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Grabbing a slice of the fuel cell cake

Cummins have been involved with fuel cells since 2003 with Solid Oxide Fuel Cells (SOFC). In 2014, Cummins joined a pilot project to explore the development of the first hydrogen-fuelled transportation system in Costa Rica. Then in 2018, the company joined the Hydrogen Council, a global coalition that explores and promotes hydrogen as a clean energy fuel source.

Image Source

The acquisition of Hydrogenics was shortly followed by an announcement that the company has entered into a memorandum of understanding with Hyundai Motor Company to jointly evaluate opportunities to develop and commercialize electric and fuel cell powertrains.

Automotive players in the fuel cell industry

Bosch – Strategic partnership with PowerCell and Ceres Power 29/4/19

Weichai Power – Ballard’s largest shareholder 19.9% (29/8/18), **Zhongshan Broad-Ocean Motor Co** (9.9%) (global supplier of small and special electric machines). Weichai’s intent to support the deployment of at least 2,000 commercial FCEVs by 2021 Press release

Elring Klinger – Serial production of components for fuel-cell driven automobiles began in 2008, initially with bipolar plates and gasket solutions. Three years later, the product range was extended to include PEM fuel cell stacks.

Michelin – global tyre manufacturer and the sole shareholder of Symbio since February 2019.

Market share

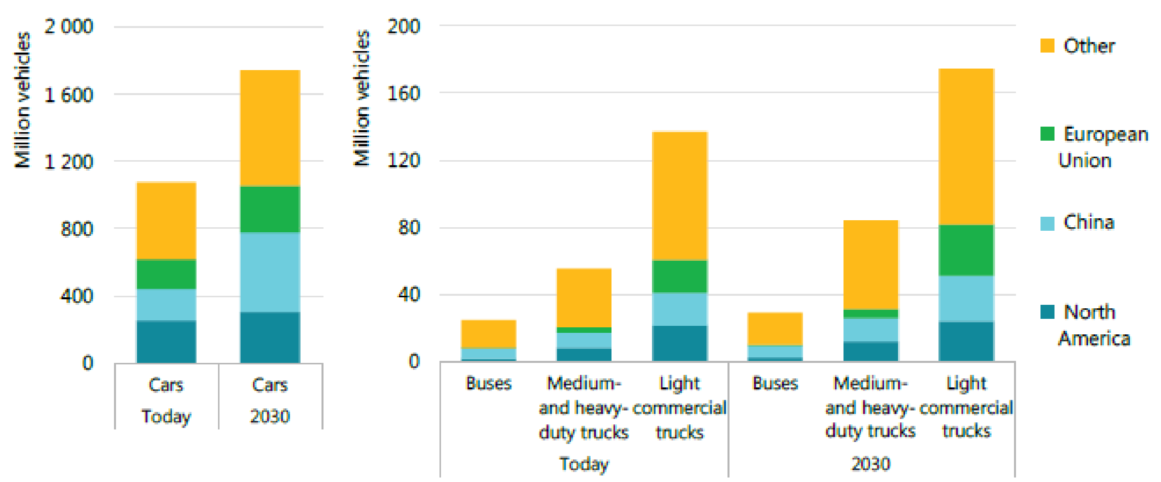
By total 2018 revenue, Bosch, Michelin, Cummins and Weichai Power ranked 1st, 9th, 13th, and 20th globally amongst automotive suppliers.[1]

Company	2018 revenue (€ billion)	Fuel cell interest	Involve in FC's since
Bosch	47.6	Strategic partnership with PowerCell, Ceres Power	2018
Michelin	24.4	Owner of Symbio	2014
Cummins	17.1	80% shareholder of Hydrogenics, MoU with Hyundai	2003 (SOFC), 2019 Hydrogenics, Hyundai
Weichai Power Co Ltd	12.5	19.9% shareholder of Ballard	2018
Broad Ocean	7.8	9.9% shareholder of Ballard	2016
Elring Klinger	1.7	Internal developing	2008

Projections for land transport

The road vehicle fleet's current fuel demand is large and is set to grow with demand for personal mobility by car and goods delivery by truck, particularly in developing and emerging economies.

Figure 1: Road vehicle fleet growth to 2030 under current trends



Producing hydrogen from low-carbon energy is costly at the moment. IEA analysis finds that the cost of producing hydrogen from renewable electricity could fall 30% by 2030 as a result of declining costs of renewables and the scaling up of hydrogen production. Latest estimates for the cost of hydrogen production (in Norway) range from 10-20 NOK/kg from steam reforming, to 33-54 NOK/kg by

[1] https://www.berylls.com/wp-content/uploads/2019/07/20190708_Study_Top_100_2019_EN.pdf

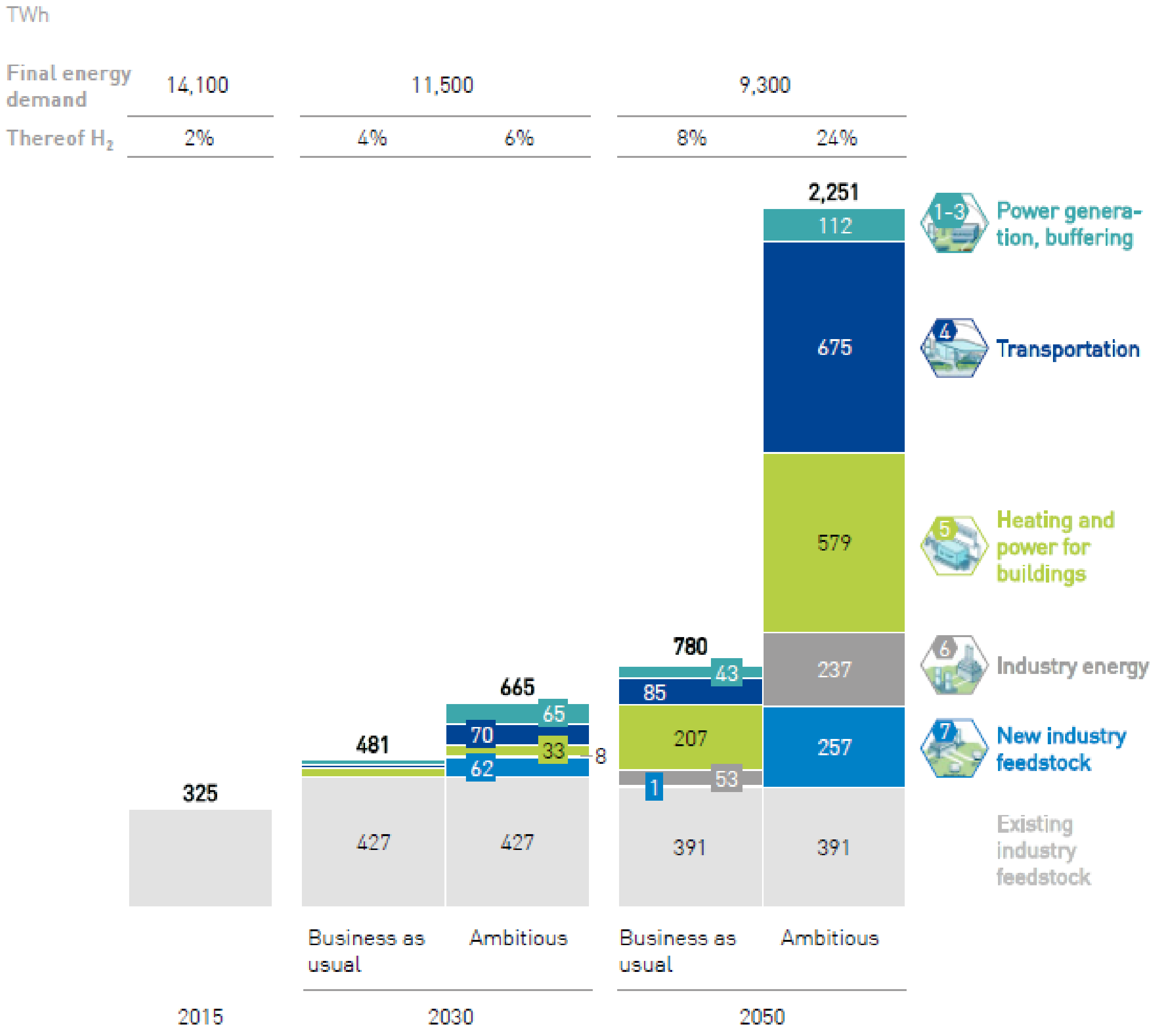
electrolysis (PWC, 2019). Fuel cells, refuelling equipment and electrolysers (which produce hydrogen from electricity and water) can all benefit from mass manufacturing.

For cars, FCEV cost could break even with BEV costs at a range of 400km. Cost reductions in fuel cells and storage tanks, together with high utilisation of stations, are the key to achieving competitiveness. Long haul and heavy-duty applications are attractive for hydrogen compared with the battery electric due to higher energy density of the system. In addition, captive vehicle fleets can help overcome challenges of low utilisation of refuelling stations. For long-haul trucks, fuel costs make up about half of the total cost of ownership, so the focus for making them competitive should be on bringing down the delivered price of hydrogen. (IEA, 2019)

Yet, transportation is not the only application of fuel cells.

The great advantage of hydrogen is its cross-sector applications – the hydrogen economy. Figure 2 shows predictions for energy supply from H_2 in 2030 and 2050 in "business as usual" and "ambitious" scenarios.

Figure 2: Hydrogen could provide up to 24% of total energy demand, or up to 2,250 TWH of energy in the EU by 2050. (FCH JU, 2019)



By acquisitions or strategic partnerships with fuel cell suppliers, traditional suppliers to the automotive industry are both future proofing their portfolio and opening-up new markets. When these cross-sector applications are coupled with the expected growth in the road vehicle fleet, it is hardly surprising that big automotive players are paying for their slice of the fuel cell cake.

Relevance to Maritime

Does the acquisition of and strategic partnerships with key fuel cell suppliers by big automotive players have any relevance to the maritime industry?

Yes.

Cummins, Bosch, Weichai, Zhongshan Broad-Ocean Motor are already players in the maritime industry to varying degrees. Maritime hydrogen is 5-10 years behind land-based hydrogen; however, the transfer of knowledge, upscaling of fuel-cell stacks and investment required will benefit from these collaborations with companies that have a foot in both camps.

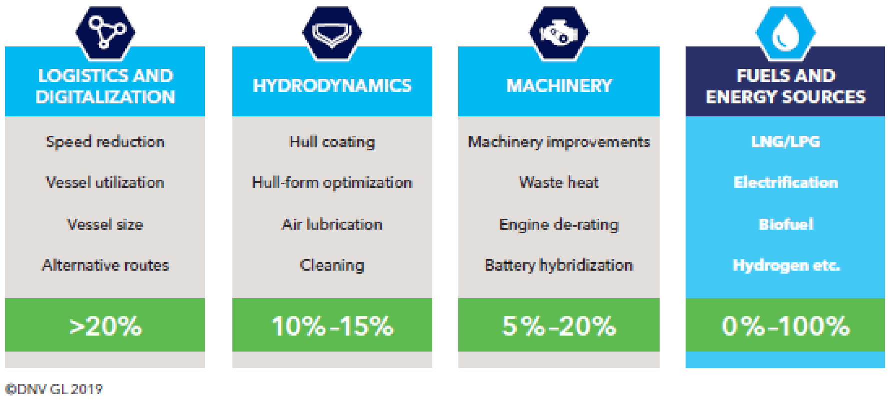
For water transport, fuel cells are most relevant for larger passenger ships such as river cruise ships and ferries, and possibly also for ocean cruise ships requiring longer autonomy. Passengers will value lower local emissions, less noise, and less water pollution. Political pressure on river, lake, and port authorities to ban ships with high local emissions of CO_2 and other air pollutants, such as soot and NO_x, is expected to increase once viable low- or zero-emission alternatives to power the marine sector become available. Besides propulsion, fuel cells can provide auxiliary power on ships, replacing diesel-based units. Prototypes for fuel-cell-powered ships are already in operation, including the MS Innogy, Energy Observer, Race 4 Water, MARANDA. The cruise operators Carnival, Royal Caribbean, and Viking Line are looking at fuel cells. (FCH JU, 2019)

Alongside the new NOx and SOx emissions limits, the IMO have has set a target of at least 50 % reduction in CO_2 emission by 2050. This equates with an 85% reduction in carbon intensity.

Figure 3: Pathways for international shipping's Carbon dioxide (CO2) emissions (Lloyd's Register, 2019)

Decarbonization could be especially challenging in the deep-sea segment, which generates 80% of the global fleet's CO_2 emissions. Energy efficiency, in both design and operation, will play a key role. In the short sea segment, we are seeing early trials and the use of low- or zero-carbon technologies that could translate to the wider fleet, including batteries and hydrogen. (DNVGL, 2019)

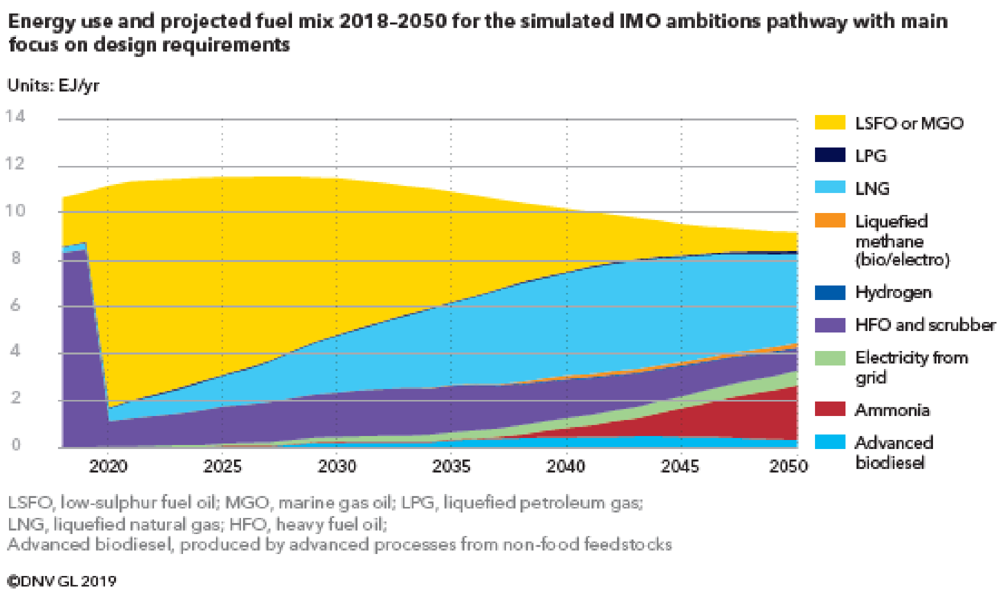
Figure 4: Overview of technologies and fuels and their GHG-reduction potential (%)



The 2050 fuel mix is heavily dependent on the specific design of the GHG regulations which are put in place, and on how fuel-converter costs (e.g. diesel engine, marine fuel cell) and fuel prices develop towards 2050.

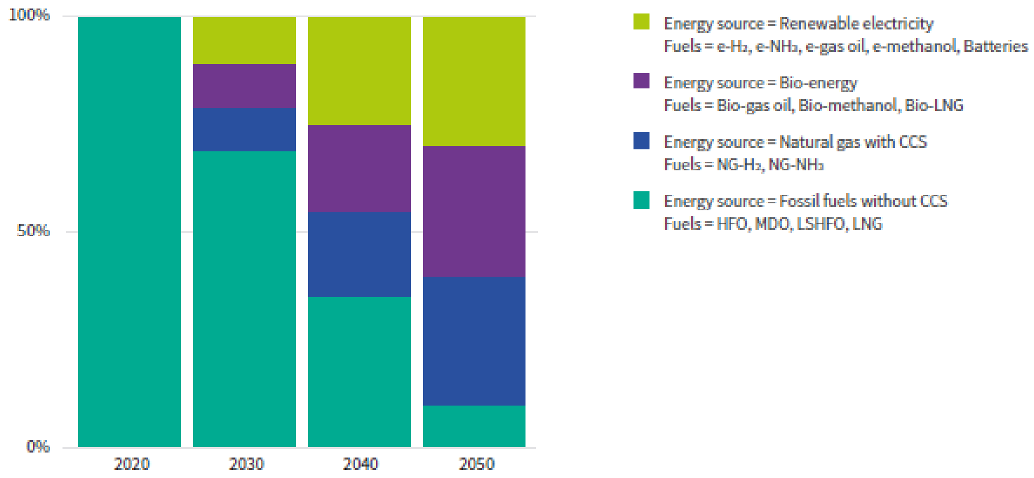
To achieve IMO GHG ambitions the share of carbon-neutral fuels must vastly increase, DNVGL, forecasts that the share of carbon-neutral fuels in world fleet energy needs to be 30%–40% in 2050. Figure 5 shows one possible pathway for international shipping achieving these ambitions; here, regulations will gradually require all newbuilds from 2040 to be almost carbon neutral. In figure 6, (Lloyd's Register, 2019) takes the IMO GHG ambitions and IPCC 1.5°C scenarios and "backcasts" 3 potential fuel mixes - resulting in a very different fuel mix.

Figure 5: Energy use and projected fuel mix 2018-2050 for the simulated IMO ambitions pathway with main focus on design requirements



"We find that minor changes to the underlying assumptions can significantly alter the forecasted fuel mix. Unless alternative fuels become price competitive with fossil fuels, introducing policy measures is a key component for addressing shipping GHG emissions." (DNV GL, 2019)

*Figure 6: Energy source and marine fuels mix assumed in **equal mix** pathway (Lloyd's Register, 2019)*



Fuel cells have several advantages over internal combustion engines for power generation, they are more efficient (30-53% for ICE vs 50-60% for fuel cells), quieter, and have zero NOx or SOx exhaust emissions (point of use). Furthermore, fuel flexibility (LNG/MGO/methanol/LBG/biofuels) is possible if high temperature – PEMFC or solid-oxide fuel cells (SOFC) are used.

"Zero-emission vessels deployment sees a consolidated set of technologies; fuel cells hold great promise as part of that consolidation." *– Lloyds Register, 2019*

With the demand for seaborne trade is projected to grow by 39% until 2050, and a continued to push for more sustainable and zero carbon solutions, many forecasts are hinting that hydrogen and electrofuels are going to play a key role in maritime transport as well as land based. There are still many questions around the hydrogen economy that are yet to be clearly answered, questions concerning: infrastructure, fuel cost uncertainty, technological maturity, social acceptance to name a few areas, however with the big automotive manufacturers throwing their hats into the ring, it is only a matter of time before these questions are answered.

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