

EU Funding Synergies for Hydrogen Mobility Scale-Up MEHRLIN & JIVE Projects

CINEA-EMFF Workshop

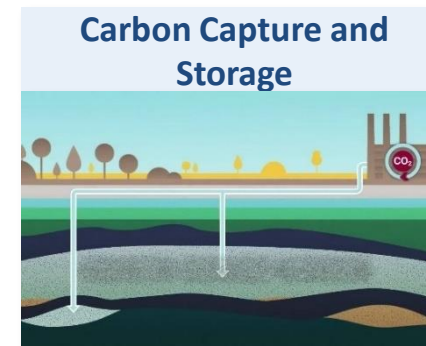
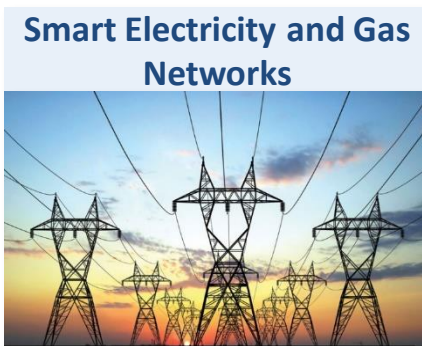
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elementenergy
an ERM Group company

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Element Energy: a consultancy focused on the low carbon energy sector

- Element Energy is a **specialist energy consultancy**, with an excellent reputation for rigorous and insightful analysis in the area of low carbon energy.
- We consult on both **technical and strategic issues** – our technical and engineering understanding of the real-world challenges support our strategic work and vice versa.
- Element Energy covers all major low carbon energy sectors:



The JIVE, JIVE 2 and MEHRLIN projects are the flagship fuel cell bus & infrastructure projects in Europe aiming to deploy over 300 buses and 20 HRS by the end of 2022

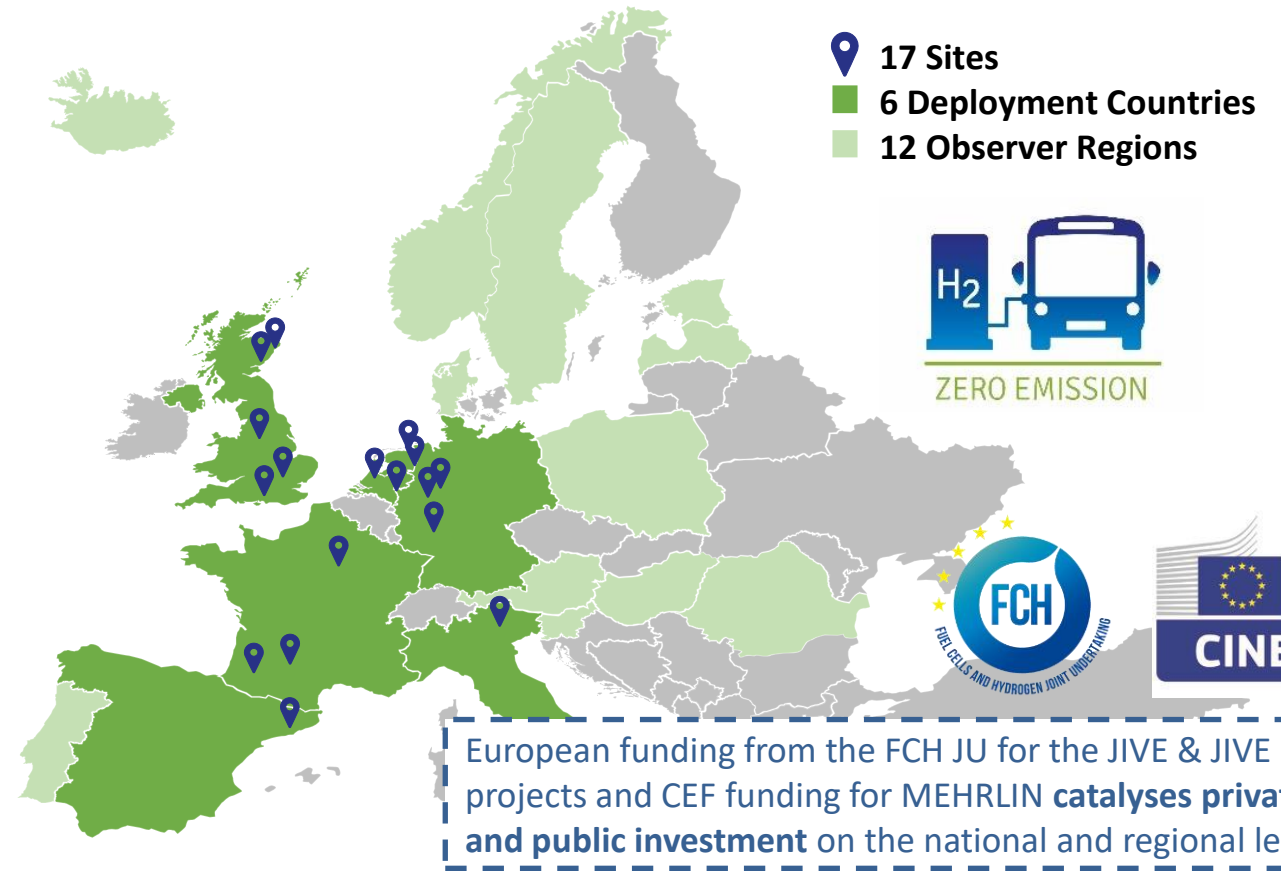
Objectives:



- Deploy 310 fuel cell buses in 17 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 20 Hydrogen Refueling Stations (7 HRS funded by CINEA under MEHRLIN)
- **Enable new cities & regions to trial hydrogen technologies**
- Demonstrate routes to low cost renewable H2
- Stimulate further large-scale uptake of hydrogen vehicles and infrastructure



Blending EU funds and financing mechanisms enabled the most ambitious coordinated deployment of fuel cell buses attempted to date

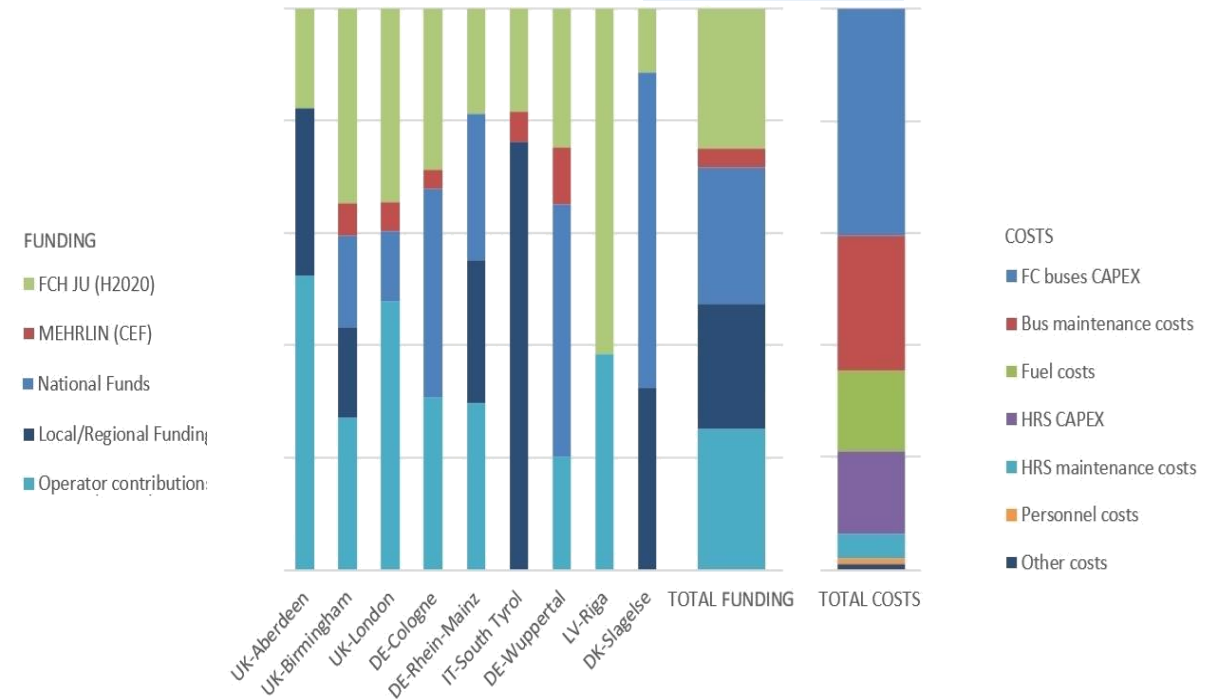
Context: JIVE, JIVE 2 & MEHRLIN were designed and continue to be coordinated by Element Energy. The 3 projects are run as a **single consortium with the same goals and actors**. Local project structure and funding mixes differ between project sites.

Funding Structure

- CINEA contributed €5.5MN (MEHRLIN) to 7 cities/regions in 2016, critical to kickstarting the rollout of hydrogen refuelling stations.
- FCH JU contributed €32MN (JIVE 1) in 2017 and €25MN (JIVE 2) in 2018, representing ¼ of overall project budget, to support fuel cell bus deployment.
- National funding programs and support was secured in the UK (OZEV), DE (NOW), FR (ADEME), NL (DKTI).
- Regional/Local funding for projects in IT, ES.
- Private sector contribution of 1/3 by bus and HRS operators.
- (CINEA provided €40MN in 2019 to support follow-on initiative, H2Bus Europe).

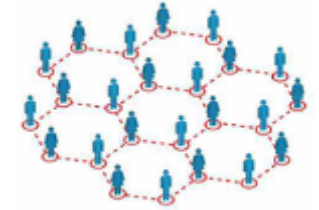
JIVE (FCH JU) + MEHRLIN
(CINEA) + MS + Regions

EUR 228 MN



The MEHRLIN / JIVE consortium encountered many challenges and barriers which have been overcome to allow the projects to ultimately achieve their objectives

- **Joint procurement exercises: not always the most appropriate model** to facilitate the commercialisation of fuel cell buses and infrastructure given the complexity – linking projects has downsides as well as benefits.
- **Multiple sources of funding** – combining local, national, and EU sources can bring costs down to near diesel parity, but this adds complexity, administrative and timescale challenges.
- **Procure HRS / H₂ supplies in parallel with buses** – fuel costs are a critical element of the total cost of ownership. Making a decision on grey, green or blue hydrogen and onsite vs. offsite production will have a big impact on TCO.
- **Incorporate 12 months of buffer time into your project plan** – when setting out your project timeline, incorporate time to resolve any unforeseen obstacles and challenges. Procurement, permitting, civils and manufacturing will always take longer than originally planned.
- **Early engagement with all project stakeholders** is critical to ensure a successful project, delivered on time and within budget. Roles, responsibilities, and expectations should be set out in the project scoping phase. **Engaging bus operators is vital.** Depots, routes, vehicle specifications etc. need to be agreed early on.
- **Achieving affordable maintenance costs** for FC buses and finding an appropriate risk sharing approach given the uncertainty over lifetime costs.

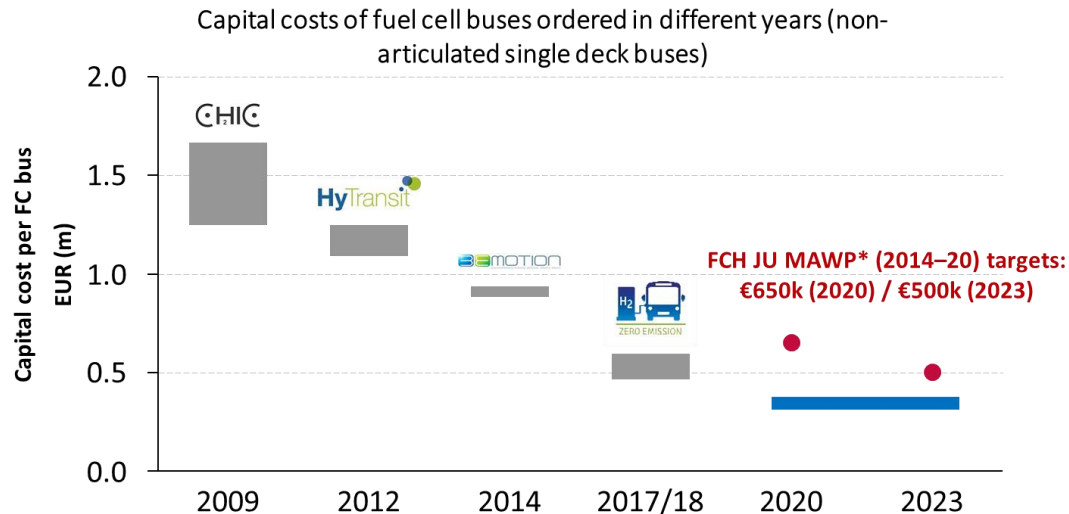


The projects rely on several mechanisms and strong relationships with EU funding bodies to develop knowledge and exploit results

Sharing Results	Impacts & Results
Quarterly Performance Assessments	<ul style="list-style-type: none">• Regular tracking of performance data from HRS and buses across all sites.• Economic data continually reviewed to build business cases for hydrogen technologies.
TRUST database reporting	<ul style="list-style-type: none">• Annual exercise to track KPIs for hydrogen mobility across FCH JU's entire portfolio of projects.
Bus Operators' Forums	<ul style="list-style-type: none">• Dedicated forum within the consortium to resolve technical challenges & share information.• User Group part of dissemination activities for new cities & regions to share best practices and access results first-hand, with a view to encouraging future deployment.
Coordinated dissemination campaign	<ul style="list-style-type: none">• Coordinated involvement of FCH JU (now known as Clean Hydrogen Partnership) and CINEA.• Flagship conference and webinar series "Zero Emission Bus Conference" developed to spread learnings from MEHRLIN & JIVE projects.
Impact: Underpinning expansion of FCB sector	<ul style="list-style-type: none">• Post-JIVE FCB projects -> H2Bus Europe received €40MN (CINEA) to deploy 600 buses and 9 HRS.• Cost reductions -> significant reduction in CAPEX of FCBs and green hydrogen supply.• "Organic" FCB orders -> via nationally-funded programmes (in Germany, Poland, France, Ireland).

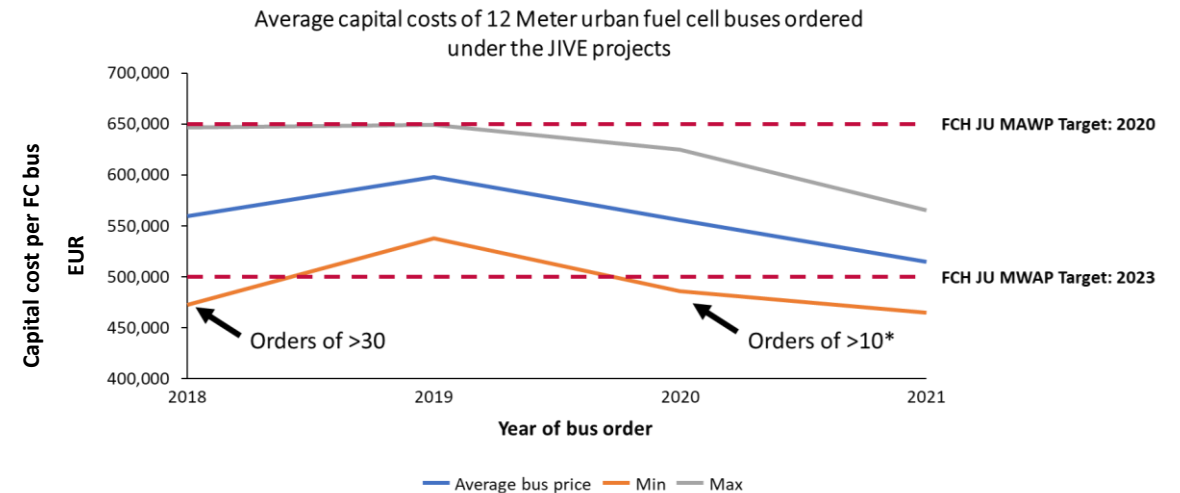
JIVE / MEHRLIN were a critical step along the fuel cell bus commercialisation pathway

Actual bus capex – historic FCB projects



Early 2020's: Some OEMs considering commercial rollout indicate capital costs of <€400k/bus are possible, assuming orders of 100 buses per year and continuity of demand. **Average costs per bus are below the FCH JU MAWP targets for 2020** and on track for the 2023 target.

Actual bus capex – JIVE & JIVE 2



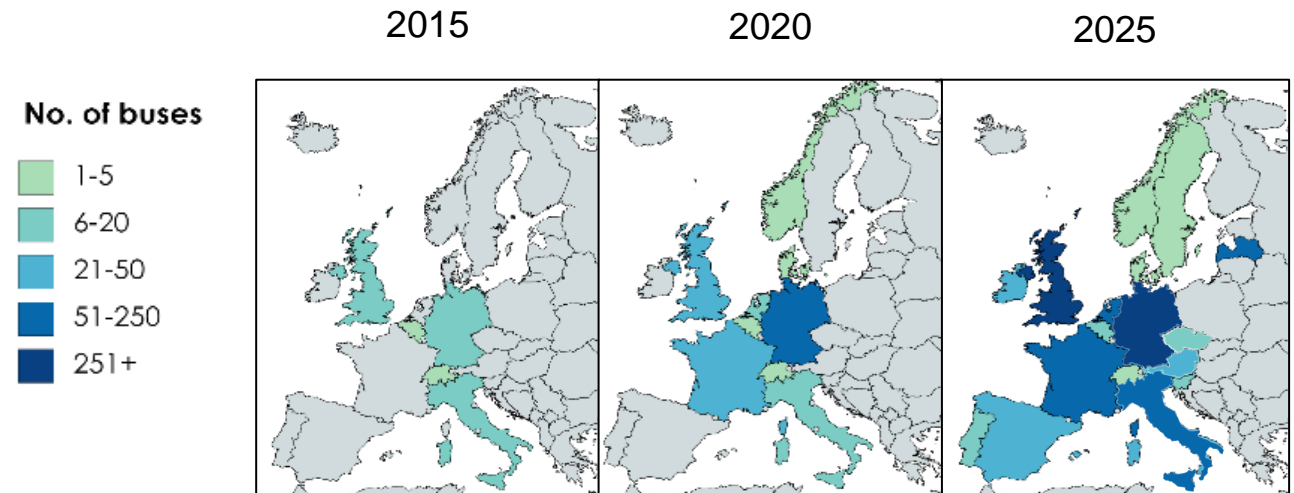
Average capital costs of FCBs has decreased substantially since the first orders were made under JIVE in 2018. **Minimum costs are accessible for vehicle orders of >10 buses.** Costs from several suppliers is still >€500,000 per bus; price varies dependent on specifications.

EU funding has stimulated demand for fuel cell buses all over Europe

City	Buses in Operation*			Buses Ordered		
	Number	Supplier	Year	Number	Supplier	Year
Austria				40	Solaris	2022
Aalborg, DK	3	Van Hool	2020			
Aberdeen, UK	15	Wrightbus	2021	10	Wrightbus	2022
Artois-Gohelle, FR	6	Safra	2019			
Auxerre, FR	5	Safra	2021			
Barcelona, ES	8	Caetano	2021, 22			
Birmingham, UK	20	Wrightbus	2021			
Bologna, IT				127	TBA	2024-26
Bolzano, IT	4 / 12	Daim/ Sol.	2015			
Brighton, UK				54	Wrightbus	2022
Cologne, DE	35 / 15	VH/Sol.	2019, 21			
Dundee, UK				12	Optare	2023
Frankfurt am Mainz, DE	10	Caetano	2021	22	TBA	2023
Gelderland, NL				10	Solaris	2022
Groningen, NL	2 / 20	Van Hool	2017,21	10	Van Hool	2022
London, UK	8 / 20	VH, WB.	2015, 21			
Pau, FR	8	Van Hool	2019	4	Van Hool	2022
Riga, LV	10	Solaris	2020			
Rotterdam, NL	4 / 20	VDL/Sol.	2020, 22			
San Remo, IT	3	Van Hool	2018			
Toulouse, FR				5	Safra	2022
Usti and Labem, CZ				20	Solaris	TBA
Versailles, FR	2 / 5	VH/Safra	2020			
Wuppertal, DE	10 / 10	VH/Sol.	2019,21			

*non-exhaustive list. Only includes fuel cell buses currently in commercial operation across Europe.

Expected Growth in Fuel Cell Bus Market up to 2025



- **Distributed knowledge across Europe:** currently 200 buses on the roads, another 260 buses are under contract for delivery by 2023.
- **Increasing options and order sizes:** more options for coaches, double deckers, and articulated buses from 2023 and orders of 20-100 buses.
- **Decreasing lead times:** as little as 6-12 months between order and delivery.
- **Competitive market:** increasing number of OEMs entering the market -> 21 suppliers currently offering FCBs for European markets.

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An illustration of an offshore oil and gas field. The scene is set against a dark blue background representing the sea and sky. In the foreground, there are three yellow vertical structures (jackets) extending from the seabed to the water surface. These structures are connected by a network of yellow pipelines that run across the water and along the seabed. In the background, there are silhouettes of offshore platforms, a large ship, and other industrial structures. The overall style is a flat, stylized illustration.

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