'A SUSTAINABLE, CLEAN, PROSPEROUS FUTURE FOR GLADSTONE'

FACTSHEET – GLADSTONE: A HYDROGEN – AMMONIA CENTRE - Vs 4 – August 2019

(Based on a presentation by Carol Holden and Hugh Bridge.)

Introduction

Four developments are now making it possible to manufacture a clean, competitive and sustainable source of energy. These open the way for Gladstone to remain a major export hub for a clean fuel for which there is growing demand world-wide. This new industry will be based on hydrogen storage as ammonia and can use similar - or the same - infrastructure now used for Liquid Natural Gas (LNG).

1. Recent research has led to vastly improved techniques which allow ammonia to be made in one step from air, water and electricity at low temperature and low pressure.
2. Ammonia (NH^3) consist of one Nitrogen (N) and three Hydrogen (H) atoms. Recent Australian research has resulted in a new economical way to separate the Nitrogen from the Hydrogen.
3. Hydrogen is used in Hydrogen Fuel Cells, which are twice as efficient as internal combustion engines. The end products are water and Nitrogen which can be returned to the atmosphere.
4. Ammonia production up to now has derived its hydrogen and electricity from fossil fuels, which are major contributors to greenhouse gas. Using renewable power will make Hydrogen and Ammonia an affordable low-emission sustainable fuel option. The only emissions involved would occur during the construction of the plant.

Hydrogen Fuel Cells (HFC)

Basically, fuel cells work by passing Hydrogen through a membrane that separates the electrons from their protons and steers each along a different path. The electrons move through wires, like ordinary electricity, and do the same jobs as the electricity we are familiar with: lighting, running electric motors of almost any size, heating etc. When the electrons have done their jobs, they recombine with the protons to reform Hydrogen. This then combines with Oxygen in the air to form water. There are no moving parts in Fuel Cells so their maintenance cost is very low.

Proven in practice

Elsewhere in the world, Hydrogen Fuel Cells of all sizes are past their development stage and are used in cars, trains, buses and trucks. In the USA, Toyota has a Hydrogen-fuelled delivery vehicle with a 670 hp engine and a range of 500 km between refuelling. Nikola Motors has 1,000 hp Hydrogen semi-trailer with a range of 1,900 km. A Hydrogen-fuelled ute, the Chevrolet Silverado ZH2, is being evaluated by the US military. China wants 5,000 Hydrogen-fuelled cars on the road by 2020 and one million by 2030. Other countries have similar targets. Germany uses Hydrogen-fuelled engines in trains and buses. Its 212-class submarines are powered by fuel cells, can remain submerged for weeks, and are virtually silent. Hydrogen-fuelled generators are used in power stations in Japan, South Korea and Italy.

Advantages of Hydrogen (H_2)

- It can be made renewably and cleanly.
- The only emission from its use is water.
- It can replace all the damaging fossil fuels.

Drawbacks of Hydrogen

Hydrogen as a potential power-source has been investigated since 1801 but its drawbacks are:

- Its molecules are very small, smaller than any others, and can leak through hoses and containers.
- It makes some metals brittle which limits the lifespan of pipes, valves and tanks.
- It is highly flammable; when mixed with even small amounts of air, it can be dangerous.
- Converting it into a liquid form for bulk storage and transport requires very low temperatures. To keep the temperature very low requires constant refrigeration which can be costly.

Naturally scientists searched for ways to get around these drawbacks to find ways to store and transport hydrogen. One such way is Ammonia.

Advantages of Ammonia (NH_3)

In bulk, Ammonia is much easier and cheaper to handle, store, and transport than Hydrogen:

- It becomes liquid at -33°C, compared to -160°C for LNG or -253°C for Hydrogen.
- It stays liquid at 150 psi at room temperature and needs no expensive refrigeration while stored.
- It is a stable molecule that does not deteriorate while in storage.
- It does not corrode steel containers.
- It does not leak easily as Hydrogen does because ammonia's molecules are larger.
- It is much less flammable than Hydrogen, so there is less risk of accidents.
- H_2 in Ammonia is cheaper to transport than H_2 itself. Ammonia has 3 Hydrogen atoms per molecule while Hydrogen has only 2 - a 50% increase in Hydrogen transported at the same cost.
- It can be stored in tanks and cylinders and transported by trucks or pipes without refrigeration.
- It can be exported by existing LNG bulk gas carriers with less refrigeration and thus less cost.

Ammonia is not mentioned in the list of green-house gases of the International Panel of Climate Change.

Risks are well understood

Worldwide production is currently about 200 million tonnes per year. It is corrosive to the skin, eyes and lungs, dangerous to life at 300 ppm, but is easily detectable at 5 ppm. It is flammable only when the ammonia/air mix is between 15% and 28%. However, its handling, storage and transportation are well understood. It has been used in industry, homes, and as a fertiliser on farms for more than 100 years.

Drawback of Ammonia

Its major drawback is that it is currently produced in a complex polluting process that requires very high pressure and high temperatures using large amounts of electricity. However, this is changing.

New research

1. Researchers overseas and in Australia are working on various ways to make ammonia using clean electricity, water, and nitrogen from the air in a one-step process, without high temperature or pressure. These methods require much less electricity in a very clean process. Research into various catalysts, and into using ionic fluids, is ongoing.
2. Salt water can be utilized since the introduction by Israel of a desalination plant which can produce 1,000 litres of fresh water for AUD $0.85c.
3. In 2017 CSIRO scientists from Brisbane announced that they had developed a membrane that takes ammonia and separates the hydrogen from the Nitrogen at 430°C to produce very pure hydrogen. This separation can be done at the point of hydrogen sale or on e.g. ships with Hydrogen Fuel Cells.

The future

Regional renewal. By combining clean electricity with these new technologies, ammonia can be made sustainably wherever there is sun and water. Solar farms, ammonia plants and ammonia storage tanks can be built in affordable sized units. The Ammonia can be used locally, trucked to regional centres or piped to Gladstone for export. The separation into Nitrogen and Hydrogen can be done at regional centres for use in Hydrogen Fuel Cell power plants. These can be increased in capacity when needed. Base load security can be guaranteed by storage of ammonia in tanks, to be used when needed.

Repower Gladstone

The production, handling and storage of liquid ammonia causes very little air, water or soil pollution, and tiny amounts of greenhouse gas, waste or dust. Unlike fossil fuels, it can be produced forever. Transporting and storing liquid ammonia needs the same pipelines, the same storage and loading facilities, the same port facilities and the same skilled workforce as LNG.

Gladstone is uniquely situated to become a major hub for exporting this sustainable low-emission fuel. It is a port located in a climate zone with abundant solar energy. It is connected through power lines and gas pipes to suitable areas where this energy can be harvested and piped to existing processing and shipping facilities. Hydrogen in Ammonia could replace all our fossil fuel exports.
Gladstone is destined to become a city to be proud of.