

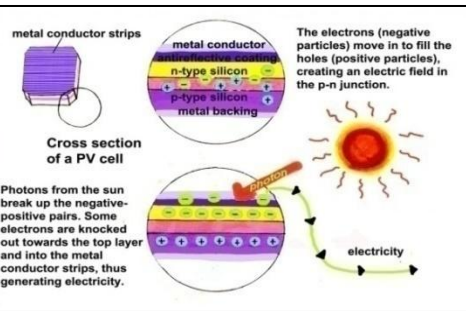


U.S. Solar Photovoltaic (PV) Factsheet

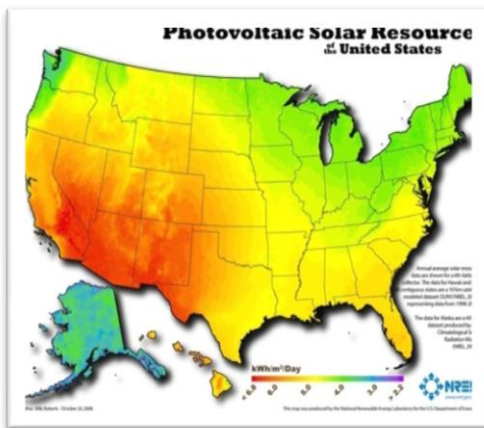
Apratim (Appy) Mukherjee

How do solar cells produce electricity?

- Made of silicon semiconductors.
- Average panel efficiency ~14-15%

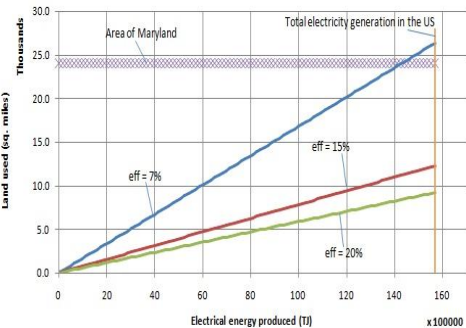


Resources, capacity & consumption

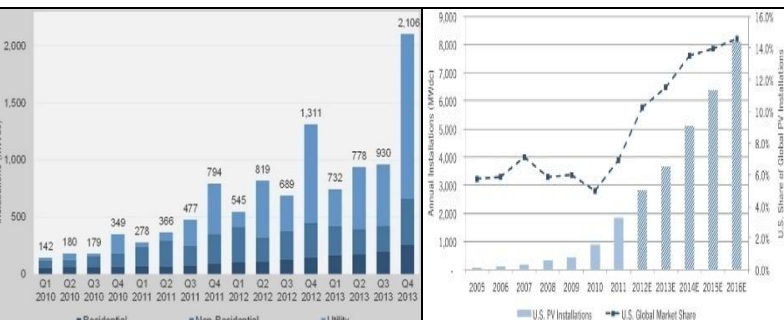


- Even at efficiency of 7%, the land area required to produce the total US electricity from only solar PV < the area of Maryland.

Land usage vs. energy produced

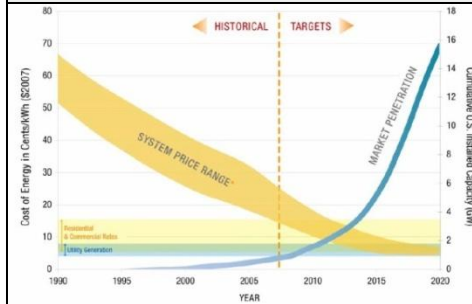


- US solar PV was 2nd biggest source of new electricity generating capacity in US in 2013 accounting for almost 25%.
- US PV installations for the utility sector increased by approximately 80% in 2013 compared to 2012, higher than % increases in the residential and non-residential sectors.

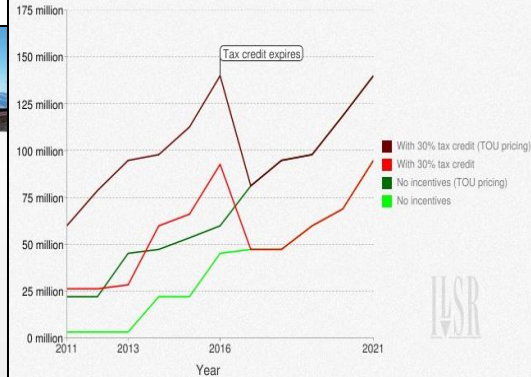


Costs associated with solar PV

New Coal Can't Deliver Power for 6-8 Years, When Solar Will Be Competitive



Number of Americans With Cheaper Solar Than Grid Power



Average Stock Price (USD) for 6 solar companies (FLSR, AEIS, SPWR, SUNE, TNS, SCTY)



Possible reasons for decreasing PV installation cost:

- Improved racking, wiring and inverter technologies
- Large scale govt. support for R&D, subsidies and renewable energy standards.

Advantages

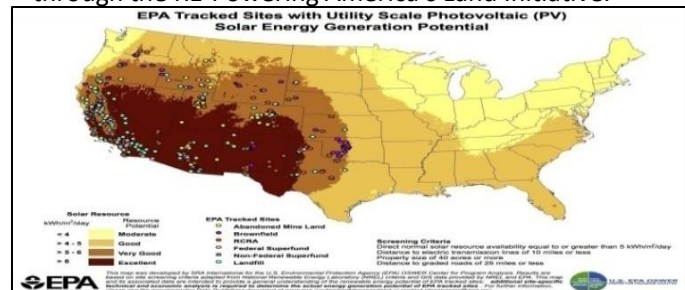
- Peak power generation usually coincides with peak energy demand
- No harmful greenhouse gas emissions involved.
- Unlimited solar resource.
- Rapidly falling price leading to an increase in future economic feasibility.
- Low operation and maintenance costs.
- Promoted through govt. subsidy funding.

Disadvantages

- Relatively high current cost compared to many other large-scale electricity generating sources.
- Intermittency and unpredictability of solar resource
- Relatively low efficiencies
- Expensive inverters required to convert the direct current produced to alternating current.
- Toxic chemicals like Cadmium and Arsenic are used in PV production.

Key current developments

- U.S. EPA has been promoting the reuse of potentially contaminated landfills for solar PV energy generation through the RE-Powering America's Land Initiative.



- Hanwha Q Cells construct the first US solar farm (10.86 MW) on Superfund site
- President Obama announces that investment tax credit will be removed from U.S. solar projects by end of 2016.



U.S. Solar Photovoltaic (PV) Factsheet

Apratim (Apy) Mukherjee

How do solar cells produce electricity?

•Figure:
Photovoltaic Glass: How does it work? (n.d.). Retrieved from <http://www.solarenergyexperts.co.uk/buyersguides/photovoltaic-glass-how-does-it-work/>

•Solar Panel efficiency:
National Renewable Energy Laboratory (n.d.). Retrieved from <http://www.nrel.gov/gis/solar.html>

Resources, capacity & consumption

•Photovoltaic solar resource figure:
National Renewable Energy Laboratory (n.d.). Retrieved from <http://www.nrel.gov/gis/solar.html>

•PV production vs. land resources
Original calculation which assumes:
- Average solar intensity of 5 (kWh-year)/m²
- Efficiencies ranging from 7-20%
- Total electrical energy generated in the U.S. in 2014 = 15.7EJ (no change from 2012).
- Area of land reqd. = 2*Area of panel

•Data regarding solar PV performance in 2013:
Hall, M. (2014, March 5). US Posts Record Year For Solar in 2013. *Photovoltaics Magazine*. Retrieved from http://www.pv-magazine.com/news/details/beitrag/us-posts-record-year-for-solar-in-2013_100014415/#ixzz2xrmJhaPV

•Sector-wise consumption fig:
Solar Market Insight Report 2013 Year In Review. *Solar Energy Industries Association*. (n.d.). Retrieved from <http://www.seia.org/research-resources/solar-market-insight-report-2013-year-review>

•Total installation fig:
Runyon, J. (2012, March 14). Solar Industry's Exponential Growth in 2011 Indicates Healthy US PV Market. *Renewable Energy World.com*. Retrieved from <http://www.renewableenergyworld.com/rea/news/article/2012/03/solar-industrys-exponential-growth-in-2011-indicates-healthy-u-s-pv-market>

Costs associated with solar PV

•New Coal can't deliver
Lacey, S. (2011, June 14). Solar is Ready Now: Ferocious Cost Reductions Make Solar PV Competitive. *The Solar Foundation*. Retrieved from <http://thesolarfoundation.org/blog/solar-ready-now-%E2%80%98ferocious-cost-reductions%E2%80%99-make-solar-pv-competitive>

•Projected market penetration date
U.S. Department of Energy, Solar Energy Technologies Program. (2008, April 15). *Multiyear program plan 2008-2012*. Washington, DC: U.S. Government Printing Office. Retrieved from http://www1.eere.energy.gov/solar/pdfs/solar_program_mypp_2008-2012.pdf

Possible reasons for decreasing PV installation cost:

•U.S. Department of Energy, Solar Energy Technologies Program. (2008, April 15). *Multiyear program plan 2008-2012*. Washington, DC: U.S. Government Printing Office. Retrieved from http://www1.eere.energy.gov/solar/pdfs/solar_program_mypp_2008-2012.pdf

•Solar PV tax credit effects
Farell, J. (2011, November 7). Nuance on Krugman's "Solar is now cost-effective". *Institute for Local Self Reliance*. Retrieved from <http://www.ilsr.org/nuance-krugmans-solar-now-cost-effective/>

•Solar stocks calculation
Original calculation with data from:
-Stock data from Yahoo finance
-Income statement reports from SEC.gov

Advantages

•Green, D. (2012, December 19). *Advantages and Disadvantages of Solar Photovoltaic*. *Renewable Energy World.com*. Retrieved from <http://www.renewableenergyworld.com/rea/blog/post/2012/12/advantages-and-disadvantages-of-solar-photovoltaic-quick-pros-and-cons-of-solar-pv>
•Shah, A., Torres, P., Tschanner, R. (1999, July 30). Photovoltaic Technology: The Case for Thin-Film Solar Cells. *Science*, 285 (5428), 692-698. Retrieved from <http://www.sciencemag.org/content/285/5428/692.long>

Disadvantages

•Green, D. (2012, December 19). *Advantages and Disadvantages of Solar Photovoltaic*. *Renewable Energy World.com*. Retrieved from <http://www.renewableenergyworld.com/rea/blog/post/2012/12/advantages-and-disadvantages-of-solar-photovoltaic-quick-pros-and-cons-of-solar-pv>
•United States Environmental Protection Agency.. (n.d.). *Renewable Energy: Solar Energy*. Retrieved from http://www.epa.gov/region1/eco/energy/re_solar.html

Key current developments

•Landfills figure:
National Renewable Energy Laboratory, U.S. Environmental Protection Agency. (2013, February). *Best Practices For Siting Solar Photovoltaics on Municipal Solid Waste Landfills*. Washington, DC: U.S. Government Printing Office. Retrieved from http://www.epa.gov/oswercpa/docs/best_practices_siting_solar_photovoltaic_final.pdf
•Hanwa Q Cells solar farm information:
Meza, E. (2014, April 9). Hanwha Q CELLSS Completes First US Solar Farm On A Superfund Site. *Photovoltaics Magazine*. Retrieved from http://www.pv-magazine.com/news/details/beitrag/hanwha-q-cells-completes-first-us-solar-farm-on-a-superfund-site_100014787/#axzz209fNwtz
•Removal of investment tax credit:
Hall, M. (2014, March 5). US Posts Record Year For Solar in 2013. *Photovoltaics Magazine*. Retrieved from http://www.pv-magazine.com/news/details/beitrag/us-posts-record-year-for-solar-in-2013_100014415/#ixzz2xrmJhaPV