## **1AC**

### **1AC---Grid**

#### **Cyber & EMP attacks are coming.**

**Owen ’23** [Joshua; Research Fellow @ the United States Naval Institute, Gunnery Sergeant in the U.S. Marine Corps; February; U.S. Naval Institute; “An EMP or Solar Incident Could Result in Blackout Warfare,” https://www.usni.org/magazines/proceedings/2023/february/emp-or-solar-incident-could-result-blackout-warfare; DOA: 3-3-2025] tristan

A coordinated physical attack on multiple targets and facilities from a state or nonstate actor must be considered an imminent threat. **An attack on an unprotected civilian grid could result in a long-term blackout event**. Since 99 percent of the military depends on the civilian electric grid and food and water infrastructure, the military could be severely crippled.

Norman Angell’s 1910 book, The Great Illusion, postulated that there might be no more great wars because Europe and the United States were so interdependent—war would be bad for business. Only four years later, World War I started. And yet, something like Angell’s ideas again hold sway. If the United States and its economy collapsed, the entire world would suffer. Why would China, Russia, or any other nation risk their country's economic growth? Why would they risk more and more sanctions on trade? But in totalitarian countries, the goal of leaders is to stay in power, not help their least powerful citizens. As Pry notes:

**Totalitarian and authoritarian states see international relations as a** “**zero-sum game**” in which there are winners and losers, the living and the dead. Economics is not the highest priority for totalitarian states. **Their highest priority is total control over the world, whatever the cost, because they believe that any nation not their slave is a potential threat and war is inevitable**. Totalitarian states want to be the last man living and make everyone else a slave or dead. **That is why they are willing to do anything to crush their enemies and win**. **EMP/Cyber Warfare**, what I term blackout warfare, **is a relatively easy, low-risk**, even benign form of warfare **compared to all-out Nuclear, Biological, and/or Chemical Warfare**—**all of which Moscow and Beijing are prepared and willing to do if they can win**.

If Pry is correct, **these leaders do not need a** “**why**” to launch a full-scale combined arms blackout war on the United States—**they are biding their time for** “**when**.”

Get Real, Get Ready

**This threat will materialize sooner or later**—probably sooner. **Leaders need to take it seriously and begin to act now**. As for the Navy and Marine Corps, they and the other armed services should introduce existing technologies for electromagnetic hardening of infrastructure and systems for military equipment, bases, and vehicles as quickly as possible. Senior commanders can submit a Universal Needs Statement (UNS) to their chains of command, and small unit commanders can begin to study how to command and control in an electronically degraded environment—useful in a variety of possible contexts. **Hardening efforts can begin to take place in phases, based on budgets for the year**.

#### **Trump magnifies risk.**

**Kirchgaessner ’25** [Stephanie; Deputy Head of Investigations for Guardian US; February 28; The Guardian; “Trump administration retreats in fight against Russian cyber threats,” https://www.theguardian.com/us-news/2025/feb/28/trump-russia-hacking-cyber-security; DOA: 3-3-2025] tristan \*\*brackets r og\*\*

The **Trump** administration has publicly and privately **signaled** that it does **not** **believe** Russia represents a **cyber** **threat** against US national **security** or **critical** **infrastructure**, marking a radical departure from longstanding intelligence assessments.

The **shift** in **policy** could make the **US** **vulnerable** to **hacking** **attacks** by **Russia**, experts warned, and appeared to reflect the warming of relations between Donald Trump and Russia’s president, Vladimir Putin.

Two recent incidents indicate the US is no longer characterizing Russia as a cybersecurity threat.

Liesyl Franz, deputy assistant secretary for international cybersecurity at the state department, said in a speech last week before a United Nations working group on cybersecurity that the **US** was **concerned** by threats perpetrated by some states but only named **China** and **Iran**, with **no** **mention** of **Russia** in her remarks. Franz also did not mention the Russia-based LockBit ransomware group, which the US has previously said is the most prolific ransomware group in the world and has been called out in UN forums in the past. The treasury last year said LockBit operates on a ransomeware-as-service model, in which the group licenses its ransomware software to criminals in exchange for a portion of the paid ransoms.

In contrast to Franz’s statement, representatives for US allies in the European Union and the UK focused their remarks on the threat posed by Moscow, with the UK pointing out that Russia was using offensive and malicious cyber-attacks against Ukraine alongside its illegal invasion.

“It’s **incomprehensible** to give a speech about **threats** in cyberspace and **not** **mention** **Russia** and it’s **delusional** to think this will turn Russia and the FSB [the Russian security agency] into our friends,” said James Lewis, a veteran cyber expert formerly of the Center for Strategic and International Studies think tank in Washington. “They **hate** the **US** and are still mad about losing the cold war. Pretending otherwise won’t change this.”

The US **policy** **change** has also been **established** behind **closed** **doors**.

A recent memo at the Cybersecurity and Infrastructure Security Agency (**Cisa**) set out **new** **priorities** for the agency, which is part of the Department of Homeland Security and monitors cyber threats against US critical infrastructure. The new directive set out priorities that included China and protecting local systems. It did **not** **mention** **Russia**.

A person familiar with the matter who spoke to the Guardian on the condition of anonymity said **analysts at the agency were verbally informed** that they were **not** to **follow** or **report** on **Russian** **threats**, even though this had **previously** been a **main** **focus** for the agency.

The person said **work** that was being **done on** something “**Russia**-related” was in effect “**nixed**”.

“Russia and China are our biggest adversaries. With all the **cuts** being **made** to different agencies, a lot of **cybersecurity** **personnel** have been **fired**. Our **systems** are **not** going to be **protected** and our **adversaries** **know** this,” the person said.

The person added: “People are saying Russia is **winning**. Putin is on the **inside** now.”

The New York Times has separately reported that the Trump administration has also **reassigned** **officials** at **Cisa** who were focused on safeguarding elections from cyber-attacks and other attempts to **disrupt** **voting**.

Another person who previously worked on US joint task forces operating at elevated classification levels to track and combat Russian cyber threats said the development was “truly shocking”.

“There are **thousands** of US government **employees** and **military** working daily on the **massive** **threat** **Russia** **poses** as possibly the most significant nation state threat actor. Not to diminish the significance of China, Iran or North Korea, but Russia is at least on par with China as the most significant cyber threat,” the person said.

The person added: “There are **dozens** of discrete **Russia** state-sponsored **hacker** **teams** **dedicated** to either producing **damage** to US government, **infrastructure** and commercial interests or conducting information theft with a key goal of maintaining persistent access to computer systems.”

#### **Investment solves.**

**Curtis ’24** [Steven; Consultant @ the Readiness Resource Group; February 15; National Defense University Press; “Microgrids for the 21st Century: The Case for a Defense Energy Architecture,” https://ndupress.ndu.edu/Media/News/News-Article-View/Article/3678506/microgrids-for-the-21st-century-the-case-for-a-defense-energy-architecture/; DOA: 3-2-2025] tristan

The Department of Defense (**DOD**) needs a **new** **approach** to electrical grid **infrastructure** to maintain **security** and access to operational energy. Recent **natural** **disasters** and **cyber**-**attacks** have exposed the **vulnerability** of the current system, posing threats to military operational **readiness**. Strategic **military** **facilities** currently acquire most of their electric **power** directly from the national **grid**, which is increasingly **vulnerable** to failures. The problems experienced to date could be **exponentially** **worse** if targeted by a **sophisticated** **adversary** with **advanced** offensive cyber **capabilities**, such as Russia or China. Simultaneously, the growth of renewables and increased DOD demand for carbon-free energy create challenges and opportunities for operational energy. To date, only a **small** fraction of **work** has been done to **create** a **system** for DOD energy that is robust, responsive, and reliable.

A **Defense** **Energy** **Architecture** (DEA) should address these **issues** by providing a **comprehensive** **approach** to **microgrid** **implementation** for defense installations and deployable energy capabilities. A DEA would simultaneously deliver increased infrastructure security and carbon-free energy with an **advanced** **microgrid** **system** based on small modular reactor (**SMR**) **nuclear** **power** and renewables, such as wind and solar, when they are available. A DEA should also emphasize the development of energy storage applications beyond batteries, specifically hydrogen. A fully integrated system of baseload (that is, on all the time) electricity production, renewables, and energy storage is necessary to maximize the benefits to DOD in both permanent installation and expeditionary environments. The focus of a DEA should be on efficient resources based on the requirements of each base in which the microgrids would be employed.

DOD needs to advance microgrid systems for several reasons. First, DOD has energy assurance and resilience needs that significantly exceed most civilian requirements, and it therefore requires a separate system for energy production and storage. Second, as one of the **largest** single **energy** **consumers** in the **world**, DOD has the **scale** to **create** a **market** **demand** signal **strong** enough to **encourage** private **investment** and drive down hardware **costs**. Finally, with suitable guidance, DOD could move quickly to reach net-zero carbon goals for energy production.

The **defense** **grid** system and energy production mechanisms must improve to **increase** **resilience** to natural **disasters** and **terrorist** attacks on the national grid and integrate clean energy improvements in a cogent manner. This article defines the concept of a Defense Energy Architecture that may guide the construction of microgrid systems to supply desired energy production while supporting energy independence, security, resiliency, and affordable power. We further recommend that DOD integrate emerging energy concepts, in both garrison and expeditionary environments. Advances in modern energy technologies provide many opportunities for DOD to modernize, increasing security and operational capabilities.

DOD Reliance on the National Electric Grid System and Vulnerabilities

The national grid was designed with one purpose: to deliver electric power from the source of production to end users. However, at the time of its creation, there was little thought given to things such as redundancy in natural disasters and certainly none given to potential problems that could not be imagined at the time, such as **cyber**-**attacks** and electromagnetic pulse (**EMP**) **weapons**. For the **security** of the **Nation**, DOD must ensure that it has continuous access to **energy**, making the entire **defense** system more robust and able to **withstand** the **emerging** **threats** of 21st-century warfare.

America’s electrical grid is the system that powers the garrison operations of DOD and provides a platform for the application of military power worldwide. For decades, the reliability of the grid system was such that the military was confident that when electricity was needed, it would be there. However, this basic assumption is being questioned as the national grid ages, shows vulnerabilities, and grapples with the challenges of incorporating distributed electricity-generating sources like solar and wind energy.1 These shortcomings—coupled with the realization that the existing system is **vulnerable** to **disruptions** from incidents both **natural** (hurricanes and solar flares) and **man**-**made** (cyber-attacks and EMPs)—call for more direct control by DOD of energy production systems.

However, rather than simply moving ahead with its current course, DOD should embrace best-in-class technologies to ensure that it is moving forward with the best solutions. Moreover, the system needs to be flexible enough to incorporate new technologies as they evolve to ensure that best-in-class remedies are delivered to address the changing nature of power generation and increasingly sophisticated potential attacks on critical infrastructure.

The current grid system struggles to deal with **vulnerabilities** that could **disrupt** **power** and **harm** American **security**, including potential **attacks** by **foreign** **adversaries** or **terrorists**. For many, Superstorm Sandy in 2012 was a wakeup call—it demonstrated a potential for widespread damage that could affect the national electrical grid, leaving 8.5 million people without power across 21 states.2 However, to those watching closely, Sandy was not an anomalous event but rather more of a culmination of a long-term trend that has revealed how susceptible the grid is to disruption from severe weather, including wildfires and extreme temperatures.3 The **potential** for **disruptive** **events** seems to be **increasing**.

As devastating as these natural events have been, many national security experts predict that damage from man-made attacks could be multiple times worse. The insurance company Lloyd’s of London has modeled a plausible scenario in which a **cyber** **attack** on the **Eastern** **Interconnection**, which services approximately **half** of the **United** **States**, could leave large areas—including dozens of military installations—**without** **power** for days.4 This is not a distant theoretical scenario: **Russia** has already **demonstrated** the **ability** to **successfully** **attack** electrical **grid** **infrastructure** in **Ukraine**, and **China** is believed to have **similar** offensive cyber **capabilities**.5 Additionally, the ransomware attacks on Colonial Pipeline in 2021 demonstrated that **criminal** **organizations** and other **nonstate** **actors** also **possess** the **tools** to sow **chaos** in American energy infrastructure.6 The national grid is **susceptible** to **large**-**scale** **disruption**, whether from devastating **natural** **weather** events, military **attacks** from near-peer competitors, or terrorists or international crime syndicates. Therefore, response **readiness** largely **depends** on a **secure** supply of **electricity** from the main grid.

We know that the military is susceptible to the same threats that menace civilian energy infrastructure. In recent years, weather events have disrupted energy service to military installations, such as Tyndall Air Force Base during Hurricane Michael in 2019 and Joint Base San Antonio–Lackland and others during the winter storms of February 2021.7 While the effect on operations was relatively minor in these instances, it does not take much to imagine that targeted attacks on military infrastructure could be orders of magnitude more harmful and severely impact readiness. DOD recognizes this possibility and has conducted a series of exercises to better understand “the growing threat associated with natural or nefarious events . . . such as missions being separated from access to the national grid.”8 The effects from such events could have major consequences on the military’s ability to respond rapidly to crises.

Defense Energy Architecture

The goal of a DEA is to ensure that the advancement of microgrids for DOD use is comprehensive and standardized. A **microgrid** can be defined as “a local energy grid with control capability, which means it can **disconnect** from the **traditional** **grid** and operate **autonomously**.”9 For our purposes, we believe this encompasses both energy generation and storage. Defining the concept must not only focus on near-term needs, but also keep options open for future adaptations. It is beyond the scope of this article to prescribe what a fully functional standard for a DEA would look like. However, we can outline key principles that must be addressed to answer the challenges that face the future of DOD energy systems. The following should be considered as the essential tasks for a DEA to address the emerging energy needs:

provide carbon- and pollution-free energy and baseload power as much as possible

provide continuous energy on demand

provide defense against attacks and resilience in the case of natural disasters

provide expeditionary capability.

Provide Carbon and Pollution-Free Energy

In recent years, DOD has increasingly focused on the potential threats posed by climate change. An example of this is the Army Climate Strategy, which set goals for 100 percent carbon- and pollution-free electricity for Army installations by 2030.10 Given this policy priority, we believe a DEA should follow the same path. The current focus for the source of this energy is renewables, primarily solar and wind. However, wind and solar power suffer from the fact that they are intermittent (they supply energy only about 30 percent of the time, and wind is not predictable). This creates reliance on fossil fuel–based electrical plants to meet operational demands for energy, which not only runs counter to low carbon goals but also maintains the vulnerable linkage to the main grid.

An ideal solution to this intermittency problem is to use small modular reactors (**SMRs**) to **integrate** baseload **nuclear** **energy** as the carbon-free backup for solar and wind. In 2021, 60 percent of the electricity generated in the United States came from natural gas and coal.11 So when renewables are not available in the desired amount, DOD and other electricity consumers plug into a system that generates over half its power from carbon-producing and -polluting resources. Instead of backing up renewables with fossil fuels, SMRs can assure that clean energy is available on demand. This shift would allow DOD to phase out fossil fuels in the energy mix over time. Each individual installation could be configured to maximize the natural resources available—for example, relying more on wind for installations on the Great Plains. Once the optimal mix of renewables is designed, SMRs would be deployed to make up the balance. The units are modular and can be added to provide more energy. This would **enable** DOD **installations** to **sever** themselves completely from the **national** **grid** over time and achieve clean energy goals.

Provide Continuous Energy on Demand

A second aspect of a DEA is to ensure the availability of continuous operational energy. Again, the intermittent nature of renewables causes issues with instantaneous accessibility to energy. For an organization with 24/7 operational needs, this would not do. Much of the DOD focus thus far has been to look at **battery** **storage** to preserve the electricity generated by solar and wind sources.12 However, lithium-ion batteries, which are the current state of the art, are best suited for intra-day storage, as their ability to store energy competitively is capped at around **8 hours**.13 In a normal operating environment, this is possibly adequate since it provides overnight storage and dispersion when demand for electricity is low. However, in a crisis scenario when high energy loads are present around the clock, this may **lead** to **shortfalls**. In addition, if a **natural** **disaster** took **solar** and **wind** capabilities **offline**, battery storage capability would be diminished rapidly after only a few hours. Therefore, a truly **independent** microgrid **system** should have **autonomous** **power** that could be provided in the case of a prolonged interruption.

While **SMRs** are ideal for providing **continuous** **energy**, a microgrid system should have backup power available in case the unit does need to go offline for any period. As stated, batteries have limited ability to provide anything beyond intra-day energy storage, which itself is a system vulnerability. **Hydrogen** has much greater capability to **integrate** with a **microgrid** **system** to meet energy storage needs. Hydrogen can be produced by splitting water molecules (H20) into their component parts of H2 and elemental oxygen. When this is done with renewable electricity, the resulting hydrogen is carbon-free or “green.” Once hydrogen is formed, it can **store** **energy** indefinitely.14 Therefore, H2 could maximize the total amount of energy produced by renewables.15

Furthermore, **hydrogen** can be **produced** by **nuclear** **power**, so it is also carbon-free and can store an almost **unlimited** amount of **energy**. **Infrastructure** investments would be **required** to store the hydrogen in a safe manner, but this is currently done globally in many industries that use hydrogen. If the SMR ever went down, **hydrogen** could provide a long-term **bridge** of **operational** **energy** until the issue was resolved. Though currently less efficient for short-duration storage than batteries, the flexibility that hydrogen provides in a microgrid system makes it extremely valuable for **energy** **assurance**. In fact, coupling hydrogen with battery storage may provide the most overall benefit for the entire system.

Provide Security and Resiliency

A third requirement for a microgrid system for defense use is the ability to safeguard it from potential attacks. We have noted that one of the vulnerabilities of the current grid is susceptibility to cyber attacks. The nature of warfare is constantly evolving. A World War I–era general transported to the 21st century would barely recognize how warfare is conducted in the age of long-range missiles, precision-guided munitions, and stealth bombers. It is not difficult to believe that future warfare may become as unrecognizable to us, since the main contested spaces in the future might not be air, land, and sea but space and cyberspace.

A **tipping** **point** may have been **reached** already with **advances** in the sophistication of **offensive** cyber **capabilities** and society’s increasing **reliance** on digital **tech**nology.16 The national electric **grid** is **vulnerable** because of **age** and the **threat** to the Supervisory Control and Data Acquisition (**SCADA**) **control** system from **cyber** **attacks**. An additional threat comes from **EMP** **weapons**, which deliver a pulse of energy from a nuclear or electromagnetic detonation “that creates a powerful **electromagnetic** **field** capable of **short**-**circuiting** a wide range of **electronic** **equipment**,” including computers and telecommunications equipment.17 The conventional grid is **exposed** to **EMP** **attacks** in the form of high-voltage control cables and transformers that regulate the grid. High-voltage transformers take 2 years to build, and the United States is inadequately stocked with backup transformers. Thus, a **large**-**scale** EMP **attack** could **bring** **down** a large section of the **grid** for an extended time.18

Certainly, military operational readiness would **suffer** if military **installations** were **still** **integrated** in the national grid at the time of such an attack. Again, this is not a scenario found only in science fiction novels and dystopian Hollywood films. Today, **China** is already believed to **possess** **super**-**EMP** **weapons** and to have **developed** **procedures** to execute a **first** **strike**.19 This rationale is arguably enough for DOD to explore alternative power delivery systems to maintain response capabilities in the event of such an assault.

Fortunately, a microgrid system based on **SMR** **technology** has significant **defensive** **advantages** to the national grid. First, by definition, a microgrid is a discrete system that provides power locally. An SMR acts as an “**island** of **power**,” which **decouples** from the larger **grid** and from other military installations, so a successful attack on one installation would be an **isolated** **incident** and not a **systemic** **failure**. In the case of a cyber-attack or EMP detonation on the **larger** grid **infrastructure**, a military **microgrid** would simply **not** be **affected** because it is **separate** from the rest of the **system**.

Direct **cyber**-**attacks** on **microgrid** infrastructure are also **possible**, but this infrastructure is more **resilient** because of its **independent** computer **control**. We recommend that both **buried** **SMRs** and underground power lines are a **standard** part of a DEA microgrid configuration. By virtue of being below surface, they are **less** **vulnerable** to overhead **EMP** **explosions**, which is not an option for systems based on solar panels and wind turbines. Increased sophistication and sheer volume of monitoring sensors required on a large grid necessitate the automated monitoring capabilities of a SCADA system. Automation not only provides efficiency of operation but also affords efficiency of disruption if cyber security systems can be breached. A series of smaller **grid** **systems** could be better **protected** **individually**, thus vastly increasing cyber security.20 Furthermore, the use of hydrogen as an energy storage medium provides a long-term reservoir of energy, and if the SMR were taken offline for a period, a reversible hydrogen stack could return the stored power in the form of electricity, assuming no damage to the transmission infrastructure.

Provide Expeditionary Capability

The fourth concept underpinning the DEA is the idea that any **investments** in energy production and storage systems should be **applicable** in **expeditionary** **environments** as well as at installations after the strategic systems become mature. The military uses doctrine, organization, training, materiel, leadership, personnel, and facilities (DOTMLPF) to assess organizational systems and the resources required to support those systems. DOD should avoid redundancy of DOTMLPF for separate systems for energy production and delivery in garrison and expeditionary environments. This just represents waste and opportunity cost.

Second, the challenges faced in deployed operations are equally well addressed by the microgrid systems that we advocate. In the wars in Afghanistan and Iraq, powering forward operating bases was one of the most challenging and deadly aspect of the conflicts. Diesel generators and vehicles required constant fueling, which gave the enemy ample opportunity to attack resupply convoys. The Army Environmental Policy Institute calculated that every 39 fuel-resupply missions resulted in a U.S. casualty.21 These are lives that are lost or irreparably changed, and no price tag can be placed on them. Additionally, it has been estimated that the financial cost of delivering fuel to the end user in the operational theater exceeded $400 per gallon.22 Given the personal and fiscal costs that result from current in-theater energy systems, the clear challenge is to develop systems that remove military operations from the “tether of logistics” as much as possible. This would not only save blood and treasure but also enhance operational flexibility of commanders since they would experience more autonomy in deploying forces.

In addition to installation energy systems, SMRs have the potential to act as the centerpiece of deployed energy systems. As DOD better understands the capabilities of mobile reactors, we expect to see the technology migrate further to the tactical level. The Navy is certainly no stranger to small nuclear reactors, as they have been employed in the fleet since the USS Nautilus launched in 1955. Project Pele, conducted by DOD,23 envisions an SMR that can be used at remote operational bases.24 Analysis has shown that SMR technology allows for production units that are small enough to be moved by a heavy truck but are large enough to produce up to 20 megawatts of energy, enough to power an Army division headquarters.25

As discussed, an SMR can be buried underground, making it a hard target in a deployed environment. While SMRs address the need for a forward operating base’s energy, they do not directly address vehicle mobility. However, the electricity from nuclear generation can be used to power electric and hybrid electric vehicles that the U.S. military is already experimenting with.26 As stated, nuclear energy can be used to create hydrogen and other fuels, and higher operating temperatures of SMRs are ideal for producing hydrogen. Because hydrogen is energy-dense, it can extend the operational range of vehicles. In fact, H2 is nearly three times as energy-dense as petroleum diesel, which means less refueling and fewer halts in missions for refueling operations.27 These expanded operational capabilities are simply not available with batteries, which have one-hundredth the energy storage capacity of hydrogen on an equal-weight basis.28 The nuclear-hydrogen synergy could provide all the energy needed for military operations in deployed environments and eliminate the fossil-fuel supply chain altogether.29 We believe a Defense Energy Architecture should unequivocally embrace an SMR-hydrogen system in deployed operations to save lives and resources and increase operational range and flexibility.

DOD Role in Advancing Energy Technology

Both **SMRs** and green hydrogen production can be **considered** emerging **commercial** **technologies**. That is, there are commercial units available, but the **industries** have **not** yet **scaled** to **optimize** production **costs**. The general trend in technologies over time is to become smaller and cheaper as the technology evolves. However, this takes place only if **demand** for the **product** is such that the product is seen as having long-term profitability, and companies have the incentive to invest in research and development that keeps technology moving forward.

The military operates nearly **800** **installations** worldwide.30 If even a **fraction** of these **installations** were to **develop** SMR **capabilities**, it would provide a **clear** **signal** to producers and **investors**. The first SMRs would be much less risky to financiers if they had long-term contracted customers once completed. In fact, the Special Capabilities Office (SCO) within the Office of the Secretary of Defense has already narrowed the selection for the first such SMRs to two commercial designs under Project Pele.31 However, this project cannot be seen as a one-off event if the scale benefits for DOD are to be realized. Project Pele could drive the procurement of the first few units within years and lay out a comprehensive plan for future purchases in the out years. A similar effort to identify promising hydrogen technologies would serve to spur investment and bring down costs for long-term, flexible energy-storage options.

The current moment is favorable for this transition in energy systems. SMR designs are being developed by more than 50 startup companies with private capitalization of greater than $2 billion.32 Instead of paying for the entire technological development cost, the **military** need only pay for the **adaptation** to **military** **standards**. Based on this, the SCO predicts the initial non-Navy military SMR market will be 300 units and the civilian market 1,000 units.33 The Department of Energy (DOE)’s Office of Nuclear Energy is already collaborating with the SCO to move the project forward and coordinate national laboratory efforts. In fact, the coauthor has personally been involved in extensive meetings at Creech Air Force Base, Nevada, to discuss the possibility of “assured energy” being supplied to the base through a prototype SMR as early as 2030.

Similarly, there is **much** **interest** in advancing green hydrogen technology. DOE has launched an initiative called the Hydrogen Shot to reduce the production cost of green hydrogen by 80 percent by 2030.34 Furthermore, the Inflation Reduction Act has announced an investment of up to $8 billion in creating regional hydrogen hubs.35 These programs will stimulate significant private investment as well and help advance the current state of hydrogen technology. DOD can draft off these efforts to ensure that developing hydrogen technologies meet the military specifications of an advanced microgrid system. The earlier the demand signal from the military (vs. DOD hoping for the appropriate solutions to emerge organically), the more likely that customized offerings will be available. DOD can play an important role in providing a market for these emerging technologies.

Conclusion

For the military, energy is the **lifeblood** to maintain **military** **capabilities**. In the event of a large-scale natural disaster or infrastructure attack, the **military** needs to maintain its **own** **systems** to **ensure** **readiness**. For these reasons, **DOD** **needs** to keep advancing **SMR**-based microgrid **systems** with adequate long-term energy storage in the form of hydrogen. For strategic facilities, this would mean that bases control their own destiny without counting on an ever more vulnerable electric grid. With SMR microgrids, **military** **bases** can **isolate** their **power** **supply** from the grid when necessary. In fact, during crises, excess power could be supplied to the civilian sector as it is available.

DOD should **double** **down** on the current efforts of **developing** **microgrids** to increase the resilience of its installations, retain the ability to deploy forces globally when needed, and provide expeditionary power without exposed refueling logistics. The benefits would be multifold. In addition to decreasing vulnerability, DOD adaptation of SMR-based microgrids would allow the military to meet clean energy goals and separate itself from carbon-producing fossil fuels. Increased **DOD** **adaptation** would **drive** **demand**, resulting in greater **competition** and **lower** **prices**. Furthermore, it would serve as a model to civilian energy planners who could observe the positive outcomes and adapt the technology to civilian requirements.

The **military** has already **determined** that **SMR** **microgrids** have **merit**, as evidenced by the maturing of Project Pele. The final solution to base supply of electricity should consider long-term efficiencies to the military of the 21st century. All sources of clean energy integration should be considered on a case-by-case basis to meet the individual needs and priorities of each base mission. Success could drive a successful transition to tactical use of SMR microgrids as well.

The **national** electric **grid** is becoming **vulnerable** because of age and the threat of the SCADA control system being compromised through **cyber** **attacks**, **EMP** **disruptions**, intermittent power **outages**, or **terrorist** **threats**. **Military** electric power supply, both strategic and tactical, **must** **adapt** to this reality and plan for increased future use of microgrids within a generation in the name of mission assurance. **Availability**, **affordability**, and uninterrupted power are the force multiplier **requirements** **governing** the **transition** away from legacy systems toward independent **microgrids**. It is **critical** that a **transition** to a defined Defense Energy Architecture, based on these principles, be developed and **implemented** **soon**.

#### **It's quick.**

**Renahan ’21** [Timothy Renahan; Lieutenant; 10-14-2021; “Realizing Energy Independence on U.S. Military Bases”; National Defense University Press; https://ndupress.ndu.edu/Media/News/News-Article-View/Article/2808076/realizing-energy-independence-on-us-military-bases/; accessed 03-05-2025] tristan

**SMR technology has reached the level of final testing and is expected to be ready for employment by 2026**.23 SMRs can provide on-demand power for a military base if the local energy grid is compromised. These miniaturized nuclear reactors have a smaller footprint compared with a microreactor and are scalable for any energy requirement.24 Although currently not defined, the cost of producing a SMR could range from 15 percent to 40 percent less than construction of a comparable nuclear plant.25 **SMRs would help the U.S. military increase readiness, reduce its carbon footprint, and lower energy-related waste, while taking up less physical space than other clean energy sources**.26

Military bases also provide an additional level of safety, security, and support. The U.S. military has had nuclear-powered vessels, with nuclear support on bases, and independent nuclear facilities since the 1950s with no incidents. Currently, the Navy has boasted approximately “5,400 reactor years of accident-free operations.”27 The Army even operated a nuclear facility at Fort Belvoir (Virginia), only miles from Washington, DC, from 1957 through 1973 without incident or fanfare.28

Drawbacks and Constraints

The biggest barrier to introducing nuclear power to military bases, besides a potential large initial investment, is the word nuclear. Despite the significant rarity of nuclear accidents, the scope and long-term effects of a “Chernobyl” still frighten the population. A 2019 poll showed that Americans were evenly divided, at 49 percent, over the use of nuclear energy as a clean energy alternative—a significant drop from 2010’s high of 62 percent in favor.29 Current political opposition to nuclear power in some states could also be a concern, especially where carbon or natural gas–based enterprises abound.

The potential for terrorist attack and/or cyber attack to a military base is always a threat. But the sheer lack of nuclear incidents in current Navy and Air Force facilities is a direct indication that physical and cyber security measures are in place and being updated.30 This strong record attests that sound processes are available for transfer within DOD, offering a blueprint for future nuclear additions to facilities. There is the possibility of increased costs to secure and transport nuclear material on the base or to a disposal facility. Current DOD efforts to evaluate nuclear power options should account for those costs in order to inform the overall overhead needed to operate the reactor.

Recommendation

**As energy technologies continue to evolve, now is the time to earmark future defense funding to create energy-independent military bases**. SMRs would be the first commercially available technology that could support the critical energy needs of a military base.31 **Current data indicate that they would be less expensive to implement compared with microreactors or other nuclear options**, although both options present a significant initial cost for purchase and infrastructure. DOD should continue to develop and research renewable energy capabilities (solar, wind, water) but should prioritize a nuclear solution to deliver to military bases energy that is independent of a local grid.

#### **Perception is enough.**

**Andres ’11** [Richard; Professor of National Security Strategy @ the National War College, Senior Fellow & Energy and Environmental Security Policy Chair @ the Center for Strategic Research at the National Defense University; February; National Defense University; “Small Nuclear Reactors for Military Installations: Capabilities, Costs, and Technological Implications,” https://ndupress.ndu.edu/Portals/68/Documents/stratforum/SF-262.pdf; DOA: 3-3-2025] tristan

Strategically, islanding bases with small reactors has another benefit. One of the **main** **reasons** an **enemy** might be **willing** to **risk** reprisals by **taking** **down** the U.S. **grid** during a period of military hostilities would be to **affect** ongoing military **operations**. **Without** the **lifeline** of **intelligence**, **communication**, and **logistics** provided by U.S. domestic bases, American **military** **operations** would be **compromised** in almost **any** conceivable **contingency**. Making bases more **resilient** to civilian power **outages** would **reduce** the **incentive** for an **opponent** to **attack** the **grid**. An opponent might still attempt to take down the grid for the sake of disrupting civilian systems, but the powerful **incentive** to do so in order to win an ongoing battle or war would be greatly **reduced**.

#### **Cyberattacks escalate.**

**Tilford ’12** [Robert; Graduate from the US Army Airborne School; July 27; Examiner; “Cyber attackers could shut down the electric grid for the entire east coast,” https://web.archive.org/web/20120812000707/http://www.examiner.com/article/cyber-attackers-could-easily-shut-down-the-electric-grid-for-the-entire-east-coa; DOA: 3-3-2025] tristan

Which means military **command** and **control** **centers** could go **dark**.

**Radar** systems that detect air threats to our country would **shut** **down** completely.

“**Communication** between commanders and their troops would also go **silent**. And many **weapons** systems would be left **without** either **fuel** or **electric** **power**”, said Senator Grassley.

“So in a few short hours or days, the **mightiest** **military** in the world would be left **scrambling** to **maintain** base **functions**”, he said.

We contacted the **Pentagon** and officials **confirmed** the **threat** of a cyber attack is something very **real**.

Top national security officials—including the Chairman of the Joint Chiefs, the Director of the National Security Agency, the Secretary of Defense, and the CIA Director— have said, “preventing a cyber-attack and improving the nation’s electric grids is among the most urgent priorities of our country” (source: Congressional Record).

So how serious is the Pentagon taking all this?

Enough to start, or end a war over it, for sure (see video: Pentagon declares war on cyber attacks http://www.youtube.com/watch?v=\_kVQrp\_D0kY&feature=relmfu).

A **cyber**-**attack** today against the US could very well be **seen** as an “**Act** of **War**” and could be **met** with a “full scale” US **military** **response**.

That could **include** the use of “**nuclear** **weapons**”, if authorized by the President.

### **1AC---Space**

#### Space col is possible now.

**Greenfieldboyce ‘25** [Nell Greenfieldboyce; NPR science correspondent & Masters of Arts degree in science writing; 02-12-2025; “Is Trump the president who will truly set a course for Mars?”; NPR; https://www.npr.org/2025/02/13/nx-s1-5294575/president-trump-elon-musk-mars-moon; accessed 04-03-2025; Willie T.]

Never before, though, has a **president** had such a **close relationship** with a would-be Mars colonizer, one who has transformed the world of rocketry.

Elon Musk, President Trump's ally who is **shaking up government agencies**, founded the company SpaceX with the goal of making humans a **multiplanetary species**. In addition to ferrying astronauts to orbit for NASA, this company is currently building and test flying a new space vehicle, **Starship**, that's designed to **transport massive amounts of cargo—including people**—and land on Mars.

"This is **quite a singular moment** for the prospects of getting to Mars," says Zubrin, who sees this as a time filled with both opportunity and peril.

"I think it actually is pretty clear right now that we're going to get a **humans-to-Mars program** started," he says.

But to succeed, any such plan would need broad political support, and he worries about Mars suddenly becoming a divisive, partisan issue.

"This is not going to work," says Zubrin, "if this is understood to be an Elon Musk hobbyhorse."

The presidents and Mars

In his inaugural address in January, President Trump got the attention of the space community when he said the United States would "pursue our **manifest destiny into the stars**, launching American astronauts to plant the Stars and Stripes on the planet Mars."

In some ways, a president inspirationally referring to Mars is nothing new.

Back in 1989, for example, President George H. W. Bush called for a return to the moon, to be followed by "a journey into tomorrow, a journey to another planet: a manned mission to Mars." He envisioned footprints in the Martian dirt by 2019, the 50th anniversary of the moon landing.

"Within a few short years after President Bush's Kennedy-esque announcement, however, the initiative had faded into history," one policy analyst wrote.

A decade and a half later, President George W. Bush refocused NASA on a return to the moon by 2020, adding that "with the experience and knowledge gained on the moon, we will then be ready to take the next steps of space exploration: human missions to Mars and to worlds beyond."

President Obama told NASA to forgo the moon, but did maintain Mars as a goal: "By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth," he said in a speech at NASA's Kennedy Space Center. "And a landing on Mars will follow."

First, the moon?

During President Trump's first administration, he issued a space policy directive that refocused NASA on a human moon landing, with missions to Mars added as a future goal.

That program, called Artemis, is what NASA has pursued ever since. It continued under President Biden, although it's been criticized as relying on a super-expensive rocket that rarely flies.

Despite delays and cost overruns, NASA says it is poised to send humans to **orbit the moon next year**. A landing is planned for the year after that.

Trump's reference to Mars, but not the moon, in his inaugural speech had some in the space community wondering if this was a result of Musk's influence.

The new Trump administration could **kill Artemis and its lunar plans**, but Casey Dreier, chief of space policy for the Planetary Society, says that would be "strange in the historical sweep of things" given that the first Trump administration basically created this program

"There's a lot of good reasons to still go to the moon, one of which is that the U.S. has made a commitment to not just its allies, but to the broader commercial space and business community here in the country," notes Dreier.

Still, he thinks that the current administration might challenge NASA to really nail down how the space agency will move from **lunar exploration to a Mars** mission.

More difficult than the moon

NASA has a "Moon to Mars Program Office," notes Dreier. He thinks, however, "there's no 'to Mars' part of it. It's all 'to moon.' "

He says NASA has constrained budgets, and there's always been concerns that the agency hasn't had enough resources to pursue both the moon and Mars.

"It's hard to express verbally, I think, how much harder Mars is than the moon and how different it is," says Dreier.

A trip to the moon takes just three days. Going to Mars, in contrast, takes months—one way.

Recently, a NASA program aimed at retrieving pristine rocks from the surface of Mars and bringing them back to Earth ran into real trouble, as costs ballooned by billions and the mission timeline slipped. One decision the Trump administration will have to make is whether, and how, to pursue this science mission.

Dreier says in terms of human exploration, NASA needs to lay out how its lunar activities will actually help get the agency **closer to going to Mars.**

"That is the key reframing that could help the long-term exploration program be more **efficient and effective**," he says.

President Trump's pick to lead NASA is Jared Isaacman, a private astronaut who flew to orbit twice in SpaceX vehicles and completed the first commercial extravehicular activity, or spacewalk. He has yet to be confirmed.

A NASA spokesperson told NPR in an email that the agency is "looking forward to hearing more about the Trump Administration's plans for our agency and expanding exploration for the benefit of all, including sending American astronauts on the first human mission to the Red Planet."

A non-partisan planet

Because of the **way the planets align**, potential launch windows to Mars open up in **2026 and 2028.**

#### **Reliable energy allows human settlement.**

**Pombo ‘21** [Daviel Vazquez Pombo, MSc in High Voltage Engineering from Aalborg University & PhD in Planning and Operation of Isolated Hybrid Power Systems from Technical University of Denmark, 4-7-2021, A Hybrid Power System for a Permanent Colony on Mars, Space: Science & Technology A Science Partner Journal, https://spj.science.org/doi/10.34133/2021/9820546, accessed 04-03-2025, Willie T.]

Many are the reasons behind establishing a colony in Mars such as the possibility of discovering extraterrestrial life, ensuring the survival of our species after a massive extinction event, and improving quality of life, etc. However, there are only a **few scientific publications** regarding Mars colonisation. The few existing **focus mostly on spacecraft concepts** and design, at the expense of hardly mentioning or even **neglecting basic day-to-day** critical infrastructures like the power system. In fact, the relevant previous work starts mostly on the 70s, later in the 90s and 2000s; a couple of very high-level publications appear that mainly update some of the base assumptions due to the discoveries obtained by different unmanned missions sent to the red planet. In any case, establishing a permanent outpost in Mars **requires** a flexible, scalable, **reliable, and safe power system**. Therefore, this paper is aimed at analysing power sources, transmission/coupling possibilities, topology, etc. for a near-future Mars colony. This is addressed by reviewing all the excellent work developed since the 50s until the early 2000s and then updating it with present methods and technologies. Culminating with a proposal of a power system suitable for the task at hand, serious dialogues must start among the scientific community as it is its duty to serve humankind’s development [1–5].

There has not been much development specifically about the power system. Early documents like [6] proposed either a purely nuclear system or a combination with solar photovoltaic (PV) [7]; some others [8] suggested radioisotope but with a back-up role. However, most of the available **work is superficial and undetailed**. Recent development in energy technology obtained as a result of the energy transition demands a revision of the sources and storage system that might be used in the power systems of surface space missions. In addition, no document has proposed a balance of plant, a proper topology, or addressed the transmission system for the colony to name a few, not to mention how to address the particular effects of the Martian environment on electrical equipment [9]. Thus, studies focusing solely on the **Martian environment and requirements** are needed. Thus, this paper is aimed at reviewing the available technologies that will conform the power system of a near-future Martian colony and propose a suitable topology. This is done by reviewing the different proposed mission designs, concluding in a reasonable evolutionary scenario for the colony and its balance of plant suitable to satisfy its power and energy needs.

Then, the structure of the paper is as follows: Section 2 reviews the history of the most important documents published targeting manned missions to Mars, the interest behind establishing a permanent outpost, and it subsequently defines a dynamic architecture for the outpost. Thereafter, different power sources are analysed on Section 3 in order to choose a suitable combination conforming the Martian hybrid power system (HyPS). Then, whether the coupling should be in AC, DC, or mixed is discussed in Section 4. Afterwards, the resulting topology of the HyPS is presented and evaluated in Sections 5 and 6, respectively. Finally, the conclusions of this work are presented in Section 7, while also pointing out research paths that might continue this work.

2. Background, Motivation, and Mission Requirements

This section reviews the most important studies targeting Mars exploration in chronological order. This is aimed at illustrating the evolving concepts in certain areas while the stagnation in others such as power systems, while also helping to define the targeted mission. Despite the intention of providing an overview of all the developed science, there is a strong focus on NASA achievements until the 2000s, since Roscosmos public documents are written in Russian, a language sadly falling out of the knowledge base of the author.

The first formal approach to reach Mars was published in 1953 [10], where the flight systems and spacecraft are envisioned. A crew of 70 would be the first humans seeing the planet up-close as the arrival date was 1965 and precursor robotic missions were not considered. However, it was not until 1988 where a space agency such as NASA published a study with a similar aim [2], followed shortly by series of studies of human and robotic exploration beyond Low Earth Orbit and the Moon, Mars, Phobos, etc. [11, 12]. Then, [13] concludes that enough technological readiness would be achieved by 2000, starting the operations shortly afterwards; envisioning crews of 4 people, doubling two years after the first arrival and, also, suggesting several schedules ranging from 2011 to 2018 for the first mission and 2014 to 2027 to inaugurate the first permanent settlement.

In any case, [13] satisfies the power needs of the missions by means of SP-100, a nuclear fission reactor designed in 1989 for lunar missions easily adaptable for Mars [6]. It is worth mentioning that all the previous publications dismiss the possibility of using any locally available resources since there was no data available until the discoveries obtained by both Viking landers. Subsequently, in 1991, [14] further elaborates about a surface operating reactor, while [15] takes an extra step by coupling it with an in situ resource utilisation (ISRU) unit. A device capable of using local water, ice, and atmospheric CO2 as raw materials for fuel, air, water, plastics food, and other supplies. However, this concept will fall into oblivion for more than 10 years [16–18]. Afterwards, [19] points out the need for further research about the Martian environment before they could design landers, space suits, and other surface systems. After 1997, the approach taken by the studies changes trying to acquire a more holistic perspective, since previous attempts like [20] ended up focusing mostly or solely into flight and trajectory designs. Then, [9, 21] represent the most complete analyses until then, aiming to be used to drive R&D plans, understand mission requirements, open discussions, establish a baseline for future proposals, and stimulate further thought by also demanding improvement in certain aspects like the power system. A crew of 6 is envisioned in [9], no attention to surface power system is paid, and no ISRU is considered despite [15] being published 6 years prior.

After entering the new millennia, a high-level review of the Mars mission is published [3] stating that human arrival to Mars is so certain that a second revision will be necessary between 2015 and 2020 to account for the actual arrival. The book reviews concepts such as [10, 19] which never envisioned the role of robotic exploration. These unmanned missions helped discover unknown phenomena that would have ruined any manned mission developed with that time’s technology. It also points to the arrival delay caused by these discoveries as the reason for funding reduction in benefit of robotic exploration. The more was discovered, the least money available for a manned mission was available. Then, [16, 17] present concepts for self-sustaining Mars colonies by means of implementing ISRU. In [16], the 500 people colony site is selected in the North polar cap due to the water/ice available, while [17] focuses on obtaining water from the atmosphere, to avoid site dependency, envisioning a modular architecture capable of either 100, 1000, or 10000 crew scenarios. Following this trend, [18] is aimed at implementing an ISRU system to support propulsion and power systems for ground and flight vehicles in two scenarios, an Antarctica-inspired 100 people scenario and another terraforming scenario with a crew of 10000.

The first document from the European Space Agency (ESA) about a Mars mission is published in 2006 [22], which presents plans to study the Martian environment by using rovers. Then, [23] revives the interest of manned missions in three different sites, discussing mobility possibilities both on the surface and underground; the arrival is estimated between 2030 and 2040. Subsequently, in 2009, [7] suggests a framework aiming to facilitate reaching Mars as a multiagency effort. The document describes the systems and operations of a robotic precursor and the first three manned missions of 6 people each in different locations. This document stands out as the first time that the power system and energy management are highlighted as a key improvement needed. Subsequently, [24], a more completed version of [7], builds upon some of the aforementioned documents like [11–14, 21, 22] and others like [25, 26]. Among the conclusions of [24], the higher importance of robot-human partnership should be mentioned. Additionally, the selected crew of 6 must land prior to 2030; otherwise, a technology reassessment will be needed. Lastly, [24] contains the first proper section about the power system, which is envisioned as a combination of nuclear and PV for the main power while radioisotope power systems (RPSs) for backup needs. Thereafter, in 2014, [27] updates [7] with the latest developments, increasing again the role of robots and identifying solar power generation, nuclear fission, and active thermal control among the critical technologies. On the other hand, ESA and Roscosmos have a shared exploration agenda; however, no manned missions are foreseen [28, 29]. India and Japan have expressed that their targets do not include Martian exploration whatsoever, while China do it independently, targeting manned missions to the Moon in 2030 in collaboration with Russia as a prior step [30, 31]. Then, the Evolvable Mars Campaign is the current NASA mission seeking to enable crewed Mars missions in the mid-2030s timeframe [32]. Lastly, SpaceX is targeting the first manned mission to Mars in 2024 as preparation for a permanent settlement to be started shortly afterwards [5]. Nevertheless, why should we keep pursuing the dream of reaching Mars?

Many publications like [7–9, 33, 34] have reviewed the numerous reasons and objectives behind reaching Mars, which can be divided into 5 categories: planetology, humanistic, scientific, technological, and political. Ultimately, the goal is the integration of all the prior and acquired knowledge, which is referred in this work as holistic. This unification of knowledge will transcend any objectives established for the Mars colonisation and will push humanity forward. A summary of the possible reasons and objectives behind the conquest of Mars is presented in Figure 1Opens in image viewer. Nevertheless, the questions risen due to this endeavour might be even more valuable than the answers we hope to find [23].

Figure 1 Reasons to go to Mars.

Once the reasons behind getting humans into the red planet have been stated, the importance of establishing a permanent settlement instead of a temporary visit should be highlighted. The most important reason backing a sustained human presence in Mars is the increased cost-effectiveness of the mission. Research potential and discoveries escalate during sustained missions, while the cost does not increase significantly [23]. However, even disregarding the difficulty of reaching the planet safely, the particularities of engineering a robust system capable of operating under the Martian conditions will unequivocally translate in technological advancement for the general humanity. Examples of this process can be [35] where cross-disciplinary research is undertaken making use of the ISRU to propel an ascent vehicle in Mars, or [36] where a prototype for a greenhouse suitable for the Martian environment is presented, or [37] which is aimed at expanding the applications of ISRU units. Additionally, since one of the objectives is to avoid a massive extinction event, establishing permanent human settlements in other celestial bodies is a key. Then, **terraformation** of Mars, which consists of warming up the planet, in order to **thicken its atmosphere**, ultimately obtaining **liquid water surface oceans** on Mars [34], would **only be interesting** to achieve if there is a sustained human presence on the planet [38]. Lastly, Mars is **not considered the end** of the space exploration, but rather a **step** in it. Future missions aimed at more distant celestial objects will **require longer stays** before returning or continuing; thus, Mars represents a great training **outpost**.

At the end of the day, there are a variety of different envisioned manned missions, with crews ranging from **4 to 10000** depending on the length of stay and the ultimate exploration objectives. Barely no attention has been paid to the configuration and actual implementation of the power and energy management system (PEMS). Manned missions might still be decades down the road; however, complex robotic missions rather than individual rovers might be closer than ever due to latest developments in the field [39, 40]. Whatever the case, **manned or unmanned**, all the infrastructures depend on having a functional power system. Therefore, a reference architecture for the colony must be defined prior to sizing the necessary PEMS as it is needed in order to estimate the mission’s power and energy needs.

#### **Affirming is key.**

**Nguyen 20** [Tien Nguyen, Ph.D. in Organic Chemistry & B.S in Chemistry with Minor in Physics, 5-15-2020, Why NASA thinks nuclear reactors could supply power for human colonies in space, Chemical & Engineering News, https://cen.acs.org/energy/nuclear-power/NASA-thinks-nuclear-reactors-supply/98/i19, accessed 04-03-2025, Willie T.] \*\*brackets in original\*\*

Fortunately, the nearby nuclear reactor is unfazed by the **lack of light**. Connected to the astronauts’ base camp by a kilometer of cables cautiously tracing the lunar surface, the reactor provides an **uninterrupted supply** of electricity for recharging rovers, running scientific instruments, and most importantly, powering the **air and heating systems** that keep the astronauts **alive.**

This is one vision of what human exploration could look like on the moon. In fact, NASA has plans to make some versionsof this scene a reality—and soon.

The agency aims to send a human mission to the moon by 2024 in an effort named the Artemis project. Congress has allocated more than $6 billion of NASA’s 2020 fiscal budget for space exploration programs including the Space Launch System rocket, the Orion spacecraft, exploration ground systems, and research and development. The agency estimates that it will cost $35 billion to land a crew on the lunar surface, including the first woman to step foot on the moon. After 2024, NASA hopes to move to launching one human mission each year and reach sustainable operations on the moon by 2028.

The lessons learned in that phase will be crucial in preparing for **future trips to Mars**. One major effort will involve figuring out which power systems—including ones that have never been tested on the lunar surface, such as nuclear power—would best support future settlements. Whether the necessary materials can be brought safely to the moon and whether systems such as nuclear fission can run **reliably under such harsh conditions** are central questions that must be answered as engineers weigh their options.

Going nuclear

Choosing a power source depends on the particular mission’s needs, says Michelle A. Rucker, an engineer at NASA’s Lyndon B. Johnson Space Center who has researched possible architectures for space settlements. Electricity may come from nuclear reactors, solar panels, batteries, fuel cells, or some combination of these technologies connected in a power grid, she says. “I’m a big fan of all the types of power.”

But each power source has distinct pros and cons to consider. Solar arrays have reliably delivered renewable power in space for decades but are useless in places that never get any light, like the potentially resource-rich craters on the moon. And on the windy, dusty surface of Mars, solar panels may **struggle to collect** enough light, making them a risky option for powering life support systems, Rucker says. **Batteries and fuel cells have limited lifetimes** for now, relegating them to **supplementary power sources at best.**

One type of nuclear device that has been used to power spacecraft is a radioisotope thermoelectric generator, which runs on the heat produced by the decay of plutonium-238. These generators have been used since the 1960s in Mars rovers and space probes sent to the outer edges of the solar system, such as the Voyager spacecraft and Cassini. Despite being the workhorses of scientific missions, the generators provide only several hundred watts of power, just enough to send radio signals back to Earth or power a camera.

On Earth, the nuclear technology used by power plants is nuclear fission, which splits uranium-235 atoms via bombardment with neutrons to generate heat that’s captured to produce electricity. Nuclear fission holds the potential to provide a **continuous, reliable source** of power for a small space settlement designed to last **for several years.**

In the 1960s, many scientists thought fission reactors for space would follow on the heels of radioisotope generators. In 1965, the US launched a small nuclear fission–powered satellite named SNAP-10A, but electrical issues caused it to fail a mere 43 days after launch; it’s still in orbit, now just another piece of space junk. The Soviet Union launched 31 nuclear fission–powered satellites over the next 2 decades.

But the development of new nuclear fission reactors for space stalled during that time because of design problems and ballooning budgets. Engineers wanted advanced performance from these systems right away, which led to complicated and expensive designs, says David Poston, a nuclear engineer at Los Alamos National Laboratory. He and Patrick McClure, who specializes in reactor safety at Los Alamos, have worked at the lab for the past 25 years and recall the days when nuclear fission had fallen out of favor.

“Pat and I were sitting around just kind of demoralized,” Poston says, “because we had gotten to the point where NASA wasn’t really interested anymore because the impression was that it was going to be too expensive and too hard to develop a fission reactor.” But the pair were convinced their team could come up with a design to dispel the funk that had settled around fission power for space.

In the early 2010s, they got their chance: researchers at Los Alamos and later the NASA Glenn Research Center and the US Department of Energy began work on a joint project called Kilopower, now renamed the Nuclear Fission Power Project. The goal is to develop a **new nuclear fission** power system for space that would be **capable of producing 10 kW of electrical energy.**

Designing the reactor

Four of these reactors could **easily provide** the 40 kW of power that Rucker estimates a six-member crew would need to live on Mars. The team’s modular, compact design is lightweight **enough for space exploration**, in which every kilogram counts. Previous hypothetical fission-power concepts required a payload of 12–14 metric tons (a 6–7 t reactor plus a backup), whereas a single Kilopower reactor would weigh an estimated 1.5 t, she says.

The team decided to approach the reactor design anew, putting one priority above all: simplicity. This meant not only maintaining a simple mechanical design but also looking for opportunities to simplify safety approvals and project management. As an example, McClure says, the team made a conscious choice to limit the size of the nuclear core to a container already being used to test nuclear materials instead of fabricating a new one.

“I hate to call it an innovation because it’s not that complicated. But it’s an innovation that we said, ‘Why don’t we just do it the simple way that we know is going to work?’ ” Poston says. “We knew it was going to work, but the world didn’t.”

The nuclear core, which is about the size of a paper towel roll and weighs 28 kg, comprises a solid alloy of about 8% molybdenum and 92% highly enriched uranium. The nuclear material is surrounded by a beryllium oxide reflector that bounces neutrons into the core to drive the fission reaction. Lodged inside the core is a rod of pure boron carbide that absorbs neutrons, quenching fission reactions.

When the boron carbide rod is slowly removed, neutrons start to strike uranium atoms, occasionally splitting them, creating more neutrons and releasing energy as heat. Once the number of neutrons lost equals the number of neutrons being produced, the reactor becomes self-sustaining. The fission-generated heat travels through sodium-filled heat pipes to a set of Stirling engines. Designed in the early 1800s, these simple piston-driven engines convert heat to electricity. Finally, the team’s reactor design includes a radiator to remove the excess heat, sloughing it off into space.

“We wanted to show not only the world but ourselves that we can still do something real because we had gotten away from actually testing real fission systems,” Poston says.

In a proof-of-concept test called DUFF, the team showed that the hardware worked to produce electricity. Then, in 2018, the team successfully tested a prototype of the reactor at the Nevada National Security Site. During the months-long KRUSTY experiment, researchers tested each of the reactor’s components and its ability to withstand various failures. (The experiment names were inspired by The Simpsons TV show.) The reactor also **successfully passed** a 28 h test, in which it **ramped up to full power**, peaking at about 5 kW, operated at a steady state, and then **shut down safely.**

The team hopes that with more optimization, such as by increasing the size of the nuclear core, it can meet its goal of producing 10 kW per reactor.

Of course, some people look at highly enriched uranium with skepticism, given its potential to harm humans and its role as a material for nuclear weapons. But McClure says transporting uranium to the moon and working alongside a reactor can be **done safely**. Uranium emits weak α particles, which **can’t penetrate a piece of paper or skin**, so the **shielding** that surrounds the nuclear core would prevent astronauts from any radiation exposure. Burying the reactor a few meters into the ground or putting it behind a big rock feature could also help keep astronauts safe from radiation when the reactor is on. Once the reactor has run its course, the radioactive waste will likely be shielded and left alone.

The worst-case scenario for such a system would involve the entire reactor blowing up midlaunch, aerosolizing and dispersing uranium particles. Even then, a person a kilometer away might receive a dose in the millirem range—less than the dose you get from solar radiation when you take a plane flight, McClure says.

Ultimately, the fission reactor’s future will depend on not only technical success but also **sufficient funding**. Dionne Hernández-Lugo of the NASA Glenn Research Center and deputy project manager of the Nuclear Fission Power Project says the proposed budget puts the team “on the path to build and send a surface power system to the moon.”

“It’ll be really exciting to test [the reactor] on the moon and get some experience under our belts before we go to Mars,” Rucker says. “On the moon, you’re close to home, so if something fails, it’s a fairly close trip to get back home, whereas on Mars, your system better be working.”

#### **US progress is crucial.**

**Harrison 24** [Todd Harrison, Senior fellow at American Enterprise Institute 5-8-2024, Building an Enduring Advantage in the Third Space Age, American Enterprise Institute - AEI, https://www.aei.org/research-products/report/building-an-enduring-advantage-in-the-third-space-age/, Willie T.]

Executive Summary The United States is leading the world into a new era of space activity known as the third space age. Unlike the militarization and exploration of the first space age (1957–90) and the diversification and stagnation of the second space age (1991–2015), the third space age (2016–present) is defined by rapid commercialization and proliferation. In this new era, US space capabilities and capacity are second to none, but China, Russia, and other nations are actively working to erode this advantage. This report provides quantitative insights and analysis of the trends in space launch, satellites, and space debris and makes recommendations for how to build an enduring advantage for the United States in space. The global annual launch rate hit an all-time high of 211 successful orbital launches in 2023, driven mainly by the **United States** and China, which each logged their highest launch rate ever at **103** and 66 **launches**, respectively. The US lead is even more stark considering that it comprised **81 percent of global effective launch capacity** in 2023—**four times the rest of the world combined**. The introduction of much **larger US launch vehicles, particularly SpaceX’s Starship** and Blue Origin’s New Glenn, and the higher **degree of reusability these** vehicles employ **will further increase the US lead**. These disruptive changes will give the United States a **unique ability to launch much larger payloads** at much **lower costs**, enabling new generations of satellites with designs unconstrained by size, weight, and power. The US **advantage in space also extends to satellite capabilities** and **production capacity**. Globally, more satellites were launched in the past five years (2019–23) than in all previous years combined. In 2023, 78 percent of satellites launched were US satellites, driven mainly by the deployment of SpaceX’s Starlink constellation. Commercial satellites comprise 84 percent of all satellites launched in the third space age, and market projections indicate that the satellite launch rate will remain high for the foreseeable future, driven by the deployment of highly proliferated commercial constellations, such as **Starlink and Amazon’**s Kuiper.

#### **That enables lateral innovation.**

**West 20** [Darrell M. West, Senior Fellow in Governance Studies @ Center for Technology Innovation of Brookings, 8-18-2020, Five reasons to explore Mars, Brookings, https://www.brookings.edu/articles/five-reasons-to-explore-mars/]

The recent launch of the Mars rover Perseverance is the latest U.S. space mission seeking to understand our solar system. Its expected arrival at the Red Planet in mid-February 2021 has a number of objectives linked to science and innovation. The rover is equipped with sophisticated instruments designed to search for the remains of ancient microbial life, take pictures and videos of rocks, drill for soil and rock samples, and use a small helicopter to fly around the Jezero Crater landing spot.

**Mars is a valuable place for exploration because it can be reached in 6 ½ months, is a major opportunity for scientific exploration, and has been mapped and studied for several decades**. The mission represents the first step in a long-term effort to bring Martian samples back to Earth, where they can be analyzed for residues of microbial life. Beyond the study of life itself, there are a number of different benefits of Mars exploration.

UNDERSTAND THE ORIGINS AND UBIQUITY OF LIFE

The site where Perseverance is expected to land is the place where experts believe 3.5 billion years ago held a lake filled with water and flowing rivers. **It is an ideal place to search for the residues of microbial life, test new technologies, and lay the groundwork for human exploration down the road.**

The mission plans to investigate whether microbial life existed on Mars billions of years ago and therefore that life is not unique to Planet Earth. As noted by Chris McKay, a research scientist at NASA’s Ames Research Science Center, that would be an extraordinary discovery. “Right here in our solar system, if life started twice, that tells us some amazing things about our universe,” he pointed out. “It means the universe is full of life. Life becomes a natural feature of the universe, not just a quirk of this odd little planet around this star.”

The question of the origins of life and its ubiquity around the universe is central to science, religion, and philosophy. For much of our existence, humans have assumed that even primitive life was unique to Planet Earth and not present in the rest of the solar system, let alone the universe. We have constructed elaborate religious and philosophical narratives around this assumption and built our identity along the notion that life is unique to Earth.

If, as many scientists expect, future space missions cast doubt on that assumption or outright disprove it by finding remnants of microbial life on other planets, it will be both invigorating and illusion-shattering. It will force humans to confront their own myths and consider alternative narratives about the universe and the place of Earth in the overall scheme of things.

As noted in my Brookings book, Megachange, given the centrality of these issues for fundamental questions about human existence and the meaning of life, it would represent a far-reaching shift in existing human paradigms. As argued by scientist McKay, discovering evidence of ancient microbial life on Mars would lead experts to conclude that life likely is ubiquitous around the universe and not limited to Planet Earth. Humans would have to construct new theories about ourselves and our place in the universe.

**DEVELOP NEW TECHNOLOGIES.**

**The U.S. space program has been an extraordinary catalyst for technology innovation.** Everything **from Global Positioning Systems and medical diagnostic tools to wireless technology and camera phones** owe at least part of their creation to the space program. **Space exploration required the National Aeronautics and Space Administration to learn how to communicate across wide distances, develop precise navigational tools, store, transmit, and process large amounts of data, deal with health issues through digital imaging and telemedicine, and develop collaborative tools that link scientists around the world.** The space program has pioneered the miniaturization of scientific equipment and helped engineers figure out how to land and maneuver a rover from millions of miles away. Going to Mars requires similar inventiveness. Scientists have had to figure out how to search for life in ancient rocks, drill for rock samples, take high resolution videos, develop flying machines in a place with gravity that is 40 percent lower than on Earth, send detailed information back to Earth in a timely manner, and take off from another planet. In the future, we should expect large payoffs in commercial developments from Mars exploration and advances that bring new conveniences and inventions to people.

ENCOURAGE SPACE TOURISM

In the not too distant future, wealthy tourists likely will take trips around the Earth, visit space stations, orbit the Moon, and perhaps even take trips around Mars. For a substantial fee, they can experience weightlessness, take in the views of the entire planet, see the stars from outside the Earth’s atmosphere, and witness the wonders of other celestial bodies.

The Mars program will help with space tourism by improving engineering expertise with space docking, launches, and reentry and providing additional experience about the impact of space travel on the human body. Figuring out how weightlessness and low gravity situations alter human performance and how space radiation affects people represent just a couple areas where there are likely to be positive by-products for future travel.

The advent of space tourism will broaden human horizons in the same way international travel has exposed people to other lands and perspectives. It will show them that the **Earth has a delicate ecosystem that deserves protecting and why it is important for people of differing countries to work together to solve global problems.** Astronauts who have had this experience say it has altered their viewpoints and had a profound impact on their way of thinking.

FACILITATE SPACE MINING

zmany objects around the solar system are made of similar minerals and chemical compounds that exist on Earth. **That means that some asteroids, moons, and planets could be rich in minerals and rare elements.** Figuring out how to harvest those materials in a safe and responsible manner and bring them back to Earth represents a possible benefit of space exploration. Elements that are rare on Earth may exist elsewhere, and that could open new avenues for manufacturing, product design, and resource distribution. This mission could help resource utilization through advances gained with its Mars Oxygen Experiment (MOXIE) equipment that converts Martian carbon dioxide into oxygen. If MOXIE works as intended, it would help humans live and work on the Red Planet.

ADVANCE SCIENCE

One of the most crucial features of humanity is our curiosity about the life, the universe, and how things operate. **Exploring space provides a means to satisfy our thirst for knowledge and improve our understanding of ourselves and our place in the universe.** Space travel already has exploded centuries-old myths and promises to continue to confront our long-held assumptions about who we are and where we come from. The next decade promises to be an exciting period as scientists mine new data from space telescopes, space travel, and robotic exploration. Ten or twenty years from now, we may have answers to basic questions that have eluded humans for centuries, such as how ubiquitous life is outside of Earth, whether it is possible for humans to survive on other planets, and how planets evolve over time.

#### **Either we successfully colonize or save humanity while trying.**

**HÉIgeartaigh 16** [Seán Ó HÉIgeartaigh, professor @ Cambridge + PhD in Genomics from Trinity College of Dublin, 10-5-2016, Technological Wild Cards: Existential Risk and a Changing Humanity, Centre for the Study of Existential Risk, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3446697]

4. WORKING ON THE (DOOMSDAY) CLOCK

**Technological progress** now **offers us a vision of a remarkable future**. The **advances** that have brought us onto an unsustainable pathway have also **raised the quality of life dramatically for many**, **and** have **unlocked scientific directions that can lead us to a safer, cleaner, more sustainable world**. With the right developments and applications of technology, in concert with advances in social, democratic, and distributional processes globally, progress can be made on all of the challenges discussed here. Advances in renewable energy and related technologies, and more efficient energy use—advances that are likely to be accelerated by progress in technologies such as artificial intelligence—can bring us to a point of zero-carbon emissions. **New manufacturing capabilities provided by synthetic biology may provide cleaner ways of producing products and degrading waste.** A greater scientific understanding of our natural world and the ecosystem services on which we rely will aid us in plotting a trajectory whereby critical environmental systems are maintained while allowing human flourishing. **Even** advances in **education and women’s rights** globally, which will play a role in achieving a stable global population, **can be aided specifically by the information, coordination, and education tools that technology provides, and more generally by growing prosperity in the relevant parts of the world.**

**There are catastrophic and existential risks that we will simply not be able to overcome without advances in science and technology.** **These include** possible **pandemic outbreaks**, **whether natural or engineered**. **The early identification of incoming asteroids**, **and approaches to shift their path, is a topic of active research at NASA and elsewhere**. While currently there are no known **techniques to prevent or mitigate a supervolcanic eruption,** this **may not be the case** with the tools at our disposal **a century from now**. **And in the longer run, a civilization that has spread permanently beyond the earth, enabled by advances in spaceflight, manufacturing, robotics, and terraforming, is one that is much more likely to endure**. However, **the breathtaking power of the tools we are developing is not to be taken lightly**. **We have been very lucky to muddle through the advent of nuclear weapons without a global catastrophe**. And within this century, it is realistic to expect that we will be able to rewrite much of biology to our purposes, intervene deliberately and in a large-scale way in the workings of our global climate, and even develop agents with intelligence that is fundamentally alien to ours, and may vastly surpass our own in some or even most domains—a development that would have uniquely unpredictable consequences.

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#### **Becoming multiplanetary avoids extinction---‘do it later’ fails.**

**Trancart 16** [Albéric Trancart, tech lead @ Theodo, studied civil engineering @ the École Nationale des Ponts et Chaussées, 10-3-2016, Why Mars matters, GatsbyJS, https://alberic.trancart.net/2016/10/why-mars-matters/, Willie T.] \*\*ellipses in original\*\*

There are always **new ways** to wipe out humans

In addition to cosmic-killer events like **gamma ray bursts** or rogue **black holes** or **giant asteroids** (which hopefully happen on astronomical timescales, quite literally), mankind is **always inventing new ways** to destroy itself. Actually, we are accidentally engineering the sixth mass extinction event in Earth history.

**Nuclear apocalypse**, **biological weapons**, **Artificial Super Intelligence**...those things are **dangerously close** and unhappily, the trigger can be pulled at **any time** because situations like these **escalate quickly** and are not so foreseeable.

The progress cognitive bias

Most people think of progress as a thing that automatically improves itself over time. That's a **huge mistake**. In fact, the truth is quite the opposite.

There is only one stable point of technology level and it is zero.

History has shown that great civilizations made huge technological advancements and then, at one point, the progress **stopped, then fell back**. The civilizations eventually collapsed some decades later. The most striking and well-known example is the one of the Western Roman Empire: it took about a thousand years before recovering a similar technological level at the end of the Middle Ages.

While progress or lack thereof do not always have a cause-consequence relation to civilizations falling, it is intimately correlated. And History repeats itself. In fact when it comes to space exploration we are already falling behind. We went to the Moon. Now humans are confined to Low Earth Orbit (LEO). At the moment, we are going into a future where humans will never make it to orbit.

The same goes for rocket technology: apart from some optimizations, we rely on the exact same techniques that were used 50 years ago… satellite building is taking off the shelf components that were designed 10 years ago, which means that most satellites in their mid-life are using technology 20 years older that what's on Earth.

Because of these three points (procrastination, new Armageddons, technology level's equilibrium at zero) you should not see the issue as a deadline until the Apocalypse but as a **set of windows**. If we do not make life multiplanetary before the last window closes, **we're done**, even if the actual extinction event happens much much later. One window opened in 1957 with the Space Race and closed in 1972 with the last Apollo mission. A **new window has opened** thanks to Elon Musk and SpaceX. From **political obstruction** to **lack of will**, there are multiple means those windows could **be closed.**

### **1AC --- Transition**

#### **Clean energy transition is inevitable but must be faster.**

**Worland 21** [Justin Worland, Senior Correspondent @ Time & BA in History from Harvard University, 7-15-2021, The Energy Transition Is in Full Swing. It’s Not Happening Fast Enough, TIME, https://time.com/6106341/green-energy-transition-iea/, Willie T.]

Even if you follow these things closely, it can be hard to understand where the world’s fight against climate change stands. On the one hand, news abounds of the clean energy revolution, as wind farms and solar panels pop up in communities across the globe and automakers promise to go electric. On the other hand, scientists continue to warn that fossil fuels have placed the planet and everyone who lives on it on an unavoidable collision course with catastrophe.

A new report from the International Energy Agency (IEA) published Wednesday explains the dynamic in sharp detail: the world has begun a **momentous shift** in how we power the economy that will touch virtually every corner of human society, with investment in oil and gas slowing and spending on clean energy rising. But it’s **not happening fast enough** to avoid dangerous levels of warming.

“A new global energy economy is emerging,” IEA Executive Director Fatih Birol tells TIME. But when it comes to the necessary levels of investment in clean energy, there is “a **gross mismatch.”**

The IEA’s annual World Energy Outlook is designed to inform policymakers about the state of global energy markets as well as the emerging trends expected to define energy in the years to come. Its origins are undeniably wonky, but this year’s report takes on new significance with climate change on the rise in public consciousness and on the international stage. The agency released the 2021 report a month early to help inform talks among the delegates who will gather in Glasgow, Scotland, in early November for the biggest United Nations climate summit in years.

Perhaps nothing is more urgent than the report’s key message that countries need to dramatically accelerate their efforts to cut emissions for the world to have any hope of limiting temperature rise to 1.5°C, the level at which scientists say we might expect to see widespread catastrophic effects of climate change. Current pledges from countries to cut emissions only reduce carbon pollution by 20% of what’s necessary to avoid reaching that marker, according to the report’s analysis.

The report offers no shortage of solutions to make up the gap. Climate politics can often end up mired in debates about controversial topics like carbon capture and nuclear energy, but the report highlights four straightforward areas that would address the problem: electrification, energy efficiency, tackling methane emissions and advancing innovation. To make all of those happen, the world needs to grow annual investment in clean energy by close to $4 trillion by the end of the decade, according to the report. “Finance is the **missing ingredient** to accelerate,” says Birol.

Looming energy crises

The analytical work that underpins the report began long before the energy crunch gripping Europe and China and threatens to spread across the globe. Nonetheless, the report warns that the energy crisis—which the IEA attributes to a rise in energy demand amid the economic recovery from the pandemic, among other things—may presage **future energy crises** that could occur if governments fail to plan carefully.

At the heart of the agency’s concern is an underinvestment in clean energy. Investment in oil and gas has stalled in a way that is consistent with **limiting warming** to 1.5°C. At the same time, spending on clean energy infrastructure remains **far below** what it needs to be, creating the possibility of **volatility** and supply disruptions much like the world is facing today. “The longer this mismatch persists, the greater the risk for increased volatility,” says Birol. “**What we need is very clear**: to increase investment in clean energy technologies.”

Even as investment in oil and gas has slowed, the IEA warns that the economic recovery from the worst of the COVID-related downturn has failed to live up to the promises of a “green recovery” that was commonly touted as governments spent trillions to help prop up their economies in 2020. Just 2% of $16 trillion spent by countries around the world on COVID economic support was spent on clean energy, according to the report. As a result, the world is now experiencing the second largest uptick in carbon emissions in history, in large part as a result of growth of coal use to power the economic recovery. “We are now witnessing an unsustainable recovery,” says Birol.

#### **Indeed,**

**Weise 24** [Zia Weise, senior reporter covering climate policy @ POLITICO & B.A. in journalism from Kingston University, 11-6-2024, Climate world absorbs a reality they’d hoped to avoid: Trump is back, POLITICO, https://www.politico.eu/article/climate-world-diplomats-donald-trump-victory-clean-energy-fossil-fuels-greenhouse-emissions/, Willie T. + sumzom]

The morning of his victory, however, officials and climate campaigners talked down Trump’s likely impact on plans to slow greenhouse gas emissions, hoping to calm nervous clean technology markets and present the transition as a **fait accompli***.*

“Those investing in clean energy are already enjoying huge wins in terms of jobs and wealth, and cheaper, more secure energy. This is because the global energy transition is **inevitable** and gathering pace, making it among the **greatest economic opportunities** of our age,” said United Nations climate chief Simon Stiell.

The challenge is that the world **isn’t moving quickly enough** to prevent dangerous global warming, and any slowdown from the world’s **second-largest emitter** — itself a major driver of the global shift to clean energy — is bound to throw a wrench into global climate efforts.

Trump hinted at what was coming in his victory speech early Wednesday morning, touting America’s abundant supplies of “liquid gold.” Addressing Robert F. Kennedy Jr., the environmental lawyer who appears likely to bring his unorthodox views on healthcare to the heart of a Trump administration, Trump said: “Bobby, leave the oil to me.”

#### **Only nuclear energy solves --- investment is key.**

**Grossi 24** [Rafael Mariano Grossi, PhD in History, International Relations and International Politics from the Graduate Institute of International Studies, 1-17-2024, 5 reasons we must embrace nuclear energy in the fight against climate change, World Economic Forum, https://www.weforum.org/stories/2024/01/nuclear-energy-transistion-climate-change/]

Globally, nuclear energy is also playing a **key role** in the transition to net zero. Fears about nuclear are slowly giving way to fact-based understanding. This year, for the first time, the document agreed at COP backed nuclear energy investment among low-emissions technologies.

One of nuclear’s key attributes is its energy intensity. A **thimble**-sized pellet of uranium produces as much energy as almost **3 barrels** of oil, more than 350 cubic metres of natural gas and about half a tonne of coal.

5 reasons we cannot ignore nuclear energy

Nuclear power, which has 20,000 reactor years of experience across the world, has five distinct advantages.

1. From cradle to grave, nuclear energy has the **lowest carbon footprint** and needs **fewer materials** and less land than other electricity source. For example, to produce one unit of energy, **solar** needs more than **17 times as much material and 46 times as much land.**

2. **Uranium in the earth's crust and oceans is more abundant** than gold, platinum and other rare metals. It is going to take us about 100 to 150 years to get through the uranium resources we deem economically recoverable today.

3. Nuclear power **doesn’t rely on the weather**. Well-run nuclear power plants, including for example those in the US, operate at least **two to three times as reliably** for two to three times as many years as intermittent low-carbon sources. As a flexible baseload for wind and solar that provides more energy when it is needed and less when it is not, nuclear power plants displace coal and enable renewables.

4. Each year, nuclear power plants produce a quarter of the world’s low-carbon electricity, saving many lives that would otherwise be cut short by the lethal pollution fossil fuels pump into the air. Nuclear energy is about as safe as solar. It is far safer than coal, gas and oil, and safer than almost every other alternative energy source.

5. It is true that spent fuel is highly radioactive and emits heat. But it is also relatively compact, and extremely carefully managed and regulated. Nuclear energy generation is so efficient that the amount of all spent fuel ever produced would — in theory — fit into 42 Olympic-sized swimming pools. Today, it is carefully stored in pools and dry storage systems or recycled. Countries like Finland and Sweden are close to putting into place deep geological repositories to dispose of spent fuel. France is also progressing in the implementation of a deep geological repository for high-level waste from spent fuel recycling.

Nuclear is one of the safest, cleanest, **least environmentally burdensome** and — ultimately, over the lifetime of a nuclear power plant — one of the cheapest sources of energy available.

But for all of nuclear energy’s positive attributes, there are hurdles to overcome. The accidents at Chernobyl and at the Fukushima Daiichi Nuclear Power Station left long shadows of mistrust and **underinvestment**. The upfront cost of building a nuclear power plant is considerable and budget overruns and long delays have made it more difficult to **gain support for new construction**.

Three levers to catalyze investment in nuclear energy

Three main levers will need to be pulled if we are to triple today’s investment levels and build the nuclear capacity that will help get us to net zero.

Lever 1: Nuclear must be acknowledged for what it is: a reliable, scalable, safe and highly affordable low-carbon source of energy. It must be treated that way when it comes to investment incentives. Today’s energy markets are not the same as those of the 1970s and 1980s. Nuclear needs private investment, even in markets where governments still take on much of the financing. Governments need to shoulder the **risk of the high capital costs at the start**. But that alone is not enough. They need to attract private financing through assured revenues and an enabling investment environment over the longer term. That means levelling the playing field nationally and internationally, including by changing the policies preventing investment in nuclear energy by many key international financial institutions and development banks.

#### **Repurposing ensures fast deployment.**

**Abdussami 24** [Muhammad R. Abdussami, M.A. in Nuclear Engineering from Ontario Tech University & PhD from University of Michigan, June 2024, Investigation of potential sites for coal-to-nuclear energy transitions in the United States, Energy Reports, https://www.sciencedirect.com/science/article/pii/S2352484724002993, Willie T.]

1.2. Literature review

The U.S. government has undertaken various initiatives to assess the potential for coal-to-nuclear (C2N) transitions at coal sites across the country. Hansen et al. drafted an extensive report for the U.S. Department of Energy (DOE) that examined key factors influencing viable transitions for a hypothetical coal plant, considered the techno-economic aspects of C2N conversions, and evaluated the potential effects on local communities during this transition (Hansen et al., 2022). Similarly, Griffith et al. investigated different nuclear reactor technologies and provided **valuable insights** into the considerations for siting and replacing coal plants with nuclear alternatives (Griffith, 2021). A few technical studies have also been carried out in the field of C2N transitions. One investigation (“Gone with the Steam How new nuclear, 2021) discovered that repurposing coal plants with advanced reactors could offer economic advantages and benefits for host communities compared to renewable energy generation. A technical report published by NuScale SMR technology highlighted the capability of NuScale SMR technology to **repurpose retired coal plants** while **ensuring the economic stability** of communities and workers (“An Ideal Solution for Repurposing U.S, 2021). Bartela et al. conducted a case study on a 460 MWe supercritical coal-fired plant in Poland, demonstrating the techno-economic benefits of replacing it with a nuclear reactor incorporating thermal energy storage (Bartela et al., 2022), (Bartela et al., 2021). Furthermore, Lukowicz et al. performed a techno-economic analysis on the same Polish coal plant, proposing the replacement of the plant's steam cycle with a small-scale modular Pressurized Water Reactor (PWR) (Łukowicz et al., 2023). Simonian et al. evaluate the potential of C2N transition at the Limestone coal plant in Texas, comparing small modular, high-temperature gas-cooled, and molten salt nuclear reactor technologies. Each technology's pros and cons are weighed against cost, risk, and C2N integration complexity. The study concludes no one-size-fits-all solution exists for C2N transitions, and specific nuclear designs and transition schemes must be carefully considered for each project based on technical specifications and feasibility (Simonian and Kimber, 2023). Notably, although these studies focused on specific candidate coal plants, comprehensive siting analyses for C2N transitions were not addressed.

The potential for advanced nuclear reactors to replace coal plants has been discussed in (“Coal-to-Nuclear Transitions, 2024), **emphasizing their compatibility** with variable renewable technologies and their capability to provide both electricity and process heat. The document (“Coal-to-Nuclear Transitions, 2024) examines economic impacts, job creation, and revenue benefits in host communities, noting **significant increases in employment and income** following a coal-to-nuclear transition. It discusses workforce requirements, educational needs, and training for transitioning workers, outlining the overlap and distinct roles between coal and nuclear plants. Policy and funding aspects, including **tax incentives** and loans, are also addressed, with a focus on achieving net-zero emissions targets by 2050 and supporting disadvantaged communities. The document emphasizes the critical role of utilities in managing transitions and presents a comprehensive outlook on infrastructure reuse and community engagement strategies for successful coal-to-nuclear conversions. In another paper, the advantages of repurposing existing site infrastructure, including transmission infrastructure, environmental permits, and water usage rights, have been examined. Repowering coal plant sites with nuclear power offers **clean, reliable, and dispatchable energy**, addressing the twin challenges of decommissioning and transitioning to low-carbon energy sources. The paper guides utilities through the key considerations and steps involved in evaluating and repurposing coal plant sites for advanced nuclear generation, focusing on the potential to retain jobs, tax bases, and community support.

In contrast to the technoeconomic analyses described above, the siting of advanced nuclear reactors within operating or retired CPPs has received relatively little attention in the literature. Belles et al. conducted an analysis using the Oak Ridge Siting Analysis for Power Generation Expansion (OR-SAGE) tool to evaluate the suitability of 13 coal power plants in the Tennessee Valley Authority (TVA) service territory for the deployment of advanced nuclear reactors (Belles et al., 2013). A similar approach was adopted in another study (Belles et al., 2021), where OR-SAGE was utilized to assess the retrofitting of advanced nuclear reactors in existing or retired coal plants. Furthermore, Omitaomu et al. employed the OR-SAGE tool to investigate the siting of advanced nuclear reactors across the contiguous United States (Omitaomu et al., 2022). In a separate study, Toth et al. employed the Advanced Nuclear Site Locator (ANSL) tool to evaluate 304 coal sites in the U.S., identifying **79** potentially feasible sites for coal-to-nuclear transitions (Toth et al., 2021). However, they reported that state-level policies could pose challenges to the demonstration of advanced nuclear reactors. Therefore, a comprehensive assessment of all coal plants in the United States, encompassing operational and retired facilities, is necessary to gain an understanding of the most suitable coal sites for transitioning to nuclear power. While the existing literature provides some valuable insights into the siting potential of advanced nuclear reactors in coal plants, the number of studies on this subject remains limited.

1.3. Contribution

This paper aims to assess the feasibility of converting each operational coal site to nuclear power using a tool called Siting Tool for Advanced Nuclear Development (STAND). The studied coal plants are classified into two different groups (Group-01 and Group-02) based on their capacity. Since advanced nuclear reactors are divided into various classes, such as micro-reactors, medium-scale reactors, and Small Modular Reactors (SMRs), it is necessary to categorize coal plants accordingly to match their capacity for a smooth transition to nuclear power. Categorization will also help in presenting the research findings and data clearly, considering the substantial amount of data involved in the analysis. To conduct this analysis, our first step was to gather information on all operational coal sites in the U.S. until January 2023. The operational coal sites are the focus of this study to **take advantage** of the existing Balance of Plant (BOP) equipment, such as transmission lines and power system protection components, which can **reduce construction time and costs**. Analyzing operational coal plants will also guide policymakers, state-level governments, and energy modelers in determining the prioritization of coal plant retirements. Furthermore, we limit our study to operational coal sites in the U.S. as many retired coal sites lack the necessary technical infrastructure for an attractive coal-to-nuclear transition. Next, we classify all operational coal sites into two clusters based on their nameplate capacity. The CPPs located in non-contiguous states (e.g., Alaska and Hawaii) are not considered due to the lack of sufficient data in STAND. Each cluster is then individually simulated in STAND using selected attribute values, as mentioned in Section 2, specifically in Table 1, Table 2, Table 3. Section 3 discusses the clustering of CPPs. Section 4 provides additional information about the STAND tool. Section 5 presents the results of the study, while Section 6 concludes the study with discussion. This paper presents a comprehensive approach for utilizing STAND in evaluating the feasibility of transitioning from coal to nuclear energy across the U.S. The detailed results and investigation will provide a clear idea on which factors one should consider for a particular region/area to C2N transitions.

#### **Peak oil guarantees economic collapse --- only accelerated transition solves.**

**Ahmed 23** [Nafeez Ahmed, PhD in International Relations from the University of Sussex’s School of Global Studies, 3-29-2023, America’s Fossil Fuel Economy is Heading for Collapse – It Signals the End of the Oil Age, resilience, https://www.resilience.org/stories/2023-03-29/americas-fossil-fuel-economy-is-heading-for-collapse-it-signals-the-end-of-the-oil-age/, tristan]

US oil production is about to peak, but the world is unprepared for the tremendous economic and political consequences. The only path through is **energy and economic transformation**.

The global economy is currently teetering **on** the **edge** of a banking crisis. The IPCC has just released its final major report warning that global carbon emissions need to peak and decline immediately if we are to avoid plunging into dangerous global warming by breaching the 1.5C ‘safe limit’. And in recent weeks and months, industry leaders have announced that the US shale oil and gas **revolution is over.**

Yet few if anyone is talking about why these things are happening at the same time, and what they really mean.

One of our biggest problems is that we tend to think in silos and sectors. But in the real world, the sectors we assume operate separately are in fact **fundamentally interconnected**. We ignore and downplay these systemic interconnections at our peril.

The persistence of global inflation has taken many economists by surprise. While they recognise that the impact of Russia’s war in Ukraine on energy and food supplies has been the biggest driver, that silo-ed assumption has led to a failure to understand why inflation is unlikely to simply disappear anytime soon.

We have good reason to believe that the underlying drivers of inflation go beyond just the war in Ukraine. Although it’s extremely difficult to quantify, climate change and environmental degradation is driving inflation by eroding agricultural productivity leading to higher food costs. The impact of extreme weather events is also creating larger and larger damages to infrastructure which in turn is incurring greater costs. As these costs feed into the system, the supply of goods and services becomes more expensive.

Less difficult to quantify is the fact that inflation is historically linked to energy price hikes. And there is mounting evidence that the world is experiencing a major shift in the global fossil fuel system that entails rising costs and diminishing returns, which will end up having a major inflationary effect for far longer and deeper than conventionally assumed.

The end of the shale boom

Since late last year, there have been a growing number of reports pointing out that the US shale revolution is coming to an end. Yet the massive global consequences of this are not being discussed.

“US Shale Boom Shows Signs of Peaking as Big Oil Well **Disappear**” read one headline in the Wall Street Journal. “The **aggressive growth era** of US shale is **over**,” Scott Sheffield, CEO of top independent shale firm Pioneer told the Financial Times. “The shale model definitely is no longer a swing producer.” And according to Bloomberg: “The specter of peak oil that haunted global energy markets during the first decade of the 21st century is once again rearing its head”.

US **industry executives are** now **openly acknowledging** that US oil production is likely to peak within the next five or six years, or perhaps in 2030. But there is mounting evidence that the peak will come much earlier, with some industry observers pinpointing its arrival as early as within the **next one or two years.**

What’s extraordinary about these admissions is how little they are impacting public debate. The implications are seismic. They contradict bullish overinflated forecasts of the industry made two decades ago – in 2005, for instance, Washington DC think-tank RAND Corp was forecasting that the US had enough shale oil to last some 400 years; and in 2012, a senior ExxonMobil executive claimed that the US has “about 100 years of natural gas supply”.

These grand claims were often breathlessly reported as unimpeachable fact by some of the most respected media institutions in the world.

Naysayers (like myself) warning that shale oil and gas would offer at best a temporary boost that was bound to peak and decline in the near-term with major global economic consequences, were dismissed as ‘doomers’.

Now, it turns out, we were right all along.

Mistakes of forecasting

That’s not to say that the traditional ‘peak oilers’ at the time were spot on. They wrongly expected that following the plateauing of conventional oil around 2005, oil prices would rocket up permanently into triple digits as global oil production would go into terminal decline. That didn’t happen. Instead, global demand shifted to the more expensive forms of unconventional oil and gas – especially US shale – which made-up much of the short-fall as conventional oil production slowed down.

But this was a recessionary environment, so global demand was much lower than expected. The massive 2005-2008 global oil price spikes helped induce a banking collapse. After the 2008 financial crash, this meant that there was much less demand for oil – but as oil production projects are planned years in advance pegged to expectations of demand, the oil just kept pumping despite much lower demand due to economic recession.

The result was a glut of shale oil and gas on world markets that allowed oil prices to drop and fuelled widespread belief in a new era of ‘Made in America’ cheap oil.

The US shale boom had a good run, no doubt about it – but its ‘healthy’ lifespan appears to be around two decades. If US shale oil and gas is about to peak and decline in the next few years, what does this mean for the US and global economy?

Coming economic contraction

Given that the US shale revolution played the key role in keeping global oil prices down and lubricating the energy requirements of continued economic activity, the retraction of the US shale revolution will have **massive economic impacts**.

US production has accounted for around **70% of the total increase** in global oil capacity since 2019, and 75% of growth in liquified gas supplies. So as US shale oil and gas peaks, plateaus and declines, global oil and gas production **will do so too very shortly after.**

Gulf oil and gas producers, however, will not be able to step-in to fill the shortfall. US oil production is currently averaging around 11 million barrels per day (mbd).

A 2022 analysis of production data among the Organisation of Petroleum Exporting Countries (OPEC) which include the biggest powerhouses such as Saudi Arabia and the UAE, suggests that the maximum OPEC could collectively increase production is around 4.5 mbd – that is, **less than half of current US shale production.**

It’s also not clear how long OPEC can deploy spare capacity to maintain maximum levels of production. This suggests that OPEC will not be able to meaningfully fill the supply gap as US shale declines, which is a clear indicator that total global oil production will eventually begin to peak and decline.

In 2017, I assessed these trends in Failing States, Collapsing Systems. I predicted that US oil and gas production would probably peak and plateau **around 2025**, and that major Middle East producers would peak and plateau around the 2030s. This scenario now appears to be **unfolding before our eyes**. Yet no one is talking about it.

The near-term **economic and financial consequences** will be devastating, and they could lead to permanent long-term consequences without significant transformative action. The impact on the US economy will be profound.

Shale production accounted for **10% of GDP growth** in the United States from 2010-2015, which means that the next decade of shale’s plateauing and decline will gradually **wipe this** out. This will be experienced as a protracted inflationary economic crisis which, in turn, will contribute to volatility in global financial markets. Pundits will likely fail to understand these systemic interlinkages, focusing instead on failing banks, financial institutions and debt, without understanding its energetic triggers.

All this implies that we are **sleepwalking into a global energy crisis** that will, without accelerating the clean transformation of the energy system, create severe economic and financial consequences by undercutting the fundamental energetic basis of global economic flows. This will compound accumulated vulnerabilities in the banking system linked to unsustainable forms of debt.

The reverberations and bailouts seen in the cases of the Silicon Valley Bank, Credit Suisse and others are merely the opening cracks, that will become widening fissures in the absence of root-and-branch economic restructuring linked to the rapid development of a new energy system.

While that new system is still emerging, it is perhaps unavoidable that we will hit a number of bottlenecks. The danger is that instead of using these bottlenecks to restructure and adapt positively, we may end up regressing, with a loss of capital and energy that forestalls the full potential of transformation.

The window for action is extremely short: we need to act within this decade. Along the way, we need to be aware of the major trends which are likely to emerge as a result of the end of the US shale boom:

1. The illusion of cheap oil is evaporating

While we may still see fluctuating prices, it is becoming clearer that the glut of cheap oil this last decade was not a permanent feature of the energy system, but a temporary symptom of highly specific circumstances as the energy system moves deeper into a state of increasing inputs and diminishing returns. The immediate impact of the peak and plateau of US shale will be sustained high oil prices.

2. The near-term beneficiaries of this will be Gulf oil and gas producers

They currently appear to be the only fossil fuel energy suppliers with sufficient capacity to maintain production. They will therefore not only begin to dominate market share, they will also of course continue to reap higher profits from this more advantageous market position amidst high oil prices.

3. Some capital will move into OPEC for safety, but this is a mirage

Just as this last decade created the illusion of fossil fuel abundance due to the US shale boom, we may see that OPEC’s near-term ability to ramp up spare capacity as shale production declines perpetuates this illusion. We can expect to see lots of bullish statements from Gulf oil producers vindicating grand plans to expand their oil and gas production. Capital will move rapidly into OPEC countries, seen as a last safe space for investors looking for stability and growth. However, OPEC producers will also begin experiencing their twilight very shortly after the decline of US shale, which means that investors will begin to make serious losses as a result far sooner than they imagine.

4. Oil prices will **fluctuate within a higher range** as US shale peaks

While we can expect significant oil price volatility due to the recessionary impact of high oil prices which would lower demand and therefore allow prices to drop, as we move further into the era of plateau and decline across US and OPEC production, the overall decline in supply is likely to lead oil price fluctuations to narrow within a far higher range which will become a ‘new normal’ as long as oil demand remains high. This may also incentivise near-term conviction in the idea that new oil and gas investments are economical. That would be a colossal mistake, though, as we will see below due to coming reductions in oil demand in the latter half of this decade that will ameliorate high prices and make fossil fuel enterprises increasingly unprofitable.

5. We can expect heightened political polarisation

Incumbent industry ideology will likely blind many energy actors from recognising the writing on the wall – which explains the regressive self-defeating actions of the Biden administration in committing to Arctic drilling. This is like betting on the losing horse after being told it’s about to be overtaken by cars. It illustrates the power of America’s oil lobbies in their last ditch desperate attempt to stay alive on the back of taxpayer subsidies – flying in the face of hard economic realities (a few years ago I broke the story of the British military study which concluded that Arctic drilling was pointless for economic reasons because the costs are so high and returns so low as to make it commercially infeasible). That in turn suggests the political battleground between fossil fuel lobbies and clean energy advocates will become more fraught as the incumbency seeks to double-down in demanding more government subsidies. **Millions of jobs** will be at risk as the US shale industry declines, and this could create further negative economic and cultural consequences as the US returns to net import status.

6. Clean energy transformation will be critical to stabilise the global **economy and restore prosperity**

The **only viable pathway** through this crisis will be to accelerate the clean energy transformation focused on the deployment of exponentially improving technologies which are already scaling because they are cost-competitive with fossil fuels – namely, solar, wind and batteries. This will lay the groundwork for other potential applications such as e-fuels or green ammonia from green hydrogen. This transformation is already underway, and provides the opportunity for the US and others to produce larger quantities of energy at a fraction of the costs of fossil fuels. In Rethinking Climate Change, a RethinkX report for which I was contributing editor, we found that even in the absence of appropriate policy-decisions and major institutional barriers, economic factors will inevitably drive incumbent industries to collapse by 2040 as they are replaced by new solar, wind and battery systems. Unfortunately, while this is far faster than conventional analysts acknowledge, this is **not fast enough** to avoid dangerous climate change.

#### **It’s irreversible, and instant.**

**Towne 09** [Gorden Towne, scholar @ Boston University A&S Writing Program, 2009, Peak Oil: Priorities in Alternative Energy Development, Boston University, https://www.bu.edu/writingprogram/files/2009/11/wrjournal1towne.pdf, Willie T.]

As more oil is extracted from existing wells, it also becomes **more difficult** to locate the remaining oil deposits. Newly discovered oil fields generally contain **significantly lower quantities** of oil than past discoveries, based on the principle that the bigger deposits are easiest to find, and thus were found and harvested first. Thus, the problem of diminishing oil production from a single field over time is compounded by the fact that it becomes **increasingly costly** to locate progressively smaller oil deposits. Modern oil exploration is conducted using **seismic detectors** aboard large trucks or **ocean-going ships**.11 These oil-prospecting vehicles have **high operating costs** per unit area explored, so as oil becomes more scarce, the overhead cost for locating any one deposit increases. When oil becomes sufficiently scarce and expensive to locate and extract, the amount that can be produced will begin to decline year over year. The point of transition from increasing to decreasing production is known as the oil peak.

The economic, political, and sociocultural implications of peak oil, when it occurs, will be **dramatic and pervasive**. At the peak and **immediately thereafter**, burgeoning world oil demand will surpass the quantity that can possibly be supplied. This discrepancy will cause the cost of oil to **skyrocket**, which will be readily visible in the price at the pump. Because transportation is embedded in the cost of nearly all goods and services, rising fuel costs will place direct **pressure on a broad range of businesses**. This effect will manifest itself in increasing unemployment, along with rising consumer costs in everything from food to clothing and electronics. Domestically, the resulting ripple effect will be sufficient to set the economy on a **cycle of stagflation**, that is, simultaneous economic recession and monetary inflation. On its surface, this is not dissimilar from the effects of previous oil shortages, most notably that resulting from the **OPEC embargo** of the **early 1970s**.1213 In this instance, a temporary, artificial supply shortage was sufficient on its own to catalyze a cycle of stagflation, sending the U.S. economy into recession. In the case of peak oil, however, once this cycle begins, oil production will only continue a downward trend. In an unmitigated situation, this will cause the supply-and-demand discrepancy to grow ever wider. Where previous fluctuations in oil supply have triggered cyclic rises and falls in domestic economic health, problems spawned by falling oil supply will only worsen as production continues to decrease.

#### **Nuclear energy insulates shocks.**

**Lee 10** [Chien-Chiang Lee, Professor of Finance @ National Sun Yat-sen University (Kaohsiung, Taiwan) & Ph.D. in International Economics @ Chung Cheng University, 6-24-2010, Nuclear energy consumption, oil prices, and economic growth: Evidence from highly industrialized countries, Energy Economics, https://sci-hub.ru/10.1016/j.eneco.2010.07.001, Willie T.]

This study utilizes the Johansen cointegration technique, the Granger non-causality test of Toda and Yamamoto (1995), the generalized impulse response function, and the generalized forecast error variance decomposition to examine the dynamic interrelationship among nuclear energy consumption, real oil price, oil consumption, and real income in six highly industrialized countries for the period 1965–2008. Our empirical results indicate that the relationships between nuclear energy consumption and oil are as substitutes in the U.S. and Canada, while they are complementary in France, Japan, and the U.K. Second, the long-run income elasticity of nuclear energy is larger than one, indicating that nuclear energy is a luxury good. Third, the results of the Granger causality test find evidence of unidirectional causality running from real income to nuclear energy consumption in Japan. A bidirectional relationship appears in Canada, Germany and the U.K., while no causality exists in France and the U.S. We also find evidence of causality running from real oil price to nuclear energy consumption, except for the U.S., and causality running from oil consumption to nuclear energy consumption in Canada, Japan, and the U.K., suggesting that changes in price and consumption of oil influence nuclear energy consumption. Finally, the results observe transitory initial impacts of innovations in real income and oil consumption on nuclear energy consumption. In the long run the impact of real oil price is relatively larger compared with that of real income on nuclear energy consumption in Canada, Germany, Japan, and the U.S.

1. Introduction

During the two energy crises in the 1970s, the price of oil **doubled, even tripled** in some countries, resulting in an increase of production cost and sharply reducing export competitiveness, which may have reduced imported-energy-dependent countries' economy performance and international competitiveness. Fossil fuels including coal, oil, and gas nowadays provide **85% of energy needs**, and fossil-fuelled economic growth is the **main factor for global warming** through the release of carbon dioxide (CO2) into the atmosphere. In December 1997 the third session of the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan adopted the Kyoto Protocol. Annex I countries agreed to reduce their collective greenhouse gas emissions by 5.2% from their 1990 level by 2008 to 2012. The U.S. President Obama's New Energy for America plans to reduce 10 million barrels of oil consumption per day by 2030 and to cut the country's collective greenhouse gas emissions by 80% from the 1990 level by 2050.

To combat these energy and environmental configurations, one of the important priorities of energy and environmental policy is to **diversify the sources of energy** and to find a **secure, cheap, and nonGHG**-emitting energy supply (Fiore, 2006; Vaillancourt et al., 2008; Wolde-Rufael, 2010). As noted by the International Energy Agency (IEA, 2008), nuclear energy may **answer these conditions**, as it **reduces the instability** of oil prices, the dependence on oil imports for many countries, and greenhouse gas emissions. Therefore, nuclear energy (non-carbon energy) may be a **crucial substitute** energy for oil, and whether imported-energy-dependent countries can adopt nuclear energy to replace the majority of fossil fuels in their economy has become an important issue

#### **Absent action, world war ensues.**

**Bunzel 18** [Theodore Bunzel; Head of Lazard Geopolitical Advisory; 5-30-2018, "Do High Oil Prices Mean More International Conflict?", American Interest, https://www.the-american-interest.com/2018/05/30/do-high-oil-prices-mean-more-international-conflict/] sumzom

Does the relationship between oil prices and Russian behavior to which Bush alluded hold true? The higher the price of oil, the more aggressive Russia becomes? And what about other petrostates? Might it be true for those as well?

We may soon have more evidence for the proposition. Oil prices are brushing off 2016 lows and hitting three-year highs. Brent crude has been hovering above $70 a barrel since April, up from lows of around $30 in early 2016, fueled by OPEC production cuts and rising geopolitical tensions (over issues like the Iran deal). Though nuances, complications, and exceptions abound, the academic and historical evidence on balance tells us that, as we transition from a lower to a higher oil price regime, we can generally expect a darker geopolitical outlook. As rising oil revenues gives Russia, Saudi, Iran, and other oil-exporters an **added sense of confidence**, it may at least selectively inflame interstate tensions and lead to more aggressive behavior. That possibility, alongside an increasingly **hawkish U.S. national** security team and a President who appears to feel rather “unchained” of late, points to a potentially combustible mix just ahead.

It is generally taken for granted that aspects of geopolitics can function as a key input into oil prices. Trump’s mere threat of a U.S. strike in Syria, for example, caused oil to spike by 2 percent on April 11. In addition to short-term effects, geopolitical competition can influence prices in other ways. To give just one general example, as Soviet power spread into parts of the Third World after the independence era, some states felt safer nationalizing their oil industries to escape Western company control (Iraq in 1961, for example), and prices rose as a consequence.

But the relationship may also work the other way around: Oil prices can also be a key input into geopolitics. Many studies have demonstrated that oil prices have a direct effect on the domestic stability of petrostates. This makes ample intuitive sense: Higher prices **fill public coffers**, allowing governments to **palliate needy populations** and **potential elite opposition groups** by dispensing more largesse. Some regime elites may reason that a firmer grip on power may free them to carry out more assertive foreign policies without fear of being undermined at home.

There are, however, several complications to this general intuition. Some states already have sufficiently buoyant revenues relative to their small populations to satisfy their publics and feed clientelistic networks. Providing largesse can also backfire if prices drop; taking away something valuable that people have grown used to is a dangerous game, especially when elites aren’t ready to play it. And then of course there is the famed “oil curse”: For all sorts of reasons, from “Dutch disease” economic distortions to the derangement of normal citizen-state relationships, oil riches can in time undermine regimes, weakening and even destroying them.

That said, a more recent body of research has empirically demonstrated the intuitive twin of this conclusion: Higher prices cause greater interstate aggression by oil-producing countries. Why would this be the case? Greater oil revenue flushes petrostates with confidence and also cash that they can put toward military spending or foreign adventures. To take one obvious example, we need only look to Iran’s using its oil revenue to **fund proxy groups** such as Hamas and Hezbollah. Furthermore, military spending by one regional oil producer can beget spending by others, fueling regional **arms races** that can make **aggression** and conflict by **miscalculation** more likely. The onset of the **Iran-Iraq War** in September 1980 may be a **prime example** of that dynamic.

Most prominent among the empirical studies is Cullen S. Hendrix’s 2014 paper, which shows a statistically significant relationship between higher oil prices and “dispute behavior” (military actions short of actual war) by oil-exporters. (Hendrix also summed it up nicely in this Washington Post piece.) He found that “all things being equal, a one standard deviation ($18.60) increase in the price per barrel of oil from the sample mean ($33.81) is associated with a **13 percent** increase in the frequency of [dispute behavior]” in oil-exporting states. He also found that, above $77 a barrel, oil-exporters are significantly more dispute prone than non-oil exporters.

Hendrix also explores the potential complication of reverse causality: Could dispute behavior by oil-exporting countries be driving prices higher, rather than the other way around? A key analytical consideration here is timing. We can all agree that geopolitical activity affects prices in the short-term (such as the Syria example mentioned above), but is this reverse causality true on a sustained basis? Parsing out long-term signal from short-term noise, Hendrix examines whether elevated aggregate dispute behavior affects oil prices at the yearly—rather than daily or weekly—level, and finds that this relationship does not hold. His explanation here is that other players typically step in to redress markets: “While dispute behavior may drive prices changes in the short term . . . the **strategic significance** of oil prices and oil-exporting states encourages major powers to act in ways that stabilize markets, either through market intervention . . . or **direct, armed intervention**.”

Jeff Colgan of Brown University has also touched on this topic, finding through his research that oil has fueled—in some way—**one quarter to one half of interstate wars since 1973**. He also notes that oil-producers are **50 percent more likely** to engage in conflict than non-oil producers. Colgan identifies eight, non-mutually exclusive causal mechanisms for how oil fuels international conflict, most of which are **implicitly exacerbated** by higher prices. They are: “(1) **resource wars**, in which states try to **acquire oil reserves by force**; (2) petro-aggression, whereby oil insulates aggressive leaders such as Saddam Hussein or Ayatollah Ruhollah Khomeini from domestic opposition and therefore makes them more willing to engage in risky foreign policy adventurism; (3) the externalization of civil wars in oil-producing states (“petrostates”); (4) financing for insurgencies—for instance, Iran funneling oil money to Hezbollah; (5) conflicts triggered by the **prospect of oil-market domination**, such as the U.S. war with Iraq over Kuwait in 1991; (6) clashes over control of oil transit routes, such as shipping lanes and pipelines; (7) oil-related grievances, whereby the presence of foreign workers in petrostates helps extremist groups such as al-Qaeda recruit locals; and (8) oil-related obstacles to multilateral cooperation, such as when an importer’s attempt to curry favor with a petrostate prevents multilateral cooperation on security issues.”

Though he doesn’t substantiate statistically that higher prices lead to more conflict through these channels, he implies it heavily. For example, he writes that, “the low oil prices of the 1990s have given way to higher and more volatile prices, increasing the magnitude of the consequences one can expect from oil-conflict linkages.”

While the emerging academic evidence may validate the claim that higher oil prices lead to more aggression, the historical and anecdotal evidence is somewhat mixed, and understandably so. Oil price is clearly only one of many inputs into foreign policy decision-making, and an indirect one at that. No leader thinks, “Now that oil is at $X, I’m going to invade my neighbor.” Context obviously matters, too: No one imagines that Ecuador or Norway is going to invade or try to blackmail a neighbor just because spot prices rise 15 or 30 percent in a given six-month period. Price levels seep into decision-making more subtly, affecting interlocking beliefs about strategic behavior generally and specific cases more particularly; they may fuel self-confidence by shoring up budget outlooks and funding the tools of more aggressive behavior in contexts where such behavior could conceivably make sense.

Moreover, there are many contravening (and occasionally countervailing) complications. Prominent among these is the fact that low oil prices can incentivize states to “wave the flag” in order to distract from domestic difficulties—so the impact of low oil prices might lead to more aggressive behavior in some cases. That suggests that neither high nor low prices per se may be the trigger affecting behavior, but rather notable changes in price that become politically salient in one way or another.

And there’s also the tricky issue of timing: Over what timeframe does increased oil revenue fuel aggression? Is it in anticipation of higher prices, in direct response to the current pricing levels, or is there more of a lag in effect as oil revenue slowly shores up—or is expected to shore up—budgets and military spending over time? The answer might depend on specific cases and leadership cadres.

There is also a scaling problem. If a 20 percent rise in oil prices makes a more assertive foreign policy more likely in a given country, does a 40 percent rise make it twice as likely? Or put differently, how much of a difference in price, and presumably in expected revenues, does it take to cross a threshold where it might have an impact on decision-making? Are there multiple thresholds?

Russia **exemplifies these issues**. Taking the same long view as George W. Bush in his interview, it seems self-evident that rising oil prices and higher government revenues over the course of the 2000s **gave Putin confidence**, funded military expansion and modernization, and helped enable Russia’s **most revanchist tendencies**. Between 2003 and 2013, **Russian military expenditure doubled** as the price of Brent crude rose from a low of around $20 a barrel in 2001 to a high of more than $140 a barrel in 2008. Russia, as the saying goes, is a gas station with nuclear weapons; a higher pump price thus means more weapons, nuclear and otherwise.

But when you cross reference this conclusion with specific acts of Russian aggression over the past roughly twenty years, the picture gets much more complicated. When Russia invaded **Georgia** in August 2008, oil was above $100 a barrel. Same with **Russia’s invasion of Crimea** in 2014. But Russia also dramatically intervened in Syria in September 2015, when oil had dropped to around $50 a barrel and the economy was sputtering due to both low energy prices and Western sanctions. Here, many analysts plausibly described these interventions as a way of rallying Russians to the flag and distracting them from domestic hardship. More likely, Putin saw an emergency in Syria that simply had to be dealt with, no matter the cost or risk; the Assad regime was in danger of collapsing, and Syria is Russia’s only ally offering ports and bases in the Mediterranean basin. So Russia is a bit of a mixed bag, but on balance its behavior—especially over a long timeframe—appears to support the thesis.

Saudi Arabia’s role in the 1973 Yom Kippur war also illustrates the tricky question of timing. Saudi funding of the effort was enabled by a financial buffer created by a rise in revenues from the late 1960s, and was likely justified by an expected rise in revenues due to an oil price increase that was anticipated, in part, because of the very war it was in the process of financing. Its reserves had already grown so large that, for the first time, Saudi Arabia could ride out a supply (and revenue) disruption and still finance a war. But the Saudis helped finance a war that they themselves did not participate in. So if rising oil prices led to greater interstate aggression, it did so in this case in a particularly indirect way.

These are all interesting and important nuances that attenuate any direct causal connection one might be tempted to draw between oil prices and conflict. So it would be nice to know if historical studies have shown any significant statistical relationship between fluctuations in key sources of government revenue (and what memoirs and archives tell us about how those situations were perceived) and interstate behavior. It would be even nicer to drill down into such studies to find cases where specific lucrative commodities—for example, European colonial profits such as from British opium sales in China, or cotton grown in Egypt—made any difference in the behavior of the relevant governments. Alas, such studies do not exist.

But regardless of the timeframe and mechanism, academic and historical studies alike do suggest that higher oil prices have generally lead to more aggressive, or at least riskier, behavior in recent decades—whether in anticipation of higher prices, immediately in their wake, or only after sufficient revenue stores are built up.

So are we at a point in the energy price cycle where, all else equal, we should expect greater interstate conflict? We’re close to Hendrix’s $77 a barrel threshold, above which oil-exporters are significantly more dispute-prone than non-oil exporters. But given the nuances just described, this specific price threshold is probably too cute. The more realistic argument to make is about the effect of a higher-price vs. lower-price paradigm over a multi-year horizon (particularly in light of the timing issue and potential lag). And if the period of the past two years (when Brent largely hovered between $40 and $60) was a lower-price paradigm, 2018-19 is potentially gearing up to be a higher-price paradigm driven by continued supply cuts by OPEC, tight global inventories, and—in a coincidental way—heightened geopolitical risks. We’ll see how these factors play out, but if oil prices remain elevated we may begin to subtly feel their effects on behavior by Iran, Saudi Arabia, Russia, and perhaps others.

None of this is to say that oil prices are the most important factor in the geopolitical outlook over the near, medium, or long-term. The reputed hawkishness of Mike Pompeo and John Bolton, the effect of the upcoming mid-term elections on Trump’s decision-making, and reactions to potential exogenous shocks (for example, a major clash in Syria between U.S. or Israeli and Iranian or Russian forces) will play a much more direct and important role in shaping the geopolitical landscape. But a higher oil price regime (if it holds) could well make petrostates like Iran, Saudi, and Russia more aggressive—either in **challenging the United States and Europe** in the case of Russia, or by exacerbating ongoing proxy conflicts in and around the Middle East in the cases of Iran and Saudi Arabia. Given these and other dynamics, we should expect a bumpy ride ahead.

## **2AC**

#### **Tech and adaptation solve**

Matthew **Child 09**, 1/xx/2009, Putting ‘Ecosystem Services’ in Their Place, http://www.conservationtoday.org/index.php?/Editorials/Matt-Child/Putting-the-ecosystem-services-argument-in-its-place.html)// JZ

**Society can get along just fine without biodiversity.** “What?! Are you high? What’s the matter with you?!” I hear you think to yourselves reservedly. But ponder it for a second: **even if we were to live in a world in which there was no longer biodiversity but some minimum level of ‘biodeficiency’** (perhaps a few plants and a few sparrows and whatever), **technology and human industriousness could** plausibly **allow us to exist on this Earth for posterity.** The advent of scenario planning has helped elucidate this possibility by imagining landscapes covered by ‘technogardens’, complete with control towers that mimic the necessities of the seasons1. In this kind of scenario, ecosystem services are created and controlled by the human endeavour. And ecosystems would be human products, subject to the same industrialisation as the panoply of our packaged lives. Such ‘efficiencies’ of land use would theoretically allow society the luxury of setting aside the remaining land for nature reserves and parks. But would we actually do that? Having finally been convinced that nature is merely utilitarian, ironically by those conservationists whose original intention was to demonstrate the opposite, it’s doubtful whether the public would put up much resistance if the remaining land were annexed by Technogarden Inc. (Whose slogan would probably be: Why leave nature to chance?) There is also no real precedent to believe that governments and industry leaders would stick to a ‘land sparing’ arrangement even if some people did decide that Wilderness (I capitalised to give it a mystical pronoun sort of feel) is invaluable. Take the contemporary example of developing-world agricultural systems: the question is whether to promote ‘wildlife friendly’ farming (a kind of integrated eco-agriculture) or ‘land sparing’ techniques (here: farm; there: nature). Research is beginning to show that land sparing is probably better for biodiversity (Ben Phalan, unpublished data), especially species sensitive to disturbance (which are most of the cool ones). So cordon off pieces of land, farm the living daylights out of it, and then leave the rest for wildlife. Well, yes. However, developing world citizens and their governments probably won’t see it that way. Just ‘leaving’ land alone for nature is anathema to anyone who doesn’t own an iPod. The truth of the matter is that, no matter how we spin it or how many justifications we give for land to be left alone to produce ‘services’, optimisation will only ever lead to optimisation. It’s the eerie way in which we’re wired: the evolutionary residue of our hoarding Pleistocene past interacting with the neon-emblazoned signs and symbols of society urge us to consume ever greater amounts. Such blatant obsession with material wealth only promulgates Thoreau’s dread observation that “fruit is not ripe until turned to dollars”. Inadvertently, the value-laden ecosystem service argument for conservation will only lead to a more impoverished world. Search your feelings: you know this to be true. By reducing nature to dollar signs destined for the cold quarantine of appraisal, we slick the conveyer belts of industrial progress. There is no way we can create a paradigm shift in the consumer conscious if we concede that ecosystems and economics exist on the same scale. The problem is twofold: firstly, if we agree that species can be valued then it can be deduced that most species are not valuable. (That’s pretty catchy, right? Maybe it’ll become a marketing campaign for Technogarden Inc.). **The majority of ecosystem services are provided by a core group of species that fulfil basic functional criteria2. And there’s no real naming of names when it comes to species and ‘services’**. In practical terms, this means that **most species can be substituted and the ‘services’ we so cherish will still be delivered.** It also means that **rare and endangered species are probably not worth the ‘cost’ of protecting because they fail to effectively** (and consistently) **produce an anthropocentric service**. “But what about keystone species?!” I hear you cry in anguish, “They’re pretty cool and can’t really be substituted!” No, they can’t really. It’d be tricky at the very least. But I’m going to say something controversial right now, brace yourselves: **the consequences of losing keystone species exists on a scale below the potential of the human endeavour to engineer solutions. Most species losses have severe ecological repercussions, this much is definitely true. But it’s probably a safe bet that, in reality, very few of these cases would translate into tangible disadvantages for humans.** Don’t get me wrong, services like flood abatement, water purification, fibre production and so on are important. But their resilience and quality is mostly determined by sound land management (burning regimes, erosion control, stocking rates), and has little or nothing to do with what most people think of when they hear the word ‘biodiversity’: birds and animals. (The ‘charismatic megafauna’, to give it a buzz phrase spin). **Ecosystems services are real and important but most of them can be produced and managed at the producer trophic level.** Bird and animal diversity is far more important for sustaining and creating biodiversity (in terms of ensuring ecological relationships and maintaining evolutionary connections). This is an important argument if we recognise and want to convince others of our role as stewards of life. But it is dishonest and ultimately destructive to the conservation movement to try and shove the ‘biodiversity’ concept into what is already a pretty shallow economic framework. Unless we are, of course, speaking about (drum-roll) the greatest hoax of all: “Existence Value”!

### **AT: RWT**

#### **Terrorists can’t do anything with uranium or waste.**

**Calma ’24** [Justine; Senior Science Reporter @ the Verge; July 20 Verge; “High hopes and security fears for next-gen nuclear reactors,” https://www.theverge.com/24201610/next-generation-nuclear-energy-reactors-security-weapons-proliferation-risk; DOA: 3-23-2025] tristan \*\*brackets r og\*\*

That 20 percent threshold goes back to the 1970s, and bad actors ostensibly have more information and computational tools at their disposal to develop weapons, Kemp and his coauthors write in the paper. It might even be possible to craft a bomb with HALEU well under the 20 percent threshold, the paper contends.

Fortunately, that would still be incredibly difficult to do. “This is not minor theft,” says Charles Forsberg, a principal research scientist at MIT and previously a corporate fellow at Oak Ridge National Laboratory. A group might have to steal a couple years’ worth of fuel from a small advanced reactor to make the kind of bomb described in the paper, he says.

Even with a working weapons design, he says it would take a sophisticated team of at least several hundred people to go through all of the steps to turn that fuel into uranium metal for a viable weapon. “Unless they’re a whole lot better than I am, and the colleagues I work with, a subnational group [like a terrorist group] doesn’t have a chance,” he tells The Verge.

#### **Domestic terrorist groups lack the organizational capacity.**

Arie **Perliger 20**, 6/28/2020, Writer for the conversation, The 'domestic terrorist' designation won't stop extremism, The Conversation, https://archive.is/t5iFb)// JZ

A federal law and a presidential executive order allow the government to designate groups as foreign terrorist organizations. Most scholars agree that some American far-right groups are involved in foreign conflicts, and others communicate with foreign groups. But that is not enough to be considered a foreign organization: American extremists do not have permanent logistical, operational and leadership apparatus abroad.

The law, or the executive order, could be revised or replaced in ways that would cover U.S.-based groups. But the real problem is that designating specific groups as terrorists doesn’t actually curb terrorism. Too little organization Many acts of far-right violence are perpetrated by individuals, not organized groups. These people may be loosely associated with, or perhaps supporters or online followers of, far-right movements. But they usually operate independently, without help or involvement from others. My research has shown that in many cases, the acts of violence.

In any case, the two major contemporary extremist movements which attracted calls to designate them as terrorist organizations, and , both lack any hierarchy or central coordination and, therefore, don’t fit the criteria of a formal organization.

No real effect on operations There are several organizations that the U.S. has designated as “terrorists” over the years – including Hamas, Hezbollah, FARC, Lashkar-e-Taiba and the Islamic State group and its affiliates. Being named to the list subjects a group and its supporters to certain legal, administrative and financial sanctions: Americans who give them money, for instance, can be imprisoned. Non-Americans who are deemed members can be deported from the U.S. or denied permission to enter the country. Banks can be ordered to seize the group’s funds.

#### **Advanced reactors solve.**

**Rehm ’23** [Thomas; Ph.D. in chemical engineering from Northwestern University; March; Science Direct; “Advanced nuclear energy: the safest and most renewable clean energy,” https://www.sciencedirect.com/science/article/pii/S2211339822000880; DOA: 3-4-2025] tristan \*\*brackets r og\*\*

Although legacy nuclear energy has been the safest form of electricity generation, it has been demonized as unsafe since the 1960s. The three well-known nuclear accidents, Three Mile Island, Chernobyl, and Fukushima, were legacy nuclear designs. Even with the best safety record of all types of electricity generation, it is time to move away from legacy nuclear to reap the benefits of a truly renewable source of safe clean energy, advanced nuclear. Solar and wind cannot hold a renewable candle to the vast renewable potential of advanced nuclear energy. The transition to carbon-neutral energy can best be made with advanced nuclear, in safety, waste minimization, true renewability for thousands of years, process heat for manufacturing, and a viable means of replacing our chemical manufacturing dependence on fossil fuels. Some of my colleagues tell me, “There are few opportunities for chemical engineers in nuclear”. I disagree. Opportunities include design and operation of high-temperature (550–750 °C) plants involving molten salts, liquid metal, and helium; application of this high-temperature capability for industrial process heating; recycling legacy nuclear ‘waste’ to provide fuel for advanced reactors; integration of the hydrogen economy into nuclear plant design and operation; improvement in moving pebble-bed advanced reactor technology; mining improvements for uranium and thorium, including mining uranium from seawater; molten salt storage systems for improving load following functionality and to provide process heat functionality; resolving corrosion challenges in molten salt reactors; and retrofitting existing oil-and-gas-based refineries to operate as nuclear biorefineries.

Introduction

Renewables are considered by many to be the solution to global warming. Yes, they can contribute. However, without advanced nuclear energy, we will not solve global warming.

Nuclear energy is much safer than solar and wind renewables and has a lower life cycle carbon footprint. The disadvantage of nuclear is its long-lived nuclear waste. To decay to a nominal background level, legacy spent-nuclear fuel requires tens of thousands of years. This paper argues for advanced nuclear, whose much smaller amount of nuclear waste (about 1% of legacy) will decay to background levels in about 400 years [1].

It is important to note that legacy nuclear waste has minimal risk associated with it [2]:

There is not much of it. All the nuclear fuel waste generated thus far, on the planet, could be stacked onto one football field to a height of about 30 feet.

It is a solid, in small pellets contained in metal rods, stored inside ultrastrong 50-ton containers.

With advanced nuclear, this minimal risk is reduced further (Table 1).

<<TEXT CONDENSED, NONE OMMITTED>>

Table 1. Vital statistics for renewables (solar/wind) versus nuclear (legacy/advanced).¶ Solar and wind are not really renewable on a 200-year timescale. Neither is legacy nuclear via current land-based uranium mining. Arguments have also been made that legacy nuclear is not safe.¶ Advanced nuclear technology is far safer than legacy nuclear. The current widespread fear of nuclear, which is based on legacy nuclear accidents, is unwarranted [11]:¶ There were no deaths and no negative health effects from the trivial radiation release from the Three Mile Island accident.¶ At Fukushima, one power plant worker involved in recovery died. There were no deaths or incidents of medical harm to any member of the public from radiation exposure. Four years later, thorough medical examinations were given to evacuees from the designated exclusion zone and many concerned residents from outside the exclusion zone. Nearly a third of a million children who were age 18 or less at the time of the accident were screened for thyroid issues. The rate of thyroid anomalies in Fukushima children was less than in other children in Japan.¶ Chernobyl was a poorly designed light water boiling reactor susceptible to thermal runaways. Reported fatalities ranged from 50 at Chernobyl to several thousand offsite [12]. Following the Chernobyl accident, other Russian RBMK designs were modified to improve safety. Some RBMK plants have been shut down but not all. No nuclear plants have been built with this design outside of the Russian federation [13].¶ Advanced nuclear technology¶ There is only one naturally occurring fissile isotope, Uranium-235 (U235). In a nuclear reactor, U235 atoms split and produce heat.¶ There are two naturally occurring fertile isotopes, Uranium-238 (U238) and Thorium-232 (Th232). They will not split until they first transmute to fissile isotopes via neutron capture, which does not occur to a significant extent in a legacy reactor. In an advanced reactor, U238 and Th232 transmute to fissile isotopes Pu239 and U233, which then split to produce heat.¶ As with any new technology, there are challenges associated with Th232, including the production of a small amount of U232 contaminant in the transmutation of Th232. The decay of U232 produces very penetrating gamma rays. These gamma rays are hard to shield, requiring more expensive spent fuel handling and/or reprocessing [14], [15].

<<PARAGRAPH BREAKS RESUME>>

Key distinctions between legacy technology and advanced technology:

A legacy reactor is designed at about 2000 psig. An advanced reactor is designed at near-ambient pressure as the normal boiling points of heat-transfer media exceed 1200 °C. A huge gain in safety.

A legacy reactor operates at about 290 °C. An advanced reactor operates at 550–750 °C, creating a much larger temperature difference with the environment, which allows more options for passive decay–heat removal systems. A huge gain in safety.

Advanced reactors operating at 550–750 °C allow for industrial process heating [16], [17].

Most legacy fuel is U238, which becomes nuclear ‘waste’ in legacy reactors. In advanced reactors, U238 transmutes to Pu239 that ‘burns’ along with U235, resulting in a waste volume of less than 1% of that from legacy reactors. A huge gain in safety.

‘Waste’ from legacy reactors requires tens of thousands of years to decay. Waste from advanced reactors requires about 400 years. A huge gain in safety.

#### **Their link evidence is specific to dirty bombs which their ev concedes is insignificant --- doesn’t trigger impact which is in the context of launching nukes**

**1NC NAE** (The National Academy of Engineering (NAE) is an American nonprofit, non-governmental organization. It is part of the National Academies of Sciences, Engineering, and Medicine (NASEM), along with the National Academy of Sciences (NAS) and the National Academy of Medicine (NAM), September 16, 2019, National Academy of Engineering , “Prevent Nuclear Terror”,https://www.engineeringchallenges.org/challenges/nuclear.aspx, DOA 3/10/25) KC

Besides uranium, another serious concern is the synthetic radioactive element plutonium. Produced by the nuclear “burning” of uranium in reactors, plutonium is a radioactive hazard in itself and also an ideal fuel for nuclear explosives. Worldwide, more than 1,000 reactors operate nowadays, some producing electric power, others mostly used for research. Plutonium produced in either reactor type could be extracted for use in weapons. Nuclear security therefore represents one of the most urgent policy issues of the 21st century. In addition to its political and institutional aspects, it poses acute technical issues as well. In short, engineering shares the formidable challenges of finding all the dangerous nuclear material in the world, keeping track of it, securing it, and detecting its diversion or transport for terrorist use. What are the challenges to preventing nuclear terror attacks? Challenges include: (1) how to secure the materials; (2) how to detect, especially at a distance; (3) how to render a potential device harmless; (4) emergency response, cleanup, and public communication after a nuclear explosion; and (5) determining who did it. All of these have engineering components; some are purely technical and others are systems challenges. Some of the technical issues are informational — it is essential to have a sound system for keeping track of weapons and nuclear materials known to exist, in order to protect againsttheir theft or purchase on the black market by terrorists. Another possible danger is that sophisticated terrorists could buy the innards of a dismantled bomb, or fuel from a nuclear power plant, and build a homemade explosive device. It is conceivable that such a device would produce considerable damage, with explosive power perhaps a tenth of the bomb that destroyed Hiroshima. With help from renegade professional designers, terrorists might even build a more powerful device, equaling or exceeding the force of the Hiroshima bomb. Detonated in a large city, such a bomb could kill 100,000 people or more. Building a full-scale bomb would not be easy, so terrorists might attempt instead to cause other forms of nuclear chaos, possibly using conventional explosives to blast and scatter radioactive material around a city. Such “dirty bombs” might cause relatively few immediate deaths, but they could contaminate large areas of land, cause potential economic havoc to the operation of a city, and increase long-term cancer incidence. There are millions of potential sources of radioactive material, which is widely used in hospitals, research facilities, and industry -- so preventing access is extremely difficult. Responding to a “dirty bomb” attack would also involve engineering challenges ranging from monitoring to cleanup, of both people and places. Concern for nuclear security complicates the use of nuclear energy for peaceful purposes, such as generating electricity. Ensuring that a nation using nuclear power for energy does not extract plutonium for bomb building is not easy. Diversion of plutonium is much more difficult when a country opts for a “once through” fuel cycle that keeps the plutonium with the highly radioactive spent fuel, rather than a “closed” fuel cycle where spent fuel is reprocessed and plutonium separated out. Simple record keeping could be faked or circumvented. Regulations requiring human inspection and video monitoring are surely not foolproof.

### **AT: Oil**

#### **The uniqueness overwhelms the link---Iran potentially developing nukes and a volatile Middle east means the U.S. will always maintain presence---squo proves.**

**Scharf ’25** [Avi; April 2; Haaretz; “Record-breaking U.S. deployment in Middle East amid Trump's nuclear ultimatum for Iran,” https://www.haaretz.com/israel-news/security-aviation/2025-04-02/ty-article/record-breaking-u-s-deployment-in-middle-east-amid-trumps-nuclear-ultimatum-for-iran/00000195-f5a6-d470-addd-f5ee0fd70000; DOA: 4-5-2025] tristan

These technological solutions have allowed producers to increase production rates for rigs as they drill new wells. Improved performance is particularly evident in the Permian region, where we observed a 9% year-over-year increase in November’s crude oil productivity per active rig.

The U.S. military has carried out its largest offensive deployment to the Middle East since the Israel-Hamas war began in October 2023, according to a Haaretz analysis of open-source aviation data.

In recent weeks, Washington has sent squadrons of fighter jets, stealth bombers and large quantities of weaponry to the region – amid its ongoing campaign in Yemen and ahead of the ultimatum issued by President Donald Trump to Iran over its nuclear program.

At least 140 heavy transport aircraft landed in Qatar, Bahrain, the United Arab Emirates, Saudi Arabia, Kuwait and Jordan during the month of March, originating from several key U.S. military bases. Most were loaded with equipment, according to data transmitted mid-flight.

Since the outbreak of Israel's war with Hamas and Hezbollah, the United States has deployed significant forces to the region and launched an airlift of weapons and equipment to Israel – particularly during the war's first weeks, and around the two major Iranian missile attacks on Israel last April and October.

This new buildup, first reported by Haaretz last week, marks a roughly 50 percent increase over the previous monthly peak in U.S. military flights to the region.

#### **No Israeli first strike.**

Zachary **Keck 15**, 2/09/2015, Wohlstetter Public Affairs Fellow at the Nonproliferation Policy Education Center and researcher at the Belfer Center for Science and International Affairs, 5 Reasons Israel Won't Attack Iran, DOA: 4/02/2023, https://nationalinterest.org/feature/five-reasons-israel-wont-attack-iran-9469)// JZ

Although the interim deal does further reduce Israel’s propensity to attack, the truth is that the likelihood of an Israeli strike on Iran’s nuclear facilities has always been greatly exaggerated. There are at least five reasons why Israel isn’t likely to attack Iran.

1. You Snooze, You Lose

First, if Israel was going to strike Iran’s nuclear facilities, it would have done so a long time ago. Since getting caught off-guard at the beginning of the Yom Kippur War in 1973, Israel has generally acted proactively to thwart security threats. On no issue has this been truer than with nuclear-weapon programs. For example, Israel bombed Saddam Hussein’s program when it consisted of just a single nuclear reactor. According to ABC News, Israel struck Syria’s lone nuclear reactor just months after discovering it. The IAEA had been completely in the dark about the reactor, and took years to confirm the building was in fact housing one.

Contrast this with Israel’s policy toward Iran’s nuclear program. The uranium-enrichment facility in Natanz and the heavy-water reactor at Arak first became public knowledge in 2002. For more than a decade now, Tel Aviv has watched as the program has expanded into two fully operational nuclear facilities, a budding nuclear-research reactor, and countless other well-protected and -dispersed sites. Furthermore, America’s extreme reluctance to initiate strikes on Iran was made clear to Israel at least as far back as 2008. It would be completely at odds with how Israel operates for it to standby until the last minute when faced with what it views as an existential threat.

2. Bombing Iran Makes an Iranian Bomb More Likely

Much like a U.S. strike, only with much less tactical impact, an Israeli air strike against Iran’s nuclear facilities would only increase the likelihood that Iran would build the bomb. At home, Supreme Leader Ali Khamenei could use the attack to justify rescinding his fatwa against possessing a nuclear-weapons program, while using the greater domestic support for the regime and the nuclear program to mobilize greater resources for the country’s nuclear efforts.

Israel’s attack would also give the Iranian regime a legitimate (in much of the world’s eyes) reason to withdraw from the Nuclear Non-Proliferation Treaty (NPT) and kick out international inspectors. If Tehran’s membership didn’t even prevent it from being attacked, how could it justify staying in the regime? Finally, support for international sanctions will crumble in the aftermath of an Israeli attack, giving Iran more resources with which to rebuild its nuclear facilities.

3. Helps Iran, Hurts Israel

Relatedly, an Israeli strike on Iran’s nuclear program would be a net gain for Iran and a huge loss for Tel Aviv. Iran could use the strike to regain its popularity with the Arab street and increase the pressure against Arab rulers. As noted above, it would also lead to international sanctions collapsing, and an outpouring of sympathy for Iran in many countries around the world.

Meanwhile, a strike on Iran’s nuclear facilities would leave Israel in a far worse-off position. Were Iran to respond by attacking U.S. regional assets, this could greatly hurt Israel’s ties with the United States at both the elite and mass levels. Indeed, a war-weary American public is adamantly opposed to its own leaders dragging it into another conflict in the Middle East. Americans would be even more hostile to an ally taking actions that they fully understood would put the U.S. in danger.

Furthermore, the quiet but growing cooperation Israel is enjoying with Sunni Arab nations against Iran would evaporate overnight. Even though many of the political elites in these countries would secretly support Israel’s action, their explosive domestic situations would force them to distance themselves from Tel Aviv for an extended period of time. Israel’s reputation would also take a further blow in Europe and Asia, neither of which would soon forgive Tel Aviv.

4. Israel’s Veto Players

Although Netanyahu may be ready to attack Iran’s nuclear facilities, he operates within a democracy with a strong elite structure, particularly in the field of national security. It seems unlikely that he would have enough elite support for him to seriously consider such a daring and risky operation.

For one thing, Israel has strong institutional checks on using military force. As then vice prime minister and current defense minister Moshe Yaalon explained last year: “In the State of Israel, any process of a military operation, and any military move, undergoes the approval of the security cabinet and in certain cases, the full cabinet… the decision is not made by two people, nor three, nor eight.” It’s far from clear Netanyahu, a fairly divisive figure in Israeli politics, could gain this support. In fact, Menachem Begin struggled to gain sufficient support for the 1981 attack on Iraq even though Baghdad presented a more clear and present danger to Israel than Iran does today.

What is clearer is that Netanyahu lacks the support of much of Israel’s highly respected national security establishment. Many former top intelligence and military officials have spoken out publicly against Netanyahu’s hardline Iran policy, with at least one of them questioning whether Iran is actually seeking a nuclear weapon. Another former chief of staff of the Israeli Defense Forces told The Independent that, “It is quite clear that much if not all of the IDF [Israeli Defence Forces] leadership do not support military action at this point…. In the past the advice of the head of the IDF and the head of Mossad had led to military action being stopped.”

#### **Their own uniqueness concedes U.S. presence is focused on deterring Iran.**

**1NC Masters ’25** [Jonathan; Deputy Editorr @ CFR; March 28; Council on Foreign Relations; “U.S. Forces in the Middle East: Mapping the Military Presence,” https://www.cfr.org/article/us-forces-middle-east-mapping-military-presence; DOA: 4-5-2025] tristan

The United States maintains a considerable military presence in the Middle East, with forces in more than a dozen countries and on ships throughout the region’s waters. That presence expanded in 2024 as the United States focused on deterring and defeating threats from Iran and its network of armed affiliates in the region, including Hamas (Gaza Strip), Hezbollah (Lebanon), the Houthis (Yemen), and several Iraq- and Syria-based militant groups. In March 2025, U.S. Central Command forces launched an offensive air strike on Houthi-controlled territories in Yemen from war ships stationed in the Red Sea.

Since the October 2023 outbreak of war between Hamas and Israel, a U.S. ally and defense partner, U.S. forces in the Middle East have been increasingly targeted by some of these groups—and have regularly responded with counterstrikes. Meanwhile, U.S. and coalition ships have been protecting merchant shipping in the Red Sea and Gulf of Aden, defending against near-daily Houthi drone and missile attacks.

#### **Perceptual impact is thumped. Iran has enriched a ridiculous amount of Uranium.**

**Liechtenstein ’25** [Stephanie; Writer @ AP News; February 24; AP News; “Iran accelerates production of near weapons-grade uranium, IAEA says, as tensions with US ratchet up,” https://apnews.com/article/iran-nuclear-iaea-weapons-grade-uranium-trump-0b11a99a7364f9a43e1c83b220114d45; DOA: 4-5-2025] tristan

VIENNA (AP) — Iran has accelerated its production of near weapons-grade uranium as tensions between Tehran and Washington rise after the election of U.S. President Donald Trump, a report by the United Nations’ nuclear watchdog seen by The Associated Press on Wednesday showed.

#### **No Middle East escalation – balanced alliances, Chinese non-intervention, and cooperation prevent great power draw-in**

Walter Russell **Mead 14**, 7/07/2014, Writer for the Huffington Post, Have We Gone From a Post-War to a Pre-War World. Huffington Post, http://www.huffingtonpost.com/walter-russell-mead/new-global-war\_b\_5562664.html)// JZ

The Middle East today bears an ominous resemblance to the Balkans of that period. The contemporary Middle East has an unstable blend of ethnicities and religions uneasily coexisting within boundaries arbitrarily marked off by external empires. Ninety-five years after the French and the British first parceled out the lands of the fallen Ottoman caliphate, that arrangement is now coming to an end. Events in Iraq and Syria suggest that the Middle East could be in for carnage and upheaval as great as anything the Balkans saw. The great powers are losing the ability to hold their clients in check; the Middle East today is at least as explosive as the Balkan region was a century ago.

GERMANS THEN, CHINESE NOW

What blew the Archduke's murder up into a catastrophic world war, though, was not the tribal struggle in southeastern Europe. It took the hegemonic ambitions of the German Empire to turn a local conflict into a universal conflagration.

Having eclipsed France as the dominant military power in Europe, Germany aimed to surpass Britain on the seas and to recast the emerging world order along lines that better suited it. Yet the rising power was also insecure, fearing that worried neighbors would gang up against it. In the crisis in the Balkans, Germany both felt a need to back its weak ally Austria and saw a chance to deal with its opponents on favorable terms. Could something like that happen again?

China today is both rising and turning to the sea in ways that Kaiser Wilhelm would understand. Like Germany in 1914, China has emerged in the last 30 years as a major economic power, and it has chosen to invest a growing share of its growing wealth in military spending.

But here the analogy begins to get complicated and even breaks down a bit. Neither China nor any Chinese ally is competing directly with the United States and its allies in the Middle East. China isn't (yet) taking a side in the Sunni-Shia dispute, and all it really wants in the Middle East is quiet; China wants that oil to flow as peacefully and cheaply as possible. AMERICA HAS ALL THE ALLIES And there's another difference: alliance systems. The Great Powers of 1914 were divided into two roughly equal military blocs: Austria, Germany, Italy and potentially the Ottoman Empire confronted Russia, France and potentially Britain.

Today the global U.S. alliance system has no rival or peer; while China, Russia and a handful of lesser powers are disengaged from, and in some cases even hostile to, the U.S. system, the military balance isn't even close. While crises between China and U.S. allies on its periphery like the Philippines could escalate into US-China crises, we don't have anything comparable to the complex and finely balanced international system at the time of World War I.

Austria-Hungary attacked Serbia and as a direct result of that Germany attacked Belgium. It's hard to see how, for example, a Turkish attack on Syria could cause China to attack Vietnam. Today's crises are simpler, more direct and more easily controlled by the top powers.

#### **Empirically disproved AND nuclear energy solves war.**

**Shellenberger ’18** [Michael; Contributor @ Forbes, Best-Selling Author, Endowed Professor @ the University of Austin, serving as CBR Chair of Politics, Censorship, and Free Speech; August 29; Forbes; “For Nations Seeking Nuclear Energy, The Option To Build A Weapon Remains A Feature Not A Bug,” https://www.forbes.com/sites/michaelshellenberger/2018/08/29/for-nations-seeking-nuclear-energy-the-option-to-build-a-weapon-remains-a-feature-not-a-bug/#55aaf61b2747; DOA: 4-2-2025] tristan

U.A.E., which has finished construction of its first nuclear plant, and has shown high-level interest in acquiring a nuclear weapon — something acknowledged by former Secretary of State Hillary Clinton;

Turkey has begun construction of a nuclear plant and, may be secretly developing a weapon or “laying the groundwork to replace the nuclear umbrella the US provides;”

Egypt will start construction of a nuclear plant in 2020 and is viewed by experts as a possible nuclear weapons state if Iran decides to acquire a weapon;

Bangladesh has shown interest in developing weapons latency in the past and currently has a nuclear plant under construction.

Brazil is seeking to a multipurpose reactor, has in the past sought a weapon, and “will leave the door open to developing nuclear weapons“ according to a new Stratfor analysis.

This trend fits the historic pattern. In the 60 years of civilian nuclear power, at least 20 nations\* sought nuclear power at least in part to give themselves the option of creating a nuclear weapon.

Of the other nations building nuclear plants, seven have weapons (France, U.S., Britain, China, Russia, India and Pakistan), two had weapons as part of the Soviet Union (Ukraine and Belarus), and one (Slovakia) was part of a nation (Czechoslovakia) that sought a weapon.

Poland, Hungary, and Finland are the only three nations (of the 26) for which we could find no evidence of “weapons latency” as a motivation.

While those 23 nations clearly have motives other than national security for pursuing nuclear energy, gaining weapons latency appears to be the difference-maker.

The flip side also appears true: nations that lack a need for weapons latency often decide not to build nuclear power plants, which can be more difficult and expensive than fossil fueled ones.

Recently, Vietnam and South Africa, neither of which face a significant security threat, decided against building nuclear plants and opted instead for burning more coal, despite suffering from air pollution and professing concern for climate change.

Why Nuclear Energy Prevents War

In 2015, two scholars at Texas A&M university, Matthew Fuhrmann and Benjamin Tkach, set out to answer two questions: how many nations have the ability to build a weapon? And what impact does nuclear weapons “latency” have on war?

A growing body of research had found that latency deters against military attacks, Fuhrmann and Tkach noted. But with Israel and U.S. threatening pre-emptive action against Iran, could latency also be a threat to peace?

Fuhrmann and Tkach found that 31 nations had the capacity to enrich uranium or reprocess plutonium, and that 71 percent of them created that capacity to give themselves weapons latency.

What was the relationship between nuclear latency and military conflict? It was negative. “Nuclear latency appears to provide states with deterrence-related benefits,” they concluded, “that are distinct from actively pursuing nuclear bombs.”

Why might this be? Arriving at an ultimate cause is difficult if not impossible, the authors note. But one obvious possibility is that the “latent nuclear powers may be able to deter conflict by (implicitly) threatening to ‘go nuclear’ following an attack.”

Nuclear isn’t the first energy technology whose adoption was driven by national security. Before World War I, the British Navy switched to petroleum-powered ships that could travel twice as far, emit less smoke (that potential enemies could see), and refuel more quickly than coal-powered ones. And today’s efficient natural gas turbines exist in large part thanks to decades of military procurement of jet turbines.

Every past energy transition has followed the same progression. The new fuel, whether coal, oil, natural gas, or uranium, starts out as a premium product more expensive than the incumbent and comes down in price over time.

For early adopters of the new fuel-technology combination, notes economist Roger Fouquet, a new energy source must offer some “superior or additional characteristics (e.g. easier, cleaner or more flexible to use).”

After over 60 years of national security driving nuclear power into the international system, we can now add “preventing war” to the list of nuclear energy’s superior characteristics.

“Your view that weapons drove nations to energy, not the other way around,” M.I.T.’s Narang told me, “may be more accurate given what we now know about many of these countries.” He pointed to Sweden and Switzerland:

Both are neutral nations outside of NATO that had a very deep interest in weapons and a program through the 1960s. Today they are championed as nonproliferation nations, but both militaries were very interested in having the basis for a nuclear weapons program if necessary. Both used nuclear energy to explore those options.

Before Iran, Narang notes, the nation most famous for nuclear weapons hedging was Japan. After six decades of peaceful nuclear power, it’s an open secret that Japan has created enough plutonium to create 6,000 bombs — as well as an excellent rocket program.