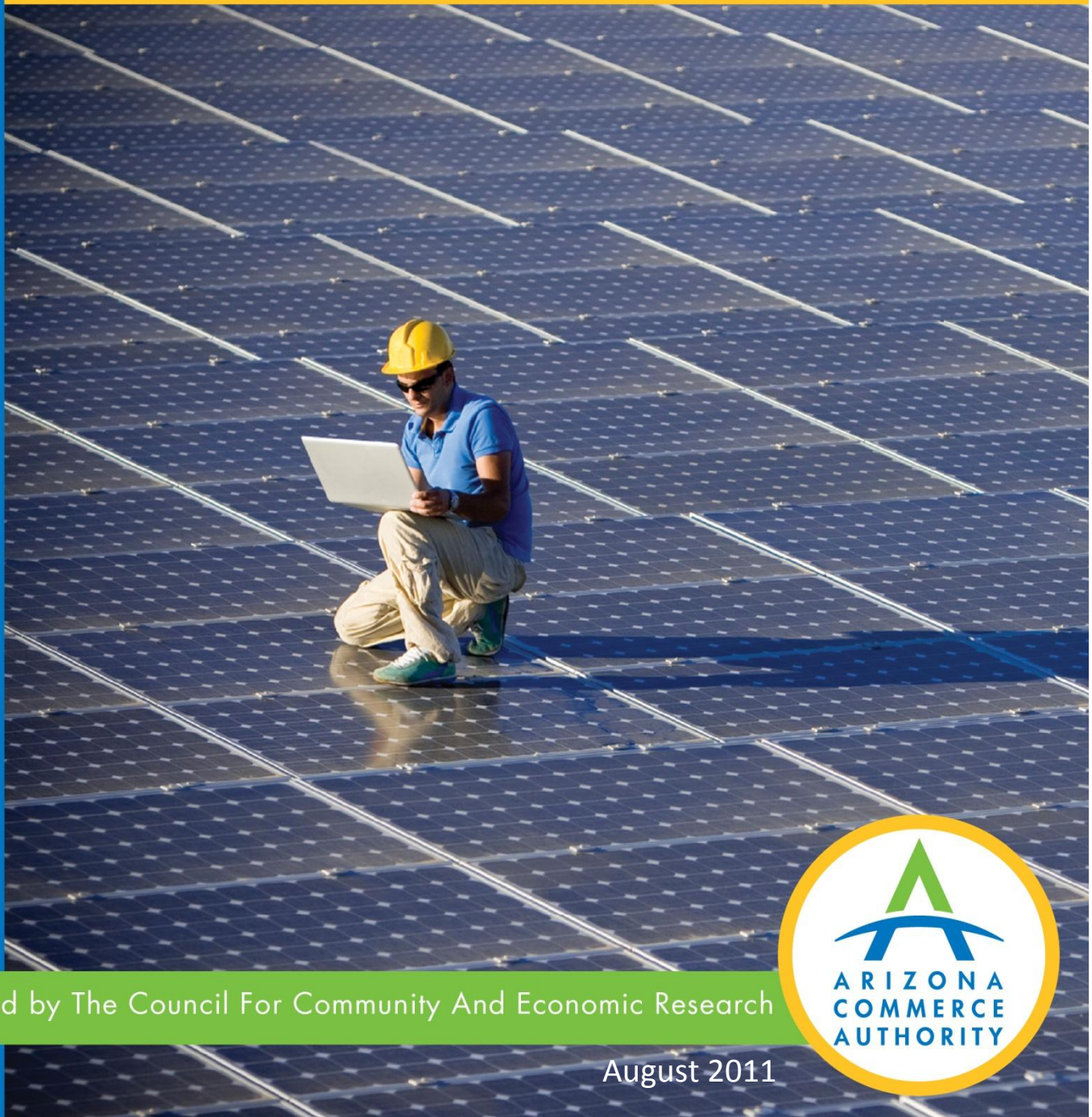


# RENEWABLE ENERGY IN ARIZONA

A Sector Profile



Prepared by The Council For Community And Economic Research



August 2011

# Renewable Energy in Arizona

*A Sector Profile*

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## Introduction

In his 2011 State of the Union speech, President Obama proposed that the United States strive to achieve 80 percent of produced electricity from "clean" sources by 2050 and put a million electric cars on the road by 2015. Given that only 10 percent of today's energy is derived from renewable resources and electric cars are just coming into mass use in 2011, this is a bold challenge. Regardless of whether the government or the private sector takes the lead in helping to reach those goals, renewable energy technologies are expected to become an ever growing part of the mix of energy production and consumption in America.

The renewable energy sector spans several industries, each related to harnessing naturally occurring events to create power, from such sources as water, sun, wind, biomass, and geothermal sources. Each source though, has its own set of market opportunities and technological challenges. Because each type of energy is most easily captured from a naturally occurring phenomenon, power generation is most likely to occur in different countries, states, or global regions where those assets are most prevalent. The regions with the most relevant natural assets often have a competitive advantage in leading in the generation of renewable energy and/or the production of technologies that create that power; however, results often depend upon how well leaders proactively take advantage of the assets and how well developed the technology is in providing power for mass consumption.

The renewable energy supply chain – those firms that participate in the production and sales of the manufacturing and production of generation technologies – is large, lucrative, and growing. These firms are competing with and facing challenges from a truly global marketplace – against firms in Germany as regularly as firms in China and Taiwan. From sluggish economies, to broad industry consolidation, to shifting public policies and incentives, the renewable energy industry has consistently been in a state of flux and adjustment, as it continues to grow and move.

Those regions that have found success in the sector, have done so through intentional policy coordination, specialized incentives built on a foundation of natural geographic advantages, and on local firms that have emerged to provide high value-added products used in generating renewable energy as well as in the distribution of the power itself.

This profile aims to provide global, national, and intra-national comparisons to put the market for renewable energy generation and production in context for Arizona policy-makers.

## Renewable Energy in the Global Economy

Renewable energy technology markets at the present time are global, fragmented, and based upon rapidly evolving technologies, making understanding market dynamics complicated, at best. Firms throughout the United States, including those in Arizona, are actively competing with others throughout Europe, Asia, and North America, while also relying on firms in those regions for key manufactured inputs. The markets to which these firms ship their end-products are driven by continuously changing incentive structures for residential, commercial, and industrial (or generator) users, making demand volatile, and unbounded by traditional market dynamics.

As the price of fossil fuels continue to rise, the efficiencies of renewable technologies continue to improve, and their production costs continue to drop, a future for renewable energy without outside intervention draws ever closer to reality. Those places that have developed the capacity to compete at this stage will be in the best position to take full advantage as market conditions improve.

This section highlights the “basics” of these renewable energy industries and their technologies, before turning to a global evaluation of the markets for renewable energy technology capacity and the key sources of renewable energy production. Throughout this report, given Arizona’s distinct advantage as a source for solar energy and the state’s clear policy focus on solar technology, particular attention is given to this rapidly-growing contributor of energy generation and economic growth in each of the aforementioned areas.

### Industry Basics

Each renewable energy industry has its own market structure and its own manufacturing sector. This section provides some basics on some of the renewable energy sectors that have the greatest presence in Arizona.

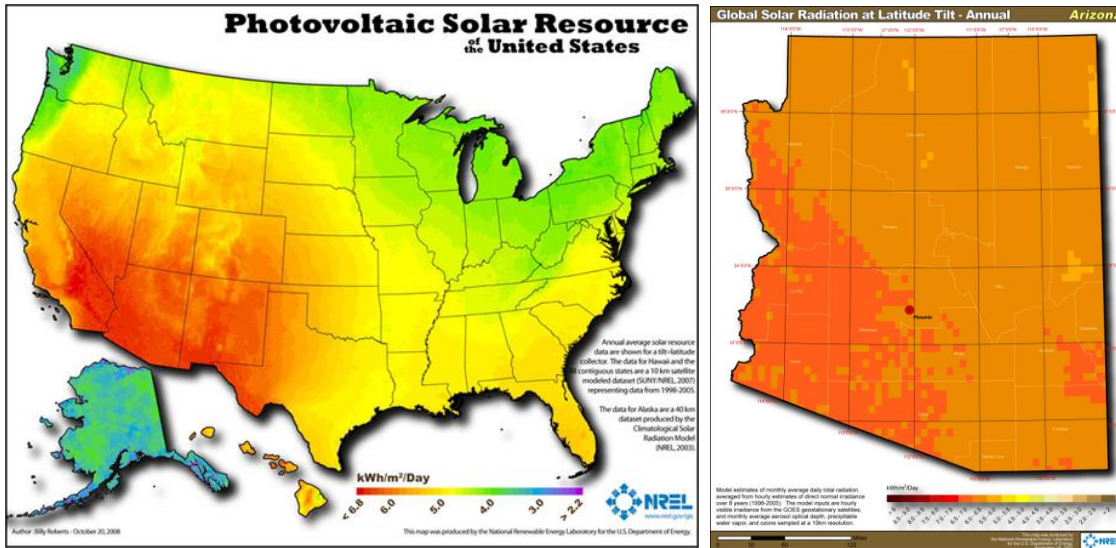
#### **Solar**

- Photovoltaic solar technology (PV) converts radiant sunlight directly into electricity, which can be stored off-grid (batteries) or can be allowed to flow onto the grid.
  - PV can be installed and produced for the distributed level (individual consumer) or at the utility-scale level.
  - The PV industry is made up of the crystalline silicon market (81%) and the thin-film solar market (18% now, but expected to grow to 30% by 2013).<sup>1</sup>
  - Thin-film, despite being considered less efficient, has lower production costs and advantages on curved, glass, and plastic surfaces, as well as in lower-light environments.
  - The U.S. Southwest represents a veritable “hot spot” for the generation of solar photovoltaic energy (See Figure 1).
    - In a “sun index” developed by the National Renewable Energy Laboratory (NREL), Arizona came in second only to Nevada with an Index of 1.18 (Nevada came in at 1.19; New Mexico at 1.16).

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<sup>1</sup> GTM Research, 2010

Figure 1: US and Arizona Solar Capacity



- Solar thermal technology can be used to directly heat buildings, water, or industrial processes (solar heating) or to indirectly generate electricity via engines or turbines through concentrated solar power (CSP).
  - Solar heating systems utilize lower levels of technology and can effectively operate with lower levels of heat. They are relatively inexpensive to maintain, and their market is large, with global installed solar collectors producing more energy in 2009 than installed wind and solar PV systems combined.<sup>2</sup>
    - These systems are especially useful in regions with high energy costs or a lack of infrastructure (i.e. China or rural areas).
  - CSP technology uses mirrors or lenses to focus down the sun’s light to a single beam, which can then be used to produce steam, and through turbines, generate electricity.
    - CSP plants are typically located in regions with low cloud coverage, high solar density, and large areas of land available for development.
    - One major obstacle to developing CSP is the requirement for large amounts of water for wet cooling, a challenge for locales where the technology would ordinarily thrive.

**Other Renewable Sources Particularly Relevant to Arizona**

- Biomass power is derived from residue produced through direct combustion, anaerobic digestion, rapid thermal processing, or gasification.
  - First generation technologies
    - The United States has largely focused on first generation technologies (i.e. ethanol), incentivizing production at the state and federal levels.

<sup>2</sup> ABS Energy Research, *Solar Thermal Power*, 2010.

- These technologies have been shown to be relatively inefficient, requiring about 1 unit of energy to generate approximately 1.5 units.
    - The technologies also often consume inputs that could otherwise be used in the food supply.
  - Second generation technologies
    - These technologies include lignocellulosic (or nonfood) crops such as fast-growing grasses and agricultural waste products.
    - They have been proven to run internal combustion engines (the greatest source of ozone-depleting carbon emissions).
  - Third generation technologies
    - These technologies aim to use algae-based biofuels for energy production.
    - They burn cleaner at levels that are 10 to 100 times more efficient than second generation biofuels, while also removing as much carbon dioxide from the atmosphere during their growth phase as it returns when burned.
    - Arizona is an emerging leader in the production of third generation biomass technology due to its investment in relevant research and development.
- Wind power production, like solar, can be done at the “plant” level or at the individual, residential or commercial level.
  - Under current technological constraints, they require sustained wind speeds.
  - Installation of large scale production windmills is often controversial in the communities that are most suited to wind energy production.

## Global Market Developments in Renewable Energy Technologies

Across the globe, nations are enacting policies designed to accelerate the adoption of renewable energy for their own consumption. These policies are driving the deployment of renewable energy technologies in different ways. **Installed renewable energy capacity both globally and in the United States has more than tripled between 2000 and 2009.**<sup>3</sup> This section provides a snapshot of top global markets for and producers of renewable energy technologies.

### Sources of Global Demand

#### Solar

- In each year from 2004-2009, the global growth rate for PV technologies was 50 percent, compounded on an annual basis.<sup>4</sup>
  - Growth forecasts differ substantially: while Navigant Consulting forecasts 19-38% CAGR through 2014. However, given an “expectation that 65% of 2011 worldwide demand will come from Europe, Morningstar believes that “global installations [could actually] shrink by 2% in 2011 and 9% in 2012” due to cuts planned in public subsidies to renewable sources.<sup>5</sup>

<sup>3</sup> 2009 Renewable Energy Data Book, U.S. Department of Energy, August 2010.

<sup>4</sup> Navigant Consulting

<sup>5</sup> “The Solar Outlook is Increasingly Gloomy,” Morningstar, April 7, 2011.

- Germany and Spain are often cited as the top two worldwide solar technology adopters. Germany led the world with over 9.6 gigawatts of capacity in 2009, close to three times that of second place Spain (see Figure 2).
- Technology adoption has grown particularly rapidly since 2005 with significant growth rates in installed capacity in Europe, Japan, the US, and developing countries as the race to install photovoltaic capacity heats up (Figure 3).
- European adoption has been largely driven by significant “feed-in” tariffs (FITs). FITs encourage renewable deployment by guaranteeing minimum prices for a set number of years to generators of electricity from specified renewable sources.

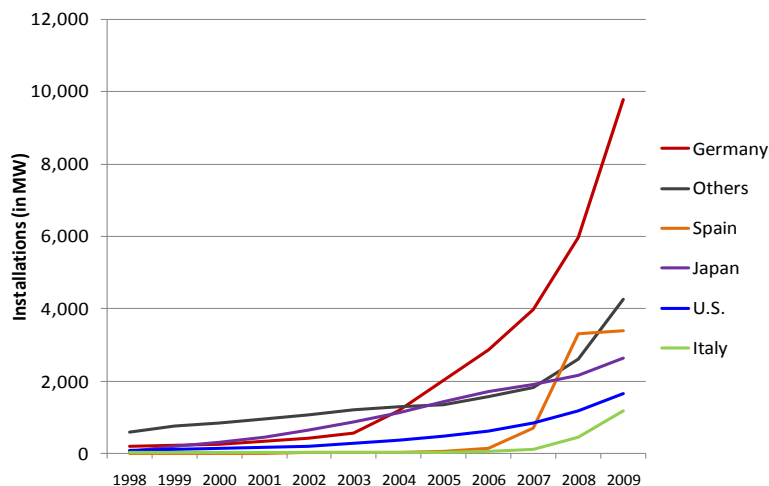
**Figure 2: Installed Solar Capacity in Select Countries (2009)**

Country	Installed Capacity (MW)
Germany	9,677
Spain	3,595
Japan	2,628
United States	2,108
Italy	1,158
France	465
Czech Republic	465
Belgium	362

Source: US Dept of Energy

- FITs can encourage market growth by providing stability (guaranteed prices), simplicity (minimal bargaining), and fairness (removing barriers to participation).
- Critics point out that: both Germany and Spain, leading implementers, have created “speculative bubbles” with FITs whose rates are often highly volatile; citizens in these countries have also been locked into “significant subsidies for 20 years.”<sup>6</sup>
- In 2011, many European countries are expected to cut or cap FITs to reduce costs: Germany (by 15%), Italy (1-2 GW cap), Czech Republic (complete cut), France (500 MW cap)<sup>7</sup>.

**Figure 3: Global Installed Capacity for Solar PV (2009)**



Source: Earth Policy Institute, 2009

<sup>6</sup> Barclay, Richard A. “Feed-In Tariffs: Too Much of a Good Thing?” *Management Quarterly*, Summer 2010.

<sup>7</sup> “The Solar Outlook is Increasingly Gloomy,” *Morningstar*, April 7, 2011.

- These cuts could result in an oversupply in the market by 2013.<sup>8</sup>
  - Morningstar projects that “solar installation growth in Europe [will] shrink by 19% in 2011 and 32% in 2012,” and will only partially be offset by expansions in “emerging solar markets, [such] as the US, Canada, China, and India.”<sup>9</sup>
- US solar cumulative installed capacity totaled about 2.6 GW in 2010, up 956 MW from 2009
  - Between 2000 and 2009, US solar PV generation grew by a factor of greater than 14.<sup>10</sup>
  - Between 2009 and 2010, the US solar market grew 67% to \$6.0 billion.<sup>11</sup>
  - US PV demand is expected to grow between 32% and 46% annually through 2014.<sup>12</sup>
  - The source of US PV demand in 2009 was 53% for commercial use, 31% for residential use, 8% for utility use, and 8% for off-grid.
- China has the largest solar heating market globally, with 87.8 GW of installed capacity
  - Europe follows with 28.5 GW.
- The largest overall markets for CSP systems have been the US and Spain
  - The relative size and infrequency of new installations mean that only a few new projects have been announced globally.
  - The US accounted for 100 percent of the CSP market in 2009.
- While relatively small now, global solar installations of CSP systems are projected to increase rapidly with annual growth rates of nearly 50 percent from 2009-2016, increasing worldwide capacity from 2009 levels of 817 MW to 13,670 MW by 2016.

### Other Renewable Sources

- Worldwide, wind energy is the fastest growing renewable energy source, with generation capacity growth increasing nine-fold between 2000 and 2009.<sup>13</sup>
  - It was even more significant in the United States, where wind grew by a factor of 14, or a 33.7% compounded annual growth rate over the period (as seen in Figure 4).
  - However, wind turbine installation decreased in 2010, the slowest year since 2007.
- The U.S. Energy Information Administration reports that renewable energy use globally is expected to double by 2035, becoming about 15 percent of all global energy consumption by 2035 (as shown in Figure 5).
- The United States leads the world in wind, geothermal, biomass, and CSP installed capacity.<sup>14</sup>

**Figure 4: U.S. Installed Renewable Electric Capacity Growth**

Renewable Source	CAGR* (2000-2009)
Wind	33.7%
Solar PV	39.3%
CSP**	2.2%
Biomass	2.0%
Geothermal	1.1%
Other (excl hydro)	13.9%

\* - Compounded Annual Growth Rate; \*\* - Concentrated Solar Power  
 Source: US Dept of Energy, 2009 Renewable Energy Book, 2010

<sup>8</sup> Navigant Consulting

<sup>9</sup> “The Solar Outlook is Increasingly Gloomy,” [Morningstar](#), April 7, 2011.

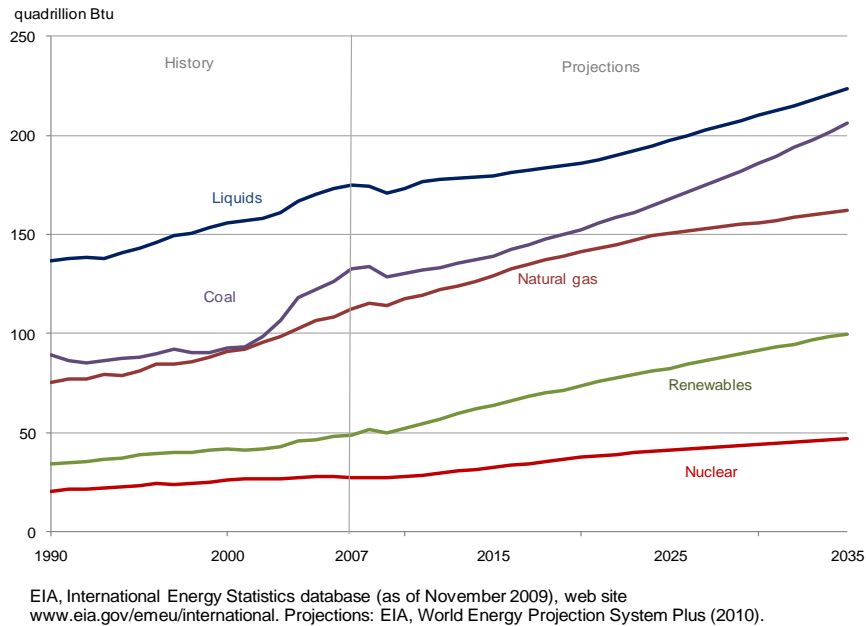
<sup>10</sup> [2009 Renewable Energy Data Book](#) US Department of Energy, August 2010.

<sup>11</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

<sup>12</sup> Navigant Consulting.

<sup>13</sup> [2009 Renewable Energy Data Book](#) US Department of Energy, August 2010.

**Figure 5: World Marketed Energy Use by Fuel Type, 1990-2035**



- Including hydropower, renewable energy represents nearly 12% of total installed capacity and more than 10% of total generation in the United States in 2009.
- Hydropower is currently the nation’s largest “renewable resource.” It provides about 78 gigawatts (GW) of the nation’s electrical generating capacity, and currently accounts for about 80% of the electricity generated from renewable sources.
- Globally, Brazil, the US and China are the largest producers of biofuels.

### Sources of Global Supply

Producers of renewable power generation technologies are globally inter-connected and established. A supplier can as easily be found in Taiwan or China as Germany or the United States. However, those nations that have been the fastest to adopt and support a market for renewable energy technologies within their own markets also tend to host higher concentrations of these firms. Demand has been an integral driver of global supply and many of the same countries with high demand (as noted earlier in Figure 3) are also locations of large suppliers of renewable power generation technologies.

- The global PV industry grew by 46 percent annually during the 1998 to 2008 period, increasing by 87 percent in 2008 alone.
  - Global demand increased from 7.1 GW in 2009 to over 17 GW in 2010.<sup>15</sup>
- The solar thermal industry (heating + CSP) had an approximate value of around \$8 billion in 2009 (according to Battelle). Driven by strong growth in water heating, the industry is expected to continue expanding with an annual growth rate of close to 20% over the next five years.

<sup>14</sup> [2009 Renewable Energy Data Book](#) US Department of Energy, August 2010.

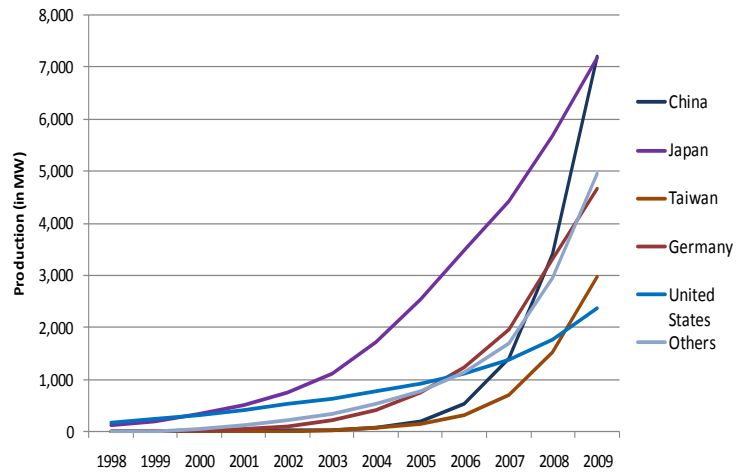
<sup>15</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

### Solar Supplier Countries

Leading countries in demanding and supplying PV technology can be seen in and Figure 6.

- China has grown faster than any other market, increasing its solar GW production output by over 170% annually during the five years between 2003 and 2008. This is clearly seen in Figure 6. In 2001, Chinese firms contributed only 1% to global production, but in 2008 they represented 27% of global production.
  - Taiwan passed US production levels in 2007 to become world’s fourth largest producer.
- In 2009, the United States imported about \$1.6 billion worth of PV-related products, and exported \$2.3 billion: \$686 million to Germany, \$409 million to Japan, \$280 million to China, and over \$939 million to other countries.
  - Thus, the U.S. was a net exporter of solar products in 2009, by over \$723 million.
  - Net export gains are seen almost exclusively within the US PV polysilicon market where the US exports over \$1.1 billion worth of goods across the globe.
- In 2010, early estimates show that the US produced 42,561 metric tons of polysilicon, 624MW of wafer, 1,058MW of cells, and 1,205MW of modules; all are critical inputs in PV manufacturing.<sup>16</sup>

Figure 6: Cumulative Solar PV Production Worldwide (2009)



Source: Earth Policy Institute, 2009

### Global Solar Companies

- The PV producer market is very competitive and volatile, with no single company holding a market-dominating position (Figure 7).
  - In 2007, Germany’s Q-cells overtook Japan’s Sharp to become the world’s number one producer of PV cells/modules. Sharp ranked fourth in 2008.
  - Arizona-based First Solar is a major global competitor in PV cell production, ranked 2<sup>nd</sup> in 2008.

Figure 7: Top PV Cell Producers (2008)

Rank	Producer	Producer Country	Capacity Produced	Percent of World
1	Q-Cells	Germany	0.57	8%
2	First Solar	US (AZ)	0.50	7%
3	Suntech	China	0.50	7%
4	Sharp	Japan	0.47	6%
5	Motech	Taiwan	0.38	5%
6	Kyocera	Japan	0.29	4%
7	Baoding Yingli	China	0.28	4%
8	JA Solar	China	0.28	4%
9	SunPower	US (CA)	0.24	3%
10	Sanyo	Japan	0.21	3%
	All Others	Various	3.50	49%

Source: US Dept of Energy, 2008 Solar Technologies Mkt Report, 2010

<sup>16</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

- Three of the current top ten firms are Chinese: Suntech, Yingli, and JA Solar. This highlights an increasing trend in the industry of producer movements towards low-cost manufacturing environments.

### ***Global Suppliers of Other Renewable Technologies***

#### Biomass

- The world-wide bio-fuel market was valued at \$60.6 billion in 2008, and is expected to increase to \$77.1 billion by 2013.
- Global capital investment in the biomass market is projected to reach between \$41 billion and \$83 billion by 2030.
- The commercialization of third generation biofuels technology is forecast to take place as early as 2017 according to the Algae Biomass Organization.
  - Arizona is positioned to become a potential leader in third-generation algae-based biofuels as a result of research currently underway in Arizona.
  - About 100 companies globally (often small) are testing potential scale-up of mass-produced algae.
  - The U.S. Department of Energy has funded several R&D consortia and pilot projects, including a 300-acre demonstration project in New Mexico led by Sapphire Energy, Inc.

#### Wind Energy

- According to the American Wind Energy Association, two-thirds of all small wind systems sold around the world in 2009 (42.5 MW) were produced by American manufacturers.
- Key global industry leaders in the wind turbine industry include: Vestas Wind Systems A/S, GE Energy, Sinovel, Suzlon Energy Limited, Gamesa, Enercon, and Siemens

## Arizona’s Renewable Energy Sector

### Power Generation

Arizona has embraced renewable energy not only through the attraction of technology producers to its natural “test bed,” but also through successfully creating a culture and environment supportive of renewable energy generation. The state’s Renewable Portfolio Standard (RPS), as discussed later within this profile, as well as its proximity to the substantial California market, are among many factors that continue to bolster demand for generation.

According to the 2009 Renewable Energy Book, produced by the US Department of Energy, Arizona consistently ranks among the top five states in photovoltaic energy generation. However, leading states, such as California and New Jersey, through heavily incentivized renewable power generation programs, have developed an already substantial lead (Figure 8).

Arizona’s renewable energy resources are not limited to solar, however. With significant amounts of electricity generated at the Hoover Dam, Glen Canyon Dam, and the Parker-Davis Dam, Arizona also stands as a national leader in hydro-electric power generation.

**Figure 8: Installed Renewable Energy Capacity by Sector (2009)**

State	Wind	PV	CSP	Geoth.	Biomass	Hydro.	Total	Per Capita excl hydro (in W)
Washington	1,980	5	0	0	0	20,807	22,792	298
California	2,794	768	364	2,566	1,271	10,032	17,794	210
Arizona	63	46	1	0	40	2,718	2,868	23
Nevada	0	36	64	427	191	1,047	1,765	272
New Mexico	597	2	0	0	449	87	1,136	522
New York	1,274	34	0	0	367	4,654	6,392	86
New Jersey	8	128	0	0	7	13	155	16

Source: US Dept of Energy, 2009 Renewable Energy Book, 2010

This section further explores Arizona’s current renewable energy generation capacity, and looks forward, identifying in-progress and proposed projects across the state.

### Solar Energy Generation

- In 2010, Arizona nationally ranked<sup>17</sup>:
  - Fourth in PV installations (54.0 MW)
    - It was one of only five states that installed over 50MW each (AZ, CA, CO, NV, NJ)
  - Third in CPS installations (1.5 MW)
  - Third in solar pool heating installations

<sup>17</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

Figure 9: Utility Scale Solar Projects in Arizona – Operating, Under Construction, and Under Development

Project	Developer	City/ County	Capacity (MW)	Type	Status
Saguaro Solar Power Project	Solargenix	Red Rock	1	CSP	Operating
Maricopa Solar Power Plant	Tessera Solar	Phoenix	2	CSP	Operating
Prescott Solar Power Plant	Arizona Public Service	Prescott	3	PV	Operating
Springerville Generating Station Solar System	Global Solar Energy	Springerville	5	PV	Operating
Solana	Abengoa Solar	Gila Bend	280	CSP	Under Construction
Paloma Solar Plant	First Solar	Gila Bend	17	PV	Under Construction
Ajo	Recurrent Energy	Ajo	5	PV	Under Construction
Cotton Center	Solon	Gila Bend	17	PV	Under Construction
Prescott	SunEdison	Prescott	10	PV	Under Construction
Copper Crossing	SunPower/ Iberdrola	Pinal	20	PV	Under Construction
Kingman Project	Albiasa	Kingman	200	CSP	Under Development
UA Tech Park Thermal Storage Demonstration Project	Bell Independent Power Corp	Tucson	5	CSP	Under Development
Sonoran Solar Energy Project	Boulevard Associates LLC	Maricopa	375	CSP	Under Development
Hualapai Valley Solar Project	Majave Sun Power	Mojave	340	CSP	Under Development
Quartzsite Solar Energy Project	SolarReserve	La Paz	100	CSP	Under Development
Crossroads Solar Energy Project	SolarReserve	Gila Bend	150	CSP	Under Development
SolarCAT Pilot Plant	Southwest Solar		10	CSP	Under Development
	Arlington Valley Solar Energy II	Maricopa	127	PV	Under Development
Agua Caliente	First Solar	Yuma	290	PV	Under Development
	Fotowatio Renewable Ventures	Tucson	25	PV	Under Development
Florence Solar Farm	GWS Technologies, Inc.	Florence	6	PV	Under Development
	Matinee Energy	Cochise	25	PV	Under Development
	Matinee Energy	Dragoon	150	PV	Under Development
Sunshine Solar Farm	Pacific Blue Energy Corporation	Coconino	20	PV	Under Development
	Pacific Blue Energy Corporation	Gila Bend	150	PV	Under Development
Mesquite Solar	Sempra Generation	Arlington	700	PV	Under Development
	Solon	Tucson	5	PV	Under Development
Hyder Solar Plant	SunEdison	Hyder	16	PV	Under Development
Chino Valley Solar Plant	SunEdison	Chino Valley	19	PV	Under Development
Luke Air Force Base	SunPower/ Iberdrola	Glendale	14	PV	Under Development
Bright Tucson	Tucson Electric Power	Tucson	2	PV	Under Development
Springerville Generating Station Solar System (exp.)		Springerville	2	PV	Under Development
Solar 1		Tonopah	15	PV	Under Development

Source: Solar Energy Industries Association, June 28, 2011

- The Solana plant, 70 miles southwest of Phoenix, will be the first major stored-heat plant in the U.S. when it comes online in 2013.
  - The facility will generate 280 MW of electricity, enough to power up to 70,000 homes
  - It will use “two giant salt tanks, each 122 feet in diameter and 34 feet deep, that together can hold and store 40 percent of the heat created by the plant,” allowing it to provide six extra hours a day of electric-generating capacity.
  - The facility will create 1,600 to 1,700 construction jobs and 85 permanent jobs for operations.
- In early 2010, the 1.5 MW Tessera/ Stirling Maricopa Dish-Engine project was completed in Arizona, one of only three such projects that came online in 2010.<sup>18</sup>

<sup>18</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

## ***Energy Generation from Other Renewable Sources***

### Biomass

- The state's major biomass electrical production facilities are:
  - Snowflake (25MW)
  - Los Reales Landfill Gas System south of Tucson
  - Tri-Cities Landfill Generation Facility in the Salt River-Pimar Maricopa Indian Community (4 MW)
  - Glendale Energy Project, Glendale, AZ (2.8MW)

## Industry Activity

This section discusses recent renewable energy industry activity taking place within Arizona and how these developments compare to those in other states and countries.

### Major Renewable Firms Active in Arizona

Arizona has a number of world-class manufacturers, far-reaching distributors, and numerous localized

Figure 10: Major Renewable Energy Firms in Arizona

Firm Name	City	Energy	Type of Firm
Abengoa	Phoenix	Solar	Distributor
Aide Solar USA	Tempe	Solar	Manufacturer
Allwest Energy	Fountain Hills	Solar/ Wind	Design; Installation
American Solar Electric	Scottsdale	Solar	Design; Installation
Blazing Solar	Mesa	Solar	Installation
CentroSolar America	Scottsdale	Solar	Manufacturer
EnviroMission (USA), Inc	Phoenix	Solar	Manufacturer; Distributor
EV Solar Products, Inc.	Chino Valley	Solar	Installation
Faist Greentek	Phoenix	Solar	Manufacturer
First Solar, LLC	Tempe	Solar	Manufacturer
Gestamp Solar Steel	Surprise	Solar	Manufacturer
Global Solar Energy, Inc.	Tucson	Solar	Manufacturer
Heliocol Solar (Green Energy Inc.)	Tempe	Solar	Installation
Hitney Solar Products	Chino Valley	Solar	Distributor
Hybrid Solar (Green Energy Inc.)	Tempe	Solar	Installation
HyperFlo	Tempe	All	Manufacturer
NanoVoltaix, Inc.	Tempe	All	Manufacturer
North Canyon Solar & Plumbing, Inc.	Phoenix	Solar	Retail; Maintenance
Northern Arizona Wind & Sun	Flagstaff	Solar/ Wind	Retail; Installation;
Perfectpower, Inc.	Phoenix	All	Customer Service
Power One	Phoenix	Solar/ Wind	Manufacturer
Rio Glass	Surprise	Solar	Manufacturer
Schletter, Inc.	Tucson	Solar	Design; Installation
SolarCity	Phoenix	Solar	Design; Installation
Solar Pool Technologies, Inc.	Phoenix	Solar	Manufacturer; Retail
SolarTech, Inc. USA	Tempe	Solar	Design; Manufacturer
Solon Corporation	Tucson	Solar	Manufacturer
Stirling Energy Systems (SES)	Scottsdale	Solar	Manufacturer
Suntech Power Holdings	Goodyear	Solar	Manufacturer; Installation
Sun Valley Solar Solutions, LLC	Chandler	Solar	Installation
Technicians for Sustainability	Tucson	Solar	Consulting

Source: Arizona Commerce Authority; Arizona Environmental Industry Directory, 2011

installers supporting the renewable energy sector at all levels, including those listed in Figure 10.

For APS Qualified Solar Panel Installers across the state, refer to the APS website at [http://www.aps.com/main/green/choice/solar/QSIList\\_1.html](http://www.aps.com/main/green/choice/solar/QSIList_1.html).

Notable firms in Arizona outside of solar include:

- Small turbine wind manufacturing company, Southwest Windpower, which focuses on producing residential and small commercial windmills.
- Other Arizona firms supporting the wind generation production supply chain include: TPI Composites, Copper State Bolt & Nut, and Valley Forge and Bolt.

### ***Recent Global Solar Project Openings***

- There are over 39 active facilities manufacturing photovoltaic components across 17 states, with over 2,000 companies existing in the US solar value chain itself.<sup>19</sup>
  - California serves not only as a leading end-market for these generation products, but also as the location for many of these firms.
  - Beyond market proximity, Oregon and Arizona have also been noted for their advantages in this market resulting from their offerings of “skilled labor and strong policy support for PV.”
- Almost half of the major announcements in solar panel production in developed countries occurred in the United States (see **Error! Reference source not found.**).
- Many of the U.S. manufacturing facilities announced during the first 9 months of 2010 were on the East Coast.
  - 11 renewable energy plants opened in the American Southwest from January through September (Figure ).
- Arizona-based First Solar continues to expand its facilities.
  - It has announced a major R&D facility in Silicon Valley.
  - It has also opened a manufacturing and R&D facility in Santa Clara, CA.
- Many of the major US solar manufacturing announcements occurred as a result of foreign investment.

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<sup>19</sup> US Solar Market Insight: 2010 Year in Review, Solar Energy Industries Association

**Other Project Announcements**

- Research at Arizona State University’s Laboratory for Algae Research has led to the spin-offs of: PetroAlgae LLC (now located in FL) and Heliae Development LLC (Gilbert, AZ).
  - Diversified Energy, located in Gilbert, is also engaged in algae-related technology development, including both the use of algae as a fuel feedstock and in the development of an algae growth system.

**Figure 11: Renewable Energy Plant Openings, Southwest United States (Jan-Sep, 2010)**

Renewable Energy Plant Openings: January - September, 2010 Arizona and Adjacent States					
Company	City	State	Product	Category	Type
First Solar*	Mesa	AZ	Thin-Film Solar Modules	New - Announced	Manufacturing
Energy Innovations	Poway	CA	Solar Cells	New	Manufacturing - Headquarters - Research & Development
Edison Mission Energy	Santa Ana	CA	Electric Power	New	Headquarters
First Solar	Santa Clara	CA	Thin-Film Solar Modules	New	Manufacturing - Research & Development
Aluwind	Castle Rock	CO	Wind Turbines	New	Dist/Warehouse
UQM Technologies	Frederick	CO	Propulsion Systems	Expansion	Manufacturing
Vestas	Louisville	CO	Turbines	New	Office - Research & Development
SGB USA, Inc.	Wheat Ridge	CO	Transformers	New	Manufacturing
Solar Distinction Inc.	Albuquerque	NM	Solar Panels	New	Manufacturing
Johnson Plate and Tower	Santa Teresa	NM	Wind Towers	New	Manufacturing
Skyonic Corp./Capitol Aggregates	San Antonio	TX	Carbon Capture	New	Manufacturing

Source: Conway Data, Inc.

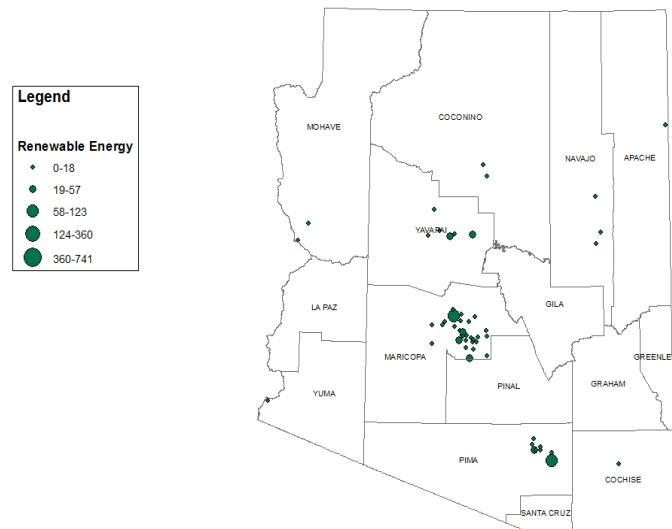
\* Announced May 17, 2011, <http://investor.firstsolar.com/phoenix.zhtml?c=201491&p=irol-newsArticle&ID=1540371>

## Employment

Renewable energy jobs are found throughout Arizona. This section describes where these jobs are located and in which occupations there are concentrations of employment.

- Estimated 2010 ‘green’ employment in Arizona totals 31,649.<sup>20</sup>
  - 11 percent of those jobs (or approximately 3,500) were classified as “renewable energy” jobs.
  - “Solar PV” and “thermal energy” employment represent the largest cohort of renewable energy jobs, estimated at 1,496.
- The Arizona Green Jobs Survey finds that most of the current jobs within the “renewable energy” industry are concentrated, largely, in the Phoenix and Tucson areas, though firms can be found throughout the state (See Figure ).
  - 35 percent of these jobs require at least an Associate’s or vocational degree.
- Most recent web-advertised vacant jobs, require a Bachelor’s degree or higher, according to Wanted Analytics.
- As shown in Figure , most renewable energy workers in 2010 were “Weatherization and Solar Installers,” accounting for 29 percent of renewable energy jobs, earning an average annual wage over \$41,000.
- “Managers and Engineers” comprised of 13 percent of Arizona renewable energy jobs and earned average annual wages above \$75,000.

**Figure 12: Geographic Concentration of Reported Renewable Energy Jobs**



**Figure 13: Most Reported Renewable Energy Occupations (2010)**

Title	Jobs	% of RE Jobs
Weatherization and Solar Installers	763	29%
Engineers	228	9%
Production Workers (exc. Recycling)	198	7%
Managers - Office	123	5%
Heavy Equipment Operators	100	4%
Administrative Workers	95	4%
Construction Builders and Contractors, exc. Weatherization and Solar Installers	93	4%
Retail Sales Workers - Technical (Including Solar)	83	3%
Agricultural and Nursery Workers	44	2%
Landscapers and Related Workers	26	1%

Source: Arizona Green Jobs Survey

<sup>20</sup> “Emerging Green Industries in Arizona: Definitions, Industry Base, and Opportunity Areas” prepared by Battelle Technology Partnership in collaboration with C2ER, 2010

## Public and Private Support, Subsidies and Investments

Many Arizona institutions and networks provide support for the state emerging renewable energy industry – particularly for the development of technologies, industries, and workers involved in solar power generation. From universities offering research and commercialization support, to community colleges training the workforce needed for generation and installation, to state-based subsidies and investments, Arizona is establishing a reputation as a more renewable-friendly environment.

In 2010, *Business Facilities Magazine* took note of Arizona’s collaborative efforts, ranking the state as a national model and leader in the alternative-energy and solar-manufacturing industries. Jack Rogers, editor of the magazine, was quoted in *The Arizona Republic* that when compiling the rankings, the Business Facilities analysts were “particularly impressed with the interaction [the state and industry had] with higher education and research and development.”

This section highlights just a few of the various supports in place within Arizona that have placed the state at the forefront of a national race for renewable energy generation and technology production.

### Academic Support

- Arizona has nine major renewable energy research centers at its three universities (Figure ). That research focuses on improving the productivity of solar cells, enhancing storage capacity, linking solar and biomass energy production, and improving energy transmission. In addition, five of the state’s community colleges have also created renewable energy programs, most of which focus on improving the skills of workers in solar energy production and facility installation. A few highlights include:
  - TUV Rheinland joined forces with Arizona State University (ASU) to create the world’s most advanced solar testing certification facility, the TUV Rheinland Photovoltaic Testing Laboratory, in Tempe.
  - The University of Arizona hosts the Arizona Research Institute for Solar Energy, created in 2007 to “provide the [global] leadership for selecting strategic direction for research, development and analysis” for the solar energy industry.
  - The University of Arizona created a “Solar Zone” at its Science & Technology Park in Tucson, believing that co-location within 200 acres of the park’s 1,345, will create a center for collaboration, innovation, and productivity between developing firms in the industry. Two firms have already emerged, REhnu and Solar Technology Resources Corporation; both focused on improving solar PV efficiency. The solar zone also contains:
    - A 1.2 MW Solon tracking PV system owned by TEP
    - A 2 MW Concentrating PV tracking system built by Amonix, Inc. (the largest CPB system in the country, and uses zero water)
  - Community colleges throughout the state, including Pima, Coconino, Chandler-Gilbert, Yavapai, and Mesa, all offer technical and/or certificate programs in actual product delivery – solar PV and/or solar thermal installation (see Figure 14).

- Science Foundation Arizona currently funds over \$30 million of renewable energy research at the major state universities: over \$25 million for solar energy and nearly \$5 million for algae-based fuel research.

Figure 14: Key Arizona University-Based Renewable Energy Programs and Centers

Center/Initiative	Location	Focus	Highlighted Programs & Grants	Website
<b>Arizona State University</b>				
Lightworks	Tempe and Mesa	Solar, Biomass, Transmission	Hosts the TÜV Rheinland Photovoltaic Testing Laboratory LLC, the Laboratory for Algae Research and Biotechnology, the Power Systems Engineering Research	<a href="http://asulightworks.com/">http://asulightworks.com/</a>
Laboratory for Algae Research and Biotechnology	Mesa	Biomass	U.S. Department of Energy (DOE) awarded a \$6 million grant to fund testing the acceptability of algal biofuels as replacements for petroleum-derived fuels	<a href="http://larb.asu.edu/">http://larb.asu.edu/</a>
Power Systems Engineering Research Center	Tempe	Transmission	ASU leads this consortium of universities and companies in its comprehensive research program for power markets, T&D technologies, and power systems to create a modern electric energy infrastructure that enables a low-carbon economy	<a href="http://www.pserc.wisc.edu/home/index.aspx">http://www.pserc.wisc.edu/home/index.aspx</a>
TÜV Rheinland Photovoltaic Testing Laboratory LLC.	Tempe	Solar	World-class facility for PV technology testing, assessment, and certification services for industry	<a href="http://www.tuvptl.com/">http://www.tuvptl.com/</a>
Center for Bio-Inspired Solar Fuel Production	Tempe	Solar, Biomass	DoE funded Energy Research Frontier Center with research focusing on potential roles of sunlight in developing fuels	<a href="http://solarfuel.clas.asu.edu/">http://solarfuel.clas.asu.edu/</a>
Arizona Center for Algae Technology and Innovation (AzCATI)	Mesa	Biomass	AzCATI, financed through \$2 million of stimulus funding, will focus on devising new commercial uses for algae	<a href="http://www.azcati.com/">http://www.azcati.com/</a>
<b>Northern Arizona University</b>				
Sustainable Energy Solutions (SES) Group	Flagstaff	Wind, Solar, Geothermal	Advocate group for the advancement of engineering design and analysis of renewable and clean energy systems, especially as applied to wind energy, solar energy, hybrid renewable energy systems and applications, renewable fuels and energy sources, utility- and village-scale energy systems, and energy efficiency	<a href="http://ses.nau.edu/">http://ses.nau.edu/</a>
<b>University of Arizona</b>				
The Arizona Research Center for Solar Energy	Tucson	Solar, Storage	The Center provides global leadership for making strategic, collaborative directions for solar research, development and analysis, which will accelerate adoption and deployment	<a href="http://www.azrise.org/">http://www.azrise.org/</a>
Center for Interface Science: Solar Electric Materials (CIS:SEM)	Tucson	Solar	Lead institution for a DoE funded Energy Research Frontier Center, focusing on solar energy conversion	<a href="http://www.er.doe.gov/bes/EFRC/CENTERS/CIS-SEM/efrc_CIS-SEM.html">http://www.er.doe.gov/bes/EFRC/CENTERS/CIS-SEM/efrc_CIS-SEM.html</a>

Community College training programs can also be found throughout Arizona, providing needed support to renewable technology industries and its current and future workforce. The state also has two major private facilities focused on fostering solar research. Both sets of resources are displayed in Figure 15.

Figure 15: Community College Training Programs

Center/Initiative	Location	Focus	Highlighted Programs & Grants	Website
<b>Private Sector/ Firm Initiatives</b>				
Arizona Public Service: Solar Test and Research (STAR) facility	Tempe	Solar	Research and demonstration site to test various solar pv and CSP equipment	<a href="http://www.solarelectricpower.org/case-studies/solar-test-and-research-center-%28star%29.aspx">http://www.solarelectricpower.org/case-studies/solar-test-and-research-center-%28star%29.aspx</a>
Southwest Solar Technologies Research Park	Phoenix	Solar	Facility for Southwest Solar Technologies and clients to evaluate new solar technologies	<a href="http://www.swsolartech.com/news/3-southwest-solar-technologies-opens-18-acre-research-park">http://www.swsolartech.com/news/3-southwest-solar-technologies-opens-18-acre-research-park</a>
<b>Community Colleges</b>				
Pima Community College	Tucson	Solar, Other	NSF-sponsored program aims to promote renewable energy technologies and increase number of graduates, with Associate's and Bachelor's degrees in Applied Science, particularly with members of underserved groups; also offers course in solar pv technology, and is developing a certification program curriculum	<a href="http://www.pima.edu/">http://www.pima.edu/</a>
Coconino Community College	Flagstaff	General	Alternative Energy Technician program offers an Associate's degree in Applied Science in Environmental Technology	<a href="http://www.coconino.edu/Pages/default.aspx">http://www.coconino.edu/Pages/default.aspx</a>
Chandler-Gilbert Community College	Sun Lakes	Solar	Technical program offered for solar PV and solar thermal; also hosts program in PV System Installation for national certification	<a href="http://www.cgc.maricopa.edu/Pages/Default.aspx">http://www.cgc.maricopa.edu/Pages/Default.aspx</a>
Yavapai College	Prescott	Solar	Certificates offered in solar installation and service	<a href="http://www.yc.edu/">http://www.yc.edu/</a>
Mesa Community College	Mesa	Solar	Certificates offered in solar installation and service	<a href="http://www.mesacc.edu/">http://www.mesacc.edu/</a>

### State and Federal Incentives

Incentive programs are one of the main drivers of the renewable energy sector. Arizona is competitive in this area, with a variety of such programs, covering a broad mix of renewable energy industries, and addressing both the industry- and consumer-sides of production.

### Renewable Portfolio Standards

Renewable Portfolio Standards (RPS) play a big role nationally in fostering renewable energy generation, and indirectly, renewable energy technology production. When states push for – or are near other states that push for – increased requirements for generation, local technology developers benefit from the “home grown market” that results for their products and generation facilities. Arizona, for instance, continues to benefit from the aggressive RPS of neighboring California.

California has consistently held a nation-leading standard, resulting in it consistently leading the nation in installation and generation of electricity from renewable sources, significant portions of which it gets from Arizona’s providers. In fact, California imports more electricity from other states than any other

state in the country.<sup>21</sup> With California's Governor, Jerry Brown, raising the state's already nation-leading RPS goal in April from 20 percent to 33 percent by the end of 2020,<sup>22</sup> this continues to bode well both for Arizona generators and product producers.

Other Renewable Portfolio Standard notes include:

- Arizona is one of 30 states with renewable portfolio standards.
- Arizona currently has an RPS of 15% by 2025, including a 4% carve out for distributed generation.
- Seven other states have set voluntary renewable portfolio goals.

### ***Federal Assistance***

The federal government has assisted Arizona's renewable energy development specifically, by guaranteeing loans for large Arizona-based projects through the Department of Energy (DOE) and by granting access to federal land through the Bureau of Land Management (BLM). Two recent highlights of such assistance include:

- Designation of Three "Solar Zones" in Arizona: On December 16, 2010, DOE and BLM identified lands in six western states "most suitable for environmentally sound, utility-scale solar energy production." Three of these "solar zones," totaling 13,735 acres of previously untouched tracts of public land, are located in Arizona. This designation is pending public comment. Should it be finalized, DOE and BLM contend that the zones would "provide directed, landscape-scale planning for future solar projects and allow for a more efficient permitting and siting process."
- Agua Caliente Solar Project in Yuma County: On January 20, 2011, DOE made a conditional offer of a loan guarantee of \$967 million for the 290MW solar photovoltaic facility expected to be completed in 2014. The project would use thin film solar panels from Arizona-based First Solar. The project, at full capacity, according to the *Solar Energy Business Review*, is expected to provide "clean, emissions-free electricity for approximately 100,000 homes."

According to one report, current federal incentives and policies in place will support US photovoltaic growth through 2016, though additional support will be needed once those expire.<sup>23</sup>

### ***State, Local & Utility Renewable Energy Incentive Programs***

- Most currently active incentive programs are flexible in terms of their applicability of renewable energy type.
  - Increasingly though, regional incentives are focusing on solar over other renewable sources.

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<sup>21</sup> US Energy Information Administration, November 2009.

<sup>22</sup> "California sets nation's most aggressive goal for renewable energy..." [Washington Post](#). April 12, 2011.

<sup>23</sup> Navigant Consulting

- Renewable Energy Tax Incentive Program (RETIP) provides tax incentives to firms in renewable energy up to 10% refundable income tax credit on qualified capital investment and up to 75% reduction on real and personal property taxes.
- A majority of the incentive programs are fairly new, making analysis of their impact difficult.
- Incentives focus on both commercial and residential installation, providing opportunities for the adoption of renewable energy technologies by businesses and individuals.
- Incentive maintenance and development remain a priority at various levels of government as well as within Arizona’s utility companies.

Figure 16 and Figure 17 compare Arizona’s current state rules, regulations, and policies, against other states, providing a baseline for future policy development.

**Figure 16: Comparison of State Rules, Regulations and Policies for Renewable Energy**

State	Public Benefits Funds	Renewable Portfolio Standards	Net Metering	Inter-connection	Contract. License	Equip. Certific.	Access Laws	Constr. & Design	Green Power Purchasing	Req'd Green Power
Federal				1				1		
Alabama										
Alaska			1-S				1-S			
Arizona		1-S	1-S 1-U	1-S	1-S	1-S	1-S	3-S 4-L		
Arkansas			1-S	1-S	1-S			1-S		
California	1-S	1-S	1-S	1-S	1-S		2-S 7-L	3-S 9-L		
Colorado	1-L	1-S	1-S	1-S			1-S 1-L	3-S 4-L		1-S
Connecticut	1-S	1-S	1-S	1-S	1-S			2-S		
Delaware	1-S 2-U	1-S	1-S	1-S			1-S	2-S		
Florida		1-U	1-S	1-S	1-S	1-S	1-S 1-L	1-S		
Georgia			1-S	1-S			1-S	1-S 2-L		
Hawaii	1-S	1-S	1-S	1-S	1-S		1-S	2-S		
Idaho			3-U				1-S			
Illinois	1-S	1-S	1-S	1-S			1-S	2-S		
Indiana			1-S	1-S			1-S	1-S 1-L		
Iowa		1-S	1-S	1-S			1-S			1-S
Kansas		1-S	1-S	1-S			1-S	1-L		
Kentucky			1-S	1-S			1-S			
Louisiana			1-S 1-L	1-S	1-S		1-S			
Maine	1-S	1-S	1-S	1-S	1-S		2-S	2-S		1-S
Maryland		1-S	1-S	1-S			1-S	1-S		
Massachusetts	2-S	1-S	1-S	1-S			1-S	3-S		
Michigan	1-S	1-S	1-S	1-S	1-S			2-S 1-L		
Minnesota	1-S	2-S	1-S	1-S		1-S	1-S	1-S		
Mississippi										
Missouri		1-S 1-L	1-S	1-S			1-S	1-S		
Montana	1-S	1-S	1-S 1-U	1-S			1-S			1-S
Nebraska			1-S	1-S			1-S			
Nevada		1-S	1-S 1-U	1-S	1-S		1-S	1-S		
New		1-S	1-S	1-S			1-S			
New Jersey	1-S	1-S	1-S	1-S			2-S	4-S		

F = Federal S = State/Territory L = Local U = Utility

Source: Database of State Incentives for Renewable Energy and Energy Efficiency, U.S. Dept. of Energy

Figure 17: Comparison of State Rules, Regulations and Policies for Renewable Energy (continued)

State	Public Benefits Funds	Renewable Portfolio Standards	Net Metering	Inter-connection	Contract. License	Equip. Certific.	Access Laws	Constr. & Design	Green Power Purchasing	Req'd Green Power
New Mexico		1-S	1-S 1-U	1-S			1-S			1-S
New York	1-S	1-S 1-U	1-S 1-U	1-S			1-S	2-S 1-L		
North Carolina		1-S	1-S	1-S			1-S 1-L	2-S 12-L		
North Dakota		1-S	1-S				2-S			
Ohio		1-S	1-S	1-S			1-S	1-S		
Oklahoma		1-S	1-S					2-S		
Oregon	1-S	1-S	1-S 1-U	1-S	1-S		1-S 2-L	3-S 2-L		1-S
Pennsylvania	1-S	1-S	1-S	1-S				1-S		
Rhode Island	1-S	1-S	1-S				1-S	1-S		
South Carolina			3-U	1-S				1-S		
South Dakota		1-S		1-S			1-S	2-S		
Tennessee							1-S			
Texas		1-S 1-U 1-L	3-U	1-S				2-S 5-L		
Utah		1-S	1-S 3-U	1-S	1-S		1-S	1-L		
Vermont	1-S	1-S	1-S	1-S			1-S			
Virginia		1-S	1-S	1-S			2-S	1-S 1-L		1-S
Washington		1-S	1-S 1-U	1-S			1-S	1-S 1-L		1-S
West Virginia		1-S	1-S	1-S						
Wisconsin	1-S	1-S	1-S	1-S	1-L		1-S 1-L	1-S		
Wyoming			1-S	1-S				1-S		
District of Columbia	1-S	1-S	1-S	1-S				1-S		
Palau										
Guam		1-S	1-S					1-S		
Puerto Rico		1-S	1-S	1-S	1-S	1-S				
Virgin Islands		1-S	1-S				1-S	1-S		
N. Mariana		1-S								
American Samoa			1-S							
Totals	22	47	69	45	14	4	58	106	0	8

F = Federal S = State/Territory L = Local U = Utility

Source: Database of State Incentives for Renewable Energy and Energy Efficiency, U.S. Dept. of Energy

A few of Arizona’s most prominent and often used renewable-energy incentive programs are listed in Figure 18.

Figure 18: Arizona Renewable Energy Incentive Programs

Financial Incentives	Eligible Renewable Technologies	Applicable Sectors	Financial Incentives	Eligible Renewable Technologies	Applicable Sectors
<b>Corporate Tax Credit</b>			<b>Personal Tax Credit</b>		
Non-Residential Solar & Wind Tax Credit (Corporate)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Cooling, Solar Pool Heating, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional	Non-Residential Solar & Wind Tax Credit (Personal)	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Solar Cooling, Solar Pool Heating, Daylighting	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Tribal Government, Fed. Government, Agricultural, Institutional
Renewable Energy Production Tax Credit (Corporate)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass	Commercial	Renewable Energy Production Tax Credit (Personal)	Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass	Commercial
<b>Industry Recruitment/Support</b>			<b>Green Building Incentive</b>		
Renewable Energy Business Tax Incentives	Solar Water Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Pool Heating, Anaerobic Digestion, Small Hydroelectric, Fuel Cells using Renewable Fuels	Commercial, Industrial	Chandler - Expedited Plan Review for Green Buildings	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Photovoltaics, Wind, Biomass, Daylighting, Small Hydroelectric	Commercial, Schools
<b>Property Tax Incentive</b>			Scottsdale - Green Building Incentives	Passive Solar Space Heat, Photovoltaics, Daylighting, Fuel Cells using Renewable Fuels	Residential, Multi-Family Residential
Energy Equipment Property Tax Exemption	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, CHP/Cogeneration, Solar Cooling, Solar Pool Heating, Daylighting, Anaerobic Digestion, Small Hydroelectric	Commercial, Industrial, Residential	Town of Buckeye - Green Building Incentive	Passive Solar Space Heat, Solar Space Heat, Photovoltaics, Geothermal Heat Pumps, Daylighting, Fuel Cells using Renewable Fuels	Residential
Property Tax Assessment for Renewable Energy Equipment	Solar Thermal Electric, Photovoltaics, Wind, Biomass, Hydroelectric, Other nonpetroleum renewable sources	Utility, Other entities that generate, transmit or distribute -- but do not use -- eligible electricity	Tucson - Permit Fee Credit for Solar Energy Systems	Solar Water Heat, Solar Space Heat, Photovoltaics, Solar Air Conditioning	Commercial, Residential
<b>Sales Tax Incentive</b>			<b>Utility Loan Program</b>		
Solar and Wind Equipment Sales Tax Exemption	Passive Solar Space Heat, Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Photovoltaics, Wind, Solar Pool Heating, Daylighting	Commercial, Residential, General Public/Consumer	Sulphur Springs Valley EC - SunWatts Loan Program	Photovoltaics, Wind	Commercial, Residential
<b>Local Rebate Program</b>			<b>Utility Rebate Program</b>		
City of Maricopa - Solar Rebate Program	Photovoltaics	Commercial, Residential	APS - Renewable Energy Incentive Program	Solar Water Heat, Solar Space Heat, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Geothermal Heat Pumps, Solar HVAC, Solar Pool Heating, Daylighting, Anaerobic Digestion, Small Hydroelectric, Other Distributed Generation Technologies	Commercial, Residential
<b>Personal Deduction</b>			Electric District No. 3 - Solar Rebate Program	Photovoltaics	Commercial, Residential
Qualifying Wood Stove Deduction	Biomass, (Wood Stoves)	Residential	SRP - EarthWise Solar Energy Incentive Program	Solar Water Heat, Photovoltaics, Solar Pool Heating	Commercial, Residential, (SRP territory)

Source: DSIRE Database, January 2011

## The Future of Renewable Energy in Arizona: Emerging Trends

The renewable energy industry is rapidly changing. Some changes could have a profound impact on Arizona's adoption of renewable energy technologies, while others may create opportunities for Arizona firms to increase market share.

### Overall Support for Renewable Energy Technologies

- Net metering has become more widely used across the country, making dispersed generation systems more attractive to customers. Arizona has embraced this trend, scoring second on a related 2009 index of states (Freeing the Grid, 2010).

### Arizona's "Solar Roadmap"

- Arizona is well positioned as a major potential source for solar energy, though other southwestern states also share this unique competitive advantage.
- Arizona's "Solar Roadmap" suggests that
  - Utility-based incentives play a key role in stimulating demand
  - Federal and state incentives can be leveraged to stimulate solar technology adoption
  - State Renewable Portfolio Standards (RPS) have helped create demand for solar power in Arizona and elsewhere
  - Payback periods for solar technologies are typically too long without subsidies, creating a hard-sell for many potential adopters
  - Technology improvements, increased adoption, and increased supply will lower costs for solar energy generation over the next several years
  - Arizona's competitive advantages for continued growth in solar include:
    - Excellent solar resources
    - Population and economic growth
    - Central location to nearby solar markets with similarly progressive renewable energy portfolio standards
    - University research centers focused on further developing solar technologies
    - Large tracts of State Trust and tribal lands suitable for large-scale solar development projects
  - Items of concern in competing within the solar market include:
    - Capital cost
    - International and domestic competition
    - Need for technological advancement
    - Need for PV skilled workforce
    - Restrictive local building codes and homeowner association covenants

### Support for Alternative Renewable Sources

- The U.S. Department of Energy announced an \$85 million stimulus initiative to invest in the development of algae biofuels.
- Arizona universities are also national leaders in algae-based biofuel development.

### Support for Manufactured Products

- Sale prices of photovoltaic panels have dropped significantly in recent years. An oversupply in the market, which is expected to last through 2013, has put downward pressure on domestic manufacturers' cost structures and may encourage outsourcing more production.<sup>24</sup>
- However, as input prices continue to decline for solar panel products, shipping, at a constant price rate, naturally becomes a larger share of the producer's overall cost. With the American market for solar continuing to grow, overseas producers may become more interested in domestically producing and shipping such products.
- Arizona has limited capacity for wind power within the state, but it has demonstrated potential for contributing to the supply chain through manufacturing components such as windframes<sup>25</sup>.
  - Small wind turbine manufacturing still maintains a presence in Northern Arizona.<sup>26</sup>

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<sup>24</sup> Batelle & C2ER, 2010

<sup>25</sup> Batelle & C2ER, 2010

<sup>26</sup> American Wind Energy Association