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16^ Conferenza Logistica

Zero emissioni, Zero carta e Zero incidenti:
le sfide della logistica chimica europea

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Come la tecnologia può aiutarci a raggiungere il traguardo
How technology can help to pursue the goal

Obiettivo #Zero_Emission

Milano, 2 luglio 2019
Auditorium Federchimica
Via Giovanni da Procida 11

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Oltre un secolo fa…

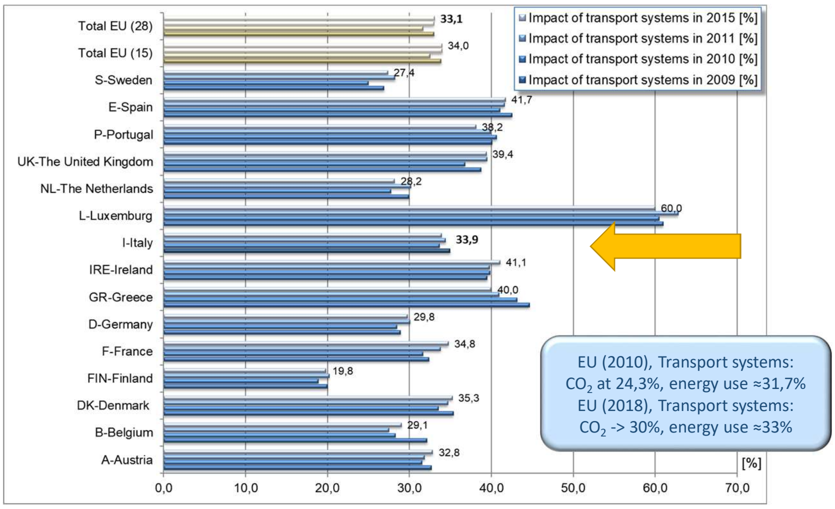
More than one century ago…

How much the transport systems impact the use of energy?

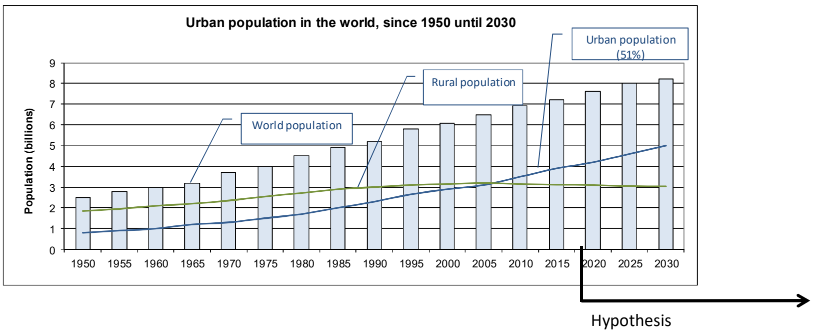
- The transport field, whose role in the modern, post-industrial economies has nowadays become essential, is the only sector to be almost exclusively based upon **a sole primary source**, i.e. **oil**:
  - indicatively, 96% in **Europe** in 2011, approx. **94%** in 2016/17;
  - 93-94% in **North America** (2011) then **92%** (2016 and 2017).
- The other sectors, on the other hand, are based upon a mixed heterogeneity of energies

- Transport accounted for half of global oil consumption until a few years ago; in 2017: ~55-60%.
- The impact in **Europe** (EU-25 then 27) of the transport systems in the overall use of the energy consumed (33% in 2011 and 2016/17 in toe) is > by nearly 10% versus the world average (20.42% in 2003, +1-4% in the following 10 years), on the grounds of the greater motorised average mobility versus other continents (individual, not motorised, mobility).

[Source: EIA – Energy Information Administration, International Energy Outlook, June 2006; UP 2014 and 2017, Data book]



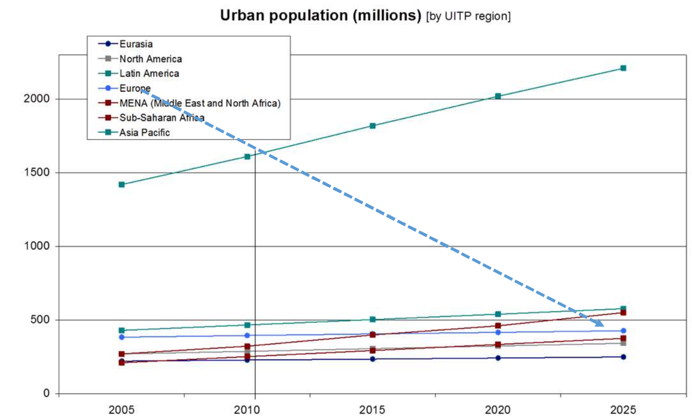
Sources: Eurostat and Databook, "Energia e Petrolio in Italia" 2012, 2013, 2014, 2015, 2017 by "Unione Petrolifera" - European Commission, Mobility and transport, " Pocketbook 2013 "



The **urban population** of the **EU-27** amounted to
73% of the total population in 2008

Population of Europe was approx. 743 10^6 on Feb. 2019; Europe population is equivalent to 9.8% of the world population; **74.5 % of the population is urban** (553,6 million people in **2019**)

[Source: EU energy and transport in figures, Statistical Pocketbook 2010, p. 18; Worldometer 2019]



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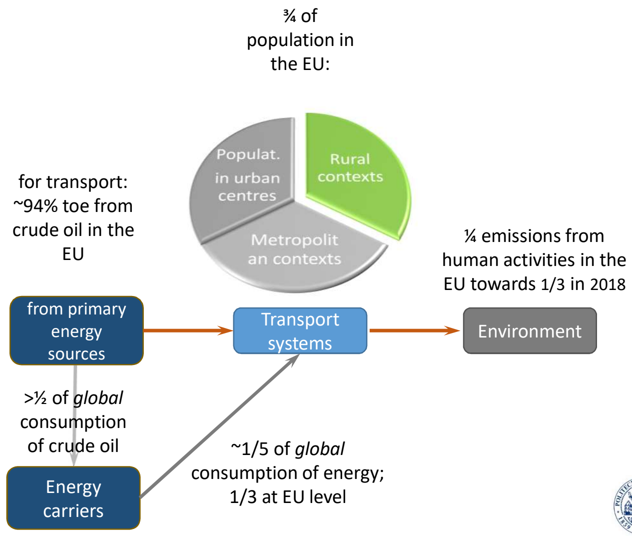

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The transport field is mainly characterised by the use of vehicles with **distributed energy use**, with the exception – in general terms – of the transport systems operating on **fixed installations (rail, rope, metros, APM)**




Almost all these transport systems are based upon **oil derived fuel**, and the alternatives are featured by significant limits; the transport systems operating on fixed installations do not strictly depend on it (electrical lines supplied by power stations) and, according to a belief widespread in the literature, allow better use of energy.

EU-25						
Transport modes	1990	2004	2010	1990-2004 Variation (%)	2004-2010 Variation (%)	Share of the overall energy consumption, 2010 (%)
Road	227'957	290'013	299'700	27%	3.3%	**82.6%**
Railway	9'125	9'250	7'400	1%	-20%	**2%**
Air	28'378	47'420	49'800	67%	5%	**13.7%**
Inland navigation	6'578	5'047	5'900	-23%	+17%	**1.7%**

~85%, I

~1.6-3%, I

*EU-25, **consumption of transport modalities** in*

- *1990,*
- *2004*
- ***2010**, in ktoe*

(EC, 2007 and EU Transport – Statistical Pocketbook 2012*).*

These numbers are not so recent but have been conservative in the last 10-15 years.

Consumption by transport modality in 1990, 2004 and 2010, in 1000 *toe, tonne(s) of oil equivalent*

[Source : Campbell, 2007 ; EU Transport – Statistical Pocketbook 2012]

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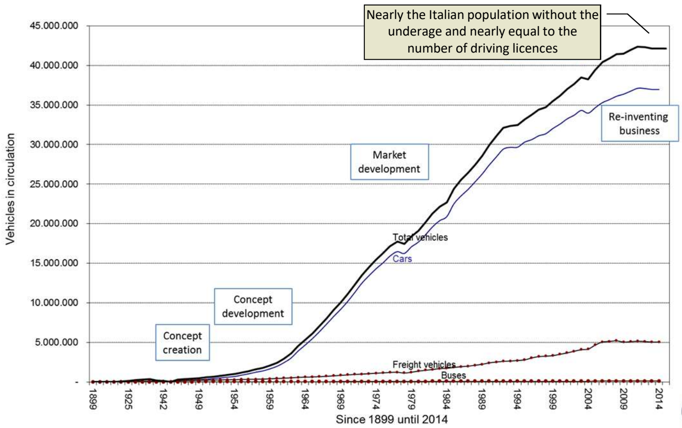
Evolution of the light and heavy-duty vehicles in Italy



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How much the use of energy impacts the different transport modes?

- Road transport
- Rail transport and other transport installations
- (Air transport)
- (Maritime transport and by inland waterways)

Cost structures are becoming increasingly similar throughout the **road haulage sector**. The relative importance of the two main cost drivers (labour and fuel costs) has now reached comparable levels throughout the EU. […] The variations of costs related to fuel range from 24% to 38% of total costs.

[Report from the Commission to the European Parliament and the Council on the State of the Union Road Transport Market, Brussels, 14.4.2014, COM(2014) 222 final]

Impact on the running cost of energy consumption in railways

- **~ 4-5%, indicatively, for the Italian railways, on the overall running cost, according to some recent data [current unofficial data]**
- ~ 11% for ATM in Milan, taken as an example, as energy cost on the 2009 budget, approximately 50% (**5.3%**) for rail systems and subway in the specific case [official data, 2009];
- **~6%** as energy impact on the budget in case of the traction for the VAL automated metro in Turin, plus an equivalent value for other electric power supply means [indicative data, 2009].
- ~ 3.7% for Ferrovie Nord, energy for traction

EU WHITE PAPER

Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system

Brussels, 28.3.2011 - COM(2011) 144 final

*"17. The challenge is to **break the transport system's dependence on oil without sacrificing its efficiency and compromising mobility**."*

European Regional Development Fund

Transport and emissions: general situation EU in various fields (not only transport systems)

CO_2

-40% of the 1990 levels by 2030

Renewables

27% by 2030 (2014)

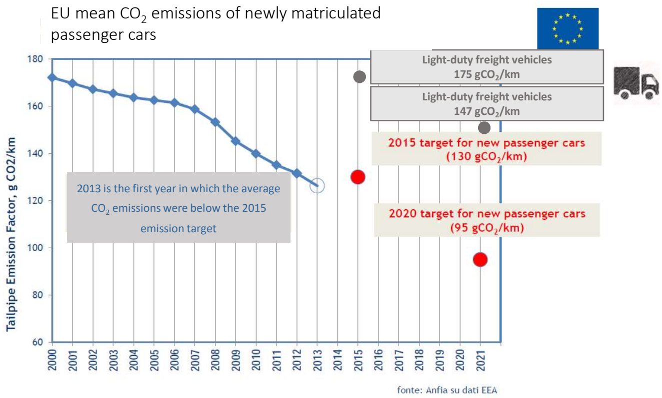
32% (2019)

Energy efficiency

27% by 2030 (2014)

32.5% (2019)

EU, 24.10.2014: constraining values at European level, indicative at national level; substitute previous target 20-20-20



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The Commission was already completing in June 2018 its agenda for a low-emission mobility system by putting forward **the first ever CO_2 emissions standards for heavy-duty vehicles**, approved in 2019.

In 2025, average CO_2 emissions from new trucks will have to be 15% lower than in 2019. For 2030, an indicative reduction target of at least 30% compared to 2019 has been introduced.

These targets are consistent with the EU's commitments under the Paris Agreement and will allow transport companies – mostly SMEs – to make significant savings thanks to lower fuel consumption.
To allow for further CO_2 reductions, the Commission is making it easier to design **more aerodynamic trucks** and is improving **labelling for tyres**. In addition, the Commission is putting forward a comprehensive **action plan for batteries** that will help create a competitive and sustainable battery "ecosystem" in Europe.

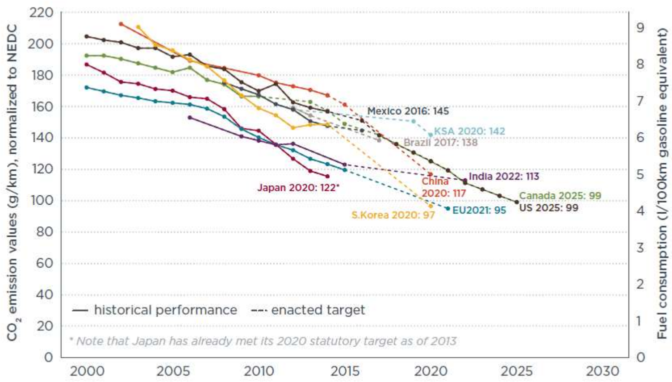
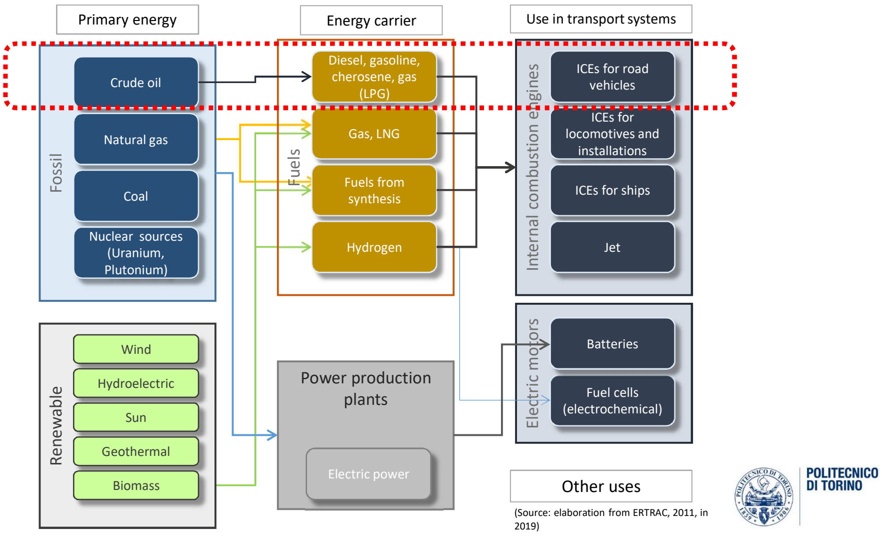


Figure 3. Comparison of global CO_2 regulations for new passenger cars.[8]

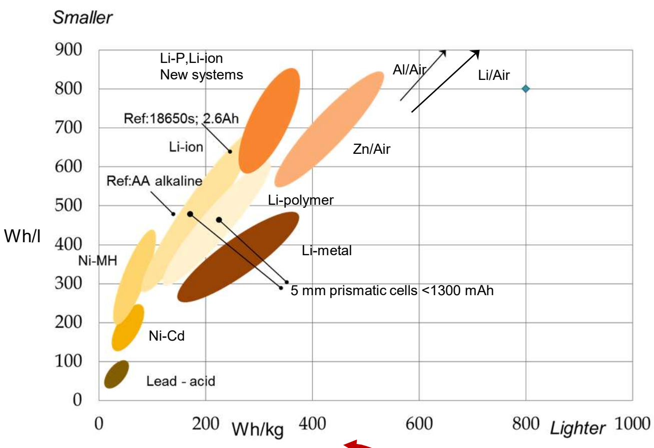
icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

JULY 2017

Pollutant	*Concentration*	*Averaging period*	*Legal nature*	*Permitted exceedences each year*
Fine particles (PM2.5)	25 µg/m³	1 year	Target value entered into force 1.1.2010 Limit value entered into force 1.1.2015	n/a
Sulphur dioxide (SO_2)	350 µg/m³	1 hour	Limit value entered into force 1.1.2005	24
	125 µg/ m³	24 hours	Limit value entered into force 1.1.2005	3
Nitrogen dioxide (NO_2)	200 µg/ m³	1 hour	Limit value entered into force 1.1.2010	18
	40 µg/ m³	1 year	Limit value entered into force 1.1.2010*	n/a
PM10	50 µg/m³	24 hours	Limit value entered into force 1.1.2005**	35
	40 µg/m³	1 year	Limit value entered into force 1.1.2005**	n/a
Lead (Pb)	0.5 µg/m³	1 year	Limit value entered into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; a 1.0 µg/m³ limit value applied from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m³	Max. daily 8 h mean	Limit value entered into force 1.1.2005	n/a
Benzene	5 µg/m³	1 year	Limit value entered into force 1.1.2010**	n/a
Ozone	120 µg/m³	Max. daily 8 hour mean	Target value entered into force 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m³	1 year	Target value entered into force 31.12.2012	n/a
Cadmium (Cd)	5 ng/m³	1 year	Target value entered into force 31.12.2012	n/a
Nickel (Ni)	20 ng/m³	1 year	Target value entered into force 31.12.2012	n/a
Polycyclic Aromatic Hydrocarbons	1 ng/m³ (expressed as concentr. of Benzo(a)pyrene)	1 year	Target value entered into force 31.12.2012	n/a



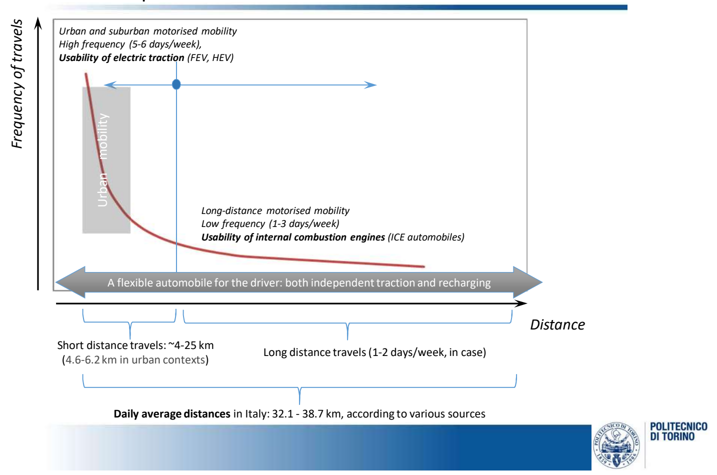
(Source: elaboration from ERTRAC, 2011, in 2019)

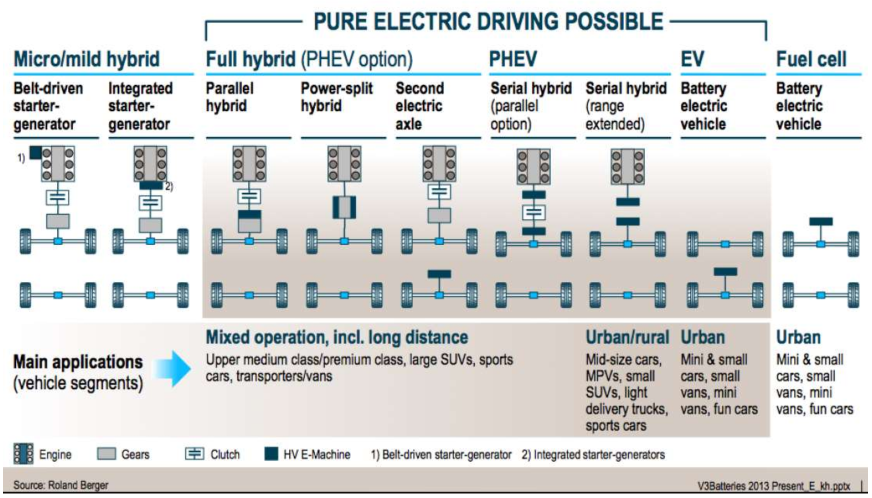


Fonte: elaborazione su dati ABB, 2009 ed anni seguenti

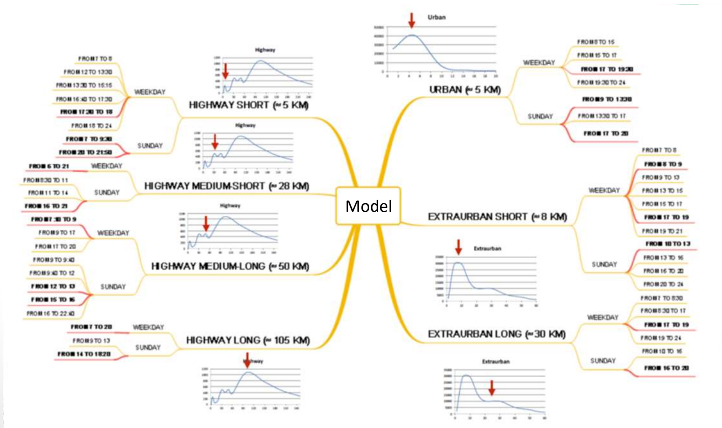
Crude oil : specific energy around 42 mega Joule/kg (11,67 kWh/kg)

Features of shipments



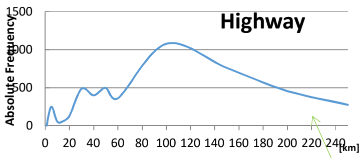


Data analysis: dendrogram scheme



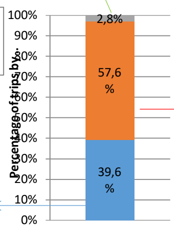
Journey length frequency [FCA]

https://www.sciencedirect.com/science/article/pii/S0967070X17305243

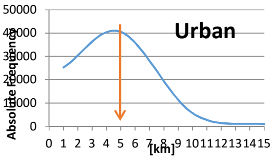


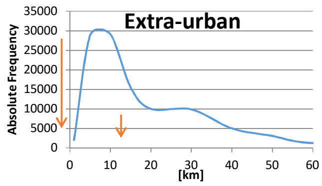
The 10% of the trips made along highways is shorter than 20 km, the 35% between 20 and 60 km; trips over 100 km are more than 55%.

The 35% of urban trips done by users in Europe cover a distance <5 km, the 90% is shorter than 10 km.



The 90% of the trips done by users in extra urban context is shorter than 30 km long, with trips around 10 and 30 km.





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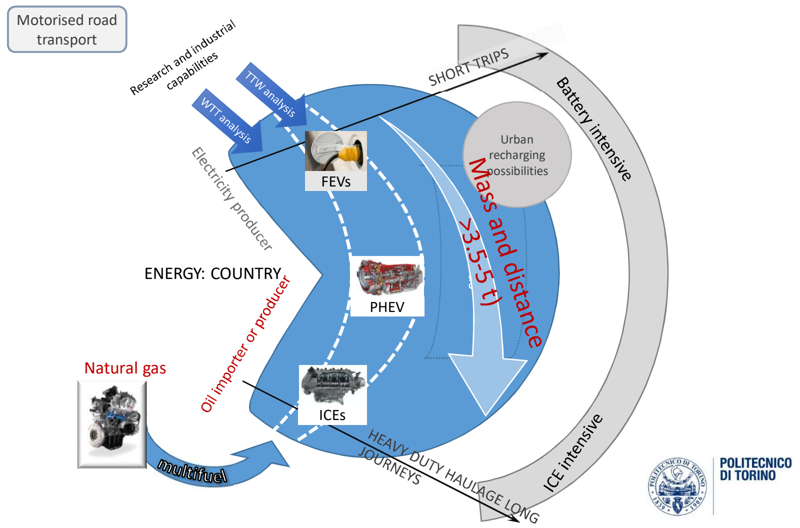
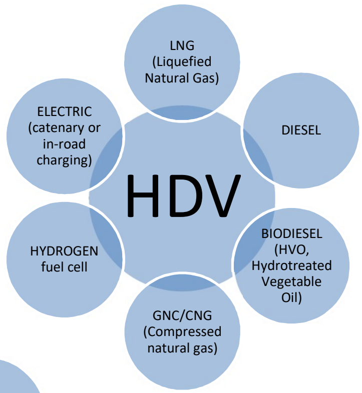
The Well to Tank (WTT) evaluation accounts for the *energy expended and the associated GHG emitted in the steps required to deliver the finished fuel into the on-board tank of a vehicle*. It also considers the potential availability of the fuels, through their individual pathways and associated costs.

The Tank to Wheels (TTW) evaluation accounts for the *energy expended and the associated GHG emitted by the vehicle/fuel combinations*. It also includes an assessment of the expected relative retail prices of the various vehicle configurations.

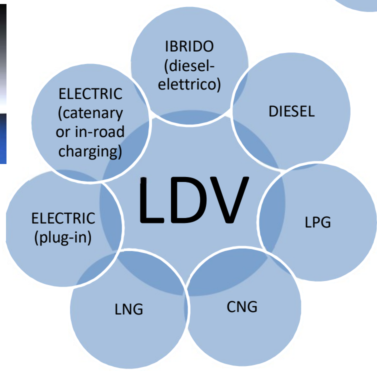
We refer to the Well to Wheels (WTW) integration, giving a global assessment of the energy required and the GHG emitted per km driven on the fuel/vehicle combinations considered.

$$WTW\left[\frac{MJ_t}{km}\right] = WTT\left[\frac{MJ_t}{MJ_f}\right] \cdot TTW\left[\frac{MJ_f}{km}\right]$$

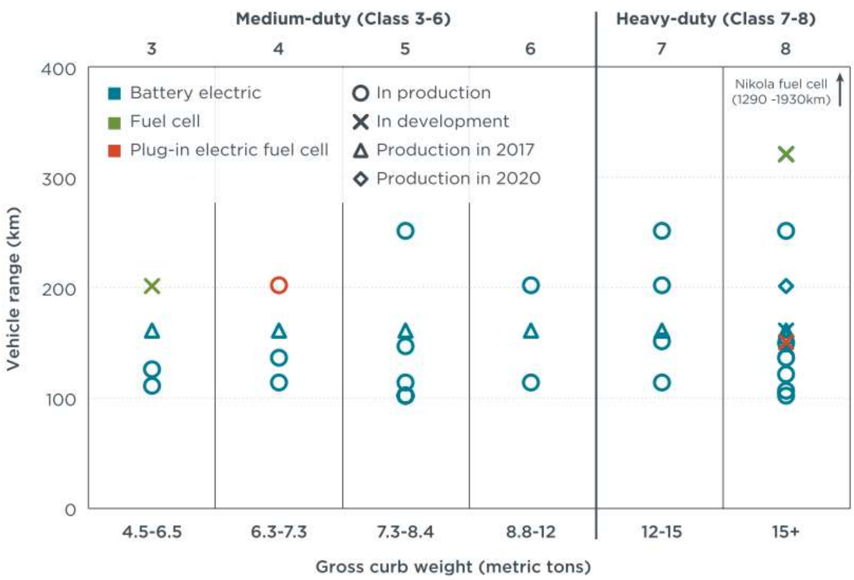




GWG: 5,6 t, 70- 200 km according to then number of batteries (1, 2 o 3) [Iveco].



Hybrid powertrain [Scania] 9,0 liters Euro 6; biodiesel; few km of autonomy in pure electric.



Moultak, M., Lutsey, N., & Hall, D. (2017). *Transitioning to zero-emission heavy-duty freight vehicles. The International Council on Clean Transportation.* (www.theicct.org)

The case of Norway

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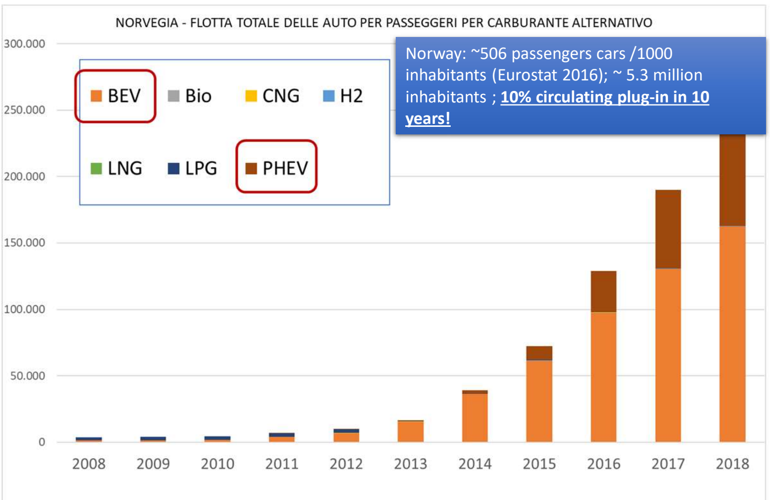
The “**zero emissions incentives”** have included:

a) No **purchase/import taxes** (1990-)
b) Exemption from 25% **VAT** on purchase (2001-)
c) No annual **road tax** (1996-)
d) No charges on **toll roads or ferries** (1997- 2017).
e) Charges were introduced on ferries with upper limit of maximum 50% of full price (2018-)
f) Charges on toll roads were introduced with upper limit of maximum 50% of full price (2019)
g) Free **municipal parking** (1999- 2017)
h) Parking fee for EVs was introduced locally with an upper limit of maximum 50% of full price (2018-)
i) Access to bus lanes (2005-).
j) New rules allow local authorities to limit the access to only include EVs that carry one or more passengers (2016)
k) 50 % reduced company car tax (2000-2018).
l) Company car tax reduction was lowered to 40% (2018-)
m) Exemption from 25% VAT on leasing (2015)
n) Fiscal compensation for scrapping of fossil vans when converting to a zero emission van (2018)
o) Allowing holders of driver license class B to drive electric vans class C1 (light lorries) up to 2450 kg (2019)

The current Government has decided to **keep the incentives for zero emission cars until the end of 2021**. The VAT exemption for zero emission cars in Norway has been approved by EFTA Surveillance Authority (ESA) until the end of 2020. After 2021 the incentives will be revised and adjusted parallel with the market development.

European Regional Development Fund



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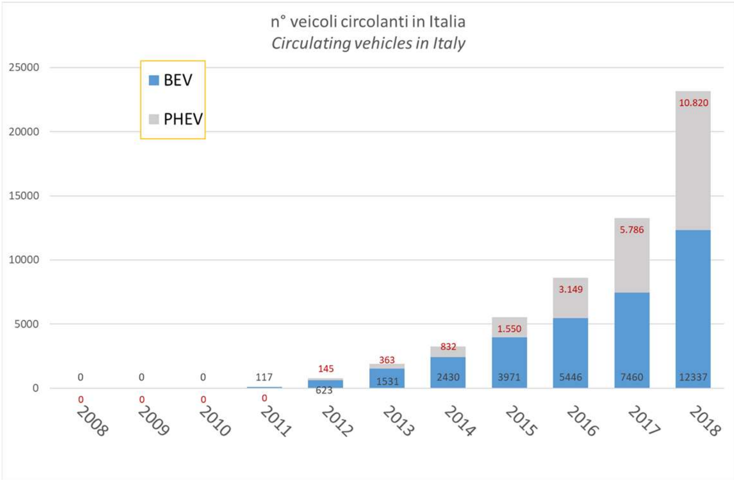
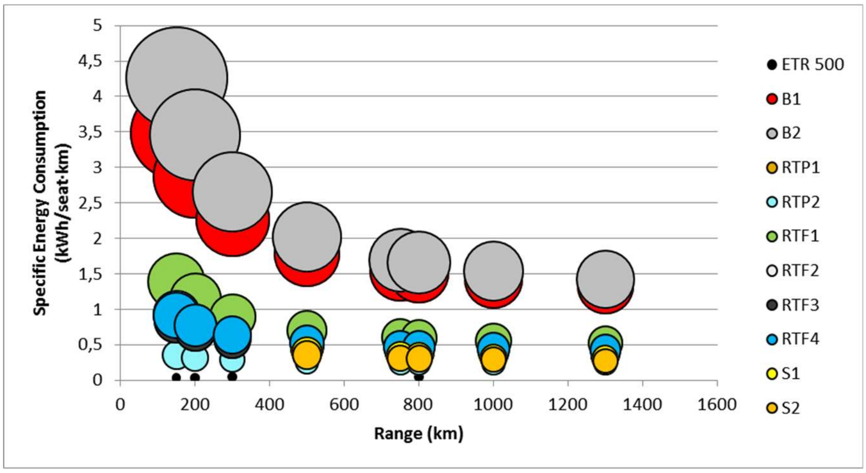


Source: EAFO, 2019

Years	Net substitution rate *(ricambio auto al netto delle vendite)*
1994	
1995	3,72%
1996	5,17%
1997	6,98%
1998	5,68%
1999	5,31%
2000	5,87%
2001	5,41%
2002	5,48%
2003	4,88%
2004	7,58%
2005	4,54%
2006	4,89%
2007	5,98%
2008	4,87%
2009	5,24%
2010	4,35%
2011	3,78%
2012	3,87%
2013	3,83%
2014	3,36%
2015	3,52%
2016	3,48%
2017	3,50%

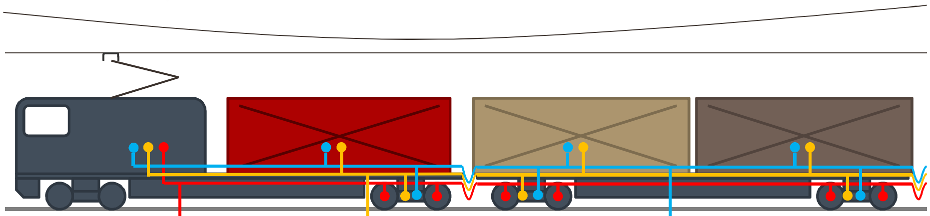
The average value of the net **substitution rate** in the last ten years is **3,98%,** which brings to nearly **80% in 20 years**.



Specific energy consumption HSR (**High speed Rail**) vs **air transport** for different route lengths

Dalla Chiara B., De Franco D., Coviello N., Pastrone D., Comparative specific energy consumption between air transport and high-speed rail transport: A practical assessment, Transportation Research Part D: Transport and Environment, Volume 52, Part A, May 2017, Pages 227-243

Distributed-power freight trains – "freight EMUs"



Power link

Distributed traction power:
- More power with the same axle load
- Better traction control
- Longer and heavier trains (35 wagons – 750 m, even on steep lines)

Control link

Active control of the whole train:
- Active traction control
- Braking control and modulation
- Control and power supply of secondary devices and plants besides cargo (refrigeration)

Supervision link

Supervision of the whole train:
- Supervision of the wagons sub-systems
- Supervision of the traction and braking sub-systems
- Wheelset supervision

- Higher speed with the same load
- Possibility to be used on HS/HC lines besides traditional railways (long trains)
- Better energy performances (better running profiles)
- Supervision of the electrical, mechanical and pneumatic sub-systems (improved maintenance)
- Cargo supervision
- Cargo refrigeration

Consumption, CO_2 e CO_2/km ↓

S : < km (with ICE)

Or the paying load is increased

T : < use in time

η :

ICE/*EME more efficient*
Filters to reduce emissions
→ < resistances

- *Aerodynamics*
- *Speed and v/t**
- r_0
- *Mass/dimens.*

Driving behaviour, «driving cycle»

**: decided by the user*

Conclusions

A. **"Zero emissions": feasible? No, globally; "yes" locally; pursuable through modal shift for local emissions**
B. **Green powertrains, energy carriers**
C. **Green, connected HDV, with assisted guidance, then possibly autonomous (now platooning, lev. 3)**
D. **In urban context**
E. **On long distances (White paper, 2011)**
F. **Influence area of rail transport; new generation of freight trains?**

Energy efficiency, more independence from crude oil, ITS

- Contacts

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Dalla Chiara B., Pellicelli M., Sustainable road transport from the energy and modern society points of view: Perspectives for the automotive industry and production, Journal of Cleaner Production, http://dx.doi.org/10.1016/j.jclepro.2016.06.015, 2016

Dalla Chiara B., Pede G, (a cura di) Valentini M.P., Coviello N., Deflorio F., **Trasporti terrestri ed energia** - Tecnologie, metodi ed applicazioni, Autori Coviello N., Dalla Chiara B., Deflorio F.P., Pede G., Valentini M.P.286 pp, EGAF, ISBN 978-88-8482-776-0

Dalla Chiara B., Deflorio F., Eid M., Analysis of real driving data to explore travelling needs in relation to hybrid–electric vehicle solutions, Transport Policy, Available online 26 April 2018, ISSN 0967-070X, https://doi.org/10.1016/j.tranpol.2018.04.009

Gerboni R., Grosso D., Carpignano A., Dalla Chiara B. (2017), Linking energy and transport models to support policy making, Energy Policy, Volume 111, December 2017, Pages 336–345, https://doi.org/10.1016/j.enpol.2017.09.045

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