Arizona’s Renewable Energy Future

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Chair, Governor’s Solar Energy Advisory Council
Presented at the Southwest Renewable Energy Conference
Flagstaff, Arizona - August 2003
Arizona’s Alternative Energy Options

Overview

1. Arizona Conditions
2. Arizona Resources
3. Research and Development
4. Opportunities and Potential
1. Conditions
Open Space
Aridity
Growth

Arizona Population, 1940 to 2025

Source: U.S. Census Bureau, March 2001
2. Energy Resources
A Rich Mix of Energy Resources
Coal
Uranium
Low to Moderate temperature ground water

Source: Arizona Geological Survey, 2001
Arizona has produced 20 million barrels of oil and 28 BCF of natural gas, although coal is the principal developed fossil fuel.

Source: Arizona Geological Survey, 2001
Arizona has several promising areas located primarily from St. Johns northwest to Cameron on the Navajo Reservation.
Geothermal Energy

Traditional Assessment
Solar Energy – Arizona Leads the Nation in Resources
Distribution of Arizona’s Solar Resource

Data source: NREL, 2002
3. Research and Development
A Sample of Research & Testing Facilities

ASU Photovoltaic Testing Laboratory

NAU Renewable Energy Laboratory; Center for Sustainable Environments

APS STAR center – Solar Testing and Research

UofA Environmental Research Laboratory
Maricopa County
- Photovoltaics
Yuma Proving Ground — Photovoltaics
Yuma Proving Grounds – Covered Parking
Sedona Pump
– drawing water from 860 feet
Correctional Facility saves $6,000 per month
Off-grid use –
Ranching Country
Million Solar Roofs
A Sample of Solar & Wind Firms in Arizona

As of 2002, there were ~70 solar and wind companies in Arizona, with more than 650 employees.
World PV Production (MW) / 2002

World PV Production 513MW (2002)

Courtesy: Bob Hammond, Prescott, AZ

Data: Photovoltaic-News Mar/2003
A Sample of Organizations and Programs

AriSEIA — The Arizona Solar Energy Industries Association

Tucson Coalition for Solar

Project Sol — Exploring the science and technology of solar energy

Scottsdale's Green Building Program

American Hydrogen Association
Arizona Solar Center
www.AzSolarCenter.org
Arizona Electrical Utility Companies

- Arizona Public Service
- Salt River Project
- Tucson Electric Power
- AEPCO
Customers per Utility
2000

- APS
- SRP
- TEP
- AEPCO

Bar chart showing the number of customers for each utility.
Generating Capacity per Utility 2000

(Megawatts)
Environmental Portfolio Standard
R14-2-1618

• March 2001, ACC establishes EPS, requiring retail sellers of electricity to provide a percentage of retail electricity sales from certain specific renewable energy resources

• Must derive at least .2% (to increase to 1.1% by 2007-12) of the total retail energy sold from new solar resources or environmentally-friendly renewable electricity technologies

• The EPS requires that at least 50% (60% by 2004) must be solar electric

• Source: ACC website
## Arizona’s Environmental Portfolio

**Standard Results (in kWh)**

**2001-2002**

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>APS</td>
<td>34,786,461</td>
<td>56,273,572</td>
</tr>
<tr>
<td>TEP</td>
<td>9,874,606</td>
<td>25,419,075</td>
</tr>
</tbody>
</table>
### EPS Results (in kWh) for 2001-2002 (APS)

<table>
<thead>
<tr>
<th>Source: THE FIRST TWO YEARS OF RESULTS FOR ARIZONA'S ENVIRONMENTAL PORTFOLIO STANDARD, presented by Ray T. Williamson at the 2003 ASES Conference</th>
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<tbody>
<tr>
<td><strong>Solar Electricity</strong></td>
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<td><strong>Solar Hot Water</strong></td>
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<td><strong>Solar Air Conditioning</strong></td>
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<td><strong>Landfill Gas</strong></td>
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<td><strong>Biomass</strong></td>
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<td><strong>Wind</strong></td>
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<td><strong>Total</strong></td>
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<td><strong>(99.1% of requirement)</strong></td>
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### EPS Results (in kWh) for 2001-2002 (TEP)

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<tr>
<td>Solar Electricity</td>
<td>2,990,538</td>
<td>9,006,169</td>
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<tr>
<td>Solar Hot Water</td>
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<td>--</td>
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<tr>
<td>Solar Air Conditioning</td>
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<td>--</td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>6,884,068</td>
<td>16,024,836</td>
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<tr>
<td>Biomass</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Wind</td>
<td>--</td>
<td>388,070</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9,874,606</strong></td>
<td><strong>25,419,075</strong></td>
</tr>
<tr>
<td>(71.7% of req)</td>
<td>(79.31% of req)</td>
<td></td>
</tr>
</tbody>
</table>

*Source: THE FIRST TWO YEARS OF RESULTS FOR ARIZONA'S ENVIRONMENTAL PORTFOLIO STANDARD, presented by Ray T. Williamson at the 2003 ASES Conference*
Arizona Public Service kW DC
Salt River Project Solar kW AC

<table>
<thead>
<tr>
<th>Year</th>
<th>kW AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>8</td>
</tr>
<tr>
<td>2000</td>
<td>12.8</td>
</tr>
<tr>
<td>2001</td>
<td>212.8</td>
</tr>
<tr>
<td>2002</td>
<td>212.8</td>
</tr>
<tr>
<td>2003</td>
<td>741.8</td>
</tr>
<tr>
<td>2004</td>
<td>841.8</td>
</tr>
</tbody>
</table>
Tucson Electric Power Solar kW DC

PV DC Capacity in kW

- 1997: 35 kW
- 1998: 40 kW
- 1999: 41 kW
- 2000: 330 kW
- 2001: 1,750 kW
- 2002: 2,850 kW
- 2003: 4,280 kW
- 2004: 5,250 kW
PV DC Watts per Person Comparison
TEP vs. Japan

Japan 2002 Actual (other years estimated w/10% /Yr Growth)

TEP by Year
Summary of Renewable and Efficiency Programs

• Public Utility Companies (solar, wind, landfill gas)
• Private Firms (~ 70)
• Arizona Green Building Council (Scottsdale)
• Arizona Energy Office (> $5 million in federal programs)
• Universities and college (> $7 million in DoE funding), plus instruction programs and energy efficiency goals
• Tribal Energy Self-Sufficiency (Comprehensive Indian Energy Program)
• Hydrogen (Phoenix Project, American Hydrogen Association, APS refueling & research)
Given our Abundant Resources, a Record of R&D, Substantial Expertise and Experience, and Great Public Enthusiasm for Renewable Development, What is the Economic Impact on the State? What Could it Be?

2003 Sales by Solar & Wind Sectors With AZ Impact & Multipliers

<table>
<thead>
<tr>
<th>Segment</th>
<th>$ Sales</th>
<th>AZ Impact</th>
<th>$ Multi.</th>
<th>$ (AZ Cash Flow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility-PV</td>
<td>20,400,000</td>
<td>5,860,000</td>
<td>1.8</td>
<td>30,948,000</td>
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<tr>
<td>RE Distributors</td>
<td>43,500,000</td>
<td>6,800,000</td>
<td>2.0</td>
<td>57,100,000</td>
</tr>
<tr>
<td>RE Dealers/Installers</td>
<td>12,450,000</td>
<td>9,270,000</td>
<td>2.2</td>
<td>32,844,000</td>
</tr>
<tr>
<td>Consultants</td>
<td>300,000</td>
<td>270,000</td>
<td>2.0</td>
<td>840,000</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>20,200,000</td>
<td>8,200,000</td>
<td>2.0</td>
<td>36,600,000</td>
</tr>
<tr>
<td>RE Architects</td>
<td>1,200,000</td>
<td>1,000,000</td>
<td>2.1</td>
<td>3,300,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$98,050,000</strong></td>
<td><strong>$31,400,000</strong></td>
<td>-</td>
<td><strong>$161,632,000</strong></td>
</tr>
</tbody>
</table>

The summary represents 36 separate inputs or consolidations of inputs

**Note that this is about .1% of the World Market**

Compiled by Lane Garrett, ETA Engineering, Tempe, AZ
4. Opportunities and Potential
Opportunities for Renewables and Efficiency

- Rapid growth favors quick and substantial benefits from sustainable architecture and engineering
- World-class resource favors solar/PV, solar hot water, and solar/hydrogen
- Open space, isolated areas of demand, rapid growth, polluted air, and scarce water favor solar and wind
- Unusual co-located resources of wind, solar, and geothermal favor ‘renewable energy parks’ (e.g. Springerville)
Renewables on Tribal Lands
Arizona Solar/Hydrogen Initiative

THE PHOENIX PROJECT
Shifting from Oil to Hydrogen with Wartime Speed, by Harry Braun, Phoenix, AZ

THE SOLAR HYDROGEN CIVILIZATION
by Roy McAlister, President Amer. Hydrogen Association, Tempe, AZ

Arizona Renewables – 2020 megawatts

<table>
<thead>
<tr>
<th>Wind</th>
<th>Geothermal</th>
<th>Solar</th>
<th>Biomass</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>660</td>
<td>480</td>
<td>1,800</td>
<td>40</td>
<td>2930</td>
</tr>
</tbody>
</table>

*Arizona exceeded all but one state in study area (Utah, Colorado, Arizona, New Mexico, Montana, Wyoming, Nevada).*

*Source: Western Resource Advocates*
Snapshot of Arizona’s Energy Situation

• Arizona’s level of population growth and renewable energy development will outpace all other mountain states
• Arizona’s benefits from energy efficiency will meet or exceed all other states
• Arizona’s greatest opportunity to meet demands with local resources is with renewable energy
• Arizona’s greatest need will continue to be to meet demands without further degrading environmental quality
Arizona Department of Commerce
Energy Office
Solar Energy Advisory Council

Goals

• Improve energy efficiency and use of passive design
• Increase development of all renewable energy resources
• Cut the $4.3B leaving the state every year in energy expenditures in half by the year 2010
• By year 2010 Arizona’s leadership in solar helps the state sustain long term economic growth with a cleaner environment.
• Improve renewable development on Tribal lands
• Move toward a renewable/hydrogen economy
• Establish Arizona as the --

Renewable Energy State