

The Clean Power Plan and Beyond – Key Roles for Energy Efficiency

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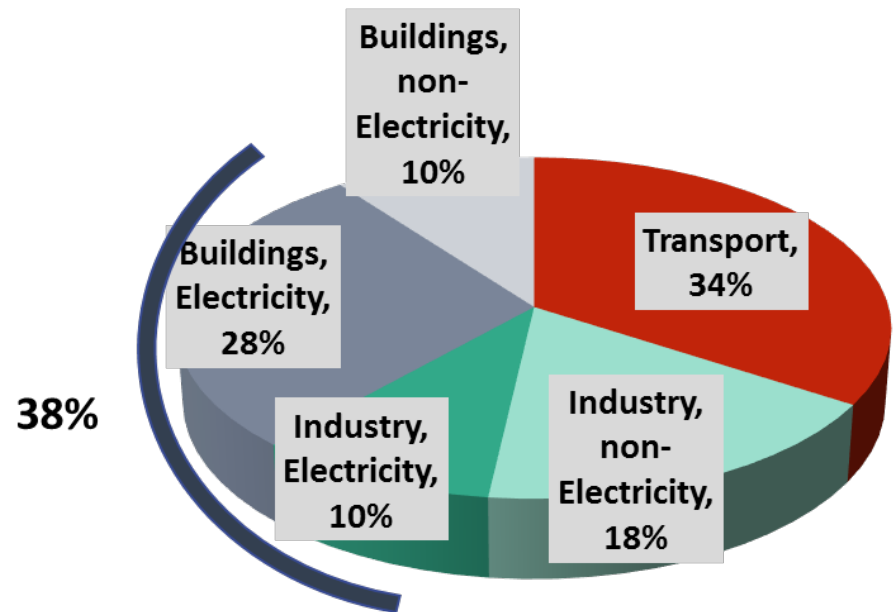


Background

The U.S. Clean Power Plan

- EIA's *Annual Energy Outlook 2016* has updated its assumptions about renewable energy costs and policies, resulting in a large uptake of renewables in its Clean Power Plan modeling.
- These modeling adjustments represent a major step forward.
- However, EIA's energy efficiency assumptions for buildings and manufacturing have barely budged.
- Indicative of this, "energy efficiency" is not mentioned in the 3-page summary of the AEO2016 scenarios released by EIA this week in "Today in Energy" on June 2, 2016.
- Our NEMS modeling of the CPP with a push on EE looks quite different.

U.S. CO₂ Emissions from the Energy Sector

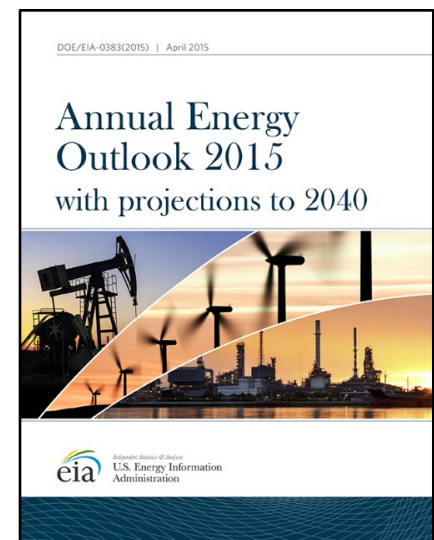


Source: EIA. 2015. *Annual Energy Outlook 2015*, Table 18.

Questions and Methodology

Methodology

- Create region-level CO₂ goals from EPA state goals
- Examine mass goals and a hybrid scenario
- Add accelerated EE deployment, lower solar costs, tax extenders and other policies
- Run these various scenarios in GT-NEMS
- Compare the compliance scenarios with the EIA Reference case
 - ✓ Fuel mix, end-use efficiency, and CO₂ emissions
 - ✓ Electricity rates and bills
 - ✓ Economic activity
 - ✓ Local air pollutants: SO₂, NO_x, and mercury
- Map the results back to states



Definition of EE+Solar Features

EE: Strengthened residential building equipment and appliance standards in targeted areas including room air conditioners, water heaters, a variety of types of lighting, and various miscellaneous energy uses such as home theater systems and ceiling fans; improved building shells to model better building codes and the CEIP.

Commercial energy-efficiency improvements including higher-efficiency space heating and cooling equipment with stronger standards for rooftop units beginning in 2018 and again in 2023, lower discount rates for commercial consumers of air conditioning and lighting; and tighter building shell requirements.

Industrial energy-efficiency includes a 30 percent investment tax credits for large-scale (40 MW+) CHP through 2040, the EIA's High Technology assumptions for CHP systems and electric motors, and process efficiency improvements in five manufacturing subsectors.

Solar: Extension of the Production Tax Credit for wind energy and extension of the Investment Tax Credit for solar energy with a higher incentive in 2020-21 to model the CEIP.

Updated cost of installed utility-scale, residential, and commercial solar PV systems based on estimates from GTM/SEIA, Bloomberg New Energy Finance, Deutsche Bank, and national laboratories.

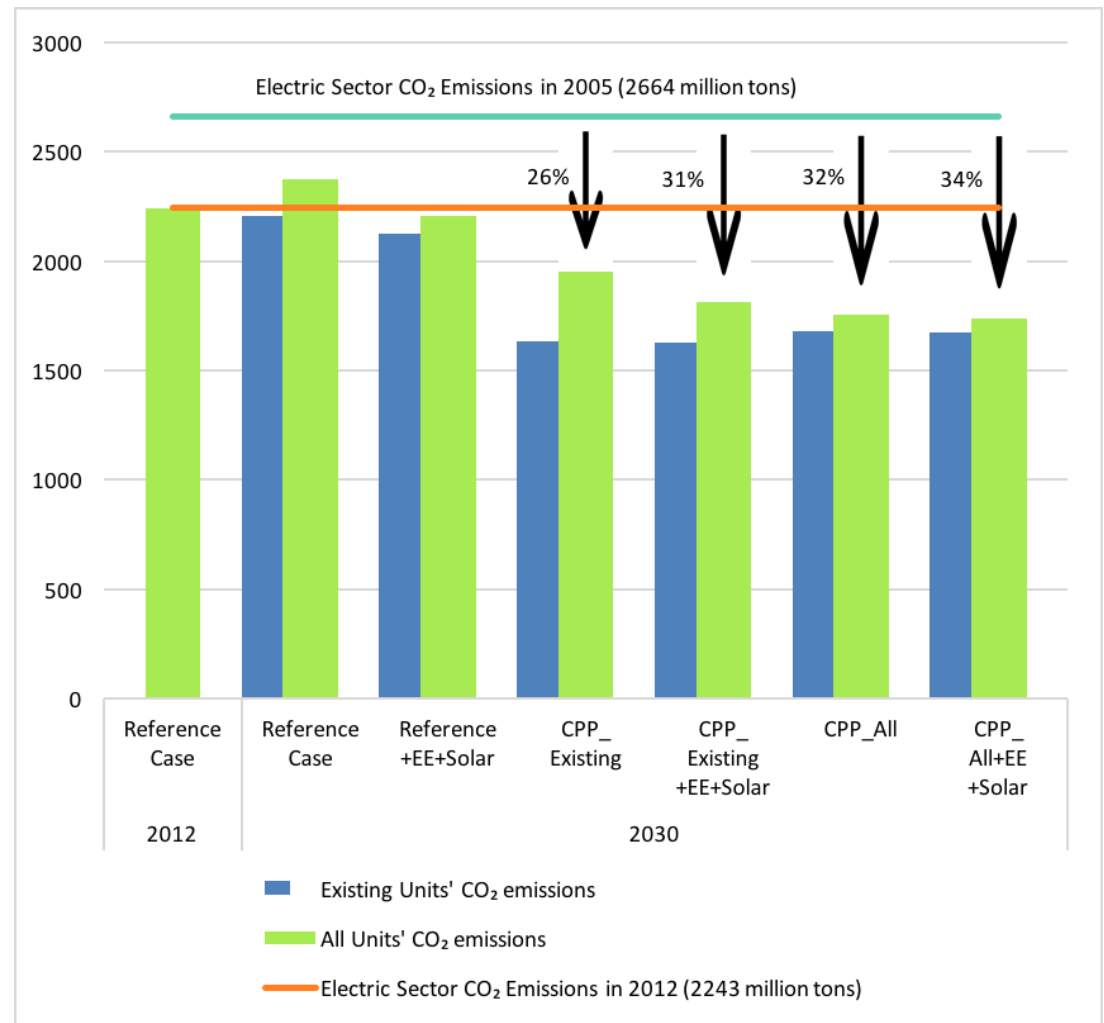
Definition of Scenarios

Scenario	Description
CPP-Existing	CPP state-level goals for CO ₂ mass emissions from existing units are modeled directly by specifying constraints on emissions in the Electricity Market Module. Constraints at the state level are aggregated into the 22 NERC region constraints using weights based on a matrix of state-to-NERC-region generation in 2012.
CPP-Existing+EE+Solar	“EE+Solar” features are added to the “CPP-Existing” compliance scenario.
CPP-All	CPP state-level goals for CO ₂ mass emissions from existing and new EGUs are modeled directly by specifying constraints on emissions in the Electricity Market Module (EMM). Constraints at the state level are aggregated into 22 NERC region constraints using weights based on a matrix of state-to-NERC-region generation in 2012.
CPP-All +EE+Solar	“EE+Solar” features are added to the “CPP-All” compliance scenario.
Beyond CPP Existing	Same as “CPP-Existing+EE+Solar,” except a \$20-ton price on carbon is applied to all electricity sector activities from 2031-2040.
Beyond CPP All	Same as “CPP-All+EE+Solar,” except a \$20-ton price on carbon is applied to all electricity sector activities from 2031-2040.
CPP-All+\$20fee+EE+Solar	Same as “CPP-All+EE+Solar,” except a \$20-ton price on carbon is applied to all electricity sector activities in 2022.
CPP-Mix+EE+Solar	Same as “CPP-All+EE+Solar,” except that seven regions representing the South comply with rate-based CPP goals instead of mass-based CPP goals.

Results

EE Helps Plug “Carbon Leakage”

- Use of mass-based goals on existing affected units causes leakage – the shift in emissions within a state from covered to uncovered fossil generators.
- Existing NGCCs face a cost under a mass system that new NGCCs do not.
- The environmental integrity of the CPP can therefore be compromised.
- EE helps mitigate carbon leakage.



EE Mostly Curtails Natural Gas

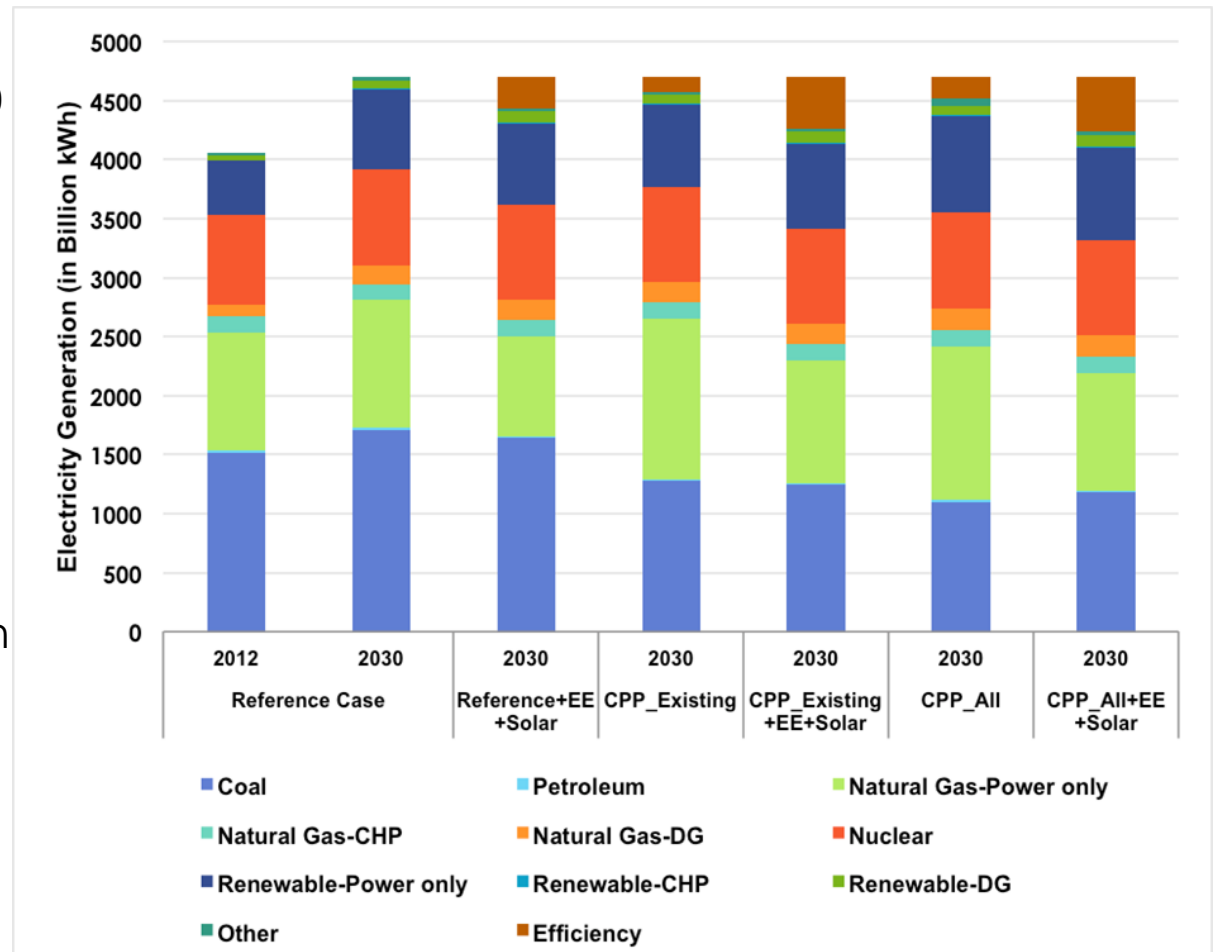
With EE+Solar, EE reduces electricity consumption in 2030 by 440-469 billion kWh.

Coal is mostly replaced by NGCC units, especially when only **existing** units are regulated.

Renewables and EE gain market share when mass-goals for **all** units are implemented.

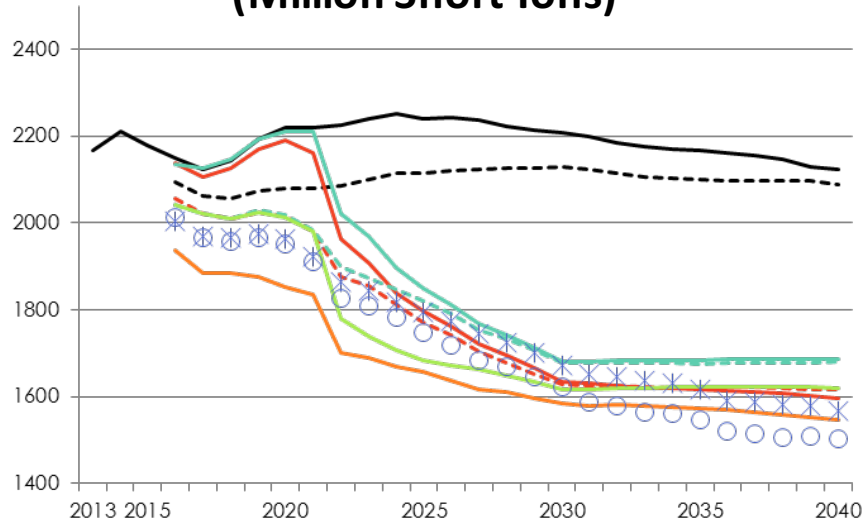
This is especially the case when the EE+Solar features are added.

The build-up of natural gas infrastructure is therefore less challenging as resource investments become more diversified.



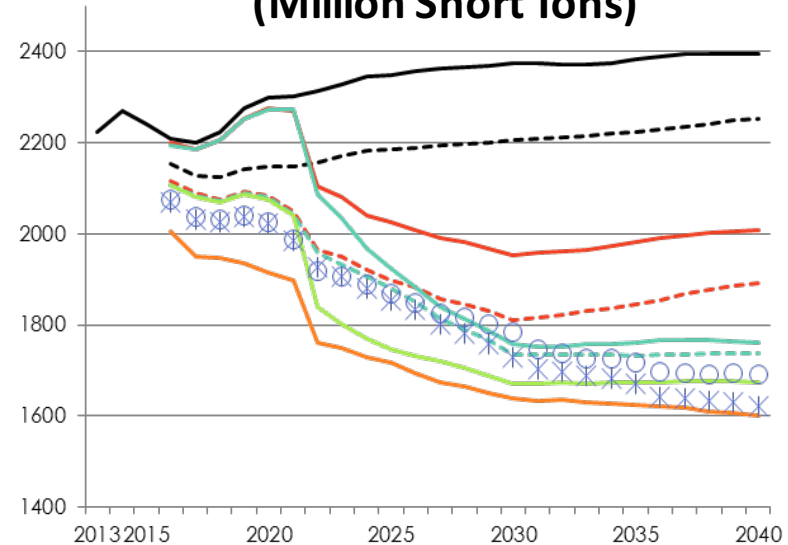
Post-2030 Uptick is Moderated by EE

U.S. CO₂ Emissions from Existing Units (Million Short Tons)



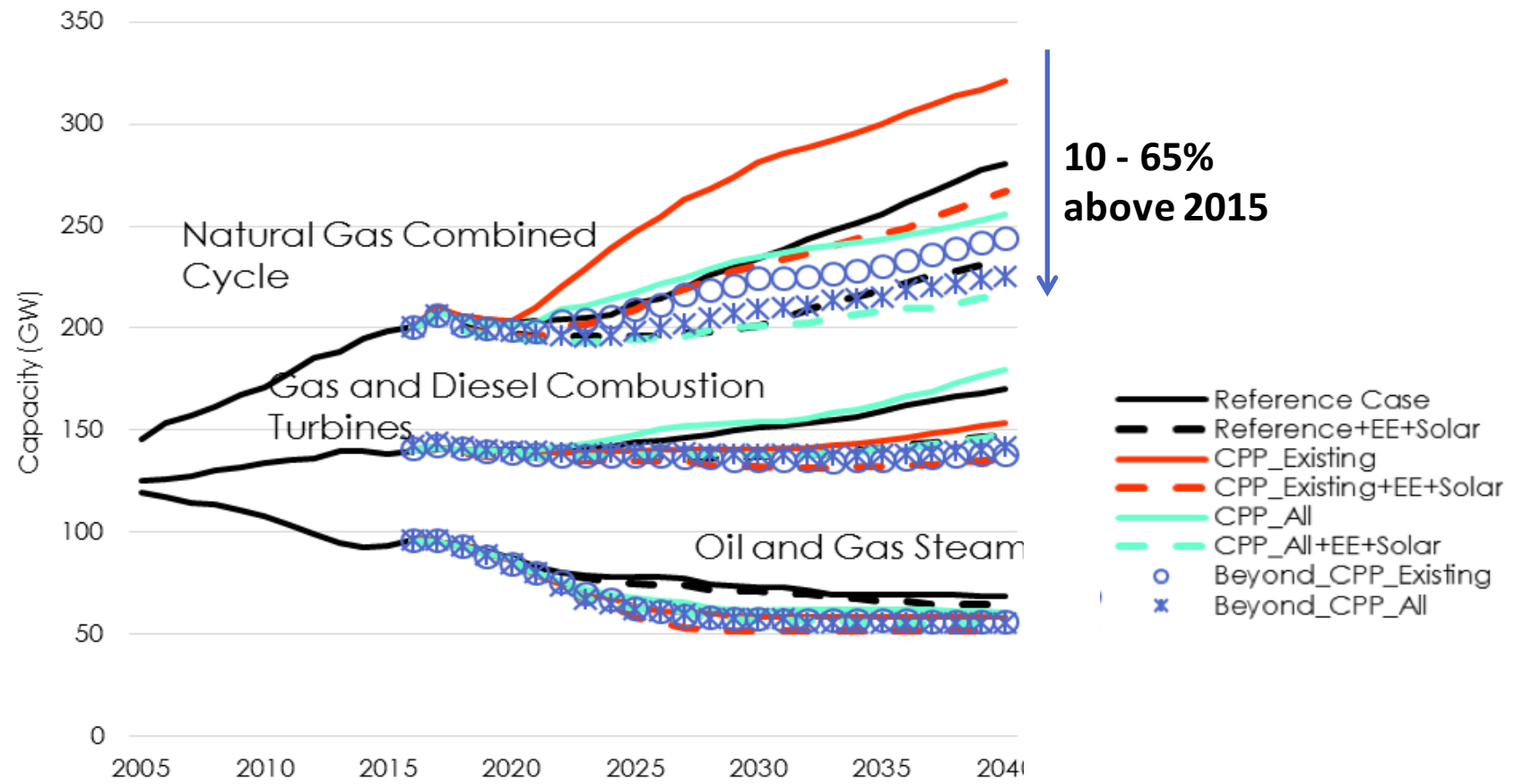
- | | |
|-----------------------|------------------------------|
| — Reference Case | - - - Reference+EE+Solar |
| — CPP-Existing | - - - CPP-Existing +EE+Solar |
| — CPP-All | - - - CPP-All +EE+Solar |
| ○ Beyond CPP Existing | * Beyond CPP All |
| — CPP-Mix+EE+Solar | — CPP-All-\$20fee+EE+Solar |

U.S. CO₂ Emissions from All Units (Million Short Tons)

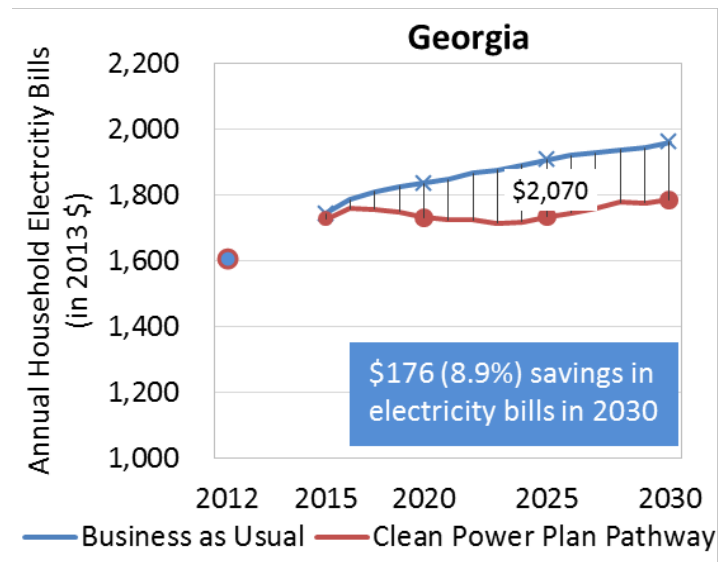
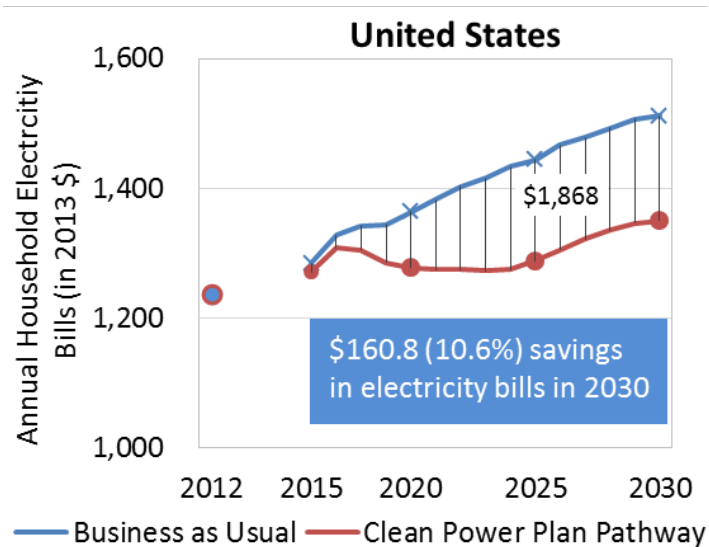


- Emissions from all units see an upward tick after 2030, which is moderated by EE.
- When 2040 goals are added, reductions continue thru 2040.

EE Reduces the Expansion of NGCC Capacity



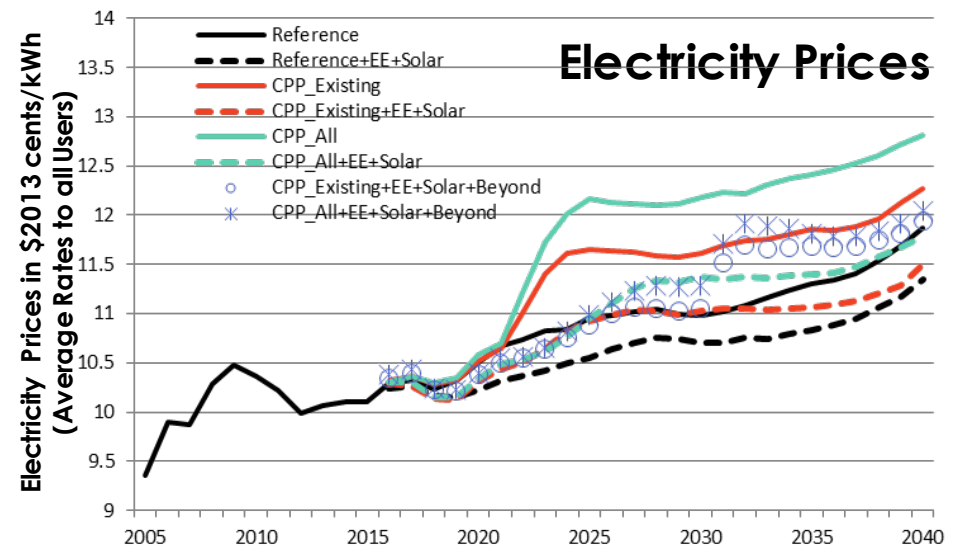
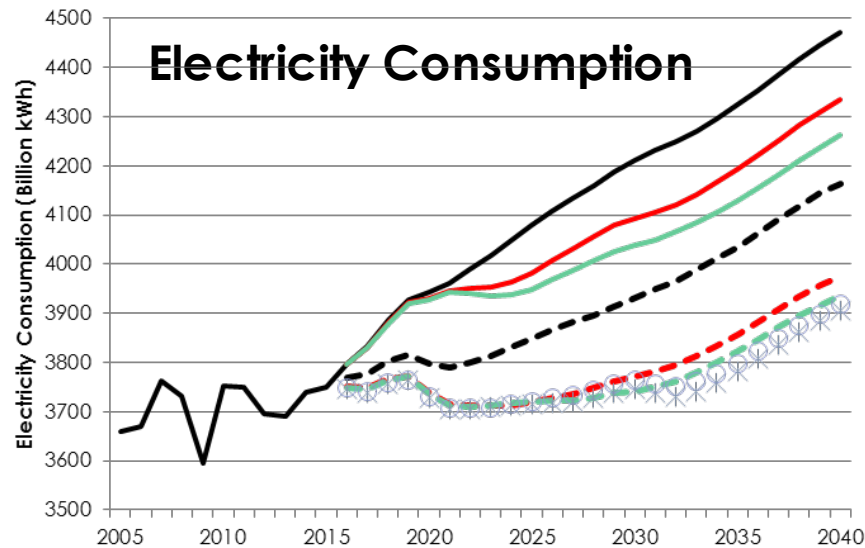
EE Makes the Clean Fuel Transformation More Affordable



*All savings are in \$2013 and are not discounted. Clean Power Plan Pathway = CPP-ALL+EE+Solar

- Cumulative electricity bill savings over the 15 years are estimated to be \$1,868 for an average U.S. household.
- Across the U.S., households could experience cumulative electricity savings of \$248 billion.

Energy Efficiency Moderates Rising Consumption, Prices, and Bills



- Natural gas use in buildings is also cut.
- Without the EE features, CPP compliance reduces electricity consumption by only 120 billion kWh in 2030, or 3% less than in the Reference case.

EE Increases Pollution Abatement Benefits

Monetized benefits in 2030 (in \$2013 B)*	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxide	Total
CPP-Existing	22	18 - 42	5 - 16	45 - 80
CPP-Existing+EE +Solar	31	25 - 57	7 - 22	63 - 110
CPP-All	29	20 - 44	6 - 19	55 - 92
CPP-All +EE+Solar	33	23 - 52	6 - 20	62 - 105

*Benefits per ton (in \$2013) = \$51.7 for CO₂, \$45,600-103,600 for SO₂ and \$12,100-38,300 for NO_x.

- The benefits of reducing CO₂, SO₂ and NO_x in the year 2030 are estimated to be \$45 - \$110 billion.
- The co-benefits from local pollution abatement exceed the benefits from carbon mitigation.
- They include avoidance of premature deaths, childhood asthma, ecosystem damage, etc.

Conclusions

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- **Expanding energy efficiency:**
 - ✓ Mitigates “carbon leakage,” ensuring the environmental integrity of the CPP
 - ✓ Displaces natural, avoiding the “lock in” of expanded gas plants
 - ✓ Does not displace distributed renewables
 - ✓ Makes the clean fuel transformation more affordable
 - ✓ Increases pollution abatement benefits
- **This analysis should be updated:**
 - ✓ Building on AEO 2016 assumptions
 - ✓ In a more participatory process to better capture the latest EE policy and technology insights

