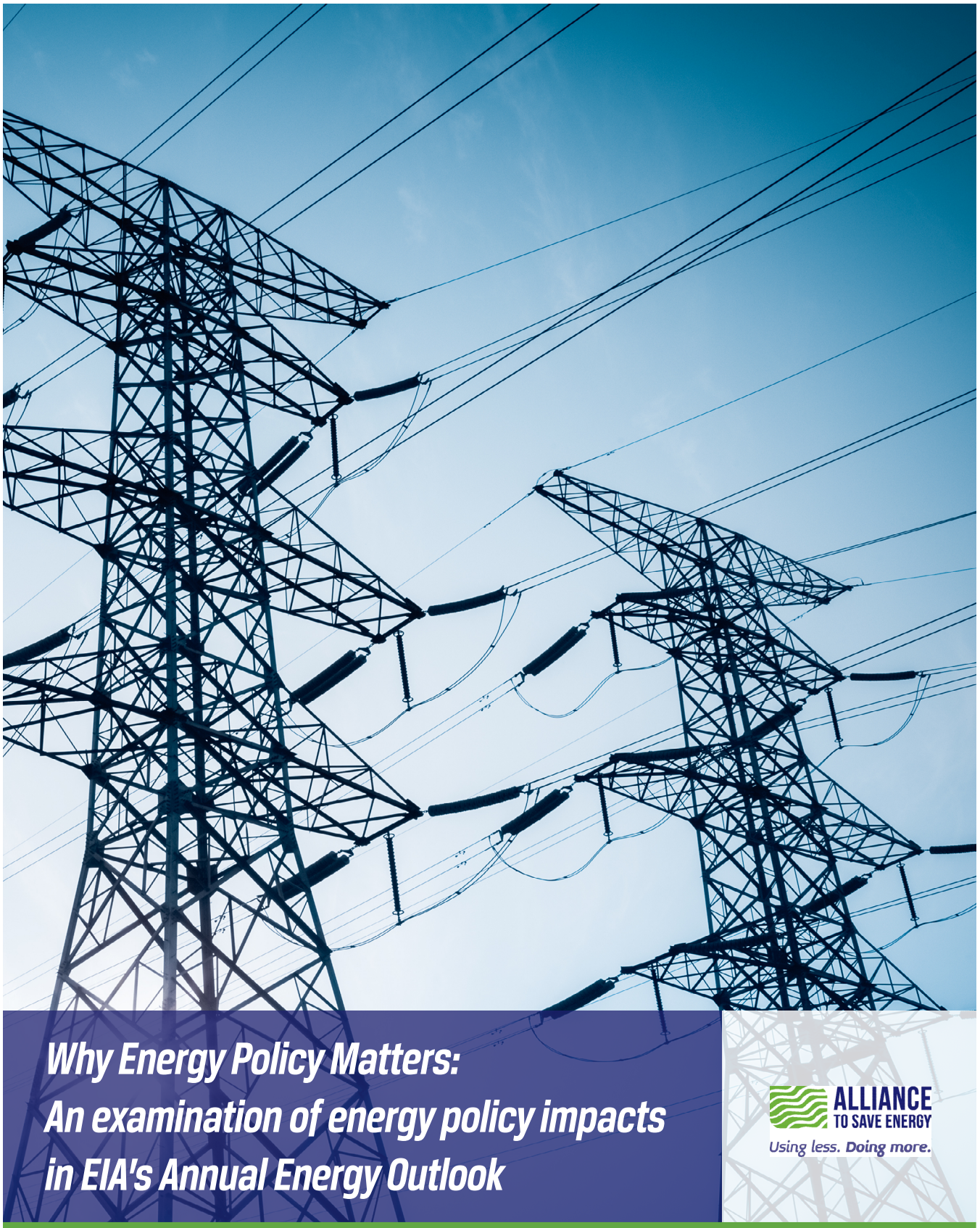

Why Energy Policy Matters: An examination of energy policy impacts in EIA's Annual Energy Outlook

ALLIANCE TO SAVE ENERGY
Using less. Doing more.

An Alliance to Save Energy White Paper

DECEMBER 2016

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Introduction

The Energy Information Administration (EIA) issued the early release of its Annual Energy Outlook (AEO) on May 17, 2016 and issued the full report on September 15, 2016. This update is substantial as it is the first to fully incorporate the many appliance standards that were finalized during 2015, the impact of the federal production tax credit (PTC) and investment tax credit (ITC) extensions for renewable energy generators, and the Clean Power Plan (CPP). EIA's Early Release contained two business-as-usual trend projections: the 2016 Reference case, which includes a mass-based, regional implementation of the CPP, and an alternative case without the CPP (2016 No CPP). The Full Release contains many additional scenarios, including an Extended Policies case that continues policy support for energy efficiency and renewable energy beyond the existing limits.

While much has happened between the September AEO release and now that may impact some of the policies analyzed here, what is clearer than ever is that we must be diligent to fully understand the future implications of the present choices we collectively make. This analysis compares different scenarios with shared fundamental assumptions on energy prices and economic growth to explore how the impact of various energy policy choices propagate through our economy. The difference in the 2040 results — and the trajectories for future years — is quite stark, and reflects the importance of making informed energy policy decisions today.

The first part of this report compares the two Early Release cases. By comparing the 2016 Reference case and the 2016 No CPP case to the 2015 Reference case (which excluded the CPP, the recent standards, and the tax extensions), one can to some degree isolate the impacts of these policy changes.

"To some degree" is an important qualifier as economic growth and oil and natural gas price forecasts are to a large degree exogenous to the NEMS model[1], and the baseline forecasts of these critical variables have changed between 2015 and 2016[2].

Additionally, EIA made changes to their capital cost forecasts for solar and wind projects that, when combined with the extension of federal tax credits, substantially impacted the projections of renewable generation deployment. Nonetheless, the directional change in energy use, carbon dioxide (CO_2) emissions, and electricity fuel mix reveal some expected and unexpected impacts from the CPP.

A WORD ON EIA'S FORECASTS.

The projections of AEO's report are based on the National Energy Modeling System (NEMS), a modeling system that projects the impact of energy policies and energy markets on the United States. Importantly, EIA's Reference case projection is based only on laws and regulations that are "on the books," meaning proposed rules aren't included in the forecast — only finalized rules. Further, EIA does not typically assume that policies will continue past their current stop dates. Thus, if the most recent CAFE standard plateaus in 2025, EIA will assume it will stay at that level going forward. EIA also analyzes many alternative cases (such as high and low natural gas prices). As you might expect, comparing the relative results of different cases is often more instructive than trying to peg a single figure from a single forecast.

The second part of the report compares the 2015 and 2016 Reference cases to the 2016 Extended Policies case. The Extended Policies case contains a number of assumptions that would require statutory or regulatory changes. One can think of the Extended Policies case as approximating a very aggressive deployment of existing technologies while assuming incremental improvements that are consistent with historical trends. EIA is careful to point out that they did not perform cost/benefit analyses on some of their assumptions, such as building code improvements, but they did indicate that nothing beyond "max tech"[3] is included in their analysis.

By comparing the Extended Policies case to the 2015 and 2016 Reference cases, one gets a sense of how aggressive deployment of energy efficiency will impact total energy use and CO_2 emissions. AEO also includes data on electricity prices, allowing one to see how policy changes impact the prices we pay on our electricity bill and at the gas pump.

Authors

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1 The National Energy Modeling System (NEMS) is the primary modeling tool that EIA uses for the AEO reports.

2 There are feedback mechanisms within the model that will cause small changes in these variables over time, but the baseline price forecast and GDP growth are generally established external to the model.

3 In appliance standards parlance, "max tech" is the highest performing commercially available product on the market.

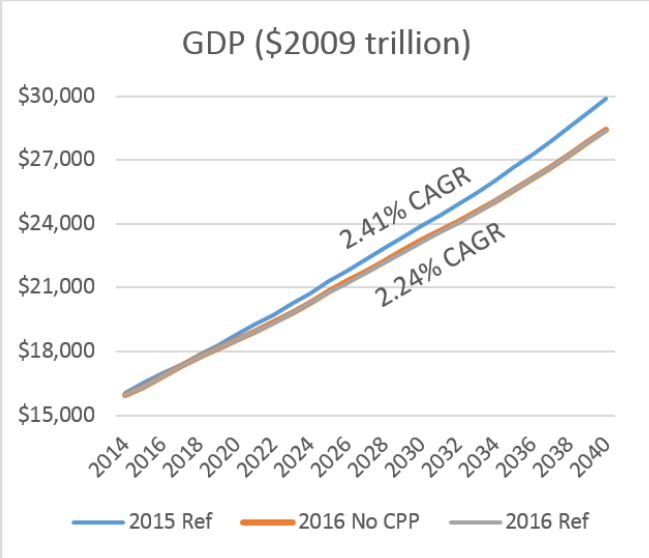
Section One – To CPP or Not To CPP

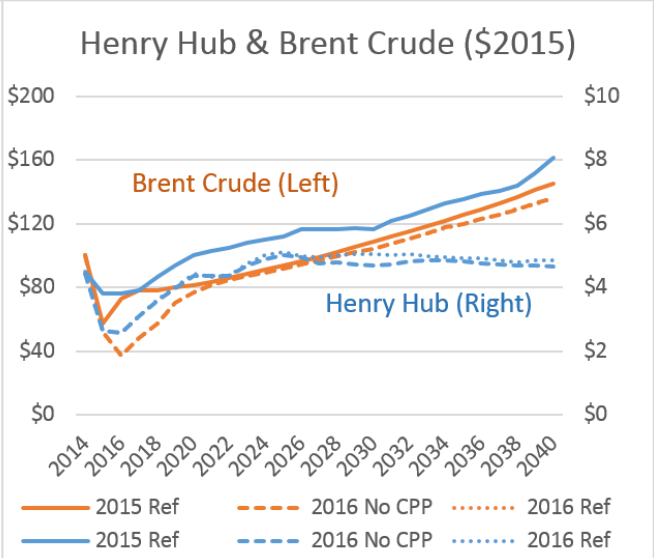
The first section of this paper will analyze results from the 2016 Reference case, which includes the CPP, and the 2016 No CPP case, which obviously does not. These are compared against the 2015 Reference case as well. The underlying data for this analysis is available on EIA's website for the Early Release edition of the AEO.

GDP, Production, and Fuel Price Updates

Annual real economic growth projections from 2015 to 2040 used in the model declined to 2.24% in 2016 from 2.41% in 2015. This has a compounding impact, and results in a real GDP that is 3.2% smaller in 2030.

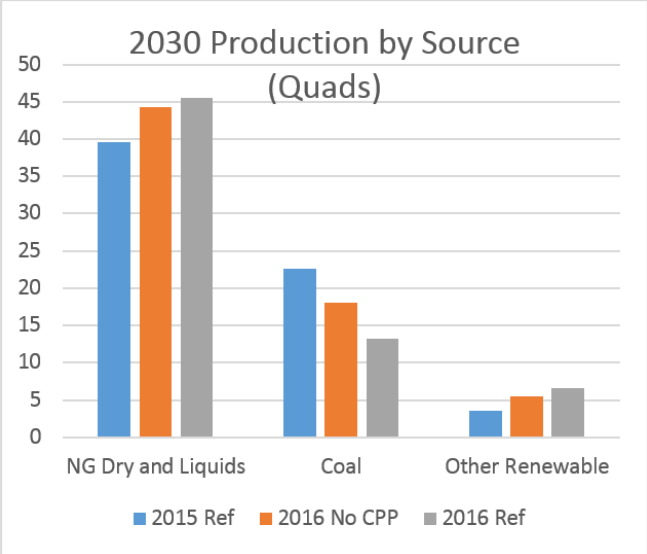
Natural gas prices have also fallen between the forecasts, both in the short-term and the long-term. Updated near-term prices more accurately reflect the recent drop in prices, and the long-term projection calls for Henry Hub prices to plateau at roughly $5/MMBtu in $2015[4] from roughly 2025 through 2040. This is quite a change from last year's forecast, which showed a steady increase in long-term prices up to $8/MMBtu by 2040.





While not as relevant in the residential and commercial sectors, the change in oil price forecast will have an impact in the transportation and industrial sectors, particularly in the near-term. The 2016 updates show substantially lower oil prices through 2020 before rejoining the previous forecast. The CPP modeling does not affect oil prices, as to be expected given the global nature of petroleum pricing and the lack of oil used in the electricity sector. However, the lower projections of near-term oil prices translate into substantially (15-20%) lower gasoline prices through 2018.

Another notable change between the forecast is in the production of energy. There is a step up in growth of natural gas production (both dry and "wet" forms[5]) in the 2016 cases, with an increase of nearly 12% by 2030. The CPP modeling produces a bit more production as well, ultimately increasing 2030 natural gas production to 45.5 quads, or nearly 15% higher than the 2015 Reference case. This increase in production has the expected impact on natural gas prices, particularly in the long run.



4 All prices are in $2015, unless otherwise noted.

5 "wet" natural gas includes other components such as ethane, propane, and butane that can be separately processed and sold

The historic trend of lower energy use from coal continues. There is a substantial drop in 2030 coal production between the 2015 Reference and 2016 No CPP scenarios, reflecting trends already unfolding in the electricity sector. The 2016 Reference case projects an even deeper drop in 2030 coal production, resulting in a figure that is 41% lower than the 2015 Reference case value.

While growing from a lower base, other renewables, (that is, non-hydro and non-biomass renewables — basically, solar and wind) see considerable increases between the scenarios as well. These other renewables grow 53% and 82% in the 2016 No CPP and 2016 Reference cases, respectively, as compared to the 2015 Reference case.

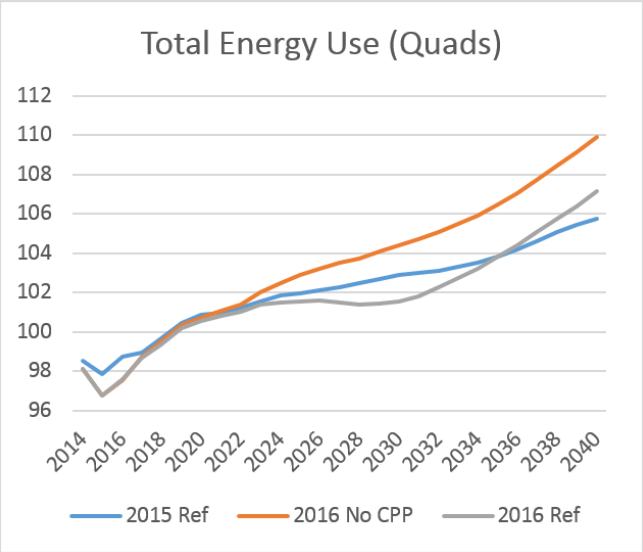
Given these changes, only some of the differences between the 2015 Reference and 2016 No CPP scenarios will be due to policy change. On the other hand, the changes between the 2016 Reference and 2016 No CPP scenarios will be due almost entirely from the modeling of the CPP (inclusive of pricing feedback loops).

Total Energy Use by Sector

The Total Energy Use forecast changed quite a bit between 2015 and 2016, independent of the CPP modeling. In the 2015 Reference scenario, energy use increased moderately through most of the analysis time period, with a slight increase in the out years. By contrast, the 2016 No CPP projection takes a rather different path. Energy use between the two diverges starting in 2023, growing at a much faster clip than before and ultimately ending 4% higher by 2040. As seen on the following page, most of this change comes from the transportation sector in the near-term and the industrial sector in the long-term.

When comparing the two 2016 projections, the impact of the CPP comes into stark relief. Energy use in the 2016 Reference case is held in check (and actually decreases a few years) through 2030, only then increasing after the final CPP goals are reached.[6] From this high level analysis, the CPP contributes to a maximum reduction of about 2.75% relative to the 2016 No CPP scenario, and avoids the cumulative consumption of about 42.5 quads between 2020 and 2040. Savings are split roughly 60/40 between the buildings (residential + commercial) sector and the industrial sector.

6 Given that EIA only models policies that are in place, it likely assumes that any additional efforts to sustain the energy reductions required for the CPP would stop post-2030 and energy use would again continue to rise. This, of course, is not how policies tend to be implemented, but that is how the AEO modeling works.



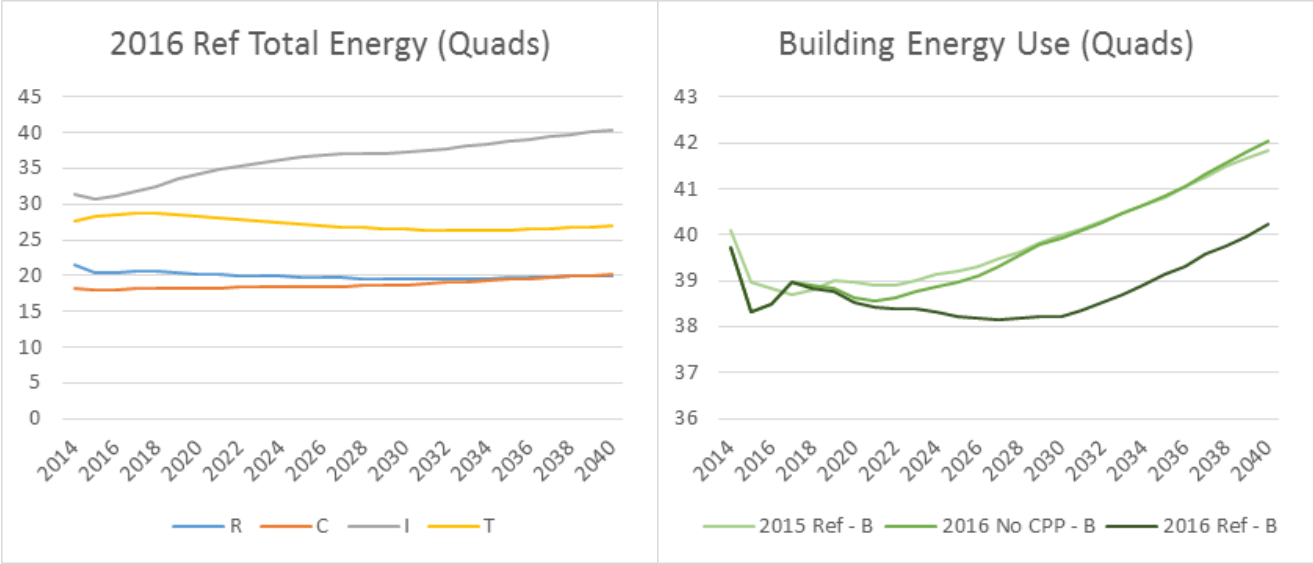
More information is available when looking at the energy use by sector data. The first chart on the following page shows residential (R), commercial (C), industrial (I), and transportation (T) sector total energy use. There is a small near-term influence of appliance standards in the R and C sectors between the 2015 Reference and 2016 No CPP scenarios, but the major difference is the assumed efficiency improvements of the CPP implementation shown in the 2016 Reference case. Energy use in the R sector is held nearly constant through the entire projection period despite an increase in the number of houses; in fact, energy use per household falls 18% between 2015 and 2040 in the 2016 Reference case. C energy use increases very slowly over the years, primarily driven by an increase in "other use" categories,[7] but energy use per square foot decreases at 0.5% per year between 2015 and 2040.

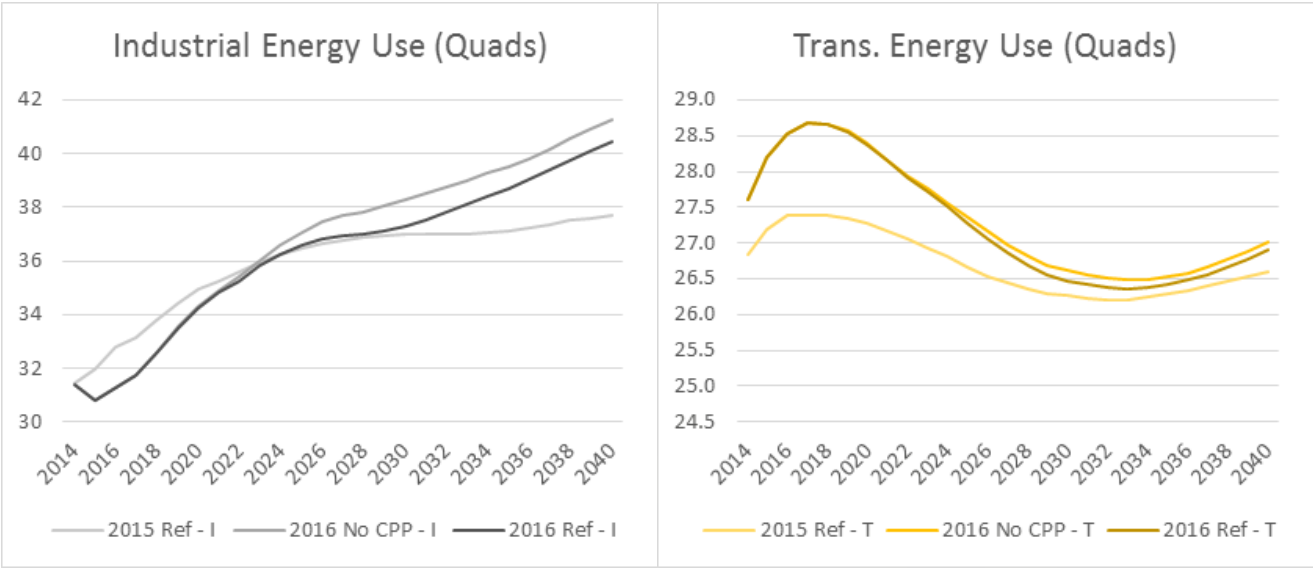
Industrial energy use shows the strongest growth of any of the sectors. This is driven primarily by the increase in economic output of the industrial sector. In particularly, the food products, transportation equipment, mining, and construction sectors see sizable increases in economic output. Energy use increases as well, primarily in petroleum and natural gas usage (the change in industrial electricity use is negligible).

Transportation sees a substantial change in near- and mid-term energy use. Gasoline price projections decreased in the near-term as well, likely driving two trends affecting transportation energy use. The near-term fall in gas prices drive up vehicle miles travelled (VMT) projections by 5-7% through 2025 and to a lesser degree through 2030. It also has markedly shifted the VMT mix from automobiles (i.e. cars) to light trucks (i.e. SUVs). In the 2015 Reference case, total energy

7 This includes items such as medical devices, elevators, escalators, and small appliances not already separately reported.

used by light-duty vehicles was 14.6 quads, split 45%/55% between automobiles and light trucks. The 2016 update increased total energy use of these vehicles to 15.7 quads (7.6%), with a 41%/59% split. Both projections converge in the long-term, with a small residual increase in incremental VMT in the 2016 forecats.





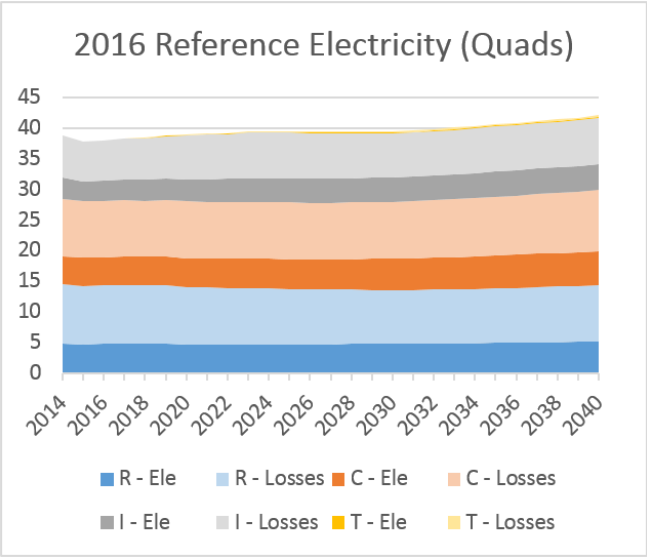
Electricity Use, Efficiency Levels, and Distributed Generation

While total energy use is primarily composed of non-electricity uses (particularly in the transportation and industrial sectors), it is still instructive to analyze the changes in electricity demand as well. The focus of this section is the buildings and industrial sector, as there is negligible (although growing) electricity use in the transportation sector.

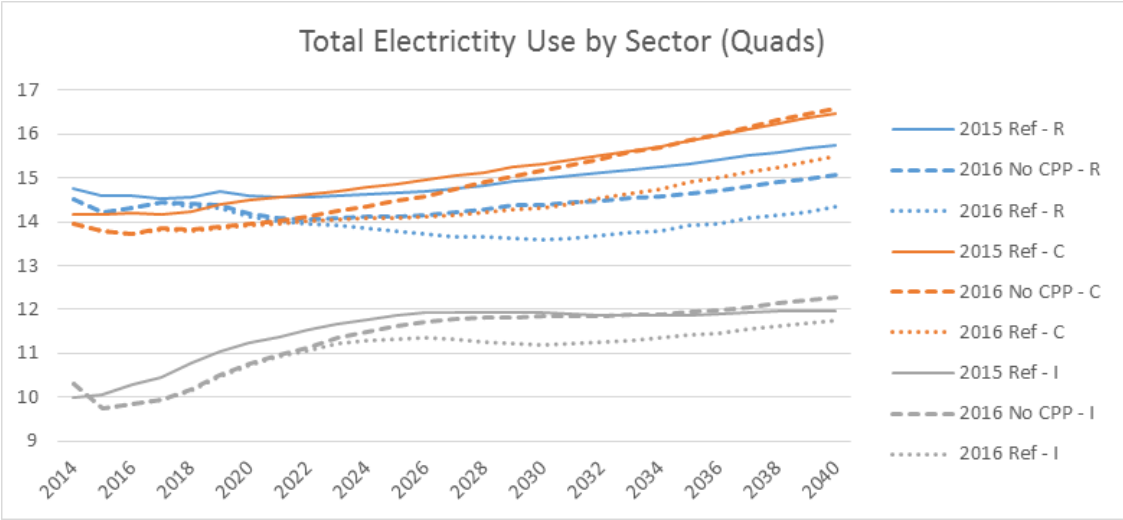
Total Electricity Use

Total electricity energy use continues to be dominated by thermodynamic losses at power plants, although the aggregate efficiency of the fleet increases over time as more efficient natural gas generators and non-combustion solar and wind resources come online.

Total electricity use in 2040 increases slightly in the 2016 Reference forecast, for the same reasons total energy tends to increase. That is, EIA assumes that incremental efforts that increased efficiency to comply with the CPP cease after the goal is met, leading to electricity forecasts that more closely follow the growth in population. This is visible in the next graph showing the change in the R, C, and I sector electricity use in each of the cases.



Total residential electricity use falls 6.4% on an absolute basis from 2014 to 2030 in the 2016 Reference case, as compared to a drop of 0.9% in the 2016 No CPP case and an *increase* of 1.6% in the 2015 Reference case. Commercial electricity use shows similar deltas between the forecasts, but the total change remains positive in all three cases. C use in 2030 grows 2.6% with the CPP in place and 8.6% without the CPP, a value which is actually quite similar to the 2015 Reference case. Industrial electricity use increases quite strongly in each case through the late 2020s, and generally steadies after that time. While electricity comprises only about one third of industrial energy consumption, increases from 2015 are moderated from 19.2% in the 2015 Reference case down to 8.8% in the 2016 Reference case. On the whole, these forecasts show the importance of policies and regulations to manage electricity use throughout all sectors of the economy.

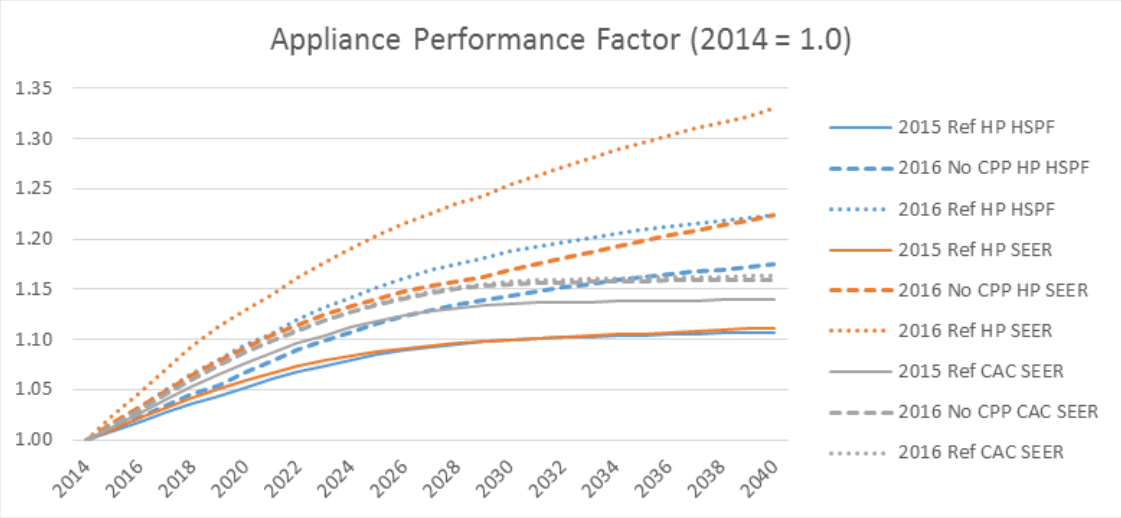


Efficiency of Installed Stock

Looking into the residential, commercial and industrial (R, C, I) sectors separately, we see two main drivers causing the differences between the scenarios. The first is the increasing strength of codes and standards working their way into the R and C sectors, accompanied by demographic shifts that change how many people use heating and cooling equipment. The second is the increasing penetration of distributed generation under both 2016 scenarios, eroding the need to purchase electricity from the power sector.

As mentioned before, the two major changes between the 2015 Reference and 2016 No CPP scenarios are updated fuel prices and the incorporation of new codes and standards. Electricity use in the R and C sectors reflect some of these changes, while changes in the I sector are less driven by standards and more by industrial activity and responsiveness to pricing.

Average energy efficiency for three major categories of residential end use are shown below: heat pump heating (HSPF), heat pump cooling (SEER), and central air conditioners (SEER). The graph shows the relative change in the rating associated with the appliances, with 2014 serving as the starting point. Improvement is visible from the 2015 Reference case (solid line) to the 2016 No CPP case (dashed). This reflects both the incorporation of new appliance standards as well as a change it the HDD/CDD weights that EIA developed for each region.[8]



But an even more dramatic change is visible between the 2016 No CPP and the 2016 Reference cases (dotted). While the addition of the CPP does not add any new codes or standards to the mix, it likely does include an increase in state activity to reduce energy use (given that EE is the least expensive way to meet the CPP, this makes intuitive sense). This is particularly visible in the change in the average efficiency of heat pumps for cooling purposes, where the relative efficiency in 2030 increases 6.3% from standards and demography shifts, but jumps another 7.2% with the implementation of the CPP. This offers a tantalizing data point between the question of how much focus should be on increasing codes and standards as compared to deploying technology or policies that are already in the market.

While not shown in this chart, the installed stock of water heaters, refrigerators, and freezers also see sizable energy efficiency improvements. Heat pump water heaters begin to be deployed in greater numbers earlier in the 2016 cases, possibly as the result of utility rebate programs designed to reduce electricity use to help with state CPP compliance, and the average stock of refrigerators and freezers use about 25% less energy per year in 2030 than in 2014.

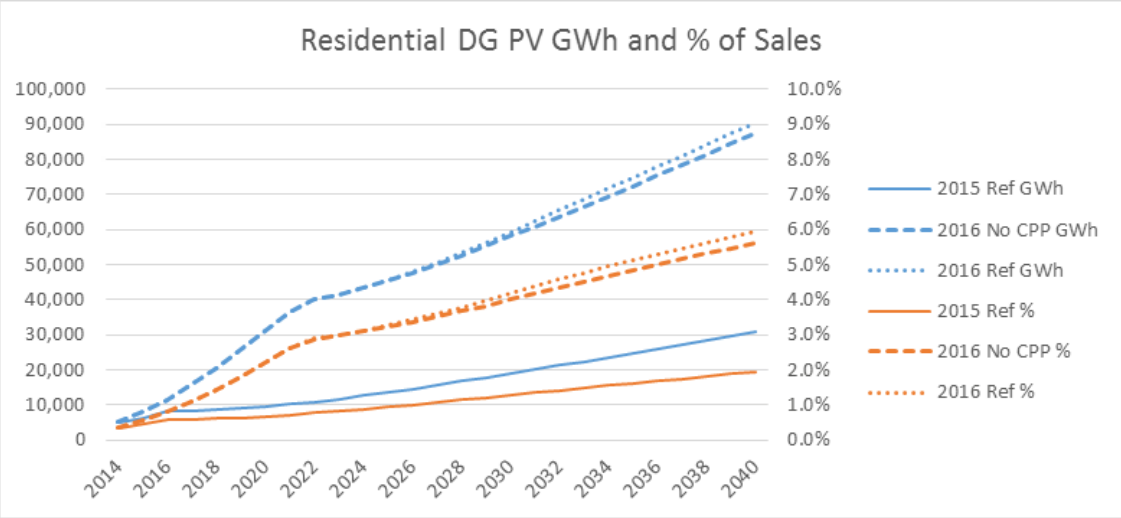
8 EIA develops a weighted HDD/CDD (heating degree day/cooling degree day) scale to reflect changes in population growth and demographics. For example, if more people move to an area with a higher HDD baseline, it will increase relative to the previous year's value. In the 2016 update, regional 2030 HDD generally increased between 2% and 5%, while regional 2030 CDD fell between 1% and 4%.

Distributed Generation

The other major change between the scenarios is the assumptions about the increase in distributed generation. While utility-scale solar and wind projections are discussed below, distributed (i.e. rooftop or behind-the-meter) solar has a direct impact on end-use energy consumption. And given that roughly 2 units of fuel are required to generate, transmit, and deliver 1 unit of electricity, on-site consumption of zero carbon, zero fuel use photovoltaic solar (PV) has a powerful multiplier effect on total energy.

The projections of residential distributed generation (DG) PV changed dramatically between 2015 and 2016. The 2015 Reference case increased total GWh of DG PV relatively quickly (~30% YOY) in 2015 and 2016 before dropping to a 3-7% YOY growth through 2040 following the expiration of the federal ITC. This took total generation from 6,418 GWh in 2015 to 30,977 GWh in 2040. By contrast, even the more conservative 2016 No CPP case held growth rates higher through 2022 (corresponding to the end of the tax extension phase out) before dropping. However, given the boost from the early compounding period, the 2016 Reference case terminates at 90,423 GWh, a three-fold increase over the 2015 Reference case.

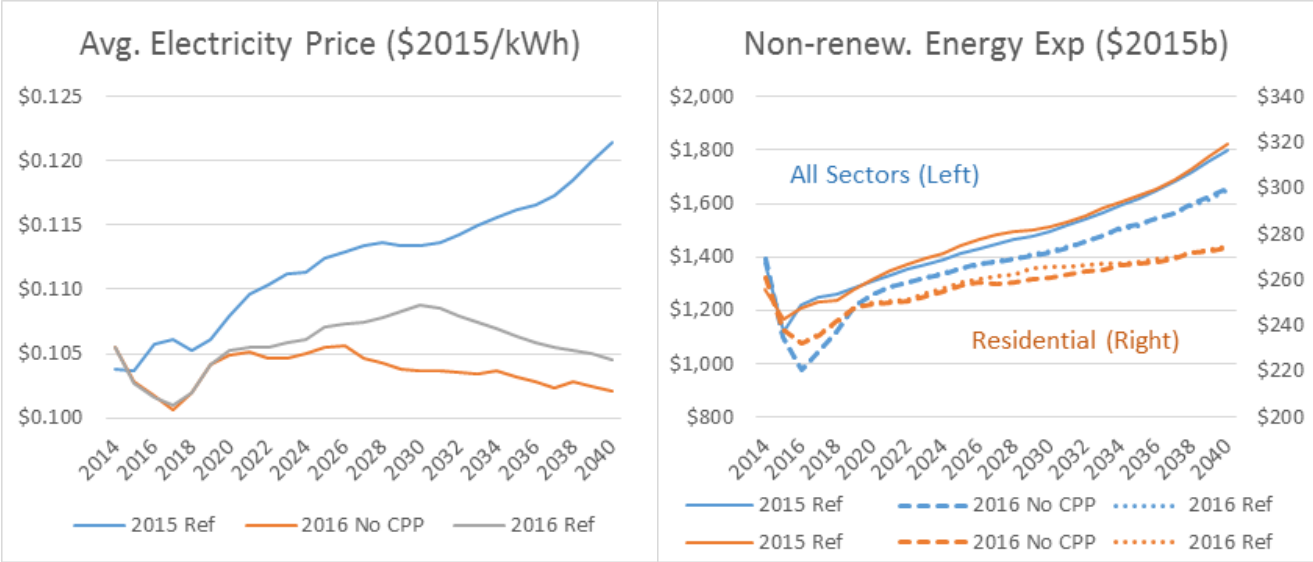
This compounding results in an increasingly relevant electricity source. While all scenarios had residential DG PV under 1% of sales through 2016, the 2015 Reference scenario only grew to 2% in 25 years. By contrast, the 2016 Reference forecast crosses the 2% threshold in 2020 on its way to nearly 6% in 2040. A similar but less pronounced effect is seen in the commercial sector.



Prices and Expenditures

The combination of these two factors contributes to lower electricity sales growth in the R and C sectors, while I sector growth drops in the 2016 Reference forecast relative to the 2016 No CPP forecast in part due to an assumption about the use of increasingly efficient motors that holds the increase in electricity down slightly.

The result of lower sales from the power sector is intuitive: lower prices. Where the 2015 Reference case showed prices increasing through most of the analysis period, both 2016 forecasts climb to a peak before falling. While the incorporation of the CPP does increase prices somewhat relative to the 2016 No CPP case, the delta is swamped by the drop in prices from the 2015 Reference to the 2016 Reference scenarios. 2016 Reference prices peak in 2030 at 10.9 cents/kWh, 6% lower than the 2015 Reference price. By 2040, the increase in distributed PV and lower gas prices push prices down to 10.5 cents/kWh, nearly 14% lower than the 2015 Reference case.



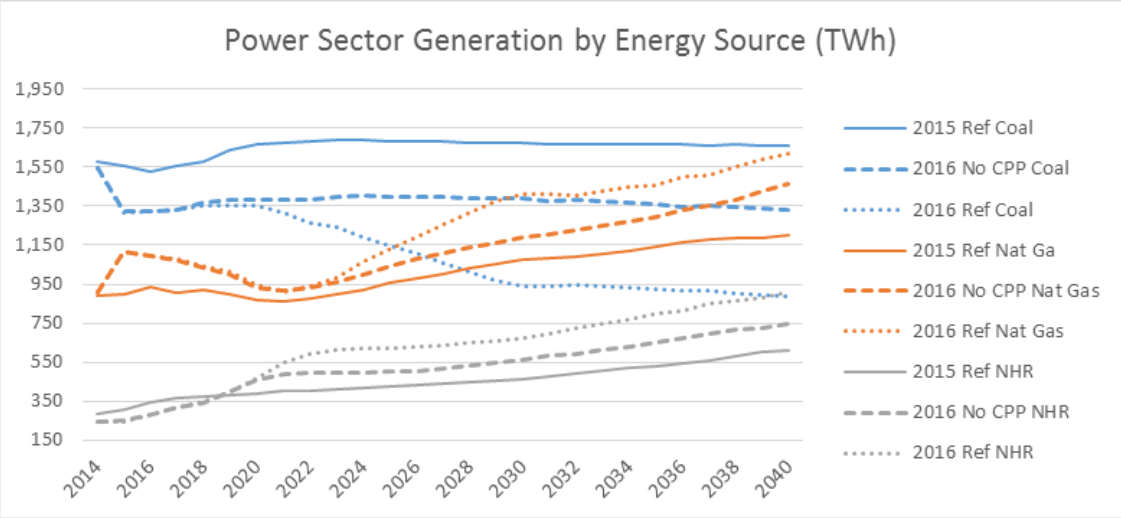
The combination of lower prices and lower consumption results in lower non-renewable energy expenditures. Both 2016 scenarios show a substantial drop in near-term expenditures, driven by lower oil and natural gas price forecasts. In the 2015 Reference case, the residential sector (orange) and all sector (blue) lines stay tightly correlated through 2040. Both 2016 cases drive total expenditures down roughly 3-5% between 2020 and 2040 compared to the 2015 Reference case. Importantly, there is almost no difference in total non-renewable expenditures between the 2016 No CPP and Reference cases, with expenditures staying within 0.2% of each other in most years.

Residential non-renewable energy expenditures show a steeper drop between the 2015 and 2016 cases. This is primarily a function of the higher proportion of electricity and natural gas expenses in this sector (household transportation costs are captured in the transportation sector). Here, we do see a slight increase in expenditures for the 2016 Reference case over the 2016 No CPP case, peaking at about 1.9% higher in 2030. That said, expenditures even with the CPP in the model stay roughly 4-6% lower through 2030 before opening a gap of roughly 8-13% in the 2030 to 2040 timeframe. Total residential non-renewable energy expenditures from 2016 to 2040 are about $485 billion lower in the 2016 Reference case than the 2015 Reference case, while all non-renewable energy expenditures are $2.2 trillion lower for the same time period.

Power Sector Electricity Generation

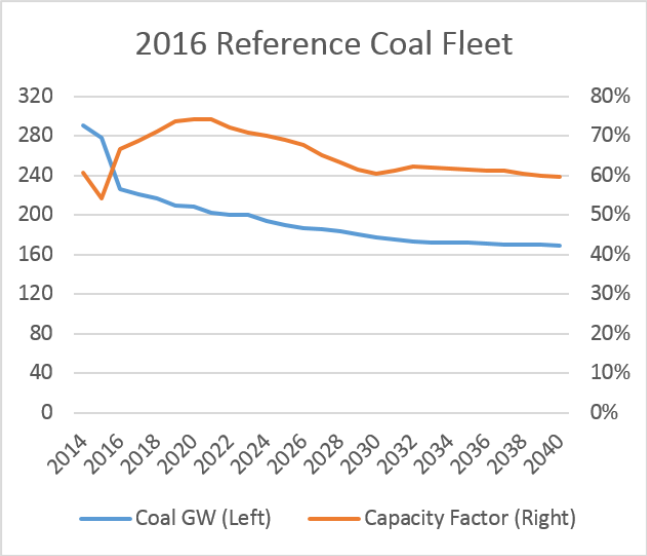
Two major changes that impact power generation occurred between the 2015 and 2016 AEO reports. First, the relative share of coal and natural gas generation, *independent of the CPP*, was affected by the spark spread[9] between these fuels. Given the relatively lower natural gas forecast in 2016 vs 2015, this is not unexpected. Total coal generation *without the CPP* is projected to fall roughly 17% in the 2020s, while natural gas generation increases 9% over the same time period. When the CPP is added, coal generation drops substantially more, with 2030 coal generation in the 2016 Reference case 32% below the 2016 No CPP case, and 44% lower than the 2015 Reference case.

Second, EIA's forecast of renewable generation is impacted by the extension of the ITC and updated capital cost estimates. EIA is notoriously conservative on renewable deployment, but it seems that some discussions between EIA and clean energy industry associations reflected a bolder outlook on renewables this year. Non-hydro renewable (NHR) growth projections are substantially higher in both 2016 cases, and obviously higher yet in the 2016 Reference case. The chart below shows power sector generation (not including distributed generation) for coal, natural gas, and NHR.



Coal Generation

The outlook for coal plants in the 2016 Reference case is fairly grim, in any scenario. There was a wave of coal plant closures between 2012 and 2016, totaling roughly 60 GW of capacity, largely in response to MATS standards[10] and economic pressures due to low natural gas prices. There are another 12 GW of coal plants that have announced retirement or conversion to natural gas through 2020. EIA's 2016 Reference scenario projects 18 GW of retirements between 2017 and 2020 (6 GW more than currently announced), 31 GW between 2020 and 2030, and an additional 7 GW of closures between 2030 and 2040. Coal capacity is projected to fall from 226 GW in 2016 to 177 GW in 2030 to 170 GW in 2040. Considering that as recently as 2011 there were 318 GW of coal plants in operation, this is a considerable change.



There is an interesting element to EIA's projections related to what types of coal plants it expects to retire. From 2015 to 2020, the total capacity factor of coal

9 The cost difference per unit of energy for fuels.

10 Many of the plants that retired when the MATS (Mercury and Air Toxics Standards) were old, inefficient peaker plants. The cost of installing environmental upgrades would have been greater than their earned revenue from staying in the market.

plants increases, suggesting that low-capacity factor plants are the ones retiring. This makes sense economically in a flat-to-falling fuel price scenario as those plants that are less efficient are also not as competitive in the market and tend to run less, earning fewer hours of dispatch and thus lower revenue.[11] But starting in 2022, the average capacity factor of the coal fleet falls. This can be caused by two factors: baseload plants run less, or baseload plants retire. It is difficult to tell from the data which of those is occurring (plants do continue to retire, but EIA does not provide enough data to determine which plants).

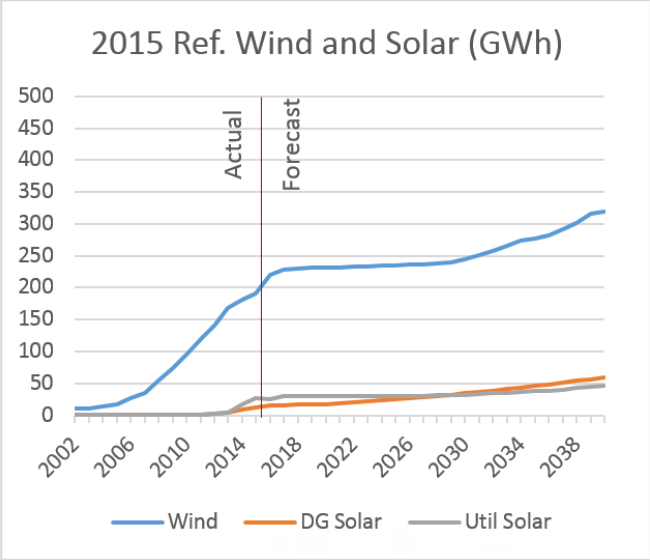
If one assumes that the most inefficient plants were culled from 2012 to 2020, then the most "healthy" will be those remaining to see their capacity factor fall from an average of 74% to 60% over the next decade. It is unclear how many of these plants, despite still being relatively efficient, can survive a 20% drop in run time without shutting down. Further, it is unknown whether a plant that was designed to run as a baseload unit (i.e. 85-90% capacity factor) is economically sustainable at 60%.

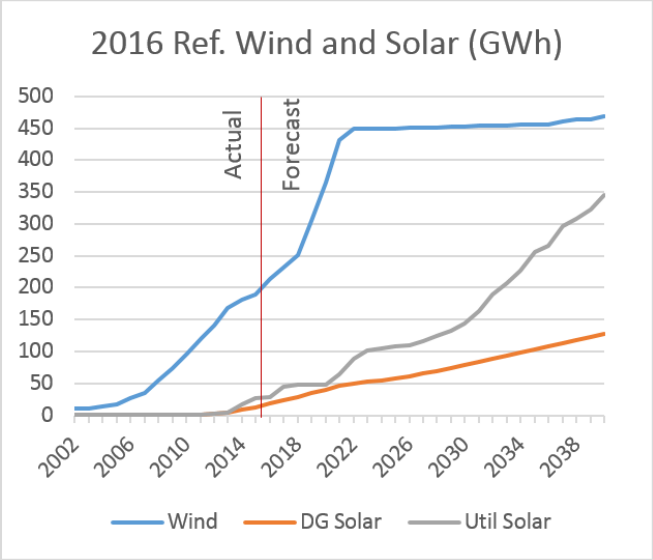
Utility-Scale Wind and Solar

While coal is facing challenges in light of sustained low natural gas prices, existing multi-pollutant regulations, and pending carbon emission protocols, renewables are well positioned. EIA has been notorious in the past for underestimating the projected growth of renewables, and while improvements have been made in the 2016 forecasts, they still contain suspect assumptions that all wind installations will stop when the PTC expires and that no utility scale solar will be built between 2017 and 2020.

That said, the forecasts have improved somewhat to better match historic trends. The 2015 Reference forecast had both solar and wind builds essentially stopping with the expiration of the federal PTC and ITC, despite the obvious trends in both of those markets and continuing support from state renewable portfolio standards. Paradoxically, the forecasted value for 2016 utility scale solar generation was below the *actual* 2015 utility scale solar generation value. Wind projections also reflected the limitations of the NEMS modeling approach, suggesting that all wind development would essentially stop for a decade before picking up slightly in 2030.

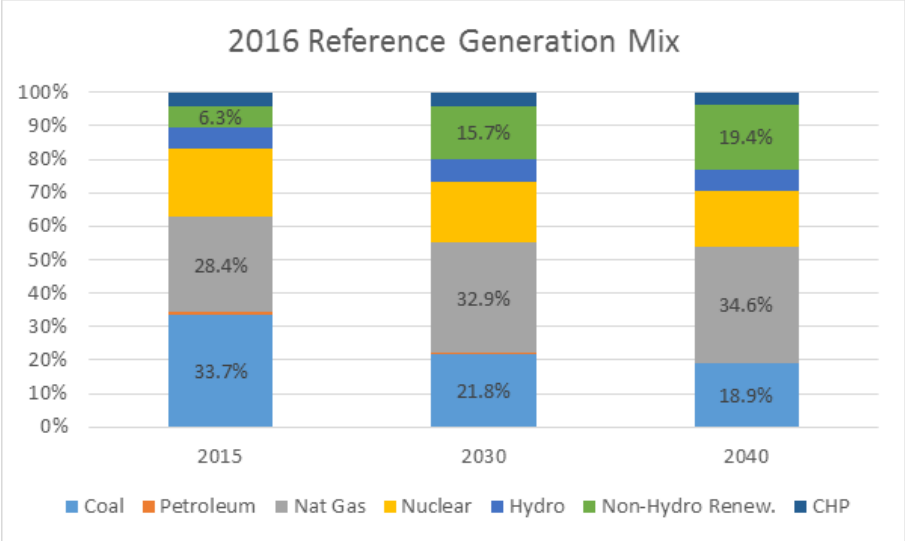
In the 2016 Reference case, we see a substantial increase in the amount of wind generation from the previous forecast, plateauing roughly 92% higher at 450 GWh a year as compared to 230 GWh a year. Solar shows an even greater increase. Where the 2015 forecast had utility and DG solar growing slowly to surpass 100 GWh a year in 2039, the 2016 Reference forecast blows through 100 GWh in 2021 (18 years earlier!) and continues to 472 GWh in 2040. Interestingly, most of the post-2030 growth in NHR is in utility-scale solar. Based on EIA's modeling, this implies that solar and natural gas become the most cost-effective generation source to meet continued load growth. To see that reflected in EIA's own forecasts is quite incredible considering the state of affairs only 10 years ago.





11 In most wholesale energy markets, generating units are told to run, or "dispatched", from the lowest marginal cost unit to the highest marginal cost unit up to the point where the total load is met. If a unit's marginal cost is too high to be selected for a given time internal, it will not earn any revenues, but will still have to cover fixed costs.

The combination of these factors changes the overall power sector fuel mix of the 2016 Reference case considerably. Coal generation falls from just over a third in 2015 to 21.8% in 2030 before landing at 18.9% in 2040. Natural gas picks up some of the slack, increasing from 28.4% to 32.9% and 34.6% in 2015, 2030, and 2040 respectively. But the largest winner by far is NHR, dominated by the increase in solar and wind. From a starting point of 6.3% in 2015, these fuel sources grow to 15.7% in 2030 and 19.4% in 2040, eclipsing coal generation at the terminus of the forecast time period.

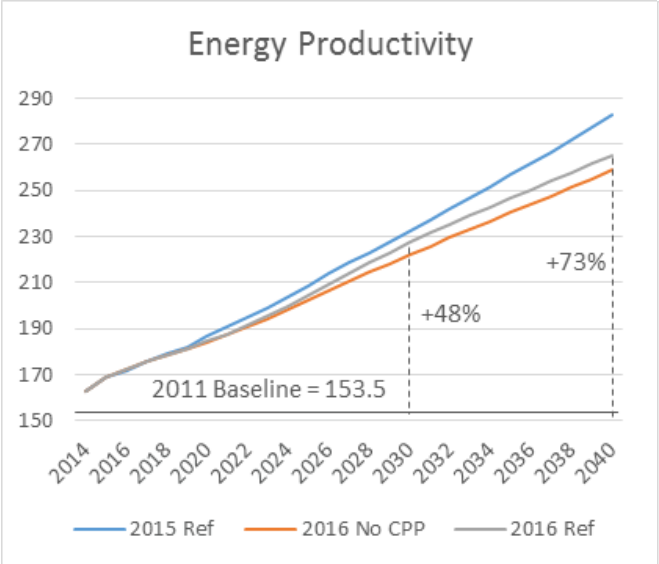


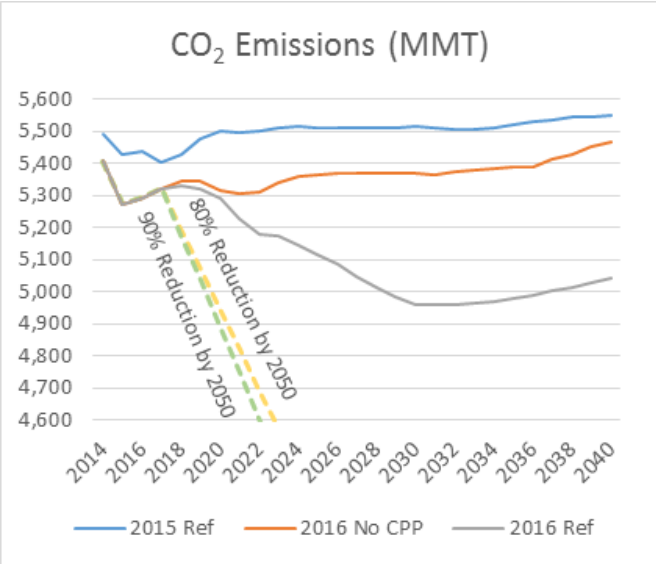
Energy Productivity and CO_2

Energy productivity is defined as the ratio of GDP to energy use. More simply, it is the amount of GDP that the country produces for each unit of energy that it uses. Energy productivity continues to increase steadily, although the change to the GDP forecast slows the 2016 growth rate compared to the 2015 growth rate. Energy productivity in 2030 falls to 227.6 ($2009/quad) in the 2016 Reference forecast from 232.2 in the 2015 Reference forecast, a drop of 2%. Compared to the 2011 baseline figure of 153.5, this results in a 48% increase by 2030. The 2016 Reference scenario puts 2040 energy productivity at 265.0 (down from 282.8 in the 2015 Reference forecast), good for a 73% increase from the 2011 baseline.

Unsurprisingly, the 2016 updates to the modeling inputs — particularly the price forecast of natural gas — reduce CO_2 independent of the CPP implementation. Where the 2015 Reference case had CO_2 levels staying roughly level at 5,500 million metric tons (MMT) per year, the 2016 No CPP case holds steady around 5,375 MMT for most of the 2030s. This reflects a continued shift from coal to natural gas in the electricity sector driven by the spark spread between the two fuels, as mentioned in the previous section.

While all well and good, the CPP implementation drives much deeper reductions in CO_2 emissions than the modeling updates. CO_2 emissions hit their lowest point in 2031 at 4,959 MMT, and then slowly climb back up to 5,044 MMT by 2040 (a consequence of the increase in total energy use discussed previously). 2005 CO_2 levels were 5,993 MMT, so the 2031 nadir represents a 17.3% drop in total emissions (the 32% CPP reduction target is just for the electric power sector) before giving back some gains to end at a 15.8% drop in 2040. While this is progress, it is obviously miles away from the 80%-90% drop in CO_2 levels that are needed just ten years later to reach deep decarbonization goals consistent with Intergovernmental Panel on Climate Change (IPCC) targets.





Concluding Thoughts

There is much to digest in the early and subsequent release of AEO 2016. The implementation of the CPP produces substantial changes to the 2015 Reference case forecast. Energy use falls, renewable generation expands, and CO_2 levels drop. While these are great results, more work is needed to continue to drive up energy productivity and drive down CO_2 levels.

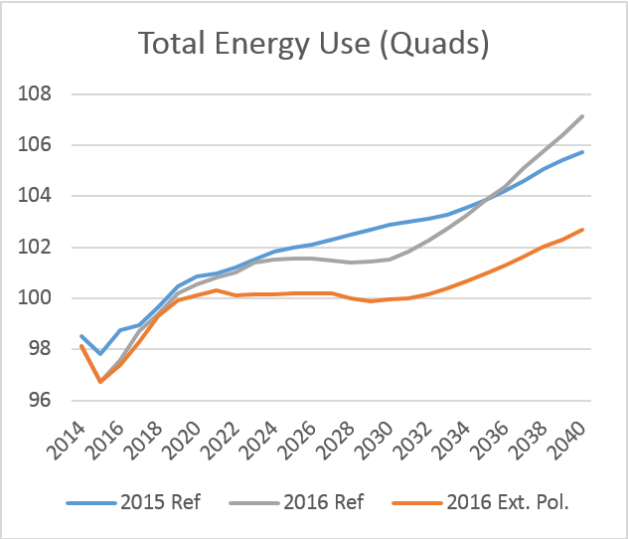
Section Two – Extended Policies Case

While the first section of this paper focused on the changes between the 2015 and 2016 cases and the impact of the CPP, this section will examine one of the side cases that EIA produces as part of its full AEO release. The point of this analysis is not to advocate for or against any of the specific policy solutions contained in this scenario, but rather to illustrate the aggregate impact that they have compared to the Reference case. In this AEO issuance, EIA developed an Extended Policies case that wraps in a number of additional assumptions beyond the currently-existing policies. These include the following:

- The PTC and ITC for renewable generation remain in effect at their current levels through 2040, rather than declining or expiring as is currently the case
- Residential and building-sector tax credits for EE and RE remain in effect in perpetuity at their current levels
- Appliance standards are strengthened per DOE's multi-year plan, and voluntary standards cover additional equipment not subject to federal standards
- Federal energy codes for residential and commercial buildings are updated in 2025 and 2034 and phased in over 9 years
- CAFE standards continue to increase 1.4% annually for new LDVs after 2025, and Phase 2 standards for MDVs and HDVs are implemented
- The CPP is extended, from 35% below 2005 levels in 2030 to 45% below 2005 levels in 2040
- Industrial sector CHP ITC continues through 2040 instead of expiring in 2016, and is expanded to include more plants

While some argue that additional policies and actions to further reduce energy use and CO_2 emissions may be damaging to our country's economic health, these analyses prove otherwise. When combined, these additional polices result in substantial additional reductions in energy use and CO_2 emissions over the Reference case, as well as increased investment in EE and RE. It is most important to note that this occurs **with a truly *de minimis* impact on GDP** (cumulative GDP from 2020 — 2040 falling by a mere 0.1%) and **an 80% improvement in energy productivity from 2011 levels**.

Total Energy Use by Sector

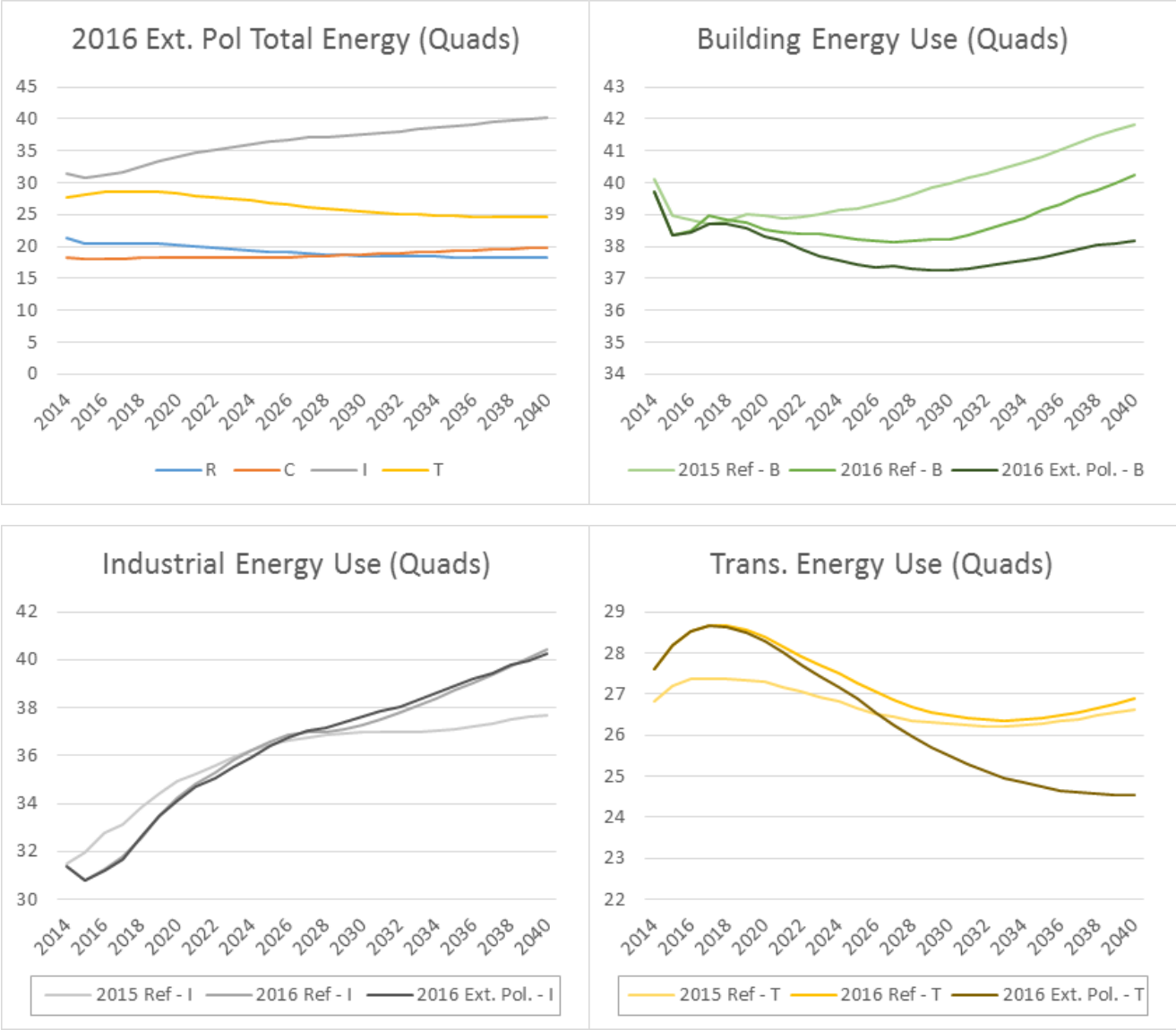


Given that the Extended Policies case includes many energy efficiency policies, it should be no surprise that total energy use is lower than in the 2016 Reference case, which itself was lower than the 2015 Reference case. However, it is instructive that an aggressive combination of policies is needed to truly make our nation more energy productive, by holding the line on energy use as population and economy grows. This case only holds energy use steady through 2032, before total energy use continues to increase (albeit more slowly than the 2016 Reference case).

The comparison between the 2016 Reference and Extended Policies case shows the importance of continued vigilance in energy efficiency policy. While the Reference case continued to push energy savings policies such as building codes and appliance standards through 2030 in part to help meet the CPP, they were assumed to relax in the post-2030 compliance period. The result is a steep increase in energy use as population and the economy grow. From 2030 to 2040, total energy use in the Reference case grows by 0.53% annually, after having remained nearly flat from 2020 to 2030. While this is considerably lower than the 1.58% annual growth from 1990 to 2000, it does result in a continued upward need for additional energy and energy infrastructure.

In contrast, the Extended Policies position is able to shift and flatten the growth curve. Total energy use is roughly 1.2% lower during the 2020s, and post-2030 growth is half as much at 0.26%.

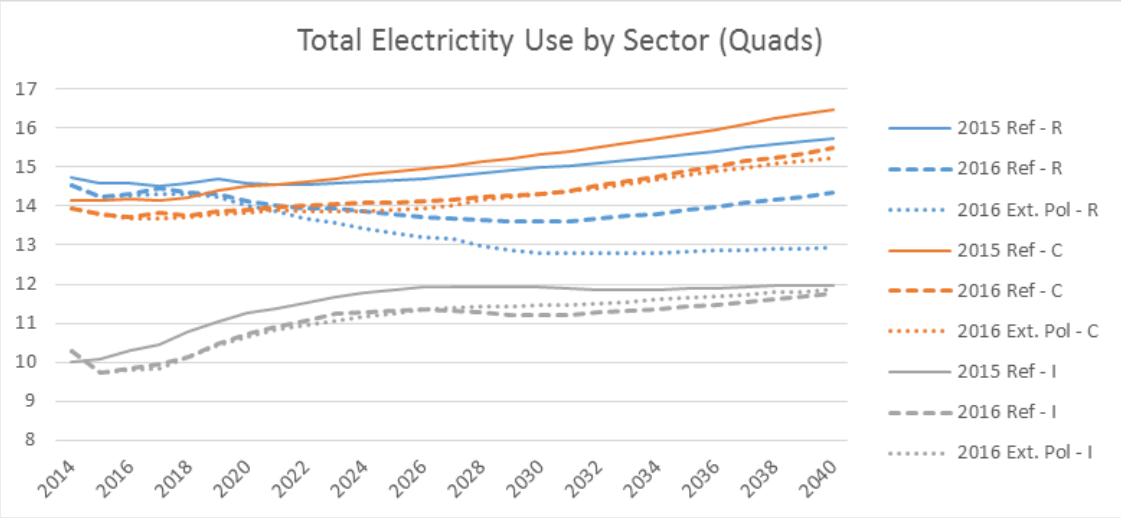
The impact of the Extended Policies case is also evident in each end use sector. Below we can see the continued impact of codes and standards on the building sector and of CAFE standards on the transportation sector. Industrial energy use, not subject to either of these regulatory pressures (although much work is done through voluntary agreements), continues to grow.



Energy Use, Efficiency Levels, and Distributed Generation

Total Energy Use and Efficiency Levels

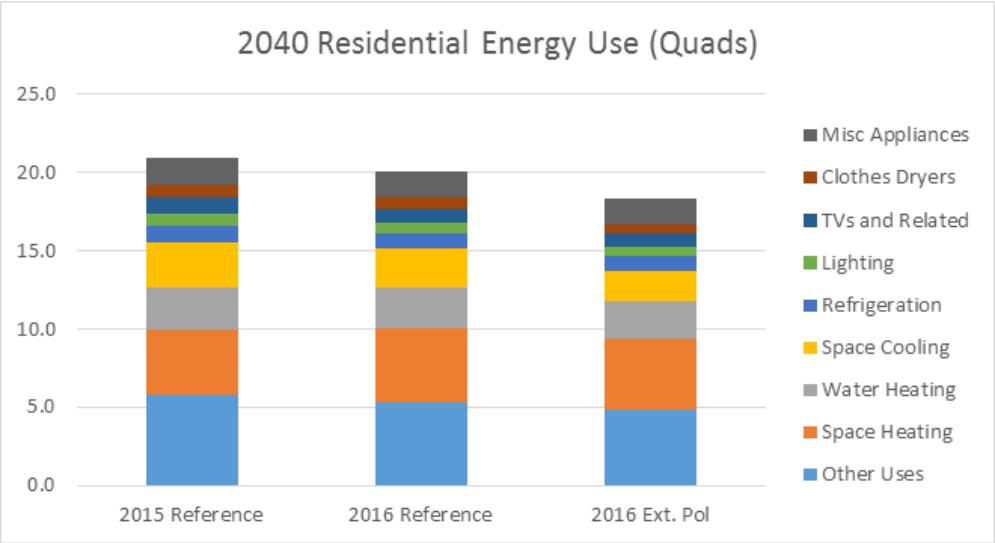
Total 2040 electricity use in the Extended Policies case is about 5% lower than the Reference case, primarily driven by an 11.5% reduction in residential electricity use. The impact of additional codes and standards in that sector is evident, although it is not immediately obvious why there was not a corresponding reduction in the commercial sector given the policies that have been implemented in this case.

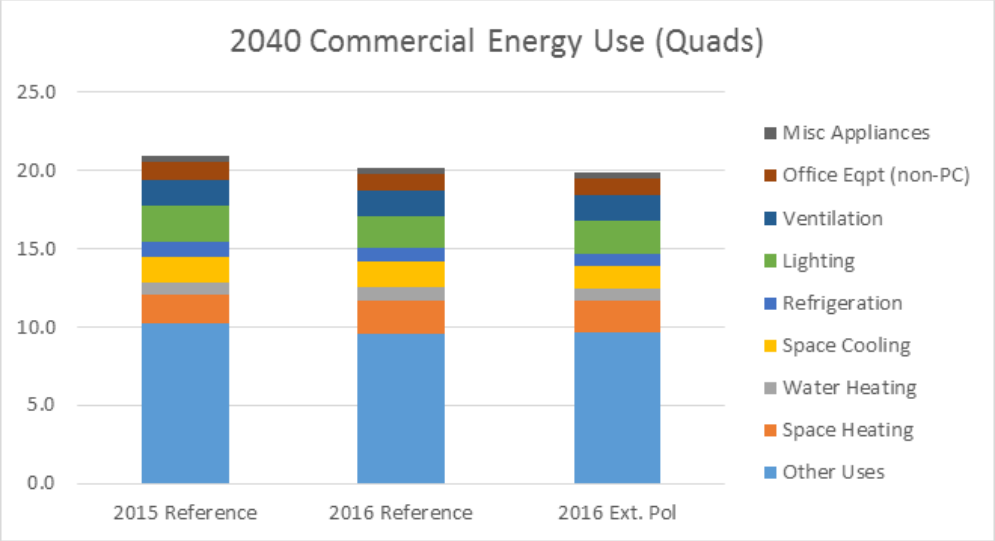


That said, AEO does include total energy use by end use category (such as lighting and refrigeration) and it is possible to see some of the reasons why the commercial sector does not improve as much as the residential sector. EIA classifies end use into several major categories, and sums the remainder in the catch-all "other uses" category. In the supplemental data, there are several additional categories that EIA delineates in the "other uses" bucket, such as set top boxes and ceiling fans for residential buildings and medical imaging systems and elevators for commercial buildings. But there still remains a persistent "other other" category of miscellaneous electrical loads (MELs) that is currently outside of EIA's data scope. These MELs comprise a substantial amount of the total electricity use, and thus a disproportionally large share of total energy, particularly in the commercial sector.[12] In fact, not only are MELs quickly becoming the largest commercial use of electricity, they represent one of the only end uses that is actually increasing between 2015 and 2040 in the Extended Policies scenario.

The trends become evident when looking at the 2040 total end use by category. In the residential sector, the Extended Policies assumptions continue to push down categories such as space cooling and water heating, leading to an 8.9% drop in sector total energy use from the 2016 Reference case. However, the domination of the commercial sector by the "other uses" category leaves less room for improvements among defined end-use categories. The Extended Policies case is only able to reduce sector total energy use by 1.5%, even as total square footage increases for commercial buildings at roughly the same rate as residential buildings.

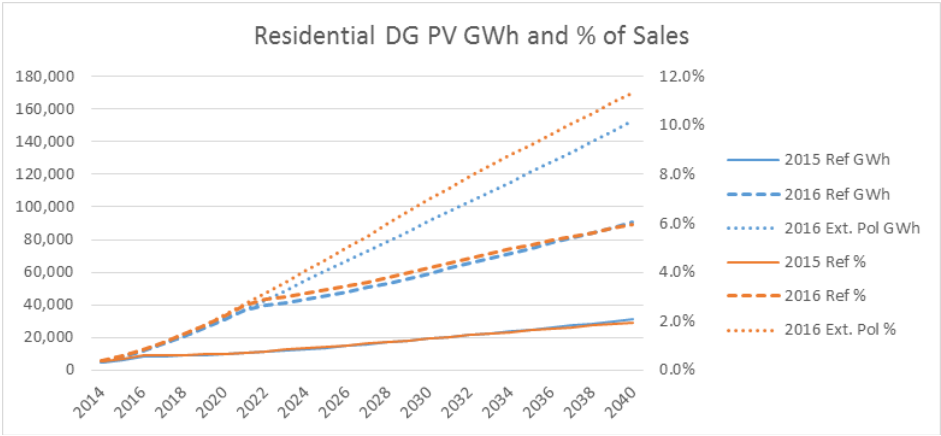
12 Recall that every unit of delivered electrical energy requires roughly three units of source energy, thus the multiplicative effect of electrical loads in the total energy data points.





Distributed Generation

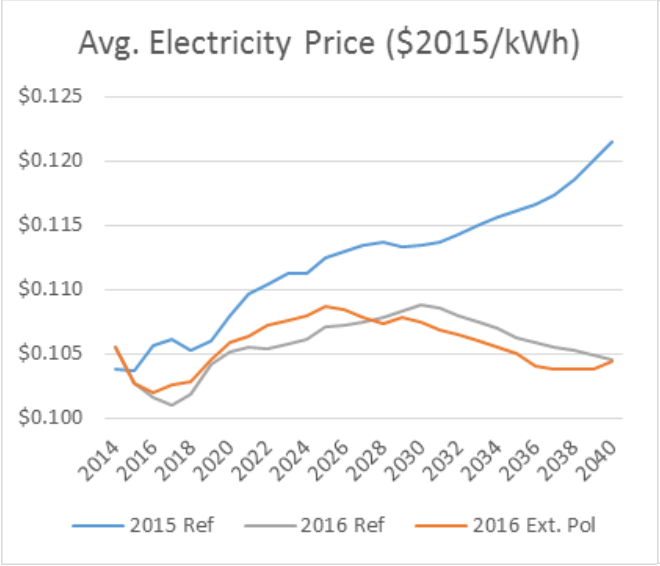
The 2016 Reference case made substantial changes to the assumptions around DG and renewable energy from the 2015 Reference case, and the 2016 Extended Policies case continues to make modifications. The extension of key tax credits for distributed solar lead to a large increase in the quantity of electricity produced in this sector. Where the 2016 Reference case has DG PV growth slowing substantially coincident to the expiration of the tax credits, the Extended Policies case show steady growth through 2040. This results in a 2040 outcome with nearly double the generation from DG PV, with DG PV representing just over 11% of total residential electricity end use.

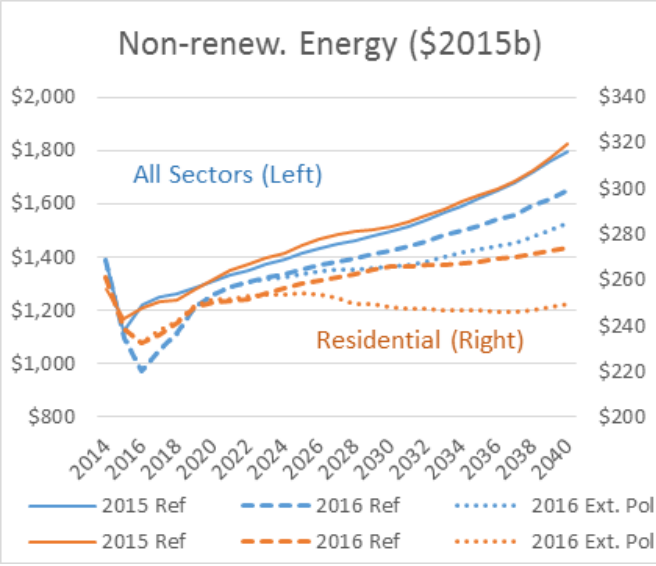


Prices and Expenditures

A reduction in electricity demand will, all else equal, produce downward pressure on electricity prices. However, the complex interplay of the various Extended Policies assumptions results in a somewhat counter-intuitive result. As we see below, in the near term, electricity prices increase. This is due in part to the lack of a pre-tax-expiration construction boom for wind systems. With the federal taxes now locked in through 2040, builders do not build as much in the early years, leaving the generation to be met with additional natural gas generation. As given the exchange for zero marginal cost wind electricity for non-zero marginal cost natural gas electricity, prices increase in the short term. This trend is reversed later in the forecast period when additional wind resources are brought on and continue to hold down electricity prices.

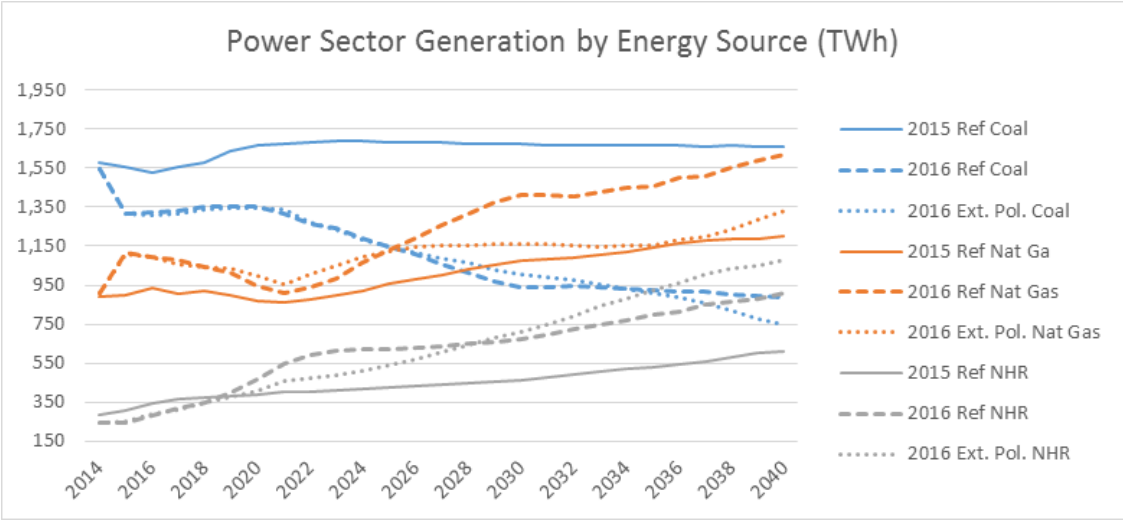
Over the 25-year span from 2016 to 2040, consumers are projected to spend almost $1.1 billion ($2015), or 3.3%, less on non-renewable electricity expenditures in the Extended Polices case compared to the Reference case. Residential customers see an even larger reduction of 4.1% in their utility costs. While these costs are offset through higher expenditures for energy efficiency and renewable energy hardware, those investments can typically be financed or amortized over a longer period of time. Meanwhile, the reductions in consumers' electricity bills are reflected each month.



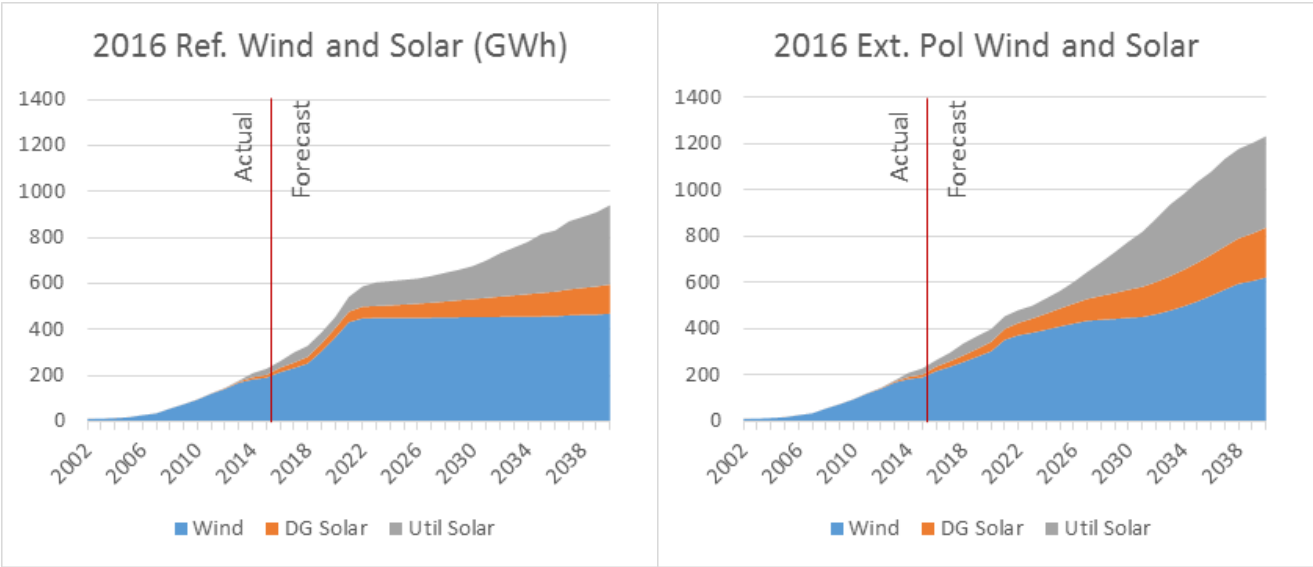


Power Sector Electricity Generation

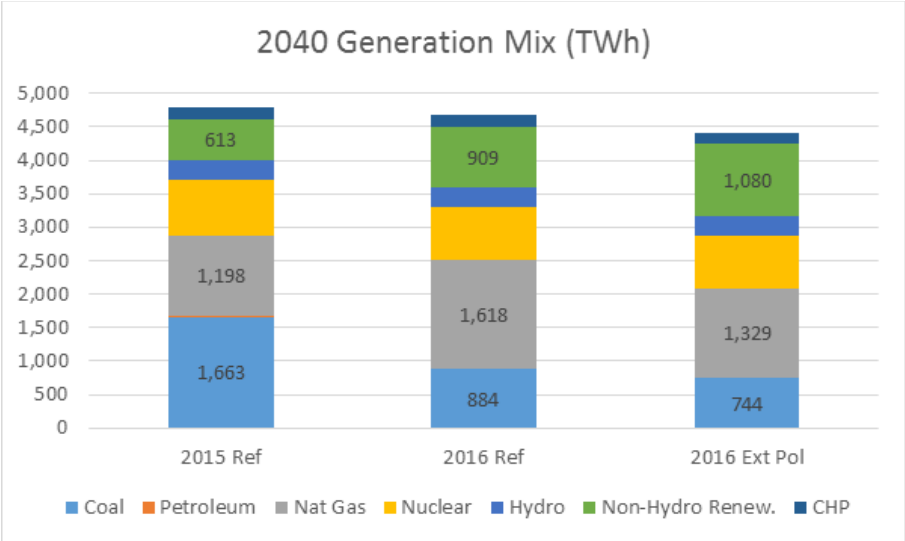
The extension of federal tax credits for renewable energy has a marked impact on the power sector generation mix. As discussed above, released of the need to build projects to beat a tax step-down and presented with a longer runway for development, utility-scale wind and solar developers respond by increasing their 2040 renewable generation output by nearly 25%. This offsets coal in the long run, with a reduction in coal generation in 2035 and beyond. While natural gas generation increases slightly in the short run due to the delay in wind construction, it sees the bulk of the displacement from additional renewable generation and lower electricity demand in the long run.



The changes in utility scale wind and solar are sizable. With the federal tax credit extensions secured, investment continues to grow past 2020, particularly in utility-scale wind. Rather than the industry crashing to a halt in 2023, growth continues through the forecast horizon, resulting in 2040 output that is 33% higher than the 2016 Reference case. Of course, it is unlikely even with the expiration of the PTC that no new utility scale wind would be constructed post-2023, but the changes in tax policy do make a difference within the confines of the model. Utility scale solar also sees a strong increase, with 2040 output increasing 14% over the 2016 Reference case.

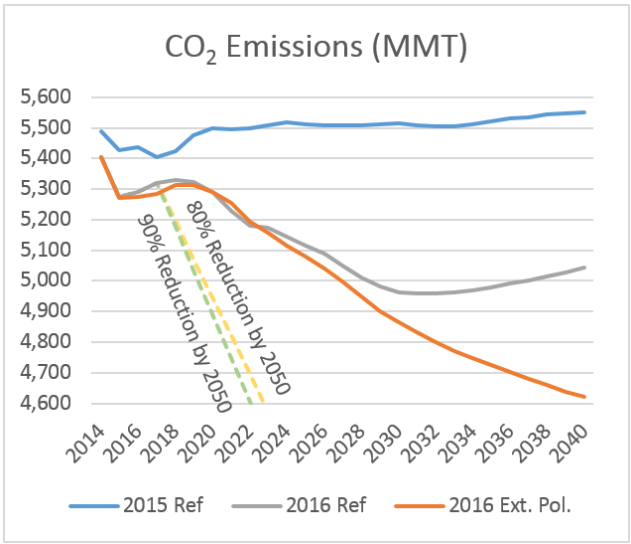


As a result, the Extended Policies case leads to a dramatically different fuel mix in 2040. By then, total electricity demand has fallen. Non-hydro renewable generation (primarily wind and solar) has increased substantially, and coal generation has been reduced dramatically. Natural gas generation falls, albeit to a lesser extent, compared to the reference.



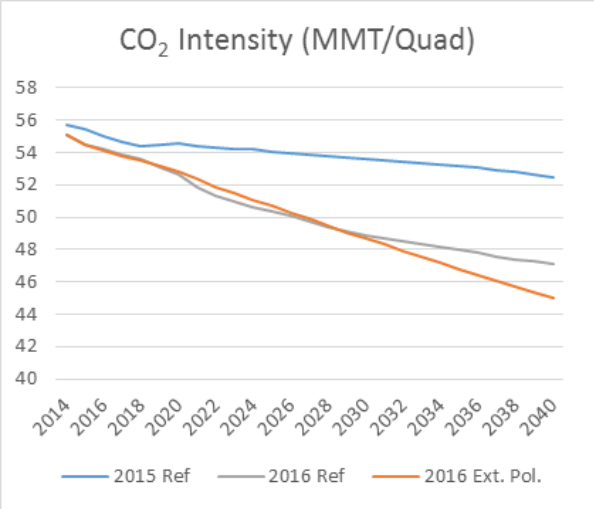
CO_2 Emissions, Energy Productivity and CO_2 Productivity

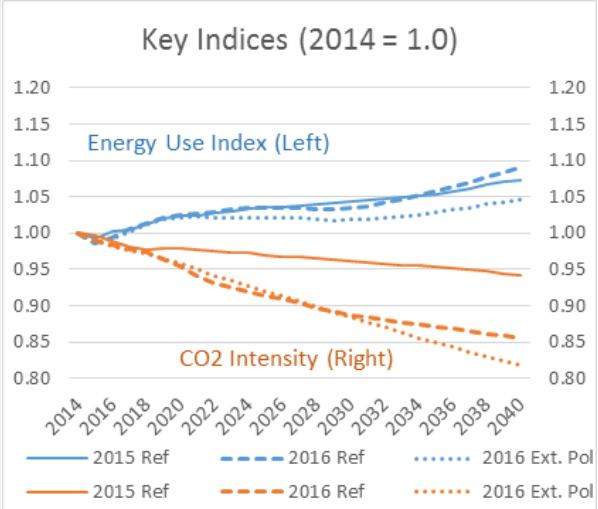
The additional policies contained in the Extended Policies case are designed to reduce energy use and decrease the CO_2 intensity of the power grid. As expected, these combined policies continue to drive a reduction of CO_2 emissions while holding the line longer on total energy use. Where the 2016 Reference case CO_2 emissions bottom out in 2031 before increasing, the Extended Policy case continues to show reductions through 2040.



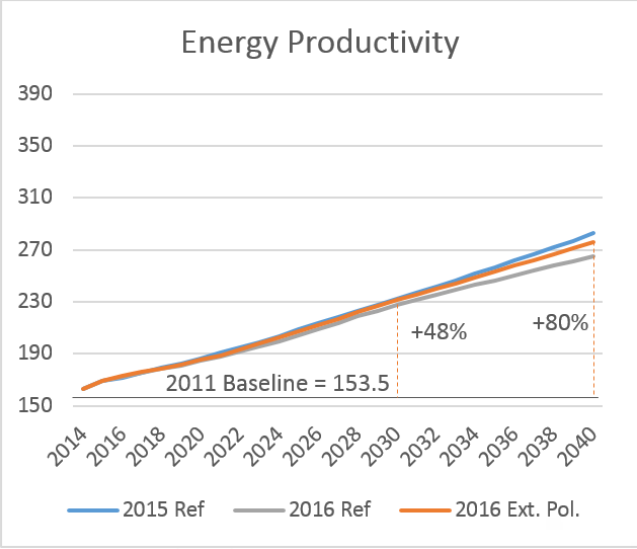
Interestingly, this CO_2 reduction occurs even as total energy use increases beyond 2031. In other words, the 2030s see CO_2 intensity decreasing at a faster pace than energy use increases. This dynamic is critical. In order to reach deep decarbonization goals recommended by the IPCC on the order of an 80%-90% reduction by 2050, energy must continue to be decarbonized at an accelerated pace.

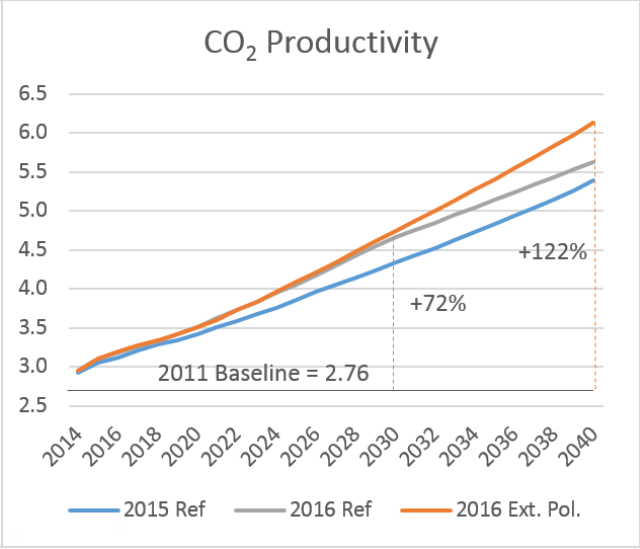
CO_2 intensity in the economy falls further and faster under the Extended Policies case. By the end of the forecast period, the amount of CO_2 emitted per quad of energy consumed has fallen by 18.3%, compared to a drop of 14.5% under the Reference case. This is primarily the result of the increase in zero carbon generation in the electrical sector.





Turning to our two productivity metrics, we see that the reduction in energy use from the Extended Policies case contributes to a faster increase in energy productivity. By 2040, energy productivity has increased by 80% compared to a 2011 baseline and has almost recovered to the 2015 Reference case (where the economic growth was higher). At the same time, due to the more rapid decarbonization of the energy sector, CO_2 productivity, measured as GDP per MMT of CO_2 emissions, increases 122% from the same 2011 baseline. Both of these graphs tell an encouraging story: the additional polices found in the Extended Policies case not only do not hamper economic growth, they increase the productivity of the economy in terms of both total energy and carbon.





Concluding Thoughts

In contrast to the assumption that deeper efficiency and carbon reduction can only come at a substantial cost to consumers and the economy, EIA's Extended Policies case demonstrates a scenario which reaches above and beyond the 2015 and 2016 Reference cases without sacrificing growth or economic prosperity. Total energy use falls, while generation shifts to cleaner sources with minimal impact on electricity prices, and energy productivity is improved.

Conclusion

The Annual Energy Outlook provides a window into different futures; one based on the status quo, and one based on increasingly aggressive energy policies. While EIA's approach may not perfectly replicate the real economy and power markets, it has made substantial improvements to its data assumptions. The internal consistency of the model allows for reasonable conclusions to be drawn by developing a range of possibilities and comparing the different outcomes.

In this paper, two of these comparisons were presented. The first investigated the impact of the CPP, and the second the impact of an increasing number of, and more progressive, energy policies. The conclusions are unambiguous. The CPP holds the line on total energy use and reduces CO_2 emissions through 2031 (when the model assumes CPP-related efforts will stop), while improving U.S. energy productivity. The Extended Policies case pushes further, reducing both absolute total energy use in the 2020s and slowing the increase in total energy use post-2030 compared to the CPP, while pushing CO_2 emissions down even further in the long term. All this while still improving U.S. energy productivity.

Best still, neither the CPP nor the Extended Policies case has a major impact on the price of electricity, the total expenditures on energy, or the country's GDP. In fact, the Extended Policies case improves both energy productivity and CO_2 productivity over the 2016 Reference case, enabling continued growth of the economy while decoupling energy use and CO_2 emissions.

That said, even the most aggressive case falls dramatically short of putting the U.S. on a path to reach the IPCC recommended CO_2 reductions of 80% to 90% by 2050. While we at the Alliance strongly support the continued use of energy efficiency in helping to meet our commitments to CO_2 reduction goals, it is patently obvious that one does not attain this goal by reducing *energy use* by 80-90%!. Rather, we recognize the need to approach energy and environmental targets in the most cost-effective way that will not cause undue economic, social, or environmental harm. To this end, we must continue to aggressively expand the use of energy efficiency as the first resource to meet the energy demands of a growing economy and population while simultaneously decarbonizing as much of our energy use as is possible. Only through a coordinated and concerted long-term effort by business, industry, advocates, and government can we develop the policies and tools needed to tackle the daunting challenge before us.