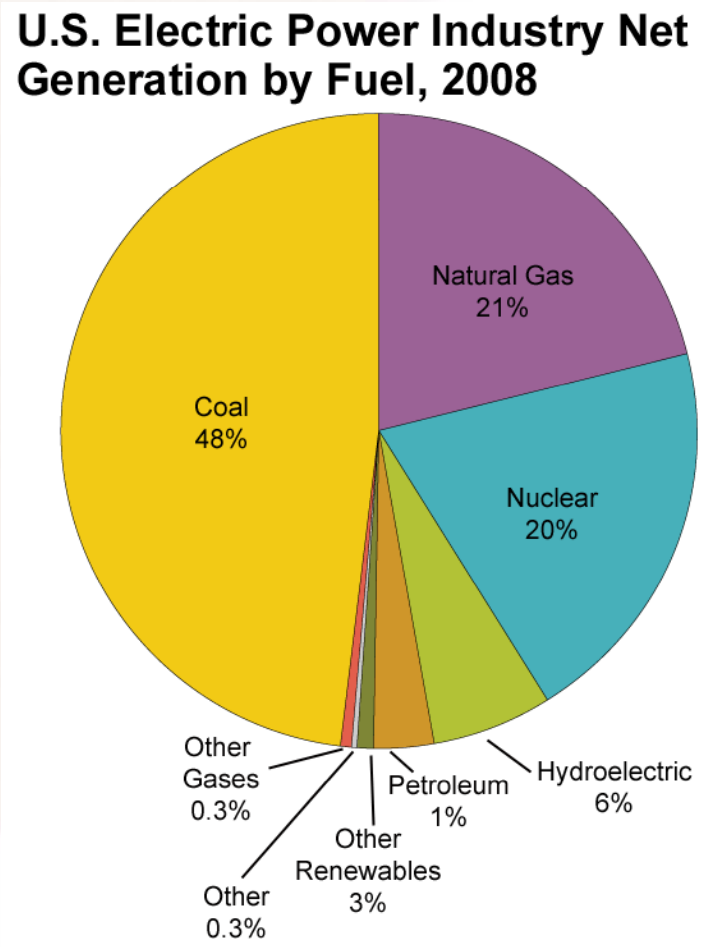
Solar Electricity: Problem, Constraints and Solutions

Student E

State of U.S. Electricity Generation

Current Generation: 4,110 TWh

- Fossil fuel based
- Price volatility and national security
- Environmental impacts
  - 2.5 billion tons of carbon dioxide
  - Sulfur dioxide and nitrogen oxides
- Presence of Solar
  - 536 MW capacity
  - 0.843 TWh net generation



Source: U.S. Energy Information Administration, *Electric Power Annual* (2010).

Principles of Operation

Diagram of a photovoltaic cell
removed due to copyright restrictions.

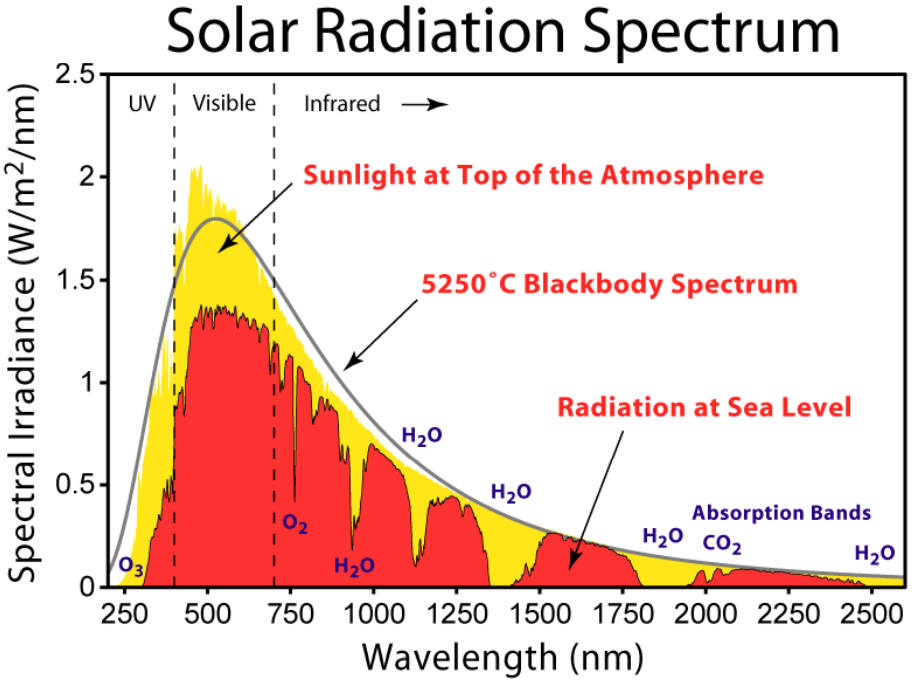


Image created by Robert A. Rohde / Global Warming Art.

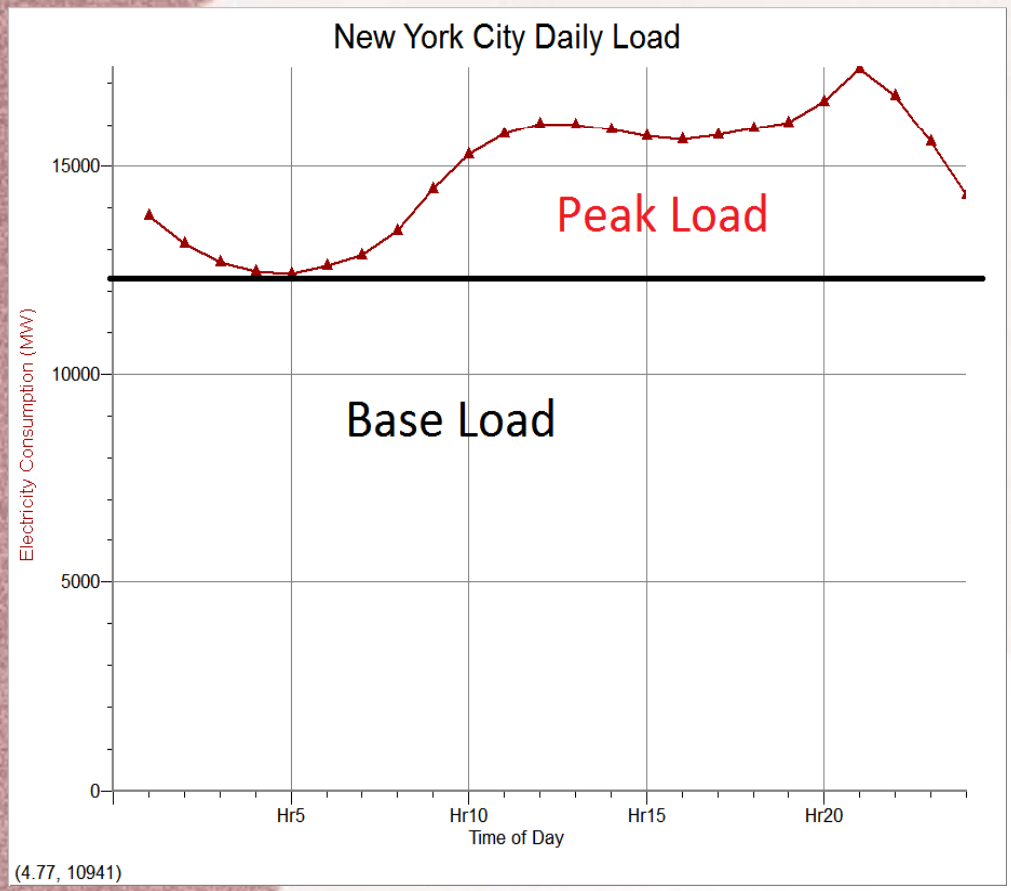
Issues: Performance, Manufacture, and Application

2016 projections

	Existing technology (Deutsche Bank)				With grating + DBR					
Technology	Efficiency	Installation cost per Watt	Module cost per Watt	System cost per Watt (1MW)	Efficiency improvement	Change in installation cost per Watt	Change in material cost per Watt	Change in capitol cost per Watt	Change in system cost per Watt	New system cost per Watt (1MW)
Organics	7%	$2.80	$0.60	$3.40	4%	($0.81)	$0.01	$0.10	($0.70)	$2.70
a-Si	9.1%	$2.08	$1.08	$3.16	2%	($0.35)	$0.01	$0.10	($0.24)	$2.92
CdTe	12.2%	$2.03	$0.71	$2.74	0%	$0.00	$0.01	$0.10	$0.11	$2.85
CIGS	13.2%	$1.99	$0.81	$2.80	0%	$0.00	$0.01	$0.10	$0.11	$2.91
thin film c-Si	13.0%	$1.99	$1.00	$2.99	1%	($0.12)	$0.01	$0.10	($0.01)	$2.98
p-Si	14.0%	$1.89	$1.00	$2.89	0%	$0.00	($0.15)	$0.10	($0.05)	$2.84
c-Si	15.4%	$1.78	$1.31	$3.09	-1%	$0.11	($0.31)	$0.10	($0.10)	$2.99

Numbers in green are taken from either Prometheus or Deutsche Bank as indicated
Numbers in light green are estimates by Thin Film Si Team
Numbers in blue are estimates by Thin Film Si Team
Numbers in black are calculated values

Markets and Applications



- Cannot produce power at night
- Peak load consists of 22-36% of maximum load
- Goals for Solar PV:
  - 30% of 752 GW U.S. peak capacity
  - Can produce 10% of total electricity.

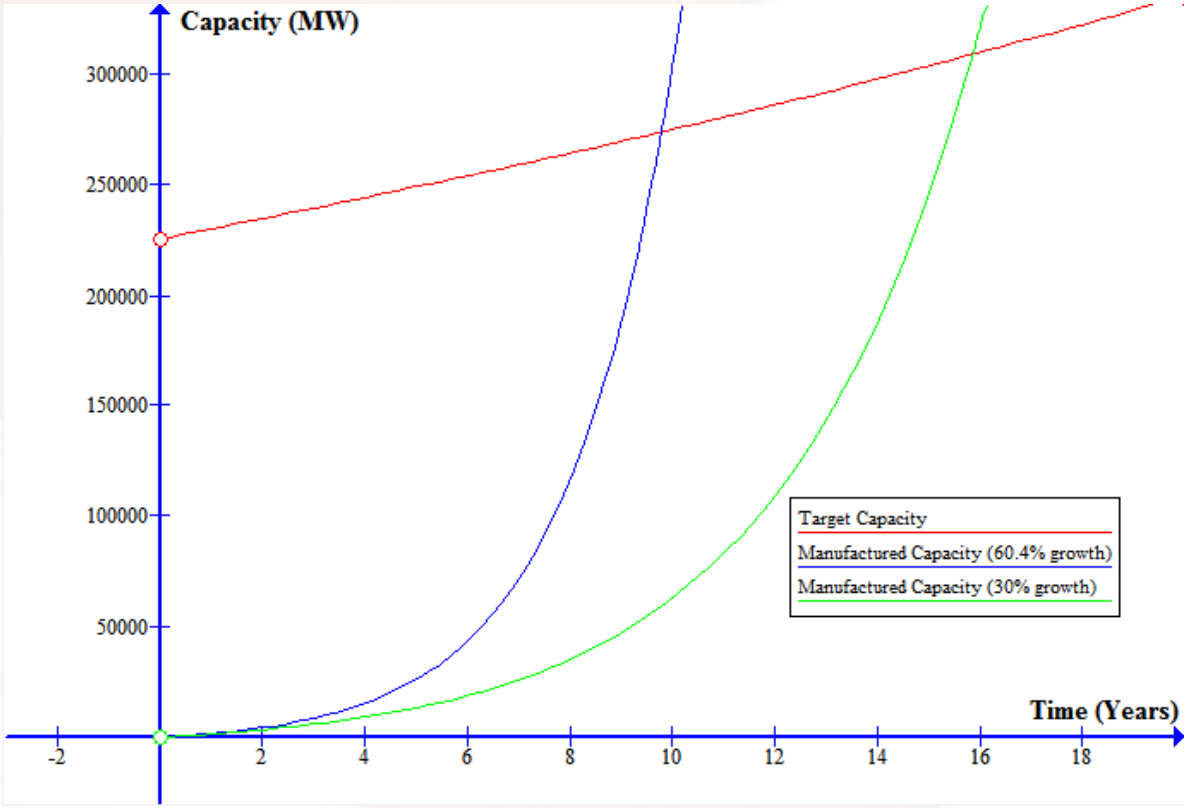
Timeline for Deployment

<u>Assumptions</u>

- Only considering CdTe from First Solar
- 308 MW in 2007, 60.4% growth rate
- 2% growth in electricity demands

<u>Limits</u>

- Amorphous Silicon
- Materials availability
- Exports to foreign countries



MIT OpenCourseWare
http://ocw.mit.edu

3.003 Principles of Engineering Practice

Spring 2010

For information about citing these materials or our Terms of Use, visit: http://ocw.mit.edu/terms.