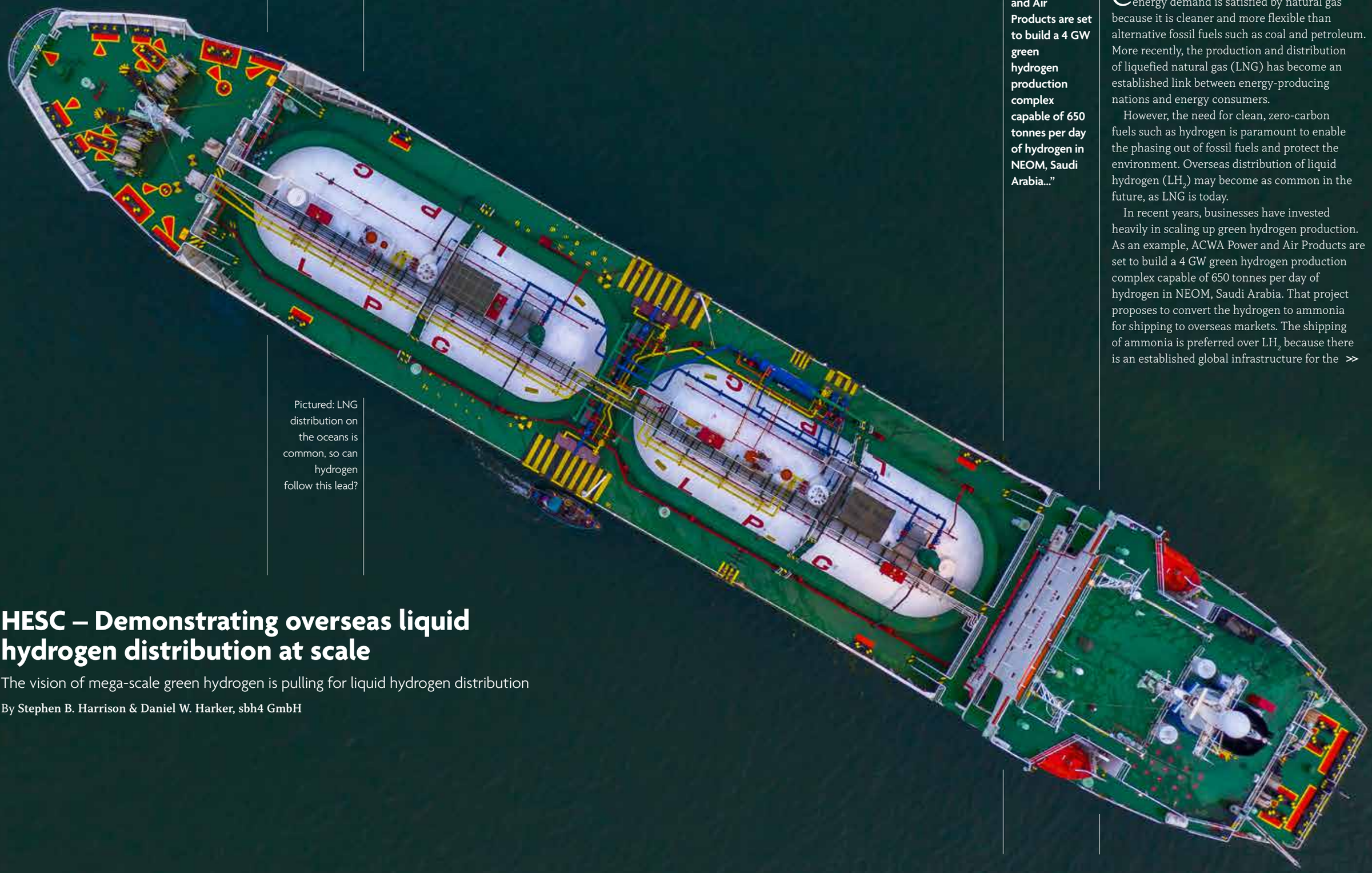

Pictured: LNG distribution on the oceans is common, so can hydrogen follow this lead?

HESC – Demonstrating overseas liquid hydrogen distribution at scale

The vision of mega-scale green hydrogen is pulling for liquid hydrogen distribution

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"ACWA Power and Air Products are set to build a 4 GW green hydrogen production complex capable of 650 tonnes per day of hydrogen in NEOM, Saudi Arabia..."

Currently, a huge proportion of the world's energy demand is satisfied by natural gas because it is cleaner and more flexible than alternative fossil fuels such as coal and petroleum. More recently, the production and distribution of liquefied natural gas (LNG) has become an established link between energy-producing nations and energy consumers.

However, the need for clean, zero-carbon fuels such as hydrogen is paramount to enable the phasing out of fossil fuels and protect the environment. Overseas distribution of liquid hydrogen (LH_2) may become as common in the future, as LNG is today.

In recent years, businesses have invested heavily in scaling up green hydrogen production. As an example, ACWA Power and Air Products are set to build a 4 GW green hydrogen production complex capable of 650 tonnes per day of hydrogen in NEOM, Saudi Arabia. That project proposes to convert the hydrogen to ammonia for shipping to overseas markets. The shipping of ammonia is preferred over LH_2 because there is an established global infrastructure for the >>

>> distribution of bulk ammonia, but not for LH_2. In order to enable the distribution of pure hydrogen at a similarly large-scale over long distances, HESC (Hydrogen Energy Supply Chain), the world's first demonstration project to transport liquid hydrogen via the sea, is an essential step in the scaling up of hydrogen as an energy vector in the 21st century.

International appeal for liquid hydrogen transportation

As of 2014, around 3,500,000km of pipeline in 120 countries around the world were used for natural gas transportation. Many of these pipelines may be adapted for use with hydrogen.

For example, the H21 Leeds City Gate and the HyNet North West projects in the UK both plan to use existing natural gas infrastructure to pipe hydrogen or a hydrogen methane gas mixture fuel into homes where it will be used for cooking and heating.

Switching our supply modes from the distribution of gases in pipelines to the long-distance overseas shipment of liquefied gases needs to begin with a demonstration project. To pave the way for LNG distribution, a pilot project took place in 1959 with the construction of the first ocean-going LNG gas carrier. The vessel, The Methane Princess, transported LNG from the US Gulf Coast to the UK.

An important factor that has received relatively little attention until recent years, is how LH_2 can be transported long distances to areas of demand overseas, in a safe and cost-effective manner, thus completing the hydrogen energy supply chain. As the world's first liquified hydrogen international shipping project, HESC will directly address this problem with a liquid hydrogen shipment from Australia to Japan which is planned for the first half of 2021.

This project will demonstrate the potential of utilising green hydrogen as an international energy vector. It has already been demonstrated that green hydrogen can be produced on an industrial scale, so this project is increasing the overall confidence that green hydrogen can also become an internationally traded commodity.

HESC relies on a breadth and depth of cryogenic expertise

The project will ship liquid hydrogen 9,000km from southeast Australia to Kobe City in Japan. A specially designed vessel named 'The SUISO FRONTIER' will be used for the ocean voyage. The ship, which was built by Kawasaki Heavy Industries, was launched on 11th December 2019 and is currently in the Kobe dockyard.

A vacuum-insulated liquid hydrogen storage tank fitted on-board will be manufactured by Kawasaki Heavy Industries at its Harima works, where the company has previously constructed LNG cryogenic storage tanks. The cryogenic liquid hydrogen tank will allow for 1,250 cubic meters of liquid hydrogen at -253ºC to be transported safely at approximately 1/800th of the volume that hydrogen gas would occupy at atmospheric pressure.

At the hydrogen unloading terminal at the dock in Hyogo Prefecture of Kobe City, the leading Japanese industrial gases company Iwatani will support the project with its cryogenic hydrogen processing expertise.

During the transportation of the liquid hydrogen, it is inevitable that small amounts of unwanted ambient heat will enter the tank, despite its sophisticated insulation. This will cause slight evaporation of the liquid hydrogen. A Gas Combustion Unit, manufactured by SAACKE Marine Systems in Germany, will be used to burn the vaporised hydrogen, which will safely burn small amounts of hydrogen boil-off from the cryogenic storage vessel.

In future versions of maritime bulk liquid hydrogen distribution, it is likely that liquid hydrogen boil-off will be fed to a fuel cell on-board the ship either for auxiliary power or to drive the ship's main propulsion unit.

Coregas plays a pivotal role in HESC

Hydrogen gas for the HESC project is produced at a gasification pilot plant in the Latrobe Valley in the state of Victoria, which is operated by J-Power. Gasification involves reacting brown coal with oxygen at a high temperature and pressure to produce syngas, which contains carbon dioxide, carbon monoxide, and hydrogen. This gas mixture is further purified to yield the desired hydrogen.

The overall process produces a high purity, low-cost hydrogen gas which can then be cryogenically cooled to -253ºC and liquefied to form LH_2 for efficient transportation.

The 'brown' hydrogen produced in this gasification process is generated from brown coal which is abundant in the region and makes up around 50% of the world's total brown coal reserves. For every tonne of hydrogen produced by the gasification of brown coal on this pilot reactor, 12 tonnes of CO_2 (carbon dioxide) are produced. When the HESC pilot project is complete, a full-scale gasification plant incorporating carbon capture and storage (CCS) will be used to make the hydrogen production process more sustainable. Hydrogen produced from coal combined with CCS is sometimes referred to as 'purple' hydrogen – a close relative of 'blue' hydrogen which is the colour generally used to describe hydrogen produced on a steam methane reformer (SMR) with CCS.

Australia's only Australian-owned industrial gases company, Coregas, is playing a central role in HESC. In the hydrogen production process, it supplies bulk liquid oxygen for use on the J-Power coal gasification plant in the Latrobe Valley. In the midstream process, Coregas is responsible for distribution of the hydrogen from the gasifier. It is moved in high pressure tube-trailers to a purpose-built liquefier near the Port of Hastings. To supplement the 'brown' hydrogen from the gasifier, Coregas provides additional 'grey' hydrogen from its SMR at Port Kembla. Coregas also built and will operate and maintain >>

"At the unloading dock in Kobe, the leading Japanese industrial gases company Iwatani will support the project with its cryogenic hydrogen processing expertise"

Pictured: Kobe harbour where the liquid hydrogen will be delivered to

>> the hydrogen liquefaction unit on behalf of its owner, Kawasaki Heavy Industries.

Coregas also supplies liquid nitrogen to the Port of Hastings liquefier site to help keep the LH_2 cool. Storing LH_2 is a bit like trying to store ice in the oven; but when the liquid hydrogen is surrounded by a blanket of liquid nitrogen it is more like storing ice in the fridge. With over 44 years of experience in cryogenic liquids and compressed gases, Coregas is well versed in the skills required for such a project.

Alongside its role in HESC, recent Coregas hydrogen projects include working with Hyundai on a hydrogen refuelling station, while the company is also a member of the Australian Hydrogen Council (AHC). Alan Watkins, Executive General Manager at Coregas, commented that, "in recent decades, and with our involvement in groundbreaking projects such as HESC, we have become an important supplier to Australian industry."

"With our emphasis on safety and innovative thinking, we will deliver highly focused, risk-managed change that reduces the financial and resource burden on Australian industries."

HESC is an A$500m project which has received support from the Japanese government, the Australian Federal and Victorian State Governments. It is seen as a beacon for future energy supply chains to North Asia, as Japan currently imports more than 90% of its energy from fossil fuels and is actively looking for more sustainable solutions. Similar statistics and goals are also relevant for South Korea.

Decarbonising hydrogen production at scale and linking producers with consumers

As interest in hydrogen energy increases, the hydrogen production aspect of the HESC supply chain could be switched to use green hydrogen, coupling renewable solar or wind power with an electrolyser, which in turn produces green hydrogen.

Strong commercial ties with major energy importers such as Japan, mean that Australia is firmly establishing itself as a key player in the emerging hydrogen economy.

Watkins concludes that, "Before hydrogen can become a crucial part of modern society at scale, a successful pilot project, such as HESC is required, to provide evidence that hydrogen is just as safe and convenient to distribute over the oceans as traditional fossil fuels such as LNG or crude oil." H2V

Pictured: Coregas plays a pivotal role in the HESC project with bulk gas supplies to the J-Power gasifier (*pictured*) in addition to construction, operation and maintenance of the hydrogen liquefier at the Port of Hastings