The myth of US energy independence

The Russia–Ukraine crisis has exposed vulnerabilities in US energy security. The US may import only a small amount of Russian oil but it is tied to Russian energy via its participation in highly globalized supply chains.

Jun Ukita Shepard and Lincoln F. Pratson

The world is feeling the economic and energy impacts of the Russian invasion into Ukraine. In the EU, energy security, or the ability to meet final energy demand from reliable sources, has decreased dramatically. The EU's dependence on Russian energy was increasing right up to the invasion in late February 2022. In 2021, the region imported 40% of its natural gas and 25% of its oil (crude and petroleum) from Russia[1,2]. The Nord Stream 2 pipeline, now stalled, would have increased natural gas capacity from Russia by 55 billion m^3 or 14% of 2021 gas demand in the region[3,4]. For months prior to the invasion, Vladimir Putin had manipulated natural gas markets, stoking fears of a hard winter in Europe, where nearly 40% of residential heating demand is met using natural gas[5,6].

In the US, the Russian invasion has exacerbated increasing gasoline prices, which averaged US$4.28 per gallon as of May 6th. On March 8th, the Biden Administration banned imports of Russian oil (both crude and petroleum), LNG, and coal[7]. In 2021, the US imported about 626,000 barrels per day of oil (7% of imports) from Russia[8]. To put this amount into context, the US produces 75% of its crude oil supply and 90% of its natural gas supply domestically. This gas is used to generate 38% of its electricity demand[9,10]. So while gasoline prices are dictated by global oil markets, many analysts consider the US to be recently energy independent[10–12]. However, we argue that this is not the case due to the critical roles Russia plays in globalized supply chains.

There are two types of energy flows that are critical for global supply chains. The first is direct energy, or the energy in the imports or exports of energy carriers. Russia is a major provider of direct energy through the crude oil and refined petroleum products it exports. The second flow is indirect energy, or the energy required to produce a good or render a service that is subsequently imported or exported. Indirect energy follows the good or service as it is used further down in the supply chain. The total energy used in a supply chain to produce a final product is called embodied energy.

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An example here would be the energy consumed to produce petroleum-derived products such as plastics and synthetic rubber, which in turn are used in the production of automobile parts and other consumer items.

In 2015, Russia was the largest exporter of total energy in the world (that is, direct plus indirect energy). Furthermore, most of this energy was transferred through indirect energy linkages, or energy connections between economies that do not otherwise trade with one another[13]. In the US's case, Russian energy that is used for manufacturing in the EU and Asia gets embodied in the goods and services imported by the US So even though the US only got 4% of its crude oil imports from Russia in 2015 ref. [14]), this value doubled to 8% with the added amount of indirect energy from Russian oil embedded in other goods imported by the US that year[13].

Over the next six years, Russia continued to establish itself as a major exporter of energy into manufacturing-intensive and highly globalized economies. China and South Korea were the largest importers of Russian crude in 2021, importing roughly 80% of the oil imported by the entire EU region[15]. That same year, China and Japan accounted for 10% of Russia's gas exports[16]. This energy was subsequently embedded into manufactured goods. The top 5 largest importers of Russian oil exported nearly US$2.7 trillion of manufactured machinery in 2020, roughly 60% of the total global market[15]. With supply chains that depend on these major manufacturing economies, the US is also indirectly dependent on Russian oil. And while the current crisis is likely to shift Russia's role as a major energy supplier to global manufacturing markets, it will not diminish it. Where Western and Asian manufacturing economies reduce demand for Russian energy resources, other manufacturing economies will, and have already started to, consume the surplus. For example, since the Russia–Ukraine crisis began, India has increased its imports of Russian oil, purchasing 13 million barrels of Russian crude in March 2022 compared to 16 million barrels in all of 2021 (ref. [17]).

While evaluating both direct and indirect energy flows is critical for US energy security, energy policy has continued to focus only on direct energy. Recent policies enacted by the US, EU, and Japan — including sanctions and the removal of Russia's favourable trade status — target direct energy flows through the global economy. Direct energy shocks are felt in the short term and their impacts can largely be anticipated. Shocks due to indirect energy use, such as higher electricity, fertilizer, and chemical prices due to gas shortages are also felt but are harder to foresee and prepare for.

US trade strategy affects US energy security. When the US imports a product instead of producing it domestically, it frees up that part of its energy budget to use elsewhere in the economy. At the same time, the imported product links the US to the energy security of the exporting nation. When the import is critical to the American economy or national security, policymakers should ideally be evaluating whether the gains from producing something else from its energy savings are worth the increased energy risk the import poses to its supply chains.

There are three ways that the US can mitigate its exposure to the energy security risks associated with global supply chains. The first is the 'Buy American' approach, in which the US reduces final demand dependence on imported goods and services. This would require a dramatic lifestyle shift. Nearly 30% of the goods and services that the US imported in 2021 were in consumer products, including electronics and apparel[18]. Pandemic-related supply chain shocks have not deterred consumer spending on such imports; in fact, the recovery of this spending as the world economy rebounds has been faster than anticipated[19]. Consequently, the lifestyle change required to shift US consumers away from imports is unlikely to occur for the sake of national energy security alone.

A second option is a 'Made in America' approach. In this approach, the US invests in domestic manufacturing of key commodities. This is the approach taken by the Biden Administration[20] and is crucial for securing technologies that are demanded across sectors. However, the US cannot achieve total energy independence simply by manufacturing these products domestically. Virtually all domestically produced goods rely on imports somewhere along their supply chains. This is especially true for key commodities, like batteries and semiconductors, which to date rely on raw material imports and are major imports themselves. This means that even when the final product is manufactured domestically, the US is still exposed to energy security risks abroad via supply chains. A solution to this issue would be to invest in innovative design that increases material efficiency and only uses materials sourced domestically as inputs. One example of such an innovation is a sodium–sulfur battery that can replace lithium–ion batteries, as the latter relies on geographically specific minerals.

A third option is for the US to promote energy security abroad to secure supply chains at home, including through investment in energy infrastructure. This is based on the rationale that to ensure its energy security, the US should increase not only its energy independence but also that of other countries, many of which the US relies upon for raw resources and key commodities. There are over a hundred manufacturing-intensive economies participating in today's global supply chains, yet there are only a handful of countries supplying the primary energy being consumed by these economies. Much of this energy is derived from geographically specific fossil fuels. 85% of oil reserves are available in only ten countries[21]. As has been repeatedly shown over the course of recent history, the stability of fossil-fuel exporting nations has an outsized, often volatile impact, on other national economies and global supply chains. Continuing to rely on such a concentrated portfolio of energy inputs is a risk that is growing too large for the global economy. Increasing US exports of oil, gas, and coal may alleviate some impacts of the current crisis but is not a long-term solution. In addition to there being far more global demand than US exports can meet, the US is itself prone to domestic energy shocks caused by extreme weather events, aging infrastructure, and even politics. To mitigate energy risks, the US should facilitate a diversification of the global energy portfolio and support the build out of secure energy systems abroad. This requires establishing or strengthening clean energy systems in manufacturing economies. Renewable energy can be produced domestically nearly universally. Clean energy technologies require an upfront investment, but the actual energy production is not subject to volatilities present in oil and gas markets.

The optimal strategy may be to not rely on one of these approaches but to use a combination of all three. The approaches can bolster one another; for instance, the Buy American approach would form a base market for commodities produced via the Made in America approach. Achieving energy security abroad through investment in clean energy systems requires technologies produced via global supply chains, many of which are currently dominated by Chinese manufacturers. A Made in America approach would reduce dependencies on China, which would increase the energy security of all countries because it diversifies the market and the portfolio of energy inputs. And lastly, it is important to note that a Made in America approach does not, and should not, detach the US from global trade networks. International trade brings countries together in ways that promote national security. It has kept nations from engaging in major conflicts to avoid damage to their economies. It allows for knowledge sharing and technological leapfrogging. Even with a Made in America approach, it is important that the US bolster energy security abroad because the US is better off maintaining and participating in robust global markets.

What does this all mean? First, the US should not only manufacture key commodities domestically, but also invest in building out their associated supply chains. This means for instance that if General Motors invests US$7 billion in electric vehicle manufacturing in Michigan[22], policymakers should make sure that inputs into those vehicles, including subcomponents and refined materials, can be produced domestically as well. Where it is not possible to source materials domestically, policymakers should invest in innovative designs for alternative technologies while securing imports of these key inputs. And to secure these imports, the US should invest in the energy independence of manufacturing economies. This includes independence from US oil and gas and points to clean energy systems. By rapidly establishing and strengthening domestic clean energy supply chains, the US can not only increase its competitiveness in global markets but promote global energy security by diversifying the world's indirect energy portfolio.

The current energy shock will have longer lasting impacts than even the COVID-19 pandemic because it will permanently alter the composition of the global energy network rather than putting it on pause. The US is at a crossroads regarding its energy independence. On one path, it can maintain the status quo of importing goods and services without regard for the energy required to produce them. On the other path, it can strengthen its energy security by enhancing the domestic capabilities of the supply chains it depends on while supporting energy independence abroad. The latter is much more secure and economically efficient in the long run. Simply put, achieving US energy security requires all countries to achieve energy security. ❐

Jun Ukita Shepard[1] ✉ and Lincoln F. Pratson[2]
[1]*Strategic Analysis and Engagement and US Programs, RMI, Boulder, CO, USA.* [2]*Nicholas School of the Environment, Duke University, Durham, NC, USA.*
✉*e-mail: jshepard@rmi.org*

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Competing interests

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