New Efficient Water Heating Technologies – What do they mean for solar thermal?

ACEEE Hot Water Forum
Future of Solar Water Heating
March 21, 2018
What is ICC-ES?

- ICC-ES evaluates products using codes and standards for the built environment and Solar Thermal Products
- Accredited by ANSI and A2LA to the requirements of ISO/IEC 17065
- Accredited by the Standards Council of Canada (SCC)
- Accredited by EMA in Mexico
- A subsidiary of the International Code Council
- An organization with a dedicated staff of:
  - Licensed Professional Engineers
  - Licensed Architects
  - Evaluation Specialists
SRCC Solar Water Heating Certifications and Listings

- Provide third-party, objective performance ratings used by incentive programs and consumers.
- Evidence to prove product complies with code and SRCC standards
- Assist new and innovative renewable energy products to enter the marketplace
- Serve as a source of objective performance data for system energy modeling
Disclaimer

This presentation features numerous examples of new and innovative solar water heating technologies and products. Inclusion of any product or technology does not imply endorsement by SRCC, or suitability for any given application, project or location. Consult a design professional for assistance in the selection and configuration of products.

Visit the SRCC website at www.solar-rating.org for objective third-party performance ratings and data.
## Legacy Water Heating Choices

### Table 2: Energy and Cost Comparison: Gas Water Heating – 50-gallon capacity

<table>
<thead>
<tr>
<th>Gas Water Heater</th>
<th>Standard</th>
<th>Tankless</th>
<th>Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Factor</td>
<td>0.575</td>
<td>0.8</td>
<td>1.016</td>
</tr>
<tr>
<td>Annual Consumption (therm/yr)</td>
<td>261</td>
<td>187</td>
<td>150</td>
</tr>
<tr>
<td>Annual Savings (therm/yr)</td>
<td>None</td>
<td>74</td>
<td>111</td>
</tr>
<tr>
<td>Annual Carbon Savings (Metric Tons of CO₂ Equivalent)</td>
<td>None</td>
<td>0.39</td>
<td>0.59</td>
</tr>
<tr>
<td>Annual Cost of Operation ($/yr)</td>
<td>$360</td>
<td>$258</td>
<td>$207</td>
</tr>
<tr>
<td>Annual Savings ($/yr)</td>
<td>None</td>
<td>$102</td>
<td>$153</td>
</tr>
<tr>
<td>Life Expectancy</td>
<td>9 years20</td>
<td>20 years22</td>
<td>20 years</td>
</tr>
<tr>
<td>Lifetime Savings (therms)</td>
<td>None</td>
<td>1480</td>
<td>2,220</td>
</tr>
<tr>
<td>Lifetime Savings ($</td>
<td>None</td>
<td>$2,042</td>
<td>$3,064</td>
</tr>
<tr>
<td>Installed Cost</td>
<td>~$86523</td>
<td>~$1,470-$2,50024</td>
<td>~$3,200</td>
</tr>
<tr>
<td>Price Premium</td>
<td>None</td>
<td>~$605-$1,635</td>
<td>~$2,335</td>
</tr>
<tr>
<td>Payback on Price Premium</td>
<td>None</td>
<td>~6-16 years</td>
<td>~15 years</td>
</tr>
<tr>
<td>Tax Credit (See detail below)</td>
<td>None</td>
<td>$150-$250</td>
<td>$960</td>
</tr>
<tr>
<td>Payback w/ Tax Credit</td>
<td>NA</td>
<td>~4.5-13.5 years</td>
<td>~9 years</td>
</tr>
<tr>
<td>Residential Annual Sales</td>
<td>~4.7 million26</td>
<td>~254,60027</td>
<td>2,430</td>
</tr>
</tbody>
</table>

More than just the “green” solution

Decision-makers are making decisions based on more than just sustainability.

• Performance
• Cost effectiveness (first and lifetime)
• Installation logistics
• Maintenance
• Reliability
• Regulatory compliance
• Sustainability programs
• Resilience
• Aesthetics
• Reputation
• GHG reduction
Today’s Water Heating Choices

More water heating and complimentary technologies than ever before.
Just a Few of the New Challenges to Solar Water Heating...

- More “sustainable” water heating options
- Rapid cost reductions for PV
- Persistently low natural gas prices
- Roof space
- Fewer incentive and rebate programs
NO
RESTING
ON LAURELS
EXCEPT SUNDAYS AND HOLIDAYS
New Reality:
Solar water heating can be an effective and efficient option for many applications, BUT –
– Not necessarily the best solution for all applications in situations
– No longer the only “green” solution on the market

Solar’s Response:
• Identify and focus on applications where solar provides real benefits and reasonable ROI
• INNOVATION
Solar Water Heating’s Innovative Responses to New Realities and Challenges

INNOVATIONS IN SOLAR WATER HEATING
Solar Water Heating 2.0

• Dual-purpose
  – Building envelope integration
  – Daylighting + Solar
  – AC System Integration

• Embracing PV
  – PV Thermal
  – PV Water Heating

• Innovative Design
Dual Purpose: Building Envelope Integration

Solar thermal module is fully integrated into a roofing panel or other building element.

- Eliminates redundant installation labor.
- Protects components.
- Improved aesthetics.
- Maximizes absorber area.

Example: Inroof.solar Nor’easter
Example: VELUX Collectors

Roof-integrated design

• Partial integration
• Structure and appearance similar to skylight
• Removes roof covering but mounts above roof deck.
• Piping and electrical connections under the collector for protection and aesthetics.
Dual Purpose: Daylighting

Application seeks to extend the purpose of fenestration to include solar thermal collection.

- Different designs impede opacity to different extents.
- Balance between functions of solar thermal, solar control and daylighting
- Some employ active controls to switch between functions
- Utilize common elements between skylights and glazed collectors

SkyLouver Installation Manual

Robin Sun https://bieberusa.com/products/features/window-solar-water-heater/
Dual Purpose: AC System Integration

- Geothermal systems have long used a desuperheater to extract heat from geothermal loops to heat water.
- Systems like the this Fire and Ice System seek to do the same with solar
- Integration between complimentary systems allows for use of thermal energy that would otherwise be lost.

*Operational Diagram Courtesy of Fire and Ice Solar*
PV Thermal Technology

- Rooftop space is becoming a premium in some cases
- PV cell performance is inversely proportional with temperature.
- PV-Thermal collectors integrate solar thermal and PV modules into a single assembly.
PVT Attributes

- Simplifies mounting
- Reduces space consumption
- Increases PV production (when supplying thermal energy to a load)
- Lower performance offset by large available area.
- Designs for new installations and retrofit.
- Fully integrated and add-on configurations
### Example: PV to PVT Power Output Comparison

#### 285W FAFCO CoolPV PVT
- **Constant 77°F inlet temp.**
- **Data courtesy of FAFCO**

<table>
<thead>
<tr>
<th>Time</th>
<th>PV Alone</th>
<th>Cool PV Electrical</th>
<th>Cool PV Thermal</th>
<th>PVT Total</th>
</tr>
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<tbody>
<tr>
<td>7:00 AM</td>
<td>44</td>
<td>44</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>8:00 AM</td>
<td>98</td>
<td>101</td>
<td>131</td>
<td>232</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>147</td>
<td>159</td>
<td>390</td>
<td>549</td>
</tr>
<tr>
<td>10:00 AM</td>
<td>186</td>
<td>210</td>
<td>625</td>
<td>835</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>210</td>
<td>243</td>
<td>772</td>
<td>1015</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>226</td>
<td>266</td>
<td>888</td>
<td>1154</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>222</td>
<td>264</td>
<td>937</td>
<td>1201</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>211</td>
<td>250</td>
<td>910</td>
<td>1160</td>
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<td>3:00 PM</td>
<td>191</td>
<td>224</td>
<td>853</td>
<td>1077</td>
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<td>4:00 PM</td>
<td>156</td>
<td>179</td>
<td>739</td>
<td>918</td>
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<tr>
<td>5:00 PM</td>
<td>109</td>
<td>120</td>
<td>504</td>
<td>624</td>
</tr>
<tr>
<td>6:00 PM</td>
<td>52</td>
<td>55</td>
<td>253</td>
<td>308</td>
</tr>
<tr>
<td>7:00 PM</td>
<td>14</td>
<td>14</td>
<td>33</td>
<td>47</td>
</tr>
</tbody>
</table>
PV Water Heating

- Direct or prioritized use of PV power for water heating
- Avoids fluids outside of conditioned space
- Robust and simple – no moving parts
- Far lower efficiency than ST on an area basis
- Some controls enable net metering, other onsite use
- Direct-connect can avoid anti-islanding for resiliency.

SunBandit Image Courtesy of Next Generation Energy
Inverter or Power Conditioner
Cloud
T
Controller
Resistive Heating Element
Main Panel
PV Array
Solar Irradiance
Utility Grid

Cloud

Resistive Heating Element

Utility Grid

Main Panel

PV Array
Innovative Design

• New form factors and geometries are breaking the mold.
  – Brings new value propositions and solutions to old problems
  – Open up new applications for solar water heating

• Advanced materials and technologies are breathing new life into “traditional” collector designs
Example: Artic Solar

- Design combines elements of concentrating collectors and evacuated tubes.
- Mfg claims operating range 100 to 400°F
  - Enables applications outside the range of many solar thermal technologies

Artic XCPC Images Courtesy of Artic Solar
Example: Sferasol Collector

Spherical collector/system design

- Directional insensitivity
- Fully integrated design
- Unique aesthetic
- Simplified mounting
- Collects reflected and high incidence angle solar radiation

Images Courtesy of Sferasol S.r.l.
Technology Upgrades for Current Designs

Advanced materials and technologies are breathing new life into “traditional” collector designs

- Nanomaterials maximizing solar absorption
- Advanced controls enabling load shifting, demand management, user programmability and predictive algorithms
- Remote monitoring and optimization
- Manufacturing methods that enhance absorber – riser tube coupling
Right Technology, Right Application

- More Support for Solar Pool Heating

- Promote use in agricultural and industrial applications
  - Crop drying, dairies, ag building heating
  - Breweries, commercial laundries, canneries, various industrial processes

- Promote uses with diversity (e.g. multi-family, institutional)
Thank You!

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