

Developments in the fuel cell industry and value chain

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8th FC International Meeting by FCDIC and FCS

25 February 2020

Content

- E4tech
- The global fuel cell market
- The fuel cell value chain
- What could 2020 bring?

E4tech

E4tech perspective: Strategy | Energy | Sustainability

- International consulting firm, offices in UK and Switzerland
- Focus on sustainable energy, transport and systems
- 22 years old this year, always independent
- Deep expertise in technology, business and strategy, market assessment, techno-economic modelling, policy support...
- A spectrum of clients from start-ups to global corporations



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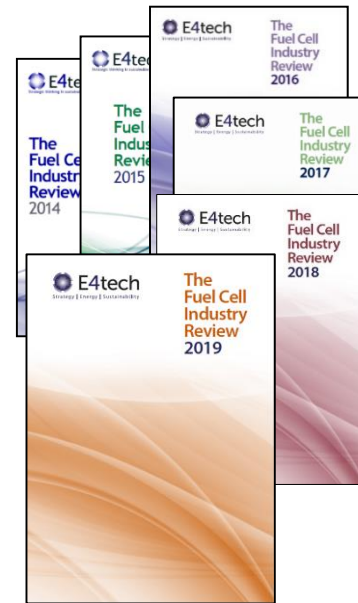
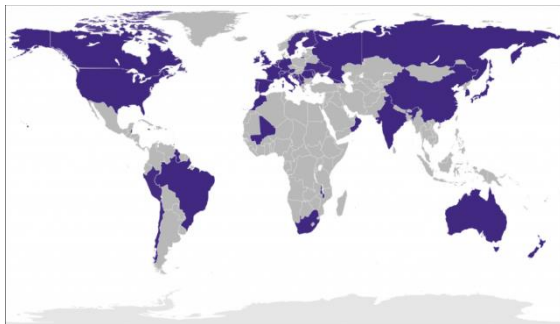


ofgem

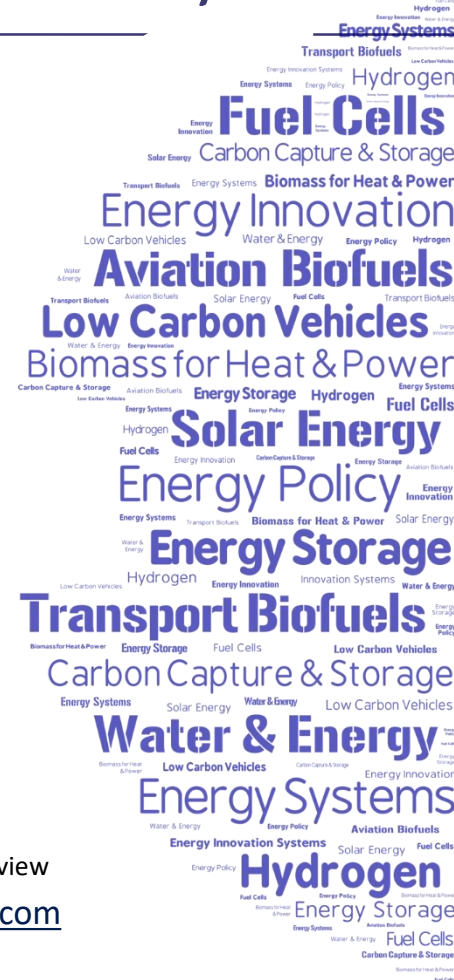
BRITISH AIRWAYS



Imperial College London



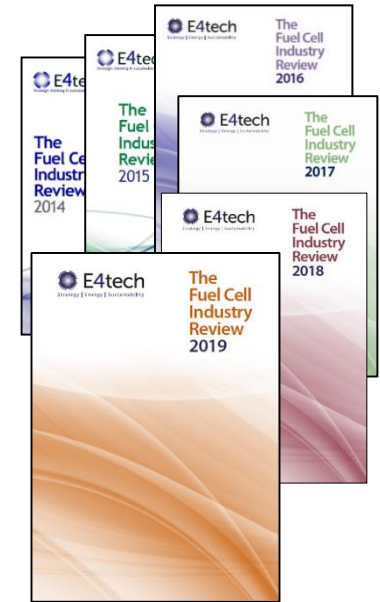
E4tech's annual Fuel Cell Industry Review
www.FuelCellIndustryReview.com



The global Fuel Cell market

E4tech has published an annual Industry Review since 2014, showing trends from original data

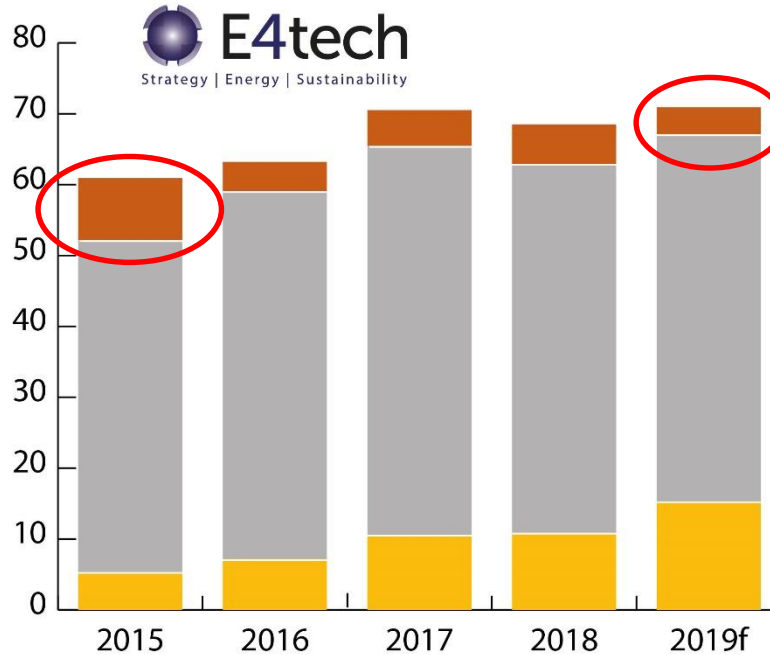
- The FCIR is free. It is intended to inform the industry about itself as well as others about the industry
- We have strong relationships in and around the industry
 - We have been fuel cell sector specialists for 20+ years
 - All fuel cell technologies, sectors and regions
- We contact many more than one hundred companies directly; our database also includes the supply chain
- Shipment data are aggregated and anonymised
- Our insights inform our consulting – but we never release the raw numbers
- The industry is maturing. Tracking it takes more time. Policies on data sharing evolve as companies mature or ownership changes
- The numbers remain dominated by a small number of companies



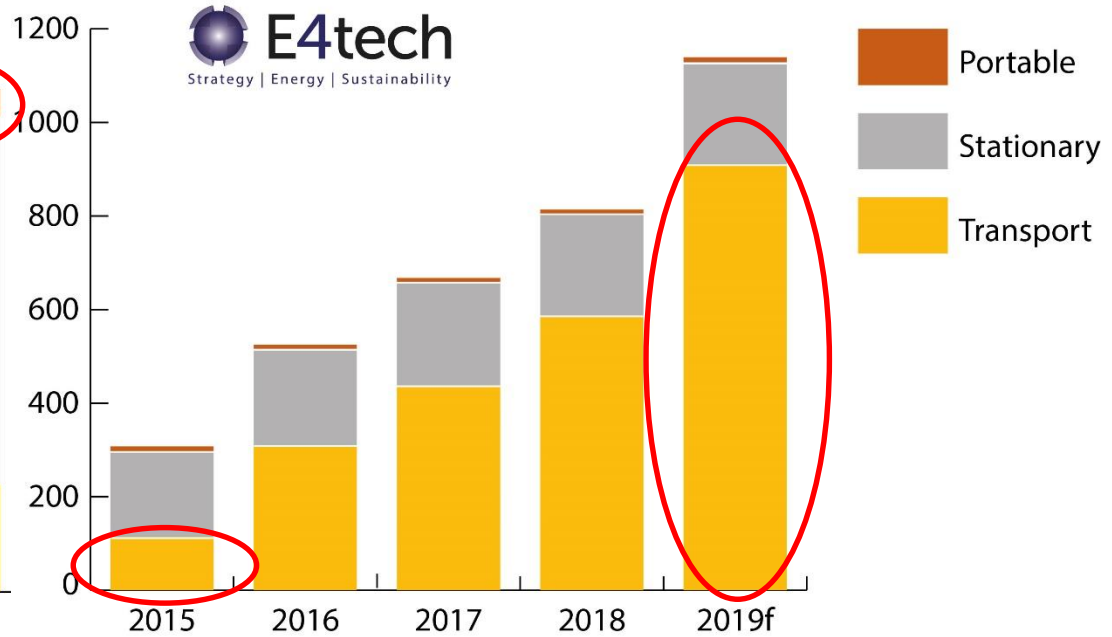
www.FuelCellIndustryReview.com

Progress has been steady in MW shipped, and is accelerating. Emphasis has shifted for unit shipments

Shipments by application 2015 - 2019 (1,000 units)



Megawatts by application 2015 - 2019

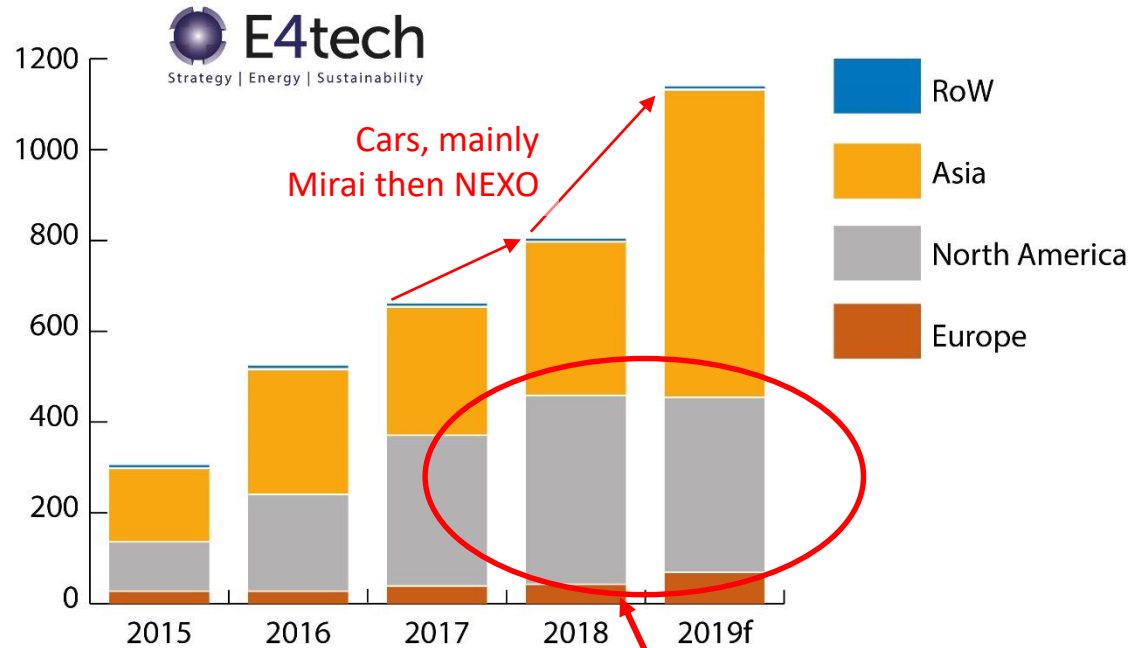
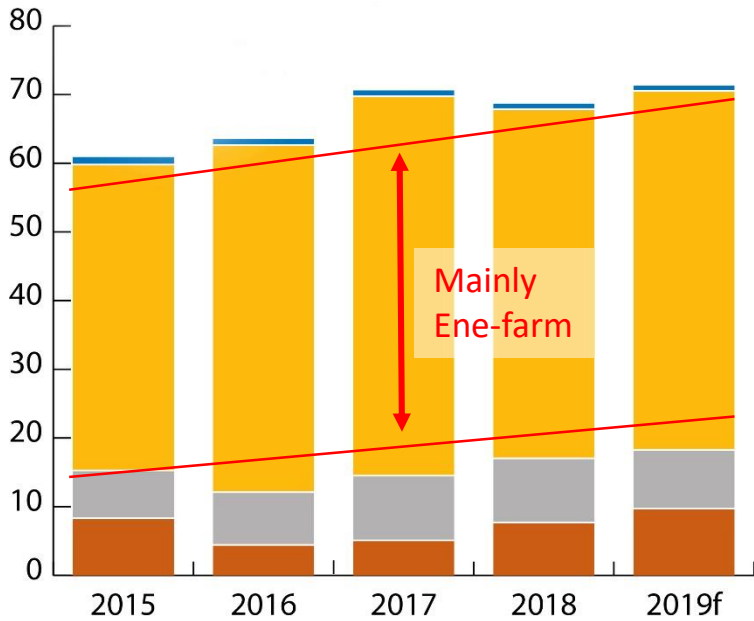


- Portable fuel cell shipments have dropped as small batteries have got better
- Stationary unit numbers remain dominated by Ene-farm
- Transport has become by far the largest contributor to MW shipments

Asia, always strong, is increasing its lead over N America. Europe lags in deployment

Shipments by region of adoption 2015 - 2019 (1,000 units)

Megawatts by region of adoption 2015 - 2019

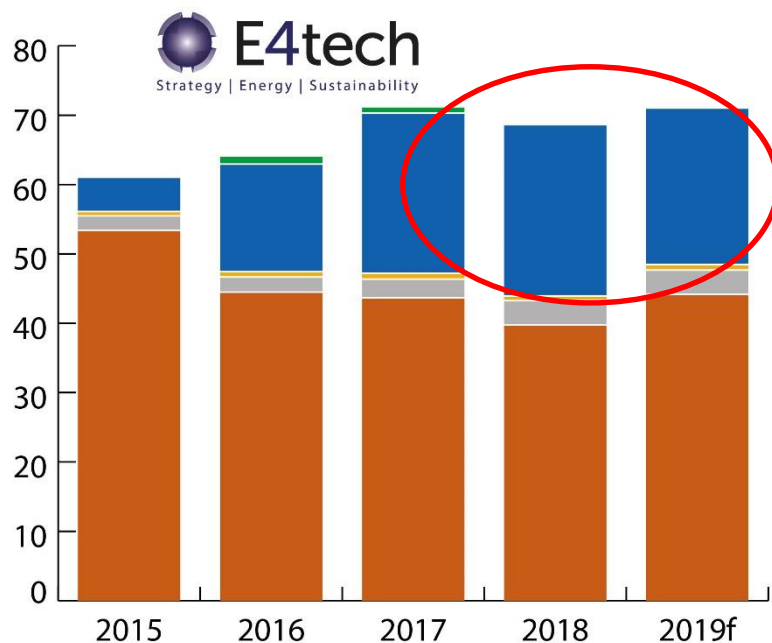


- Japan dominates unit shipments through Ene-Farm
- Asia has only just overtaken N America on annual MW deployed
- Europe has never yet supported large-scale roll-out

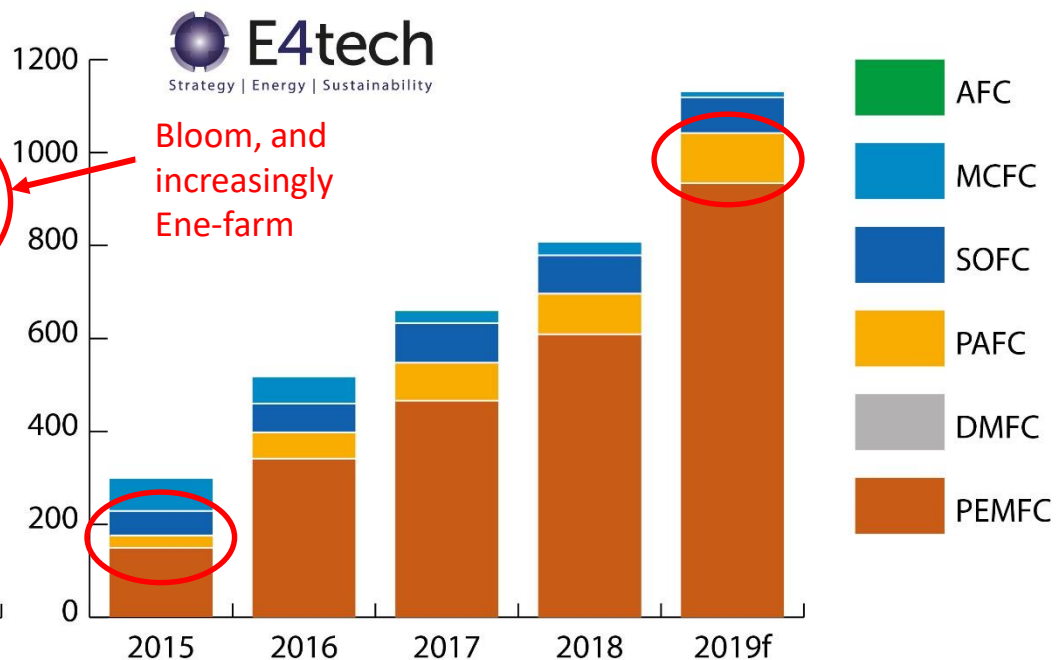
Impact of
- federal tax credit hiatus
- difficult period for FCenergy

The split by fuel cell type remains mixed. PEM and SOFC are establishing themselves, but others will remain

Shipments by fuel cell type 2015 - 2019 (1,000 units)



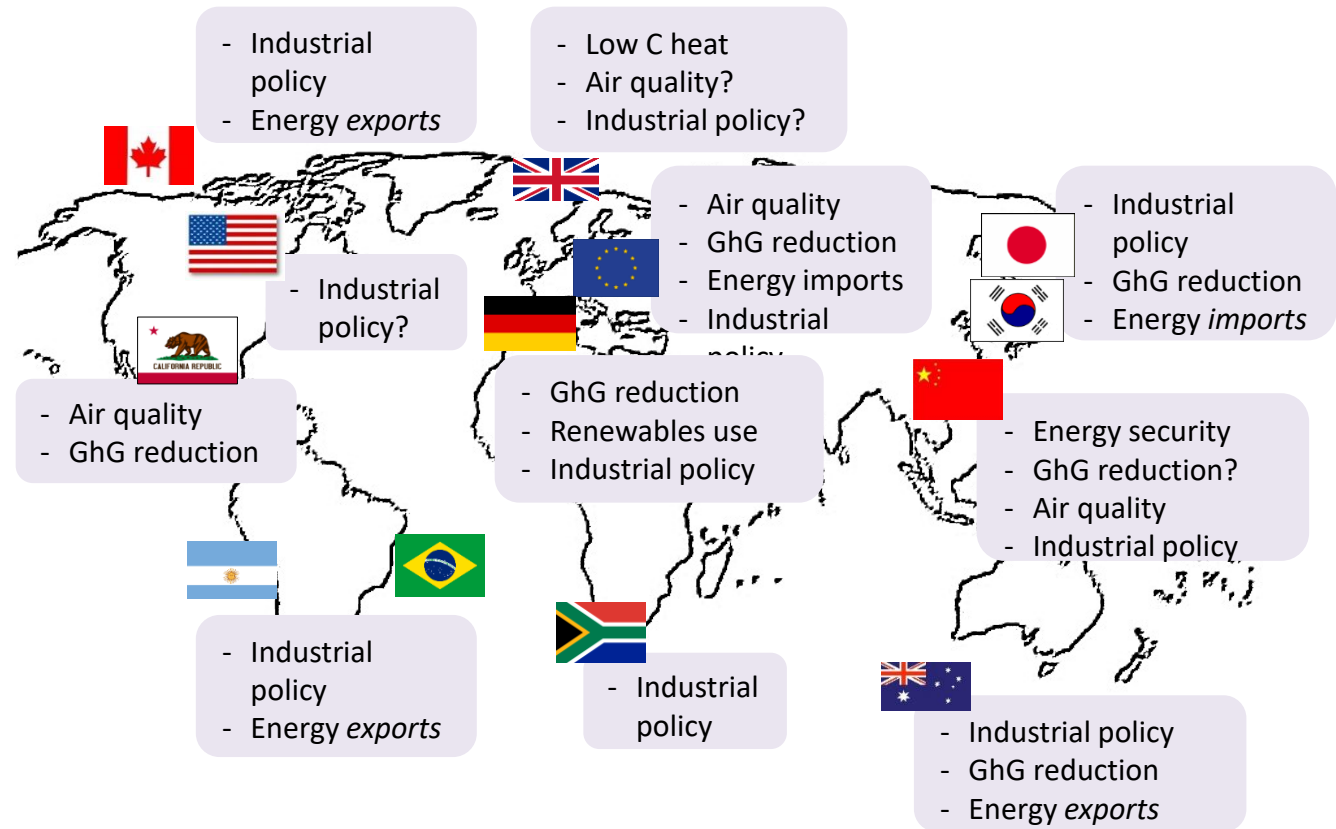
Megawatts by fuel cell type 2015 - 2019



- PEM dominates – this is likely to continue
- Doosan and Korean policy are almost totally behind PAFC's strength
- More SOFC units are being sold in Japan for Ene-farm
- Other chemistries remain niche

Massive changes in hydrogen policy (partially) affect fuel cells and definitely affect businesses

- **Japan's** commitment is large, across government and industry
- **Korea** has followed a scaled-up version of Japan's path
- **China** has moved from solar and wind, through batteries, to fuel cells and hydrogen support
- **Europe** has less deployment but strong supply chain players



The industry is becoming noticeably more dynamic, with some major companies investing in options

- Cummins bought most of Hydrogenics and invested in Loop... and have an MoU with Hyundai, who have put money into Rimac
- Toyota is supplying to Higer, FAW, Beiqi Foton, SinoHytec and CaetanoBus (with Re-Fire as an integrator)
- Sinopec invested in Shanghai Re-Fire
- Michelin has a JV with Faurecia – Symbio to make stacks
- Iveco (Case New Holland) has invested in Nikola and will also supply
- Miura unveiled a commercial FC CHP using Ceres technology
- Doosan (also working with Ceres) split off its fuel cell business – into several units
- And even venture capital is back – AP Ventures announced investments from Mitsubishi Corporation and Plastic Omnium



Sources: Toyota, Miura

The Fuel Cell value chain

E4tech led analysis of FCH value chains in Europe

E4tech led a study for the FCHJU to examine the value of HFC technologies

13 applications

Supply chain maps

Global and EU deployment scenarios

Critical components

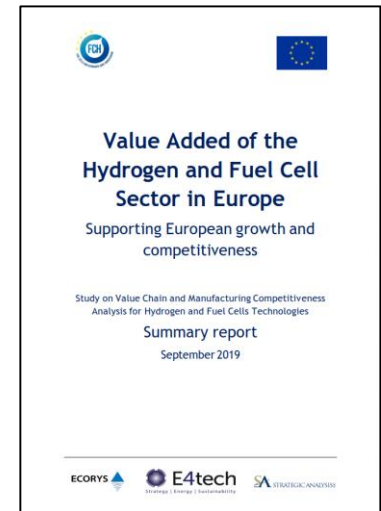
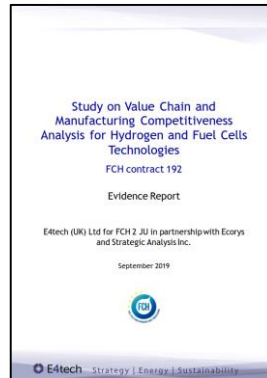
Cost projections

8 down-selected applications

Industry scenarios

Value analysis

Socio-economic impacts



Study Team

Project management
FCH expertise



Socio-economic analysis



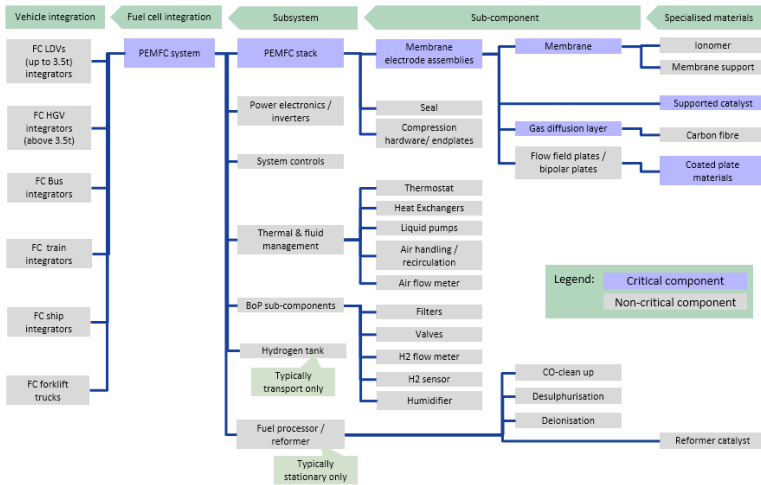
FCH expertise
Cost analysis



NB: Analysis only covers FCH-specific elements of applications

Socio-economic value analysis draws on multiple inputs. The FULL study is available from the FCHJU website:
<https://www.fch.europa.eu/page/FCH-value-chain>

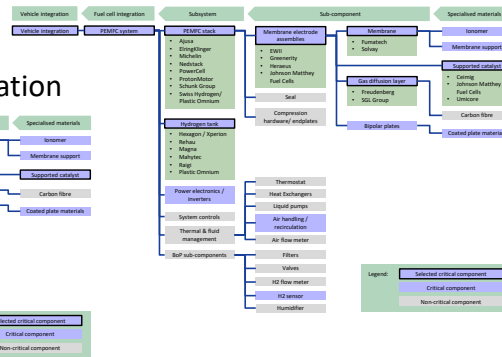
Supply chain diagrams show European actors. A map of actors shows their geographic distribution



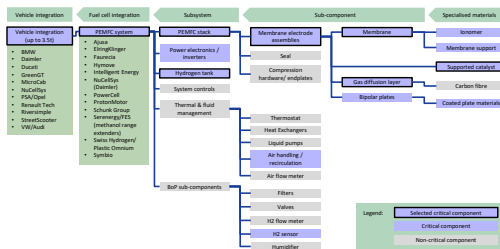
- Transport applications
 - System integration
 - Upstream supply chain actor
 - Vehicle integration
 - Knowledge based actor
 - Testing
 - Association/Agency
 - Consulting
 - Unspecified
- Stationary applications
 - System integration
 - Knowledge based actor
 - Testing
 - Upstream supply chain actor
 - Unspecified
 - Association/Agency
 - Consulting
- Knowledge based actors



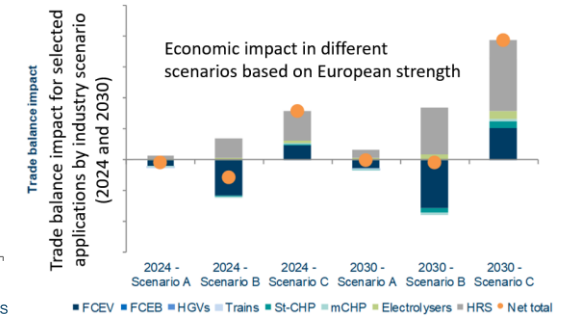
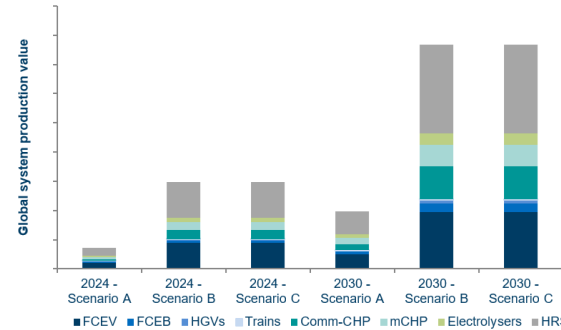
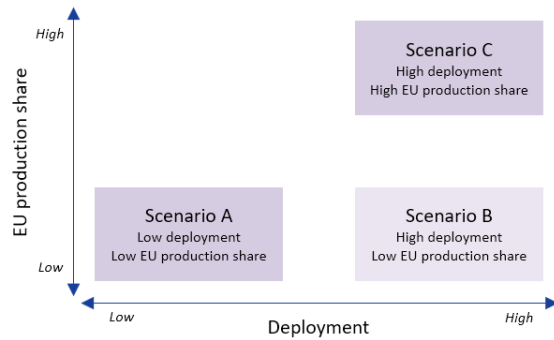
Component level actors by chemistry



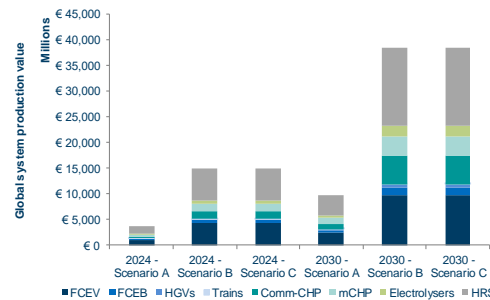
System level actors by application



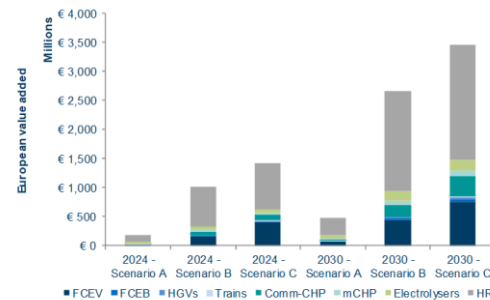
Different industry scenarios investigate and broadly characterise measures and impacts



Global system **production value** for the selected applications by industry scenario (2024 and 2030)



European **value added** for the selected applications by industry scenario (2024 and 2030)



Production value is only for selected parts of the chain; *value added* is only the difference between inputs and outputs

What could 2020 bring?

2020 *should* see more deployment, lower costs, and the start of a virtuous cycle

- FC car deployments should continue to increase
 - The supply chain will improve, costs reduce, investors engage
- Heavy duty will remain a hot topic:
 - FC buses will continue to prove the technology to the public
 - The first mid-scale ferries should go in the water
 - More rail and truck products will emerge
- Tokyo's Olympic showcase will keep up the HFC profile
- Stationary will grow slowly:
 - Existing markets will continue
 - Commercial-scale CHP could start to get traction
- More entrepreneurs will find opportunities using FC
- China remains uncertain
- But we can envisage 2GW+ deployed, if all goes well



Source: creative commons

If you have questions, or wish to discuss any aspects of fuel cells or hydrogen, please get in touch

Thank you!

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