Solar Homes for Loudoun County

North Virginia's First Dedicated Solar Homes Community

Alden Hathaway

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Carter Morrow

President
Bay Homes
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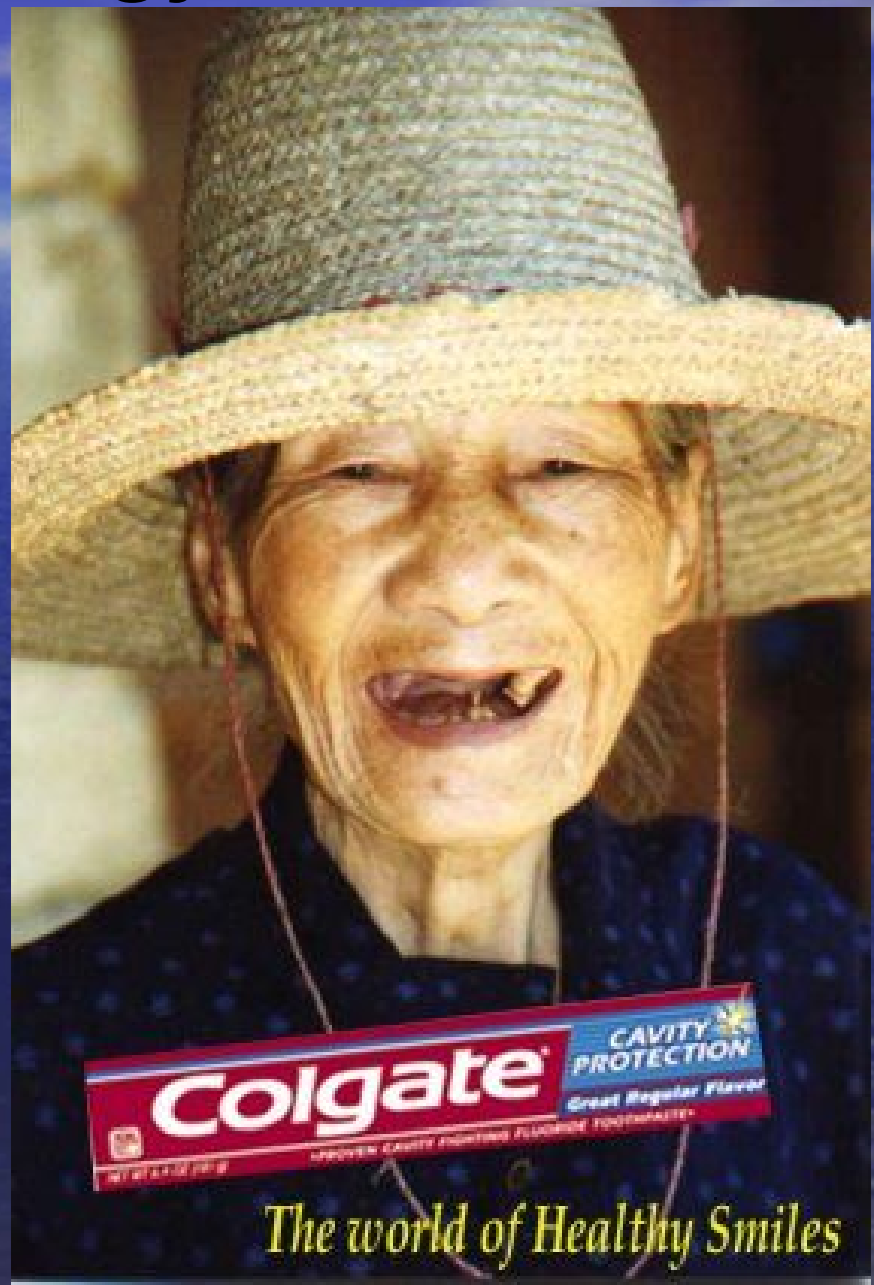
Solar Zero Energy Homes

A lot of people sell something that they don't use or even know much about.

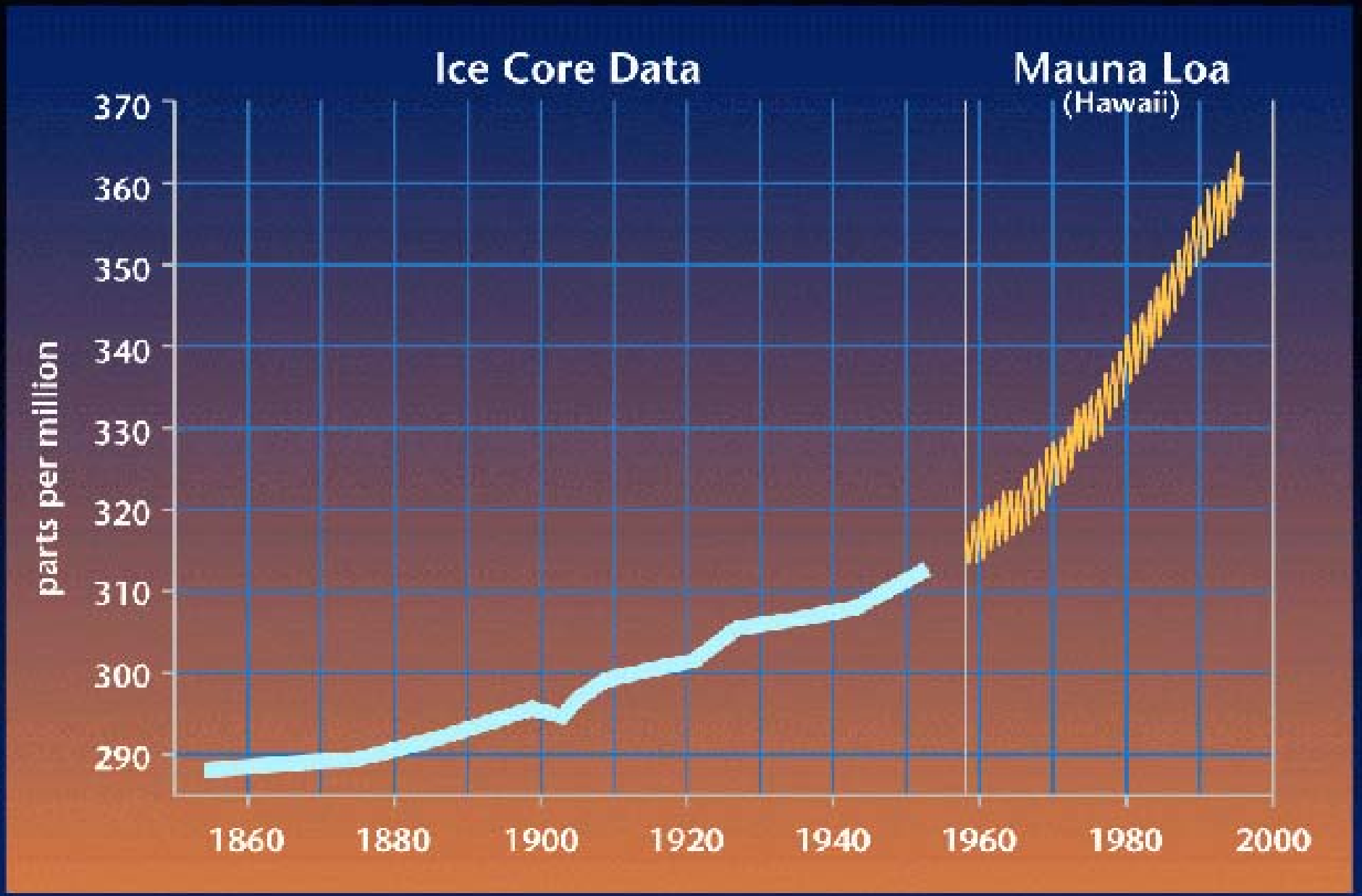
I believe in the product!

I use the product!!

I've written about the product!!!

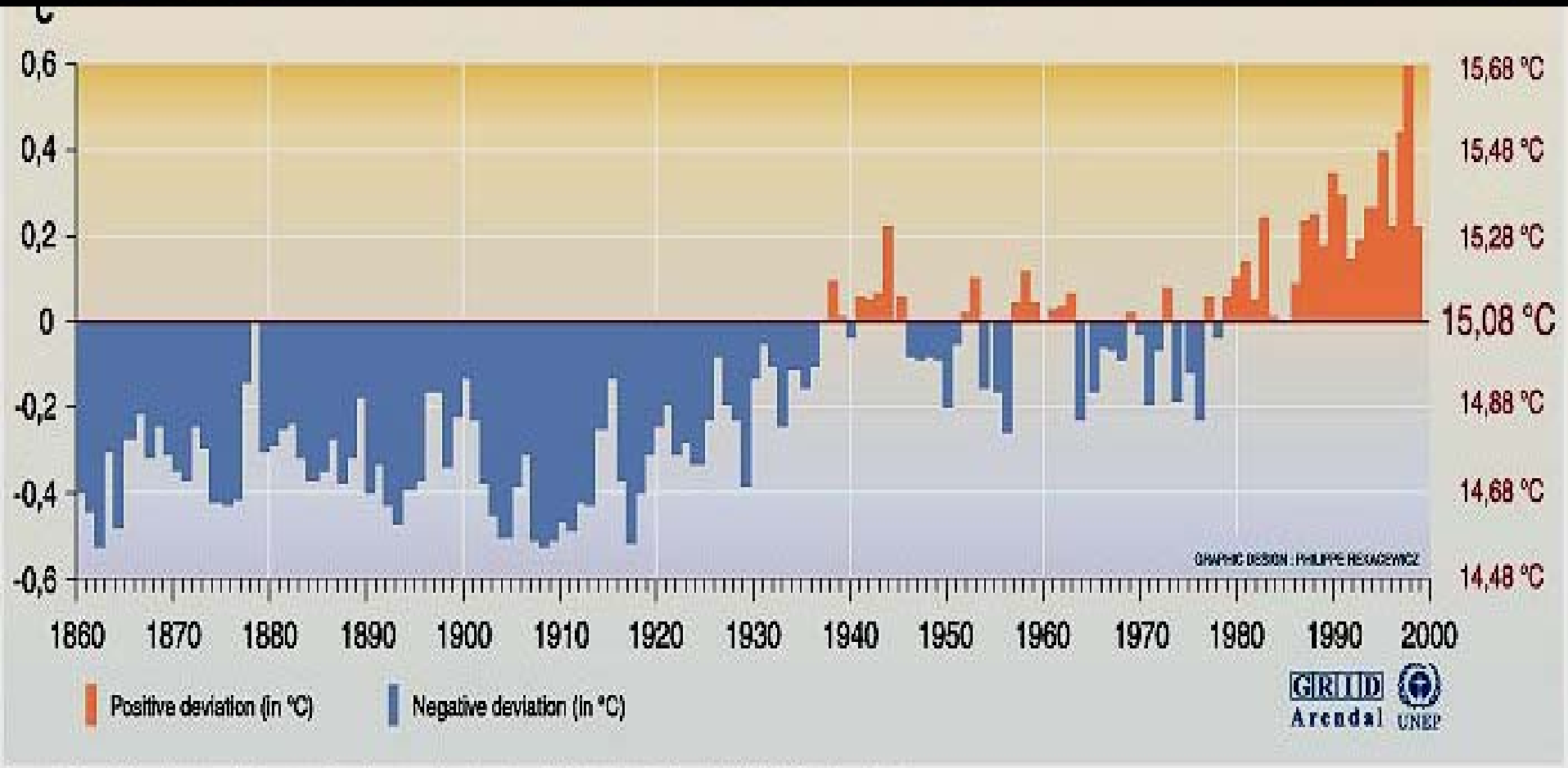


Carbon Dioxide Concentrations



Mt. Storm Coal Plant – Source for Majority of Northern Virginia Electricity

Global Average Temperature



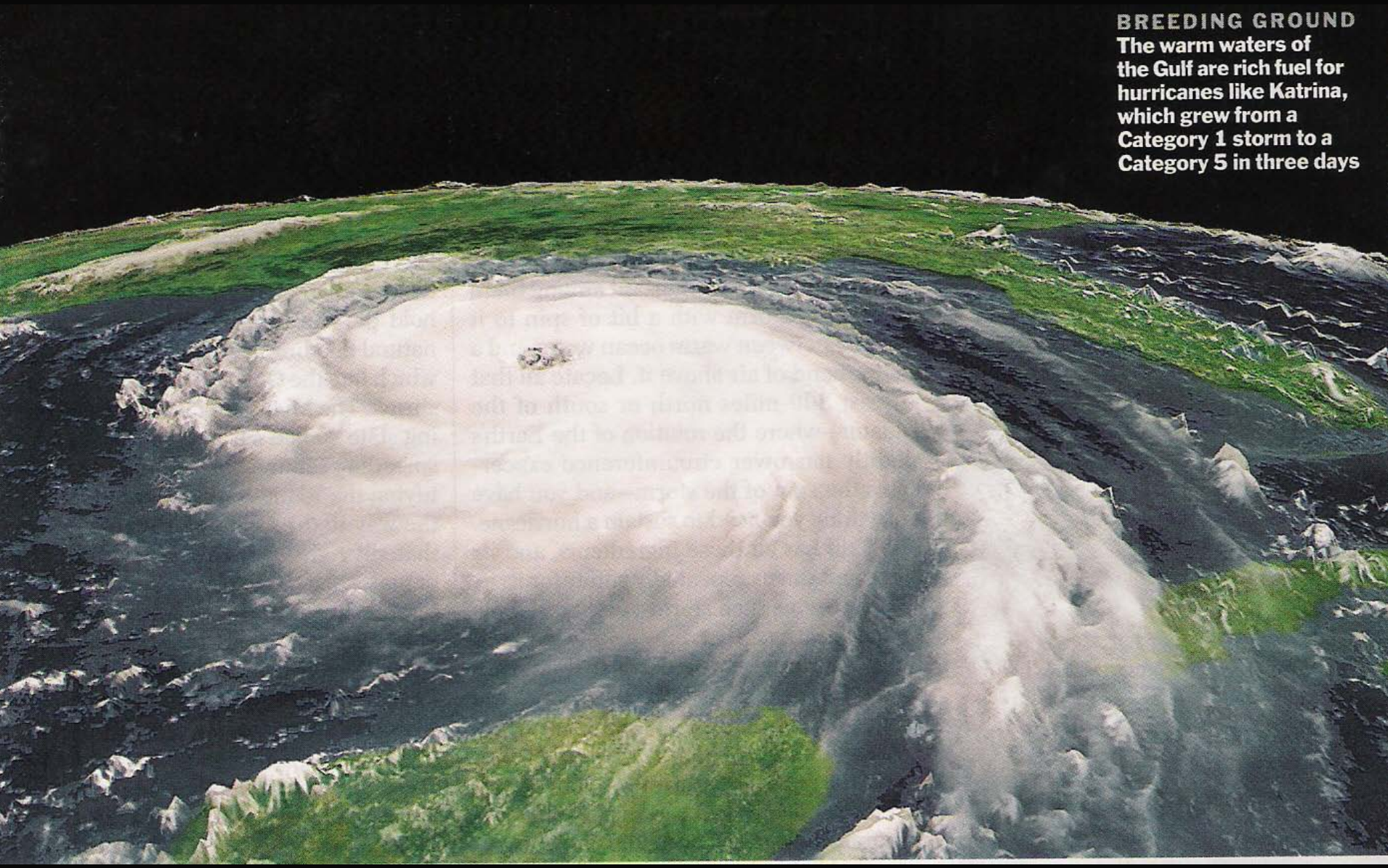
Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.

Here's how much polar ice has already melted in the last 25 years.

(pictured to the left) Source: **"Defusing the Global Warming Time Bomb",**
James Hansen
Scientific American, Vol. 290, No. 3, (March, 2004), p. 69

(Pictured above)
Source: *Nature's Voice*, Natural Resources Defense Council (Jan/Feb, 2004)

Our Leaders Say Everything is Fine



Source: TIME, Special Report. “An American Tragedy”, September 12, 2005

Source: TIME, Special Report. “An American Tragedy”, September 12, 2005

From the poorer neighborhoods of New Orleans to the …..

Source: TIME, Special Report. “An American Tragedy”, September 12, 2005

polar bears of the arctic …..

Source: TIME, Special Report. “An American Tragedy”, September 12, 2005

What must be Done to Stabilize the Climate?

We must curb U.S. CO_2 emissions by 60-80% from current levels

Many say we have just ten years left or it will be impossible to turn around

Let what you do in home, transportation, and consumption be guided by this and be prepared to overhaul your living with new technology

Not the kind of Technology that is complicated

World GHG Statistics

Average per Capita Consumption Based GHG*:

United States	21.5 Tons
Canada	16.8 Tons
India	0.9 Tons
Rest of the World (Excl US)	3.6 Tons
Total World	4.6 Tons

* Wackernagel & Rees, Our Ecological Footprint, New Society Publishers, 1996

Chief Consumer Impacts to GHG Emissions

Home Energy Use	35%
Transportation	32%
Food Consumption (approx)	20%

Brower and Leon, The Consumers Guide to Effective Environmental Choices, Union of Concerned Scientists, Three Rivers Press, copyright 1999, figures derived from Table 3.1, pg. 51

Recommendations

Home Energy Use Measures – Percent Savings

Energy Efficient Lights	10-15%
Energy Star Appliances	10-15%
Energy Efficient HVAC	15-20%
Energy Efficient Windows	5-10%
Insulation and Weather Strip	5-10%
Solar Hot Water System	5-8%
Solar PV Electric System	20-40%
Total Potential	100%

Uses of Solar (Photovoltaic) Energy

EMERGENCY

SPORTS

AIRPORT

SOLAR TOWN

CAR PARK

EXPO

Solar

- PV panels in very high demand throughout U.S. and world
- High demand, costs driving world shortages and price increases (10 – 20%).
- Recently signed energy bill makes solar more economical.
- Many states now have incentives for solar installation, including tax credits, low interest loans, and even substantial grants: www.dsire.gov

National Energy Bill

Signed by President Bush August 8, 2005

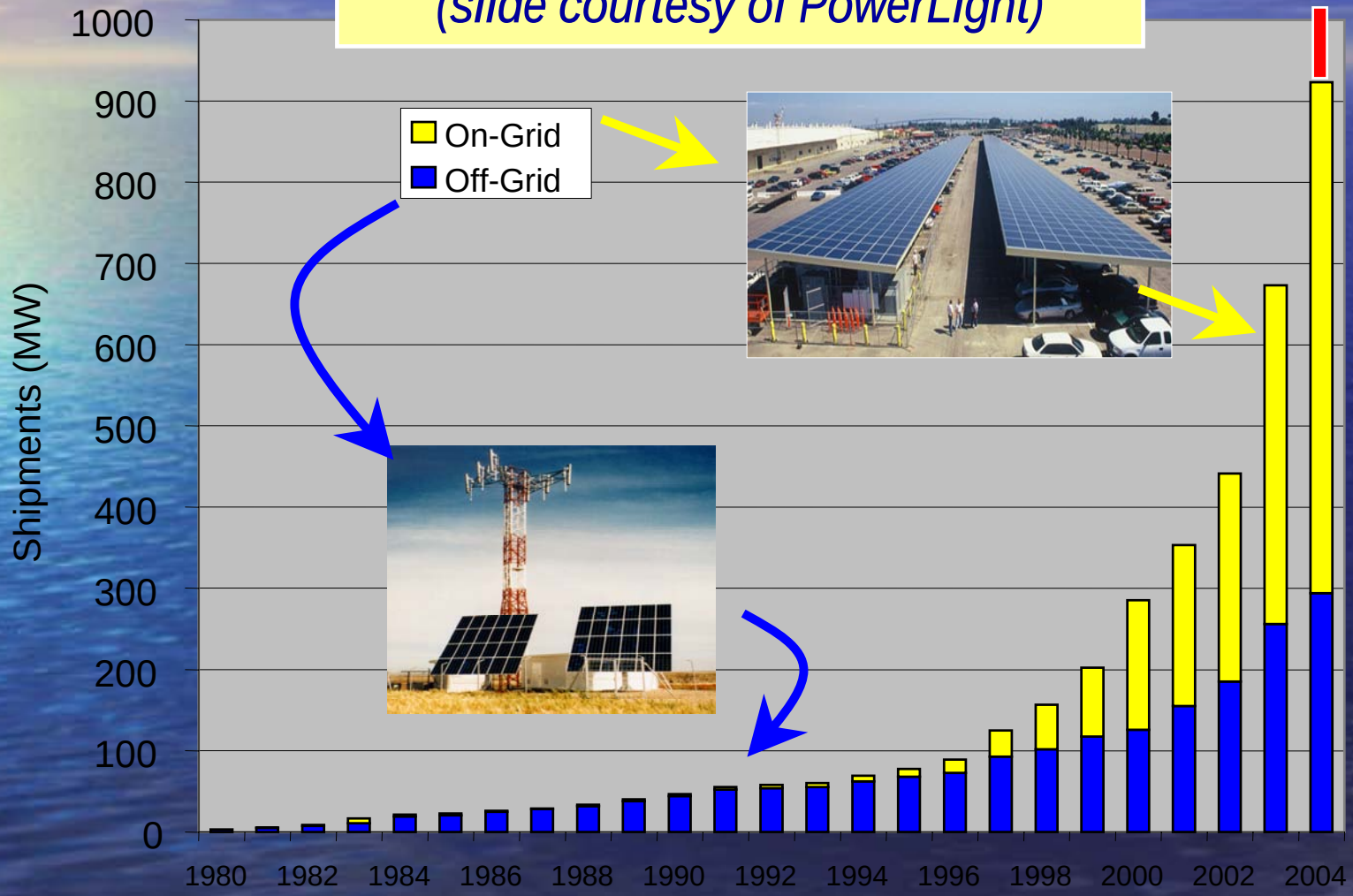
- 30% Tax Credit for PV and Solar Thermal Investment;
- Residential Capped at $2,000 each; No cap on Commercial/Industrial Systems;
- Real Time Pricing Available for All Requesting within 18 months;
- Accelerated Depreciation for remaining cost basis.

Photovoltaics (PV) 7 Yr Growth:

Industry: *35%/yr*

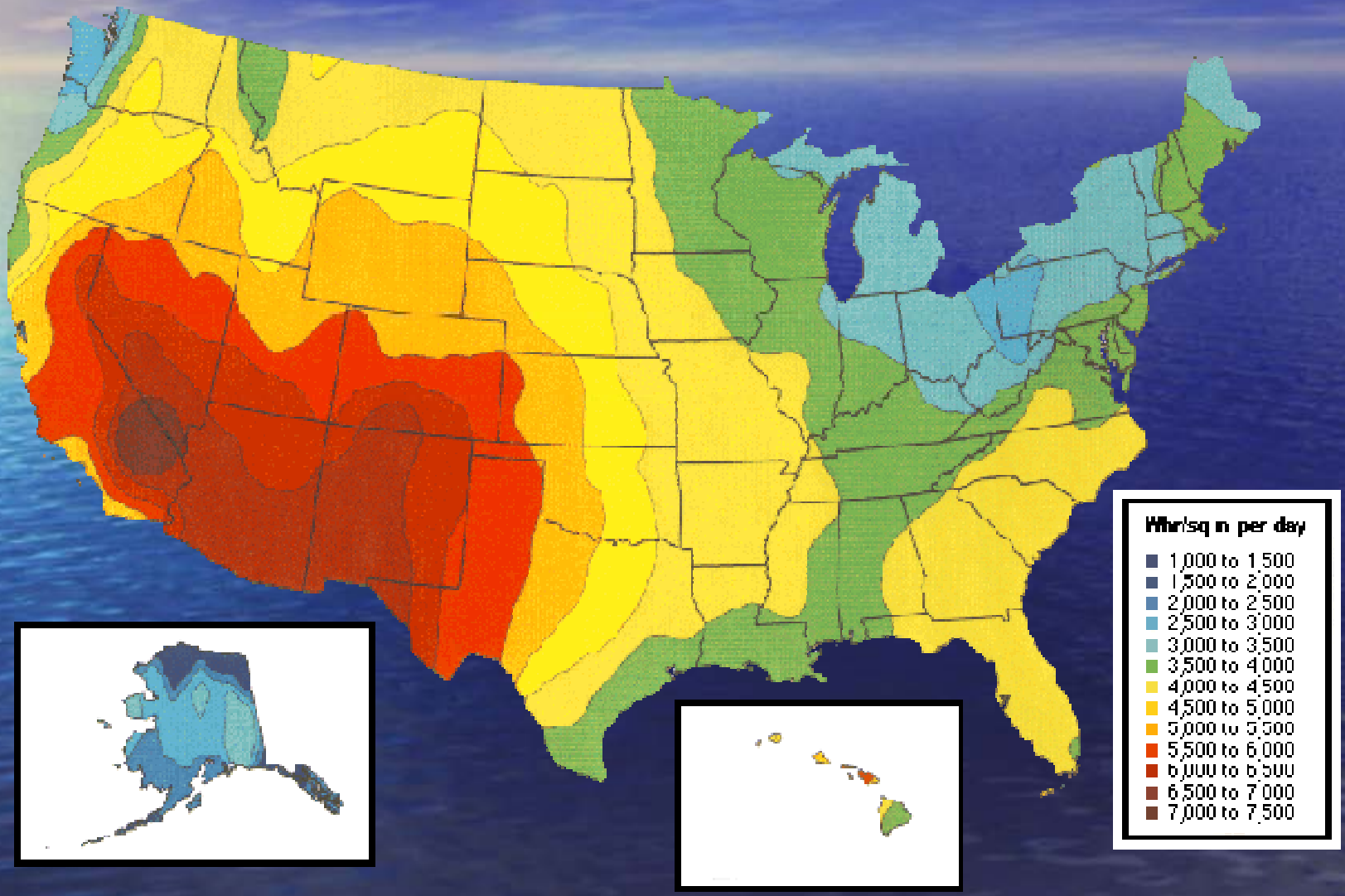
On-Grid: *55%/yr*

(slide courtesy of PowerLight)



Average Solar Insolation

1961-1990



Source: ETA Engineering


Oops!
Your next shipment of fossil fuel will be just a little bit delayed!!


solar
fabrik
Freiburg


solar
fabrik

Building Integrated Design


Solar - Fabrik

Solar power curtain wall and daylighting

Solar Integrated Roofing Systems

Hurricane Rating: Cat 3; Working on Cat 5 Rating for Guam Military Base

Emergency Power?

- Building Integrated Design
  - Roof & Wall Integrated PV Decreases Solar Costs/Enhances Appearance

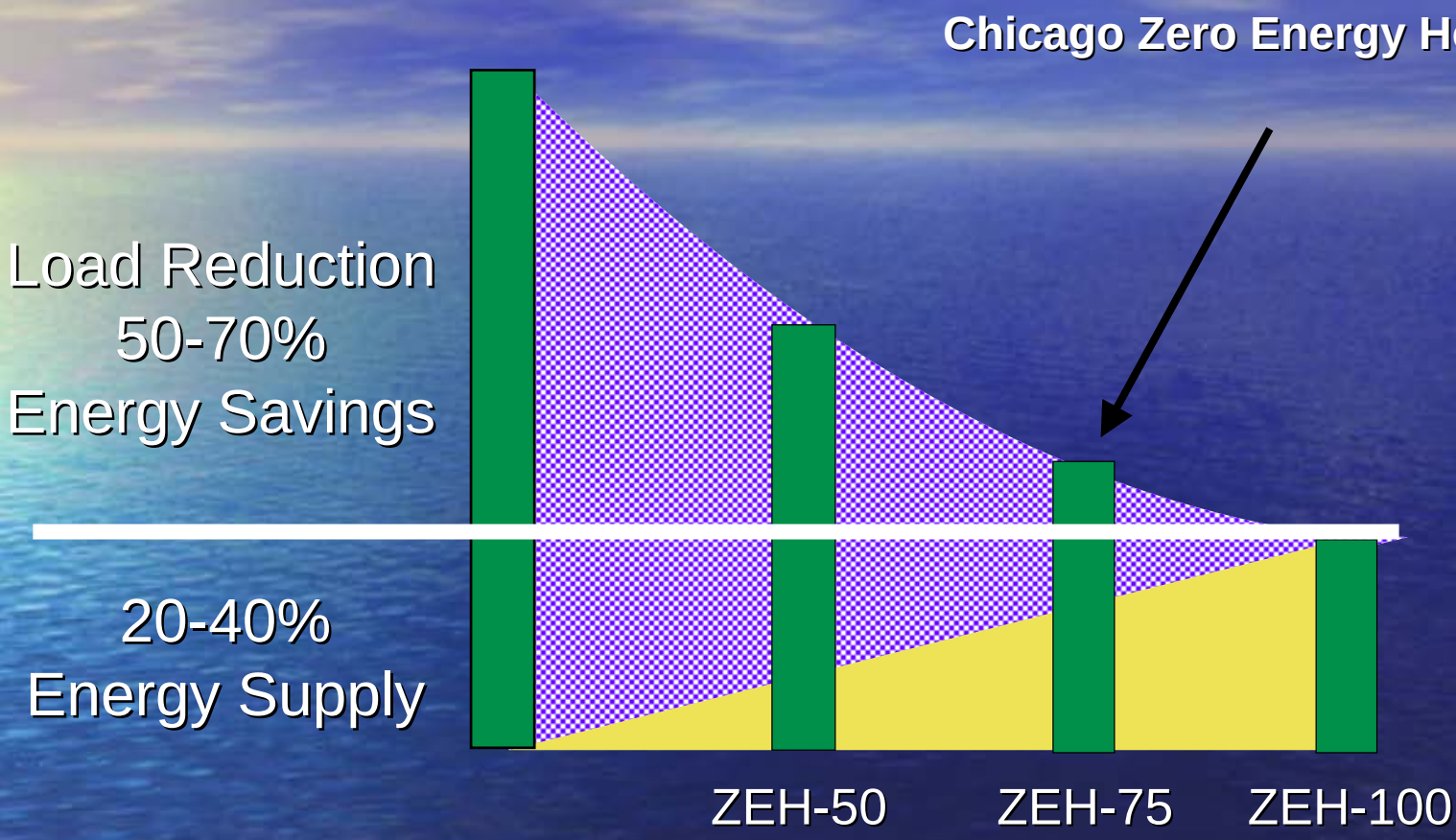
20 KW Solar Roof on Gas Station Canopy

This Solar Array can provide enough power to keep the electrically powered fuel pumps operating.

Putting Solar together w/ Energy Efficiency
Zero net Energy Houses (ZEH)

(Boston Edison House, Solar Design Associates)

Energy Efficiency and Solar



Chicago ZEH Solar Homes Program - Using Solar Shingles

Zero Net Energy House—even in Maine!

Using Polycrystalline Roof-Integrated Modules

The Lord House—Solar Design Associates

www.solarhouse.com

Our ZEH Solar Home in Hillsboro, VA

Combination of Amorphous Silicon Standing Seam Modules and Monocrystalline Modules

6.0 Kilowatt Solar System combined with energy efficiency provides 90% of our energy needs.

Our Journey to Reduce GHG Impact by 57%

Two Publications About our Solar House

National Renewable Energy Laboratory (NREL) The Hathaway "Solar Patriot" House: A Case study in Efficiency and Renewable Energy, May, 2005

http://www.nrel.gov/docs/fy05osti/37731.pdf

Hathaway, Alden, Building an Affordable Solar Home, February, 2004

www.ert.net/solarhome

Solar Patriot – June, 2005

www.ert.net/solarhome

The Solar Roof features 36 PVL 128 Laminates from Uni-Solar – 4.0 kW
Also, Passive Solar Overhangs; Double Paned Windows with Bali Insulating Shades

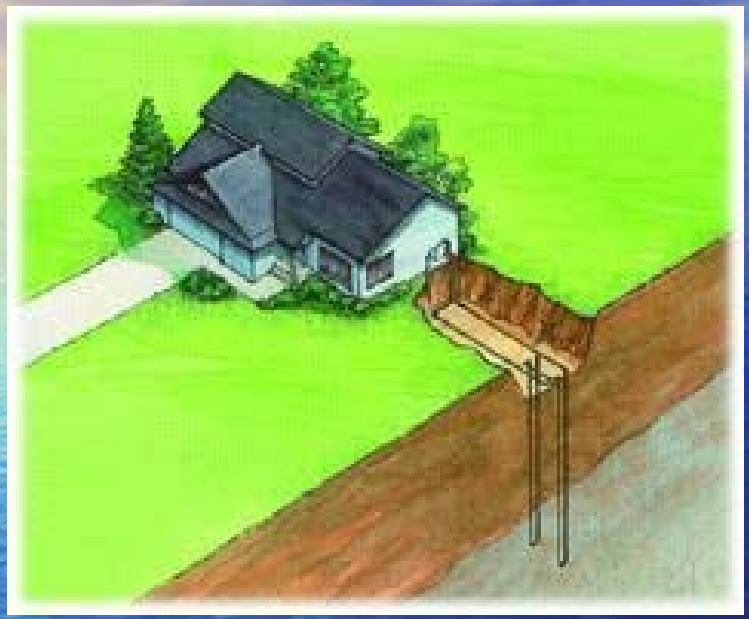
Peal & Stick PV Laminate – Standing Seam Pan

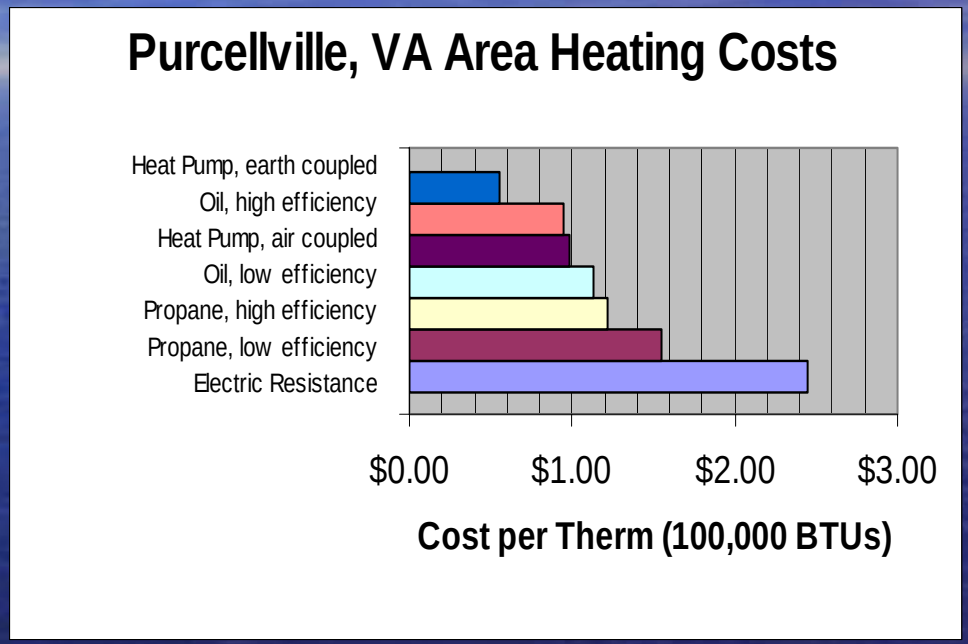
The Uni-Solar PVL is applied to the Standing Seam Pan on site by the roofing contractor.

The Solar Patriot w/ Additional Solar Power

Featuring 36 75-Watt Monocrystalline Modules from BP Solar Array size – 2.0 kW
2 CPC 2000 Hot Water Concentrator Panels from Solargenix Electric Equiv; 2 kW

Geothermal Heat Pump





ECR Technology 5.0 Ton Geothermal Heat Pump

Editor's Note: *NREL performed tests on our geothermal heat pump and concluded that we were attaining a COP value of 3.6 for heating and 3.2 for cooling for an average COP of 3.5. An add-on Heat Exchanger for heating water was measured with a COP value of 1.6.*

Compact Fluorescent Lamps

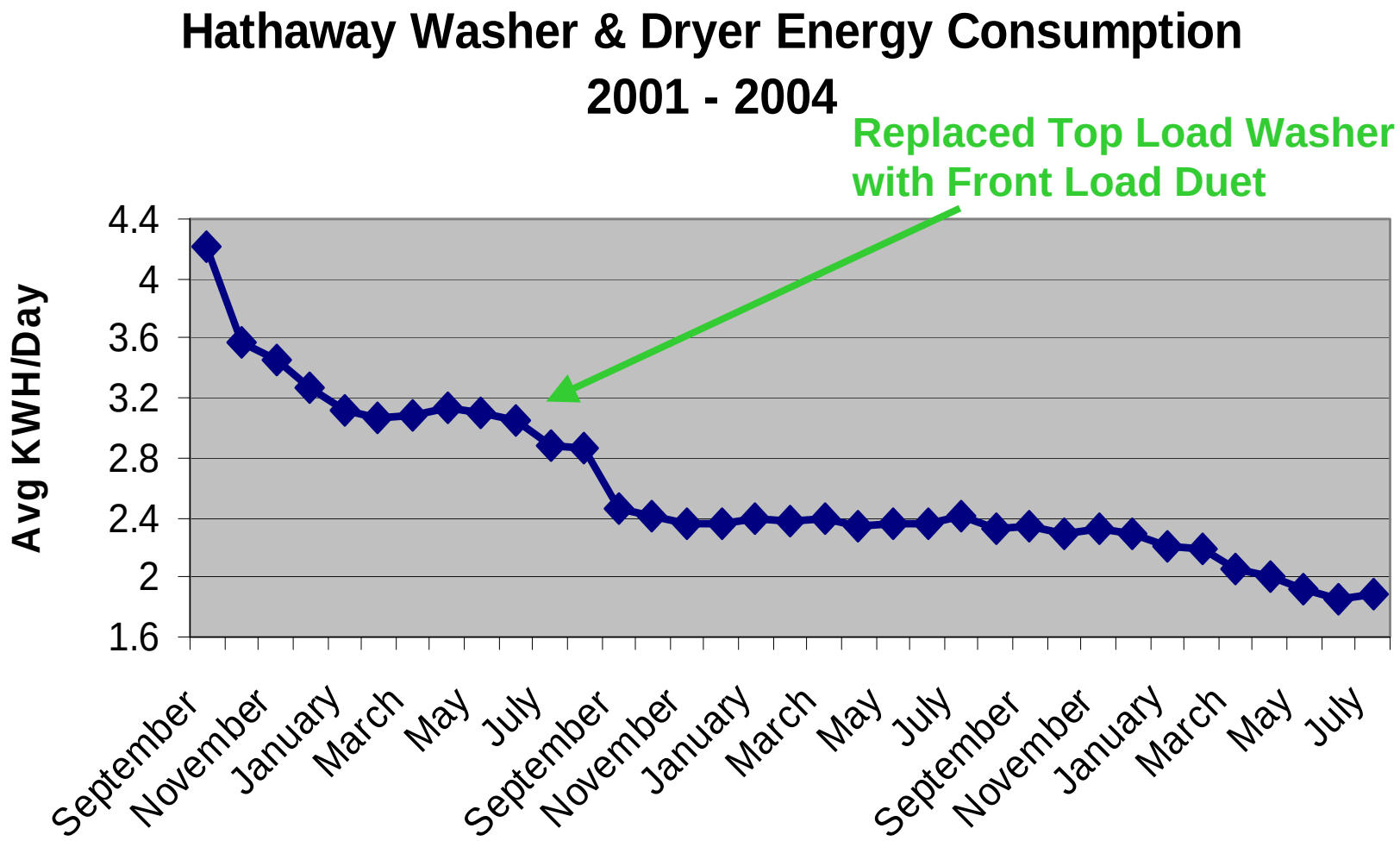
First Line of Defense in Reducing Energy Use

Energy Star Appliances

Whirlpool Duet Wash/Dryer; Conquest Refrigerator; Fisher Paykel DishDrawer

All four appliances are performing as projected or better.

Front Load vs. Top Load Washer



* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 6, pg 63, Chart 4; www.solarhome.beplaced.com

Solar Patriot Specifications

Home: Design Homes, Bloomsburg, PA

Solar PV: UniSolar Amorphous Silicon PVL Laminates		4.0 kW
BP Solar MonoCrystalline Modules		2.0 kW
Inverters: Trace SW-4048 (48 volt DC Bus)		8.0 kW
Batteries: Concord 8 200 A-H Sealed Gel Cells	Storage Capacity	12 kWH
Solar Hot Water: Solargenix 2 CPC2000	Equivalent Electric Rating	2.0 kW
HVAC: ECR Technologies Geothermal Heat Pump (6.0 kW)		5 Tons

Passive Solar Design: Solar Strategies

Thermal Blinds: Bali Shades

Washer/Dryer: Whirlpool Duet – Front Load	3.2 Ft^3
Refrigerator: Whirlpool Conquest	25.5 Ft^3

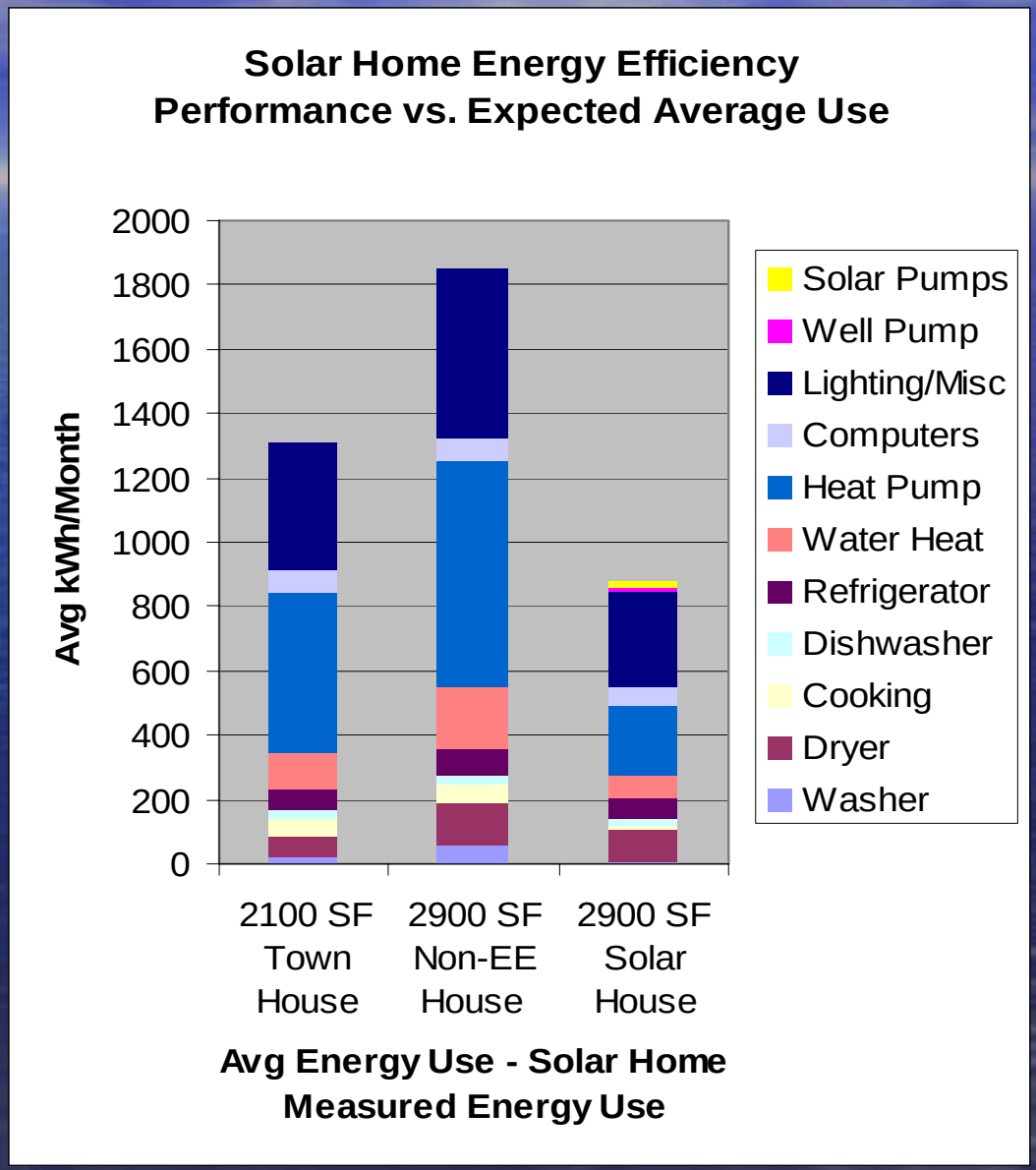
Dishwasher: Fisher-Paykel Double Dish Drawer

Lighting: Osram-Sylvania; GE; Commercial Lighting Compact Fluorescent

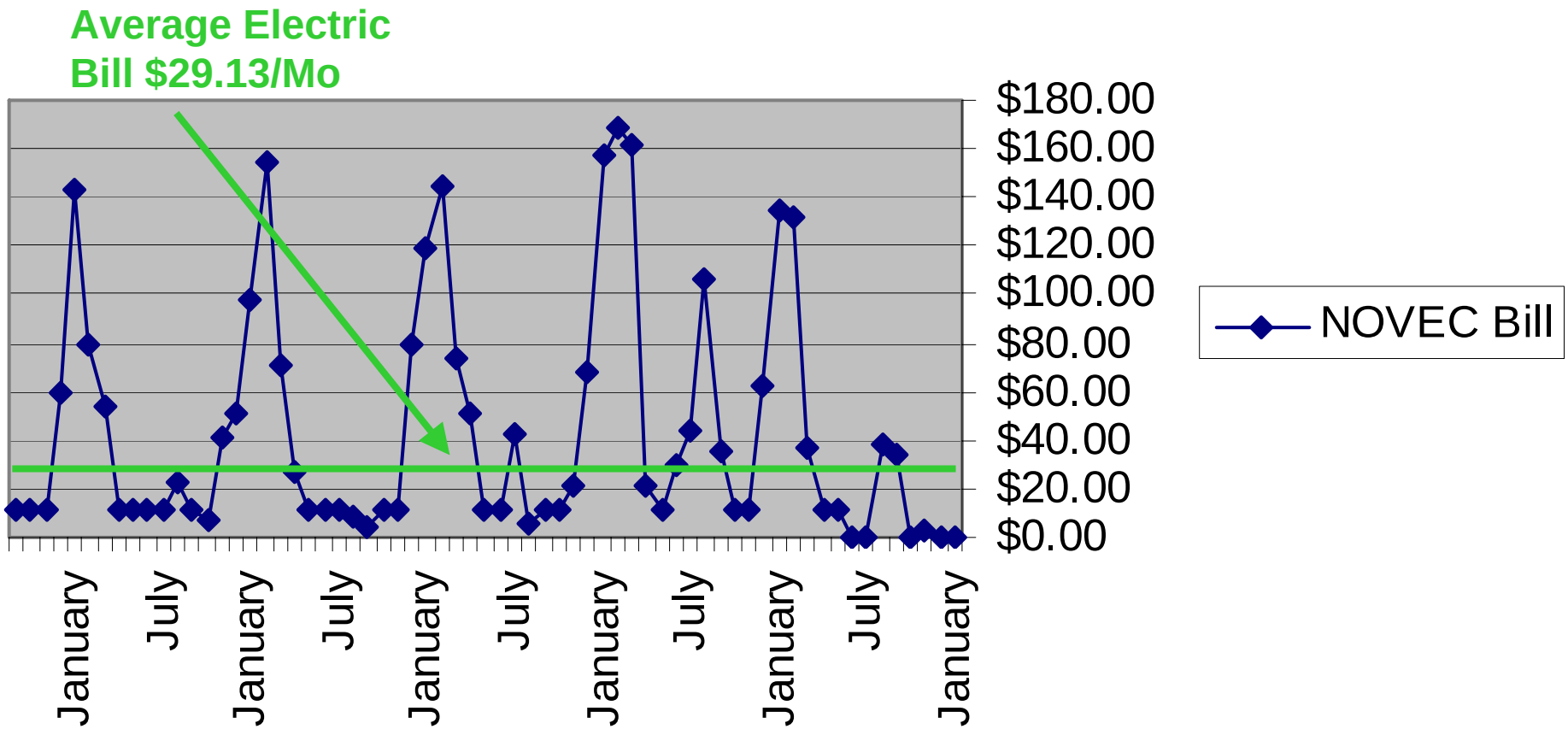
Fireplace: Heat and Glow – Heat Recovery with Insulating Doors

Getting to Zero Energy

A non EE house will require twice the solar power capacity to be Zero Energy, increasing the house cost by almost 30%. By incorporating energy efficiency we keep the increase for both solar and EE to 15% of house cost.

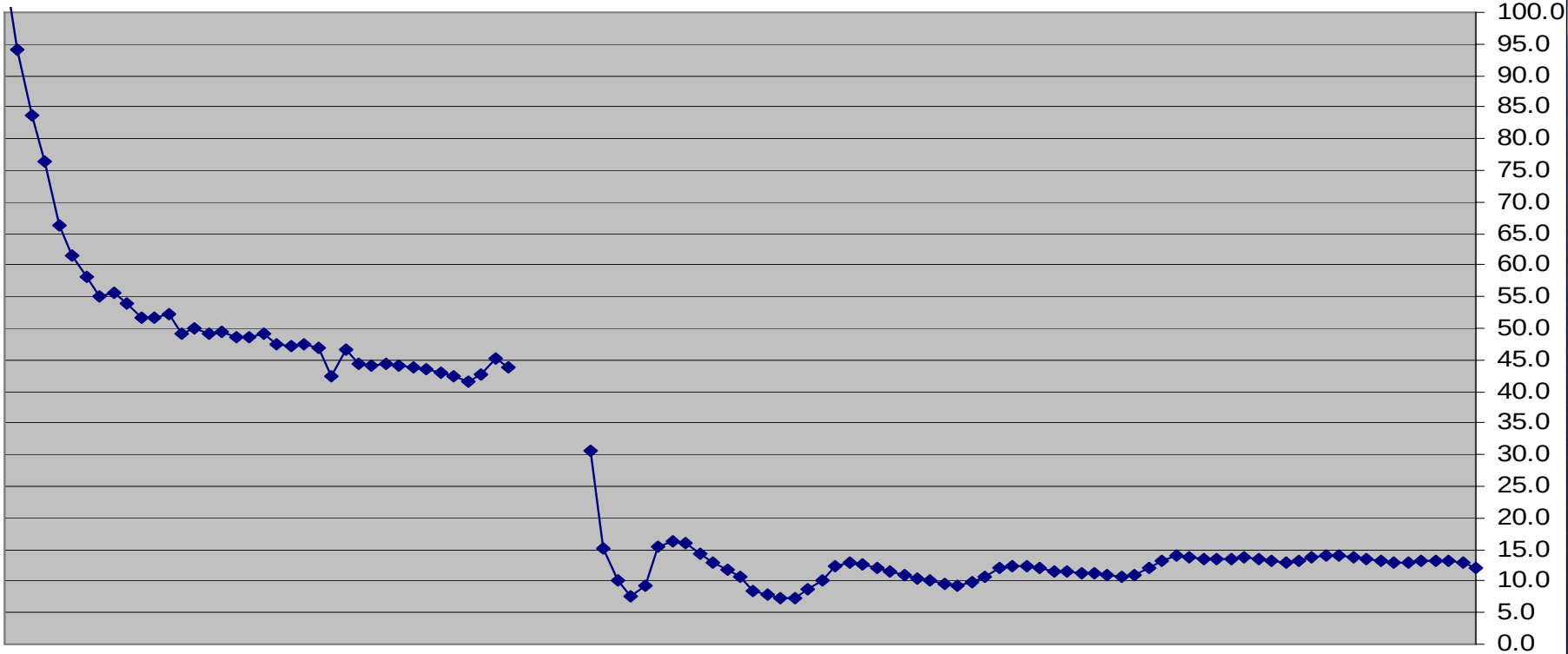


Actual Monthly Bill vs. Average Bill (2001 - 2007)



Average Household Electric Bill:	$29.13
Includes $11.16 per Month Connect Fee:	$11.16
Net Energy Cost per Month:	$17.97

Hathaway Energy History
Average Electric Consumption
(kWH/Day)
1998 - 2007



Average Household Energy Consumption in Solar House:	32.4 kWH/Day
Average Solar Energy Output since Turning Solar System On:	20.1 kWH/Day
Average Net Energy Consumed since Turning Solar System On:	12.3 kWH/Day

Solar Patriot Savings (6 Years)

100 – 12.3 = 87.7

Energy Savings vs. Non EE; Non Solar (Six Years):

87.7 kWh/D x 2190 D x $.1179/kWH = $22,644 or $314.50 per Month

Increase Mortgage Cost less Interest Deduction for Solar and Energy Efficiency:

$335 per Month Principal, Interest, Taxes*

-$122 per Month Tax Deduction on Interest*

-$314.50 per Month Energy Savings

Net Savings: $101.50 per month vs Non EE; Non Solar
(Positive Cash Flow)

* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 7, ppg 74-75; www.solarhome.beplaced.com

Solar Patriot Economics

(2001 Prices)

Total Cost of House:	$440,000*
6.0 kW Solar Roof, Solar Thermal and Energy Efficient Package:	$58,000*
Cost per Square Foot:	$137.50
Energy Savings per Month vs. Non EE – Non Solar:	$314.50
Simple Rate of Return	6.5%

* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 7, ppg 74-75; www.solarhome.beplaced.com

Solar Patriot Economics

(2001 Prices + 2006 Tax Credits)

Total Cost of House:	$440,000*
6.0 kW Solar Roof, Solar Thermal and Energy Efficient Package:	$58,000*
Federal Tax Credits	($2,600)
Cost per Square Foot:	$136.69
Energy Savings per Month vs. Non EE – Non Solar:	$314.50
Simple Rate of Return	6.8%

* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 7, ppg 74-75; www.solarhome.beplaced.com

Solar Patriot Economics

(2001 Prices + 2006 Tax Credits)

Total Cost of House:	$440,000*
6.0 kW Solar Roof, Solar Thermal and Energy Efficient Package:	$58,000*
Federal Tax Credits	($2,600)
Cost per Square Foot:	$136.69
Energy Savings per Month vs. Non EE – Non Solar:	$314.50
Simple Rate of Return	6.8%

I would have missed out on $18,870 in energy savings waiting for the Tax Credits

* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 7, ppg 74-75; www.solarhome.beplaced.com

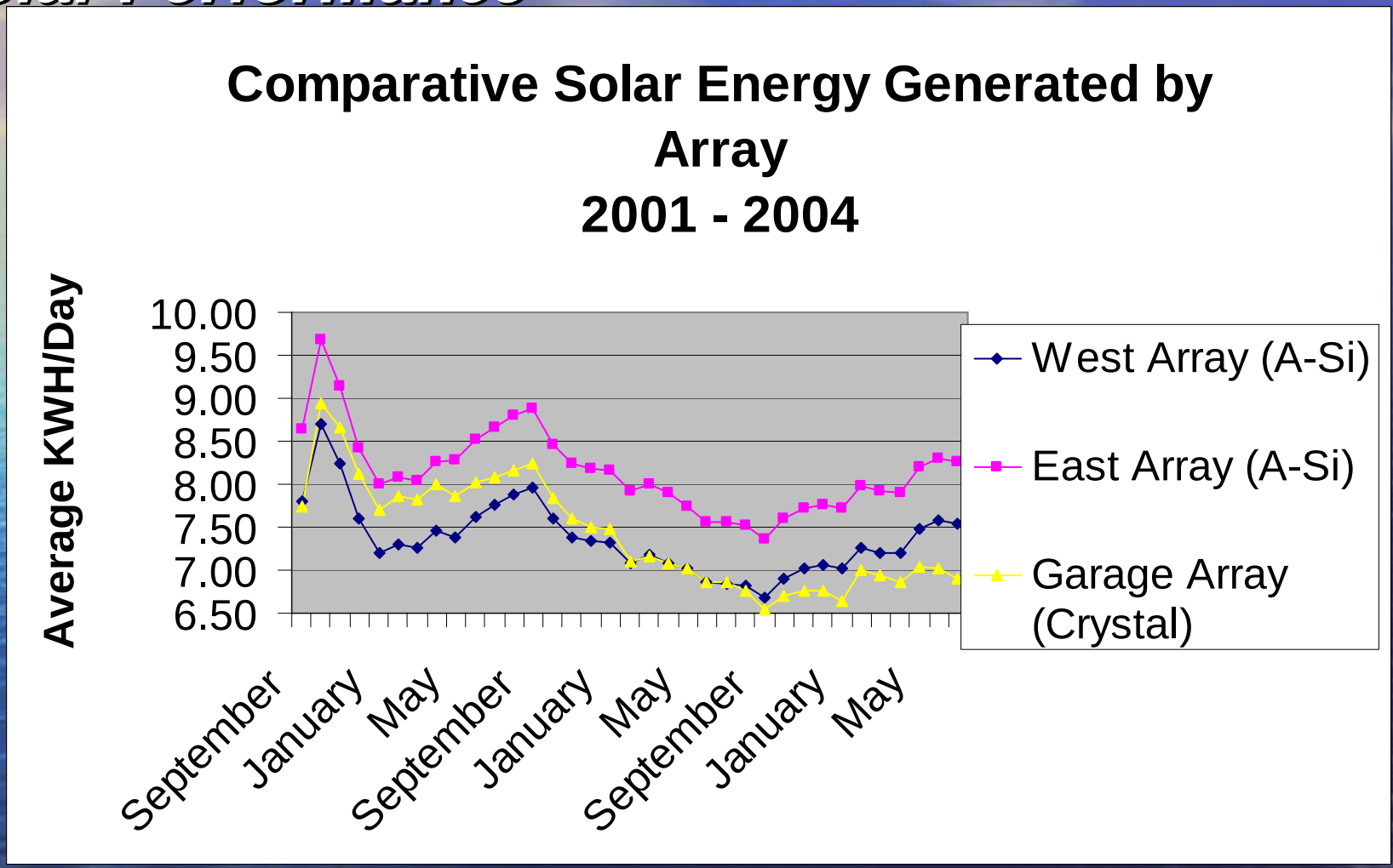
Pleasant Surprises About the House

Solar Performance

Our Solar House on Christmas Day, 2002 after a three inch snow fall. Just two hours after the snow ended, it was already sliding off the Uni-Solar modules.

Pleasant Surprises About the House

Solar Performance



Average energy production for all three solar arrays. Each array's name plate power capacity is approximately 2 KW. Note the East and West solar arrays (triple junction amorphous silicon) are clearly out performing the crystalline array.

Pleasant Surprises About the House

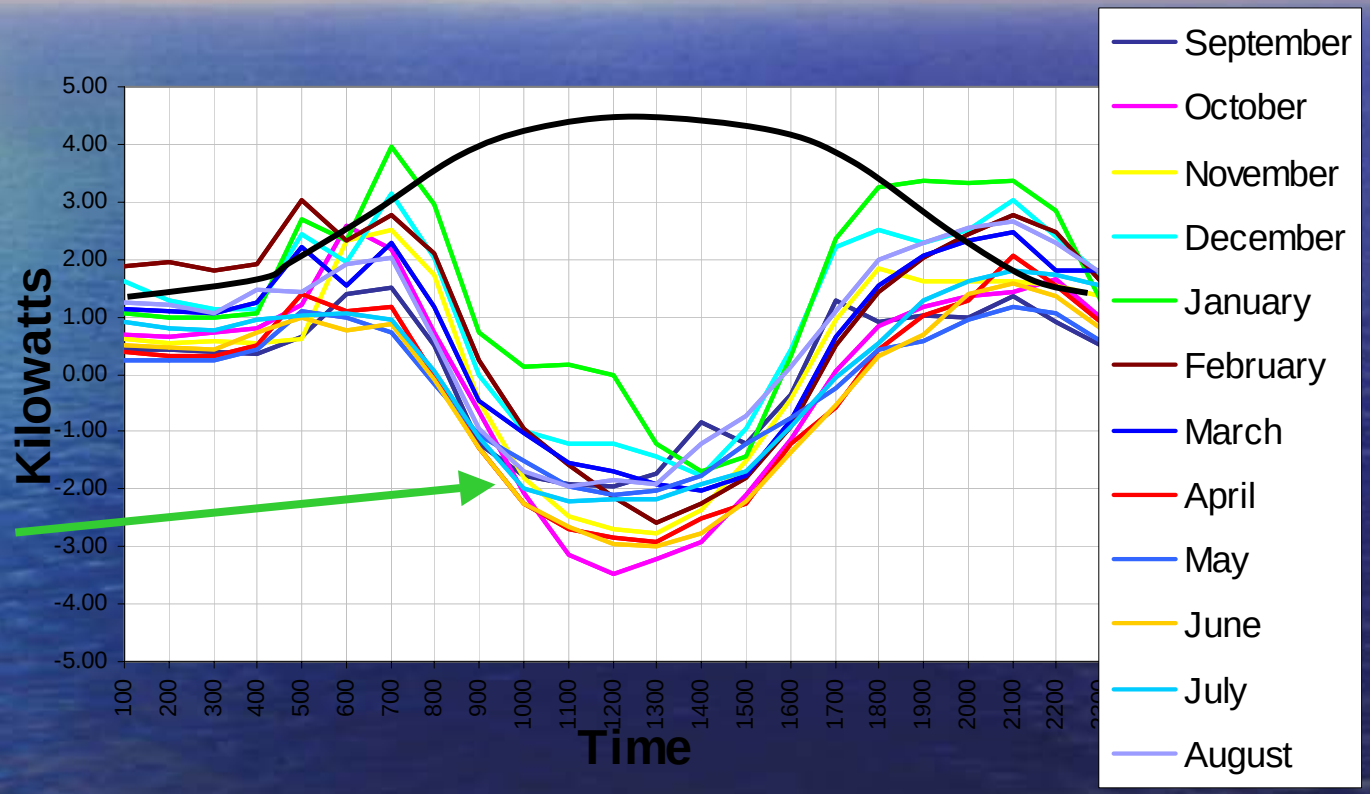
Ease of Emergency Power

Our house as it appeared early morning, Friday, September 19, 2003 during the passage of Hurricane Isabel, and operating off solar battery powered backup. The neighborhood had already been out of power for almost ten hours, a condition that would last over five days.

Pleasant Surprises About the House

Peak Power to the Electric Grid throughout the Year

Net Power Bought
Average Hourly Profile - Solar Patriot



Represents energy being shipped to the grid – typically high value kWHs

The average monthly load profile of our solar house compared to the typical electric load profile (solid black line) of a similar sized non-solar house or building.

Pleasant Surprises About the House

New Energy Bill Could Increase Solar Patriot Savings

The President's new Energy Bill theoretically makes it possible for me to request real time rates based on peak and off-peak power costs.

However, my utility, NOVEC, and my State, Virginia, have yet to respond, in the affirmative, to my request for such rates.

Real Time Rates could add an additional $400 - $600 per year in electric cost savings, increasing my simple return on investment from 6.5% to 7.6%, and adding to my $101.50 per month positive cash flow $18.25 per month.


What about automobiles?


Need to find another gas station?


Oops! Maybe not that one!

We Replaced Our Cars too!

EPA Estimate: www.fueleconomy.gov

17.7 Miles Per Gallon

17.4 MPG (measured by Hathaway)

1999 GMC Safari

Replaced with CRV then Prius

23 Miles Per Gallon

Combined Both Cars 19 MPG

1996 Mercury Sable

Replaced with Toyota Prius in 2000

With Fuel Efficient Cars including two Hybrids

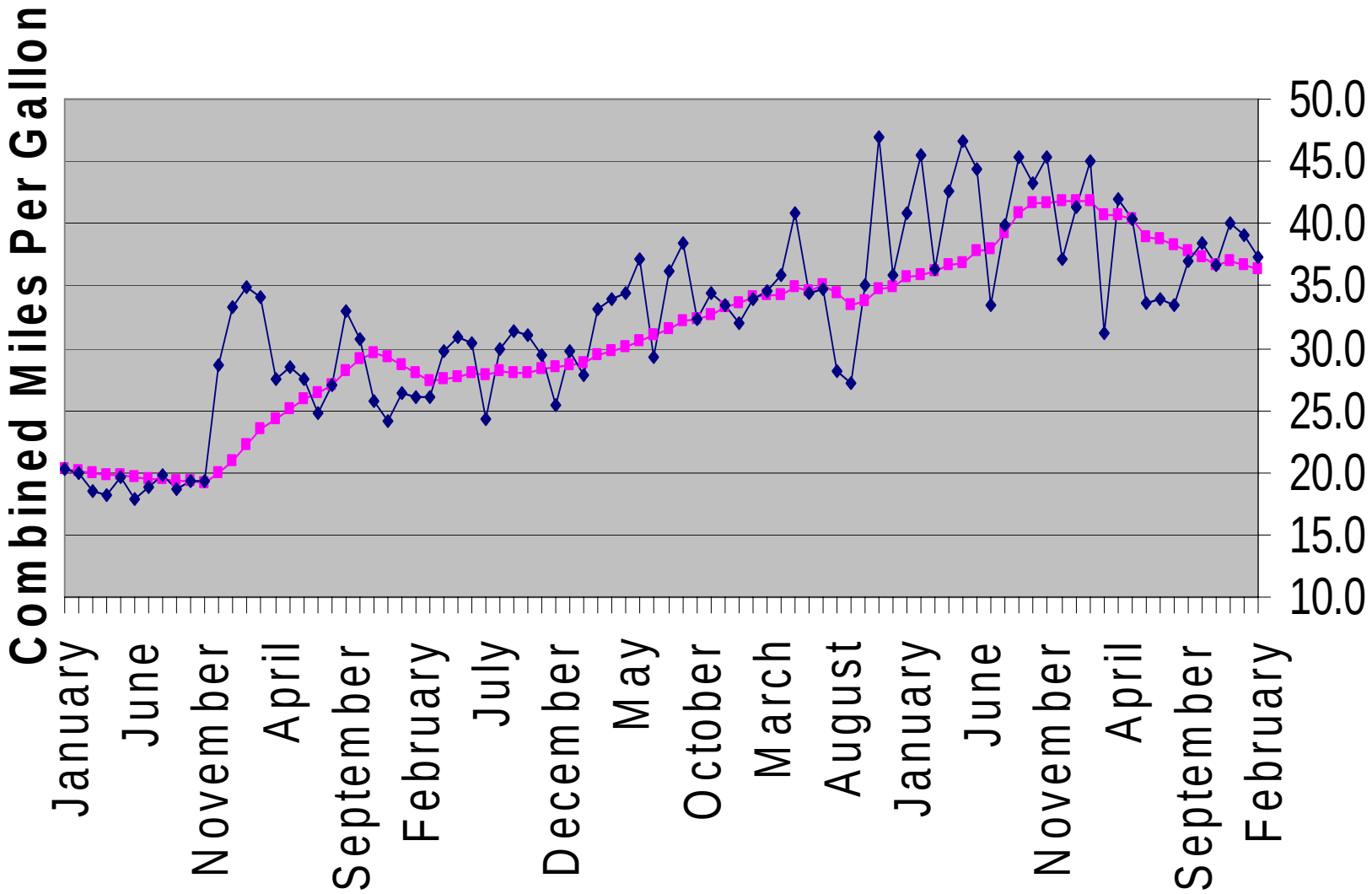
EPA Estimate: www.fueleconomy.gov

49 Miles Per Gallon	23 Miles Per Gallon	57 Miles Per Gallon
46 MPG (Actual)	24 MPG (Actual)	46 MPG (Actual)

2001 Toyota Prius #1 Bought Nov, 2000	2003 Honda CRV Bought Feb, 2003	2005 Toyota Prius #2 Bought Oct, 2004

Our combined miles per gallon for all three cars is: 36.7 vs. 19 prior to 2001

Hathaway Average Automobile Fuel Economy
2000 - 2007



Since 2000 We have saved 11,500 Gallons of Gasoline

1 8,000 Gallon Tanker

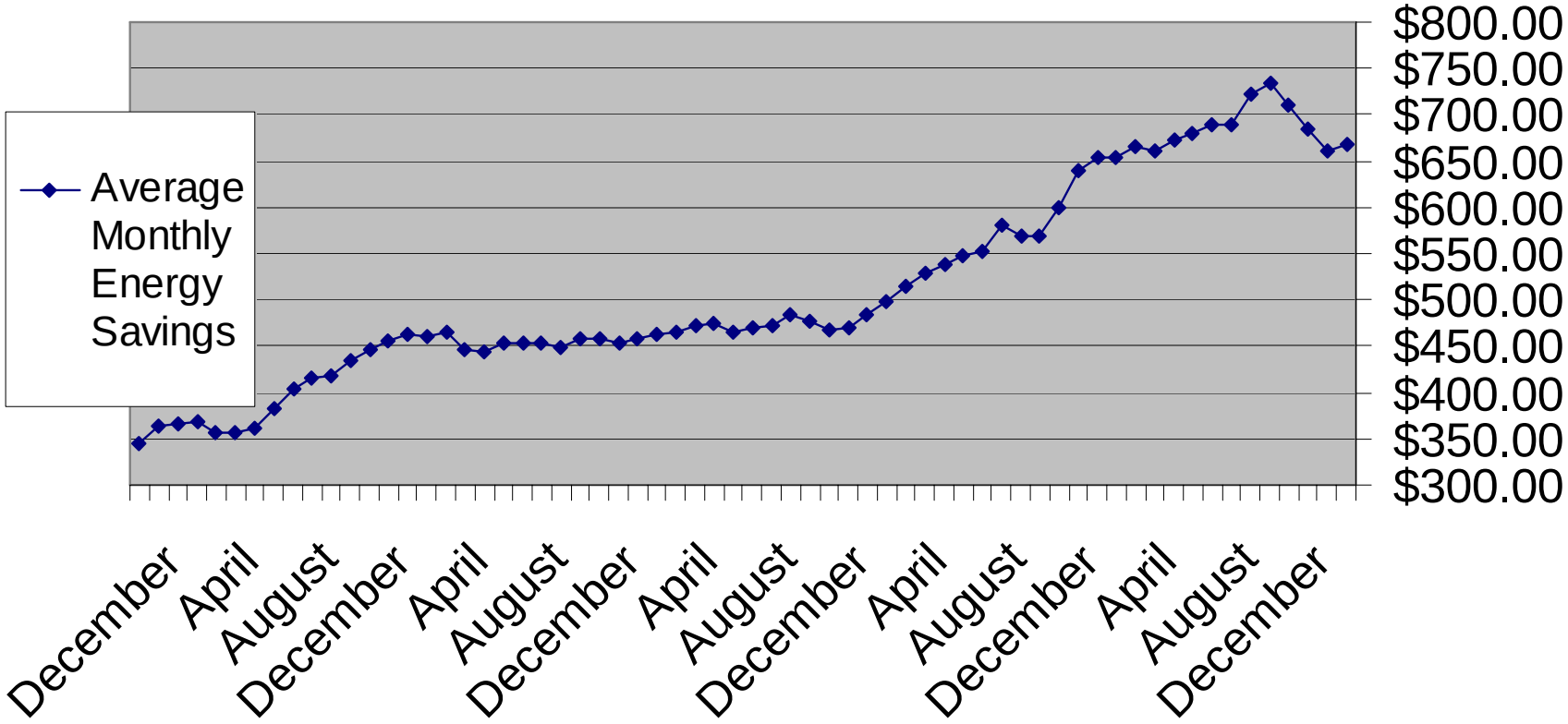
+

1 3,500 Gallon Tanker

$28,750 *

* @ 2.50/Gallon

Hathaway Auto and Home Energy Savings
2001 - 2006



Solar Patriot/Auto Combined Economics

Total Savings over previous 5.5 Years:		$36,816
Expected Savings over next 5.5 Years:		$44,022
Average Savings per Month:		$667
Net Investment:	Solar Patriot:	$58,000
	Prius #1:	$4,500
	CRV:	$8,000
	Prius #2:	$8,500
		$79,000

Simple Rate of Return **10.1%**

Solar Home/Hybrid Auto Combined Economics

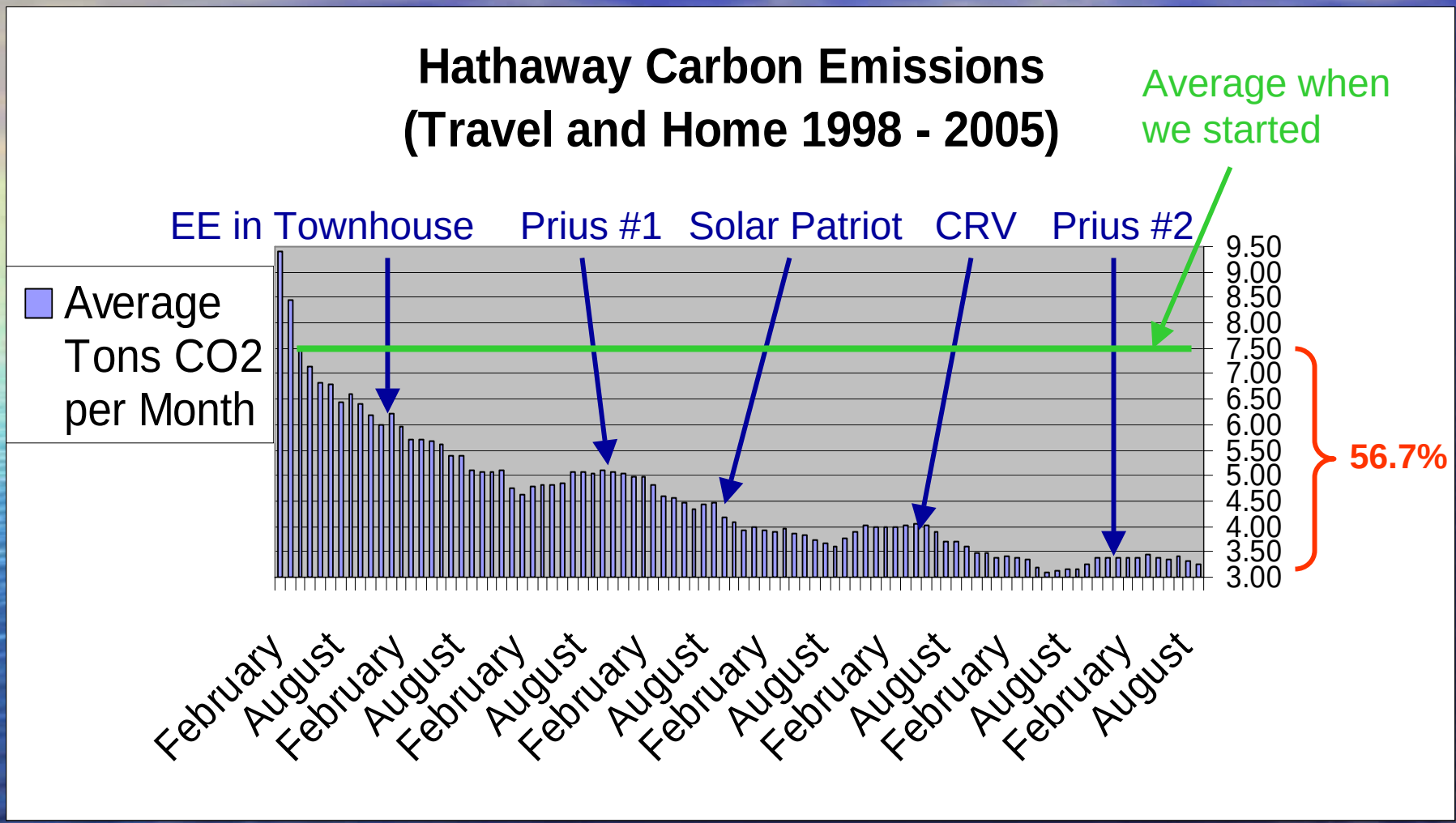
Tax Credits:

Solar PV Roof System	$2,000
Solar Hot Water System	$ 600
1 Toyota Prius	$2,000
TOTAL	**$4,600**

Solar Home/Hybrid Auto Combined Economics

Projected Savings per Month (Home):	$350
Projected Savings per Month (Prius):	$170
Total Savings/Month	$520
Net Investment (Solar Home and Auto):	$70,000
Tax Credits	- $4,600
	$65,400
Simple Rate of Return	**9.5%**

Our Carbon Impact



Hathaway Carbon Emissions due to Energy Reduced by nearly 57%

* Hathaway, Alden, Building an Affordable Solar Home, 2003, Chapter 10, pg 98; www.solarhome.beplaced.com

How Do We Reduce Our Carbon Impact to "0"

Purchase GHG Offsets to Offset Hathaway's 3.25 Tons/Month

Presented to

INLAND EMPIRE UTILITIES AGENCY

The Environmental Resources Trust, Inc. has verified the environmental performance of the Inland Empire Utilities Agency anaerobic digester project and has registered 5,825 metric tons (vintage 2004) of verified carbon dioxide equivalent emission reductions. These reductions are designated by serial numbers 120,145,048 through 120,150,872 in the GHGRegistry®.

Presented this 13th day of February 2006.

GHGRegistry

Wiley Barbour
Executive Director, Environmental Resources Trust

Inland Empire UTILITIES AGENCY
A Municipal Water District

At $8 per Ton

Annual GHG Offset Cost:

$312.00

ERT Registered GHG Offsets – 202-785-8577 x 13

What if 10% of Americans Purchased Solar Homes and Hybrid Cars and an additional 20% of our grid electricity came from renewable energy?

Average per Capita Consumption Based GHG:

United States	21.5 Tons
Canada	16.8 Tons
India	0.9 Tons
Rest of the World (Excl US)	3.6 Tons
Total World	4.6 Tons

What if 10% of Americans Purchased Solar Homes and Hybrid Cars and an additional 20% of our grid electricity came from renewable energy?

25% Reduction in overall US GHG Emissions per Year

Average per Capita Consumption Based GHG:

United States	16.1 Tons
Canada	16.8 Tons
India	0.9 Tons
Rest of the World (Excl US)	3.6 Tons
Total World	4.3 Tons

6% Reduction in overall World GHG Emissions per Year


What Are You Waiting For?
More of this?


or this?


or this?

What Are You Waiting For?

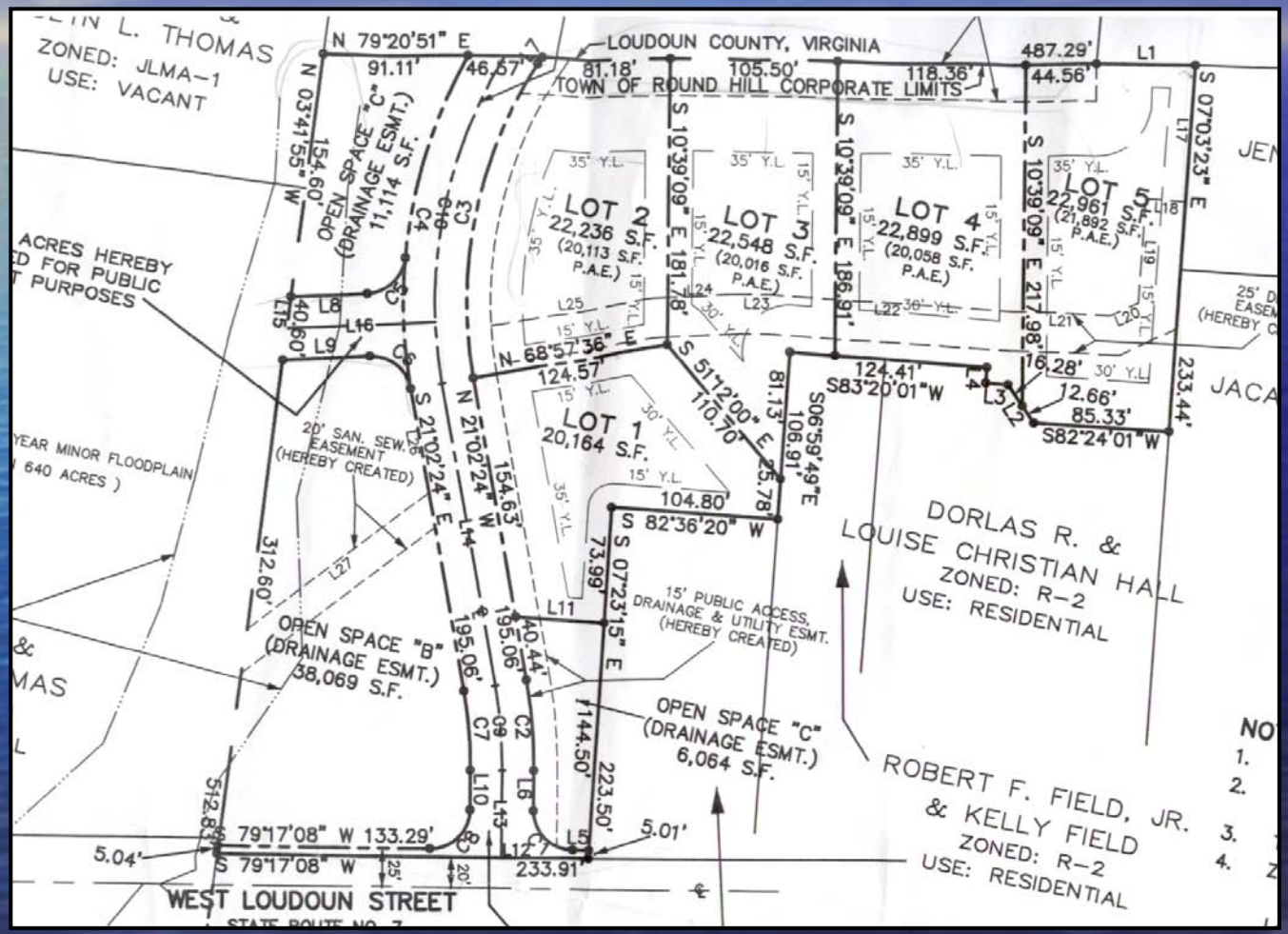
- Luxurious and Sustainable Living
- 9+% (Risk-Free) ROI
- Positive Cash Flow
- Increase Equity through Energy Savings
- Meet Personal GHG Reduction Goal
- Finance America's Alternative Energy Future

Bay Homes

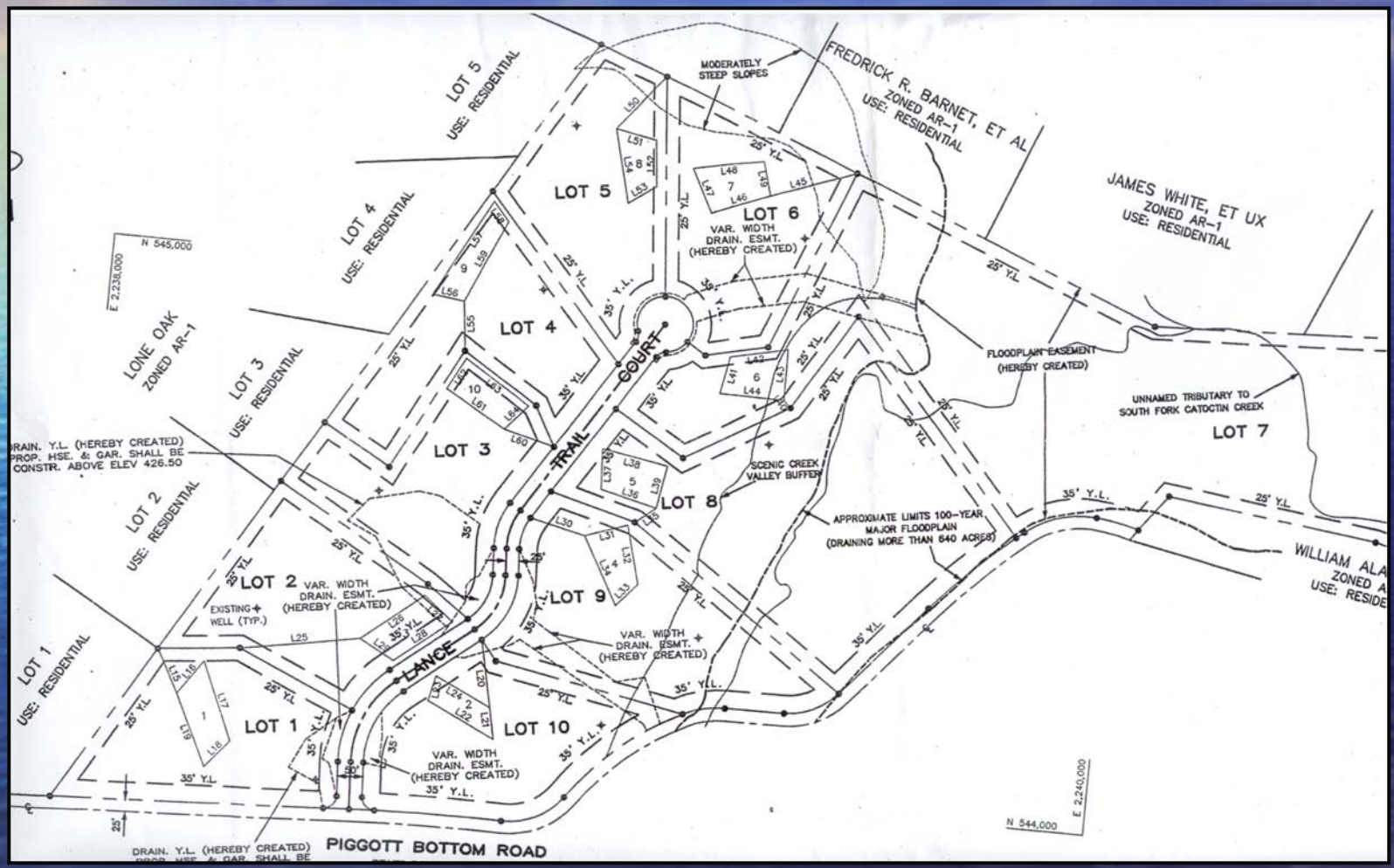
- Round Hill West and Dakota Projects Offer New Solar Homes Featuring Hybrid House Technology Package.

Round Hill West

Round Hill West
Phase One Site Plan



Dakota Site Plan



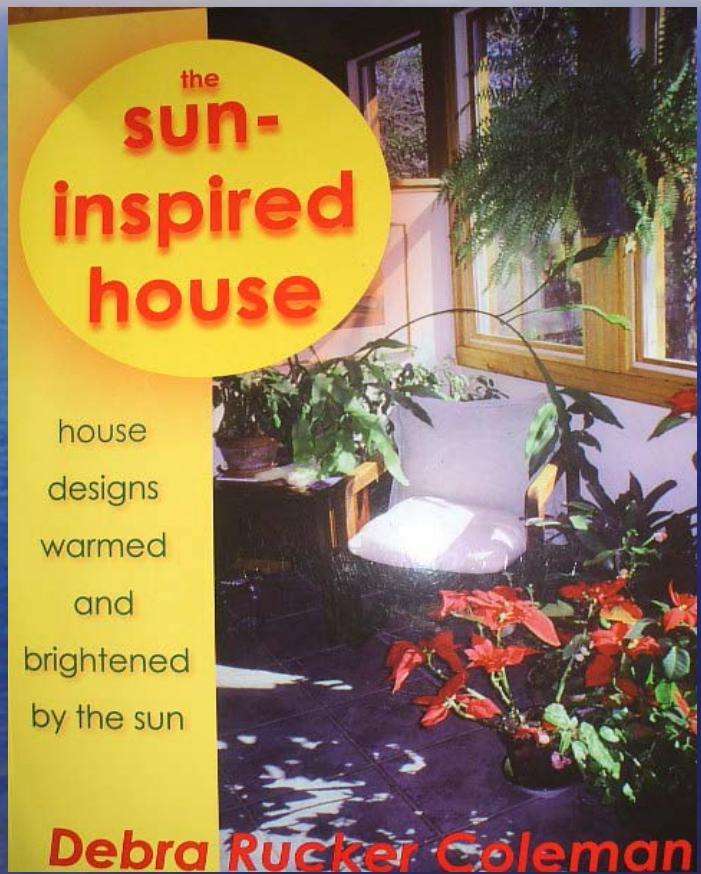
Round Hill West

Solar Pathfinder At Round Hill West

Solar Chestnut House

Solar Oak House

Other Solar House Plans or a Custom Plan



Hybrid House Technology Package

- Passive Solar Orientation and Design Details
- Solar Landscaping
- Super Shell w/Blown In Cellulose Insulation
- Heliodyne Solar Hot Water System
- 4 KW Grid Tied PV Solar System
- Energy Star Appliances and CF Lighting
- Dual Fuel Air Coupled Heat Pump/LP Gas Furnace with 14+ SEER AC

Passive Solar

- Hybrid Walk-Up Basements with Lots of Windows

Solar Landscaping

- Evergreen Screen to North and West and low and deciduous to East and South

Super Shell

- House Wrap
- Caulked Top Plate to Drywall
- Low E Argon High Performance Windows
- R-21 Walls, R-48 Ceilings
- Air-Seal and Fire Stopping Package
- Insulated Composite Doors
- Exterior Combustion Air

Solar Hot Water

Helio-Pak Solar Water Heaters

Sensible Technology™ from Heliodyne, the Leading Manufacturer since 1976

Closed-Loop Systems with High-Efficiency Heat Exchangers
for Safe Installation and Year-round Operation in All Areas

No Collector Freezing or Boilout

Specified and Installed on Homes, Businesses, National and State Parks

Helio-Pak DW CL Appliance

Proven, Non-Freezing, Smart

- Modular and easy to install
- Solid and clean appearance
- Copper double wall heat exchanger
- Efficient counterflow design
- Food-grade heat transfer fluid
- Automatic operation
- Electronic tank temperature setting
- Adapts to standard tank sizes
- Several sizes to fit collector needs
- 150 psi rated for boilout protection

Gobi Solar Collectors

Favorites of Installers and Homeowners

- Skylight appearance, attractive looks
- Solid and built to last
- Certified high performance
- All-copper blackchrome absorber plate
- Durable tube-to-fin absorber bond
- Double strength tempered solar glass
- Anti-glare finish
- Modular hardware for any tilt
- Wind and impact resistant
- Structural certification
- High output even on marginal days
- Sold and installed in many countries

Photo courtesy *In Hot Water*

Made in the USA

SRCC OG-100 and OG-300 certified

HELIODYNE, INC.
510-237-9614 www.heliodyne.com
Fax: 510-237-7018 info@heliodyne.com

HP163-1-05MJS

4 KW Grid Tied PV Array

UNI-SOLAR

Solar Laminate PVL-Series

Model: PVL-136

Data Sheet

- **High Temperature and Low Light Performance**
- **20 Year Warranty on Power Output at 80%**
- **Quick-Connect Terminals***
- **Bypass Diodes for Shadow Tolerance**
- **UL Listed to 600 VDC**
- **Meets IEC 61646 Requirements**

PERFORMANCE CHARACTERISTICS

Rated Power (Pmax): 136W
Production Tolerance: ± 5%

CONSTRUCTION CHARACTERISTICS

Dimensions: Length: 5486mm (216"), Width: 394mm (15.5"), Depth: 4mm (0.2"), 16mm (0.6") including junction box.
Weight: 7.7 kg (17.0 lbs.).
Output Cables: ~2.5mm² cable with weatherproof DC rated quick-connect terminals* 560mm (22") length.
By-pass Diodes: Connected across every solar cell.
Laminate Encapsulation: Durable ETFE (e.g. Tefzel®) high light-transmissive polymer.
Adhesive: Ethylene propylene copolymer adhesive-sealant with microbial inhibitor.
Cell Type: 22 triple junction amorphous silicon solar cells 356 x 239mm (14" x 9.4") connected in series.

QUALIFICATIONS AND SAFETY

Listed by Underwriter's Laboratories for electrical and fire safety (Class A Max. Slope 2/12, Class B Max. Slope 3/12, and Class C Unlimited Slope fire ratings) for use in systems up to 600 VDC.

APPLICATION CRITERION

- New or other qualified roof installations
- 16" minimum steel pan width
- PVDF Coated (Galvalume® or Zincalume® steel metal pan)
- Steel pans with flat surface (without pencil beads, stiffening ribs, or decorative stippling)
- Installation by certified installers only
- Installation temperature between 10°C - 40°C (50°F - 100°F)
- Maximum roof temperature 85°C (185°F)
- Refer to manufacturer's installation guide for approved substrates & installation methods

LAMINATE STANDARD CONFIGURATION

Photovoltaic laminate with potted terminal housing assembly with output cables and quick connect terminals*.

OPTIONAL CONFIGURATION

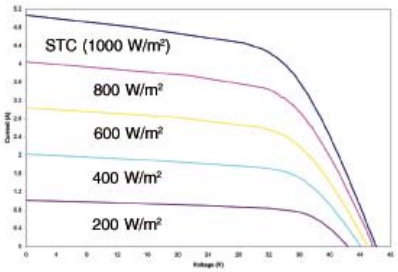
Photovoltaic laminate with junction box.
*e.g., Multi-Contact (MC®) connectors.

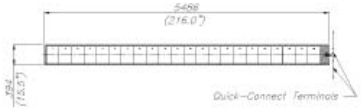
UNI-SOLAR

FLEXIBLE · LIGHTWEIGHT · NO-GLASS · DURABLE · SHADOW TOLERANT · HIGH TEMP PERFORMANCE

Solar Laminate PVL-Series Model: PVL-136 UNI-SOLAR

IV Curves at various levels of irradiance at Air Mass 1.5 and 25° C Cell Temperature





PVL-136

All measurements in mm.
Inches in parentheses.
Tolerances Length: ± 5mm (1/4")
Width: ± 3mm (1/8")

ELECTRICAL SPECIFICATIONS: STC

(1000 W/m², AM 1.5, 25° C Cell Temperature)

Maximum Power (Pmax):	136 W
Voltage at Pmax (Vmp):	33.0 V
Current at Pmax (Imp):	4.1 A
Short-circuit Current (Isc):	5.1 A
Open-circuit Voltage (Voc):	46.2 V
Maximum Series Fuse Rating:	8 A

NOCT

(800 W/m², AM 1.5, 1 m/sec. wind)

Maximum Power (Pmax):	105 W
Voltage at Pmax (Vmp):	30.8 V
Current at Pmax (Imp):	3.42 A
Short-circuit Current (Isc):	4.1 A
Open-circuit Voltage (Voc):	42.2 V
NOCT:	46° C

TEMPERATURE COEFFICIENTS

(at AM 1.5, 1000 W/m² irradiance)

Temperature Coefficient of Isc:	5.1mA/K
Temperature Coefficient of Imp:	4.1mA/K
Temperature Coefficient of Voc:	-176mV/K
Temperature Coefficient of Vmp:	-102mV/K
Temperature Coefficient of Pmax:	-286mW/K

NOTES:
1. During the first 8-10 weeks of operation, electrical output exceeds specified ratings. Power output may be higher by 15%, operating voltage may be higher by 11% and operating current may be higher by 4%.
2. Electrical specifications are based on measurements performed at standard test conditions of 1000 W/m2 irradiance, Air Mass 1.5, and Cell Temperature of 25° C after stabilization.
3. Actual performance may vary up to 10% from rated power due to low temperature operation, spectral and other related effects. Maximum system open-circuit voltage not to exceed 600 VDC per UL.
4. Specifications subject to change without notice.

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- Grey Water Systems
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Questions?

Alden Hathaway and Carter Morrow