

# Gorgon Carbon Capture and Storage: The Sting in the Tail

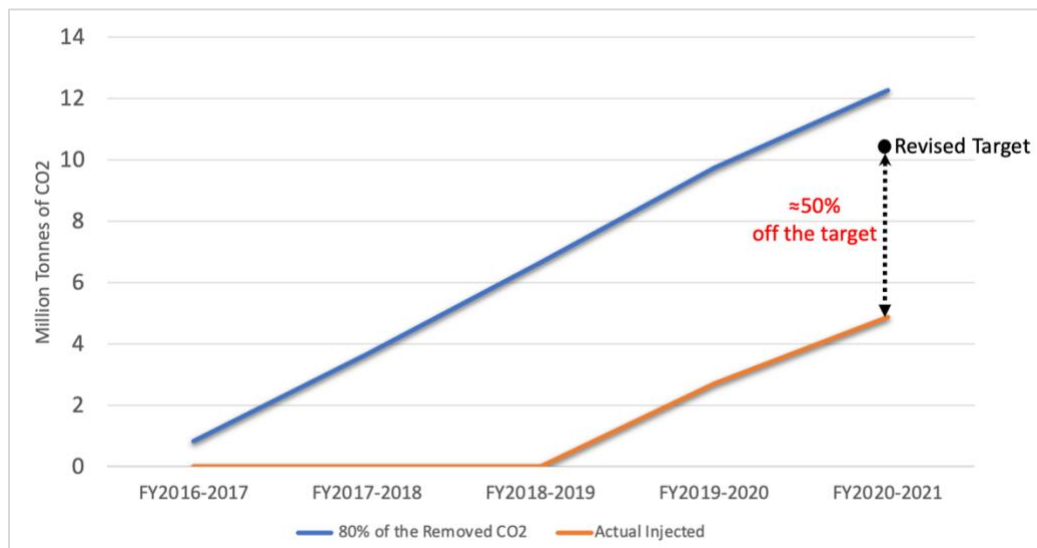
## Executive Summary

The Gorgon project in Western Australia is an example of the unique challenges that each carbon, capture and storage (CCS) project faces.

Gorgon began operations in 2016 and is owned by a blue-chip list of companies including oil and gas global majors Shell, ExxonMobil and Chevron.

Despite this pedigree, the Gorgon CCS project has failed to deliver, underperforming its targets for the first five years by about 50%.

### Gorgon CCS Plant's Performance (Cumulative Trend, 2016-2021)



Source: Gorgon Environmental Performance Reports 2015-2020 & 2021.

CCS technology has been in operation for half a century, from when the Terrell Natural Gas Processing plant was commissioned in 1972 in Texas, U.S. Despite its maturity, CCS has proved an unreliable technology in several cases.

The majority of projects globally using CCS have had unique engineering challenges that led to underperformance and cost blow-outs.

The introduction of carbon offset pricing/markets – requiring gas project operators and other big polluters to pay for carbon credits to offset the emissions they fail to abate or capture – suggests the cost of CCS projects will likely blow-out even further.

Gorgon has recently agreed to acquire and surrender credible greenhouse gas offsets recognised by the West Australian Government to offset its target shortfall of 5.23 million tonnes of carbon dioxide (CO<sub>2</sub>). Estimates of what this may cost Gorgon vary from US\$100 million to US\$184 million. The recent changes to the Clean Energy Regulator's Emissions Reduction Fund (ERF) could reduce the offsetting cost for Chevron and its partners by tens of millions of dollars.

**Offsetting its carbon  
dioxide target shortfall  
may cost Gorgon  
US\$100 - US\$184 million.**

The project is expected to run for 40-45 years, after which there will be a closure period of 15 years.

The sting in the tail for Australian taxpayers is that they are liable for the project post-closure.

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## Introduction

One of the largest gas projects in the world, the Gorgon LNG project on Barrow Island off the Pilbara coast of Western Australia (WA), has export capacity of 15.6 million tonnes (MT) of liquefied natural gas (LNG) and provides the state with up to 300 terajoules (TJ) of domestic gas daily.<sup>1</sup>

The construction of the LNG plant and carbon capture and storage (CCS) project, including CO<sub>2</sub> capture and injection facilities, began in 2009 targeting a start date of 2016.<sup>2</sup>

Since its first commissioning in 1972, historically, CCS has predominantly been used as a method of enhanced oil recovery (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<sub>2</sub> again when the oil is burnt, making any initial “carbon capture” negligible.

**Historically, carbon capture has predominantly been used as a method of enhanced oil recovery.**

According to the Global CCS Institute, currently about 73% of carbon capture globally is applied to EOR projects.<sup>3</sup> Of the remainder, which are mostly newer projects with dedicated geological storage for sequestering CO<sub>2</sub>, Gorgon is by far the largest. It has a nominal maximum capacity of 4 million tonnes per annum (MTpa) accounting for 40% of the capacity of all CCS projects with dedicated geological storage operating around the globe.<sup>4</sup>

The Gorgon CCS project was initially planned to capture and inject underground up to 4MT of reservoir CO<sub>2</sub> each year, or more than 100MT over its life. This was supposed to reduce greenhouse gas (GHG) emissions from the Gorgon project by approximately 40%.<sup>5</sup>

In the lifecycle of gas, the majority of emissions occur when the gas is being *used* (burnt), and less when it is being *produced*<sup>6</sup>, such as at the Gorgon LNG facility. The suggested ~40% reduction of GHG emissions at the Gorgon project only applies to the production of the LNG, not its end use. Discussing the nominal capacity of CCS projects is of limited use if they never achieve or sustain such figures, as is the case with Gorgon.

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<sup>1</sup> WA Department of Mines, Industry Regulation and Safety. [Gorgon Carbon Dioxide injection project](#).

<sup>2</sup> Massachusetts Institute of Technology. CCS Project Database. [Gorgon Fact Sheet](#).

<sup>3</sup> Global CCS Institute. [Global Status of CCS 2021](#). 2020.

<sup>4</sup> Global CCS Institute. [Global Status of CCS 2021](#). 2020.

<sup>5</sup> Chevron. [Gorgon Gas Development and Jansz Feed Gas Pipeline Five-year Environmental Performance Report 2015–2020](#). Page 4. October 2020.

<sup>6</sup> National Energy Technology Laboratory. [Life Cycle Analysis of Natural Gas Extraction and Power Generation](#). 2019.

This report examines the extent to which the Gorgon project has failed to achieve its promised target and what that means for the project proponents and ultimately, taxpayers.

## Ownership

The Chevron-operated Gorgon Project comprising LNG plant and CCS facility is a joint venture between the Australian subsidiaries of Chevron (47.3%), ExxonMobil (25%), Shell (25%), Osaka Gas (1.25%), Tokyo Gas (1%) and JERA (0.417%).<sup>7</sup>

## Gorgon CCS Project's Five-year Performance

### *Troubled History and Underperformance*

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).<sup>8</sup>

The \$3.1 billion Gorgon plant produced its first LNG cargo in March 2016<sup>9</sup> but the first CO<sub>2</sub> injection from its CCS facility<sup>10</sup> did not occur until August 2019 – three and a half year 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.<sup>11</sup>

Technical problems did not end there. In January 2021, it was reported<sup>12</sup> 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. Essentially, sand was blocking the well that reinjects water underground, compromising the essential pressure management system.

**Gorgon's frequent inefficiencies are typical of the technical risks involved in CCS projects.**

IEEFA notes Gorgon's frequent inefficiencies – and problems that led to underperformance in capturing carbon and re-injecting it – are typical of the technical risks involved in CCS projects. Despite the technology being in use since the 1970s, each CCS project appears to have unique difficulties and uncertainties. In

<sup>7</sup> Chevron. [Gorgon Carbon Capture and Storage Fact Sheet](#). 2021.

<sup>8</sup> Chevron. [Gorgon Carbon Capture and Storage Fact Sheet](#). 2021.

<sup>9</sup> Chevron. [Gorgon Carbon Capture and Storage Fact Sheet](#). 2021.

<sup>10</sup> Financial Times. [Monster problem; Gorgon project is a test case for carbon capture](#). 26 July 2021.

<sup>11</sup> The West Australian. [Carbon hiccup for Chevron with 5 million-tonne greenhouse gas problem at Gorgon LNG plant](#). 19 December 2017.

<sup>12</sup> Boiling Cold. [Chevron's Gorgon emissions to rise after sand clogs \\$3.1bn CO<sub>2</sub> injection system](#). 12 January 2021.

the Gorgon project, sand was a known risk. Chevron had targeted its water extraction at depths thought<sup>13</sup> not to be prone to sand, and got it wrong.

## *A Closer Look at the Five-Year Performance of the Gorgon Project*

The maximum nominal amount of CO<sub>2</sub> that the Gorgon CCS facility *can* capture each year is 4MT, which is sometimes misinterpreted as the amount that the facility *should* capture each year.

Calculated on a five-year rolling average commencing on 18 July 2016, Chevron committed to ensure that at least 80% of reservoir CO<sub>2</sub> removed during processing at the gas treatment plant, that would otherwise be vented to the atmosphere, would be injected underground.<sup>14</sup>

The CCS project was meant to start operations concurrently with the LNG plant in March 2016. As technical problems meant CCS injection did not start until August 2019, the facility completely missed its target for the first three and a half years.

According to the project's environmental performance reports, the plant removed 15.3MT of CO<sub>2</sub> between July 2016 and July 2021. Given the pre-defined 80% target, the Gorgon CCS plant should have captured at least 12.3MT of the removed CO<sub>2</sub> in this period.

**As CCS injection did not start until August 2019, the facility completely missed its targets for the first three and a half years.**

However, Chevron is not accountable for the entire shortfall from the 80% minimum target. The WA government, on recommendations from the Environmental Protection Authority of Western Australia (WA EPA)<sup>15</sup>, revised Gorgon's environmental conditions in mid-2020 and as a result, emissions associated with Gorgon's second and third LNG trains before July 2018 were not counted. The reasoning was that the two trains operated to that date were under a construction licence, not an operating licence.<sup>16</sup>

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<sup>13</sup> Boiling Cold. [Chevron's Gorgon emissions to rise after sand clogs \\$3.1bn CO2 injection system](#). 12 January 2021.

<sup>14</sup> Chevron. [Gorgon Gas Development and Jansz feed Gas Pipeline Environmental Performance Report 2021](#). Page 45. November 2021.

<sup>15</sup> Chevron. [Gorgon Gas Development and Jansz Feed Gas Pipeline Five-year Environmental Performance Report 2015–2020](#). Pages 67 and 68. October 2020.

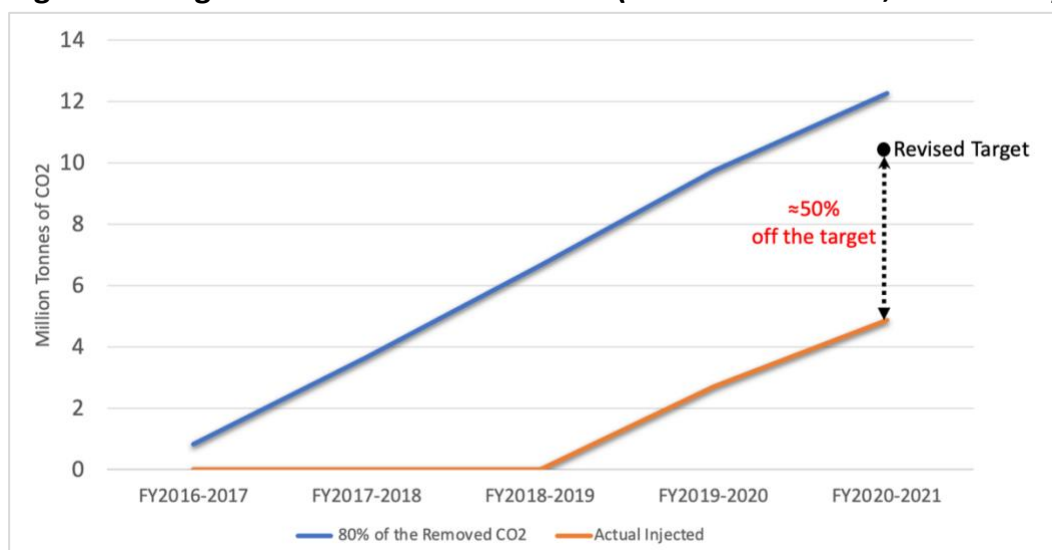
<sup>16</sup> Sydney Morning Herald. [Chevron's five years of Gorgon carbon storage failure could cost \\$230 million](#). November 2021.

Data in the company's environmental performance reports 2015-2021 show that the plant had injected only 4.9MT by July 2021. The shortfall from the five-year target is claimed to be 5.23MT CO<sub>2</sub>.<sup>17</sup>

Putting all this together, it can be inferred that the Gorgon CCS project target for the first five-year period was about 10.1MT and it failed to meet this target by about 50%.<sup>18</sup>

Figure 1 below shows the cumulative trend of Gorgon's sequestered CO<sub>2</sub> versus the cumulative target trend.

**Figure 1: Gorgon CCS Plant's Performance (Cumulative Trend, 2016-2021)**



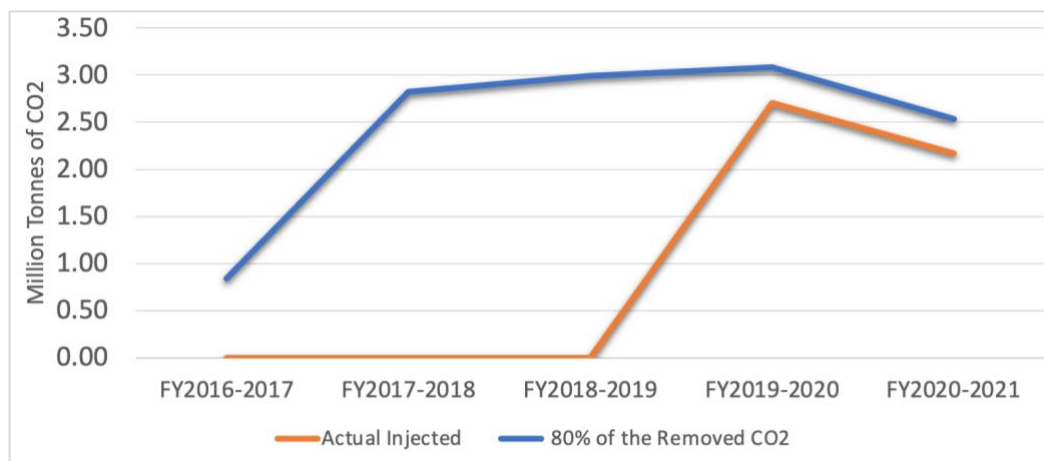
Source: Gorgon Environmental Performance Reports 2015-2020 & 2021.

Figure 2 depicts the yearly performance of Gorgon's CCS plant. The CCS plant was non-operational during the first three years of the operation of the LNG plant, and started injecting CO<sub>2</sub> in the two most recent financial years (FY2019-2020 and FY2020-2021). For these years, it still underperformed by about 13%, injecting about 70% of the CO<sub>2</sub> that would otherwise be vented, rather than the targeted 80%.

<sup>17</sup> Chevron. Gorgon Gas Development and Janz feed Gas Pipeline Environmental Performance Report 2021. Page 45. November 2021.

<sup>18</sup> In its latest environmental performance report published in November 2021, four months after the first five-year period ended, Chevron stated that 5.5MT had been injected in the five years of the project's lifetime.

**Figure 2: Gorgon CCS Plant's Yearly Performance (2016-2021)**



Source: Gorgon Environmental Performance Reports 2015-2020 & 2021.

According to Chevron, one of the reasons for the large shortfall between the volume of reservoir CO<sub>2</sub> extracted and injected was the delay in bringing three compressor modules and nine injection wells online. This took place progressively between August 2019 and February 2020.<sup>19</sup>

After commissioning the injection modules, the project faced further technical problems in November 2020. The presence of solids in produced formation water had to be resolved before injection could resume. Chevron said it undertook significant remedial work, including ordering customised solids removal equipment from overseas. Tackling such technical challenges meant the operation and maintenance costs of the project exceeded that of regular operation and maintenance expenses.<sup>20</sup>

In Gorgon's 2021 environmental performance report, Chevron cited planned and unplanned maintenance among other causes for the underperformance of the plant.<sup>21</sup>

Gorgon's technical troubles and ongoing "unplanned" maintenance after five years of operation illustrate some of the inherent and unique risks of CCS, despite the technology's decades of operation.

<sup>19</sup> Chevron. Gorgon Gas Development and Jansz Feed Gas Pipeline Five-year Environmental Performance Report 2015-2020. Page 67. October 2020.

<sup>20</sup> Chevron. Gorgon Gas Development and Jansz feed Gas Pipeline Environmental Performance Report 2021. Page 44. November 2021.

<sup>21</sup> Chevron. Gorgon Gas Development and Jansz feed Gas Pipeline Environmental Performance Report 2021. Page 44. November 2021.



## Penalties for Underperformance

Chevron claims the shortfall from its five-year target is 5.23MT CO<sub>2</sub>.<sup>22</sup> To compensate this shortfall in capturing and injecting CO<sub>2</sub>, Chevron has agreed to acquire and surrender credible GHG offsets recognised by the WA government by 17 July 2022.

To do this, Chevron is considering a number of options:

- Australian Carbon Credit Units (ACCU) issued under the Carbon Credits (Carbon Farming Initiative) Act 2011,
- Verified Emission Reductions issued under the Gold Standard program,
- Verified Carbon Units issued under the Verified Carbon Standard program, and/or
- Other offset units that the Minister has notified in writing meet integrity principles and are based on clear, enforceable and accountable methods.<sup>23</sup>

The company has yet to determine the proportion of each.

As the ACCU market is an evolving and relatively small market, a huge purchase (which seems unlikely due to supply) would lead to a dramatic spike in the unit price. This could be one of the potential reasons why Chevron is considering other internationally verified carbon offsets.

As evolving concepts, offsetting carbon and carbon markets have been controversial since the beginning. There is little consensus on the credibility of the offsets in effectively reducing emissions.

**There is little consensus on the credibility of carbon offsets in effectively reducing emissions.**

In Australia, the ACCU market – which is dominated by carbon credits generated through carbon farming, regenerative agriculture and vegetation<sup>24</sup> – has been a matter of debate recently as to its validity and credibility. International offsets such as those issued under the Verified Carbon Standard Program by Verra, a global

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<sup>22</sup> Chevron. [Gorgon Gas Development and Janz feed Gas Pipeline Environmental Performance Report 2021](#). Page 45. November 2021.

<sup>23</sup> Chevron. [Gorgon Gas Development and Janz feed Gas Pipeline Environmental Performance Report 2021](#). Page 46. November 2021.

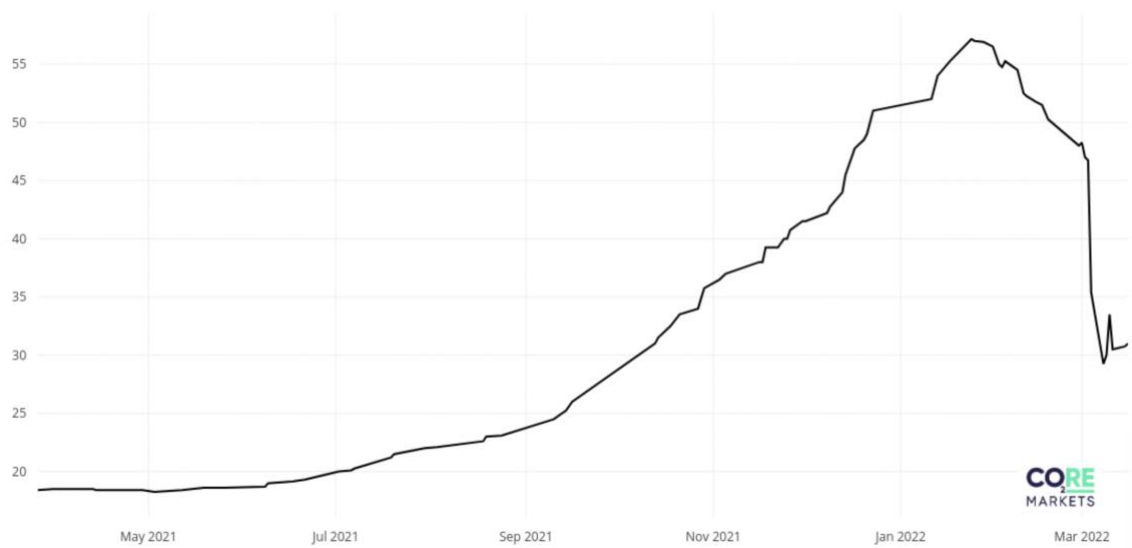
<sup>24</sup> Australian Financial Review. [Money grows on trees in Australia's secret carbon market](#). June 2021.

organisation that develops and manages carbon market standards<sup>25</sup>, have also come in for criticism.<sup>26</sup>

Apart from credibility questions about the offsets, Gorgon's underperformance in meeting its emission targets has brought about a material cost for Chevron and its partners. According to Australia's Clean Energy Regulator, the ACCU spot price increased by more than \$A7 in Q3 of 2021 to \$A26.50 before climbing to \$A47 in December 2021, an increase of more than 180% over the course of 2021.<sup>27</sup>

In 2022, the ACCU spot price continued to rise, reaching around \$A57 until the end of January. It then started to fall during February and plunged dramatically in March after the Federal Government - as the largest buyer of emission offsets - indicated it would let offset providers terminate their fixed-price contracts with the government and enter the open market.<sup>28</sup> A huge supply of additional ACCUs could enter the market as a consequence of the policy change, causing the price slump. ACCUs are now trading at around \$A30 as depicted in Figure 3.

**Figure 3: ACCU Price in Australia's Open Carbon Market (March 2021- March 2022)**



Source: *Renewable Energy Hub – Core Market – 2022.*

<sup>25</sup> Verra. [About Verra.](#)

<sup>26</sup> The Guardian. [Carbon offsets used by major airlines based on flawed system, warn experts.](#) May 2021.

<sup>27</sup> Australian Government, Clean Energy Regulator. [Australian carbon credit units \(ACCUs\).](#)

<sup>28</sup> RenewEconomy. [Taylor walks away from Emissions Reduction Fund, carbon prices to plunge.](#) March 2022.

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Such a sudden reduction in price would create an opportunity for big polluters such as Chevron to offset the emissions they have failed to reduce, at a much lower cost. For example, Chevron could buy ACCUs at \$A30 rather than the previous \$A57, saving \$A27 per ACCU or around \$A140 million if they bought the ACCUs and offset their shortfall now instead of January 2022, one month prior to the government's Emissions Reduction Fund (ERF) change.

Although such shocks are transitory, and the historical upward trend of carbon offset prices would dominate market dynamics as the energy transition continues, big polluters such as Chevron may seize this opportunity.

Either way, estimates on the cost of offsetting to the Gorgon partners vary from US\$100 million (S&P Global Platts<sup>29</sup>) to US\$184 million (Reuters<sup>30</sup>).

Chevron also has also agreed to invest A\$40 million in West Australian lower carbon projects as part of the company's commitment to working with the state government on arrangements relating to lower carbon investment.<sup>31</sup>

## **The Sting in the Tail for Australian Taxpayers**

The extent of the technical failure of Gorgon CCS cannot be overstated. It prompts the question: if the engineers from the project backers – the super major oil companies Chevron, Shell and Exxon – cannot get CCS to work as forecast, who can?

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<sup>32</sup> – essentially, Australian taxpayers.

Meanwhile, profits during the project's lifetime go to Chevron, Exxon and Shell's global shareholders.

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<sup>29</sup> Australian Financial Review. [Chevron to invest \\$40m, buy credits to offset CCS shortfall](#). November 2021.

<sup>30</sup> Reuters. [Chevron, partners to fork out for carbon offsets for Gorgon LNG carbon capture shortfall](#). November 2021.

<sup>31</sup> Chevron. [Gorgon Gas Development and Janz feed Gas Pipeline Environmental Performance Report 2021](#). Page 46. November 2021.

<sup>32</sup> WA Department of Mines, Industry Regulation and Safety. [Gorgon Carbon Dioxide injection project](#).

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## About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. [www.ieefa.org](http://www.ieefa.org)

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