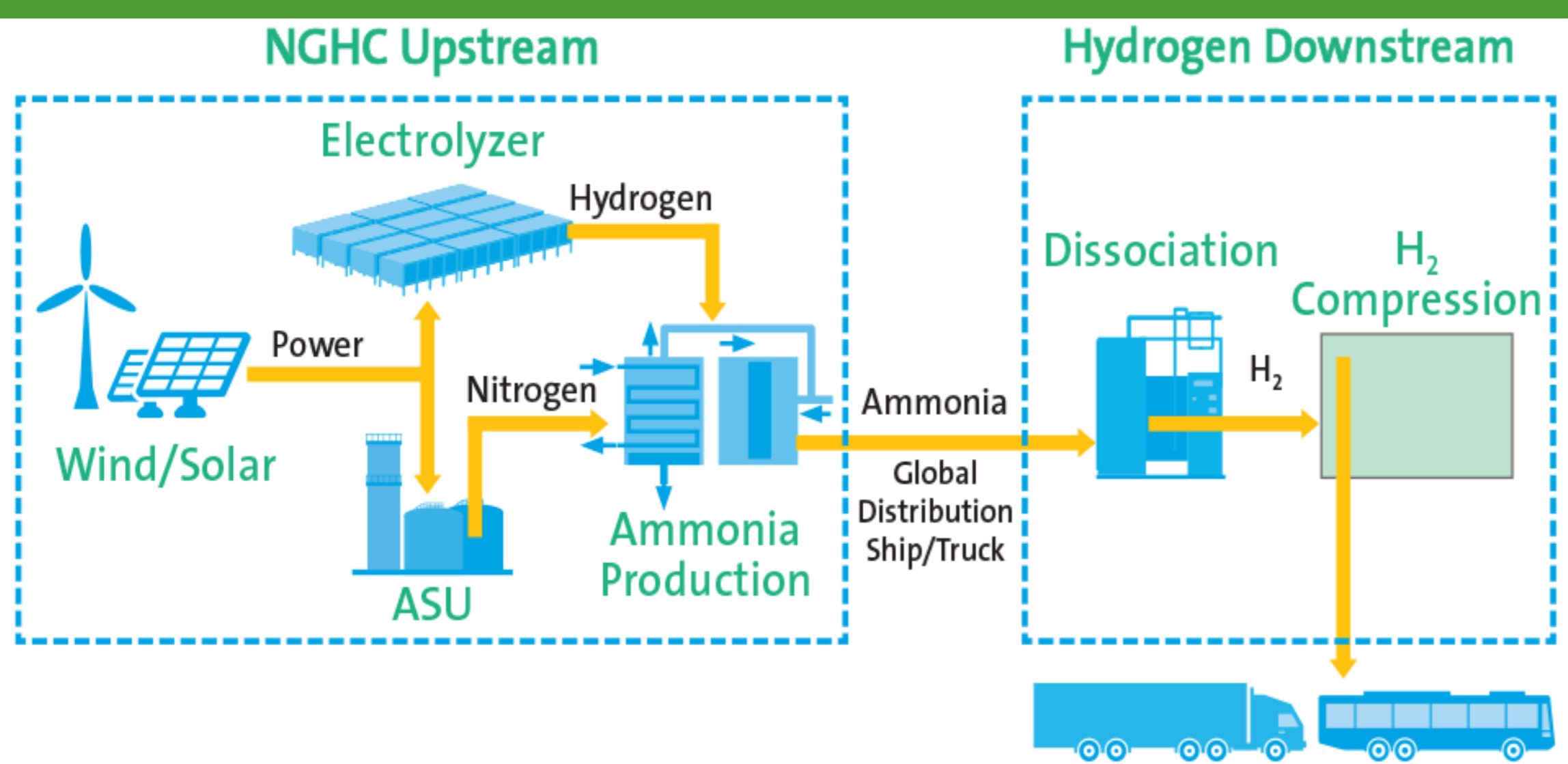


Priority Topic Area: Clean Energy and Climate Action

1 – Proposing Green Ammonia for H₂ Supply

Many companies are reluctant to initiate projects to produce green hydrogen due to large capital cost, lack of experience in the design & operation and concerns over demand for green hydrogen. Several industries are looking for ways to decarbonize their operations, green hydrogen is one of the way in which they can do this, but there is no large producer of green hydrogen. In 2020, Air Products, NEOM and ACWA Power announced the joint venture: NEOM Green Hydrogen Company. Air Products established a source of green ammonia produced in Neom to be converted back to green hydrogen in Europe.



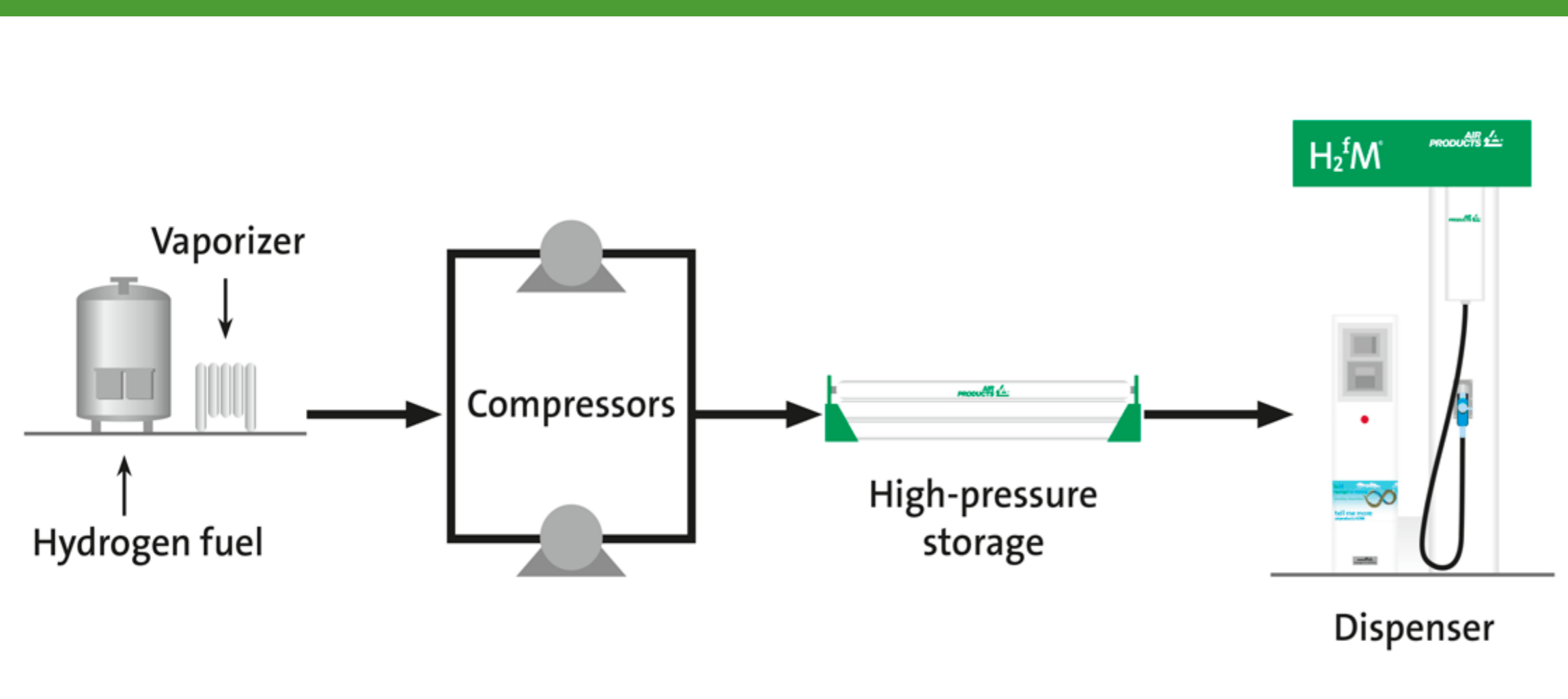
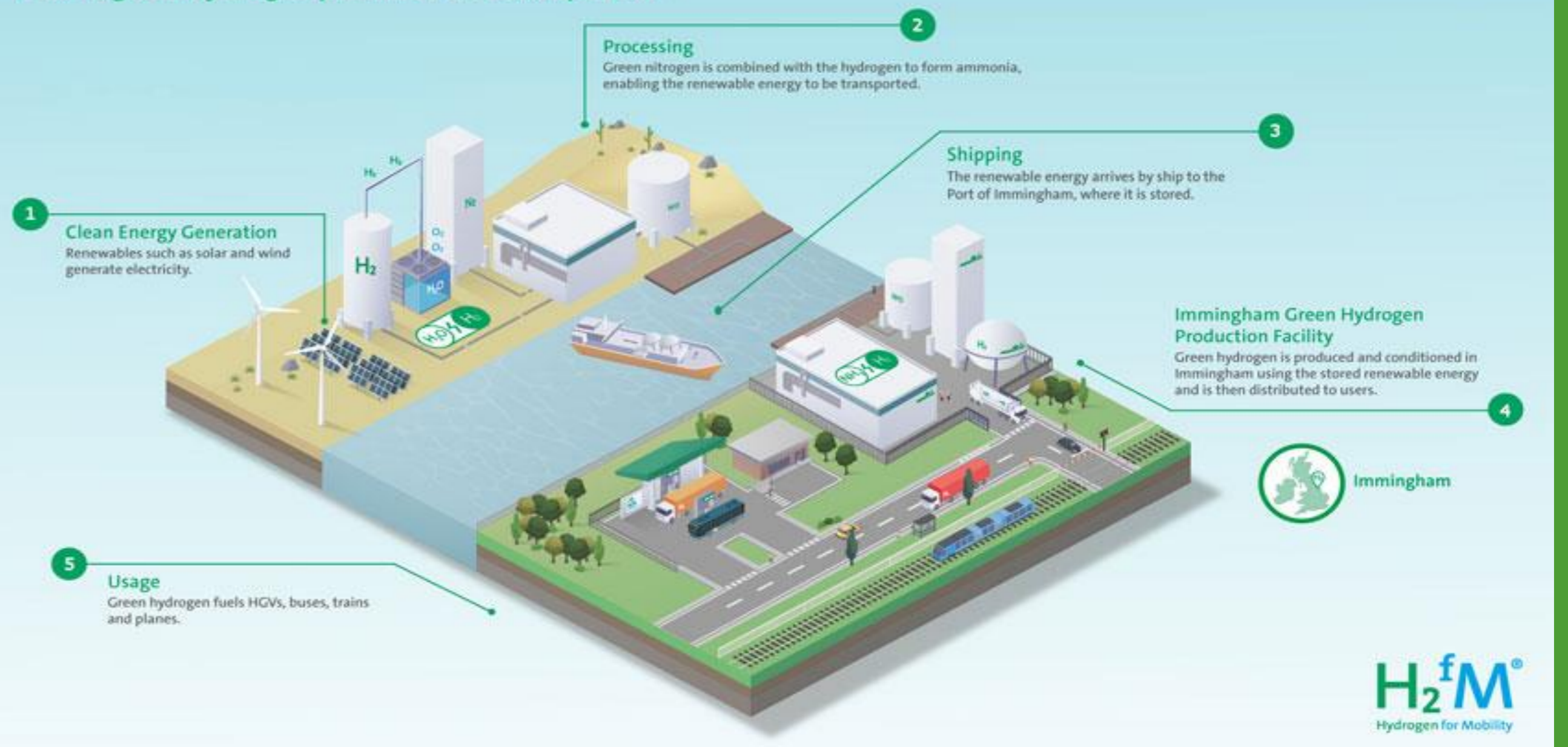
2 – Why Ammonia?

Transporting hydrogen gas overseas requires a large volume to mass ratio. Hydrogen molecules are very light, transporting hydrogen as a liquid requires a smaller volume for the same mass. Hydrogen has a boiling point of -252°C, this makes it vulnerable to losses due to heat leak during transportation, in addition to large energy costs to liquify the hydrogen. Ammonia has a boiling point of -33°C, making it less vulnerable to heat loss than liquid hydrogen. Ammonia also has a greater hydrogen intensity, one ammonia molecule contain 3 hydrogen atom, compared to the 2 atoms in a pure hydrogen molecule.

3 – Engineering and Planning

Four years on from its announcement, the Neom Green Hydrogen Project is under construction. Dissociator terminals at Immingham and Rotterdam have been announced and are now being executed, with many more currently under proposal. Air Products is also in the process of constructing hydrogen refueling systems to supply commercial vehicles with the hydrogen cracked from the dissociator terminals. Since the announcement of the ammonia/hydrogen supply chain, numerous companies have expressed interest in buying green ammonia/hydrogen, with several companies following Air Products' footsteps in announcing their own green ammonia projects.

How is green hydrogen produced and transported?



4 – Hydrogen for Mobility

Hydrogen does not produce carbon emissions when combusted or consumed in a fuel cell. Green hydrogen offers a carbon free alternative to existing fuels for the transport industry, which aids in the transition away from fossil fuels to reach net zero targets. Without the availability of green hydrogen, the ability of countries and companies, which rely on heavy transport, to reduce their carbon intensity disappears. HGVs, JCBs, ferries, buses and planes which can run off hydrogen are already being used in some parts of Europe (such as the buses at Eurovision 2023), with many more hydrogen powered transport under development.

5 – Continued Growth

Since the announcement of Neom, several companies have followed Air Products' lead of using ammonia as a carrier for hydrogen. To encourage further uptake of green hydrogen, further research and development must be continued to increase the affordability and reliability of the product and technology need to sustain the process.