Testimony to the House Select Committee on the Climate Crisis

Solving the Climate Crisis: Manufacturing Jobs for America's Workers

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Good afternoon Chair Castor, Ranking Member Graves, and members of the committee. Thank you for the opportunity to have a discussion today about how clean energy manufacturing can help address the climate crisis and create jobs in the United States.

My name is Tarak Shah. From 2014-2017, I served as Chief of Staff to the Under Secretary for Science and Energy and the U.S. Department of Energy (DOE). I now work as an independent consultant to private sector and non-government organizations that are advancing clean energy technology and policy.

Innovation as the Key to Long Term Economic Growth

For decades, economists have recognized that technological innovation is the principal driver of long-term growth in living standards and the broader economy.[1] And, according to the National Science Foundation, U.S. manufacturing firms were responsible for two thirds of the R&D conducted and paid for by companies in the U.S. in 2016.[2] Taken together, we know that there are critical links between manufacturing innovation and the health of our economy.

We also know that climate change is impacting us now, that if left unchecked the effects over the next century will fundamentally and negatively change the way humans live. While it is not too late to prevent its worst potential impacts, to do so, we need to completely transform the ways we use and produce energy, and at a scale and pace never before accomplished.

Unfortunately, there is no silver bullet to ending the climate crisis. Instead, we must take steps to eliminate greenhouse gas pollution from multiple sectors at once – steps like increasing energy efficiency and zero-emitting power generation at record pace, electrifying buildings and transportation systems in order to replace fossil fuel use, transitioning industrial processes to be carbon neutral, and capturing already-emitted carbon from the atmosphere.

There are two principle ways we can achieve this transformation – first, by enacting a comprehensive set of new policies to curb pollution and deploy clean energy technologies and second, by simultaneously developing new energy technologies. Today, I will

[1] Moses Abramovitz, "Resource and Output Trends in the U.S. since 1870," *American Economic Review* 46, no. 2 (May 1956). http://www.nber.org/chapters/c5650.pdf

[2] "Business Research and Development and Innovation: 2016," *National Science Foundation* (May 2019). https://ncses.nsf.gov/pubs/nsf19318/ - &

describe strategies that cut greenhouse gas emissions, while also creating millions of new jobs and better economic opportunities for Americans as well.

To share the bottom line up front, Congress has the ability to significantly alter our nation's future by stimulating more domestic clean energy manufacturing.

Winning the Global Clean Energy Race

Congress can make a large impact on our clean energy economy because new Federal investments and policy changes can help U.S. workers access the huge global opportunity associated with addressing climate change. The International Energy Agency estimates that nearly $60 trillion will be invested in global energy markets over the next 20 years.[3] Given the enormous size of this economic opportunity, countries around the world will be competing for shares of this market, using all the tools they can bring to bear.

Much of the opportunity in this space lies in manufacturing – both in building tomorrow's energy technologies like solar, wind, batteries, efficient appliances and carbon capture technologies and in reducing the energy demand and GHG emissions associated with everything we manufacture, particularly in energy intensive industries like petroleum refining, chemicals, iron and steel, and cement.

For many of these technologies, the U.S. has led the globe on their research and development. But without care, we risk seeing the benefits of taxpayer funded technology investments being reaped by other countries.

For example, solar photovoltaics (PV) were invented by American industry and nurtured for decades in government labs. However, about a decade ago, just as the price of the technology began to make it competitive with other forms of power generation, Chinese companies, with substantial assistance from their government, stepped in to become the world's low-cost manufacturer.[4]

Today, over 60% of the world's solar panels are manufactured in China.[5] In fact, China has now developed an entirely domestic solar manufacturing supply chain – from polysilicon to finished modules. The jobs associated with mining, making solar cells, module assembly, even manufacturing the equipment that makes solar panels are all now primarily based in China. In addition, that expertise is now spilling over into other high-value industries like semiconductor manufacturing. As those industries dramatically expand over the coming years, China will continue to benefit.

There are effective steps we can take now to prevent the same from happening to the next generation of low and zero carbon technologies.

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[3] "World Energy Outlook 2018," *International Energy Agency* (November 2018). https://www.iea.org/weo/

[4] Varun Sivaram, "Unlocking Clean Energy," *Issues in Science and Technology* (Winter 2017). https://issues.org/unlocking-clean-energy/

[5] "Renewables 2017," *International Energy Agency* (October 2017). https://www.iea.org/publications/renewables2017/

Key Technology Focus Areas
Opportunities to innovate and hold manufacturing preeminence exist for technologies across the clean energy spectrum, and I will briefly mention several.

First, with solar energy, the U.S. should continue to compete. Total domestic PV capacity is expected to double over the next five years.[6] Capturing even some of the manufacturing associated with that increase would represent a significant economic opportunity. In addition, the U.S. leads on developing new solar technologies including multi-junction cells and perovskites, and as they commercialize, we should build them here, which will correspond with high-quality jobs for Americans.

Offshore wind is huge untapped opportunity in the U.S. Driven by state-level policy commitments, particularly in the Northeast, the market is expected to grow from 5 turbines deployed today, to at least one thousand by 2030, which represents enough capacity to power roughly 5 million homes.[7] Despite this, there are no U.S.-flagged installation vessels or any domestic manufacturing centers yet built.

Nearly 10% or 231,000 of the 2.5 million workers in the domestic auto industry worked with electric vehicles (EV) in 2018.[8] But this industry is rapidly evolving. Domestic EV demand in other countries that manufacturing cars is higher than in the U.S. As companies in these countries develop robust supply chains and scale to satisfy domestic demand, they will also gain an exporting advantage.

Nearly one third of the cost of an EV is in the battery that powers the vehicle.[9] China already controls about 73% of the global lithium cell manufacturing capacity, while the U.S. has about 12%.[10] China has used this early lead to become the global manufacturer for electric buses.

The key driver of U.S. wind, solar and EV deployment over the past decade has been tax policy. That policy has not been stable and has introduced long-term uncertainty for companies across the supply chain, including manufacturers. In some cases, that has led to factory closures and layoffs. Congress can stave off this uncertainty by acting now to extend credits for a variety of low carbon technologies before they expire.

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[6] "Solar Market Insight Report – Q2 2019," *Solar Energy Industries Association* (June 2019). https://www.seia.org/research-resources/solar-market-insight-report-2019-q2
[7] "2018 Offshore Wind Technology Market Report," *U.S. Department of Energy* (August 2019). https://www.energy.gov/sites/prod/files/2019/08/f65/2018%20Offshore%20Wind%20Market%20Report.pdf
[8] "2019 U.S. Energy and Employment Report," *Energy Futures Initiative* (March 2019). https://www.usenergyjobs.org
[9] Electric Car Price Tag Shrinks Along With Battery Cost," *Bloomberg New Energy Finance* (April 2019). https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost
[10] "Why China is Dominating Lithium-Ion Production," *Forbes* (August 2019). https://www.forbes.com/sites/rrapier/2019/08/04/why-china-is-dominating-lithium-ion-battery-production/- 1e39ab423786

In the power sector, the world needs 100 times more carbon capture capacity by 2030 than it currently has to maintain a path to prevent an increase in global average temperatures of more than 2 degrees C.[11] Each of these facilities require huge machines – machines that can and should be built in America, not to mention the hundreds of construction jobs and dozens of permanent jobs associated with their installations and operation. The largest carbon capture facilities in the world are in the United States, but other countries are taking concrete steps to deploy this technology. We need to act now to build a CCUS industrial base in the U.S. that exports this homegrown technology around the world.

Advanced nuclear power offers another very important zero-carbon manufacturing opportunity for the United States. The nuclear supply chain already employs nearly 5,000 Americans[12]. Domestic small modular reactor manufacturing could also support export markets.

Hydrogen has a wide variety of potential applications, particularly in industry. For example, hydrogen produced by renewable energy can replace metallurgical coal to dramatically reduce carbon pollution emitted during steel making, providing a competitive advantage for U.S. steel industry jobs, including in steel-making regions like Representative Palmer's district. Renewable hydrogen could also act as a form of low carbon energy storage, be used to replace fossil fuels in industrial heating processes, and be converted to green fertilizers.

The U.S. has an early lead in additive manufacturing, also known as 3-D printing, thanks to early investments by the U.S. Department of Energy. As the first step in the supply chain for a variety of finished high-value energy-efficient products in the aerospace, energy, and transportation sector, it is important to continue to support development of this technology domestically.

Finally, energy efficiency products including LED bulbs, solid state power electronics, better motors, and high efficiency appliances are a source of manufacturing strength for the U.S. Manufacturing these products employed over 320,000 Americans in 2018. Many of these products are made in America and exported around the world.

All of these technologies would benefit from a long-term price signal on greenhouse gas pollution. Valuing the low/no carbon aspects of these technologies could help them better compete with existing energy resources, create spillover benefits across our economic sectors and thus spur growth in manufacturing capacity in the U.S.

Role of the Federal Government

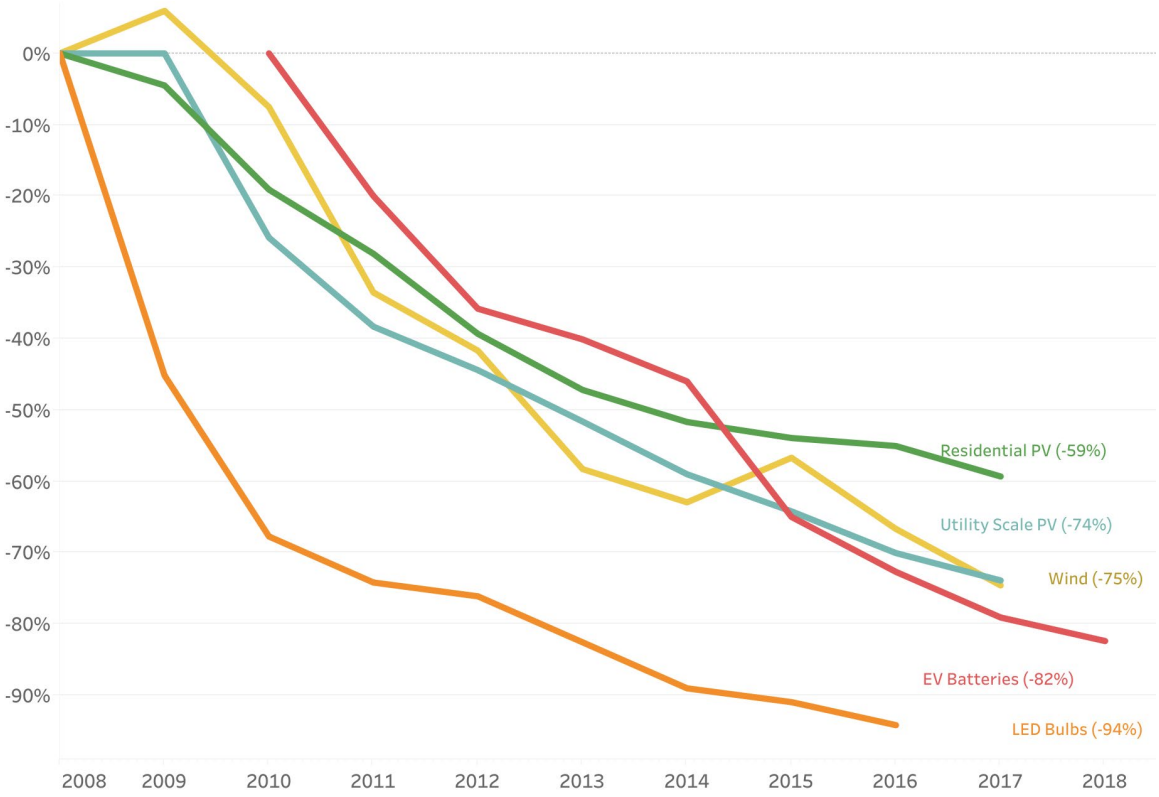
The Federal government currently supports clean energy manufacturing in two principal ways – by supporting research and development and through workforce development.

[11] "Tracking Clean Energy Progress," *International Energy Agency* (June 2019). https://www.iea.org/tcep/power/

[12] Ibid. 8

Clean energy manufacturing R&D is supported by a variety of programs at the Department of Energy and concentrated in the Advanced Manufacturing Office (AMO). Over the past few decades, several technologies fostered by DOE have left the lab and entered the market with great success. These include solar panels, wind turbines, grid-scale batteries, and LED light bulbs (see Figure 1). In each case, DOE has supported both the initial development of the technology and subsequent innovations in manufacturing these products to bring down costs.

Figure 1: Cost Reductions in Major Clean Energy Technologies



Source: Natural Resources Defense Council, Revolution Now. https://www.nrdc.org/revolution-now

Key Message: Federal investments have driven down the price of clean energy over the past decade.

DOE sponsors programs to make U.S. manufacturers more competitive vis-à-vis foreign competitors. For example, the Innovation in Manufacturing Competitiveness program in the Solar Energy Technology Office funds projects that are helping rebuild the solar module industry and supply chain in America.

AMO pursues a large variety of programs to do the same, including through the Manufacturing USA Institutes, a national network of federally sponsored manufacturing institutes, each with their own technological concentration, but designed to accelerate

U.S. manufacturing as a whole. For 2019, Congress appropriated $320 million for the Advanced Manufacturing Office, or less than 1% of DOE's overall appropriation.[13]

In addition, through the R&D tax credit, the Federal government rewards companies for performing research in the U.S. It was made permanent in 2015 and has provided companies over $11B in credits annually in recent years. This tax credit generally benefits all firms, including clean energy manufacturers who perform R&D.

Government labs are also playing a role, not only in developing new technology, but in supporting energy and manufacturing innovators. Programs like Cyclotron Road at Lawrence Berkeley National Laboratory support entrepreneurial scientists and engineers through a two-year fellowship program, giving then access to the unique expertise and world-class facilities of the laboratory. Fellows in the program work on hard science products like microelectronics, carbon nanotubes, fibers and polymers, and electrochemical storage devices. Once commercialized, these products will create innovative manufacturing jobs across the country.[14]

DOE also supports some workforce development programs, which are important to ensure that domestic manufacturers can access a trained pool of engineering and technical talent to meet demand from the growing clean energy market. Programs like the Solar Instructor Training Network and the Collegiate Wind Competition have been successful in training the next generation of clean energy professionals. DOE's Industrial Assessment Centers also train the next generation of collegiate engineers as they perform energy audits at small and medium sized manufacturing facilities around the country. As a result of this program, students are given valuable learning experiences while American businesses receive energy saving advice.

The Federal Government Can Do Much More

With Congress' help, the Federal government can do much more to support clean energy manufacturing in three primary ways – focusing and strengthening its support of manufacturing R&D, deploying advanced energy manufacturing technologies, and ramping up workforce development programs. Taking these steps will not only help strengthen the competitiveness of U.S. manufacturing, but also help increase U.S. exports and support domestic job and wage growth.

Many of these recommendations and others are included in a forthcoming report I have written along with staff at the Natural Resources Defense Council. I look forward to sharing the full report with the Committee.

In the area of R&D, Congress should immediately double funding for the entire suite of federal energy innovation efforts, including advanced clean energy manufacturing. DOE programs are oversubscribed – meaning that there are many more qualified research

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[13] "Joint Explanatory Statement of the Committee of Conference," *U.S. Congress*. September 2018. https://docs.house.gov/billsthisweek/20180910/Joint Statement.pdf

[14] "Cyclotron Road 2018 Impact Report," *Lawrence Berkeley National Laboratory*. (2019).https://www.cyclotronroad.org/

applicants than there is funding available. Additional funding will yield faster clean energy innovation. Congress should also make manufacturing competitiveness and exports an explicit authorized goal of DOE research.

In addition, because many technology options to decarbonize the U.S. industrial sector are currently very expensive or non-existent, DOE should establish a new R&D effort to investigate the full range of decarbonization options for the industrial sector, including electrification, low-carbon fuels, and carbon capture, utilization, and sequestration (CCUS). H.R. 3978, the Clean Industrial Technology Act of 2019, which Representative Casten has introduced, would do exactly this.

In the area of deployment, Congress should reinstitute the 48C Advanced Clean Energy Manufacturing Tax Credit. That tax credit, jointly administered by DOE and the Department of the Treasury from 2009 to 2017, provided $2.3 billion in funding through a 30% investment tax credit to hundreds of firms around the nation.[15] These firms used the funding to expand domestic manufacturing capacity for parts and equipment for clean energy projects.

Funding helped American manufacturers expand production for efficient HVAC systems, cleaner trucks, efficient lightbulbs, smart power electronics, electric vehicles and SUVs, wind turbines, lithium-ion batteries, and much more. These projects generated tens of thousands of jobs while making our economy cleaner and more efficient. A new program, double the size of the previous one, could help stimulate manufacturing supply ecosystems for the next generation of clean energy technologies.

Under a provision of the Bayh-Dole Act, DOE's Energy Efficiency and Renewable Energy (EERE) and Advanced Research Projects Agency-Energy (ARPA-E) programs require award applicants to submit U.S. Manufacturing Plans.[16] These plans state an awardee's commitment to manufacture technologies resulting from DOE awards in the United States.

Congress should ask DOE to strengthen this requirement by applying it to all applied energy RDD&D programs (not just EERE and ARPA-E) and to develop recommendations for strengthening proposed manufacturing plans. Specifically, the current law gives the Federal government very few mechanisms to enforce the commitments that awardees make in their plans. These mechanisms could include clawback provisions for intellectual property or financial compensation for U.S. taxpayer sponsored technology that is manufactured offshore.

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[15] "48C Phase II Advanced Energy Manufacturing Tax Credit Program Fact Sheet," *U.S. Department of Energy* (December 2013). https://www.energy.gov/downloads/48c-phase-ii-advanced-energy-manufacturing-tax-credit-program-fact-sheet

[16] "Determination of Exceptional Circumstances Under the Bayh-Dole Act for Energy Efficiency, Renewable Energy, and Advanced Energy Technologies," *U.S. Department of Energy* (September 9, 2013). https://www.energy.gov/sites/prod/files/2014/01/f6/DEC for Energy Efficiency Renewable Energy %26 Advanced Energy.pdf

Congress can also expand the remit of DOE's Loan Programs Office's Advanced Technologies Vehicles Manufacturing program. The program provides loans to automotive or automotive component manufacturers to build or expand manufacturing facilities that produce fuel-efficient vehicles. The program has supported the production of more than four million fuel-efficient and electric vehicles, including Tesla's California factory and Nissan's Tennessee factory, which produces the Leaf.[17] While the program has $17.7B in loan authority left, it is not currently allowed to invest in efficient heavy-duty truck and bus manufacturing. Congress can expand ATVM's authority with no additional scoring implications and, in doing so, support new manufacturing facilities and jobs in the U.S.

Additionally, incentives to develop regional ecosystems focused on the manufacturing of new energy technologies, like new battery chemistries, multi-junction solar cells, perovskites, and others discussed today will help grow the economy. These ecosystems are made up of strong supply chains, workforce development programs, investors, and national labs and universities (i.e. sources of innovation) and will create more jobs and make it more likely that the manufacturing of these technologies will stay in the U.S.

Stronger trade and environmental standards with effective enforcement provisions could help even the playing field for U.S. manufacturers of clean energy. Foreign firms that manufacture clean energy products while polluting the environment have a leg up on U.S. firms that are subject to stricter state and Federal laws. Cross-border adjustment mechanisms that price carbon and other pollution could help ensure that U.S. manufacturers are not disadvantaged for stewarding the planet.

U.S. manufacturers have a history of developing innovative, energy efficient products. DOE's Appliance Standards program sets and implements minimum energy performance standards for appliances and devices in our homes, businesses, and factories. These appliance standards have already saved consumers nearly $1 trillion dollars over the past three decades.[18] By implementing rigorous appliance standards, innovative American firms would have an advantage over less efficient foreign products, thereby incentivizing U.S. manufacturing and creating jobs domestically.

Finally, California has recently instituted a "Buy Clean" procurement policy for steel, glass, and insulation purchased for state-funded projects. The policy considers a manufacturer's GHG emissions in state purchasing decisions, rewarding those manufacturers that have invested in pollution reduction. Congress should require the Federal agencies to adopt this policy, require that such products be made in America, and expand it to other finished goods and construction materials.

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[17] "Advanced Vehicles Manufacturing Projects," *U.S. Department of Energy* (June 2017). https://www.energy.gov/lpo/advanced-technology-vehicles-manufacturing-atvm-loan-program

[18] "Saving Energy and Money with Appliance and Equipment Standards in the United States," *U.S. Department of Energy* (June 2017). https://www.energy.gov/sites/prod/files/2017/01/f34/Appliance and Equipment Standards Fact Sheet-011917_0.pdf

And to develop and deploy these technologies, we need a competitive, growing manufacturing sector that has the workforce, the engineering talent, and capacity to innovate in order to meet the dual challenges of producing more clean energy and reducing the use of carbon emitting fuels.

Workforce development programs that teach skills in topics like clean energy manufacturing, robotics, artificial intelligence, and green construction are lacking and required. Such training programs should be conducted in partnership with industry, to provide a clear pathway to job placement. In addition, these programs should be coordinated with other agencies, including the National Science Foundation and the Departments of Labor and Education. DOE workforce development programs also must include diversity and inclusion as a key criterion. Finally, DOE's Manufacturing USA Institutes could be tasked with workforce development for both engineers and technicians in their focus areas.

Taking these steps will help maintain our national human capital lead, which is an important factor that firms consider when choosing where to locate their facilities.

Concluding Thoughts

The United States is competing in a global clean energy race, along with every other country on the planet. Whoever wins will lead the planet in addressing climate change – which is the most serious challenge of our time – while also gaining the millions of jobs, the higher living standards, and the other economic opportunities that accompany it. Everything about our national innovation model – our world-leading academic and National lab systems, the entrepreneurial spirit of our private sector, and our national technological embrace tells me that we can win this race.

What we need now is for Congress to give the Federal agencies the tools to catalyze our private sector into taking that leading position.

Thank you very much for holding a hearing on this important topic.