Hydrogen Energy Supply Chain

DEVELOPING A HYDROGEN INDUSTRY FOR AUSTRALIA'S FUTURE

Hydrogen is a fuel of the future and has the potential to provide a secure and clean source of energy as countries tackle the challenge of meeting national and international emissions reduction targets.

In 2014, global hydrogen production was in excess of 64 million tonnes estimated to be valued at AUD$132 billion[1]. The Hydrogen Council, a global organisation of leading energy, transport and industry companies with an interest in hydrogen estimates that the international hydrogen market will be worth approximately US$2.5 trillion in 2050[2].

As a first step in developing a viable hydrogen industry in Australia, the Victorian and Australian Governments are supporting a world-first project which is backed by the Japanese Government and led by Kawasaki Heavy Industries (KHI), working together with Electric Power Development Company (J-Power), Iwatani Corporation (Iwatani), Marubeni Corporation (Marubeni) and AGL. The project will produce hydrogen in the Latrobe Valley in south-east Victoria for export to Japan.

Image provided by Kawasaki Heavy Industries (KHI)

Hydrogen — a clean source of energy

Hydrogen is a gas that can be used to produce energy with only water vapour being emitted at the point of use. It can be made from coal and gas products with low emissions by using Carbon Capture and Storage (CCS) and can also be made using renewable energy technologies.

Hydrogen can be used in fuel cell vehicles (vehicles powered by hydrogen gas), for power generation and for energy storage.

The Hydrogen Energy Supply Chain Pilot Project

The Hydrogen Energy Supply Chain (HESC) Pilot Project presents an opportunity for Australia to be at the forefront of the rapidly expanding and increasingly important hydrogen production industry.

The HESC Pilot Project will develop and trial a fully integrated supply chain for hydrogen starting with the production of hydrogen in the Latrobe Valley in south-east Victoria and ending with the transport of that hydrogen in liquefied form to Japan.

While the focus of the project is on demonstrating the successful production and export of hydrogen to Japan, it does provide an opportunity for the development of a domestic hydrogen market.

1 Hazer Group, *Prospectus*, 2015
2 Hydrogen Council, *Hydrogen Scaling Up*, 2017

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THE SUPPLY CHAIN

The HESC Pilot Project aims to demonstrate how the critical elements of a supply chain for hydrogen could operate and work together. Each of these seven elements involves technologies that are largely proven. The Pilot Project is a critical first step in Australia developing a fully commercialised hydrogen production and export industry.

1 SUPPLY CHAIN ELEMENT
Gasification of brown coal in the Latrobe Valley

Led by J-Power, a leading Japanese energy company, the first element of the HESC Pilot Project aims to successfully demonstrate the use of proven technologies to dry, mill and gasify Victorian brown coal to produce a synthetic gas (or syngas).

This syngas is composed mainly of carbon monoxide (CO) and hydrogen (H_2)

2 SUPPLY CHAIN ELEMENT
Refining of the gas to produce hydrogen

The second element of the HESC Pilot Project will see the syngas refined to produce high-purity hydrogen.

To achieve this the syngas will be combined with steam (water vapour) in a reactor with a special catalyst to drive a water-gas shift reaction. This reaction involves the conversion of the carbon monoxide (CO) in the syngas and steam (H_2O) to produce carbon dioxide (CO_2) and additional hydrogen (H_2).

$$CO + H_2O \rightarrow CO_2 + H_2$$

The hydrogen is then separated from the carbon dioxide and other minor impurities to a high-purity making it suitable for transportation.

3 SUPPLY CHAIN ELEMENT
Transportation

After purification, the gaseous hydrogen will be transported by a tube trailer to the Port of Hastings in Victoria. A similar trailer to transport hydrogen is currently used within Japan and a number of local companies also use these trucks to safely transport hydrogen within Australia.

The trailer to be used in the HESC Pilot Project has the capacity to transport 140 kilograms of hydrogen and is expected to make one trip to the Port of Hastings every month over the one year of the Pilot Project's operation.

In the future, if the Pilot Project results in a fully commercialised Australian hydrogen operation, hydrogen would be transported by pipeline from the Latrobe Valley to a port location to minimise road transportation.

4 SUPPLY CHAIN ELEMENT
Liquefaction

Once the hydrogen has been transported to the Port of Hastings it will be converted into a liquid form. Specially constructed refrigeration equipment is used to cool the gaseous hydrogen to -253 degrees Celsius at which point it becomes a liquid. This reduces the hydrogen to 1/800th of its volume, produces no unwanted by-products and allows for the transportation of more hydrogen than would be possible if it was in its gaseous form.

5 SUPPLY CHAIN ELEMENT
Storage and loading

The liquefied hydrogen will then be loaded into a storage tank and onto a specially built carrier for transport to Japan.

6 SUPPLY CHAIN ELEMENT
Liquid hydrogen shipping

The HESC Pilot Project will be the first of its kind to transport mass quantities of liquefied hydrogen by sea.

KHI has developed the concept design for the world's first liquefied hydrogen transport system. The carrier will be built by KHI with Shell to lead operation of the carrier for the Pilot Project, with support from Iwatani.

7 SUPPLY CHAIN ELEMENT
Unloading and storage in Japan

The HESC Pilot Project will involve the construction and operation of a liquefied hydrogen storage, loading and unloading plant by KHI and Iwatani, with support from Shell. The plant will be able to store up to 45 times more energy than the world's largest battery and enough energy to refill 35,000 hydrogen fuel cell vehicles.

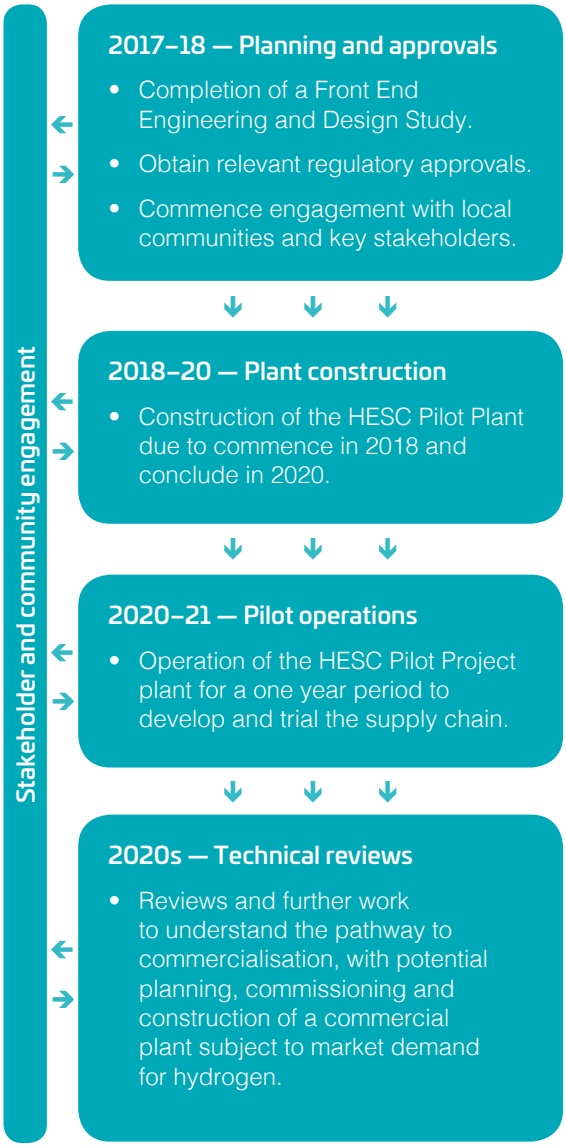
The Japanese consortium is working closely with the Kobe City local government authority for the facility to be located in the Port of Kobe.

CARBON OFFSETS

The HESC Pilot Project will offset carbon emissions produced.

A PATHWAY TO COMMERCIALISATION

The following timelines provide detail on when the various phases will be occurring.



Investment and jobs in Victoria's Latrobe Valley

The Pilot Project will see significant investment and benefits flow into the Victorian and Australian economy. It creates a pathway for the establishment of a fully commercial hydrogen industry in Australia, based in the Latrobe Valley. It also has the potential to set the foundation for the economic transition of the Latrobe Valley to low emissions use of the local resources.

The Pilot Project will see around half a billion dollars in investment across the full supply chain in Australia and Japan. Approximately half of this investment will be in Victoria where the Pilot Project is expected to create a number of jobs during its planning, construction and one year of operation.

Based on a number of factors – including the successful completion of the Pilot Project, regulatory approvals, social licence to operate and hydrogen demand, the decision to proceed to a commercial phase will be made in the 2020s with operations targeted in the 2030s. Comprehensive community engagement would be ongoing during this period and build on the engagement undertaken during the Pilot Project.

It is estimated that more than half of the multi-billion dollar investment required for a full commercial operation would be spent on infrastructure located in Australia, with thousands of jobs set to be created during the commercial phase.

What role does coal play in the project?

The Latrobe Valley, in Victoria's south-east, is home to the world's second largest brown coal deposit and this resource can be used to produce hydrogen. This world class brown coal resource is located in close proximity to world-class, deep offshore geological storage sites.

These natural storage sites and the ability to capture and sequester carbon emissions will play a key role in realising the commercial potential of Victoria's brown coal assets.

Hydrogen can be produced from both brown coal and from renewable energy sources. Currently, producing mass quantities of hydrogen from brown coal is cheaper than producing mass quantities of hydrogen from renewable sources.

A role for Carbon Capture and Storage

A Carbon Capture and Storage (CCS) solution is critical to any future commercial operation. The Victorian and Australian Governments' CarbonNet Project has the potential to deliver the CCS solution for the commercial project.

The CarbonNet Project is investigating the potential for establishing a commercial-scale CCS network. The network would bring together multiple carbon dioxide (CO_2) capture projects in Victoria's Latrobe Valley, transporting CO_2 via a shared pipeline and injecting it into deep underground offshore storage sites in Bass Strait.

CCS is a proven technology, with 22 large-scale CCS facilities currently underway worldwide across several industrial sectors. For example, in North America alone, there are almost 6,000 kilometres of CO_2 pipelines and in Norway, the offshore Sleipner Project has stored over 17 million tonnes of CO_2 since 1996.

Keeping the community informed

The Victorian and Australian Governments are committed to keeping communities fully informed about the HESC Pilot Project as it progresses.

Opportunities for the community to learn more about the project as it progresses will be provided in a range of ways, including through additional fact sheets and web and electronic news updates.

Further information can be found at the relevant government and project partner websites:

invest.vic.gov.au/opportunities/hydrogen-energy-supply-chain
industry.gov.au/HESC
hydrogenenergysupplychain.com

An opportunity for Victoria and Australia

The HESC Pilot Project puts Australia in a strong position to be the first place in the world to create a thriving hydrogen export industry that will bring significant economic benefits in the form of jobs and investment to the Latrobe Valley, Victoria and Australia.

The project also allows Victoria to play a leading role in developing a clean, new source of energy for domestic consumers and markets.

In Australia, opportunities for and interest in hydrogen is growing. CSIRO is currently developing a National Hydrogen Roadmap. The purpose of the study is to set out a strategy for the development of an economically sustainable industry in Australia. The roadmap considers the full scope of potential applications for hydrogen and assesses the commercial models, regulatory frameworks and research and development investment priorities needed to allow hydrogen to become competitive in the identified markets.

Australia's research sector also stands to benefit significantly from the HESC Pilot Project through collaboration with the project partners during the life of the project.

The HESC Pilot Project builds on both Victoria's and Australia's long and well-established relationship with Japan and provides an opportunity for Australia to lead the way in the production of the fuel of the future.

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Image provided by Kawasaki Heavy Industries (KHI)