Arizona's Solar Energy Future

Fact Sheet 1 in a series

Arizona's Solar Energy Future

An Overview

A SHINING OPPORTUNITY

Abundant sunlight, vast tracts of flat land, and a mandate for renewable energy. All signs point to a remarkable opportunity for Arizona to become the solar capital of the United States and, in practical terms, the world.

This is the first in a series of fact sheets developed by the Sonoran Institute that explores how Arizona can best capitalize on its solar potential.

The world has recognized that global warming, caused by a concentration of carbon dioxide (CO_2) and other greenhouse gases in our atmosphere, is a real and imminent threat to the survival of our planet. Since fossil-fuel based energy production is a major contributor of CO_2 emissions, replacing this energy with zero-carbon power has become a priority. The challenge is daunting. Stabilizing and eventually reducing CO_2 levels will require an ambitious amount of carbon-free energy generation.

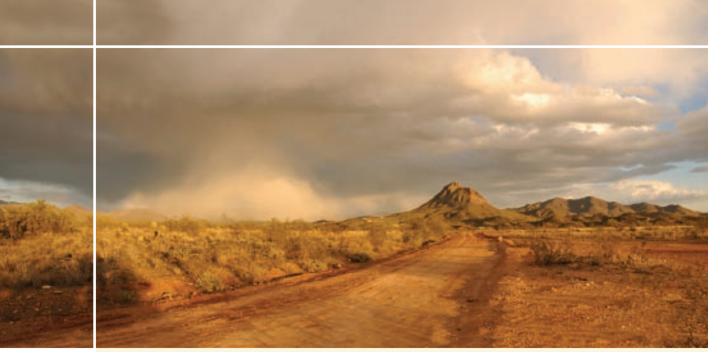
As a start, many states have mandated that a certain percentage of their energy production come from renewable sources by a particular date. In Arizona this policy is known as the Renewable Energy Standard (RES) and requires that 15 percent of the retail electricity sold by the state's regulated utilities be produced from renewable sources by 2025.[1]

Where does the state stand today with renewable power, how far does it need to go to achieve its RES requirements, and what is the best way to quickly and cost-effectively ramp up renewable energy production and realize our solar potential? These are questions we begin to examine here and explore in further detail in subsequent fact sheets.

SONORAN INSTITUTE

Shaping the Future of the West

www.sonoraninstitute.org



What Makes Arizona's Solar Resources so Good?

Arizona has some of the sunniest weather in the country and in the world, with Yuma and Phoenix topping cities in the U.S. for the highest average number of clear days annually, with 242 and 211, respectively.[2] This sunshine is coupled with expanses of open, relatively flat ground that is favorable for locating large solar energy plants. Further enhancing this opportunity, proximity to major markets will allow Arizona to help satisfy an increasing demand for electricity in-state and in southern California.[3]

Where are we today?

Despite the significant opportunities for renewable solar energy, as of 2007, less than 1 percent of the state's total power generation came from renewable generation defined as eligible under the RES. This compares poorly to the renewable generation of surrounding states: 11 percent for California and Nevada, 8 percent for Colorado, and 6 percent for New Mexico.[4]

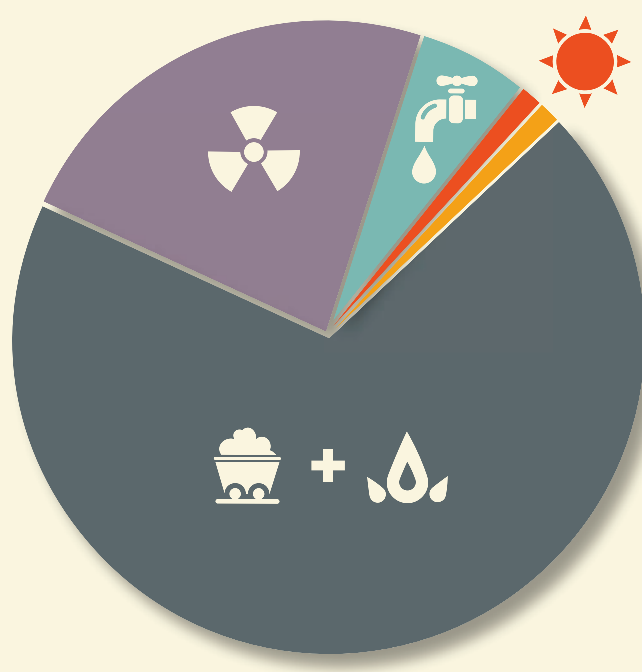
How Can We Achieve RES?

Arizona's RES allows utilities to use solar, wind, biomass, biogas, geothermal and other "clean" energy technologies to satisfy the requirements. Of these, solar is considered to be Arizona's best renewable option. The solar energy technologies commercially available and viable today fall into two categories: photovoltaic (PV) and concentrated solar thermal (CST). Familiar to most people, PV systems are made up of panels containing semiconductor materials that generate electricity by absorbing sunlight and releasing electrons. CST systems use large mirrors to focus the sunlight in order to heat a fluid to high temperatures. This fluid undergoes a process to create steam that turns a turbine generating electricity, much like the steam turbines used by conventional power plants.

Generation from either technology involves two primary options: large utility-scale plants typically greater than 100 megawatts (MW), and distributed renewable installations (commercial and residential rooftop solar installations) typically measured in kilowatts (kW).[5] Because they are modular, PV systems can be more flexible that CST in terms of system size. By adding more panels, a PV system can scale up from a small residential rooftop system, all the way to a large, utility-size power plant. This allows PV systems to offer a middle ground, a "community-scale" generation option that falls in between small rooftop and utility-scale systems. An example of community-scale generation would be a PV solar installation supplying power to a residential subdivision.

Arizona's Energy Generation Mix Today*[6]

- 70% Coal and Natural Gas
- 24% Nuclear
- 6% Hydro
- Less than 1% Non-Hydro Renewables
- Less than 1% Other



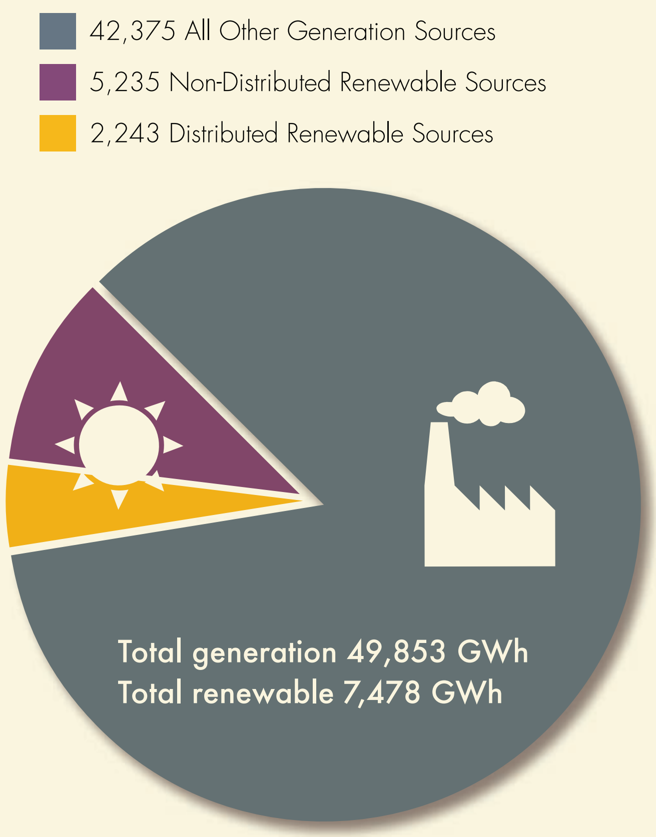
*Based on 2007 data.

Requiring Distributed Generation

Utilities have historically used very large-scale power generation, usually 500 to 1000 MW of generating capacity, to capture economies of scale and because it is much simpler for a utility or power grid operator to adjust the output of a few large power plants than of numerous dispersed power generators. However, with the advances in digital control and communication—so-called "smart grid" technology—it may soon be feasible to move toward a more distributed power generation model. With distributed generation, like a residential rooftop system or the housing development example above, the power source is located at the same location or close to the end user, reducing the amount of energy lost due to moving electricity long distances over electric transmission systems.

The Arizona RES recognizes the importance of developing smaller renewable sources in addition to the large, utility-scale plants and requires that a growing percentage of the renewable power come from distributed generation, which it describes as "residential or non-utility owned installations."[7] This distributed energy requirement started at 5 percent of the total renewable energy mix in 2007 and grows to 30 percent after 2011.[8] This requirement is expected to encourage development of solar energy sources at a variety of scales.

RES: 15% of Arizona's Energy Must Come from Renewable Sources by 2025*[9]



*Based on retail electric sales from the state's regulated utilities.

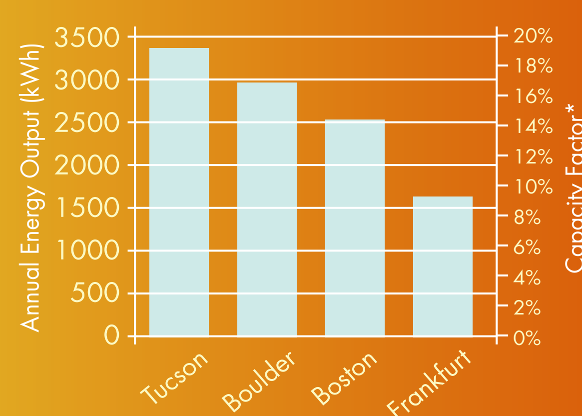
THE RISK OF CONFUSING *POWER FOR ENERGY*

When we talk about a 250 MW CST or a 2 kW PV solar plant, we refer to the plant's maximum capacity to generate *power*. Unfortunately the capacity of a plant is not, by itself, a good indicator of how much *energy* the plant will produce over a given period of time (a kilowatt hour [kWh] is power x time=energy), since most plants do not constantly run at maximum capacity. In particular, a solar plant's ability to generate maximum power depends on the availability of the sun, which is not constant.

The risk of ignoring this distinction is that we could spend a great deal of time and money constructing many watts of renewable energy capacity that in reality would produce very little energy and not make the emissions reductions the world needs.

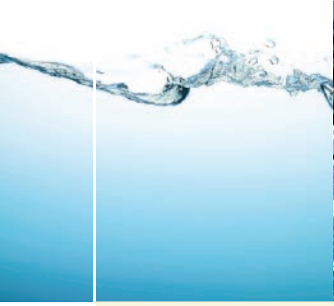
Where is solar the best option? The chart below shows that relative to Tucson, the same 2 kW PV system located in Frankfurt, Germany, will deliver only 45 percent as much annual electricity, since the amount of sun the two systems are exposed to is quite different. If we were to assume the system in Frankfurt delivers the same amount of solar energy (and thus environmental benefits) as the system in Tucson, we would be significantly over counting.

Energy From Identical PV Systems



*Capacity factor: the ratio of the actual output of a power plant over a period of time and its output if it had operated at full capacity the entire time.

Source: The Sonoran Institute.



Further Investigation
As we look to capitalize on our solar energy opportunity, there are a number of issues that need further investigation and understanding. We will explore these issues in subsequent fact sheets:

- **Water:** PV requires very little water, while CST plants built with wet-cooling systems may require up to 1,000 gallons of water/MWh. However, advanced cooling systems can reduce this water consumption dramatically.
- **Size and Scale:** A handful of utility-scale solar power generators, or solar panels on every rooftop: What is the most efficient and effective way to maximize our solar energy generation?
- **Land requirements:** Located primarily on rooftops, distributed PV systems would have minimal land impact. CST requires large tracts of land, but this impact can be minimized by utilizing previously disturbed land.
- **Grid Stability and Control:** Occurring behind the scenes, grid control is vitally important to utilities. PV does not allow for utility control and is subject to abrupt changes in generation caused by the passage of a large cloud. CST offers more stability by storing power that can be turned on and off by the utility when needed.

Conclusion

With its world class solar energy resources and the technologies currently available, Arizona seems well positioned to generate a significant amount of renewable energy through a variety of solar generation systems and scales. While there are issues and obstacles to overcome, promising new technologies are expected to help make it easier for Arizona to realize its solar potential.

Select photos courtesy of National Renewable Energy Laboratory (NREL).

The Sonoran Institute inspires and enables community decisions and public policies that respect the land and people of Western North America.

Footnotes

1 Based on the retail electricity sales of Arizona's regulated utilities and electric cooperatives. The Salt River Project in Tempe, AZ, is not a regulated utility and therefore not required to comply with the RES.

2 Western Regional Climate Center. Retrieved from: http://www.wrcc.dri.edu/htmlfiles/westcomp.clr.html

3 Mehos, Mark S. (2006). Analysis of Solar Resource Potential and Siting Opportunities for the State of Arizona. Presentation to Arizona Corporation Commission, October 6, 2006. Retrieved from: http://www.cc.state.az.us/divisions/utilities/electric/environmental.asp

4 Shadid, F. Renewable Energy: Tracking State Output and Standards. SNL Energy Research. Retrieved from: http://www.snl.com/sectors/energy/whitepages_library.aspx

5 Note the difference in units here. The smallest utility-scale power plants, at 100 MW, are 50,000 times larger than a typical 2 kW residential system.

6 Department of Energy, Energy Information Administration, Form EIA 906, *Power Plant Report* and EIA 920, *Combined Heat and Power Plant Report*.

7 Arizona Corporation Commission Decision # 69127, Docket # RE-00000-05-0030, *In the Matter of the Proposed Rulemaking for the Renewable Energy Standard & Tariff Rules* (2006). Retrieved from: http://www.azcc.gov/divisions/utilities/electric/res.pdf

8 IBID.

9 IBID.

CONTACT:
John Shepard — Senior Adviser
jshepard@sonoraninstitute.org
tel 520.290.0828 | fax 520.290.0969
7650 E. Broadway, Suite 203
Tucson, Arizona 85710

SONORAN INSTITUTE

Go to our website: www.sonoraninstitute.org to see our other Solar Fact Sheets.