ASSIGNMENT COVERSHEET

UTS STUDENT(S). UNIVERSITY OF TECHNOLOGY, SYDNEY

UTS: ENGINEERING & INFORMATION TECHNOLOGY

SUBJECT NUMBER	NAME OF STUDENT(s) (PRINT CLEARLY)	
42908	Robert Makepeace	13886357
SUBJECT NAME: Engineering Project Preparation	SURNAME / FIRST NAME	

STUDENT EMAIL	STUDENT CONTACT NUMBER
Robert.w.makepeace@student.uts.edu.au	0408 357 646

NAME OF TUTOR	TUTORIAL GROUP	DUE DATE
David Tydd	N/A	01/05/2022

ASSESSMENT ITEM NUMBER/ TITLE

ASSIGNMENT 3 Literature Review

X I confirm that I have read, understood and followed the guidelines for assignment submission and presentation on page 2 of this cover sheet.

X I confirm that I have read, understood and followed the advice in my Subject Outline about assessment requirements.

X I understand that if this assignment is submitted after the due date it may incur a penalty for lateness unless I have previously had an extension of time approved and have attached the written confirmation of this extension.

Declaration of Originality: The work contained in this assignment, other than that specifically attributed to another source, is that of the author(s) and has not been previously submitted for assessment. I understand that, should this declaration be found to be false, disciplinary action could be taken and penalties imposed in accordance with University policy and rules. In the statement below, I have indicated the extent to which I have collaborated with others, whom I have named.

Statement of Collaboration:

Signature of Student(s) Robert Makepeace Date 01/05/2022

✂- -

ASSIGNMENT RECEIPT

To be completed by the student if a receipt is required

SUBJECT NAME/NUMBER	NAME OF TUTOR

SIGNATURE OF TUTOR	RECEIVED DATE

A techno-economic analysis of the export of Green Hydrogen – Literature Review

42908 Engineering Project Preparation

By Robert Makepeace [13886357]

Word Count: 2489 words (without references)

Abstract

Green hydrogen, produced from renewable electricity, has the potential for being a significant new energy carrier for international trade. Green hydrogen can be transported long distances in multiple mediums including pure, converted or with a carrier form. Physically this transportation occurs in pipelines, on ships or trucks. There are numerous salient factors in selecting transportation options in distance, volume, safety, application use and cost. Techno-economic methods are a process of understanding and analysing the viability of processes, such as export of hydrogen across several different case studies. Topical issues in the literature include understanding the source of the hydrogen with embedded carbon emissions, technology safety issues and public perceptions of the technology. Green hydrogen can potentially play a critical role environmentally in the decarbonisation of the economy especially in hard-to-abate sectors and provide a significant economic opportunity for Australia with its large renewable energy resources.

1. Introduction

Green Hydrogen is hydrogen produced from renewable energy without the emissions of greenhouse gases. Whilst hydrogen is currently produced mostly using methods with significant carbon emissions, the role of renewably powered electrolysis is predicted to reduce cost and take a much larger role in the future (Alvera, 2021). Hydrogen is seen as a versatile and powerful energy carrier in the decarbonisation of the world economy to replace fossil fuel usage with renewable and sustainable technologies (Judkins and O'Brien, 2019). The transport of hydrogen long distances and export internationally is seen as a significant mechanism for reducing greenhouse emissions and a large economic opportunity for Australia with its extensive renewable energy resources (Walsh et al., 2021). The green hydrogen export concept as part of the hydrogen economy was first suggested by Bockris (1975); "Once we have got the energy into the form of hydrogen by electrolysing brackish water, it would be possible to pipe it over very long distances for quite cheap prices" (Bevan, 2022). Bockris' foundational research in the field is exemplary in its foresight, but some of his predictions were inaccurate with liquefied hydrogen ending up generally cheaper than pipelines.

2. Review of the Literature

2.1 Existing Forms of Energy Exports

Traditionally fossil fuels such as coal, natural gas and oil, and nuclear fuels such as uranium have dominated the long-distance energy carrier trade. This is due to high energy density, cheap prices, wide range of application usages and the geographically localised source of these fuels (Balat, 2008).

Gulagi et al. (2017) discusses the opportunity of exporting energy from Australia to Asia using excess renewable solar and wind electricity through long distance efficient high voltage direct current (HVDC) connections. Garnaut (2019) agrees with Gulagi on the opportunities of large and cheap renewable electricity generation in Australia providing cheaper prices than internationally made electricity. However, Garnaut argues that due to the transmission losses and capital costs, the electricity would be better utilised by moving energy intensive processes to Australia such as aluminium smelting.

The Hydrogen Energy Supply Chain (HESC) pilot project involves the production of hydrogen gas from brown coal in Australia's Latrobe Valley and export to Japan using a liquefied hydrogen carrier ship (Australian Government, 2019). While the first stage of the project has been successful, the challenge will be modifying the hydrogen production to incorporate a carbon capture and storage (CCS) scheme using sequestration technology. These CCS schemes for hydrogen produced from fossil fuels are currently very costly and have mixed effectiveness (Howarth and Jacobson, 2021).

An effective energy transportation medium in a decarbonised world needs to be cheap, versatile and have low emissions to become widely used (IEA, 2021).

2.2 Hydrogen Generation

Currently 70 MT of pure hydrogen are produced each year typically through thermochemical processes from the conversion of fossil fuels such as natural gas and coal or as a by-product from chemical processes (Boretti, 2020). These non-renewable sources also coproduce carbon dioxide which is a primary cause of the greenhouse gas effect. The primary method of green hydrogen production is electro-chemical through electrolysis of water using renewable electricity (wind or solar photovoltaics) (Longden et al., 2020). There are some other methods for renewably produced hydrogen such as biomass, fermentation and biological production but these methods currently have low levels of technological readiness. Feitz et al. (2019) discusses potential locations for hydrogen generation on an Australian wide scale with access to raw material resources, water, transport infrastructure and population centres being the key factors. Site selection is impacted by the intended usage of the hydrogen; for local Australian applications or for international export (ARUP, 2019).

It is noted that this literature review focuses on the export of hydrogen rather than hydrogen production methods, as other students under the same supervisor will study the hydrogen production in more detail.

2.3 Green Hydrogen End Use Applications

Hydrogen has numerous potential future applications across industries currently powered by hard-to-abate fossil fuel sourced energy (NSW Government, 2021). It is expected that the levelised cost of hydrogen is expected to drop in the next few decades making it competitive or cheaper than the alterative fossil fuel (Owen and Cockroft, 2006).

The most economically viable application will be in the transportation sector powering vehicles with hydrogen fuel cells (Bureau of Infrastructure, 2019). This includes cars, bikes, trucks, buses and potentially ships and planes at a later stage (Sharma and Ghoshal, 2015). The widespread use of hydrogen in vehicles has three challenges; in competition with electric vehicles, the rollout of refuelling infrastructure and safety concerns (Floyd et al., 2019)

Hydrogen can be used to produce electricity through hydrogen fuel cells (Australian Government, 2017). This can be done on a small scale for backup electricity generators to large scale energy storage and electricity generation for the electricity grid (Bones and O'Brien, 2020). Hydrogen can also be used for direct combustion for heating and for chemical production as an industrial feedstock for oil refineries, ammonia, methanol and other synthetic fuels and chemicals (IRENA, 2021). Green steel is an application of replacing coke with green hydrogen as the reducing agent to minimise the carbon emission of that industry (Bhaskar et al., 2020).

2.4 Hydrogen Mediums for Transportation

The generation and consumption of hydrogen do not necessarily occur at the same location leading to a need for transportation (Victorian Government, 2021). Long distance transport opens the world for international hydrogen trade, being able to deliver from the cheapest generation to the biggest consumers. To make the transportation economically viable, hydrogen is converted to different forms to increase its density (Australian Government, 2021b). These transportation mediums overlap with hydrogen storage mechanisms (Hirscher et al., 2020). The properties of a good transportation method include high energy density, safety, efficiency in conversions (if required) and cost effectiveness. The major viable options for hydrogen transportation are listed in Table 1.

To increase its density for transport, pure hydrogen is either compressed, liquefied or both (called cryo-compressed) (Faye et al., 2022). Compressed hydrogen is more practical for short distance transport and storage as the conversion energy and costs are minor. Liquefied hydrogen is currently the common method for bulk transport internationally due to its higher density. Liquefication is very energy intensive as it requires extremely low temperatures and has issues of boil-off during transport and reconversion prior to local distribution (Aziz, 2021).

Green Hydrogen can be converted to existing transportable fuels prior to transportation instead of using the fossil fuel pathway for these fuels. Ammonia (Chehade and Dincer, 2021), methanol (Li and Tsang, 2018) and synthetic natural gas (SNG) (Becker et al., 2019) are three potential candidates. The concept is for the hydrogen to be converted to the end use chemical closer to the production as the chemical has better transportation properties. Chehade's paper discusses a higher technological readiness of ammonia and versatility as a fuel, whereas Li's and Becker's papers focus on early-stage research and development.

Carrier mediums for storing the hydrogen in other forms include liquid organic hydrogen carriers (LOHCs) (He et al., 2015), metal hydrides (Sakintuna et al., 2007) and porous carbon materials (Andrews et al., 2021).

These methods aim to have a reversible process for effectively and efficiently storing hydrogen within a carrier medium. He and Andrews discuss novel technical details of their methods, but do not discuss the practicalities of large scale. Conversely, Sakintuna includes critical assessment on the viability of the current materials against the requirements for transport.

2.5 Physical Transport Modes

The choice of the physical method of hydrogen transportation depends on distance, volume, timing, safety, and costs factors. Regional transport typically occurs with trucks, rail or pipelines from the generation or port facility to a centralised processing facility for reconversion to the end use application. Export transport occurs for bulk transfers of hydrogen typically using shipping or pipelines. IEA (2019) provides some levelised costs for different transportation methods in terms of fixed and variable costs on distance components (Hydrogen Council, 2017).

For hydrogen gas, pipelines can be used to transport hydrogen gas for both local distribution and long-distance distribution. These are advantageous for not requiring additional conversion. There are some early stage pilot projects about 20% blending green hydrogen into existing natural gas pipelines (Ríos-Mercado and Borraz-Sánchez, 2015). The advantage of this approach is building up hydrogen infrastructure prior to a full transition, but is limited by the low energy throughput (GPA Engineering, 2019b). GPA Engineering (2019a) discusses using the existing natural gas pipeline for pure hydrogen gas transport with some retrofitting, discussing some challenges with the leaking of hydrogen due to its low density and hydrogen embrittlement. Bruce et al. (2018) argues for hydrogen transportation - new tailored pipelines are required which can cost up to twice as much as retrofitting (Hydrogen Council, 2021). Table 1 summarises these pipeline options for transporting hydrogen gas.

Table 1:Comparson of Hydrogen Technology Methods

Category	**Hydrogen Medium**	**Physical Transport Method**	**Current Usage**	**Technological Readiness**	**Cost**	**Advantages**	**Disadvantages**	**References**
Pure Hydrogen	Compressed	Truck / Rail	Local storage / short distance	High	Cost Effective for short distance	Proven technology, Low conversion cost	Low density, High Pressure	(Hydrogen Council, 2020)
	Liquefied	Shipping / Truck	Long distance	High	Cost Effective for long distance	Proven technology, High density	Conversion energy, Safety issues	(Balat, 2008)
	Cryo-compressed	Shipping / Truck	R&D	Low	Expensive	High density	Technology not proven	(Faye et al., 2022)
Converted Compounds	Green Ammonia	Shipping / Truck	Wide usage (non-green ammonia)	High	Cheap (non-green forms)	High density storage. Ready for application	Toxic, energy intensive conversion	(Chehade and Dincer, 2021)
	Green Methanol	Shipping / Truck	R&D	Low	Expensive	High density storage	Technology not proven	(Li and Tsang, 2018)
	Synthetic Natural Gas (SNG)	Shipping / Truck	R&D	Low	Expensive	Existing Infrastructure	Technology not proven	(Becker et al., 2019)
Carrier Substance	Metal Hydrides	Shipping / Truck	R&D	Medium	Expensive	Reversible, High density	Temperature issues	(Sakintuna et al., 2007)
	Liquid Organic Hydrogen Carrier (LOHC)	Shipping / Truck	Future Long distance	Medium	Potential to be cheaper in future	Safe and cheap, High density	Conversion energy	(He et al., 2015) (Makepeace et al., 2019)
	Porous Carbon Materials	Shipping / Truck	R&D	Low	Expensive	High conversion efficiency	Technology not proven	(Andrews et al., 2022)
Pipeline	Blending into Natural Gas	Pipeline	Local distribution	Medium	Cheap	Uses existing infrastructure	Low energy throughput. Fixture compatability	(Frontier Economics, 2020)
	Existing / New Hydrogen Pipeline	Pipeline	Local distribution / export	Medium	Moderate	Better throughput	More expensive	(Frontier Economics, 2020)

2.6 Techno-Economic Analysis Method

Techno-economic analysis is a method of evaluating the economic performance of industrial applications through considering the process, equipment sizing, and financial costs (Mezher et al., 2011). Batan et al. (2016) incorporates uncertainties into the techno-economic model by using the Monte Carlo method, a stochastic simulation method to produce a probabilistic profile of the expected costs in an exemplary paper.

Kannah et al. (2021) provides an extensive techno-economic analysis of the different hydrogen generation techniques and associated financial costs of these projects. Kannah's paper focuses on the specific economics of each hydrogen production technology, whereas, Walsh et al. (2021) analyses the economics for hydrogen production in terms of broader geographical, infrastructure and resource factors to identify the best regions in Australia.

Walsh and Kannah focus the techno-economic analysis on the hydrogen production stage of the hydrogen economy. However, there is a gap in the literature in detailed techno-economic analysis for hydrogen transportation. Currently, Hydrogen Council (2021) provides some simplistic analysis of a few hydrogen transportation case studies with different mediums but does not incorporate the whole generation to application chain. IEA (2019) provides more granular economic analysis on the different methods of transportation compared to the Hydrogen Council and de Vos (2021), but focuses on local distribution and regional transport, and does not consider the carbon emissions of the transportation infrastructure nor local government policies and grants (Utz, 2019).

2.7 Hydrogen Guarantee of Origin Schemes

Australia currently exports ammonia to Japan which is used to co-combust with the coal in existing coal power stations (Stocks et al., 2022). Whilst this project reduces carbon emissions in Japan as ammonia burns cleanly, the ammonia produced from steam methane reforming and the Haber-Bosch process has significant carbon emissions in Australia. Stocks argues the emissions offset in replacing the coal in ammonia is replaced by the emissions in the ammonia production albeit in a different country. Understanding the source of the hydrogen and any embedded carbon emissions in its production is becoming a topical issue in the literature.

An emerging issue in the international trade of hydrogen is a guarantee of origin scheme for the purchaser to understand the source of the hydrogen and any carbon emissions made in its production (Australian Government, 2021a). Transparency of the source of hydrogen allows for the competitiveness of "clean hydrogen" in trade against hydrogen produced from fossil fuels and hydrogen produced with CCS. Understanding the full history of products will be important in application industries in assessing their total carbon emissions and meeting local regulations around carbon pricing schemes such as carbon taxes, etc. Dawood et al. (2020) goes further than the Australian government in considering the cradle to grave carbon emissions.

2.8 Hydrogen Safety and Public Perceptions

A significant factor affecting the export of hydrogen is the safety of the technology and the public perceptions of the safety. The physical and chemical properties of hydrogen make it dangerous, with the key properties of a wide flammability range, low ignition energy, colourless flame and propensity to leak (Najjar, 2013). There needs to be significant care in the design and operation of hydrogen systems to minimise the risk of an accident and to ensure public confidence in the technology (Lambert and Ashworth, 2018). Hydrogen transport infrastructure may need additional equipment for monitoring and safety devices. While Najjar's analysis is rigorous for storage and applications, it does not consider alternate transportation methods beyond pipelines. Furthermore, Ashworth et al. (2019) discusses improving public perceptions through delivering pilot projects, developing realistic expectations, communicating timeframes and engaging with the community.

3. Conclusions

The production of hydrogen from renewably produced electricity has the potential to play a critical role in the decarbonisation of many industries. The ability to export energy in the form of green hydrogen internationally is a significant opportunity economically and environmentally. There are multiple methods for transporting hydrogen that may be viable across different case-study scenarios. There are some challenges to these technologies, in the properties of hydrogen, the required conversions/reconversions, safety concerns and economic viability. The economic viability of different technology mediums can be assessed using techno-economic analysis methods.

4. References

ALVERA, M. 2021. *The Hydrogen Revolution A Blueprint for the Future of Clean Energy*, Basic Books.

ANDREWS, J., NIYA, S. R. & OJHA, R. 2022. Electrochemical hydrogen storage in porous carbons with acidic electrolytes: Uncovering the potential. *Current Opinion in Electrochemistry,* 31**,** 100850.

ANDREWS, J., OJHA, R., NIYA, S. M. R. & SEIBT, S. 2021. Electrochemical storage reactions of hydrogen in activated carbon from phenolic resin. *Catalysis Today*.

ARUP 2019. Australian Hydrogen Hubs Study Technical Study. ARUP.

ASHWORTH, P., WITT, K., FERGUSON, M. & SEHIC, S. 2019. Developing Community Trust in Hydrogen. University of Queensland: Brisbane.

AUSTRALIAN GOVERNMENT 2017. The Strategic Road Map for Hydrogen and Fuel Cells - Industry-academia-government action plan to realize a "Hydrogen Society". Hydrogen and Fuel Cell Strategy Council.

AUSTRALIAN GOVERNMENT 2019. Australia's National Hydrogen Strategy. Australian Government COAG Energy Council.

AUSTRALIAN GOVERNMENT 2021a. A Hydrogen Guarantee of Origin scheme for Australia Discussion Paper. Australian Government.

AUSTRALIAN GOVERNMENT 2021b. State Of Hydrogen. Australian Government.

AZIZ, M. 2021. Liquid hydrogen: A review on liquefaction, storage, transportation, and safety. *Energies,* 14**,** 5917.

BALAT, M. 2008. Potential importance of hydrogen as a future solution to environmental and transportation problems. *International journal of hydrogen energy,* 33**,** 4013-4029.

BATAN, L. Y., GRAFF, G. D. & BRADLEY, T. H. 2016. Techno-economic and Monte Carlo probabilistic analysis of microalgae biofuel production system. *Bioresource technology,* 219**,** 45-52.

BECKER, W. L., PENEV, M. & BRAUN, R. J. 2019. Production of synthetic natural gas from carbon dioxide and renewably generated hydrogen: a techno-economic analysis of a power-to-gas strategy. *Journal of Energy Resources Technology,* 141.

BEVAN, M. 2022. 50 years ago, John Bockris saw the future of Australia's climate crisis. *ABC*.

BHASKAR, A., ASSADI, M. & NIKPEY SOMEHSARAEI, H. 2020. Decarbonization of the iron and steel industry with direct reduction of iron ore with green hydrogen. *Energies,* 13**,** 758.

BOCKRIS, J. O. 1975. Energy: the solar-hydrogen alternative.

BONES, D. & O'BRIEN, L. 2020. GHD. GHD Hydrogen to Support Electricity Systems.

BORETTI, A. 2020. Production of hydrogen for export from wind and solar energy, natural gas, and coal in Australia. *International journal of hydrogen energy,* 45**,** 3899-3904.

BRUCE, S., TEMMINGHOFF, M., HAYWARD, J., SCHMIDT, E., MUNNINGS, C., PALFREYMAN, D. & HARTLEY, P. 2018. CSIRO National Hydrogen Roadmap Pathways to an economically sustainable hydrogen industry in Australia. CSIRO.

BUREAU OF INFRASTRUCTURE 2019. Hydrogen as a Transport Fuel Location options for a freight-based limited initial deployment of hydrogen refuelling stations. Bureau of Infrastructure, Transport and Regional Economics.

CHEHADE, G. & DINCER, I. 2021. Progress in green ammonia production as potential carbon-free fuel. *Fuel,* 299**,** 120845.

DAWOOD, F., ANDA, M. & SHAFIULLAH, G. 2020. Hydrogen production for energy: An overview. *International Journal of Hydrogen Energy,* 45**,** 3847-3869.

DE VOS, R. 2021. CEFC Australian hydrogen market study Sector analysis summary. CEFC.

FAYE, O., SZPUNAR, J. & EDUOK, U. 2022. A critical review on the current technologies for the generation, storage, and transportation of hydrogen. *International Journal of Hydrogen Energy*.

FEITZ, A., TENTHOREY, E. & COGHLAN, R. 2019. Geoscience Australia Prospective hydrogen production regions of Australia. Geoscience Australia.

FLOYD, H., HIBBERT, A. & AMICO, A. 2019. Hydrogen for Transport Prospective Australian Use Cases. Aurecon Australasia.

FRONTIER ECONOMICS 2020. Indicative Analysis Of Blending Hydrogen In Gas Networks – Update. Frontier Economics.

GARNAUT, R. 2019. *Superpower: Australia's Low-Carbon Opportunity*, Black Inc.

GPA ENGINEERING 2019a. Hydrogen Impacts on Downstream Installations and Appliances. COAG Energy Council Technical Review.

GPA ENGINEERING 2019b. Hydrogen In The Gas Distribution Networks. GPA Engineering.
GULAGI, A., BOGDANOV, D., FASIHI, M. & BREYER, C. 2017. Can Australia power the energy-hungry Asia with renewable energy? *Sustainability,* 9**,** 233.
HE, T., PEI, Q. & CHEN, P. 2015. Liquid organic hydrogen carriers. *Journal of energy chemistry,* 24**,** 587-594.
HIRSCHER, M., YARTYS, V. A., BARICCO, M., VON COLBE, J. B., BLANCHARD, D., BOWMAN JR, R. C., BROOM, D. P., BUCKLEY, C. E., CHANG, F. & CHEN, P. 2020. Materials for hydrogen-based energy storage–past, recent progress and future outlook. *Journal of Alloys and Compounds,* 827**,** 153548.
HOWARTH, R. W. & JACOBSON, M. Z. 2021. How green is blue hydrogen? *Energy Science & Engineering,* 9**,** 1676-1687.
HYDROGEN COUNCIL 2017. Hydrogen Scaling Up A Sustainable Pathway For The Global Energy Transition.
HYDROGEN COUNCIL 2020. Path To Hydrogen Competitiveness A Cost Perspective. Hydrogen Council.
HYDROGEN COUNCIL 2021. Hydrogen Council - Hydrogen Insights 2021. Hydrogen Council.
IEA 2019. The Future of Hydrogen Seizing Today's Opportunities.
IEA 2021. Global Hydrogen Review 2021.
IRENA 2021. Green Hydrogen Supply A Guide To Policy Making.
JUDKINS, M. & O'BRIEN, J. 2019. Deloitte Australian and Global Hydrogen Demand Growth Scenario Analysis. Deloitte.
KANNAH, R. Y., KAVITHA, S., KARTHIKEYAN, O. P., KUMAR, G., DAI-VIET, N. V. & BANU, J. R. 2021. Techno-economic assessment of various hydrogen production methods–A review. *Bioresource Technology,* 319**,** 124175.
LAMBERT, V. & ASHWORTH, P. 2018. University of Queensland The Australian public's perception of hydrogen for energy. University of Queensland.
LI, M. M.-J. & TSANG, S. C. E. 2018. Bimetallic catalysts for green methanol production via CO 2 and renewable hydrogen: a mini-review and prospects. *Catalysis Science & Technology,* 8**,** 3450-3464.
LONGDEN, T., JOTZO, F., PRASAD, M. & ANDREWS, R. 2020. Green hydrogen production costs in Australia: implications of renewable energy and electrolyser costs. *Centre for Climate & Energy Policy: Canberra, Australia*.
MAKEPEACE, J. W., HE, T., WEIDENTHALER, C., JENSEN, T. R., CHANG, F., VEGGE, T., NGENE, P., KOJIMA, Y., DE JONGH, P. E. & CHEN, P. 2019. Reversible ammonia-based and liquid organic hydrogen carriers for high-density hydrogen storage: Recent progress. *international journal of hydrogen energy,* 44**,** 7746-7767.
MEZHER, T., FATH, H., ABBAS, Z. & KHALED, A. 2011. Techno-economic assessment and environmental impacts of desalination technologies. *Desalination,* 266**,** 263-273.
NAJJAR, Y. S. 2013. Hydrogen safety: The road toward green technology. *International Journal of Hydrogen Energy,* 38**,** 10716-10728.
NSW GOVERNMENT 2021. NSW Hydrogen Strategy - Making NSW a global hydrogen superpower.
OWEN, A. D. & COCKROFT, C. 2006. A Cost-Benefit Analysis of Perth's Hydrogen Fuel Cell Buses. Murdoch University. March.
RÍOS-MERCADO, R. Z. & BORRAZ-SÁNCHEZ, C. 2015. Optimization problems in natural gas transportation systems: A state-of-the-art review. *Applied Energy,* 147**,** 536-555.
SAKINTUNA, B., LAMARI-DARKRIM, F. & HIRSCHER, M. 2007. Metal hydride materials for solid hydrogen storage: a review. *International journal of hydrogen energy,* 32**,** 1121-1140.
SHARMA, S. & GHOSHAL, S. K. 2015. Hydrogen the future transportation fuel: From production to applications. *Renewable and sustainable energy reviews,* 43**,** 1151-1158.
STOCKS, M., FAZELI, R., HUGHES, L. & BECK, F. J. 2022. Global emissions implications from co-combusting ammonia in coal fired power stations: An analysis of the Japan-Australia supply chain. *Journal of Cleaner Production,* 336**,** 130092.
UTZ, C. 2019. Hydrogen Industry Legislation A report scoping out legislation, regulations and standards relevant to the development of a national hydrogen industry in Australia.: Department of Industry, Innovation and Science.
VICTORIAN GOVERNMENT 2021. Victorian renewable hydrogen industry development plan.
WALSH, S. D., EASTON, L., WENG, Z., WANG, C., MOLONEY, J. & FEITZ, A. 2021. Evaluating the economic fairways for hydrogen production in Australia. *International Journal of Hydrogen Energy,* 46**,** 35985-35996.