

Policy, Technology, and Economic Uncertainty

Which matters the most for global energy system modeling?



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Answer depends on assumptions

- Key uncertainties affect projections of the global energy system
 - Policy (laws and regulations), technology change, consumer choice, macroeconomic trends
 - Model structural uncertainty, parameter uncertainty (data quality and availability)
- Trade-offs in handling these uncertainties can bias model results
 - Scale of cause (national regulation) vs. scale of effect (global emissions)
 - Interactions between region of interest and rest of world
 - Robustness of answer to changes of input assumptions (side cases)

Caveats

- Cannot quantify uncertainty in EIA models
 - Side case scenarios are not probabilistic
 - Can't just compare changes from high/low macroeconomic growth cases to high/low resource assumption cases, for example
- Can show some illustrative examples that might inform the discussion
 - U.S. Clean Power Plan (CPP) as a policy example
 - High/Low global macroeconomic growth side cases
 - High/Low U.S. oil and gas resource and technology assumptions cases

Results in this presentation represent ongoing research into modeling methods and do not constitute official EIA data

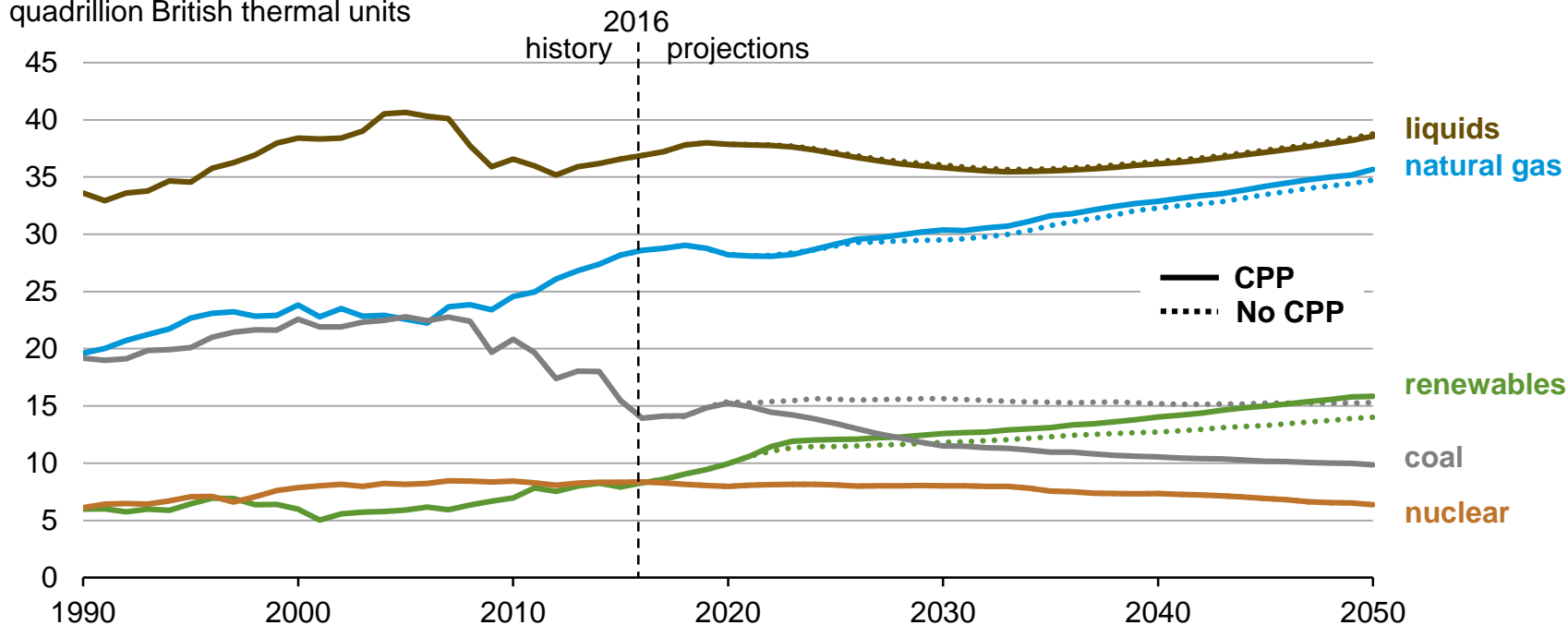
Summary of U.S. Clean Power Plan (CPP)

- Regulation limiting carbon dioxide emissions from existing power plants
 - Promulgated by Environmental Protection Agency, based on authority from Clean Air Act
 - State-based program, each state has different emissions targets
- CPP implemented in NEMS as regional emissions caps
 - State-based program but implemented as a region-based program in NEMS (22 regions)
 - Limits begin in 2022, increase linearly until 2030 to meet average and target emissions levels
 - No intertemporal banking/borrowing, emissions limits assumed to increase linearly
 - Limits held constant after 2030, since the regulation is silent about post-2030 plans

CPP affects composition of U.S. energy consumption

U.S. energy consumption

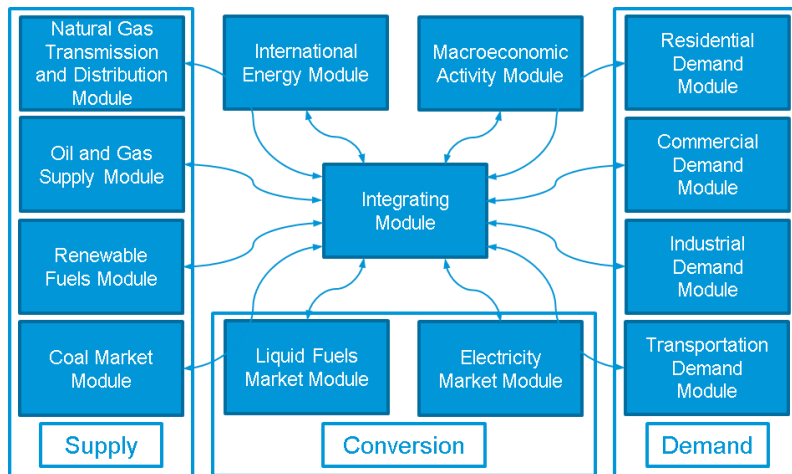
quadrillion British thermal units



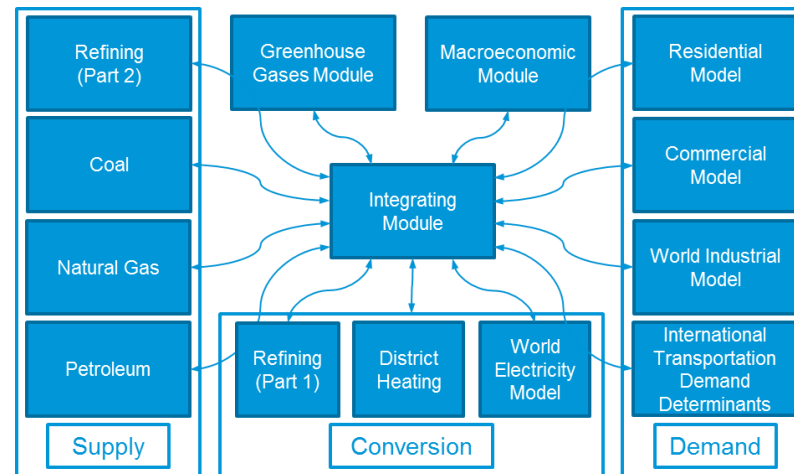
Source: EIA Annual Energy Outlook 2017 (Reference case with, without CPP)

Both of EIA's long-run energy models used in this analysis

National Energy Modeling System (NEMS)
U.S. model
used in Annual Energy Outlook



World Energy Projection System (WEPS)
16-region global model
used in International Energy Outlook



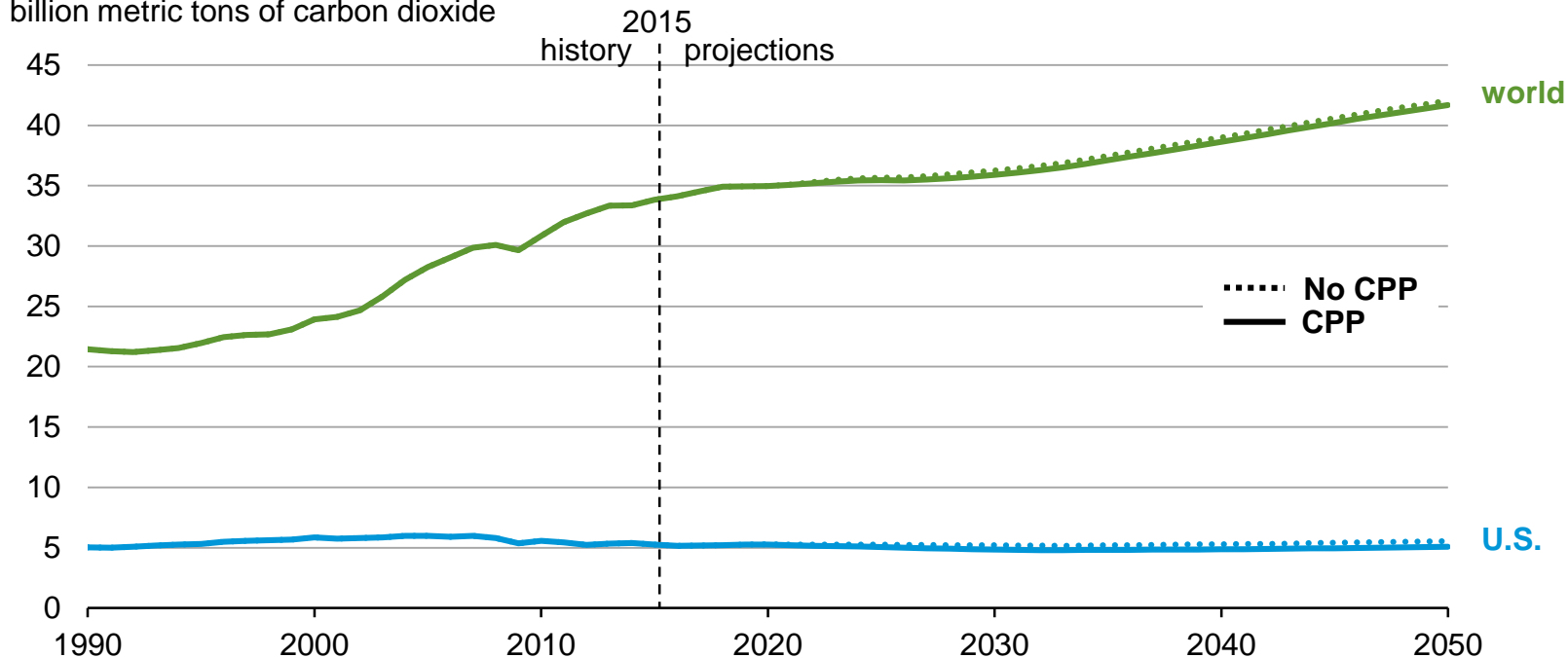
Innovation: Linking NEMS and WEPS

- Generated multiple scenarios using detailed U.S. model, NEMS:
 - NEMS Reference, with and without CPP
 - NEMS High/Low Resource and Technology, with and without CPP
 - NEMS High/Low Macroeconomic Growth, with and without CPP
- Ran NEMS results through world model, WEPS, to get global response
 - WEPS Reference + NEMS Reference, with and without CPP
 - WEPS Reference + NEMS High/Low Resource and Technology, with and without CPP
 - WEPS High/Low Macroeconomic Growth + NEMS High/Low Macroeconomic Growth, with and without CPP
- Results should be informative, but do not represent official EIA data

CPP impacts projections of world emissions by about 1%

energy-related carbon dioxide emissions

billion metric tons of carbon dioxide

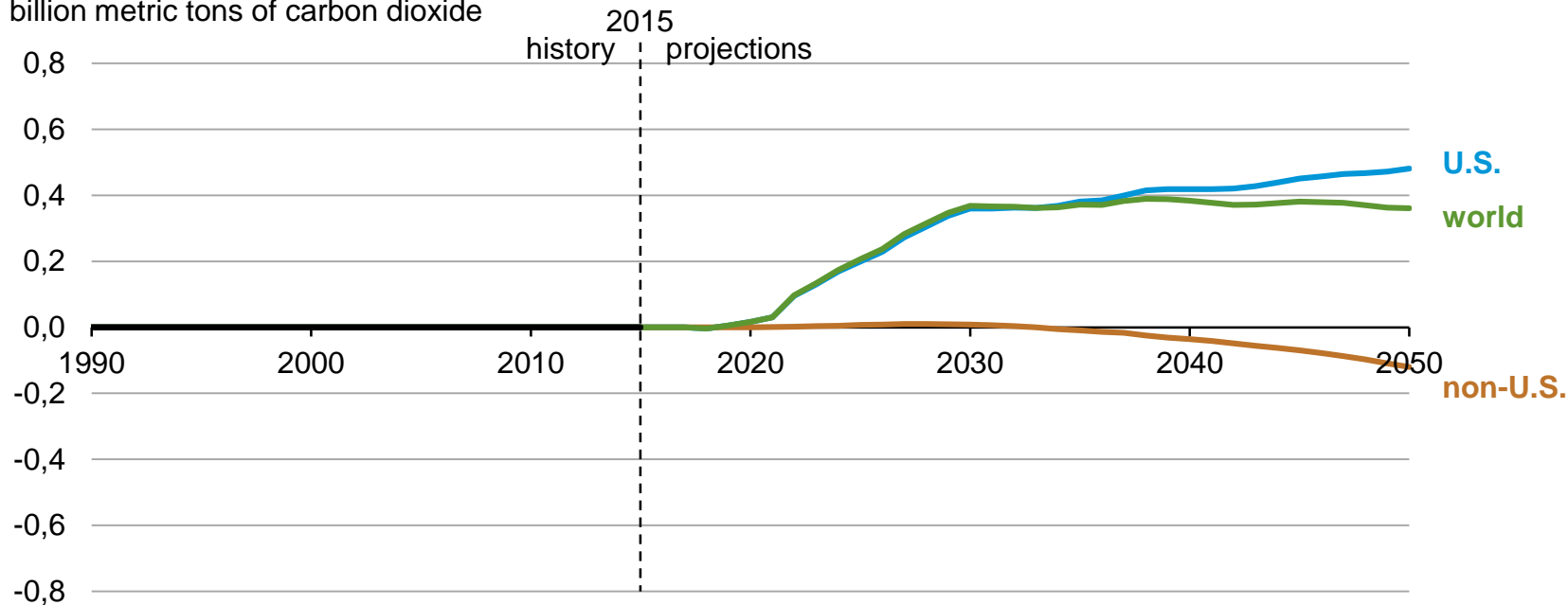


Source: EIA WEPS runs 2017.05.22_160052 (Reference), 2017.05.22_160120 (noCPP)

CPP also has emissions implications outside the U.S.

change in energy-related carbon dioxide emissions from removal of CPP

billion metric tons of carbon dioxide

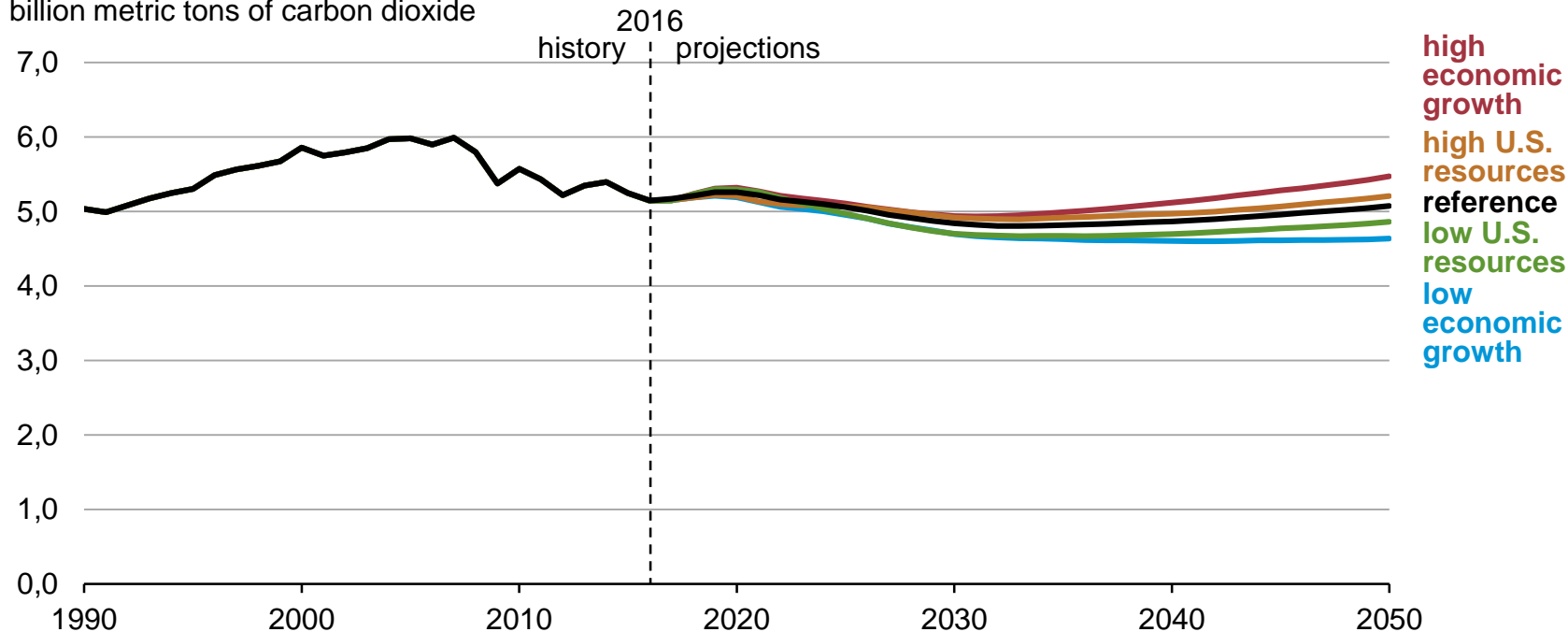


Source: EIA WEPS runs 2017.05.22_160052 (Reference), 2017.05.22_160120 (noCPP)

Side cases impact emissions by up to 8% per year in the U.S. by 2050

U.S. energy-related carbon dioxide emissions with CPP

billion metric tons of carbon dioxide

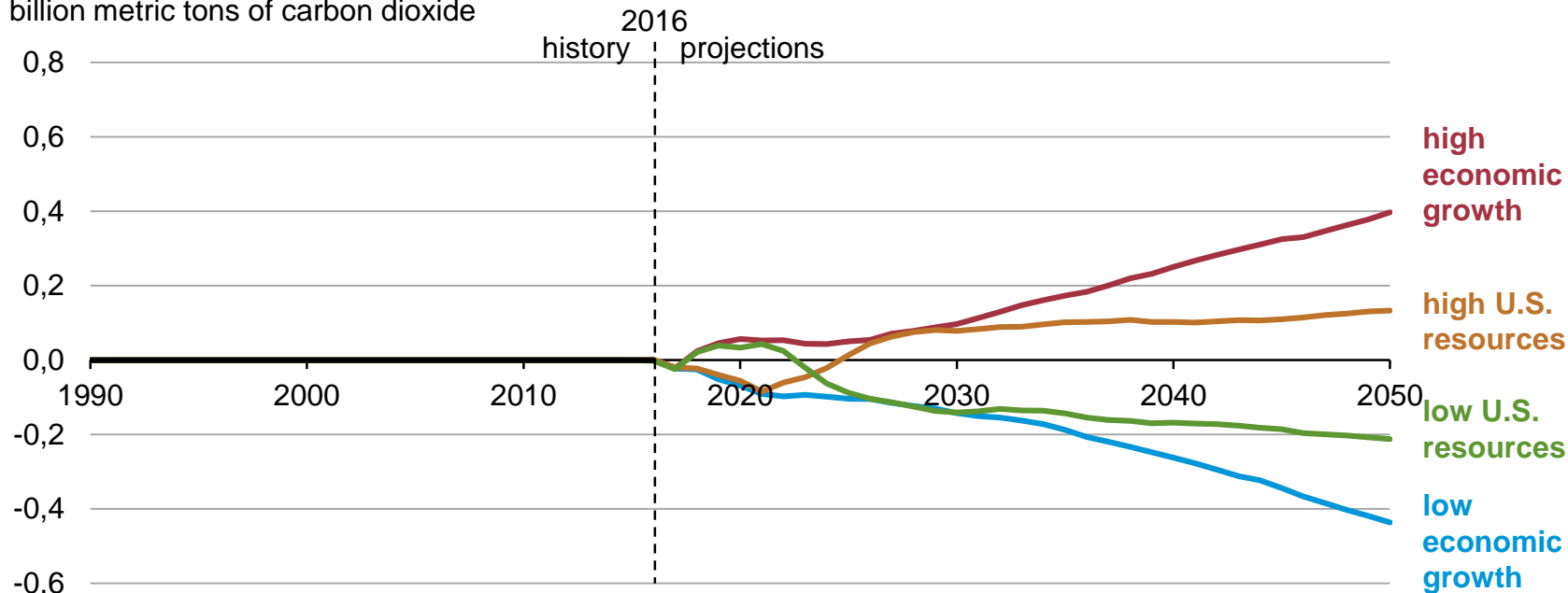


Source: EIA, AEO2017

Side case emissions trajectories differ non-trivially from reference

U.S. energy-related carbon dioxide emissions, difference from Reference, CPP included

billion metric tons of carbon dioxide

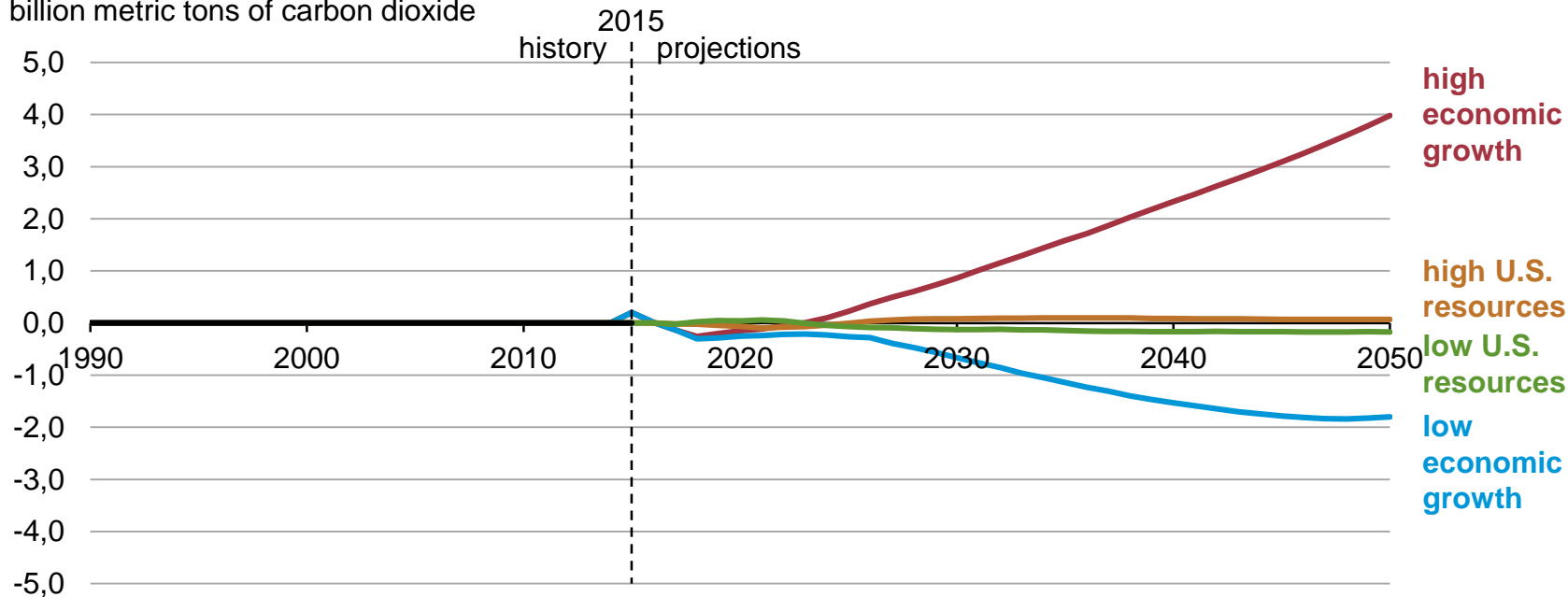


Source: EIA, AEO2017

Side case impacts can be large at the world scale

world energy-related carbon dioxide emissions, difference from Reference, CPP included

billion metric tons of carbon dioxide

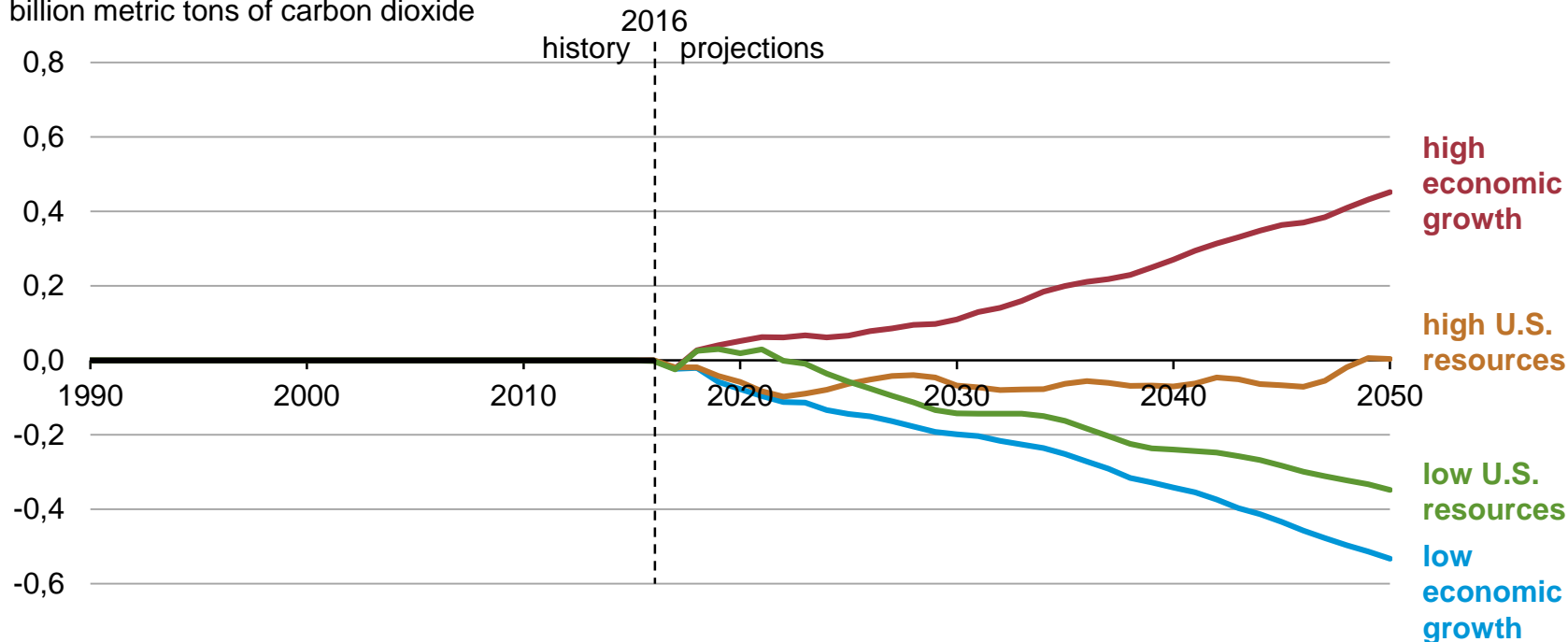


Source: EIA, WEPS runs with CPP: 2017.05.22_160052 (Reference), 2017.0606_103604 (High Macro), 2017.0606_103614 (Low Macro), 2017.0607_165905 (High Resource), 2017.0607_165913 (Low Resource)

Side cases impact emissions in the U.S. differently without CPP

U.S. energy-related carbon dioxide emissions, change from Reference, no CPP

billion metric tons of carbon dioxide

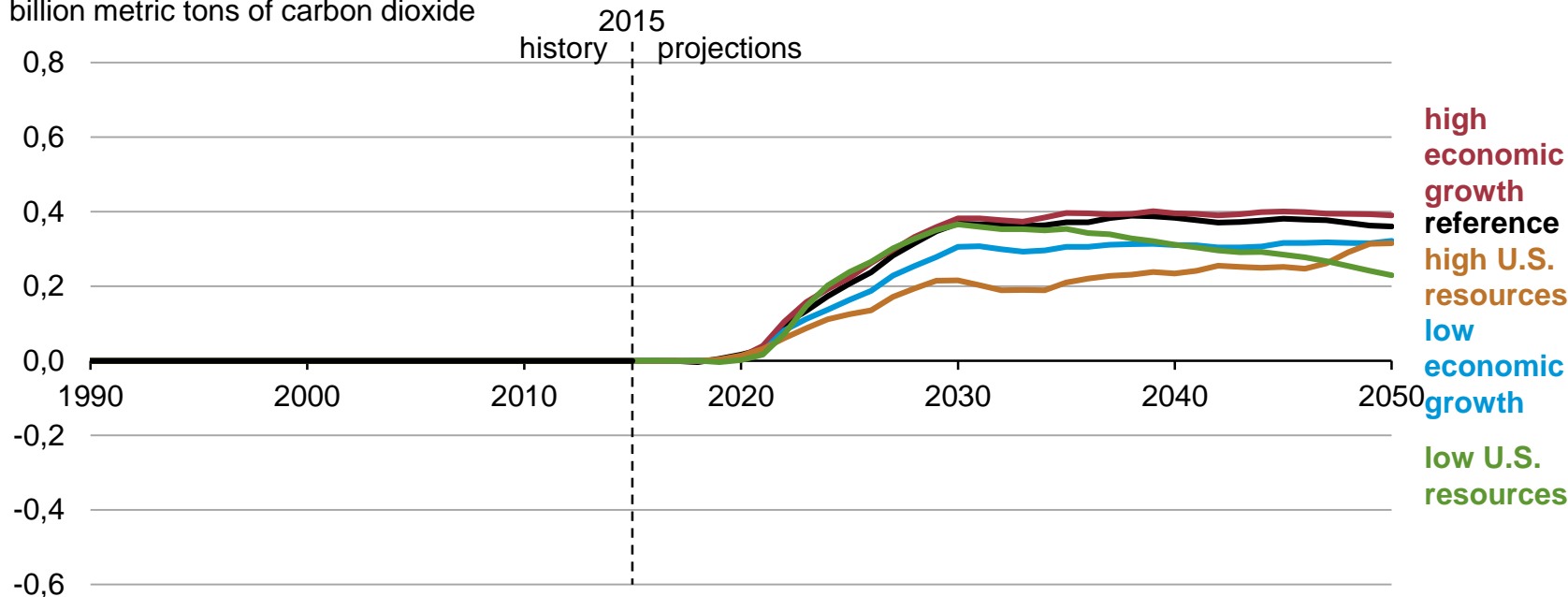


Source: EIA, WEPS runs without CPP: 2017.0522_160120 (Reference), 2017.0606_103607 (High Macro), 2017.0606_103620 (Low Macro), 2017.0607_135603 (Low Resource), 2017.0607_135552 (High Resource)

World emissions increase due to removal of CPP depends on case

change in world energy-related carbon dioxide emissions from removal of CPP

billion metric tons of carbon dioxide



Source: EIA, WEPS runs with CPP: 2017.05.22_160052 (Reference), 2017.0606_103604 (High Macro), 2017.0606_103614 (Low Macro), 2017.0607_165905 (High Resource), 2017.0607_165913 (Low Resource); WEPS runs without CPP: 2017.0522_160120 (Reference), 2017.0606_103607 (High Macro), 2017.0606_103620 (Low Macro), 2017.0607_135603 (High Resource), 2017.0607_135552 (Low Resource)

Three takeaways for evaluating national policy scenarios

1. Consider geographic scales of policy and impact
 - Laws are national, carbon dioxide emissions are measured globally
 - Some policies may have impacts at multiple scales
2. Account for impacts beyond the region of interest
 - How does the policy impact trade with other countries?
 - How does it impact economic activity both within and outside the region of interest?
3. Check policy impacts across side cases as well as reference
 - The same policy changes can have different impacts in different projection scenarios
 - Robustness checking policy impacts across alternate side cases is important

Backup slides

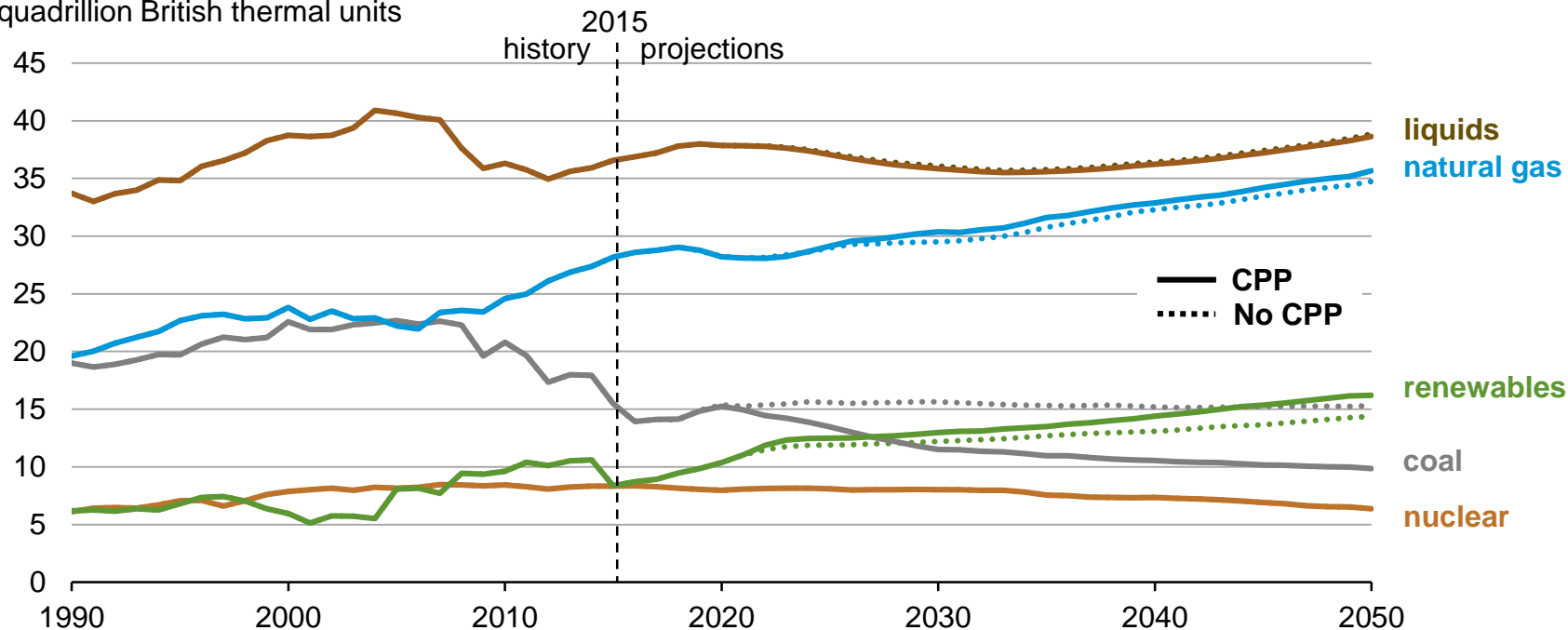
Who is EIA?

- Independent statistical agency
 - Part of USG (DOE)
 - Independent both by statute and by tradition
 - Policy neutral, but not policy irrelevant
- Collect and disseminate official energy data for U.S.
- Also, produce forward-looking outlooks to inform policy, inter alia
 - Short-Term Energy Outlook (STEO): monthly forecast, U.S. only, 13-24 months
 - Annual Energy Outlook (AEO): annual projection, U.S. only, 25-35 years
 - International Energy Outlook (IEO): annual projection, world, 25-35 years

Removal of CPP impacts projections of U.S. energy consumption

U.S. energy consumption

quadrillion British thermal units

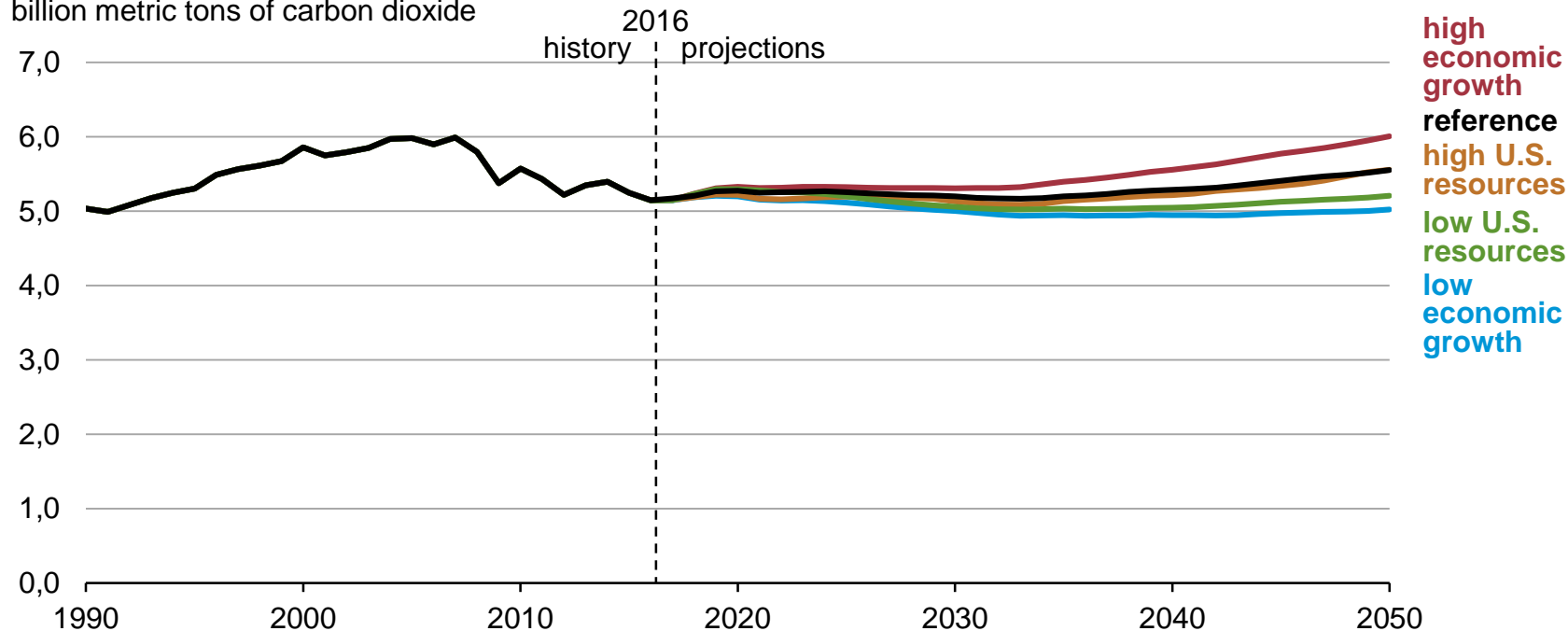


Source: EIA WEPS runs 2017.05.22_160052 (Reference), 2017.05.22_160120 (noCPP)

Side cases impact emissions in the U.S. without CPP

U.S. energy-related carbon dioxide emissions, no CPP

billion metric tons of carbon dioxide

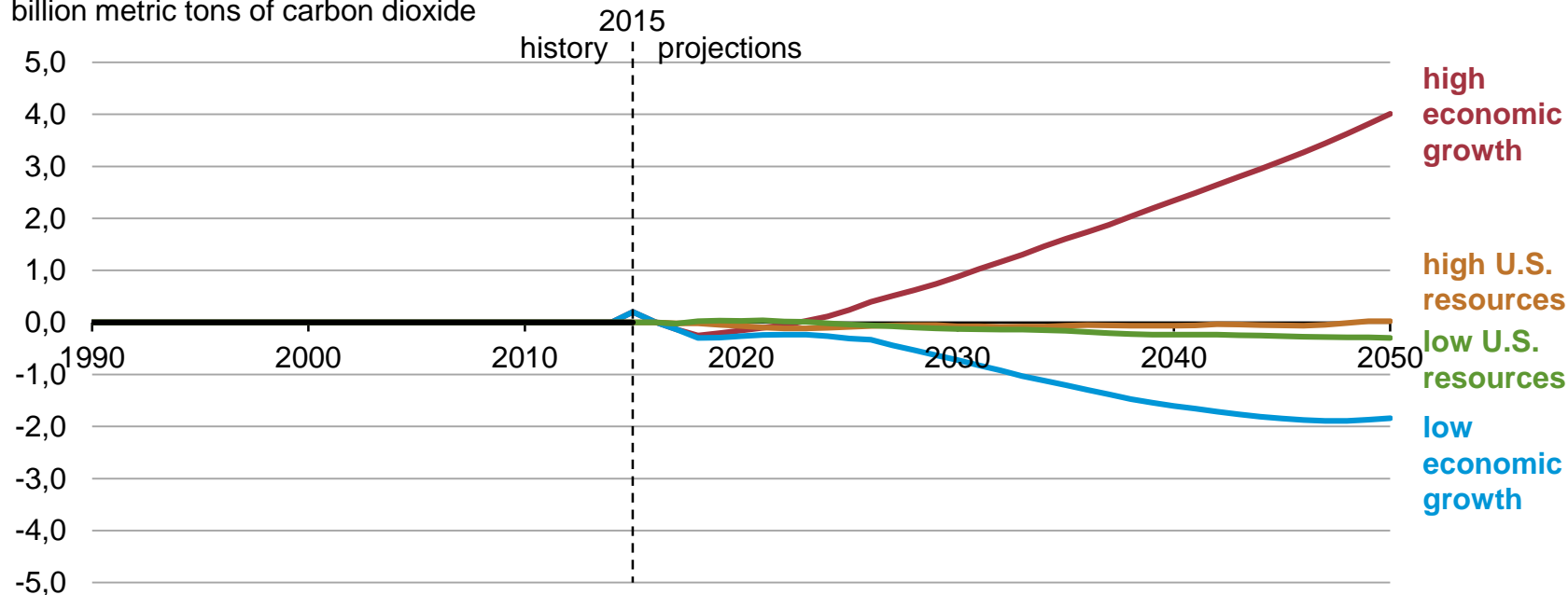


Source: EIA, NEMS runs without CPP: (Reference), etc.

Side cases impact world emissions without CPP

world energy-related carbon dioxide emissions, change from Reference, no CPP

billion metric tons of carbon dioxide

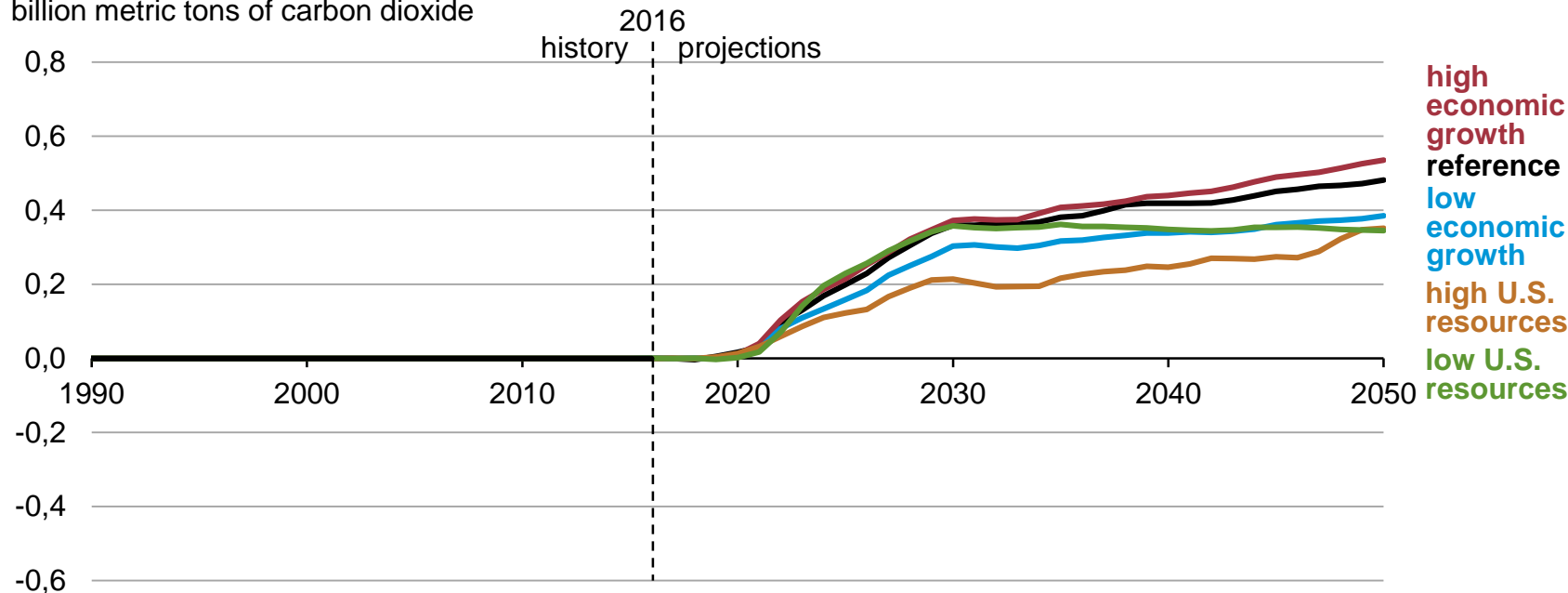


Source: EIA, WEPS runs without CPP: 2017.0522_160120 (Reference), 2017.0606_103607 (High Macro), 2017.0606_103620 (Low Macro), 2017.0607_135603 (High Resource), 2017.0607_135552 (Low Resource)

Removal of CPP results in greater emissions in the U.S.

change in U.S. energy-related carbon dioxide emissions from removal of CPP

billion metric tons of carbon dioxide



Source: EIA, WEPS runs with CPP: 2017.05.22_160052 (Reference), 2017.0606_103604 (High Macro), 2017.0606_103614 (Low Macro), 2017.0607_165905 (High Resource), 2017.0607_165913 (Low Resource); WEPS runs without CPP: 2017.05.22_160120 (Reference), 2017.0606_103607 (High Macro), 2017.0606_103620 (Low Macro), 2017.0607_135603 (High Resource), 2017.0607_135552 (Low Resource)

For more information

U.S. Energy Information Administration home page | www.eia.gov

Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | www.eia.gov/ieo

Monthly Energy Review | www.eia.gov/mer

Today in Energy | www.eia.gov/todayinenergy

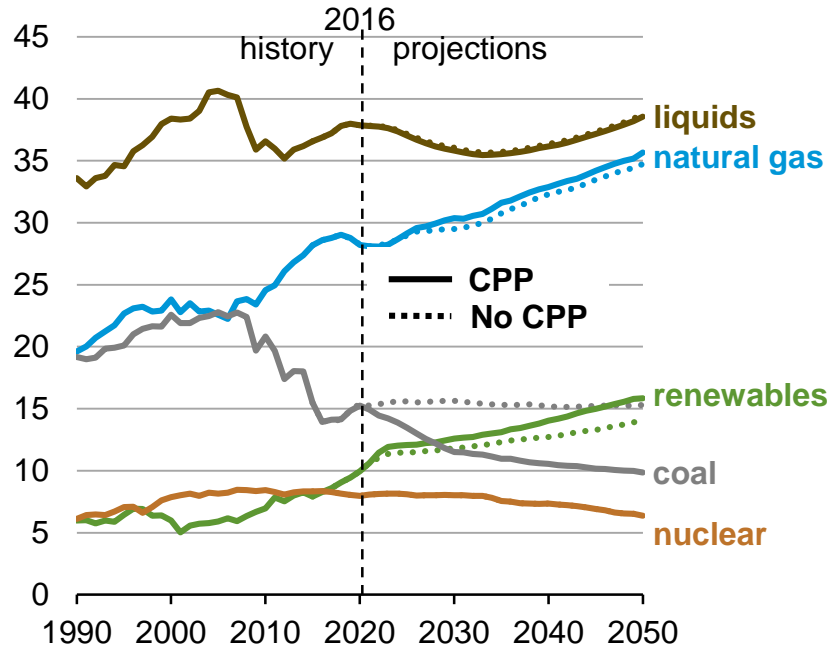
State Energy Profiles | www.eia.gov/state

Drilling Productivity Report | www.eia.gov/petroleum/drilling/

International Energy Portal | www.eia.gov/beta/international/?src=home-b1

Figure 1

Figure 1a: U.S. energy consumption, with and without CPP
quadrillion British thermal units



Source: EIA Annual Energy Outlook 2017 (Reference case with, without CPP), WEPS runs 2017.05.22_160052 (Reference), 2017.05.22_160120 (noCPP)

Figure 1b: change in global energy-related carbon dioxide emissions from removal of CPP, billion metric tons

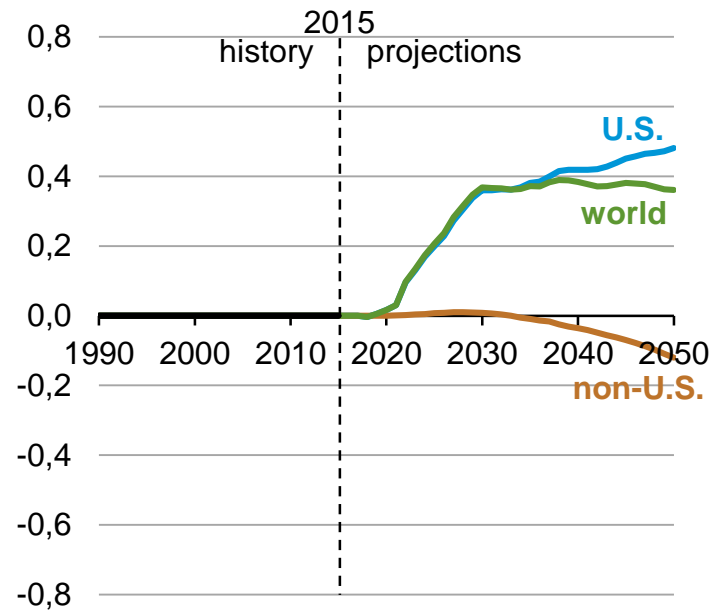
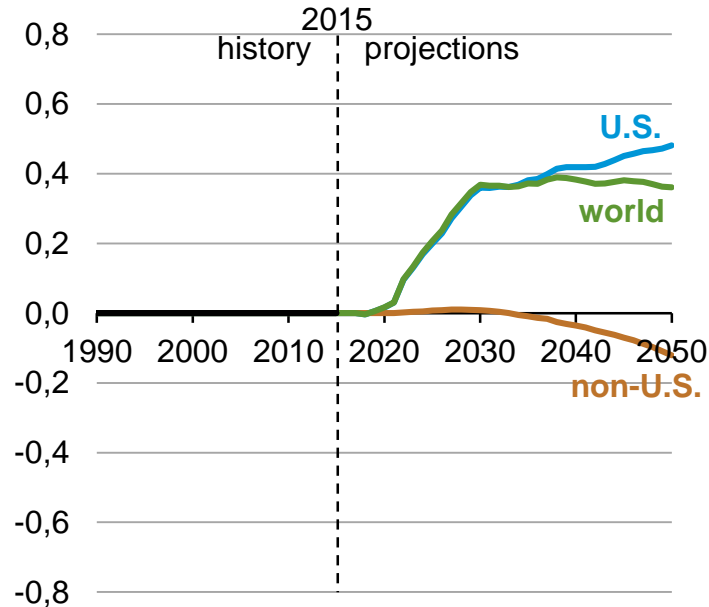


Figure 1

Figure 1: Change in world energy-related carbon dioxide emissions from removal of CPP, billion metric tons.

a) U.S. and non-U.S. emissions in the reference case



b) world emissions across various side cases

