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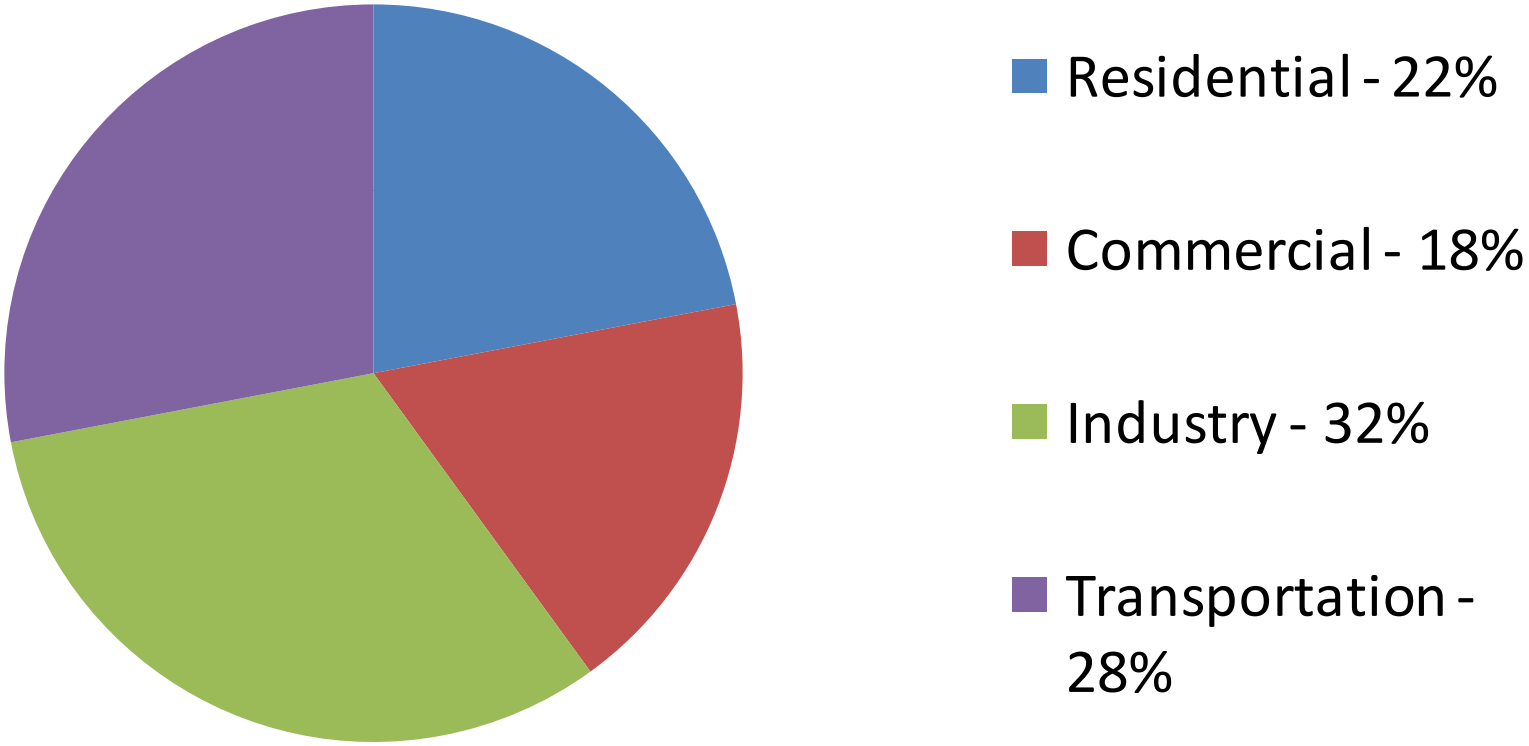
DISTRIBUTED GENERATION:

Solar Power Integrated Building Design

Building Share of U.S. Primary Energy Consumption, 2005



From the U.S. Department of Energy 2007 Buildings Energy Data Book

Kansas Census Division

	Consumers	Avg. Monthly Consumption (kWh)	Avg. Retail Price (Cents per Kilowatthour)	Avg. Monthly Bill
Residential	1,250,241	920	8.91	$75.40
Commercial	230,660	5,591	6.83	$381.61

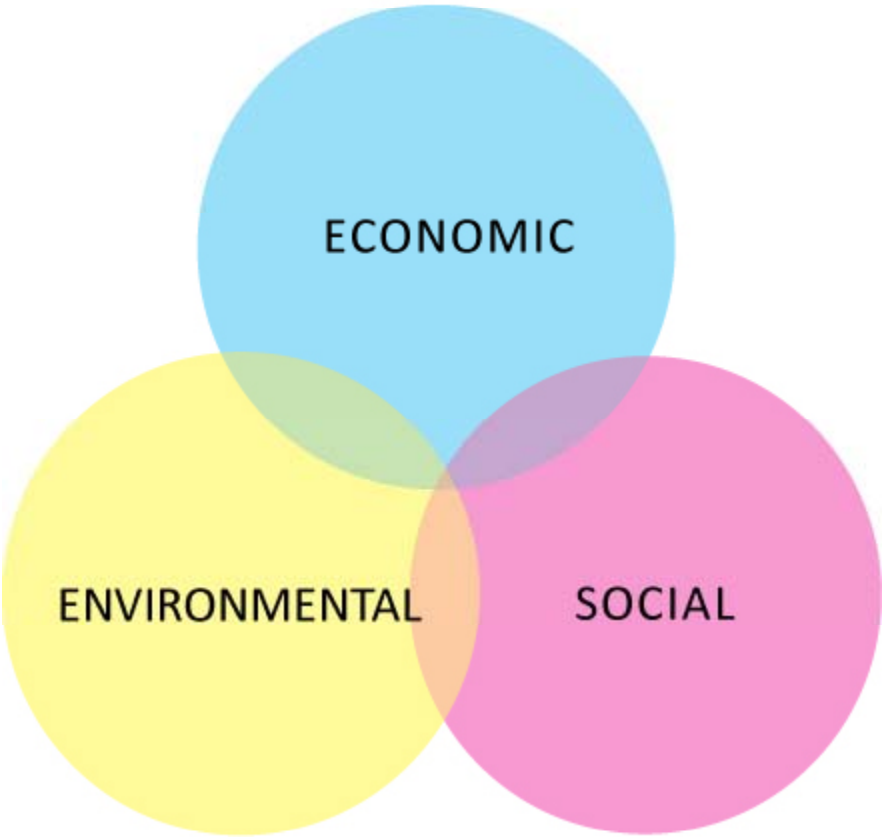
Table 5. U.S. Average Monthly Bill by Sector, Census Division, and State 2007

Coal - Kansas's primary electricity source

Resulting in 37.7 million metric tons of CO_2 emissions per year

EIA 2005 statistics

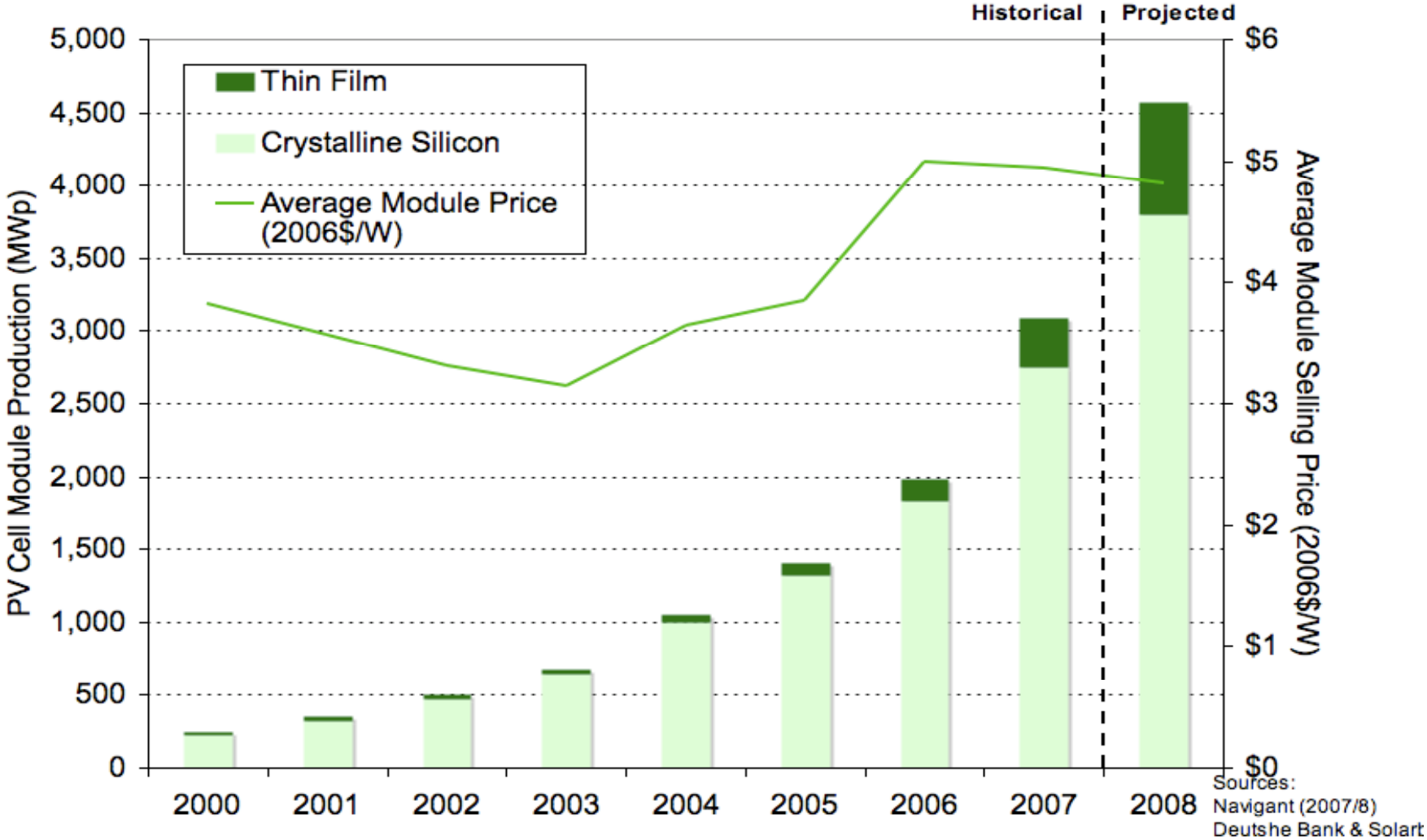
Triple Bottom Line

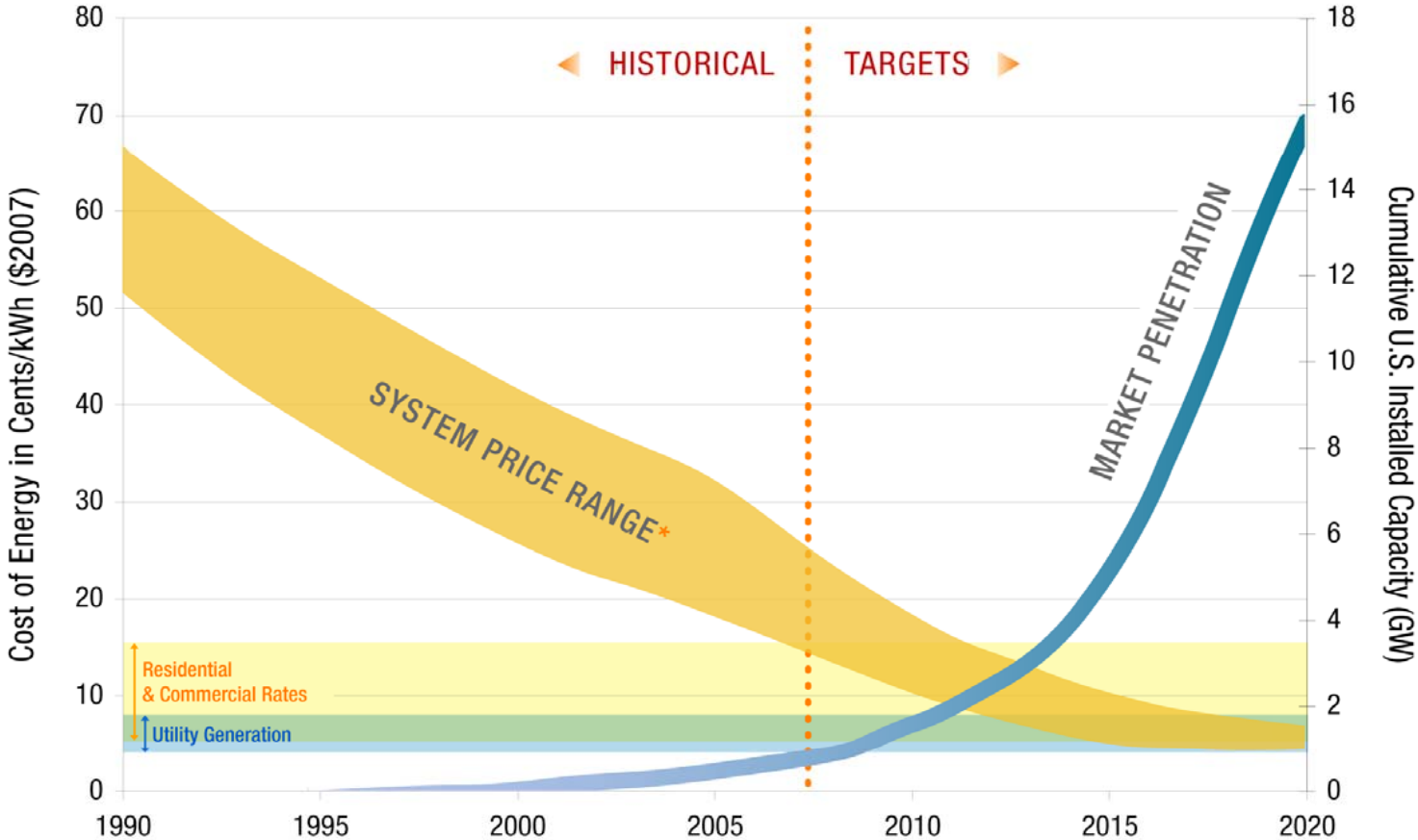


Dependant on several factors:

1. Cost of initial panel
2. Installation and tie in to system
3. Efficiency of panel (12 – 15%)
   - Angle of mounting
   - Amount of sun in zone

What is the cost of building integrated PV systems?





Market Sector	Current U.S. Market Price Range (¢/kWh)	Cost (¢/kWh) Benchmark 2005	Cost (¢/kWh) Target 2010	Cost (¢/kWh) Target 2015
Residential	5.8 - 16.7	23 - 32	13 - 18	8 - 10
Commercial	5.4 - 15.0	16 - 22	9 - 12	6 - 8
Utility	4.0 - 7.6	13 - 22	10 - 15	5 - 7

The DOE's SETP is focused on enabling high penetration of solar energy technologies and achieving grid parity by 2015.

PV module research balances various materials through joint industry R&D and long-term research.

Thin Films (aSi) 5%

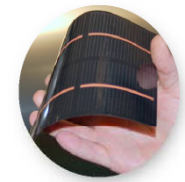
Advancing amorphous and wafer replacement crystal silicon film solar cells on low-cost substrates

5% Thin Films (CdTe)

Simplifying deposition while retaining performance and transferring record device architecture to manufacturing processes

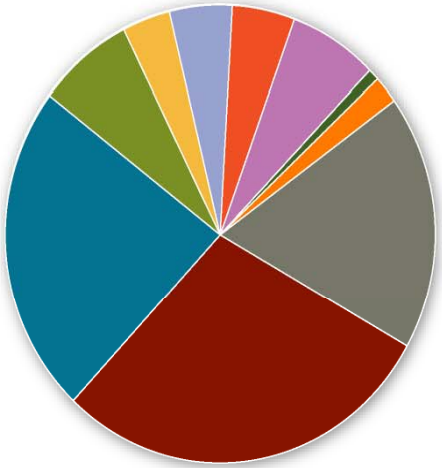
7% Thin Films (CIGS)

Supporting the manufacture of non-vacuum processes and transferring record efficiency device performance into large area commercial modules



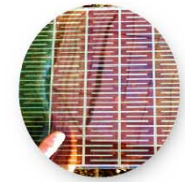
Organic PV 4%

Customizing molecules, substrates, and deposition techniques to yield ultra low-cost modules



1% Dye-Sensitized Cells

Advancing the efficiency and stability of inexpensive dye-based solar cells with novel nanostructures



Next Generation 7%

Investigating advanced concepts aimed at delivering revolutionary performance improvements

2% Building Integrated PV

Creating module form factors aimed at dramatically reducing or eliminating solar installation costs

Crystalline Silicon 23%

Developing higher efficiency devices and lower cost processing methods for traditional silicon cells

28% Crosscut

Synergistic technologies, evaluation approaches, and process engineering approaches applicable across multiple absorber materials and processes

18% Concentrating PV

Combining new, lower cost multijunction cells and innovative optical packages

PV module research balances various materials through joint industry R&D and long-term research.

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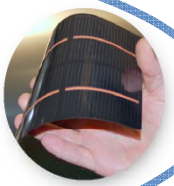

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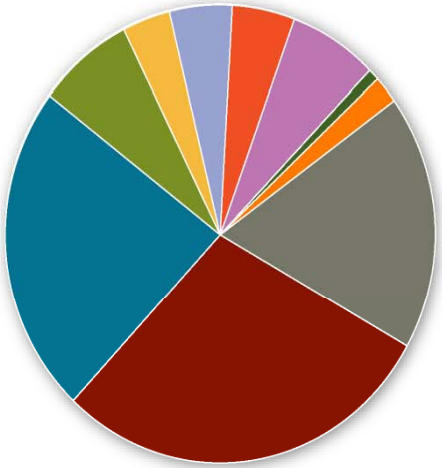

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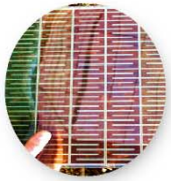

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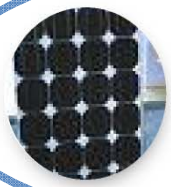

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Tax Incentives

Federal

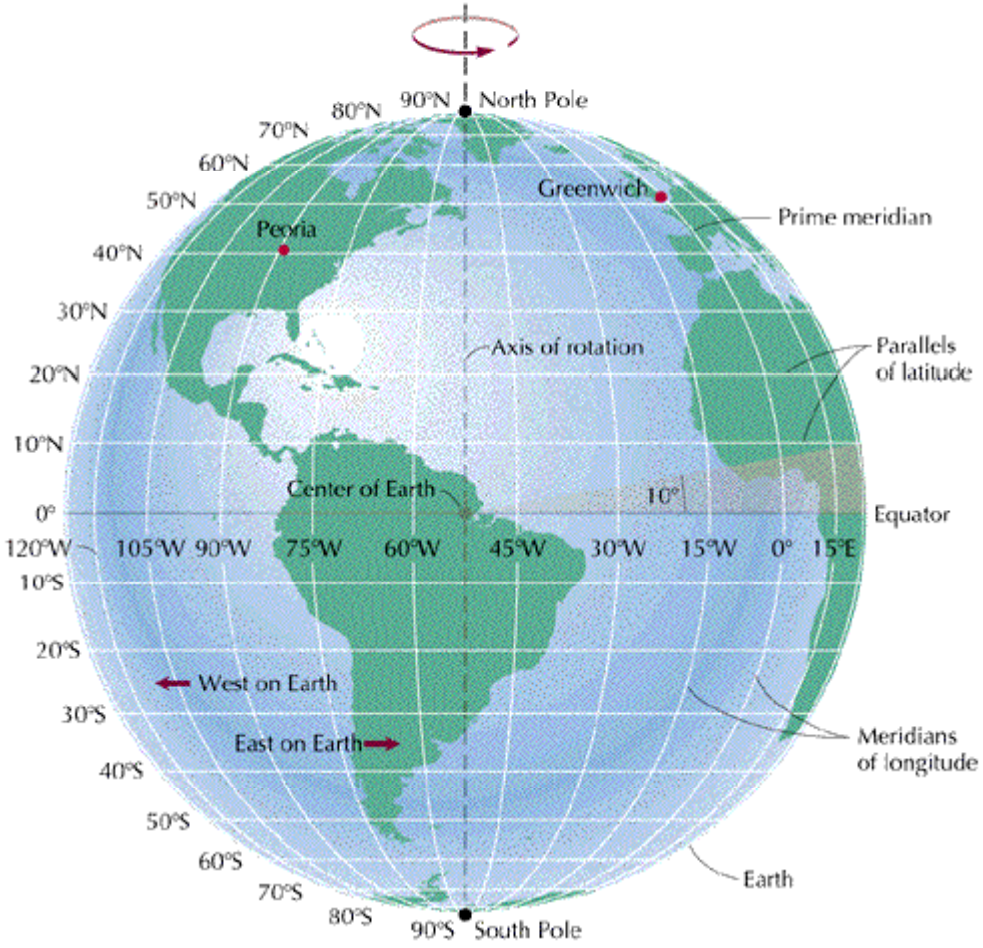
30% tax rebate on panels, installation and related materials required for system. www.dsireusa.org

State

property tax exemption – 100% on value of renewable energy equipment

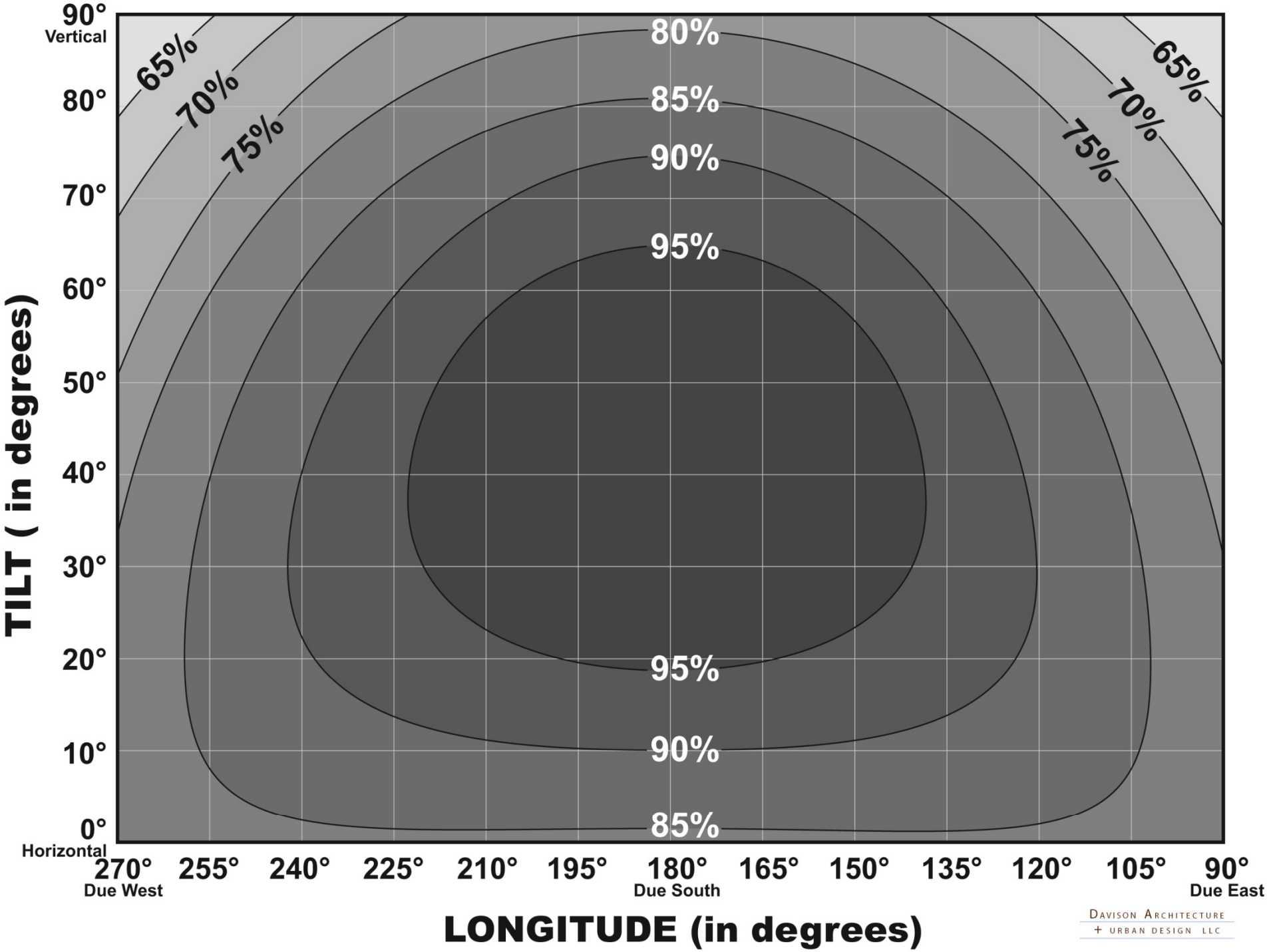
Utility

Kansas City Board of Public Utilities and Kansas City Power & Light – rebate programs


90°N
North Pole
80°N
70°N
60°N
50°N
40°N
30°N
20°N
10°N
0°
10°S
20°S
30°S
40°S
50°S
60°S
70°S
80°S
90°S
South Pole
Greenwich
Prime meridian
Peoria
Axis of rotation
Parallels
of latitude
Center of Earth
10°
Equator
120°W
105°W
90°W
75°W
60°W
45°W
30°W
15°W
0°
15°E
West on Earth
East on Earth
Meridians
of longitude
Earth

Consider highest load needed – winter or summer?

Latitude x .9 – 29 = optimal angle for winter
Summer = winter optimal angle – 52.5


90°
Vertical
80°
70°
60°
50°
40°
30°
20°
10°
0°
Horizontal
TILT (in degrees)
65%
70%
75%
80%
85%
90%
95%
95%
90%
85%
65%
70%
75%
270°
Due West
255°
240°
225°
210°
195°
180°
Due South
165°
150°
135°
120°
105°
90°
Due East
LONGITUDE (in degrees)
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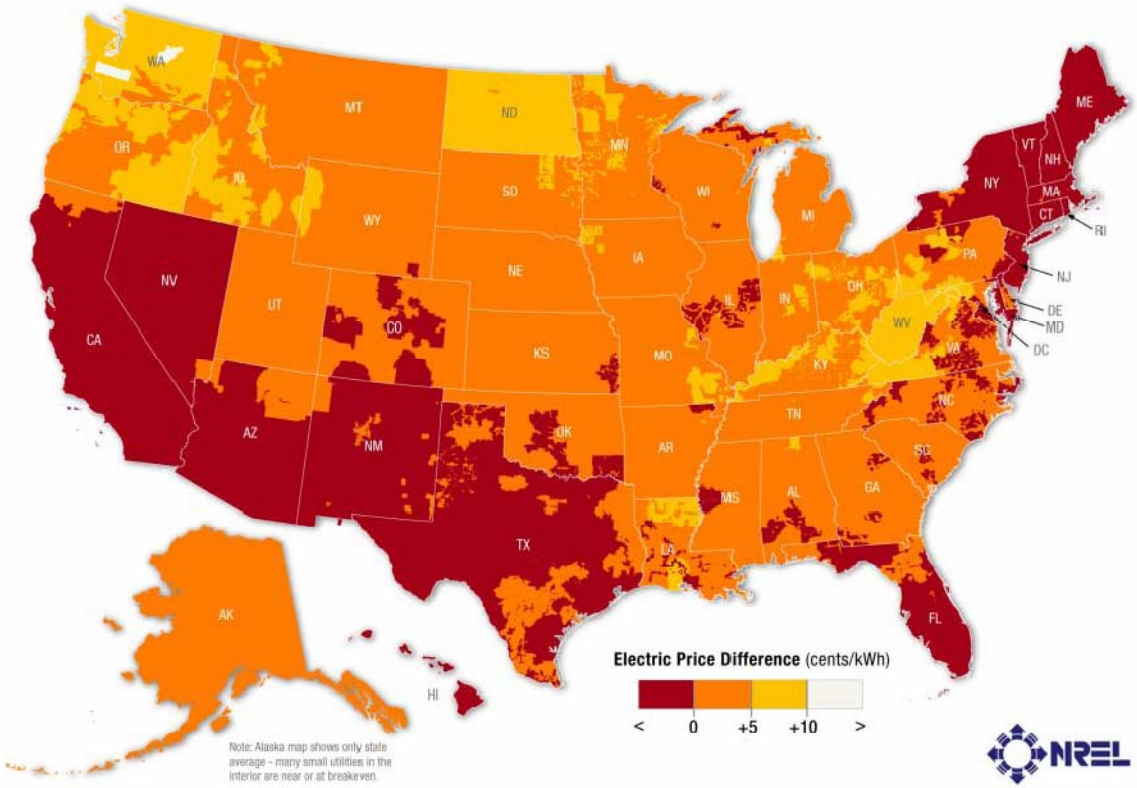
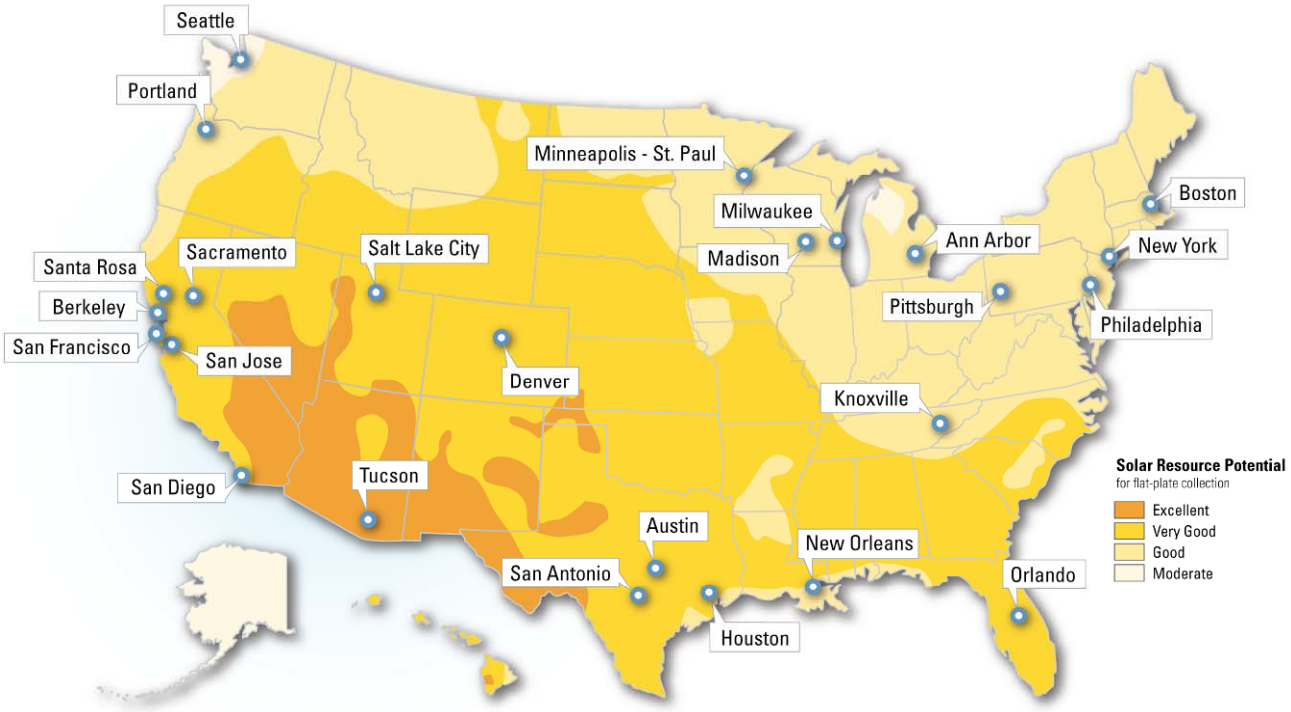
The conservative forecast - 2015 residential without incentives and moderate (1.5% PA) increase in real electricity prices

- PV is less expensive in 250 of 1,000 largest utilities, which provide ~37% of U.S. residential electricity sales
- 85% of sales (in nearly 870 utilities) are projected to have a price difference of less than 5¢/kWh between PV and grid electricity



Notes: The installed system price is set at $3.3/Wp.

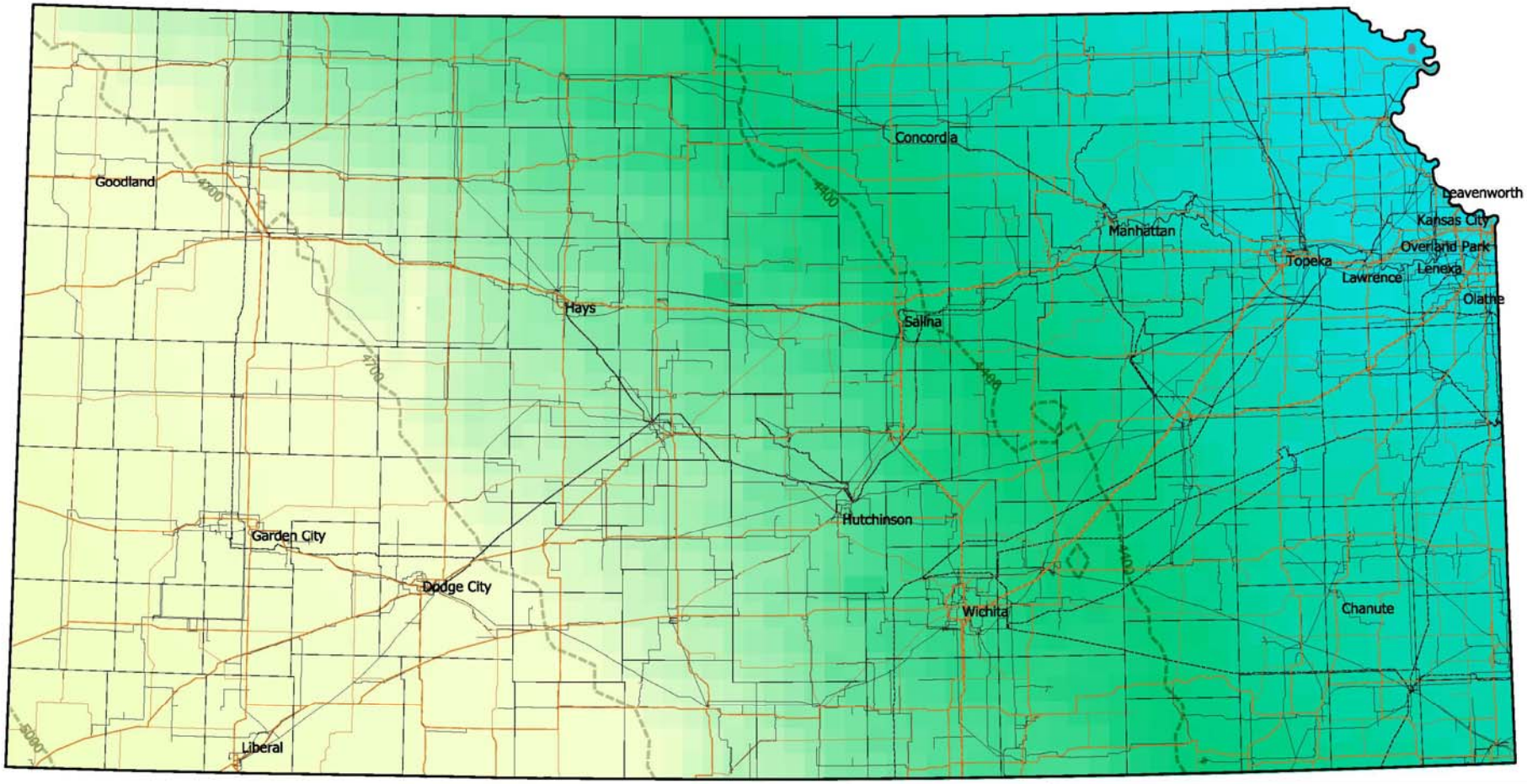
Kansas is located almost entirely in a very good resource zone for solar power



DOE's Activity Objective

- Streamline city-level regulations and practices that affect solar adoption by residents and local businesses (e.g. permitting, inspections, local codes)
- Promote solar technology among residents and local businesses (e.g., outreach, curriculum development and/or implementation, incentive programs, etc.)

Kansas Solar Resource Map



voltage in kV	Kansas Roads	Solar Radiation
34.50	State Route	W-Hr/m^2
69.00	US Route	Value line
115.00	Interstate Route	4100
138.00		4400
161.00		4700
230.00		5000
345.00		

Coriolis
architecture · energy
www.coriolis-ae.com

Kansas Corporation Commission
Energy Programs

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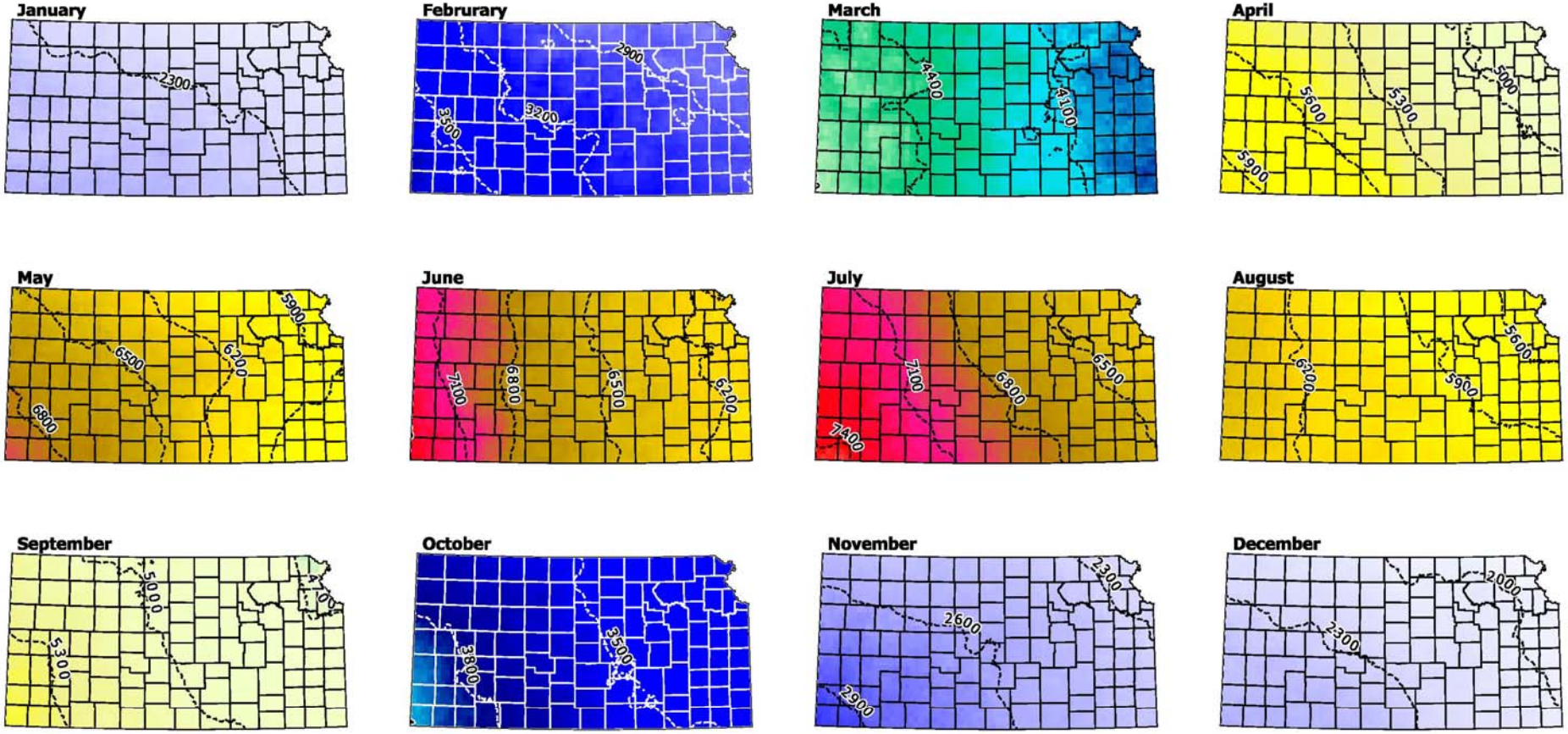
Kansas Solar Resource Map



Solar Radiation W-Hr/m^2				
	2900	4400	5900	7100
1700	3200	4700	6200	7400
2000	3500	5000	6500	7700
2300	3800	5300	6800	
2600	4100	5600		

The average annual solar energy falling on one square mile in central Kansas is about four billion KWh or fifteen trillion Btu, the equivalent of two and one-half million barrels of oil. About 70 square miles receive solar energy equal to Kansas's annual energy consumption. Plants using photosynthesis might convert 1% or lessof this energy to biomass. Solar thermal systems might convert 30-40% to useful heat, and solar photovoltaic systems might convert 5-20% to high value electricity. Matching the availability of the resource to the demand for energy is an important factor in making solar energy systems feasible, technically and economically. The maps above show monthly solar energy in Watt-hours per square meter for Kansas.

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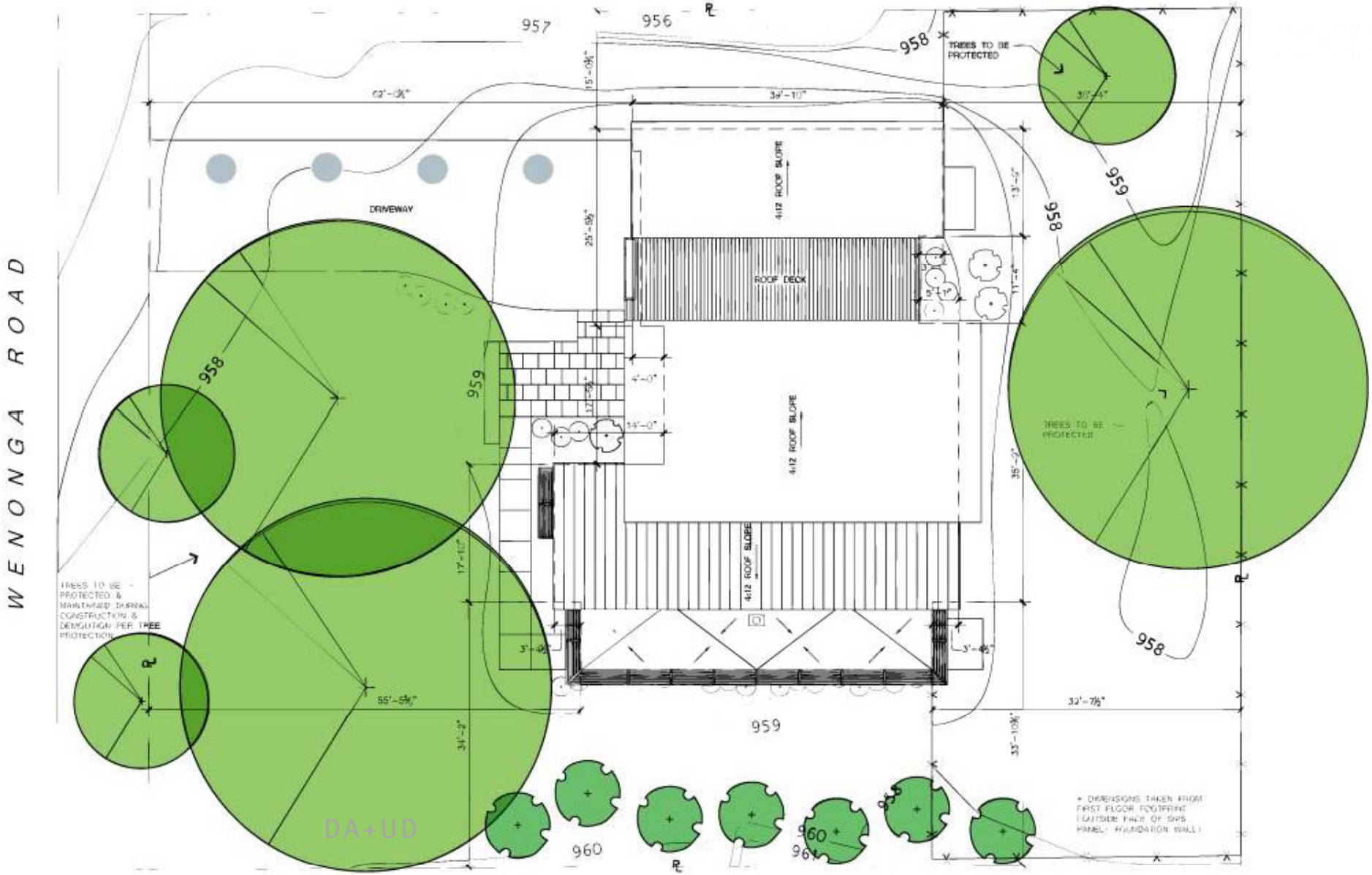

1 Site Plan

Scale: 1/8" = 1'-0"

N

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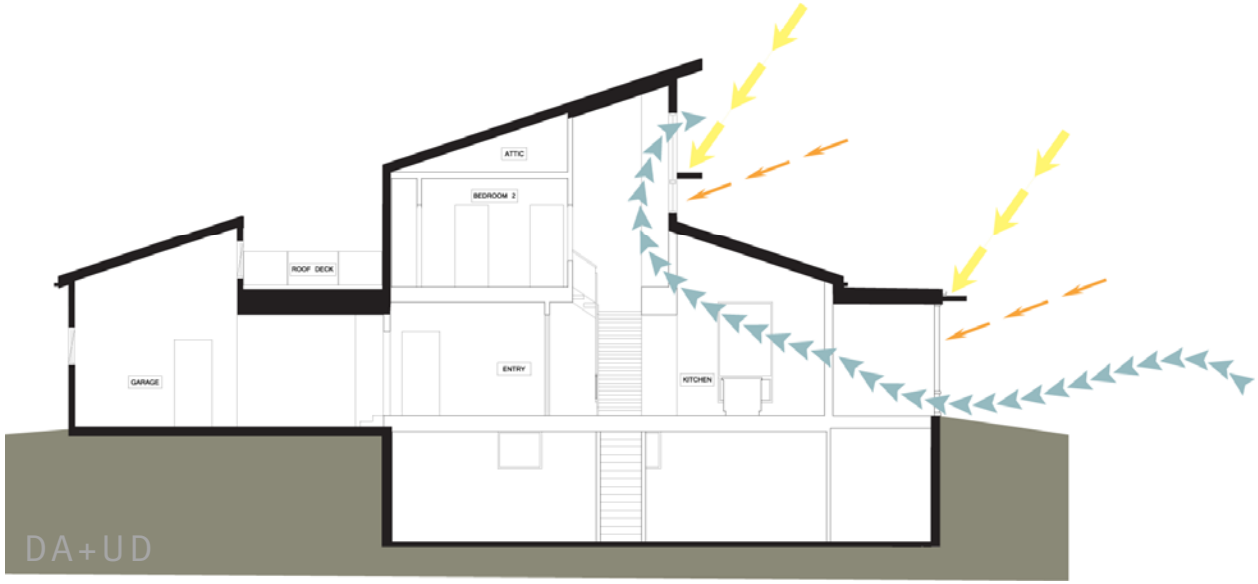

5 KWh system planned, building integrated PV panels.

PV Tile Options

Madison environmental group

Davison Architecture + urban design llc

Madison environmental group

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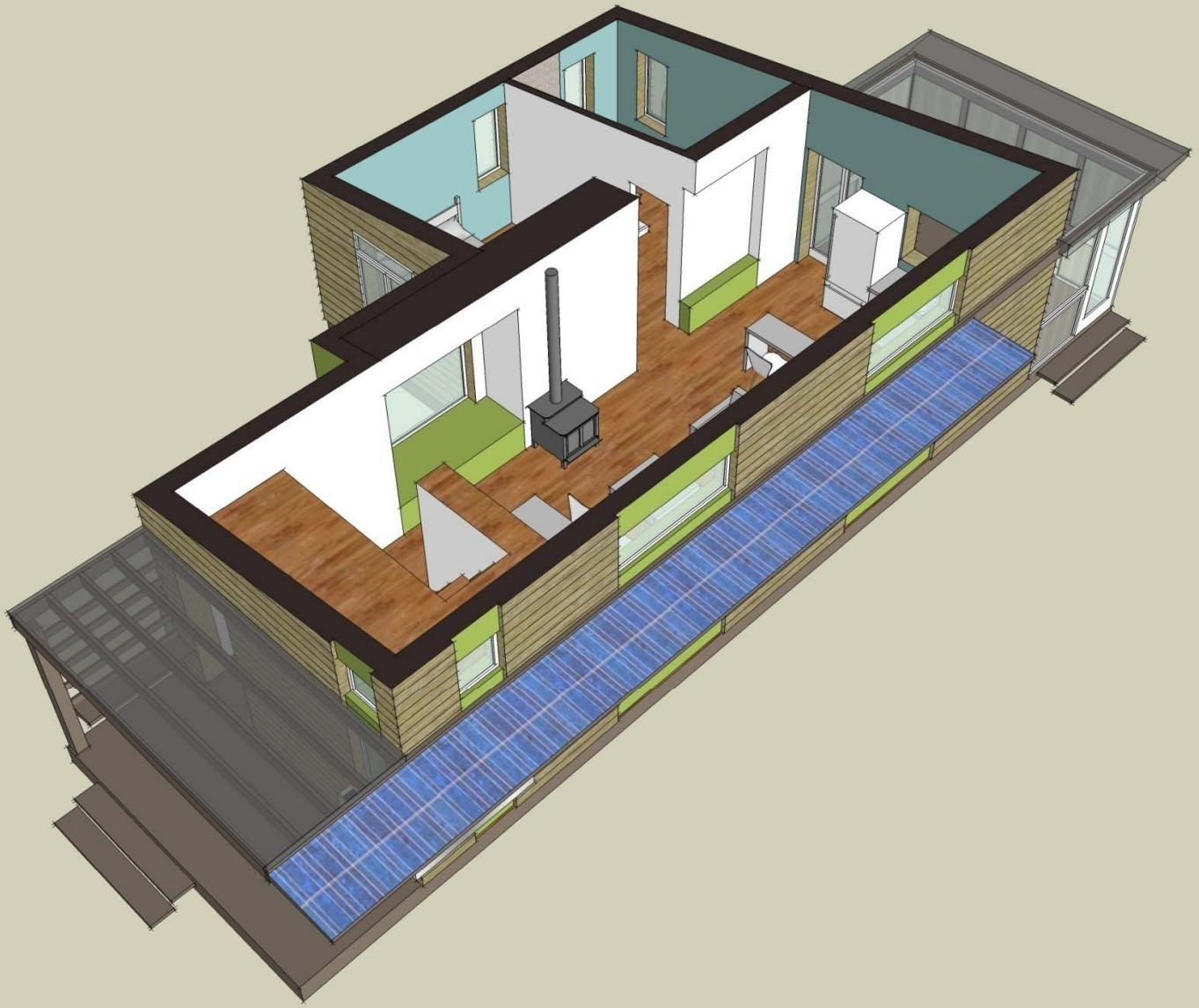

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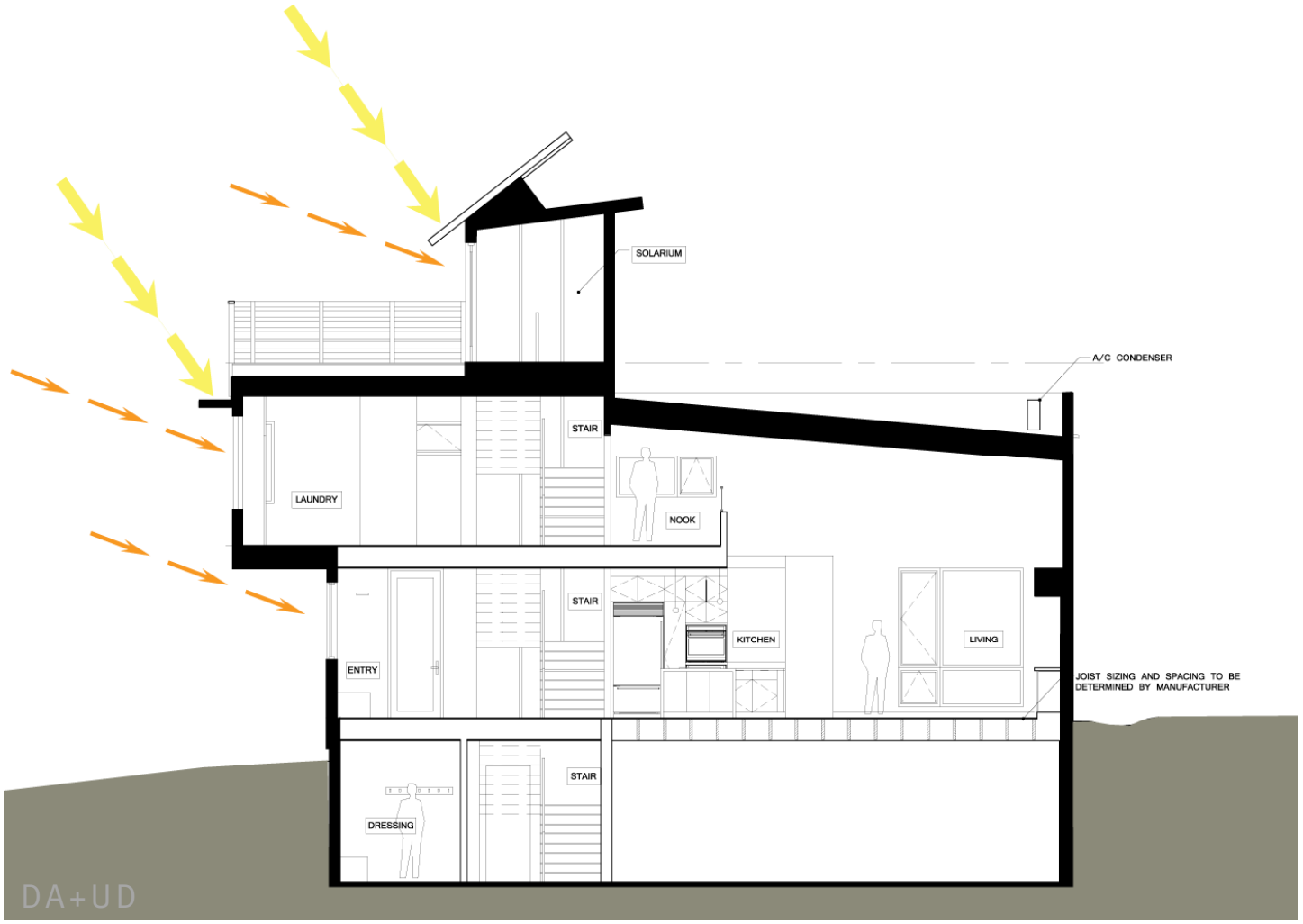

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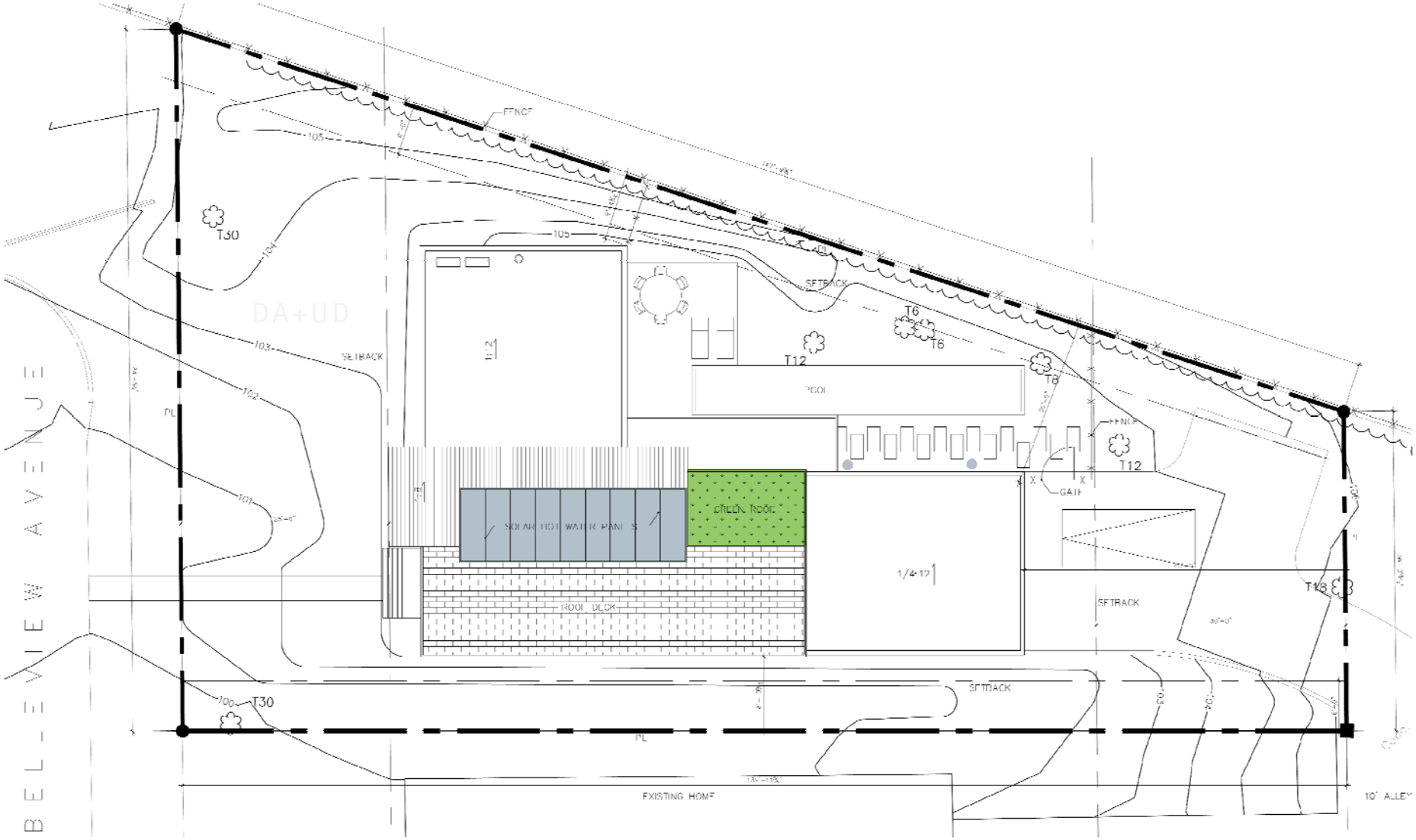

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Scale: 1/8" = 1'-0"

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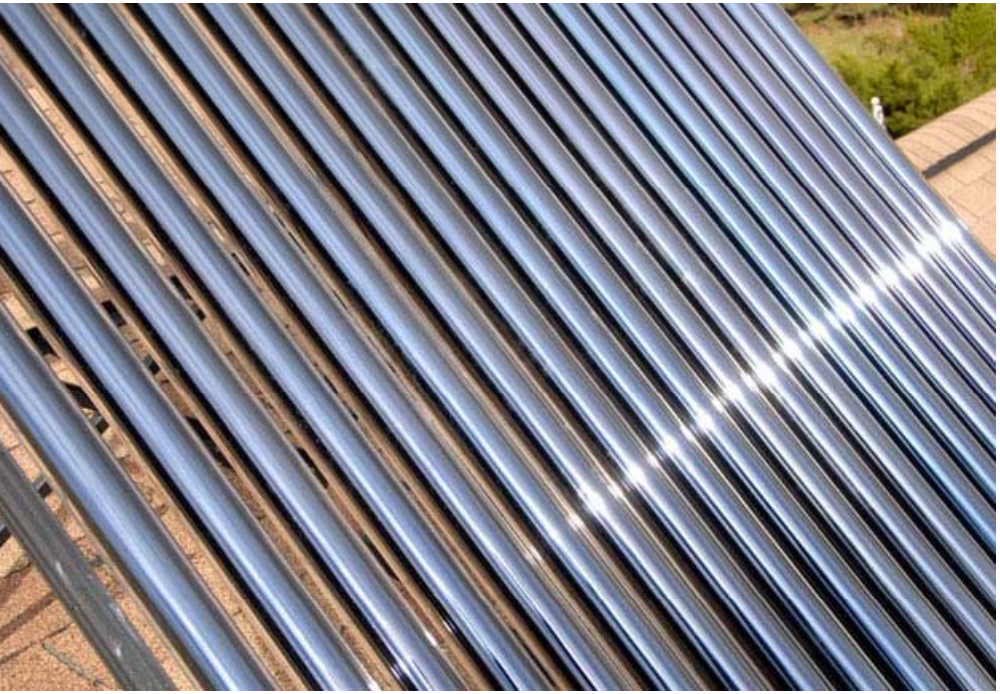
Solar Hot Water Panels



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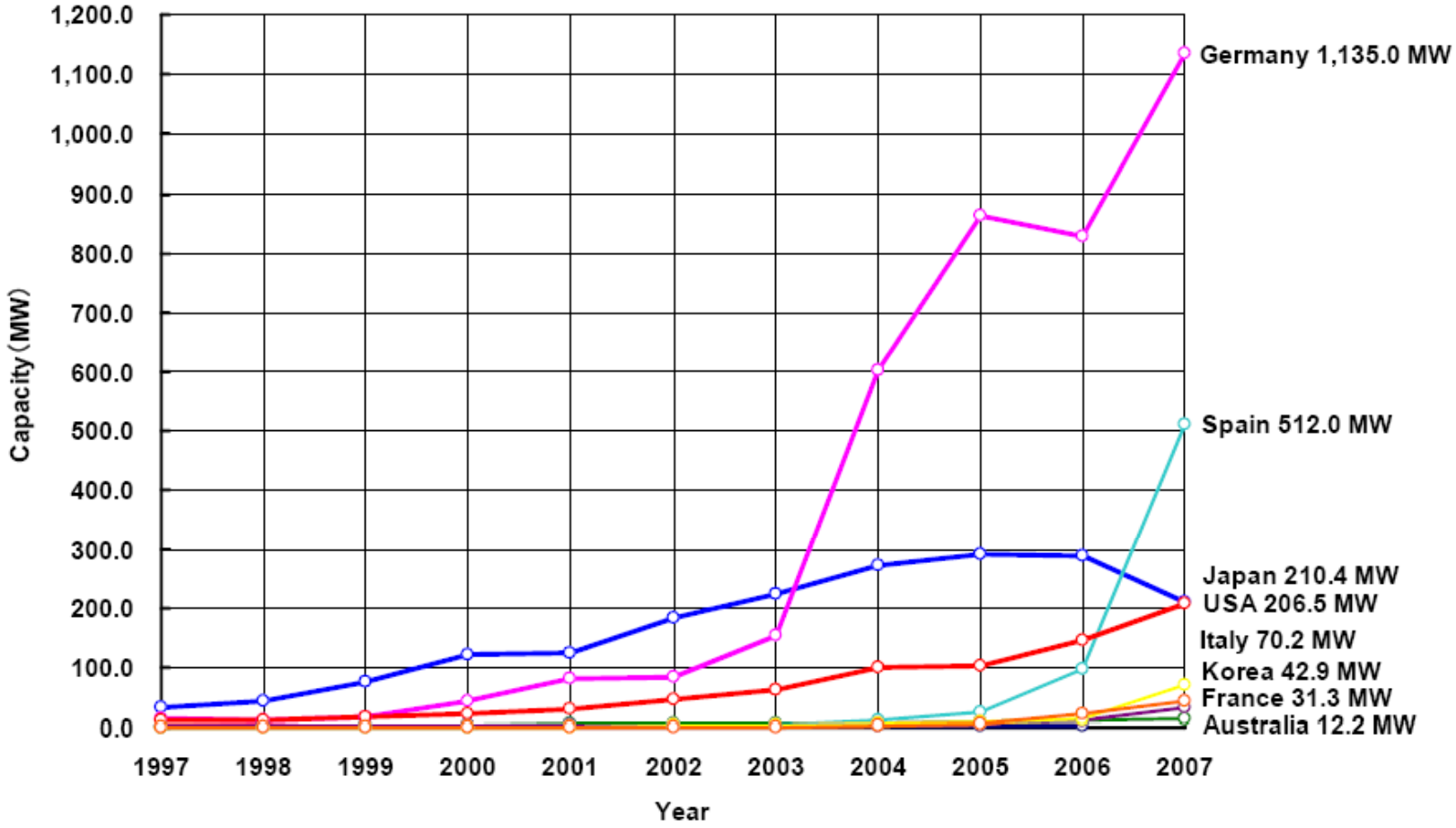
1,200.0
1,100.0
1,000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
Capacity (MW)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Germany 1,135.0 MW
Spain 512.0 MW
Japan 210.4 MW
USA 206.5 MW
Italy 70.2 MW
Korea 42.9 MW
France 31.3 MW
Australia 12.2 MW

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