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Abstract

This study investigates whether or not energy independence in the United States is possible in terms of quadrillion British thermal units (QBTU) and/or balance of payments in dollars. We used data from the U.S. government-based Energy Information Administration (EIA) 2013 annual energy outlook report [citation]. EIA data suggested that energy independence in both energy balance in QBTU and in balance of payments is unattainable in the foreseeable future. **The conclusion of the study is that without mass adoption of natural gas and biomass as feedstock for transportation fuels to replace oil, the US and its economy will both be dependent on foreign oil and will be forced comply with the inflated prices set by the oil market. In addition even with the projected increased growth of domestic oil production the total cost of oil import will continue to top $300 billion a year.** In other words, any projected increase in oil production will be eclipsed by larger projected increase in oil price.

Contents

Introduction

With the recent discovery of natural gas reserves and tight oil in the United States, the idea that we could finally become “energy independent” has surfaced. Major news sources such as The Wall Street Journal, Business Insider, and The Globe and Mail have proclaimed the birth of “Saudi America,” and the beginning of a new era where America is “energy independent” (WSJ) (Wiles) (Milner). “Energy independence,” however, is a fickle term that can have multiple meanings.

One meaning is that, as a country, we produce more British Thermal Units (BTUs) than we consume, regardless of the source. The other meaning is that, as a country, we are no longer reliant on imports to meet our economy’s energy needs, in other words, it is energy self-sufficient in terms of balance of payment. The third meaning is that not only is the country self-sufficient we become the price setter in the energy market. At a glance, it may seem these definitions are one and the same. After all, if we are producing more BTUs then we are consuming, why should we have to rely on imports to meet our energy needs? The distinction comes into play when you consider that energy cannot be used universally across all sectors. Coal and gasoline both contain BTUs, but only one can power a conventional internal combustion engine found in the vast majority of vehicles on the road today. In the same vein, producing the same amount of BTUs from different types of fuels costs different amounts. Our questions in this study are: Will the United States become energy self-sufficient in both, neither or just one of the ways defined above? And if the United State becomes energy self-sufficient will that also mean energy independence (i.e. not susceptible to oil price shocks)?

Hopefully a definitive answer to those questions will help guide policy makers and the American public in deciding the direction of our energy sector.

Using data from the Energy Information Administration (EIA) this study compares the United States’ energy consumption and production on both a BTU basis alone and a dollar per BTU basis.

Methods

In this study, the vast majority of statistics and data were taken from the Annual Energy Outlook 2013 report that the Energy Information Administration (EIA) composed.

Since the goal was to determine whether or not the United States would be able to attain energy independence (by either definition of the term) by 2035, our first step was to determine the United States' energy consumption and production rates based on EIA projections. When talking about energy content, quadrillion British thermal units (QBTUs) were used unless noted otherwise.

Constructing EIA consumption and production

EIA numbers for the total energy consumption and production were given in QBTUs. We used EIA data and projected data for the years 2010, 2015, 2020, 2025, 2030 and 2035.

The categories for energy production are: crude oil and lease condensate, natural gas plant liquids, dry natural gas, coal, nuclear, hydropower, biomass, other renewable energy and other (Energy, p. 121). Hydropower, biomass, other renewable energy and other were grouped into a single category entitled "Renewables.' Crude oil and lease condensate and natural gas plants liquids were spread across two categories — liquid fuels (finished motor gasoline, aviation gasoline, kerosene-type jet fuel, distillate fuel oil, residual fuel oil and miscellaneous petroleum products) and other non-energy petrochemicals (liquefied petroleum gases). After calculations, these categories were combined into a single category titled "Total Petroleum Products" for the purpose of calculating our energy balance. This created five categories: total petroleum products, natural gas, coal, nuclear and renewables.

The categories for energy consumption were: liquid fuels and other petroleum, natural gas, coal, nuclear, hydropower, biomass, other renewable energy and other (Energy, p. 121). Hydropower, biomass, other renewable energy and other were grouped into a single category entitled "Renewables." During calculations, the liquid fuels and other petroleum category was divided into two categories — liquid fuels (E85, motor gasoline, jet fuel, distillate fuel oil, residual fuel oil and other petroleum fuels) and other non-energy petrochemicals (liquefied petroleum gases and other petroleum non-fuels) — before being combined into total petroleum products for calculating our energy balance. This created five categories: total petroleum products, natural gas, coal, nuclear and renewables. We used these categories when breaking down total energy content throughout the whole study.

Constructing a cost model

To determine the total cost of our consumption and production, we first determined the average price to all users in 2011 dollars per million BTU (USD/MMBTU) for 2010 and projected average price to all users in USD/MMBTU for 2015, 2020, 2025, 2030 and 2035 (Energy, p. 126).

To properly price petroleum products in terms of USD/MMBTU, we broke down the different types of petroleum products in order to account for the differing cost of refinement. Some subcategories were not given an average end-use cost, so for those categories the USD/MMBTU of a barrel of crude oil at the Brent Spot Price was used. To calculate this we used the ratio of 1 MMBTU =

0.18 barrel of oil equivalent (BOE) (Unit Juggler). It should be noted that this ratio can vary slightly because the energy content of a barrel of crude can vary slightly depending on where it is extracted from.

For coal and natural gas, we used the average end use cost projected through 2035 given by the EIA.

For nuclear, we took the average cost calculated by CleanTechnica (Shahan). There were no projected costs, so we applied the EIA's projected percent change in electricity costs to approximate the cost of nuclear in future years. The number was given in USD per kilowatt hour (USD/kWh) and converted to USD/MMBTU by the following ratio:

1USD/kWh = 293 USD/MMBTU (Evergreen BioFuels Inc.)

For renewables, we took the average cost calculated by CleanTechnica (Shahan). The number was given in USD per kilowatt hour (USD/kWh) and converted to USD/MMBTU by the following ratio: 1USD/kWh = 293 USD/MMBTU (Evergreen BioFuels Inc.). Because we had one overall renewables category, we calculated each renewable's makeup of the overall renewable category with the following formula:

(Individual renewable source)/(total renewable amount) = percentage share of renewable category

We then took the cost of hydropower ($0.04 per kWh), biomass ($0.08 per kWh) and other ($0.12 per kWh) and determined the current/projected cost of all renewables by averaging them relative to their makeup of the renewable energy category by respective year.

Below is a table containing the subcategories that were used and their prices according to the EIA or our calculations, as explained above.

Average price to all users (2011 dollars per million btu)	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Propane	$16.23	$10.94	$13.69	$16.07	$18.14	$20.43
E85	$25.56	$24.94	$29.64	$27.27	$26.94	$29.19
Motor gasoline	$23.06	$25.99	$27.84	$29.26	$30.72	$32.99
Jet fuel	$16.57	$19.52	$21.50	$23.73	$26.03	$28.52
Distillate fuel oil	$22.17	$24.05	$26.25	$28.62	$30.48	$32.88
Residual fuel oil	$11.06	$14.51	$15.97	$17.72	$19.59	$21.61
Crude oil	$14.65	$17.28	$19.02	$21.14	$23.50	$26.19
Coal	$2.42	$2.57	$2.77	$2.94	$3.10	$3.25
Natural gas	$7.27	$6.68	$7.07	$7.76	$8.27	$9.31
Nuclear	$6.27	$6.19	$5.69	$5.84	$5.91	$6.05
Renewables	$22.70	$23.61	$23.61	$23.71	$23.81	$24.03

Calculating cost in billions of dollars

Cost totals were calculated in 2011 dollars. To determine the total cost, the following formula was used to figure the cost from each sector before being combined to reach the total cost.

Amount of source (QBTU) x average price to all users of source (2011 USD/MMBTU) = cost of source (billions of 2011 dollars)

Or:

1 x10^{15} BTU	1 USD	1 x 10^{9} USD
	1 x 10^{6} BTU	

For petroleum products, each individual output (i.e., motor gasoline, jet fuel and propane) was calculated with the above method by each output's respective price and makeup of total petroleum product. The results were added together and represented by the total petroleum products category. It should be noted that the amount of each individual output that made up total petroleum products varied between consumption and production.

Calculating total energy balance in QBTU

Once total consumption and production in QBTU was calculated, the next step was to obtain the energy balance. This was done with the following formula:

Energy production of source (QBTU) - energy consumption of source (QBTU) = energy balance of source (QBTU)

Calculating total energy balance in billions of dollars

Once total consumption and production in billions of dollars was calculated, the next step was to obtain the energy balance. This was done with following formula:

Energy production of source (billions of dollars) - energy consumption of source (billions of dollars) = energy balance of source (billions of dollars)

Results

Figure 1 shows the EIA projections of our total energy consumption in QBTUs, while Figure 2 shows the EIA projections of our total energy consumption in billions of 2011 dollars. Total petroleum products achieved the highest total proportion of QBTU and dollars consumption through 2035, although total petroleum products dollars consumption had much higher totals, more than quadrupling the next highest consumption source in 2010 and 2015, and more than tripling the next highest consumption source in 2020, 2025, 2030 and 2035.

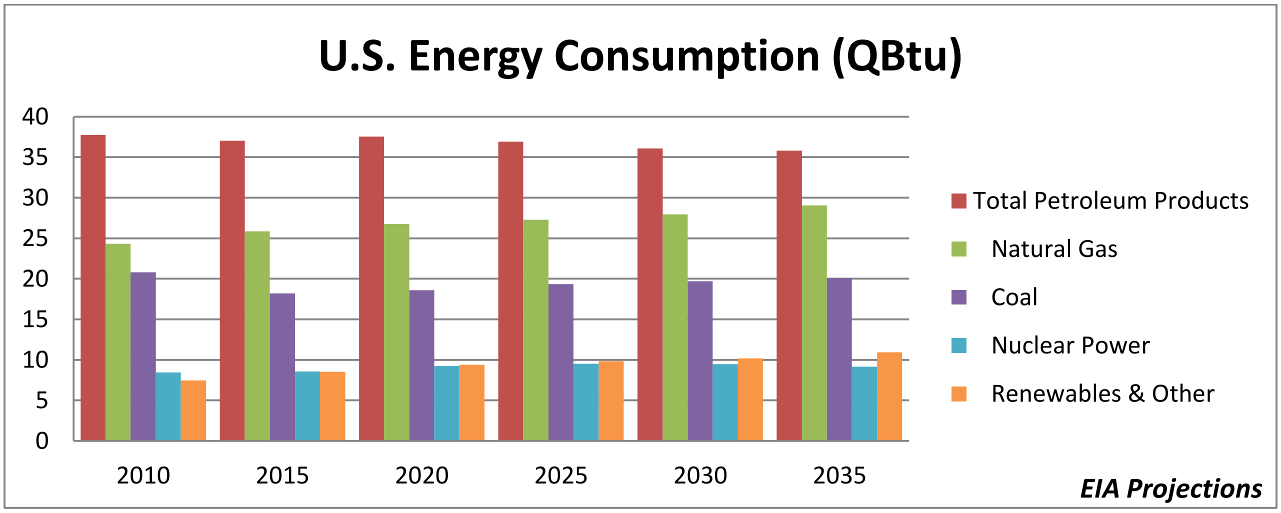

Figure 1: Energy consumption in QBTUs (EIA)

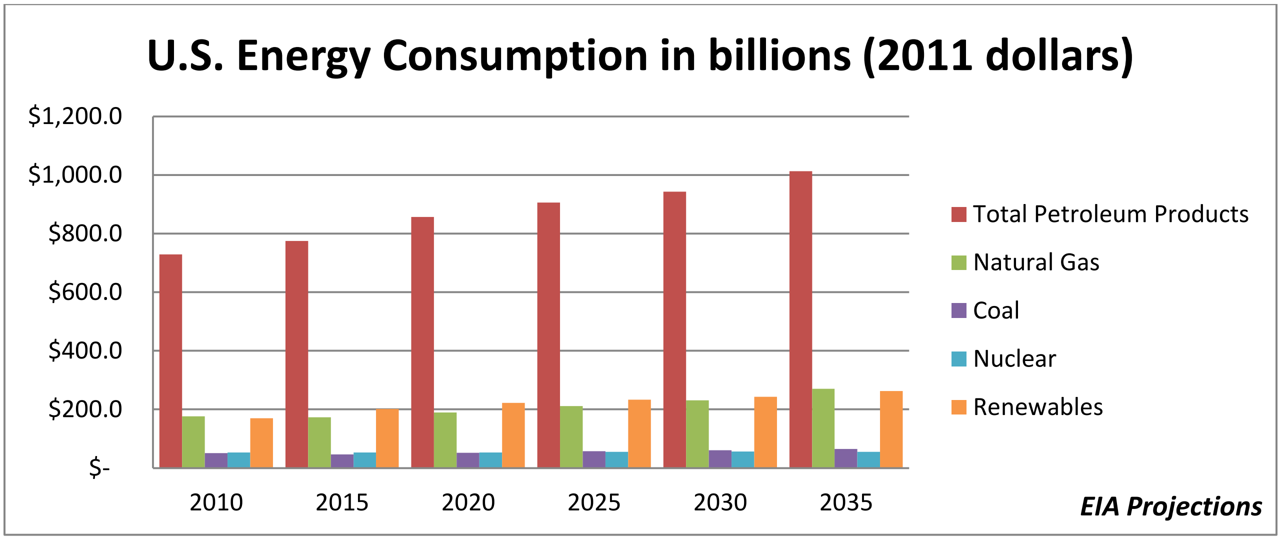

Figure 2: Energy consumption in billions of 2011 dollars (EIA)

Figure 3 shows the EIA projections of our total energy production in QBTUs, while Figure 4 shows the EIA projections of our total energy production in billions of 2011 dollars. Natural gas followed by coal consistently made up the largest amount of energy production in terms of QBTUs, but total petroleum products composed the largest portion of energy production in terms of billions of 2011 dollars for all years, even doubling the next highest source of production in every year except for 2035.

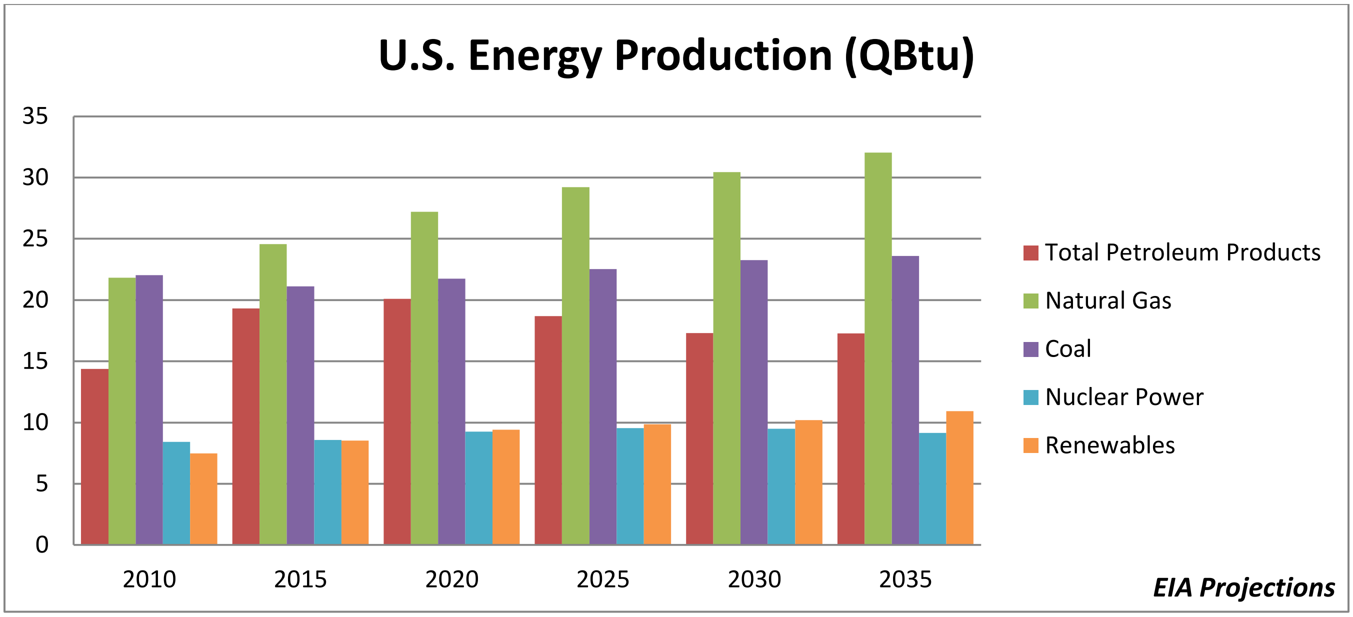

Figure 3: Energy production in QBTUs (EIA)

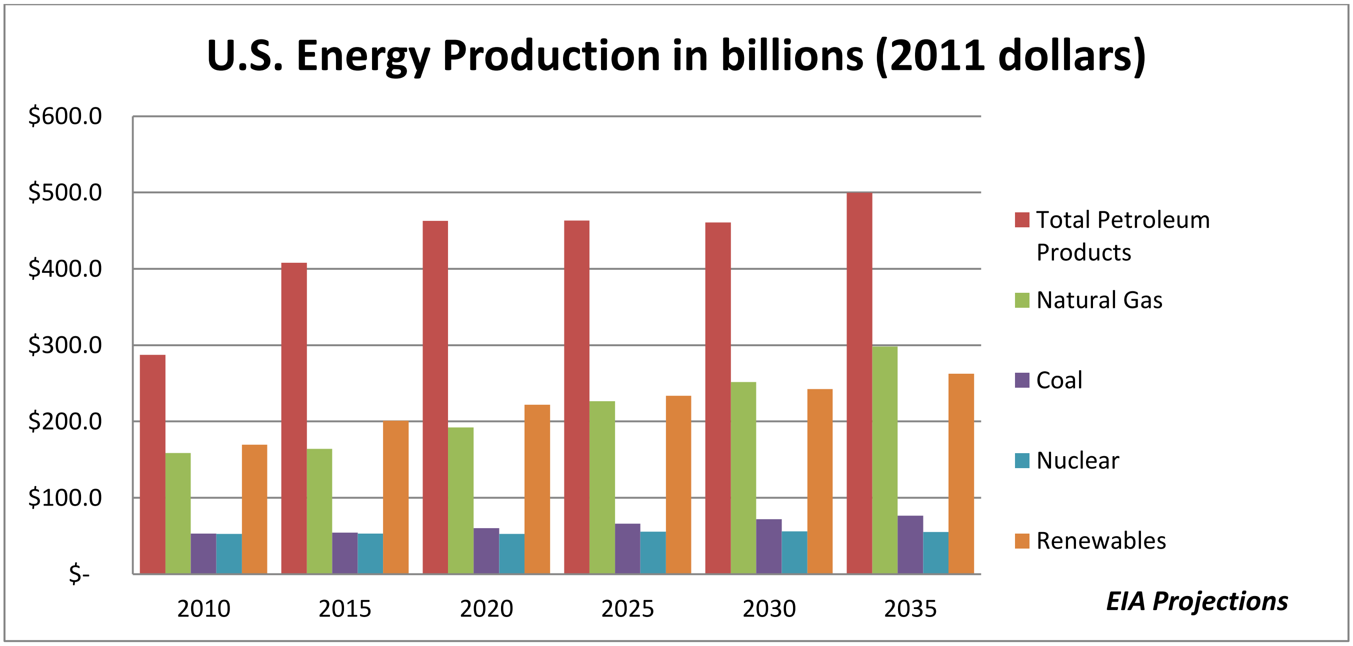

Figure 4: Energy production in billions of 2011 dollars (EIA)

The United States' energy balance in QBTUs from EIA data is shown in Figure 5. Our total energy balance is consistently negative through 2035, although it does gradually decrease as time goes on. Total petroleum products were primarily responsible for the deficit in every projected year. Interestingly, nuclear and renewable energy did not affect the results one way or another.

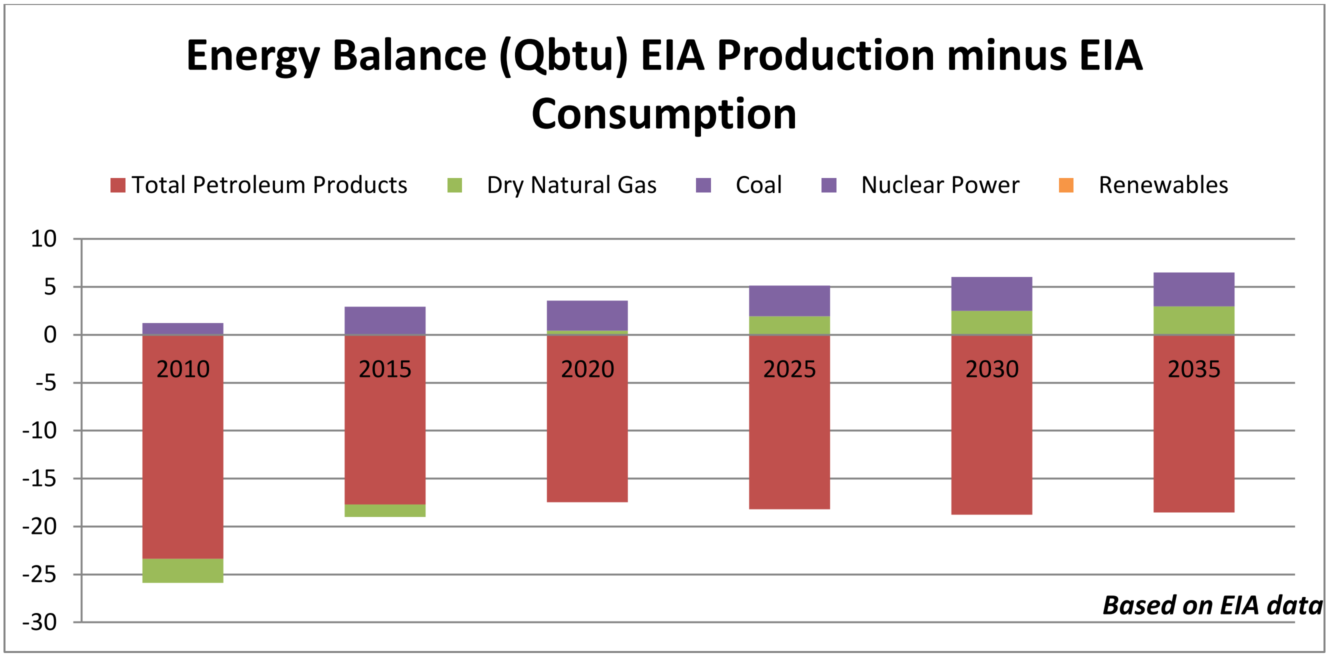

Figure 5: Projected energy balance in QBTUs (EIA)

The United States' energy balance in billions of 2011 dollars from EIA data is shown in Figure 6. As with QBTU energy balance, total petroleum products were primarily responsible for the deficit. Interestingly, our total energy balance deficit drops from 2010 through 2020, before increasing from 2020 through 2035 to deficit levels above where they were in 2010. As with the energy balance of QBTUs, nuclear and renewables did not affect the results one way or another.

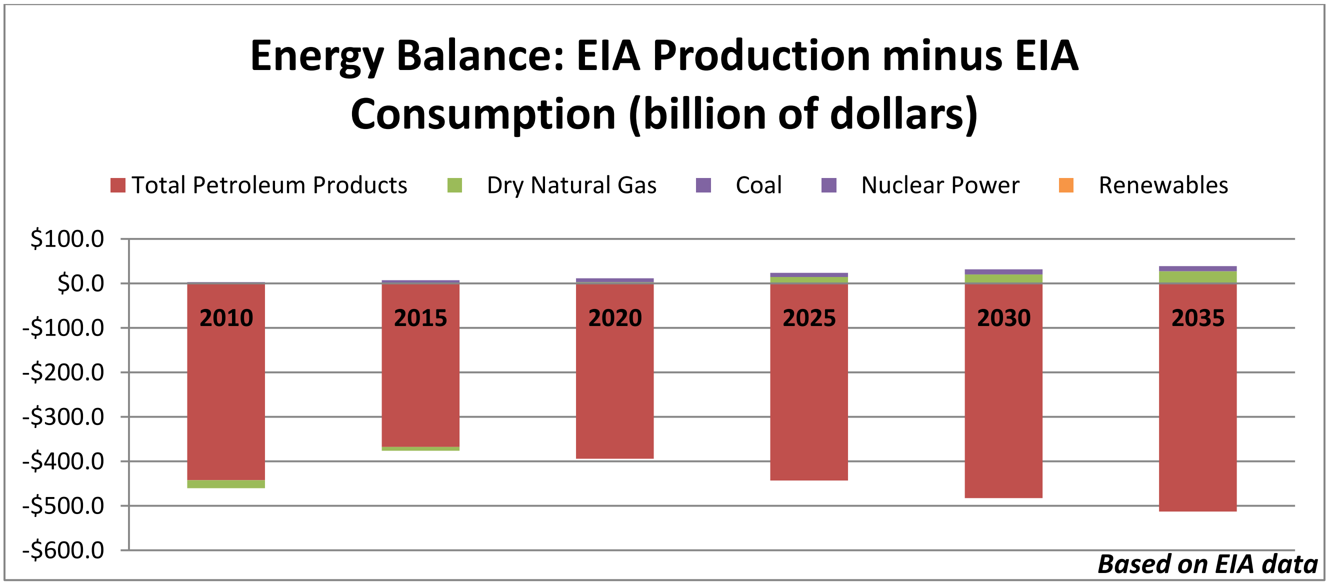

Figure 6: Projected energy balance in billions of 2011 dollars (EIA)

Conclusion

While it is necessary to keep in mind that this study was working primarily with projections and not recorded data, we believe that this study suggests that energy independence for the United States in terms of dollars will definitely not come to pass by 2020 or even 2035 if current trends continue. In fact, EIA data pointed to strongly negative energy balances in billions of dollars for all years — never dropping below a $300 billion deficit and even returning to a 2010 level deficit by 2035 after a slight drop through 2020.

In terms of QBTUs, the picture is similar. EIA data points to a negative QBTU balance for all years — never dropping below a 10 QBTU deficit.

It is our belief that the dollars per BTU projections are far more important to the United States' energy security than QBTU projections. Attaining QBTU energy independence will not lessen our overall deficit, nor will it protect us from global oil price shocks. In essence, QBTU energy independence does not free the United States' economy from the burden of foreign oil. Dollar per BTU energy independence on the other hand, has the potential to do so, as money will no longer be leaving our economy through the energy sector. Only dollar per BTU energy independence will have an effect on our economy and dependence on foreign oil.

What was intriguing is that nuclear and renewable energy did not affect the energy balance. We believe this is due the fact that we do not import or export nuclear and renewable energy. Regardless, their numbers are not in a position to affect our energy independence in either sense of the term by 2035.

What should be highlighted, is that for all years, across QBTU and dollars per BTU energy balances, total petroleum products consistently posted negative balances. On top of this, total petroleum products consistently composed the largest negative portion of the total energy balance for both types of energy independence.

While the EIA data projections are not perfect, they are one of the foremost energy statistic authority figures in the United States and the international community. If their data is to be believed, "energy independence," "Saudi America," and consequently, control of our energy future are developments that will not come to pass anytime soon if current trends continue.

In other words, not only that the United States is NOT going to be energy independent (i.e. sets its own energy prices and is isolated from oil shocks) the United States will not even be energy self-sufficient.

Acknowledgements

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