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To: Senate Standing Committees on Environment and Communications

RE: Inquiry into the Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023 [Provisions]

Thank you for the opportunity to present IEEFA's submission to this inquiry.

Regards

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Executive summary

- The proposed bill will neither use new technology nor fight climate change.
- Carbon capture and storage (CCS) only addresses 10-15% of total emissions from gas projects.
- CCS is only a cover for gas companies to keep opening new gas fields.
- The proposed bill puts Australia's 2030 emissions reduction targets in jeopardy.

The proposed amendments to the Environment Protection (Sea Dumping) Act 1981 (the Sea Dumping Act) will do little to support the aims expressed in the title of the proposed legislation Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023 [Provisions], as it will neither use new technology, nor will it flight climate change.

The plan to use a 50-year-old technology such as carbon capture and storage (CCS) to fight climate change is an initiative advocated by the oil and gas sector that has little to do with the reality of dealing with a warming planet. CCS has been around since the 1970s and continues to fail to live up to the expectations promoted by oil and gas producers. Moreover, it only deals with a fraction of the total greenhouse gas (GHG) emissions, as it ignores the 85% to 90% of total emissions from the energy sector that are the Scope 3 emissions when oil and gas is burned by the consumer.

CCS only perpetuates production of oil and gas, which are major contributors to global GHG emissions each year. Global energy-related carbon dioxide ($CO_{2)}$ emissions totalled 36.8 gigatonnes in the calendar year 2022, whereas CCS sequestered a little more than 40 million tonnes of CO_2 in the same period. This equates to a rounding error in the totality of emission pumped into the atmosphere each year.

IEEFA believes that the amendments proposed should not be passed in the Senate as they will exacerbate climate change by allowing gas producers to open new fields and increase GHG emissions. The proposed amendments would put Australia more at risk of failing to meet CO_2 reductions targets that are consistent with the Paris Climate Agreement of keeping the rise in global average temperatures to 1.5°C.

Senators should seek amendment of the draft legislation to enhance legal and environmental protections, transparency and accountability of proposed transboundary CCS projects. Further amendments should include provision to obtain more information regarding proposed CCS import/export proposals in Australia, with a particular focus on the Bayu-Undan CCS project in the Timor Sea (and in the maritime territory of Timor Leste), and on the Middle Arm CCS project in Darwin.

The proposed Bill puts in jeopardy Australia's relatively modest 2030 emissions reduction target and the objectives of the Safeguard Mechanism, and amounts to an act of systemic greenwashing.

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Introduction

The proposed amendments to the Environment Protection (Sea Dumping) Act 1981 (the Sea Dumping Act) will do little to support the aims expressed in the title of the proposed legislation Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023 [Provisions], as it will neither use new technology, nor will it flight climate change.

The proposed Bill represents a wish list for the oil and gas sector[1] by allowing Australia to trade CO_2 streams. This is part of the industry's strategy to appear to be tackling climate change while actually continuing with 'business as usual' by developing more oil and gas fields and increasing global emissions.

There should be amendments in the Bill that include provisions to obtain more information regarding any additional regulatory and legal steps that must be undertaken before CCS export/import can occur.

Australia hosts one of the largest CCS facilities in the world, the Gorgon CCS system. Not only was it late in starting operations, but it has consistently sequestered far less CO_2 than it was designed to do, and has only captured less than 4% of the total emissions the Gorgon liquefied natural gas (LNG) project pumps into the atmosphere each year.

Gorgon CCS shows the shortcomings of an old technology

CCS technology has been in operation for more than half a century, from when the Terrell Natural Gas Processing plant was commissioned in 1972 in Texas, U.S.[2] Despite its maturity, CCS has proved an unreliable technology in several cases, and none more so than the Gorgon CCS facility near Barrow Island, off Western Australia.

The CCS facility at the 15.6 million tonne per annum (mtpa) Gorgon LNG project has spectacularly underperformed in its ability to sequester CO_2. Since it started development, it has cost Gorgon's operator Chevron and its partners ExxonMobil and Shell A$3.2 billion (US$2.14 billion) to the period 30 June 2022[3]. The project was late in starting, and it does not seem to be improving the rate of CO_2 capture. Amendments to the proposed legislation should be made to ensure greater penalties are imposed for any further shortfalls in the performance of CCS facilities.

Chevron and its Gorgon partners buried a total of 6.5 million tonnes (mt) of CO_2 in the period from August 2019 to 17 July 2022[4]. That equates to an average cost of A$492 per tonne of CO_2 to inject. Chevron and its partners injected 1.65mt of CO_2 in the Gorgon CCS project in the 2021-22 fiscal year to 30 June, from the 5.04mt of CO_2 that was removed from the Gorgon gas field and other reservoirs used in the Gorgon LNG project over the same period. This is well below the 3.3mtpa to 4mtpa it planned to bury[5], and below the 2.17mt of CO_2 that was injected in 2020-21.[6] This means that the CCS plant only removed one-third of the CO_2 emitted from the Gorgon

[1] Australia Petroleum Production and Exploration Association (APPEA). APPEA Federal Budget 2023/24 Submission. Page 2.
[2] IEEFA. Gorgon carbon capture and storage: The sting in the tail. April 29 2022
[3] Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline. Environmental Performance Report 2022. 4 November 2022. Page 44.
[4] Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline. Environmental Performance Report 2022. 4 November 2022. Page 44.
[5] Government of Western Australia, Department of Mines, Industry Regulation and Safety. Gorgon carbon dioxide injection project.
[6] Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline. Environmental Performance Report 2021. 17 November 2021. Page 44.

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reservoir in 2021-22, and about 40% of all CO_2 emissions since it started injecting CO_2 into the CCS facility in August 2019. This is well below the 80% capture rate required by the federal government.[7] See the table below for Gorgon's CCS performance.

Gorgon Carbon Capture and Storage performance against target

Year	mt			
	Volume of CO_2 removed	Volume of CO_2 injected	Target 80% of CO_2 removed	Shortfall from Target
2016-17	1.0	0	0.8	0.8
2017-18	3.5	0	2.8	2.8
2018-19	3.7	0	3.0	3.0
2019-20	3.9	2.7	3.1	0.4
2020-21	3.2	2.2	2.5	0.4
2021-22	5.0	1.6	4.0	2.4
Total	**20.4**	**6.5**	**16.3**	**9.8**

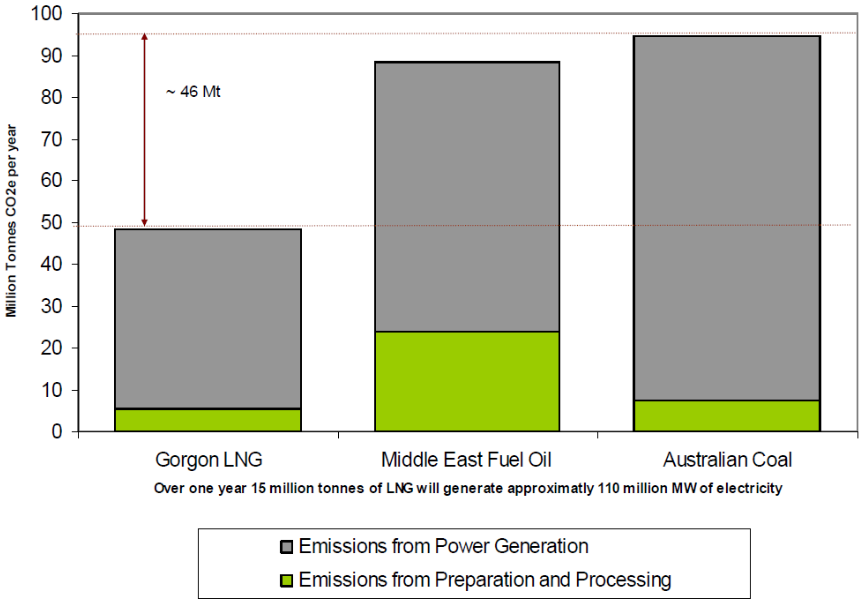
Notes to table. 1) The maximum nominal amount of CO_2 that the Gorgon CCS facility can capture *is 4mtpa, which is sometimes misinterpreted as the amount that the facility should capture each year. Calculated on a five-year rolling average starting on 18 July 2016, Chevron committed to ensure that at least 80% of reservoir CO_2 removed during processing at the gas treatment plant, that would otherwise be vented to the atmosphere, would be injected underground.[8]*
2) The CO_2 injection system commenced on 6 August 2019, as such 2019-20 is the first year of data for volume of reservoir CO_2 injected[9]

The volume of CO_2 stored in the Gorgon CCS system, where CO_2 is injected into the Dupuy formation at depths of 2,500 metres, is even less in relative terms when also taking into account the emissions from the Gorgon liquefaction plant, which is the facility that chills the gas into liquid for transportation. The combined CO_2 emissions from the Gorgon field reservoirs and the Gorgon LNG liquefaction plant were 8.32mt of CO_2 in the 2021-22 fiscal year.[10]

This means that the Gorgon liquefaction plant emitted 3.32mt of CO_2 in 2021-22, and therefore the Gorgon CCS system captured just 19.2% of the combined Scope 1 and 2 emissions (the emissions generated from turning the gas into LNG) of the Gorgon LNG project in 2021-22. When the total emissions are assessed, including the Scope 3 emissions when the gas is burnt by customers, the proportion of CO_2 captured in 2021-22 is 3.2% based on Chevron's data. See table below.

[7] Financial Times. Monster problem: Gorgon project is a test case for carbon capture. 26 July 2021
[8] Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline Environmental Performance Report 2021. Page 45
[9] Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline Five-year Environmental Performance Report 2015-2020.
[10] Clean Energy Regulator. 2021-22 Safeguard facilities data Gorgon operations.

Table 1 – Comparison of life-cycle greenhouse gas emissions for electrical power generation in Asia.[11]



Source: Chevron

In Table 1, Chevron based its data on a study conducted by the CSIRO into the life-cycle advantages of LNG from the Gorgon Gas Development compared to alternative base load fuels such as coal and fuel oil.[12] The data is based on the assumption of 15mtpa of LNG from Gorgon, which is estimated to generate 110,000GW of electricity at gas-fired plants in the Asia Pacific region. This volume of electricity fuelled by Gorgon gas emits almost 50mtpa of CO_2. Of this, 96% was not captured based on the 2021-22 data for Gorgon CCS and using the data from this scenario, given that Chevron has not reported total emissions or Scope 3 emissions for 2021-22. The fact that the Gorgon CCS system – despite being much vaunted by the gas industry – captures less than 4% of the total Gorgon emissions each year underlines IEEFA's view that CCS is not a climate fighter but an enabler for more emissions.

CCS is an ineffective solution to a small portion of the total emissions from gas production and use. Despite the significant shortcomings of CCS for gas production, the Gorgon CCS project started with great fanfare as the world's largest CCS project with a dedicated geological structure. It received A$60 million from the Australian Government as part of the Low Emissions Technology Demonstration Fund (LETDF).[13]

The A$81 billion (US$54 billion) Gorgon LNG plant produced its first LNG cargo in March 2016[14] but the first CO_2 injection from its CCS facility did not occur until August 2019[15] – three and a half years late. Start-up checks in late 2017 found leaking corroded valves and excess water in the pipeline between the LNG plant and the injection wells, a potential cause of corrosion.[16]

[11] Chevron. Gorgon Gas Development Revised and Expanded Proposal. Public Environment Review. September 2008. Page 252.
[12] Ibid. Page 251.
[13] Chevron. Gorgon Carbon Capture and Storage Fact Sheet. 2021.
[14] Chevron. First
[15] Western Australia Government Department of Mines, Industry Regulation and Safety. Gorgon carbon dioxide injection project.
[16] The West Australian. Carbon hiccup for Chevron with 5 million-tonne greenhouse gas problem at Gorgon LNG plant. 19 December 2017.

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Gorgon CCS has been plagued by other technical problems. In January 2021, it was reported that Gorgon had been ordered by the WA Department of Mines, Industry Regulation and Safety (DMIRS) to turn down the volume of carbon captured by the project due to structural issues.[17] This was due to sand blocking the well that reinjects water underground, which compromised the essential pressure management system.

The extent of the technical failure of Gorgon CCS cannot be overstated. It prompts the question: if the engineers from the super major oil companies Chevron, Shell and Exxon, cannot get CCS to work as forecast, who can? Santos does not have the depth and breadth of engineering capability that these three companies have, and yet it is planning a larger and more ambitious CCS project than the Gorgon partners. Greater scrutiny is required to ensure the issues confronting the Gorgon CCS project are not repeated at Santos's proposed Bayu-Undan CCS project, as not only will it lead to more emissions in the atmosphere, but it risks triggering transboundary issues with Timor Leste.

The Gorgon project is expected to run for 40-45 years, after which there will be a closure period of 15 years. Post-closure, the liability of the project is handed over to the state government[18] – essentially, Australian taxpayers. A similar arrangement is expected to be made for future CCS projects in Australia.

Australia can't have more Gorgon CCS failures

The oil and gas industry are planning several CCS projects, with Santos at the forefront of these proposals. Its most ambitious CCS project is the Bayu-Undan venture in the Timor Sea to capture and store 10mtpa of CO_2. The timing of the proposed legislative changes come ahead of Santos's plan to make a final investment decision on the Bayu-Undan CCS in 2025[19], with CO_2 from the Barossa gas field in Australia's Bonaparte basin, also operated by Santos, to be the first CO_2 to be injected into Bayu-Undan from around 2027. [20]

IEEFA believes that the proposed legislative amendments should be delayed until Santos has completed its studies on whether Bayu-Undan is a suitable reservoir to bury CO_2. There is little point in changing the legislation until Bayu-Undan is proven as a CCS facility. IEEFA is also of the view that if the Bayu-Undan CCS project is sanctioned it should come on at the same time as the Barossa gas field, which Santos has projected to come online by 2025[21], or two years before the Bayu-Undan CCS facility is ready. However, the Barossa project is facing delays following legal rulings[22] and the Bayu-Undan CCS facility, which would store Barossa's emissions, has yet to receive any regulatory approval.

Santos needs to disclose more details on the liability for any emissions if they are leaked from the Bayu-Undan field, as it would involve CO_2 sourced from Australia and buried in the maritime area under the jurisdiction of Timor-Leste, while operated by Santos.

The gas fields proposed for development in Australia are becoming more CO_2-intensive. Santos's Barossa has an average CO_2 content of 18%, which would make it then most carbon-intensive gas field used for LNG export in Australia, exceeding Gorgon's 14% CO_2 content[23]. The Barossa

[17] Boiling Cold. Chevron's Gorgon emissions to rise after sand clogs $3.1bn CO2 injection system. 12 January 2021.
[18] WA Department of Mines, Industry Regulation and Safety. Gorgon Carbon Dioxide injection project.
[19] Santos. MOUs executed for potential CO2 supply to underpin Santos' Bayu-Undan CCS project. 3 May 2023.
[20] Santos. 2022 Investor Briefing Day. 8 November 2022. Page 43.
[21] Santos. Barossa Gas Project.
[22] IEEFA. Santos back to the drawing board on unapproved Barossa gas project. 14 December 2022.
[23] Trupp et al presentation to 15th International Conference on Greenhouse Gas Control Technologies. Developing the world's largest CO2 Injection system – a history of the Gorgon Carbon Dioxide Injection System. 15-18 March 2021.

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field has an estimated annual Scope 1 and 2 GHG emissions of 3.38mtpa of CO_2.[24] This is three times the average of the near-depleted Bayu-Undan field that Barossa is replacing.[25]

Italian energy firm ENI plans to develop the Evans Shoal gas field, now renamed the Verus project, in the Bonaparte basin with an average CO_2 of 27% or 50% higher than Barossa's average CO_2 content.[26] Verus' emissions profile is even greater with annual emissions of an estimated 7.53mtpa of CO_2 based on a 4mtpa LNG second train at Darwin LNG and emissions from the liquefaction process, which amount to around 2.05mtpa of CO_2.

Although the proposed Bayu-Undan facility would be the largest CCS project of its kind, it still would not be enough to capture all of the Scope 1 and 2 emissions from the Barossa and Verus fields. Moreover, there would be no space for Timor Leste to dispose of its own CO_2 in Bayu-Undan if it was to develop the Sunrise gas field in the Timor Sea, which is operated by Woodside Energy but is majority-owned by the Timor Leste state.

The three gas fields that comprise the Browse gas project have an average CO_2 content of 10%[27], and estimated average annual Scope 1 and 2 emissions of 4mtpa of CO_2.[28]

Total emissions from LNG are projected to rise to 41mtpa of CO_2 by 2030[29], or 41% of emissions allowable under the revised Safeguard Mechanism.[30] This volume of emissions is based on Australian LNG exports of 88mtpa in 2030, up from 79mtpa in 2020,[31] and equates to an average increase of 0.466t of CO_2/t of LNG.

The government's proposed amendments to the legislation to allow the import and export of CO_2 follow plans by Australia to increase emissions with state support for the Middle Arm and Petrochemicals Hub. The Northern Territory government is seeking the approval to turn land on Darwin Harbour into an export hub for petrochemicals and hydrogen using gas produced from Barossa and the onshore Beetaloo basin in the Northern Territory.[32] The proposal has been allocated A$1.5 billion in federal funding,[33] which was originally pledged by the former Liberal-National coalition government.[34]

Middle Arm is another project supported by Australia's gas sector based on the industry's expectations of ever-increasing demand for LNG exports. These exports will be accompanied by more CO_2 emissions, marking another federal government policy that appears to be doing more to increase emissions and not reduce them in a meaningful way. Both Middle Arm and the proposed legislation to allow the import and export of CO_2 are based on the premise that CCS can be scaled up to absorb global emissions.

[24] ConocoPhillips Australia. Barossa area development offshore project proposal. 5 March 2018. Page 128.
[25] IEEFA. Santos' loss forces them back to the drawing board on unapproved Barossa gas project. 14 December 2022.
[26] IEEFA. Eni's Verus Not So True on Net Zero. 8 May 2023
[27] Woodside. Proposed Browse to NWS Development, EPBC Act and EP Act Environmental Referrals, Supporting document. November 2018. Page 29.
[28] Ibid.
[29] Department of Climate Change, Energy, the Environment and Water. Australia's emissions projections 2022. December 2022. Page 47, Table 23.
[30] Parliament of Australia. Safeguard Mechanism (Crediting) Amendment Bill 2022. 30 March 2023.
[31] Ibid. Page 47.
[32] IEEFA. Middle Arm Gas and Petrochemicals Hub: Combination of problems makes it unprofitable for business and a red flag to the public. June 2023.
[33] ABC. Business case for Middle Arm Sustainable Development Precinct triggers climate concerns from critics. 29 December 2022.
[34] Australian Financial Review. New Darwin port floated to check Chinese control of key asset. 31 March 2022

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The total life-cycle emissions from the Beetaloo sub-basin over a 20-year period are 1,358mt under a high-production scenario for LNG exports and domestic consumption.[35]

The claims by the oil and gas sector over CCS provide a solid basis for the Australian Competition and Consumer Commission (ACCC) to investigate the possibility of greenwashing, which this senate inquiry should pursue. In the ACCC's report titled 'Green marketing and the Australian Consumer Law' it states that: "Firms which make environmental or 'green' claims should ensure that their claims are scientifically sound and appropriately substantiated. Consumers are entitled to rely on any environmental claims you make and to expect these claims to be truthful."[36]

The fact is that CCS projects around the world have failed to store the claimed amounts of CO_2 they were intended to, and that CCS only addresses a small proportion of the emissions along the gas supply chain. This hardly makes gas a sustainable fuel.

CCS – A history of failure, and a threat to climate

After 50 years of CCS and its accompanying promotion by the oil and gas sector, there was a global CCS capacity of 42.5mtpa to the period mid-September 2022.[37] This would only cover all the emissions of Australia's largest polluter AGL Energy in the 2021-22 fiscal year, when it emitted 39.5mtpa[38], and just 8.7% of Australia's total GHG emissions in 2021-22.[39]

The figure of 42.5mtpa in total CCS capacity is also generous to the sector, as almost two-thirds of the CCS plants in operations are used for enhanced oil recovery (EOR), and only 13 of the 35 plants in operation are dedicated to storing CO_2.[40]

The challenge of sequestering the 36.8 gigatonnes of global energy-related CO_2 emissions released in calendar year 2022 is probably on a scale the fossil fuel sector cannot meet. This is underlined by the fact that in that year, global CO_2 emissions rose by 321mt from 2021 levels.[41] In other words, global energy-related emissions rose in one year by 7.5 times the global CCS capacity accumulated after 51 years, a gap that that is unlikely to ever be bridged by CCS given its costs, technical uncertainties and the ambiguity of regulatory oversight.

This disparity between global emissions and CCS capacity underlines that sequestering CO_2 in offshore depleted oil and gas fields is an inadequate tool to tackle climate change as it only addresses the Scope 1 and 2 emissions, which represent the emissions from the extraction of oil and gas, and the processing of the fuel before it is sold to customers. Together Scope 1 and 2 represent between 10% and 15% of total emissions, with the vast majority of emissions from the extraction of gas, oil and coal released at the Scope 3 level, when the fossil fuels are burned by consumers such as power stations, industrial and commercial facilities, transportation and households. Hence all CCS does is give oil and gas producers an excuse to produce more emissions through their respective oil and gas projects, and undermine the Paris Climate Agreement's ambition 'to limit the temperature increase to 1.5°C above pre-industrial levels' or its

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35 RepuTex Energy. Analysis of Beetaloo Gas Basin Emissions & Carbon Costs. October 2021.
36 ACCC. Green marketing and the Australian Consumer Law. 2011
37 Global CCS Institute. Global Status of CCS 2022.
38 Clean Energy Regulator. National Greenhouse and Energy Reporting 2021-22 published data highlights
39 Australian Government, Department of Climate Change, Energy, the Environment and Water. Quarterly: Update of Australia's National Greenhouse Gas Inventory: June 2022.
40 Global CCS Institute. Global Status of CCS 2022. Pages 53-54
41 International Energy Agency. CO2 Emissions in 2022. Page 3.

overarching goal to hold 'the increase in the global average temperature to well below 2°C above pre-industrial levels.'[42]

Since its first commissioning in 1972, historically CCS has been predominantly used as a method of EOR. When CCS is used for EOR, the captured carbon is reinjected into a well to increase the rate of oil production, which emits CO_2 again when the oil is burnt, making any initial "carbon capture" negligible.[43] One of the world's oldest CCS plants, Exxon Mobil's Shute Creek Treating Facility, has used around 95% of its captured CO_2 for EOR to push out more oil or gas from near-depleted fields, which in turn emit more CO_2.[44] This is not a climate solution.

CCS has not been proven feasible or economic at scale and can only contain a fraction of source emissions. CCS facilities around the world have consistently captured less than they intended.[45] There are more than 20 large-scale CCS projects in operation around the world, storing about 40 mtpa of CO_2.[46] The fact that it has taken 50 years to sequester a fraction of the global emissions of 36.8 gigatonnes of CO2 from energy production in 2022[47] underlines that CCS is unlikely to provide an adequate response to lowering global GHG emissions.

The CCS chain

The "capture" part of CCS requires stripping CO_2 from a mixture of produced hydrocarbons, typically comprising primarily methane gas, or removing it from industrial processes post-combustion before it reaches a venting stack. It is then compressed into a supercritical state – somewhere between gas and liquid – for transportation via pipeline.[48]

The next step of CCS from a climate change perspective is the "S" part: storage. CO_2 is injected at high pressure into wells that deliver it deep underground in quantities that range from thousands up to one million tonnes per annum. The injection release point should be located at least 800 metres below the surface, where ambient temperatures and pressures keep the CO_2 supercritical, reducing the chance that it turns back to gas and more readily percolates to the surface.

That storage needs to be permanent if the aim of reducing atmospheric CO_2 is to progress. But how can engineers and advocates of CCS assure the world that the CO_2 will stay in the ground? This proposition is fraught with high technical complexity, inherent unknowns and, as a result, material risks of failure.

Decades of research have gone into trying to improve CO_2 removal, handling, and use or disposal. Still, the successes of CCS, as proponents would define it, have been limited for the most part to the oil and gas industry.[49] It has already failed spectacularly in the coal industry.

CCS promises of clean coal also failed to deliver

There is a history of abandoned CCS projects, such as the Kemper 'clean coal' project in Mississippi.[50] However, the fossil fuel sector tends not to dwell upon this fact and prefers to call

42 United Nations Climate Change. The Paris Agreement.
43 IEEFA. Gorgon carbon capture and storage: The sting in the tail. April 29 2022. Page 4.
44 IEEFA. Carbon capture to serve enhanced oil recovery: Overpromise and underperformance. Shute Creek, the world's largest CCUS facility, consistently fails to meets its targets. March 2022
45 IEEFA. The Carbon Capture Crux. Lessons Learned. September 2022. Page 34.
46 Santos. Darwin Pipeline Duplication Project. Supplementary Environmental Report, May 2023. Page 110.
47 International Energy Agency (IEA) CO2 Emissions in 2022. Page 3.
48 IEEFA. Norway's Sleipner and Snøhvit CCS: Industry models or cautionary tales? 14 June 2023. Page 9.
49 IEEFA. Carbon capture has a long history. Of failure. Robertson. September 2, 2022.
50 IEEFA. Southern Company demolishes part of $7.5 billion Kemper power plant in Mississippi. October 14, 2021.

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CCS an emerging technology. This narrative has filtered down to the Australian government, as shown in the name of this proposed amendment, with the words 'Using New Technologies To Fight Climate Change' implying that CCS is a new technology, when it clearly is not.

The Massachusetts Institute of Technology (MIT) used to maintain a database of abandoned CCS projects until September 2016.[51] A click on the website shows an extensive list of cancelled or inactive CCS projects, some with bold names such as FutureGen, Trailblazer and ZeroGen. Most of these projects were associated with coal-fired power plants, in an era when the coal industry was spending a lot of advertising dollars and lobbying efforts to convince the world of the viability of 'clean coal'.

An IEEFA report in 2018 'Holy Grail of Carbon Capture continues to Elude Coal Industry' highlighted the exorbitant costs and technical challenges associated with clean coal. The US, where many of the clean coal projects were proposed, would require a significant network of pipelines (and associated infrastructure) to transport captured CO_2 to sequestration sites. Such a network would be costly and extremely time-consuming to permit and build, and would require excessive volumes of water.[52]

The coal sector was nonetheless successful in getting US taxpayers to fund their clean coal projects, with a report by the US Government Accountability Office (GAO) estimating that the US Department of Energy provided US$684 million (A$1.03 billion) to eight clean coal projects of which only one become operational and subsequently closed down.[53]

Like the coal industry, the oil and gas sector are seeking taxpayer funding for their social licence to operate by marketing CCS as a solution for reducing emissions.

[51] MIT. Carbon Capture & Sequestration Technologies @ MIT.
[52] IEEFA. Holy grail of carbon capture continues to elude coal industry. Page 2.
[53] US Government Accountability Office (GAO) Report to Congressional Committees Carbon Capture and Storage Actions Need to Improve DOE Management of Demonstration Projects. Page 2.

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CCS mythology

The oil and gas sector appear to have turned to Norse mythology when it comes to CCS, citing the Sleipner and Snøhvit CCS facilities in Norway as proof of the technology's viability. A recent report by my colleague Grant Hauber at the Institute for Energy Economics and Financial Analysis (IEEFA) cast doubt on the assertion that these facilities can be used as a template to scale up the CCS capacity to make a meaningful difference to rising CO_2.[54]

The Sleipner and Snøhvit offshore fields have been operating since 1996 and 2008 respectively. The facilities separate CO_2 from their respective produced gas, then compress and pipe the CO_2 and reinject it underground. Between Sleipner and Snøhvit, an average of 1.8mtpa of CO_2 are disposed of in this manner, accumulating 22 million tonnes in storage so far.[55]

Following from Sleipner's and Snøhvit's purported success, there are now nearly 200 proposed offshore CCS projects worldwide seeking to sequester hundreds of millions of tonnes of CO_2 annually – potentially billions over their operating lives. These proposals represent hundreds of billions of dollars in capital investment and billions of dollars in ongoing operating costs. More importantly, they are said to be the key to making a material dent in the over 37 billion tonnes of CO_2 emitted globally each year. The International Energy Agency (IEA)has begun tracking these undertakings as well, and in March 2023, it published a database of current and proposed CCS projects.[56]

Research conducted by IEEFA has revealed that storing CO_2 underground is not an exact science. It may carry even more risk and uncertainty than drilling for oil or gas, given the very limited practical, long-term experience of permanently keeping CO_2 in the ground.

The subsurface areas of Sleipner and Snøhvit are among the most studied geological fields in both oil and gas and CO_2 storage globally. More seismic and other forms of subsurface study and monitoring of these two fields have been conducted than nearly any other place on the planet. Over 150 academic papers have been published. Their seismic datasets have been downloaded more than a thousand times.

The academic literature on Sleipner and Snøhvit reveals that field operators must expect the unexpected, make detailed plans, continually update those plans, and prepare for contingencies. Above all however, the literature fails to call out the fact that neither the performance nor the integrity of storage sites can be guaranteed, whether up front or over time; at most, the studies tend to undermine certainty when it comes to CO_2 storage.

Questions can be raised regarding the technical viability and risk associated with developing and managing these proposed undertakings, which are, after all, meant to permanently store CO_2. Subsurface structures behave differently when materials are put back into them than when things are taken out. To make room for deposition, something has to be displaced or transformed, often under varying temperatures and very high pressures.

Moreover, CO_2 storage geologic structures are targeted at significant depths in order for the compressed gas to remain in a gel-like supercritical state, which allows for better uptake in the subsurface formation. Introducing this gel to subsurface structures consistently over long periods of operations can lead to unpredictable outcomes.

Despite the studies, experience and passage of time, the security and stability of the two fields have proven difficult to predict. In 1999, three years into Sleipner's storage operations, CO_2 had already risen from its lower-level injection point to the top extent of the storage formation and into a previously unidentified shallow layer. Injected CO_2 began to accumulate in this top layer in unexpectedly large quantities. Had this unknown layer not been fortunate enough to be geologically bounded, stored CO_2 might have escaped.

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[54] IEEFA. Norway's Sleipner and Snøhvit CCS: Industry models or cautionary tales? Grant Haber. 14 June 2023.
[55] IEEFA. Norway's Sleipner and Snøhvit CCS: Industry models or cautionary tales? 14 June 2023, page 5.
[56] IEA. CCUS Projects Database. March 2023.

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At Snøhvit, problems surfaced merely 18 months into injection operations despite detailed pre-operational field assessment and engineering. The targeted storage site demonstrated acute signs of rejecting the CO_2. A geological structure thought to have 18 years' worth of CO_2 storage capacity was indicating less than six months of further usage potential. This unexpected turn of events baffled scientists and engineers while at the same time jeopardising the viability of more than US$7 billion of investment in field development and natural gas liquefaction infrastructure. Emergency remedial actions and permanent long-term alternatives needed to be, and were, identified on short notice and at great cost.

Rather than serving as entirely successful models for CCS that should be emulated and expanded, Sleipner and Snøhvit instead call into question the long-term technical and financial viability of the concept of reliable underground carbon storage. They cast doubt on whether the world has the technical prowess, strength of regulatory oversight, and unwavering multi-decade commitment of capital and resources needed to keep CO_2 sequestered below the seafloor – as the Earth needs – permanently.

Sleipner and Snøhvit have required – and will continue to require – extensive monitoring and survey throughout their life at material cost. Changes in how CO_2 behaves and where it migrates can happen even years into operations, and engineers must continually monitor storage evolution, planning for contingencies.

The scale of the two Norwegian projects is far smaller than most CCS projects being proposed globally. The injection rates and total capacity – 0.85mtpa to 1.0mtpa for Sleipner, and 0.7mtpa for Snøhvit – are smaller than many of the CCS proposals. To develop a hub of envisaged capacity, multiple subsurface formations need to be identified, studied, monitored and managed. Given that CCS cluster projects will require subsurface storage space many times the size of Sleipner or Snøhvit, they may face magnified risks arising from geophysical deviations. For many of the larger proposals, the infrastructural configurations and sizes of Sleipner and Snøhvit do not provide reasonable proxies for scope, scale or risk. It raises valid questions about equipment and field sizes, redundancy, the need for contingency planning, and the funding available to pay for this – all on a greater scale than anything previously considered. It is not clear that CCS projects can be scaled safely and efficiently.

Another question needs to be asked of governments: are they truly prepared to oversee, regulate and potentially operate these complex projects?

Several important implications arise from the Sleipner and Snøhvit experience. There are technical implications, scale implications, regulatory implications and, of course, climate implications to these developments. These matters are all the more important in a world that is seeing hundreds of larger and more intensive CCS projects proposed.

Such developments raise questions about whether two data sources the size of Sleipner or Snøhvit are sufficient to form a reliable basis for secure storage of greenhouse gases on a scale hundreds of times their size, and to do so permanently.

Before Sleipner and Snøhvit, there was the In Salah project in Algeria, a carbon capture project with a total cost of US$2.7 billion. Injection started in 2004 and was suspended in 2011 due to concerns about the integrity of the seal and suspicious movements of the trapped CO_2 under the ground.[57] Both Norwegian projects have experienced unexpected subsurface behaviours once in operation, where risks were realised and remedial actions needed.

The Sleipner and Snøhvit case studies raise more questions about the proposed amendments. What monitoring system will be put in place to monitor and oversee the CO_2 injection and storage of each CCS facility?' 'How much of the cost will be borne by taxpayers and how much by the industry itself? Furthermore, how independent will this monitoring body be, and how immune from industry influence?

[57] MIT. In Salah Fact Sheet: Carbon Dioxide Capture and Storage Project.

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Conclusion

IEEFA believes that the proposed amendments to the Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023 [Provisions] are based on a flaw in the Amendments to the London Protocol and the Convention for the Protection of the Marine Environment of the North-East Atlantic (or OSPAR Convention) to allow for CO_2 storage in offshore geological formations. This is due to the fact that the amendments to the London Protocol were based on using the Sleipner CCS project as a benchmark.[58]

IEEFA's research into the Sleipner and Snøhvit CCS projects demonstrates that there are many complex issues to contemplate. No potential CCS basin is the same, and there is no guarantee that the CO_2 will remain within a proposed reservoir given the different geological formations of each planned CCS facility and the challenges of keeping CO_2 in a liquid state so that it does not leak.

Only 10 of the 53 contracting parties to the London Protocol have ratified the 2009 amendment[59]. This is well short of the two-thirds support (around 35 contracting parties) required to bring the 2009 amendment, to allow the export of CO_2 streams from a contracting party to another country, into force.[60] The international trading of CO_2 should not occur until CCS technology has been proven to work at scaled-up capacity larger than Sleipner or Snøhvit to avoid potential litigation between countries over CO_2 leakages or the CCS reservoir's ability to absorb CO_2.

Despite the oil and gas industry over the past 14 years trying to change international conventions that protect the marine environment, it has not invested or built anyway near the scale that it claims is required to store CO_2, with a mere 3mtpa of CCS capacity added each year since 2010.[61] This signals that the oil and gas sector either does not have full confidence in CCS or it prefers not to address the issues of rising temperatures caused by increased concentrations of CO_2 in the atmosphere. Instead, it focuses its efforts on changing laws that weaken the protection of the environment.

The amendments to allow the international trade of CO_2 go against the intent of the United Nations Convention on the Law of the Sea covered under 'Section 5. International rules and national legislation to prevent, reduce and control pollution of the marine environment'. Increased concentration of CO_2 in the world's oceans is having a significant impact on the marine environment and does not need the additional risk of leaking CO_2 from CCS projects.

[58] Institution of Civil Engineers. Sleipner carbon capture and storage project. 3 February 2017
[59] Parliament of Australia. House Standing Committee on Climate Change, Energy, Environment and Water. Inquiry into the 2009 and 2013 amendments to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol). Chapter 2 – The Proposed Amendments.
[60] Ibid
[61] Global CCS Institute. Global Status of CCS 2022. Page 5, Figure 1.