Pipe Dreams

2022

STRANDED ASSETS AND MAGICAL THINKING IN THE PROPOSED GLOBAL GAS PIPELINE BUILDOUT

Baird Langenbrunner, Julie Joly, and Greig Aitken

ABOUT GLOBAL ENERGY MONITOR

Global Energy Monitor (GEM) develops and shares information on energy projects in support of the worldwide movement for clean energy. Current projects include the Global Coal Mine Tracker, Global Coal Plant Tracker, Global Gas Infrastructure Tracker, Global Oil and Gas Extraction Tracker, Europe Gas Tracker, CoalWire newsletter, Inside Gas newsletter, Global Gas Plant Tracker, Global Registry of Fossil Fuels, Global Steel Plant Tracker, Latin America Energy Portal, and GEM.wiki.

ABOUT GLOBAL GAS INFRASTRUCTURE TRACKER (GGIT)

The Global Gas Infrastructure Tracker (GGIT) is an online database that identifies, maps, describes, and categorizes natural gas pipelines and LNG terminals. Originally released by GEM in January 2018 as the Global Fossil Infrastructure Tracker (GFIT), the pipelines and terminals data are updated twice annually, and the tracker uses footnoted wiki pages to document each pipeline or terminal. For further details see the tracker landing page and methodology overview.

ABOUT THE COVER

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FURTHER RESOURCES

For additional data on proposed and existing natural gas pipelines and LNG terminals, see Summary Tables. For links to reports based on GGIT data, see Reports & Briefings. To obtain primary data from the GGIT, visit the Download Data page.

Global Energy Monitor

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INTRODUCTION

A massive expansion of the global gas pipeline network threatens climate goals and creates a US$485.8 billion stranded asset risk, according to a new survey by Global Energy Monitor (GEM). After a Covid-19-related drop in pipeline commissionings in 2021, the gas industry and gas-positive countries led by China, India, Russia, Australia, the United States, and Brazil are pushing ahead with plans to commission tens of thousands of kilometers of gas pipelines in 2022.

This expansion is occurring despite the International Energy Agency (IEA) warning that gas usage must peak within the next few years and that the world must quickly transition from fossil fuels to renewables. For 2021, GEM's survey found that cancellations and delays in some parts of the world were offset by rapid expansions elsewhere, particularly in Asian countries, perpetuating a dangerous status quo incompatible with the IEA's 1.5°C net-zero scenario.

EXECUTIVE SUMMARY

- Globally, there are 70,900 kilometers (km) of pipelines in construction, with an additional 122,500 km in pre-construction development. Together these would cost an estimated US$485.8 billion in capital expenditure.
- In 2021, global pipeline commissionings fell to 6,500 km, their lowest level since 1996, but much of this decline was due to the economic and logistical chaos caused by the Covid-19 pandemic. With 36,800 km under construction and scheduled to be commissioned in 2022, and a further 59,500 km scheduled to be commissioned between 2023–2030, the global gas network is poised for a large, rapid expansion.

- China leads the globe in gas pipeline development, with 26,300 km of gas transmission pipelines in construction and an additional 29,800 km proposed, amounting to a total stranded asset risk of US$89.1 billion. The Chinese pipeline boom is happening under the direction of the newly created conglomerate PipeChina, the world's second-largest developer of gas pipelines behind Russia's Gazprom.

- India ranks second among global leaders in gas pipeline development, with 16,200 km under construction and a further 2,200 km that have been proposed, representing a stranded asset risk of US$14.7 billion.

- Sticking to its 2020 plan for a "gas-fired recovery" from the Covid-19 pandemic, Australia is developing 12,200 km of gas pipelines, though just 600 km are currently under construction. These pipelines represent an estimated stranded asset risk of US$18.6 billion.

- In the U.S., rising opposition from NGOs and activists, and a shifting legal and regulatory landscape contributed to the defeat of several high-profile pipelines in 2020–21; however there are still pipelines costing an estimated US$47.6 billion being developed, and the U.S. is expected to become the world's leading exporter of gas in 2022.

- In the U.S., a focus on new LNG terminals and export infrastructure such as the TransCameron pipeline in Louisiana led to record LNG exports in December 2021, while at the same time contributing to a domestic gas shortage that is driving up prices and harming consumers.

- In Brazil, the development of gas pipelines is expected to rapidly accelerate under its New Gas Law, which restructures the country's gas markets and infrastructure systems to promote development by actors besides state-owned Petrobras. Brazil has US$22.2 billion of gas pipelines in development, with 7,700 km proposed and 400 km under construction.

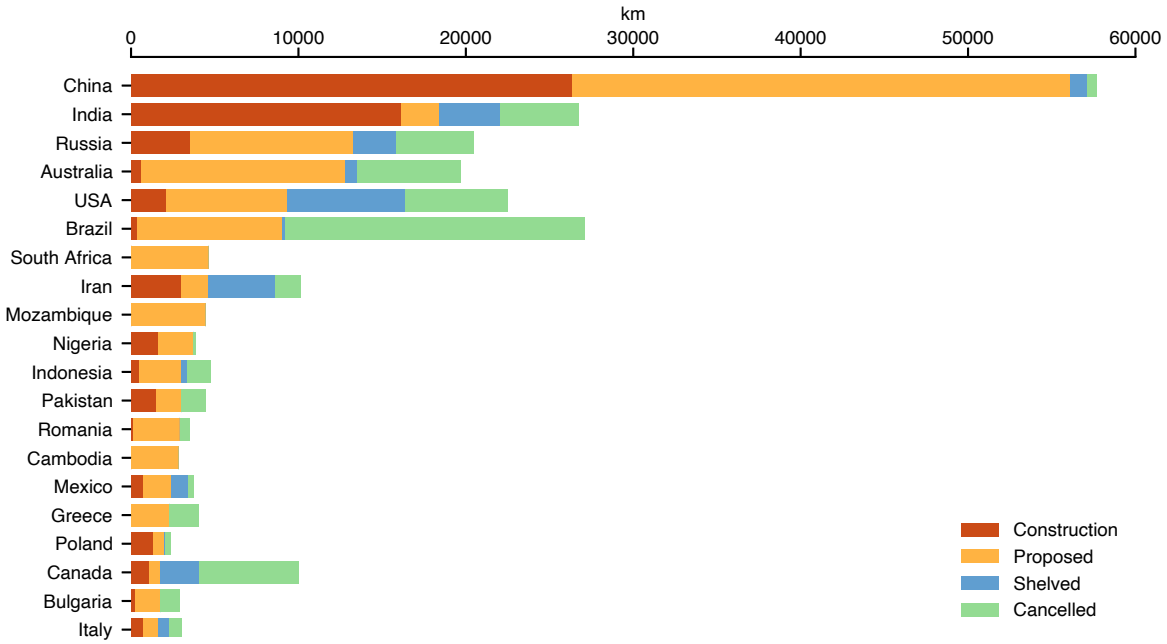
- While little headway has been made by commercial financiers to restrict or end their financing of gas pipelines, commitments made by 39 countries to end international public finance for fossil fuels—including gas—by the end of 2022 have provided momentum for reducing investments which drive pipeline development.

1.1 NATIONAL PIPELINE BUILDOUT

China, India, Russia, Australia, the U.S., and Brazil lead the globe in gas pipeline development, with China's planned pipeline length over three times that of the next largest country, India (Figure 1). The leading 20 countries are found across Asia, the Americas, Europe, Eurasia, and Africa, reinforcing the global nature of the gas pipeline expansion. According to Rystad, global gas and LNG investments will increase by 14% in 2022, global shale investments by 18%, offshore investments by 7%, and conventional onshore by 8%. Leading these trends are Australia (greenfield gas developments) and the Middle East, where the leading developers are Qatar and Saudi Arabia.

In GEM's database, China alone accounts for 30% of the planned kilometers of gas pipeline worldwide. The leading 6 countries constitute 61% of new global pipeline kilometers in development, and the top 20 countries make up 82%.

Figure 1. Kilometers of pipeline in the proposed, construction, shelved, and cancelled stages, showing the top 20 countries ranked by km of in-development (Proposed and Construction) pipeline.



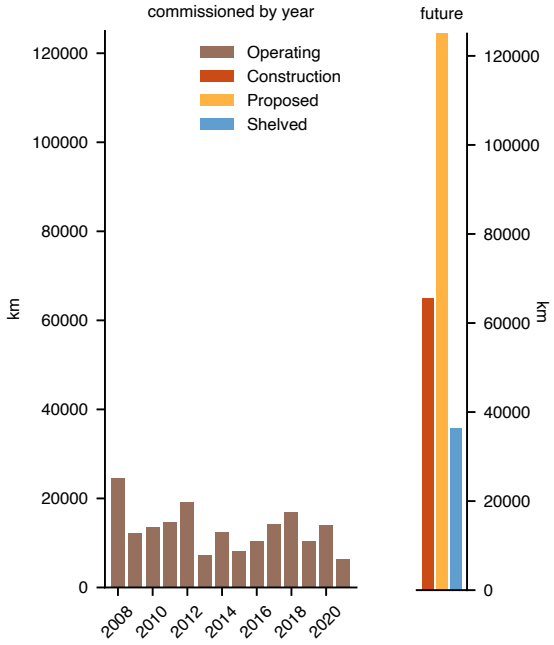
1.2 GLOBAL TRENDS IN GAS PIPELINE COMPLETION

Globally, 408 new gas pipelines are under construction or in pre-construction development, amounting to 193,400 km. In addition, 510 capacity expansions and upgrades to existing infrastructure are in construction or planned. The costs and potential stranded asset risks of these capacity expansions are not included in GEM's global figure of US$485.8 billion.

In 2021, pipeline commissionings as measured by length (Figure 2) fell to their lowest global level since 1996 as developers experienced a combination of Covid-related logistical delays, difficulties in obtaining financing, and increasing skepticism from the public about the merits of any new fossil fuel projects in the face of catastrophic climate change.

However, GEM's survey estimates that around 25,000 km of under-construction pipeline and an additional 3,900 km of proposed pipeline were intended for commissioning by 2021 but have been delayed. The gas industry therefore appears poised for a resurgence in 2022. After falling 6% in 2020, CO_2 emissions among the world's 20 richest nations rose by 4% despite the disruptions of the pandemic. Including delayed projects, GEM estimates as many as 36,800 km of pipeline already under construction, and an additional 7,800 km of proposed pipelines, are proposed by developers to become operational in 2022.

Figure 2. Left, km of operating gas pipelines built globally, from 2008 to present, summed according to the year they became operational. Right, km of possible future proposed, in-construction, and shelved pipelines globally.



1.3 STRANDED ASSET RISK

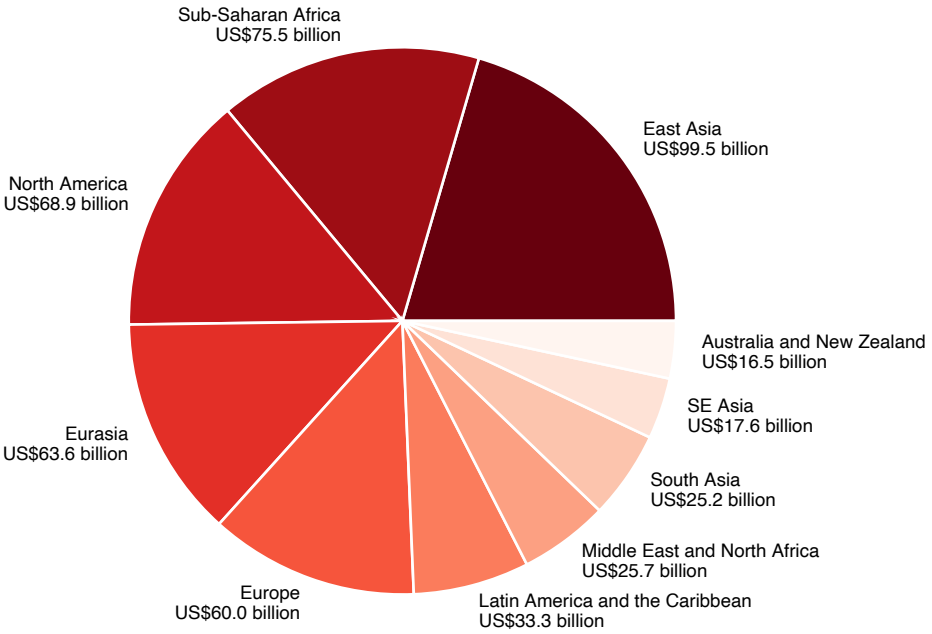
Building all pipelines in development worldwide would amount to an estimated capital expenditure of US$485.8 billion (Table 2 and Figure 3). Globally, about 36% of planned pipeline kilometers are already in the construction phase, and when complete this infrastructure will account for nearly 32% of this capital expenditure estimate.

With many major economies committing to net-zero goals by 2050 and drastic mid-term emissions decreases by 2030, and current trends of renewables getting cheaper, this infrastructure would be economically unfeasible far sooner than the approximately 50-year lifetime of a pipeline, and early forced retirement of such infrastructure risks hundreds of billions of USD in stranded assets. Many nations leading this global gas boom continue to explore and develop new gas fields, and these costs, along with the infrastructure required for new up-, mid-, and downstream gas processing, have a substantially larger footprint than pipeline infrastructure assets alone. Green hydrogen is touted by the gas industry as a possible way to upcycle pipeline infrastructure and in some cases used to justify gas pipeline proposals, though critics point to unresolved technical challenges such as pipeline embrittlement and leakage. Some have termed the promotion of hydrogen/methane blends "tech-crastination," a means by the gas industry of delaying the transition to more economical electrification of end uses, such as heating.

Table 1. Estimated capital expenditures for in-development pipelines (Proposed, Construction, and their sum), in billion USD. These are determined using regional cost estimates discussed in the online methodology.

Region	Proposed	Construction	In Development (Proposed + Construction)
East Asia	54.9	44.6	99.5
Sub-Saharan Africa	54.2	21.3	75.5
North America	48.9	20.0	68.9
Eurasia	45.3	18.3	63.6
Europe	44.2	15.8	60.0
Latin America and the Caribbean	31.8	1.5	33.3
Middle East and North Africa	12.9	12.8	25.7
South Asia	4.7	20.5	25.2
SE Asia	15.2	2.4	17.6
Australia and New Zealand	15.7	0.7	16.5
Total	**327.8**	**158.0**	**485.8**

Figure 3. Estimated capital expenditures for in-development pipelines (third column in Table 1).



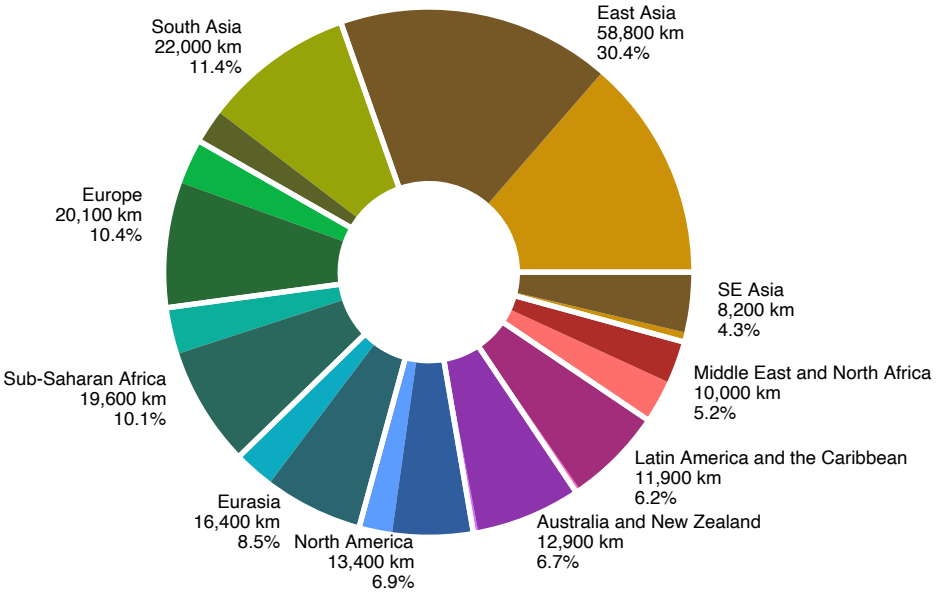
2.1 REGIONAL AND NATIONAL TRENDS, CAPITAL EXPENDITURES, OWNERSHIP

The proposed gas pipeline buildout in Asia is more than twice the size of that in any other region (Table 2; Figure 4). In addition, the likelihood that proposed pipelines ultimately make it to operational status within the intended construction timeframe is relatively high in Asia compared to the rest of the world, and in particular in China, given the relatively small fraction of pipelines in this region that are shelved or cancelled (Figure 1).

Table 2. Regional total km of pipeline in development worldwide, rounded to the nearest hundred km (same data as shown in Figure 3).

	Proposed	Construction	Proposed + Construction
East Asia	32,400	26,300	58,800
South Asia	4,100	17,900	22,000
Europe	14,800	5,300	20,100
Sub-Saharan Africa	14,000	5,500	19,600
Eurasia	11,700	4,700	16,400
North America	9,500	3,900	13,400
Australia and New Zealand	12,400	600	12,900
Latin America and the Caribbean	11,400	500	11,900
Middle East and North Africa	5,000	5,000	10,000
SE Asia	7,100	1,100	8,200
Total	**122,500**	**70,900**	**193,400**

Figure 4. Regional total km of pipeline proposed (darker colors) and in construction (lighter colors) worldwide, rounded to the nearest hundred km. Percents of global in-development pipeline km are included in figure text. See Table 1 for more information.



2.2 GAS PIPELINE OWNERSHIP

Globally, 250 companies are developing gas pipelines projects. The leading 20 (Table 3) are building 58% of planned gas pipelines worldwide, and this list underscores the global scope of the expansion. State-owned companies in Russia, China, India, and Nigeria are the largest players. Brazilian Petrobras's high ranking is not likely to remain, as the company is offloading existing and planned assets as major reforms to the nation's National Gas Law that took effect in January 2022. Mozambique's Empresa Nacional de Hidrocarbonetos is associated with extensive gas pipeline expansions for which construction has yet to begin, though there is doubt that Mozambique's planned natural gas expansion will ultimately come to fruition.

Table 3. Top 20 gas pipeline developers in the world, sorted by km of in-development pipeline (third column) rounded to the nearest hundred km.

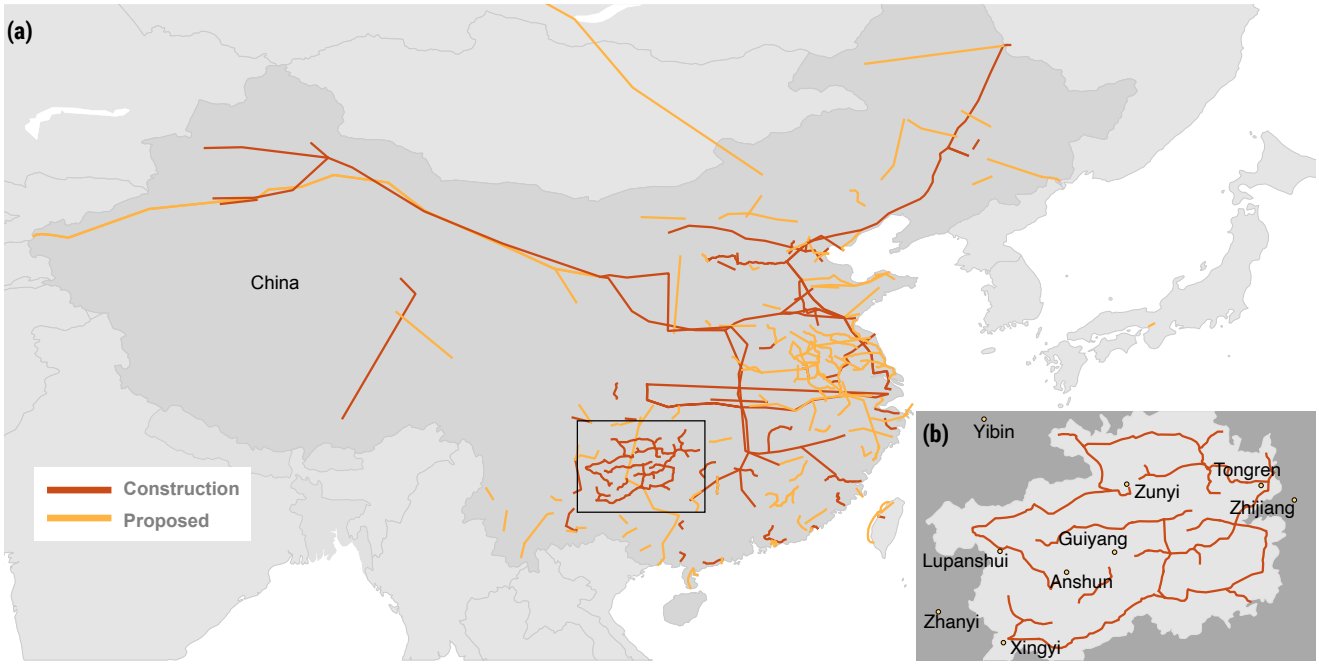
Parent Company	Proposed	Construction	In Development (Proposed + Construction)	Ownership	Country
Gazprom	12100	4000	16100	Private / State	Russia
PipeChina	8600	3900	12500	State	China
Sinopec	1600	8700	10300	State	China
GAIL (India) Limited	900	6900	7800	State	India
Nigerian National Petroleum Corporation	4300	1400	5700	State	Nigeria
China National Petroleum Corporation	900	3800	4700	State	China
Transnet	3900	0	3900	State	South Africa
Ministry of Petroleum of Iran	0	3800	3800	State	Iran
Guizhou Wujiang Energy Group Co., Ltd.	0	3100	3100	State	China
Moroccan National Board of Hydrocarbons and Mines	0	2800	2800	State	Morocco
Transgaz	2700	100	2800	State	Romania
Alaska Gasline Development Corporation	2800	0	2800	State	USA
Indian Oil Corporation Ltd.	200	2300	2500	State	India
Turkmengaz	300	2100	2400	State	Turkmenistan
Gujarat State Petronet	200	2100	2300	State	India
TC Energy	700	1500	2200	State	Canada
Empresa Nacional de Hidrocarbonetos de Mozambique	2000	0	2000	State	Mozambique
Gaz-System	600	1300	1900	State	Poland
Jiangsu Coastal Gas Pipeline Co., Ltd.	1900	0	1900	State	China
Petrobras	1200	400	1600	State	Brazil

Full Chinese character names for state-owned enterprises in China are: PipeChina, 国家石油天然气管网集团有限公司; Sinopec, 中国石油化工股份有限公司; CNPC, 中国石油天然气集团公司; Guizhou Wujiang Energy Group Co., Ltd., 贵州乌江能源集团有限责任公司; Jiangsu Coastal Gas Pipeline Co., Ltd., 江苏省沿海输气管道公司.

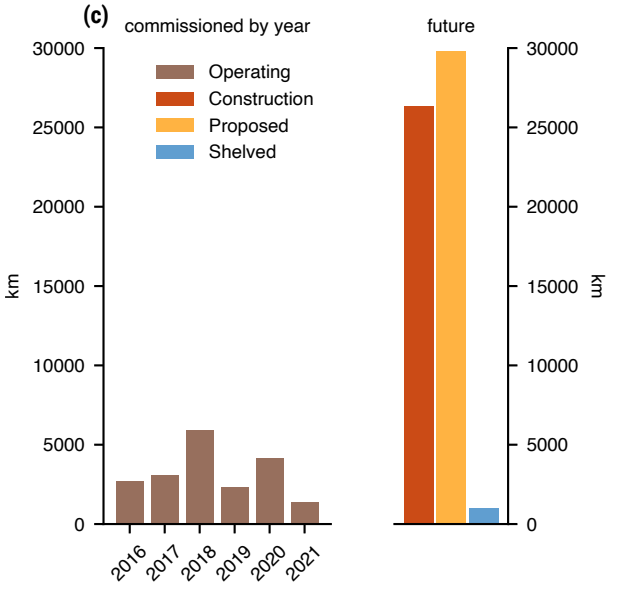
COUNTRY SUMMARIES

China

Figure 5. (a) Proposed (yellow) and in-construction (red) pipelines with routes that are located within China; black box shows outline for inset. (b) Enlarged view of Guizhou Province and its Guizhou Gas Pipeline Network, with major cities for reference. (c) Number of pipeline km by start year (brown bars) and pipeline km in development within China (in-construction in red, proposed in yellow, shelved in blue).



China leads the globe in gas pipeline development, with 26,300 km of major midstream pipelines in construction and an additional 29,800 km proposed (Figure 5a), amounting to a total stranded asset risk of US$89.1 billion. Analysts for S&P Global recently forecast slightly slower growth for Chinese gas infrastructure in 2022 due to high spot pricing, but gas remains a cornerstone of China's Five-Year plan for 2021–2025.



The rise of PipeChina

China is the world's largest natural gas importer via pipelines and LNG terminals, with imports comprising around 45% of its 2019 natural gas consumption, though it also holds substantial shale gas resources. In 2020 China's central government began collecting midstream gas infrastructure—pipelines,

LNG import terminals, and storage facilities—into the conglomerate PipeChina.

Before this consolidation, most of China's midstream gas assets were concentrated among three state-owned enterprises: CNPC (China National Petroleum Corporation), Sinopec (China Petroleum & Chemical Corporation), and CNOOC (China National Offshore Oil Corporation). The consolidation aims to improve what has been seen as a disjointed national pipeline network with insufficient interconnections, duplicated and inefficient transmission systems, and oligopolistic behavior, including blocking third-party pipeline access. PipeChina ranks second for in-development pipeline ownership among Chinese companies (Table 3), while Sinopec and CNPC are close behind. This allocation will continue to shift as PipeChina acquires more of these assets.

14th Five-Year Plans

China's 14th Five-Year Plan for 2021–2025 calls for a significant expansion in renewables but also large growth in gas and oil infrastructure, along with continued reliance on coal. This ongoing expansion of fossil fuel infrastructure is at odds with President Xi Jinping's stated goal of carbon neutrality by 2060; in order for such a target to be achieved, the country will need to have net-zero carbon emissions by 2050. President Xi also stated the country's intention to peak carbon emissions by 2030, though experts believe this would need to happen by 2025 for the country's Paris Agreement goals to be achieved. Much of China's planned gas expansion is contained within individual provinces' Five-Year Plans, designed to carry out national goals and bring gas to rural regions. See the planned gas pipeline infrastructure in Guizhou Province in Figure 5b as an example.

Chinese Covid-19 stimulus spending is also three times more concentrated in fossil fuel-intensive energy resources relative to low-carbon energy. Of the approximately US$2.95 trillion investment planned across eight provinces, US$317 billion has been allocated for fossil fuel projects, while spending on non-fossil energy—renewables, hydropower, and nuclear—totals about US$91.3 billion.

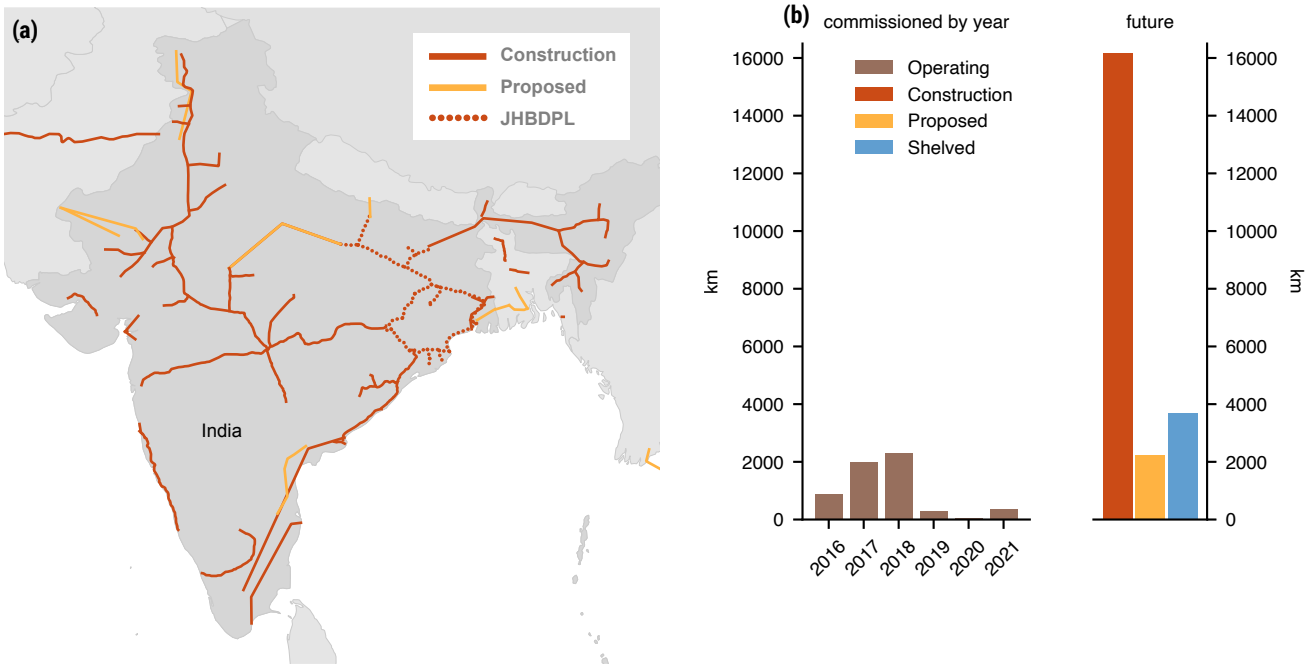
India

India ranks second globally in gas pipeline development, with 16,200 km of pipeline in construction—some of which is already operating within longer pipelines that are not fully complete—as well as 2,200 proposed km (Figure 6). Together this represents a stranded asset risk of US$14.7 billion.

Prime Minister Narendra Modi has stated India's goal is to increase the gas fraction from 6.7% to 15% of the country's energy mix by 2030. Currently, however, infrastructure is the primary constraint on national gas growth, and India is still largely focused on coal in the power sector. In the past two years, there has been a massive push to develop gas pipeline networks, with a goal of expanding from an existing 17,500 kilometers up to 34,500 kilometers over the next 4–5 years, as part of the "one nation, one gas grid" plan to integrate five existing regional gas grids.

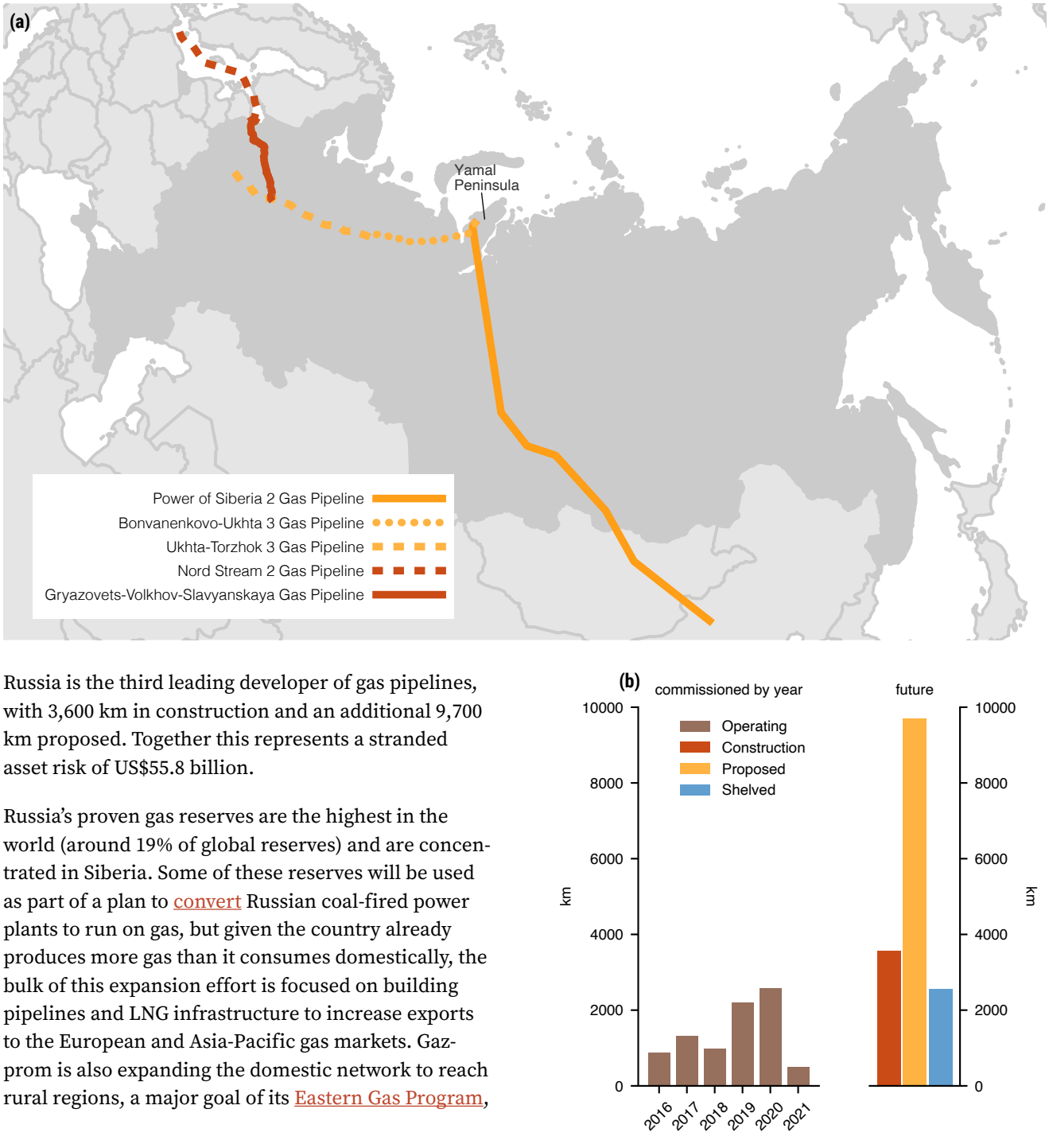
Two major transmission pipelines that are part of this national expansion include the 1000-km Kochi-Koottanad-Bangalore-Mangalore Gas Pipeline, of which 450 km have been commissioned, and the 3000-km Jagdispu–Haldia–Bokaro–Dhamra Pipeline (see dashed pipeline route in Figure 6a).

Figure 6. (a) In-construction (yellow) and proposed (red) gas pipelines in India; the Jagdispu–Haldia–Bokaro–Dhamra Pipeline (JHBDPL) is shown as a dashed line. (b) Number of pipeline km by start year (brown bars) and pipeline km in development within India (in-construction in red, proposed in yellow, shelved in blue).



Russia

Figure 7. (a) Major proposed and in-construction pipelines in Russia that, if built, would source gas from the Yamal Peninsula. (b) Number of pipeline km by start year (brown bars) and pipeline km in development within Russia (in-construction in red, proposed in yellow, shelved in blue).



Russia is the third leading developer of gas pipelines, with 3,600 km in construction and an additional 9,700 km proposed. Together this represents a stranded asset risk of US$55.8 billion.

Russia's proven gas reserves are the highest in the world (around 19% of global reserves) and are concentrated in Siberia. Some of these reserves will be used as part of a plan to convert Russian coal-fired power plants to run on gas, but given the country already produces more gas than it consumes domestically, the bulk of this expansion effort is focused on building pipelines and LNG infrastructure to increase exports to the European and Asia-Pacific gas markets. Gazprom is also expanding the domestic network to reach rural regions, a major goal of its Eastern Gas Program,

and to tap large gas resources in the Yamal Peninsula megaproject.

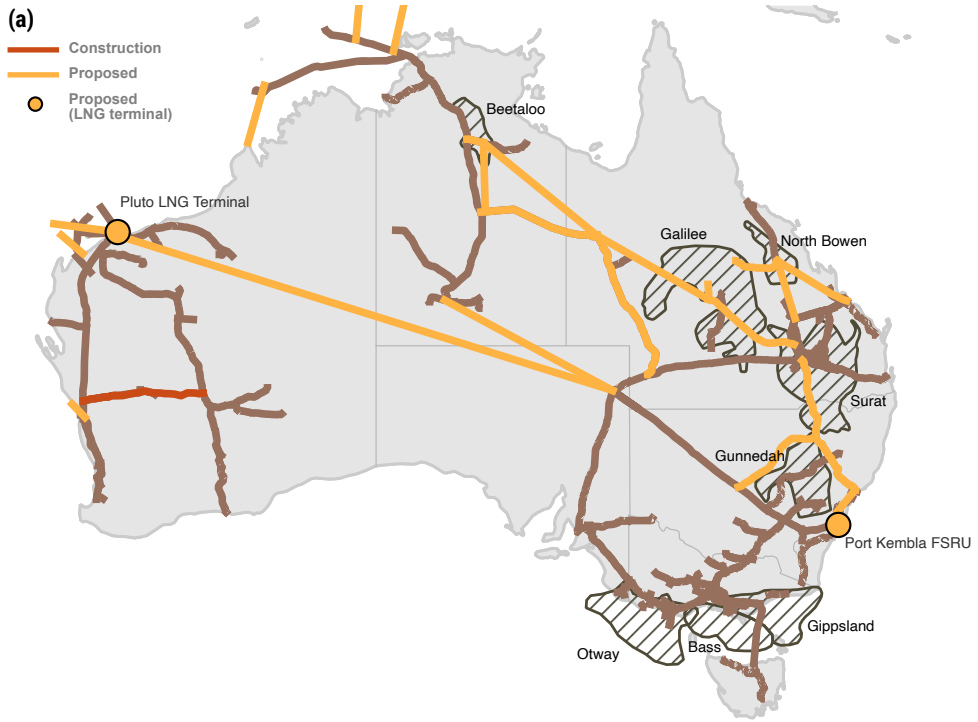
These aims drive the majority of planned expansion in Russia. Nord Stream 2 Gas Pipeline passes under the Baltic Sea and bypasses Ukraine, connecting Russia and Germany for export to European markets (especially Germany). The pipeline was nearly complete at the end of 2020 but has been stalled amidst diplomatic tensions between Russia, Germany, and the U.S. and the prospect of a Russia launching a military invasion of Ukraine. In January 2022, the U.S. Senate rejected the re-imposition of sanctions on the pipeline. GEM's complete list of Russian gas export pipelines under development is available here.

The Power of Siberia Gas Pipeline is already operating and will reach full capacity of 38 billion cubic meters per year (bcm/y) by 2025, and a 30-year contract with China implies it will have a major and long-term impact beyond net-zero commitments. The Power of Siberia 2 Gas Pipeline is proposed for export to China, with a planned capacity of 80 bcm/y. Additional pipeline infrastructure in western Siberia is intended for export to Europe, including the Ukhta–Torzhok 3 Gas Pipeline (paralleling the existing first and second Ukhta–Torzhok routes) and Bovanenkovo–Ukhta 3 Gas Pipeline (parallel to the first and second routes).

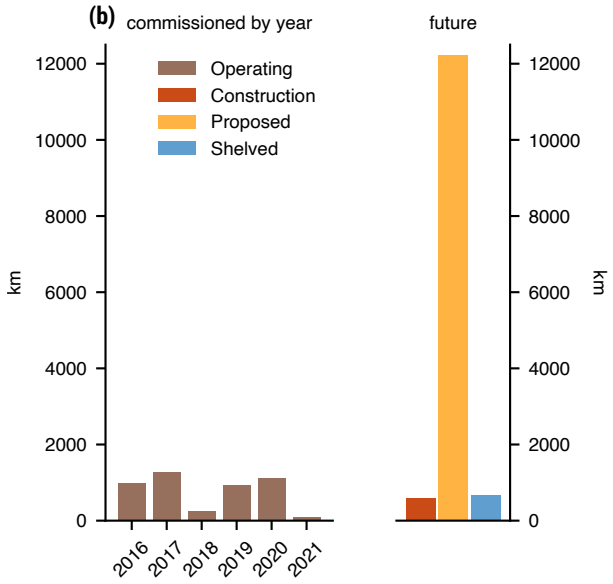
State-owned Gazprom, the leading pipeline developer among global companies, is known to be corrupt and non-transparent. For example, there is suspicion that some of the pipeline projects above rely on gas fields with hasty geological surveys and poor estimates of available gas resources. Reserves in Power of Siberia's major gas field sources, Chayandinskoye and eventually Kovyktinskoye gas fields, were reportedly overestimated. This miscalculation is thought to have driven a major change in the Power of Siberia 2 route, initially planned to feed into northwestern China but now crossing through Mongolia closer to where Power of Siberia enters China.

Australia

Figure 8. (a) Australia's existing pipeline network (brown), along with proposed (yellow) and in-construction (red) pipelines. Major gas basins mentioned in the Australian National Gas Infrastructure Plan (NGIP) are labelled, and the locations of two proposed LNG export terminals (Pluto LNG Terminal and Port Kembla FSRU) are shown. (b) Number of pipeline km by start year (brown bars) and pipeline km in development within Australia (in-construction in red, proposed in yellow, shelved in blue).



The fourth leading developer of gas pipelines, Australia has 600 km of pipeline in construction and a staggering 12,200 km proposed, amounting to an estimated stranded asset risk of US$18.6 billion. There are also substantial capacity expansions planned along the existing national network, largely part of a recent national plan to expand gas infrastructure in the country to meet rising domestic and export demands. This expansion highlights the Australian government's unbridled enthusiasm to encourage private-sector midstream gas development while failing to establish more stringent carbon mitigation goals within the next decade.



Gas-fired recovery and fossil-fuel holdout

Australia is a net exporter of fossil fuels and a holdout on coal among OECD nations, slow to commit to a 2050 net-zero pledge in a plan that still relies heavily

on coal and gas. Despite pressure, the government has refused to strengthen its near-term emissions commitments by 2030, currently a 26–28% reduction relative to 2005, the lowest among wealthy G20 nations. This directly serves the "gas-fired recovery" announced in 2020 that will drive major gas infrastructure expansion in the next decade (Figure 8). The government has already committed AUD$38.7 million to support critical gas infrastructure projects during 2021–2022, plus tens of millions more to complement them.

2021 National Gas Infrastructure Plan and east-coast gas expansion

The gas-fired recovery's National Gas Infrastructure Plan (NGIP) focuses on the east coast gas market and domestic supply, outlining priorities to avoid forecasted gas shortages in the mid-2020s and longer-term recommendations for expanding the gas market through 2040. If even some of these plans come to fruition, Australia would be locking in decades of natural gas production that are in direct conflict with its net-zero goals.

Prioritize southern basins The NGIP's first recommendation is to prioritize new production, primarily in the southern Otway, Bass, and Gippsland Basins, with new gas supplies coming online by 2025. In addition, the Narrabri Gas Project is a major proposed development in the Gunnedah basin, and the NGIP suggests a pipeline that connects this resource to the east coast market. These options include the 461-km Western Slopes Pipeline and the 820-km Queensland Hunter Gas Pipeline, with a NGIP recommendation for being in service by 2028. The plan also mentions at least five proposed LNG import terminals in Victoria and New South Wales that would add additional supply to the east coast, with the Port Kembla FSRU being the most advanced and scheduled to become operational in 2022.

Expand northern gas production Another new resource is the Beetaloo Sub-basin in the Northern Territory. Exploration is underway, and the NGIP has created small- and large-scale development pathways based on how large the gas reserves turn out to be.

- The small-scale development pathway would require that Beetaloo volumes be commercialized by 2025 via one of three possible routes for a new Beetaloo Lateral Pipeline. This pipeline would carry gas from the Beetaloo Sub-basin to either the Amadeus Gas Pipeline, the Northern Gas Pipeline, or directly to Mount Isa to connect with the Carpentaria Gas Pipeline. This small-scale expansion would require one of these connected pipelines to undergo capacity expansions by 2025.

- The large-scale development pathway would need to come online by 2028 and includes several major capacity expansion and pipeline twinning projects, as well as a major extension to the Northern Gas Pipeline and the building of the Galilee Gas Pipeline.

Explore and develop South Galilee and North Bowen Basins To develop resources in these basins, the NGIP suggests several potential routes: the Galilee to Moranbah Gas Pipeline, the Blue Energy Bowen Gas Pipeline, and the Arrow Bowen Pipeline. The plan recommends the route that gets built is commissioned by 2028, and this would also require major capacity expansions for existing connected pipelines.

West coast gas expansion

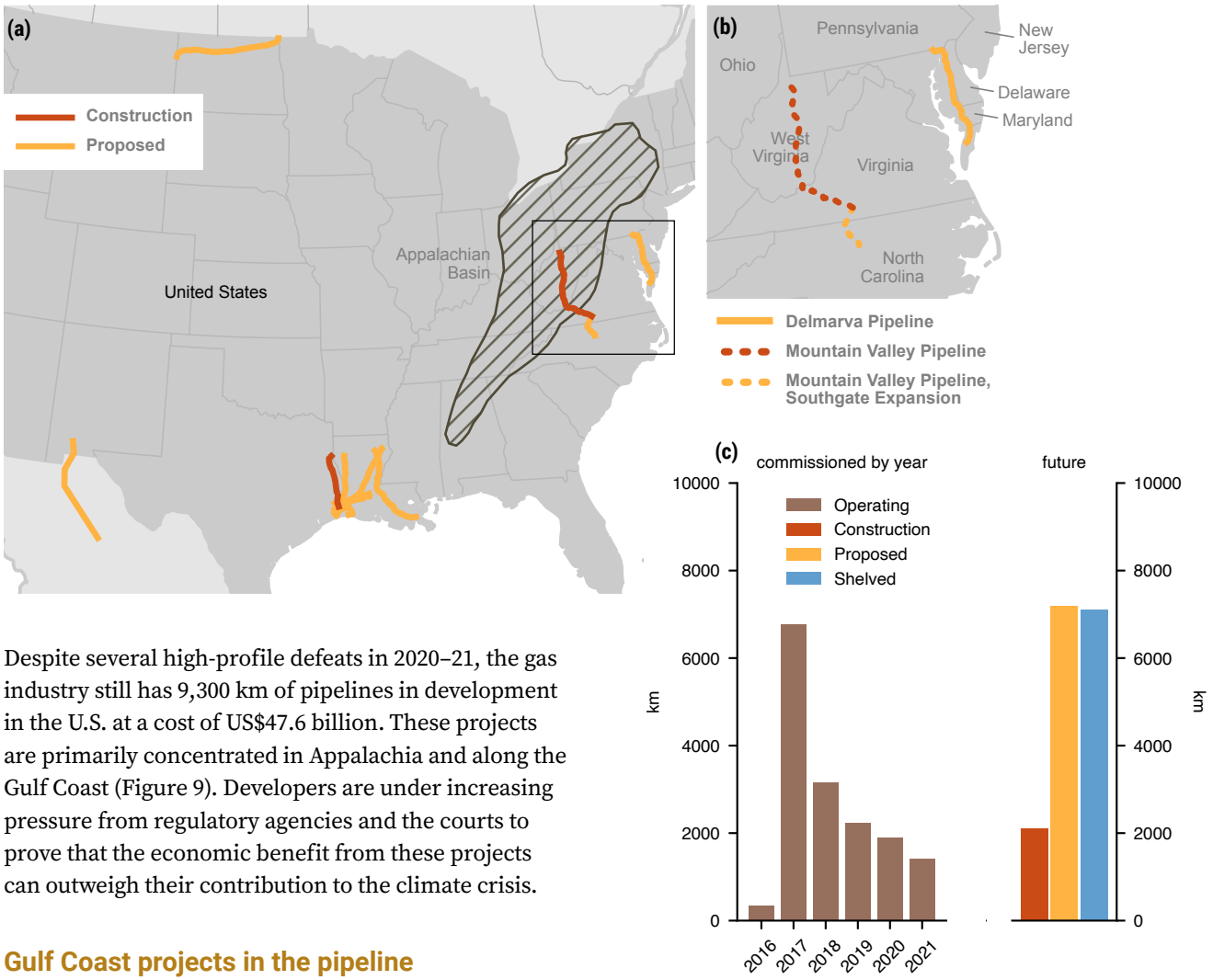
While the NGIP focuses on the east coast gas market, Western Australia (WA) is also rapidly expanding gas infrastructure. One major project, a US$5.6-billion expansion to Woodside's Pluto LNG Terminal, typifies the risk of stranded assets in the western market. The

Pluto terminal sources gas from the offshore Scarborough and North Scarborough gas fields and is currently operating one export train. It recently received a final investment decision for a second train that will expand its gas production tenfold. Importantly, this expansion would connect to the Dampier to Bunbury Natural Gas Pipeline, opening up the gas supply to the WA gas market.

The project hasn't been without opposition, however. Woodside's application for the expansion claimed it was consistent with a 1.5°C goal, but analysis by Climate Analytics argues this is unjustified, finding Woodside grossly underestimated the project's lifecycle emissions, supporting a previous assessment by the WA Conservation Council that concluded the same. The project's profitability is also highly uncertain, given the terminal is constructed to export LNG to the Asia-Pacific for decades into the future as importing countries will inevitably begin to transition their energy systems in accordance with net-zero commitments. Two challenges have been made by environmental groups against Woodside in WA's Supreme Court, asserting the state did not properly consider the environmental impacts of the project before approving it. Pressure is also building on major Australian banks that are financing it.

United States

Figure 9. (a) Map of the U.S. showing a subset of major planned pipelines (proposed in yellow, in-construction in red); an approximate outline of the Appalachian Basin is included for reference. (b) Several major proposed and in-construction pipelines along the Appalachian Basin and in Maryland. (c) Number of pipeline km by start year (brown bars) and pipeline km in development within the U.S. (in-construction in red, proposed in yellow, shelved in blue).



Despite several high-profile defeats in 2020–21, the gas industry still has 9,300 km of pipelines in development in the U.S. at a cost of US$47.6 billion. These projects are primarily concentrated in Appalachia and along the Gulf Coast (Figure 9). Developers are under increasing pressure from regulatory agencies and the courts to prove that the economic benefit from these projects can outweigh their contribution to the climate crisis.

Gulf Coast projects in the pipeline

The U.S. Gulf Coast is experiencing a major gas infrastructure boom that includes over 20 LNG terminal projects and over 2,200 km of proposed or in-construction pipeline. The pipelines in construction or proposed are listed in Table 4, with associated operating or in-development LNG export terminals where relevant.

In the Appalachian Basin, gas pipelines are being constructed to tap fracked gas resources (Figure 9b), including the Mountain Valley Gas Pipeline and its Southgate Expansion, though the project has experienced multiple recent court setbacks and continued opposition. The Delmarva Pipeline, proposed to run along the entire eastern shore of Maryland, has also been opposed by local groups but received water-crossing permits in early 2021 from the state. These approvals don't always guarantee

Table 4. Pipelines in development along the U.S. Gulf Coast, with associated LNG export infrastructure included where relevant. Pipeline capacity units are in million cubic feet per day (MMcf/d); length is rounded to the nearest whole km.

Pipeline	Status	Capacity	Length	Associated LNG export terminal	Terminal status
Columbia Gas Transmission Louisiana XPress Expansion Project	Construction	493 MMcf/d	Capacity expansion only	Sabine Pass LNG Terminal	Operating, expansion under construction
Corpus Christi Pipeline Expansion Project	Construction	1530 MMcf/d	34 km	Corpus Christi LNG Terminal	Operating, expansion under construction
Gemini Gulf Coast Pipeline	Construction	1500 MMcf/d	241 km	—	—
Golden Pass Gas Pipeline	Construction	2500 MMcf/d	111 km	Golden Pass LNG Terminal	Construction
Gulf Run Pipeline	Construction	1650 MMcf/d	216 km		
TransCameron Pipeline	Construction	1900 MMcf/d	39 km	Calcasieu Pass LNG Terminal	Construction
Commonwealth LNG Pipeline	Proposed	1440 MMcf/d		Commonwealth LNG Terminal	Proposed
CP Express Pipeline	Proposed	4000 MMcf/d	5 km	CP2 LNG Terminal	Proposed
Delfin Offshore Pipeline	Proposed	1500 MMcf/d	147 km	Delfin LNG Terminal	Proposed
Delta Express Pipeline	Proposed	2050 MMcf/d	48 km	Delta LNG Terminal	Proposed
Driftwood LNG Pipeline	Proposed	3500 MMcf/d	459 km	Driftwood LNG Terminal	Proposed
Driftwood LNG Pipeline Line 200 Expansion	Proposed	2400 MMcf/d	154 km		
Driftwood LNG Pipeline Line 300 Expansion	Proposed	4600 MMcf/d	60 km		
Freeport LNG Terminal Pipeline	Proposed	740 MMcf/d	48 km	Freeport LNG Terminal	Partially operating, expansion proposed
Gator Express Gas Pipeline	Proposed	1970 MMcf/d	17 km	Plaquemines LNG Terminal	Proposed
Evangeline Pass Gas Pipeline	Proposed	1000 MMcf/d	43 km		
Lake Charles LNG Pipeline	Proposed	3100 MMcf/d	21 km	Lake Charles LNG Terminal	Proposed
Leidy South Pipeline	Proposed	580 MMcf/d	29 km	Cove Point LNG Terminal	Operating
Magnolia Gas Pipeline	Proposed	1362 MMcf/d	20 km	Magnolia LNG Terminal	Proposed
Port Arthur Gas Pipeline	Proposed	2000 MMcf/d	2 km	Port Arthur LNG Terminal	Proposed
Rio Bravo Gas Pipeline	Proposed	4500 MMcf/d	266 km	Rio Grande LNG Terminal	Proposed
West Delta LNG Pipeline	Proposed	900 MMcf/d	220 km	West Delta LNG Terminal	Proposed
Total			**2212 km**		

the infrastructure will ultimately be built or commissioned, however, as environmental groups are mounting increasingly sophisticated legal challenges against them.

FERC and gas pipelines

The Federal Energy Regulatory Commission (FERC) long served as a rubber stamp for oil and gas pipelines in the U.S., rejecting just two out of 400 such projects between 1999–2017. Beginning in 2016, however, an Obama administration rule required FERC to consider a pipeline's greenhouse gas (GHG) emissions in the permitting process and decide whether each project could be justified in light of its impact on the environment. This GHG provision was not strictly applied to projects during the Trump administration. In December 2021, however, the appointment of Biden nominee Willie L. Phillips to FERC gave Democrats a 3–2 a majority, which may now give the committee the voting power to reject pipelines on the grounds that their economic benefits do not outweigh their contribution to the climate crisis.

More broadly, FERC's pipeline approval frequency has decreased as its approach to GHG emissions becomes

more circumspect. In the first half of 2021, the commission approved 14 gas pipeline projects, half as many as the same window in 2020. On May 27, 2021, the commission delayed the approval of five pipeline projects to complete an environmental impact statement (EIS) for each project assessing its climate change impact. Unfortunately, every EIS completed so far (in October and November 2021) has stated that "FERC staff continues to be unable to determine significance with regards to climate change impacts." So while approvals may be delayed, the outcomes are unlikely to be meaningfully different unless the agency changes its methodology. A straightforward approach would be the simple recognition that any additional contribution to national GHG emissions will lead the U.S. to contribute to overshooting the 1.5°C goal, according to the IEA, and any new emissions are therefore "significant." Or as stated by Oil Change International in a 2016 report, "no new fossil fuel extraction or transportation infrastructure should be built, and governments should grant no new permits for them," as continued construction would likely "commit the world to exceeding 2°C of warming."

Furthermore, according to Jennifer Danis, a senior fellow at Columbia University's Sabin Center for Climate Change Law, "Part of FERC's objective should be to counteract persistent narratives that new gas supply is necessary for the energy transition in the absence of long-duration battery storage, and instead focus on using existing capacity in a better way." Another issue with measuring GHG emissions is tracking the full extent of emissions created by the extraction, shipping, and burning of gas that a pipeline will carry. In October 2021, the sponsors of the Mountain Valley Pipeline asked FERC to consider only the pipeline's operational emissions, not those caused by drilling, storage, and transportation.

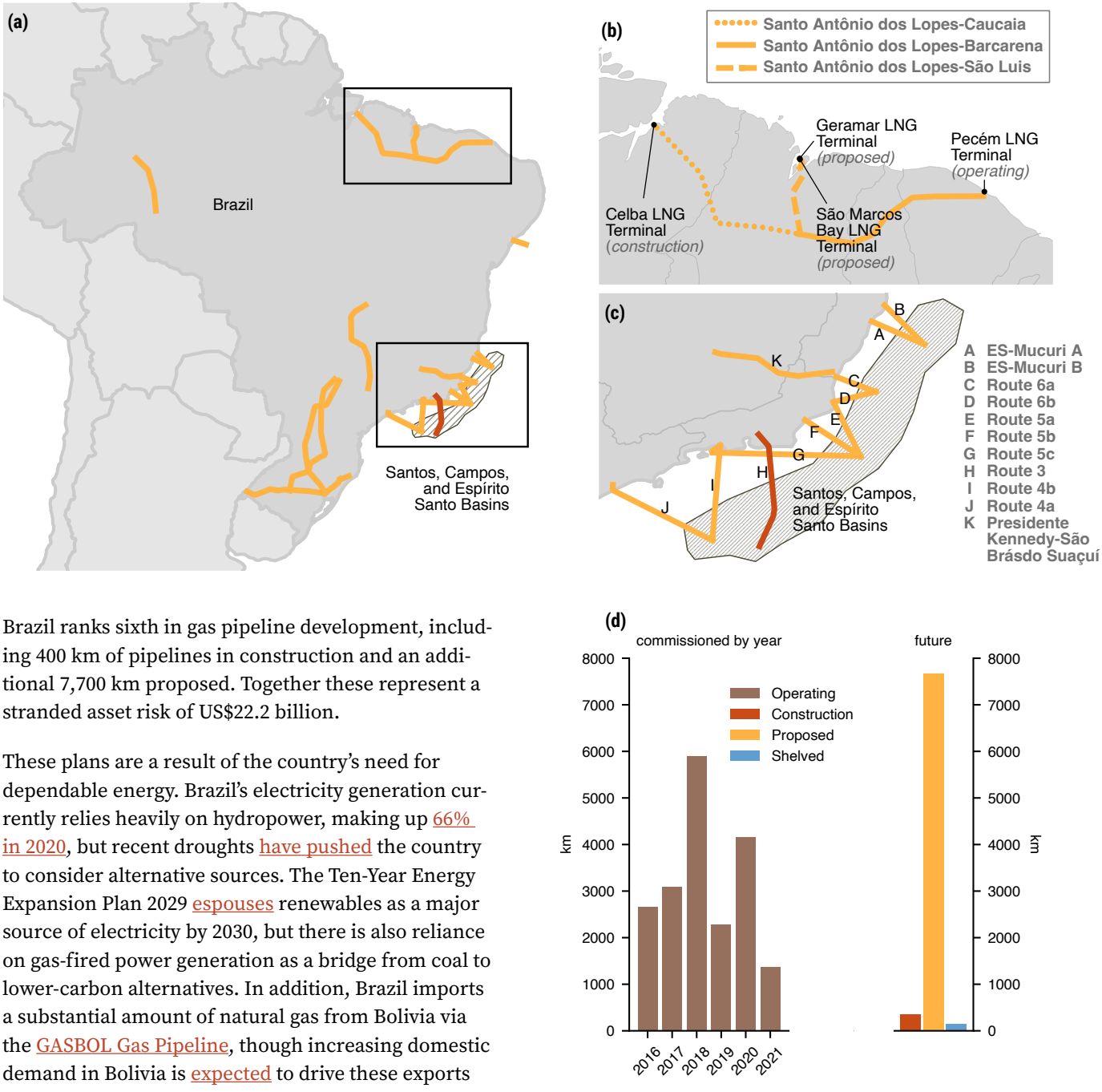
Challenges to FERC's environmental review process are being made with regard to other aspects of the process. The environmental group Healthy Gulf is arguing that FERC must consider not only the environmental implications of the immediate project under consideration, but also "all of the many projects that will be constructed and associated with the project." Healthy Gulf's complaints focus on the CP2 LNG Terminal and CP Express Pipeline, which are likely to be followed by other projects that often arise to serve these facilities but are not captured in FERC's analysis of the original projects. So far, FERC has refused to engage in such programmatic environmental impact statements.

Abundant gas for exports, but domestic shortages

Recent increases in U.S. fracked gas prices have led to 30% higher price forecasts during winter 2022. The primary driver of this is diminished domestic supply due to increased gas exports, primarily from the build-out of gas infrastructure along the U.S. Gulf Coast. Given an ongoing Gulf Coast gas boom, this impact on gas prices is likely to repeat itself, and environmentalists and consumer advocates argue the Biden administration has a legal responsibility to approve only proposed projects that are in the public interest, including meeting the administration's climate goals and environmental justice commitments, and keeping gas prices lower. Most recently, Sen. Angus King (I) of Maine announced plans to introduce the Natural Consumer Gas Protection Act, legislation that would require the Department of Energy to consider the effect of any natural gas project on domestic prices, employment, regional impacts, and industrial competitiveness prior to approving it. While King's platform is not driven by ending fossil fuel reliance, the end result dovetails with environmental groups hoping to end Gulf Coast LNG infrastructure expansion and amounts to a criticism of the priorities of the U.S. energy industry. Other projects proposed for increased natural gas export may also be vulnerable to such criticism, including the proposed Paso Norte Pipeline to Mexico and Tioga to Emerson Pipeline to Canada.

Brazil

Figure 10. (a) Proposed (yellow) and in-construction (red) gas pipelines in Brazil, with an approximate location of offshore gas basins along Brazil's east coast. (b) Enlarged view of northeast Brazil, including in-development LNG terminals. (c) Enlarged view of Eastern Brazil, where offshore pipelines are proposed to source gas from offshore Basins. (d) Number of pipeline km by start year (brown bars) and pipeline km in development within Brazil. (in-construction in red, proposed in yellow, shelved in blue).



Brazil ranks sixth in gas pipeline development, including 400 km of pipelines in construction and an additional 7,700 km proposed. Together these represent a stranded asset risk of US$22.2 billion.

These plans are a result of the country's need for dependable energy. Brazil's electricity generation currently relies heavily on hydropower, making up 66% in 2020, but recent droughts have pushed the country to consider alternative sources. The Ten-Year Energy Expansion Plan 2029 espouses renewables as a major source of electricity by 2030, but there is also reliance on gas-fired power generation as a bridge from coal to lower-carbon alternatives. In addition, Brazil imports a substantial amount of natural gas from Bolivia via the GASBOL Gas Pipeline, though increasing domestic demand in Bolivia is expected to drive these exports down in the coming years.

Proposed infrastructure

Brazil's natural gas market is set to expand rapidly. The New Gas law mandates construction of 8 GW of new gas plants, many of which would be built inland and supplied with gas through new pipelines. Many in-development pipelines are in the southern part of the country (Figure 10a,c), intended to increase the infrastructure around Brazil's oil- and gas-rich Santos, Campos, and Espírito Santo Basins off the Atlantic coast (Figure 10c), terminating at coastal facilities and supplying new gas plants in the region. The gas resources in these basins are buried nearly 3 km deep under layers of rock and salt, and developing and extracting these "pre-salt" oil and gas layers is expensive. Other challenges to developing the pre-salt fields include the fact that 30% of them may be too far from the coast to be economically feasible, and gas from the fields is rich in both carbon dioxide and methane and will contribute significantly to Brazil's overall GHG emissions. These factors have not deterred investors, however, given successful auctioning of some of the 11 total blocks on permanent offer in late 2021. Unlocking these deepwater oil and gas resources contradict Brazil's recent commitment to net-zero by 2050, and fossil fuel companies rely on unproven technological innovation and CCS to decrease emissions from oil and gas extraction, rather than keeping fossil fuels locked offshore.

Various other pipelines are proposed. The Uruguaiana-Porto Alegre Gas Pipeline could import Argentine gas and connect to the Vaca Muerte-Brazil Gas Pipeline, but the cost of these projects, plus competition from LNG imports and domestic production, make them unlikely. Additional north–south routes would bring gas south from the GASBOL Gas Pipeline, including the Bilac-Santa Maria Gas Pipeline and Penápolis-Canoas Gas Pipeline.

In the northeast (Figure 10b), proposed pipelines add transmission capacity to Maranhão and Pará states, connecting the GASFOR Gas Pipeline and Pecém LNG Terminal to regions to the west, including the under-construction Celba LNG Terminal and possibly two early-stage proposed terminals, the Geramar LNG Terminal and São Marcos Bay LNG Terminal. This region is a climate change and deforestation hotspot yet is rich in wind resources and accounts for the majority of Brazil's wind farms. A major gas pipeline buildout here is therefore vulnerable to criticism over climate and environmental impacts and local cost comparisons to renewables.

New Gas Law

Until recently, the Brazilian natural gas market has been highly vertically integrated, controlled primarily by the state-owned Petrobras. In March 2021, the government approved the New Gas Law intended to increase competition in the natural gas industry. This represents a major restructuring of federal law for natural gas and formally came into effect in January 2022. Four major changes include:

- **"Unbundling" market control,** meaning gas network operators cannot be controlled by companies with stakes in other aspects of the gas value chain, including exploration, production, importing, and commercialization. Brazil's gas market has historically been vertically integrated, with state-owned Petrobras one of the largest players. Because of debt and the requirements of the New Gas Law, Petrobras has been selling off assets in recent years and will continue to.
- **Open access to infrastructure,** which will allow natural gas market participants to access "essential facilities" (pipelines, processing plants, LNG terminals, underground storage facilities).
- An easier **entry–exit transmission reservation system** and **more capacity and pricing transparency** provided by operators to market participants.

The National Agency of Petroleum, Natural Gas and Biofuels (ANP) will regulate and control the new gas market and is tasked with implementing anti-competitive policies, though concerns remain over how effective this will be. For example, a pending sale of Petrobras' subsidiary Gaspetro to Compass threatens vertical integration, and the ANP has recommended

that Brazil's antitrust agency reject the acquisition, though a decision has yet to be made. Allowing this sale risks simply transferring monopolistic power from Petrobras to other companies. Tensions also exist between federal and state power. In September 2021, ANP blocked São Paulo Sao Paulo from regulating a gas network.

RESTRICTIONS ON MIDSTREAM GAS FINANCING ARE ON THE WAY

The glacial shift away from financing new gas projects showed signs of accelerating in the EU in 2021 as French bank La Banque Postale and the Dutch pension fund ABP introduced ambitious policies comprehensively ending their support for the gas industry as a whole. In the case of La Banque Postale, it became the world's first significant commercial bank to commit to fully ending financial services to the oil and gas industry by 2030, with its policy including an immediate suspension of financial services to companies engaged in oil and gas expansion. ABP will, by the beginning of 2023, phase out all of its investments in companies which derive more than one percent of their revenues from activities in the coal, oil and gas sectors.

Rather than enhancing their climate action with tangible finance restrictions reaching across the oil and gas sectors as a whole, as has been progressively achieved with coal over the last five years, major banks are for now congregating around the Net-Zero Banking Alliance whereby they are committing to reduce the greenhouse gas emissions linked to their lending and investment portfolios to net-zero by 2050. This is being viewed by many as a banking sector holding pattern on fossil fuels. 'Net-Zero' banks can continue to finance oil and gas even as the Net-Zero Emissions scenario of the International Energy Agency—traditionally a guiding influence for investment decisions in the energy sector—insists on no new expansion of the sector if global warming is to be kept below the 1.5°C threshold set by the Paris Agreement.

Pressure on banks to take more concrete steps to rein in their short- to medium-term oil and gas financing is mounting, though, from investors. At the same time, banking regulators around the world are expected to begin moving forward with stress tests to determine banks' exposures, via their fossil fuel financing, to climate change. The American Petroleum Institute has made clear its opposition to the U.S. Federal Reserve's potential stress testing of U.S. banks which continue to finance oil and gas.

Momentum to reduce financing for oil and gas has been stepped up at the country level. At COP26 in Glasgow, 39 countries committed to ending international public finance for unabated coal, oil, and gas by the end of 2022, and instead will prioritise clean energy finance. The precise details of what this will mean for state financing of gas pipelines are still to emerge but the expectation is that these commitments should result in at least US$24 billion per year drying up for fossil fuels, which will have implications for disincentivizing private sector financing of midstream gas.

CONCLUSION

The world is at an inflection point, where it can hasten the transition to renewables or further entrench itself in fossil fuels. It is choosing the latter, with 194,400 km of new gas pipelines in development representing an expenditure of US$485.8 billion on assets counterproductive to the 1.5°C Paris goal and a green transition. The scale and lifetime of this intended expansion stands in misguided defiance of the IEA's net-zero pathway, which stresses no new investment in fossil fuel supply projects.