Challenges and opportunities for the treatment of water for hydrogen production

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Introduction

- The emergence of the near-zero emission hydrogen industry has become prominent to transition away from fossil fuels
- Hydrogen and water sectors will need to take an integrated approach and consider water within each "colour" of hydrogen production, as outlined in Figure 1
- It is critical that water aspects of hydrogen production are considered, waste disposal and management of sources without impacting local water security concerns and nearby communities
- Australia is well placed to produce renewable energy for green hydrogen due to our climate however, recent floods, droughts and bushfires have shifted focus towards water resilience
- Figure 2 below depicts the Australian continent with a comparison made to areas of water stress
- Four hydrogen production development projects (from concept to pre-FEED) have recently been completed allowing comparison between scenarios. Lessons learnt, challenges and opportunities are highlighted

Case study projects

Inland Green Hydrogen
- Located 50km inland in semi-arid location, some agriculture and townships nearby
- Brackish groundwater source (3,000 ppm salinity)

Inland Blue Hydrogen
- Located several 100kms inland, no agriculture or population centres nearby
- Brackish ground and produced water (2,000 – 4,000 ppm salinity)

Coastal Blue Hydrogen
- Located at a relatively remote coastal location, small population centre nearby and no agriculture
- Sea water only available (40,000 ppm salinity)

Coastal Green Hydrogen
- Coastal on a river estuary, near population centres / agriculture
- Multiple potable water sources: Sea water, dam water, sewage effluent, saline estuary water (30,000 ppm salinity)

Summarised findings from projects

Table 1 summarises the water demands and waste stream production for each case studies. Figure 3 presents a generic schematic for Green Hydrogen

Inland Green Hydrogen
- Brackish groundwater desalination the only option at this site
- Lack of source water quality / quantity information evident and additional sampling required to observe seasonality and variation
- Challenges for brine management exist for this site

Inland Blue Hydrogen
- Low quality water sources – brackish ground and produced water
- Some water sources 40km from WTP
- Complex treatment due to hydrocarbons / oils in source water

Coastal Blue Hydrogen
- Sea water was the only source available
- Water quality samples were >10 years old, sampling required
- Significant regulatory hurdles and investigations due to saline water release into a large bay with rare marine fauna identified

Coastal Green Hydrogen
- Significant water availability constraints including limited fresh water and challenging alternative sources including saline estuary water with high organics and nutrients
- Saline estuary water desalination shortlisted and discussions with surface water supplier ongoing
- Significant regulatory requirements / investigations due to saline waste release to river estuary (i.e. toxicology and dispersion)

Common challenges and opportunities

- Location siting - Water sources, export, energy, and cooling
- Water security and feed water chemistry – Uncertainty, variation in sources regulations, sample quality e.g. number and methods
- Brine management strategy – end of life, storage, thermal, reuse
- Recycling of waste streams – WTP, hydrogen unit, increase RO recovery
- Cooling water requirements – Air vs water cooled vs chilling
- Site steam application opportunities – Blue HPU steam can drive thermal desalination or thermal brine evaporation / crystallisation
- Waste heat recovery opportunities – Use for desalination, brine minimisation and cooling
- Oxygen reuse opportunities – Reuse from electrolyser in WTP

Conclusions

- Water treatment for green and blue hydrogen projects, whether inland or coastal, all have specific challenges and opportunities
- Water is a key aspect to the emerging hydrogen industry i.e. demineralised water is key for hydrogen production, water for cooling and challenges relating to the waste streams produced
- It is important that water requirements are not underestimated as this may be detrimental for the social license to operate, affect communities already impacted by water scarcity and, ultimately, may be an impediment to hydrogen production
- The variable water volume requirements for the hydrogen projects outlined within this study need to be considered carefully and cannot be removed from project planning from an environmental, cost, or social license perspective. It is important that water requirements are not underestimated as this may be detrimental for the social license to operate, affect communities already impacted by water scarcity and, ultimately, may be an impediment to hydrogen production

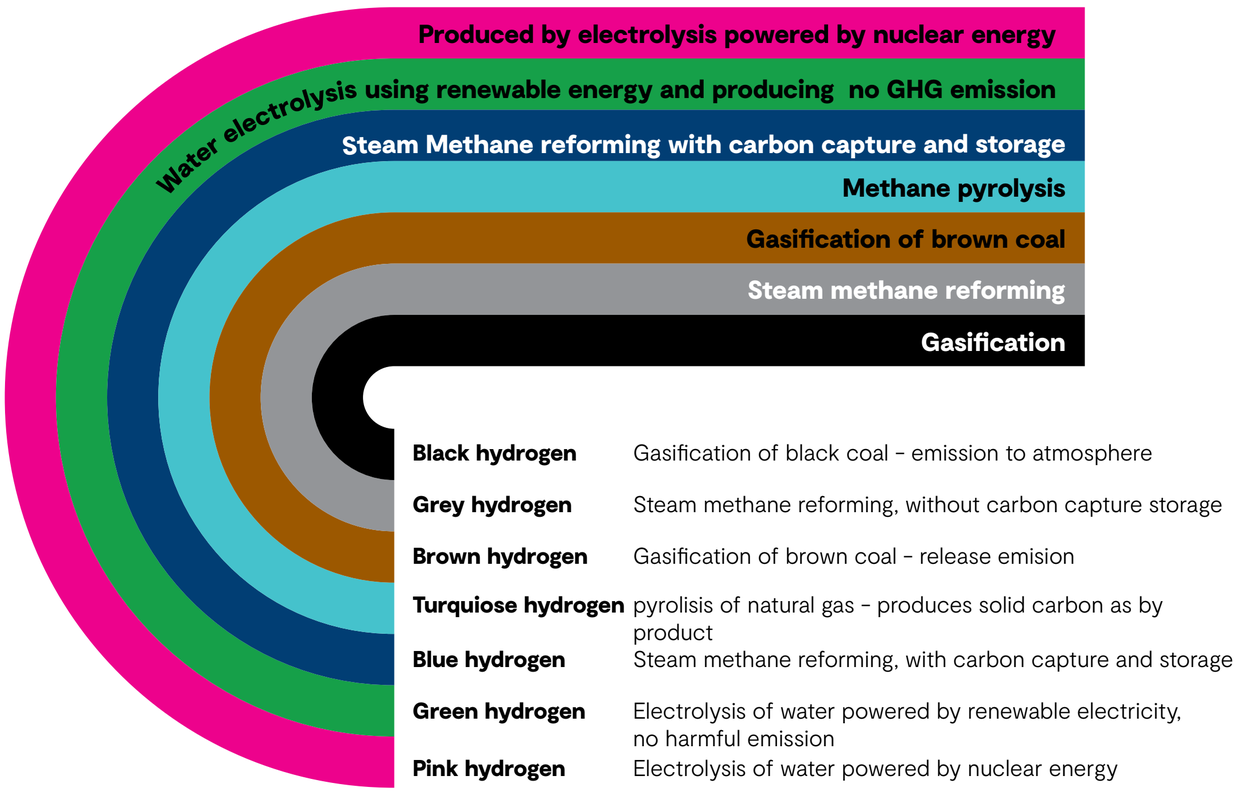

Figure 1: Hydrogen colours associated with the production method used

Figure 2: Water scarcity risk map of Australia in 2050 based on current trend (Source: WWF Water Risk Filter)

Table 1: Summary of case study water demands

Project	Raw Water (L/kg H2)	Waste Stream (L/kg H2)	Cooling (L/kg H2)	Demin for H2 & NH3 (L/kg H2)
Inland Green H2 (Brackish Ground Water)	16	3	3	10
Coastal Green H2+NH3 (Saline Estuary Water)	176*	114	46	16
Inland Blue H2 - Steam Methane Reforming (Brackish Ground & Produced Water)	13	5	Chilling	8
Inland Blue H2 - Auto-Thermal Reactor (Brackish Ground & Produced Water)	5	2	Chilling	3
Coastal Blue H2 - Steam Methane Reforming (Sea Water)	23	15	Air	8

*Note: * indicates additional water required for NH3 production (i.e. for hydrogen transport).*

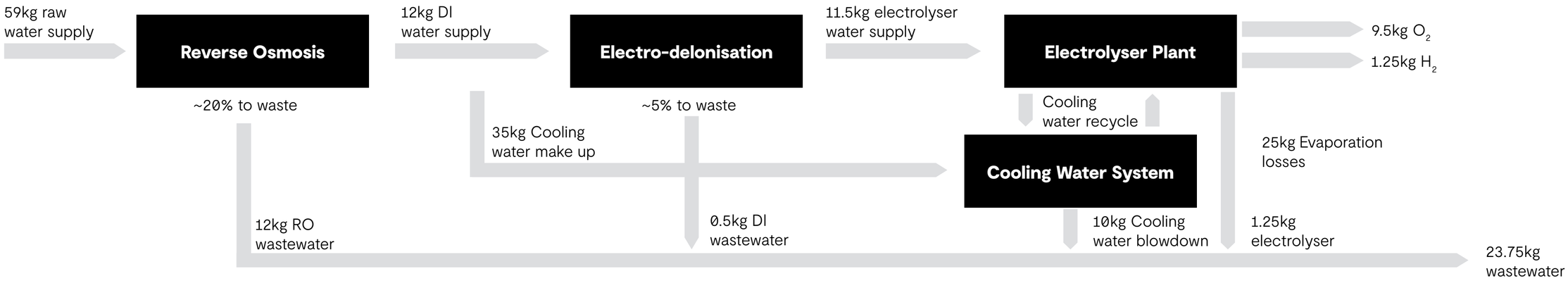

Figure 3: Example schematic for Electrolyser Water Treatment for Brackish Water Supply