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How to implement an EU embargo on Russian oil

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The Russian war on Ukraine is financed in large part by the export of oil. The US, the EU, the UK and other countries have intensified various sanctions on Putin's leadership group and their economy, but Russian export revenues since the invasion on 4 February have risen; the volume of oil exported has not fallen, and the world price of oil is up.² In fact, the movement of Russian crude by tanker ship was just over 3 million barrels per day in February and March, but more than 4 million barrels per day in the first 17 days of April.³

Despite the evidence of atrocities in Bucha and elsewhere, and the deliberate targeting of civilians with missile attacks (for example, at Kramatorsk railway station), Western countries remain reluctant to impose sanctions on Russian oil exports, fearing the consequences for fuel prices around the world.

Most notably, the EU buys 2.2 million barrels of oil and 1.2 million barrels of petroleum product from Russia every day.⁴ This creates a deep contradiction in EU policies that now becomes painfully apparent. Speaking in early April, Josep Borell, the EU High Representative for Common Foreign and Security Policy, pointed out that while the EU had pledged €1 billion to Ukraine for military aid:

“€1bn is what we pay Putin every day for the energy he provides us. Since the beginning of the war we have given him €35bn.”⁵

1 We thank colleagues and industry sources for extensive comments on this project. All sources prefer to remain anonymous, unless identified explicitly in the text. All the views expressed here are entirely personal

2 Russia is also running a large current account surplus, for example when compared with the same period in previous years through February 2022; March data should be published shortly (see <https://twitter.com/RobinBrooksIIF/status/1506551801813909505>).

3 The working assumption at the International Energy Agency and among other analysts is that pipeline flows from Russia will adjust, if at all, after seaborne flows decline. In the fourth quarter of 2021, Russia exported 7.7 million barrels per day of crude and petroleum products. Of this, 4.9 million barrels per day was crude, with 2.3 million barrels per day of that going to the EU (0.7 million b/d by pipeline and 1.6 million b/d by tanker). The EU also received 1.2 million barrels per day of 'product' (0.4mb/d of diesel, 0.2mb/d of naphtha, 0.3mb/d of fuel oil, and 0.3mb/d of other products) (IEA 2022b: 5).

4 “Factbox: How much oil does the European Union import from Russia?” (Reuters, 6 April 2022). The International Energy Agency (2022b: 5) says that 2.3 mb/d of crude and 1.2 mb/d of refined product went to the EU. The exact numbers in the fourth quarter of 2021 were: total Russian exports of 7.7 mb/d (crude plus refined products), of which 3.5 mb/d went to the EU (45%), 0.5 mb/d went to “Other Europe” (6.5%), and 1.7 mb/d (22.1%) went to China. China received only crude oil, not refined products, so its share of Russian crude oil exports was higher, at 35%.

5 “1bn for Ukraine, €35bn for Russian energy: top EU diplomat calls out funding gap” (*The Guardian*, 6 April 2022).

According to press reports, much of Russia's hard currency revenue is now being spent on reequipping the Russian military and preparing for the next offensive.⁶

There is also an unseemly and morally appalling scramble by some European and Asian countries to increase their purchases of Russian oil. According to publicly available data, as shown in Figure 1, some nations that claim to be fully in support of Ukrainians appear to have significantly increased their purchases of Russian oil since the invasion.

If our objective is to reduce Western financing of the Russian military effort, the only logical next step is for the US, the EU, the UK and others to prohibit all Russian oil and oil product exports, and to make it illegal to carry such cargo in European-owned tankers. This blanket provision would trigger force majeure clauses in most contracts for vessel owners, oil traders, insurance companies and other providers of financial services – allowing them to break existing contracts without penalty.

The key point is to avoid a situation in which the EU imposes an embargo on the import of Russian oil, resulting only in more of that oil flowing to Asian markets. Given the large market share of EU-owned tanker fleets, a prohibition on those vessels carrying Russian oil and oil products is essential for sanctions to be meaningful.⁷

An EU embargo and associated system of sanctions could be combined with a tightly controlled and centralised system of waivers. These waivers would allow limited purchases of Russian oil by designated countries and in specified tankers. The prices charged should be monitored and preferably set below the world price for oil.⁸

In addition, all payments for Russian oil under the waiver programme could go into supervised escrow accounts. The funds in these accounts should be available to Russia only once there is a ceasefire and, even in that case, should be used to buy food and medicine only – no weapons or industrial components that can be used to make weapons or military equipment of any kind.

As an additional safeguard, all approved imports into Russia also need to be supervised carefully, to ensure that only humanitarian supplies are getting through. In addition to all standard border controls, Ukrainian-appointed inspectors should participate in checking every shipment of freight to Belarus or Russia.

This would require hiring many inspectors, but there are currently more than two million adult Ukrainian refugees in European countries – so there is no shortage of people who need a job and who are willing to work. Their salaries should be paid from the Russian oil escrow accounts.

Any country that receives a permit to buy Russian oil should also publicly commit to reduce its consumption of fossil fuels over time. To facilitate those energy transitions, all forms of appropriate technology should be shared widely. As we discuss in the appendix below, the development of off-shore windfarms is among the most appealing ways to reduce oil consumption in the medium run.

6 “Russia seeks military equipment and aid from China, U.S. officials say” (*The Washington Post*, 13 March 2022) and “Russia using weapons smuggled by Iran from Iraq against Ukraine” (*The Guardian*, 11 April 2022).

7 From 24 February to 22 March, EU-, US- and UK-owned ships carried more than 70% of the barrels of oil shipped from Russian ports in the Black Sea and Baltic Sea (based on analysis provided by a commercial firm).

8 The average oil price over the past five years is about \$50 per barrel. The marginal cost of production for West Siberian crude is no more than \$10 per barrel. This estimate is based on private communication with oil industry experts.

Background

In 2019, pre-pandemic, Russian crude oil exports were worth \$122.2 billion and petroleum products (refined oil) generated another \$66.9 billion. Oil-related exports were worth more than three times the value of gas exports (\$51 billion), while all other exports combined were worth less than \$50 billion.⁹

Before its invasion of Ukraine on 24 February 2022, Russia exported an average of about 5 million barrels of crude oil and 2.85 million barrels of refined petroleum product every day (IEA 2022a). Of the crude oil exports, on average before the invasion between 3 and 3.5 million barrels were moved by tanker every day.¹⁰ Crude oil tankers are tracked by TankerTrackers.com, a web-based tracking service. Information on tankers carrying crude oil and refined products is available from Spire, a maritime tracking service, confirmed with industry sources. The discussion here relies on an integration of these data sources provided by The Wednesday Group (TWG).¹¹

In 2019, the price for benchmark Brent crude was \$64 per barrel on average, while the world price for crude oil was about \$80 per barrel at the end of 2021 and around \$90 per barrel at the end of January 2022. The price of Brent crude rose to over \$120 per barrel during the early weeks of the invasion and has recently fluctuated in the range of \$100–110.¹²

In the initial aftermath of the invasion, the US imposed an embargo on imports of Russian oil and gas. There was also some self-sanctioning by European countries and tanker companies. For example, deliveries of crude oil by tanker to Denmark were 7.525 million barrels in February 2022, but nearly zero in March. Other Nordic countries, Poland, Romania and Lithuania similarly cut back in March, and leading Scandinavian shipping countries are refusing to transport Russian oil.¹³

Figure 1 shows the data for crude oil plus refined products; this is close to the picture for just crude, but with some differences – for example, in the case of Denmark.

Unfortunately, other countries have stepped up to buy more oil since the invasion. For example, in February crude oil deliveries by tanker to the Netherlands amounted to 9.497 million barrels, but in March this was up to 16.121 million barrels.¹⁴ China received 12.388 million barrels of Russian crude in February and 19.617 million barrels in March. India bought almost no Russian oil in February (25,550 barrels) and 12.816 million barrels in March.¹⁵

9 The pattern was similar in 2021, with slightly high revenue from gas exports: “Russia’s export machine: the 2021 current account surplus of +\$122 bn is mostly due to oil exports of +\$181 bn, followed by natural gas of +\$63 bn & coal of \$17 bn” (source: <https://twitter.com/robinbrooksiiif/status/1513138506494849026>).

10 According to the International Energy Agency, Russian pipeline exports of crude oil in the fourth quarter of 2021 were 0.7 mb/d to the EU and 0.8 mb/d to China. With total crude exports of 4.9mb/d, this implies total seaborne lift of up to 3.4 mb/d (IEA 2022b: 5).

11 We focus on tankers because these can be physically observed by third parties and data concerning cargo and destination can be checked with multiple sources. At least at this stage, there does not appear to have been much change in the movement of Russian oil by pipeline. Please note that recent (last few weeks) information on tanker destinations are subject to confirmation on arrival and revision in the underlying data. We have used the most recent available information at the time of publication.

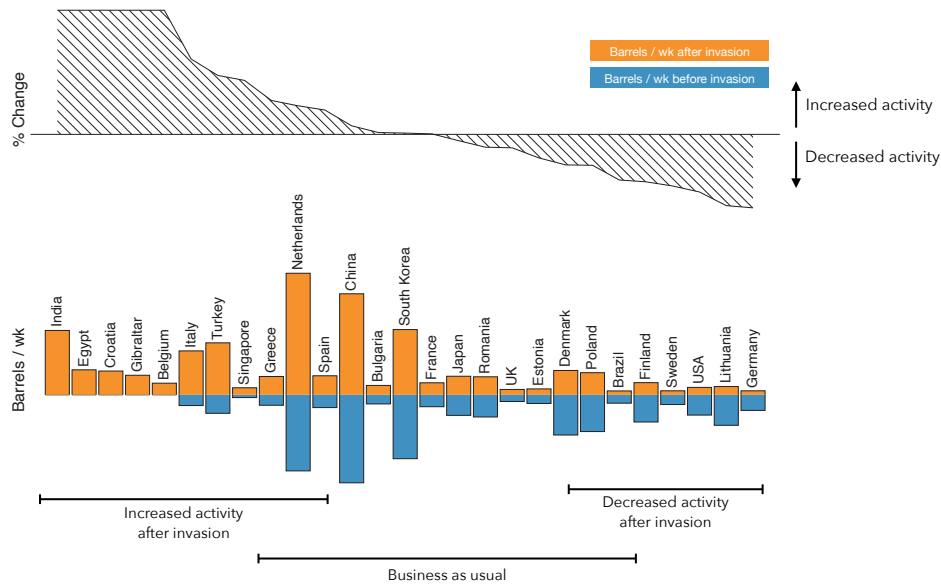
12 In the initial weeks after the invasion, there were reports of a discount on Russian Urals crude of up to \$30 relative to Brent. However, as Asian buyers have entered the market, this discount appears to have shrunk.

13 The purchasing pattern for Russian crude remains fluid even among countries that would seem, based on their rhetoric, least likely to buy from Russia.

14 It seems implausible that the Netherlands could consume this much oil. Given that Rotterdam and the surrounding area has the largest oil refinery complex in Europe, presumably the oil is being stored – to be refined and then shipped to other countries, inside and outside the EU. This is a topic for further investigation.

15 The specific data points discussed in this and the following paragraphs are from TankerTrackers.com for Russia: February, March, and April 2022 (last accessed on 18 April 2022; premium subscription required).

Figure 1 Countries importing Russian oil



Other countries that received more Russian oil in March than in February include Italy (from 2.367 to 7.501 million barrels), Turkey (from 2.314 to 4.633 million barrels) and Croatia (from nothing in February to 2.209 million barrels in March).¹⁶

Japan and South Korea continue to buy large amounts of Russia oil, at about the same rate as before the invasion (2.867 and 8.902 million barrels in March, respectively).

Deliveries by tanker to France were down, but only slightly, from 2.260 million barrels to 1.950 million barrels. Tanker deliveries of crude to Germany fell from 2.190 million to 725,000 barrels, although apparently pipeline deliveries and tanker deliveries of diesel and other refined products remain robust.

Also notable is the UK, where the government has consistently expressed strong support for Ukraine and has received praised for the assistance it provided. However, in February the UK received only 432,000 barrels of Russian crude, while in March this rose to 726,000 barrels. Valuing those additional purchases at the average oil price for March would suggest that the British paid Putin's regime nearly \$35 million more in March for oil deliveries than they did in February.

For crude oil lifted by tanker, in February 2022, Russia exported an average of 3.14 million barrels per day at an average price of \$97.12 per barrel. In March 2022, average oil exports by tanker were 3.11 million barrels, at an average price of \$118.04. In the first ten days of April, average oil exports by tanker were 4.036 million barrels per day, although world oil prices were down slightly.¹⁷

At the same time, some European-owned tanker companies have increased the amount of oil and refined products that they lift from Russian ports. According to available data and industry sources, in the first weeks post-invasion, about 46% of Russian oil was lifted in the Black Sea and Baltic Sea by Greek-owned tanker companies, up from a market share of around 35% before the invasion.¹⁸

¹⁶ All these data are subject to revision as final destinations are not necessarily known until after the voyage is completed. The values here are from TankerTrackers.com on 18 April 2022.

¹⁷ There are also reports of Russian oil being shipped under the label of 'Latvian blend' (Blas 2022). This is a significant development that is hard to quantify currently.

¹⁸ This estimate is based on data from a commercial analyst, shared privately. TWG analysis, based on data from Equasis, suggests that the Greek-owned share of the tanker market in the Black Sea may be as high as 70%.

Oil trading companies claim that they are only lifting oil under existing contracts, even though the TWG data indicate some charterers are now carrying more than they did immediately before the invasion (see Figure 2). The owners of tankers involved in trading with Russia make similar claims, but again some are doing significantly more Russian business than before the invasion (Figure 3). (To be clear, in the absence of sanctions on Russian oil, none of these companies has done anything illegal.)

Figure 2 Charterers of tankers carrying Russian oil

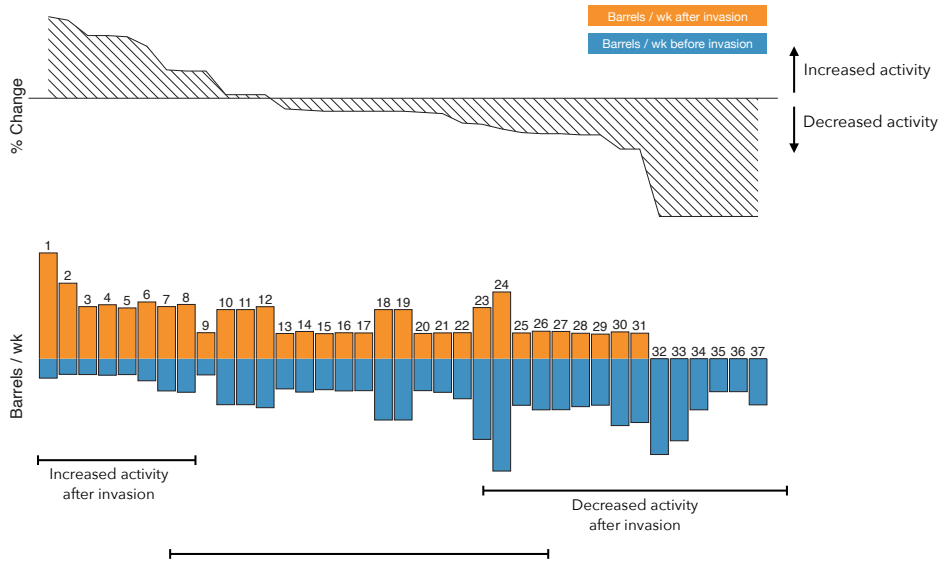
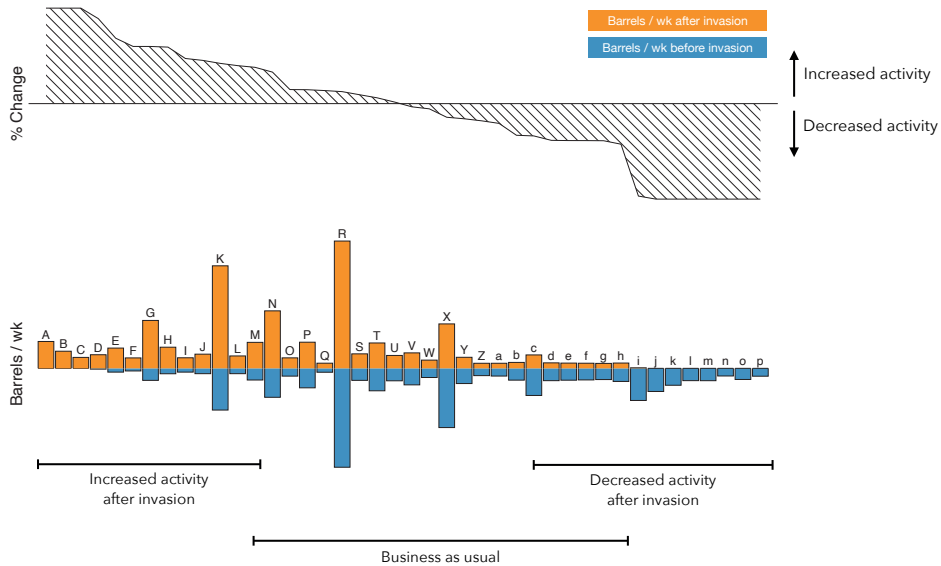


Figure 3 Owners of tankers carrying Russian oil



In private conversations, charterers, owners, and their insurance companies emphasise that if sanctions were to be imposed, in the form of a prohibition on all Russian oil trade activities, that would activate force majeure clauses in their contracts – enabling them to break off trade with Russia without penalty.

However, in the absence of sanctions there appears to be no chance that Russian revenues from oil exports will decline in the foreseeable future. In fact, given that domestic demand for fuel has fallen sharply, there are also indications that Russia plans to export even more oil in the coming months.

At the same time, we need to recognise that Russia is a large supplier of oil to the world market. Sanctions should be designed with this in mind.

Proposed structure for sanctions

Taking these factors and market conditions into consideration suggests the following general approach:

1. All Russian oil and oil products should be sanctioned by the US, the EU, the UK and any other countries that are willing to stop Putin's war on Ukraine. (Similar sanctions should be applied to Belarus.)
2. The carrying of Russian-origin oil and oil products in any US, European, British and other vessel should also be prohibited.
3. The provision of financial services in any form to any entity involved in the Russian oil and gas value chain should also be prohibited.
4. The combination of 1, 2 and 3 will trigger force majeure in all commercial contracts for the buying, transportation and financing of Russian oil cargo.
5. The EU should declare a complete embargo on all Russian oil and seek alternative suppliers of crude oil and refined products. The available spare capacity in Saudi Arabia and the United Arab Emirates (UAE) is roughly equal to the amount of crude oil that the EU currently buys from Russia daily.¹⁹
6. A system of waivers should be put in place to allow the controlled export of some Russian crude and refined products subject to centrally issued permits.
7. Administering this permit system would be costly, and appropriate fees should be charged. An initial user fee of \$50 per barrel seems plausible.²⁰
8. International permits would allow energy exports subject to the following conditions:
 - a. All proceeds from these transactions go into escrow accounts.
 - b. These accounts are frozen until Russian forces withdraw from Ukraine.
 - c. Once unfrozen, these accounts can be used to buy food, medicine, and other humanitarian supplies only.
 - d. The supplies purchased under license are shipped to Russia only through a few tightly controlled land crossings (vehicle and train) – for example, on the Poland-Belarus border and on the Finland-Russia border. In addition to local and EU border officials, there should also be Ukrainian inspectors present for every inspection of all cargo. All shipments need to be inspected, without exceptions.

¹⁹ The IEA (2022b) shows "spare capacity" (in million barrels per day) relative to February supply as 2.00 for Saudi Arabia, 1.13 for UAE, 0.56 for Iraq, 0.24 for Nigeria and 0.18 for Kuwait (table on p.19). The total "OPEC-10" spare capacity was 4.19 million barrels per day. In February 2022, total OPEC+ production was 44.14 million barrels per day and "total demand" for 2022 was projected at 99.7 million barrels per day.

²⁰ For example, if the world price of oil is \$110 and an Asian country agrees to buy Russian oil at a cost to it of \$100, then a \$50 fee per barrel would imply that Russia receives \$50 per barrel sold into its escrow account – which is still \$40 more than the marginal cost of production for each barrel. Of course, Russia would like to receive more than \$50 and the Asian market would like to pay less than \$100, creating the potential for smuggling. Intense monitoring of potentially smuggling will be needed; this is another international cost that can be covered by fees and another effort that can be staffed by Ukrainians who have been made underemployed or unemployed by the Russian invasion.

9. Ukrainian refugees should be hired and trained as cargo inspectors. Their salaries should be paid out of the escrow accounts. In addition to assisting with the immediate task of ensuring no weapons or parts for weapons are smuggled into Russia, training these workers will help rebuild the Ukrainian customs service in line with EU best practices.
10. The central authority to provide licenses and authorise inspections could be administered by the IEA, acting under the authority of the governments involved.
11. To the extent that additional specialists are needed to staff any dimension of this effort – including monitoring tankers, determining whether sanctions are being violated and assessing potentially questionable financial transactions – highly qualified Ukrainians are available. Given that the Russian invasion is estimated to have caused a nearly 50% decline in Ukraine's GDP, employing these talented people in this fashion seems entirely appropriate. Again, their salaries can be paid from the escrow accounts.
12. In effect, the proposed structure would create an 'Inverse OPEC', comprised of countries that are willing to limit the ability of Russia to buy destructive weapons. This arrangement is obviously a violation of competitive market principles, but so is OPEC.
13. All participating countries should agree to taper their purchases of Russian fossil fuels as quickly as possible. Measures to reduce consumption of oil should be put in place everywhere, with sharing of all relevant technology. Industrial country governments should ensure that poorer countries have expedited access to any technology that would be helpful.
14. At the same time, all countries should work towards long-term solutions to reduce their dependence on oil (see the appendix). These efforts gain great urgency considering the national security implications that the Russian invasion of Ukraine highlights.

Potential outcomes

The impact of these sanctions would obviously depend on how Russia and other countries respond.

First, Russia may refuse to supply any oil to the world market under these conditions. As Russia has very little onshore storage, it would need to immediately shut down oil wells, which is costly and hard to manage on a large scale.

Putin's regime would lose almost all its hard currency revenue and most of its remaining budget revenue. The pressure on Russian public finances would be immense. It is unlikely that the war can continue for long in this scenario, but the world should be prepared for this possibility.

The combination of nuclear weapons, free cash flow from oil and expansionist intentions will prove toxic for a long time. The world needs to transition away from buying energy from Russia, and this requires a broader reduction in dependency on oil. The only question now is how fast that transition needs to be and which technologies to focus on (see the Appendix below).

Second, if EU diplomacy is persuasive enough or if oil prices rise sufficiently during this transition, OPEC countries may decide to produce more oil. There are about 2–2.5 million barrels of oil in available capacity currently, mostly in Saudi Arabia and UAE. If these countries agree to provide this oil to the world market, then it will be possible for the world to wean itself off Russian fossil fuels sooner and at lower cost.

However, if OPEC countries refuse to cooperate and allow oil prices to rise further, then the EU and other countries can only redouble their efforts to reduce consumption of all fossil fuels. OPEC countries must decide for themselves whether they would like to be regarded as trustworthy partners for the coming decades, or whether they prefer to damage the world economy and their long-term trading relationships.

Third, some countries may decide to import Russian oil without a license. However, it will be hard to move significant amounts of oil from Russia by tanker under the proposed prohibitions on EU-owned tankers, as all those shipments are monitored, and additional sanctions can be imposed on countries, tanker owners, charterers, insurers and financial institutions that break with the international regime.

Exporting 1–2 million barrels of Russian oil per day by pipeline and sea to China may be possible.²¹ However, moving large amounts of Russian oil to India will be difficult without the involvement of European-owned tanker fleets. One advantage of the proposed waiver programme is that it would greatly reduce the incentive to smuggle Russian oil.

Fourth, China may decide to form a new, more explicit trading axis with Russia. Per day, China consumes about 12.8 million barrels and produces about 5 million barrels of oil, so it could conceivably buy all of Russia's available production.

The problem with that arrangement would be on the other side of the trading balance. Russia has a population of about 145 million and a total GDP of only around \$1.6 trillion. The most important foreign markets for China include the US (300 million people; GDP of \$21 trillion) and the EU (450 million people; GDP of around \$17.1 trillion).

Russia can supply China's energy needs, but if China pivots to rely primarily on selling to Russia, such a strategy seems unlikely to prove consistent with rapid Chinese economic growth.

Conclusion

The consequences of the Russian invasion of Ukraine are being actively debated in policy circles,²² including active consideration of how best to help rebuild Ukraine (Becker et al 2022). The World Bank, the United Nations Development Programme (UNDP) and others are reportedly working on specific plans. But no lasting reconstruction is possible until the fighting stops.

Early Western attempts to end the invasion included extensive financial sanctions on Russia's central bank and parts of its financial system (Cecchetti and Schoenholtz 2022). These have been supported by further measures against individuals and various other parts of the Russian economy, but the export of oil and gas remains exempted (Bown 2022).

European political leaders are now thinking further about the urgent need to stop Putin's aggression. It is becoming increasingly clear that this must involve cutting off or severely curtailing Russia's ability to use energy export revenue to support its war effort (Garicano 2022).

²¹ In the fourth quarter of 2022, China received 0.8 million barrels per day from Russia by pipeline and 0.8 million barrels per day by sea (IEA 2022b: 5, which shows total Russian oil to China as 1.7 mb/d in that period.)

²² See, for example, the Vox debate on "The economic consequences of war" [here](#).

The best way to achieve this goal would be include an EU embargo of Russian oil, alongside a comprehensive set of sanctions that would raise the cost of transporting this oil to other markets. An organised waiver programme could help reduce smuggling and ensure that the proceeds from the sale of Russian oil are not used to buy weapons.

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Appendix: Levers for reducing Russian revenue from oil

There are essentially only two ways to reduce Russian revenue from oil:

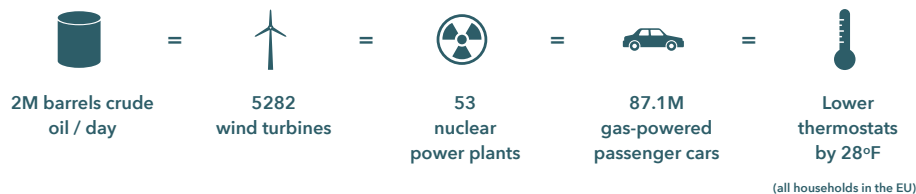
1. pay less for the oil we buy from Russia, or
2. buy less oil from Russia.

In the second case, we can either replace the oil by buying it from other sources or consume less oil. The back-of-the-envelope calculations below compare the feasibility of each of these scenarios.

For each calculation, we assess the short-term feasibility (i.e. could this impact Russian military spending in the next weeks to months?) and the long-term prospects (i.e. what is the outlook, on the scale of years to decades?). In addition, these estimates only consider energy balance and ignore the losses and complexities associated with moving energy, storing energy, economic and political factors, and so on. Hence the estimates below should be considered optimistic as they only account for constraints set by the laws of physics.

As a baseline, we will consider the revenue Russia is generating today: approximately 5 million barrels of crude oil per day at approximately \$100 per barrel, yielding half a billion dollars per day.²³ This establishes the order of magnitude of the problem: to have a significant impact, we require strategies that reduce daily revenues by hundreds of millions of dollars. In each of the options below we consider the question: *What would it take to reduce Russia's daily oil generated revenue by \$200 million?* (This is roughly comparable to the revenue coming from EU crude oil purchases.)

Figure 4 Schematic summary of prominent energy sources/uses



Buy less oil from Russia by reducing consumption: transportation

Crude oil is most commonly converted to gasoline or diesel and used to power vehicles. Hence, we begin by estimating how many petrol-engine cars would need to be removed from the road to reduce Russia's daily revenue by \$200 million (or equivalently, at the current price, reduce exports by 2 million barrels per day).

In the EU people drive approximately 11,300 km per year. Currently, the EU has mandated average fuel economies of 57 miles per gallon (mpg), up from 41.9 mpg in 2015. Given that most people are likely not driving brand new cars, we will use the fuel standards of 2015. This implies that, on average, European cars are consuming 168 gallons of gas per car per year, or 0.46 gallons per car per day. Given that a barrel of oil produces approximately 20 gallons of gasoline, **we would need to remove 87.1 million petrol-driven cars from the road** to reduce consumption by 2 million barrels/day. There were approximately 268 million passenger cars in the EU in 2018, so 87.1 million corresponds to approximately 32.5% of the European fleet.

²³ This analysis could be extended to include Russia's production and export of refined petroleum products.

Short-term prospects: Not feasible under current circumstances. To have a significant impact on Russian revenues, we would need to remove tens or hundreds of millions of cars from the EU (or incentivise all car owners to reduce driving by at least 30%).

Long-term prospects: Our need for transportation (of both goods and people in the US and the EU) is unlikely to decrease; in order to remove vulnerability associated with oil dependence, we need plasticity in the fleet, i.e. electric cars and trucks that are agnostic to their underlying source of energy.

Buy less oil from Russia by switching to alternate sources: wind power

Although natural gas and coal plants far outnumber oil power plants in the EU, there are still hundreds of oil power plants that could be replaced by alternate sources of energy. Optimistically, consider wind turbines capable of generating 10 MW of power. Given that the total energy in one barrel of crude oil is about 1,668 kWh, and estimating the efficiency of oil power plants as approximately 38%, **we would need to install 5,282 wind turbines** to reduce oil consumption by 2 million barrels per day, replacing approximately 53 GW of oil-generated power.

Short-term prospects: Not feasible, given the time needed to permit and construct this equipment. However, building offshore wind farms is worth considering as an EU-wide priority. There will be opposition, but the alternative is continued long-term dependence on Russian oil.

Long-term prospects: The largest (planned) wind farm in the world is the Jiuquan Wind Power Base in China, currently operating at 8 GW and planned to grow to 20 GW. Other wind energy behemoths include Jaisalmer Wind Park (India), Alta Wind Energy Center (US) and Muppandal Wind Farm (India), all of which operate at approximately 1.5 GW. To offset 2 million barrels of oil per day, we would need to build 35 wind farms in Europe comparable in scale to Jaisalmer.

Buy less oil from Russia by switching to alternate sources: nuclear power

A typical nuclear power plant produces about 1 GW of power. Using the same conversion numbers as above, we find that **we would need to add 53 nuclear power plants** to offset 2 million barrels of oil per day.

Short-term prospects: Not feasible. The political opposition to a scaled-up EU-wide nuclear programme will likely be stronger than the opposition to offshore wind farms. In addition, the Russian invasion of Ukraine has highlighted the difficulty of keeping civilian nuclear power plants and radioactive material safe for 50 years, let alone 10,000 years.

Long-term prospects: Unclear. Nuclear power is currently one of the very few alternatives that can currently be scaled to replace fossil fuels. However, wind seems likely become competitive, with large wind farms now producing power on the order of 1 GW, comparable to a typical nuclear reactor. (However, challenges associated with wind and other renewables – intermittency, energy storage, noise, turbine location, etc. – still exist and need to be addressed as a top priority).

Buy less oil from Russia by consuming less energy: turn down the thermostat

The amount of energy consumed per year per household in the US and the EU ranges from 10,000 to 15,000 kWh; about half of that is spent on heating. The power required for heating scales like the difference between the external temperature and the internal temperature, and the percent savings in the power requirement is approximately:

$$\% \text{ savings} \sim (\text{Change in thermostat}) / (T_{\text{inside}} - T_{\text{outside}}) \times 100.$$

Estimating the average low temperatures in Europe as 40° Fahrenheit and assuming that people set their thermostats at about 70° Fahrenheit suggests that lowering the thermostat by 1° Fahrenheit would result in an energy savings of about $\frac{1}{(70-40)} \times 100 = 3\%$ per household. Given that there are about 195 million households in the EU, this results in a total savings of 64,058 barrels of oil per day (assuming oil heating has an efficiency of 90%), far short of the 2 million barrel savings we require. To save 2 million barrels, **we would have to lower our thermostats by about 28°**, setting internal temperatures at about 42° Fahrenheit.

Short-term prospects: It is feasible to lower thermostats by several degrees, but that is not enough to have sufficient impact. Lowering the thermostat any amount is better than keeping it at the current temperature or raising it; 3% only moves the needle slightly, but it moves it in the right direction.

Long-term prospects: Not close to being a sufficient solution. Lowering the thermostat is helpful but it does not produce reductions on the scale we require.

Buy less oil from Russia by switching to alternate sources: buy from other nations

OPEC cut back on production significantly during the COVID pandemic and is only now ramping back up. There is an agreed increase in production schedule, which implies about 2–2.5 million barrels of spare capacity currently – almost all in Saudi Arabia and the UAE.

So far, those countries have indicated that they are not willing to provide this additional production to the market. However, if the price of oil rises far enough, OPEC typically does increase production – fearing otherwise that the result would be a ‘destruction of demand’ that is not consistent with their medium-term goals. It is unclear exactly what price would induce this supply reaction.

If OPEC members view Russia as an important long-term partner, they are less likely to increase supply in response. However, as Russia continues to escalate the war, kill civilians and commit war crimes, it is unlikely that OPEC will resist EU entreaties indefinitely.

Short-term prospects: Likely, but unclear at what oil price this will happen.

Long-term prospects: The current crisis emphasises that it is in the long-term interests of Europe to remove the vulnerability associated with energy production that EU countries cannot control. Although the EU, the US and other countries have made great strides towards energy independence, Russia’s invasion of Ukraine illustrates that we do not have enough flexibility to absorb large shocks to the system.

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