Renewable Energy Options for (Cambridge) Landlords

Photovoltaic (PV)
&
Solar Thermal Technologies

CAMBRIDGE ENERGY ALLIANCE

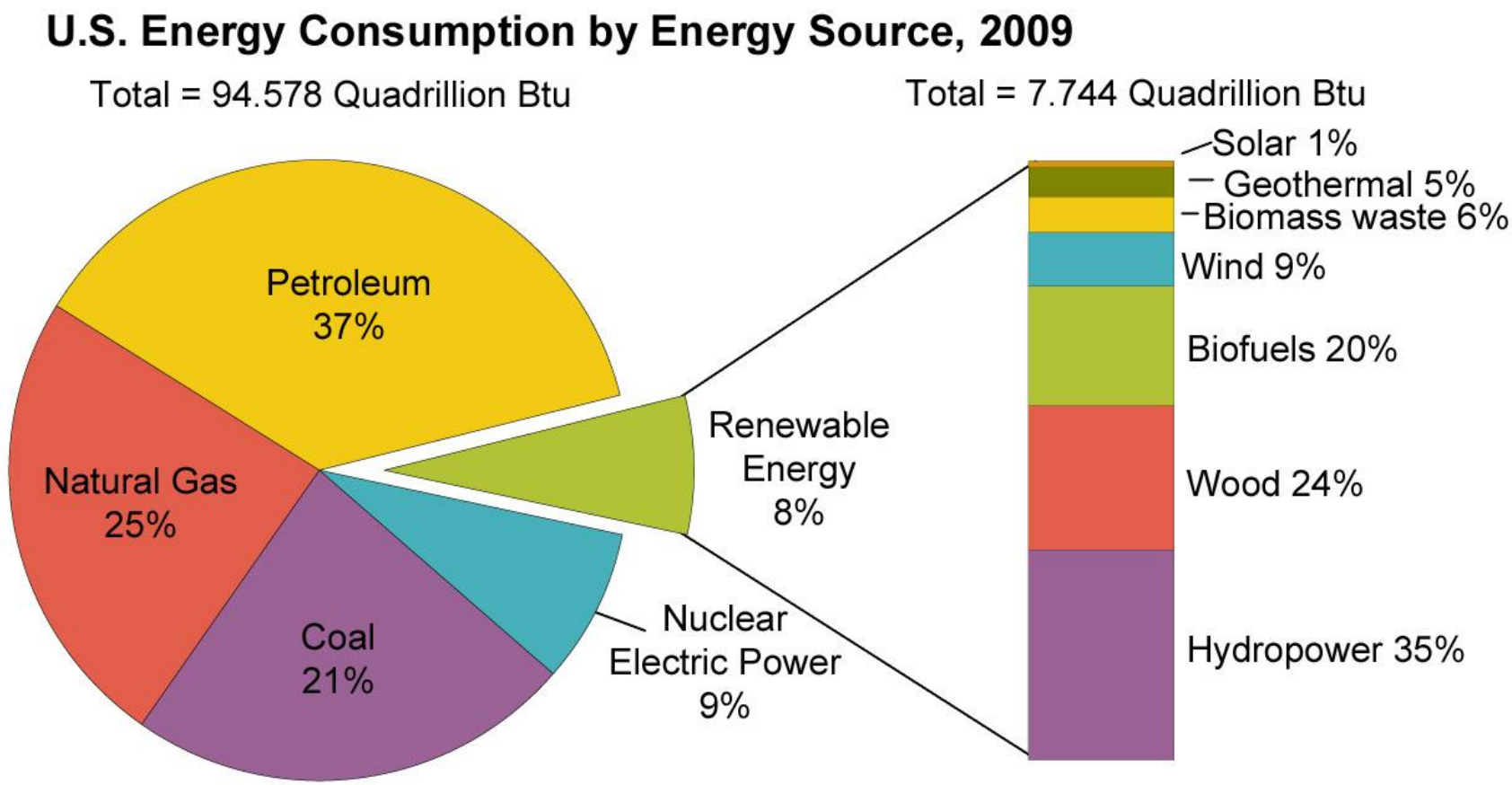
S+H construction
QUALITY • INTEGRITY • VALUE

Eric Lorenz, S +H Construction Renewable Energy Division

Overview

- Residential Energy Consumption
- PV Options – solar electricity
- Solar Thermal Options – domestic hot water
- Installer’s Role
- Landlord’s Role
- Tenant’s Role
- Benefits of Renewable Energy

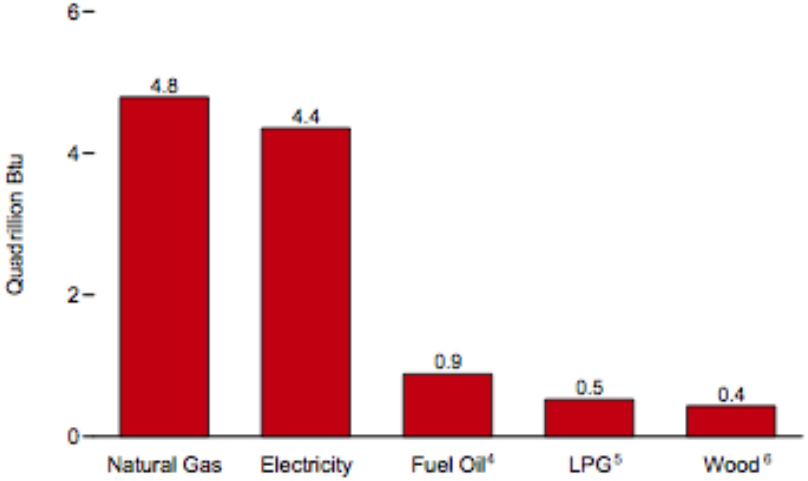
US Energy Consumption by Energy Source



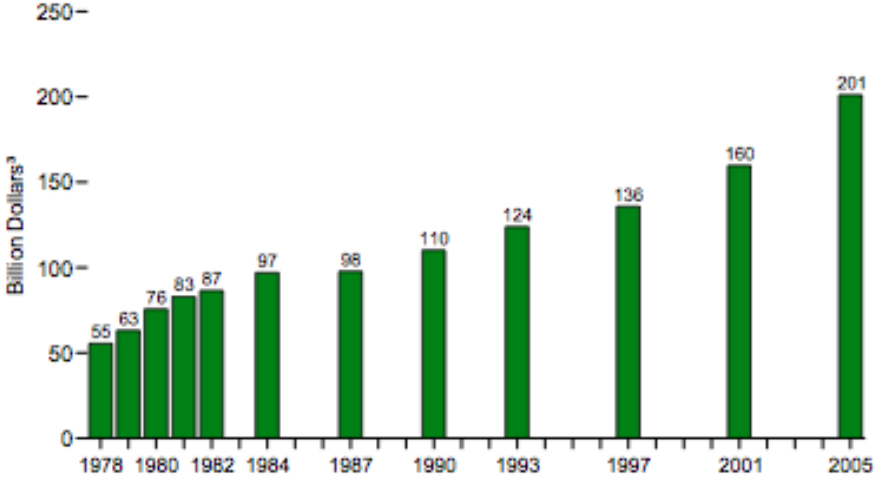
Note: Sum of components may not equal 100% due to independent rounding.
Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).

Figure 2.5 Household Energy Consumption and Expenditures

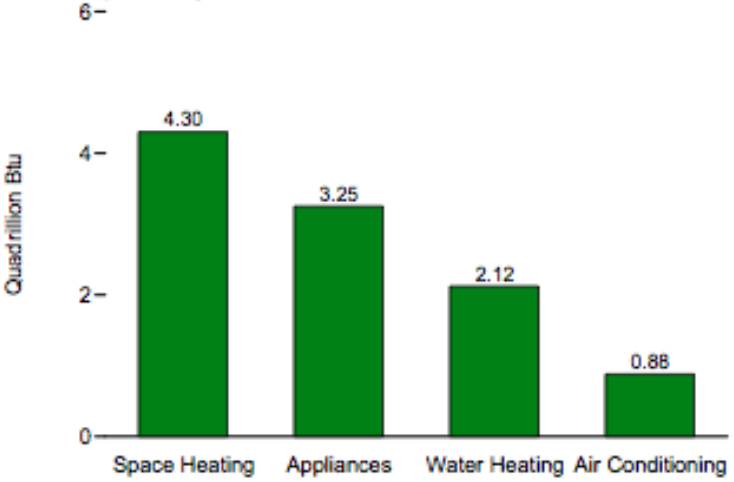
Consumption by Energy Source, 2005



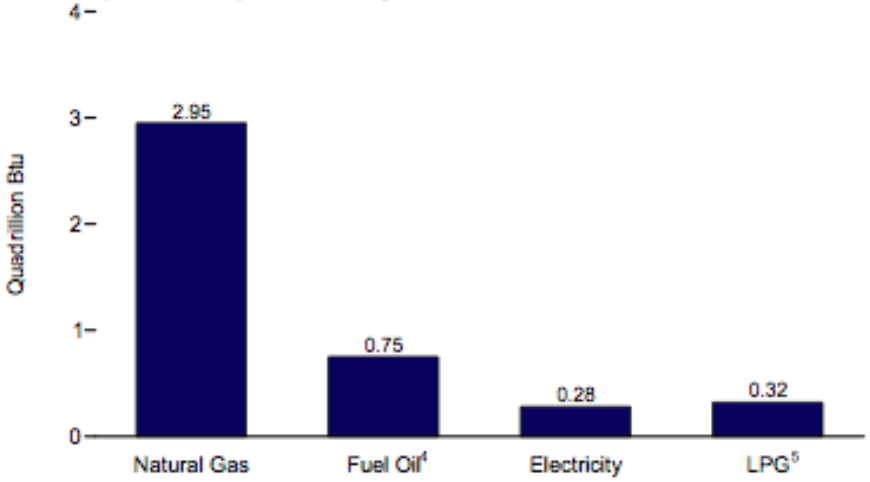
Expenditures[1], Selected Years, 1978-2005[2]



Consumption[1] by End Use, 2005

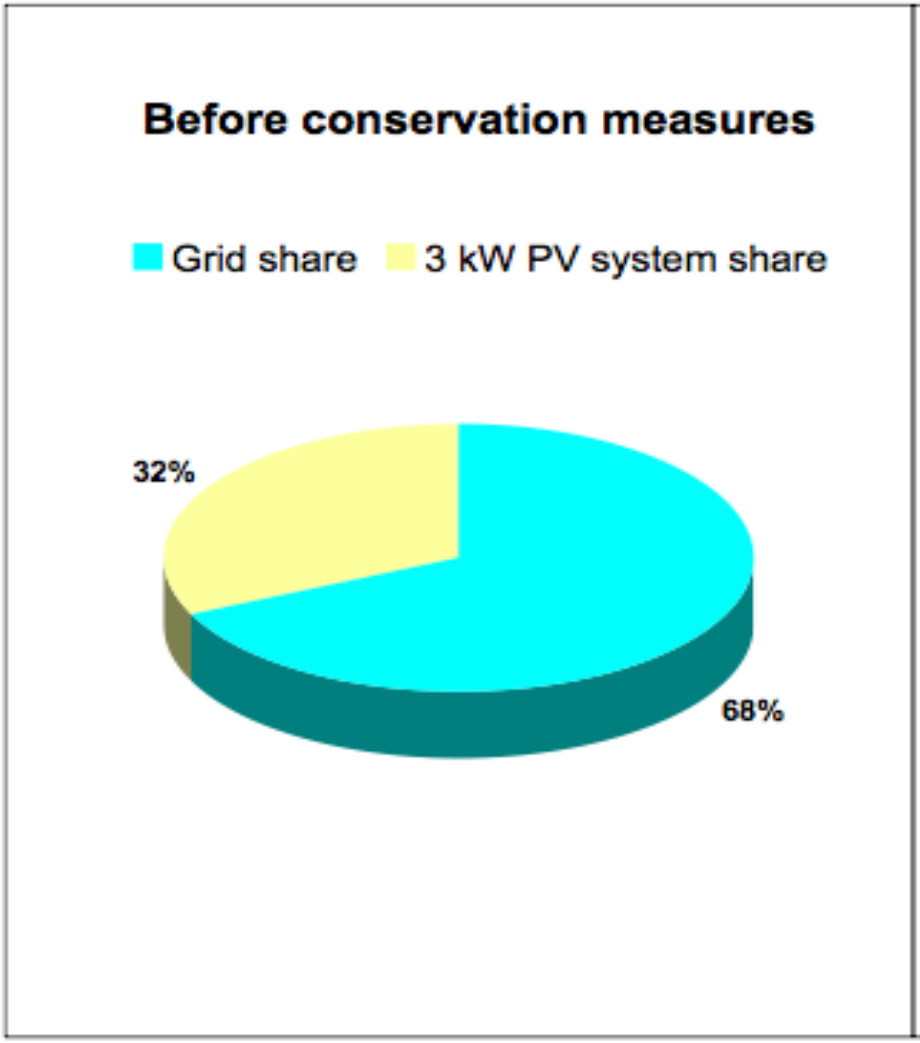


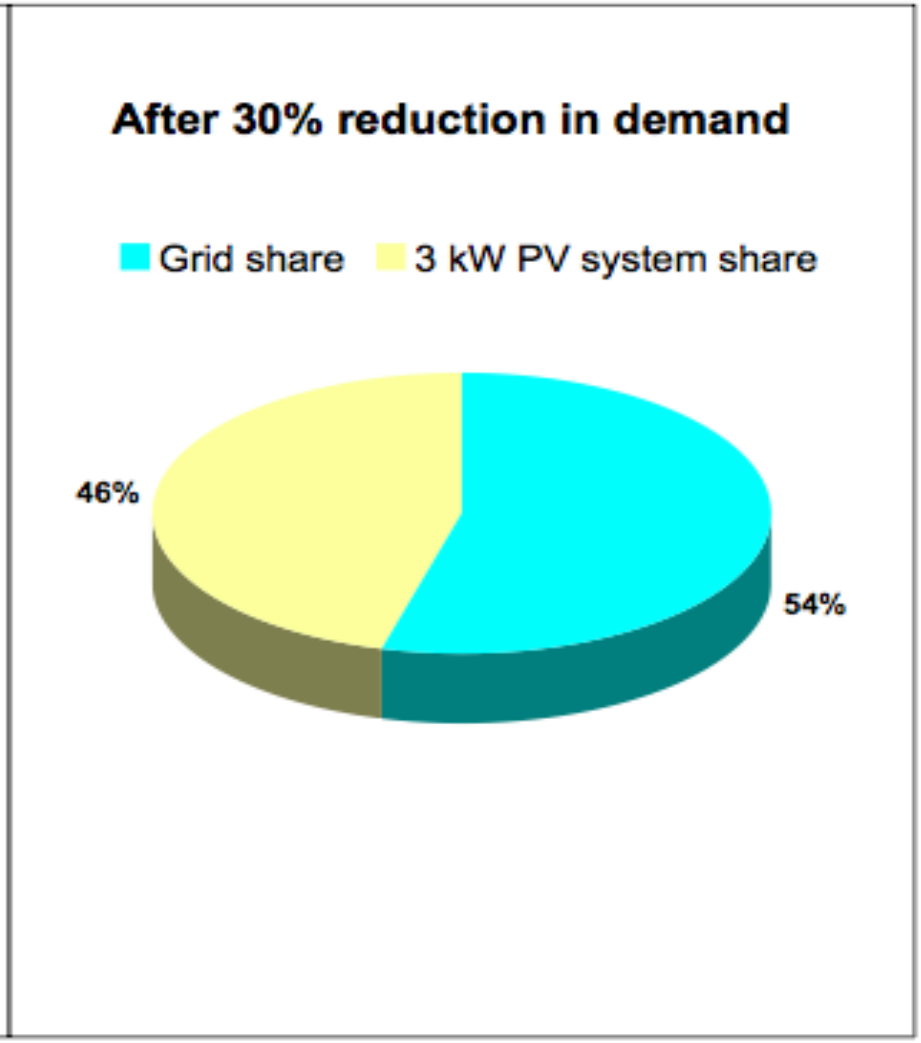
Consumption[1] for Space Heating, 2005



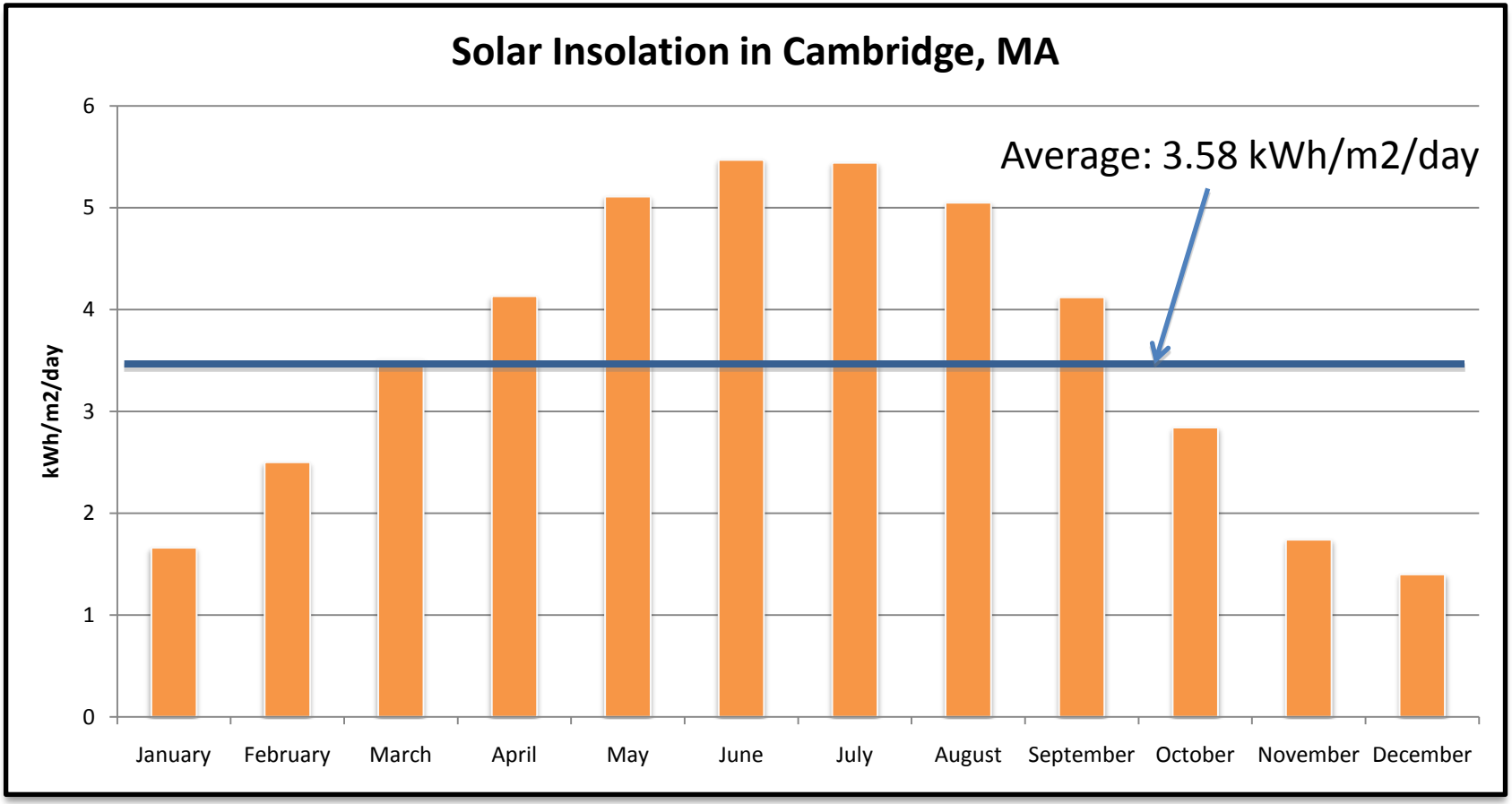
[1] Does not include wood, which is used for both space heating and ambiance.
[2] For years not shown, there are no data available.
[3] Prices are not adjusted for inflation. See "Nominal Dollars" in Glossary.
[4] Distillate fuel oil and kerosene.
[5] Liquefied petroleum gases.
[6] Used for both space heating and ambiance.
Source: Table 2.5.

Practice Energy Conservation First



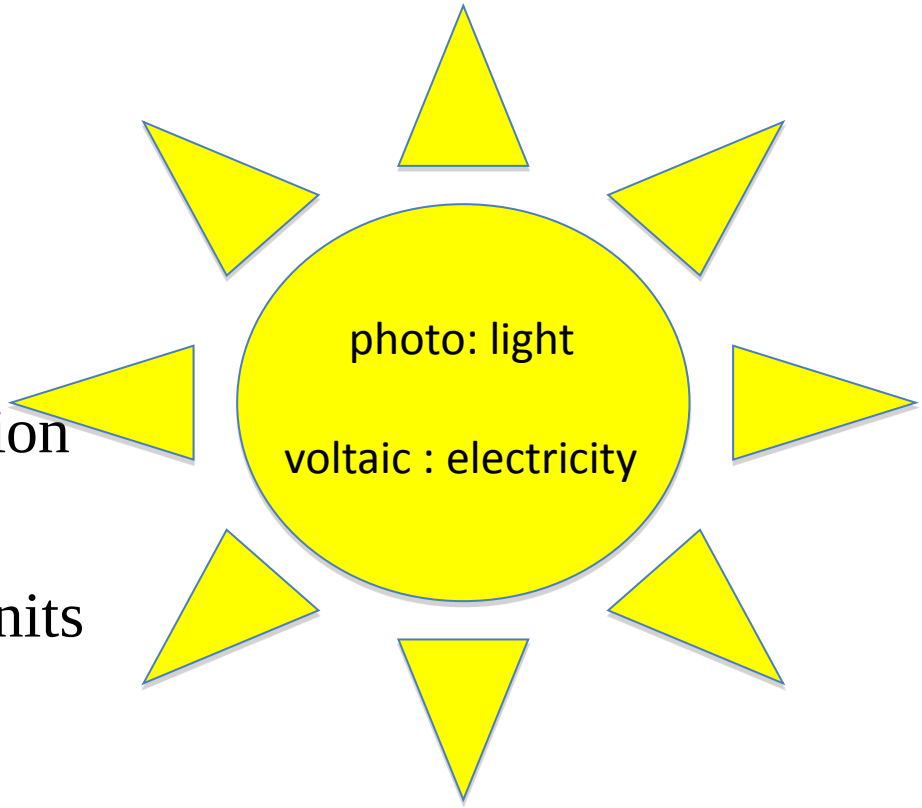


Solar Energy Potential – Cambridge, MA

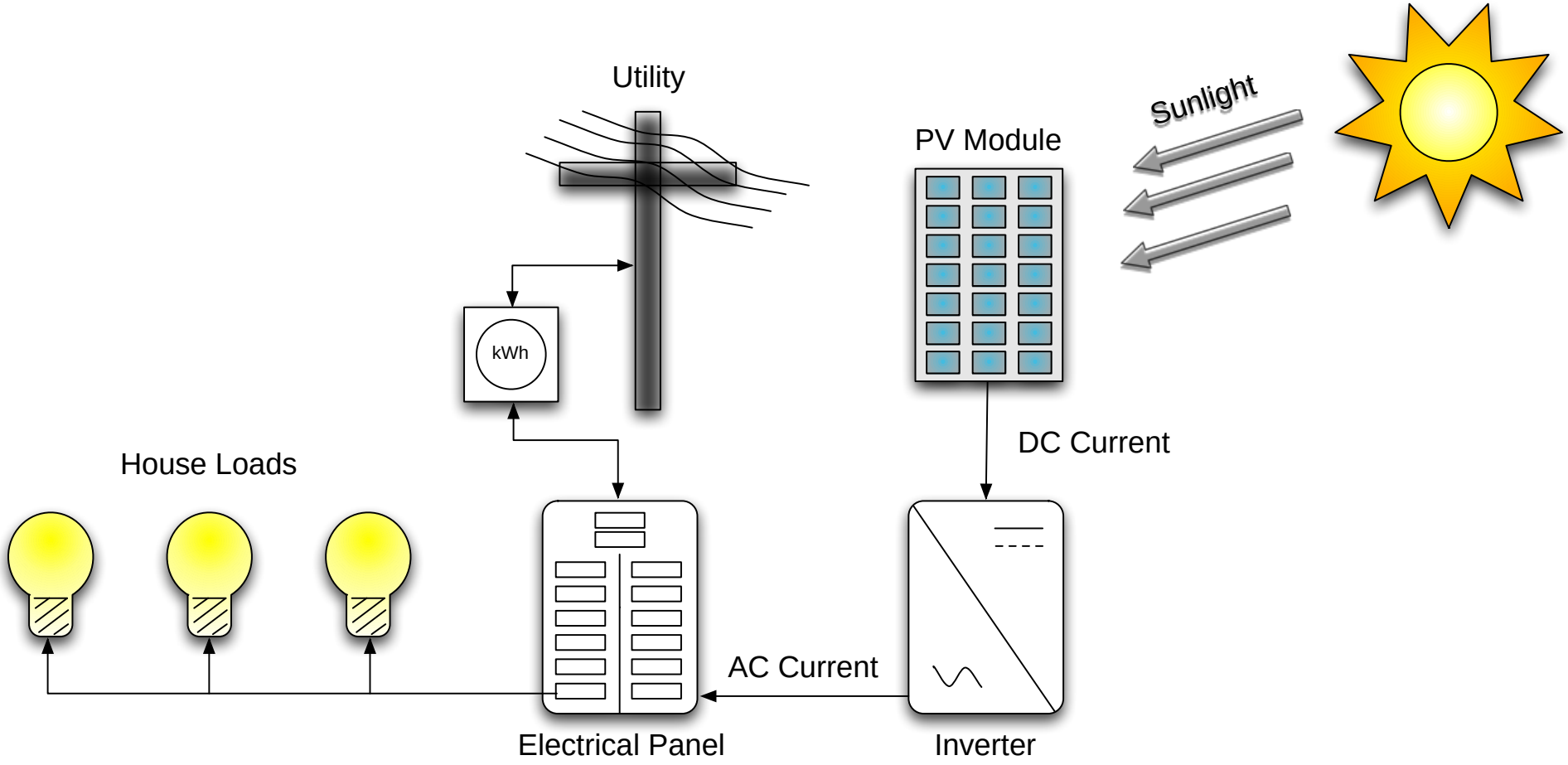


Photovoltaic Systems

- System overview
- System components
- Grid-tied system & installation options
- Integrating PV with rental units
- Installed systems –
  - Energy production



The sun's energy is converted to usable electricity for our homes



Parts of the PV Generation System

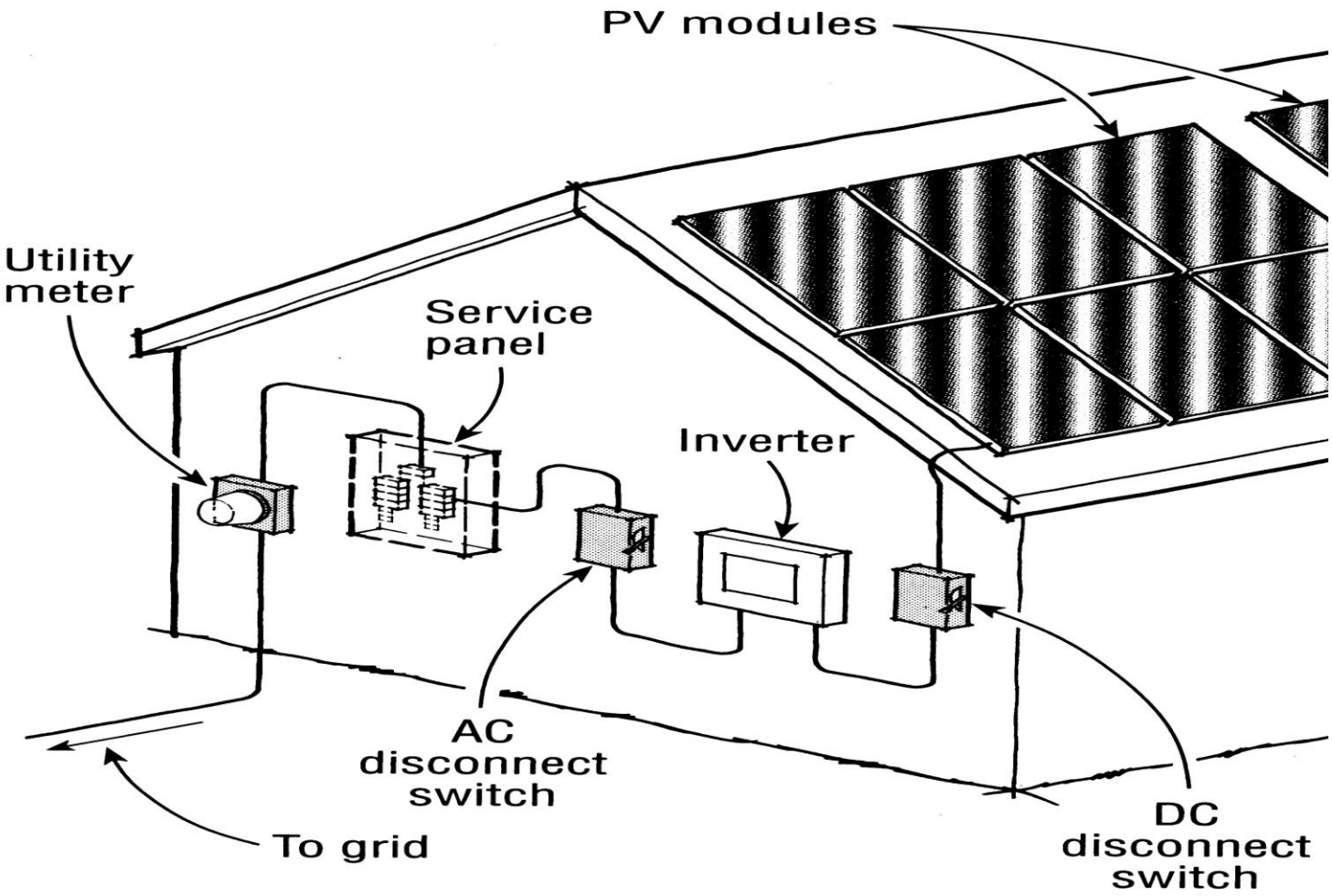


Image from Journal of Light Construction March 2005

Grid-Tied PV Systems

- Grid-Tied PV systems: solar electric systems that are interconnected to the electric utility
- Net metering: the net production/consumption of electricity is metered by the utility. Excess electricity fed to the grid is usually credited to the metered account at retail prices.
- If the grid goes down, the PV system shuts down
- Battery backup systems are an option, but will not be covered here

Array Locations and Mounting Methods

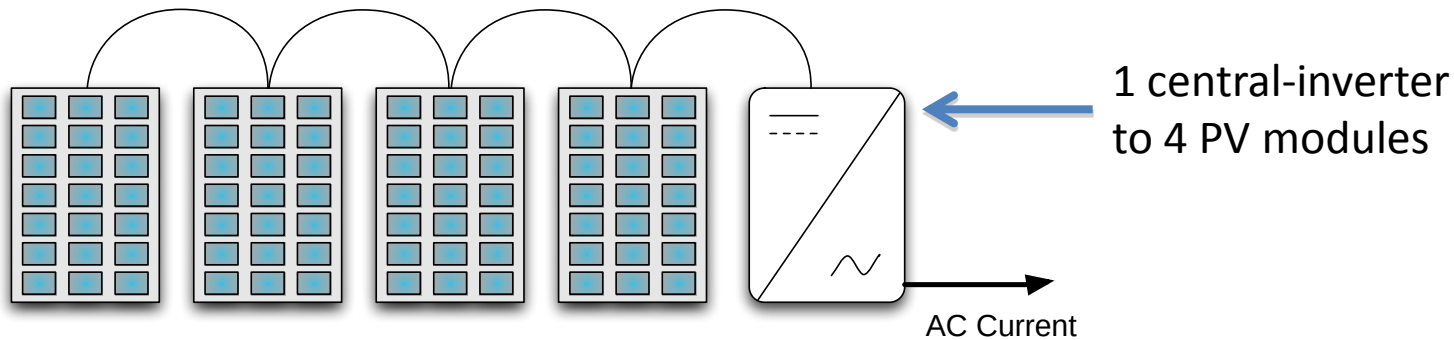
- Rooftop, pole or ground mounted arrays
- Fixed vs tracking

Rooftop Options

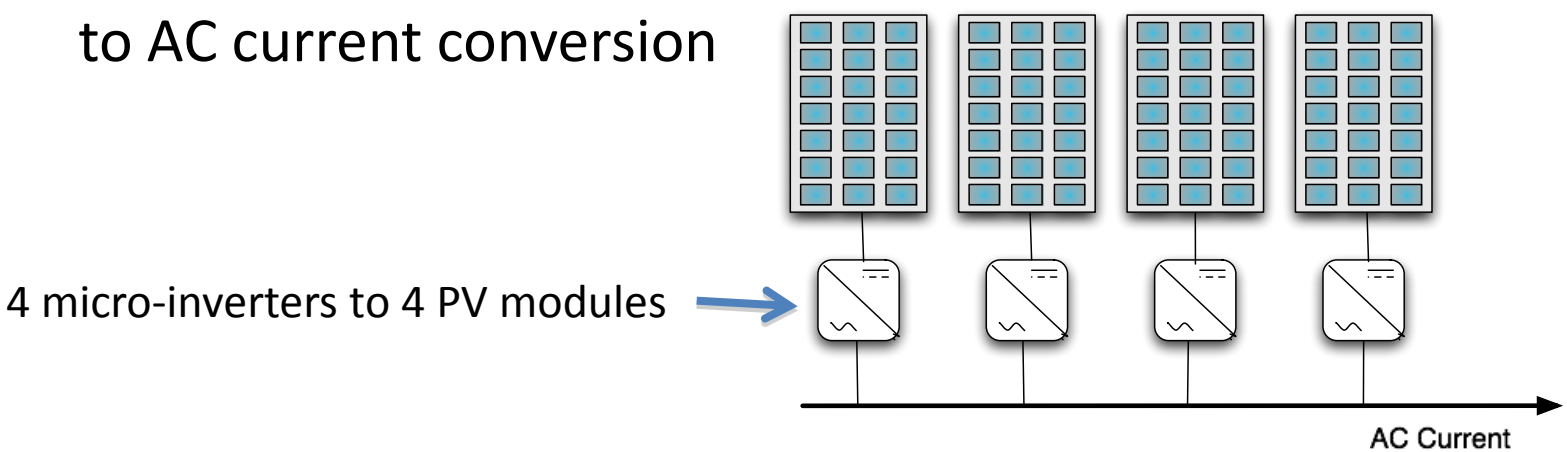
- Flush mounted – array installed parallel to roof plane
- Tilt mounted – modules tilted to increase overall PV system production
- Fastened vs ballasted racking systems
  - Fastened systems require many roof penetrations
  - Ballasted systems place more dead loads on roofing structures – they are heavy, but no roof penetrations, installed on large commercial flat roofs

Inverter Options

- Central Inverter: PV array output circuits meet at a single (or multiple) inverter(s) to convert the DC current to AC current



- Micro (distributed) Inverter: one inverter per module for DC to AC current conversion



Central vs Micro

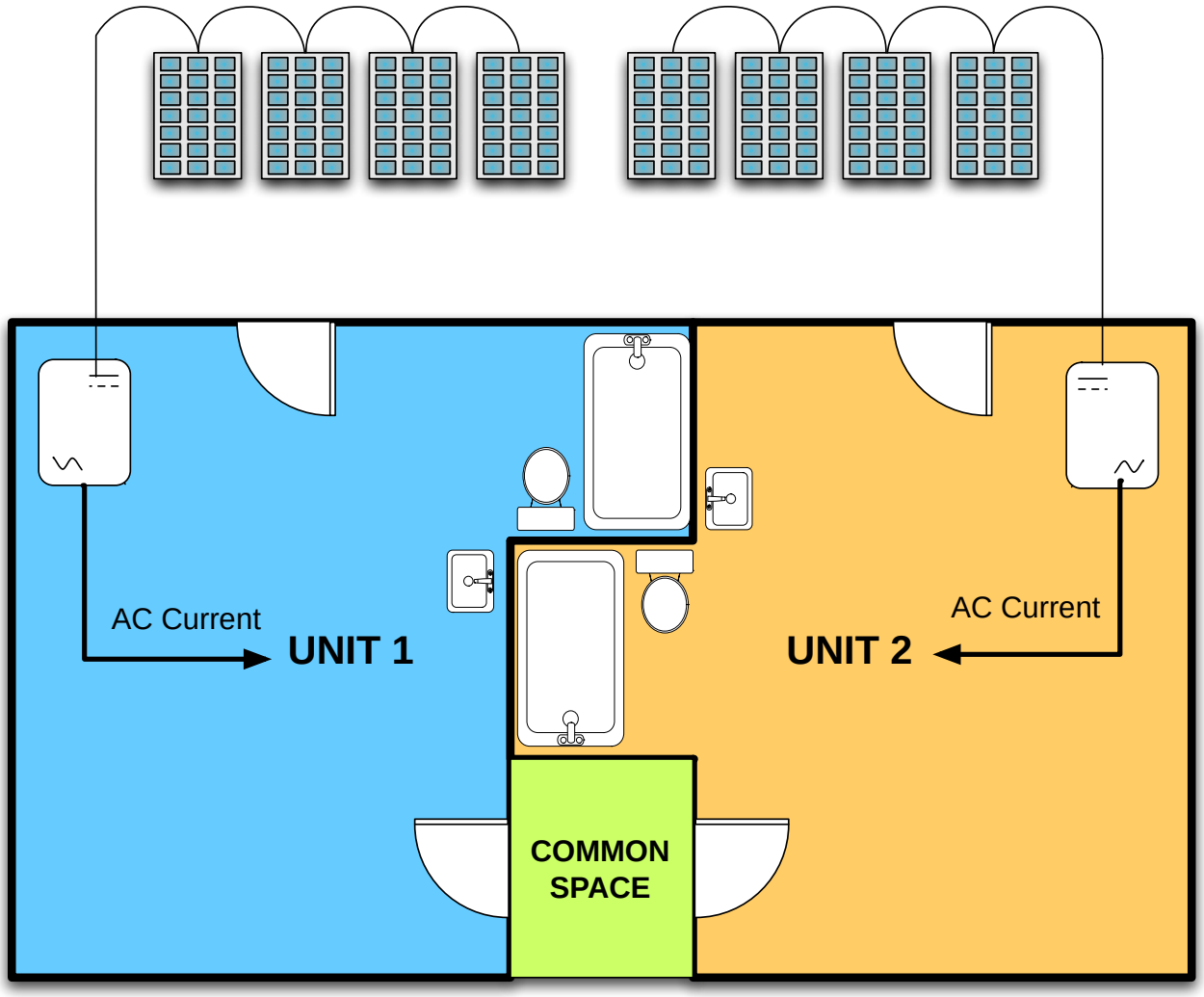
Central	Micro
Pros:	Pros:
• Better suited for larger systems • One point of maintenance	• Module level MPPT tracking • Better array production values when partial shading occurs • Allows for multiple azimuth and/or tilt arrays
Cons:	Cons:
• Partial shading can have a dramatic affect on array production values • Do not allow module-direct monitoring	• Maintenance on larger and/or difficult-to-access arrays


DC Disconnect
SOLECTRIA
UAT131-XQF

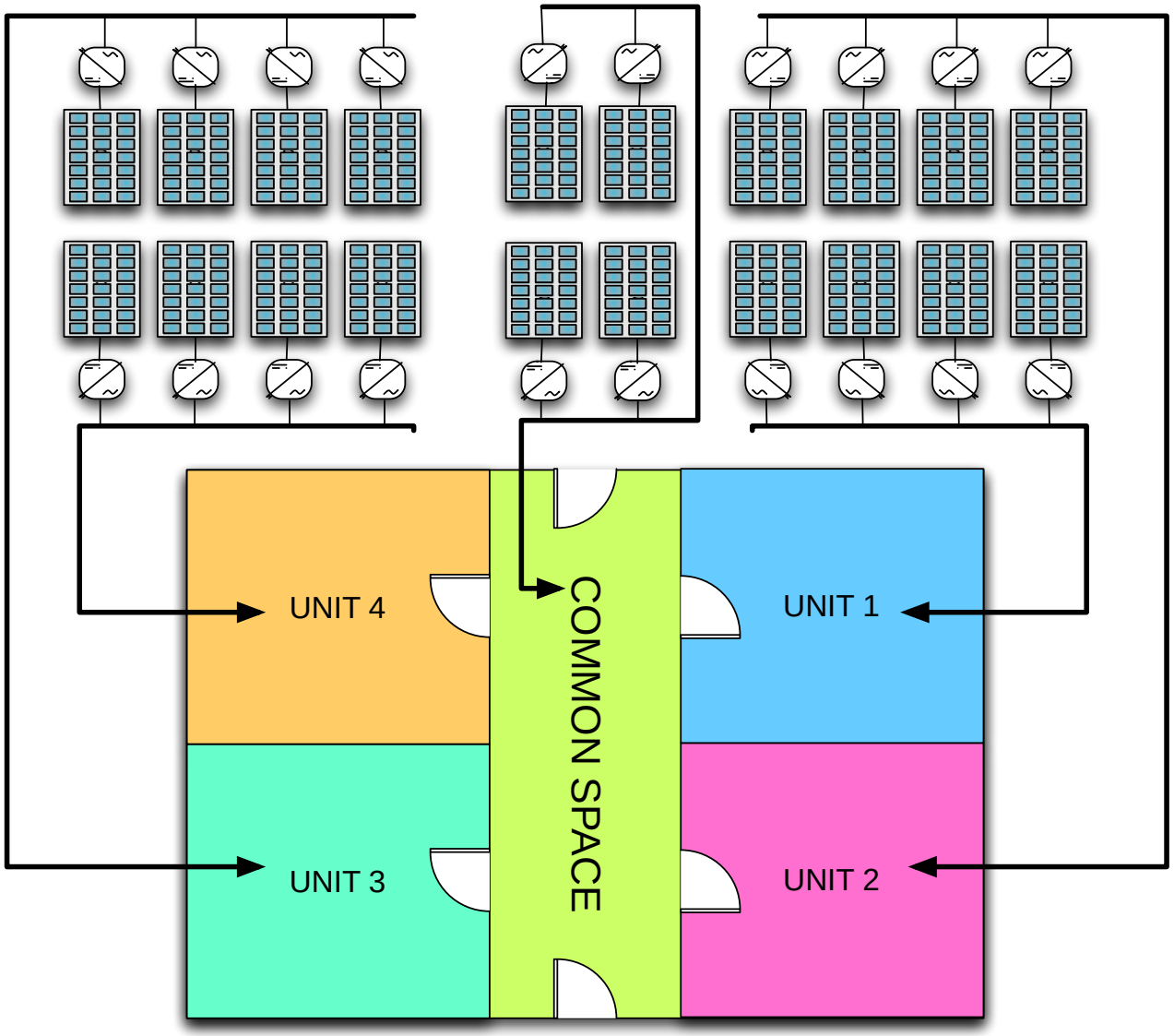

enphase
ENERGY

PV Systems for Multi-Unit Buildings

1 Array 2 Inverters, 2 Meters



1 Array (20 modules) 20 Inverters, 5 meters



Example SolrenView Monitoring System

Solar

[Refresh in 14:59]

System Info

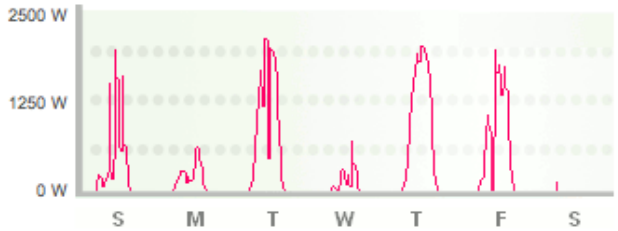
Location

Monitoring Started Fri Aug 21, 2009

Installer S+H construction inc. QUALITY • INTEGRITY • VALUE

Inverter Models	Inverter WAC	Qty.	Total Capacity (WAC)
Solectria PVI 2500	2500	1	2500
Solar Modules	**Module WDC**	**Qty.**	**Total Capacity (WDC)**
Sanyo 200	200	12	2400

AC Power- Past 7 days- Inverter-Direct



[Site picture not yet available]

System Status Now *[Sat Mar 19, 2011 8:31 am EDT]*

Online *[last update: Sat Mar 19, 2011 8:26 am EDT]*

System Status, Inverter-Direct :	**Active**
Energy generated today:	**0** kWh
Lifetime energy generated:	**4185** kWh
Lifetime CO_2 emission offset:	**5231** lbs
System AC power now:	**318** W

View Inverter-Direct

Solar Thermal Systems

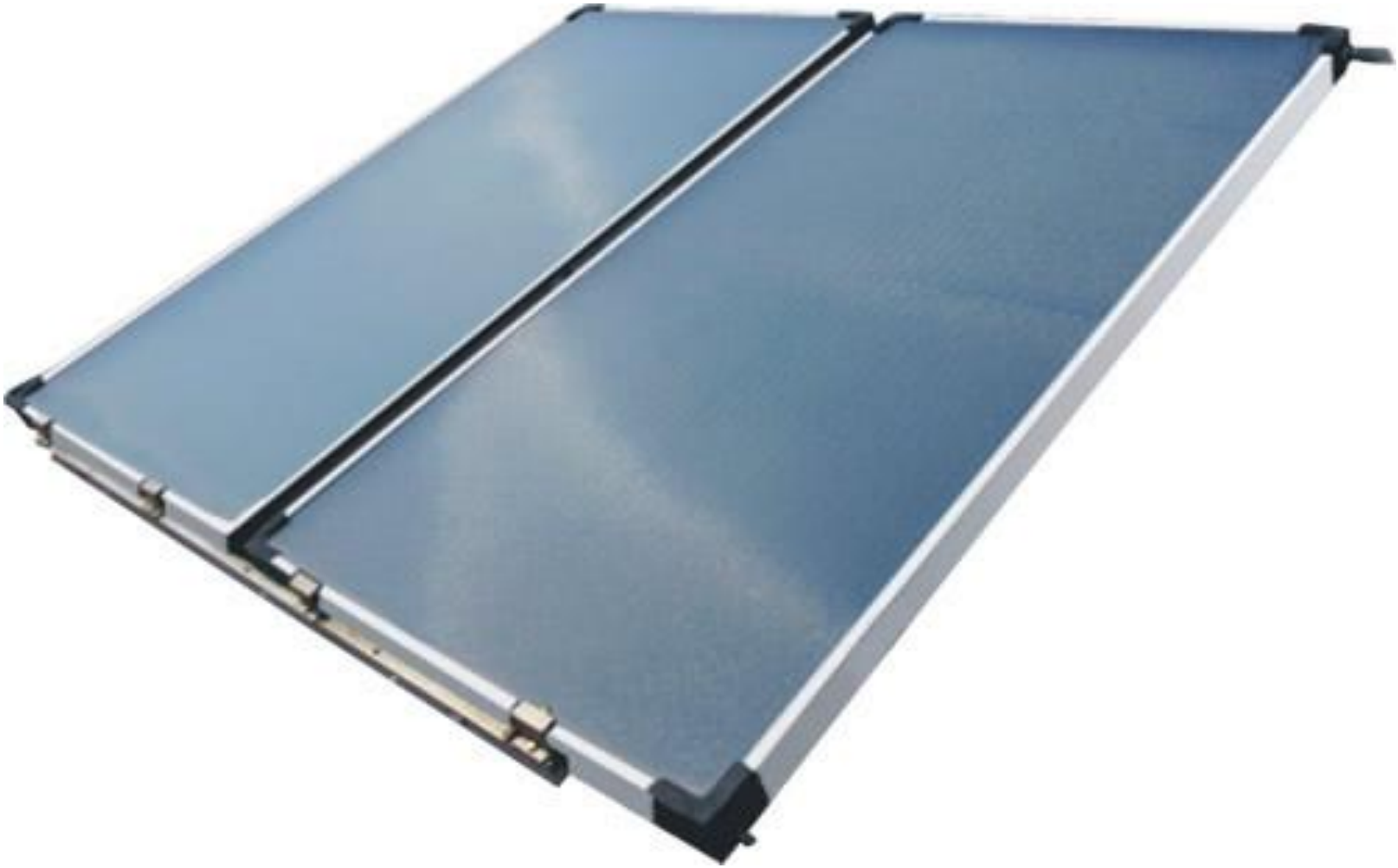
- System overview
- System components
- Integrating Solar Thermal with rental units
- Installed systems –
  - Photos
  - Energy production

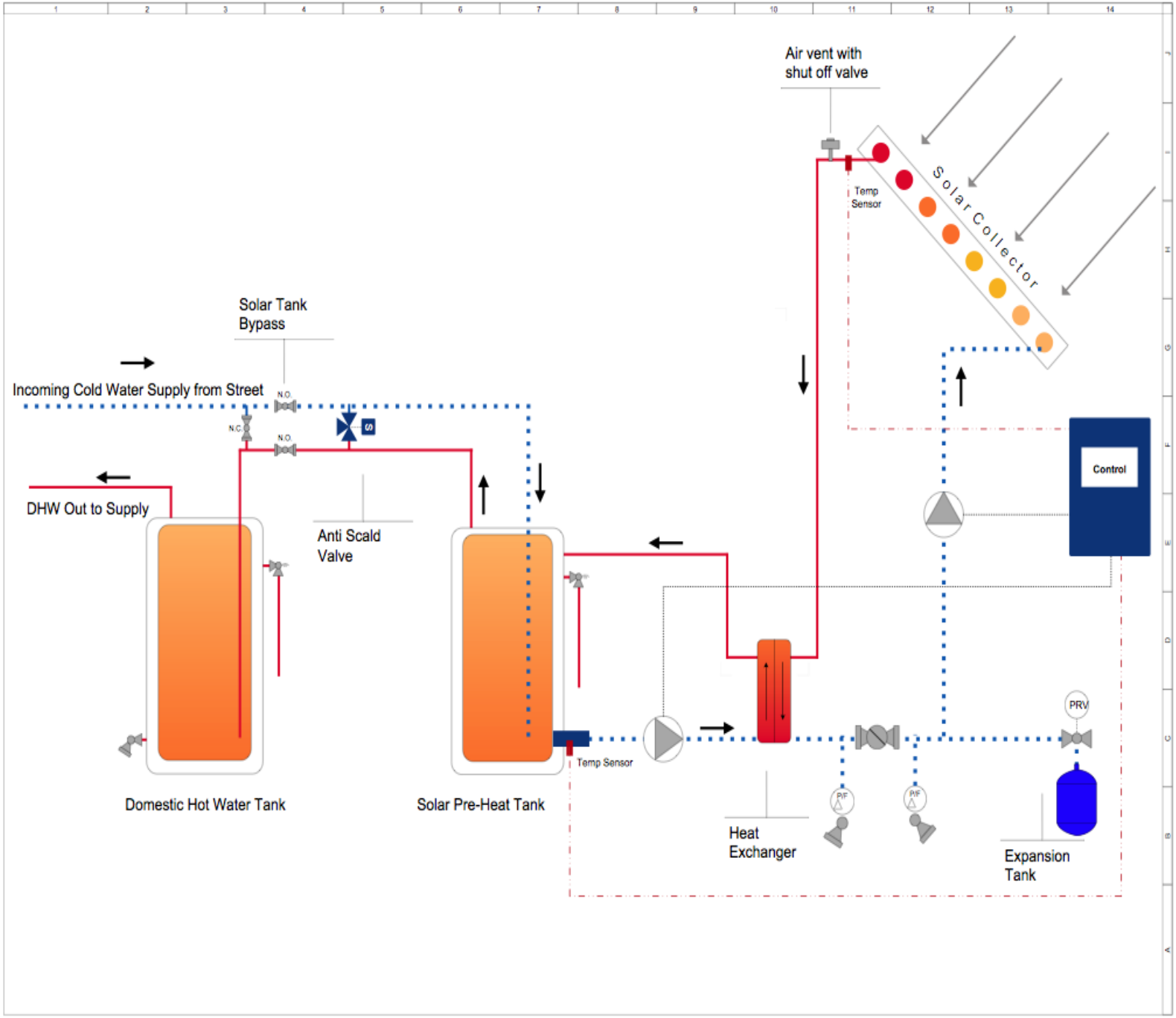
Solar Thermal Domestic Hot Water

- Roof or ground mounted collectors warm up a heat transfer fluid (HTF) that warms up a solar water storage tank. The HTF is separated by heat exchangers from the potable water in the tank. Water from the street is diverted through the pre-heat tank then into the regular domestic heater.
- The generic system makes roughly 95+% of the summer load and 35% of the winter load. Plus it provides some backup hot water, more storage, is small, simple, reliable, and inexpensive.
- Rough costs after incentives $5,000 to $8,000.
- Collectors take up between 4’ x 8’ and 10’ x 10’ of roof space.
- Flat panel or evacuated tube collectors? This is an esoteric argument. Both work fine. Your solar guy will undoubtedly have an opinion - let him make the case.

Solar Thermal Domestic Hot Water *ctd*

- Drainback or closed loop? Drainback systems essentially turn off and drain the collectors unless there is sun energy to harvest and somewhere to put it in the house. Great for oversized solar heating systems. More pump energy at start-up, hard to pipe, must use flat plates, might take more space in the mechanical area.
- Closed loop systems are always filled with pressurized fluid. Pump-efficient, compact, easier to pipe, must be able to handle a condition where the collectors stagnate, must use for evacuated tubes.
- Whatever you do make sure the design is warrantied not to blow up if it gets too hot, and that yearly maintenance is not required. Realistically a system should be able to handle power failures, vacations, neglect, etc. and run for a design life of 25 years.
- Avoid systems where the solar loop and primary heater both have coils in a single tank. This harvests much less energy in our climate area.





S+H Construction
26 New Street
Cambridge, MA,02138
T:617.876.8286 F:617.864.1850

S+H construction | RENEWABLE ENERGY DIVISION

Date:
Scale:
Job Number:

S+H Solar
Drawn by:
Sheet Title:

SHW System

Sheet Number:

Active Thermal Space Heating

- Space heating with collectors takes more roof space. Collectors should be tilted steeply for winter gain, and orientation is sensitive.
- Systems that can make a useable amount of heat during the winter need to be designed not to freak out in the summer. There is about a 5.5 to 1.75 seasonal ratio of energy in New England.
- Low-water temperature delivery system can be either independent, or boiler integrated
- Independent panel radiators: independent controls, easy to retrofit, requires tank storage, scalable, adds the expense of another distribution layer.
- Radiant tubes and slabs: independence is possible, thermal mass of a slab can be much of the storage, distribution can also function for passive gain, may be hard to retrofit.
- Boiler integration: the issue is efficient harvest. You do not want the fossil heater working on the solar storage tank or storage mass.

Heliodyne System Performance – Controller Production – Heliodyne Web Monitoring

http://monitoring.heliodyne.com/pages/viewpage.action?pageId=458763&gra

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Heliodyne System Performance – ...

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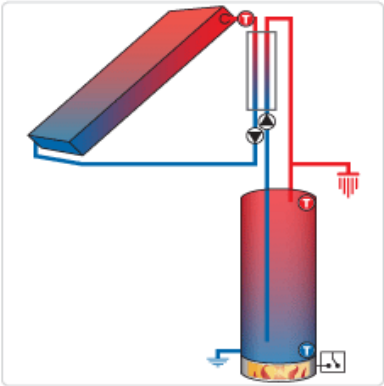
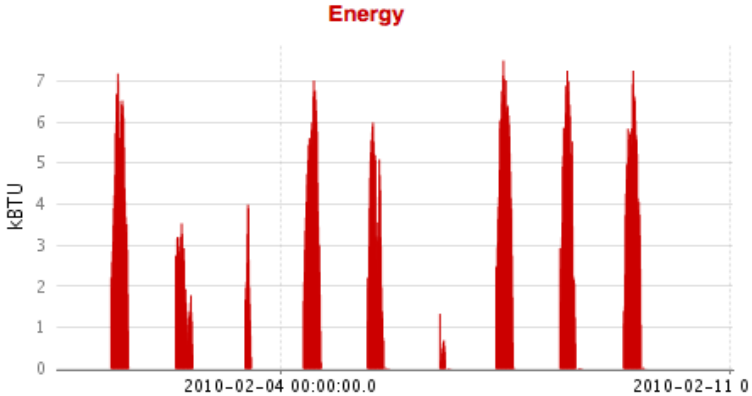
[MENU]

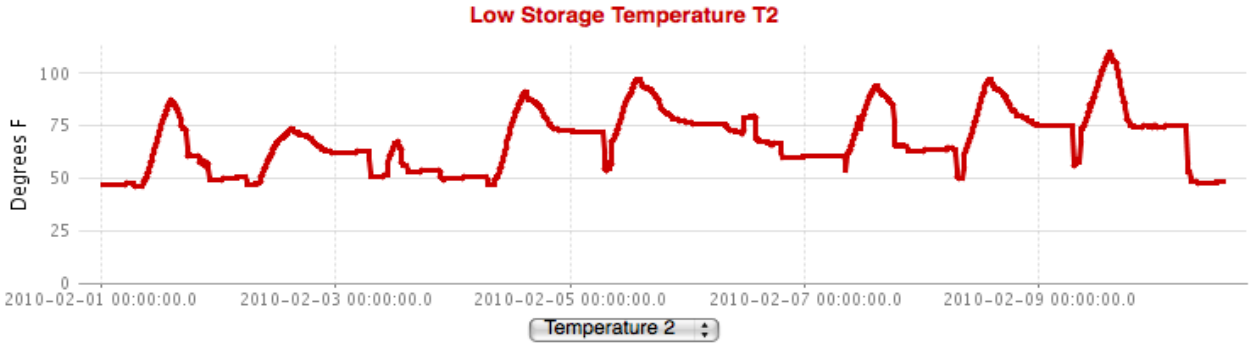
Heliodyne System Performance

46 Appleton Street, Cambridge, MA, 02138

Display Range: This Month **kBTU** | kWh







*Values are shown per hour.

Done

Incentives

- Commonwealth Solar II
- Commonwealth Solar Thermal (Pilot)
- Federal and State tax credits
- State excise, sales and property tax considerations
- Net metering
- Solar Renewable Energy Certificates (SRECs) and the SREC market
- Commercial depreciation MACRS
- Funding Programs

Commonwealth Solar II Rebate

- Residential Rebate
  - System size > 1 kW
  - Rebate capped at 5 kW
  - Base: $0.75/watt installed
  - MA component adder: $0.10/watt
  - Moderate Home Value **or** Moderate Income adders: $0.85/watt
  - Maximum system size: 10 kW
- Commercial Rebate
  - System size > 1 kW and < 10 kW
  - Rebate capped at 5kW
  - Base: $0.75/watt installed
  - MA component adder: $0.10/watt

Commonwealth Solar Thermal

- Brand new pilot program for 2011
- Base rebate:
  - $25 per collector * SRCC thermal performance rating of the collectors (kBTU/panel/day for Category C, Mildly Clouy climates)
  - This roughly translates to $450 - $650 for a 4’ x 8’ solar thermal collector
- MA component adder:
  - $200 per system
- Example: Heliodyne GOBI 408 collector – SRCC rating is 23.6 kBTU/panel/day
- Multiply this rating by $25/collector:
  - $25*23.6 = $590 rebate per collector

Federal and State Tax Credits

- Massachusetts State Tax Credit – PV or thermal
  - 15% of installation costs (after any cash rebates)
  - Capped at $1,000
  - Must be installed on an individual's primary residence
- Federal Tax Credit (Personal or Corporate)
  - 30% of installation costs (after any cash rebates)
  - No maximum

Additional Tax Incentives

- Massachusetts Sales Tax Exemption
  - Massachusetts law exempts from the state's sales tax "equipment directly relating to any solar, windpowered; or heat pump system, which is being utilized as a primary or auxiliary power system for the purpose of heating or otherwise supplying the energy needs of an individual's principal residence in the commonwealth."
- Massachusetts Property Tax Exemption
  - Massachusetts law provides that solar-energy systems and wind-energy systems used as a primary or auxiliary power system for the purpose of heating or otherwise supplying the energy needs of ***taxable property*** are exempt from local property tax for a 20-year period.
- Modified Accelerated Cost Recovery System
  - "eligible property placed in service after September 8, 2010 and before January 1, 2012 qualifies for 100% first-year bonus depreciation."

Solar Renewable Energy Certificates (SRECs)

- Part of Massachusetts' Renewable Portfolio Standard
  - requires each regulated electricity supplier/provider serving retail customers in the state* to include in the electricity it sells 15% qualifying renewables by December 31, 2020.
- The sale of SRECs allows electric suppliers to buy these certificates in order to meet their solar RPS requirement.
- One SREC is "minted" for every 1 MWh that a recognized system produces
- System owners are required to report their renewable energy generation on a monthly basis to the Production Tracking System (PTS) overseen by Mass. CEC
- Participation in the SREC market is voluntary and can be done for a maximum period of 10 years
- Aggregation Services are available to manage your SREC portfolio
- Example Income: 5kW system could potentially produce 6.6 MWh of solar energy annually; therefore, 6 SRECs would be "minted" and sold at a price of $510 each resulting in an income of $3,060.

Funding Programs

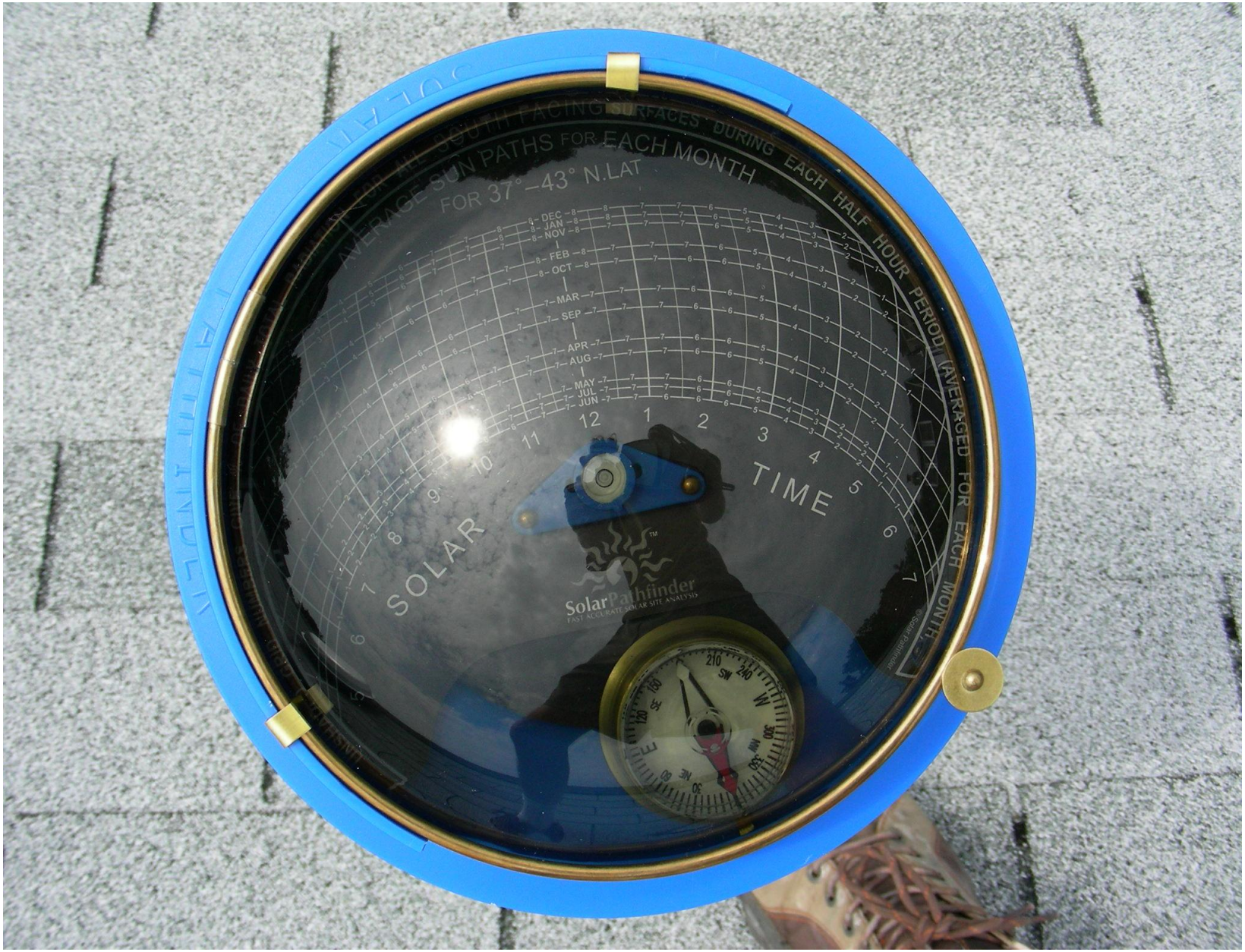
- Massachusetts HEAT Loan
  - Zero percent financing of $2,000 - $15,000 for a period of up to 7 years
  - Solar Thermal systems and energy efficiency measures
- New Generation Energy Community Solar Lending Program
- Please see the handout from today's conference for other funding programs

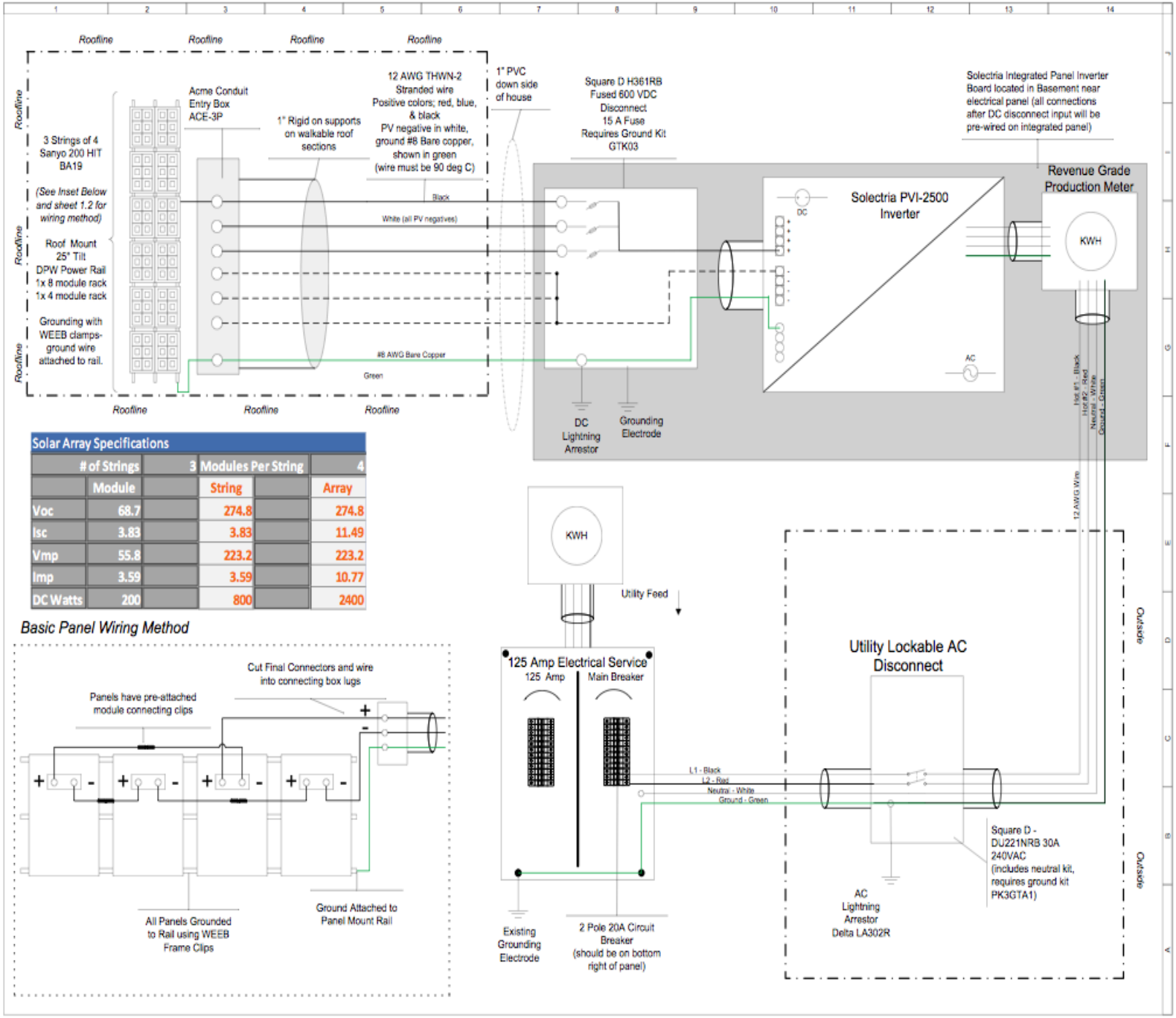
Benefits Specific to Landlords

- Added value to property without increased tax liability
- Property becomes more attractive to renters
- Likelihood of having long-term tenants versus single-lease tenants:
  - A more stable source of rent income
  - Long-term tenants tend to take better care of property
  - Happier tenants send rent checks on time
- Broader reduction in carbon footprint
- Reduced operating cost

The Integrator's Job

- Design the system
  - Site feasibility: electric service, roof condition structure and size, access, shading, utility usage
  - Insolation study
  - Engineering - 1-Line and piping diagrams
  - Energy audit
- Demonstrate feasibility
  - Energy generation estimate and/or financial payback modeling
  - Com Solar application sets the bar
  - NGRID asks for RETScreen for solar thermal -estimated use
- Get an interconnection agreement and process the Commonwealth Solar rebate application for PV.
- Obtain electrical, plumbing, mechanical and/or building permits
  - Code compliance - grounding and warning labels
- Turnkey contract and insurance


AVERAGE SUN PATHS FOR EACH MONTH
FOR 37° –43° N.LAT
SOLAR TIME
SolarPathfinder
FAST ACCURATE SOLAR SITE ANALYSIS



Solar Array Specifications

# of Strings	3	Modules Per String	4
Module		String	Array
Voc	68.7	274.8	274.8
Isc	3.83	3.83	11.49
Vmp	55.8	223.2	223.2
Imp	3.59	3.59	10.77
DC Watts	200	800	2400

Basic Panel Wiring Method

S+H Construction
26 New Street
Cambridge, MA,02138
T:617.876.8286 F:617.864.1850

Ramey PV
101 Chilton Street
Cambridge, MA, 02138

Jeannie Ramey & Bruce Biewald
101 Chilton Street
Cambridge, MA, 02138
T: 617.876.8386

Electrician
Robert Fairchild
Fairchild & Sanchez
358 Washington Street
Cambridge, MA, 02139
T:(617) 232-2140
#A14488

Electrical System: Single Phase
Size: 125A
Utility: NSTAR

S+H construction — RENEWABLE ENERGY DIVISION

Date: 3/17/2009
Scale: None
Job Number: 080821

S+H Solar
Drawn by: Ben
Sheet Title:
PV System Line Diagram

Sheet Number:
PV 1.0

S+H Construction Solar Electric Financial Model

Address

Project Cost

System size in watts DC	3,600
Base system cost	**$ 31,088.88**
Projected Commonwealth Solar rebate	$ 3,600.00
Invoice cost	**$ 27,488.88**
Projected tax credits and REC value	$ 9,915.81
Net system cost	**$ 17,573.07**

Equipment

Panels	Canadian Solar CSP6	200	Watts, DC
# of panels	18		
Inverter	Enphase M200		
Rack	Unirac flush mount	color matched to panels	

Project Production

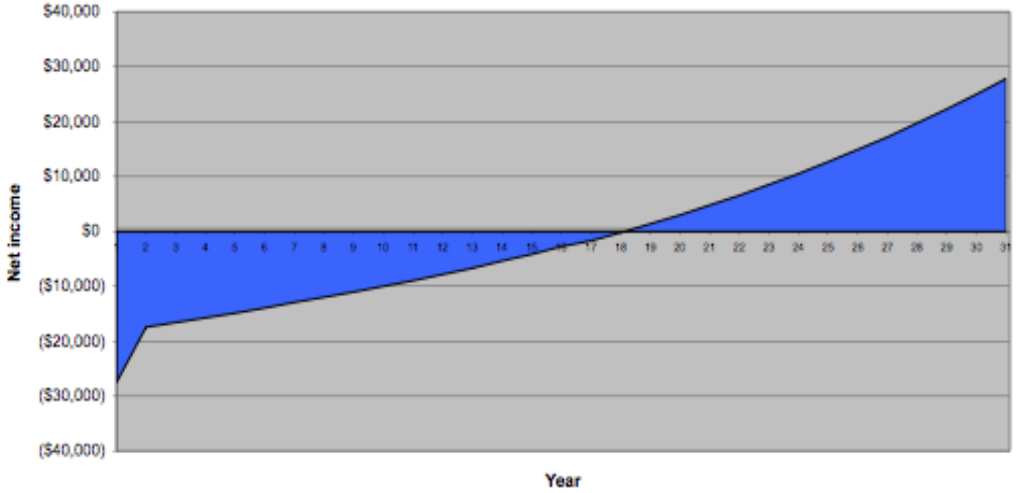
Estimated first year production in kWh	3,802
Value of solar energy harvested in the first year	$ 684.36
Value of solar energy harvested over project life	$ 45,828.89
Pre-purchased solar electricity per kWh rate	$ 0.18
Projected solar fraction	14%

Layout

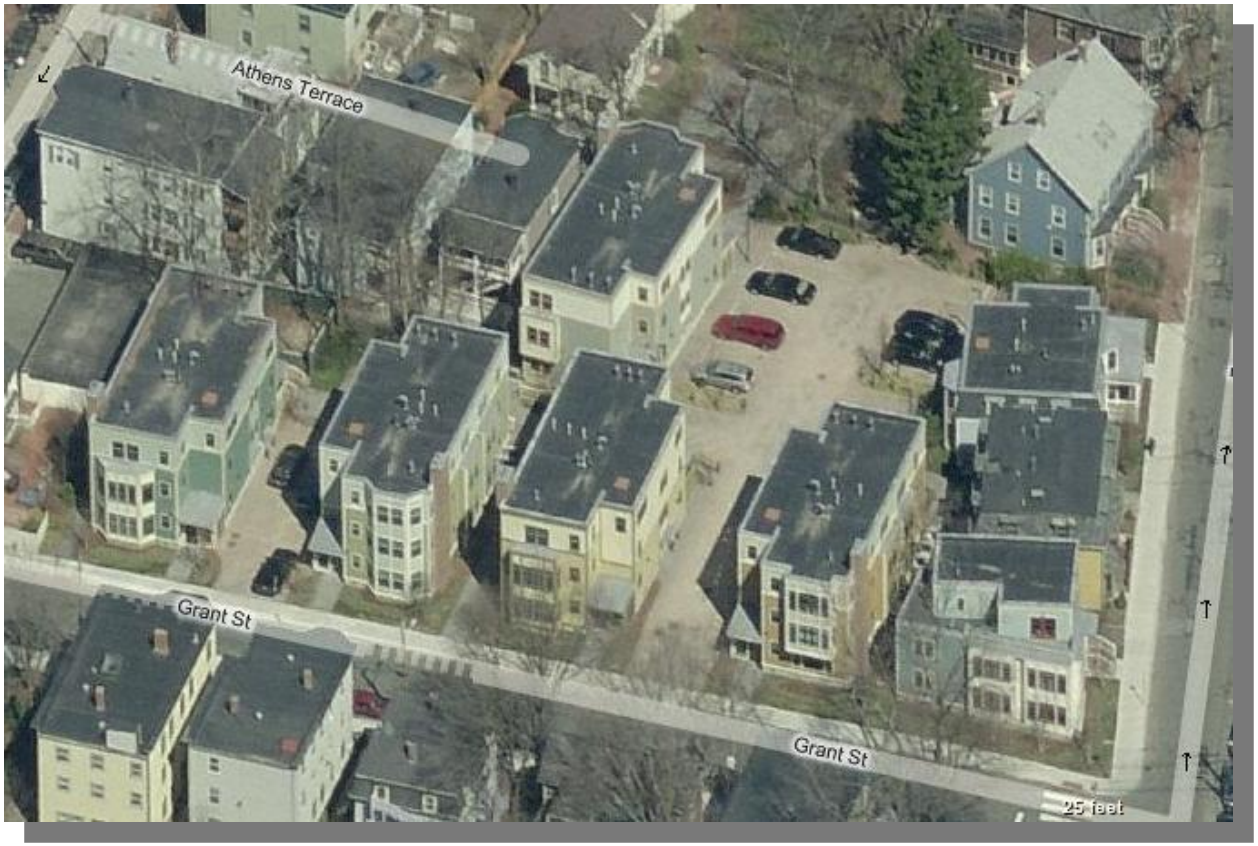
Carbon Savings

Pounds of carbon saved in the first year	5,703
Pounds saved over the project lifetime	150,529

Cash Flow



Last Words - all this available roof space and no solar



Approximately 2,650,000 kWh per year
(370,400kWh converted PV power)

Thank You!

Eric Lorenz, Project Manager

S+H Construction

Renewable Energy Division

eric@shconstruction.com

617-676-8947

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