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For a Nuclear-Free, Carbon-Free World

WRITTEN TESTIMONY OF
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BEFORE THE
U.S. House Financial Services Committee,
Subcommittee on National Security, Illicit Finance, and International Financial Institutions

IN A HEARING ENTITLED:

"International Financing of Nuclear Energy"

January 17, 2024

Chairman Luetkemeyer, Ranking Member Beatty, and Members of the House Financial Services Subcommittee on National Security, Illicit Finance, and International Financial Institutions, thank you for this opportunity to testify today regarding International Financing of Nuclear Energy.

Since January 2014, I have served as the Executive Director of the Nuclear Information and Resource Service; prior to that, I served as Associate Director beginning in September 2013. NIRS is a non-profit environmental organization established in 1978 to serve as a national information and networking hub for grassroots organizations and people concerned about nuclear energy and interested in sustainable, renewable energy sources. Prior to working for NIRS, I had served as an analyst, *pro se* intervenor, and grassroots organizer, watchdogging nuclear power plants where I lived in Central New York since 1997. I have tracked the U.S. nuclear industry through four major developmental periods during that time. In an overlapping chapter, I also served as a union member, union organizer, campaigner, and policy analyst in the labor movement, which also informed my analysis of the economic impacts and development policies in communities near nuclear power plants and those experiencing deindustrialization. More recently, I have been a contributing author to the *World Nuclear Industry Status Report* since 2022, a definitive annual report on the status of the nuclear industry, worldwide.[1] I have also

[1] Schneider, Mycle, Antony Froggat, et al. World Nuclear Industry Status Report 2022. Paris, London. September 15, 2022.
https://www.worldnuclearreport.org/-World-Nuclear-Industry-Status-Report-2022-.html
Schneider, Mycle, Antony Froggat, et al. World Nuclear Industry Status Report 2023. Paris, London. December 6, 2023.
https://www.worldnuclearreport.org/-World-Nuclear-Industry-Status-Report-2023-.html

published several reports and briefing papers on the economics and climate justice impacts of nuclear energy, including a 2018 report published by the Rosa Luxemburg Stiftung-New York City at the COP24 climate summit, entitled "Nuclear Power and Climate Action: An Assessment for the Future."[2]

The topic of today's hearing is part of an especially timely and urgent discussion about the United States' role in global energy infrastructure finance and development. Much of the world is eager for the U.S. to play a major role in that process. Many countries are unable to access sufficient finance for their infrastructure needs, and resolving that lack of access is essential to reducing greenhouse gas emissions and preserving a livable climate. Millions of people throughout the U.S. are eager for our government to follow through and do its part, both to reduce our own emissions and to provide the financial assistance other countries need. If the U.S. does come through with what other countries need, on terms that benefit them and advance their own interests, it will also generate goodwill and benefit our own country, in turn.

However, using the U.S.'s influence within international finance institutions (IFIs) and our own export and development finance programs to *prioritize* nuclear energy projects, as House Resolution 806 (H.R. 806) would do, will not accomplish those goals. We would be putting our eggs in the wrong basket, at exactly the wrong time, for something that will not help. History will not look on it as a wise decision, and neither will most other countries. Doing so would benefit the nuclear industry by limiting competition from more affordable energy sources, and it would benefit the fossil fuel industry by prolonging countries' reliance on coal, oil, and gas. But advocating for IFIs to prioritize finance for nuclear energy projects will not benefit countries that are in need of energy infrastructure finance, nor will it benefit the United States, as the testimony I offer today will explain.

I preface my comments by acknowledging my own and my organizations' opposition to nuclear power as an energy source. There are many good reasons to oppose nuclear energy projects: the environmental impacts of uranium mining and radioactive waste; the health, environmental, and economic impacts of radioactive pollution and catastrophic nuclear accidents; the high economic costs of nuclear power plant construction and operation; the climate opportunity costs of investing in nuclear projects that cost far more and take far longer than other low- or zero-emissions resources, including energy efficiency programs, solar photovoltaics, and wind power; the national security and nuclear weapons proliferation risks posed by nuclear energy and waste storage facilities; and the societal costs of decommissioning and environmental cleanup of nuclear facilities, and of establishing permanent repositories or long-term management programs for irradiated ("spent") fuel and high-level radioactive waste. There are major environmental justice impacts throughout the nuclear industry's operations, with Indigenous peoples, communities of color, and economically disadvantaged communities bearing health and environmental burdens at disproportionate rates. For instance, there are over 15,000 abandoned uranium mines in the United States, the majority of which are on Native American lands or near to Indigenous communities. There are over 500 abandoned mines on the Navajo Nation alone, which have contaminated drinking water sources, and led to increases in cancer and other

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[2] Judson, Tim. "Nuclear Power and Climate Action: An Assessment for the Future." Rosa Luxemburg Stiftung-NYC Office. November 2018.
https://rosalux.nyc/wp-content/uploads/2020/11/RLS-NYC_Nuclear_Power_Climate_Action.pdf

medical conditions. Black communities near a fuel factory in Columbia, South Carolina, as well as the nuclear waste, energy, and weapons production complex spanning the Savannah River in South Carolina and Georgia suffer contamination of drinking water sources and threats to their health.

Some of those concerns help to explain *why* IFIs and the Export/Import Bank have not financed very many nuclear energy projects. However, the environmental impacts and beliefs about the dangers of nuclear energy are not among those factors. In fact, through the global policy regimes formalized under the Nuclear Nonproliferation Treaty (NPT), access to nuclear energy is consistently promoted as a carrot to countries for signing the NPT and opting not to pursue their own nuclear weapons programs. The International Atomic Energy Agency (IAEA) was established both to monitor compliance with the NPT, and to promote the development of nuclear energy. The IAEA's governing statute sets forth its primary objectives: "The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."[3]

IFIs, on the other hand, also have a fiduciary duty to the borrowing countries and the countries that fund and govern them. Financing energy projects with high costs, long construction times, and above-average cancellation rates entails high credit risk. Lenders throughout the finance sector typically use credit risk evaluations to determine if a loan application represents too great a potential for default. If countries develop plans for nuclear energy projects that demonstrate a lower credit risk, then IFIs would be able to approve them. But for the U.S. to direct IFIs to prioritize finance for nuclear energy projects as a blanket policy would be counterproductive. It would either expose the international finance system to increasing default rates; discourage countries from seeking loans for energy projects that would be more affordable and beneficial to them; or it would drive them to seek financing from institutions not associated with the United States. None of those outcomes would benefit the U.S.

The U.S. has even acknowledged the high financial risks of nuclear power projects in our own policies. The Energy Policy Act of 2005 created loan guarantee programs for energy projects that would have difficulty accessing finance through banks and other conventional lending institutions. By 2008, Congress had authorized up to $18.5 billion in loan guarantee authority for "advanced nuclear" power plants.[4] Nuclear utilities have also eased access to credit for reactor construction projects through state policies that reduce their risk of default by offloading the expense to consumers, such as the construction-work-in-progress (CWIP) programs that allow utilities to charge their ratepayers for the finance payments on nuclear construction loans before the nuclear reactor is completed. Many, if not most, reactors in the U.S. were originally built under CWIP ratemaking. Before the first of two new reactors in Georgia came online last summer, Georgia Power's household customers had paid, on average, $926 toward the utility's finance costs for the project since 2013—without receiving a single kilowatt-hour of electricity

[3] United Nations. "The Statute of the IAEA." International Atomic Energy Agency. https://www.iaea.org/about/statute

[4] O'Grady, Eileen. "Five U.S. nuclear plants make DOE loan short-list." Reuters. February 18, 2009. https://www.reuters.com/article/utilities-nuclear-loan/update-1-five-u-s-nuclear-plants-make-doe-loan-short-list-idUKN1846256420090218/

from the project.[5] Loan guarantees and CWIP policies have lowered the credit risk to nuclear utility companies, but only by offloading those risks onto U.S. taxpayers and captive ratepayers.

Prioritizing nuclear project finance through IFIs would effectively do the same thing, by limiting countries' access to credit for projects that are less affordable, either burdening their own economies with high electricity costs and taxes, or leading to defaults that would be borne by U.S. taxpayers.

Economic and Climate Opportunity Costs of Nuclear Export Financing

The COP28 global climate summit concluded last month with nearly 200 countries, including the U.S., adopting a statement that calls for reducing worldwide greenhouse gas emissions 43% by 2030, and, in order to meet that goal, tripling the amount of renewable energy and doubling energy efficiency by 2030.[6] The statement also notes that "developing country Parties" cannot obtain enough capital to finance the infrastructure they need to meet those goals and to protect their populations from severe storms, flooding, drought, crop failures, extreme heat, and other intensifying effects of climate change. In order to meet countries' needs, the U.S., along with other industrialized nations, has been called upon to do our part to ensure sufficient access to finance for renewable energy, energy efficiency, and climate-resilient infrastructure. If the U.S. chooses to prioritize financing nuclear energy projects rather than what the world has clearly and unambiguously stated that countries need, that policy will be seen as a failure and a refusal to be a partner in financing energy and other public infrastructure when the world needs it the most.

Building nuclear power plants is far more expensive than renewable energy sources (which are also environmentally safer and cleaner), and they take far longer to complete and begin producing energy. In the ten years from 2013-2022, sixty-six new reactors were built worldwide, with an average construction time of 9.4 years; for the 27 reactors built in nine countries other than China, the average time to build was 14 years. Nuclear projects experience very high rates of major cost overruns and construction delays, in the U.S.[7] and most other countries.[8] Even if nuclear reactor exports are put on order today, there is a good chance that none of them would be online and generating power before H.R. 806 would expire in ten years, much less before 2030.

For countries that rely on IFIs and export finance, the level of financial risk is too great. The reason why nuclear energy projects frequently do not qualify for financing through IFIs and the U.S. Export-Import Bank is that the credit risk to developing nations for those projects is too

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[5] Newsome, Tom, et al. "In the Matter Of: Georgia Power Company's Twenty-Eighth Semi-Annual Vogtle Construction Monitoring ('VCM') Report—Direct Testimony and Exhibits." Georgia Public Service Commission Public Interest Advocacy Staff, Before the Georgia Public Service Commission. June 22 , 2023. https://services.psc.ga.gov/api/v1/External/Public/Get/Document/DownloadFile/204891/86214

[6] Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, Fifth session. "Outcome of the first global stocktake." United Nations Framework Convention on Climate Change. United Arab Emirates. December 13, 2023. https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf

[7] Eash-Gates, Philip, et al. "Sources of Cost Overrun in Nuclear Power Plant Construction Call for a New Approach to Engineering Design." *Joule*, vol. 4, issue 11, pages 2348-2373. November 18, 2020. https://www.sciencedirect.com/science/article/pii/S254243512030458X

[8] Potter, Brian. "Why Does Nuclear Power Plant Construction Cost So Much?" Institute for Progress. May 1, 2023. https://ifp.org/nuclear-power-plant-construction-costs/

great.[9] In addition, because energy infrastructure loans are generally paid back with revenue from energy sales, the amount of debt needed for nuclear construction would result in higher energy prices or taxation for the host country, creating a drag on its economy, while limiting the amount of finance countries can access for the rest of their infrastructure needs.

Costs and Construction Trends for Nuclear Power Projects

The track record indicates that nuclear energy projects are both significantly more expensive than other energy sources, and far more prone to significant cost overruns, delays, and cancellations. For instance, of twenty-eight reactors proposed in the U.S. from 2007-2008, all but two were canceled or indefinitely suspended.[10] Twenty-four were canceled before beginning construction. Twelve did receive combined construction and operating licenses (COLs) from the Nuclear Regulatory Commission; utilities later withdrew the other twelve applications or asked NRC to suspend their review. Two reactors at the V.C. Summer nuclear power plant in South Carolina were canceled in 2017, after $9 billion was spent and construction was over 35% complete.[11]

The two-reactor expansion project at Plant Vogtle in Georgia is now nearing completion. The first reactor began commercial operation on July 31, 2023. NRC approved the second for fuel loading at around the same time, but startup has been delayed by the failure of a coolant pump in October, which has had to be replaced. The project is seven years behind schedule and $17 billion over budget–so much that Georgia Public Service Commission staff testified in July 2023 that "cost increases and schedule delays have completely eliminated any benefit on a lifecycle cost basis."[12] The cost overruns on the Vogtle 3&4 and V.C. Summer 2&3 projects led to the bankruptcy of Westinghouse in 2017,[13] the cancellation of its proposed projects to build AP1000 reactors in the United Kingdom,[14] and indefinite suspension of plans to build six of the reactors in India.[15]

The experience has been similar or worse in most other countries. The decade between 2013 and 2022 saw the largest number of reactors built since the decade ending in 1990, with a total of sixty-six reactors coming online worldwide. As detailed above, global average times from construction are over nine years—and construction times are significantly greater that average

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[9] International Atomic Energy Agency. *Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects.* IAEA report. July 2017. https://www-pub.iaea.org/MTCD/Publications/PDF/P1765_web.pdf

[10] "Combined License Applications for New Reactors." U.S. Nuclear Regulatory Commission. July 3, 2023. https://www.nrc.gov/reactors/new-reactors/large-lwr/col.html

[11] Schneider, Mycle, et al. "World Nuclear Industry Status Report 2023." December 6, 2023. See pages 245-247. https://www.worldnuclearreport.org/IMG/pdf/wnisr2023-v4-hr.pdf

[12] Associated Press. "The First US Nuclear Reactor Built From Scratch in Decades Enters Commercial Operation in Georgia." July 31, 2023. https://www.usnews.com/news/technology/articles/2023-07-31/first-american-nuclear-reactor-built-from-scratch-in-decades-enters-commercial-operation-in-georgia

[13] Schneider, Mycle, et al. "World Nuclear Industry Status Report 2023." December 6, 2023. See pages 238-242, 94, and 244-247. https://www.worldnuclearreport.org/IMG/pdf/wnisr2023-v4-hr.pdf

[14] Vaughan, Adam. "UK nuclear power station plans scrapped as Toshiba pulls out." *The Guardian.* London. November 8, 2018. https://www.theguardian.com/environment/2018/nov/08/toshiba-uk-nuclear-power-plant-project-nu-gen-cumbria

[15] Chaudhury, Dipanjan Roy. "NPCIL-Westinghouse deal: Still many differences to resolve." *The Economic Times*. February 27, 2020. https://economictimes.indiatimes.com//industry/energy/power/npcil-westinghouse-deal-still-many-differences-to-resolve/articleshow/74328698.cms

outside of China.[16] Cost overruns and construction delays have also plagued projects using France's European Pressurized-water Reactor (EPR) design,[17] and contributed to the bankruptcy of nuclear services giant Areva (now named Orano, after a corporate restructuring and transfer of the company's new reactors division to nuclear utility Électricité de France (EDF)).[18] Construction of EPRs in Finland and France have taken more than a decade longer than originally projected, and the costs have escalated to about 400% of the original projections.

The track record of large cost overruns, delays, and cancellations led to a loss of confidence in the development of large, light-water reactor (LWR) designs that had been the hallmark of the industry since the 1970s. Prior to that time, the industry had tested many other types and sizes of reactors, including liquid sodium-cooled fast neutron reactors and graphite-moderated, high-temperature-gas-cooled reactors.[19] Most countries decided, by the 1970s, that building LWRs, as large as possible and in multi-reactor power plants, was the most economical approach. The larger the reactor, the relative amount of high-grade steel, concrete, and sophisticated components is proportionally less; and the use of ordinary light water as the moderator and primary coolant made reactors both less expensive to build and operate and technically simpler.

It is not that no large LWRs are being built today; it is that the vast majority of reactors being built are either in countries without open-market economies (e.g., China); in countries that can self-finance with high levels of sovereign wealth, without regard to the total cost (e.g., the United Arab Emirates); or under export deals that include full project financing (e.g., Russia's deals with Bangladesh, Egypt, and Turkey.) However, the bankruptcies of Westinghouse and Areva and the recognition of credit risk and the high cost to electricity consumers has paused most new construction in countries with open-market economies and public regulation of utility rates, since 2017.

More recently, however, the U.S. government has started negotiating agreements with other countries to build large LWRs using the Westinghouse AP1000 design, including in Poland[20] and Ukraine.[21] In 2023, Westinghouse and Ukraine announced that a plan to build the first of these at the Khmelnytskyi Nuclear Power Plant, at a cost of $5 billion and with a claimed completion

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[16] Schneider, Mycle, et al. "World Nuclear Industry Status Report 2023." December 6, 2023. https://www.worldnuclearreport.org/IMG/pdf/wnisr2023-v4-hr.pdf

[17] Bass, Frank. "European Pressurized Reactors (EPRs): Next-generation design suffers from old problems." Institute for Energy Economics and Financial Analysis. February 2, 2023. https://ieefa.org/resources/european-pressurized-reactors-eprs-next-generation-design-suffers-old-problems

[18] Biegert, Claus, et al. *The Uranium Atlas: Facts and Data about the Raw Material of the Atomic Age.* Nuclear Free Future Foundation, Rosa-Luxemburg-Stiftung, Beyond Nuclear, and International Physicians for the Prevention of Nuclear War 2020. See page 47. https://www.rosalux.de/fileadmin/rls_uploads/pdfs/sonst_publikationen/UraniumAtlas_2020.pdf

[19] Lyman, Edwin. *"Advanced" Isn't Always Better: Assessing the Safety, Security, and Environmental Impacts of Non-Light-Water Nuclear Reactors.* Union of Concerned Scientists. March 18, 2021. https://www.ucsusa.org/sites/default/files/2021-05/ucs-rpt-AR-3.21-web_Mayrev.pdf

[20] "Historic Contract Paves the Way for Site Work on Poland's First Nuclear Power Plant." Westinghouse. September 27, 2023. https://info.westinghousenuclear.com/news/historic-contract-paves-the-way-for-site-work-on-polands-first-nuclear-power-plant

[21] "Ukraine and Westinghouse sign agreement for Khmelnitsky AP1000." World Nuclear News. December 18, 2023. https://www.world-nuclear-news.org/Articles/Ukraine-and-Westinghouse-sign-agreement-for-Khmeln

date of 2029.[22] The announcement did not explain how Westinghouse and Ukraine would achieve so large a reduction in cost and construction time for the AP1000, nor how construction of the reactor would be undertaken while the country is still under attack by Russia.

Projected Costs and Construction Times for New Nuclear Reactor Designs
These factors have led the nuclear industry to revisit reactor design concepts that were largely abandoned for commercial development after the 1960s, and to pursue innovation paths and business models popularized in the information technology industry in an effort to find a viable path forward for the industry. As a result, a relatively large number of "nuclear startup" firms and some long-established firms (e.g., GE-Hitachi and Westinghouse) are trying to commercialize new reactor designs, and there has been an influx of venture capital into the industry that did not exist at a significant level twenty years ago.

There are now many claims being made about these new reactor designs, asserting that they will lead to significant reductions in the costs of construction and operation of new reactors and in the amount of time that it would take to build them.[23] Such claims have yet to be proven.

Specifically, there are two, overlapping categories of new reactor designs on which the industry is focused, often lumped together into a broader category of "advanced reactors": small modular nuclear reactors (SMRs) and non-light-water reactors (non-LWRs, or nLWRs). SMRs are reactors that not only have much less generation capacity than the average large LWRs that are mostly in operation today; the claimed reductions in cost and construction time depend on designing the reactors to be built assembly-line-style in factories and shipped to the power plant location where they would be installed. It should be noted that the AP1000, while a large LWR (1,110 megawatts), incorporated modular manufacturing for the same reason. Large sections of the reactors were built in factories and shipped to the construction sites to be assembled. However, there were problems with quality control in the factories and the manufacturers had difficulty with the specifications, leading to some of the delays and cost overruns.[24] Many SMR power plant designs envision co-locating several reactors in the same facility, and offering the power plant owner the option to scale the plant to their generation needs by adding reactors as needed. Again, this feature is not unique to SMRs, as large LWRs have also been built in multi-reactor configurations in the U.S. and many other countries. The Fukushima Dai-Ichi nuclear power plant in Japan had six General Electric boiling water reactors (BWRs), as many as NuScale planned for its Carbon Free Power Project SMR plant in Idaho.

Non-LWRs are nuclear reactors that would use a medium besides regular water as the neutron moderator and primary coolant for the nuclear fuel. These designs also tend to have lower generation capacity than large LWRs. Some non-LWR designs also qualify as SMRs (such as X-

[22] "Westinghouse reactor set to boost Ukraine's Khmelnytskyi NPP output by 2029." The New Voice of Ukraine. December 20, 2023. https://english.nv.ua/nation/energoatom-says-when-westinghouse-reactor-at-khmelnytskyi-npp-to-be-launched-50378000.html

[23] Lyman, Edwin. *"Advanced" Isn't Always Better: Assessing the Safety, Security, and Environmental Impacts of Non-Light-Water Nuclear Reactors.* Union of Concerned Scientists. March 18, 2021. https://www.ucsusa.org/sites/default/files/2021-05/ucs-rpt-AR-3.21-web_Mayrev.pdf

[24] Hals, Tom, and Emily Flitter. "How two cutting edge U.S. nuclear projects bankrupted Westinghouse." Reuters. May 2, 2017. https://www.reuters.com/article/idUSKBN17Y0C7/

Energy's Xe-100 design), but not all of them are. For instance, Terrapower's Natrium reactor is 345 megawatts (MW), larger than the common definition of SMR (300 MW or less); and it is designed to be deployed as a stand-alone reactor. Designers of some non-LWRs claim that they will reduce construction and operating costs by being "inherently safer" and that their size and the form of their fuel would not require the inclusion of an expensive concrete and steel radiation containment structure or as many complex safety systems as LWRs. As mentioned above, however, most non-LWR designs are based on reactor concepts that were conceived and tested previously but did not prove to be economically or technically viable for commercial power generation.

Worldwide, only four reactors described as SMRs are currently in operation: two in Russia and two in China. All four experienced multi-year construction delays, and all appear to have faced operational problems that have kept them offline most of the time since they were built.[25] Currently, there are at most five additional SMRs that are currently under construction. Russia is building two more of its barge-based light-water SMRs, and one of a different non-LWR design. China is building an SMR of a different design, which is estimated to be six years behind schedule.[26] Argentina has been in the process of building a 25 MW reactor since the 1980s, which is now often characterized as a SMR. Current projections are that it may be completed in 2027.[27]

The first SMR power plant project in the US was announced in 2015 by NuScale. The Carbon Free Power Project (CFPP) was originally planned to have twelve 50 MW NuScale VOYGR reactors, the first of which would be generating electricity in 2024; the total project cost was estimated to be $3 billion (or $5 million/MW).[28] NuScale canceled the project in November 2023,[29] before breaking ground,[30] because its projected cost ballooned to $9.3 billion ($20 million/kW, significantly greater than the final cost rate of the Vogtle reactors).[31] NuScale was unable to secure enough customers to make continued investment in the project viable. The projected price for electricity had jumped to $89 per megawatt-hour (MWh)—a 53% increase from NuScale's previous target price, even after taking into account the federal Clean Electricity Investment Tax Credits (CEITC), which were included in the Inflation Reduction Act in 2022.

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[25] Schneider, Mycle, et al. "World Nuclear Industry Status Report 2023." December 6, 2023. See pages 316-333. https://www.worldnuclearreport.org/IMG/pdf/wnisr2023-v4-hr.pdf

[26] Ibid.

[27] Ibid.

[28] Hopkins, John L. "Testimony of NuScale Power before the Committee on Energy and Natural Resources of the U.S. Senate: Hearing to Examine the Status of Innovative Technologies Within the Nuclear Industry." U.S. Senate. May 17, 2016. https://www.energy.senate.gov/services/files/D642CB8F-4B4E-4A56-82E4-C5A26B3A7F59

[29] Gardner, Timothy, and Manas Mishra. "NuScale ends Utah project, in blow to US nuclear power ambitions." Reuters. November 9, 2023. https://www.reuters.com/business/energy/nuscale-power-uamps-agree-terminate-nuclear-project-2023-11-08/

[30] Kemp, David, and Peter Van Doren. "Nuclear Power's Newest Cautionary Tale." Cato Institute. November 10, 2023. https://www.cato.org/blog/nuclear-powers-newest-cautionary-tale

[31] Schlissel, David. "Eye-popping new cost estimates released for NuScale small modular reactor." Institute for Energy Economics and FInancial Analysis. January 11, 2023. https://ieefa.org/resources/eye-popping-new-cost-estimates-released-nuscale-small-modular-reactor

The U.S. Department of Energy (DOE) had already paid NuScale $583 million dollars[32] out of a $1.355 billion cost-sharing grant that it approved in 2020,[33] after the company had announced a previous increase in the projected cost of the CFPP.[34]

There are significant doubts about the commercial viability of SMRs and non-LWRs, even among supporters of nuclear energy. In 2018, a research team based at Carnegie Mellon University published an article in the *Proceedings of the National Academy of Sciences* that expressed grave doubts about the commercial viability of new reactors of all types in the 2050 timeframe; and about the feasibility of building a large export market for U.S.-made reactors:

> For several years, we have been evaluating the potential role that new nuclear power technologies might play in this decarbonization by conducting a variety of studies that investigate the technical, economic, and political challenges that face it, both in the United States and around the world. We have concluded that, barring some dramatic policy changes, it is most unlikely that nuclear power will be able to contribute to decarbonization in the United States, much less provide a new carbon-free wedge on the critical time scale of the next several decades. With the exception of a few other nations, including China, the same may also be true across the rest of the world.
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> … From the foregoing, we conclude that in the absence of a dramatic change in market conditions, political will, and substantial subsidies, there is virtually no chance that the United States will be able to undertake the construction of additional large LWR power plants in the next several decades. Indeed, if the United States is going to retain most of its existing fleet of large LWRs, additional programs to subsidize their life extension and continued operation will have to be implemented in just the next few years.
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> Because the United States will probably not build any new large LWRs, and there is no practical way to bring advanced reactor designs to achieve widespread commercial viability in the United States in less than several decades, we have argued that only factory-manufactured SMRs could contribute a significant new nuclear carbon-free wedge on that time scale. For that to happen, several hundred billion dollars of direct and indirect subsidies would be needed to support their development and deployment over the next several decades, since present competitive energy markets will not induce their development and adoption. … Moreover, a serious national commitment would have to be made to deeply decarbonize the energy system. The signal that this is happening must be strong enough for investors to confidently assume that the direct or indirect cost of emitting carbon dioxide to the atmosphere will lie in the range of $100 per ton of CO2

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[32] Cooke, Stephanie. "The End of DOE's Flagship SMR — A Cautionary Tale." Energy Intelligence. November 17. 2023. https://www.energyintel.com/0000018b-cf50-dbb5-a5ef-df7378750000

[33] Utah Associated Municipal Power Systems. "DOE cost-share award of $1.355 billion is approved for UAMPS' Carbon Free Power Project." UAMPS. Press Release. October 16, 2020. https://www.uamps.com/file/41df5556-8f47-47c3-af10-d3665271fd20

[34] Gardner, Timothy. "Trump administration approves $1.35 billion for small-scale nuclear reactor project." Reuters. October 16, 2020. https://www.reuters.com/article/usa-nuclearpower-nuscale-idUSL1N2H71LZ/

> within a decade. All these developments are possible, but we believe they are most unlikely. …[35]

More recently, on January 9, 2024, former DOE Secretary Ernest J. Moniz published a commentary in the *Boston Globe* that identified a litany of technical, policy, and financial challenges to meeting the nuclear industry's worldwide expansion goals, announced at the COP 28 climate summit:

> A new system will need to deliver standardized products rather than costly and risky one-off multi-decade projects. This could mean relying on proven designs of gigawatt-scale reactors, or embracing a selection of new smaller designs amenable to assembly-line methods (analogous to those in the airline and shipbuilding industries), or some combination of both. Many countries, including the United States, have expressed strong interest in small modular reactors, but the reality is that little progress is being made.
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> It will require groups of customers of zero-carbon always-available electricity — utilities, large industrial users, large IT companies — to agree to purchase electricity or heat from dozens of nuclear plants of the same design. This so-called "orderbook" approach, common in the aviation industry, would address many flaws of the current model by sending a durable demand signal to the nuclear supply chain, pooling resources, and unlocking workforce development, thereby reducing risks and costs. With each new reactor built, countries, companies, investors, and policy makers also learn more, saving time and money.
>
> Public-private partnerships will probably be needed to implement this vision. Governments can help motivate the parties by offering financial risk backstops that could provide further confidence to private-sector developers, lowering first-of-a-kind risks. But more may be needed to launch a true nuclear renaissance, since nuclear construction is capital intensive.[36]

Assuming all of those challenges could be addressed, Moniz also recommends that global nuclear energy expansion may require establishing an international regulatory body "charged with issuing a single globally accepted generic certification for reactor designs would further lower the barriers to nuclear deployment."[37] He also suggests modeling the nuclear industry approach after the aviation industry's regulatory model, but curiously does not address the disasters with Boeing's 737 MAX passenger planes over the last several years. These considerations must be taken seriously when talking about the nuclear energy industry, especially with respect to the potential of SMRs, which would be mass-produced in factories in similar fashion to commercial passenger planes. SMR companies have not explained how they would

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[35] Morgan, M. Granger, Ahmed Abdulla, Michael J. Ford, and Michael Rath. "US nuclear power: The vanishing low-carbon wedge." Proceedings of the National Academy of Sciences of the United States of America. 115 (28) 7184-7189. July 10, 2018. http://www.pnas.org/content/115/28/7184

[36] Moniz, Ernest J. "The world wants to triple nuclear energy: What will it take?" *Boston Globe.* January 9, 2024. https://www.bostonglobe.com/2024/01/09/opinion/ernest-moniz-nuclear-power-reactors-international-standards-climate-change/

[37] Ibid.

address design flaws or manufacturing errors after dozens or hundreds of SMRs were shipped to and installed in power plants.

Assuming that all of those challenges were addressed, Moniz notes that the industry would have to sustain an unprecedented rate of construction in order to meaningfully expand nuclear energy:

> "To make good on the [nuclear industry's expansion] pledge, accounting for a ramp-up time, the world will soon need to build the equivalent of about 50 large nuclear power reactors per year until 2050. This is two-thirds more than were built at nuclear power's peak in the early 1980s, and the current pace of construction is well short of that."[38]

Such a rate of construction is not only unprecedented on an annual basis, but it would have to be sustained over the next twenty-five years. The peak years for global reactor construction were 1984 and 1985, when thirty-three reactors started up each year.[39] The fastest average startup rate over a 20-year period was from 1971-1990, when there were only 19.3 startups per year. The pace has been far slower over the last twenty years, it has been less than five per year. Also, if SMRs were truly to lead global nuclear energy growth, the rate of construction would have to be far higher still: instead of fifty large LWRs per year, it would require more like bringing 750-800 NuScale VOYGR (77 MW) or X-Energy Xe-100 (80 MW) SMRs online each year, and to sustain that pace over decades.

Nuclear Energy Growth vs. Renewable Energy Growth
While the nuclear energy industry has never demonstrated that it can achieve such rates of deployment, there are emissions-free energy sources that have: solar photovoltaics (PV) and wind energy.[40] Last week, the International Energy Agency issued a report that finds renewable energy growth is occurring at a pace that puts the world on track to triple renewable energy capacity by 2030.[41] The IEA projects that renewable energy sources provided 30% of global electricity generation in 2023, more than three times the share that nuclear energy provided. Renewable energy sources increased by 507 gigawatts (GW) in 2023 alone—over 37% more than total nuclear generating capacity. 95% of renewable energy growth came from wind and solar PV, and the IEA projects generation from both energy sources will surpass nuclear generation in 2025 and 2026, respectively.[42] Based on its findings, the agency projects that the world is already on track to increase renewable capacity by 250% in 2030, to nearly 9,500 GW. Among the four primary obstacles to achieving the full 300% target is "insufficient financing in emerging and developing economies."[43]

While pushing IFIs to prioritize nuclear energy finance will do nothing to expand low-/zero-emissions energy in the critical remainder of this decade, increasing access to financing for

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[38] Ibid.
[39] [39] Schneider, Mycle, et al. "World Nuclear Industry Status Report 2023." December 6, 2023. See pages 49-50. https://www.worldnuclearreport.org/IMG/pdf/wnisr2023-v4-hr.pdf
[40] DiGangi, Diana. "Renewables growth puts COP28 goals within reach, but acceleration is needed: IEA." UtilityDive. January 12, 2024. https://www.utilitydive.com/news/renewable-energy-cop28-growth-economics-global/704446/
[41] "Renewables 2023." International Energy Agency. January 2024. https://www.iea.org/reports/renewables-2023
[42] Ibid.
[43] Ibid.

renewable energy projects is exactly what is needed. Moreover, filling the renewable energy finance gap will provide a critical test of the relevance of international nuclear energy finance. Based on IEA's projections, tripling capacity over the next seven years would lead to renewable generation comprising over 50% of worldwide electricity in 2030, and annual growth rates would reach about 1,000 GW/year—more than 2.5 times total nuclear generation capacity today. The total *increase* in renewable generation in eight years (from 2022-2030) would be around 8,000 terawatt-hours per year (TWh/yr.), exceeding the total annual amount of nuclear generation 27 years from now, if the nuclear industry actually achieved its new goal for 2050.

Assessments by nuclear energy advocates of the global market for reactor construction are not reflective of the economic and practical realities. For instance, a 2022 report by Third Way estimated a tripling of the global market for nuclear energy, assuming an electricity price of $90 per megawatt-hour (MWh).[44] That cost projection is both substantially greater than the cost of renewable energy sources (wind at $50 and solar at $60 in 2023), and substantially lower than the actual cost of new reactors ($180/MWh in 2023).[45] These cost disparities have resulted from a consistent trend over the last 15 years: from 2009-2023, wind and solar costs decreased 63% and 83% respectively, while nuclear costs increased 62%.[46]

Finance policies for nuclear energy projects should not be based on cost projections that the industry has not demonstrated that it is close to meeting. This is a mature global industry, which has a more than sixty-year track record on which to evaluate the prospective creditworthiness of development projects. As mentioned above, even NuScale's last electricity price estimate for the CFPP of $89/MWh applied the 30% CEITC and the $1.355 billion DOE grant toward reducing the cost to consumers. On an unsubsidized basis, the cost of generation for the CFPP would have close to $120/MWh—more than double the unsubsidized cost of wind and solar in 2023.[47] It is important to remember that renewable energy sources are also eligible for similar incentives in many countries to the ones that NuScale's project would have received, so it is not clear why the market for nuclear energy would triple by assuming a cost of $90/MWh in the 2030s and 2040s, when countries could access wind and solar for less than half that price today. Advocating for U.S.-affiliated IFIs to prioritize financing for nuclear energy projects would only succeed in pressuring countries to make uneconomical investment decisions, or it would drive them to seek financing from other sources for the investments they want to make.

National Security Impacts of Nuclear Power Plants

The findings in H.R. 806 that exporting nuclear energy facilities to other countries would benefit the U.S.'s national security interests focus on establishing transactional relationships predicated

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[44] Ahn, Alan, et al. "2022 Map of the Global Market for Advanced Nuclear: Emerging International Demand." Third Way. October 24, 2022. http://thirdway.imgix.net/pdfs/2022-map-of-the-global-market-for-advanced-nuclear-emerging-international-demand.pdf

[45] Lazard. "Lazard's LCOE+ (April 2023)." April 2023. https://www.lazard.com/media/2ozoovyg/lazards-lcoeplus-april-2023.pdf

[46] Ibid.

[47] Schlissel, David. "Eye-popping new cost estimates released for NuScale small modular reactor." Institute for Energy Economics and Financial Analysis. January 11, 2023. https://ieefa.org/resources/eye-popping-new-cost-estimates-released-nuscale-small-modular-reactor

on putting other countries in a position of dependency on the U.S. for energy security.[48] However, there are real and countervailing factors with exporting nuclear energy infrastructure that could compromise both the U.S.'s and the other country's security.

Nuclear safety and security experts have known for some time that commercial nuclear energy facilities have vulnerabilities to a wide array of attacks and acts of malice, creating significant and unique types of national security threats. The Nuclear Regulatory Commission has regulations requiring nuclear power plants to have certain minimum security forces, and it conducts inspections of nuclear reactor sites to evaluate the adequacy of security measures. In 2006, at the request of Congress, a panel of the National Academies of Sciences, Engineering, and Medicine reviewed the security of irradiated ("spent") nuclear fuel storage facilities at U.S. power plants. Among its conclusions, it found that "a terrorist attack that partially or completely drained a spent fuel pool could lead to … the release of large quantities of radioactive materials to the environment."[49]

Russia's war on of aggression on Ukraine has put the national security impacts of nuclear energy infrastructure in even sharper focus. Ukraine's commercial nuclear power plants have proven to be a major risk to Ukraine's national security. Throughout the war, Russia has exploited the vulnerability of nuclear power plants. Its illegal occupation and seizure of the Zaporizhzhia Nuclear Power Plant (ZNPP) have repeatedly put Ukraine and the entire region at risk, intentionally and at times unintentionally. Russian rocket attacks also continually target sites near Ukraine's other three operational nuclear power plants (including the Khmelnytskyi plant where Westinghouse has now agreed to build a new reactor within the next 5 years). Russia's military has also used the Chernobyl and ZNPP sites to stage its military operations, knowing that Ukrainian forces would not attack them there for fear of igniting a nuclear disaster. Nuclear facilities remain a major risk factor both for escalation of the conflict and doomsday-type scenarios, with evidence that Russian forces have placed explosives around the site.[50]

There is no convenient way for the U.S. to assure the security of nuclear power plants that we finance in other countries. We cannot assure that those countries will not be engaged in military conflicts or civil wars decades down the line, in which nuclear power and waste facilities may be directly attacked or sabotaged, suffer catastrophic damage, or be compromised by collateral incidents, such as damage to the electricity grid that could cause reactors' cooling systems to be inoperable for extended periods of time. Thefts or diversion of fissile materials could occur more easily in military conflicts, creating additional risks for nuclear weapons proliferation and/or acquisition of materials for dirty bombs. It would potentially compromise U.S. national security, if the U.S. were called upon or otherwise drawn into a foreign or civil war in order to protect against attacks on or sabotage of nuclear power plants that we had financed and exported.

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[48] Rep. McHenry, Patrick T. "H.R.806 - International Nuclear Energy Financing Act of 2023." Library of Congress. See Sec. 2(4). February 2, 2023. https://www.congress.gov/bill/118th-congress/house-bill/806/text

[49] National Academies of Sciences, Engineering, and Medicine. *Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report.* Washington, DC: The National Academies Press. 2006. https://doi.org/10.17226/11263

[50] El-Bawab, Nadine. "What could happen if Russia blows up the Zaporizhzhia Nuclear Power Plant?" ABC News. July 8, 2023. https://abcnews.go.com/US/happen-russia-blows-zaporizhzhia-nuclear-power-plant/story?id=100846888

By contrast, it would be far more beneficial to both other nations' and U.S.'s security to provide financing for renewable energy infrastructure and energy efficiency programs. By their very nature, wind and solar PV generation do not pose the risk of widespread environmental and public health disasters if they are damaged by military strikes. By being more geographically dispersed—even maximally so, with rooftop and distributed solar PV—renewable generation can provide more resilient power supplies in the case of extreme weather events, natural disasters, and military conflict. In addition, distributed renewable generation is naturally compatible with more flexible and resilient energy infrastructure, such as battery and thermal energy storage and islandable micro-grids. Most renewable energy sources, particularly solar and wind, do not rely on deliveries of fuel to produce energy, improving countries' energy independence and self-sufficiency.

Such features clearly benefit the energy security and national security of countries seeking finance for renewable energy projects, in ways that nuclear energy infrastructure simply cannot. These advantages would also benefit the U.S.'s national security, both by reducing the potential that the U.S. could get drawn into other countries' military conflicts, and by generating greater good will on the part of other countries for assisting them in improving their energy security and resilience to extreme weather, natural disasters, and military conflict.

Lifecycle Costs and Environmental Impacts of Nuclear Energy Exports

Nuclear energy generation entails unique and longstanding environmental impacts, the full costs of which must also be considered in making energy finance decisions. Even if countries that IFIs provided financing for nuclear projects relied on the U.S. or other strategic allies to provide uranium enrichment and fuel supplies, the operations of nuclear power facilities generate radioactive pollution and incur large expenses for decommissioning, environmental remediation, radioactive waste management, and possible nuclear disasters, all of which add to the total lifecycle cost of nuclear projects.

In addition, in most countries with commercial nuclear energy, the federal government limits the liability of the industry for nuclear disasters (Price-Anderson Act) and takes responsibility for long-term management of spent nuclear fuel (Nuclear Waste Policy Act). Commercial nuclear energy companies have insisted that such arrangements be embodied in U.S. nuclear export agreements, for instance, as we have seen in spades with the U.S.-India Civil Nuclear Agreement.[51] IFI financing for nuclear projects must evaluate countries' economic capacity for covering multi-billion-dollar liabilities for nuclear disasters and permanent disposal of spent nuclear fuel.

The IAEA estimates that decommissioning, environmental remediation, and other steps to fully retire a nuclear power plant in the range of $500 million-$2 billion per reactor.[52] This may not

[51] Tellis, Ashley J. "Completing the U.S.-India Civil Nuclear Agreement: Fulfilling the Promises of a Summer Long Past." Carnegie Endowment for International Peace. November 27, 2023. https://carnegieendowment.org/2023/11/27/completing-u.s.-india-civil-nuclear-agreement-fulfilling-promises-of-summer-long-past-pub-91043

[52] O'Sullivan, Patrick. "Nuclear Decommissioning: Addressing the Past and Ensuring the Future." *IAEA Bulletin*, vol. 64-1. April 2023. https://www.iaea.org/bulletin/nuclear-decommissioning-addressing-the-past-and-ensuring-the-future

change dramatically for SMRs or non-LWRs. A team of researchers from Stanford University found, in a study published in the Proceedings of the National Academy of Sciences in 2022, those types of reactors would likely produce larger amounts of radioactive waste than conventional large LWRs, on a lifecycle basis.[53]

Long-term management of the irradiated ("spent") fuel rods, or emplacement of them in permanent repositories, has still not been completed anywhere in the world. However, it is expected to be a large expense, even for countries with a relatively small number of reactors. The UAE just started operating its first nuclear power plant in 2020 and plans to put its fourth reactor in service next year. The IAEA reported in 2023 that the country expects "the cost of establishing a geological repository for the disposal of long-lived radioactive waste and spent fuel can run to several billion dollars." For countries that would only build the equivalent of 1-4 conventional reactors, these tail-end costs of nuclear generation can entail billions of dollars in additional costs.

It is not even clear that the U.S. and other countries with established nuclear industries have planned effectively for these costs. The Government Accountability Office issued a report in 2017, which found that the DOE did not have reliable cost estimates for its nuclear waste repository program.[54] This was, in part, because DOE did not include essential elements of the program in its estimates, "such as site selection, site characterization, and waste packaging and transportation." Separately, DOE estimated transportation of waste to a repository alone to cost $20 billion, and that other costs could amount to $11.5 billion, in addition to DOE's repository cost estimates of up to $85 billion for a repository.[55] With these estimates alone, the costs of managing the U.S.'s inventory of commercial irradiated ("spent") nuclear fuel could be over $100 billion. Yet, DOE reported in FY2021, the federal Nuclear Waste Fund had a balance of $44.3 billion.[56] Under a court judgment against DOE in 2013, the agency has been prohibited from collecting annual nuclear waste fund fees from the industry for nearly a decade. The Nuclear Waste Policy Act requires DOE to assess the fees, but the court ordered DOE to stop collecting them until the agency "has conducted a legally adequate fee assessment."[57] A decade later, the agency has failed to do so.

If leading countries in the industry have not set an example by planning for the cost of nuclear waste management, then IFIs do not even have a firm basis for evaluating the full financial risk that financing nuclear energy projects would expose to borrowing nations.

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[53] Krall, Lindsay M., Allison M. Macfarlane, and Rodney C. Ewing. "Nuclear waste from small modular reactors." Proceedings of the National Academy of Sciences, 119 (23) e2111833119. May 31, 2022. https://www.pnas.org/doi/10.1073/pnas.2111833119
[54] Government Accountability Office. "Nuclear Waste: Benefits and Costs Should Be Better Understood Before DOE Commits to a Separate Repository for Defense Waste." January 2017. https://www.gao.gov/assets/gao-17-174.pdf
[55] Ibid.
[56] U.S. Department of Energy. "Nuclear Waste Fund (NWF) Annual Financial Report Summary: FY2021 and Cumulative." https://www.energy.gov/sites/default/files/2021-12/FY21%20-%20NWF%20Annual%20Financial%20Report%20Summary.pdf
[57] Van Ness Feldman LLP. "Nuclear Waste Fee to Be Suspended Indefinitely." November 21, 2013. https://www.vnf.com/1099

Conclusion
The U.S. has the opportunity to play a major role in ensuring that other countries have sufficient access to finance to meet their needs for zero-emissions energy and climate-resilience infrastructure. Indeed, the rest of the world is eager for the U.S. to do our part, as the closing statement adopted by nearly 200 countries last month at the COP28 climate summit in Dubai demonstrates. Doing so would have a lasting and world-saving impact on billions of people and dozens of countries facing dire threats from climate disruption. However, those needs would not be met by enacting H.R. 806, which would put our eggs in the wrong basket. The world's governments have concluded that we must do everything we can to cut greenhouse gas emissions by at least 43% by 2030, and the best shot we have is to triple renewable energy capacity and double energy efficiency rates in that time.

Prioritizing financing for new nuclear power plants will not help to meet those goals. It would be counterproductive and result in a failure of the U.S. to demonstrate true leadership and responsiveness to other countries' needs and best interests. It would also forsake economic opportunities for the U.S. to expand our own renewable energy industries and the jobs, opportunity, and prosperity that could benefit people throughout our country. I recommend a negative report on H.R. 806 and I encourage the subcommittee to develop alternative legislation that would, instead, prioritize increasing international finance for renewable energy, energy efficiency, and climate resilience infrastructure.