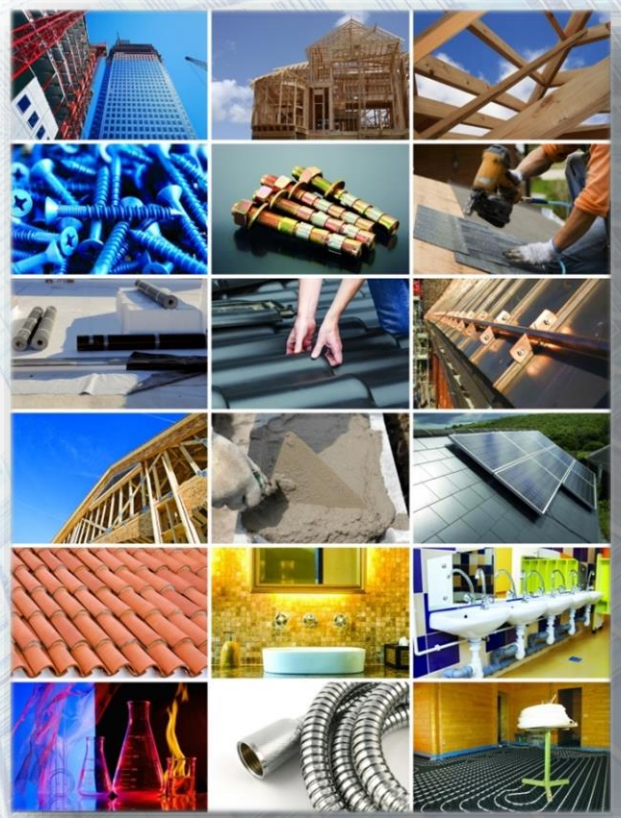
# New Efficient Water Heating Technologies – What do they mean for solar thermal?

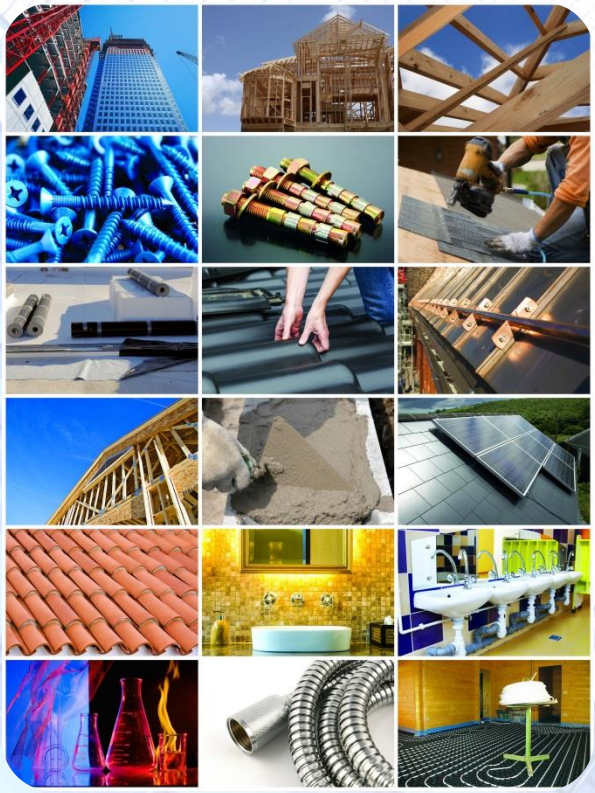
ACEEE Hot Water Forum

Future of Solar Water Heating

March 21, 2018

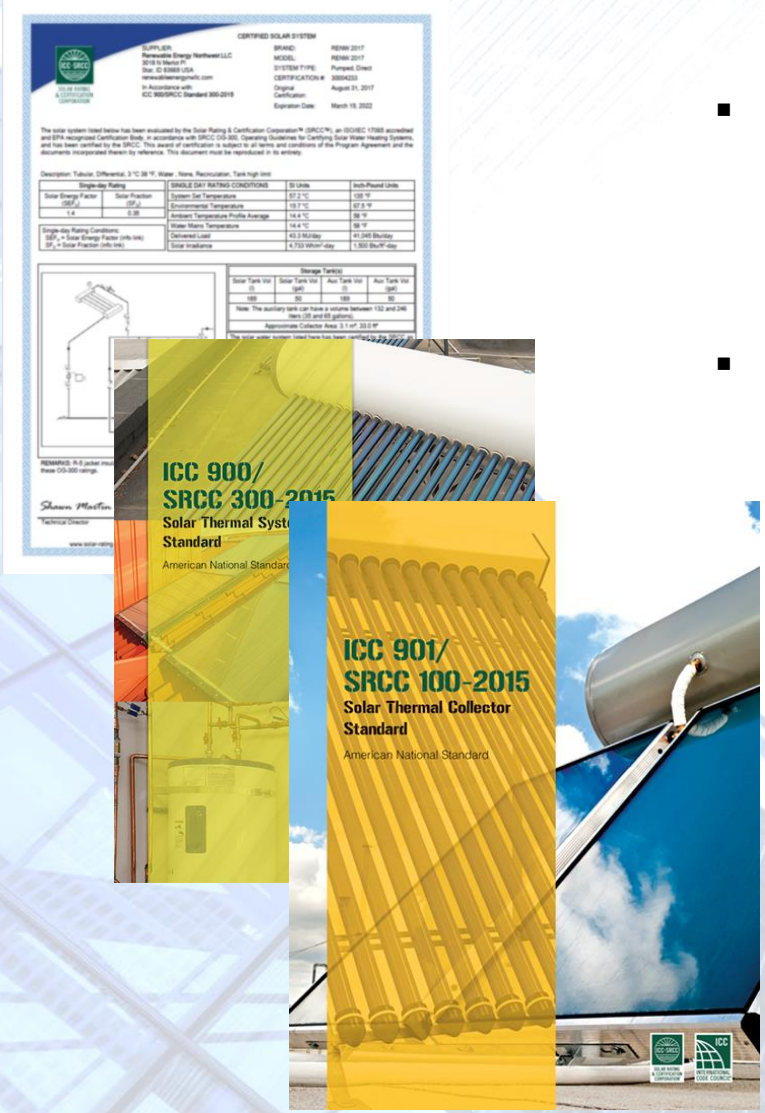


# What is ICC-ES?



- 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

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

| Gas Water Heater | Standard | Tankless | Solar |
|---|---|---|---|
| Energy Factor | 0.575 | 0.8 | 1.016 |
| Annual Consumption (therm/yr)17 | 261 | 187 | 150 |
| Annual Savings (therm/yr) | None | 74 | 111 |
| Annual Carbon Savings (Metric Tons of $CO_2$ Equivalent) | None | 0.39 | 0.59 |
| Annual Cost of Operation ($/yr) | $360 | $258 | $207 |
| Annual Savings ($/yr) | None | $102 | $153 |
| Life Expectancy | 9 years20 | 20 years22 | 20 years |
| Lifetime Savings (therms) | None | 1480 | 2,220 |
| Lifetime Savings ($) | None | $2,042 | $3,064 |
| Installed Cost | ~$86523 | ~$1,470-$2,50024 | ~$3,200 |
| Price Premium | None | ~$605-$1,635 | ~$2,335 |
| Payback on Price Premium | None | ~6-16 years | ~15 years |
| Tax Credit (See detail below) | None | $150-$250 | $960 |
| Payback w/ Tax Credit | NA | ~4.5-13.5 years | ~9 years |
| Residential Annual Sales | ~4.7 million26 | ~254,60027 | 2,430 |

*Domestic Water Heating Technologies – GHG Reduction, InterSolar 2015, Merrigan, NREL*
*U.S. Department of Energy, ENERGY STAR Program. "ENERGY STAR Residential Water Heaters: Draft Criteria Analysis." February 2007*
*Greenhouse Gas Equivalencies Calculator | Clean Energy | US EPA*

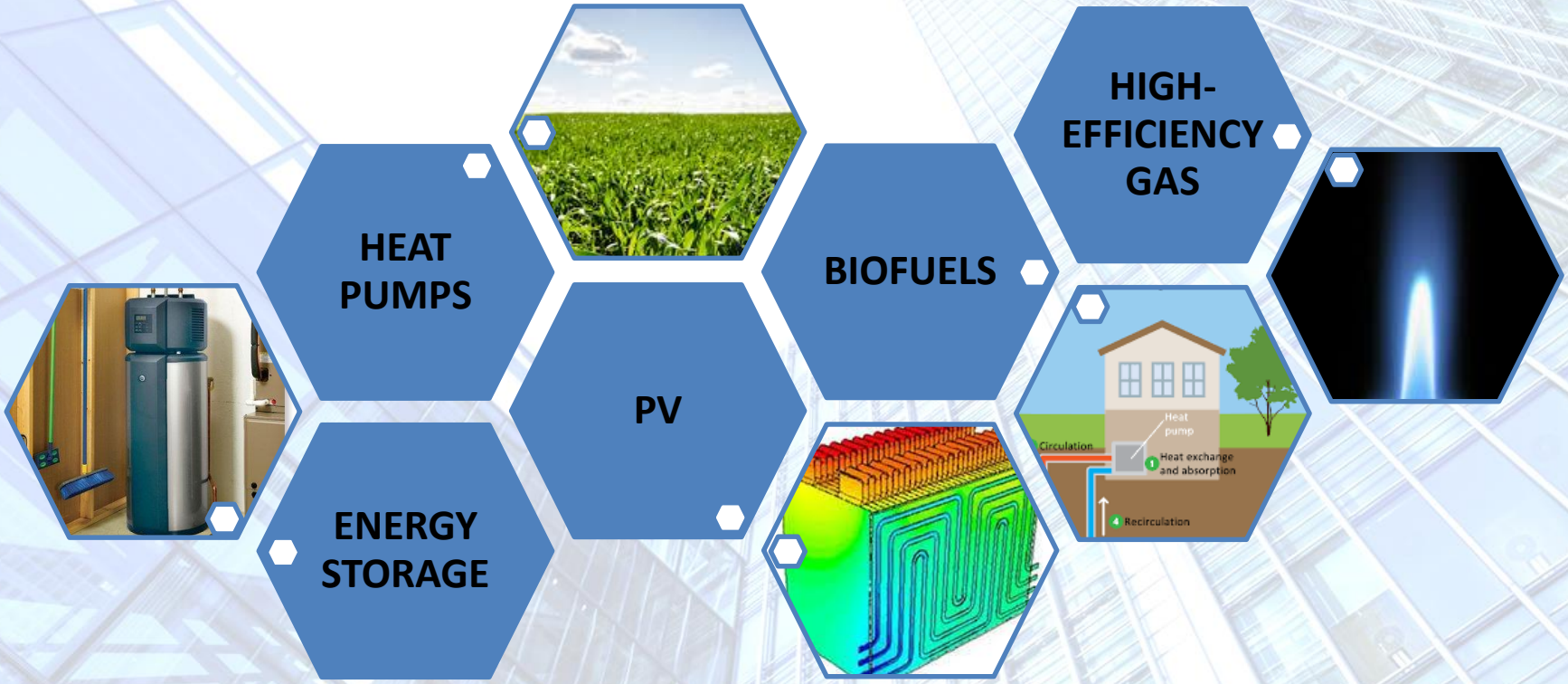
# More than just the “green” solution

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

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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.

*Progress In Building-Integrated Solar Thermal Systems, C. Maurer et al. / Solar Energy 154 (2017) 158–186*

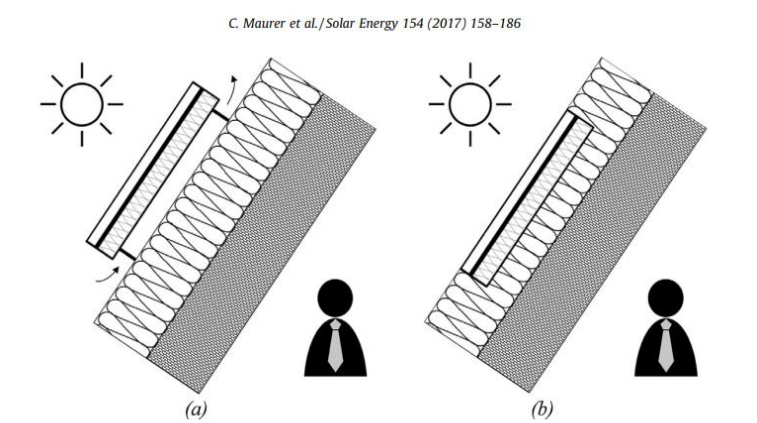


**Fig. 1.** Schematic drawings of a rear-ventilated solar thermal collector (a) and a non-ventilated solar thermal collector (b).

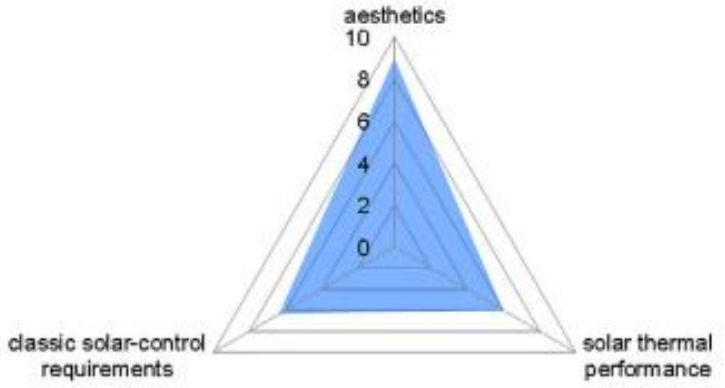


**Fig. 3.** Radar chart of the functions of the BIST installation of Fig. 2.

# Example: Inroof.solar Nor’easter

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hartford Green 0.72 | Forest Green 0.71 | Everglade Moss 0.68 | Patina Green 0.61 | Hemlock Green 0.72 | Dove Gray 0.72 | Slate Gray 0.60 | Charcoal Gray 0.70 | Matte Black 0.72 |
| Royal Blue 0.72 | Pacific Blue 0.72 | Slate Blue 0.69 | Bone White 0.33 | Stone White 0.38 | Galvalume Plus 0.32 | Prewether Galvalume 0.62 | Champagne 0.62 | Sandstone 0.49 |
| Dark Bronze 0.71 | Mansard Brown 0.69 | Burgundy 0.65 | Colonial Red 0.63 | Deep Red 0.58 | Terra Cotta 0.65 | Metallic Copper 0.56 | Medium Bronze 0.68 | Sierra Tan 0.65 |

*Photos Courtesy of Inroof.solar – used with permission*

# Example: VELUX Collectors

Roof-integrated design

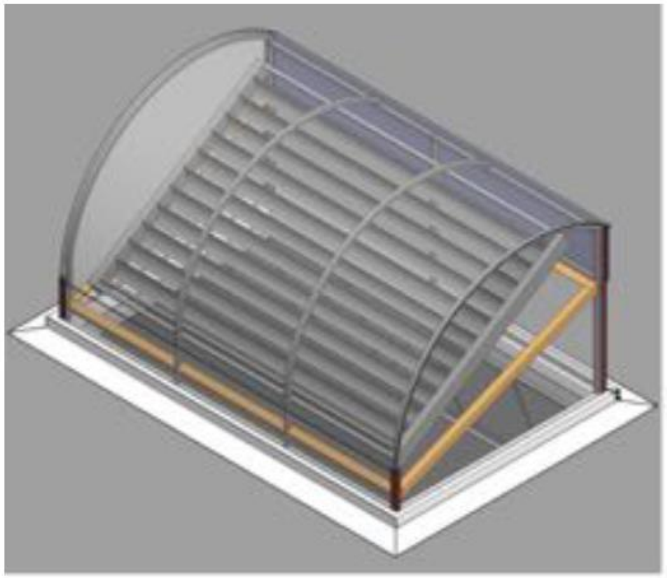
- Partial integration
- Structure and appearance similar to skylight
- Removes roof covering but mounts above roof deck.
- Piping and electrical connections under the collector for protection and aesthetics.

*VELUX Solar Water Heating Brochure*

# 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

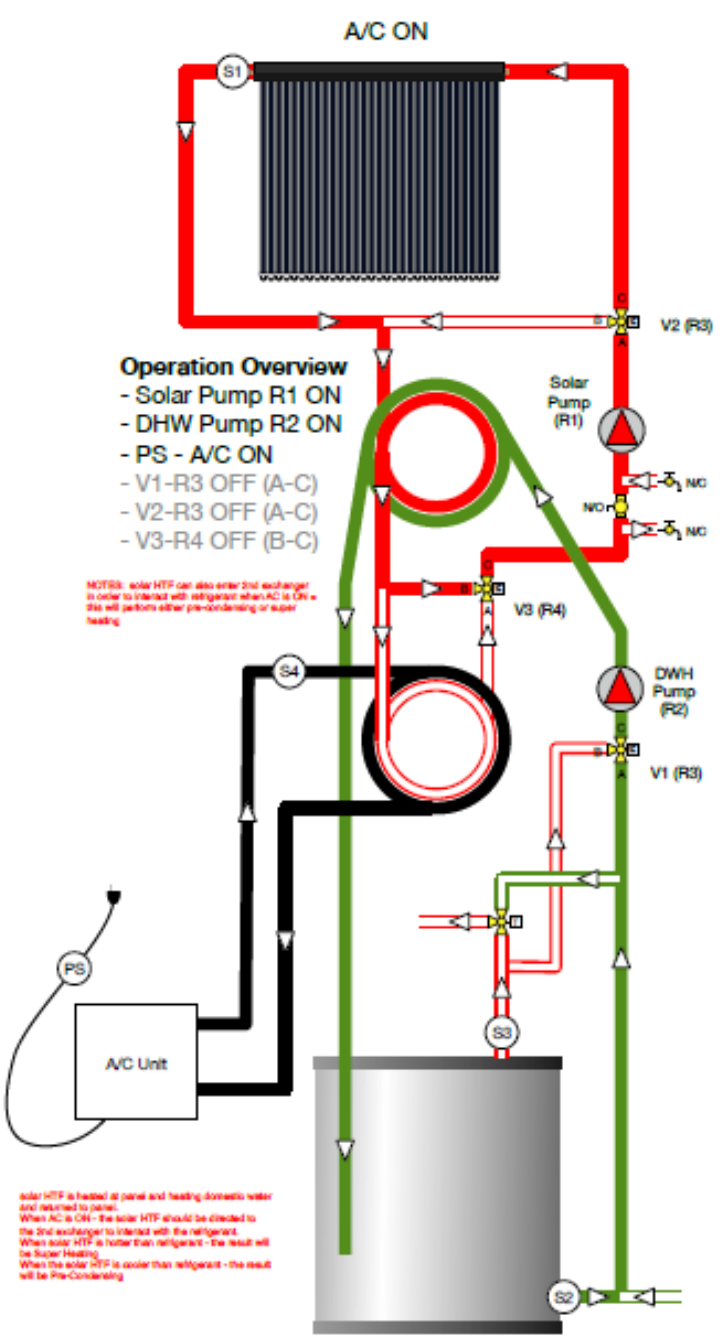


*SkyLouver Installation Manu*

[Robin Sun https://bieberusa.com/products/features/window-solar-water-heater/](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

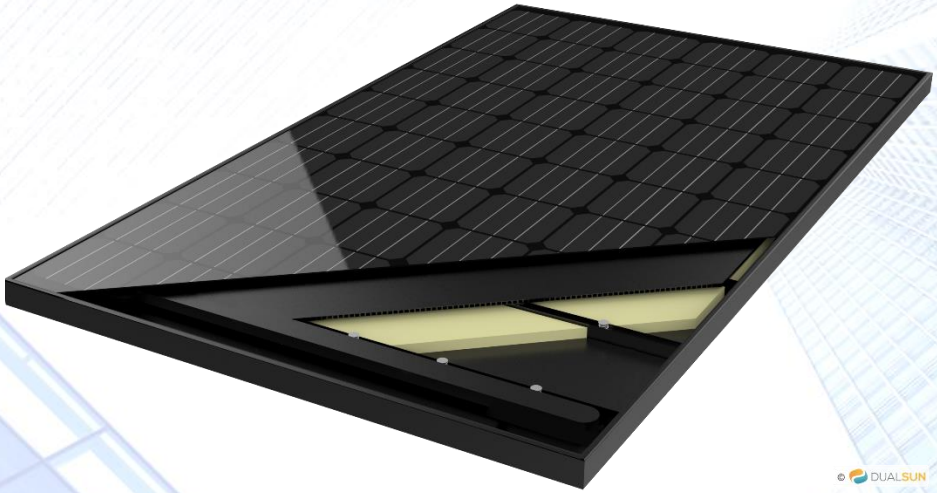



*Diagram Courtesy of DualSun Solar– used with permission*

- 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

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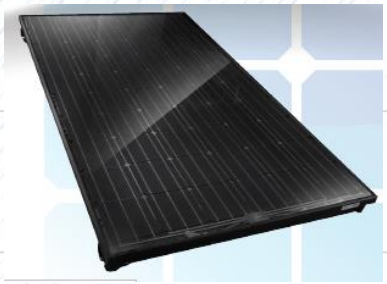


*285W FAFCO CoolPV PVT*
*Constant 77 F inlet temp.*
*Data courtesy of FAFCO*

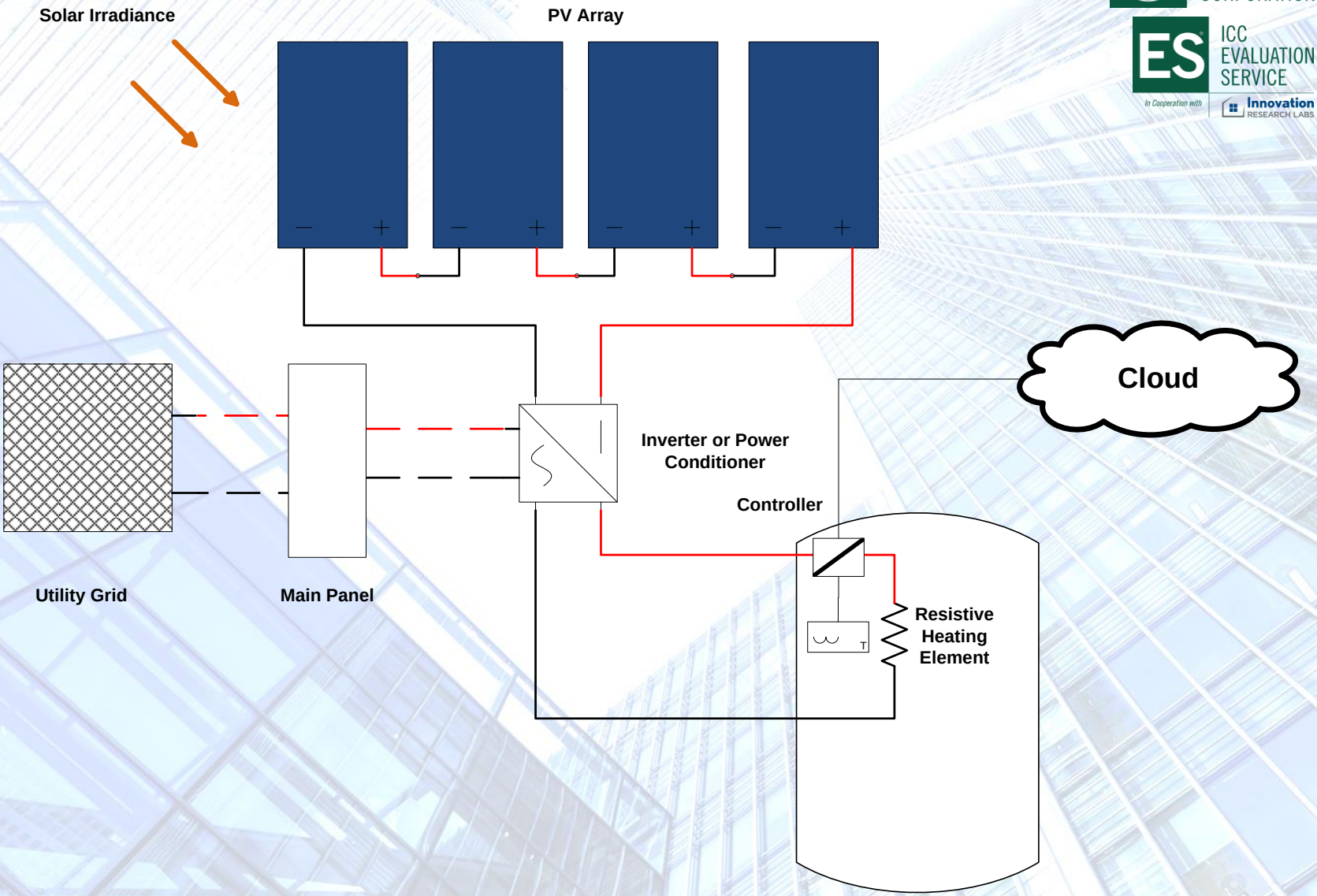



| | 7:00 AM | 8:00 AM | 9:00 AM | 10:00 AM | 11:00 AM | 12:00 PM | 1:00 PM | 2:00 PM | 3:00 PM | 4:00 PM | 5:00 PM | 6:00 PM | 7:00 PM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PV Alone | 44 | 98 | 147 | 186 | 210 | 226 | 222 | 211 | 191 | 156 | 109 | 52 | 14 |
| Cool PV Electrical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

# PV Water Heating


*SunBandit Image Courtesy of Next Generation Energy*

- 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.


Solar Irradiance
PV Array
Cloud
Inverter or Power Conditioner
Controller
Utility Grid
Main Panel
Resistive Heating Element

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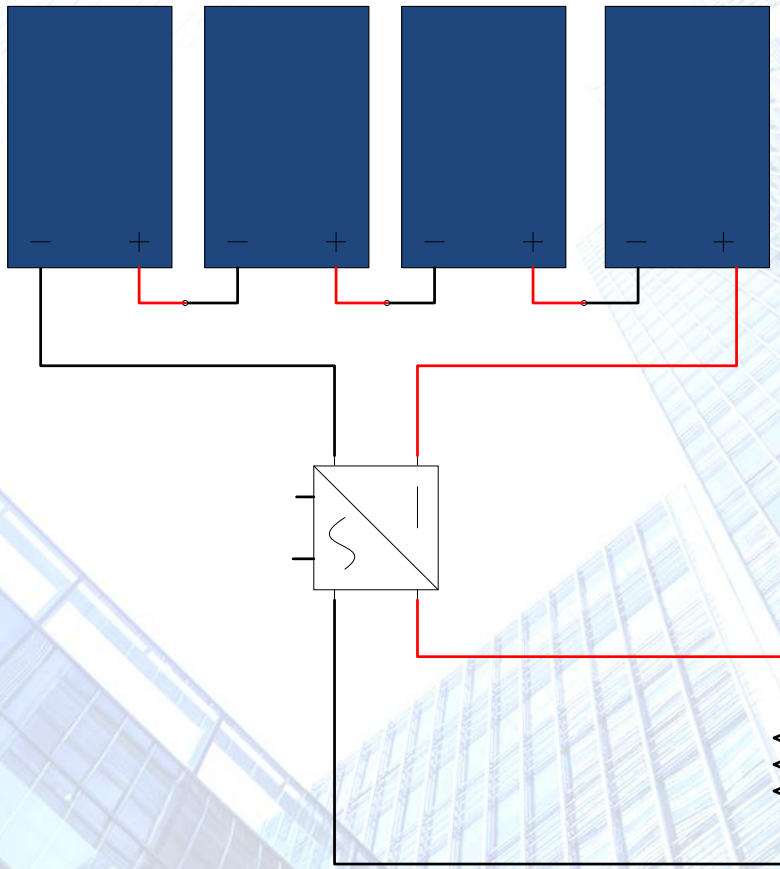
**SOLAR RADIATION**

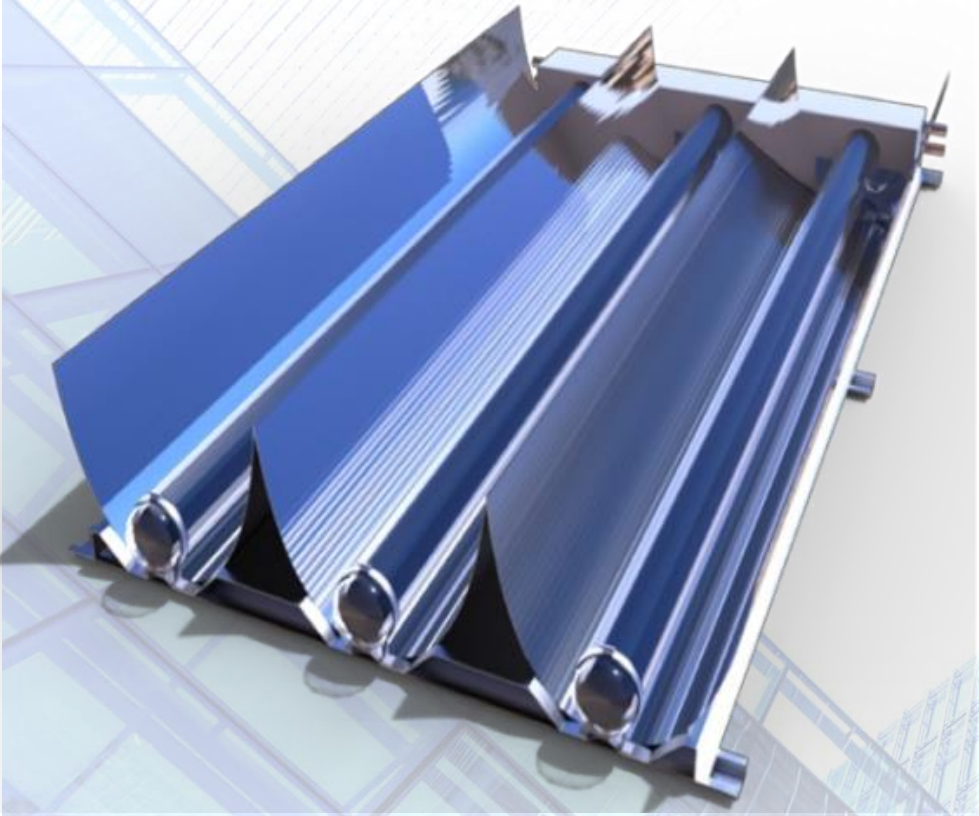


**THERMAL ENERGY (in water)**

# 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



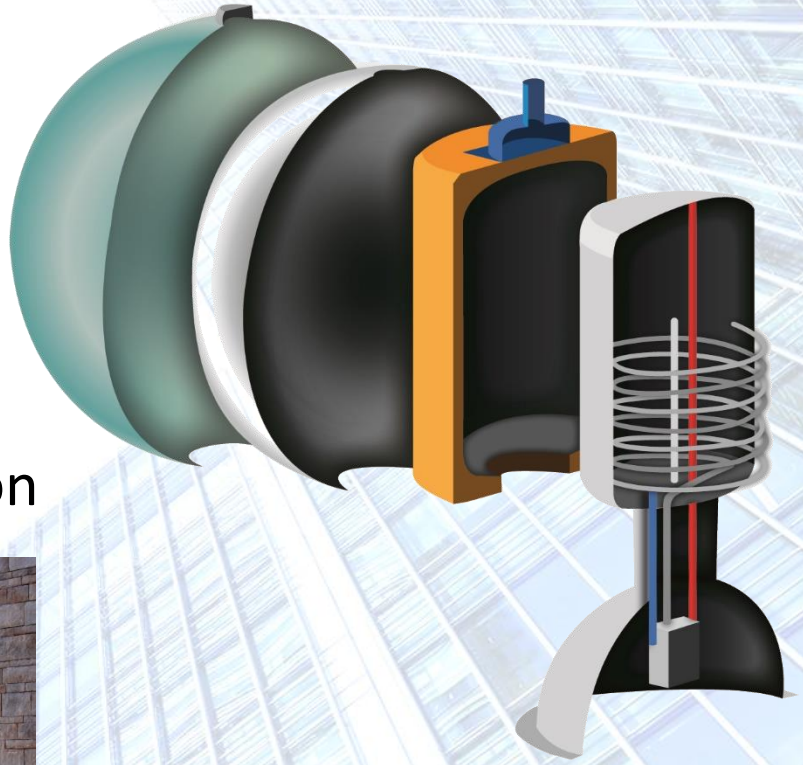
*Artic XCPC Images Courtesy of Artic Solar*

- 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

# 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.*

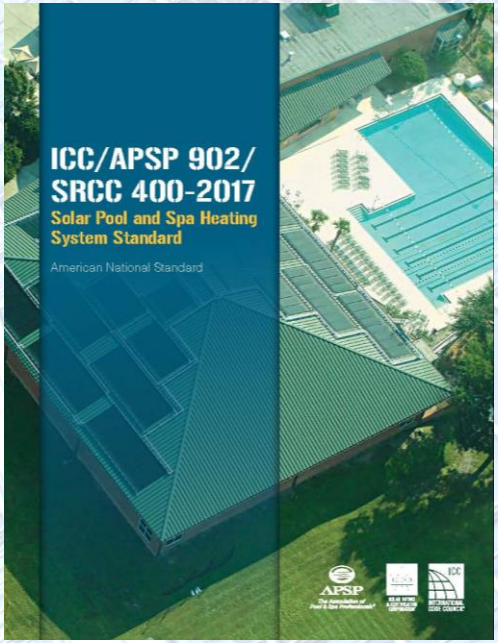
# Technology Upgrades for Current Designs

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
  - ICC 902/APSP 902/SRCC 400 Solar Pool and Spa Water Heating Standard (Released in 2017)
- 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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