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Brown Coal, Greenwash

The true emissions impact of the Hydrogen Energy Supply Chain Project

The Hydrogen Energy Supply Chain (HESC) Project uses brown coal gasification, the most polluting method possible, to make hydrogen.

Despite being labelled as 'clean energy', none of the emissions HESC has produced in its pilot phase have been buried through Carbon Capture and Storage.

Contrary to claims that HESC will reduce emissions by 1.8 million tonnes (Mt) per year when at full production, the project will instead likely increase emissions by up to 3.8 Mt per year.

Discussion paper

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April 2022

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ISSN: 1836-9014

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Summary

The Hydrogen Energy Supply Chain (HESC) project produces hydrogen from brown coal gasification for export to Japan. The project is led by an industry consortium with support from state and federal governments.

Gasification of brown coal is the most emissions-intensive way of producing hydrogen. Approximately 35 per cent of the energy from brown coal is lost in the conversion to hydrogen, meaning hydrogen produced with brown coal is far more emissions-intensive than simply burning coal itself as a fuel.

Despite this, the project is presented as 'clean' and as though it will reduce emissions on the basis that in the commercialisation phase carbon dioxide from the project would be captured and stored using carbon capture and storage (CCS). The federal government defines 'clean hydrogen' as hydrogen produced using renewable energy or using fossil fuels with substantial CCS.

The HESC consortium claims that the project will reduce emissions by 1.8 million tonnes per year, the equivalent of removing 350,000 petrol cars from the road. Freedom of Information (FOI) documents show that the claim is untrue, despite the fact that it has been repeated by the Australian Government and media a number of times.

The claim is based on the misleading comparison between the theoretical emissions best-case scenario for hydrogen made from brown coal gasification *with* CCS, with hydrogen made from fossil gas *without* CCS.

The problem is twofold. Firstly, the consortium has not invested any money in CCS for the HESC project but is relying on a separate project called CarbonNet. CarbonNet is a public commercial-scale CCS project being developed entirely separately to HESC. It is not part of the HESC project, it has no private investors and has not even reached a pilot phase. It is entirely possible that the HESC project will proceed without CCS and remain a coal gasification hydrogen export project, an extremely polluting form of energy production.

The challenges facing the CarbonNet project are considerable. The history of CCS projects is that they are expensive, complicated and rarely successful. Australia's only serious attempt at CCS, the Gorgon CCS project, has failed to reach full operation. There are no coal gasification projects in the world with CCS, yet the project proponent claims assume an almost perfect level of carbon capture of 90 per cent.

For the pilot phase, HESC offset its emissions, which is itself a controversial process. In addition, the carbon credits used by the HESC project were from a 'Human Induced

Regeneration' carbon credit method that has recently been found to have no integrity. While the federal government's current definition of 'clean hydrogen' does not include offset emissions, it is consulting stakeholders on whether the definition should be expanded to include fossil hydrogen that has been 'offset'. A number of fossil fuel producers support this expansion of the definition.

Secondly, while it would be reasonable to assume that the HESC project will displace hydrogen made from fossil gas without CCS, this is not the case. The HESC consortium anticipates that the HESC project will tap into a new market for hydrogen and will be looking to compete with other energy sources and hydrogen sources.

When compared to the equivalent production of renewable hydrogen, which is a zero-emissions production process for hydrogen, the HESC project (without CCS) would *add* between 2.9 and 3.8 million tonnes of CO_2 emissions, the equivalent to adding 550,000-735,000 petrol cars to the road. If full CCS for HESC cannot be achieved at the outset, the HESC project will result in increased emissions from day one of operation.

Given the willingness of the HESC consortium and supporting governments to proceed with the project despite the expense and the sheer level of risk and uncertainty, it appears likely that the real purpose of HESC is to find a new market for Victoria's brown coal reserves as Victoria's brown coal power stations close. The likely result is that the HESC project will raise emissions and put Australia further behind on its path to reach net zero emissions by 2050.

Introduction

As Victoria's highly polluting brown coal power stations close, proponents are looking for new markets for brown coal. [1] However, brown coal has a high water content and can spontaneously combust when dry, making it ill-suited for export.

Previous attempts to export brown coal with new technology or turn it into fertiliser have failed. [2] [3] Similarly, when brown coal power stations closed in South Australia in 2014, a highly polluting underground coal gasification project was proposed in an attempt to find an ongoing market for brown coal. [4] The controversial process has been banned in Queensland after a disastrous contamination incident occurred due to the self-proclaimed 'clean energy' project.[5]

Brown coal is the most emissions-intensive form of coal. Because building new projects with such an emissions-intensive resource is unacceptable given its climate impact, proponents are increasingly attempting to reinvent the energy source. This idea has found a new home with the production of hydrogen.

Hydrogen can be made from either renewable energy or fossil fuels. It is made from renewable energy by splitting water into hydrogen and oxygen using a process called electrolysis. If the electricity for electrolysis is supplied by renewable energy it has no direct emissions.[6]

The two main ways hydrogen can be made from fossil fuels are from fossil gas using a process called steam reforming methane (SMR) or using coal gasification. Both coal

[1] Whittaker (March 2021) Energy Australia to close Yallourn power station early and build 350 megawatt battery, https://www.abc.net.au/news/2021-03-10/yallourn-power-station-early-closure/13233274

[2] Fyfe (2009) Green fury at plans to sell brown coal to India, https://www.smh.com.au/environment/green-fury-at-plans-to-sell-brown-coal-to-india-20090912-fljn.html

[3] Hopkins (2009), $2bn fertiliser plant for Latrobe Valley https://www.smh.com.au/business/2bn-fertiliser-plant-for-latrobe-valley-20080602-2kwp.html

[4] Government of South Australia, Department of Energy and Mining- Energy Resources (2022) Leigh Creek Energy in-situ gasification, https://www.petroleum.sa.gov.au/regulation/projects-of-public-interest/leigh-creek-in-situ-gasification

[5] Martin (May 2019) Underground coal gasification technology, banned in Queensland, holds hope for Leigh Creek, https://www.abc.net.au/news/2019-05-08/controversial-coal-gas-ucg-tech-holds-hope-for-sa-town/11086634

[6] IPCC (2018) AR4, WG1, Chapter 2 Changes in Atmospheric Constituents and in Radiative Forcing, p.21, https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf. Pearman (2020) *Don't rush into a hydrogen economy until we know all the risks to our climate* https://theconversation.com/dont-rush-into-a-hydrogen-economy-until-we-know-all-the-risks-to-our-climate-140433. Note hydrogen can have an indirect effect on the atmosphere by impacting other greenhouse gases.

gasification and SMR are highly emissions-intensive. Coal gasification is more emissions-intensive than steam reforming methane.

Furthermore, because much of the energy from whichever source is used to make hydrogen is lost in the conversion process, it will always be more emissions-intensive to use hydrogen from coal or gas as an energy source than just using coal or gas for fuel directly.

Proponents of COAL GASIFICATION and SMR often claim their projects will provide 'clean energy' and reduce emissions by claiming that the emissions will be captured and stored using carbon capture and storage (CCS). In practice no COAL GASIFICATION projects with CCS exist anywhere in the world, and the two SMR projects that claim to use CCS are very small and neither reduce emissions.[7][8] [9]

However, this hasn't stopped the growth of the fossil fuel-based hydrogen industry. The Australian Government has assisted the industry through the invention of a new term: "clean hydrogen". The National Hydrogen Strategy defines clean hydrogen as "renewable hydrogen or fossil fuel hydrogen with the use of CCS".[10]

This terminology allows fossil fuel-based hydrogen projects, including brown coal hydrogen production, to claim their fossil fuel product is clean (as long as it is coupled with a promise to bury emissions) and justify its ongoing use in a low carbon economy.

The Federal Minister for Resources, Matt Canavan, articulated this concept by claiming that that brown coal hydrogen "has the opportunity to develop an alternative and value-adding use of its abundant brown coal reserves in the Latrobe Valley…. with commercial scale operations required to use carbon capture and storage to ensure a low emission source of hydrogen."[11]

WHAT IS HESC?

Hydrogen Energy Supply Chain (HESC) is a project to export hydrogen produced from brown coal (also known as lignite) gasification from Victoria's Latrobe Valley to Kobe, Japan.

[7] Global CCS Institute (2021) The Global Status of CCS), https://www.globalccsinstitute.com/resources/global-status-report/

[8] Air Products (n.d.) *Megaprojects Around the World*, https://www.airproducts.com/company/innovation/megaproject-expertise

[9] Global Witness (January 2022) Hydrogen's Hidden Emissions, Shell's misleading climate claims for its Canadian fossil hydrogen project, https://www.globalwitness.org/en/campaigns/fossil-gas/shell-hydrogen-true-emissions/

[10] Department of Industry, Science, Energy and Resources (2019) *Australia's National Hydrogen Strategy*, https://www.industry.gov.au/data-and-publications/australias-national-hydrogen-strategy

[11] Canavan (2019) *Landmark pilot hydrogen project underway*, https://www.mattcanavan.com.au/landmark_pilot_hydrogen_project_underway

It is operated by a consortium of companies including Kawasaki Heavy Industries, Ltd (KHI), Electric Power Development Co., Ltd. (J-POWER), Iwatani Corporation (Iwatani), Marubeni Corporation (Marubeni), AGL Energy (AGL) and Sumitomo Corporation (Sumitomo). Royal Dutch Shell (Shell), ENEOS Corporation and Kawasaki Kisen Kaisha, Ltd. (K-Line) are also involved in the Japanese portion of the project.[12]

The project aims to produce 225,000 tonnes of liquid hydrogen annually from a coal gasification plant located at AGL's Loy Yang A coal power station.

The initial pilot project included the construction of the coal gasification facility, hydrogen liquefaction facilities at the Port of Hastings in Victoria and the commissioning of one of the world's first dedicated vessels for hydrogen transport. It is estimated to cost $500 million of which $57.5 million has been provided by Australian taxpayers[13] and $50 million from Victoria.[14] Up until the development of the National Hydrogen Strategy in 2019, HESC was the most heavily subsidised hydrogen project in the country.

Its first stage was the recently completed pilot project which produced 1 tonne of hydrogen using brown coal gasification. The project purchased a further 1.6 tonnes of fossil gas hydrogen to ensure sufficient hydrogen for loading. The hydrogen was trucked from the Latrobe Valley to the Port of Hastings where it was loaded onto a transport vessel, the Suiso Frontier which has capacity for around 88 tonnes of liquid hydrogen and left Australia for Kobe, Japan on January 21, 2022. [15]

The emissions were not captured or stored with CCS. The project was never going to use CCS during the pilot, but the consortium claims it will during the commercial phase.

CARBONNET

HESC claims that if it proceeds to commercialisation, it intends to utilise the CarbonNet CCS project – a project which aims to store CO_2 in geological formations in the Bass Strait off the Victorian coast (if the project proceeds). CarbonNet has received $150 million in funding

[12] HESC website, https://www.hydrogenenergysupplychain.com/about-hesc/

[13] The Hon Angus Taylor MP (21 January 2022) Hydrogen industry marks milestone with first shipment of liquid hydrogen to Japan, https://www.minister.industry.gov.au/ministers/taylor/media-releases/hydrogen-industry-marks-milestone-first-shipment-liquid-hydrogen-japan

[14] CSIRO (January 26, 2022) Hydrogen Energy Supply Chain – Pilot Project, https://research.csiro.au/hyresource/hydrogen-energy-supply-chain-pilot-project/

[15] Mazengard (February 2020) Australia's first "milestone" hydrogen shipment carried just one tonne of "clean" hydrogen, https://reneweconomy.com.au/australias-first-milestone-hydrogen-shipment-carried-just-one-tonne-of-clean-hydrogen-2/

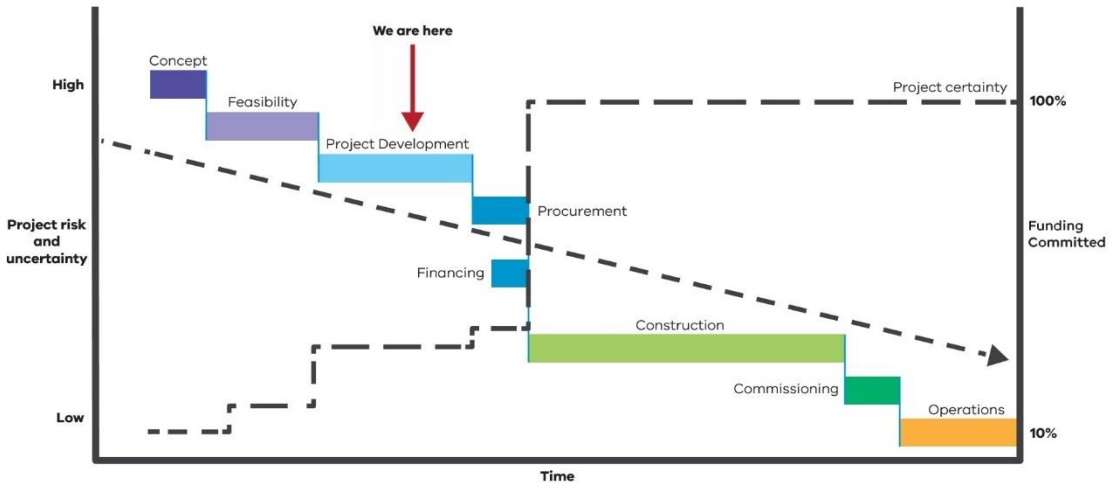
from the Victorian and Commonwealth Governments and is managed by the Victorian State Government. [16] [17]

It is important to note that CarbonNet is a separate project to HESC. This means that HESC can proceed without making any provision of its own project for CCS, and still label it 'clean' based on an unenforceable promise that the emissions will be sequestered by another project. If the CarbonNet project does not proceed, HESC can continue to export hydrogen from brown coal gasification without CCS.

Despite benefiting from around $150 million in subsidies from the Australian and Victorian Governments to date, the CarbonNet project has not attracted any private sector funding and the Victorian Government does not expect the project to be operational before 2030 if it goes ahead at all.[18]

As shown in Figure 1, the Victorian Government still regards the CarbonNet CCS project risk as high. The dotted line in heading diagonally downward from left to right is the level of project risk and uncertainty marked on the left vertical axis. At the current project stage marked by the red arrow, the level of risk and uncertainty is closer to high than low, suggesting the project is more likely to fail than ever operate.

Figure 1: CarbonNet stages diagram



Source: Victorian Government, Earth Resources, The CarbonNet Project, About the Project, https://earthresources.vic.gov.au/projects/carbonnet-project/about-the-project

[16] Victorian Government, Earth Resources (2022) The CarbonNet Project, About the Project, https://earthresources.vic.gov.au/projects/carbonnet-project/about-the-project#:~:text=The%20CarbonNet%20Project%20aims%20to,storage%20sites%20in%20Bass%20Strait.

[17] Victorian Department of Primary Industries (September 2012) The CarbonNet Project, https://www.globalccsinstitute.com/archive/hub/publications/50856/carbonnet-corporate-brochure.pdf

[18] Victorian Government, Earth Resources, The CarbonNet Project, About the Project, https://earthresources.vic.gov.au/projects/carbonnet-project/about-the-project

Even this is optimistic. The record of CCS projects is one of near total failure in Australia and globally.[19]

Clean hydrogen is a reinvention of the concept 'clean coal'. Despite decades of development and billions in subsidies, there are no 'clean coal' projects that capture emissions from coal power stations in Australia. Globally only one million tonnes per year have been captured from a coal power station in Canada.[20] Somewhat perversely, the emissions captured from that Canadian station are then sold to an oil company for enhanced oil recovery (EOR) to increase oil production, which in turn increases emissions when the oil is burned.

Three quarters of the projects that the peak global CCS lobby group, The Global CCS Institute, refers to as CCS are in fact EOR projects. One of the few, and by far the largest dedicated CCS project operating in the world, Chevron's carbon injection project at Barrow Island in Western Australia has been beset by faults and delays and still only operates at half its capacity. [21] [22]

'CLEAN' HYDROGEN INCREASES EMISSIONS

According to the Global CCS Institute, there are only two projects in the world that claim to be hydrogen production with CCS. They both produce hydrogen with fossil gas (that is through SMR).[23]

The first project is Air Products Steam Methane Reformer in the United States that captures one million tonnes per annum (mtpa).[24] However, the project uses the CO_2 it captures for enhanced oil recovery (EOR), which as discussed can result in net increase in emissions when the emissions from the additional oil are taken into account. This could not be considered to be "taking cars off the road" in terms of equivalent emissions, but rather adding cars instead.

[19] Readfearn (2021) *Australia's only working carbon capture and storage project fails to meet target*, https://www.theguardian.com/australia-news/2021/nov/12/australias-only-working-carbon-capture-and-storage-project-fails-to-meet-target

[20] MIT (2016) Boundary Dam Fact Sheet: Carbon Dioxide Capture and Storage Project, http://sequestration.mit.edu/tools/projects/boundary_dam.html

[21] Swann (2018) Gorgan-tuan Problem, https://australiainstitute.org.au/report/gorgon-tuan-problem/

[22] Lewis (February 2022) Chevron's flagship Gorgon CCS project still failing to live up to expectations, https://www.upstreamonline.com/energy-transition/chevrons-flagship-gorgon-ccs-project-still-failing-to-live-up-to-expectations/2-1-1166185

[23] Global CCS Institute (2021) The Global Status of CCS), https://www.globalccsinstitute.com/resources/global-status-report/

[24] Air Products (n.d.) *Megaprojects Around the World*, https://www.airproducts.com/company/innovation/megaproject-expertise

The other ‘clean hydrogen’ project is Quest in Alberta, Canada, which claims to sequester 1.2 mtpa. However, this project only captures 48 per cent of its emissions and a recent analysis found the project creates significantly more emissions than it sequesters.[25]

[25] Global Witness (January 2022) Hydrogen's Hidden Emissions, Shell’s misleading climate claims for its Canadian fossil hydrogen project, https://www.globalwitness.org/en/campaigns/fossil-gas/shell-hydrogen-true-emissions/

The claimed emissions of the HESC project

Not only is coal gasification the most emissions-intensive way of producing hydrogen, but it is also far more emissions-intensive than simply burning coal to produce the same amount of energy.

Although hydrogen can be burned as a fuel, it is not a source of energy. It needs to be made from other sources of energy including directly from fossil fuels or from electricity by splitting water into hydrogen and oxygen through a process known as electrolysis. If it is made from electricity, that electricity can be supplied from renewable energy which has no direct emissions.[26]

Hydrogen is made using fossil fuels as a feedstock by separating the hydrogen from the carbon in the coal and gas. These processes are very emissions-intensive.

Around three quarters of hydrogen produced globally is made from fossil gas using a process called steam methane reforming (SMR). 23 per cent is made from coal using a process called coal gasification with oil and electricity making up the remaining 2 per cent.[27]

The process of separating hydrogen from black coal using coal gasification produces around 157 kg of emissions for every gigajoule (GJ) of energy embodied in the hydrogen (157 kg CO2e/ GJ) compared around 74 kg CO2e/GJ for hydrogen made from fossil gas with SMR. This is more than twice as emissions-intensive as SMR, and coal gasification from brown coal is more emissions-intensive again producing around 170 kg CO2e/ GJ.[28] These 'process emissions' are the result of the chemical processes of separating hydrogen from the carbon in coal and gas. In addition to the process emissions, both SMR and coal gasification create significant 'direct emissions' from burning coal and gas for energy in the form of heat drive the chemical processes.

[26] However, hydrogen is an indirect greenhouse gas if it leaks to the atmosphere, Warrick et al (April 2022) Atmospheric implications of increased Hydrogen use, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067144/atmospheric-implications-of-increased-hydrogen-use.pdf, reported: Collins (April 2022) Hydrogen 'twice as powerful a greenhouse gas as previously thought': UK government study, https://www.rechargenews.com/energy-transition/hydrogen-twice-as-powerful-a-greenhouse-gas-as-previously-thought-uk-government-study/2-1-1200115

[27] IEA (2019) The Future of Hydrogen, p.38, https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf

[28] Longden, Beck, Jotzo, Andrews, Prasad (2021) ''Clean' hydrogen? An analysis of the emissions and costs of fossil fuel based versus renewable electricity based hydrogen', *CCEP Working Paper 21-03 March 2021*

Figure 2 below shows Australian National University (ANU) analysis comparing the full lifecycle emissions of these processes.

It shows the relative lifecycle emissions from various ways of producing fossil hydrogen. It also compares the emissions from hydrogen produced by fossil fuels with emissions from burning the fuel directly to produce the same amount of energy.

Using hydrogen from brown coal is 70 per cent more emissions-intensive than simply using brown coal to produce the equivalent amount of energy. Brown coal cannot be exported because it can instantaneously combust under certain conditions, but hydrogen is also around 60-70 per cent more emissions-intensive than burning black coal and almost three times as emissions-intensive as gas, both of which can be and are exported to Japan. These figures do not include the emissions from shipping coal, gas or hydrogen overseas, or the emissions from liquefying gas or hydrogen to enable their export.

Even with a theoretical best case using CCS for brown coal, the emissions are significant, almost half those of black coal, and two thirds the emissions of gas.

Figure 2: Lifecycle emissions intensity of different fuels

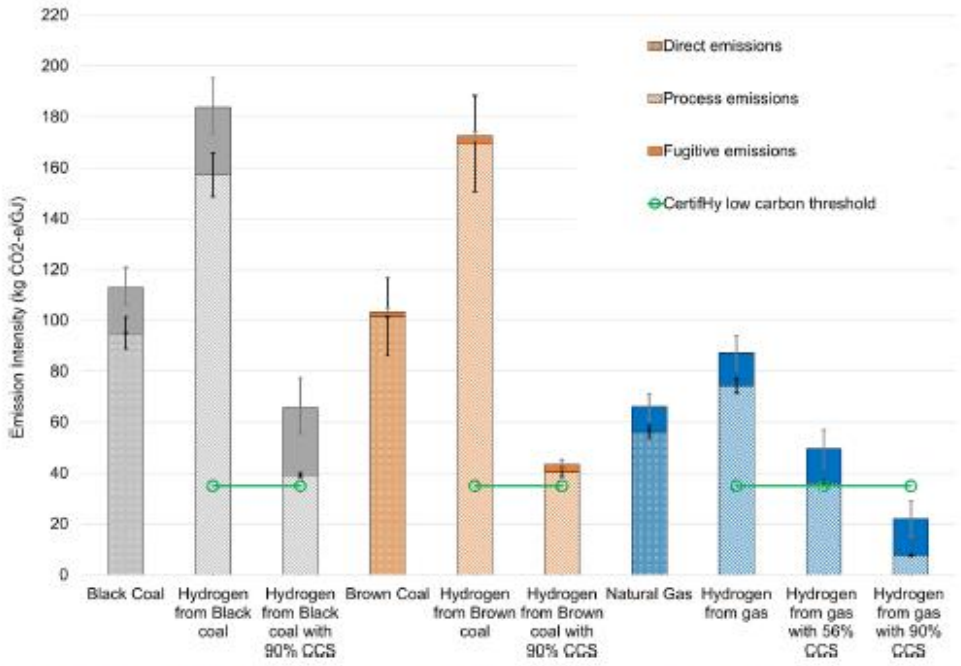
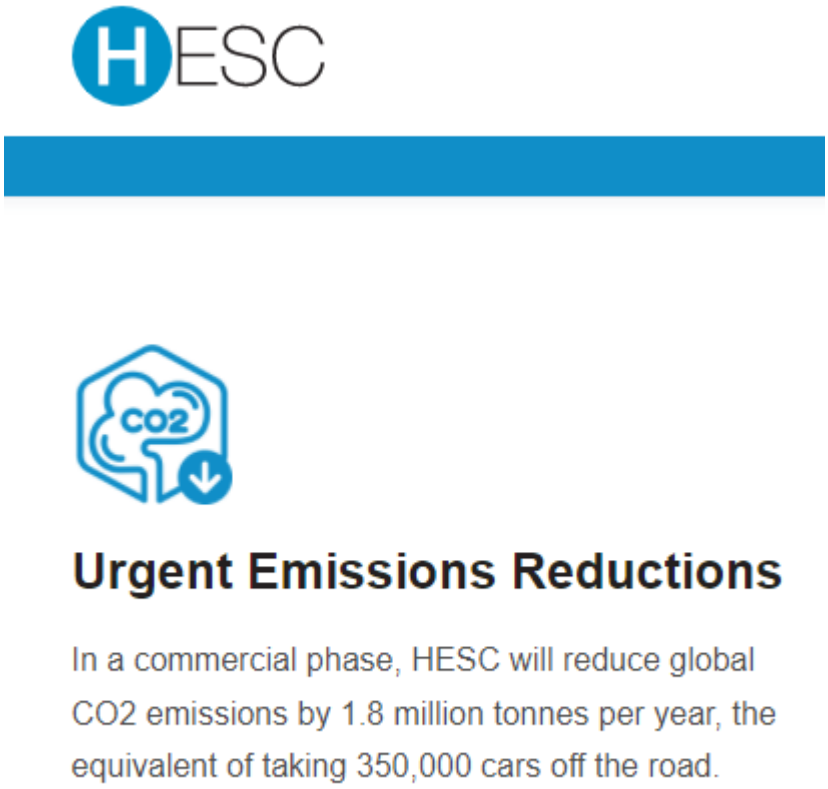


Fig. 1. Total emissions intensity of different fuels, including direct emissions from the combustion of brown/black coal and natural gas, process emissions associated with the production of hydrogen from these fossil fuels, and fugitive emissions from fossil fuel extraction. Emissions factors are taken from IPCC default data tables [41]. The error bars for direct and process emissions show the variation in emissions that occurs due to natural differences in the carbon content of fossil fuels. The error bars for fugitive emissions show the low and high values provided by the IPCC to account for global variations in fugitive emissions. Emissions from hydrogen production are also compared to the CertifHy low carbon threshold, which is defined as a 60% reduction in emission intensity below a standard steam methane reforming (SMR) production process.

HESC'S EMISSIONS CLAIMS

Despite coal gasification being the most emissions-intensive form of producing hydrogen and far more emissions-intensive than burning coal directly, the HESC consortium refers to the project as "clean liquid hydrogen" and claims it will reduce emissions by 1.8 million tonnes per year, the equivalent to taking 350,000 petrol engine cars off the road.[29]

Figure 3: HESC emissions reduction claim



Source: HSEC website, Sustainability, https://www.hydrogenenergysupplychain.com/community-and-sustainability/

Australia's Minister for Industry, Energy and Emissions Reduction, Angus Taylor repeated these claims in January this year.

> It is estimated the 225,000 tonnes of carbon neutral liquefied hydrogen (LH2) produced by HESC in a commercial phase will help reduce global emissions by

[29] HSEC website, Sustainability, https://www.hydrogenenergysupplychain.com/community-and-sustainability/

> around 1.8 million tonnes per year, or the equivalent of emissions from 350,000 petrol cars.[30]

Documents acquired under Freedom of Information (FOI) show that when the Minister Taylor's department (Department of Industry, Science, Energy and Resources, DISER) was asked about the basis of these claims by a journalist, the Department asked HESC to explain the figures to them.

HESC responded that they had compared the emissions from the HESC project using a CSIRO emissions factor for coal gasification for CCS, with emissions from hydrogen using SRM. [31] Put simply, HESC subtracted the amount of emissions from hydrogen produced by coal gasification *with* CCS under a theoretical best case (as CCS for coal gasification does not exist) from the amount of emissions that would be created by fossil gas hydrogen from SMR *without* CCS.

Using this highly selective comparison, HESC claimed, when operating at full capacity, the project would result in 1.8 million tonnes per year less than hydrogen produced by SMR *without* CCS. An explanation of the calculations for the project are shown in an excerpt of correspondence between DISER and the HESC consortium representative from the FOI document in Figure 3 below.

[30] The Hon Angus Taylor MP (21 January 2021) Hydrogen industry marks milestone with first shipment of liquid hydrogen to Japan, https://www.minister.industry.gov.au/ministers/taylor/media-releases/hydrogen-industry-marks-milestone-first-shipment-liquid-hydrogen-japan

[31] The 0.71 kg CO2/ kg H2 is for "best case coal gasification with CCS" CSIRO (2018) National Hydrogen Roadmap, Appendix A p.67, https://www.csiro.au/-/media/Do-Business/Files/Futures/18-00314_EN_NationalHydrogenRoadmap_WEB_180823.pdf

Figure 4: FOI-DISER- correspondence regarding Minister Taylor's HESC emissions reduction claim.

DISER - Released under the FOI Act LEX 70496 - Document 1

The hydrogen and HESC teams have provided the following information. Please note, the CoxInall PR man for HESC has now received the same query from the same journalist. So could you copy any response to us, and we'll make sure he sees what you send back.

The estimate on emissions saved is from the HESC project. The following lines explain how they came up with the estimate, based on IEA and CSIRO estimates and data in the National Hydrogen Strategy.

The estimation has been calculated as follows:

Most of the hydrogen produced today is via steam methane reforming (SMR) with no CCS. Data in Australia's National Hydrogen Strategy reports that this produces around 8.5 tonne[4] of CO_2 per tonne of hydrogen.

CSIRO data states that coal gasification with CCS produces around 0.71 tonne of CO_2 per tonne of hydrogen[5].

Therefore, the HESC Project could save 1.8 million tonnes of CO_2 per year. (8.5 minus 0.71 multiplied by 225,000).

Regards,

s22 .

Source: DISER FOI Disclosure Log, 22/012/70496, https://www.industry.gov.au/about-us/freedom-of-information/freedom-of-information-disclosure-log-2022

The HESC representative justifies the comparison of coal gasification hydrogen *with* CCS to SMR hydrogen *without* CCS by saying that "most hydrogen produced today is produced with steam reforming methane (SMR) without CCS".

It is true that most hydrogen produced today is produced with SMR, but the HESC is not aiming to displace hydrogen produced this way (therefore theoretically displacing the emissions from this process).

Because hydrogen from the project is being exported it will not be replacing SMR hydrogen produced in Australia for domestic use, and because Australia currently doesn't export *any* hydrogen, it is not displacing existing SMR hydrogen exports. Nor is it likely that HESC hydrogen displace SMR hydrogen produced in customer countries as around 70 per cent of the energy used to make hydrogen is lost in conversion and transport making it almost certainly far more expensive than SMR hydrogen produced domestically in customer countries.

If the purpose of 'clean hydrogen' exports is to provide energy with lower emissions than current energy sources in customer countries, then HESC should be compared to other forms of so called 'clean hydrogen'. These include SMR hydrogen *with* (theoretical) CCS, or hydrogen produced with electrolysis from renewable energy.

COMPARING HESC TO SMR WITH (THEORETICAL) CCS

As discussed above, there are no coal gasification or SMR hydrogen projects with CCS projects that genuinely reduce emissions. However, a theoretical comparison of the emissions from these technologies using emissions factors used by the Australian Government can be made.

The emissions intensity figures from the National Hydrogen Strategy measure emissions per kilogram of hydrogen produced rather than per unit of energy (gigajoule) in the ANU analysis shown in Figure 4 above and are based on different assumptions. Here the National Hydrogen Strategy figures can be used to enable a consistent comparison with the emissions reduction claims of the HESC project.

As shown in Figure 5 below, the National Hydrogen Strategy uses an emissions intensity factor of 0.71 kg CO2/kgH2 which is in turn from the CSIRO's National Hydrogen Roadmap.[32]

Figure 5: Australian Government estimates of emissions intensity of various methods of hydrogen production

Emissions intensity of production

Production technology	Emissions (kg CO_{2-e}/kg hydrogen)[vi]
Electrolysis – Australian grid electricity[vii]	40.5
Electrolysis – 100% renewable electricity	0
Coal gasification, no CCS[viii]	12.7 – 16.8
Coal gasification + CCS – best case[ix]	0.71
Steam methane reforming (SMR), no CCS[x]	8.5
SMR + CCS – best case[xi]	0.76

Source: COAG Energy Council (2019) Australia's National Hydrogen Strategy, p.xiv, https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf

This factor is entirely theoretical because no coal gasification hydrogen project in the world has CCS. It is for an unspecified "best case" project. There is no way of knowing what the "best case" is because the reference in CSIRO's National Hydrogen Roadmap refer to an "internal CSIRO calculation".[33] This means that there is no indication of key assumptions such as how much of the emissions are assumed to be captured. The CSIRO is at odds with

[32] Bruce S, Temminghoff M, Hayward J, Schmidt E, Munnings C, Palfreyman D, Hartley P (2018) National Hydrogen Roadmap. CSIRO, Australia, file:///C:/Users/Mark/Downloads/18-00314_EN_NationalHydrogenRoadmap_WEB_180823%20(7).pdf

[33] Ibid. p.67.

other research including from the ANU which uses an emissions factor around four times higher than that used in the National Hydrogen Strategy.[34]

However, taking the CSIRO National Hydrogen Strategy emissions intensity factors at face value, the emissions for coal gasification *with* CCS are only 0.05 Kg CO2/KgH2 or 7 per cent less emissions-intensive than SMR *with* CCS.

Under this comparison, the HESC project would reduce emissions by 11,250 tonnes of CO_2, making the 1.8 million tonnes claim a 160-fold overstatement. This is shown in Table 1 below.

[34] Longden et al (2021) '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_1.pdf

The real emissions of HESC

Given hydrogen coal gasification and SMR with CCS are still not operating commercially, the most relevant comparison is of the HESC project's emissions with renewable hydrogen, which has no direct emissions.

Under this comparison, using emissions factors from the National Hydrogen Strategy, the HESC project would add between 2.9 -3.8 Mt CO_2 to the atmosphere each year, equivalent to adding 550,000- 735,000 cars to the road annually.

Table 1: Comparison of emissions from various hydrogen production methods

Method of producing hydrogen	Emissions factor	Emissions for 225,000 tonnes of hydrogen	Car equivalent [35]
	Kg CO2/ Kg H2	Tonnes per year	Cars
Coal gasification without CCS	12.8- 16.8	2,857,500- 3,780,000	556,000-735,000
Coal gasification with CCS	0.71	159,750	372,000
SMR with CCS	0.76	171,000	33,250
SMR without CCS	8.5	1,912,500	371,875
Renewable hydrogen	0	0	0

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[35] Car equivalents have been calculated using the same emissions per car used by HESC to claim that reducing 1.8 million tonnes of emissions is equivalent to taking 350,000 petrol cars off the road.

Offsets

Despite not capturing or storing the emissions from its pilot phase with CCS, the HESC proponents maintained their claim of 'clean hydrogen' by offsetting the emissions from its pilot shipment.

> The HESC Project has entered into an arrangement with South Pole to invest in Australian Carbon Credit Units (ACCUs). ACCUs are issued by the Clean Energy Regulator. The units HESC has purchased are contributing to a 'human induced' vegetation regeneration initiative in rural Australia: the Boobera Carbon Project in Queensland. This is fully offsetting the emissions from the HESC Pilot project, ensuring the project can support a low-carbon future in Australia from its pilot phase.[36]

There are serious concerns about the integrity of Australian Carbon Credit Units (ACCUs). The former chair of the Australian Government committee that oversees the integrity of projects for which ACCUs are issued has become a whistleblower, alleging that up to 80 per cent of ACCUs lack integrity and are effectively a "rort".[37] This includes the 'human induced' vegetation regeneration method which underpins the credits purchased by HECS.

Even if the offsets purchased by HESC genuinely sequester emissions, it is not equivalent to avoiding emissions from coal gasification being released to the atmosphere in the first place.

Carbon released to the atmosphere as part of the gasification process would otherwise have been permanently stored underground. Sequestration in vegetation only occurs over decades, meaning it does not mitigate the emissions in the short term, so critical for avoiding climate tipping points. Sequestration from vegetation is high risk and highly uncertain bringing into question the permanence of land-based sequestration.[38]

Using carbon credits to offset hydrogen production emissions is not included in the 'clean hydrogen' definition under the National Hydrogen Strategy, meaning that the hydrogen produced with the HESC pilot cannot be described as 'clean'. This definition is currently being reviewed by the federal government. If it is decided that carbon credits cannot be

[36] HESC website, https://www.hydrogenenergysupplychain.com/community-and-sustainability/

[37] Long (March 2022), Insider blows whistle on Australia's greenhouse gas reduction schemes https://www.abc.net.au/news/2022-03-24/insider-blows-whistle-on-greenhouse-gas-reduction-schemes/100933186

[38] Foley (November 2021) CSIRO study proves climate change driving Australia's 800% boom in bushfires, https://www.smh.com.au/politics/federal/csiro-study-proves-climate-change-driving-australia-s-800-per cent-boom-in-bushfires-20211126-p59cgr.html

used to offset the emissions from the HESC project, then the HESC proponents must find a CCS project to partner with or stop referring to its product as 'clean hydrogen'.

In a submission to the Australian Government's Hydrogen Guarantee of Origin scheme, the HESC project partners' views on non-CCS offsets were described as "ambivalent" and suggested the scheme should "not support hydrogen production pathways that use fossil fuels without CCS," but that non-CCS offsets could be used for a "small proportion" of total emissions.

> The Project Partners are ambivalent on whether non-CCS offsets (e.g., land use offsets) should be included in the scheme but believe that they should only be used to offset any remaining post-CCS emissions. While preferences for offsets may vary amongst international customers, the scheme should not support hydrogen production pathways that use fossil fuels without CCS. One option could be to limit the use of non-CCS offsets to a small portion of a production pathway's total emissions (e.g., the materiality threshold in Q29). This would reduce their potential to create additional demand for ACCUs, as the bulk of the heavy lifting would be done through the surrender of siloed CCS ACCUs.[39]

However, the HESC consortium has not invested any money themselves in CCS for the project and are relying on an entirely public-funded CCS project with no private investors. The operators of the CarbonNet scheme, the Victorian Government, acknowledge the uncertainty of its CCS project ever being operational (as shown in Figure 1).

If the CarbonNet scheme does not eventuate, it seems unlikely that the HESC consortium would abandon a project that its partners have invested billions of dollars in to export hydrogen to Japan, along with its rights to the Victorian brown coal resources. There appears to be no legal or regulatory requirement for it to do so in the absence of CCS.

[39] Hydrogen Engineering Australia (2021) H2 Guarantee of Origin Consultation, HESC Project Responses, p.4, https://consult.industry.gov.au/hydrogen-guarantee-of-origin-scheme/submissions/view/63

Conclusion

The HESC project appears to be an attempt by industry and government to continue the exploitation of Australia's highly polluting brown coal resources.

Brown coal cannot be exported directly as it is prone to spontaneous combustion when it dries out. However, it can be exported indirectly when it is used to make hydrogen through gasification. Hydrogen from brown coal gasification is the most polluting possible way to make hydrogen and is more polluting than simply exporting black coal or LNG.

The continued exploitation of brown coal in the form of coal-fired power generation is increasingly unacceptable in the transition to a low carbon economy. However, proponents have attempted for decades to present it as 'clean' by the claiming emissions associated with its burning will be captured and stored with CCS in the future. 'Clean' hydrogen made with coal is the latest iteration of this attempt.

There are no coal gasification hydrogen projects in the world with CCS, and the CarbonNet project that HESC claims will sequester its emissions is far from certain. If that project does not go ahead or is unsuccessful, it seems that the HESC project will remain simply a brown coal gasification hydrogen project, amongst the most polluting forms of energy in the world.

FOI documents show HESC claims that it will reduce emissions are based on a flawed comparison and are therefore untrue. They also show that when Minister Taylor repeated this claim publicly, his Department did not know the basis for the claims.

The HESC project should be seen for what it is, a highly polluting energy projects that, like other proposed fossil-based hydrogen projects in Australia, seems designed to increase the longevity of gas and coal, not reduce emissions.