PROPOSED HYDROGEN PRODUCTION, DISTRIBUTION, AND EXPORT FACILITY WITHIN THE PORT BOTANY AND KURNELL PRECINCTS, NSW, AUSTRALIA

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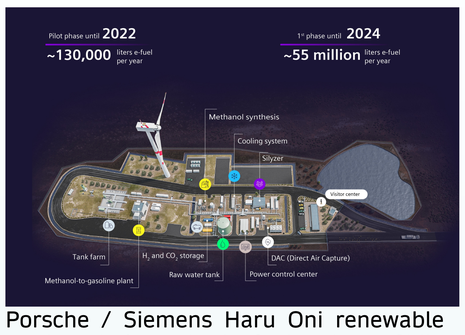
Kurnell refinery precinct [left] Port Botany Brotherson Docks [right] [*Google Maps, 2021*]

Sydney Desalination plant top [centre], and the former lubricating oil refinery tank farm [*Sydney Desalination plant, 2018*]

Siemens Energie park Mainz, Germany [*Siemens GmbH, 2021*]

Oberon Fuels bio-DME plant, California USA [*Oberon Fuels, 2021*]



Porsche / Siemens Haru Oni renewable methanol / synthetic fuels plant, Chile [*Siemens GmbH, 2021*]

ABSTRACT

This poster considers a proposed hydrogen production, distribution, and export facility within the Port of Botany, and Kurnell precincts in NSW, Australia.

It will evaluate the production, distribution, and export of hydrogen in the form of : ammonia; dimethyl ether [DME]; methanol; and/or liquid organic hydrogen carriers [LOHC], thereby transforming existing under-utilized infrastructure that may be combined for another use.

This may be achieved through proposed modifications to existing water treatment infrastructure at the Sydney Desalination plant, and land within the former Ampol lubricating oil refinery precinct, by employing renewable energy generated at the Woodlawn Capital Energy wind farm that might be converted into hydrogen, and/or other energy carriers within the former refinery precinct.

In doing so the author will consider how existing liquid fuels infrastructure might be accessed thereby responding to the opportunity, but also how existing petroleum, and waste disposal industries might be transformed through the production of molecules, rather than electrons.

Thus, this presentation considers the proposed export of the energy carrier from existing facilities in New South Wales thereby drawing inspiration from the:

- Siemens Energie Park Mainz power-to-gas facility, Mainz, Germany [*Energie Park, Mainz, 2021*];
- the George Olah Renewable Methanol plant, Svartsengi, Iceland [*Carbon Recycling Int, 2020*];
- the H2Ocean project, European Union [*Serna A, Tadeo F, 2013*];
- Porsche / Siemens Energy - Haru Oni facility, Chile [*Siemens Energie GmbH, 2020*];
- the Raffinerie Heide conversion project, Schleswig-Holstein, Germany [*Raffinerie Heide, 2020*];
- the RH2INE Initiative, Zuid Holland, the Netherlands [*RH2INE, 2021*]; and
- the Chiyoda SPERA project, Sungai Liang Industrial Park, Brunei Darussalam [*Chiyoda, 2019*]

INTRODUCTION

Kurnell, is a suburb located around 25km from the Sydney CBD and is sited on the southern shore of Botany Bay, NSW.

Accordingly, with the former Ampol oil refinery [circa. 135,000 barrels /day] closing in 2014, the land was to be reconfigured into a fuel import terminal, thereby clearing the site of existing refinery equipment, with the intent to expand the fuel storage capacity in existing tank farms, but also the liquid fuels loading berth located on Prince Charles Parade, Kurnell [*Caltex Australia, 2013*].

Located adjacent to the refinery, the Sydney Desalination plant has a production capacity of 250ML water / day in the existing form, with approval for an additional 250 ML / day for stage two [*Sydney Desalination plant, 2018*]. At present the plant is powered by renewable energy sourced from the 330 MW Capital Wind farm located in regional NSW, with the reverse osmosis trains having had minimal use since the facilities initial commissioning between 2010 – 2012 [*Infigen Energy, 2010*]. As a result, the plant is only turned on when Sydney's total dam storages fall below 60% capacity.

Therefore, this poster envisages another potential use for the facility, and examines whether curtailed renewable energy contracted to the desalination plant might be redirected to power electrolysers located along Sir Joseph Banks Drive, thereby enabling the production of green molecules within the former lubricating oil refinery. By contrast, the contracted energy is currently sold into the National Energy Market (when in standby mode), and whereby the overall financial performance is offset through an efficiency and energy adjustment safeguard mechanism underwritten by consumers [*IPART, 2012*].

Thus, in understanding that the desalination plant's primary purpose is to provide drinking water for NSW residents in times of drought, this study will evaluate whether the demand for green molecules might also be met through the concurrent operation of the Woodlawn Eco-precinct at other times, where: the existing combustion of landfill biogas into electricity; might be extended to the production of bio-methanol; and/or dimethyl ether when Kurnell is serving its existing market.

Consequently, with Veolia operating both: the Sydney Desalination plant, and the Woodlawn Eco-precinct then there may be an opportunity to combine the operation of these assets: individually, or in tandem, thereby facilitating the production of potentially higher value products, that might be sold into international markets.

LANDFILL GAS PRODUCTION

Currently, Veolia freights garbage from the Banksmeadow, and Clyde rail terminals to the Crisps Creek terminal at Tarago where it is conveyed for deposit into the pit, and whereby landfill gas is collected through a network of horizontal, and vertical pipes set within the layers of garbage, and clay. As a result, around 1.33 MW of electricity is generated per tonne of garbage as it decomposes, with this biogas combusted in a series of landfill gas co-generation engines [*Veolia, 2018*].

Alternatively, the biogas might be converted into bio-methanol, or dimethyl ether within the Woodlawn Eco-precinct, with the energy carrier conveyed via ISO tank containers on the return journey to Port Botany by : road; rail; and/or future ocean-going vessels.

$$CH_4 + H_2O \leftrightarrows CO + 3H_2 \Delta^0_{298K} = 206.1\ kJ/mol$$
$$CO + H_2O \leftrightarrows CO_2 + H_2 \Delta^0_{298K} = -41.15\ kJ/mol$$
$$CO_2 + 3H_2 \leftrightarrows CH_3OH + H_2O \Delta H^0_{298K} = -50\ kJ/mol$$
$$CO + 2H_2 \leftrightarrows CH_3OH \Delta H^0_{298K} = -91\ kJ/mol$$

As a result, this bio-methanol might be exported via container ships in a modular form, perhaps similar to the Chiyoda SPERA project in Brunei Darussalam, or alternatively to fuel the new classes of methanol powered container ships recently launched by Maersk [*A.P. Moller Maersk, 2021*].

Similarly, this bio-methanol may also be suitable for those international markets where fleets of: methanol fuelled combustion engine vehicles [*Koenigsegg, 2020*], [*Geely New Energy Vehicles, 2020*]; and/or methanol fuel cell vehicles [*Roland Gumpert, 2020*] are increasingly manufactured in large numbers.

The bio-methanol may also be utilised as a building block in the chemical industry for: synthetic jet fuels [*Roland Berger, 2020*]; synthetic petroleum [*Siemens GmbH, 2021*],[*ExxonMobil, 2021*]; and synthetic olefins for sustainable polymer and/or plastic production [*Carbon Recycling International, 2021*],[*Jiangsu Sailboat Petrochemicals, 2021*].

OTHER ENERGY CARRIERS

Similarly, whilst it may be feasible to : produce bio-methanol; or bio-dimethyl ether at Woodlawn; or hydrogen; methanol; and ammonia at Kurnell, the use of toluene-based energy carriers such as Methylcyclohexane [Chiyoda, 2019]; and Dibenzyl toluene [*Hydrogenious Technologies, 2019*] may complement the refining industries existing strengths [*Chiyoda, 2019*].

As a result, Hydrogenious Technologies GmbH Storage BOX technologies may only requires a source of power; heat; and hydrogen in order to store ~ 57 kg of hydrogen per m^3 of LOHC [*Hydrogenious Technologies, 2019*], and whereby a 13,500 litre ISO tank container might be stored temporarily at Port Botany prior to dispatch to overseas markets.

Alternatively, e-methanol and anhydrous ammonia might also be produced from hydrogen within the refinery precinct, at times when there is reduced demand for desalinated water by NSW consumers, and whereby the excess capacity might be utilised by industrial customers located on the Kurnell peninsula.

Therefore, in noting the availability of the Continental Carbon site within a short distance of the desalination plant, but also the vacant pipeline easement connecting the former carbon black factory to the refinery, then there may be an opportunity to explore partnerships between: Ampol; Jemena; the NSW State Government; the Sydney Desalination plant; Veolia; and/or customers overseas.

Ultimately, any further collaboration between the parties may rely on what the highest value for the curtailed energy may be, and whether there is more value in distributing molecules via: ISO containers; hydrogen fuel cell vehicles; pipelines [power-to-gas]; and polymers; and/or to refuel ocean going vessels. At the present time any excess electrons are simply sold to the National Energy Market.

CONCLUSION

Thus, in examining the literature the writer considers that the above concepts have enough merit for further investigation, although to date my progress has been stymied in my numerous attempts to access suitable data in order to calculate a levelized cost of hydrogen [LCOH] from the stakeholders.

Similarly, with the NSW coronavirus pandemic lockdown limiting face to face access with the decision makers, but also analytical facilities to analyse water, and/or landfill gas samples this poster represents a summary of the authors postgraduate research thus far.