U.S. Markets & Technologies for Solar Thermal

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Large Area Systems - History

Packerland Solar: Green Bay WI.

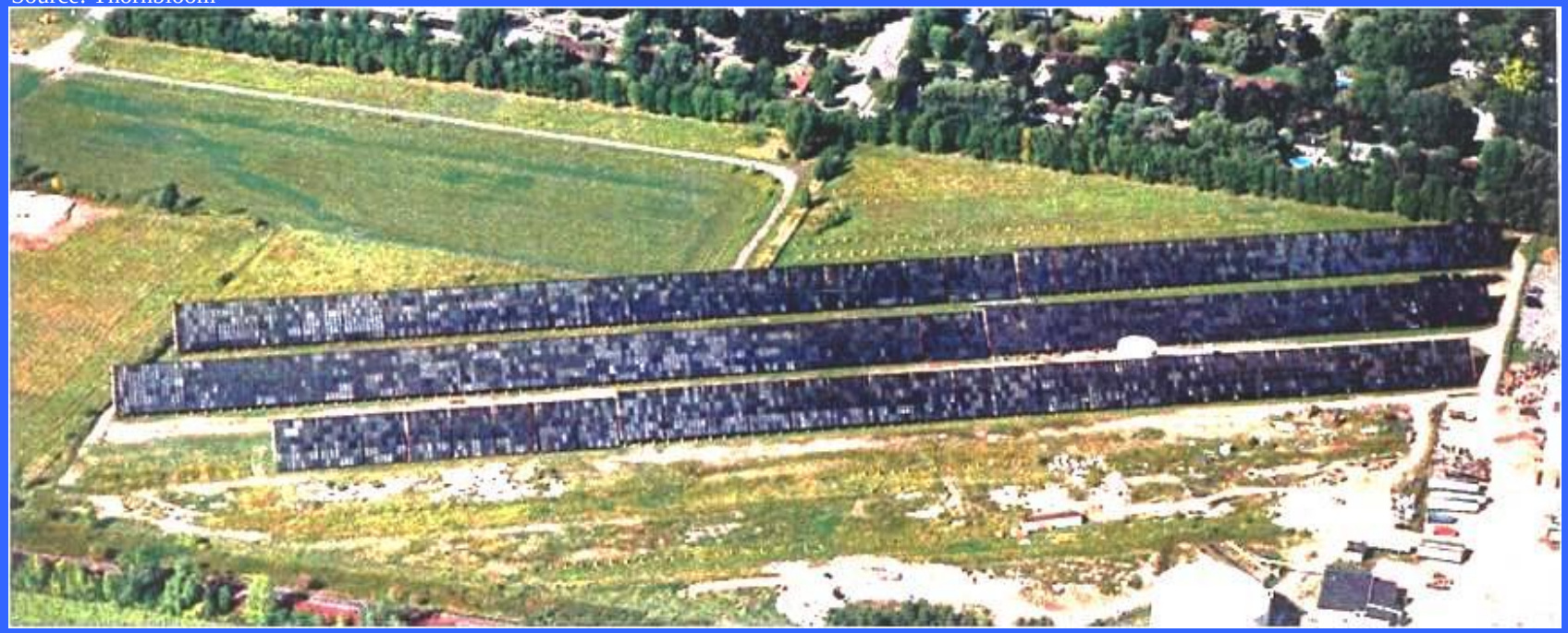
Preheat for meatpacking / slaughterhouse

168,000 ft^2 = 15,600 m^2 ~19.9 MWth

(~ Ringkoeping; > Jaegerspris, Kungalv1; <Marstal)

Operational 1980's (~12 yrs?); glycol, avg 40F /22C rise

Source: Thornbloom



The State of Solar in the U.S.

SPH vs. Large Area

Solar Process Heat: “There is None!”

(NOT TRUE: history; a few demos, STAC)

Solar Large Systems: “There are some!”

- District Energy Saint Paul

  1 MWp ~ 1400 m2, Saint Paul Minnesota

  operational March 2011

- SOLID: Gatoraide,4m2, Desert Mountain

1.9MWc, AZ Prison system ~1.9MW

The State of Solar in the U.S.

SPH, PV

Solar Process Heat: “There is None!”

- Some history; a few demos, STAC

Photovoltaics (Residential & Commercial)

- 2000: 3.9MW; 2009: 435MW
- Avg. 69%/yr growth
- 2010 year to date (3Q10): 525 MW (21% vs ‘09)
- Top 5 (3Q10): CA, NJ, FL, AZ, PA
- 2009: 6.5% of world, after Germany, Italy, Japan

CSP: Leading the Way!

Concentrating Solar Power .

Utility-scale solar (thermal) electricity

Trough, Dish, Fresnel, Power Tower

Projected: 25x current capacity in pipeline

Some **synergies** with SHC (espec. C&I, SPH):

- **public familiarity** with solar thermal
- some technology **overlap**

C.S.P.
History

1980's: Solar One & Two (tower)

SEGS I-IV:

- 354 MW (trough)
- >20yr operation

Mar. 2010: 432 MW

- Spain second

Shown: SEGS array, CA

C.S.P.

Under development :

10 GW (**25x today**)

46 projects:

56% trough

21% tower

21% dish

02% CPV

Source: SRP

Year	MW	Name	Loc
2007	64	Nevada Solar One trough (Acciona)	NV
2008	5	Kimberlina, CLFR (AREVA Solar/Ausra)	CA
2009	5	Sierra SunTower tower (eSolar)	CA
2009	1	Holaniku micro-CSP trough (Sopogy)	HI
1Q'10	1.5	**Maricopa**, Dish (Tessera/SES/SRP)	AZ
2Q'10	1	Solar Cameo Hybrid trough (Abengoa)	CO
2Q'11?	75	Martin Hybrid, (FP&L)	FL

Martin County Solar Hybrid (FP&L)

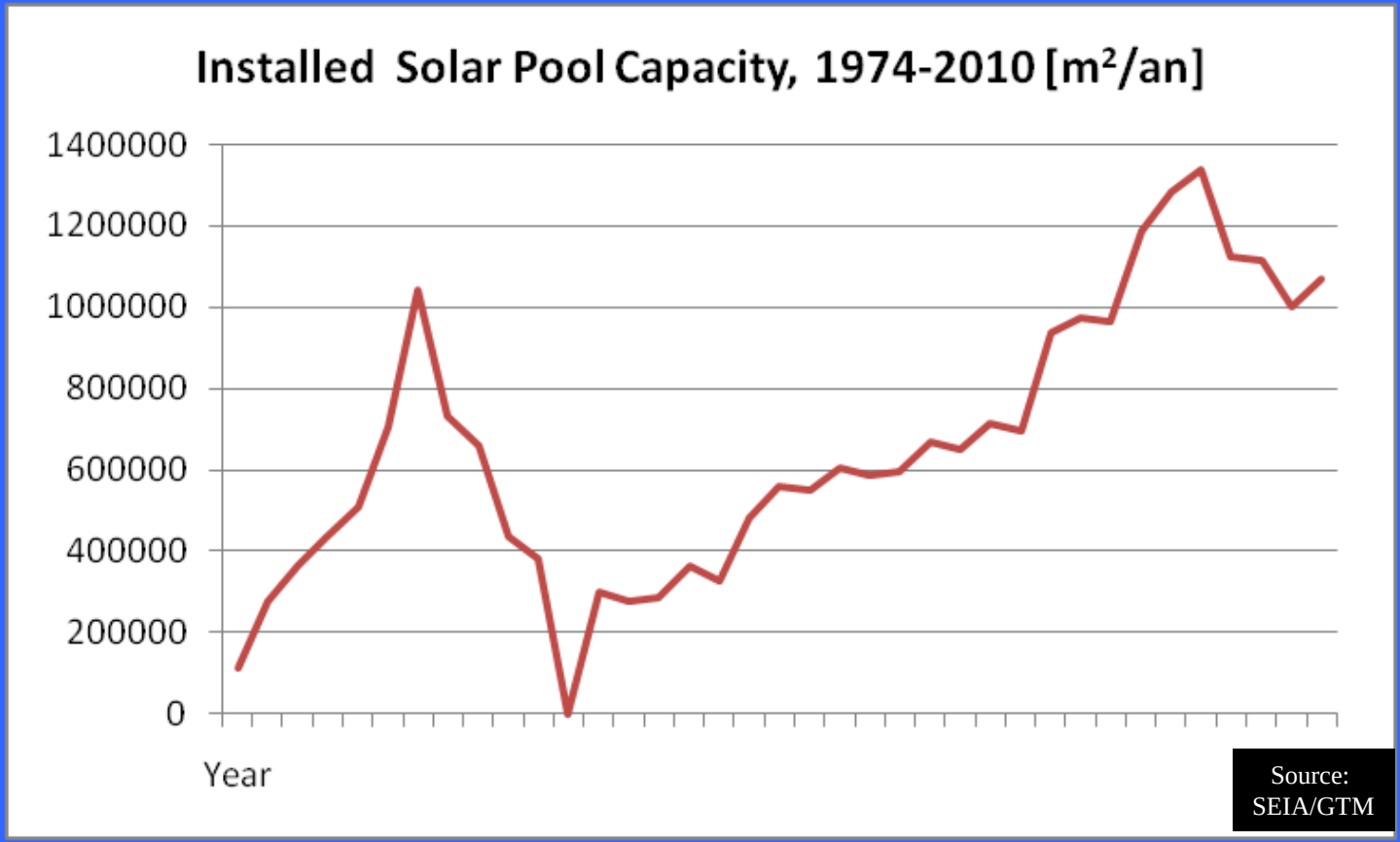
Webcam view, 02 February 2011

190,000 troughs to combined cycle plant

Solar Pool Heat: History in U.S.

1990's, 2000's: 10x to 20x SWH

Today: ~5x SWH



Solar Pool Heat

Unglazed, polymer, direct flow

Very cost-effective, not eligible for tax credit (yet)

Growth:

2008: 1.114.800 m^2 /an (-1%)

2009: 1.001.090 m^2 (-10%)

(housing collapse)

2010: est. 1.071.137 m^2 (+7%)

2011: "robust"

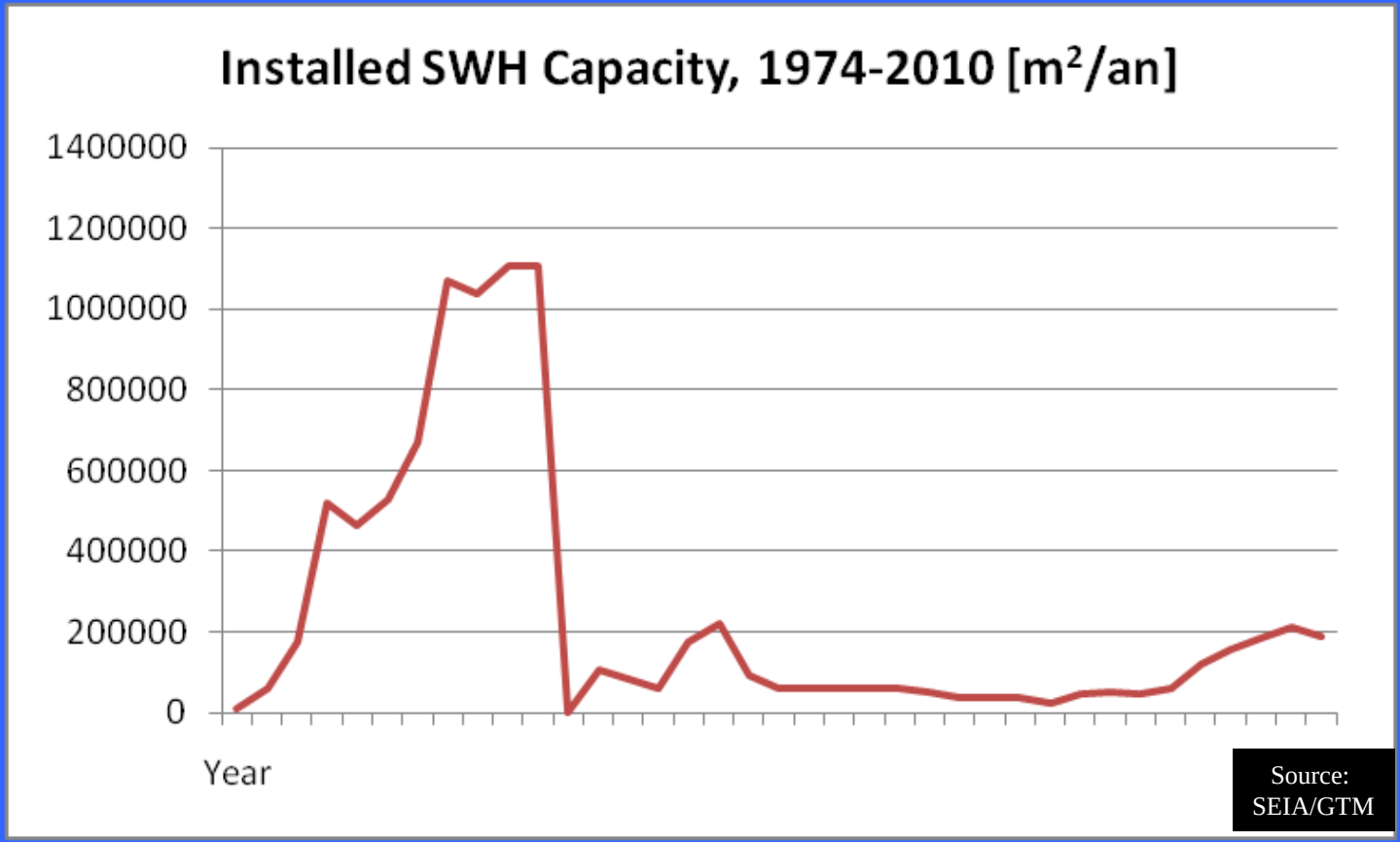
(commercial tax credit)

Shown: unglazed residential pool heat, FL

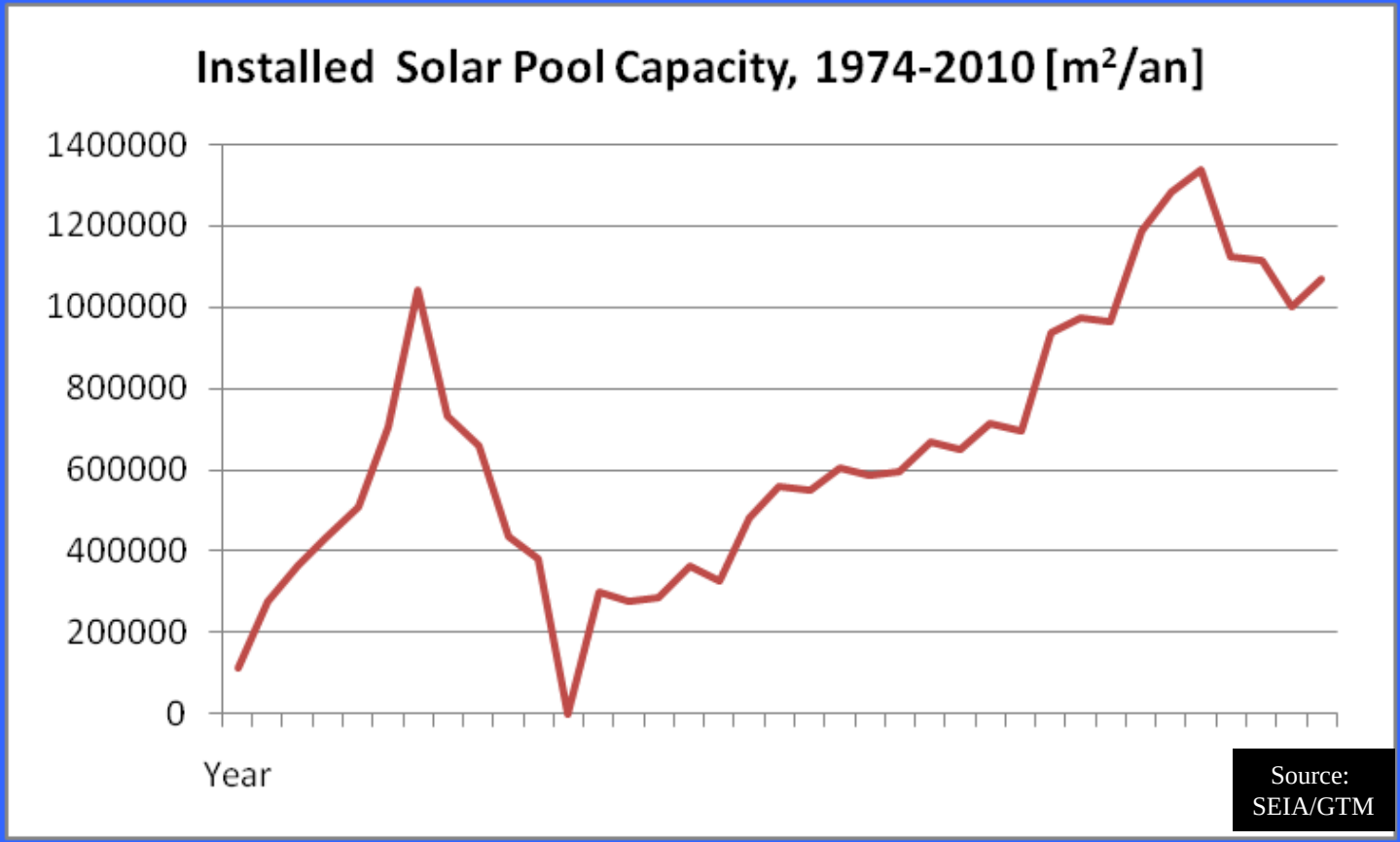
Solar Water Heat: History in U.S.

1974 – 2000's: glazed flat plate collectors

2000's – today: flat plate, evac. tubes



COMPARE:
Solar Pool Heat



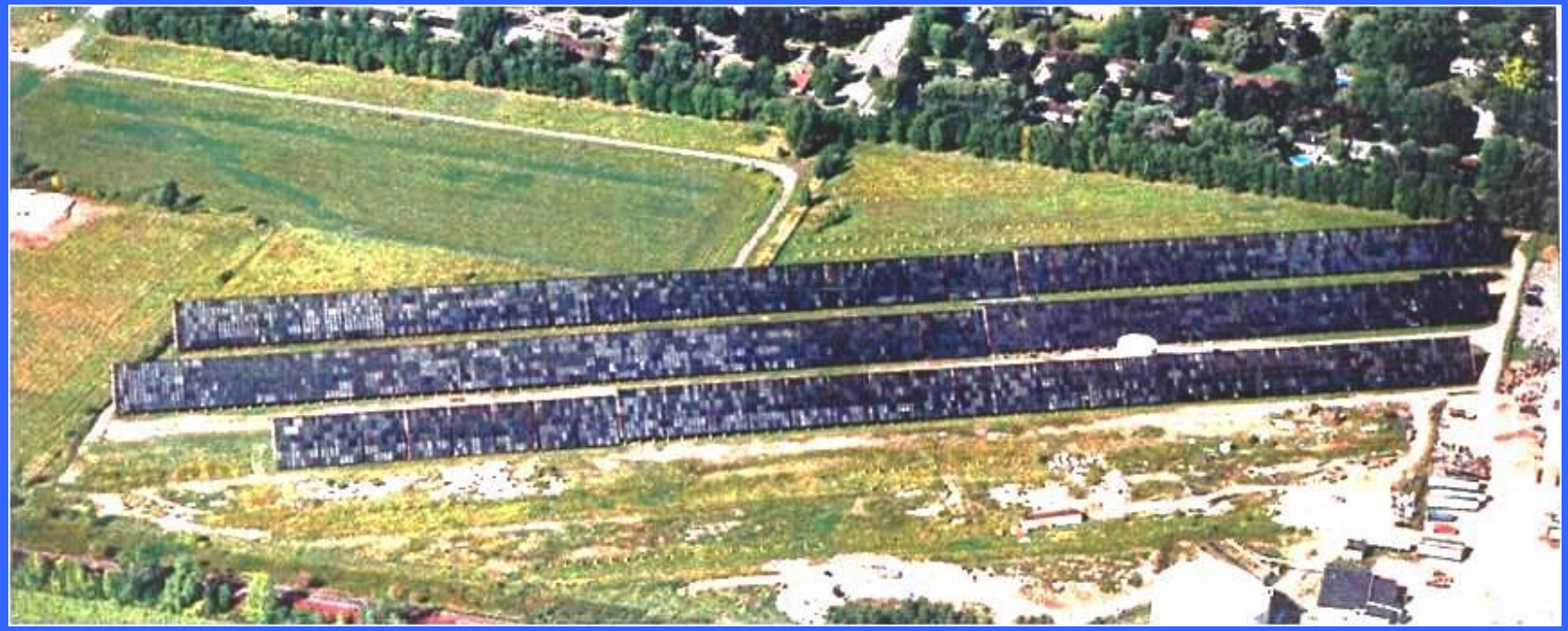
SWH Growth

2004 – 2nd Quarter 2010: steady, avg 39%/an.

2009: 212,650 m^2 (+14%)

2010: est. 189,500 m^2 (-11%)

Shown: Packerland meat packing preheat, Green Bay WI, ca. 1980's Source: Thornbloom



SWH Outlook: 2011

Rate: “sluggish moderate growth” (economy, natural gas prices)

Growth areas: combi-systems (R, C), solar cooling, SPH

Left: DHW preheat (Correctional Center, CO)

Source: NREL

Right: desiccant STAC (Tyndall AFB, FL)

Source: Thornbloom

Dominant Market Segments

"Not just residential pool heat and water heating any more!"

Dominant Market Segments

U.S. consumption relevant to SPH:

- 12.27 quads (12.9 EJ = 12.9 x 10^{18} Joules)

Industry Sector:

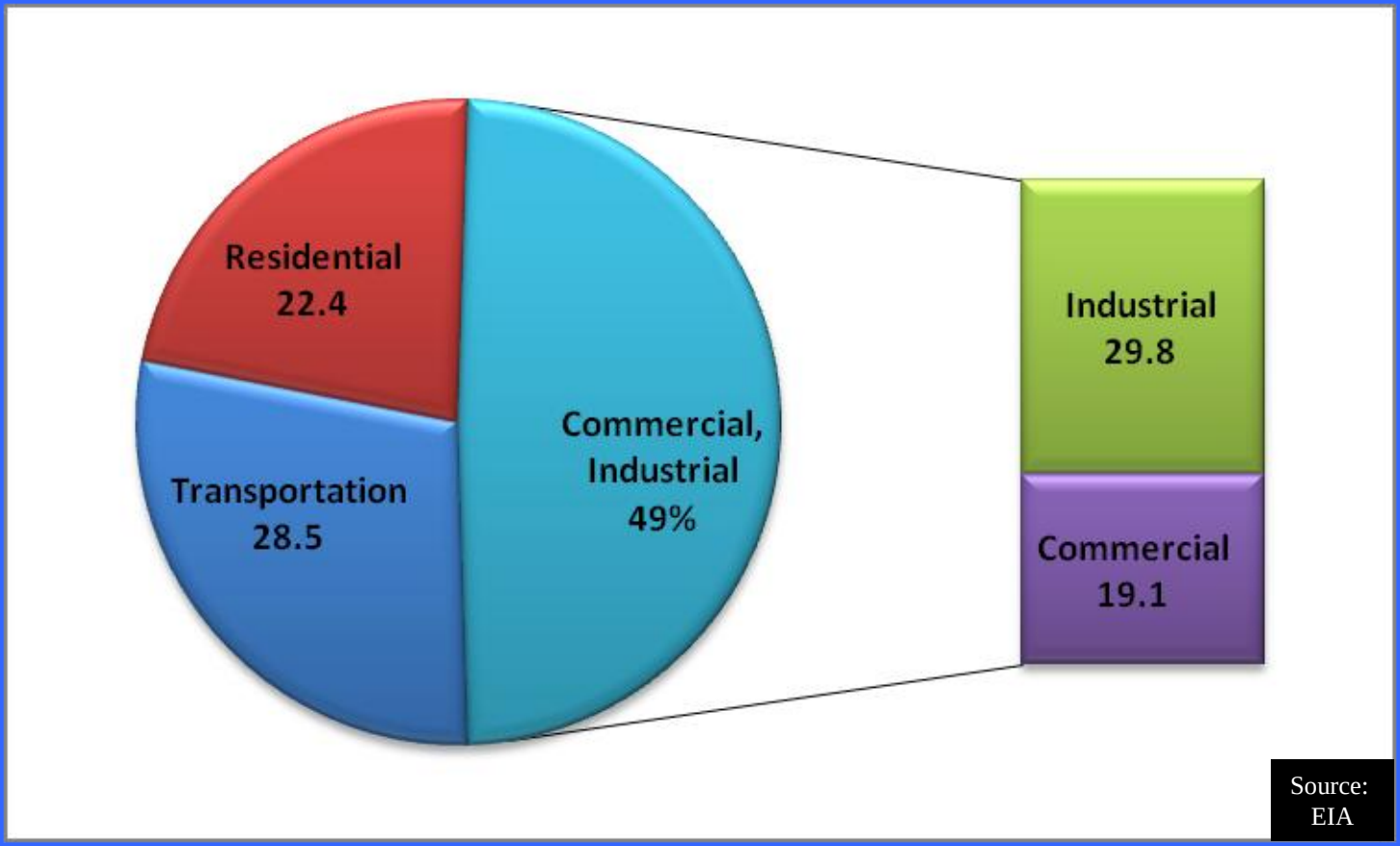
- 7.1 EJ (Chemicals, Food & Beverage, Textiles)
- RE's: 2.0 EJ (8%)

Commercial Sector:

- 5.9 EJ (Space Heat & Cooling, Water Heat)
- RE's: 0.2 EJ (2%)

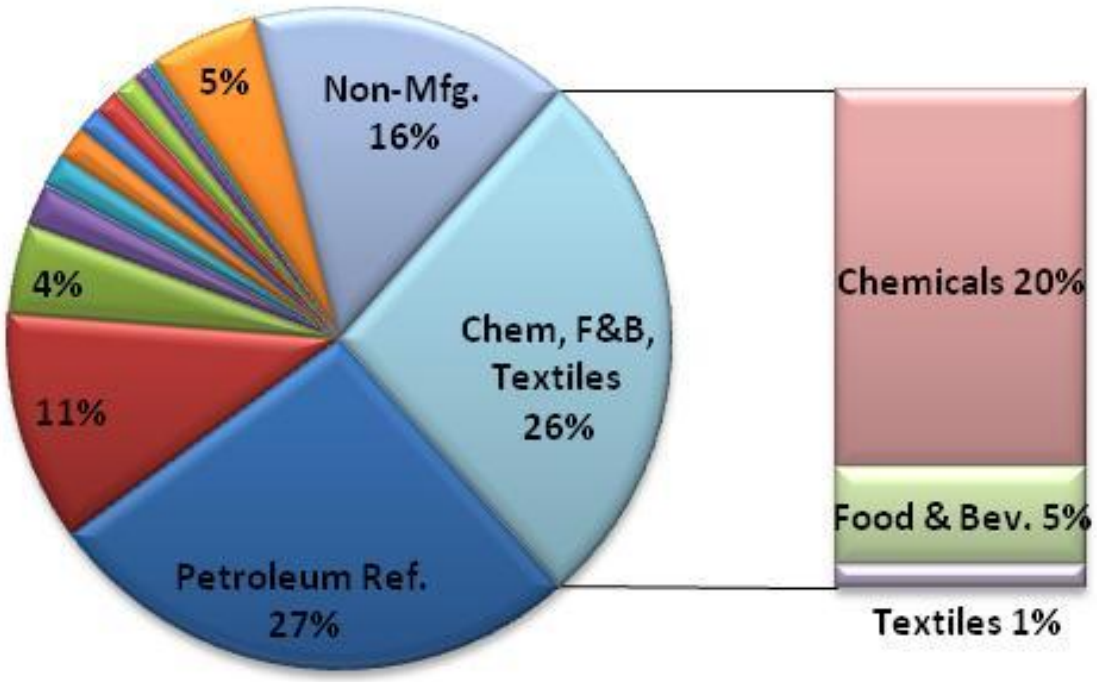
U.S. Total Energy Use

99.7 EJ (incl. G&T)



Industry Use by Subsector

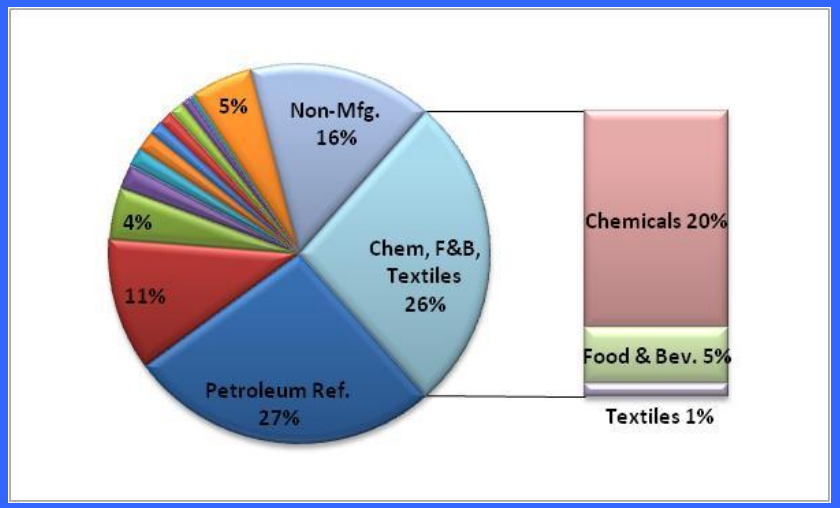
Chemicals, F&B, Textiles: 7.1 EJ



Source:
EERE ITP

Industry Subsectors

- Chem. F&B, Textiles: 7.1 EJ (1/4)
- (G&T not included)
- **Opportunities in all subsectors**

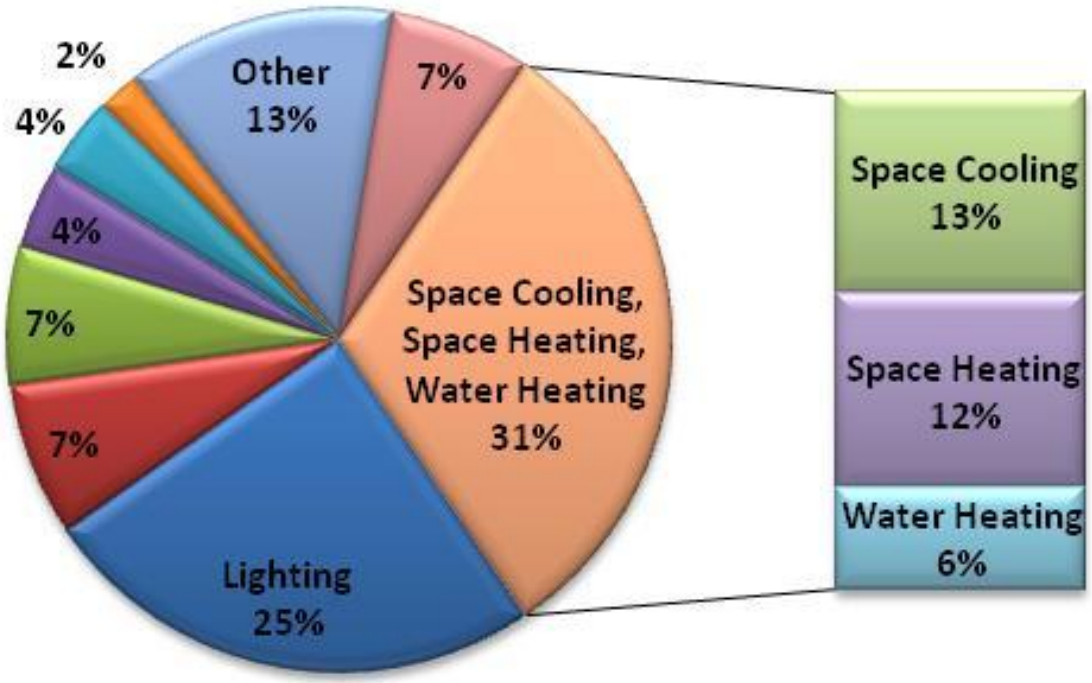


2006 Industry Energy End Use	[EJ]
Chemicals	**5.4**
Food & Beverage	**1.4**
Textiles	**0.3**
Petroleum Refining	7.0
Forest Products	3.0
Iron & Steel	1.2
Transportation Equipment	0.5
Cement	0.4
Fabricated Metals	0.4
Aluminum	0.3
Glass	0.3
Plastics & Rubber Products	0.3
Metal Casting	0.2
Computers & Electronics	0.1
Other Manufacturing	1.4
Non-Mfg Ind. (Ag., Forestry, Fishing; Construction; Mining)	4.1
TOTAL	26.3

Commercial Use by Subsector

Space Heat &Cooling, Water Heat: **5.9 EJ**

(**53%** of Residential SH&C, WH)

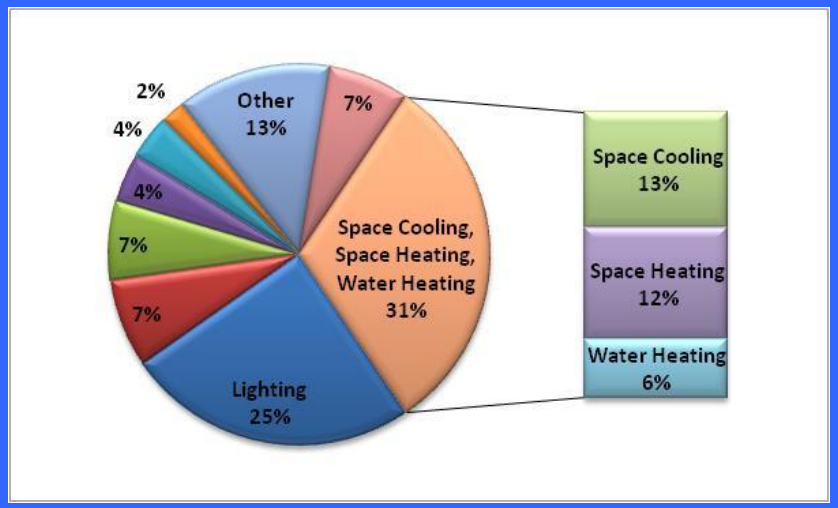


Source:
EERE Buildings Energy Databook

Commercial Subsectors

- Total: 18.9 EJ
- **SC, SH, WH: 31%**
- G&T not included
- R.E. (biomass): 0.2 EJ (2%)

2006 Commercial Energy End-Use	[EJ]
Space Cooling	**2.4**
Space Heating	**2.3**
Water Heating	**1.2**
Lighting	4.7
Electronics	1.4
Ventilation	1.3
Refrigeration	0.8
Computers	0.7
Cooking	0.4
Other	2.5
Adjust to SEDS	1.3
TOTAL	18.9



SWH Destinations

In 2008, 75% to:

FL (35%), CA (26%), AZ, HI

In 2010, 50% to:

FL, CA, AZ, HI, PR

WIDENING OF FIELD

Left: dehumidification (Ken. Space Ctr, FL)

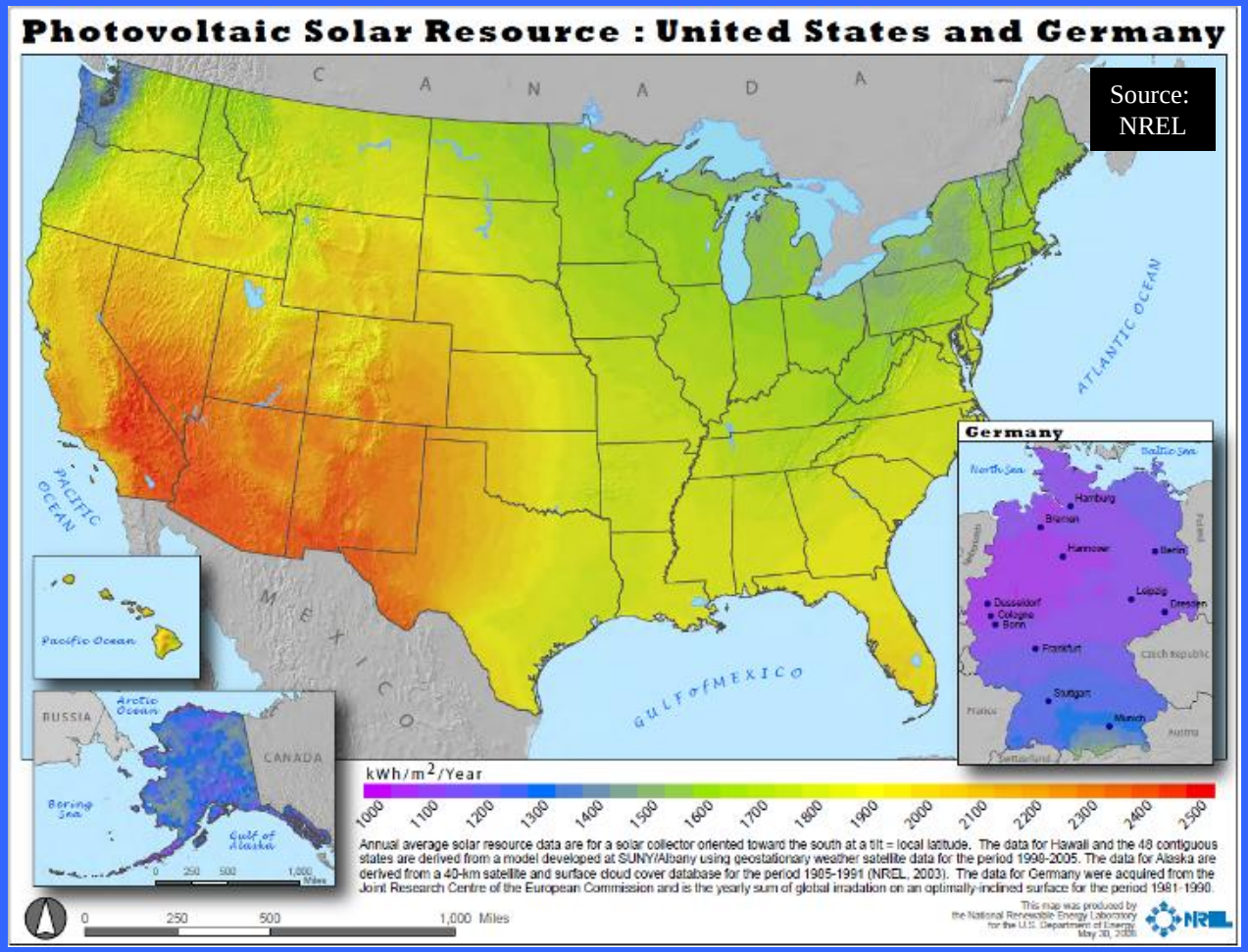
Right top: space heat (warehouse, MI)

Right bottom: DHW preheat (prison, FL)

Sources: Sunsiaray (RT), Thornbloom (RB, L)

Factors Influencing US SHC

Solar Resource: Excellent!



Factors Influencing US SHC

Incentives: federal good; state is limited

State	Dates	Incentives
(Fed.)	2009-2016	30% of installed cost of solar thermal equipment
CA	Oct 2010-2018	$0.12/MJ ≤ $500,000 (gas), ≤ $250,000 (electric)
CT	Oct 2010-Mar 2012	US$450/MMBtu
NH	Nov2010-Jun 2011	$0.04/kBtu <25% of installed cost or $50,000
NY	Dec2010-Dec 2011	R only; $29/kBtu up to $1500
MA	Jan 2011 start	R only; ~$1,000/system

Factors Influencing US SHC

Federal mandates: helpful

1. The 2005 Energy Policy Act set the primary renewable energy requirements for federal agencies. It requires that- to the extent economically feasible and technically practicable - the following amounts of the total electricity used by the federal government come from renewable energy: 2010-2012: not less than 5%, 2013 forward: not less than 7.5%.

2. The 2007 Energy Independence and Security Act requires that 30% of the hot-water demand in of new federal buildings (and for major renovations) be met with solar hot-water equipment provided that it is life-cycle cost effective.

NOTE: definition of underlined text is debatable

Factors Influencing US SHC

Polls & Studies: hopeful

1. SEIA Survey 2009: 92% of Americans think it is important to use solar energy. Higher than puppy dogs and ice cream!

2. CalSEIA Study 2010: In SWH displacing natural gas, Commercial benefit 18% to 20% better than Residential.

3. DeMarVa Poultry Industry Study, 2005: predicted ROI of 16% @ US$0.70/gallon #6 fuel oil, ROI = 30% @ US$1.30/gallon.

4. FL Governor's Energy Office Study, 2008: Predicted a commercial "Technical potential" of over 1 GWth by 2020 (systems >2MW on 568 hospitals, hotels, etc). It did not include other opportunities (large scale commercial, SPH, solar cooling, or utility-scale).

Thank You!

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