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DOE Report on US LNG Exports: Implausible Scenarios and Flawed Assumptions

OIES ENERGY COMMENT

Mike Fulwood, Senior Research Fellow, OIES

Key Points

- The US Department of Energy (DOE) has published key scenarios on the outlook for US LNG exports which draw conclusions that are implausible and outliers in comparison with scenarios developed by industry players and reputable consultants, especially as regards the projected growth in LNG trade to 2050.
- The DOE scenarios include very aggressive growth in long-term gas demand in India and hence its LNG imports, much too high a level of LNG imports into Japan and China, as well as Argentina, Brazil and Pakistan. In addition, under the DOE scenarios, Russia and Central Asia begin importing large quantities of LNG and, even more bizarrely, Norway stops exporting pipeline gas to the EU and UK and instead ramps up LNG exports to over 150 bcm! These outcomes suggest a high degree of implausibility.
- The DOE scenario on which the key conclusions of the report rest, suggests that the unconstrained expansion of US LNG will increase gas demand in key LNG importing countries by displacing other fuels such as coal, oil and renewables. This is based on the cost assumptions in the model used (the Global Climate Analysis Model or GCAM) which would seem to be flawed since the full cost of delivering US LNG to Europe and Asia is in the $10 to $11 per MMBTU range, based on the Henry Hub prices from the DOE scenarios. The only way that an expansion of LNG exports would lead to a displacement of coal and oil would be to drive spot gas prices down to very low levels – maybe $5 or less – as we saw in 2019. In order to displace renewables, these prices would need to be sustained for a long period, which would make US LNG uneconomic.
- Under the scenarios, the unconstrained expansion of US LNG also leads to the displacement of LNG exports from the rest of the world in key LNG importing countries by US cargoes. Again, the cost assumptions in GCAM would seem to be flawed to achieve this result, since a significant proportion of the LNG displaced by US LNG is from the Middle East, mainly Qatar, with a delivered cost, to Europe and Asia, which is half the delivered cost of US LNG.

1. Introduction

In mid-December, the US Department of Energy (DOE) finally published its long-awaited report on the Energy, Economic and Environmental Assessment of US LNG Exports[1]. The report consists of a summary and four appendices, contains a vast amount of data and comes to a number of key conclusions. This brief Comment will focus on two aspects and conclusions:

1. In comparison to the scenario where only existing US plants, plus those which have taken FID, are assumed to operate, the Defined Policies scenario with unconstrained US LNG exports results in Henry Hub prices being some 31% higher in 2050 ($4.62 per MMBTU compared to $3.53 per MMBTU in the existing and FID plants scenario at real 2022 prices). The modelled price increase is equivalent to about $0.03/MMBtu for every Bcf/d of increased LNG export above existing and FID levels.
2. The Defined Policies scenario with unconstrained US LNG exports leads to an *increase* in GHG emissions compared to the existing and FID plants scenario. This seemingly happens because the much higher level of US LNG exports, displaces not only gas production in other countries but also leads to an increase in gas demand, with gas displacing some coal and oil but renewables as well. It is presumably largely the displacement of renewables with US LNG which leads to the higher GHG emissions.

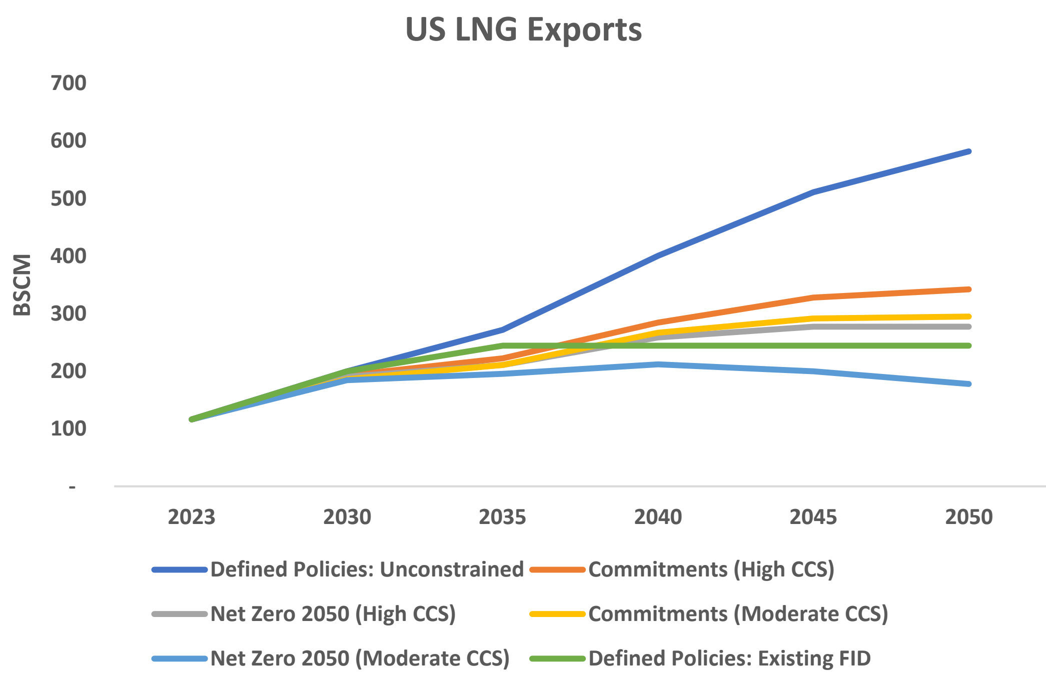
[1] ENERGY, ECONOMIC, AND ENVIRONMENTAL ASSESSMENT OF U.S. LNG EXPORTS, US Department of Energy, December 2024

The conclusions of the report – higher US domestic prices and more GHG emissions with much higher US LNG exports – would seem to fit the narrative the outgoing Democratic administration would have wanted. However, that does not mean these conclusions are credible.

The conclusion, that much higher US LNG exports would lead to higher Henry Hub prices, would seem to be reasonable. The issue relates more to the magnitude of the increase, which in turn relates to the Defined Policies unconstrained US LNG exports scenario, which incorporates implausibly high levels of US LNG exports.

The DOE report considers a number of scenarios for US LNG exports, as shown in Figure 1. The scenarios are fully defined in the DOE report. The analysis in this Comment will focus on the Defined Policies scenarios which will be referred to as Defined Policies: Unconstrained[2] and Defined Policies: Existing FID. In the latter case US LNG exports level out at just over 240 bcm while in the unconstrained case they reach over 580 bcm by 2050.

Figure 1: US LNG Export Scenarios



Source: US DOE Report

The report uses the Global Change Analysis Model (GCAM) to develop the scenarios. A more detailed description of GCAM is contained in the report. The report includes considerable amounts of data on the outputs of the scenarios but there is almost no information on the key assumptions, particularly in respect of the cost assumptions. The report notes[3] that *the demand for U.S. LNG exports in turn depends on its competitiveness relative to other sources of natural gas such as LNG from other major natural gas producing regions, availability and competitiveness of pipeline gas, and availability and competitiveness of domestic natural gas resources*. However, it is not possible to ascertain from the report what the key cost assumptions for those alternatives are. These are critical in respect of understanding how US LNG exports might displace gas production in other countries, lead to an increase in gas demand and also displace other fuels including renewables. This will be explored further in the Flawed Assumptions section. Firstly, the Defined Policies: Unconstrained and Defined Policies: Existing FID scenarios will be reviewed.

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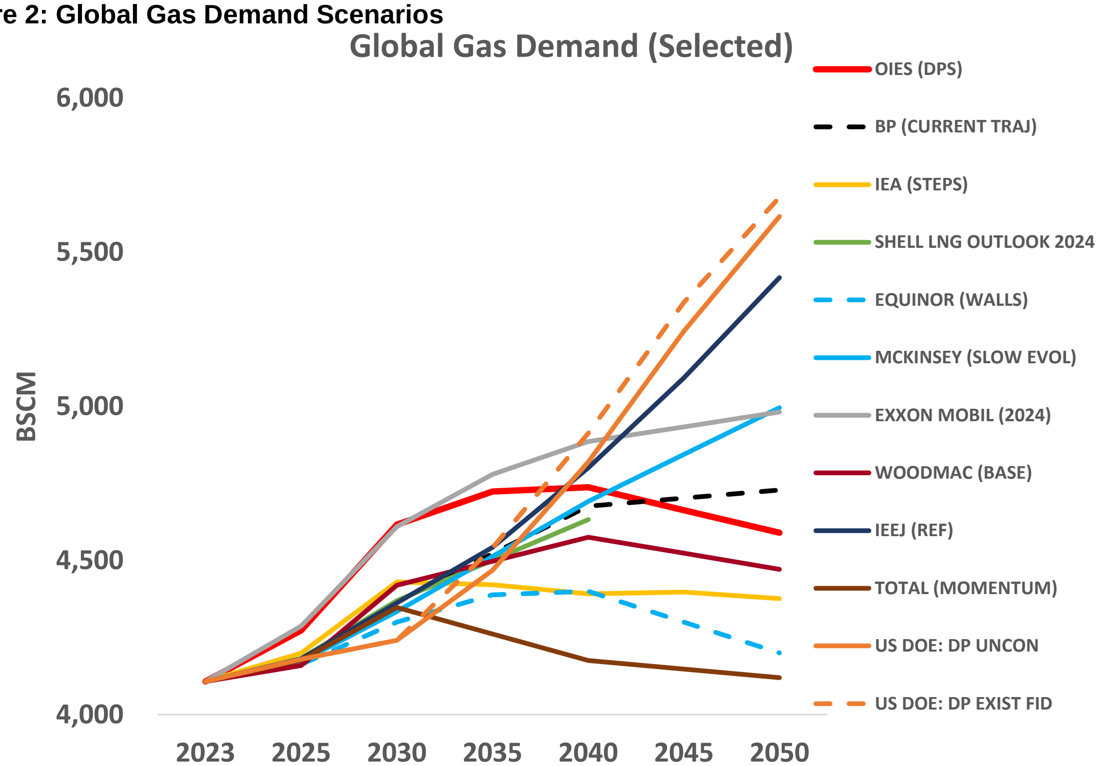
[2] This is Defined Policies: Model Resolved in the DOE report

[3] Appendix A page A-10

2. Implausible Scenarios

In the report, the Defined Policies: Unconstrained scenario using the GCAM resolves with US LNG exports unconstrained. Figure 2 below compares the two Defined Policies[4] scenarios with a number of recent scenarios, including the IEA STEPS and the OIES Declared Policies scenario. All these scenarios are not decarbonisation scenarios and certainly are nowhere near to achieving net zero. They might be broadly categorised more as "business as usual" or based on existing policies, which have some decarbonisation elements.

Figure 2: Global Gas Demand Scenarios



Source: DOE Report, IEA and various industry sources

The scenarios include recent ones from Shell, BP, Total, ExxonMobil and Equinor as the LNG industry players, as well as Woodmac, S&P Global and McKinsey as consultants and the IEEJ from Japan. The DOE scenarios are the only ones, apart from IEEJ which have global gas demand rising above 5,000 bcm in the period to 2050. ExxonMobil and McKinsey get close to that level by 2050 but the other scenarios peak in the 2030s or 2040s at 4,700 bcm or less. The IEA STEPS plateaus around 4,400 bcm with the OIES DPS peaking at over 4,700 bcm in the 2030s before declining slightly to 4,600 bcm by 2050.

The DOE scenarios have lower global gas demand than other scenarios through the early 2030s, before accelerating sharply thereafter. By 2050 the DOE scenarios are over 5,600 bcm compared with 4,700 for BP and 4,600 for OIES – some 20% or so higher. While the DOE scenarios are on the high side, relative to the "industry", they could be seen as being reasonably plausible at the global level. Looking at some of the individual countries, the DOE scenarios have China gas demand at over 600 bcm in the 2040s, which is a bit higher than other scenarios but not necessarily out of line with internal China projections. In the case of India, the DOE scenarios have demand at around or over 400 bcm by 2050 (2023 demand was 67 bcm),

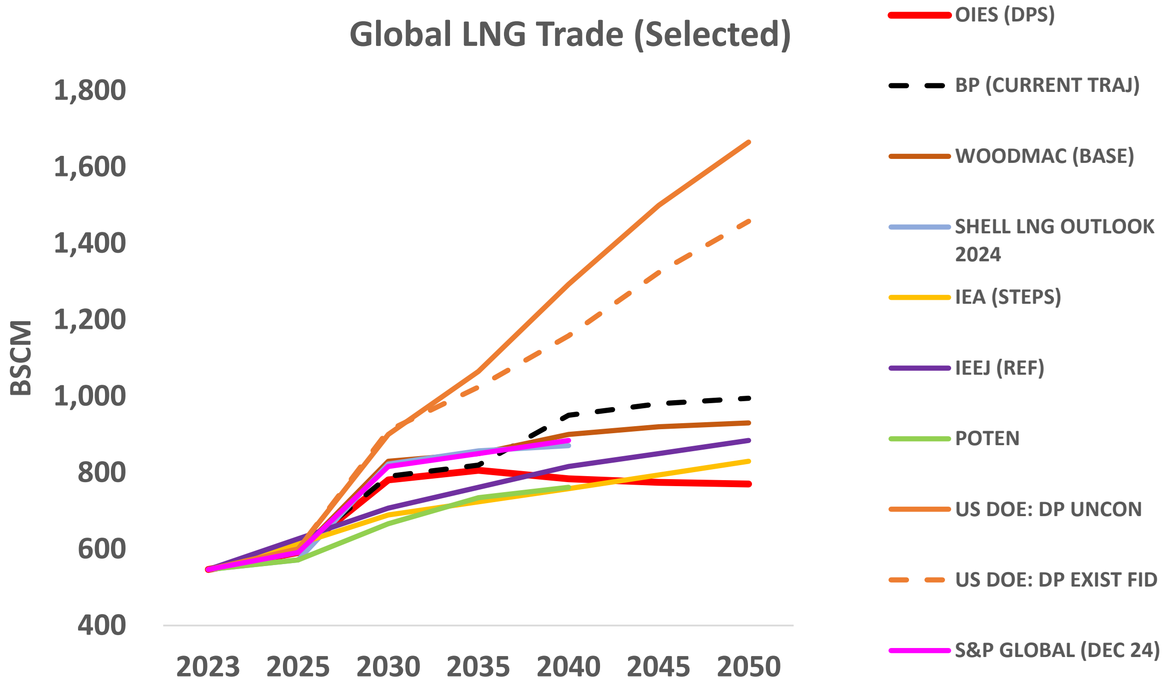
[4] The DP Exist FID scenario has slightly higher global gas demand than the DP Uncon scenario which seems odd as global LNG trade is much higher and gas demand is higher in the key LNG importing countries

which is considerably higher than almost all other scenarios and are definitely outliers. Japan demand also looks too high in the DOE scenarios, seemingly plateauing at some 125 to 135 bcm over the period, compared to current and declining demand of around 85 bcm. US demand also is projected to rise to around 1,100 bcm by 2050 (demand in 2023 was some 920 bcm)[5].

One of the problems of using GCAM may be that the model is calibrated to 2015 with the model parameters fitted to the IEA historical data. A lot has happened between 2015 and now, so projecting from 2015 means it is almost certain the model is diverging in its projections between 2015 and now compared to what has actually happened. This automatically builds in divergences which get amplified going forward.

Figure 3 shows the comparisons for LNG trade.

Figure 3: LNG Trade Scenarios



Source: DOE Report, IEA and various industry sources

There are fewer comparisons for LNG trade, but the DOE scenarios are significantly higher than industry and consultant scenarios, including IEA and OIES. LNG trade in the DOE DP Unconstrained scenario reaches over 1,650 bcm by 2050 and in the DP Existing FID over 1,450 bcm. The highest of the other scenarios – BP Current Trajectory – reaches just under 1,000 bcm by 2050, with other scenarios ranging between just under 800 bcm and just over 900 bcm. There is a degree of consensus, through to 2040, amongst Shell, Woodmac and S&P Global (in its most recent report), with LNG trade reaching some 900 bcm or just below that. The Woodmac base case then plateaus thereafter, reaching some 930 bcm by 2050. These 2040 and 2050 levels are somewhat higher than our OIES DPS, which may reflect our more sanguine view on China and India demand (especially India, where we are at the pessimistic end of gas demand). The Shell, Woodmac and S&P Global scenarios however are extremely plausible and the higher level of LNG trade than our OIES DPS and IEA STEPS can be easily explained.

In contrast, the DOE DP Unconstrained LNG trade scenario is some 80% higher by 2050 than, for example, the Woodmac scenario, with the DP Existing FID some 60% higher. The problems with the DOE scenarios

[5] The US demand numbers coming out of GCAM are at odds with the numbers in Appendix B of the report, which is the domestic US analysis the DOE National Energy Modelling System, where gas demand in 2050 is around 820 bcm.

relate to the level of LNG trade, even in the DP Existing FID case and then the spread between the two DOE scenarios. The following are some key issues and highlights in relation to LNG imports in the DOE scenarios:

- China's LNG imports rise to almost 300 bcm by 2050 in DP Unconstrained, representing 45% of total China gas demand (slightly less in DP Existing FID). The 45% level is reached in 2025 with LNG imports at some 219 bcm – LNG imports are currently less than half that level. The 2050 level of just under 300 bcm is much higher than China production of 227 bcm. This seems highly unlikely from a Chinese government policy perspective, even if the level of China's gas demand in the DOE scenarios is reasonable.
- Japan's LNG imports average between 120 and 130 bcm over the 2025 to 2050 period, whereas they are now declining at around 85 bcm.
- India's LNG imports reach 260 bcm in DP Unconstrained and 230 bcm in DP Existing FID. These reflect the very aggressive gas demand growth in the scenarios and as noted earlier and are definite outliers.
- Argentina's LNG imports reach some 42 bcm in DP Unconstrained and Brazil's some 90 bcm. In both countries, domestic production barely increases, which doesn't seem credible given their abundant gas reserves, particularly Argentina.
- Pakistan LNG imports reach some 75 bcm in 2050 in DP Unconstrained – imports at present are less than 10 bcm and while some increase is expected, affordability tests the credibility of this projection.
- Europe is importing over 200 bcm of LNG in 2050 in DP Unconstrained and some 30 bcm less in DP Existing FID, but this seems to be a consequence of importing little or no pipeline gas from Norway, as Norway switches to exporting lots of LNG instead – see below.
- In a bizarre turn, Russia's LNG imports reach some 75 bcm in DP Unconstrained in 2050, which is three times higher than Russia's LNG exports. It is unclear what might drive Russia to import LNG.
- Even more bizarrely, Central Asia imports some 30 bcm of LNG in 2050 in DP Unconstrained despite being landlocked (apart from Georgia).
- All regions of Africa also import significant quantities of LNG, despite in some cases exporting LNG as well and having abundant gas reserves. Mexico's LNG imports also increase sharply, but neither DOE scenario has any LNG exports from Mexico.

There are also a number of problems in relation to LNG exports in the DOE scenarios:

- LNG exports from North Africa are projected to rise to over 150 bcm by 2050 in DP Unconstrained, several multiples of the current level, despite patchy resource depth and surging domestic demand growth, limiting gas available for LNG exports.
- There are almost no LNG exports from Southern Africa (which includes Mozambique and Tanzania) in either scenario, despite the region currently exporting from Coral FLNG and further facilities being built.
- The EU and Eastern Europe (defined as Belarus, Moldova and Ukraine) also export material quantities of LNG despite none of the countries having any LNG export facilities and no prospect of having any.
- While there are huge increases in US LNG exports in DP Unconstrained, Canada also sees LNG exports increase to 130 bcm by 2050. While some increase is likely this level seems implausible.

- LNG exports from the European Free Trade Association – in effect Norway – reach some 150 bcm by 2050 in DP Unconstrained – compared to 6 bcm at present. This level seems to be achieved by Norway stopping pipeline exports to the EU and UK and instead building multiple LNG export facilities, presumably sending some of this LNG to the EU! Maybe someone should notify the Norwegian Ministry of Energy to get their thoughts!
- Another region which supposedly is and will export LNG under the scenarios is South Asia, which in GCAM regions comprises Afghanistan, Bangladesh, Bhutan, Sri Lanka, Maldives and Nepal.

The above points on LNG imports and exports are just some of the key highlights, but the main point is that the levels of LNG imports and the source of LNG exports are not credible.

The difference between DP Unconstrained and DP Existing FID is a huge unconstrained rise in US LNG exports. The effect of this increase is twofold. Gas demand increases in LNG importing countries and US LNG also displaces LNG from other countries, leading to a decline in gas production in those countries. The analysis of what might drive these changes is discussed in the next section. The annual difference between US LNG exports in DP Unconstrained and DP Existing FID is some 150 bcm by 2040, 265 bcm in 2045 and 340 bcm by 2050. Around 60% of this increase seems to come from increases in gas demand in the LNG importing countries, notably in China, India, the EU and Japan, with just under 40% from the displacement of LNG from other exporting countries. This reduction in LNG from other exporting countries is across the board but notably LNG exports from the Middle East are some 40 bcm lower in the DP Unconstrained scenario than in the DP Existing FID scenario.

3. Flawed Assumptions

GCAM, from its description, appears to be driven by relative costs and technologies, so the gain in US LNG exports, both in displacement and gas demand increases is driven by relative costs. Unfortunately, no information is provided in the DOE report on the cost assumptions used in the GCAM, so we are very much in the dark as to how GCAM generated the gas demand increases in LNG importing countries and the displacement of LNG from other exporting countries by US LNG.

If the additional US LNG exports in the DP Unconstrained scenario are to increase gas demand in the LNG importing countries, then the LNG needs to displace other fuels, just over half of which seems to be renewables, followed by coal and then oil. The displacement of these other fuels, in the cost driven GCAM would only occur if the additional US LNG succeeded in reducing gas and LNG prices so that other fuels were displaced. By 2050 the Henry Hub price is $3.53 in DP Existing FID and $4.62 in DP Unconstrained, in real 2022 prices. Using the $3.53 as a basis for calculating the full delivered cost of US LNG to Asia and Europe, then the additional costs would be an extra 15% of Henry Hub for the cost of gas used in the liquefaction process ($0.50), the liquefaction capacity cost (say $2.50 to $3.00), the cost of shipping (some $1.50 to the Netherlands and $2.80 to Japan – depending on oil prices and tanker charter rates) plus the cost of regasification and entry to the pipeline system (assume some $0.45). The delivered cost of US LNG to Europe would be in the range $8.50 to $9.00 and to Japan in the range $9.80 to $10.30 - China and India would be another $0.20 higher. The higher $4.62 Henry Hub price would increase the delivered prices to Europe and Asia by another $1.25, raising the European delivered cost to around $10.00 and the Japan delivered cost to over $11.00.

The bulk of the increase in gas demand generated by the additional US LNG is in the Asian markets, notably China and India, with additional demand in Europe and also Argentina and Brazil. The output from GCAM is asking you to believe that $10 to $11 delivered US LNG to Asia can displace locally produced coal, or coal imported into Asian markets from neighbouring countries such as Indonesia and Australia. While displacement of oil might be possible – depending on the oil price – the displacement of coal seems unlikely at these prices. It can only be assumed that GCAM costs of delivered US LNG are much lower, unrealistically so. In respect of Europe, coal will have been largely eliminated from the energy mix by 2040, which means that any displacement by US LNG is likely to be renewables. Again, this seems unreasonable given a projected delivered cost of as much as $10 for US LNG to the European market.

The second element of the increase in US LNG exports between DP Unconstrained and DP Existing FID, is the displacement of LNG exports from other sources. A large proportion of the LNG is displaced from the Middle East, followed by North Africa, Canada and Australia, with smaller reductions from other sources. The market for that displaced LNG is Asia, from where some 60% of global demand is derived. It is particularly questionable that US LNG can displace Middle East LNG, predominantly Qatari LNG, in the Asian markets or indeed in European or other markets. Qatar LNG is particularly low cost, with the resource cost from the North field being very low because of the associated liquids, likely lower liquefaction capacity costs, and in respect of Asia at least, especially India, lower shipping costs. The delivered cost of Qatari LNG to Japan and Europe is likely to be in the $5 to $6 range, principally because of the very low resource cost – almost half the delivered cost of US LNG. North Africa LNG is principally destined for the European market, with low resource and shipping costs, while Australian LNG has the advantage of short shipping distances to Asian markets. Even Canadian LNG (West Coast) benefits from much lower shipping costs to the Asian markets than US LNG.

US LNG is relatively high-cost LNG in the current global market, especially if shipped to Asian markets, so it is difficult to see how $10+ LNG could displace other fuels in these markets and even displace much lower cost LNG from places such as Qatar. There have been episodes in the past, when low gas prices have led to an increase in the demand for gas relative to other fuels, notably in 2019 when a surge of LNG supply led to lower gas prices in Europe and Asia and coal to gas switching occurred (especially in Europe). Spot prices in Europe and Asia averaged around $5 per MMBTU in 2019 and were heading down, tipping below $3 in Europe even before Covid-19 hit. Spot prices at these levels also encouraged gas demand in the price-sensitive Indian market. Displacing coal and oil in the short term through lower prices, in fuel switchable markets, is one thing but displacing renewables is more of a long-term investment decision. While sustained prices at $5 to $6 per MMBTU might incentivise more gas-fired power, rather than renewables, these prices would destroy the long-term economics of US LNG – and most other LNG projects outside Qatar. Prices at $10 per MMBTU or above, however, seem unlikely to generate additional demand for gas.

The other element to note is that the LNG market remains heavily contracted and all the US plants are financed by long-term contracts. All the existing projects and those which have taken FID have long-term contracts. Even some of those yet to take FID have long-term contracts lined up in principle. In the DP Existing FID scenario, US LNG exports plateau at 244 bcm. By 2050 in the DP Unconstrained scenario, US LNG exports reach 582 bcm – some 338 bcm higher. Who will contract for this incremental volume? It is plausible that an additional 50 bcm could go to FID and be contracted and even slightly higher numbers but not an additional 300 bcm plus. The market for LNG needs to be established for contracts to be concluded.

The final element that should be mentioned is that the LNG market has an element of self-regulation, as we saw in 2020, a feature especially true for US LNG. In 2020, as Covid-19 hit demand, spot prices in Europe began to drop below $3 per MMBTU and by summer were below $2. This narrowed the spreads between TTF and Henry Hub to below $1.25, at which point US LNG began to be shut in and did not start returning until the last quarter of 2020 when differentials widened again. This exposes the dichotomy at the heart of the DOE report scenarios. It may require $5 or $6 spot prices in key markets to generate gas demand but with Henry Hub at $4.62 per MMBTU in 2050, the margins are very tight, suggesting that a lot of US LNG would simply be shut-in.

4. Conclusions

In launching the report on 17 December, the outgoing US energy secretary Jennifer Granholm declared that "We can now assess the future of natural gas exports based on the facts". Unfortunately, even a brief review suggests the "facts" as outlined in the DOE report are much closer to fantasy, with implausible scenarios and flawed assumptions.

The two DOE scenarios discussed in this Comment are very much high outliers in comparison to other scenarios, principally generated by the industry and reputable consultants. The DOE scenarios contain a number of totally implausible outcomes in terms of LNG imports. In the DP Existing FID scenario, these include Russia importing some 58 bcm and Central Asia some 28 bcm, Europe's LNG imports totalling some 175 bcm by 2050 as a result of Norway's pipeline exports being replaced with LNG. Making sensible adjustments by eliminating Russia and Central Asia imports and reducing Europe's LNG imports by reversing the phasing out of pipeline imports from Norway, would reduce global LNG imports by some 220 bcm. In addition, Japan's LNG imports are some 40 bcm too high, Pakistan's imports some 30 bcm too high, India maybe 80 bcm too high and Argentina and Brazil at least 100 bcm too high – making an additional 250 bcm to add to the 220 bcm for Europe, Russia and Central Asia. In DP Existing FID total LNG trade was 1,458 bcm in 2050, so taking off some 470 bcm would get trade below 1,000 bcm, which is towards the top end of the range of industry and consultant scenarios from Figure 3, but at least close to a plausible scenario.

To move from the DP Existing FID scenario to the DP Unconstrained, where total LNG trade is 200 bcm higher, requires gas to displace other fuels, notably renewables, in Asian and European markets. The cost assumptions which drive this in GCAM are not disclosed but based on realistic cost assumptions this does not seem plausible. If this increase in gas demand replacing renewables doesn't happen then the conclusion, from the DOE report, that a large increase in US LNG exports would increase global GHG emissions, completely falls apart.

Finally, the idea that US LNG would displace LNG from other exporting countries, especially Qatar, on a relative cost basis, also seems unlikely, based on more realistic costs than those used in GCAM.

However, this does not mean that US LNG exports could not be higher than the existing plus FID projects. With global LNG trade reaching some 900 to 1,000 bcm by 2050, as opposed to the OIES DPS and IEA STEPS which are around 800 bcm in 2050, then there is scope for US LNG exports to be some 50 to 100 bcm higher. This is far short, however, of the DP Unconstrained scenario. Based on the DOE report assessment of the impact on Henry Hub prices of $0.03 per MMBTU for every 1 bcf/d of higher US LNG exports, this would increase prices by between $0.15 to $0.30 per MMBTU – a much more realistic assessment of the possible impact. Additionally, there would be no increase in GHG emissions and, to the extent that modestly higher US LNG did lead to some displacement of coal in power plants – driven by policy rather than relative costs – then GHG emissions would be lower.