

U.S. Energy Information Administration Projections Consistently Underestimate Renewable Energy and Overstate the Promise of Fossil Fuels

Molly May, Clean Energy Action

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While the historical energy information gathered by the U.S. Energy Information Administration (EIA) has proven useful for analyzing many energy issues, EIA projections of future energy trends often have little predictive value.

The U.S. EIA was created to gather information and create predictions to stabilize energy markets in response to the 1970's energy crisis. It gathers historical information on everything from the price of coal to detailed breakdowns of energy consumption in the United States. The EIA also provides projections of future energy sources and prices.

Policymakers, utility commissions, investors, and energy companies rely on the EIA's data for a wide range of energy analyses and historical data provided by the EIA has been extremely useful in many arenas. However, the EIA's projections of future trends are often quoted as though they were facts. The future, of course, is always unknown and while trying to predict future trends can be useful, predictions must always be used with due caution.

The EIA's track record in modeling future energy market trends is particularly dubious as shown in a number of analyses.^{2,3,4} Some examples of previously reported inaccuracies in EIA projections related to wind, solar, natural gas, and coal prices are summarized below. In addition, this paper provides what we believe is the first look at the EIA's inaccurate projections of U.S. coal production in almost a decade.⁵

Mistaken projections have real impacts on energy markets. For example, chronically overestimating the cost of wind and solar power generation could indicate that investing in natural gas plants is more economical for energy providers than strengthening their renewable

¹ Research Intern, Clean Energy Action, CleanEnergyAction.org

² Energy Watch Group. *The projections for the future and quality in the past of the World Energy Outlook for solar PV and other renewable energy technologies* (2015)

³ Gilbert and Sovacool. *Looking the Wrong Way: Bias, Renewable Electricity, and Energy in the United States*. Energy (2015). Also note that the EIA published a response to Gilbert and Sovacool titled *On Inaccuracies Published in a Journal Article* in April 2016.

⁴ Rocky Mountain Institute. *Utility-Scale Wind and Natural Gas Volatility: Uncovering the Hedge Value of Wind for Utilities and Their Customers* (2012)

⁵ National Research Council of the National Academies. *Coal: Research and Development to Support National Energy Policy* (2007) p. 47

energy portfolio. Decisions made on the basis of inaccurate projections can lead to unnecessary environmental damages and prove costly for ratepayers if their utility makes long-term investments based on inaccurate predictions of future fossil fuel prices and production.

Wind and Solar—Projections Miss Explosive Growth

The projections published in the EIA’s Annual Energy Outlook (AEO) have invariably overestimated the cost of renewable electricity generation and fallen sadly short of predicting new additions of wind and solar capacity. For example, Figure 1 shows that EIA projections repeatedly underestimated the amount of solar PV capacity in the U.S. from 2010 to 2015 and continue to predict that solar installations will largely stall through about 2025.⁶

In reality, however, utility-scale solar capacity is growing at an unprecedented rate. The Solar Energy Industries Association reported that by the third quarter of 2016, the cumulative U.S. utility-scale solar PV capacity (including capacity which was under contract but not yet operating) exceeded the AEO2015 projection for capacity in 2039. Accounting for capacity which had been announced but was not yet under contract by Q3 2016 indicates that utility-scale solar PV capacity will soon far surpass all AEO projections for 2040.⁷

The EIA is not alone in its struggle to predict growth in the renewable energy industry. The International Energy Agency (IEA), which was created to ensure reliable energy supplies for a coalition of 29 countries including the United States, publishes a World Energy Outlook (WEO) each year with predictions that consistently fail to keep up with the rapid growth in renewable generation capacity as shown in Figure 2.⁸

After several years of criticism, the EIA released an internal review of its wind and solar projections⁹ with the promise of a plan to improve them. The review explained several sources of error in their models but identified changing laws and regulations as the main reason for the disparities between their predictions and reality. The EIA addressed this issue by publishing projections for growth with and without the Clean Power Plan (CPP) in its Annual Energy

⁶ U.S. Energy Information Administration. *Annual Energy Outlook (2011-2016) Renewable Energy Generation by Fuel*. Numbers represent projections for the reference case and although information about whether the capacity is given in GWdc or GWac is not provided, the EIA has specified that solar capacity is given in GWdc in other publications (see, for example, *Wind and Solar Data and Projections from the U.S. Energy Information Administration: Past Performance and Ongoing Enhancements*) so this unit is assumed.

⁷ Solar Energy Industries Association. *U.S. Solar Market Insight Executive Summary Q3 2016* (2016) Figure 2.2. Note that the capacities from this source are given in GWdc. Also note that historical data was taken from SEIA U.S. *Solar Market Insight Executive Summaries* from 2011-2015.

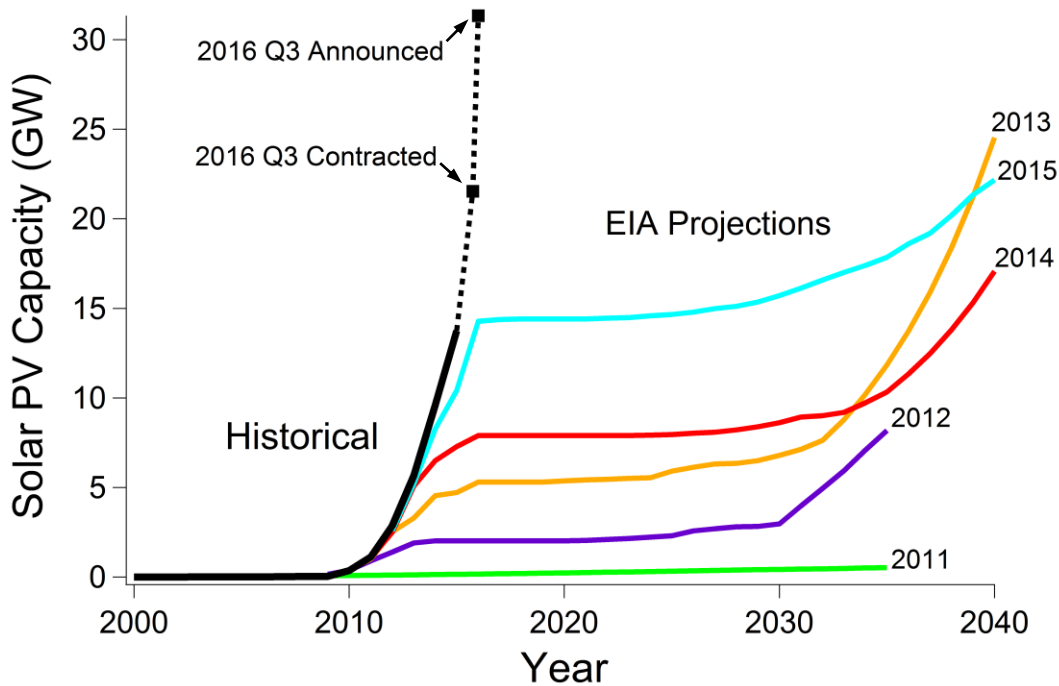
⁸ Figure taken from: Energy Watch Group. *The projections for the future and quality in the past of the World Energy Outlook for solar PV and other renewable energy technologies* (2015) Figure 11

⁹ U.S. Energy Information Administration. *Wind and Solar Data and Projections from the U.S. Energy Information Administration: Past Performance and Ongoing Enhancements* (2016)

Outlook 2016. An example plot from the 2016 outlook, which displays electricity generation from natural gas, renewables, nuclear, and petroleum with the CPP in place (AEO2016 reference) and with no CPP, is shown in Figure 3.¹⁰

While the new projection method is designed to give readers a sense for the uncertainty in EIA models, the projections are strikingly similar with and without the CPP. Only time will tell whether the EIA’s review improved their projections, but it does send an important message to policy makers and investors hoping to use EIA projections that models are only as good as their underlying assumptions and should be used with caution.

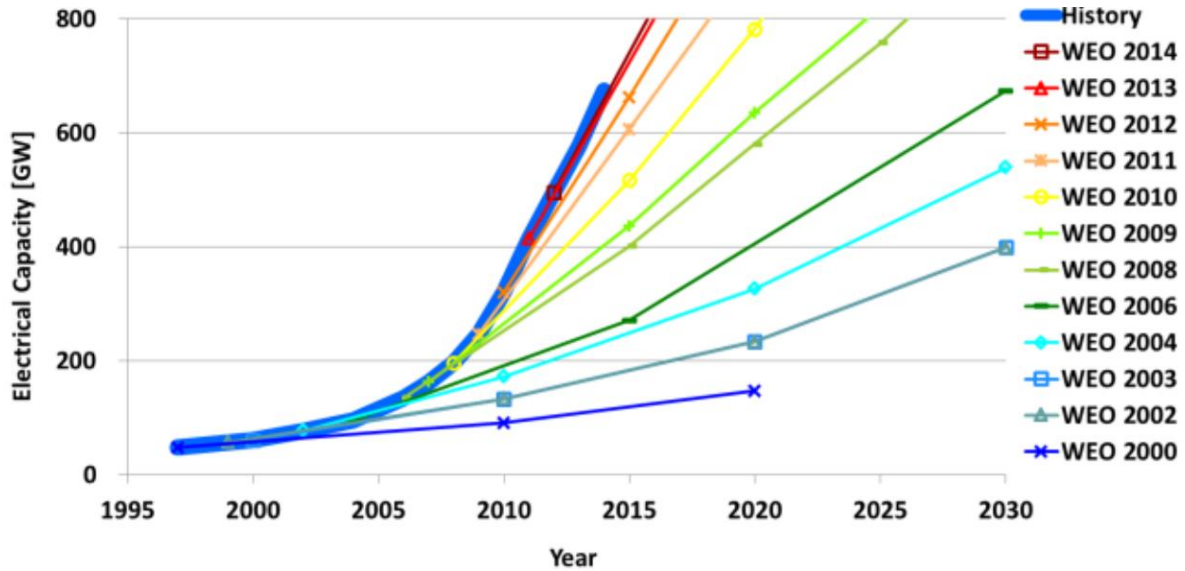
Figure 1. U.S. Utility-Scale Solar PV Capacity Projections in AEO 2011-2015 Reference



EIA projections of U.S. utility-scale solar PV capacity and historical capacity as well as points which include planned capacity under contract in Q3 of 2016 and planned but pre-contract installations as of Q3 2016. Projection data taken from the EIA's Annual Energy Outlook, historical data taken from the Solar Energy Industries Association's U.S. Solar Market Insight Reports.

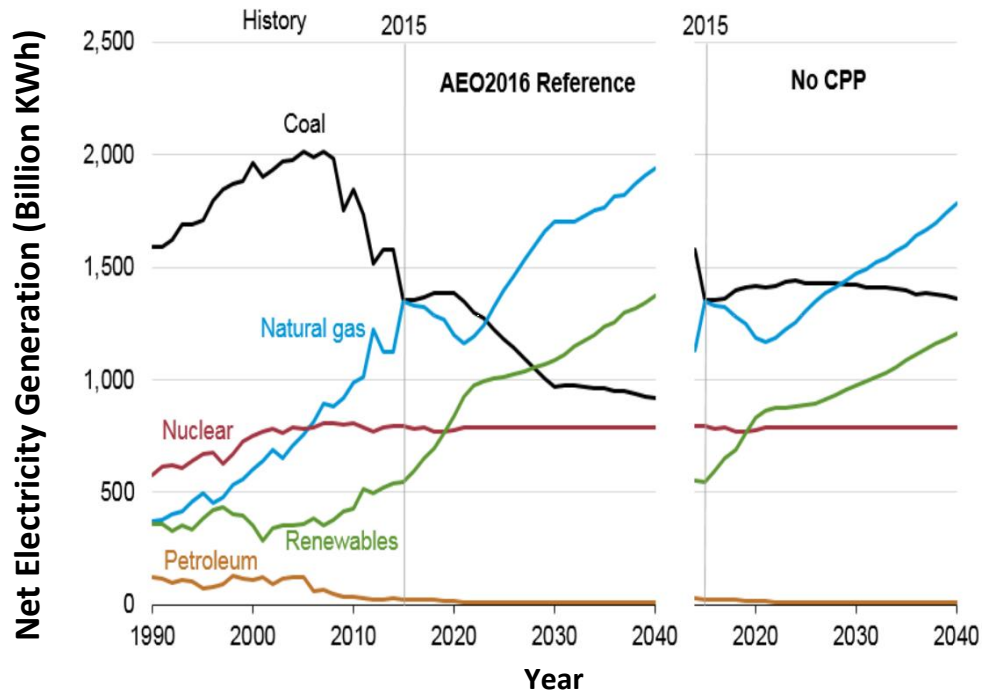
¹⁰ Figure taken from: U.S. Energy Information Administration. *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases* (2016) Slide 24

Figure 2. WEO Predictions vs. Actual Installed Renewable Capacity



Predictions of new installed renewable capacity (excluding hydro power) published by the World Energy Outlook (WEO) and historical data. Figure taken from: Energy Watch Group's *The projections for the future and quality in the past of the World Energy Outlook for solar PV and other renewable energy technologies* (2015) Figure 5.

Figure 3. 2016 EIA Projections of Net Electricity Generation with and Without the CPP



AEO 2016 projections for net electricity generation by source with the CPP in place (reference) and without the CPP. Figure taken from: the EIA's *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases* (2016) slide 24.

Natural Gas— EIA Fails to Represent Volatility or Full Greenhouse Gas Potential

The United States is investing heavily in natural gas for electricity generation (see Figure 3), and the EIA’s failure to accurately represent either the volatility of natural gas prices or its full greenhouse gas potential could make it difficult for decision makers to account for these issues.

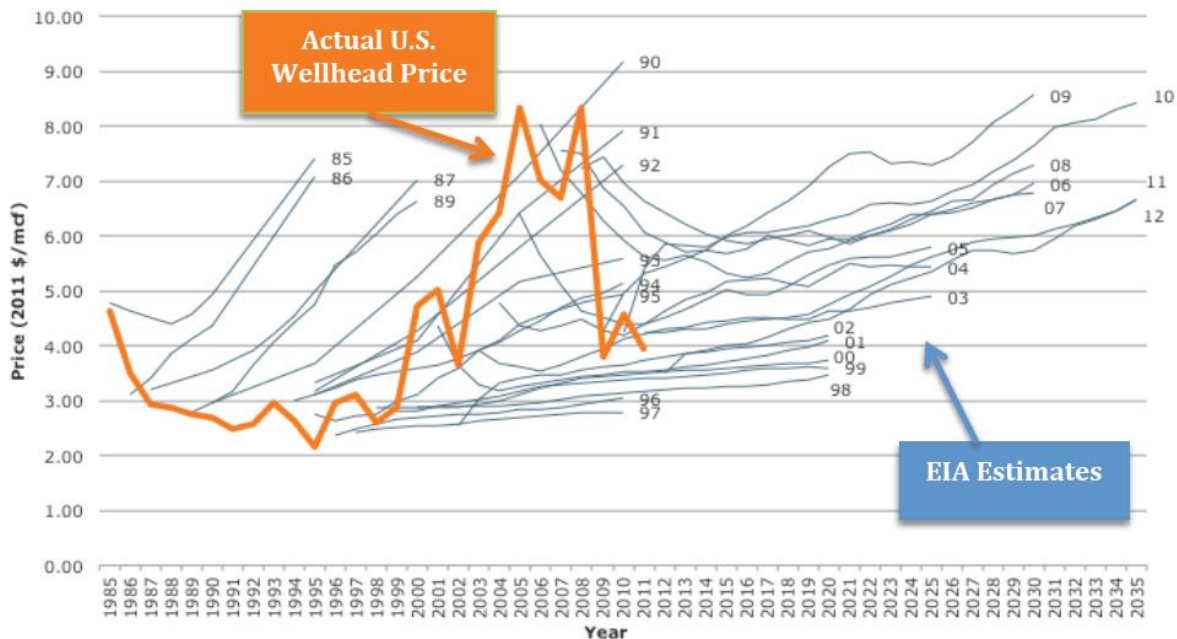
Volatility

Natural gas prices are notoriously volatile and difficult to predict and this uncertainty introduces risk into utility contracts, resulting in higher costs for consumers.¹¹ However, EIA projections tend to predict stable, almost linear changes in natural gas prices which completely fail to capture this volatility as illustrated in Figure 4.¹²

Greenhouse Gas Potential

The early release of Annual Energy Outlook 2016 also predicts that carbon dioxide emissions per dollar of GDP will decline steadily at a rate of 1.8% until 2040 and attributes this partly to

Figure 4. EIA Estimates vs. Historical Wellhead Natural Gas Prices



EIA projections of natural gas prices and historical wellhead price data. Figure taken from: Rocky Mountain Institute’s *Utility-Scale Wind and Natural Gas Volatility* report (2012) page 6.

¹¹ Rocky Mountain Institute. *Utility-Scale Wind and Natural Gas Volatility* (2012)

¹² Figure taken from: Rocky Mountain Institute *Utility-Scale Wind and Natural Gas Volatility* (2012) p. 6

increasing power generation by natural gas.¹³ However, much of the greenhouse gas footprint of the natural gas industry comes from methane leaks¹⁴ and so far, the AEO seems to have neglected this contribution entirely.¹⁵ Understating greenhouse gas emissions not only impacts the environment but it could lead to higher costs for rate payers if penalties for carbon emissions become more widely instated.

EIA projections' failure to represent both the volatility of natural gas prices and its full greenhouse gas emissions could lead to unforeseen risk and increased costs for ratepayers served by utilities that have significant reliance on natural gas for their power.¹⁶

Coal— EIA Fails to Project Either Coal Price or Production Accurately

Coal plants can't operate without a stable supply of coal over their entire lifetime, which means that projections of future coal prices and supplies are essential for analyzing the security of long-term coal plant investments (independent of concerns about climate change and greenhouse gas emissions). Both the price and production of coal changed dramatically over the last two decades in ways largely unpredicted by the EIA, which in some cases led to much higher operating costs for coal plants than investors and regulators predicted.

Coal Prices

At the turn of the century, the EIA predicted that coal prices would decrease steadily for decades,¹⁷ which encouraged large investments in coal-fired power plants. However, in reality coal prices rose dramatically as shown in Figure 5,¹⁸ making coal plants much more expensive to operate.

¹³ U.S. Energy Information Administration. *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases* (2016) slide 14

¹⁴ Howarth, R. *A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas*. Energy Science and Engineering (2014)

¹⁵ U.S. Energy Information Administration. *Annual Energy Outlook 2015* (2015).

¹⁶ Union of Concerned Scientists *Rating the States on Their Risk of Natural Gas Overreliance* (2015)

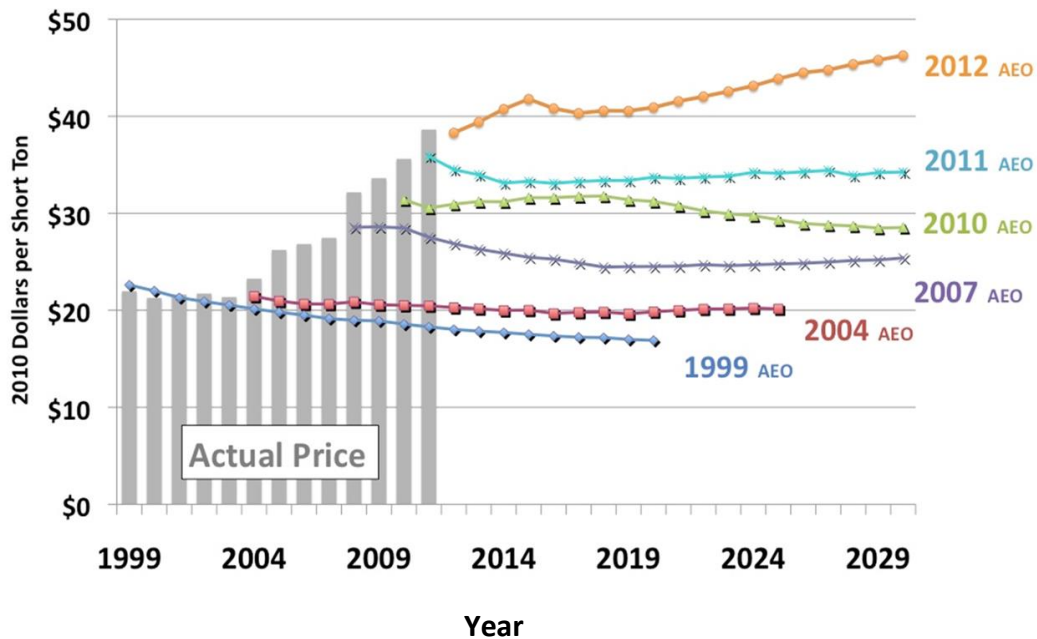
¹⁷ U.S. Energy Information Administration. See, for example, *Annual Energy Outlook 1999 With Projections to 2020* (1999)

¹⁸ Figure used with permission from Matt Wasson with Appalachian Voices. Data was taken from the EIA's *Annual Energy Outlook* and adjusted to 2010 dollars based on the U.S. 2010 Federal Budget-Section 20, Gross Domestic Product and Implicit Outlay Deflators.

Coal Production

EIA projections also missed the dramatic downturn in coal production over the last decade. Once again, their predictions failed to pick up on the trend year after year and still predict flat or rising national coal production, as shown in Figure 6.¹⁹

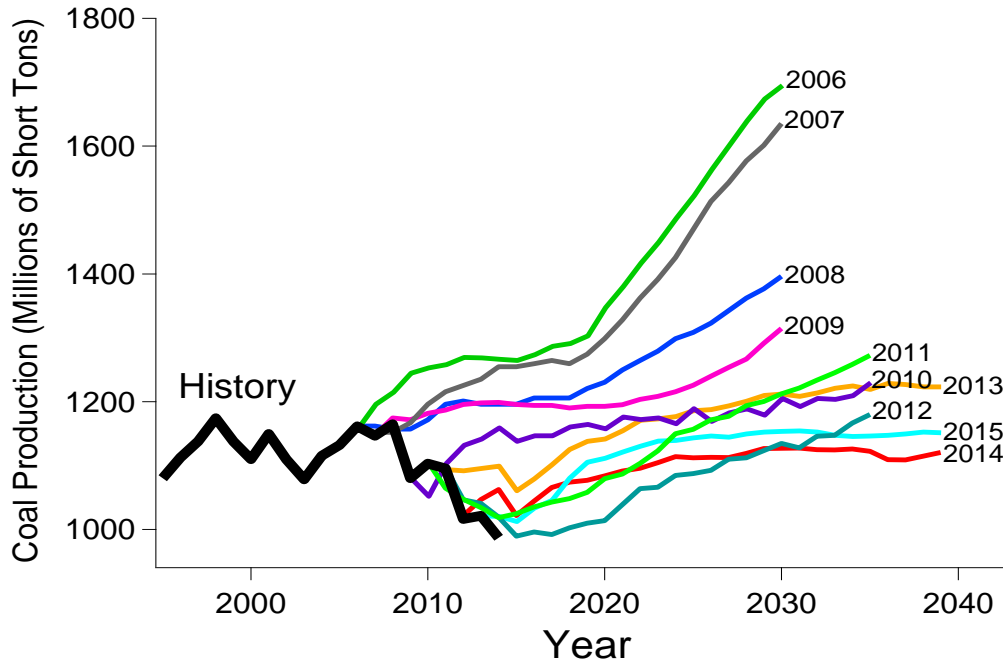
Figure 5. Average U.S. Coal Prices and EIA Projections



AEO projections for average U.S. coal prices and historical prices. Figure used with permission from: Matt Wasson with Appalachian Voices.

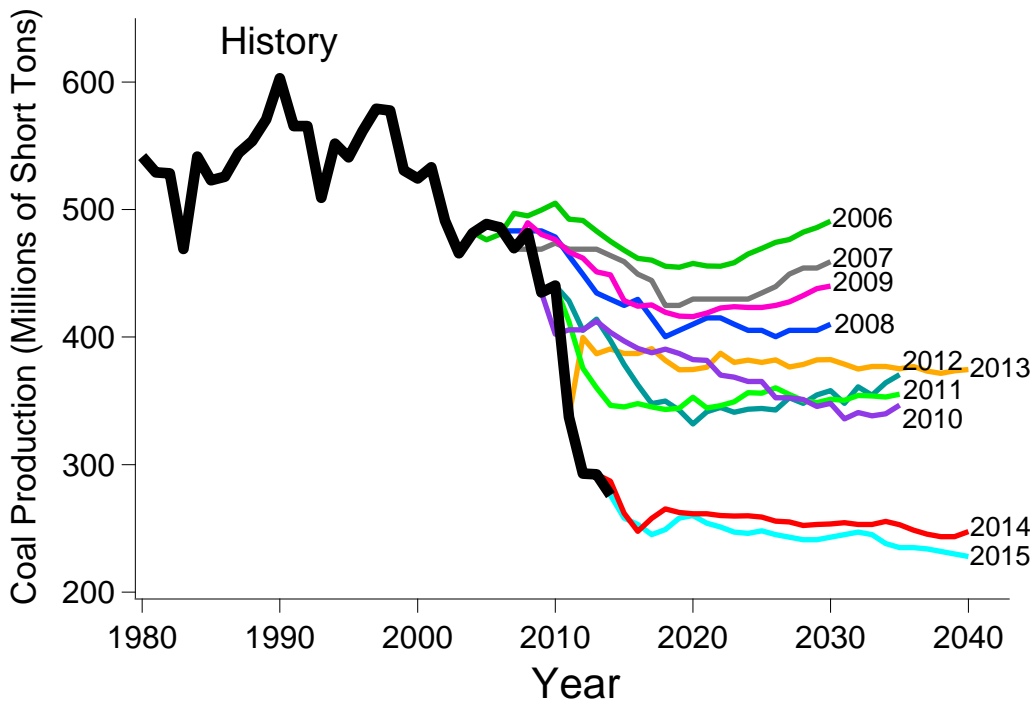
¹⁹ Data taken from the U.S. Energy Information Administration's *Annual Energy Outlook*. Projections for 2007-2013 were given in Quadrillion Btu and the EIA used many different conversion factors to convert millions of short tons to quadrillion Btu. Because conversion factor data was not provided, a conversion factor of 48.82 million short tons/quadrillion Btu was used here and data were vertically offset to match historical production. Projection data were anchored to the historical trend two years before the publication date because final numbers for the previous year were not yet known at the time of publication. Finally, note that projection durations changed from year to year; for example, the projections published before 2010 only went until 2035.

Figure 6. U.S. Coal Production and EIA Projections



History (black, bold) and annual EIA projections of U.S. coal production from 2006 to 2015. Note that the vertical axis starts at 950 million short tons for clarity. Data taken from: the EIA's Annual Energy Outlook.

Figure 7. Appalachia Coal Production and EIA Projections



History (black, bold) and annual EIA projections of Appalachian coal production from 2006 to 2015. Data taken from: the EIA's Annual Energy Outlook. Note that the vertical axis starts at 200 million short tons for clarity.

Rising coal prices and decreasing production are both tied to the geology of coal mining: as coal is mined, the most easily accessible deposits of coal are extracted first. For example, in open pit mines, coal deposits that lie close to the Earth's surface and are relatively inexpensive to mine are extracted first. Once these coal deposits have been exhausted, miners begin to extract other seams which are covered by increasing amounts of dirt and rock called *overburden*, that must be moved in order to access the coal. As the ratio of moving dirt to mining coal increases, productivity decreases and production costs grow.²⁰

The Appalachian region has some of the oldest coal mines in the country and the production costs for mines in this region have increased steadily over the last 15 years²¹ as the coal has become more difficult to access and the distances between coal deposits and existing rail lines have grown. Coal production plummeted in this region over the last decade while EIA projections persistently predicted that it would level out and even rise, as shown in Figure 7.²²

EIA models seem to assume that if there is a demand for coal then the coal will be produced and that all new power needs can inevitably be met by coal. This logic ignores the geological and financial realities facing U.S. coal producers and leads to dangerous projections which assure citizens and investors nearly infinite coal reserves. In reality, *coal is not a renewable resource* and it is becoming much more difficult and expensive to mine.²³ Decreasing coal production across the country indicates that the coal that can be mined at a profit in the U.S. is quickly being depleted.^{24,25}

Moving Forward

EIA projections have struggled to keep up with quickly changing renewable energy markets and failed to convey several emerging trends in fossil fuel markets. These persistent problems with EIA models emphasize that predicting the future of complex economic systems is fraught with uncertainty and that the accuracy of a projection depends on its underlying models and assumptions. Projections of future energy trends, including EIA projections, can be extremely useful but they should be evaluated for accuracy and relied on with due caution.

²⁰ U.S. Geological Survey. *The National Coal Resource Assessment Overview* (2009) Chapter D, p. 13

²¹ Clean Energy Action. *Updated Trends in U.S. Delivered Coal Prices: Volatility in U.S. Coal Prices Increases Pressure to Phase Out Coal Power* (2016)

²² Data taken from the U.S. Energy Information Administration's *Annual Energy Outlook*. Data was processed in the same manner as it was for Figure 6 (see Footnote 18).

²³ Luppens, J. et. al. *Coal Geology and Assessment of Coal Resources and Reserves in the Powder River Basin, Wyoming and Montana*. Reston, Virginia: United States Geological Survey (2015)

²⁴ Clean Energy Action. *Warning: Faulty Reporting of U.S. Coal Reserves* (2013)

²⁵ Clean Energy Action. *Coal: Cheap and Abundant. . . Or Is It?* (2009)