Australian Government

COAG Energy Council

NATIONAL HYDROGEN STRATEGY

Issues paper series

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This issues paper discusses the importance of traceability and certification to support regulatory systems and customer choices for hydrogen. The paper also explores international models, scheme requirements and governance arrangements.

A list of questions is presented at the end seeking further input from interested stakeholders.

Guarantees of origin

This paper has been informed by submissions to the *Request for Information* released in March this year, as well as:

- targeted visits to countries that have already started to develop hydrogen technologies and markets
- the stakeholder roundtables that were held throughout May and June

The COAG Energy Council Hydrogen Working Group would like to thank industry and community members for their engagement in the strategy development process.

In this paper, unless otherwise indicated, 'hydrogen' refers to 'clean hydrogen,' defined as being produced using renewable energy or using fossil fuels with carbon capture and storage (CCS). This definition reflects the principle of technology neutrality set by COAG Energy and Resources Ministers when they commissioned the Working Group to a comprehensive and ambitious strategy for the development of an Australian hydrogen industry.

Background

It is almost impossible to tell how a given unit of hydrogen has been produced. A guarantee of origin allows for a standardised process of tracing and certifying the provenance of hydrogen and the associated environmental impacts (for example, greenhouse gas emissions or water use). It allows comparison of similar products delivered by different supply chains to inform consumer choice and sourcing. A guarantee of origin could allow companies who purchase hydrogen to demonstrate corporate commitment to climate change mitigation, whether to customers, to investors, or to governments; and to go beyond compliance towards best practice emissions management. It can also be used to comply with regulatory measures designed to reduce emissions.

Why are guarantees of origin important for an Australian hydrogen industry?

Australian consumers already show a preference for transparent information around the products and services that they purchase. They like to know how these are made, and what benefits or impacts they might have. For example, to allow informed choice, food sold in Australia must be clearly labelled with information about its country of origin.

Preliminary testing of Australian consumer attitudes to hydrogen (undertaken by the University of Queensland) reveals consumers do care about how their hydrogen is made, and do differentiate between hydrogen made from renewable energy and hydrogen made from fossil fuels.[1] Origin labelling for hydrogen will also be important for corporations wishing to use hydrogen to reduce their emissions or achieve carbon neutral status.

Potential major export markets have already signalled that the emissions associated with hydrogen production are important to them. The Japan Basic Hydrogen Strategy notes that imports will need to be ‘carbon-free’ from 2030 onwards.[2] Korea’s [Hydrogen Strategy] indicates that major overseas production of hydrogen should come from water electrolysis and be ‘CO2-free’ between 2030 and 2040.[3] For Australian imports to be accepted by these markets it will be essential for Australian hydrogen to have its origins certified in a way that meets market requirements.

Guarantees of origin also help investors assess risk. They can get a better sense of the likely offtake price for hydrogen, and future risks of carbon exposure in their investment portfolio.

International examples

Worldwide, there is currently only one guarantee of origin program for hydrogen, Europe’s CertifHy scheme. CertifHy was developed by industry with government funding, and is currently in a pilot phase. The IP for CertifHy is privately owned. Table 1 summarises the two types of certification available through CertifHy. A number of other carbon labelling schemes exist in Australia and in overseas markets, including the Australian Government’s Carbon Neutral label. These are summarised in Table 5, at the end of this paper. Most of these schemes are designed to certify the lifecycle emissions or environmental impacts of products and services. This does not mean they cannot be used to certify hydrogen, but they may need adjustments or new methodologies developed to do so.

Table 1: CertifHy guarantees of origin[4]

CertifHy ‘Green Hydrogen’	CertifHy ‘Low Carbon Hydrogen’
Must come from renewable energy sources (as defined in the EU’s Renewable Energy Directive)	Can come from any source
Must have lifecycle emissions below 36.4 gCO2-e / MJ (approximately 4.4 kg CO2-e / kg hydrogen)	
Lifecycle emissions calculations for CertifHy do not include emissions associated with building the hydrogen production plant, transport and supply of hydrogen to consumers, emissions abatement from using hydrogen, and emissions from product end of life.	

A new scheme may be needed

It is clear that international customers and domestic consumers are likely to demand a guarantee of origin for Australian hydrogen. A guarantee of origin also provides an incentive for hydrogen facilities to pursue best practice emissions management.

One option would be to adopt Europe’s CertifHy guarantee of origin. This would encourage international consistency, and allow Australian producers to interface with the European market. However, CertifHy currently has no plans to expand eligibility beyond EU member countries at present. In any case, it was developed to allow European consumers to compare hydrogen lifecycle emissions with other alternative transport fuels. It was not designed with other uses or international commodity trade in mind though there may be opportunities to build on the methodological development undertaken. Another concern with CertifHy is the threshold for 'low-emissions hydrogen': 4.4 kgCO_2-e / kg of hydrogen is well above best-practice emissions management for hydrogen from fossil fuels.[5] At this level, a guarantee of origin is unlikely to encourage companies to go beyond compliance in their emissions management.

A second option would be to use the Australian Government's Carbon Neutral certification program. However, because the program is designed to certify a wide range of goods and services, it allows certified entities some flexibility in choosing boundaries for calculating lifecycle emissions, consistent with guidance from the World Resources Institute.[6] This could make it difficult for consumers to meaningfully compare between hydrogen from different producers because consistent boundaries may not have been used.

One advantage of adopting an existing label, such as CertifHy or Carbon Neutral, is that it could lead to a common international standard. However, this is only advantageous to Australia if that standard is recognised in markets where we trade, and if it is meaningful to Australian consumers. Acceptance of CertifHy in Asian markets is unknown, and while Carbon Neutral is used by some Australian companies in overseas markets, it is not recognised by other governments as a guarantee of carbon neutrality. As well, it is a voluntary program, which may not lend itself to guaranteeing certification between countries.

It is the Hydrogen Working Group's view that a new scheme is needed, but further work is required to decide on scope and governance. This work should draw on the work done to date overseas (such as CertifHy) and in Australia, to ensure that a new label both meets the needs of Australian customers and overseas consumers, and retains consistency with other schemes. To facilitate access to future markets in other countries, a new scheme must be able to interface or achieve mutual recognition with schemes in other countries – without this, a barrier to trade will emerge. If developing a new guarantee of origin, Australia should proactively engage with other countries as part of that process to ensure the scheme gains global acceptance quickly.

Scope of a guarantee of origin

It is the Working Group's initial view that a guarantee of origin should cover emissions only. While it was apparent from submissions to the discussion paper that many consumers are concerned about water impacts, and these may be significant overall, there would be little variation in water consumption between hydrogen production plants, because water consumption is a function of a chemical reaction. As well, a single label is not well-suited to covering multiple environmental impacts. However, the Working Group is open to considering whether other impacts should be included. Water consumption and its impact on local communities is discussed in more detail in the *Understanding community concerns for safety and the environment* paper.

The box below shows the different types of emissions that could be covered by a guarantee of origin. There are advantages and disadvantages to including or excluding each type, as shown in Table 2. The Working Group's initial view is that a starting point for a guarantee of origin could be scope 1 and scope 2 emissions, because these are easiest to measure consistently. Scope 3 emissions could be added at a later date. However, the Working Group seeks stakeholder views on the appropriate scope for a guarantee of origin, noting the importance of reflecting community and destination market concerns.

What are scope 1, scope 2 and scope 3 emissions?

Developing a guarantee of origin that quantifies emissions impacts requires deciding which emissions to include. The IPCC divides emissions into three categories:

Scope 1 emissions are those released into the atmosphere as a direct result of an activity, or series of activities at a facility. For hydrogen produced through electrolysis, scope 1 emissions would be zero, for hydrogen produced from natural gas without CCS, scope 1 emissions would be around 10 kg CO2-e per kg of hydrogen.[7]

Scope 2 emissions are indirect greenhouse gas emissions from consumption of purchased electricity, heat or steam. Most scope 2 emissions represent electricity consumption, but can include other forms of energy transferred across facility boundaries. For hydrogen produced from 100% renewable energy, scope 2 emissions would be zero. For hydrogen produced from grid electricity, scope 2 emissions would be almost 55kg CO2-e per kilogram of hydrogen. For hydrogen produced from fossil fuels, they would vary from plant to plant.

Scope 3 emissions are indirect emissions from other sources. These might include emissions from business travel, water use, emissions from the production of fuels used at a facility, emissions associated with disposing of waste (such as carbon capture and storage), or emissions from transporting finished products to an end user. Scope 3 emissions are always specific to choices that a company makes in deciding what to include, so it is not possible to make a general estimate of scope 3 emissions for hydrogen production.

Lifecycle emissions, which are often used in consumer labelling schemes, provide a systems perspective and include emissions generated from natural resource extraction, processing, manufacturing, transportation, through to disposal of a product, material, or service. This will include scope 1 and scope 2 emissions, and some or all scope 3 emissions.

Table 2: options for emissions scope in a guarantee of origin

Scope 1	• Simplest to determine • Not technology-neutral, as would label hydrogen produced from grid electricity as zero emissions
Scope 1 + scope 2	• Consistent with National Greenhouse and Energy Reporting System which requires estimation and reporting of scope 1 and scope 2 • More complex to determine, but not overly so • May not address potential consumer concerns about emissions associated with transporting hydrogen long distances, or transporting CO_2 for sequestration[8] • Mostly technology-neutral, noting that CCS fugitive emissions may not be included.
Lifecycle (sum scopes 1, 2 + 3, plus disposal)	• Most complex to determine, and adds to difficulty of comparing between projects • Truly technology-neutral • Can only be zero for fossil fuel hydrogen if carbon offsets are allowed.

Interaction with existing frameworks

The Australian National Greenhouse Accounts Framework sets out rules and guidelines for emissions calculations and reporting consistent with those set by the Inter-governmental Panel on Climate Change. This ensures that emissions are calculated consistently and that our estimates can be compared to other countries easily and transparently.

Using the rules established under the Framework for a guarantee of origin will mean companies can use existing data and measurement systems. It will also ensure that emissions reductions or increases from expanded hydrogen production can be easily assessed. And, it will make it easier for export markets to understand how emissions for the guarantee of origin were calculated, because the calculation will use internationally recognised rules.

The *Understanding concerns for safety, the environment and community impacts* paper discusses in detail how existing emissions regulations will apply to hydrogen production from fossil fuels. A guarantee of origin would provide an incentive for companies to go beyond compliance, by providing recognition of extra efforts.

Origin labelling could also play a role in ***future regulatory measures*** designed to drive hydrogen uptake. For example, if a jurisdiction introduced a requirement for a percentage of distributed natural gas to be replaced with hydrogen, a certificate of origin could act as the compliance unit, in a similar way to renewable energy certificates in the electricity market.

Regulation in destination markets may also drive Australian origin labelling. Destination markets may have regulations about acceptable emissions intensity of imports. Foreign customers and consumers may have preferences regarding emissions intensity and environmental impacts of production. Without transparent arrangements and mutual recognition, destination market regulation can act as a barrier to trade. Bilateral or multi-lateral arrangements may be required to ensure Australian guarantees of origin are recognised in destination markets.

Testing consumer and customer preferences

A Guarantee of Origin will need to grapple with the many different adjectives that are used in different communities, companies and countries to describe the environmental impacts of producing hydrogen. Some of these are listed in Table 3. All of those listed can incorporate a lifecycle emissions approach (see Box 1).

A Guarantee of Origin will need to recognise how consumers interpret and understand these definitions. While there has been some focus group work done on attitudes of individual Australian consumers to hydrogen production, questions remain about the detail. We know that Australian consumers have a preference for hydrogen from 'renewable energy', with some comfortable with carbon capture and storage as an interim technology, and another smaller group comfortable with it as a long-term solution.[9]

What is not known is whether consumers would prefer to make a binary purchasing choice (buying hydrogen that is zero emissions, or not) or whether they would choose based on relative levels of emissions (choosing between zero emissions, low emissions, emissions with an attached offset and high emissions). It is also unclear whether consumers care only about emissions from production, or emissions associated with the full lifecycle.

Similarly, while potential destination markets have indicated a preference for hydrogen without associated emissions, the exact details of this preference remain undefined. Potential acceptance in these markets of hydrogen with CCS or offsets is currently untested, as is a preference for lifecycle emission assessment or production-based emissions only. As well, these markets already have established environmental labelling schemes that may have significant consumer recognition (see Table 5). To avoid barriers to trade emerging, it will be important to resolve this point with destination markets in the very near future.

Testing may reveal significant differences between Australian consumer preferences and overseas customer preferences. Should this be the case, consideration may need to be given to a dual system or to two systems – one for domestic sales and one for exports. This could, however, increase costs of compliance.

Table 3: Different ways of describing hydrogen

Green or renewable	Generally used to describe hydrogen produced via electrolysis where the electricity comes from renewable sources. Note that the definition of 'renewable' can vary between countries, and that 'electricity from renewable sources' may include using a power purchase agreement rather than constructing dedicated renewable plants.
Carbon-free or zero-carbon	Silent on production pathway provided emissions are zero or close to zero.
Clean	Generally used to describe hydrogen with zero or minimal associated emissions. Requires agreeing a threshold for maximum allowable emissions. May allow offsets or CCS.
Blue	Hydrogen produced from natural gas with CCS. Emissions may vary depending on the amount of CO2 captured and stored
Brown	Usage varies. Sometimes used for hydrogen from any fossil fuel (regardless of carbon capture), sometimes used for hydrogen produced from brown coal.
Grey	Usage varies, but generally means hydrogen produced from a fossil fuel without carbon capture and storage
Yellow	Uncommon, but refers to hydrogen produced entirely from solar energy, whether via an electrolysis pathway or direct solar catalysis.
Purple	Not commonly used in Australia, refers to hydrogen produced via electrolysis where electricity comes from nuclear power. Would be emission-free but may raise other concerns in the community about the desirability of nuclear power

For both Australian and overseas markets, a guarantee of origin will need to consider whether to include a threshold for eligibility. Hydrogen whose emissions were above the threshold would not be eligible for certification. Table 4 shows emissions from different production processes, and how they compare to the most common method currently used (steam methane reforming). The Working Group seeks views on whether a threshold should be used, and what a reasonable level would be, noting the further consumer and destination market test will be required on this topic.

Table 4: possible thresholds for a guarantee of origin

Production technology	Emissions (kg CO2-e/kg hydrogen)	% reduction in emissions (relative to SMR without CCS)
Electrolysis – NEM average electricity[10]	54.6	-542% (increase in emissions)
Coal gasification, no CCS[11]	12.7 – 16.8	-49% — -98% (increase in emissions)
Quest project, Canada (SMR, partial CCS)[12]	6.5	24%
Steam methane reforming (SMR), no CCS[13]	8.5	--
CertifHy threshold for 'low-emissions'[14]	4.4	48%[15]
SMR + CCS – best case[16]	0.76	91%
Coal gasification + CCS – best case[17]	0.71	92%
Electrolysis – 100% renewable electricity	0	100%

The Hydrogen Working Group's view is that more work needs to be done to establish evidence around consumer and destination market preferences, to better inform a guarantee of origin. The Working Group seeks views and input from stakeholders to inform this knowledge base.

Governance

A final consideration is ***who makes and administers the rules*** for a guarantee of origin. One option would be an industry-developed and operated scheme. Industry ownership can reduce red tape and increase buy-in from participating companies. However, it may be viewed with some cynicism by consumers, and may not be satisfactory to potential overseas markets.

A second option is for government to develop and operate the scheme. Another alternative would be separating development and operation (for example, government develops and maintains the rules, in consultation with industry, and industry or a third party administers them).

Regardless of who administers a guarantee of origin, it will be important to strike a balance between stringency and efficiency. The more stringent the system of verification, the more confident consumers and customers can have in their purchase. However, a more onerous verification process could drive costs up and efficiency down, particularly if this goes beyond consumer and customer expectations. As well, an administrator would need to ensure systems for detecting and removing fraudulent certification, in order to maintain high confidence in the system.

Questions

The National Hydrogen Taskforce is seeking responses to the questions below. You can submit your comments via the Department of Industry, Innovation and Science's consultation Hub: https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers

1. *When should Australia aim to have a guarantee of origin in place? Why is this timing important?*

2. *What would be the best initial scope for a guarantee of origin? Why? Should there be two separate schemes for international and domestic requirements?*

3. *Beyond the University of Queensland report referenced above, and published hydrogen strategies from Japan and Korea, what intelligence on consumer and market preferences is available to inform an Australian guarantee of origin?*

4. *Should a guarantee of origin have an eligibility threshold? If yes, what should it be based on?*

5. *Who is the most appropriate body to develop and maintain criteria for a guarantee of origin and administer certification? Why?*

Table 5: Comparison of relevant labelling schemes

Scheme	Jurisdiction	Administered by	Scope	Label characteristics
CertifHy[18]	European Union	Private company - Hinico	Lifecycle emissions, hydrogen only	Two categories: green hydrogen (produced from renewable sources) and low-emissions hydrogen (able to demonstrate carbon intensity below 4.4 kg CO2-e / kg hydrogen)
Carbon Neutral[19]	Australia	Australian Government Department of the Environment and Energy	Lifecycle emissions, any product or service	Applicants must show that all emissions are abated or offset
GreenPower[20]	Australia	NSW Government	Scope 1 emissions, electricity	Electricity must be produced from defined renewable sources.
Eco-leaf[21]	Japan	Industry Association - Japan Environmental Management Association for Industry	Multiple environmental impacts, various products and services	Discloses grams of pollutant and energy per unit of product
CFP[22]	Japan	Industry Association - Japan Environmental Management Association for Industry	Lifecycle emissions various products and services	Discloses grams CO2-e per unit of product
CFP[23]	Korea	Government - Korea Environmental Industry and Technology Institute	Lifecycle emissions	Two categories: one that discloses CO2 produced per unit of product, and one that awards low-carbon status to products that produce less than the average CO2 per unit of product.

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[1] Lambert, V & Ashworth, P 2018, 'The Australian public's perception of hydrogen for energy', University of Queensland, Brisbane, p18.

[2] Ministry for Economy Trade and Industry 2019, 'The Strategic Road Map for Hydrogen and Fuel Cells', Government of Japan, viewed 23 May 2019, https://www.meti.go.jp/english/press/2019/pdf/0312_002a.pdf.

[3] Government of Korea, 2019, 'Hydrogen Economy Roadmap of Korea', internal translation.

[4] CertifHy 2019, 'CertifHy-SD Hydrogen Criteria', CertifHy, viewed 4 June 2019, https://www.certifhy.eu/images/media/files/CertifHy_2_deliverables/CertifHy_H2-criteria-definition_V1-1_2019-03-13_clean_endorsed.pdf.

[5] For example, CSIRO's Hydrogen Technology Roadmap, for example, gives a value for lifecycle emissions from hydrogen from fossil fuels of between 0.71 and 0.76 kgCO2-e/kg hydrogen, see Bruce, S, Temminghoff, M, Hayward, J, Schmidt, E, Munnings, C, Palfreyman, D & Hartley, P 2018, 'National hydrogen roadmap', CSIRO, p67.

[6] Department of the Environment and Energy, 'National carbon offset standard for products and services', https://www.environment.gov.au/system/files/resources/69279b0f-5056-4309-932c-dc9512c84769/files/ncos-products-and-services.pdf, viewed 4 June 2019.

[7] Bruce, S, Temminghoff, M, Hayward, J, Schmidt, E, Munnings, C, Palfreyman, D & Hartley, P 2018, 'National hydrogen roadmap', CSIRO, p67.

[8] Carbon capture and storage never results in complete abatement of emissions, because as with all gas handling, there is inevitable leakage at all stages of the process. These emissions would be considered Scope 3 for a hydrogen production plant, because they occur outside the facility.

[9] Lambert, V & Ashworth, P 2018, 'The Australian public's perception of hydrogen for energy', University of Queensland, Brisbane, p18.

[10] Working Group calculation, based on 50% losses converting electrical energy to hydrogen energy, energy content of hydrogen of 33.31 kWh/kg or 120 MJ/kg, requiring 66.63 kWh/kg produced, at a NEM average of 0.82 kg CO2 / kWh (see Department of the Environment and Energy 2018, 'National greenhouse accounts factors', https://www.environment.gov.au/system/files/resources/80f603e7-175b-4f97-8a9b-2d207f46594a/files/national-greenhouse-accounts-factors-july-2018.pdf, accessed 6 June 2019.

[11] CSIRO calculation based on Burgt, M.v.d. & Higman, C. 2011, *Gasification*, 2nd edn, Elsevier Science & Technology, Oxford.

[12] Massachusetts Institute of Technology 2016, 'Quest fact sheet: Carbon dioxide capture and storage project', https://sequestration.mit.edu/tools/projects/quest.html, viewed 6 June 2019.

[13] Office of Air and Radiation, 2008, 'Technical support document for hydrogen production: proposed rule for mandatory reporting of greenhouse gases', US Environmental Protection Authority, viewed 12 May 2019,

https://www.epa.gov/sites/production/files/2015-02/documents/subpartp-tsd_hydrogenproduction.pdf

[14] CertifHy 2019, 'CertifHy-SD Hydrogen Criteria', CertifHy, viewed 4 June 2019, https://www.certifhy.eu/images/media/files/CertifHy_2_deliverables/CertifHy_H2-criteria-definition_V1-1_2019-03-13_clean_endorsed.pdf.

[15] Note this is a 50% reduction against CertifHy's benchmark, which is not the same as the value for SMR quoted in Table 4. We have shown all values in Table 4 against the same SMR benchmark for ease of comparison

[16] Bruce, S, Temminghoff, M, Hayward, J, Schmidt, E, Munnings, C, Palfreyman, D & Hartley, P 2018, 'National hydrogen roadmap', CSIRO, p67

[17] Bruce, S, Temminghoff, M, Hayward, J, Schmidt, E, Munnings, C, Palfreyman, D & Hartley, P 2018, 'National hydrogen roadmap', CSIRO, p67

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[20] GreenPower, 2018, 'About us', NSW Government, viewed 23 April 2019, https://www.greenpower.gov.au/About-Us/.

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[22] Asia Carbon Footprint Network, 2017, 'Information paper: carbon footprinting and labelling in Japan', viewed 23 April 2019, http://acfnetwork.net/wp-content/uploads/2017/10/Information-Paper_Japan.pdf.

[23] Carbon Footprint International, 2019, 'Republic of Korea: CFP labelling system', viewed 23 April 2019, http://www.carbonfootprintinternational.com/republic-of-korea/.