In Hot Water

Experiences of Solar Hot Water
Arizona

Arizona Solar Center, Inc. and Salt River Project

May 15th 2012
The Mission of the Arizona Solar Center is to enhance the utilization of renewable energy, educate Arizona residents on solar technology development, support commerce and industry in the development of solar and other sustainable technologies and coordinate these efforts throughout the state of Arizona.
APS and SRP had discussions in early 2010 on field installs through an independent third party.

Audit tools and process established

Pilot study of approximately 250 sites

Program immediate implementation (failure rate upper 90’s%)

Utility requested two special site visits

Results were surprising
Utility Perspectives, Incentives, Actions
Joel Dickinson, Senior Engineer SRP

Installation Findings, Lessons Learned, SRCC Guidelines
Geoff Sutton, Project Coordinator, Az Solar Center

Building on findings
Daniel Aiello, President, Az Solar Center
In Hot Water: Solar Hot Water Issues in Utility Programs

Joel Dickinson, P.E.
Sr. Engineer
Salt River Project

May 15, 2012
Who is SRP?

- Established in 1903 after Theodore Roosevelt signed the National Reclamation Act of 1902
- Largest water supplier to the Valley of the Sun
- Third largest public power utility in the nation
- 935,000 electric customers
- 6,800 MW peak load
SRP’s Resource Mix

Coal: 47%
Natural Gas: 32%
Nuclear: 15%
Sustainable Resources: 6%
Arizona RPS calls for 15% of retail electric sales renewable by 2025

2004 – SRP established sustainable portfolio (includes: renewables and energy efficiency measures) with target of 2% of retail sales by 2010

2006 – SRP adopted target of 15% of retail sales by 2025

2011 – SRP adopted target of 20% of retail sales by 2020
Sustainable Portfolio Mix
Fiscal Year 2011

- Energy Efficiency: 39%
- Biomass: 1%
- Fuel Cell: < 1%
- Hydro: 39%
- Landfill Gas: 5%
- Solar: 2%
- Wind: 14%

Total 6.98% of Retail Sales
Renewable Energy Resources

Hydrogeneration
Low Impact Hydro
Geothermal

Solar
Landfill Gas
Wind
SRP Solar Energy Program
Program Goals

- Incentives provided in exchange for the renewable energy credits
- Ensure customer experience is rewarding, easy, and pleasant
  - Simplify the process wherever possible
  - Be a customer advocate by instituting consumer protection measures
  - Work with contractors to ensure safe, quality construction
SRP Solar Thermal Incentive Structure

- Incentive is paid to customer in exchange for 20 years of Environmental Attributes associated with the solar water heater
- Third party rating agency determines the annual net energy savings in kWh or therms
  - OG-300 rating for residential systems
  - OG-100 rating for thermal panels
- Solar Rating and Certification Corporation (SRCC) or International Association of Plumbing and Mechanical Officials (IAPMO) accepted rating agencies
Residential Solar Water Heater Incentive

- Incentive is $0.40 per kWh of annual energy savings
- Solar offset gas or electric
- Only OG-300 rated systems eligible
- Pro-rate OG-300 rating 80% for panels facing east, west or flat
## Residential SHW Typical Cost

### SunEarth SOLARAY

<table>
<thead>
<tr>
<th>OG-300 Rating</th>
<th>Typical Cost</th>
<th>SRP Solar Incentive</th>
<th>AZ Tax Credit</th>
<th>Fed Tax Credit</th>
<th>Net Cost</th>
<th>Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,880 kWh</td>
<td>$6,033</td>
<td>$1,152</td>
<td>$1,000</td>
<td>$1,810</td>
<td>$2071</td>
<td>$288</td>
<td>7.2 years</td>
</tr>
</tbody>
</table>

### Pacific West Solar Freeze Safe

<table>
<thead>
<tr>
<th>OG-300 Rating</th>
<th>Typical Cost</th>
<th>SRP Solar Incentive</th>
<th>AZ Tax Credit</th>
<th>Fed Tax Credit</th>
<th>Net Cost</th>
<th>Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,860 kWh</td>
<td>$5,185</td>
<td>$1,144</td>
<td>$1,000</td>
<td>$1,556</td>
<td>$1,485</td>
<td>$286</td>
<td>5.2 years</td>
</tr>
</tbody>
</table>

### FAFCO 200 Series

<table>
<thead>
<tr>
<th>OG-300 Rating</th>
<th>Typical Cost</th>
<th>SRP Solar Incentive</th>
<th>AZ Tax Credit</th>
<th>Fed Tax Credit</th>
<th>Net Cost</th>
<th>Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,200 kWh</td>
<td>$9,208</td>
<td>$880</td>
<td>$1,000</td>
<td>$2,762</td>
<td>$4,566</td>
<td>$220</td>
<td>20.8 years</td>
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</tbody>
</table>

**AZ State Tax Credit:** 25%, $1,000 cap  
**Federal Tax Credit:** 30%, no cap
Application Receipt History

FY05  FY06  FY07  FY08  FY09  FY10  FY11  FY12 to date

0  200  400  600  800  1000  1200  1400  1600  1800  2000
Solar Incentive Programs

Solar incentive programs to date launched August 2004

<table>
<thead>
<tr>
<th>Program Description</th>
<th>Systems Pending</th>
<th>Systems Paid</th>
<th>Total Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Solar Electric</td>
<td>351</td>
<td>2,685</td>
<td>3,036</td>
</tr>
<tr>
<td>Residential Solar Water Heating</td>
<td>667</td>
<td>3,967</td>
<td>4,634</td>
</tr>
<tr>
<td>Commercial Solar Electric</td>
<td>106</td>
<td>109</td>
<td>215</td>
</tr>
<tr>
<td>Commercial Solar Water Heating</td>
<td>22</td>
<td>32</td>
<td>54</td>
</tr>
</tbody>
</table>

16.3 MW installed and pending (Residential) and 18.3 MW installed and pending (Commercial)

34.6 MW total
Program Evolution

- Require copy of building permit
- SRP incentive paid to contractor on customer behalf as a “buy down”
- Pro-rate incentive based on panel orientation to allow more participation
- Require SRP inspection to verify installed to OG-300
- Charge contractor for 3 or more audits on same system
Solar Water Heating Program Audit
SRP hired Arizona Solar Center (AzSC), an independent third-party, to perform Pilot audits.

Goal of Pilot to verify systems installed to OG-300 Standards.

Random sample of 100 systems installed in 2009.

Due to increase in customer complaints.
Examples of Safety / Performance Issues

Safety Issues
- Mixing valve missing
- Temperature and pressure relief valve installed wrong
- No label on system related to heat transfer fluid used

Performance Issues
- Lack of appropriate insulation
- Shaded collectors
- Systems were not operating
- System did not match the plans or application
Lessons Learned

- Don’t assume the solar contractor is pulling a building permit for the customer
- Don’t assume the city or AHJ (Authority Having Jurisdiction) is going to perform inspections
- Anticipate heavy marketing to a non-solar savvy customer base
- Have a good relationship with rating agency
Action Plan

- All new water heating applications will require an inspection before an incentive will be issued
- Improve program documents and contractor guidelines to enhance current incentive program
- Better communication with installers and dealers
- Sponsor workshops for best practices and lessons learned
In Conclusion

- SRP and the utility industry, face many challenges related to growth, climate change, and balancing costs for our customers as we strive to provide a sustainable energy supply.

- Solar Water Heating can be a cost effective way to fulfill a solar portfolio.

- Communication with other incentive managers and industry is important for a successful solar program.
Connect with SRP

- twitter.com/srpconnect
- facebook.com/srpconnect
- youtube.com/srpconnect
Questions?

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For more information on the SRP EarthWise Solar Energy Program:
www.srpnet.com/solar
SOLAR WATER HEATING SYSTEMS
ARIZONA

Geoff Sutton
Project Coordinator
Arizona Solar Center

Special Site
Installation Findings
Lessons Learned
SRCC System Guidelines
Summer of 2010 one of the utilities has two upset customers with their Solar Hot Water System Installs.

This is what was found:
One foot square hole directly into unconditioned attic

Old lines not removed

Lines not insulated

System drains up

Contractor had incorrect RoC license

Lines not insulated

Circulation module lines are reversed

Drip pan has been cut into

Tie-down tearing out of roof
Sensor wire runs inside whirlly bird
Tank not insulated
Hole knocked into wall for plumbing
No insulation on lines
No mixing valve
Inlet and Outlet on same side of collectors
No Sikaflex
System drains up
Open hole into attic, insulation falling into house

PEX not insulated

Tank not insulated

No drip pan

Circulation module lines reversed

No Labels

Allen Key used for mixing valve

Insulation from attic falling into house
Drains Up

Incorrect Flashing install

Sensor not installed correctly floating, note roof needs to be replaced

Multiple missed holes not correctly flashed on roof
Pilot Program

APS and SRP in the 2nd half of 2010 did a random sampling of approximately 250 systems to see how they matched up to the SRCC OG-300 installation guidelines. This is to conform to the Renewable Energy Standard and Tariff (REST) as required by the regulated utilities (APS) under the ACC. http://www.azcc.gov/divisions/utilities/electric/environmental.asp

SRP has a separate program that closely mirrors the ACC requirements. http://www.srpnet.com/environment/earthwise/solar/default.aspx

What was found in the Pilot Program
Installation Findings

TE-40P-80-1
Installation Findings

VDB-24UX2-50G-50S
Lessons Learned

What was Concluded

- Installers were not familiar with the product
- Installers were not correctly trained on the product
- All National, State, Local programs, and the alphabet of codes (IPC, UPC, IBC, NEC, IFC, IECC, IMC) in place are not protecting the consumer
- Many systems were not likely performing to the SRCC OG-300 annual saving numbers that APS and SRP use for their incentive program
- Some homeowners felt disappointed about the product
- Some homeowners had no idea of how the system works
- Lack of system compliance (by AHJ) permitted an easing in the installation standards
- It became the Utilities responsibility
Arizona Utilities APS, SRP, TEP must comply under A.R.S. to use a standard “as prescribed by a solar rating and certification corporation” for the incentive payments.

All three utilities use the SRCC OG-300 published “Annual Savings” to determine their incentive, all three programs are different.
SRCC Document OG-300  June 2011 edition

Checklist relies on: “6.0 Certification of Criteria”  pages 16 to 31

Too much information for home audits, rely on the manufacturers booklets and the SRCC accepted drawing for components and correct install locations. i.e. system sizing (modules, tanks), check valves, thermistor, etc...

Audit is very visual orientated, need to assume correct piping is used (should be insulated), correct pumps are installed, lines are sweated correctly.

There is around 20 main points to look at, allowing around 20 to 30 minutes per on site system audit.
APS and SRP Audit Checklists

APS

SRP

Are Components New: The incentive is paid for the utility acquiring the environmental attributes (RECs) of the system. The OG-300 systems are packages for the performance rating and as such need to be new.
Tilt and Azimuth: The incentive payments are based on the OG-300 annual savings for the REC rights.

http://www1.solmetric.com/cgi/insolation_lookup/lookup.cgi
6.1.1.2 Isolation and Bypass

6.1.6.11 Piping System

The system is plumbed to the OG-300 drawing with all valves labeled showing normal operating position.
6.1.1.3 Expansion tanks  Are expansion tanks installed and properly supported
6.1.1.11 Airborne Pollutants
6.1.2.2 UV Radiation
6.2.2 Solar Degradation

Are components protected from the elements. i.e. Ozone, Moisture, UV
6.1.5.5 Control lines and Sensors

Degradation from the environment or system. Incorrect wire sheathing, moisture damage, system operating temperatures
6.1.5.6 Temperature Control  

Mixing valves need to be installed to the OG-300 drawing. Need to be installed to the manufactures guidelines.
6.1.6.3 Insulation

Needs to be a high temperature EPDM or fiber type based insulation with an R2.6 or better. Needs to conform to 6.1.1.11 Airborne Pollutants, 6.1.2.2 UV Radiation, 6.2.2 Solar Degradation
6.2.4 Incompatible Materials

Incorrect Piping like PEX on a drainback at the collector outlet
6.2.5 Freeze Protection

Refactrometer is used to make sure that glycol is present in the system to the lowest recorded historical low temperature.
6.3.5 High Temperature Control

6.3.16 Pressure Relief

PV powered systems have a high temperature shut off
Pressure relief devices are installed to the OG-300 drawing and set below system maximum design pressure
6.3.7 Fluid Safety Labeling

Labels to the manufactures and OG-300 guidelines are met.
6.4.1 Operating Indicators

Working visual indicators to the manufacturers and OG-300 drawing are present.
6.5.1 Fire Stopping

Use it!
6.5.5 Building Penetrations

Correctly incorporated flashings and sealants in joists, members, wall systems
6.5.6 Water Damage

Water tanks in or above a conditioned space shall have a drip pan with a drain line to a safe location
- Waivers
- Water Alarms
6.5.13 Shading of Collector

Collectors will be substantially un-shaded year round

Upper around 14:00, right around 15:30
6.5.14 Pipe and Component Supports

Piping will conform to the IPC Table 308.5 for hanger spacing. Compression or damage to insulation is to be avoided.
6.5.15 Pitch or Angle of Piping Insulation

Collectors and piping is pitched in a manner to permit evacuation of fluids on drainback systems.
6.5.18 Control Sensor Installation  Wind, moisture, UV, high voltage wiring, hot piping, electrical tape, zip ties, etc...
6.6.1 Provision for Manuals

Manual is to be the version accepted by the SRCC
STILL IN HOT WATER

On-going audit program (APS, SRP) and establishment of utility educational programs - APS Qualified Solar Installers, etc..

Arizona Solar Center has seen an improvement in compliance rates

Over last 6-months, initial visits APS ~67%

Revisits APS ~97%

ISSUES REMAIN
STILL IN HOT WATER – ISSUES REMAIN
Az. utilities should NOT be the industry policemen

- SRP and APS are leading the State in addressing the issue, constrained by:
  1. Incentive Programs
  2. Legal boundaries

- Legal entities and trade associations have been minimally involved
- Competency and quality in the solar hot water equipment industry
- Lack of adherence to national, State, local programs, guides, and codes in place to protect consumers
- Limited knowledge of local, county, and State jurisdictions and lack of consistency between jurisdictions
- Lack of consistent and accurate information
- Limitations in professional licensing and certification
- Public disappointment with performance to what was sold
- Public understanding of system is poor

These issues are not unique to Arizona and can be seen in various scenarios, nationally
BUILDING ON FINDINGS

Where are the other players?

- Solar installers - Quality/competency issues
- Solar business/contractors - Oversight of subcontractors/field crews
- Jurisdiction inspections – Legal authority
- Utilities - Limited to incentive program context
- Construction/Design industry - Great holes in information base
- Owner - Ultimate beneficiary and least knowledgeable

Peripheral elements that have an effect:

- Federal, State, PUC programs
- Registrar of Contractors - limited oversight and context
- Industry Trade Association - Lack of participation, & lack of member oversight and education
- Education/Training Institutions - Lack of information and focus on found problem areas
ARIZONA SOLAR CENTER ACTIVITIES

Looking forward 4000 audits later...

- DEVELOPMENT OF TOOLS APPROPRIATE FOR EACH ELEMENT
- INFORMATION TRANSFER RE: FINDINGS AND EXPERIENCE
- CREATE ACCURATE AND ACCESSIBLE INFORMATION REPOSITORY
- COLLABORATE WITH INDUSTRY AND APPROPRIATE ENTITIES
- CONTINUED WORK IN DEVELOPING AND IMPLEMENTING PROGRAMS WITH UTILITIES
- WORKING WITH STATE AND LOCAL GOVERNMENT FOR IMPLEMENTING INSPECTION COMPETENCY
- WORK WITH THE DESIGN AND CONSTRUCTION INDUSTRY
- DEVELOP INFORMATION, TOOLS, AND ACTION PLANS FOR EXPANDED IMPLEMENTATION; COMMERCIAL SHW AND PV INSTALLATIONS
- WORK WITH INDUSTRY AND STATE AGENCIES; MARKETING PRACTICES
Arizona Solar Center

The Arizona Solar Center continues to work as a neutral 3\textsuperscript{rd} party. The Utility programs have resulted in a significant compliance from single digits in 2010 to the upper 90\% range currently.

In Hot Water

A Positive thing!!!!
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