



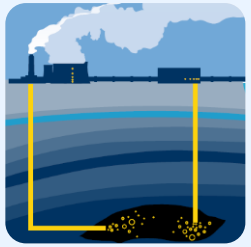



Hydrogen in heavy duty transport: overview of European deployment activities

World Hydrogen Energy Summit

16th November 2021

elementenergy
an ERM Group company

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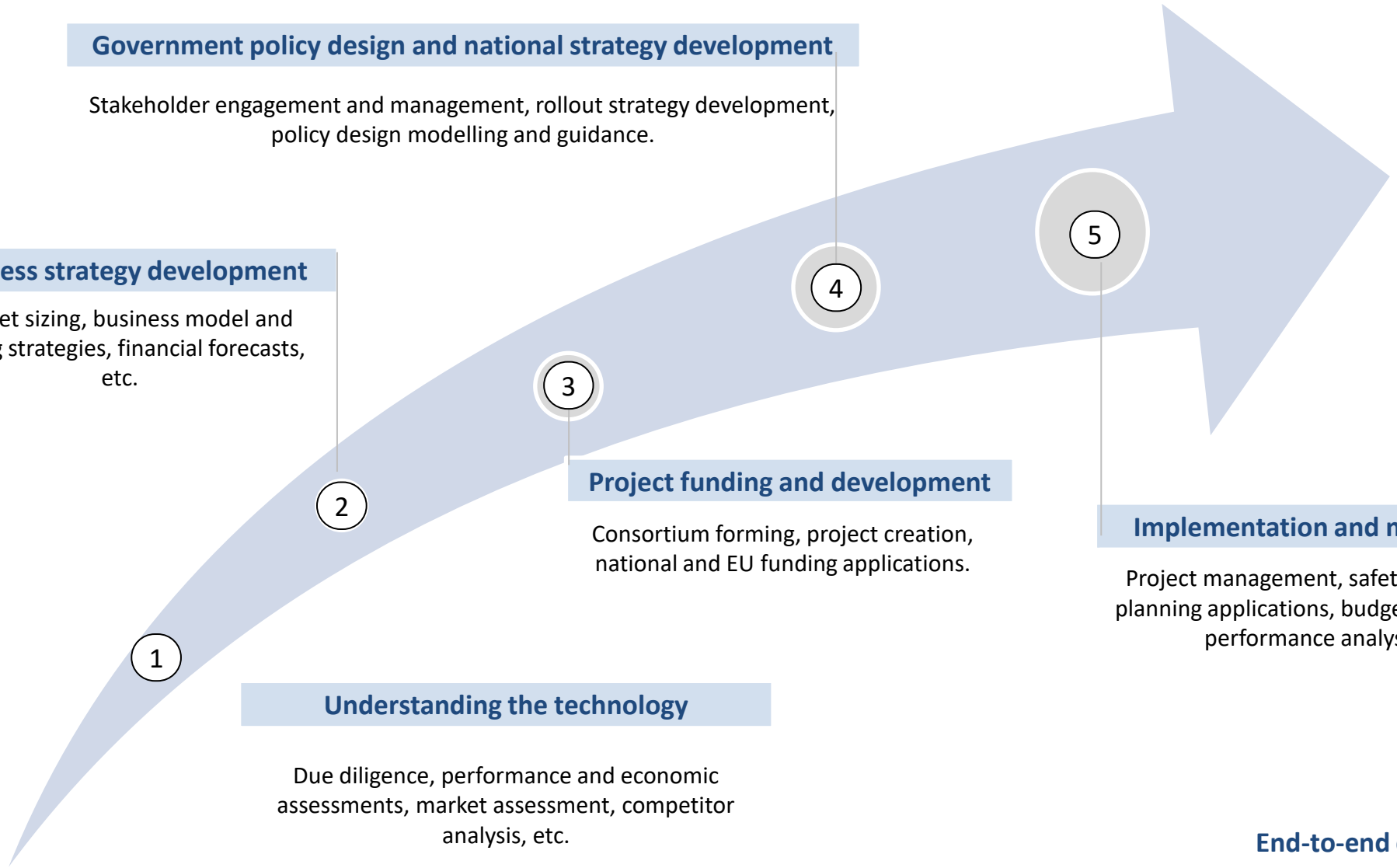
Presentation overview

- Company introduction
- Buses – overview of the JIVE programme
- Trucks – overview of major projects / announcements
- Conclusions and outlook

Element Energy has been providing consultancy and management services at all points along the hydrogen technology value chain since formation in 2003



Government policy design and national strategy development

Stakeholder engagement and management, rollout strategy development, policy design modelling and guidance.

Business strategy development

Market sizing, business model and pricing strategies, financial forecasts, etc.

Project funding and development

Consortium forming, project creation, national and EU funding applications.

Implementation and management

Project management, safety assessments, planning applications, budget management, performance analysis, etc.

Understanding the technology

Due diligence, performance and economic assessments, market assessment, competitor analysis, etc.

End-to-end consultancy services

EE has initiated or is in involved in many of the largest H_2 mobility deployment projects to date in Europe

Hydrogen mobility projects initiated by Element Energy (EE)

Project	Target
JIVE / ZERO EMISSION	306 buses 18 cities and regions
Hydrogen Mobility Europe	1,400 cars and vans 45 HRS
ZEFER	180 high use fleet vehicles in Brussels, Paris and London
H2HAUL	16 long haul heavy duty trucks 4 locations
H2BUS	600 fuel cell buses 3 locations

Other H_2 mobility projects supported by EE

Project	Target
REVIVE H_2	16 refuse trucks 4 locations
H2Accelerate	EU wide roll-out of H_2 trucks and infrastructure
UK H_2 MOBILITY; Hydrogen Mobility Ireland; Mobilité Hydrogène France	Support for H_2 mobility industry groupings

+ others and more in development…

EE is now part of ERM, the world's largest pure play environmental, health and safety, risk and sustainability consultancy

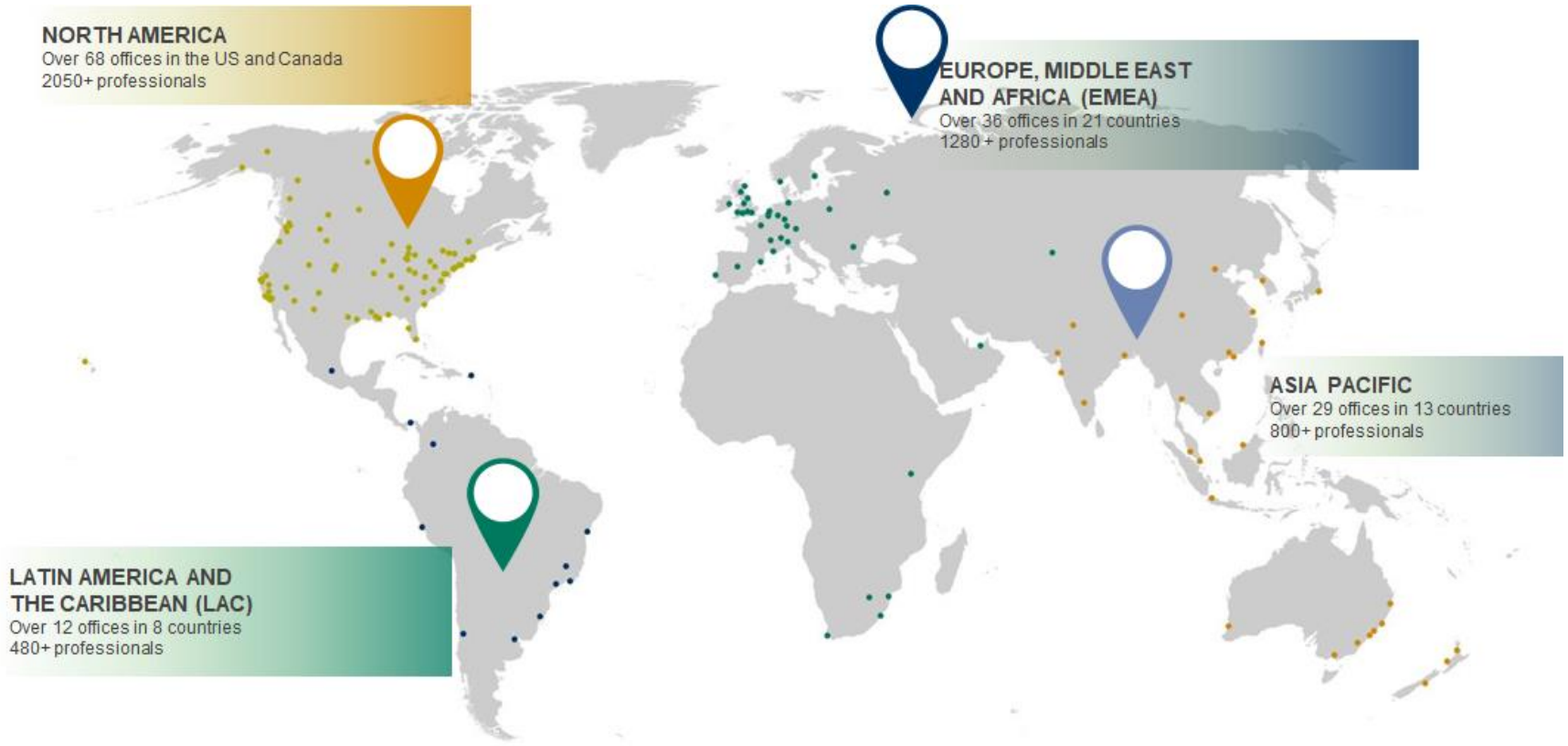
Introduction to ERM

History
Leading sustainability consultancy providing environment, social and governance services for 40+ years to global corporate clients and the financial services industry

People
Unique blend of 5,500 staff i.e. technical, strategy,
commercial and financial experience, in over 160 offices in 40 countries

Sustainability Services
We understand business and provide transaction and financing environmental and social risk management support, at the assessment and implementation stages

Thought Leader
Based on over 10 years of climate change scenario
analysis, we supported the Taskforce on Climate-related Financial Disclosure to develop its recommendations for applying scenarios



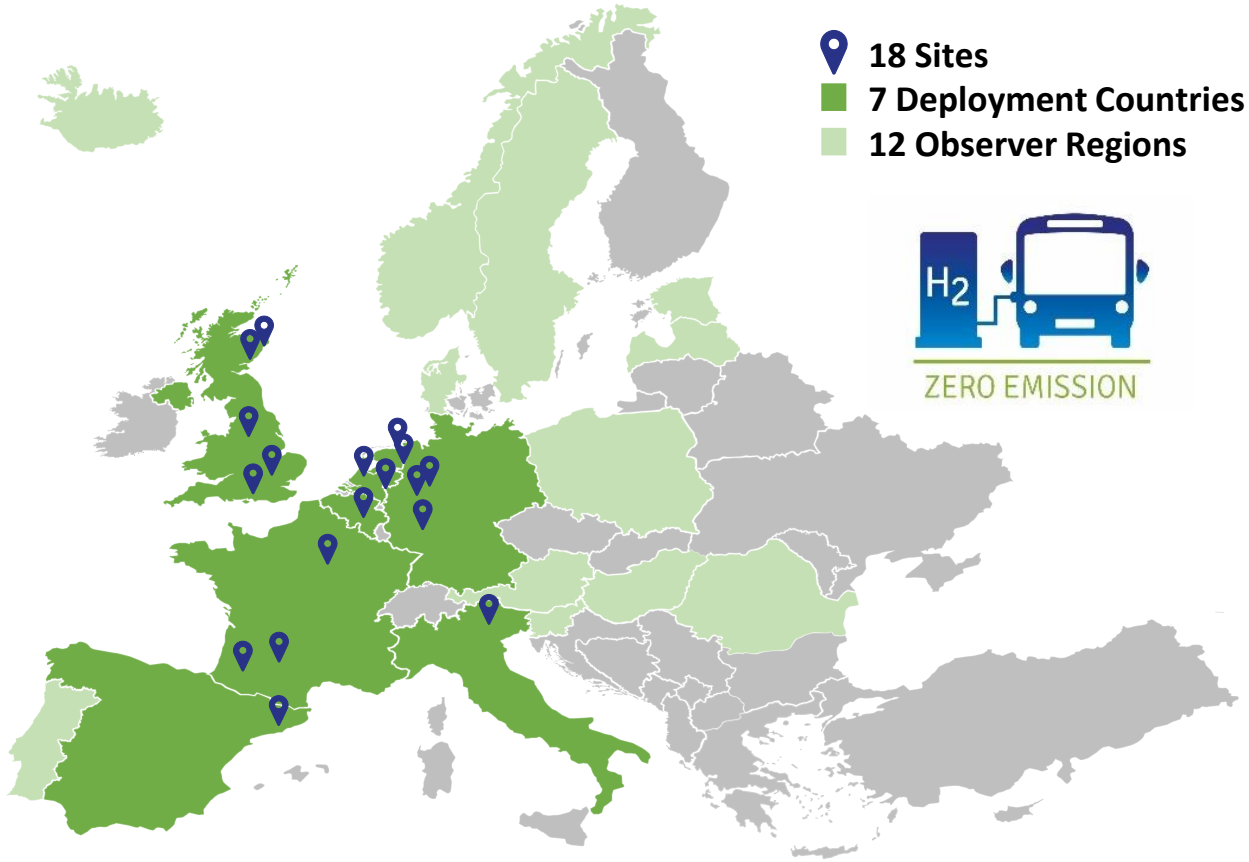
With EE and ERM's combined skills, experience and expertise we are now supporting hydrogen project development globally

The JIVE project is supporting deployment of over 300 fuel cell buses and associated refuelling infrastructure across Europe

Objectives:

- Deploy 306 fuel cell buses in 18 cities & regions across Europe
- Validate large scale fleets in operation
- Stimulate the FCB market
- **Achieve a maximum price of €650k (JIVE) and €625k (JIVE 2)** for a standard fuel cell bus
- Trial joint procurement methods to **access economies of scale**

- Deploy 18 Hydrogen Refueling Stations
- **Enable new cities & regions to trial hydrogen technologies**
- Demonstrate routes to low cost renewable H_2
- Stimulate further large-scale uptake of fuel cell vehicles

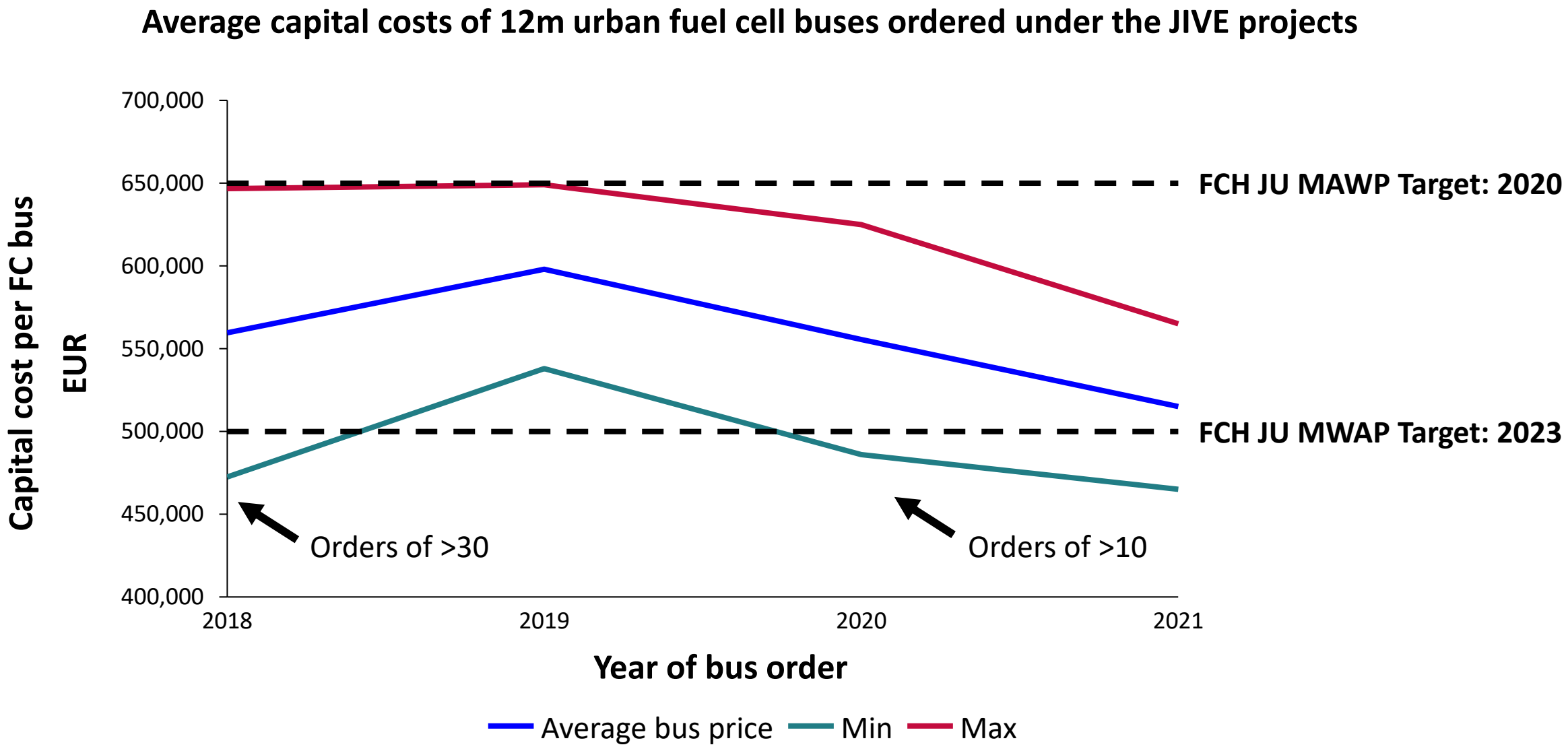








The JIVE projects have reduced the capital costs for fuel cell buses below the FCH JU targets



Recent news from the project (last 6 months)

- **Orders placed for 276/310 (89%)**, final vehicle order expected soon**. 127 buses are now operational.**
- Additional orders from 2 sites during summer 2021 – 4 additional buses for Pau and 32 for Brighton – **increasing the total number of buses for the project** to 310.
- **7 HRS are fully operational** with the opening of 3 new stations in the last 6 months.

Bus/station recent launching events

Auxerre (13th October): 5 buses now operational

London (June): 20 buses now operational

Key KPIs

- Total distance driven by JIVE fleet: **1,400,000km**
- Average consumption between **6–9kg/100km**
- PTOs are basing deployments on operational lifetime expectation of **8–12 years**

Data/Communication

- First reliable operational data from project buses now **being transmitted for analysis**.
- Continuing **successful project dissemination** (ZEBINARS, FCH JU PRDs, policymaker roundtable, presentations, conferences)
- Engagement with a set of wider stakeholders (**JIVE User Group**)

- **Successful first demand aggregation workshop** held focusing on **Spanish-speaking** markets (June 2021)
- Sites beginning to plan for **post-JIVE further FCB deployment** across various vehicle types (12m; 18m, coaches). Continued dialogue with **European OEMs** on this topic

CO_2 emission regulations for heavy duty vehicles will foster the uptake of zero emission solutions

L 198/202 EN Official Journal of the European Union 25.7.2019

REGULATION (EU) 2019/1242 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 20 June 2019

setting CO_2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC

(Text with EEA relevance)

European Commission

European Parliament

Council of the European Union

Targets for HDV manufacturers:

- 15% CO_2 reduction from 2025
- 30% CO_2 reduction from 2030*

CO_2 regulations for heavy-duty vehicles will require truck suppliers to develop innovative solutions. Substantial penalties are foreseen in case of non-compliance.

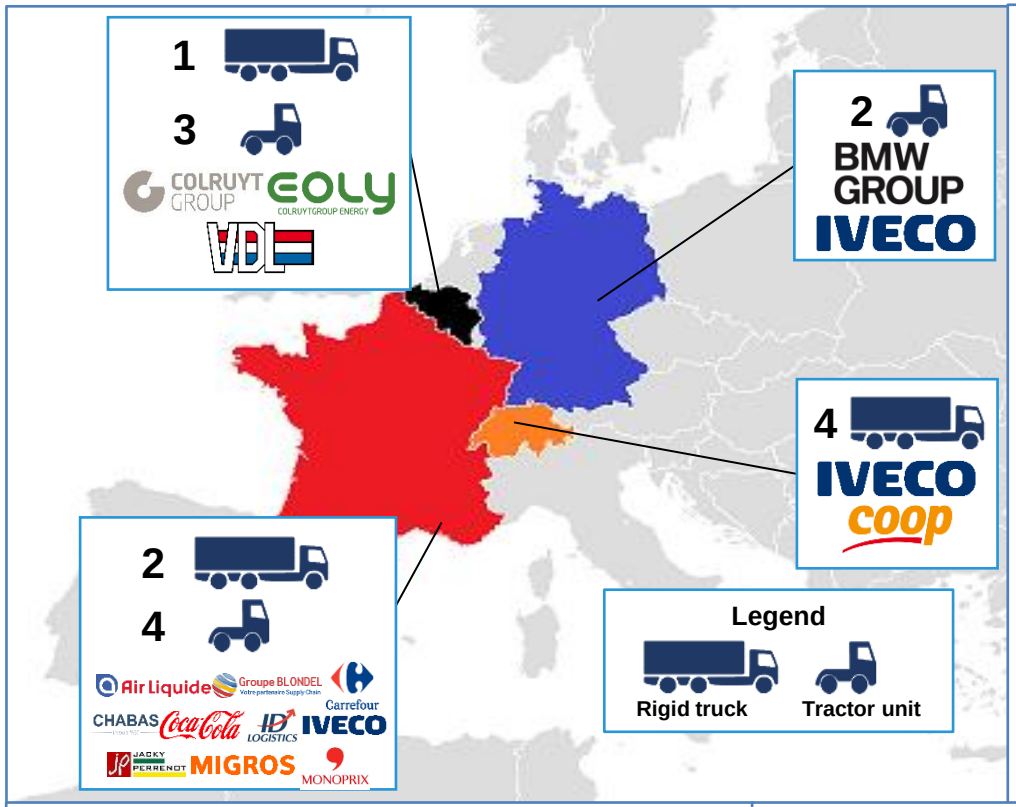
*From a 2019 baseline. To be reviewed in 2022.

Several heavy-duty vehicles in Europe are at the prototype / small-scale demo phase

Selection of fuel cell heavy-duty vehicles in Europe (non-exhaustive)

Project / product	Coop FC truck demo	ASKO FC truck demo	H2-Share	Hydrogen region 2.0	GenH2	MAN	GOH! (Generation of Hydrogen)	Man&Shell demo	Xcient Fuel Cell	Nikola TRE/IVECO
OEM	MAN (ESORO)	Scania	VDL	VDL	Daimler	MAN	GreenGT/(Kamaz)	MAN	Hyundai	IVECO
GVW	34t	27t	28t	40t	40t	-	40t	40t	18t (34t with trailer)	40t
No. of trucks	1	4	1	1	-	-	1	1	1,600	TBC
Demo location	CH	NO	BE, DE, FR, NL	BE	-	Bavaria	CH	DE	CH – others potentially	TBC
Dates	2016/17	From 2019	2017–20	From 2016	2023 (trial) 2030	2023	2019	2022	From 2020	2023
	 Source: Netinform	 Source: fuelcellworks	 Source: Waterstofnet	 Source: Waterstofnet	 Source: Daimler	 Source: H2Haul	 Source: fuelcellworks	 Source: BMVI and LinkedIn	 Source: Hyundai	 Source: Nikola

H2Haul: deploying 16 heavy-duty trucks across four European countries



Objectives

- Develop **long-haul heavy-duty (26-44t) fuel cell trucks** that meet customers' requirements in a range of operating environments
- **Homologate three fuel cell truck types**
- **Install hydrogen refuelling infrastructure** at each site and provide high reliability hydrogen supplies that maximise environmental benefits
- **Achieve >2 million kilometres** of day-to-day driving, proving the viability of the technology
- **Monitor the performance of the vehicles and infrastructure** to provide evidence on the availability, efficiency, and environmental benefits
- Develop the business case to **prepare the European market for further roll-out** of fuel cell trucks

Vehicle, component, and infrastructure suppliers

Air Liquide · BOSCH · elringklinger · FPT POWERTRAIN TECHNOLOGIES · H2energy · IVECO · POWERCELL · VDL

Coordination, dissemination & analysis

elementenergy · Hydrogen Europe · IRU PROJECTS · sphera · Waterstof Net

Observer Group

A.E.B.T.R.I. · Ahold Delhaize · antram · astic · BeMobility · BGL · Groupe BLONDEL · BMW GROUP · Carrefour · CETM · Coca-Cola · CHABAS · COLRUYT GROUP · coop · DELANCHY · DHL · FEBETRA · ID LOGISTICS · IRHA · JACKY PERRENOT · MALHERBE · MIGROS · MONOPRIX · ÖLGERÐIN · PETER APPEL Transport · AUTOMOTIVE INDUSTRY NL · STEF · SVERIGES ÅKERIFÖRETAG · TLN · TÜVRheinland · UNIFR · XPO Logistics

A large-scale roll-out of Hyundai trucks is underway in Switzerland

Hyundai will deliver 1,600 trucks to Swiss customers by 2025 via the joint Venture [Hyundai Hydrogen Mobility]

- 18t (34t with trailer)
- 400 km range
- Refuelling in 7 – 15 minutes

- 18 Swiss companies active in fuel distribution and logistics will develop a nationwide network of hydrogen refuelling stations.
- They represent together over 2,000 stations and 5,000 trucks.

Source: https://h2mobilitaet.ch/en/verein/committee/ (January 2020)

NIKOLA and IVECO/FPT announced a joint venture to develop battery electric and fuel cell trucks

- Joint venture announced in December 2019 to develop and distribute battery electric and fuel cell trucks for the European market
- NIKOLA TRE fuel cell version to be available from 2023
- Truck based on the new IVECO S-WAY platform
- 800 km range

Source: www.iveco.com/en-us/press-room/release/Pages/IVECO-FPT-Industrial-and-Nikola-Corporation-launch-their-partnership-to-achieve-zero-emissions-transport.aspx

Daimler Trucks has started testing its GenH2 Truck prototype, which was unveiled in 2020

- GenH2 truck with a range of more than 1,000 km
- Customer trials to start from 2023
- Plan to deliver series-produced GenH2 Trucks from 2027
- 40 t GVW
- Joint venture with Volvo to develop and commercialise fuel cell systems for use in heavy-duty trucks and other applications

Source: https://www.daimler.com/innovation/drive-systems/hydrogen/start-of-testing-genh2-truck-prototype.html.
https://media.daimler.com/marsMediaSite/en/instance/ko/Daimler-Truck-AG-and-Volvo-Group-fully-committed-to-hydrogen-based-fuel-cells--launch-of-new-joint-venture-cellcentric.xhtml?oid=49834035

The H2Accelerate consortium is seeking to accelerate the uptake of green hydrogen for trucking in Europe

H2Accelerate

The H2Accelerate consortium is collaborating to:

- **Seek funding opportunities** – for pre-commercial projects
- **Provide information** – evidence on technical & commercial viability of hydrogen trucks at scale
- **Communicate with policy makers** – to encourage policies to support sustainable zero emission trucking market

Daimler Truck IVECO VOLVO OMV Shell TotalEnergies Linde

Source: https://h2accelerate.eu/

Conclusions: early projects have laid the foundations for vehicle deployments to accelerate, but there is more to be done for FCEVs to fulfil their potential

- Technical performance of hydrogen transport solutions has been proven
- Significant momentum around hydrogen is building across Europe and beyond
- Scale up in vehicle manufacturing is needed to meet targets and for cost competitive manufacture (particularly for trucks)
- Policy support is still needed to incentivise deployment during this scale up period
- Ingredients for success:
  - Reliable technologies (vehicles & infrastructure)
  - Scale of demand
  - Low cost (renewable) energy for hydrogen supplies