

Renewable Ready

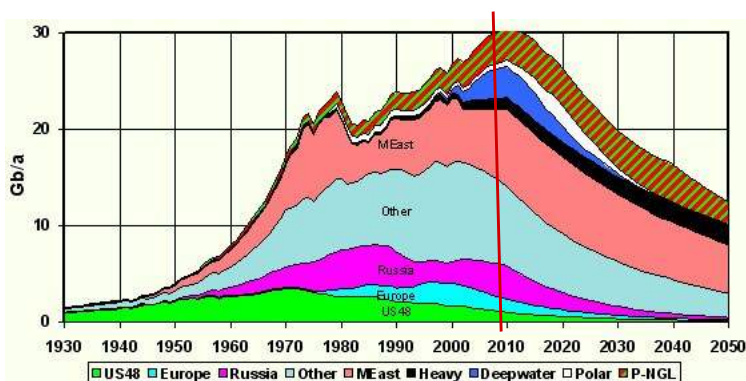
Solar Energy *Today's Clean Energy Choice*

Presented to:
Better Buildings by Design Conference – 2008
Leigh Seddon
Solar Works, Inc.



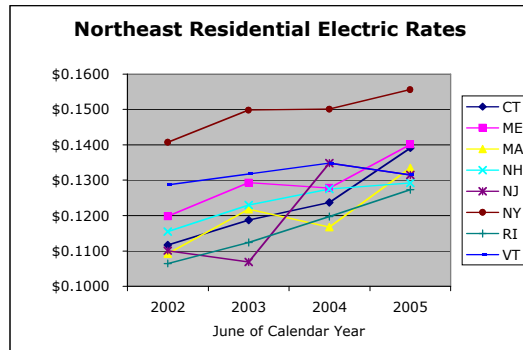
End of an Energy Era

100 years of exponential growth in fossil fuel use HAS come to an end due to environmental and economic constraints



Escalating Electric Rates

Northeast utility electric rates **ARE** escalating rapidly due increased oil and natural gas prices.



Source: U.S. Dept of Energy

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The burning of fossil fuels **IS** having a large impact on Vermont

- Acid Rain
- Mercury
- Global Warming



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Solar Energy



Solar Corona: Yohkoh Satellite



The Solar Energy Resource

- » In a single one hour period, the sun sends enough energy to our planet to meet all of our energy needs for an entire year.
- » 100,000 kWh a year of solar energy falls on the average residential roof in the Northeast.
- » The availability and cost of delivering energy from the sun to our planet has remained remarkably constant for 4 billion years.





Solar technology is proven, affordable, and cost-effective in Vermont.

Why is it so under utilized?

*Solar electric and thermal system
Annual energy savings – 4,000 kWh
Weybridge, VT*



Solar Energy

Clear Choice for Environment & Economy

- »» Zero emissions/zero greenhouse gases
- »» Reduces fossil & nuclear fuel use
- »» Silent
- »» Produced domestically
- »» Accessible to all
- »» Lowest life-cycle cost



Solar Technologies

- » Daylighting
 - » 0 - 4¢/kWh saved
- » Passive Heating & Cooling
 - » 0 - 4¢/kWh saved
- » Active SDHW & Process Heat
 - » 4 - 8¢/kWh saved
- » Photovoltaics
 - » 15 -30¢/kWh saved



Daylighting

- Cut lighting loads
30% to 50%
- Reduce A/C loads
- Improve learning,
performance, and
health in schools
and offices.



Passive Direct Gain Systems



← Sunspace



Water Wall →

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Residential SDHW System

4 x 8 Flat Plate
Collectors

Closed Loop
w/ Antifreeze

PV circulator

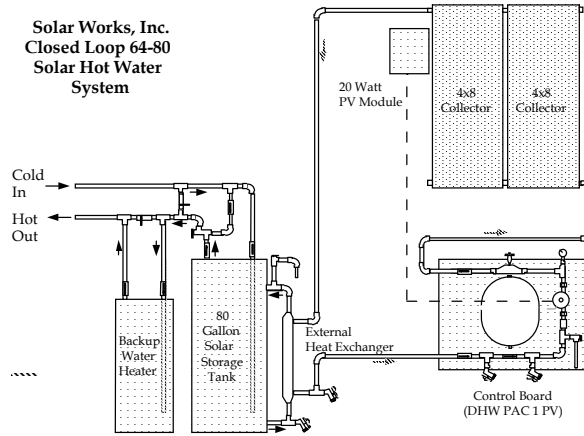
2,800 kWh per
year savings



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Closed-Loop Anti-freeze System

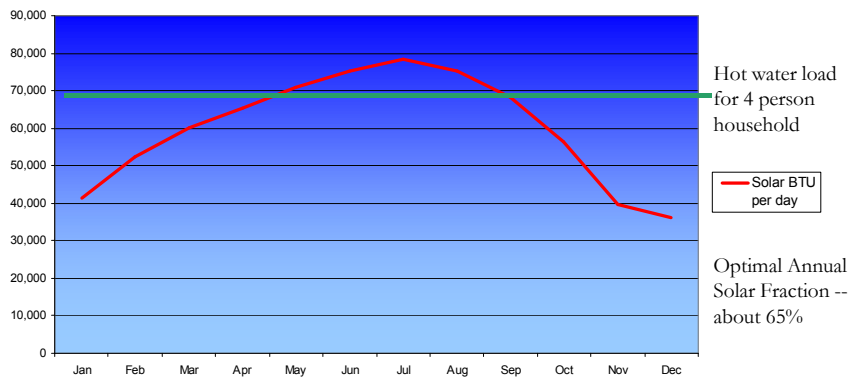
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Closed Loop 64-80
Solar Hot Water
System



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Daily Solar Energy – New England

Average BTU per Day by Month
Plate Plate collectors - 9 sq meters
Boston, MA Insulation



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Life-Cycle Analysis – An Example

<u>Cost Item</u>	<u>Electric</u>	<u>LPG</u>	<u>Solar</u>
Capital Cost	\$750	\$750	\$6,250*
First year fuel cost	\$850	\$860	\$250
25-yr fuel cost**	\$18,760	\$18,980	\$5,520
25-yr maintenance**	<u>\$550</u>	<u>\$550</u>	<u>\$1,500</u>
Total Life Cycle Cost	\$20,910	\$21,140	\$13,520

* includes \$750 for back-up LPG hot water heater, less state incentives

** present worth based on inflation at 4%, discount rate at 7%

** prices based on January 2006 average cost for New England



SDHW & Radiant Floor Heating

6 - 4x10 Flat Plate
240 Sq. Ft Array
10,000 kWh/Year
thermal

*60 degree collector
tilt to optimize
winter performance*



Building Integrated Systems

Integration at design phase can provide:

- Easier installation
- Better aesthetics
- Better performance
- Material savings



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Thermal Storage Systems

- » Sizes up to 1,000 gallons
- » Non-pressurized tank
- » EPDM rubber lining
- » Ships as 4 x 12 flat
- » Copper coil heat exchangers



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Commercial Heating Systems



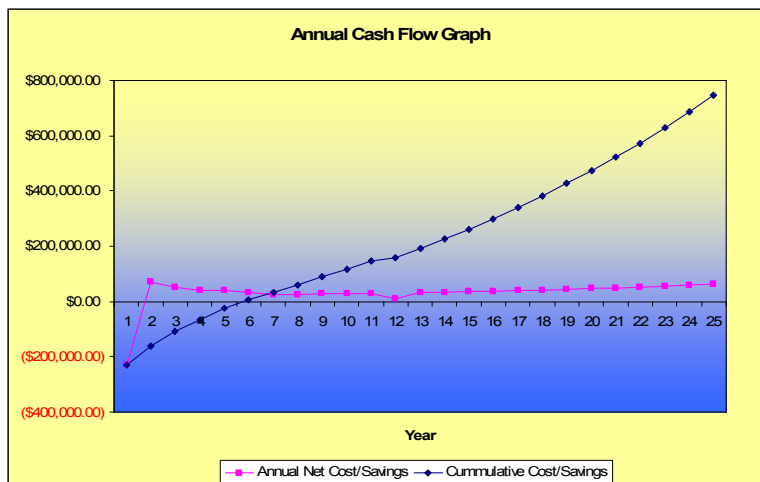
- Pool heating
- Process heat
- Dairy farms
- Hotels
- Laundramats

Very cost-effective due to high solar conversion efficiency and economies of scale

*Southern VT Recreation Center, Springfield VT
130 kW thermal array saves \$15,000 a year in fuel*



Cash Flow Example



Commercial Radiant Floor Heat

Thermodynamics
Halifax, NS

90 sq. meters
Collector surface

285 MMBTU/yr



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Vertical Wall Installation

Thermodynamics, LTD
Halifax, NS

5 4x8 collectors
per “bank” to
control expansion

Building integrated
but using modular
collectors



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Evacuated Tube or Flat Plate?

Which is best depends on application, climate, and delivery temperature

Thermomax System
Pentagon
Washington, DC



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Photovoltaic Technology

Direct conversion of sunlight into electricity

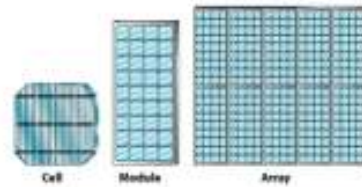
Efficiency now
Approaching 20%



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PV Cells Combined to Create a Module

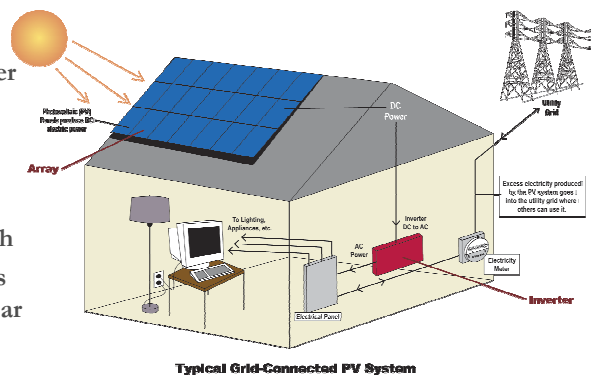
- » A solar *cell* is the basic building block of a PV system.
- » Solar cells are combined together to create *modules* or panels which are further arranged into *arrays* to get desired voltage and current.



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Net Metering

- » Excess solar power flows into grid
- » Utility gives you kWh credits if meter read goes negative for month
- » 1 kW PV produces 1,000 kWhs per year in Vermont



Typical Grid-Connected PV System

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Solar with Battery Backup (UPS)



Bi-modal inverters operate in both grid-connect and off-grid modes. UL listed 1741

Maintenance-free battery bank 48VDC typical with 15 kWh of storage capacity.



Typical Retrofit Situation



Common design problems

- Skylights
- Vent pipes
- Chimneys



A Solar Ready Roof

**The Phantom Lab
15 kW Grid-Tie PV
Greenwich, NY**

**Annual Savings
19,000 kWhs**

**20-year
CO₂ Savings
1,250,000 lbs.**

**No roof
penetrations**



Architect: Bill Maclay

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Roof Integrated PV

**SunPower high
efficiency modules in
custom mounting**

**Forced air ventilation
under array to
capture heat and cool
PV modules**



Architect: Jay Purcell

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Ground Mount Tracking Arrays

25% greater annual output in the Northeast than a fixed array

Zomeworks passive track rack



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Commercial Systems eligible for 30% federal tax credit without cap

50 kW Grid-Tie PV

Non-penetrating roof mount

Annual Savings
60,000 kWhs

20-year
CO₂ Savings
4,125,000 lbs.



Stonyfield Farm, Londonderry, NH

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Inverter technology and performance has improved dramatically

DC to AC
Conversion

modular sizes
2 – 500 kW

92-95% efficiency

UL listed for
standardized
interconnection



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Energy Roof Concept

Integrated design to provide
electricity, thermal heat, and
daylighting is possible in a
modular roof system

Impact 2000 House
Brookline, MA
Steve Strong, Designer



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Quiz

- »» What state has the highest per capita number of solar installers?
- »» In what state was the first New England solar collector manufacturer located?
- »» The contractor who installed the first White House solar system in 1978 was located in what state?

Vermont is Solar Ready!

