THE FAST TRACK TO THE HYDROGEN ECONOMY

EUROPEAN HYDROGEN ENERGY CONFERENCE

EHEC 2024
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AeH2
SPANISH HYDROGEN ASSOCIATION

HYDROGEN USES IN INDUSTRY AND MOBILITY: CAF GROUP DEVELOPMENTS

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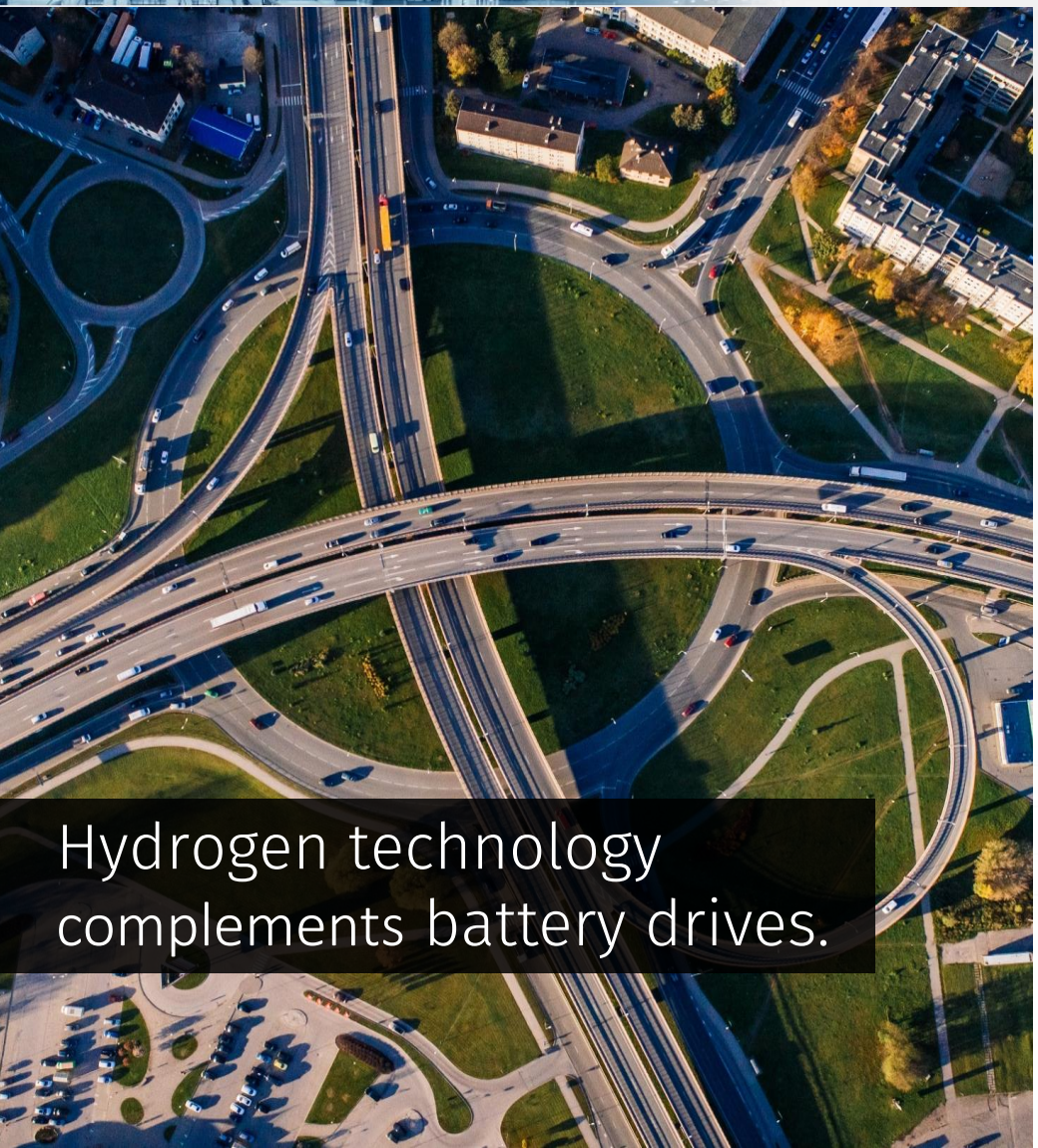
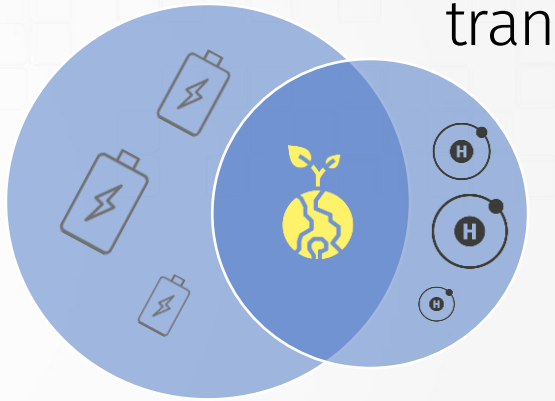


Hydrogen technology complements battery drives.

E-mobility is the future

The synergy of the development of all electro-mobility branches is indispensable to ensure efficient decarbonisation of transport.



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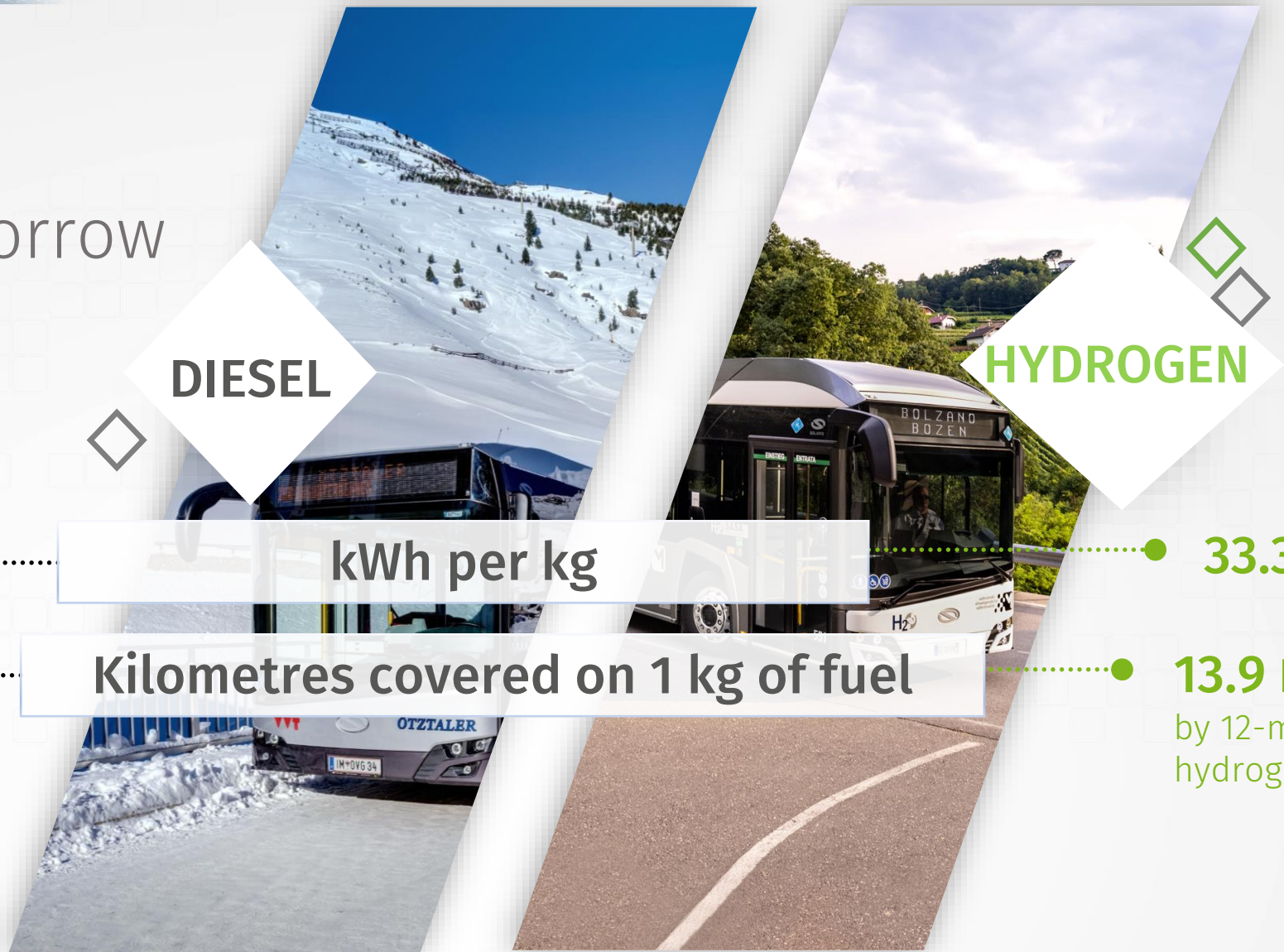
Hydrogen

The fuel of tomorrow



DIESEL		HYDROGEN
12.2 kWh/kg	kWh per kg	33.3 kWh/kg
3.3 km by 12-metres diesel bus	Kilometres covered on 1 kg of fuel	13.9 km by 12-meter hydrogen bus

When to use **hydrogen?**

Hydrogen-powered vehicles are best suited for the following applications and requirements:

Long-range

Heavier loads

Routes requiring **fast refueling**

A great need for **flexibility**

Why to use **hydrogen?**

- All the advantages of an electric drive
  - completely emission-free driving
  - extremely quiet
  - vibration free
- Wide range
  – 350 km for urban buses and up to 800km for trains
- Fast refueling
  – about 10 minutes for buses and 20 minutes for trains
- Hydrogen fuel cell guarantees reduction of carbon emissions, the only by-product of the chemical reaction taking place in the hydrogen cell is water

Deployment **barriers**

- High upfront costs (comparing to ICE and BE)
- Limited hydrogen resources
- Technological barriers

Hydrogen buses
in Solaris offer

Length:
12 m

Solaris Urbino
12 hydrogen

Length:
18 m

Urbino 12 hydrogen

BALLARD FC-MOVE

57%

60-80°C

temperature of the coolant in the cell at stabilized operation

- Rated power **70 kW**
- Maximum efficiency **57%**
- Estimated lifetime of the product **>30 000 man-hours**
- Storage at temperatures down to -**40°C**
- Cold start **from -25°C** (no need for preconditioning or external power supply)
- Operation in temperatures **-30°C to +50°C**
- No need for external power supply

Urbino 18 hydrogen

- Rated power
  100 kW
- Maximum efficiency
  57%
- Estimated lifetime of the product
  >30 000 man-hours
- Storage at temperatures
  -40°C to +80°C
- Cold start
  from -25°C (No need for preconditioning and external power supply)
- Operation in temperatures
  -30°C to +50°C
- No need for external power supply

57%

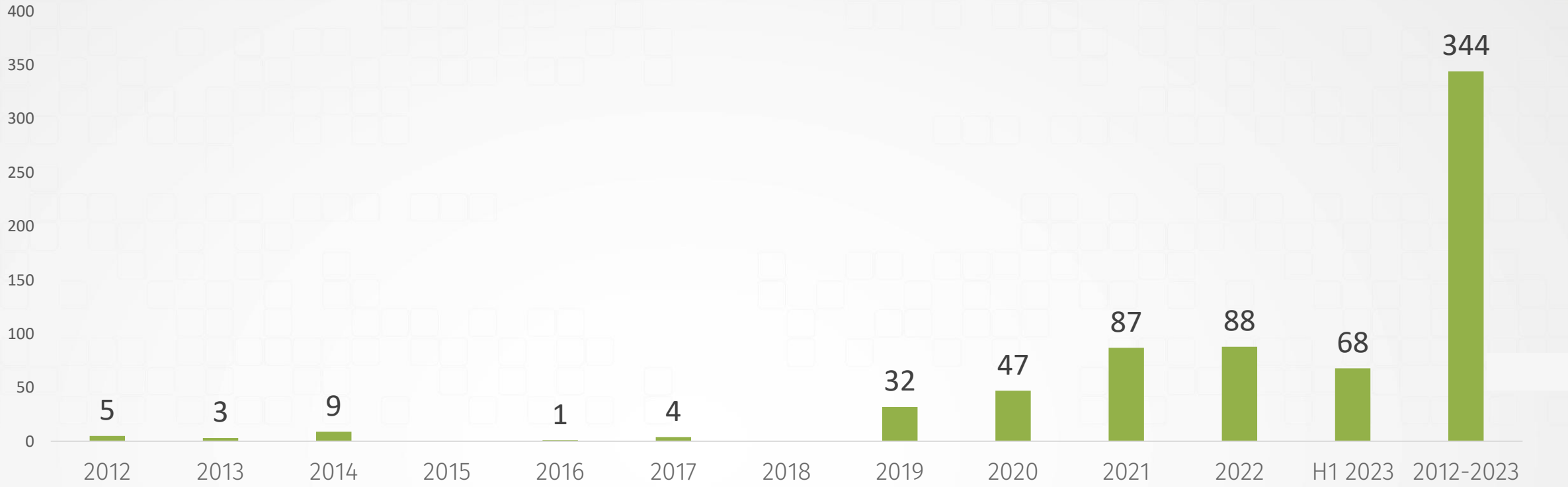
60-80°C

temperature of the coolant in the fuel cell at stabilized operation

BALLARD FCmove™-HD+

Hydrogen drives – dynamically growing trend

34% Solaris cumulated market share, 2012-H1 2023



Newly registered hydrogen buses in Western Europe+Poland, without UK and Ireland, 2012-2019, EU+UK+NO+CH in 2020-2023, Source: CME Solutions

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Hydrogen Solaris buses
on the roads of European cities

40
customers

710 Urbino hydrogen

- **180** delivered
- **530** contracted

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Hydrogen Solaris buses

delivered

180

Urbino 12 hydrogen

Villach, **Austria**

Richard Wien, **Austria**

Lyon, **France**

Bolzano, **Italy**

Venezia, **Italy**

Cologne, **Germany**

Hofolding, **Germany**

Groß-Zimmern, **Germany**

Frankfurt, **Germany**

Wuppertal, **Germany**

Weimar, **Germany**

Arnhem, **Netherlands**

Doetinchem, **Netherlands**

Konin, **Poland**

Lublin, **Poland**

Poznan, **Poland**

Bratislava, **Slovakia**

Madrid, **Spain**

Palma de Mallorca, **Spain**

Sandviken, **Sweden**

Lucern, Zug, **Switzerland**

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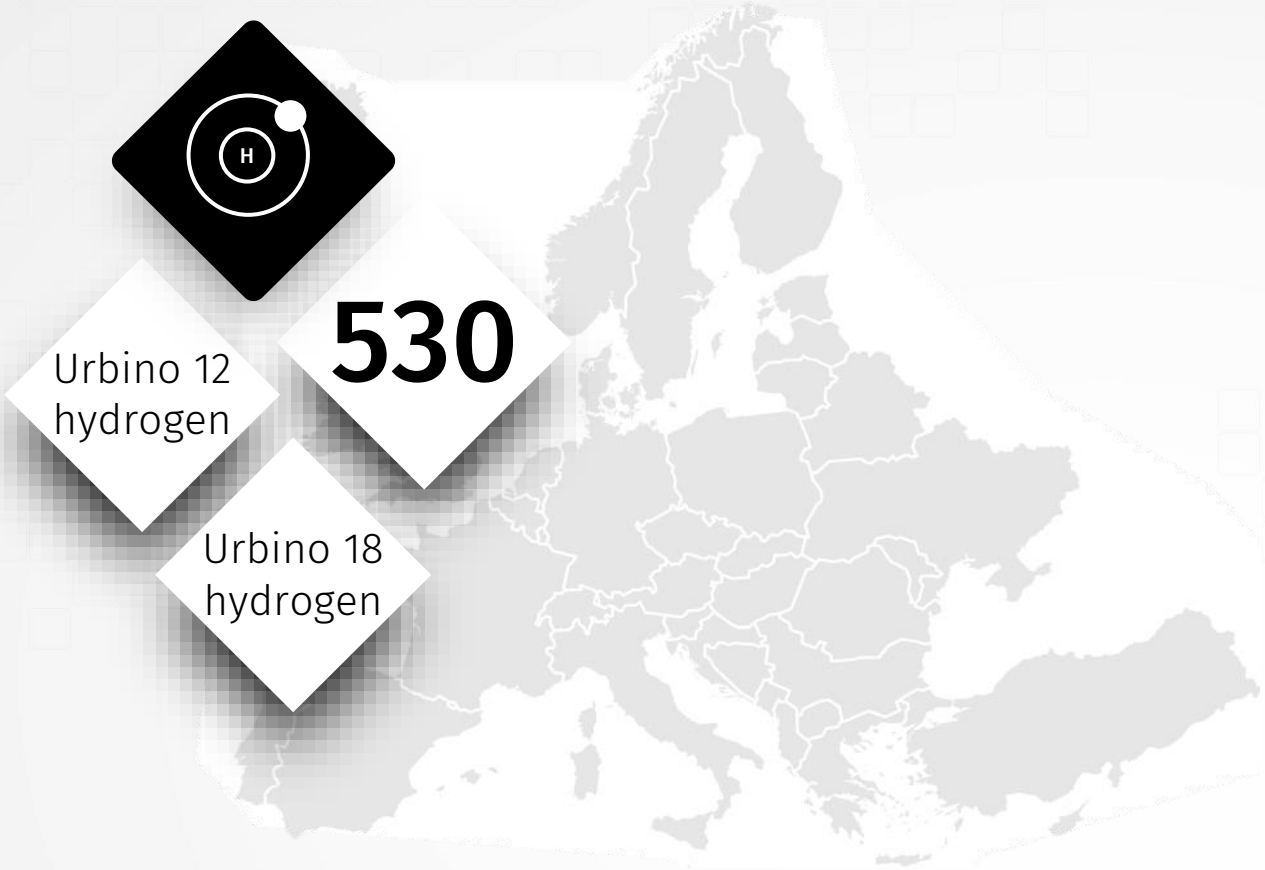
Hydrogen Solaris buses

to be deployed in 2023-2025



Bologne, **Italy**

Venezia, **Italy**

Breda, **Netherlands**

Wałbrzych, **Poland**

Torrejon, **Spain**

Bern, **Switzerland**

Aschaffenburg, **Germany**

Cologne, **Germany**

Duisburg, **Germany**

Frankfurt, **Germany**

Groß-Gerau, **Germany**

Güstrow, **Germany**

Hamburg, **Germany**

Krefeld, **Germany**

Hydrogen trains: Regiolis H2

- Contract SNCF – Consortium ALSTOM / CAF
- Amendment H2 N°11 of Régiolis Frame Contract
- 12 trains + 2 in option
- NTP (Notification) : 31st March 2021
- Delivery: End 2025 and 2026

Hydrogen trains: Regiolis H2

Main feature :

- 12 trains type Bimodal (H2 /25 kV/1500V)
- Max speed: 160 km/h
- Fuel cells : 2 x 330kW
- Autonomy : 400 to 600 km depending on route profile.

Hydrogen trains: CIVIA H2

UE FUNDED PROJECT

NTP: January 1st, 2021

DURATION : 48 Months

BUDGET: Clean Hydrogen Partnership H2020 Program

2 DEMONSTRATORS:

- FCHPP Test Bench
- Train Demonstrator with #2 PP

CONSORTIUM MEMBERS

Under strict confidentiality agreement

RS Manufacturer and Technical Leader	CAF
Railway Operator	renfe
Infrastructure Manager	adif, Infraestruturas de Portugal
FC Manufacturer	TOYOTA
Technological Centers	DLR, Centro Nacional del Hidrógeno
Other suppliers	Stemmann-Technik, A Wabtec Subsidiary

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CIVIA H2

Canfranc station

June 2023

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CIVIA H2

Soria November 2023

CIVIA H2

Teruel December 2023

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CIVIA H2

Madrid February 2023

CIVIA H2
Extremadura
February 2023

CIVIA H2: Key achievements

- More than 800km on one refueling.
- 7000km driven on tests

THANK YOU!

Armando Ansón

Zero Emission Innovation Program Manager
Energy Supply | Technical direction
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www.caf.net

CAF

TRUST IN MOTION