ALTERNATIVE FUELS

(581) - (*) - A COMPARISON OF THE MOST PROMISING LOW-CARBON HYDROGEN PRODUCTION TECHNOLOGIES

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Draft Paper

Coping the energy transition is one of the most extensive and challenging missions nowadays. To achieve the 1.5° target set in the Paris Climate Agreement, global greenhouse gas (GHG) emissions must be massively reduced in the decades ahead. The critical key step towards a climate-neutral energy system is the significant increase in the use of renewable energy. However, for the decarbonization of the entire energy system to be successful, the energy transition has also created an interest in obtaining large amounts of climate-neutral hydrogen in a way that is as efficient and cost-effective as possible. Hydrogen offers the possibility of storing the increasing, fluctuating share of renewable electricity over long periods, rendering the energy transportable and flexible to use across different sectors. Furthermore, in its "Hydrogen Strategy for a climate-neutral Europe" the European Commission addresses not only the potential of hydrogen to compensate for the seasonal fluctuations of renewable energy sources, but also the opportunity to decarbonize sectors such as the steel or chemical industry in which it has been difficult to reduce the CO_2 emissions so far.[1]

Hydrogen is currently mainly produced by the conventional method of steam methane reforming (SMR).[2] However, in the course of the decarbonization this technique is no longer acceptable due to its high GHG emissions. For this reason, electrolysis powered by electricity from renewable energy is becoming increasingly important and is considered by the European Union as the essential technology that needs to be implemented as a long-term solution. In addition, other low-carbon technologies, such as methane pyrolysis or SMR in combination with carbon capture and utilization (CCU), have to be taken into account to achieve climate goals. No CO_2 is released during the methane decomposition process, but instead solid carbon emerges as a byproduct. Therefore, this process is also a promising low-carbon hydrogen technology. Another option is combining the currently prevailing hydrogen process - SMR - with a CCU system. Standard SMR with carbon capture and storage (CCS) should nowadays be considered as an interim solution only.

As the importance of low-carbon hydrogen keeps increasing, this paper assesses the most promising low-carbon hydrogen technologies. The typical electrolysis including alkaline, PEM, and high temperature electrolysers are addressed, as well as the methane pyrolysis based on plasma, thermal and catalytic pyrolysis. Furthermore, SMR with CCU is mentioned along with SMR using CCS. The various methods are compared on the basis of assessment criteria such as the scalability, the technological readiness level (TRL), the efficiency, and the economic and ecological aspects of the individual technologies. Moreover, it is discussed to what extent using of by-products such as oxygen from electrolysis or solid carbon from methane pyrolysis can increase the efficiency. This holistic comparison intends to evaluate which technologies can prevail and thus contribute to a successful energy transition.

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[1] European Commission. A Hydrogen Strategy for a climate-neutral Europe, 2020

[2] IEA - International Energy Agency. World Energy Outlook 2018

Palavras-chave : low-carbon hydrogen, methane pyrolysis, electrolysis, steam methane reforming with CCU