Before the United States Senate Environment and Public Works Committee

Hearing on the Discussion Draft of S___, the Advanced Nuclear Infrastructure Act of 2020

Testimony of Armond Cohen, Executive Director, Clean Air Task Force

August 5, 2020

SUMMARY OF TESTIMONY

Decarbonizing America's economy by midcentury is a stiff challenge. We not only need to remake the 80% of America's energy supply (and 60% of electricity) that is powered by uncontrolled fossil fuels; we may need to double total electricity supply by 2050 to help decarbonize industry, transport and buildings.

Fortunately, we have several options to achieve that goal, especially in the electricity sector. We have made strong progress on wind and solar energy, which now supplies 3.6% of America's total annual energy, and 9% of our electricity. We have emerging potential renewable sources such as super hot rock geothermal. We have demonstrated carbon capture and storage that removes carbon from fossil fuel use either before (to make hydrogen) or after combustion, and there many innovative technologies on the horizon that could make those technologies less expensive. And finally, we have America's largest zero carbon source of electricity, nuclear energy, providing 20% of total electricity generation, but only 8% of total energy consumed.

The evidence suggests that nuclear energy can play an important role in our future economy, but there are many challenges to address, just as there are with all other zero carbon energy sources.

The advantages of nuclear energy are, first, that it is firm or "dispatchable," and not dependent on weather, allowing us to avoid very expensive energy storage to ride through the weeks and months when wind and sun are at low ebb in most regions of the country. Second, nuclear energy plants are very compact, taking up a hundred to a thousand times less space per unit energy produced than an equivalent amount of wind and solar at very high penetrations, and significantly less transmission capacity; high power density may be a valuable attribute in a nation where siting any energy facility is controversial. And because nuclear units produce so much power, we can build them quickly when conditions are right; France eliminated 80% of its grid carbon emissions in only two decades through a scale up of nuclear energy. Third, nuclear energy can provide carbon-free heat to displace fossil fuels in industrial processes and buildings, and to efficiently create hydrogen, a zero carbon fuel that can be combusted for electric power without carbon emissions in natural gas turbines and which will be needed for decarbonizing the industrial and transport sectors. While in theory we could provide 100% of our electricity and other fuels with renewable energy, that is a risky bet; more options are likely to increase our chance of success.

At the same time, nuclear energy faces many challenges. Foremost among these are the high cost and delays associated with recent American and European projects. However, high cost and delay are not inevitable, as best construction and project management practices and the building of standardized multiple units have shown elsewhere in the world. In addition, advanced reactor designs using different coolants and other innovations could lower costs even further. We must also address another triad of issues: waste disposal, weapons nonproliferation, and public perception of safety. Some, but not all, of these issues, can be addressed through advanced reactor designs.

The Advanced Nuclear Infrastructure Act of 2020 would begin to address some of these challenges. In particular, provisions that would provide incentives to support continued operation of the current nuclear fleet and examine permitting for advanced nuclear in non-electric applications such as heat demands by heavy industry such as cement and steel are important as the world transitions to zero-carbon energy production. Beyond what is currently in this bill, I would urge this committee to do more to create incentives for using nuclear power to produce zero-carbon fuels such as hydrogen.

The discussion draft before this committee today is a start. However, this bill proposes some alterations to environmental permitting that this Committee must reconsider. These provisions are not necessary, and could even be damaging, to the future of the advanced nuclear industry. Additional streamlining of environmental regulations such as the National Environmental Protection Act is not helpful for the nuclear industry or for our goals for decarbonization. This Committee has already provided the framework necessary to move forward with more efficient advanced nuclear licensing and permitting – through the recently passed Nuclear Energy Innovation and Modernization Act of 2019 and until 2022 through the Fixing America's Surface Transportation Act of 2015. Because of the work of this Committee, the Nuclear Regulatory Commission now has a good framework in place for environmental review of advanced nuclear technologies and development. I would urge this Committee not to include additional provisions to streamline environmental review of nuclear projects in any legislation, but instead to let the implementation of the Nuclear Energy Innovation and Modernization Act of 2019 proceed. Clean Air Task Force recommends removing Section 201 and Section 203 of this legislation.

Additionally, Clean Air Task Force has recommended changes to this draft legislation that include but are not limited to:

- Give NRC the authority to deny the imports of fuels by foreign adversaries, through establishment of an import license program, instead of denying domestic licenses to possess fuel that are held by utilities (Section 102);
- Establish three prizes, one each for a light water advanced small modular reactor, a non-light water advanced modular reactor, and a microreactor (Section 202);
- Include study of the use of advanced reactors for repowering of existing fossil fueled generation facilities in the report requested by Congress on unique licensing issues and requirements (Section 204)
- Put a cap on the value of the credit that can be awarded to existing nuclear generation, or consider a reverse auction for funds (Section 301)

We applaud the Chairman for proposing legislation that included the following provisions, and look forward to continuing to work with all Members of this committee to find a way to move these provisions forward that will support advanced and existing nuclear power:

- A report to Congress on the unique licensing considerations relating to the use of nuclear energy for non-electric purposes, specifically industrial applications and production of zero-carbon fuels (Section 204)
- Preserving at-risk nuclear facilities through an incentive program that is transparent and prioritizes safety, while protecting taxpayers and ratepayers against unnecessary compensation for utilities (Section 301)
- A report to Congress on advanced manufacturing and construction for nuclear energy applications (Section 403)
- An annual report on the spent nuclear fuel and high-level radioactive waste inventory in the United States (Section 502)

As this Committee considers this draft legislation, I urge you not to compromise on safety. The Nuclear Regulatory Commission is in the best position to focus on its role as regulator for this industry. Only with a truly independent and strong regulator can we build the trust that will be necessary for a low carbon future that includes nuclear energy in the United States.

Finally, I'd like to offer some important steps that will be necessary for making nuclear a scalable option for future decarbonization:

- Preserve the existing nuclear fleet to lower emissions during the transition and preserve our knowledge and sites
- Create market demand for advanced nuclear through government support, as we did for wind and solar, to achieve scale, and reduce costs through learning-by-doing
- Support research and development for advanced nuclear, particularly focusing on innovative business models, load following, and zero carbon fuel production
- Continue our progress in vigilant but fit-for-purpose regulation that enables advanced reactor innovation and safety, including through support for international harmonization of nuclear safety regulation
- Resolve key nuclear waste challenges
- Revive a federal research program on low dose radiation health impacts

Chairman, Ranking Member, and Distinguished Members of the Committee:

My name is Armond Cohen and I am Executive Director of Clean Air Task Force, an environmental organization dedicated to the protection of Earth's atmosphere, with a strong focus on strategies to commercialize carbon-free energy. I appreciate the opportunity to testify today.

My testimony will first lay out the scale of the climate challenge and the value of nuclear energy to decarbonization. Then, after summarizing the important challenges associated with nuclear power, I will discuss how advanced nuclear energy could provide a solution. Finally, I will specifically provide comments on how this draft legislation does and does not help achieve those solutions.

I. The scale of the climate challenge and the options

Earth's atmosphere has more carbon dioxide than at any time in human experience, most of it added in the last half century. To preserve a natural world anything like we have known, we will likely need to build a 100% carbon-free energy economy by 2050, and then progressively withdraw some of the carbon we've put into the skies already. Achieving climate stabilization targets, as Figure 1 below shows, will require essentially zeroing out energy-related greenhouse emissions from all sectors of the economy around 2050. That means not just the electric sector, but also transportation, industry, buildings and agriculture. And we must accomplish this feat as global demand for energy could as much as double in the coming decades, as developing economies get richer. So, U.S. comprehensive climate legislation with the goal of zero-carbon emissions by midcentury must cover all of these sectors.

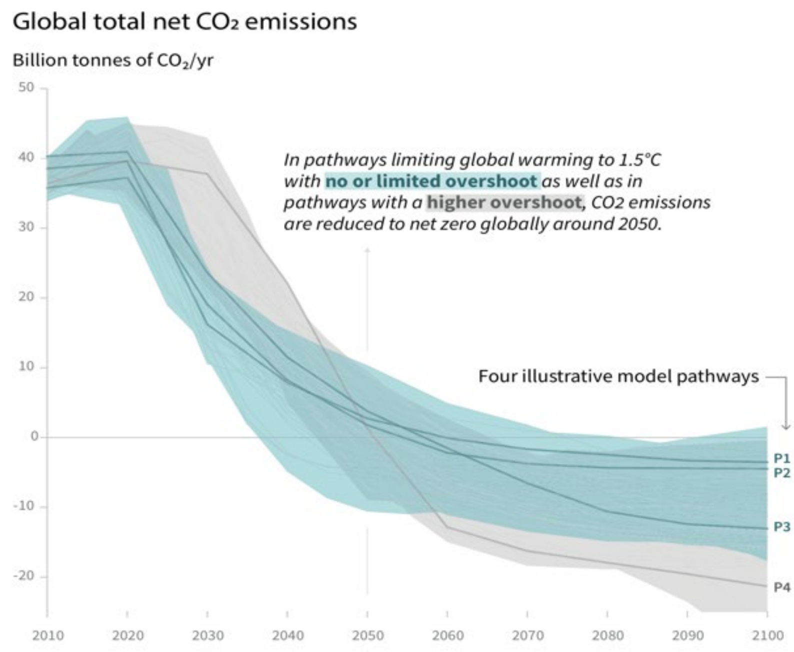

Figure 1: Pathways to limit global temperature to the Paris Agreement target of no more than 1.5 degree warming (Source: IPCC, Special Report: Global warming of 1.5^0 C, 2018)

Although there are significant challenges, the pathway to a carbon-free economy is in concept straightforward: replacing existing greenhouse gas-emitting energy sources with zero-emitting resources and building additional zero-emitting resources to meet future growth. Eventually, we will also likely need to progressively withdraw some of the carbon we have put into the atmosphere already[1].

Decarbonizing America's economy by midcentury is a stiff challenge. We not only need to remake the 80% of America's energy supply (and 63% of electricity) that is powered by uncontrolled fossil fuels; we may need to double total electricity supply by 2050 to help decarbonize industry, transport and buildings.

I was honored in 2018 to be part of a group of authors who published an article in *Science* entitled "Net-zero emissions energy systems" which explored this challenge.[2] The key insight of that article is that it is best to think of a net-zero greenhouse gas emissions energy economy as a ***system*** of complementary and overlapping parts. These parts include zero-carbon electricity, fuels, storage, low-carbon industrial processes, and carbon capture and sequestration from

[1] This testimony addresses creating a carbon-free energy supply. It does not address energy efficiency improvements, carbon in agriculture, which represents roughly 25% of the greenhouse gas emissions problem, or carbon dioxide removal.

[2] Davis, Steven J., et al. "Net-zero emissions energy systems." *Science* 360.6396 (2018): eaas9793.

fossil fuel use. A greatly simplified schematic picture of such a system can be seen in Figure 2 below.

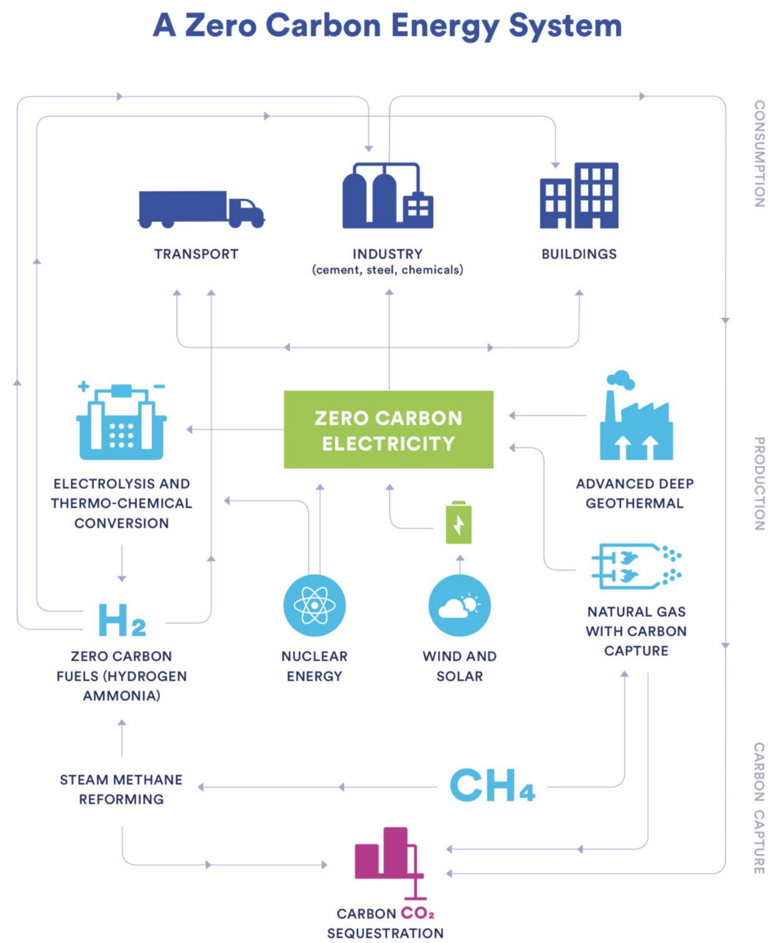

Figure 2: Schematic of a zero-carbon energy system (Source: Clean Air Task Force, 2019)

Building this zero carbon energy system is an enormous lift. Let's just take electricity. Figure 3 below shows the rate at which we will have to scale zero carbon electricity to decarbonize the grid by midcentury, assuming more electrification to decarbonize other sectors. To do so, we would need to build as much as 35 average Gigawatts per year every year from now until 2050. This is ***roughly five to ten times the rate*** at which we have ever deployed zero carbon technology.[3]

[3] And it is roughly three times the rate at which we deployed all generation technologies, predominantly gas, which are much faster and easier to site, in the 28 years from 1990 to 2018. See https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php

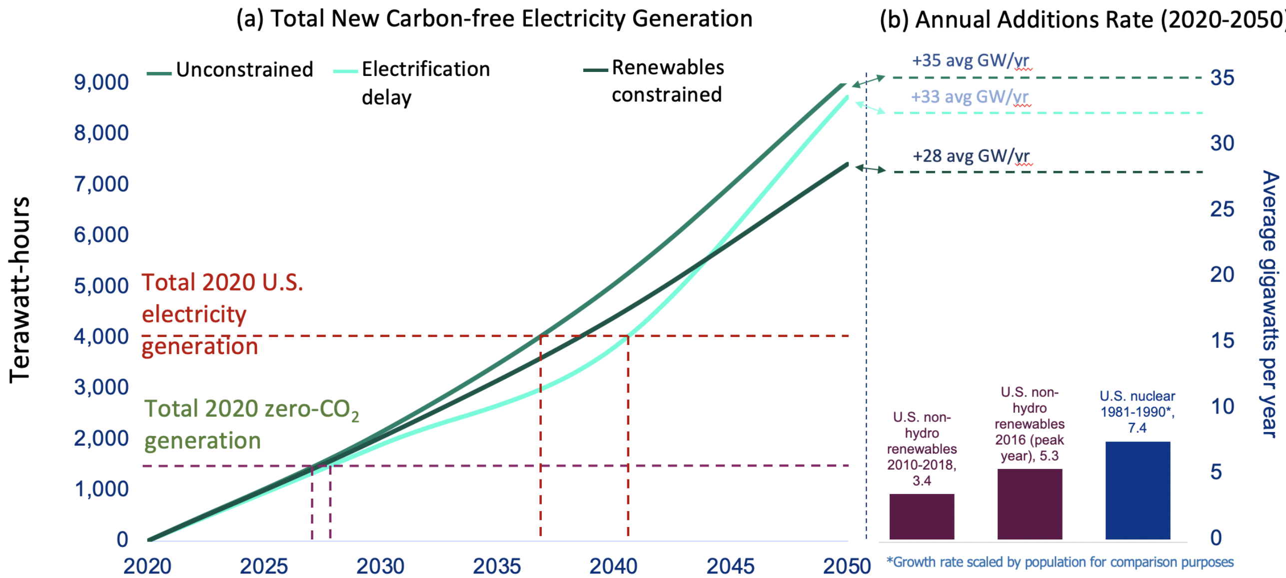

Figure 3: Scaling rates to decarbonize US electricity. Source: J. Jenkins, Princeton University , https://cpree.princeton.edu/sites/cpree2019/files/media/2020-02-010_-_wws_bradford_seminar_-_getting_to_zero.pdf

And that's just electricity, which represents about 40% of total American energy production and 33% of total US carbon dioxide emissions from fossil fuel burning. The other 60% of US energy is derived from oil, gas and coal for transportation, industrial process, and building heat. We need to decarbonize those sectors too. Some we can decarbonize with electricity, but many end uses will be difficult to electrify, especially heavy transport and high temperature heat in industry. For those, and perhaps for parts of the light duty transport and building sector, we'll need a zero carbon fuel, likely hydrogen-based. Today, we produce almost no zero carbon fuels for energy end uses.

Fortunately, we have several options to achieve the zero carbon goal, especially in the electricity sector. We have made strong progress on wind and solar energy, which now supplies 3.6% of America's total annual energy, and 9% of our electricity. We have emerging potential renewable energy sources such as super hot rock geothermal.[4] We have demonstrated carbon capture and storage that removes carbon from fossil fuel use either before (to make hydrogen) or after combustion, and there many innovative technologies on the horizon that will make those technologies less expensive.[5] And finally, we have America's largest zero carbon source of electricity, nuclear energy, providing roughly 20% of total US power consumption.

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[4] See https://www.catf.us/resource/catf-eon-geothermal-workshop/

[5] See https://www.globalccsinstitute.com/resources/global-status-report/ and https://www.globalccsinstitute.com/wp-content/uploads/2019/08/Global-CCS-Institute_Response-to-the-National-Hydrogen-Strategy-Issues-Papers_July-2019-002.pdf

The question for this hearing is whether nuclear energy[6] can play a significant role in a future zero carbon economy. The evidence suggests it can, but there are many challenges to address, just as there are with all other zero carbon energy sources.

II. The value for multiple technological options to address climate change

A large literature has grown up in recent years on various paths to energy system decarbonization. There are some who contend that an energy system powered mostly if not exclusively by wind and solar energy is the most effective way forward, and that all other options such as nuclear and carbon capture are not worth pursuing. CATF has come to a different conclusion, based on our review of, and participation in, scores of studies of this issue addressing multiple pathways. This literature is concisely surveyed in a recent review of these studies.[7] The authors of that meta-study offer this assessment:

> Despite differing methods, scopes, and research questions, several consistent insights emerge from this literature... The literature outlines potentially feasible decarbonization solutions, but also clarifies several challenges that must be overcome along each path to a zero-carbon electricity system. In light of these challenges, and the considerable technological uncertainty facing us today, we conclude that a strategy that seeks to improve and expand the portfolio of available low-carbon resources, rather than restrict it, offers a greater likelihood of affordably achieving deep decarbonization.

Given the size of the climate problem and related energy system transformation task, and the consequences of failure to decarbonize in time, we face a very large risk management challenge. Every zero carbon energy technology has its challenges at large scale.[8] Nuclear energy, although it has scaled rapidly in the past, today faces challenges of cost and delivery time, as detailed later in this testimony. Carbon capture and storage is in its early commercial stages, and will be challenged by the task of siting the storage and pipeline network required. And wind and solar, while likely to be able to provide a majority of the power for future energy grids, at very large scale is likely to face both economic and siting challenges. All of these energy sources, at scale, in many geographies, face formidable opponents as well as supporters.

Portfolio theory and common sense suggests that reliance on any one pathway creates a higher risk of failure. This is illustrated through the simple generic example in Figure 4, where even an 80% chance of success in meeting each condition of deployment of a technology can result in a 50% probability of failure, which are very poor odds for climate mitigation. Creating more

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[6] In this testimony, I address only nuclear fission, and do not address fusion energy.

[7] See Jenkins, Jesse D., Max Luke, and Samuel Thernstrom. "Getting to Zero-carbon Emissions in the Electric Power Sector." *Joule* 2.12 (2018): 2498-2510.

[8] See Loftus, Peter J., et al. "A critical review of global decarbonization scenarios: what do they tell us about feasibility?" *Wiley Interdisciplinary Reviews: Climate Change* 6.1 (2015): 93-112.

options for zero carbon electricity, transport fuel, heat and industry will increase our chances of success.

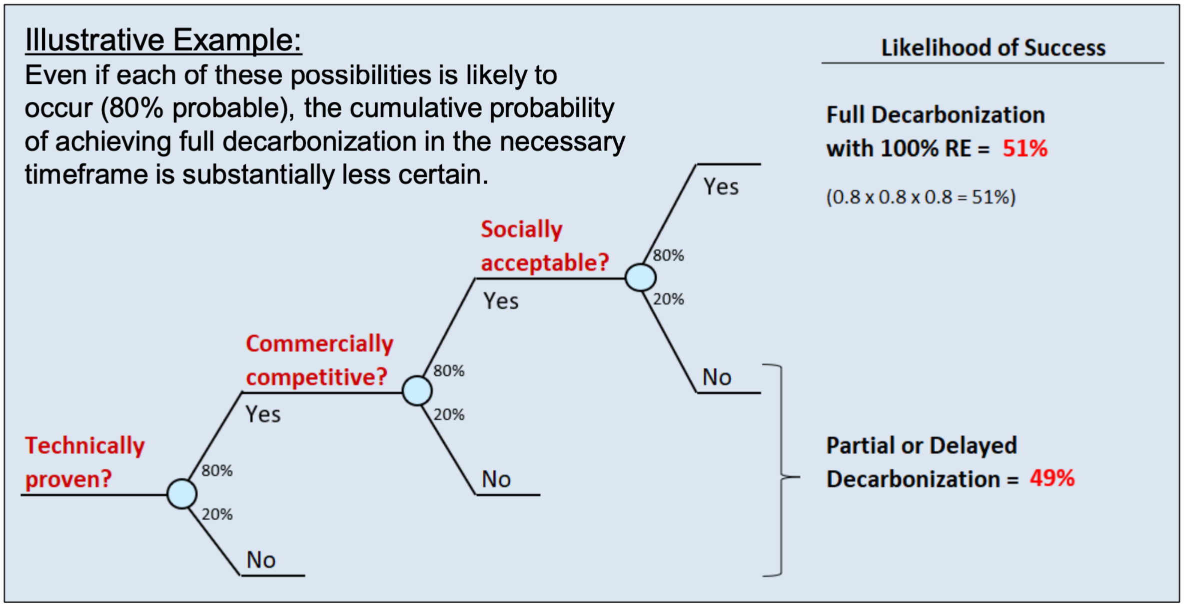

Figure 4: Risk of reliance on a single technology pathway to decarbonize. Illustration courtesy of Bruce Phillips, The Northbridge Group.

III. Some potential values of nuclear for decarbonization

The advantages of nuclear energy are, first, that it is firm or "dispatchable," and not dependent on weather, allowing us to avoid very expensive energy storage to ride through the weeks and months when wind and sun are at low ebb in most regions of the country; this value may be larger in less predictable future inevitably changed climate states. Second, nuclear energy plants are very compact, taking up a hundred to a thousand times less space per unit energy produced than other zero carbon energy forms, and significantly less transmission capacity; high power density may be a valuable attribute in a nation where siting any energy facility is controversial.

Scale and power density

Partly because of the enormous amount of energy that a nuclear power plant can provide per unit space, and the fact that nuclear energy plugs into existing grids quite easily without extensive modification, history has shown that nuclear energy can scale rapidly when policy is aligned to do so and there is a standard product available that can be built repeatedly. Figure 5 illustrates that nuclear energy has scaled quite rapidly in several countries.

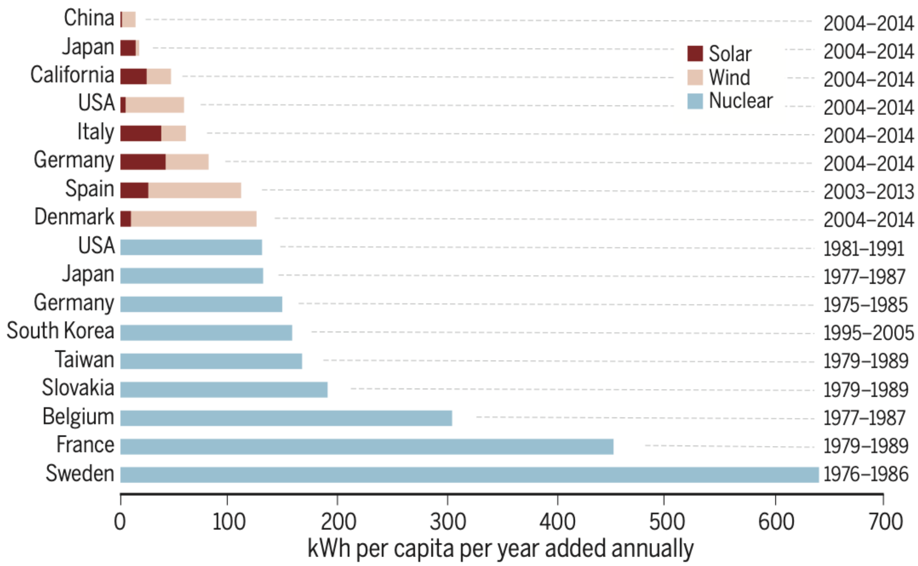

Figure 5: Average annual increase of carbon-free electricity per capita during decade of peak scale-up. Source: Cao, J., Cohen, A., Hansen, J., Lester, R., Peterson, P., & Xu, H. (2016). China-US cooperation to advance nuclear power. *Science*, *353*(6299), 547-548.

The most dramatic example of scaling is France, which nearly completely decarbonized its electric grid in 15 years through the deployment of nuclear energy, shown in Figure 6 below:

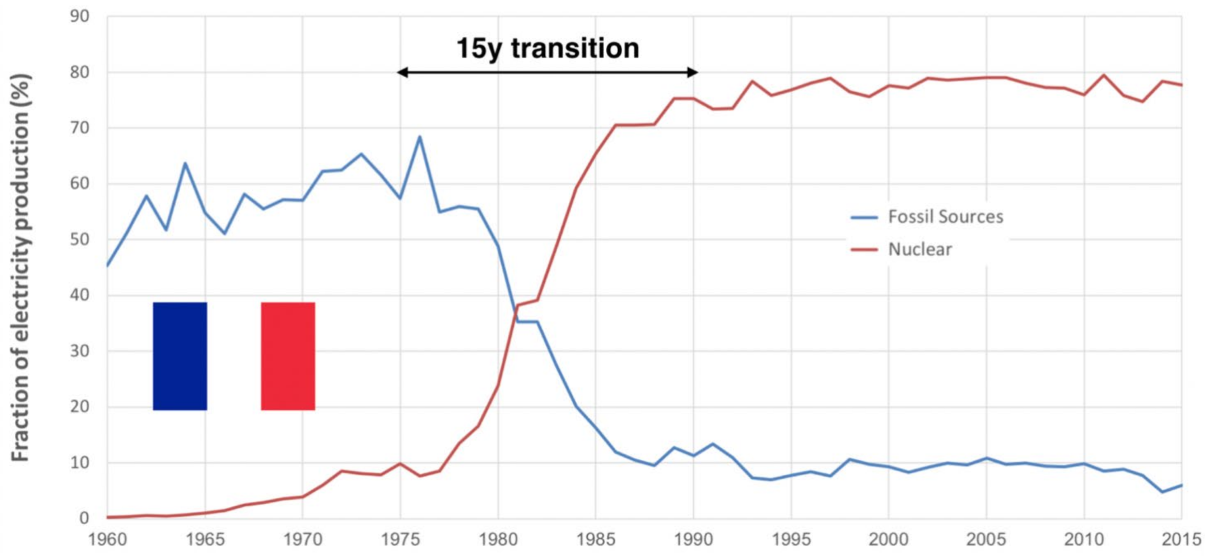

Figure 6: French electricity sources 1960-2015. Source: CATF based on World Bank Development Indicators

As discussed later, to achieve nuclear scaling rates like these again, we will need to improve nuclear business models and supporting policies. But it can be done.

Capability to produce zero carbon fuels

As noted at the outset, electricity represents only 40% of America's energy production and 33% of the US energy/CO_2 problem (see Figure 7 below):

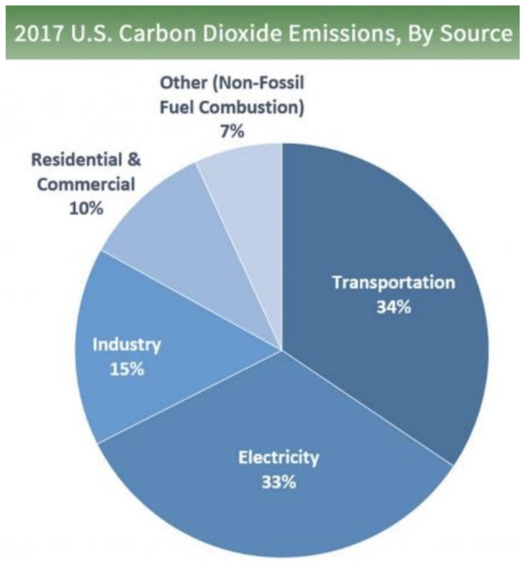

Figure 7: Sources of US carbon dioxide emissions. Source: US Energy Information Administration.

While we may be able to electrify substantial portions of the US economy and power them with a zero carbon electricity grid, there are likely to be substantial remaining demands for non-electric fuels for heavy transport, industrial processes like cement and steel, and building heat. Nuclear energy can provide carbon-free heat to displace fossil fuels in industrial processes and buildings, and to efficiently create hydrogen, a zero carbon fuel.

Additionally, existing nuclear power plants (and those future plants without sufficiently high temperatures) can utilize low-cost electricity to power electrolysis facilities and provide hydrogen for use in a zero carbon fuel system. High temperature reactors are currently on the horizon and poised to make a large impact on hydrogen production at greater efficiency. We don't need to wait for a complete hydrogen economy to start using this zero carbon fuel. Blending nuclear-produced hydrogen into existing natural gas pipelines can have a measurable impact on overall emissions without much infrastructure improvements. Currently, Hawaii blends 12% hydrogen into its natural gas pipelines in some areas[9], reducing overall emissions -- and additional pilot programs are underway in nations like the UK[10].

Nations like the United States, where some nuclear power plants are economically challenged, are looking at hydrogen production very seriously as a way to improve the economics of existing units. In September 2019, the U.S. DOE announced that it had partnered the Idaho

[9] https://www.hawaiigas.com/clean-energy/hydrogen/

[10] https://www.theguardian.com/environment/2020/jan/24/hydrogen-uk-gas-grid-keele-university

National Lab with three utilities (FirstEnergy, Xcel Energy, and Arizona Public Service) to pioneer nuclear electrolysis technology and future forms of hydrogen production.[11] Prior to that, Exelon and Nel Hydrogen began a DOE sponsored project to scale up existing proton exchange membrane electrolyzer technology for use with a nuclear power plant, and that effort is still ongoing.[12] Additionally, a 2013 IAEA report[13] discusses nuclear hydrogen production R&D (mostly theoretical and some government sponsored) in Canada, China, the EU, France, India, Japan, Russia, South Africa, South Korea, and the United States.

In short, nuclear-produced heat and hydrogen could be a very powerful tool in the decarbonization toolkit, even if nuclear power ultimately proves not to be needed to decarbonize electric grids.

III. *The challenges of nuclear power*

At the same time, nuclear energy faces many challenges. Foremost among these are the high cost and delays associated with recent American and European projects. The two are related, as delays result in additional interest costs during construction.

However, high cost and delay are not inevitable, as best construction and project management practices and the building of standardized multiple units have shown elsewhere. A recent study[14] for the UK-based Energy Technologies Institute analyzed the costs associated with more than two dozen large light water nuclear plants built over the last few decades. The first observation from the study is that nuclear costs have varied widely, by a factor of six, as shown in Figure 8 below:

[11] https://apnews.com/bd2475e2fc604c9c8b85b60360fd7f4c

[12] https://www.theengineer.co.uk/nuclear-norwegian-hydrogen/

[13] Hydrogen Production using Nuclear Energy, IAEA, 2013, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1577_web.pdf

[14] Energy Technologies Institute, "The ETI Nuclear Cost Drivers Project," Energy Technologies Institute (2018), https://d2umxnkyjne36n.cloudfront.net/documents/D7.3-ETI-Nuclear-Cost-Drivers-Summary-Report_April-20.pdf

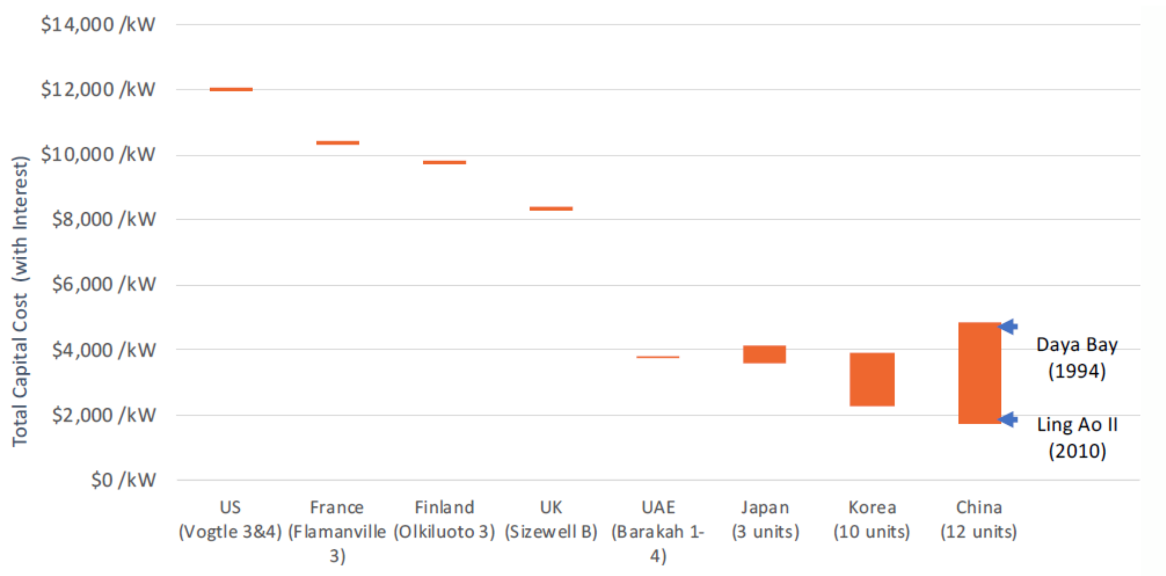

Figure 8: Variations in recent nuclear power plant costs. Source: see footnote 14.

The report, while showing Asian costs to be lower than OECD costs, decomposed cost drivers through a detailed scorecard method and found that ***the difference in unit costs was not primarily driven by differences in regulation or unit labor costs in Asia***, but rather by the efficiency of project management and other best practices. Specifically, top factors that led to higher costs included:

- The challenges of a delivery model that relies heavily on a bespoke "project" model that relies heavily on on-site construction of civil works (a substantial portion of which is necessary to contain water under high pressure) rather than upstream manufacturing and pre-assembly.
- Commencing construction with only a partially completed design.
- Doing "one off" projects rather than multiple builds, thus sacrificing learning by doing and economies of scale.

IV. Why new and advanced reactors?

Cost reductions may be achievable through more advanced designs many of which rely on coolants other than water. Small modular light water reactors as well as microreactors offer opportunities for entry into new markets for nuclear energy, and potentially new revenue streams. Examples of some advanced nuclear plants[15] being developed in North America and around the world include but are not limited to those in the table below:

[15]https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf?fbclid=IwAR09CR2mjhsZq6uh9cy2N0PDGSvbUUmy9zbaOp79mt_6OKfbcJMPeGRdYjU

Coolant	Thermal Neutron Spectrum	Fast Neutron Spectrum
Water	Small Modular Reactor (SMR)	
Helium	High Temperature Gas-Cooled Reactor (HTGR) and Very High Temperature Reactor (VHTR)	Gas-Cooled Fast Reactor (GFR)
Liquid Metal	—	Sodium Fast Reactor (SFR), Lead-Cooled Fast Reactor (LFR)
Molten Salt	Fluoride-Cooled High Temperature Reactor (FHR), Molten Salt Reactor-Fluoride (MSR-fluoride)	Molten Salt Reactor-Chloride (MSR-chloride)

Advanced nuclear plant types Source: see footnote 15.

Some advantages of these reactors:

- Fast reactors use more energetic neutrons to propel the reaction, potentially increasing fuel utilization and/or reducing back-end waste.
- Reactors operating with liquid metal coolant operate at high power density, therefore reducing overall radioactive material and size, due to the thermochemical properties of the coolant. Liquid metals also have higher boiling points (in the hundreds to thousands degrees Celsius) and can reduce the risk and/or severity of a “loss of coolant” event such as occurred in the three major nuclear accidents to date.
- Molten Salt has a high boiling point, similar to liquid metal, but allows for fuel to be mixed in solution with coolant, in some designs, reducing overall volume.
- Gas cooled reactors can leverage existing gas technology, and some utilize more robust fuel designs such as TRISO.
- Many reactors cooled by substances other than water can operate at reduced pressures compared to existing reactors offering potential benefits such as decreasing the need for expensive high pressure containment.

Across the board, these advanced reactor concepts utilize passive safety characteristics, such as reduced pressures, higher coolant boiling points, and/or meltable release plugs that eliminate auxiliary equipment and improve economics while reducing accident probability as well as the consequences of accidents.

The value proposition of these advanced reactors could be substantial:

- Significantly lower capital and/or operational costs than existing plants
- Reduced material inputs
- Manufacturability or rapid deployment capability
- Passive safety systems and inherent safety strategies
- Ease of operation and maintenance
- Reduced emergency planning zones
- Reduced offsite impact during an accident and increased flexibility/scalability of siting
- Increased proliferation resistance, decreased waste production and/or actinide management capacity, and more efficient use of fuel resources

- Hybrid generation adaptability (e.g. hydrogen production, desalination, etc.) and/or load following

All of these attributes could lead to substantially lower capital, licensing and operating costs. A recent detailed study[16] of cost inputs to eight different advanced reactor offerings concluded that the levelized cost of energy from these designs was likely to average $60/MWH, with some as low as $40/MWH. These costs are well within the range of other firm generating capacity options in North America such as combined cycle gas, and even competitive with other zero carbon energy sources such as wind and solar (sources with much lower firm capacity value) in many parts of the country. The estimated cost spread is shown in Figure 9 below.

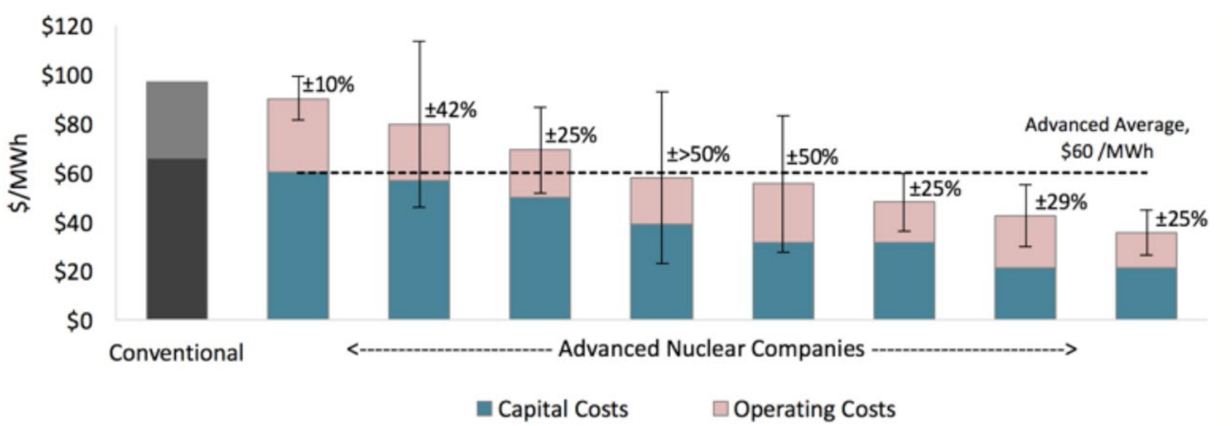

Figure 9: Advanced reactor cost estimates. Source: see footnote 16.

V. The Advanced Nuclear Infrastructure Act of 2020

Clean Air Task Force has provided extensive comments on the most recent draft of the legislation, which I will summarize here.

First, it is laudable that this Committee is dedicated to expanding our decarbonization options and creating a pathway for advanced nuclear technologies. The Clean Air Task Force applauds the leadership of the Chairman, Ranking Member, and others on this Committee who have sought to build legislative frameworks in which a more economically relevant nuclear industry can succeed.

However, there are provisions of this legislation that would not achieve this goal. In fact, the provisions that would additionally streamline environmental laws could have the unintended

[16] Energy Innovation Reform Project, "*What will advanced nuclear power plants cost?" (2016),*
https://www.innovationreform.org/wp-content/uploads/2018/01/Advanced-Nuclear-Reactors-Cost-Study.pdf

effect of damaging the advanced nuclear effort. Without strong environmental standards, confidence in this industry would not increase to levels needed to see deployment of nuclear technologies at industrial sites, repowering generation facilities, and for other purposes in communities around this country. Clean Air Task Force recommends removing Section 201 and Section 203 of this legislation.

Other Clean Air Task Force recommended changes to this draft legislation include:

- Give the Nuclear Regulatory Commission the option of creating an International Advanced Nuclear Reactor Export and Innovation Division within the Office of New Reactors, instead of a new Branch to coordinate international activities including regulatory cooperation on advanced reactors (Section 101);
- Give NRC the authority to deny the imports of fuels by foreign adversaries, through establishment of an import license program, instead of denying domestic licenses to possess fuel that are held by utilities (Section 102);
- Establish three prizes, one each for a light water advanced small modular reactor, a non-light water advanced modular reactor, and a microreactor (Section 202);
- Include study of the use of advanced reactors for repowering of existing fossil fueled generation facilities in the report requested by Congress on unique licensing issues and requirements (Section 204)
- Put a cap on the value of the credit that can be awarded to existing nuclear generation, or consider a reverse auction for funds (Section 301)
- Do not require that lessons learned from the COVID-19 emergency on any processes or procedures be implemented at the Nuclear Regulatory Commission as a part of regular licensing and regulatory processes (Section 303)
- Use the OECD instead of NATO to designate investment by allies (Section 304)
- Do not require the Nuclear Regulatory Commission to enter into an additional MOU with the Department of Energy in order to exchange expertise on fuels (Section 401)
- Do not create a strategic uranium reserve (Section 402)

Finally, we applaud the Chairman for introducing legislation that included the following provisions, and look forward to continuing to work with all Members of this committee to find a way to move these provisions forward:

- A report to Congress on the unique licensing considerations relating to the use of nuclear energy for non-electric purposes, specifically industrial applications and production of zero-carbon fuels (Section 204)
- Preserving at-risk nuclear facilities through an incentive program that is transparent and prioritizes safety, while protecting taxpayers and ratepayers against unnecessary compensation for utilities (Section 301)
- A report to Congress on advanced manufacturing and construction for nuclear energy applications (Section 403)
- An annual report on the spent nuclear fuel and high-level radioactive waste inventory in the United States (Section 502)

Thank you for the opportunity to address this Committee, and I look forward to your questions.