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BALANCING OFFSHORE WIND POWER WITH PEM ELECTROLYSIS FOR HYDROGEN PRODUCTION

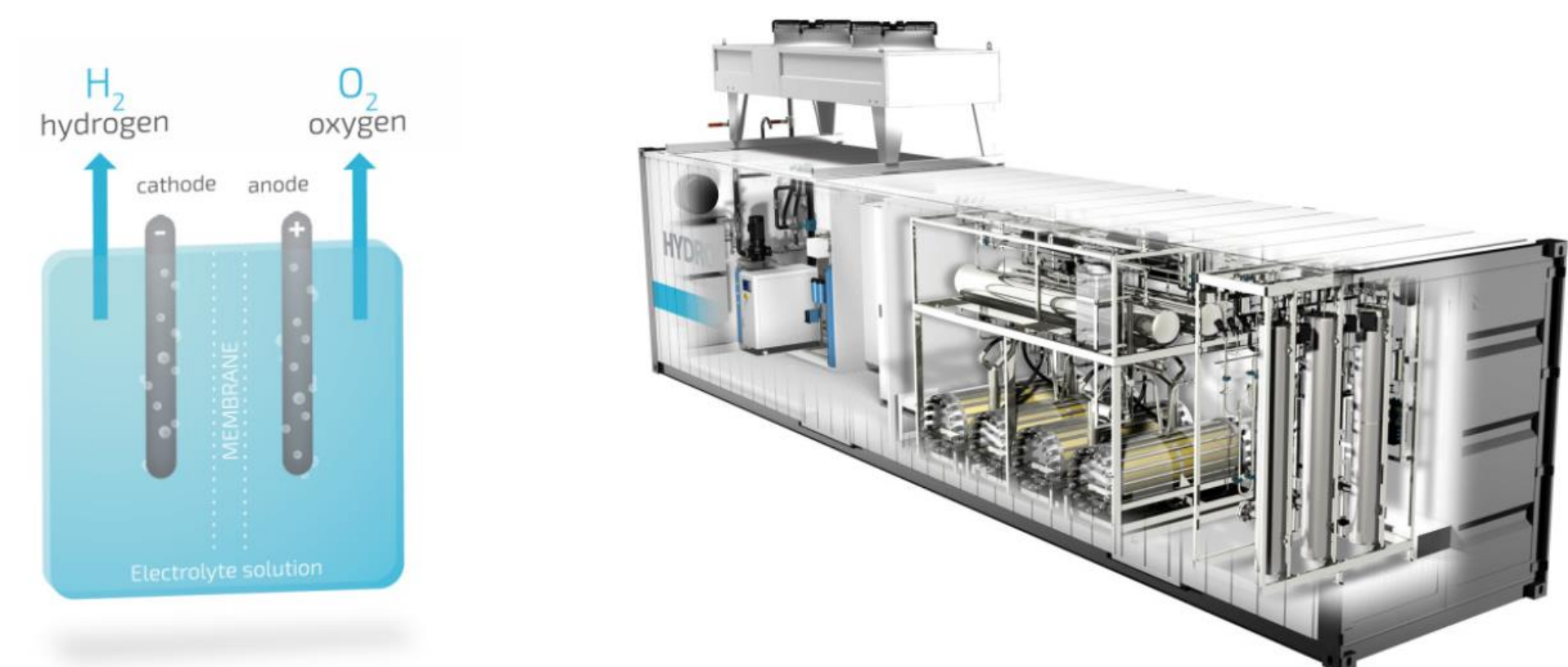
INTRODUCTION AND MOTIVATION

The GREENPORTS project aims to develop a comprehensive model of the power system based primarily on both onshore and offshore wind energy and hydrogen produced by proton exchange membrane (PEM) water electrolysis, assuming an ability of the electrolyser to provide balancing services to the power grid. The results will be implemented in a pilot case in the port of Zeebrugge and pave the ground for the integration of large-scale Power-to-Gas (P2G) installations into the energy system in Flanders, Belgium.

POWER-TO-GAS DEFINITION

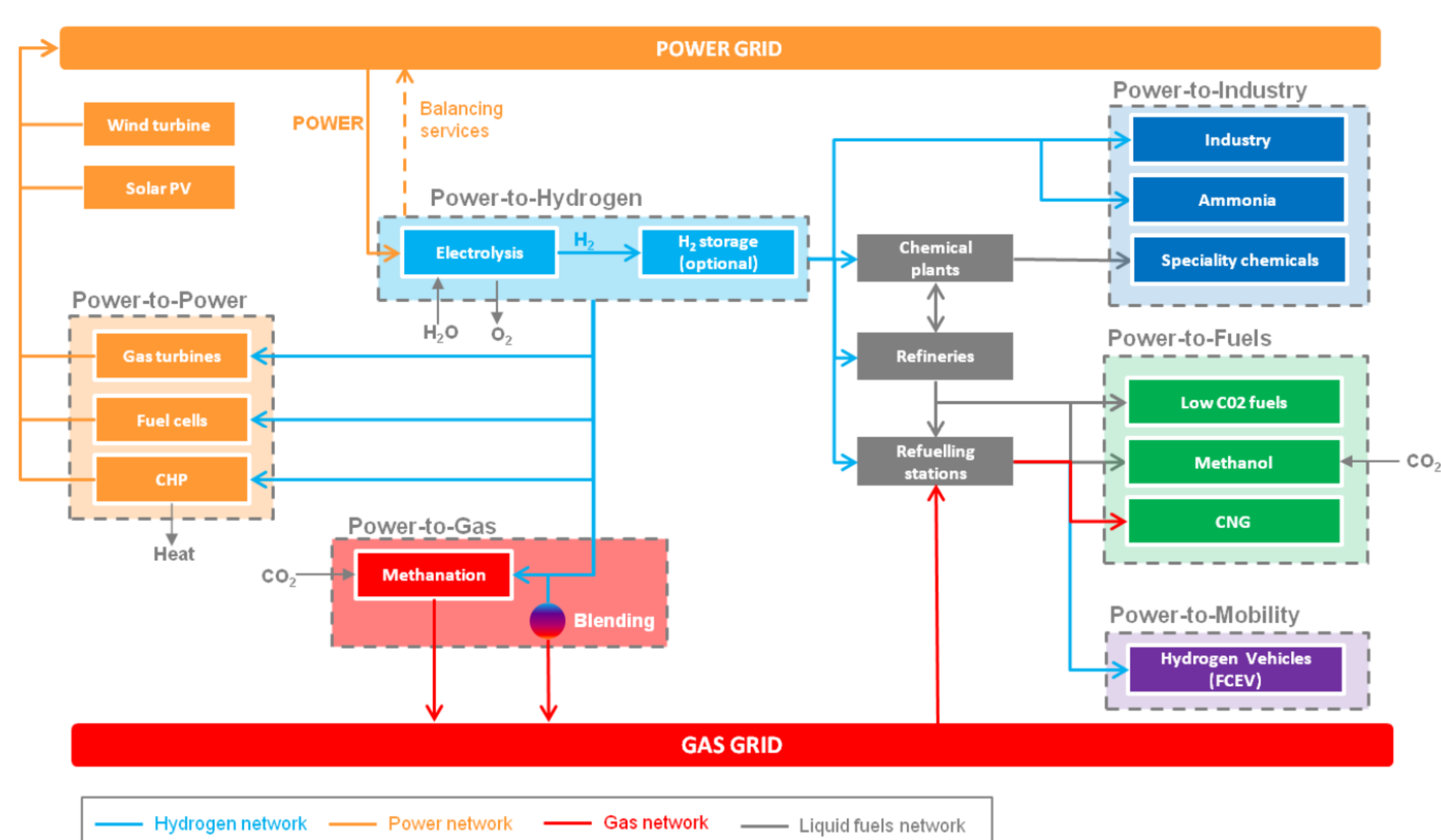
Storing renewable electricity in hydrogen is a solution to balance fluctuating power. In this method, the electrical energy is used for the dissociation of water molecules into hydrogen and oxygen by means of the electrolysis process. The resulting hydrogen is injected into the natural gas grid or is used in mobile and stationary applications.

The water electrolysis reaction and example of a 60Nm³/h electrolyser



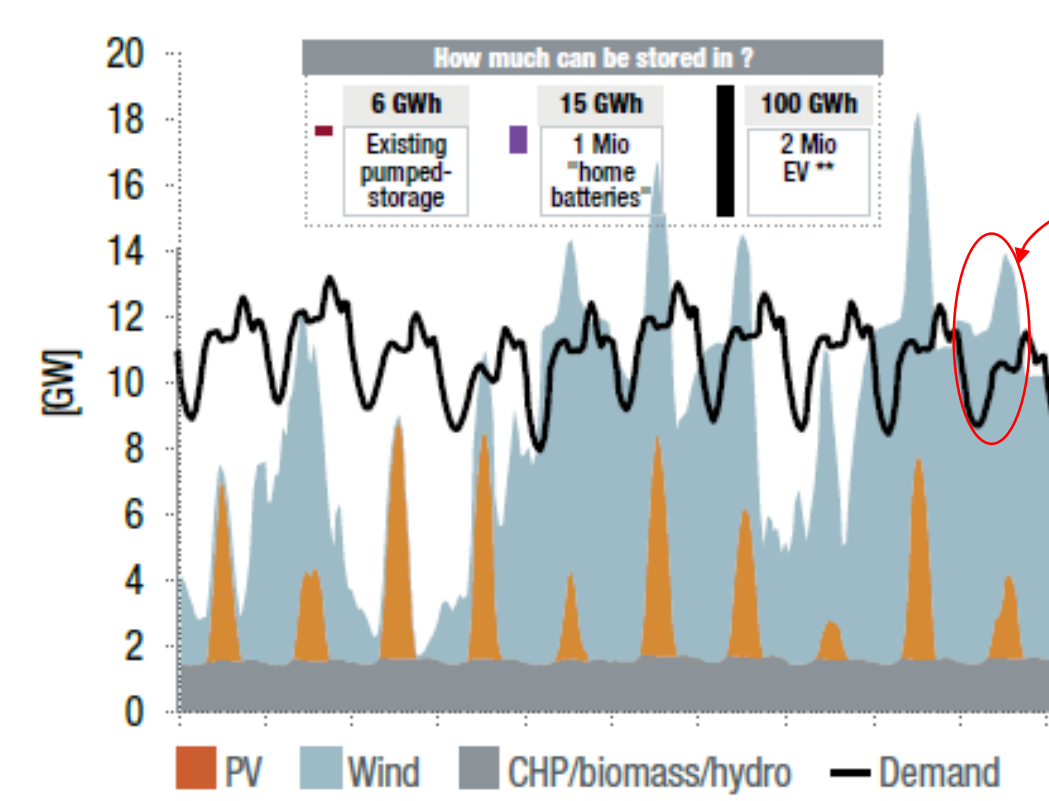
Source: Hydrogenics, www.hydrogenics.com

POWER-TO-GAS VARIOUS VALORISATION PATHWAYS



Source: Thomas D. (Hydrogenics), Mertens D. (Colruyt), Meeus M. (Sustesco), Van der Laak W., Francois I. (WaterstofNet): Power-to-Gas Roadmap for Flanders; Brussels, October 2016

FLEXIBILITY NEEDED TO COPE WITH VARIABLE ENERGY SOURCES



Long-term storage of excess wind energy as a hydrogen gas could be appropriate to bridge this gap and to bring the needed flexibility to deal with such imbalances.

Source: Electricity scenarios for Belgium towards 2050: Elia's quantified study on the energy transition in 2030 and 2040; Brussels, November 2017

THE PIPELINE INFRASTRUCTURE IN FRANCE, BELGIUM AND NETHERLANDS

The total length of pipeline network: 2 225 km

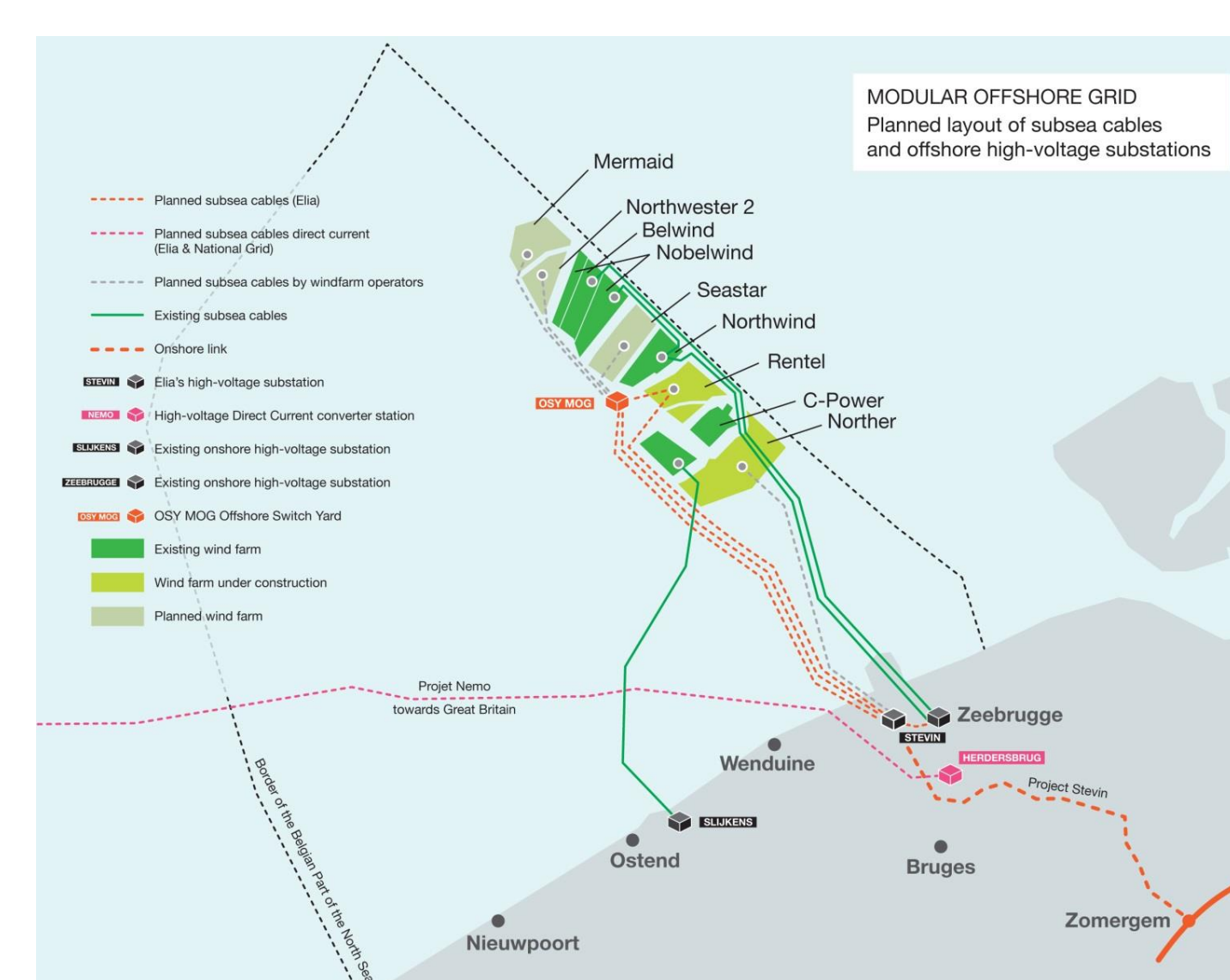
The length of hydrogen pipeline network: 964 km, of which

613 km in Belgium
187 km in the Netherlands
164 km in France



Source: Air Liquide, www.airliquide.com

THE CURRENT WIND FARMS SITUATION IN THE PORT OF ZEEBRUGGE



Source: Elia, www.elia.be

WIND FARM	CAPACITY	TURBINES
Belwind (2010)	171 MW	55 x 3 MW, 1 x 6 MW
Northwind (2014)	216 MW	72 x 3 MW
Nobelwind (2017)	165 MW	50 x 3.3 MW
Rentel (2018)	309 MW	42 x 7.35 MW
Norther (2019)	370 MW	44 x 8.4 MW
Total	1 231 MW	

CONCLUSIONS AND FUTURE DEVELOPMENTS

This research project analyses the future development of a power system model to be used to apply P2G concepts, applicable today to a wind-hydrogen energy system and analyses the role of an electrolyser in balancing the power system based on both onshore and offshore wind energy.

The goals of the GREENPORTS project are:

- The possible operation and performance of the future power system based primarily on onshore/offshore wind energy sources and hydrogen produced by PEM water electrolysis will be modeled and simulated, assuming an ability of an electrolyser to provide balancing services to the power grid;

- The dynamic simulation model of the power system's components and the whole system itself will provide insight into the system's behavior and variety of different design options for implementation of a pilot project;
- The application of the results to a pilot case in the port of Zeebrugge for multiple applications of renewable hydrogen in industry, for mobility applications, and Power-to-Gas technology to move from renewable electricity to hydrogen and other products.

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GREENPORTS in collaboration with industry partners