

The Future of Alternative Energy

Will Solyndra Be the Exception or the Rule?

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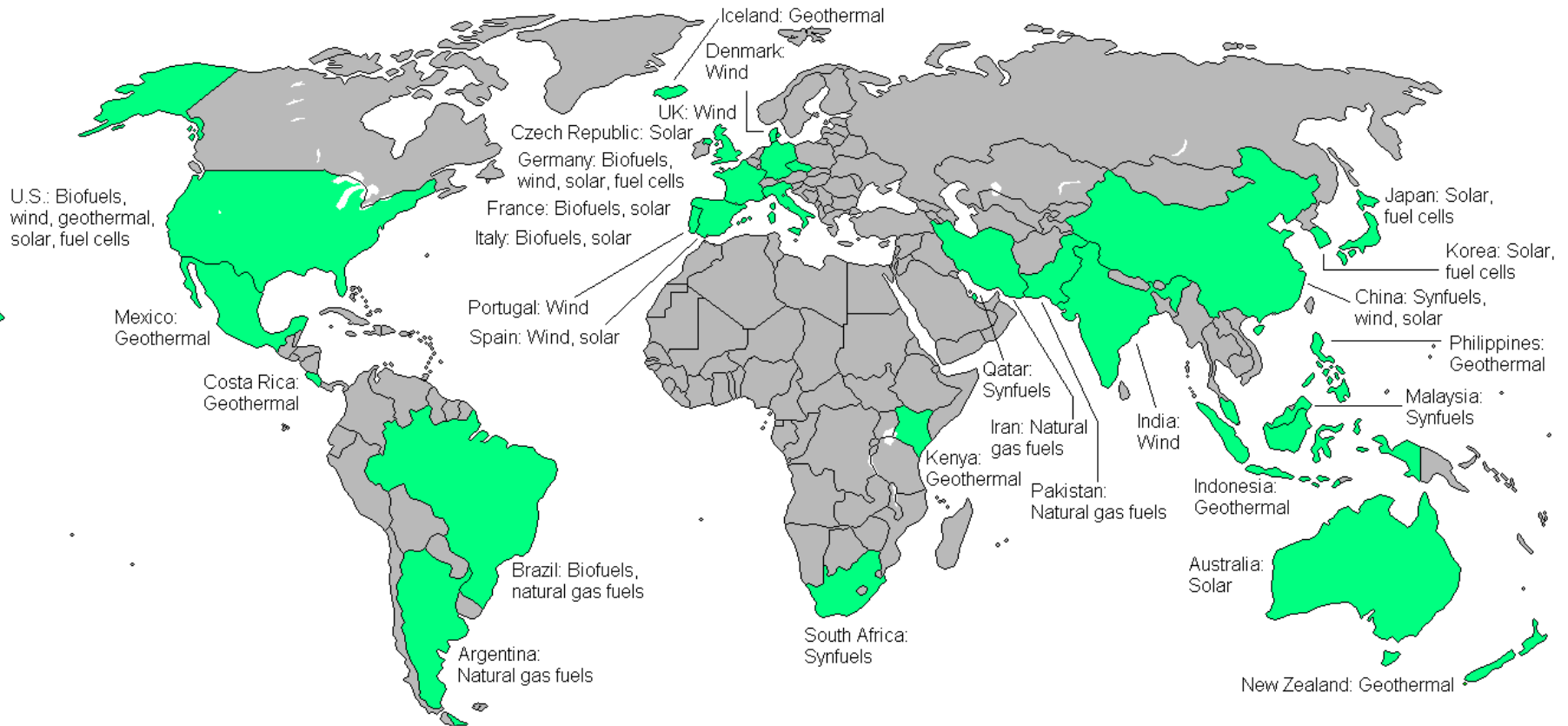
Presentation to the Charlotte Economics Club

January 2012

RAYMOND JAMES
EQUITY CAPITAL MARKETS

The World of AE

- Alternative energy is a global reality, found in countries with diverse geography, resource availability and economic development
- The map below shows some of the key AE markets



Key Investment Themes

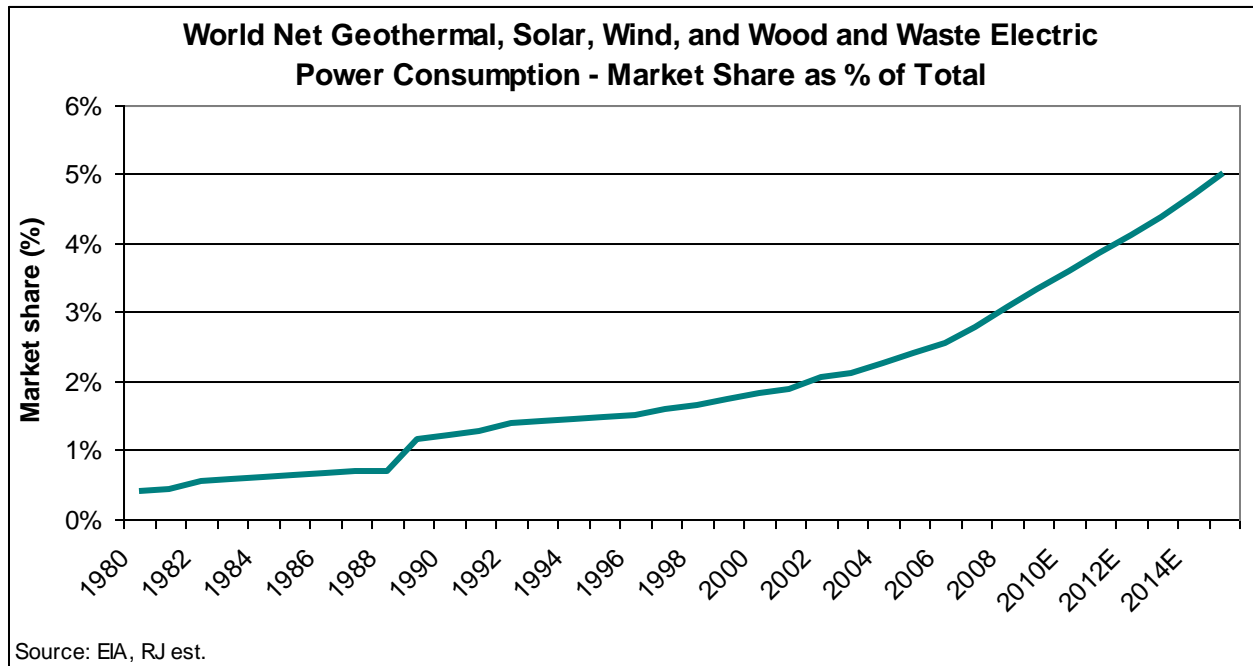
- **Theme #1:** Constraints in traditional energy sources
 - Concerns about near-term security and long-term availability of oil and gas supply highlight the importance of diversifying the energy mix
- **Theme #2:** Sustainable, long-term growth from a low base
 - Even though hydrocarbon energy sources will continue to comprise the vast majority of the energy mix for the foreseeable future, the growth of AE significantly exceeds that of conventional energy
- **Theme #3:** Steadily improving commerciality (with risks)
 - A downward cost curve helps AE technologies increasingly become commercially viable options, but rapid cost reductions can cause dislocation for companies across the value chain
- **Theme #4:** Supportive, but volatile, public policy
 - Governments worldwide provide support to AE with subsidies, mandates and other policies – though in many markets, incentives are being curtailed over time
- **Theme #5:** Environmental dimension
 - The global debate about climate change and sustainable development underscores the benefits of zero-carbon and low-carbon AE

Theme #1

- Oil supply, and to a lesser extent natural gas supply, face risks on both a short-term and a long-term basis
- **Short-term risks:** Geopolitical supply disruptions
 - “Wildcard” countries – Saudi Arabia, Russia, Iran, Venezuela, and Nigeria – produce over 25% of the world’s oil within the context of an oil market with limited excess capacity
 - In the natural gas market, Gazprom’s periodic supply cut-offs have led European customers to seek a more diversified import mix
- **Long-term risks:** “Hubbert’s Peak”
 - Although the timing of peak oil is difficult to predict, it must eventually happen, because oil is a finite, non-renewable resource
 - Most of the main AE technologies – solar, wind, biofuels, and others – are renewable, which means they are not subject to Hubbert’s Peak (coal-to-liquids and natural gas fuels are the main exceptions, since they involve processing one form of hydrocarbon into another)

Theme #2

- Within the context of generally growing energy markets, AE is expanding at significantly above-average rates
- In fact, AE's market share has been increasing every year, demonstrating that this is a secular long-term trend
- However, the market share remains very small in absolute terms, hence the outlook for sustained future expansion

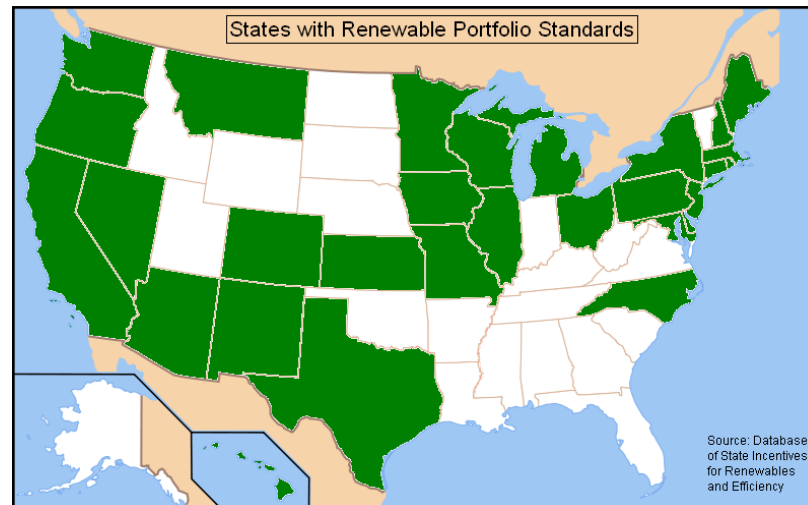


Theme #3

- There is much variety within AE subsectors, both technological and geographic, but we can generalize about their current commerciality
- **Wind power:** Onshore wind is at or below grid parity in many parts of the U.S. and several international markets; offshore wind remains hindered by higher costs
- **CNG / LNG:** Although natural gas vehicle fuels are a niche market in North America, the economics are solid, due to the wide spread between the prices of oil (~\$90/Bbl) and natural gas (~\$4.00/Mcf)
- **Biofuels:** Conventional ethanol and biodiesel are already in mainstream use, albeit with slim margins due to high feedstock costs; advanced biofuels are in the process of being scaled up
- **Solar power (PV):** On the cusp of grid parity in markets with high power prices (Japan, Italy); for grid parity in the U.S., installed system costs must drop from \$3.00-5.00/watt to \$2.00-3.00/watt
- **Synthetic fuels:** In large part due to its carbon intensity, CTL is unlikely to gain significant adoption globally; in North America, GTL is a more viable option given the abundance of natural gas
- **Fuel cells:** Stationary fuel cells are in limited commercial use; to be competitive with the grid, their non-fuel costs must decline; automotive fuel cells are still in the development stage

Theme #4

- While Europe has historically led the way, the political context for AE is positive worldwide: (1) politically popular (“green jobs”) and often bipartisan; (2) channels funding to favored projects (“pork spending”); and (3) seen as part of “energy security”
- In addition to direct financial incentives, many governments provide a guaranteed “floor” for AE demand via binding mandates
 - **EU**: 20% (on average) renewable energy market share by 2020
 - **U.S.**: Federal RPS unlikely for now; already in place in 25+ states
 - **China**: 100 GW of wind by 2020
- The main risk here is that incentives are being curtailed in many markets (e.g., solar FITs in Europe), sometimes in an abrupt way



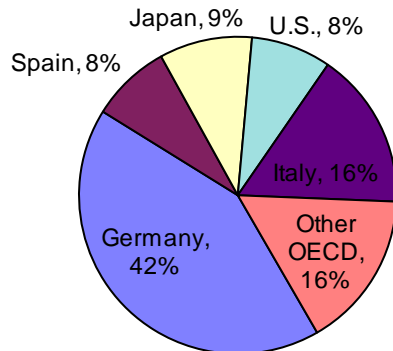
Theme #5

- AE may benefit from concerns about climate change due to its environmental advantages (e.g., lower carbon footprint), though political will for legally binding carbon cuts is currently slim in most countries
- In particular, following the Fukushima nuclear disaster, AE can help partially replace politically controversial nuclear reactors with another low-carbon (albeit less consistent) source of power
- **EU:** Already enforcing carbon trading – world’s largest program
- **U.S. and Canada:** National cap-and-trade not politically feasible for the foreseeable future; regional initiatives in place in the Northeast and on the West Coast
- **China and India:** No prospect of binding carbon targets anytime soon; modest voluntary targets in place
- **Australia:** Carbon tax set to take effect in July 2012 but remains highly controversial
- Alongside governments, a growing number of companies in the private sector are proactively implementing green energy programs

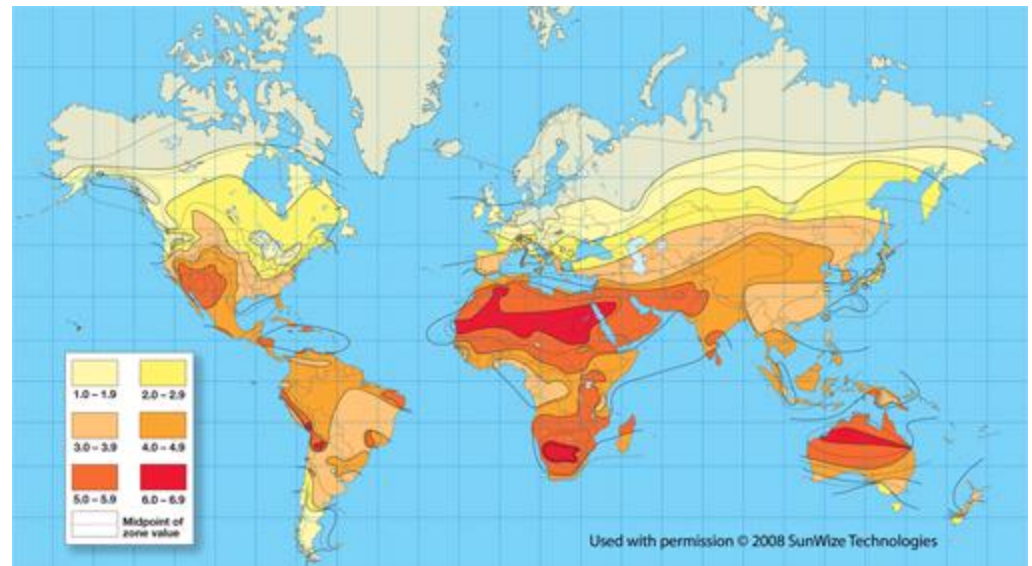
Overview of Solar Power

- The global photovoltaic (PV) industry is in the midst of a period of turbulence and requires significant rationalization
- While Europe has historically comprised the vast majority of global PV demand, these markets have been markedly slowing down, and growth is increasingly coming from the U.S., China and other geographies
- On the supply side, production capacity additions are set to continue to outpace global demand, particularly as Chinese manufacturers take market share from higher-cost European and U.S. competitors
- New entrants, particularly in thin film, are also creating competitive pressures for existing players

Installed PV Capacity in the OECD, 2011



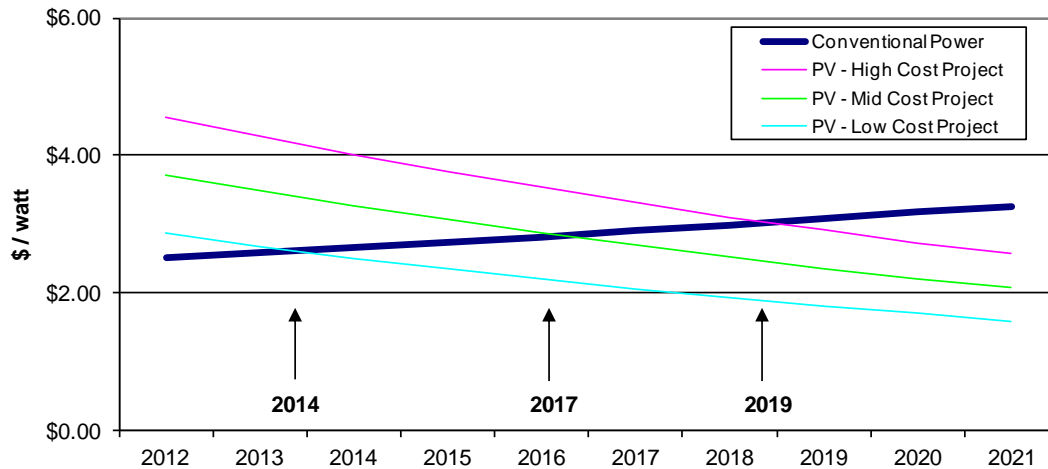
Source: IEA, RJ est.



Path Towards Grid Parity

- For PV to make a systematic penetration into the U.S. power market, installed system costs must drop from \$3.00-5.00/w to \$2.00-3.00/w
- “Grid parity” – cost-equivalence with conventional power, without subsidies – is achievable in about half of U.S. states by mid-decade
- Grid parity in markets with above-average power prices (such as Japan and Italy) should come earlier

Progression to Grid Parity for Crystalline Silicon PV in the U.S.



Source: RJ est.

(\$/watt)	2012		2016		
	c-Si	CdTe	c-Si	CdTe	CIGS
Module cost	\$0.81	\$0.69	\$0.65	\$0.50	\$0.51
Benchmark ASP	\$0.96	\$0.86	\$0.73	\$0.65	\$0.71
Commercial systems					
BoS cost	\$1.90	\$2.00	\$1.50	\$1.58	\$1.52
All-in system cost	\$2.86	\$2.86	\$2.23	\$2.23	\$2.23
Residential systems					
BoS cost	\$3.60	NM	\$2.80	NM	\$2.82
All-in system cost	\$4.56	NM	\$3.53	NM	\$3.53

Source: RJ est.

Variety of Supportive Policy Mechanisms, but with Risks

- By far the most effective policy supporting PV adoption is the feed-in tariff, which is most common in Europe but spreading to other regions
- Widespread FIT reductions in Europe have caused dislocation as developers and manufacturers adapt to the lower economics

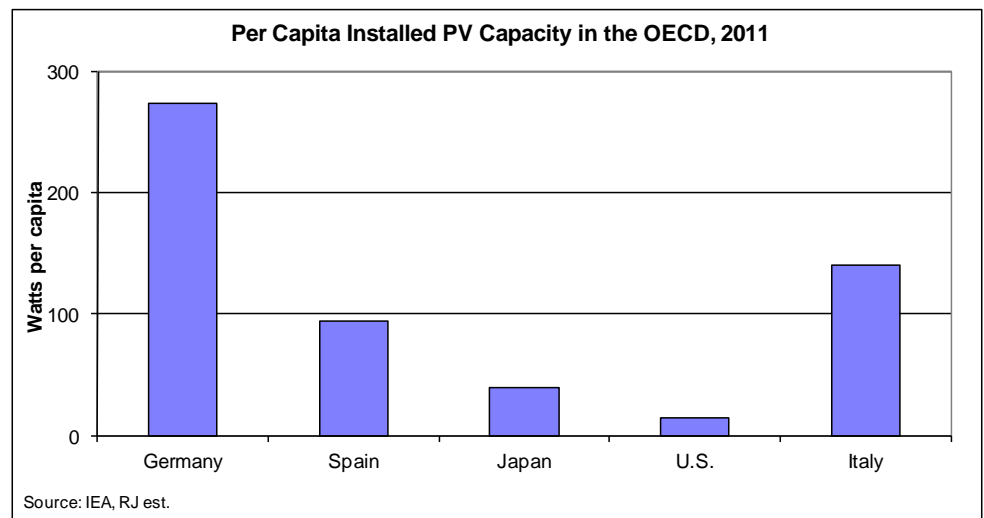
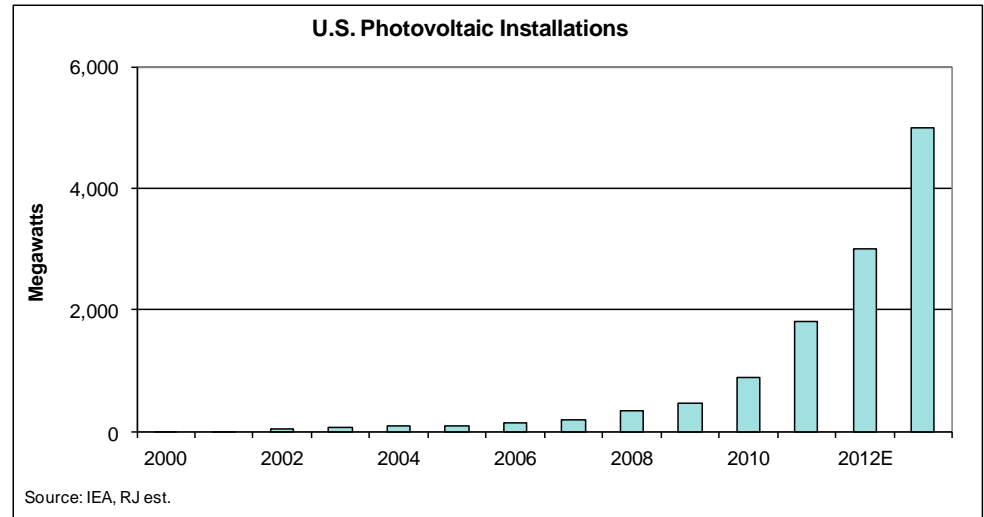
Demand Drivers in PV Markets			
	Sunlight Patterns	Power Prices	Pro-Solar Policies
Major PV Markets			
China	Various	Moderate	FIT / rebates / RPS
Germany	Below average	High	FIT / RPS
Italy	Attractive	Very high	FIT / RPS
Japan	Attractive	Very high	FIT / rebates / RPS
U.S.	Various	Moderate	FIT (state) / rebates / RPS (state)
Secondary PV Markets			
Australia	Highly attractive	Moderate	FIT (state) / rebates / RPS
Belgium	Below average	High	FIT / RPS
Canada	Average	Moderate	FIT (provincial) / RPS (provincial)
Czech Republic	Average	Moderate	FIT / RPS
France	Average	Moderate	FIT / RPS
Korea	Average	Moderate	FIT / RPS
Spain	Highly attractive	High	FIT / RPS
Early-Stage PV Markets			
Greece	Highly attractive	Moderate	FIT / RPS
India	Various	Moderate	FIT (state) / RPS (state)
Israel	Highly attractive	Moderate	FIT / RPS
Netherlands	Below average	High	FIT / RPS
Portugal	Highly attractive	High	FIT / RPS
South Africa	Highly attractive	Low	FIT / RPS
Switzerland	Average	Moderate	FIT / RPS
Turkey	Highly attractive	Moderate	FIT
United Kingdom	Below average	High	FIT / RPS

Source: EIA, Apricus Solar, RJ research

Note: FIT = Feed-in tariff; RPS = Renewable Portfolio (or Energy) Standard

U.S. Growth in PV

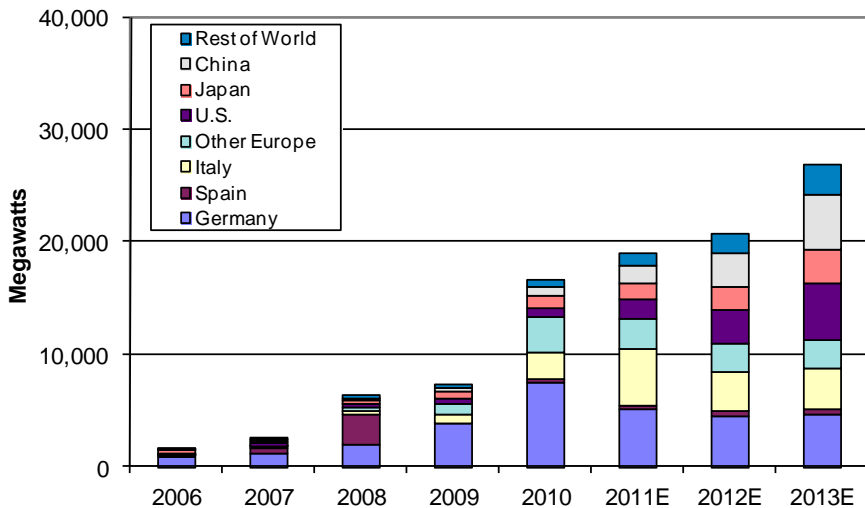
- U.S. PV installations have grown steadily, a combination of utility, commercial and residential demand
- Against the backdrop of constrained discretionary spending by consumers, utilities provide a highly visible source of PV demand, mainly due to compliance with RPS requirements
- Per capita PV capacity data shows that the U.S. has a long way to go if it is to “catch up” with Germany and Italy
- Improved incentives would certainly help, but PPAs and other financing options are also key demand drivers



International Growth in PV

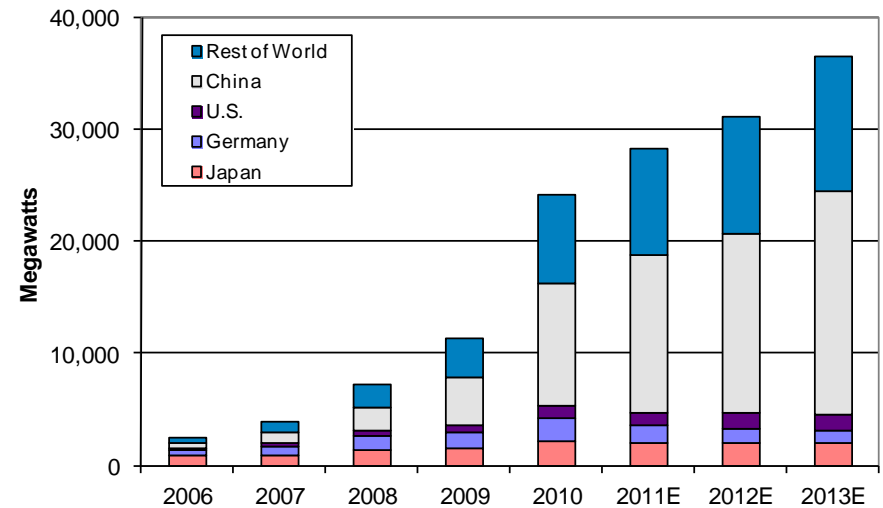
- While PV demand has been historically driven by a small number of key markets, the demand profile is becoming more geographically diverse over time
- The flip side is that rising demand is paralleled by expanding manufacturing capacity – with Chinese wafer/cell/module producers especially aggressive about taking market share
- Low barriers to entry + market fragmentation = a recipe for structural overcapacity across the value chain (and hence declining ASPs)

Global PV Demand



Source: EPIA, RJ est.

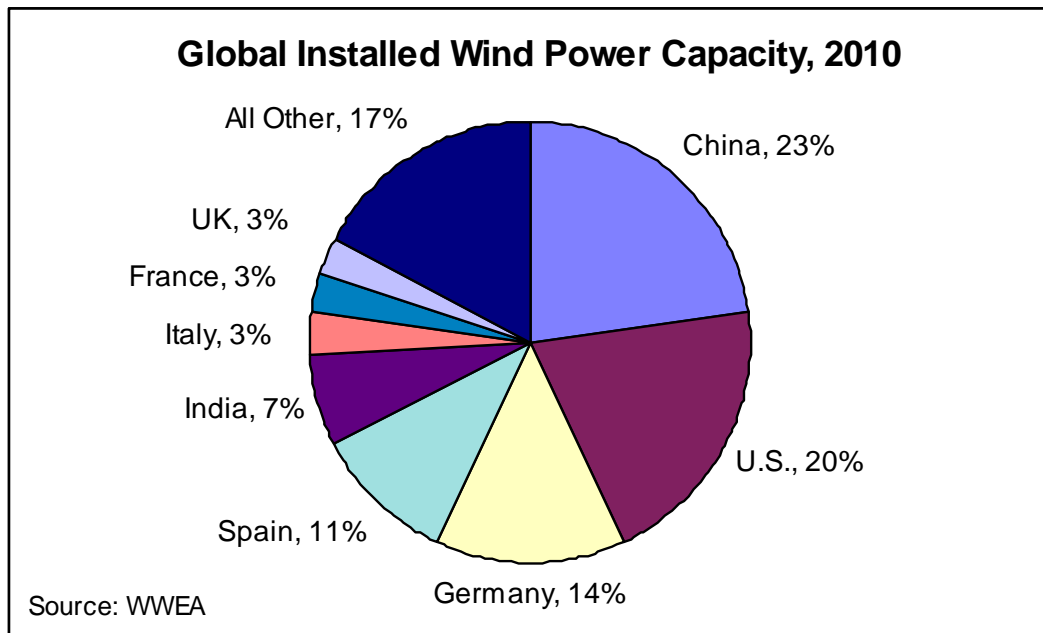
Global PV Supply



Source: Earth Policy Institute, RJ est.

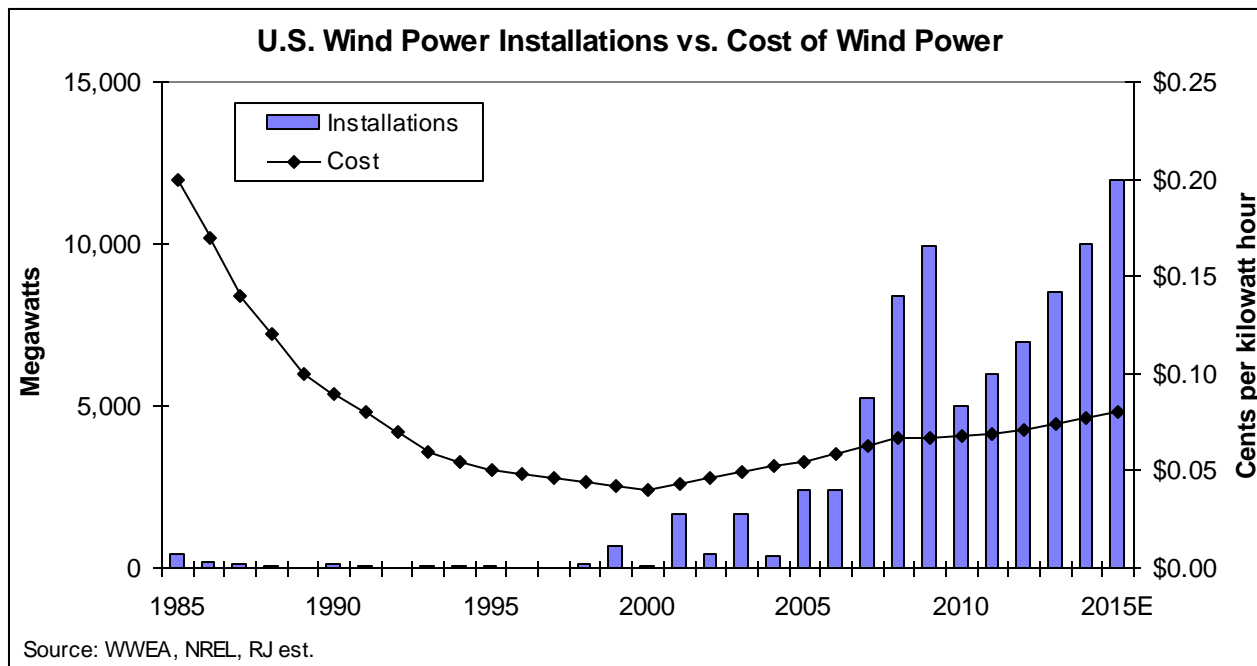
Overview of Wind Power

- Wind power has been on a rapid growth curve, but its market share within the overall power market remains small, which bodes well for continued growth
- Given the high scalability of wind farms, market share gains could be significant, though bottlenecks in the power grid would need to be addressed for wind to reach its full potential
- Similar to PV, commoditization of wind turbine manufacturing has led to declining ASPs and margin pressures along the value chain



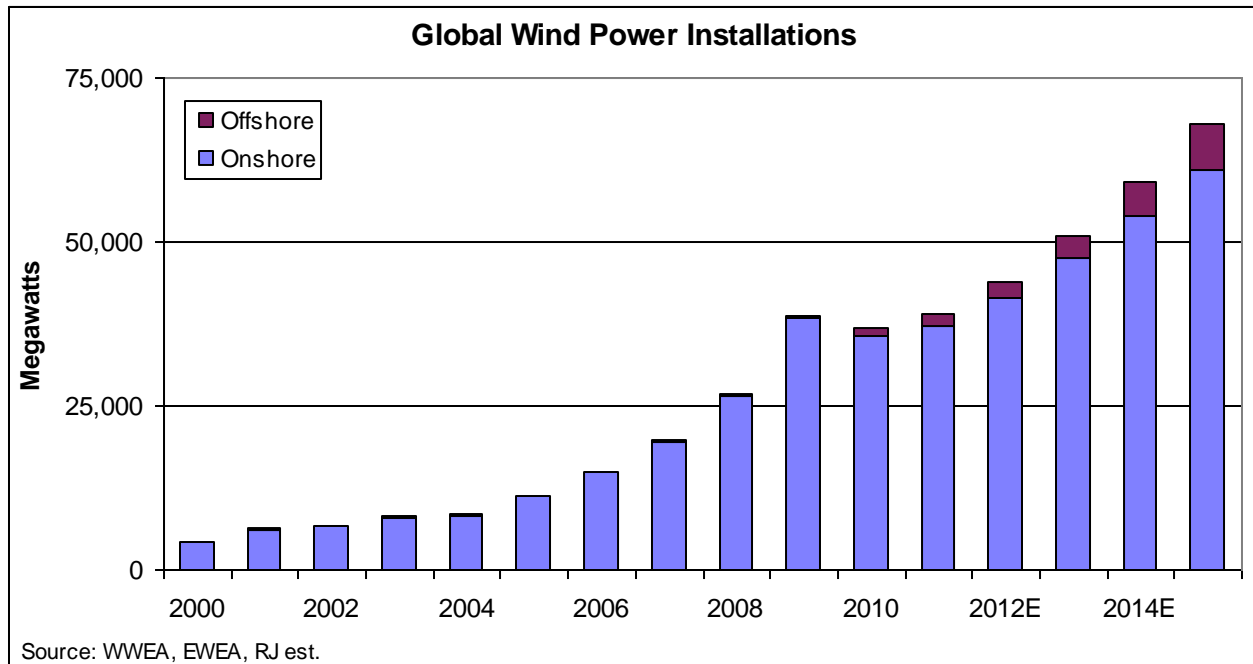
U.S. Growth in Wind

- The cost of wind power in the U.S. has decreased over 60% since the mid-1980s, reaching ~\$0.07/kWh currently (for onshore wind farms)
- These cost reductions have been driven primarily by more efficient engineering and rising turbine sizes
- However, depressed North American natural gas prices have diminished the competitive advantage of wind, leading to currently slow installations



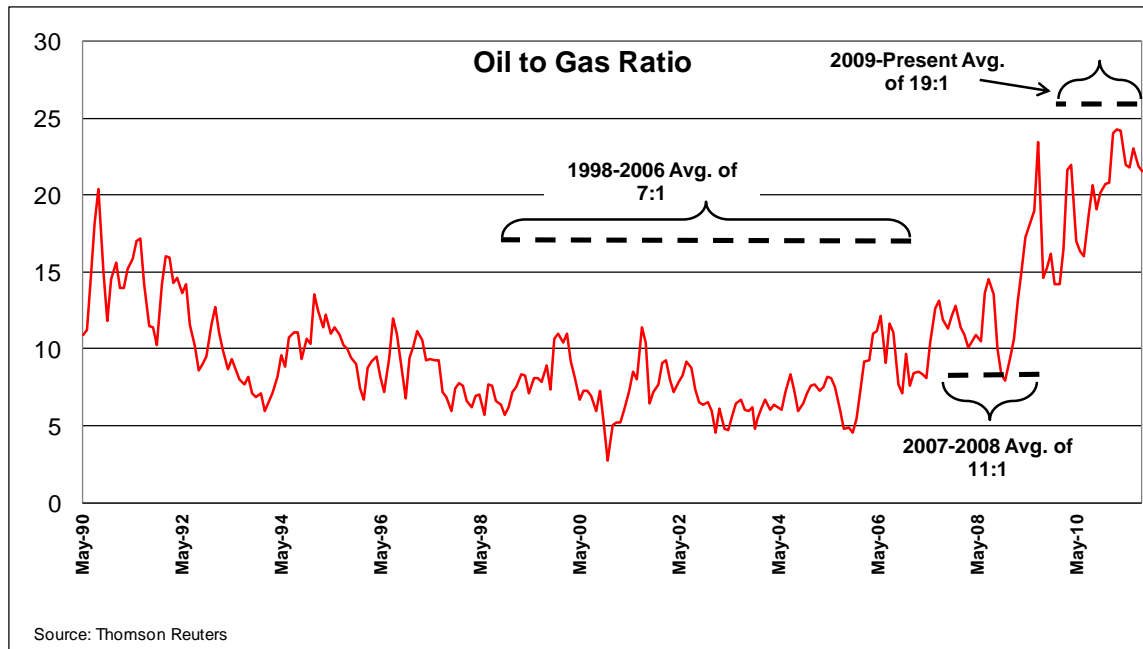
International Growth in Wind

- Internationally, major wind markets include China (the world's #1 wind market), India and the North Sea region
- While offshore wind remains a small component of the overall wind market, due to higher costs and inadequate grid infrastructure, its growth is well above average



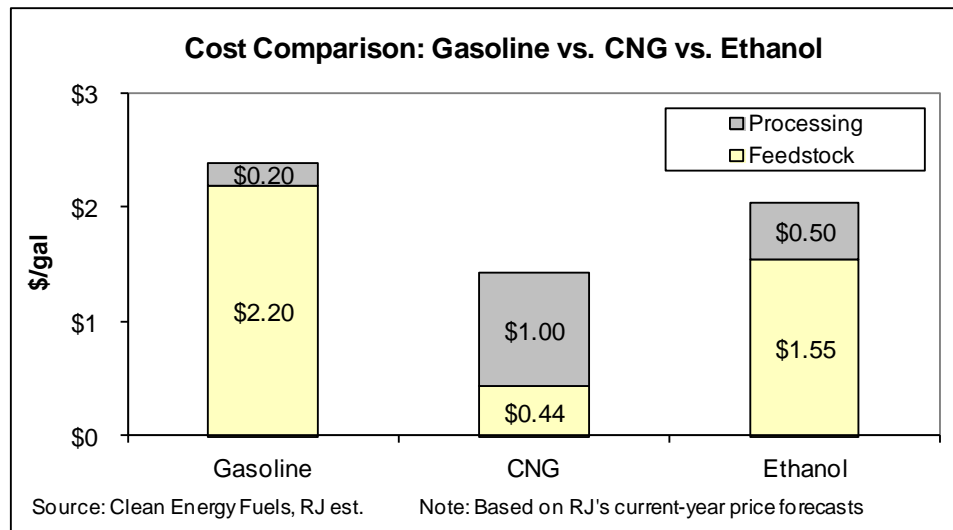
Overview of the U.S. Natural Gas Market

- Given the structural oversupply of natural gas in North America, domestic gas prices for the foreseeable future are set to remain far below the theoretical BTU parity of 6:1 vs. oil
- For 2012, our commodity forecast of \$92.50/Bbl WTI crude oil and \$3.50/Mcf gas implies a price ratio of 26:1
- These market conditions are optimal for natural gas fuels: compressed natural gas (CNG) and liquefied natural gas (LNG)



Economics of CNG/LNG

- The key “conversion formula” is that one Mcf of natural gas can yield eight gallons of CNG – thus, a \$3.50/Mcf gas price implies a feedstock cost of \$0.44/gal
- By comparison, \$92.50/Bbl oil equates to a feedstock cost of \$2.20/gal
- Although the processing costs of CNG are far higher than that of conventional refining, CNG still comes out ahead on an all-in basis
- In addition to the lower cost structure, CNG as compared to conventional fuel also offers (1) environmental benefits, i.e. reduced emissions; (2) higher octane; and (3) less noise for some vehicles



Natural Gas Vehicles

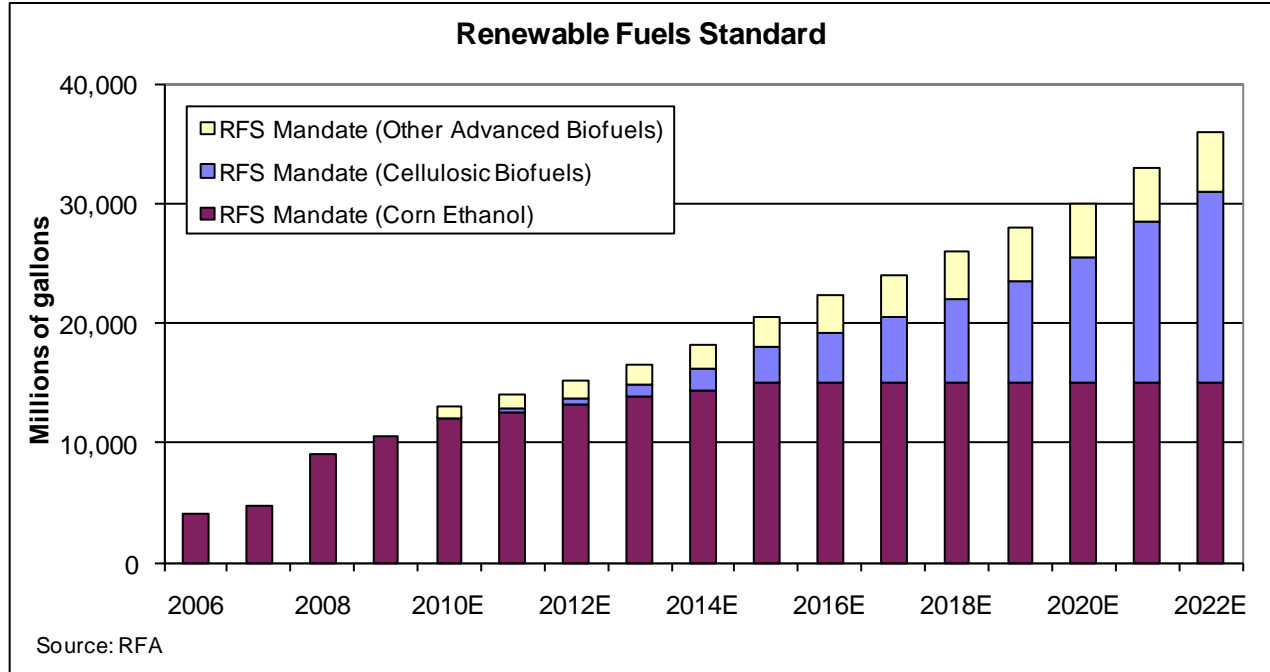
- **CNG:** A substitute for gasoline or diesel, CNG is generally used in light to medium-duty trucks, refuse trucks, transit buses, and (less commonly) passenger automobiles
- **LNG:** A substitute for diesel, LNG is generally used in trucks and other medium to heavy-duty vehicles
- The major downside to CNG/LNG is this: Existing vehicles must have their engines retrofitted to run on natural gas, and federal tax credits covering a portion of the incremental cost have expired
- Factory-made natural gas vehicles (NGVs) are available, but almost all are medium and heavy-duty
- Because CNG/LNG economics improve the more fuel a vehicle consumes, this is overwhelmingly a commercial/institutional market

Natural Gas Vehicle Economics					
	Transit bus		Light truck		
	50% credit	No credit	50% credit	No credit	
Incremental cost	\$35,000	\$35,000	\$15,000	\$15,000	
Less: Fed. tax credit	(\$17,500)		(\$7,500)		
Net cost	\$17,500	\$35,000	\$7,500	\$15,000	
Avg. gallons/year	16,500	16,500	4,000	4,000	
Est. savings per gal	\$1.15	\$1.15	\$1.15	\$1.15	
Est. savings/year	\$18,944	\$18,944	\$4,592	\$4,592	
Payback (years)	0.9	1.8	1.6	3.3	

Source: Clean Energy Fuels, RJ est.

Overview of Biofuels

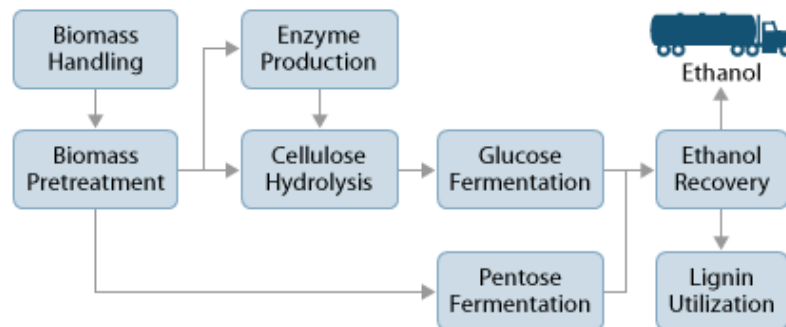
- Biofuels can be divided into two broad categories:
 - **Conventional biofuels:** Corn ethanol, sugarcane ethanol, soybean oil-based biodiesel
 - **Next-generation biofuels:** Cellulosic ethanol, renewable diesel, biobutanol, biocrude, biojet
- The federal Renewable Fuels Standard (RFS) requires annual increases in biofuels consumption through 2022, and the vast majority of the growth must come from biofuels other than corn ethanol



Cellulosic Biofuels: An Early-Stage but Promising Concept

- Corn ethanol's central economic flaw is the systemic challenge of managing the crush spread between ethanol (an energy commodity linked to gasoline) and corn (an agricultural commodity)
- Cellulosic ethanol and other cellulosic biofuels address this problem: Because they use non-food feedstocks such as wood chips, switchgrass or municipal waste – materials with minimal intrinsic value – costs are immune from volatility in agricultural prices
- Cellulosic biofuels can be produced via either a biochemical process (fermentation) or a thermochemical process – both have their own advantages and risks

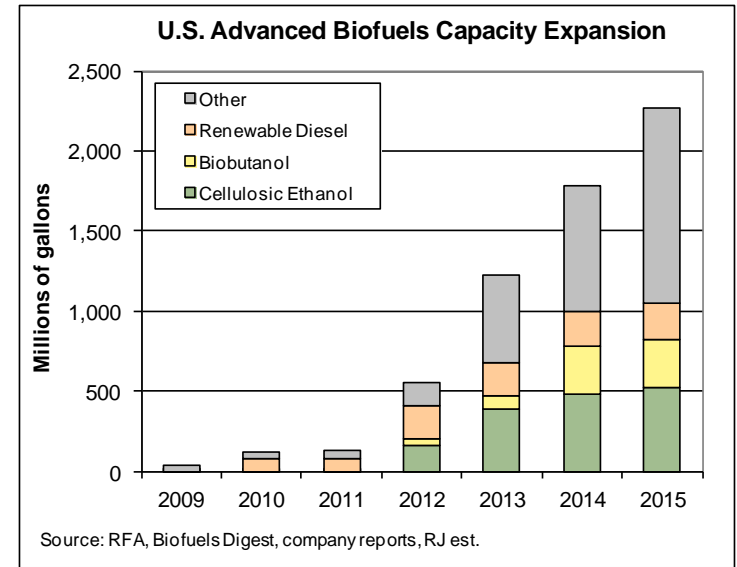
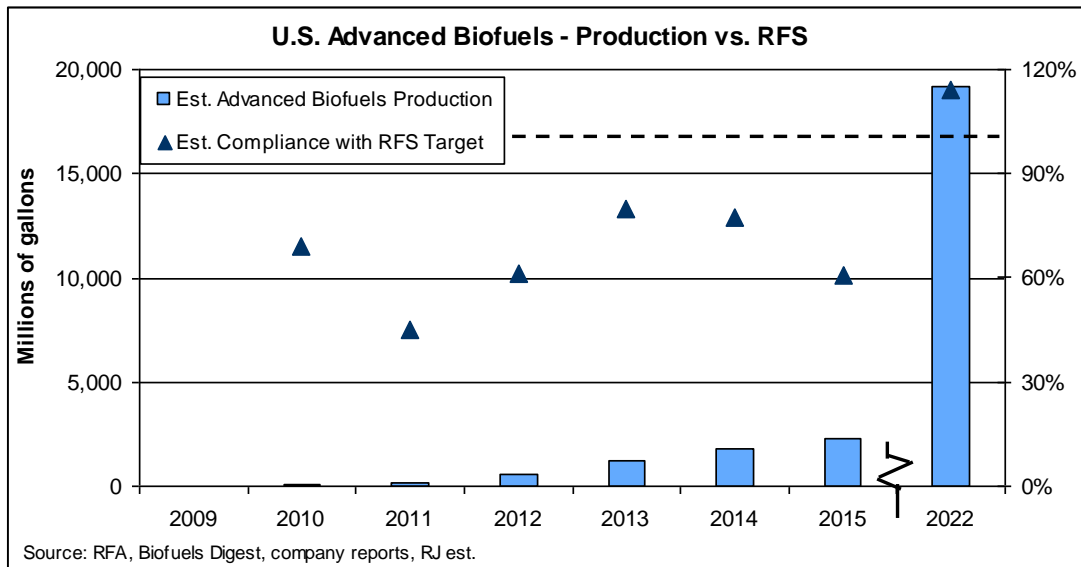
Schematic of a Biochemical Cellulosic Ethanol Production Process



Source: DOE

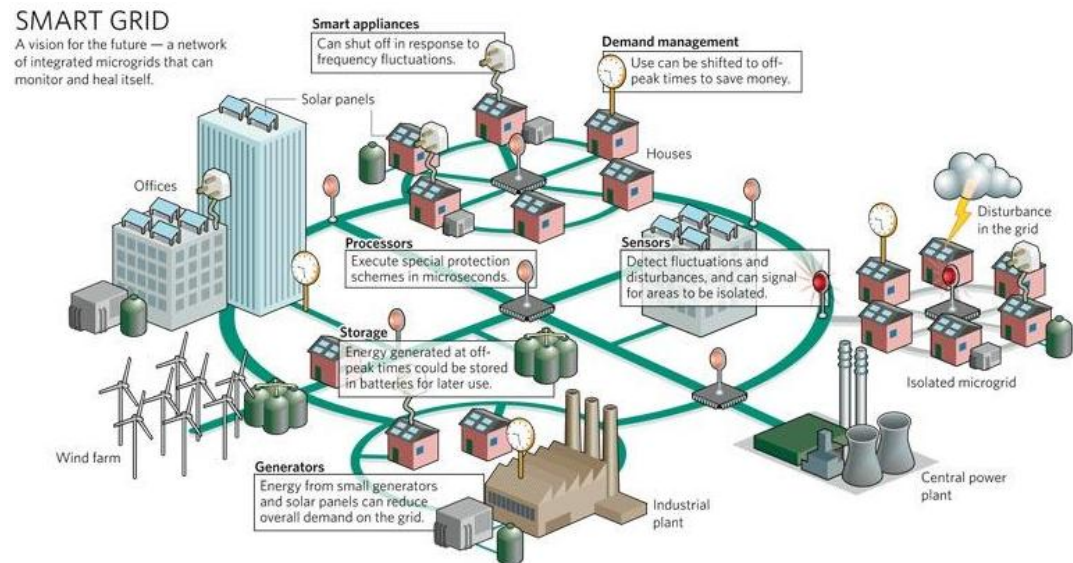
Can the Advanced Biofuel Targets of the RFS Be Met?

- Based on the current ramp-up of U.S. production capacity for advanced biofuels, we project that it will be 2016 at the earliest before the industry can meet the RFS mandate
- In fact, these figures are an overstatement, because many advanced biofuel developers are focused on selling into the chemicals arena due to superior pricing
- To comply with the RFS, additional volumes will presumably need to come via imports, mainly from Brazil



Overview of the Smart Grid

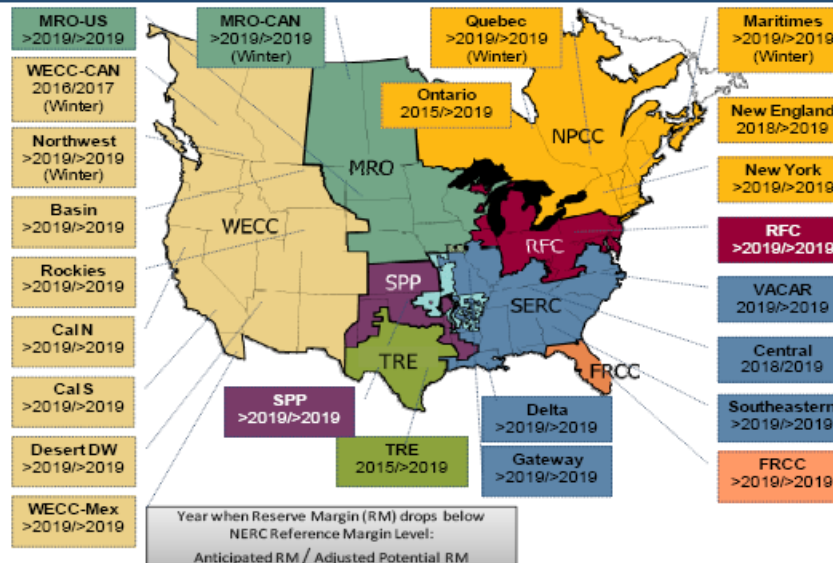
- The traditional power grid has structural flaws – lack of storage, geographic constraints, and minimal monitoring and control – that diminish stability and increase the frequency of blackouts
- The smart grid – an overarching framework that leverages modern communication architecture – can make the grid more efficient, stable and economical in the long run
- The value chain comprises a wide range of products and services
 - Advanced metering infrastructure
 - Networking equipment and software
 - In-home/business monitoring
 - Smart appliances
 - Electric vehicle integration
 - Demand response



The Rationale for Demand Response

- Due to tight transmission capacity and supply/demand balance, the power grid faces widespread choke points and low reserve margins
- Historically, the only proactive solution was to increase supply-side capacity – in fact, about 10% of grid infrastructure is typically built to meet peaks in demand that occur less than 1% of the time
- Demand response provides an alternative solution that enables power usage to be temporarily curtailed in times of peak demand in order to balance the market, thereby avoiding blackouts

Figure 2: Anticipated and Adjusted Potential Reserve Margins Compared to the NERC Reference Margin Level



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