXES



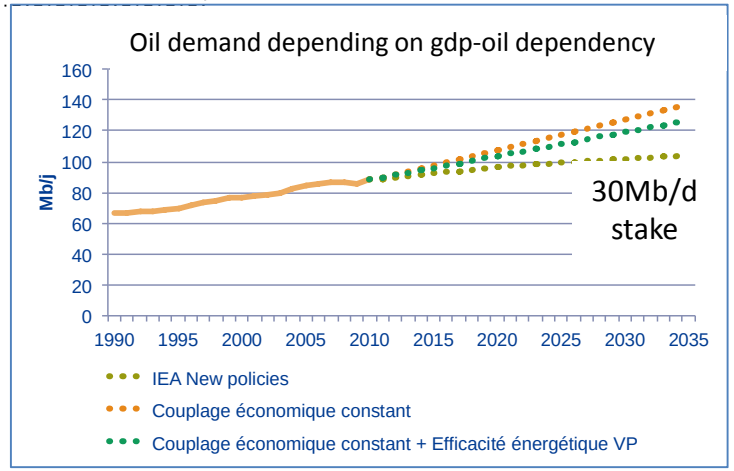
Energy & Car market



Energy scenarios present contrasted hypothesis concerning :

- *Oil Offer Evolution*
- *Dependency of GDP Growth to Oil Demand*

=> **Key issue for automotive market**



I Limits of natural ressources

ratio GDP-OIL

Scenarios World Energy Council

	1990-2000	2000-2010	2010-2020	2020-2030	2030-2040	2040-2050
Jazz	2.9	2.8	3.2 (3.9)	3.1 (3.8)	2.9 (3.5)	2.6 (3.1)
Symphony	(3.2)	(3.5)	2.8 (3.3)	2.6 (3.2)	2.5 (3.0)	2.2 (2.7)

WEM- LT	Jazz	Sympho
GdP_{market}	2,9%	2,5%
Energy	1,2%	0,6%

Ratio 1/4

Ratio 1/3

Ratio GDP-OIL

The elasticity approach

Oil Demand Price and Income Elasticities
(Subsample, 1990–2009)

	Short-Term Elasticity		Long-Term Elasticity	
	Price	Income	Price	Income
Combined OECD[1] and Non-OECD	–0.019 [–0.028, –0.009]	0.685 [0.562, 0.808]	–0.072 [–0.113, –0.032]	0.294 [0.128, 0.452]
OECD	–0.025 [–0.035, –0.015]	0.671 [0.548, 0.793]	–0.093 [–0.128, –0.057]	0.243 [0.092, 0.383]
Non-OECD	–0.007 [–0.016, 0.002]	0.711 [0.586, 0.836]	–0.035 [–0.087, 0.013]	0.385 [0.193, 0.577]

IMF source

Ratio 1/3

II Multiplication of big cities

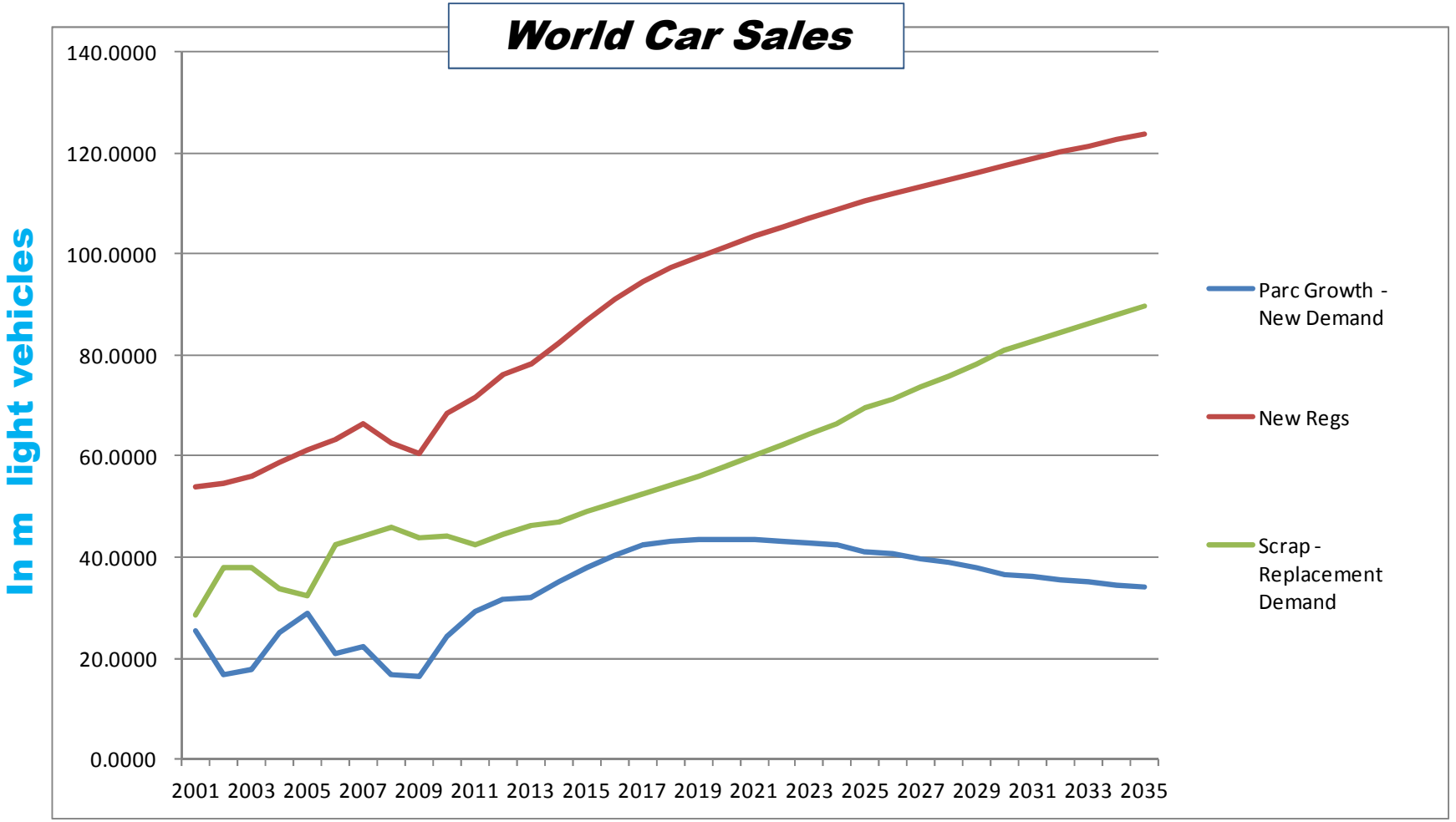
A World 50% urban By 2035, it will be 60%

Impact of urbanization on the car market

- An external modelization
  - a non linear Model
  - a model with retroaction feedback

A) Scenario baseline

linear model

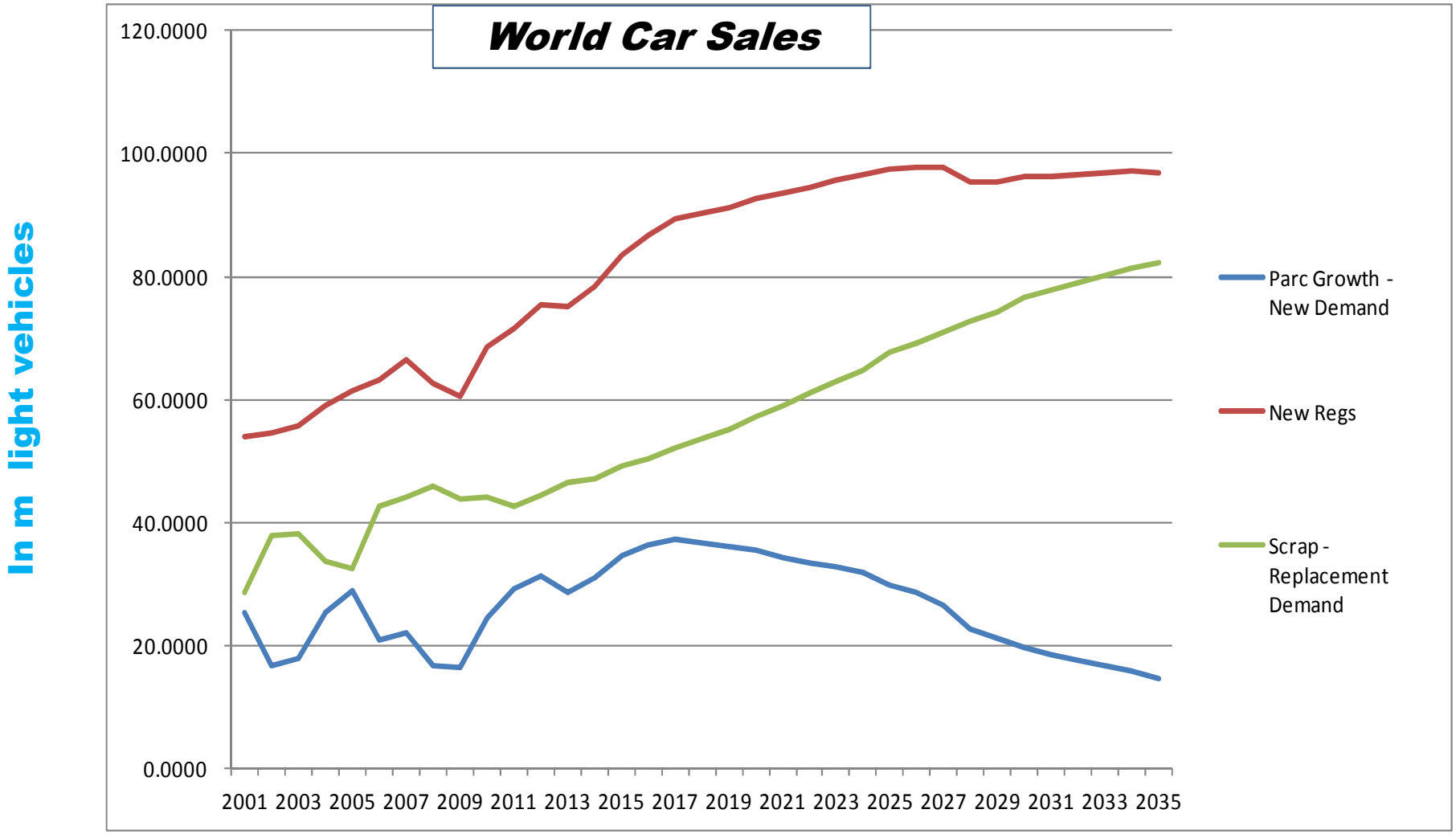


The new global demand for motorisation will rise until early 2020's before peaking - then vehicle replacement kicks in as a growth engine for sales

B) Scenario NUM

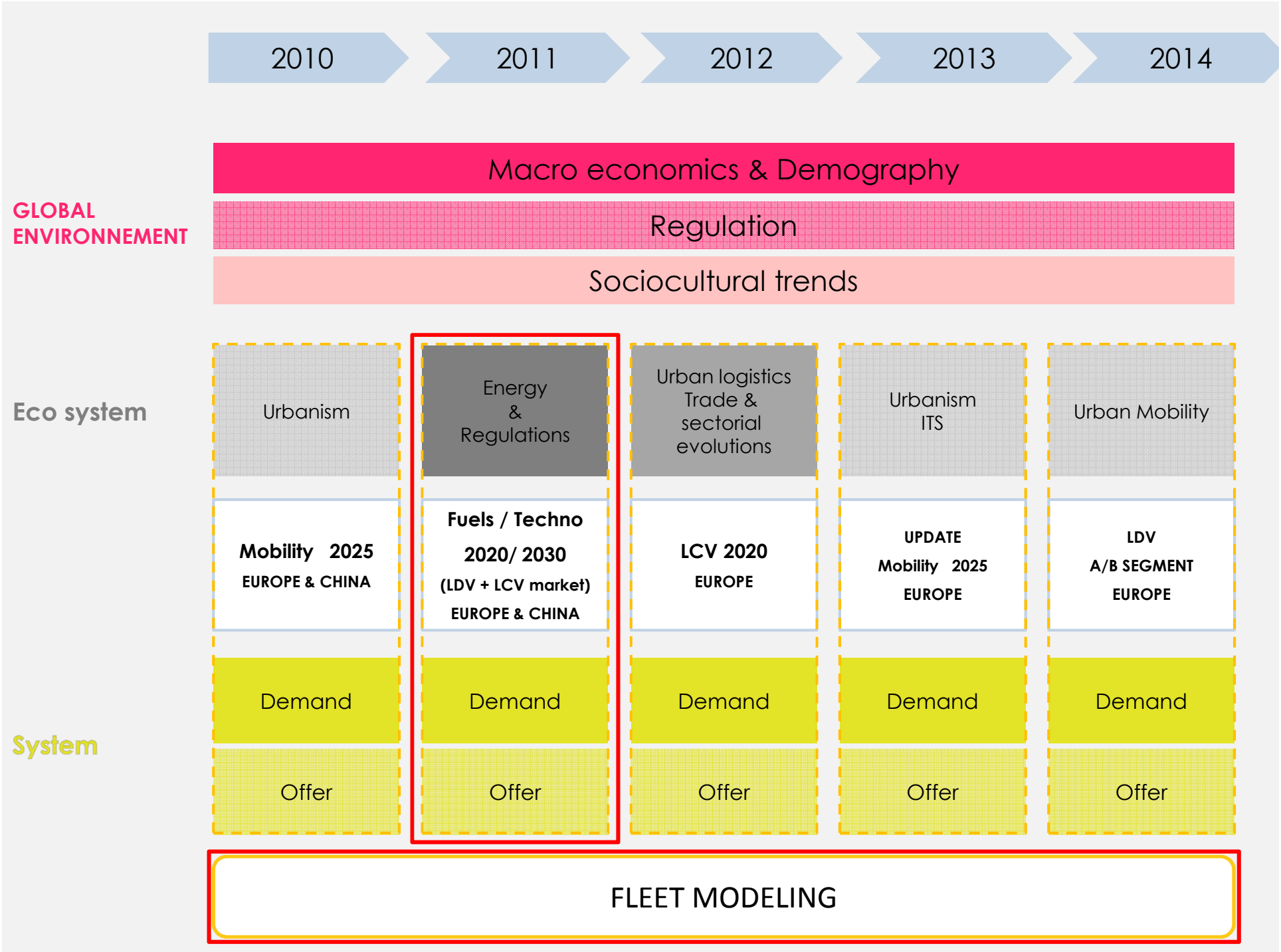
New Urban Market

non linear model



The new global demand for motorisation would peak before 2020 and begin to slide- slowing growth rates of new vehicle sales below industry expectations

PROSPECTIVE SCENARIOS
&
AUTOMOTIVE MARKET MODELING


2010
2011
2012
2013
2014
GLOBAL ENVIRONNEMENT
Macro economics & Demography
Regulation
Sociocultural trends
Eco system
Urbanism
Energy & Regulations
Urban logistics Trade & sectorial evolutions
Urbanism ITS
Urban Mobility
Mobility 2025 EUROPE & CHINA
Fuels / Techno 2020/ 2030 (LDV + LCV market) EUROPE & CHINA
LCV 2020 EUROPE
UPDATE Mobility 2025 EUROPE
LDV A/B SEGMENT EUROPE
System
Demand
Demand
Demand
Demand
Demand
Offer
Offer
Offer
Offer
Offer
FLEET MODELING

POWERTRAIN MARKET MIX : FUELS & TECHNOLOGIES

Motivation

Since 2000’ from 2 historical to more than 10 powertrain technologies

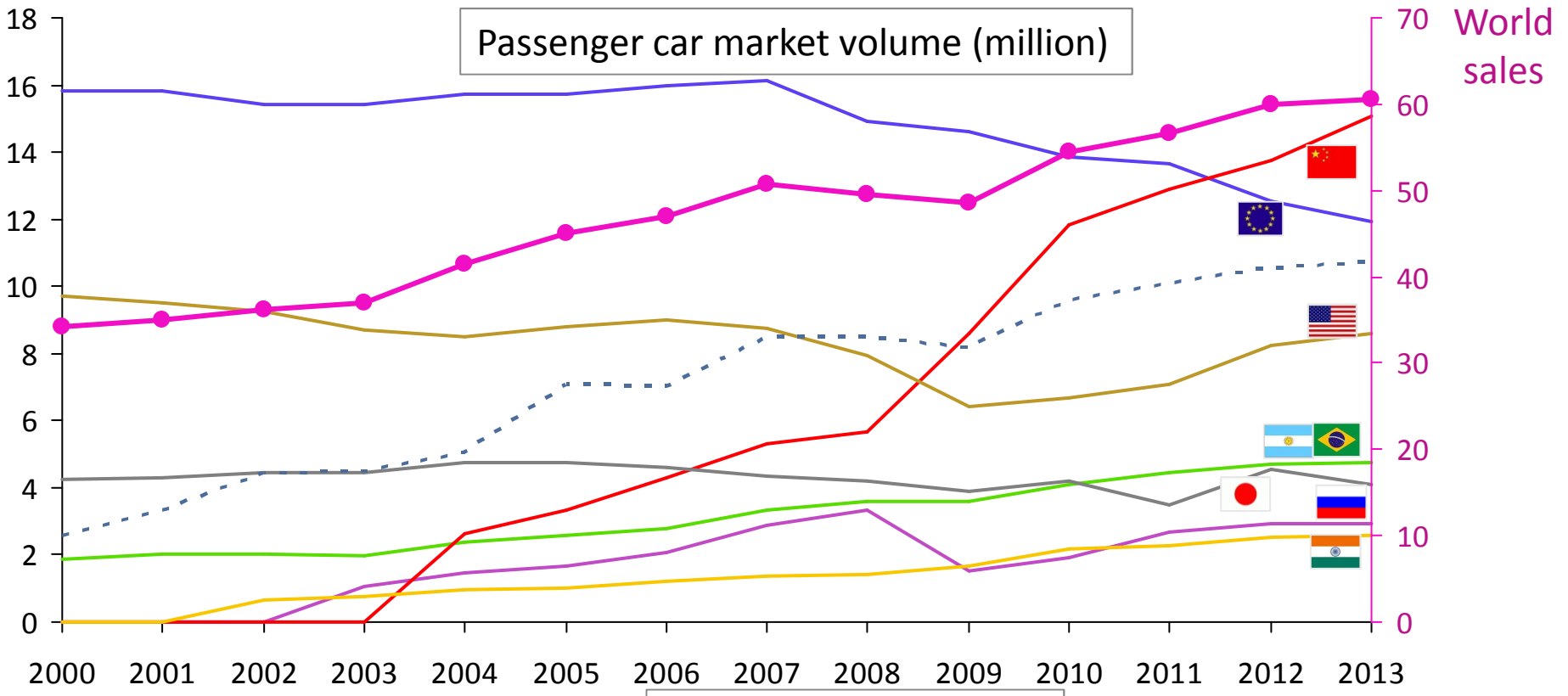
Energy \ Techno	Base (incl. STT)
Diesel	
Gasoline	
LPG	
CNG (GNV)	

Stake ≈ 500 M€ CAPEX/R&D

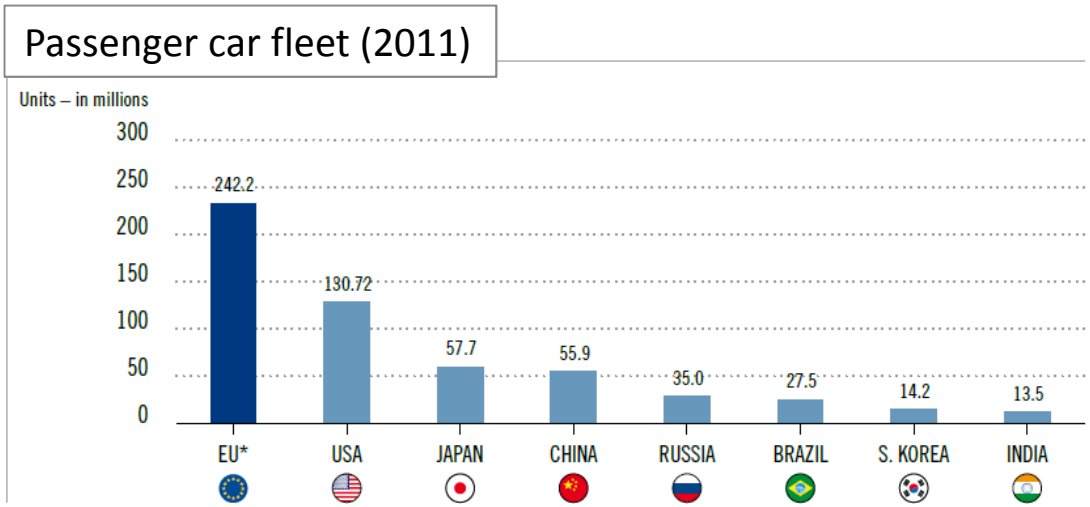
Powertrain CAPEX/R&D share is increasing

- **Base** : ICE with or with-out STT
- **Mild HEV** : Mild hybrid – exple : Honda Insight
- **HEV** : ZEV at low speed – exple : Prius, HY4
- **PHEV** : Full-Hybrid + ZEV from 20 to 50 km
- **REX** : **arround** 50-70 km ZEV + ICE for range extension and/or polyvalence

Global Choice for Different Markets



- ❑ Car type
- ❑ Fuels
- ❑ Maturity & Dynamic
- ❑ Customers



Model Presentation

- Global environment & Eco-system
- Technology & product offer
- Customers

Energy & Resources	Macro Economy & Demography	Government & Regulation

- Global environment assumptions per scenario :
  - GDP growth , oil price, fuel taxation, city access restrictions, refueling / recharging network expansion …

Technology & product offer

- Assumptions on each technology roadmap until 2020:
  - Manufacturing cost, fuel consumption, CO2 emissions, ZEV autonomy, …
- Efforts on vehicle performance features (weight, aero, Crr)
- OEMs product offer in 2020

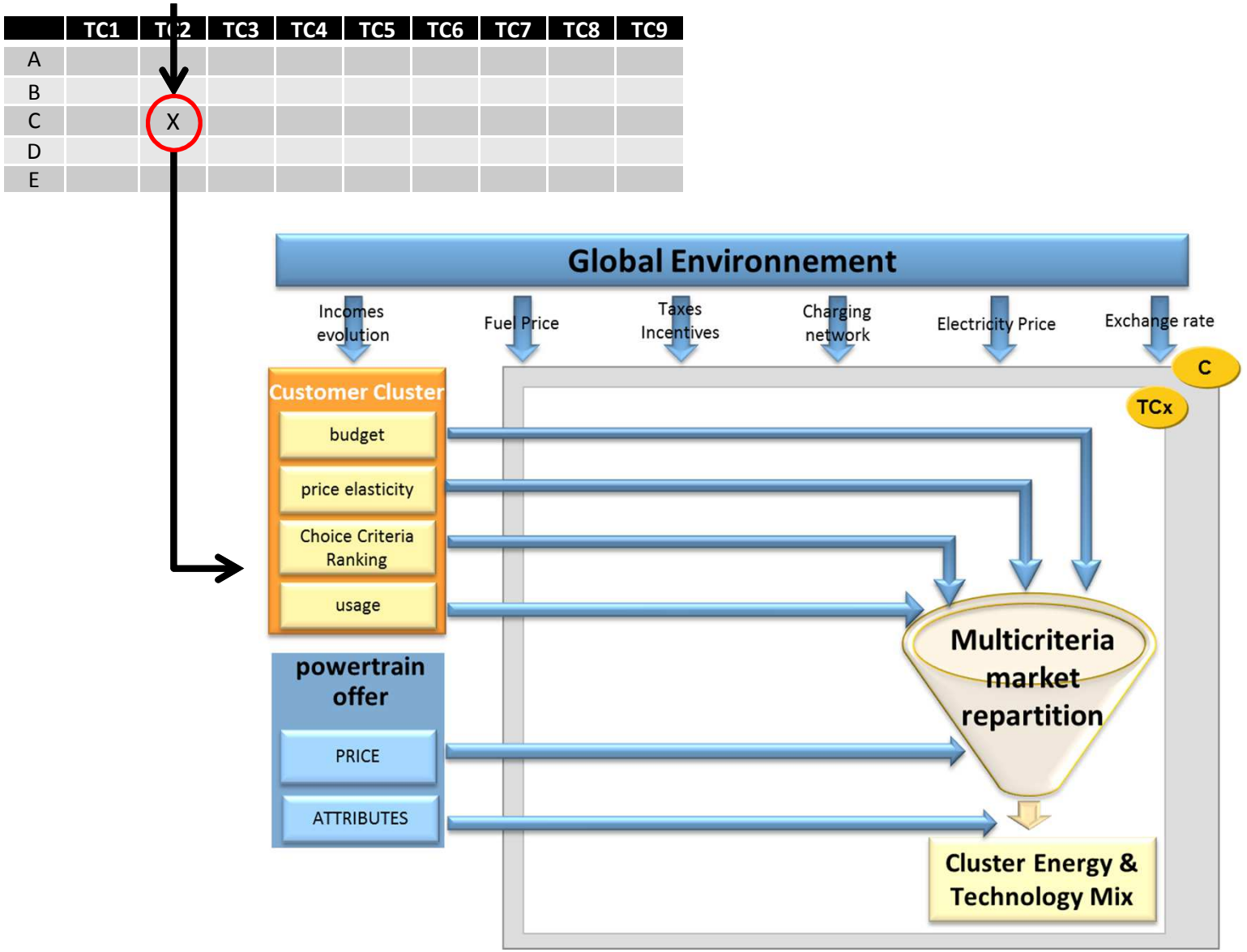
Energy & Technology mix model

Customers

- Detailed customers segmentation
- Observed characteristics per cluster in 2010 :
  - Usage type, annual mileage, buying criteria, new car purchase budget...
- Assumptions for 2020-30

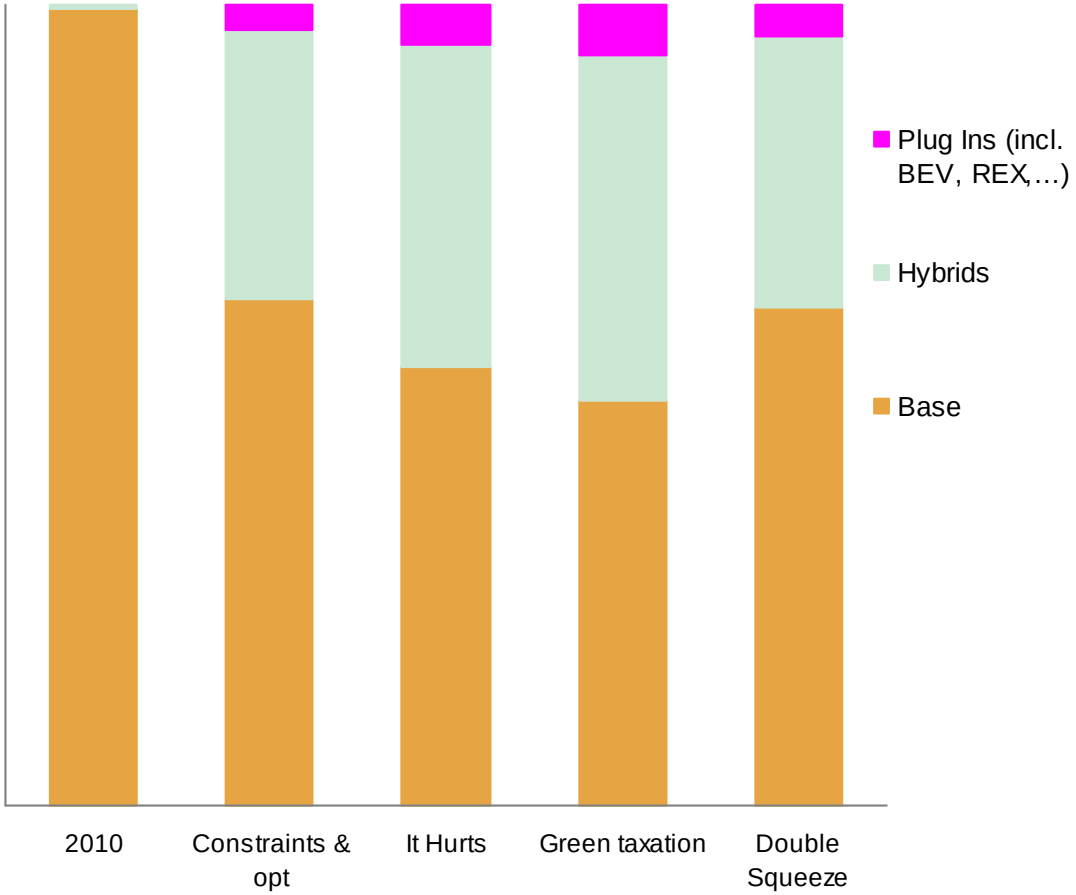
Model Presentation : Model mesh & Principles

Principles: modelization step by step of each customer cluster's Mix technology

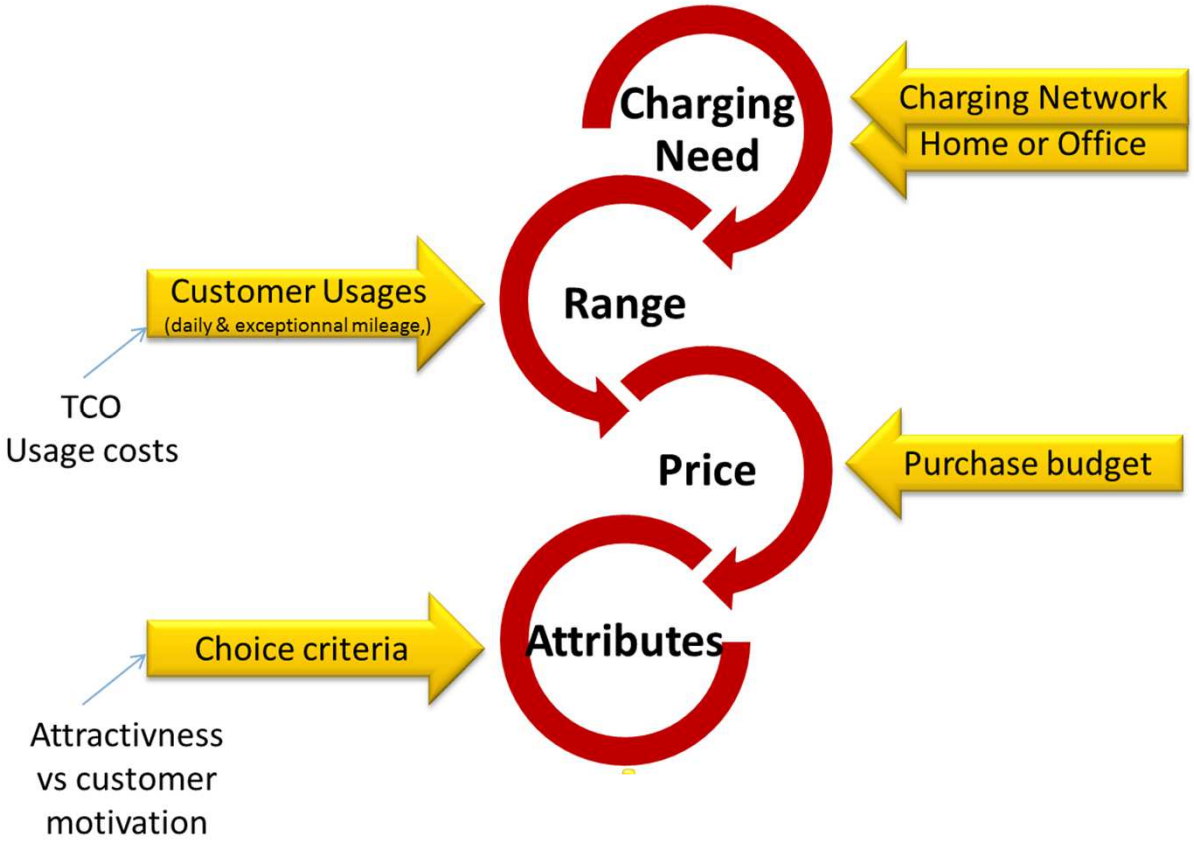


Hybrid market potential : scenarios sensitivity

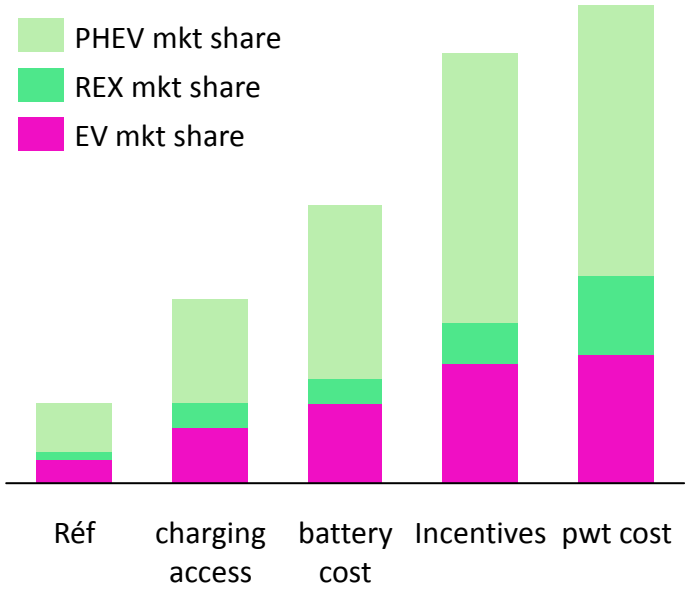
2020 Hybridization / electrification potential
% New vehicles sales



Bottlenecks for electrified mobility market development



market share
% passenger car



FLEET MODEL

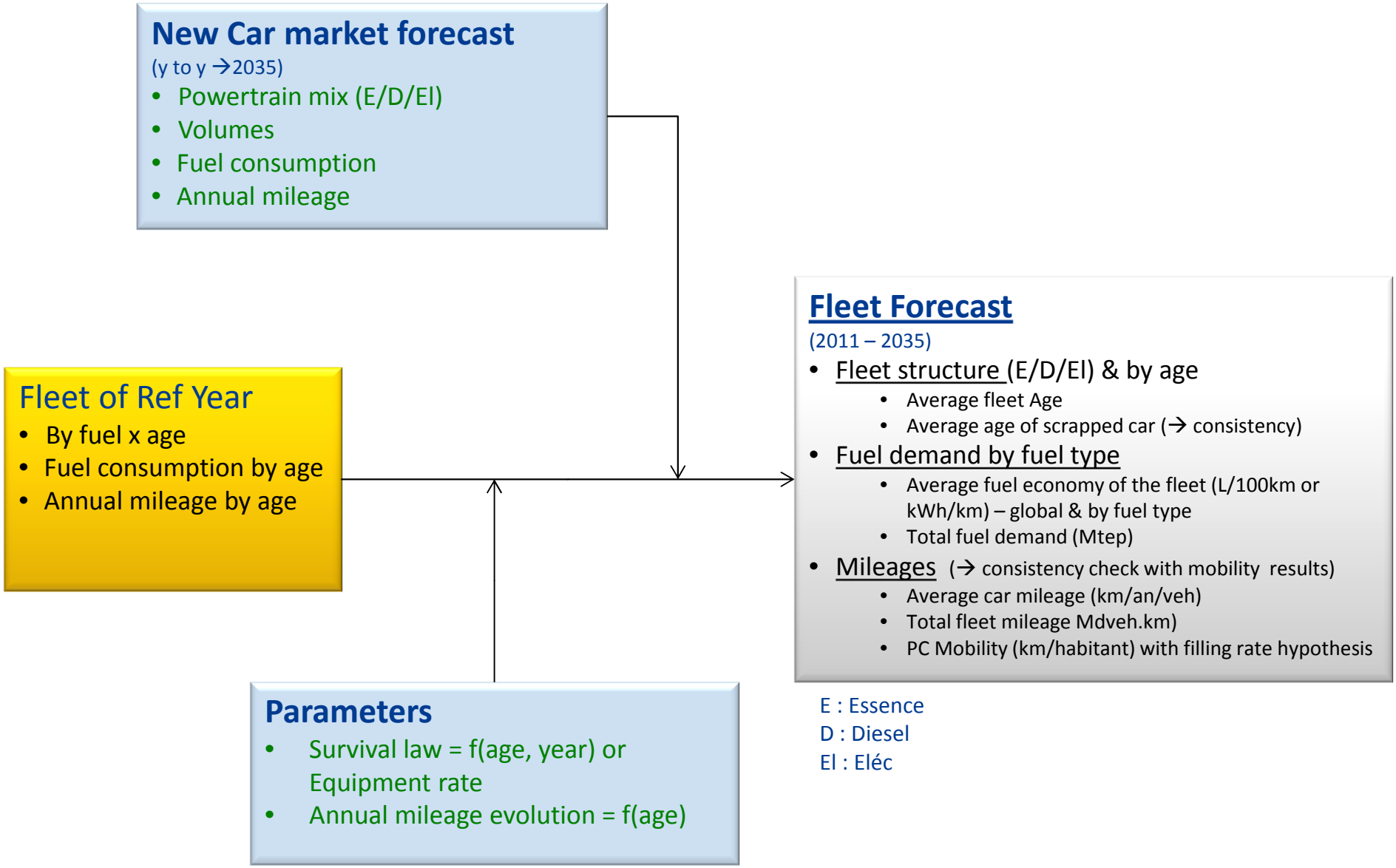
Motivation

- Impact on fuel demand (& CO2 emissions)
  - Powertrain fuel & technology mix
  - Market volume & segmentation (Vehicle size / body shape)

- Feed back to improve consistency between models
  - Equipment rate forecast
  - Market volume forecast
  - Fleet mobility
  - …

- Compare results with fleet fuel demand from external scenarios (exple : IHS, IEA)

Fleet model


New Car market forecast
(y to y →2035)
• Powertrain mix (E/D/El)
• Volumes
• Fuel consumption
• Annual mileage
Fleet of Ref Year
• By fuel x age
• Fuel consumption by age
• Annual mileage by age
Parameters
• Survival law = f(age, year) or Equipment rate
• Annual mileage evolution = f(age)
Fleet Forecast
(2011 – 2035)
• Fleet structure (E/D/El) & by age
• Average fleet Age
• Average age of scrapped car (→ consistency)
• Fuel demand by fuel type
• Average fuel economy of the fleet (L/100km or kWh/km) – global & by fuel type
• Total fuel demand (Mtep)
• Mileages (→ consistency check with mobility results)
• Average car mileage (km/an/veh)
• Total fleet mileage Mdveh.km)
• PC Mobility (km/habitant) with filling rate hypothesis
E : Essence
D : Diesel
El : Eléc

Reduce fuel demand (& CO2 emissions)

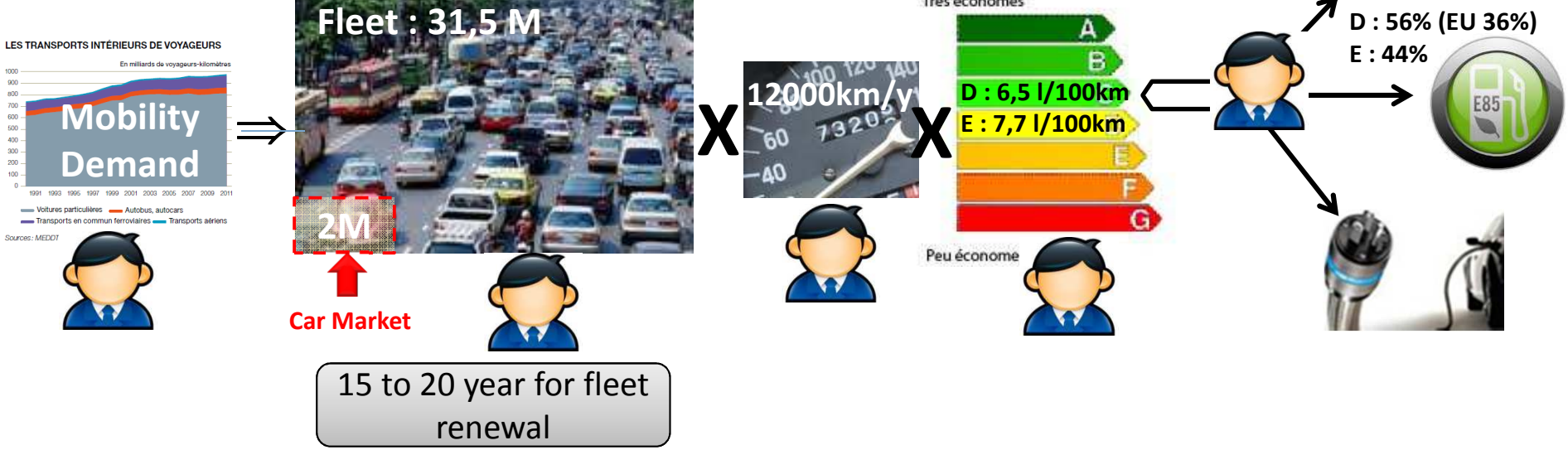
a question of fleet

How ?

- Produce Very Energy Efficient car

- Use « clean » & abundant energy

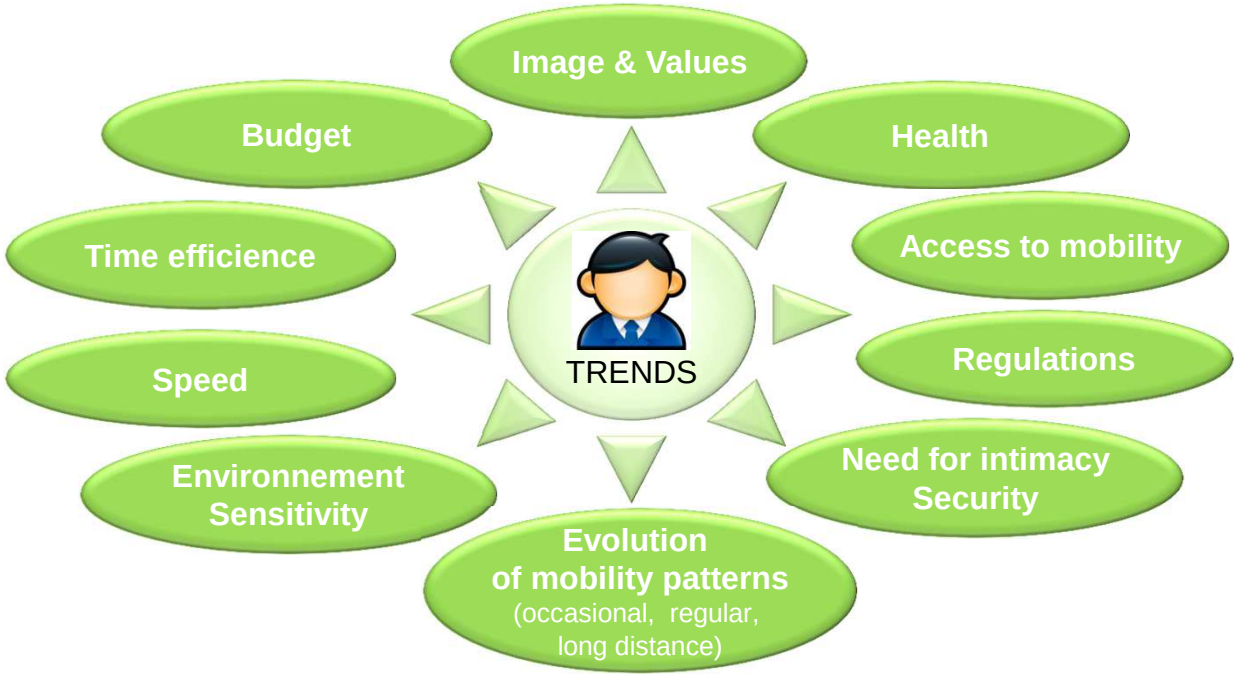
…. but for efficiency measure, fleet dynamic is key :



Customers

different + key player

- Needs
- Motivations
- Constrains



➔ Need for wide product & service offer

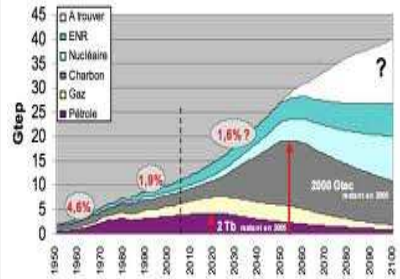
- Attractive
- Adapted
- Efficient (€ & Energy)

For a given mobility, 3 levers

Car

Usage

Driving style



Car

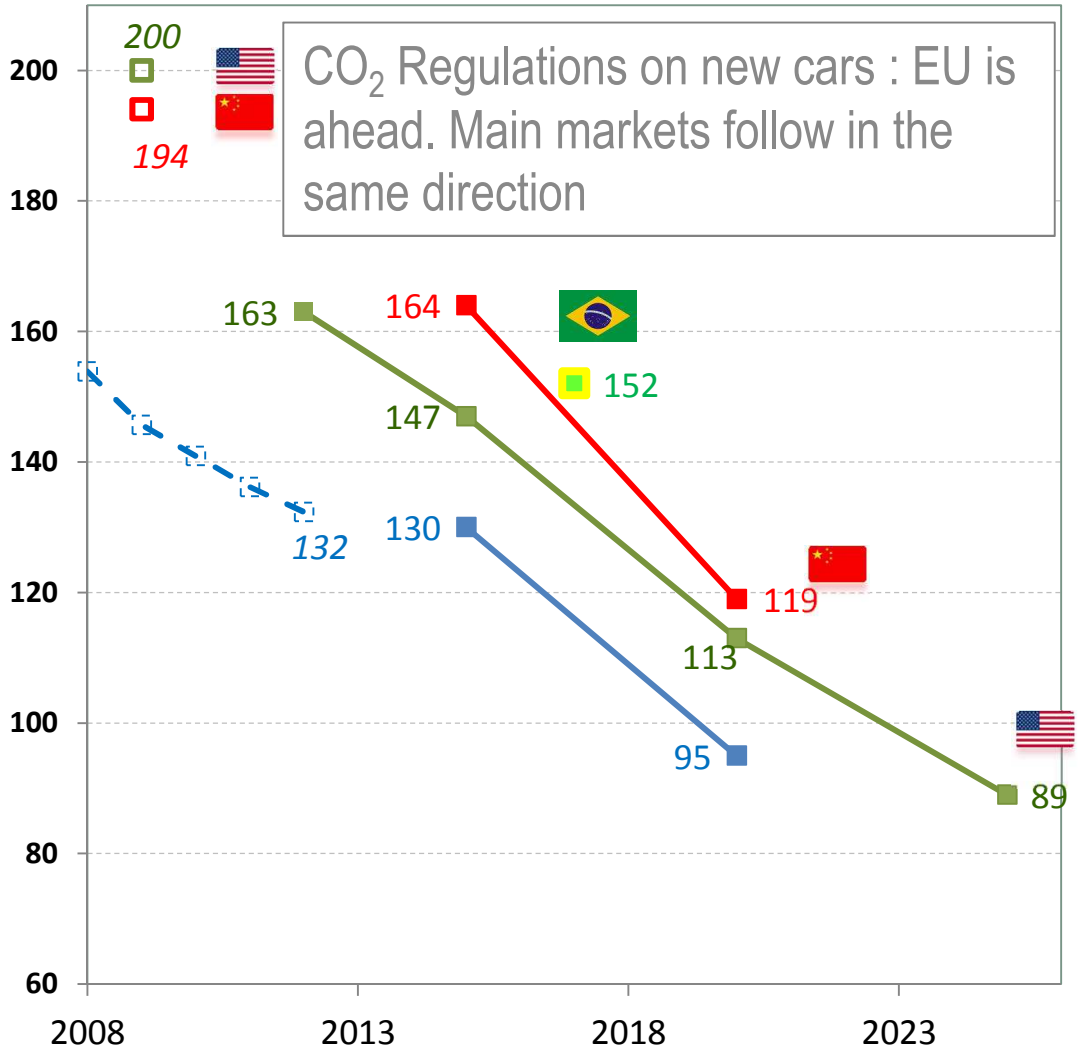
NEW CARS

Efficiency

- Bodyshape
  - Weight
  - Aero
  - Tyres

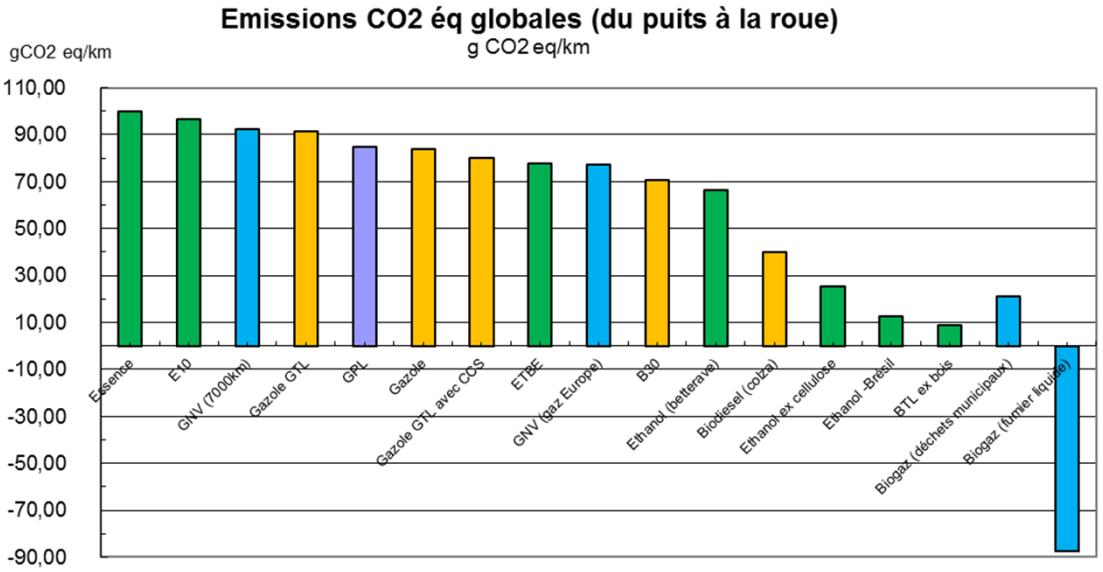
- Powertrain
  - efficiency
  - Energy recovery

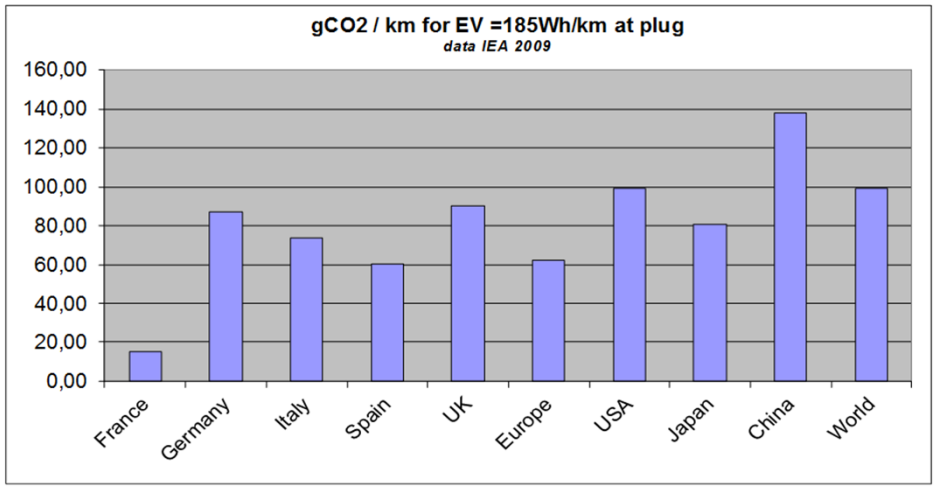
} Incl. hybrids



Car

FLEET





"Fuels"

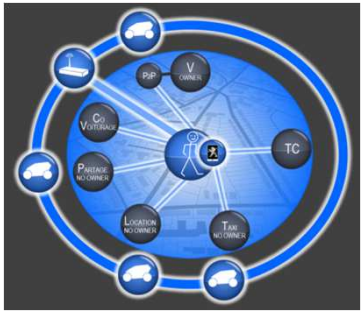
- Fossil fuels
  - Gasoline
  - Diesel
  - NGV
  - LPG
- Biofuels
  - 1st, 2nd, 3rd generation
- Electricity
  - Coal, Wind, Nuclear, Gaz, Sun, Hydro, …

Usage

1,2

Car pooling

FLEET



Carsharing

Co-ownership

Very Short Term Rental

NEW CARS

- **ACCELERATE FLEET RENEWAL**
- **PARK SEARCH TRAFFIC REDUCTION**

Driving Style

FLEET

NEW CARS

SPEED

110 → 130 km/h

≈1l/100km

SMOOTH versus NERVOUS DRIVING

≈ 1 à 3 l/100

ECO COACHING

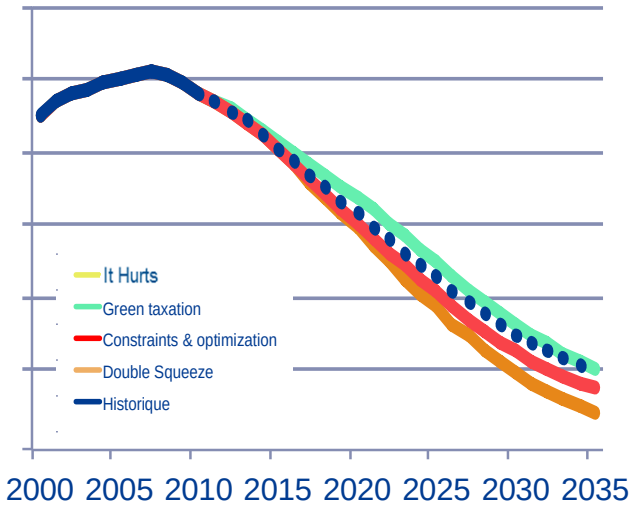
DRIVING AUTOMATISATION

EQUIPEMENTS

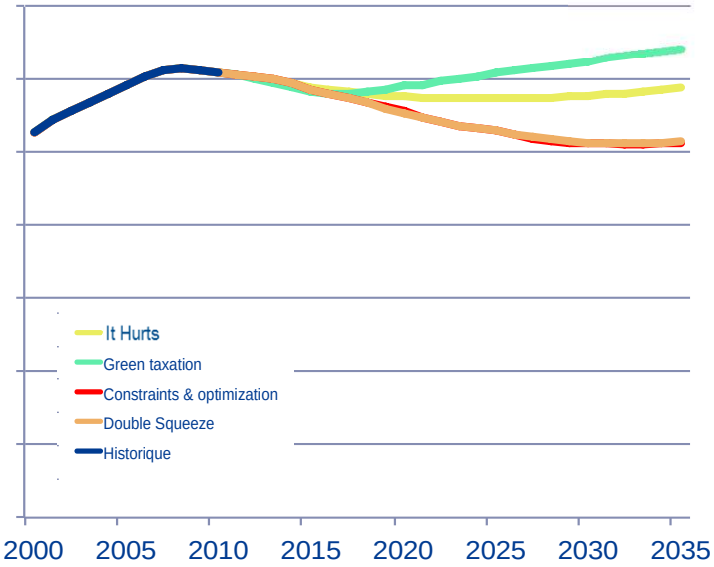
+10% à +30%

Exemple of Scenarios & fleet fuel demand

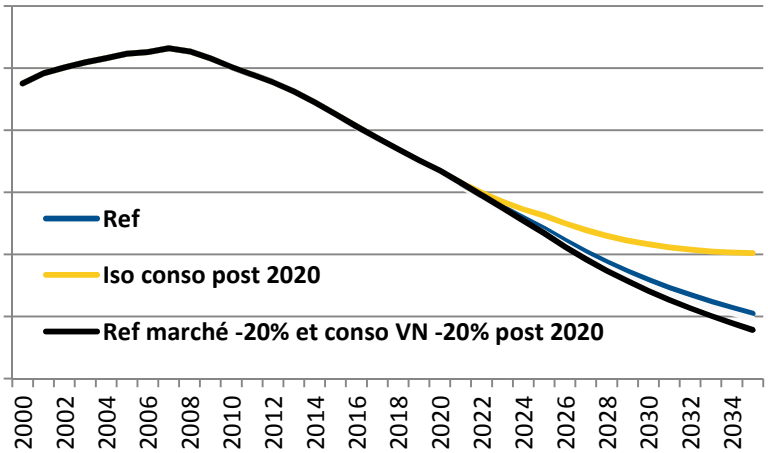
PC fleet fuel demand MTep



PC fleet mobility – Mdveh.km



- PC fleet fuel demand in « Green taxation » is close to « It Hurts ». This is due to fleet mobility increase in Green Taxation witch compensate efficiency benefits of the fleet.
- PC fleet fuel demand in « Constraints & Optimization » & « Double Squeeze » are bellow it Hurts.



Fuel demand : scenarios comparison