



ACCELERATING THE TRANSITION TO CLEAN ENERGY

AUGUST 2015

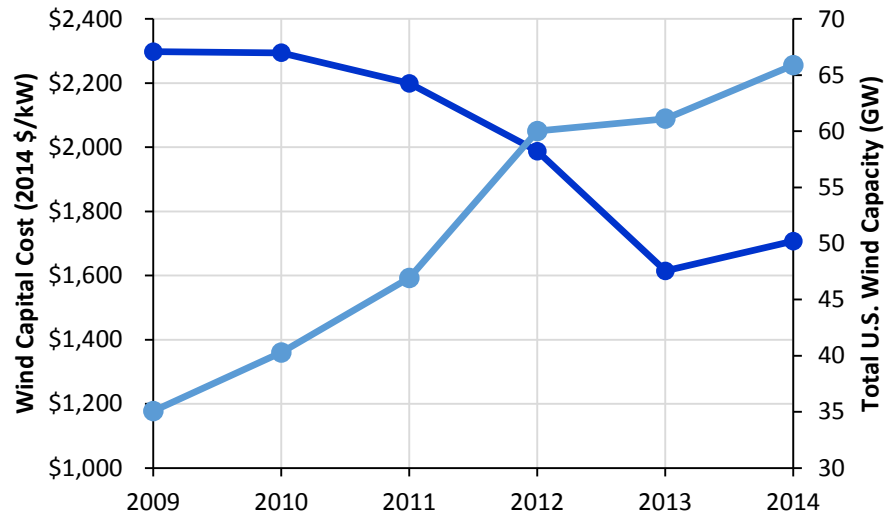
Earlier this year, President Obama announced a new goal to increase the share of renewables – beyond hydropower – in the U.S. electricity generation mix to the level of 20 percent by 2030. Since President Obama took office, the deployment of renewable energy technologies has increased dramatically, whether measured in terms of overall capacity of the generation equipment or by the overall amount of renewable electricity generated. Since 2008, total generation of electricity at utility scale (i.e., at facilities with capacity greater than 1 megawatt) from solar, wind, and geothermal resources tripled while costs have fallen. Electricity generation from wind tripled, solar electricity generation increased 20 times, and geothermal generation grew by 12 percent. Meanwhile, wind costs have declined by nearly 20 percent since 2008, median utility scale PV costs have decreased by nearly 60 percent, and residential distributed PV costs have declined by over 50 percent. In fact, U.S. distributed solar prices fell 10 to 20 percent in 2014 alone.

Wind Power

Since President Obama took office, wind energy generation has tripled, enough to power more than 17 million homes currently supporting over 73,000 American jobs powers. In fact, the United States currently ranks number one in the world in wind energy generation. There are more than 500 manufacturers across 43 states supplying the wind industry, creating even more new jobs across the country. In 2014, the average price of newly signed Power Purchase Agreements reached an all-time low of 2.35 cents per kilowatt-hour, down from 7 cents per kilowatt-hour in 2009.

Improvements in wind energy technologies such as taller towers and larger blades have increased the performance and efficiency of wind projects and are leading to the economic deployment of wind energy systems in areas that have typically been characterized by low wind speeds. Compared to 1998-1999, the average nameplate capacity of newly installed wind turbines in the United States in 2014

was 1.9 megawatts, up more than 170 percent; the average hub height in 2014 was 83 meters, up 48 percent; and the average rotor diameter was 99 meters, up 108 percent since 1998–1999, all of which contributed to the overall reductions in wind costs.

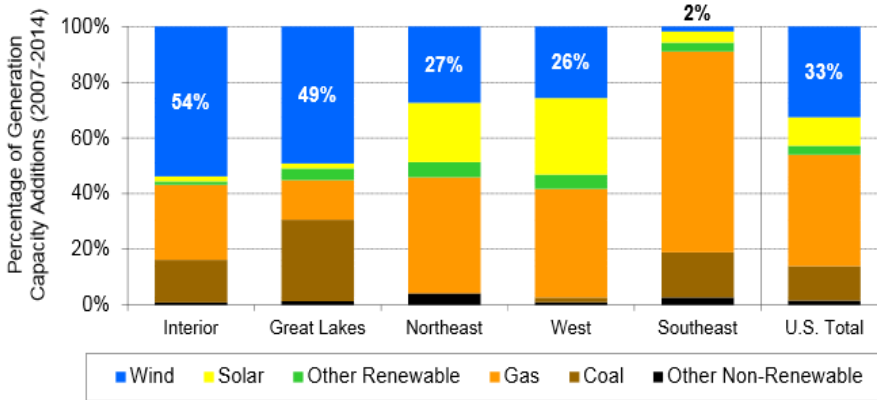


Wind Costs going down, deployment going up

Wind energy is emerging as a powerhouse in the U.S. energy mix. Reductions in cost and technological improvements have led to a significant increase in wind deployment in the United States, reaching a total of over 66 gigawatts (GW) in 2014. This represents a more than 160 percent increase in wind capacity since 2008. The level of wind deployment is significant relative to other

forms of energy: from 2007 to 2014, wind comprised 33 percent of capacity additions nation-wide, and a much higher proportion in some regions.

In March 2015, DOE released the *Wind Vision Report*, underscoring progress in the development of the wind industry and quantifying the positive economic and environmental benefits of continued wind energy development. The report highlighted key findings, including: (1) wind



power could help America combat climate change by avoiding more than 12.3 billion tons of carbon pollution cumulatively by 2050, equivalent to avoiding one-third of global annual carbon emissions; (2) the wind industry could support

more than 600,000 jobs by 2050; and (3) wind energy could save approximately 260 billion gallons of water by 2050, all while reducing national average electricity costs by two percent. Furthermore, in May 2015, the Administration released a report entitled *Enabling Wind Power Nationwide*, highlighting the technical potential of advanced wind turbines with taller towers and larger rotors in the United States and mapping how advancements in turbine technology will unlock wind energy potential in all 50 states, specifically the previously untapped Southeast.

Solar Power

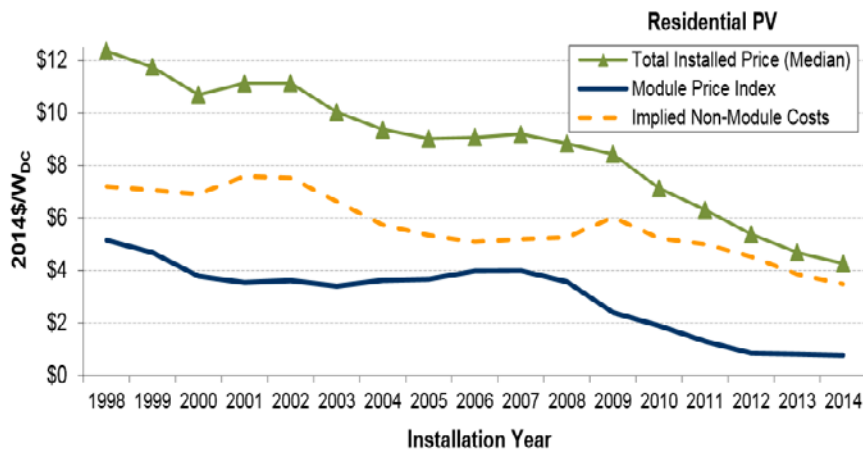
Solar power advances U.S. energy independence, bolsters its energy security, creates jobs, and combats climate change. In fact, today, across all solar technologies the United States harnesses about twenty times as much electricity from the sun as it did when President Obama took office. And in the process of cutting emissions and combatting climate change, today's solar industry is adding jobs ten times faster than the rest of the economy.

Decreasing Costs

Only halfway into the President's decade-long SunShot Initiative, the solar industry is nearly 70 percent of the way to achieving SunShot's goal to make solar power fully cost-competitive with traditional energy sources, without incentives, by 2020. SunShot is partnering with national laboratories, universities, private companies, state and local governments, and utilities on more than 250 research and development projects that aim to make solar power affordable for American families and businesses across the nation.

In fact, the cost of residential photovoltaics has decreased by over 50 percent since 2008. Steep reductions in module prices primarily drove price reductions for residential consumers from 2008 to 2012, but since then cost reductions have arisen from lowering soft costs, demonstrating the impact of policy and industry actions in this area.

Utility scale solar photovoltaic costs have also undergone drastic reductions in cost, falling by nearly 60 percent since 2008. With these falling costs as a key factor, nearly 20 GW_{DC} of solar photovoltaics have now been deployed in the United States, nearly 20 times the amount deployed

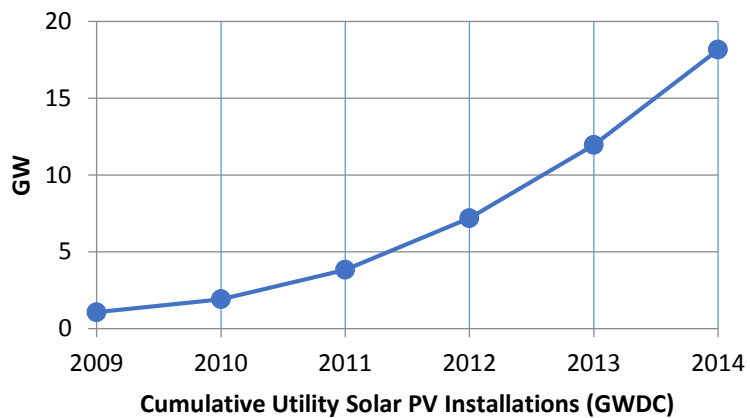


Notes: The Module Price Index is the U.S. module price index published by SPV Market Research (Mintz 2015). Implied Non-Module Costs are calculated as the Total Installed Price minus the Module Price Index, and therefore include installer profit margin.

in 2008. Concentrating solar power (CSP) has also expanded, quadrupling its capacity over the same time period. These falling utility costs have allowed a succession of new record low power purchase agreements in the past two years, with a number of recent announcements at or below 5 cents per kilowatt-hour.

Increasing Capacity

As a result of DOE’s SunShot Initiative investments and the industry’s accelerated pace to meet the SunShot goal, 2014 was a record breaking year for solar deployment in the United States. Solar deployment was up nearly 40 percent over 2013 with 20 gigawatts of installed capacity, enough to power the equivalent of 4 million homes. There are approximately 800,000 solar projects operating across the country and the United States has become the third largest solar market in the world. During 2014, solar energy represented 32 percent of all new electric generating capacity in the United States.



(Data source: US Solar Market Insight Report, 2014 Year In Review, January 2015, SEIA/GTM Research)

Creating Jobs

As deployment has soared, so have solar jobs. Today, the U.S. solar industry employs nearly 174,000 workers in high-paying jobs, up 22 percent over 2013. To help achieve the Administration’s goal to train 75,000 workers to enter the solar industry by 2020, earlier this year, the President launched the Solar Ready Vets program. This program will train transitioning military service personnel to enter the solar workforce by joining with SunShot’s Solar Instructor Training Network and leveraging the DOD’s Skillbridge transition authority authorized by Congress in 2012. The program is based on the specific needs of high-growth solar employers, is tailored to build on the technician skills that veterans have acquired through their service, and

incorporates work-based learning strategies. Service members will learn how to size and install solar panels, connect electricity to the grid, and interpret and comply with local building codes to prepare them for careers in the solar industry as installers, sales representatives, system inspectors, and other solar-related occupations.

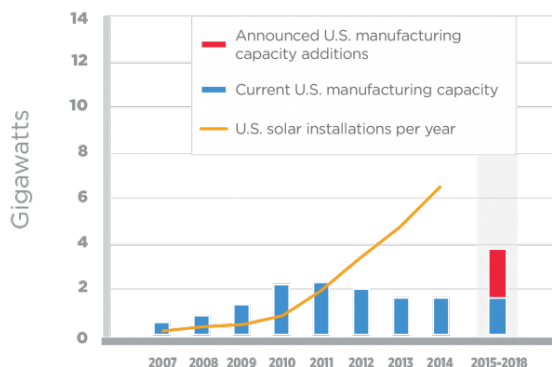
Driving Domestic Solar Manufacturing

DOE's SunShot program is supporting innovation in manufacturing to ensure

U.S. developed technologies can capture a larger portion of the global value in solar manufacturing, currently estimated to be about \$120 billion worldwide. SunShot has supported numerous companies through programs like Solar Manufacturing Technology and SUNPATH in the development and implementation of innovative technologies that reduce costs and increase efficiency in manufacturing processes used to make PV and CSP technologies.

Three SunShot awardees—Suniva, SolarCity/Silevo and SolarWorld—announced new factories or factory expansions in the United States in 2014.

U.S. Solar Manufacturing Making a Rebound



Geothermal Power

Geothermal energy continues to grow gradually and expand its role as a significant part of the nation's renewable power portfolio. Geothermal energy takes a very small environmental footprint to develop and provides predictable, constant energy regardless of environmental conditions, meaning it is available 24/7 and can balance the voltage swings of variable energy resources. By developing, demonstrating, and deploying innovative technologies, DOE's efforts are helping stimulate the growth of the geothermal industry within the renewable energy sector and encouraging quick adoption of technologies by the public and private sectors.

The potential for the geothermal is just beginning to be tapped. The United States Geological Survey estimates a potential 30 GW of undiscovered hydrothermal resource and a much vaster 100 GW of potential heat resource accessible by enhanced geothermal systems (EGS), which could contribute to up to 10 percent of current U.S. electricity generation. As a method for electricity production as well as a thermal source for heating and cooling buildings, geothermal power significantly reduces U.S. greenhouse gas production. The total electricity capacity of geothermal power in 2014 was over 3.6 GW, which saves around 54 million barrels of oil and avoids emissions of 27 million tons of CO₂.

Phase 1 FORGE Selection; Accelerating EGS Deployment

In April, DOE announced five project teams selected for Phase 1 of the Frontier Observatory for Research in Geothermal Energy (FORGE) initiative. Candidate FORGE sites in California, Idaho, Nevada, Oregon, and Utah will compete for the opportunity to serve as the location for a collaborative subsurface laboratory that will in turn create a commercial pathway to enhanced geothermal systems technologies. The Phase 1 award—which will ultimately be down-selected to one team and one site—will yield mission-critical technical and logistical preparation that will demonstrate site viability and the team’s capacity to fully characterize and equip the field site for transformative research.

Lowering Non-technical Barriers

Navigating the regulatory requirements can increase the time it takes to explore and develop geothermal power in a region, which significantly increases the costs and risks of such projects. In 2013, DOE issued the RAPID Toolkit for 10 geothermal-rich states to help developers navigate the regulatory requirements required for deploying geothermal energy projects.

National Geothermal Data System

In 2014, Secretary Moniz announced deployment of the National Geothermal Data System, a “best-in-class” data collection and dissemination effort. The public data platform encompasses thousands of databases, geologic maps, and reports, drawing from millions of digitized records from all DOE-funded projects and various agencies in all 50 states that were previously unavailable. The National Geothermal Data System will allow academia and industry to access technical data in digital format to simulate geological features and to locate and monitor geothermal reservoirs, breaking down one of the geothermal energy industry’s greatest barriers to development and deployment.

AltaRock Newberry EGS; Accelerating EGS Deployment

The AltaRock Newberry enhanced geothermal system (EGS) demonstration project is one of only a small number of EGS technology demonstrations in the world today. Numerous technical "firsts" have been realized at the Newberry project. In 2012 and 2014, the Newberry team demonstrated the first multi-zone EGS stimulation utilizing a novel chemical diversion technology, increasing the volume of rock that is available for heat. In 2014, five years of field work culminated in the development of a new reservoir surrounding the injection well. Additionally, in collaboration with DOE and the Bureau of Land Management, AltaRock developed and executed the community's most robust and comprehensive Induced Seismicity Mitigation Plan to date.

Hydropower & Marine Hydrokinetic Power

The technical resource potential of untapped stream-reaches in the United States is 85 GW of capacity. Hydropower currently supplies approximately [seven percent of the U.S. electricity supply](#) – enough to power more than 20 million homes. Within the last decade, the industry has supported more than 55,000 direct domestic jobs across the country, and helps offset 200 million metric tons of carbon emissions per year, equivalent to the emissions from more than 42 million passenger vehicles.

In 2015, the Energy Department launched the Wave Energy Prize Competition. With a grand prize of \$1.5 million, the Wave Energy Prize is designed to increase the diversity of organizations involved in Wave Energy Converter (WEC) technology development, while motivating and inspiring existing stakeholders. The Energy Department envisions this competition will achieve game-changing performance enhancements to WEC devices, establishing a pathway to sweeping cost reductions on a commercial scale. With a record breaking 92 teams having applied, the Energy Department recently selected the [top 20 teams](#) that will be competing for a chance to test their device at the nation's most advanced wave-making facility, the Naval Surface Warfare Center's Maneuvering and Seakeeping Basin at Carderock, Maryland.

Azura Wave Energy Device Explores New Depths in Hawaii

In June, in coordination with the U.S. Navy, Northwest Energy Innovations (NWEI), the Energy Department brought online a prototype of the Azura wave energy converter (WEC) device. The 20-kilowatt demonstration project is now the first grid-connected wave energy device producing power in North America to be validated by a third party—the University of Hawaii—a major milestone for the emerging American marine and hydrokinetic (MHK) energy industry. If successful, the advancements made possible by this major demonstration project will provide clean, renewable electricity that can be used by millions of homes and businesses throughout the country, furthering America's progress in proving wave energy as a viable source for our nation's clean energy future.