COMPLEMENTARY ELEMENTS TO AEMO'S DRAFT INTEGRATED SYSTEMS PLAN (ISP) FOR AN AUSTRALIAN ENERGY SYSTEM

INTRODUCTION

This submission by Winwick Business Solutions P/L is in response to AEMO's invitation to engage in its Draft ISP for 2020. Rather than just focussing on Eastern Australia, the complementary elements extend the ISP not only to the whole continent, but also to our opportunities to provide secure and renewable energy to some of our northern neighbours and to use our unmatched energy resources to generate value-added exports and job opportunities. It is the proposed: scale; the comprehensiveness of the integration; the way it opens scope for extension, deepening and amendment by AEMO; and the high voltage direct current (HVDC) infrastructure that lend this concept its comparative advantage. Being a high level concept, it does not attempt to encompass what is required of a full roadmap or plan. That is left to the relevant experts, policy makers and corporate interests.

An earlier version of this submission has been published by COAG's Hydrogen Working Group at https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers/consultation/view_respondent?_b_index=0&sort=excerpt&order=descending&uuId=1014180121 an updated version of which is included below.

It is important to realise that the capital costs, delays and risks of transporting power from renewable sources are far greater when they are done using hydrogen pipelines (of either cryogenic or high-pressure type) than by simply using HVDC power lines. There is thus no need for large, hydrogen exporting hubs to be built near high quality solar and wind power resources. Instead, they should be built near seaports where HVDC lines exist or be planned. In most cases, hydrogen should be produced on-demand using HVDC renewable power and either seawater, non-potable bore water, industrial or domestic waste water, mine water, or water stored seasonally.

Furthermore, regarding Queensland's own mines and industries, inclusive of those pictured in the graphic but not limited thereto, the Scheme could be used for the value-added production of blue and green hydrogen, geochar, methanol, and stockfeed protein from natural gas and CO2, as well DME general-purpose fuel, industrial chemicals, cement, fertilizer, stockfeed protein, aluminium, lithium, titanium, vanadium, nickel, cobalt, manganese, copper and silicon, as well as providing low-cost, renewable and reliable (because of energy storage technologies) power to the grid. Importantly, this scheme provides for the smooth and rapid transition from using grey to blue to green hydrogen for fuel cell electric vehicles, as well as making the infrastructure more affordable because it largely replaces expensive hydrogen pipelines and storage facilities with on-demand, local hydrogen production using shallow-buried, safe and economical HVDC powerlines.

You will note that a key part of the Sunny Scheme concept described below is that it does **NOT** depend significantly upon the costly and otherwise problematic pipeline transmission, storage and usage of compressed or cryogenic hydrogen, replacing it with less hazardous, less costly and more efficient HVDC transmission of renewable power and makes use of blue hydrogen (as a temporary bridge in current use by industry), electrolysed seawater/wastewater (green hydrogen) in the longer term, and the manufacture of other electrofuels, industrial chemicals, fuels and vat protein. The soon-to-be-lowered cost hydrogen could also be used to produce CO2-emission-free silicon, manganese, lithium, nickel, cobalt and other metals from their ores, as well as iron, steel and aluminium as shown in the attachment. An additional HVDC line utilising the same easement as the natural gas pipeline linking Karratha to Esperance might serve many of Australia's mining operations with sustainable power to convert their ores into metals and white sand into silicon.

THE SUNNY SCHEME

SUBMISSION BY SEV CLARKE, CEO OF WINWICK BUSINESS SOLUTIONS P/L, TO THE COUNCIL OF AUSTRALIAN GOVERNMENTS (COAG) HYDROGEN WORKING GROUP

Four, key delaying factors in achieving a hydrogen economy are: the current high cost of electrolytic hydrogen; there being no existing hydrogen infrastructure for it and that hydrogen pipelines and storage are costly and problematic; that methods for generating electrolytic/biological hydrogen have yet to move far down the Experience Curve and to reach industrial scale; and that some methods for transporting, storing and utilising hydrogen are still under intense development. All these have solutions. The **current high cost** can be avoided by making temporary use of hydrogen and CO2 generated from natural gas in the interim. **Little**, expensive (and probably hazardous) hydrogen **infrastructure** is required if hydrogen is generated where it is to be used, by making use of renewable energy transported by HVDC power, or else when it is to be transported by ship in various forms from the port of its generation to its global users. Once the HVDC infrastructure is planned and being put in place to transport abundant renewable energy, corporates using technology-neutral, proven or rapidly developing technologies for its energy storage, generation and usage would **compete** for the privilege. So, **all** the government would have to provide initially would be diplomatic support, some de-risking R&D and modelling, and the HVDC lines - and Sun Cable and ICE are already planning to deliver much of this within several years. The green hydrogen could be generated anywhere the HVDC lines run and where there is a supply of seawater, borewater or wastewater, with little requirement for lengthy hydrogen pipelines or storage infrastructure.

It seems far better to have green hydrogen produced at major user sites using HVDC powerlines, electrolysers (or other methods of producing hydrogen such as methane splitting or with the use of microbes), and local seawater, borewater or wastewater rather than having to install expensive, delaying and hazardous hydrogen pipelines and bulk storage facilities. The WA/InterContinental Energy and NT/SunCable proposals might readily be physically integrated into the Sunny Scheme, as well as supplying New Jakarta (Indonesia’s proposed new capital in East Kalimantan) with renewable power. Lightly-pressurised DME is also a much better general-purpose liquid fuel than is hydrogen.

The Sunny Scheme diagram attached shows how Australia’s magnificent resources of sun, wind, minerals, location, built and buildable infrastructure might, with appropriate technology, be made to provide power, electrofuels (such as hydrogen, ammonia and DME), geochar and animal-free fodder protein to a regional population of some 500m (178m by shipped electrofuels (Japan and S. Korea) and another 328m (Singapore, Malaysia, Indonesia, Timor Leste and Australia) by both HVDC electricity, electrofuels, fertiliser and vat-protein. We could also replace much of our mineral exports of bauxite and iron ore with metals produced using renewable hydrogen or electricity, rather than coal. Implemented, such a scheme would provide a useful contribution to closing the global emissions gap, and one that might be followed elsewhere in the world. The geochar or carbon black would be produced from NW Shelf gas using Monolith Materials' method of using electrically-generated plasma to split methane into hydrogen and carbon.

Should the carbon produced be used like biochar as a soil enhancing material that helps plants sequester CO_2 from the atmosphere, reduce water and fertiliser requirements, as well as run-off, the whole process could be carbon negative.

Regarding the electrolytic/biological cost of hydrogen, several prospective technologies are currently under intense development. Morgan Stanley Research (MSR) has estimated how low and how fast the cost will go in one of the links, but a physicist or chemical engineer should be able to calculate what is theoretically the lowest energy cost for generating hydrogen from seawater. Others have already estimated how the costs of solar power and energy storage will be reduced even further over time. I surmise that electrolytic/biological hydrogen plants would utilise much of the excess energy that could not be used by those attached to the HVDC lines I propose. The pumped hydro and molten salt energy storage facilities would be the other balancing elements taking low/no-cost, excess renewable energy that the solar and wind facilities generated at times. The cost of seawater electrolysers is also forecast to fall dramatically as demand for them, and for larger versions, increases.

As it may take a few to several years for the price of electrofuels to become competitive, I have integrated into my Sunny Scheme concept the NW Shelf Gas extraction industry. This would allow cheap hydrogen to be produced from the natural gas in the interim, whilst the CO_2 content of the gas, plus any produced as a by-product of the hydrogen generation would, for a much longer time, act as the carbon sources required for the production of bacterial protein by NovoNutrients' and other methods, as well as DME and butanol. These last two, you will realise, can act as (close-to or additive) drop-in liquid, energy-dense fuels for those industries that otherwise would have difficulty going low-carbon, such as older automobiles, aviation, shipping, and remote/transportable/backup fuel cells, heating, cooking and transport. Ammonia and its derivatives would also be produced from the hydrogen and renewable energy. The CO_2 from the gas wells might either be pumped to the mainland for conversion into carbon products, oxygen, protein, electrofuels and derivative products, or else the HVDC power could be taken to the offshore processing facilities to perform the same tasks. Waste CO_2 and water might also be converted electrolytically to such compounds as formic acid (HCOOH), ethanol and n-propanol using this method https://www.nature.com/articles/s41560-019-0451-x using a bismuth catalyst and renewable energy.

Together, transporting the electricity generated by renewable sources thousands of kilometres by efficient, high voltage direct current (HVDC) power lines; using low-loss forms of energy storage, such as pumped hydro and molten salt; producing electrofuels and vat-protein from electrolytic hydrogen, harvested CO_2, and less-needed-immediately power generation peaks; producing cement, directly-reduced iron and steel from hydrogen; and making use of low-cost hydrogen and CO_2 produced from natural gas or other sources until the costs of electrolytic hydrogen are brought down sufficiently by technologies currently under rapid development and by better & bigger electrolyzers should make a competitive and flourishing hydrogen economy feasible before 2030. Once governments had established the necessary HVDC infrastructure, corporates would probably be willing to make the investments in energy storage, renewable energy production, CO_2 harvesting & transportation, ore refining, electrofuels, and food/fodder production facilities that made the whole system work to human and ecological benefit. The vat protein that could be produced using harvested solar power & CO_2, hydrogen (derived from natural gas then electrolytically) and NovoNutrients microbial mix could be enough to feed global fish farms and terrestrial stock, largely replacing the need for grinding up wild-caught small fish and potentially reducing farming pressure on land and ruminant methane emissions.

With fairly minor adjustments to engines, the electrofuel dimethyl ether (DME) can be made ‘drop-in’ suitable for aircraft (both piston and jet), shipping, land vehicles, gas turbines and engines, and fuel cell driven devices, possibly including even portable ones. DME is also far easier, safer and more economical to store and transport than is hydrogen or even ammonia. The Sunny Scheme largely avoids the difficulties, costs and delays inherent in a national network of hydrogen pipelines.

My company and its UK collaborator, Perlemax, have devised major ways to improve both CO2 separation from flue gas, biorefinery operations, bacterial fermentation and harvesting, which should help NovoNutrients and DME production to upscale fast. Details are available. Major companies such as Chevron, Rio, BHPB and some of the larger fodder/feed producer companies like GrainCorp, Feedworks, Elanco, Lallemand, Nutreco, ForFarmers, De Heus, ADM, Cargill, CP Group, JA Zen-Noh, NongHyup Feed, and New Hope Group should be interested in participating in such a seminal project.

Other relevant documents and websites are:

https://asianrehub.com/about/

https://www.ecogeneration.com.au/singapore-powered-by-tennant-creek-nt-gives-major-project-status-to-10gw-solar-export-plant/?utm_source=Ecogeneration&utm_campaign=ebba4fc62b-EMAIL_CAMPAIGN_2017_01_25_COPY_01&utm_medium=email&utm_term=0_cd04baabb5-ebba4fc62b-137130981

https://5b.com.au

https://science.sciencemag.org/content/sci/360/6396/eaas9793.full.pdf

https://www.energycouncil.com.au/analysis/green-hydrogen-is-it-still-in-the-pipeline/

https://science.sciencemag.org/content/360/6396/eaas9793

https://www.sciencedirect.com/science/article/pii/S0378775316308631

https://www.biofuelsdigest.com/hydrogen/2019/08/06/hydrogen-production-how-much-will-be-sustainable-how-sustainable-when-and-how/

https://monolithmaterials.com/innovative-technology/

http://www.biofuelsdigest.com/bdigest/2019/07/14/the-digests-2019-multi-slide-guide-to-novonutrients/18/

https://news.mongabay.com/2019/07/indonesias-president-signals-a-transition-away-from-coal-power/

https://www.woodmac.com/press-releases/chevron-phillips-chemical-in-$15-billion-bid-to-acquire-nova-chemicals/

https://www.researchgate.net/publication/305845413_A_review_of_fuel_cell_systems_for_maritime_applications https://www.researchgate.net/publication/332665704_What_would_it_take_for_renewably_powered_electrosynthesis_to_displace_petrochemical_processes

https://www.nature.com/articles/s41560-019-0451-x

https://www.technion.ac.il/en/2019/09/fuel-of-the-future/

https://www.ecogeneration.com.au/australia-the-natural-energy-exporter/?utm_source=Ecogeneration&utm_campaign=5110f65974-EMAIL_CAMPAIGN_2017_01_25_COPY_01&utm_medium=email&utm_term=0_cd04baabb5-5110f65974-137130981

The IP of the overall concept is free, though some of the individual technologies may not be.

Your thoughts?

Best wishes,
Sev Clarke