INTERSESSIONAL PANEL OF THE UNITED NATIONS COMMISSION ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (CSTD)

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Contribution of the United States of America

to the CSTD 2017-18 priority theme on 'The role of science, technology and innovation to increase substantially the share of renewable energy by 2030'

1. What are the policies (renewable energy strategies, regulations, standards, fiscal measures, financial incentives, etc.) in place in your country/region that encourage renewable energy projects or aim at increasing the share of renewable energy in your country's energy mix? Who are the main actors in the renewable energy sector and what are the linkages between them? Do you have any documentation, references, web addresses or reports on the cited policy measures? If yes, please share it with us.

The U.S. has diverse wholesale and retail electricity market environments. Due to the heterogeneity of the U.S. electricity system, the various combinations of U.S. federal, state, and local policies must be evaluated separately regarding their applicability to jurisdictions across the developing world. U.S. deployment of renewable power has been spurred by a combination of state renewable portfolio standards; private sector sustainability goals; consumer choice; federal and state incentives; and technology cost declines.

Key trends:

Combined, wind, utility-scale and distributed PV accounted for over 66% of all new capacity installed in the nation in 2015. (Revolution Now)

- "Decades of investments by the federal government and industry in five key clean energy technologies are making an impact today. The cost of land-based wind power, utility and distributed photovoltaic (PV) solar power has fallen by 41%, 64%, and 54% between 2008 and 2016. These cost reductions have enabled widespread adoption of these technologies with deployment increasing across the board." (Revolution…Now! 2016 Update; https://www.energy.gov/sites/prod/files/2016/09/f33/Revolutiona%CC%82%E2%82%ACNow%202016%20Report_2.pdf)

- In fact, costs are dropping even faster than DOE originally projected. "The solar industry has achieved the 2020 utility-scale solar cost target set by the SunShot Initiative. When DOE launched the SunShot Initiative, it set ambitious goals to make grid-connected solar electricity market-competitive with other forms of energy, without subsidies, by 2020. Three years earlier than expected, the average price of utility-scale solar is now 6 cents per kilowatt-hour (kWh)." https://energy.gov/eere/sunshot/articles/2020-utility-scale-solar-goal-achieved

Recent Installed Price Reductions Have Been Driven Primarily by Declines in Soft Costs

A period of rapidly falling installed prices began in 2009, prompted by a steep drop in global prices for PV modules. Since 2012, however, module prices have remained relatively flat, while installed prices have continued to fall as a result of continuing reductions in the variety of other, non-module costs. Reductions in inverter and racking equipment costs constitute roughly 20% of the drop in non-module costs for residential systems in recent years. Much of the remainder can be attributed to reductions in the aggregate set of "soft" costs, which have fallen partly as a result of increases in system size and

module efficiency, though also because of a broader array of efforts within the industry and among policymakers to target soft cost.(https://emp.lbl.gov/sites/default/files/tracking_the_sun_ix_report.pdf)

- Private sector procurement of renewable power has accelerated rapidly: "Corporations are procuring utility-scale photovoltaic (PV) generation to meet their renewable energy and financial goals for electricity. The corporate procurement of utility-scale PV has grown from less than 1% of annual installed utility-scale capacity in 2014 to 9% in 2016 (Shiao et al. 2017), and it accounted for 17% in early 2017 (Honeyman et al. 2016). Through July 2017, corporate customers contracted for more than 2,300 MW of utility-scale solar, primarily using financial power purchase agreements (PPAs) and green tariff or bilateral contracts with utilities (43% and 36%, respectively)." (https://www.nrel.gov/docs/fy17osti/69080.pdf)

- New renewable technologies are entering the market: Advances in wind technology have increased wind generation capacity factors (ratio of an actual electrical energy output over a given period of time to the maximum possible electrical energy output over the same amount of time). "The average 2016 capacity factor among projects built in 2014 and 2015 was 42.5%, compared to an average of 32.1% among projects built from 2004–2011 and just 25.4% among projects built from 1998 to 2001." (https://energy.gov/sites/prod/files/2017/08/f35/2016_Wind_Technologies_Market_Report_0.pdf)

- DOE funded research is driving geothermal technologies forward. "In 2013, Sandia National Laboratories (SNL) successfully completed the development of a high-temperature drilling technology able to withstand the harsh conditions present in geothermal reservoirs." (https://energy.gov/eere/success-stories/articles/eere-success-story-percussive-hammer-enables-geothermal-drilling)

- DOE continues to investment in emerging technologies, for example: "The Energy Department…announced… an open-water, grid-connected national wave energy testing facility. The facility will be constructed in Newport, Oregon, by the Northwest National Marine Renewable Energy Center at Oregon State University and will support innovations in wave energy technologies capable of harnessing the significant wave energy resources along United States coastlines…The planned facility, to be completed by early 2020, includes four grid-connected berths where researchers can test full-scale wave energy conversion device concepts. Prototype testing is essential to gather critical performance data to address technical risks, lower costs, and inform future designs to accelerate the commercialization and deployment of mass-produced wave energy technologies." (https://energy.gov/articles/energy-department-announces-investment-wave-energy-test-facility)

Annotated Outline of Key Energy Policies and Initiatives

1. Energy technology research, development, demonstration, and deployment

a. R&D efforts by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

The Office of Energy Efficiency and Renewable Energy in the U.S. Department of Energy is a multi-billion-dollar organization focused on research and development of renewable energy, energy efficiency, and sustainable transportation technologies. EERE's vision is a strong and prosperous America that is powered by clean, affordable, and secure energy. In the context of this vision, EERE's mission is to create and sustain American leadership in the transition to a global clean energy economy. This mission requires that EERE perform its work at the intersection of national energy, economic, and environmental systems, as well as across industry and other stakeholder organizations. EERE focuses on a range of renewable power technologies including solar, wind, geothermal and water. (https://energy.gov/sites/prod/files/2015/12/f27/EERE_Strategic_Plan_12.16.15.pdf)

The Water Power Technologies Office researches, tests, evaluates, and develops innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water resources. This includes hydropower as well as marine & hydrokinetic (MHK) energy technologies.

The Water Power Program identifies and undertakes RD&D to assess the potential extractable energy from water resources and facilitates the development and deployment of renewable, environmentally-sound, and cost-effective energy from domestic rivers, estuaries, and marine waters. MHK technologies capture energy from waves, tides, ocean currents, the natural flow of water in rivers, and marine thermal gradients without building new dams or diversions. Conventional hydropower uses dams, diversionary structures, and impoundments to generate electric power from water resources.

The Water Power Program conducts work in four key areas at the forefront of water power research: developing innovative renewable water power technologies, breaking down market barriers to deployment, building the infrastructure to test new technologies, and assessing water power resources for integration into our nation's grid.

The Solar Energy Technologies Office (SETO) is a U.S. DOE program that conducts RD&D on solar energy technologies and systems, including improvement of the efficiency and performance of solar cells; development of new installation—or balance of systems—technologies; advancement of solar energy grid integration; and research in new materials and processes for solar PV technologies.

SETO focuses on achieving the goals of the SunShot Initiative, which seeks to make solar energy cost-competitive with other forms of electricity by the end of the decade. Since the SunShot Initiative was announced in February 2011, the Solar Program has funded more than 350 projects in the following areas: Photovoltaics (PV), Concentrating solar power (CSP), Balance of systems costs (soft costs), and Systems integration.

In addition to RD&D, SETO conducts market transformation activities that work to ensure that new technologies become accepted in the marketplace. SETO addresses the removal of non-technical market

barriers such as through: updating codes and standards, improving interconnection agreements among utilities and consumers, and analyzing utility value capacity credits for utilities. SETO's initiatives help consumers, businesses, and utilities make more informed decisions when considering renewable energy, and also facilitate the purchase of solar energy.

b. Grid integration

The Grid Modernization Initiative (GMI) works across the U.S. Department of Energy (DOE) to create the modern grid of the future. Our extensive, reliable power grid has fueled the nation's growth since the early 1900s; however, the grid we have today does not have the attributes necessary to meet the demands of the 21st century and beyond.

https://energy.gov/under-secretary-science-and-energy/grid-modernization-initiative

"EERE's grid integration activities focus on the seamless integration of energy efficiency, renewable power, and sustainable transportation technologies into the electrical power system. Clean energy technologies connect through the grid and form power systems at a variety of physical scales, from individual buildings to distribution systems to regional systems that can stretch across continents. Interactions and interdependencies are increasing within and among power system infrastructures and other interrelated systems such as communications networks. These interactions can have profound implications for the reliability and security of the energy system.

The suite of technologies and techniques required for successful grid integration includes improved renewable power forecasting; energy storage technologies; advanced power electronics; "grid responsive" building technologies; vehicle-to-grid technologies; and new grid sensing, control, and operations approaches. Furthermore, close engagement and collaboration with and among industry, regulators, and other stakeholders are needed to develop and deploy the standardized communication and control protocols that enable these devices to successfully interface and interact, enabling grid operations at the lowest cost possible while maintaining or improving grid reliability.

To foster this collaboration and accelerate progress towards our Nation's energy goals, DOE has developed the Grid Modernization Initiative (GMI), a strategic partnership between the DOE and its National Laboratories.
(https://energy.gov/sites/prod/files/2015/12/f27/EERE_Strategic_Plan_12.16.15.pdf)

2. Federal policies and incentives

a. Federal renewable energy production tax credit (PTC) and investment tax credit (ITC)

The Investment Tax Credit (ITC) and energy production tax credit (PTC) are two key Federal tax incentives that have been instrumental in accelerating the construction of renewable electricity

projects. Both of these incentives are designed for use by entities that pay Federal taxes and are subject to strict treatment under both the Internal Revenue Code and generally accepted accounting principles. These attributes have major implications for who utilizes the incentives and how projects are developed. Because they do not pay Federal income taxes, entities like municipal utilities and cooperative utilities cannot currently monetize these tax credits. For regulated utilities, the Internal Revenue Service requires that any ITC benefits be normalized for ratemaking purposes. The net result of these nuances is that independent developers have played an outsized role in the deployment of wind and solar relative to previous technologies.

In December 2015, the ITC and PTC were both extended by 5 years through 2021 and 2019, respectively, with each tax credit on a different declining schedule. Solar system owners have primarily claimed the ITC, while wind power, which has higher capacity factors and lower capital costs, has benefitted from the PTC. A recent National Renewable Energy Laboratory (NREL) study estimates that the December 2015 extension of the ITC and PTC could result in an additional 53 GW of renewable electricity capacity by 2020 as compared to a case with no tax credit extensions, corresponding to 540 million metric tons of avoided CO_2 cumulatively by 2030, again compared to the no extension case."

(U.S. Department of Energy, Quadrennial Energy Review Second Installment (QER 1.2), https://www.energy.gov/epsa/downloads/quadrennial-energy-review-second-installment

b. Public Utility Regulation Policies Act (PURPA)

PURPA created a market for power from non-utility power producers. Before PURPA, only utilities could own and operate electric generating plants. PURPA requires utilities to buy power from independent companies that can produce power for less than what it would cost for the utility to generate the additional power, called the "avoided cost." Because the avoided (marginal) cost is higher than the utilities average cost of electricity generation, projects using renewable energy or high-efficiency fossil fuel power may be cost competitive. The EPACT 2005 and EISA 2007 both added standards that utilities "must consider" whether or not to adopt verbatim regarding: efficient generation of power; net and time-based metering; rate design promoting energy efficiency investments; and smart grid promotion. PURPA encouragement of non-utility generation has contributed to increased electricity production from geothermal, biomass, waste, solar, and wind. Biomass and waste-to-energy qualify as long as they meet a 5% of useful steam threshold. The impact of PURPA waned over time as states sharpened the definition of avoided costs and turned to competitive bidding to meet resource needs.

PURPA established a new class of generating facilities called Qualified Facilities (QFs) which would receive special rate and regulatory treatment. QFs have the right to sell energy and capacity to a utility. QFs may include congeneration facilities and small (< 80MW) renewable generators.

3. Key state and local policies and incentives

a. Renewable portfolio standards (RPS)

"State RPS policies are key drivers of renewable energy growth. Twenty-nine states have renewable or alternative energy portfolio standards that require utilities or other electricity providers to meet a minimum portion of load with qualifying forms of renewable energy. Of the 230 terawatt-hours (TWh) of total non-hydro renewable electricity generation growth since 2000, over half (or 130 TWh) was to meet RPS mandates." RPS rules vary from state to state, each with different targets, timeframes, and sometimes specific carve outs for solar or distributed generation (DG).

(U.S. Department of Energy, Quadrennial Energy Review Second Installment (QER 1.2), https://www.energy.gov/epsa/downloads/quadrennial-energy-review-second-installment)

The state programs that are listed on DSIRE are the most comprehensive source of information on incentives and policies driven by the national, state and local government and electric companies that support renewables and energy efficiency in the United States. California and Texas are the leading states when it comes to renewable energy initiatives. California's Renewables Portfolio Standard have resulted in a requirement for California's electric utilities to have 50% of their retail sales derived from eligible renewable energy resources such as wind, solar, geothermal, and biopower by 2030 and all subsequent years. Texas is the leading producer of wind energy with production higher than the top three states combined (Iowa, Oklahoma, California). Texas' Renewable Portfolio Standard in part is responsible for the wind boom, which mandates a target of 10,000 MW of renewable energy capacity by 2025.

b. Net metering

"Net metering is a rate mechanism wherein customers with onsite generation like rooftop solar are charged for the value of their net consumption (electricity consumed less electricity produced by solar), crediting onsite generation at the full retail rate. Currently, 41 states and the District of Columbia have a statewide net metering policy, and 6 states have alternative compensation mechanisms for DG. States that adopted net metering policies were likely motivated by a desire to generate electricity from zero- or low-emitting sources, to support deployment of a new technology, and to give consumers the option of generating their own power.

(U.S. Department of Energy, Quadrennial Energy Review Second Installment (QER 1.2), https://www.energy.gov/epsa/downloads/quadrennial-energy-review-second-installment

c. Third-party financing/ownership of Renewable Energy

"States can allow third-party ownership of renewable assets, which expands the type of financing available to the residential sector and encourages expansion of residential sector deployment. Third-party ownership models, such as solar leases or residential power purchase agreements, can take

advantage of more tax incentives than homeowners can typically realize, ultimately reducing the up-front costs of a photovoltaic (PV) system. As a result, these third-party models are attractive alternatives to direct ownership of a residential PV system but require states to pass enabling legislation to allow them to happen."

(https://energy.gov/eere/slsc/renewable-energy-distributed-generation-policies-and-programs)

d. Interconnection standards

Interconnection standards determine how generation can be connected to the electric grid. For small generators, interconnection procedures can add significant costs to deployment, and numerous efforts at the federal, state, and local levels have targeted reducing these so called 'soft costs'. (For example, see PG&E case study: https://www.nrel.gov/docs/fy15osti/65066.pdf)

As renewable power penetration increases (both distributed and at the bulk power system level), interconnection standards have evolved, including requirements that renewable generation provide reliability services including low-voltage ride-through, reactive power support, and frequency regulation.

(https://www.nrel.gov/docs/fy16osti/66724.pdf)

2. Can you share success stories of renewable energy projects in your country or region? How do you ensure the sustainability of the project, and scale or replicate it? In your answer please include information on the following: location, time period of implementation/starting date, main actors, beneficiaries, funding, technology and innovation used, issues addressed, stage of implementation, sustainability, etc. Do you have any documentation, references, web addresses or reports on the specific examples cited? If yes, please share it with us.

SunShot Initiative

The U.S. Department of Energy lead the SunShot Initiative which is a national effort to support solar energy adoption by making solar energy affordable for all Americans through research and development efforts in collaboration with public and private partners. SunShot funds cooperative research, development, demonstration, and deployment projects by private companies, universities, state and local governments, nonprofit organizations, and national laboratories to drive down the cost of solar electricity. When DOE launched the SunShot Initiative, it set ambitious goals to make grid-connected solar electricity market-competitive with other forms of energy, without subsidies, by 2020. Since then, solar deployment has grown more than tenfold in the U.S. with more than one million solar installations currently operating across the country. The cost of solar energy has also dropped as much as 65%. Three years earlier than expected, the average price of utility-scale solar is now 6 cents per kilowatt-hour (kWh). In August 2017, SunShot announced the utility-scale goal had been met three years earlier than expected.

The SunShot Initiative is comprised of five subprograms: **Photovoltaics, Concentrating Solar Power, Systems Integration, Soft Costs, Technology to Market.**

PowerAmerica

PowerAmerica, a public-private partnership between industry, the U.S. Department of Energy, national labs, and academia seeks to save energy and create U.S. manufacturing jobs my accelerating the development and large-scale adoption of wide bandgap semiconductor technology. The Institute was founded in 2015 with funding for DOE, the state of North Carolina, N.C. State University and industry partners. Wide band gap conductors operate at much higher voltages, frequencies, and temperatures than conventional semiconductors. They are also smaller and more efficient than the power electronic widely available today. This partnership works to reduce cost, improve reliability, enhance performance capabilities, bring together all facets of the supply chain, and accelerate the development of an advanced manufacturing workforce.

STEM, Energy, Economic Development (SEED): Coalitions for Community Growth

The U.S. Departments of Energy and Housing and Urban Development have partnered with the U.S. Department of Education to build human capital and continue significant investments in infrastructure

upgrades and energy retrofits to conserve resources. This program is an innovative place-based initiative to create economic opportunity and energy-literate communities, including energy literacy, STEM education, and job-driven skills training.

Women and Girls in STEM

Empowering Women in Clean Energy to Lead. The Department of Energy's Office of Policy and International Affairs continues to grow and strengthen the U.S. Clean Energy Education and Empowerment (C3E) program to advance women in clean energy. The United States is one of nine governments supporting the C3E initiative, a network of national-level actions to increase women's participation in clean energy careers worldwide. The United States is working to close the gender gap with a three-part program including an annual C3E Symposium to build a community of professional women advancing clean energy; annual C3E Awards for mid-career leadership and achievement; and the ongoing engagement of the C3E Ambassadors, a group of distinguished senior professionals who serve as spokespersons and champions. At the 4th Clean Energy Ministerial meeting in New Delhi, the C3E initiative launched C3Enet.org, an online network to connect women around the world.

Advancing Female Role Models in STEM to Promote The STEM Workforce. The Department of Energy's Office of Economic Impact and Diversity created the Women @ Energy series in March 2013, posting over 150 profiles of women in the Energy Department workforce who share their passion for STEM, their work at the Department, tips for engaging women and minorities in STEM, and their personal stories. The profiles have been featured in classrooms around the country, gaining more than 20,000 page views since the launch, and profiles are continuing to be added to the site. Additionally, in January 2014 the Department of Energy launched a #WomeninSTEM video series to highlight women in clean energy careers.

Promote Women's Entrepreneurship in the Energy Sector. In November 2013, the Department of Energy's Office of Energy Efficiency and Renewable Energy's Small Business Innovation Research Program launched an outreach and education effort to increase the number of women and minority business applicants.