



*Hybrid (Photovoltaic/Thermal) innovations
in heating and cooling*



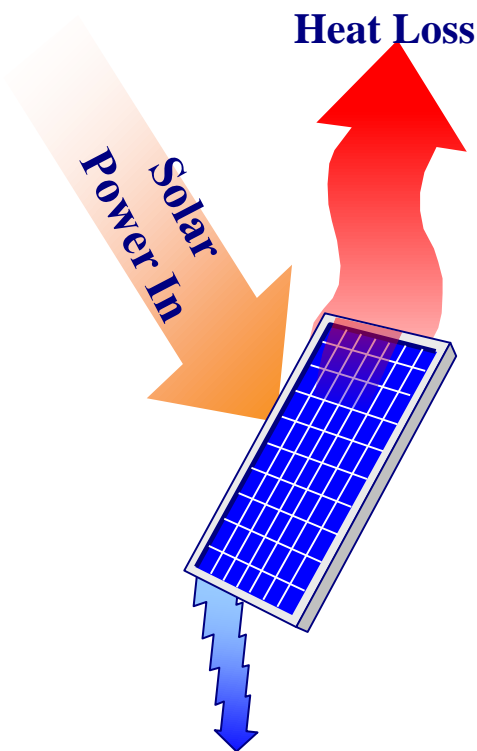
Michael Intrieri

Video

<https://www.youtube.com/watch?v=DPXfiY50GMU&feature=youtu.be>

SunDrum® Solar Advantages

Conventional PV Panel

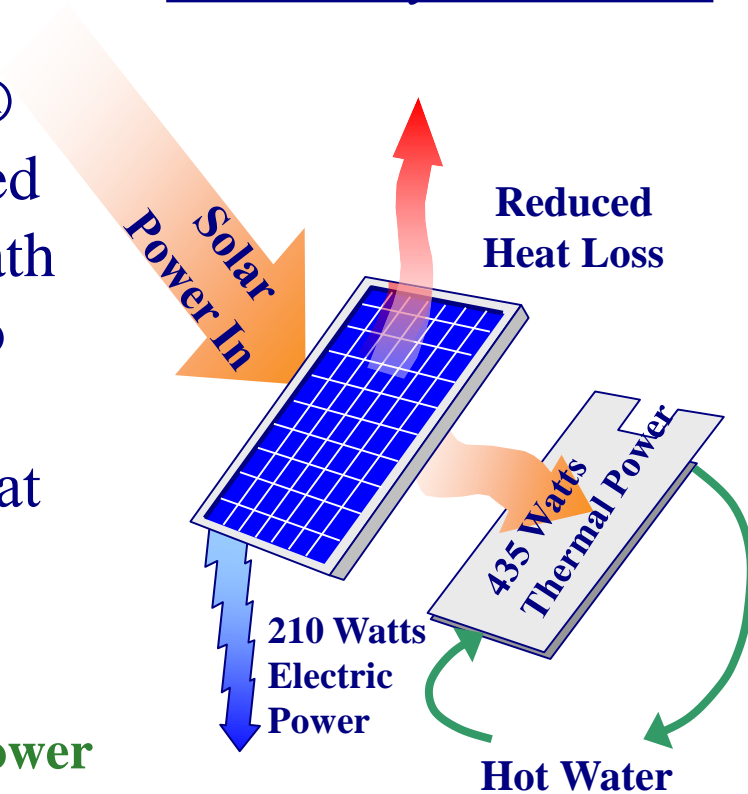


195 Watts Total Power

The SunDrum® collector is placed directly underneath the PV panel to absorb the PV panel's waste heat

- Increased electrical power
- Significant thermal power
- 3X power improvement

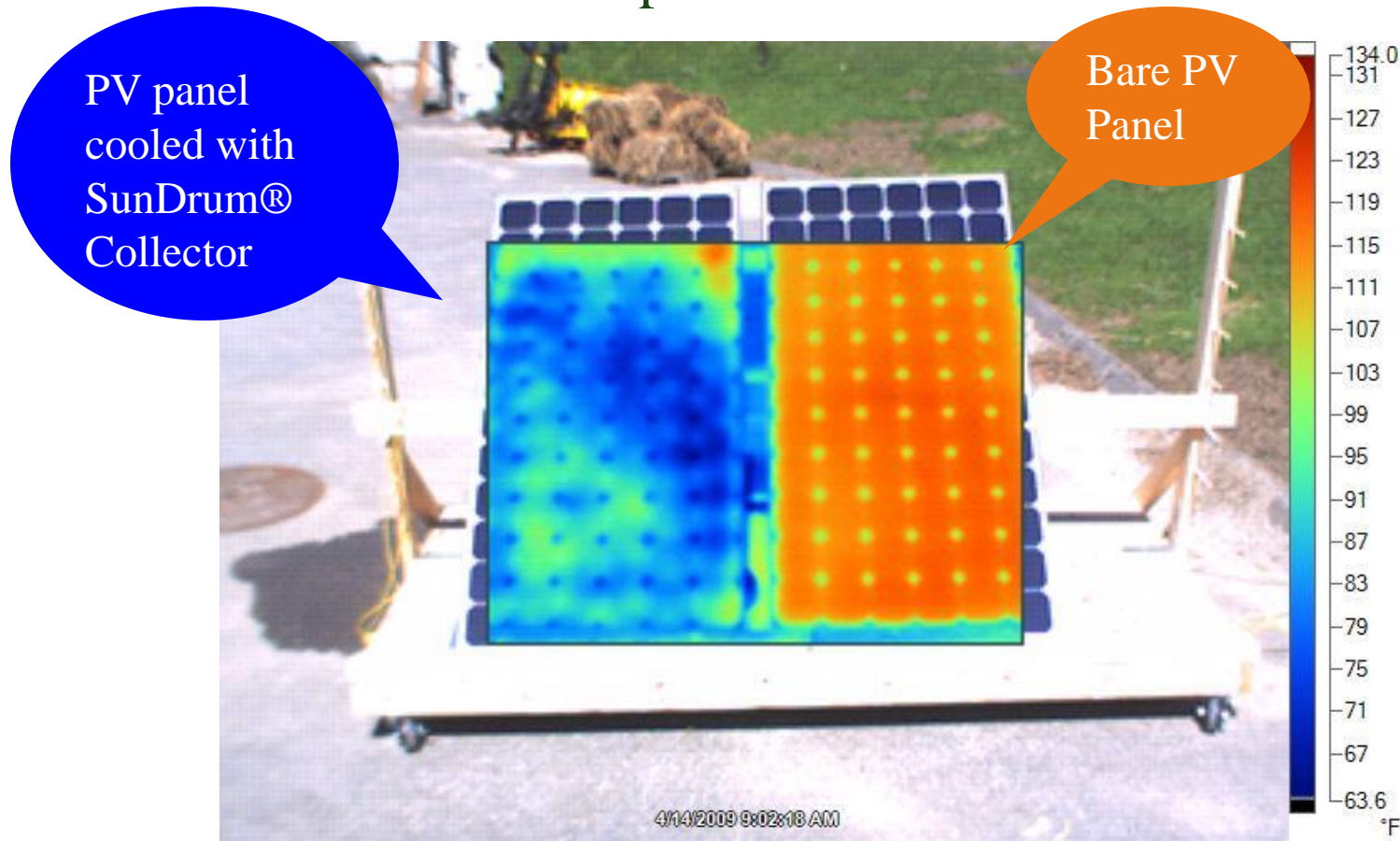
SunDrum Hybrid PV Panel



645 Watts Total Power

Thermal Imaging Demonstrates SunDrum® Collector Cooling

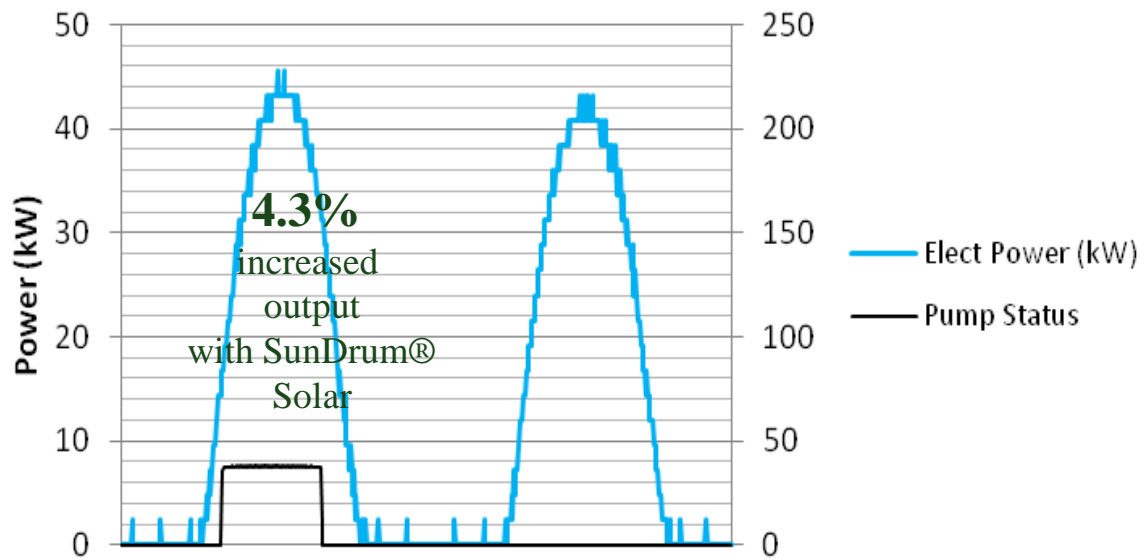
SunDrum collectors can improve the PV array
performance 4-10%



Commercial Electrical Improvement



SunDrum Solar Electrical Benefit at Brown University



Brown University

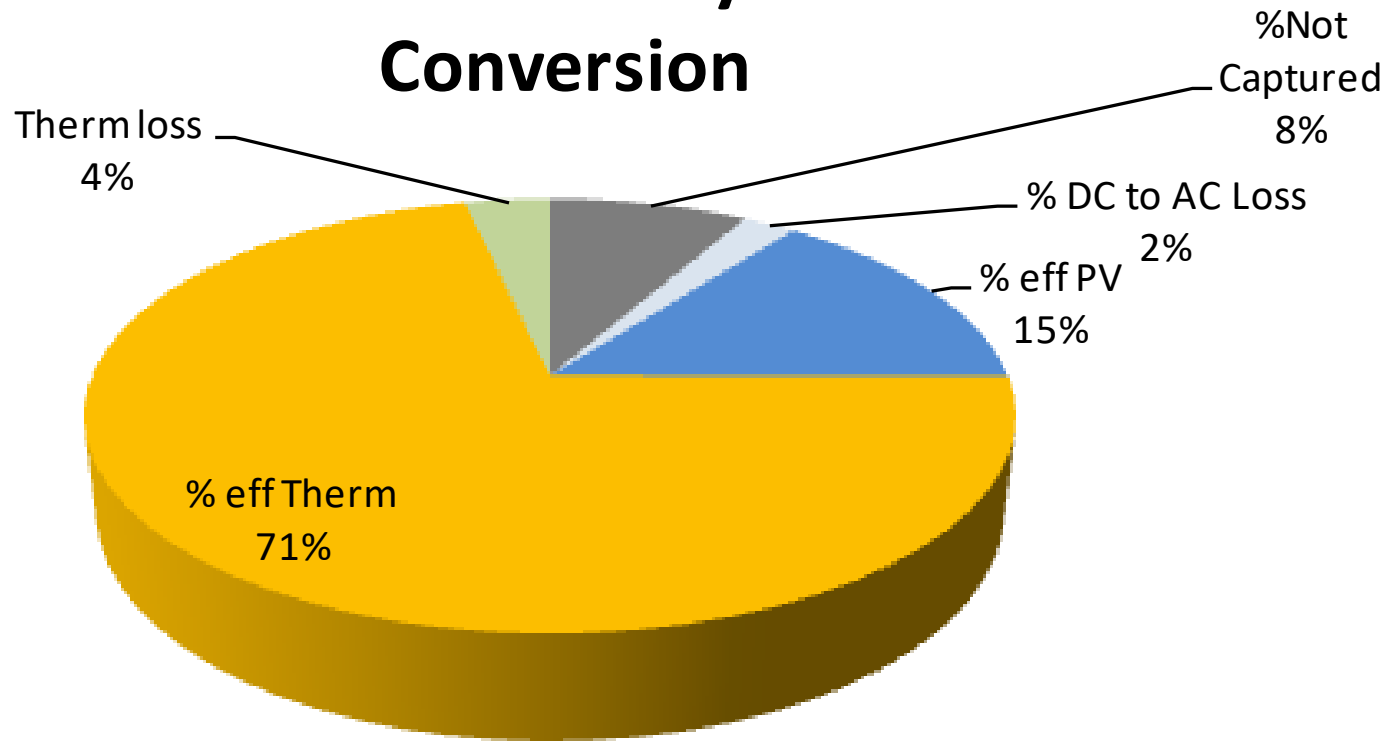
- 4.3% electrical benefit

Norwalk Housing Assisted living facility

- 4% electrical benefit

Establishing Record Solar Efficiency

86% SunDrum Solar Hybrid Record Conversion



Residential Installations



**Successfully Installing Residential Systems
Since 2008**



All Photos
SunDrum
Solar
Installations



Since 2011 Commercial Installations



TP O'Neill Federal Office Building



Retirement Home

Customer Quote:
“SunDrum Solar was very Responsive to any concerns raised and work diligently through one of our worst winters (2010) in the area to install the system. We are exceptionally satisfied with system Performance.” JS 6/12

References available upon Request



Assisted Living



Brown University Aquatics



SunDrum® Solar HarvestHP™

The HarvestHP system combines the most efficient solar collectors in the world with heat pump technology to provide unprecedented performance.



When the sun is shining, the system in active mode captures thermal energy and electrical energy from the sun.



When the sun's direct rays are not available, "Harvest mode" allow our collectors to absorb energy from the air and use a heat pump to increases its useable temperature. In addition by reversing the energy flow space cooling can be provided.

Residential HarvestHP™

Typical system provides:

DHW heating

Pool Heating

Space Heating

and

World Class Solar Air Conditioning.

At night Solar system has the unique capability to reject heat to space only cool your home but also the planet.

During the day heat from the home is directed to the pool providing the dual benefit of space cooling and pool heating.

Residential HarvestHP™ wins AEE 2017 International Innovation award

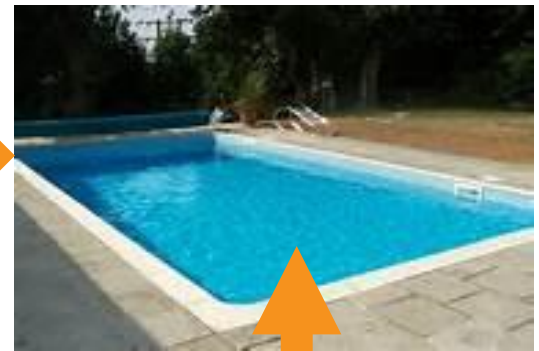
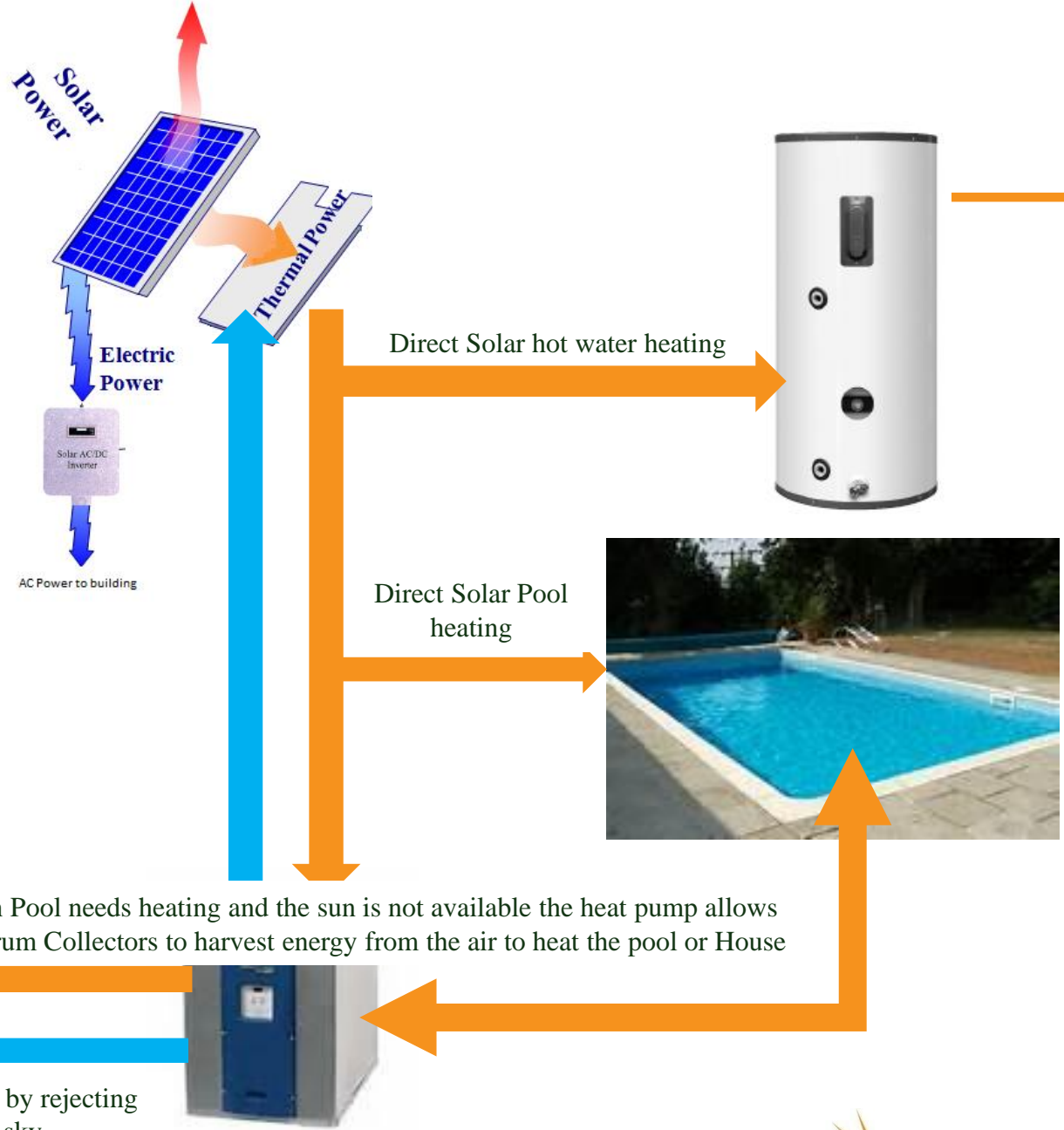
- 27kW hybrid array
 - 15.5kW thermal
 - 11.5kW electric
 - 2100/600ft² home/pool
- Annual energy
 - 100% pool heating
 - >95% space cooling
 - 86.1% space heating
 - 84.3% DWH
 - 75.3% electric



Net Zero Meter

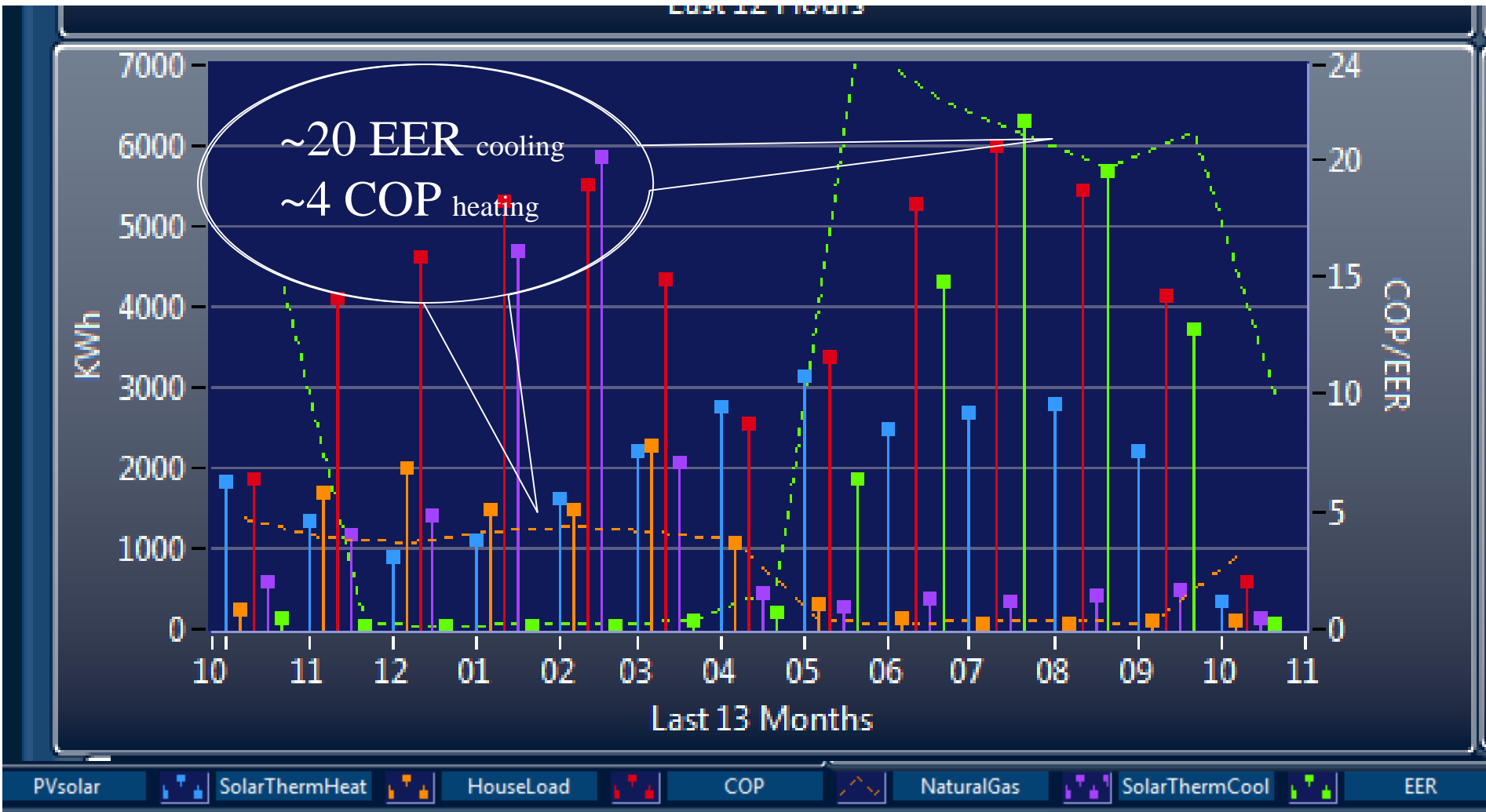


SunDrum® Solar HarvestHP™ system delivers electrical and thermal Energy to the customer. The combination allows for all a homes electrical, heating, and cooling needs to be delivered from the sun.



The HarvestHP system also cools the home by rejecting the houses heat to the pool or night sky.





Excluding Jan + Feb 2015, Delivered 74% of homes total energy need
 100% space cooling, 62% heating needs. (44% heating including 2015)

New!! Residential HarvestHP™ controller interface with WEB access

The screenshot displays the Sundrum Solar controller interface with the following components:

- Page 1 / Page 2** navigation tabs.
- Sundrum Solar** logo and current time: **08:32 AM 8/5/2016**.
- Left Panel (Menu):** Initialize, WaitForTimeStamp, Calibration, ReadMultiDAQSensors, ReadM-BusSensors, ReadModbusSensors, ConvertUnits, InitializeIndicators, SetDigitsOutputs, SetEnvironmentIndicat, SetRealtimeIndicators, AddDataToChartArrays, CreateBarCharts, CreateRollingPlot, WritePNGsToRepository, FTPFilesToWeb, GenerateReport, Stop.
- Top Section:** Solar Radiation W/m² (0), Array °F (80), DHW °F (58), Pool °F (82), BuffT1°F (76.24), SecondsToday (30720).
- Controls:** Override buttons for Solar Radiation, Array, DHW, Pool, BuffT1, and SecondsToday. HVAC1demand set to COOL with a Cool button.
- RelayResources Table:**

RelayResource	Status
DHW Pump	on
Source Pump	on
Load Pump HP on	on
BTPump B2 Valve	on
B4 Valve	on
B3 Valve	off
HPrev	on
B1 Valve	off
- Operating Mode:** DHW Active, HVAC1cool DualMode.
- Bottom Panel:** Windows taskbar with icons for Start, File Explorer, Edge, and Sundrum Solar. System tray shows time: 8:32 AM 8/5/2016.

View system operation from anywhere with internet access

Soon to be added!! – monitoring capability to track savings and performance

Commercial HarvestHP™

Typical system provides:

DHW heating

Pool Heating

and

World Class Solar Air Conditioning.

At night Solar system has the unique capability to reject heat to space only cool your home but also the planet.

During the day heat from the building is directed to the pool providing the dual benefit of space cooling and pool heating.

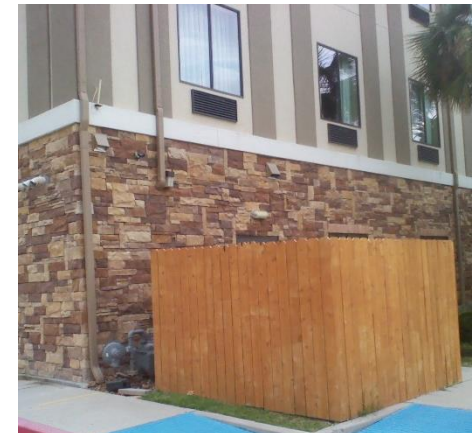


Houston Texas Holiday Inn

- 64kW hybrid array
 - 19.5kW thermal
 - 25kW electric
- 4 ton water to water heat pump
- System designed to provide 60% DHW heating



Mechanical room



1000 gal un-pressurized
Storage tank

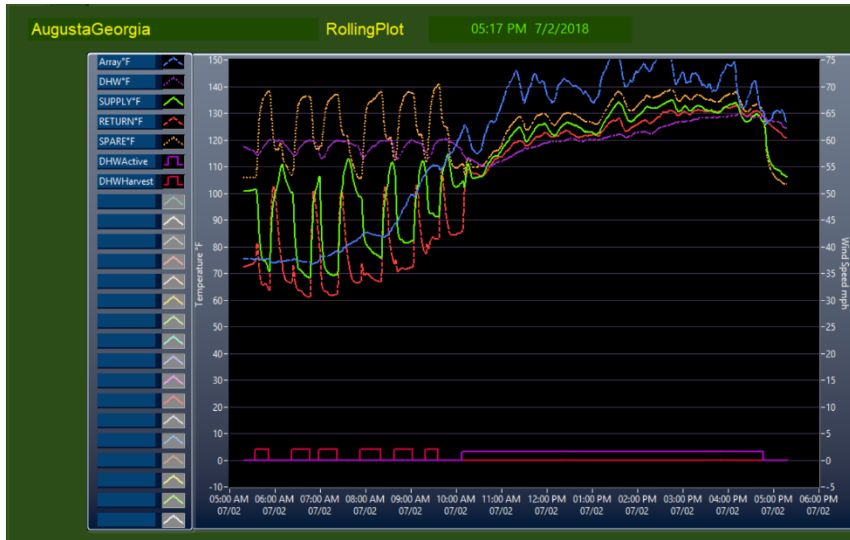
Augusta Ga Homewood Suites



Roof array



Augusta Ga Homewood Suites



Solar Pre-heat tanks maintaining
>110F for significant savings

Real time monitoring for system
Reliability and reporting.

Storage closet adjacent to
Mechanical room. Systems
are typically only two tanks now

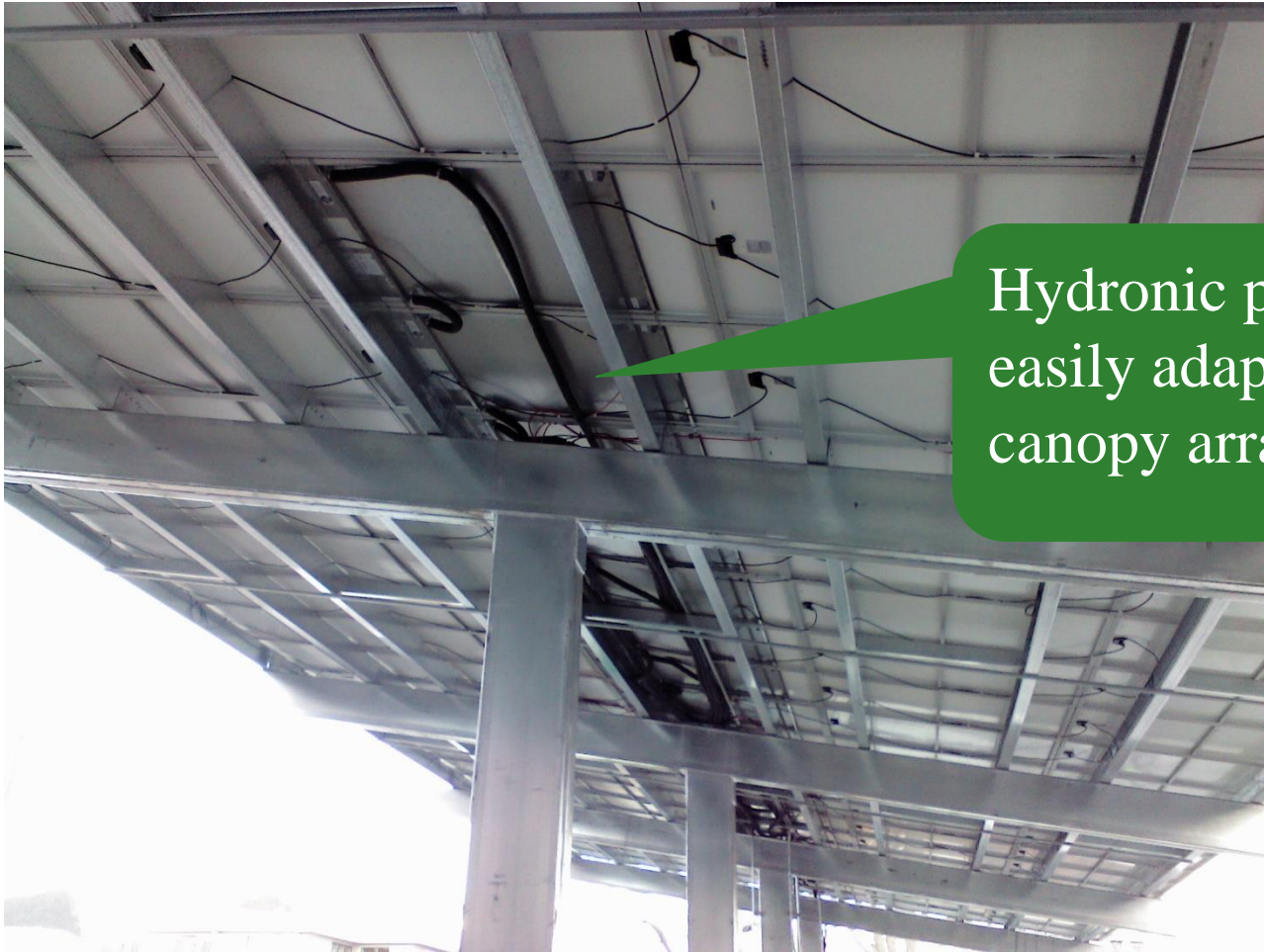
Carport Array, 78kWt, 10 ton pool heating



Piping and manifolds



Side view



Hydronic piping easily adapts to canopy array.

Ground mount array, 80kWt collectors 10 ton, commercial laundry and 2.2MW field array



SunDrum® Solar HarvestHP™

Advantages

- On Demand - Able to supply Solar energy 24/7.
 - Traditional solar dependent on limited solar conditions.
- Reduced Storage requirements.
 - No need for to increase storage for rainy day.
 - 4x less storage at ½ day vs 2 day consumption.
- Dual mode operation (Heating and Cooling)
 - Depending upon application
 - provide heating 24/7 or split loads with nocturnal cooling.
- Generates all energy requirements.
 - Hybrid electrical and thermal.

Contact

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2000 ft² apartment Somerville Ma

Apartment has a 9.74 kW hybrid array (28 PV panels with 6 converted to hybrid modules). Revenue grade electrical and thermal energy monitoring.
(364 ft² PV with 59ft² hybrid: 6.86kWdc, 2.88kWtherm)



Notables:

- 28 PV panels = 8.7MWh while the apartment used 6.6MWh for a net surplus of 2.1MWh
- Annual Thermal energy from 6 SDM100 collectors 78 therm or 2.3MWh.
- **Hybrid panels enabled the home to achieve Net zero.**

Holiday Inn System demonstrating 50 therms per collector annual performance

Hotel HarvestHP operating modes

