Global Energy Monitor

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Coal-to-gas switching threatens energy, security, and global climate goals

The global shift away from coal risks becoming a long-term shift toward gas, according to data from Global Energy Monitor, which show that approximately 89.6 gigawatts (GW) of gas plants in development,[1] totalling 5,070 million tonnes CO_2e lifetime emissions if built, are coal-to-gas conversions or replacements. The economic case for leapfrogging gas and switching to renewables is supported by the increased volatility of gas prices and the tightening supply of imported gas to Asian countries, as well as the rapidly declining costs of renewables and battery storage. Any reductions in CO_2 emissions from cancelling coal plants could be offset by an increase in methane emissions, a more potent greenhouse gas. These gas projects will undermine countries' climate commitments and the successful work of activists to gradually shut down the coal plant pipeline.

Expanding gas-fired capacity poses the risk that plants built now could lock in gas use for decades. Mitigating the worst impacts of the climate crisis and meeting global climate goals depends on transitioning to renewables without any new investment in fossil fuel infrastructure.

Highlights:

- Based on the August 2022 update of GEM's Global Gas Plant Tracker, approximately 89.6 GW, or 13%, of the 692.5 GW of global gas-fired capacity in development are coal-to-gas conversions or replacements. The regions with the largest in-development coal-to-gas conversions or replacements are East Asia, Europe, and North America.

- Building all of the in-development coal-to-gas conversions or replacements in the world would result in 5,070 million tonnes of CO_2e lifetime emissions. [Table 1]

- East Asia has the most coal-to-gas conversions or replacements in development, 29.6 GW, which would produce 1,843 CO2e lifetime emissions. Leading countries in the region are South Korea with 12.7 GW and Taiwan with 11.3 GW.

- Europe has 19.7 GW of coal-to-gas conversions or replacements in development, representing approximately 29% of the region's 68 GW gas-fired capacity, which would produce 972.1 CO2e lifetime emissions. Leading countries in the region are Poland with 5.4 GW and Germany with 4.1 GW.

- North America has 18.6 GW of coal-to-gas conversions or replacements in development, representing approximately 44% of the region's 42.6 GW gas-fired capacity in development. The United States has 16.8 GW and Canada has 1.8 GW.

1. In development includes announced, pre-construction, and in-construction gas-fired projects.

- There is a planned US$797.4 billion expansion of gas infrastructure underway in the regions of North America (US$389.2 billion), Europe/EU (US$135.4 billion), and East Asia (US$262.8 billion), representing an enormous potential stranded asset risk. [Table 2]

- The EU is the region with the most delays or cancellations of coal-to-gas conversions, totalling 3,480 MW of coal-to-gas project cancellations and 1,346 MW of coal-to-gas shelved projects in 2022.

- Global Methane Pledge signatories South Korea, the United States, and Germany are paradoxically leaders in the coal-to-gas conversion movement.

- The rapidly declining cost of renewables and battery storage, combined with the increased volatility of gas prices, has made the coal to clean energy switch more attractive. Accelerating the transition to renewables reinforces energy security by reducing reliance on gas imports. Continued investment in fossil fuels will expose regions to economic and geopolitical risks, including volatile gas prices and supply instability.

- Continuing to invest in fossil fuel infrastructure represents a stranded asset risk as the global energy transition unfolds, since these investments will need to be retired early if governments move to reduce gas capacity to meet a net-zero pathway, and increasingly competitive renewables will cause much of the gas capacity currently in development to be underutilized.

Table 1: In-development coal-to-gas conversions/replacements lifetime CO_2 equivalent emissions (million tonnes)

Region	Announced	Pre-construction	Construction	In Development (Announced + Pre-construction + Construction)
East Asia	816.8	439.3	587.4	1,843.5
European Union	250.4	492.6	229.1	972.1
North America	372.1	206.7	238.5	817.3
SE Asia	414.5			414.5
Eurasia	196.7	122.4	55.5	374.6
South Asia	257.2			257.2
Europe[2, 3]	18.8	185.1		203.9
Middle East & North Africa			116.4	116.4
Latin America and the Caribbean	34.9			34.9
Africa (sub-Saharan)	35.8			35.8
Australia/New Zealand				
Total	**2,397**	**1,446**	**1,227**	**5,070**

Source: Global Energy Monitor. See CO2 emissions methodology for details.

2. The Europe region includes: Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Isle of Man, Italy, Latvia, Lithuania, Malta, Moldova, Netherlands, North Macedonia, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Ukraine, and the United Kingdom.
3. Coal-to-gas conversions or replacements are occurring only in North Macedonia, Serba, Ukraine, and the United Kingdom.

Table 2: Estimated investment for Planned Gas Infrastructure in Select Regions (US$ Billions)

	Gas plants		Pipelines		Terminals		
Region	Proposed	Construction	Proposed	Construction	Proposed	Construction	Total
Europe/EU	53.7	9.7	36.3	5.9	26.3	3.6	**135.4**
East Asia	62.4	34.8	45.7	38.7	50.0	31.3	**262.8**
North America	24.2	14.1	55.1	10.5	256.9	28.3	**389.2**

Source: Global Energy Monitor. Estimates[4, 5] are based on global and regional average capital expenditures for building new gas infrastructure, and may diverge from projected costs at the project level.

Background

According to the IEA's 1.5°C net-zero pathway, in order to reach net zero emissions by 2050, unabated gas-fired generation must peak by 2030 and be 90% lower by 2040, compared to 2020 levels. Recent findings from TransitionZero show that, in certain regions, it is now cheaper to switch from coal to clean energy compared to switching from coal to gas. [Table 3, Table 4] However, GEM's data demonstrate that many countries are continuing to invest in new gas development. Continued investment in fossil fuels will expose regions to economic and geopolitical risks, including volatile gas prices and supply instability.

Gas has been touted as a "bridge fuel" to transition from coal to renewables, since burning gas has about a 50% lower carbon intensity than burning coal. However, these CO2 emissions do not account for methane leakage[6] in gas production and transportation, which can account for up to 9% of gas produced, according to a recent study. Methane, the main component in gas, has a warming impact that is 84 times greater than CO2 over a 20-year period. If methane leaks are more than 3% of its methane content, generating power with gas is worse for the climate than using coal.

As of June 2022, over 120 countries, representing half of global methane emissions and nearly three-quarters of the global economy, have signed the Global Methane Pledge, endorsing its goal of reducing methane emissions at least 30% from 2020 levels by 2030. Yet, continued investment in gas infrastructure and power will make meeting the goals of these pledges impossible.

4. Gas plant costs are estimated using the August 2022 Global Gas Plant Tracker database. The estimate for OECD member countries is based on CCGT capital costs ($1000/kW) for the U.S. and Europe from IEA World Energy Model inputs. The estimate for non-OECD countries (except China) is based on CCGT capital costs that average India ($700/kW) and EU ($1000/kW) CCGT capital costs from IEA World Energy Model inputs. China uses CCGT capital costs of $560/kW from IEA World Energy Model inputs. CCGT technology is assumed for gas plants with technology type that is not known. OCGT capital costs are estimated to be 74.4% of CCGT costs, based on a comparison of costs for "Combustion Turbine H Class, 1100-MW Combined Cycle" to "Combustion Turbine F Class, 240-MW Simple Cycle," as detailed in 2020 EIA Report.
5. Pipeline and LNG terminal costs are estimated from the Global Gas Infrastructure Tracker database (January 2022 version for pipelines and July 2022 version for terminals, both with interim updates until September 2022). For pipelines, regional average costs per unit km are calculated to estimate missing costs: Europe/EU ($3.14 million per km), East Asia ($1.70 million per km), and North America ($4.72 million per km). For onshore import terminals, regional average costs per unit capacity are used to estimate missing costs: Europe/EU ($233 million per mtpa) and East Asia ($352 million per mtpa). For onshore export terminals, a regional average cost per unit capacity is used for North America ($578 million per mtpa). For offshore/floating terminals, a separate global mean cost per unit capacity is used for import terminals ($138 million per mtpa) and export terminals ($567 million per mtpa).
6. Recent research has found that methane emissions have been significantly underestimated, and various studies show a wide range of methane leakage rates. A recent study from Carbon Mapper found significantly higher methane loss rates, between 23 - 66%, from oil and gas platforms in the U.S. Gulf of Mexico than from typical onshore production.

Europe

According to GEM's latest survey, Europe has 19.7 GW of coal-to-gas conversions or replacements in development, representing approximately 29% of the region's 68 GW gas-fired capacity in development. There is a planned US$135.4 billion expansion of gas infrastructure underway in Europe. In all, there are plans in the region for 68.2 GW of new gas-fired power plants, 171 million tonnes per annum (mtpa) of liquefied natural gas (LNG) import capacity, and 17,200 kilometers (km) of gas pipelines, according to data from Global Energy Monitor. This expansion would increase the region's gas power capacity by 29% while increasing the region's 175 mtpa of LNG import capacity by 97%. [Table 2]

The European Union's own Climate Law calls for a 55% reduction in emissions by 2030, with gas use slated to fall 30% by that date and then decline rapidly. The Russian invasion of Ukraine and the resulting energy crisis has only strengthened the EU's commitment to renewables. Under the revised RePowerEU package, a target of 45% from renewable energy by 2030 was set as well as plans to double its solar capacity by 2025. A recent report from Ember shows that 70–80% of the power system in Europe could be supplied by wind and solar generation, with only 5% supplied by fossil fuels, by 2035. However, while climate targets in the EU have been strengthened this year, in a controversial decision, the European Parliament voted in July to allow certain gas projects to be labeled as "green," thereby granting these projects access to green financing and subsidies.

While there has been a slight increase in coal usage in the power sector in Europe due to gas supply cuts from Russia, this is expected to be a short-term effect. Medium- to long-term renewable energy targets are now expected to accelerate. Analysis by Ember and CREA has found that EU countries are now planning for 63% renewables by 2030, up from 55% under previous commitments. The RePowerEU plan will lead to a further increase to 69% of electricity from renewables in 2030.

Another recent report from Ember shows that coal is not making a comeback in the EU and remains firmly in long-term structural decline. While there are temporary, emergency measures being implemented, including reactivating coal plants, long-term climate commitments in Europe are not in jeopardy.

> *"... burning gas to produce electricity is, today, stupid. ... You can produce electricity better, cheaper, without using gas."*
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> —Francesco Starace, CEO of Enel

Facing a potential energy supply crisis, the Council of the EU has adopted a regulation calling for a voluntary reduction of gas demand by 15% this winter. In case of a severe shortage, the 15% reduction target could become mandatory. There are also some examples of coal-to-gas conversion or replacements being postponed due to the gas supply uncertainty. There were a total of 3,480 MW of coal-to-gas project cancellations and 1,346 MW of coal-to-gas shelved projects in 2022. For example, Germany's Herne power station announced that the unit would continue using coal until spring 2023 and the coal-to-gas conversion would be postponed one year. The Wolfsburg North and Wolfsburg West power stations were supposed to be converted to gas in 2022 but plans have now been shelved in light of the energy crisis. In some cases, such as the planned Brindisi Sud power station coal-to-gas conversion in Italy, the proposed gas plant has been cancelled in favor of renewables.

As gas prices have soared in the last year and renewables plus storage costs have continued to dramatically decline, there has been a significant shift in the competitiveness of renewables compared to gas. Analysis from think tank TransitionZero shows that investing in clean energy is overwhelmingly economical on a levelized cost of energy (LCOE)[7] basis in Europe. [Table 3]

Table 3: TransitionZero LCOE Analysis, Europe

Country	In development coal to gas conversion/ replacement (MW)	Average of Solar + Storage LCOE ($/MWh)	Average of Onshore wind + Storage LCOE ($/MWh)	Average of Natural gas LCOE ($/MWh)
Poland	5,380	$116.7	$96.0	$322.5
Germany	4,106	$85.3	$88.7	$328.1
United Kingdom	3,128	$110.3	$86.3	$282.6
Romania	2,175	$98.9	$96.0	$341.6
Italy	1,700	$104.8	$99.2	$324.4
Bulgaria*	730	$103.5	$90.5	$376.9
Hungary	500	$97.4	$96.7	$332.6
North Macedonia*	460	$103.5	$90.5	$376.9
Czech Republic	536	$109.6	$102.5	$318.1
Denmark	362	$95.3	$83.3	$329.2
Belgium*	320	$103.5	$90.5	$376.9
Slovenia	170	$111.0	$104.8	$396.6
Serbia*	120	$103.5	$90.5	$376.9

Source: TransitionZero September 2022 analysis
* Assumes TransitionZero EU 2022 weighted average values

7. Levelized cost of energy (LCOE) is defined by TransitionZero as "the average total costs of building and operating a power plant, based on per unit of electricity generated over its assumed lifetime."

The LCOE for gas power represents the price per megawatt hour ($/MWh) at which project costs can be recovered and investors can achieve a minimum rate of return – known as the "hurdle rate" – on the capital and lifetime operational costs of the plant. This includes the fixed costs of building and maintaining the plant as well as the short-run marginal cost of buying fuel and operating it.

For utility-scale solar or onshore wind with storage, LCOE is the price ($/MWh) needed to recover project costs and attain a required hurdle rate on investment. The methodology assumes a battery with half the capacity of the paired renewable source, capable of discharging for four hours. For example, a 10 megawatt (MW) solar site would have a 5MW battery holding 20MWh.

East Asia

East Asia has 26.9 GW of coal-to-gas conversions or replacements in development, representing approximately 19% of the region's 141 GW gas-fired capacity in development. These are mostly concentrated in South Korea and Taiwan. South Korea has pledged to reach net-zero emissions by 2050, and China is aiming for "carbon neutrality" by 2060.

There is a planned US$262.8 billion expansion of gas infrastructure underway in East Asia. In all, there are plans in the region for 141.1 GW of new gas-fired power plants, 241 mtpa of LNG import capacity, and 57,100 km of gas pipelines, according to data from GEM. This expansion would increase the region's gas power capacity by 57% while increasing the region's 444 mtpa of LNG import capacity by 54%. [Table 2]

South Korea has approximately 12.7 GW of announced coal-to-gas conversions or replacements. While South Korea has committed to no new coal plants entering into construction and phasing out coal by 2050, the government is planning to meet the energy demand by converting 24 of the 30 currently operating coal plants into LNG plants. In fact, guidelines published by the Ministry of Environment in January 2022 have temporarily classified LNG as a "green fuel" in an effort to prioritize decreasing coal, which amounts to about 40% of the electricity supply.

In August 2022, South Korea announced that it is seeking to purchase additional LNG cargo outside of its long-term contracts in order to meet its increased forecasted demand. This will only further exacerbate the global gas supply crunch and increase gas prices.

Taiwan has 11.3 GW of coal-to-gas conversions or replacements in the pre-construction or construction phase. Under the Renewable Energy Development Act, Taiwan has set a goal to increase gas-fired generation to 50% and renewable power to 20% by 2025. The target also calls for coal-fired generation to fall to about 30% from the current 47% level. Taiwan plans to add around 10 GW of gas-fired capacity in order to meet this energy plan goal.

Analysis from TransitionZero shows that the LCOE from solar with storage is below the cost of gas-fired power in China, South Korea, and Taiwan. The LCOE from wind with storage is below the cost of gas-fired power in China and Taiwan. [Table 4]

High gas prices and increasingly tighter global gas supply are undermining the industry-driven narrative that LNG is a viable "bridge fuel" from coal. A recent study from the Institute for Energy Economics and Financial Analysis (IEEFA) found that sustained high gas prices and competition for supply has impaired medium- to long-term demand as countries are shifting to alternative energy sources.

Table 4: TransitionZero LCOE Analysis, East Asia

Country	In development coal to gas conversion/ replacement (MW)	Average of Solar + Storage LCOE ($/MWh)	Average of Onshore wind + Storage LCOE ($/MWh)	Average of Natural gas LCOE ($/MWh)
China	2,865	$91.0	$72.9	$114.2
South Korea	12,720	$120.0	$168.0	$150.9
Taiwan	11,300	$91.0	$72.9	$114.2

Source: TransitionZero September 2022 analysis
*Assumes TransitionZero 2022 average values for China

North America

North America has 18.6 GW of coal-to-gas conversions or replacements in development, representing approximately 44% of the region's 42.6 GW gas-fired capacity in development. There is a planned US$389.2 billion expansion of gas infrastructure underway in North America. In all, there are plans in the region for 42.6 GW of new gas-fired power plants, 398 mtpa of LNG export capacity, and 11,500 km of gas pipelines, according to data from Global Energy Monitor. This expansion would increase the region's 73.9 mtpa of LNG export capacity by 539%.

According to the EIA, approximately one fifth of the coal plants retired since 2010 were converted to or replaced by gas-fired plants.

The United States has historically been insulated from high global gas prices. However, this shifted once the U.S. started exporting LNG in 2016, exposing its domestic market to the global gas market. Increased pressure from rising demand as a result of the Russian invasion of Ukraine has pushed Henry Hub gas prices to nearly $10/mmBtu.

In the U.S., passage of the Inflation Reduction Act (IRA) will help incentivize investment in clean energy. Analysis from Energy Innovation finds that the IRA's power sector provisions will drive about two thirds of its GHG emissions reductions, expanding 2030 wind and solar capacity by 2 to 2.5 times pre-IRA projections. One section of the new law provides up to $27 billion for a clean energy and sustainability accelerator program, which "would leverage public and private funds to invest in clean-energy technologies and infrastructure." Such massive investments in clean energy could further expand renewables' price advantage.

> *"We have no room to build anything that emits CO_2 emissions."*
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> —Fatih Birol, Executive Director, International Energy Agency, 2018

A Rocky Mountain Institute study that examined new gas plant projects in the United States found that at least 80% of these projects could be cost-effectively avoided by investing in clean energy portfolios, renewables with storage, and demand-side management, instead. A June 2022 NextEra presentation highlights the falling costs of renewables, showing that the levelized cost of new gas-fired generation is up 39% in the last year, compared to 16% for new solar and 11% for new wind.

Conclusion

While the fundamental move away from coal power over the last decade has been a positive development, the coal-to-gas shift poses a risk to global climate objectives. Favorable economics of renewables with storage, volatile gas prices and gas supply instability, and stranded asset risk all support leapfrogging gas entirely and accelerating the switch to clean energy. At a time when it is overwhelmingly evident that gas is not a viable bridge fuel, switching coal projects to run on gas is antithetical to climate goals and makes no economic sense.

Methodology

Global Energy Monitor is a nonprofit research organization developing information on energy projects worldwide. In 2020, Global Energy Monitor launched its Global Gas Plant Tracker (GGPT). The tracker is an online database that identifies and maps every known gas-fired generating unit and every unit proposed since 2020 (20 MW and larger in the European Union and United Kingdom, 50 MW or larger elsewhere). Following our latest update, it now contains more than 1,831 GW of operational gas power capacity in 130 countries across the globe and covers another 692 GW of new capacity under development. The GGPT uses footnoted wiki pages to document each plant and is updated biannually. For further details see the tracker landing page and methodology overview. To obtain primary data from the GGPT, visit the Download Data page.

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