WATER POLICY CONSIDERATIONS

Deploying Solar Power in the State of Arizona

A Brief Overview of the Solar-Water Nexus

WATER POLICY CONSIDERATIONS

Deploying Solar Power in the State of Arizona: A Brief Overview of the Solar-Water Nexus – May 2010

Office of Senator Jon Kyl
Hart Senate Office Building • Suite 730
Washington, DC 20510
Phone 202.224.4521

Introduction

In order for Arizona and the nation to have readily available, clean, affordable energy, Arizona and the federal government will need to recognize that the production of energy is inextricably linked to a sustainable supply of water. Water supplies in Arizona and across the Southwest are limited and could be seriously impacted by federal and state energy policy, particularly those policies aimed at displacement of fossil energy production with utility-scale conventional concentrating solar power (CSP).[1] Conventional CSP consumes more water per megawatt-hour (MWh) than most other types of thermal energy production including coal and nuclear. Moreover, it is likely that a considerable amount of the power produced by CSP in Arizona would be exported to other states, effectively resulting in the exportation of Arizona's limited water supply to the rest of the country.

A major objective of federal and state energy policy is to accelerate the adoption of renewable energy technologies and invest in renewable energy development on both public and private land. Numerous incentives and mandates are being established at both the federal and state level to accomplish this objective.[2] At the federal level, the Department of Energy and the Department of the Interior (DOI) have announced a solar energy initiative to promote utility-scale solar energy development on public land in the Southwest. The initiative, announced last year, targets 24 areas in the Southwest as suitable for solar development.[3] Such policies have resulted in a rush of solar development applications primarily in three states, Arizona, California, and Nevada. The DOI's Bureau of Land Management has received 34 applications in Arizona.[4] Approximately 30 of those applications are for conventional CSP projects. A majority of the land that has been identified as having the most solar energy potential is also located in some of the most water challenged parts of the state. Not all of those projects will be constructed, but the

---

1 Conventional Concentrating Solar Power is defined in this report as solar thermal power that uses a "wet" cooling system.

2 Lynn J. Cunningham, Beth A. Roberts, *Renewable Energy and Energy Efficiency Tax Incentive Resources,* Congressional Research Service Rept., R40455 (March 23, 2009).

3 Department of the Interior Press Release, *Secretary Salazar, Senator Reid Announce 'Fast Track' Initiative for Solar Energy Development on Public Lands,* (June 29, 2009), http://www.doi.gov/news/pressreleases/2009_06_29_release.cfm.

4 Solar Energy Applications in Arizona, Bureau of Land Management, December 2009, http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/energy.Par.62807.File.dat/Solar_Applications.pdf (last visited April 2010).

potential impact on water resources is alarming. In Arizona, the Arizona Corporation Commission has adopted a Renewable Portfolio Standard (RPS) mandating that regulated electric utilities supply 15 percent of customer load with electricity from eligible renewable energy sources by 2025.[5] Currently, Arizona's RPS favors solar, requiring that 4.5 percent of electric sales by 2012 be from distributed energy resources.[6] In addition to Arizona's RPS, the state and local governments provide additional subsidies including tax credits that favor solar.[7]

The purpose of this paper is to raise awareness within Arizona about the harmful impact solar energy production has on the state's limited water supply. Arizona lawmakers have an obligation to protect the state's limited water supply and put its water resources to their highest and best use. Using Arizona's water supplies to produce conventional CSP that will most likely be exported out of state does neither. Although it is important for Arizona to promote and develop its domestic energy resources including solar, policymakers should not lose sight of what is sustainable from a water resource standpoint.

---

5 RPS requirements in Arizona are applied to investor-owned utilities and electric service providers. The RPS requirements do not extend to municipal utilities and cooperatives, as these entities are predominately self-regulated. However, some municipal utilities and cooperatives are voluntarily complying with the RPS. The Salt River Project is an example.

6 Database of State Incentives for Renewable Energy (DSIRE), Arizona, Renewable Energy Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=AZ03R&re=1&ee=1(last visited April 19, 2010).

7 DSIRE, Arizona, Incentives/Policies for Renewables & Efficiency, http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=AZ (last visited April 19, 2010).

Chapter

1

Concentrating Solar Power Technology

Developing CSP in Arizona and the Southwest poses challenges for water resource management that must be analyzed and fully considered. CSP technology uses ground-based mirrors to concentrate sunlight onto a heat transfer medium.[8] The heat is used to boil water to generate steam via a heat exchanger to run a steam turbine, which generates electricity, similar to other forms of thermal electricity generation.[9] Currently, there are four primary CSP systems: (1) parabolic/solar trough; (2) linear Fresnel Reflectors; (3) power tower; and (4) dish/engine.

There are two major water processes in a steam turbine system—the steam cycle and the cooling process. Because most of the water is consumed during the cooling process, the choice of the cooling technology largely determines the amount of water consumed at a facility.

CSP Cooling Technologies

1. *Wet Cooling*

The most common cooling technology is "wet cooling," in which water is used to remove the heat from the condenser.[10] This water then flows to an evaporative

---

8 Solar thermal power is different from photovoltaic solar (PV) systems, which are usually found on rooftops and are used for domestic purposes and some commercial purposes. PV converts sunlight directly to electricity using semiconductor materials in solar panels and uses a minimal amount of water. Nicole T. Carter & Richard J. Campbell, *Water Issues of Concentrating Solar Power (CSP) Electricity in the U.S. Southwest*, Congressional Research Service Rept., R40631, at 1 (June 8, 2009). It, however, is not used for the same type of large-scale energy production as solar thermal power.

9 Memorandum from Nicole T. Carter & Richard Campbell, Congressional Research Service, *Water Implications of Concentrating Solar Power in the Southwest*, at 3 (Apr. 24, 2009) (on file with author).

10 *Id.*

cooling tower that dissipates the heat energy to the environment.[11] Much of the water used in wet cooling is lost as clouds of water vapor to the atmosphere as the condensed water contacts the air and the cooling tower.[12] Evaporative losses increase and efficiency decreases the hotter and dryer the ambient air is. All 11 large-scale CSP facilities operating in the U.S. utilize wet cooling.[13]

2. *Dry Cooling*

Other cooling techniques, such as "dry cooling," use air instead of water. The waste heat from the power plant is ejected into the air. A significant temperature difference, however, is necessary to provide adequate heat exchange. As a result, the condenser temperature is about 30 to 50 degrees Fahrenheit higher than the ambient air temperature, which results in a higher condensate temperature on hotter days. This higher temperature raises the condenser pressure causing the steam turbine to be less efficient.[14] According to the Department of Energy (DOE), "[d]ry cooling systems are more expensive and result in lower plant thermal efficiency, especially in hot climates and on hot days – typically when and where peak power is most in need."[15] Wet cooling is generally more economical than dry cooling for CSP plants because it has a lower capital cost and higher thermal efficiency, and it maintains consistent efficiency levels year-round.[16] Despite the efficiency and cost drawbacks, all of the latest CSP plant projects being proposed in California anticipate using dry-cooling technology because they use much less water.

3. *Hybrid Wet/Dry Cooling*

Hybrid cooling is designed to reduce water consumption compared to wet cooling and enhance performance in warm weather compared to dry cooling.[17] This technology consists of parallel wet and dry cooling facilities, with wet cooling operating on hot days.[18] Hybrid plants are generally more expensive than water-cooled plants, but less expensive than an air cooled plants.

---

11 *Id.*

12 *Id.*

13 *Id.*

14 *See* U.S. Department of Energy, Report to Congress, *Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation,* at 11, *available at* http://www1.eere.energy.gov/solar/pdfs/csp_water_study.pdf.

15 *Id.* at 13.

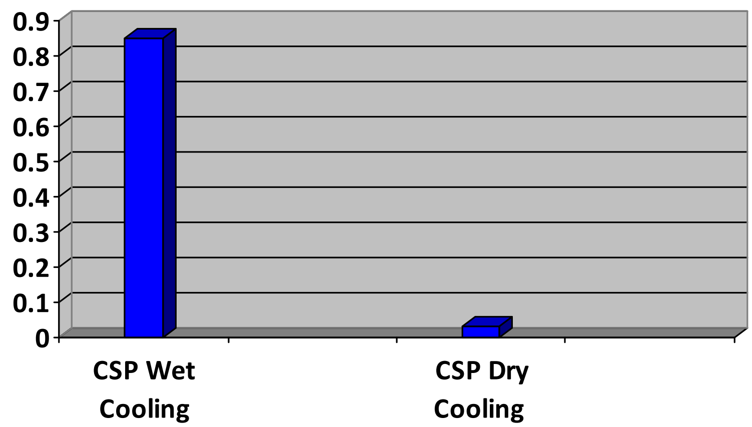
16 *Id.* at 4.

17 *Id.* at 14-15.

18 Carter & Campbell, *supra* note 8*,* at 11.

Generally, conventional CSP using wet cooling technology uses 95 percent ***more*** water per kilowatt hour than CSP using dry cooling technology. Chart 1 shows on average that a CSP wet cooled plant will use 0.85 gallons/KWh, compared to a CSP dry cooled one that uses 0.03 gallons/KWh.[19]

Chart 1 – CSP Wet Cooling vs. Dry CSP Cooling – Gallons / KWh



CSP Water Consumption Compared to Other Electricity Generation

Although most electricity generation requires and consumes water, CSP consumes more water per megawatt-hour (MWh) generated than most other generation technologies (See Table 2).[20] According to DOE, the water intensity, or the amount of water consumed per MWh of electricity produced, from a CSP plant with wet cooling is approximately twice as much as fossil fuel facilities and is generally higher than a nuclear plant with the same type of cooling technology.

[19] Bright Source Energy Company Power Point Presentation (March 2010) (on file with the author).

[20] Carter & Campbell, *supra* note 8, at 7.

Table 2. Water Intensity of Electricity by Fuel Source and Generation Technology[21]

Generation Technology	Wet Cooling Water Consumption[a] (gal/MWh)	Other Water Consumption[b] (gal/MWh)
Solar Trough	760-920	8
Solar Tower	750	8
Photovoltaic Solar	0	5[c]
Wind	0	0
Fossil	300-480	35-104
Biomass[22]	300-480	Highly variable depending on whether biomass is irrigated[d]
Nuclear	400-720[e]	75-180
Geothermal	1,400	Not available
Natural Gas Combined Cycle	180	18-21

21 Data calculated from U.S. Department of Energy, Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water (Dec. 2006), *available at* http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf. Carter provided notes. *See* Carter & Campbell*, supra* note 8, at 8.

a. Data is for cooling tower technology.

b. Includes water consumed in producing or enhancing the fuel source and in generation; excluding cooling water consumption.

c. National Renewable Energy Laboratory (NREL), Fuel from the Sky: Solar Power's Potential for Western Energy Supply, NREL/SR-550-32160 (July 2002), at 99.

d. CRS provided note.

e. Cooling ponds which are commonly used at nuclear facilities consume roughly 720 gal/MWh.

f. IGCC is Integrated Gasification Combined-Cycle.

22 The biomass referenced in Table 2 does not include woody biomass.

Generation Technology	Wet Cooling Water Consumption[a] (gal/MWh)	Other Water Consumption[b] (gal/MWh)
Coal Integrated Gasification Combined-Cycle (IGCC)[f]	200	140
Hydroelectric		Highly variable, avg. 4,500 due to evaporation

According to industry sources, coal power plants in Arizona consume approximately 460 to 680 gallons of water per MWh. The Palo Verde Nuclear Power Plant outside of Phoenix consumes approximately 800 gallons per MWh.[23] Palo Verde's water usage is slightly higher than the range cited in Table 2 primarily because of the hot and dry climate in central Arizona.[24]

Industry sources also report that the estimated water consumption for CSP *in Arizona* would range from 940 gallons to 1,080 gallons/MWh based on the design estimates being used for solar parabolic trough plants in the state.
Other estimates for CSP plants *in Arizona* are in the range of 800 gallons to 1,000 gallons/MWh.[25] As in the case of Palo Verde, water usage estimates for CSP plants in Arizona are slightly higher than the range cited in Table 2 because of Arizona's climate.

Table 3 below summarizes the amount of water consumed by power plants *throughout the U.S.* using different cooling technologies such as dry and hybrid cooling. As discussed above, however, there are cost and efficiency issues with these cooling technologies.

23 Because of its desert location, Palo Verde is the only nuclear power plant in the world that uses treated effluent. The treated effluent is piped from the 91st Avenue Wastewater Treatment Plant in Phoenix to Palo Verde, where it is further treated and recycled to meet the nuclear energy plant's cooling needs.

24 As noted, evaporative losses increase and efficiency decreases the hotter and dryer the ambient air is.

25 Martin Pasqualetti & Scott Kelley, Arizona Water Institute, *The Water Costs of Electricity in Arizona,* at 2, *available at* http://www.azwaterinstitute.org/media/Pasqualetti%20fact%20sheet (last visited May 5, 2009).

Table 3. DOE comparison of consumptive water use of various power plant technologies using various cooling methods[26]

Technology	Cooling	Gallons/ MWhr	Performance Penalty *	Cost Penalty **
Coal / Nuclear	Once-Through	23,000 – 27,000 ***		
	Wet Cooling	400 – 750		
	Dry	50 – 65		
Natural Gas				
	Wet Cooling	200		
Solar Power Tower	Wet Cooling	500 – 750		
	Combination Hybrid Parallel	90 – 250	1 – 3%	5%
	Dry	90	1.3%	
Solar Parabolic Trough	Wet Cooling	800		
	Combination Hybrid Parallel	100 – 450	1 – 4%	8%
	Dry	78	4.5 – 5%	2 – 9%

* = Annual energy output loss is relative to the most efficient cooling technique.
** = Added cost to produce.
*** = Majority of this amount is returned to the source, but at an elevated temperature.

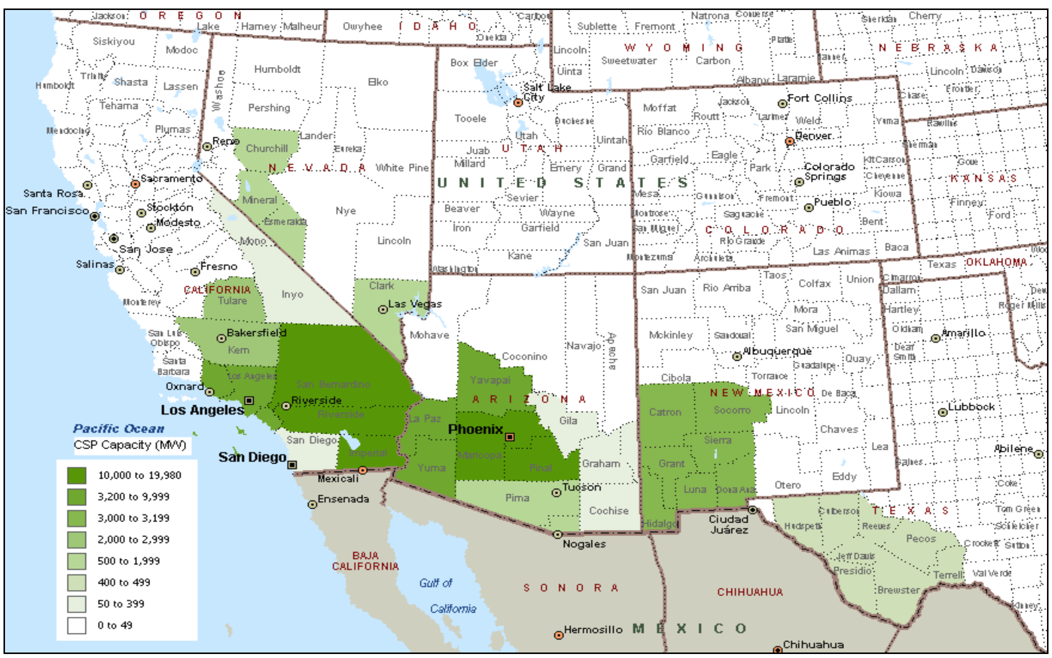
26 DOE, Report to Congress, *supra* note 14, at 17.

Chapter 2

CSP Deployment and Water Constraints Converge

CSP solar power plants require large tracts of land with good solar resources. Given the sunshine and large desert landscapes in the Southwest, a model prepared by the U.S. Department of Energy's National Renewable Lab (NREL) projects CSP deployment predominantly in Arizona and California (See Figure 1).[27] Figure 1 represents a projection of where CSP may be deployed based on, among other things, federal and state policies. NREL projects that 55 gigawatts (GW) of CSP will be deployed by 2050.

Figure 1. NREL Projected CSP Capacity in 2050[28]



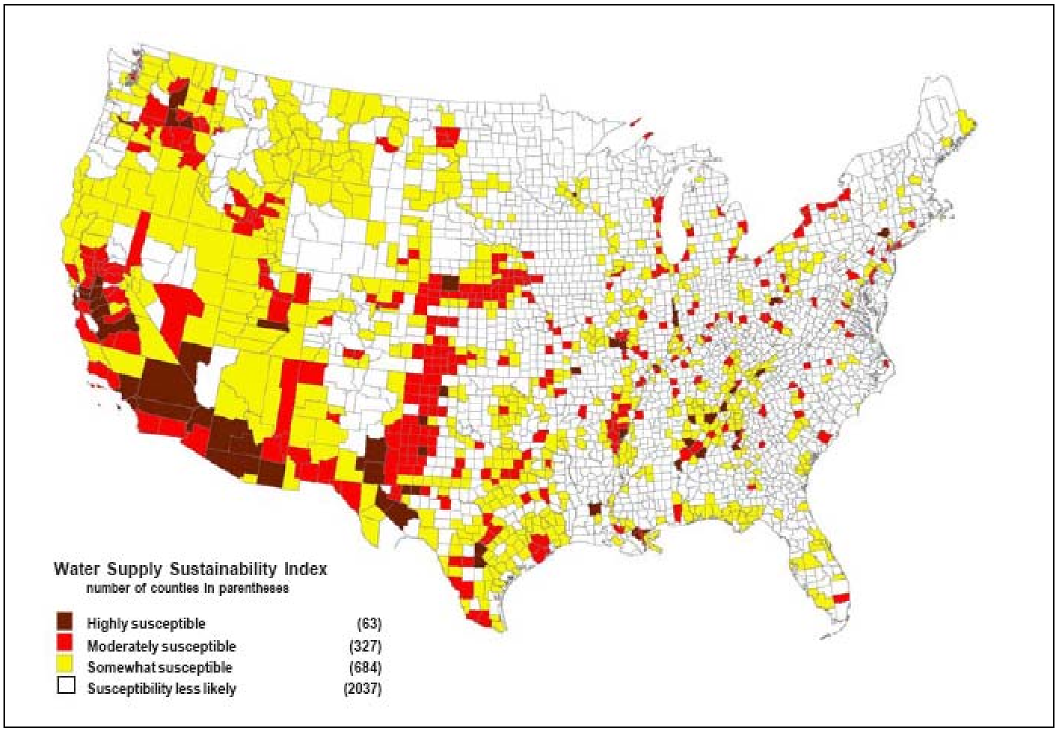
---

27 Nate Blair, *Concentrating Solar Deployment Systems (CSDS) – A New Model for Estimating U.S. Concentrating Solar Power Market Potential* (undated), at 1, *available at* http://www1.eere.energy.gov/solar/review_meeting/pdfs/p_55_blair_nrel.pdf. The model used by NREL to project CSP deployment looked at siting issues and load location and load growth to select the purportedly economically best sites for CSP.

28 *Id.* at 2.

The area highlighted in Figure 1, however, is in same area the Electrical Power Research Institute (EPRI) has found to be the most susceptible to water supply constraints. EPRI prepared an index of the susceptibility of U.S. counties to water supply constraints by using information on the availability of renewable water, including current supply, groundwater use, endangered species, drought susceptibility, estimated growth in water use, and summer deficits in water supply (See Figure 2).

Figure 2. EPRI Water Constraint Index[29]



As Figures 1 and 2 demonstrate, there is considerable overlap, especially in Arizona, of NREL's projection for CSP deployment and areas that are susceptible to water supply constraints. According to the data compiled by NREL and EPRI, Arizona is one of the most susceptible states to water supply constraints <u>and</u> at the same time has one of the highest capacities for CSP. In other words, one of the most targeted areas for solar development is also one of the most water-constrained areas in the United States.

[29] EPRI, *A Survey of Water Use and Sustainability in the United States with a Focus on Power Generation: Topical Report* 5 (2003).

Despite the seriousness of these water constraints, solar power companies have largely ignored water concerns and continue to propose water-intensive conventional CSP plants in Arizona. Water management by the majority of solar developers is largely focused on securing access to greater supplies of water rather than looking at more water-efficient ways to produce energy. Research is being conducted at various universities, as well as at private sector companies and national laboratories on alternative cooling systems and non-traditional sources of water to reduce water use; however, due to long lead times, costs and the push to produce solar energy quickly, these efforts will not be given the chance to abate water constraints and avoid an energy-water crisis in the state.

An Electricity-Water Crisis Scenario Projected - Congressional Research Service

The nonpartisan Congressional Research Service (CRS) developed a scenario using NREL's deployment projection that 55 GW of CSP would be deployed by 2050.[30] CRS posited that if 55 GW of capacity is achieved using wet cooling by 2050, the water requirements would be approximately 505,000 acre-feet/year.[31]

Under CRS's scenario, the 55 GW would be distributed across the five states that are shown in Table 4. Of the 505,000 acre-feet required for this energy production, 165,000 acre-feet per year would come out of Arizona's water supply – representing the largest percentage of any state's water requirement to produce solar power. In other words, Arizona would use more of its water budget for CSP production than any other state under CRS's scenario.[32]

30 *See* Carter & Campbell, *supra* note 8, at 14.

31 One acre-foot is approximately 325,000 gallons.

32 *See* Carter & Campbell, *supra* note 8, at 14.

Table 4. An Illustrative Water Consumption Scenario for 55 GW CSP with Storage and Wet Cooling[33]

State	CSP Capacity (GW)[a]	Wet-Cooled CSP Water Use (ka-f/yr)[b]	State Water Use (ka-f/yr)[c]	Wet Cooled CSP as % of State Use
Arizona	18	165	4,290	3.9%
California	25	230	28,560	0.8%
Nevada	3	28	1,500	1.8%
New Mexico	8	73	2,220	3.3%
Texas	1	9	11,760	<0.1%
Total	*55*	*505*		

Current applications for permits to construct solar facilities indicate that NREL's predictions may come true.[34] Indeed, the U.S. Bureau of Land Management (BLM) has received approximately 34 right-of-way applications for utility-scale solar projects in Arizona, encompassing 452,519 acres of public land.[35] Currently, the BLM is moving on an accelerated schedule to process an application for a

---

33 *Id.* Source: CRS compiled using noted data.
Notes:
a. CRS derived using a coarse approximation of the distribution of CSP as shown in Figure 1.
b. A capacity factor of 43 percent and an average of 800 gal/MWh of water intensity for wet cooled CSP were used.
c. Water consumption data from United States Geological Survey (USGS), *Estimated Use of Water in the United States in 1995* (Circular 1200: 1998).

34 *See* U.S. Bureau of Land Management Arizona, Solar Applications, (December 2009) http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/energy.Par.62807.File.dat/Solar_Applications.pdf. In addition to the water-related concerns discussed above, there are also environmental issues associated with solar energy. Jim Abbott, the acting California State Director of the U.S. Bureau of Land Management, recently testified before Congress that because of the "land disturbance footprint," the potential effects of proposed solar energy developments on wildlife habitat and sensitive species merit special attention and concern. He also testified that solar projects "could . . . require significant reallocations of land resources and have local and regional environmental impacts. Depending on the technology employed, solar projects could also require access to significant water supplies in arid regions where supplies are already in high demand." Testimony of Jim Abbott, Acting California State Director, Bureau of Land Management, U.S. Department of the Interior, Bureau of Land Management, Oversight Field Hearing, *Solar Energy Development on Federal Lands: The Road to Consensus,* House Natural Resources Committee, Subcommittee on Energy and Mineral Resources (May 11, 2009).

35 The BLM and the DOE have also initiated the preparation of a joint programmatic environmental impact statement to assess the environmental, social, and economic impacts associated with solar energy development on BLM-managed lands in the states of Arizona, California, Colorado, Nevada, New Mexico, and Utah. *See* Solar Energy Development Programmatic EIS, Solar Energy Study Area Maps, http://solareis.anl.gov/eis/maps/index.cfm.

conventional CSP plant south of Buckeye, Arizona.[36] The BLM is expediting this application in order to enable the solar developer to qualify for federal cash grants under the American Recovery and Reinvestment Act (ARRA) that expire in December 2010. Additional projects are being proposed on state and private land. At least 10 applications have been filed with the Arizona State Land Department for CSP plants on state trust land. Although not all of the proposed power plants may actually be constructed, the number of applications confirms that there is serious interest in deploying CSP in Arizona.

CSP Demand for Water May Not Be Constrained by Arizona's AMAs

All of the proposed plants on state trust land and a significant number of the proposed plants on BLM land are outside state Active Management Areas (AMAs),[37] and most would likely use groundwater to operate. Since the plants would be located outside AMAs, there would be little, if any, state regulation of their groundwater pumping.[38] As a result, there would be essentially no limit on the amount of groundwater these plants could withdraw and use. Such pumping can alter the naturally balanced hydrological cycle by depleting water resources at a faster rate than they can be replenished. Pumping groundwater itself is energy-intensive. The more groundwater that is depleted, the more electricity is needed to obtain the supply and deliver the water.

---

[36] Bureau of Land Management, Notice of Intent to Prepare an Environmental Impact Statement for the Proposed Sonoran Solar Energy Project, 74 Fed. Reg. 129, 32641-32642. (July 8, 2009). The Sonoran Solar Energy Project would require approximately 4,000 acres of public land south of the town of Buckeye to construct and operate a 375-megawatt plant using parabolic trough technology. The plant would be wet cooled. BLM estimates the recirculating wet cooling system would use about six to 13 acre-feet per year per MW for the system with three hours of thermal storage. A draft Environmental Impact Statement was released on April 9, 2010, and a final EIS is expected by the end of the year. In order for the project to be eligible for ARRA grant assistance, it must be ready for construction by the end of the year. More information on the project is *available at* http://www.blm.gov/az/st/en/prog/energy/solar/sonoran_solar.html.

[37] Arizona's Groundwater Management Act (the "Act") imposes certain restrictions on property owners' common-law groundwater rights. *See* Ariz. Rev. Stat. Ann. §§ 45-701 to -704 (2009). The Act delineates as AMAs several "geographical areas where groundwater supplies are imperiled." *Town of Chino Valley v. City of Prescott,* 131 Ariz. 78, 80, 638 P.2d 1324, 1236 (1981). It imposes strict limits on the extraction and use of groundwater within the AMAs, and also limits the pumping of water outside an AMA for use within an AMA. Ariz. Rev. Stat. Ann. § 45-551 (2009). There are currently five AMAs: Prescott, Phoenix, Pinal, Tucson, and Santa Cruz. Ariz. Rev. Stat. Ann. §§ 45-411, 45-411.03 (2009).

[38] The Arizona Power Plant and Transmission Line Siting Committee, however**,** may and does consider the use of water in determining whether to grant a Certificate of Environmental Compatibility (CoC) to a proposed power plant but is not specifically required to by statute. *See* Ariz. Rev. Stat. § 40-360.06 (outlining the factors to be considered in issuing a CoC).

Proposed power plants within AMAs would be subject to stricter regulations, but would still be able to consume a considerable amount of limited groundwater supplies.

Water Consumption in CSP Siting

Until recently, CSP water consumption was not a prominent concern in solar deployment. That is starting to change. For example, the U.S. National Park Service (NPS) has raised a number of concerns about the plans for large-scale solar power plants in southern Nevada. Recently, in a memo from then-NPS Pacific Regional Director Jon Jarvis (now NPS Director) to the BLM, Jarvis stated:

> The NPS asserts that it is not in the public interest for BLM to approve plans of development for water-cooled solar energy projects in the arid basins of southern Nevada, some of which are already over-appropriated, where there may be no reasonable expectation of acquiring new water rights in some basins, and where transference of existing points of diversion may be heavily constrained for some basins.[39]

The same arguments raised by NPS are applicable to the deployment of conventional CSP in Arizona. Indeed, it is not in the public interest for the state to approve, or even worse encourage, solar thermal power plants when Arizona's water supplies are so constrained and other energy sources are available that use much less water per MWh.

In Arizona, there are a number of proposed CSP plants on retired agricultural land. Some argue that the significant amount of water used for CSP is mitigated by the fact that the proposed solar plant would be using less water than the previous agricultural use. Arizona, however, is in the midst of a long-term drought and faces ever increasing demands on its finite water supply. Therefore, policymakers should ask whether a wet-cooled CSP plant makes sense from a state-wide water management perspective, not whether a wet-cooled CSP plant uses less water than another very water-intensive use on a specific parcel of land. This is especially true since other technology is available such as dry or hybrid cooling that uses a fraction of the water used in wet cooling. California has already determined that wet-cooling is not a wise use of its water supply and requires all new CSP projects under its regulatory control to be dry-cooled unless

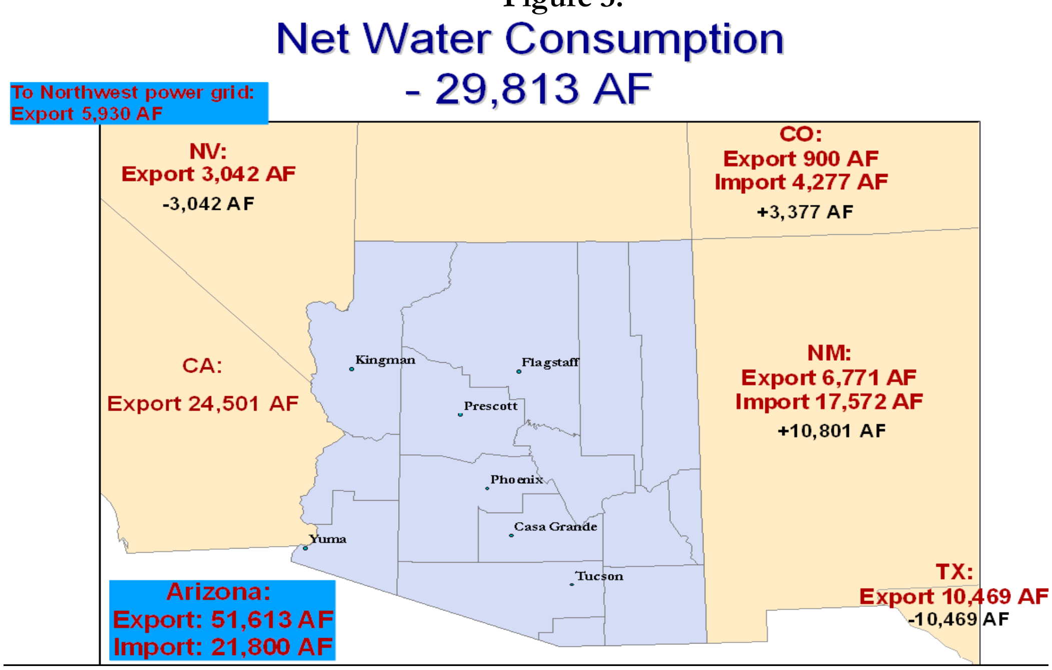
[39] Memorandum from Jon Jarvis, Regional Director, Pacific West Region, NPS, to Amy Leauders, Acting State BLM Director, at 6 (February 5, 2009) (on file with author).

they have degraded water readily available, such as city wastewater.[40] Arizona should be following California's lead on this issue.

Using Arizona Water for Solar Energy Exports

Historically, Arizona produces more electricity than it consumes.[41] For instance, between 2002 and 2006, on average Arizona exported electricity that consumed approximately 52,000 acre-feet of water per year. This amount was offset by the amount of electricity Arizona imported from other states, which consumed energy equivalent to 22,000 acre-feet of water use.[42] *As a result, Arizona's net water loss from energy production on average between 2002 and 2006 was about 30,000 acre-feet (or 9,775,500,000 gallons) per year, which is enough to supply 120,000 people at current water usage rates in Arizona.*[43] See Figure 3.

Figure 3.[44]



[40] CSP Today, Industry Insight, *US regulation: Short, sharp shock treatment for developers?,* http://social.csptoday.com/industry-insight/us-regulation-short-sharp-shock-treatment-developers.

[41] Pasqualetti & Kelley, *supra* note 25, at 2 (referencing years 2002 through 2006). *See also* Carter & Campbell, *supra* note 8, at 10.

[42] Pasqualetti & Kelley, *supra* note 25, at 2.

[43] *Id.*

[44] *Id.*

According to the NREL, increased development of CSP in Arizona is likely to significantly increase the electricity exports out of the state.[45] (Figure 1 maps projected capacity and Figure 4 maps where CSP (MWh) would likely be shipped.) As a result, the effective amount of water Arizona would be exporting out the state would also significantly increase.

Figure 1. NREL Projected CSP Capacity in 2050[46]

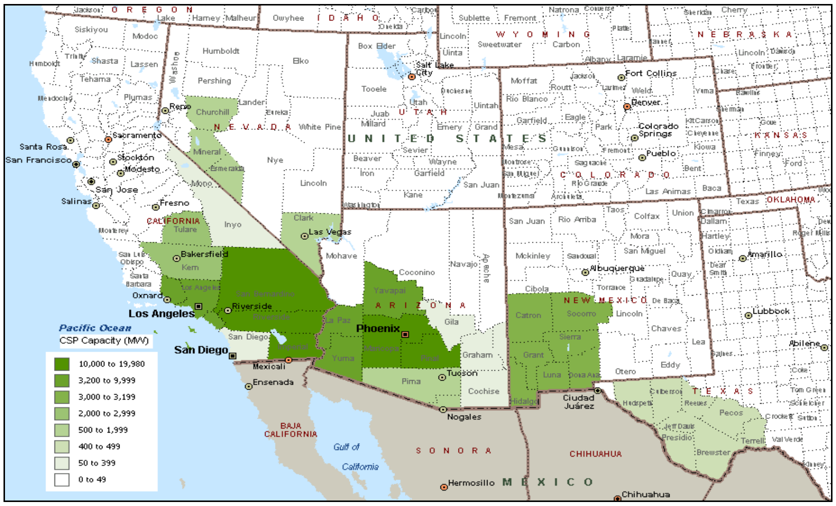
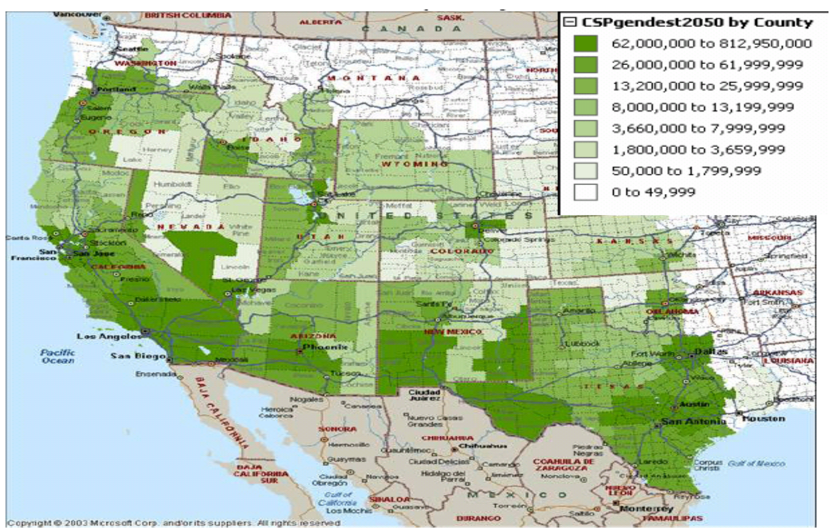


Figure 4. NREL Projection of where power produced in Figure 1 would be shipped [47]



---

45 *See* Carter & Campbell, *supra* note 8, at 10.

46 Blair, *supra* note 27.

47 *Id.*

Although electricity generated by coal and nuclear plants within Arizona is exported out of the state, neither qualifies for renewable financial incentives, unlike conventional CSP. Moreover, neither energy source counts towards Arizona's RPS, and neither would likely count towards any potential federal RPS.

Given the interstate nature of electricity and water in the West, officials at the state, local, and federal levels must work to prevent a regional electricity-water crisis. Placing additional demands on Arizona's water supply in order to export "renewable energy" to other states that have greater energy demands is unsustainable.[48] Arizona should not become a solar energy farm for the rest of the country, especially when its water supply is limited and it is currently in the midst of a long-term drought.[49]

---

48 Other states with solar resource potential such as California and Nevada consume more electricity than they generate. *See* Carter & Campbell, *supra* note 8, at 10 n.20.

49 *See* Arizona State Drought Monitoring Technical Committee, *Drought Status Update* (March 2009), *available at* http://www.azwater.gov/AzDWR/StatewidePlanning/drought/documents/March_2009_Drought_Status_Update.pdf (last visited April 15, 2010).

Chapter 3

CSP Policy Recommendations

Water intensive conventional CSP is a poor choice for renewable energy production in the Southwest, particularly in Arizona where consumer demand for power does not exceed current capacity. Since conventional CSP continues to be the solar technology of choice for utility-scale solar, federal and state officials need to address its potential water use.

State Renewable Portfolio Standards (RPS)

As discussed in the Introduction of this report, Arizona along with 28 other states and the District of Columbia have an RPS.[50] An RPS creates an artificial demand for qualifying renewable energy resources that can be satisfied by either producing more renewable energy in the state or purchasing tradable renewable energy credits (RECs) that represent an equivalent amount of renewable energy production.[51] RECs are given to qualifying facilities and can be traded between states so that solar power RECs from Arizona could be used to meet RPS requirements in other states. Given the water constraints in the state, Arizona should consider:

- Redefining the definition of renewable with respect to solar to factor in water consumption.

- Eliminating the eligibility of CSP for the RPS unless the plant will be dry-cooled or will use an alternative water source such as treated effluent.

Siting and Permitting CSP Projects

As discussed in Chapter 2 of this report, some of the most water constrained parts of the country also have the greatest solar potential. Given this reality, water consumption must be a major factor in the siting and permitting of CSP projects.

---

[50] DSIRE, Rules, Regulations & Policies for Renewable Energy, *available at* http://www.dsireusa.org/summarytables/rrpre.cfm (last visited April 19, 2010).

[51] Fred Sissine, *Renewable Energy: Background and Issues for the 110th Congress*, Congressional Research Services Rept. RL34162, at 24 (December 10, 2008).

The Arizona Corporation Commission and the State Legislature should consider:

- Following California's lead and requiring all new CSP projects under its regulatory control to be dry-cooled unless they have degraded water readily available, such as city wastewater.[52]

- Developing criteria for permitting that include a cost-benefit and water budget impacts analysis of using Arizona water to produce energy that will be exported out of state.

- Amending Arizona Revised Statute §40-360.06 to specifically require the Power Plant and Transmission Line Siting Committee to consider water resource and supply impacts in issuing a certificate of environmental compatibility.

The Department of the Interior and the Department of Energy should:

- Be more aggressive in protecting arid state water resources to ensure that multiple-use objectives can be sustained on public land. At a minimum, all Environmental Impact Statements for solar energy applications should require companies proposing to use wet-cooling technologies to analyze an alternative that conserves water, such as dry cooling.

- Deny right-of-way applications for those projects that do not have a sustainable water supply or do not adequately protect water resources needed to sustain other multiple uses in the area.

Congressional Action

The environmental impacts of deploying renewable energy on public land will be significant, particularly for solar power. Appropriate siting and system size limitations are critical to ensure that pristine landscapes and limited water resources are protected. Recognizing this fact, Congress has required the Department of the Interior and the Forest Service to report on the criteria used for siting renewable energy projects, including the extent to which protection of water resources will be considered.[53]

Congress is also considering adopting a federal RPS and already provides tax credits and other incentives for CSP.[54] Any federal RPS should also consider the factors discussed above and require solar thermal generation to forgo any incentives and credits that would negatively impact a state's water supply for the benefit of the rest of the country—especially if that water supply is not renewable such as groundwater.

---

52 *See* CSP Today, *supra* note 40.

53 H.R. Rep. No. 111-316, at 75-6 (2010) (Conference Report).

54 Cunningham & Roberts, *supra* note 2, at 3 -5.

Conclusion

While Arizona's sunny climate is conducive to solar energy production, its arid landscape poses significant challenges to the deployment of solar energy systems. Conventional concentrating solar power (CSP), the preferred technology for utility-scale solar energy production, consumes more water per megawatt-hour than most other types of thermal energy production. The consumption of water for solar energy production could, therefore, strain Arizona's limited water supplies. Moreover, a considerable amount of the power produced by CSP in Arizona could be exported to other states, effectively resulting in the exportation of the state's water to the rest of the country. In order to protect Arizona's limited water supplies, state and federal policymakers should ensure that energy policy takes into account the amount of water needed to produce solar energy and does not contribute to existing water constraints.