Gas Bubble 2020

TRACKING GLOBAL LNG INFRASTRUCTURE

Lydia Plante, James Browning, Greig Aitken, Mason Inman, and Ted Nace

Global Energy Monitor

Global Energy Monitor is a network of researchers developing collaborative informational resources on fossil fuels and alternatives. Current projects include:

- Global Coal Plant Tracker
- Global Fossil Infrastructure Tracker
- Europe Gas Tracker
- Global Gas Plant Tracker
- Global Coal Mine Tracker
- Global Steel Plant Tracker
- CoalWire newsletter
- GEM.wiki energy wiki.

ABOUT THE GLOBAL FOSSIL INFRASTRUCTURE TRACKER

The Global Fossil Infrastructure Tracker is an online database that identifies, maps, describes, and categorizes fossil gas pipelines and liquified natural gas (LNG) terminals. Developed by Global Energy Monitor, the tracker uses footnoted wiki pages to document each project. For further details see http://ggon.org/fossil-tracker/

AUTHORS

Lydia Plante, Greig Aitken, and Mason Inman are research analysts at Global Energy Monitor. James Browning is communications director at Global Energy Monitor. Ted Nace is executive director at Global Energy Monitor.

PRODUCTION

Design by Charlene Will and Mimi Heft. Additional design and page layout by David Van Ness.

PERMISSIONS/COPYRIGHT

FURTHER RESOURCES

For additional global on proposed and existing pipelines and terminals, see Summary Data at http://ggon.org/fossil-tracker/, which provides over 35 tables compiled from the Global Fossil Infrastructure Tracker (GFIT), broken down by nation and region. To obtain primary data from the GFIT, contact Ted Nace (ted@tednace.com).

ABOUT THE COVER

Cover photo: Bigstock

Gas Bubble 2020

TRACKING GLOBAL LNG INFRASTRUCTURE

Lydia Plante, James Browning, Greig Aitken, Mason Inman, and Ted Nace

EXECUTIVE SUMMARY

In the past year, the fossil gas industry worldwide has more than doubled the amount of liquefied natural gas (LNG) terminal capacity under construction, a strategy driven by the U.S. and Canada as they seek to create new markets for LNG supplied from North America by tanker ship. This boom in construction threatens to lock in massive amounts of greenhouse gas (GHG) emissions and negate any chance of limiting global warming to the 1.5°C tipping point identified by the Intergovernmental Panel on Climate Change (IPCC). Yet even measured against the balance sheets of their own financial and political backers, the future of many of these projects is tenuous due to low gas prices caused by global oversupply, now compounded by the COVID-19 pandemic. Meanwhile, growing concern about the role of methane emissions in climate change is threatening the industry's social license to promote and build fossil fuel projects.

This report provides the results of a worldwide survey of LNG terminals completed in May 2020 by Global Energy Monitor. The report includes the following highlights:

- In the past year the amount of LNG terminal capacity under construction worldwide has more than doubled, with total capital expenditure rising from $82.8 billion to $196.1 billion.

- The collapse in global oil and gas demand and pandemic-related worksite restrictions have forced many companies to declare *force majeure* delays and reschedule final investment decisions (FIDs). As of late June 2020, at least 11 major projects have reported significant new difficulties, typically citing combinations of pandemic disruption, low prices, and organized opposition.

- For projects in earlier stages of development and not yet committed to construction, there has been a widespread pullback, including the quiet abandonment of a large number of projects. Overall, the failure rate for proposed LNG export terminal projects for the period 2014–2020 is 61%.

- The social license of LNG has come under growing challenge as studies have debunked the portrayal of fossil gas as an environmentally benign "bridge fuel" to a low-carbon future. In 2016 the authors of the IPCC's 2014 assessment concluded that methane's impact on global warming is about 25% higher than previously estimated. Fugitive emissions from gas fields and other points in the gas supply chains further undermine the case for gas (see the sidebar "LNG's Greenhouse Gas Emissions" on page 8).

- Protests against LNG projects are becoming increasingly sophisticated and effective. In Canada, a protest and rail shutdown begun by the Wet'suwet'en tribe in British Columbia launched a nationwide movement of students, environmentalists, and other Indigenous groups that led to the cancellation of an LNG terminal in Quebec.

- As competition from renewables intensifies for power sector applications of fossil gas, the longer term outlook for LNG infrastructure continues to worsen. Hundreds of billions of dollars in sunken investments for LNG infrastructure face the risk of becoming underutilized or stranded assets long before their useful life of 30–40 years.

- Due to the consequences of further locking in fossil combustion rather than transitioning to renewable power, switching from coal to gas does not appear to offer a useful strategy to achieve rapid cuts in greenhouse gas emissions to achieve carbon neutrality. Lifecycle emissions for power from LNG—including recent estimates of methane leakage throughout the system—are from 29% lower to 16% higher than coal-fired power.

BACKGROUND: THE GRAND STRATEGY BEHIND THE LNG EXPANSION

The shift by the U.S. from exporting no LNG in 2015 to leading the world in exports by 2024, as projected by the International Energy Agency, requires more than simply increased levels of gas production (IEA 2019). As described in GEM's 2019 report "The New Gas Boom," such a change also requires restructuring the gas supply sytem from a collection of regional markets into a global market increasingly supplied by LNG tanker (GEM 2019). Based on projections in line with the IEA's Stated Policies Scenario, the share of LNG in fossil gas trade will rise from 26% in 2000 to 53% by 2030 (IEA 2019).

The massive capital expenditures required to build new LNG infrastructure—pipelines, storage facilities, terminals, and tankers—with dovetailed expansions of export and import capacity, depend on government promotion and leveraging of financial support. Strategically targeted funding by U.S. and Japanese policy banks and export credit agencies has unlocked much larger funding by private entities (Aitken 2020). The program of promoting new LNG infrastructure and developing overseas markets has proceeded across both Democratic and Republican administrations in the U.S., and across both Conservative and Liberal administrations in Canada.

LOCKING IN DEMAND FOR GAS

Three different regions have increased their imports of LNG or are primed to do so: China, Europe, and a collection of non-OECD countries with coastal access. Another key driver of the expansion of LNG import capacity has been Japan, whose government set out to expand its LNG imports and shore up electric power supply after the 2011 Fukushima disaster. As of May 2020, Japan accounted for 24% of global LNG import capacity, as shown in Table 5, but for less than 1% of new capacity under construction and in pre-construction development. Yet Japan's partnership with the U.S. looms large in the overall expansion of the global LNG system. Under the stated goal of ensuring its energy security by fostering a larger LNG trading system, the Japanese government along with Japan's private banks have supplied tens of billions in finance capital to projects in other countries, as detailed in "Gambling on Gas: Risks Grow for Japan's $20 Billion LNG Financing Spree" (Aitken 2020).

Leading the list of growing markets is China, where gas has been promised as a cleaner energy source by leaders seeking to defuse public dissatisfaction with local air pollution levels caused by coal. Among U.S. economic planners, exports of gas to China were additionally seen as a means to shrink the U.S. trade deficit. China accounts for only 9% of current LNG import capacity but it accounts for 40% of capacity under construction and in pre-construction development, as shown in Table 5 (on page 17).

A second growth market for LNG is European countries looking to counter Russia's use of gas for geopolitical ends, with European Union and private banking capital promoting import terminals in countries such as Croatia and Sweden in which only a small percentage of current energy needs are met by gas. Already accounting for 19% of global LNG import capacity, Europe also accounts for 23% of capacity under construction and in pre-construction development (GEM 2020). Exports of LNG to Europe were promoted as "freedom gas" by Energy Secretary Rick Perry in 2019: "The opportunity for Europe to have a very substantial supportive alternative to Russian gas is on display here."

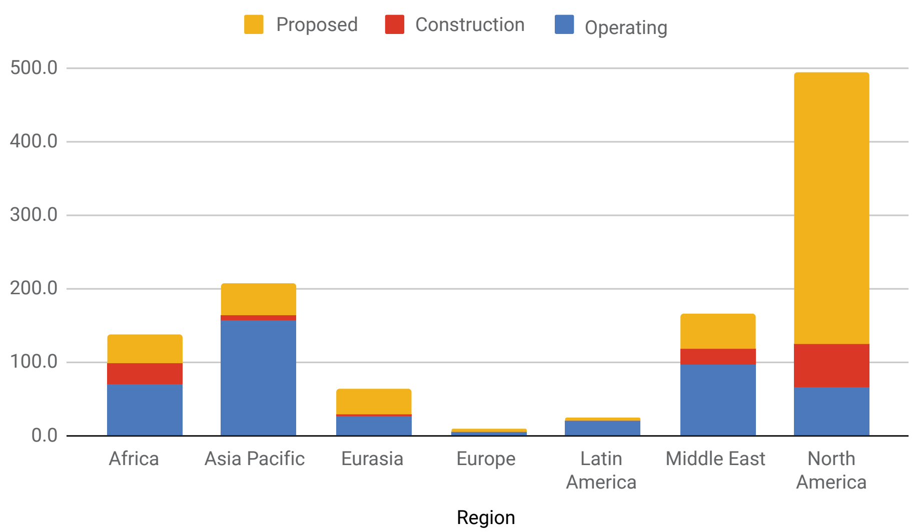
A third growing market for LNG is non-OECD nations with coastal access such as El Salvador, the Philippines, Vietnam, and Sierra Leone, where imported gas is viewed as a quick way to ramp up power supplies or supply industrial feedstocks or process heat. Since 2016, when the U.S. began exporting LNG for the first time, the number of LNG importing countries has grown rapidly, from 19 countries in 2016 to 35 in 2019. Non-OECD countries (other than China) accounted for 198 million tons per annum (MTPA) of operating LNG import capacity in May 2020, or 23% of the global total (GEM 2020). These countries also accounted for 88.5 MTPA (31%) of import capacity in pre-construction development and 75.9 MTPA (53%) of import capacity under construction.

In its comprehensive report *Gas 2018,* the International Energy Agency threw its analytical weight behind LNG growth as both beneficial and inevitable, endorsing "the growing role of gas in the world's energy mix and its importance to maintaining electricity security as well as for improving air quality, in the context of a growing and more globalized LNG market." IEA Executive Director Faith Birol wrote, "Natural gas should contribute to all of the energy-related Sustainable Development Goals, climate mitigation, improved air quality and universal access." Among the alternative energy futures that the IEA presented in the report, gas demand grew in all scenarios, including the Sustainable Development Scenario, presented as the option with the lowest climate impact (IEA 2018).

The grand strategy of North America–led LNG expansion is reflected in the regional distribution of projects, shown in Figures 1 and 2. While North America currently ranks fourth among regions in LNG export capacity, terminals in development would shift the region into a position of global leadership. Current construction includes 14 MTPA in Canada and 46.2 MTPA in the U.S., amounting to half of the 122 MTPA in construction worldwide. For projects in pre-construction development, 290.3 MTPA is in the U.S., 16.6 MTPA is in Mexico, and 61.6 MTPA is in Canada, for a regional total of 368.5 MTPA. This represents 68% of the global total.

Figure 1. Existing and Planning LNG Export Capacity, April 2020

(million tonnes per annum)

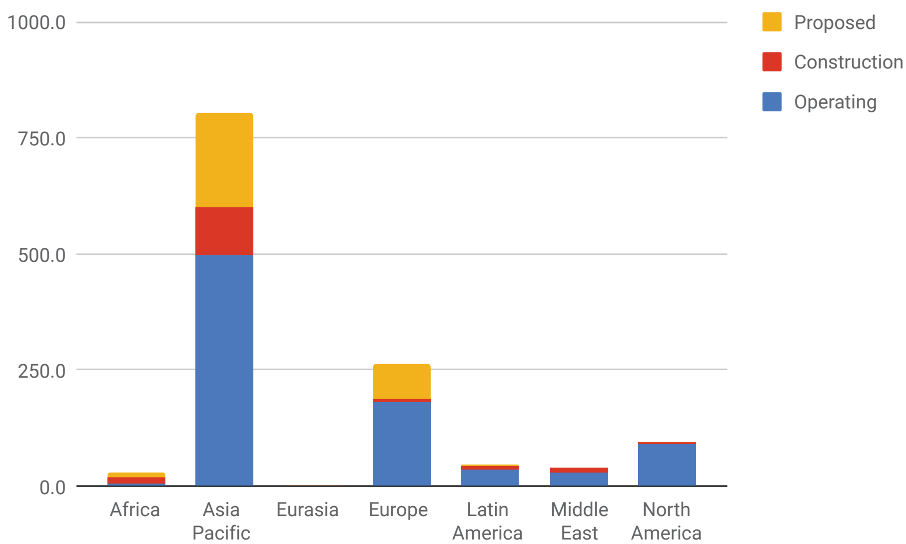


Source: Global Energy Monitor, Global Fossil Infrastructure Tracker, May 2020

As shown in Figure 2, import capacity growth is concentrated in Asia and Europe. As shown in Table 1, the growth is also reflected in the number of countries with LNG import capacity, which grew from 10 countries in 2000 to 43 countries in 2020. Projects under construction will add six new countries (Croatia, Cyprus, El Salvador, Ghana, Philippines, Vietnam); projects in pre-construction development will add 15 new countries (Australia, Benin, Cambodia, Croatia, Ecuador, Estonia, Germany, Ireland, Ivory Coast, Latvia, Morocco, Myanmar, Romania, South Africa, Sri Lanka). If all projects are built, the number of countries importing LNG will reach 64 by 2030.

Figure 2. Existing and Planning LNG Import Capacity, April 2020

(million tonnes per annum)



Source: Global Energy Monitor, Global Fossil Infrastructure Tracker, May 2020

Table 1. LNG Importing Countries, 2000, 2020, and 2030

(projects in construction in red, projects in pre-construction development shown in blue).

Year	Countries
2000	Belgium, France, Greece, Italy, South Korea, Spain, Taiwan, Turkey, USA
2020	Argentina, Bahrain, Bangladesh, Belgium, Brazil, Canada, Chile, China, Colombia, Dominican Republic, Egypt, Finland, France, Gilbraltar, Greece, India, Indonesia, Israel, Italy, Jamaica, Japan, Jordan, Kuwait, Lithuania, Malaysia, Malta, Mexico, Netherlands, Pakistan, Panama, Poland, Portugal, Russia, Singapore, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, USA
2030	Argentina, Australia, Bahrain, Bangladesh, Belgium, Benin, Brazil, Cambodia, Canada, Chile, China, Colombia, Croatia, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Finland, France, Germany, Ghana, Gilbraltar, Greece, India, Indonesia, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kuwait, Latvia, Lithuania, Malaysia, Malta, Mexico, Morocco, Myanmar, Netherlands, Pakistan, Panama, Philippines, Poland, Portugal, Romania, Russia, Singapore, South Africa, South Korea, Spain, Sri Lanka, Sweden, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, USA, Vietnam

Source: Global Energy Monitor, Global Fossil Infrastructure Tracker, May 2020

LNG'S GREENHOUSE GAS EMISSIONS

Fossil gas has been touted as a "clean" fuel, one that can serve as a "bridge fuel" allowing the world to shut down coal-fired power plants, as a stopgap measure until renewable energy becomes cheaper. This "bridge fuel" argument has been based primarily on the fact that, compared with using coal, burning gas releases about half as much carbon dioxide, the main greenhouse gas. Thus there has been a push for expanding the natural gas system worldwide, with a rapid expansion of the LNG system a crucial part of this (IEA 2019).

However, the fossil gas system suffers from a major problem: leakage. Fossil gas is mainly methane, a greenhouse gas that is much more powerful than CO_2. Methane leaks from many parts of the fossil gas system, from extraction wells, compressors, and pipelines.

Methane leakage is a problem worldwide, with major sources of methane emissions in many gas-producing countries (ESA 2020). Most of the studies to date of methane leakage have focused on the U.S., where recent studies have found much more gas leaking from the system than estimated by the US Environmental Production Agency (Alvarez 2018).

Average leakage rates for the U.S. for different parts of the fossil gas system are:

- 1.9% leakage rate for production areas (Alvarez 2018)
- 0.3% leakage rate for pipelines in the US (Alvarez 2018)
- 0.5% leakage rate for additional transmission pipeline travel for LNG exports (Pace Global 2015)
- 1.3–2.7% leakage rates for several large cities: Los Angeles, Boston, New York, Philadelphia, Baltimore, and Washington, DC (McKain et al 2015, Plant et al 2019, Wennberg et al 2012)

The most comprehensive study to date of the U.S. fossil gas system estimated the overall leakage to be 2.3% (Alvarez 2018). At that rate, emissions from methane leakage are about the same as the emissions from burning the natural gas in power plants or for heat, when evaluated over a 20-year period—thus doubling the warming from simply burning the gas (Alvarez 2018).

Some areas have shown higher leakage. A recent satellite study that found the Permian basin in Texas and New Mexico—the most intensive area for fracking in the U.S. now—is leaking 3.7% of the fossil gas produced (Zhang 2020). Gas from the Permian is increasingly viewed as a major source to be exported as LNG, with large pipelines recently built, under construction, and proposed to connect to LNG terminals on the coast of the Gulf of Mexico.

Given the leakage rates in the US fossil gas system, using fossil gas for electricity can at best achieve only minor reductions in warming compared with using coal, while locking in long-term fossil infrastructure that will slow the transition to combinations of renewables and battery storage. Exact comparisons are difficult due to the apples-and-oranges nature of the global warming profiles of methane versus carbon dioxide. Depending on the assumptions about methane leakage rates, the relative efficiencies of the coal-fired and gas-fired power plants being compared, and the period over which warming is being measured, the global warming impact of building a new gas plant instead of a new coal plant, assuming the gas plant is supplied by LNG, can range from 29% lower to 16% higher (GEM analysis; see technical discussion here.) Overall, due to the consequences of further locking in fossil combustion rather than transitioning to renewable power, switching from coal to gas does not appear to offer a useful strategy to achieve rapid cuts in greenhouse gas emissions to achieve carbon neutrality.

Shipping fossil gas as LNG significantly increases the greenhouse gas footprint. Cooling gas to the very low temperatures needed to to turn it into a liquid (LNG) requires huge energy inputs to run compressors. In an LNG export terminal, typically 10–20% of the incoming gas is burned to power the liquefaction process (Lowell 2013). LNG tankers traveling long distances—such as from Texas to Japan, the largest LNG importer—add more emissions from the fuel they burn. Overall, using fossil gas as LNG adds around 25% more CO_2 emissions, on top of those from burning the gas for electricity or heat (Pavlenko et al 2020).

Fossil gas is also increasingly used for transportation—in cars, trucks, and ships—as a replacement for liquid fossil fuels traditionally used in transportation (gasoline and diesel for road transport; heavy fuel oil and marine gas oil for ships). But given the methane leakage rates in the US fossil gas system, switching from liquids to gas actually increases the overall emissions from these vehicles (Pavlenko 2020, Alvarez 2012).

Factoring in the large methane leakage found in recent studies could further tip the balance away from fossil gas.

GRAND STRATEGY MEETS CLIMATE AND ECONOMIC REALITY

"The gas industry's future looks bright over the next five years," was the optimistic headline of the press release for the International Energy Agency's *Gas 2018* report. The report reflected the heady atmosphere in which massive allotments of capital were being committed to new LNG infrastructure projects. Yet only four months later, in October 2018, the Intergovernmental Panel on Climate Change released a special report, *Global Warming of 1.5°C,* with a strong contrary warning (IPCC 2018). According to the IPCC, in order for the world to maintain a two-in-three chance of limiting global warming to 1.5°C, gas use in 2030 relative to 2010 will need to decrease by 20% to 25% (based on scenarios that do not include overshoot or major use of carbon capture and storage). By 2050, gas use will need to drop by 53% to 74%. Alongside the IPCC's call for a decrease in global gas consumption has come a growing recognition of the size and ubiquity of methane emissions, a highly potent greenhouse gas, throughout the gas supply chain. (See sidebar, "LNG's Greenhouse Gas Emissions" on page 8.)

Expanding on the IPCC analysis, a 2019 report by several NGOs and the UN Environment Programme, titled *The Production Gap,* warned that under the IEA's New Policies Scenario, the global economy was on course to produce 70% more gas by 2030 than would be consistent with 1.5°C warming. The report stated, "A production gap of this magnitude implies a risk of substantial over-investment in fossil fuel exploration, development, and infrastructure" (SEI 2019).

Even before the twin shocks of the COVID-19 pandemic and global gas price collapse, LNG projects were facing an increasingly difficult economic environment. Even though only a small portion of the planned increase in LNG capacity had gone into operation, gas markets worldwide were so oversupplied that prices had fallen far below the levels considered necessary for expensive new infrastructure to be viable. Further clouding the future scenarios of massive growth in gas demand were the continued competitive threat from renewables combined with battery storage in power markets, as detailed in the sidebar, "The Deteriorating Economics of Gas for Power Generation."

THE DETERIORATING ECONOMICS OF GAS FOR POWER GENERATION

Power generation remains the largest use of gas, accounting for 38.5% of global demand (IEA 2019b). Recent analyses of the relative economics of gas versus renewable power packages that include storage conclude that renewables will make increasing inroads and eventually dominate the space currently occupied by gas, long before the 30–40 year lifespan of today's new LNG infrastructure. A project-by-project analysis of the U.S. by Rocky Mountain Institute (RMI) projected that clean energy portfolios (CEPs)—optimized combinations of demand-side management and wind, solar, and storage technologies—will be lower in cost than 90 percent of proposed gas-fired power units (Teplin et al. 2019). For the 68 GW proposed to be built in the U.S. as of late 2019, the RMI study found the savings from implementing CEPs rather than gas plants to be US$29 billion. With imported LNG prices significantly higher in overseas markets than domestic gas costs in the U.S., the cost differential would be even greater in such markets. Similarly a Carbon Tracker Institute study of South Korea found that the levelized costs of offshore wind, utility-scale solar PV, and onshore wind are already cheaper than the levelized cost of power from new gas plants, and could be cheaper than the levelized cost of power from existing gas plants as early as 2023–2025 (Gray et al. 2020).

DEMAND SHOCK

In the spring of 2020, with the onset of the Saudi–Russia oil war and COVID-19 becoming a pandemic, the level of economic challenge facing many new LNG projects suddenly intensified to an issue of sheer survival. The IEA described the situation as "the largest recorded demand shock in the history of global natural gas markets" (IEA 2020). The issue was more than simply a matter of inconvenience and delay, since the duration of the downturn was hard to predict and many projects were already on shaky ground due to the chronic oversupply condition of the global gas market. Moreover, the drop in demand occurred at a time when numerous projects had newly entered construction.

From April 2019 to May 2020, global LNG export capacity grew by 6%, from 415.5 MTPA to 441.6 MTPA (GEM 2019, 2020). At the same time, the amount of LNG export capacity under construction surged from 45.5 MTPA to 122.0 MTPA. Based on International Gas Union estimates of $1,501 per tonne of annual capacity for greenfield export terminals, $458 per tonne for brownfield export terminals, $274 per tonne for import terminals, and $170 per tonne for floating import terminals, the amount of capital expenditures for LNG export projects in construction has increased from $59.2 billion to $159.6 billion. For import terminals, the amount of capacity in construction has similarly grown, from 51.4 MTPA in 2019 to 143.8 MTPA in 2020, and the amount of capital expenditures for projects in construction has increased from $23.6 billion to $36.6 billion. Combined, the amount of capital expenditure for import and export projects in construction has increased from $82.8 billion to $196.1 billion.

Given the economic headwinds facing the industry, the doubling of capacity in construction represents a massive expansion of risk for developers and their financial backers at the exact moment when the project risks are particularly high. For that reason, it appears that projects that have not yet committed to construction are quietly being abandoned by their promoters. In the past year, concurrent with the surge in projects under construction, there has been a notable decline in the number of projects in pre-construction stages of development. This decline in the number of projects moving toward construction demonstrates the growing recognition that the industry is significantly overbuilt. As of May 2020, Global Energy Monitor has identified 127.5 MTPA of export projects on hold and 445.4 MTPA of projects that have been cancelled or abandoned since 2014. In addition, at least 80 MTPA of export projects that previously had been progressing are now reporting difficulties such as delays in final investment decisions, often ascribed to a combination of low prices, pandemic-related workforce disruptions, and intensifying environmental opposition.

Overall, since 2014, a total of 288 MTPA of LNG export terminals have been built or have entered construction, compared to 572.6 MTPA of LNG export projects that have been canceled or abandoned, an implementation rate of 39% versus a project failure rate of 61%. Yet even that reduction in the expansion ambitions of the LNG industry may be an understatement of the ultimate level of contraction, given the severity of the overcapacity problem and the large amount of additional capacity in construction.

Table 2 (on the next page) lists some of the major export terminals that have been shelved, cancelled, abandoned, or reported to be in jeopardy in recent years, including projects newly delayed and in danger of cancellation.

Table 2. Cancelled or Troubled LNG Terminals

Terminal	Country	Capacity (MTPA)	Notes
American Coast LNG Terminal	USA	8.0	No progress since 2014
Atlantic Coast LNG Terminal	Canada	16.0	No progress since 2016
Aurora LNG Terminal	Canada	24.0	Cancelled in September 2017
Browse LNG Terminal	Australia	12.0	2020: delay in FID announced due to global oil price collapse and Woodside's falling stock value
Canaport LNG Export Terminal	Canada	7.5	Cancelled in March 2016
Damietta Segas LNG Terminal expansion	Egypt	5.6	2020: Project reported cancelled due to adverse economics amplified by pandemic
Discovery LNG Terminal	Canada	20.0	No progress since 2015
Driftwood LNG Terminal	USA	27.6	2020: Tellurian restructured business, negotiated loan extension, and laid off 40% of workforce
Energie Saguenay LNG Terminal	Canada	11.0	Berkshire Hathaway pulls $3 billion in 2020, but project still being pursued
G2 LNG Terminal	USA	14.0	No progress since 2015
Goldboro LNG Terminal	Canada	10.0	Negotiations to delay final investment decision deadline to June 2021 due to depressed market and pandemic
Gothenburg LNG Terminal	Sweden	0.4	Sweden withdrew the project from the EU PCI list in 2019
Grassy Point LNG Terminal	Canada	25.0	Cancelled in 2018
Kitsault LNG Terminal	Canada	8.0	No progress since 2015
Kwispaa LNG Terminal	Canada	24.0	Work stopped in February 2019
Lake Charles LNG Terminal	USA	16.5	2020: Shell announced exit due to global oil price collapse
Magnolia LNG Terminal	USA	8.8	2020: Project reportedly near collapse
Malahat LNG Terminal	Canada	6.0	Cancelled in 2017
New Times Energy LNG Terminal	Canada	14.0	No progress since 2016
Oregon LNG Export Terminal	USA	9.6	Cancelled in April 2016
Pacific Northwest LNG Terminal	Canada	21.0	Cancelled in July 2017
Papua New Guinea LNG Terminal (Exxon) Train 3	Papua New Guinea	3.3	2020: Poten & Partners announced FID for Train 3 delayed due to plunging demand and low prices.
Papua LNG Terminal (Total)	Papua New Guinea	5.4	2020: Sponsor delayed FID, citing plunging demand and low prices
Pluto LNG Terminal expansion	Australia	5.0	2020: Lead sponsor Woodside delays FID amid plunging stock market value
Prince Rupert LNG Terminal	Canada	21.0	Cancelled in March 2017
Scarborough LNG Terminal	Australia	7.0	2020: Woodside delayed FID investment decision amid plunging stock market value
Shannon LNG Terminal	Ireland	2.0	2020: Ireland's two main political parties agree to withdraw project from EU PCI list
Stewart Energy LNG Terminal	Canada	30.0	No progress since 2014
Woodfibre LNG Terminal	Canada	2.1	Delayed to 2021 due to construction disruption.

Source: Global Fossil Infrastructure Tracker, May 2020

THE COMBINATION OF ORGANIZED OPPOSITION AND BAD ECONOMICS

Opposition—including public protests, organized opposition campaigns, and opposition lawsuits brought against project developers or regulators—has targeted 19 of 168 LNG export terminals scheduled for operation in 2016 or later, and 37 of 175 LNG import terminals scheduled for operation in 2016 or later (GEM 2020). Such opposition threatens to create delays or to cause governmental subsidies to be withheld, toppling projects already weakened due to the recession and pandemic resulting in low gas prices.

Berkshire Hathaway drops Energie Saguenay LNG: While many projects face opposition from local communities, the case of the Energie Saguenay LNG Terminal in Quebec shows the potential for a local protest to galvanize a national movement. In March 2020, Warren Buffet announced the withdrawal of Berkshire Hathaway's CA$4 billion investment from the project, citing "the current Canadian political context." The story of Berkshire Hathaway's change of heart on LNG begins in British Columbia, where the Wet'suwet'en nation sought to block several pipelines from crossing their land, including TC Energy's CA$6.6 billion Coastal GasLink Pipeline that would supply natural gas to the proposed CA$40 billion LNG Canada Terminal. After the camp was forcibly cleared by the Royal Canadian Mounted Police in February 2020 so that construction of this pipeline could proceed, large numbers of students, environmental groups, and other First Nations tribes took action in solidarity across Canada, including rail blockades that disrupted freight and passenger travel and threatened to derail the country's economy.

Ireland nixes Shannon LNG: A key to the U.S. LNG industry's export strategy has been Ireland's Shannon LNG Terminal, part of a proposed deepwater port that would be able to receive the largest class of gas supertankers, including LNG tankers carrying fracked gas from the U.S.and. First proposed in 2008, the terminal has been delayed by numerous lawsuits and a coalition of opponents that now includes Friends of the Irish Environment (FIE) and dozens of local groups, American celebrities such as Cher and Mark Ruffalo, and Pope Francis. In response to a lawsuit by FIE, in April 2020 the European Court of Justice ruled that Shannon LNG will have to make a new application from scratch with an Environmental Impact Assessment to comply with the European Union's Habitats Directive. Reflecting the shift in public opinion against the project and LNG in general, in June 2020 Ireland's two main political parties, Fine Gael and Fianna Fáil, agreed with the Green Party to withdraw Shannon LNG from the EU Projects of Common Interest list in 2021, which would mean it would no longer be eligible for public funds from the EU.

Gothenburg LNG loses support: In October 2019 climate activists in Sweden were successful in convincing the government to withdraw support for the proposed Gothenburg LNG Terminal and remove it from the EU's Projects of Common Interest list, arguing that the project was incompatible with Sweden's commitments under the Paris climate accords. Activists also argued that the terminal was an attempt by the LNG industry to create a market for its product where none exists, with Sweden getting just 1.5% of its energy from gas.

Krk Floating LNG Terminal: In Croatia, opponents of the proposed Krk Floating LNG Terminal are focused on the damage it would do to the ecologically sensitive Krk Bay, and challenging public funding for the project in the form of 101.4 million euros from the EU and 100 million euros from the Croatian government.

Goldboro LNG on the ropes: Recently, the proposed Goldboro LNG Terminal in Nova Scotia, Canada, has become an example of the multiple perils now confronting many planned LNG terminals. In May 2020, Alberta's provincial energy regulator declined to approve the sale of extensive gas infrastructure from Shell Canada to Pieridae Energy on the grounds that there were uncertainties over which of the two companies would be liable for subsequent clean-up costs following the transfer of the assets. In order to try to keep the project alive, Pieridae was seeking US$4.5 billion in loan guarantees from the German government while also lobbying federal and provincial governments for approximately CA$1 billion in public handouts.

Woodfibre LNG struggles to survive: With numerous other LNG projects on the west coast of Canada failing to materialize, the sponsors of Woodfibre LNG Terminal hoped to bring to fruition. The project has faced well-organized opposition from members of Squamish Nation, from citizen groups such as My Sea to Sky, from the Council of Canadians, and most recently from the District of Squamish, which voted in May 2020 not to support the project's request for a five-year license extension unless the project agreed to reduce its emissions in line with targets set by the Intergovernmental Panel on Climate Change. Construction has been delayed until mid-2021 due to pandemic-related supply chain disruption and construction contractor bankruptcy.

LNG FINANCE: HEARTBURN AT MAJOR INSTITUTIONS

Construction of LNG terminals requires massive amounts of capital: as noted by the International Energy Agency, four projects approved in the past few years will exceed US$20 billion each, and some are the largest private-sector investments in the history of their respective countries. Meanwhile the market for LNG is so oversaturated that prices have dropped to historic lows. The combination of massive capital at risk and collapsing market conditions is a recipe for financial losses on a grand scale.

Financing in 2019 for the LNG industry from the world's top 35 commercial banks totalled US$22.4 billion, the highest level it has reached since 2016 when the same banks provided the sector with US$21.9 billion via project finance, general corporate finance and the underwriting of corporate bonds (RAN 2020). At the time of writing, only three major commercial banks have introduced marginal policy restrictions to their financing of LNG projects and companies. The French bank BNP Paribas and the Italian bank UniCredit have recently prohibited financing for companies which own or operate LNG terminals *only if* they are dependent on gas which has been fracked. Royal Bank of Scotland/NatWest will no longer lend to "major Oil and Gas producers unless they have a credible transition plan aligned with the 2015 Paris Agreement in place by the end of 2021," a general policy stricture which applies to only some LNG companies (BankTrack 2020).

International commercial banks' largely unrestricted financing of LNG now stands in stark contrast to the array of increasingly tight restrictions on financial support for coal power which most of them have enacted since the Paris Agreement was signed. (The main exceptions are Chinese banks, such as Industrial and Commercial Bank of China.) This major policy gap on LNG will need to be addressed quickly if the UN's Principles for Responsible Banking (PRB) initiative is to live up to its name and its goals. Under this framework, by 2023 more than 130 international banks have committed to align their business strategies with the Paris Agreement aim of limiting the global temperature rise to 1.5°C over the pre-industrial average (UNEP 2020). Continued unfettered support for LNG is not Paris compliant given the sector's hugely detrimental climate impacts.

Significantly in April 2020, Japan's Mizuho and Sumitomo Mitsui Banking Corporation (SMBC), two of the world's heaviest financiers of LNG, issued policy language which formally recognises the climate and financial risks associated with oil and gas investments going forward. According to SMBC, "[A]s the transition to a low-carbon society progresses, it is important to consider the risk of stranded assets that will cause the value of the assets owned to decline in the future" (Sumitomo Mitsui 2020). In an announcement on "Taking firm action toward a low-carbon society," Mizuho also noted that "in light of the fact that oil, gas, and other fossil fuels contribute to emissions of greenhouse gases, we undertake engagement with clients to confirm their measures for addressing transition risk accompanying climate change" (Mizuho 2020). If it's to be credible, this encouraging rhetoric needs to be backed up by concrete policy commitments from the banks.

The most striking fossil fuels-related policy intervention in the last 12 months from a major international financier came from the publicly owned European Investment Bank (EIB) in November 2019 when it announced that after 2021 it will end nearly all funding of fossil fuel projects (EIB 2019). Outlining the EIB's rationale for this breakthrough policy decision, Andrew McDowell, the bank's vice president in charge of energy, said, "The EIB, like many other financial institutions, is increasingly worried about being left with stranded assets on its balance sheet." Nonetheless, a policy caveat could result in the EIB still financing certain LNG terminal projects beyond 2021 if they are present on the European Commission's fourth list of Projects of Common Interest (PCI). Currently 24 LNG import terminals are proposed or under construction in EU member states, five of which are included on the fourth PCI list with an estimated total

FLOATING LNG TERMINALS

Floating storage and regasification units (FSRU) were first conceptualized in 2005 when an LNG vessel was refurbished to include regasification technology. Since then, the FSRU model has exploded in popularity, with 30 units deployed and 36 under development as of May 2020. Companies have targeted developing countries for FSRU technology: 50% of the FSRUs in development are destined for developing countries, 38% of which will be first-time LNG importers (GEM 2020).

As of May 2020, 30 operating FSRUs account for 111.7 MTPA of LNG import capacity, or 13.3% of global operating LNG import capacity. Projects in construction or in pre-construction development account for 87.7 MTPA, or 19.8% of total LNG import capacity under development.

Floating LNG export terminals (FLNGs) are also increasingly popular, though not to the same degree as FSRUs. Five operating FLNG export terminals represent 16.6 MTPA or 3.8% of total global LNG export capacity; 11 FLNG export terminals are in development, representing 88.2 MTPA or 13.1% of total in-development LNG export capacity (GEM 2020).

Industry selling points for FSRU technology include speed of installation and lower cost (Norrgård 2018). FSRUs require 10–20 fewer months from planning to operation than similarly sized onshore terminals, allowing them to be brought online at twice the speed of onshore terminals (Offshore Magazine 2017). While faster installation may exist under ideal conditions, the failure rate for FSRU terminals implemented since 2016 is 65%, somewhat higher than the 57% failure rate for all LNG import terminals in the same time period (GEM 2020).

The industry's pitch to developing countries has been that FSRU technology is less expensive and comes online faster than onshore terminals (The Economist 2017, Offshore Technology 2017). While upfront costs for FSRUs are about 62% of those for similarly sized onshore terminals (Offshore 2017), operating costs are 50% higher; after six to 12 years, FSRUs become more expensive than onshore terminals of similar size (Norrgård 2018). FSRUs are usually only offered on leases of 10 to 12 years. This skews their short-term competitive advantage, leaving those leasing the technology vulnerable to sticker shock when the initial contract ends (Offshore Technology 2017). One analysis noted that if the emerging market fails to pay the heavy premium, owners can simply move the FSRU to another location (Bloomberg Intelligence 2018).

Also dampening the attractiveness of FSRUs is susceptibility to extreme weather. Among projects now in-development, almost 30% are destined for the coastlines of India or Southeast Asia, areas subjected to severe coastal weather (GEM 2020). In 2018, Bangladesh announced that it would no longer utilize floating terminals because the first one commissioned was too difficult to operate during the extreme weather of Bangladesh's monsoon season (TankTerminals.com 2018). Later that same year, a different FSRU in Bangladesh was stalled due to inclement weather, resulting in a dispute between Excelerate and Petrobangala, with Excelerate declaring *force majeure* on the project (Zawadzki 2018). Malta has had similar concerns with its Delimara FSRU Terminal, which has to be moved at least three times a year due to inclement weather, leading to a complete shutdown of the island's gas-fired power plants (Camilleri 2016). Because of this, Malta is now planning an onshore terminal to replace the FSRU (Debono 2020).

As of May 2020, 12 projects amounting to 39.3 MTPA of capacity have shown no developmental progress in at least two years and are likely headed toward abandonment or cancellation, given the depth of the industry recession (Global Fossil Infrastructure Tracker 2020). In that event, the project failure rate in the 2014–2020 period would rise to 69%.

cost of 1.7 billion euros (GEM 2020). Many of these LNG terminal projects in the EU are being challenged by communities and activists. The emerging disparity between already excessive EU gas import capacity and a highly expensive new fleet of LNG import terminal proposals could present financiers with a growing stranded assets challenge before too long (Inman 2020).

OWNERSHIP

Table 3 shows the top 25 owners of LNG export terminals, based on pro-rata ownership shares and ranked by total amount of capacity in the developmental pipeline. These companies account for 75% of export capacity under development. U.S. companies dominate the list, taking four of the top five spots and 13 out of 25 overall. Three Australian companies are represented, and one each from Qatar, France, Kuwait, Russia, the Netherlands, Mexico, Norway, India, and Canada. Among the top 25, only four are state-owned or quasi state-owned (Qatar Petroleum, Kuwait National Petroleum Company, Alaska Gasline Development Corporation, and Equinor).

Table 3. Top 25 Developers of LNG Export Capacity, May 2020 (Million Tons per Annum)

Parent Company	Country	Operating	Construction	Pre-Construction
Qatar Petroleum	Qatar	39.4	10.9	46.8
NextDecade	U.S.	0.0	0.0	43.5
Cheniere Energy	U.S.	34.0	9.5	23.0
Venture Global LNG	U.S.	0.0	10.0	20.0
Alaska Gasline Development Corporation	U.S.	0.0	0.0	26.6
Total S.A.	France	21.8	4.4	20.9
Woodside Energy	Australia	8.0	0.0	22.8
Kuwait National Petroleum Company	Kuwait	0.0	22.0	0.0
Novatek	Russia	10.6	1.3	19.8
ExxonMobil	U.S.	27.3	5.5	14.5
Sempra Energy	U.S.	4.3	2.0	15.3
Royal Dutch Shell	Netherlands	35.7	7.0	10.2
Liquefied Natural Gas Limited	Australia	0.0	0.0	16.8
Energy Transfer Equity	U.S.	0.0	0.0	16.4
Tellurian Inc.	U.S.	0.0	0.0	15.2
AC LNG	India	0.0	0.0	13.5
EnergyWorld	Australia	0.0	2.0	10.0
Freeport-McMoRan Inc	U.S.	0.0	0.0	12.0
Mexico Pacific Limited	Mexico	0.0	0.0	12.0
United LNG	U.S.	0.0	0.0	12.0
Equinor	Norway	1.4	0.0	10.0
Pieridae Energy	Canada	0.0	0.0	10.0
Chevron	U.S.	17.3	0.0	9.0
Commonwealth LNG	U.S.	0.0	0.0	8.4
Midstream Energy Group	U.S.	0.0	0.0	7.3

Source: Global Fossil Infrastructure Tracker, May 2020

Ownership of LNG import capacity under development is dispersed among at least 322 companies, of which China accounts for five of the top six, as shown in Table 4. State-owned Sinopec is the largest developer, with 16 MTPA in pre-construction and 18.13 MTPA in construction. India's H-Energy is the second largest developer, followed by Xintian Green Energy, Zhejiang Energy Group, China National Petroleum Corporation, and Hanas Group, all Chinese companies.

Table 4. Top 25 Developers of LNG Import Capacity

Parent Company	Country	Operating	Construction	Proposed
Sinopec	China	10.1	18.1	16.0
H-Energy	India	0.0	12.0	10.5
Xintian Green Energy	China	0.0	21.0	0.9
Zhejiang Energy Group	China	0.9	2.4	12.0
China National Petroleum Corporation	China	13.6	5.0	8.8
Hanas Group	China	0.0	0.0	12.0
Kuwait National Petroleum Company	Kuwait	7.7	11.3	0.0
BP	U.K.	3.9	10.6	0.0
China Huadian	China	0.0	0.0	9.5
GCL-Poly	China	0.0	0.0	9.0
Engie	France	19.2	0.0	7.8
PTT Public Company Limited	Thailand	11.5	0.0	7.5
Petrobangla	Bangladesh	5.0	0.0	7.5
Engro Corporation	Pakistan	2.7	5.9	1.1
China National Offshore Oil Corporation	China	23.5	6.0	0.7
Genpact	U.S.	0.0	0.6	6.0
S.B. Adani Family Trust	India	2.5	6.1	0.0
Enel	Italy	0.0	0.0	6.0
Hubei Energy	China	0.0	0.0	6.0
RomGaz	Romania	0.0	0.0	6.0
Sambolo Resources	Ireland	0.0	0.0	6.0
BW Group	Bermuda	5.7	5.6	0.0
BOTAŞ	Singapore	5.9	0.0	5.4
Singapore LNG Corporation	Singapore	11.0	0.0	5.3
Office National de l'Electricite et de l'Eau Potable	Morocco	0.0	0.0	5.2

Source: Global Fossil Infrastructure Tracker, May 2020

Table 5. LNG Export and Import Capacity by Country and Developmental Status (million tonnes per annum), May 2020

	Export Terminals			Import Terminals		
Country	Operating	Construction	Proposed	Operating	Construction	Proposed
Algeria	29.3	0.0	0.0	0.0	0.0	0.0
Angola	5.2	0.0	0.0	0.0	0.0	0.0
Argentina	0.5	0.0	5.0	3.8	0.0	0.0
Australia	87.6	0.0	24.0	0.0	0.0	7.0
Bahrain	0.0	0.0	0.0	9.0	0.0	0.0
Bangladesh	0.0	0.0	0.0	8.5	0.0	7.5
Belgium	0.0	0.0	0.0	6.6	0.0	0.0
Benin	0.0	0.0	0.0	0.0	0.0	0.5
Brazil	0.0	0.0	0.0	9.6	5.6	0.0
Brunei	7.2	0.0	0.0	0.0	0.0	0.0
Cambodia	0.0	0.0	0.0	0.0	0.0	3.6
Cameroon	2.4	0.0	0.0	0.0	0.0	0.0
Canada	0.0	14.0	61.6	7.5	0.0	0.0
Chile	0.0	0.0	0.0	5.5	0.6	2.7
China	1.5	0.0	0.0	76.0	54.2	117.3
Colombia	0.0	0.0	0.0	3.0	0.0	0.0
Croatia	0.0	0.0	0.0	0.0	2.0	3.2
Cyprus	0.0	0.0	0.0	0.0	0.6	0.0
Djibouti	0.0	3.0	0.0	0.0	0.0	0.0
Dominican Republic	0.0	0.0	0.0	1.9	0.0	0.0
Ecuador	0.0	0.0	0.0	0.0	0.0	0.4
Egypt	7.2	0.0	5.0	5.7	10.6	0.0
El Salvador	0.0	0.0	0.0	0.0	0.5	0.5
Equatorial Guinea	3.7	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	0.0	0.0	0.0	0.0	1.8
Finland	0.0	0.0	0.0	0.5	0.1	0.0
France	0.0	0.0	0.0	26.5	0.0	7.8
Germany	0.0	0.0	0.0	0.0	0.0	17.2
Ghana	0.0	0.0	0.0	0.0	2.0	0.0
Gibraltar	0.0	0.0	0.0	0.1	0.0	0.0
Greece	0.0	0.0	0.0	5.1	0.0	4.5
India	0.0	0.0	0.0	47.5	34.0	19.0
Indonesia	26.5	5.8	9.5	12.4	2.9	1.6
Ireland	0.0	0.0	0.0	0.0	0.0	8.9
Israel	0.0	0.0	5.0	3.5	0.0	0.0
Italy	0.0	0.0	0.0	10.9	0.3	6.0
Ivory Coast	0.0	0.0	0.0	0.0	0.0	3.0
Jamaica	0.0	0.0	0.0	9.7	0.0	0.0
Japan	0.0	0.0	0.0	196.3	3.4	0.0
Jordan	0.0	0.0	0.0	3.8	0.0	0.0

continues on next page

Table 5. *(continued)*

Country	Export Terminals			Import Terminals		
	Operating	Construction	Proposed	Operating	Construction	Proposed
Kuwait	0.0	22.0	0.0	9.6	11.3	0.0
Latvia	0.0	0.0	0.0	0.0	0.0	1.1
Lithuania	0.0	0.0	0.0	3.0	0.0	0.0
Malaysia	27.9	1.5	0.0	7.3	0.0	0.0
Malta	0.0	0.0	0.0	0.5	0.0	0.0
Mauritania	0.0	10.0	0.0	0.0	0.0	0.0
Mexico	0.0	0.0	16.6	17.1	3.0	0.0
Morocco	0.0	0.0	0.0	0.0	0.0	5.2
Mozambique	0.0	16.3	15.2	0.0	0.0	0.0
Myanmar	0.0	0.0	0.0	0.0	0.0	4.0
Netherlands	0.0	0.0	0.0	9.0	0.0	1.5
Nigeria	22.2	0.0	7.6	0.0	0.0	0.0
Norway	4.7	0.0	0.0	0.0	0.0	0.0
Oman	10.8	0.0	0.0	0.0	0.0	0.0
Pakistan	0.0	0.0	0.0	14.5	5.9	12.7
Panama	0.0	0.0	0.0	1.5	0.0	0.0
Papua New Guinea	6.6	0.0	8.7	0.0	0.0	0.0
Peru	4.5	0.0	0.0	0.0	0.0	0.0
Philippines	0.0	0.0	0.0	0.0	1.5	0.0
Poland	0.0	0.0	0.0	3.6	1.8	3.3
Portugal	0.0	0.0	0.0	5.8	0.0	0.0
Qatar	77.4	0.0	46.8	0.0	0.0	0.0
Romania	0.0	0.0	0.0	0.0	0.0	6.0
Russia	26.8	3.2	34.8	2.7	0.0	0.0
Singapore	0.0	0.0	0.0	11.0	0.0	5.3
South Africa	0.0	0.0	0.0	0.0	0.0	1.0
South Korea	0.0	0.0	0.0	102.8	0.0	3.6
Spain	0.0	0.0	0.0	45.7	2.0	0.2
Sri Lanka	0.0	0.0	0.0	0.0	0.0	2.7
Sweden	0.0	0.0	0.0	0.6	0.0	0.4
Taiwan	0.0	0.0	0.0	12.0	0.0	4.8
Thailand	0.0	0.0	0.0	11.5	0.0	7.5
Trinidad and Tobago	15.5	0.0	0.0	0.0	0.0	0.0
Turkey	0.0	0.0	0.0	23.2	0.0	5.4
Turkmenistan	0.2	0.0	0.0	0.0	0.0	0.0
United Arab Emirates	8.4	0.0	0.0	7.0	0.0	0.0
United Kingdom	0.0	0.0	0.0	37.4	0.0	6.0
USA	65.6	46.2	290.3	64.8	0.5	0.0
Vietnam	0.0	0.0	0.0	0.0	1.0	6.6
Total	**441.6**	**122.0**	**530.1**	**844.0**	**143.8**	**289.6**

REFERENCES

Aitken, G., and T. Nace. "Gambling on Gas: Risks Grow for Japan's $20 Billion LNG Financing Spree." Global Energy Monitor. 2020. https://bit.ly/2NmTrXg

Alvarez R. et al. "Greater focus needed on methane leakage from natural gas infrastructure." Proceedings of the National Academy of Sciences. 2012. https://doi.org/10.1073/pnas.1202407109

Alvarez R. et al. "Assessment of methane emissions from the U.S. oil and gas supply chain." Science. 2018. https://bit.ly/2VvGGvi

BankTrack. "Banks and liquefied natural gas." BankTrack policy tracker, accessed June 2020. https://bit.ly/2Y3f9Wr

Bloomberg. "Gas Industry Sees Opening in the EIB's Move Against Fossil Fuels," Bloomberg, November 15, 2020. https://bloom.bg/37xJ4sY

Bloomberg Intelligence. "Emerging market LNG flow feeds high potential but also has pitfalls". September 10, 2018. https://bloom.bg/2ZTBcjX.

Camilleri, I. "No gas power plant during storms." *Times of Malta*. October 22, 2016. https://bit.ly/36X4PCs.

Debono J. "Gas pipeline needs 8,000 square metres in land reclamation." *MaltaToday*. April 23, 2020. https://bit.ly/3dj1Czn.

The Economist. "Global LNG giants turn to poor countries for new markets." September 14, 2017. https://econ.st/2ZWVqt6.

European Investment Bank (EIB). "EU bank launches ambitious new climate strategy and Energy Lending Policy," European Investment Bank, November 14, 2019. https://bit.ly/2N4yrVm

European Space Agency (ESA). "Mapping methane emissions on a global scale." 2020 https://bit.ly/37y20b3

Global Energy Monitor (GEM). "Capacity of LNG Terminals by Region and Project Status." May 2020. https://bit.ly/30C4vI4

Gray, M, et al. "Whack-a-Mole: Will South Korea's coal power transition be undermined by overcompensated gas." Carbon Tracker Initiative and Solutions for Our Climate. 2020. https://bit.ly/2AaWAGQ

Inman, M. "Gas at a Crossroads: Why the EU should not continue to expand its gas infrastructure." Global Energy Monitor, February 2020. https://bit.ly/2VN9V0x

Intergovernmental Panel on Climate Change (IPCC). "Global Warming of 1.5°C." 2018. https://www.ipcc.ch/sr15/

International Energy Agency (IEA). "Energy Technology Perspectives." 2017. https://bit.ly/2NqPDoe

International Energy Agency (IEA). "Gas 2018." https://bit.ly/2XHj8bm

International Energy Agency (IEA). "Gas 2019." https://bit.ly/2MAulUr

International Energy Agency (IEA). "World Energy Outlook 2019." https://bit.ly/2NPjdUP

Lowell, D. "Assessment of the fuel cycle impact of liquefied natural gas as used in international shipping." International Council on Clean Transportation. 2013. https://bit.ly/2UMAmSF

McKain, K, et al. "Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts." Proceedings of the National Academy of Sciences. 2015. https://bit.ly/3e5BaJS

Mizuho. "Strengthening our sustainability initiatives: Taking firm action toward a low-carbon society." April 15, 2020. https://bit.ly/2Y7pJvI

Norrgård, J. "LNG terminals – land-based vs. floating storage and regasification technology." Wärtsilä Technical Journal. May 15, 2018. https://bit.ly/2zHSSo5.

Offshore magazine. "Review of LNG terminal options shows advantages of FSU facilities." September 14, 2017. https://bit.ly/3crhmz0

Offshore Technology. “Is floating LNG really the best option for emerging economies?” April 4, 2017. https://bit.ly/2Ax4LgE.

Pace Global. “LNG and Coal Life Cycle Assessment of Greenhouse Gas Emissions.” Prepared for the Center for Liquefied Natural Gas. 2015. https://bit.ly/2KDE251

Pavlenko, N., et al. “The climate implications of using LNG as a marine fuel.” International Council on Clean Transportation. Working Paper 2020-02. https://bit.ly/2AHqAuf

Plant, G., et al. “Large Fugitive Methane Emissions From Urban Centers Along the U.S. East Coast.” *Geophysical Research Letters.* 2019. https://bit.ly/2UPZAOY

Rainforest Action Network (RAN). “Banking on Climate Change: Fossil Fuel Finance Report 2020,” https://bit.ly/3d7IPpP

SEI, IISD, ODI, Climate Analytics, CICERO, and UNEP. “The Production Gap: The discrepancy between countries’ planned fossil fuel production and global production levels consistent with limiting warming to 1.5°C or 2°C.” 2019. http://productiongap.org/

Sumitomo Mitsui Banking Corporation (SMBC). “Consideration of ESG risks.” April 16, 2020. https://bit.ly/3d7oGQT

TankTerminals.com. “No More Floating LNG Terminals.” November 26, 2018. https://bit.ly/2U00g4R.

Teplin, C., et al. “The Growing Market for Clean Energy Portfolios.” Rocky Mountain Institute (RMI). 2019. https://bit.ly/3ayPNE8

Tong, D., et al. “Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target.” 2019. *Nature.* https://go.nature.com/2N0zOUL

United Nations Environment Programme (UNEP). “Principles for Responsible Banking: Key Steps to be Implemented by Signatories.” accessed June 2020. https://bit.ly/2BeWL3W

Wennberg, P., et al. “On the Sources of Methane to the Los Angeles Atmosphere. *Environmental Science & Technology.* 2012. https://bit.ly/2YaKCq5

Zawadzki, S. “Bangladesh sees stalled floating LNG terminal starting operations in days.” *Gas Processing and LNG.* 2018. https://bit.ly/3gFIihL.

Zhang, Y., et al. “Quantifying methane emissions from the largest oil-producing basin in the United States from space.” *Science Advances.* 2020. https://bit.ly/3e6LGk1

APPENDIX A. METHODOLOGY

The Global Fossil Infrastructure Tracker uses a two-level system for organizing information. Summary data is maintained in Google sheets, with each spreadsheet row linked to a page on GEM.wiki. Each wiki page functions as a footnoted fact sheet, containing project parameters, background, and mapping coordinates. Each worksheet row tracks an individual pipeline or terminal. Under standard wiki convention, each piece of information is linked to a published reference, such as a news article, company report, or regulatory permit. In order to ensure data integrity in the open-access wiki environment, Global Energy Monitor researchers review all edits of project wiki pages by unknown editors. For each project, one of the following status categories is assigned and reviewed on a rolling basis:

- **Proposed:** Projects that have appeared in corporate or government plans in either pre-permit or permitted stages.
- **Construction:** Site preparation and other development and construction activities are underway.
- **Shelved:** In the absence of an announcement that the sponsor is putting its plans on hold, a project is considered "shelved" if there are no reports of activity over a period of two years.
- **Cancelled:** In some cases a sponsor announces that it has cancelled a project. More often a project fails to advance and then quietly disappears from company documents. A project that was previously in an active category is moved to "Cancelled" if it disappears from company documents, even if no announcement is made. In the absence of a cancellation announcement, a project is considered "cancelled" if there are no reports of activity over a period of four years.
- **Operating:** The project has been formally commissioned or has entered commercial operation.
- **Mothballed:** Previously operating projects that are not operating but maintained for potential restart.
- **Retired:** Permanently closed projects.

To allow easy public access to the results, Global Energy Monitor worked with GreenInfo Network to develop a map-based and table-based interface using the Leaflet Open-Source JavaScript library. The public view of the Global Fossil Infrastructure Tracker can be accessed at http://ggon.org/fossil-tracker/.