

Port of Rotterdam: Towards a CO2 neutral port with a new Hydrogen and Electricity energy system

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ABSTRACT

The maritime industry accounts for 2.8% of global GHG emissions, with emissions rising over 90% since 1990 due to rapid growth in shipping. UNFCCC 2015 The Paris Agreement emphasizes the need for significant decarbonization efforts by mid-century. Moreover, The IMO's initial GHG strategy targets a 40% reduction in CO2 emissions by 2030 and 70% by 2050 and the majority of efforts should be focused on replacing fossil fuels with renewable alternatives. As the maritime sector transitions alongside the energy sector, the Port of Rotterdam Authority is working with partners to develop a new energy system aimed at achieving a CO2-neutral port by 2050.

INTRODUCTION

The port industry has recently undergone a "green" revolution, as depicted by the significant transition to sustainable electricity generation in Europe (Figure 1). The amount of electricity produced from renewables steadily grows between 2014 and 2050, reducing reliance on fossil fuel and nuclear sources. Additionally, Figure 2 illustrates the growing energy demand within the European transport sector, with a transition toward cleaner energy sources like electricity and hydrogen from 2013 to 2050, indicating a progressive shift to Sustainability Trends in the European Energy Market. Innovations like shore power and renewable energy sources can reduce environmental impact while meeting demands.

HYDROGEN

The Port of Rotterdam Authority and its partners are developing a hydrogen system to achieve a CO2-neutral port, focusing on blue and green hydrogen. Key components of this system include:

- **Hydrogen Infrastructure:** Hynetwork Services and the Port Authority are creating a new hydrogen pipeline, which will connect to national and international networks, linking Rotterdam to other regions.
- **Conversion Park:** A 24-hectare site on Maasvlakte is designated for converting green electricity from offshore wind farms into green hydrogen through electrolysis. The project aims to develop a 250 MW electrolyser by 2025, producing 100-180 kt of green hydrogen annually.
- **Green Hydrogen Imports:** By 2050, it is projected that 18Mt of hydrogen will be imported via the port, with numerous projects underway to facilitate this. All Hydrogen generation and import will be showcased in Figure 3.
- **CO2 Storage:** The Porthos project aims to transport and store 2.5 Mt of CO2 annually from industrial companies in depleted gas fields under the North Sea with operations expected to start in 2026.

Overall, Rotterdam aims to become Europe's Hydrogen Hub, significantly contributing to the transition to sustainable energy.

Figure 3. Development of the Hydrogen value chain

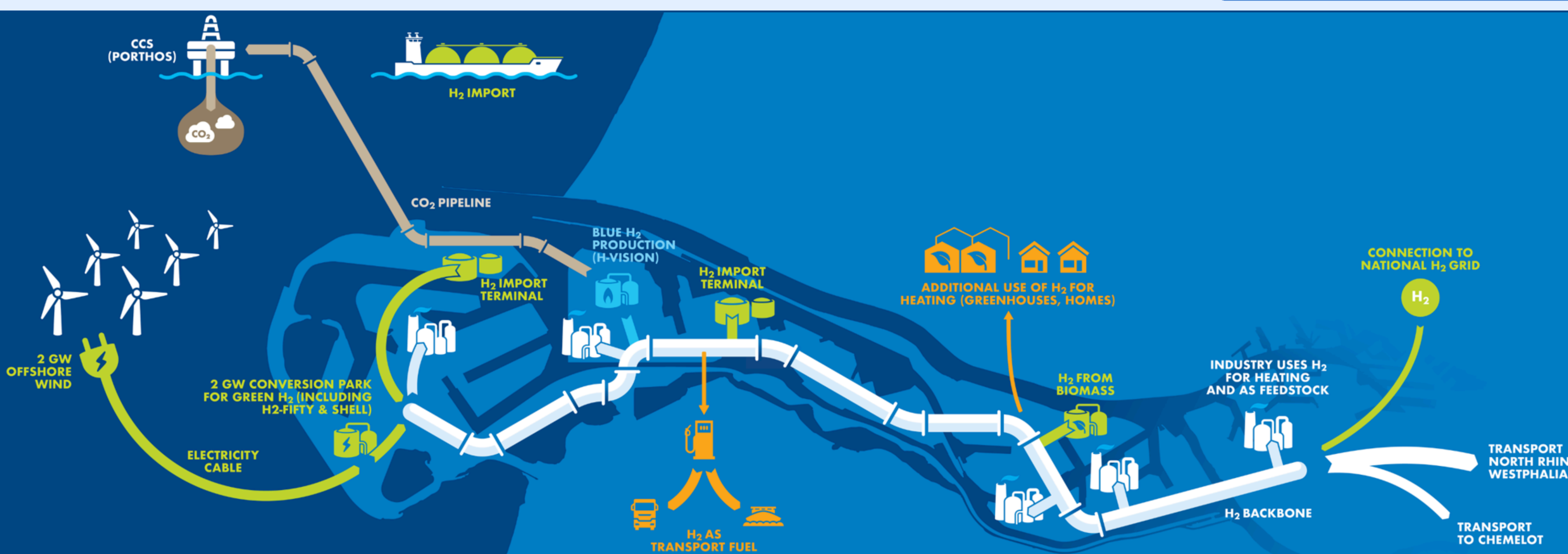
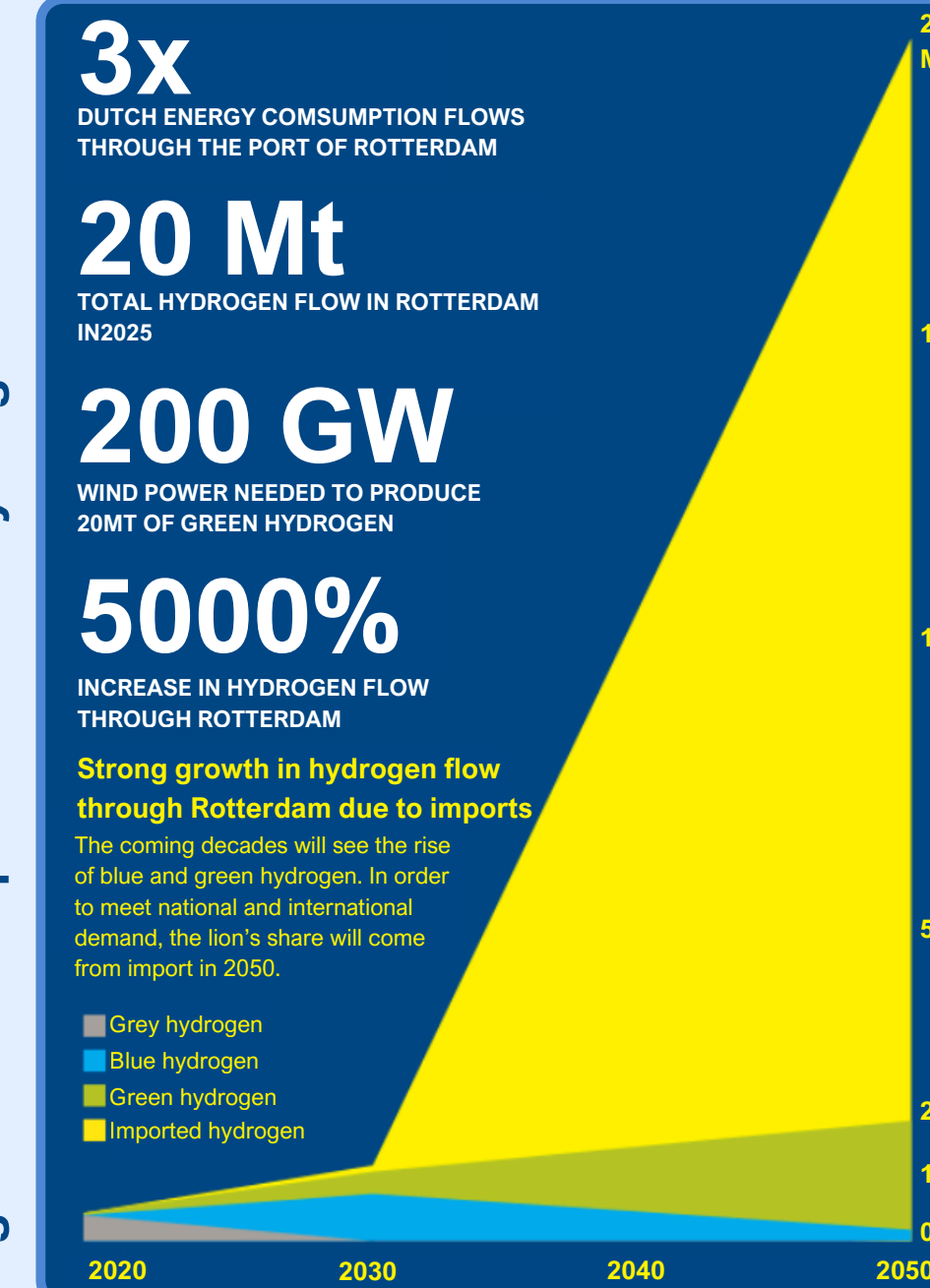


Figure 4. New energy system of Port of Rotterdam

ELECTRICITY

The Port of Rotterdam integrates the shore power for lighting, heating, cooling, and other onboard systems while docked with electricity from the Hollandse Kust Zuid offshore wind turbine farms and will be joined by two further offshore wind farms: IJmuiden Ver and Nederwiek by 2030, providing 7.4 GW of capacity, reducing the emission of carbon dioxide, nitrogen, particulate matter, and noise pollution. Moreover, it extends the lifespan of equipment on board ships and reduces the failure rate, which promotes maintenance costs minimization.

The Port of Rotterdam Authority, in collaboration with grid operators TenneT and Stedin, is implementing several projects to upgrade the power grid. This initiative aims to ensure an adequate supply of green energy and enhance sustainability. Additionally, they have established the New Energy Taskforce, a team of experts in the energy sector focused on identifying and developing possible solutions for bottlenecks and potential grid congestion. The overall of new Hydrogen and Electricity system conducted in Port of Rotterdam showcased in Figure 4.

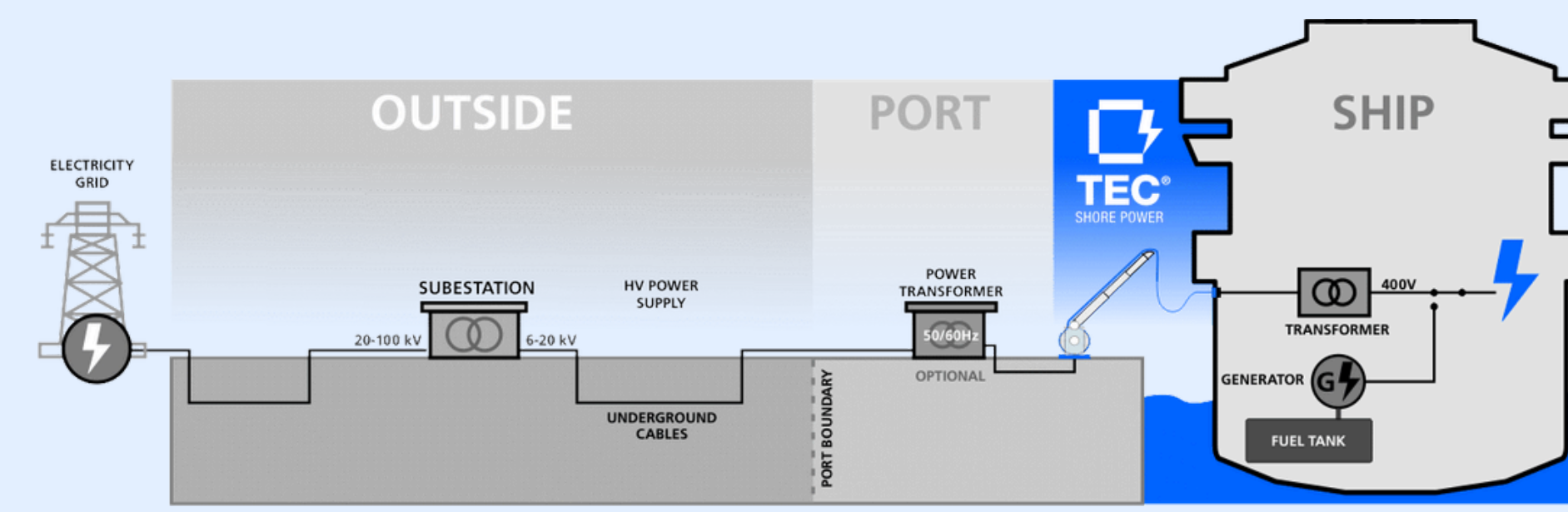


Figure 5. Shore power procedure

DISCUSSION

Challenges:

- **Investment & Infrastructure:** Significant investment is needed to build Rotterdam's hydrogen infrastructure, alongside technological challenges in scaling electrolysers and production.
- **Storage & Distribution:** Blue hydrogen's reliance on CO2 storage presents technical and regulatory hurdles, particularly for the Porthos project.
- **Global Competition:** Facing competition from regions like the Middle East and North Africa, Rotterdam must secure reliable hydrogen sources and strategic partnerships to maintain its lead.

Opportunities:

- **Economic Growth & Jobs:** Leadership in the hydrogen economy can create new industries, attract investment, and generate jobs in renewable energy.
- **Sustainable Transport & Industry:** Hydrogen integration will help decarbonize transport and industrial sectors, reducing emissions.
- **Environmental Impact:** Hydrogen projects and shore power initiatives will improve air quality and urban health by reducing emissions and noise.

PREDICTION

Rotterdam's development of a hydrogen pipeline network, leveraging hydrogen's sustainable byproduct properties, is predicted to result in a substantial reduction in industrial CO2 emissions by 2040. This pipeline network aims to integrate hydrogen into existing industrial processes. Additionally, the Rotterdam Shore Power program and European legislation are expected to significantly enhance shore power utilization among vessels calling at the port during the next five years.

CONCLUSION

Rotterdam Port leads in CO2 reduction through hydrogen, shore power, and renewables. Initiatives like green hydrogen infrastructure, offshore wind, and sustainable electricity contribute to the decarbonization. Collaborating with multiple partners, the port develops a hydrogen pipeline for national and international networks, including building new hydrogen infrastructure with offshore wind farms and upgradation in power grid. Despite high costs and technological hurdles, economic growth, jobs, and investment outweigh its downsides.

References

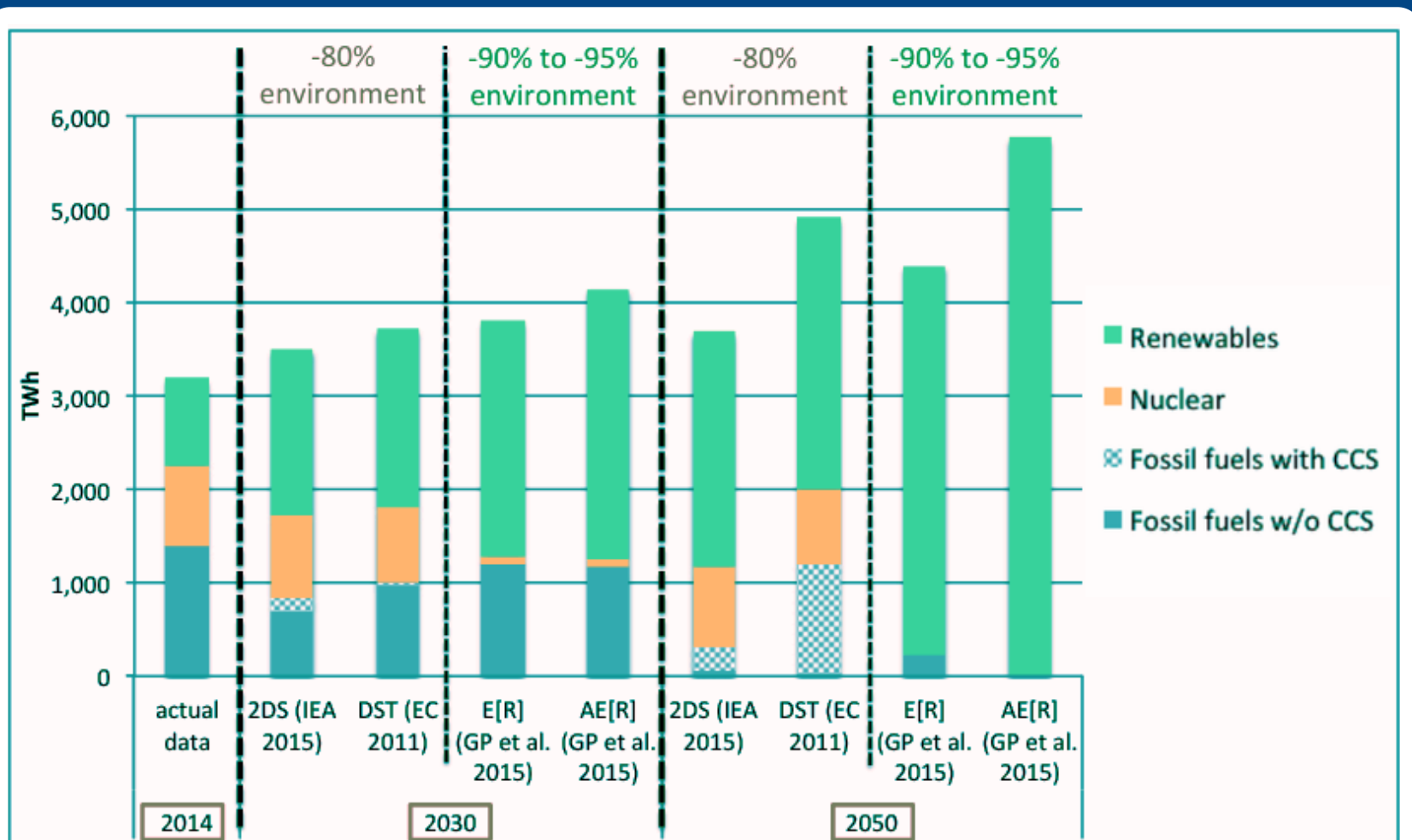
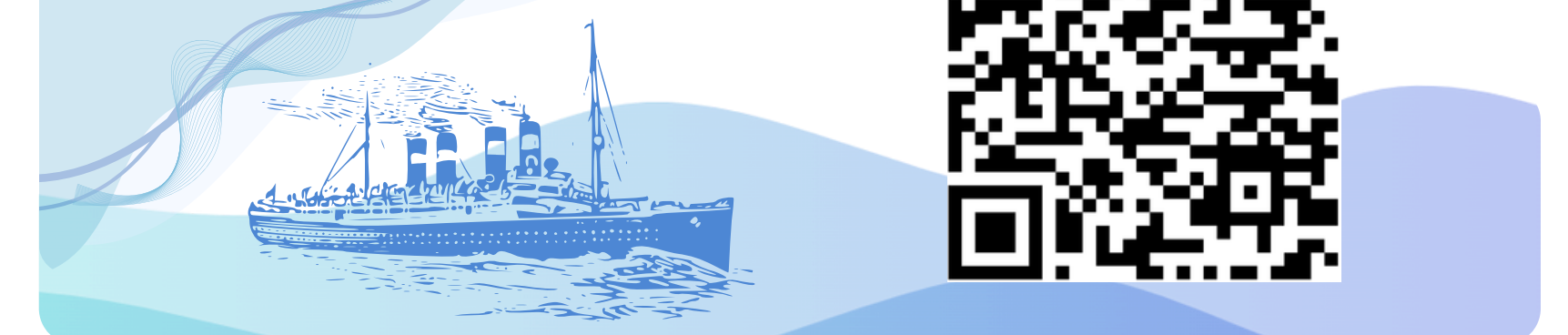


Figure 1. Gross electricity generation in Europe between 2014 and 2050

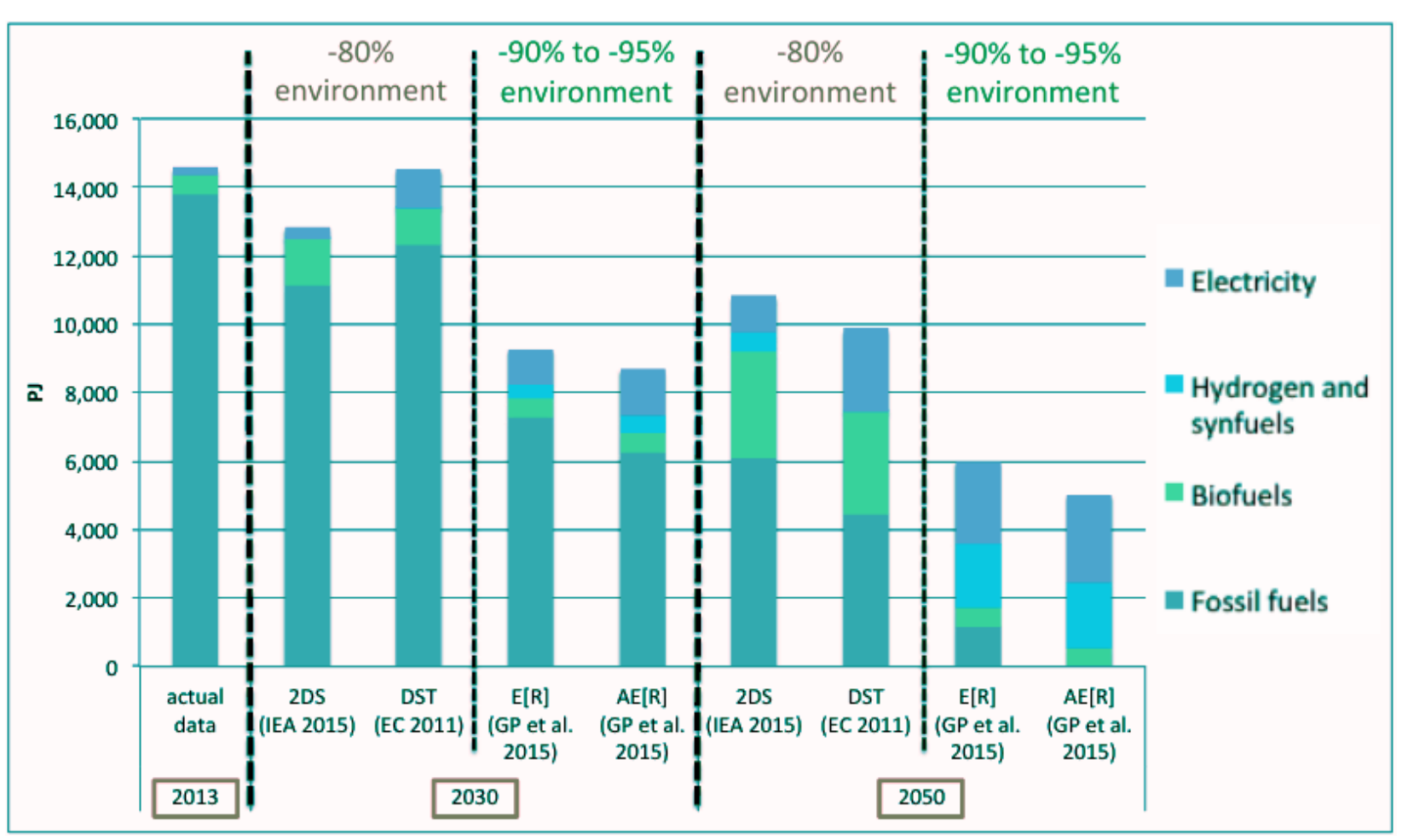


Figure 2. Energy demand in the European transport sector between 2013 and 2050

