

Task 48 – Quality Assurance and Support Measures for Solar Cooling

Subtask C: Market Support Measures

C1: Review of Relevant International Standards, Rating and Incentive Systems

Country: United States of America

Milan, Italy – March 26, 2012

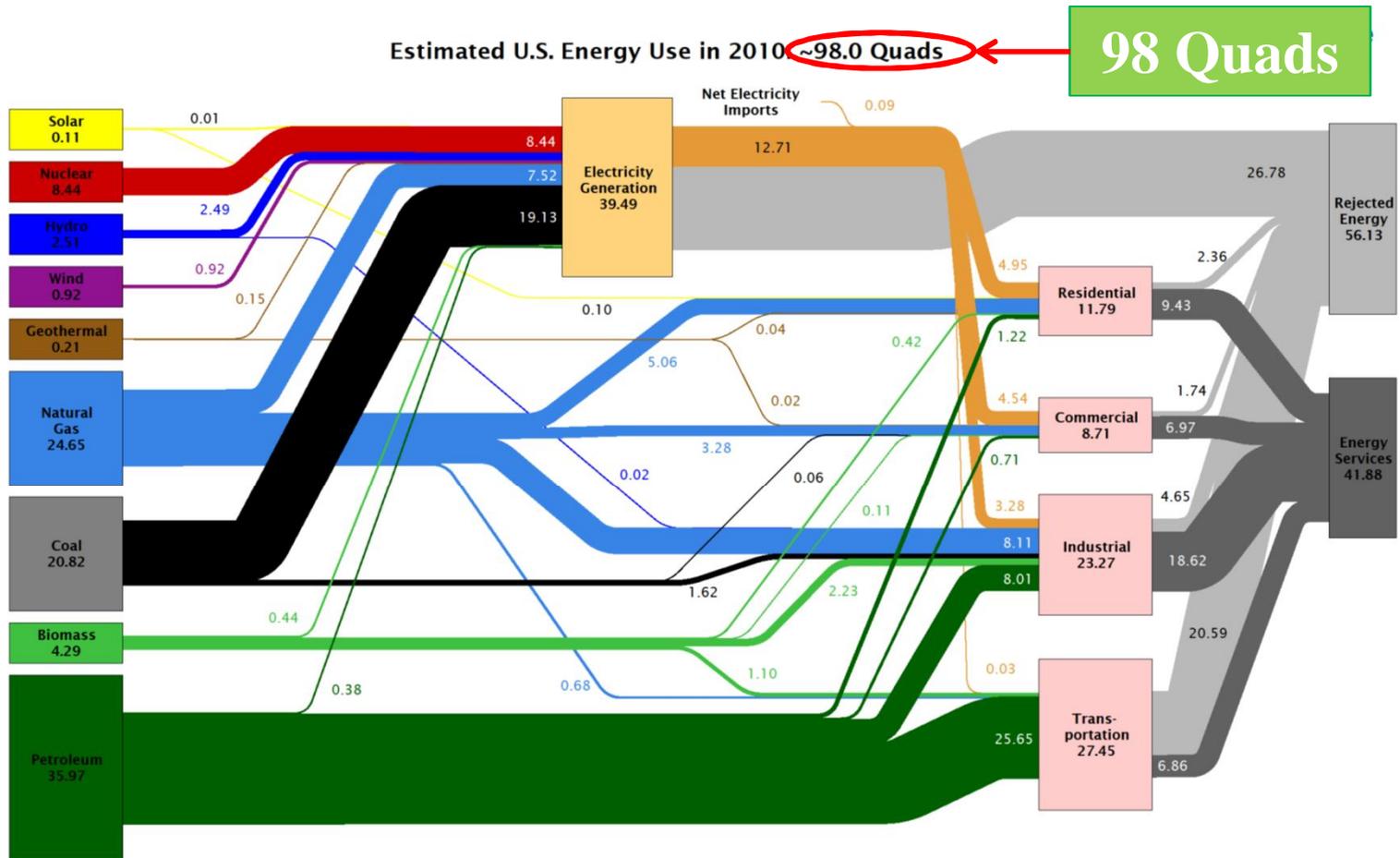
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Energy Management Consulting Group

Agenda

- **Introduction**
- **US Solar Thermal Market**
- **Current Trends**
- **Solar Thermal Industry Rating & Certification**
- **Rebates & Incentives**

U.S. Energy Flow Trends – 2010



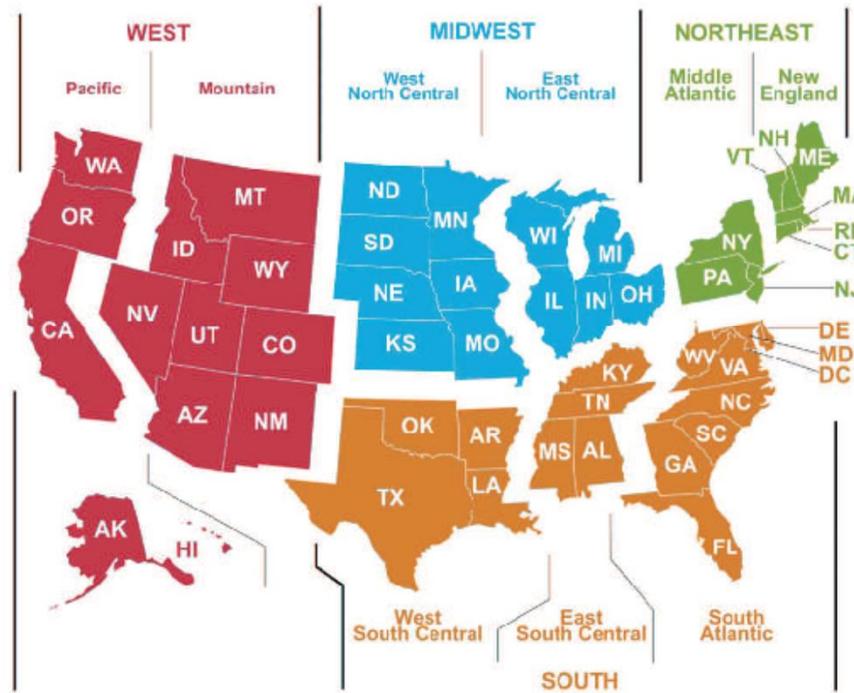
Source: LLNL 2011. Data is based on DOE/EIA-0384(2010), October 2011. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for hydro, wind, solar and geothermal in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." (see EIA report for explanation of change to geothermal in 2010). The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Source: Lawrence Livermore National Laboratory

U.S. Census Regions and Divisions

Appendix C

Figure C1. U.S. Census Regions and Divisions



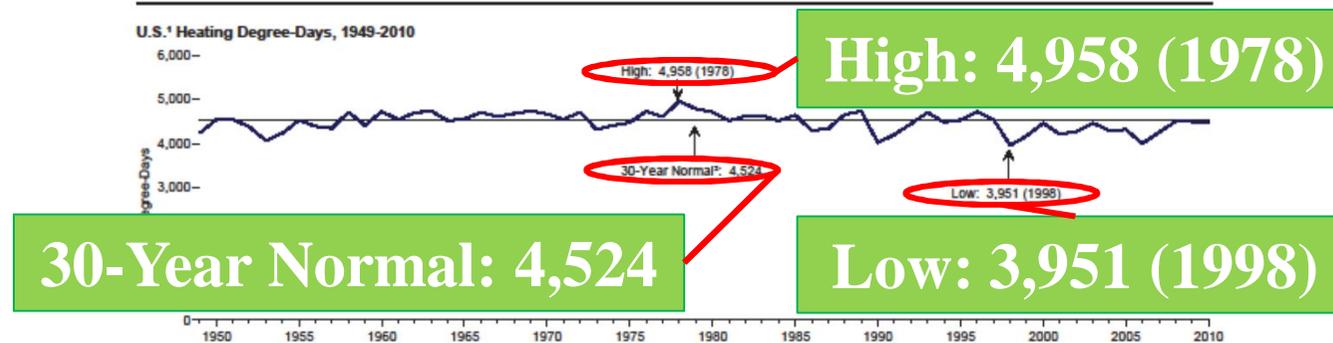
Note: Map not to scale.
Web Page: See www.census.gov/geo/www/us_regdiv.pdf.

Source: U.S. Department of Commerce, Bureau of the Census.

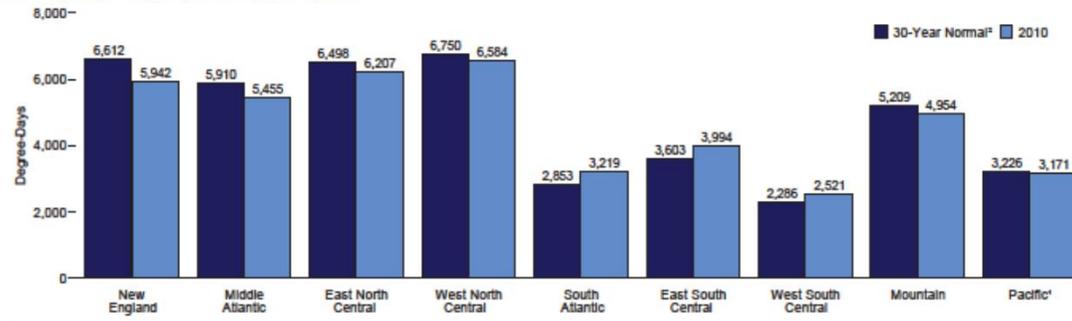
Source: U.S. Energy Information Administration / Annual Energy Review 2010

Heating Degree-Days by Census Division

Figure 1.9 Heating Degree-Days by Census Division



Heating Degree-Days by Census Division, 2010



¹ Excludes Alaska and Hawaii.

² Based on calculations of data from 1971 through 2000.

Note: See Appendix C for map of Census divisions.
Source: Table 1.9.

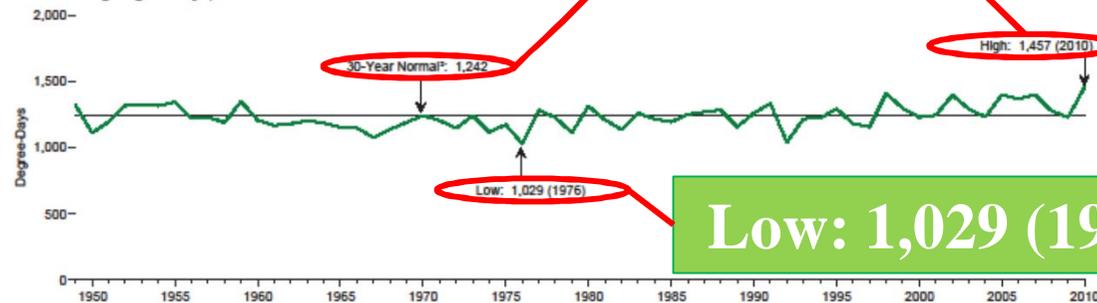
Cooling Degree-Days by Census Division

30-Year Normal: 1,242

High: 1,457 (2010)

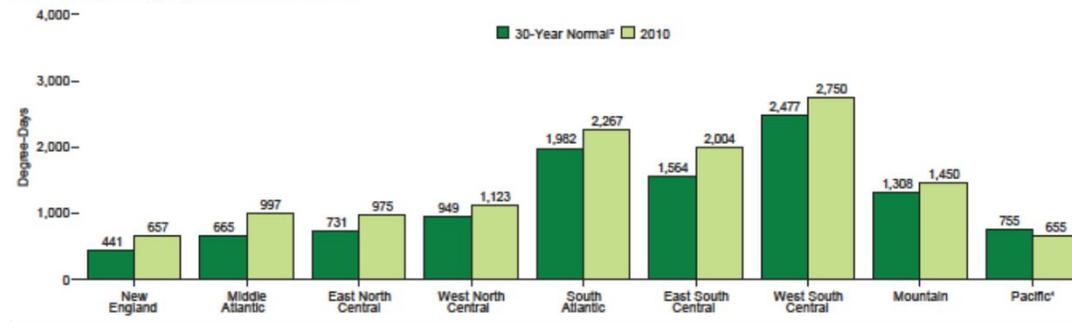
Figure 1.10 Cooling Degree-Days by Census Division

U.S.¹ Cooling Degree-Days, 1949-2010



Low: 1,029 (1976)

Cooling Degree-Days by Census Division, 2010



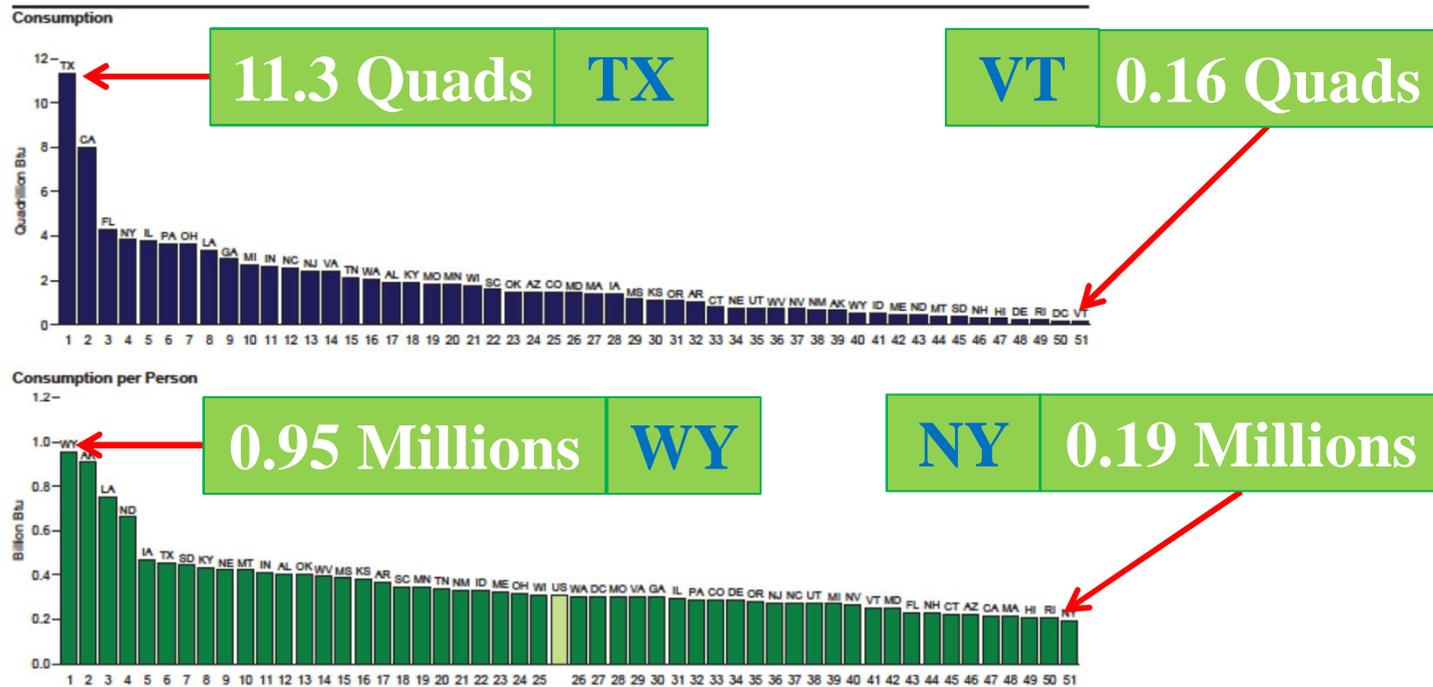
¹ Excludes Alaska and Hawaii.

² Based on calculations of data from 1971 through 2000.

Note: See Appendix C for map of Census divisions.
Source: Table 1.10.

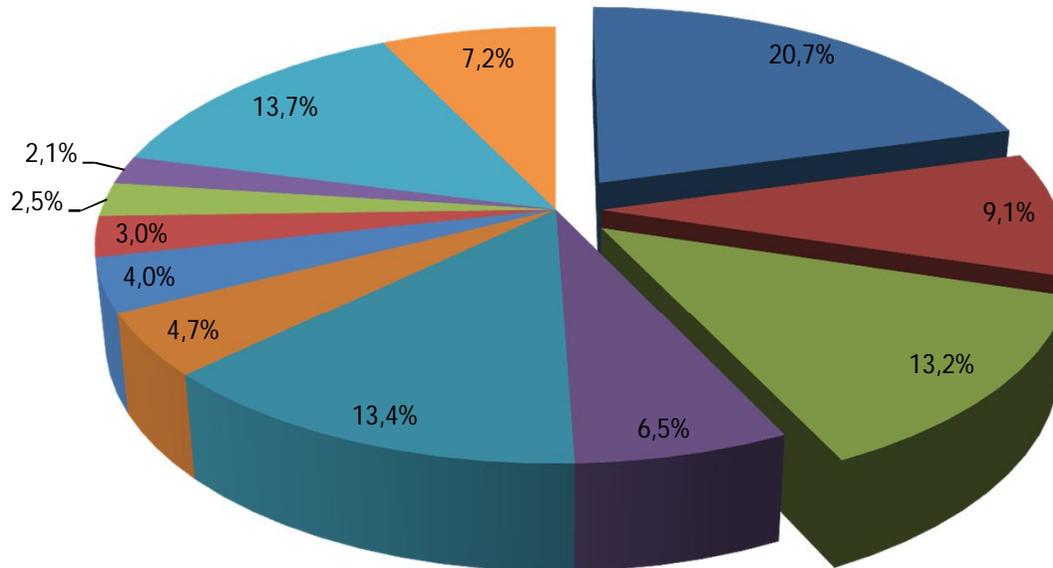
State-Level Energy Consumption Estimates and Estimated Consumption per Person in 2009

Figure 1.6 State-Level Energy Consumption Estimates and Estimated Consumption per Person, 2009



Source: Table 1.6.

2010 U.S. Buildings Energy End-Use Splits



Space Heating: 20.7%
+
Water Heating: 9.1%
+
Space Cooling: 13.2%

Total: 43% of US
Buildings Energy Use

■ Space Heating ■ Water Heating ■ Space Cooling ■ Refrigeration ■ Lighting ■ Electronics
■ Ventilation ■ Computers ■ Wet Cleaning ■ Cooking ■ Other ■ Adjust to SEDS

Source: 2010 Building Energy Data Book by U.S. DOE/EERE, Table 1.1.5

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Solar Collectors in Operation by Country at the end of 2007

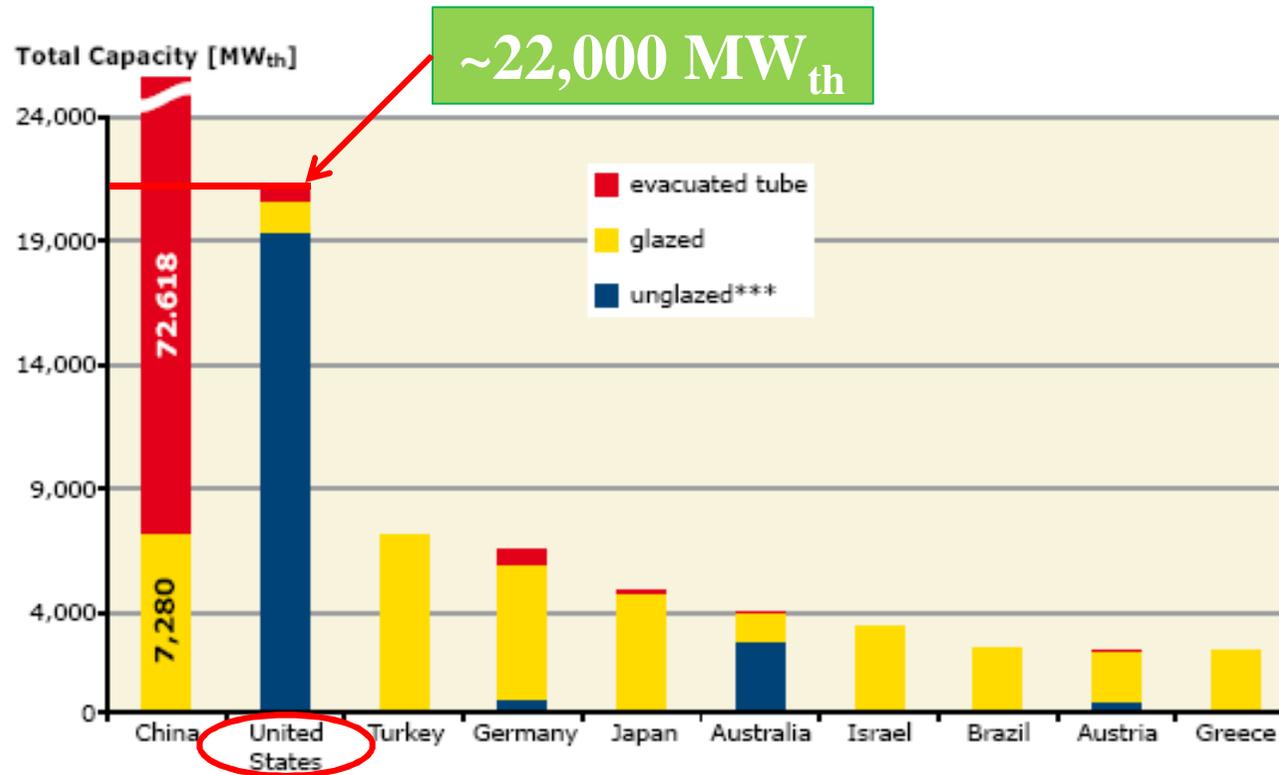
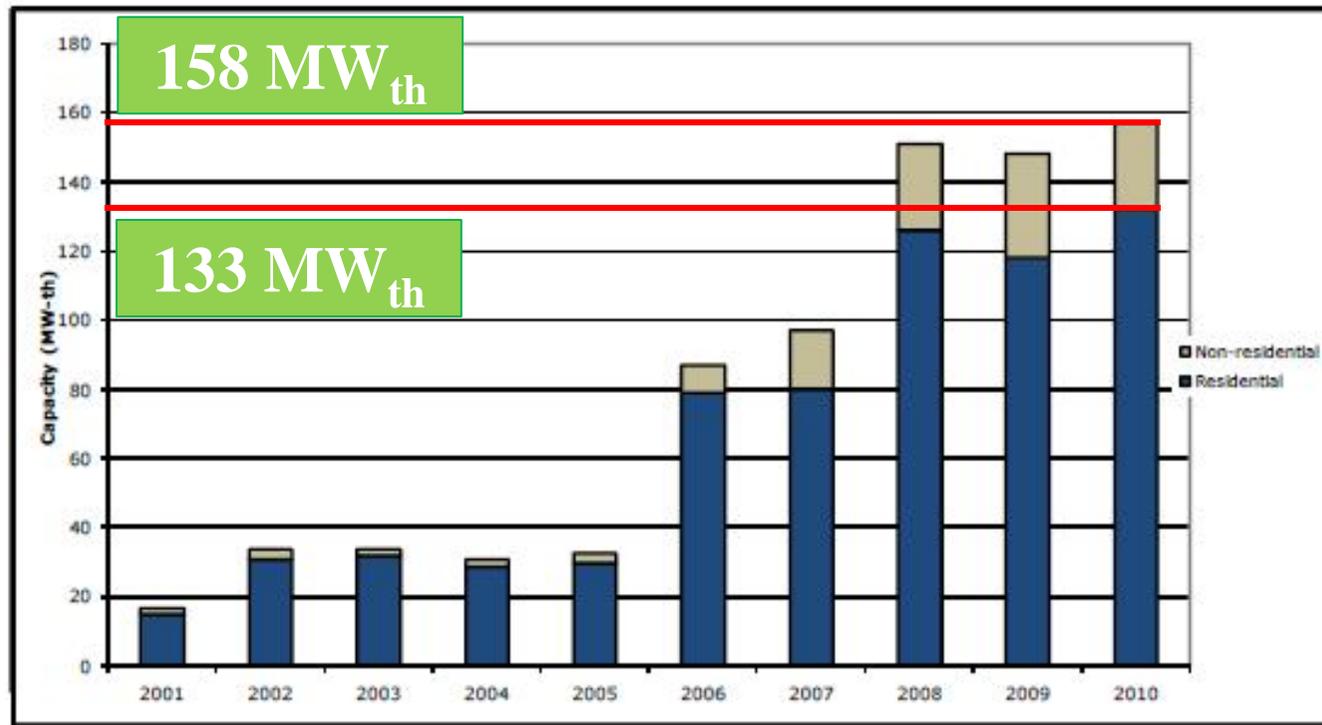


Figure 4: Total capacity in operation of water collectors of the 10 leading countries at the end of 2007

Source: Solar Heating & Cooling Worldwide – 2010 Edition

Annual Installed U.S. Capacity for Solar Heating & Cooling (2001-2010)



Based on analysis of collector shipment data from EIA and GTM/SEIA.

Source: U.S. Solar Market Trends 2010 / June 2011

- **84% of these installations are in the residential sector**

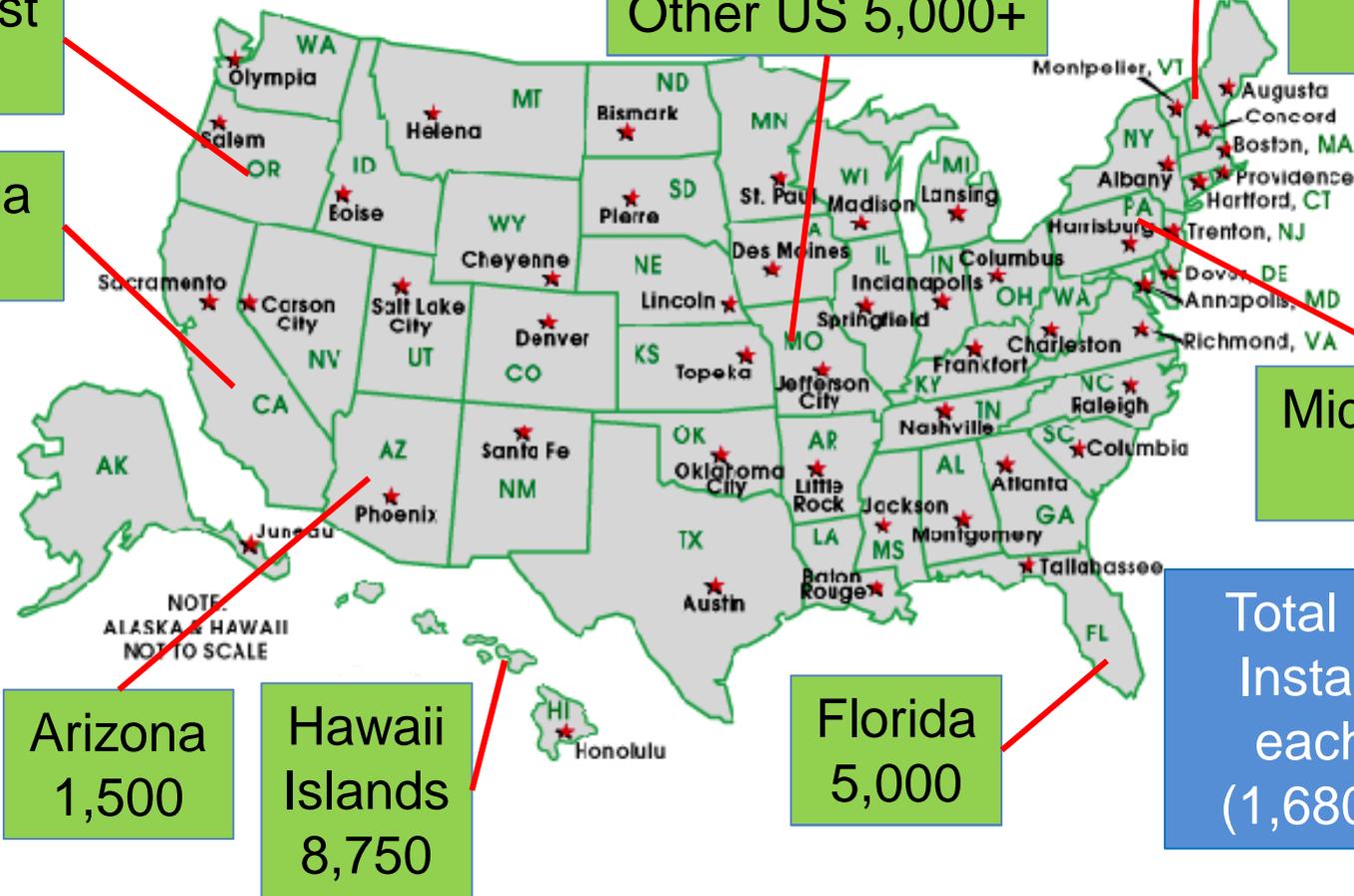
US Solar Thermal Installations Estimated in 2009

Northwest
500

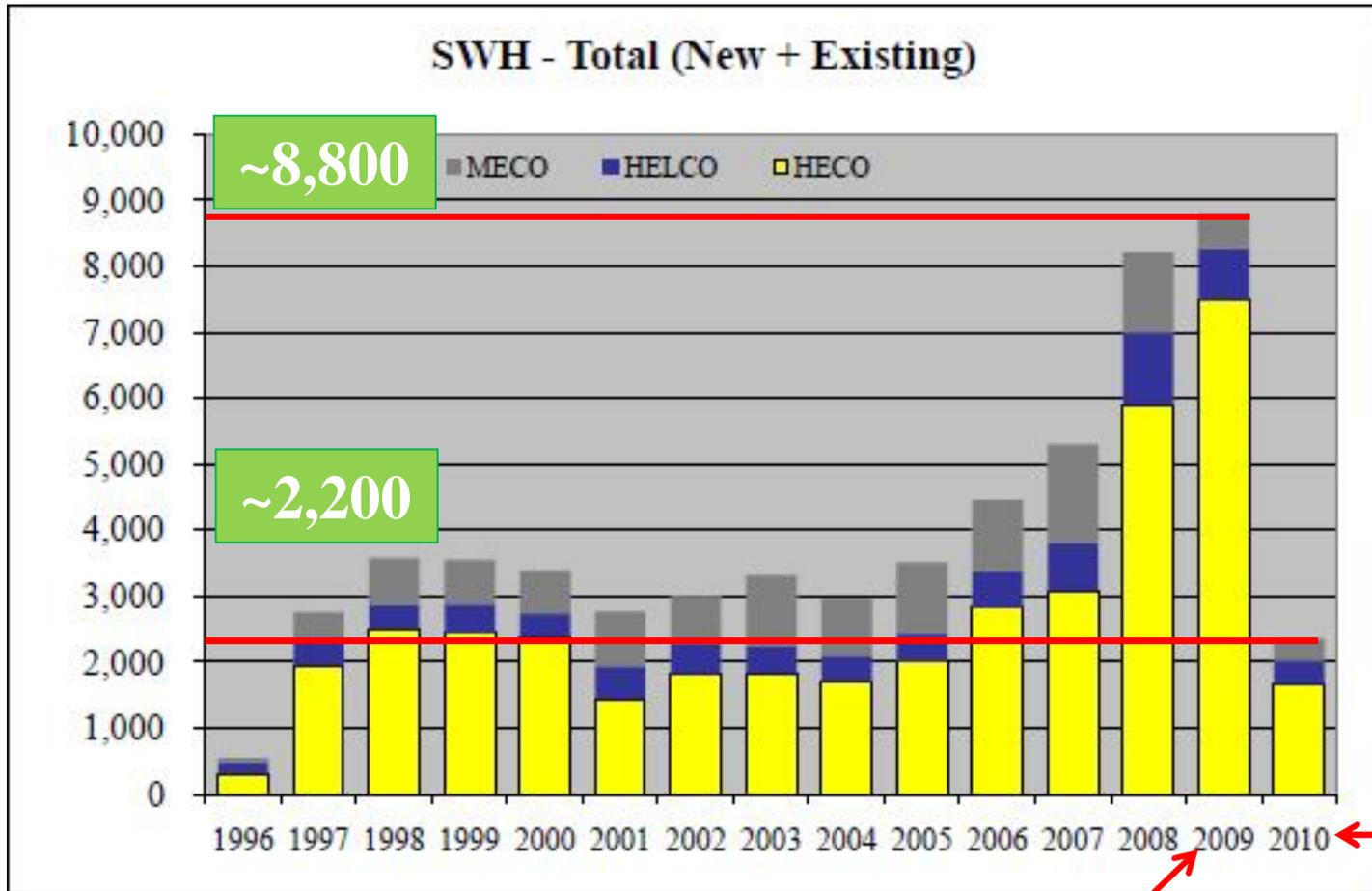
California
1,000

Midwest and All
Other US 5,000+

New
England +
New York
3,000



Hawaii Residential Energy Efficient Water Heater Program (1996-Q2 2010)



Source: Hawaii Utility Administrators

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Current Trends

Solar Water Heating

- Evacuated Tube Collectors are getting increased popularity

Solar Swimming Pool Heating

- More and more systems are installed with an average of 350-400 ft²/system

Solar Space Heating

- Interest on combined heating and hot water systems (Combi-Systems) is growing

Solar Air Conditioning

- SAC is gaining interest especially in geographical regions with generous incentives, and high energy cost

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Solar Rating and Certification Corporation

- **SRCC is a Non-profit organization established in 1980**
- **OG-100: Solar Collectors**
- **OG-300: Solar Water Heating Systems**
- **110 SRCC Participants**

SRCC Certified Solar Collectors as of Q1 2012

- **946 Glazed (OG-100)**
- **43 Unglazed (OG-100)**
- **4 Concentrating (OG-100)**
- **20 Integral Collector Storage (ISC) and Non-Separable Thermosiphon Collector (OG-100)**
- **2,115 Certified Systems (OG-300)**

Typical Solar Collector Certification and Rating

SOLAR COLLECTOR CERTIFICATION AND RATING



SRCC OG-100™

CERTIFIED SOLAR COLLECTOR

SUPPLIER: **Viessmann Manufacturing Company (US) Inc.**
 45 Access Road
 Warwick, RI 02886 USA

MODEL: **Vitosol 100-F, SV1/SH1**

COLLECTOR TYPE: **Glazed Flat-Plate**

CERTIFICATION#: **2007042A**

Original Certification Date: **19-NOV-08**

SOLAR COLLECTOR CERTIFICATION AND RATING



SRCC OG-100™

CERTIFIED SOLAR COLLECTOR

SUPPLIER: **Viessmann Manufacturing Company (US) Inc.**
 45 Access Road
 Warwick, RI 02886 USA

MODEL: **Vitosol 300-T, SP3 -3m2**

COLLECTOR TYPE: **Tubular**

CERTIFICATION#: **2005020B**

Original Certification Date: **09-AUG-06**

COLLECTOR THERMAL PERFORMANCE RATING

Kilowatt-hours Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY (6.3 kWh / m ² .day)	MILDLY CLOUDY (4.7 kWh / m ² .day)	CLOUDY DAY (3.1 kWh / m ² .day)	CATEGORY (Ti-Ta)	CLEAR DAY (2000 Btu / ft ² .day)	MILDLY CLOUDY (1500 Btu / ft ² .day)	CLOUDY DAY (1000 Btu / ft ² .day)
A (-5 °C)	11.3	8.5	5.8	A (-9 °F)	38.6	29.1	19.7
B (5 °C)	10.3	7.5	4.8	B (9 °F)	35.2	25.7	16.3
C (20 °C)	8.8	6.0	3.3	C (36 °F)	30.0	20.6	11.4
D (50 °C)	5.8	3.3	1.0	D (90 °F)	19.7	11.2	3.3
E (80 °C)	3.0	0.9	0.0	E (144 °F)	10.1	3.1	0.0

COLLECTOR THERMAL PERFORMANCE RATING

Kilowatt-hours Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY (6.3 kWh / m ² .day)	MILDLY CLOUDY (4.7 kWh / m ² .day)	CLOUDY DAY (3.1 kWh / m ² .day)	CATEGORY (Ti-Ta)	CLEAR DAY (2000 Btu / ft ² .day)	MILDLY CLOUDY (1500 Btu / ft ² .day)	CLOUDY DAY (1000 Btu / ft ² .day)
A (-5 °C)	12.7	9.5	6.4	A (-9 °F)	43.2	32.5	21.9
B (5 °C)	12.2	9.1	6.0	B (9 °F)	41.7	31.1	20.4
C (20 °C)	11.5	8.4	5.3	C (36 °F)	39.3	28.7	18.0
D (50 °C)	10.1	7.0	3.9	D (90 °F)	34.6	24.0	13.5
E (80 °C)	8.6	5.5	2.7	E (144 °F)	29.5	18.9	9.1

A- Pool Heating (Warm Climate) B- Pool Heating (Cool Climate) C- Water Heating (Warm Climate) D- Water Heating (Cool Climate) E- Air Conditioning

A- Pool Heating (Warm Climate) B- Pool Heating (Cool Climate) C- Water Heating (Warm Climate) D- Water Heating (Cool Climate) E- Air Conditioning

COLLECTOR SPECIFICATIONS

Gross Area:	2.494 m ²	26.84 ft ²	Net Aperture Area:	2.34 m ² 25.13 ft ²
Dry Weight:	42.2 kg	93. lb	Fluid Capacity:	1.7 liter 0.4 gal
Test Pressure:	1103. KPa	160. psig		

COLLECTOR SPECIFICATIONS

Gross Area:	4.287 m ²	46.15 ft ²	Net Aperture Area:	3.29 m ² 35.36 ft ²
Dry Weight:	68.0 kg	150. lb	Fluid Capacity:	1.8 liter 0.5 gal
Test Pressure:	130. KPa	19. psig		

COLLECTOR MATERIALS

Frame:	Aluminum	Pressure Drop	
Cover (Outer):	Low Iron Tempered Glass		
Cover (Inner):	None	Flow	ΔP
		ml/s	gpm
			Pa
			in H ₂ O
		20.00	0.32
		50.00	0.79
		80.00	1.27

COLLECTOR MATERIALS

Frame:	Aluminum	Pressure Drop	
Cover (Outer):	Glass Vacuum Tube		
Cover (Inner):	None	Flow	ΔP
		ml/s	gpm
			Pa
			in H ₂ O

Absorber Material: Tube - Copper / Plate - Copper Sheet

Absorber Coating: Black Chrome

Insulation Side: None

Insulation Back: Mineral Fibre

Absorber Material: Tube - Copper / Plate - Copper fin

Absorber Coating: Sputtered cermet

Insulation Side: Vacuum

Insulation Back: Vacuum

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta] Y INTERCEPT SLOPE

SI Units: η = 0.769 -3.61400 (P)/l -0.01358 (P)²/l 0.776 -4.427 W/m².°C

IP Units: η = 0.769 -0.63661 (P)/l -0.00133 (P)²/l 0.776 -0.780 Btu/hr.ft².°F

Incident Angle Modifier [(S)=1/cosθ - 1, 0° < θ <= 60°]

K_{τα} = 1 -0.100 (S) -0.215 (S)² Test Fluid: Water

K_{τα} = 1 -0.32 (S) Linear Fit Test Flow Rate: 20.0 ml/s.m² 0.0295 gpm/ft²

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta] Y INTERCEPT SLOPE

SI Units: η = 0.508 -0.91560 (P)/l -0.00300 (P)²/l 0.509 -1.095 W/m².°C

IP Units: η = 0.508 -0.16128 (P)/l -0.00029 (P)²/l 0.509 -0.193 Btu/hr.ft².°F

Incident Angle Modifier [(S)=1/cosθ - 1, 0° < θ <= 60°]

K_{τα} = 1 0.519 (S) -0.743 (S)² Test Fluid: Propylene Glycol & Water

K_{τα} = 1 -0.26 (S) Linear Fit Test Flow Rate: 20.5 ml/s.m² 0.0302 gpm/ft²

REMARKS:

REMARKS: Collector tested with long axis of tubes oriented north-south. IAM perpendicular to the tubes is listed above. IAM parallel to the tubes = 1.0 - 0.31(S)



Laboratories Offering SRCC Accredited Testing Programs in US as of Q1 2012

1. Atlas Weathering Services Group

45601 N. 47th Avenue
Phoenix, Arizona 85087

Accreditation Date: May 14, 2010

SRCC Test Program Accredited to Perform:

- Qualification Tests (Standard 100)
- Glazed Liquid-heating Collector Efficiency (Standard 100)

2. Florida Solar Energy Center

1679 Clearlake Road
Cocoa, FL 32922-5703

Accreditation Date: October 1980

SRCC Test Program Accredited to Perform:

- Qualification Tests (Standard 100)
- Glazed Liquid-heating Collector Efficiency (Standard 100)
- Unglazed Liquid-heating Collector Efficiency (Standard 100)
- ICS and Non-separable Thermosiphon Systems (SRCC TM-1)

Laboratories Offering SRCC Accredited Testing Programs in US as of Q1 of 2012 (Cont.)

3. Pacific Energy Testing, LLC

3517 Edison Way, Suite A
Menlo Park, CA 94025

Accreditation Date: January 31, 2010

SRCC Test Program Accredited to Perform:

- Qualification Tests (Standard 100)
- Glazed Liquid-heating Collector Efficiency (Standard 100)
- Unglazed Liquid-heating Collector Efficiency (Standard 100)
- Glazed Air-heating Collector Efficiency (ASHRAE 93)
- ICS and Non-separable Thermosiphon Systems (SRCC TM-1)

4. TUV Rheinland PTL, LLC

2210 South Roosevelt Street
Tempe, AZ 85282

Accreditation Date: March 1, 2010

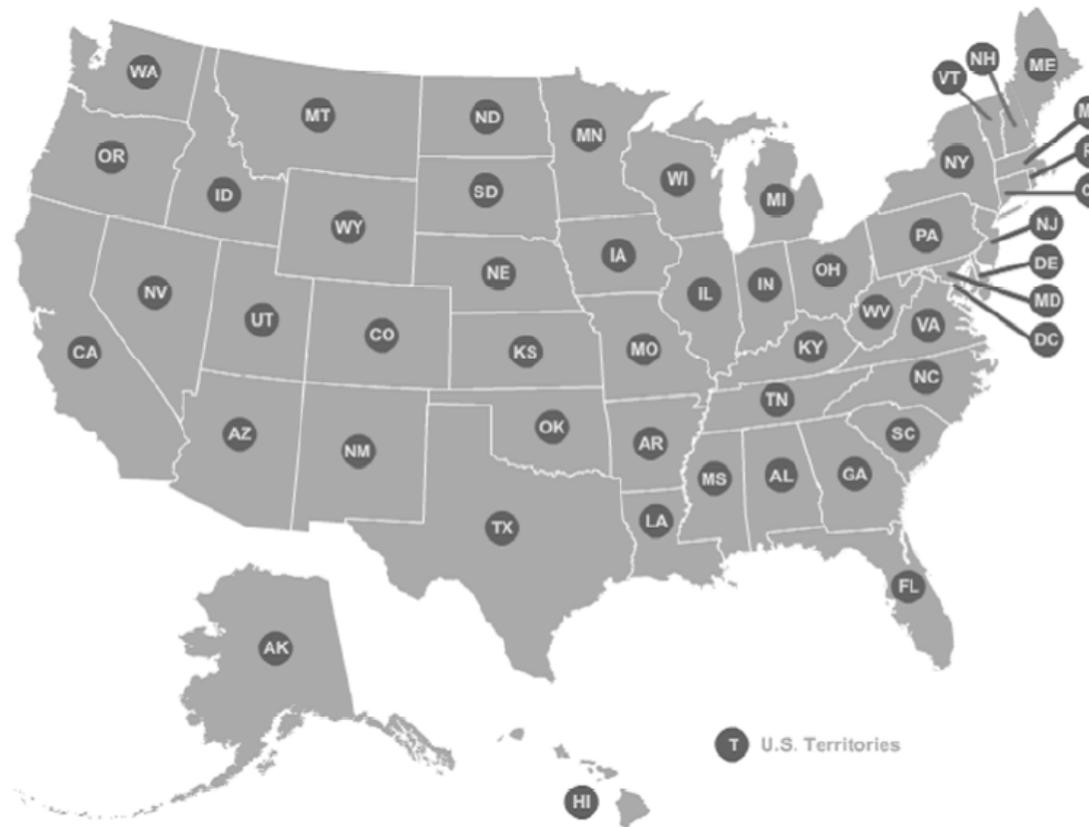
SRCC Test Program Accredited to Perform:

- Qualification Tests (Standard 100)
- Glazed Liquid-heating Collector Efficiency (Standard 100)
- Unglazed Liquid-heating Collector Efficiency (Standard 100)

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Database for State Incentives for Renewables & Efficiency (DSIRE)



Source: <http://www.dsireusa.org/>

California Solar Initiative – Solar Water Heating Rebate Program

- Solar equipment must be SRCC certified
- \$12.82 per estimated therm displaced of natural gas
- \$0.37 per estimated kWh displaced of electricity

Maximum Incentives:

- Single-family residential systems that displace natural gas: \$1,875
- Single-family residential systems that displace electricity: \$1,250
- Commercial and multifamily residential systems that displace natural gas: \$500,000
- Commercial and multifamily residential systems that displace electricity: \$250,000

New York - LIPA Residential Solar Water Heating Rebate Program

- Systems must be new; collectors must be SRCC OG-100 certified
- \$20 per kBTU (based on SRCC collector rating)

Maximum Incentives:

- \$1,500 or 50% of installed cost

Installation Requirements:

- Customer must have an existing electric water heater; system orientation must be south, southeast, or southwest; system must be owned by the customer (i.e., leased systems are not eligible)

Hawaii Energy - Solar Water Heater Rebate Program

- Equipment must be SRCC OG-100 certified.
- Residential: \$750.
- Commercial: \$50 per 5,000 Btu/hr derated capacity.

Oregon Energy Trust - Solar Water Heating Buy-Down Program

- Systems must be new. Expansions to existing solar systems are not eligible. System must be listed as eligible by Energy Trust and must be SRCC-certified.
- Systems must be installed by a qualified Energy Trust solar contractor.
- \$1,500 for residential systems; 35% of system cost for commercial.

Florida Beaches Energy Services - Solar Water Heating Rebate Program

- Solar Water Heater Rebate: \$500

Equipment Requirement:

- Must be Florida Solar Energy Center (FSEC) certified
- All system components must be new
- Systems must be guaranteed against freeze damage
- Solar pool heating systems ineligible

Installation Requirements:

- Newly constructed homes are not eligible for rebate
- Systems must be installed by a licensed Florida contractor according to manufacturer specifications
- System must be at least 80% shade free
- Systems must be installed prior to the issuance of a rebate

Thank you!

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