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#### OST Credibility is high now – no violations.

Stuart 17 Jill Stuart 1-27-2017 "The Outer Space Treaty has been remarkably successful – but is it fit for the modern age?" <https://theconversation.com/the-outer-space-treaty-has-been-remarkably-successful-but-is-it-fit-for-the-modern-age-71381> (Visiting Fellow, Department of Government, London School of Economics and Political Science)//Elmer

Space exploration is governed by a complex series of international treaties and agreements which have been in place for years. The first and probably most important of them celebrates its 50th anniversary on January 27 – The Outer Space Treaty. This treaty, which was signed in 1967, was agreed through the United Nations, and today it remain as the “constitution” of outer space. It has been signed and made official, or ratified, by 105 countries across the world. The treaty has worked well so far but challenges have increasingly started to crop up. So will it survive another 50 years? The Outer Space Treaty, like all international law, is technically binding to those countries who sign up to it. But the obvious lack of “space police” means that it cannot be practically enforced. So a country, individual or company could simply ignore it if they so wished. Implications for not complying could include sanctions, but mainly a lack of legitimacy and respect which is of importance in the international arena. However it is interesting that, over the 50 years of it’s existence, the treaty has never actually been violated. Although many practical challenges have been made – these have always been made with pars of the treaty in mind, rather than seeking to undermine it entirely.

#### Normal Means requires amending the OST – that causes a runaway amendment convention.

Vedda 18 Jim Vedda May 2018 <https://aerospace.org/sites/default/files/2018-05/OuterSpaceTreaty.pdf> (senior policy analyst, PhD in Political Science at University of Florida)//Elmer

Treaty Amendment. If decisionmakers conclude that the Outer Space Treaty isn’t broken but is just showing its age, targeted changes are an obvious solution—especially in the areas of orbital debris, space salvage, and resource rights, as noted earlier; however, the process of reaching consensus on changes would entail years of diplomatic effort, with no guarantee that the end result would be better than (or as good as) what exists today. The amendment process may not remain limited to the one or two issues that prompted it. The U.N. Committee on the Peaceful Uses of Outer Space has 84 member countries,11 any of which could bring up its own amendments, which could be objectionable to the major stakeholders. Several countries, including China and Russia, have proposed treaty language that would ban all weapons in space,12 a position opposed by the United States. There is a strong possibility that similar language would be submitted as an amendment if the treaty were to be opened for revision. This could bog down the process and derail prospects for achievement in the specific areas originally targeted. In May 2017, the Senate space subcommittee held a hearing on the Outer Space Treaty,13 specifically asking whether it needed amendment to remove roadblocks to space commerce. All seven witnesses—with backgrounds in law, business consulting, and space entrepreneurship—testified that there is no need to amend the treaty, and attempting to do so could leave industry worse off. They described the treaty as minimally burdensome, and emphasized that priority should be given instead to making the U.S. licensing and regulation regime for space commerce more stable, predictable, and transparent. This is not to suggest that amendments should never be attempted, but rather that the amendment process must be undertaken with eyes wide open. The Outer Space Treaty and other space agreements exist in a dynamic environment. Technology continues to advance, and the amount and type of space activity keeps changing— so treaties may need periodic updating. But at present, higher priority should be assigned to development of a well-reasoned and comprehensive national space strategy.

#### That wrecks the OST.

Melroy 17 Pamela Melroy 5-23-2017 “Reopening the American Frontier: Exploring How the Outer Space Treaty Will Impact American Commerce and Settlement in Space” <https://www.hsdl.org/?abstract&did=807259> (Retired NASA Astronaut)//Elmer

There are many exciting activities and proposals in commercial space. With respect to the Outer Space Treaty, I am deeply concerned that we would be opening a Pandora’s Box by attempting to change it. My concern is that the likely outcome would be a lack of consensus, resulting in no amendments. Instead, we will have a weakened dedication to the Principles of the Treaty and the sustainability of space. Great changes are occurring and many countries are developing capabilities that previously were the purview of only a few nation states. Our ability to compete both economically and technologically in space is crucial. These Principles form the basis for the dialog that we have with other countries about what is appropriate and what is not. Without them, the dialog becomes chaos.

#### Asteroid mining specifically throws it into chaos – also a reason the aff gets circumvented

**Evanoff 17** [Kyle Evanoff, Kyle is a research associate in international economics and U.S. foreign policy at the Council on Foreign Relations 10/10/17, "The Outer Space Treaty’s Midlife Funk," Council on Foreign Relations [https://www.cfr.org/blog/outer-space-treatys-midlife-funk accessed 12/11/2021](https://www.cfr.org/blog/outer-space-treatys-midlife-funk%20accessed%2012/11/2021)] Adam

Half a century later, however, the Outer Space Treaty has entered something of a funk. Despite the universal aspirations of the UN Committee on the Peaceful Uses of Outer Space, which molded the document into its completed form, many of the principles enshrined within the text are less suited to the present than they were to their native Cold War milieu. While the anachronism has not reached crisis levels, current and foreseeable developments do present challenges for the treaty, heightening the potential for disputes. At the crux of the matter is the ongoing democratization of space. During the 1950s and ‘60s, when the fundamental principles of international space law took shape, only large national governments could afford the enormous outlays required for creating and maintaining a successful space program. In more recent decades, technological advances and new business models have broadened the range of spacefaring actors. Thanks to innovations such as reusable rockets, micro- and nanosatellites, and inflatable space station modules, costs are decreasing and private companies are crowding into the sector. This flurry of activity, known as New Space, promises nothing less than a complete transformation of the way that humans interact with space. Asteroid mining, for example, could eliminate the need to launch many essential materials from Earth, lowering logistical hurdles and enabling largescale in-space fabrication. Companies like Planetary Resources and Deep Space Industries, by extracting and selling useful resources in situ, could help to jumpstart a sustainable space economy. They might also profit from selling valuable commodities back on terra firma. As a recent (bullish) Goldman Sachs report noted, a single football-field-sized asteroid could contain $25 to $50 billion worth of platinum—enough to upend the terrestrial market. With astronomical sums at stake and the commercial sector kicking into high gear, legal questions are becoming a major concern. Many of these questions focus on Article II of the Outer Space Treaty, which prohibits national appropriation of space and the celestial bodies. Since another provision (Article VI) requires nongovernmental entities to operate under a national flag, some experts have suggested that asteroid mining, which would require a period of exclusive use, may violate the agreement. Others, however, contend that companies can claim ownership of extracted resources without claiming ownership of the asteroids themselves. They cite the lunar samples returned to Earth during the Apollo program as a precedent. Hoping to promote American space commerce, Congress formalized this more charitable legal interpretation in Title IV of the 2015 U.S. Commercial Space Launch Competitiveness Act. Luxembourg, which announced a €200 million asteroid mining fund last year, followed suit with its own law in August. Controversies like the one surrounding asteroid mining are par for the course when it comes to the Outer Space Treaty. The agreement’s insistence that space be used “for peaceful purposes” has long been the subject of intense debate. During the treaty-making process, Soviet jurists argued that peaceful meant “non-military” and that spy satellites were illegal; Americans, who enjoyed an early lead in orbital reconnaissance, interpreted peaceful to mean “non-aggressive” and came to the opposite conclusion. Decades later, the precise meaning of the phrase remains a matter of contention. While the Outer Space Treaty has survived past disputes intact, some experts and policymakers believe that an update is in order. Senator Ted Cruz (R-TX), for instance, worries that legal ambiguity could undermine the nascent commercial space sector—a justifiable concern. Russia and Brazil, among other countries, hold asteroid mining operations to constitute de facto national appropriation. And while there are plenty of asteroids to go around for now (NASA has catalogued nearly 8,000 near earth objects larger than 140 meters in diameter), more supply-side saturation could lead to conflicts over choice space rocks. The absence of clear property rights makes this prospect all the more likely. Plans to establish outposts on the moon and Mars present a bigger challenge still. Last week, prior to the first meeting of the revived National Space Council, Vice President Mike Pence described the need for “a renewed American presence on the moon, a vital strategic goal” in an op-ed for the Wall Street Journal. His piece came on the heels of SpaceX Founder and Chief Executive Officer Elon Musk’s announcement at the 2017 International Astronautical Congress of a revised plan to colonize the red planet, with the first human missions slated for 2024. Musk hopes for the colony to house one million inhabitants within the next fifty years. While mining might require only temporary use of the celestial bodies, full-fledged colonies would necessarily be more permanent affairs. With some national governments arguing that mining operations would constitute territorial claims, lunar and Martian bases are almost certain to enter the legal crosshairs. And, even under the favorable U.S. interpretation of the Outer Space Treaty, states and private companies would need to avoid making territorial claims. If viable colony locations are relatively few and far between, fierce competition could make asserting control a practical necessity. Even so, policymakers should avoid hasty attempts to overhaul the Outer Space Treaty. The uncertainties associated with altering the fundamental principles of international space law are greater than any existing ambiguities. Commercial spacefaring already entails high levels of risk; adding new regulatory hazards to the mix would jeopardize investment and could slow progress in the sector. While the current property rights regime may be untenable over longer timelines, it remains workable for now.

#### Credible OST solves Space War – they said that’s bad

Johnson 17 Christopher Johnson 1-23-2017 “The Outer Space Treaty at 50” , <http://thespacereview.com/article/3155/1> (graduate of Leiden University’s International Institute of Air and Space Law and the International Space University)//Elmer

As mentioned, many of the provisions of the Outer Space Treaty were borrowed from previous UN General Assembly resolutions. But as resolutions alone, these documents were non-binding and did not require states to alter their behavior. And while UN General Assembly resolutions are not normally law-making exercises, they do record the commonly-held expression of intentions by the states in the General Assembly, and make political recommendations to UNGA Members (or to the UN Security Council). UNGA Resolutions can also set priorities and mold opinion for inclusion in subsequent treaties. The prohibition on the placement of nuclear weapons and other weapons of mass destruction in outer space or their installation on celestial bodies was taken from UNGA Resolution 1884 of 1963. The resolution: [s]olemnly calls upon all States… [t]o refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, installing such weapons on celestial bodies, or stationing such weapons in outer space in any other manner. This prohibition was transferred to the Outer Space Treaty, and thereby remade into international treaty law. As President Johnson pointed out in his recommendation to Congress to ratify the Outer Space Treaty, “the realms of space should forever remain realms of peace.”5 He continued: We know the gains of cooperation. We know the losses of the failure to cooperate. If we fail now to apply the lessons we have learned, or even if we delay their application, we know that the advances into space may only mean adding a new dimension to warfare. If, however, we proceed along the orderly course of full cooperation we shall, by the very fact of cooperation, make the most substantial contribution toward perfecting peace.6 The agreement contained in Article IV of the Outer Space Treaty reflects an agreement between the US and the USSR, as obligations restricting their freedom of action. Why would a state intentionally place a restriction on itself? Isn’t it better to merely keep outer space as unregulated as possible? Since there were only two states then capable of venturing into outer space, why did either state agree to rules governing its actions? It may seem counterintuitive, but the deeper rationale behind security arrangements like this is that the parties actually benefit in the long-term from placing mutual restrictions on their behavior. Agreeing to restrict your freedom of action has deep links to the usefulness or utility of law itself. Consider driving a car: in order to get a license, you agree to observe certain rules, and the license signals your obligation to obey these rules. However, sometimes adhering to those rules is not only inconvenient (such as stopping at stop signs when there’s nobody else at the intersection), it is also against your short term-interests (you have an appointment or will otherwise suffer from observing the rules.) However, agreeing to operate within a system where your freedoms are sometimes restricted can have the effect of actually increasing your freedom over the long term. Wouldn’t you rather live in a state where traffic laws exist, and other drivers agree to observe them? Isn’t that system preferable to living in a state without traffic rules? Indeed, a system with traffic rules increases not just freedom in general, but overall safety and orderliness. Consequently, because the system with rules is preferable to the system without rules, your willingness to use the roads allows you to travel with greater security and ease. You are better assured of the likelihood that you will get to your intended destination without some other driver crashing into you. Knowing that safe travel is likely, you are more willing to take trips more often, and to farther destinations. Your freedom is actually increased over the long term because you are willing to suffer temporary, short-term restrictions such as inconvenient red lights. Long-term rationality warrants adherence to efficient systems of law. Correctly-balanced rules help increase long-term benefits (like safety and security) that would otherwise be unattainable without a system of rules. It is this rationale that also underpins international treaty-making. Today, the current absence of nuclear weapons or other weapons of mass destruction in outer space attests to the bargain struck in the Outer Space Treaty being a successful one, where security (and the liberty and freedom possible with security) were furthered by the mutual exchange of restrictions that states placed upon themselves. The more than 50 years of peaceful uses of outer space, including cooperation between states who remain rivals elsewhere, are the rich long-term gains resulting from the Outer Space Treaty.

# Case

### Mining

#### 1 – Private mining ventures cause resource wars – empirics prove.

Kelvey 14 [Jon Kelvey, writer and journalist based in central Maryland. Is It Legal to Mine Asteroids?,” 10/13/14, *Slate*, https://slate.com/technology/2014/10/asteroid-mining-and-space-law-who-gets-to-profit-from-outer-space-platinum.html]

If these mining ventures are successful, the world could see billions of dollars flowing down from space to American companies. Is there a system for dealing with any conflicts that asteroid mining will likely arouse? The historical record certainly suggests the possibility of bitter, even violent disputes.

Just consider the Arctic. Impenetrable ice was once the foil for those who dreamed of a Northwest Passage, but global warming has made the oil- and natural-gas-rich Arctic seabed accessible for the first time, and there has been a rush to lay claims to territory. The United States and Canada have been making careful geological measurements in order to determine territorial boundaries. Russia has pursued a different path: In 2007, the country used a submersible to plant its flag on the seabed at the North Pole. It’s an example of how contested things can get even when there is a system of rules in place, according to Joanne Gabrynowicz, a space lawyer and editor emeritus of the Journal of Space Law at the University of Mississippi School of Law. There is a system of international governance in place for the Arctic, but she says it is being strained by the recent thaw because, “it’s so much easier to govern something when you can’t get to it.”

If emerging space technologies can be thought of as melting Arctic ice, it might be time to start discussing some basic rules before everything thaws.

#### Privatization of outer space runs counter to international law. And, Violating I-law is non-universalizable as it entails breaking a promise or contract that states rationally agreed upon

van Eijk 20 [(Cristian, finishing an accelerated BA in Law at the University of Cambridge. He holds a BA cum laude in International Justice and an LLM in Public International Law from Leiden University, and has previously worked at the T.M.C. Asser Institute and the International Commission on Missing Persons.) “Sorry, Elon: Mars is not a legal vacuum – and it’s not yours, either,” 5/11/20, Völkerrechtsblog, [https://voelkerrechtsblog.org/sorry-elon-mars-is-not-a-legal-vacuum-and-its-not-yours-either](https://voelkerrechtsblog.org/sorry-elon-mars-is-not-a-legal-vacuum-and-its-not-yours-either%20)]

On October 28th, Elon Musk’s company SpaceX published its Terms of Service for the beta test of its Starlink broadband megaconstellation. If successful, the project purports to offer internet connection to the entire globe – an admirable, albeit aspirational, mission. I must confess: Starlink’s terrestrial impact is a pet issue of mine. But this time, something else caught my attention. Buried in said Terms of Service, under a section called “Governing Law”, I discovered this curious paragraph: “Services provided to, on, or in orbit around the planet Earth or the Moon… will be governed by and construed in accordance with the laws of the State of California in the United States. For Services provided on Mars, or in transit to Mars via Starship or other colonization spacecraft, the parties recognize Mars as a free planet and that no Earth-based government has authority or sovereignty over Martian activities. Accordingly, Disputes will be settled through self-governing principles, established in good faith, at the time of Martian settlement.” CAN HE DO THAT? In short, the answer is a resounding “no”. Outer space is already subject to a system of international law, and even Elon Musk cannot colombus a new one. Who’s responsible for Elon Musk? Two provisions of the Outer Space Treaty (OST), both also customary, are particularly relevant here. OST article II: “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.” OST article III: “States… shall carry on activities in the exploration and use of outer space, including (…) celestial bodies, in accordance with international law”. SpaceX is a private entity, and is not bound by the Outer Space Treaty – but that does not mean it can opt out. Its actions in space could have consequences for the United States in three ways. First, the US, as SpaceX’s launch state, bears fault-based liability for injury or damage SpaceX’s space objects cause to other states’ persons or property (OST article VII, Liability Convention articles I, III). Second, the US, as SpaceX’s state of registry, is the sole state that retains jurisdiction and control over SpaceX objects (OST article VIII, Registration Convention article II). Both refer to objects in space and are irrelevant. According to article VI OST, States “bear international responsibility for national activities in outer space”, including Mars, including those by “non-governmental entities”. The US, as SpaceX’s state of incorporation, must authorise and continuously supervise SpaceX’s actions in space to ensure compliance with the OST (OST article VI) and international law (OST article III). In practice, this task is done by the US Federal Communications Commission, which licenses and regulates SpaceX. Article VI OST sets a specific rule of attribution, supplementing the customary rules of state responsibility (Stubbe 2017, pp. 85-104). SpaceX acts with US authorisation, and its conduct in space within and beyond that authorisation is attributable to the US (ARSIWA articles 5, 7). In the absence of circumstances precluding wrongfulness, the result is straightforward. If SpaceX breaches a US obligation under international law, the US bears responsibility for an internationally wrongful act..

#### Space mining wrong for a few reasons:

**Fickling 20,** David Fickling, 12-21-2020, "Space Mining on Asteroids Is Never Going to Happen", https://www.bloomberg.com/opinion/articles/2020-12-21/space-mining-on-asteroids-is-never-going-to-happen, accessed 1-15-2022, [David Fickling is a Bloomberg Opinion columnist covering commodities, as well as industrial and consumer companies. He has been a reporter for Bloomberg News, Dow Jones, the Wall Street Journal, the Financial Times and the Guardian.] PHS-CB

It’s wonderful that people are shooting for the stars — but those who declined to fund the expansive plans of the nascent space mining industry were right about the fundamentals. Space mining won’t get off the ground in any foreseeable future — and you only have to look at the history of civilization to see why.

One factor rules out most space mining at the outset: gravity. On one hand, it guarantees that most of the solar system’s best mineral resources are to be found under our feet. Earth is the largest rocky planet orbiting the sun. As a result, the cornucopia of minerals the globe attracted as it coalesced is as rich as will be found this side of Alpha Centauri.

Gravity poses a more technical problem, too. Escaping Earth’s gravitational field makes transporting the volumes of material needed in a mining operation hugely expensive. On Falcon Heavy, the large rocket being developed by Elon Musk’s SpaceX, transporting a payload to the orbit of Mars comes to as little as [$5,357 per kilogram](https://archive.fo/o/bR0eo/https:/www.spacex.com/media/Capabilities&Services.pdf) — a drastic reduction in normal launch costs. Still, at those prices just lofting a single half-ton drilling rig to the asteroid belt would use up the annual exploration budget of a small mining company.

Power is another issue. The international space station, with 35,000 square feet of solar arrays, generates up to 120 kilowatts of electricity. That drill would need a [similar-sized power plant](https://archive.fo/o/bR0eo/https:/www.rocktechnology.sandvik/en/products/exploration-drill-rigs-and-tools/compact-core-drill-rigs/) — and most mining companies operate multiple rigs at a time. Power demands rise drastically once you move from exploration drilling to mining and processing. Bringing material back to Earth would raise the costs even more. Japan’s [Hayabusa2 satellite spent six years](https://archive.fo/o/bR0eo/https:/nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=2014-076A%23:~:text=Total%20cost%20of%20the%20mission,yen%20(roughly%20$150%20million%20U.S.)) and 16.4 billion yen ($157 million) recovering a single gram of material from the asteroid Ryugu and returning it to Earth earlier this month.

What might you want to mine from space? Water is an essential component of most earth-bound mining operations and a potential raw material for hydrogen-oxygen fuel that could be used in space. The [discovery in October of ice molecules](https://archive.fo/o/bR0eo/https:/www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon/) in craters on the Moon was taken as a major breakthrough. Still, the concentrations of 100 to 412 parts per million are extraordinarily low by terrestrial standards. Copper, which typically costs about $4,500 per metric ton to refine, has an average ore grade of about 6,000 ppm.

The more promising commodities are platinum, palladium, gold and a handful of rare related metals. Because of their affinity for iron, these so-called siderophile elements mostly sunk toward the metallic core of our planet early in its formation, and are relatively scarce in the Earth’s crust. Estimates of their abundance on some asteroids, such as [the enigmatic Psyche 16](https://archive.fo/o/bR0eo/https:/solarsystem.nasa.gov/asteroids-comets-and-meteors/asteroids/16-psyche/in-depth/) beyond the orbit of Mars, suggest concentrations several times higher than can be found in terrestrial mines.

Still, human ingenuity is all about cutting our coat according to our cloth. If such platinum-group metals are going to justify the literally astronomical costs of space mining, they’ll need to count on sustained high prices for the decade or so that would be needed to get such an operation up and running — and that sort of situation is all but unheard-of in the materials industry.

When prices of an essential commodity get excessively high, chemists get extraordinarily good at finding ways to avoid using it, scrap merchants improve their recycling rates, and miners discover new deposits that wouldn’t have been viable at lower prices. Even [criminals get in on the game](https://archive.fo/o/bR0eo/https:/www.bbc.com/news/business-49767195). That eventually pushes supply up and demand down, so that prices rebalance — a dynamic we’ve seen play out in the markets for rare earths, lithium and cobalt in recent years. The world mines about [three times more platinum](https://archive.fo/o/bR0eo/https:/www.bloomberg.com/opinion/articles/2017-09-26/platinum-s-lesson-for-lithium-ion-batteries?sref=5JzLFdzD) than it did in the early 1970s, but prices have barely changed once adjusted for inflation.

That might sound a disappointing prospect to those looking for excuses for humanity to colonize space — but really it should be seen as a tribute to our ingenuity. Humanity’s failure to exploit extraterrestrial ore reserves isn’t a sign that we lack imagination. If anything, it’s a sign of the adaptive genius that put us in orbit in the first place.

### Grid Security

#### No grid security impact

**Walton 21,** Robert Walton, 10-28-2021, "Sophisticated hackers could crash the US power grid, but money, not sabotage, is their focus", Utility Dive, https://www.utilitydive.com/news/sophisticated-hackers-could-crash-the-us-power-grid-but-money-not-sabotag/603764/, accessed 1-15-2022, [] PHS-CB

DOE Secretary Jennifer Granholm in June told CNN that enemies of the United States have the capability to shut down the U.S. power grid, and "there are very malign actors trying, even as we speak."

Granholm was discussing President Joe Biden's push to better secure the utility sector, which faces a growing threat from ransomware and attacks on operational technology. There are mandatory security requirements and high levels of redundancy built into the U.S. bulk power system, but when asked if a sophisticated hacker has the capability to crash the grid she replied soberly, "Yeah, they do."

That may bring to mind worst-case doomsday scenarios, but security experts say there is little imminent risk that hackers will cause a widespread blackout, despite a near-constant barrage of attacks on utilities and grid assets.

"I don't think the threat to reliability is imminent" even as more operational technology (OT) is internet accessible, said Lila Kee, general manager for GlobalSign's North and South American operations. "Attackers are getting smarter and as we move OT online the threat surface will be wider, but what these hackers are doing is espionage. They're going after data, they're going after [intellectual property]."

"If they wanted to go after the OT networks, from a sabotage standpoint, that's an act of war," Kee said. "And I don't think even some of the biggest state actors are going to poke that bear."

There are a variety of hackers and groups, "and their goals are similarly varied," Kevin Perry, formerly the director of critical infrastructure protection at Southwest Power Pool, said in an email. Perry retired in 2018.

"Most cyber attacks today are financially motivated," Perry said, with hackers attempting to steal credentials, company or customer financial information, or intellectual property. "Basically, information that can be used for financial gain."

But "there are attackers whose aim is to disrupt the business, either with ransomware or by attacking and manipulating the business-critical systems," Perry added.

Crashing the grid would require a sophisticated attack and knowledge of electricity systems. Like Kee, Perry also sees little appetite for the most dramatic attacks.

"OT systems are very complex and the attacker will need a certain level of knowledge and sophistication. That [would] most likely be a nation-state backed hacking group," he said. "An activity of a nation-state actor that intentionally causes a blackout will likely be viewed as an act of war and will likely result in a kinetic or electronic response, or both, once the actor has been positively identified."

Right now, hacking groups in Russia, China, Iran and North Korea, are all known to have high levels of sophistication. The electric industry, however, says it is prepared for a future where more hackers have those capabilities.

"Sophistication can ultimately be bought," Edison Electric Institute (EEI) Vice President for Security and Preparedness Scott Aaronson said. EEI represents investor-owned utilities, which provide electricity for about 220 million people in the U.S.

Taking down the grid would require a very complex attack but "we are preparing for that possibility today," Aaronson said.

Less sophisticated attacks are frequent, say experts, and often have little or no impact on operations.

"We've responded to intrusions at generation plants and within control centers," said Ben Miller, vice president of professional services and research and development for Dragos, a security firm focused on operational technology (OT) environments. "But did those cause a blackout or outage? No."

The attacks were opportunistic and in many cases hackers may not have even known what OT environment they were in, Miller said.

"Gaining access into a grid facility is certainly in the realm of possible, even accidentally," Miller said. But between gaining access and having a particular impact "is a lot more sophistication than ransomware or a malicious piece of malware, and it does rise into that state-aligned category."

And the U.S. grid is designed with such redundancy in mind, that even if a hacker were able to take down the largest generating asset on the grid — the 6.8 GW Grand Coulee Dam in Washington — it would not cause a blackout, said security consultant Tom Alrich.

"Plants being down should never be the cause of an outage," Alrich said. "That's the whole idea of a reliability coordinator. They make sure there's always enough backup to cover any contingency."

All that said, experts agree it is possible for hackers to cause a blackout.

"Now, if you start to have a bunch of plants go down at the same time, that's another story," Alrich said. "But plants are not the problem. ... When you're talking about really serious attacks, you're talking about attacks on control centers or attacks on substations."

For the most part, the United States has avoided grid impacts from cybersecurity threats. A 2018 attack interrupted communications on the Midcontinent Independent System Operator, grid but customers ultimately felt no reliability impacts. But there is history.

Bottom of Form

The most well known grid cyberattack in the world occurred in 2015 when hackers knocked out power to almost a quarter million people in Ukraine. The attack, widely attributed to Russia-backed hackers, was possible because "there was not proper isolation between the IT and OT systems," said Perry.

Hackers compromised IT systems via a successful phishing email attack, he said, and were then able to move throughout the network to attack the utility's energy management system. They downloaded malicious firmware that impacted grid operators' ability to communicate with substations while also controlling key equipment.

Experts say the Ukraine outage remains largely consistent with how hackers could attack the U.S. grid today.

Other vulnerabilities have been studied. In 2007, Idaho National Laboratory's Aurora Generator Test proved a cyberattack could physically destroy a generator by connecting it to the grid out of phase, which leads to extreme torque and the machine breaking down.

Most recently, the North American Electric Reliability Corp. (NERC) said the 2020 SolarWinds attack, in which sophisticated malware was inserted into the software supply chain, exposed a quarter of the electric utilities it regulates to the vulnerability. The electric sector could take years to determine the full impacts of that attack, say experts.

And the attack on Colonial Pipeline, which transports refined oil products, had no electric grid impacts but is an example of unintended consequences. Hackers attacked Colonial's IT system and the company defensively shut down the pipeline.

 "When there's a ransomware attack in the IT network, it will inevitably result in an outage on the OT network," Alrich said. Utilities aren't going to turn off the power to mitigate a cyberattack, he said, but the MISO attack is an example where a control center was taken offline to avoid impact.

SolarWinds and Colonial are good examples of the threats facing the energy sector, said NERC Senior Vice President Manny Cancel, who is also CEO of NERC's Electricity Information Sharing and Analysis Center (E-ISAC).

SolarWinds illustrates the threat to supply chains, "and in that case, the adversaries solved the 1-to-many problem," said Cancel, compromising a single platform and subsequently infecting thousands of users. The Colonial shutdown shows hackers "don't necessarily have to target control systems" to have societal impacts.

And the threat shows no sign of abating, he added. The number of software vulnerabilities announced for control systems in 2021 "substantially eclipses" prior year warnings.

E-ISAC is preparing to facilitate GridEx VI, a biennial security exercise, Nov. 16-17. The event allows electric utilities to test their cyber and physical security plans in response to mock attacks, and the 2019 iteration drew more than 6,500 participants. The 2021 exercise will include a simulated software compromise, said Cancel.

… [more paragraphs that describe what a cyberattack would look like]