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UNI in STRADA

QUADRO ATTUALE E PROSPETTIVE PER LA TRANSIZIONE ENERGETICA

Venerdì 31 marzo 2023 - ore 16.45 – 18.45

Napoli > Mostra d'Oltremare > Padiglione 6 > Sala Vesuvio

MOBILITÀ SOSTENIBILE: SCENARI E OPZIONI A CONFRONTO

Gianfranco RIZZO

eProInn, Spin-off dell'Università di Salerno

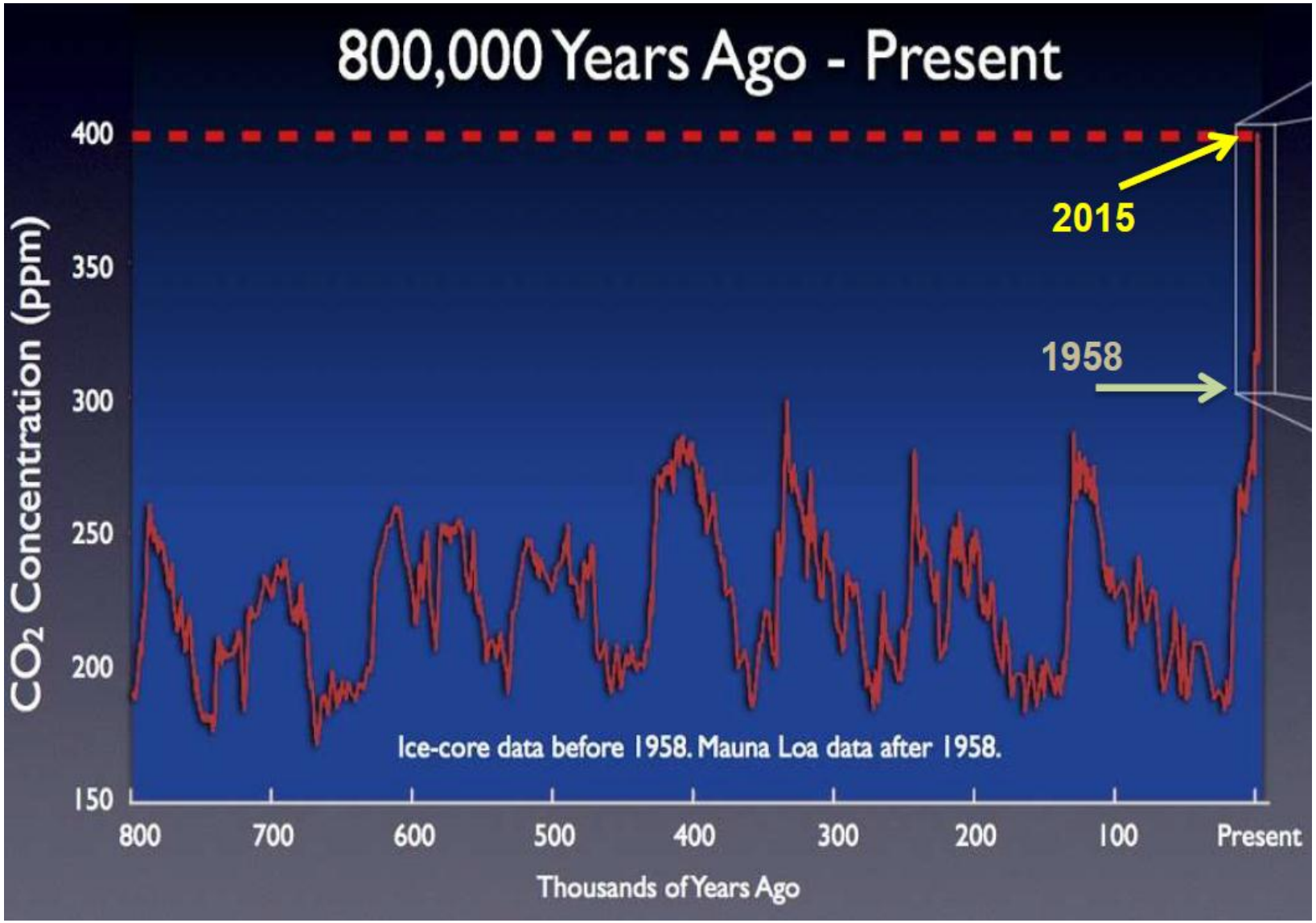
CO2 and global warming

Pro's and Con's

In last **800.000 years** CO_2 has oscillated between 180 and 280 ppm.

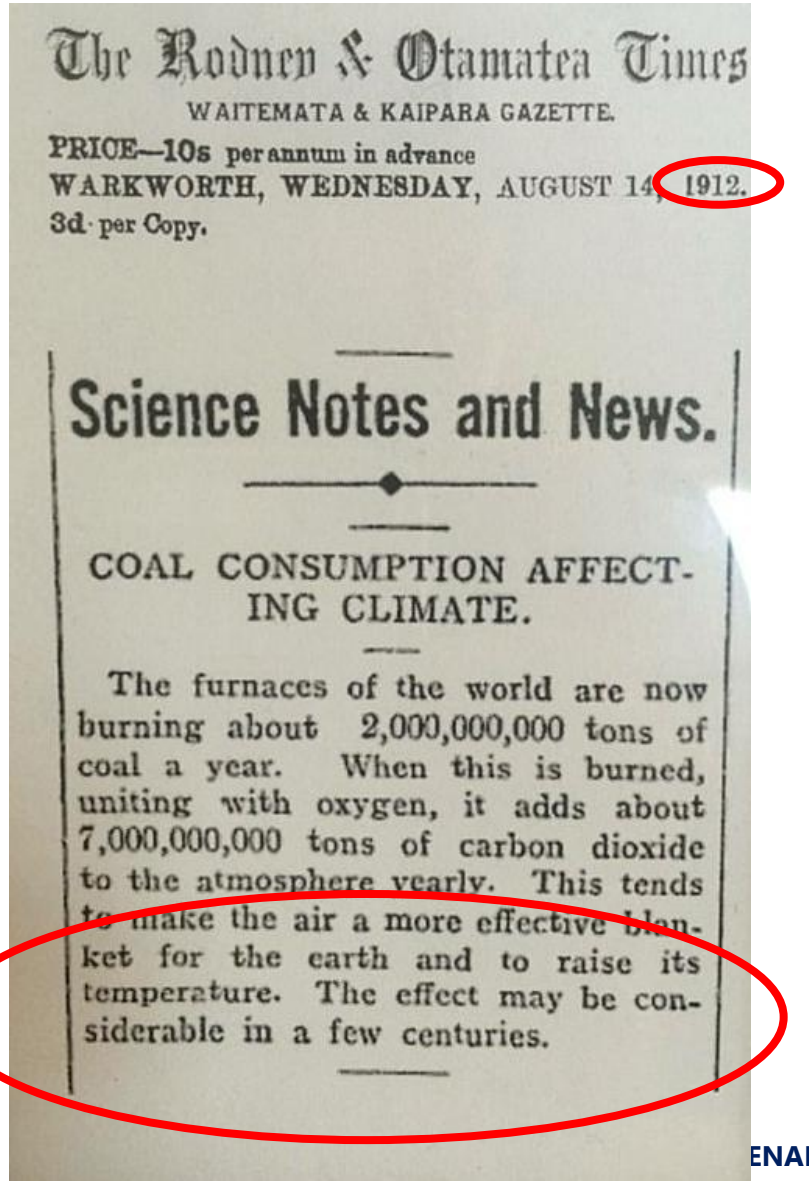
In a **few decades** it has reached 403 ppm and is **still increasing**.

Last time that CO_2 was attaining such levels the **human life was not yet started**.



Nothing new!

A New-Zelander magazine alerted about **global warming** due to CO2 more than a **century ago**!



The Rodney & Otamatea Times

WAITEMATA & KAIPARA GAZETTE.

PRICE—10s per annum in advance
WARKWORTH, WEDNESDAY, AUGUST 14, 1912.
3d per Copy.

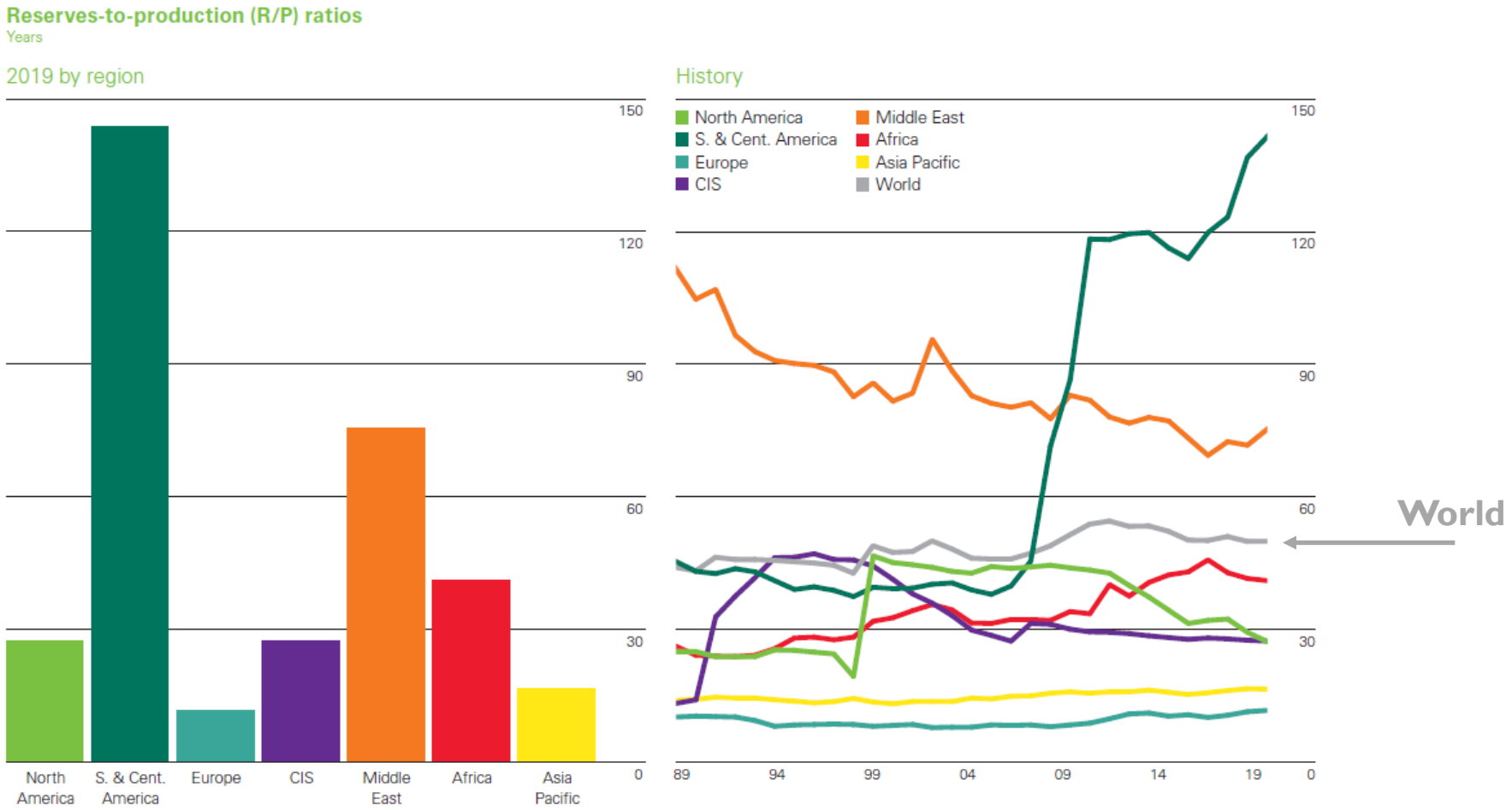
Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

Fossil fuels: a limited resource

Fossil fuel reserves are expected to be **exhausted** in the next future (50 years for oil and gas, 120 years for coal).



BP Statistical Review of World Energy 2020

https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf

Everybody's Health

HARVARD UNIVERSITY

COVID-19 PM2.5

A national study on long-term exposure to air pollution and COVID-19 mortality in the United States

SIMA

CORRIERE DELLA SERA

Coronavirus e polveri sottili, la conferma: il particolato atmosferico trasporta il virus

Urban pollution aggravates virus infection

WORLD ECONOMIC FORUM

The deadly link between COVID-19 and air pollution

Pittsburgh Post-Gazette

Study finds link between air pollution and COVID-19 fatalities

ANSA it

Coronavirus: accertata presenza nel particolato atmosferico

The way we will move around

COVID-19: UIA ANNOUNCES FURTHER FORCED FLIGHT CANCELLATIONS

The New York Times

Worried About Coronavirus on the Subway? Here's What We Know

Increasing use of private cars for personal transportation

BBC Sign in

NEWS

News Sport Reel Worklife Travel Future

Home UK World Business Politics Tech Science Health Family & Education

Health

Coronavirus: What's the risk on public transport?

Global

Ipsos

Impact of Coronavirus to new car purchase in China

Transport is a major issue for EU

63%

Oil consumption

29%

CO2 emissions

6.3%

Union's GDP

13M

People employed

Transport

12%

CO2 emissions

2007: 159 g/km
2021: 95 g/km

CO2 targets

Passenger Cars

Hybrid and Electric Cars

Pro's and Con's

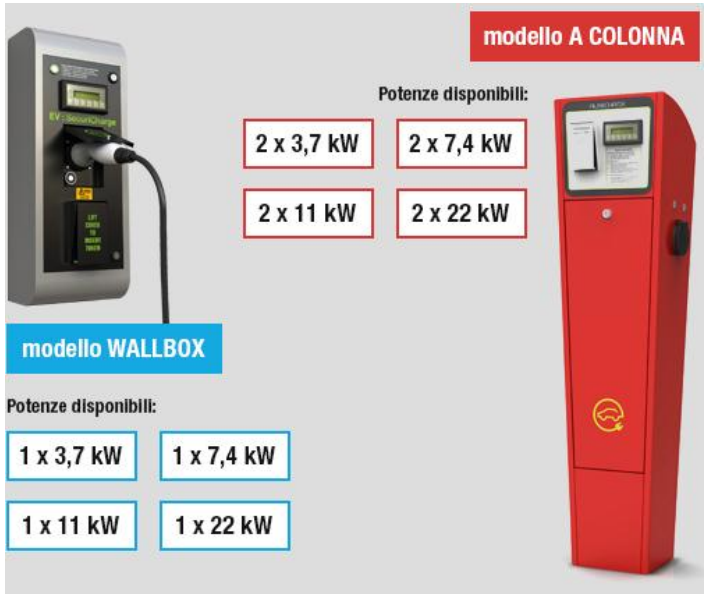
Electric Vehicles

- **Battery Electric Vehicle (BEV)**
  - Pollution free
  - Low noise
  - Large amount of carbon free electricity needed
  - Hydrogen supply and storage
  - Limited range
  - Cost and life of batteries
  - No free heat energy on board
  - Recharging issues
- **Fuel Cell Electric Vehicle (FCEV)**

Hybrid Vehicles

- **Parallel HEV**
- **Combined HEV**
- **Series HEV**
- **Through-The-Road (TTR) Parallel HEV**
- **Plug-In HEV (PHEV)**
  - Lower emissions compared to ICEVs
  - Extended range
  - Carbon free electricity needed for PHEVs
  - Cost and life of batteries
  - Recharging issues PHEVs
  - No zero emissions

Recharge: ICE vs EV



MJ/kg	42
€	50
Minutes	2
€/liter	1,50
Density kg/dm3	0,75
Liters	33,33
l/s	0,28
kg/s	0,21
MW	**8,75**

Power (energy per unit time) in input during «recharge»:

3.7-22 kW

Fast DC recharge:

about 100 kW

Mass car electrification is the future
<u>but it is not</u> behind the corner

2035: what will happen?

REUTERS® World Business Legal Markets Breakingviews Technology Investi

Climate Change | Sustainable & EV Supply Chain | Sustainable Markets

3 minute read · March 21, 2023 3:50 PM GMT+1 · Last Updated 2 days ago

Exclusive: EU drafts plan to allow e-fuel combustion engine cars

By Markus Wacket

EXPRESS

2035 petrol and diesel car ban may be delayed with 'e-fuel' loophole

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Report

REPORT

EU could allow e-fuel combustion-engine cars after 2035

A vehicle category in Europe would be created for cars that can only run on carbon-neutral fuels

Automotive News Europe

Automotive News

HOME FEATURES OPINION PHOTOS PODCASTS CAR CUTAWAYS EVENTS MORE

Home › Environment/Emissions

March 23, 2023 05:02 AM | UPDATED 3 HOURS AGO

EU hopes to avoid summit showdown on combustion-engine phaseout

The EU's plan to end sales of new CO2-emitting cars in 2035 has been halted by Germany's demands on e-fuels.

euronews.green NEWS CLIMATE NATURE LIVING ECO-INNOVATION OPINION SERIES

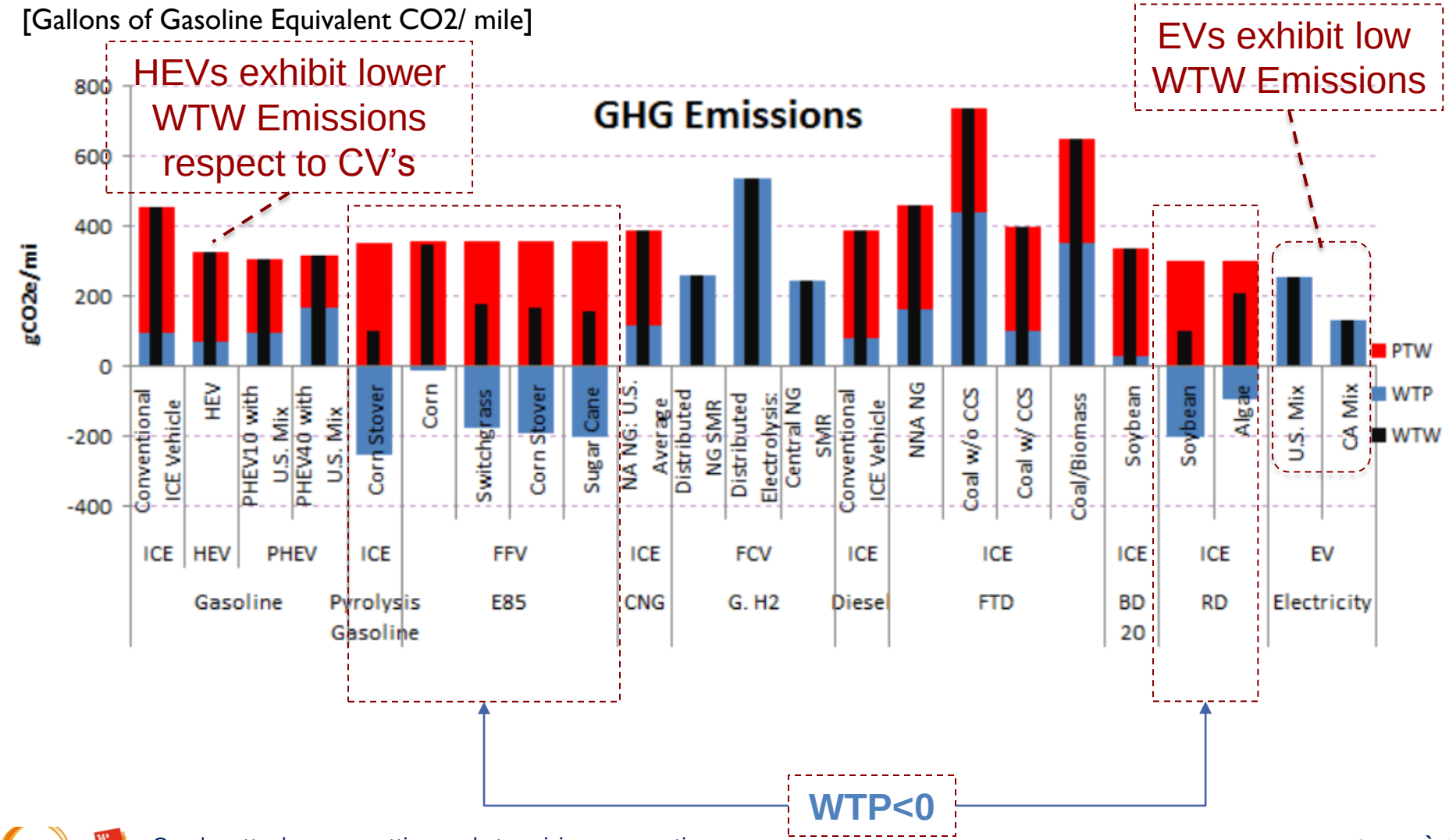
GREEN NEWS

Could e-fuel cars stop the argument over the EU's 2035 petrol and diesel engine ban?

Green House Gas Emissions

eFuels and Bio-Fuels

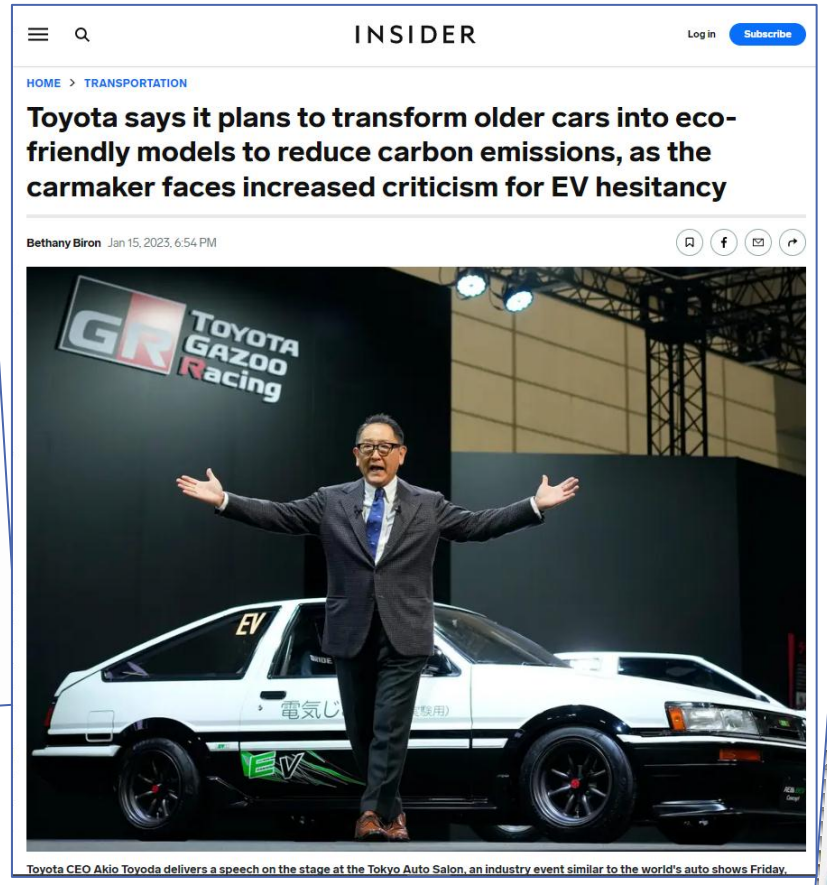
[Gallons of Gasoline Equivalent CO2/ mile]



Green House Gas Emissions
PTW Pump to Wheel
WTP Well to Pump
WTW Well-to-Wheel

Source: GREET 2012
http://greet.es.anl.gov/

What about converting old cars?



https://timesofindia.indiatimes.com/auto/news/toyota-looking-to-retrofit-older-cars-with-electric-motors-and-fuel-cells-to-promote-ev-adoption/articleshow/97032897.cms

Massive disposal: a sustainability perspective?

Vehicle conversion

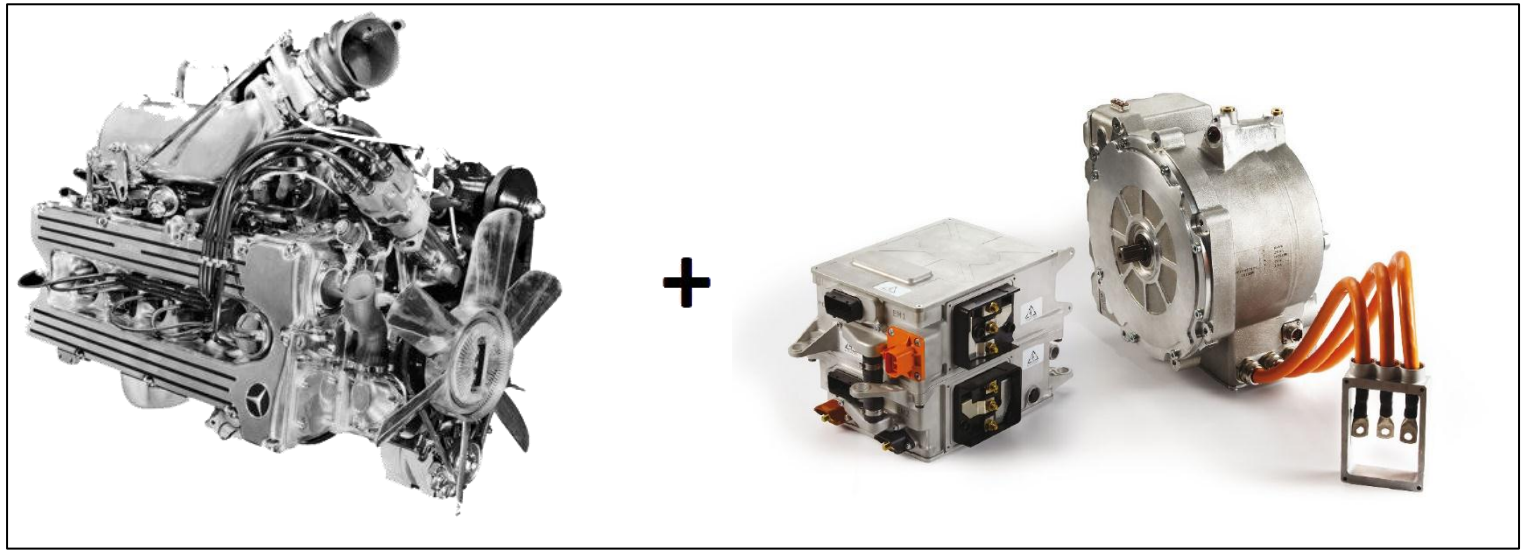
A possible solution is the **conversion** of existing vehicles

- **Electrification** consists in removing the internal combustion engine and install an **electric powertrain**.
- Specific regulations have been introduced by **Italy** and **France**.

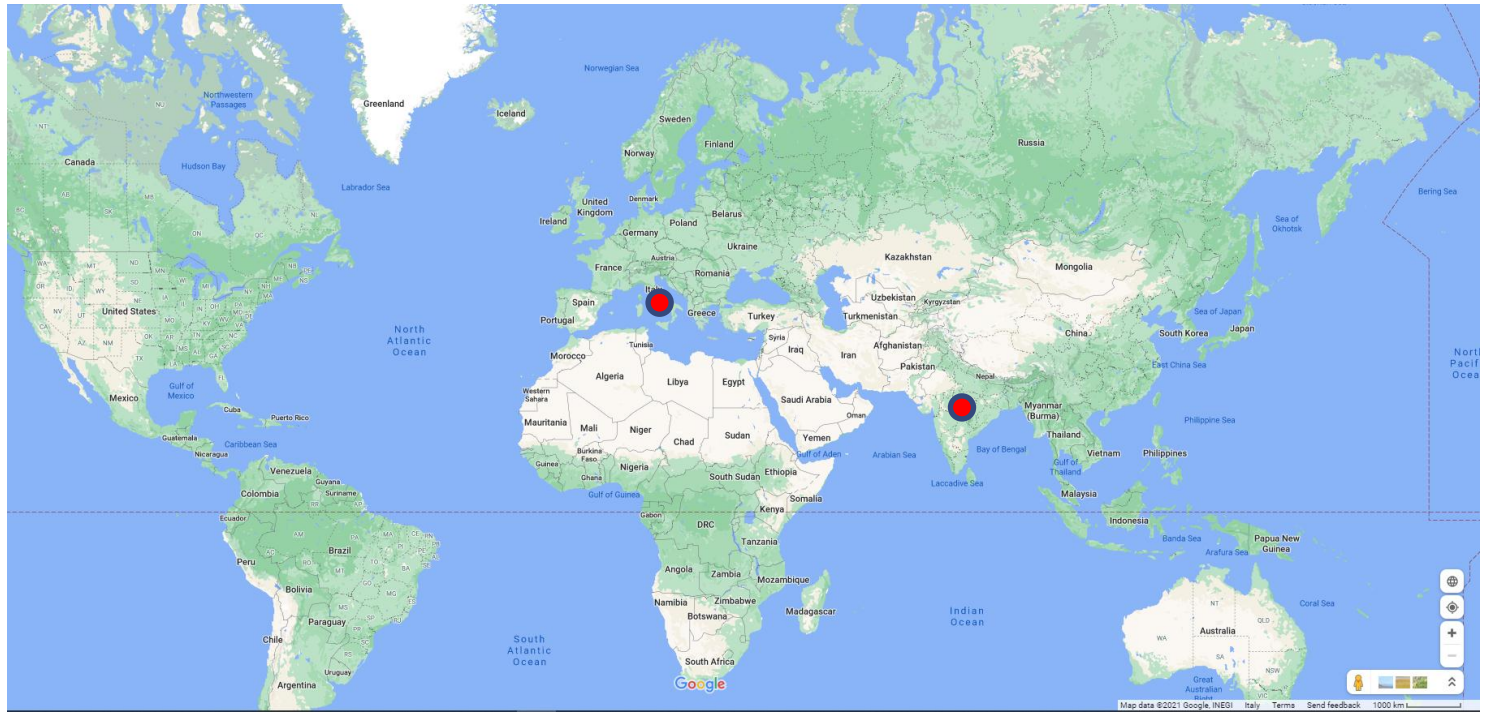
Vehicle conversion

A possible solution is the **conversion** of existing vehicles

- **Electrification** consists in removing the internal combustion engine and install an **electric powertrain**.
- Specific regulations have been introduced by **Italy** and **France**.
- **Hybridization** consists in adding an **electric powertrain to a conventional vehicle**



Vehicle Hybridization



India was the first world Country to introduce specific regulation for hybridization.

Italy recently introduced a law allowing the conversion of vehicles into hybrid ones.
First Country in Europe!

Convert a car into hybrid: now is possible.

Supplemento ordinario alla "Gazzetta Ufficiale" n. 228 del 14 settembre 2020 - Serie generale

Spediz. abb. post. - art. 1, comma 1 Legge 27-02-2004, n. 46 - Filiale di Roma

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13-bis. *All'articolo 17-terdecies, comma 1, del decreto-legge 22 giugno 2012, n. 83, convertito, con modificazioni, dalla legge 7 agosto. 2012, n. 134, dopo le parole: «ad esclusiva trazione elettrica,» sono inserite le seguenti: «ovvero a trazione ibrida con l'installazione di motori elettrici,».*

Converting a car into a hybrid solar vehicle

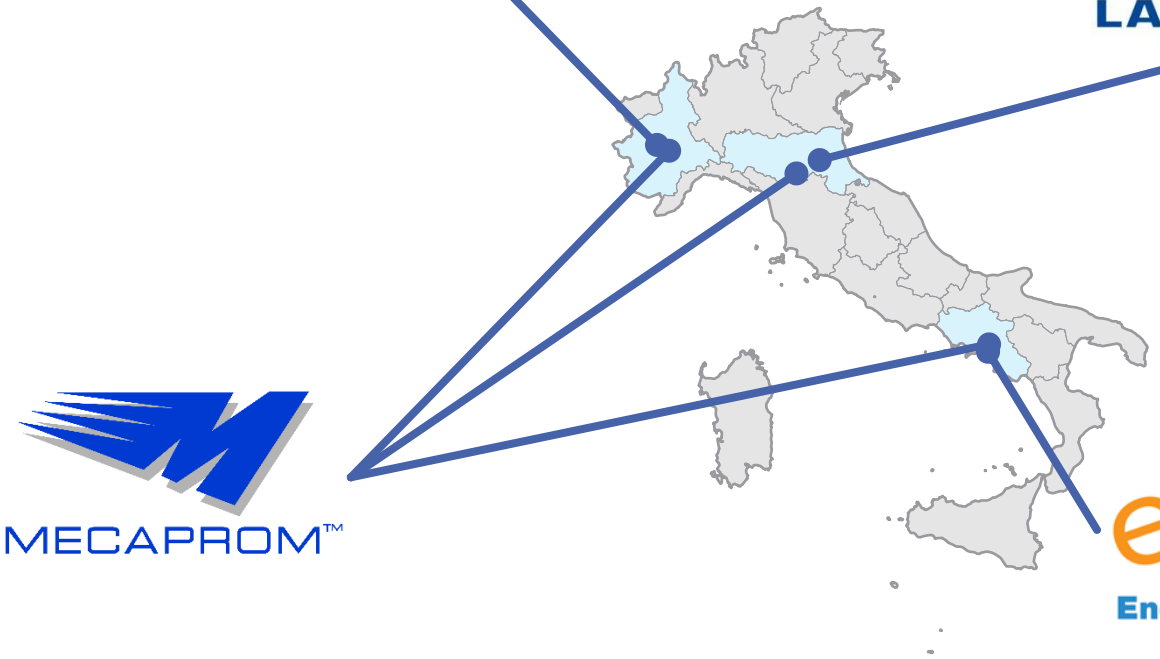
LIFE-SAVE Projects and Partners

Solar Aided Vehicle Electrification

SOLBIAN

Life

LANDIRENZO



MECAPROM™

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Energy and Propulsion Innovation

MECAPROM™

ePro-Inn
Energy and Propulsion Innovation

Sun Motive

LANDIRENZO

SOLBIAN

The 3 R's of Sustainability

The proposal of solar hybridization complies with all the major criteria of sustainability

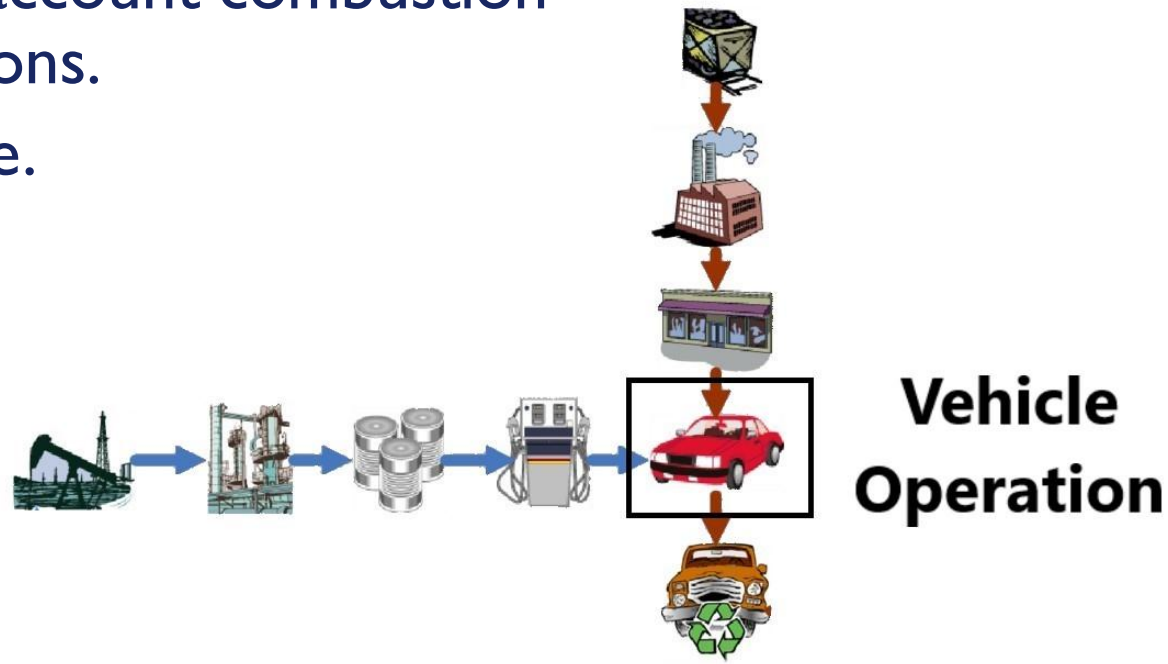
Reducing fossil fuel consumption and emissions

Reusing existing cars, avoiding fleet scrapping

Recycling kit components and reusing them on a new car

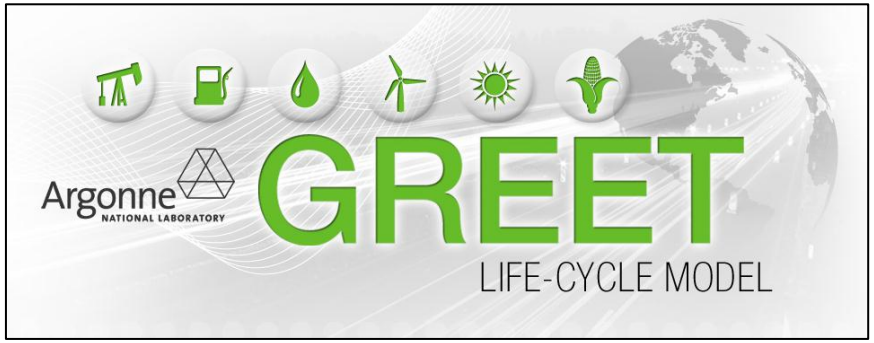
GREET Model: Vehicle Operation

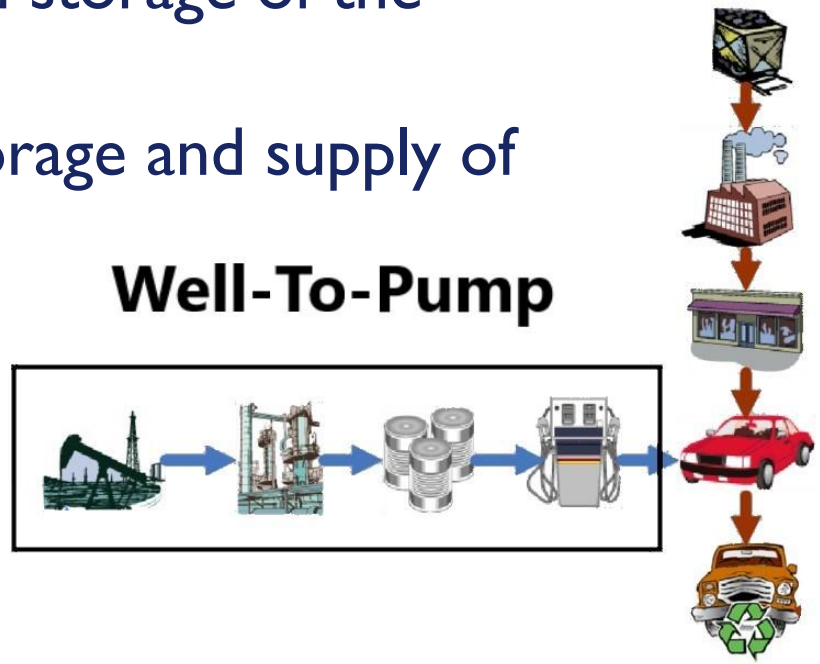
- The **vehicle operation model** contains aggregate data on the following processes per each fuel type:
  - Usage of fuel, taking into account combustion and other chemical reactions.
  - Maintenance of the vehicle.



GREET Model: Fuel-cycle

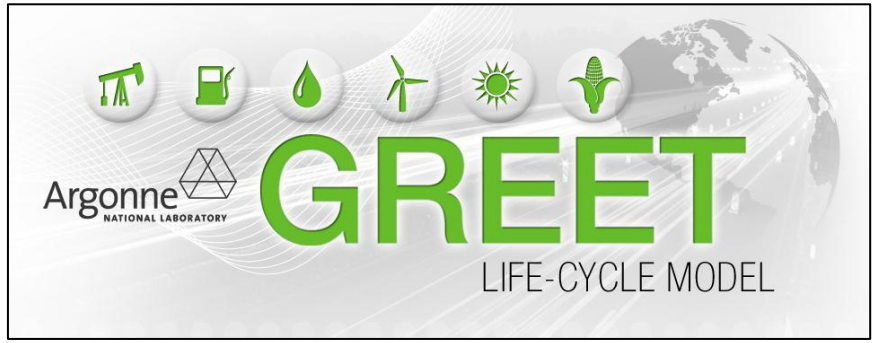
- The **fuel-cycle model** contains aggregate data on the following processes per each fuel type:
  - Production, transport and storage of the primary energy source;
  - Production, transport, storage and supply of fuel.

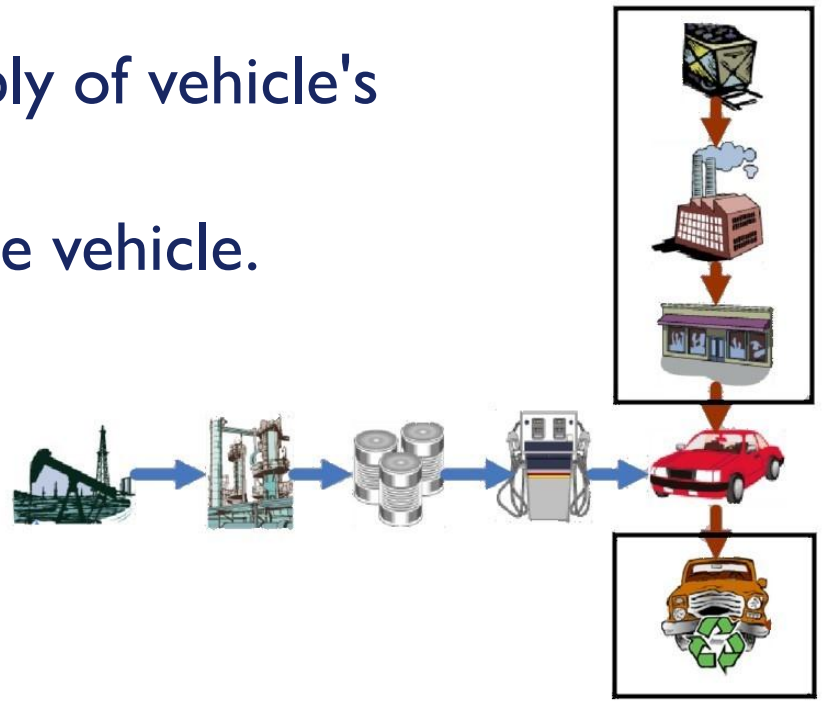




GREET Model: Vehicle Cycle

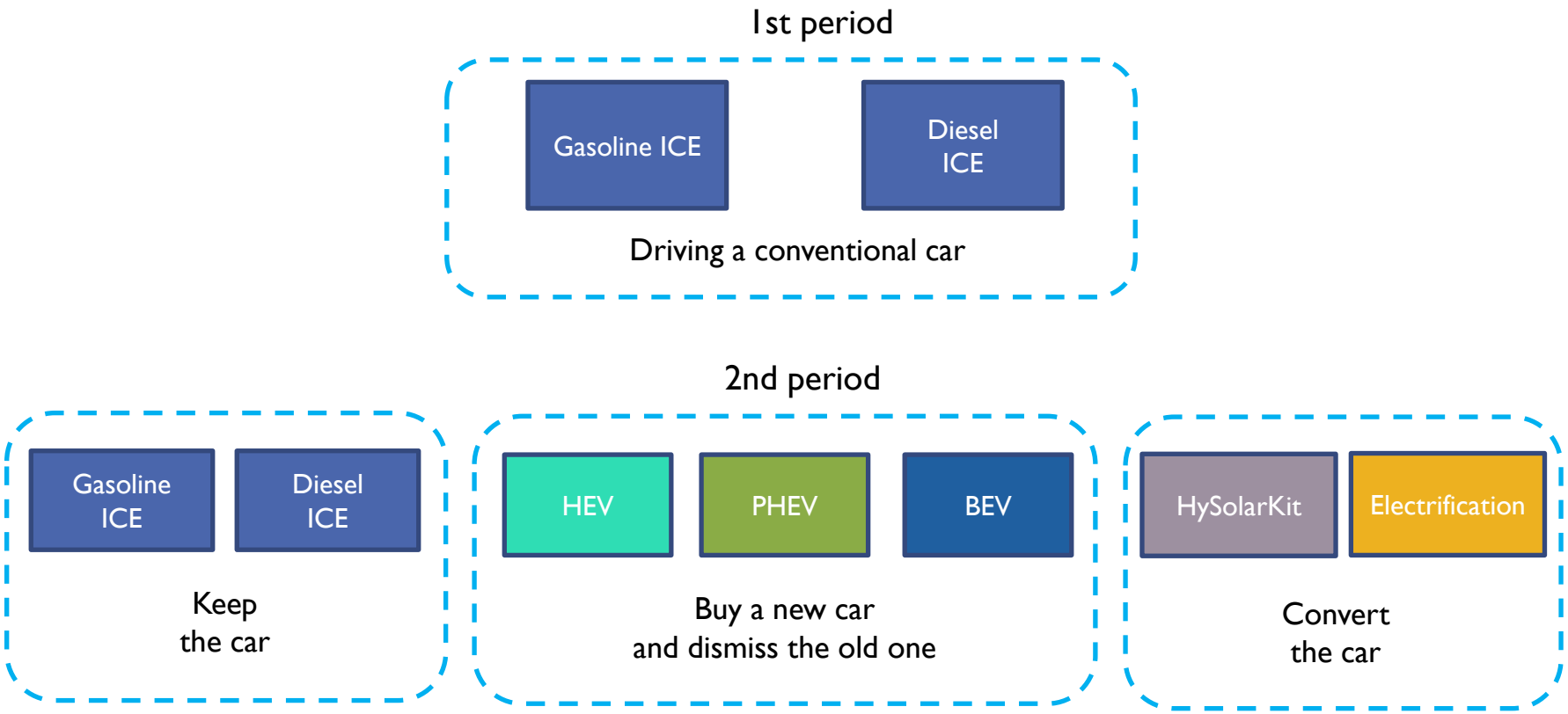
- The **vehicle-cycle model** takes into account:
  - Extraction, recycle and processing of raw materials;
  - Manufacturing and assembly of vehicle's components;
  - Disposal and recycle of the vehicle.





Vehicle Cycle

The scenarios



Tiano, F A; Rizzo, G Life Cycle Assessment (LCA) study for different options of sustainable mobility, including vehicle conversion *International Journal of Powertrains*, **2020**, *9(1-2)*, 122-149

Summary of the results

	Energy Consumption (kJ/kg)				Percent			
	Fuel	Vehicle	Operation	Total	Fuel	Vehicle	Operation	Total
Diesel	290	459	1385	2134	*13.6%*	*21.5%*	*64.9%*	*100%*
Gasoline	460	459	1672	2591	*17.8%*	*17.7%*	*64.5%*	*100%*
PHEV	601	666	1040	2307	*26.1%*	*28.9%*	*45.1%*	*100%*
HEV	330	466	1199	1995	*16.5%*	*23.4%*	*60.1%*	*100%*
EV	448	618	512	1578	*28.4%*	*39.2%*	*32.4%*	*100%*
Diesel+HySolarKit	232	20	1108	1360	*17.1%*	*1.5%*	*81.5%*	*100%*
Gasoline+HySolarKit	369	20	1337	1726	*21.4%*	*1.2%*	*77.5%*	*100%*
Converted EV	448	39	512	999	*44.8%*	*3.9%*	*51.3%*	*100%*
Mean Value	**397**	**343**	**1096**	**1836**	***23.2%***	***17.1%***	***59.7%***	***100%***

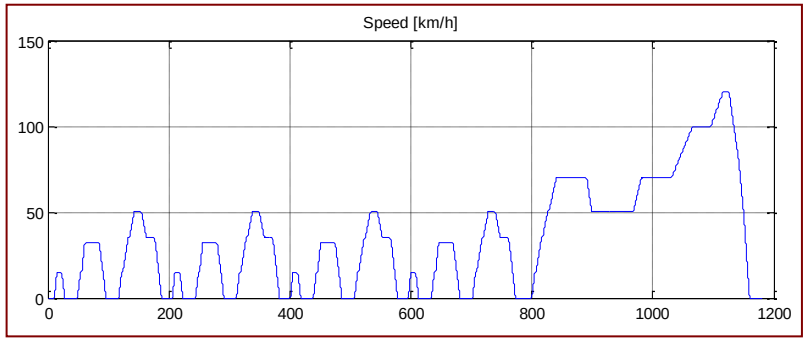
	GHG emissions (g/km)				Percent			
	Fuel	Vehicle	Operation	Total	Fuel	Vehicle	Operation	Total
Diesel	25	29	106	160	*15.6%*	*18.1%*	*66.3%*	*100%*
Gasoline	31	29	123	183	*16.9%*	*15.8%*	*67.2%*	*100%*
PHEV	61	42	38	141	*43.3%*	*29.8%*	*27.0%*	*100%*
HEV	22	30	88	140	*15.7%*	*21.4%*	*62.9%*	*100%*
EV	50	39	0	89	*56.2%*	*43.8%*	*0.0%*	*100%*
Diesel+HySolarKit	20	2	85	107	*18.7%*	*1.9%*	*79.4%*	*100%*
Gasoline+HySolarKit	25	2	98	125	*20.0%*	*1.6%*	*78.4%*	*100%*
Converted EV	50	3	0	53	*94.3%*	*5.7%*	*0.0%*	*100%*
Mean Value	**36**	**22**	**67**	**125**	***35.1%***	***17.3%***	***47.6%***	***100%***

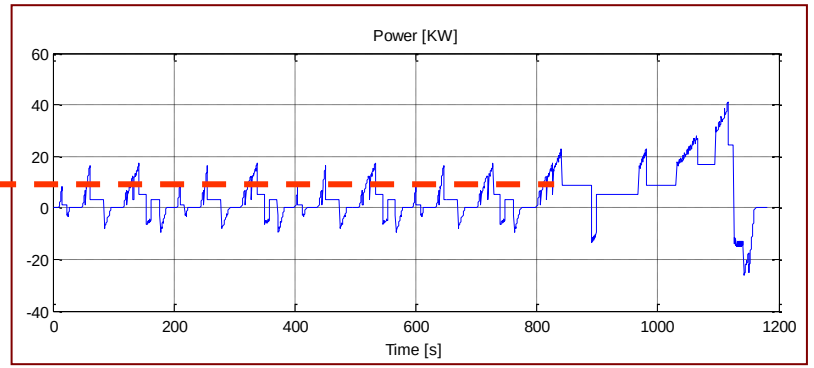
- **Vehicle operation** has a major role (59/53 % for energy consumption and GHG).
- **Fuel cycle** accounts in average for 22/27%, while **Vehicle cycle** for 19%.
- **Vehicle conversion** is a good option both in terms of energy consumption and GHG emissions.

Use of photovoltaic in automotive

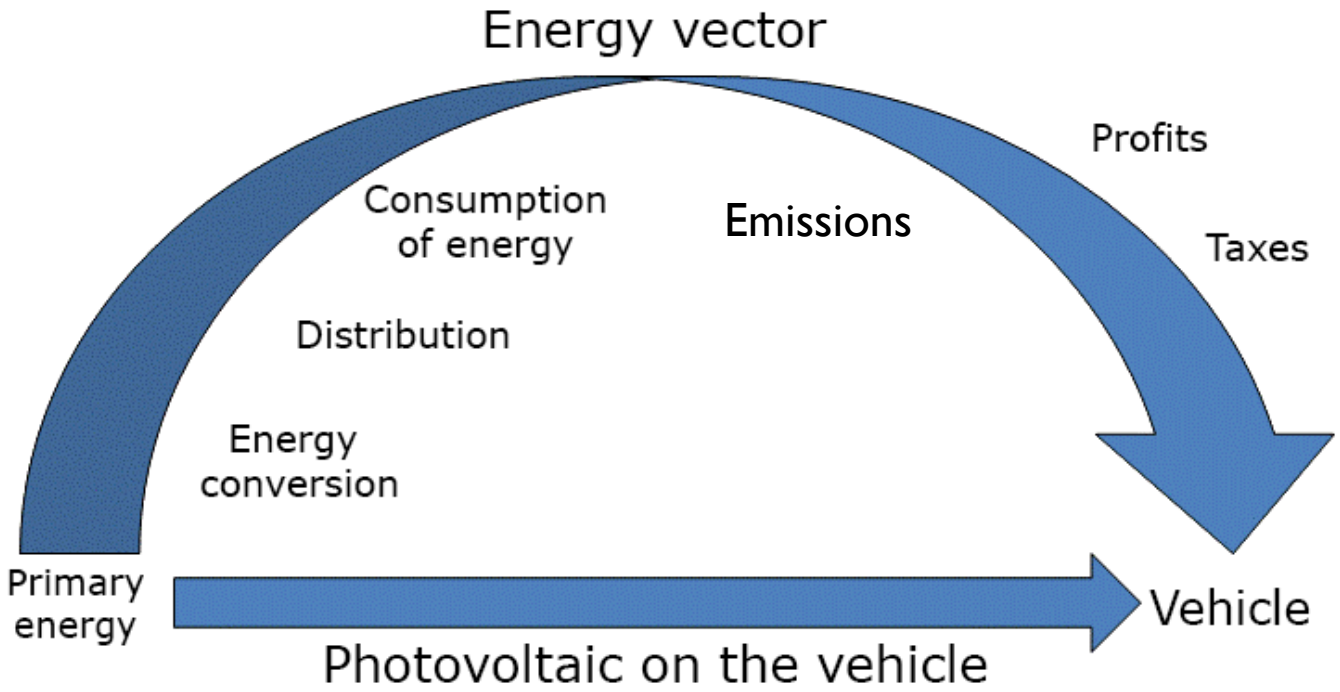
Use of photovoltaic on vehicle allows the creation of a short circuit of renewable energy usage.

On average, in an energy approach, photovoltaic can contribute up to 25% of daily energy in urban driving.





Average power in urban driving



	Power	Average	Time	Energy
Engine	60 kW	8 kW	1 h	8 kWh
Photovoltaic	0.3 kW	0.2 kW	10 h	2 kWh
Percentage	0.5%	2.5%		25%

The prototypes

Fiat Grande Punto
1.3 liters Diesel engine
7 kW DC In Wheel Motors
4 kWh custom battery

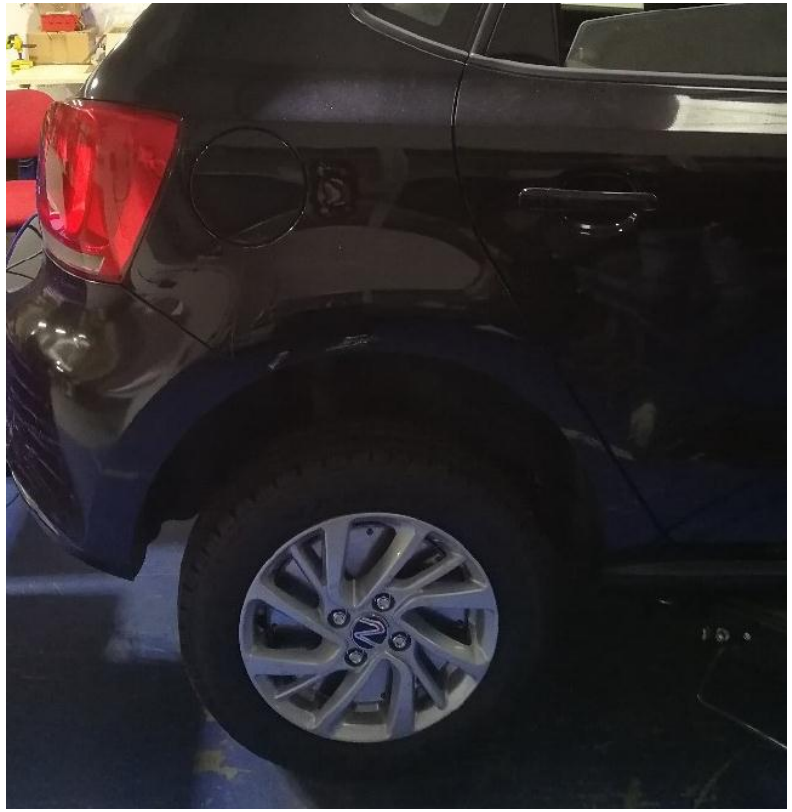
TRL = 5-6

VolksWagen Polo
1.4 liters Diesel engine
10 kW AC In Wheel Motors
10 kWh automotive battery

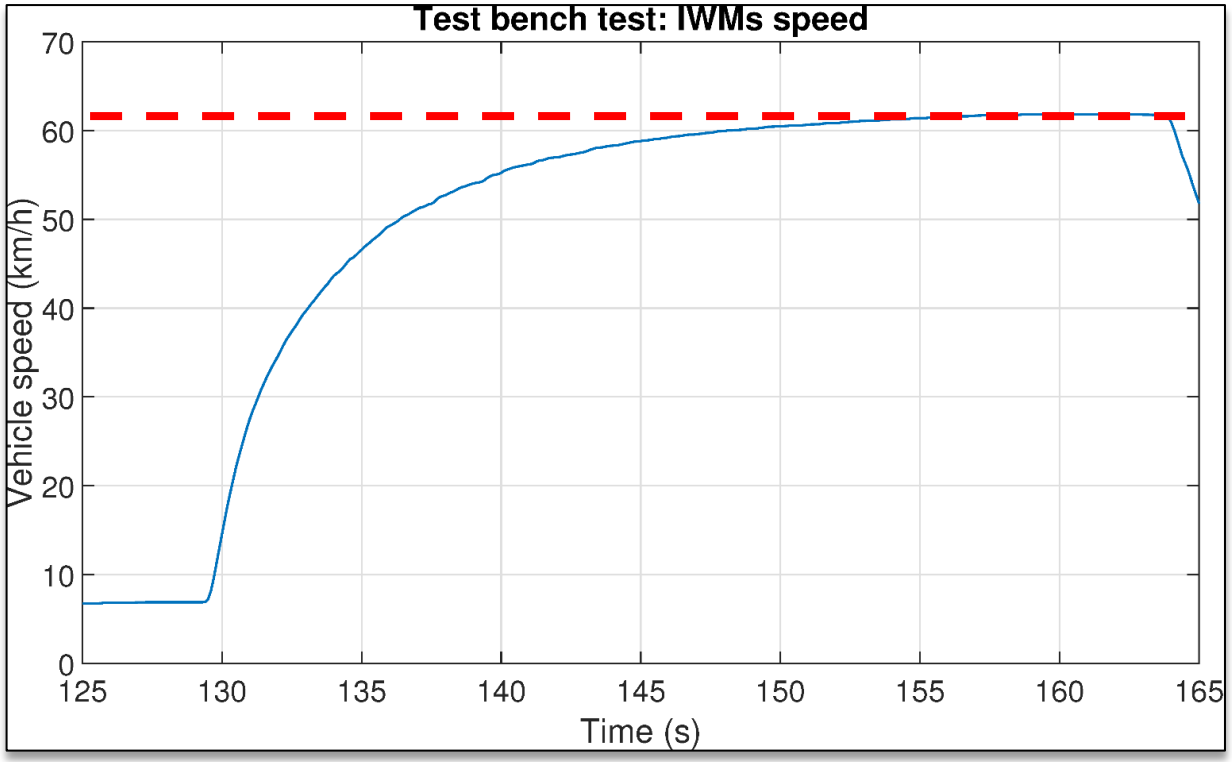
TRL = 8-9

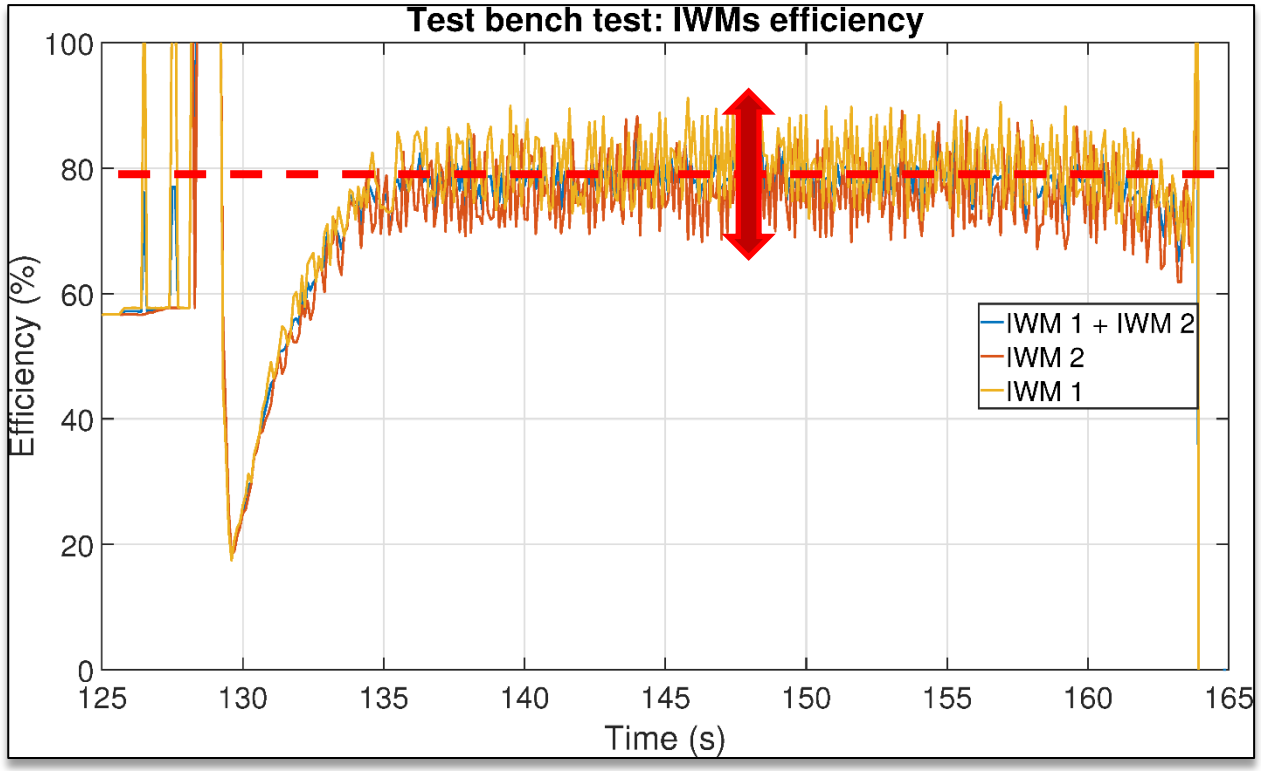
New wheel motors

New **wheel motors**, with **integrated brakes** and **improved performance**, have been tested on the bench and mounted on a **VW Polo**.



Test bench tests

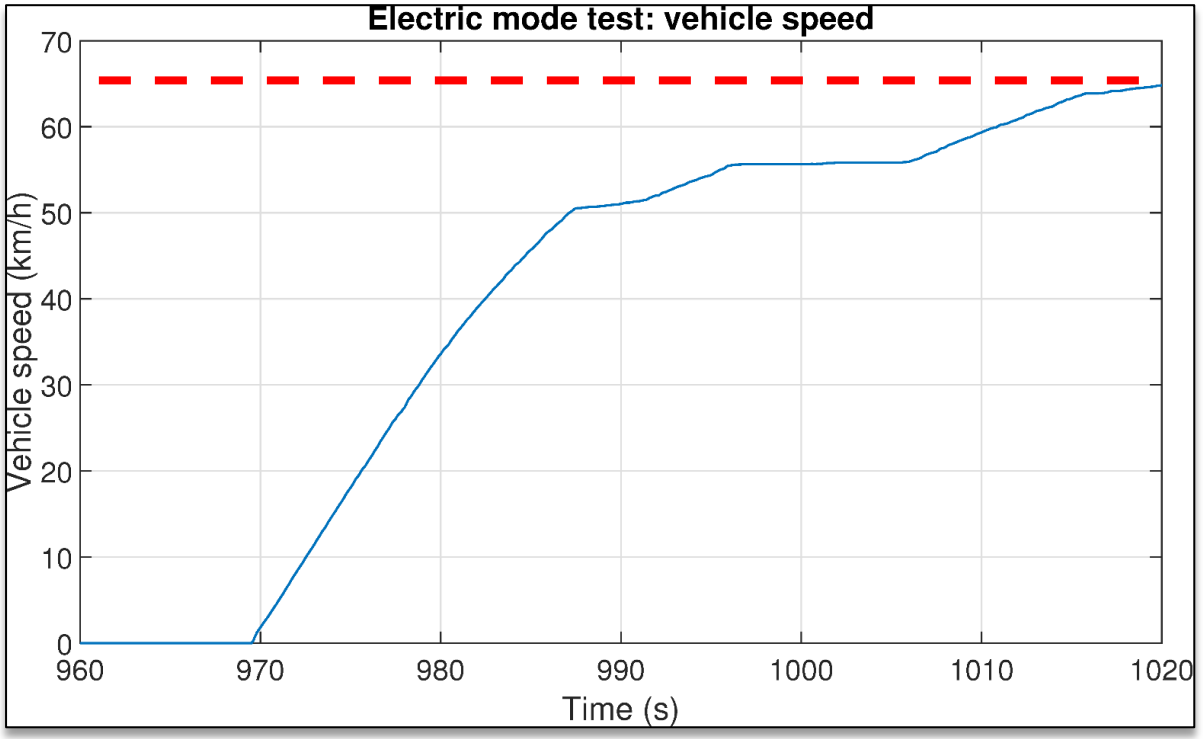


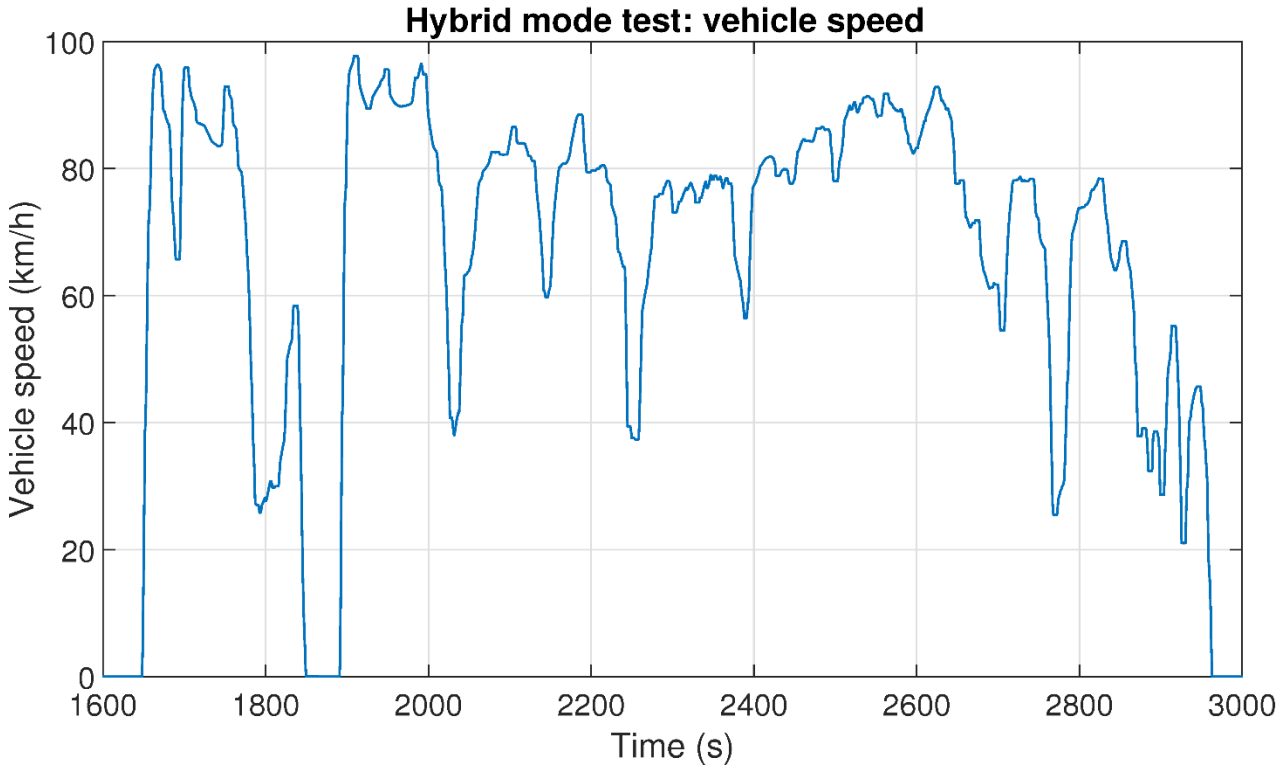


The car reached a top speed of around 60 km/h in electric mode

The calculated efficiency of the IWMs showed an average value around 80%

Road tests

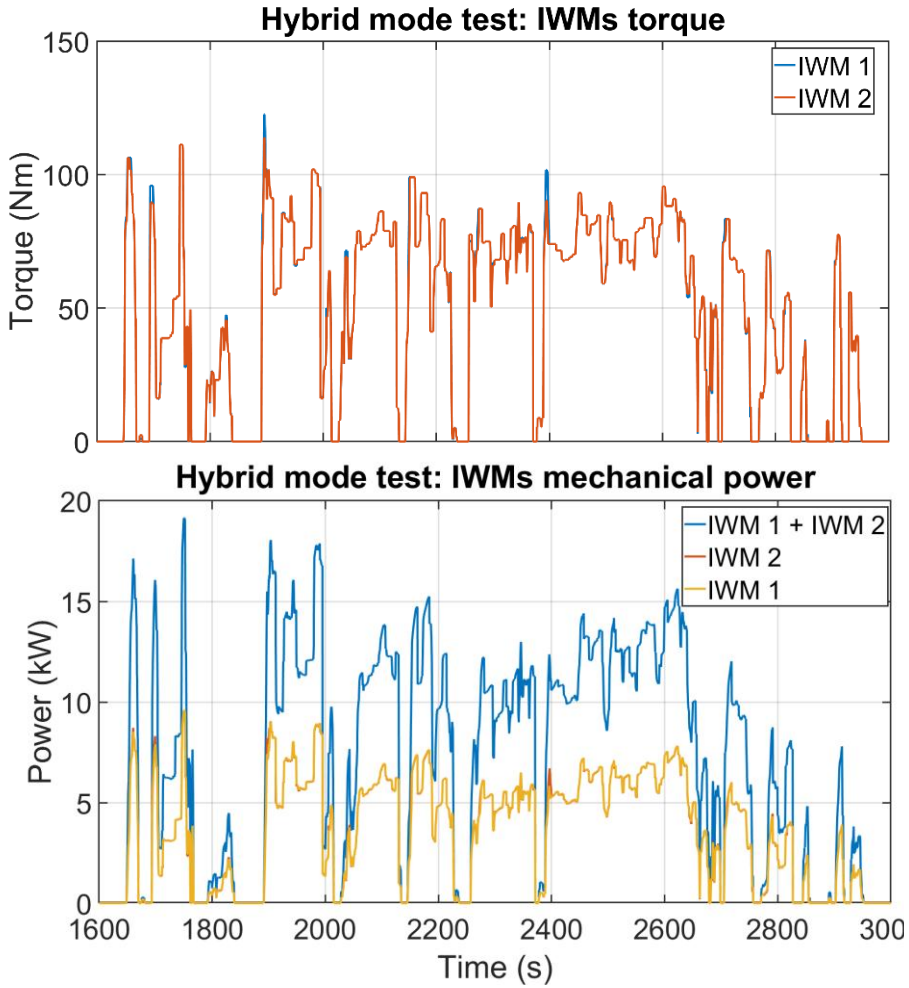


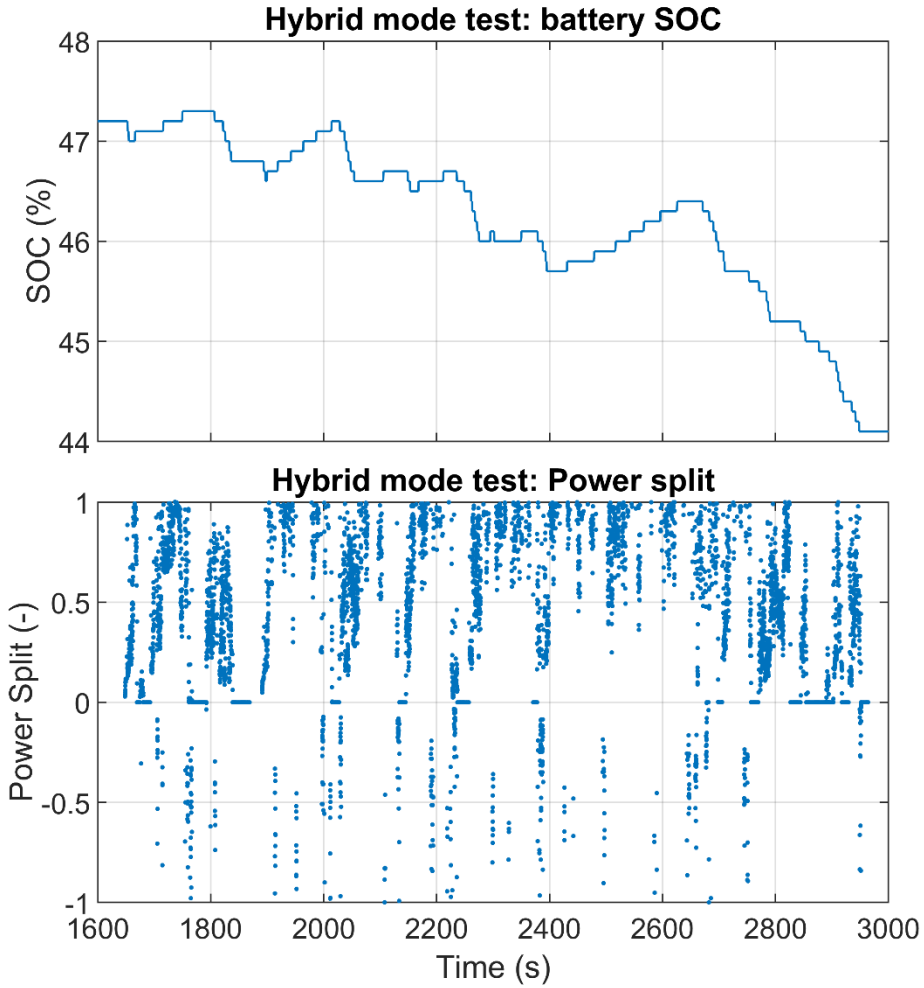


In pure electric mode the vehicle top speed reached around 65 km/h

Tests in hybrid mode up to 100 km/h have been performed

Road test: hybrid mode





Business Models

BUSINESS TO CLIENT

The kit is sold in **after-market** and mounted on the **existing cars** by an installers network. A **very large potential market** is addressable, allowing the **reuse** of most of the existing fleet, with large **global benefits on fuel consumption and pollution**.

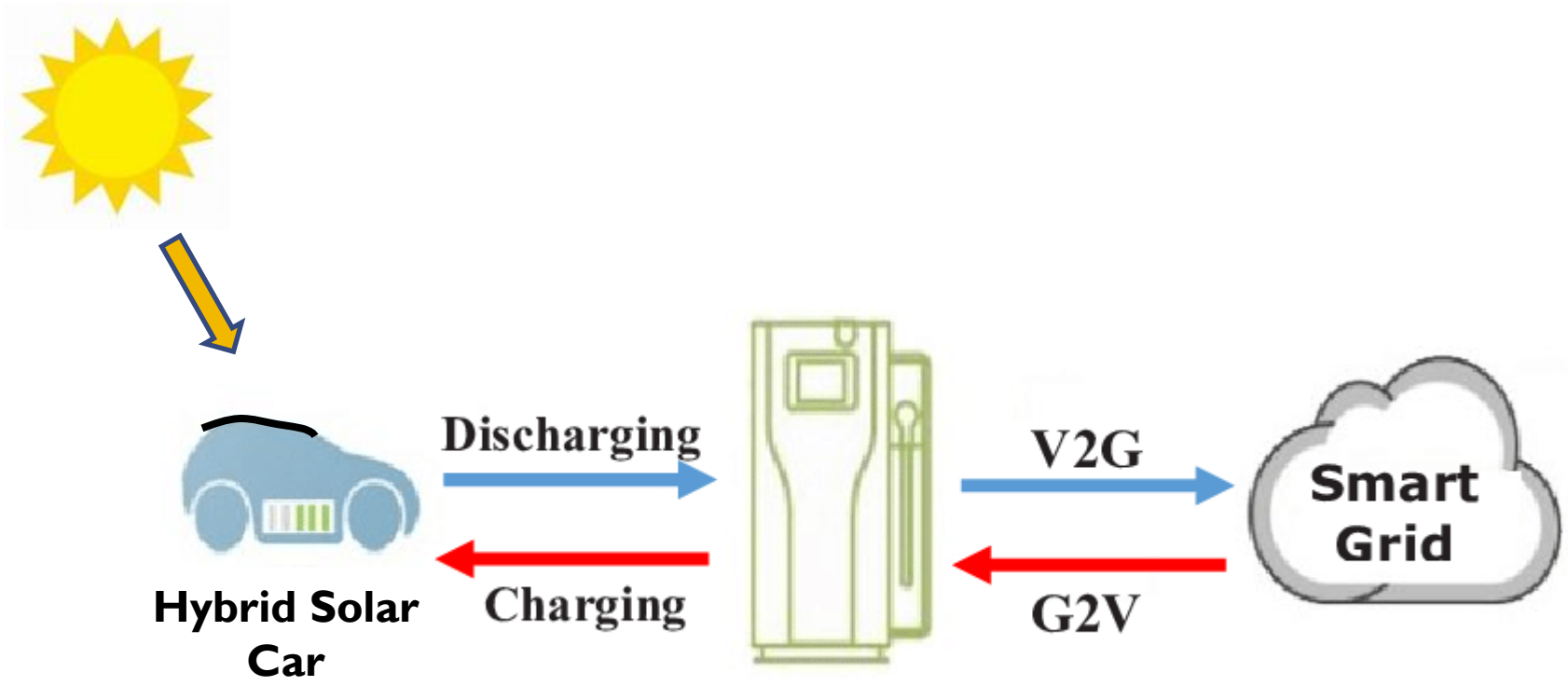
BUSINESS TO BUSINESS

The kit can be applied to **new cars** by OEMs at the **end of line**, so **enlarging the range** of models offered to clients with **ecological versions** of their cars, **without expensive reconversions of production lines**.

TO FLEET OWNERS

The kit of solar hybridization can be also applied to the **ecological reconversion** of **car fleets** owing to private/public companies and institutions.

V2G – Benefits of HySolarKit



The use of V2G on solar-hybridized cars allows to extend the capacity of the electrified fleet, adding many of the conventional cars to the fleet of BEV and PHEV

PV panels give additional benefits:
i) Reduction of grid overload during vehicle charging;
ii) Grid feeding with renewable PV power during discharging.

Conclusions

Mass transition to **Electric Vehicles** is not behind the corner, while **Hybrid Vehicles** may represent a valuable solution in short/medium term.

A massive substitution of conventional cars to EV and/or HEV is **not affordable** for many users and is **not the most sustainable option** in short term, in a **LCA perspective**.

Reuse and conversion of existing vehicles is a good **short term option** within a portfolio of possible solutions. The Italian Parlamient has approved a law allowing **conversion in hybrid**.

There are incresing interest and good market forecasts for direct application of **PhotoVoltaics on cars** (VIPV). It also helps in reducing the **impact on the grid**.

Solar Hybridization has advantages with respect to full electrification, in terms of **range and recharging**. It may also contribute to enlarge the battery capacity connected to the grid, and to **provide green power the grid**.

The EU project LIFE-SAVE, aiming at the development of prototypes ready to **industrialization** is at an advanced stage, and **access to the market** with the NewCo **SunMotive** is planned in 2023.