Vision 2050

A pathway for the evolution of the Refining Industry and Liquid Fuels

An Industrial Opportunity

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Petroleum X – 10th Ukrainian International Conference

Kiev, 3rd October 2018

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REFINING PRODUCTS FOR OUR EVERYDAY LIFE

FuelsEurope represents 41 Member Companies ≈ 100% of EU Refining

A vision ? What for ……..

Contributing to delivering the Paris Agreement:

EU 2050 climate objectives

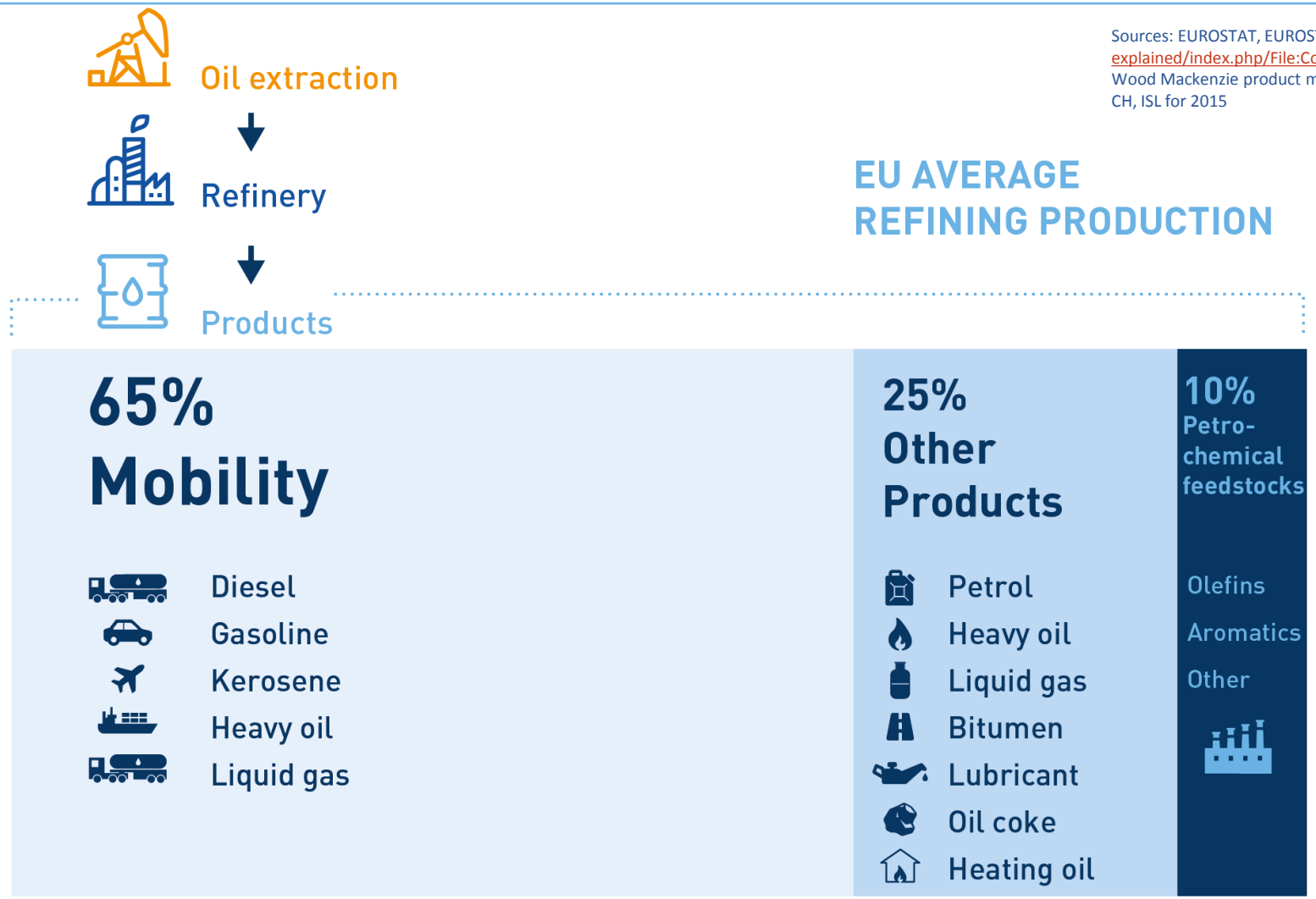
Reducing transport GHG emissions

Air Quality

Describing how the refining industry can contribute to the transition to a low carbon economy

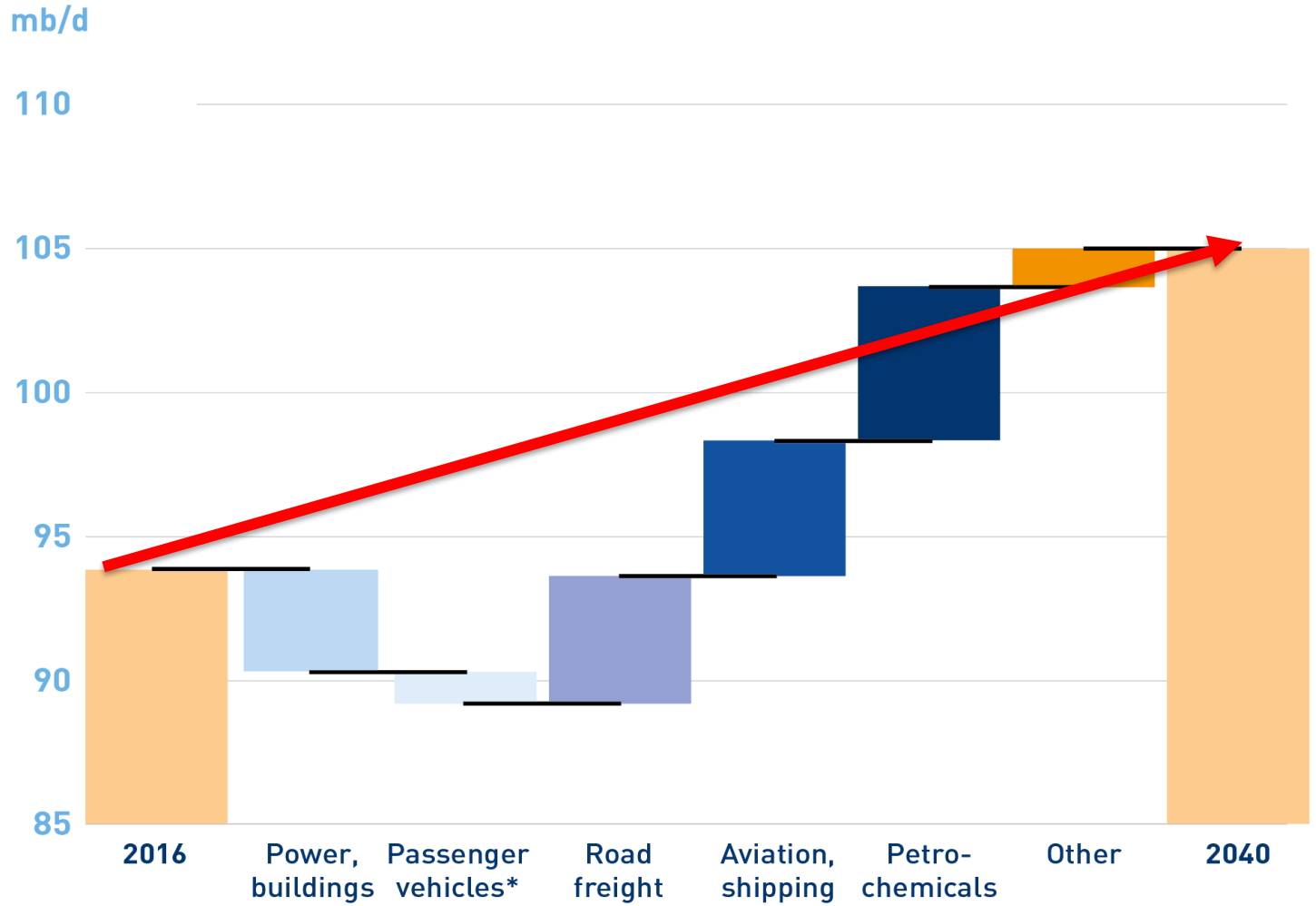
An industrial opportunity for the EU

EU average refining production



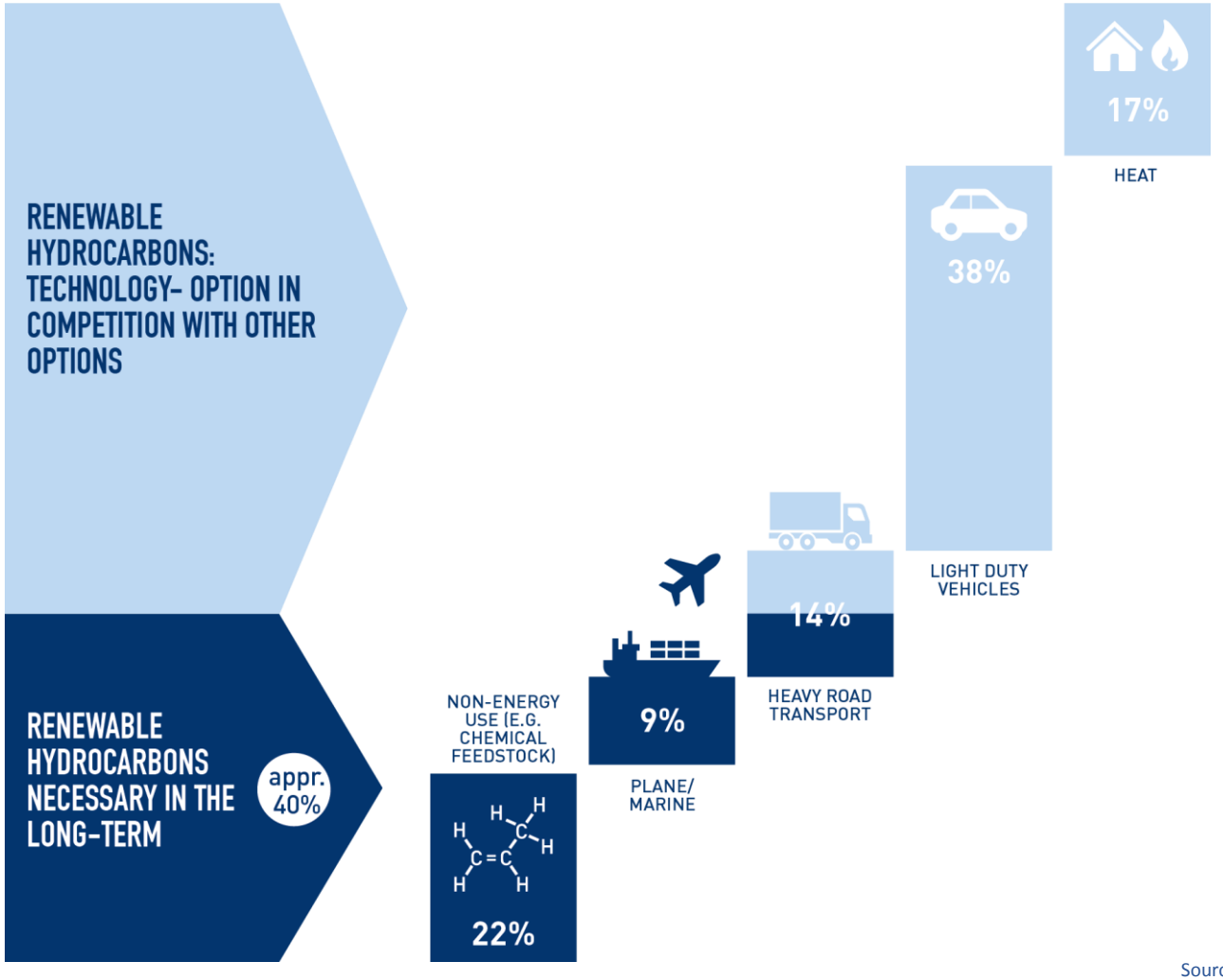
Sources: EUROSTAT, EUROSTAT, http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Consumption_of_oil_EU-28,_2015,_percentage.png and Wood Mackenzie product markets long-term outlook H2 2017 Demand in EU 28, NOR, CH, ISL for 2015

Change in world oil demand by sector in the New Policies Scenario - IEA WEO 2017



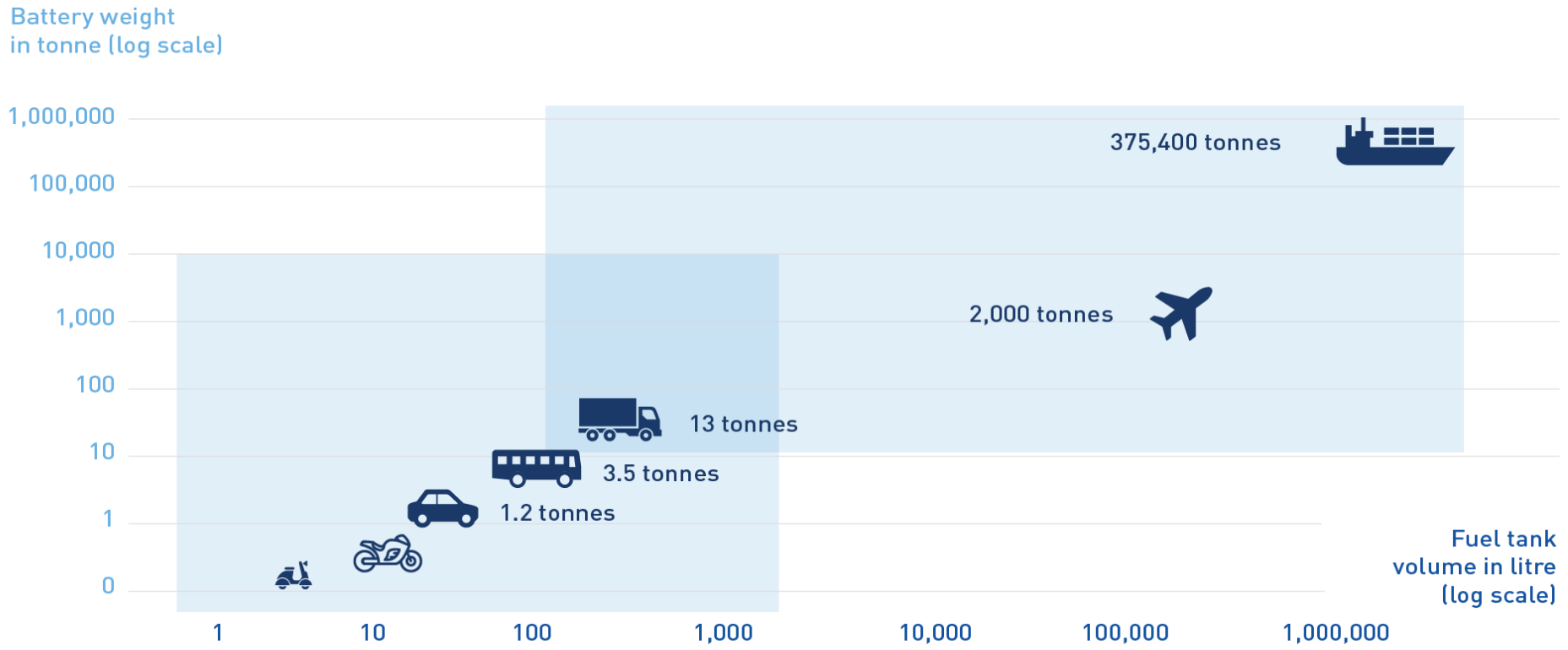
Source: IEA, WEO 2017

Low-carbon liquid fuels and products



Source: Prognos AG, Berlin

No Silver Bullet : Limited electrification beyond the bus and light truck segment



Aviation and energy storage

Boeing 787

230 tons
at take-off

Jet fuel

100 tons[1]

Electric battery

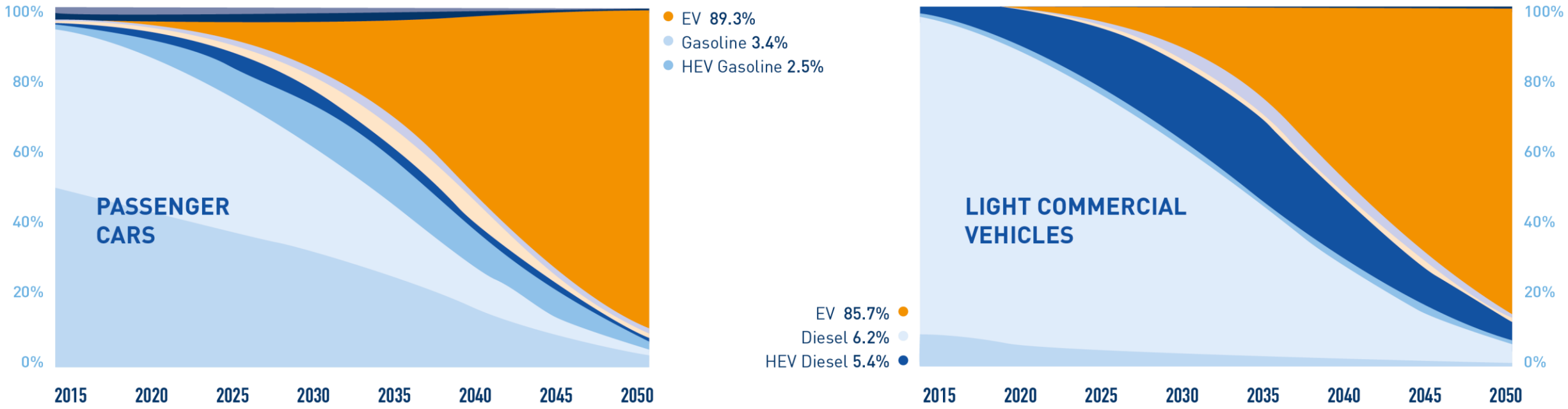
2000 tons[1]

(1) http://www.latimes.com/business/la-fi-electric-aircraft-20160830-snap-story.html

GHG emissions and Climate Change

- FuelsEurope recognises that climate change is real and warrants action.
- Answering the demand for energy while limiting the GHG emissions is a critical challenge.
- What are the options for example for Light Duty Vehicles (LDV)?
  - Mass Electrification scenario or Low-Carbon Liquid Fuels scenario

Mass Electrification



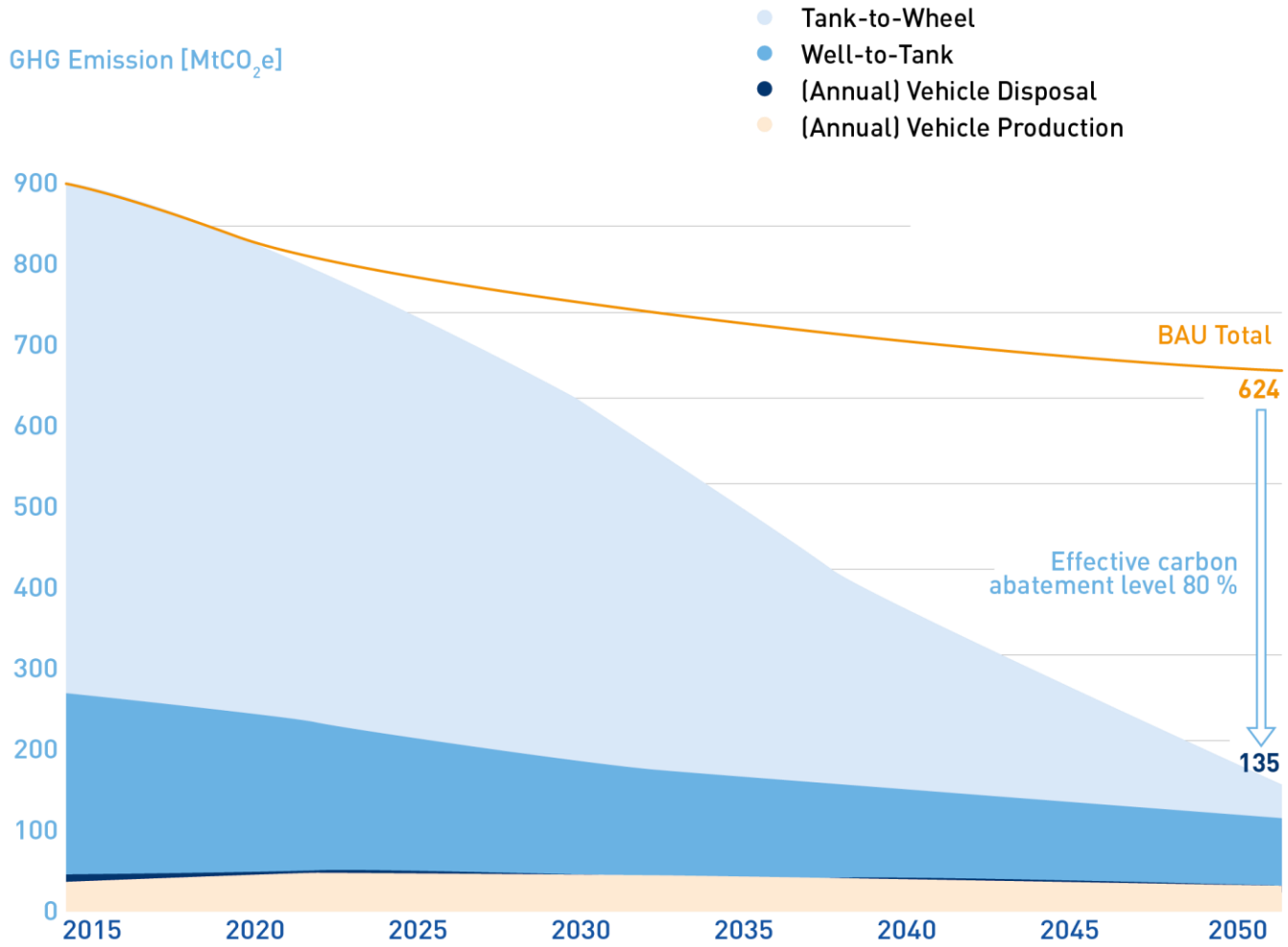
Source: Ricardo, Impact Analysis of Mass EV Adoption and Low Carbon Intensity Fuels Scenarios, August 2018

- This scenario shows 90% electrification of passenger cars and light duty vehicles in 2050
- It assumes that, as of 2040, 100% registrations are battery electric vehicles.

Source: Ricardo Energy & Environment SULTAN modelling and analysis

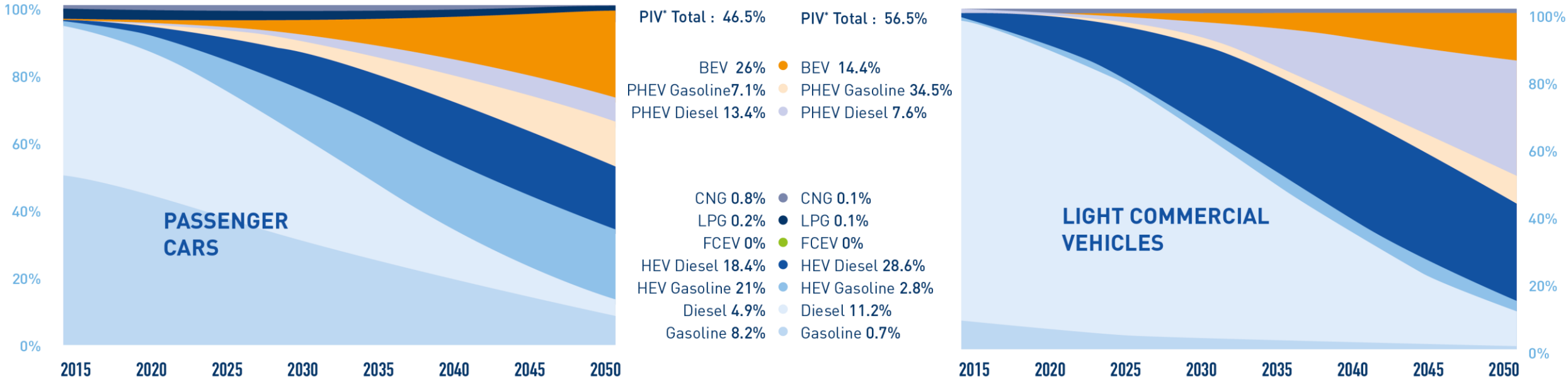
Mass Electrification

- It is expected to achieve 87% reduction of net GHG emissions in 2050 vs 2015.



Source: Ricardo Energy & Environment SULTAN modeling and analysis

Low-Carbon Liquid Fuels



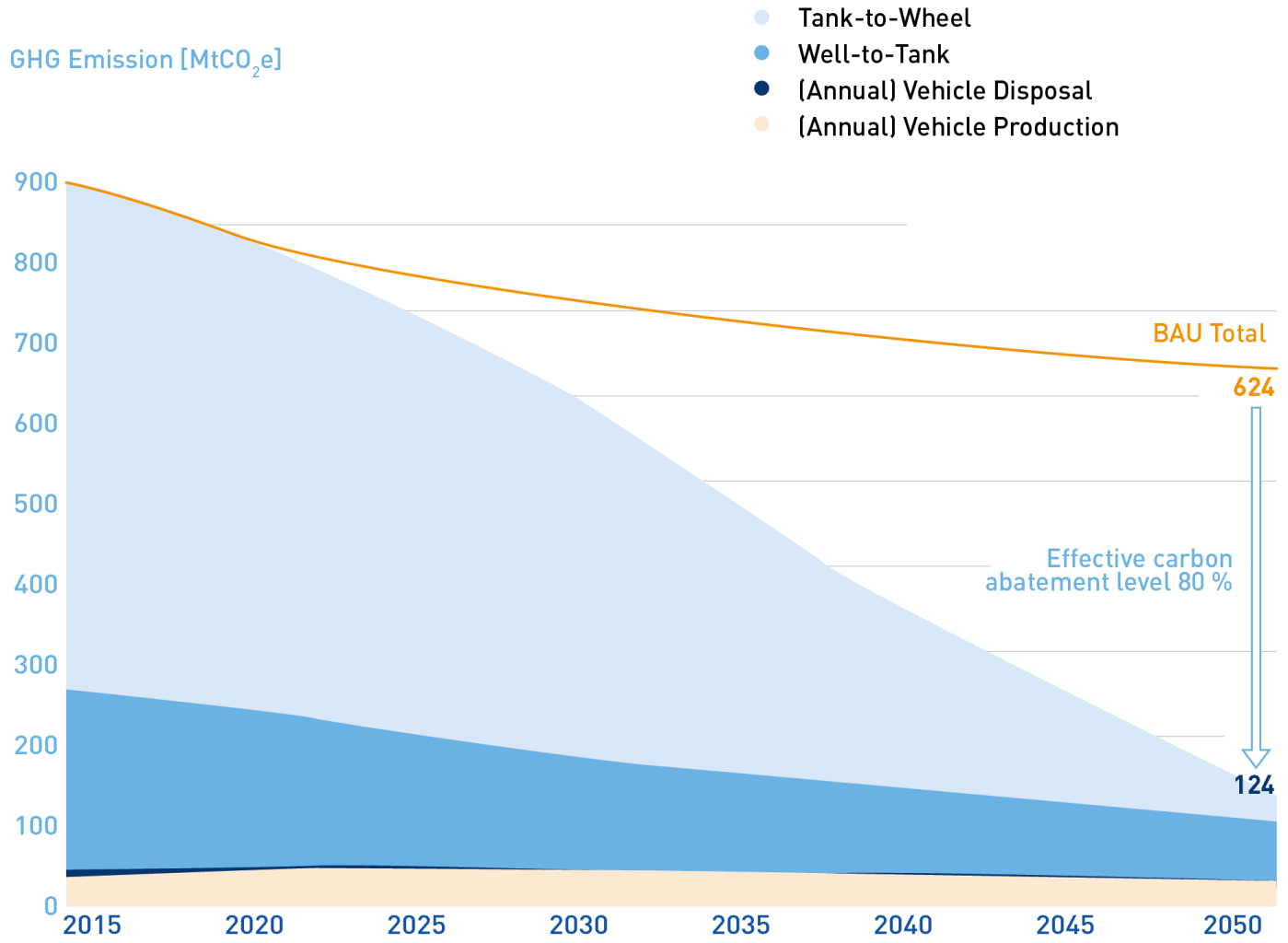
Source: Ricardo, Impact Analysis of Mass EV Adoption and Low Carbon Intensity Fuels Scenarios, August 2018

- This Low Carbon Liquid Fuel scenario show that the share of liquids will reach 68%. It will be complemented by 23% of electricity.

Source: Ricardo Energy & Environment SULTAN modelling and analysis

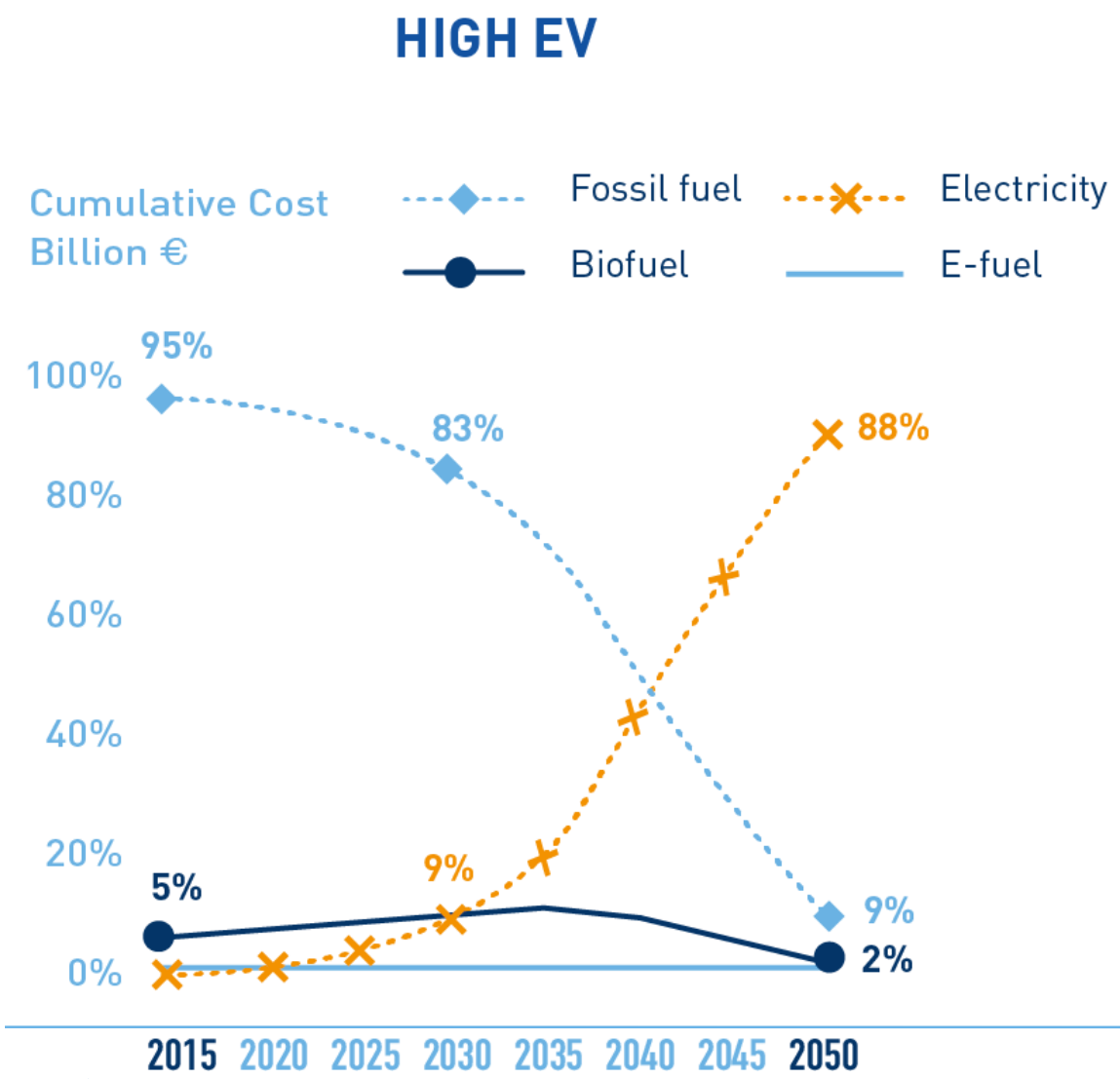
Low-Carbon Liquid Fuels

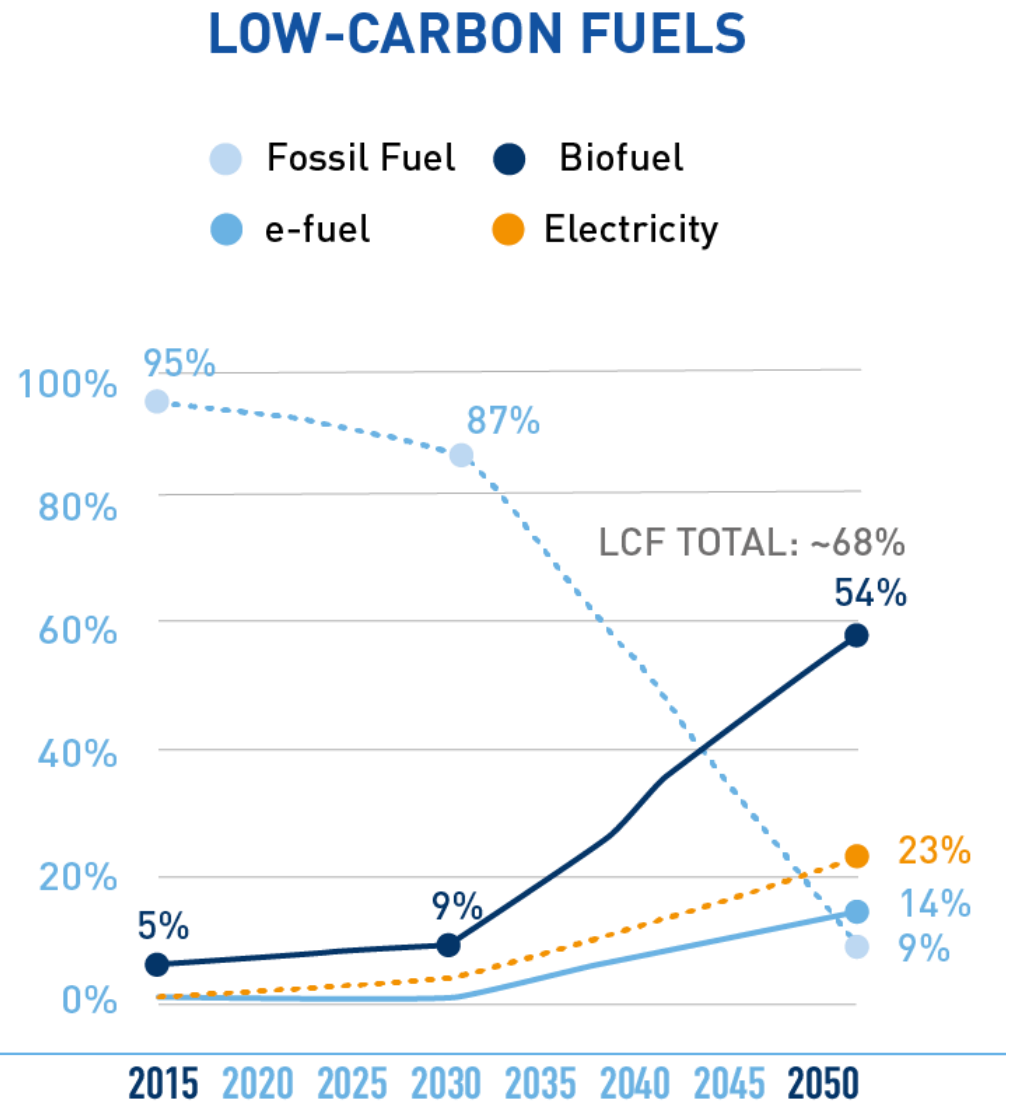
- It is also expected to achieve 87% reduction of net GHG emissions in 2050 vs 2015.



Source: Ricardo Energy & Environment SULTAN modeling and analysis

Energy Mix in the High EV and Low-Carbon Liquid Fuels scenarios





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Source: Ricardo Energy & Environment SULTAN modeling and analysis

Comparison between the Mass EV and the Low-Carbon Liquid Fuel scenarios

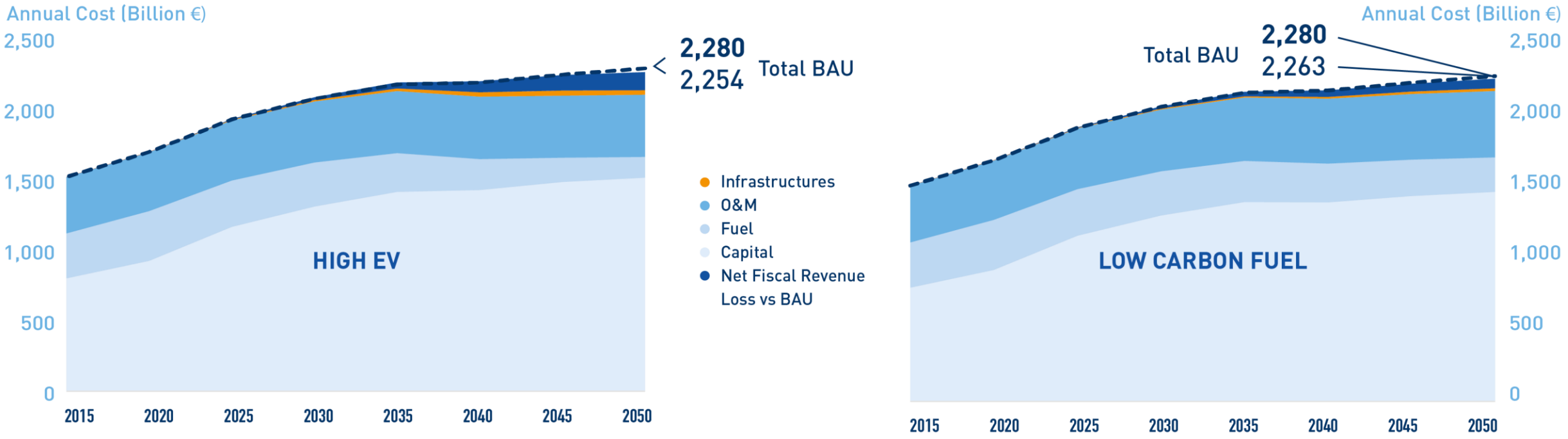
Mass Electrification scenario

- An estimated investment in EV charging and network infrastructure between 630B€ to 830B€ to 2050.
- Electricity demand for charging EVs in the Light Duty Vehicle segment will represent 17,5% of EUs' 2015 electricity generation.
- Measures to address the annual loss of 66B€ in fiscal revenue from fuel sales.
- The construction of 15 Gigafactories to supply batteries to the European EV market (550TWh).
- Significantly increased Lithium extraction just for the full electrification of the European cars and vans, with a peak estimated at 6 times the 2016 Lithium global production level in the world.
- Construction of an equally large battery recycling industry will be needed, with unknown power requirements and environmental impact.

Low-Carbon Liquid Fuels scenario

- Requiring significantly lower infrastructure investments since only 50% of the recharging capacity of the High EV scenario will be needed (326 to 390B€).
- Only require 5 or 6 Gigafactories for battery production and significantly limit dependency on demand of raw materials to less than half of the High EV scenario requirements
- Offer a sustainable alternative for other transport segments such as Aviation, Marine and Heavy Duty road transport
- The opportunity to supply to the entire existing light duty fleet as these low-carbon fuels appear on the market, thereby enabling a wider GHG reduction compared to the usual fleet renewal scenario.

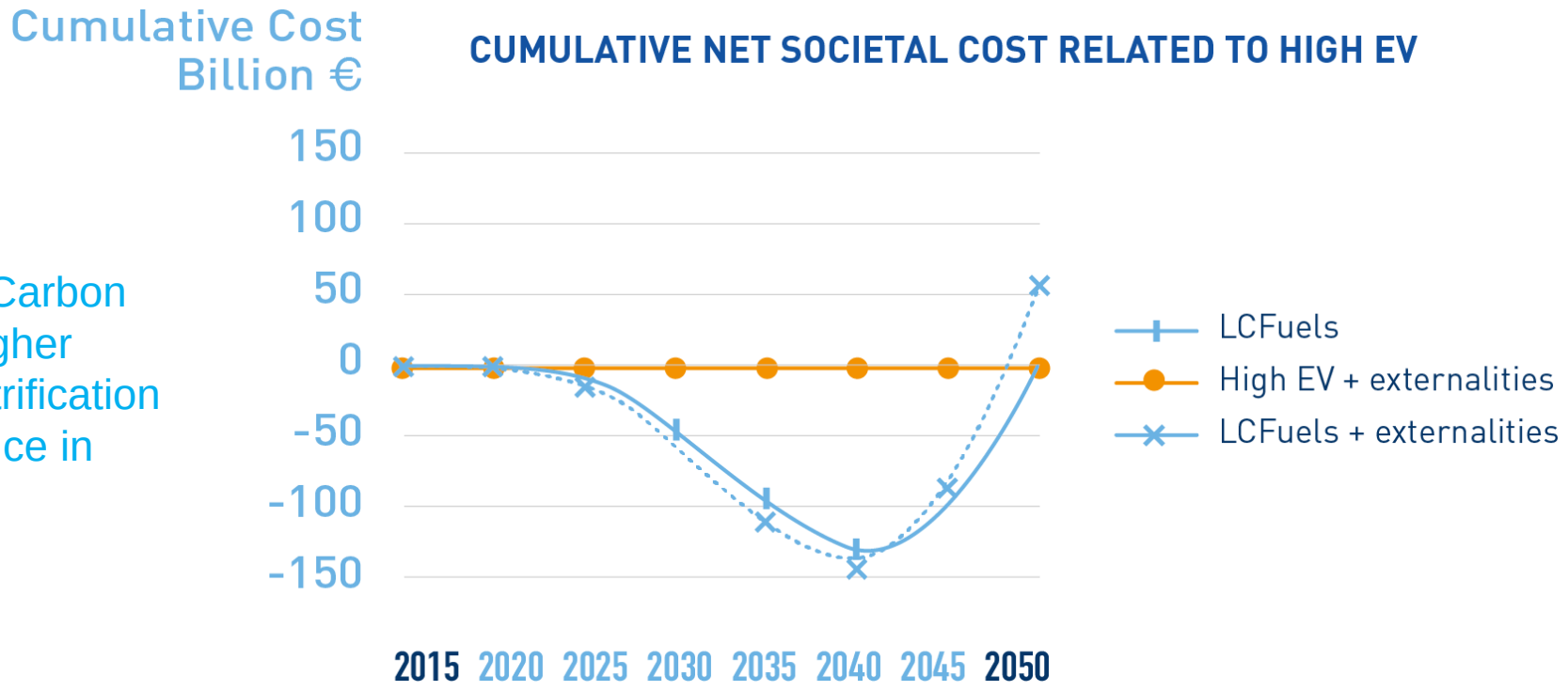
Cost comparison between the Mass EV and the Low-Carbon Liquid Fuel scenarios



Source: Ricardo Energy & Environment SULTAN modeling and analysis

Cumulative societal cost comparison between the Mass EV and the Low-Carbon Liquid Fuel scenarios

- From the graph we can see that externalities related to the Low-Carbon Liquid Fuels scenario are not higher than what would be the full electrification scenario, serving as the reference in this assessment .



Source: Ricardo Energy & Environment SULTAN modeling and analysis

External costs (or 'externalities') are the monetary value attached to the impacts of GHG, air quality pollutant emissions and other impacts such as noise and congestion due to indirect effects, for example on public health and other elements

Mass EV scenario – What about raw materials and import dependency ?

Comparing costs and import dependency

Costs of fuel and batteries over a vehicle lifetime – Base Scenario

	Mini (VW Polo, Nissan Leaf*)	Small Family (VW Golf, BMW i3)	Executive (BMW 5, Tesla S)
			
Vehicle Lifetime and Mileage	16 years, 15,000 km/year. Battery lifetime 10 years.		
BEV Battery size	25 kWh	35 kWh	75 kWh
Cost of battery 2017	$180-270/kWh		
Cost of battery 2027	$75-115/kWh		
ICE Fuel Efficiency**	0.050 l/km	0.060 l/km	0.075 l/km
Oil prices	IEA WEO 2016 oil prices		
Imports**	Oil for ICE: 89%, Batteries for BEV: 91%		
ICE Fuel Cost (PV €) ***	2,100 – 2,600	2,500 – 3,100	3,100-3,900
BEV Battery Cost (PV €) ***	4,100 – 6,200	5,800 – 8,700	12,400 – 18,500

* Nissan Leaf 2016 on sale in 2017 had a battery size of around 25kWh, newer models available in 2018 have a larger battery size more comparable to small family car

** Includes Real Driving Effects

*** Base Scenario treats Norway as outside EU, for consistency with Eurostat statistics on import dependence. We also show a sensitivity case where Norwegian production is treated as within Europe for the purpose of calculating import shares.

**** PV calculated using discount rates of 10%

Source: NERA Economic Consulting

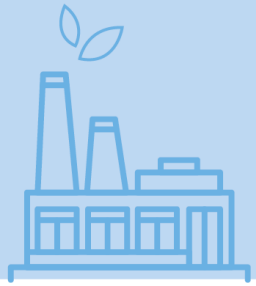
Take away from these scenarios

- Both scenarios enable developing a low carbon transport system by reaching a similar level of GHG reduction.
- Both scenarios entail a similar overall cost but the Mass EV scenario is likely to require a significant upfront public investment for infrastructure up 830B€ for the EU
- The Low Carbon Liquid Fuel scenario will also be a sustainable option for transport sectors where electrification is currently not an option.
- Low-Carbon Liquid Fuels will **supply to the entire existing light duty fleet as these appear on the market, thereby enabling a wider GHG reduction compared to the usual fleet renewal scenario.**

Can the EU refining industry can effectively contribute to address this challenge ?

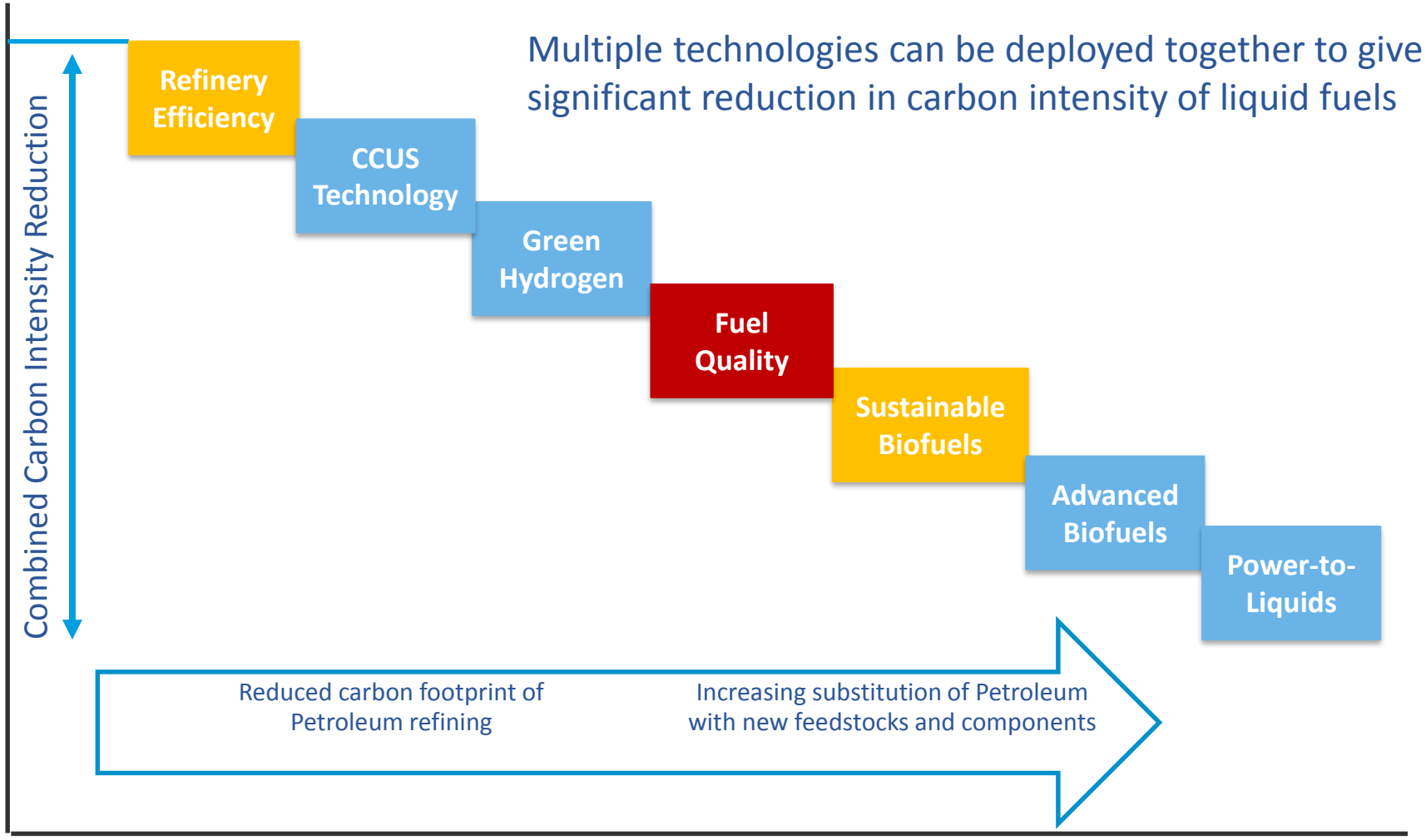
1 **Early-stage**
High efficiency operation

2 **Evolution**
Progressive introduction of low-emission components and low-carbon feedstocks



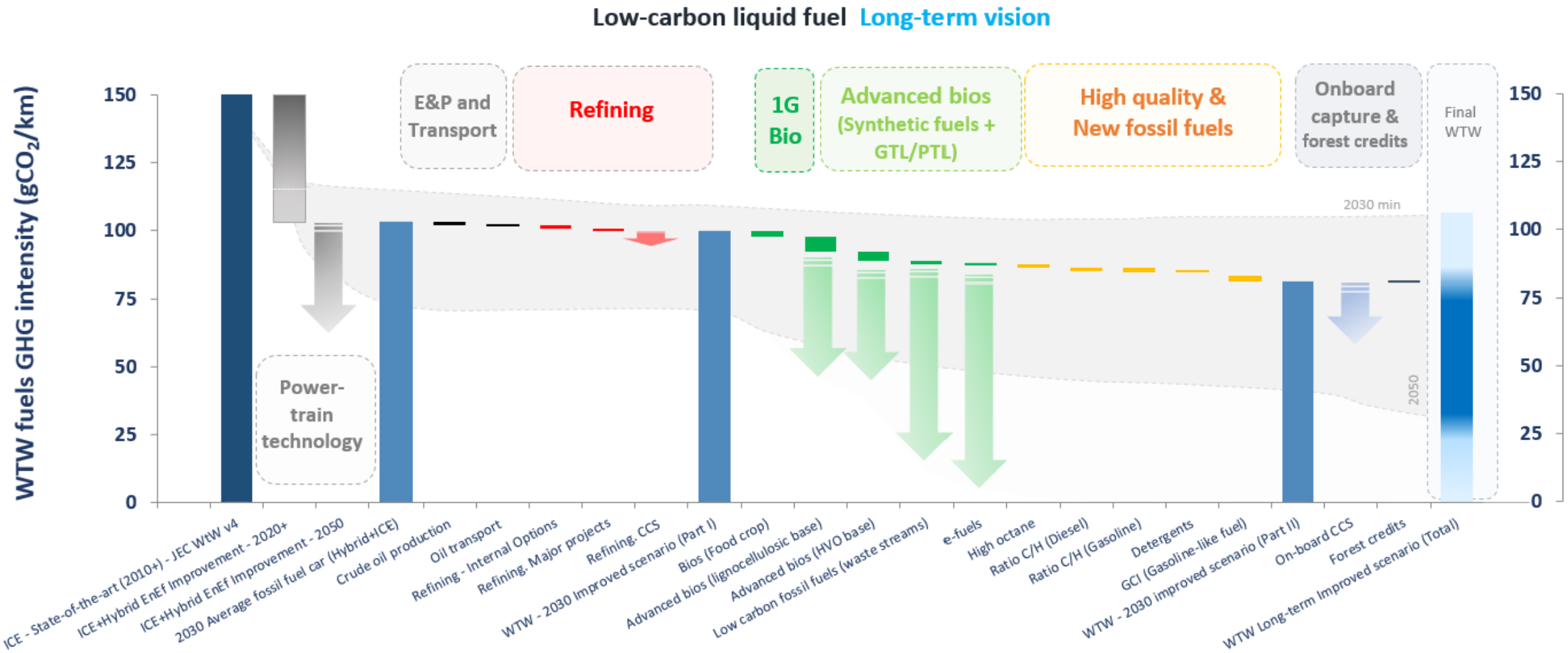
3 **Future-stage**
Hub for production and distribution of low-emission energy products and raw materials

We have the technologies…

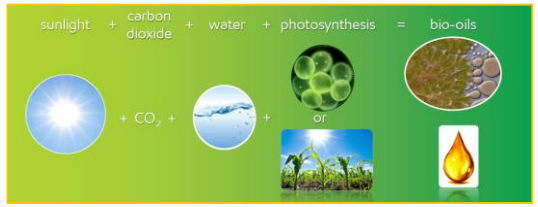


We have the technologies…

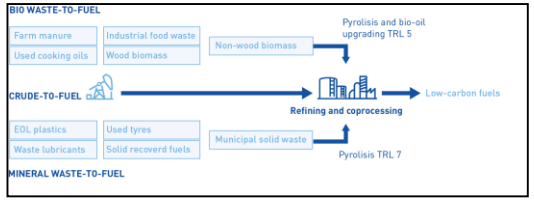
Multiple pathways towards low carbon transport



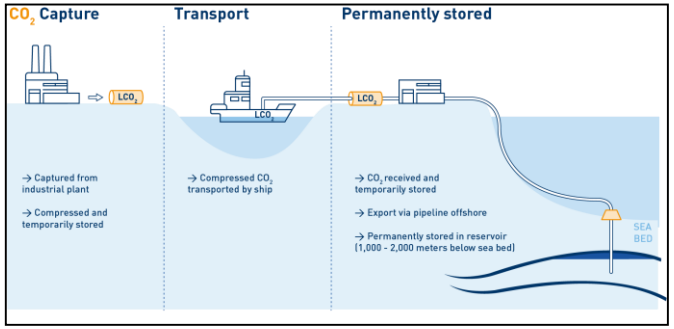
The technologies are being developed….

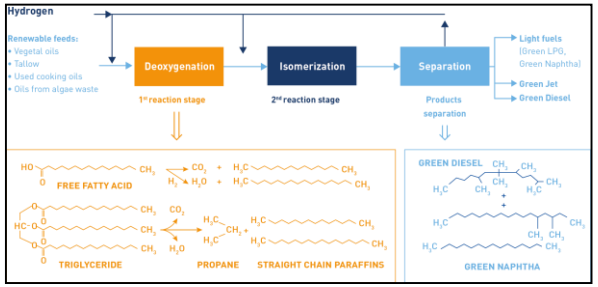


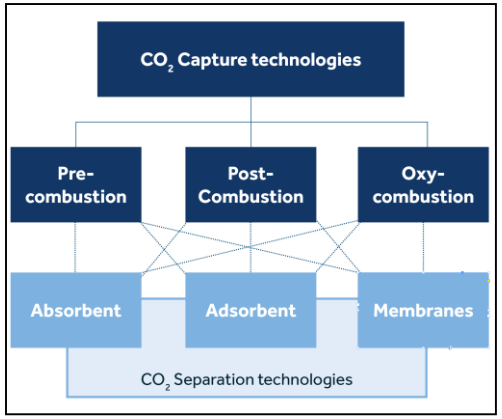
REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE

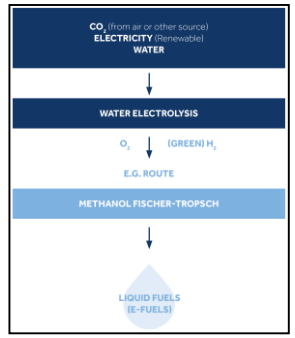


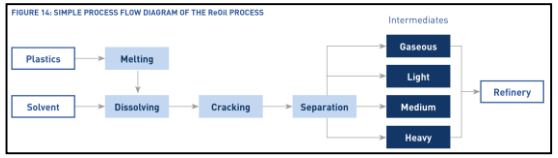
…….and this is just a sample of all the R&D and Innovation projects currently underway

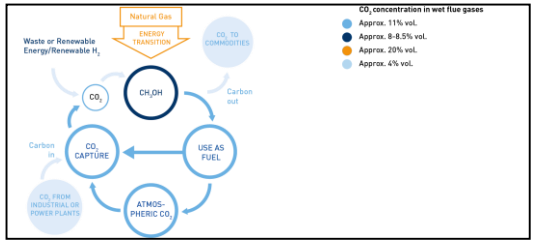


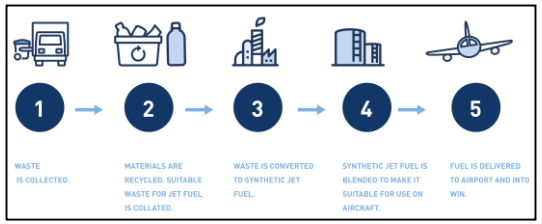




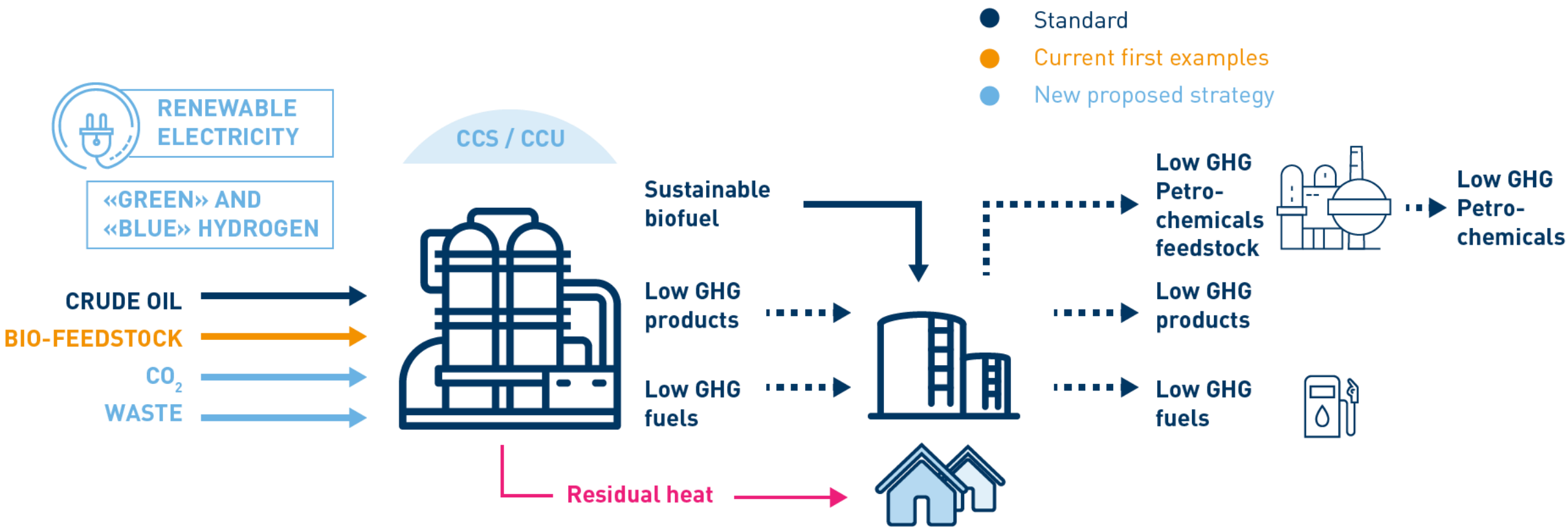








The refinery as an ENERGY HUB within an INDUSTRIAL CLUSTER



Why can refinery industry lead?

- **Extensive corporate R&D capability.**
- **Deep experience in hydrogen and biofuels technologies.**
- **Growing experience in CCU & CCS.**
- **Close involvement in industrial clusters.**
- **Financial & project capability.**
- **Already subject to strong regulation.**

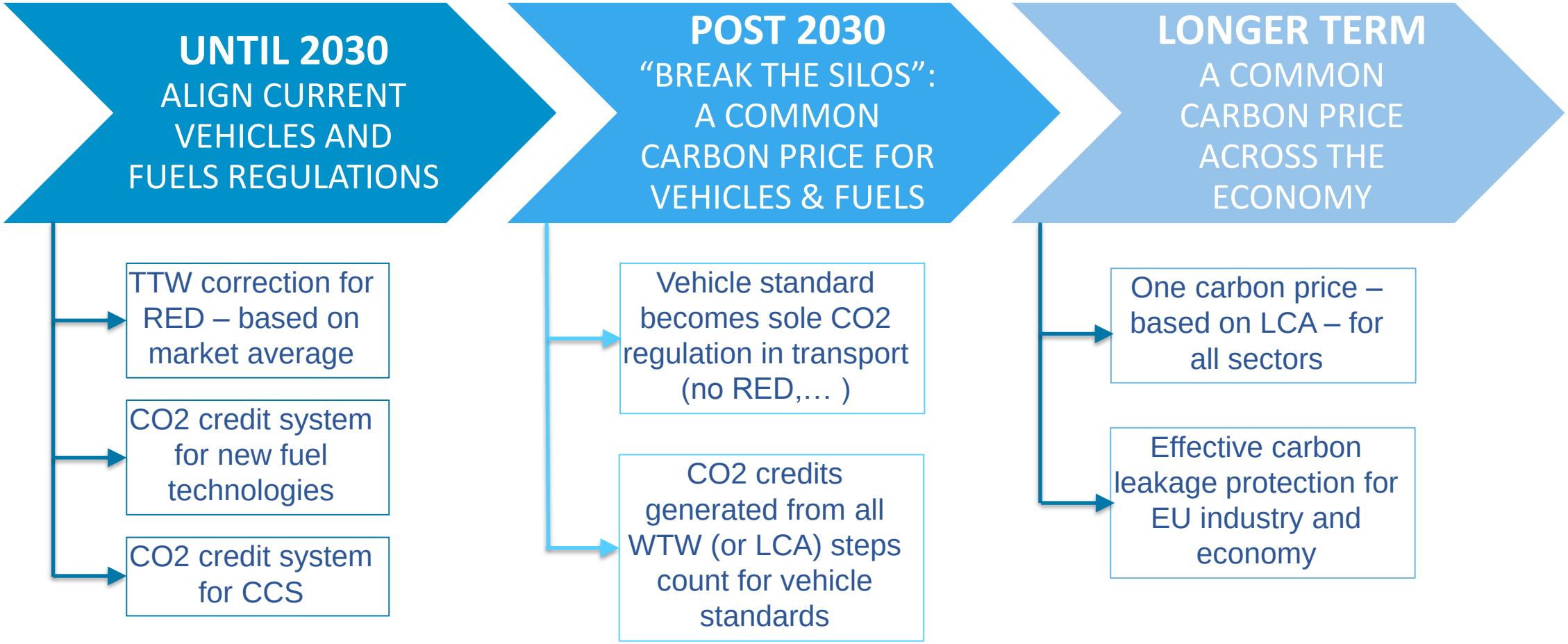
Why is this an attractive solution for the EU?

- **Industrial clusters** exploit synergies and jointly develop innovative low carbon technologies.
- Low carbon liquid fuels reduce emissions of **all the vehicles in circulation immediately.**
- Complements Europe's **global lead on ICE technologies.**
- Full **utilisation of existing infrastructure** from refineries to service stations.
- **Industrial opportunity for EU** to export technologies to the rest of the world.
- **Skilled jobs, energy security, technological leadership** for EU economy.

Policy enablers and requests

- Ensure refinery and fuels low-carbon transition are included in **the EU's industrial and technology strategies.**
- Policy framework and regulatory system for **long-term investor confidence.**
- Retain refineries' **economic viability** despite aggressive **international competition.**

Policy framework: a proposal



Conclusion

Reinforcing European climate leadership through technologies and industrial strategy.

THANK YOU FOR YOUR ATTENTION

This document was presented by:

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FuelsEurope Vision 2050

A Pathway for the Evolution of the Refining Industry and Liquid Fuels

https://www.fuelseurope.eu/vision-2050/

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