THE NEW CENTER

Policy Paper

Think Centered

Energy and Climate

DOUBLE DOWN ON FEDERAL R&D FOR BREAKTHROUGH ENERGY TECHNOLOGIES

NEW CENTER SOLUTION:

Double Down on Federal R&D For Breakthrough Energy Technologies

The right wants to ignore climate change. The left wants to radically disrupt virtually every part of America's economy and society to fight it.

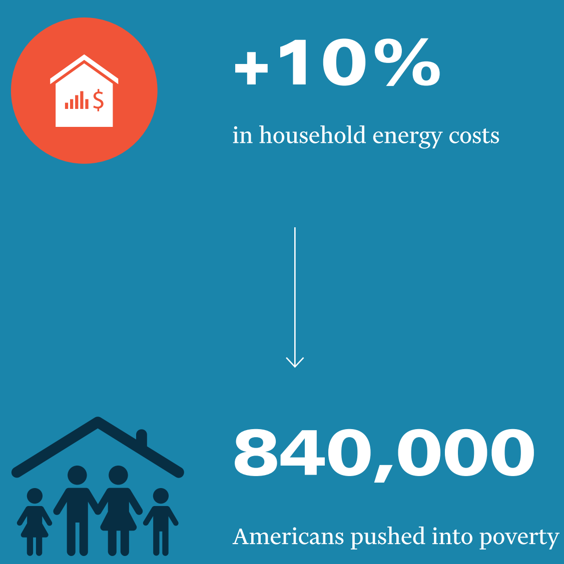
Neither approach makes sense.

Climate change is exacting a real cost on our economy and environment now and if the right doesn't end its relentless—and indefensible—climate denial, the costs will keep adding up. But the left's utopian vision to fight climate change could exert significant costs too. Consider the fact that if household energy costs went up just 10%, it would push almost 840,000 Americans into poverty.[1]

What if the Green New Deal turns out to be far more expensive and disruptive than its advocates suggest? There are more than a few government initiatives that fit that description.

The fight against climate change is a multi-decade challenge, which means it needs to be sustained across multiple presidencies and sessions of Congress. If recent history is any guide, that will include periods with unified Republican and Democratic control as well as divided government. That's why any climate change solution—to have any chance to last—must be forged in the center.

Impact of increased energy costs



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Historic Solutions

Our Fossil Fuel Past

So what to do about climate change and its effects? Ironically, the solution to a cleaner energy future may be found in our fossil fuel past.

In the early 2000s, energy experts were sounding a dire warning.

The U.S. was running out of oil and gas. A popular book released at the time called "The End of Oil" reflected the growing conventional wisdom that global supplies of crude oil would soon peak, bringing an era of soaring energy prices and economic upheaval.[2]

In 2003, the *Oil and Gas Journal* reported the United States had just 22.5 billion barrels of proven oil reserves.[3]

But today the U.S. is estimated to have 264 billion barrels of proven oil reserves— more than Saudi Arabia or Russia.[4]

So how did America go in the span of 15 years—a period when we were consuming a whole lot of oil—to actually increasing our oil reserves by a factor of more than 10?

Technology.

An advanced drilling technique—called fracking—allowed us to access energy we never thought we could reach.

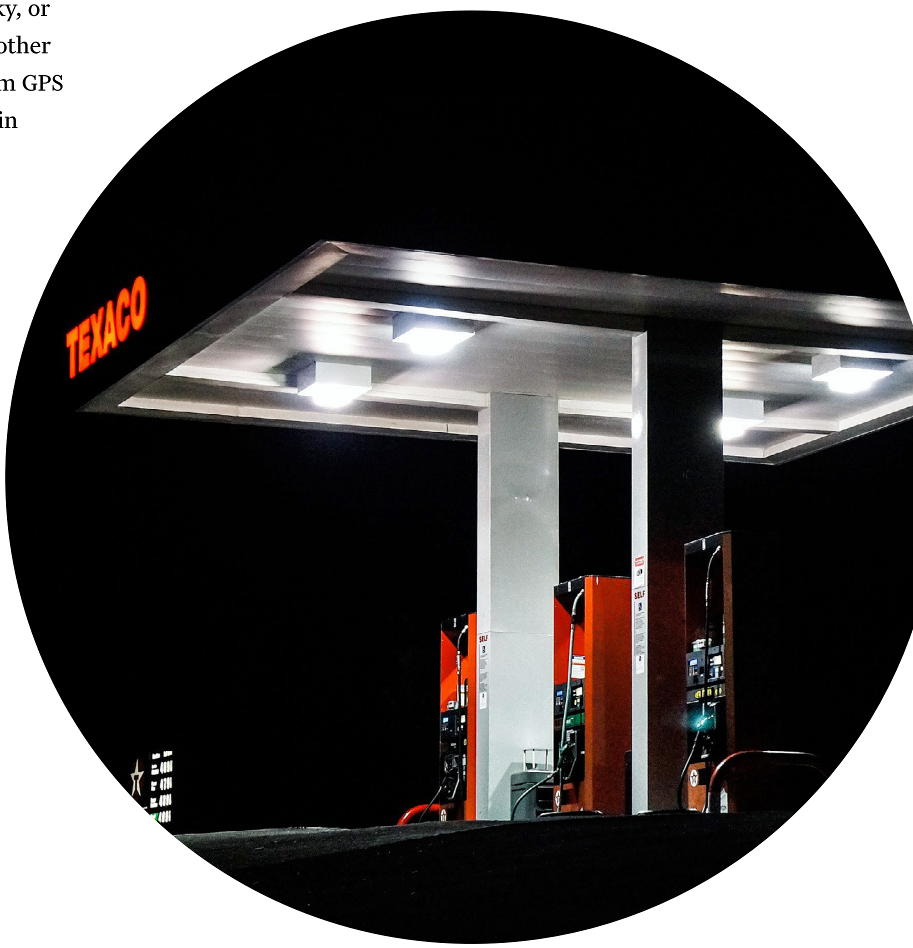
HOW THE FRACKING REVOLUTION IS A MODEL FOR A CLEAN ENERGY REVOLUTION...

In July 2013, George P. Mitchell—the Founder of Mitchell Energy—passed away at the age of 94. In his obituary, the Associated Press called Mitchell the "Father of Fracking" and credited him with sparking the American shale gas revolution.

Although Mitchell's company came to market in the 1990s with a revolutionary fracking technique, it also drew on technology that was invented, funded, or subsidized by Uncle Sam.

To cite just two examples: Sandia National Laboratories developed the seismic modeling and imaging technology that allowed Mitchell to more precisely locate oil and gas reserves; meanwhile, the U.S. Department of Energy funded joint ventures that ultimately produced the diamond-tipped drilling bits and pioneered horizontal drilling techniques that were later adapted for commercial use by Mitchell Energy.[5]

The lesson here is that government can play a critical role in funding the basic energy research that is too long-range, risky, or expensive for the private sector to handle alone. It's true in other industries as well, as breakthrough technologies ranging from GPS and the internet to memory foam mattresses got their start in government research labs.



…AND HOW OPPORTUNITY WAS BORN FROM A GLOBAL CRISIS

The early 1970s were a period when America's dependence and demand for oil—much of it imported from abroad—was increasing.

The OPEC oil embargo in 1973 would wake America up to its foreign oil dependency, change the nature of global energy policies, and focus the attention of U.S. policymakers on developing energy alternatives.

In the years following the OPEC crisis, the U.S. government passed clean energy legislation which included tax incentives, credits, and significant funding for the development of breakthrough technologies. The recent exponential growth in wind and solar power can be traced back to these early government investments:

- A study prepared by TIA Consulting and 1790 Analytics for the Department of Energy on the 30 years of research and investment funded through the Department of Energy's Wind Energy Program found that "more wind energy patent families assigned to leading wind energy companies are linked to DOE research than are linked to any other leading organization. Within the wind energy industry, DOE-supported patents are strongly linked both to leading manufacturers of utility-scale wind turbines and of distributed-use turbines. Key patents from companies such as General Electric, Vestas, Clipper, Distributed Energy, and ABB have built extensively on earlier DOE-supported patents."[6]
- Similarly, between 1975 and 2008, the Department of Energy was responsible for funding more projects that led to solar energy related patents than any other organization in the world. To cite one example of this success, the SunShot Initiative, an arm of the DOE created in 2011, works to make solar energy cheaper and more cost competitive. It achieved its goals years ahead of schedule when the cost of installing utility-scale solar dropped to about $1.00 per watt in 2017.[7]

When government lays the foundation for innovation, and the private sector is empowered to build on that foundation, new products can come to market, new jobs are created, and new solutions are found to old problems.

This is how a president governing from the center could attack the climate change challenge.

China and India are not building hundreds of new coal plants because they are intent on destroying the world. They are doing it because it's the cheapest way to power their economies and to pull people out of poverty.

This will not change until energy alternatives or technologies emerge that provide the same thing that coal and other fossil fuels do for these countries: cheap, abundant, and affordable power on a massive scale.

How about we create those technologies in the U.S.?

Breakthrough Technologies

Double Down on Federal R&D for Breakthrough Energy Technologies

According to the Pew Charitable Trust, energy investments have accounted for only one percent of the federal government's R&D budget since the 1990s.

In 2018, the Department of Energy received $15 billion for energy R&D and related activities. These funds go toward advancing work on nuclear energy technologies, reactor concepts, renewable energy resources, carbon capture, advanced energy systems, and electricity efficiency. Of that $15 billion, ARPA-E (the Advanced Research Projects Agency-Energy)—which funds some of the most ambitious and cutting-edge energy research—only received $353 million.[8]

The American Energy Innovation Council—a project of the Bipartisan Policy Center—recommends that the budget for ARPA-E should be at least tripled to over $1 billion per year.[9]

Although this would represent a significant funding increase, it would still pale in comparison to the amount the U.S. government spends on defense R&D. In 2018, the Defense Department spent $805 billion, $93.5 billion of which was for RDT&E (research, development, test, and evaluation).[10]

With increased funding, the Department of Energy would be able to explore and invest in several possible breakthrough energy technologies—with the potential to increase our supply of energy and to combat climate change—like carbon capture and storage, energy and battery storage, and next generation and modular nuclear reactors.

Although many of these technologies have great promise, they are currently being held back by cost, scalability, and performance hurdles. That's common in the early stages of developing new technology.

Significant new federal R&D research in these areas could accelerate the timeframe for innovators to clear these hurdles.

The technologies are:

1. Carbon Capture, Utilization, and Storage

2. Advanced Energy and Battery Storage

3. Next Generation Nuclear Reactors

1.

Carbon Capture, Utilization, and Storage (CCS)

Carbon capture, utilization, and storage aims to reduce CO_2 emissions entering the atmosphere from industrial activity. First, the carbon dioxide is "captured" by separating it from the other gases that are produced as waste in industrial processes. The captured CO_2 is then stored in geological formations or depleted oil reservoirs.[11]

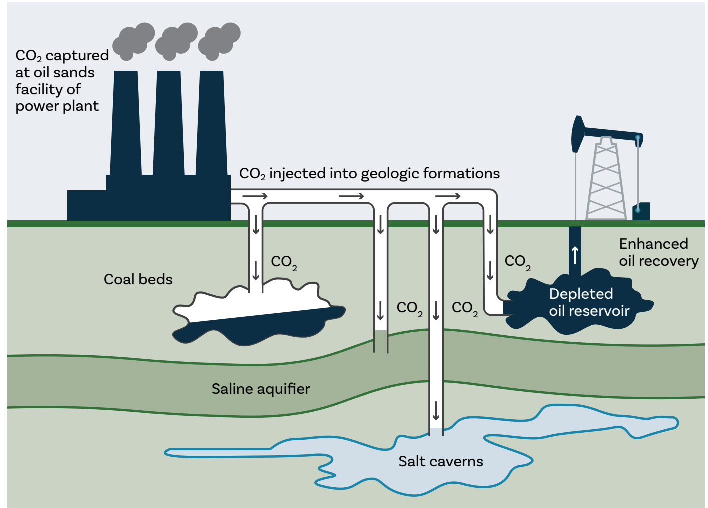
A report by the UN's Intergovernmental Panel on Climate Change notes that "all analyzed pathways limiting warming to 1.5°C with no or limited overshoot use CDR (carbon dioxide removal) to some extent."[12] In short, there is no realistic path to limiting the worst effects of climate change without figuring out how to store or sequester massive amounts of carbon.

As of 2018, the Global CCS Institute reports that there are 43 large scale CCS facilities around the world. Eighteen of them are in the commercial operation stage, five are currently under construction, and twenty are in development phases.[13]

But these 18 commercial CCS plants only capture about 40 million metric tons of carbon per year—0.1% of global emissions.[14]

ISSUES WITH CCS

- High Costs: At about $92 per megawatt-hour, operating a coal plant is already an expensive endeavor. But fitting one with CCS capabilities? That currently increases operating costs by two-thirds, just to produce the same amount of energy.[15]
- Investment Gets Allocated, but not Spent: According to the International Energy Agency, $28 billion worth of public funding was set aside in the past decade for CCS projects, but only 15% of these funds have actually been spent.[16] And, since 2014, public and private support have tapered off significantly. In 2017, the private sector spent only $90 million on CCS, while governments spent $70 million.[17]
- Public Concern for Potential Leakage: In Cameroon in 1986, a lake overturning—in which dissolved carbon dioxide suddenly erupts from underground—sent between 100,000 and 300,000 tons of carbon dioxide into the air, killing 1,700 people and 3,200 animals nearby.[18] The disaster was a natural occurrence, but is cited as one of many examples of what could happen if carbon storage went awry. A 2017 report published by a team of Princeton researchers notes that "levels of leakage based on simulations at hypothetical subsurface carbon dioxide storage locations, even in a worst-case scenario, would not make the cost of the technology prohibitive in the global energy system."[19] But public perception can be hard to shake.



Carbon capture, utilization, and storage plant. Sourced from Energy Watch.[20]

Despite these hurdles, the U.S. government continued to promote CCS research, development, and commercialization. Since 2010, CCS R&D has been on a steady incline, and the Department of Energy has received $5 billion so far towards carbon capture research and development.[21]

In fact, the United States hosts one of only two coal-fired power plants with CSS technology in the world: the Petra Nova Facility near Houston, Texas.

With a $190 million grant from the DOE, NRG Energy and JX Nippon Oil retrofitted Petra Nova at an upfront cost of approximately $1 billion. According to NRG Energy, "within the first 10 months, the plant delivered more than 1,000,000 tons of captured carbon dioxide."

In 2018, Congress managed to work together to pass carbon capture and storage legislation that has the potential to spur private sector investments in CCS.

One piece of legislation amended Section 45Q of the International Revenue Code to make carbon sequestration more appealing by eliminating caps on credits, increasing credit amounts, expanding what is considered qualifying carbon use, and lowering qualification thresholds for captured carbon amounts.[22]

The Trump Administration's 2019 budget requested only $502 million for CCS R&D—$225 million less than what was appropriated by Congress in FY 2018. The Administration requested a lower amount on account of an emphasis on private sector R&D responsibility.[23] In spite of this, House and Senate appropriations legislation for 2019 increased funding to $727 million—well above the Trump administration's requests.[24]

2.

Advanced Energy and Battery Storage

The sun isn't always shining, and the wind isn't always blowing. This inhibits the ability of solar and wind to be used as the baseload power that utilities need to keep the lights on whether it's rain or shine, hot or cold.

Unlocking the full potential of solar and wind power requires dramatic improvements in the price and performance of energy storage, which captures energy that is produced—usually at a low demand time—for later use at a high demand time.

Energy storage exists in many forms, including but not limited to: thermal storage, compressed air storage, hydrogen storage, pumped hydroelectric storage, flywheels, and batteries. Of all of these different technologies, pumped hydroelectric storage makes up about 96% of the United States' total energy storage capacity of approximately 25 gigawatts (GW). This current electricity grid capacity is equivalent to that of about 38 standard coal plants.[25]

The increased use of energy storage can provide significant benefits to consumers and to industry. Energy storage can help with peak shaving—which is the process of reducing energy purchased from a utility company during peak demand hours—uninterrupted energy services, and load shifting, which includes charging batteries when electricity is cheap and using them when electricity gets more expensive.[26]

According to the Department of Energy, energy storage also leads to decreased emissions, an "increase in the economic value of wind and solar power," and "new income sources for rural landowners and tax revenues for wind and solar development areas."[27]

ISSUES WITH ENERGY AND BATTERY STORAGE

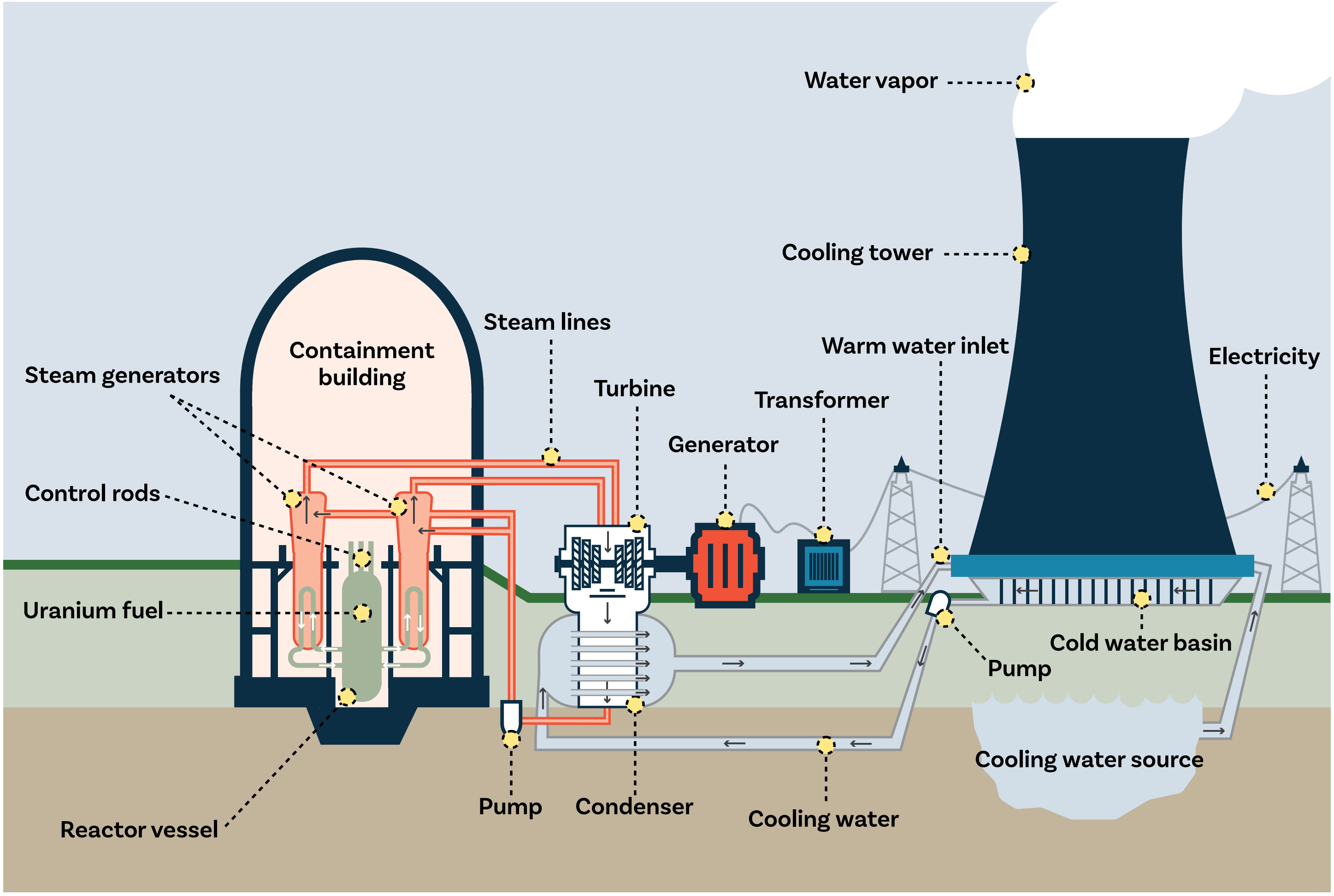
- High Costs: Currently, energy storage technologies are unable to compete with the prices of traditional sources of energy. A study conducted by the U.S. Energy Information System from November 2016 showed that the overnight capital cost for Battery Storage was $2,813 ($/kW), while the overnight capital cost of a new natural gas plant ranged from $978 to $1,342.[28]
- Lack of Commercial Projects: Pumped hydroelectric storage accounts for 96% of the United States' total energy storage capacity, and there are very limited commercial-scale projects for other technologies with a proven track record of success.[29]
- Battery Storage Limitations: Lithium-ion batteries are currently the most popular choice for battery storage facilities to use, but they only provide enough storage capacity to run for about four hours. This means these batteries are currently capable of enhancing grid reliability but not of serving as a significant source of energy.
- Demand is Low: Given that there is currently no significant need for further storage capacity for a reliable grid, there is limited demand for expanding energy storage projects.

Research and development for energy storage initiatives are supported on a variety of fronts through the Department of Energy. The Joint Center for Energy Storage Research, for example, allocated $24 million in funding in FY 2018.[30] As of December 2015, ARPA-E had spent $75.5 million on completed projects relating to energy storage, and is currently funding 36 projects at $108 million.[31]

3.

Next Generation Nuclear Reactors

Nuclear plants utilize the power of nuclear reactions such as fission and decay to produce electricity. Nuclear energy has the highest capacity factor per year (electrical energy output) out of any other energy source, and because it produces very few or no emissions, two billion tons of carbon dioxide emissions are avoided globally due to its use every single year.[32]



Nuclear Plant Block Diagram. [33]

In the United States, most plants are "light water reactors", with the most common design being a pressurized water reactor in which heat from nuclear reactions generates steam, which in turn powers a turbine generator that produces electricity.[34] This energy is produced through the nuclear fission of either uranium and plutonium atoms, and plutonium use is responsible for over one-third of energy being produced from nuclear plants.[35]

Although nuclear energy has had a few high-profile disasters—Chernobyl, Fukushima, and Three Mile Island in the United States—the industry's overall safety record is still excellent. According to Yale Environment 360, "studies indicate that even the worst possible accident at a nuclear plant is less destructive than other major industrial accidents."[36]

In 2017, the International Energy Agency estimated that global energy demand would rise by 30% by 2040, particularly as economies develop and urbanization occurs.[37] It is hard to imagine carbon emissions being reduced during this time if nuclear energy is not a part of the solution.

During the last few decades, a group of fourteen nations including the United States has been meeting through the Generation IV International Forum (GIF) to establish development plans for safe, clean, and reliable nuclear energy systems. These "next generation" nuclear systems include: gas-cooled reactors, lead-cooled reactors, molten salt reactors, supercritical water-cooled reactors, sodium-cooled fast reactors, very high-temperature reactors, and smaller modular nuclear reactors.[38]

This next generation of nuclear reactors could come with significant benefits:

- Low, cost-competitive prices within the range of $1,000 per Kilowatt-electric
- Improved safety measures to minimize accidents and increase reliability
- More efficient nuclear waste disposal and uranium utilization
- Nonproliferation mechanisms

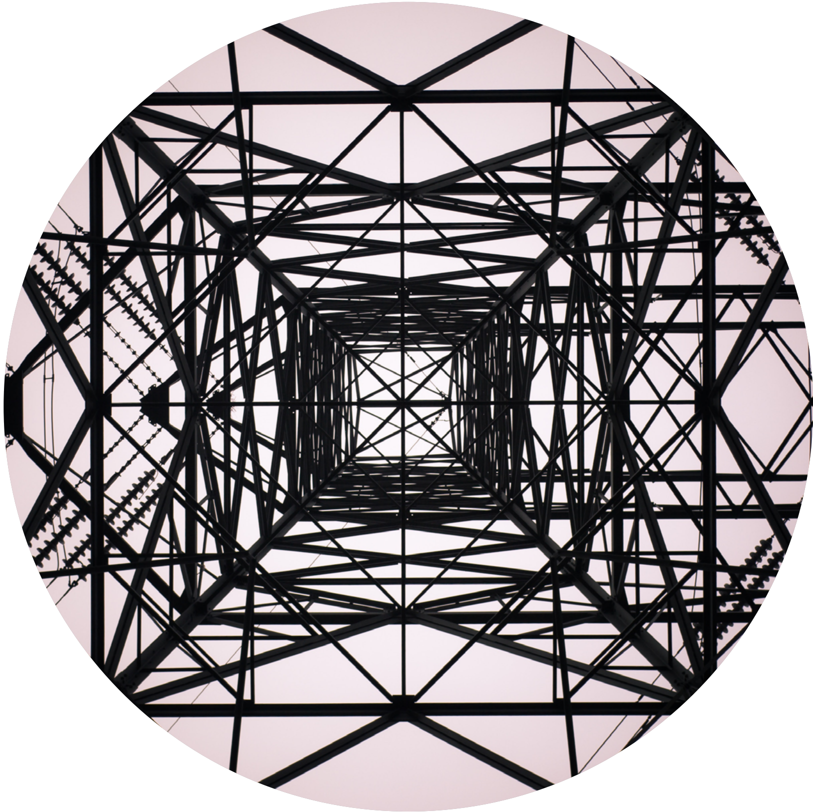
ISSUES WITH NEXT GENERATION NUCLEAR REACTORS

- Red Tape: The high risk associated with nuclear plant accidents has resulted in long and arduous regulatory review processes. Daniel Kammen, a former Science Envoy for the State Department, noted that “it could easily take the advanced nuclear projects 30 years to get through regulatory review, fix the unexpected problems that crop up along the way, and prove that they can compete.”[39]
- High Costs: Long review processes and the complex nature of these next-generation nuclear reactors have created delays and increased expenses. According to the World Nuclear Association, the cost to build a new nuclear plant was $5.8 billion in 2015, up $3.7 billion from 1998.[40]
- The Costs and Delays are Hitting Some Companies Hard: French nuclear company AREVA asked its government for a €4.5 billion bailout due to one of its projects undergoing a 10-year delay.[41]

Despite these regulatory and monetary hurdles, the Office of Nuclear Energy within the DOE places significant emphasis on breakthrough nuclear technologies. In FY 2018, the Department of Energy received $1.2 billion towards nuclear energy research and development to support initiatives within the Office of Nuclear Energy such as the Next Generation Nuclear Plant, Advanced Reactor Concepts, and Advanced Small Modular Reactor Programs.[42]

And, in March 2019, the Department of Energy announced that it was allocating $19 million in funds for projects that addressed domestic advanced nuclear technology.[43]

Still, nuclear plant commercialization in the United States is at a standstill, reflecting the expensive and slow process of developing, building, and commercializing. As a consequence of red tape—and concerns over safety after the Three Mile Island Accident—no new nuclear reactors were built in the U.S. between 1977 and 2013.[44] Only two nuclear reactors are under construction.[45]



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