THE OXFORD INSTITUTE FOR ENERGY STUDIES

Quarterly Gas Review
Analysis of Prices and Recent Events

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Thanks to Argus Media, we have updated our "LNG tightness" metric that measures the spread between the US Gulf Coast LNG FOB and the Henry Hub price. It is interesting to keep track of this 'LNG tightness' in a fast-changing LNG world. The LNG market continues to grow with now 42 importing countries and the willingness of market participants to move it into a global traded commodity. On top of continued strong demand in South Korea and China due to coal-to-gas switching to reduce air pollution in major cities, in July, LNG was pulled into the Mexican regas terminal to cool down Californians.

In Europe, the Brexit unknowns are increasing, and the gas markets have still not been addressed leaving little time before March 2019 to find a commonly agreed solution.

Quarterly Focus: How Europe could profit from becoming the worldwide energy storage provider

The coupling of Russian spare capacity and high European storage capacity is currently providing the only global buffer to balance worldwide supply and demand as we've already seen this winter. With LNG market share growing, the gas storage business will be further impacted. Europe, which is currently long on storage could become even longer once the UK (with little storage capacity) leaves the EU if it manages to successfully integrate Ukraine in the Energy Union. This section analyses the options going forward if Ukrainian storage is fully integrated into EU storage:

- Could there be more closures to make the remaining storage profitable?
- Could we all benefit from more storage by designing a new business model in an energy transition world?

We argue that the EU should look into any opportunity to avoid closure of any gas storage that, for now, provides the only worldwide buffer for any unexpected events that could be technical, political or the extreme weather patterns we are witnessing more and more. We even suspect that the EU should be better off by allowing its Member States to use gas storage to meet the actual crude and refined products strategic obligation. With an emphasis on electricity and a reduction of oil intensity, the actual oil obligation is not rational any longer and should be amended for the benefit of all. The EU Commission should consider transforming the actual crude and refined products strategic obligations into an energy storage obligation, allowing all fuels (oil, gas, water and electricity) to come up with the cheapest way to provide the required energy storage buffer. This could be achieved by changing the Directive 2009/119/EC imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products that was designed at a time when oil was more relevant than today, the energy transition hadn't really started, and energy markets were not fully functional. Finally, in a fast-changing world, the actual pro-oil Directive is neither fuel- nor technology-neutral and is therefore hindering innovation and competition. We therefore argue that making all EU energy storage compete on a level playing field could allow the market to select greener and cheaper options, something that should please both policymakers and taxpayers.

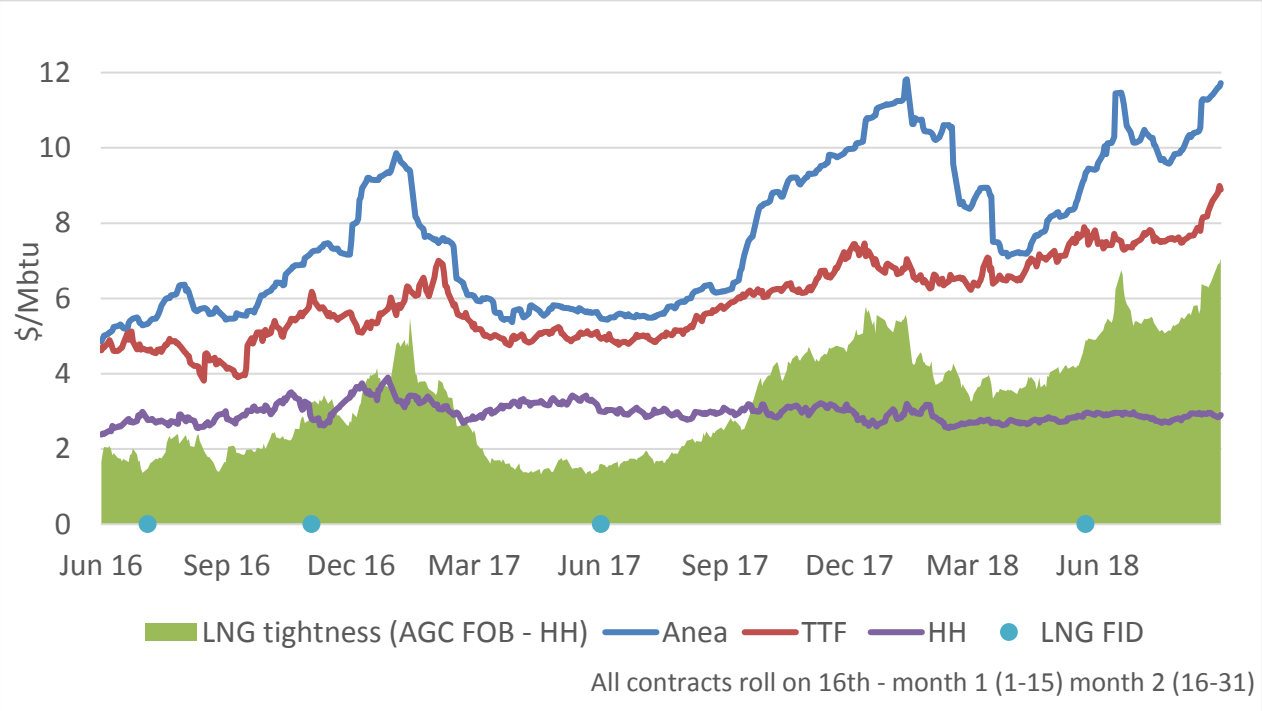
Thierry Bros

Analysis of Prices and Recent Events

Our 'LNG tightness' indicator[1] graph designed with the kind assistance of Argus Media shows:

- TTF Month Ahead (Netherlands) which reflects hub pricing in Europe for both pipeline gas and LNG
- HH Month Ahead (US) which reflects pipeline gas pricing in North America
- ANEA Month Ahead which reflects DES LNG spot pricing in Northeast Asia as assessed by Argus
- The AGC[2] LNG FOB – HH spread, labelled 'LNG tightness': a low spread would suggest a close alignment of worldwide prices (due to higher US prices or increased global competition) while a high spread would suggest that LNG needs to be attracted to demand centres in Asia, Europe, Latin America or the Middle East. A prolonged high spread could also be indicative of the need to invest in new liquefaction capacity. This spread shows the sensitivity of the LNG market: it normally slackens in the summer when Northern Hemisphere gas demand falls but gets tighter during the winter as demand increases
- To better monitor when Final Investment Decisions (FIDs) are taken for LNG projects we also add them[3].

Figure 1: Worldwide gas prices and LNG tightness



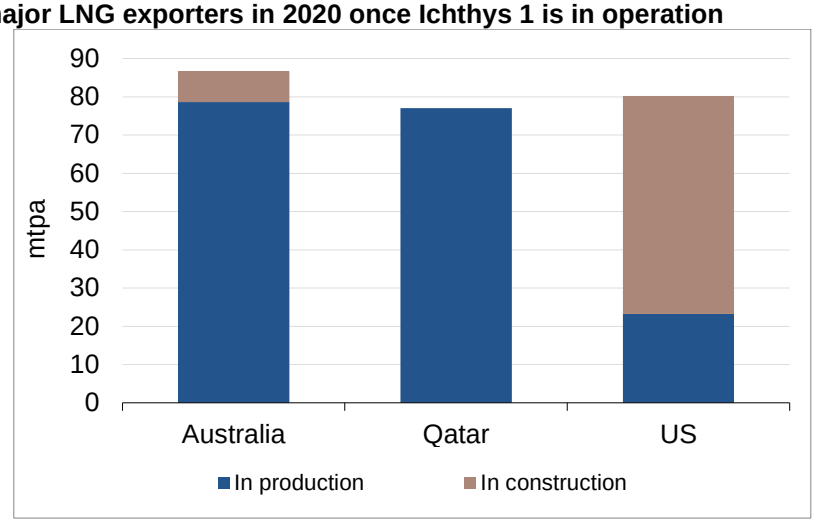
Source: Argus Media, thierrybros.com

[1] T. Bros, March 2018 available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events/
[2] Since 23 August, after consultation, Argus has renamed its US Gulf Coast LNG FOB (USGC FOB LNG) to Argus Gulf Coast LNG FOB (AGC LNG FOB) to better distinguish the Argus physical price assessment from calculated values of Gulf Coast LNG.
[3] For detailed information please refer to Quarterly Gas Review – Issue 2 by T. Bros, June 2018 available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events-issue-2/

It is interesting to keep track of this 'LNG tightness' in a fast-changing LNG world. We witnessed on the supply side the commercial start-up of Wheatstone LNG, train 2 (4.5 mtpa) in June followed, in August, by Yamal train 2 (5.5 mtpa)[4]. This quarterly supply addition represents 2.7% of the total installed nameplate capacity[5]. And on the demand side, Panama and the delayed Bangladesh FSRU joined the ranks of LNG importing countries. There are now 42 countries importing LNG.

In July, Japan's Inpex[6] commenced production of gas from the wellhead at its Australian Ichthys 8.9 mtpa project and remains on track for first LNG production by the end of September. Once train 1 of this project is up and running, Australia will become the largest worldwide LNG producer, ahead of Qatar.

Figure 2: The 3 major LNG exporters in 2020 once Ichthys 1 is in operation



Source: GIIGNL, thierrybros.com

In July, the derivatives marketplace CME Group said it will develop the first physically deliverable US liquefied natural gas futures contract[7] as the US is becoming a key LNG exporter. The contract will take delivery at Cheniere Sabine Pass LNG export terminal in Louisiana. Once launched, it will trade on the CME's New York Mercantile Exchange (NYMEX) like its Henry Hub natural gas futures. This reinforces our idea that LNG is soon to become a liquid commodity and that our 'LNG tightness' indicator is one of the best ways to describe the supply-demand balance for gas on a worldwide level as LNG will balance any unforeseen event.

While the US HH price seems to never move from its c. 3$/Mbtu range, European gas prices recovered since the end of 2017 due to some market tightness then cold snaps in late February and March and finally the need to refill depleted storage during the summer. Except for the US HH, all energy prices are moving up with worldwide coal and European electricity and CO_2 hitting recently multi-year highs.

In Asia, ANEA prices softened in summer going briefly South of 10$/Mbtu in July before rebounding in August as demand in South Korea and China is still strong due to continued coal-to-gas switching to reduce air pollution in major cities. Our 'LNG tightness' shows very well that, this summer, gas markets have not been relaxed, as our indicator never went below 5$/Mbtu showing that all US FOB LNG cargoes have been produced in a profitable way. And again, in July, due to high gas prices at 40$/Mbtu in California, LNG was pulled into Mexico to cool down Californians who kept air conditioners on full blast to mitigate a heat wave[8].

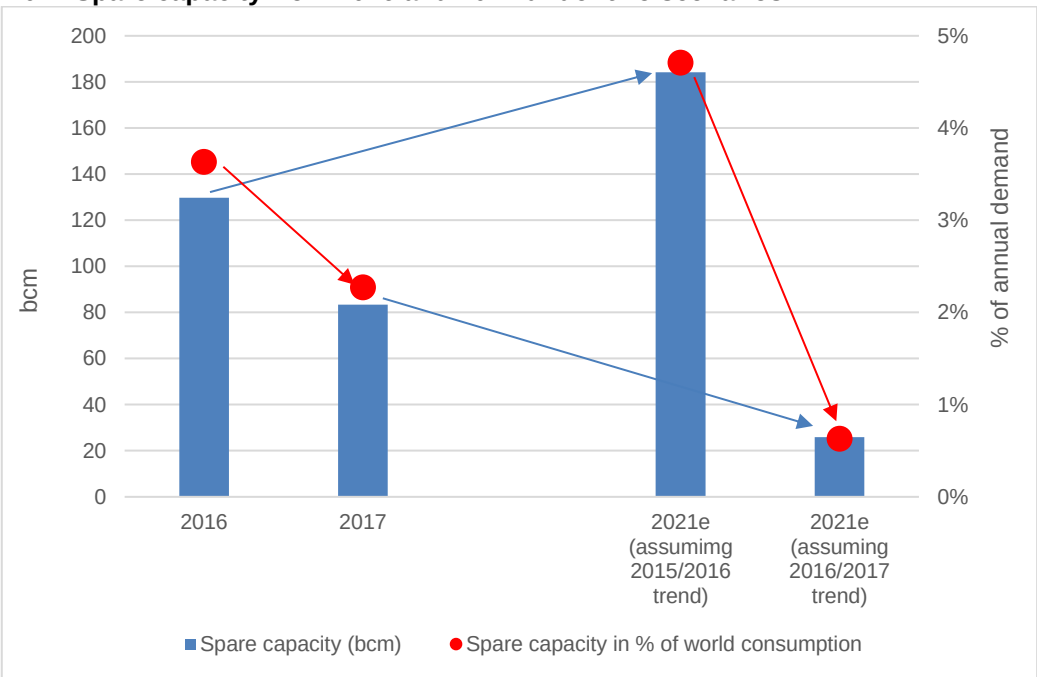
[4] http://www.novatek.ru/en/press/releases/index.php?id_4=2563
[5] 365 mtpa at end 2017 according to GIIGNL Annual report 2018.
[6] http://www.inpex.com.au/news-media/news/inpex-operated-ichthys-lng-project-commences-production/
[7] https://www.cmegroup.com/media-room/press-releases/2018/7/10/cme_group_and_cheniereenergyincreachagreementtodevelopfirst-ever.html
[8] https://www.bloomberg.com/news/articles/2018-07-24/-dangerous-heat-sends-california-gas-prices-to-10-year-high

LNG and soybeans were on the menu of the US-EU[9] meeting held on 25 July in Washington. Thanks to EU importing these commodities, a trade war was avoided as long as negotiations were on-going. In a press release[10] a few weeks later, the EU explained what was already taking place before this agreement: increase of US LNG imports since first arrival in April 2016 and the list of co-financed or committed to co-finance LNG infrastructure projects worth over €638m. We still need to see what the 25 July agreement will add.

Following the publication of our first quarterly review[11], we have updated our estimate of gas spare capacity measured under 2 scenarios:

- For the first, we start from 2016 and assume that the 2015-2016 low demand trend is applied for the full period (we also ran all liquefaction plants at the 2016 load factor: 78 per cent)
- For the second, we start from 2017 and assume that the 2016-2017 high demand trend is applied for the full period (we also ran all liquefaction plants at the 2017 load factor: 79 per cent)

Figure 3: 2021 Spare capacity from 2016 and 2017 under two scenarios



Source: thierrybros.com

The first outcome is obvious: market sentiment shifted from a forever more relaxed supply/demand position (more than 4% spare capacity in 2021e) to an extremely tight one (less than 1% spare capacity) in just a year. Secondly, as a recent KAPSARC study[12] found, OPEC's spare capacity reduces oil price volatility and generates between $170 and $200bn of annual economic benefits for the global economy. A too low gas spare capacity could also be detrimental to the broader economy and to the entire gas industry. This also shows that linear forecasting is always wrong: in a world of ample supplies, lower prices tend to boost demand, while in a tight market, higher prices tend to lead to demand destruction. Investments in spare capacity provide value to the economy because deploying the production held in response to disruptions

[9] http://europa.eu/rapid/press-release_SPEECH-18-4701_en.htm
[10] http://europa.eu/rapid/press-release_IP-18-4920_en.htm
[11] T. Bros, March 2018 available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events/
[12] 'OPEC's Impact on Oil Price Volatility: The Role of Spare Capacity' in the Energy Journal, Vol. 39, No. 2, 2018

saves costs that result from price volatility. Too low spare capacity in oil and gas increases volatility leading to customers moving away from those fuels faster than we could forecast in a COP-21 scenario[13].

The gas industry started to solve this investment problem with Cheniere[14] in May 2018 taking FID on Corpus Christi LNG expansion. But since then, the industry has moved backwards:

- After Schlumberger[15] ended its participation in Fortuna FLNG, operator Ophir Energy, in July, opted to defer the start of capital expenditure for this project to 2019[16], signaling yet further delays to the project.
- Woodside decided, also in July, to pull out of Sempra's 11 mtpa Port Arthur LNG export project in the US as it was not able to provide an adequate return[17].

This news shows that even if the LNG market is and should stay tight in the foreseeable future (as witnessed by our 'LNG tightness indicator'), investors are still worried about adequate returns and will carefully select the right projects. But with our 'LNG tightness' that doesn't show the usual summer dip, we are now even more confident that other FIDs are going to be taken sooner rather than later.

Finally, in early August, China planned to impose a 25% tariff on US LNG exports as a retaliation against Trump trade barriers[18]. This could delay new FID in the US but could push the LNG market to become soon a fully traded commodity as more reloads, more changes in destinations and swaps will be needed to accommodate this Chinese tariff proposal (FOB would become the preferred option to take delivery of LNG). This could also impact our 'LNG tightness' indicator, built on the assumption of free trade from the US Gulf of Mexico. If US cargoes were avoiding China, then we would need to reconsider our metric. But the other likely destinations to measure a worldwide LNG netback have major drawbacks: Australia or Qatar, the 2 other major producers, do not sell their LNG FOB and Europe, that provides reloads, does not produce LNG.

Brexit update

After more than a year of talks, the UK Government finally published a White Paper[19] "The future relationship between the United Kingdom and the European Union" where climate change[20] and electricity and gas[21] are mentioned. Interestingly electricity interconnectors are mentioned[22] but the White Paper is silent about gas interconnectors. About the European Trading Scheme (ETS) that provides a trading price for CO_2, it says: "The UK's world leading climate ambitions are set out in domestic law and are more stretching than those that arise from its current obligations under EU law. The UK will maintain these high standards after withdrawal". This tends to show that the UK will not remain in the ETS. Also, the EU "polite" answer to the UK White Paper was that Brexit cannot and will not justify increased bureaucracy in Brussels[23]. This smart answer makes it even more likely that the UK will leave the ETS post-2020 as the EU will not provide a better link than Switzerland. After years of negotiations, the EU and Switzerland signed, in November 2017, an

[13] For example, in the face of high oil prices, electric vehicles are becoming more appealing to customers even if they still lack some autonomy.
[14] T. Bros, Quarterly Gas Review – Issue 2, June 2018 available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events-issue-2/
[15] Information provided during Golar Q1 2018 results on 31 May available at http://www.golarlng.com/investors/press-releases/pr-story.aspx?ResultPageURL=http://cws.huginonline.com/G/133076/PR/201805/2196480.xml
[16] https://otp.tools.investis.com/clients/uk/ophir_energy/rns/regulatory-story.aspx?cid=1111&newsid=1113200
[17] https://www.reuters.com/article/us-woodside-lng-sempra/woodside-exits-sempra-port-arthur-lng-export-project-in-texas-idUSKBN1KA2TA
[18] https://www.bloomberg.com/news/articles/2018-08-03/china-proposes-25-tariff-on-u-s-lng-in-retaliation-to-trump
[19] https://www.gov.uk/government/publications/the-future-relationship-between-the-united-kingdom-and-the-european-union
[20] Page 40 of the white paper
[21] Page 44 of the white paper
[22] Paragraph 139 of the white paper
[23] M. Barnier speech on 20 July 2018

agreement to link their emissions trading systems[24] allowing ratification when both sides are technically ready.

As we have already mentioned, if the UK leaves the ETS on 31 December 2020 without the EU having implemented a strategy to cut further permit allowances, the EU ETS will nose dive. If the EU wants to be stronger and united, it is now the perfect time to sit down and think of a more robust EU-27 ETS system able to deliver what citizens want: a greener world[25].

[24] https://ec.europa.eu/clima/news/eu-and-switzerland-sign-agreement-link-emissions-trading-systems_en

[25] Please refer to T. Bros, Quarterly Gas Review, June 2018, available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events-issue-2/ and T. Bros, EU ETS: fasten your seat belts, June 2017, available at https://www.oxfordenergy.org/publications/eu-ets-fasten-seat-belts/

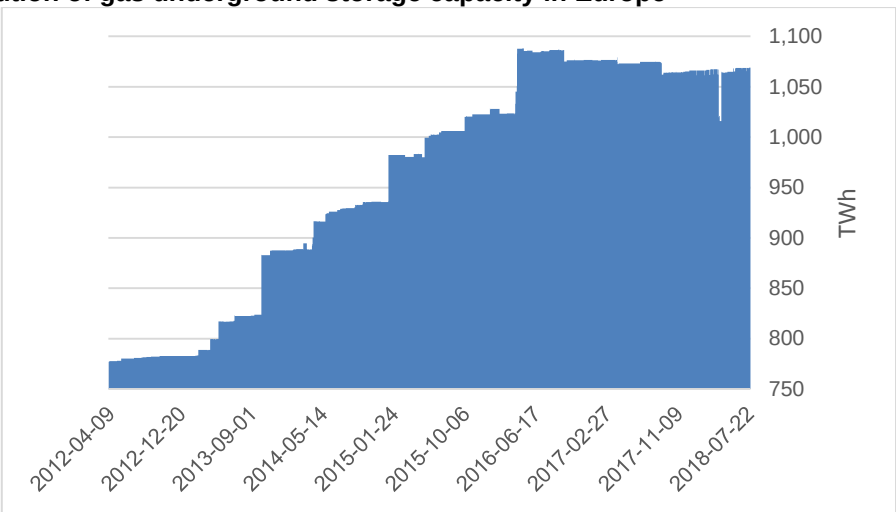
How Europe could profit from becoming the worldwide energy storage provider

The EU Commission published in September 2017 an LNG and storage strategy[26] where the LNG part was compromised[27] by compliance issues and lack of knowledge. But the concept of revisiting EU storage in a more liquid LNG market is to be praised. And this just before we saw the first Yamal LNG cargo loaded in December 2017 arriving in Boston in January 2018. And in July, LNG was pulled into Mexico to cool down Californians. We therefore could envisage a situation in the future where Europe becomes the worldwide energy storage operator. Europe would also benefit from the fact that the only spare gas production capacity is available next door, in Russia (83 bcm in 2017)[28]. This coupling of Russian spare capacity and high European storage capacity are currently providing the only global buffer to balance worldwide supply and demand.

With LNG supply growing, the storage business will be impacted, as we've already seen this winter. Europe, which is currently long on storage,[29] should focus on this to find an alternative solution to the one being pursued today, namely closing down storage. Too high maintenance capex in front of a poor winter-summer spread forced Rough storage in the UK to be decommissioned. LNG supply cannot provide any swing capacity at liquefaction plants that operate at a worldwide load factor of 79% but can provide it at the regas level (more ships berthing during winter) and more importantly, the more LNG carriers, the more LNG on the water that can be considered as storage. This is an old oil concept that could become important for gas traders in the future.

Even if seasonal facilities are increasingly being eclipsed by shorter term storage that cycles many times during the year, and for these facilities deliverability is a more important measure than working capacity, we decided to look at the actual energy in storage. For this paper we therefore looked only at the working storage capacity of underground gas storages[30].

Figure 4: Evolution of gas underground storage capacity in Europe

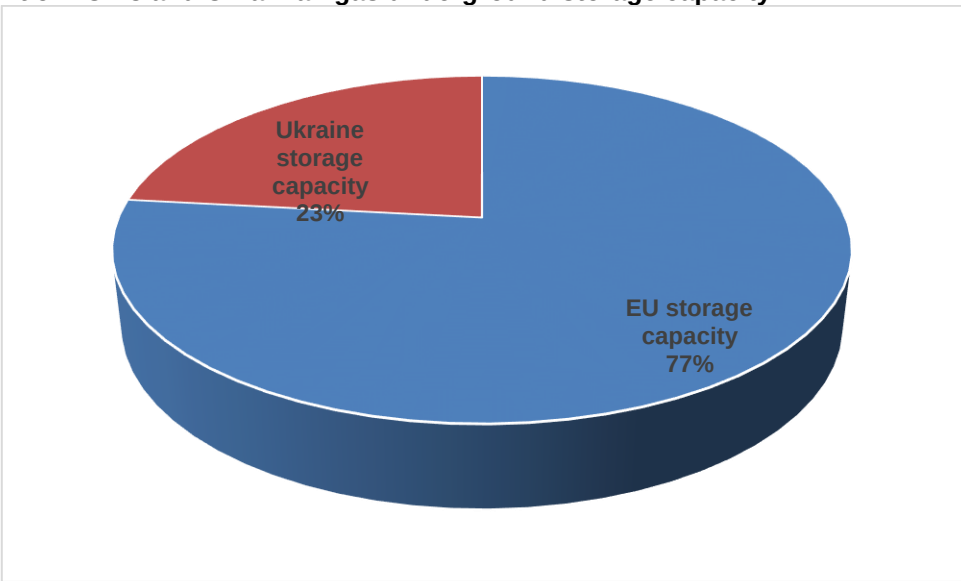


Source: GIE, thierrybros.com

[26] https://ec.europa.eu/energy/sites/ener/files/documents/follow_up_study_lng_storage_final_01.pdf
[27] https://www.naturalgasworld.com/premium-55663
[28] Please refer to T. Bros, Quarterly Gas Review #1, March 2018 available at https://www.oxfordenergy.org/publications/quarterly-gas-review-analysis-prices-recent-events/
[29] If we focus the analysis on Europe only. As described in this paper if Europe provides the storage service for the whole Northern Hemisphere then storage capacity could even be viewed as too low.
[30] We took no account of LNG tank capacity.

According to the Gas Infrastructure Europe (GIE) transparency platform[31], EU storage capacity reached a maximum of 1,085 TWh in 2016 before declining to 1,069 TWh in 2018 with some closure (Rough 30 TWh) and some mothballing. Including Ukrainian storage capacity[32] would bring the total capacity to 1,393 TWh.

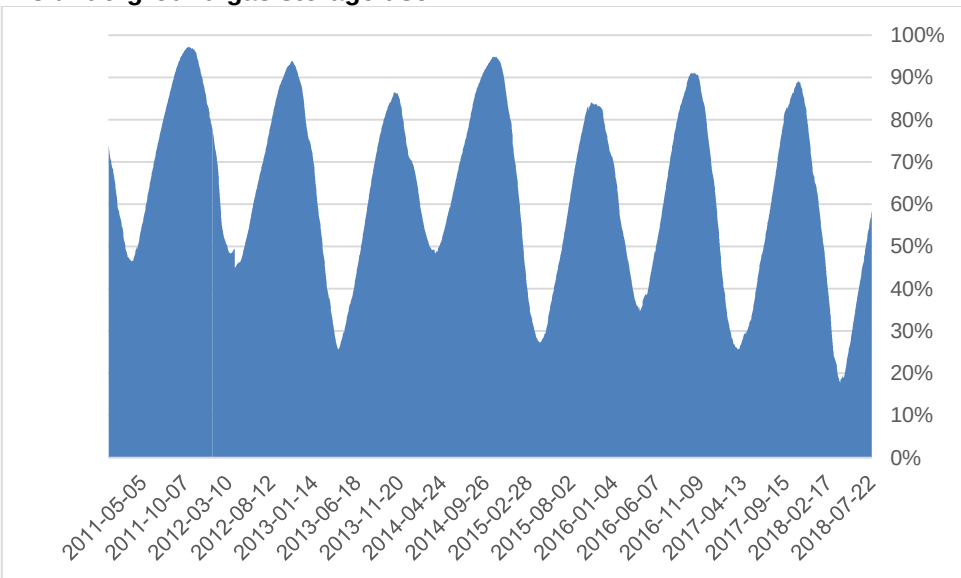
Figure 5: Split of EU-28 and Ukrainian gas underground storage capacity



Source: GIE, thierrybros.com

While EU storage is fully used (95% full at the beginning of winter), Ukrainian is much less used (max 55% in October 2015).

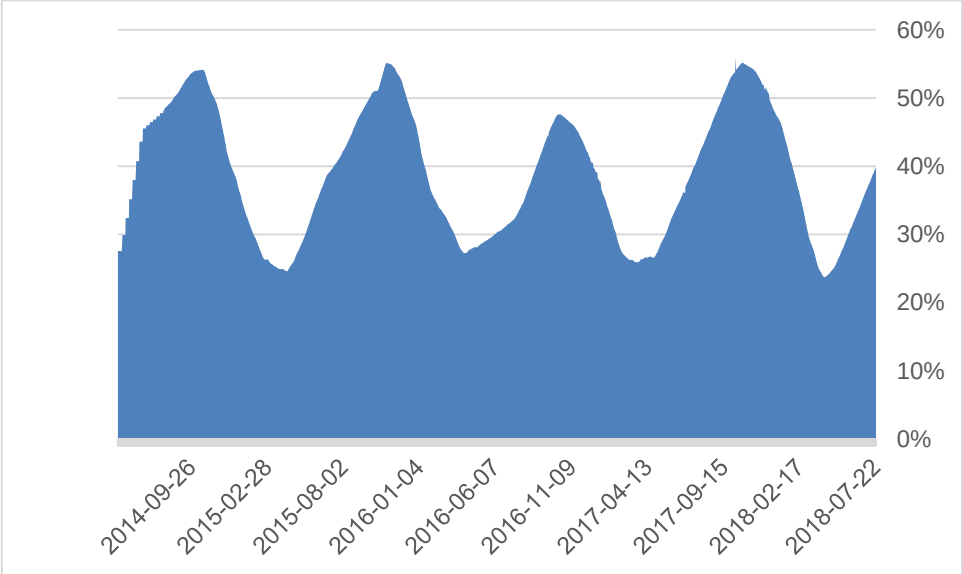
Figure 6: EU-28 underground gas storage use



Source: GIE, thierrybros.com

[31] https://agsi.gie.eu/#/
[32] Using the data provided by Ukrtransgaz to GIE

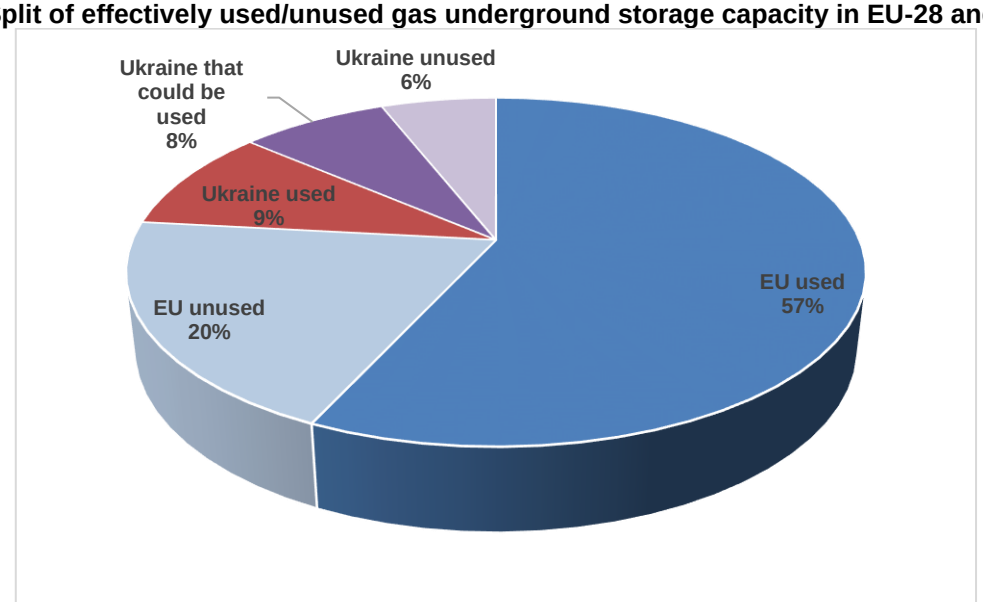
Figure 7: Ukraine underground gas storage use



Source: GIE, thierrybros.com

The maximum volumes used in the EU-28 and Ukraine are respectively 793 TWh (74% of the total capacity) and 133 TWh (41% of the total capacity). If Ukraine achieved an EU-28 usage level, there could be an extra 108 TWh of effective storage room in Ukraine alone. That is equivalent to an extra 8% of total combined storage capacity.

Figure 8: Split of effectively used/unused gas underground storage capacity in EU-28 and Ukraine



Source: GIE, thierrybros.com

With Ukraine willing to integrate further with the EU and Ukrainian storage already reporting their daily level via the GIE transparency platform, the options going forward are:

- Could there be more closures to make the remaining storage profitable?
- Could we all benefit from more storage by designing a new business model in an energy transition world?

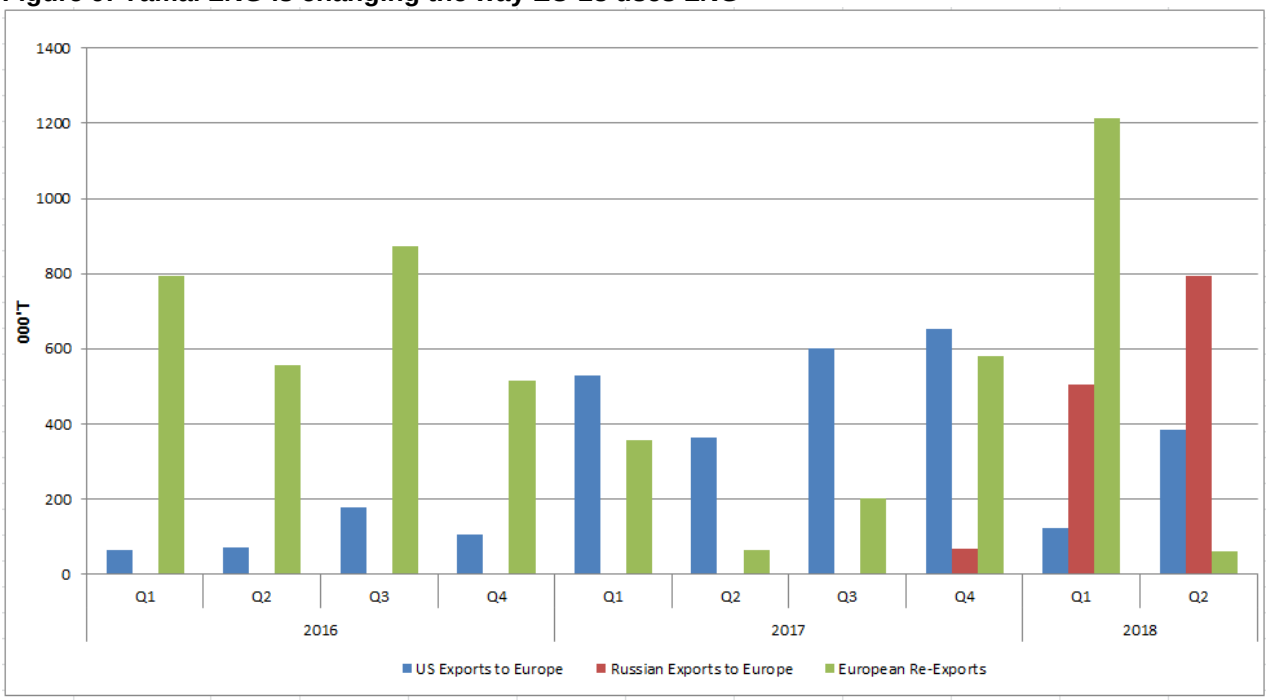
In short, in a business as usual scenario, the integration of Ukrainian storage will make every storage operator in Europe worse off. Hence, the only way for the EU to benefit from this extra storage is to revisit the seasonal energy storage concept. From being a major underground storage operator, the EU is also becoming an LNG storage operator able to store LNG/gas on a worldwide level (to provide LNG to Boston, China, etc.) as Yamal LNG cargoes have to come in winter into EU waters. The EU is not only increasing its security of supply but should also revisit the way it could store energy in the future. A new energy storage strategy could be designed for the benefit of the EU, its citizens and companies operating there. By relying on markets, Yamal LNG allows even more LNG price-driven arbitrage in Europe. This can be achieved:

- directly from ship-to-ship or transshipment via the jetty not even accounted as LNG received in Europe (unless the second ship arrives in another EU regas terminal), or

- using the terminal storage tanks as an intermediary, blurring the country origin of the gas.

In this latter case, the LNG will be accounted as both received (with a country origin) and re-exported. We argue that the reloads that the EU provided post-Fukushima and are now being provided by the Yamal business model which has to ship cargoes west in winter, could also be viewed as storage as the LNG transits via EU tanks.

Figure 9: Yamal LNG is changing the way EU-28 uses LNG



Source: Cedigaz

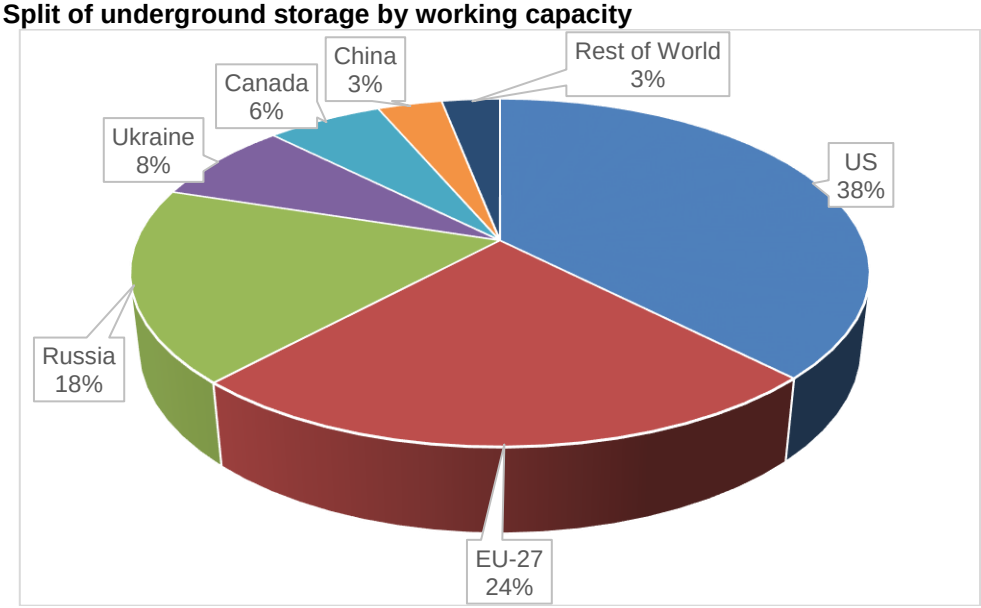
This graph shows that thanks to trading markets, the EU is able to take the cheapest LNG, from Yamal, which has pushed out US LNG in H1 2018. Going forward, to attract (US) LNG or retain (Yamal) LNG, the

EU price must be competitive with other major demand markets. And for the first time, North West Europe is in August exporting more LNG than it is feeding into the region's pipeline networks[33].

All the directives, rules and regulations published by the EU Commission in the last 20 years to allow an efficient internal energy market can also now benefit Europe as the only demand area where LNG price arbitrages can take place. Following our work on the 'LNG tightness indicator' we tend to believe, like CME, that the trading of a worldwide LNG index could start in the US Gulf of Mexico (please see first part) but the physical worldwide storage could be held in the EU. EU gas storage operators could benefit not only from local winter-summer spreads (that are too low to keep all storage in operation) but also from any worldwide spike that could trigger some reloads from the EU. In addition, if all energy storages are in competition inside the EU we will be able to plot a merit curve (that could be dynamic and change with time) allowing EU customers to benefit from the cheapest options and countries further away (US and China for example) to use the expensive options if they need.

To evaluate the EU storage options we must first look at a worldwide split of storage.

Figure 10: Split of underground storage by working capacity

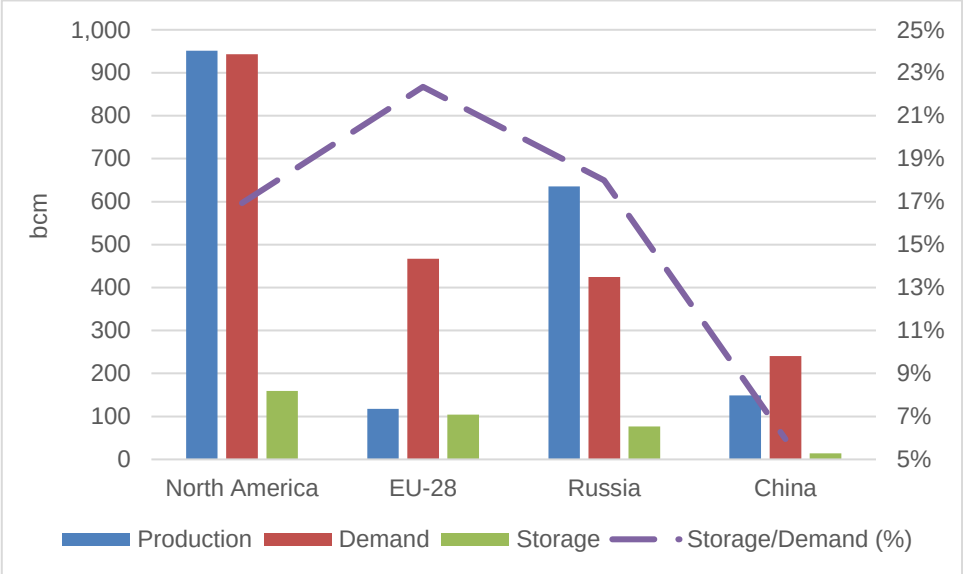


Source: Cedigaz (with end 2016 storage data), thierrybros.com

This split is not very relevant for our exercise as even with the biggest storage capacity, as we've seen recently, the US needed to call on LNG on the water to mitigate the impact of unexpected weather patterns. Hence the need to look at another metric to understand how major demand centres are operating. On top of the 3 actual major centres, we added China as this country is now the biggest gas importer and we looked at storage vs demand.

[33] https://www.bloomberg.com/news/articles/2018-08-21/lng-heads-out-the-door-as-asia-outbids-european-utilities

Figure 11: 2017 production, demand and underground storage capacity in major gas markets



Source: Cedigaz (with end 2016 storage data), BP Statistical Review June 2018, thierrybros.com

Because it has imported gas for many years, EU-28 has designed a resilient gas infrastructure with more underground storage capacity than the 2 other demand areas.

Even the major exporter, Russia, that has as much (in % terms) storage as the US, would like to expand its storage capacity as gas needs to be delivered to domestic customers during harsh winters.

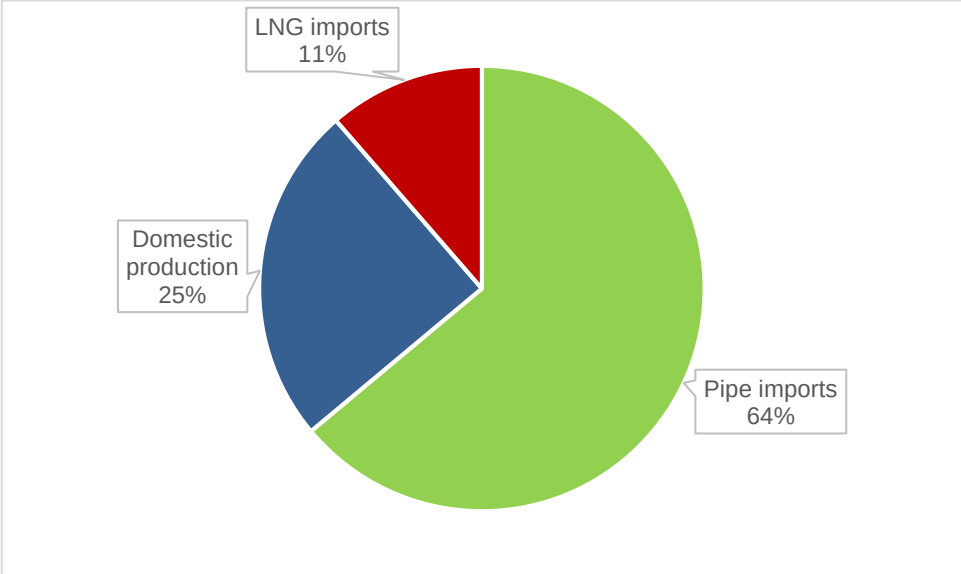
To avoid a repeat of the January 2014 price spike, the US, whose industry was designed at a time of conventional production, could have invested in extra storage. But the price spike was then so short-lived that this investment made no economic sense. It was a local problem and a local solution was found (higher prices in the region affected). The January 2018 cold bomb cyclone was similarly a local problem but this time, as markets are more interconnected, the solution was both local (higher prices) and global (rerouting of LNG cargos). And in July 2018 LNG was pulled into Mexico to cool down Californians because access to the Aliso Canyon storage facility was restricted after a 2015 leak makes it more difficult to meet demand[34]. Those examples show that even North America with high production and high underground storage capacities needs LNG to mitigate the impact of unpredictable extreme weather patterns.

China is using LNG as a substitute for its lack of underground storage even more. The Chinese National Development and Reform Commission targets to continue to promote gas consumption. China should increase the share of gas in its primary energy mix to 10% by 2020 and 15% by 2030 and expand underground gas storage capacity to 35 bcm by 2030. But even this more than doubling of the storage capacity by 2030 will not change the overall picture: China will have, in demand percentage, much less storage capacity than any other major gas markets[35]. It is also interesting to compare how the 2 biggest importers source their gas.

[34] https://www.bloomberg.com/news/articles/2018-07-24/-dangerous-heat-sends-california-gas-prices-to-10-year-high

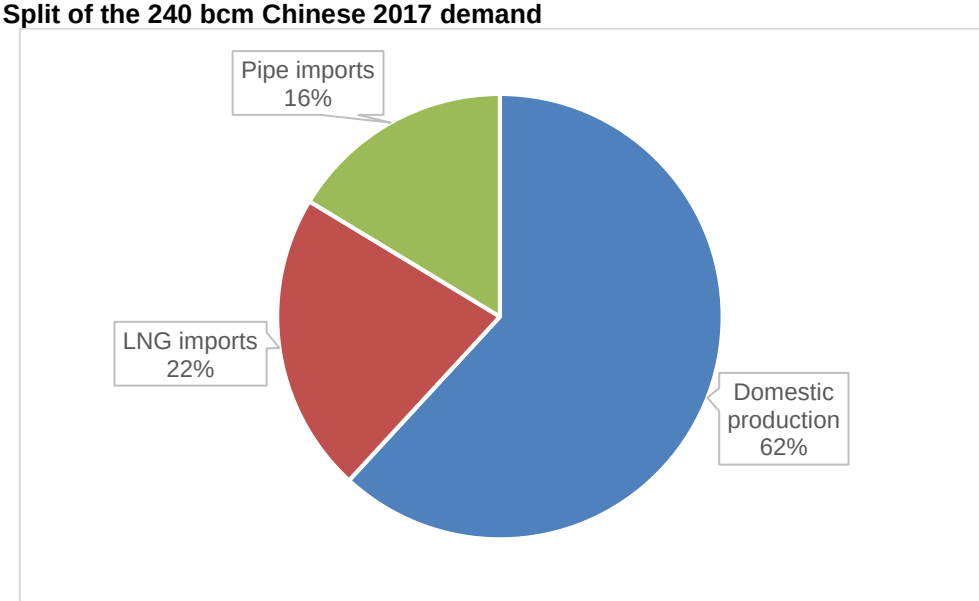
[35] In fact, due to seismic reasons Japan has very little underground storage and is using LNG tanks to balance supply and demand on a seasonal level.

Figure 12: Split of the 467 bcm EU-28 2017 demand



Source: BP Statistical Review June 2018, thierrybros.com

Figure 13: Split of the 240 bcm Chinese 2017 demand



Source: BP Statistical Review June 2018, thierrybros.com

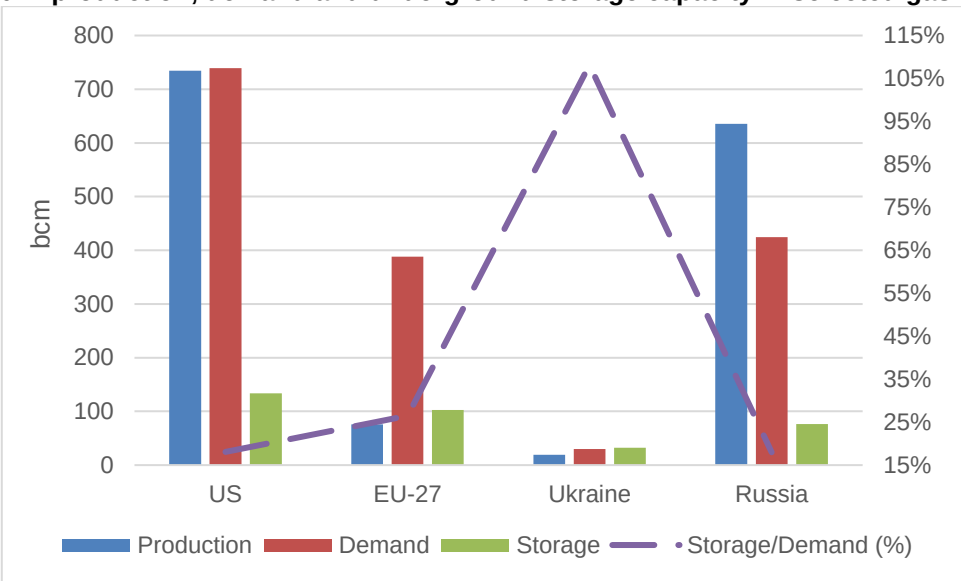
Interestingly, both markets imported the same amount of LNG in 2017 (c. 53 bcm). But China will, from December 2019, have a new and direct access to 38 bcm/y of Russian pipe gas (via the Power of Siberia pipeline) meaning that the LNG flow patterns could change post 2020. But with the design capacity[36] of the Power of Siberia not much above the long-term contract level, once the ramp-up is complete (post-2026),

[36] As the Amur gas processing plant in Russia just before the Chinese border has a 42 bcm/y capacity, we can assume that the maximum capacity of the Power of Siberia is the same. For more info https://static1.squarespace.com/static/5795c94359cc68a490d7c0b9/t/57ff864dd1758eabfaca10a3/1476363862304/TBROS+From+Nord+Stream+1+to+Power+of+Siberia+1+article.pdf

China will have to use this line as baseload and rely on LNG for seasonal swings as its storage capacity will still be too low.

On the political level, the EU is going through some changes with the UK (with very little storage capacity) leaving and Ukraine willing to integrate with the Energy Union, so that we need to fine tune this first analysis by first focusing on the EU-27 without the UK after Brexit.

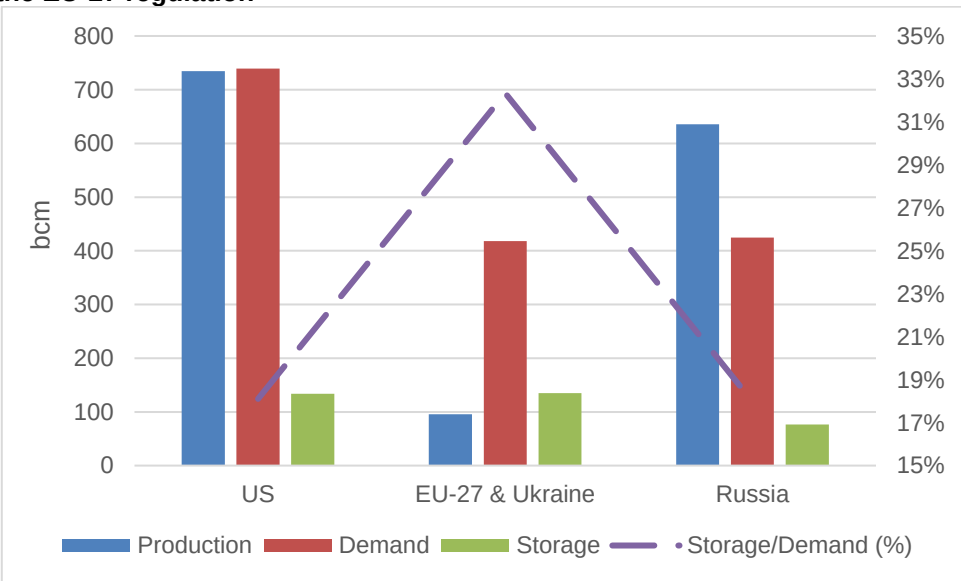
Figure 14: 2017 production, demand and underground storage capacity in selected gas markets



Source: Cedigaz (with end 2016 storage data), BP Statistical Review June 2018, thierrybros.com

And if Ukraine manages to meet EU gas requirements (in particular full unbundling), a better picture for this exercise could even be integrating EU-27 and Ukraine.

Figure 15: 2017 production, demand and underground storage capacity post-Brexit with Ukraine integrating the EU-27 regulation



Source: Cedigaz (for end 2016 storage data), BP Statistical Review June 2018, thierrybros.com

This shows that the EU-27 & Ukraine are way longer in storage than the 2 other major consumers (US and Russia) without mentioning China's lack of storage. This leads us back again to the same question: what to do with this enormous gas underground storage capacity?

The first obvious answer would be: in a capitalist world, the least profitable storage will, sooner or later, have to close down to allow the remaining storage to become profitable. And we could guess that at the end of the process we would have a picture that would look more or less the same in terms of % of demand covered by storage in all major markets (18% in the US and Russia and up to c. 26% in the EU-27+Ukraine). In this case, integrating Ukraine into the EU-27 will lead to a massive storage closure and hence value destruction.

Alternatively, the EU could re-visit the global gas markets keeping in mind that:

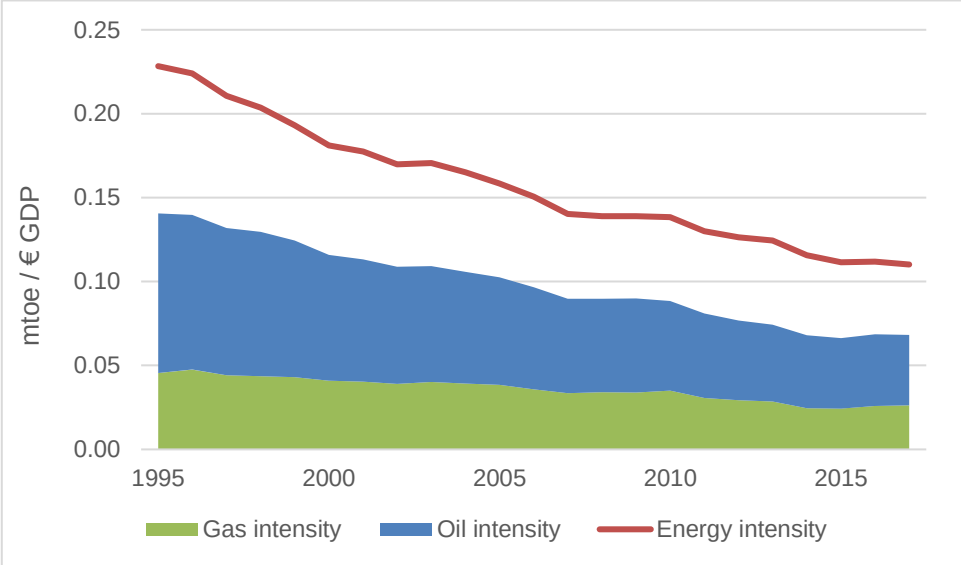
- Seasonal storage can only be provided with gas storage so far and it would need to find ways to keep present capacities on-line before any alternative cost-effective technologies are mature;
- China will still depend on LNG swing as a substitute for its lack of storage until after 2030;
- If Ukraine storages are filled more, in an interconnected market they could increase the Security of Supply of Eastern European Countries (and this even more if Nord Stream 2 is built).

The EU could therefore re-think storage use in a global world in energy transition. Traders could continue to grow LNG transshipments and re-loadings while profiting from those price arbitrages while using even more European underground storage. If LNG is reloaded away from EU tanks to higher priced markets, EU storage will be called more to balance the domestic supply-demand balance. Using more reloads should, as stated earlier in this paper, increase European Security of Supply and trade (im)balance. Everyone in the EU wins! In short, before China manages to build its storage capacity the European gas industry could provide this service to China, that won't have any alternatives (and would therefore have to pay for it). In an intermittent renewable world where additional energy is provided by gas producers that might lack the required spare capacity, it would be foolish before closing around 10% of their storage capacity not to think first of any alternative mechanism that could be profitable and/or increase Security of Supply.

Strategic oil stocks are a 1970s solution that needs updating both from economical and climate change perspectives

In the 1970s OECD countries designed strategic oil storage mechanisms to mitigate the impact of any supply disruption. While oil accounted for more than 50% of the EU energy mix in 1970, it now only accounts for 38%. On the other hand, the gas market share moved up during the same period from less than 10% to 24%. This means that with our energy intensity (energy needs per unit of GDP) trending down, oil is much less valuable for the EU economy today than it was in the 1970s. In 2017, EU energy intensity decreased by 1.5% compared with a -2.4% CAGR for the 2007-2017 period. This relatively poor overall performance was achieved as gas intensity increased by 1.1% between 2016 and 2017, showing that we are moving away from oil into gas

Figure 16: Gas, oil and total primary energy intensity in the EU-28



Source: BP Statistical Review June 2018, RichesFlores Research, Macrobond, thierrybros.com

With gas becoming more important than oil, it would therefore make absolutely no sense to close European gas storage capacity while continuing to have large strategic oil stocks that are very seldom used. If in 1974, oil stocks were needed due to the oil intensity of the EU economy this is much less the case today. Also in a world that is more and more electrified and where extreme weather patterns are more and more likely, gas stocks are much more useful than oil stocks that cannot, in the EU, be used to generate electricity. The money spent by taxpayers on those strategic oil stocks would be much better used to keep gas storage capacity on-line.

If some strategic oil storage is still needed for military purposes[37], then this should be looked at on a different level but not mixed with civilian energy storage, which is needed to avoid blackouts and make the economy more resilient.

EU should move from an oil stock obligation to an energy storage obligation

In an energy transition world, regulation must now be updated to avoid discrepancies between different conflicting goals. Strategic Petroleum Stocks are an example of an old outdated concept that served well in the 70s but not in today's world where electricity is more important than oil. The Australian 2016-2017 case where Tesla batteries have been deployed to avoid blackouts shows us that strategic oil stocks have fewer and fewer uses.

The EU was the first to allow refined products in strategic oil stocks[38]. But the 2009 Council Directive 2009/119/EC "imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products"[39] was designed at a time when oil was more relevant than today, the energy transition hadn't really started, and energy markets were not fully functional. The EU should now move one step ahead and replace the concept of strategic oil storage by strategic energy storage. This could be done by setting an amount of energy to be stored for the EU and the Energy Community and allowing market players to come with the cheapest solution for this. Gas storage would, because of the sunk cost and the need to meet

[37] See T. Bros Chapter "Energy Security" of the Book "The Oxford Handbook of International Security", March 2018
[38] More information on https://ec.europa.eu/energy/en/topics/imports-and-secure-supplies/eu-oil-stocks
[39] https://eur-lex.europa.eu/legal-content/EN/ALL/;jsessionid=0g1BTRSFG7fv1TNKJvrNFLqnrfYl5nLWpxHSXp6gpK5JvvN9v516!2097610408?uri=CELEX%3A32009L0119

regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply[40], be able to compete before electricity batteries (or any other technology) take over. It would reflect our climate change concerns and our need to move away from oil with actual water reservoirs for hydroelectricity taking a preeminent role[41]. It would increase our resilience and provide some needed revenues to European gas storage operators if they can compete vs the present oil storage operators. A review of this 2009 directive is now urgently needed to ensure policy remains fit for purpose. The International Energy Agency (IEA) might object to this EU change but fortunately the IEA has other issues to deal with[42]. The energy abundant US, that is already releasing some volumes to raise money[43], shouldn't much object to a change in EU internal energy regulation that would be for the benefit of integrating Ukraine and making Eastern European states wore resilient. Russia, as the only country in the world with spare production capacity and both trading capabilities and storage in the EU, would also benefit from this change. And the climate change lobbyists should use this change in regulation to push for an even faster energy transition, as the actual Directive will look more and more obsolete in a post-COP21 world where we should use less coal and oil. In the longer term, the EU will eventually also have to make sure that electricity storage technology is provided with minimum geopolitical risks (in particular the availability of the chemical elements[44]). But until we achieve this, why not use gas storage? The actual pro-oil Directive is neither fuel- nor technology-neutral and is therefore hindering innovation and competition in a fast-changing energy world; it therefore needs to be revised. The actual wording doesn't even recognize the greener way to store energy (gas stocks and water reservoirs for hydroelectric plants). The system should also be dynamic to allow each fuel to be stored when it is cheapest[45]. In this case some additional work will be needed to assess the difference between short and long-term storage capacities.

To be as competitive as possible gas storage would have to rely on the present sunk infrastructure and the gas industry would have to decide whether to fast track the Quo Vadis[46] idea of the EU Commission that wanted a single EU network[47]. The actual pancaking of entry/exit fees could make gas storage uncompetitive but that would be an industry choice and the market will rightly find a cheaper energy storage option. The Ukrainian gas industry would also need to be fully unbundled and be competitive; if Ukrainian transport fees and/or storage fees are too high vs all alternatives then the market will rightly select a cheaper way to store energy. The latest transit fees proposal is better than the one discussed in "Has Ukraine scored an own-goal with its transit fee proposal?"[48] but is still uncompetitive vs Nord Stream 1. And the price increase for gas underground storage imposed by the state gas shipper Ukrtransgaz on 1 August is a step in the wrong direction[49].

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[40] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.280.01.0001.01.ENG&toc=OJ:L:2017:280:TOC

[41] In some countries like Brazil we effectively see that LNG is used as pricier storage when water reservoir levels are too low.

[42] The IEA aim is to integrate more countries to increase the amount of world strategic oil stocks in a world where oil consumption should be curtailed and to provide long-term analysis and price forecasts that never materialise.

[43] https://www.bloomberg.com/news/articles/2018-08-20/u-s-to-sell-11-million-barrels-of-government-oil-in-october

[44] 49% of the cobalt comes from Congo and 47% of the lithium comes from Chile (BP Statistical Review). And in OECD, only Australia and the US have rare earth reserves with only respectively 2.8% and 1.2%.

[45] Innovative companies / traders could, for example, provide a mixed energy storage offer allowing them to reduce cost by selecting the cheapest fuel at any time (water reservoir in spring/summer replaced by gas in summer/fall) taking planned maintenance into consideration.

[46] The study "Quo Vadis EU gas regulatory framework" was carried out to analyse whether the current regulatory framework in the EU gas sector is efficient in order to maximise overall EU welfare or whether changes may be necessary, and if so provide recommendations. More info on https://ec.europa.eu/energy/en/studies/study-quo-vadis-gas-market-regulatory-framework

[47] For a Quo Vadis proposal see T. Bros & Sund Energy "Designing gas markets for the future, better for consumers and simpler for producers" available at https://static1.squarespace.com/static/5795c94359cc68a490d7c0b9/t/5821d9f25016e1bf5d3f358b/1478613499400/Designing+better+gas+markets+final.pdf

[48] T. Bros, November 2016 available at https://www.oxfordenergy.org/publications/ukraine-scored-goal-transit-fee-proposal/

[49] Info not available in English on the company website. On 10 August the old tariff was still available on the English web on http://utg.ua/en/utg/business-info/tariffs.html. The 6 August Press release is only available in Ukrainian at http://utg.ua/utg/media/news/2018/08/ukrtransgaz-perehodit-na-novi-taryfy-zberigannia-gazu-v-psg.html

The new proposal will make the European gas industry consider its own responsibilities: if companies along the gas chain are willing to compete in a low-cost energy world they have a chance, if they still behave as a rent seeking industry then the market will rightly leap frog from oil storage to electricity storage.

Following the recent EU-Russia WTO energy dispute settlement[50], the Commission is now in a much stronger position vis-à-vis full unbundling. After 20 years of negotiations with its Member States and most gas operators dragging their feet to implement unbundling, if the EU Commission wants to go for full ownership unbundling all over the EU, it could now go ahead with a new directive proposal. As the 2016 "Quo Vadis" study imagined, the EU Commission could even aim at a single EU-wide wholesale and tariff system. The Commission could even favour "diversification of supply" smartly with a 2 entry fees system. The general entry could allow all suppliers to enter the EU gas market on a level playing field as long as no-one has a market share above 40%[51]. A much higher entry fee would be levied if one supplier gets above this level. The 2 exit fees would differentiate customers needing Security of Supply (premium) and others. Following the WTO ruling, European transportation companies won't be in a position to resist this simple and easy to grasp design that would benefit consumers. This will also preserve competition.

This market-based system would also allow China to be in a position to reload as much LNG as it needs from the EU as long as it pays a price covering all costs and providing the traders with a profit. It would mitigate the effects of any Chinese winter spike demand and would also allow the Chinese authorities to have a market price of storage. They would then decide whether to pursue their (expensive) strategy[52] to grow gas storage or they could even decide (less likely) to continue to use EU storage via LNG reloads and to move directly into electricity storage to avoid investing in a technology (gas storage) that could become stranded if cheap batteries are available soon thanks to their own research.

The idea of a global approach to energy storage goes well with the Energy Union initiated by the present Commission. Also in a world where tax euros have to be spent in the wisest way, moving away from an OECD oil-storage to an EU-energy storage policy should be less costly (more fuels will compete) and more protective to EU consumers. Diversification of storage would also allow more risk-mitigation, at a time when extreme weather patterns are on the rise. It could therefore be an idea for the next Commission in 2019. As usual the devil is in the details when drafting a new directive, but a common sensible position could be ironed out in less than 5 years. A very simple way to start would be to have an exact value of the strategic oil storage total cost and to allow any energy storage operator to bid and to select the cheapest bidders (on a €/MWh[53] basis as we are moving away from oil into electricity). If oil is the cheapest, everything will stay the same, if hydro reservoirs, gas underground storage or LNG in tanks are cheaper, we would collectively have more energy stored for the same tax payer burden. And we suspect that by just starting this process, all energy storage operators would be willing to compete with oil, which is unfairly benefiting from a protected position that makes no more sense today. A market approach will also allow the most expensive EU-wide storage options to be closed down and the cheapest / most innovative solutions to thrive. It will be a truly EU wide solution to one of the great climate change challenges we have to solve fast.

[50] https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds476_e.htm#bkmk476r
[51] To meet article 102. Please refer to http://ec.europa.eu/competition/antitrust/procedures_102_en.html
[52] The National Development and Reform Commission (NDRC) recently issued special measures to allow central government subsidies for gas storage in the prioritized regions critical to China's air pollution control
[53] And with the UK out of the EU, the latter would be in a perfect position to discard any British units like MBtu or th.