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Select Committee on the Climate Crisis

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"Keeping the Lights on:
Strategies for Grid Resilience and Reliability"

Questions for the Record

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The Honorable Kathy Castor

1. **The United States is blessed with affordable and abundant renewable energy resources, but they are often located far away from densely populated cities. Upgrading and expanding our electric grid could help ensure that every American can access clean energy. The Biden Administration has already launched an initiative to use existing rights-of-way to site transmission to make this easier.**

    a. **How would upgrading and expanding the electric grid improve electric grid reliability and resilience as we transition to a clean energy economy?**

Building high capacity, high voltage, and long-distance transmission lines underground along existing transportation corridors to connect abundant and affordable renewable energy to demand centers will improve both electric grid reliability and resilience. Such transmission facilities will enable wind and solar development where it is most abundant and cost-effective and from areas otherwise constrained by lack of access to transmission. These interstate and often interregional transmission facilities will help avoid blackouts and allow renewable energy resource-sharing among regions. For example, underground transmission cable installation along railroad rights-of-way provides a climate resilient lifeline between states, regions, and energy markets to stabilizes the grid, ensuring weather-related events have minimal impacts. Taking advantage of opportunities to develop high-capacity underground transmission will help ensure power reliability as the clean energy transition accelerates. The Biden Administration announced the Building a Better Grid initiative that will be solving for multiple challenges at once. From an infrastructure standpoint, the U.S. needs to expand transmission by 60% by 2030 and perhaps triple it by 2050.[1] Funding in the Bipartisan Infrastructure Bill will enable transmission build-out that in turn is foundational for achieving the Administration's goal of 100% clean electricity by 2035. Grid Strategies' analysis of Winter Storm Uri's impact on Texas one year after Winter Storm Uri makes the case for resilience through better transmission planning and investment.[2] As an example of a state taking decisive action to tie transmission build-out to resilience, the California Independent System Operator recently approved 23 transmission projects totaling nearly $3B that are expected to increase resilience in the state.[3]

[1] https://www.environmentalleader.com/2022/01/doe-launches-initiative-to-upgrade-nations-electric-grid/
[2] https://gridprogress.files.wordpress.com/2022/02/the-one-year-anniversary-of-winter-storm-uri-lessons-learned-and-the-continued-need-for-large-scale-transmission.pdf
[3] https://www.pv-tech.org/caiso-approves-us2-9bn-of-transmission-projects-to-enhance-reliability/

b. How would upgrading and expanding the electric grid help consumers save money on electric bills?

Expanding the power grid will unlock otherwise inaccessible high quality and low-cost renewable energy resources that can benefit consumers. Providing much needed export paths to market for such resources will directly help consumers save money on electric bills. Access to such affordable resources will be increasingly important as more aspects of our economy are electrified, including homes and transportation. It is estimated that for every $1 spent on transmission, $3 of savings are achieved by consumers.[4] PJM, the largest energy market in the world, runs over 84,000 miles of transmission and estimates that transmission lines that link PJM zones together allow them to share capacity and leverage load diversity, reducing the need for additional generation by up to $3.78 billion annually. New transmission projects in the works could save $100 million in the first four years of commercial operations.[5] In late 2020, Local Solar for All, the Coalition for Community Solar Access, Vote Solar, and Vibrant Clean Energy released a road map for the lowest cost grid. Their modeling shows that local distributed solar plus storage could save customers $473B by 2050, while unlocking the full potential of utility scale wind and solar.[6] Stepping back to look at the entire U.S. electricity sector, if it were to be fueled entirely by clean energy, consumers would avoid using 437 million tons of coal,[7] 11.6 trillion cubic feet of natural gas,[8] 72 million gallons of oil,[9] and avoid approximately $107 billion in costs used to purchase these fuels (at 2021 prices) each year. Transitioning to a cleaner grid should save consumers on their electricity bills.

2. How would the Bipartisan Infrastructure Law and the initiative to use existing rights-of-way facilitate transmission development without compromising environmental protections?

Pernicious siting and permitting issues often impede the deployment of overhead interregional transmission lines. Such projects typically take ten or more years to develop, assuming they can be built at all given landowner opposition, environmental impacts, among other barriers. In contrast, installing high voltage transmission lines safely underground along existing railroad rights-of-way manages the typical impediments to long distance transmission development. By protecting landowners, avoiding eminent domain, and eliminating visual impacts, underground installation along existing transportation corridors simplifies and expedites permitting, allowing the project to be built in half the time of traditional overhead transmission projects while avoiding nearly all environmental impacts associated with major linear infrastructure development. This underground rail co-location development approach can use horizontal directional drilling to avoid any sensitive habitats, ecosystems, or waterways, further ensuring environmental protections. There are several programs within the BIL that provide support for using existing transmission rights of way. One project example is that of SOO Green HVDC (High Voltage Direct Current) Link, which would follow existing rail and highways rights of way to bury HVDC lines connecting wind resources in Iowa to load centers in Chicago. Because the rights of way were already developed by rail and roadways, burying cable along the same path would have minimal environmental impact.[10] Another example would be using overhead transmission technologies, such as high-ampacity

[4] https://gridprogress.files.wordpress.com/2022/02/the-one-year-anniversary-of-winter-storm-uri-lessons-learned-and-the-continued-need-for-large-scale-transmission.pdf
[5] https://pjm.com/-/media/library/reports-notices/special-reports/2019/the-benefits-of-the-pjm-transmission-system.ashx?la=en
[6] https://www.vibrantcleanenergy.com/wp-content/uploads/2020/12/LocalSolarRoadmap_FINAL.pdf
[7] https://www.eia.gov/energyexplained/coal/use-of-coal.php
[8] https://www.eia.gov/tools/faqs/faq.php?id=50&t=8#:~:text=In%202020%2C%20the%20United%20States,(Tcf)%20of%20natural%20gas
[9] https://www.eia.gov/tools/faqs/faq.php?id=33&t=6#:~:text=EIA%20uses%20product%20supplied%20to,day%20over%20consumption%20in%202020
[10] https://www.soogreenrr.com

low sag lines and HVDC, as well as MVDC (Medium Voltage Direct Current), that can move more power than conventional Alternating Current transmission lines within existing rights of way with less or no additional impact on the environment. Other new technologies include superconductors that could move five-times the amount of power over long-distances in the same space as conventional overhead transmission with shorter towers, a narrower right of way, and far less environmental impact.[11] Research funds in the BIF would help accelerate the development of this technology with significant benefit to the electric grid, while reducing impact on the environment.

3. **Energy efficiency is a critically important near-term strategy because it can help Americans save money on their household energy bills and on their transportation fuels as well as reduce carbon pollution. In your testimony, you also highlighted the energy efficiency investments from the Bipartisan Infrastructure Law and referenced the Solar Energy and Loan Fund from my home state of Florida. Could you please help us understand how energy efficiency *also* helps improve grid reliability and resilience to power interruptions and other disruptive events?**

The Department of Energy's Better Buildings program has developed case studies and other resources for communities and consumers who want to deploy energy efficiency technologies to increase resilience. Energy efficiency alone can allow for passive survivability during a disaster, while also providing reduced disruption from demand spikes, lower costs for energy, greater comfort, and healthier air quality during normal grid operations. By including onsite generation like solar power and storage, customers can continue electric service during a disruptive event.[12] Many providers of renewable energy resources first install energy efficiency measures to maximize the savings from the solar resource. For example, before installing rooftop solar, PosiGen, a Louisiana-based rooftop solar company that focuses on low-income communities, conducts an energy audit and installs energy efficiency measures to ensure bill savings from the solar system are achieved and protected.[13]

4. **In your testimony, you highlighted that the EV charging investments in the Bipartisan Infrastructure Law are important for grid resilience. You also cited a study from the American Council for an Energy-Efficient Economy which concluded that increased electrification of vehicles and buildings paired with energy efficiency would *increase* grid reliability. Could you please describe how deploying more EVs and distributed energy resources (DERs) helps improve grid reliability? How can EVs and DERs serve as resources to a modernized grid?**

A recent study by the Pacific Northwest National Laboratory looked at how a distribution system operator (DSO) along with active customer engagement (Transactive Energy) could coordinate a variety of flexible assets such as electric vehicles (EVs) and distributed energy resources (DERs) to reduce load, lower energy prices, and lessen needed infrastructure.[14] The grid is constantly working to maintain balance between supply and demand; an overbalance of either or disruption to delivery lines can cause the entire system to falter. DERs, when properly incentivized and constructed, improve grid reliability by giving more options for grid operators to manage that supply and demand. In PJM alone, DERs account for between 15-25% of demand response**.** EVs have the promise of similarly serving as flexible demand. A future grid would ideally be able to take advantage of these mobile services by allowing EV-to-Grid operations where EVs can charge or discharge where needed to support the grid. California is

[11] See technology being developed by VEIR: https://veir.com
[12] https://betterbuildingssolutioncenter.energy.gov/resilience/about
[13] https://www.posigen.com
[14] https://www.pnnl.gov/sites/default/files/media/file/EED_1574_BROCH_DSOT-ExecSumm_v11.pdf

experimenting now with using EVs to power homes as electricity demand and renewable energy both increase.[15]

5. **In your testimony, you noted that additional climate investments like the clean energy and energy storage tax credits and the Greenhouse Gas Reduction Fund will help encourage more private sector investment in climate solutions. Could you please help us understand how Federal investments can unlock private sector capital, which is a much bigger market? What are some examples of public private partnerships?**

The goal of the federal government should be to send market signals that organize the nation around clear goals—in this case the goal of reducing our nation's impact on the climate—and to fill gaps that the private sector is unable to fill. In the case of the Greenhouse Gas Reduction Fund, we know that last year state green banks drove nearly $2B in investment and in total have caused $9B in total investment, leveraging private capital three to one. While 42 states, the District of Columbia, and Puerto Rico all have active or nascent green banks, a national entity would capitalize and supercharge this state activity. Many of these state programs do not have enough state funding to leverage with that of the private sector; this national fund would ensure those state entities are able to run their own entities while also financing projects of broad national importance.

Another way in which policy can unlock private sector capital is through tax credits with direct pay provisions. The current regime forces project developers to work through financial middlemen in a supply constrained tax equity market to monetize the tax credit for renewable energy. The legal cost of this is prohibitive for many distributed energy projects which have a capital expenditure of under $1 million and is even more difficult for residential projects, especially for those customers who do not have a tax burden at all and would not be able to take advantage of an investment tax credit. As Jon Powers, President of CleanCapital states in a recent article in PV magazine, "to say this creates a major bottleneck in clean energy investment and deployment is an understatement. At a time when the opportunity for the energy transition is greatest, two thirds of wind projects set to being construction this year are still seeking tax equity financing, along with more than half of large-scale solar projects. These delays hold America back from its potential as a global clean energy leader."[16] Smaller projects face an even more difficult path to monetization. And yet, despite these numbers, solar has grown 52% annually since enactment of the ITC in 2006.[17] While solar and other renewables would expand exponentially with a more efficient direct pay option, even this constrained ITC has already made a significant impact in encouraging private sector investments in climate solutions. This construct also creates opportunity for not-taxed entities like municipalities and tribes to better extract value from the incentive.

6. **How would American companies benefit from the Section 48C incentive to manufacture climate solutions in this country?**

According to the National Association of Manufacturers, manufacturing jobs have one of the highest multiplier effects of any industry.[18] Modeling done by Data for Progress concluded that federal investments of $8 billion through 48C would create nearly 140,000 direct and indirect jobs nationwide

[15] https://www.morningbrew.com/emerging-tech/stories/2022/03/18/california-s-vehicle-to-grid-experiments-offer-a-glimpse-of-the-future
[16] https://pv-magazine-usa.com/2022/02/28/clean-energy-tax-credit-reform-is-our-last-best-chance-for-a-net-zero-future/
[17] https://www.seia.org/sites/default/files/2021-01/SEIA-ITC-Factsheet-2021-Jan.pdf
[18] https://www.nam.org/facts-about-manufacturing/

over the next several years, and would add over $27 billion to our Gross Domestic Product (GDP).[19] The think tank Third Way, in collaboration with Industrial Economics, Inc., found in their modeling that for every $1 billion issued annually through a new 48C credit program, $3.6 billion in GDP would be added and roughly 8,000 direct jobs created across the country, a number that would reach 23,000 annually with indirect supply chain and "induced jobs."[20] Not only manufacturers would benefit--the entire ecosystem will. For example, underground HVDC transmission cable is not currently manufactured in the U.S. Creating incentives for cable manufacturing will thus impact the speed and cost of transmission development. Another example is in hydropower, a zero-emission resource. Small turbines—between 5-30 megawatts--are not manufactured in the U.S. Based on the U.S. DOE Hydropower Vision, 13GW zero emission hydropower could be added to the clean energy mix by simply upgrading existing plants and adding power at existing dams.[21]

7. **High-voltage direct current transmission lines could help connect transmission interconnections and transmission regions, which would allow more Americans to access clean energy. What Federal investments could ensure that these HDVC transmission lines are themselves resilient to the unavoidable impacts of climate change?**

Direct current lines do not have same sensitivity to higher ambient temperatures as AC lines since they do not generate heat within the line, so in the case of extreme temperatures, DC lines will perform better. Investments should also be made in sensor-based Dynamic Line Rating (DLR) technology that provide transmission owners and grid operators with improved situational awareness and real-time visibility, increasing the resilience of the system overall. Real-time sensors equip grid operators with data on the performance of their transmission lines, helping to optimize safety and reliability of the transmission grid. Conductor asset health reports provide valuable information used for prioritizing maintenance activities and efficiently dedicating resources. DLRs can also unlock greater grid flexibility, enabling operators to accommodate shifting loads and reduce interconnection queues while also improving reliability in N-1 scenarios.

8. **Why is it important for the federal government to invest in recycling and reuse of critical minerals that are important inputs to batteries and other clean energy technologies? For instance, the Bipartisan Infrastructure Law invests $7 billion in critical mineral supply chains, including a $140 million program recently announced by the Department of Energy to develop a first-of-a-kind refinery to extract rare earth elements from coal ash waste. How could these efforts complement new mining and processing domestically and around the world?**

Many of the materials essential for Lithium-Ion Batteries (LIBs) are not found in the U.S., making it vital that the U.S. invests in minerals processing and a supportive trade policy with nations that have these natural resources. Nickel, for example, is an essential element for today's batteries. Most of the nickel used for the LIB industry today comes from mature Western and Japanese nickel companies making nickel powder, briquette and nickel sulphate. There is currently no nickel mining and/or processing of nickel salts for the battery industry in the U.S. and today's nickel price does not support investment in new mines and processing facilities. Given that Indonesia and Philippines are the key countries for nickel deposits, U.S. refiners will most likely have to rely on growth of new feed coming from these countries in the coming years, with smaller amounts from new mines in Australia, New Caledonia, and Brazil.

[19] https://www.dataforprogress.org/memos/the-cepp-amplifies-the-jobs-impacts-of-the-48c-tax-credit
[20] https://www.thirdway.org/memo/manufacturing-the-future-of-clean-energy-with-48c
[21] https://www.energy.gov/sites/default/files/2018/02/f49/Hydropower-Vision-021518.pdf

Lithium is of course another essential element for LIBs. Most lithium comes from brine resources in South America and rock resources in Australia. The U.S. currently has one active lithium mine, Albemarle's Silverpeak, a small brine-based lithium carbonate production in Nevada. Additionally, North Carolina hosts two conversion assets from carbonate to hydroxide from both Livent and Albemarle in addition to a halted spodumene mine at Kings Mountain. The U.S. also has a diverse lithium junior company community that is exploring geothermal and clay to more conventional lithium resources like brine and spodumene.

Cobalt is still an important element used in the cathode for most LIBs, especially those used for electric vehicles. The U.S. does not have any significant domestic sources of cobalt, nor does it have cobalt refiners. Cobalt is not mined on its own but is rather most commonly a by-product from copper or nickel mining. Over 60% of the global cobalt supply originates from the Democratic Republic of Congo. Furthermore, cobalt refining is predominantly a China-based business. One company—Umicore--is an exception to the Chinese cobalt refining dominance, operating the only significant non-Chinese cobalt refining operations in Kokkola, Finland and Olen, Belgium that is used to supply western nations.[22]

For the U.S. to meet its needs for these metals and an advanced energy economy, we should focus on working with trusted allies to increase its access to supply. Additionally, the U.S. can invest in the low-cost, low-emission technologies needed to process battery raw materials, ideally using resources found in the U.S. to convert them into a form used in LIBs. This could help support the development of a market for the precursor materials which require these raw materials and are in turn used to produce cathodes for LIBs.

To further mitigate risk for the U.S. market, the Department of Energy and other U.S. policymakers could create a policy framework that incentivizes domestic manufacturers along the battery supply chain. Refining materials and manufacturing cells within U.S. borders would mitigate a great deal of supply chain risk for this growing domestic industry. The North American LIB supply chain could be incentivized through a revised regional approach. Currently, there are no incentives to locally produce components (i.e., cathode active materials) used in LIB production. A regional agreement in North America could motivate important regional supply production investment, mitigating domestic national security risk, while promoting increased collaboration with allies such as Canada which has important raw material resources.

Taking steps that result in the growth of a robust U.S. electric vehicle market will help to reduce investment risk and uncertainty for LIB supply chain participants who are considering establishing manufacturing in the U.S. In addition, this market certainty would foster an environment in which critical materials recyclers, such as Umicore which operates a battery recycling plant in Belgium,[23] would want to site their plants here in the U.S. closer to the EV and battery manufacturing ecosystem.

9. How can we help industries with expertise in legacy fossil fuel technologies become partners in the transition to a clean energy economy?

While it might seem counterintuitive, it is critical to engage oil, gas, and fossil fuel companies in energy transition efforts if we want to make our 2050 climate goals. Given that the next 10-20 years will be

[22] https://csm.umicore.com

[23] https://www.umicore.com/en/newsroom/news/new-generation-li-ion-battery-recycling-technologies-and-announces-award-with-acc/

crucial in preventing the worst impacts of climate change, we must work with the fossil fuel industry to reduce their emissions as they continue to be a sizable part of our energy mix.

As an example of the incumbent fossil fuel industry stepping up to scale a low carbon future, Greentown Labs in Houston, TX, has been collaborating with oil and gas companies since their founding. Shell and Chevron were some of the Lab's earliest partners and both helped Greentown expand nationally. These corporate partners understand and can provide the scale needed to deploy energy transition solutions; existing fossil fuel companies have the capital, talent, and operational capacity to bring new technologies to scale within the looming climate timeframe. Hydrogen and CCUS/carbontech are two of the most promising solutions to decarbonize power generation as well as two of the fastest growing sectors of climate tech. Greentown Labs is currently running two programs in partnership with industry partners: the Low Carbon Hydrogen Accelerator[24] and the Carbon to Value Initiative.[25] With both initiatives, corporate partners like Shell, NRG, Fluor, and ConEdison leverages company expertise and incubation services to drive an innovation ecosystem for commercializing climate mitigating technologies.

10. **What types of Federal investments would increase equity and access to clean energy while also enhancing grid resilience and reliability?**

To ensure programs and federal investments are equitable and allow access by all Americans, we must be intentional in our policy development. We cannot assume that by using the word "equity" that it will then happen. A coalition of private sector companies, environmental and civil rights groups collaborated to develop a roadmap that would ensure equity is included through federal climate policy.[26] These policies include direct pay provisions in the tax code, bonus credits for low and middle income communities, and, crucially, funding for state, local, and tribal governments to fund existing and new distributed and community solar programs to ensure that at least 50% of incentives support underserved communities, communities of color, indigenous communities, rural, and low to moderate income households. All of these policies not only expand access to clean energy, but also increase resilience inherent in those technologies.

11. **While the Investment Tax Credit has been helpful in driving down the costs of solar energy, there are still additional barriers to deployment at the scale required by the climate crisis. Could you please describe the scale of solar deployment we need and describe some of the remaining barriers? How could extension of the Investment Tax Credit help? What other Federal policies would be helpful?**

The Investment Tax Credit was momentous for the solar industry, and yet more is needed to address, for example, consumers who rent their homes or who live in multi-family housing, communities that are in low- and middle-income areas, and those who live in areas historically adversely impacted by extractive or polluting industries. Direct pay, bonus credits, and interconnection tax credits as well as complementary credits for energy storage, microgrids, and transmission will all create the market signals for an ecosystem of U.S. investment in clean energy. For solar specifically, the Solar Energy Industries Association has set a goal of 100 GW (30%) by 2030;[27] the Coalition for Community Solar Access has set

[24] https://greentownlabs.com/lcha/
[25] https://www.c2vinitiative.com
[26]https://static1.squarespace.com/static/5f4637895cfc8d77860d0dbc/t/607de3e8885bd43ae87deded/1618863082445/Building+Back+Better_+A+Roadmap+to+Expand+Solar+Access+for+All+-+FINAL.pdf
[27] https://www.seia.org/research-resources/solar-decade-american-renewable-energy-manufacturing

a goal of 20 GW by 2025 for community solar.[28] These goals align with the Biden Administration and indicate a commitment by industry to deploy apace once policy certainty is in place.

12. **In your view, could you please describe the types of Federal policies that would enable the country to meet President Biden's goal of reducing economy-wide emissions by 50% by 2030?**

Federal policy will be an important part of achieving 50% emissions reduction by 2030. Policies that can enable that goal include a combination of tax incentives, grant programs, rebates, appliance standards, building codes, emissions regulation, and consistent research and development to foster and seed ideas for the future energy transition. The Select Committee on the Climate Crisis released a report and action plan with many of those policy recommendations[29] and the Build Back Better Act[30] in concert with the Bipartisan Infrastructure Law will send the appropriate market signals to the private sector that clean energy transition investments will create jobs, reduce risk from climate change, lower costs, and increase resilience.

13. **From your work on global decarbonization, could you please describe the kinds of technologies that are most beneficial to developing countries to help them meet their climate and economic development goals? How would renewable energy and electric vehicles help developing countries leapfrog over legacy fossil fuel technologies?**

Many people in mature markets have an impression that developing economies simply need a solar panel to serve a light bulb and perhaps a sewing machine or a refrigerator. To be clear, those technologies can be life changing for girls and women to study and gain economic independence.[31] Emerging economies, however, need more than just solar panels, and most of the issues facing these economies are not technology related. According to Blackrock, emerging economies will need $1T in investment for the zero emission transition, not because of technology issues but because of political, legal, regulatory, and macroeconomic risk.[32] Another report from IEA and the World Economic Forum discusses financing opportunities in emerging markets for energy efficiency, electrification, clean power, and emissions-intensive sectors.[33] The issue in all of these analyses is not about technology solutions but about financing and policy structures that can reduce risk and accelerate deployment.

<u>The Honorable Garret Graves</u>

1. **In your testimony you state that transmission ties could have helped bring power from states like Alabama and Louisiana to Texas in the aftermath of Winter Storm Uri to ultimately reduce recovery time. You blamed a lack of investment in transmission as why**

[28] https://www.communitysolaraccess.org/community-solar-industry-commits-to-develop-20-gw-of-capacity-by-2025-in-alignment-with-u-s-department-of-energy-goals/
[29] https://climatecrisis.house.gov/report
[30]https://climatecrisis.house.gov/sites/climatecrisis.house.gov/files/Climate%20Investments%20In%20The%20Build%20Back%20Better%20Act%20Fact%20Sheet%2011-19.pdf
[31] Companies like Solar Sister have made an enormous difference in the lives of women in Sub-Saharan Africa: https://www.un.org/en/chronicle/article/sustainable-energy-all-empowering-women
[32] https://www.reuters.com/business/sustainable-business/emerging-markets-need-1-trln-year-get-net-zero-blackrock-2021-10-14/
[33] https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies?utm_content=buffer7259e&utm_medium=social&utm_source=twitter-ieabirol&utm_campaign=buffer

this didn't happen. In our hearing, you stated that "there are plenty of ways to get transmission built." I agree that we need to make smart investments to deploy innovative technologies, but all the money in the world won't overcome the other barriers to deployment of these technologies, particularly for projects that cross state lines.

a. How many federal agencies are involved in the permitting process for projects like this, and how many permits would these projects need?

The number of agencies involved in permitting will vary based on the technology and application. Energy projects are not materially different from developing any infrastructure policy in the approvals needed to proceed.

b. Do you think the currently regulatory barriers that are in place—that often delay projects like the ones you reference by 7-10 years—should be reformed to allow for faster deployment?

Based on my experience, the regulatory barriers that exist today are often caused by a lack of adjustment in regulation to include new technologies with new characteristics that were not contemplated at the time of the original regulation. It is helpful when federal agencies set up processes or platforms to help developers track progress and approvals for projects.

c. Your testimony references "market signals"—would one of those signals be a permitting process that provides certainty to developers and utilities alike to attract investment and actually get things built?

Certainty is crucial for investment. In fact, many investors are sitting on the sidelines today awaiting passage of the reconciliation package for exactly that reason. Developers and utilities must plan several years ahead, so understanding how the policy landscape will look over the next decade is of utmost importance. I am party to several Integrated Resource Planning proceedings throughout multiple states, including Louisiana, and know it is very difficult for utilities to model and plan long term without an understanding of policies that will be in place that can impact their supply and demand side resources.

2. The Princeton University study that I cited in our hearing found that in order to meet net zero by 2050, "high voltage transmission capacity expands ~60% by 2030 and triples by 2050… total capital invested in transmission is $330 billion through 2030 and $2.2 trillion by 2050."[34]

a. Do you think this massive expansion of capacity and the needed capital investment will increase costs for utilities and therefore increase rates for consumers?

While there is a need to expand transmission investments, that investment does not necessarily translate into higher costs for consumers. Based on the report by Grid Strategies that I cited in my testimony, for each gigawatt of transmission capacity, more than $100 million of consumer savings can be generated during an extreme weather event. An Investment Tax Credit for transmission could spur $37B in new transmission deployment, resulting in $75B in customer savings.[35] In addition, there are low-cost solutions with Grid Enhancing Technologies (GETs) like Dynamic Line Ratings that can maximize capacity for renewables integration. A recent study by The Brattle Group found that GETs can double the

[34] Pg. 108: Princeton%20NZA%20FINAL%20REPORT%20(29Oct2021)%20(4)
[35] https://gridprogress.files.wordpress.com/2022/02/the-one-year-anniversary-of-winter-storm-uri-lessons-learned-and-the-continued-need-for-large-scale-transmission.pdf

amount of renewable energy integrated onto the grid, and deliver $5B in consumer cost savings nationally, with a payback of under six months.[36] Importantly, these technologies can be deployed in weeks or months, and at a unit cost of less than 5% of traditional projects. To minimize the potential cost impacts of future infrastructure development, technology solutions that can enable additional capacity with existing infrastructure at a fraction of the cost of traditional transmission line construction projects and without requiring a time-consuming permitting process could be prioritized.

b. Have you seen any strategic plans laying out how to specifically achieve the amount of expanded capacity that is needed to achieve these goals?

Many analysts have considered how to achieve a future of zero carbon emissions. One example is Energy Systems Integration Group that has focused on the grid and found that the cheapest solutions to the transition are coordinated transmission and distributed energy planning. Their modeling team found that "when clean electricity is not a target, the savings materialize immediately and reach to over $300 billion cumulatively by 2050. When clean electricity is mandated, the savings are less in the early years (through 2030), but expand rapidly to over $470 billion by 2050."[37] Barclay's released a five pillar approach to zero emissions that lays out the need for ending waste, increasing electrification, reinvigorating bioenergy, investing in hydrogen, and sequestering carbon.[38] There are no zero emission scenarios that promote the increase of the use of fossil fuels and even given the current situation in Ukraine, the International Energy Agency (which has proposed a scenario to move to net zero by 2050[39]) has proposed an acceleration of electrification and renewable energy deployment to reduce EU's reliance on Russian natural gas.[40] S&P Global found that climate change could have huge financial costs for corporations and almost 80 percent of the S&P Global 1200, which includes the world's largest companies, will be exposed to moderate-to-high physical risks from climate change by 2050.[41]

3. In your testimony you stated that "One of the most important market tools is in the tax code. Access to tax credits will drive down the cost of energy storage of all types, opening up new markets in dozens of States."

a. How long has the Investment Tax Credit (ITC) been in place for?

The Energy Policy Act of 2005 (P.L. 109-58) created a 30 percent ITC for residential and commercial solar energy systems that applied to projects placed in service between January 1, 2006, and December 31, 2007.The Solar Energy Industries Association has been tracking the credit and the growth it has spurred in the sector.[42]

b. What percentage of the nation's power is generated by solar energy?

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[36] https://watt-transmission.org/unlocking-the-queue/
[37] https://www.esig.energy/coordinated-deployments-of-transmission-and-distribution-scale-resources-provide-the-lowest-cost-electricity/
[38] https://www.cib.barclays/our-insights/Emission-impossible-closing-in-on-net-zero.html?cid=paidsearch-textads_google_google_themes_decarbonization_us_research_net-zero_phrase_892853615478&gclid=CjwKCAjwiuuRBhBvEiwAFXKaNJVM7KvTLbEBW2zg-RLx1B8uDv6y6GHMINRBwZcyHJbKgVw-bzKYeBoCFfcQAvD_BwE&gclsrc=aw.ds
[39] https://www.iea.org/reports/world-energy-model/net-zero-emissions-by-2050-scenario-nze
[40] https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas
[41] https://www.greenbiz.com/article/state-net-zero-now
[42] https://www.seia.org/initiatives/solar-investment-tax-credit-itc

Based on the Energy Information Administration and the Federal Energy Regulatory Commission, renewable energy resources provide 25.81% of total U.S. available installed generating capacity, more than coal, which generates 18.49% and three times more than nuclear power, at 8.29%. - a share significantly greater than that of coal (18.49%) and more than three times that of nuclear power (8.29%). More information is available in the References Page. Of the total renewable energy resources installed, solar energy, including utility scale and distributed solar, makes up 98.2 Gigawatts, or roughly 3%. Solar resources are projected to grow to 20% by 2050.[43] [44]

c. At what point do you believe we need to allow the free market to work and ensure that technologies can stand on their own two feet, rather than perpetually subsidizing a technology that hasn't been widely adopted in the market?

A 2021 International Monetary Fund report found that in 2021 fossil fuels—oil, natural gas and coal—were globally subsidized at $5.9 trillion, $660 billion of that in the U.S.[45] One could argue that those incentives are provided to proven technologies in long-profitable sectors. What is called the "free market" is a set of market signals—in part from states and the federal government –that encourage or discourage investment in certain sectors based on prioritization of attributes and characteristics of those resources. Because of the global and U.S. commitment to greenhouse gas reduction, it would follow that policy would send signals to the market to incentivize deployment of zero emission technologies.

[43] https://www.eia.gov/todayinenergy/detail.php?id=50357
[44] https://www.environmentalleader.com/2022/03/us-renewables-accounted-for-81-of-new-generating-capacity-in-2021-says-sun-day-campaign/
[45] https://www.imf.org/en/Publications/WP/Issues/2021/09/23/Still-Not-Getting-Energy-Prices-Right-A-Global-and-Country-Update-of-Fossil-Fuel-Subsidies-466004

Additional References (EIA and FERC)

"Energy Infrastructure Update for December 2021" was released by FERC on March 8, 2022. https://cms.ferc.gov/media/energy-infrastructure-update-december-2021. See in particular the tables "New Generation In-Service (New Build and Expansion)," "Total Available Installed Generating Capacity," and "Generation Capacity Additions and Retirements."

"Energy Infrastructure Update for December 2020" report by FERC.
https://cms.ferc.gov/media/energy-infrastructure-update-december-2020

"Short-Term Energy Outlook" released by EIA on March 8, 2022 includes 2021 data for wind, utility-scale solar, and distributed solar.
https://www.eia.gov/outlooks/steo/report/electricity.php

"Electric Power Monthly" report by EIA released on February 25, 2022,"Total Electric Power Industry Summary Statistics, Year-to-Date 2021 and 2020."
https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_es1b