PERMIT TO KILL

Potential Health and Economic Impacts from U.S. LNG Export Terminal Permitted Emissions

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Flaring from the Venture Global Calcasieu Facility is visible for miles in the night sky.

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The Liquified Natural Gas Tanker Maran Gas Mystras is maneuvered by tug boats as it arrives at The Cameron LNG facility in Cameron, Louisiana.

TABLE OF CONTENTS

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KEY FINDINGS

- **Liquefied natural gas (LNG) export** terminals are permitted to emit levels of **air pollution** that **cause serious health harms** for people living in the region where the terminals are built.

- Air pollution from currently operating LNG export terminals is estimated to cause **60 premature deaths** and **$957 million in total health costs per year**. If all the planned LNG terminals and expansion projects are built, those numbers would **increase to 149 premature deaths** and **$2.33 billion in health costs per year**.

- **By 2050**, the same permitted air pollutants from currently operating LNG export terminals alone would yield cumulative impacts of **2,020 premature deaths** and **$28.7 billion in total health costs**, with these figures **rising to 4,470** and **$62.2 billion** respectively in a scenario where all planned terminals are built.

- Parishes and counties in and around **Southwest Louisiana**, where a cluster of LNG terminals are located, are **slated to suffer the worst** air pollution **impacts per capita**. However, several **parishes and counties farther away** – including Orleans Parish, Harris County, and Dallas County, which is over 250 miles from the nearest terminal – are **slated to suffer high premature deaths** due to large populations exposed to air pollution from terminals.

Health benefits from avoided air pollution if LNG projects not currently authorized by DOE are not built (2023 – 2050)

707 – 1,110
avoided deaths

$9.88 – 15.1 billion
avoided health costs

3,070
avoided cases of childhood asthma

510,000
avoided asthma symptom occurrences

210,000
avoided school loss days

3,100
avoided work loss days

- There is a strong overlap between areas that are already environmentally overburdened and the **35 counties and parishes** that would experience the worst air pollution impacts from the full LNG buildout. Of the total population within these counties and parishes, **70% live within EPA nonattainment zones**. Moreover, the **majority** of these counties and parishes **rank above the Climate Vulnerability Index's 82nd national percentile**.

- At the **national level, Black and Hispanic Americans** would respectively **experience air pollution** from LNG terminals at **151–170%** and **110–129% the rate of white Americans**. This partly reflects that Texas and Louisiana have high average exposure rates to LNG terminal air pollution and disproportionately large Black and Hispanic American populations.

- If the **Department of Energy (DOE)** ceases to approve LNG export applications, it **would save** an estimated **707 to 1,110 lives** and **avoid $9.88 to $15.1 billion in health costs** through 2050, by comparison to a scenario where all projects are built. A policy to phase out all LNG exports, consistent with limiting warming to 1.5C, would save even more lives and health costs.

- This study does not consider the likely public health harms associated with air pollution from infrastructure upstream or downstream of LNG terminals, hazardous air pollutants such as benzene, the impacts from explosions or other emergencies, or the climate impacts of LNG's life cycle emissions.

KEY RECOMMENDATIONS

- DOE's review of the studies and analysis it uses to assess LNG exports, as well as its review of individual LNG export project applications, should make clear that any projects that exacerbate climate change or worsen local health outcomes are simply not in the public interest and must be rejected.
- DOE, Federal Energy Regulatory Commission (FERC), and other agencies should reject any approvals or permits for LNG export terminals, as well as related pipelines and compressor stations.
- DOE and FERC should assess the cumulative impacts of air pollution from existing and the slate of planned LNG terminals when evaluating the impacts of any specific project on the surrounding communities.

Recommendations are continued on page 26

Tug boats move the LNG tanker Grace Dahlia past the LNG Tanker Stena Crystal Sky as ideparts from the Cheniere Liquified Natural Gas Facility in Sabine Pass, Texas.

People fish across from Golden Pass LNG in Sabine Pass, Texas. Golden Pass LNG is adding liquefaction and export capabilities to its existing facility in Sabine Pass, Texas.

INTRODUCTION

Exports of U.S. liquefied natural gas (LNG) have flooded global markets in recent years and have the potential to surge even higher in the next decade. This LNG boom is made possible by a rapid buildout of liquefaction and export terminals mostly concentrated along the Gulf Coast in Texas and Louisiana, as well as the rapid increase in domestic methane gas production due to fracking.[1] The boom has reshaped global energy politics, jeopardized our climate goals,[2] increased health risks for local communities,[3] and raised energy costs for families.[4,5] Recognizing this complex mix of factors, the Biden Administration paused Department of Energy (DOE) approvals for new export facilities and is undertaking a review of the studies and analysis that it uses to determine if a project is in the public interest.[6] Although a federal court later reversed this official "pause", DOE is under no obligation to approve any pending export authorizations while it reviews the studies underlying this determination.

While much attention and analysis has focused on the climate and geopolitical aspects of the LNG expansion,[7] less attention has been paid to the local health and environmental justice impacts. This briefing describes the health impacts of air pollution from existing and planned LNG export terminals. Our analysis makes use of the U.S. EPA's CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA), which estimates health impacts due to exposure to fine particulate matter ($PM_{2.5}$) and ozone (O_3) air pollution.[8] We make these findings available to inform the DOE process.

The LNG Tanker Stena Crystal Sky at the Cheniere Liquified Natural Gas Facility in Sabine Pass, Texas.

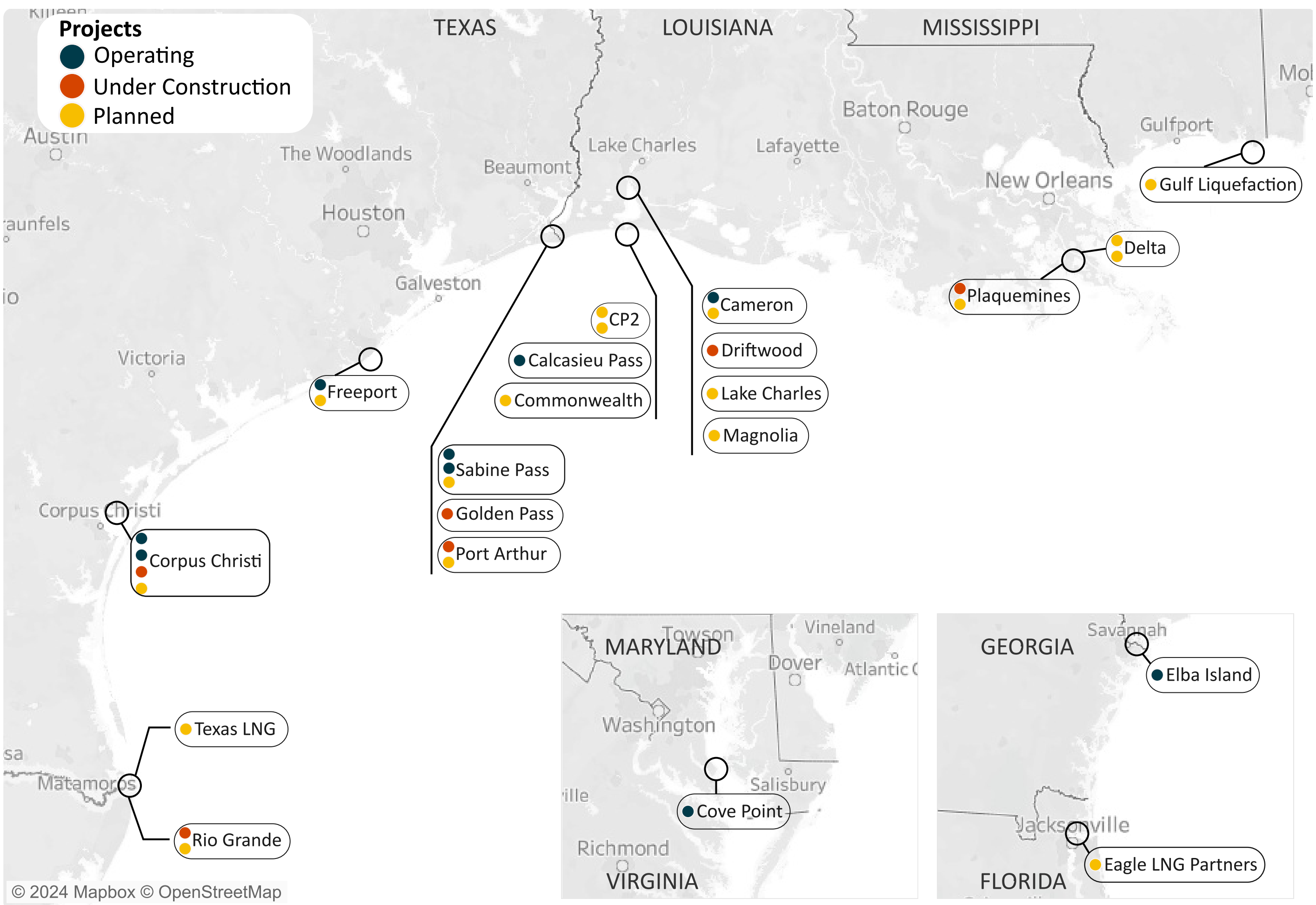
LNG EXPORT TERMINAL BUILDOUT

There are numerous operating, under construction, and planned LNG export terminals in the United States, many of which have also announced expansion projects. In this briefing, we analyze the LNG buildout at the project level, meaning that an individual export terminal may have multiple projects of varying capacity that become operational at different times.

There are currently 7 operating LNG export terminals in the United States representing 9 projects with a total liquefaction capacity of 14.35 billion cubic feet per day (Bcf/d).[9] Another 6 projects are currently under construction, which would bring an additional 13.95 Bcf/d of capacity online. In addition, there are 8 planned projects (total capacity 10.06 Bcf/d) that have already received both Federal Energy Regulatory Commission (FERC) approval and DOE's non-free trade agreement export authorization,[10, 11] but have not yet started construction. The Biden administration's "pause" on DOE export authorizations impacted a further 10 projects (total capacity 14.29 Bcf/d) that do not have DOE non-free trade agreement export authorization yet. Furthermore, there are several other planned projects that have not yet filed for their authorizations, which would then be assessed in light of DOE's updated public interest analysis. U.S. gas exported via pipeline is also fueling new LNG projects in Mexico.

For the classification of these projects and terminals we use data from the Sierra Club's U.S. LNG Export Tracker.[12] The tracker lists 52 U.S. projects, 10 of which have been canceled. Because COBRA only models onshore emissions in the lower 48 states, we exclude 3 projects in Alaska and 3 offshore

Figure 1: Map of current LNG export projects analyzed in this study



projects. Our methodology relies on information gathered from Clean Air Act permits, so we exclude three projects that have not yet applied for air permits and a fourth whose air permits have expired. This leaves 32 projects with official estimates of potential air pollution emissions that are analyzed in this report. Figure 1 and Table 1 summarize the status of the LNG projects considered in this briefing, and Table 2 summarizes air permit information.

Table 1: Current LNG export projects analyzed in this study.

Project	Primary Owner	Cap. (Bcf/d)	Status	FERC Permit	DOE Permit	County / Parish
Calcasieu Pass LNG	Venture Global LNG	1.76	Operating	approved	approved [*]	Cameron, LA
Cameron LNG Phase I	Sempra	2.06	Operating	approved	approved	Cameron, LA
Cameron LNG Phase II	Sempra	0.93	Planned	approved	approved	Cameron, LA
Commonwealth LNG	Kimmeridge Texas Gas LLC	1.21	Planned	approved [**]	pending review	Cameron, LA
Corpus Christi LNG Stage I	Cheniere Energy Inc.	1.60	Operating	approved	approved	San Patricio, TX
Corpus Christi LNG Stage II	Cheniere Energy Inc.	0.80	Operating	approved	approved	San Patricio, TX
Corpus Christi LNG Stage III	Cheniere Energy Inc.	1.58	Under Construction	approved	approved	San Patricio, TX
Corpus Christi LNG Midscale 8-9	Cheniere Energy Inc.	0.45	Planned	pending review	pending review	San Patricio, TX
Cove Point LNG	Berkshire Hathaway Inc.	0.79	Operating	approved	approved	Calvert, MD
CP2 Phase I	Venture Global LNG	1.98	Planned	approved	pending review	Cameron, LA
CP2 Phase II	Venture Global LNG	1.98	Planned	approved	pending review	Cameron, LA
Delta LNG Phase I	Venture Global LNG	1.38	Planned	pre-filing	no DOE application	Plaquemines, LA
Delta LNG Phase II	Venture Global LNG	1.38	Planned	pre-filing	no DOE application	Plaquemines, LA
Driftwood LNG	Tellurian Inc.[***]	3.81	Under Construction	approved	approved	Calcasieu, LA
Eagle LNG Partners	The Energy & Minerals Group	0.13	Planned	approved	approved	Duval, FL
Elba Island LNG	Blackstone Inc.	0.41	Operating	approved	approved [*]	Chatham, GA
Freeport LNG	Freeport LNG Investments LP	2.38	Operating	approved	approved	Brazoria, TX
Freeport LNG Expansion	Freeport LNG Investments LP	0.74	Planned	approved	approved	Brazoria, TX
Golden Pass LNG	Qatar Energy	2.57	Under Construction	approved	approved	Jefferson, TX
Gulf LNG Liquefaction	Kinder Morgan Inc.	1.50	Planned	approved	approved	Jackson, MS
Lake Charles LNG	Energy Transfer LP	2.27	Planned	approved	pending review	Calcasieu, LA
Magnolia LNG	Glenfarne Group LLC	1.22	Planned	approved	pending review	Calcasieu, LA
Plaquemines LNG Phase I	Venture Global LNG	1.89	Under Construction	approved	approved [*]	Plaquemines, LA
Plaquemines LNG Phase II	Venture Global LNG	1.89	Planned	approved	approved [*]	Plaquemines, LA
Port Arthur LNG	KKR & Co.	1.86	Under Construction	approved	approved	Jefferson, TX
Port Arthur LNG Expansion	Sempra	1.86	Planned	approved	pending review	Jefferson, TX
Rio Grande LNG Phase I	Global Infrastructure Partners LP	2.24	Under Construction	approved	approved	Cameron, TX
Rio Grande LNG Phase II	NextDecade Corporation	1.49	Planned	approved	approved	Cameron, TX
Sabine Pass LNG Phase I	Cheniere Energy Partners LP	3.03	Operating	approved	approved	Cameron, LA
Sabine Pass LNG Phase II	Cheniere Energy Partners LP	1.52	Operating	approved	approved	Cameron, LA
Sabine Pass Stage V	Cheniere Energy Partners LP	2.34	Planned	pending review	pending review	Cameron, LA
Texas LNG Brownsville	Glenfarne Group LLC	0.62	Planned	approved	approved	Cameron, TX

[*] Indicates that a proposed capacity increase is pending review by DOE.
[**] In July 2024, the US Court of Appeals for the DC District returned FERC's approval of Commonwealth LNG back to FERC for reconsideration, while stopping short of vacating the approval.
[***] Tellurian Inc. to be acquired by Woodside Energy Group Ltd in Q4 2024, dependent on "customary closing conditions," such as receipt of regulatory approvals. [https://ir.tellurianinc.com/press-releases/detail/291/tellurian-to-be-acquired-by-woodside-for-approximately-900]
All capacities shown are from FERC and include any proposed small uprates. Current as of July 23, 2024.

AIR POLLUTION, PUBLIC HEALTH, & ENVIRONMENTAL JUSTICE

Each stage of the oil and gas life cycle generates air and water pollution that can harm the health of communities nearby,[13] even before considering the impact on the global climate that comes from burning those fuels. In the case of LNG,[14] deadly air pollution is associated with gas wells,[15] pipelines and compressor stations,[16] liquefaction and export terminals, LNG tankers,[17] and the end-use of the gas in importing nations. For this study we only consider health harms from the liquefaction and export terminals.

The Clean Air Act governs the regulation of air emissions from LNG facilities. Most LNG terminals are classified as "major sources" of air pollution because they typically emit more than 100 tons per year of harmful criteria air pollutants and more than 10 tons per year of deadly hazardous air pollutants. The facilities must obtain a New Source Review pre-construction permit and a Title V operating permit. Often these permits are granted by state environmental agencies with delegated authority from EPA to implement the Clean Air Act. A majority of the projects in this study are permitted either by the Texas Council on Environmental Quality (TCEQ) or Louisiana Department of Environmental Quality (LDEQ).[18, 19]

Permit requirements can vary based on whether the facility is located in a region that already suffers from poor air quality. The U.S. EPA sets National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants and designates regions that violate these standards as nonattainment zones. If a facility is located in a nonattainment zone,[20] it is subject to more stringent air emissions regulations. If the facility is not in a nonattainment zone, then its permits must target a "Prevention of Significant Deterioration" (PSD) in local air quality. Of the 32 projects considered in this report, only 3 are located in existing ozone nonattainment zones – Freeport LNG and its expansion (located in Brazoria County, TX) and Cove Point LNG (located in Calvert County, MD).

There are published studies of the air pollution and health impacts of LNG facilities for some geographies and contexts,[21, 22, 23] but the health impacts of the rapid growth of LNG in the U.S. Gulf Coast have not yet been fully explored in the literature. The Environmental Integrity Project (EIP) has tracked air pollution emissions from LNG terminals and associated pipelines and compressor stations.[24] The Sierra Club has also published an analysis of the health risks due to air pollution from these terminals.[25] Recent reports have highlighted pollution issues at terminals in Louisiana[26] and terminals planned for the Rio Grande Valley.[27]

Localized pollution from oil and gas life cycles disproportionately harm Black, Brown, Indigenous and poor communities – a long-standing and pervasive problem that has been described as *fossil fuel racism*.[28] Some existing and planned LNG projects cause disproportionately distributed health impacts and are sited in communities that are already overburdened by existing industrial pollution, raising the question of whether the rapid LNG buildout will follow the same fossil fuel racism pattern.[29]

In May 2024, the Bullard Center for Environmental and Climate Justice published a landmark report looking at the cumulative impacts of the LNG buildout in Texas and Louisiana.[30] Their work helps to address important research gaps in terms of assessing impacts of LNG infrastructure, as previous analyses presented only a limited review of the environmental justice implications of these facilities. The report looks at six LNG export terminals and presents data on pollution impacts, health and safety risks, and exacerbated climate risks stemming from their operations as well as pre-existing pollution burdens and health disparities tied to their siting. The report highlights that the selected LNG export facilities degrade the air quality and public health of adjacent communities through the release of various criteria pollutants (including NO_x and particulate matter) as well as various hazardous air pollutants (e.g. benzene, toluene, formaldehyde) which are known to cause respiratory illness, cancer, and birth defects through prolonged exposure. Moreover, this study catalogs repeated instances in which LNG export terminal operators violated their permitted levels of emissions and faced few repercussions from state regulatory agencies, including at the currently operating Freeport LNG and Corpus Christi LNG facilities. While the Bullard Center's study serves as a foundational resource in assessing especially near-source environmental justice implications stemming from the health and safety risks posed by select operating LNG facilities, the analysis we undertake using the COBRA tool assesses health impacts under a different scope of inquiry. Our analysis focuses on the impacts of criteria pollutants (including ozone), at a larger geographic scale (county and state levels), and includes a wider range of LNG export projects (operating, planned, and under construction). Given these differences in scope and scale, the approach we've taken in developing this study yields findings that are a strong complement to those presented in the Bullard Center report.

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Construction is visible at the Plaquemines LNG, south of New Orleans. Venture Global is developing a LNG export facility in Plaquemines Parish, Louisiana, approximately 20 miles south of New Orleans.

METHODOLOGY

MODELING APPROACH

We use the EPA's COBRA model (v5.1) to estimate health impacts of air pollution from existing, under construction, and planned LNG export projects in the U.S.

COBRA is a screening tool that "provides estimates of the impact of air pollutant emission changes on ambient fine particulate matter ($PM_{2.5}$) and ozone (O_3) air pollution concentrations, translates this into health effect impacts, and then monetizes these impacts."[31] COBRA takes as inputs emissions of $PM_{2.5}$, nitrogen oxides (NO_x), sulfur dioxide (SO_2) and volatile organic compounds (VOCs), which can be specified either as absolute increases (or decreases) measured in tons, or else as a percentage increase (or decrease) relative to the existing emissions baseline. We model all emissions as absolute increases. Emissions are specified at the county level for the contiguous 48 states. COBRA also specifies the sector (or "tier") where the emissions originate, which determines the stack height of the facility used in the model. COBRA does not natively model LNG terminals, and we therefore directly specify that emissions are released from the "low" stack height category (less than 250 meters in height).

Based on these inputs, COBRA models $PM_{2.5}$ and ozone formation and estimates increases (or decreases) in concentrations for all impacted receptor counties.[32] Based on these concentrations, COBRA then outputs a wide range of health metrics at the county level, and monetizes the results. COBRA assumes that most health effects and their economic values occur in the year of analysis, with the exception of changes in adult premature deaths and non-fatal heart attacks that are assumed to occur over a 20-year timespan. We use a 2% discount rate to account for these effects, in-line with the U.S. Office of Management and Budget's guidance,[33] and express economic effects in 2023 dollars.

COBRA assumes that air pollution exposure levels within a county are well-represented by the county average exposure levels. The extent to which this may over- or under-estimate the health effects in a county where an LNG project is sited may depend on the exact location of the project relative to the population within the county, but the vast majority of estimated health effects per LNG project are not within-county. This is because primary $PM_{2.5}$, as well as $PM_{2.5}$ and ozone precursors, are transported downwind and disperse broadly from the emissions source, causing health impacts well beyond their point of origin.

COBRA potentially underestimates some air pollution exposure. For example, COBRA does not consider impacts from hazardous air pollutants, notably formaldehyde and benzene. COBRA may also underestimate ozone formation due to methane (CH_4) emissions, which are likely highly relevant for LNG facilities.[34, 35] EPA's regulatory definition of VOCs excludes methane,[36] although studies have identified significant ozone-related health benefits from reducing methane emissions.[37, 38] Overall, the results of our analysis are a conservative estimate of the total health burden from the assessed LNG projects' direct air pollution. This study does not attempt to quantify the health burden associated with upstream or downstream impacts such as gas production, transport, and combustion, although these factors are highly relevant for LNG project developers and regulators to consider.

PERMITTED AIR POLLUTANT VOLUMES FROM LNG PROJECTS

We compiled a database of air pollution emissions from each terminal's Clean Air Act permits, reported in (short) tons per year, and use these as inputs for COBRA. Where available, we use facility-wide emissions summaries from the last-issued final air permit. If there is no final permit issued, we use draft permits, and if no draft permit exists, we use emissions estimates from the permit application. Some projects with final permits have new permit modifications pending; we make note of these projects, but do not use these data.[39]

Flaring at Sabine Pass LNG in Southwest Louisiana.

Permitted emissions are not a perfect representation of emissions from these facilities. Actual pollutant emissions may vary over time and between normal operation and emergency conditions. Permitted emissions levels can both under- and overestimate actual emissions, and may also vary by nonattainment status, between states, and with the technology used by each project. Nonetheless, the permit data set allows us to estimate the scale of legally allowed health impacts and to meaningfully compare existing facilities with the larger number of under construction and planned projects. Table 2 includes emissions values for the four pollutants for each project.

Table 2: Permitted levels of air pollution emissions for each selected LNG project

Project	$PM_{2.5}$ (t/y)	NO_x (t/y)	SO_2 (t/y)	VOC (t/y)	Data Source	Permit Status	Cite	Note
Calcasieu Pass LNG	236.00	708.07	96.25	87.17	Final Air Permit	Issued 7/1/2021 [a]	[p1]	
Cameron LNG Phase I	211.17	1,532.35	20.05	180.02	Final Air Permit	Issued 9/19/2023	[p2]	[c]
Cameron LNG Phase II	95.35	691.86	9.05	81.28	Final Air Permit	Issued 9/19/2023	[p3]	[c]
Commonwealth LNG	223.93	375.63	63.25	151.91	Final Air Permit	Issued 3/28/2023 [a]	[p4]	
Corpus Christi LNG Stage I	56.87	2,360.93	32.93	235.41	Final Air Permit	Issued 10/19/2020 [a]	[p5]	[d]
Corpus Christi LNG Stage II	28.43	1,180.47	16.46	117.70	Final Air Permit	Issued 10/19/2020 [a]	[p6]	[d]
Corpus Christi LNG Stage III	19.56	151.42	12.04	92.80	Final Air Permit	Issued 3/28/2023 [a]	[p7]	
Corpus Christi LNG Midscale 8-9	3.97	69.58	3.40	77.76	Pending Air Permit	Pending	[p8]	[e]
Cove Point LNG	124.20	279.30	none listed	50.90	Final Air Permit	Issued 9/15/2022	[p9]	[f]
CP2 LNG Phase I	194.91	460.28	127.64	96.85	Permit Application	Pending	[p10]	
CP2 LNG Phase II	173.97	447.82	126.65	78.29	Permit Application	Pending	[p11]	
Delta LNG Phase I	179.06	442.96	87.30	112.79	Permit Application	Pending	[p12]	
Delta LNG Phase II	176.66	420.89	87.02	102.45	Permit Application	Pending	[p13]	
Driftwood LNG	356.20	1,700.92	73.60	554.45	Final Air Permit	Issued 11/20/2023	[p14]	
Eagle LNG Partners	7.08	103.28	37.80	50.65	Final Air Permit	Issued 5/8/2019	[p15]	[g]
Elba Island LNG	9.53	39.23	34.24	33.51	Permit Application	Issued 6/23/2015	[p16]	[h]
Freeport LNG	61.40	39.55	19.22	26.32	Final Air Permit	Issued 1/30/2018 and 4/19/2018 [a]	[p17]	[i]
Freeport LNG Expansion	19.09	12.30	5.98	8.18	Final Air Permit	Issued 2/6/2018 and 4/25/2018 [a]	[p18]	[i]
Golden Pass LNG	118.91	670.89	9.42	256.51	Final Air Permit	Issued 11/17/2014 [a]	[p19]	
Gulf LNG Liquefaction	69.88	288.80	164.93	100.96	Permit Application	Pending	[p20]	[j]
Lake Charles LNG	149.89	502.55	39.35	114.12	Final Air Permit	Issued 8/31/2023	[p21]	
Magnolia LNG	29.19	737.82	18.85	72.91	Final Air Permit	Issued 3/21/2016 [a]	[p22]	
Plaquemines LNG Phase I	187.24	466.60	72.57	74.91	Final Air Permit	Issued 4/16/2024 [a]	[p23]	
Plaquemines LNG Phase II	186.00	445.37	72.33	69.70	Final Air Permit	Issued 4/16/2024 [a]	[p24]	
Port Arthur LNG	214.21	947.51	31.51	103.03	Final Air Permit	Issued 9/17/2022 [b]	[p25]	[k]
Port Arthur LNG Expansion	214.21	947.51	31.51	103.03	Final Air Permit	Issued 9/17/2022 [b]	[p26]	[k]
Rio Grande LNG Phase I	154.45	667.38	11.71	289.09	Final Air Permit	Issued 11/2/2020	[p27]	[l]
Rio Grande LNG Phase II	102.97	444.92	7.80	192.72	Final Air Permit	Issued 11/2/2020	[p28]	[l]
Sabine Pass LNG Phase I	125.08	4,333.10	25.49	229.19	Final Air Permit	Issued 9/17/2020 [a]	[p29]	[m]
Sabine Pass LNG Phase II	62.54	2,166.55	12.75	114.59	Final Air Permit	Issued 9/17/2020 [a]	[p30]	[m]
Sabine Pass LNG Stage V	170.30	642.28	10.54	145.56	Permit Application	Pending	[p31]	
Texas LNG Brownsville	6.35	104.90	76.80	13.20	Final Air Permit	Issued 5/7/2020	[p32]	

[a] Project also has a subsequent permit modification or amendment that is pending, but not yet finalized.
[b] Permit status is pending legal proceedings.
[c] Total emissions split between Phase I and II proportional to capacity.
[d] Total emissions split between Stage I and II proportional to capacity.
[e] Total emissions split between Trains 1-7 and Trains 8-9 proportional to capacity.
[f] No limit specified for SO2.
[g] FDEP Technical Evaluation & Preliminary Determination document from Oil and Gas Watch database used.
[h] Final permit did not include total emissions; data found in corresponding permit application document from Oil and Gas Watch database.
[i] Combined emissions from terminal and pretreatment plant. Total emissions split between original and expansion proportional to capacity.
[j] Emissions data found in corresponding permit application document from Oil and Gas Watch database.
[k] Total emissions split between original and expansion proportional to capacity.
[l] Total emissions split between Phase I and II proportional to capacity.
[m] Total emissions split between Phase I and II proportional to capacity.
Full citations for the referenced air permits are found in the Appendix. Current as of June 10, 2024.

RESULTS

First, we use COBRA to model the single-year health impacts of each LNG terminal and project as if it were operating in 2023 (Table 3). This approach allows us to understand the health impacts corresponding to each project by modeling the projects separately.

Next, we use information about LNG projects' estimated start dates and DOE permit statuses to construct three buildout scenarios covering the 2023–2050 timeframe and use COBRA to model each scenario (Table 4). This approach provides useful information about the health benefits of policy interventions such as a denial of new project approvals, and allows us to estimate the cumulative health impacts of many LNG projects over time.

COBRA outputs more than 20 non-overlapping health impacts and their economic equivalents at the county level. In this briefing, we focus on eight key metrics, including some aggregated measures of health impact, as follows:

- **Total Premature Deaths, high and low estimates**. Total premature deaths are the sum of $PM_{2.5}$-related adult and infant premature deaths, adult premature deaths from long-term ozone exposure, and premature deaths across all age groups from short-term ozone exposure. The high and low estimates reflect uncertainty in the relationship between $PM_{2.5}$ exposure and adult premature deaths based on the results of two different cohort studies.[40, 41] EPA's standard practice is to report both values separately.

- **Total Health Costs, high and low estimates**. COBRA estimates the economic impact of the various health endpoints. The largest economic impact of a health outcome is the $14 million value assigned to one "statistical" premature death.[42] The high and low estimates of total health costs differ based on whether they use the corresponding high or low estimate of total deaths.

- **Asthma Onset and Symptoms**. The asthma onset metric reflects new childhood asthma cases due to $PM_{2.5}$ and ozone exposure. The asthma symptoms metric includes $PM_{2.5}$-related episodes of asthma symptoms that require albuterol use, and ozone-related chest tightness, cough, shortness of breath, and wheezing.

- **Lost Work and School Days.** These metrics reflect the number of lost work days due to $PM_{2.5}$-related illnesses and the number of school absences due to ozone-related illnesses.[43]

Unless otherwise noted, we present health impacts summed over the contiguous 48 states and default to presenting the high estimates of total premature deaths and health costs, as well as showing the low estimates in parentheses.[44] Health incidence results, including premature deaths, are not necessarily shown as whole numbers because COBRA estimates health impacts by summing many small risk reductions across an entire population.[45] Full COBRA results and maps are available through our Tableau dashboard.[46]

SINGLE-YEAR HEALTH IMPACTS

Table 3 shows single-year health metrics for each LNG project as if the project were operating in 2023. Although the under construction and planned projects are not yet operating, we compare them with operating projects using 2023 as the common analysis year to avoid confounding factors such as population growth in future years.

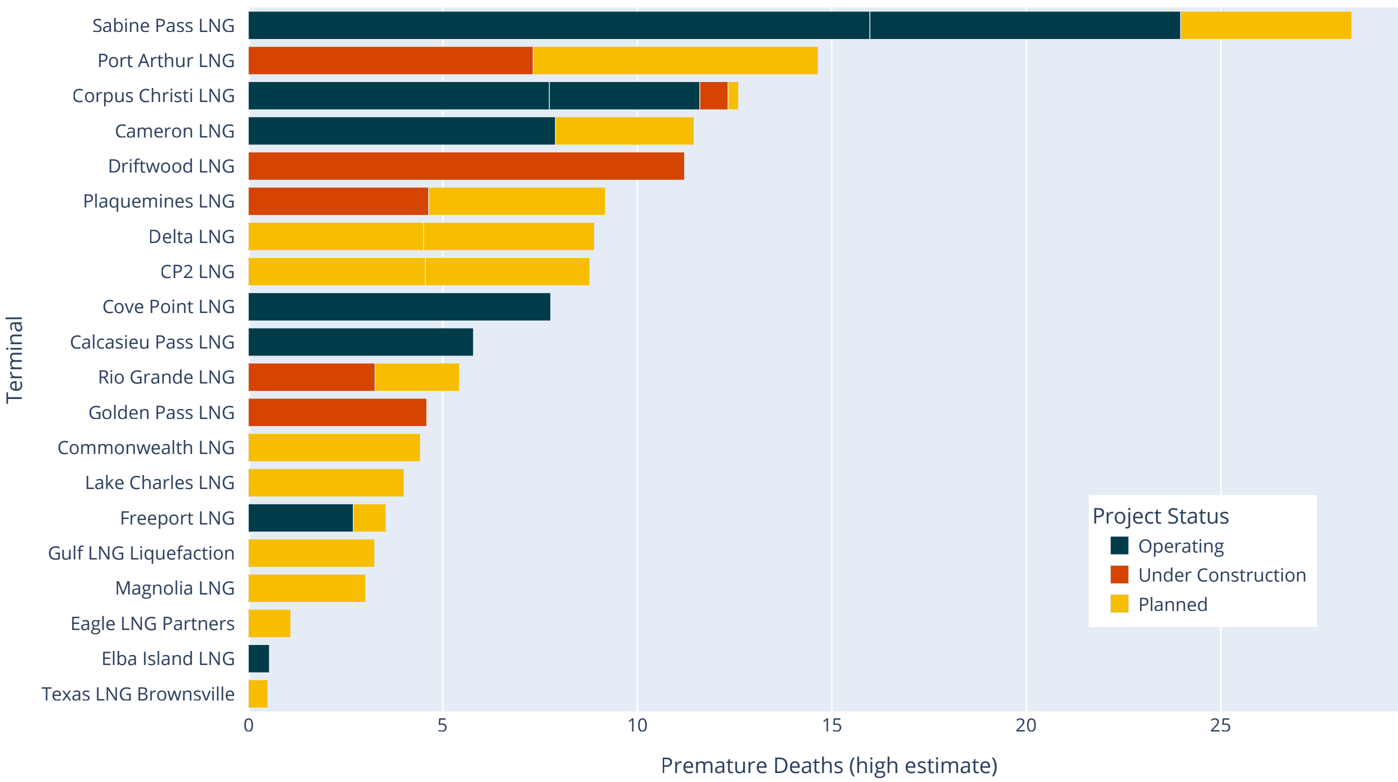
Currently operating terminals are responsible for an estimated 60.3 (44.2) premature deaths and $957 ($723) million in total health costs per year. If the full LNG buildout occurred in 2023, those numbers would increase to 149 (99.5) premature deaths and $2.33 ($1.61) billion in health costs per year.

Figure 2 shows total premature deaths by LNG terminal and project status based on the high estimate. Permitted emissions from Sabine Pass LNG are by far the deadliest out of any terminal. The operational units' permitted emissions result in an estimated 24 (19.5) premature deaths per year, and the planned expansion would add another 4.4 (2.8). The next deadliest terminals, if fully built, would be Port Arthur LNG (14.6 [9.2] deaths), Corpus Christi LNG (12.6 [10.4] deaths), Cameron LNG (11.5 [8.1] deaths), Driftwood LNG (11.2 [7.4] deaths), and Plaquemines LNG (9.2 [5.1] deaths).

Table 3: Single-year health impacts by LNG project

Project	Total Premature Deaths		Total Health Costs ($ million)		Asthma		Lost Days	
	High	Low	High	Low	Onset	Symptoms	Work	School
Grand Total	**149**	**99.5**	**$2,330**	**$1,610**	**566**	**89,300**	**5,520**	**41,800**
Total Operating	**60.3**	**44.2**	**$957**	**$723**	**276**	**42,900**	**1,870**	**22,100**
Sabine Pass LNG Phase I	16.0	13.0	$257	$214	82.0	12,600	319	7,030
Sabine Pass LNG Phase II	8.0	6.5	$129	$107	41.0	6,310	160	3,520
Cameron LNG Phase I	7.9	5.6	$124	$90.6	32.0	5,010	245	2,500
Cove Point LNG	7.8	4.3	$118	$67.6	18.1	3,020	419	963
Corpus Christi LNG Stage I	7.7	6.4	$128	$109	52.0	7,880	162	4,490
Calcasieu Pass LNG	5.8	3.5	$89.0	$56.1	17.5	2,820	240	1,150
Corpus Christi LNG Stage II	3.9	3.2	$64.0	$54.6	26.0	3,940	81.2	2,240
Freeport LNG	2.7	1.2	$40.6	$19.3	6.3	1,090	219	128
Elba Island LNG	0.5	0.3	$8.2	$5.0	1.4	218	23.1	82.9
Total Under Construction	**31.7**	**20.3**	**$493**	**$326**	**112**	**17,900**	**1,280**	**7,880**
Driftwood LNG	11.2	7.4	$174	$119	39.8	6,300	402	2,910
Port Arthur LNG	7.3	4.6	$113	$73.7	24.8	3,950	311	1,680
Plaquemines LNG Phase I	4.6	2.6	$70.5	$40.6	11.2	1,840	209	650
Golden Pass LNG	4.6	3.0	$71.5	$48.5	16.9	2,670	180	1,210
Rio Grande LNG Phase I	3.3	2.1	$51.7	$35.5	15.9	2,520	150	1,130
Corpus Christi LNG Stage III	0.7	0.5	$11.6	$8.6	3.8	579	25.5	296
Total Planned	**57.1**	**35.0**	**$880**	**$557**	**178**	**28,500**	**2,380**	**11,900**
Port Arthur LNG Expansion	7.3	4.6	$113	$73.7	24.8	3,950	311	1,680
CP2 LNG Phase I	4.6	2.6	$69.6	$41.7	12.4	2,020	202	753
Plaquemines LNG Phase II	4.5	2.5	$69.1	$39.6	10.8	1,780	207	620
Delta LNG Phase I	4.5	2.5	$68.4	$39.3	10.8	1,770	204	622
Commonwealth LNG	4.4	2.5	$67.3	$38.9	11.1	1,830	207	621
Sabine Pass LNG Stage V	4.4	2.8	$68.2	$45.3	14.9	2,360	167	1,050
Delta LNG Phase II	4.4	2.4	$66.7	$38.1	10.4	1,710	201	590
CP2 LNG Phase II	4.2	2.5	$64.7	$39.3	11.8	1,920	185	732
Lake Charles LNG	4.0	2.5	$61.8	$39.7	12.6	2,020	160	855
Cameron LNG Phase II	3.6	2.5	$56.1	$40.9	14.4	2,260	111	1,130
Gulf LNG Liquefaction	3.2	2.0	$49.7	$31.0	8.6	1,390	124	572
Magnolia LNG	3.0	2.4	$48.3	$39.2	14.7	2,280	66.5	1,250
Rio Grande LNG Phase II	2.2	1.4	$34.5	$23.6	10.6	1,680	100	756
Eagle LNG Partners	1.1	0.8	$16.9	$12.0	3.7	577	34.2	280
Freeport LNG Expansion	0.8	0.4	$12.6	$6.0	2.0	340	68.0	40
Texas LNG Brownsville	0.5	0.3	$8.0	$5.5	2.4	377	22.0	175
Corpus Christi LNG Midscale 8-9	0.3	0.2	$4.4	$3.6	1.7	254	7.2	140

Figure 2: Single-year premature deaths by LNG terminal (high estimate)



TIMELINE HEALTH IMPACTS

LNG projects are financed under the assumption that they will operate for decades. Most DOE export approvals—while revocable at any time—cover a term ending in 2050, as a result of a Trump-era decision intended to bolster the LNG market.[48] Consequently, single-year health impacts will accumulate over the lifetime of each project.

We use three LNG buildout scenarios to investigate the cumulative impact of the LNG industry over the 2023–2050 timeframe under different assumptions.

- The **Full Buildout scenario** assumes that all 32 of the projects in our report come online. This reflects a policy of returning to unrestricted LNG export approvals.
- The **No New Permits scenario** assumes that all projects with DOE export authorization are brought online but no new export applications are approved for pending projects.
- The **Operating Projects Only scenario** assumes that current operating projects continue operating but no new projects, including under construction projects, come online.

For the Full Buildout and No New Permits scenarios, we assume that operations begin January 1 of the calendar year following the estimated date of first LNG delivery (Appendix Table A1), as taken from the Sierra Club U.S. LNG Export Tracker[49]. These LNG company-stated dates are uncertain, and using the following calendar year reflects the possibility of project delays, as well as the possibility that a given project may take some time to move from first delivery to full commercial operations.

For each year in the analysis, we calculate total emissions from all active terminals.[50] We employ future population, health incidence, and valuation baselines provided by COBRA for the years 2028, 2030, 2035, 2040, 2045 and 2050.[51] For a given year, we conservatively use the most recent previous population, health incidence, and valuation files (i.e. we use the 2030 baseline for years 2030-2034). All costs are expressed in 2023 dollars using a 2% discount rate for years after 2023. We assume that the project lifespan is 35 years, meaning no projects are decommissioned before 2050 (the last year of our analysis).

Table 4 shows the cumulative health impacts from 2023 through 2030, 2040, and 2050 for our eight health metrics across the three scenarios.

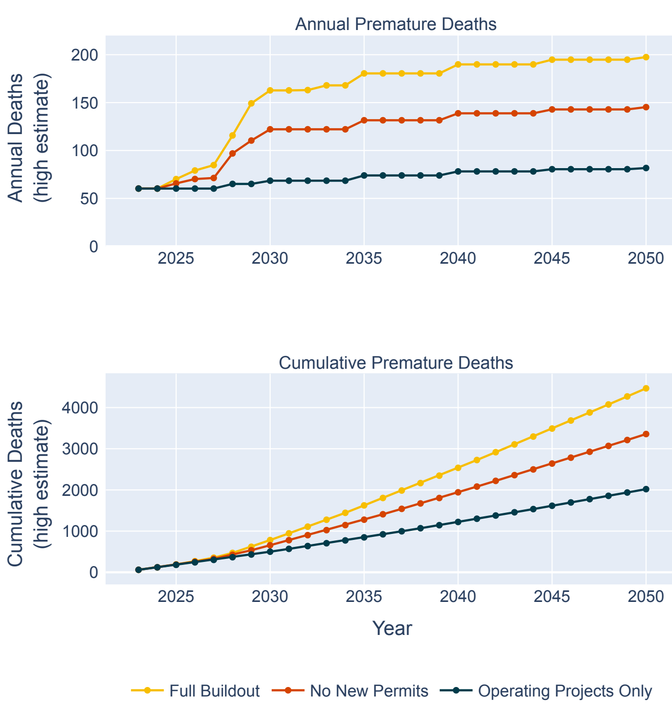
Table 4: Cumulative health impacts in each scenario

		Operating Projects Only (2023 –)			No New Permits (2023 –)			Full Buildout (2023 –)		
		2030	2040	2050	2030	2040	2050	2030	2040	2050
Total Premature Deaths	High	500	1,220	2,020	657	1,940	3,360	782	2,540	4,470
	Low	369	911	1,520	470	1,380	2,400	545	1,750	3,110
Total Health Costs ($ million)	High	$7,650	$18,000	$28,700	$9,990	$28,300	$47,100	$11,800	$36,700	$62,200
	Low	$5,810	$13,800	$22,100	$7,360	$20,700	$34,600	$8,500	$26,100	$44,400
Asthma	Onset	2,250	5,250	8,450	2,760	7,550	12,700	3,100	9,200	15,700
	Sympt.	354,000	838,000	1,350,000	439,000	1,220,000	2,050,000	495,000	1,490,000	2,560,000
Lost Days	Work	15,200	35,500	58,000	21,400	62,800	109,000	26,500	85,900	152,000
	School	182,000	431,000	697,000	218,000	596,000	1,000,000	240,000	708,000	1,210,000

Currently operating terminals are responsible for 2,020 (1,520) premature deaths and $28.7 ($22.1) billion in total health costs through 2050. If the full LNG buildout occurs, those numbers more than double to 4,470 (3,110) deaths and $62.2 ($44.4) billion in health costs.

Figure 3 shows the annual and cumulative premature deaths in each scenario over time. The scenarios differ in terms of which projects are built, with the Full Buildout scenario including all planned projects, the No New Permits scenario including all projects with export authorization, and the Operating Projects Only scenario only including projects that were operating as of July 2024.

Figure 3: Annual and cumulative premature deaths (high estimate) across three LNG buildout scenarios



In the No New Permits and Full Buildout scenarios, the biggest jump in annual premature deaths occurs between 2027 and 2030. This coincides with the addition of nine projects in the No New Permits scenario and fourteen projects in the Full Buildout scenario between 2028 and 2030 (Appendix Table A1).[52] The added projects in this timeframe with the most single-year premature deaths include Driftwood LNG and Port Arthur LNG, which DOE has approved for LNG exports, and the Port Arthur LNG expansion, which DOE has not to date approved. By comparison, the "Operating Projects Only" scenario only shows increases in annual premature deaths due to baseline population increases.[53]

In the Full Buildout scenario, annual premature deaths total 163 (111) by 2030 compared to 122 (86) in the No New Permits scenario and 68.5 (51.1) in the Operating Projects Only scenario. By 2050, annual premature deaths increase to 197 (139) in the Full Buildout scenario, 145 (105) in the No New Permits scenario, and 81.7 (62.1) in the Operating Projects Only scenario. Increases in annual premature deaths between 2030 and 2050 in all three scenarios are mainly the result of population growth (i.e., larger population exposed to air pollution).

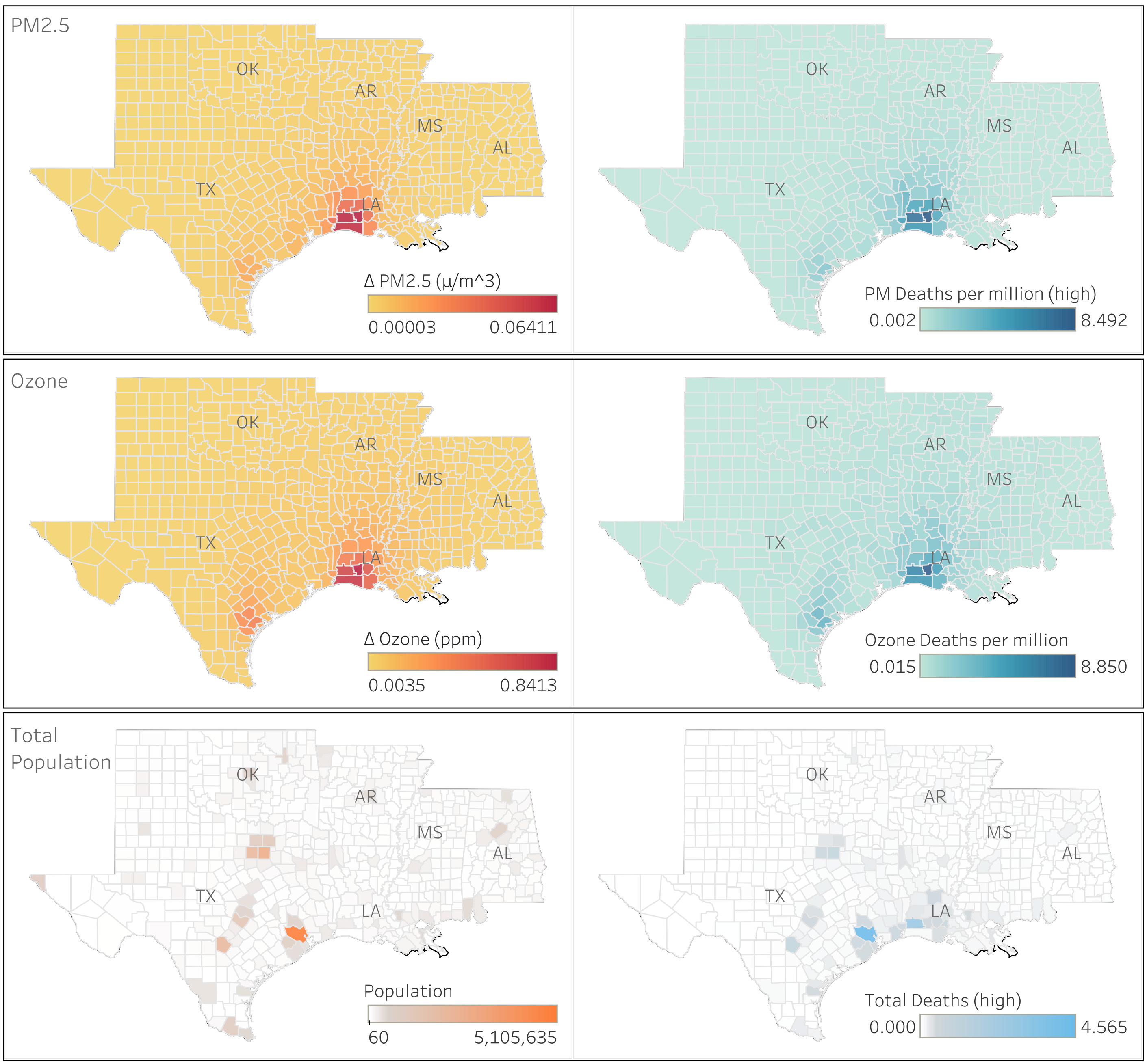
ANALYSIS & DISCUSSION

COUNTY IMPACTS

County Impacts In 2023

COBRA tracks health impacts due to $PM_{2.5}$ and ozone, both of which are air pollutants that exhibit local and regional effects relative to the emissions source.[54, 55, 56, 57] Pollutant concentrations are highest close to the emissions source. As a result, individuals in counties close to the emissions source experience higher health impacts than individuals in counties further away. The top two rows of Figure 4 illustrate this trend using side-by-side comparisons of air pollutant concentrations and premature deaths per million people from currently operating projects in 2023.

Figure 4: Side-by-side comparisons for 2023, Operating Projects Only: Modeled change in PM2.5 concentration vs. excess deaths per million people caused by LNG terminal PM2.5 (top row), modeled change in ozone concentration vs. excess deaths per million people caused by LNG terminal ozone (middle row), county population vs. excess deaths caused by LNG terminal PM2.5 and ozone (bottom row)



At the same time, the total population-level exposure to air pollution (and, hence, total health effects) can be higher in high-population areas that might be farther away from the emissions source. The bottom row of Figure 4 shows this using a side-by-side comparison of county population in 2023 and total premature deaths from LNG terminal air pollution from currently operating projects in 2023.

Table 5 shows the top 10 counties and parishes with the highest premature deaths, in absolute terms, due to operating LNG projects in 2023. Harris County, Texas – home to the city of Houston with a population of 2.3 million people – tops this list. In addition to suffering 4.6 (2.8) premature deaths for each year of LNG terminal emissions, Harris County can expect 30.9 additional cases of childhood asthma, 4,760 asthma symptom occurrences, and 2,160 school day absences, among other impacts, from permitted operating LNG terminal emissions. The terminals that most impact Harris County's public health are Sabine Pass LNG (31%), Freeport LNG (28%), and Corpus Christi LNG (21%), collectively accounting for $59.5 million ($39.9 million) in annual health costs out of the county's $74.7 million ($48.9 million) health costs attributed to air pollution from operating LNG terminals. Dallas County also ranks highly (#3) on the list of total deaths, even though it is more than 250 miles from the closest LNG terminal. Nearly half of the health burden in Dallas County is attributable to Corpus Christi (48%), followed by Sabine Pass LNG (32%) and Cameron LNG (10%). All of the terminals with the highest impact on Harris and Dallas Counties have planned expansions.

Table 6 shows the top 10 counties and parishes with the most premature deaths per million people due to operating LNG projects in 2023. These counties and parishes are very concentrated in and around Southwest Louisiana, close to operating LNG terminals. Per year of emissions, there are estimated to be 10.1 (7.3) premature deaths per million people in Cameron Parish, which is home to Sabine Pass LNG, Cameron LNG, and Calcasieu Pass LNG. In Jefferson Davis Parish, Calcasieu Parish, and Orange County, Texas, which all share a border with Cameron Parish, there are estimated to be 17.4 (12.7), 13.1 (9.2), and 7.9 (5.3) premature deaths per million people per year of emissions, respectively.

Table 5: Counties and parishes with the highest premature deaths from operating LNG terminals in 2023

	Total Premature Deaths		Premature Deaths Per Million		Total Health Costs ($ million)		Asthma		Lost Days		
County / Parish	High	Low	High	Low	High	Low	Onset	Symptoms	Work	School	Highest Impact Terminals
Harris, Texas	4.6	2.8	0.9	0.5	$74.7	$48.9	30.9	4,760	296	2,160	Sabine Pass (31%), Freeport (28%), Corpus Christi (21%)
Calcasieu, Louisiana	2.7	1.9	13.1	9.2	$42.4	$30.5	9.4	1,480	73.4	720	Sabine Pass (57%), Cameron (23%), Calcasieu Pass (19%)
Dallas, Texas	1.0	0.8	0.4	0.3	$17.6	$14.0	8.9	1,340	37.7	730	Corpus Christi (48%), Sabine Pass (32%), Cameron (10%)
Bexar, Texas	1.0	0.8	0.5	0.4	$17.3	$13.4	7.7	1,180	37.0	641	Corpus Christi (73%), Sabine Pass (16%), Cameron (5%)
Tarrant, Texas	0.8	0.6	0.4	0.3	$13.5	$11.1	6.2	933	24.4	516	Corpus Christi (52%), Sabine Pass (30%), Cameron (9%)
Jefferson, Texas	0.8	0.5	3.2	2.0	$12.6	$8.3	2.6	424	30.4	187	Sabine Pass (53%), Cameron (22%), Calcasieu Pass (18%)
Lafayette, Louisiana	0.8	0.6	2.8	2.1	$12.4	$9.7	5.1	769	23.9	421	Sabine Pass (61%), Cameron (21%), Calcasieu Pass (16%)
Fort Bend, Texas	0.7	0.4	0.8	0.5	$11.3	$7.8	4.7	753	46.3	357	Freeport (30%), Corpus Christi (29%), Sabine Pass (25%)
Montgomery, Texas	0.7	0.5	1.1	0.8	$11.0	$8.1	3.2	490	26.0	240	Sabine Pass (36%), Corpus Christi (28%), Freeport (15%)
Orange, Texas	0.7	0.5	7.9	5.3	$10.3	$7.1	1.6	261	16.8	117	Sabine Pass (56%), Cameron (23%), Calcasieu Pass (19%)

Table 6: Counties and parishes with the highest premature deaths per million people from operating LNG terminals in 2023

County / Parish	Premature Deaths Per Million		Highest Impact Terminals
	High	Low	
Jefferson Davis, Louisiana	17.4	12.7	Sabine Pass (58%), Cameron (23%), Calcasieu Pass (18%)
Calcasieu, Louisiana	13.1	9.2	Sabine Pass (57%), Cameron (23%), Calcasieu Pass (19%)
Cameron, Louisiana	10.1	7.3	Sabine Pass (57%), Cameron (23%), Calcasieu Pass (19%)
Acadia, Louisiana	8.7	6.5	Sabine Pass (61%), Cameron (22%), Calcasieu Pass (17%)
Allen, Louisiana	8.2	5.8	Sabine Pass (59%), Cameron (22%), Calcasieu Pass (18%)
Orange, Texas	7.9	5.3	Sabine Pass (56%), Cameron (23%), Calcasieu Pass (19%)
Beauregard, Louisiana	6.9	4.6	Sabine Pass (57%), Cameron (23%), Calcasieu Pass (19%)
Evangeline, Louisiana	6.7	5.1	Sabine Pass (62%), Cameron (21%), Calcasieu Pass (15%)
Vermilion, Louisiana	5.9	4.5	Sabine Pass (61%), Cameron (22%), Calcasieu Pass (17%)
Refugio, Texas	5.5	4.4	Corpus Christi (92%), Sabine Pass (4%), Cameron (2%)

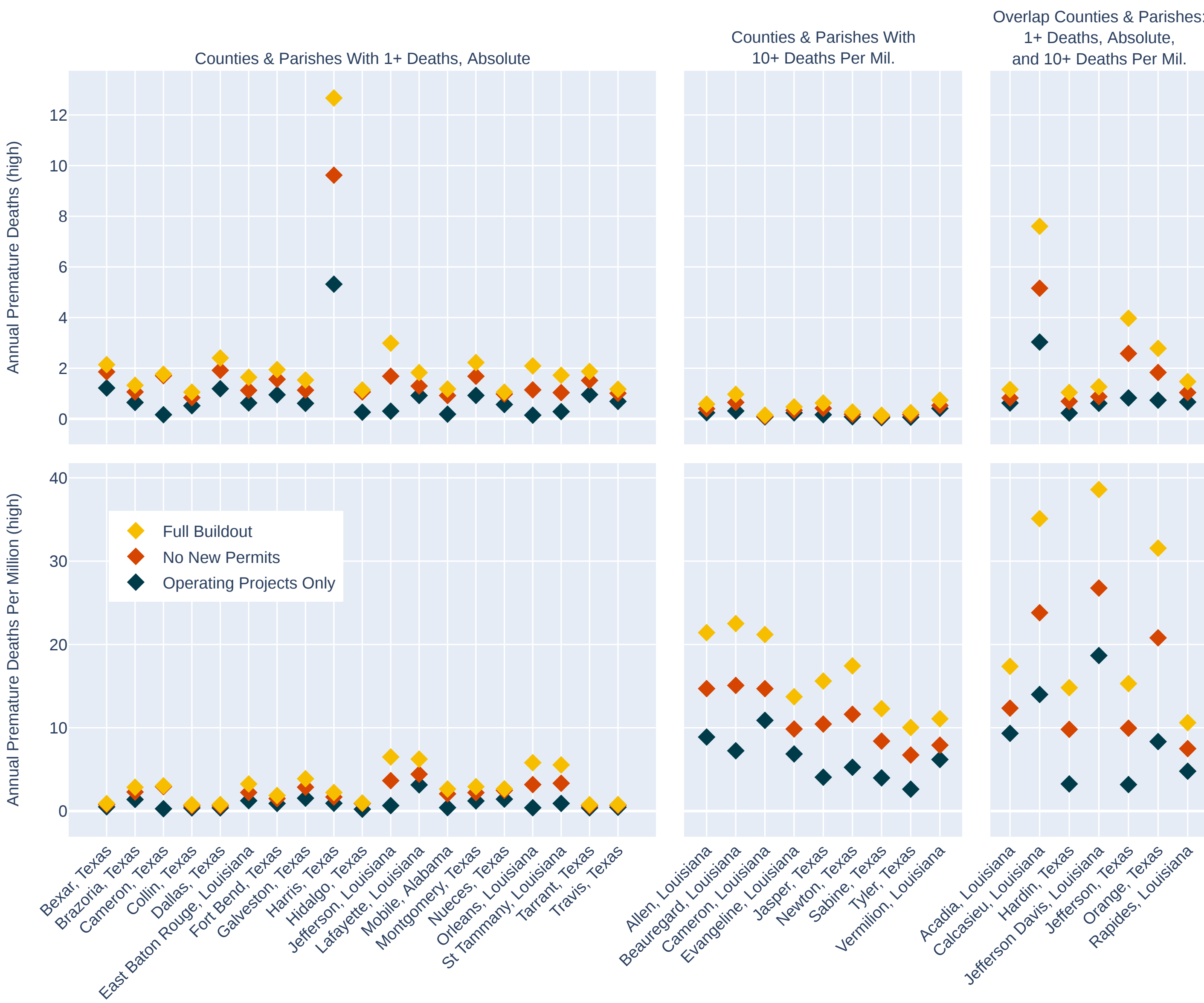
"Full Buildout" County Impacts In 2030

The vast majority of LNG projects in our analysis are slated to be in operation by 2030. Using the 2030 annual results of the Full Buildout scenario, we identify counties with at least 1 premature death, in absolute terms, or 10 premature deaths per million people (high estimate) to investigate further. A combined total of 35 counties, which we refer to as "Most Impacted Counties and Parishes," meet these thresholds: 14 in Louisiana, 20 in Texas, and 1 in Alabama (Figure 5 and Appendix Table A2). Our analysis does not represent the full range of LNG terminal air pollutants or sub-county level impacts, so this list should be understood as a heuristic tool rather than a definitive list of counties that are most impacted by the LNG buildout.

Although the Most Impacted Counties and Parishes list is determined from the results of the Full Buildout scenario, Figure 5 shows the absolute and per million premature deaths for these counties across all three buildout scenarios. If all projects slated for 2030 are in operation, Harris County, Texas would suffer the most premature deaths, in absolute terms: 12.7 per year of emissions (up from 5.3 in the Operating Projects Only scenario). Jefferson Davis Parish, Louisiana would suffer the most premature deaths per million: 38.6 per year of emissions (up from 18.7 in the Operating Projects Only scenario). The absolute number of premature deaths in Jefferson Davis Parish, and some other nearby counties and parishes, may appear relatively low due to the small population of the county, but individual residents face a very high health burden.

Calcasieu Parish, Louisiana; Jefferson County and Orange County, Texas; and Jefferson Davis Parish are among the most impacted counties for both absolute and per million premature deaths. Per year of emissions, if all planned projects are built, Calcasieu Parish would experience 7.6 premature deaths (35.1 per million), Jefferson County 4 (15.3 per million), and Orange County 2.8 (31.6 per million).

Figure 5: Annual absolute and per million premature deaths (high estimate) for the Most Impacted Counties and Parishes across all three buildout scenarios in 2030



ENVIRONMENTAL JUSTICE ANALYSIS

Environmental justice (EJ) is relevant to consider in the context of LNG export authorizations. Energy infrastructure is frequently sited nearby and directly harms communities of color and low income communities. The Biden Administration's Executive Order 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis clearly states that federal agencies must take steps to advance environmental justice.[58]

We evaluate the overlap between the Most Impacted Counties and Parishes and populations that are already overburdened, and the extent to which different racial and ethnic groups are projected to experience LNG terminal air pollution. For this, we use nonattainment, Climate Vulnerability Index (CVI), and population datasets for current conditions, reflecting pre-existing overburden and vulnerabilities to the full buildout. COBRA provides results at the county level; more geographically specific data would enable us to conduct additional EJ analysis.

Most Impacted Counties and Parishes Cumulative Impacts

For the Most Impacted Counties and Parishes, we look at county nonattainment status as a representation of current air quality and the Climate Vulnerability Index ranking as a cumulative assessment for county health, pollution, socioeconomic vulnerability, climate, and environment (Figure 6).

Nonattainment

As mentioned previously, nonattainment zones are regions, typically counties and parishes, that violate the EPA's NAAQS for one or more criteria air pollutants. Thus, these regions already suffer from poor air quality, and local facilities must abide by stricter regulations. Out of the 11 counties and parishes that the LNG projects are sited within, 2

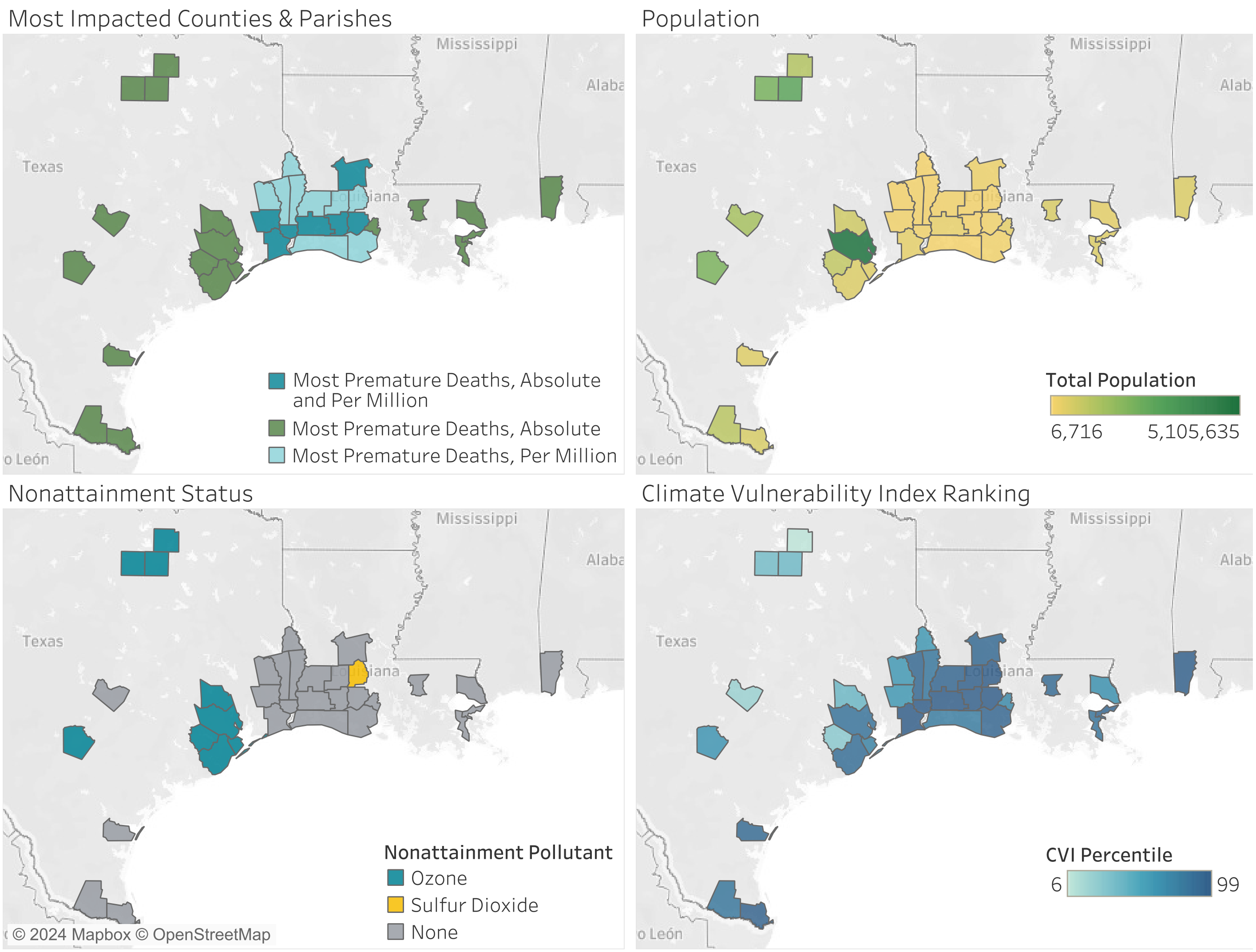
Most Impacted Counties and Parishes
From Full Buildout scenario 2030 annual results

Most Premature Deaths, Absolute: subset of Most Impacted Counties and Parishes that experience at least 1 premature death in absolute terms (only)

Most Premature Deaths, Per Million: subset of Most Impacted Counties and Parishes that experience at least 10 premature deaths per million (only)

Most Premature Deaths, Absolute and Per Million: subset of Most Impacted Counties and Parishes that experience at least 1 premature death in absolute terms, and 10 premature deaths per million

Figure 6: Map of Most Impacted Counties and Parishes and overlap with EPA Nonattainment Zone and CVI datasets



are currently in nonattainment (~18%) for ozone. Our results show that pollution from individual and cumulative LNG projects can increase $PM_{2.5}$ and ozone levels in counties and parishes many miles away, leading to premature deaths, respiratory related illness, and high costs. We look at nonattainment zone impacts beyond the LNG sited counties and parishes to take into consideration the spread of these criteria air pollutants and the collective effect of these projects.

When considering the 35 Most Impacted Counties and Parishes we selected, 9 are currently in nonattainment for ozone and 1 for sulfur dioxide (Figure 6, Appendix Table A3). These 10 counties and parishes contain approximately 70% of the total estimated population of the 35 Most Impacted Counties and Parishes. The ozone nonattainment counties and parishes correlate with the counties and parishes that experience the highest total premature deaths. These counties and parishes tend to have higher populations and may have more sources for ground-level ozone such as motor vehicle traffic and fossil fuel power plants. Ground-level ozone exposure can inflame and damage airways, increase lung susceptibility to infection, and exacerbate lung disease such as chronic bronchitis and asthma, and even increase the frequency of asthma attacks. Sensitive vegetation and ecosystems can also be harmed.[59] Acute exposure to sulfur dioxide can harm the human respiratory system and affect the ability to breathe, especially for sensitive and vulnerable groups. Sulfur dioxide can react to form sulfur oxides that are precursors for $PM_{2.5}$, and contribute to harmful acid rain and haze.[60]

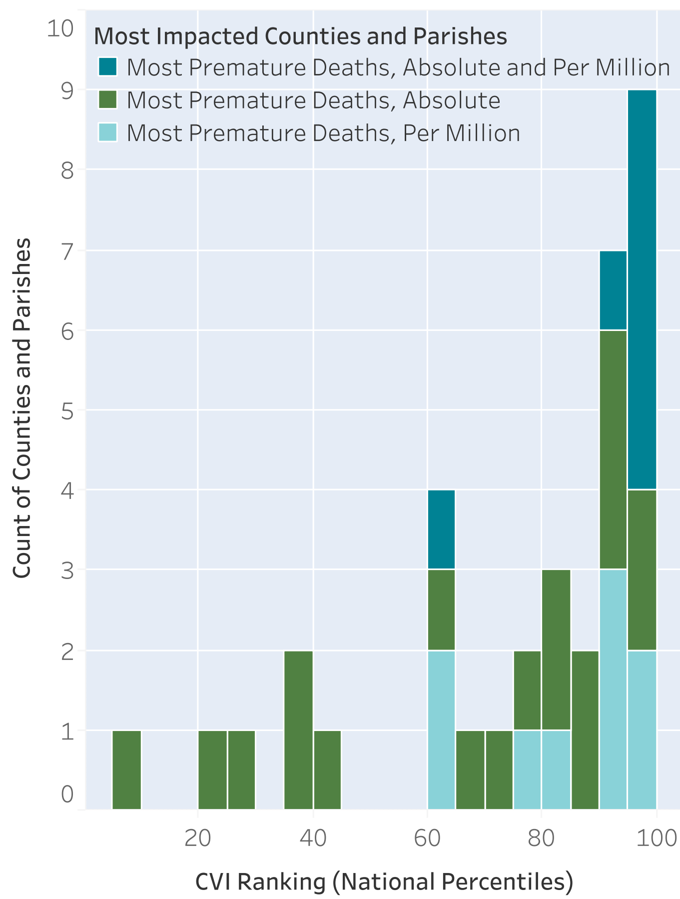
Currently, air emissions regulations applicable to LNG projects are based on the nonattainment status for the area (county) in which an LNG terminal is sited. This limited scope of evaluation may exclude air pollution spread and health harms to communities in nonattainment areas across affected regions, perpetuating poor air quality and working against policy and regulatory efforts to curb pollution.

Climate Vulnerability Index

The Climate Vulnerability Index[61], developed by the Environmental Defense Fund and Texas A&M University, is a cumulative impacts assessment that integrates 184 indicators that span socioeconomic vulnerability, pollution exposure, health outcomes, infrastructure conditions, and climate and environmental conditions and risk. The goal of the CVI is to determine communities' vulnerability to climate destabilization, which cannot be done without considering the cumulative impacts that can shape a community. The CVI analysis framework produces an overall score that factors in these various metrics and ranks counties through a national percentile.

We find that the majority of the Most Impacted Counties and Parishes are above the 82nd percentile, meaning that their cumulative burden exceeds that of 82% of the United States, and the distribution of rankings tends towards higher percentiles (Figure 7, Appendix Table A4). When looking at the

Figure 7: Climate vulnerability ranking of Most Impacted Counties and Parishes



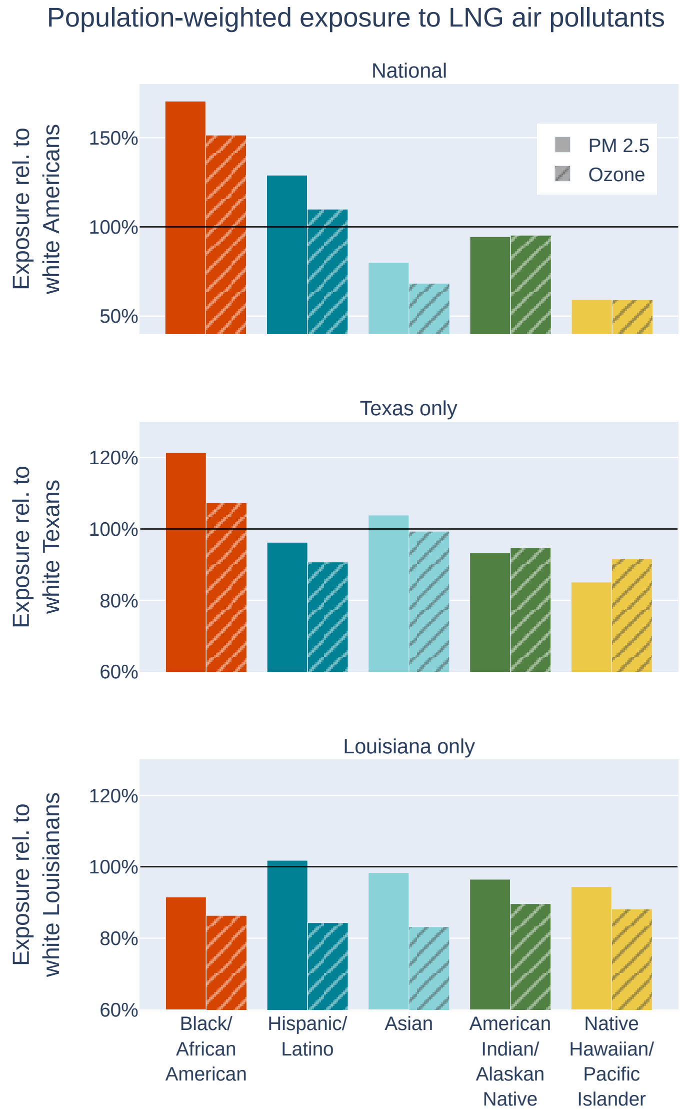
most impacted counties by subset, we find that the majority of counties with the most total deaths and deaths per million (both) rank the highest for the CVI, at the 99th percentile. The majority of counties with the most premature deaths per million (only) are above the CVI 92nd percentile. These two county subsets correlate with highest pollution concentrations from the LNG buildout. The majority of counties with the most total premature deaths (only), correlating with highest population counties, rank above the CVI 75th percentile. These findings strongly suggest an overlap between extremely overburdened areas and communities with LNG air pollution.

The CVI rankings also show that these impacted areas are highly vulnerable and at risk to the climate crisis. The fossil fuel industry is a major contributor to greenhouse gas emissions and environmental degradation, all of which drive the climate crisis. Thus, LNG facilities have the compounding effect of polluting communities with pre-existing health and pollution burdens, and exacerbating climate destabilization, which disproportionately harms these communities.

LNG Air Pollution Exposure for Racial and Ethnic Groups

Population-weighted exposure represents how different groups experience pollution based on where their populations are concentrated. In physical terms, it measures the average pollution exposure for individuals in a group, so if members of that group are disproportionately close to the emissions source, their population-weighted exposure would be higher. In this section, we calculate the population-weighted exposure to LNG terminal air pollution for census-designated racial groups and Hispanic vs. non-Hispanic Americans. We conducted the analysis for the entire population of the contiguous U.S., as well as Texas and Louisiana individually, using county-level projected population data and COBRA results for the Full Buildout scenario analysis year 2030 in combination with demographic percentages from the 2018–2022 American Community Survey (U.S. census). Figure 8 shows the results of this analysis for each non-white population group relative to the white group's population-weighted exposure.[62]

Figure 8: PM 2.5 and ozone exposure relative to the white population[49]



If all projects slated for 2030 reach operation, nationally Black and Hispanic Americans would have much higher exposure to $PM_{2.5}$ and ozone pollution from LNG terminals than white Americans. For Black Americans, the relative exposure levels for $PM_{2.5}$ and ozone would respectively be 170% and 151%. For Hispanic Americans, the relative exposure levels would be 129% and 110%. This partly reflects that Louisiana and Texas are slated to have high average exposure rates to LNG terminal air pollution and have a larger share of the country's Black and Hispanic populations than its white population. In other words, high pollution exposure rates in Louisiana and Texas would have a larger impact on the national average exposure rates for the Black and Hispanic populations than the white population.

The fossil fuel industry's domineering presence in these states is no accident. Both states have long used tax concessions, low wages, and minimal regulatory oversight to court the industry, in addition to possessing oil and gas reserves.[63] In conjunction with the state, fossil fuel corporations have set up and operated highly polluting projects at the doorstep of poor neighborhoods and neighborhoods of people of color, for instance, along the Mississippi River stretch known as "Cancer Alley." The area's Black residents, who suffer from under-representation in state politics, have been the most affected.[64]

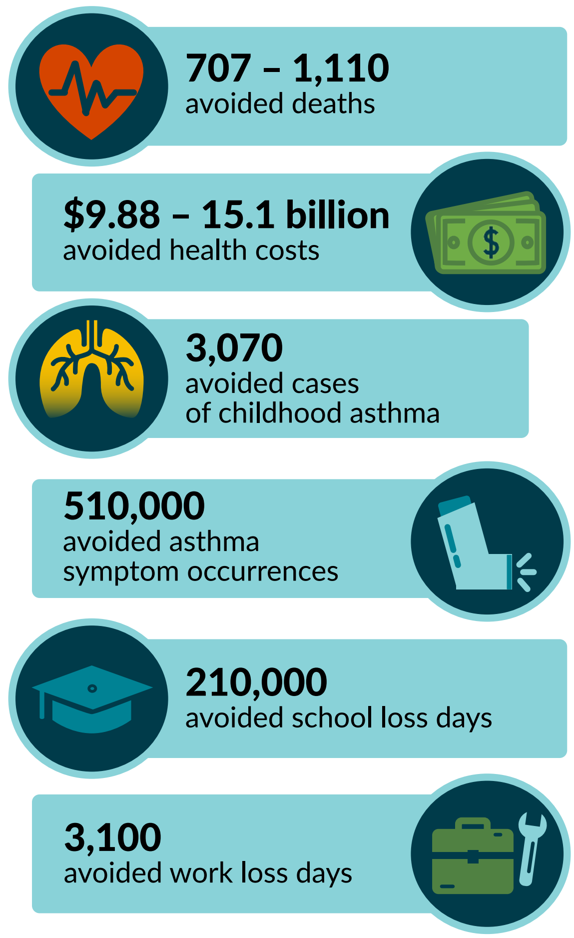
The LNG terminal buildout is influenced by this legacy, as well as reflecting certain factors—like the need for vast acreage and coastal access—more strongly than in the past. Our analysis shows that within Texas, the Black population's relative exposure levels for $PM_{2.5}$ and ozone pollution from LNG terminals would respectively be 121% and 107%. At the same time, white Texans and Louisianans would not be shielded from LNG terminals' air pollution. In Texas, the white population's exposure to $PM_{2.5}$ and ozone pollution from LNG terminals would respectively be 4% and 10% higher than the Hispanic population's exposure. In Louisiana, the white population's exposure to ozone pollution from LNG terminals would be 12 to 20% higher than all non-white demographic groups' exposure.

STOPPING THE LNG BUILDOUT

Many climate and environmental justice groups applauded the Biden administration's announcement that the Department of Energy would implement a "temporary pause" on approving new LNG permits in order to update the studies used to inform the public interest determination for LNG export applications. Since there are converging lines of evidence to suggest that LNG projects are not in the public interest, this reassessment opens the door to a clarification of LNG's impacts that slows the LNG industry's growth.[65, 66] Figure 9 summarizes the health benefits that would accrue through 2050, solely from reduced LNG terminal air pollution if LNG projects that are not currently authorized are not built compared to the Full Buildout scenario.

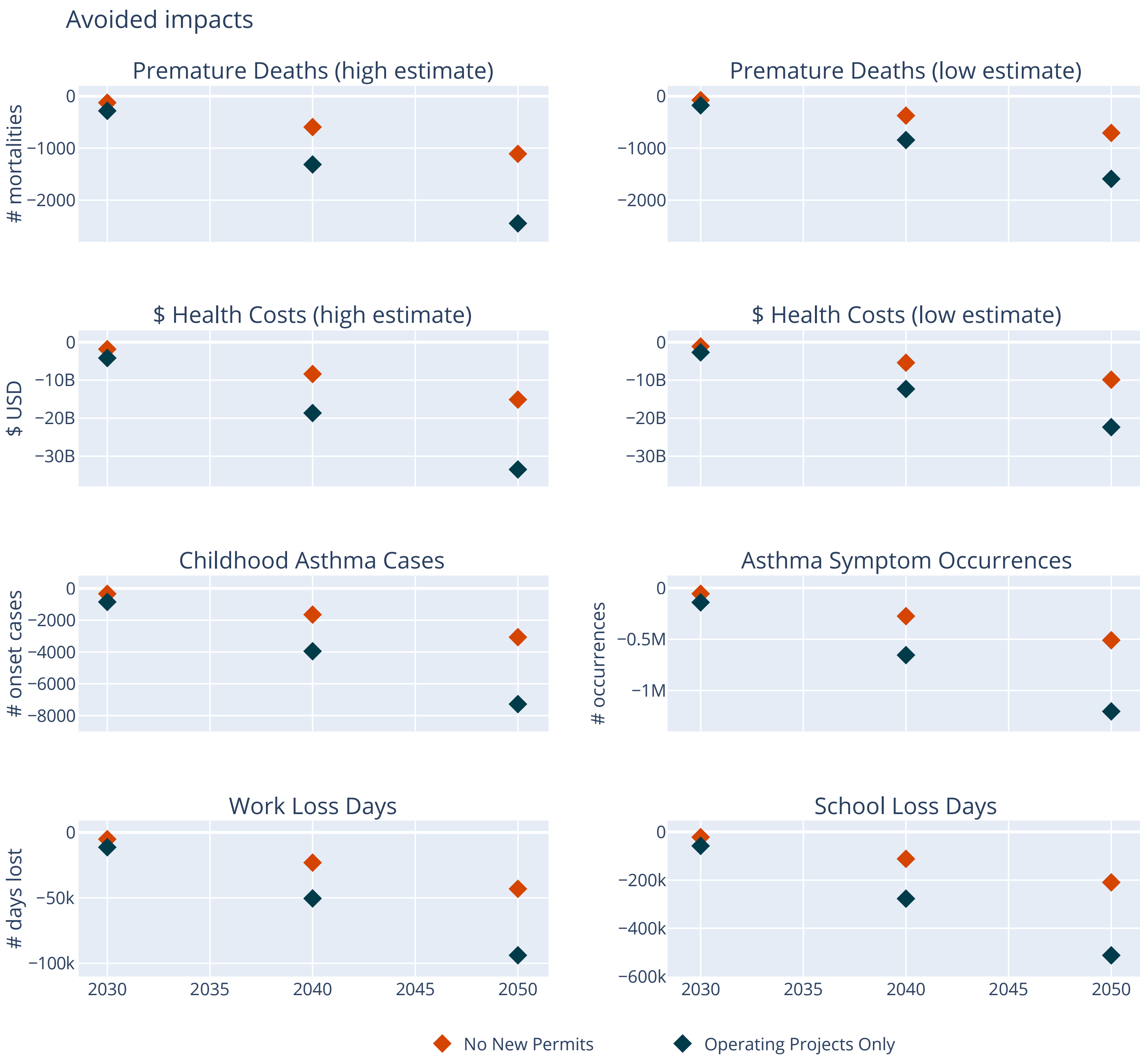
Figure 9: Stopping new LNG export authorizations would carry major health benefits from reduced LNG terminal air pollution

Health benefits from avoided air pollution if LNG projects not currently authorized by DOE are not built (2023 –2050)



Scenarios aligned with limiting global warming to 1.5ºC show a peak in global LNG trade around 2025-2030 followed by a decline to 2050.[67, 68] If U.S. LNG exports are to follow that trajectory, it would necessarily require no new LNG exports and imply a managed phase-out of currently operating LNG exports. Constructing a scenario of this nature is beyond the scope of our study. Instead, we examine the health benefits that would result from the Operating Projects Only scenario—our most stringent scenario—alongside those that would result from the No New Permits scenario (Figure 10).

Figure 10: Avoided health impacts relative to the Full Buildout scenario: No New Permits vs. Operating Projects Only



The Operating Projects Only scenario would avoid an estimated 2,450 (1,590) premature deaths, 7,280 cases of childhood asthma onset, 1.2 million asthma symptom occurrences, 93,900 lost work days, and 513,000 school absences by 2050, by comparison to the Full Buildout scenario. The cumulative public health benefits by 2050 would total an estimated $33.5 ($22.4) billion—more than doubling the savings that would result from the No New Permits scenario.

RECOMMENDATIONS

This briefing shows that the LNG buildout poses significant health risks both for communities living near these facilities, as well as regionally. These health harms are occurring today, and they will only increase as more export terminals and expansion projects come online. This health threat demands an expeditious policy response.

We make the following recommendations:

- DOE, FERC, and other agencies should reject any approvals or permits for LNG export projects, as well as related pipelines and compressor stations.
- DOE's review of the studies and analysis it uses to assess LNG exports, as well as its review of individual LNG export project applications, should make clear that any projects that exacerbate climate change or worsen local health outcomes are simply not in the public interest and must be rejected.
- DOE and FERC should evaluate the cumulative impacts of air pollution from existing and the slate of planned LNG terminals when evaluating the impacts of any specific project on the surrounding communities.
- EPA must develop and enforce more robust controls on the cumulative impacts of air pollution for the most overburdened communities.
- DOE and other agencies should create frontline community member boards to inform of concerns that arise from LNG operations such as high pollution emitting events (e.g., flaring, leaks); and consult with them as new studies are developed for the public interest determination process, and for LNG permitting decisions.

Any policy to phase out fossil fuels exports must be paired with ambitious investments in impacted communities. We join calls for a Green New Deal to create millions of new jobs, build resilience to climate impacts, and ensure a just transition for workers and communities throughout the Gulf South region.[69] In addition, phasing out fossil fuel exports should be paired with increased funding for global climate mitigation and adaptation to help importing nations transition to renewables and resist locking-in dependence on LNG.

ACKNOWLEDGMENTS

Greatest thanks to our colleague, Ade Samuel, Energy Analyst at NRDC, for his direct and crucial contributions to this briefing. We wish to highlight EIP's Oil and Gas Watch website[70] and their Emissions Increase Database[71] as invaluable resources in understanding LNG facility air permits. We would like to express our deepest appreciation to Louisa Eberle and Tom Gosselin, previously at Sierra Club's Environmental Law Program, for generously sharing their insights and answering questions on the air permitting process and permits for the LNG projects investigated in this briefing. This briefing was made possible thanks to the EPA COBRA tool and its development team. We are grateful to Colby Tucker, EPA Senior Policy Analyst, and David Cooley, Abt Associates Senior Associate, for answering our COBRA-related questions. Lastly, we would like to give thanks to our coalition of partners on the frontlines and across the country for their detailed review of this briefing and their unrelenting work for a better climate and environment for all.

APPENDIX

PERMIT CITATIONS

1. Louisiana Department of Environmental Quality. Final Minor Modification; Permit No. 0560-00987-V4. Calcasieu Pass LNG (AI# 194203) 7/1/2021. p.19. https://edms.deq.louisiana.gov/app/doc/view?doc=12782236

2. Louisiana Department of Environmental Quality. Title V Regular Permit Renewal/Modification; Permit No. 0560-00184-V11. Cameron LNG (AI# 99407) 9/19/2023. p.4. https://edms.deq.louisiana.gov/app/doc/view?doc=13992626

3. Louisiana Department of Environmental Quality. Title V Regular Permit Renewal/Modification; Permit No. 0560-00184-V11. Cameron LNG (AI# 99407) 9/192023. p.4. https://edms.deq.louisiana.gov/app/doc/view?doc=13992626

4. Louisiana Department of Environmental Quality. Initial Title V; Permit No. 0560-00997-V0. Commonwealth LNG (AI# 221642) 3/28/2023. p.3. https://edms.deq.louisiana.gov/app/doc/view?doc=13750139

5. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 105710 and GHGPSDTX123M1. Corpus Christi LNG (RE# RN104104716). 11/19/2020. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=5422379

6. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 105710 and GHGPSDTX123M1. Corpus Christi LNG (RE# RN104104716). 11/19/2020. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=5422379

7. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 139479, PSDTX1496, and GHGPSDTX157. Corpus Christi LNG (RE# RN104104716). 3/28/2023. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=6491877

8. Texas Council on Environmental Quality. Preliminary Determination Summary; Permit No. 139479, PSDTX1496M1, and GHGPSDTX157M1. Corpus Christi LNG (RE# RN104104716). 5/8/2024. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=7060010

9. Maryland Department of the Environment. Renewal Part 70/Title V Operating; Permit #24-009-0021. Cove Point LNG (Permit 009-0021). 9/15/2022. p356-357. https://mde.maryland.gov/programs/permits/AirManagementPermits/Test/CovePoint2022IssuedT5FSCO-2BudgetPermit.pdf

10. Venture Global CP2 LNG, LLC. Initial Title V Permit and PSD Permit Application Vol 1. CP2 LNG (AI# 232172). 7/29/2022. p.21, Table 1-3, Scenario 2. https://edms.deq.louisiana.gov/app/doc/view?doc=13411196

11. Venture Global CP2 LNG, LLC. Initial Title V Permit and PSD Permit Application Vol 1. CP2 LNG (AI# 232172). 7/29/2022. p.21, Table 1-3, Scenario 4. https://edms.deq.louisiana.gov/app/doc/view?doc=13411196

12. Venture Global Delta LNG, LLC. Initial Title V Permit and PSD Permit Application Vol 1. Delta LNG (AI# 218335). 11/19/2019. p.19, Table 1-3, Scenario 2. https://edms.deq.louisiana.gov/app/doc/view?doc=11961839

13. Venture Global Delta LNG, LLC. Initial Title V Permit and PSD Permit Application Vol 1. Delta LNG (AI# 218335). 11/19/2019. p.19, Table 1-3, Scenario 4. https://edms.deq.louisiana.gov/app/doc/view?doc=11961839

14. Louisiana Department of Environmental Quality. Title V Renewal/Modification; Permit No. 0520-00504-V1. Driftwood LNG (AI# 201334). 11/20/2023. p.3. https://edms.deq.louisiana.gov/app/doc/view?doc=14074716

15. Florida Department of Environmental Protection. Technical Evaluation & Preliminary Determination. Eagle LNG Partners (ARMS No. 0310632; Project No. 0310632-001-AC). 4/5/2019. p.19. https://api.oilandgaswatch.org/d/4d/09/4d092fc6c9004bbc834a5da2786b1e31.1640189472.pdf

16. Kinder Morgan. Air Permit Application for Construction. Elba LNG (AIR No. 04-13-05-10003). 12/30/2013. p.7. https://api.oilandgaswatch.org/d/a6/42/a642b260298544e99b74042182c2f783.1646068982.pdf

17. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 100114. Freeport LNG (RE# RN103196689). 1/30/2018. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5269541&Rendition=Web ; Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 104840 and N170. Freeport LNG Pretreatment Facility (RE# RN106481500). 4/19/2018. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5269544&Rendition=Web

18. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 100114. Freeport LNG (RE# RN103196689). 1/30/2018. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5269541&Rendition=Web ; Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 104840 and N170. Freeport LNG Pretreatment Facility (RE# RN106481500). 4/19/2018. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5269544&Rendition=Web

19. Texas Council on Environmental Quality. Construction Permit Source Analysis & Technical Review; Permit No. 116055 and PSDTX1386. Golden Pass LNG (RE# RN107053530). 11/17/2014. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5336210&Rendition=Web

20. Gulf LNG Liquefaction Company, LLC. Application for Permit to Construct and Operate Air Emissions Equipment - Revision. 04/2017. p.222. https://api.oilandgaswatch.org/d/ce/48/ce48bce899ee46a286a71011dcb43d97.1641263448.pdf

21. Louisiana Department of Environmental Quality. Title V Regular Permit Modification; 0520-00509-V1. Lake Charles LNG (AI# 212290). 8/31/2023. p.10. https://edms.deq.louisiana.gov/app/doc/view?doc=13976740

22. Louisiana Department of Environmental Quality. Permit No. 0520-00481-V0. Magnolia LNG (AI# 185639). 3/21/2016. p.3. https://edms.deq.louisiana.gov/app/doc/view?doc=10127850

23. Louisiana Department of Environmental Quality. Title V Minor Modification; Permit No. 2240-00443-V3. Plaquemines LNG (AI# 197379). 4/16/2024. p.5, Permitted Emissions, Scenario 2. https://edms.deq.louisiana.gov/app/doc/view?doc=14252040

24. Louisiana Department of Environmental Quality. Title V Minor Modification; Permit No. 2240-00443-V3. Plaquemines LNG (AI# 197379). 4/16/2024. p.5, Permitted Emissions, Scenario 4. https://edms.deq.louisiana.gov/app/doc/view?doc=14252040

25. Texas Council on Environmental Quality. Construction Permit Source Analysis & Technical Review; Permit No. 158420, PSDTX1572, and GHGPSDTX198. Port Arthur LNG (RE# RN104517826). 9/17/2022. p.2. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=7138529&Rendition=Web

26. Texas Council on Environmental Quality. Construction Permit Source Analysis & Technical Review; Permit No. 158420, PSDTX1572, and GHGPSDTX198. Port Arthur LNG (RE# RN104517826). 9/17/2022. p.2. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=7138529&Rendition=Web

27. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 140792, GHGPSDTX158 and PSDTX1498. Rio Grande LNG (RE# RN109222851). 11/2/2020. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=5435884

28. Texas Council on Environmental Quality. Permit Amendment Source Analysis & Technical Review; Permit No. 140792, GHGPSDTX158 and PSDTX1498. Rio Grande LNG (RE# RN109222851). 11/2/2020. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_APD_SEARCH_GET_FILE&xAPDParent=5435884

29. Louisiana Department of Environmental Quality. Title V Regular Permit Renewal/Modification; Permit No. 0560-00214-V8. Sabine Pass LNG (AI# 119267). 9/17/2020. p.4. https://edms.deq.louisiana.gov/app/doc/view?doc=12358481

30. Louisiana Department of Environmental Quality. Title V Regular Permit Renewal/Modification; Permit No. 0560-00214-V8. Sabine Pass LNG (AI# 119267). 9/17/2020. p.4. https://edms.deq.louisiana.gov/app/doc/view?doc=12358481

31. Cheniere Energy, Inc., Sabine Pass Liquefaction, LLC. Title V Permit Modification and a Prevention of Significant Deterioration (PSD) Permit - Application. Sabine Pass LNG (AI# 119267). 2/29/2024. p10, Table 1-2. https://edms.deq.louisiana.gov/app/doc/view?doc=14194030

32. Texas Council on Environmental Quality. Construction Permit Source Analysis & Technical Review; Permit No. 139561. Texas LNG Brownsville (RE# RN109146928). 5/7/2020. p.1. https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_EXTERNAL_SEARCH_GET_FILE&dID=5288674&Rendition=Web

Table A1: Mapping between LNG Projects and LNG Buildout Scenarios with Modeled Project Start Year*

LNG Project	Start Year*	Scenario		
		Operating Projects Only	No New Permits	Full Buildout
Sabine Pass LNG Phase I	2017	X	X	X
Cove Point LNG	2019	X	X	X
Cameron LNG Phase I	2020	X	X	X
Corpus Christi LNG Stage I	2020	X	X	X
Elba Island LNG	2020	X	X	X
Sabine Pass LNG Phase II	2020	X	X	X
Freeport LNG	2021	X	X	X
Corpus Christi LNG Stage II	2022	X	X	X
Calcasieu Pass LNG	2023	X	X	X
Corpus Christi LNG Stage III	2025		X	X
Delta LNG Phase I	2025			X
Plaquemines LNG Phase I	2025		X	X
Delta LNG Phase II	2026			X
Golden Pass LNG	2026		X	X
CP2 LNG Phase I	2027			X
Eagle LNG Partners	2027		X	X
Cameron LNG Phase II	2028		X	X
CP2 LNG Phase II	2028			X
Plaquemines LNG Phase II	2028		X	X
Port Arthur LNG	2028		X	X
Rio Grande LNG Phase I	2028		X	X
Commonwealth LNG	2029			X
Driftwood LNG	2029		X	X
Freeport LNG Expansion	2029		X	X
Lake Charles LNG	2029			X
Magnolia LNG	2029			X
Port Arthur LNG Expansion	2029			X
Texas LNG Brownsville	2029		X	X
Gulf LNG Liquefaction	2030		X	X
Rio Grande LNG Phase II	2030		X	X
Corpus Christi LNG Midscale 8-9	2032			X
Sabine Pass LNG Stage V	2033			X

*For the Full Buildout and No New Permits scenarios, we assume that operations begin January 1 of the calendar year following the estimated date of first LNG delivery (as taken from the Sierra Club U.S. LNG Export Tracker as of July 15, 2024).

Table A2: 2030 Most Impacted Counties and Parishes: Counties with at least 1 premature death, in absolute terms, or 10 or more premature deaths per million people

County/Parish	Most Impacted Subset	Population*	
		2023	2030
Mobile, AL	Most Premature Deaths, Absolute	432,787	445,355
Acadia, LA	Most Premature Deaths, Absolute and Per Million	64,978	66,836
Allen, LA	Most Premature Deaths, Per Million	26,523	27,106
Beauregard, LA	Most Premature Deaths, Per Million	39,861	43,057
Calcasieu, LA	Most Premature Deaths, Absolute and Per Million	207,864	216,630
Cameron, LA	Most Premature Deaths, Per Million	6,716	6,828
East Baton Rouge, LA	Most Premature Deaths, Absolute	478,550	504,272
Evangeline, LA	Most Premature Deaths, Per Million	34,153	34,395
Jefferson Davis, LA	Most Premature Deaths, Absolute and Per Million	32,213	32,780
Jefferson, LA	Most Premature Deaths, Absolute	450,074	460,480
Lafayette, LA	Most Premature Deaths, Absolute	266,393	292,924
Orleans, LA	Most Premature Deaths, Absolute	369,026	359,932
Rapides, LA	Most Premature Deaths, Absolute and Per Million	136,011	138,569
St Tammany, LA	Most Premature Deaths, Absolute	280,388	310,572
Vermilion, LA	Most Premature Deaths, Per Million	63,590	66,740
Bexar, TX	Most Premature Deaths, Absolute	2,138,223	2,391,550
Brazoria, TX	Most Premature Deaths, Absolute	403,850	464,139
Cameron, TX	Most Premature Deaths, Absolute	504,326	581,792
Collin, TX	Most Premature Deaths, Absolute	1,127,906	1,367,658
Dallas, TX	Most Premature Deaths, Absolute	2,823,032	3,081,257
Fort Bend, TX	Most Premature Deaths, Absolute	865,051	1,042,376
Galveston, TX	Most Premature Deaths, Absolute	357,248	395,195
Hardin, TX	Most Premature Deaths, Absolute and Per Million	63,483	70,367
Harris, TX	Most Premature Deaths, Absolute	5,105,635	5,694,849
Hidalgo, TX	Most Premature Deaths, Absolute	1,006,869	1,172,359
Jasper, TX	Most Premature Deaths, Per Million	38,026	40,055
Jefferson, TX	Most Premature Deaths, Absolute and Per Million	256,433	259,468
Montgomery, TX	Most Premature Deaths, Absolute	641,439	759,483
Newton, TX	Most Premature Deaths, Per Million	14,890	15,481
Nueces, TX	Most Premature Deaths, Absolute	378,297	394,599
Orange, TX	Most Premature Deaths, Absolute and Per Million	86,087	88,140
Sabine, TX	Most Premature Deaths, Per Million	11,015	11,584
Tarrant, TX	Most Premature Deaths, Absolute	2,211,514	2,443,768
Travis, TX	Most Premature Deaths, Absolute	1,341,045	1,511,576
Tyler, TX	Most Premature Deaths, Per Million	23,130	24,506
Totals		22,286,624	24,816,679

*Population from COBRA 5.1

Table A3: Nonattainment status and pollutant for Most Impacted Counties and Parishes

County/Parish	Nonattainment	Pollutant	Class
Acadia, LA	No	None	
Allen, LA	No	None	
Beauregard, LA	No	None	
Bexar, TX	Yes	8-Hour Ozone (2015)	Moderate
Brazoria, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Calcasieu, LA	No	None	
Cameron, LA	No	None	
Cameron, TX	No	None	
Collin, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Dallas, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
East Baton Rouge, LA	No	None	
Evangeline, LA	Yes	Sulfur Dioxide (2010)	
Fort Bend, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Galveston, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Hardin, TX	No	None	
Harris, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Hidalgo, TX	No	None	
Jasper, TX	No	None	
Jefferson Davis, LA	No	None	
Jefferson, LA	No	None	
Jefferson, TX	No	None	
Lafayette, LA	No	None	
Mobile, AL	No	None	
Montgomery, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Newton, TX	No	None	
Nueces, TX	No	None	
Orange, TX	No	None	
Orleans, LA	No	None	
Rapides, LA	No	None	
Sabine, TX	No	None	
St Tammany, LA	No	None	
Tarrant, TX	Yes	8-Hour Ozone (2008/2015)	Severe 15/Moderate
Travis, TX	No	None	
Tyler, TX	No	None	
Vermilion, LA	No	None	

Current as of June 2024.

Table A4: Climate Vulnerability Index ranking for Most Impacted Counties and Parishes

County/Parish	CVI National Percentile
Acadia, LA	99
Allen, LA	97
Beauregard, LA	93
Bexar, TX	63
Brazoria, TX	88
Calcasieu, LA	99
Cameron, LA	79
Cameron, TX	96
Dallas, TX	38
East Baton Rouge, LA	90
Evangeline, LA	99
Fort Bend, TX	27
Galveston, TX	75
Hardin, TX	61
Harris, TX	85
Hidalgo, TX	83
Jasper, TX	92
Jefferson Davis, LA	98
Jefferson, LA	84
Jefferson, TX	99
Lafayette, LA	71
Mobile, AL	97
Montgomery, TX	40
Newton, TX	82
Nueces, TX	90
Orange, TX	99
Orleans, LA	93
Rapides, LA	91
Sabine, TX	61
St Tammany, LA	65
Tarrant, TX	36
Travis, TX	20
Tyler, TX	60
Vermilion, LA	93
Collin, TX	6

Current as of July 2024.

Figure A1: Single-year premature deaths by LNG terminal (low estimate)

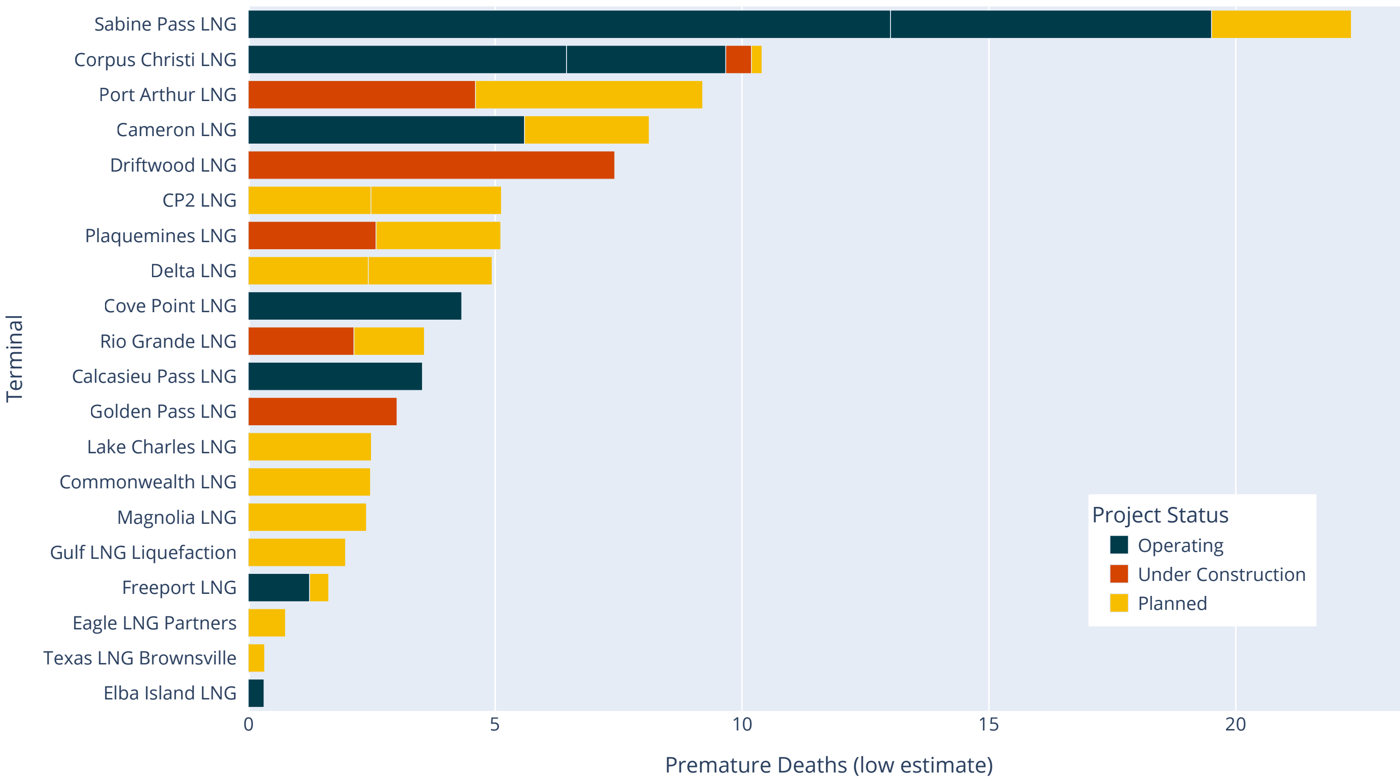
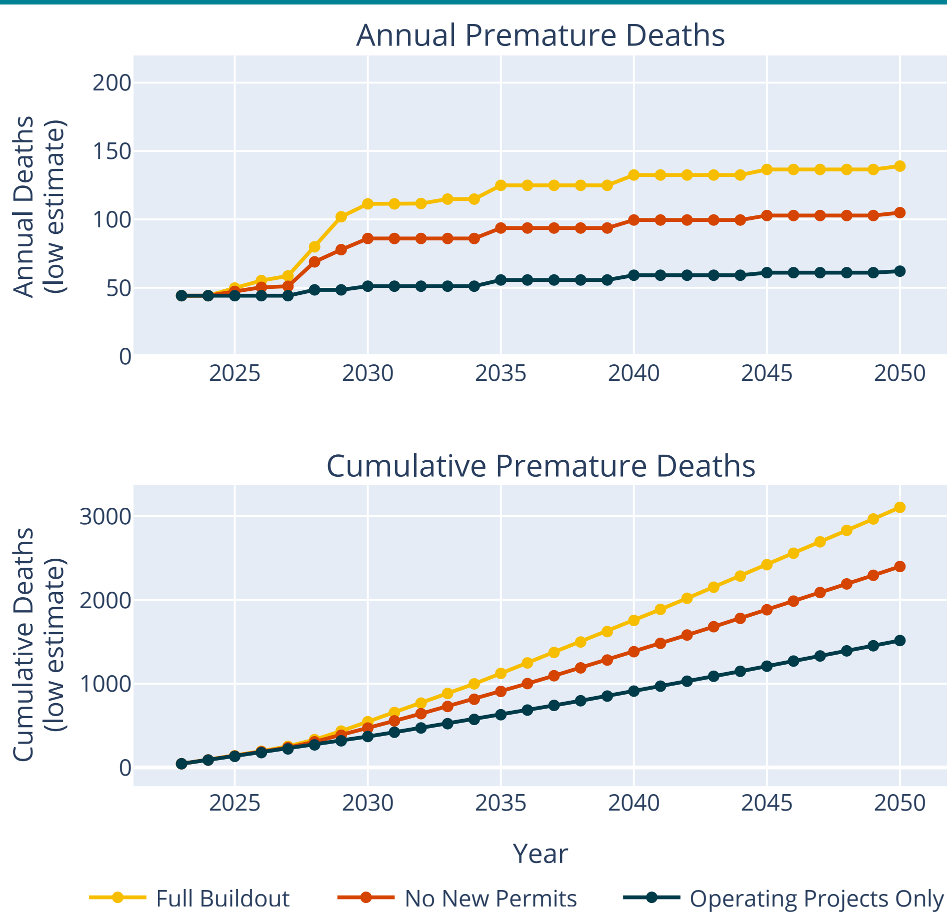


Figure A2: Annual and cumulative premature deaths (low estimate) across three LNG buildout scenarios



ENDNOTES

1 EIA. 2024. Today in Energy: U.S. natural gas production grew by 4% in 2023, similar to 2022. March 27. [https://www.eia.gov/todayinenergy/detail.php?id=61646]

2 Sierra Club. 2022. Climate and Public Health Impacts of LNG Exports. August 16. [https://www.sierraclub.org/articles/2022/08/climate-and-public-health-impacts-lng-exports]

3 Saha, R., R.D. Bullard & L.T. Powers. 2024. *Liquefying the Coast: A Cumulative Impact Assessment of LNG Buildout in Louisiana and Texas*. Bullard Center, May. [https://www.bullardcenter.org/resources/liquefied-natural-gas-lng]

4 Williams-Derry, C. 2024. Gas exports cost U.S. consumers more than $100 billion over 16-month period. IEEFA, January 29. [https://ieefa.org/resources/gas-exports-cost-us-consumers-more-100-billion-over-16-month-period]

5 Public Citizen & Symons Public Affairs. 2024. The Impact of LNG Exports on U.S. Energy Bills and Inflation. May. [https://www.citizen.org/article/the-impact-of-lng-exports-on-u-s-energy-bills-and-inflation/]

6 The White House. 2024. Fact Sheet: Biden-Harris Administration Announces Temporary Pause on Pending Approvals of Liquefied Natural Gas Exports. January 26. [https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/26/fact-sheet-biden-harris-administration-announces-temporary-pause-on-pending-approvals-of-liquefied-natural-gas-exports/]

7 Donaghy, T., A. Ghiotto & C. Preaux. 2023. Who Profits From War? How Gas Corporations Capitalise from War in Ukraine. Greenpeace International, April. [https://www.greenpeace.org/international/publication/59432/who-profits-from-war/]

8 U.S. Environmental Protection Agency. CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA). [https://www.epa.gov/cobra]

9 All capacities shown are from FERC and include any proposed small uprates. [https://www.ferc.gov/media/us-lng-export-terminals-existing-approved-not-yet-built-and-proposed]

10 Terminal construction permits are approved by FERC (for onshore facilities) or MARAD (for offshore facilities). Projects also typically need a permit from the DOE to export gas to non-free trade agreement nations. Other federal, state and local regulatory processes are also required.

11 In this briefing, DOE Permits, DOE exports, and DOE LNG export approvals refers specifically to non-free trade agreement export authorizations.

12 Sierra Club. US LNG Export Tracker. Current as of July 15, 2024. [https://www.sierraclub.org/dirty-fuels/us-lng-export-tracker]

13 Buonocore, J.J. et al. 2021. A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy. *Environ. Res. Lett.* 16 054030. https://doi.org/10.1088/1748-9326/abe74c

14 Environmental Health Project. 2023. Liquefied Natural Gas (LNG): Health and Climate Impacts. August 10. [https://www.environmentalhealthproject.org/post/liquefied-natural-gas-lng-health-and-climate-impacts]

15 Buonocore, J.J. et al. 2023. Air pollution and health impacts of oil & gas production in the United States. *Environ. Res.: Health* 1 021006. http://doi.org/10.1088/2752-5309/acc886

16 Physicians for Social Responsibility. 2019. Climate and Health Risks of Liquified Natural Gas. November. [https://psr.org/wp-content/uploads/2019/11/LNG-WHITE-PAPER-11262019.pdf]

17 Aseel, S.; Al-Yafei, H.; Kucukvar, M.; Onat, N.C. Life Cycle Air Emissions and Social Human Health Impact Assessment of Liquified Natural Gas Maritime Transport. Energies 2021, 14, 6208. https://doi.org/10.3390/en14196208

18 Texas Council on Environmental Quality: Air Permitting [https://www.tceq.texas.gov/permitting/air]

19 Louisiana Department of Environmental Quality: Air Permits [https://deq.louisiana.gov/page/air-permits]

20 U.S. EPA. Current Nonattainment Counties for All Criteria Pollutants. [https://www3.epa.gov/airquality/greenbook/ancl.html]

21 Al-Yafei, H.; Kucukvar, M.; AlNouss, A.; Aseel, S.; Onat, N.C. A Novel Hybrid Life Cycle Assessment Approach to Air Emissions and Human Health Impacts of Liquefied Natural Gas Supply Chain. *Energies* 2021, 14, 6278. https://doi.org/10.3390/en14196278

22 Carerras-Sospedra, M., M. Lunden, J. Brouwer, B. Singer, & D. Dabdub. 2011. Air Quality Impacts of Liquefied Natural Gas in the South Coast Air Basin of California. California Energy Commission. Publication Number: CEC-500-2011-041. [https://escholarship.org/content/qt0kf2n9cr/qt0kf2n9cr_noSplash_fb5cbaf88a20d348aaf0a49bde020bf5.pdf]

23 Abdul-Wahab, S.A., Fadlallah, S.O., Al-Riyami, M. et al. A study of the effects of CO, NO2, and PM10 emissions from the Oman Liquefied Natural Gas (LNG) plant on ambient air quality. Air Qual Atmos Health 13, 1235–1245 (2020). https://doi.org/10.1007/s11869-020-00876-w [pdf]

24 Shaykevich, A. & C. Otto. 2020. Troubled Waters for LNG: The Covid-19 Recession and Overproduction Derail Dramatic Expansion of Liquefied Natural Gas Terminals. Environmental Integrity Project, October. [https://environmentalintegrity.org/wp-content/uploads/2020/10/LNG-Report-10.5.20-updated.pdf]

25 Sierra Club. 2022. Climate and Public Health Impacts of LNG Exports. August 16. [https://www.sierraclub.org/articles/2022/08/climate-and-public-health-impacts-lng-exports]

26 Louisiana Bucket Brigade. 2022. Gas Export Spotlight: Operational Problems at Cameron LNG and Calcasieu Pass. [https://labucketbrigade.org/wp-content/uploads/2023/01/Gas_Export_Spotlight_CameronCalcasieuPass.pdf]

27 Rainforest Action Network, et al. 2022. Rio Grande Valley At Risk From Fracked-Gas Export Terminals. [https://www.sierraclub.org/sites/www.sierraclub.org/files/2022-10/RGV_LNG_2022_FINAL_WEB_0.pdf]

28 Donaghy, T.Q., N. Healy, C. Jiang, C. Pichon Battle. 2023. Fossil fuel racism in the United States: How phasing out coal, oil, and gas can protect communities. Energy Res Soc Sci. https://doi.org/10.1016/j.erss.2023.103104

29 Sierra Club. 2022.

30 Saha, R., R.D. Bullard & L.T. Powers. 2024. *Liquefying the Gulf Coast: A Cumulative Impact Assessment of LNG Buildout in Louisiana and Texas*. Bullard Center for Environmental and Climate Justice, May. [https://www.bullardcenter.org/resources/liquefied-natural-gas-lng]

31 U.S. EPA. 2024. User's Manual for the Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) Version: 5.1. June. [https://www.epa.gov/system/files/documents/2024-04/cobra-user-manual-v5.0.pdf]

32 "County" or "counties" include both counties and parishes.

33 U.S. Office of Management and Budget (OMB). 2023. Circular No. A-4. [https://www.whitehouse.gov/wp-content/uploads/2023/11/CircularA-4.pdf]

34 Abrahams et al. 2015. Life Cycle Greenhouse Gas Emissions From U.S. Liquefied Natural Gas Exports: Implications for End Uses. *Environ. Sci. Technol.* 2015, 49, 5, 3237–3245. https://doi.org/10.1021/es505617p

35 Howarth, R.W. 2024. The Greenhouse Gas Footprint of Liquefied Natural Gas (LNG) Exported from the United States. In review. [https://www.research.howarthlab.org/publications/Howarth_LNG_assessment_preprint_archived_2023-1103.pdf]

36 U.S. EPA. What is the definition of VOC? [https://www.epa.gov/air-emissions-inventories/what-definition-voc]

37 M.C. Sarofim, S.T. Waldhoff, S.C. Anenberg. Valuing the ozone-related health benefits of methane emission controls. *Environ. Resour. Econ*., 66 (2017), pp. 45-63, https://doi.org/10.1007/s10640-015-9937-6

38 Nguyen, L., A. Quintana, A. Rowland, & G. Vegh-Gaynor. 2023. *Mitigating Methane: A Global Health Strategy — Overview*. Abt Associates & Global Climate and Health Alliance. [https://climateandhealthalliance.org/wp-content/uploads/2023/08/MethaneReport-Overview-FINAL.pdf]

39 Environmental Impact Statements prepared by FERC also often contain information on air emissions, but we do not rely on that information in this study.

40 Pope et al. 2019. Mortality Risk and Fine Particulate Air Pollution in a Large, Representative Cohort of U.S. Adults. *Env Health Pers* 127(7): 077077. https://doi.org/10.1289/EHP4438

41 Wu et al. 2020. Evaluating the impact of long-term exposure to fine particulate matter on mortality among the elderly. *Science Advances* 6:eaba5692. https://doi.org/10.1126/sciadv.aba5692

42 COBRA Manual. 2024. Appendix F: Economic Value of Health Effects

43 COBRA does not include health endpoints for work loss days due to ozone-related illnesses or school loss days due to $PM_{2.5}$-related illnesses. We presume this is due to the limited scope of suitable epidemiological studies for determining concentration-response functions in the COBRA model.

44 Since the estimates rely on two different epidemiological studies, they are reported separately instead of combining into a range.

45 EPA. COBRA Questions and Answers. [https://www.epa.gov/cobra/cobra-questions-and-answers#17]

46 Permit to Kill: LNG Air Pollution, Tableau Dashboard [https://public.tableau.com/app/profile/johanna.heureaux.torres/viz/PermittoKill_LNGAirPollution/LNGHealthAirPollution]

47 A version of this figure using the low estimate of total premature deaths can be found in the Appendix.

48 Mallen et al. 2024. Implications of US Department of Energy Decision to 'Pause' Authorizations of Liquefied Natural Gas Exports May Extend Beyond Delays to Pending Projects. Akin, January 31. [https://www.akingump.com/en/insights/alerts/implications-of-us-department-of-energy-decision-to-pause-authorizations-of-liquefied-natural-gas-exports-may-extend-beyond-delays-to-pending-projects]

49 Sierra Club. US LNG Export Tracker (current as of 7/15/2024). [https://www.sierraclub.org/dirty-fuels/us-lng-export-tracker]

50 For analysis years 2023–2027, we use the 2023 emissions file provided by COBRA as a baseline, and for analysis years 2028–2050, we use the 2028 emissions file provided by COBRA as a baseline. The choice of emissions baseline file, however, does not have a large impact on our results because the health functions used by COBRA are near-linear at the ranges under examination.

51 U.S. EPA. COBRA Future Input Files. [https://www.epa.gov/cobra/cobra-future-input-files]

52 Actual expected start dates ranging from 2027–2029.

53 The stepwise characteristic of these premature death increases reflects the five-year spacing of population baseline data.

54 Jenkin, M. 2007. Trends in ozone concentration distributions in the UK since 1990: Local, regional and global influences. *Atmospheric Environment*. https://doi.org/10.1016/j.atmosenv.2008.02.036

55 Zhang, H. and Ying, Q. 2011. Contributions of local and regional sources of NOx to ozone concentrations in Southeast Texas. *Atmospheric Environment*. https://doi.org/10.1016/j.atmosenv.2011.02.047

56 Pitiranggon et al. 2021. Long-term trends in local and transported PM2.5 pollution in New York City. *Atmospheric Environment*. https://doi.org/10.1016/j.atmosenv.2021.118238

57 Wang, Y. et al. 2022. Two Typical Patterns of Regional PM2.5 Transport for Heavy Air Pollution Over Central China: Rapid Transit Transport and Stationary Accumulation Transport. *Front. Environ. Sci*. https://doi.org/10.3389/fenvs.2022.890514

58 United States, Executive Office of the President [Joseph Biden]. Executive Order 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis. 20 January 2021. *Federal Register*, vol. 86, no. 14, pp. 7037-7043. [https://www.federalregister.gov/documents/2021/01/25/2021-01765/protecting-public-health-and-the-environment-and-restoring-science-to-tackle-the-climate-crisis]

59 U.S. EPA. Ground-level Ozone Basics. [https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#effects]

60 U.S. EPA. What are the harmful effects of SO2? [https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects]

61 Climate Vulnerability Index [https://map.climatevulnerabilityindex.org/map/cvi_overall/usa?mapBoundaries=Tract&mapFilter=0&reportBoundaries=Tract&geoContext=State]

62 The white population control group refers to the non-Hispanic, white alone population. Racial group data refer to the "total" population corresponding to the group (including Hispanic and non-Hispanic, as well as the specified race alone or in combination). Hispanic/Latino refers to the "total" Hispanic/Latino population.

63 Saha, R., R.D. Bullard & L.T. Powers. 2024. *Liquefying the Gulf Coast: A Cumulative Impact Assessment of LNG Buildout in Louisiana and Texas*. Bullard Center for Environmental and Climate Justice, May. [https://www.bullardcenter.org/resources/liquefied-natural-gas-lng]

64 "*We're Dying Here": The Fight for Life in a Louisiana Fossil Fuel Sacrifice Zone*. 2024. Human Rights Watch, January. [https://www.hrw.org/report/2024/01/25/were-dying-here/fight-life-louisiana-fossil-fuel-sacrifice-zone]

65 Chang, A. 2024. What Biden's LNG Pause Does and Doesn't Do. *Greenpeace USA*. [https://www.greenpeace.org/usa/research/draft-what-bidens-lng-pause-does-and-doesnt-do/]

66 Parker, L. et al., 2024. Factors the Department of Energy Must Consider for a Robust and Defensible Public Interest Determination. *Center for Biological Diversity*. [https://www.biologicaldiversity.org/programs/climate_law_institute/energy_and_global_warming/pdfs/Public-Interest-Baseline_FINALSUBMISSION.pdf]

67 International Energy Agency. 2021. Net Zero by 2050. Figure 4.17. [https://www.iea.org/reports/net-zero-by-2050]

68 BP. 2024. Energy Outlook. [https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/energy-demand/natural-gas.html?sectionSlug=eo24-page8-section2]

69 Gulf South for a Green New Deal. 2019. Policy Platform. [https://www.gulfsouth4gnd.org/policy-platform]

70 Environmental Integrity Project. Oil and Gas Watch Database. [https://oilandgaswatch.org]

71 Environmental Integrity Project. Emissions Increase Database. [https://environmentalintegrity.org/download/eip-emissions-increase-database/]

72 A version of this figure using the low estimate of total mortalities can be found in the Appendix.

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People fish in Walter Umphrey Park on the Texas side of the Sabine Lake, across the water from the Cheniere LNG plant in Cameron, Louisiana.

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