Development of technologies for the use of carbon dioxide emissions by obtaining methanol as a prerequisite for the transformation of energy

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Main idea

In the development of CCS (carbon capture storage) technology for capturing and burying CO2 emissions from thermal power plants (TPPs), it is proposed to introduce CCU (carbon capture usage) technologies for obtaining methanol from CO2 captured in TPPs with subsequent generation of electricity or its accumulation in renewable energy sources

3 Why methanol?

From the point of view of energy transformation, the main value of methanol lies in the ability to utilize the greenhouse gas CO2 in thermal power plants and accumulate excess electricity in renewable sources for a long time.

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A task

To implement the main idea, it is required to identify a set of existing completed developments that can be involved in the entire process. These are technologies for producing e-methanol from CO2, generating electricity from methanol, high-power fuel cells (FC), reforming methanol to obtain hydrogen in transport.

CRI plant, Iceland. 2011. 4 thousand tons of renewable methanol per year

Visualization of a 100,000 tpy renewable methanol plant based on the ETL (The Emissions-to-Liquids Technology) platform supplied by CRI

First 1 MW (250 kW × 4) MCFC fuel cell power plant at California University, 2007

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A 1 MW fuel cell power plant running on hydrogen from the SolVin plant (Belgium). 2011. Manufacturing Companies MTSA (NL), JMFC (GB), NFCT (NL)

JMFC's technological breakthrough (GB)

JMFC has done a great job, thanks to which it became possible for the first time to build fuel cells (FC) of a single high power. Membrane electrode assemblies for FCs have previously been produced in relatively small quantities using single piece manufacturing techniques that were not suitable for large volumes.
For the production of electrodes in large volumes, all operations had to be performed on rolls, which created new, difficult requirements for the technology.

Hydrogen from methanol is cheaper

The experience of creating the first stations for 1MW and more may be useful for the sale of e-methanol. However, an additional link is needed - a reformer to produce hydrogen from methanol.

The competitive advantage of hydrogen production from methanol is the following fact: according to the Danish Methanol Institute, the cost of hydrogen obtained from methanol is 5-8 times less than the cost of industrial hydrogen.

The first 50 MW waste hydrogen plant.

Occupied area 20 t. Sq. M. 2020. Developed by Hanwha Energy (KR). Includes 144 fuel cells PAFC of Doosan Fuel Cell Co Ltd. (KR)

Methanol reforming routes for transport

$CH_3OH + H_2O \rightarrow 3H_2 + CO_2$ - traditional steam conversion

$CH_3OH \rightarrow 2\,H_2 + CO$ – decomposition on a catalyst based on copper with zinc

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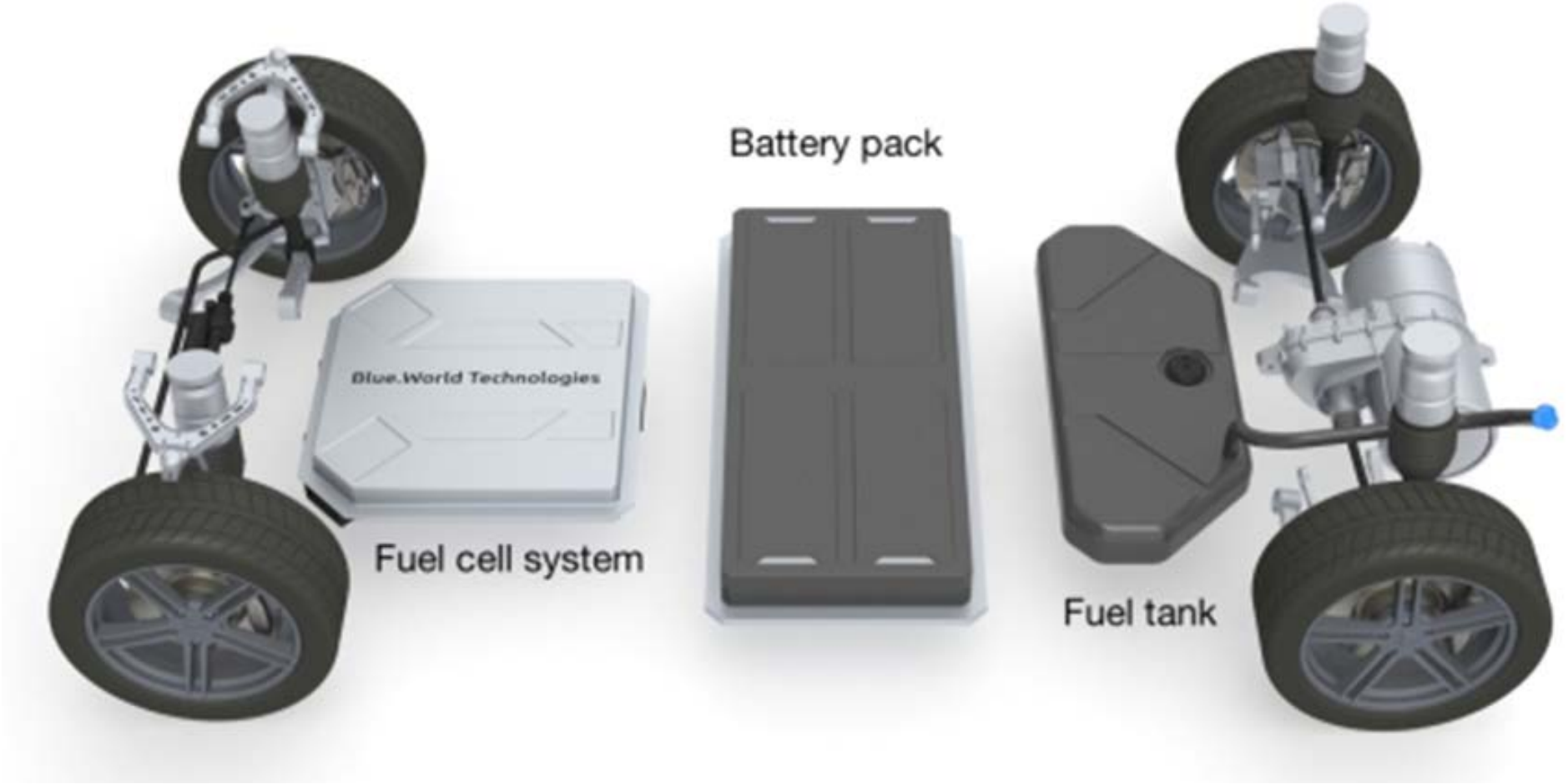
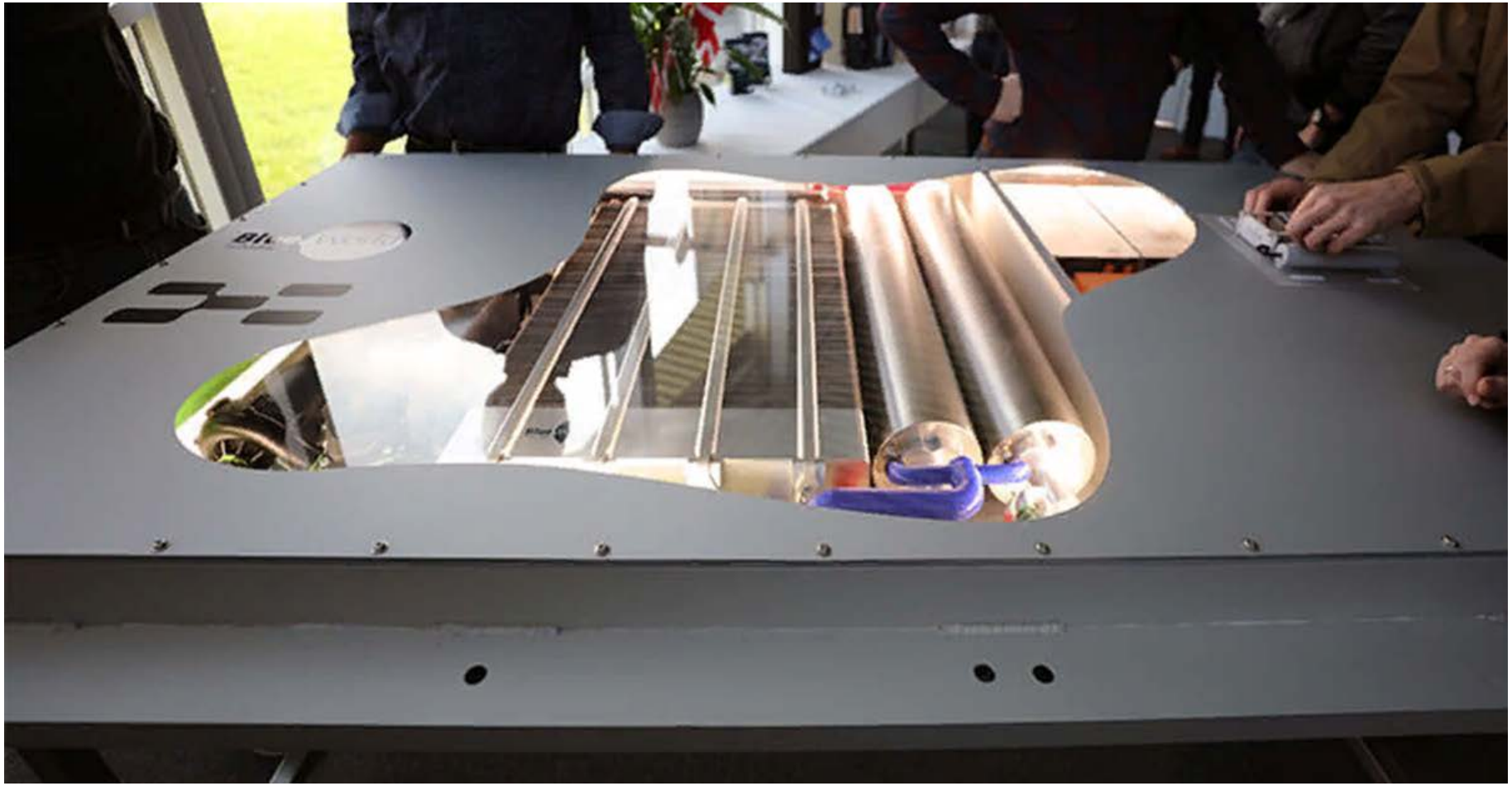
The reforming of methanol to produce hydrogen on board was first used in the Necar 3 experimental vehicle in 1997

Blue World Technologies (DK) methanol fuel cell car schematic. 2020. 1000 km mileage per one refueling. 3 min. refueling



Blue World Technologies power car model with fuel cell and reformer



Fuel cell module from Freudenberg Sealing Technologies (FST) (DE), methanol, 100 kW, scalable to tens of MW, internal reformer. 2020

Methanol as a storage for renewable electricity

The availability of renewable electricity allows electrolysis of water to produce "green" hydrogen. The CO2 required for the reaction can be delivered from a nearby thermal power plant or an industrial source. The opposite approach is not excluded.

The minimum cost of production of renewable methanol is about $565 per ton, which is more expensive than the traditional method, but in line with market conditions.

Conclusions

Based on the reviewed technologies of the companies Carbon Recycling International (CRI) (IS), Johnson Matthey Fuel Cells (JMFS) (GB), Freudenberg Sealing Technologies (FSI) (DE) and others, it becomes possible to intensively develop technologies for the utilization of carbon dioxide by producing methanol and storing renewable electricity.

Thank you for attention!