The Solar Market in 2040

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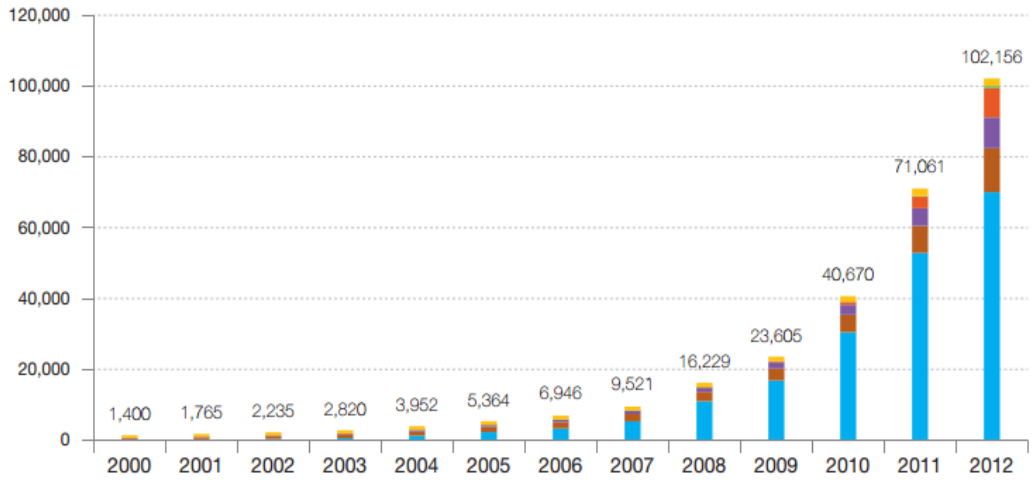
Outline

- Cumulative installed PV worldwide has been growing at an exponential rate
- Incentives have contributed significantly to growth
- Necessary factors for mass deployment of PV
  - Competitive LCOE without incentives
  - Compatibility with electric grids

Evolution of global PV cumulative installed capacity 2000-2012 (MW)*



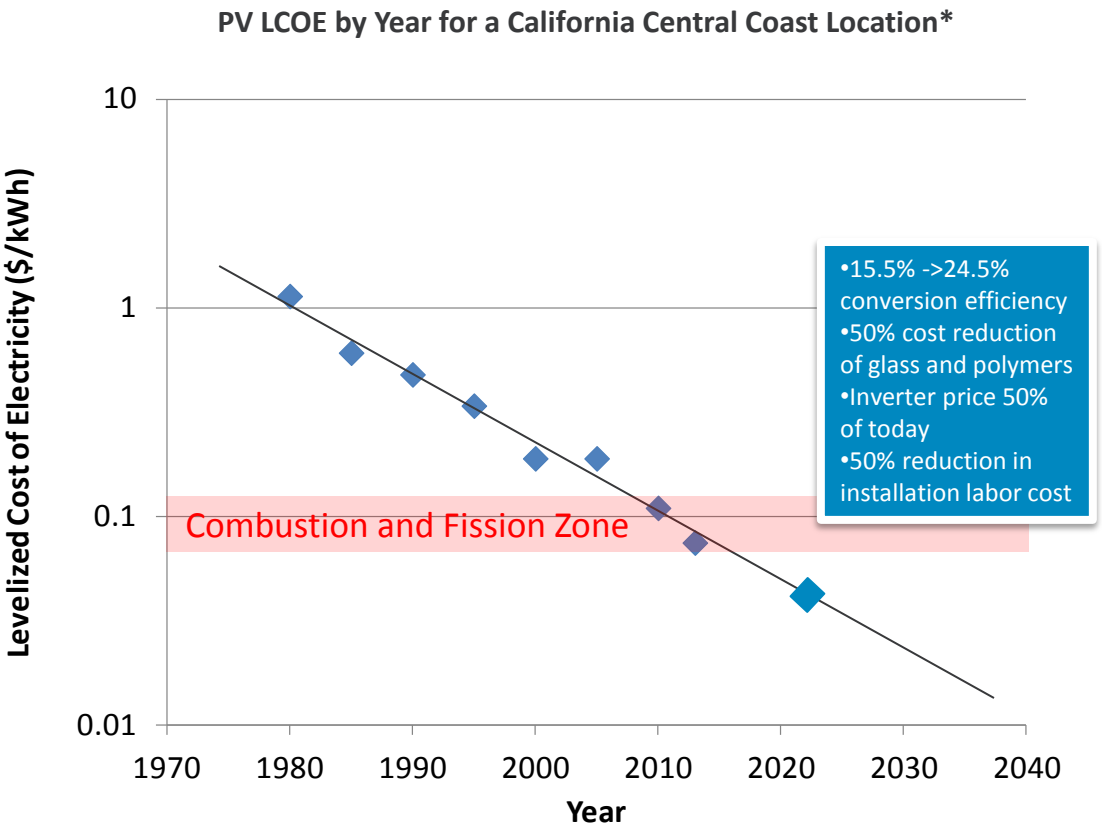
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ROW	751	807	887	964	993	1,003	1,108	1,150	1,226	1,306	1,590	2,098	2,098
MEA	n/a	n/a	n/a	n/a	1	1	1	2	3	25	71	192	601
China	19	24	42	52	62	70	80	100	140	300	800	3,300	8,300
Americas	146	178	225	290	394	501	650	863	1,209	1,752	2,780	4,959	8,717
APAC	355	495	686	916	1,198	1,500	1,825	2,096	2,631	3,373	4,956	7,628	12,397
Europe	129	262	396	598	1,305	2,289	3,281	5,310	11,020	16,850	30,472	52,884	70,043
Total	1,400	1,765	2,235	2,820	3,952	5,364	6,946	9,521	16,229	23,605	40,670	71,061	102,156

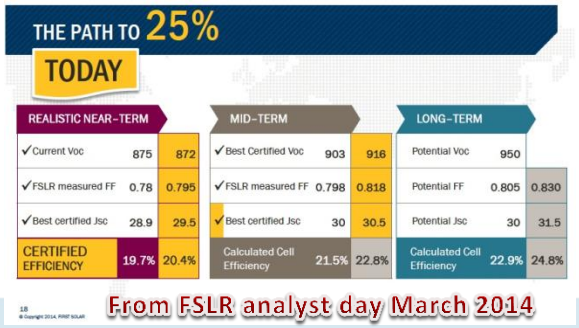
ROW: Rest of the World. MEA: Middle East and Africa. APAC: Asia Pacific.

*European Photovoltaic Industry Association • GLOBAL MARKET OUTLOOK FOR PHOTOVOLTAICS 2013-2017

Competitive LCOE for continued Growth

- For 3 decades, PV LCOE has shown a log linear decrease with time (Swanson was right?)
- PV LCOE is now within a factor of two of the cheapest fossil fuel method of electricity generation for first time in history
- Extrapolating to $0.01/kWh in 2040… it is a great time to be in solar
- What does it take to get PV LCOE of $0.04/kWh, well below $0.06/kWh for natural gas fired power plants?
- $0.04/kWh seems achievable





*Historic PV ASP provided by Paula Mints, SPV Market Research

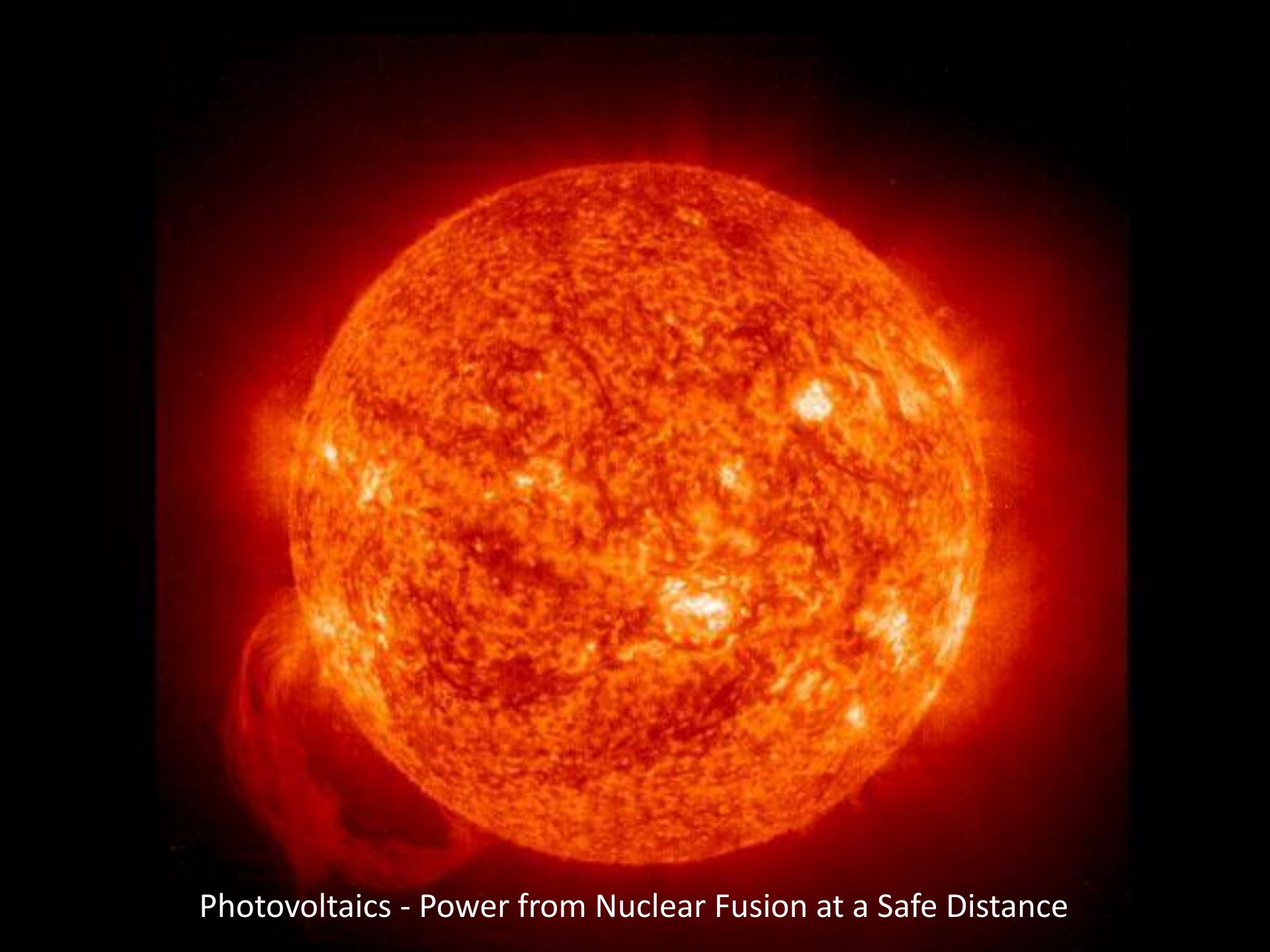
PV LCOE between $0.01 and $0.10/kWh

- Growth of PV will be supply constrained
- Large scale deployment of PV will require us to deal with electricity grid stability issues*
- Distributed generation is an excellent way to generate power where it is needed, therefore reduce grid transport
  - What will be the role of light weight PV for industrial roofing market, especially for developing countries?
- PV electricity generation combined with storage seems a promising path to grid robustness
  - Large scale: Utility size solar combined with hydropower
  - Medium scale (neighborhoods): community solar with large batteries
  - Small scale: behind the meter generation and storage (or fully off-grid)
  - Robustness against calamities are maximum at the smallest scale
  - Plugged in electric vehicles concentrate backup power where most people are present
- Optimizing these combination technologies (PV and Storage together) will help opening up markets in developing countries and may enable "leapfrogging" beyond an electric grid (cell phone analogy)

*See for example: Der Spiegel, August 16, 2012

Summary

- PV LCOE has entered the most interesting range in its history
- Grid stability issues due to mass deployment of PV will have to be dealt with
- Distributed PV generation and PV generation combined with storage will be helpful to mitigate these issues
- A significant fraction of the distributed PV market will require light weight panels



Photovoltaics - Power from Nuclear Fusion at a Safe Distance