

Solar Energy: Emerging from the Shadows

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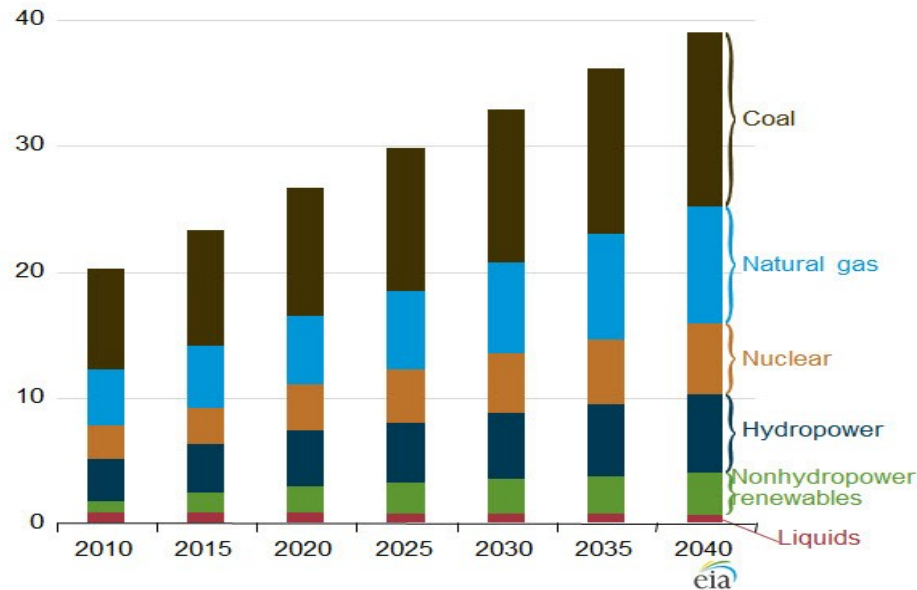
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Renewables: The Global Perspective

Figure 6. World net electricity generation by energy source, 2010-2040

trillion kilowatthours



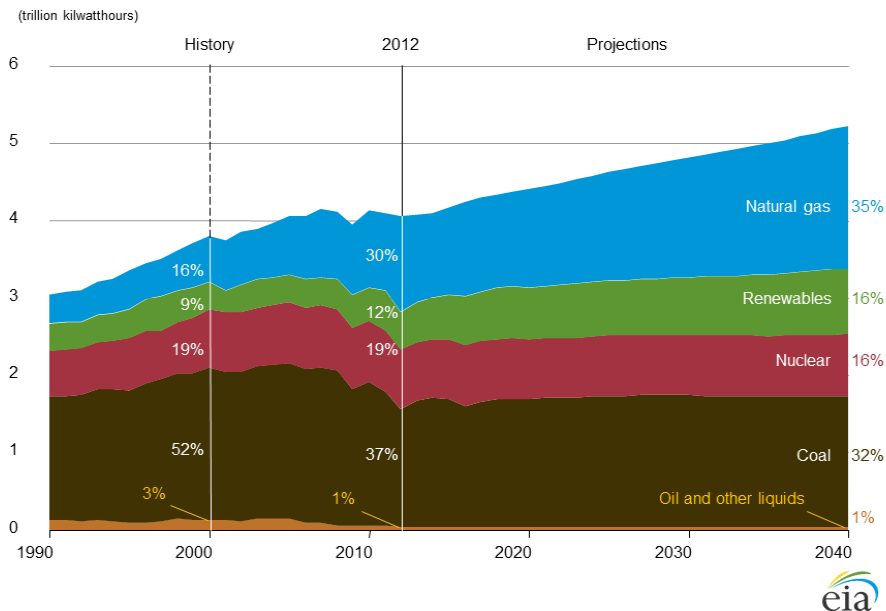
Source: U.S. Energy Information Administration International Energy Outlook, July 2013

EIA Reference Case Profile for World Net Electricity Generation in 2040:

- ▶ Coal will remain the leading form of electricity generation
- ▶ Natural gas will become a more formidable challenger
- ▶ Non-hydropower renewables will generate about 9% of the world's electricity
- ▶ Contribution of renewables will increase 336% compared to 2010

Renewables: The U.S. Perspective

Figure 13. Electricity generation by fuel, 1990-2040



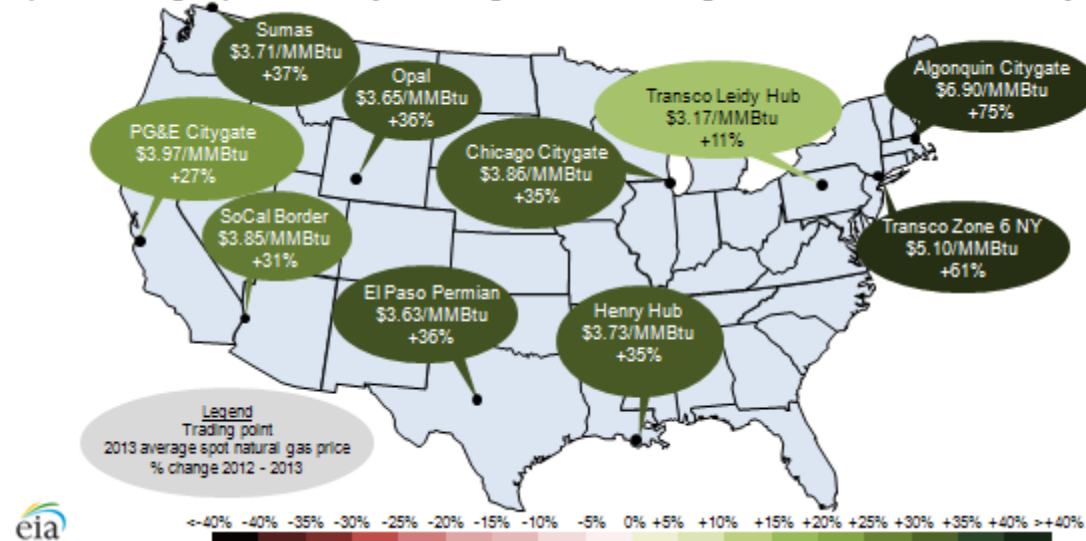
Source: *U.S. Energy Information Administration 2014 Annual Energy Outlook, January 2014*

EIA Reference Case Profile for U.S. Net Electricity Generation in 2040:

- ▶ Natural gas will supplant coal as the leading form of electricity generation (35% of total generation)
- ▶ Coal will remain a major source of electricity (32%)
- ▶ Renewable energy (including hydropower) will represent 16% of total generation
- ▶ Renewable energy (excluding hydropower) will account for 28% of overall growth in electricity generation

Is Natural Gas Really the Answer?

Spot natural gas prices at major trading locations through December 31, 2013 delivery date



Source: *U.S. Energy Information Administration 2014 Annual Energy Outlook, January 2014*

Volatility of NG prices jeopardizes its ability to be a cheap bridge to a sustainable energy future

Recent U.S. Natural Gas (NG) Pricing:

- ▶ NG prices have risen rapidly from 2012 low of \$2/MMBtu
- ▶ December 2013 average NG price was about \$4.30/MMBtu
- ▶ U.S. Northeast NG prices were much higher than average due to pipeline constraints and cold weather demand
- ▶ At \$4 to \$5/MMBtu NG prices, coal pricing for power generation can be competitive or even cheaper
- ▶ Coal use for power generation actually rose 2% in 2013 while NG use dropped by 3%
- ▶ U.S. CO₂ emissions rose 2% in 2013 commensurate with the increase in coal use

Can Solar Capacity Top Projections?

2015 Projected Installed Solar Capacity (GW)	EIA 2013	Deutsche Bank 2014
Europe	64	73
USA	19	30
China	14	39
Japan	7	28
World Total	113	>200

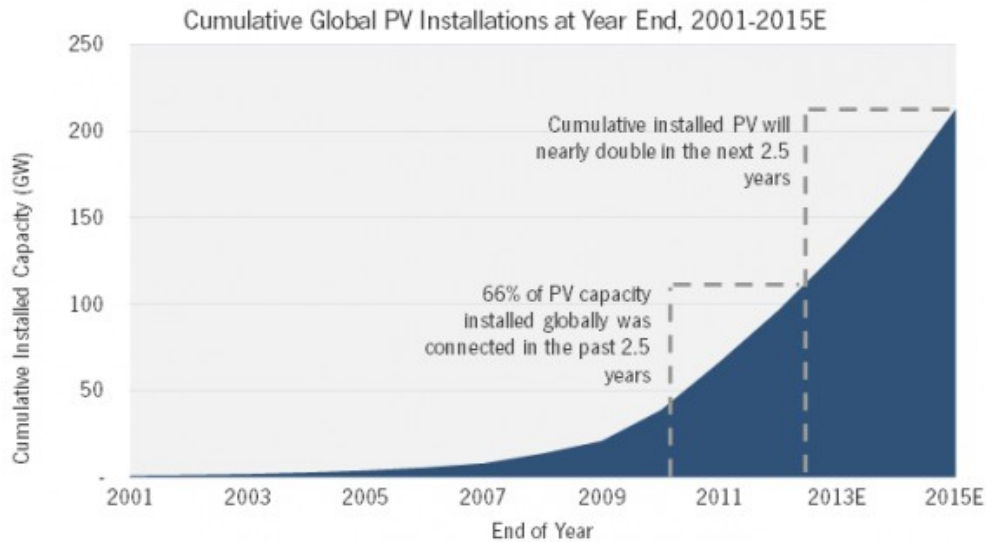
Source: *US Energy Information Administration International Energy Outlook 2013, July 2013*
Deutsche Bank Energy Sector Report, January 2014

Installed solar capacity is following a more rapid trajectory than U.S. EIA projected due to plummeting prices and unforeseen world events

Deutsche Bank Solar Capacity Projections Far Exceed U.S. EIA Projections:

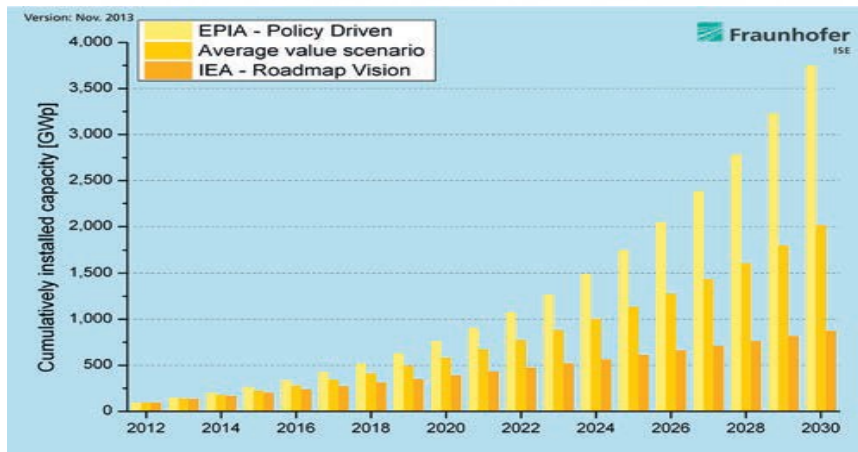
- ▶ DB estimating slower turndown of European market
- ▶ Lower all-in costs and potential elimination of tax incentives in 2017 are increasing US deployments
- ▶ EIA report significantly under estimated Japanese increase in solar usage resulting from nuclear turndown and generous solar incentives
- ▶ Recent Chinese incentives have spurred solar deployments in that country
- ▶ Maturing of the solar industry and rapidly declining all-in costs are driving solar deployments worldwide

Solar Industry is Definitely Growing



Global PV Capacity Findings:

- ▶ Deployment of the first 100GW of global PV capacity required about 12 years
- ▶ Deployment of the second 100GW of global PV capacity will be completed in the next 2.5 years
- ▶ Installed PV Capacity could increase globally by 20X to 2000GW by 2030



EPIA=European Photovoltaic Industry Association 2013 Forecast, IEA=International Energy Agency 2010 Forecast

Sources: Greentech Media Research,
Fraunhofer ISE Renewable Energy LCOE Study, Nov 2013

Solar Demand: Global Outlook

Figure 3: Demand Outlook

MW	2010	2011	2012	2013E	2014E	2015E
China	520	2,000	3,510	8,000	12,000	13,800
y/y (%)	128%	285%	76%	128%	50%	15%
Japan	991	1,290	2,088	7,000	8,000	8,800
y/y (%)	105%	31%	61%	236%	14%	10%
Germany	7,218	7,485	7,604	3,502	2,801	2,801
y/y (%)	90%	4%	2%	-54%	-20%	0%
Italy	2,321	8,971	3,337	1,500	750	788
y/y (%)	224%	287%	-63%	-55%	-50%	5%
Spain	369	400	278	278	278	304
y/y (%)	515%	8%	-31%	0%	0%	10%
France	719	1,500	1,079	1,079	1,349	1,619
y/y (%)	228%	109%	-28%	0%	25%	20%
Rest of Europe	658	2,007	3,190	3,127	3,127	3,847
y/y (%)	370%	205%	59%	-2%	0%	23%
USA	878	1,800	3,313	5,000	8,000	12,000
y/y (%)	85%	82%	107%	51%	60%	50%
Canada	188	297	288	223	288	295
y/y (%)	119%	59%	-10%	-17%	20%	10%
India	158	190	980	990	1,980	2,771
y/y (%)	120%	20%	416%	1%	100%	40%
Others	1,012	1,104	2,312	5,800	7,560	9,072
y/y (%)	141%	18%	94%	142%	35%	20%
Total	15,028	26,940	27,955	36,297	46,111	56,096
y/y (%)	124%	79%	4%	30%	27%	22%

Source: Deutsche Bank, Official Country Sources where available for historicals

Deutsche Bank Forecast Indicates Solar Markets are Shifting:

- ▶ European Domination is Rapidly Waning
- ▶ Asia Demand, led by China and Japan, is Surging
- ▶ US Demand is Projected to Be Second Only to China by 2015
- ▶ Approximately 25% Annual Solar Growth Rate Globally

Industry Economics are Improving

Installation Type	Projected 2014 All-in Cost (\$/W)	Projected 2017 All-in Cost (\$/W)
Residential Rooftop	\$3.00	\$2.15
Commercial Rooftop	\$2.50	\$1.85
<1MW Ground-Mounted	\$2.00	\$1.60
>2MW Ground-Mounted	\$1.60	\$1.35

► **All-in Costs of U.S. Solar Installations are Plunging:**

► **Solar Power Can Offer Competitive Retail Electricity Rates in 15 to 20 States in the US by 2017***

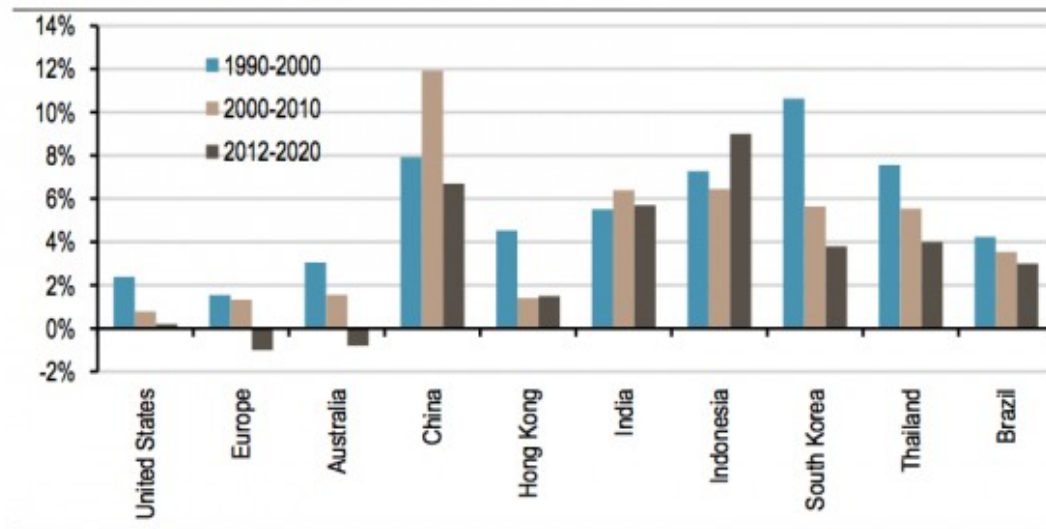
*Assumes 10% Investment Tax Credit and 6.5% Project Cost of Capital

Source: Sol Systems, Bloomberg New Energy Finance, Greentech Media

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Power Demands are Trending Down

Figure 13: Power demand CAGR for select countries over different periods: declining trends for most markets

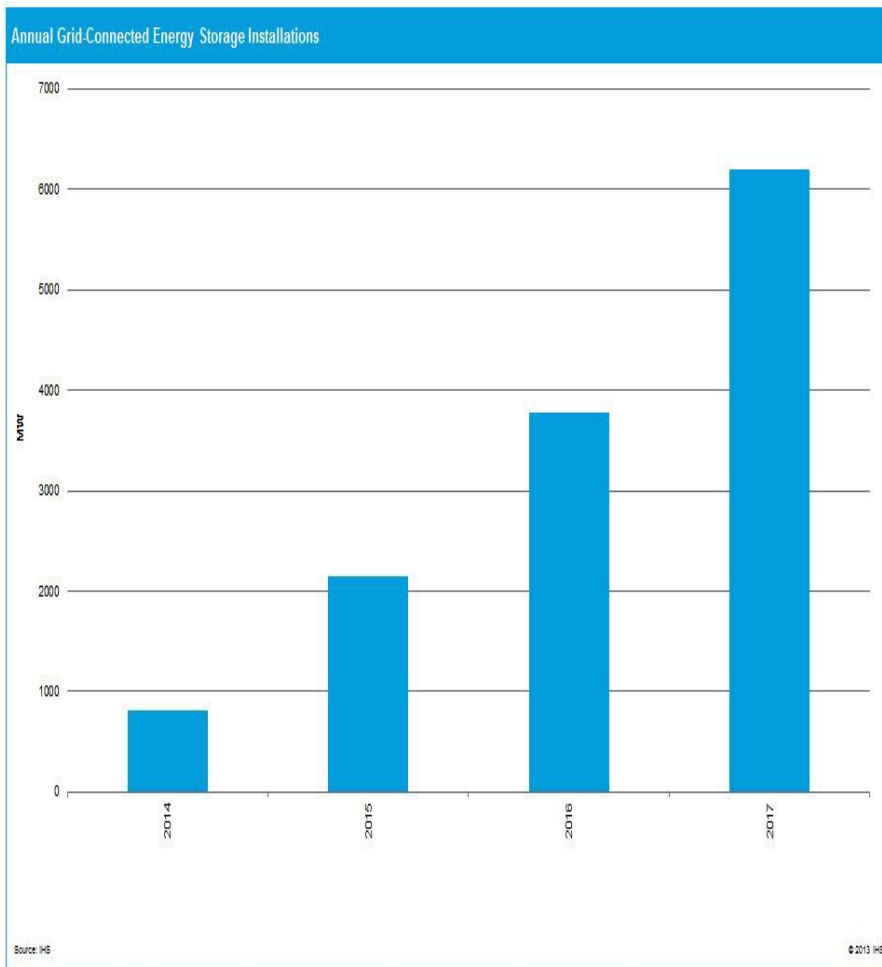


Source: EIA, UBS estimates

Implications on Future Power Generation:

- ▶ Developed Countries Will Need Less Centralized Power Plants
- ▶ Emerging Countries Could Adopt More Localized or Distributed Generation
- ▶ Utility Focus will Switch from Adding Capacity to Managing Time-of-Use
- ▶ Renewable Power Could Provide an Increasing Share of Future Distributed Electricity Generation

Energy Storage: Key PV Enabler?



Source: *IHS*

Battery Storage Outlook:

- ▶ Help reduce or eliminate grid intermittency effects
- ▶ Allow use of stored solar energy at night
- ▶ Mitigate commercial peak demand charges
- ▶ Adoption of technology highly dependent on \$/kWh price of stored energy which is currently too high, but predicted to trend down at about 10% to 15% annually
- ▶ Subsidies or regulations may be required for the foreseeable future to surmount current cost challenges and permit industry to scale
- ▶ IHS predicts cumulative installed global storage capacity of 6GW by 2017 and 40GW by 2022
- ▶ Early adopters include Germany, Japan, UK, California, Hawaii, and Puerto Rico driven by subsidies, regulation, or high electricity rates

Trends Influencing Solar Growth

Inhibitors

- ▶ Potential of long-term natural gas prices below \$4/MMbtu could slow the growth rate of solar in U.S.
- ▶ World economic slump could result in substantial reduction in worldwide solar subsidies
- ▶ Transmission and distribution grid capacity constraints could slow deployment of utility-scale solar plants

Igniters

- ▶ Increasing global demand and decreasing system costs will help lower the Levelized Cost of Energy for solar generation
- ▶ Renewable energy contributed over 50% of net additions to new electric generating capacity globally in 2012
- ▶ Introduction of cost-competitive energy storage technology will help mitigate solar intermittency limitations

Sources: Solar Energy Industries Association, European Photovoltaic Industry Association, California Solar Initiative, Greentech Media

2014 Solar Landscape

Positives

- ▶ Solar PV generation exceeds 100GW globally with 66% of new global PV installed in the past 2.5 years
- ▶ Solar module pricing is beginning to stabilize and should level out below \$0.50/W
- ▶ All-in Costs continue to decrease and are now below \$3.00/W in the US
- ▶ China and the US will represent over 40% of worldwide demand for the projected 50GW+ new solar capacity in 2015
- ▶ New entrants such as South Africa, India, Brazil, Chile, Mexico, Turkey and the Middle East could create substantial new demand for solar

Negatives

- ▶ Solar module shakeout still causing jitters in the financing industry
- ▶ All-in costs must decrease further to compete globally without subsidies
- ▶ Feed-in Tariffs in Europe are decreasing rapidly, and solar generation “fees” are being explored
- ▶ No US national energy policy is in the works, and renewable initiatives will be driven at the state level
- ▶ Venture financing for US solar technology is slowing considerably
- ▶ Despite impressive growth rates, solar production currently provides less than 1% of global electricity needs

Sources: EU Joint Research Center, SEIA, European Photovoltaic Industry Association, Lawrence Berkeley National Laboratory, Greentech Media

Summary

- ▶ The first 100GW of solar growth took over 12 years, the second 100GW could occur in 2 years (2014-2015)
- ▶ By 2015, solar projects will spread around the world with Asia and the US representing over 60% of all of the new installed capacity
- ▶ By 2017, solar should be able to compete more widely on price with other world energy sources as system and installation costs continue to decrease, and conversion efficiencies increase
- ▶ Natural gas is a serious competitor to renewable energy for new U.S. electricity generation, but price volatility and GHG regulations could slow the projected migration to natural gas

Outlook

The companies that will thrive in the solar industry will demonstrate the following characteristics:

- ▶ More system-oriented product offerings with higher system efficiencies
- ▶ More vertical-integration from a project implementation standpoint
- ▶ Increased emphasis on project integration and monitoring services revenue rather than equipment sales
- ▶ Lower Balance of System (BOS), customer acquisition, and soft costs
- ▶ Greater global presence either directly or through strategic partnerships
- ▶ Strong financing partners

The RevGen Group assists high technology clients to

- ▶ Bring products to market and through transitions in the life-cycle
- ▶ Develop business based on objective, customized intelligence
- ▶ Perform technology assessment and validation
- ▶ Manage due diligence

Fields of expertise:

- ▶ Solar energy
- ▶ Wireless communications
- ▶ PC software, Web 2.0, enterprise networking
- ▶ Semiconductor equipment and technology

We deliver:

- ▶ Advice, strategies, models and tools, alternatives
- ▶ Research, analysis, evaluation, validation
- ▶ Operational assistance