NATO ENERGY SECURITY
CENTRE OF EXCELLENCE

ENERGY HIGHLIGHTS

Content

Impact of COVID-19 on NATO energy security - view on fuels, gas and renewable energy

by **K. H. Juutilainen, Ugnė Grikinytė**

SUMMARY

COVID-19 has caused exceptional turmoil in world energy markets and societies, but long term effects are extremely hard to assess. The pandemic was an additional "trouble layer" on an already distressed international system suffering economic problems, international power completion and rising tensions within countries.

From a short term perspective, NATO energy security was not hindered during 2020 and both alliance and its individual member countries had secure energy security. From mid and long term perspectives, closure of European oil refineries are problematic for NATO energy security, since it lowers resilience during conflict. Oil refinery capacity will move to China, which is bound to be the world's largest oil refiner in a few years. Remaining refineries have to increasingly compete with Asian refineries. COVID-19's impact on gas and energy security has been minor, but as a whole NATO energy security needs more diversified natural gas imports and better gas transmission infrastructures in Europe. Renewable energy was most resilient during the pandemic, but fossil liquid fuels clearly remains the primary energy staple. Renewable energy is not a threat to NATO energy security, since it lessens dependency of hydrocarbon imports. Also, the use of liquid biofuels was technically already tested by NATO armed forces almost a decade ago. The expansion of the NATO pipeline system to the Eastern Flank has been long delayed. Expansion would improve NATO energy security during a more lethal pandemic, armed conflict or other contingency while lowering carbon dioxide emissions. More flexible acquisition and training planning processes would allow enlargement of strategic crude oil storages and especially increase military flight hours.

Information cut-off date of this product is 8 December 2020.

INTRODUCTION

The coronavirus (COVID-19) pandemic has created the biggest global crisis since WWII, sending shock waves through health systems, economies and societies around the world. Confronted with an unprecedented situation, governments are focused on bringing the pandemic under control and reviving their economies.

The energy sector is also severely affected by the pandemic, which has slowed transport, trade and economic activity across the globe. According to the International Energy Agency, (IEA) countries in full lockdown are experiencing an average of 25% decrease in energy demand per week and countries in partial lockdown, an average decrease of 18%. (IEA 2020) Figure 1 shows IEA's key estimated energy demand, CO2 emissions and investment indicators, in 2020 relative to 2019.(IEA 2020)

China, the country first affected by the virus (16% of global gross domestic product (GDP) and 24% of energy demand in 2019) implemented lockdown measures with strong macroeconomic impacts in late January 2020. These were followed by lockdowns in many European countries and later by the rest of the world with different degrees of measures. (IEA 2020) The second wave of COVID-19 and the challenges in vaccine development and distribution with evolving virus variants have continued distressing global economy and making economical predictions extremely difficult. The difficulty on making predictions is obvious when comparing the post-COVID-19 strategies of major oil and gas companies, since chosen strategies are very dissimilar.

The international market system had already cumulated stress before the pandemic: globalization had passed its peak, the growth of public debt, growing inequalities within countries causing political tensions, sharp differences in population growth and structures and increasing great power competition between nations. COVID-19 amplified all of these hidden but manageable challenges and has brought the world much closer to potential major discontinuities, especially as international cooperation continues to deteriorate. (Luciani, 2020)

There are two general themes in assessment of COVID-19 effects. One is that uncertainty about the longer term is even greater than usual, because of the unpredictability of how governments and consumers are going to behave in a post-COVID world. The other is the tension between short-term imperatives (financial stresses) and the longer-term need for investment and adaptation that is also unusually high. (Oxford Energy Report, 2020)

The IEA estimates that energy demand in 2020 is set to be 5% lower than in 2019. Since the most carbon-intensive fuels, coal and oil, are the major portions of this reduced demand and renewables are have been the least affected, CO2 emissions are set to fall by nearly 7%. Capita investment in the energy sector is anticipated to fall by 18% in 2020, with the largest drop in spending on new oil and natural gas supply. This slump in investment is likely to have major repercussions for energy markets in the coming years, even though the economic downturn is also placing downward pressure on demand. The crisis is meanwhile provoking changes in the strategic orientation of companies and investors, as well as in consumer behavior.(IEA WEO 2020)

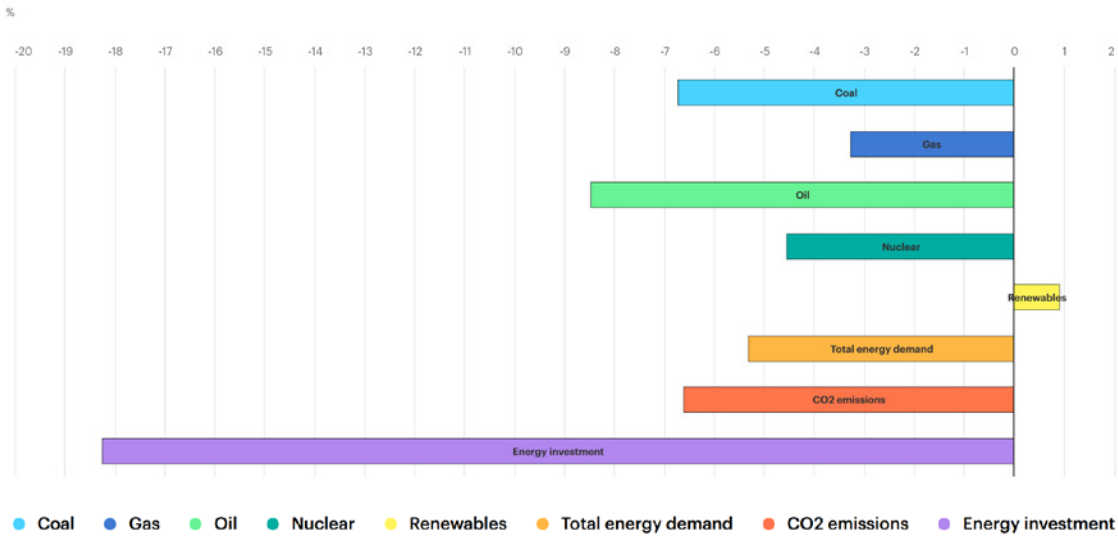


Figure 1: Key estimated energy demand, CO2 emissions and investment indicators, 2020 relative to 2019 according to IEA.

METHODOLOGY

This paper is the ENSEC COE's first explorative view on COVID-19's impact on NATO's energy security and will be updated and expanded after feedback throughout 2021, when more statistics regarding the year 2020 are available and interviews and consultations are easier to arrange. Since the topic is wide and dynamically evolving, the approach is a strategic-level evaluative analysis (Pherson & Pherson, 2013).

NATO's role in energy security was first defined in 2008 at the Bucharest Summit and has since been strengthened. The disruption of energy supply could affect the security of societies of Allies and partners, and have an impact on NATO's military operations. While these issues are primarily the responsibility of national governments, NATO Allies continue to consult on energy security and further develop NATO's capacity to contribute to energy security, concentrating on areas where it can add value. A stable and reliable energy supply, the diversification of routes, suppliers and energy resources, and the interconnectivity of energy networks are of critical importance and increase resilience. (NATO 2020)

This paper aims to explore the topic qualitatively. The research is evaluative and uses inductive reasoning to develop broad generalizations based on patterns observed in the data analyzed. The secondary data, such as academic articles, reports of relevant organizations, policy papers, and to a smaller extent, news articles, are collected and analyzed. Such methodology use is due to the novelty of the topic. It calls for the need to track the emerging ideas and patterns. Thus, the data has not been decided on beforehand but updated through the process. Furthermore, the inductive approach fosters the generation of new ideas that are especially relevant in the eyes of such an unprecedented pandemic.

This paper focuses on fuels, natural gas and examines a general outlook for renewables. First, oil markets and the oil supply chain are reviewed from production (upstream) all the way to refining and end-user demand. Then, the natural gas supply chain is examined and finally renewables are discussed.

OIL MARKETS

Oil markets are vital for the global energy system. Crude oil is one of the main drivers of economic activity that contributes the most to global energy production and consumption. (IEA, 2019) Compared to natural gas, oil is truly a globalized commodity and easier to transport transcontinentally. Oil and its end products are widely used from vehicles to petrochemical products. The strategic significance of oil is underlined by the fact that throughout the 1900s, armed forces collapsed during wars when armies had run out of oil. that Liquid fuels still remains the key to projecting military power. On the other hand, countries like Iran and Russia, which are currently challenging international order, financetheir regimes, armed forces and international support to destabilizing actors with oil revenues. In Russia's case, the historically high oil prices between 2000 and 2014 provided incomes for Putin's regime and for renewal of Russian armed forces (BP, 2020). To sum it up: oil availability is the key to NATO's ability to project military power.

GENERAL

Oil markets were already in a turbulent state early 2020 before COVID-19. OPEC countries and Russia teamed up to reduce their supply to the market since 2017, in their attempt to force out US shale oil production with lower oil prices. COVID-19 and the dissolution of the OPEC+ agreement generated large shockwaves through oil and financial markets. Brent crude, the international oil marker, dropped below $20 a barrel in late March to an 18-year low. It has since rebounded to above $45 a barrel as supply curbs by major producer countries coincide with a demand recovery. Overall it is projected that worldwide supply could fall by 7.1m b/d in 2020 before rising by 1.7m b/d in 2021.(Raval 2020)

Before the coronavirus spread around the world, there were already questions about the future of the energy industry as the world increasingly turned towards renewables. The pandemic has only further disrupted the sector. The challenges facing the industry include: plunging profits, record-low oil demand and questions on how to promote a green economic recovery after COV-

ID-19. (Brover & Raval 2020)

Prediction of oil markets development is always difficult, but now it is exceptionally hard. When strategies of major international oil companies (IOC) during COVID-19 are reviewed, they have chosen very different paths for recovery. For example British Petroleum (BP) said in its strategy update in August 2020 that it would cut its oil and gas output by 40% by 2030 and spend $5 billion a year on low carbon projects that it hopes will turn it into one of the world's biggest green power producers. It is also planning to sell oil and gas assets that will not be economically viable with lower oil prices to raise $25 billion by 2025 to help fund its transition to cleaner energy. (BP 2020)

On the other hand, ExxonMobil, another major oil company has chosen an opposite strategy to BP's. Exxon intends to increase its fossil fuel output by almost a third in the next four years. Exxon acknowledges that there will be a global energy transition, but it believes oil will remain crucial for the world's economy. Exxon estimates that demand will reach 111m b/d in 2040, compared to about 100m in 2019. A production increase equivalent to adding another Saudi Arabia would be needed just to meet this projected extra thirst for oil. (Brower 2020)

Another oil major company, Royal Dutch Shell has not yet announced its post-COVID-19 strategy, but according to the Financial Times, Shell's chosen path is somewhat between BP's and ExxonMobil's (Raval & Hook, Shell executives quit amid discord over green push, 2020). Whatever their chosen strategy is, the IOCs find themselves in a very difficult position.

When oil markets are reviewed from nation perspectives, it is apparent that countries reliant on revenues from oil sales are suffering more from the crude price collapse. It is likely that the continuing low oil prices will cause wider political instability and greater poverty in these countries. Political instability often leads to violence and wider interstate conflict or sometimes conflict between nations. Besides increased refugee flows, armed conflicts in oil and gas producing countries can have an effect on NATO energy security by disrupting oil and gas supplies. However, it is generally extremely hard to predict the stability and capabilities of oil producing nations to function when they are dependent on oil incomes in a context where oil prices are low and production is shrinking. Venezuela is an excellent example of an oil producing country in which the regime is staying against all odds. (Shaffer, 2017) As 2011 events in Libya have shown that quality of missing oil from the supply chain is sometimes as significant as quantity. Libya's importance to the oil market in 2011 stemmed not only from its substantial production, but also from the light, sweet quality of its crude grades. Light crudes are generally the easiest to process and can be run by relatively "simple" refineries that may not be able to handle heavier or sourer substitutes. A loss of light, sweet crude volumes is, as a rule of thumb, more difficult to deal with than a loss of heavier and sourer ones.[1] (U.S. Energy Information Administration, 2011)

Oil companies have declared almost no new drilling activity for the rest of 2020, dramatically changing their original plans for production pre-COVID-19. Offshore drilling is very capital intensive, with long time spans between discovery and production. In the current price climate, many offshore drilling projects are therefore being delayed or cancelled. Operational budgets have also been reduced, which, in some cases, could include delayed maintenance, which has an effect on the contractors that supply drilling rigs or on oil field service companies that are seeing reduced demand for their services. Among onshore producers, while production costs have come down, shale oil extraction remains an expensive process. There too, falling prices and reduced demand have led companies to cut production, again with a severe impact on the contractors supporting the industry. The effects vary for "downstream" (oil refining) oil industry companies as well. The drop in demand for fuel, gasoline and diesel has hit refiners hard, with many slowing or even shutting down production. Conversely, many petrochemical companies are ben-

[1] This is not only because the refineries that run light, sweet grades have limited feedstock flexibility, but also because most of the spare crude production capacity tends to be of the heavy, sour type of oil.

efitting from the low prices for the oil on which their products are based.

Companies that have been forced to cut salaries or lay off employees face issues of employee retention and motivation. Additionally, for some, the availability of key site personnel due to COVID-19 is affecting the staffing levels of operations, integrity and engineering functions. Meanwhile, companies that have shut down refining operations or processing plants must recognize strict adherence to procedures to restart operations – often the riskiest stage in the process cycle.

SUPPLY CHAIN

In order to understand the impact of COVID-19 on oil and gas market, it is crucial to differentiate different timescales in oil and gas production and difference between upstream, midstream and downstream. A very rough military analogy would be upstream – strategic; midstream - operational and downstream - tactical. Figure 2 presents simplified oil and gas supply chain.

Upstream refers to anything having to do with exploration and producing oil and gas. Duration from exploration to production is a long process; it takes years and is very capital intensive. The upstream part includes very little preliminary processing for removing impurities, etc. Midstream refers to the transportation and storage phase, between the Upstream and Downstream phases. Depending of the country, midstream can be a national process, but in most cases, it is an international and/or an intercontinental process of transportation. The downstream phase refers to refining processes where oil and natural gas is refined or distributed to end users as it is often common with natural gas.

UPSTREAM AND MIDSTREAM

COVID-19 has affected supply chain through all its phases, upstream, midstream and downstream. First, lockdowns and lack of demand have disrupted global oil and gas investment activity. As mentioned before, several international oil companies have decided to divest from fossil fuels altogether. At a more hands-on level, but still affecting on a strategic level, there have been delays in licensing rounds, approvals and permitting processes because of disruptions to the work of the regulatory authorities. Several countries, including Bangladesh, Brazil, India, Liberia, Senegal, South Sudan, Thailand and the United Kingdom, have already changed planned licensing round activities.(IEA May 2020)

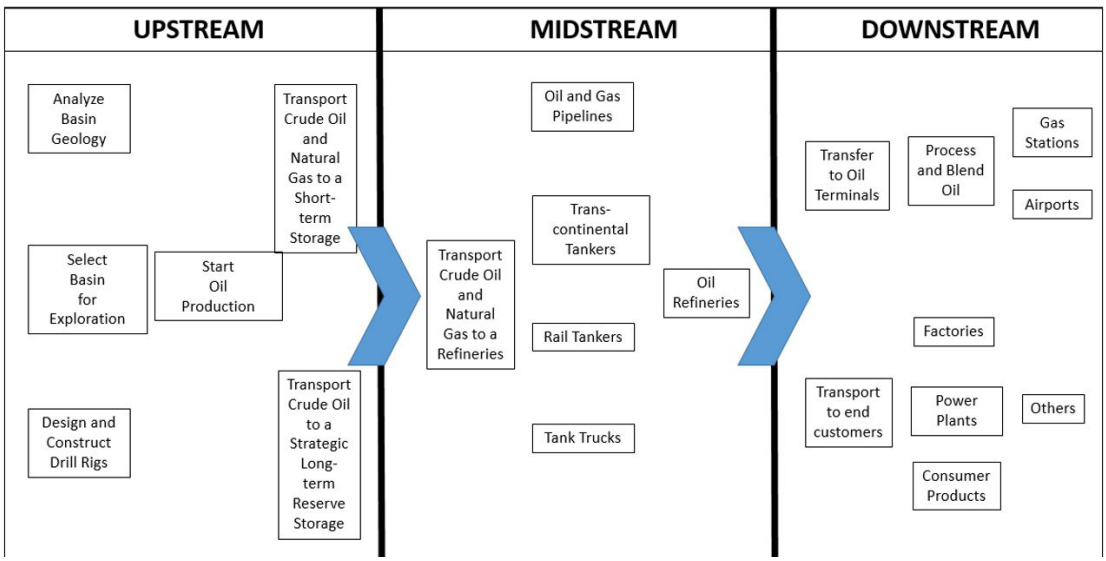


Figure 2: General, simplified oil and gas supply chain description.

The IEA estimates that alongside planned reductions in capital expenditure, those practical considerations are delaying start-up or implementation of many projects, representing a further downside risk to spending in 2020 as activity is pushed back into 2021 (or beyond, in some cases). According to this IEA's estimate, upstream spending is lower than what would be suggested only by company announcements.(IEA May 2020)

In addition to the above mentioned effects to the supply chain on strategic, upstream level, there have been other practical implications for investment projects and supply chain. Starting from upstream level, the most obvious are the risks to teams living and working together on existing onshore or offshore projects. Workers on these facilities typically stay in close quarters in camps or on rigs, making social distancing almost impossible. Regular rotations of staff also increase the possibilities for infections to spread. Companies have been trying to mitigate these risks with regular health screenings, by limiting the number of people on site and by extending the stays of those who remain. Even without an outbreak of the infection, the risk-mitigation measures affect the speed at which projects move ahead. (IEA May 2020) However, COVID-cases and their impact on upstream production on camps and offshore rigs have been limited, which has been a proof of effective measures securing the supply chain.(Slattery, Stillman 2020)

Exemption of this rule has been Mexico and its state-owned Pemex. There have been numerous COVID-cases among Pemex onshore and offshore workers and by September over 300 Pemex workers had died from COVID-19. However, despite the fact that Pemex is missing its production output targets of 2020, it is almost certain that the reason is mismanagement of Pemex-mature oil fields, which are inevitably declining. (Waine 2020)

Another practical effect on oil and gas supply chain has been the restriction on movement of personnel. Companies rely on national and international mobility to staff their projects and provide services, and this has been severely curtailed according to the IEA. This inevitably creates delays where either the company itself, or the sending or receiving country, has introduced restrictions on travel, especially when a company is looking to start or ramp up investment activity. This has contributed to a raft of announced project delays.(IEA May 2020)

IEA research has noted that production and delivery of material and machinery for projects have been interrupted in some cases because of lockdowns, either because the factories themselves are affected or because transport (e.g. port facilities) is disrupted. For example, out of a global total of 28 floating production, storage and offloading vessels that were under construction in the first quarter of 2020, 22 were being built at shipyards in China, Korea and Singapore, all countries where industrial activity was severely affected. Likewise, the Lombardy region of Italy, which was among the first areas of Europe to be locked down, is a major manufacturing center for specialized engineering equipment for the oil and gas industry.(IEA May 2020)

When Midstream part of oil & gas supply chain is evaluated besides challenges in delivery of material and machinery, globally there have not been meaningful difficulties delivering oil and natural gas to the downstream part of the supply chain. Decline of oil and gas demand combined with proper safety precautions regarding key personnel left considerable safety margins running midstream oil and natural gas transportation as required. Midstream's largest challenges are economical. Midstream energy companies' exposure to energy prices is generally thought to be indirect.

STRATEGIC OIL RESERVES

Strategic oil reserves can be considered part of midstream of oil supply chain. Global strategic petroleum reserves (GSPR) refer to crude oil inventories held by the government of a particular country, as well as private industry, to safeguard the economy and help maintain national security during an energy crisis. (Wikipedia, 2020) These reserves were created along IEA after Oil Crisis of 1973. Each IEA country has an obligation to hold emergency oil stocks equivalent to

at least 90 days of net oil imports. In case of a severe oil supply disruption, IEA members may decide to release these stocks to the market as part of a collective action. There are three approaches to guarantee overall stock levels to meet a country's 90 days requirement: industry stocks, government stocks and agency stocks. Several countries use only one category of stocks while most use a combination of the three. (IEA, 2019) Since world oil markets were full with oil even before COVID-19 and the pandemic did not cause production or delivery problems in oil supply chain, there was no need to release oil from global strategic petroleum reserves. Vice versa, during COVID-19, oil was flowing to strategic oil reserves. For example, the US national oil storage (SPR, Strategic Petroleum Reserve) was buying oil and filling storages to help alleviate struggling US oil producers. (Department of Energy, 2020). China, Australia and India are examples of oil importing countries, which are using opportunity to buy bargain priced oil for build-up strategic oil reserves of their own. For example, according to estimates, India saved $685 million while purchasing oil during March-April 2020. (Taylor, 2020) (Hydrocarbon Processing, 2020) (Energyworld.com, 2020)

DOWNSTREAM AND FUEL MARKETS

Before COVID-19, the downstream sector was growing to strong transport fuel demand and there were a lot of investments in refining and petrochemical product capability. Since the drop of demand, European and U.S. oil refineries have faced threat of closures due to decreasing fuel demand, tightening environmental rules and overseas competition. In some cases, the option for refinery owners is to convert uneconomical refinery into biofuel production. According to the IEA's World Energy Outlook 2020's Stated Policies Scenario (Steps), 14 percent of today's refining capacity in advanced economies face the risk of lower utilization or closure by 2030. (IEA, 2020) In a Steps scenario, up to 2030, refinery is expected to grow at only 50 percent of the growth seen between 2010 and 2020. Refiners will also a face a structural shift in oil use away from transport fuels and towards petrochemical feedstock.

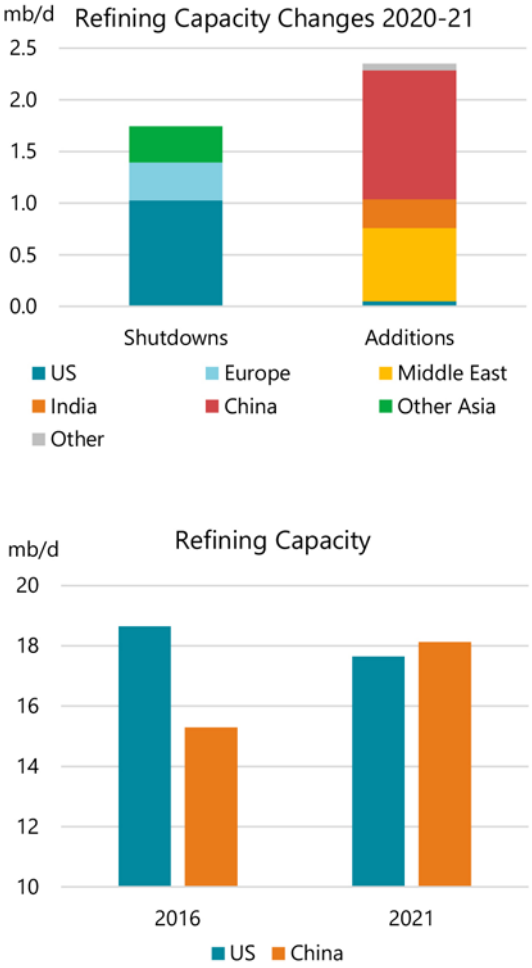


Figure 3 : Refinery capacity changes in millions of barrels a day 2020-21. (IEA Monthly Oil Report November, 2020)

According to the IEA, emerging markets and developing economies in Asia-Pacific and the Middle East will continue to add capacity in the mid-term. Asia-Pacific and the Middle East account for two thirds of global refining investments in the past five years and for more than 80 percent of capacity currently under construction, and these markets take over as the largest global refining centers by 2030. Figure 3 illustrates the global refinery capacity changes. (IEA, 2020)

Falling demand for core products and rising global competition force refiners to choose between attempt to increase profitability or closing down.

Other options are to increase petrochemical production. Some may diversify into low carbon businesses, such as chemical recycling, biofuels production or hydrogen production, as a way of securing new revenue sources. "With rising demand for electric vehicles and slowing overall car sales growth, the period of fuel-centric growth is slowly drawing to a close," the IEA states. (IEA, 2020)

EUROPE:

Many European refineries were already having problems with profitability, but COVID-19 is a new challenge. There is refinery overcapacity in Europe and refineries in Europe are generally globally older. Additionally, European governments have initiated phasing out some fossil fuels from transport. (Brower & Sheppard, 2020) With around 1.3mn b/d of capacity offline for maintenance, some may hold off on unit restarts until the pricing outlook improves and others may look to idle units unable to operate profitably. Around 700,000 b/d of crude processing is already switched off due to unprofitability, including some longer-term mothballing. For example, Total, Repsol (Spain), Neste (Finland) and Galp (Portugal) all have announced operating losses in their European refining businesses during 2020. Finland's Neste will permanently close its 55,000 b/d Naantali refinery and convert its 197,000 b/d refinery to renewable fuel processing. Total is converting its 93,000 b/d Grandpuits (France) refinery for renewable fuels. Trading firm Gunvor has shut its loss-making 115,000 b/d Antwerp refinery permanently. Sweden's Preem all plan to convert some European refining capacity to renewables processing. At least two refineries in the Mediterranean region are considering permanent closure. (Riley-Gould, Harvey, &

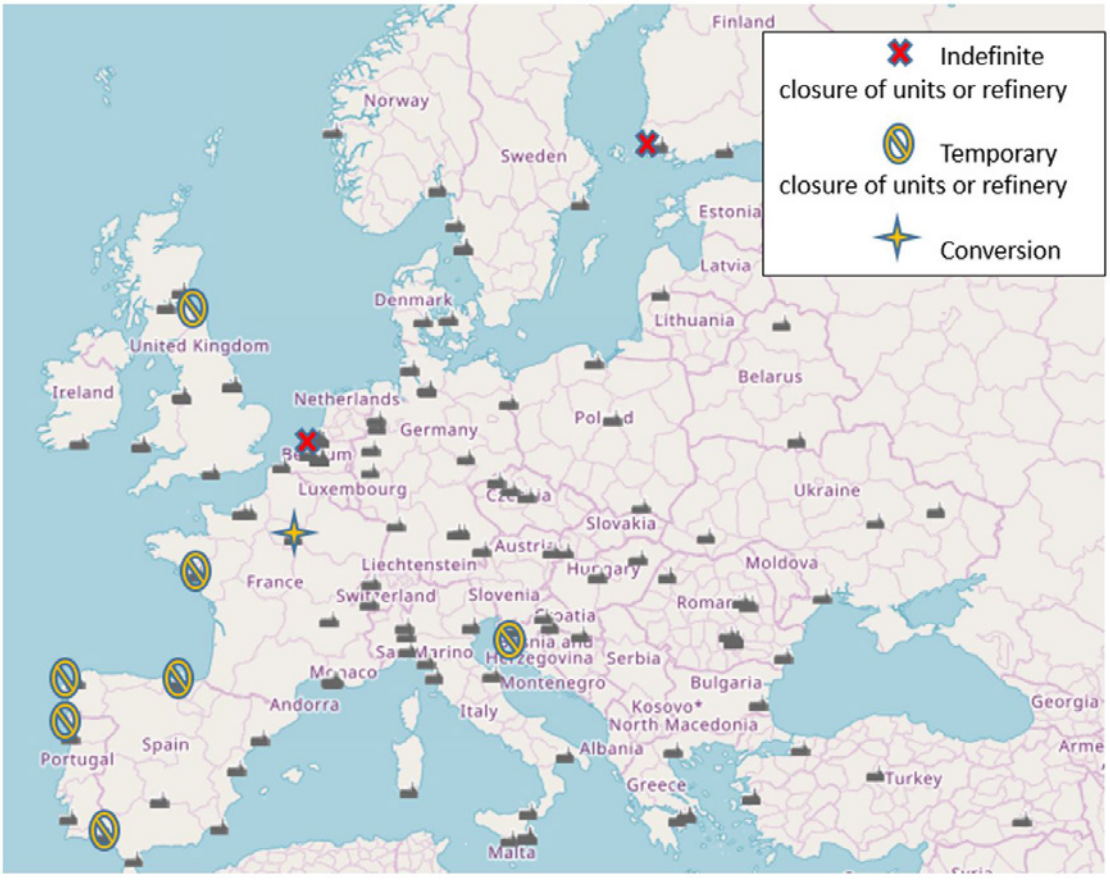


Figure 4: European oil refineries as of December 2020. (European Commission, 2020) (Turner E. , 2020)

George, 2020) Figure 4 illustrates the status of European oil refineries.

When risks of European refineries are reviewed, it can be estimated that complex refineries are less at risk, although minimal discounts for heavy crudes to light crudes have eroded their advantage. In addition, refineries in Central Europe are less prone to global competition and can earn higher margins. If a refinery has a role in local power production, it can help in acquiring government subsidies (Bousso, 2020). Refineries most at risk are independent refineries with small cash reserves and limited access to capital. (George, 2020) (Bousso & Sanicola, 2020). According to UBS's estimates, almost 3m barrels a day of refining capacity, equivalent to about twice as much as the UK consumes or roughly 3 percent of the global total, needs to be removed from the global market by the end of 2021 in order to restore the refinery sector's profitability. (Brower & Sheppard, 2020)

UNITED STATES

The downstream sector of the United States is facing challenges similar to European refineries. Since the onset of the pandemic, at least six refineries have said that they are planning to close at least a portion of their facilities and in many cases, refineries have plans to convert to biofuel production. One example of US refineries difficulties is Shell's Convent refinery near New Orleans, which is closing down. This refinery had a refining capacity of 240,000 barrels a day of crude and before deciding to close, Shell tried to sell it without success. (Winning & Elliot, 2020) Figure 5 illustrates how U.S. gross refinery input compares to five-year average.

ASIA AND CHINA

There has been a trend of global refining capacity moving to Asia and especially to China and COVID-19 is now speeding this shift. When the Chinese economy was expanding, oil consumption also increased. Oil refineries were first built for Chinese consumption but now these refineries are also a force on oil product export markets and they are forcing older, higher cost North American and European refineries out of the market (Sundria, Freitas, & Graham, 2020)

China is the only country in the world expected to see year-on-year growth in oil demand in 2020 – a marginal 0.3% to 14.8 million b/d. Overall, Asian refined product demand is expected to decline 1.7 million b/d this year.

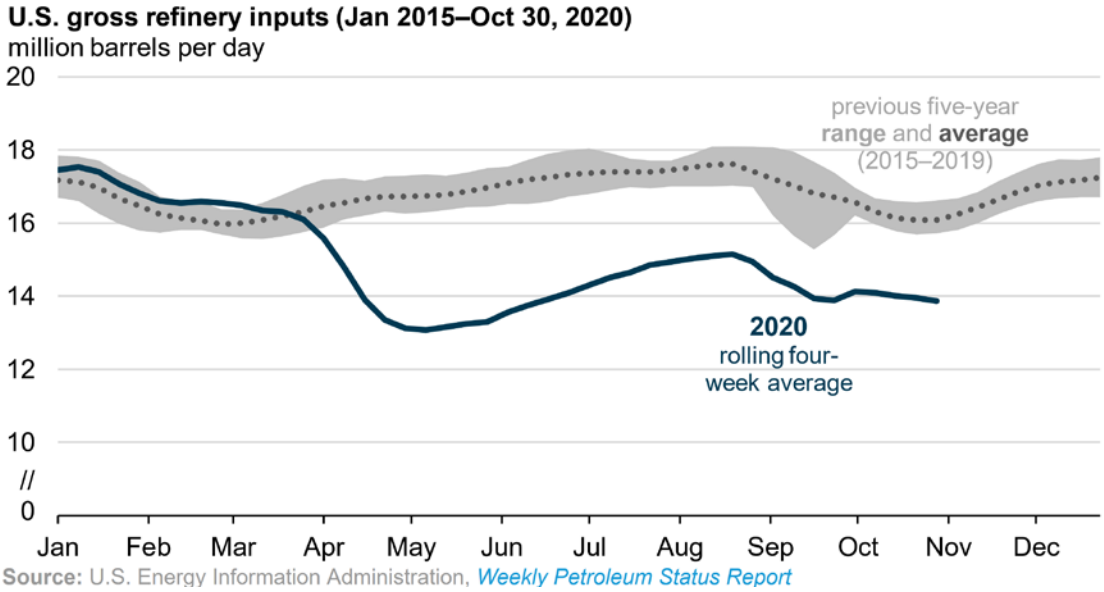


Figure 5: U.S. gross refinery inputs lower than the five-year range. (U.S. Energy Information Agency , 2020)

Oil refineries in the Philippines and the Oceania region have either already announced closures or are seriously considering it, leaving them dependent on imports to meet most of their oil demand needs. (Jaipuriyar, 2020) Australia is the extreme example of diminishing downstream energy security. A decade ago Australia had seven refineries, but in 2020 it only has four and in the near future possibly only one. As of 2018, domestically refined fuels met just 40% of the demand in Australia. (Winning & Elliot, 2020) If all closures go through the Philippines and Oceania, a little under 700,000 b/d of capacity will be removed, opening up export opportunities for other refiners in the region, particularly the Chinese and South Korean refineries.

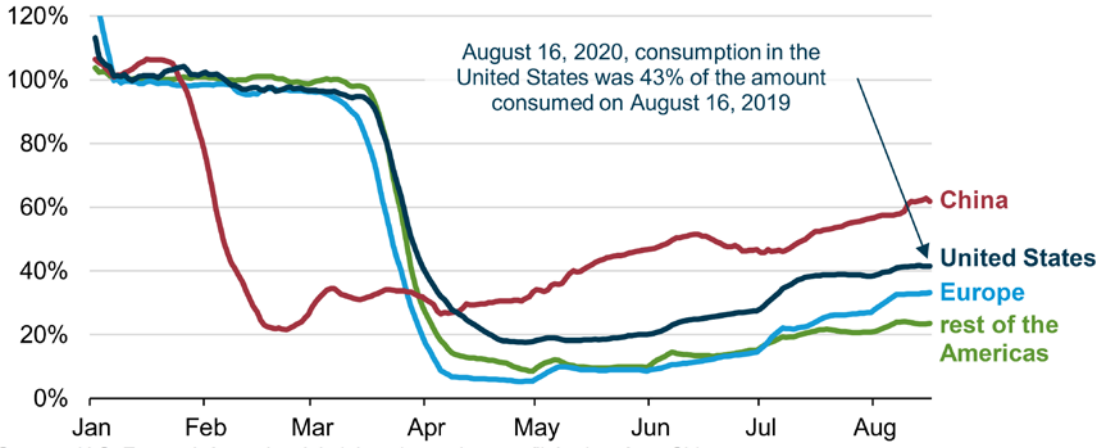
Chinese refiners are likely to be the best placed to supply these emerging outlets given the flexibility of their plants – being able to produce varying grades of fuel and, so far, to seasons of prolonged weak regional margins, with a strong post-lockdown domestic demand helping to sustain refinery economics. (Jaipuriyar, 2020)

RUSSIA

Russia has implemented a large, government-sponsored oil refinery modernization program since 2011. Russia's oil refineries were predominantly built between 1940 and 1970 and in 2011 Russia's gasoline supplies almost ran dry due to a lack of modern refining capacity. (Nazarov, 2015) This $55 billion modernization program of refineries included also changes to the tax system to favor production of cleaner and higher-quality fuel. The ongoing modernization program has already led to a surge in output of light products and exports, which has hurt European refineries' margins. (Soldatkin & Nazarov, 2018) This refinery modernization program, the highly tuned oil industry tax system and Russia's low oil production costs will continue to cause harm to margins of European refineries. COVID-19 has delayed the Russian refinery modernization program, but there are no indications of closure (except for maintenance and upgrades) of Russian refineries due to the pandemic.

AVIATION FUEL MARKET

As the global aviation activity collapsed, jet fuel was the oil product with the largest decline in demand relative to 2019. Continued low demand for jet fuel will account for 80 percent of the year 2021, 3.1-million-bpd gap in oil demand compared to pre-pandemic levels. (IEA, 2020) Figure 6 illustrates how jet fuel consumption by commercial passenger jets dropped globally in 2020 compared to the previous year. Jet fuel and kero-



Source: U.S. Energy Information Administration, using raw flight data from Cirium
Note: China* inclusive of Hong Kong and Macau; consumption assigned to the region from which each flight departed.

Figure 6: Ratio of 2020 jet fuel consumption by commercial passenger jets to 2019 consumption, seven-day moving average (January 1, 2020 – August 16, 2020) (U.S. Energy Information Agency, 2020)

sene demand will increase by 720,000 b/d next year, but will remain 2.5mn b/d below pre-pandemic levels. Jet fuel and kerosene "will account for around 80pct of the overall 3.1mn b/d shortfall in consumption in 2021 versus 2019" according to the IEA. (IEA, 2020) The global collapse of jet fuel demand is the most significant reason for the ongoing low demand of oil.

OIL MARKET'S CONCLUSION

Oil markets have met unprecedented turmoil in 2020-21 with collapsing demand in environment with already ocean of inventories and full storages. This led even to briefly negative prices in the US. OPEC and Russia agreed to drastic supply cuts in order to stabilize the market. Despite this, oil companies were forced to change investment plans while European energy majors began to look into investments in renewable energy. According to the IEA, average oil demand will likely rise in 2021, but demand will likely still be below the pre-COVID-19 level. The IEA predicts that consumption will rise by almost 6m barrels a day in 2021 but will average just 96.9m b/d , still well below the pre-pandemic record of 100m b/d in 2019. Before the pandemic, oil demand was expected to expand by about 1m b/d in 2020 and in 2021. If the IEA's current prediction is correct, in 2021 global oil demand will be 5m b/d below where it would have been without the coronavirus. If we compare the demand drop to the one during the financial crisis of 2008-2009, the global oil demand then fell by just over 1m b/d. Oil demand losses come from three different areas: (1) jet fuel consumption that is 2.5m b/d less than before the pandemic: (2) gasoline and diesel demand due to decreased car usage and finally from (3) economic consequences as a result of a reduced oil demand from the manufacturing industry and a decreased maritime traffic and shipping. Covid-19 containment measures will also reduce demand for other oil products such as LPG, ethane, naphtha and residual fuel, but the impact is likely to be less acute than for gasoline, diesel and jet fuel. Demand is increasing for certain petrochemical products because of greater consumer demand for packaging and demand for personal protective equipment, with a notable potential for increased PET demand. The oil outlook crucially depends on the duration of the Covid-19 outbreak and the strength of the subsequent restart of economic activity. (IEA, 2020)

GAS MARKETS

Natural gas markets are globally less important for several reasons. The value of natural gas markets is lesser than oil markets and natural gas price does not have a similar impact on the stability of nations dependent on energy export incomes. Natural gas used for fuel in vehicles is still insignificant for oil fuels and from a military point of view, natural gas has only recently appeared in theoretical fuels for warships, nothing else. On the other hand, natural gas is often a side product, a so called associated gas of oil production. For example, in the United States associated gas production is about 12% of the total natural gas production (IEA, 2019). If global oil production is decreasing, associated gas production is also decreasing. However natural gas' role as transitional fuel between coal, oil and renewables has been increasing, especially due to LNG.

GENERAL

Early in 2020, gas demand was already declining, due to historically mild temperatures in the first months of the year. Gas consumption was expected to fall by 4% in 2020, under the successive impacts of lower heating demand from the warm winter, the implementation of lockdown measures in almost all countries and territories to slow the spread of the virus, and a lower level of activity caused by the Covid-19-induced macroeconomic crisis. (IEA, 2020) The IEA estimated that consumption would return close to pre-crisis level in mature markets, while emerging markets would benefit from an economic rebound and lower natural gas prices. The impact of the 2020 crisis is expected to have an effect on the medium-term growth potential and result in about 75 bcm of lost growth until 2025. The Asia Pacific region accounts for over half of the incremental global gas consumption in medium-term, driven for the most part by the development of gas in China and India. (IEA, 2020)

UPSTREAM AND MIDSTREAM

The US shale gas which has been mainly respon-

sible for global gas output growth over the recent years, is particularly vulnerable in the COVID19-context. US upstream spending on shale tight oil and gas was set to decline by 50% in 2020. The US shale gas ability to rebound is crucial in delivering the incremental gas production needed by the US market to replace its declining conventional production and supply its additional LNG export capacity under development. Production growth in the Middle East (mainly Saudi Arabia, Iran, Israel, Iraq and Qatar) in region's large conventional gas projects is in danger because of the collapse of oil price. Gas production in Russia is almost entirely driven by export-oriented projects and there is a short-term uncertainty on whether demand drop will cause delays for Russia's new natural gas projects (IEA, 2020).

Figure 7 shows Rystad Energy's assessment of global natural gas production until 2025 and illustrates how natural gas production is associated with oil fields.

China is the main bright spot in the global market with demand continuing to rise rapidly – a 50 percent rise by 2025 from 2019. Production in China is also rising but there is room for both pipeline and LNG imports to increase as well, although LNG imports could come under pressure in the next few years as Russian gas from the Power of Siberia line is ramping up volumes. Significant volumes of LNG have been shut in 2020 and this seems likely to continue in 2021 and 2022, notwithstanding the anticipated recovery in demand in the key Asian markets, as LNG export capacity has risen sharply in 2019 and 2020. (OIES July 2020)

DOWNSTREAM

According to Anouk Honoré and Oxford Institute for Energy Studies, in the first half of the 2010s, slow economic recovery and (very) high gas prices kept gas demand low in the European industrial sector although the main factor was a much lower demand in the power sector where

Global natural gas production by field type
Billion cubic meters

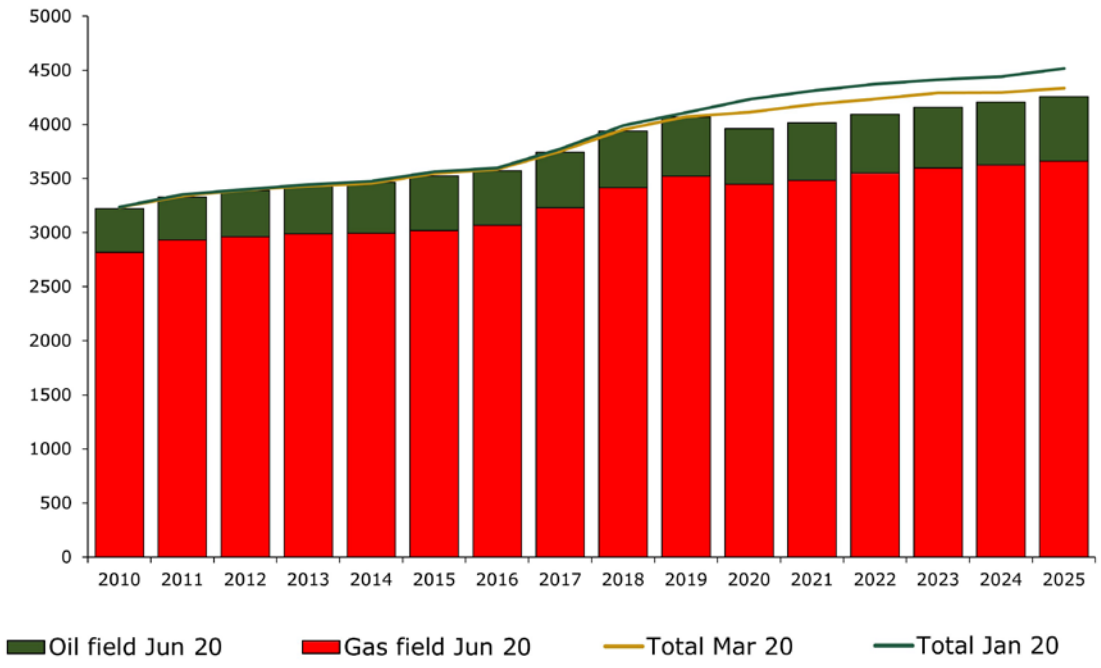


Figure 7 Global natural gas production by field type 2010 – 2025, bcm.: (Rystad Energy, 2020)

gas could not compete against coal (in a context of low coal and carbon prices) and the rise of non-market based renewable capacity. This time, low gas prices (and very favourable coal/gas price spread) will support gas demand in the early 2020s, especially if we witness an accelerated coal phase-out in the next one or two years, which could come from a combination of economic reasons and/or governmental decisions. However, this support would only be for a few years and (fossil) gas demand in Europe should not be expected to recover for much longer. What happens in and post 2020 will only define how quickly the role of unabated gas will decline (or disappear) from the energy mix. Furthermore, the post COVID-19 future seems even more uncertain. Will recovery measures and policies affect (fossil) gas demand earlier than expected, in the 2020s? (Honoré, 2020) Despite the turmoil in the energy market, there has not been any significant impact on natural gas supplies due to COVID-19.

RENEWABLES

Since the recognition of climate change as a threat to human lives and economies by governments and the public worldwide, energy transition has become increasingly relevant. Switching from traditional fossil fuels to carbon-neutral alternatives is the goal of a new sustainable energy system. Besides capturing, utilizing, and storing CO2 emissions, scientists have proposed using renewable energy resources, like sunlight, wind, water, heat from the earth's surface, or biomass.

GENERAL

According to the International Energy Agency (IEA), the generation and consumption of such clean energy were rapidly growing in recent years. (IEA, Renewable energy market update, 2020) Stable policy initiatives and ambitious targets set by governments worldwide made renewable energy cost-competitive and a mainstream electricity source for the last several years. (REN21, 2020) Assumingly, the year of 2019 and 2020 had to continue with the growth of renewable capacity additions. Nevertheless, the emergence of COVID-19 has altered the trend since it had numerous unforeseen effects on the development of the renewable industry, some of which are still unfolding. Therefore, this research aims to clarify the long-term ramifications of COVID-19 on the renewable energy sector and NATO energy security.

NATO has acknowledged the saliency of the energy transition to its goals for energy security. In explaining the importance of renewable energy for NATO, the 4 A's classification of energy security, combining the concepts of Accessibility, Availability, Affordability, and Acceptability, was adopted. (Cherp & Jewell, 2011) Theoretically, at least, the Accessibility of renewables is satisfactory for every country because renewable resources are obtainable by anyone, unlike the ones of traditional energy. That enables the political and economic independence from oil and natural gas exporters, such as Russia or the Middle Eastern countries nowadays. Reducing energy import dependence is crucial for NATO countries since it prevents ideologically different oil and gas producers from having a resource advantage and using it as a political tool. Furthermore, sunlight, wind, water, or other renewable resources are limitless, meaning that their availability is endless. Renewable sources provide for a naturally replenished system in almost all the regions in the world. For NATO, this aspect improves the security of energy supplies and the soldiers especially during peace-support operations. This boosts the operational efficiency of the missions. Regarding Affordability, renewable energy is increasingly cost-competitive with fossil fuels. Finally, the environmental Acceptability of renewables helps meet the objectives of the NATO Green Defence framework. (NATO, 2014)[4] Despite being environmentally friendly per se, NATO needs to prevent damage to the environment, as climate-induced factors might lead to even more instability and tension. In sum, renewable energy becoming mainstream not only limits environmental damage and economic spending but also ensures the political independence of NATO member states and the operational efficiency of its missions.

COVID-19 AND RENEWABLES

Since the spread of the COVID-19, scholars have been researching the effects of it on the world's

[4] NATO adopted the 'Green Defence' framework in 2014. It aims to make NATO more operationally effective by reducing fuel consumption in the military while also protecting the environment.

energy system. They generally agree on the positive effects of a decrease in greenhouse gas emissions and even on the energy transition to some extent (Luciani, 2020) (Linares, 2020) (Fuentes, 2020). First, the pandemic has fundamentally changed the behaviour of people, many of whom have found themselves staying at home more, and thus using any means of transportation less, which shifted the energy demand. The change in daily routine decreased the energy demand for conventional sources, such as oils and coal, as people used more electricity than fuel-related energy. Nevertheless, the overall demand for renewables has also decreased, with many renewable power plants forced to stop production and others kept on operating with a minimum amount of staff. (Eroğlu, 2020) The logistics of trade, and thus global cooperation have seriously been disrupted not only by the labor shortage due to social distancing requirements, but also by the national lockdowns around the world, and their different timing. (Pensado & Singh, 2020) The adverse effects on global cooperation, has seriously delayed the supply chain of the materials needed to produce new renewable power plants that had been upcoming. The uncertainty of investors due to the financial difficulties brought about has further minimized the potential of renewables too. (Fiestas, 2020) Generally, many of the projects have had to be stopped or postponed, thus making it more difficult for the governments to meet climate targets. As a response, national governments have shown vast differences in the importance they placed on the renewable sector in their stimulus plans. In summary, the uncertainty brought about by the crisis has put governments, energy suppliers, and investors in a difficult position, forcing them to think fast and prioritize.

The COVID-19 adjustments have made a considerable impact on the traditional and renewable energy industries alike. However, the consensus in academia seems to be that the renewable electricity sector has suffered the least of all the energy sectors. (IEA, Renewable energy market update, 2020) (IRENA, 2020) In the first quarter of 2020, while the overall energy demand plummeted, for instance, coal and oil demand fell by 8% and 5%, respectively, renewables recorded growth. (REN21, 2020) The energy mix of 2020 had the largest proportion of renewables in China, India, Europe, and the US, for the first time in their history. It happened due to the changed consumer behaviour, which increased the demand in electricity. On the other hand, industrial heat and transportation, which extensively rely on fossil fuels, have been left behind. The fact that renewables can operate at a low cost and have favorable market regulations, especially in the leading countries, made it an adequate alternative to traditional sources of electricity. (IRENA, 2020) The increased production is also due to the record-level capacity additions of renewables in 2019. Although the growth in renewables has been far lower than expected before the spread of the infection, the result is still fascinating, given the situation. In sum, renewables are the most resistant source of electricity generation during the pandemic.

Despite renewables being more resistant than other sources of energy, COVID-19 has affected the sector considerably. First of all, the development of biofuels, which have never constituted a vast amount of energy demand, has been further slowed down. (IRENA, 2020) In liberalized markets, even those having quite favorable market regulations, the falling demand has exposed renewables to the risks, shielded against in the past, and decreased the electricity prices, curtailing down the output. (IRENA, 2020) The other reasons that hindered the production of renewables came from the new restrictions that aimed to stop the spread of the virus, namely the social distancing and partial or full national lockdowns. The fact that people had to keep distance between each other, and follow many additional safety regulations, has indeed lowered the efficiency of production. Widening the distance between the workers, and the finite space within factories, has made many of them lose their jobs or work fewer hours, which resulted in a labor shortage. In turn, multiple wind and solar power plants have stopped production. (Eroğlu, 2020) Also, the different lockdowns in countries have not been synchronized globally due to the diverse numbers of infections. (Pensado & Singh, 2020)

Related to the failing global cooperation, the

problem of supply chain disruptions, in terms of both materials and investments, has been major factors to the lowered production of renewable technology. (IEA, Renewable energy market update, 2020) (REN21, 2020) (IRENA, 2020) Due to the ambitious targets set by many governments, there have been a great deal of projects planned or on the way, such as new solar power plants or wind turbines. Many of them had to be stopped or postponed until further notice. That is because the materials needed for the production of renewables are mined and processed in a few countries. For instance, China, where COVID-19 started to spread and had a severe effect on its economy, is the primary source of many clean energy technologies and the materials needed to produce them. Also, Ecuador produces 90% of the world's balsa required for most of the wind turbine blade cores. Therefore, the closing of factories and other restrictions there have affected the manufacturing and implementation of renewables everywhere else, not to mention, the emerging financial challenges that have resulted in sharp cuts in capital expenditures having impacted the decision making of investors, encouraging uncertainty in where and when to invest. (Attiga & Benali, 2020) (IEA, Renewable energy market update, 2020) (REN21, 2020) (IRENA, 2020) , Thus, the flow of materials and money has been affected.

The adverse consequences of the pandemic led to the failure of meeting the deadlines for tax levies for many of the renewable energy companies. (IEA, Renewable energy market update, 2020) (REN21, 2020) (IRENA, 2020) Recalling the pre-COVID-19 environmental objectives, leading governments have proposed some beneficial incentives for the renewable sector to make it easier for them to become competitive. The United States and other leading countries have implemented tax credits, feed-in-tariffs, renewable portfolio standards, and other more specific regulations. (C2ES, 2020) The fact that the pandemic seriously harnessed the development of renewables made it increasingly demanding to meet the requirements for the financial help available. IEA is arguing that the governments must extend tax levies for the renewable sector to ensure its fiscal viability. (IEA, Renewable energy market update, 2020) Nevertheless, generally, renewable energy investments and incentives have been placed on the second plan due to the urgency of investing in the instant needs of the society fighting the pandemic and reduced the availability of finance. (Eroğlu, 2020) For instance, the US, the second-largest market for renewables, did not include any help for the renewables in their most immense coronavirus stimulus package. (St.John, 2020) Most of the other countries have also chosen to look inward and postpone the tackling of climate change. (Pensado & Singh, 2020) In contrast, the European Commission has presented the most sustainable recovery plan of all the regions in the world, aiming to focus on the Green Deal. (European Commission, 2020) In sum, the national policies amid the crisis, except for the EU, has been generally failing to help the suffering renewable sector.

The long-term effects of COVID-19 for renewable energy is highly uncertain, not only due to the pending end of the pandemic but also the upcoming behaviour of governments and consumers. However, assuming that the outbreak is going to end shortly, the scholars within Oxford Institute for Energy Studies (2020) determined the two sources of uncertainty concerning the future of energy. (Oxford Energy Report, 2020) The first part of the uncertainty is concerned with the behaviour of governments and consumers in the post-COVID world. Some scholars suggest people will strive to get back to their pre-crisis routines, while others think the new 'low contact' economy is emerging. The dispute among short- and longer-term imperatives is the second source of uncertainty. It is seen as essential to tackle the economic crisis caused by the pandemic to ensure the short-term well-being of the people. Nevertheless, it is also crucial to think of the longer-term, the health of the people and ecosystems, and the need for investment and adaptation.

Before all else, it is paramount that most of scholars agree on the fact that energy transition is an economical solution and not an impediment to financial recovery. Scholars argued that monetary recovery could go hand-in-hand with green recovery. The IEA, in cooperation with the Inter-

national Monetary Fund (IMF) and the International Renewable Energy Agency (IRENA), issued guiding reports for policymakers on sustainable recovery. (IRENA, 2020) (IEA, 2020) These international organizations, as well as other academic communities, such as Renewable Energy Policy Network for the 21st Century (REN21) and individual scholars (Linares, 2020) (Turner & Delasalle, 2020) argue that governments have the means to enhance environmental and economic wellbeing at the same time. Therefore, according to academia, green transition is not only possible but also economically feasible, despite the challenges posed by COVID-19. The uncertainty in projecting the future left is the upcoming choices of the governments and consumers. It might seem as if it is an easy choice to follow the guidelines of the scholars; however, in reality, it takes courage to implement innovative, ground-breaking solutions for such unprecedented crises.[5] Returning to business-as-usual and staying on good terms with the long-present business partners and office-holders often seems like a safe option. The solutions suggested by academia would require new reforms to be made, which is a challenge and would likely cause disappointment from multiple groups of stakeholders involved. Therefore, despite the scholarly agreement on the possibility of sustainable recovery, the post-COVID actions of the governments and consumers are highly uncertain.

The measures that will be taken by the governments worldwide are not only uncertain but also expected to differ across the regions, which makes the consensus unlikely. First of all, not all countries acknowledge climate change as an immediate threat. Much of the developing world, including the Middle East and CIS, do not always see it as vital to make environmentally friendly commitments. On the other hand, the European Union perceive climate change more seriously. Furthermore, there are some developing countries, for instance, China, that also see energy transition as salient; however, they often view it as a part of technological and economic competition rather than environmental protection. Therefore, such regional differentiations are not making a consensus on a global level straightforward. Despite this, scholars suggest other reasons for why there are not going to be any global initiatives for energy transition and renewables soon. The COVID-19 crisis has already highlighted the tendency of the governments to adopt an inward-looking approach and prioritize national socioeconomic and political agendas. (Pensado & Singh, 2020) This became evident when countries worldwide competed for the securitization of the medical supplies, as well as in the stimulus plans of the United States, and China, as they focused on the economic recovery, disregarding the importance of energy transition, and their international commitment to the Paris Agreement (Friedman & Villegas, 2020) (Gosens & Jotzo, 2020) (Myllyvirta, 2020) Furthermore, scholars observed that the consumers have been more risk-averse and conservative during this and the past crises. (Pensado & Singh, 2020) Such risk-averseness means that consumers purchase goods more carefully, and little voluntary extra costs are made, for the environmentally-friendly alternatives, or alike.

Despite the absence of a global consensus, some influential regions or countries are expected to continue the upward trend of renewable development, despite the crisis. Those are mainly the countries that have been the leaders in the field and have ideological commitments. Amidst the pandemic, the European Commission has issued "the next generation EU" plan, which integrates the Green Deal as a central part of the financial recovery. (European Commission, 2020) In turn, the European Union is investing in clean technologies and other green initiatives to build back better and boost their economy in new ways, rather than come back to the old and polluting traditions of doing business. This plan has been the only one worldwide that committed its partners to a sustainable recovery and is going to have a positive impact on the renewable sector. As for the US, 2021 might change the overall

[29] As Niccolo Machiavelli once said: "there is nothing more difficult to take in hand, more perilous to conduct, and more uncertain in its success, than to take the lead in the introduction of a new order of things, because the innovator has for enemies all of those who have done well under the old conditions and lukewarm defenders in those who may do well under the new."

picture for renewables. Build Back Better plan of president Biden is determined to creating numerous clean energy jobs in general.

On the other hand, the prospects for China are less definite. China is a developing nation, ruled by the government of a few, the Communist Party; thus, the private forces are not as powerful there. The governmental decisions are the key, and in terms of energy transition, they are often ambiguous. As has been mentioned above, the government often lacks the ideological commitment to environmental protection and perceives the development of renewables as a competitive tool. According to multiple scholars, such developing nations are more likely to choose for the cheaper, shorter-term focused recovery and continue investing in the polluting energy sources. (Luciani, 2020) China has been simultaneously increasing consumption of coal and the share of renewables in the overall energy mix, which makes the scholarly prediction even more plausible. Such ambivalence in the energy sector is of a complex causation. At the national level, subnational level actors have been pushing for the protection of the coal industry, while the deadline for vanishing poverty, as promised, has been approaching. At the global level, China's relations with the US have been deteriorating. (Geall, 2020) Due to COVID-19 further hindering the relationship between the US and China, Chinese authorities have been increasingly perceiving fossil fuels, which are abundant in the country, as energy secure option. (Garcia, 2020) Having said that, President Jinping, in September 2020, has publicly announced the zero-emissions target by 2060. Despite not providing any practical measures to achieve the goal, such a promise to the international community is beneficial. Some scholars suggest that environmental protection could help China advance on the world stage and that its leader is signaling its interest in doing so. (Geall, 2020) Therefore, China is expected to keep on investing in renewables and other environmentally friendly technology, aiming to become a leader in tackling climate change. However, it is unlikely for them to abandon the fossil fuel industry anytime soon.

Similarly, the Middle Eastern and Commonwealth of Independent States (CIS) countries are also ambiguous in developing the renewable sector and tackling climate change. On a positive note, according to the report of Middle East Business Intelligence (MEED), the only source of energy that shows no signs of disappearance is renewable, as the region remains committed to diversifying its energy sources and lowering the costs. (MEED, 2020) Due to the rise in electricity demand and a shortage of readily available natural gas, the expansion of renewables is an economical solution. Furthermore, some experts suggest that the decrease in oil prices is unlikely to adversely affect renewables, mainly because the oil industry was under pressure before COVID-19 too. According to Wood Mackenzie, "Middle Eastern countries will add thousands of megawatts of new solar-power capacity through at least 2025." (Paola, 2020) Therefore, the governments that have made ambitious commitments to energy transition should continue realizing their vision, even if there will be many forces working against them and thus slowing down the progress. As for the CIS, it is looking the worst among all regions concerned in terms of renewable energy development. Despite the targets set by their governments, according to the Paris agreement, practical improvements are not visible. The CIS, due to its extreme vulnerability to the costs of energy, and lack of governmental commitment, is expected to continue using cheap fossil fuels. (Evans & Pearce, 2020) Not only the economic reasons, but also the lack of ideological commitment in the region is hindering the progress. For instance, in Russia, one of the largest oil companies Rosneft openly criticized the choice of BP, Shell, and other European companies, switching to renewables, for doing so. (Raval & Sheppard, 2020) Despite the suggestions of the IEA to diversify the energy sources to prevent the risks associated with a peak in demand, Russia continues doing business as usual.

LIQUID BIOFUELS AND MILITARY

From a military point of view, liquid biofuels are potentially important as improving energy security since they can be used as a substitution of imported fossil fuels used in military vehicles, vessels and aircraft. For example, the US Navy and

US Air Force had from 2010 to 2016 ambitious biofuel programs. The US Navy "Great Green Fleet" was an experimental Strike Group comprising of an aircraft carrier, a cruiser, two destroyers and a fuel tanker. The carrier, the USS Nimitz, was nuclear powered, but everything else, including the Nimitz's aircraft, ran on a 50:50 mix of petroleum and biofuel derived from cooking oil and algae. (Reardon, 2012) While these US biofuel programs and other military biofuel experiments elsewhere were technically successful (Macdiarmid, 2015), military biofuels were not globally introduced for various reasons, including higher price compared to fossil fuels, lack of political support and reliable supply chain.

The biofuels industry has been strongly impacted by the Covid-19 pandemic. According to the IEA, the global transport biofuel production in 2020 is anticipated to be 2 480 thousand barrels per day (kb/d) – an 11.6% drop from 2019's record output and the first reduction in annual production in two decades. A lowering of crude oil prices since the start of the pandemic has made biofuels less competitive with fossil transport fuels. However, usage of biofuels is expected to increase in medium term and are expected to meet around 5.4% of road transport energy demand in 2025, rising from just under 4.8% in 2019. (IEA, 2020) Many oil refineries are converting to biofuel production and economic stimulus programs especially in Europe targeted in reducing CO2-emissions, but it is still difficult to assess if COVID19 will increase armed forces' possibilities to use liquid biofuels.

In summary, it seems as if all regions are going to continue the same pattern of development in the energy transition, which has been well underway before the crisis. However, some disorders are still likely. The EU and the US are likely to do their best in achieving the goals set under the Paris agreement. For these regions, the trend will go upwards as many coal power plants are closing, and renewable energy is becoming more and more economical. Furthermore, despite the pandemic, China continues to have a double role, aiming to become a leader in tackling climate change, as well as continuing to expand and support its coal industry. However, the ambitious target set during the pandemic to reduce greenhouse gas emissions to zero by 2060 only suggests the inevitability of the coal industry to decrease its production. Withal, the Middle East is likely to continue the development of renewables under their climate targets. Although oil prices are on the decline, solar power remains to be the cheapest kW in the Middle East due to its reliance on private funding rather than governmental spending. (Paola, 2020) On the other hand, the Commonwealth of Independent States, which, as a developing region, is especially vulnerable to the costs of energy, are expected to focus on financial recovery mostly, using the decreased prices of traditional sources of energy to their advantage. However, the regional climate targets and some of the renewable projects give hope for at least a slow move towards energy transition. To conclude, the renewable energy development will continue to differ across regions, with the EU, the US, and China, building back somewhat better, while the Middle Eastern countries aiming to join the lead, and CIS continuing to lag.

Specifically for NATO and its energy security, COVID-19 effects have been important as well. The goal of NATO to make the military greener and thus more efficient in its operations is not going to be achieved very rapidly. The adverse economic effects of the pandemic have slowed progress, and the renewable energy usage in the military is not such a big priority. It can be expected that it will not be a priority for the upcoming years, as the world aims to recover financially. Nevertheless, this effect of COVID-19 on the operations of NATO military forces and their energy security is not permanent and does not hinder the long-term vision.

The other not less important factor is the deteriorating US and China relations. (Schmid, 2019) Such relations are not a consequence of COVID-19, but the pandemic did indeed make the tensions higher. Either way, the US will continue to invest in their local capabilities of exploration, mining, research, and recycling of critical raw materials, needed for the production of renewable technology. The US also sees it as important to diversify their imports, and rely more on the ideologically compatible countries, such as Can-

ada, and Australia, that are rich in raw materials. However, research and development as well as new partnership agreements would take more time and might slow the progress of renewable energy. Regardless, the long-term vision for the renewable energy sector should remain similar.

Generally, the pandemic and its adverse effects on the renewable sector have highlighted the vulnerabilities of the global supply chains, geographic concentration of critical raw materials, and energy dependence on those regions. History has shown that such crises (for instance, Japan-China dispute over raw materials (Smith, 2013)) encourage the vulnerable countries to diversify their suppliers and invest in domestic production, research on substitution, and recycling. In sum, the COVID-19 pandemic has mainly delayed and postponed the development of renewable energy. The US and other important countries within NATO are likely to continue the pre-crisis patterns of development while becoming even more aware of the vulnerability of their supply chains.

Before the COVID-19 crisis, the development of renewable electricity was well underway worldwide, and especially so in North America, the European Union, and China. The global pandemic has had an adverse effect on the energy industry. However, renewable electricity has shown to be the most resilient. The renewable electricity development has been slowed down due to the lowering demand, discrepancies in the global supply chains, social distancing, and other national policies, implemented to tackle the pandemic. In comparison with renewable electricity, the slowly growing renewable fuels industry, had always failed to compete with traditional fuels. The pandemic has harmed the already weak performance further. The fact that the pandemic is ongoing makes it difficult to project the future of renewables and the energy security of the NATO. The renewable electricity sector is expected to continue its development, even if it will not be as fast and fluent as expected before the pandemic. History suggests that such exposure of supply chain vulnerabilities and resource dependency often results in the more pronounced diversification of suppliers and an inward-looking approach.

CONCLUSION AND COVID-19'S IMPACT TO NATO'S ENERGY SECURITY

COVID-19 is called "black swan" as a metaphor for an extremely rare event that is unforeseen and has an enormous impact. The metaphor that is more accurate is "gray rhino," which refers to highly probable but neglected threats that have an enormous impact, since there have been science-based warnings about the new pandemic for a long time, but the timing of the new pandemic was unpredictable. From a global energy market point of view, COVID-19 happened at time that was already exceptional since there was ongoing price war at oil markets and there was a wider energy transition process.

The pandemic was an additional "trouble layer" on an already distressed international system suffering economic problems, international power completion and rising tensions inside countries. Vaccines are unlikely to significantly boost demand until well into 2021. With a COVID-19 vaccine unlikely to rescue the global oil market for some time, the combination of weaker demand and rising oil supply provides a difficult environment to both oil producers and refiners. Unless the fundamentals change, the task of rebalancing the market will make slow progress. However, it is far too early to know how and when vaccines will allow normal life to resume. (IEA Oil Market Report, 2020)

COVID-19's effects to the global energy markets have been huge regarding economics and demand drop, but there have not been any significant energy availability challenges. This would have been a possibility, if virus variants had been more lethal and critical energy production/distribution facilities' personnel had been infected in masses. Energy industry's global safety measures were generally excellent regarding COVID-19.

There have been no problems with energy supply, since the pandemic is not particularly lethal so production has been able to continue, but vice versa there has been a lack of demand of energy.

Resilience is an "expensive word" and in post-Cold War world dominated by globalization and

global economic competition costs were cut effectively from processes of energy industries and preparedness of nations. COVID-19 has also shown that due to cost-cutting and economical effectiveness many critical supply chains were located outside Europe and Asia.

The effect of COVID-19 to NATO Energy security has been so far been minimal, but the more crucial effects are visible in medium and long-term. The most significant effect is the ongoing closures of European oil refineries for economic reasons and due to the drops in demand. Oil refineries are highly vulnerable military targets in kinetic military conflict and fewer European refineries equals less resilience during an armed conflict.

Another indirect impact of COVID-19 to energy security is the cyber threat dimension. Its impact is hard to estimate but it is very likely that COVID-19 and sudden transition to remote working and remote meetings in spring 2020 often using ad hoc tools have offered more intelligence, vulnerabilities and attack surfaces for usage from cyber attackers. It is known that for example government-sponsored Russian, Chinese and Iranian APTs (Advanced Persistent Threats) have been probing NATO-countries energy supply chain with cyber tools for years. (US CERT, 2018) (Bartz, 2011) (Palmer, 2020) It is almost certain that Russia prepares to use cyber attacks against critical energy infrastructure in case of armed conflict with NATO as Russia has practiced in Ukraine. (Greenberg, 2019)

Next, the COVID-19's impact on NATO's energy security is analyzed based on findings in short/near term (up to 2 years), medium/mid term(3-5 years) and long term (6-20+ years).

IMPACT ON SHORT TERM

When COVID-19 impact on NATO's energy security is reviewed on short (up to two years) term, consequences of COVID-19 are minor. Oil and gas markets were full of oil and gas products due to the unexceptional hydrocarbon market environment. NATO fuel supply chain had no supply disruptions and it is likely that the fuel supply chain is not threatened by COVID-19 over the next two years since vaccinations have started and the oil industry has proven procedures for protecting up-, mid and downstream personnel and whole production, transportation and refining processes. However, other pandemics or another variant of COVID-19 with a different transmission means/lethality combination compared to the current form is possible, but lessons learned from current mitigation measures will likely alleviate impacts. Permanent oil refinery plant shutdowns are highly likely to continue in 2021, especially in Europe and to a lesser extent in the United States. On a short term perspective, NATO energy security was not hindered during 2020 and both the alliance and its individual member countries had sustained energy security.

IMPACT ON MEDIUM AND LONG TERM

COVID-19 has caused exceptional turmoil in world energy markets and societies, but the assessment of COVID-19 impact on NATO energy security in a longer time perspective of medium/mid term(3-5 years) and long term (6-20+ years) is very difficult in the current complex global politico-economic environment. In the medium term, the main challenges are the closures of oil refineries especially in Europe, but also in the United States due to the economic reasons and lack of demand. The fewer number of oil refineries in NATO countries will make NATO fuel supply chain more vulnerable during armed conflict. Oil refineries are vulnerable targets especially to cruise and ballistic missiles, but also to cyber-attacks. Although the target was the upstream oil processing plants rather than the technically more vulnerable downstream oil refining plant, the attack to Saudi-Arabia's Abqaiq and Khurais oil infrastructure by cruise missiles and drones in 2019 is an example of vulnerability of key oil infrastructure. (Said, Faucon, & Jones, 2019) Figure 8 illustrates the damage caused to the oil processing plant.

Renewable energy is the winner of COVID-19, but fossil liquid fuels are here to remain for a long time. Clean energy transitions are at the center of economic recovery and stimulus plans especially in Europe. The renewable energy is not a threat

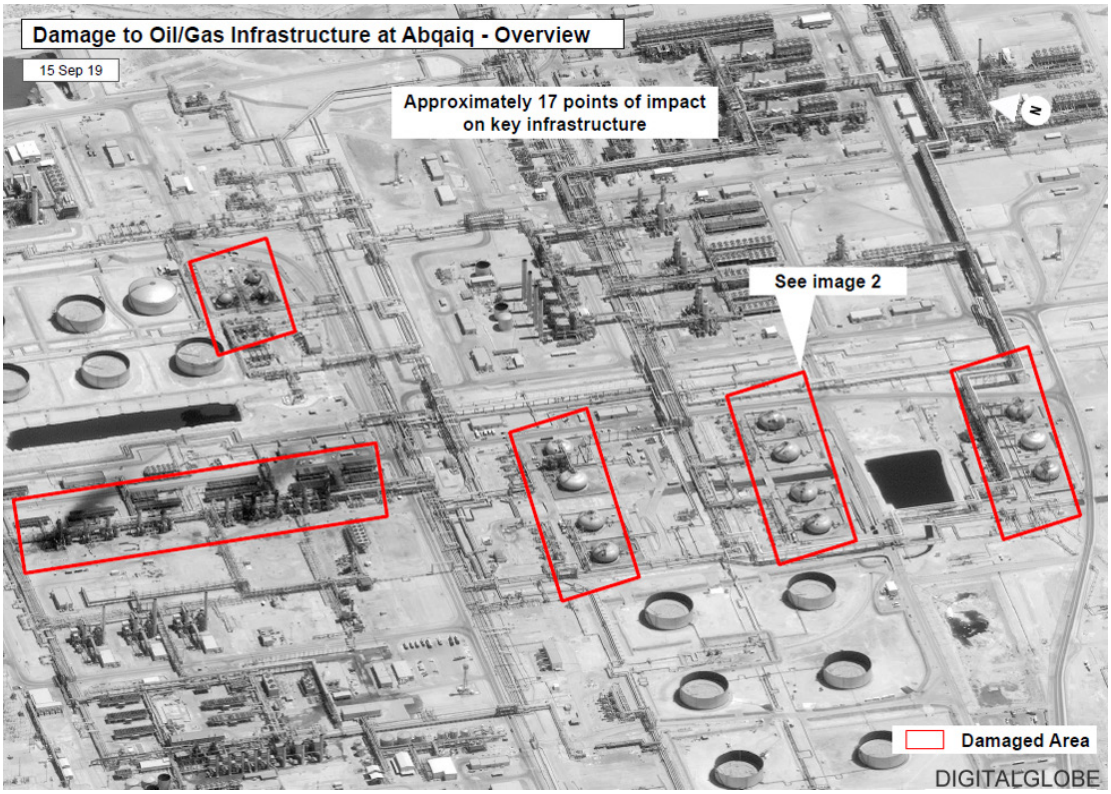


Figure 8: Damage to Abqaiq oil processing plant after cruise missile and drone strike in September 2019. (U.S. Government/Digital Globe via Associated Press)

to NATO energy security, since it lessens dependency of hydrocarbon imports. Also, the use of liquid biofuels has been technically tested by NATO armed forces already for almost a decade. The implications of the pandemic for energy systems and clean energy transitions are still evolving but energy security remains a cornerstone of our economies especially during turbulent times. Electricity security and resilient energy systems are more indispensable than ever for modern societies. COVID-19's impact on energy security of natural gas has been minor, but as a whole NATO energy security needs more diversified natural gas import and better gas transmission infrastructures in Europe. Oil refinery capacity will move to China, which is bound to be world's largest oil refiner in a few years. This will improve China's own energy security, but also its ability to successfully engage in long-term armed conflict.

RECOMMENDATIONS

STRENGTH & WEAKNESSES OF POST-COVID-19 FUEL SUPPLY CHAIN

When strengths and weaknesses of NATO's Post-COVID-19 fuel supply chain are assessed, it has to be noticed that the worst short-term fears of COVID-19's impact on NATO's energy security were not realized. During 2020, the availability of oil and refined products were even better than "normal" times, deliveries were fast and at bargain-prices. Global oil industry implemented preventive measures that protected fuel supply chain all the way from upstream to downstream. This was helped by the nature of the early COVID-19-variant which was not as lethal or transmissible as it could have been. The apparent strength of NATO's Post-COVID-19 fuel supply chain has proven to be working and efficient even during the most exceptional times of the pandemic. NATO countries have significant strategic

oil reserves, and geographically widely dispersed oil refineries in member countries. The most important strength of NATO fuel supply chain is the NATO Pipeline System (NPS) which consists of eight national pipeline systems and two multinational systems. NPS has ten distinct storage and distribution systems for fuels and lubricants. In total, it is approximately 12.000 kilometers long, runs through 13 NATO countries and has a storage capacity of 5.5 million cubic meters.

THE NATIONAL PIPELINE SYSTEMS ARE:

the Greek Pipeline System (GRPS);

the Icelandic Pipeline System (ICPS);

the Northern Italy Pipeline System (NIPS);

the Norwegian Pipeline System (NOPS);

the Portuguese Pipeline System (POPS);

the Turkish Pipeline System (TUPS), which comprises two separate pipeline systems known as the Western Turkey Pipeline System and the Eastern Turkey Pipeline System;

the United Kingdom Government Pipeline and Storage System (UKGPSS).

THE TWO MULTINATIONAL PIPELINE SYSTEMS ARE:

the North European Pipeline System (NEPS) located in Denmark and Germany;

the CEPS covering Belgium, France, Germany, Luxembourg and the Netherlands. (NATO, 2020)

When weaknesses of NATO's Post-COVID-19 fuel system are reviewed, two strategic weaknesses appear: one that is slowly creeping up and one that is already here. The incoming threat is related to economic problems of oil refineries of NATO and PfP-countries in North America, Europe and Oceania. Due to profitability problems, NATO and PfP-countries oil refineries are closing and oil refining capacity is moving to Asia and China and in a lesser extent also to Russia. The fewer number of refineries is a major challenge during a large scale armed conflict where fewer vulnerable key refineries are targeted by both cruise and ballistic missiles and cyber-attacks. If conflict lasts over three months and refined products are needed to be transported by maritime shipping, this likely tie up significant naval resources for tanker protection.

The other strategic weakness of NATO's post-COVID fuel supply chain is that the NATO Pipeline System has not been extended to NATO's Eastern Flank. During large-scale conflict, large NATO ground formations need advanced fuel logistics while maneuvering combined arms operations. This second strategic NATO fuel supply weakness is interconnected to the first, refinery-related one in the Eastern Flank perspective: many regional refineries in Lithuania, Slovakia, Poland, Hungary, and Germany, rely on the soviet-era, Druzhba pipeline system supplying crude oil from Russia for fuel production, though, some of these refineries have alternative pipeline options. (Antas & Wojcik, 2020) The so-called Druzhba pipeline incident in April-June 2019 revealed some of the vulnerabilities for refineries dependent on Druzhba oil. (Yermakov, 2019)

COVID-19 has been globally an expensive, but useful lesson on resilience and limited resources and there are two main recommendations for NATO.

EXPAND NPS AND ITS STORAGES

The existing NATO fuel supply infrastructure in Western Europe has not been extended to cover Baltic and Black Sea region allies, not even to the eastern part of Germany. The closures of several European oil refineries equals increasing critical vulnerabilities for NATO energy security during possible military conflict. Subsidizing refineries economically is an unlikely option, but the NATO Pipeline System (NPS) should be expanded to NATO's eastern flank to ensure Allied crisis readiness. Expanding NPS and its storages would offer resilience for NATO energy security during both kinetic conflict and peacetime contingencies. The next pandemic (Newey, 2020) could be more lethal (Cyranoski, 2020) and a pipeline system is more resilient than rail, road and water transportation of fuels. An additional bonus is that a pipeline system is less energy consumption intensive than before mentioned other forms of

fuel transports. Academic research proves that pipeline shipments are substantially less energy consuming than rail, road, and water transport. In turn, pipelines reduce greenhouse gas emissions by between 61 and 77 percent compared to rail for transporting oil over long distances. (Jankowski & Wieczorkiewicz, 2020) Expanding the NATO pipeline system to the eastern flank would reduce carbon dioxide emissions and stimulate post-pandemic economic recovery.

MORE FLEXIBLE ACQUISITION AND TRAINING PLANNING PROCESSES

Countries like China and India have used the oil price collapse for increased buying of crude oil to expand their strategic oil reserves. If countries have unused strategic crude oil storage capacity, this kind of oil price collapse is the right time to buy cheap oil and build a nation's strategic reserves and resilience. In refined oil products in which shelf life is limited (like aviation fuel) the key is a more flexible acquisition process and ability to increase training use of fuels when the price is exceptionally low. Especially in flight training, aviation fuel cost is a major share of the total flight hour costs. The ability to use exceptional aviation fuel prices as a flexible acquisition and thus increase unplanned training is however difficult.

PROBABILITY ASSESSMENT DEFINITIONS

Definitions used in this product:

Almost certain >90%

Highly likely 75-85%

Likely 55-70%

Possible 40-55%

Plausible 25-40%

Unlikely 15-20%

Highly unlikely <10%

Short term 0-6m

Near term 6kk-2y

Mid term 3-5y

Long term 6-20+

ACRONYMS

APT Advanced Persistent Threat
Bcm billion cubic meters
b/d Barrels per day
BP British Petroleum
CEPS Central European Pipeline System
CIS Commonwealth of Independent States
CO2 Carbon dioxide
COVID-19 Coronavirus disease 2019
GDP Gross Domestic Products
GRPS Greek Pipeline System
GSPR Global Strategic Petroleum Reserves
ICPS Icelandic Pipeline System
IEA International Energy Agency
IOC International Oil Company
LNG Liquefied Natural Gas
NATO North Atlantic Treaty Organizations
NEPS North European Pipeline System
NIPS Northern Italy Pipeline System
NOPS Norwegian Pipeline System
NPS NATO Pipeline System
OPEC Organization of the Petroleum Exporting Countries
PEMEX Petróleos Mexicano
PfP Partnership for Peace
POPS Portuguese Pipeline System
TUPS Turkish Pipeline System
UBS Union Bank of Switzerland
UKGPSS United Kingdom Government Pipeline and Storage System

BIBLIOGRAPHY

Antas, L. (2020, March). Military Mobility - a new old question to address. Retrieved from www.Esperis.pl: https://esperis.pl/home-en-2-3/our-reports-2-3/

Antas, Ł., & Wojcik, R. (2020, May 13). Running on Empty. Retrieved from CEPA.org: https://cepa.org/running-on-empty/

Antas, Ł., & Wojcik, R. (2020, May 13). Running on Empty. Retrieved from CEPA: https://cepa.org/running-on-empty/

Attiga, A., & Benali, L. (2020, July). Energy after COVID-19: Financing a neo-renaissance. Oxford Energy Forum, 123.

Bartz, D. (2011, February 2). Chinese hackers infiltrated five energy firms: McAfee. Retrieved from Reuters: https://www.reuters.com/article/us-energy-cyber-china-idUSTRE7190XP20110210

Bousso, R. (2020, October 13). Exclusive: Italian refiner Saras plans cost cuts, biofuel expansion. Retrieved from Reuters: https://www.reuters.com/article/us-italy-oil-saras-exclusive-idUSKBN26Y1D5

Bousso, R., & Sanicola, L. (2020, October 19). Facing wave of closures, oil refiners turn to biofuels. Retrieved from Reuters: https://www.reuters.com/article/europe-refining/facing-wave-of-closures-oil-refiners-turn-to-biofuels-idUSL8N2H4324

BP. (2020, August 4). From International Oil Company to Integrated Energy Company: bp sets out strategy for decade of delivery towards net zero ambition. Retrieved from bp.COM: https://www.bp.com/en/global/corporate/news-and-insights/press-releases/from-international-oil-company-to-integrated-energy-company-bp-sets-out-strategy-for-decade-of-delivery-towards-net-zero-ambition.html

BP. (2020, June). Statistical Review of World Energy. Retrieved from www.BP.com

Brower, D. (2020, October 28). Why ExxonMobil is sticking with oil as rivals look to a greener future. Retrieved from Financialtimes.com: https://www.ft.com/content/30ffa51b-2079-400e-84f1-2e45991194c8

Brower, D., & Sheppard, D. (2020, July 7). Oil crash piles pressure on bloated refining sector. Retrieved from Financial Times: https://www.ft.com/content/ec1f514c-9289-4ce6-8df3-4d715c109233

C2ES. (2020, September 12). Renewable Energy. Retrieved from C2es.org: https://www.c2es.org/content/renewable-energy/

Cherp, A., & Jewell, J. (2011, August 3). The three perspectives on energy security: intellectual history, disciplinary roots and the potential for integration. Current Opinion in Environmental Sustainability, 3(4), 202-212.

Cyranoski, D. (2020, May 4). Profile of a killer: the complex biology powering the coronavirus pandemic. Retrieved from Nature.com: https://www.nature.com/articles/d41586-020-01315-7

Department of Energy. (2020, April 2). U.S. Department of Energy to Make Strategic Petroleum Reserve Storage Capacity Available to Struggling U.S. Oil Producers. Retrieved from https://www.energy.gov/articles/us-department-energy-make-strategic-petroleum-reserve-storage-capacity-available-struggling

EIA. (2019, November 4). Associated gas contributes to growth in U.S. natural gas production. Retrieved from https://www.eia.gov/todayinenergy/detail.php?id=41873#

Energyworld.com. (2020, September 23). India tops up strategic reserves with cheaper crude, saves over $685M. Retrieved from https://energy.economictimes.indiatimes.com/news/oil-and-gas/india-tops-up-strategic-reserves-with-cheaper-crude-saves-over-685m/78272276

Eroğlu, H. (2020, June 2020). Effects of Covid-19 outbreak on environment and renewable energy sector. Environment, development and sustainability, 1-9.

European Commission. (2020, December 14). PCI Transparency platform . Retrieved from INNOVATION AND NETWORKS EXECUTIVE AGENCY / ENERGY: https://ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/main.html

European Commission. (2020, July 21). Recovery plan for Europe. Retrieved from https://ec.europa.eu/info/strategy/recovery-plan-europe_en

Evans, S., & Pearce, R. (2020, March 26). Mapped: The world's coal power plants. Retrieved from CarbonBrief: https://www.carbonbrief.org/mapped-worlds-coal-power-plants

Fiestas, H. (2020, July). Post-COVID-19 green recovery through the lens of an investor. In the Oxford Institute for Energy Studies. Oxford Energy Forun, 123.

Friedman, L., & Villegas, A. (2020, March 25). Climate and the $2 Trillion Stimulus Package. Retrieved from New York Times: https://www.nytimes.com/2020/03/25/climate/nyt-climate-newsetter-coronavirus-drought.html

Fuentes, R. (2020, July). A climate change approach to COVID-19 and its implications for the energy transition. Oxford Energy Forum, 123.
Garcia, P. (2020, July). Covid-19 and the Energy Transition. Oxford Energy Forum, 123.

Geall, S. (2020, July). China's climate commitments and energy ambitions beyond COVID-19. Oxford Energy Forum(123).

George, B. (2020, November 20). Europe's refiners face losses, capacity closures. Retrieved from Argus Media: https://www.argusmedia.com/en/news/2161918-europes-refiners-face-losses-capacity-closures

Gosens, J., & Jotzo, F. (2020, August 6). China's post-COVID-19 stimulus: No Green New Deal in sight. Environmental Innovation and Societal Transitions. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7406429/

Greenberg, A. (2019). Sandworm - A New Era of Cyberwar and the Hunt for the Kremlin's Most Dangerous Hackers. New York: Doubleday.

Gustaffson, T. (2020). The Bridge - Natural Gas in a Redivided Europe. Harvard University Press.
Honoré, A. (2020, June). Oxford Energy Research June 2020: "Natural gas demand in Europe: The impacts of COVID-19 and other influences in 2020. Retrieved from https://www.oxfordenergy.org/wpcms/wp-content/uploads/2020/06/Natural-gas-demand-in-Europe-the-impacts-of-COVID-19-and-other-influences-in-2020.pdf

Hydrocarbon Processing. (2020, July 20). China's record crude oil storage flies under the radar. Retrieved from https://www.hydrocarbonprocessing.com/news/2020/07/chinas-record-crude-oil-storage-flies-under-the-radar

IEA. (2019). Data and Statistics 2019. Retrieved from https://www.iea.org/data-and-statistics/data-tables?country=WORLD&energy=Oil&year=2019

IEA. (2019, November 27). The global oil market remains vulnerable to a wide range of risk factors. Retrieved from https://www.iea.org/areas-of-work/ensuring-energy-security/oil-security

IEA. (2020, June). Gas 2020. Retrieved from Fuel Report 2020: https://www.iea.org/reports/gas-2020/2021-2025-rebound-and-beyond

IEA. (2020). Global Energy Review 2020 - The impacts of the Covid-19 crisis on global energy demand and CO2 emissions.

IEA. (2020, June). IEA Gas 2020. Retrieved from

IEA.org: https://www.iea.org/reports/gas-2020

IEA. (2020, May). IEA World Energy Investment 2020. Retrieved from IEA: https://www.iea.org/reports/world-energy-investment-2020

IEA. (2020, March). Oil Market Report - March 2020. Retrieved from https://www.iea.org/reports/oil-market-report-march-2020

IEA. (2020, May). Renewable energy market update. Retrieved from IEA: https://www.iea.org/reports/renewable-energy-market-update

IEA. (2020, November). Renewables 2020. Retrieved from IEA Fuel Report: https://www.iea.org/reports/renewables-2020/transport-biofuels

IEA. (2020, June). Sustainable Recovery - World Energy Outlook Special Report. Retrieved from International Energy Agency: https://www.iea.org/reports/sustainable-recovery

IEA. (2020, October). World Energy Outlook 2020. Retrieved from IEA.org: https://www.iea.org/reports/world-energy-outlook-2020

IEA Oil Market Report. (2020, November). Retrieved from IEA: https://www.iea.org/reports/oil-market-report-november-2020

IRENA. (2020, June). The Post-COVID Recovery: An agenda for resilience, development and equality. Retrieved from IRENA: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Post-COVID_Recovery_2020.pdf

Jaipuriyar, M. (2020, November 12). Coronavirus to leave behind shuttered refineries and increased Asian reliance on Mid East crude. Retrieved from S&p Global Platts: https://www.spglobal.com/platts/en/market-insights/blogs/oil/111220-asia-refining-middle-east-crude-oil-coronavirus
Jankowski, D., & Wieczorkiewicz, J. (2020, June 15). Op-Ed: Toward a "Greener" NATO. Retrieved from https://berlinpolicyjournal.com/op-ed-toward-a-greener-nato/

Linares, P. (2020, July). Cab we use a COVID-19 crisis to move towards a more sustainable economy? Oxford Energy Forum(123).

Luciani, G. (2020, July). Other Impending Crisis. Oxford Energy Forum.

Macdiarmid, A. (2015, January 1). Biofuels in The DoD: Impact on System Reliability, Availability, and Maintainability. DSIAC Journal. Retrieved from https://www.dsiac.org/resources/articles/biofuels-in-the-dod-impact-on-system-reliability-availability-and-maintainability/

Mckinsey.com. (2020). Downstream oil and gas amid COVID-19: Succeeding in a changed market.

MEED. (2020, April). REPORT: MENA Renewables 2020 with coronavirus update. Retrieved from Middle East Business Intelligence: https://buy.meed.com/product/renewable-energy-in-the-mena-region-report/

Myllyvirta, L. (2020, September 23). Analysis: China's Covid stimulus plans for fossil fuels three times larger than low-carbon. Retrieved from https://www.carbonbrief.org/analysis-chinas-covid-stimulus-plans-for-fossil-fuels-three-times-larger-than-low-carbon

NATO. (2014, February). Green Defence Framework. Retrieved from https://natolibguides.info/ld.php?content_id=25285072

NATO. (2020, December). NATO Pipeline System. Retrieved from https://www.nato.int/cps/en/natohq/topics_56600.htm?selectedLocale=ru

NATO. (2020, April 2). NATO's Role in Energy Security. Retrieved from NATO.int: https://www.nato.int/cps/en/natohq/topics_49208.htm

Nazarov, M. (2015, April 3). Russia's refinery modernization push slowed by sanctions. Retrieved from Reuters: https://www.reuters.com/article/us-russia-refineries-idUSKBN0MU10C20150403?edition-redirect=uk

Newey, S. (2020, December 2). The next pandemic: New diseases could spread undetected in some of world's most connected cities. Retrieved from Telegraph.co.uk: https://www.telegraph.co.uk/global-health/terror-and-security/next-pandemic-new-diseases-could-spread-undetected-worlds-connected/

Offshore Engineer. (2020, August 4). Neptune Energy Halts Drilling Op in Norway After COVID-19 Cases on Seadrill Rig. Retrieved August 4, 2020, from Oedigital.com: https://www.oedigital.com/news/480678-neptune-energy-halts-drilling-op-in-norway-after-covid-19-cases-on-seadrill-rig

Oxford Energy Report. (2020, July). COVID-19 and the energy transition, Issue 123. Retrieved from Oxfordenergy.org: https://www.oxfordenergy.org/publications/oxford-energy-forum-covid-19-and-the-energy-transition-issue-123/

Palmer, D. (2020, January 23). Suspected Iranian hacking campaign targets European energy companies. Retrieved from Zdnet: https://www.zdnet.com/article/suspected-iranian-hacking-campaign-targets-european-energy-sector/

Paola, A. d. (2020, May 5). Mideast Petro-States Look Past Oil Rout to Chase Solar Power. Retrieved from Bloomberg.com: https://www.bloomberg.com/news/articles/2020-05-05/mideast-petro-states-look-past-oil-s-crash-to-chase-solar-power

Pensado, P., & Singh, H. (2020, July). Drawing energy transition lessons from COVID-19 on in-

ternational cooperation and individual behavior. Oxford Energy Forum, 123.

Pherson, K., & Pherson, R. (2013). Critical Thinking for Strategic Intelligence. Thousand Oaks: CQ Press.

Raval, A. (2020, July 10). IEA warns rise in Covid-19 cases 'casting a shadow' over oil recovery. Retrieved from www.ft.com

Raval, A., & Hook, L. (2020, December 8). Shell executives quit amid discord over green push. Retrieved from Financial Times: https://www.ft.com/content/053663f1-0320-4b83-be31-fefbc49b0efc

Raval, A., & Sheppard, D. (2020, September 28). Rosneft warns BP and Shell creating 'existential crisis' for oil supplies. Retrieved from Financial Times: https://www.ft.com/content/1394d8a1-6e85-451b-a858-ac6218b79d06

Raval, D. B. (2020, May 21). Q&A: Will the oil industry recover from the Covid-19 crisis. Retrieved from FinancialTimes.com: https://www.ft.com/content/04620c59-7ce4-42fa-9930-59e4e-625a00e

Reardon, S. (2012, 11 3). Eco-Warriors: The Next Wave. New Scientist, 216(2889), 6-8.
REN21. (2020, June). Renewables 2020 Global Status Report. Retrieved from REN21: https://www.ren21.net/gsr-2020/

Riley-Gould, H., Harvey, R., & George, B. (2020, October 23). Second Covid-19 wave adds to European refiners' woes. Retrieved from Argus Media: https://www.argusmedia.com/en/news/2153072-second-covid19-wave-adds-to-european-refiners-woes

Rystad Energy. (2020, November 25). As global oil demand outlook weakens, planned refining capacity boom set to keep utilization low. Retrieved from https://www.rystadenergy.com/clients/articles/press-releases/as-global-oil-demand-outlook-weakens-planned-refining-capacity-boom-set-to-keep-utilization-low/

Rystad Energy. (2020, June 23). Global gas output set to fall by 2.6% in 2020, associated gas to take the hardest hit. Retrieved from https://www.rystadenergy.com/clients/articles/press-releases/global-gas-output-set-to-fall-by-2point6-in-2020-associated-gas-to-take-the-hardest-hit/

Said, S., Faucon, B., & Jones, R. (2019, September 22). Aramco's Repairs Could Take Months Longer Than Company Anticipates, Contractors Say. Retrieved from https://www.wsj.com/articles/aramcos-repairs-could-take-months-longer-than-company-anticipates-contractors-say-11569180194

Schmid, M. (2019). Rare Earths in the Trade Dispute Between the US and China: A Deja vu. Review of European Economic Policy, Volume 54(6), 378–384. Retrieved from https://www.intereconomics.eu/contents/year/2019/number/6/article/rare-earths-in-the-trade-dispute-between-the-us-and-china-a-deja-vu.html

Shaffer, B. (2017, December). A Guide to the Application of Energy Data for Intelligence Analysis. Studies in Intelligence, 61(4).

Slattery, G. (2020, July 13). Brazil's offshore oil workers chilled by coronavirus outbreaks. Retrieved July 13, 2020, from Reuters.com: https://www.reuters.com/article/us-health-coronavirus-brazil-oil-insight-idUSKCN24E1A4

Smith, S. (2013, April 22). A Sino-Japanese Clash in the East China Sea. Retrieved from Council on Foreign Relations - Center for Preventive Action: https://www.cfr.org/report/sino-japanese-clash-east-china-sea

Soldatkin, V., & Nazarov, M. (2018, March 2018). Russia ramps up fuel exports in fight for European market. Retrieved from Reuters: https://www.reuters.com/article/us-russia-diesel-exports/russia-ramps-up-fuel-exports-in-fight-for-european-market-idUSKCN1GP03T

St.John, J. (2020, March 25). Senate Strikes Deal on Coronavirus Stimulus Package That Excludes Help for Renewables. Retrieved from Green Tech Media: https://www.greentechmedia.com/articles/read/clean-energy-assistance-wont-be-part-of-massive-coronavirus-stimulus-bill

Stillman, A. (2020, 7 15). Covid-19 Is Killing Oil Workers at an Unparalleled Pace in Mexico. Retrieved from Bloomberg.com: https://www.bloomberg.com/news/articles/2020-07-15/covid-19-is-killing-oil-workers-at-unparalleled-pace-in-mexico

Stillman, A. (2020, September 10). How AMLO's Crown Jewel Became the World's Deadliest Covid Company. Retrieved from Bloomberg.com: https://www.bloomberg.com/news/features/2020-09-10/oil-producer-pemex-has-the-most-covid-19-deaths-of-any-company-in-the-world#:~:text=Tom%C3%A1s%20Morales%20Vega%20on%20a%20Pemex%20platform%20in%202016.&text=Pemex%20has%20reported%20the%20deaths,number%2

Sundria, S., Freitas, G., & Graham, R. (2020, November 22). China to Take Oil-Refining Crown Held by U.S. Since 19th Century. Retrieved from Bloomberg Markets: https://www.bloomberg.com/news/articles/2020-11-21/china-is-set-to-eclipse-america-as-world-s-biggest-oil-refiner

Taylor, A. (2020, April 22). Australia to boost fuel security and establish national oil reserve. Retrieved from https://www.minister.industry.gov.au/ministers/taylor/media-releases/australia-boost-fuel-security-and-establish-national-oil-reserve

The Oxford Institute for Energy Studies. (2020, May). Quarterly Gas Review 9. Retrieved from Oxfordenergy.org: https://www.oxfordenergy.org/publications/quarterly-gas-review-issue-9/

Turner, A., & Delasalle, F. (2020, July). 7 priorities to help the global economy recover while building a healthier, more resilient, net zero-emissions economy. Oxford Energy Forum, 123.

Turner, E. (2020, December 16). FEATURE: More gloom for European refiners in 2021 on weak margins, new capacity. Retrieved from S&P Global Platss: https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/121620-feature-more-gloom-for-european-refiners-in-2021-on-weak-margins-new-capacity

U.S. Energy Information Administration. (2011, March 7). Libyan supply disruption may have both direct and indirect effects. Retrieved from Today in Energy: https://www.eia.gov/todayinenergy/detail.php?id=390

U.S. Energy Information Agency . (2020, November 9). U.S. refinery runs remain lower than the five-year range. Retrieved from https://www.eia.gov/todayinenergy/detail.php?id=45816

U.S. Energy Information Agency. (2020, September 2). EIA. Retrieved from Demand for jet fuel in the U.S. is recovering faster than in many other markets: https://www.eia.gov/todayinenergy/detail.php?id=44996

US CERT. (2018, March 16). Russian Government Cyber Activity Targeting Energy and Other Critical Infrastructure Sectors. Retrieved from https://us-cert.cisa.gov/ncas/alerts/TA18-074A

Waine, C. (2020, September 11). Pemex scales back upstream goals. Retrieved from Petroleum-Economist.com: https://www.petroleum-economist.com/articles/upstream/exploration-production/2020/pemex-scales-back-upstream-goals

Wikipedia. (2020, September 21). Retrieved from Global Strategic Petroleum Reserves: https://en.wikipedia.org/wiki/Global_strategic_petroleum_reserves

Winning, D., & Elliot, R. (2020, December 6). Pandemic pushes fuel makers in richer countries to the brink. Retrieved from Wall Street Journal: https://www.wsj.com/articles/pandemic-pushes-fuel-makers-in-richer-countries-to-the-brink-11607259604

Yergin, D. (2020). The New Map. Penguin Random House UK.

Yermakov, V. (2019, June). Oxford Institute for Energy Studies. Retrieved from The Druzhba Pipeline Crisis: The Lessons for Russia and for Europe: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/06/The-Druzhba-Pipeline-Crisis-The-Lessons-for-Russia-and-for-Europe.pdf