Utility-Scale Solar Development Scenarios for Arizona

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Introduction

As national and state energy priorities change, it is expected that Arizona will experience growth in the development of solar resources. These resources, in the form of solar thermal, power tower, dish sterling, and photovoltaic technologies, will be used to meet in-state energy demand (known as native load) and for export to California and other western states. The development of new energy generation facilities will have both positive and negative effects on the state.

This paper provides estimates on the amount of solar energy--in megawatts (MW)[1]--that may be developed by 2020 and translates those estimates into potential land use numbers. An appendix is provided that lists factors that will affect the amount of solar that may be developed in Arizona. It is hoped that the paper will provide information to frame dialogue on the land impacts of a robust solar future.

Estimated Solar Development Scenarios and Land Impacts

There has been wild speculation about the amount of solar energy that may be developed in Arizona in the mid-term (assumed here as 2020[2]). Speculation has been fueled by the number of applications for land leases for solar projects received by the U.S. Bureau of Land Management (BLM) and Arizona State Land Department (ASLD), the number of solar projects requesting to interconnect to the transmission grid, and myriad announcements by solar developers about prospective projects[3].

To help create realistic expectations on the impacts on solar energy generation on the state of Arizona, development estimates have been prepared. Estimates for potential solar generation likely to be developed by 2020 have been derived by compiling estimates provided by Arizona's largest utilities, Arizona Public Service Company, Salt River Project and Tucson Electric Power Company[4].

The estimates in Table I are for the development of utility-scale solar. These estimates do not include distributed solar energy. Distributed solar energy will be largely deployed on roof tops of homes and businesses and not require large amounts of land. Table I provides estimates for solar energy that will be developed to meet native load.

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[1] Solar energy estimates can be given in megawatts or megawatt hours. This paper is using megawatts as the focus is to calculate land use.

[2] Ten years is a common time for both resource and transmission planning by electric utilities. Uncertainty can increase greatly beyond 10 years.

[3] The federal government is offering grants in lieu of the investment tax credits for solar plants that break ground by the end of 2010, which is creating a rush of project approvals in 2010.

[4] Estimates could also have been collected from developers and investors. However, this paper relies on utility numbers as they are the major purchasers of energy to meet customer demand and are in control of the majority of transmission. Estimates for native load from one utility were only provided through 2014.

Table I.

Potential Energy Generation from Solar (in MW) by 2020 to meet Native Load

Estimate	Native Load
Low	900
Moderate	1,250
High	2,400

For the purpose of comparison to the estimates in Table I, the three major utilities in the state (Arizona Public Service Company, Salt River Project, and Tucson Electric Power Company) have a combined peak load of approximately 17,000 MW in 2009. That load is projected to grow by approximately 4,400 MW, to 21,400 MW in 2019[5] Table I shows that under the low scenario approximately 20% of the energy needed to meet growth in Arizona electric demand may come from utility-scale solar energy. However, based on the high scenario over half of all the energy needed in the next ten years could be derived from solar energy.

The next step in determining the amount of solar energy that could be located in the state of Arizona is to estimate the amount of solar energy that may be built to export of other states. Table II provides estimates for native load and export.

Table II.

Potential Energy Generation from Solar (in MW) by 2020 Native Load & Export

Estimate	Native Load	Export	Total
Low	900	2,000	2,900
Moderate	1,250	3,000	4,250
High	2,400	4,000	6,400

[5] Arizona Public Service, Resource Plan Report, January 29, 2009, page 14, Figure 2, APS Resource Plan – Loads and Resources; SRP Peak Demand and Energy Forecast powerpoint, August 5, 2009, Jan Miller, Manager, Strategic Economic Services; and TEP Portfolio Strategies, Michael Sheehan, Director, Resource Planning, 2009.

Estimating the amount of solar power that could be exported to other states is difficult and subject to myriad factors (outlined in the appendix). However, one of the most important constraints in the medium term is the availability of transmission. If transmission is not available as the highway to export solar electrons to other states, then projects will not be developed for export[6]. The estimates for export in Table II are based on the capacity (or room) on the existing transmission system to move power out of Arizona and the assumption that only one new major transmission line linking to California markets will be completed by 2020.

Applications v. Estimates

In the past few years, the ASLD and BLM have been besieged by applications for permits to lease land for the construction of solar facilities. For example, in September 2009 the BLM listed applications for a total possible development of 20,000 MW of power generation consuming almost 500,000 acres of land.

There is a three-fold difference between the highest estimates in Table II and the applications just pending at one public agency BLM. One must also keep in mind that in addition to applications for land before the BLM and ASLD there are also proposals for development on private lands. All in all, the applications and estimates are many times what is likely to be built in the next 10 years.

Land Impacts

Electricity generation from solar is relatively land intensive compared to other power sources as the "fuel," the sun, is a diffuse energy source. To determine land impacts from possible solar development, Table III translates megawatts of energy into the acreage needed. The acreage numbers are general and are based on the assumption that it takes about 640 acres of land for each 100 MW of solar energy. The 640 acre figure is base on land needs of concentrating solar power. Photovoltaic, dish stirling, and other technologies may use less land[7].

Table III

Potential Land Impact for Solar in Acres

Estimate	Acres		
	Native	Export	Total
Low	5,760	12,800	18,560
Moderate	8,000	19,200	27,200
High	15,360	25,600	40,960

[6] The Arizona Corporation Commission has recognized this obstacle and has required the regulated electric utilities to identify transmission to support the development of renewable energy. See http://www.azcc.gov/divisions/utilities/electric/Biennial.asp

[7] The amount of land required will change based on technological improvements and the type of cooling chosen for the facility.

For context, there are 640 acres of land in a square mile. The low estimate for native load would require 5,760 acres of land or approximately nine square miles over a 10-year period. If the maximum estimate of solar energy for export and native is developed, it will require 40,960 acres of land or about 64 square miles over the next decade.

But, let's consider the moderate case for native load and export, which may be the most realistic. If the state were to develop solar resource just to meet its own needs, we would need to dedicate approximately 8,000 acres in 10 years or 12.5 square miles. To be able to meet state needs, and sell solar energy to other states, it would require 27,200 acres or 42.5 square miles.

If we break this down even further and look at annual development the state of Arizona, to meet a moderate solar development scenario for native load and export for just one year, we would need to dedicate just 2,720 acres per year or 4.25 square miles of land.

Interesting comparisons can be drawn between land for solar development and land for residential development. In 2007, the highest year for land disposition by the ASLD, it sold 4,262[8] acres of state trust land for the primary purpose of residential development[9]. This amount of land sold in one year is more than twice the amount of land that would need to be dedicated to solar for native load and export for one year under the moderate scenario. To provide another residential land comparison, the master planned community of Vistancia, on the Westside of the Phoenix metropolitan area, is planned for 7,100 acres. This is a similar amount of land that would be dedicated to solar development for a decade to meet the state's energy needs.

Geographic Diversity

For a number of reasons, solar projects are expected to be developed in a number of Arizona's best solar resource areas. The initial focus of development in the state has been in the area west of the Phoenix metropolitan area. This is largely due to the existence of the Palo Verde Hub, a confluence of power generating facilities and transmission lines in the state. However, this area will not remain the only focus. There are strong solar resource areas between the Phoenix and Tucson metropolitan areas, on the Tohono O'Odham Indian Reservation, and in the northwest part of the state along the Colorado River.

If solar development were to be contiguous, the visible impact, water consumption, tax revenue, and transmission infrastructure would all be concentrated, having dramatic effects on the local area. It is expected, however, that solar development will be geographically dispersed thus lessening the impacts (both good and bad) on any one particular area. The reasons projects will be dispersed include availability of land, transmission availability, desire for different locations to lessen the effects of storms on energy production, desire of local communities to have solar projects for jobs and tax revenues, and land lease processes by the BLM and ASLD.

[8] 2007Arizona State Land Department Annual Report, page 3 http://www.land.state.az.us/report/report2007_full.pdf

[9] The ASLD is responsible for managing 9.3 million acres of State Trust Lands. These lands may be sold or leased for the purposes that benefit the beneficiaries of the Trust.

Conclusion

If Arizona is to build a robust solar energy future, it will require the dedication of a significant amount of land. The state has long relied upon the use and sale of lands for economic prosperity. Certainly the development of housing projects has been a major consumer of land and source of wealth in the state. Similarly, of the state's 72.7 million acres of land, over one-third is in agricultural production[10]. The development of solar will use land in Arizona but it will also provide wealth just as other land-consuming segments of the economy provide.

Applications for public lands far exceed the amount of solar that is estimated to be built in the next 10 years. If the state of Arizona develops the highest development scenario for native load and export in the next decade, the state will need to dedicate just 0.2% of its land mass to solar energy.

Questions and comments
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[10] University of Arizona Cooperative Extension http://www.agclassroom.org/kids/stats/arizona.pdf

Appendix

Factors that will Drive Solar Development in Arizona

A myriad of factors will influence the rate of solar development in Arizona. The follow section provides a list of many of the variables that are in play in the developing the state's solar market.

Market Variables

Factors in Arizona and across the globe will affect development of solar markets in the state including but not limited to:

- Price of natural gas
- Rate of growth in electricity consumption
- Health of the Arizona and U.S. economies
- Emergence of storage technologies
- Price of solar technologies and technological improvements
- Availability and price of domestic and international equipment
- Liquidity of capital markets

National and State Policy

The following policies will affect the speed of development in Arizona.

- Existence of Arizona's Renewable Energy Standard and Tariff (REST) currently requiring regulated utilities to derive 15% retail energy sales by 2025 from renewable energy sources and future increases of this standard.
- Contemplation by the state of California to increase their renewable portfolio standard (RPS) to 33% by 2022 and allowance of non-California energy resource to qualify
- Renewable energy requirements adopted by Arizona's non-regulated electric utility
- Imposition of a national Renewable Portfolio Standard
- Greenhouse gas mitigation legislation and/or carbon tax
- Access to federal land through development of BLM's Solar Programmatic Environmental Impact Statement and similar federal policy
- Access to Arizona State Trust Lands through a leasing policy for land for solar development
- Water extraction, use, or disposal policy

Infrastructure

- Availability of in-state transmission
- Availability of transmission to California and other western states
- Implementation of Western Area Power Administration's loan guarantee program for transmission
- Availability/access to water

Additional Factors

- Public perception/acceptance
- Utility acceptance