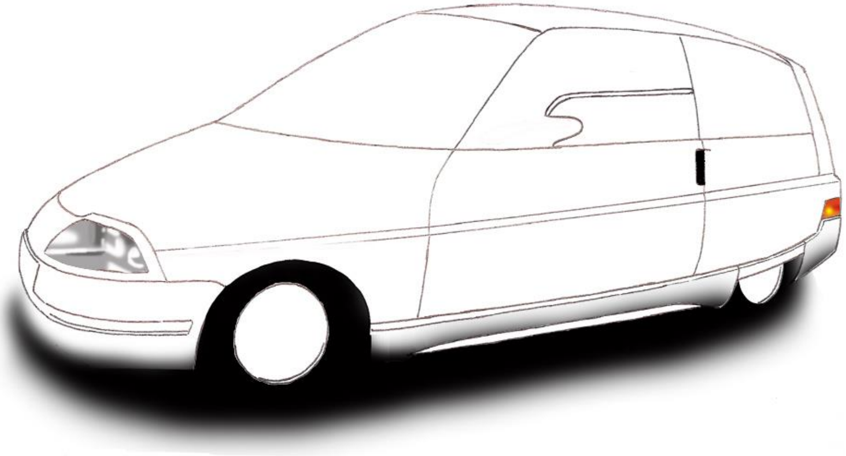
Why Light is Right?



Nicolas Meilhan
Principal Consultant, Frost & Sullivan

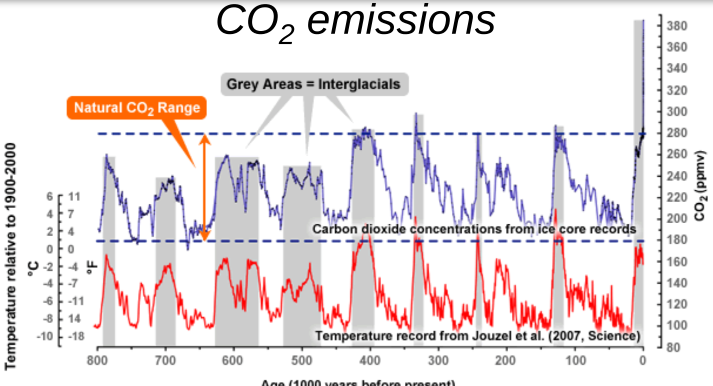
September 2014

7 major challenges to be taken into account to develop the mobility of the future

2 global challenges - CO_2 emissions & end of cheap oil, 3 local challenges – pollution, congestion & parking and 2 economic challenges - unemployment & trade deficit

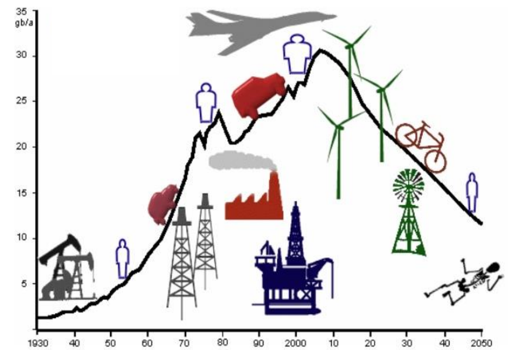
2 Global Challenges

CO_2 emissions



Courtesy of Dieter Lüthi

End of cheap oil



3 Local Challenges

Pollution

Congestion

Parking

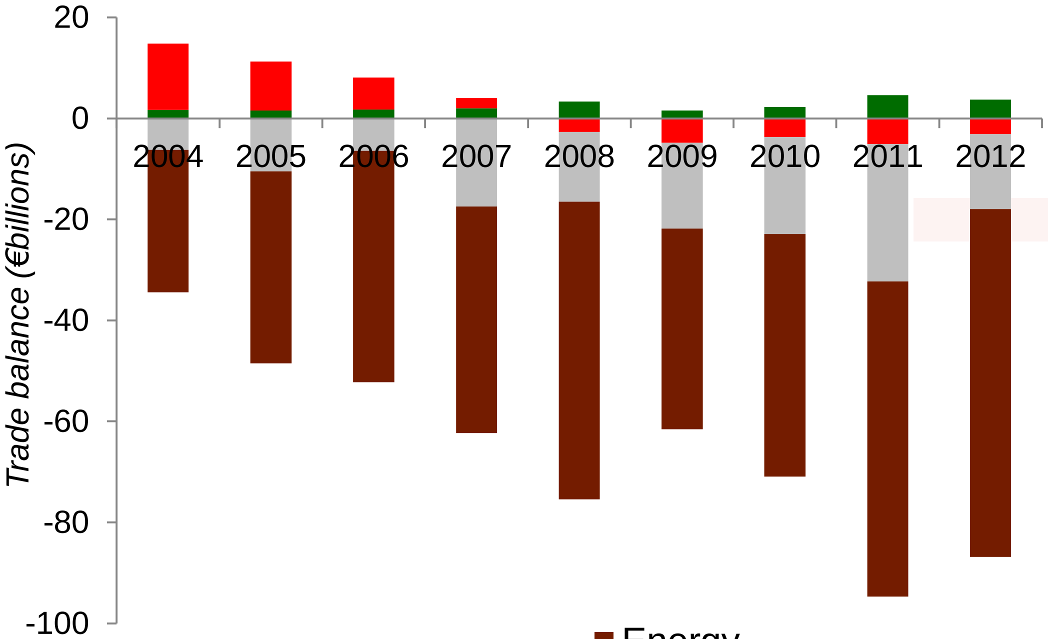
2 Economic Challenges – rising unemployment & trade deficit

"In France, we don't have any oil but we have ideas!"

85% of the €65 bn trade deficit increase from 2004 to 2012 is due to rising oil & gas prices (hence imports) as well as the decline of the French automotive industry

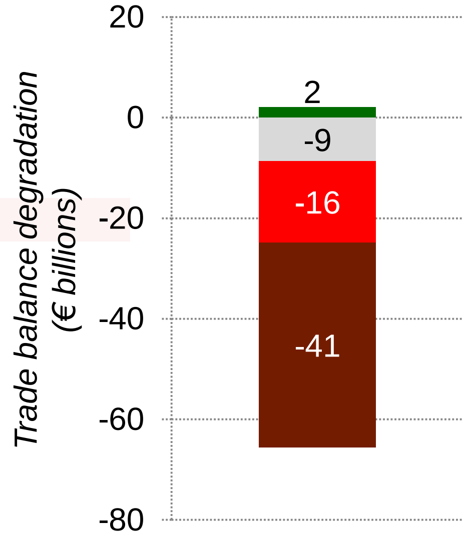
Trade *balance by sector from* 2004 to 2012

- € billions-



Trade balance *degradation by sector from* 2004 to 2012

- € billions-



- Energy
- Manufacturing industry (excluding energy & automotive)
- Automotive Industry
- Agriculture

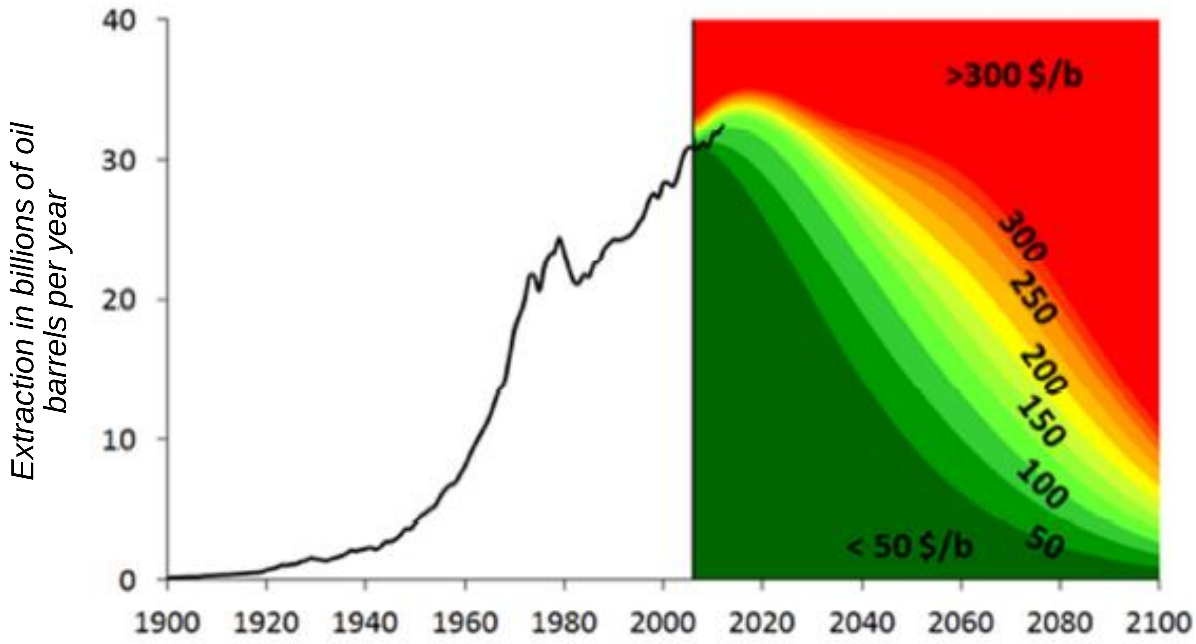
Source : http://lekiosque.finances.gouv.fr

Is "bike for all" as soon as 2030?

If we don't significantly reduce our car energy consumption, it might actually happen earlier than that!

Liquid fuels extraction

-1900 to 2100 -



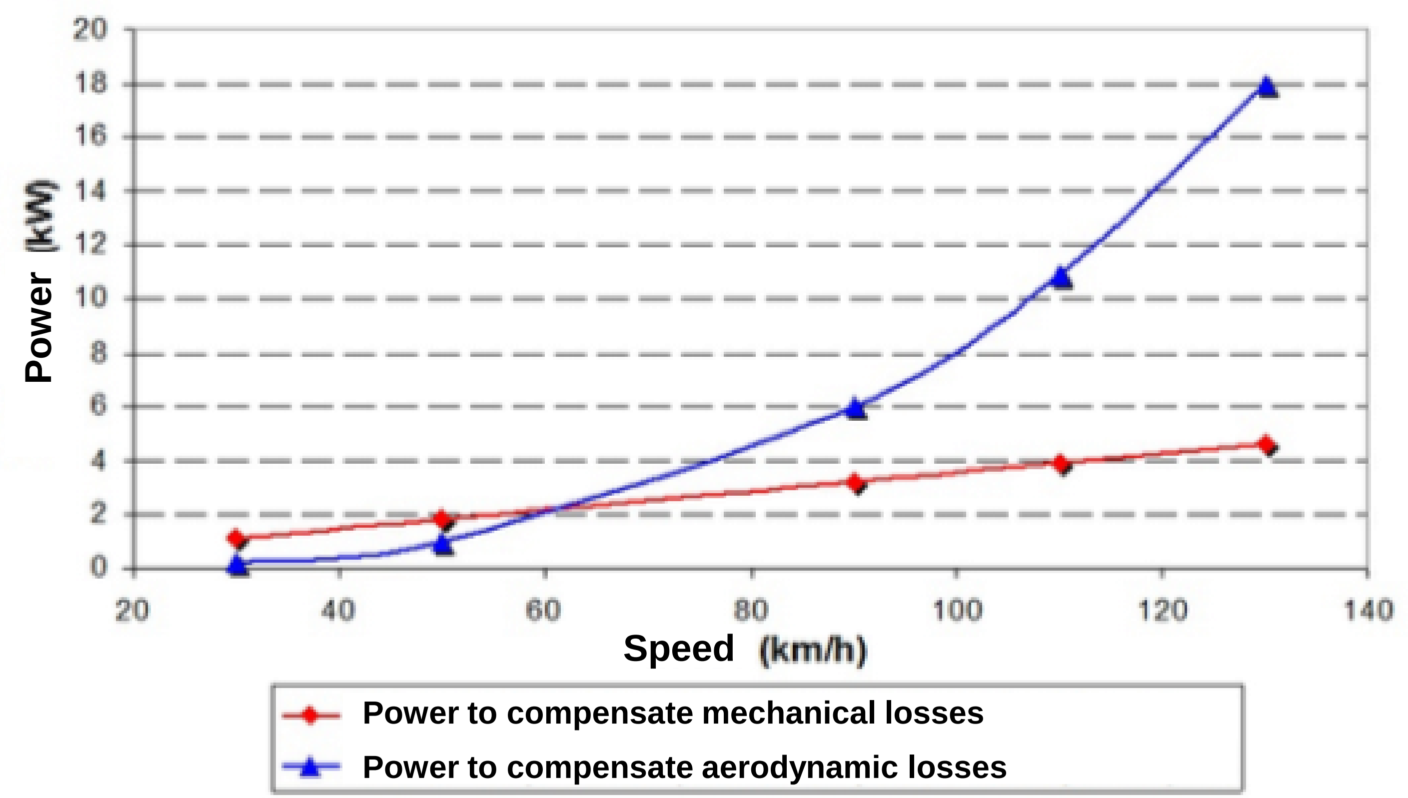
- Future belongs to fuel efficient vehicles as well as low-cost cars (such as Logan)
- In Japan, 40% of passenger cars sold in 2012- 2 millions in total - were kei-cars – small cars with length limited to 3,5 m and engine power limited to 660 cc

Reducing energy consumption is even better!

What consumes energy when we drive?

At lower speeds– in cities– mechanical losses, which are correlated to vehicle weight, have the biggest impact on the energy consumption of vehicles

Power required to compensate mechanic & aerodynamic friction forces



Accelerations, which is increasing the speed of a given mass, is what requires the most energy when driving in a urban environment

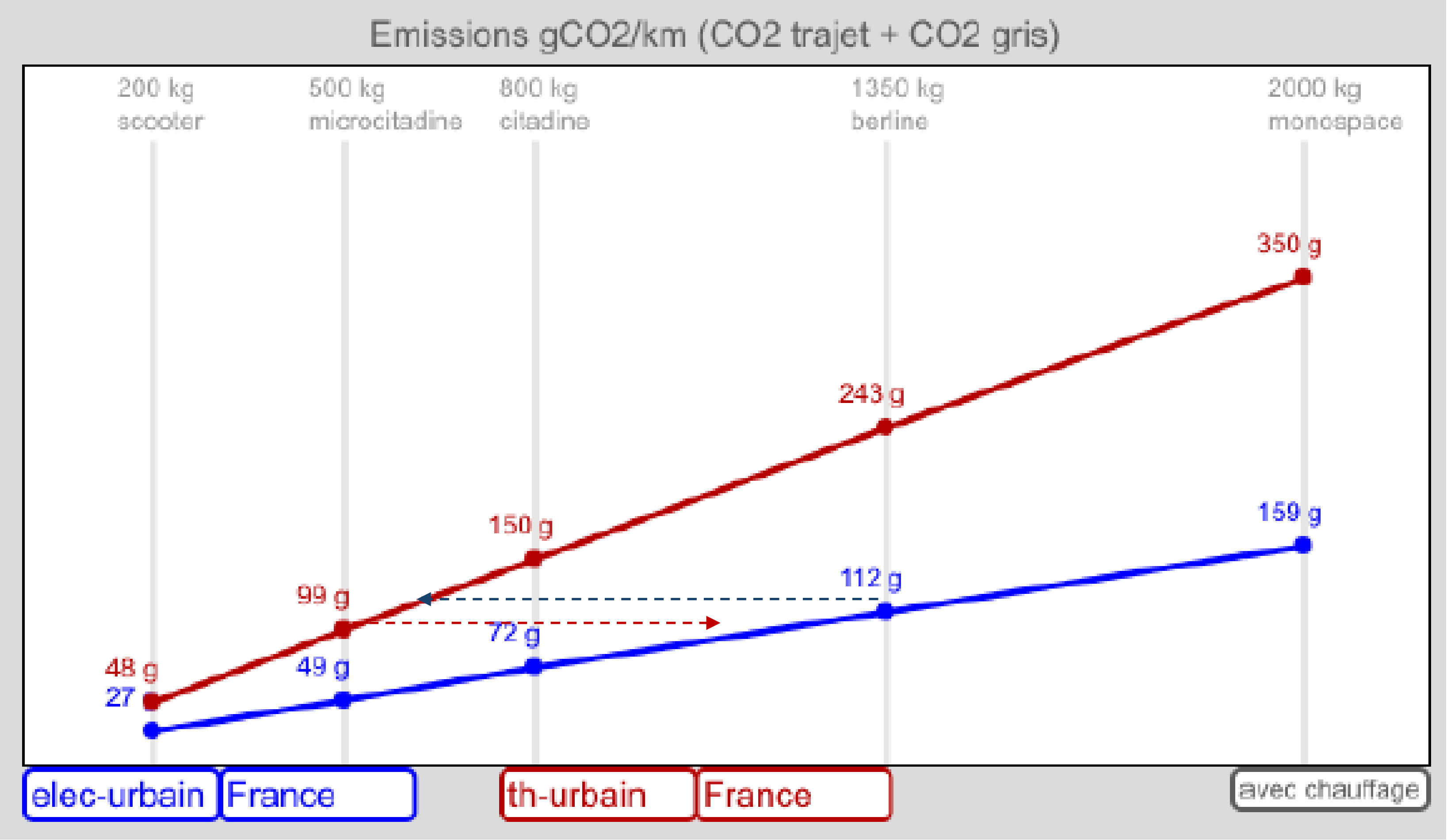
Source : Gregory Launay - www.gnesg.com

Is there anything we could do if we really care about CO2?

Reducing car size (and weight) could be an idea....

Total CO2 emissions

- ICE vs. Electric car in France -

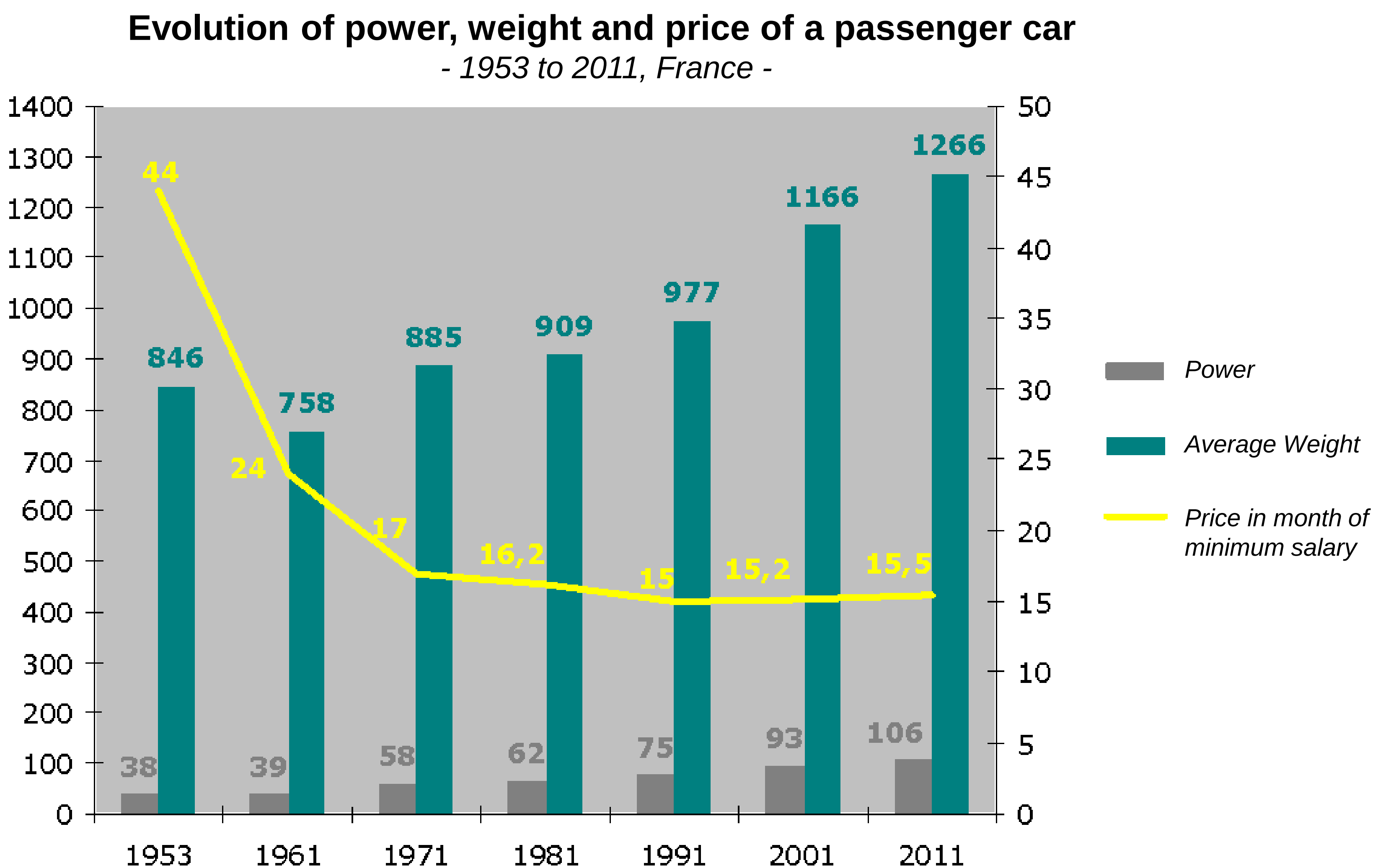


Source: CEA http://www.theshiftproject.org/sites/default/files/files/conf_tsp_ve_david_cea_0.pdf

Weight and engine power of the average French car in the last 50 years

→10 kg increase per year, 500 kg in 50 years!

→Engine power multiplied by more than 2,5

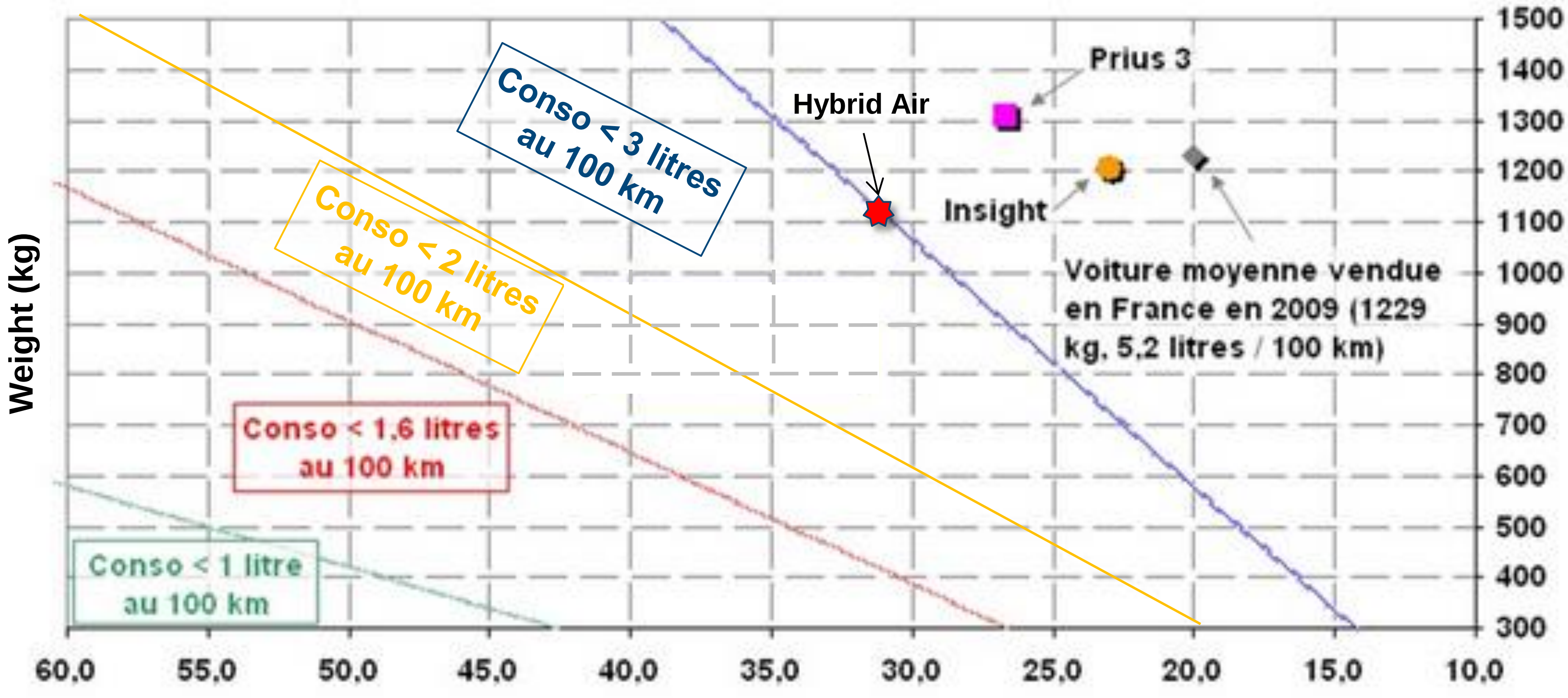


Source : L'Argus

1 L /100km – Impossible?

Fuel consumption of a 600 kg electric car with a small range extender is as low as 1 L/100 km

Fuel consumption of a car vs. weight and energy efficiency



Tank to wheel energy efficiency (%)

Source : Gregory Launay - www.gnesg.com

Low-tech or high-tech approach for 1L/100 km fuel consumption?

Vesta 2 and Eolab - 2 different ways to reach 1L/100 km fuel consumption

➔ 500 kg & a Cx < 0.2 or 1000 kg for a range-extended electric vehicle

Renault Eolab - 2014

Renault Vesta 2 - 1987

Technical specification	Vesta 2	Eolab
Weight	473 kg	955 kg
C_x	0,19	0,23
Fuel consumption	1.94 L/100 km	1 L/100 km
Top speed	138 km/h	200 km/h
Thermal engine	3 cylindres - 716 cc 20 kW	3 cylindres - 999cc 57 kW
Electric motor		40 kW @ 160Nm
Battery capacity	-	6.7 kWh
Electric range	-	60 km

The Mathis Andreau 333 (1946) is a very good example of a light energy efficient car that we should follow!

3 wheels, 3 persons, 385 kg, 3 meter 40, 3.5 Litres / 100 km, developed 2 x 33ans ago

MATHIS ANDREAU 333 (1946)

Description

Dimensions	3,400 m x 1,740 m x 1,425 m (L x l x h) Voie 1,5 m ; Empattement 2,3 m
Sièges	3
GMP	Bicylindre 4 temps 700 cm^3 Refroidi par liquide
Puissance	15 cv à 3000 t/min
Boite de vitesse	4 vitesses

Performances

Masse à vide [kg]	385 kg			
Charge utile [kg]	260 kg			
Cx_p [-]	0,22			
Sf [m²]	1,887 m²			
$S_f.Cx_p$ [m²]	0,41 m²			
Vitesse max	105 km/h			
Consommation	3,5 Litres/100 km			
Vitesse moyenne [km/h]	40	50	60	70
Litres aux 100 km	1,95	2,08	2,3	2,45
Autonomie	Environ 500 km (réservoir de 18 litres)			

Une photo particulièrement rare : La Mathis-Andreau 333 à la pompe !

Jean ANDREAU (l'homme au béret) devant son oeuvre : la Mathis-Andreau 333

Source : Matthieu BARREAU & Laurent BOUTIN , Réflexions sur l'énergétique des véhicules routiers

How the car of the future looks like in an energy constrained world?
→ 4 seats, a weight of 600 kg & an hybrid powertrain

Specification of the car of the future

- 4 seats vehicle
- Weight of 600 kg (150 kg / person)
- Hybrid powertrain

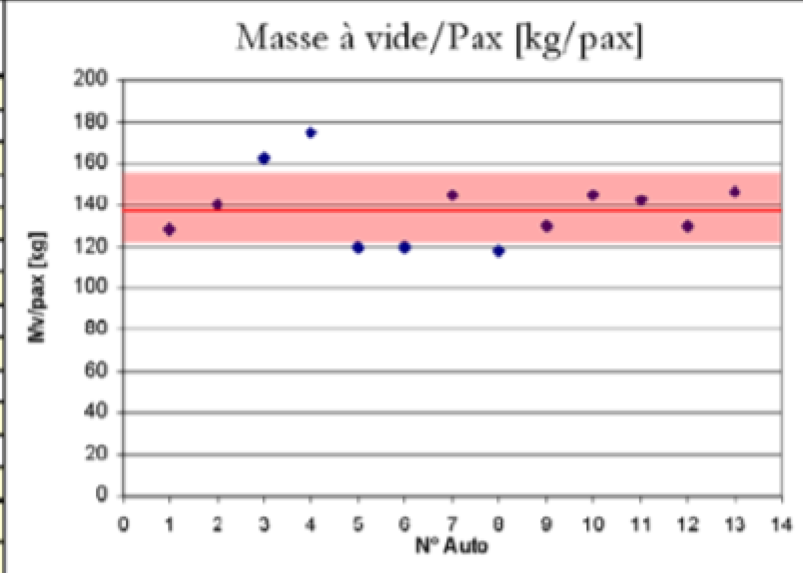
➔*Fuel consumption of 1,5 L/100 km at 90 km/h*

➔*Fuel consumption <1 L/100 km at 50 km/h in urban environment*

Some examples to follow

Masses à vide / Pax

N°	Date	Nom	masse à vide Mv [kg]	Charge utile Mu [kg]	Nb Pax	Masse à vide / Pax Mv/pax [kg/pax]
1	1946	Mathis Andreau 333	385	260	3	128,3
2	1946	Aérocarène	280	200	2	140
3	1948	Panhard Dynavia	650	400	4	162,5
4	1953	ISO-BMW ISETTA	350	230	2	175
5	1953	Messerschmitt KR 200	240	200	2	120
6	1984	Citroën ECO 2000	480	400	4	120
7	1986	Citroën AX diesel	725	430	5	145
8	1987	Renault VESTA II	473	400	4	118,25
9	1996	TWINGO SMILE	650	400	5	130
10	2002	VW VORTEX Concept 1L	290	200	2	145
11	2005	DAIHATSU UFE II	570	400	4	142,5
12	2005	LOREMO	520	400	4	130
13	2005	DAIHATSU UFE III	440	300	3	146,67
		Moyenne	465,6 kg			138,7 kg/Pax
		Ecart type	154,4 kg			16,9 kg/Pax



Source : Matthieu BARREAU & Laurent BOUTIN , Réflexions sur l'énergétique des véhicules routiers

Smaller cars are much better than 2.2t tanks such as Tesla S

...and it is even better if you share the ride – carpooling - and if you share your car with your neighbour (peer-to-peer) car sharing)

4 ways to address congestion & parking issues

More Roads

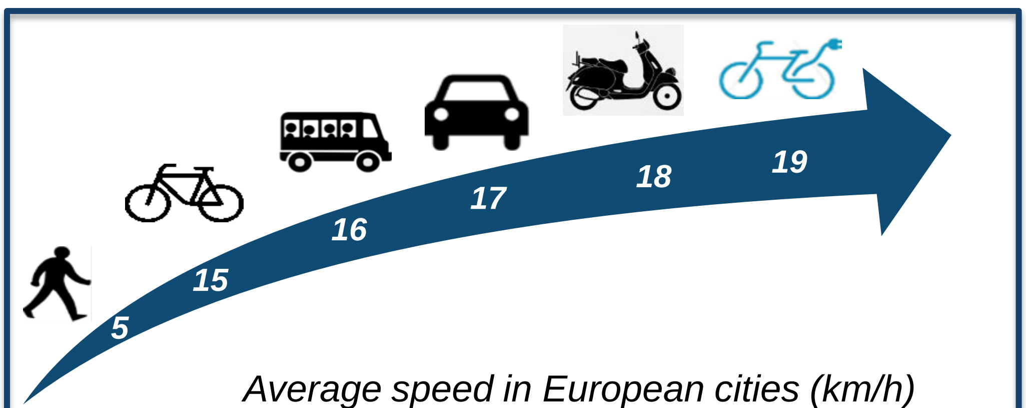
Smaller Vehicles

More People per Car

Less Cars

What is the most efficient transport mode in a city?

Whether it is on the energy side or the physical footprint, the most efficient transport mode in a city where space is limited are bus, scooters & bikes



Car
1,4 t 10 m² 1,3 person
➔ >1000 kg & 7.7 m² per person

Quadricycle
500 kg 3 m² 1 person
➔ 500 kg & 3 m² per person

Bus
12 t 42 m² 30 persons
➔430 kg & 1.4 m² per person

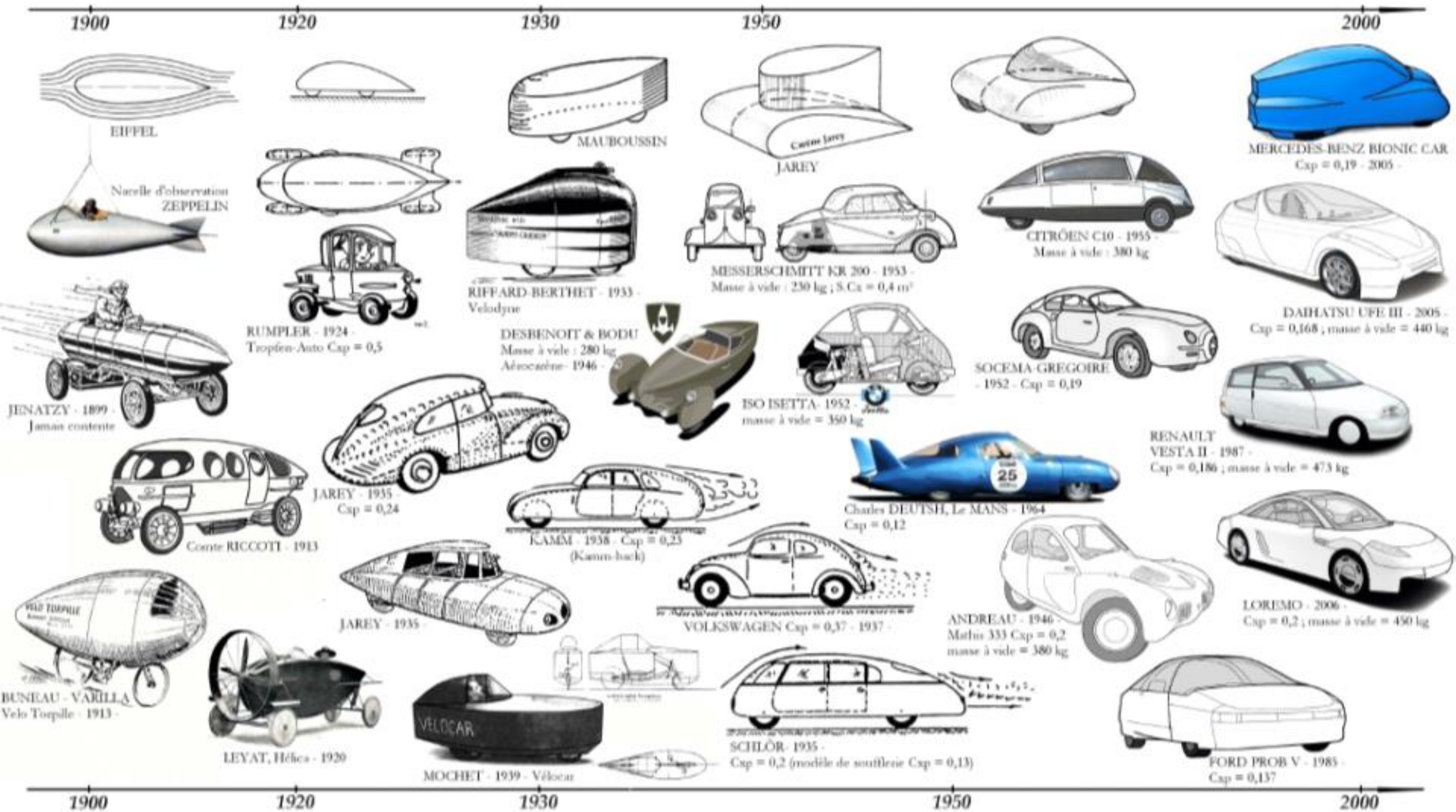
Scooter
125 kg 2 m² 1 person
➔ 125 kg & 2 m² per person

Electric bike
20 kg 1 m² 1 person
➔ 20 kg & 1 m² per person

Bike
10 kg 1 m² 1 person
➔ 10 kg & 1 m² per person

Source: Frost & Sullivan, PREDIT, 6t - Bureau de Recherche.

Small is Beautiful & Light is Right!



Source : Matthieu BARREAU & Laurent BOUTIN , Réflexions sur l'énergétique des véhicules routiers

FROST & SULLIVAN

Nicolas Meilhan
Principal Consultant
Energy & Transportation Practices

(+33) 1 42 81 23 24

nicolas .meilhan@frost.com

my LinkedIn profile

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