A report by the Staff of the
Public Utilities Commission of Ohio

Ohio Long Term Forecast of Energy Requirements

July 22, 2015

Ohio | Public Utilities Commission

Disclaimer for the *2015 Ohio Long Term Forecast of Energy Requirements Report* by the staff of the Public Utilities Commission of Ohio.

Pursuant to R.C. 4935.01(A), PUCO staff presents year by year forecasts of the prevailing energy, economic and demographic trends in the U.S., Ohio and utility service areas in Ohio over a 20-year period. PUCO staff issues the following report which consists of forecasts that are projections dependent upon assumptions and historical data and trends. The future, however, is unknown. Periodic reviews of past forecasts are, therefore, a wise and necessary step to both test the validity of the current forecast scenarios and be able to identify and monitor emerging alterations in prevailing trends due to the impacts of more recent historical events. The forecasts presented in this report consider the anticipated developments in the national and international economic environment, and assess their potential impact on Ohio. These forecasts are presented solely for the purposes of ORC 4935.01(A) and should not be used or relied upon for any other purpose.

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1.0 Introduction

Ohio long-term forecast of energy requirements 2014–2033 presents year by year forecasts of the prevailing energy, economic and demographic trends in the United States (U.S.), Ohio and utility service areas in Ohio, over a 20 year period. Historical patterns observed in the development of the prevailing trends, and the dynamic relationships among them, are analyzed, assessed and taken into consideration in the formulation of the forecasting models, and the forecast scenarios. Anticipated alterations in the prevailing trends, due to anticipated business cycles or other severe macro economic shocks, are specifically included in the forecast scenarios when deemed relevant and feasible.

This publication is prepared by the Forecasting, Markets and Corporate Oversight Division of the Public Utilities Commission of Ohio (PUCO). The intent of the report is to fulfill the PUCO's mandate under Ohio Revised Code (ORC) Section 4935.01 (A), which states that:

The Commission Shall:

(1) Estimate statewide and regional needs for energy for the forthcoming five- and ten-year periods which, in the opinion of the Commission, will reasonably balance requirements of state and regional development, protection of public health and safety, preservation of environmental quality, maintenance of a sound economy, and conservation of energy and material resources. Other factors and trends which will significantly affect energy consumption such as the effects of conservation measures shall also be included.

(2) Estimate statewide and regional demands within the state for energy for twenty years ahead, to be used in formulation of long-range policies and proposals for reduction of demand, conservation of energy, development of potential sources of energy, and action to affect the rate of growth in demand for energy.

The forecasts presented in this report include the annual requirements for energy resources, *i.e.*, natural gas, petroleum products, coal, and nuclear energy, by the residential, commercial, industrial, transportation and electric utilities sectors of the state of Ohio from 2014 through 2033. Peak load forecasts for the U.S., Ohio and the service areas of investor-owned electric distribution utilities (EDUs) operating in Ohio, are also presented for the 2014 through 2033 forecast horizon.

1.1 Organization of the report

In addition to Section 1, Introduction, the report includes the following sections:

Section 2, *Systemic background and forecast assumptions,* presents an analysis of certain recurrent and non-periodic historic singularities that have induced sudden, significant and sustained alterations in economic, demographic and energy consumption trends in the U.S. and in Ohio. It provides an assessment of the future incidence of such singularities over the 2014-2033 forecast horizon, and considers the possible impacts of such singularities upon the business cycle and energy consumption behavior in Ohio. This section concludes with an overview of the specific assumptions underlying this years forecasts.

Section 3, *Peak load demand forecast,* starts with a presentation of the PUCO staff's (staff) annual peak load forecast for the U.S. as a whole. Next, peak load growth forecasts for the service areas in Ohio of the following EDUs: Cleveland Electric Illuminating Company, Dayton Power & Light Company, Duke Energy Ohio Inc., Ohio Edison Company, Ohio Power Company, and Toledo Edison Company. Individual service area forecasts mentioned above are then combined with a consolidated forecast for Buckeye Power Inc., AMP-Ohio, and Ohio Valley Electric Corporation (OVEC) to obtain a statewide non-coincident peak load demand forecast.

Section 4, *The demand for energy by fuel type,* presents an analysis and assessment of the total demand for each one of the fuel types considered in this report (*i.e.*, coal, nuclear, and hydro generation; natural gas; and petroleum products) and presents this information in a series of tables and graphs. Total demand for each fuel type is presented in terms of its composition by the sectorial demands for that fuel (*i.e.*, residential, commercial, industrial, transportation and electric utilities).

Section 5, *The demand for energy by economic sector,* provides the information presented in Section 4 from a different perspective. Total demand for energy within each economic sector is presented in terms of the demands for specific fuel types within that sector.

2.0 Systemic background and forecast assumptions

Annual accounting time series that follow long-term trends, such as income, population, inflation, and energy and peak load demands, change abruptly at or around certain critical points in time, at or during which certain historical shocks, or systemic singularities, are known to have occurred. Among the better known examples of such systemic singularities, one could recount the onset and the conclusion of WWI, WWII and the Great Depression. From a more recent historical perspective, the traumatic fluctuations in crude oil prices between 1973 and 1986, and the surge in crude oil prices since 2003, would also qualify as systemic singularities of a lower magnitude or intensity. In the process of absorbing, reacting, adjusting, and adapting to such recurrent and non-periodic systemic shocks, or singularities, the world and the U.S. economy display sudden, significant and sustained fluctuations in the time paths of critical energy and economic magnitudes. Unless such critical changes are explicitly accounted for during the modeling process, accurate descriptions of the historical behavior of annual accounting time series, such as population, income, inflation and product price and consumption levels, become problematic. Similarly, if the possibility of future singularities are ignored in the design of long-term forecast scenarios, significant divergences may emerge between the *ex ante* forecasts and the *ex post* observations, as the forecast horizon is transformed into history through the passage of time.

Table 2.0.1 and Figure 2.0.1 present the behavior of nominal crude oil prices in the U.S. between 1946 and 2014. After a period of near complete stability between 1948 and 1973, crude oil prices increased over seven fold, from $4.75/barrel (bbl) in 1973 to $37.42/bbl in 1980. The surge in the relative price of crude oil was accompanied by manifold increases in the relative prices of all energy inputs. In nominal dollars, the residential price of natural gas in Ohio increased from $1.11/thousand cubic feet (Mcf) in 1973 to over $6.00/Mcf in 1982. Similarly, the price of residential electricity increased from 2.4 cents per kilowatt hour (kWh) in 1973 to 7.5 cents per kWh in 1984. The price of coal burned by Ohio electric utilities increased from $9.64/ton in 1973 to $40.00/ton in 1982. The surging energy prices contributed to an inflationary spiral that induced two recession-recovery cycles of 1973–1975–1978 and 1978–1982–1984, which, in turn, resulted in lower overall per capita income growth for the 1973–1984 period relative to the 1960-1973 period. The impact of the recession-recovery cycles on real per capita incomes in Ohio and the U.S. are presented in Figure 2.2.1. Inflation adjusted crude oil prices are presented in Figure 2.0.2.

The surging crude oil prices and declining real per capita incomes reduced the rate of growth of demand for petroleum products, among other things, through public and private conservation measures and programs, through the development and adoption of new and more efficient energy consumption

technologies, and the enactment of mandatory efficiency standards. On the supply side, the significantly higher returns to producers induced and encouraged exploration, discovery, and production of crude oil in novel places including the North Sea, Gulf of Mexico and Alaska. As demand growth declined and supply growth increased, crude oil prices came down from a peak of $37.32/bbl in 1980 to $14.44/bbl in 1986, a drop of more than 60 percent.

From 1986 to 2003, a new dynamic balance was established between the growth in demand for crude oil and the available supplies of crude oil, such that nominal crude oil prices remained below $28/bbl throughout this period.

Crude oil prices increased steadily from $27.69/bbl in 2003 to $98.47/bbl in 2008. After falling precipitously from this level as part of the most recent economic recession, crude prices have once again risen, averaging $89.08/bbl in 2014.

Not included in Figure 2.0.1 or Table 2.0.1 is the recent drop in oil prices experienced in early 2015, with prices once again dropping below $50.00/bbl. This price drop can be explained through both supply and demand side market fundamentals. On the supply side, new technologies have made the extraction of shale gas and oil more cost-effective. On the demand side, slow growth in international economies has also exerted downward pressure on prices. It is unclear at this time whether the current low prices are more than a temporary phenomenon, and to what extent suppliers will respond to lower prices by curtailing output.

Staff forecasts presented in this report are designed to take into account the observed impacts of historical singularities upon the prevailing long-term trends in the time path trajectories of the business cycle, population growth, energy prices, and energy consumption and peak load demand levels.

Trends in the long-term business cycle are defined and measured in terms of trends in the trajectory of growth of real per capita personal income. Population and real per capita personal income characterize the demographic size and the per capita purchasing power of the U.S. and of Ohio as two interdependent economic systems.

The business cycle and energy consumption move in overlapping and interdependent cycles that vary by economic sector and fuel type. For example, demand for electricity in the residential sector is dynamically more stable than the demand for electricity in the industrial sector, which is more responsive to swings in the business cycle. In the process of forecasting, the relationships between economic, demographic and energy trends are identified, analyzed, and assessed. An understanding of their behavior is

hypothesized within the context of the past historical singularities and prevailing systemic conditions. Future trends and behavior are projected on the basis of this understanding operating as a working hypothesis.

Pursuant to the mandate of the ORC, staff has been analyzing, assessing and forecasting the magnitudes presented in this report for more than 20 years. On the other hand, the future is unknown by definition. Periodic review and updating of past forecasts is a wise and necessary process both to test the validity of the current forecast scenarios, and to be able to identify and monitor emerging alterations in prevailing trends due to changes in the systemic conditions or the impact of more recent historical singularities.

The analytical methodology utilized for the modeling and estimation of historical time path trajectories, and for the development of forecast scenarios, involves mathematical modeling with a generalized Gompertz spline function as the deterministic model. Generalized Gompertz spline functions are a class of S-curve spline functions through which growth, decline, or recurrent fluctuations over successive intervals of time can be modeled and measured. A multi-normal distribution function is utilized as the stochastic model. The modeling process, the estimation procedures and the computer programming required for the application of this methodology were developed in-house using SAS computer programming language. An extensive analytical discussion of the methodology was presented in the PUCO publication Technical Appendix to Ohio Long Term Forecast of Energy Requirements 1995–2015 (PUCO, 1996).

2.1 Demographic background: historical perspective and forecast implications

Table 2.1 and Figure 2.1.1 present the historical behavior of U.S. population growth in terms of four successive trends. The first trend, generally referred to as the "baby boom", begins in 1947 and continues through 1964. From 1965 through 1990, population growth follows a slower growth trend. From 1991 through 2000, it switches to a relatively faster growth trend. A minor downward adjustment to the post-1990 trend is observed in the 2001 through 2014 period. Without detailing the socioeconomic and political factors influencing the establishment of these trends, staff observes that the average duration of the post WWII trends in population growth is approximately 20 years. Staff projects a slightly lower growth trend between 2014 and 2033.

The population of the U.S. was 316 million persons in 2013. It is expected to be 338 million persons in 2023 and 359 million persons in 2033. The standard error of the forecast is 0.07 percent.

Figure 2.1.2 presents the historical behavior of population growth in Ohio. In the case of Ohio, a reduction in the post WWII fast growth trend occurs between 1972 and 1988. This trend represents no population growth, and corresponds to a period of major structural changes in the state's economy, when established traditional manufacturing industries were replaced or restructured under the influence of higher energy input costs induced by the oil price increases of 1973 and 1978, as well as the costs of compliance with the emissions requirements of the Clean Air Act. Beginning in 1989, Ohio population levels display a relatively robust positive growth trend through 1997. Population growth in Ohio slows in a discernable manner between 1998 and 2013. Staff expects this population growth trend to prevail through the forecast time horizon.

The population of Ohio was 11.6 million persons in 2013. In 2033, it is expected to be 11.9 million. The standard error of the forecast is 0.19 percent.

2.2 Macro economic background: historical perspective and forecast implications

Figure 2.2.1 documents the dynamic behavior of real per capita personal income growth in Ohio and the U.S. It is clear that Ohio closely follows the national pattern. The difference between the two patterns is increasing over time.

It is clear by inspection of Figure 2.2.1 that the growth in real per capita personal income per year does not follow a smooth trajectory over time. It follows a trajectory characterized by consecutive recession and recovery phases of the long-term business cycle. The dynamic behavior of real per capita personal income is an important determinant of expenditures on goods and services in general. It is, therefore, an important determinant of the dynamic behavior of demand for energy resources as well. Consequently, accurate analyses and assessments of the historical dynamics of growth in peak load and energy resource demands require accurate analyses and assessments of the historical dynamics of the long-term business cycle and its impact upon the trajectories of growth in question.

Although the timing, duration, intensity and the precipitating cause of each long-term recession recovery cycle may be different and manifold, it is nevertheless a matter of historical fact that any consecutive 20 year period depicted in Figure 2.2.1 includes at least two recession recovery cycles of one sort or the other. Based upon this fact, staff anticipates a cyclical event of mild to moderate intensity and duration between 2014 and 2033. The first recessionary phase of the forecast business cycle is associated with the economic recession that began in 2008 and the slow recovery that followed. Another mild to moderate business cycle is projected with the recessionary

phase starting in 2021 and lasting through 2023, with a recovery phase starting in 2024 and lasting through the end of the forecast horizon.

The forecasts presented in this report consider the anticipated developments in the national and international economic environment, and try to assess their impact on Ohio. They are consistent with historical reality. On the other hand, they are not prophetic proclamations. They are simply attempts to provide a consistent and informed characterization of what is likely to happen. The future will always include pleasant and unpleasant surprises, as well as precedented and unprecedented developments. It is therefore essential to monitor the macroeconomic and microeconomic developments in Ohio, the U.S. and the world at large, to detect significant deviations in actual versus predicted energy consumption patterns and in actual versus predicted economic and demographic growth patterns as early as possible. The system theoretical forecasting models utilized by staff are inherently equipped to perform this monitoring duty effectively and efficiently so that forecast scenarios may be similarly modified in a timely manner.

The future size and duration of U.S. budget and foreign trade deficits should also be closely monitored due to their possible impacts upon the business cycle. A failure to address unsustainable structural and financial conditions at the national or international level could fundamentally alter the incidence and magnitude of the business cycles projected in this report. This, in turn, would similarly alter the energy forecast trajectories presented herein.

Table 2.0.1.
Domestic Crude Oil Prices
1946 - 2014

Year	Domestic Crude Oil Prices in Nominal Dollars Per Barrel[1]	Domestic Crude Oil Prices in 1982 Dollars Per Barrel[2,3]
1946	$1.63	$8.35
1947	$2.16	$9.67
1948	$2.77	$11.51
1949	$2.77	$11.62
1950	$2.77	$11.51
1951	$2.77	$10.67
1952	$2.77	$10.44
1953	$2.92	$10.92
1954	$2.99	$11.13
1955	$2.93	$10.95
1956	$2.94	$10.82
1957	$3.14	$11.16
1958	$3.00	$10.38
1959	$3.00	$10.30
1960	$2.91	$9.83
1961	$2.85	$9.53
1962	$2.85	$9.44
1963	$2.91	$9.51
1964	$3.00	$9.68
1965	$3.01	$9.56
1966	$3.10	$9.57
1967	$3.12	$9.34
1968	$3.18	$9.14
1969	$3.32	$9.05
1970	$3.39	$8.74
1971	$3.60	$8.89
1972	$3.60	$8.61
1973	$4.75	$10.70
1974	$9.35	$18.97
1975	$12.21	$22.70
1976	$13.10	$23.02
1977	$14.40	$23.76
1978	$14.95	$22.93
1979	$25.10	$34.57
1980	$37.42	$45.41
1981	$35.75	$39.33
1982	$31.83	$32.98
1983	$29.08	$29.20
1984	$28.75	$27.67
1985	$26.92	$25.02
1986	$14.44	$13.18
1987	$17.75	$15.63
1988	$14.87	$12.57
1989	$18.33	$14.78
1990	$23.19	$17.74
1991	$20.20	$14.83
1992	$19.25	$13.72
1993	$16.75	$11.59
1994	$15.66	$10.57
1995	$16.75	$10.99
1996	$20.46	$13.04
1997	$18.64	$11.61
1998	$11.91	$7.31
1999	$16.56	$9.94
2000	$27.39	$15.91
2001	$23.00	$12.99
2002	$22.81	$12.68
2003	$27.69	$15.05
2004	$37.66	$19.94
2005	$50.04	$25.62
2006	$58.30	$28.92
2007	$64.20	$30.97
2008	$91.48	$42.49
2009	$53.48	$24.93
2010	$71.21	$32.65
2011	$87.04	$38.68
2012	$86.46	$37.66
2013	$91.17	$39.13
2014	$89.08	$37.75

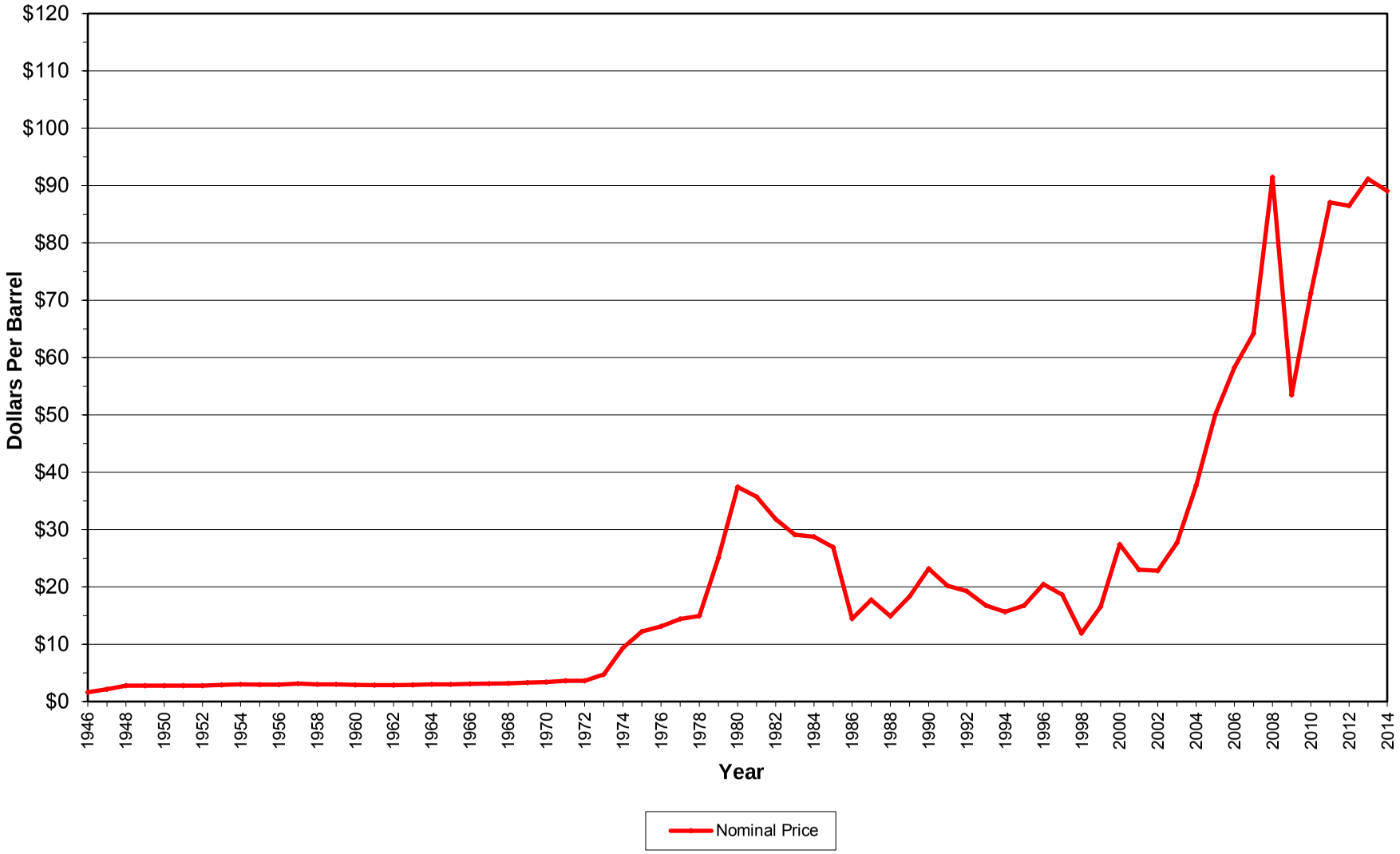
Sources

1. www.inflationdata.com "Historical Crude Oil Prices" as published by Illinois Oil and Gas Association (IOGA).

2. Prices in 1982 Dollars = Nominal Prices Divided by CPI-U, 1982 = 1.00.

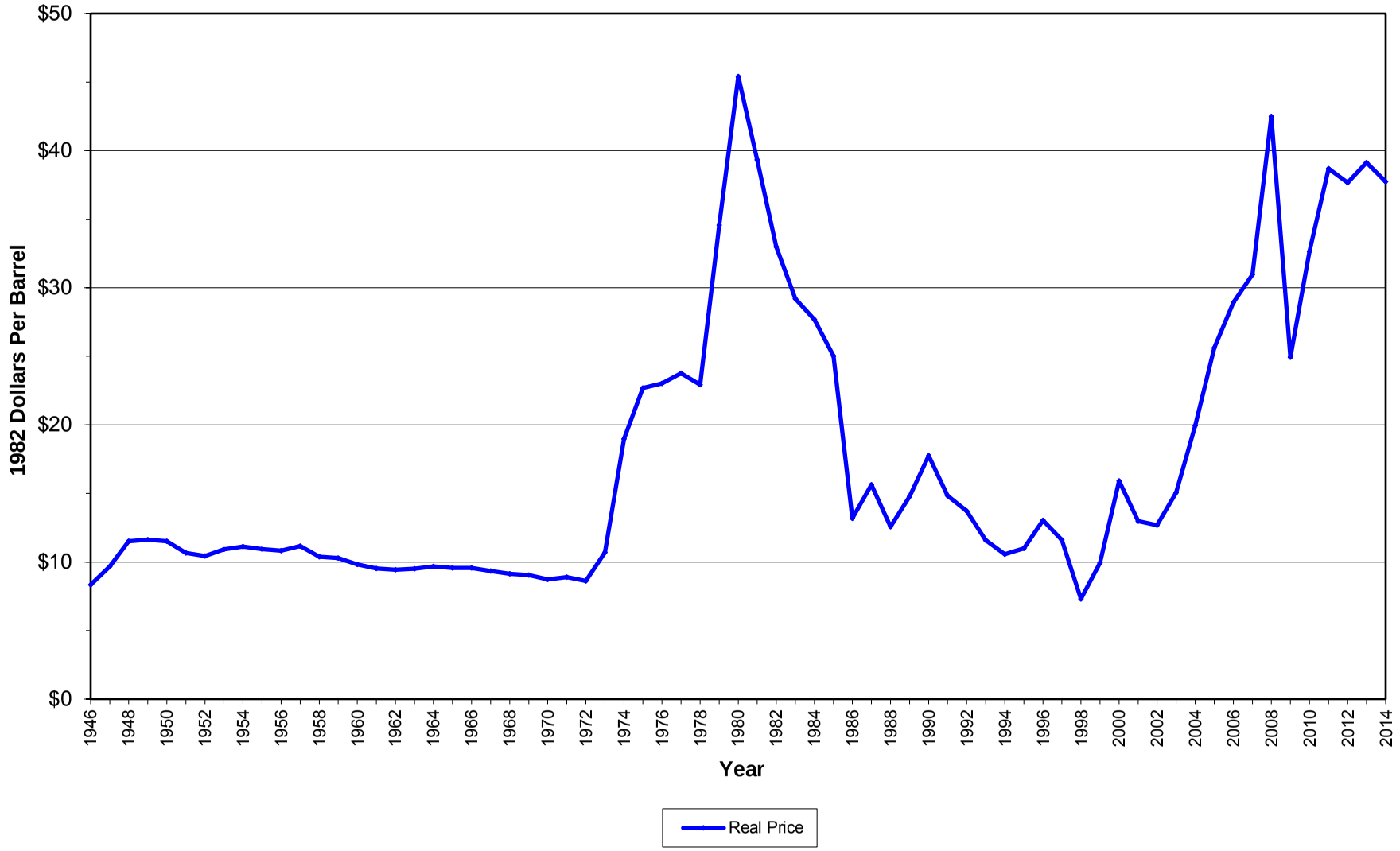
3. CPI-U numbers from Bureau of Labor Statistics

Figure 2.0.1. Time Path Trajectory of Nominal Domestic Crude Oil Prices
(1946 - 2014)



Sources: 1. www.inflationdata.com "Historical Crude Oil Prices" as published by Illinois Oil and Gas Association (IOGA). 2. Prices in 1982 Dollars = Nominal Prices Divided by CPI-U, 1982 = 1.00. 3. CPI-U numbers from Bureau of Labor Statistics

Figure 2.0.2. Time Path Trajectory of Domestic Crude Oil Prices in 1982 Dollars
(1946 - 2014)



Source: www.inflationdata.com "Historical Crude Oil Prices" as published by Illinois Oil and Gas Association (IOGA).

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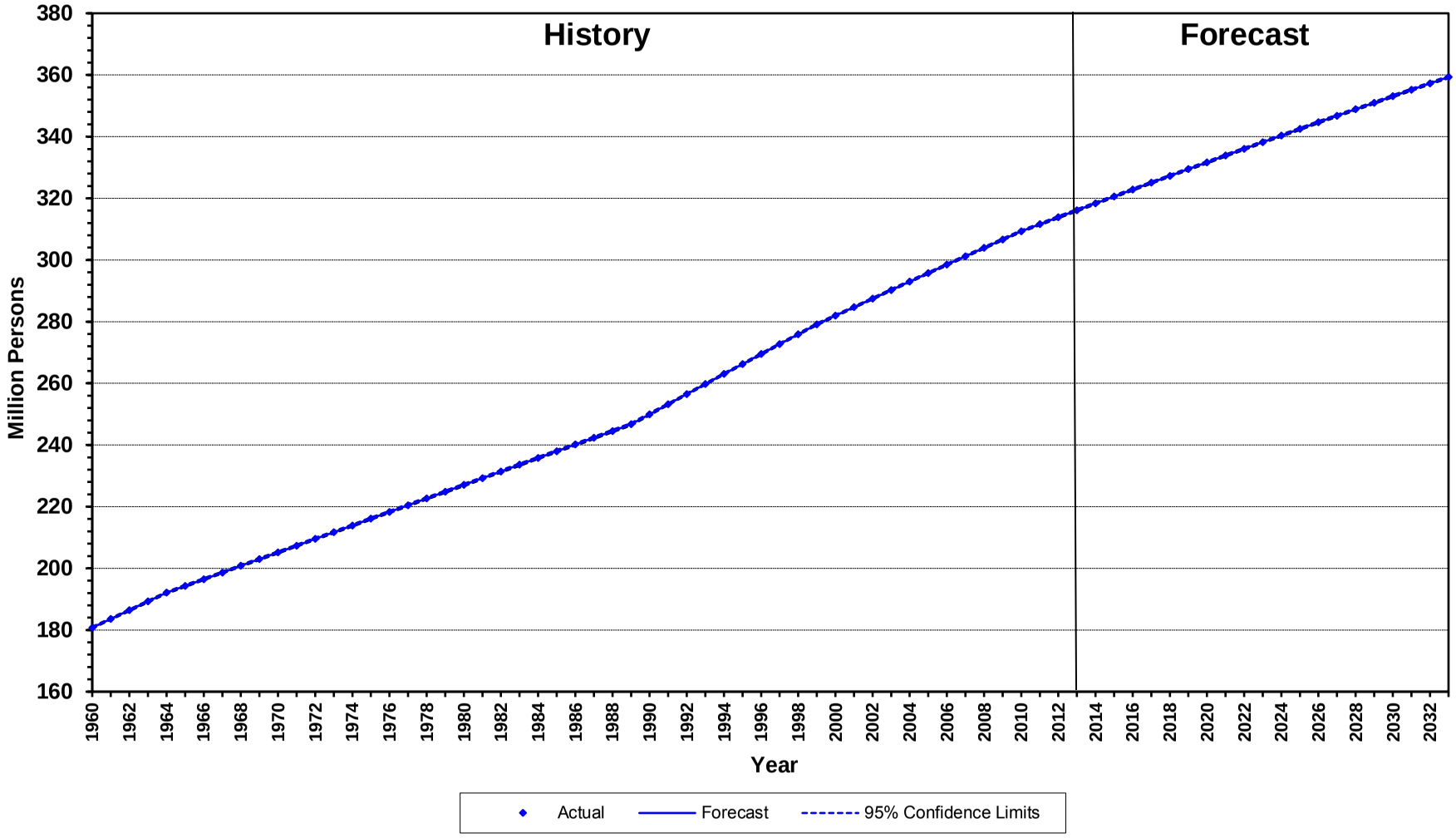
Table 2.1
U.S. & Ohio Population and Real Per Capita Personal Income
(2006 - 2030)

	Year	U.S. Population (million persons)	U.S. Real Per Capita Personal Income (thousand 1982 dollars per capita per year)	Ohio Population (million persons)	Ohio Real Per Capita Person Income (thousand 1982 dollars per capita per year)
-5	2008	304	18.98	11.52	16.91
-4	2009	307	18.37	11.53	16.56
-3	2010	309	18.42	11.55	16.60
-2	2011	312	18.83	11.55	17.17
-1	2012	314	19.27	11.55	17.52
0	2013	316	19.23	11.57	17.62
1	2014	318	19.52	11.61	17.85
2	2015	321	19.71	11.63	18.00
3	2016	323	19.91	11.64	18.14
4	2017	325	20.10	11.66	18.29
5	2018	327	20.29	11.68	18.44
6	2019	329	20.49	11.69	18.59
7	2020	332	20.68	11.71	18.74
8	2021	334	20.52	11.73	18.60
9	2022	336	20.36	11.74	18.45
10	2023	338	20.20	11.76	18.31
11	2024	340	20.39	11.78	18.46
12	2025	343	20.58	11.79	18.61
13	2026	345	20.77	11.81	18.76
14	2027	347	20.96	11.82	18.90
15	2028	349	21.15	11.84	19.05
16	2029	351	21.34	11.86	19.20
17	2030	353	21.53	11.87	19.35
18	2031	355	21.53	11.87	19.35
19	2032	357	21.53	11.87	19.35
20	2033	359	21.53	11.87	19.35
Standard Error of the Forecast		0.07%	1.20%	0.19%	1.16%

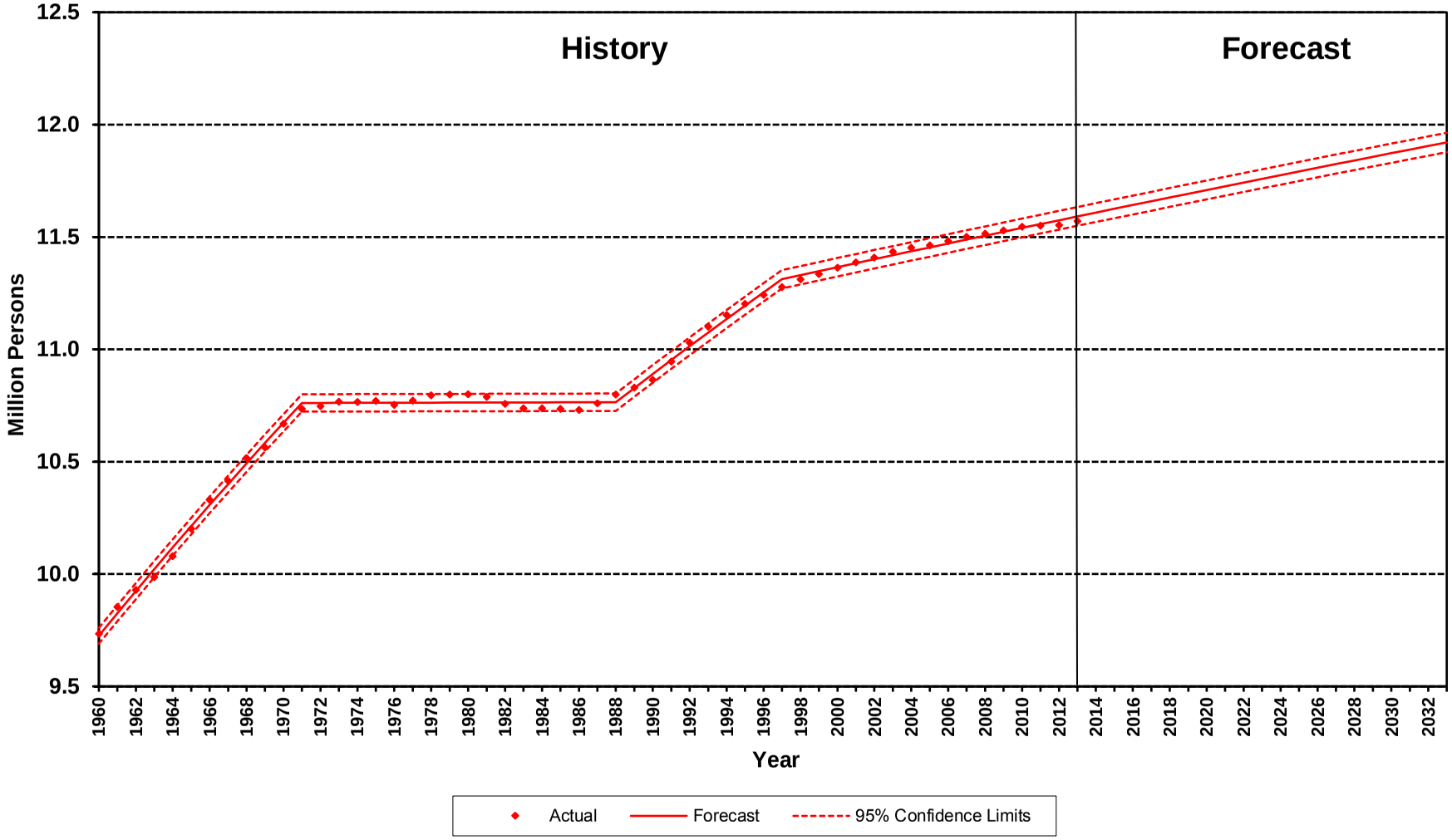
Source: U.S. Department of Commerce, Survey of Current Business and PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 2.1.1. Time Path Trajectory of U.S. Population (1960 - 2033)



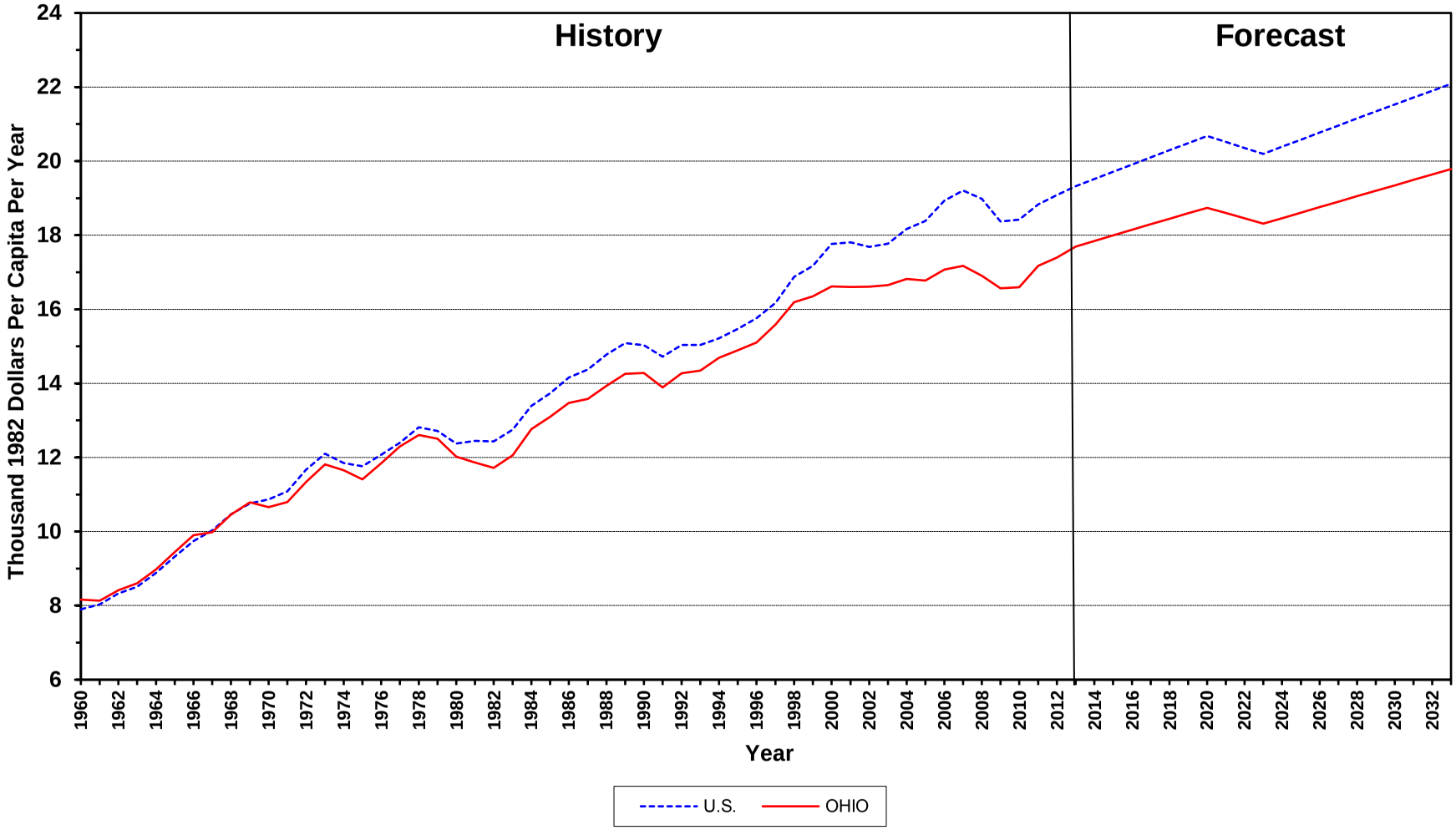
'Source: U.S. Department of Commerce, Survey of Current Business and PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 2.1.2. Time Path Trajectory of Ohio Population (1960 - 2033)



'Source: U.S. Department of Commerce, Survey of Current Business and PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 2.2.1. Time Path Trajectories of U.S. and Ohio Real Per Capita Personal Incomes (1960 - 2033)



'Source: U.S. Department of Commerce, Survey of Current Business and PUCO, Division of Forecasting, Markets, and Corporate Oversight

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3.0 Peak load demand forecasts

In this section, staff presents non-coincident annual peak load demand forecasts for the U.S., the state of Ohio and the service areas of investor-owned EDUs operating in Ohio. The investor-owned EDUs in question include Cleveland Electric Illuminating Company, Dayton Power and Light Company, Duke Energy Ohio, Ohio Edison Company, Ohio Power Company and Toledo Edison Company. Note that since the last forecast report was published in 2012, Columbus Southern Company and Ohio Power Company have merged to become the newly formed Ohio Power Company.

3.1 U.S. peak load forecast

Since 1964, the U.S. has been a summer peaking system. Therefore, since 1964, the U.S. annual peak load is the U.S. summer peak load.

Figure 3.1.1 presents the U.S. per capita annual peak load growth trajectory from 1960 through 2033. The impact of space cooling demand is a major contributing factor to the high growth trend which is visible upon inspection from 1966 through 1973. The sudden, significant, and sustained reduction in this high growth trend, starting in 1974, is also visible upon inspection. The quadrupling of crude oil prices in 1973, and their doubling again in 1978, were the starting points of a series of economic and political repercussions, including higher inflation levels, even higher energy prices, and the implementation of voluntary and mandatory energy conservation measures, standards, and policies. All of these factors may have had a share in the establishment of the post-1973 trend in U.S. per capita peak load growth.

What is even more remarkable, from a historical and a practical perspective, is the stability of the post-1973 trend. Between 1973 and 2013, neither the deterministic trend nor the standard error of the observations around the trend, have changed significantly. However, staff observes that the geopolitical uncertainty and the associated oil price increases experienced since 2004 have both put a slight downward pressure on the U.S. per capita annual peak demand of electricity and have increased the volatility of the most recent observations.

Figure 3.1.2 presents the U.S. annual peak load growth trajectory from 1960 through 2033. It is calculated by multiplying the U.S. per capita annual peak load trajectory presented in Figure 3.1.1, with the U.S. population growth trajectory presented in Figure 2.1.1. Table 3.1 presents the year by year forecast magnitudes for the U.S. per capita annual peak load demand, U.S. population and U.S. annual peak load demand.

U.S. annual peak load demand was 771,871 megawatts (MW) in 2013. It is expected to be 802,360 MW in 2023 and 824,249 MW in 2033. The standard error of the forecast is 2.96 percent.

3.2 Peak load growth in Ohio

In Ohio, the growth rate of peak load demand has mostly paralleled the growth rate of U.S. peak load demand. Since 1992, the peak load growth rate has been slowly declining. The peak load forecast for Ohio in this report still anticipates slightly positive load growth. Additionally, the volatility of the observations has increased. The most drastic volatility has been observed around recessionary events, roughly the years 2000 and 2008.

The annual non-coincident peak load demand forecast for Ohio is performed in three stages. In the first stage, annual peak load demands for the six investor-owned utilities operating in Ohio are analyzed and forecast individually. These forecasts are presented in Table 3.2 and Figures 3.2.1 through 3.2.6. It is expected that all companies will be summer peaking utilities.

In 2013, the non-coincident annual peak load for the six investor-owned utilities in question was 27,563 MW. It is expected to be 28,836 MW in 2023 and 29,011 MW in 2033. The standard error of the forecast is 2.6 percent.

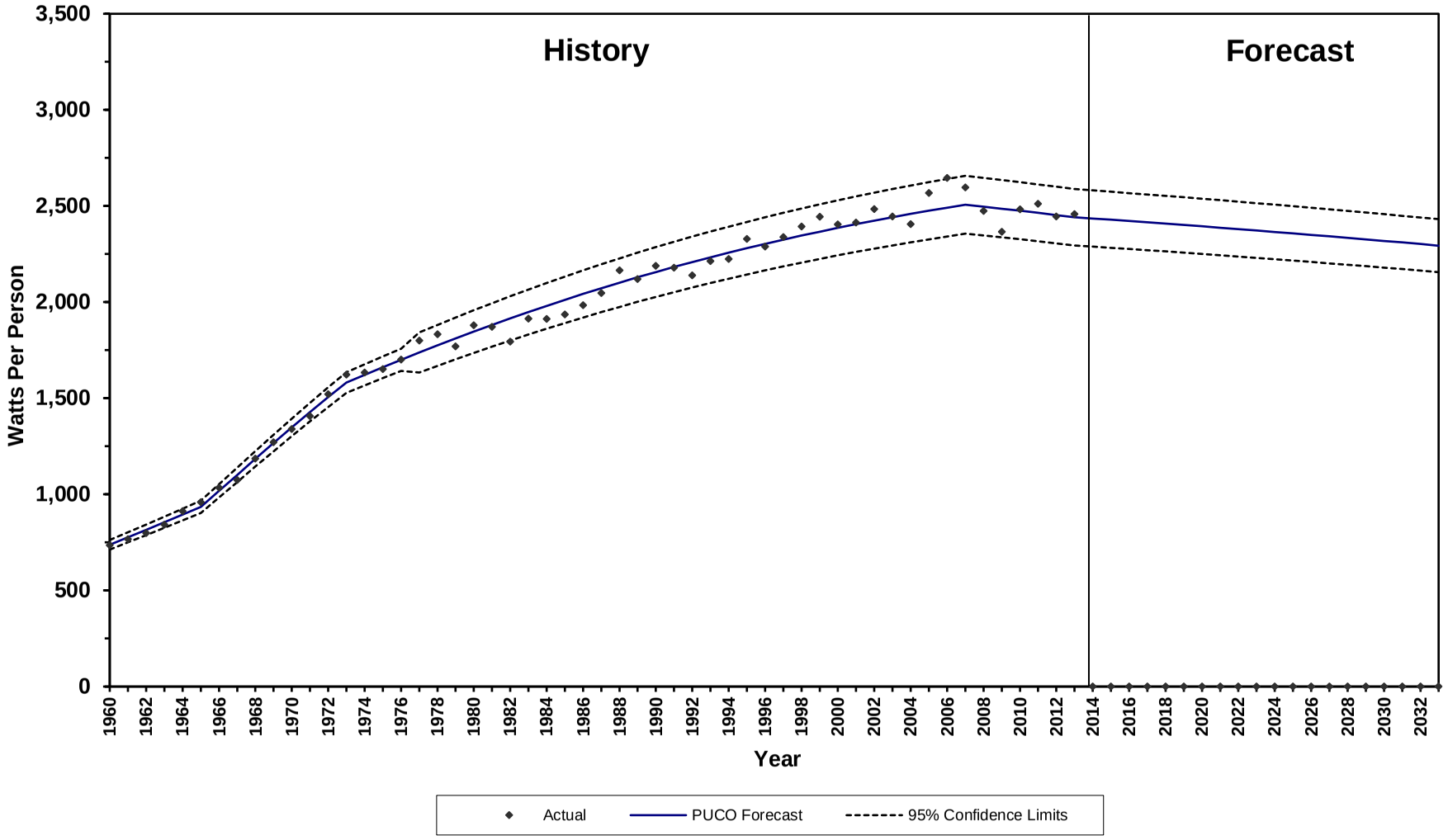
In the second stage, the summer peak load forecasts for Buckeye Power Inc., American Municipal Power-Ohio Inc. and OVEC are consolidated into one category called “other.”

In 2013, the non-coincident summer peak load for the “other” category was 3,841 MW. It is expected to be 3,991 MW in 2023 and 4,144 MW in 2033. The standard error of the forecast is 4 percent.

In the third stage, the peak load forecast for the “other” category is added to the consolidated forecast of the six investor-owned utilities to get the total non-coincident annual peak load demand for the state of Ohio. The result is presented on Table 3.2 and Figure 3.2.7.

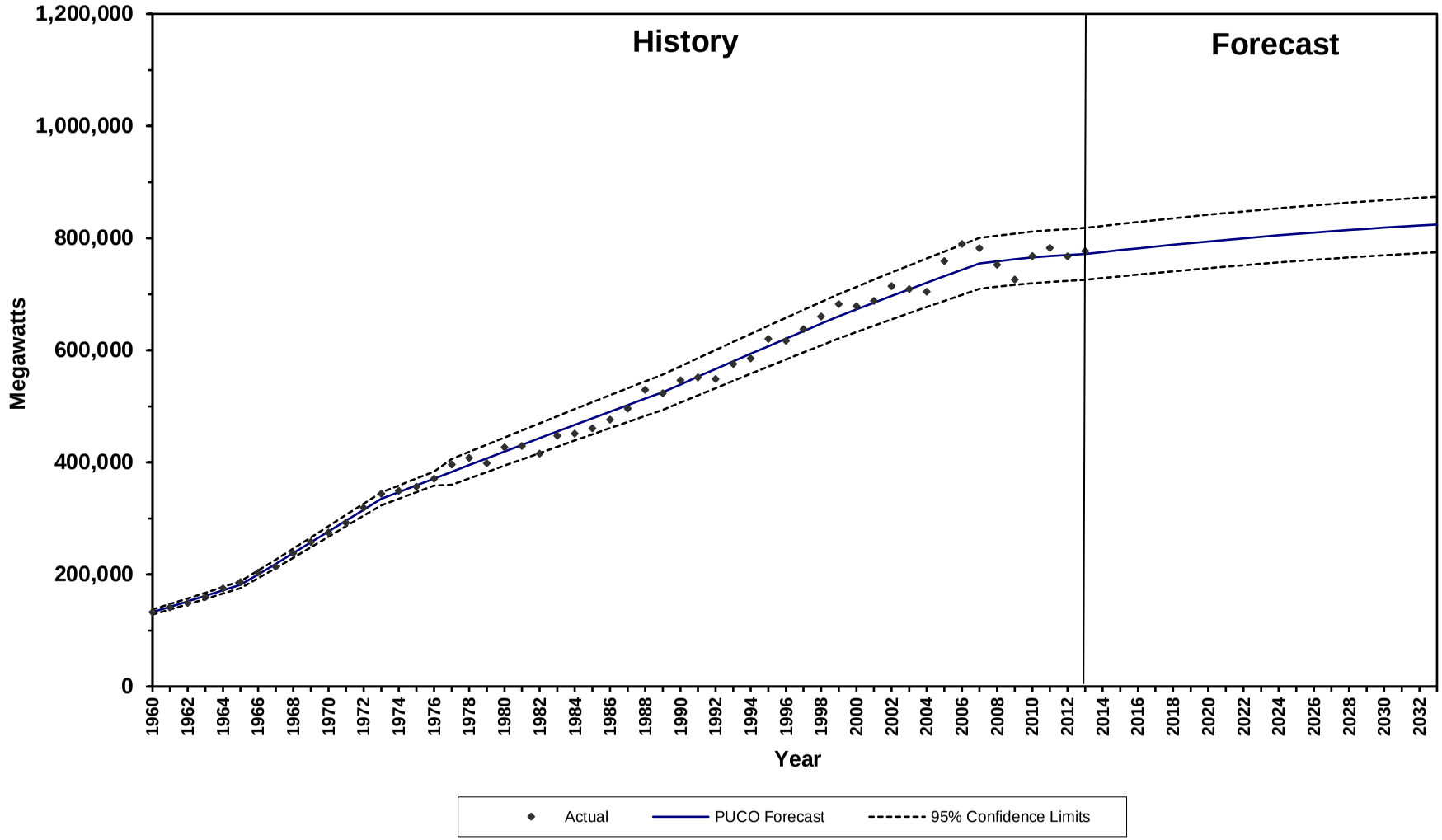
In 2013, the non-coincident summer peak load for the state of Ohio was 31,404 MW. It is expected to be 32,827 MW in 2023 and 33,156 MW in 2033. The standard error of the forecast is 2.6 percent.

Figure 3.1.1. Time Path Trajectory of U.S. Per Capita Annual Peak Load (1960 - 2033)



Source: EEI Statistical Yearbook and PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 3.1.2. Time Path Trajectory of U.S. Annual Peak Load (1960 - 2033)



Source: EEI Statistical Yearbook and PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 3.1
U.S. Per Capita Annual Peak Load, Population and Annual Peak Load
(2005 - 2033)

	Year	U.S. Per Capita Annual Peak Load (watts/person)	U.S. Population (million persons)	U.S. Annual Peak Load (megawatts)
-5	2008	2,474	304	752,470
-4	2009	2,366	307	725,958
-3	2010	2,483	309	767,948
-2	2011	2,464	312	767,914
-1	2012	2,453	314	769,970
0	2013	2,442	316	771,871
1	2014	2,435	318	775,280
2	2015	2,429	321	778,611
3	2016	2,422	323	781,865
4	2017	2,415	325	785,038
5	2018	2,408	327	788,132
6	2019	2,401	329	791,144
7	2020	2,394	332	794,074
8	2021	2,387	334	796,920
9	2022	2,380	336	799,683
10	2023	2,372	338	802,360
11	2024	2,365	340	804,951
12	2025	2,357	343	807,455
13	2026	2,350	345	809,872
14	2027	2,342	347	812,199
15	2028	2,334	349	814,437
16	2029	2,326	351	816,584
17	2030	2,318	353	818,639
18	2031	2,310	355	820,603
19	2032	2,302	357	822,473
20	2033	2,294	359	824,249
Standard Error of the Forecast		± 2.35%	± 0.07%	± 2.96%

Source: EEI Statistical Yearbook and PUCO, Division of Forecasting, Markets, and Corporate Oversight.

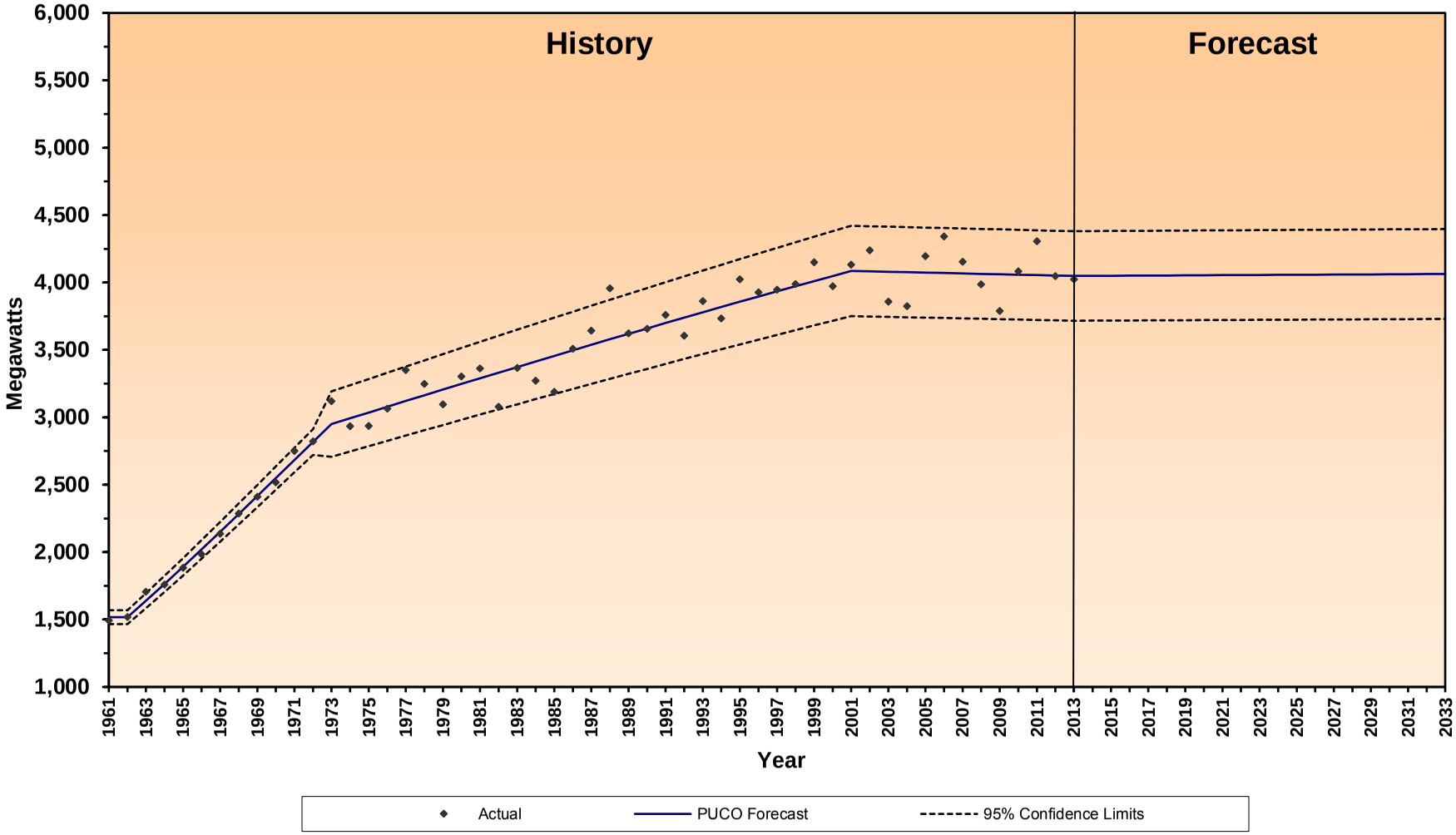
Table 3.2.
Annual Peak Load Forecasts for the State of Ohio and EDU Service Areas in Ohio
History (2008 - 2013), Forecast (2014 - 2033)
(Megawatts)

	Year (1)	Cleveland Electric Illuminating (2)	Ohio Power Company (3)	Dayton Power & Light (4)	Duke Energy Ohio (5)	Ohio Edison Company (6)	Toledo Edison (7)	Investor-Owned Utility Total (8) ∑[(2)-(7)]	Other Ohio [1] (9)	State of Ohio Total (10) (8)+(9)
-5	2008	3,986	9,864	3,027	4,230	4,997	1,899	28,003	3,700	31,703
-4	2009	3,790	9,097	2,912	3,994	4,682	1,841	26,316	3,501	29,817
-3	2010	4,083	9,632	2,956	4,414	5,135	1,980	28,200	3,798	31,998
-2	2011	4,307	9,752	3,146	4,514	5,679	2,138	29,536	3,921	33,457
-1	2012	4,047	9,408	3,046	4,412	5,428	2,342	28,683	3,824	32,507
0	2013	4,025	9,071	2,937	4,167	5,242	2,121	27,563	3,841	31,404
1	2014	4,050	9,622	3,050	4,247	5,502	2,137	28,607	3,916	32,524
2	2015	4,050	9,634	3,049	4,249	5,509	2,141	28,633	3,925	32,558
3	2016	4,051	9,646	3,048	4,252	5,517	2,145	28,658	3,933	32,592
4	2017	4,052	9,658	3,047	4,254	5,524	2,149	28,684	3,942	32,626
5	2018	4,053	9,670	3,046	4,256	5,531	2,153	28,709	3,950	32,659
6	2019	4,053	9,682	3,045	4,259	5,538	2,158	28,734	3,959	32,693
7	2020	4,054	9,694	3,044	4,261	5,546	2,162	28,760	3,967	32,727
8	2021	4,055	9,706	3,043	4,263	5,553	2,166	28,785	3,975	32,760
9	2022	4,055	9,718	3,042	4,265	5,560	2,170	28,810	3,983	32,794
10	2023	4,056	9,729	3,041	4,268	5,567	2,174	28,836	3,991	32,827
11	2024	4,057	9,741	3,040	4,270	5,575	2,178	28,861	3,999	32,860
12	2025	4,058	9,753	3,039	4,272	5,582	2,182	28,886	4,007	32,894
13	2026	4,058	9,765	3,038	4,275	5,589	2,186	28,911	4,015	32,927
14	2027	4,059	9,777	3,037	4,277	5,596	2,191	28,936	4,023	32,960
15	2028	4,060	9,789	3,035	4,279	5,603	2,195	28,961	4,031	32,992
16	2029	4,061	9,800	3,034	4,282	5,611	2,199	28,986	4,039	33,025
17	2030	4,061	9,812	3,033	4,284	5,618	2,203	29,011	4,047	33,058
18	2031	4,061	9,812	3,033	4,284	5,618	2,203	29,011	4,079	33,091
19	2032	4,061	9,812	3,033	4,284	5,618	2,203	29,011	4,112	33,123
20	2033	4,061	9,812	3,033	4,284	5,618	2,203	29,011	4,144	33,156
Standard Error of the Forecast		± 4.1%	± 4.3%	± 3.6%	± 4.3%	± 6.7%	± 3.0%	± 2.6%	± 4.0%	± 2.6%

Source: PUCO, Division of Forecasting, Markets and Corporate Oversight.

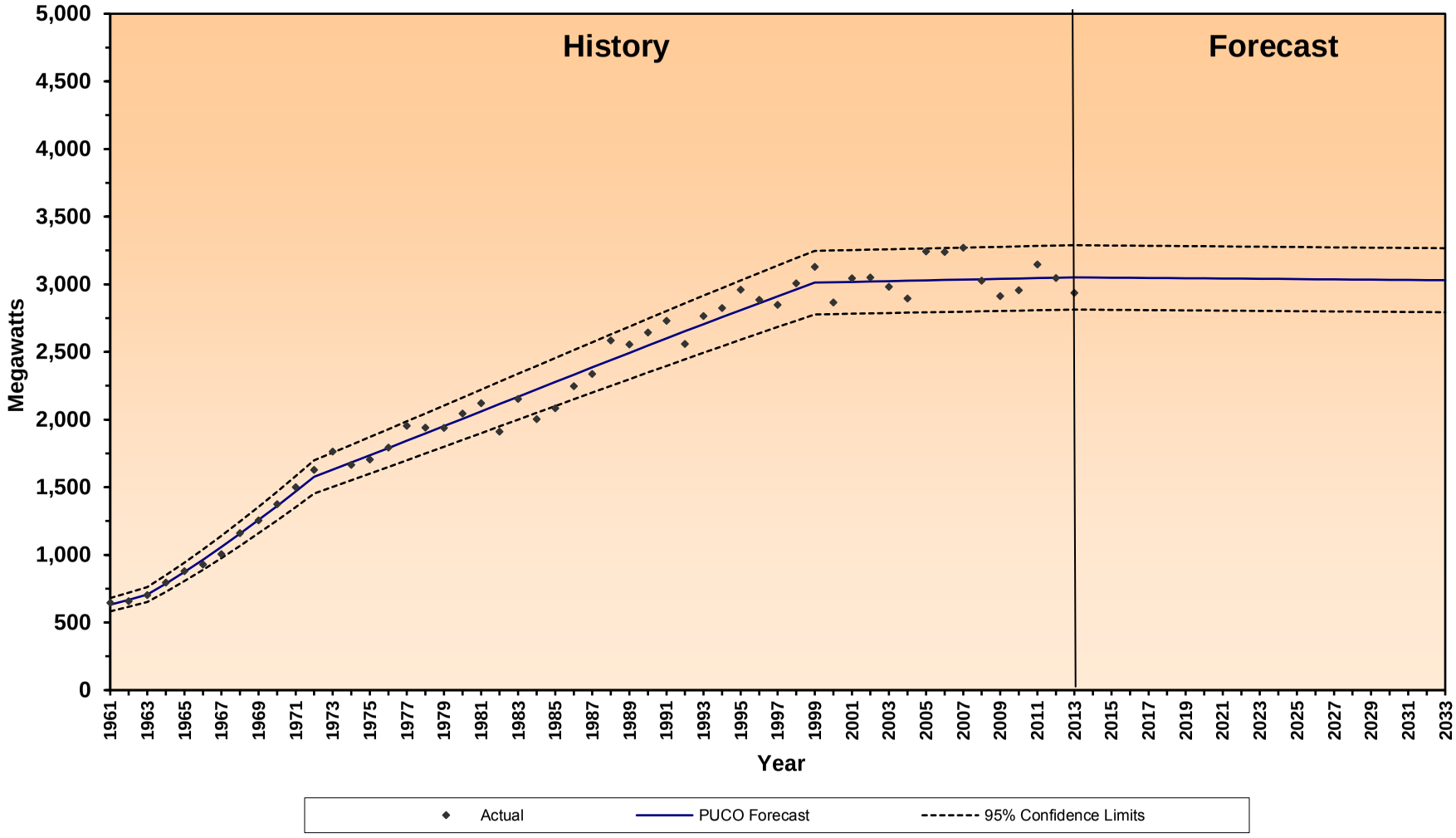
Note 1: Other Ohio includes OVEC, Buckeye Power and AMP-Ohio. It also includes Ormet for years 1999 - 2006 when Ormet received Power from non-Ohio sources.

Figure 3.2.1. Cleveland Electric Illuminating Company Summer Peak Load (1961 - 2033)



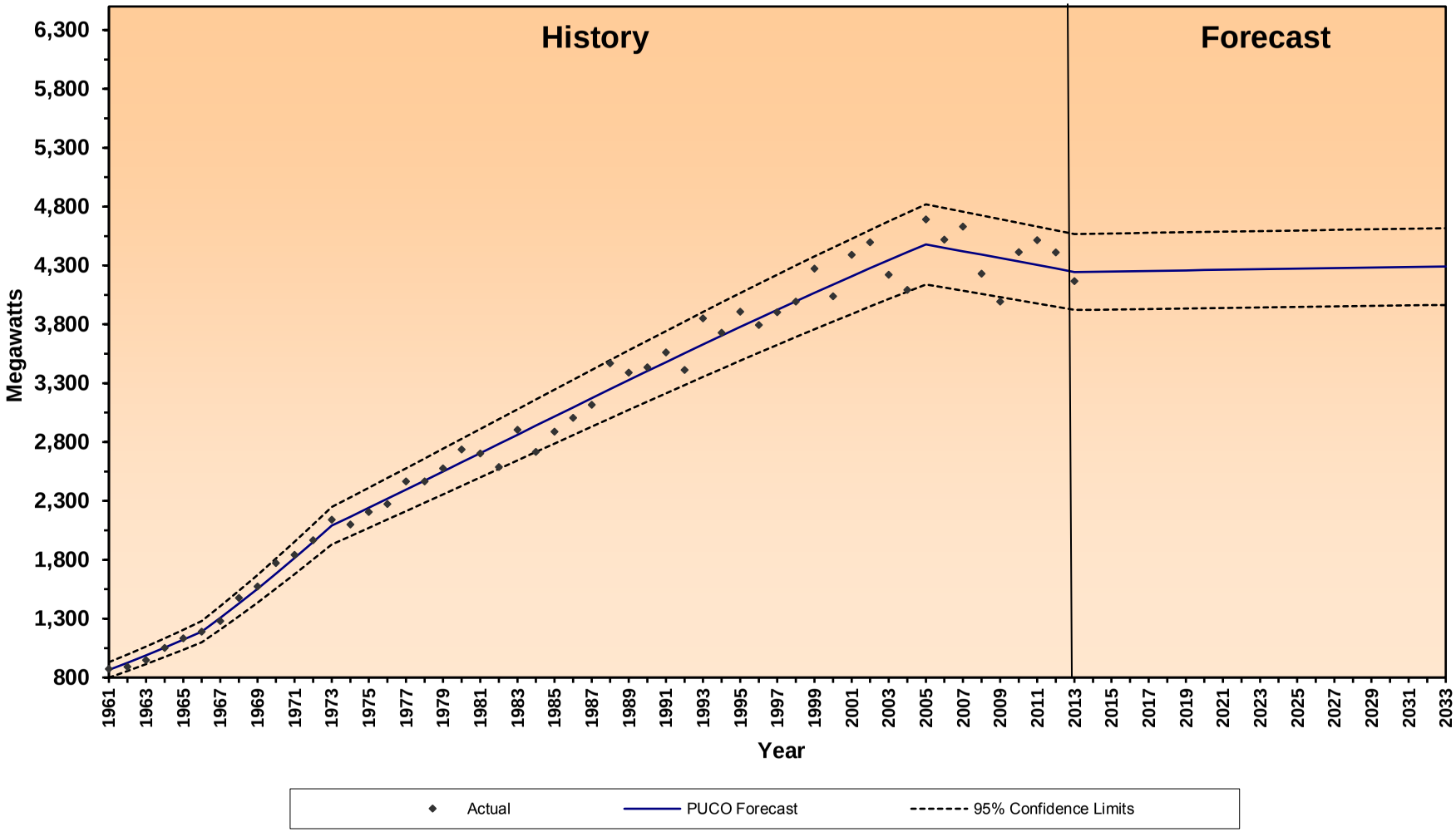
Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.2. Dayton Power & Light Company Summer Peak Load (1961 - 2033)



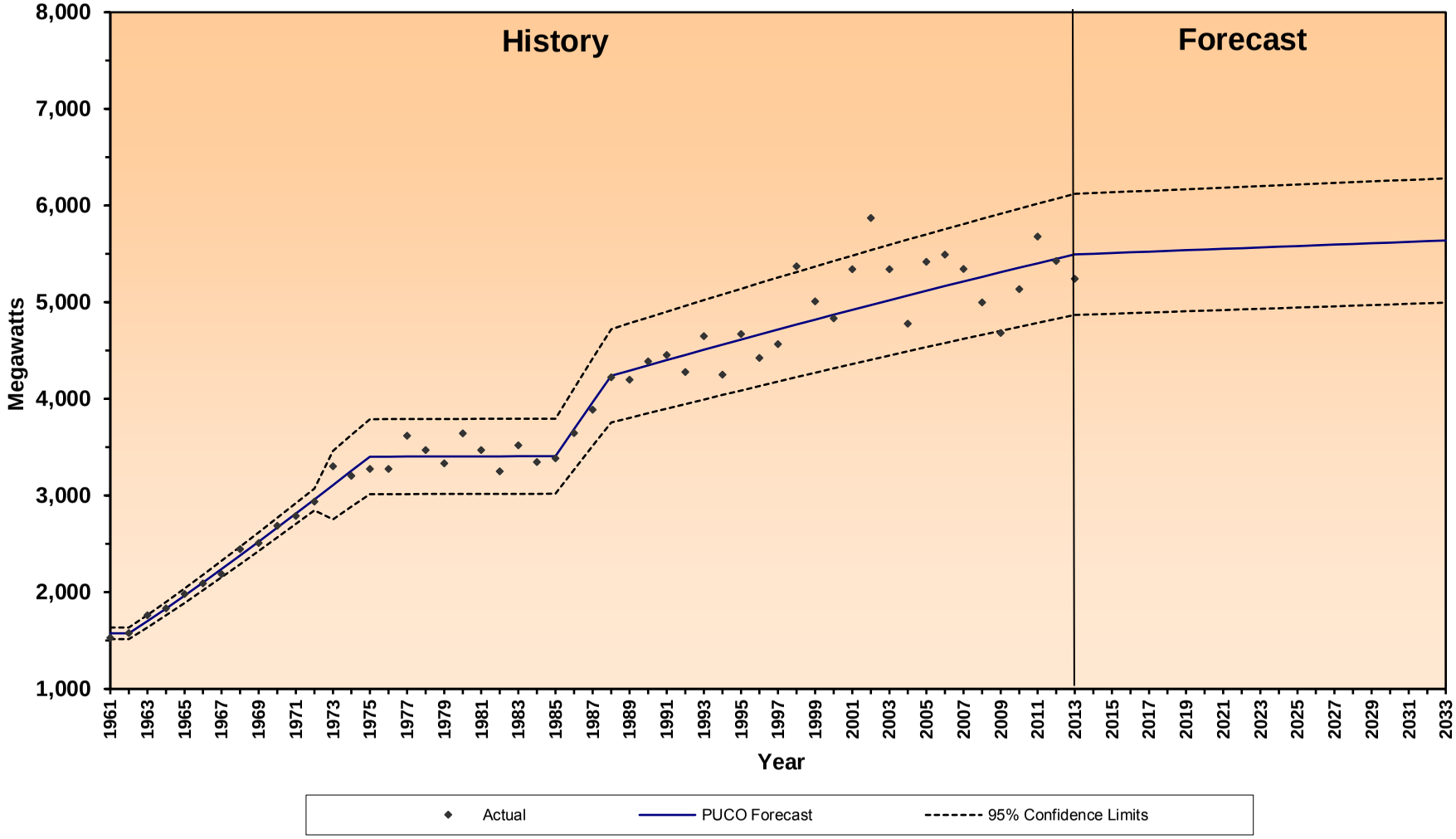
Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.3. Duke Energy Ohio, Inc. Summer Peak Load (1961 - 2033)



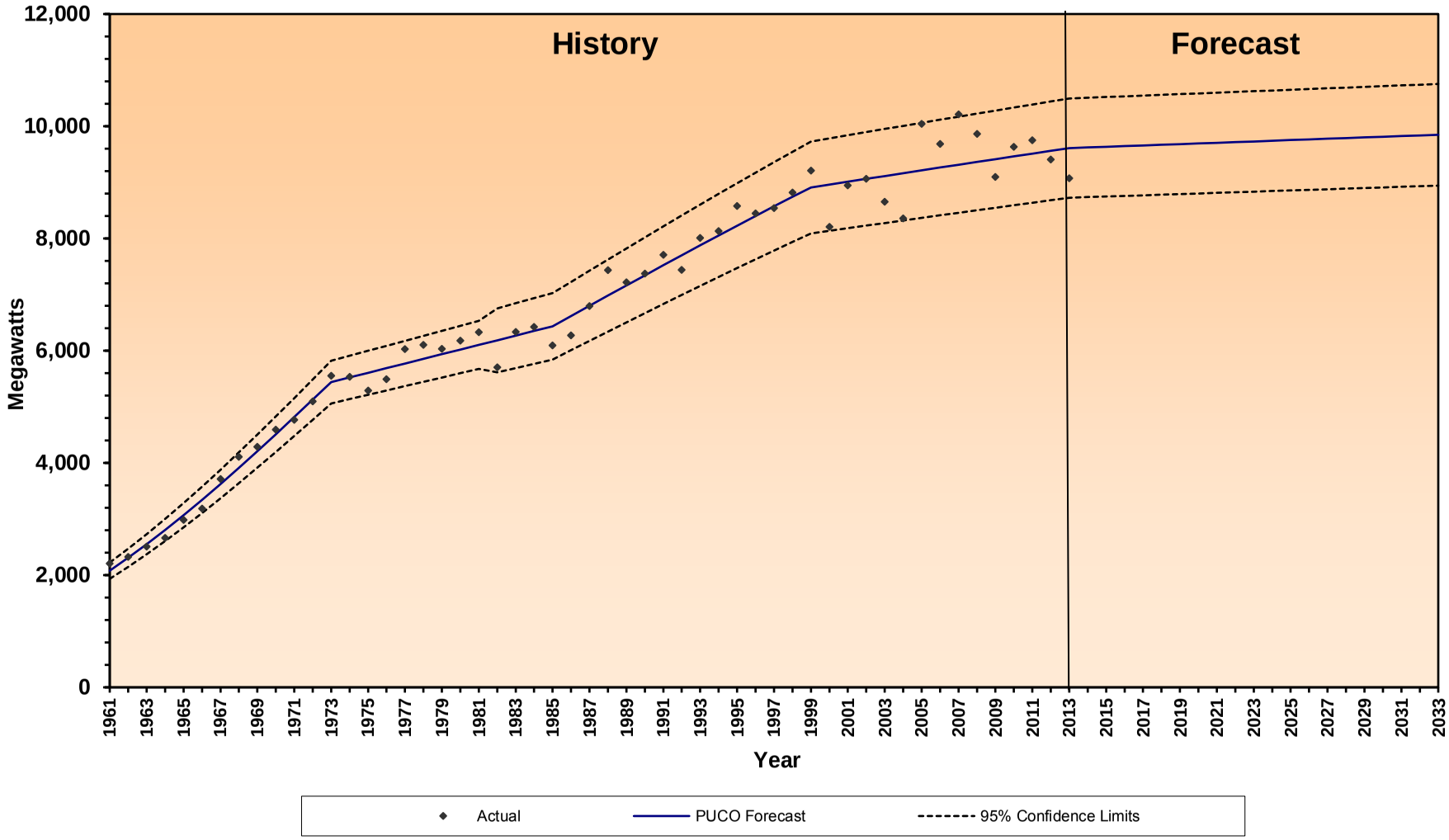
Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.4. Ohio Edison Company Summer Peak Load (1961 - 2033)



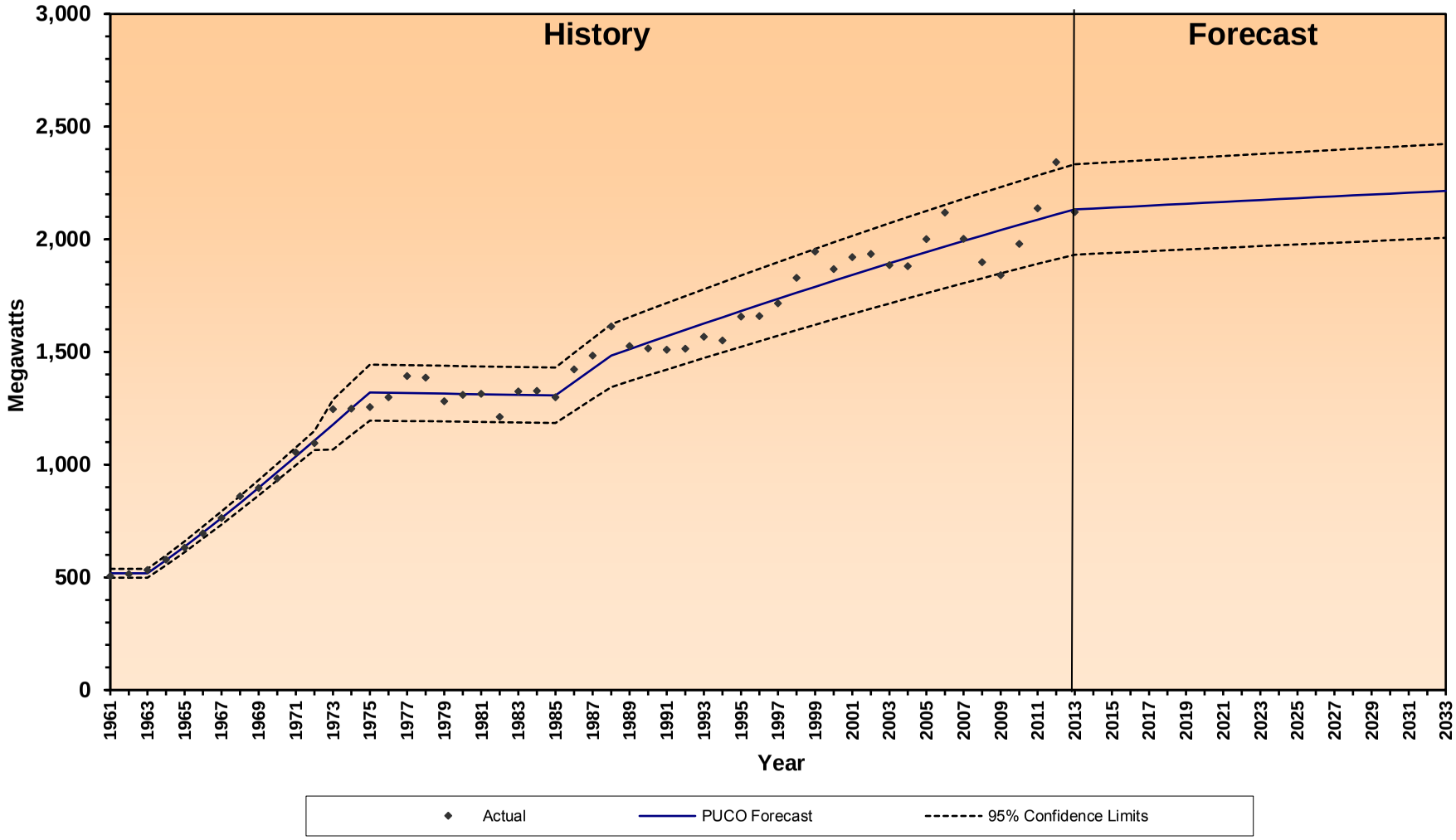
Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.5. Ohio Power Company Summer Peak Load (1961 - 2033)



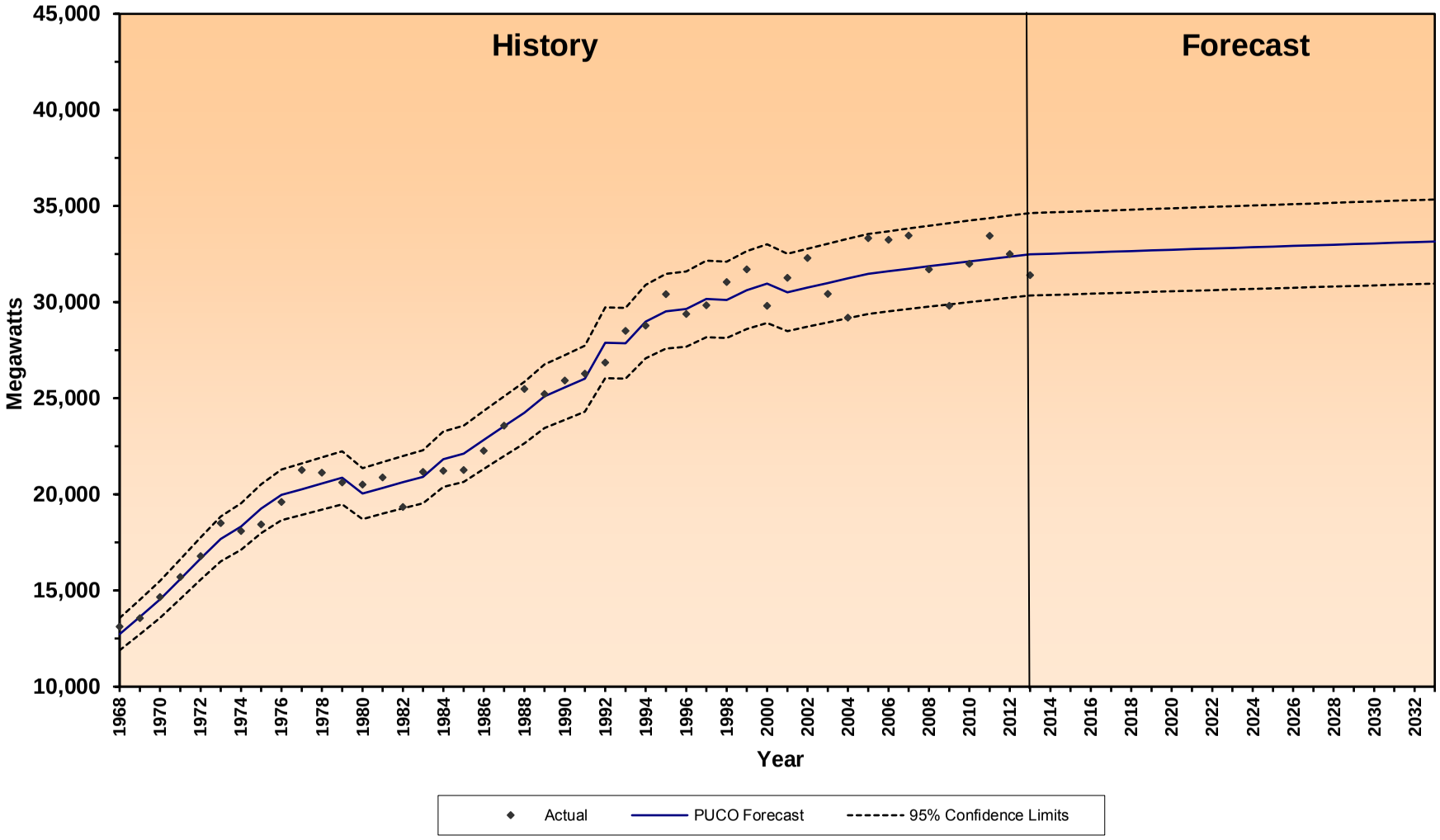
Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.6. Toledo Edison Company Summer Peak Load (1961 - 2033)



Source: PUCO, Division of Forecasting, Markets, and Corporate Oversight

Figure 3.2.7. State of Ohio Non-Coincident Internal Annual Peak Load (1968-2033)



Source: PUCO, Division of Forecasting.Markets, and Corporate Oversight.

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4.0 The demand for energy by fuel type in Ohio

The composition of total energy requirements in Ohio in terms of primary fuels consumption is presented in Figure 4.0.1 and Table 4.0.1. Historically, growth in energy demand leveled off in Ohio between 1973 and 1978 at around 3,950 trillion British thermal units (TBtu) per year. During the 1979 to 1982 recessionary phase of the business cycle, energy demand declined sharply and bottomed out at 3,171 TBtu in 1983, reflecting in part the predicament of the rust-belt industries in Ohio. It has been increasing slowly but steadily since 1983, with mild to moderate fluctuations reflecting the sensitivity of the industrial sector's demand for energy to the business cycle. Demand for energy in Ohio, in terms of primary fuels consumption, declined slightly from 2008 through 2010, in tandem with the recessionary phase of the latest business cycle. It is projected to continue to grow slowly with the anticipated economic recovery from 2014 through 2020. Another mild to moderate recession is predicted between 2021 through 2023, with the accompanying mild reduction in energy consumption. Slow growth is projected to resume from 2024 to the end of the forecast horizon.

The estimates for TBtu were derived by converting the forecast of physical units consumed into energy content. For coal, the conversion factor is a projection based on the historic trend in the heat content of coal consumed in Ohio. That historical trend was adjusted to account for the expected impact of recent United States Environmental Protection Agency (U.S. EPA) rules, such as the Mercury Air Toxics Standard, on the electric generation industry, which may result in a slightly higher average heat content of coal consumed in Ohio going forward. These rules are likely to cause a change in coal-basin fuel mixture at coal-fired power plants which will cause increases in the fuel heat content.

In 2013, the demand for energy from primary fuels in Ohio was 3,369.8 TBtu. It is expected to be 3,379.6 TBtu in 2021, 3,349.8 TBtu in 2024 and 3,410.8 TBtu in 2033. The standard error of the forecast is 1.7 percent.

4.1 Electricity

Electricity requirements in Ohio by sector are presented in Figure 4.1.1 and Table 4.1.1. The historical fluctuations in industrial demand in response to the business cycles are easily discernable in Figure 4.1.1. In the latest business cycle, the industrial load growth experienced a sharp decline beginning in 2008 but only lasting through 2009 declining from 51.0 million megawatt hours (MWh) to 42.9 million MWh due to recessionary pressure. Since 2009, the industrial electricity demand in Ohio has experienced modest recovery from the recessionary pressure that occurred in 2008 with demand rising from 42.9 million MWh in 2009 to 46.8 million MWh in 2012.

In 2013, the industrial demand in Ohio experienced another decline to 44.0 million MWh due to the loss of a few large industrial consumers. Industrial electricity demand is projected to continue to fluctuate with the projected business cycles specified in the macroeconomic forecast scenario presented in section 2.2. However, the prevailing trend is anticipated to be a slight increase in industrial electricity consumption through year 2033.

Industrial sector demand for electricity is expected to be 45.9 million MWh in 2021, 43.8 million MWh in 2024, and 45.3 million MWh in 2033. The standard error of the forecast is 2.4 percent.

The commercial sector demand for electricity has experienced slow but steady growth along a trend prevailing since 1995 to the present. Electricity consumption in the commercial sector will continue to be positive throughout the forecast horizon as growth in the number of commercial enterprises, and employment in the commercial sector is expected to continue to grow over the forecast horizon. The magnitude of the trends along which this future growth is expected to take place will be influenced by the impact of the projected business cycles, and the anticipated fluctuations in crude oil price levels.

Commercial sector demand for electricity was 46.8 million MWh in 2013. It is expected to be 47.2 million MWh in 2021, 47.3 million MWh in 2024 and 48.3 million MWh in 2033. The standard error of the forecast is 2.7 percent.

The trend characterizing the trajectory of growth of residential electricity demand in Ohio has not changed since 1983. Staff expects the same slow but steady growth to continue throughout the forecast horizon with minor adjustments to the magnitude of the long-term growth trends to reflect the possible impacts of the projected business cycles, and the anticipated fluctuations in crude oil price levels.

Residential sector demand for electricity was 52.2 million MWh in 2013. It is expected to be 52.9 million MWh in 2021, 53.2 million MWh in 2024 and 54.1 million MWh in 2033. The standard error of the forecast is 2.6 percent.

Total end use demand for electricity was 143.0 million MWh in 2013. It is expected to be 146.0 million MWh in 2021, 144.3 million MWh in 2024 and 147.7 million MWh in 2033. The standard error of the forecast is 1.7 percent.

4.2 Coal

Energy requirements for coal by sector are presented in Figure 4.2.1 and Table 4.2.1. The generation of electricity currently accounts for 88.8 percent of the coal consumption in Ohio. In 2013, coal consumption in the electricity generation sector of Ohio was 40.7 million short tons. It is expected to be 30.3 million short tons in 2021, 31.1 million short tons in 2024 and 33.7 million short tons in 2033. The standard error of the forecast is 2.6 percent.

It should be noted that Staff, in preparing the forecasts for this report, is able to take into account the effect of the adopted U.S. EPA rules on Cross-State Air Pollution, Mercury and Air Toxic Standards, Cooling Water Intake and Coal Ash. A significant amount of generation retirements have been announced in the PJM market and some generation has, in fact, already deactivated due to a combination of low natural gas prices and the cost of retrofits required by the environmental rules mentioned above. To the extent deactivation decisions have been made, Staff has adjusted the coal consumption forecast for the electricity generation sector to account for those announced coal-fired generation deactivations.

Industrial sector coal consumption, both as coking coal and in other industrial utilizations, has declined from a historical peak of 29.9 million short tons in 1970 to 5.0 million short tons in 2013. The demise of the traditional iron and steel mills and the requirements of the Clean Air Act are among the contributors to the decline of coal consumption in the industrial sector. A steady trajectory of industrial coal consumption is projected to continue throughout the forecast horizon. With the units expressed in millions of short tons per year, no noticeable change in requirements is apparent.

Industrial sector coal consumption was 5.0 million short tons in 2013. It is expected to be 6.5 million short tons in 2033. The standard error of the forecast is 5.6 percent.

Coal consumption in the residential and the commercial sectors is virtually non-existent, and is expected to remain that way throughout the forecast horizon. Additionally, coal consumption in the residential sector is trivial; therefore, it is not included in this report.

Total demand for coal was 45.8 million short tons in 2013. It is expected to be 35.9 million short tons in 2021, 37.1 million short tons in 2024 and 40.4 million short tons in 2033. The standard error of the forecast is 2.6 percent.

4.2.1 Nuclear and hydro

The energy requirements for electricity generated by nuclear and hydroelectric stations are included in Table 4.0.1. Since there are no readily available measures of the energy resource inputs that go into nuclear or hydro generation (*i.e.*, pellets of radioactive fuel or cubic feet of water), staff imputes the energy input requirements of nuclear and hydro generation in terms of the additional amount, and the British thermal unit (Btu) content, of the coal that would be required to replace the kWh generated by nuclear and hydro generators with coal-fired generation.

Nuclear and hydro generation was 16.6 million MWh in 2013. It is projected to be 17.0 million MWh, on average, from 2014 through 2033. This projection assumes that the Davis-Besse and Perry nuclear power stations will continue to operate at current levels through the forecast horizon.

4.3 Natural gas

Sectorial natural gas requirements in Ohio are presented in Figure 4.3.1 and Table 4.3.1. Natural gas usage peaked in 1972 at 1,144.4 billion cubic feet (Bcf). The market price of natural gas rose in tandem with the oil price increases in the 1970s. However, federal price controls at the wellhead for natural gas to be used in interstate commerce led to supply shortages in the volumes of natural gas that were actually available for interstate commerce. Consequently, in Ohio, which depended upon interstate supplies for more than 90 percent of its natural gas requirements, base allocations of natural gas were curtailed for commercial and industrial customers, and new customer hookups were banned for residential customers between 1973 and 1978. The Natural Gas Policy Act of 1978 deregulated the wellhead price of natural gas in a gradual manner between 1978 and 1985.

The increasing price of natural gas and restrictions on availability led to declines in demand in all sectors between 1973 and 1985. Technological improvements, which led to higher efficiencies in natural gas burning appliances, widespread insulation of new and existing buildings, and governmental policies to promote and encourage energy conservation measures, were among the means through which these reductions in demand were realized. The increasing price of natural gas also led to increased investment in exploration and improved recovery methods which, in turn, led to more abundant supplies, and dampened further price increases from 1985 to until recently.

Between 1985 and 1996, natural gas demand increased in the commercial and industrial sectors and increased very slowly in the residential sector.

Since 1996, the trends for commercial and industrial natural gas demands in Ohio have also been declining slowly but steadily. In all sectors, the sensitivity of demand to weather conditions is very significant.

Staff projects that residential, commercial, and industrial demands for natural gas will be influenced by fluctuations in the phases of the forecast business cycles. The projections of natural gas consumption across all sectors have been revised upwards from Staff's 2012 published forecast, driven primarily by the expectation that the abundance of natural gas reserves will continue to exert a downward pressure on natural gas prices for an extended period. Demand for natural gas is forecast to increase most dramatically in the electric utilities sector, as coal-to-gas fuel switching occurs for purely economic reasons and in response to environmental regulatory requirements promulgated by the U.S. EPA. Growth in natural gas consumption is tempered, however, by increased energy efficiency, most notably in the residential sector, where per capita consumption is expected to continue its modest decline over time.

Residential sector natural gas demand was 297.4 Bcf in 2013. It is expected to be 288.8 Bcf in 2021, 284.5 Bcf in 2024 and 284.3 Bcf in 2033. The standard error of the forecast is 4.8 percent.

Commercial sector natural gas demand was 169.1 Bcf in 2013. It is expected to be 158.7 Bcf in 2021, 155.6 Bcf in 2024 and 165.0 Bcf in 2033. The standard error of the forecast is 4.3 percent.

Industrial sector natural gas demand was 273.1 Bcf in 2013. It is expected to be 290.8 Bcf in 2021, 290.3 Bcf in 2024 and 318.0 Bcf in 2033. The standard error of the forecast is 4.1 percent.

Electric utility sector natural gas demand was 160.2 Bcf in 2013, which is nearly triple the demand from 2010. A large portion of this increase can be explained by the Fremont Energy Center and the Dresden Energy Facility adding over 1,200 MW of capacity between 2011 and 2012. The electric utility sector natural gas demand is expected to be 359.4 Bcf in 2021, 351.6 Bcf in 2024 and 372.6 Bcf in 2033. Forecast adjustments were made in years 2015 through 2020 representing expected new combined cycle power plants coming into operation. Staff made adjustments in the forecast to account for all additional natural gas combined-cycle power plants that are certificated by the Ohio Power Siting Board and are expected to be operating by 2020.[1] For the purposes of forecasting natural gas consumption, new combined-cycle plants are assumed to operate at a 70 percent capacity

[1] http://www.opsb.ohio.gov/opsb/index.cfm/siting-case-breakdown/approved-cases/

factor. Uncertainty around whether these plants actually progress from certification to completion, and in what year, also represents a significant source of forecast error. The standard error of the forecast is 19.5 percent.

Total natural gas demand was 910.4 Bcf in 2013. It is expected to be 1,111.8 Bcf in 2021, 1,096.3 Bcf in 2024, and 1,154.7 Bcf in 2033. The standard error of the forecast is 3.3 percent.

4.4 Petroleum products

Demand for petroleum products by sector are presented in Figure 4.4.1 and Table 4.4.1. In 2013, 78.5 percent of the total demand for petroleum products was generated by the transportation sector, and 15.5 percent was generated by the industrial sector. The remaining 6 percent was used by the residential, commercial and electricity generation sectors combined.

Petroleum products consumption in Ohio peaked at 250 million barrels in 1978. Between 1978 and 1983, in response to the higher crude oil and finished product prices, as well as the prevailing economic recession at the time, petroleum products consumption declined to 185 million barrels. Since 1983, petroleum products consumption levels in Ohio have increased slowly along a trajectory that fluctuates in response to the phases of the business cycle and temporary perturbations in crude oil prices. High crude prices and the accompanying economic slowdown resulted in significant declines in petroleum products consumption in Ohio from 2008 to 2013. A similar downturn in petroleum products consumption is anticipated from 2020 on. The projections of petroleum consumption in the transportation sector have also been trending downwards in response to the Corporate Average Fuel Economy (CAFE) standards established by the Energy Independence and Security Act of 2007.

Transportation sector demand for petroleum products was 171.1 million barrels in 2013. It is expected to be 167.5 million barrels in 2021, 163.2 million barrels in 2024 and 157.9 million barrels in 2033. The standard error of the forecast is 1.6 percent.

Industrial sector demand for petroleum products was 33.8 million barrels in 2013. It is expected to be 37.8 million barrels 2021 and remain flat through 2033. The standard error of the forecast is 5.8 percent.

Total demand for petroleum products in Ohio was 217.9 million barrels in 2013. It is expected to be 217.9 million barrels in 2021, 213.7 million barrels in 2024 and 208.4 million barrels in 2033. The standard error of the forecast is 1.8 percent.

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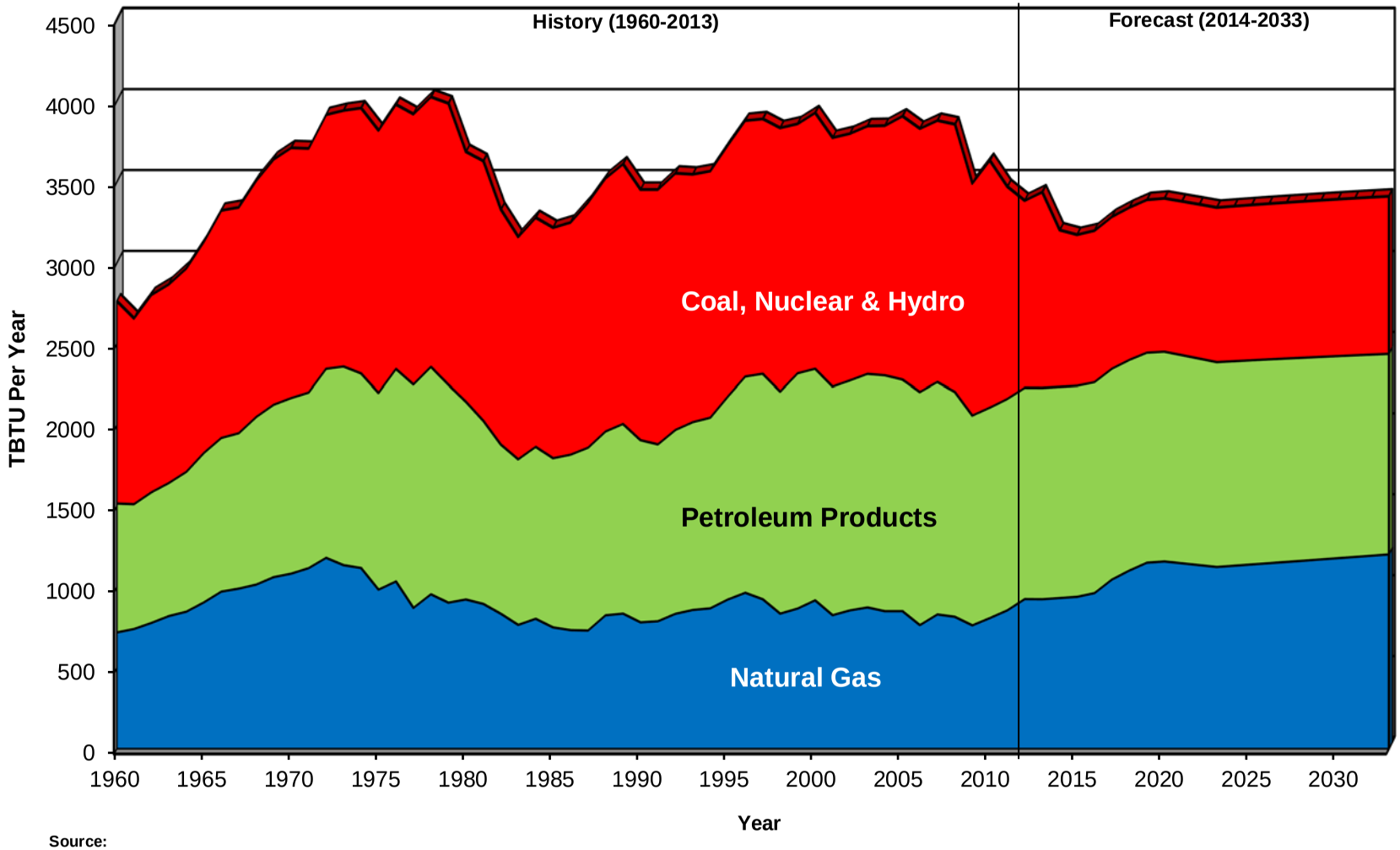
Figure 4.0.1. Total Energy Requirements in Ohio (1960-2033)



Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 4.0.1
Summary of Total Energy Requirements in Ohio by Primary Fuel Types
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Petroleum Products	Coal	Total Fossil Fuel	Nuclear &[1] Hydro	Total
-5	2008	816.7	1388.6	1462.8	3668.2	188.0	3856.1
-4	2009	763.7	1296.2	1265.2	3325.1	165.2	3490.3
-3	2010	808.6	1299.9	1352.7	3461.3	170.5	3631.7
-2	2011	849.1	1214.4	1218.4	3281.9	160.4	3442.2
-1	2012	868.9	1217.5	978.5	3064.9	183.8	3248.7
0	2013	939.6	1194.0	1062.1	3195.6	174.2	3369.8
1	2014	932.7	1303.6	790.9	3027.1	174.8	3201.9
2	2015	940.1	1302.6	755.5	2998.2	175.2	3173.4
3	2016	963.2	1301.4	758.5	3023.1	175.6	3198.6
4	2017	1047.3	1300.1	761.3	3108.7	176.0	3284.7
5	2018	1102.9	1298.7	764.0	3165.6	176.3	3342.0
6	2019	1151.1	1294.9	766.6	3212.6	176.7	3389.3
7	2020	1158.7	1293.2	769.1	3221.0	177.1	3398.1
8	2021	1147.4	1283.3	771.4	3202.1	177.5	3379.6
9	2022	1136.0	1273.3	773.7	3182.9	177.9	3360.8
10	2023	1124.6	1263.1	775.8	3163.4	178.2	3341.7
11	2024	1132.5	1261.0	777.8	3171.2	178.6	3349.8
12	2025	1140.3	1258.8	779.7	3178.8	179.0	3357.8
13	2026	1148.2	1256.5	781.4	3186.0	179.4	3365.4
14	2027	1156.0	1254.0	783.0	3193.0	179.7	3372.7
15	2028	1163.7	1251.4	784.5	3199.7	180.1	3379.8
16	2029	1171.4	1248.7	785.9	3206.0	180.5	3386.5
17	2030	1179.1	1245.8	787.2	3212.2	180.9	3393.0
18	2031	1186.8	1242.9	788.3	3218.0	181.3	3399.3
19	2032	1194.4	1239.8	789.3	3223.6	181.6	3405.2
20	2033	1202.0	1236.6	790.2	3228.8	182.0	3410.8
Standard Error of the Forecast		± 3.3%	± 2.7%	± 2.8%	± 1.8%	±10.5%	± 1.7%

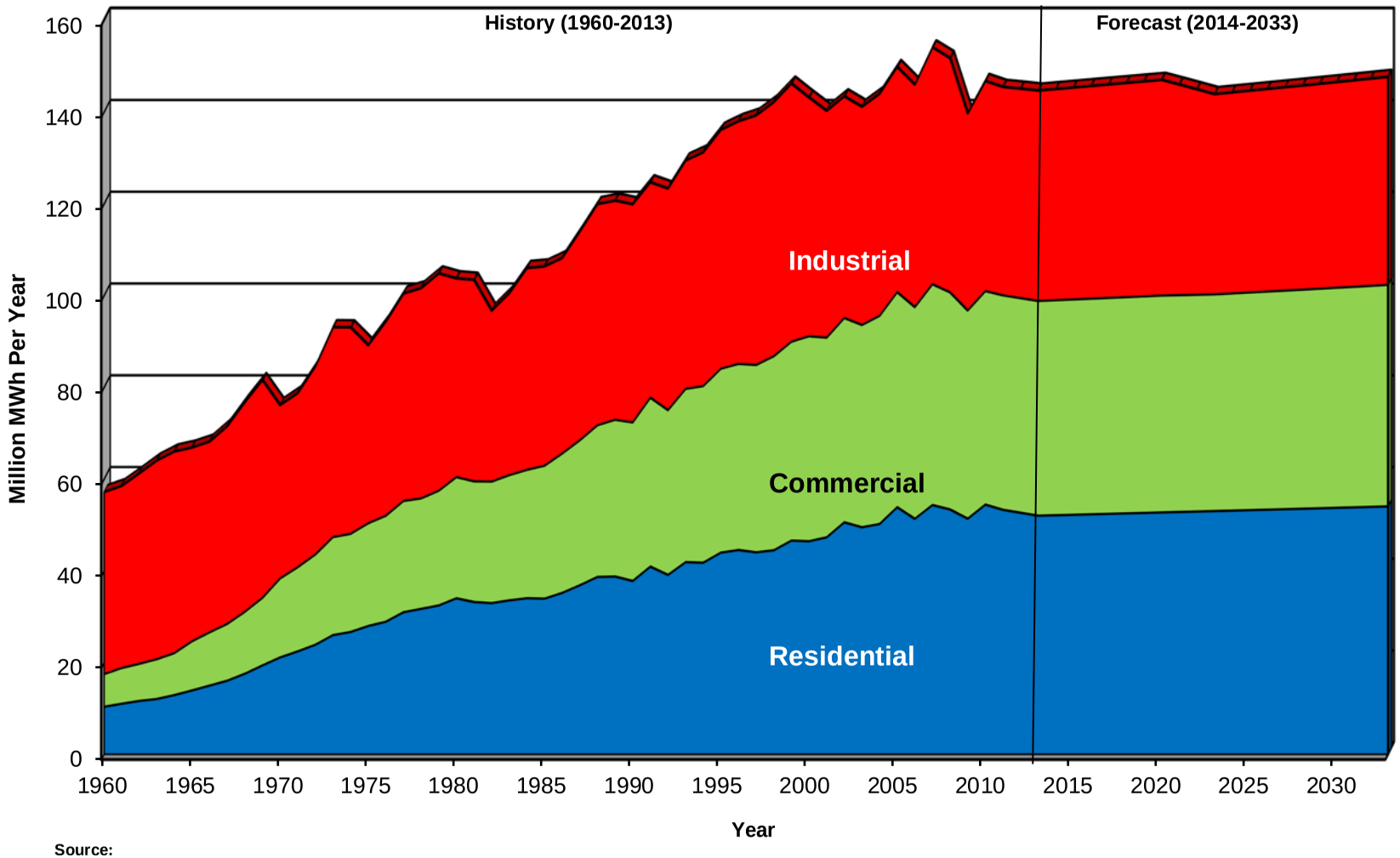
Source:

Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Note1: This category represents the energy associated with the additional coal inputs that would be required, if nuclear and hydro generation were to be replaced, by coal fired generation.

Figure 4.1.1. Electricity Requirements in Ohio (1960-2033)



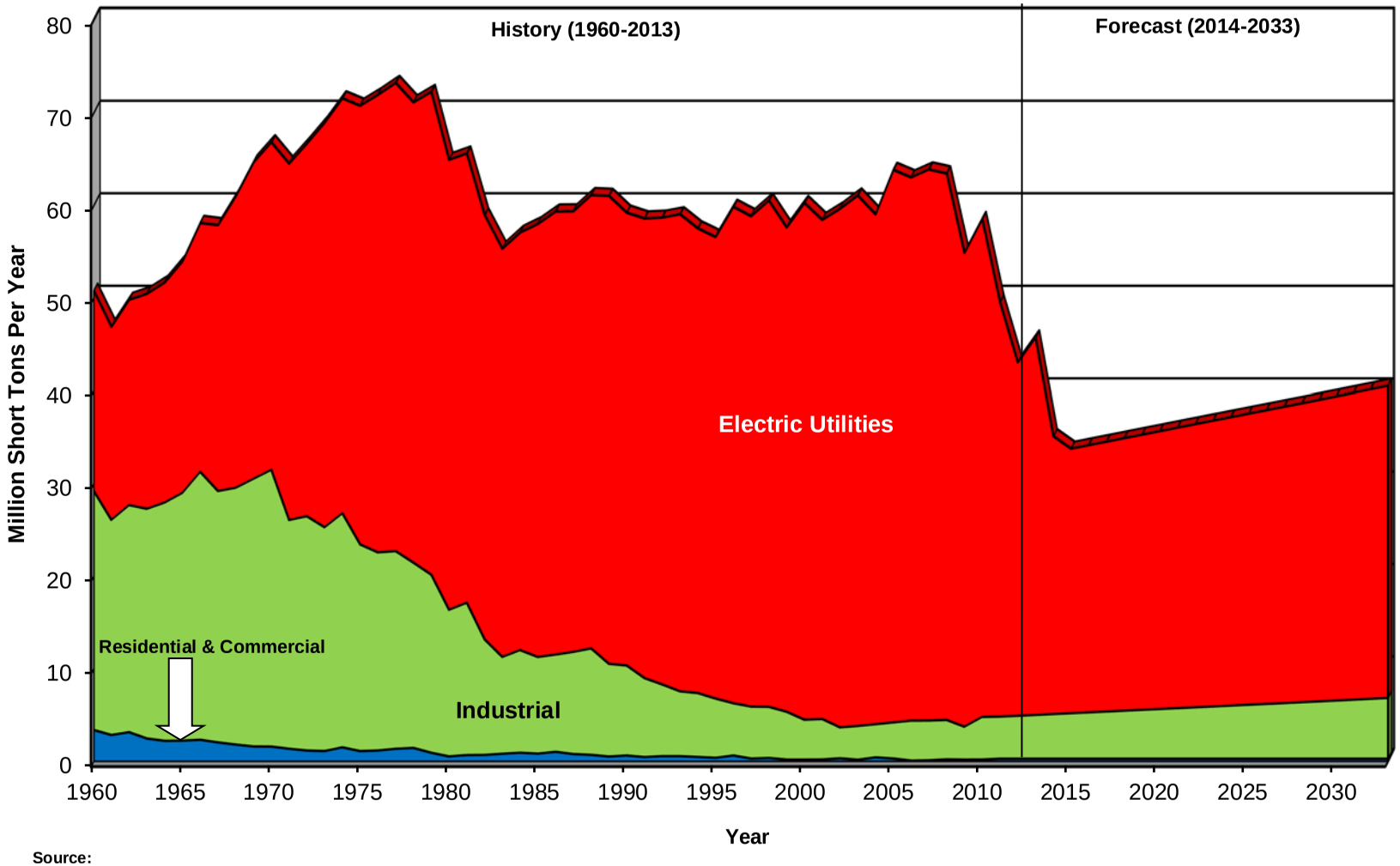
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 4.1.1
Summary of Electricity Requirements in Ohio by End Use Sectors
History (2008-2013), Forecast (2014-2033)
Million Megawatt-Hours per Year

	Year	Residential	Commercial	Industrial	Total
-5	2008	53.4	47.3	51.0	151.7
-4	2009	51.4	45.4	42.9	139.7
-3	2010	54.5	46.5	45.8	146.8
-2	2011	53.9	47.1	47.6	148.6
-1	2012	52.3	46.8	46.8	145.8
0	2013	52.2	46.8	44.0	143.0
1	2014	52.2	46.9	46.0	145.0
2	2015	52.3	46.9	46.1	145.3
3	2016	52.4	47.0	46.3	145.7
4	2017	52.5	47.1	46.5	146.0
5	2018	52.6	47.1	46.6	146.3
6	2019	52.7	47.2	46.8	146.7
7	2020	52.8	47.3	47.0	147.0
8	2021	52.9	47.2	45.9	146.0
9	2022	53.0	47.2	44.7	144.9
10	2023	53.1	47.2	43.6	143.9
11	2024	53.2	47.3	43.8	144.3
12	2025	53.3	47.4	43.9	144.6
13	2026	53.4	47.5	44.1	145.0
14	2027	53.5	47.6	44.3	145.4
15	2028	53.6	47.8	44.5	145.8
16	2029	53.7	47.9	44.6	146.2
17	2030	53.8	48.0	44.8	146.5
18	2031	53.9	48.1	45.0	146.9
19	2032	54.0	48.2	45.1	147.3
20	2033	54.1	48.3	45.3	147.7
Standard Error of the Forecast		± 2.6%	±2.7%	± 2.4%	± 1.7%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 4.2.1. Coal Requirements in Ohio (1960-2033)



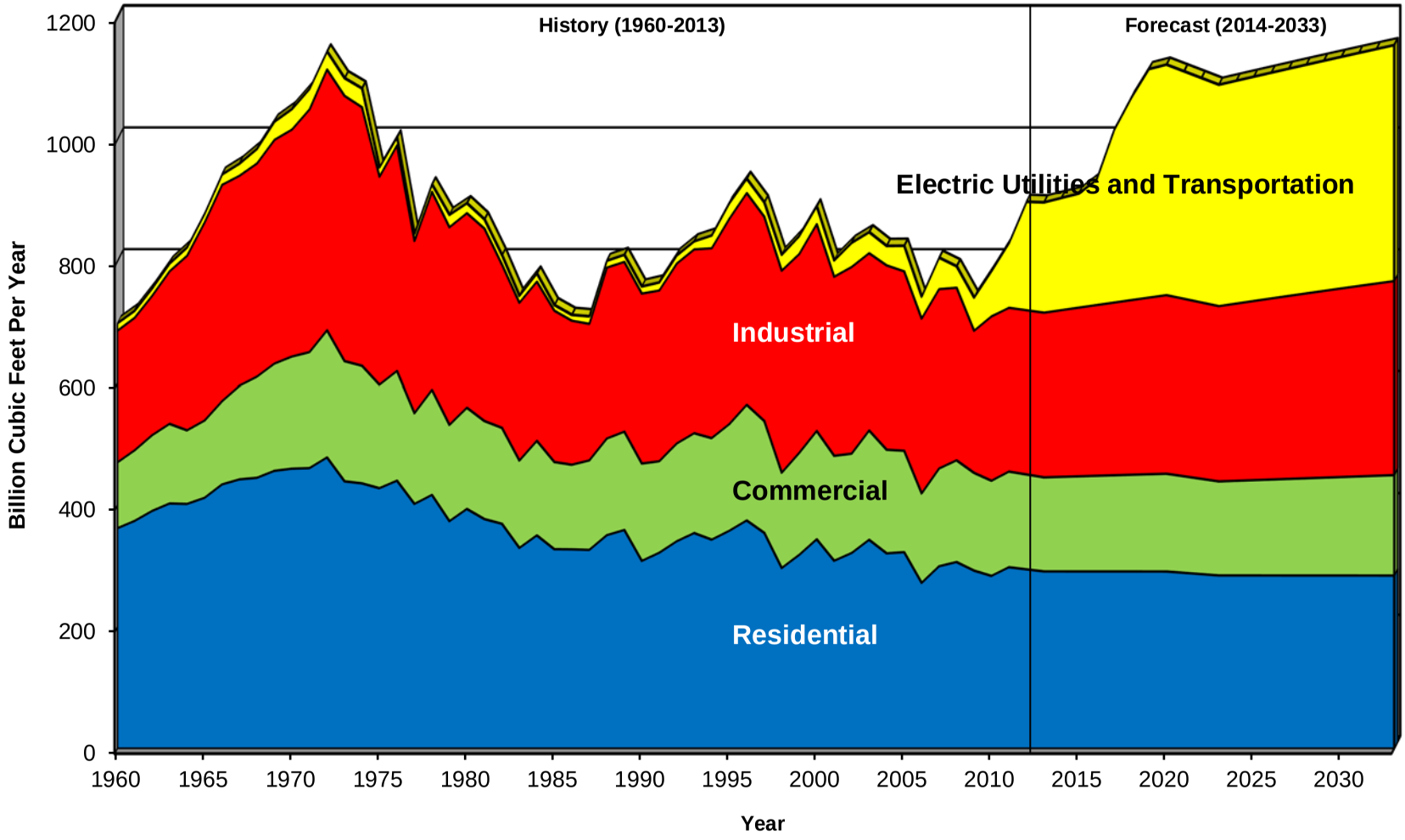
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 4.2.1
Summary of Coal Requirements in Ohio by End Use Sectors
History (2008-2013), Forecast (2014-2033)
Million Short Tons per Year

	Year	Commercial	Industrial	Electric Utilities	Total
-5	2008	0.24	4.2	59.0	63.4
-4	2009	0.22	3.5	51.1	54.9
-3	2010	0.23	4.6	53.7	58.5
-2	2011	0.19	4.5	48.1	52.8
-1	2012	0.13	4.9	37.1	42.2
0	2013	0.15	5.0	40.7	45.8
1	2014	0.22	4.8	30.0	35.0
2	2015	0.22	4.9	28.5	33.7
3	2016	0.22	5.0	28.8	34.1
4	2017	0.22	5.1	29.1	34.4
5	2018	0.22	5.2	29.4	34.8
6	2019	0.22	5.3	29.7	35.2
7	2020	0.22	5.4	30.0	35.6
8	2021	0.22	5.5	30.3	35.9
9	2022	0.22	5.5	30.6	36.3
10	2023	0.22	5.6	30.8	36.7
11	2024	0.22	5.7	31.1	37.1
12	2025	0.22	5.8	31.4	37.5
13	2026	0.22	5.9	31.7	37.8
14	2027	0.22	6.0	32.0	38.2
15	2028	0.22	6.1	32.3	38.6
16	2029	0.22	6.2	32.5	38.9
17	2030	0.22	6.3	32.8	39.3
18	2031	0.22	6.4	33.1	39.7
19	2032	0.22	6.5	33.4	40.1
20	2033	0.22	6.5	33.7	40.4
Standard Error of the Forecast		± 17.5%	± 5.6%	± 2.6%	± 2.6%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 4.3.1. Natural Gas Requirements in Ohio (1960-2033)



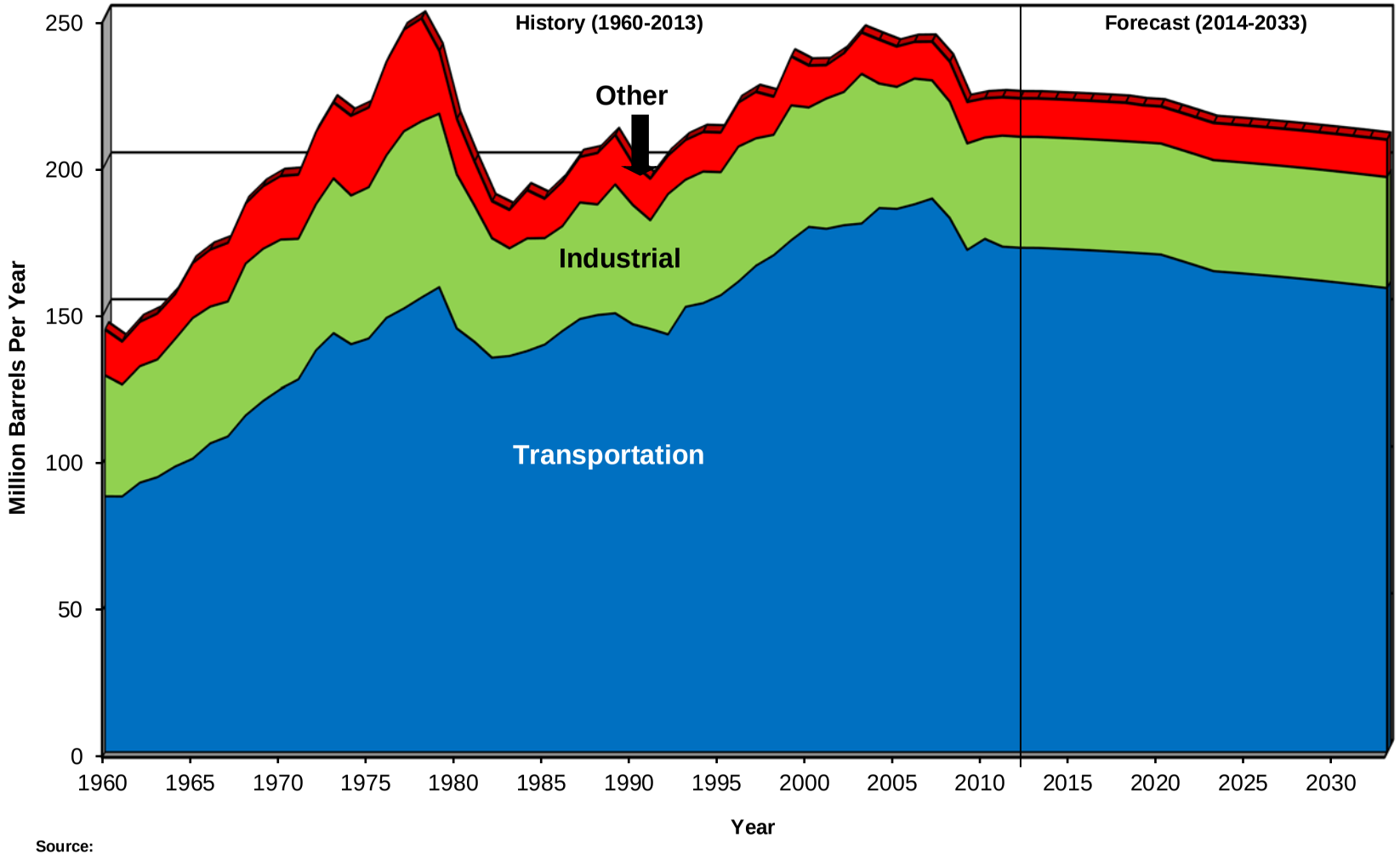
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 4.3.1
Summary of Natural Gas Requirements in Ohio by End Use Sectors
History (2008-2013), Forecast (2014-2033)
Billion Cubic Feet per Year

	Year	Residential	Commercial	Industrial	Transportation	Electric Utilities	Total
-5	2008	306.5	167.1	282.8	11.5	23.5	791.4
-4	2009	292.4	160.6	232.6	16.7	37.7	740.0
-3	2010	283.7	156.4	269.3	16.0	58.2	783.5
-2	2011	286.1	161.4	268.0	14.3	92.8	822.8
-1	2012	250.9	145.5	264.4	9.6	171.6	842.0
0	2013	297.4	169.1	273.1	10.7	160.2	910.4
1	2014	291.1	155.5	273.1	13.7	170.5	903.7
2	2015	291.1	156.3	276.4	13.7	173.5	911.0
3	2016	291.1	157.2	279.7	13.8	191.6	933.3
4	2017	291.0	158.1	282.9	13.9	268.9	1014.8
5	2018	291.0	158.9	286.2	13.9	318.7	1068.7
6	2019	291.0	159.8	289.4	14.0	361.2	1115.4
7	2020	291.0	160.7	292.6	14.0	364.5	1122.8
8	2021	288.8	158.7	290.8	14.1	359.4	1111.8
9	2022	286.6	156.6	289.0	14.2	354.4	1100.8
10	2023	284.5	154.6	287.1	14.2	349.3	1089.7
11	2024	284.5	155.6	290.3	14.3	351.6	1096.3
12	2025	284.4	156.7	293.5	14.4	353.9	1103.0
13	2026	284.4	157.8	296.7	14.4	356.3	1109.5
14	2027	284.4	158.8	299.8	14.5	358.6	1116.1
15	2028	284.4	159.9	302.9	14.6	360.9	1122.6
16	2029	284.3	160.9	306.0	14.6	363.2	1129.1
17	2030	284.3	161.9	309.0	14.7	365.6	1135.6
18	2031	284.3	163.0	312.1	14.7	367.9	1142.0
19	2032	284.3	164.0	315.1	14.8	370.2	1148.4
20	2033	284.3	165.0	318.0	14.9	372.6	1154.7
Standard Error of the Forecast		± 4.8%	± 4.3%	± 4.1%	± 7.0%	± 19.5%	± 3.3%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 4.4.1. Petroleum Products Requirements in Ohio (1960-2033)



Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 4.4.1
Summary of Petroleum Products Requirements in Ohio by End Use Sectors
History (2008-2013), Forecast (2014-2033)
Million Barrels per Year

	Year	Residential	Commercial	Industrial	Transportation	Electric Utilities	Total
-5	2008	7.7	3.4	39.6	181.8	2.4	235.1
-4	2009	7.9	3.9	36.3	171.0	2.3	221.3
-3	2010	7.1	3.8	34.5	174.7	2.5	222.5
-2	2011	6.9	3.4	33.2	172.9	2.6	219.1
-1	2012	5.3	3.4	33.6	168.7	2.9	213.9
0	2013	5.9	4.5	33.8	171.1	2.6	217.9
1	2014	7.1	3.4	37.8	171.4	2.5	222.2
2	2015	7.1	3.4	37.8	171.1	2.5	222.0
3	2016	7.1	3.4	37.8	170.8	2.5	221.7
4	2017	7.1	3.4	37.8	170.5	2.6	221.4
5	2018	7.1	3.4	37.8	170.1	2.6	221.0
6	2019	6.6	3.4	37.8	169.8	2.6	220.2
7	2020	6.6	3.4	37.8	169.4	2.6	219.8
8	2021	6.6	3.4	37.8	167.5	2.6	217.9
9	2022	6.6	3.4	37.8	165.6	2.6	216.0
10	2023	6.6	3.4	37.8	163.7	2.6	214.1
11	2024	6.6	3.4	37.8	163.2	2.6	213.7
12	2025	6.6	3.4	37.8	162.7	2.6	213.2
13	2026	6.6	3.4	37.8	162.2	2.6	212.7
14	2027	6.6	3.4	37.8	161.7	2.6	212.1
15	2028	6.6	3.4	37.8	161.1	2.6	211.6
16	2029	6.6	3.4	37.8	160.5	2.6	211.0
17	2030	6.6	3.4	37.8	159.9	2.6	210.4
18	2031	6.6	3.4	37.8	159.3	2.7	209.8
19	2032	6.6	3.4	37.8	158.6	2.7	209.1
20	2033	6.6	3.4	37.8	157.9	2.7	208.4
Standard Error of the Forecast		± 5.6%	± 8.1%	± 5.8%	± 1.6%	± 16.5%	± 1.8%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

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5.0 The demand for energy by economic sector in Ohio

Sections 4.0 through 4.4 present the dynamic composition of total demand for each energy resource, namely electricity, coal, nuclear, and hydro, natural gas, and petroleum products, in terms of the composition of the demands for the resources in question by economic sectors. Sections 5.0 through 5.5 present the same information from an alternative perspective. These sections explain the dynamic composition of total demand for energy in each economic sector, namely residential, commercial, industrial, transportation and electricity generation, in terms of the demands for all fuels consumed within the economic sector in question.

The composition of total demand for energy in Ohio, in terms of energy requirements by sector, is presented in Figure 5.0.1 and Table 5.0.1. The industrial and transportation sectors still account for most of the energy use in the state. The net energy for generation, presented in Figure 5.0.1 and Table 5.0.1, is the difference between the total primary energy inputs into the electricity generation sector in Ohio less the total end use demand for electricity in Ohio. Since end-use demand for electricity is already included in the energy demand by sector, it has to be subtracted from the total energy inputs into the electricity generation sector in order to avoid double counting.

As required by generally accepted accounting principles, and the first order predicate logic requiring that the whole be equal to the sum of its parts, the trajectory of total demand for energy in Figure 5.0.1 and Table 5.0.1 is identical to the trajectory of total demand for energy in Figure 4.0.1 and Table 4.0.1.

5.1 The electricity generation sector

The demand for energy resource inputs into the electricity generation sector are presented in Figure 5.1.1 and Table 5.1.1.

In 2013, the demand for coal was 72.3 percent of the total demand for energy resource inputs into the electricity generation sector, the coal equivalent of nuclear and hydro generation was 13.6 percent, and natural gas and petroleum products were 14.1 percent. In 2033, energy from coal is projected to be 51.2 percent of the total demand for energy inputs into the electricity generation sector, the coal equivalent of nuclear and hydro generation is projected to be 15.0 percent, and natural gas and petroleum products are projected to be 33.8 percent. This notable change in Ohio's generation resource mix is driven primarily by anticipated generation retirements and new construction of natural gas combined cycle resources.

Generation from renewable resources (other than hydro) is not delineated in these forecasts, because historically low usage in Ohio makes it impractical to independently forecast their contribution based upon historical observations. To the extent that generation from renewable resources expands in the future, the fossil fuel components of energy input for electricity generation as illustrated in Figure 5.0.1 and Table 5.0.1 would be reduced accordingly, though not necessarily on a one-to-one energy equivalent basis.

Total energy input demand into the electricity generation sector was 1,285.0 TBtu in 2013. It is expected to be 1,192.2 TBtu in 2021, 1,186.5 TBtu in 2024 and 1,214.9 TBtu in 2033. The standard error of the forecast is 2.6 percent.

5.2 The industrial sector

Industrial sector energy requirements are presented in Figure 5.2.1 and Table 5.2.1. The industrial sector energy demand trajectory displays the most dynamically varying behavior among all sectors. This is attributable, in part, to the usual and customary dynamic of the business cycle. As real per capita income declines during the recessionary phase of the business cycle so does the demand for durable goods. As industrial output is reduced to meet the lower demand levels, demand for industrial inputs, including energy inputs, are also reduced. During the recovery phase of the business cycle, as real per capita income grows so does the demand for durable goods. As industrial output increases to meet the increasing demand levels, demand for industrial inputs, including energy resources, also increases.

Historical economic singularities involving sudden, significant, and sustained increases in energy resource prices have led to sudden, significant and permanent declines in industrial demand for energy resources, as witnessed by the predicament of conventional iron and steel mills in the U.S. and in Ohio during and in the aftermath of the 1973–1984 oil price cycle. As production costs in energy intensive industries increased in response to the nature and extent of the energy input price increases, many firms were not able to maintain their competitive advantage in the global market place and had to cease or scale down production. As industrial production went down, so did the demand for energy resource inputs in the industrial sector. The recessionary phases of business cycles that are preceded by, or accompanied by, sudden significant and sustained energy price increases are, therefore, characterized by sudden, significant, and permanent reductions in the industrial demand for energy resources.

The alteration in the structure of the state's industrial base can be surmised from the behavior of the industrial demand for coal, which fell from a high of

696 TBtu in 1970 to a low of 82 TBtu in 2002, an 88 percent decline in demand. This decline is clearly reflected in, among other things, the predicament of traditional manufacturing industries in Ohio, including iron and steel mills, and the decline of other direct industrial uses for coal.

Higher energy resource costs eventually led to an increase in the demand for the development and wide scale adoption of more energy efficient technologies by new or surviving industrial firms. More energy efficient production technologies, in turn, led to slower growth in energy demand during the recovery phase of a business cycle associated with an energy price shock. These and other considerations are among the contributing factors to the observed stepwise decline in the time path trajectory of industrial demand for energy in Ohio, and its rather moderated growth during the recovery phases of the business cycle, since the early 1970s.

Industrial sector energy demand peaked and stabilized at about 1,545 TBtu between 1969 and 1974. Demand declined to approximately 1,400 TBtu between 1975 and 1979. As production costs and competitive advantage in iron and steel production continued to shift further in favor of overseas producers during the 1979 to 1982 recessionary period, industrial energy demand declined precipitously from 1,412.4 TBtu in 1979 to 936.9 TBtu in 1983. Industrial energy demand stabilized from 1983 through 1999 fluctuating between a range of 936.6 TBtu and 1,055.4 TBtu. Between 1999 and 2001 industrial energy demand declined from 1,145.7 TBtu to 1011.3 TBtu. It stabilized again between 2001 and 2007, fluctuating within a range of 1011.3 TBtu and 967.2 TBtu.

The actual impact of the current and projected business cycles on industrial sector energy demand is difficult to estimate at this point in time. That they will further reduce industrial sector energy demand in Ohio, staff considers as a given. However, in constructing scenarios depicting the possible behavior of energy consumption in the state's industrial sector in response to the predicted future recession recovery cycles, staff is not forecasting any large future declines in industrial energy consumption.

Industrial sector energy demand in Ohio was 787.3 TBtu in 2013. It is projected to be 926.3 TBtu in 2021, 929.7 TBtu in 2024 and 979.4 TBtu in 2033. The standard error of the forecast is 3.8 percent.

5.3 The commercial sector

Commercial sector energy requirements are presented in Figure 5.3.1 and Table 5.3.1. Since 1983, the Ohio economy has continued to become more service oriented and less manufacturing oriented. The expansion of the service sector in Ohio has led to a slow but steady growth in commercial energy demand from 286.1 TBtu in 1983 to 362.6 TBtu in 1997. Since 1997,

commercial sector energy consumption has stabilized around a near zero annual growth trend.

Electricity and natural gas are the fuels of choice in the commercial sector. Growth in commercial sector electricity demand has increased consistently from 90.4 TBtu in 1982 to 159.8 TBtu in 2013. Natural gas demand has been more susceptible to the phases of the business cycle, variations in weather conditions and the fluctuations in the price of natural gas.

Commercial sector energy demand in Ohio was 361.3 TBtu in 2013. It is expected to be 347.5 TBtu in 2021, 344.6 TBtu in 2024 and 357.1 TBtu in 2033. The fluctuations in the forecast behavior of commercial sector energy requirements reflect the anticipated impacts of the projected recession recovery cycles, and the anticipated impacts of higher electricity and natural gas prices, over the forecast horizon. The standard error of the forecast is 2.5 percent.

5.4 The residential sector

Residential sector energy requirements are presented in Figure 5.4.1 and Table 5.4.1. Total residential energy demand peaked in 1972 at about 678 TBtu. Subsequent declining demand reflects a lagged response to rising fuel prices in terms of increasing investment in weatherization and other energy conservation measures.

The impact of conservation is seen most clearly in the demand for natural gas, the most widely used fuel for space heating requirements. Natural gas demand fell from a high of 478 TBtu in 1972 to a low of 340 TBtu in 1983, a 29 percent decrease. From 1983 on, residential sector natural gas consumption levels in Ohio have been declining very slowly along a long-term trend. The volatility of year–to–year observations along the trend, however, has increased fivefold from 1.1 percent, in years preceding 1972, to 5.4 percent, from 1972 to the present. In other words, natural gas conservation is very effective during moderate to mild winters but demand spikes up sharply during severe winters. Staff expects the high volatility around the long-term trend to continue throughout the forecast horizon.

Staff projects that residential sector demand for natural gas will be influenced by the fluctuations in the phases of the forecast business cycles. Fluctuations in future levels of crude oil prices are also expected to put similar pressures on natural gas prices as well, and thus further encourage conservation, keeping long-term trends in demand growth slightly negative.

Residential sector demand for natural gas was 306.9 TBtu in 2013. It is expected to be 298.1 TBtu in 2021, 293.6 TBtu in 2024 and 293.4 TBtu in 2033. The standard error of the forecast is 4.8 percent.

The trend characterizing the trajectory of growth of residential electricity demand in Ohio has not changed since 1983. Staff expects the same slow but steady growth to continue throughout the forecast horizon with minor adjustments to the magnitude of the long-term growth trends to reflect the possible impacts of the projected business cycles, and the anticipated fluctuations in crude oil price levels.

Residential sector demand for electricity was 178.0 TBtu in 2013. It is expected to be 180.4 TBtu in 2021, 181.4 TBtu in 2024 and 184.5 TBtu in 2033. The standard error of the forecast is 2.6 percent.

Residential sector total demand for energy resources was 511.2 TBtu in 2013. It is expected to be 508.1 TBtu in 2021, 504.6 TBtu in 2024 and 507.5 TBtu in 2033. The standard error of the forecast is 3.5 percent.

5.5 The transportation sector

Transportation sector energy requirements are presented in Figure 5.5.1 and Table 5.5.1. Ninety-nine percent of transportation sector energy requirements are comprised of petroleum products. Transportation sector demand for energy is highly susceptible to the fluctuations in the business cycle. As industrial output and the need for transportation of industrial output declines during the recessionary phase of the business cycle, so does the demand for commercial transportation. To the extent that nearly all of the recessionary cycles since 1973 have been accompanied by significant rises in petroleum prices, the demand for personal transportation also suffers. The price effect of higher petroleum prices exacerbates the amplitude of the fluctuations in the demand for transportation energy requirements during the business cycle. It also contributes to the slowdown in the overall long-term growth in the demand for petroleum products by encouraging the production and acceptance of more fuel efficient vehicles.

Conversely, on the supply side, higher prices lead to increased exploration activities and production efforts, and to the development of novel and more advanced technologies to enhance exploration and production. The faster growth in supplies coupled with the slower growth in demand will eventually bring product prices down from their initial peaks. This process, however, is not instantaneous, and may take up to 10 or 12 years to work itself out.

Transportation sector energy demand in Ohio was 938.1 TBtu in 2013. It is expected to be 926.5 TBtu in 2021, 904.2 TBtu in 2024 and 880.0 TBtu in

2033. The fluctuations in the forecast behavior of transportation sector energy requirements reflect the anticipated impacts of the projected recession recovery cycles and the anticipated impacts of higher crude oil and petroleum products prices over the forecast horizon. At this time, based upon industry research, Staff does not expect a significant increase in natural gas and electric vehicle penetration into the marketplace during the forecast horizon. The standard error of the forecast is 1.6 percent.

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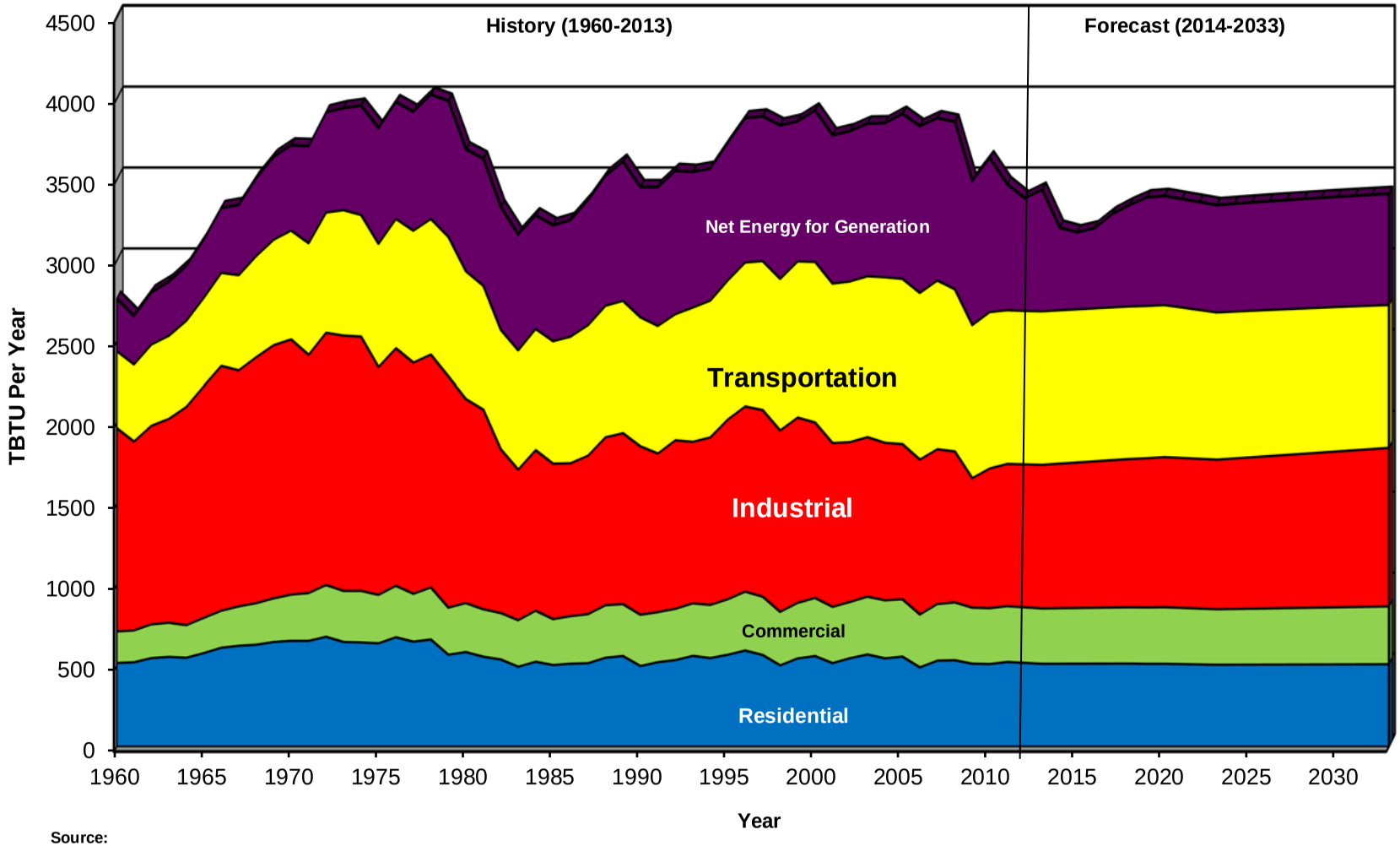
Figure 5.0.1. Total Energy Requirements in Ohio by Sector (1960-2033)



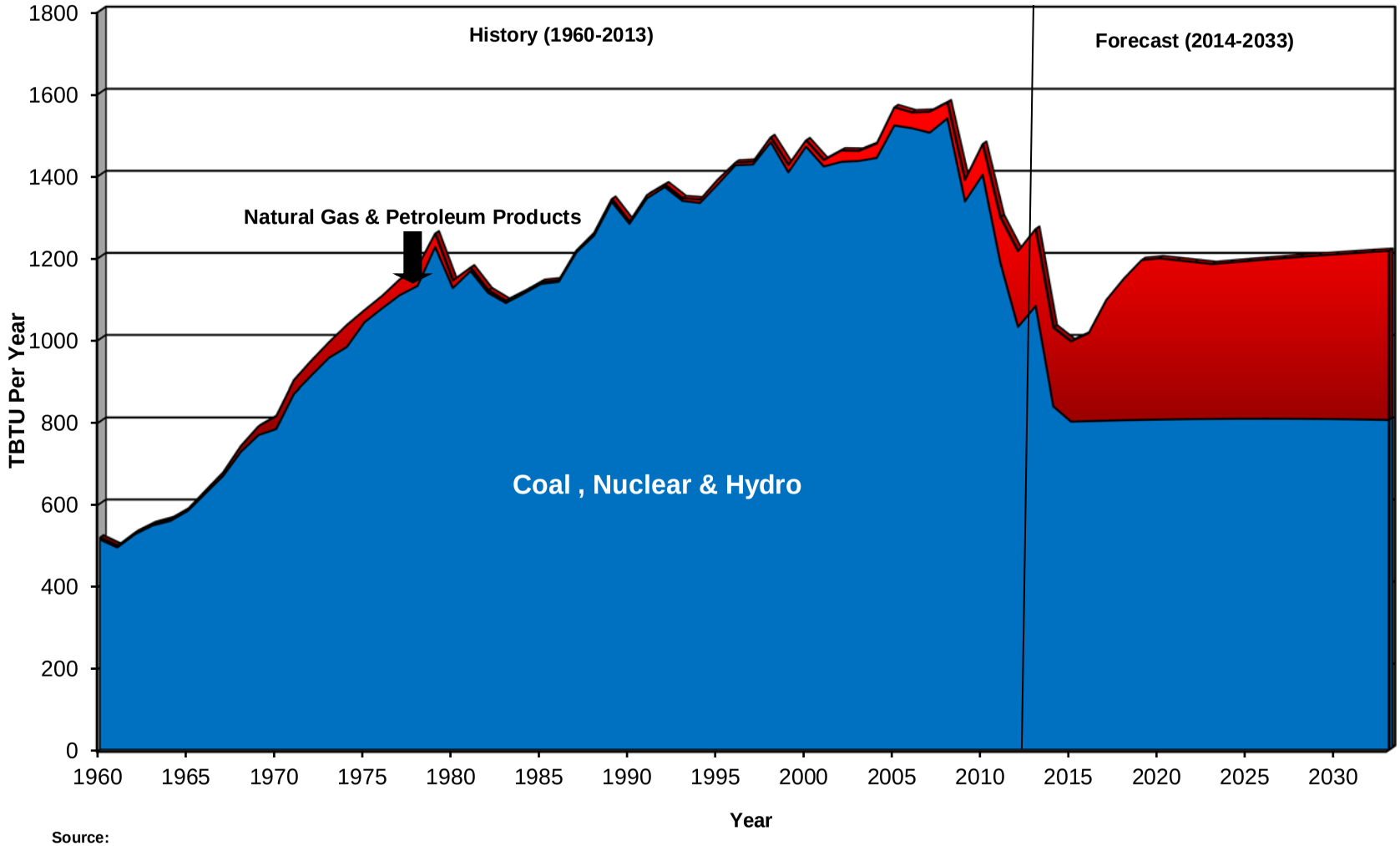
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.0.1
Summary of Energy Requirements by End Use Sectors in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Residential	Commercial	Industrial	Transportation	Net Energy for Generation	Total
-5	2008	533.9	357.3	932.8	999.0	1,033.1	3,856.1
-4	2009	512.6	346.1	800.0	942.6	889.0	3,490.3
-3	2010	510.4	345.2	862.9	963.4	949.9	3,631.7
-2	2011	509.9	349.9	786.2	953.1	843.2	3,442.2
-1	2012	461.1	330.9	817.3	924.1	715.2	3,248.7
0	2013	511.2	361.3	787.3	938.1	771.9	3,369.8
1	2014	512.1	343.2	893.1	944.3	509.1	3,201.9
2	2015	512.4	344.3	898.9	943.3	474.5	3,173.4
3	2016	512.8	345.4	904.6	942.2	493.7	3,198.6
4	2017	513.1	346.5	910.3	940.9	573.9	3,284.7
5	2018	513.4	347.6	916.0	939.5	625.5	3,342.0
6	2019	511.5	348.6	921.7	938.0	669.5	3,389.3
7	2020	511.8	349.7	927.4	936.3	673.0	3,398.1
8	2021	509.9	347.5	926.3	926.5	669.5	3,379.6
9	2022	508.0	345.3	925.2	916.5	665.9	3,360.8
10	2023	506.0	343.1	924.0	906.3	662.2	3,341.7
11	2024	506.3	344.6	929.7	904.2	665.0	3,349.8
12	2025	506.7	346.0	935.3	902.0	667.7	3,357.8
13	2026	507.0	347.4	940.9	899.7	670.4	3,365.4
14	2027	507.3	348.8	946.5	897.3	672.8	3,372.7
15	2028	507.6	350.2	952.1	894.7	675.2	3,379.8
16	2029	507.9	351.6	957.6	892.0	677.4	3,386.5
17	2030	508.2	353.0	963.1	889.2	679.6	3,393.0
18	2031	508.5	354.4	968.6	886.3	681.6	3,399.3
19	2032	508.8	355.8	974.0	883.2	683.4	3,405.2
20	2033	509.1	357.1	979.4	880.0	685.2	3,410.8
Standard Error of the Forecast		± 3.5%	± 2.5%	± 3.8%	± 1.6%	± 4.1%	± 1.7%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 5.1.1. Energy Requirements for Electricity Generation in Ohio (1960-2033)



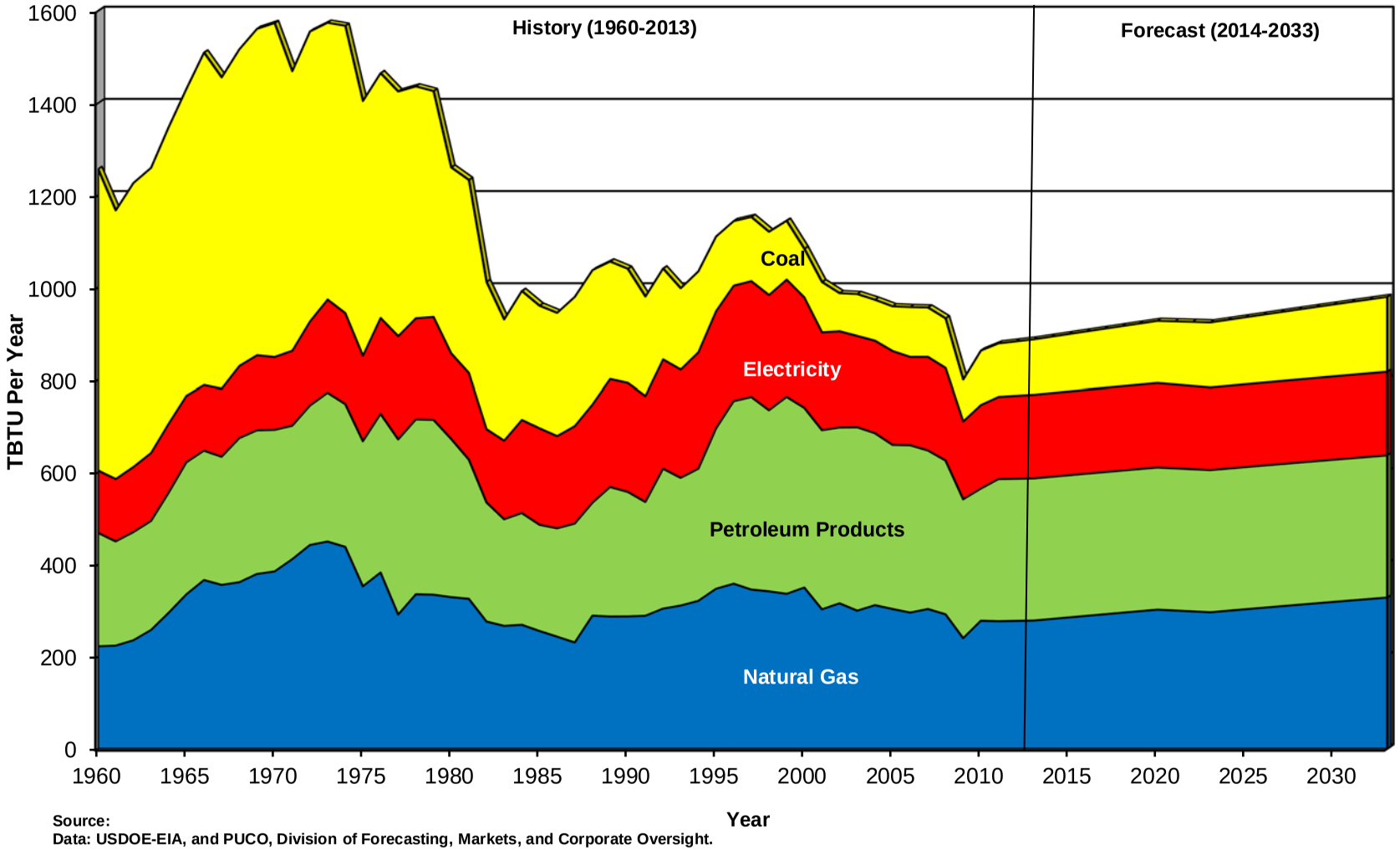
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.1.1
Summary of Energy Requirements for Electricity Generation in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Coal	Petroleum Products	Total Fossil Fuel	Nuclear & Hydro	Total	BTU Equivalent of Total Electricity Sales in Ohio	Net Energy For Generation
	(1)	(2)	(3)	(4)	(5) ∑(2)+..+(4)	(6)	(7) (5)+(6)	(8)	(9) (7)-(8)
-5	2008	24.2	1,350.1	14.5	1,388.8	188.0	1,576.8	535.0	1,041.8
-4	2009	38.9	1,170.5	13.5	1,222.8	165.2	1,388.0	516.1	871.9
-3	2010	60.0	1,230.4	14.8	1,305.2	170.5	1,475.7	520.0	955.7
-2	2011	95.8	1,100.0	15.6	1,211.4	160.4	1,371.8	519.5	852.3
-1	2012	177.1	848.2	17.1	1,042.4	183.8	1,226.1	518.9	707.2
0	2013	165.4	929.8	15.6	1,110.8	174.2	1,285.0	518.3	766.6
1	2014	175.9	662.5	15.0	853.4	174.8	1,028.3	519.1	509.1
2	2015	179.0	625.1	15.1	819.2	175.2	994.4	519.9	474.5
3	2016	197.7	625.9	15.1	838.8	175.6	1,014.4	520.7	493.7
4	2017	277.5	626.7	15.2	919.4	176.0	1,095.3	521.5	573.9
5	2018	328.9	627.3	15.2	971.4	176.3	1,147.7	522.2	625.5
6	2019	372.7	627.8	15.3	1,015.8	176.7	1,192.5	523.0	669.5
7	2020	376.2	628.2	15.3	1,019.7	177.1	1,196.8	523.8	673.0
8	2021	370.9	628.5	15.3	1,014.7	177.5	1,192.2	522.7	669.5
9	2022	365.7	628.6	15.4	1,009.7	177.9	1,187.5	521.7	665.9
10	2023	360.5	628.6	15.4	1,004.5	178.2	1,182.8	520.6	662.2
11	2024	363.9	628.6	15.5	1,007.9	178.6	1,186.5	521.5	665.0
12	2025	367.3	628.3	15.5	1,011.2	179.0	1,190.2	522.4	667.7
13	2026	370.8	628.0	15.5	1,014.3	179.4	1,193.7	523.3	670.4
14	2027	374.2	627.6	15.6	1,017.3	179.7	1,197.1	524.3	672.8
15	2028	377.6	627.0	15.6	1,020.2	180.1	1,200.4	525.2	675.2
16	2029	381.1	626.3	15.7	1,023.0	180.5	1,203.5	526.1	677.4
17	2030	384.5	625.5	15.7	1,025.7	180.9	1,206.6	527.0	679.6
18	2031	387.9	624.5	15.8	1,028.2	181.3	1,209.5	527.9	681.6
19	2032	391.4	623.5	15.8	1,030.6	181.6	1,212.3	528.8	683.4
20	2033	394.8	622.3	15.8	1,032.9	182.0	1,214.9	529.7	685.2
Standard Error of the Forecast		± 19.5%	± 2.9%	± 16.5%	± 2.8%	± 10.5%	± 2.6%	± 2.8%	± 1.6%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 5.2.1. Industrial Sector Energy Requirements in Ohio (1960-2033)



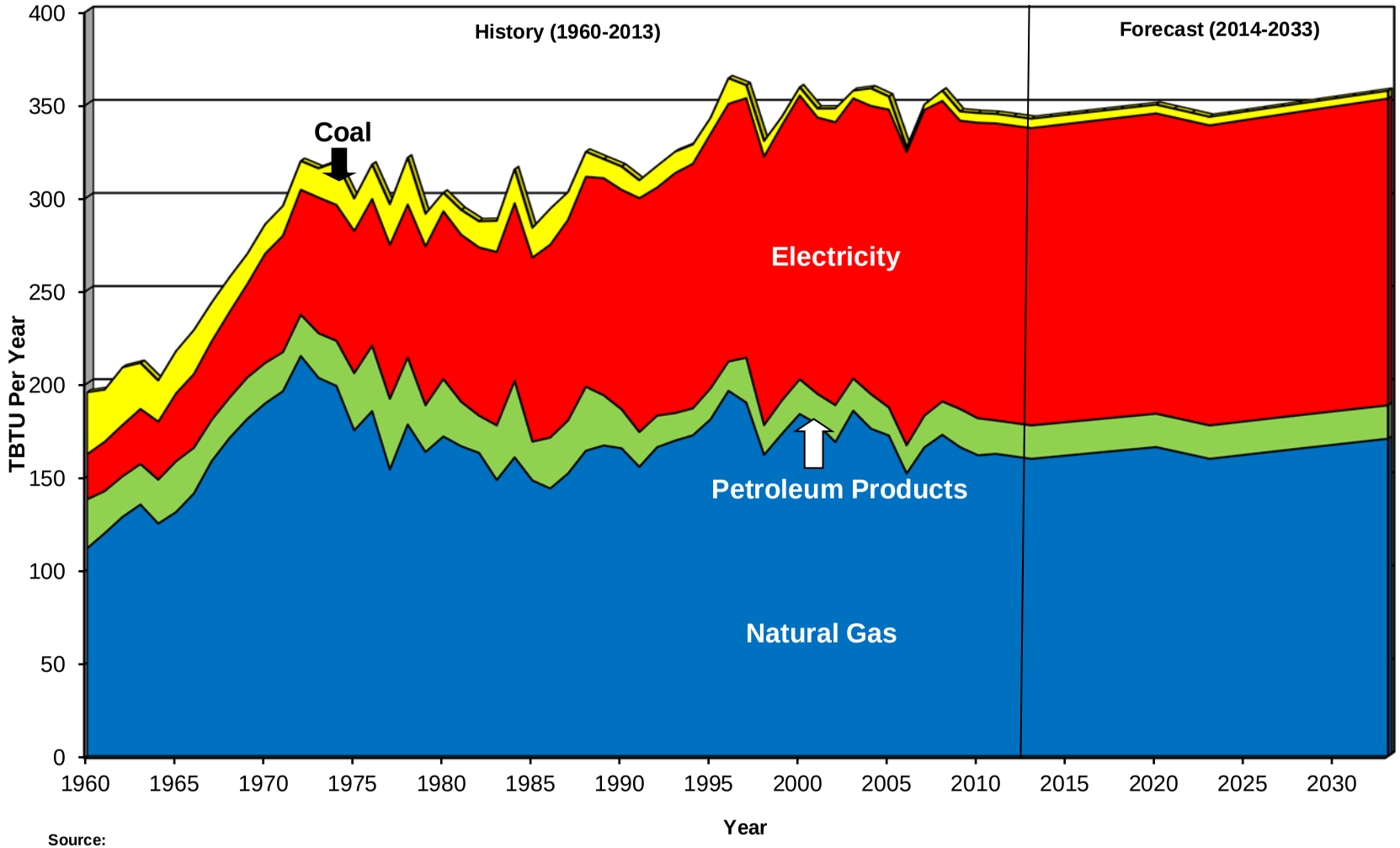
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.2.1
Summary of Industrial Sector Energy Requirements in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Coal	Petroleum Products	Electricity	Total
-5	2008	291.9	107.2	333.7	200.0	932.8
-4	2009	240.1	89.7	301.4	168.8	800.0
-3	2010	277.9	117.2	286.6	181.2	862.9
-2	2011	276.6	114.0	211.6	184.0	786.2
-1	2012	272.9	127.3	235.0	182.1	817.3
0	2013	281.8	128.9	201.2	175.3	787.3
1	2014	281.8	121.5	308.5	181.3	893.1
2	2015	285.2	123.7	308.5	181.5	898.9
3	2016	288.6	125.8	308.5	181.7	904.6
4	2017	292.0	128.0	308.5	181.9	910.3
5	2018	295.3	130.1	308.5	182.1	916.0
6	2019	298.7	132.3	308.5	182.3	921.7
7	2020	302.0	134.4	308.5	182.5	927.4
8	2021	300.1	136.5	308.5	181.1	926.3
9	2022	298.2	138.7	308.5	179.8	925.2
10	2023	296.3	140.8	308.5	178.4	924.0
11	2024	299.6	143.0	308.5	178.6	929.7
12	2025	302.9	145.1	308.5	178.8	935.3
13	2026	306.2	147.2	308.5	179.0	940.9
14	2027	309.4	149.4	308.5	179.2	946.5
15	2028	312.6	151.5	308.5	179.4	952.1
16	2029	315.8	153.7	308.5	179.6	957.6
17	2030	318.9	155.8	308.5	179.9	963.1
18	2031	322.1	157.9	308.5	180.1	968.6
19	2032	325.1	160.1	308.5	180.3	974.0
20	2033	328.2	162.2	308.5	180.5	979.4
Standard Error of the Forecast		± 4.1%	± 5.7%	±9.6%	± 2.4%	± 3.8%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 5.3.1. Commercial Sector Energy Requirements in Ohio (1960-2033)



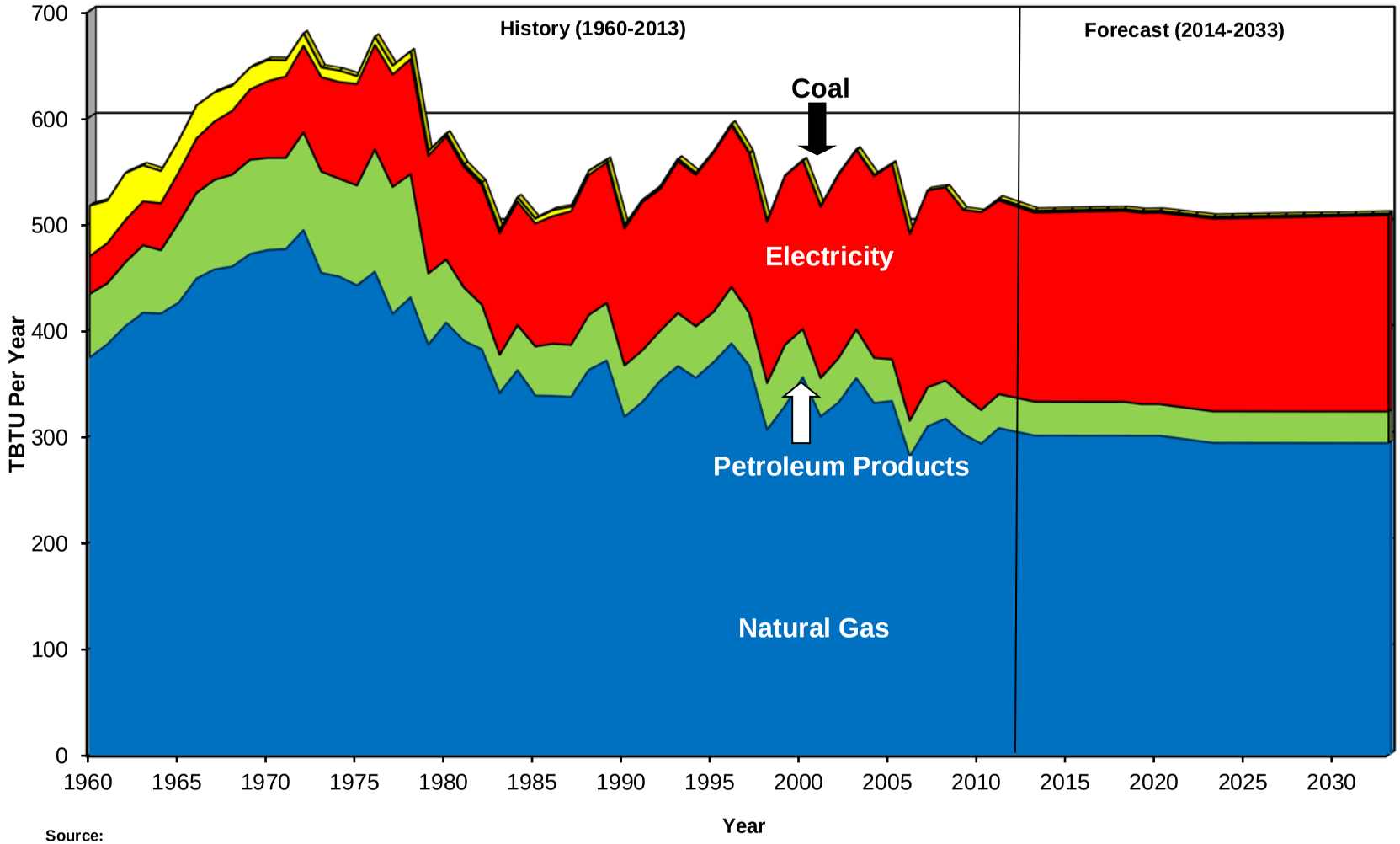
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.3.1
Summary of Commercial Sector Energy Requirements in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Coal	Petroleum Products	Electricity	Total
-5	2008	172.4	5.5	17.9	161.4	357.3
-4	2009	165.8	5.0	20.5	154.8	346.1
-3	2010	161.4	5.2	19.9	158.7	345.2
-2	2011	166.6	4.4	18.1	160.7	349.9
-1	2012	150.1	3.0	18.3	159.5	330.9
0	2013	174.5	3.3	23.8	159.8	361.3
1	2014	160.4	5.0	17.9	159.9	343.2
2	2015	161.3	4.9	17.9	160.1	344.3
3	2016	162.2	4.9	17.9	160.3	345.4
4	2017	163.1	4.8	17.9	160.6	346.5
5	2018	164.0	4.8	17.9	160.8	347.6
6	2019	164.9	4.7	17.9	161.0	348.6
7	2020	165.8	4.7	17.9	161.3	349.7
8	2021	163.7	4.7	17.9	161.2	347.5
9	2022	161.6	4.6	17.9	161.2	345.3
10	2023	159.5	4.6	17.9	161.1	343.1
11	2024	160.6	4.5	17.9	161.5	344.6
12	2025	161.7	4.5	17.9	161.8	346.0
13	2026	162.8	4.4	17.9	162.2	347.4
14	2027	163.9	4.4	17.9	162.6	348.8
15	2028	165.0	4.4	17.9	162.9	350.2
16	2029	166.1	4.3	17.9	163.3	351.6
17	2030	167.1	4.3	17.9	163.7	353.0
18	2031	168.2	4.2	17.9	164.0	354.4
19	2032	169.3	4.2	17.9	164.4	355.8
20	2033	170.3	4.2	17.9	164.7	357.1
Standard Error of the Forecast		± 4.3%	± 17.7%	± 8.3%	± 2.7%	± 2.5%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 5.4.1. Residential Sector Energy Requirements in Ohio (1960-2033)



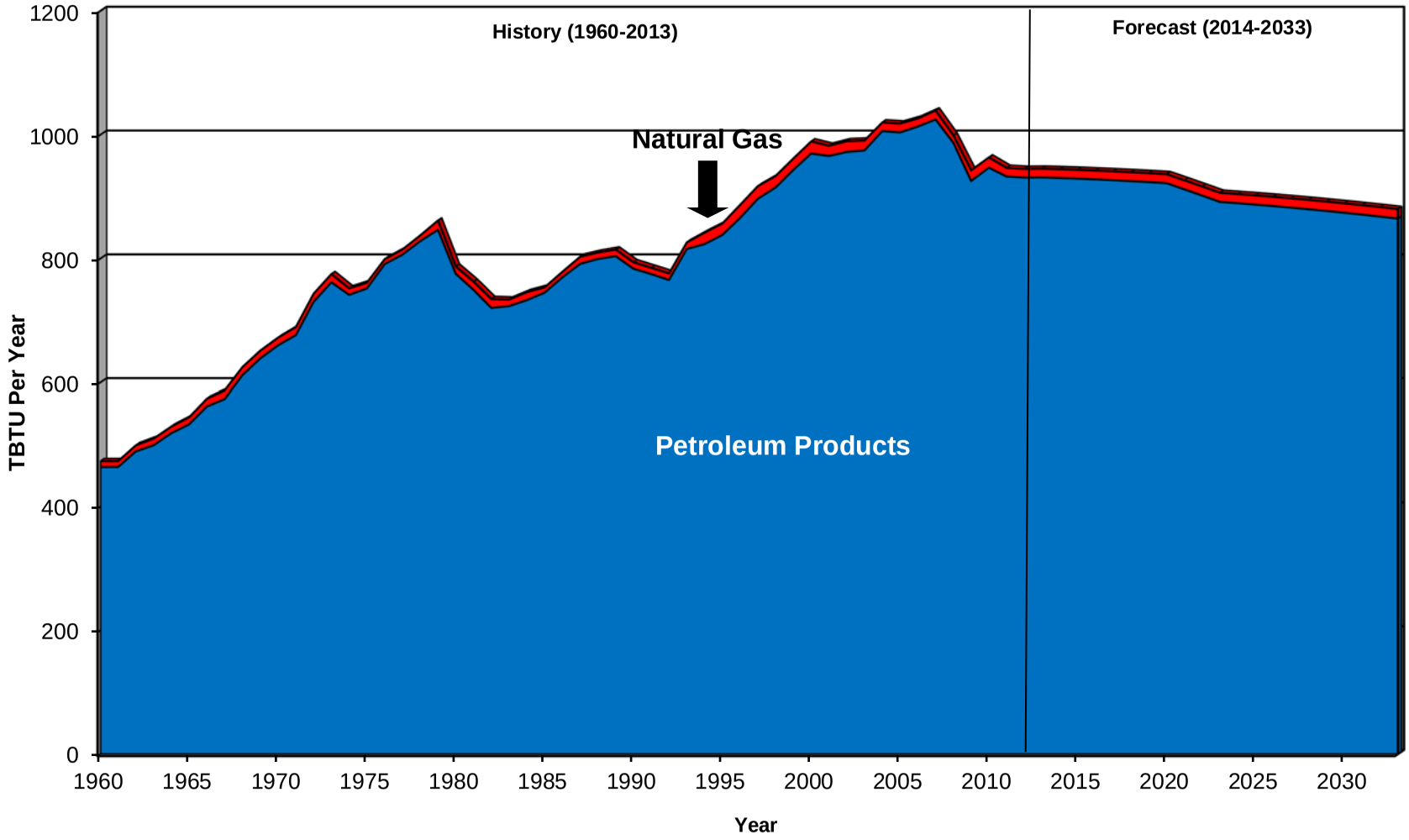
Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.4.1
Summary of Residential Sector Energy Requirements in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Petroleum Products	Electricity	Total
-5	2008	316.3	35.3	182.2	533.9
-4	2009	301.8	35.4	175.4	512.6
-3	2010	292.8	31.7	185.9	510.4
-2	2011	295.3	30.8	183.8	509.9
-1	2012	258.9	23.8	178.4	461.1
0	2013	306.9	26.3	178.0	511.2
1	2014	300.4	31.9	178.0	510.2
2	2015	300.4	31.9	178.3	510.6
3	2016	300.4	31.9	178.7	510.9
4	2017	300.4	31.9	179.0	511.2
5	2018	300.3	31.9	179.4	511.6
6	2019	300.3	29.6	179.7	509.6
7	2020	300.3	29.6	180.1	510.0
8	2021	298.1	29.6	180.4	508.1
9	2022	295.8	29.6	180.7	506.2
10	2023	293.6	29.6	181.1	504.3
11	2024	293.6	29.6	181.4	504.6
12	2025	293.5	29.6	181.8	504.9
13	2026	293.5	29.6	182.1	505.3
14	2027	293.5	29.6	182.5	505.6
15	2028	293.5	29.6	182.8	505.9
16	2029	293.4	29.6	183.1	506.2
17	2030	293.4	29.6	183.5	506.5
18	2031	293.4	29.6	183.8	506.9
19	2032	293.4	29.6	184.2	507.2
20	2033	293.4	29.6	184.5	507.5
Standard Error of the Forecast		± 4.8%	± 5.6%	± 2.6%	± 3.5%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Figure 5.5.1. Transportation Sector Energy Requirements in Ohio (1960-2033)



Source:
Data: USDOE-EIA, and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

Table 5.5.1
Summary of Transportation Sector Energy Requirements in Ohio
History (2008-2013), Forecast (2014-2033)
Trillion BTUs per Year

	Year	Natural Gas	Petroleum Products	Total
-5	2008	11.8	987.2	999.0
-4	2009	17.2	925.4	942.6
-3	2010	16.5	946.9	963.4
-2	2011	14.8	938.3	953.1
-1	2012	10.0	914.2	924.1
0	2013	11.0	927.1	938.1
1	2014	14.1	930.2	944.3
2	2015	14.2	929.2	943.3
3	2016	14.2	928.0	942.2
4	2017	14.3	926.6	940.9
5	2018	14.4	925.2	939.5
6	2019	14.4	923.6	938.0
7	2020	14.5	921.8	936.3
8	2021	14.6	911.9	926.5
9	2022	14.6	901.8	916.5
10	2023	14.7	891.6	906.3
11	2024	14.8	889.5	904.2
12	2025	14.8	887.2	902.0
13	2026	14.9	884.9	899.7
14	2027	15.0	882.3	897.3
15	2028	15.0	879.7	894.7
16	2029	15.1	877.0	892.0
17	2030	15.2	874.1	889.2
18	2031	15.2	871.0	886.3
19	2032	15.3	867.9	883.2
20	2033	15.3	864.6	880.0
Standard Error of the Forecast		± 7.0%	± 1.6%	± 1.6%

Source:
Data: USDOE-EIA and PUCO, Division of Forecasting, Markets, and Corporate Oversight.
Forecast: PUCO, Division of Forecasting, Markets, and Corporate Oversight.

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