conservation council of western australia (inc.) abn 35 982 476 107
citywest lotteries house 2 delhi street west perth western australia 6005
t 08 9420 7266 f 08 9420 7273 conswa@ccwa.org.au

Renewable Hydrogen Target for electricity generation in the South West Interconnected System
Consultation Paper October 2022

Submission by the Conservation Council of Western Australia Inc.

10 November 2022

About the Conservation Council of WA (CCWA)

The Conservation Council of WA (CCWA) is the state's foremost non-profit, non-government conservation organisation representing more than 100 environmental organisations across Western Australia.

We have been a prominent and forthright voice for conservation for more than 50 years working directly with the government, media, industry, community groups, and political parties to promote a more sustainable WA and to protect our natural environment.

CCWA represents more than 100 environmental organisations across Western Australia, with tens of thousands of engaged individuals state-wide. This broad collective of like-minded groups and individuals creates a vibrant and passionate community, dedicated to the conservation of our unique and diverse state.

www.ccwa.org.au

Submitted to:
Energy Policy WA
Level 1, 66 St Georges Terrace
Perth WA 6000

By email: EPWA-info@dmirs.wa.gov.au

For further information on this submission, please contact:

Maggie Wood
Acting Executive Director
maggie.wood@ccwa.org.au
08 9420 7266

Dr Kelly Duckworth
Policy & Research Manager
kelly.duckworth@ccwa.org.au
08 9420 7266

Liam Lilly
Research Officer
liam.lilly@ccwa.org.au
08 9420 7266

Renewable Hydrogen Target for electricity generation in the South West Interconnected System - Consultation Paper October 2022

Summary

The Conservation Council of Western Australia (CCWA) welcomes the opportunity to provide comments on the Renewable Hydrogen Target for electricity generation in the South West Interconnected System Consultation Paper, and the key design considerations, costs and risks associated with its introduction.

CCWA strongly supports efforts to decarbonise the SWIS and commends the WA Government on their 80% emissions reduction target for state owned assets by 2030. Western Australia has massive potential to be a world leader in the investment in and utilisation of renewable energy technologies. To achieve this decarbonisation target, any electricity generation delivered to the SWIS must be produced in a safe, economical, reliable, and environmentally sensitive manner.

Of the four strategic focus areas presented in the Consultation Paper: export, remote applications, hydrogen blending in natural gas networks, and transport, there are few applications that are both necessary and meet the above standards.

CCWA's main concerns with using hydrogen for electricity generation are summarised as follows:

- It is inherently inefficient, and always will be as it is in direct competition with its own source of energy, that being direct electrification.
- It is costly and will take away valuable resources from the renewable energy transition desperately required to minimize global heating.
- Hydrogen is an inferior alternative to direct electrification in most applications.
- Decarbonisation is delayed and undermined.
- Emissions reductions are not prioritized.
- That the lifetime of the fossil fuel industry is prolonged through the proposed hydrogen infrastructure.
- The Target proposal will require massive infrastructure changes that support the continued use of fossil fuels and detract from the renewables industry.
- Molecular hydrogen itself produces environmental impacts and exacerbates global heating.
- Fugitive hydrogen emissions are not addressed in the Consultation Paper, nor are hydrogen combustion emissions.
- The Target proposal involves unaddressed export and supply challenges.
- The Consultation Paper is not specific enough on costing.
- The Consultation Paper does not address the side-effects of the hydrogen industry, and how fossil fuels will still play their part.
- The Consultation Paper ignores the redundancies already inherent in the hydrogen industry.
- The Consultation Paper fails to reflect on the significant and residual environmental impacts of poorly planned hydrogen projects.

This submission will expand on these concerns and address relevant consultation questions.

1. ***The Consultation Paper inadequately addresses the inefficiencies of hydrogen use in electricity generation***

In part, the Consultation Paper acknowledges the inefficiencies embedded in using hydrogen for electricity generation, stating that 'renewable hydrogen's role as a source of baseload generation is less clear in the short term, on account of the round-trip inefficiencies associated with using VRE to produce hydrogen to then combust to create electricity – with energy losses in each step.'

There are various steps involved in hydrogen production and utilisation, these being: electricity to hydrogen to storage to convert to electricity (HtoE) or use as gas (HtoG); electricity to hydrogen to ammonia to storage to convert to electricity (HtoAtoE); electricity to hydrogen to ammonia or to synthetic fuels to combustion in engines such aircraft and ships. Each of these routes has differing efficiency, and more energy is lost with each step.

Using green hydrogen to produce electricity will always be inefficient, as electricity is required to produce green hydrogen. Electrolysers use high-virtue renewable electricity to convert water to low-virtue hydrogen.Hydrogen also needs to be transported and stored, which again requires high energy inputs. This low-virtue energy of hydrogen then requires reconversion back to high-virtue electricity.

Electrolysers (used to create green hydrogen) have a poor energy utilisation rate, retaining only approximately 65% of the initial available energy contained in the renewable electricity used to produce it. These energy inefficiencies are further exacerbated with each step along the distribution network. Using typical electrolysers, compression and liquification systems, transport options and gas turbines, the efficiency comes down to approximately 25% for domestic uses and less again for export options (including ammonia).

Any electrolysis facility will house a storage compound which will require the energy intensive process of compression, and hence the use of additional supplies of electricity.

When transporting hydrogen, compression losses in pipelines can be up to four times greater than for other gases. If it were the case that hydrogen needed to be trucked to refilling stations, with only a capability to truck around 300-400 kg/semitrailer, that too would be a source of significant efficiency loss.

The use of renewable electricity to export hydrogen for energy (liquid, compressed, or ammonia) presents further efficiency losses, and reducing overall efficiency to around 15%. Once shipped, the compressed/ liquified hydrogen or ammonia needs to be pressurised, transported, distributed and then converted to electricity, again resulting in efficiency losses.

Hydrogen for use in transport through fuel cells use 23-26% of original available energy for propulsion, compared to 73% for battery powered electric vehicles. For home heating, hydrogen proves to be far less efficient than electric heat pumps.

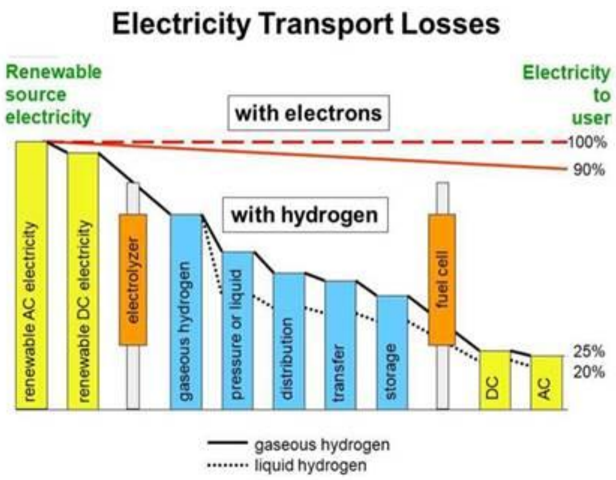

Figure 1: Efficiency losses associated with transport of

renewable electricity vs. hydrogen-based electricity.[1,2]

Renewable energy electrification with pumped hydro and/or batteries would lead to efficiencies of 80-90%.

The Consultation Paper seeks to address the efficiency problems inherent with hydrogen by stating 'however, in the long run, as the dynamics of the energy system change this may no longer be the case.' CCWA considers this to be an inadequate fallback, with no explanation provided as to how this will be achieved.

2. The Consultation Paper inadequately addresses the need for direct electrification

The production of hydrogen for use as electricity is inherently inefficient compared to using renewable energy for direct electrification. CCWA views efficiency improvements and electrification as a priority in the renewables transition; investment in hydrogen only delays this transition. It is far more efficient to use renewable energy directly, rather than waste it producing green hydrogen.

Nearly all of the applications of hydrogen mentioned in the Consultation Paper can be replaced by direct electrification for land-based applications. Direct electrification using renewable electricity firmed with pumped hydro, compressed air storage and battery storage can be used to decarbonise electricity networks, gas networks, road and rail transport in the first tranche. There are no existing technology gaps for these applications.

As green hydrogen production requires electricity from renewable energy, it will never be able to compete with direct electrification from renewable electricity sources for any land-based energy uses. Electricity and gas networks, gas turbines, diesel and petrol powered vehicles, heating, cooking, and rail transport can all be replaced with direct electrification through renewables.

Unsubsidised, hydrogen fails against direct electrification, and will typically require between three to six times more renewable energy input than the energy needed for direct electrification.[3,5,11]

CCWA acknowledges that every delay in direct electrification stalls our efforts to decarbonise our economy.

3. The Consultation Paper inadequately addresses the more prudent use of renewable energy to prevent the stalling of decarbonisation

Despite ample resources, WA has not yet achieved 100% renewable capacity. As the SWIS currently uses only approximately 20% renewable energy, any unnecessary removal of renewables from the grid delays the urgent need to decarbonise. Using newly developed renewables projects to inefficiently create green hydrogen, instead of dispatching renewably sourced electricity straight to the grid means that fossil fuels will continue to make up an unnecessarily greater proportion of electricity dispatch on the SWIS, and this will allow the fossil fuel industry in WA to prosper.

Electrolysis is hugely energy intensive, to the point that most countries do not have enough renewable energy to produce commercial quantities of green hydrogen. Producing green hydrogen will use renewable energy that otherwise could have gone directly to the SWIS.

The resources, technology, and storage options are all abundantly available for WA to reach 100% renewable electricity supply. Delaying this process places exacerbates the climate emergency and makes it harder for WA industries to meet legislated carbon emissions reduction targets. Any exported hydrogen will have a similar effect in other nations, who could also opt for direct electrification from local sources.

The most prudent use of renewable energy for electricity is in areas where the carbonisation factors of existing fossil fuel processes are highest, that being coal, followed by gas. A fuel that releases zero greenhouse gas emissions on its full trajectory from production to end use would have a carbonisation factor of zero. CCWA asserts that hydrogen should not be considered as a replacement for these electricity sources as it has a high decarbonisation obstruction factor.

Type of plant	Typical efficiency	Locations	Carbonisation factor
Steam turbines (coal)	30%	NSW, VIC QLD and WA	2/0.30=6.6
Simple cycle below 50 MW (gas)	35%	All states and Territories	1/0.35=2.9
Simple cycle aero derivative (gas)	45%	All states and Territories	1/0.45=2.2
Simple cycle over 50 MW (gas)	40%	All states and Territories	1/0.40=2.5
Combined cycle (gas)	65%	All states and Territories	1/0.65=1.65

Figure 2: Carbonisation factors of coal and gas plants. As these types of plant can be replaced with direct electrification and given the amount of emissions these are the highest priority. Efficiencies are indicative and may be lower, or slightly higher in some specific circumstances, in general they will be optimistic.[11,13]

CCWA believes that renewable energy is the most valuable tool we have for decarbonisation, it should be used in a direct and efficient manner. Hydrogen for electricity cannot be used for an effective decarbonisation of society, any only acts to obstruct urgent decarbonisation. Emissions reductions would be greater if any available renewable electricity is used for displacing fossil fuels in current energy supplies, rather than allocating those available renewable electricity supplies to making green hydrogen.

At electrolysis plants, there will be need for compression and storage of hydrogen. This process being fed by renewable energy would take away more renewable capacity from the grid. This process being fuelled by fossil fuels will contribute to the climate emergency.

Direct emissions reductions from hydrogen do not compare well to direct electrification through renewables. For instance, as stated in the Consultation Paper, a 10% hydrogen blend (by volume) will reduce emissions by approximately 2-3%, whilst continuing to enable the fossil fuel industry. 10% is the maximum mix-rate quoted, as high hydrogen volumes are not compatible with current gas distribution infrastructure. This does not meet the decarbonisation contribution required by new technologies to minimise global heating. Again, if the renewable energy used to make green hydrogen is directly deployed to displace gas powered electricity, emissions reductions will be much greater.

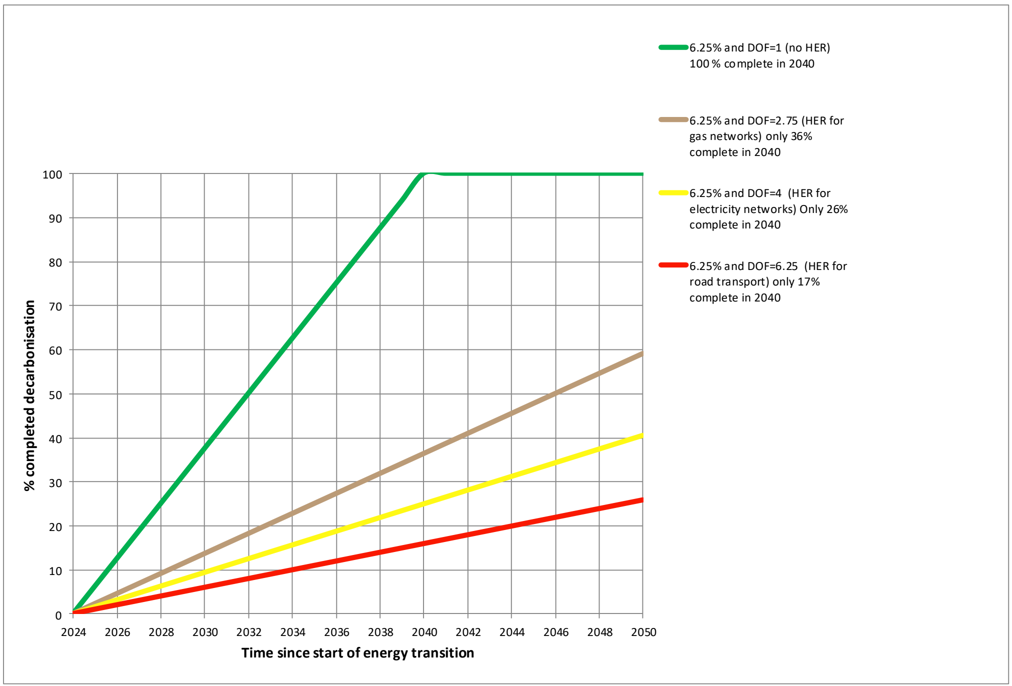

Figure 3: At a 6.25% replacement rate after 16 years, the replacement using direct electrification is complet. Even with a relatively 'efficient' hydrogen transition decarbonisation obstruction factor of 2.75, decarbonisation will not even reach 40% after 16 years.

Figure 3 shows various decarbonisation routes at a yearly replacement rate of 6.25%. The green line displays the decarbonisation rate using no hydrogen replacement. Under this mechanism, decarbonisation will be complete by 2040. The brown line represents decarbonisation whilst using hydrogen for gas networks, with a decarbonisation obstruction factor of 2.75. The yellow line represents decarbonisation whilst using hydrogen for electricity networks, with a decarbonisation obstruction factor of 4. The red line represents decarbonisation whilst using hydrogen in the transport sector, with a decarbonisation obstruction factor of 6.25.

6.25% represents an installed capacity requirement of 11.3 GW/ year over a continuous period of 16 years, based on renewable capacities required to overcome intermittency and provide storage capacities for reservoirs and charge batteries. If that 11.3 GW was not already challenging enough, then this annual rate must be multiplied further by an average factor of 5 leading to 56.5 GW/year if a mixture of different hydrogen routes is used instead.

That is, for every GW of fossil fuels displaced by a hydrogen routes, these hydrogen routes will require between 8 and 11 GW of renewable energy firmed electricity supplies to fulfil the domestic and overseas demand.

CCWA submits that not only is blending renewable hydrogen with natural gas hugely inefficient and stalling decarbonisation, it directly enables the continuation of the fossil fuel industry through use of existing gas infrastructure and required upgrades to this infrastructure.

4. ***Incidental emissions from the hydrogen industry not addressed in the Consultation Paper.***

CCWA is concerned that any hydrogen market will be open to manipulation from the fossil fuel industry via the form of brown, grey, or blue hydrogen. Blue and grey hydrogen are produced from natural gas (methane + carbon dioxide + others), through an energy-intensive and polluting method called the steam reforming process. Once the methane is isolated, the steam reforming process breaks it down into hydrogen, carbon monoxide, and carbon dioxide. Carbon monoxide and carbon dioxide are waste products and are released into the atmosphere.

Total carbon dioxide equivalent emissions for blue hydrogen are estimated to be only 9%-12% less than for grey hydrogen. Because this involves using natural gas to power the processing of yet more natural gas, the greenhouse gas emissions from blue hydrogen are greater than simply burning the natural gas (used for hydrogen production) by approximately 20%. When hydrogen is used in combustion turbines the by-products of this process are nitrogen oxides (NO, NO_2) which are greenhouse gases, and are released into the atmosphere.

Hydrogen requires transportation via pipelines and distribution networks where compressors at compressor stations are typically powered locally by gas. In many cases, blending involves connecting electrolysers to a gas and or coal electricity power generation grid, and the compressors are also operated from grid (firmed) power. In WA, there is a mixed system (coal and gas powered); the result of these activities is an increase in net emissions of around 9% for every 1% of energy displacement by hydrogen. This even applies to the periods a hydrogen plant is powered by renewables as this entire activity detracts from decarbonisation.

The Consultation Paper acknowledges the inappropriateness of relying on electricity network firming to make green hydrogen. If the electricity supply for hydrogen production is firmed by a fossil fuel plant then there will be an increase in CO_2 emissions. Power for electrolysers is often supplied with firming from fossil fuels.

5. The Renewable Hydrogen Target requires review regarding prioritising emissions reductions and decarbonising the economy

The priorities of the Consultation Paper require review. It is clearly stated that the key priority and goal of implementing the strategy is to stimulate local demand for hydrogen to develop our domestic hydrogen industry. The most important objective of the proposal, as stated in the Consultation Paper (p. 6-7), is 'Industry development.' Decarbonisation of the electricity grid is secondary to this, and decarbonisation of the Western Australian economy ranked lowest. The Consultation Paper prioritises potential export profits over reducing WA's emissions and decarbonising the economy.

The Consultation Paper also fails to mention battery storage as a mechanism for overcoming renewable intermittency.

CCWA argues that hydrogen energy routes should not be prioritised above electrification. As stated previously, direct electrification has a decarbonisation obstruction factor of 1.0. Blending hydrogen into the SWIS carries a decarbonisation obstruction factor of 4.0. Any factor greater than 1 is obstructing emissions reductions.

6. The use of hydrogen for electricity generation on the SWIS should be reviewed as it extends the life of fossil fuel industries

Promoting a hydrogen industry that is reliant on fossil fuel infrastructure and blending with fossil fuels offers an unnecessary and dangerous life extension to the fossil fuel industry.

The fossil fuel industry promotes gas as a 'natural resource' which will help produce 'clean hydrogen.' As WA's pipelines can only handle a small proportion of hydrogen mixed with majority gas, any hydrogen production is guaranteeing the continued use of fossil fuels in WA well into the future. Hydrogen being billed as a 'clean fuel' is misleading and, instead, locks WA into continued fossil fuel use and additional investments in fossil fuel infrastructure.

Any studies on the feasibility of hydrogen implementation should be viewed with caution, particularly if the studies are undertaken or financed by the gas industry.

7. *The Consultation Paper fails to address the impacts of fugitive hydrogen emissions*

In the short term, hydrogen can do more damage than the CO_2 it replaces. Over a 20-year span, molecular hydrogen has a heating potential 33 times greater than an equivalent amount of carbon dioxide. Traditional metrics of climate forcing agents model warming effects over a 100-year timeframe, and can often mask bigger, more immediate influences, such as that posed by molecular hydrogen.

Hydrogen is not a greenhouse gas, as it does not trap heat directly, but it is billed as an 'indirect greenhouse gas' as it is involved in chemical reactions in the atmosphere that enable or enhance the effects of other greenhouse gases.
Hydrogen interacts with the atmosphere in several ways that exacerbate global warming by:

a) Interfering with the breakdown of atmospheric methane. Ozone and water vapour react with sunlight to produce hydroxyl radicals (OH) in the atmosphere. OH is a powerful oxidant, which breaks down methane. Hydrogen reacts with OH, leaving less OH in the atmosphere available to breakdown methane, meaning that hydrogen emitted into the atmosphere will enable methane to have a longer atmospheric life expectancy.

b) Increasing stratospheric water vapour (potent greenhouse gas)

c) Increasing ozone (greenhouse gas and key component of smog) levels in the troposphere.

Damage potential depends entirely on leakage rates. As witnessed in the existing gas industry, leakage rates can be significant, and are often under-reported. In high leakage situations, hydrogen emissions could yield nearly twice as much global heating as the fuels they replace in the short-term (first five years).[4]

Fugitive emissions play a major role in WA's UNFCCC emissions profile, accounting for more than 10 MtCO2e in recent years.

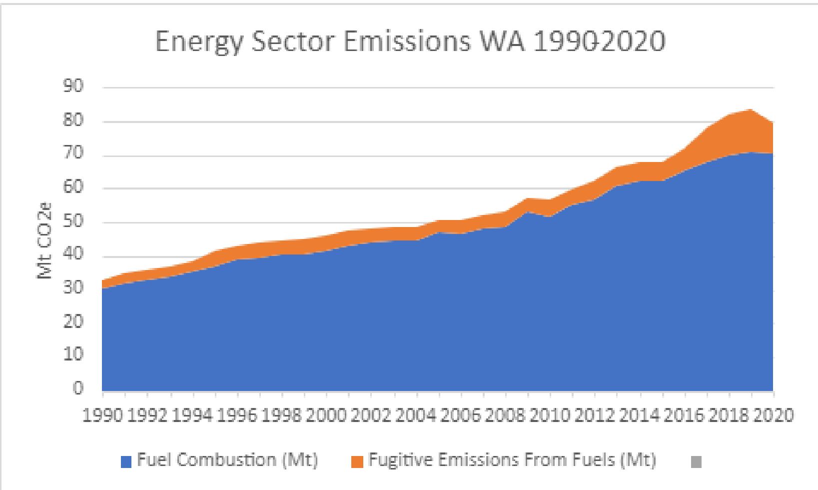

Figure 4: Official UNFCCC fugitive emissions from WA sources, 1990-2020.

This is a major concern for any hydrogen implementation, as molecular hydrogen itself will exacerbate global heating. Molecular hydrogen is far smaller than methane, and therefore has a greater predisposition to leakage. Shipping hydrogen through old gas pipelines, and burning hydrogen at home, pose huge leakage potential.

The Consultation Paper fails to address hydrogen leakage potential in WA's hydrogen network.

8. *The Consultation Paper inadequately considers the cost of infrastructure upgrades*

Any hydrogen economy in WA will require significant infrastructure upgrades at substantial costs. Again, the funding for resources required by hydrogen implementation would become unavailable for any renewable transition, further delaying decarbonisation.

Three different connections from green hydrogen production facilities and existing gas turbines are currently feasible, those being: existing gas transmission infrastructure, new hydrogen pipeline infrastructure and trucking.

Typically, gas transmissions pipelines are made from materials that cannot be used to transport hydrogen and may suffer catastrophic failure unless strict operating limits are imposed.[10] Centrifugal compressors, as currently constituted, would also have difficulty coping with hydrogen. Extensive alterations to all turbines (i.e. combustors and gas trains) located downstream from the hydrogen injection points will be also be required.

Furthermore, pipe sizes of existing gas networks are generally too small to carry high hydrogen loads at practical velocities and, therefore, gas networks would require major upgrades. All appliances, gas meters, consumer installations and, high-pressure gas transmission pipelines would need to be replaced, and pipe wall thickness increased.

The gas network upgrades required for hydrogen will be far more costly than the electricity network upgrades required for renewable integration.

Significant infrastructure upgrades will also be required for any export industry, again to the detriment of decarbonisation. Hydrogen has low volumetric energy density, storing and shipping will rely on extremely high pressures or extremely low temperatures requiring specific containments. All whilst overseas industrial customers could arrange direct electrification and firming with battery storage and pumped hydro.

9. *The Consultation Paper inadequately reflects on the prohibited costs related to the proposed Renewable Hydrogen Target*

As hydrogen for electricity supply must compete with its own energy source, it will always be an expensive fuel. Blending hydrogen into gas supplies for use in power generation is likely to be prohibitively expensive. Despite hydrogen being costed at around 12-times the price of gas in the Consultation Paper, such an estimate is still skewed strongly in favour of hydrogen. There is no delivery processes costed for hydrogen, and the costs of hydrogen delivery systems are many times more than existing gas delivery solutions. Furthermore, the cost to convert or replace existing power plants is not included in the Consultation Paper estimates. Once these extra costs have all been factored in, the cost increase for hydrogen is likely to be significantly higher than the 12-fold increase stated.

The Consultation Paper does not detail how the cost of hydrogen will drop from $78.02/GJ stated, to the proposed $50.72/ GJ upon scheme commencement.

Compared to direct electrification through renewables, the capital costings of hydrogen implementation are significantly higher. Hydrogen production, processing, compression and storage equipment will exceed the renewable energy input equipment, and again, will interrupt the outlay of direct renewables available to SWIS. Wholesale energy cost of energy delivered via hydrogen routes domestically can be as much as 12 to 24 times more than direct electrification.

There is a low marginal benefit of blending hydrogen into gas networks. New equipment for production, compression, storage and transport will all be necessary. Compressors along the distribution system are very sensitive to changes in gas composition. Swings in blending could vary between 0 and 25%. These variations would make standalone centrifugal compressors/ driver configurations unviable. To the best of CCWA's knowledge, there are currently no centrifugal compressors available for neat hydrogen.

As the cost of hydrogen is expected to be at least 12 times greater than gas, even 10% blending will drive up costs significantly. This means that consumers and/or taxpayers may be subject to subsidising these endeavours that fail to decarbonise our energy use.

Despite hydrogen being costed at around 12 times the cost for gas in the consultation paper, such estimate is still slanted in favour of hydrogen as there is no delivery process costed for hydrogen. The consultation paper is also unclear as to whether compressors, liquification and storage of hydrogen are factored into costs.

For transportation, trucking hydrogen would be the most expensive option per kg and carries with it a high risk of adverse events. Then there are further costs of conversion processes like ammonia and synthetic fuels, as well as untold new hydrogen appliances that would be required. Fluctuations in hydrogen concentrations present difficulties for residential and commercial appliances. Billing with such intraday variances in hydrogen quantities would struggle to meet the spirit of fair and equitable trading.

Electrolysers present a huge cost in hydrogen infrastructure. Electrolysers typically require more than 50 kWh input energy to produce 1 kg of hydrogen if produced at a workable pressure of 30 Bar. Assuming that the cost of firmed renewable electricity is $10.00/MWh then the input energy works out to $0.50/kg. However, if the electrolysers are to be operated from electricity that is not firmed then naturally vastly more electrolyser capacity is required, which will also be operating at very poor utilisation rates, thus making the $2.00 pricing point even far less attainable.

Restrictions currently apply to residential energy producers exporting their excess electricity generation (predominantly solar PV) onto the grid. Commercial consumers are also restricted with their exports. If these export energy flows can be increased, it would free up more capacity to charge energy storage batteries and/or pumped hydro.

Fossil fuel and hydrogen projects such as the Tallawarra B plant are diverting resources from renewable energy production.

10. Are parts of the hydrogen economy already redundant?

Even before being widely implemented, the hydrogen economy already has inherent redundancies due to its poor efficiencies, excessive amounts of renewable energy diversion, increases of emissions instead of reductions, and excessive costs, than when compared to direct electrification.

Minister MacTiernan acknowledged on 8 October 2022 that hydrogen blending into the gas network "is probably not the best way forward". If blending in the gas networks will not work then power generation holds an even lower likelihood of success, with even greater complexities and costs to manage. Variability of intra-day blending rates requiring real-time gas analysis at each delivery location would need to be used for certificates, further adding to complexities of the program.

Virtually all manufacturers of electric vehicles are opting for batteries over hydrogen fuel cells - there will be few FCEVs in the market in years to come. Hydrogen is also more easily ignitable than gas, and so far no odorants have been identified which could be added to make it safer.

11. Certificate/ Credits

Schemes like the proposed Renewable Hydrogen Electricity Generation Certificate have been a failure in market experimentation and proven to be ineffective at lowering carbon emissions. They are also open to extortion and exceptions being granted, and hold the potential to become a vehicle to subsidise an uncompetitive hydrogen industry.

12. The broader environmental impacts of renewable hydrogen projects are not addressed in the Consultation Paper

CCWA has previously provided comment on the environmental assessment of renewable hydrogen projects to state and federal government regulatory agencies. The themes emerging from the regulatory assessment processes have highlighted several issues relating to significant and residual environmental impacts from large renewable hydrogen projects in WA. The main concerns raised by CCWA in these forums have related to:

a) Landuse and environmental impact
b) Water supply
c) Emissions
d) Cultural impacts

a) <u>Landuse and environmental impact</u>

Renewable hydrogen projects are dependent on securing large areas of land for the development of key infrastructure - for energy generation from wind and solar; desalination plants; ammonia production plants; storage facilities; and transport (road rail, shipping and pipeline). Each of these aspects of a project needs to be carefully assessed for its capacity to generate greenhouse gas emissions and for environmental impact more broadly.

Without careful assessment of landuse environmental impacts from the hydrogen production strategy, the decarbonisation objective of the Renewable Hydrogen Target cannot be substantiated.

Furthermore, the location chosen for renewable hydrogen projects is important. The clearing of native vegetation, the impact to Threatened Ecological Communities or Priority Ecological Communities, the proximity to regions of social or cultural importance, and the impacts from the construction of new infrastructure, all require careful consideration in environmental assessments and must be factored into emissions calculations.

The Green Hydrogen Standard (The Green Hydrogen Organisation, 2022), launched at the Green Hydrogen Global Assembly & Exhibition in Barcelona in May 2022, asserts that renewable hydrogen projects be subject to environmental impact assessment to define environmental risks in the broadest possible terms.

b) <u>Water supply</u>

Renewable hydrogen facilities require significant supplies of fresh water. Typically, water supply is from groundwater or seawater, requiring desalination. The incorporation of a desalination plant increases the energy needs of a facility and can also produces emissions that have the potential to cause environmental impact, for example, through groundwater abstraction or discharge of hypersaline brine into the marine environment.

c) Emissions

Renewable hydrogen projects produce a range of emissions – brine discharges, hazardous air emissions from ammonia production plants, transport emissions. By way of example, the GHG emissions for the proposed Murchison Hydrogen Renewables Project, with associated ammonia production facility, were projected to be 15.86 Mt CO_2 for the lifetime of the facility.

The Green Hydrogen Standard (The Green Hydrogen Organisation, 2022), proposes that green hydrogen projects operate at ≤ 1kg CO_2e per kg H_2 (averaged over 1 year). It is not established in the Consultation Paper if this goal will be, or can be, supported.

d) Cultural impacts

CCWA emphasises the value of consultation with Traditional Owner groups and the importance of free, prior and informed consent. Human rights must be respected and promoted where energy is produced.

Recommendations

Considering the above information on the Consultation Paper for a Renewable Hydrogen Target for Electricity Generation in the SWIS, CCWA makes the following recommendations.

1. CCWA acknowledges that decarbonisation is key to mitigating climate change, and that the Renewable Hydrogen Target for electricity generation in the South West Interconnected System would inhibit direct electrification and therefore hinder climate change mitigation. CCWA therefore recommends that the Renewable Hydrogen Target for electricity generation in the South West Interconnected System is not implemented.
2. The priorities of the Consultation Paper are reviewed, with decarbonisation of the WA grid and economy becoming the top priorities.
3. Hydrogen routes should only be explored for specific industries, and only after the proportion of the economy which is able to be electrified is electrified through renewable energy sources.
4. Before any large-scale rollout, there is a requirement for further research to ensure hydrogen emissions are contained and therefore unable to alter atmospheric interactions.
5. WA should not commit to the National Hydrogen Strategy and should abandon all hydrogen options for the SWIS and gas networks in Western Australia.
6. WA should acknowledge that hydrogen infrastructure obstructs decarbonisation. Any funding committed to electricity generation through hydrogen should be diverted to direct electrification through renewables.
7. All gas blending initiatives, including pilot projects, designed to promote these technologies be abandoned until any emissions reductions claims can be substantiated.
8. The Target should be reviewed for its bias in favour of extending the use of fossil fuels. The Target should review the use of subsidies for hydrogen projects for both domestic and export uses.
9. Prioritise direct electrification through renewables to replace coal and gas-powered electricity generation, as well as electrifying road and rail transport in WA.
10. The export of hydrogen, for example, as ammonia, should be reevaluated for its environmental impacts.

11. The Target should consider the impacts of prolonged emissions from diversions of renewable electricity destined for direct electrification.
12. The Target should review the need for large-scale electrolysers, fuel cells and hydrogen compression and processing equipment, which are not needed in Australia until direct electrification is nearing completion. Only then should a decision to double the renewable electricity supplies to support hydrogen routes for remaining emissions be considered.
13. It is an expectation of The Green Hydrogen Standard (2022) that renewable hydrogen projects be subject to environmental impact assessment to evaluate and mitigate environmental impacts via applicable regulatory mechanisms. Accordingly, CCWA asserts that all renewable hydrogen proposals for WA be assessed under Part IV of the Environmental Protection Act.
14. Hydrogen as a means of electricity production is costly, inefficient, and harmful to the environment and should not be pursued or implemented in WA. No merits for the environment, or the population of WA can be identified within the consultation paper. Profits and export markets are the sole incentive. The consultation paper should be withdrawn and re-written to focus on electrifying the WA economy through renewable energy.

References

1. *U. Bossel et al The Future of the Hydrogen Economy: Bright or Bleak?*

https://www.researchgate.net/publication/232983331_The_Future_of_the_Hydrogen_Economy_Bright_or_Bleak/link/55d9c00e08aeb38e8a881c63/download

2. *Ulf Bossel, Does a Hydrogen Economy Make Sense? Proceeding of the IEEE October 2006https://www.industrializedcyclist.com/ulf%20bossel.pdf*
3. *Why a hydrogen economy doesn't make sense*

https://phys.org/news/2006-12-hydrogen-economy-doesnt.html

4. *Hydrogen for heating: atmospheric impacts*

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760538/Hydrogen_atmospheric_impact_report.pdf

5. *Bringing an evidence based viewpoint into the political discussion on hydrogen*

Hydrogen Science Coalition | Bringing an evidence based viewpoint into the political discussion on hydrogen (h2sciencecoalition.com)

6. *Hydrogen is Big Oil's Last Grand Scam - CleanTechnica*

https://cleantechnica.com/2021/02/24/hydrogen-is-big-oils-last-grand-scam/

7. *I Staffell et al The role of hydrogen and fuel cells in the global energy system. Energy Environ. Sci., 2019, 12, 463-491*
8. *R Kurz et al*

Hydrogen in pipelines: impact of hydrogen transport in natural gas pipelines

Proceedings of ASME Turbo Expo 2020 Turbomachinery Technical Conference and Exposition GT2020, June 22-26, 2020, London, England, GT2020-14040

https://www.researchgate.net/publication/344544616_GT2020-14040_HYDROGEN_IN_PIPELINES_IMPACT_OF_HYDROGEN_TRANSPORT_IN_NATURAL_GAS_PIPELINES

9. *Tim Forcey*

https://thefifthestate.com.au/columns/spinifex/hydrogen-in-the-gas-grid-is-a-great-idea-if-you-own-the-gas-grid/

10. *Hydrogen and fire safety:*

Detecting the most flammable element on earth

https://ifpmag.mdmpublishing.com/hydrogen-and-fire-safety-detecting-the-most-flammable-element-on-earth/

11. *JP Hodges et al, Injecting hydrogen into the gas network – a literature search, HSE RR 1047, 2015*
12. *DOE Hydrogen and Fuel Cells Program Record 9013*

https://www.hydrogen.energy.gov/pdfs/9013_energy_requirements_for_hydrogen_gas_compression.pdf

13. *'Clean' hydrogen? An analysis of the emissions and costs of fossil fuel based versus renewable electricity based hydrogen*

https://www.anu.edu.au/files/document-collection/ZCWP02-21%20Clean%20hydrogen%20emissions%20and%20costs_1.pdf

14. *Beware fossil-gas suppliers bearing hydrogen gifts*

https://reneweconomy.com.au/beware-fossil-gas-suppliers-bearing-hydrogen-gifts-73041/

15. *A key step on the pathway to Net Zero emissions - EVIDENCE REPORT*

IGEM-TSP-20-084 A key step on the pathway to Net Zero emissions- Evidence report.pdf

16. *Amounts of fuel used to generate electricity in the United Kingdom (UK) from 1998 to 2020, by fuel type*

https://www.statista.com/statistics/427870/fuels-used-electricity-generation/

17. *Energy Post Hydrogen production in 2050: how much water will 74EJ need?*

https://energypost.eu/hydrogen-production-in-2050-how-much-water-will-74ej-n

18. *2050Energy Scenarios The UK Gas Networks role in a 2050 whole energy system*

https://www.northerngasnetworks.co.uk/wp-content/uploads/2017/04/KPMG-2050-Energy-Scenarios-The-UK-Gas-Networks-role-in-a-2050-whole-en...1.pdf

19. *Nuno Bimbo, The unbearable lightness of hydrogen. The Chemical Engineer, 16th August 2019. https://www.thechemicalengineer.com/features/the-unbearable-lightness-of-hydrogen/*
20. *Rooftop solar sends Victorian power prices to zero every day for two months*

https://reneweconomy.com.au/rooftop-solar-sends-victorian-power-prices-to-zero-every-day-for-two-months/

21. *Robert W. Howarth, Mark Z. Jacobson How green is blue hydrogen?*

https://onlinelibrary.wiley.com/doi/full/10.1002/ese3.956