MEMORANDUM

Carbon Capture, Utilisation and Storage (CCUS)
A False Solution That Is Ineffective, Unproven and Expensive

Submitted by

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To

Ministry of Economy

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Endorsed by,

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A False Solution That Is Ineffective, Unproven and Expensive

1.0 Introduction

The past few years have seen increased global attention and investment in carbon capture technology, especially by oil and gas firms[1] marketing the technology as a “climate solution” that, theoretically, would enable the capture of climate-change-causing carbon emissions from carbon-intensive industrial processes such as oil and gas production, before they enter the atmosphere. However, due to the expensive price tag and historical underperformance, governments are often called upon to provide substantial financial incentives for deploying these technologies at the expense of taxpayer money.[2]

Malaysia is no different. The upcoming first implementation of carbon capture in the country, the Kasawari project in the waters off Sarawak, is being undertaken by Petroliam Nasional Berhad (PETRONAS),[3] the state-owned national oil and gas company that contributes significantly to government revenue. Further, the government is very bullish on carbon capture, outlining its importance through several policy documents and the upcoming carbon capture legislation, whilst facilitating the implementation of such technologies by the private sector through financial incentives.[4]

2.0 The Basics of Carbon Capture

2.1 Carbon Capture and Storage (CCS)

CCS involves a process designed to **“capture” carbon dioxide (CO_2) generated by high-emitting activities** like coal- or gas-fired power production. The captured emissions are then transported to sites where they are stored underground.[5]

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[1] Craig Bettenhausen. “Big Oil and Gas Firms Deepen Investment in CO_2 Capture.” Chemical & Engineering News. April 10, 2024. https://cen.acs.org/energy/Big-oil-gas-firms-deepen/102/web/2024/04

[2] Oil Change International (OCI). “Funding Failure: Carbon Capture and Fossil Hydrogen Subsidies Exposed.” August 2024. https://www.oilchange.org/wp-content/uploads/2024/08/OCI_funding_failure_Final_09_10_24.pdf

[3] Petroliam Nasional Berhad (PETRONAS). “PETRONAS Carigali Reaches Final Investment Decision for Kasawari CCS Project Offshore Sarawak.” November 29, 2022. https://www.petronas.com/media/media-releases/petronas-carigali-reaches-final-investment-decision-kasawari-ccs-project

[4] Malaysia Investment Development Authority (MIDA). “Equilibrium Through Carbon Capture: Malaysia’s Path to Net-Zero Emissions.” May 31, 2023. https://www.mida.gov.my/equilibrium-through-carbon-capture-malaysias-path-to-net-zero-emissions/

[5] Center for International Environmental Law (CIEL). “Carbon Capture and Storage - Center for International Environmental Law.” February 13, 2024. https://www.ciel.org/issue/carbon-capture-and-storage/

2.2 Carbon Capture, Utilisation and Storage (CCUS)

CCUS is essentially the same as CCS but **instead of the CO_2 being stored in the ground, it is utilised for a variety of purposes** such as being converted into carbon-based products like chemicals, plastics, building materials and even for biofuels and animal feed.

However, **the main use for captured CO_2 today is for enhanced oil/gas recovery (EOR/EGR)**, a process that increases the maximum amount of oil and gas that can be extracted from an oil reservoir that would not have been pumped out otherwise.[6]

2.3 Key Difference Between CCS and CCUS

The core difference between CCS and CCUS thus lies in the end product of the captured CO_2. CCS focuses solely on capturing and permanently storing the captured CO_2 whilst CCUS expands upon CCS by utilising the captured CO_2 to create products and services instead of storing it.

2.4 Carbon Capture Is a Combination of Complicated Processes

Carbon capture and its consequent disposal or utilisation is not one single activity, but instead is a string of multi-faceted processes, each with its own complexities and associated risks. The process starts upstream where the CO_2 is captured and will then undergo purification/separation. It is then followed by the midstream at which the CO_2 will be compressed for transportation via pipelines or maritime vessels. Lastly, the CO_2 would be further compressed for it to be injected into the storage site or be utilised for EOR/EGR. Each process is complex and poses critical challenges with multiple potential points of failure throughout the whole process.[7]

2.4.1 Upstream

The upstream is where CO_2 is captured, typically from carbon-intensive sources such as oil and gas production, industrial cement and steel manufacturing, and coal and gas-fired power plants. Following capture, the CO_2 undergoes a two-step process. First, it is separated from any remaining impurities, ensuring that the gas stream is free from contaminants. Next, the purified CO2 is compressed and converted into a supercritical fluid to allow for transportation and subsequent storage in geological formations.

[6] Energy & Climate Intelligence Unit. "Carbon Capture, Usage and Storage (CCUS): What, Why, How?." October 25, 2021. https://eciu.net/analysis/briefings/net-zero/carbon-capture-usage-and-storage-ccus-what-why-how

[7] Grant Hauber. "The Carbon Dioxide Disposal Chain: Elements, Goals and Risks." Institute for Energy Economics and Financial Analysis (IEEFA). September 4, 2024. https://ieefa.org/sites/default/files/2024-09/2024Conf%20The%20carbon%20dioxide%20disposal%20chain.pdf

2.4.2 Midstream

CO_2 needs to be highly compressed for transportation in the midstream. The compressed CO_2 makes pipelines transporting it prone to ruptures which can lead to massive leaks that can affect public health and safety to the point of fatality along with negative impacts on environmental integrity.[8] The other proposed mode of transporting CO_2, via maritime vessels, does not even exist in the real world. CO_2 pipelines, which in comparison to these vessels have been utilised at scale for transporting CO_2, already face high risks of ruptures and leaks. For the non-existent, unproven and untested mode of transporting CO_2 via maritime vessels, the safety concerns and associated risks would surely be much higher.

2.4.3 Storage

CO_2 storage is by far the greatest consideration for carbon capture. Storage of CO_2 needs to be permanent and safe; failing to achieve this would negate any benefits of carbon capture, with potentially devastating ramifications for the public and the environment. It is the most important and yet also the most complex piece in the carbon capture jigsaw, with many unknowns and variables that cannot be controlled.

Core to this unknown is the unpredictability of how the CO_2 will react once it is injected underground. There have been multiple instances where CO_2 storage facilities have had to be sealed to prevent further complications, despite many years and vast sums of money spent on research by engineers and scientists to determine the suitability of specific storage locations.[9] CO_2 storage failures have led to near-instances of leakage and contamination of groundwater while already causing small-scale earthquakes.[10]

The complexity and inherent risks of carbon capture especially in the handling of the captured CO_2 raise parallels to nuclear energy, which has in many cases been vehemently opposed by local communities due to the complications that may arise from the operation of a nuclear power plant. Any implementation of carbon capture should entail the same level of scrutiny as that of nuclear energy, [11] where there needs to be a "zero loss / leak tolerance". For CCS to be even considered as a climate solution, it must be able to ensure that CO_2 remains stored underground indefinitely which the proponents have failed to prove.

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[8] Dan Zegart. “Gassing Satartia: Carbon Dioxide Pipeline Linked to Mass Poisoning.” HuffPost, September 17, 2021. https://www.huffpost.com/entry/gassing-satartia-mississippi-co2-pipeline_n_60ddea9fe4b0ddef8b0ddc8f

[9] Grant Hauber. “Norway’s Sleipner and Snøhvit CCS: Industry models or cautionary tales?.” Institute for Energy Economics and Financial Analysis (IEEFA). June 2023. https://ieefa.org/sites/default/files/2023-06/Norway%E2%80%99s%20Sleipner%20and%20Sn%C3%B8hvit%20CCS-%20Industry%20models%20or%20cautionary%20tales.pdf

[10] Mia DiFelice et al. “Why Carbon Storage Is a Bad Idea.” Food & Water Watch. December 8, 2023. https://www.foodandwaterwatch.org/2023/09/06/carbon-storage-bad-idea/#:~:text=Already%2C%20we've%20seen%20earthquakes,contaminate%20nearby%20groundwater%20or%20soil

[11] Ibid.

2.5 Capturing the Narrative: Carbon Storage or Carbon Disposal?

In their desperation to remain profitable and relevant in the transition to a low-carbon future, fossil fuel companies spend billions of dollars to greenwash their image.[12] A direct example of this is how they have relabelled themselves from oil and gas companies to "energy companies".

Carbon storage is another example of such greenwash. CO_2 in the climate context has negative connotations. It is considered as a waste product from the production and usage of fossil fuels, and its accumulation in the atmosphere presents a planetary hazard. Waste is not "stored"; it is disposed of accordingly, and the accumulation of waste is frowned upon as it invites health, safety and environmental hazards.

Carbon "storage" in essence is the accumulation of a risky waste product. But by calling it "storage" instead of disposal, this dangerous activity can be greenwashed and its hazards wiped away from the reader's imagination. Hence, calling it carbon disposal would be the more accurate nomenclature. A breakdown of the risks of carbon disposal will be further elaborated in this paper.

3.0 Critique of Carbon Capture

3.1 Perpetuate and Prolong Fossil Fuel Use

Carbon capture is often marketed as a carbon reduction measure for otherwise hard-to-abate processes such as cement and steel manufacturing and coal-fired power plants. However, the majority of carbon being captured today is not from power plants or industrial processes like steel or cement production. Instead, 67% of CO_2 captured today comes from fossil fuel extraction and processing,[13] and the planned large-scale deployment of carbon capture across the world can potentially lock in and prolong fossil fuel dependency and further delay the transition to clean sources of energy.

This is contrary to what is needed to confront climate change, which is to phase out fossil fuels, as the world's supply is already beyond the threshold of reaching carbon neutrality by 2050 and ultimately the 1.5°C global warming limit. According to the International Energy Agency (IEA), "Investment in oil and gas today is almost double the level required in the Net-Zero Emissions (NZE) Scenario in 2030, signalling a clear risk of protracted fossil fuel use that would put the 1.5°C goal out of reach."[14]

[12] Kate Yoder. "Oil Companies Say They're Going Green, But Their Investments Tell Another Story." Grist. September 8, 2022. https://grist.org/accountability/oil-companies-marketing-greenwashing-report/

[13] Oil Change International (OCI). "Carbon Capture's Publicly Funded Failure." August 29, 2024. https://oilchange.org/publications/ccs-data/#top

[14] International Energy Agency (IEA). "World Energy Outlook 2023." October 2023. https://www.iea.org/reports/world-energy-outlook-2023/executive-summary

Furthermore, carbon capture only deals with emissions from the production of fossil fuels (scope 1), which make up less than 10% of the total life cycle emissions of fossil fuels;[15] 85%-90% of emissions will be released when the fuel is actually burned by the end user, for example in cars or for energy generation (scope 3). Hence, any mitigation benefit of carbon capture is severely outweighed by the total life cycle emission that fossil fuels produce.

3.1.1 Capturing Carbon to Produce More Fossil Fuels

Due to the overall high costs of carbon capture applications, companies often offset their expenditure by monetising the carbon capture process through various means, with enhanced oil/gas recovery being the most prominent, accounting for 73% of captured carbon worldwide.[16]

EOR/EGR is a process where the captured CO_2 will be pumped into a depleted oil/gas reservoir to extract more oil/gas than was previously possible, essentially allowing more fossil fuels – 30%-60%, or more, of the reservoir's original oil capacity – to be extracted.[17]

Hence, the push for carbon capture by oil and gas companies as a "climate solution" is in actuality a push to extract more fossil fuels. In any event, as shown below, carbon capture is not a reliable solution and is a dangerous distraction from implementing real solutions, such as energy conservation and efficiency as well as the further scaling up of renewable energy like solar.

3.2 Overpromise and Underperformance

The proponents of carbon capture, especially from the private sector, like to contend that it can operate at an efficiency of 90%, which means that 90% of the CO_2 from a carbon-intensive process will be captured and subsequently stored,[18] with some even saying that capture rates of over 95% are both "feasible and possible".[19]

However, the reality of the matter is that none of the current real-world applications of carbon capture have ever lived up to the ambitious promise of a 90% capture rate. The global average

[15] International Energy Agency (IEA). "Emissions from Oil and Gas Operations in Net Zero Transitions: A World Energy Outlook Special Report on the Oil and Gas Industry and COP28." June 2023. https://www.iea.org/reports/emissions-from-oil-and-gas-operations-in-net-zero-transitions

[16] Institute for Energy Economics and Financial Analysis (IEEFA). "Carbon Capture: A Decarbonisation Pipe Dream." September 1, 2022. https://ieefa.org/articles/carbon-capture-decarbonisation-pipe-dream

[17] United States Department of Energy. "Enhanced Oil Recovery." https://www.energy.gov/fecm/enhanced-oil-recovery

[18] Massachusetts Institute of Technology. "How efficient is carbon capture and storage?." MIT Climate. February 23, 2021. https://climate.mit.edu/ask-mit/how-efficient-carbon-capture-and-storage#:~:text=CCS%20projects%20typically%20target%2090,will%20be%20captured%20and%20stored

[19] Global CCS Institute. "CCS Explained: Capture." https://www.globalccsinstitute.com/ccs-explained-capture/

capture rate of carbon capture projects is around 49%,[20] with rates even going as low as 10%.[21]

3.2.1 Carbon Capture Is a Carbon Emissions Bomb

The Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (AR6) explores several potential pathways to meet the 1.5°C target, and one of them relies on the extremely high deployment of carbon capture at a rate of 39% of primary energy from fossil fuels by 2050 (10% by 2030), with the assumption of very high capture rates ranging from 90%-95%.

Given the poor track record of CCS (overpromising and underdelivering), this assumed capture rate is not grounded in reality. If the assumed capture rate is reduced to the average capture rate of CCS today (49%),[22] the huge amount of uncaptured carbon emissions is predicted to use up to 30% (86 $GtCO_2e$)[23] of the remaining global carbon budget for the 1.5°C target (275 $GtCO_2e$[24]).[25]

3.3 Most Expensive Yet Least Effective

According to the IPCC, when compared to the adoption of more proven climate change mitigation measures such as the mass adoption of renewables like wind and solar, carbon capture is the most expensive, yet delivers the least reduction of CO_2 emissions.[26] This is true across the board for all carbon capture applications, be it for carbon capture in industry (cement, steel), for fossil fuel energy sources, or for bioenergy with carbon capture (BECCS).

Carbon capture is expected to reduce a total of just 1.1% of current global annual emissions from fuel combustion and industrial processes.[27] Despite this meagre sum, it is projected that dependence on carbon capture to reach net zero targets would be "highly economically damaging", costing at least USD30 trillion (RM133.2 trillion) more than a route based primarily on renewable energy, energy efficiency and electrification.[28]

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[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Neil Grant et al. "Unabated: the Carbon Capture and Storage 86 billion tonne carbon bomb aimed at derailing a fossil phase-out." Climate Analytics. December 2023. https://climateanalytics.org/publications/unabated-the-carbon-capture-and-storage-86-billion-tonne-carbon-bomb-aimed-at-derailing-a-fossil-phase-out
[24] Based on the latest study, the remaining carbon budget for a 50% likelihood of limiting global warming to 1.5ºC has declined to 75 $GtCO_2e$ (275 $GtCO_2e$) from the beginning of 2024, equivalent to around seven years, assuming 2023 emission levels.
[25] Pierre Friedlingstein et al. "Global Carbon Budget 2023." December 5, 2023. https://essd.copernicus.org/articles/15/5301/2023/
[26] Intergovernmental Panel on Climate Change (IPCC). "Climate Change 2023: Synthesis Report." https://www.ipcc.ch/report/ar6/syr/
[27] BloombergNEF. "CCUS Market Outlook 2023: Announced Capacity Soars by 50%." November 9, 2023. https://about.bnef.com/blog/ccus-market-outlook-2023-announced-capacity-soars-by-50/
[28] Andrea Bacilieri et al. "Assessing the relative costs of high-CCS and low-CCS pathways to 1.5 degrees." Oxford Smith School of Enterprise and the Environment. December 4, 2023. https://www.smithschool.ox.ac.uk/news/heavy-dependence-carbon-capture-and-storage-highly-economically-damaging-says-oxford-report

3.3.1 No Evidence of Technological Learning or Associated Cost Reductions for CCS in the Past 40 Years

According to the Institute for Energy Economics and Financial Analysis (IEEFA), on average, upcoming carbon capture projects show no reduction in the average cost of capture per tonne compared to those currently in implementation.[29] Further, a study by the University of Oxford found that despite over 40 years of significant effort and investment in research and development programmes, by both the public and private sectors, carbon capture technology has not been improving, in the sense that costs have not declined at all and there is also no evidence to suggest that costs will likely fall in the future to a level that allows for carbon capture to contribute seriously to emissions mitigation.[30] Instead, it is forecasted that carbon capture will get even more expensive.[31]

3.4 Capital-, Energy- and Water-Intensive, Potentially Exacerbating Costs of Electricity Generation and Transport

According to the IPCC, carbon capture cost presents a key challenge, remaining higher than USD50 (RM219.75) per ton of CO_2 for most technologies and regions, with the capital cost of coal or gas electricity generation facilities with CCS being almost double that of facilities without CCS. Additionally, the energy penalty[32] increases the fuel requirement for electricity generation by 13%-44%, leading to further cost increases.[33] Water withdrawals for plants equipped with CCS are also 25%-200% higher than for plants without CCS.[34] Further, the upfront cost of capital for the implementation of carbon capture itself is very high, often upwards of USD1 billion (RM4.39 billion).[35]

The high use of capital, energy and water from the implementation of carbon capture can have environmental implications and potentially exacerbate the cost of electricity and oil and gas production, which would be later passed down to consumers or subsidised by the government using taxpayer money. Moreover, it dwarfs the costs of electricity generation from renewable sources.

4.0 Associated Risks and Potential Liabilities of Carbon Capture

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29 Kevin Morrison. "The Good, the Bad, and the Ugly Reality about CCS (Carbon Capture and Storage)." Institute for Energy Economics and Financial Analysis (IEEFA). March 12, 2024. https://ieefa.org/sites/default/files/2024-03/CCSpresentation4-MPCMarch24_CK.pdf

30 Ibid.

31 S&P Global. "UK CCUS deployment costs double, while demand case shrinks." March 13, 2024. https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/031324-uk-ccus-deployment-costs-double-while-demand-case-shrinks-carbon-tracker

32 The energy penalty refers to the extra energy required to power CCS equipment.

33 Ibid.

34 Ibid.

35 Nan Wang et al. "What went wrong? Learning from three decades of carbon capture, utilization and sequestration (CCUS) pilot and demonstration projects." Energy Policy Vol. 158. November 2021. https://doi.org/10.1016/j.enpol.2021.112546

4.1 Project Failure and Cancellation Risks

Carbon capture implementation is associated with multiple high-level risks and exposure to liabilities for the public at large. Such risks and liabilities may doom carbon capture projects to failure even from the planning phase. A study that looked into three decades of carbon capture projects found that from 1995 to 2019 alone, 43% of announced CCUS projects were cancelled or put on hold.[36] Moreover, among large-scale pilot and demonstration plants, i.e., those with a project size greater than 0.3 Mt CO_2 per year, the aforementioned rate of carbon capture plants put on hold or cancelled climbs to 78%.[37]

The same study also labels carbon capture projects as being of high risk and low return, and states that projects larger than 1 Mt CO_2 per year are very likely to fail within the first 10 years.[38] As a consequence of the high risks and failure rates, it is difficult to attract financing through equity and debt for carbon capture projects, which makes them heavily reliant on public funding.[39]

On top of technological and financial risks, carbon capture has problems with public acceptance. The Barendrecht carbon capture project in the Netherlands was cancelled in 2010 due to intense public opposition.[40] Now, with even more research findings and real-life precedents showing how hazardous carbon capture can be to the public, coupled with the frenzy of unproven carbon-capture-related infrastructure and projects being pushed forward without proper and meaningful public consultation, public opposition has become much more intense than ever before, trapping carbon capture implementation in a negative feedback loop of ever-heightened risks and failures.

4.2 Public Finance Black Hole

Carbon capture has a long history of putting public resources to waste. Substantial public money has gone into subsidising such projects. In the past 40 years alone (1984-2024), nearly USD30 billion (RM131.85 billion) of public money has been spent on carbon capture and fossil hydrogen globally.[41]

A substantial sum of that public money was spent on carbon capture projects that have failed to reach promised CO_2 capture rates or are contributing to continued or increased fossil fuel extraction through gas processing or EOR, or both.

Even worse, billions of dollars were spent on projects that did not even see the light of day or have ceased operations entirely. From 2008 to 2010 alone, over USD7 billion (RM30.77 billion) of public money was spent, primarily in the United States, Canada, Norway and the EU, for carbon capture projects where around 45% of this figure was spent on projects that

[36] Ibid.
[37] Ibid.
[38] Ibid.
[39] Ibid.
[40] Massachusetts Institute of Technology (MIT). "Barendrecht Fact Sheet: Carbon Dioxide Capture and Storage Project." https://sequestration.mit.edu/tools/projects/barendrecht.html
[41] Ibid.

are not even operational today. The FutureGen project is a prime example, where the US government, having promised USD1 billion (RM4.39 billion) in public funding with USD200 million (RM879 million) already delivered,[42] subsequently abandoned the project as costs kept on rising and public opposition to the project intensified.[43]

Whilst carbon capture has been a huge black hole for public funding thus far, the haemorrhage could get even worse in future. Tracking carbon capture policies announced since 2020, it is estimated that over USD230 billion (RM1.009 trillion) in public money will be needed to support carbon capture and fossil hydrogen,[44] and with more governments being bullish on the prospect of this false solution, that amount is expected to jump much higher. This will take away much-needed public finance from the communities that need it most (those that have done the least to cause the climate crisis but are enduring its greatest impacts) and from key enabling infrastructure for a just transition, as well as investments in cleaner energy alternatives.

4.3 Cost Blowouts

As iterated earlier, there has been no evidence of technological learning or associated cost reductions for CCS in the past 40 years, and also no evidence to suggest that costs will likely fall in the future to a level that allows for carbon capture to contribute seriously to CO_2 reduction.

In fact, studies show that the cost of carbon capture has been rising exponentially, and this trend is expected to continue in the near future. In the United Kingdom, it is shown that the cost estimates for deploying carbon capture have more than doubled from the GBP20 billion (RM109.66 billion) in taxpayer funding initially scoped just a year prior (2023).[45] Standard and Poor's Global (S&P Global) determined that global carbon capture's capital expenditure increased by 23%-31% in the last three years (2020-2023, and is expected to increase further out to 2030, which poses challenges for carbon capture projects under development.[46]

Additionally, the disparity between promised carbon capture rates during project planning and the real rates reflected during implementation can have huge financial consequences. Oil company Chevron's Gorgon carbon capture plant in Barrow Island, Western Australia, serves as a cautionary example of this. An analysis of the environmental performance report published by Chevron shows that the capture rate has cumulatively been 50% lower than the promised 80% for the first three years of its operations (2019-2021),[47] with it consistently being

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[42] Ibid.
[43] Jeff Tollefson. "US government abandons carbon-capture demonstration." Nature. February 5, 2015. https://www.nature.com/articles/nature.2015.16868
[44] Ibid.
[45] Lorenzo Sani. "Curb your enthusiasm: Bridging the gap between the UK's CCUS targets and reality." Carbon Tracker. March 13, 2024. https://carbontracker.org/reports/curb-your-enthusiasm/
[46] Ibid.
[47] Bruce Robertson and Milad Mousavian. "Gorgon Carbon Capture and Storage: The Sting in the Tail." Institute for Energy Economics and Financial Analysis (IEEFA). April 2022. https://ieefa.org/resources/gorgon-carbon-capture-and-storage-sting-tail

the single highest point of industrial carbon emissions in the whole of Australia.[48] As a penalty for failing to achieve the promised rates of capture, Chevron had to acquire and surrender credible greenhouse gas (GHG) offsets, which are expected to be as high as USD184 million (RM809.22 million).[49] These penalties are expected to increase as the plant continues to underdeliver with capture rates slumping even further than before.[50]

4.4 Stranded Assets

Even as the hype surrounding carbon capture rose, projections for its implementation on the road to achieving carbon neutrality have been going downhill with similar rapidity. The IEA, in each of its editions of the World Energy Outlook from 2021 until the latest 2023 edition, has reduced the estimated contribution of fossil fuels with carbon capture to global energy supply as part of its Net Zero Emissions by 2050 Roadmap (NZE).[51] Gas with carbon capture took the biggest hit with an almost 60% reduction from original estimates in 2021.

When this is added to the long history of project failures, cancellations and underperformance, the ever-increasing public opposition and the rapid progress of already proven mitigation solutions such as renewable energy and energy storage that would crowd out investment and the need for carbon capture, it is not hard to fathom a future where expensive carbon capture plants are unutilised and consequently stranded.

4.5 Hazard to the Public and Environment

Environmental, social and health risks are inherent in carbon capture projects, especially in the transportation and storage of CO_2. As highlighted in a UN Special Rapporteur's report on the toxic impacts of some proposed climate change solutions, the carbon capture process relies on large amounts of chemicals and can release significant quantities of highly toxic ammonia into surrounding communities. At high concentrations, CO_2 is a toxic gas and an asphyxiant which can cause circulatory insufficiency, coma and death. There are also risks relating to leakage where leakage to adjacent geological formations may cause geochemical reactions, including stimulation of seismic activity, and mobilisation of potentially polluting elements, such as heavy metals, which can contaminate drinking water and underground water.[52]

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48 Peter Milne. "Chevron's Gorgon Hits Record Gas Exports at the Expense of Emissions." WAtoday. April 11, 2023. https://www.watoday.com.au/national/western-australia/chevron-s-gorgon-hits-record-gas-exports-at-the-expense-of-emissions-20230410-p5czaz.html

49 Sonali Paul. "Chevron, Partners to Fork Out for Carbon Offsets for Gorgon LNG Carbon Capture Shortfall." Reuters. November 11, 2021. https://www.reuters.com/business/sustainable-business/chevron-invest-29-mln-address-co2-injection-shortfall-australia-lng-site-2021-11-11/#:~:text=MELBOURNE%2C%20Nov%2011%20(Reuters),capture%20and%20storage%20(CCS)

50 Peter Milne. "Chevron's Troubled Carbon Capture and Storage at Gorgon Set to Worsen in 2023." WAtoday. July 11, 2023. https://www.watoday.com.au/national/western-australia/chevron-s-troubled-carbon-capture-and-storage-at-gorgon-set-to-worsen-in-2023-20230711-p5dngj.html

51 Amandine Denis-Ryan. "Is CCS competitive with alternative solutions?." Institute for Energy Economics and Financial Analysis (IEEFA). September 4, 2024. https://ieefa.org/sites/default/files/2024-09/2024Conf%20Is%20CCS%20Competitive.pdf

52 Marcos Orellana. "The toxic impacts of some proposed climate change solutions: report of the Special Rapporteur on the Implications for Human Rights of the Environmentally Sound

Transporting CO_2, be it via a network of pipelines or maritime vessels, poses risks to public safety and environmental integrity. Pipelines carry lethal concentrations of compressed CO_2 and are susceptible to ruptures that pose serious risks to the public at large, including loss of life due to asphyxia. The unproven approach of shipping CO_2 in maritime vessels further heightens risks due to the multiple unknowns associated with it, and any leakage can cause ocean acidification on top of the aforementioned health and environmental hazards.

The United States has about 8,300 km of CO_2 pipelines; while this is the largest such network in the world,[53] it pales in comparison to the global web of oil and gas pipes. Despite this, there have already been repeated cases of pipeline ruptures and CO_2 blowouts, with one such incident in Satartia, Mississippi, in February 2020 leading to mass poisoning of the local population.[54]

4.5.1 Integrity and Permanence of Disposed Carbon

The permanent disposal of CO_2 is the most complicated part of the carbon capture process due to the many unknowns and the unpredictability of carbon once it is injected underground. Further, each carbon disposal facility has its own unique geology, requiring bespoke solutions[55] in the sense that what might work in a specific carbon capture project might not work in another.

The Sleipner and Snøhvit CCS projects in Norway serve as prime examples of this. For context, these projects have relatively small storage capacity of 0.85 million tonnes per annum (MTPA) and 0.7 MTPA respectively. The gas that will be extracted only has a CO_2 content of less than 9%. The Norwegian government spent billions on R&D in these facilities along with the CCS infrastructure. As a result, more geological studies monitoring these two carbon capture and disposal fields have been conducted than in nearly any other place on the planet, with over 150 academic papers being published.[56]

Despite of the small scale, low CO_2 content of the extracted gas and the most extensive studies done for a CCS project in the world, both of these projects still faced significant challenges in disposing of the captured carbon due to unexpected subsurface storage behaviours which almost led to CO_2 leakage and, in the case of Snøhvit, potential subsurface geological failure.[57]

Management and Disposal of Hazardous Substances and Wastes." United Nations Human Rights Council. July 13, 2023. https://digitallibrary.un.org/record/4017702?v=pdf

[53] Justin Jacobs. "Oil and gas pipeline industry tries to reinvent itself with carbon capture plans." Financial Times. September 1, 2021. https://financialpost.com/financial-times/oil-and-gas-pipeline-industry-tries-to-reinvent-itself-with-carbon-capture-plans

[54] Ibid.

[55] Grant Hauber. "Norway's Sleipner and Snøhvit CCS: Industry models or cautionary tales?." Institute for Energy Economics and Financial Analysis (IEEFA). June 14, 2023. https://ieefa.org/resources/norways-sleipner-and-snohvit-ccs-industry-models-or-cautionary-tales

[56] Ibid.

[57] Ibid.

Elsewhere, a leakage occurred at a carbon storage facility in Illinois, United States, in September 2024 resulting in 8,000 metric tons of CO_2 escaping the underground rock formation where it was supposed to be stored, affecting groundwater area to the extent that it violated federal safe drinking water rules.[58] In the Cogdell oil field in Texas, ever since it started the injection of CO_2 into the subsurface, 18 earthquakes of 3.0 magnitude upwards have occurred in the vicinity over the span of five years, with one almost reaching 5.0 magnitude. The area had faced no earthquakes in the 20 years[59] prior to CO_2 injection in its subsurface.

5.0 Carbon Capture Implementation in Malaysia

5.1 Federal and State Policies and Legislation on Carbon Capture

The Malaysian federal and Sarawak state governments have both enacted and proposed further policies and legislation to facilitate the implementation of carbon capture in the country. At the federal level, substantial information on the nation's carbon capture strategy can be accessed through the National Energy Transition Roadmap. The Carbon Capture, Utilisation and Storage Bill (CCUS Bill) is expected to be tabled in Parliament in 2025.

The Sarawak government enacted the first piece of legislation in the country pertaining to carbon capture, the Land (Carbon Storage) Rules 2022 which are a part of its Land Code. There are suggestions that the federal government's proposed CCUS Bill should not be applicable to Sarawak.[60]

From an international standpoint, Malaysia is looking to position itself as a regional carbon disposal hub where countries like South Korea and Japan can dump their carbon. Towards this end, PETRONAS together with Petroleum Sarawak Berhad (PETROS) are having continuous engagement and are inking agreements with several Japanese and South Korean companies and government ministries. These arrangements have gone on without adequate transparency and meaningful consultations with the public.

5.1.1 National Energy Transition Roadmap (NETR)

The NETR, launched in August 2023 and developed by the Ministry of Economy, is the nation's energy transition strategy policy. Carbon capture is heavily emphasised in the NETR, with it being one of the six energy transition levers along with a "CCS for Industry" flagship established with two key initiatives outlined in the NETR.

The first initiative is the establishment of a carbon capture regulatory framework led by the Ministry of Economy, which entails the development of a policy and regulatory framework to

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[58] Leah Douglas. "ADM Pauses CO2 Injection at Carbon Capture Storage Site After Finding Potential Leak." Reuters. October 2, 2024. https://www.reuters.com/sustainability/climate-energy/adm-pauses-co2-injection-carbon-capture-storage-site-after-finding-potential-2024-10-02/

[59] Wei Gan and Cliff Frohlich. "Gas injection may have triggered earthquakes in the Cogdell oil field, Texas." Proceedings of the National Academy of Sciences (PNAS). November 4, 2013. https://doi.org/10.1073/pnas.1311316110

[60] Malay Mail. "Putrajaya's Proposed Carbon Trading Law Not Applicable in Sarawak, Says State Deputy Minister." May 23, 2024. https://www.malaymail.com/news/malaysia/2024/05/23/putrajayas-proposed-carbon-trading-law-not-applicable-in-sarawak-says-state-deputy-minister/135985

facilitate the implementation of carbon capture projects which includes transboundary disposal of carbon.

The second initiative is the development of the Kasawari and Lang Lebah carbon capture plants in Sarawak by PETRONAS. This is through the implementation of carbon capture in the highly-CO_2-concentrated gas fields in Kasawari and Lang Lebah in collaboration with the Sarawak government. These plants are expected to be in operation by 2026 and 2028 respectively. The CO_2 captured from the gas production will subsequently be disposed of in depleted oil and gas fields.

The Malaysian government projects that there will be three carbon capture hubs by 2030, two in the Peninsula and one in Sarawak, with a combined CO_2 storage capacity of up to 15 MTPA. The number of carbon capture hubs is expected to grow, with three more to be added by 2050 with a total storage capacity of 80 MTPA.

The NETR outlines that the government push for widespread adoption of CCS hinges on its economic viability in the sense that the costs of carbon capture technologies go on a steady decline. This projection has however been debunked as shown above, with costs not only having not gone down in the past 40 years but expected to increase exponentially in the near future.

The cost to implement carbon capture as envisioned in the NETR is estimated to be RM170 billion to deliver a total of 5% emissions reduction in the energy sector by 2050. This would take up 13.1% of the total RM1.3 trillion of investment needed for the NETR by 2050, despite carbon capture only being expected to deliver 5% of total emissions reduction.

The government's grand carbon capture strategy as outlined in the NETR is susceptible to all the critiques against the technology and is likely doomed to face the same fate that befell failed carbon capture initiatives from across the world, all at the expense of public money.

The NETR, which is supposed to be an energy transition policy, is strongly pushing for carbon capture which in actuality is a tool that prevents the transition to low-carbon energy solutions and instead locks in fossil fuel dependency. Further, carbon capture's weakness of being the most expensive and least effective emissions reduction solution is clearly seen in the NETR through the mismatch between the emission reductions it is projected to deliver (5% of total expected reductions) and the price tag of its implementation (RM170 billion or 13.1% of total needed investments). The 5% figure itself should also be thoroughly scrutinised for potential discrepancy between promised and actual capture rates.

5.1.2 Public Consultation and Transparency of Carbon Capture Projects

As with any other projects that infringe on the public commons, any proposed carbon capture project must adhere to the principle of free, prior and informed consent (FPIC) particularly when it involves the rights of indigenous peoples.[61] Governments and companies must be transparent on any proposed carbon capture projects and allow untethered access for

[61] United Nations Declaration on the Rights of Indigenous Peoples.

communities and concerned citizens to information pertaining to the development of such projects. This must be the premise of good governance, as case law in the country has established the fundamental right of every citizen under the federal constitution to a clean environment, as set out in the famous case of *Tan Tek Seng v Suruhanjaya Pendidikan & Anor.*[62]

Further, as carbon capture is intrinsically a risk to public safety and environmental integrity, public consultations must be mandated by law, and such consultations should be meaningful and genuine in the sense that enough room and time is given for the public to engage with any concerns and that comments are taken into serious consideration.

One of the steps in ensuring transparency and public involvement in carbon capture projects can be through improvements to the Environmental Impact Assessment (EIA) regime. Currently, the EIA guidelines and process for carbon capture be it CCS or CCUS is not mandatory and is not listed among the prescribed activities in Schedule 2, which requires public display and consultations.

Due to this leniency, the Kasawari carbon capture project in Sarawak was approved in 2022 without any public consultation by the federal Department of Environment, raising the ire of local communities, indigenous peoples and public interest and environmental groups. Requests by civil society to obtain the EIA from the government authorities have also been disregarded.

The current weak EIA process in this regard is highly inadequate, as there are too many unknowns in subsurface conditions and potential deviations from the original plans or operations, based on the lessons learned from the implementation of carbon capture in other countries. Further, there are grave concerns about whether the competency, capacity and comprehensiveness requirements of the EIA process itself are sufficient to enable proper assessments and evaluation in respect of carbon capture projects from a life-cycle perspective, including on the part of the government authorities.

For a nascent and controversial technology with inherent social and environmental risks such as carbon capture, a thorough and transparent review of the governance regime to ensure meaningful public consultation and scrutiny is fundamental for sound decision-making, transparency, good governance and accountability on the part of the government authorities.

5.1.3 Public Money for Carbon Capture

As iterated earlier, the high cost, risk and failures associated with carbon capture make it very difficult to attract private financing, thus putting heavy reliance on public funding. Malaysia is no different; with the intent of spurring carbon capture project development in the country, extensive financial incentives have been given by the government, with new ones being announced every year.

[62] [1996] 1 MLJ 261.

In three consecutive government budgets (Budget 2023 - Budget 2025), extensive tax allowances and duty exemptions have been allocated for companies undertaking carbon capture activities. It will not be surprising if this trend of incentives continues and expands, considering the big bill of RM170 billion that carbon capture is expected to cost the country up until 2050.

Money spent by government-linked companies (GLCs) like PETRONAS for carbon capture could have been channelled towards better use by the government, instead of being gambled on an unproven technology. PETRONAS is expected to spend RM4.5 billion just to set up the Kasawari carbon capture facility.

Enormous amounts of public money are thus being funnelled into carbon capture projects that, with their high risks and failure rates, can end up becoming an enormous financial liability with negative ramifications for the public at large.

Tackling climate change requires huge amounts of resources and, for a developing country like Malaysia that has limited funds, requires prudent and strategic allocation of public financing. The huge sums allocated for carbon capture can be better directed towards tried and tested mitigation solutions or much-needed climate adaptation measures such as flood prevention that is expected to cost the country a cumulative RM392 billion up until 2100.[63]

5.2 Kasawari Carbon Capture Plant

Malaysia's first foray into carbon capture will be the Kasawari project, located in Block SK316, about 200 km off Bintulu in Sarawak.[64] It is meant to capture carbon generated by one of the most CO_2-laden gas fields planned for extraction globally, with gas of up to 40% CO_2 content.[65]

The Kasawari project is separated into two phases: Phase 1 is the natural gas extraction platform rig itself, which carries a cost of RM2.5 billion, while Phase 2 is the CCS platform connected to the gas extraction platform rig, which costs RM4.5 billion.

Once in operation, Kasawari will be the largest offshore CCS project in the world by volume of CO_2 captured, with the claimed ability to capture up to 3.7 MTPA of CO_2.[66] Overall, around 76 million tonnes of CO_2 from the facility are projected to be reinjected into the depleted M1 field via a 138-km-long 16-inch subsea pipeline.

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[63] Borneo Post. "Almost RM400 Bln Needed to Overcome Flood Issues until 2100, Says Minister." September 5, 2022. https://www.theborneopost.com/2022/09/05/almost-rm400-bln-needed-to-overcome-flood-issues-until-2100-says-minister/

[64] NS Energy. "Kasawari Carbon Capture and Sequestration (CCS) Project, Malaysia." February 4, 2023. https://www.nsenergybusiness.com/projects/kasawari-carbon-capture-and-storage-project/

[65] Trent Jacobs. "What You Should Know About Offshore and Sour Gas CCS: High Cost, Leak Mitigation, and Transportation." JPT, June 1, 2022. https://jpt.spe.org/what-you-should-know-about-offshore-and-sour-gas-ccs-high-cost-leak-mitigation-and-transportation

[66] Melisa Cavcic. "'World's Largest Offshore' Carbon Capture Project Is a Go in Malaysia." Offshore Energy. February 11, 2023. https://www.offshore-energy.biz/worlds-largest-offshore-carbon-capture-project-is-a-go-in-malaysia/

The sheer difference in value between Phase 1 and Phase 2 underlines just how expensive carbon capture technology is, with its installation costing almost twice as much as the original gas extraction platform rig itself.

The sheer size and cost of Malaysia's first attempt at carbon capture, undertaken without thorough research and development and without public consultation, point to a significant lack of good governance, accountability and transparency.

As iterated earlier, the failure rates and risks go up exponentially for a big carbon capture plant. The current largest carbon capture plant by volume of CO_2 captured, the Gorgon in Western Australia, has consistently faced issues and to date is capturing significantly less CO_2 than what was promised.

Meanwhile, as pointed out above, the most studied carbon capture plants in the world, the Norwegian Sleipner and Snøhvit CCS projects, have significantly smaller expected capture rates of 0.85 MTPA and 0.7 MTPA respectively, while capturing gas that only has a CO_2 content of less than 9%, and even then, they have not lived up to the promised capture rates and have incurred extensive difficulties in disposing of the captured CO_2.

Contrast this with the Kasawari carbon capture plant which is expected to capture up to 3.7 MTPA of CO_2 in one of the most CO_2-laden gas fields planned for extraction globally, with gas of up to 40% CO_2 content that is nearly 5 times more than both Sleipner and Snøhvit – yet is being developed with zero public consultation.

It is truly unacceptable that such a large-scale project is allowed to go ahead while being shrouded from public scrutiny and lacking a public accountability mechanism.

5.3 Transboundary Transport and Disposal of CO_2

Transboundary transport and disposal of CO_2 is the process of capturing CO_2 in one country and transporting it to another country for disposal. This process is governed under international law through the London Protocol.[67] A serious question that arises is whether Malaysia has ensured compliance with the London Protocol.

Transboundary transportation and disposal of CO_2 however has not been implemented in the real world before and currently remains only a theoretical concept. Despite this, the Malaysian Ministry of Economy has made it one of the key features of carbon capture in the country through the NETR. As iterated earlier, multiple agreements have been inked between Malaysia, South Korea and Japan to make Malaysia essentially the carbon dumpster of these two countries. Sahabat Alam Malaysia along with Friends of the Earth Japan jointly sent an open letter to the governments of Japan and Malaysia urging both to cease such plans.[68]

[67] International Energy Agency (IEA). "Carbon Capture and Storage and the London Protocol." October 2011. https://www.iea.org/reports/carbon-capture-and-storage-and-the-london-protocol
[68] https://foe-malaysia.org/wp-content/uploads/2024/03/240321-SAM-FoE-J_Open-Letter_-Reduce-CO2-at-Source_F2Send.pdf

Malaysia is not unique in this situation; similar agreements have been inked by the same countries (Japan and South Korea) with both Australia and Indonesia. A global petition expressing concerns on such developments was signed by 90 organisations from across 26 countries.[69]

This is an issue that indeed raises a lot of concern. Firstly, several of these transboundary transport and disposal agreements envisage marine vessels as the mode of transport of CO_2, a method that has not been implemented before as the technology for it does not even exist in the real world as explained earlier above.

By betting on a non-existent mode of CO_2 transportation, Malaysia is essentially making itself a lab rat, exposing itself to various potentially compounding economic and environmental risks. As pointed out above, even the decades-old technology of transporting CO_2 through pipelines has seen multiple instances of leakage and rupture that have had health and environmental implications. Committing to be on the receiving end of an unknown technology just heightens and compounds such risks.

Further, Malaysia as the CO_2 disposal site will have to face liabilities that may arise from storage in the long term. The intended liability period of the disposers of CO_2 has not been made public. Anything that happens beyond this period can have severe environmental and economic implications that can far outweigh any short-term economic benefits that being a carbon dumpster provides. This aspect requires greater transparency and scrutiny.

Malaysia is still facing the adverse consequences of being a plastics dumping ground subjected to the rich world’s waste colonialism, which has had severe implications on our environmental integrity and public health. Willingly opening up the country now as a carbon dumpster on a wave of carbon colonialism will be a repeat of the same mistake, but with much graver potential implications.

5.4 Liability Issues

In addition to the specific concerns above surrounding the London Protocol, there are pressing questions regarding how the government would address liability for potential accidents, leaks or other negative environmental impacts associated with carbon capture projects. These questions extend to the safeguards that will be implemented to mitigate such risks and to assurances and guarantees of the safety of carbon capture technology.

Such urgent questions highlight the need for a more critical and comprehensive approach from the government in its carbon capture strategy, an approach that would protect the interest of the public. The government must ensure such questions are seriously considered to ensure there is accountability should any liability arise.

[69] https://foe-malaysia.org/wp-content/uploads/2024/05/SAM-Signatory-in-Petition-08-May-2024-Carbon-capture-and-storage-is-not-a-solution-to-the-climate-crisis-but-a-dangerous-distraction-EN.pdf

6.0 Recommendations and Conclusion

Carbon Capture Is a False Climate Solution

Carbon capture is a false climate solution that only seeks to prolong the lifeline of the fossil fuel industry. It is expensive, ineffective, energy-intensive and could potentially increase CO_2 emissions instead of decreasing them.

Carbon Capture Is a Public Liability

Carbon capture poses a serious threat to public safety and environmental integrity. It is a serious hazard that can result in severe implications for the people and environment.

Climate Action Should Not Be Captured by Fossil Fuel Interests

Fossil fuel lobbyists do not care about real climate action and instead promote false solutions such as carbon capture that extend the industry’s lifeline and maximise their profits at the expense of the climate. Committing the country's future to carbon capture technologies perpetuates fossil fuel dependency and diverts us from a true transition.

Resources for Climate Action Must Be Spent on Real Solutions That Align with Public Needs and Interests

Any solution to the climate crisis must be both effective and proven. To robustly confront the crisis, resources must be maximised on scaling up genuine and proven solutions that serve public needs and interests instead of false solutions that put profits as the priority.

Foreign Carbon Dumping Must Not Be Tolerated

Carbon should be considered as a waste product whose accumulation presents health, safety and environmental hazards. Therefore, foreign carbon dumping, particularly by developed countries onto developing nations, should be seen as a form of carbon colonialism that must be unequivocally condemned as it can have severe implications for the wellbeing of recipient countries, directly contrary to the principle of environmental justice.

Developed nations must take full responsibility for their carbon rather than evading such obligations by transferring it to developing countries.

Meaningful Public Involvement and Consultation Is Paramount

Given the significant risks associated with carbon capture technologies, it is imperative that any plans involving these technologies be subject to rigorous public scrutiny. Establishing transparent mechanisms for public assessment and oversight is essential to ensure accountability from governments regarding proposed projects. The situation surrounding the Kasawari project underscores this need, as it exemplifies the absence of such a meaningful public engagement process.

In light of widespread concerns over carbon capture technologies, rushing through the CCUS Bill and the Kasawari project without comprehensive consultations would be premature and undermine both public trust and government credibility. Thorough engagement must precede both legislative actions and project implementation to ensure that community needs and concerns are adequately considered.

Conclusion

Sahabat Alam Malaysia firmly opposes carbon capture as a viable climate solution, viewing it as a deceptive, dangerous distraction and ultimately a false solution. This technology carries significant uncertainties, long-term liabilities, and serious environmental and social risks, all of which could impose substantial costs on both the government and the public.

Instead, the government should prioritise real solutions that advance a just and equitable transition to a low-carbon future, such as increasing the renewable energy mix in the electricity grid, enhancing energy efficiency and fostering sustainable development that genuinely benefits the public.

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