

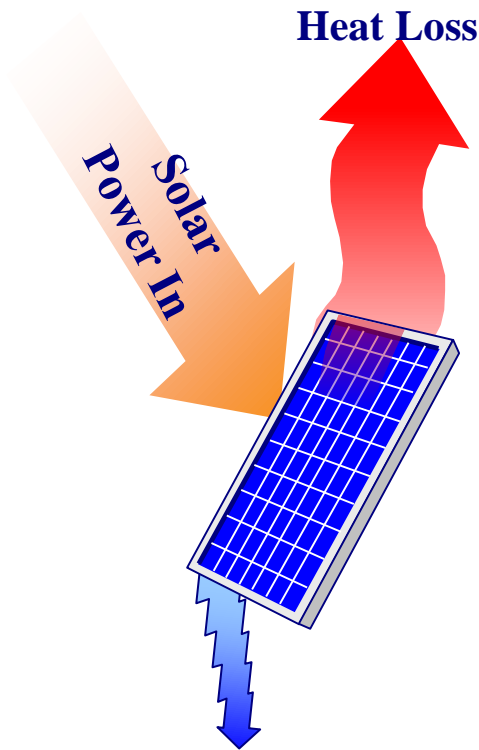


Since 2008 providing, Hybrid (Photovoltaic/Thermal) innovations in heating and cooling. Our HarvestHP® Systems provide zero emission; electricity, heating, and cooling, while also helping to cool the Planet



SunDrum® Solar Advantages, Operating Mode: Direct Solar

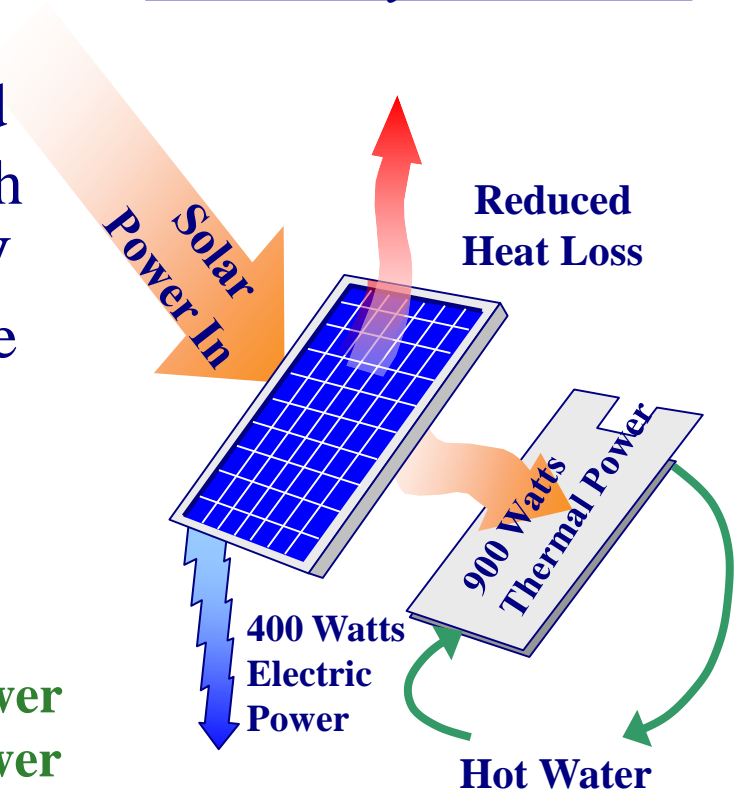
Conventional PV Panel



The SunDrum® collector is placed directly underneath a conventional PV panel to absorb the PV panel's waste heat with no increase in area.

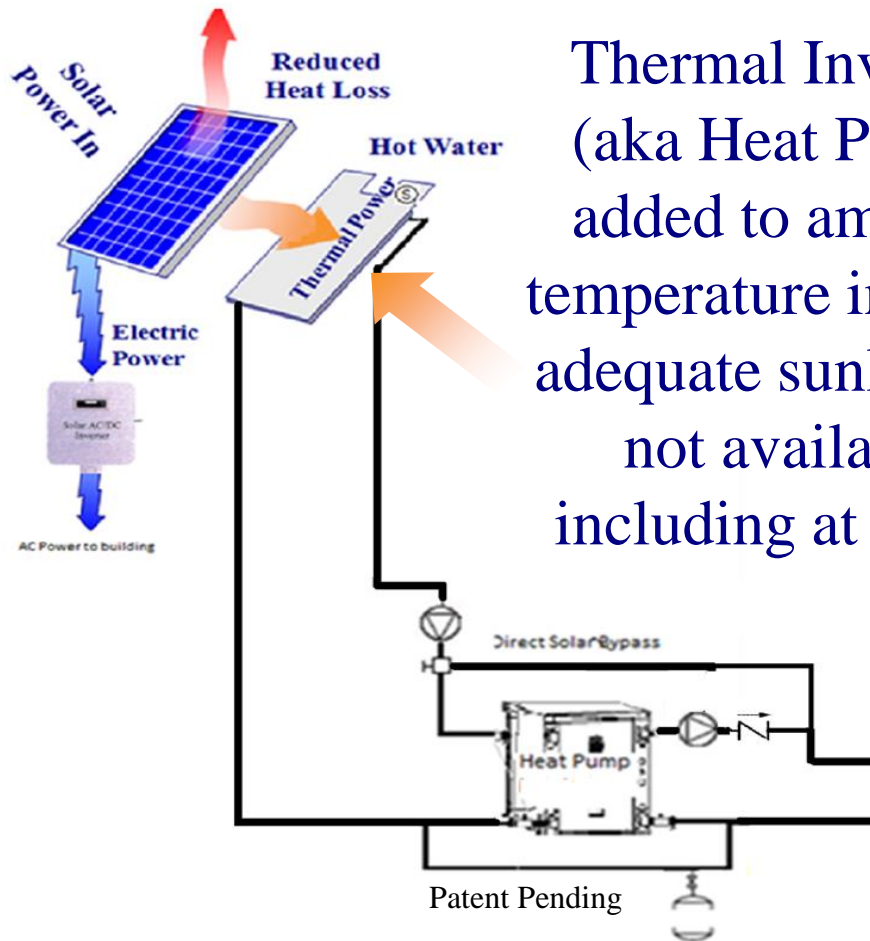
- Increased electrical power
- Significant thermal power
- >3X power improvement
- Retrofit and Field attachment

SunDrum Hybrid PV Panel



1,300 Watts Total Power

SunDrum® Solar Advantages, Operating Mode: HarvestHP®



Thermal Inverter
(aka Heat Pump)
added to amplify
temperature in when
adequate sunlight is
not available
including at night.

- System becomes a 24/7 solar boiler.
- Heating Loads up to 160F including space heating and industrial process.
 - Can replace fossil fuel heating.
- 6X power improvement vs PV
- Cools the planet by recycling ambient heat.
- Uses less electricity than air source system.
- Can use 4x less HFC than air source systems.

Hotels/Multi Family

- Volume DHW loads of Multi Family or Hotels are excellent solutions for solar heating.
- This system in San Francisco is on tract to save 2470 therms of natural gas per year.
- Most cost effective when centralized heating is designed into architecture.
- Need to remove Solar policy disincentives on Multi Family homes
 - Low-income commissions
 - Distributed heating

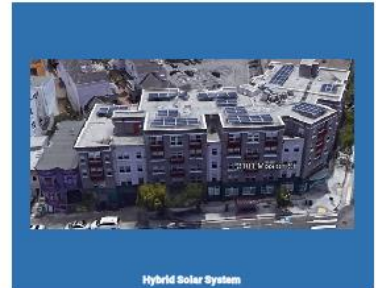
Solar Heating & Cooling - Case Study



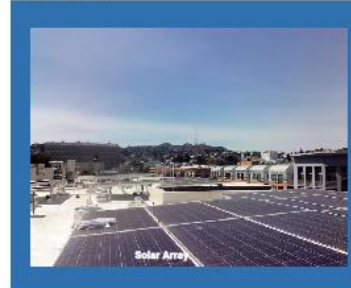
Multi-Family PV and ST System - San Francisco, CA.

Introduction

Sun Light & Power, in conjunction with SunDrum® Solar, retrofitted an existing PV array by adding a 27.2 kWh HarvestHP® solar thermal (ST) hot water system. The ST system comprises 34 SDM100-400 800 watt collectors with a 48,000 Btu/h heat pump to provide hot water twenty-four hours a day. When the sun is bright, the collectors will directly preheat the water. At night, or whenever the San Francisco fog is present, the collectors will absorb energy from the environment and send it to the heat pump to boost the temperature of the energy. This energy delivery design is well-suited to the multi-family housing market. The ST hot water system includes revenue grade Btu monitoring that reports real time energy delivery. The system has been in operation for five months and is on track to save over 2,400 therms of natural gas annually with a COP near 6.0. By implementing this PV & ST system, the owner maximized both the solar energy production and utility cost savings in a location with limited available space.



Hybrid Solar System



Solar Array

System Information

Location:	San Francisco CA., USA
Application:	110°F DHW pre-heat water
Rated Power Output:	27.2kWt, retrofit
Yearly Energy Output:	48.3MMWh, 1648 Therms
Yearly CO2 Reduction:	19,000lbs
Solar Collectors:	34 SDM100-400, 800Wt
System Format:	Indirect Closed Loop
Storage Capacity:	480gal
Backup Heating:	Natural Gas



Mechanical Room

Contact Information

SunDrum Solar | www.sundrumsolar.com



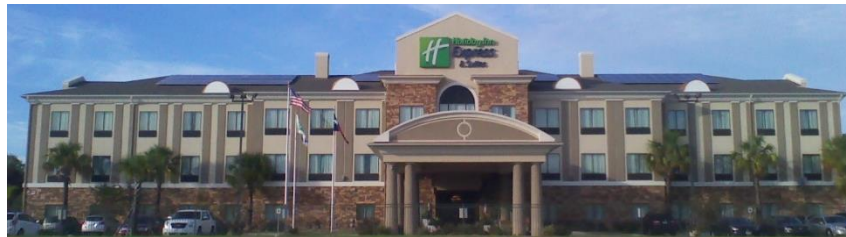
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August 2021

Commercial/Hospitality



Hotels/Multi Family

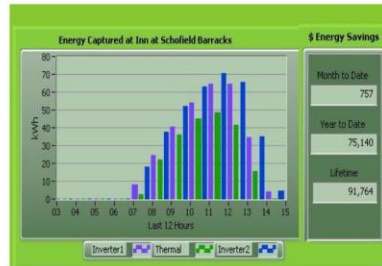
Hawaii Hotel achieves significant financial savings with SunDrum® Solar



Schofield Inn Hybrid system, installed in October 2012, generates both Electrical and Thermal energy in the same footprint. Technology has produced 2.9X solar energy on Hotel/multi tenant housing applications

Inn saved 43% of net system cost in first year!!

System payback on track for less than 2.5yrs or over 30% IRR



Pool, Barracks, and Laundry heating

Solar Heating & Cooling - Case Study



The Elks Lodge, Palo Alto, CA

Introduction

The Elks Lodge in Palo Alto CA decided to retrofit their 1000+ panel 362kW Canopy PV array with 120 SunDrum® Solar SDM100-300 collectors (78kWh) to heat their 3300 ft² pool. The system goal was to eliminate natural gas consumption except for 8 weeks in the winter. The system is meeting this goal only requiring some natural gas back up on the most inclement days. The system is on track to save over 13,000 therms (400,000kWh) and offset nearly 160,000lbs CO2 annually.

Retrofit Existing Array

Freedom Solar retrofitted 120 SDM100-300 collectors onto the back of the existing PV panels converting them to hybrid modules or (PV-T). The collectors have a surface area of 1560 ft² or roughly half of the pool surface area. To allow this small area to heat the pool year round, the HarvestHP™ system uses some of the arrays electrical energy to power a heat pump and convert thermal energy to useable temperatures similar to how an electrical inverter will take 35Vdc energy and convert it to 120Vac.



Overhead view of Lodge and pool

System Information

Location:	Palo Alto, CA, USA
Application:	Pool & Domestic Hot Water
Rated Power Output:	78kWh
Yearly Energy Output:	400,000 kWh
Yearly CO2 Reduction:	160,000 lbs
Solar Collectors:	120 SDM100-300 650Wth
System Format:	Indirect closed loop
Storage Capacity:	3300 ft ² Pool
Backup Heating:	Natural Gas



Collectors visible underneath the carport.

Contact Information

SunDrum Solar | www.sundrumsolar.com
Freedom Solar | www.freedomssolar.net



Great Lakes Naval Station Hybrid Solar System

Introduction

In 2019, SunDrum Solar commissioned a 1,300-collector hybrid solar PV-T Campus at Naval Station Great Lakes in North Chicago Illinois. The systems provide hot water to dormitories and base laundry. The commissioning phase included demonstrating winter performance where the systems were exposed to (-28F) temperatures. The systems have provided over 4000 therms of energy during a cold winter month while providing over 5500 therms of energy during a summer month. The thermal systems include 6 dormitory systems and one additional system supporting the base laundry. The largest Dormitory system consists of 240 SunDrum Solar's SDM100-400 800Wt collectors mounted behind Hanwah Q-Cell 330W PV panels, plus two 10 ton water-to-water heat pumps, with 4000 gal of solar preheat storage. During the summer the system demonstrated the capability of providing 57 Therms of energy per day, reducing the amount of steam required to heat hot water. The laundry system comprises over 7000 PV panels of which 100 have SDM100-400 collectors mounted behind them. This over 2MWe system has put to use the retired, on site, landfill. Providing useful electricity to the base and hot water to their laundry.



Dormitories

System Information

Location:	North Chicago Illinois, USA
Application:	DHW + Laundry
Rated Power Output:	3.8MW, (11MWh, 2.3MWe)
Yearly Energy Output:	1,825MWh
Yearly CO2 Reduction:	2,304,000lbs
Solar Collectors:	1,300 SDM100-400, 800Wt
System Format:	Indirect Closed Loop
Storage Capacity:	24,500gal
Backup Heating:	Steam



Mechanical Room



Landfill Array

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Commercial pool heating

***3500 ft² pool
in
Palo Alto CA.
On carport***



Savings of 13,000
therms nat gas,
68 metric tons
CO₂ avoidance,
annually

Brewery/Food Processing

- When there are complementary loads (need for both chilled and hot water) we will maximize performance by removing energy to cool a load and use that energy to heat a different load. It can be looked at as free cooling.
- On our Maui Brewing system, we provide 160F brew water plus <40F chilled water.
- The design can operate at a **COP of 16**. This means the system provides 94% thermal energy and only requires 6% electricity. Note: PV electrical inverters are typically also about 94%.
- System can annually reject over 10,000 tons of heat off the planet.

Solar Heating & Cooling - Case Study



Maui Brewing Co Solar Hot and Chilled Water System

Introduction

SunDrum® Solar has completed a 220 module hybrid solar PV-T array at Maui Brewing Corporation, Kihei HI. This array includes 220 SDM100-400 800Wt collectors matched with Solar World 325We modules and 16 GK 3133 glazed collectors with 30 tons of heat pump capacity. The system provides 160F brew water to the brew house hot liquor tank and <40F chilled water to the cold liquor tank.

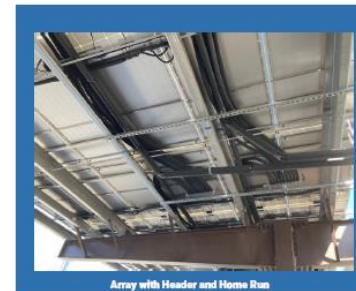
The system is designed to use the PV-T modules to provide electricity and pre-heat brew water up to 140°F, then during daylight hours the glazed system will top off to 160°F. Also during the day thermal energy will be removed from the 3000 gal cold storage tanks to make chilled water and be used to pre-heat brew water to 110°F. At night when there is no hot brew water demand the array will be used as an emitter to reject energy extracted from the cold storage tanks using the black body effect. Up to 40% of the energy can leave the planet resulting in a system that not only provides chilled water but cools the planet. The system is modeled to run at an unprecedented COP of 16. Typical air sourced heat pump water heaters run at a COP of 3 or less to provide the same energy.



Hybrid Solar System

System Information

Location:	Kihei HI, USA
Application:	160°F process water + <40°F chilled water
Rated Power Output:	248kW, (220kWt, 72kWe)
Yearly Energy Output:	128MWh, 1.575MWh
Yearly CO ₂ Reduction:	860,000lbs
Solar Collectors:	220 SDM100-400, 800Wt
System Format:	Indirect Closed Loop
Storage Capacity:	9,000gal
Backup Heating:	Propane Steam



Array with Header and Home Run



Solar Control Center

Contact Information

SunDrum Solar | www.sundrumsolar.com



www.seia.org/shc

June 2021



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.
- **Cools the Planet**

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



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