

Zero Emission: Details of Hydrogen Use In Heavy Goods Vehicles

ECTA Webinar
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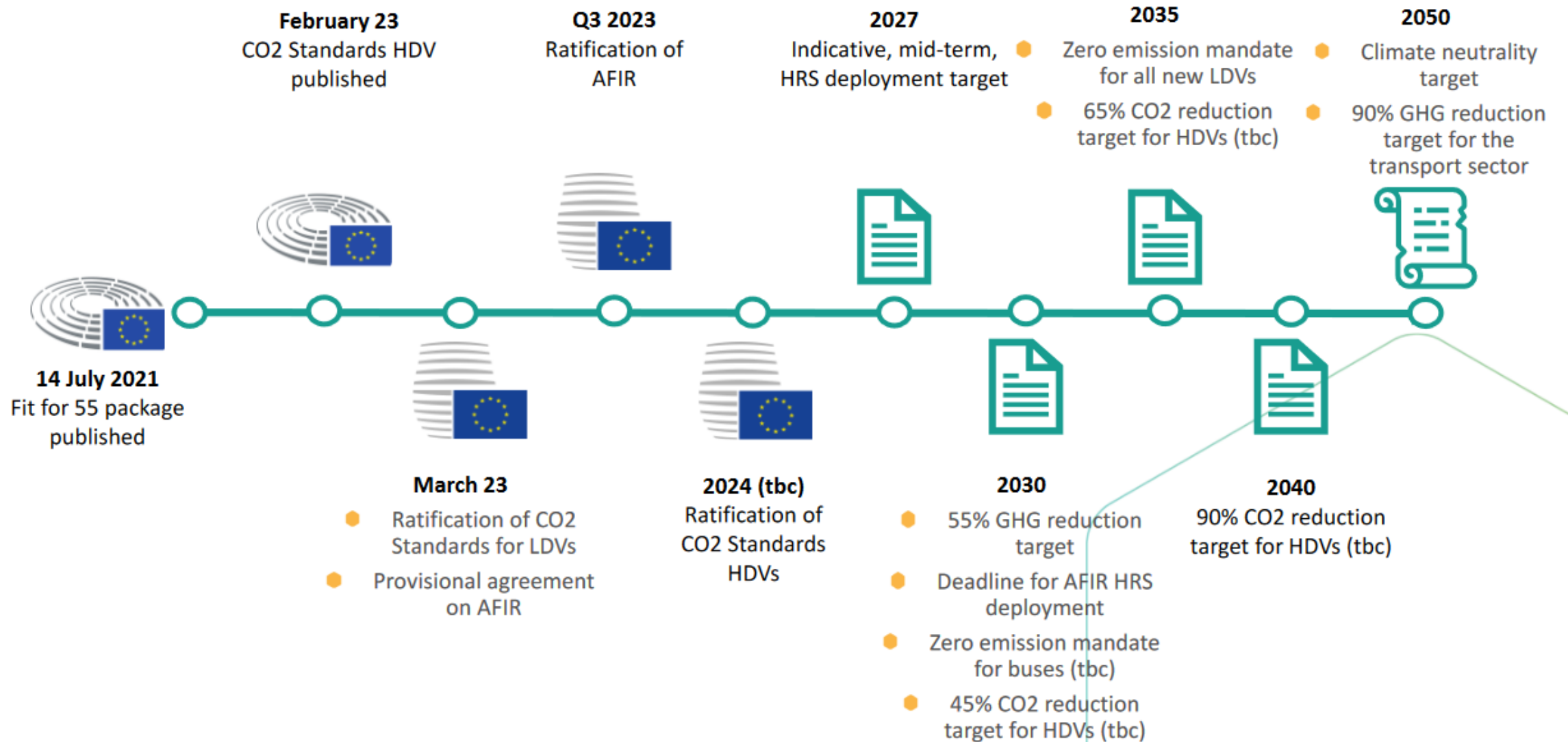
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Topics covered

1. EU legislation update: standards for HDVs, renewable energy targets, definition of renewable hydrogen, emission savings threshold for advanced biofuels, methodology calculation and updated legislation on decarbonized road transport
 - Renewable Energy Directive (RED 3)
 - EU Delegated Act for Renewable gaseous and liquid transport Fuels of Non Biological Origin (RFNBOs)
 - EU Delegated Act on Recycled Carbon Fuels (advanced biofuels) and GHG emissions calculation methodology
2. Revised EU Emissions Trading Scheme (ETS 2) covering transport, building and other small sectors not covered by current ETS scheme
3. Implication and new standards for road transport sector
4. ISO 14083
5. Hydrogen use cases in transport sector and Lhyfe's proposal

Legislation on decarbonized road transport - Timeline overview



▶ Renewable Energy Directive 2023 (RED 3)

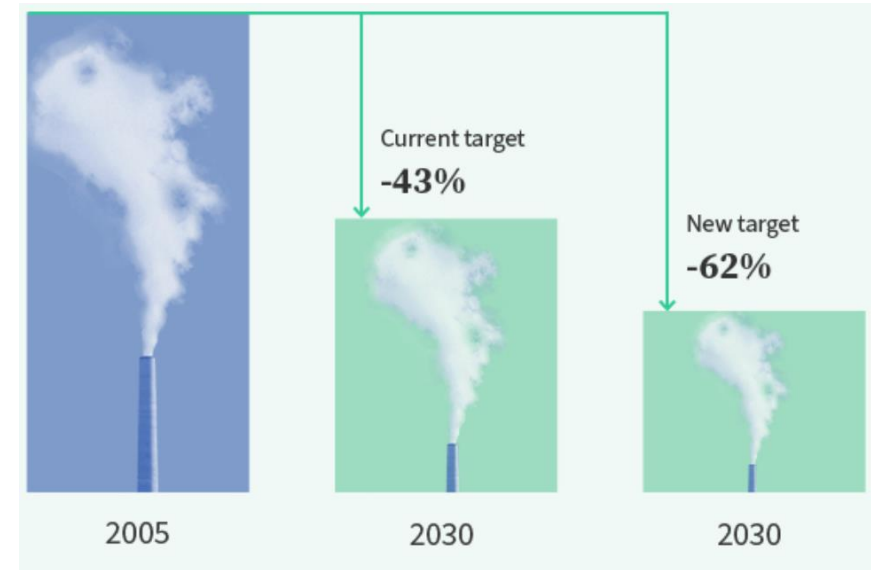
- On 12 September 2023, the EU formally approved amendments to the Renewable Energy Directive (RED 3)
- RED 3 legislation sets minimum legally **binding targets for renewable energies** in the final EU energy consumption to **42,5% by 2030** (up from 32% in RED2). Currently it stands at 22%. Wind (offshore/onshore) and solar will play a major role
 - **For transport sector, renewables target raised to 29%** (from 14% in RED 2, 2018). Includes all fuels and electricity supplied to the transport sector (road, rail, aviation and shipping)
 - **Renewables in the transport sector to reduce emissions by 14,5% by 2030 (compared to 2005 levels)** by using advanced biofuels (Recycled Carbon Fuels or RCFs) and renewable hydrogen (Renewable gaseous or liquid transport Fuels of Non-Biological Origin or RFNBO) => **for HDV transport 45% CO2 reduction target by 2030**
- **Renewable Hydrogen** and advanced biofuels recognized as key to the implementation of renewables across Europe, especially in sectors **where direct electrification is not possible.**
- Delegated Acts published in June 2023
 - 1) Renewable liquid or gaseous Fuels of Non-Biological Origin or RFNBO: defines renewable hydrogen and details the rules under which it can be produced
 - 2) Definition of Recycled Carbon Fuels (advanced biofuels) and CO2 emissions calculation methodology
- RED 3 therefore sets out Union-wide binding targets for the use of RFNBOs and RCFs and provides a **level playing field** for imports and local production

Definition of renewable (green) hydrogen (RFNBO), recycled carbon and min GHG emissions savings required

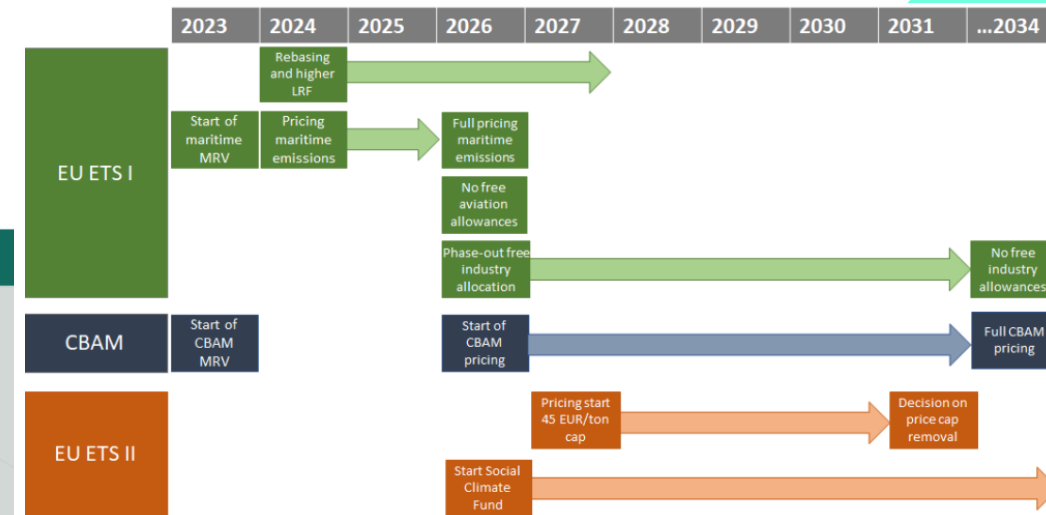
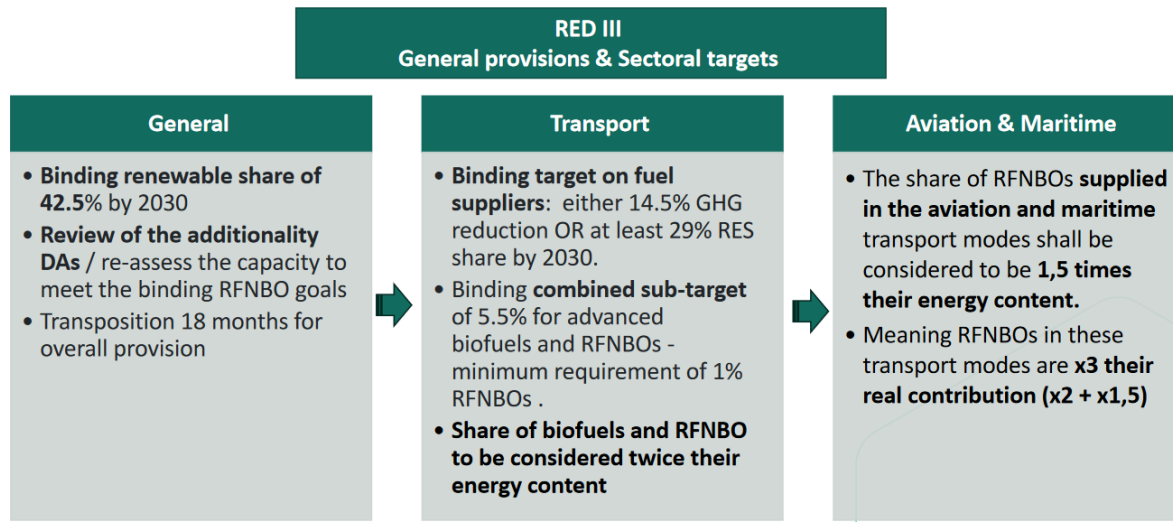
- EU commission Delegated Act 2023/1184 for Renewable gaseous or liquid transport Fuels on Non-Biological Origin (RFNBO) => renewable hydrogen
- General principle: **renewable hydrogen** is produced by water electrolysis **using renewable electricity**
- **Recycled carbon fuels (RCF)** or advanced biofuels/e-fuels: produced with CO₂
- **Advanced biofuels** to increase use of waste and residue (non food) feedstock, cap on crop based biofuels remains at 1,7%
- **GHG savings** from RCFs and RFNBOs to **meet min 70% threshold** compared to fossil fuel comparator (**renewable H₂ will bring CO₂ savings of over 90%**)
- **Fossil Fuel comparator:** 94 gCO₂/MJ (11,28 KgCO₂eq/Kg H₂): RFNBOs and RCF to meet min threshold of 28,2 gCO₂/MJ to be considered low carbon/renewable. LHV to be considered for H₂: 120 MJ/Kg, 33,33 KWh/Kg, 3,6 MJ/KWh
- Emissions intensity from renewable energy producing assets are considered to be **zero**
- **Production and transport** of product to customer is included in the GHG emissions calculation

EU Emissions Trading Scheme boosted (ETS 2)

- ETS is a cornerstone for the Fit for 55 agreement (55% CO2 reduction target by 2030)
- **Current ETS covers around 40%** of EU's total emissions (includes energy sector, industrial installations and aviation)
- **Current ETS targets reviewed**
 - **62% CO2 emissions reduction by 2030** (compared to 2005 levels); up from previous target of 43% reduction
 - **Maritime sector included:** until 2026 only larger vessels > 5000T gross tonnage; smaller vessels thereafter
 - **Phase out of free CO2 emissions allowances detailed** (CO2 credit): industry by 2034, aviation and maritime by 2026
 - **Stricter rules for industry** (obligation to have energy audits and a decarbonisation plan). Additional fees for non-compliance
- **ETS extended:** New ETS (called ETS 2), includes buildings, road transport and additional sectors (to be defined)
 - **All road transport** included
 - **Monitoring, reporting and verification (MRV) starts in 2025;** CO2 pricing launched in 2027
 - **Price cap of 45 eur/T CO2 until 2030**



Source: European Union

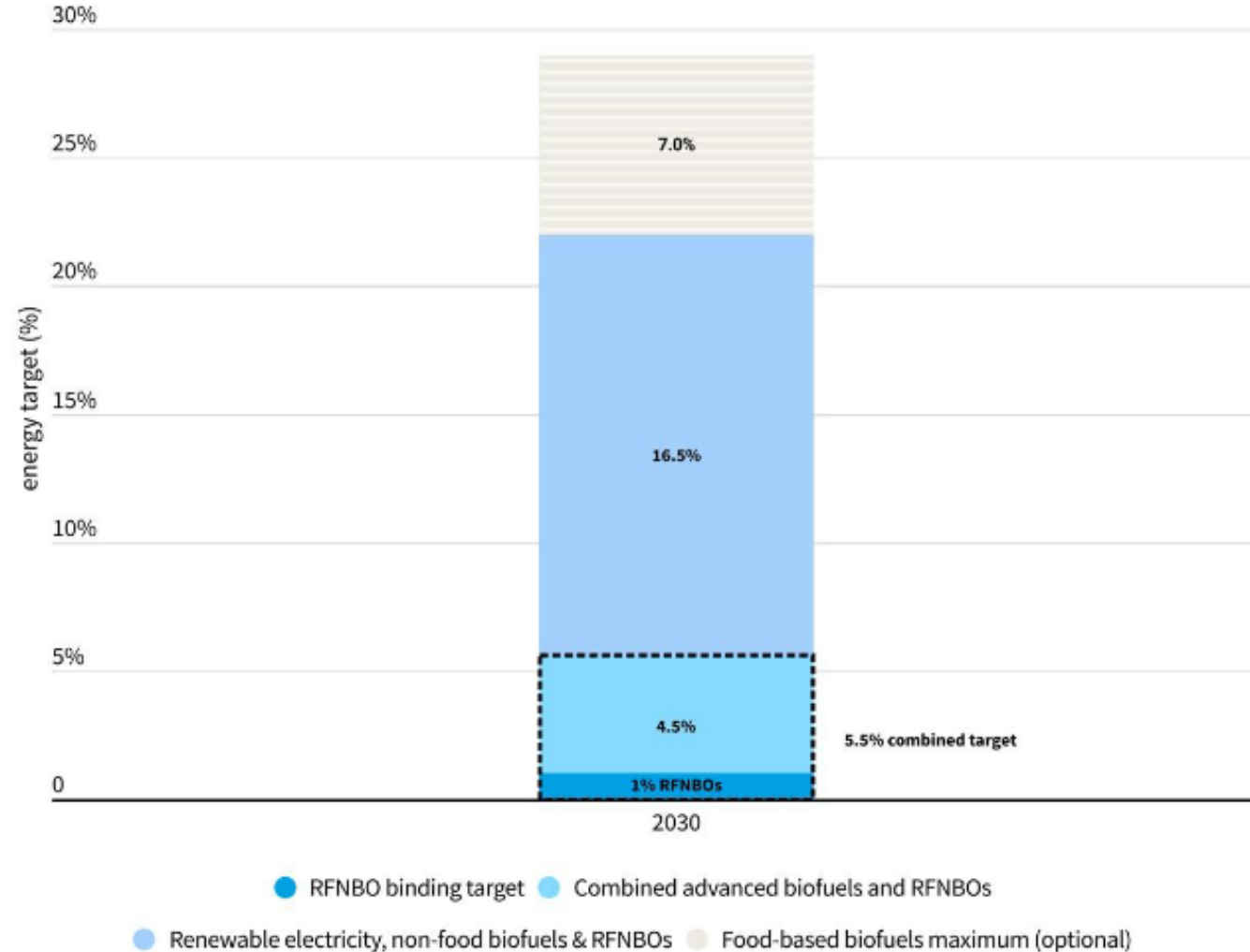


Source: Carboner

Sector targets for Renewable Fuels of Non-Biological Origin and Recycled Carbon Fuels

Sector		2025	2030	2032	2034	2035
Industry	Replacing fossil based hydrogen (grey)		42%			60%
Road Transport	RFNBO and biofuels considered	1%	5,5% (minimum 1% for RFNBO)			
Aviation	Intra EU airports		1,2%	2%		
Maritime	Intra EU ports		1,2% (soft target)		2% (hard target)	

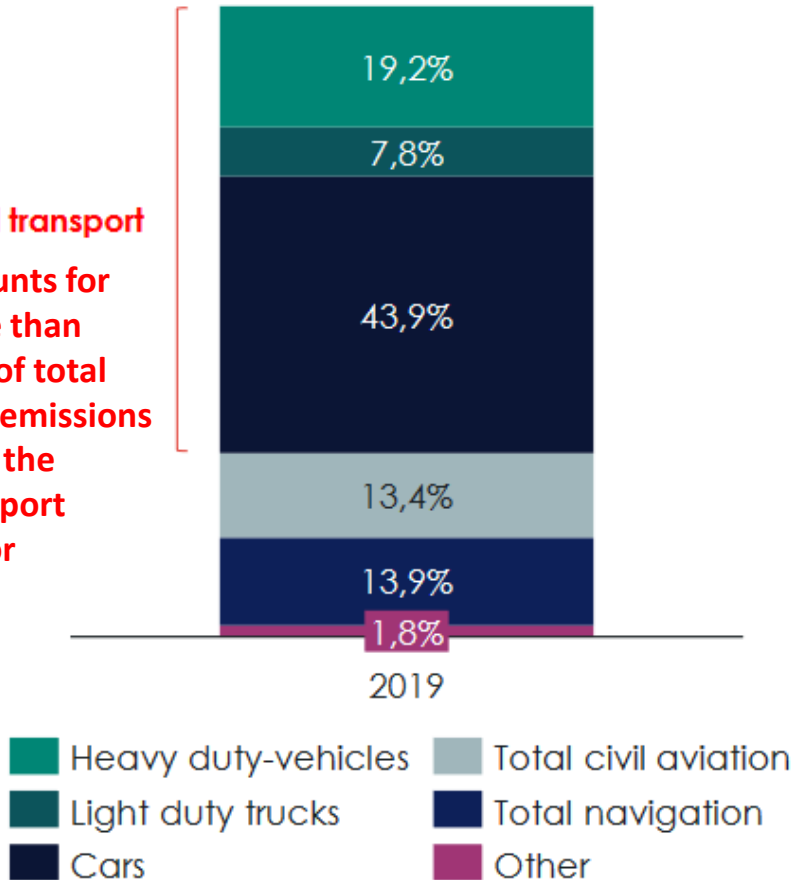
- **Binding target:** combined sub target for green hydrogen and advanced biofuels for road transport of 5.5% by 2030, of which at least 1% needs to be supplied by Renewable Fuels of Non-Biological Origin (RFNBOs), i.e. green hydrogen and e-fuels
- **Maritime:** fossil based low carbon fuels allowed
- **Aviation:** sustainable (low carbon) fuels
- **Certification scheme** for RFNBO to be centralized at EU level (mass balance)



Why transport sector and impact of new legislation

Share of GHG emissions in the transport sector by mode

Road transport accounts for more than 70% of total GHG emissions from the transport sector



Source: [European Commission](#) / [EEA](#)

New standards for new HDVs (CO2 reduction)

	Old text	New proposal
2025	-15%	-15% (maintained from old text)
2030	-30%	-45% (100% target for buses)
2035	n/a	-65%
2040	n/a	-90%

- Emission Standards only apply to new vehicle registrations and are meant to encourage fleet renewal, replacing older vehicles with new zero emission ones
- Two separate standards: Light-Duty (cars, vans) and Heavy-Duty (trucks, buses, coaches)
- LDV file ratified despite DE-led row on eFuels
- Eligible technologies for HDV Standards: battery electric, fuel cell, (monofuel/dualfuel) H2ICE

Impact assessment CO2 Standards on new HDVs sales by type (proportion of new vehicles sold)

Type	2030				
	Diesel	Gas	PHEV	BEV	H2
[5-7.5] t	54.5%	11.0%	19.5%	13.0%	2.0%
[7.5-16] t	45.5%	9.5%	13.5%	27.5%	4.0%
> 16 t	60.5%	11.0%	0.5%	12.5%	15.5%

- European Automobile Manufacturers' Association (ACEA) anticipates 70 000 new H2 vehicles required by 2030

▶ Standard for HDVs weight and length updated

Diesel road train: 40t



H2 road train: 44t



Longer wheelbase with additional axle reduces axle load for better weight distribution and creates enough space for fitting H2 tanks

- 90cm length allowance for zero emission vehicles
- Weight allowance of zero emission, five or six axle vehicle combinations increased to 4t (=44t max weight)
- Weight allowance of drive axle of vehicle combinations and zero emission two axle buses increased to 12,5t (= +1t)
- Sunset clause for diesel trucks involved in intermodal operations in 2034

What about ADR for BEV/FCEV/H2ICE/Dual Fuel transport in the chemical sector

▶ After legislation comes the infrastructure

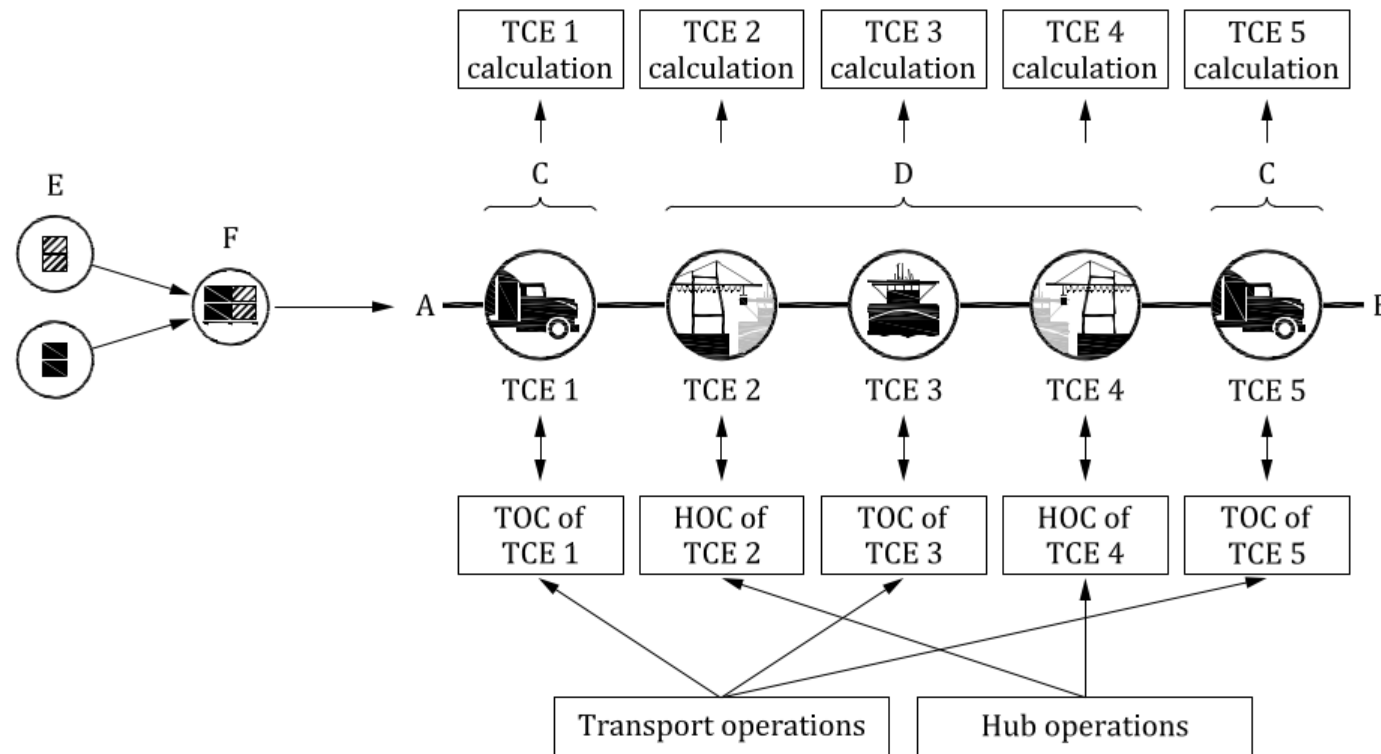
- Law ratified for Alternative Fuel Infrastructure deployment (**AFIR**) along the Trans European Transport Network (**TEN-T**)

- TEN-T Regulation **defines timelines and standards** for establishing of Europe-wide network of transport infrastructure for all modes
- **mandatory** deployment targets for **electric recharging and hydrogen refueling** infrastructure for the road sector
- It determines **eligibility for funding** under the CEF Transport envelope (Connecting Europe Facility), including AFIF (Alternative Fuels Infrastructure Facility)
- **657 HRS stations needed along** core network by **2030**
 - 424 HRS needed in urban nodes
 - 233 HRS needed along TEN-T core networks every 200km
- **Priorities**
 - Increase the share of **sustainable modes of transport** for freight and passengers
 - **Deploy infrastructure** for zero and low emission vehicles
 - Improve connectivity, digitalization and efficiency



ISO 14083: Greenhouse gases - Quantification and reporting of greenhouse gas emissions arising from transport chain operations

- Scope: transport chain operations (passenger and freight), includes logistic hubs
- All modes: land, sea, air
- All means (vessel, pipeline, vehicle, aircraft)
- Includes back haul
- Fuel feedstock emissions (production and distribution) are included
- ISO 14083 gives a global framework and guidelines for calculating GHG emissions across the transport chain (scope 2 & 3 level)



ISO 14083: Greenhouse gases - Quantification and reporting of greenhouse gas emissions arising from transport chain operations

The Processes included

- vehicle operational processes
- hub equipment operational processes
- vehicle energy provision processes
- hub equipment energy provision processes
- loaded and empty trips made by vehicle, hence including diversionary and/or out-of-route distance;
- start-up and idling of vehicles, pipelines, transshipment and (de)boarding equipment;
- cleaning/flushing operations for pipelines;
- combustion and/or leakage of energy carriers at vehicle or hub equipment level;
- leakage of refrigerants used by vehicles or hubs.

Processes not included

- production and supply processes of refrigerants
- waste produced;
- processes at the administrative (overhead) level of the organizations involved in the transport services;
- processes for the construction (e.g. embedded GHG emissions associated with vehicle production), maintenance, and scrapping of vehicles or transshipment and (de)boarding equipment;
- processes of construction, service, maintenance, and dismantling of transport infrastructures used by vehicles (e.g. roads, inland waterways, rail infrastructure) or transshipment and (de)boarding infrastructure;
- businesses co-located within a hub such as retail and hospitality services, whose functions are severable and incidental to the transportation operation of the hub.

➤ **Carbon offsetting and GHG emissions trading are not to be taken into account for quantification and reporting of GHG emissions from transport operations**

Emissions aspects in transport chains		EN 16258 (EU)	GLEC 2.0 (Global)	ISO 14083 (Global)
Transport Type	Freight and passenger	✓	✓	✓
Transport chain elements	Transport operations	✓	✓	✓
	Hub operations (WH, terminals, DC, ports)		✓	✓*
Transport modes	Air, rail, road, water (sea, waterways)	✓	✓	✓
	Pipelines			✓
	Cable car			✓
Emission sources	Energy consumption of the vehicles (WTT, TTW)	✓	✓	✓
	Emissions from auxiliary processes		✓	✓
	Fuel spills			✓
	Empty trips	✓	✓	✓
	Energy consumption of logistic sites processes		✓	✓
	Refrigerants leakages (transport and logistics sites)		✓	✓
	Repackaging services and packaging waste			✓
	IT services			✓
Reporting	Reporting requirements			✓
	Reporting templates			✓
Out of scope	Offsetting		✓	✓
	Production / Disposal infrastructure of refrigerants		✓	✓
	Emissions from capital goods (manufacturing of vehicles)		✓	✓
	Construction of transport infrastructure		✓	✓
	Administrative overheads (staff commuting, business trips, computer systems, and the operation of office buildings unrelated to logistics)		✓	✓
	Emissions from upstream leased assets		✓	✓
Default emission factors values and recommended sources for emission factors		✓	✓	✓

* Unlike GLEC 2.0, ISO 14083 considers emissions from storage as voluntary for calculating and reporting

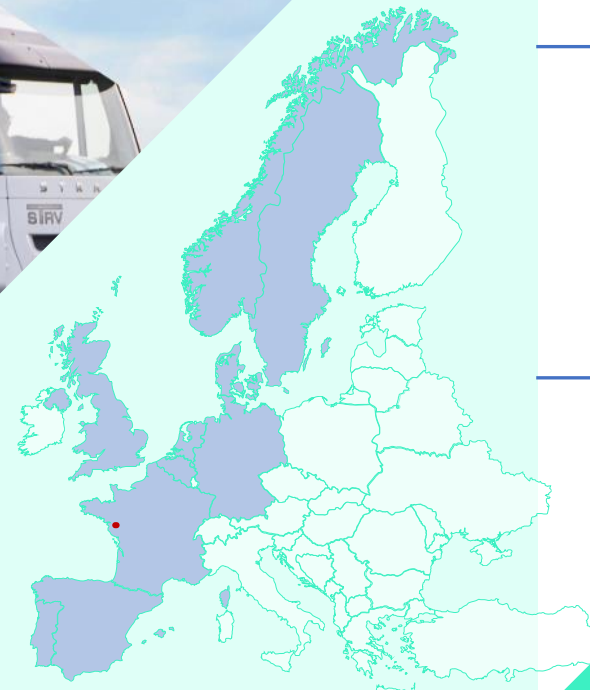
Lhyfe, Producer & Supplier of Green & Renewable Hydrogen



• **200+**
Talented
people (End 2023)

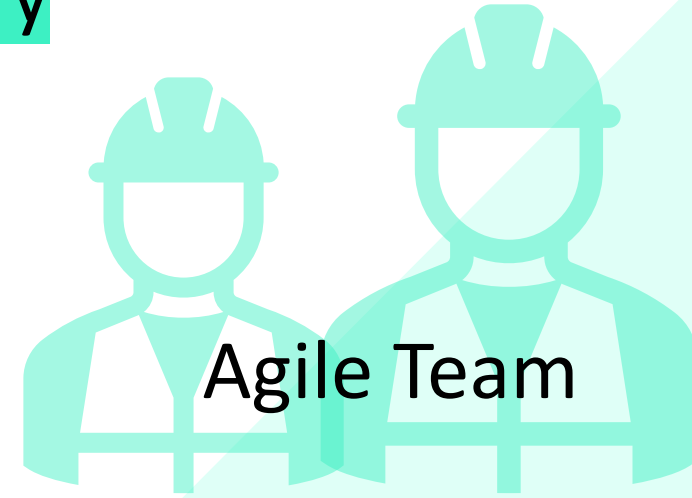
Independent company
founded in
• **2017**

• **12**
Countries



A Pure Hydrogen Player

Our Expertise: From Development to H2 Delivery



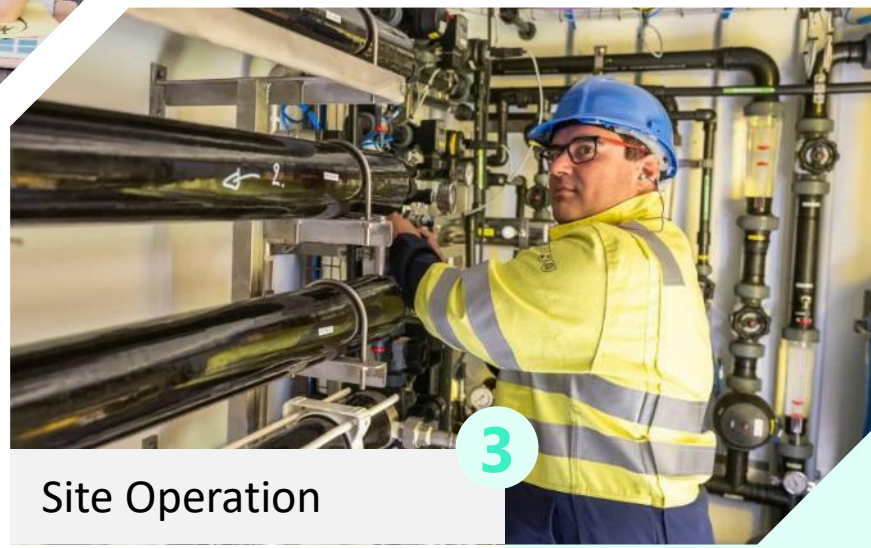
Project Development

1



Plant Construction

2



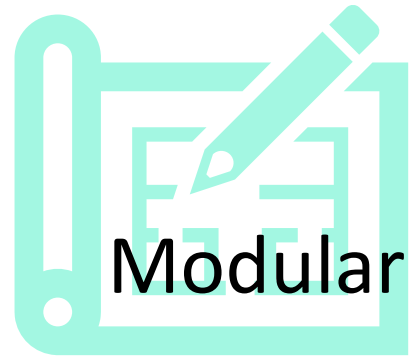
Site Operation

3



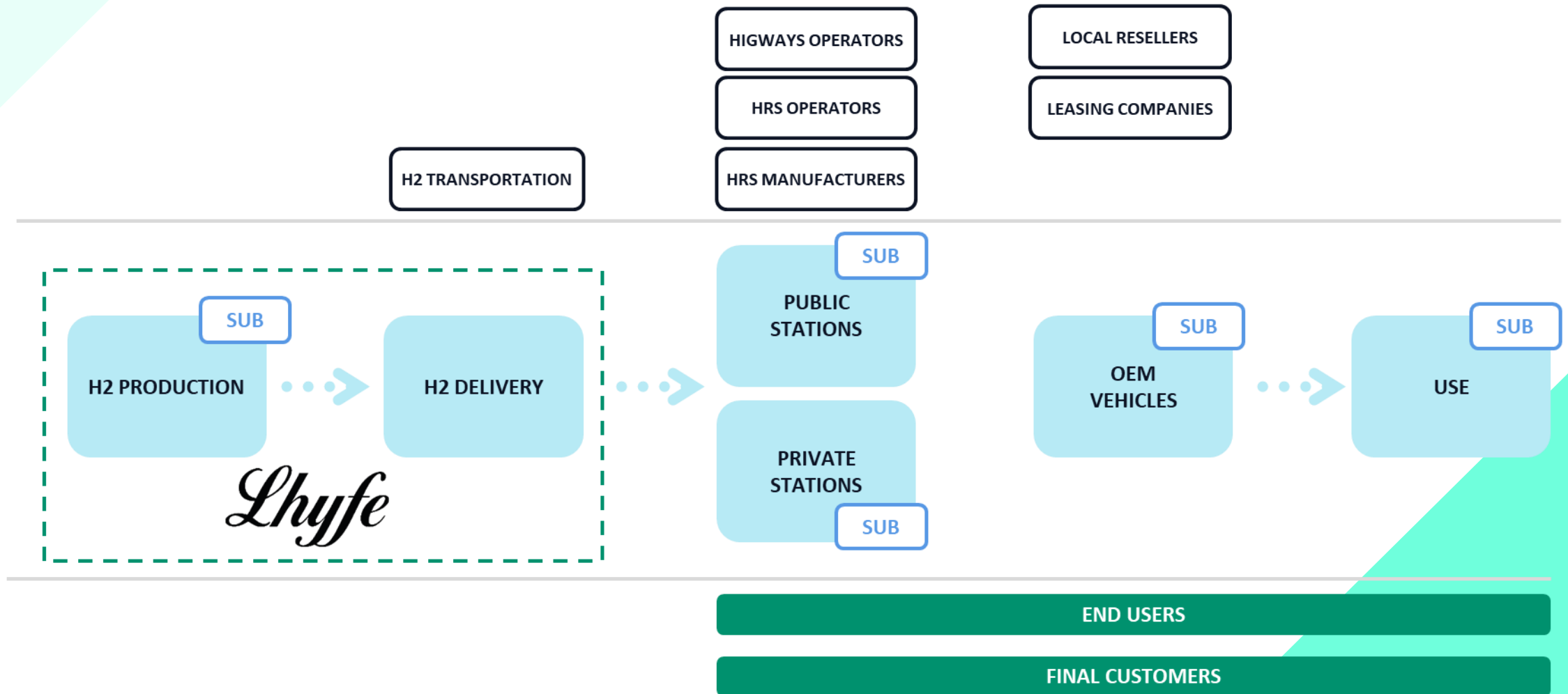
Hydrogen Delivery

4



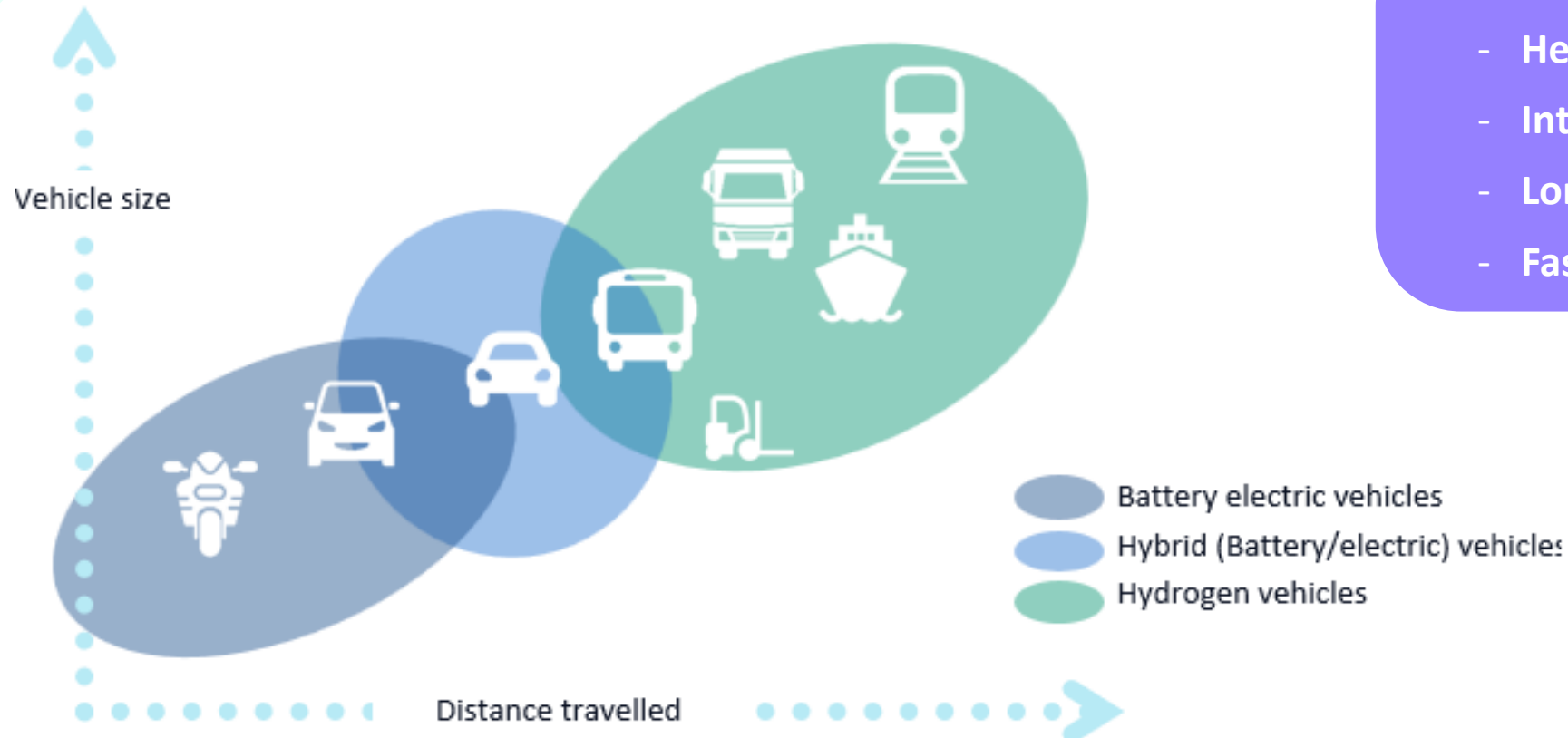
Modular Design

▶ Lhyfe in the hydrogen value chain



- Lhyfe is an independent pure player renewable H2 producer and supplier
- Developing H2 production network (every 300km) to serve mobility customers
- Working on building ecosystems and partnerships in the H2 value chain

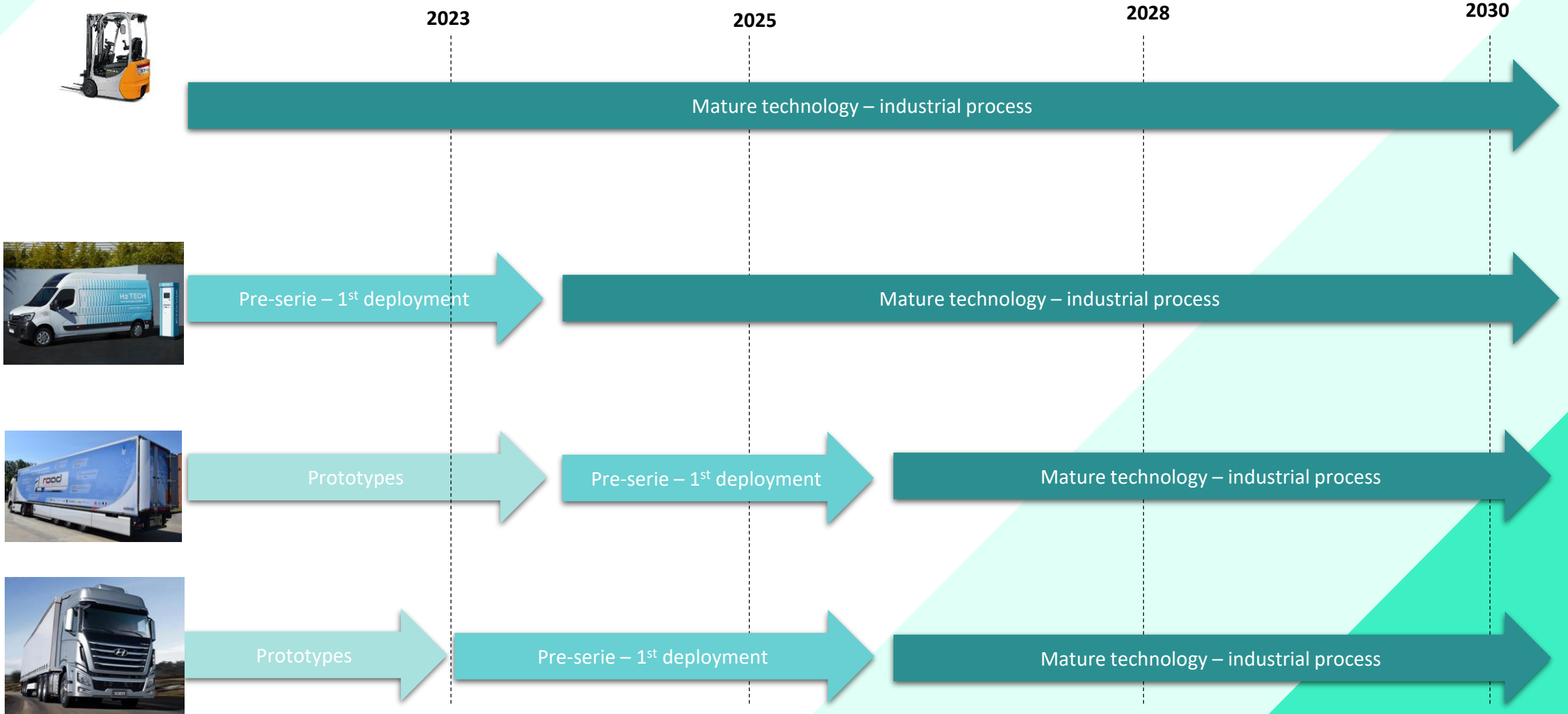
The position of renewable hydrogen as a fuel in a renewable energy system



Use-cases for Hydrogen mobility:

- Heavy Duty
- Intensive use
- Long range
- Fast refueling

► Maturity for each technology





The position of renewable hydrogen as a fuel for transport

Well-to-wheel emissions of truck trailer (GVW 40 tonne) with different fuels and drivelines (Netherlands)

Source: Outlook Hinterland and Continental Freight 2020, CE Delft, TNO

	MJ/km	WTW g CO ₂ -eq/Mj	WTW CO ₂ -eq/km	0	500	1000	1500	2000
Diesel	11.1	95	1,051					
LPG	12.0	74	886					
CNG	10.5	69	728					
LNG	10.5	75	783					
FCEV-PEM (H ₂ -gas)	9.2	105	964					
FCEV-PEM (H ₂ -average electricity)	9.2	205	1,880					
BEV (electricity-average mix)	6.1	133	811					
Biodiesel (FAME, HVO)	11,1	14	149					
Bio-CNG	10.5	24	252					
Bio-LNG	10,5	29	307					
FCEV-PEM (H ₂ -wind energy)	9.2	6	54					
BEV (electricity-wind enery)	6.1	4	23					

H2 can be produced when power from wind and solar is available and stored for supply when needed

At current power grid carbon intensity

Renewable H2

Realistic? Wind and Solar not always available

▶ H2 stations available in Europe (350 bar HD)



- Total 350 bar 70 stations operational for heavy duty (out of total 233)
- New to be operational: 73 stations at 350 bar vs 42 stations at 700 bar
- Price range at the pump: 9,99 eur/kg (very few) to 21,8 eur/Kg. Average price 13 to 15 eur/kg
- Price forecast at HRS
 - Infrastructure needs
 - Utilization rates ramp up
 - OEM offering for transport companies
 - 15 years lifetime
 - 40% price decrease at pump expected by 2030, linked to utilization rate: 7,7 to 9,7 eur/kg

► Experience: 1st **OPERATIONAL SITE: BOUIN (FRANCE)**

Our 1st production unit in Bouin, France – in operation since summer 2021
2.5 MW – 1 t/d H₂
Mostly dedicated to serve the local mobility market



3 wind mills
directly connected to the
production unit

Operation centre for remote supervision
and R&D

6 filling stands
For loading Tube trailers / Containers

Underground cable 20 kV
Direct connection

Pumped sea water =
raw material



Vendée: The emergence of a renewable hydrogen region



60 km

Bouin Plant <>
Roche sur Yon filling station

200 kilos a day

Quantity of hydrogen that the station can supply

STATION MULTI-ÉNERGIES VERTES
& LOCALES POUR UNE MOBILITÉ DÉCARBONÉE

BIBREVÉ ÉLECTRICITÉ VERTÉ HYDROGÈNE VERT H2

Selection of recent projects for mobility





Lhyfe

Lhyfe

23
104

S1RV

450

S1RV

WECO

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