AEE INSTITUTE

# COMPETITIVENESS OF RENEWABLE ENERGY AND ENERGY EFFICIENCY IN U.S. MARKETS

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This report was prepared by the Advanced Energy Economy Institute with assistance from Sarah Hill of S.E. Hill & Associates.

# ABOUT AEE INSTITUTE

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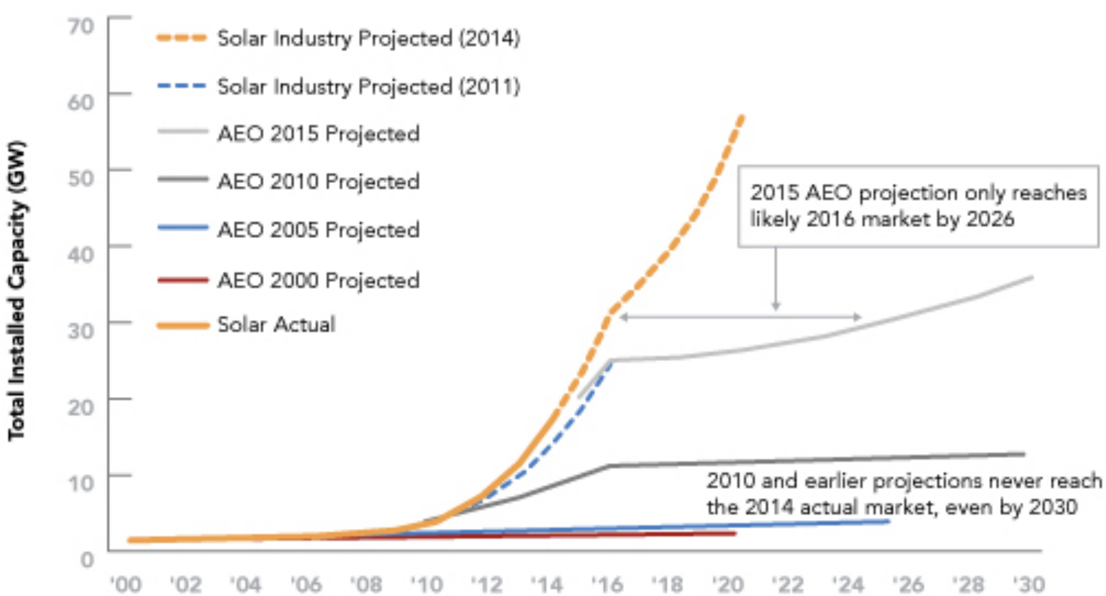
# EXECUTIVE SUMMARY

Questions have been raised about whether renewable energy (RE) and energy efficiency (EE) resources can provide substantial emission reductions at reasonable cost under EPA's proposed Clean Power Plan (CPP). These concerns reflect fundamental misperceptions about the performance and cost of today's renewable energy and energy efficiency technologies, rooted in outdated information and perpetuated by inaccurate official market projections. This paper shows that RE and EE are competitive resources in today's marketplace that will not only be cost-effective mechanisms for CPP compliance but should also be expected to grow strictly on the basis of competitiveness.

## EIA Forecasts Consistently Underestimate RE and EE Compared to Market Realities

Official U.S. government energy forecasts are widely used by policymakers and other stakeholders for analyzing energy supply and demand for long-term planning and policy development purposes. But the RE projections bear little resemblance to market realities. The U.S. Energy Information Administration's *Annual Energy Outlook* (AEO), the primary source of information on U.S. power market projections, consistently and significantly underestimates RE growth. For example, the installed generating capacity of solar power is likely to double between 2014 and 2016, based on market analyses that take into account actual projects in the pipeline. Yet in the AEO 2015 forecast, solar capacity does not double until 2026. Similarly, U.S. wind installations have averaged about 6.5 GW per year from 2007 to 2014, but the 2015 AEO projects a total of 6.5 GW of new wind capacity will be added between 2017 and 2030, less than one-tenth the average rate in recent years.

**Figure A. Actual vs. Projected U.S. Installed Solar Power Capacity**




Sources: *Solar Actual* data are from Interstate Renewable Energy Council, and SEIA/Greentech Media, and include PV and CSP. *Solar Industry Projected* are SEIA/GTM projections from 2011 and 2015 Solar Market Insight (SMI) Reports, and include PV and CSP. Solar actual and industry data were converted from DC to AC using a factor of 0.77 for utility-scale and 0.87 for residential and commercial. *AEO Projected* data are for the EIA Reference Case.

This underestimation of RE growth is nothing new. AEO 2010 projected that the solar market would grow from about 2.5 GW in 2010 to about 13 GW in 2030, yet the solar market surpassed this level in 2014. Similarly, AEO

2010 projected that the wind market would grow from about 40 GW in 2010 to 69 GW by 2030, but with 8-10 GW of new wind power expected in 2015, installed capacity will reach about 75 GW by year's end. As these examples show, AEO forecasts are consistently off by a wide margin, always underestimating – and never overestimating – future deployment of renewables. Such persistent inaccuracy is indicative of a more fundamental problem in understanding the dynamics of growth for these technologies, as well as constraints on how the EIA is required to conduct its modeling.

Comparing market realities to projections for energy efficiency is more challenging. To quantify EE, you need to measure something that was avoided, namely the energy that would have been used absent the energy efficiency measures. Still, official projections are inconsistent with trends in EE implementation and the impact of efficiency improvements on electricity consumption. The trend in overall electric demand growth has been consistently downward in recent years, in parallel with the rise in EE spending, which more than tripled from 2005 to 2013. Retail electricity sales have also been flat to slightly declining since 2010, even as the economic recovery gained momentum and the U.S. economy grew about 9% in real terms from 2010 to 2014. Yet the AEO 2015 projection shows future demand growth steady at a little less than 1% per year out to 2040, apparently discounting the potential, or likelihood, that EE improvement – through investment and innovation – would continue to reduce demand growth in the coming years.

## Renewable Energy is Increasingly Cost Competitive with Other Power Sources

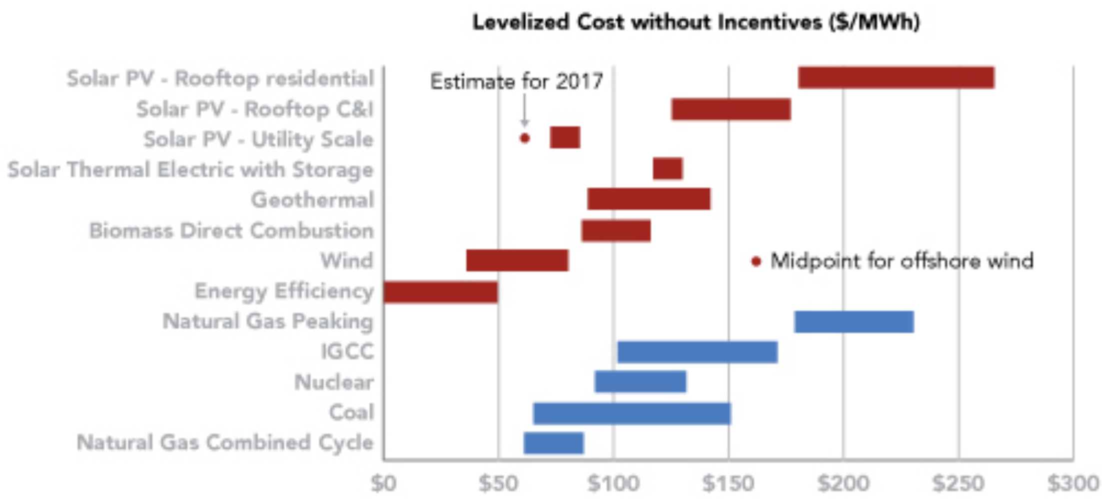
There is every reason to believe that renewable energy will continue to grow in the United States based on economic competitiveness. The most basic indicator of power technology competitiveness is the levelized cost of energy (LCOE), which measures the average cost of electricity over the life of a project, including the costs of upfront capital, operations and maintenance, fuel, and financing. Since 2007, Lazard, a financial advisory and asset management firm, has tracked the LCOE of power technologies using a consistent methodology. Lazard's annual analyses show that from 2009 to 2014, the LCOE for utility-scale wind and solar power has declined by 58% and 78%, respectively, such that RE technologies are increasingly competitive with other power sources.

Market data in the form of power purchase agreement (PPA) prices confirm these LCOE estimates, with wind projects offering competitive PPA prices relative to wholesale prices for most of the past decade. In 2013, the average wind power PPA price was \$24/MWh. Similarly, solar PPAs, which provide utilities with peaking power, have declined from \$125-\$150/MWh in 2008 to current levels of \$50-\$75/MWh, driven in part by a 40% drop in the installed cost of utility-scale PV systems over five years, from \$5/$W_{DC}$ in 2008 to \$3/$W_{DC}$ in 2013. Today, the best-in-class utility-scale solar projects are being installed for about \$1.50/$W_{DC}$, which is about half the cost assumed by the EIA in its AEO 2015 for a 2016 year-in-service date. Hydropower, geothermal and biomass technologies are also competitive in some parts of the country. Although their markets are smaller than solar or wind, capacity continues to be added at a rate of several hundred megawatts per year among them.

Utility RE purchases that were once driven primarily by state policies (e.g., renewable portfolio standards) are now increasingly made based on economics. In Texas, Austin Energy signed a 20-year contract in 2014 for 150 MW of solar energy at a price estimated at less than \$50/MWh. In 2013, American Electric Power (AEP) bought three times more wind power in Oklahoma than it originally intended because of its value to ratepayers. None of this is lost on corporate America, which is directly purchasing a growing share of RE. In 2014, more than 23% of wind power contracts were with large corporate or non-utility groups.

The market for residential and commercial building PV systems, usually installed on rooftops, is also expanding in response to declining costs, rising retail electricity rates, new financing options, and increased customer demand for choice and control over energy use and costs. Prices for residential and small commercial PV systems dropped by almost 60% between 2002 and 2013, with most of that occurring since 2009. As the solar supply chain achieves scale (about 2 GW of distributed PV was installed in the United States in 2014), the industry is driving down so-called "soft costs" such as permitting, customer acquisition, and installation.

**Figure B: Levelized Cost of Energy (LCOE), All Sources, 2014**




Source: *Lazard's Levelized Cost of Energy Analysis—Version 8.0.* "C&I" = Commercial & Industrial; "IGCC" = Integrated Gasification Combined Cycle. High end of range for *IGCC* and *Coal* includes 90% carbon capture and compression. See original report for additional assumptions.

## Energy Efficiency Costs Less than Electric Supply

This report shows that EE is even more competitive. Indeed, in most cases, it is the least-cost option for meeting electricity needs. As a result, EE investment should continue to grow and have a downward impact on electricity load growth beyond official projections, based on its economic value. There are two main ways in which EE is delivered today, each representing about half of the U.S. market: utility-run programs and performance-based contracting offered by Energy Service Companies (ESCOs). Both markets have exhibited strong growth over the last decade, with the ESCO market driven principally based on the value (i.e., cost reduction) of saved energy in the marketplace. ESCOs, which typically serve institutional, government, and larger commercial/industrial customers, use a financing model where energy savings pay for EE investments over time – by definition, therefore, these projects must be cost effective if they are to generate the necessary cash flow to make the project financially viable. The ESCO market grew from about $2.5 billion in 2005 to about $6 billion in 2013, and is projected to reach $11-$15 billion by 2020.

At the same time, utility-run EE programs continue to demonstrate cost effectiveness and value to utility ratepayers. Lawrence Berkeley National Laboratory estimates the U.S. average "total cost of saved energy" for customer-funded utility EE programs at $46/MWh, based on an analysis of programs in 20 states over a five-year period. This is less than half the average cost of retail power in the United States and lower than the levelized cost of new supply options, with the possible exception of wind power in some markets. The total cost of saved energy varies by state, ranging from a low of $29/MWh in New Mexico to $79/MWh in Massachusetts, but is consistently less expensive than retail electric supply in the local market.

Utility programs effectively split the cost of EE between utilities and program participants, providing economic benefits for both. The utility cost of providing EE programs is significantly less than the cost of acquiring new generation, whereas participants see immediate reductions in their monthly utility bills. On a system level, since the total cost of EE is below the LCOE of new supply options, its implementation also lowers the total cost of providing electricity to all customers, thereby benefitting EE program participants and non-participants alike.

Over time, EE investments can avoid or defer other investments in utility infrastructure, thereby increasing the net benefits.

The basic framework under which EE is delivered via utility-sponsored programs ensures that only cost-effective EE is pursued: utility-run EE programs cannot be implemented unless they have a benefit-to-cost ratio greater than one. Simply put, if customer-funded utility programs are not cost-effective, state utility commissions will not authorize their funding. States that are leading on EE are consistently demonstrating the ability to achieve 2% or more annual EE savings while still meeting cost-effectiveness criteria.

## RE and EE Will Play an Increasing Role Based on Economic Value

The electric power industry has entered a period of fundamental change. Underpinning this change is the emergence of RE and EE as competitive options for meeting system and customer needs at scale. Along with other advanced energy technologies, including flexible and efficient natural gas generation and increasingly intelligent hardware and software for the grid, RE and EE are transforming the way electricity is generated and used. Recent cost analyses and market data show that this transformation is well under way and that RE and EE technologies are cost competitive and offer compelling value propositions to a range of stakeholders.

RE already represents roughly 50% of all new capacity additions in the United States, and is likely to exceed this figure for 2015. At the same time, EE markets have more than tripled in size since 2005. Continuous technological improvements coupled with product and service innovation create ongoing opportunities to increase deployment and reduce costs, even while many states have barely scratched the surface with respect to EE and RE potential. We expect RE and EE technologies to be an important part of grid modernization efforts as well. RE and EE will become increasingly important tools for mitigating rate increases associated with replacing older "poles and wires," or from investments in resilience. Thus there is every reason to believe that RE and EE will continue to play an increasing role in our changing electric power system strictly on the basis of the economic value they provide. In addition, as states consider ways to comply with EPA's Clean Power Plan between now and 2030, RE and EE measures will be competitive with other options and available to provide substantial emission reduction opportunities.[1]

[1] In May 2015, the EIA released it first analysis of the CPP: Analysis of the Impacts of the Clean Power Plan. Their main conclusions support the findings in this paper, that RE and EE are the main options for achieving compliance, although EE still appears underrepresented by the EIA relative to other options. Their analysis also shows very modest electricity price impacts of 3%-4% in 2030, relative to the no CPP scenario.

# 1.0 Introduction

Once finalized, the U.S. EPA's Clean Power Plan (CPP)[2] will establish targets for each state to reduce the amount of carbon emissions from electricity generation, with the goal of lowering national power sector carbon emissions 30% by 2030, relative to 2005. EPA's CPP proposal, which was released in June 2014, laid out state-specific emissions reduction targets based on EPA's assessment of each state's potential to: 1) improve the performance of existing coal plants, 2) displace higher-emitting technologies with existing natural gas combined cycle units, 3) increase the use of zero-emission resources, such as nuclear, solar, wind, and other renewable technologies, and 4) expand energy efficiency to reduce the emissions associated with the generation that would be needed to meet higher demand. Under the proposal, states have broad flexibility in how they meet their targets, including the use of the resources listed above, the use of other emission reduction options not listed, and working with other states in multi-state approaches.

When EPA announced its state targets, some stakeholders[3] voiced concern about the competitiveness of renewable energy (RE) and energy efficiency (EE) in the marketplace and therefore the ability of states to use them for achieving substantial emission reductions. However, these concerns do not take into account the considerable advances in performance, innovation, and cost reduction of the past five years, as a result of which RE and EE technologies and services now compete directly with other energy resources on a scale previously believed impossible. The doubts raised in the CPP conversation clearly indicate that fundamental misperceptions remain about performance and cost of RE and EE resources, rooted in outdated information. This paper highlights a few of these misperceptions and provides information demonstrating that RE and EE technologies are in fact competitive in today's marketplace and are likely to continue to be a leading part of a broad mix of technologies for meeting future electricity needs, regardless of federal policy.

# 2.0 Market Realities vs. Projections

Energy technology and market forecasting is a difficult task. Forecasters use complex economic models to try to understand how technologies, policies, energy prices and macroeconomic trends interact to drive investment in new electric generating capacity and end-use technologies. The job of forecasting is made even more challenging by the dynamic nature of the electricity industry today, including rapidly falling RE costs and improving performance, rapidly rising EE deployment, and more generally, the regulatory and business model changes taking place in the utility industry. Given this, it is important to understand how well widely used energy system forecast models perform when trying to predict the future of the market.

In particular, policymakers and other groups, such as the EPA and the North American Electric Reliability Corp. (NERC), rely on the assumptions and projections of the U.S. Energy Information Administration (EIA) for their own analyses and decision-making. Whether the EIA projections are "right" or "wrong" is not the question. They are projections, after all, and cannot be expected to match exactly what happens in reality. The more relevant question is whether or not the projections are accurate enough to provide useful insights to aid decision-making and policy development, or are inaccurate in ways that distort policy considerations. While the

[2] In June 2014, EPA issued a proposed rule under the Clean Air Act Section 111(d), to regulate $CO_2$ emissions from existing power plants. Final rules for existing, new, modified, and reconstructed power plants are due out in mid 2015.
[3] For example, see, In Their Own Words: A Guide to States' Concerns Regarding The Environmental Protection Agency's Proposed Greenhouse Gas Regulations for Existing Power Plants, U.S. Chamber of Commerce, Institute for 21st Century Energy.

EIA does an excellent job of tracking industry data and making these data readily available, EIA's flagship projection – the *Annual Energy Outlook* (AEO) – does a poor job of forecasting renewable energy and energy efficiency market growth, leading to misperceptions of the reality and potential of these resources in the energy marketplace.

## 2.1 Renewable Energy

Data from the last several years shows that new power generation capacity additions comprise a mix of roughly 50:50 renewable energy and other technologies (see Figure 1). The Federal Energy Regulatory Commission (FERC) provides reports of annual capacity additions that show RE technologies, including a mix of hydro, wind, biomass, geothermal, and solar, have provided roughly half of all new capacity additions for the past three years (52% in 2012, 43% in 2013, and 50% in 2014).[4] Since FERC data does not track projects under one MW in size, this actually understates the RE contribution, underestimating solar contributions by roughly one third and excluding other small installations, such as some landfill gas, distributed wind, and small hydropower projects. Nevertheless, the trends evident in the FERC data are expected to continue into 2015, with the EIA estimating that, based on information reported by generators (not model projections), capacity additions will again be dominated by RE technologies, including an estimated 9.8 GW of wind, 2.2 GW of solar, and about 0.5 GW of other renewables. Other expected capacity additions for 2015 include 4.3 GW of natural gas and 1.1 GW of nuclear.[5] As with the FERC data, here, too, the solar estimate is significantly underestimated. Greentech Media and the Solar Energy Industries Association (GTM/SEIA) provide projections for solar capacity additions that have proven far more accurate than the EIA's (see below). They estimate that solar additions will be significantly higher, with 6.6 $GW_{AC}$ expected for 2015 and another 10 $GW_{AC}$ in 2016, dominated by planned utility-scale projects (11.5 $GW_{AC}$). If this projection is realized, as seems likely, it will result in a doubling of U.S. total installed solar capacity in just two years.[6]

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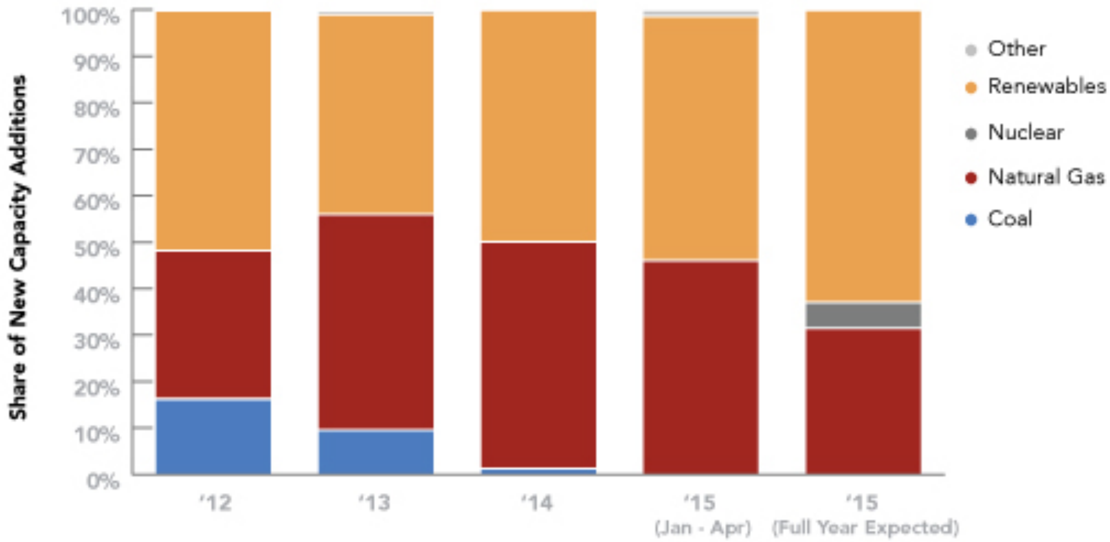
[4] 2012 new generation in service: http://www.ferc.gov/legal/staff-reports/2013/dec-energy-infrastructure.pdf, 2013 new generation in service: http://www.ferc.gov/legal/staff-reports/2014/dec-infrastructure.pdf

[5] EIA scheduled 2015 capacity additions, March 2015. Data exclude small-scale PV systems. http://www.eia.gov/todayinenergy/detail.cfm?id=20292

[6] GTM Research and SEIA. *Solar Industry Data.* http://www.seia.org/research-resources/solar-industry-data. PV data is reported based on the direct current rating of the systems. These have been converted from DC to AC power using an estimated average conversion factor of 0.82.

**Figure 1: Mix of New Capacity Additions, 2012-2015 (new build plus expansions)**




Source: Historical data are from FERC's Energy Infrastructure Updates as follows: 2012: http://www.ferc.gov/legal/staff-reports/2013/dec-energy-infrastructure.pdf; 2013 and 2014: http://www.ferc.gov/legal/staff-reports/2014/dec-infrastructure.pdf; 2015 year to date: http://www.ferc.gov/legal/staff-reports/2015/apr-energy-infrastructure.pdf; 2015 full year expected additions are from the EIA's "Scheduled 2015 capacity additions mostly wind and natural gas; retirements mostly coal", March 10, 2015 (http://www.eia.gov/todayinenergy/detail.cfm?id=20292).
Note: data exclude small projects (under 1 MW) and so underrepresent RE contributions, especially solar.

U.S. transmission interconnection queues provide another indicator of market activity, and these also show a large pipeline of RE projects. In 2013, 42 GW of natural gas capacity and 33 GW of combined wind and solar power entered the queue, in addition to 93 GW of wind already waiting in the queue.[7] While not all of these projects will ultimately be built, leveraging this substantial wind potential depends in part on increased transmission capacity, which has remained a barrier to accessing the most attractive sites. However, 3,500 miles of new transmission lines were built in 2013, and 15 near-term projects have been identified that could bring 60 GW of wind capacity online if completed.[8]

Despite these current market trends and the price competitiveness of RE technologies in today's marketplace (see Section 3.1 below), the AEO consistently and significantly underestimates RE capacity growth. To illustrate this we focus below on solar and wind power – two technologies with widespread application that have experienced significant growth in the last decade and that represent the bulk of new RE capacity additions.

### 2.1.1 Solar Power

The disparity between several AEO forecasts, including the most recent, and actual solar installed capacity is shown in Figure 2 The AEO 2000 and 2005 solar projections remained close to zero indefinitely, based on the assumption that solar costs would remain high compared to other resources. In these projections, the AEO failed to anticipate the substantial growth that began in 2006. The AEO 2010 initially projected growth at the rate established from 2005 to 2010 – which we can now see was far below the growth that actually occurred after 2010. Then the forecast for new capacity additions fell to near zero with the scheduled reduction of the investment tax credit (ITC) for commercial solar (utility and third-party owned installations) from 30% to 10% (and to zero for residential installations) at the end of 2016. The AEO 2015 forecast exhibits the same pattern, initially extrapolating based on the most recent trend and then dropping precipitously post-ITC change. Thus, even in this most recent forecast the EIA does not capture the impact of rapidly falling costs and other drivers of

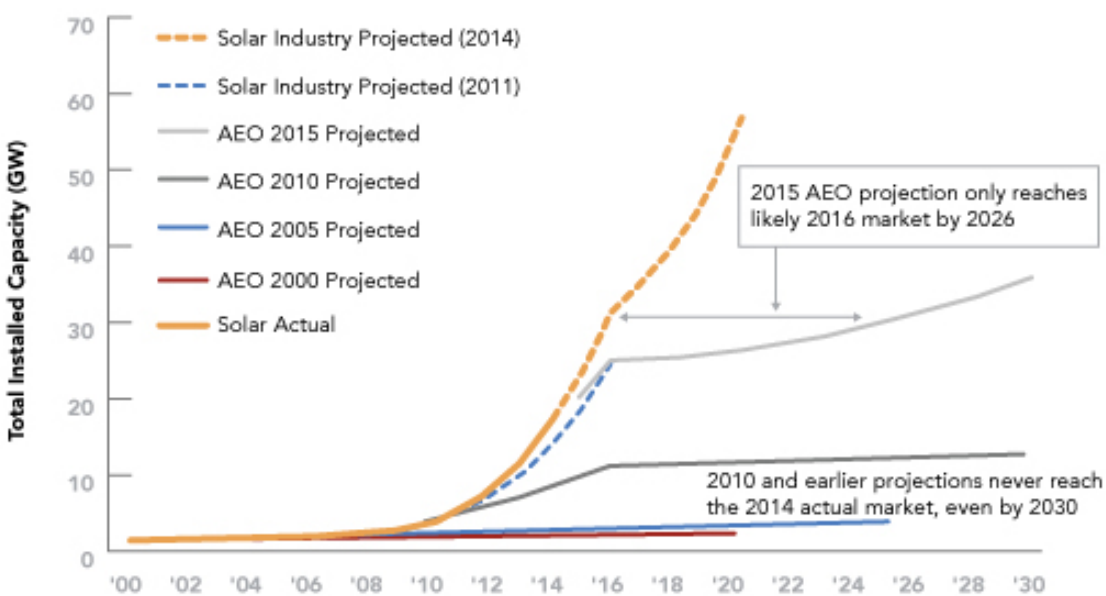
[7] LBNL, Wind Technologies Market Report, August 2014, p.v.
[8] Ibid, p.x.

solar demand. The AEO 2015 assumes utility-scale solar PV installation costs of $3.28/$W_{AC}$ (~$2.70/$W_{DC}$) in 2016.[9] By comparison, Lazard assumes a capital cost for utility-scale PV plants of $1.50-$1.75/$W_{DC}$ for 2014, falling to $1.25/$W_{DC}$ by 2017, and GTM/SEIA reports that in Q4 2014, prices were about $1.75/$W_{DC}$.[10] The Electric Reliability Council of Texas (ERCOT) used similar capital cost figures in its recent report on system planning, using a range of $1.70-$2.40/$W_{AC}$ (~$1.40-$1.97/$W_{DC}$) for the year 2018.[11]

As a result of overstating the cost of solar PV, annual solar capacity additions in the AEO 2015 are projected to never recover to levels anywhere close to actual solar installations in 2014. Even as far out as 2040 (not shown in Figure 2) the EIA projects the solar market growing by just 2.5 GW in that year in its Reference Case, and 5.7 GW per year in a high economic growth case.

These projections stand in sharp contrast to current market realities and near-term industry projections, which have proved far more accurate (e.g., see the dark purple dotted line in Figure 2). In 2014, total solar power capacity added was approximately 6.5 $GW_{AC}$, and the industry projection for the next two years alone shows 20 $GW_{DC}$ (about 16 $GW_{AC}$) being added, something that does not take place until 2026 in the AEO 2015 projection. In fact, even industry forecasts of solar capacity additions have tended to underestimate actual growth, but to a much lesser extent than the AEO.

**Figure 2. Actual vs. Projected U.S. Installed Solar Power Capacity**




Sources: *Solar Actual* data are from Interstate Renewable Energy Council, and SEIA/Greentech Media, and include PV and CSP. *Solar Industry Projected* are SEIA/GTM projections from 2011 and 2015 Solar Market Insight (SMI) Reports, and include PV and CSP. Solar actual and industry data were converted from DC to AC using a factor of 0.77 for utility-scale and 0.87 for residential and commercial. *AEO Projected* data are for the EIA Reference Case.

The expectation for such dramatic near-term growth is driven, in part, by the scheduled reduction in the ITC – not surprisingly, developers and others are rushing to complete projects to take advantage of the ITC. This is a rational business decision, but it does not follow that there would be virtually no solar deployment after the ITC is scaled back. The 2014 Solar Market Insight report projects a decline in new installations in 2017, but does not show the market stopped in its tracks.

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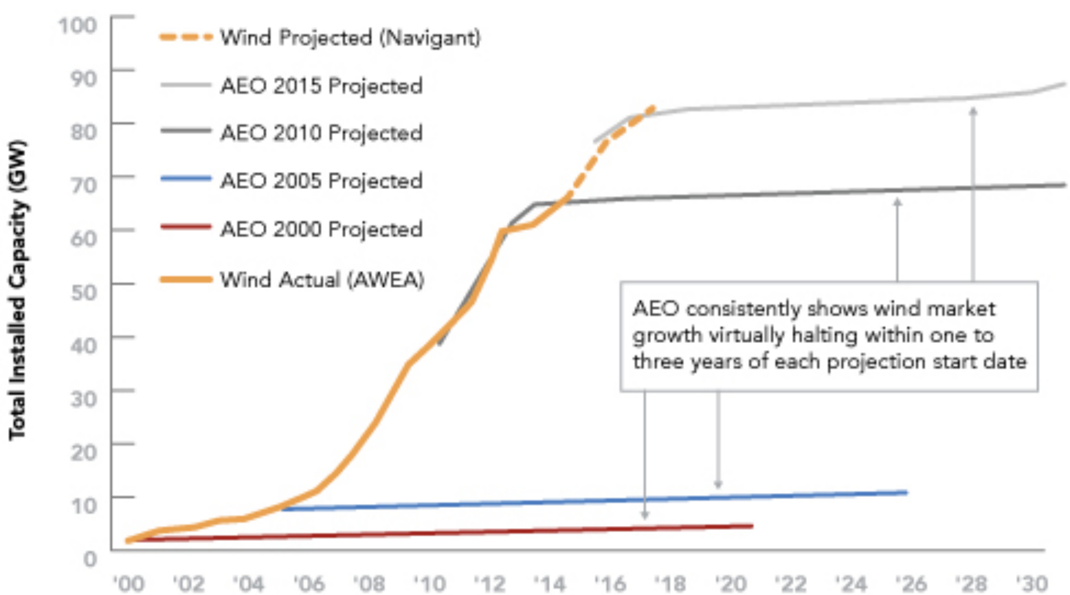
[9] http://www.eia.gov/forecasts/aeo/assumptions/pdf/table_8.2.pdf.
[10] http://www.seia.org/research-resources/solar-market-insight-report-2014-q4
[11] ERCOT System Planning, 2014 Long-Term System Assessment for the ERCOT Region, December 2014.

### 2.1.2 Wind Power

The AEO projections for wind power follow a very similar pattern, with near-term market dynamics (1-3 years) captured to a reasonable degree (because development activity is generally known) but sharp and sustained declines following expiration of the production tax credit (PTC) (Figure 3). Wind power markets in the United States have certainly been unstable over the past 15 years, driven to a large degree by the on-again off-again nature of the PTC. Market volatility is a predictable response when an industry is subject to policy uncertainty. But underneath this volatility is the reality of technology improvement and increasing economic attractiveness occurring over that time period. Given what we know about wind power's current economic competitiveness, projections that show an almost permanent collapse after 2016 do not reflect reality.

The 2015 AEO shows just 6.5 GW of total new wind power capacity additions between 2017 and 2030, less than the average *annual* additions from 2007 to 2014. Even in the year most recently impacted by PTC uncertainty – 2013 – 1.1 GW of wind power was added. Taking this as a worst-case scenario for the period 2017-2030, this would mean that about 15 GW would be added in this time period, more than twice as much as the AEO 2015 projection.

**Figure 3. Actual vs. Projected U.S. Installed Wind Power Capacity**




Sources: *Wind Actual* data are from AWEA, *Wind Projected* data are from Navigant Consulting, *US Wind Market Outlook* presentation, May 2015. *AEO Projected* data are from the Reference Case for each year shown.

### 2.1.3 Shortcomings of the AEO modeling framework

There are several reasons why the AEO projections fall short when it comes to predicting actual outcomes. These include the requirement that the EIA only model policies as they exist in statute; they cannot model scenarios based on alternative policy options. But the EIA also bases its projections on assumptions that fail to recognize cost and performance improvements in RE technology. As noted above, the AEO 2015 uses utility-scale solar PV capital costs in 2016 that are nearly double current costs. Also, EIA assumes that the cost of wind energy increases over time, rather than falls, as might be expected with technological improvement and growth in scale. EIA makes this assumption on the basis of the most attractive sites being developed first.[12] However,

[12] Greentech Media, "Why EIA's Energy Outlook Misses the Real Value of Renewable Energy," April 2015.

turbine design enhancements, such as larger rotors and taller towers, are raising capacity factors, improving the economics of wind power production at lower-quality wind sites and opening up markets that were formerly not accessible. Thus, while the best wind sites are likely to be developed first, there is no reason to assume that wind power prices will rise over time, especially in the face of market trends showing the exact opposite.

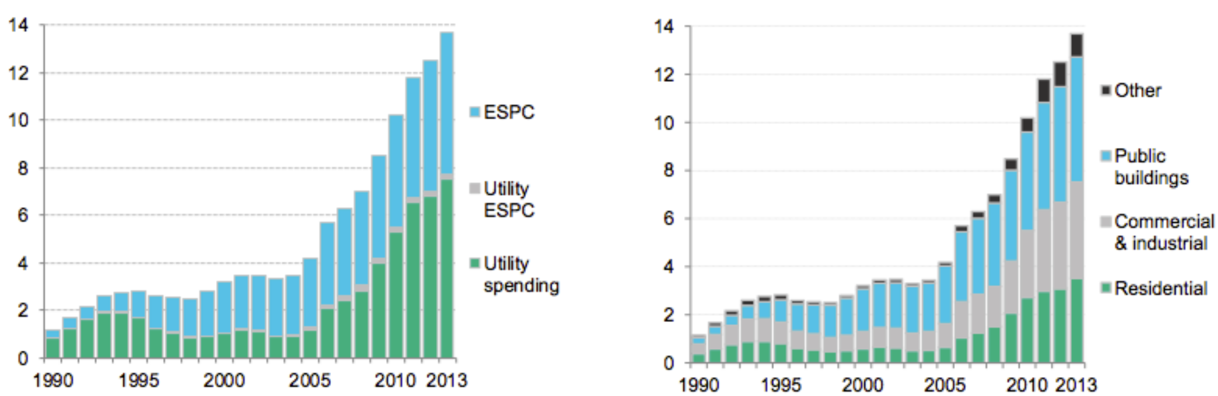
More generally, the EIA applies a learning curve approach to technology improvement. The concept is sound, based on empirical evidence that costs tend to fall by a certain percentage (typically 5%-20%) for every doubling of production. When markets are small, costs fall rapidly as doubling can occur quickly. As the market grows, each cumulative doubling requires more deployment, which slows the rate of cost reduction as technologies mature. The weakness in this approach is that EIA projections do not accurately project capacity additions, which leads to underestimating the rate of technology improvement. This shortcoming becomes self-reinforcing, leading to year-after-year underestimation of technological improvement, followed by further underestimation of the market, and so on.

Finally, the basic technology assumptions and modeling approaches do not appear to capture the true dynamics and decision-making in today's market – decision-making by a range of stakeholders, from large utilities and project developers down to commercial and residential building owners. The economic optimization models in use were developed for a different set of circumstances – when utilities made decisions based on comparing the costs of competing large-scale central generation technologies with similar characteristics.

## 2.2 Energy Efficiency

Comparing market realities to projections for energy efficiency is more challenging. To quantify EE, you need to measure something that was avoided, namely the energy saved. Nevertheless, it is possible to look at trends in EE deployment and electricity consumption, and from that, get a sense of whether long-term projections sync up. EE spending (Figure 4) has more than tripled from 2005 to 2013, with growth broad based, covering all sectors of the energy economy.

**Figure 4. Growth in Energy Efficiency Spending in the United States ($billion, nominal)**

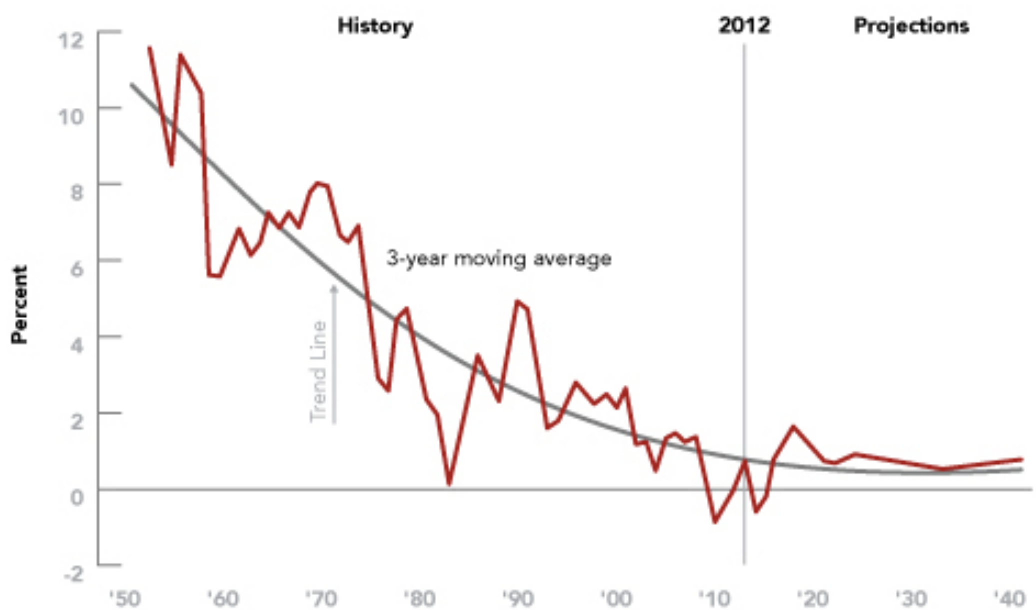



Source: Bloomberg New Energy Finance, *Sustainable Energy In America, 2015 Factbook*, February 2015. Note: BNEF estimates are based on several primary sources. “ESPC” = Energy Savings Performance Contract.

This growth in EE investment correlates with with the trend of slowing demand growth for electricity, as shown in Figure 5 below. The question is whether or not the downward trend shown in the historical data will continue or if demand growth will level out at a little less than 1% as the EIA projection suggests (note this projection is from the AEO 2014, but the AEO 2015 is similar). The EIA extrapolation of the trend line in Figure 5  from the three-year moving average based on historical data seems to settle at just under 1% annual growth, for no apparent reason. The trend in EE deployment, if sustained, would suggest that electricity demand growth could continue to slow in the coming years, rather than grow at a rate similar to population growth.

For a different look at the relationship between energy use and the economy, consider U.S. GDP and total retail electricity sales, as shown in Figure 6. These data show retail sales diverging from GDP starting in 2003, with the gap growing over time. Following the "Great Recession," as the economy began to recover, retail electricity sales stayed essentially flat, and as of 2014, they were still lower than the peak in 2007. Still, the growth rate in retail sales is slightly negative between 2010 and 2014, even as the economy grew by 9% in real terms. The growth in EE innovation and deployment is clearly one of the factors involved, although there are likely others, including shifts in economic activity (from production to service) and the growth of distributed solar.[13] Nevertheless, EIA should consider the possibility that electricity consumption could remain flat or decline even as population and economy growth continue.

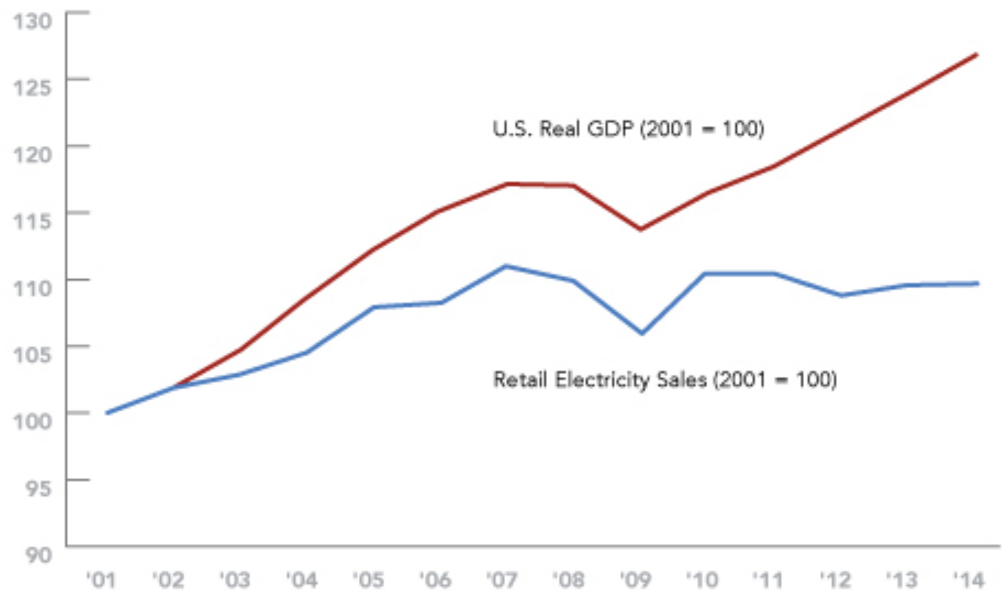
**Figure 5: U.S. Electricity Demand Growth (historical and projections)**




Source: Figure MT-29. U.S. electricity demand growth in the Reference case, 1950-2040. History: U.S. Energy Information Administration, Monthly Energy Review, September 2013, DOE/EIA-0035(2013/09). Projections: AEO2014 National Energy Modeling System, run REF2014.D102413A.

[13] The rise in the deployment of distributed solar does cut into retail sales, but the effect over the period covered in Figure 6 is small compared to other factors. Total generation from distributed PV was less than 0.4% of total retail sales in 2014 (AEEI estimates).

**Figure 6: U.S. Real GDP and Retail Electricity Sales**




Sources: Retail electricity sales from the EIA's Electricity Data Browser: http://www.eia.gov/electricity/data/browser/; GDP data from the Department of Commerce, Bureau of Economic Analysis, Table 1.1.6. Real Gross Domestic Product, Chained Dollars.

# 3.0 RE and EE: Choosing Value

Competitiveness can be looked at in different ways. For electricity, one way is to examine the costs of a technology and how that translates to the cost of electricity. For the most part, electricity is a commodity, and cost is how most people look at the issue of competitiveness. Increasingly, electricity, and the services it enables, is seen through the lens of value and not just cost. For example, can a technology provide a good price now, but also provide other economic benefits to the grid (e.g., lower price volatility, increased reliability and resiliency)? Do certain technologies better meet the needs and expectations of customers for performance (e.g., comfort, security) or the desire to have greater control over energy use and costs? If different ways of producing and using electricity offer value along these and other dimensions, then the technologies that can deliver those benefits will be competitive.

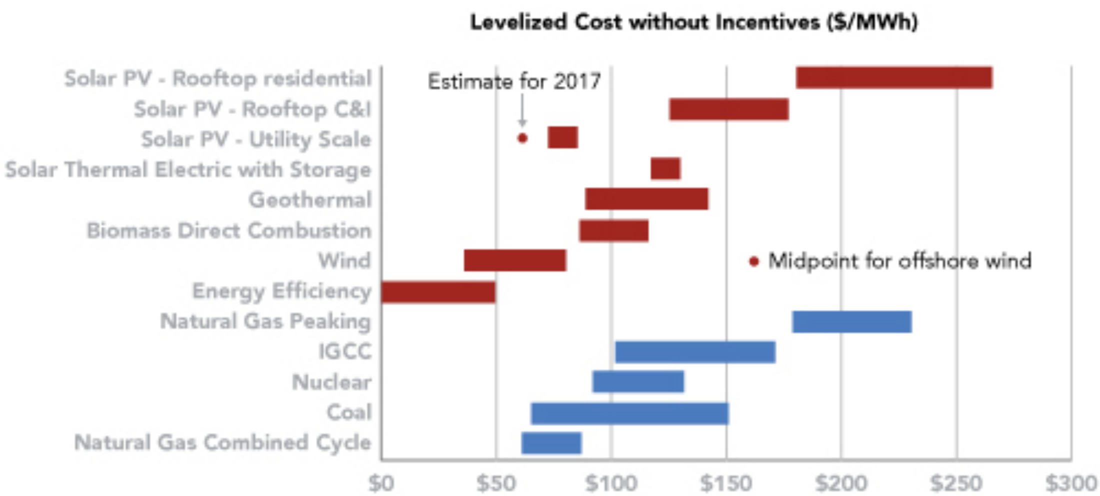
In this section, we review the range of considerations for competitiveness of RE and EE.

## 3.1 Renewable Energy

The most basic indicator of power technology competitiveness is the levelized cost of energy (LCOE), which measures the average cost of electricity over the life of the asset, including the upfront capital cost, operations and maintenance costs, fuel costs, and financing. Since 2007, Lazard, an independent financial advisory and asset management firm, has been tracking the economics of power technologies and publishing LCOE assessments using a consistent methodology, allowing for year-over-year comparison. These annual assessments document declining costs and show that RE technologies can be competitive with conventional technologies (Figure 7). Since the Lazard analysis excludes externalities and financial incentives, it provides a useful and transparent calculation of the fundamental economics of RE.

Solar and wind technologies have achieved rapid improvements in cost and performance, and are now challenging traditional sources in U.S. power markets. According to Lazard, in the past five years, the LCOE for wind power and utility-scale solar has declined by 58% and 78%, respectively. During the same time period, LCOE for concentrating solar power has dropped by 59%, geothermal by 11%, and biomass by 5%.[14]

**Figure 7: Levelized Cost of Energy (LCOE), All Sources, 2014**




Source: *Lazard's Levelized Cost of Energy Analysis—Version 8.0.* "C&I" = Commercial & Industrial; "IGCC" = Integrated Gasification Combined Cycle. High end of range for *IGCC* and *Coal* includes 90% carbon capture and compression. See original report for additional assumptions.

As Figure 7 shows, wind is currently the lowest cost power source among all supply options. Notably, utility-scale solar projects deliver electricity at prices comparable to natural gas combined cycle plants, and for less than half the cost of gas peaking units. The LCOE of solar PV rooftop systems is double that of utility-scale PV systems, but rooftop systems deliver power at the building level, where the comparison is to retail electricity rates, which are on average about twice the price of wholesale power.

To get another sense of how rapidly RE costs are falling, a recent analysis[15] describes how quickly assumptions that went into the National Renewable Energy Laboratory's (NREL) 2012 *Renewable Energy Futures* study became outdated. The multi-volume NREL study, which looked at producing 80% of our 2050 electricity needs with renewable energy, used 2010 cost data. In 2014, a follow-up study examined new technology cost reduction scenarios. The authors found that the 2012 study's most aggressive estimates for 2050 solar and wind costs under an "incremental technology improvement" scenario had already been achieved by 2014, based on data from GTM/SEIA for solar and The Lawrence Berkely National Laboratory (LBNL) for wind.

Analyses such as the Lazard LCOE studies and the NREL Renewable Energy Futures study do not tell the whole story on their own. To get a more complete picture it is necessary to look at what is actually happening in the marketplace.

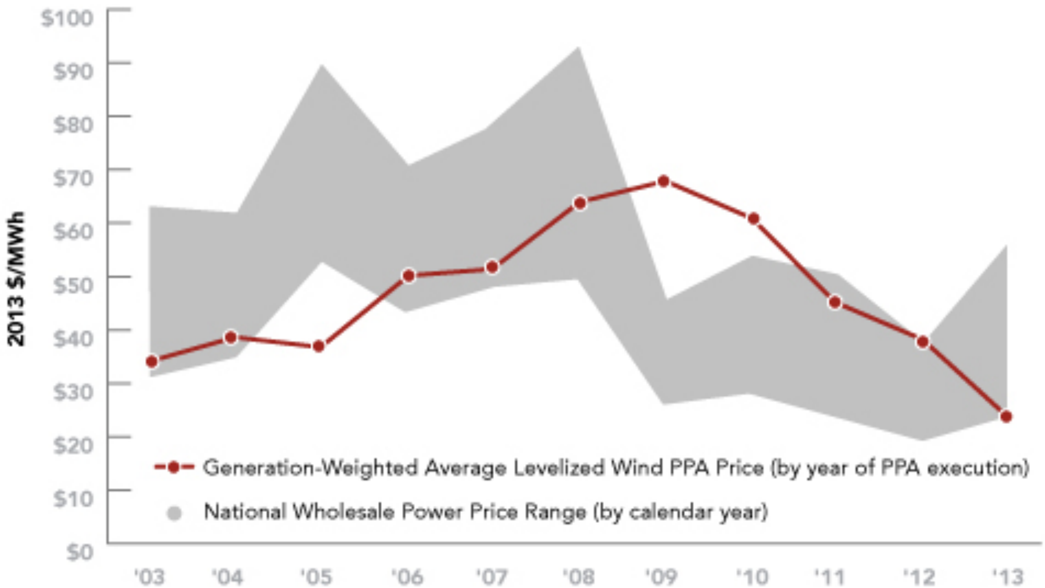
Figure 8 shows the price of long-term power purchase agreements (PPAs) for wind relative to wholesale power prices. Because they are long-term fixed-price contracts, PPAs prices are closely related to LCOE. Wind projects have offered favorable PPA prices relative to nationwide average wholesale prices for most of the past decade. In 2009, natural gas prices fell sharply and wholesale power prices dropped accordingly, but by 2011 wind PPA prices were once again competitive, and achieved historic lows by 2013. Although wind PPA prices during this

[14] Lazard's Levelized Cost of Energy Analysis, Versions 8.0 (2014) and 3.0 (2009). Represents the average percentage decrease of high and low LCOE ranges for each technology.

[15] America's Power Plan. "Are Policymakers Driving Blind with Yesterday's Cost Numbers?" Newsletter Volume 19. May 2015.

period included the federal PTC, the price without the PTC would have been competitive as well, since the PTC is worth about $20/MWh on a levelized basis.[16]

**Figure 8: Average Wind PPA Prices and Nationwide Wholesale Power Prices**




Source: LBNL, *2013 Wind Technologies Market Report*, August 2014.

Similarly, the cost of solar PPAs declined from a range of $125-$150/MWh in 2008 to current levels of $50-$75/MWh,[17] in part reflecting a 40% drop in the average installed cost of utility-scale PV systems over a five-year period, from $5/$W_{DC}$ in 2008 to $3/$W_{DC}$ in 2013.[18] Lowest cost (best-in-class) utility-scale solar projects are currently being installed for about $1.50/$W_{DC}$.

As a result of these price declines, utility RE purchases that were once driven primarily by state policy (e.g., renewable portfolio standards) are now increasingly being made based on economics. In Texas, Austin Energy signed a 20-year contract in 2014 for 150 MW of solar energy[19] at a price reported at less than $50/MWh. In 2013, wind power prices were so low that even with no requirement to purchase renewable energy, American Electric Power (AEP) bought three times more wind power in Oklahoma than it originally intended because of its value to ratepayers.[20] In the same year, Xcel Energy signed PPAs for 700 MW of wind energy at prices below most of its natural gas-fired generation, and the company expects to save as much as $590 million in fuel costs over the life of the contract.[21] In Michigan, utilities are eliminating surcharges on customer bills associated with that state's RPS because wind power is so cheap.[22]

The residential and commercial market for smaller PV systems, usually installed on rooftops, is also expanding in response to declining costs, rising retail electricity rates, and new financing options (discussed in the following

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[16] The Federal production tax credit (PTC) is valued at $23/MWh for the first ten years of production. The value of the PTC on a levelized cost basis will depend on factors such as tax rates, project life, and assumed discount rates.

[17] GTM Research. "The One Chart That Shows Why 2014 Was a Breakthrough Year for Utility-Scale Solar in America." http://www.greentechmedia.com/articles/read/the-one-chart-that-shows-why-2014-was-a-pivotal-year-for-us-solar

[18] LBNL. *Tracking the Sun VII*. September 2014.

[19] Austin Energy. 2014 press releases. www.austinenergy.com

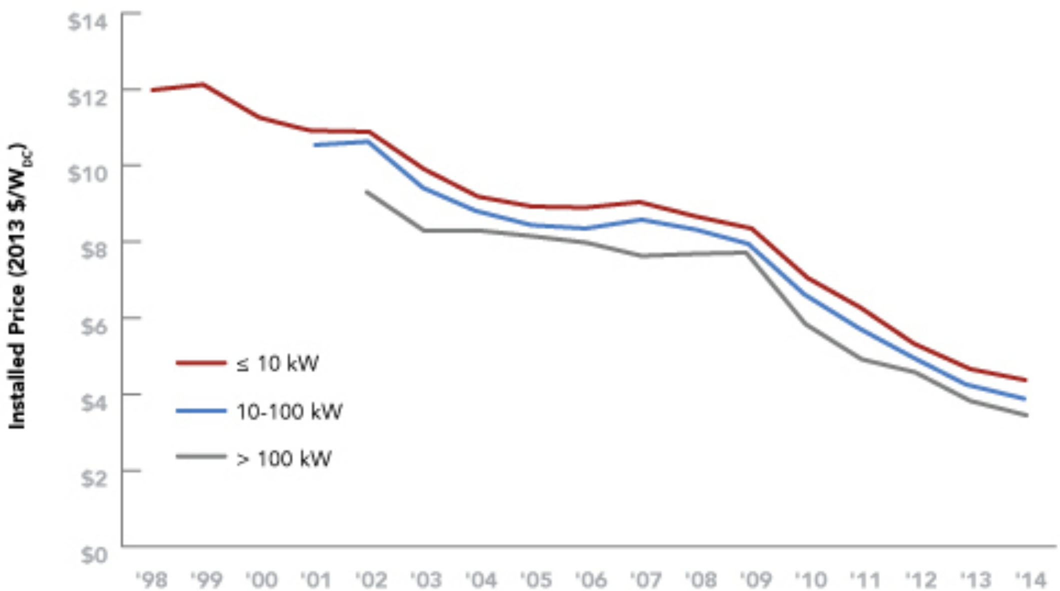
[20] New York Times. "Solar and Wind Energy Start to Win on Price vs. Conventional Fuels." Nov 23, 2014.

[21] AWEA. "Citing low costs, Xcel Energy plans 'significant increase' in wind purchases." July 11, 2013. http://aweablog.org/blog/post/citing-low-costs-xcel-energy-plans-significant-increase-in-wind-purchases

[22] Clean Technica. "Cheap Michigan Wind Energy Set To Save Consumers $15 Million Annually." https://cleantechnica.com/2015/06/09/cheap-michigan-wind-energy-set-save-consumers-15-million-annually. June 9, 2015.

section). Residential and small commercial system prices dropped by almost 60% between 2002 and 2013, as shown in Figure 9. As the solar industry achieves scale (about 2 GW of residential and commercial PV were installed in the United States in 2014), it is working to drive down so-called "soft costs," such as permitting, customer acquisition, and installation. For utility-scale projects, these costs are spread across a much larger investment, but for small, distributed projects such as rooftop solar, these costs still represent a significant portion of total installed costs.

**Figure 9: Median Values for Installed Price of Residential and Commercial PV Systems**




Source: LBNL, *Tracking the Sun VII*, September 2014.
* 2014 values are for the first half of the year and cover a subset of states for which full year 2013 median values were actually slightly higher than what is shown here.

It is important to note that hydropower, geothermal, and biomass, are also competitive power sources today, though markets for them are smaller than solar or wind. Based on the FERC data presented earlier, capacity for these RE technologies continues to be added on a scale of several hundred megawatts per year. Geothermal resources are generally limited to a few western states, and biomass, while having potential throughout the country, is more prominent in the eastern half of the country. Nevertheless, both markets continue to grow and the United States is the global leader in geothermal power. Biomass is deployed mainly, but not exclusively, as high efficiency combined heat and power (CHP) in the forest products industry. Though not included in Figure 7, landfill gas (LFG) projects are also cost-effective, with LCOEs ranging from $45/MWh to $109/MWh.[23] About 2,200 MW of landfill gas capacity is in operation today; EPA estimates that 855 MW of potential LFG sites remain in the United States.[24] Small hydropower and anaerobic digestion are two other cost-effective RE technologies with untapped potential. Emerging technologies such as enhanced geothermal systems and marine and hydrokinetic energy offer significant future potential as they mature and come down the cost curve.

### 3.1.1 Renewable Energy Market Dynamics and Trends

Wind and solar technologies are mature and reliable today, and innovation continues to drive down costs and improve performance. Wind technology advances have improved turbine output in a wide range of regimes, expanding the potential for wind power at sites that have previously been less attractive. States in the Great

[23] Citi Research. Evolving Economics of Power and Alternative Energy, 23 March 2014, p 20.
[24] EPA, Landfill Methane Outreach Program, http://www.epa.gov/methane/lmop/projects-candidates/index.html

Lakes, West, and Northeast regions will benefit from technology improvements as higher output turbines drive down the cost of wind power production. Similar advances in solar PV have improved panel efficiency and driven down balance-of-system and "soft costs" by improving equipment design and streamlining installation processes. The Southwestern United States has historically been the primary focus of solar growth, but cost reductions have driven solar industry growth in the Southeast, Midwest, and Northeast.

In addition, long-term RE contracts provide a hedge against fuel price volatility, which is an important consideration for utilities and private sector buyers. Grid-connected RE also provides system-wide benefits in the form of wholesale price suppression. Because most renewables have no fuel requirement, their marginal cost is near zero, which lowers wholesale market clearing prices, to the benefit of all consumers.[25]

These and other benefits have made renewable energy supplies attractive for their economic value. In the heart of petroleum-rich Texas, the city of Georgetown plans to meet its power needs with wind and solar by 2017.[26] Like AEP's decision to purchase bulk wind power based on price and value, Georgetown's decision was not driven by a regulatory mandate, but by lower electricity costs, plus less water usage. In 2014, wind power operating in the United States saved 68 billion gallons of water.[27] Water considerations are becoming critical in power supply decision-making, particularly in the Southwest.[28]

None of this is lost on corporate America, which is purchasing renewable energy supply for its own purposes, and at prices that pass muster. In 2014, more than 23% of wind power contracts were with large corporate or non-utility groups, such as universities and government agencies[29], and similar trends are seen with solar. Google and Apple are investing in wind and solar projects and committing to long-term contracts for renewable energy supplies to reduce the impact of their high electricity demand. Google currently meets 35% of its power requirements with renewable energy and has a goal of achieving 100%. To this end, Google recently signed a 20-year wind PPA with NextEra Energy Resources, which is replacing older turbines at Altamont Pass in California with up-to-date technology. Apple recently signed an $848 million 25-year PPA with First Solar in California, and has invested in ownership of 77.5 MW of capacity from four solar plants.[30]

Major retailers such as Walmart, IKEA, and Staples are pursuing similar strategies, cutting costs and improving their public profile by setting corporate goals to reduce energy use and procure renewable electricity. Walmart owns and/or contracts for 380 MW of solar and wind capacity, and intends to meet all of its power needs with renewable energy by 2020.[31] According to the Solar Energy Industries Association (SEIA), as of August 2014, more than 569 MW of solar capacity has been installed at 1,100 facilities across the country by the 25 leading corporate solar users.

### 3.1.2 Innovation in Renewable Energy Financing

Robust financing mechanisms are an important indicator of technology competitiveness, market strength, and market maturity, as the financial sector recognizes the value of renewable energy. For rooftop solar, the advent of third-party financing has allowed homeowners and businesses to avoid the upfront cost of PV installations and to lease systems or execute PPAs instead. This innovation opened the door to increased market penetration in the residential and commercial sectors by overcoming the first-cost barrier and transferring

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[25] Ohio PUC, Renewable Resources and Wholesale Price Suppression, August 2013. http://www.midwestenergynews.com/wp-content/uploads/2013/09/PUCO-renewable-energy-standard-study.pdf

[26] Financial Times, "Renewables ride the wave of success as prices fall and spending jumps," April 20, 2015.

[27] AWEA, "Ten Top Trends for Wind Power in 2014," http://www.aweablog.org/ten-top-trends-for-wind-power-in-2014/. April 15, 2015.

[28] U.S. Global Change Research Program, http://www.globalchange.gov/explore/southwest

[29] AWEA, "Market grows for wind energy as leading U.S. brands lock in low prices" April 8, 2015. http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=7408

[30] EDF, "Clean Energy is Just Smart Business for Leaders like Apple, Google." Feb 2015.

[31] Ibid.

technology and project risk to a third party. According to NREL, two-thirds of homeowners who installed rooftop solar in 2013 chose third-party financing.[32] Although self-financing can offer better returns over the project life, the simplicity and "day one" savings of third-party-owned systems have stimulated interest. Still, as prices have fallen, companies that focused on third-party ownership are beginning to offer loan options. Community solar, also known as shared solar, is growing as well, allowing customers who do not have suitable sites of their own to participate in shared ownership. The dynamic market for PV technology and services is a sign of a healthy, competitive industry.

As the amount of money being invested in RE projects has grown, yieldcos have emerged as a financing option that is facilitating development of wind, solar, and hydro projects. These entities all have similar characteristics: costs associated with the initial capital investment, once built, have low operational risk and long-term contracts that provide steady revenues. By bundling the assets of projects, yieldcos generate portfolios that are low-risk and attractive to investors, providing a new source of capital to fuel growth of the RE industry.[33]

In just three years, the yieldco market has grown to $27 billion in value, and Jeff McDermott of Greentech Capital Advisors expects it to reach $100 billion based on the ability to deliver dividends that exceed the returns of corporate bonds.[34] At the MIT Energy Conference in early 2015, Raymond Wood, Managing Director and Head of Global Power and Renewables at the Bank of America Merrill Lynch, said the drop in solar and wind costs has eliminated earlier investor skepticism, and the use of yieldcos represents a turning point for the wind and solar industries.[35]

At the other end of the spectrum, SolarCity, the nation's largest installer/third-party owner of residential solar power systems, is now offering solar bonds to individual investors, who can buy in with as little as a $1,000 investment. These bonds pay attractive interest rates and allow anybody to participate in financing of third-party-owned solar.

## 3.2 Energy Efficiency

EE is not only cost-effective, it is generally the least-cost option for meeting electricity needs today, as well as for meeting CPP targets. Lazard estimates that the LCOE for EE[36] is between zero and $50/MWh (Figure 7). Similarly, the LBNL estimates that the U.S. average "total cost of saved energy" by customer-funded utility-sponsored EE programs is $46/MWh, based on an analysis of programs in 20 states over a five-year period.[37] This is less than half the average retail price of electricity in the United States.[38] The total cost of energy saved through these programs varies by state, ranging from a low of $29/MWh in New Mexico to a high of $79/MWh in Massachusetts. EE programs have been in place in Massachusetts for 25 years, but high electricity prices make more EE investments cost-effective.

As Figure 10 shows, utility programs split the cost of EE between utilities and participants, resulting in economic benefits for both. For the utilities (as program administrators) the cost of providing the EE programs is less than the cost of acquiring or developing new generation. For participants, implementation of EE measures immediately reduces monthly utility bills, paying for themselves over time. On a system-wide level, since the

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[32] NREL, "Banking on Solar: An Analysis of Banking Opportunities in the U.S. Distributed Solar Market, Nov 2014.

[33] NREL, "A Deeper Look into Yieldco Structuring," Renewable Energy Project Finance, 2014.

[34] AEE blog, "Yieldco Activity Continues to Scale, May Soon Reach $100 Billion." http://blog.aee.net/finance-direct-purchases-of-advanced-energy-yieldcos-close-in-on-100b. April 30, 2015.

[35] Lupkin, Lea, "MIT Energy Conference Explores Efficiency and Yieldcos", Clean Energy Finance Forum, Yale Center for Business and the Environment. http://cleanenergyfinanceforum.com/2015/03/17/mit-energy-conference-explores-efficiency-and-yieldcos/. March 2015.

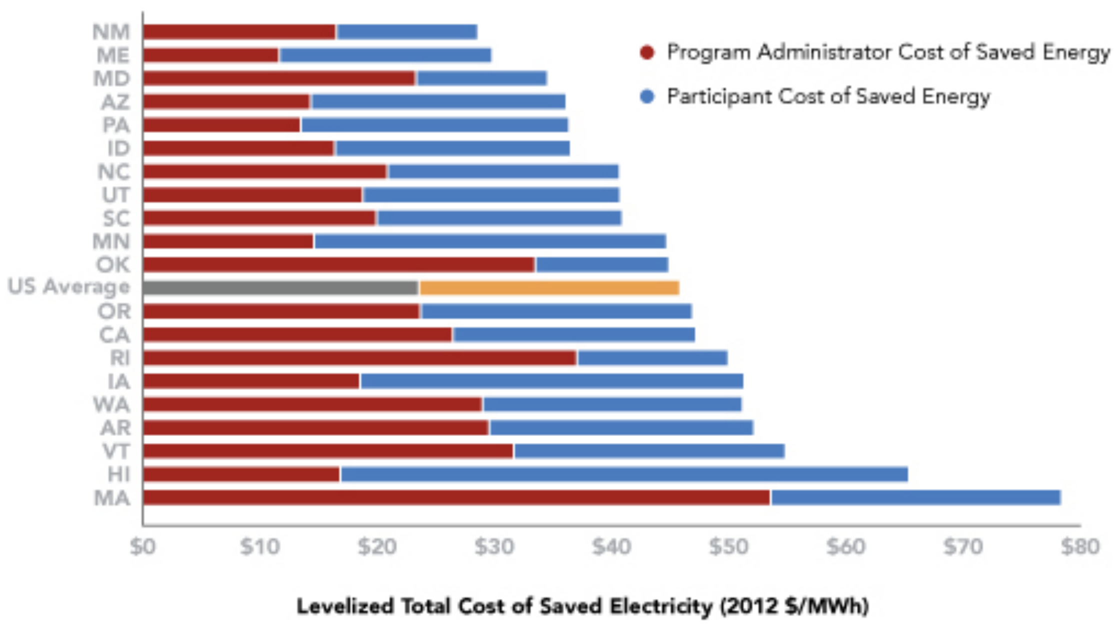
[36] Lazard's LCOE for energy efficiency measures the cost of avoided electricity, not the cost of generation, but is an appropriate point of comparison as an alternative to generating a unit of power.

[37] LBNL, The Total Cost of Saving Electricity through Utility Customer-Funded Energy Efficiency Programs, April 2015.

[38] EIA Electric Power Monthly, April 27, 2015. Table 5.3 shows an average retail price of power in 2014 of $0.1045/kWh ($10.45/MWh).
http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_03

total cost of EE is also below the cost of acquiring new resources, such as power from a new GTCC at about $60-$80/MWh (see Figure 7), EE implementation also lowers the total cost of energy supply for the utility and its ratepayers, program participants and non-participants. Over time, EE can also defer or avoid upgrades to the transmission and distribution system, providing additional savings to all utility customers. Also, like RE, EE resources can reduce wholesale market prices by reducing demand, and thus induce additional savings across the system.[39]

**Figure 10: Savings-Weighted Average Total Cost of Saved Electricity**




Source: Hoffman, Ian M., Gregory M. Rybka, Greg Leventis, Charles A. Goldman, Lisa C. Schwartz, Megan A. Billingsley, and Steven R. Schiller. "The Total Cost of Saving Electricity Through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level." Lawrence Berkeley National Laboratory. April 2015. http://emp.lbl.gov/sites/all/files/total-cost-of-saved-energy.pdf

In addition to empirical evidence of cost-effectiveness, consider the basic framework under which EE is delivered via utility-sponsored programs. These programs must meet quantitative cost-effectiveness tests. Although different tests are applied differently state by state, they all share one basic common element, in that they compare the costs of the programs/measures to the savings. Generally speaking, utility-run EE programs cannot be implemented unless they have a benefit-to-cost ratio greater than one (although adjustments can be made for certain customer classes such as low or moderate income customers). Simply put, if customer-funded utility programs do not save money, state utility commissions will not authorize funding for them.

Two cost-effectiveness tests in wide use today are the Total Resource Cost Test (TRC) and the Program Administrator Cost Test (PAC). The TRC seeks to answer the question of whether the total cost of energy in the utility service territory will increase or decrease. The PAC answers the question of whether or not total utility bills will increase or decrease

In California, Southern California Edison's (SCE) 2014 EE program report to the California Public Utilities Commission (CPUC) shows a total resource cost (TRC) of $494.4 million, producing $566.9 million in savings to ratepayers, for a TRC ratio of 1.13. SCE spent $313.2 million to administer its EE program in 2014, yielding a

[39] This effect is called "DRIPE" for Demand Reduction Induced Price Effect.

PAC ratio of 1.78. Other California utilities reported TRC ratios as high as 1.42 at San Diego Gas and Electric, and PAC ratios ranging from 2.17 at Southern California Gas to 2.48 at San Diego Gas and Electric.[40]

In addition to utility-sponsored EE programs, the other market for EE is for ESCO performance contracts. Here, too, cost-effectiveness is key. With performance contracting, ESCOs install packages of EE measures, typically at little or no initial cost to the customer. ESCOs are paid by the realized energy savings. As such, the EE measures implemented under performance contracts must be realized by savings sufficient to pay for the project and provide adequate returns.

**Examples of ESCO Performance Contracting**

The following three examples show how performance contracting is bringing EE to customers that might otherwise not have the resources to implement comprehensive EE packages:

**Clayton County, Georgia**

Like many county governments, Clayton County, Georgia, was seeing its facilities' maintenance and energy costs rise, but lacked the resources to invest in system upgrades. Through a performance contract with Trane, it was able to benefit from a $5.5 million investment that addressed inadequate air conditioning systems, lighting upgrades, automated building controls and sensors, and a methane recovery project at the county landfill. With no upfront investment by the county, the efficiency projects are saving $361,000 in annual utility costs.[41]

**University of Massachusetts**

The University of Massachusetts at Amherst faced decaying energy infrastructure, backlog of deferred maintenance, and inadequate resources to get ahead of the problems. Working with Johnson Controls under a 10-year performance contract, the university was able to leverage a $40 million investment in energy projects that produced $54 million in guaranteed savings over the contract term. The long-term savings have allowed the university to invest in other projects.[42]

**City of Baltimore**

In Baltimore, Johnson Controls implemented $14 million in energy efficiency measures that included design and construction of a 2.4 MW digester gas cogeneration plant at the Back River Wastewater Treatment Plant. The plant uses the methane gas previously been flared at the digester facility, saving $1.4 million per year in energy costs. Additional energy efficiency measures implemented under this performance contract yielded a total annual savings of $1.8 million for the city.[43]

Utility EE programs today focus mainly on residential and small commercial customers, whereas ESCOs primarily target medium and large sized facilities in public and institutional sectors, including municipal buildings, universities, K-12 schools and hospitals – the so-called "MUSH" market. Bloomberg New Energy Finance estimates total U.S. investments in EE at almost $14 billion in 2013, including $7.3 billion in utility-sponsored programs and $6.2 billion in performance contracts through ESCOs.[44] LBNL expects the ESCO market alone will reach $11-$15 billion by 2020.[45]

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[40] California Public Utilities Commission, California Energy Efficiency Statistics, 2014 Annual Reports, Table 4. http://eestats.cpuc.ca.gov/Views/Documents.aspx
[41] AJW Inc., "Greenhouse Gas Reductions Through Performance Contracting Under EPA's Clean Power Plan." Appendix C. http://ajw-inc.com/wp-content/uploads/2014/11/PC-111d-technical-paper-with-appendices.pdf Nov 26, 2014.
[42] Andre E. Davis. *Using Performance Contracting and Incentives to Accelerate Energy Efficiency Projects.* http://www.johnsoncontrols.com/content/dam/WWW/jci/be/white_papers/GIWhitepaper.pdf. 2013.
[43] Ibid.
[44] Bloomberg New Energy Finance. *Sustainable Energy in America, 2015 Factbook*. February 2015.
[45] LBNL. *Current Size and Remaining Market Potential of U.S. ESCO Industry*. http://emp.lbl.gov/sites/all/files/lbnl-6300e-ppt.pdf. September 2013.

Given the value of EE for program participants and non-participants alike, many states have implemented EE policies, including utility-run programs, enhanced building energy codes, and programs to install combined heat and power (CHP). State initiatives frequently include direct financial incentives, disclosure rules for residential and commercial buildings to report energy consumption, institutional support for performance contracting with ESCOs, and EE technology R&D.[46] Most states offer some EE program,[47] and 24 states have established Energy Efficiency Resource Standards (EERS) that set binding annual targets for reducing electricity consumption and often natural gas consumption as well.[48]

The majority of states have just begun to tap their EE potential (Table 1). Twenty-six states have no EERS in place and among those that do, annual savings targets range from 0.1% in Texas to 2.6% in Massachusetts. States such as Massachusetts, Rhode Island, Vermont, and Arizona, are demonstrating that is it possible to sustain 2% or greater annual EE reductions, while still meeting cost-effectiveness criteria. Thus, there is likely to be significant untapped EE potential in states with established EERS, and additional opportunity for those states without EERS to consider implementing programs modeled on existing ones.

[46] ACEEE. The 2014 State Energy Efficiency Scorecard. p 73
[47] Ibid., p 17
[48] Ibid., p vi

**Table 1. Current Status of U.S. State EERS Programs**

| States With EERS | Annual Electric Savings Target (%) | Gas Target Included |
|---|---|---|
| Arizona | 2.4 | Yes |
| Arkansas | 0.8 | Yes |
| California | 0.9 | Yes |
| Colorado | 1.5 | Yes |
| Connecticut | 1.4 | Yes |
| Hawaii | 1.4 | No |
| Illinois | 0.9 | Yes |
| Iowa | 1.3 | Yes |
| Maine | 1.6 | Yes |
| Maryland | 1.6 | No |
| Massachusetts | 2.6 | Yes |
| Michigan | 1.0 | Yes |
| Minnesota | 1.5 | Yes |
| Nevada | 0.4 | No |
| New Mexico | 1.0 | No |
| New York | 1.0 | Yes |
| North Carolina | 0.4 | No |
| Oregon | 1.4 | Yes |
| Pennsylvania | 0.8 | No |
| Rhode Island | 2.3 | No |
| Texas | 0.1 | No |
| Vermont | 2.0 | No |
| Washington | 1.4 | No |
| Wisconsin | 0.7 | Yes |

| States Without EERS |
|---|
| Alabama |
| Alaska |
| Delaware |
| Florida |
| Georgia |
| Idaho |
| Indiana |
| Kansas |
| Kentucky |
| Louisiana |
| Mississippi |
| Missouri |
| Montana |
| Nebraska |
| New Hampshire |
| New Jersey |
| North Dakota |
| Ohio |
| Oklahoma |
| South Carolina |
| South Dakota |
| Tennessee |
| Utah |
| Virginia |
| West Virginia |
| Wyoming |

Source: ACEEE, *2014 State Energy Efficiency Scorecard*, Appendix D, AEEI.

Similarly, LBNL estimates the untapped market for energy savings from ESCO performance contracts at between $71 billion and $133 billion,[49] based on a review of market penetration by sector relative to total U.S. building inventory data and typical project costs (Table 2).

**Table 2. Estimated Remaining U.S. ESCO Market Potential (billions of 2012 dollars)**

| Sector | Low Estimate | High Estimate |
|---|---|---|
| K-12 Schools | $15.8 | $29.4 |
| Health/Hospital | $15.0 | $25.6 |
| Private Commercial | $14.4 | $33.5 |
| State/Local | $10.6 | $16.3 |
| Public Housing | $4.7 | $5.7 |
| Universities/Colleges | $5.7 | $9.8 |
| Federal | $4.9 | $12.7 |
| **Total** | **$71.2** | **$133.0** |

Source: LBNL, Current Size and Remaining Market Potential of U.S. ESCO Industry, 2013.

These estimates notably exclude the potential for upgrades in buildings that have already implemented EE measures in the past, which suggests they are likely to be conservative. Technical innovation leads to continuous EE improvements in areas such as lighting, energy management systems, smart thermostats, and improved appliances, which provide potential for additional savings in buildings that have already undergone older upgrades. For example, compact fluorescent lights (CFLs) replace incandescent lights and cut energy use by about 75%. Now, LEDs are transforming the lighting sector, offering even deeper energy savings, longer operating lives, more flexible operation, and better integration with intelligent digital controls than CFLs. Smart thermostats are an improvement over existing programmable thermostats and provide more opportunities for saving energy while offering consumers improved comfort.

As is the case with most technologies, reduced energy use is not achieved at the expense of performance, with today's energy efficient technologies offering superior performance. Many buildings retrofitted with EE technologies in the past can pursue upgrades and achieve additional improvements in comfort as well as cost.

EE programs will be enhanced by smart grid technology and the products and services it enables, providing customers with actionable data on their energy use. Advanced metering functionality and time varying rates (TVR) that send real-time price signals to consumers are important parts of the solution. Forty percent of U.S. households and about 20% of commercial establishments have advanced metering,[50] and deployment will expand as utilities and regulators modernize the grid to give consumers more choices and control, and facilitate integration of distributed energy resources.

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[49] LBNL, Current Size and Remaining Market Potential of the U.S. Energy Service Company Industry, 2013.
[50] EIA, http://www.eia.gov/tools/faqs/faq.cfm?id=108&t=3, US Census Bureau, http://quickfacts.census.gov/qfd/states/00000.html

# 4.0 Conclusion

The electric power industry has entered a period of fundamental change. Underpinning this change is the emergence of RE and EE as options for meeting system and customer needs at scale. RE and EE technologies and services are set to transform the way electricity is generated and used in the United States. This transformation is well under way. RE and EE technologies present competitive options for meeting electricity needs and complying with Clean Power Plan requirements at low cost.

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