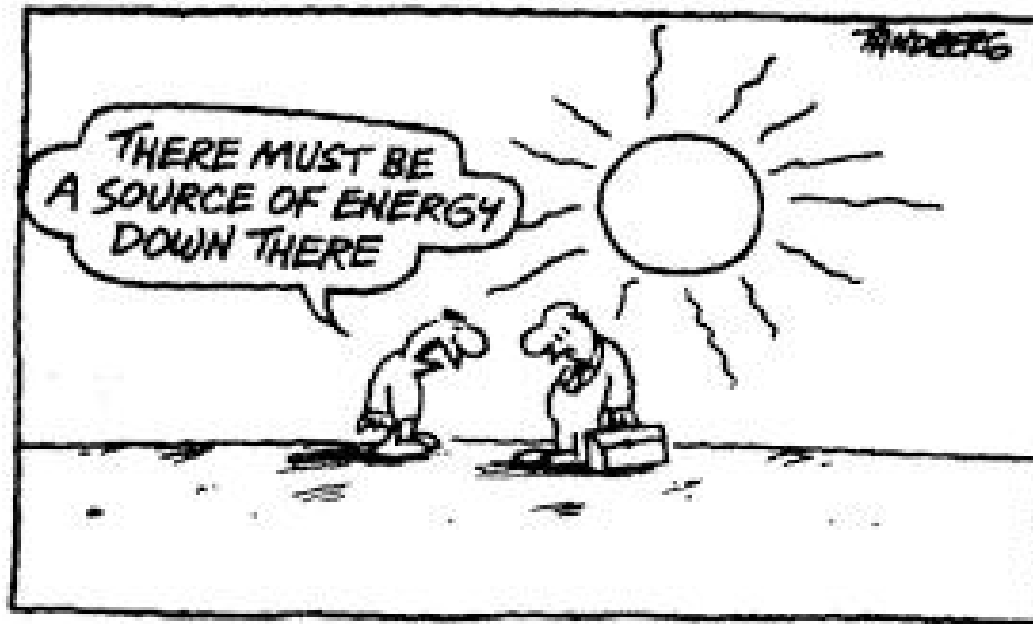


Making Hay While the Sun Shines

Debunking 10 Popular Myths about Solar Energy



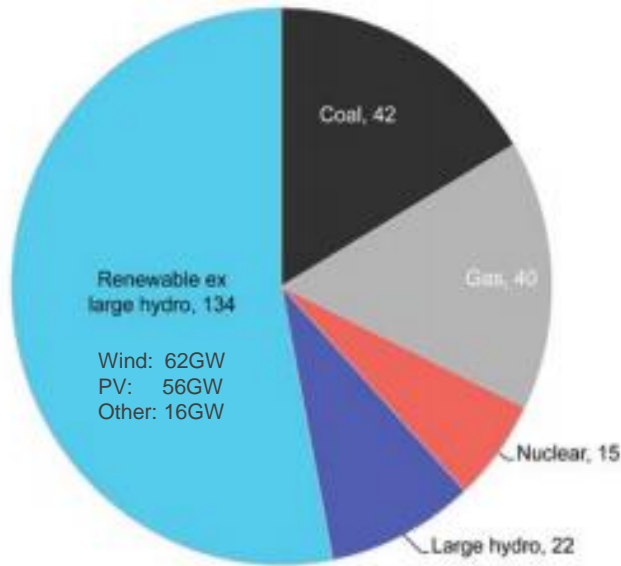
Energy
"Lookin' for ~~Love~~ in All the Wrong Places"

Mort Cohen
RevGen Consulting Group
Mort.Cohen@RevGenGroup.com

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Myth #1: Solar Power Remains a Small Percentage of New Electricity Generation

Net Power Generating Capacity Added in 2015
by Main Technology, GW



Source: Bloomberg New Energy Finance

(1) *Global Trends in Renewable Energy Investment, Bloomberg New Energy Finance, March 2016*

(2) *U.S. Solar Market Insight Report, SEIA, Q2 2016 Report*

Facts and Forecasts:

- ▶ Solar power generated about 22% of all new global electric capacity in 2015, more than coal or natural gas⁽¹⁾
- ▶ Solar power generated about 30% of all new US electric capacity in 2015⁽²⁾

Insights:

- ▶ In the U.S., solar moved ahead of natural gas in 2015 as the fuel source for new power generation despite plunging natural gas prices
- ▶ If future peak demand can be met with energy storage rather than generation, solar power as a percentage of total capacity adds could be even larger

Myth #2: Growth of Solar Deployments Will Really Driven by a Few Major Developed Countries

Projections for PV Capacity by Region (GW)
Years 2013, 2030, 2050

Year	US	Other OECD Americas	EU	Other OECD	China	India	Africa	Middle East	Other developing Asia	Eastern Europe and former Soviet Union	Non-OECD Americas	World
2013	12.5	1.3	78	18	18	2.3	0.3	0.1	1.4	3	0.2	135
2030	246	29	192	157	634	142	85	94	93	12	38	1721
2050	599	62	229	292	1738	575	169	268	526	67	149	4674

Source: International Energy Agency OECD=Organization for Economic Cooperation and Development (34 countries)

(1) *Solar Technology Roadmap, International Energy Agency, 2014 Edition*

(2) *GTM Research Latin America PV Playbook, January 2016*

Facts and Forecasts:

- ▶ In 2013, China, Europe and the US deployed 86% of solar in the world⁽¹⁾
- ▶ In 2050, China, Europe and the US are projected to deploy about 61% of solar in the world⁽¹⁾

Insights:

- ▶ Latin America is expected to deploy >2GW of solar in 2016, most without use of subsidies⁽²⁾
- ▶ India, Asia, and Middle Eastern countries are projected to be the largest solar growth areas
- ▶ California could lead the world in 2016 with 10% of annual power generation coming from solar (including utility and distributed PV plants)

Myth #3: Solar Power Will Never Offer Competitive Electricity Rates

Projections for LCOE for new-built utility-scale PV plants to 2050 (USD/MWh)

USD/MWh	2013	2020	2025	2030	2035	2040	2045	2050
Minimum	119	96	71	56	48	45	42	40
Average	177	133	96	81	72	68	59	56
Maximum	318	250	180	139	119	109	104	97

Source: International Energy Agency

LCOE=Levelized Cost of Energy

(1) *Solar Technology Roadmap, International Energy Agency, 2014 Edition*

(2) *GTM Research, U.S. Residential Solar Economic Outlook, Feb 10, 2016*

(3) *Financing the Future of Energy, University of Cambridge and PwC, March 2015*

Facts and Forecasts:

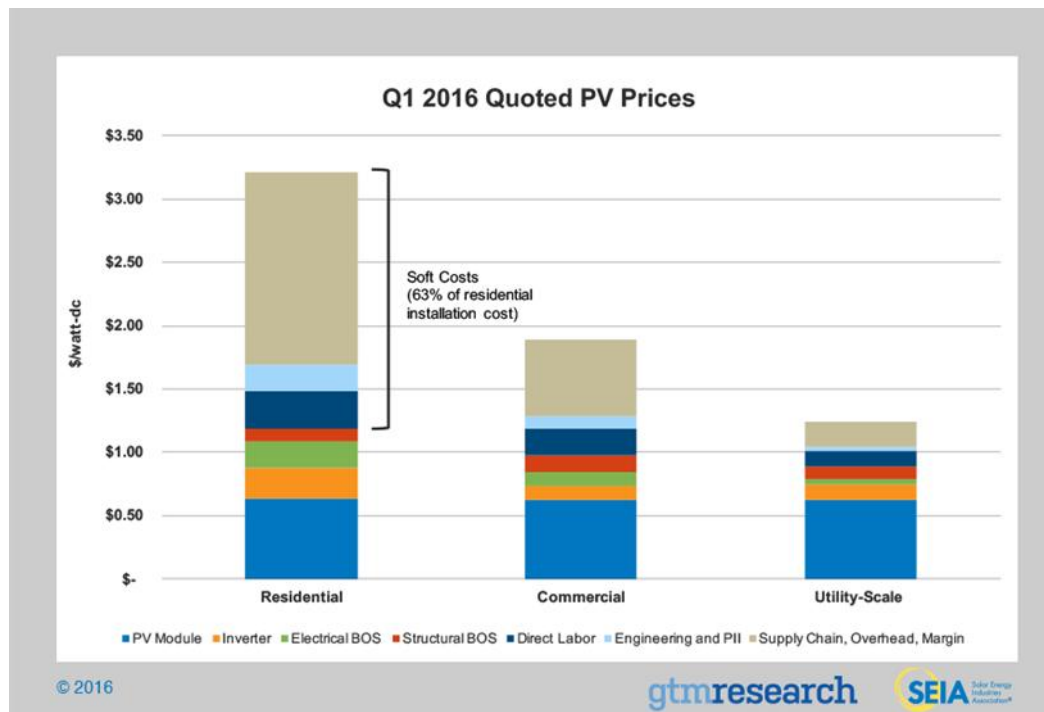
- ▶ The average unsubsidized solar LCOE is projected to be less than 10 cents per kWh by 2025 which is competitive with natural gas plants⁽¹⁾
- ▶ Twenty US states were at or below grid parity in 2015. Forty-two US states are projected to be at or below grid parity by 2020⁽²⁾

Insights:

- ▶ Solar PV power is expected to reach grid parity in 80% of countries before 2020⁽³⁾
- ▶ The U.S. DOE Sunshot Initiative goal of <\$0.06/kWh total cost of solar installation by 2020 now appears to be achievable as Balance of System (non-module) costs and soft (non-hardware) costs are decreasing

Myth #4: Only Chinese Module Suppliers Benefit from the Growth of Solar Industry

US PV Installation Cost Breakdown



Source: SEIA Solar Industry Data, April 2016

(1) SEIA Solar Industry Data, April 2016

Facts and Forecasts:

- ▶ PV module costs currently represent <30% of total US residential and commercial solar installation costs⁽¹⁾
- ▶ More than 60% of total US residential and commercial solar installation costs are incurred locally⁽¹⁾

Insights:

- ▶ Over 200,000 workers are employed in the US solar industry, more than double the number from 2010
- ▶ US solar companies now employ nearly three times the number of workers in the US coal mining industry
- ▶ US solar companies now employ more workers than the US oil and gas extraction industries

Myth #5: Solar Company Profits are Surging as PV Industry Expands

2015 Financials of Leading Residential Solar Installers

	Revenue	Gross Margin	Net Income
Solar City	\$400M	30%	-\$58M
SunRun	\$305M	8%	-\$53M
Vivint	\$64M	-42%	-\$199M

2015 Financials of Leading PV Module Suppliers

	Revenue	Gross Margin	Net Income
Trina Solar	\$3B	19%	\$77M (2.6%)
Canadian Solar	\$3.5B	16%	\$172M (5%)
Jinko Solar	\$2.4B	20%	\$103M (4.3%)

Source: Company Financial Statements, Yahoo Financial

Facts and Forecasts:

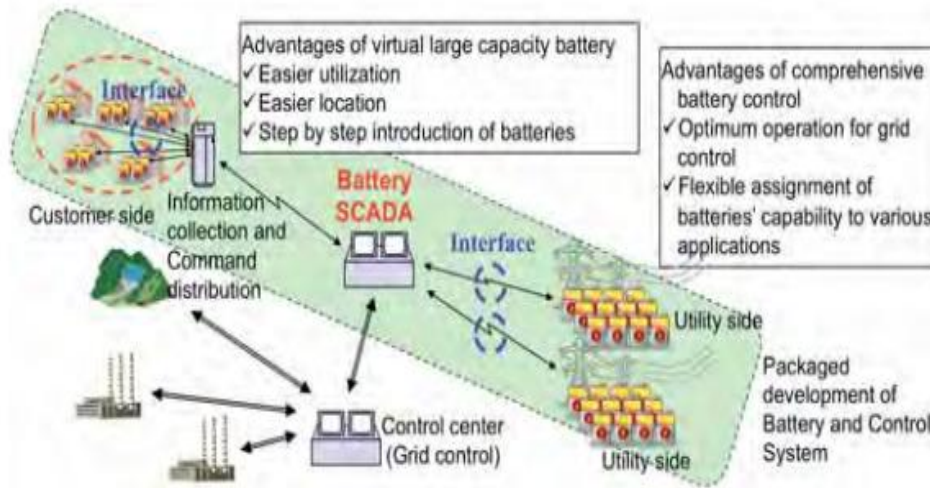
- ▶ Although leading U.S. residential solar installer revenues increased by >50% in 2015, their net income remained negative
- ▶ Net income of leading PV module suppliers remained below 5% despite a >50% increase in MW of capacity sold

Insights:

- ▶ Residential leasing structures require many years of lease payments to offset the high initial capital expense for installation; non-module costs must decrease considerably to accelerate profitability
- ▶ Leading Chinese PV module suppliers are facing eroding gross margins due to decreasing ASPs, small profit on Chinese sales, and worldwide tariffs

Myth #6: Hardware and Cost Improvements will Accelerate Solar Power Market Penetration

Yokohama City, Japan Software-Controlled
Virtual Battery Demonstration



Source: International Electrotechnical Commission Electrical /Fraunhofer Institute Energy Storage White Paper, 2014

Yokohama Smart City Demonstration led by Tokyo Electric Power Company and Toshiba to evaluate software-controlled supply side and demand side aggregated battery storage using off-the-shelf Li-Ion batteries

Facts and Forecasts:

- ▶ Increased conversion efficiency and lower costs will help make solar power more competitive with traditional energy sources
- ▶ Software may prove as important by allowing aggregation and control of distributed energy resources and associated storage devices to build virtual batteries that intelligently deliver power to the grid

Insights:

- ▶ Software can optimally stagger and stack individual batteries to become a very flexible power system in the aggregate
- ▶ Software platforms can utilize prior historical demand trends, weather, demographics, real-time power pricing and remaining useful battery to optimize power delivery and energy storage

Myth #7: Plentiful Natural Gas Will Obviate the Need For Solar Energy

Power Generation Fuel Costs
(dollars per million Btu)

	2014	2015	2016	2017
Coal	\$2.36	\$2.23	\$2.18	\$2.20
Natural Gas (NG)	\$4.98	\$3.22	\$2.77	\$3.56

Source: U.S. Energy Information Administration Short Term Energy Outlook, June 2016

(1) U.S. Solar Market Insight Report, SEIA, Q2 2016 Report

(2) BP Energy Outlook 2035 Fact Sheet, January 2016

Facts and Forecasts:

- ▶ Despite low natural gas prices in the U.S. in 2015, solar power generated more new electrical capacity than natural gas⁽¹⁾
- ▶ Globally, renewable energy usage will grow within a range of 6% to 9% per year while natural gas usage will grow by about 2.5% per year through 2035⁽²⁾

Insights:

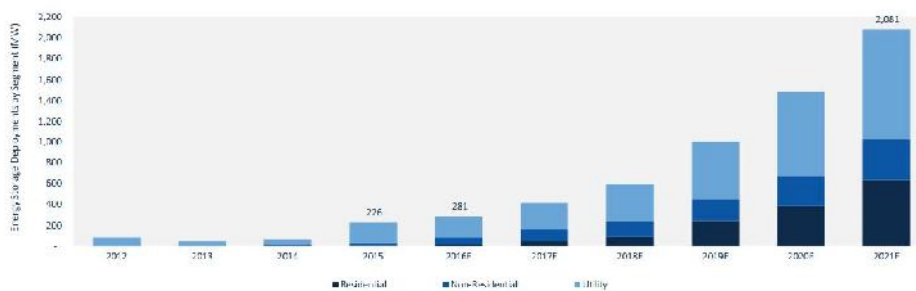
- ▶ Increasing demand for NG as coal plants are retired could add to NG price volatility
- ▶ Export of LNG from US to other countries where gas prices are higher could add to NG price volatility

Myth #8: Energy Storage Will Be Crucial for Near-Term US Solar Energy Expansion

U.S. PV Installations With and Without ITC Extension, 2010-2020



Projected U.S. Energy Storage Deployments, 2012-2021E



(1) *U.S. Solar Market Insight Report, SEIA, Q2 2016 Report*
 (2) *GTM Research/ESA US Energy Storage Monitor, Q22016*

Facts and Forecasts:

- ▶ Extension of the Investment Tax Credit (ITC) is forecast to increase cumulative PV deployments by almost 30GW by 2020⁽¹⁾
- ▶ New US solar energy storage deployments are forecast to be <10% of newly installed solar PV capacity in 2020⁽²⁾

Insights:

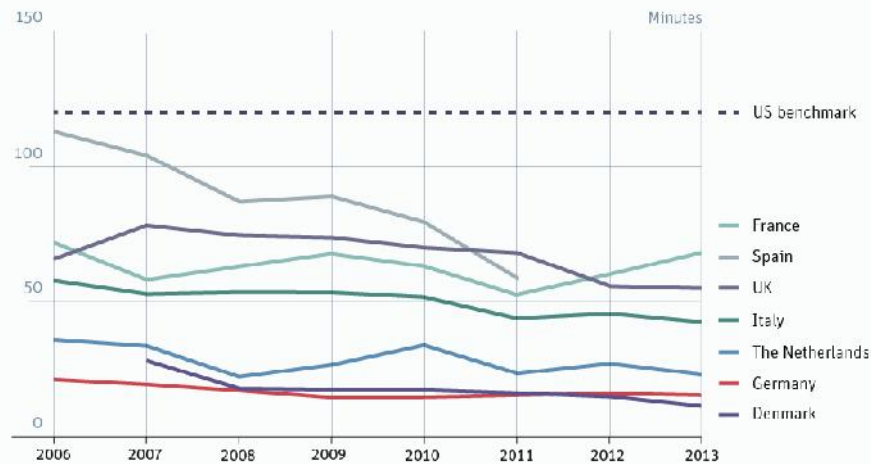
- ▶ Through 2020, declining solar costs, the ITC extension, and the growth of community solar projects will spur the growth of US solar installations
- ▶ Relaxation of regional power import/export rules and cost-competitive energy storage will be major drivers of solar growth in the next decade

Myth #9: Intermittent Nature of Solar Power Will Soon Severely Impact Grid Reliability

Grid reliability and renewable growth seem to go hand in hand

Minutes of power outages per year (excl. exceptional events), based on Saidi

Source: CEEF and own calculations



German Energy Transition energytransition.de

Source: *The German Energiewende*, energytransition.de

(1) *The German Energiewende*, energytransition.de

(2) *Electric Power Research Institute Smart Grid Demonstration Initiative*, January 2015

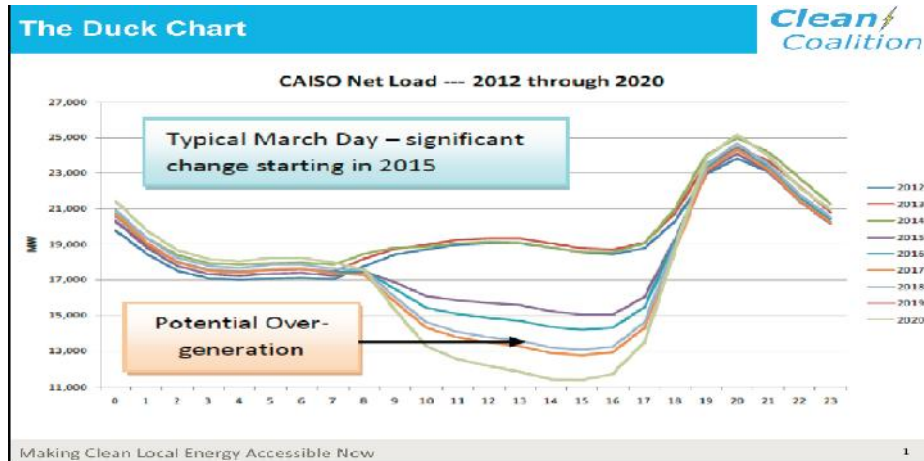
Facts and Forecasts:

- ▶ Germany, with >25% renewable power on average fed to the grid, has an average of 15 minutes of grid outages per year which is among the lowest in the world⁽¹⁾
- ▶ Reactive power in AC transmission systems, not real power, is frequently the bottleneck when it comes to stabilizing the grid⁽¹⁾

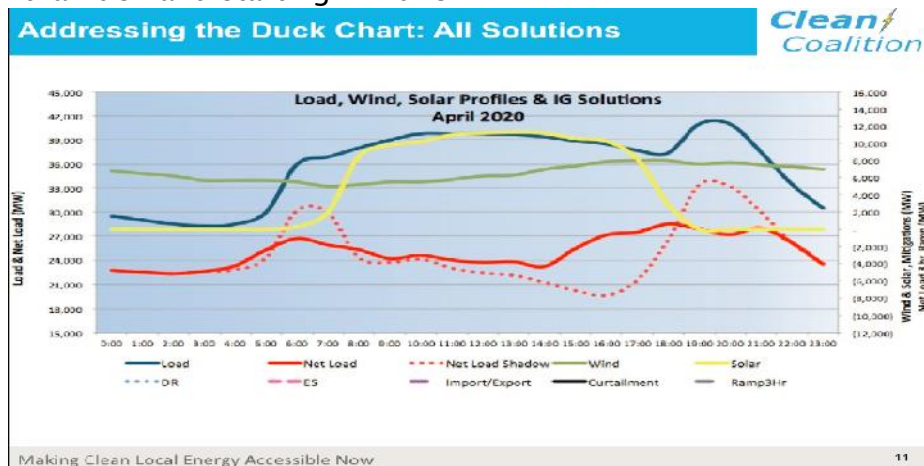
Insights:

- ▶ Using Volt-VAR control to manage voltage levels and reactive power can have a significant impact on distribution network stability⁽²⁾
- ▶ Potential solutions to ensure grid reliability include:
 - Regional cross-border grid optimization
 - Flexible renewables power mix
 - Flexible back-up capability
 - Demand management
 - In the longer term, energy storage

Myth #10: California's "Duck Curve" Illustrates the Need for More Peaker Plants



Duck Curve=Increasing solar generation plus non-dispatchable base power (nuclear+less flexible gas) can create more supply than demand starting in 2018



(1) Clean Coalition Renewables Integration White Paper, May 2013

Facts and Forecasts:

- ▶ CA Independent System Operator (CAISO) projects potential over generation during peak solar periods starting approximately 2018⁽¹⁾
- ▶ Largest load ramp occurs 2 hours before the sun comes up, and 2 hours after the sun goes down requiring either “fill-in” generation, or demand management or curtailment ⁽¹⁾

Insights:

- ▶ In lieu of new gas peaker plants, anticipated load ramping can be addressed by a combination of:
 - Enabling power import and export between grid operating authorities
 - Demand response programs
 - Intelligent inverters and grid technology
 - Battery and power-to-gas energy storage

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For an annotated version of this presentation or for further details on the topic,
contact Mort.Cohen@RevGenGroup.com