Solar Air-Conditioning, Peak Power and Building Efficiency

InterSolar, San Francisco July 14 2011

CHROMASUN


Solar Heat & Power 2002-2003

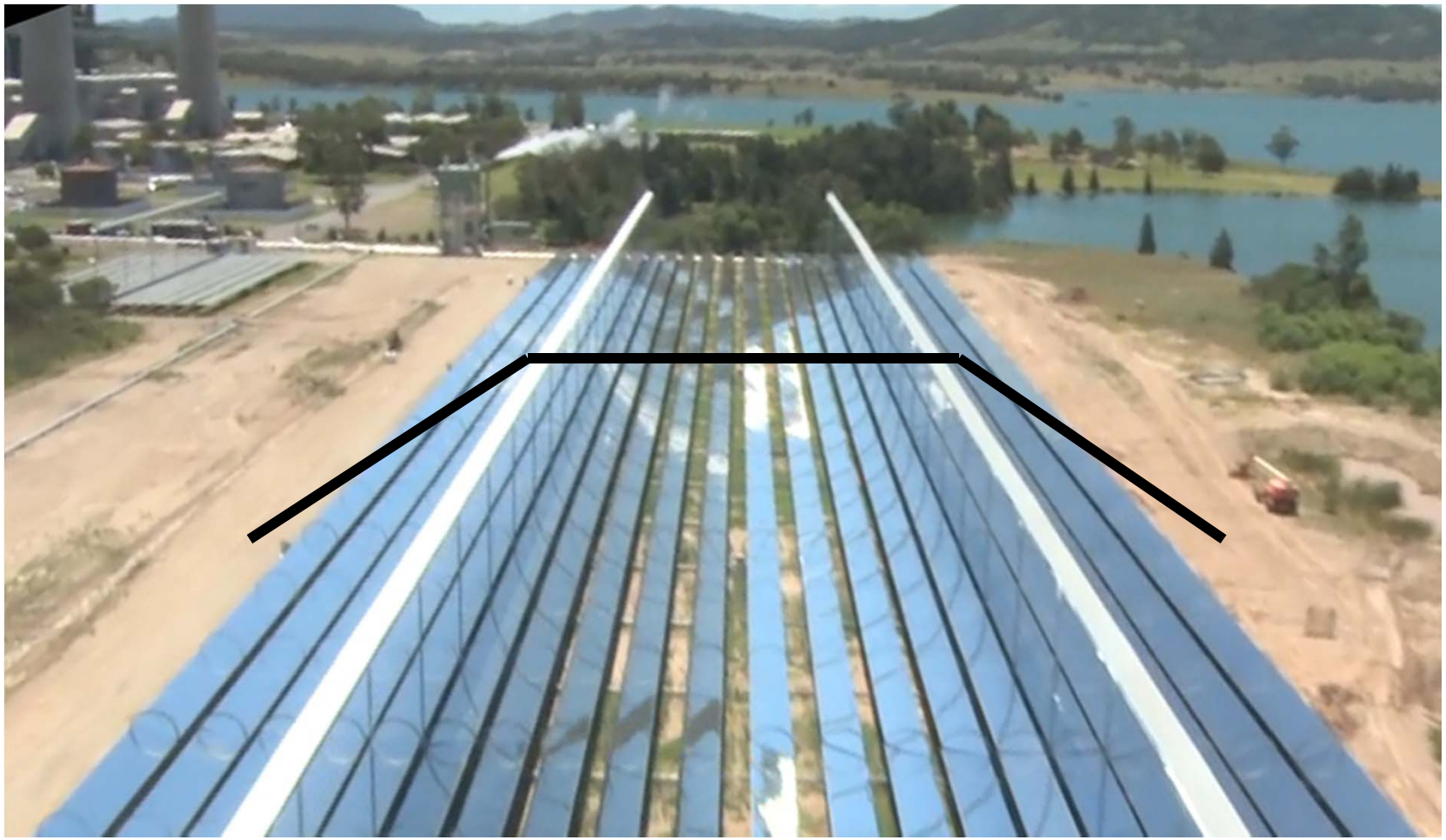
Linear Fresnel Systems

Source: Macquarie Generation http://www.ausramediaroom.com/download/LiddelSolarThermal_17Nov09_MPEG-4-1280x720.mp4.zip

Two-Axis Tracking Heliostat Systems

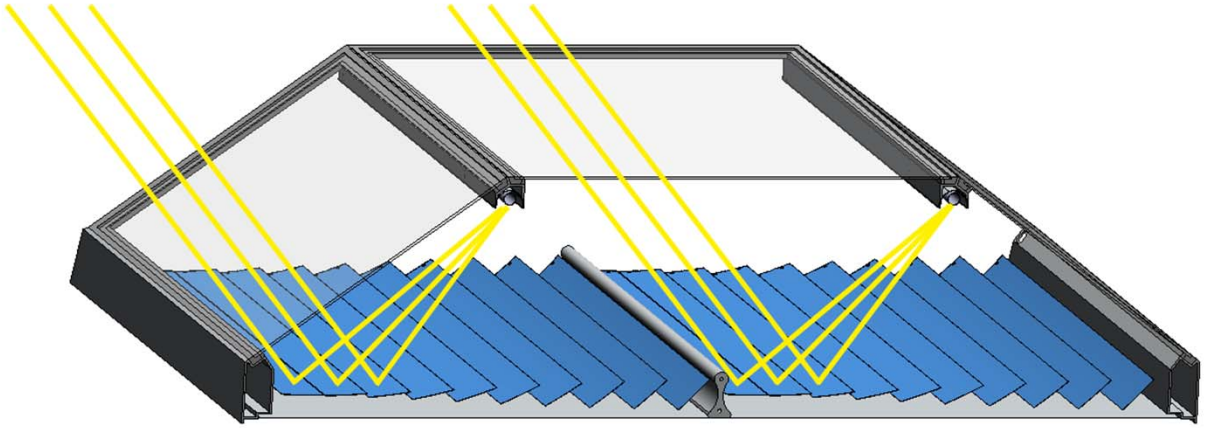
CSIRO 2011 Plant

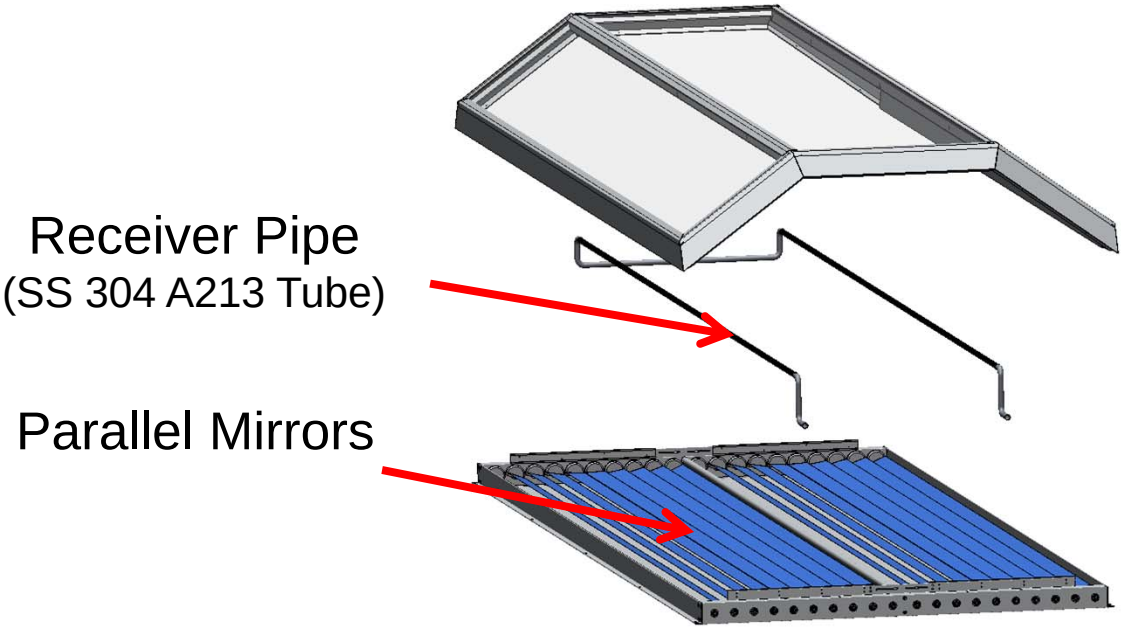
2008 Chromasun Formed




Micro-Concentrator (MCT)
And made it 100X smaller!

MCT Exploded View



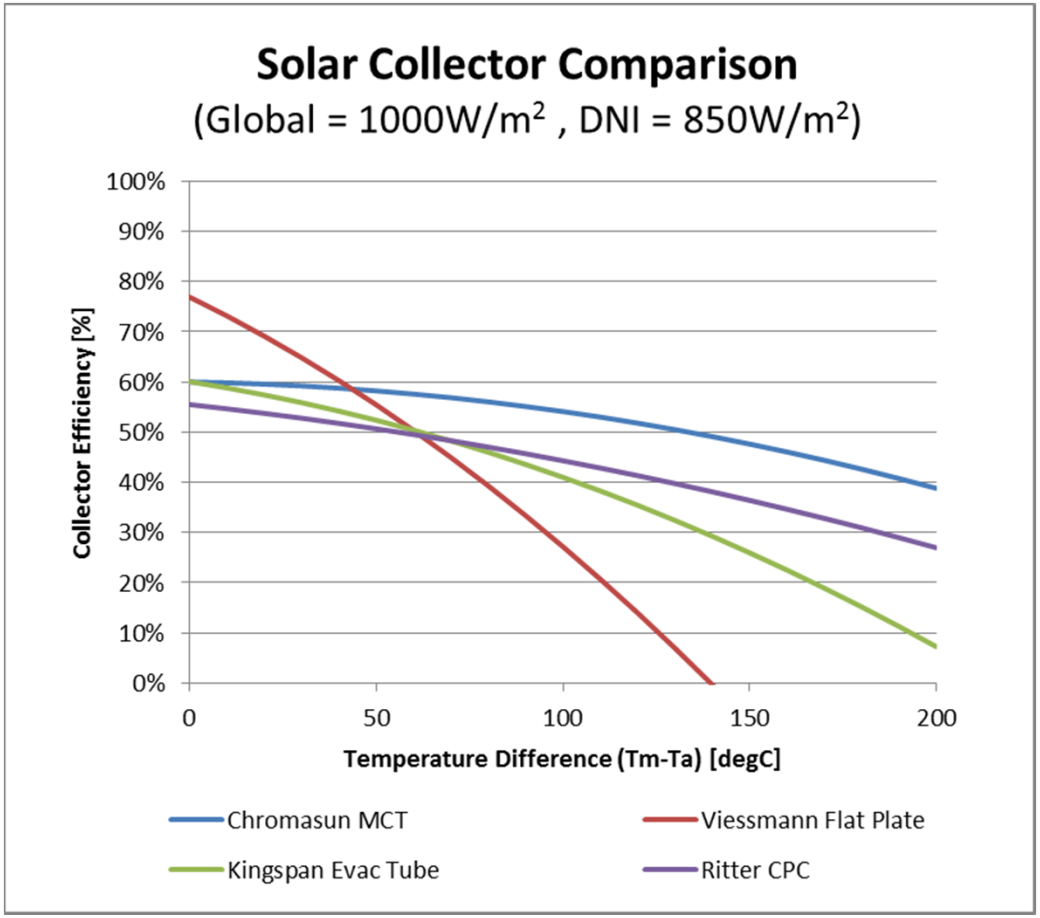


Receiver Pipe
(SS 304 A213 Tube)

Parallel Mirrors

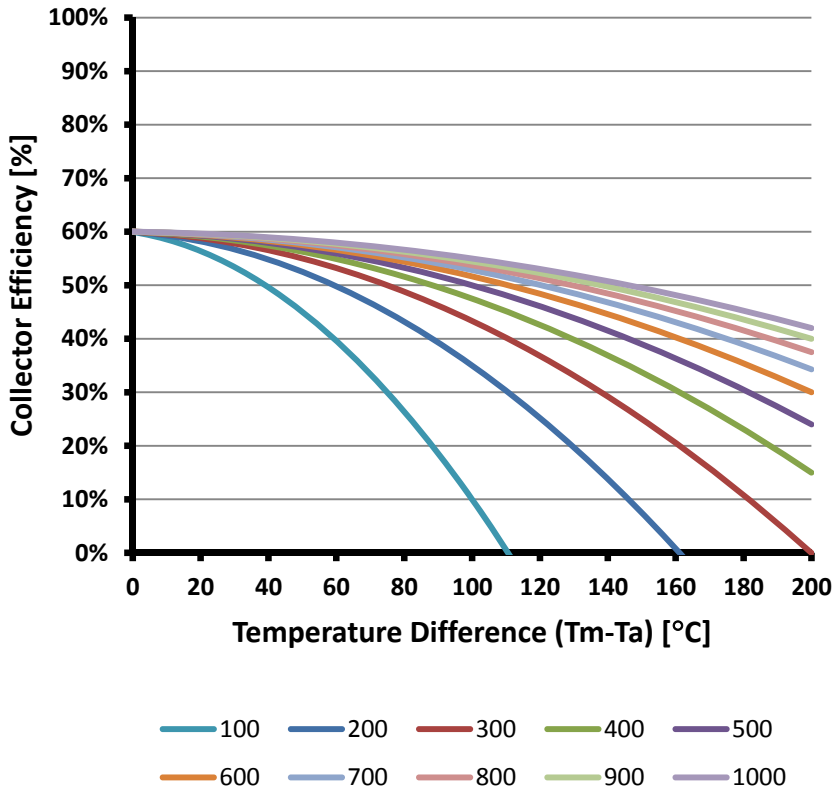
Competitive Analysis

Highest temperature rated solar collector in the USA (179ºC /354ºF)

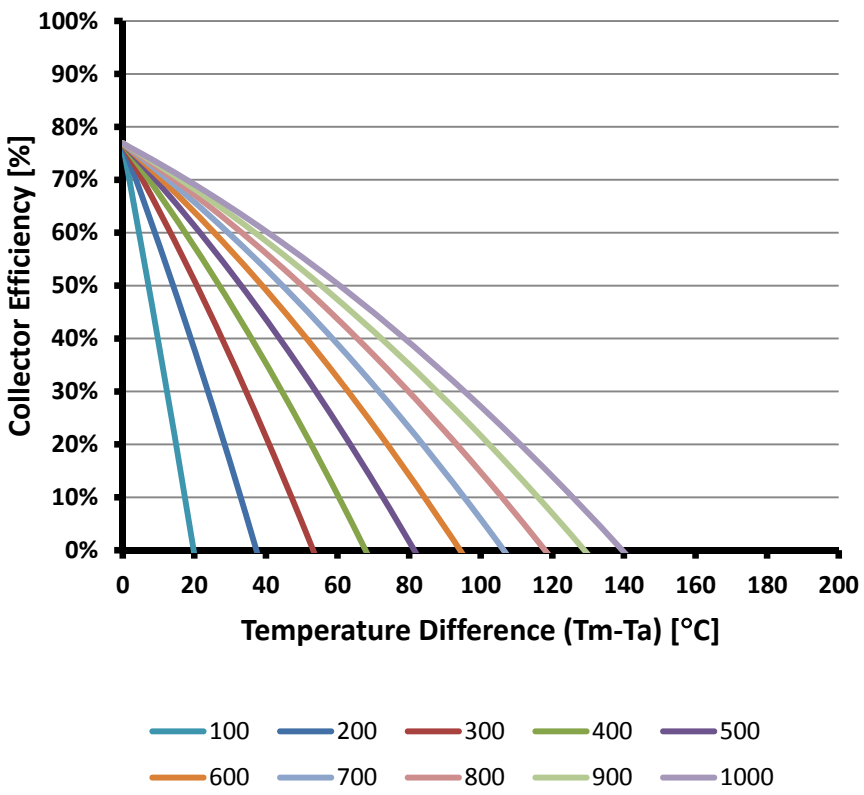


MCT vs Flat Plates

Solar Concentrator Efficiency



Flat Plate Collector Efficiency



Chromasun's Global Approach to Testing

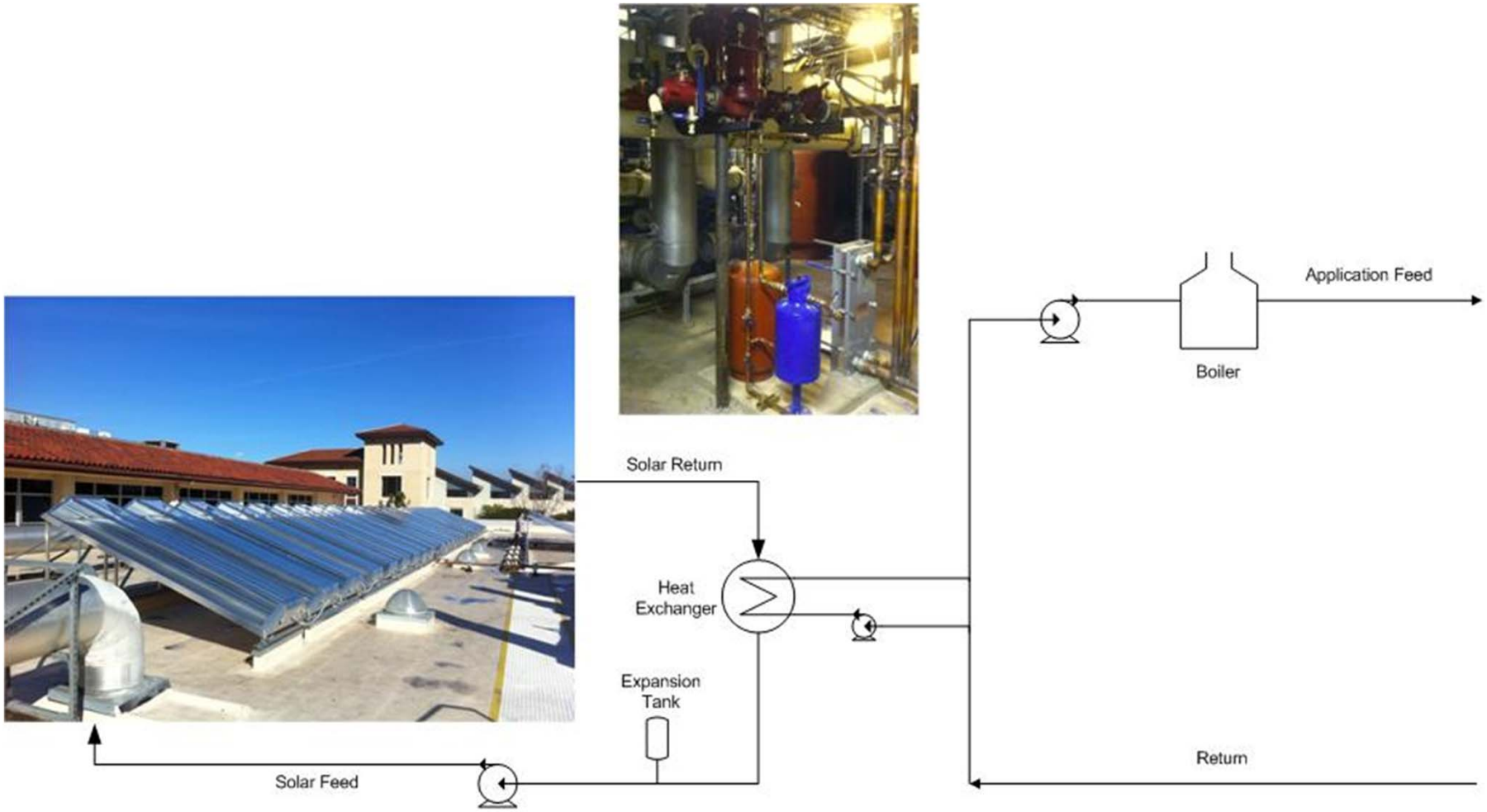





Santa Clara University Showcase Project

Chromasun MCT – Simple Installation

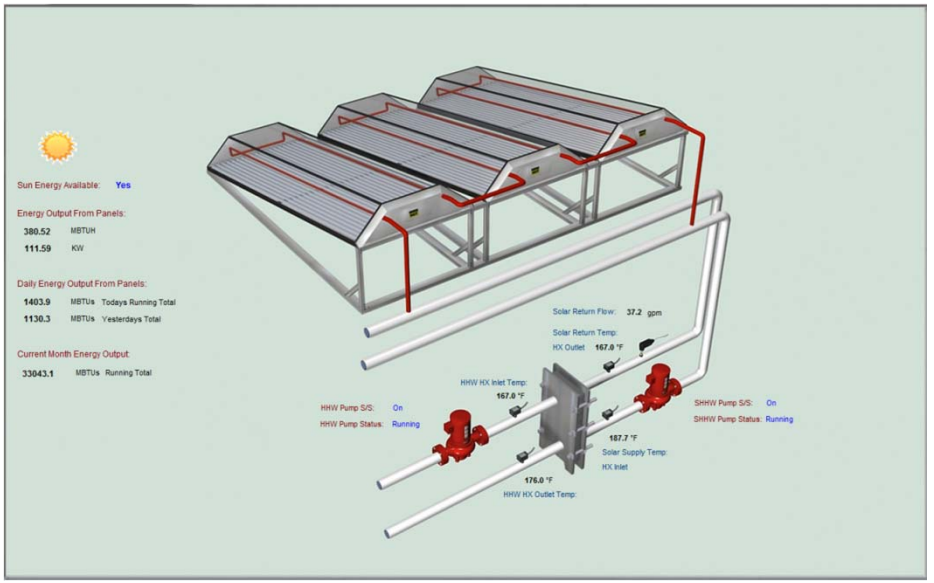
SCU Benson System Schematic



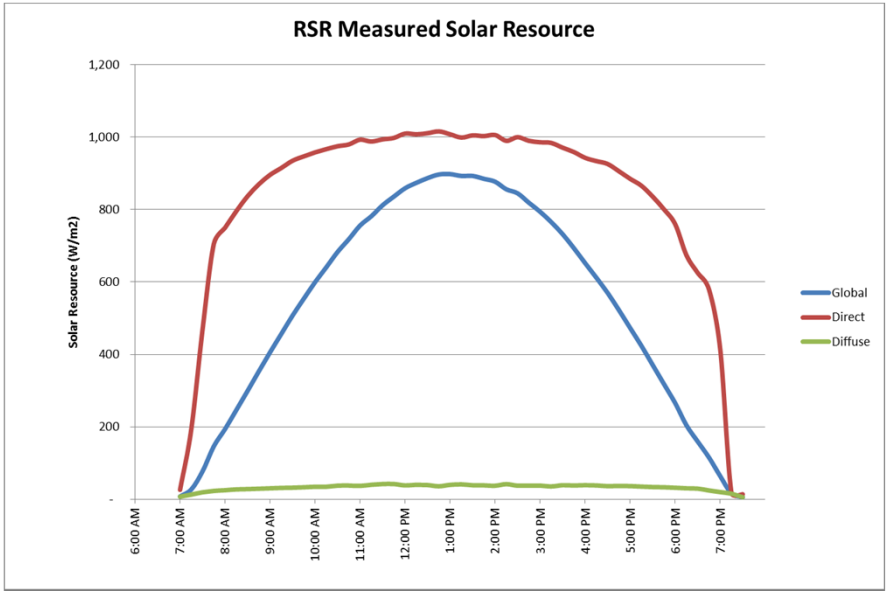
SCU Solar Monitoring

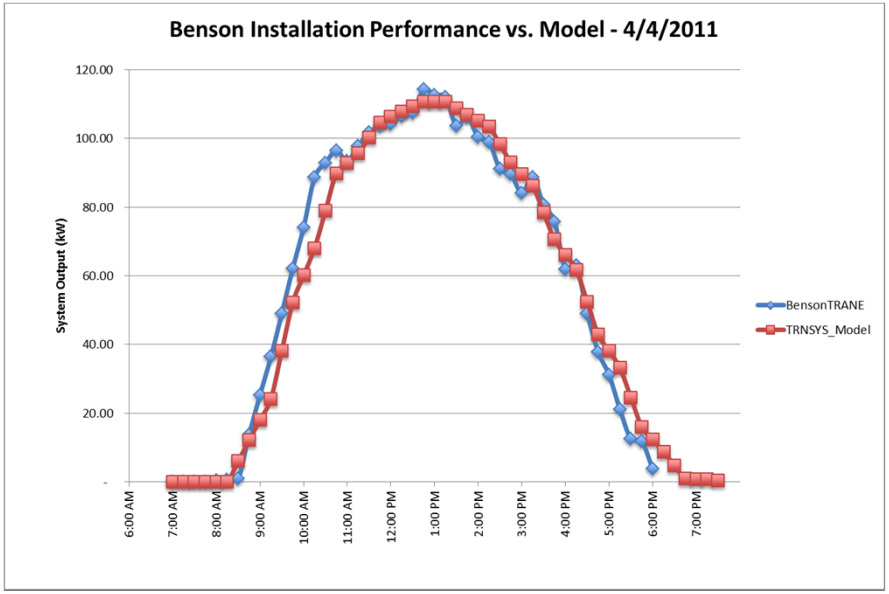
Solar Monitoring Equipment

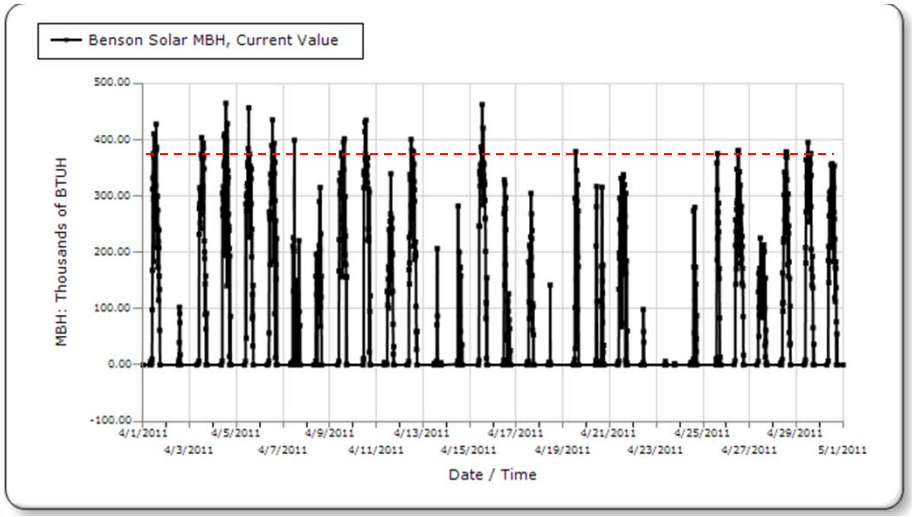
Thermal/BTU Metering



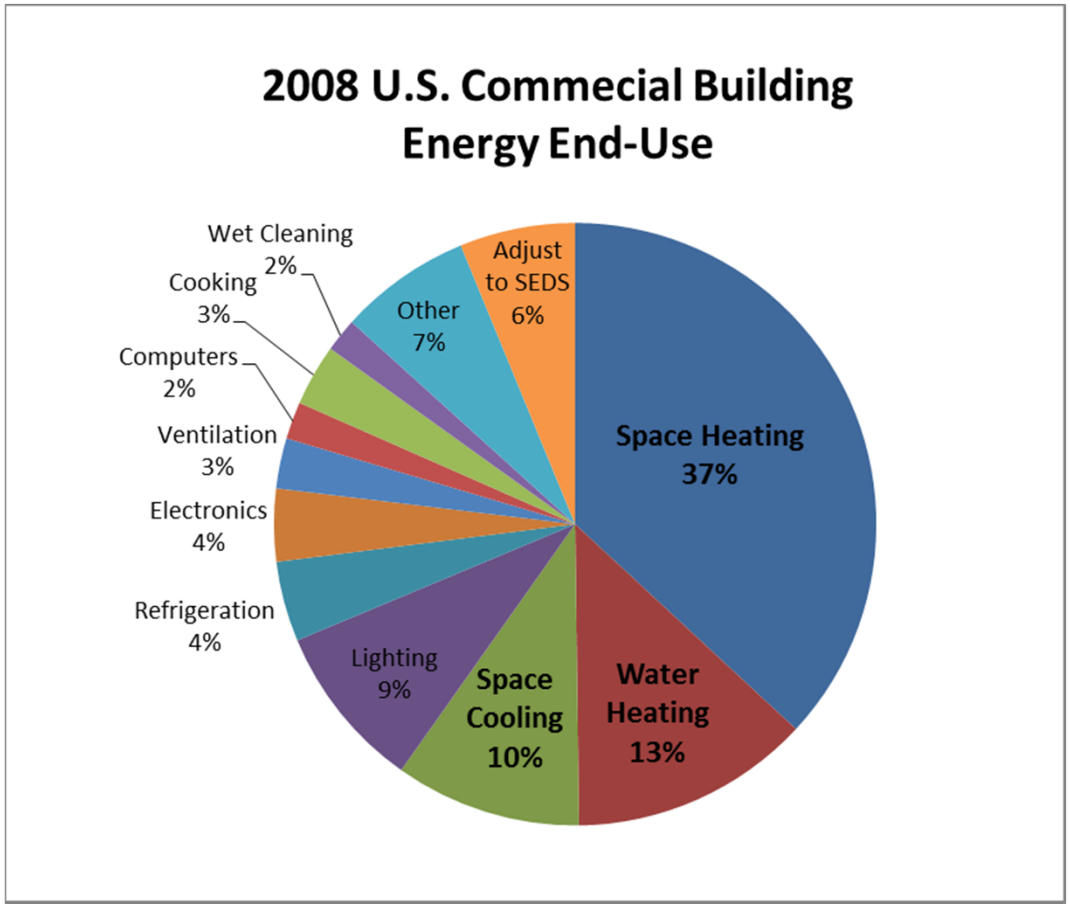
SCU Performance



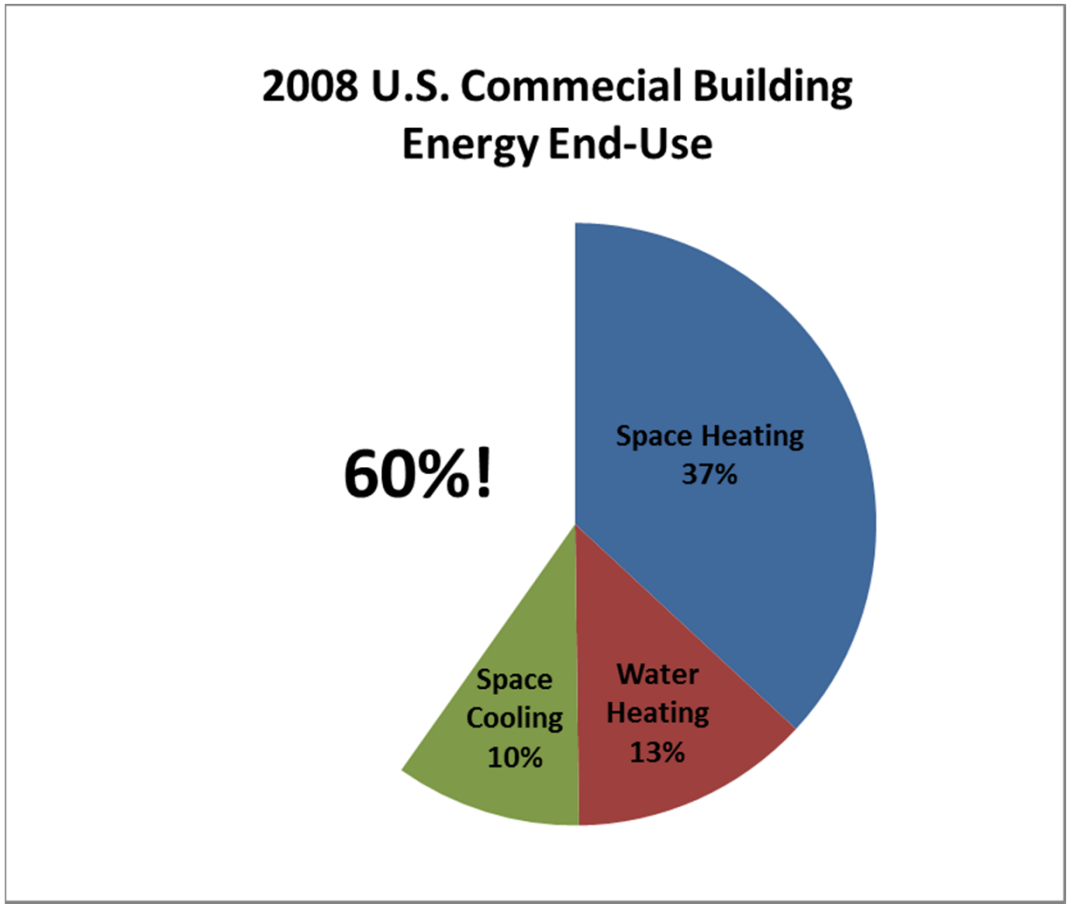




US Commercial Building Energy Consumption

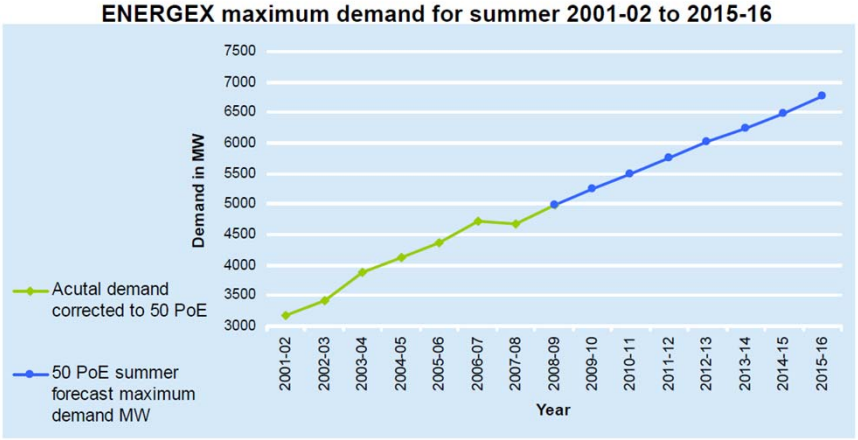


Market Niche

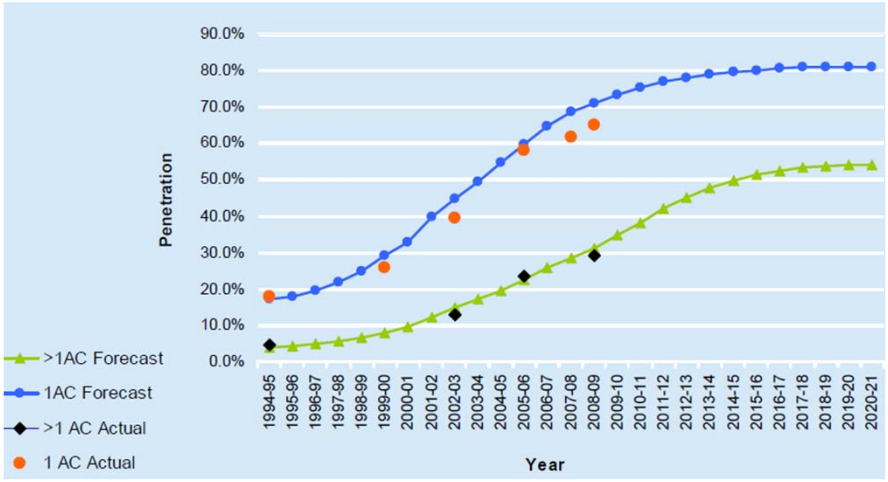


Air-conditioning driving peak demand

Peak demand forecast

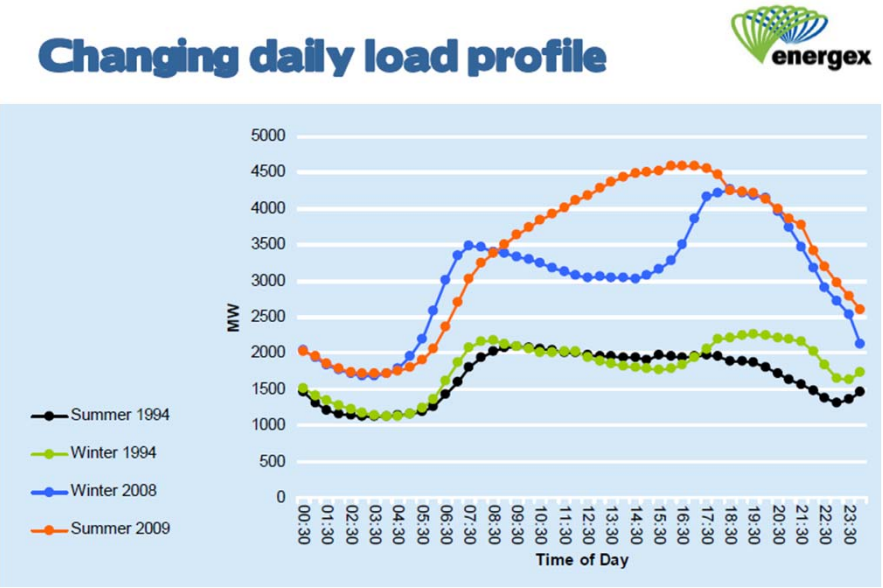


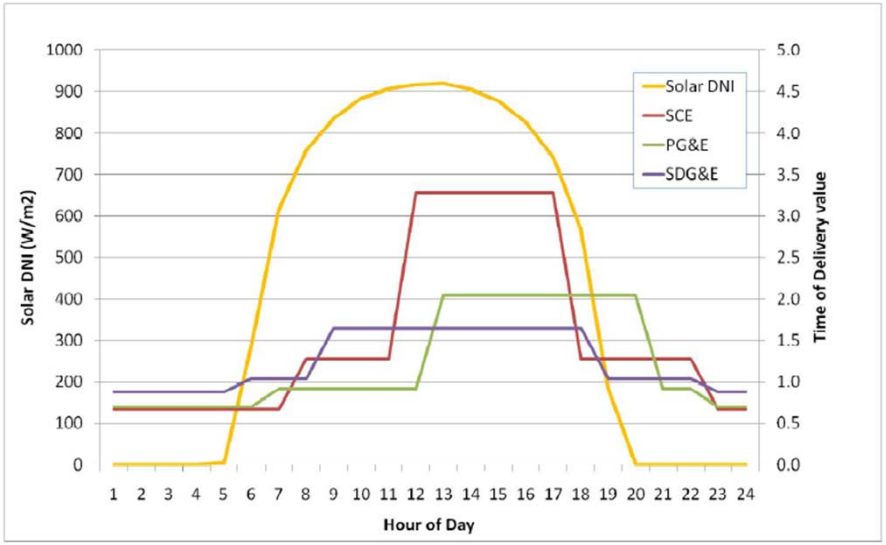
Air-conditioners driving peak demand



Air-conditioning is driving summer peaking electricity and the growth in electricity

Time of Day Peaking correlates well with Solar Resource

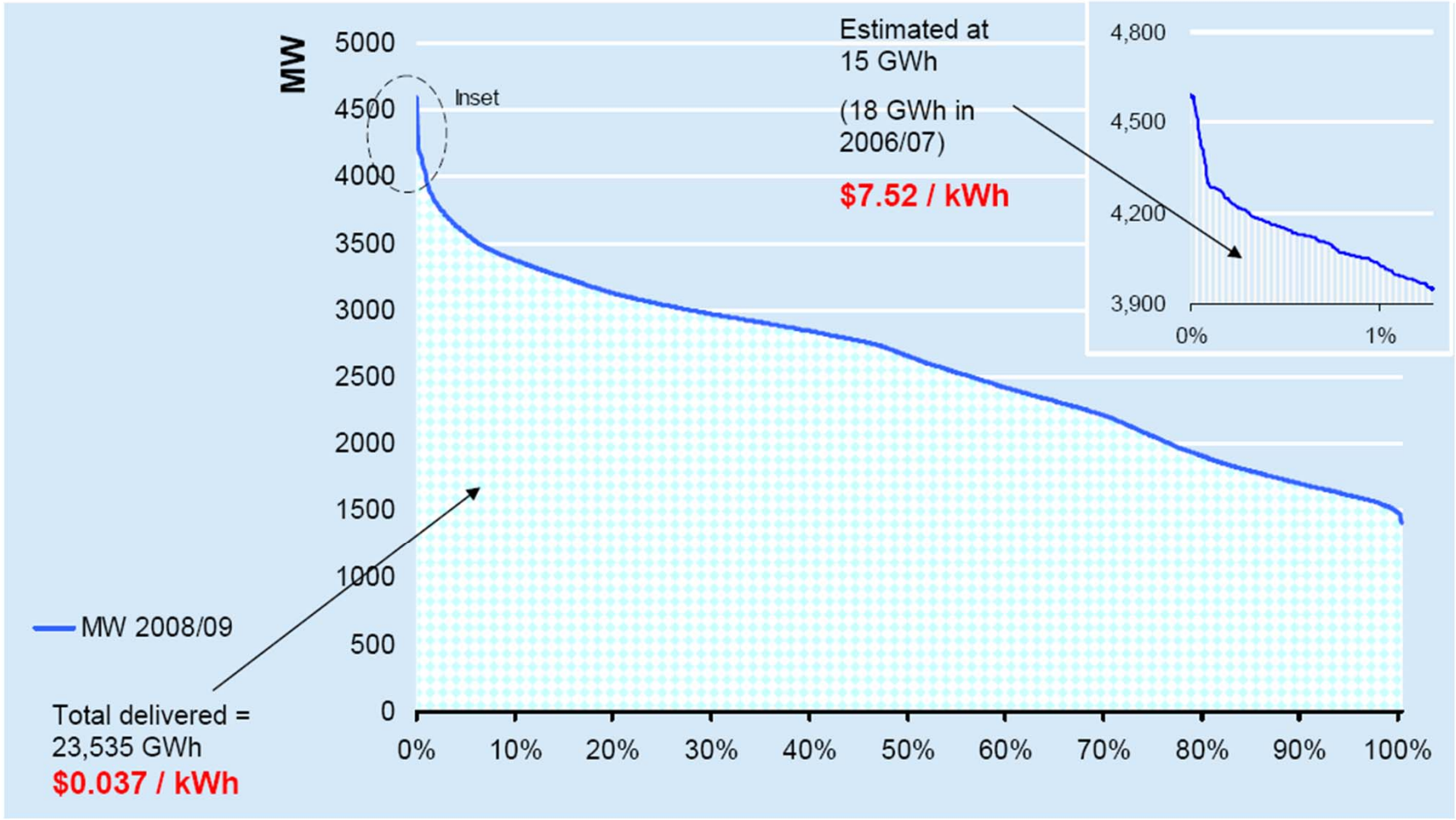




There is strong correlation between when electricity is peaking and the solar resource. Utilities value the energy greater during these times

Load duration curve 2008/09

200X the price!!!



Source: Energex

CHW and CW with Solar Thermal Panels

Sunlight

MCT Panels

1 @ 175ºC / 350ºF

HHW

and/or Natural Gas

Cool Building

1.35

@ 7ºC / 44ºF

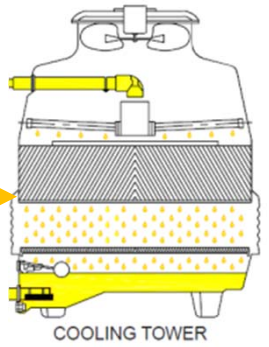
CHW

DE Multi-Fire Absorption Chiller

2.35

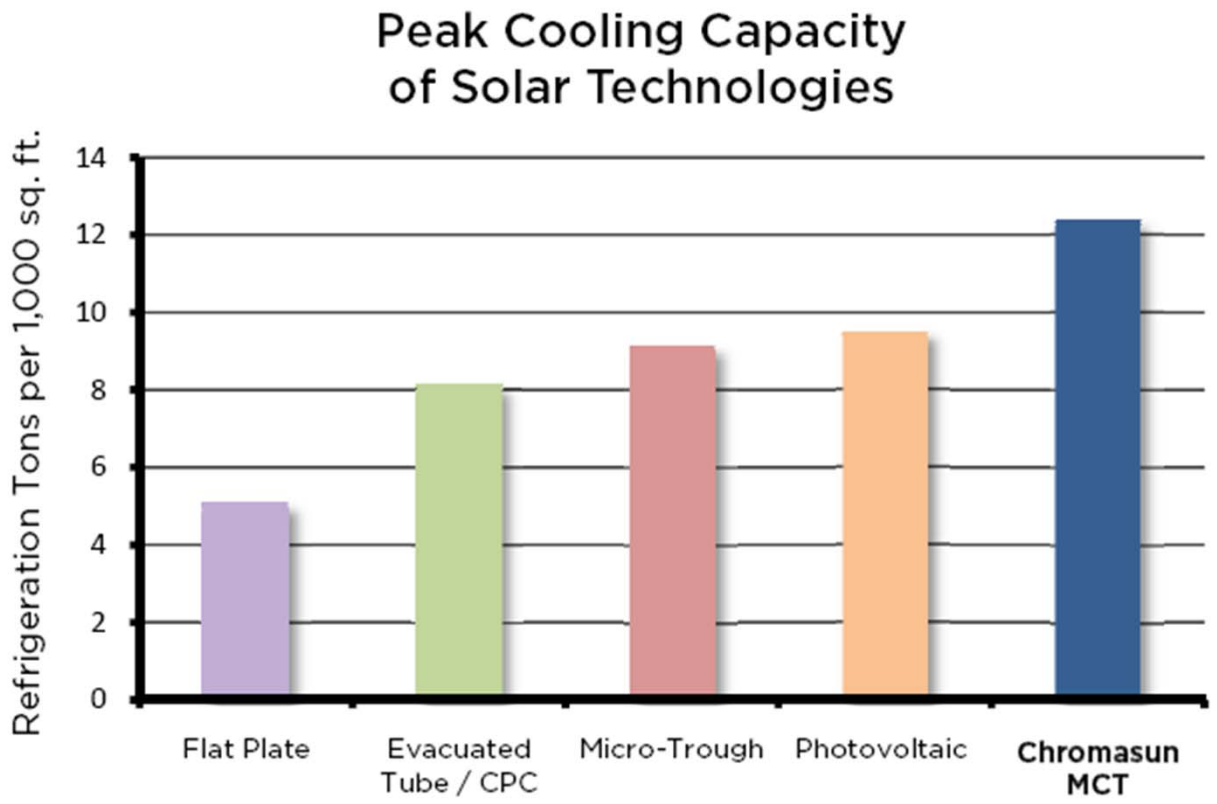
@ 30ºC / 85ºF

CW



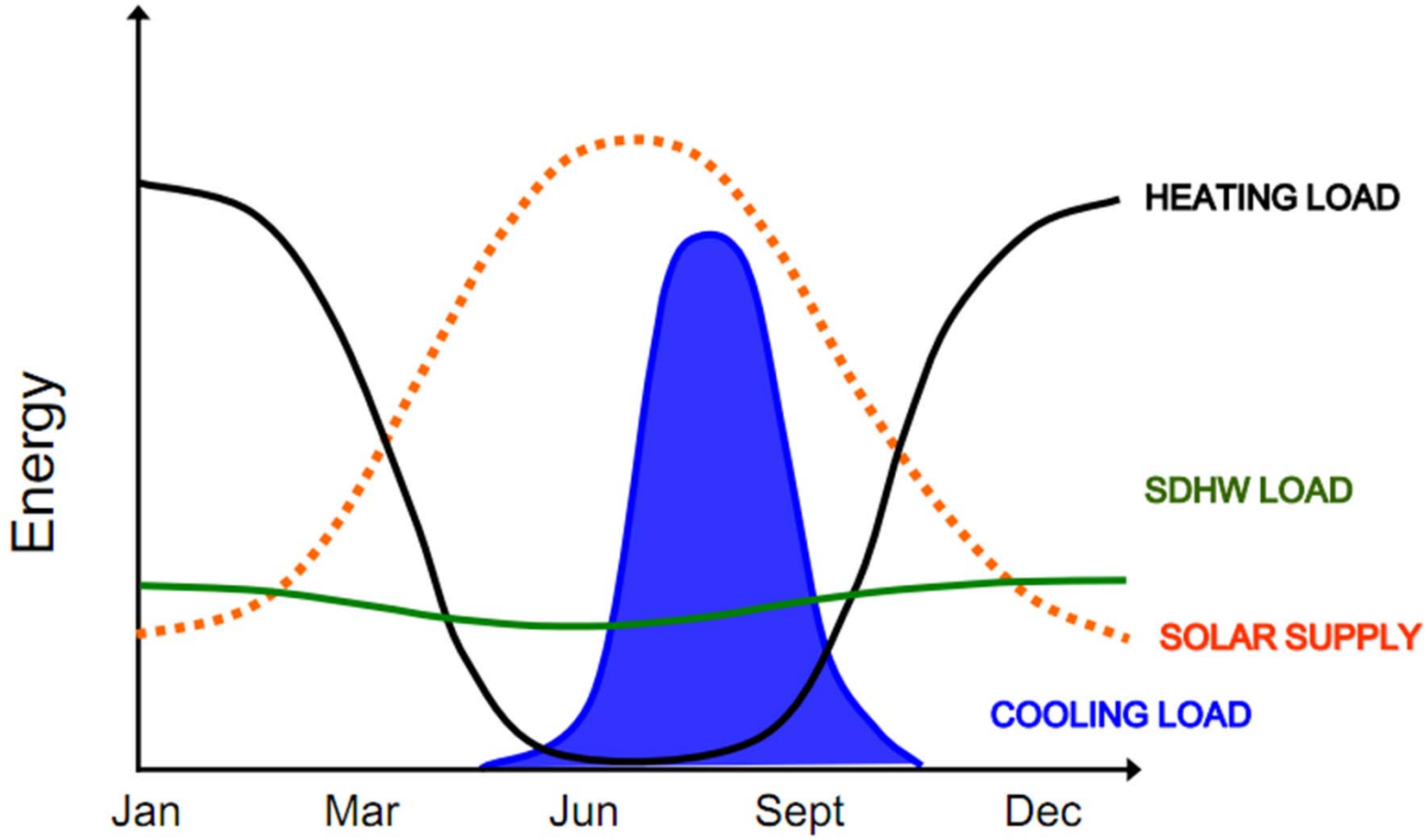
Heat Rejection

Roof Area Utilization

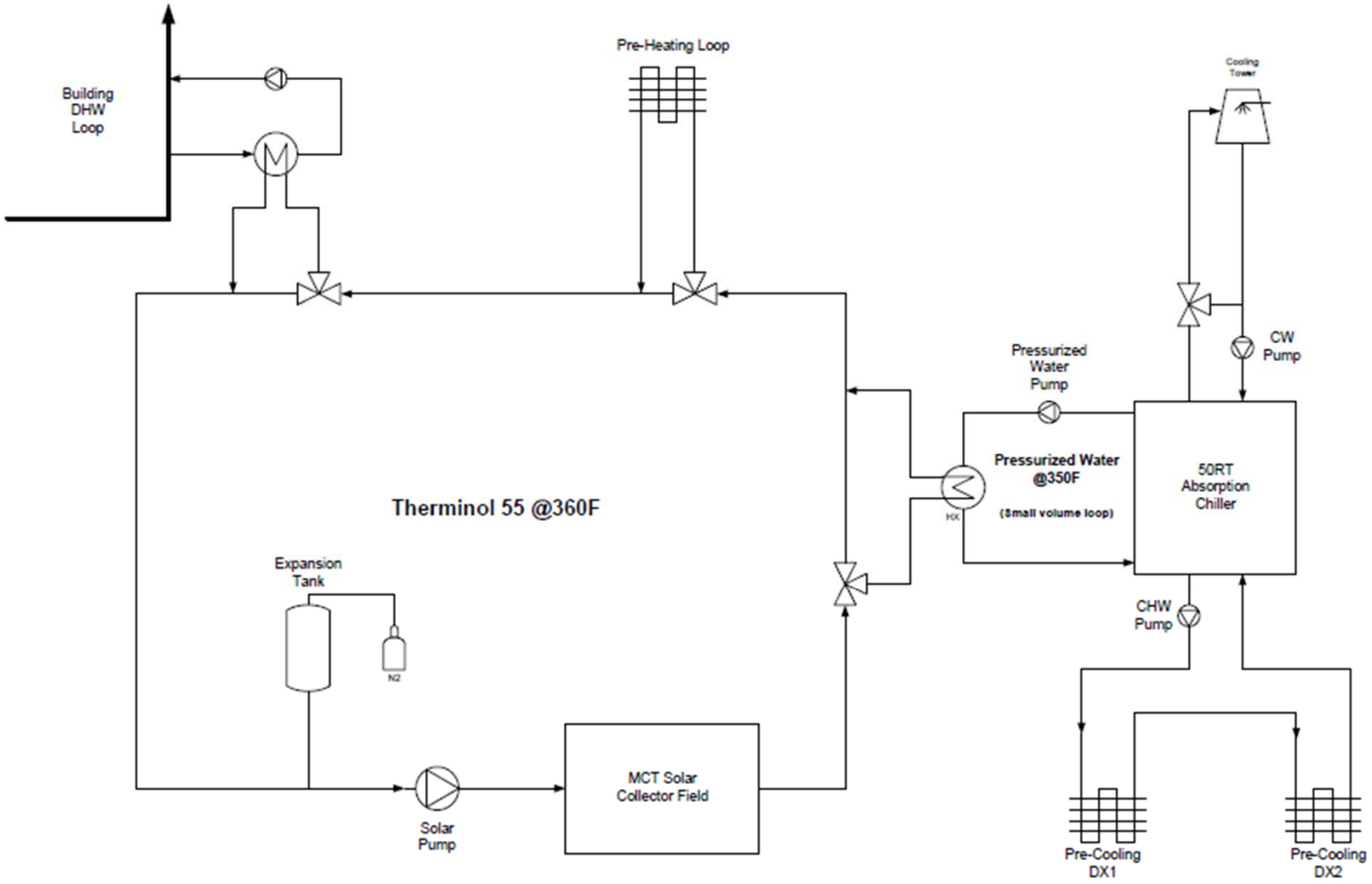


An MCT array in conjunction with a two-stage absorption chiller is best in class for rooftop area utilization

Energy Demand Schedule



Solar Cooling System Schematic



CHW and DHW with Solar Thermal Panels

Sunlight

MCT Panels

1 @ 115ºC / 240ºF HHW

and/or

Natural Gas

Cool Building

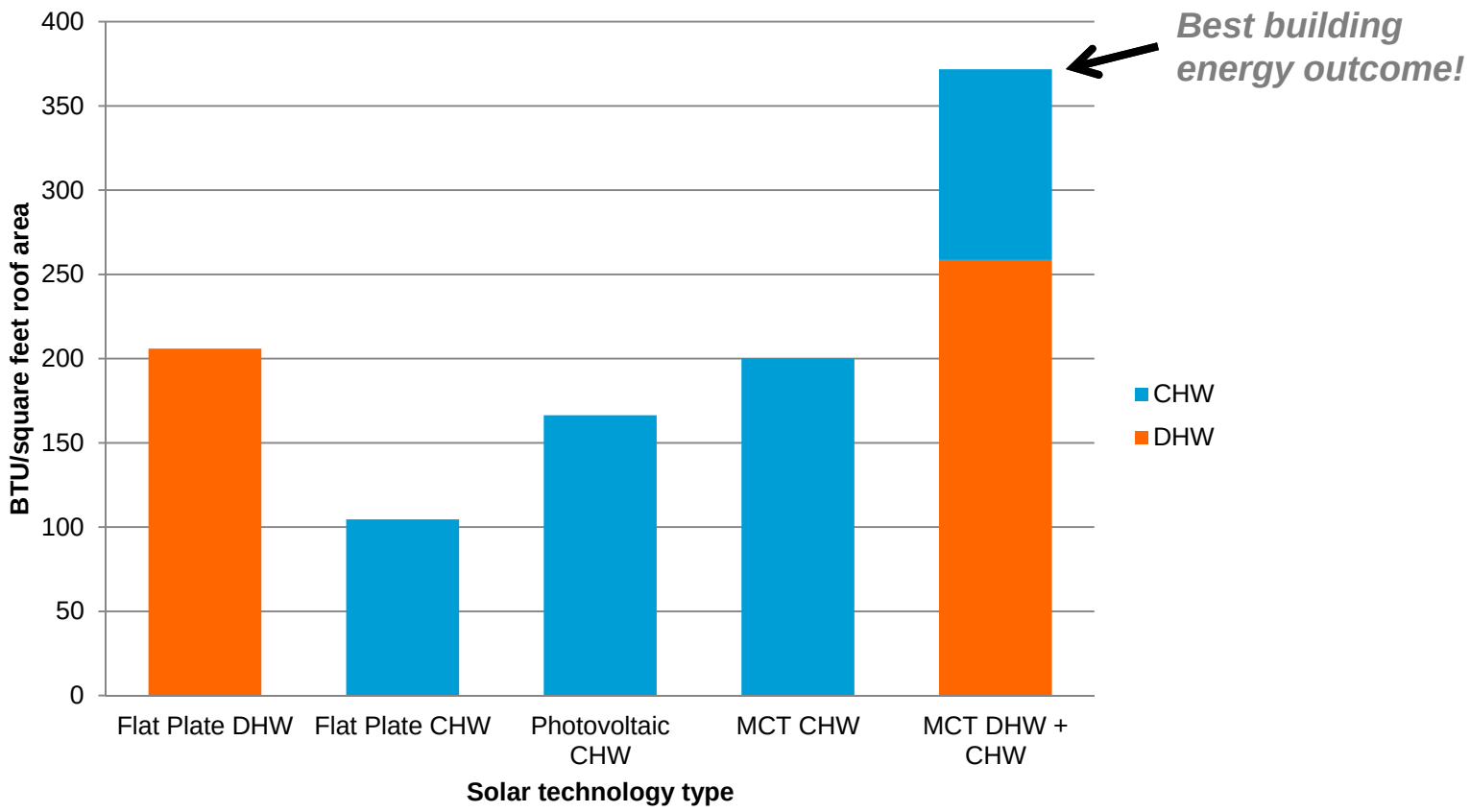
0.6 @ 7ºC /44ºF CHW

NH3 Multi-Fire Absorption Chiller

1.6 @ 54ºC /130ºF DHW

Hot Water

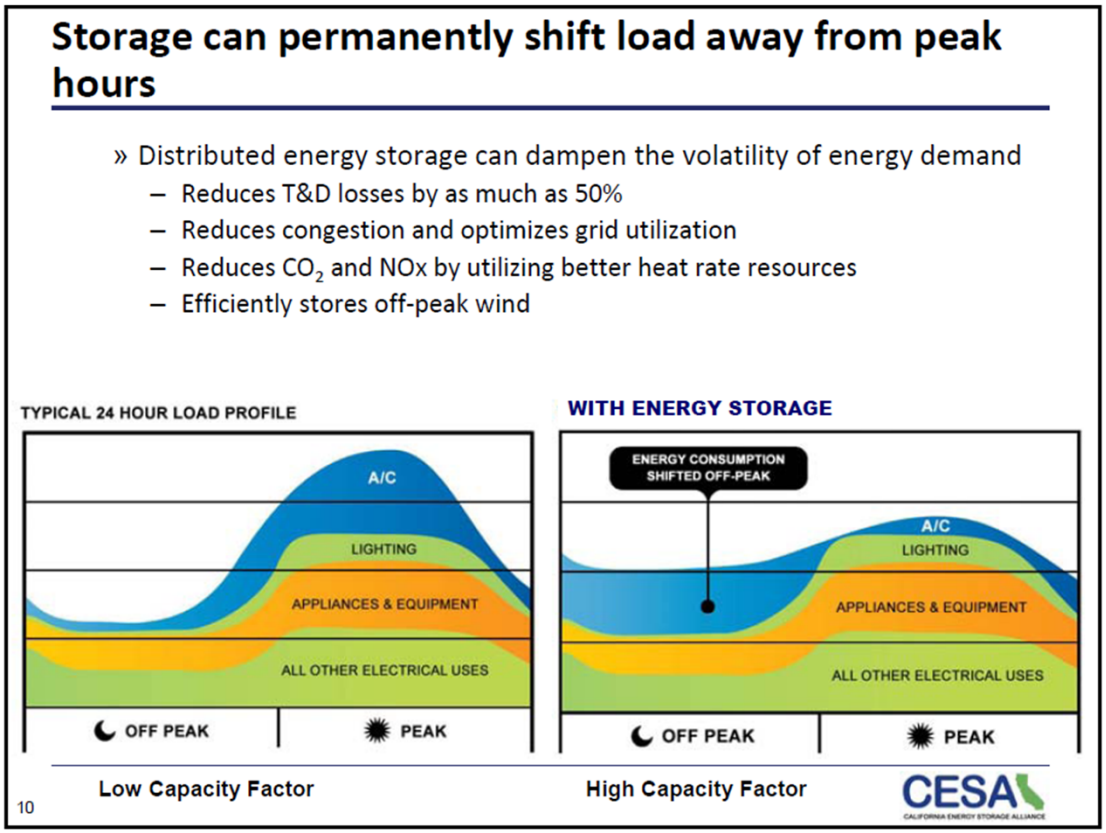
Rooftop solar energy yields for the building



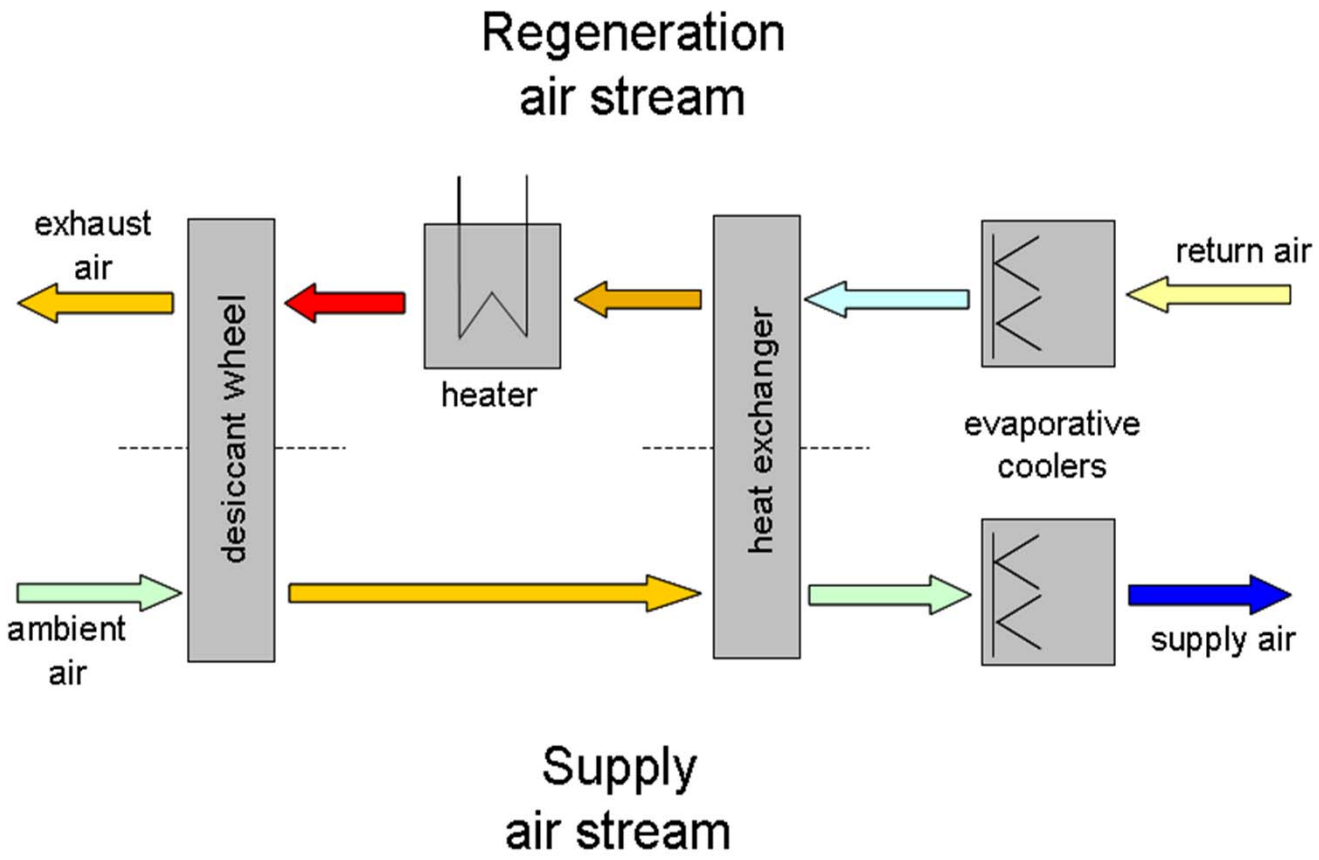
1000W/global, 850W/DNI solar resource

Energy Storage for Solar Cooling

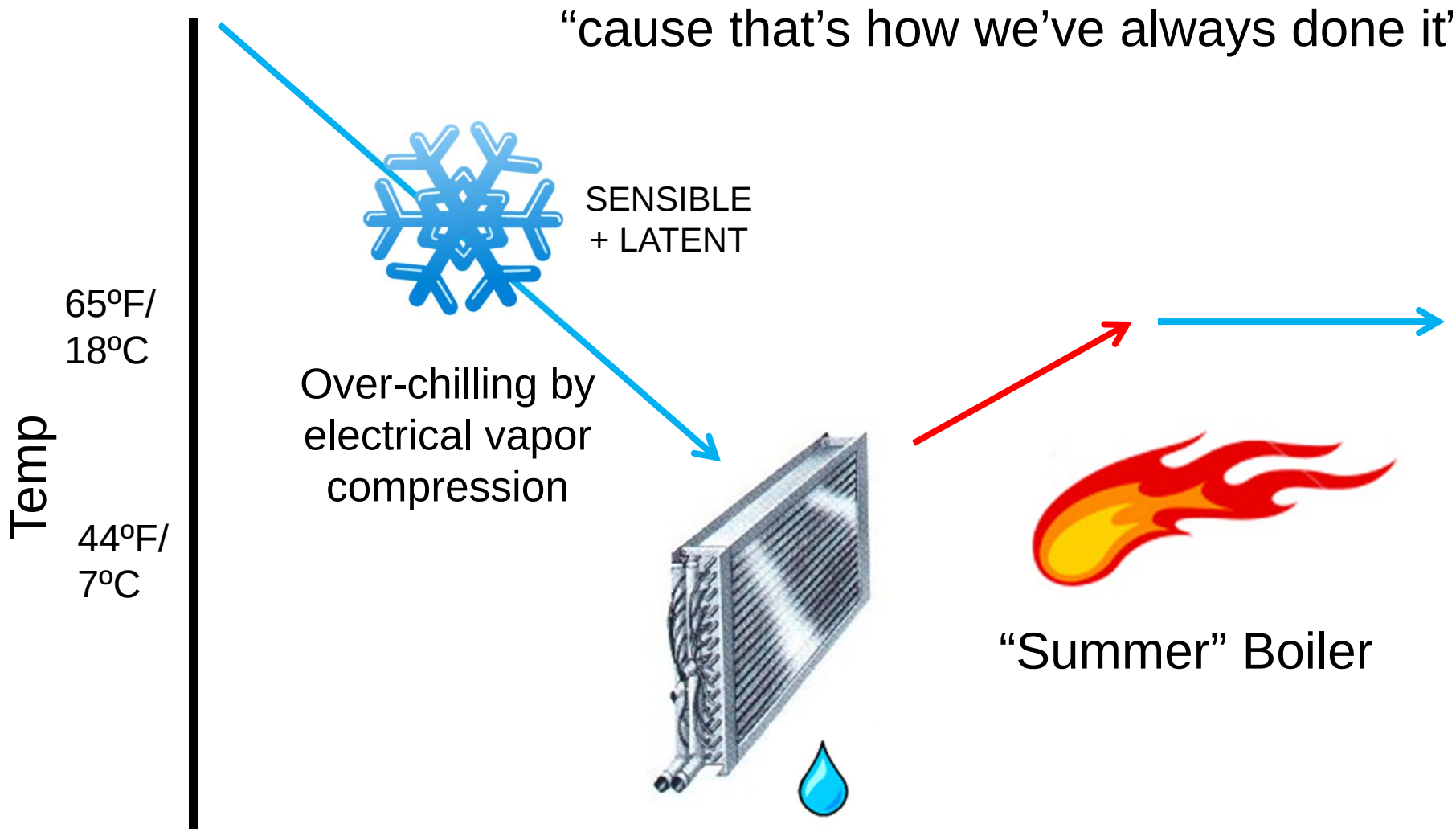
- 75gals/280L of water would provide enough sensible heat to offset 1kWh of electricity
- 60lbs/120kg (300gal 80L) of Phase Change Material (Salt) would also store 1kWh at $25-$50/kWh



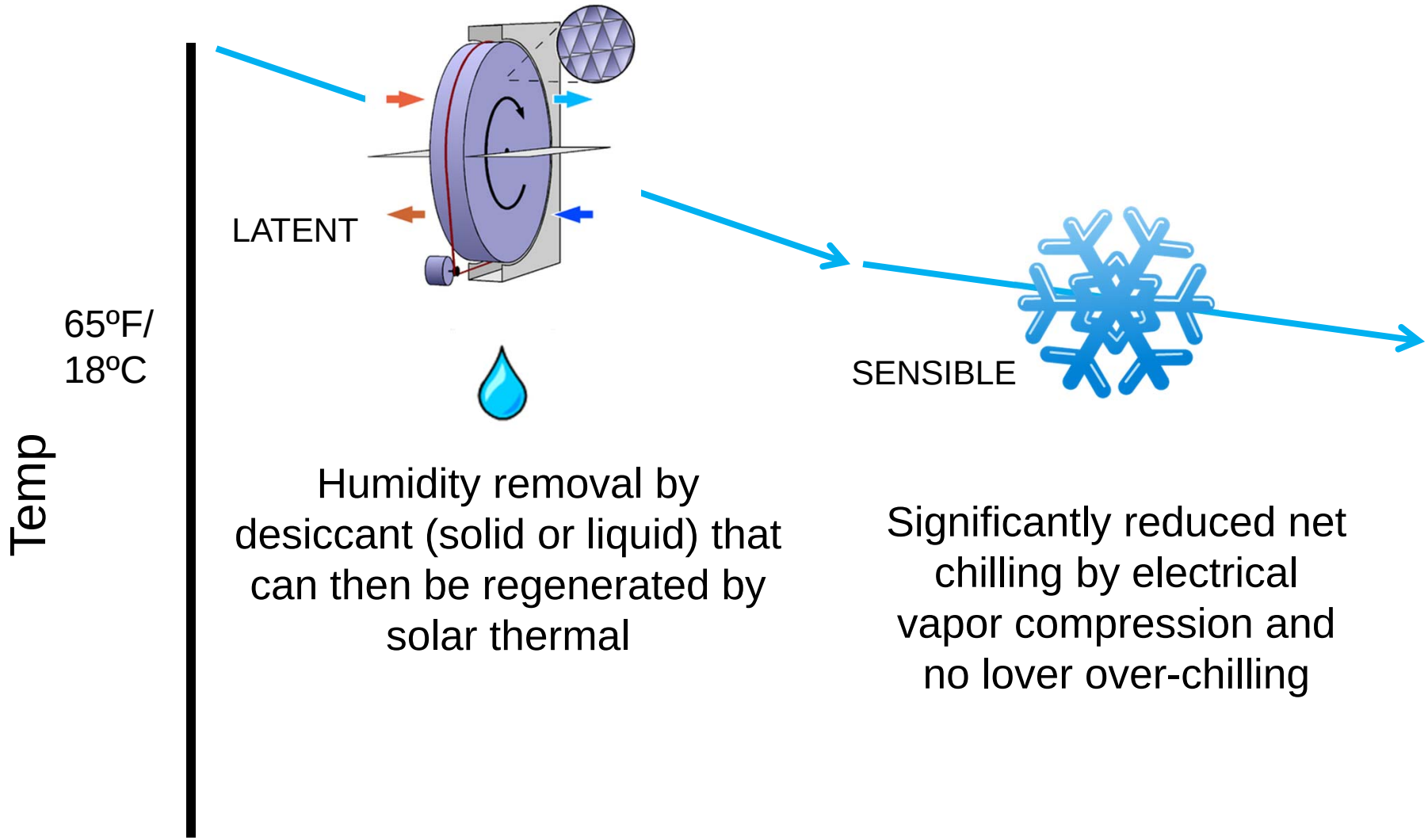
Desiccant Cooling



Traditional Cooling



Latent Heat Removal with Desiccants



Humidity removal by desiccant (solid or liquid) that can then be regenerated by solar thermal

Significantly reduced net chilling by electrical vapor compression and no lover over-chilling

CHW and DHW with Solar Thermal Panels

MCT Panels

1Q @ 120ºC

HHW

NH3 Absorption Chiller

Hot Water

1.6Q
@ 54ºC

0.6Q
@ 7ºC

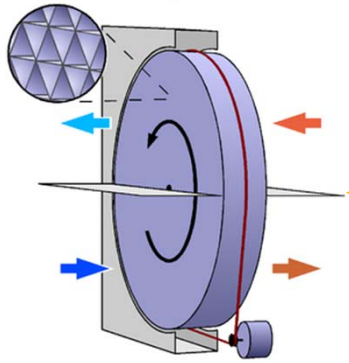
CHW

Cool Building

Cool Dry Air

Sensible Cooling

Dry Air



Latent Cooling

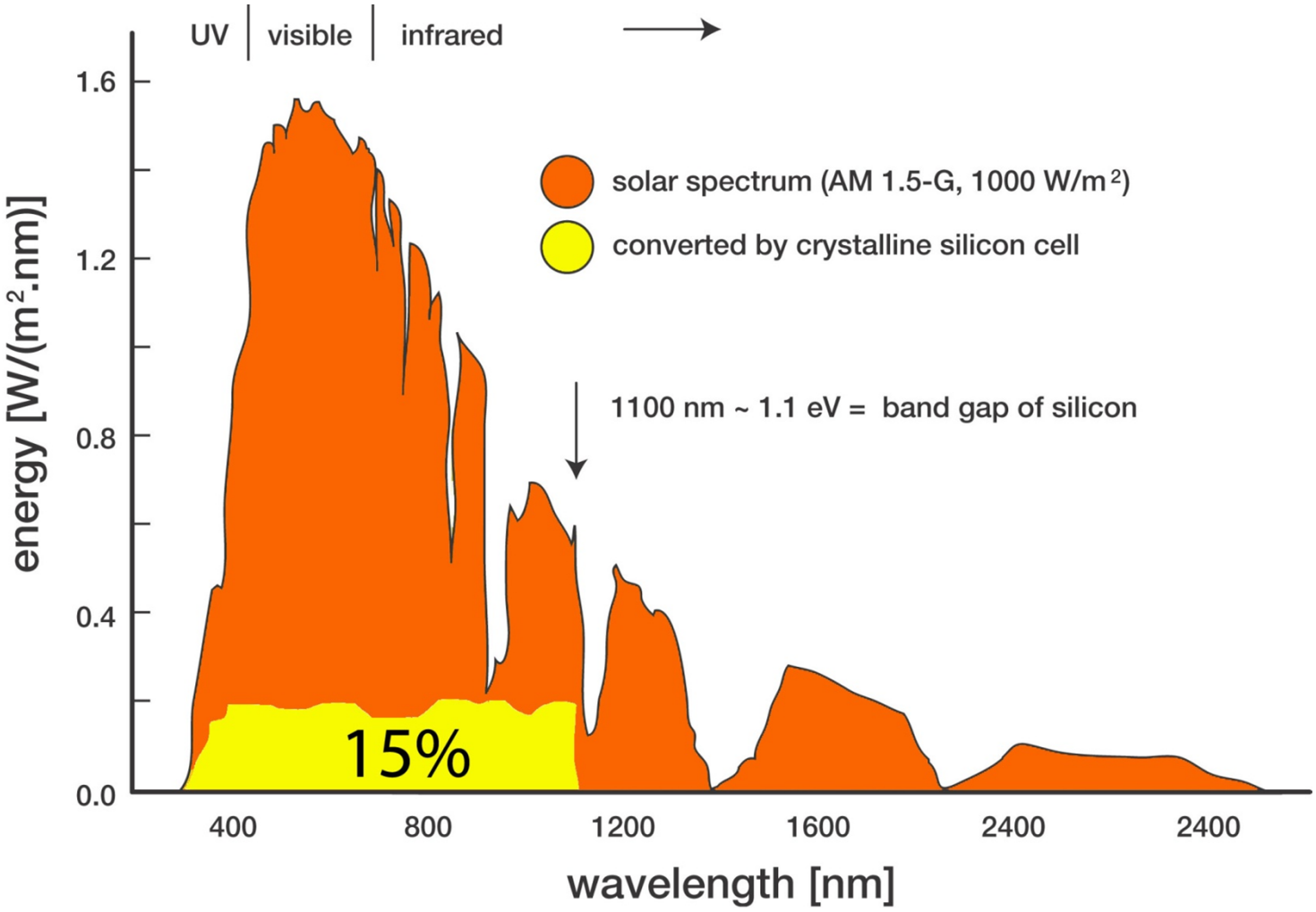
Hot Humid Air

Opportunity Summary

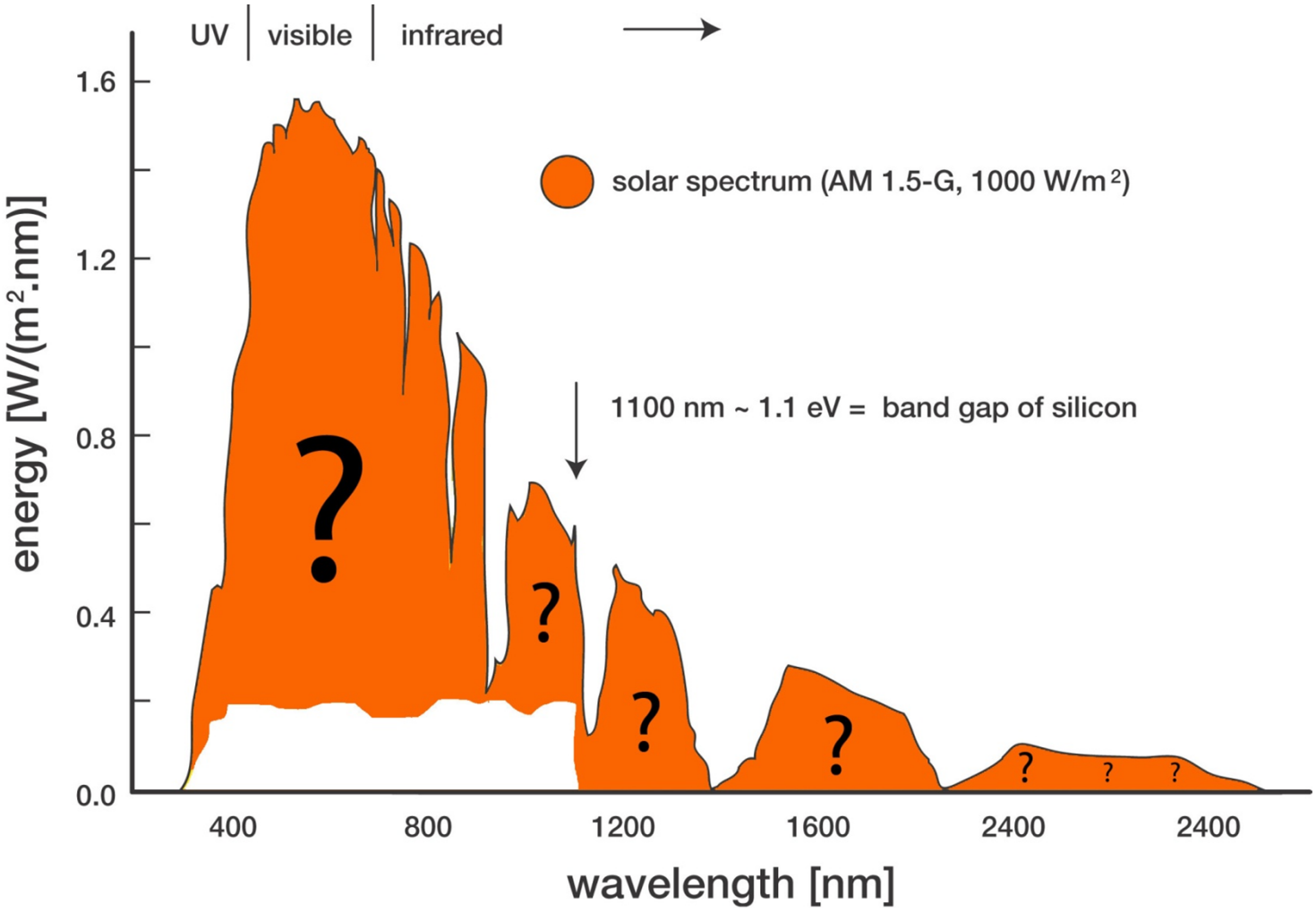
- Three market segments identified for Chromasun MCT product

Segment A	Segment B	Segment C
Process Heat Applications	**Solar Heat Pump Applications**	**Hybrid Applications**
• Hot Water • Heating Hot Water • Steam	• Chilled Water • Hot Water	• Electricity • Hot Water • Desiccant Cooling
Large market	Undeveloped market	Unknown market
Existing Solar Channel Partners	Inexperienced Channel Partners	Existing Solar Channel Partners

AM 1.5 Solar Spectrum – PV Capture

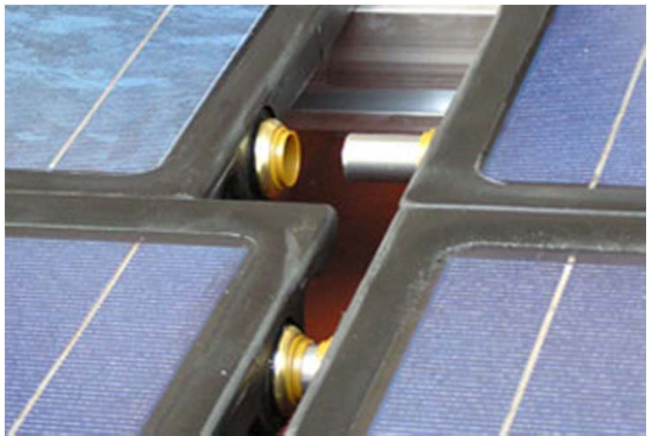


AM 1.5 Solar Spectrum - Unharnessed



Flat Plate PV-T

PVT Solar / Echo



Wiosun

Solimpeks

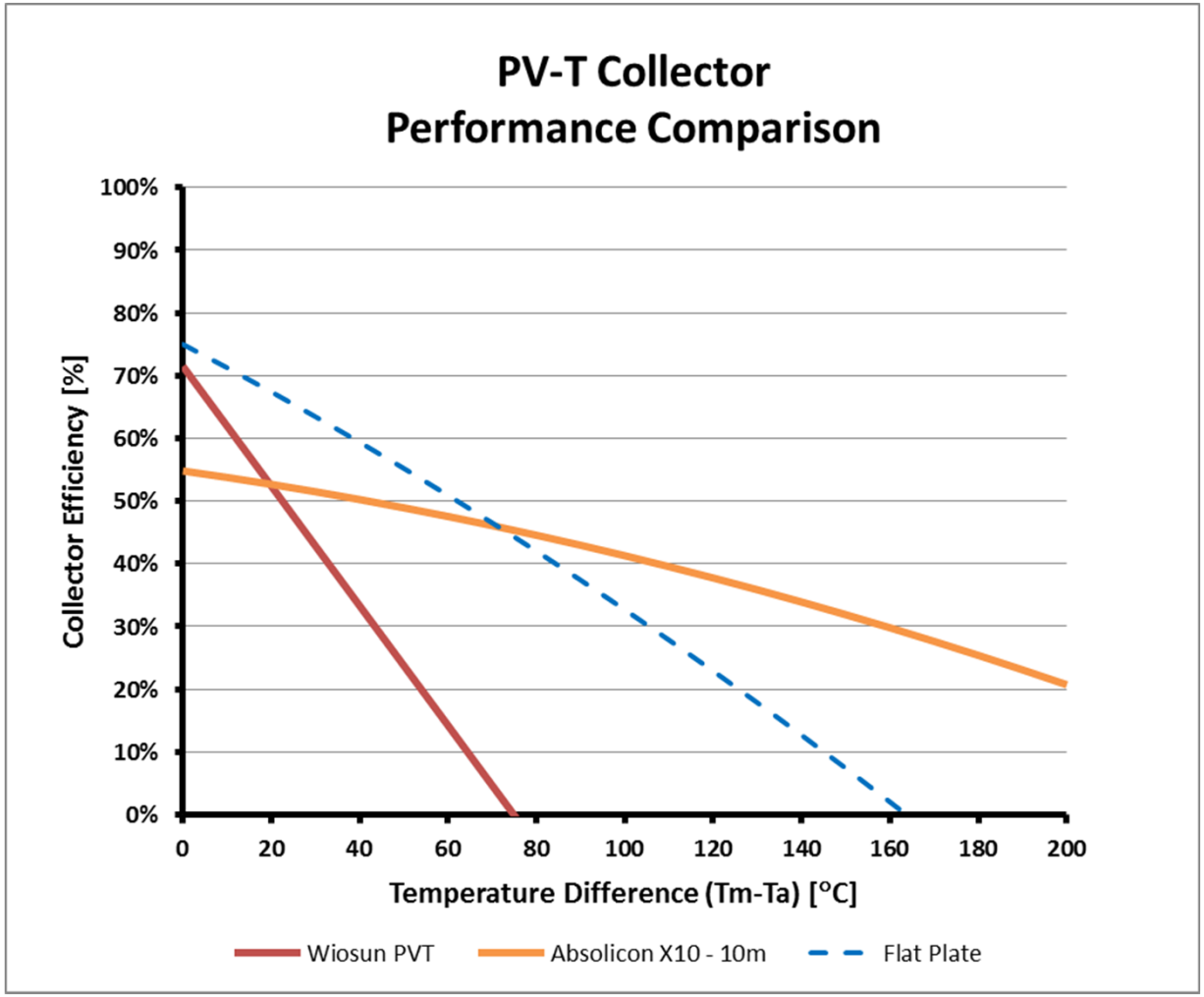
Linear Concentrating PV-T

Two-Axis Tracking PV-T

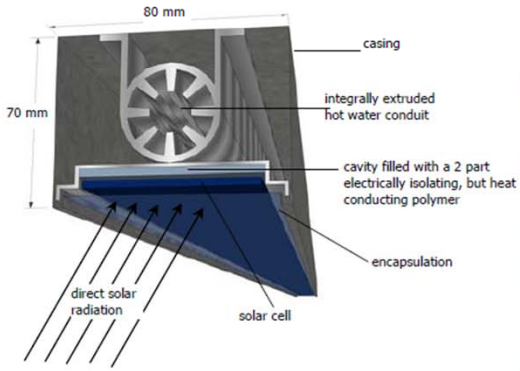
Solergy

Zenith Solar

Hybrid PV-Thermal Performance

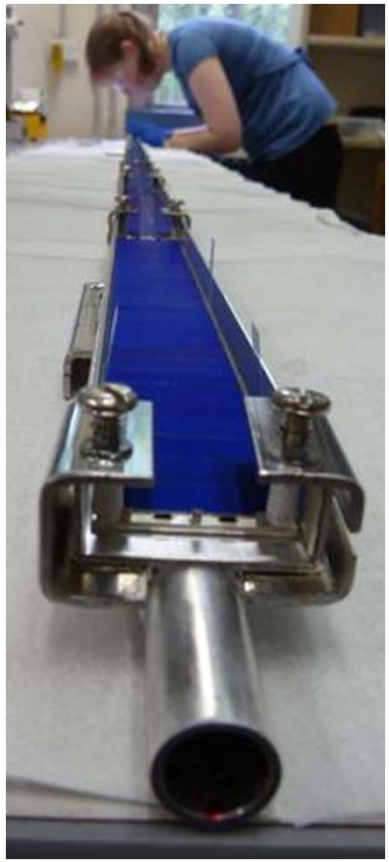


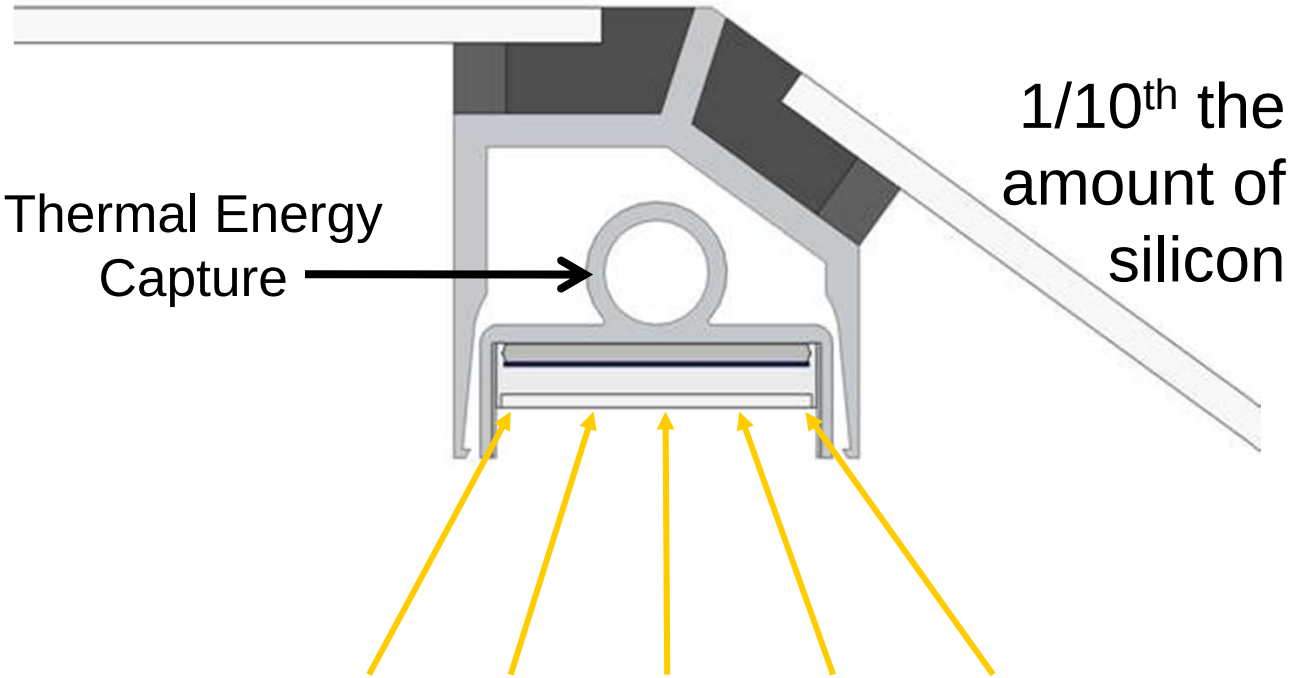
Australian National University – CHAPS (2004)



Hybrid-MCT (PV + Thermal)

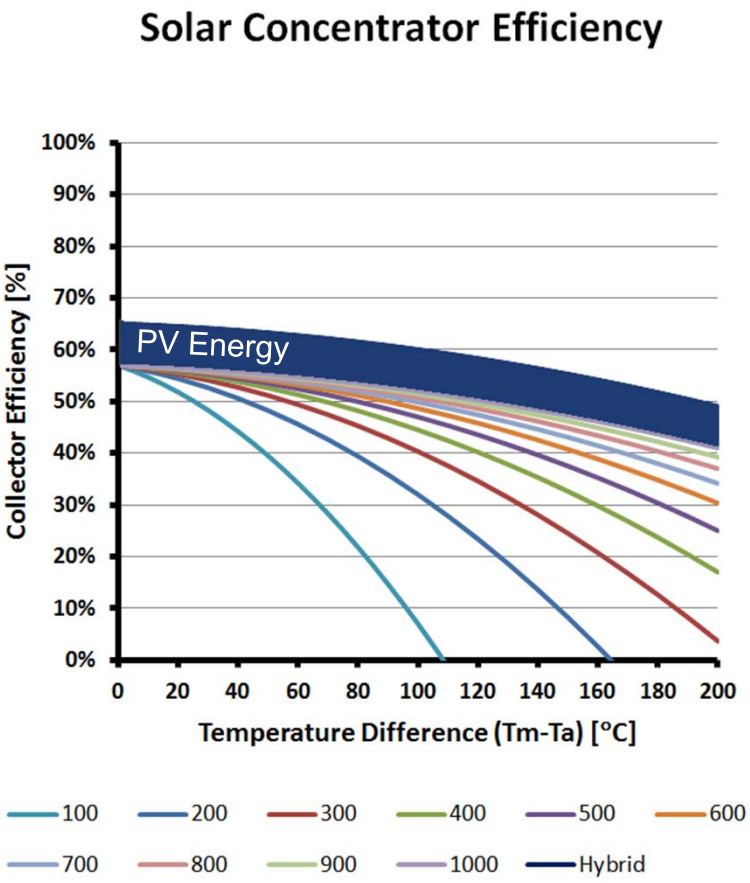
Concentrating PV receiver option for Electrical and Thermal Output (<90ºC)

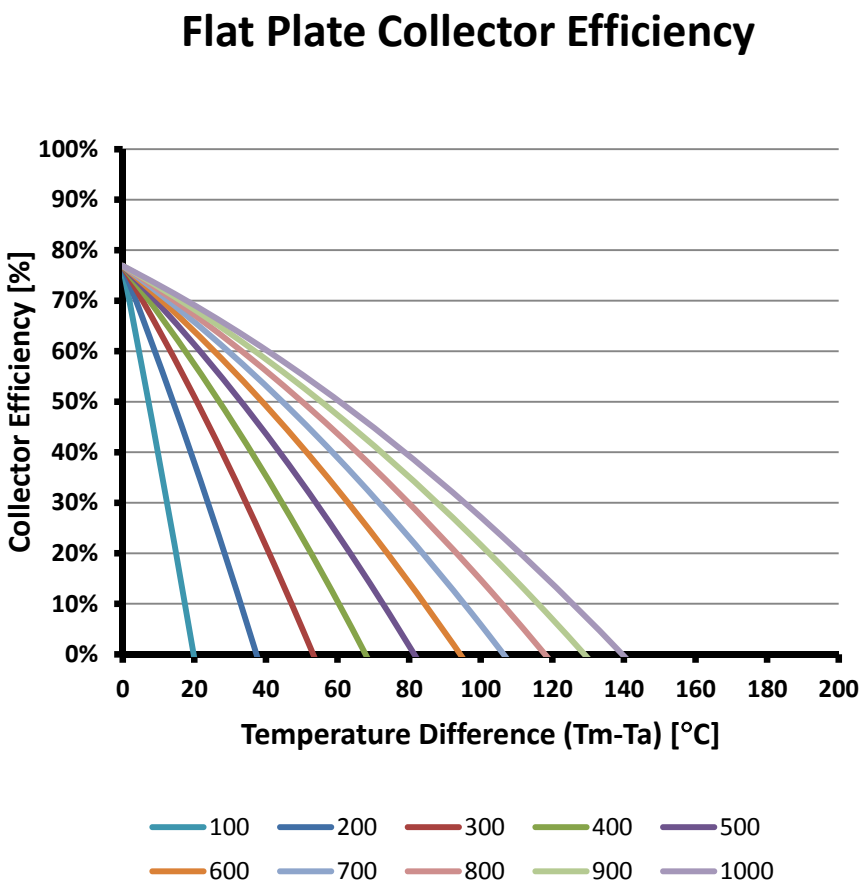




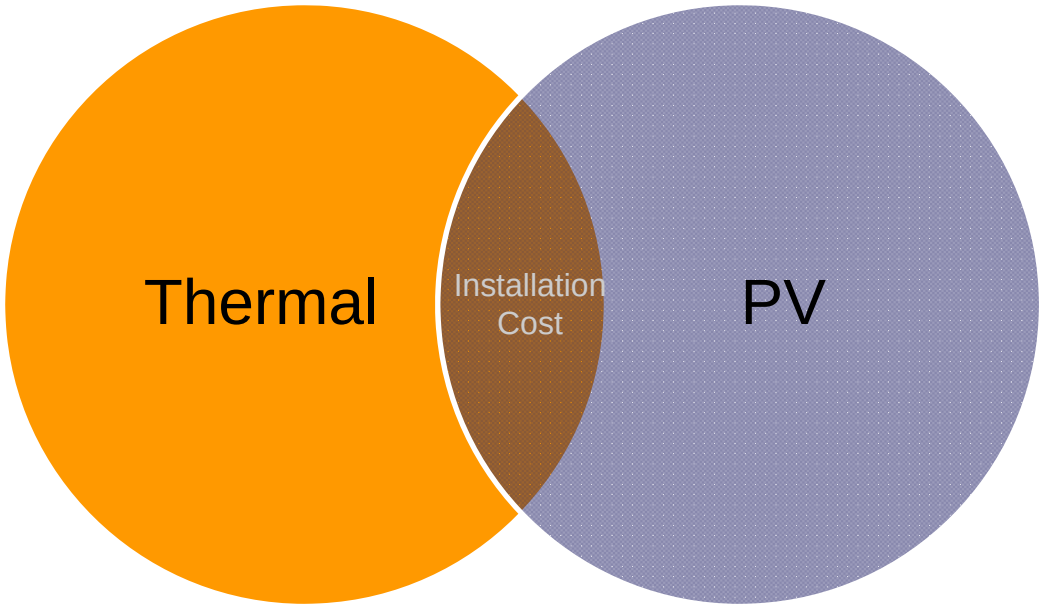
15% PV + 50% Thermal = 65% Total Yield
Diffuse Light is available for Day-lighting

MCT-Hybrid Efficiency





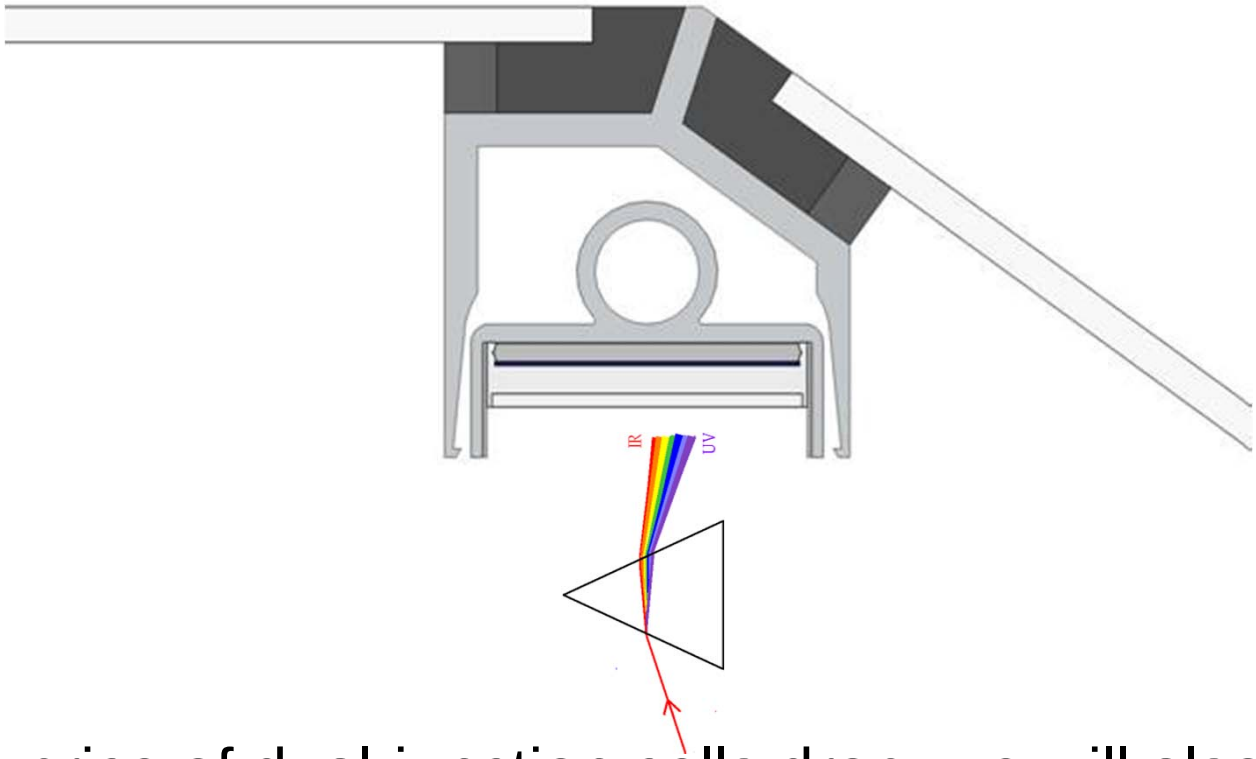
Shared Integration Cost



Technology cost is <<50% of the total system cost so coupling the installation of PV and Thermal together reduces the total installed cost ($/W) and ultimately LCOE

High Temperature PV-Thermal

In 2010, Chromasun won a $3.2M Grant in conjunction with the CSIRO, ANU and UNSW to develop high temperature hybrid (150ºC/300ºF)



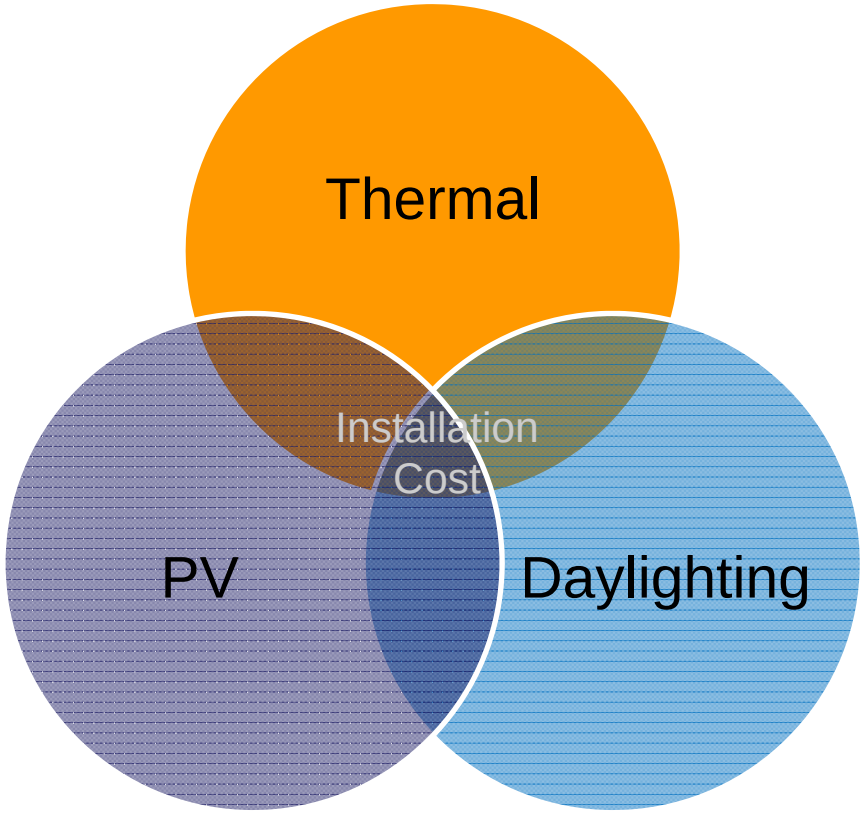
As the price of dual-junction cells drop, we will also be able to integrate these without (30% efficiency)

Rooftop Real Estate Grab

- Technologies vying for a space on the rooftop:
  - Solar PV
  - Solar Thermal
  - Day-Lighting / Sky-Lights

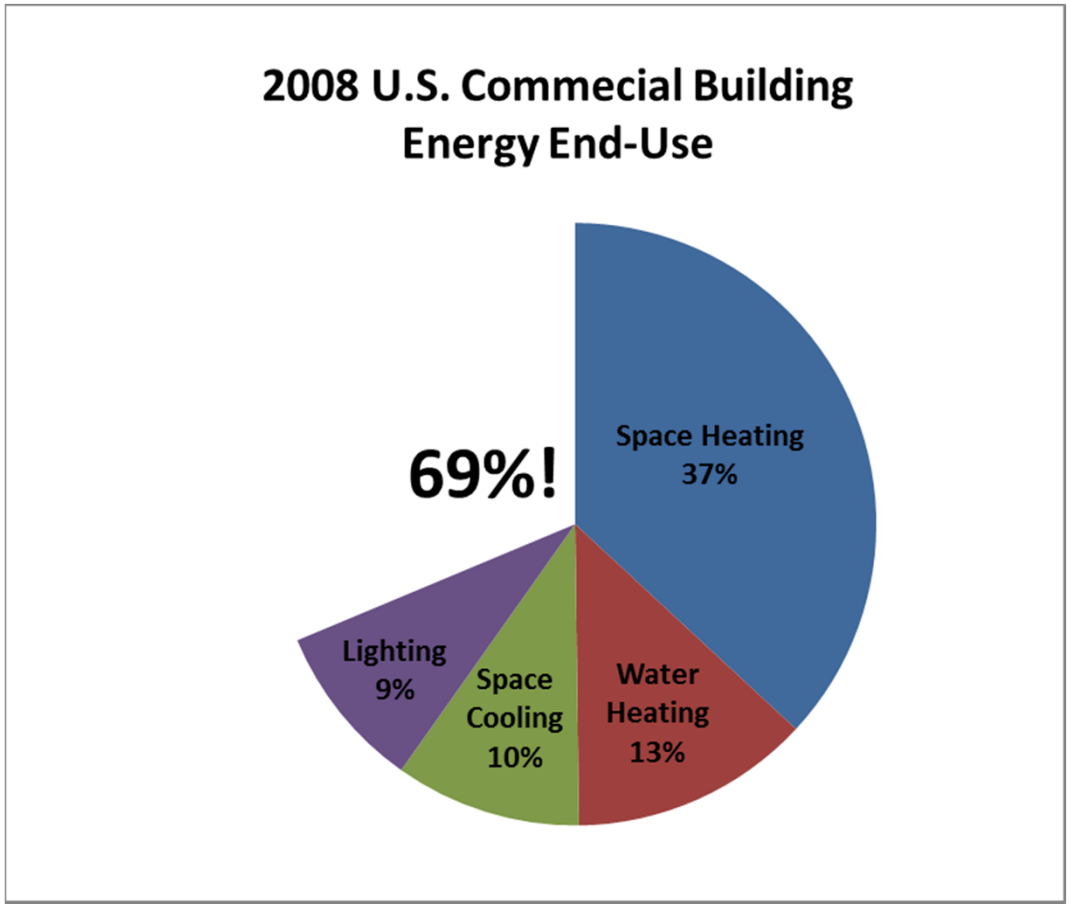
Day-lighting MCT

Shared Integration Cost

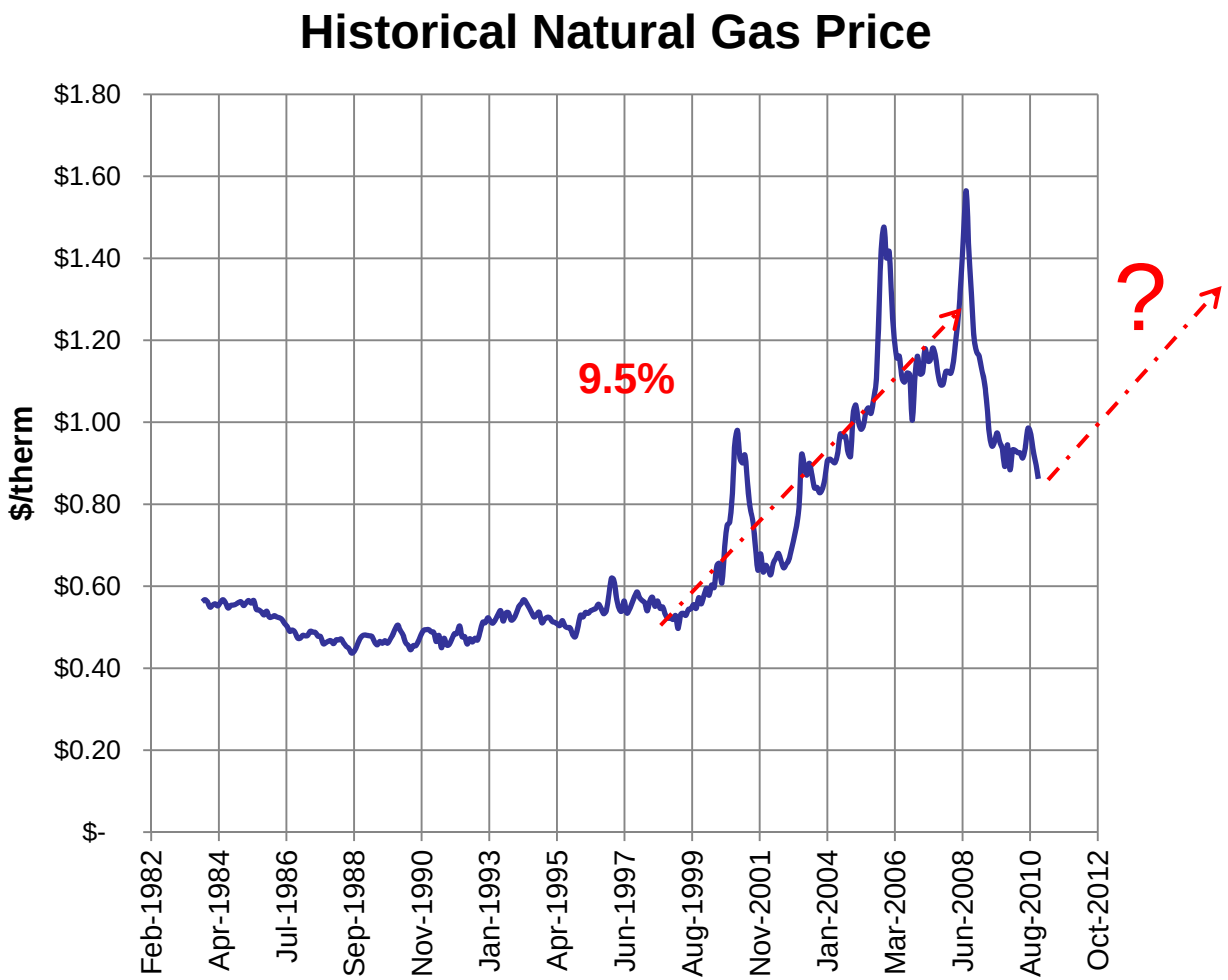


Integration cost could further be shared with the installation cost allocated for day-lighting

MCT Day-Lighting

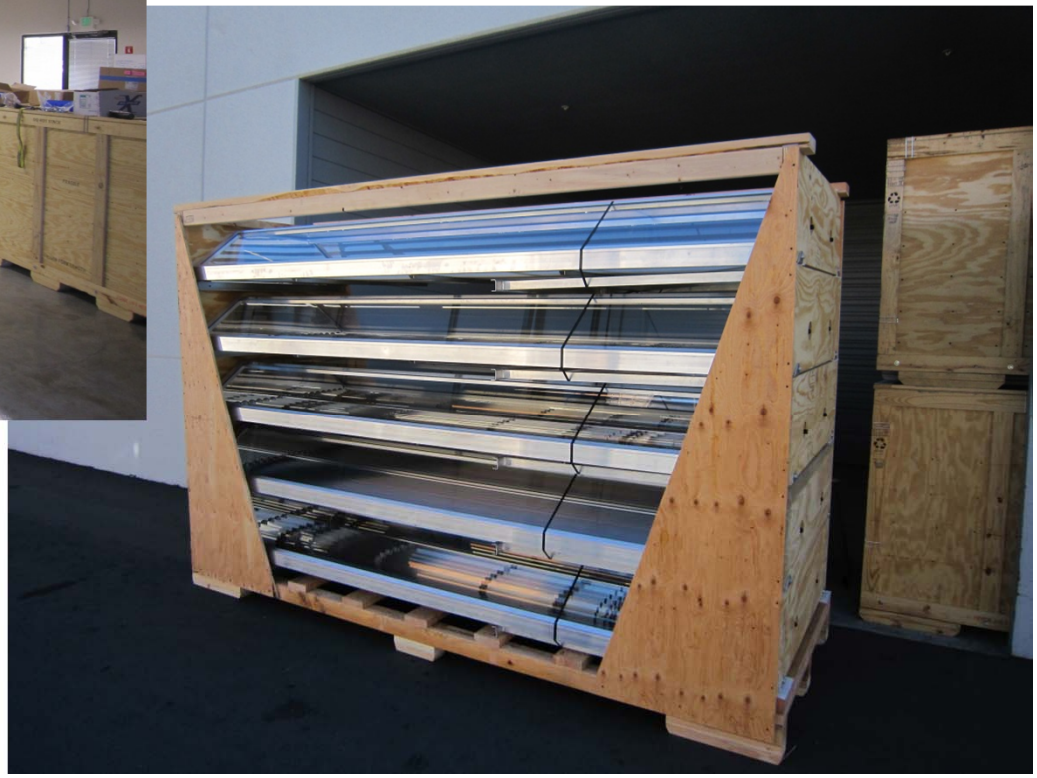


Thermal PPA's



- 30% Federal ITC
- 100% Bonus Depreciation
- CSI Thermal Rebate

Chromasun 10MW / Annum San Jose facility



Solar Thermal Summary

- The niche is a lot bigger than people realize
- Solar thermal has the ability to offset twice as CO_2 than PV
- Thermal Energy Storage can be used cost effectively to offset electricity and assist in the reduction of peaking electricity
- Hybrid PV-Thermal collectors are emerging that will enable both heat and electricity to be supplied to the building envelope from one product
- Concentrating Hybrid PV-Thermal products enable the delivery of useful heat

Solar Cooling Summary

- Solar resource and maximum solar thermal output correlates extremely well with peaking electricity
- Double-Effect absorption chilling using concentrating solar is the most space efficient way to cool a building on a rooftop
- Solar thermal also has a heat pump option
- Solar thermal paired with a heat pump can produce more than twice the energy than any other solar configuration and also is effectively a 160% boiler able to be co-fired on gas
- Desiccant cooling is an effective way to eliminate over-cooling and reheat as well as also reducing the net amount of sensible cooling done by traditional chillers

MCT Product Summary

- Chromasun MCT is based on existing CSP technology and over a decade of experience in large-scale solar
- Concentrating the sun's energy enables the MCT to consistently deliver up to 200ºC (400ºF) on the rooftop
- SRCC Certified
- MCT has flat glass and no externally moving parts, reducing O&M
- The delivery of higher grade heat enables compatibility with absorption chillers and thermally driven heat pumps
- Hybrid MCT to be showcased in Q4 2011
- Project financing available through Chromasun
- Company has only burnt $2.5M in funding in 3 years of product development. Targeting $10-12M funding round in Q3/Q4

THANK YOU

CHROMASUN

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