RESEARCH & INNOVATION FOR EU TRANSPORT:

WHERE TO INVEST NOW FOR NET-ZERO EMISSIONS BY 2050

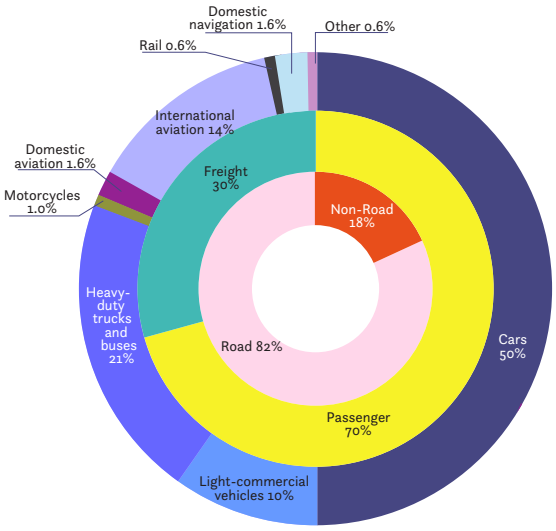
Strategic importance of decarbonising Europe's transport sector:

- Transport is responsible for nearly 30 percent of Europe's carbon emissions, more than any other sector. Road transportation accounts for nearly three-quarters of this. As more people become more mobile, transport is the only EU sector where carbon emissions are rising and are above 1990 levels.
- 14.6 million people work in the transport sector in Europe (6.4% of the total employed in EU-28 countries). An additional 3% (6.8 million) work in transportation services.
- In 2015, the transport sector accounted for about 5% of EU GDP.
- In 2017, EU transportation companies invested €58 billion in R&I.
- Europe imports 92 percent of the oil needed to fuel its transport sector — about €200 billion worth of oil for its cars, trucks, planes and ships.
- Transport pollution is causing the illness and premature deaths of hundreds of thousands of Europeans.
- Combining and aligning public research funding with private sector R&I investors, notably through challenge-based missions such as net-zero carbon cities and transport systems, can enable the decarbonisation of the economy by 2050.

Investments in innovation are key to decarbonising the transport sector

Innovation area	Priority areas for innovation investments
Society & Consumers	Development of shared mobility systems through focus on demand, lifestyles, choices, modes and technologies
	Integration of consumer behaviour data into low-carbon transport feasibility studies
Electrification	Light vehicle-based transportation systems, ports and short distance ships & planes
Green Hydrogen	Sustainable & renewable supply, comprising production, storage and use in aviation, heavy trucks & ships
	Low cost electrolysis technology
New Materials	Battery value chain, including new battery chemistries as well as the re-use and recycling of batteries
Energy Sector Integration	Electricity grid enforcements on a spatially detailed level (i.e. distribution network)
	Smart integration of EVs and charging networks in the power grid
	Retail electric markets to help deploy more EVs

EU emissions by mode/style of transport



EU-28 national transport sector CO_2 emissions (including international aviation) in 2015
Sources: European Commission, 2018; UNFCCC, 2017; European Environment Agency, 2018

Case Study

Croatian automotive company leverages EU R&I funding to shake up EV, battery markets

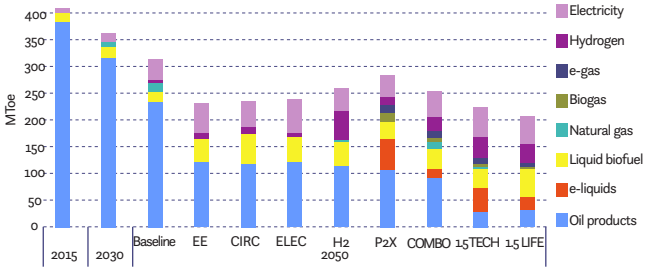
RIMAC AUTOMOBILI

Founded in 2009 and jumpstarted by Horizon Europe SME funding, Rimac Automobili is a vertically integrated company selling its Made-in-Croatia electrical parts to much larger automotive companies

- **Based outside Zagreb, it employs 550 workers.**
- **It builds electric vehicles with batteries that have a 650-kilometer range and can charge within a half-hour thanks to a 250-kilowatt fast-charging system.**
- **Recently, it received a second investment from Porsche, which now owns about 15.5% of the company.**
- **In addition to its super cars and high-voltage batteries, the company also develops:**
  - **Electric powertrains**
  - **Digital interfaces between humans and machines**
  - **Electric bikes with 100-kilometer ranges**

Commission "Clean Planet for All" strategy scenarios for 2050 all transport fuel use

Source: PRIMES, 2018



EE: Energy efficiency
CIRC: Uptake of circular economy
ELEC: Switch from direct use of fossil fuels to electricity
H2: Switch to hydrogen
P2X: Switch to e-fuels
Combo: Combines actions and technologies of the previous scenarios relying on negative emissions technologies

1.5TECH: Combines all previous technologies relying heavily on the deployment of biomass and carbon capture and storage technologies
1.5LIFE: Relies less on technology options and more on changes in consumer preferences & lifestyles to achieve a fully circular economy

"Note: Fuel consumption not to be confused with fleet composition. 1.5 scenarios correspond to a 96% EU fleet share of zero-emission cars."

"To become the world's first climate-neutral continent, Europe must reduce emissions further and faster. Transport will be a central part of the European Green Deal."

Ursula von der Leyen,
President-elect of the European Commission

NET ZERO 2050

RESEARCH & INNOVATION FOR EU TRANSPORT:

ALIGNED POLICY ENVIRONMENT REQUIRED TO SCALE-UP INVESTMENTS

Net-zero emissions European transport by 2050 is achievable

Electrification and electrofuels are essential to deliver a zero emissions transport sector by 2050. Therefore, the following technologies need to be prioritised:

1. Road Transport: Zero-emission vehicle technology, i.e. battery-electric & fuel cell vehicles
2. Trains: Electrification of railways, hydrogen fuel cell locomotives
3. Shipping: Battery-electric and green hydrogen/ ammonia-based propulsion systems, including fuel cells
4. Aviation: Breakthrough fuels, such as synthetic e-fuels produced from additional renewable electricity

Demand side R&I priorities

- Societal and business model innovation to grow e-mobility services and encourage:
  - Increased uptake of low carbon alternatives and healthier lifestyles;
  - Acceptance, security and good governance of automated vehicles, with more smart sensors, 3D HD maps, and advanced data-processing.
- Facilitate inter-modal shifts to lower emissions solutions and increase sharing and pooling:
  - Optimise transport demand and encourage soft mobility modes (e.g. walking, cycling, clean buses, trains)
  - Improved digital infrastructures, interconnectivity and interoperability for competitive logistics and supply chains; and
  - Big Data, Internet of Things (IoT), artificial intelligence, and advanced satellite navigation services (Galileo/EGNOS).

Supply side R&I priorities

- Provide zero-emission mobility and logistics by developing:
  - Clean road vehicles technologies, vehicle management systems, advanced and digital manufacturing technologies, and their infrastructure;
  - Systemic technologies to integrate clean vehicles and new system services;
  - Low-carbon and digital rail transport solutions that reduce congestion, improve energy security and innovate new ways to manufacture locomotives.
- Accelerate aviation decarbonisation technologies (eg. H2, electric & volocopters) and improve operational procedures.
- Deliver competitive and low carbon maritime solutions:
  - Hybrid & full battery electric, fuel cell and low-carbon fuel propulsion;
  - On-board renewable energy, improved vessel design, and automation;
  - Floating ports using renewables and new capacity management for mega ships.

R&I investments need an aligned policy environment to decarbonise transport

1. Exponentially increase the share of zero emission electricity at low cost
2. Improve performance standards for fuel efficiency/ tailpipe CO_2 emissions
3. New EU gas decarbonisation strategy designed to foster the deployment of e-fuels in shipping and aviation
4. Implement sustainable production standards for the sourcing of raw materials, battery manufacturing, circularity and end-of-life recycling
5. Public lending, subsidies, grants, or guarantees (where private investment is unavailable) to speed up the deployment of enabling infrastructure
6. Ensure that taxation and regulations on vehicle sales are in line with the objective to achieve climate neutrality by 2050
7. Implement policies to support the standardization of charging infrastructure

Case Study

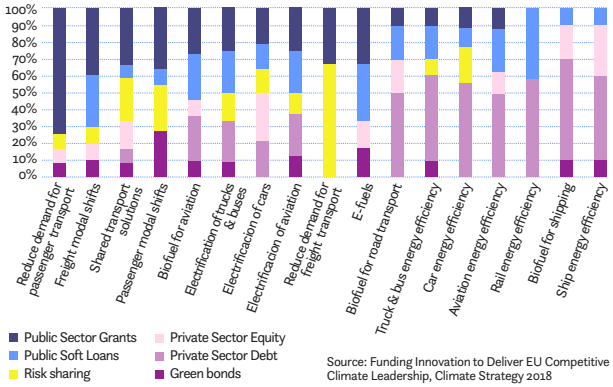
HySeasIII

Plying the high seas with hydrogen-powered ferries

Consortium HySeas III intends to convert surplus wind power from the Orkney Islands (Scotland) and convert it to hydrogen to power the local car and passenger ferry boat.

- ✓ **Its technology resembles the hydrogen fuel cell-battery hybrid power system used in buses.**
- ✓ **The only byproduct from the production and use of HySeas III's hydrogen fuel is water.**
- ✓ **If successful, this cutting-edge maritime transport project could help boost the economies of coastal communities.**
- ✓ **And help position the EU as a global leader in the hydrogen-powered maritime transport and shipping industry.**
- ✓ **HySeas III has received €9 million in funding from the EU R&I programme Horizon 2020.**

Finance Instruments needed to decarbonise EU transport according to expert survey



Source: Funding Innovation to Deliver EU Competitive Climate Leadership, Climate Strategy 2018

Participant Institutions:

CLIMATE & STRATEGY PARTNERS

TRANSPORT & ENVIRONMENT

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E3G

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This report has been commissioned by the European Climate Foundation (ECF). It is part of the Net-Zero 2050 series, an initiative of the ECF with contributions from a consortium of experts and organisations. The objective of Net-Zero 2050 is to start building a vision and evidence base for the transition to net-zero emission societies in Europe and beyond, by mid-century at the latest. The Paris Agreement commits us to making this transition, and long-term strategic planning shows that many of the decisions and actions needed to get us on track must be taken imminently. With acknowledgement of the source, reproduction of all or part of the publication is authorised, except for commercial purposes. For more information, please contact Erica Hope, Erica.Hope@europeanclimate.org