Gibbstown LNG Export Terminal: Lifecycle GHG Emissions Analysis

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EXECUTIVE SUMMARY

Since 2017, four companies have been working to advance an unprecedented fossil fuel project to transport liquefied natural gas (LNG) by train and truck between a proposed liquidation facility in Wyalusing, Pennsylvania and a proposed LNG export terminal in Gibbstown, New Jersey.[1] The companies have proposed this project, called the Wyalusing-Gibbstown Project in this report, despite upcoming state and national emissions reduction targets. Delaware Riverkeeper Network hired Synapse Energy Economics to examine the lifecycle emissions impact of the proposed facilities.

Overall, the Wyalusing-Gibbstown Project structure is unique because the liquefaction facility and export terminal are not located together at the same site. Most liquefaction and re-gasification facilities in the United States are located at or adjacent to their respective export or import terminals. By locating the two facilities separately, the companies are in effect bypassing a comprehensive review of the entire project's emissions and environmental impacts. Because the different components of this project are designed as a single operation and will work together to liquefy and export LNG, the environmental impact of all aspects of this project should be analyzed as one. The unique structure further means that the project should be closely analyzed to determine any potential harmful impacts to the environment or climate change because of the separated facilities and additional transportation steps.

Using two different methodologies, we analyzed data from the Wyalusing-Gibbstown Project applications and permits, combined with data from similar projects or national emissions rates, to estimate the emissions impact of the Wyalusing-Gibbstown Project.

We found that during 25 years of project operation, the total lifecycle emissions would be approximately 211 million metric tons of CO_2e (20-year global warming potential, or GWP). The Wyalusing-Gibbstown Project's emissions are equivalent to the emissions from 2 million gasoline cars driven every year for the 25 years of project operation.[2] See Table 1, below, for a full breakout of emissions by lifecycle step.

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[1] The four companies include: New Fortress Energy (parent company of Bradford County Real Estate Partners, LLC), Delaware River Partners, LLC, Energy Transport Solutions, LLC, and Bradford County LNG Marketing, LLC.

[2] U.S. Environmental Protection Agency. 2022. "Greenhouse Gas Equivalencies Calculator." Available at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Table 1. Lifecycle emissions for 25-year operating period

Lifecycle Step	Upfront Emissions	Ongoing Emissions	Total Emissions	***Emissions Percent out of Total***
	metric tons CO_2e (20-year GWP)	*metric tons CO_2e (20-year GWP)*	*metric tons CO_2e (20-year GWP)*	*%*
Facility Construction[1]	88,420	0	88,420	0.04%
Gas Production[2]	129,285	46,130	175,415	0.08%
Pipeline and Compressor Station	0	94,231	94,231	0.04%
Liquefaction Facility[1]	0	25,825,765	25,825,765	12.22%
Domestic Transport	0	932,757	932,757	0.44%
Export Facility[1]	0	349,229	349,229	0.17%
Sea Transport	0	6,742,687	6,742,687	3.19%
Regasification	0	2,623,454	2,623,454	1.24%
Foreign Pipeline Transport	0	163,531	163,531	0.08%
End-Use Combustion	0	174,353,929	174,353,929	82.50%
Total	**217,706**	**211,131,711**	**211,349,417**	**100.00%**

Note 1: Emissions associated with the construction of the liquefaction facility and export facility were estimated as a single component, due to a lack of data associated with construction emissions for each component.

Note 2: The gas production lifecycle step includes emissions from both the annual drilling of new wells (upfront emissions) and from the continuous extraction of natural gas from those wells.

In the lifecycle emissions, end-use combustion accounts for 82 percent of emissions, liquefaction facility operation accounts for 12 percent of lifecycle emissions, and all other steps account for the remaining 5 percent of lifecycle emissions.[3] The emissions from the proposed Wyalusing-Gibbstown Project local to Pennsylvania and New Jersey would total 1.1 million metric tons CO_2e (20-year GWP) for constructing the two facilities and the first year of operation. This would amount to a 12.9 percent increase in Pennsylvania and New Jersey's aggregated 2021 petroleum and natural gas emissions.

[3] Due to rounding, these values may not sum to 100 percent.

Overall, the Wyalusing-Gibbstown Project will lead to a significant increase in annual emissions for Pennsylvania and New Jersey, thereby exacerbating climate change. Policymakers should consider the entire lifecycle emissions of the Wyalusing-Gibbstown Project when deciding whether to allow the project to proceed. The liquefaction facility in Pennsylvania is a particularly energy intensive process that produces a considerable amount of greenhouse gas emissions on its own. Moreover, the train transportation of LNG between Wyalusing and Pennsylvania is a unique method with large GHG emissions impacts. Transporting LNG by train and truck also poses significant health impacts on the local populations in Pennsylvania and New Jersey due to the non-greenhouse gas emissions.

1. BACKGROUND

In November 2022, the U.S. Environmental Protection Agency (EPA) proposed additional standards to limit greenhouse gas (GHG) emissions throughout the United States.[4] The proposal establishes enhanced leak standards for the oil and natural gas industries. The proposal also builds on another EPA oil and gas emissions proposal from the prior year; the 2022 proposal strengthened the methane emissions limits and increased the types of emissions sources covered under the November 2021 proposal.[5] Together, these two proposals strengthen the GHG emissions limitations and monitoring under the *Clean Air Act*. The increased standards also come about as the United States is working towards decarbonizing the economy and reaching net-zero emissions by 2050.[6]

Many state governments, including New Jersey and Pennsylvania, have set their own emissions reduction targets. In 2019, New Jersey passed the *Global Warming Response Act* to set the goal of reducing statewide GHG emissions by 80 percent by 2050, relative to 2006 levels.[7] This equates to net GHG emissions of 24.1 million metric tons[8] of carbon dioxide equivalent (CO_2e) in 2050.[9] Similarly, Pennsylvania aims to achieve an 80 percent reduction in net GHG emissions statewide by 2050, and 26 percent reduction in GHGs by 2025, relative to 2005 levels.[10,11]

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[4] U.S. Environmental Protection Agency. 2022. "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review." *Federal Register*. Vol 87 No. 233. Available at: https://www.federalregister.gov/documents/2022/12/06/2022-24675/standards-of-performance-for-new-reconstructed-and-modified-sources-and-emissions-guidelines-for.

[5] U.S. Environmental Protection Agency. 2021. "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review." *Federal Register*. Vol 86 No. 217. Available at: https://www.federalregister.gov/documents/2021/11/15/2021-24202/standards-of-performance-for-new-reconstructed-and-modified-sources-and-emissions-guidelines-for.

[6] U.S. Department of State and the U.S. Executive Office of the President. 2021. "The Long-Term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas Emissions by 2050." Available at: https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf.

[7] New Jersey Department of Environmental Protection. 2020. "New Jersey's Global Warming Response Act: 80x50 Report." Available at: https://www.nj.gov/dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf.

[8] Throughout the report, all "tons" values are presented in metric tons, as it is the most commonly used unit for greenhouse gas emissions analyses. Short tons is another common unit to use in the United States. One metric ton is equivalent to 1.102 short tons.

[9] Ibid.

[10] Pennsylvania Department of Environmental Protection (PA DEP). 2021. "Pennsylvania Climate Action Plan." Available at: http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=3925177&DocName=2021%20PENNSYLVANIA%20CLIMATE%20ACTION%20PLAN.PDF%20%20%3cspan%20style%3D%22color:green%3b%22%3e%3c/span%3e%20%3cspan%20style%3D%22color:blue%3b%22%3e%28NEW%29%3c/span%3e%209/21/2023.

[11] Another state in the Delaware River watershed, New York, has more stringent emissions reduction requirements than New Jersey and Pennsylvania. Through the state's *Climate Leadership and Community Protection Act* (CLCPA), New York is

Despite EPA's GHG-reduction proposal and state and nationwide decarbonization goals, companies throughout the United States continue to propose building large and expensive fossil fuel projects that have substantial emissions impacts. Since 2017, at least four separate companies have proposed aspects of a natural gas liquefaction facility and liquefied natural gas (LNG) export facility in Pennsylvania and/or New Jersey. New Fortress Energy (parent company of Bradford County Real Estate Partners, LLC) applied to the Pennsylvania Department of Environmental Protection (DEP) to build a liquefaction facility in Wyalusing, Pennsylvania.[12] Then, Delaware River Partners, LLC, applied to build an LNG export terminal in Gibbstown, New Jersey.[13] A third company, Energy Transport Solutions, LLC, applied to the Pipeline and Hazardous Materials Safety Administration (PHMSA) for a special permit to transport LNG between the Wyalusing and Gibbstown facilities by train.[14] Related applications have also proposed that LNG be transported by truck between the two facilities.[15] Finally, Bradford County LNG Marketing, LLC, applied to the U.S. Department of Energy to export up to 128 billion cubic feet (BCF) of LNG annually from the Gibbstown facility.[16]

Through the many separate applications and permits related to the Wyalusing-Gibbstown Project, these companies have implied that each individual project has a small environmental impact. In actuality, the idiosyncratic structure of the Wyalusing-Gibbstown Project is masking the true environmental impact of the project.[17] Typically, liquefaction facilities and LNG export terminals are located together, making their impacts easier to assess, as opposed to the staggered model of the Wyalusing-Gibbstown Project.[18] Because the different components of the Wyalusing-Gibbstown Project will operate all together, the environmental impact of all aspects of this project should be analyzed as one. The unique

required to reduce statewide GHGs by 40 percent of 1990 levels by 2030 and by 85 percent of 1990 levels by 2050. Source: New York State Department of Environmental Conservation. 2023. "Statewide Greenhouse Gas Emissions Report." Available at: https://www.dec.ny.gov/energy/99223.html.

12 Pennsylvania Department of Environmental Protection. 2023. "New Fortress Energy." Available at: https://www.dep.pa.gov/About/Regional/North-central-Regional-Office/Community-Information/Pages/New-Fortress-Energy.aspx.

13 U.S. Army Corps of Engineers: Philadelphia District. 2019. Public Notice: Application No. CENAP-OP-R-2016-0181-39. Available at: https://www.nap.usace.army.mil/Portals/39/docs/regulatory/publicnotices/Public-Notice-2016-0181-39-Updated.pdf.

14 PHMSA, *Application for a Special Permit to Transport Methane, Refrigerated Liquid in DOT 113 Tank Cars*, available at https://www.regulations.gov/document/PHMSA-2019-0100-0941.

15 U.S. Department of Energy. 2021. *Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Free Trade Agreement Nations.* FE Docket No. 20-131-LNG. Available at: https://www.energy.gov/sites/prod/files/2021/03/f83/ord4670.pdf.

16 Bradford County LNG Marketing, LLC. 2020. "Application of Bradford County LNG for long-term, multi-contract authorization to export liquefied natural gas to free trade agreement nations." *U.S. Department of Energy, Office of Fossil Energy*. Docket No. 20-131-LNG. Available at: https://www.energy.gov/sites/prod/files/2020/11/f80/20-131-LNG.pdf.

17 New Fortress Energy, Delaware River Partners LLC, Energy Transport Solutions LLC, and Bradford County LNG Marketing LLC will be referred to as "the Companies" throughout this report and the projects described here will together be referred to as the "Wyalusing-Gibbstown project."

18 Pipeline and Hazardous Materials Safety Administration. 2022. "LNG facility Siting." *U.S. Department of Transportation*. Available at: https://www.phmsa.dot.gov/pipeline/liquified-natural-gas/lng-facility-siting.

structure of this proposed project, with its separate facilities and its multi-faceted, land-based, transportation structure, places an even greater responsibility for government review that closely analyzes any and all potential harmful impacts to the environment and climate change.

To better understand the unique structure and impact of the Gibbstown and Wyalusing facilities on climate change, we analyzed each component of the lifecycle GHG emissions of the project. Specifically, we calculated the GHG emissions for every step the natural gas takes from initial wellhead extraction to end-use combustion for gas that passes through the Wyalusing and Gibbstown facilities. This lifecycle analysis includes emissions from wellhead natural gas extraction, liquefaction, transatlantic sea transportation, regasification, and end-use combustion, as well as transportation of natural gas between these steps and construction of the Wyalusing and Gibbstown facilities. For a full list of steps in the natural gas lifecycle, see Figure 2 on page 8.

This analysis accounts for both initial emissions related to the construction of two new facilities and annual operating emissions related to each step in the natural gas lifecycle. However, this analysis does not include construction emissions associated with already existing facilities. For example, we did not include construction emissions for the natural gas power plants that will ultimately consume this gas, as we assumed there was significant potential that the power plants either already exist or would be constructed regardless of the Wyalusing-Gibbstown Project.

As currently planned, the natural gas for the Wyalusing-Gibbstown Project will be extracted from the Marcellus Shale in Pennsylvania, processed, and transported through a pipeline to the Wyalusing liquefaction facility (see Figure 1). There, the facility will convert the gas to a liquid state for easier transatlantic transport. Unlike other liquefaction export facilities in the United States, for this project, the companies have proposed transporting the LNG from Wyalusing to Gibbstown both by truck and train, rather than by pipeline, to a joint liquefaction and export terminal. The companies have not yet specified how they plan to divide the transportation between the two modes.

In Gibbstown, the plan is to load the LNG onto transatlantic transport ships. These ships are mainly powered by a share of the LNG they are transporting. The ultimate destinations of this gas are still unknown, but likely choices are Ireland and Puerto Rico, as assumed in our analysis.[19] Next, the two import terminals convert the LNG back from a liquid to a gas in a re-gasification step; then the gas is transported through pipelines to gas power plants. Finally, the power plants burn the gas to generate electricity.

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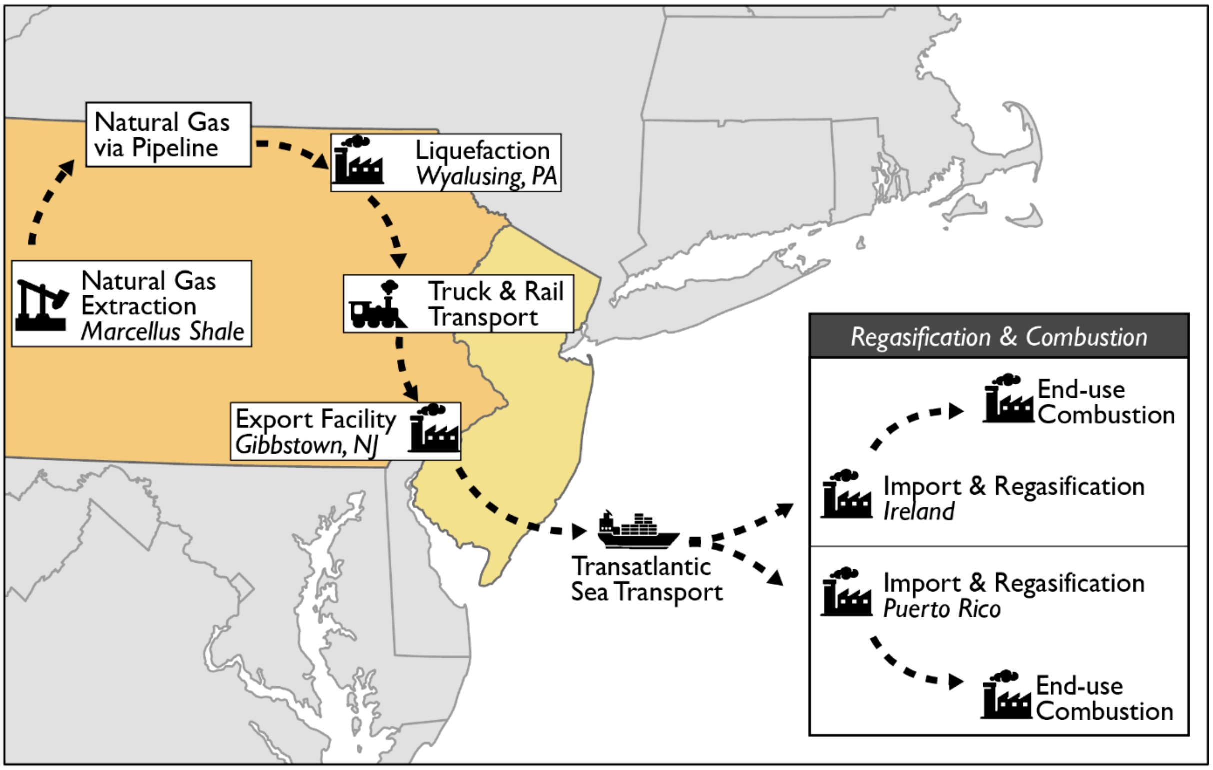
[19] Greenfield, N. 2022. "Gibbstown LNG Terminal: A Catastrophe Waiting to Happen." *Natural Resources Defense Council.* Available at: https://www.nrdc.org/stories/gibbstown-lng-terminal-catastrophe-waiting-happen.

Figure 1. Route of natural gas in Wyalusing-Gibbstown Project lifecycle



Note: The above map is for illustrative purposes only and is not to scale.

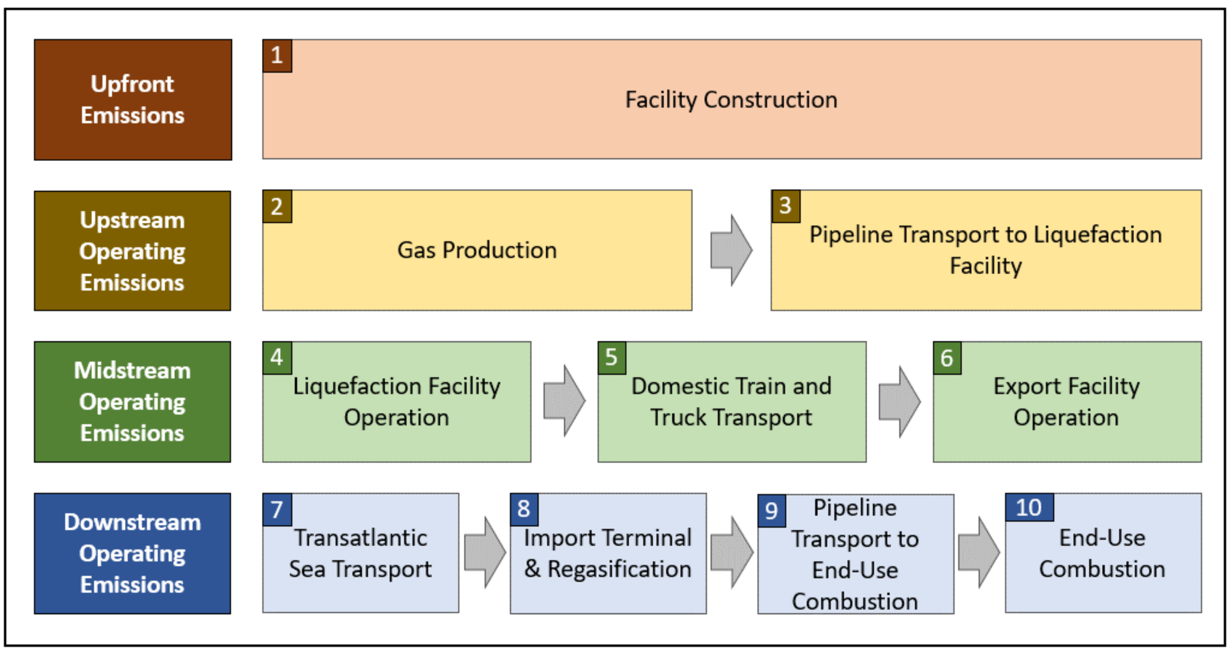
2. METHODOLOGY

We relied on two different methodologies for our analysis. Wherever possible, we used specific emissions from the Wyalusing-Gibbstown Project applications and permits. We input these values directly into the analysis.

When the applications did not contain the necessary emissions data or there was not a specific facility to analyze in the lifecycle step, we estimated the emissions impact based on emissions from similar projects or on national emissions rates, scaled to the size of the Wyalusing-Gibbstown Project.

This chapter includes 11 sections. Section 2.1 discusses global warming potentials (GWP) and how they are used in this analysis. Section 2.1 also includes an overview of natural gas volume loss throughout the lifecycle. Sections 2.2 through 2.11 describe the detailed methodology or emissions estimates for each step of the natural gas lifecycle. See Figure 2 for the full list of analyzed steps from the natural gas lifecycle.

Figure 2. Steps in the lifecycle of natural gas in the Wyalusing-Gibbstown Project



2.1. Emissions Assumptions Applied to All Lifecycle Steps

Some emissions analysis factors apply to all steps in the natural gas lifecycle, including GWPs and natural gas volume loss. GWPs are conversion factors for understanding emissions from different types of GHGs in the same relative scale of CO_2e emissions units. Natural gas volume loss is the concept that each step of the natural gas lifecycle entails using or emitting some portion of the natural gas. As a result, the volume of natural gas throughput varies some between each step and there are additional emissions impacts on this variation between lifecycle steps.

Global Warming Potentials

For all steps in the lifecycle analysis, we converted the GHG emissions into 20-year GWP CO_2e based on the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6).[20] Carbon dioxide, methane, and nitrous oxide all have different impacts on climate change and stay in the atmosphere for different lengths of time. Notably, carbon dioxide stays in the atmosphere for a long time (thousands of years) and has a continuous impact on climate change over that time. Because of its abundance, it is used as the reference for GWPs. That means that the other GHGs are scaled to a metric that has the same impact on global warming as carbon dioxide: a carbon dioxide equivalent, or CO_2e, value.[21]

Most significantly for this analysis, methane (the primary component of natural gas) stays in the atmosphere for a much shorter period of time than carbon dioxide (around 10 years). In that time, however, methane has a much bigger impact on the climate. In a 100-year timescale, one ton of emitted methane can have 30 times the impact on global warming as one ton of carbon dioxide. However, since methane stays in the atmosphere for less time than carbon dioxide, many analysts prefer to think of it in the 20-year timescale instead. This better attributes its impact to its lifetime. In the 20-year timescale, one ton of methane can have around 83 times the impact as compared to one ton of carbon dioxide.[22]

While less of a focus in this analysis, nitrous oxide typically remains in the atmosphere for over 100 years and can be used with either timescale. One ton of nitrous oxide has over 270 times the impact on global warming as one ton of carbon dioxide over a 20- or 100-year timeframe.[23]

Natural Gas Volume Loss

Natural gas volume loss occurs throughout the project lifecycle due to leakage, venting, and direct use of the natural gas (such as for fuel in transatlantic sea transport vessels). As a result of this loss, more natural gas must be extracted from wellheads than will be used in end-use combustion. Throughout our analysis, we incorporated emissions from leakage, venting, and direct natural gas use in our total

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[20] Forster, P., T. Storelvmo, K. Armour, W. Collins, J.-L. Dufresne, D. Frame, D.J. Lunt, T. Mauritsen, M.D. Palmer, M. Watanabe, M. Wild, and H. Zhang. 2021. "The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity." *Climate Change 2021: The Physical Science Basis*. Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 923–1054, doi:10.1017/9781009157896.009. Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07.pdf.

[21] U.S. Environmental Protection Agency. "Understanding Global Warming Potentials." Greenhouse Gas Emissions. Accessed January 2023. Available at: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

[22] Forster, P. et al. 2021. "The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity."*Climate Change 2021: The Physical Science Basis*. Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 923–1054, doi:10.1017/9781009157896.009. Available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter07.pdf.

[23] Ibid.

emissions measurement. However, due to the complexity of re-integrating these losses back into the total volume of natural gas throughput in each step, we simplified our approach.

For this analysis, we have knowledge of the volume of LNG that would be exported from the Gibbstown facility each year (128 BCF) based on the companies' applications. In order to export 128 BCF of LNG, slightly more natural gas must be extracted from the wellhead to account for losses. After being exported, slightly less than 128 BCF of natural gas will ultimately be combusted at an end-use facility. However, for this analysis, we assumed that 128 BCF of natural gas would be extracted from the wellheads and 128 BCF of natural gas would be combusted at an end-use facility. As a result, our analysis underestimates emissions from losses in the lifecycle steps preceding the export facility but overestimates emissions from losses in the steps that follow export. Because the export facility step is roughly halfway in the entire lifecycle process, it is likely that these over- and under-estimates are similar in size, and may cancel each other out when taken together over the entire lifecycle process.

Note that this simplification only impacts the emissions from losses associated with the volume difference in each step. For example, if 101 BCF of natural gas needs to be extracted in order to export 100 BCF of LNG from an export facility, our simplification only applies to losses associated with the 1 BCF difference between these two volumes. We are estimating losses associated with the 100 BCF.

Based on a 2014 National Energy Technology Laboratory (NETL) lifecycle analysis of natural gas emissions in the United States, natural gas loss from wellhead extraction to end-use combustion is around 8 percent.[24] However, that analysis did not include LNG operations, and thus does not include volume losses from natural gas liquefaction or LNG transatlantic sea transport. In 2019, NETL released an analysis of LNG lifecycle emissions around the world ("NETL 2019a"). This analysis found that approximately 7 percent of the natural gas volume is used, lost, or otherwise unable to be unloaded during the LNG sea transport lifecycle step.[25] This LNG sea transport loss factor is similar in magnitude to the loss factor from the domestic natural gas lifecycle. Nonetheless, as described above, the natural gas volume loss variations before and after the export facility are expected to net each other out to some extent.

2.2. Construction

To estimate emissions associated with building the facilities necessary to liquefy and export natural gas, we analyzed emissions over three separate steps: Facility Construction, or emissions associated with ongoing construction work and equipment operation; Concrete Production, which encompasses

[24] National Energy Technology Laboratory. 2014. "Life Cycle Analysis of Natural Gas Extraction and Power Generation." *US Department of Energy: Office of Fossil Energy*. Available at: https://www.energy.gov/sites/prod/files/2019/09/f66/Life%20Cycle%20Analysis%20of%20Natural%20Gas%20Extraction%20and%20Power%20Generation%2005_29_14%20NETL.pdf.

[25] Roman-White, S., S. Rai, J. Littlefield, G. Cooney, T. J. Skone, P.E. 2019. "Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States: 2019 Update." *National Energy Technology Laboratory.* Available at: https://www.energy.gov/sites/prod/files/2019/09/f66/2019%20NETL%20LCA-GHG%20Report.pdf.

emissions from producing the concrete material used for facility structures; and Dredging, which address emissions from embodied carbon in dredged river sediment.

Facility Construction

Emissions associated with construction include those emissions resulting from operation of construction vehicles and equipment, marine traffic, vehicle fuel emissions, and fugitive dust. This analysis does not include emissions due to building material production other than concrete. For the purposes of this analysis, we define construction emissions as "upfront" emissions because they only occur once prior to operation of the facilities and are not a continual source of GHG emissions for the duration of the facility operating life.

At the time of this report, the companies have not provided an emissions analysis or an air quality impacts statement for activities associated with facility construction for the Gibbstown and Wyalusing facilities. Thus, we estimated the upfront emissions from construction of the liquefaction and export facilities by scaling construction emissions from other LNG liquefaction and export facilities in the United States. The Wyalusing-Gibbstown Project is unique in that the site of natural gas liquefaction is not co-located with the export terminal, unlike other LNG import or export terminals in the United States. We chose to treat the two facilities' construction emissions as a single source for the purposes of scaling construction emissions from other LNG terminals, whose liquefaction facilities and export facilities were constructed simultaneously.

We collected operating and construction emissions and duration data for five other LNG export facilities in the United States. We chose facilities which are of a similar scale (1 to 8.24 million metric tons per annum, or mtpa) to the proposed Wyalusing-Gibbstown Project, which has an export capacity of 2.6 mtpa. The five assessed facilities include: Eagle Jacksonville in Duval County, Florida, Texas LNG in Cameron County, Texas, Cove Point LNG in Calvert County, Maryland, Gulf LNG in Jackson County, Mississippi, and Corpus Christi LNG in San Patricio County, Texas.[26,27,28,29,30] We retrieved data for the emissions associated with these facilities' construction from each facility's Federal Energy Regulatory Commission (FERC) Environmental Impact Statement (EIS).

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[26] Federal Energy Regulatory Commission. 2019. "Jacksonville Project Final Environmental Impact Statement." Available at: https://www.ferc.gov/sites/default/files/2020-05/04-12-19-FEIS.pdf.

[27] Federal Energy Regulatory Commission. 2019. "Final Environmental Impact Statement - Texas LNG Project." Available at: https://www.ferc.gov/sites/default/files/2020-05/volume-I.pdf.

[28] Federal Energy Regulatory Commission. 2014. "Environmental Assessment for the Cove Point Liquefaction Project." Available at: https://www.energy.gov/sites/prod/files/2014/11/f19/EA-1942-FEA-2014%20%282%29.pdf.

[29] Federal Energy Regulatory Commission. 2019. "Gulf LNG Liquefaction Project, Final Environmental Impact Statement." Available at: https://www.ferc.gov/sites/default/files/2020-05/FEIS-GulfLNGLiquefactionProject.pdf.

[30] Federal Energy Regulatory Commission. 2014. "Final Environmental Impact Statement - Corpus Christi LNG Project." Available at: https://cms.ferc.gov/sites/default/files/2020-05/corpuschristiFEIS.pdf.

Next, we calculated the average monthly construction emissions for each facility, and then scaled those emissions by the mtpa of export capacity for each facility. We then averaged those values to get an estimate of monthly construction emissions per mtpa of export capacity (646 metric tons CO_2e per month per mtpa). We used construction duration and export capacity for the Gibbstown and Wyalusing facilities from the companies' 2019 land development and Dock 2 construction applications, and the construction agreement with Black & Veatch Construction for the Wyalusing facility.[31,32,33] Based on the total project construction duration for the Gibbstown and Wyalusing liquefaction and export facilities and the total project export capacity, we calculated the total estimated construction emissions using the average of the monthly construction emissions per export capacity of the other LNG projects.

To convert from the CO_2e value of GHG emissions provided in the LNG facilities' environmental impact statements, we calculated the volume percent share of carbon dioxide, methane, and nitrous oxide emissions. The final environmental impact statement for the Lake Charles LNG terminal breaks down construction emissions by carbon dioxide, methane, and nitrous oxide.[34] We scaled the estimated construction emissions by the gas ratios from the Lake Charles LNG project to convert the emissions to the CO_2e value with the appropriate global warming potential.

Concrete Production

Concrete is a primary building material for industrial applications. At the same time, concrete has a large carbon footprint; at least 8 percent of man-made global emissions comes from the cement industry, a primary ingredient to concrete.[35] Despite their vast greenhouse gas emissions, the carbon footprints of concrete and other building materials are not traditionally included in environmental impact assessments. For example, the embodied emissions from concrete production are not included in the construction emissions filed in the FERC environmental impact statements for LNG facilities. This convention undercounts the emissions associated with building these types of facilities.

Neither the Gibbstown export facility nor the Wyalusing liquefaction facility has provided construction details or volumes of concrete used. To account for the emissions from concrete production in our calculation of construction emissions, we estimated the volume of concrete used for other recently built LNG export facilities. We averaged the cubic yards of concrete by export capacity for three other LNG

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[31] Delaware River Partners, LLC. November 2019. "Application for Land Development." Available at: https://www.delawareriverkeeper.org/sites/default/files/Files%20from%20Greenwich%20Twp.%20GLC%20Dock%202%20Site%20Plan.pdf.

[32] Delaware River Partners, LLC – Gibbstown Logistics Center Dock 2. 2020. Delaware River Basin Commission, Docket No. D-2017-009-2. Available at: https://www.state.nj.us/drbc/library/documents/dockets/061219/2017-009-2.pdf.

[33] Engineering, Procurement, and Construction Agreement (January 2019) Available at: https://www.sec.gov/Archives/edgar/data/1749723/000114036119001592/s002392x11_ex10-17.htm.

[34] Federal Energy Regulatory Commission. 2015. "Final Environmental Impact Statement - Lake Charles Liquefaction Project." Available at: https://cms.ferc.gov/final-environmental-impact-statement-lake-charles-liquefaction-project.

[35] *Nature*. 2021. "Concrete needs to lose its colossal carbon footprint." *Nature* 597, 593-594. doi: https://doi.org/10.1038/d41586-021-02612-5.

facilities: Eagle Jacksonville LNG in Florida, Cove Point LNG in Maryland, and Cameron LNG in Louisiana.[36,37,38] We scaled this average value by the export capacity of the Gibbstown project to estimate the concrete used during construction of the Wyalusing and Gibbstown buildings and facilities.

Prusinski et al. have conducted a lifecycle inventory analysis of cement concrete and calculated emissions outputs per cubic yard for concrete production.[39] Using these emission factors, we calculated the upfront construction emissions from concrete for the combined Gibbstown and Wyalusing facilities. Prusinski et al. provide emissions factors for various strengths of concrete ranging from 3,000 to 10,000 psi. We averaged the emissions factors from concrete across the different types of concrete because industrial construction can use a range of concrete types depending on the application.[40] For example, the CO_2 emissions factor ranged from 97 to 368 kg per cubic yard with an average of 190 kg per cubic yard.

Dredging

Dredging is the removal of sediments from the bottom of bodies of water to maintain or increase the depth of berthing docks or navigation channels in waterways.[41] Dredged soil from rivers contains embodied organic compounds that are released into the atmosphere when exposed to the air.[42] As part of the construction of the Gibbstown export facility, a new berthing dock (Dock 2) will be constructed on the Delaware River, and port operators will dredge a volume of 665,000 cubic yards of sediment to accommodate the deep-water berths.[43]

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[36] Federal Energy Regulatory Commission. 2019. “Jacksonville Project Final Environmental Impact Statement.” Available at: https://www.ferc.gov/sites/default/files/2020-05/04-12-19-FEIS.pdf.

[37] Zou, D. April 2017. "Dominion completes four-fifths of construction at Cove Point." *Southern Maryland News*. Available at: https://www.somdnews.com/recorder/spotlight/dominion-completes-four-fifths-of-construction-at-cove-point/article_b1c658aa-0ab4-526f-b1f3-d309315871af.html.

[38] Nikolewski, R. February 2019. "How Sempra decided to go all in on natural gas - $10 billion worth." *Sun Sentinel*. Available at: https://www.sun-sentinel.com/sd-fi-sempra-lng-cameron-20190217-story.html.

[39] Prusinski, Jan R, Medgar L Marceau, and Martha G VanGeem. n.d. “Life Cycle Inventory of Slag Cement Concrete.” https://www.ecocem.co.uk/wp-content/uploads/2016/08/ECL009_Life_Cycle_Inventory_of_GGBS_Cement_Concrete.pdf.

[40] Gra-Rock. “Understanding Concrete Strength.” Available at: https://www.gra-rock.com/post/understanding-concrete-strength#:~:text=Concrete%20used%20in%20warehouses%2C%20factories,often%20require%204%2C000%2D5%2C000%20psi.

[41] National Ocean Service. “What is dredging?” *National Oceanic and Atmospheric Administration.* Available at: https://oceanservice.noaa.gov/facts/dredging.html.

[42] Sugimura, Yoshihisa, Tomonari Okada, Tomohiro Kuwae, Yugo Mito, Ryoji Naito, and Yasuyuki Nakagawa. 2022. “New Possibilities for Climate Change Countermeasures in Ports: Organic Carbon Containment and Creation of Blue Carbon Ecosystems through Beneficial Utilization of Dredged Soil.” *Marine Policy* 141 (July): 105072. https://doi.org/10.1016/j.marpol.2022.105072.

[43] Delaware River Partners, LLC – Gibbstown Logistics Center Dock 2. 2020. Delaware River Basin Commission, Docket No. D-2017-009-2. Available at: https://www.state.nj.us/drbc/library/documents/dockets/061219/2017-009-2.pdf.

The Delaware Estuary Benthic Inventory includes data of total organic carbon content in Delaware River Sediment.[44] To account for variation in the sample dataset, we averaged the total organic carbon content values within a five-mile radius of the Gibbstown Dock 2 site. We used this total organic carbon content value to calculate the volumetric carbon concentration of Delaware River sediment, an estimated 0.012 metric tons of carbon per cubic meter of sediment. From this, we calculated the carbon emissions resulting from the material dredged during the site preparation of Gibbstown Dock 2. For simplification purposes, we assumed all the total organic carbon content is released to the atmosphere as carbon dioxide. This is a rough approximation. Overall, dredging emissions are a very small part of the overall life-cycle emissions (only 0.003 percent of total lifecycle emissions and 7 percent of construction emissions).

See Table 2 for total construction emissions from the Wyalusing-Gibbstown Project, including from facility construction, concrete production, and dredging.

Table 2. Construction emissions

Upfront Emissions	**Annual Operating Emissions**
Metric tons CO_2e/year	*Metric tons CO_2e/year*
88,420	0

2.3. Gas Production

Emissions associated with gas production include emissions produced annually during the drilling of wells and extracting natural gas from those wells in the Marcellus Shale in Pennsylvania. Emissions tabulated in this step include both the emissions associated with the upfront annual drilling of new wells and annual operations of the wells, including venting and leakage of natural gas. We considered new wellhead drilling “upfront” emissions in this analysis, similar to the construction emissions described above. However, new wells are drilled for each year of facility operation and therefore the total emissions impact will change based on the duration of project operation.

For this step, we did not have specific project-related emissions from the Wyalusing-Gibbstown Project applications. Instead, we used the LNG volume exported each year (128 BCF per year) and emissions rates from a 2019 natural gas pipeline lifecycle emissions analysis by NETL (“NETL 2019b”).[45] For the upfront emissions component, we used an emissions rate of 52 kg of CH_4 per well and determined that the project would need approximately 1,205 wells per year to produce 128 BCF of LNG. The ongoing emissions rates include: 6 kg of CH_4 per well per year from compressor blowdowns, 1.7 kg of CH_4 per

[44] Delaware Estuary Benthic Inventory. 2016. “Bay Bottom Inventory - Total Organic Carbon.” Partnership for the Delaware Estuary. Available at: https://delawareestuary.org/data-and-reports/bay-bottom-inventory/.

[45] Littlefield, J., S. Roman-White, D. Augustine, A. Pegallapati, G. G. Zaimes, S. Rai, G. Cooney, and T. J. Skone. April 2019. "Life Cycle Analysis of Natural Gas Extraction and Power Generation." National Energy Technology Laboratory. Available at: https://www.netl.doe.gov/energy-analysis/details?id=3198.

well per year from pressure relief valve upsets, 1.5 kg of CH_4 per well per year from vessel blowdowns, and 9.4 kg of CH_4 per well per year from gathering mishaps.

See Table 3 for annual gas production emissions from the Wyalusing-Gibbstown Project.

Table 3. Gas production emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
5,171	1,845

2.4. Pipeline and Compressor Stations

After extraction and processing in the Marcellus Shale gas fields, the natural gas is transported via pipeline to the liquefaction facility in Wyalusing, Pennsylvania. These pipelines include compressor stations to maintain pressure in the pipeline. The companies' applications did not include specific emissions for this lifecycle step. Instead, we relied on emissions rates from the NETL 2019b report (1.1 metric tons of CH_4 per mile of transmission pipeline and 3.2 metric tons of CH_4 per pneumatic device and processing facility).[46] We also estimated the distance the natural gas would travel along pipelines, based on pipeline maps of the Marcellus Shale (see Figure 3).[47] We estimated that the natural gas would travel around 30 miles through pipelines from the wellheads to the Wyalusing liquefaction facility, based on two potential locations in Bradford County, Pennsylvania. We also estimated that the natural gas would require an average of 3.8 pneumatic devices and processing facilities per year, based on the same NETL 2019b report.

[46] Littlefield, J., et al. April 2019. "Life Cycle Analysis of Natural Gas Extraction and Power Generation." National Energy Technology Laboratory. Available at: https://www.netl.doe.gov/energy-analysis/details?id=3198.

[47] Kelso, Matt. 2018. "Pennsylvania Pipelines and Pollution Events." FracTracker Alliance. July 27, 2018. Available at: https://www.fractracker.org/2018/07/pennsylvania-pipelines-pollution/.

Figure 3. Map of natural gas pipelines leading to Wyalusing LNG facility

Source: Kelso, Matt. 2018. "Pennsylvania Pipelines and Pollution Events." FracTracker Alliance. July 27, 2018. Available at: https://www.fractracker.org/2018/07/pennsylvania-pipelines-pollution/. Added Point A, Point B, and Wyalusing LNG Facility locations to the map.

See Table 4 for annual pipeline and compressor stations emissions from the Wyalusing-Gibbstown Project.

Table 4. Pipeline and compressor stations emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	3,769

2.5. Wyalusing Liquefaction Facility

The proposed plan is to transport the natural gas via pipeline for processing at the liquefaction facility in Wyalusing, Pennsylvania. The liquefaction facility would receive natural gas by pipeline and process it for distribution to commercial markets by converting the gaseous substance into a liquid state. Ongoing liquefaction emissions would include annual facility operating emissions and fugitive facility emissions. This includes air emissions from processing equipment such as compressor turbines, gas turbine generators, steam boilers, and the thermal oxidizer, as well as flares and fugitive emissions from equipment leaks.

The data sources for this step were the air permit application filed by the companies with the Pennsylvania DEP and the associated air quality plan approval for the proposed Natural Gas Processing Plant (liquefaction facility).[48,49] These included calculations of estimated GHG emissions (as CO_2e) from facility equipment, flares, and leaks. Because the emissions were already calculated as CO_2e, we used EPA's AP-42 emissions factors to convert the CO_2e values provided in the air plan application into percent shares of methane and carbon dioxide.[50] This conversion allowed us to present the values with our desired GWP. The total facility greenhouse gas emissions did not include carbon dioxide or methane fugitive emissions. We used the fugitive emissions tables provided in the air plan application to calculate those emissions separately.

See Table 5 for annual Wyalusing liquefaction emissions. Note that the upfront emissions from this step are combined with the export facility construction emissions and presented in Table 2.

Table 5. Wyalusing liquefaction facility emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	1,033,031

2.6. Domestic Train and Truck Transport

The project plan calls for LNG to be transported to the export facility in Gibbstown, New Jersey after liquefaction at the Wyalusing facility. Unlike other LNG export facilities in the United States (which are co-located with or adjacent to liquefaction facilities), this proposed project would transport LNG between these two facilities by either truck or by rail. In 2017, the companies involved applied for a special permit from the PHMSA to transport LNG by rail in special cryogenic tank cars. LNG had previously only been authorized for transport by road in trucks or in ocean carriers. PHMSA granted this special permit in 2019, which allows the companies to transport LNG between Gibbstown and Wyalusing by rail.[51] Since the approval of the special permit, the companies have not divulged how they

[48] PA DEP. Minor Source Plan Approval Application for Natural Gas Processing Plant. December 2018. Available at: https://files.dep.state.pa.us/RegionalResources/NCRO/NCROPortalFiles/NewFortressEnergy/New%20Fortress%20Energy%20LNG%20Plant%20Plan%20Approval%20Application%20(December%202018).pdf.

[49] PA DEP Air Quality Plan Approval 7/24/2019, available at: https://files.dep.state.pa.us/RegionalResources/NCRO/NCROPortalFiles/NewFortressEnergy/Air_Quality_Plan_Approval_7-24-19.pdf.

[50] AP 42 Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources. Available at: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors#5thed.

[51] PHMSA *SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars*, available at https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/safe-transportation-energy-products/72911/environmental-assessment.pdf.

plan to allocate the LNG transport between train and truck transport. While the special permit expired in November 2021, the companies have applied for an extension. If PHMSA approves the extension to the special permit, the companies may decide to transport all of the LNG by train, but no specific information is available to confirm their plans at the time of this report.

Emissions during domestic transport include both the engine emissions from the trucks and trains and fugitive emissions from loading and unloading the LNG onto the vehicles at each facility. We used the engine GHG emissions factors for trucks (1001 grams of CO_2 per truck per mile) and trains (145 grams of CO_2 per train car per mile) from the PHMSA special permit environmental assessment.[52] The companies' special permit application stated they would operate up to two "unit trains" per day, with a "unit train" ranging from 50 to 100 cars in length, or 100 to 200 train cars in total.[53] We averaged these numbers to estimate 150 train cars per day (assuming all transport is done by train). We estimated the number of trucks per day from vehicle traffic and truck loading data from the companies' air plan approval application to the Pennsylvania DEP (400 trucks per day, assuming all transport is done by truck).[54]

Based on the companies' Pennsylvania air plan approval application, we estimated that trucks could transport almost all (90.4 percent) of the LNG output volume of the liquefaction facility. However, due to PHMSA's approval of the special permit, it would also be possible for all of the LNG to be transported by train. Thus, for emissions calculation purposes, we assumed an even split of transportation by truck and by rail. The Delaware Riverkeeper Network created an interactive map of the proposed LNG Gibbstown facilities, including potential train and truck routes between Wyalusing and Gibbstown.[55] We calculated the length of Truck Route A (174 miles) and Rail Route A (255 miles) to determine the distances by which LNG would be transported by truck and rail, respectively.

We calculated the venting, flaring, and fugitive emissions during domestic transport based on the number of trucks and rail cars and an estimated number of fugitive sources per car or truck (pumps, valves, connectors, etc.). Our estimate assumes that the number of fugitive source components per car or truck is comparable to the data provided for refrigerated equipment leaks in the companies' Pennsylvania air plan approval application.[56] The American Petroleum Institute (API) publishes a

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[52] PHMSA *SP 20534 Special Permit to transport LNG by rail in DOT-113C120W rail tank cars*, available at https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/safe-transportation-energy-products/72911/environmental-assessment.pdf.

[53] PHMSA, *Application for a Special Permit to Transport Methane, Refrigerated Liquid in DOT 113 Tank Cars*, available at https://www.regulations.gov/document/PHMSA-2019-0100-0941.

[54] PA DEP. Minor Source Plan Approval Application for Natural Gas Processing Plant. December 2018. Available at: https://files.dep.state.pa.us/RegionalResources/NCRO/NCROPortalFiles/NewFortressEnergy/New%20Fortress%20Energy%20LNG%20Plant%20Plan%20Approval%20Application%20(December%202018).pdf.

[55] Delaware Riverkeeper Network. "LNG Gibbstown Interactive Map" Available at: https://www.delawareriverkeeper.org/taxonomy/term/1174.

[56] PA DEP. "Table A-10.d Fugitive Emissions: Refrigerated Liquid Equipment Leaks." Minor Source Plan Approval Application for Natural Gas Processing Plant. December 2018. Available at: https://files.dep.state.pa.us/RegionalResources/NCRO/NCROPortalFiles/NewFortressEnergy/New%20Fortress%20Energy%20LNG%20Plant%20Plan%20Approval%20Application%20(December%202018).pdf.

Compendium of GHG Emissions Methodologies, which includes venting, loss rates, and methane emissions factors per fugitive source component.[57] Using these values, shown in Table 7Table 6, we estimated the venting, flaring, and fugitive emissions from the vehicles during transport.

Table 6. Train and truck transportation venting, flaring, and fugitive emissions factors

Component	Component Count	Component Emissions Factor
	count	*standard cubic feet of CH_4 per hour per component*
Valves	1,059	1.19
Pump Seals	0	4.00
Connectors	962	0.34
Other Leak Sources	0	1.77
Vapor Recovery Compressors	0	4.17

See Table 7 for estimated annual domestic train and truck transport emissions from the Wyalusing-Gibbstown Project.

Table 7. Domestic train and truck transport emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	37,310

2.7. Gibbstown Export Facility

After liquefaction, LNG is proposed to travel by truck or rail from the liquefaction facility in Wyalusing, Pennsylvania, to the export facility in Gibbstown, New Jersey. Ongoing emissions at the export facility would likely come from the arrival and loading or unloading of rail cars, trucks, and ships. As of the time of this report writing, the Gibbstown export facility has not needed to provide an emissions analysis or air quality impact assessment.

To calculate an estimate of the operational GHG emissions from the export facility, we scaled emissions from another LNG facility based on equipment and size. We chose a Canadian LNG export terminal (LNG Canada) because its environmental impact statement separately identifies operational emissions sources, particularly by separating flaring and marine activity from gas turbine or other combustion emissions sources. We scaled each LNG Canada emissions source based on the annual volume of LNG

[57] The LEVON Group, LLC. May 2015. "Liquefied Natural Gas (LNG) Operations: Consistent Methodology for Estimating Greenhouse Gas Emissions." *Energy API.* Available at: https://www.api.org/~/media/Files/EHS/climate-change/api-lng-ghg-emissions-guidelines-05-2015.pdf.

exported from each facility. The Gibbstown facility export volume would be equivalent to 8 percent of the Canada LNG export volume.[58]

See Table 8 for annual Gibbstown export facility emissions. Note that the upfront emissions from this step are combined with the liquefaction facility construction emissions and presented in Table 2.

Table 8. Gibbstown export facility emissions results

Upfront Emissions	**Annual Operating Emissions**
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	13,969

2.8. Transatlantic Sea Transport

The sea transport step involves moving the LNG from the Gibbstown export terminal to two likely import terminals: one in Ireland and one in Puerto Rico.[59] While the companies' application data included the amount of LNG that would be exported from the facility each year, the applications did not include emissions related to sea transport. As a result, we scaled transportation emissions from a case study in which LNG was transported from Corpus Christi, Texas to Zeebrugge, Belgium and the empty vessel returned to Corpus Christi.[60] The round-trip LNG transport to Belgium resulted in around 10,218 metric tons of CO_2e (20-year GWP) emissions per trip. Based on the relative distances of each trip, transporting LNG from Gibbstown to Ireland would result in around 79 percent of the emissions of the Corpus Christi to Belgium trip, and around 56 percent of the emissions for the Gibbstown to Puerto Rico trip. We also assumed there would be 19 trips per year to each of the two project destinations based on the relative volumes of LNG transported in the Belgium trip and the Wyalusing-Gibbstown Project capacity.

See Table 9 for annual transatlantic sea transport emissions from the Wyalusing-Gibbstown Project.

[58] LNG Canada Export Terminal Environmental Assessment Application. Available at: https://www.jbic.go.jp/ja/business-areas/environment/projects/pdf/62412_24.pdf.

[59] Greenfield, N. 2022. "Gibbstown LNG Terminal: A Catastrophe Waiting to Happen." *Natural Resources Defense Council.* Available at: https://www.nrdc.org/stories/gibbstown-lng-terminal-catastrophe-waiting-happen.

[60] Balcombe, P., D. Heggo, and M. Harrison. June 2022. "Total Methane and CO2 Emissions from Liquefied Natural Gas Carrier Ships: The First Primary Measurements." Environmental Science & Technology. Available at: https://pubs.acs.org/doi/pdf/10.1021/acs.est.2c01383 and Balcombe, P., D. Heggo, and M. Harrison. June 2022. "Total Methane and CO2 Emissions from Liquefied Natural Gas Carrier Ships: The First Primary Measurements: Supplemental Information." Environmental Science & Technology. Available at: https://pubs.acs.org/doi/suppl/10.1021/acs.est.2c01383/suppl_file/es2c01383_si_001.pdf.

Table 9. Transatlantic sea transport emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	269,707

2.9. Import Terminal and Regasification

Emissions in the import terminal and regasification step include those emissions related to the Ireland and Puerto Rico import terminals and the re-conversion of the LNG back into a gaseous form of natural gas (re-gasification). As with most liquefaction facilities (the proposed Wyalusing-Gibbstown Project being an exception) import terminals and regasification facilities are typically located at the same site. Accordingly, we assumed the two import terminals and regasification facilities were located together in the two destination countries.

We did not have specific facility data for the import terminals or regasification facilities. Instead, we used 11 years of historical data from the Everett LNG terminal in Everett, Massachusetts to approximate the emissions from the two import terminals. We chose the Everett LNG import terminal because the facility is relatively similar in capacity to the amount of gas that would be exported from the Gibbstown export terminal (the Everett LNG import terminal has averaged 57 BCF of imports per year, with a maximum of 135 BCF per year from 2011 to 2021). Additionally, the Everett LNG import terminal has relatively consistent emissions per million cubic feet of LNG imported, suggesting it is a reasonable resource to scale against.

We calculated an average emissions rate for each GHG from the Everett LNG import terminal (820 metric tons CO_2e per BCF per year). We then multiplied these rates by the total amount of LNG planned for import to Ireland and Puerto Rico together. This methodology assumes that the LNG import terminals in both Ireland and Puerto Rico have comparable emissions rates to each other and to the Everett LNG import terminal and regasification facility.

See Table 10 for annual import terminal and regasification emissions results from the Wyalusing-Gibbstown Project.

Table 10. Import terminal and regasification emissions results

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	104,938

2.10. Pipeline Transport to End-Use Combustion Facility

Emissions in this step involve the transport of the natural gas via pipeline from the import terminal and regasification facility to the end-use combustion at a power plant. To calculate the emissions from natural gas transport by pipeline from the regasification facility to the end-use combustion gas power plants, we used the same methodology as in the domestic pipeline step (i.e., 1.1 metric tons of CH_4 per mile of transmission pipeline and 3.2 metric tons of CH_4 per pneumatic device and processing facility with 3.8 pneumatic devices and processing facilities per year). We also estimated the distance the natural gas would travel by pipeline from an import terminal to a nearby gas power plant in each of the two destination countries. We assumed that the power plant would be located within 40 miles of the import terminal in Ireland and within 20 miles of the import terminal in Puerto Rico. These distances are approximations based on the assumption that the natural gas power plants would be located relatively close to the import terminals, but not directly on site.

See Table 11 for annual pipeline transport to end-use combustion facility emissions from the Wyalusing-Gibbstown Project.

Table 11. Pipeline transport to end-use combustion facility emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	6,541

2.11. End-Use Combustion

The last set of emissions produced in the natural gas lifecycle is in end-use combustion. Here, we assume that half of the LNG exported would be combusted at a natural gas power plant in Ireland and the other half would be combusted at a natural gas power plant in Puerto Rico.

There are not yet data sources for specific emissions from end-use combustion at these sites. As such, we used EPA data on GHG emissions per unit of natural gas combusted (54,586 metric tons of CO_2e per BCF).[61] We multiplied these rates by the volume of natural gas combusted at the two power plants (128 BCF) to estimate the emissions from combustion. We assumed that the power plants in Ireland and Puerto Rico would have similar emissions rates.

See Table 12 for annual end-use combustion emissions from the Wyalusing-Gibbstown Project.

Table 12. End-use combustion emissions

Upfront Emissions	Annual Operating Emissions
Metric tons CO_2e/year	*Metric tons CO_2e/year*
0	6,974,157

[61] US Environmental Protection Agency. January 2016. "Direct Emissions from Stationary Combustion Sources." Available at: https://www.epa.gov/sites/default/files/2016-03/documents/stationaryemissions_3_2016.pdf.

3. RESULTS

We analyzed the total emissions impact the proposed Wyalusing-Gibbstown Project would have over the maximum years of potential operation. Although the exact facility construction start date is unknown, we assumed project construction begins in 2023 and lasts approximately two-and-a-half years, as laid out in the companies' construction agreement.[62] The Gibbstown and Wyalusing facilities are then assumed to begin operations in 2025 and operate through 2050, which is the timeframe for the companies' export application for the Gibbstown facility.[63]

Under this framework, we estimated that the Wyalusing-Gibbstown Project will emit 211 million metric tons of CO_2e (20-year GWP) over a 25-year operational lifetime. Table 13, below, has the full breakout of emissions by lifecycle step, including both upfront emissions and operating emissions. Appendix A includes a table for just one year of operating emissions.

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[62] Bradford County Real Estate Partners, LLC, Company and Black & Veatch Construction, Inc. Contractor. 2019. "Engineering, Procurement and Construction Agreement for the Marcellus LNG Production Facility I." Exhibit 10.17. Available at: https://www.sec.gov/Archives/edgar/data/1749723/000114036119001592/s002392x11_ex10-17.htm.

[63] U.S. Department of Energy. 2021. *Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Free Trade Agreement Nations.* FE Docket No. 20-131-LNG. Available at: https://www.energy.gov/sites/prod/files/2021/03/f83/ord4670.pdf

[63] Bradford County LNG Marketing, LLC. 2020. "Application of Bradford County LNG for long-term, multi-contract authorization to export liquefied natural gas to free trade agreement nations." *U.S. Department of Energy, Office of Fossil Energy*. Docket No. 20-131-LNG. Available at: https://www.energy.gov/sites/prod/files/2020/11/f80/20-131-LNG.pdf.

Table 13. Lifecycle emissions for 25-year operating period

Lifecycle Step	Upfront Emissions	Ongoing Emissions	Total Emissions	Emissions as a Percent of Total
	metric tons CO_2e (20-year GWP)	*metric tons CO_2e (20-year GWP)*	*metric tons CO_2e (20-year GWP)*	*%*
Facility Construction[1]	88,420	0	88,420	0.04%
Gas Production[2]	129,285	46,130	175,415	0.08%
Pipeline and Compressor Station	0	94,231	94,231	0.04%
Liquefaction Facility[1]	0	25,825,765	25,825,765	12.22%
Domestic Transport	0	932,757	932,757	0.44%
Export Facility[1]	0	349,229	349,229	0.17%
Sea Transport	0	6,742,687	6,742,687	3.19%
Regasification	0	2,623,454	2,623,454	1.24%
Foreign Pipeline Transport	0	163,531	163,531	0.08%
End-Use Combustion	0	174,353,929	174,353,929	82.50%
Total	**217,706**	**211,131,711**	**211,349,417**	**100.00%**

Note 1: Emissions associated with the construction of the liquefaction facility and export facility were estimated as a single component, due to a lack of data associated with construction emissions for each component.

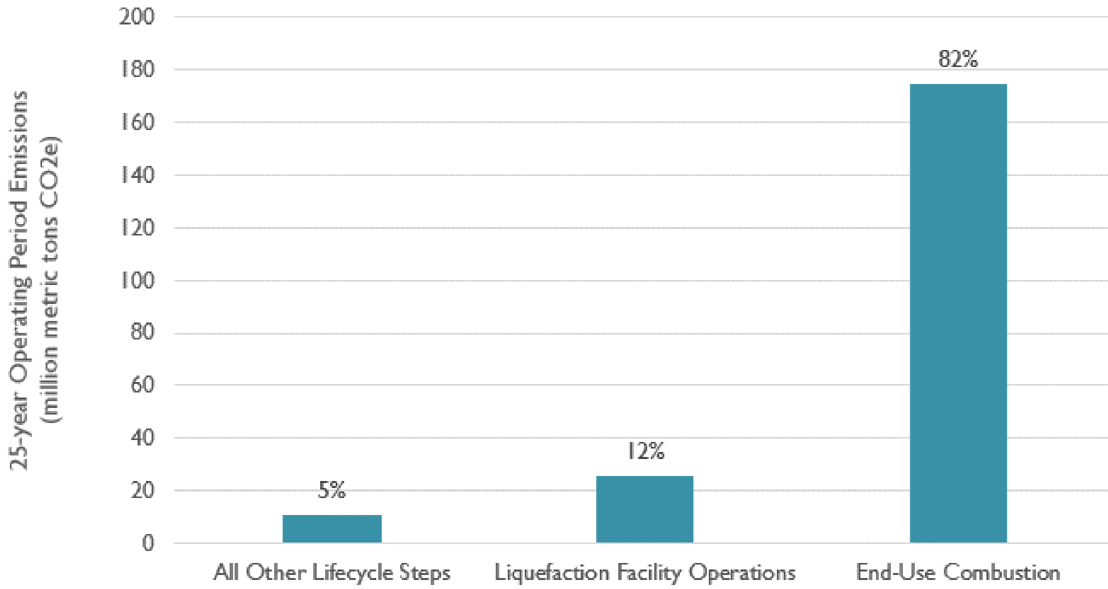
Note 2: The gas production lifecycle step includes emissions from both the annual drilling of new wells (upfront emissions) and from the continuous extraction of natural gas from those wells.

In the natural gas lifecycle, the end-use combustion step produces most of the emissions from the proposed Wyalusing-Gibbstown Project. End-use combustion alone accounts for 82 percent of emissions (see Figure 4). This step produces the majority of emissions because it involves burning all of the remaining natural gas throughput to produce electricity.

The second-most emissions are produced from the liquefaction facility step. We found that this step accounts for 12 percent of the lifecycle emissions, or more than two-thirds of the non-end-use combustion emissions. The liquefaction facility results in four times the emissions as the next highest step, sea transport. This speaks to the intensive and high energy process of compressing natural gas from a gaseous form to a liquid form.

The remaining 5 percent of emissions are spread out over the other steps in the natural gas process, including construction of the liquefaction facility and export terminal. These steps nonetheless produce a substantial amount of GHGs and contribute to climate change.

Figure 4. Lifecycle emissions for 25-year operating period



According to the EPA's Greenhouse Gas Reporting Program data, in 2021 the total GHG-sourced emissions in Pennsylvania and New Jersey were 137.4 million metric tons CO_2e and 24.2 million metric tons CO_2e (AR6 20-year GWP values), respectively.[64] Of this, 5 percent and 9.7 percent were associated with petroleum and natural gas systems, in each state respectively. This is equivalent to 6.8 million metric tons CO_2e in Pennsylvania and 2.3 million metric tons CO_2e in New Jersey using a 20-year AR6 GWP. The gas production through export facility lifecycle steps (the first six lifecycle emission steps) of the proposed Wyalusing-Gibbstown Project would occur in Pennsylvania and New Jersey. From our calculations, these emissions from the proposed Wyalusing-Gibbstown Project local to Pennsylvania and New Jersey would total 1.2 million metric tons CO_2e in the first year. This would amount to a 12.9 percent increase in Pennsylvania and New Jersey's aggregated petroleum and natural gas emissions.

[64] U.S. Environmental Protection Agency. 2021. "GHGRP 2021 Summary Fact Sheet – Pennsylvania." Available at: https://www.epa.gov/ghgreporting/ghgrp-state-and-tribal-fact-sheet.

4. Recommendations and Next Steps

Overall, the Wyalusing-Gibbstown Project—if operational—would lead to a substantial increase in annual emissions for Pennsylvania and New Jersey and contribute to worsening the effects of climate change. **Policymakers should consider the entire lifecycle emissions of the Wyalusing-Gibbstown Project when deciding whether to allow the project to proceed.** Since the impact of GHG emissions is not contained within state or country borders, the full lifecycle emissions should be considered to best understand the impact of a project. Although the end-use combustion emissions would not take place within Pennsylvania and New Jersey, allowing the projects to be built in these two states also allows for the eventual end-use combustion and increase in global emissions. In addition, the liquefaction facility in Pennsylvania is an energy intensive process that produces a significant amount of GHG emissions on its own.

Also of concern are the Wyalusing-Gibbstown Project's non-GHG emissions' health impacts on local populations in Pennsylvania and New Jersey. Although we have not quantified these impacts in this study, they are likely to be substantial. In particular, transportation emissions from trucking and rail are known to be significant contributors to poor air quality. **State agencies should consider estimating and including these health impacts, as well as the climate change impacts, when deciding whether to approve facilities such as those in the Wyalusing-Gibbstown Project.** Moreover, the train transportation of LNG between Wyalusing and Pennsylvania is an unusual method with unknown health risks and hazards. For example, there are additional safety hazards due to train or truck accidents while transporting the LNG. Such accidents could lead to rapid LNG regasification and large-scale methane leaks or fires. **The emissions estimates and safety hazards associated with this step are also not fully known, since there have not been comparable projects to use in emissions impacts analysis. These impacts should be fully considered before proceeding with the project.**

We further note that there are concerning land-use impacts not included in this analysis, such as the non-emissions environmental impacts of dredging or construction. These lifecycle steps in particular can decrease carbon sequestration, and they can also impact wildlife habitats. **Decision-makers reviewing the Wyalusing-Gibbstown Project's various applications and approvals should consider these land-use impacts in order to understand the full environmental impact of the project.**

Appendix A. ONE YEAR OPERATING PERIOD LIFECYCLE EMISSIONS RESULTS

Table 14 includes upfront construction emissions and one year of operation for the Gibbstown and Wyalusing facilities.

Table 14. Lifecycle emissions for a 1-year operating period

Lifecycle Step	Upfront Emissions	Ongoing Emissions	Total Emissions	*Emissions as a Percent of Total*
	metric tons CO_2e (20-year GWP)	*metric tons CO_2e (20-year GWP)*	*metric tons CO_2e (20-year GWP)*	*%*
Facility Construction[1]	88,420	0	88,420	1.04%
Gas Production[2]	5,171	1,845	7,017	0.08%
Pipeline and Compressor Station	0	3,769	3,769	0.04%
Liquefaction Facility[1]	0	1,033,031	1,033,031	12.10%
Domestic Transport	0	37,310	37,310	0.44%
Export Facility[1]	0	13,969	13,969	0.16%
Sea Transport	0	269,707	269,707	3.16%
Regasification	0	104,938	104,938	1.23%
Foreign Pipeline Transport	0	6,541	6,541	0.08%
End-Use Combustion	0	6,974,157	6,974,157	81.68%
Total	93,592	8,445,268	8,538,860	**100.00%**

Note 1: Emissions associated with the construction of the liquefaction facility and export facility were estimated as a single component, due to a lack of data associated with construction emissions for each component.

Note 2: The gas production lifecycle step includes emissions from both the annual drilling of new wells (upfront emissions) and from the continuous extraction of natural gas from those wells.