

## Response to *Nature Climate Change* article by Almond et al.

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A [paper](#) published in the journal *Nature Climate Change* by SIPA Professor Doug Almond along with Xinming Du and Anna Papp, “Favorability towards natural gas relates to funding source of university energy centers,” claims to find that “fossil-funded centres are more favourable in their reports towards natural gas than towards renewable energy,” while “centres less dependent on fossil funding show a reversed pattern.”

The Almond et al. article raises important questions about the influence of funding on research, but it does not claim to identify or measure this influence. The authors acknowledge that the paper provides no *causal* evidence on funding sources and research outcomes.

As explained in further detail below, there are three additional reasons the paper does not support the suggestion, for which it is often cited, that CGEP’s research is biased or influenced by corporate funding:

1. The paper claims that its sentiment analysis tool finds a positive sentiment *toward* “natural gas” within sentences of CGEP reports. In reality, the tool evaluates the general sentiment of sentences *containing the phrase “natural gas,”* rather than isolating sentiment *directed at natural gas itself*. For example, we used the tool to assess the sentence “*We are all happy because we got rid of natural gas,*” and it rates it as highly positive despite clearly having a very negative sentiment toward natural gas. When comparing whether sentences in CGEP reports are positive or neutral toward natural gas, ChatGPT reaches almost precisely the opposite result to the findings in Almond et al.
2. The way the authors configured the control groups results in CGEP being compared to dissimilar organizations that focus on climate and sustainability issues rather than comparable organizations that focus on broader energy-related topics, including geopolitics, markets, economics, and development.
3. The authors selectively highlight empirical results that support their main conclusions and ignore their own findings that are counter to or could raise questions about reaching their conclusions.

We explain each of these issues further in turn.

### 1. Data science problems

First, the tool used by Almond et al. is flawed for the intended purpose. In the article, the authors used a sentiment analysis tool called VADER (Valence Aware Dictionary and sEntiment Reasoner). The paper extracted 1,556 sentences that contain the phrase “natural gas” from 87

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<sup>3</sup> We are grateful to Garud Iyengar, Noah Kaufman, Gautam Jain, and Kriste Krstovski for their helpful comments and assistance. Errors are our own.

CGEP reports published between January 2014 and December 2020. Because the authors did not take issue with any of the substantive arguments made in any CGEP publications but rather relied on a data science tool with which the energy experts at CGEP are unfamiliar, we asked experts at **Columbia's Data Science Institute** to evaluate the use of the tool VADER to derive the conclusions in the paper.

That analysis revealed several potential issues with how the sentiment analysis was conducted, outlined below:

- **Sentiment analysis computation:** The authors state that “Sentiment analysis of the text provides an objective and comprehensive metric of favorability.” That statement fails to acknowledge the limitations of VADER described below.<sup>4</sup> Just as importantly, the statement holds true only if the “metric of favorability” specifically measures sentiments *toward* natural gas, as the paper claims. Instead, the authors’ method evaluates the general sentiment of sentences containing the phrase “natural gas” rather than isolating sentiment *directed at natural gas itself*. Measuring only the overall sentiment of a sentence without assessing the syntactic role of the phrase “natural gas” creates challenges in accurately interpreting the sentence’s favorability toward natural gas.
  - **Example:** To test this proposition, we used the same VADER methodology to assess the sentiment of the following sentence toward natural gas: “*We are all happy because we got rid of natural gas.*” Any reasonable reading of the sentiment would see it as having a *negative* sentiment toward gas. The way the authors used VADER to analyze sentences, however, rated it *very* positively toward gas. (VADER regards any score above 0.05 as positive, between -0.05 and 0.05 as neutral, and below -0.05 as negative, with a normalized range from -1 to +1. This sentence scored 0.735 on VADER.)
  - In contrast, we asked ChatGPT to assess the sentiment of the same sentence and received the following result: “The sentiment toward natural gas in the sentence is negative. The phrase ‘*we are all happy because we got rid of natural gas*’ indicates that people view natural gas unfavorably and are pleased with its absence, with the positive emotion (‘happy’) directed at its removal, suggesting a negative stance toward natural gas itself.” Self-evidently, ChatGPT delivers a more common-sense result than the tool used by Almond et al.
- **Sentence extraction:** Because the original reports were in PDF format, which is designed for visual presentation rather than structured data storage, the sentences extracted were often fragmented or arranged non-linearly, especially in complex, multi-column layouts common in reports. Common problems we identified included fragmented sentences, text extracted and pieced together from tables, and footnote text combined with text from the last line of a page. Indeed, *of the 1,556 sentences used by the authors in their sentiment analysis toward natural gas, roughly one-third were clearly*

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<sup>4</sup> In addition, Vader was developed with manually curated rules from analyzing a Twitter dataset, but research suggests that there is “poor domain transferability” for sentiment analysis tools developed and validated in a particular study context and applied in other contexts. See: Lu He, Tingjue Yin, and Kai Zheng, “They May Not Work! An evaluation of eleven sentiment analysis tools on seven social media datasets,” *Journal of Biomedical Informatics* 132 (August 2022): 104142.

*determined not to be proper sentences. These “sentences” were either information from figures, data from tables, text combined with data from tables, page headers and page numbers intermingled with text when a sentence carried over to another page, titles of sections, equations, or non-sensical sentences extracted from text in a two-column format.* These texts provide no useful information about the sentiment of the reports and should have been removed from the dataset. Yet in the Almond et al. analysis, they were used, and VADER returned positive sentiment scores for almost 80% of these “sentences.”

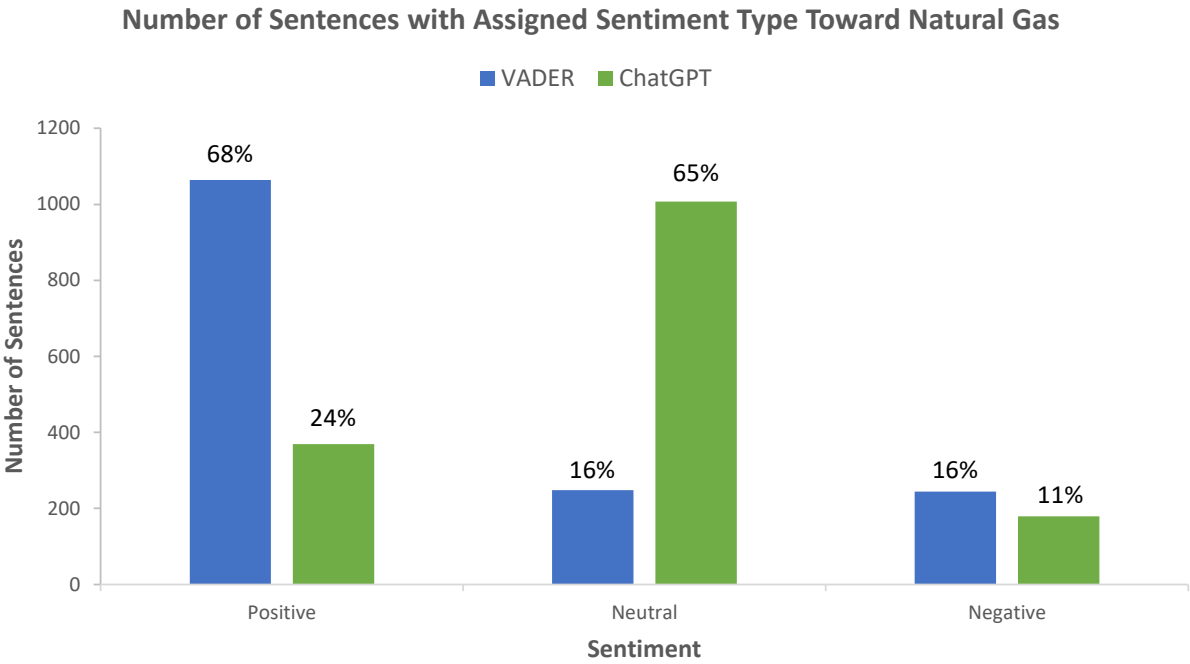
- **Example:** In several cases, mere *tables of data* along with the text in the row and column headings—such as one showing the prices of CO<sub>2</sub>, gas, and coal in different columns by year—were converted to text and assigned a “positive sentiment” toward natural gas.
- **Sentiment analysis tool used:** VADER relies on a predefined lexicon in which words are assigned sentiment scores but with which the tool has a limited ability to interpret context. As with many lexicon-based tools, VADER struggles with complex sentences or texts that require deeper contextual understanding. It thus misses nuanced emotional expressions that fall outside its lexicon. It was initially developed for and tested on social media posts, where it demonstrated high accuracy, but its accuracy on text from research reports remains unvalidated—as the above example (“We are all happy because we got rid of natural gas”) demonstrates.
  - **Results from an alternate tool:** Given VADER's limitations as a rudimentary rules-based sentiment analysis tool, we compared its results with those produced by ChatGPT, a state-of-the-art large language model. While ChatGPT can also make errors, it provides a summary description of why it assigns a specific sentiment, which makes it highly advanced in comparison with VADER. Knowing this, we used ChatGPT to analyze sentiment toward “natural gas” in the same set of 1,556 sentences from CGEP reports containing this term that the authors examined in their study. The prompt used in ChatGPT was: “*What is the sentiment toward natural gas in the following sentence?*”—focusing explicitly on sentiment directed toward natural gas itself. This approach differs from Almond et al.’s use of VADER, which assesses the overall sentiment of each sentence rather than isolating sentiment toward specific elements within it.

The results obtained are displayed in the figure below.<sup>5</sup> In the authors' analysis, VADER assigned a positive sentiment to 68% of the 1,556 sentences, a neutral sentiment to 16%, and a negative sentiment to the remaining 16%. In contrast,

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<sup>5</sup> In the Methods section, Almond et al. state that “Each body of text produced a vector of sentiment scores with negative, neutral, positive and compound polarities. The negative, neutral and positive polarities were normalized to fall between 0 and 1. The compound score could be considered an aggregate measure of all the other sentiments normalized between -1 and 1.” While it is not clearly stated what thresholds were used for the compound score to determine if a statement was positive, neutral, or negative, based on the raw data file, we interpreted that they assigned positive sentiment when the score was greater than 0, neutral when the score was 0, and negative when the score was less than 0. In VADER’s documentation, a compound score between -0.05 and +0.05 is determined to be neutral, a score  $\geq 0.05$  is determined to be positive, and a score  $\leq -0.05$  is determined to be negative. Even if we were to use VADER’s methodology, the results shown above would not change materially.

ChatGPT assigned a positive sentiment to 24% of the sentences—2.8 times lower than VADER—while 65% of the sentences were deemed to have a neutral sentiment—4 times higher than VADER—and 11% were assigned a negative sentiment. *ChatGPT is, therefore, interpreting the sentiment in sentences that contain the phrase "natural gas" in CGEP reports as broadly neutral, in stark contrast to VADER's positive assessment. This significant discrepancy in the results between VADER and ChatGPT on the same dataset, especially considering how much more advanced ChatGPT is in comparison, calls into question the veracity of the authors' claims.*



- **List of top 10 sentences with the most positive sentiment toward natural gas:** To provide a more granular sense of how this sentiment analysis tool was used on CGEP reports, we extracted the 10 sentences that scored the highest positive compound sentiment scores out of the 1,556 that were used in the analysis, meaning these are purported to be the top 10 *most* pro-natural gas sentences in all CGEP publications. Each of the 10 is reproduced in full in separate tables in the appendix of this document.

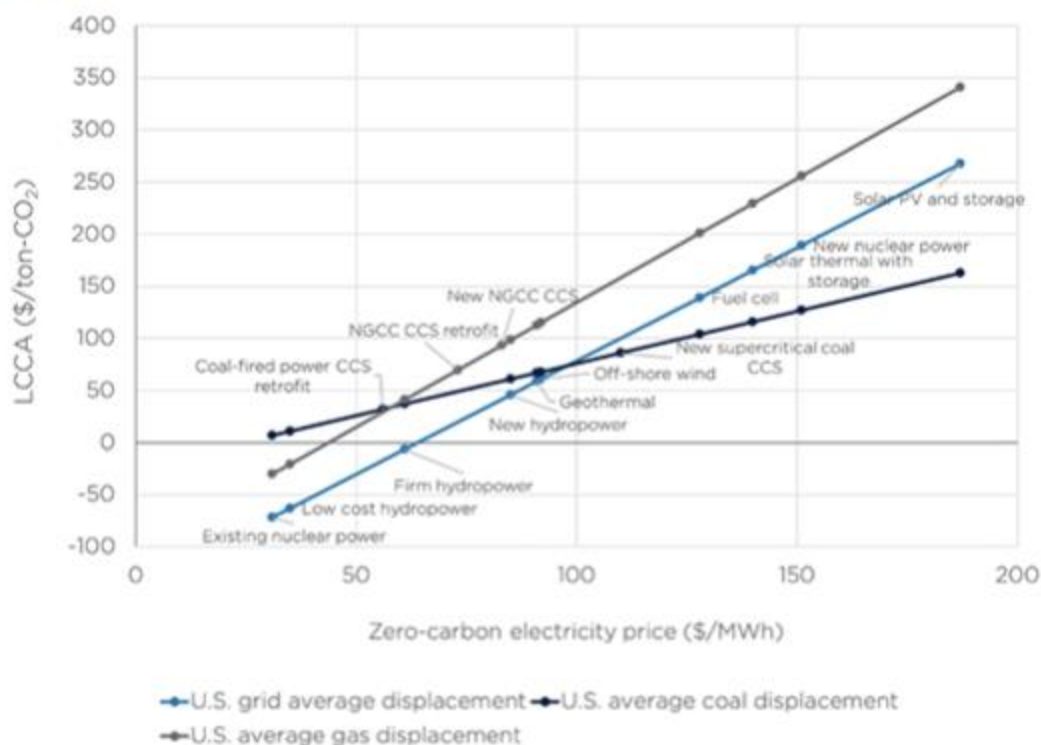
What is most immediately striking is that fully half of the 10 purportedly most pro-gas sentences are not the substantive writing of the author(s) at all: three are text and data from figures or tables; one is text from the titles of a few of the references used in the paper that are listed in a footnote; and one is text from an appendix explaining how a model developed and maintained by the International Energy Agency was used by Rhodium Group, a well-respected consultancy. In two more instances, the authors analyzed fragmented sentences that were nonsensical when taken as a whole because the software was unable to identify page breaks or two columns of text within a single page.

For comparison purposes, the tables below also include ChatGPT's interpretation of these 10 sentences. *ChatGPT deems the sentiment in 7 of these 10 sentences with the highest positive sentiment to be neutral, 2 to be positive, and 1 to be negative.*

The five sentences extracted that are actual sentences from reports, purportedly the most pro-natural gas in any of the CGEP publications analyzed, would be reasonably read by most outside observers, not just other AI tools like ChatGPT, to be neutral or mere statements of fact. For example:

- **Extracted text:** "Renewable Portfolio Standards and Clean Energy Standards: Mostly Redundant
  - Both renewable portfolio standards and clean energy standards (which include all forms of zero-carbon electricity, including nuclear energy) can be effective means of encouraging the deployment of zero-carbon electricity sources, but a carbon tax does the same and likely does so more efficiently from the perspective of reducing GHG emissions. While a carbon tax discourages fossil fuel electricity generating sources in proportion to their carbon intensity, RPSs and CESs typically do not differentiate between electricity produced with natural gas, petroleum, or coal. Alongside a carbon tax, an RPS or CES would also reduce government revenues by directing money from emitting generators to zero-carbon generators (in payment for renewable energy credits [RECs] or zero emissions credits [ZECs]) instead of into federal coffers. RPSs and CESs also do not directly increase power prices like a carbon tax."
- **VADER score:** 0.959 (very high positive sentiment)
- **ChatGPT's interpretation:** The sentiment towards natural gas in the sentence is neutral. It explains that renewable portfolio standards and clean energy standards, while effective in encouraging the deployment of zero-carbon electricity sources, may not differentiate between electricity produced with natural gas, petroleum, or coal. Additionally, it suggests that a carbon tax may be a more efficient way to reduce greenhouse gas emissions compared to RPSs and CESs.
- **Other examples:** Beyond the top 10 sentences with the most positive sentiment scores derived by the authors in their analysis, a few others are worth highlighting:
  - VADER assigned a very high score of 0.86—showing significant positive sentiment toward natural gas—to the information extracted from this figure:

**Figure 12:** LCCA of zero-carbon electricity as a function of electricity costs



Note: Comparisons of LCCA are between US grid (blue), a captive coal (navy) or natural gas plant (grey) with US average values. Local grids and local captive plants would have different slopes and intercepts. LCOE data source: Lazard 2018.

- Many factual statements—such as “Roughly half of buildings use natural gas for heating,” “The emissions rate for natural gas is 117 lb. of carbon dioxide per million Btu,” and “In 2018, China was the world’s third largest consumer of natural gas, behind the United States and Russia”—were seen as having a positive sentiment toward natural gas by VADER. In contrast, ChatGPT identified them as neutral.
- VADER also tagged the following texts as having positive sentiment toward natural gas:
  - For more information, please visit [www.sipa.columbia.edu](http://www.sipa.columbia.edu) THE IMPACT OF US LNG ON RUSSIAN NATURAL GAS EXPORT POLICY BY TATIANA MITROVA AND TIM BOERSMA DECEMBER 2018 1255 Amsterdam Ave New York NY 10027 [www.energypolicy.columbia.edu](http://www.energypolicy.columbia.edu) @ColumbiaUenergy THE IMPACT OF US LNG ON RUSSIAN NATURAL GAS EXPORT POLICY ACKNOWLEDGEMENTS For comments on earlier drafts of this paper and editorial guidance, the authors would like to thank Jason Bordoff, Jonathan Elkind, Anna Galkina, Matthew Robinson, Morena Skalamera, Rik Komduur, and Megan Burak (VADER score: 0.89).
  - Tim Boersma is a Senior Research Scholar and Director of Global Natural Gas Markets at the Center on Global Energy Policy (VADER score: 0.56).

- [ENERGYPOLICY.COLUMBIA.EDU](https://energypolicy.columbia.edu) | DECEMBER 2018 | 56 THE IMPACT OF US LNG ON RUSSIAN NATURAL GAS EXPORT POLICY 57 | CENTER ON GLOBAL ENERGY POLICY | COLUMBIA SIPA (VADER score: 0.56).
- THE ROLE OF NATURAL GAS IN EUROPE’S ELECTRICITY SECTOR THROUGH 2030 BY TIM BOERSMA, TATIANA MITROVA, JOHANA TYPOLTOVA, ANNA GALKINA, AND FEDOR VESELOV AUGUST 2018 ABOUT THE CENTER ON GLOBAL ENERGY POLICY The Center on Global Energy Policy provides independent, balanced, data-driven analysis to help policymakers navigate the complex world of energy (VADER score: 0.86).

## **2. Flawed organizational comparisons**

The paper’s conclusions are fundamentally flawed because they rest on comparisons of CGEP to dissimilar organizations, meaning the control groups for the analysis were not created properly, as they do not correctly capture the nuances of the research emphasis of different centers. CGEP is an energy center that studies myriad complex energy issues including climate change and also energy geopolitics, markets, economics, and development. Yet many of the organizations CGEP is compared to in the paper are sustainability and environment centers, not foreign policy institutions such as the Council on Foreign Relations or Belfer Center at Harvard’s Kennedy School.

For example, CGEP wrote extensively about the geopolitical and economic impacts of Russia’s cutting natural gas exports to Europe after its invasion of Ukraine, and about the geopolitical implications of negotiations between Russia and China over a major new natural gas pipeline between the two countries. It is only natural that reports on such broad geopolitical topics would discuss natural gas differently than reports from organizations that focus solely on the harmful emissions from natural gas.

As just one example, consider the following sentence Almond et al. found to have one of the highest positive sentiment scores possible (0.94) toward natural gas: “Energy and geopolitics have always been closely linked. The twentieth century saw access to energy resources become a major factor in determining the winners of wars, oil producers banding together to create new global alliances, and price swings that spurred or deterred the adventurism of superpowers. [...] Will the United States continue to invest in peace and stability in the Middle East and the security of sea transit given the new abundance of oil and natural gas production in the United States?”

The primary findings of the Almond paper, even if the analyses were carried out appropriately (which the discussion above shows was not the case), could be fully explained by this failure to compare CGEP to a control group of similar organizations, which has nothing to do with funding sources. The findings provide evidence that CGEP is addressing a broader set of issues than the centers focused solely on sustainability and the environment, not that its research is biased.

## **3. Selective data reporting**

Third, even ignoring the methodological flaws, the authors highlight empirical results that support their conclusion that “fossil-funded” centers have more positive sentiments toward

natural gas than toward renewables and ignore their own empirical results that do not align with this conclusion.

For example, the analysis tests the sentiment toward *both* oil and natural gas. The results show favorable sentiment toward natural gas but *no* favorable sentiment toward oil. The authors chose to write only about their findings regarding the sentiment toward natural gas and not for oil, presumably because the results for oil did not back up their thesis, even though most oil and gas companies that support energy centers referred to as “fossil-funded” by the authors earn *far more* revenue from oil than from gas.

Similarly, the paper repeatedly highlights the finding that “non-fossil-funded” centers display a more positive sentiment toward renewable energy than toward natural gas. In reality, their own analysis finds this is only partly true. They find this is true for solar and hydropower but not for wind. Their analysis finds that “non-fossil-funded” centers display a *more positive* sentiment for natural gas than for wind, which does not align with the paper’s thesis; the authors chose not to highlight this result that contradicts the paper’s primary conclusion.



## Appendix

The following tables provide details on sentences from CGEP reports that received the 10 highest positive sentiment scores for natural gas in the Almond et al. analysis.

Table 1: Highest Positive Score

Sentiment	0.980
Year	2015
Report	<a href="#">The New Geopolitics of Energy</a>
Line Text	Aside from US interests in Middle East peace, America by 2035, but also make North America a hub our alliance with Israel, and the potential reverberations for stability in energy markets that is founded on private- of unchecked Islamic extremism in the Middle East and led growth and political stability in democratically elected globally, there is also a sharp security cost to isolationism. states. <sup>14</sup> About 85 percent of the oil going through the Strait of Hormuz goes to Asia, and it would be unrealistic to think 8   →→→ center on Global Energy Policy   Columbia SIPA The new geopolitics of energy that China would not accelerate its investments to develop Natural gas prices present a complicated and regionally a deep-sea fleet to protect transit if the United States does diverse story.
Actual Text	America's energy abundance, supply growth in Canada, and the potential for growth under Mexico's reforms to drive private investment in hydrocarbons not only point to potential oil and gas self-reliance in North America by 2035, but also make North America a hub for stability in energy markets that is founded on private led growth and political stability in democratically elected states. [...] Aside from US interests in Middle East peace, our alliance with Israel, and the potential reverberations of unchecked Islamic extremism in the Middle East and globally, there is also a sharp security cost to isolationism. [...] Natural gas prices present a complicated and regionally diverse story. As shown in Figure 2, natural gas prices began to diverge regionally in 2008, especially as key markets shifted from oil-indexed prices for gas toward gas-on-gas competition. In the United States, sharp increases in shale gas production drove prices down.
ChatGPT Assessment	The sentiment towards natural gas in the sentence is neutral. The text mentions natural gas prices as presenting a complicated and regionally diverse story, without expressing a clear positive or negative sentiment towards natural gas.

Report Image with Text	<p>only point to potential oil and gas self-reliance in North America by 2035, but also make North America a hub for stability in energy markets that is founded on private-led growth and political stability in democratically elected states.<sup>14</sup></p> <hr/> <p>8   CENTER ON GLOBAL ENERGY POLICY   COLUMBIA SIPA</p> <hr/> <p>THE NEW GEOPOLITICS OF ENERGY</p> <hr/>	
	<p>increases. Aside from US interests in Middle East peace, our alliance with Israel, and the potential reverberations of unchecked Islamic extremism in the Middle East and globally, there is also a sharp security cost to isolationism. About 85 percent of the oil going through the Strait of Hormuz goes to Asia, and it would be unrealistic to think</p>	<p>that China would not accelerate its investments to develop a deep-sea fleet to protect transit if the United States does</p>

Table 2: Second Highest Positive Score

Sentiment	0.974
Year	2019
Report	<a href="#">Guide to Chinese Climate Policy 2019</a>
Line Text	<p>7 Stephen O, Sullivan, China: Growing import volumes of LNG highlight China, rising energy import dependency, Oxford Institute for Energy Studies (June 2019) at p.6; , Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019, Seeking Alpha (April 8, 2019) 8 , China, LNG import terminals and storage facilities, Reuters (August 16, 2019; , Research Report on Natural Gas Import in China, 2019-2023, Business Wire (May 9, 2019); ), Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019, Seeking Alpha (April 8, 2019); Michael Lelyveld, China Revives Oil And Gas Reform Plan, Radio Free Asia (March 11, 2019); David Sandalow, Akos Losz and Sheng Yan, A Natural Gas Giant Awakens, Columbia Center on Global Energy Policy (June 27, 2018) &lt; BACK TO TABLE OF CONTENTS 82 GUIDE TO CHINESE CLIMATE POLICY 2019 Figure 11-1: China, Natural Gas Pipeline Netwo</p>
Actual Text	<p>Stephen O' Sullivan, China: Growing import volumes of LNG highlight China's rising energy import dependency, Oxford Institute for Energy Studies (June 2019) at p.6; "Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019," Seeking Alpha (April 8, 2019)</p> <p>8 "China's LNG import terminals and storage facilities," Reuters (August 16, 2019; "Research Report on Natural Gas Import in China, 2019-2023," Business Wire (May 9, 2019); ); "Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019," Seeking Alpha (April 8, 2019); Michael Lelyveld, "China Revives Oil And Gas Reform Plan," Radio Free Asia (March 11, 2019); David Sandalow, Akos Losz and Sheng Yan, A Natural Gas Giant Awakens, Columbia Center on Global Energy Policy (June 27, 2018)</p>

ChatGPT Assessment	The sentiment towards natural gas in the sentence is neutral, as it simply mentions China's growing import volumes of LNG and provides various sources discussing the outlook of liquefied natural gas and pipeline gas in China.
Report Image with Text	<p>7 Stephen O' Sullivan, <a href="#">China: Growing import volumes of LNG highlight China's rising energy import dependency</a>, Oxford Institute for Energy Studies (June 2019) at p.6; "<a href="#">Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019</a>," <i>Seeking Alpha</i> (April 8, 2019)</p> <p>8 "China's LNG import terminals and storage facilities," Reuters (August 16, 2019; "Research Report on Natural Gas Import in China, 2019-2023," <i>Business Wire</i> (May 9, 2019); ); "<a href="#">Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019</a>," <i>Seeking Alpha</i> (April 8, 2019); Michael Lelyveld, "China Revives Oil And Gas Reform Plan," <i>Radio Free Asia</i> (March 11, 2019); David Sandalow, Akos Losz and Sheng Yan, <a href="#">A Natural Gas Giant Awakens</a>, Columbia Center on Global Energy Policy (June 27, 2018)</p>

Table 3: Third Highest Positive Score

Sentiment	0.973
Year	2014
Report	<a href="#">Meeting China's Shale Gas Goals</a>
Line Text	Accelerate Market-Based Reforms ,ÄÜRealizing the Chinese dream of the great national rejuvenation would mean China,Äôs becoming a prosperous country, a revitalized nation, and a happy people.,Äù ,ÄÏ President Xi Jinping, March 13, 2013 134 In this section we discuss four market-based reforms ,ÄÏ some already underway ,ÄÏ that can help China meet its shale gas objectives. (i) Continue Natural Gas Price Reform Natural gas price reform has the potential to stimulate technology and lead to a boom in shale gas production, as happened in the United States after natural gas price controls were lifted in the 1980s.
Actual Text	<p>A. Accelerate Market-Based Reforms</p> <p>"Realizing the Chinese dream of the great national rejuvenation would mean China's becoming a prosperous country, a revitalized nation, and a happy people." — President Xi Jinping, March 13, 2013</p> <p>In this section we discuss four market-based reforms — some already underway — that can help China meet its shale gas objectives. (i) Continue Natural Gas Price Reform Natural gas price reform has the potential to stimulate technology and lead to a boom in shale gas production, as happened in the United States after natural gas price controls were lifted in the 1980s.</p>
ChatGPT Assessment	The sentiment towards natural gas in the sentence is positive, as it is seen as a key factor in helping China meet its shale gas objectives and stimulate technology and production.

Report Image with Text	<p>A. <u>Accelerate Market-Based Reforms</u></p> <p><i>"Realizing the Chinese dream of the great national rejuvenation would mean China's becoming a prosperous country, a revitalized nation, and a happy people." — President Xi Jinping, March 13, 2013<sup>134</sup></i></p> <p>In this section we discuss four market-based reforms — some already underway — that can help China meet its shale gas objectives.</p> <p>(i) <u>Continue Natural Gas Price Reform</u></p> <p>Natural gas price reform has the potential to stimulate technology and lead to a boom in shale gas production, as happened in the United States after natural gas price controls were lifted in the 1980s.</p>
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Table 4: Fourth Highest Positive Score

Sentiment	0.968
Year	2020
Report	<a href="#">Building a New Grid without New Legislation</a>
Line Text	<p>Many examinations of electric transmission siting note the sharp contrast between the FPA,Äôs grant of limited federal authority to site electric transmission facilities and the Natural Gas Act,Äôs grant of expansive and exclusive authority to site interstate natural gas pipelines and use eminent domain to acquire rights-of-way for approved projects.<sup>67</sup> Congress granted the Federal Power Commission (FERC,Äôs predecessor agency) exclusive authority to site interstate natural gas pipelines (i.e., the power to issue CPCNs for pipelines) in 1938 and in 1947 granted pipelines with commission-approved certificates the right to exercise eminent domain.<sup>68</sup> Natural gas pipeline developers benefit greatly from the consolidated federal approval process that has resulted.<sup>69</sup> Interstate natural gas pipeline developers must still overcome several permitting hurdles; the list can include permits to dredge and fill federally regulated waters issued by the Army Corps of Engineers pursuant to section 40</p>
Actual Text	<p>Many examinations of electric transmission siting note the sharp contrast between the FPA's grant of limited federal authority to site electric transmission facilities and the Natural Gas Act's grant of expansive and exclusive authority to site interstate natural gas pipelines and use eminent domain to acquire rights-of-way for approved projects. Congress granted the Federal Power Commission (FERC's predecessor agency) exclusive authority to site interstate natural gas pipelines (i.e., the power to issue CPCNs for pipelines) in 1938 and in 1947 granted pipelines with commission-approved certificates the right to exercise eminent domain. Natural gas pipeline developers benefit greatly from the consolidated federal approval process that has resulted. Interstate natural gas pipeline developers must still overcome several permitting hurdles; the list can include permits to dredge and fill federally regulated waters issued by the Army Corps of Engineers pursuant to section 404 of the federal Clean Water Act and</p>

	to disturb critical habitat issued by the Fish and Wildlife Service pursuant to the Endangered Species Act, as well as others required by federal law and the laws of states through which the project passes
ChatGPT Assessment	The sentiment towards natural gas in this sentence is positive, highlighting the benefits of the consolidated federal approval process for interstate natural gas pipeline developers. The contrast in authority and support from Congress for natural gas pipelines is emphasized, showcasing a favorable sentiment towards the industry.
Report Image with Text	<p>Many examinations of electric transmission siting note the sharp contrast between the FPA's grant of limited federal authority to site electric transmission facilities and the Natural Gas Act's grant of expansive and exclusive authority to site interstate natural gas pipelines and use eminent domain to acquire rights-of-way for approved projects.<sup>67</sup> Congress granted the Federal Power Commission (FERC's predecessor agency) exclusive authority to site interstate natural gas pipelines (i.e., the power to issue CPCNs for pipelines) in 1938 and in 1947 granted pipelines with commission-approved certificates the right to exercise eminent domain.<sup>68</sup></p> <p>Natural gas pipeline developers benefit greatly from the consolidated federal approval process that has resulted.<sup>69</sup> Interstate natural gas pipeline developers must still overcome several permitting hurdles; the list can include permits to dredge and fill federally regulated waters issued by the Army Corps of Engineers pursuant to section 404 of the federal Clean Water Act and to disturb critical habitat issued by the Fish and Wildlife Service pursuant to the Endangered Species Act, as well as others required by federal law and the laws of states through which the project passes.<sup>70</sup> However, FERC coordinates the process as a whole,<sup>71</sup> has seldom rejected a pipeline proposal,<sup>72</sup> and has generally managed to overcome state efforts to prevent pipeline development.<sup>73</sup></p>

Table 5: Fifth Highest Positive Score

Sentiment	0.968
Year	2018
Report	<a href="#">The Role of Natural Gas in Europe's Electricity Sector Through 2030</a>
Line Text	15   ➔➔➔CENTER ON GLOBAL ENERGY POLICY   COLUMBIA SIPA THE ROLE OF NATURAL GAS IN EUROPE,ÂS ELECTRICITY SECTOR THROUGH 2030 Table 4: Assumed CO2, natural gas and coal prices in the EU by scenario 2030 2015 Scen1                      Scen2                      Scen3 CO2 price, \$/t                      8.5                      5 25                      45 8.0                      10.3                      11.1 EU gas, \$/MMBTU (GCV) 7.0 CGEP,Âs assumptions                      IEA NP                      IEA CP 74                      74 80 EU coal, \$/t IEA NP                      IEA NP                      IEA NP ENERGYPOLICY.COLUMBIA.EDU   AUGUST 2018 ➔➔➔   16 THE ROLE OF NATURAL GAS IN EUROPE,ÂS ELECTRICITY SECTOR THROUGH 2030 2.
Actual Text	A table
ChatGPT Assessment	The sentence provides data on the assumed prices of CO2, natural gas, and coal in the EU by scenario for 2030. It does not express a positive or negative sentiment towards natural gas.

Report  
Image with  
Text

THE ROLE OF NATURAL GAS IN EUROPE'S ELECTRICITY SECTOR THROUGH 2030

Table 4: Assumed CO<sub>2</sub>, natural gas and coal prices in the EU by scenario

	2015	2030		
		Scen1	Scen2	Scen3
CO <sub>2</sub> price, \$/t	8.5	5	25	45
EU gas, \$/MMBTU (GCV)	7.0	8.0 CGEP's assumptions	10.3 IEA NP	11.1 IEA CP
EU coal, \$/t		74 IEA NP	74 IEA NP	80 IEA NP

Table 6: Sixth Highest Positive Score

Sentiment	0.965
Year	2014
Report	<a href="#">American Gas to the Rescue?</a>
Line Text	<p>APPENDIX I MODEL DOCUMENTATION in this report are from the simulation runs conducted by RHG.141 We chose these models because they are publicTo assess the impact of LNG exports from the United States ly available and fully documented, and because they are on international natural gas markets, this study leverages a used to produce the Annual Energy Outlook (AEO) and set of interconnected energy-economic models developed International Energy Outlook (IEO), the most frequently and updated by the US Energy Information Administrareferenced projections of US and global energy supply and tion (EIA).140 Rhodium Group (RHG) maintains an indemand respectively. house version of each of these models and results presented Figure 1: Structure of the World Energy Projections System Plus (WEPS+) Source: EIA. energypolicy@columbia.edu   SEPTEMBER 2014 →→→   43 AMERICAN GAS TO THE RESCUE?</p>
Actual Text	<p>APPENDIX I MODEL DOCUMENTATION To assess the impact of LNG exports from the United States on international natural gas markets, this study leverages a set of interconnected energy-economic models developed and updated by the US Energy Information Administration (EIA).140 Rhodium Group (RHG) maintains an inhouse version of each of these models and results presented in this report are from the simulation runs conducted by RHG.141 We chose these models because they are publicly available and fully documented, and because they are used to produce the Annual Energy Outlook (AEO) and International Energy Outlook (IEO), the most frequently referenced projections of US and global energy supply and demand respectively.</p>



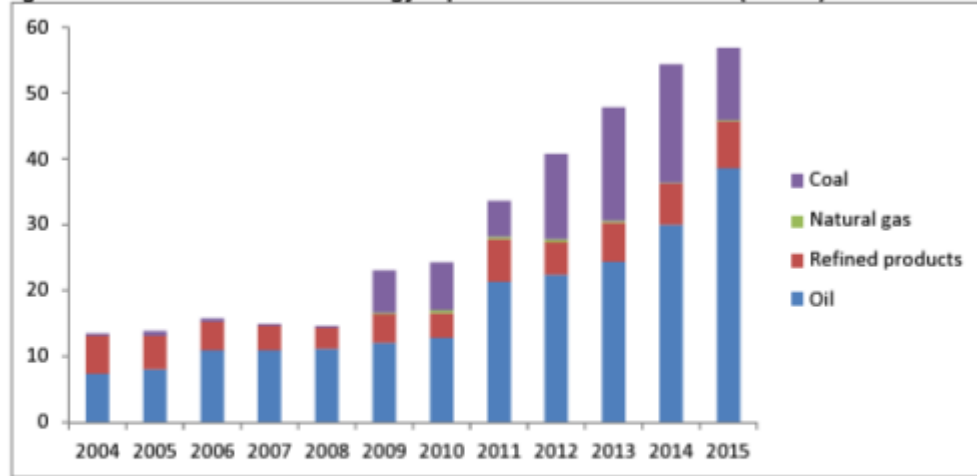
ChatGPT Assessment	The sentiment towards natural gas in the sentence is neutral. The sentence discusses the usage of natural gas models for assessing the impact of LNG exports from the United States on international natural gas markets.
Report Image with Text	<div>AMERICAN GAS TO THE RESCUE?</div> <div>APPENDIX I</div> <div> <p><b>MODEL DOCUMENTATION</b></p> <p>To assess the impact of LNG exports from the United States on international natural gas markets, this study leverages a set of interconnected energy-economic models developed and updated by the US Energy Information Administration (EIA).<sup>140</sup> Rhodium Group (RHG) maintains an in-house version of each of these models and results presented</p> <p>in this report are from the simulation runs conducted by RHG.<sup>141</sup> We chose these models because they are publicly available and fully documented, and because they are used to produce the Annual Energy Outlook (AEO) and International Energy Outlook (IEO), the most frequently referenced projections of US and global energy supply and demand respectively.</p> </div> <p>Figure 1: Structure of the World Energy Projections System Plus (WEPS+)</p>

Table 7: Seventh Highest Positive Score

Sentiment	0.960
Year	2016
Report	<a href="#">Energy Relations between Russia and China: Playing Chess with the Dragon</a>
Line Text	<p>5 Greenpeace, September 2013, „China clean air plan to slow coal consumption,“ 3 August 2016 - Energy Relations between Russia and China: Playing Chess with the Dragon</p> <p>Figure 4: Breakdown of Russian energy exports to China in 2004-2015 (mmtoe) 60 50 40 Coal 30 Natural gas Refined products 20</p> <p>Oil 10 0 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015</p> <p>Source: Federal Custom Service of the Russian Federation The total value of Russia's energy exports to China peaked in 2014 at \$27.75 billion, and although this fell in 2015 to \$18.9 billion (Figure 5) due to the decline in commodity prices, the share of energy exports to China as a proportion of the Russian total energy exports remained stable at around 8%.</p>
Actual Text	<p>A chart followed by " Source: Federal Custom Service of the Russian Federation The total value of Russia's energy exports to China peaked in 2014 at \$27.75 billion, and although this fell in 2015 to \$18.9 billion (Figure 5) due to the decline in commodity prices, the share of energy exports to China as a proportion of the Russian total energy exports remained stable at around 8%."</p>
ChatGPT Assessment	The sentence provides information on the breakdown of Russian energy exports to China, showing that natural gas is a significant part of the exports along with other energy sources. The overall tone is neutral, presenting facts without expressing a clear positive or negative sentiment towards natural gas.

Report  
Image with  
Text

Figure 4: Breakdown of Russian energy exports to China in 2004-2015 (mmtoe)



Source: Federal Custom Service of the Russian Federation

The total value of Russia's energy exports to China peaked in 2014 at \$27.75 billion, and although this fell in 2015 to \$18.9 billion (Figure 5) due to the decline in commodity prices, the share of energy exports to China as a proportion of the Russian total energy exports remained stable at around 8%. Although this figure seems relatively low it reflects the comparatively recent change in emphasis from the Russian state on the diversity of its export sales.

Table 8: Eighth Highest Positive Score

Sentiment	0.959
Year	2019
Report	<a href="#">Interactions between a Federal Carbon Tax and Other Climate Policies</a>
Line Text	Renewable Portfolio Standards and Clean Energy Standards: Mostly Redundant Both renewable portfolio standards and clean energy standards (which include all forms of zero-carbon electricity, including nuclear energy) can be effective means of encouraging the deployment of zero-carbon electricity sources, but a carbon tax does the same and likely does so more efficiently from the perspective of reducing GHG emissions. <sup>215</sup> While a carbon tax discourages fossil fuel electricity generating sources in proportion to their carbon intensity, RPSs and CESs typically do not differentiate between electricity produced with natural gas, petroleum, or coal. <sup>216</sup> Alongside a carbon tax, an RPS or CES would also reduce government revenues by directing money from emitting generators to zero-carbon generators (in payment for renewable energy credits [RECs] or zero emissions credits [ZECs]) instead of into federal coffers. <sup>217</sup> RPSs and CESs also do not directly increase power prices like a carbon tax
Actual Text	Renewable Portfolio Standards and Clean Energy Standards: Mostly Redundant Both renewable portfolio standards and clean energy standards (which include all forms of zero-carbon electricity, including nuclear energy) can be effective means of encouraging the deployment of zero-carbon electricity sources, but a carbon tax does the same and likely does so more efficiently from the perspective of reducing GHG emissions. While a carbon tax discourages fossil fuel electricity generating sources in proportion to their carbon intensity, RPSs



	and CESs typically do not differentiate between electricity produced with natural gas, petroleum, or coal. Alongside a carbon tax, an RPS or CES would also reduce government revenues by directing money from emitting generators to zero-carbon generators (in payment for renewable energy credits [RECs] or zero emissions credits [ZECs]) instead of into federal coffers. RPSs and CESs also do not directly increase power prices like a carbon tax
ChatGPT Assessment	The sentiment towards natural gas in the sentence is neutral. It explains that renewable portfolio standards and clean energy standards, while effective in encouraging the deployment of zero-carbon electricity sources, may not differentiate between electricity produced with natural gas, petroleum, or coal. Additionally, it suggests that a carbon tax may be a more efficient way to reduce greenhouse gas emissions compared to rps and cess.
Report Image with Text	<p><b>Renewable Portfolio Standards and Clean Energy Standards: Mostly Redundant</b></p> <p>Both renewable portfolio standards and clean energy standards (which include all forms of zero-carbon electricity, including nuclear energy) can be effective means of encouraging the deployment of zero-carbon electricity sources, but a carbon tax does the same and likely does so more efficiently from the perspective of reducing GHG emissions.<sup>216</sup> While a carbon tax discourages fossil fuel electricity generating sources in proportion to their carbon intensity, RPSs and CESs typically do not differentiate between electricity produced with natural gas, petroleum, or coal.<sup>216</sup></p> <p>Alongside a carbon tax, an RPS or CES would also reduce government revenues by directing money from emitting generators to zero-carbon generators (in payment for renewable energy credits [RECs] or zero emissions credits [ZECs]) instead of into federal coffers.<sup>217</sup> RPSs and CESs also do not directly increase power prices like a carbon tax (and may in some cases decrease prices<sup>218</sup>) and therefore do less to promote efficiency and conservation, and they do not "differentially disadvantage fossil technologies in relation to their emissions intensity." For all of these reasons, RPSs and CESs arguably make poor complements to a carbon tax.</p>

Table 9: Ninth Highest Positive Score

Sentiment	0.955
Year	2020
Report	<a href="#">Strengthening Nuclear Energy Cooperation between the United States and Its Allies</a>
Line Text	The FOCD restriction effectively decreases the value of nuclear assets compared with other ENERGY.POLICY.COLUMBIA.EDU   JULY 2020   43 STRENGTHENING NUCLEAR ENERGY COOPERATION BETWEEN THE UNITED STATES AND ITS ALLIES energy projects, because other energy generation technologies (e.g., solar, wind, natural gas, coal) are not subject to the same statutory limitations on foreign investment.
Actual Text	The FOCD restriction effectively decreases the value of nuclear assets compared with other energy projects, because other energy generation technologies (e.g., solar, wind, natural gas, coal) are not subject to the same statutory limitations on foreign investment. Foreign investors have invested billions in the US shale industry, including outright acquisitions.


ChatGPT Assessment	The sentiment towards natural gas is negative in this sentence, as it is mentioned as one of the energy generation technologies not subject to statutory limitations on foreign investment, which decreases the value of nuclear assets.
Report Image with Text	<p>The FOCD restriction effectively decreases the value of nuclear assets compared with other</p> <p>ENERGYPOLICY.COLUMBIA.EDU   JULY 2020   43</p>  <p>energy projects, because other energy generation technologies (e.g., solar, wind, natural gas, coal) are not subject to the same statutory limitations on foreign investment. Foreign investors have invested billions in the US shale industry, including outright acquisitions.<sup>10</sup></p>

Table 10: Tenth Highest Positive Score

Sentiment	0.952																																																						
Year	2019																																																						
Report	<a href="#">Low-Carbon Heat Solutions for Heavy Industry: Sources, Options, and Costs Today</a>																																																						
Line Text	<div>Assumption Summary Table B.1.1: Products cost and original fuel assumptions</div> <table><thead><tr><th>Original</th><th>Original price</th><th>Original heat</th><th>Original heat</th><th>Industry</th><th>Product</th></tr><tr><th>specific heat (\$/ton)</th><th></th><th>type</th><th>price</th><th>price (\$/GJ)</th><th></th></tr></thead><tbody><tr><td>Clinker</td><td>40</td><td>Coal</td><td>75 \$/ton</td><td>2.41</td><td>Iron and steel</td></tr><tr><td>iron</td><td>400</td><td>Coal</td><td>75 \$/ton</td><td>2.41</td><td>Glass</td></tr><tr><td>300</td><td>Natural gas</td><td>3.5 \$/MMBTU</td><td>3.32</td><td>Ammonia</td><td>Ammonia</td></tr><tr><td>500</td><td>Natural gas</td><td>3.5 \$/MMBTU</td><td>3.32</td><td>Methanol</td><td>Methanol</td></tr><tr><td>432</td><td>Natural gas</td><td>3.5 \$/MMBTU</td><td>3.32</td><td colspan="2">Table B.1.2: Products energy and carbon intensity assumptions</td></tr><tr><td></td><td></td><td></td><td></td><td>Process</td><td>Heat carbon</td></tr><tr><td></td><td>carbon Heat intensity</td><td></td><td>Heat emission</td><td>Indus</td><td>Total</td></tr></tbody></table>	Original	Original price	Original heat	Original heat	Industry	Product	specific heat (\$/ton)		type	price	price (\$/GJ)		Clinker	40	Coal	75 \$/ton	2.41	Iron and steel	iron	400	Coal	75 \$/ton	2.41	Glass	300	Natural gas	3.5 \$/MMBTU	3.32	Ammonia	Ammonia	500	Natural gas	3.5 \$/MMBTU	3.32	Methanol	Methanol	432	Natural gas	3.5 \$/MMBTU	3.32	Table B.1.2: Products energy and carbon intensity assumptions						Process	Heat carbon		carbon Heat intensity		Heat emission	Indus	Total
Original	Original price	Original heat	Original heat	Industry	Product																																																		
specific heat (\$/ton)		type	price	price (\$/GJ)																																																			
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				Process	Heat carbon																																																		
	carbon Heat intensity		Heat emission	Indus	Total																																																		
Actual Text	Two tables																																																						
ChatGPT Assessment	The sentiment towards natural gas in the sentence is neutral as it is just one of the fuel assumptions listed in the table. The table provides information on various products and their corresponding heat and carbon intensity assumptions.																																																						

## B1. Assumption Summary

**Table B.1.1:** Products cost and original fuel assumptions

Industry	Product	Original price (\$/ton)	Original heat type	Original heat price	Original specific heat price (\$/GJ)
Cement	Clinker	40	Coal	75 \$/ton	2.41
Iron and steel	Pig iron	400	Coal	75 \$/ton	2.41
Glass	Raw glass	300	Natural gas	3.5 \$/MMBTU	3.32
Ammonia	Ammonia	500	Natural gas	3.5 \$/MMBTU	3.32
Methanol	Methanol	432	Natural gas	3.5 \$/MMBTU	3.32

**Table B.1.2:** Products energy and carbon intensity assumptions

Industry	Process for heat replacement	Heat intensity (GJ/ton)	Heat carbon intensity (ton/ton)	Total carbon intensity (ton/ton)	Heat emission fraction
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