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This article introduces the EU-wide energy security impacts and green technology transition challenges in the wake of the Russian invasion of Ukraine. Then it uses Germany, Europe's economic powerhouse and the largest importer of Russian gas throughout the war, as a case study to examine the challenges in transitioning to green technology and the possible solutions that will promote both energy independence and cyber-secure energy critical infrastructure across Europe in the decades to come. It argues that Europe will be economically stronger and more secure if Germany invests in long-term energy security rather than short-term solutions that contradict its environmental, economic, and geostrategic goals.

As of this writing, Russia halted gas supplies on April 27 to Poland, Bulgaria, Finland, the Netherlands, Denmark, and to Shell customers in Germany who refused to pay in rubles. This stoppage caused another 28 percent surge in European gas prices. Yet if Europe stays its course, a total embargo of Russian gas by next winter will leave Europe with a 10 to 15 percent energy demand gap to fill. After all, Russia supplies 40 percent of Europe's natural gas.

So why not switch to renewable technologies to fill that gap? It is not that simple. The European Union receives 37 percent of its electricity from renewable sources--largely wind, hydropower, and solar power--and 22 percent of Europe's overall energy consumption comes from renewables. Renewable technology cannot double without lead time to backstop a gas crisis. Hydropower facilities and solar and wind farms take time and land space to build. Solar and wind technology is reliant on the right wind and sun conditions to produce maximum energy. In addition, natural gas provides 32 percent of EU final energy consumption to households, which are unable to switch to renewable energy overnight.

Since the invasion, the EU has experienced increasing cyber-attacks on energy critical infrastructure, especially on green technology. After the Ukrainian government repelled a major Russian cyberattack on Ukraine's grid on April 8, the cyber agencies of the Five Eyes warned on April 20 that Russia was preparing to target the critical infrastructure of sanctioning countries. Recent attacks have taken advantage of the lack of cyber protection on emerging technologies, such as wind farms, impacting energy security in Europe.

Russia has progressively utilized hybrid warfare to challenge energy security, not just in Ukraine, but across NATO member states as Russia seeks to repel the alliance's influence in Europe and expand its power on the world stage. The situation in Germany since the Russian invasion of Ukraine is a prime example of how Moscow's hybrid warfare has challenged energy security via the grid, oil, or gas, generating impacts across NATO and European Union member states far beyond Ukraine's borders.

Germany's Energy Dilemma and Its Impact on Europe

What about importing from other countries in Europe? Even if Germany imported gas more heavily from



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terminals in France, Belgium, and the Netherlands and used existing regasification terminals that were running at maximum capacity, Germany would have to reduce their gas usage by 30 percent in order to cease Russian gas consumption.

Meanwhile, Germany decided to reactivate the coal power plants it planned to shut down in line with its EU green energy commitments to phase out emissions-producing coal by 2030. At the same time, the country announced on March 8 that it would not reconsider plans to shut down the last of its nuclear plants, which do not produce emissions, this year. While the German government called the increase in coal usage a "temporary emergency measure," Germany will need to adjust to both energy supply and demand if it plans to reach the 65 percent emissions cuts by 2030 from 1990 levels called for in their national climate law.

While the German government aims to increase renewables, renewable power companies, especially wind energy firms and firms responsible for grid upkeep, are skeptical that they can produce at the speed the government is asking of them. Licensing challenges, supply chain issues, and lack of workers hinder an accelerated increase in renewables. For ultimate energy independence, Germany should pay better attention to financing long-term renewable solutions rather than investing in short-term LNG terminals which lack the urgently needed supply.

On April 7, the government rolled out its "biggest energy policy reform in decades," which plans for the country to move to a 100 percent renewable power supply by 2035. To make this vision a reality, Germany will need to provide incentives for the education of personnel in the renewables field, cut down its famous bureaucracy around licensing, update its grid networks, and ensure more domestic supply of green technology parts.

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War and conflict have profound effects on society, including the critical fields of science. The paper argues that scientific protectionism, which includes restricting international collaborations and open science, threatens innovation,…

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