Evergy Missouri West

Volume 3

Load Analysis and Load Forecasting

Integrated Resource Plan

20 CSR 4240-22.030

April 2024

Table of Contents

Section 1: Selecting Load Analysis Methods 2
Section 2: Historical Database for Load Analysis 2
Section 3: Analysis of Number of Units 15
Section 4: Use Per Unit Analysis 18
Section 5: Selecting Load Forecasting Models 24
Section 6: Load Forecasting Model Specifications 28
Section 7: Base-Case Load Forecast 41
Section 8: Load Forecast Sensitivity Analysis 66

Table of Figures

Figure 1: MO West Residential Daily Energy vs Average Temp 9
Figure 2: MO West Residential Daily Peak Demand vs Average Temp 9
Figure 3: MO West Small General Service Daily Energy vs Average Temp 10
Figure 4: MO West Small General Service Daily Peak vs Average Temp 10
Figure 5: MO West Medium General Service Daily Energy vs Average Temp 11
Figure 6: MO West Medium General Service Daily Peak Demand vs Average Temp 11
Figure 7: MO West Large Power Daily Energy vs Average Temp 12
Figure 8: MO West Large Power Daily Peak Demand vs Average Temp 12
Figure 9: MO West Sales for Resale Daily Energy vs Average Temp 13
Figure 10: MO West Sales for Resale Daily Peak Demand vs Average Temp 13
Figure 11: Households 34
Figure 12: Employment Non-Manufacturing 35
Figure 13: Employment Manufacturing 36
Figure 14: Gross Metro Product Non-Manufacturing 37
Figure 15: Gross Metro Product Manufacturing 38
Figure 16: Net System Input (NSI) Historical and Forecasts 39
Figure 17: Peak Demand Historical and Forecasts 40

Figure 18: Estimates of MO West Residential Monthly Cooling, Heating, and Base ... 43
Figure 19: Estimates of MO West Commercial Small General Service Monthly Cooling, Heating, and Base ... 44
Figure 20: Estimates of MO West Big Commercial (SGS, LGS, & LP) Monthly Cooling, Heating, and Base ... 45
Figure 21: Estimates of MO West Industrial Monthly Cooling, Heating, and Base ... 46
Figure 22: Other MO West Load (SFR & Lighting) ... 47
Figure 23: Base Year (2023) Net System Summer Peak Day Load Profiles ... 49
Figure 24: Base Year (2023) Net System Winter Peak Day Load Profiles ... 49
Figure 25: Fifth Year (2028) Net System Summer Peak Day Load Profiles ... 50
Figure 26: Fifth Year (2028) Net System Winter Peak Day Load Profiles ... 51
Figure 27: Tenth Year (2033) Net System Summer Peak Day Load Profiles ... 51
Figure 28: Tenth Year (2033) Net System Winter Peak Day Load Profiles ... 52
Figure 29: Twentieth Year (2043) Net System Summer Peak Day Load Profiles ... 52
Figure 30: Twentieth Year (2043) Net System Winter Peak Day Load Profiles ... 53
Figure 31: KC Metro Households ... 54
Figure 32: KC Metro Employment Non-Manufacturing ... 55
Figure 33: KC Metro Employment Manufacturing ... 56
Figure 34: KC Metro Gross Metro Product Non-Manufacturing ... 57
Figure 35: Gross Metro Product Manufacturing ... 58
Figure 36: DOE Stock Average Appliance Efficiency Projections ... 59
Figure 37: DOE UEC Projections (<1000 kWh/year) ... 60
Figure 38: DOE UEC Projections (>1000 kWh/year) ... 61
Figure 39: DOE Electric Appliance Saturation Projections (< 100%) ... 62
Figure 40: DOE Equipment Saturation Projections ... 63
Figure 41: DOE Commercial EUI Projections ... 64

Figure 42: MO West Base, Low, High, Significant Loss and Electrification Net System Input Forecast 69
Figure 43: MO West Base, Low, High, Significant Loss and Electrification Peak Demand Forecast 70
Figure 44: MO West Base, Low, High, and Extreme Weather Peak Demand Forecast 71
Figure 45: MO West Base Case Actual and Weather Normalized Summer Energy Plots 72
Figure 46: MO West Base Case Actual and Weather Normalized Non-Summer Energy Plots 72
Figure 47: MO West Base Case Actual and Weather Normalized Total Energy Plots ... 73
Figure 48: MO West Base Case Actual and Weather Normalized Summer Peak Demand Plots 74
Figure 49: MO West Base Case Actual and Weather Normalized Winter Peak Demand Plots 74
Figure 50: MO West Base Case Actual and Weather Normalized Total Peak Demand Plots 75
Figure 51: MO West Base-Case, Low-Case, and High-Case Summer Energy Plots 76
Figure 52: MO West Base-Case, Low-Case, and High-Case Non-Summer Energy Plots 77
Figure 53: MO Metro Base-Case, Low-Case, and High-Case Total Energy Plots 77
Figure 54: MO West Base-Case, Low-Case, and High-Case Summer Peak Demand Plots 78
Figure 55: MO West Base-Case, Low-Case, and High-Case Winter Peak Demand Plots 79
Figure 56: MO West Base-Case, Low-Case, and High-Case Total Peak Demand Plots 79

Table of Tables

Table 1: WN Model for MO West Residential Sales 5
Table 2: WN Model for MO West Small GS Commercial Sales 5
Table 3: WN Model for MO West Big GS Commercial Sales (MGS, LGS and LP) 6
Table 4: WN Model for MO West Industrial Sales (SGS, MGS, LGS and LP) 6
Table 5: MO West Residential Customers 16
Table 6: MO Metro Small GS Commercial Customers 17
Table 7: MO West Big GS Commercial Customers (MGS, LGS and LP) 17
Table 8: MO West Industrial Customers 17
Table 9: Residential Product Categories Covered by DOE Standards 26
Table 10: Commercial/Industrial Product Categories Covered by DOE Standards[ii] 27
Table 11: Lighting Product Categories Covered by DOE Standards[ii] 27
Table 12: MO West Residential kWh per Customer 30
Table 13: MO West Small GS Commercial kWh per Customer 31
Table 14: MO West Big GS Commercial kWh per Customer (SGS, LGS, & LP) 31
Table 15: MO West Industrial Sales 32
Table 16: Data Table of MO West Residential Monthly Cooling, Heating, and Base 43
Table 17: Data Table of MO West Small General Service Monthly Cooling, Heating, and Base 44
Table 18: Data Table of MO West Big Commercial (SGS, LGS, & LP) Monthly Cooling, Heating, and Base 45
Table 19: Data Table of MO West Industrial Monthly Cooling, Heating, and Base 46
Table 20: Data Table Other MO West Load (SFR & Lighting) 47
Table 21: Economic Growth Rates for KC Metro Area **Confidential** 54
Table 22: MO West Residential 67
Table 23: MO West Commercial 67
Table 24: MO West Industrial 68

Table of Appendices

Appendix 3 2023 Commercial SAE

Appendix 3.1 EIA Commercial Demand Module Documentation m066(2020)

Appendix 3.2 EIA Commercial Demand Module Documentation m067(2020)

Appendix 3.3 Residential SAE Update

Appendix 3A Evergy Missouri West Reports: Missouri 20 CSR 4240-22.030 (2.D.1)

Appendix 3A1 Evergy Missouri West Reports: Missouri 20 CSR 4240-22.030 (2.D.3)

Appendix 3B Evergy Missouri West Reports: Missouri 20 CSR 4240-22.030 (7.A.6)

Appendix 3C Evergy Missouri West Reports: Missouri 20 CSR 4240-22.030 (7.A.7)

Appendix 3D Evergy Missouri West Reports: Missouri 20 CSR 4240-22.030 (8.C)

Volume 3 – Load Analysis and Load Forecasting

Highlights

- Evergy Missouri West expects energy consumption to grow 0.7% and peak demand to grow 0.5% annually from 2023-2043.
- Industrial energy consumption is expected to provide the most growth over the next 20 years.
- Evergy Missouri West customers are expected to grow 0.0% annually from 2023-2043.
- Key forecast uncertainties include the impact of rising prices, technological advancement in renewable energy sector, adoption of new consumer products and energy efficiency.

Section 1: Selecting Load Analysis Methods[1]

1.1 Identification of End-Use Measures[2]

See Volume 5: Demand Side Resource Analysis.

1.2 Purpose: Derivation of Data Set of Historical Values[3]

Evergy maintains a historical data set of load research and AMI data to support the Load forecast.

1.3 Analysis of Impacts of Implemented DSM And Demand-Side Rates on Load Forecasts[4]

See Volume 5: Demand Side Resource Analysis.

1.4 Reservation of Load Analysis in Historical Database[5]

Evergy preserves the historical data used to derive the load forecasts and provides this data in work papers and within the forecasting models.

Section 2: Historical Database for Load Analysis[6]

2.1 Customer Class Detail[7]

Evergy Missouri West (MO West) maintains a historical database of its loads for each major class, which are Residential, Small General Service (SGS), Large General Service (LGS), Large Power (LP), Lighting and Sales for Resale (SFR). In addition, SGS, LGS and LP are split into the subclasses Commercial and Industrial. This data begins in May 2005 for Evergy Missouri West and will be maintained with at least 10 years of history going forward. Beginning with the 2015 IRP filling, Evergy Missouri West forecasts its loads for each major class, which are Residential, Commercial Small General Service (SGS), Commercial Big (The sum of LGS, and LP), Industrial (The sum of SGS, LGS, and LP), Lighting, and Sales for Resale (SFR).

---

[1] 20 CSR 4240-22.030(1)
[2] 20 CSR 4240-22.030(1)(A)
[3] 20 CSR 4240-22.030(1)(B)
[4] 20 CSR 4240-22.030(1)(C)
[5] 20 CSR 4240-22.030(1)(D)
[6] 20 CSR 4240-22.030(2)
[7] 20 CSR 4240-22.030(2)(A)

2.2 Load Data Detail[8]

2.2.1 Actual and Weather Normalized Energy, And Number of Customers[9]

MetrixND files are used to maintain this data for each subclass listed in 22.030 (2) (A). These files also contain the models used to forecast the number of customers and weather-normalize and forecast monthly energy sales.

2.2.2 Actual and Weather Normalized Demands[10]

Actual and weather-normalized coincident demands are provided in Appendix 3B. This data is available beginning in 2005 for Evergy Missouri West. Some earlier years are also available. Class level hourly loads are currently weather normalized when a rate case is prepared. Jurisdiction level peaks are weather normalized annually when forecasting peak demand for the triennial IRP or IRP update.

2.2.3 Actual and Weather Normalized System Peak Demands[11]

Actual and weather-normalized Net System Input (NSI) is contained in the MetrixLT files.

2.3 Load Component Detail[12]

2.3.1 Units Component[13]

The number-of-units is the number of customers for residential and SGS commercial. For the other subclasses, MWh sales are modeled because it is more stable than kWh sales per customer and the model fit statistics are higher. In the big commercial and Industrial customer classes, the size of customers varies more than in the smaller classes and use per customer can vary substantially as customers enter or exit the class.

[8] 20 CSR 4240-22.030(2)(B)
[9] 20 CSR 4240-22.030(2)(B)(1)
[10] 20 CSR 4240-22.030(2)(B)(2)
[11] 20 CSR 4240-22.030(2)(B)(3)
[12] 20 CSR 4240-22.030(2)(C)
[13] 20 CSR 4240-22.030(2)(C)(1)

2.3.2 Update Procedure[14]

Evergy Missouri West has developed a MetrixND model for each subclass of kWh sales that weather normalizes sales or sales per unit. These models will update weather normalized sales at the subclass level whenever these models are updated. This procedure is automatic. Major class level demands are currently weather normalized only for a rate case and this process is not automatic as it requires many manual steps.

Heating and cooling degree days calculated with different base temperatures were tested and kept in the models if statistically significant so that nonlinear weather response functions could be represented.

2.3.3 Weather Measures and Estimation of Weather Effects Description and Documentation[15]

In this IRP filing, Evergy Missouri West used different methods to model the effects of weather for normalization and for forecasting. One reason for using different methods is that the sample period for WN needed to cover the entire period that historical data was available so that data could be WN. On the other hand, the forecasting models often need a more recent shorter sample period since the focus is on calibrating an end-use forecast to recent data. The method of WN used in this IRP filing is different than that used in the rate cases because it is designed to WN many years of data whereas the rate case models are based on only two years of data. Also, the method used here is much less labor intensive and can be updated more routinely.

Degree days computed at different base temperatures were tested in explaining the effects of weather on sales and system load. Degree days computed with more than one base temperature were tested in the same model to determine if the load response is nonlinear. The statistical results of model estimation in the weather normalization models of monthly sales are presented in this section. Additional information is available in the MetrixND model files that are included in the electronic workpapers. This additional

[14] 20 CSR 4240-22.030(2)(C)(2)
[15] 20 CSR 4240-22.030(2)(C)(3)

information includes formulas that define the explanatory variables, plots and tables of residuals, plots and tables of actual, weather-normalized, and predicted values, plots and tables of explanatory variables and model statistics and coefficients. The model coefficients were estimated using ordinary least squares regression in MetrixND. The estimation period for each class may be different, but generally includes the time period from January 2009 to June 2023.

Table 1: WN Model for MO West Residential Sales

Variable	Coefficien	StdErr	T-Stat	P-Value	Units	Definition
CONST	25.78	0.607	42.498	0.00%		Constant term
mWthrRevPD.HDD55	0.877	0.01	90.782	0.00%		
mWthrRevPD.CDD65	1.808	0.018	100.383	0.00%		
mBin.TrendVar	-0.223	0.024	-9.266	0.00%		
ResAvgUsePD.June2012	-1.934	0.403	-4.799	0.00%		
ResAvgUsePD.Aug2017	1.733	0.79	2.193	2.96%		
ResAvgUsePD.Jan2009	3.079	0.793	3.885	0.02%		
ResAvgUsePD.COVID	1.095	0.269	4.065	0.01%		
ResAvgUsePD.sum21	-2.73	0.572	-4.774	0.00%		
MA(1)	0.268	0.077	3.463	0.07%		

Table 2: WN Model for MO West Small GS Commercial Sales

Variable	Coefficien	StdErr	T-Stat	P-Value	Units	Definition
CONST	63.556	1.073	59.218	0.00%		Constant term
mWthrRevPD.CDD65	2.076	0.055	37.923	0.00%		
mWthrRevPD.HDD55	0.815	0.03	27.02	0.00%		
ComSmlAvgUsePD.Consolidation	16.904	0.525	32.216	0.00%		
ComSmlAvgUsePD.May2018	19.874	2.5	7.95	0.00%		
ComSmlAvgUsePD.Mar2017	14.589	2.477	5.889	0.00%		
ComSmlAvgUsePD.Aug2017	6.901	2.541	2.716	0.73%		
ComSmlAvgUsePD.CCB	-12.328	1.271	-9.699	0.00%		
ComSmlAvgUsePD.COVID	-12.776	1.622	-7.877	0.00%		
ComSmlAvgUsePD.Feb21	9.234	2.503	3.688	0.03%		
ComSmlAvgUsePD.calib	-8.524	0.942	-9.044	0.00%		
MA(1)	0.189	0.082	2.307	2.23%		

Table 3: WN Model for MO West Big GS Commercial Sales (MGS, LGS and LP)

Variable	Coefficien	StdErr	T-Stat	P-Value	Units	Definition
CONST	5118072	227642.1	22.483	0.00%		Constant term
mWthrRevPD.CDD65	111358.7	4877.719	22.83	0.00%		
mWthrRevPD.HDD55	12584.61	2642.87	4.762	0.00%		
ComBigSalesPD.Consolidation	-670567	53188.08	-12.607	0.00%		
ComBigSalesPD.May17	-766413	271962.6	-2.818	0.54%		
ComBigSalesPD.COVID	-533641	106529.6	-5.009	0.00%		
ComBigSalesPD.calib_trend	25441	9553.587	2.663	0.85%		
MA(1)	-0.169	0.078	-2.176	3.09%		

Table 4: WN Model for MO West Industrial Sales (SGS, MGS, LGS and LP)

Variable	Coefficien	StdErr	T-Stat	P-Value	Units	Definition
CONST	5419473	704044.2	7.698	0.00%		Constant term
mWthrRevPD.CDD60	17171.03	1432.332	11.988	0.00%		
mBin.Jan	-237248	31129.99	-7.621	0.00%		
mBin.Aug	145759.6	33632.87	4.334	0.00%		
mBin.Dec	-175019	30310.77	-5.774	0.00%		
mBin.Jan10	-430856	111812.4	-3.853	0.02%		
mBin.Feb10	647823.6	108723.7	5.958	0.00%		
mBin.Yr09	-243594	33546.95	-7.261	0.00%		
IndSalesPD.Trend2010	-4001.9	1253.118	-3.194	0.17%		
IndSalesPD.TrendVarAfter2015	-5950.42	891.792	-6.672	0.00%		
IndSalesPD.AfterApril2018	-148804	43603.43	-3.413	0.08%		
IndSalesPD.Year2019	-226928	33768.58	-6.72	0.00%		
IndSalesPD.May20	-420259	107950.8	-3.893	0.02%		
IndSalesPD.Jun21	-684647	108464.3	-6.312	0.00%		
IndSalesPD.May22	282113	108640.8	2.597	1.03%		
mBin.Nucor	-59232.9	23497.53	-2.521	1.27%		

2.4 Assessments[16]

For the current Evergy Missouri West filing, historical sales and customers broken out by class cost of service and commercial and industrial customers was available beginning in January 2000. Going forward, Evergy Missouri West will maintain this data for at least the previous 10 years.

[16] 20 CSR 4240-22.030(2)(D)

2.4.1 Historic End-Use Drivers of Energy Usage and Peak Demand[17]

Historical plots of customers and kwh/customer for energy usage and peak demand can be found in *Appendix 3A.*

Residential customer growth for Evergy Missouri West was near 2% during the housing boom of the early 2000s. Beginning in 2008, customer growth slowed to below 1% and slow growth continued until growth in housing development began to occur in 2013. A catch-up effect has resulted in average customer growth of .9% for 2012-2022.

Evergy Missouri West SGS Commercial customer growth was negative (-0.5%) in the late 2000s but has risen slightly since 2012. Growth from 2012 to 2022 averaged 1.2%. Commercial Big (MGS, LGS, LP) saw rapid customer growth in the late 2000s, averaging 1.9% from 2005 to 2010. Since then, many customers have switched classes due to rate cases or consolidations, resulting in somewhat sporadic customer counts. Over the last 3 years, 2019-2022, customers have declined slightly -0.5%.

Industrial customer growth has largely declined over the last 10 years, averaging -0.8% since 2010.

Residential MWh use per customer reveals a very slight downward trend (-0.2%) over the last 10 years 2012-2022. The downward trend in is due in part to increasing efficiency of air conditioning units and lighting among other things, partially offset by increase in electric space heat saturation.

For Commercial SGS, both summer and non-summer use per customer increased through the year 2012. During the last decade, use per customer saw annual growth for both summer 2.3% and non-summer 3.0% due to the impact of customer migrations between classes.

[17] 20 CSR 4240-22.030(2)(D)(1)

Commercial Big (MGS, LGS, LP) use per customer increased prior to 2012 for both summer (0.7%) and non-summer (2.0%) Use per customer has been increasing for both summer (5.5%) and non-summer (5.8%) since 2012 as efficiency gains in end uses have been dwarfed by the impact of customer migrations between classes.

From 2005 to 2010 Industrial use per customer increased at an annual rate of (2.0%) for summer and (2.8%) for non-summer months. Industrial use per customer was flat 2010-2019 annually, while customers and employment have steadily declined. This points to an increase in equipment use over labor use amongst area manufacturers. Industrial average use increased 2019 3.2%, primarily due to increased load from Nucor.

2.4.2 Weather Sensitivity of Energy and Peak Demand[18]

The following plots illustrate the weather response function of daily energy and peak demand for each major class. This data is weather normalized in the rate case process during which the weather response function is represented with an equation estimated with statistical regression analysis for July 2021 through June 2023. The blue symbols in the plot represent weekdays and the red symbols represent weekends.

[18] 20 CSR 4240-22.030(2)(D)(2)

Figure 1: MO West Residential Daily Energy vs Average Temp

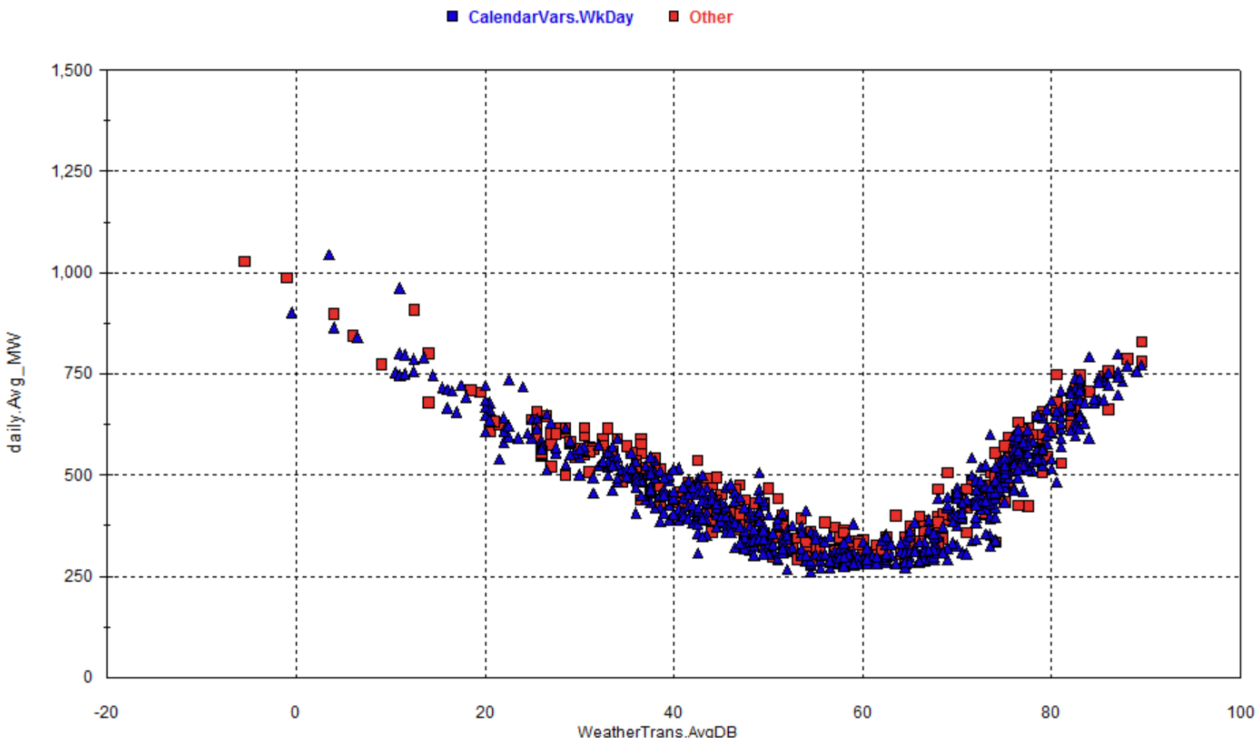


Figure 2: MO West Residential Daily Peak Demand vs Average Temp

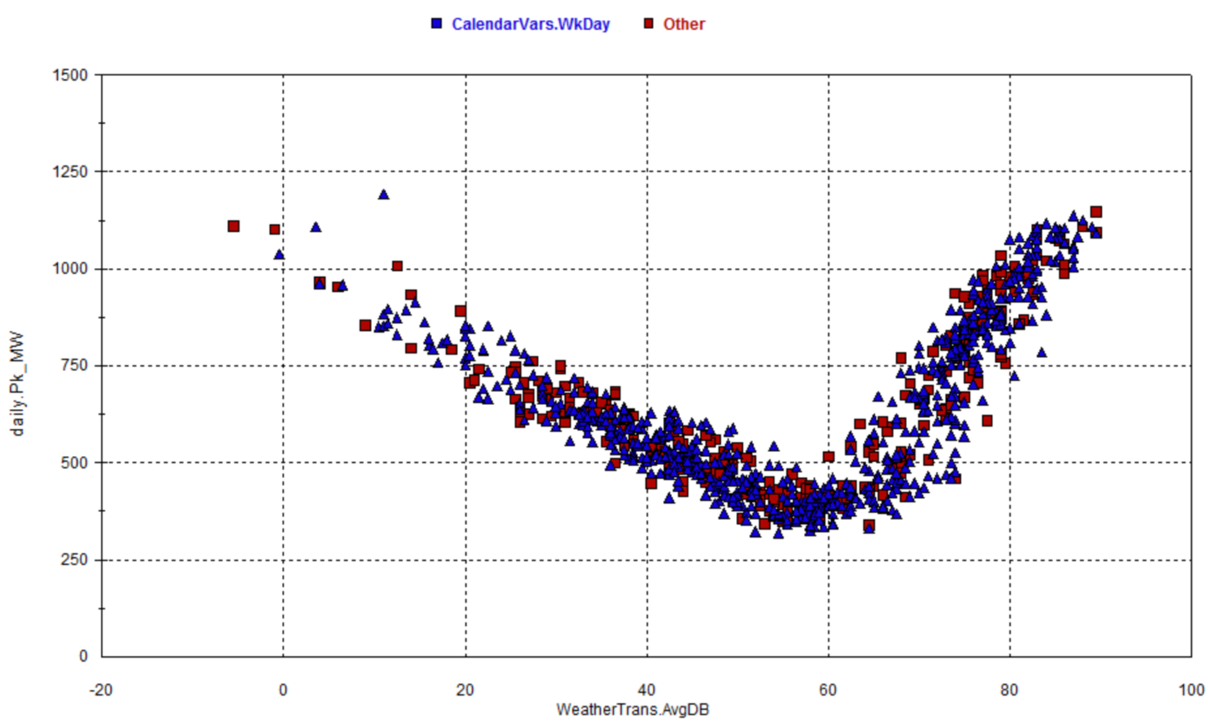


Figure 3: MO West Small General Service Daily Energy vs Average Temp

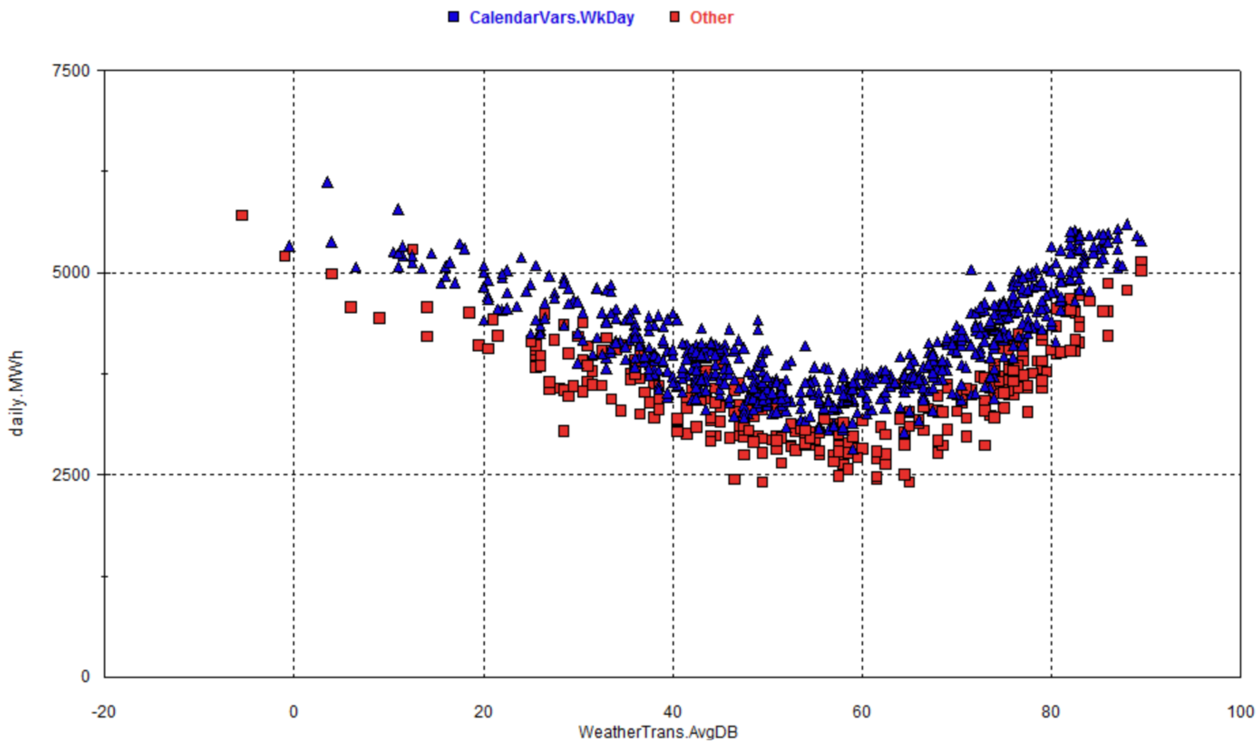


Figure 4: MO West Small General Service Daily Peak vs Average Temp

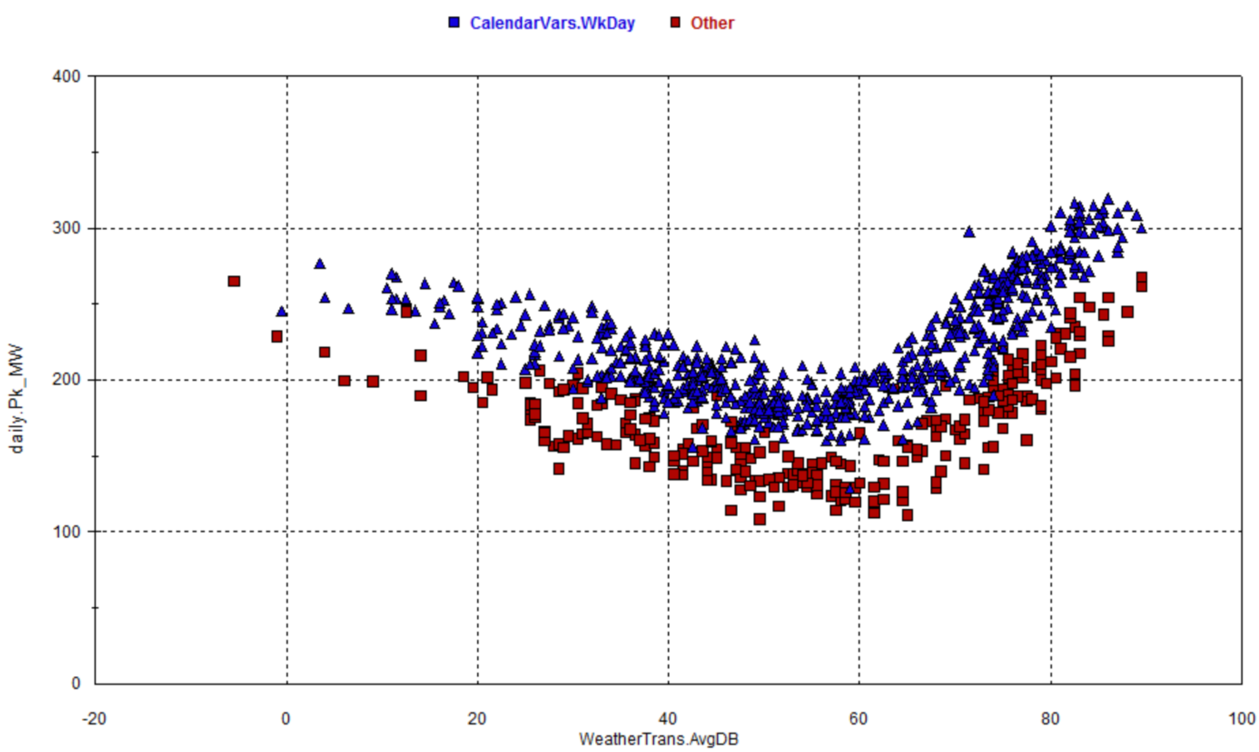


Figure 5: MO West Medium General Service Daily Energy vs Average Temp

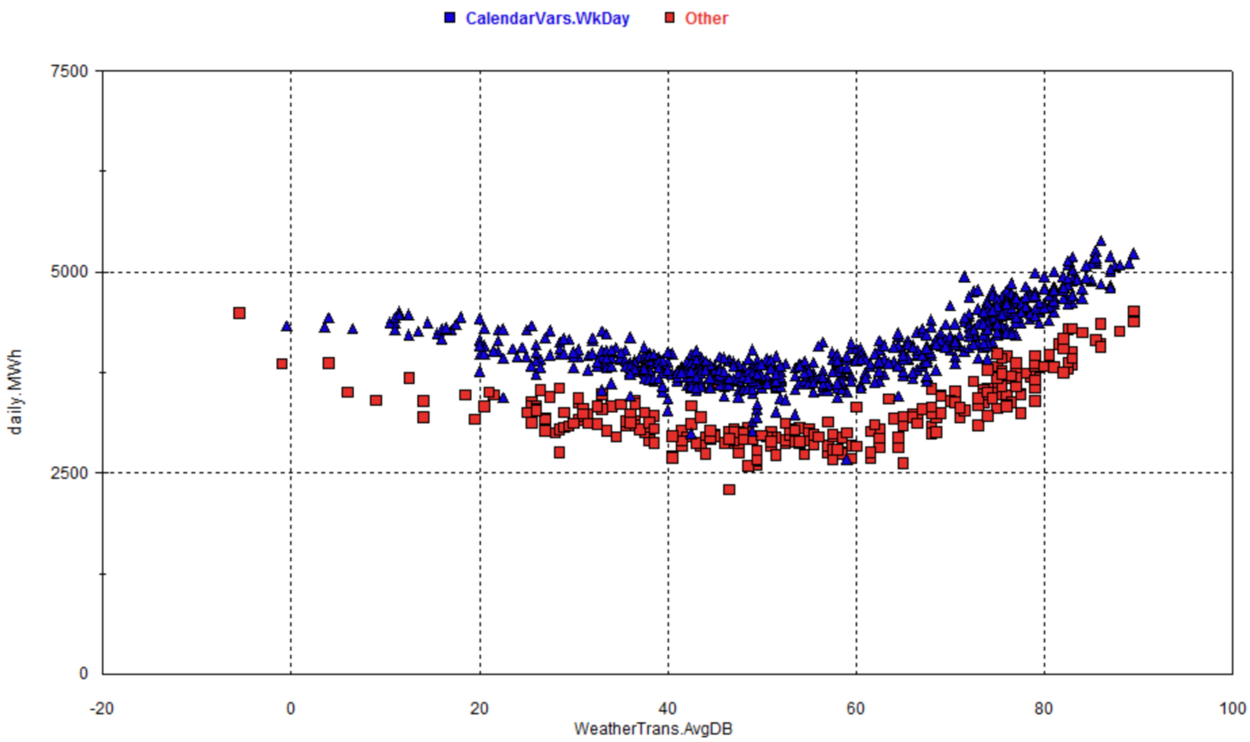


Figure 6: MO West Medium General Service Daily Peak Demand vs Average Temp

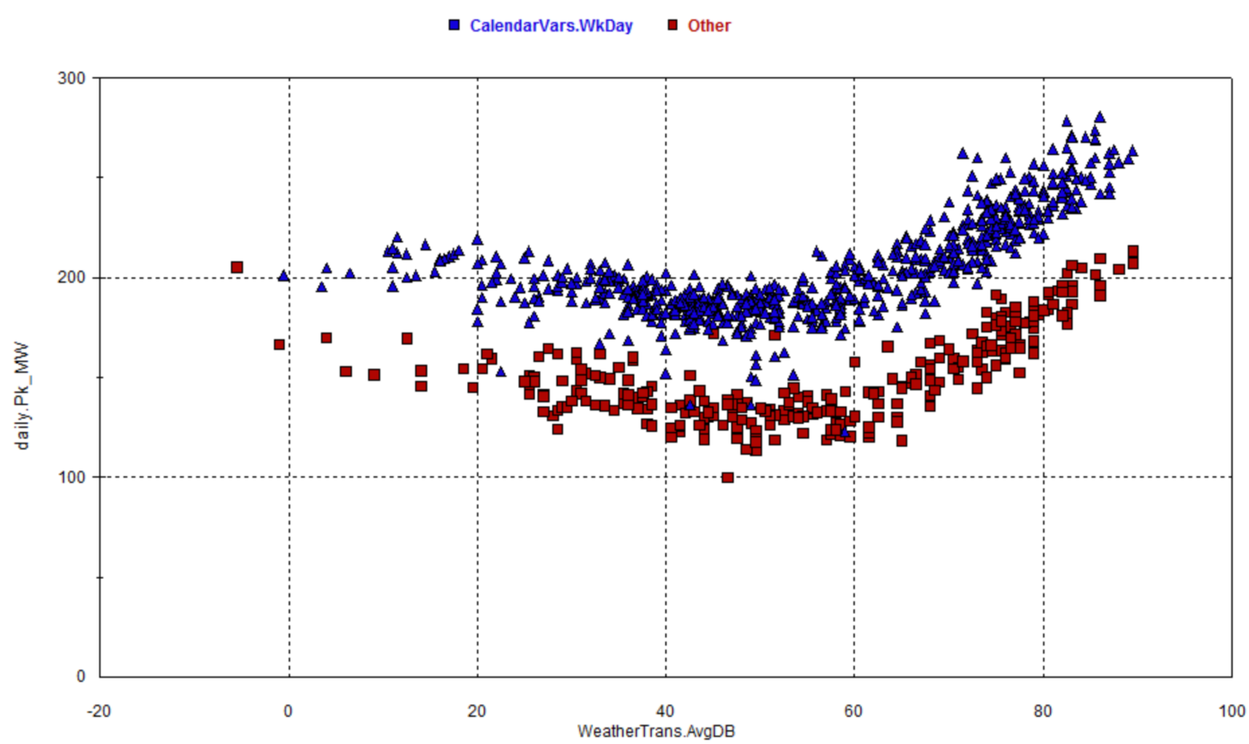


Figure 7: MO West Large Power Daily Energy vs Average Temp

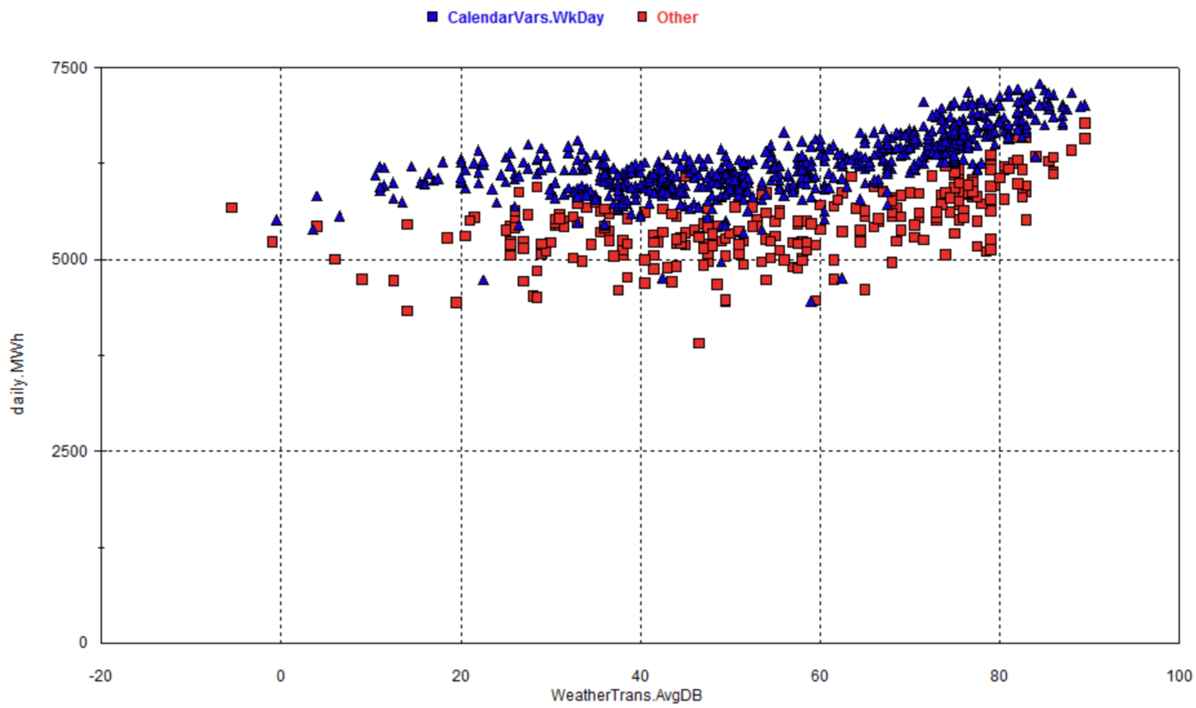


Figure 8: MO West Large Power Daily Peak Demand vs Average Temp

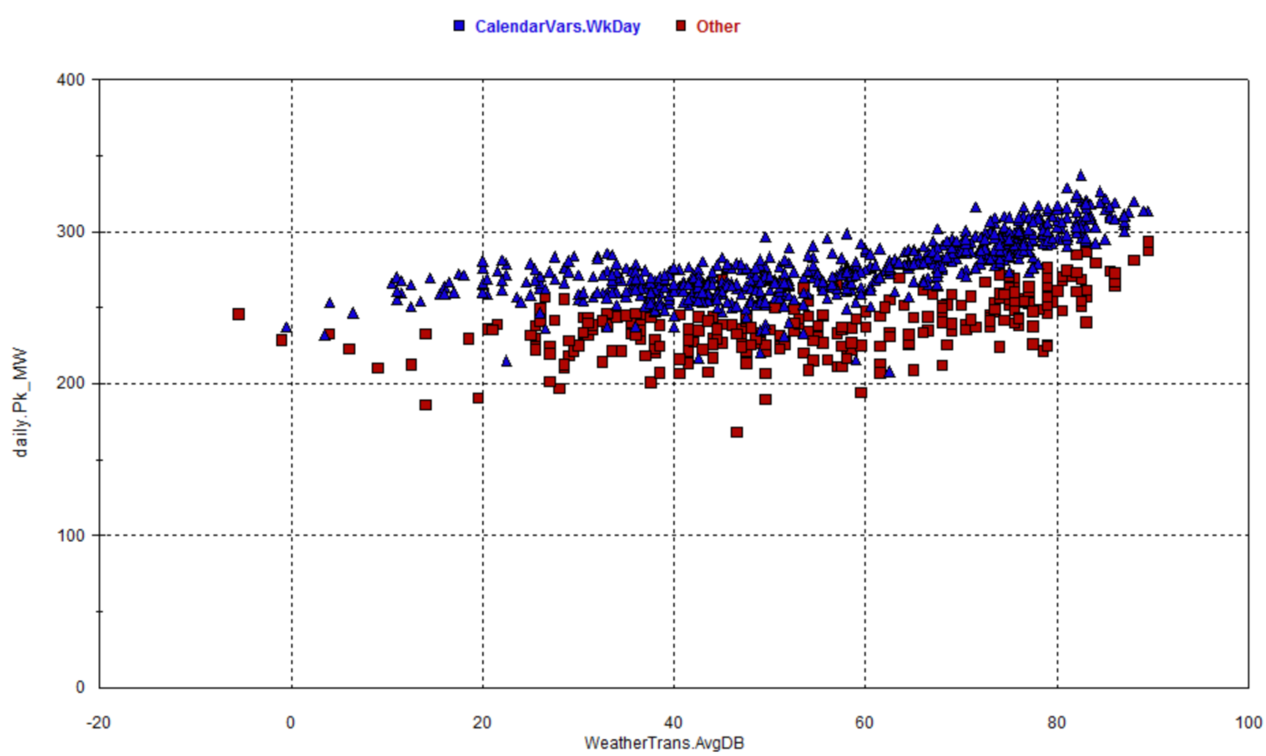


Figure 9: MO West Sales for Resale Daily Energy vs Average Temp

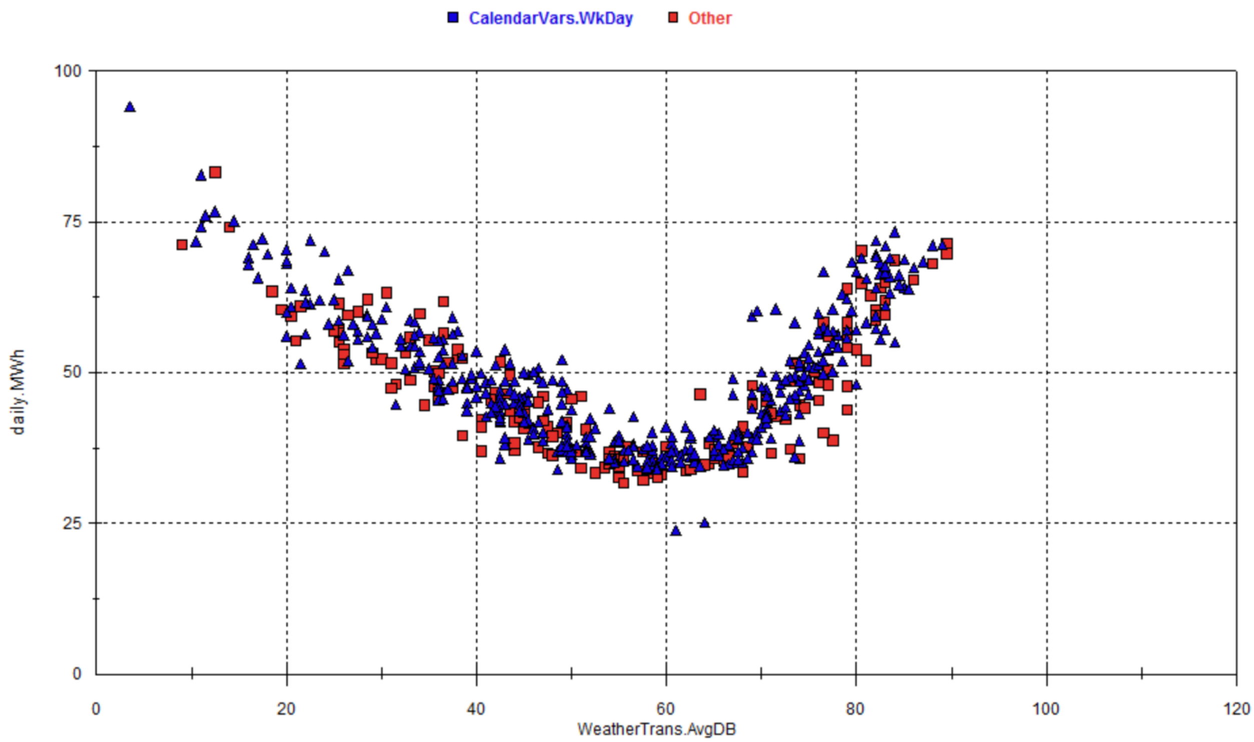
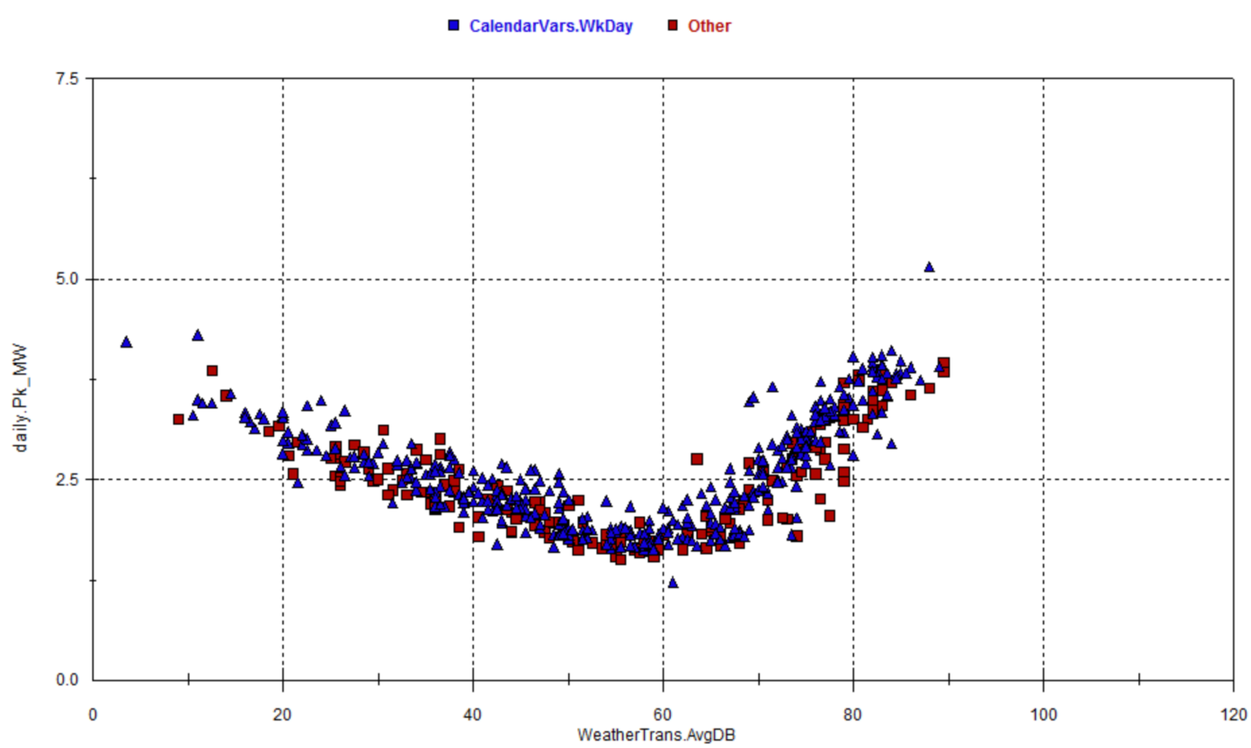


Figure 10: MO West Sales for Resale Daily Peak Demand vs Average Temp



2.4.3 Plots Illustrating trends materially affecting electricity consumption[19]

Historical class plots of customers, kwh, average use, and peak are provided in *Appendix 3A1* and were discussed above in section *2.4.1 Historic End-Use Drivers of Energy Usage and Peak Demand.*

2.5 Adjustments to Historical Data Description and Documentation[20]

Evergy Missouri West used binary variables in regression models to explain outliers rather than adjust the data***.***

2.6 Length of Historical Database[21]

For Evergy Missouri West, historical sales and customers broken out by class cost of service and commercial and industrial customers was available beginning in January 2000. Going forward, Evergy Missouri West will maintain this data for at least the previous 10 years.

[19] 20 CSR 4240-22.030(2)(D)(3)
[20] 20 CSR 4240-22.030(2)(E)
[21] 20 CSR 4240-22.030(2)(F)

Section 3: Analysis of Number of Units[22]

3.1 Identification of Explanatory Variables[23]

A forecast of the number of households in the KC metro area from Moody's Analytics was the driver for the number of residential customers of Evergy Missouri West. The KC metro area is the same as the Metropolitan Statistical Area (MSA) defined by the US Census Bureau and it includes some counties in both states that are not served by Evergy Missouri West. Also, Evergy Missouri West's service area includes some counties that are not included in the MSA.

Despite these inconsistencies in geographic areas, the number of households in the metro area is a good driver to predict the number of our residential customers because the metro area functions economically as a single entity and the metro area includes the vast majority of our customers. Many people live on one side of the state line and work on the other side. Many people shop on both sides of the state line. And many companies each year move from one side of the state line to the other. Documentation for Moody's forecast of economic activity is provided in the workpapers in the folder *\models* Evergy Missouri West *Base Case\Data\Economics* and Documentation\Economics.

Evergy Missouri West tested the use of county level forecasts from Moody's several years ago but saw no improvement in forecasting accuracy. This might be because it is difficult to forecast economic activity for a small geographic area, or because economic activity crosses county lines in the metro area.

The residential customer models were tested with both households and population used as drivers and the one with the best fit was chosen. If neither was significant or had a positive coefficient, the driver was tested without a constant term in the model, and if still insignificant, a driver was not used. Typically, households had the best fit.

[22] 20 CSR 4240-22.030(3)
[23] 20 CSR 4240-22.030(3)(A)

The main driver for the number of small general service customers was the number of residential customers or households. This driver was chosen because it has worked well in the past and because most small commercial customers exist to serve households and these customers will increase in areas where there are new housing developments. Examples of small commercial customers that serve households are medical offices, grocery stores, drug stores, restaurants, churches, schools, hair salons, and movie theaters.

In the models for Big (Large GS and Large Power) commercial customers, both non-manufacturing employment and non-manufacturing gross metro product were tested as drivers as well as population and households. The one with the best fit was chosen. If neither was significant or had a positive coefficient, the driver was tested without a constant term in the model, and if still insignificant, a driver was not used.

3.2 Statistical Model Documentation[24]

The following tables show the statistics for the variables in the regression models. Additional statistics and residual plots are available in the Metrix ND model files and a word document located in Evergy Missouri West\Evergy Missouri West Model Statistics.docx.

Table 5: MO West Residential Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	206699.414	22359.459	9.244	0.00%
Economics.Population	465.811	38.343	12.149	0.00%
mBinaryVars.Mar	282.501	86.246	3.276	0.13%
mBinaryVars.May	227.122	89.386	2.541	1.19%
mBinaryVars.Nov	-335.083	86.903	-3.856	0.02%
RES_Cust.May10	-1927.574	348.118	-5.537	0.00%
RES_Cust.Apr19	-1103.521	342.017	-3.227	0.15%
RES_Cust.Aug22	-889.067	336.384	-2.643	0.90%
RES_Cust.TrendCalib	-21.586	2.356	-9.163	0.00%
RES_Cust.Jun21toMar22	-1301.331	342.675	-3.798	0.02%
RES_Cust.Jul08	1099.749	389.276	2.825	0.53%
RES_Cust.Jun08	-1979.160	392.623	-5.041	0.00%
RES_Cust.Feb08	829.767	339.915	2.441	1.57%
AR(1)	0.920	0.030	30.443	0.00%

[24] 20 CSR 4240-22.030(3)(B)

Table 6: MO Metro Small GS Commercial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value
Economics.Population	17.383	0.448	38.809	0.00%
SML_Cust.AfterMar2017	1638.266	80.908	20.249	0.00%
mBinary.Feb	-159.448	42.307	-3.769	0.03%
SML_Cust.Feb_2017	489.576	112.491	4.352	0.00%
SML_Cust.April_2019	-334.792	92.932	-3.603	0.04%
SML_Cust.FebMar_2013	-486.933	78.980	-6.165	0.00%
SML_Cust.Feb_2018	-467.617	104.838	-4.460	0.00%
SML_Cust.CCB	-172.842	81.192	-2.129	3.51%
SML_Cust.Feb11	-454.233	96.607	-4.702	0.00%
SML_Cust.Jun18	-446.257	103.544	-4.310	0.00%
AR(1)	0.986	0.010	100.425	0.00%
MA(1)	-0.362	0.082	-4.432	0.00%
SMA(1)	0.407	0.088	4.626	0.00%

Table 7: MO West Big GS Commercial Customers (MGS, LGS and LP)

Variable	Coefficient	StdErr	T-Stat	P-Value
Economics.Population	0.187	1.925	0.097	92.28%
mBinary.GMOConsolidation	345.751	52.390	6.600	0.00%
BIG_Cust.Feb2018	8.913	49.379	0.180	85.70%
BIG_Cust.Feb2018Binary	336.559	37.847	8.893	0.00%
BIG_Cust.AfterMay2018	-175.473	95.800	-1.832	6.88%
BIG_Cust.Mar_June_2017	-413.458	52.924	-7.812	0.00%
BIG_Cust.Oct_2017	104.054	37.780	2.754	0.66%
BIG_Cust.Aug_2017	103.048	41.285	2.496	1.36%
BIG_Cust.April_2018	-115.712	61.396	-1.885	6.13%
AR(1)	0.996	0.010	101.058	0.00%
MA(1)	0.227	0.093	2.428	1.63%

Table 8: MO West Industrial Customers

Variable	Coefficient	StdErr	T-Stat	P-Value	Units	Definition
CONST	6.056	6.984	0.867	38.69%		Constant term
IND_Cust.LagDep(1)	0.993	0.007	143.912	0.00%		
IND_Cust.Aug08	41.028	10.177	4.031	0.01%		
IND_Cust.Aug09	-35.832	10.258	-3.493	0.06%		
IND_Cust.May14	36.233	10.026	3.614	0.04%		
IND_Cust.Feb18	-35.183	10.695	-3.289	0.12%		
IND_Cust.Mar18	52.321	10.685	4.897	0.00%		
AR(1)	-0.399	0.066	-6.019	0.00%		

Section 4: Use Per Unit Analysis[25]

4.1 Significant Energy and/or Peak Demand use for each Major Class[26]

4.1.1 End-Use Load Information[27]

Residential Sector[28]

The list of residential end-uses for which Evergy Missouri West maintains the number of units and energy use per unit include electric furnaces, heat pumps with electric resistance backup, heat pumps with natural gas backup, ground source heat pumps, central air conditioning without a heat pump, window or wall AC units, electric water heaters, electric ovens, cook tops and ranges, full-sized refrigerators, small refrigerators and wine coolers, freezers, dishwashers, clothes washers, electric dryers, TVs, air cleaners, computers, video game systems, hot tubs, swimming pools, electric vehicles and miscellaneous uses.

Commercial Sector[29]

Evergy Missouri West maintains information on saturations per square foot of floor space and energy use per square foot (EUI) for end-uses including heating, cooling, ventilation, electric water heating, electric cooking, refrigeration, outdoor lighting, indoor lighting, and office equipment and miscellaneous uses. In this filing, secondary data from the U.S. DOE for the West North Central region was adopted EVERGY MISSOURI WEST. The region includes the states of North Dakota, South Dakota, Minnesota, Iowa, Nebraska, Kansas and Missouri.

The results are combined across building types using building type weights. The building types include assembly (theaters, libraries, churches etc.), education, food sales, food service, health care, lodging, small office, large office, mercantile/service, warehouse and other. This data is maintained in *ComIndices_GMO.xls*. The building types are defined in

[25] 20 CSR 4240-22.030(4)
[26] 20 CSR 4240-22.030(4)(A)
[27] 20 CSR 4240-22.030(4)(A)(1)
[28] 20 CSR 4240-22.030(4)(A)(1)(A)
[29] 20 CSR 4240-22.030(4)(A)(1)(B)

NEMS to NAICS Mapping*.xls*. The building types are defined in NEMS to NAICS Mapping*.xls*. These spreadsheets were provided to EVERGY MISSOURI WEST by Itron, Inc. through the Energy Forecasting Group (EFG). The spreadsheets are documented in *2023CommercialSAE.pdf*. These files are provided in the workpapers.

Industrial Sector[30]

Evergy Missouri West has a relatively small industrial sector, accounting for approximately 16% of retail sales. EVERGY MISSOURI WEST lacks the concentration of heavy industry that some utilities have. As such, we have modeled our industrial sector with a statistically adjusted employment-based intensity model. Major end-uses are cooling and other.

4.1.2 Modification of End-Use Loads[31]

Removal or Consolidation of End-Use Loads[32]

Evergy Missouri West dropped attic fans from its residential survey since these do not contribute significantly to energy use or peak demand.

Additions to End-Use Loads[33]

In 2011 Evergy Missouri West added electric vehicles (including PHEVs) to our database. In the 2023 base year forecast we incorporated EV adoption forecasts produced in an ongoing study of Evergy Missouri West service territory EV usage conducted in partnership with the Electric Power Research Institute.

Starting with the 2013 base year forecast, we began tracking solar installations and merged that tracking with the EIA forecast estimate in 2015 to start generating a solar end-use intensity forecast for use in our residential and commercial forecasts. Starting with the base year 2022 forecast, we used the EIA forecast estimate combined with

[30] 20 CSR 4240-22.030(4)(A)(1)(C)
[31] 20 CSR 4240-22.030(4)(A)(2)
[32] 20 CSR 4240-22.030(4)(A)(2)(A)
[33] 20 CSR 4240-22.030(4)(A)(2)(B)

Evergy territory solar adoptions to produce a standalone solar forecast for Residential and Commercial.

Modification of End-Use Documentation[34]

Evergy Missouri West dropped the end-uses listed in the previous section A because they do not contribute significantly to energy use. The following end-uses were added to the residential survey: well pumps, video game systems, medical equipment, smart speaker, streaming devices, home theater system because these use substantial amounts of energy or we believed that these had a significant saturation in our service areas.

The DOE lighting end use estimates for both Residential and Commercial were adjusted for slope as well as total size to better align with historical Evergy Metro adoption of efficient lighting technologies and to align with the estimated remaining efficiency potential. The appliance saturation surveys were used to calibrate the DOE lighting projections. Documentation of this calibration is included in the class end use worksheets located in the folder Evergy West\Models\GMO Base Case\Data\Indices.

A study and projection of electric vehicle utilization and load impact was incorporated as an end-use in the current forecast. The study suggests that electric vehicle utilization is likely to significantly impact our energy load in the future. The available resources underlying the study results are included in our work papers.

4.1.3 Schedule for Acquiring End-Use Load Information[35]

Evergy Missouri West completed a DSM potential study in 2022. The study collected detailed end-use saturation and efficiency data from our customers in the residential sector. Evergy Missouri West provided copies of the completed study to the stakeholders' group.

[34] 20 CSR 4240-22.030(4)(A)(2)(C)
[35] 20 CSR 4240-22.030(4)(A)(3)

4.1.4 Weather Effects on Load[36]

Evergy Missouri West used statistical regression analysis applied to the hourly AMI load data to develop HELM like hourly load profiles for base, heating and cooling loads. Daily temperature was used in the regression models to identify the heating and cooling portions of the loads. The profiles were developed for each CCOS. The regressions were performed in MetrixND project West_ClassProfile.NDM using July 2020 – June 2023 hourly load data.

These load profiles are used in this IRP filing to allocate base, heating and cooling energy to each hour annually and monthly. These profiles are stored in WEST_*SystemLoad.ltm and* WEST_*SystemLoadWN.ltm.*

4.2 End-Use Development[37]

4.2.1 Measures of The Stock of Energy-Using Capital Goods[38]

Evergy Missouri West has conducted a residential appliance saturation survey every 3 years for many decades. The surveys have been conducted by mail historically and recently by a mix of mail and internet methods. The last survey was conducted in the third quarter of 2022 in conjunction with the 2022 potential study and included a combination of both paper and web surveys. Evergy West received 976 survey responses from residential customers in Missouri respectively. The survey responses were matched with each customers' billing records for the previous 12 months and with heating and cooling degree days computed for the billing period and the combined data was used in a conditional demand study to estimate the energy used by each type of appliance.

Evergy Missouri West conducted a DSM potential study that was completed in 2022. This study collected detailed end-use saturation and efficiency data from our customers in the residential sector. Evergy Missouri West provided copies of the final report to the Stakeholders' group.

[36] 20 CSR 4240-22.030(4)(A)(4)
[37] 20 CSR 4240-22.030(4)(B)
[38] 20 CSR 4240-22.030(4)(B)(1)

A commercial and industrial (C&I) saturation survey was conducted in 2019 in addition to the residential appliance saturation survey. The C&I survey was conducted as a single jurisdictional survey due to the sample size. The survey targeted a sample of 845 surveys which was allocated across strata and by SIC segment (Office, Retail, Restaurant, Grocery, College, Schools, Health, Lodging, Warehouse, Misc., Energy Intensive Mfg., Non-Intensive Mfg., Other Industrial, and Unknow). The C&I surveys were completed via Computer-Assisted Telephone Interviewing (CATI).

The C&I survey captured information about a wide range of features of customer business facilities, including the following:

- Business / building characteristics
- Heating and cooling systems (fuel type, primary /secondary, controls, and % of space)
- Water heating (type, fuel, and size)
- Lighting (number by type, controls, and operating hours)
- Electronic equipment
- Other end uses (electronics, kitchens, warehouse space, motors, etc.)
- Energy efficiency-related improvements

4.2.2 End-Use Energy and Demand Estimates[39]

Monthly energies for the end-uses that are included in our SAE models are calibrated in the SAE models to monthly billed sales for each CCOS. The coefficients for the base, heating and cooling loads calibrate those loads and the coefficient for the base load raises or lowers all the components of the base load when the base load is calibrated to monthly billed sales.

Monthly demand for the major end-uses that are included in our SAE models are calibrated to the time of the monthly system peaks. This is done in the models by taking

[39] 20 CSR 4240-22.030(4)(B)(2)

the hourly system demands and matching them to the hourly class end-use demands. This computes the coincident peak by class and end-use. To calibrate class end-use demands to the weather normalized system peak, the system peak and weather normalized peaks are used to develop a calibration factor applied to each class and end-use. This process is done for Evergy Missouri West Consolidated. This process is completed in an Excel worksheet provided in the workpapers.

Section 5: Selecting Load Forecasting Models[40]

5.1 Consumption Drivers and Usage Patterns[41]

Evergy Missouri West uses the Statistically Adjusted End-use (SAE) method to forecast energy sales and demand for all classes except lighting and sales for resale. The SAE method creates a forecast of sales at the end-use level and then for each class aggregates the forecasts into base, heating and cooling energy and then calibrates these loads to monthly billed sales using statistical regressions.

Our end-use level forecasts are developed using both primary data collected by Evergy Missouri West and secondary data and projections produced by the U.S. Department of Energy (DOE) for the West North Central region of the U.S. DOE projections used in our models include projections of saturations for household appliances and equipment used in commercial buildings and projections of efficiencies for appliances, buildings and equipment. DOE has a large professional staff responsible for constructing and maintaining energy demand models and managing contractors. The contractors survey households, businesses and buildings on a regular schedule. Contractors are also used to conduct special studies. DOE's projections are designed to account for changes in consumer preferences, technology and building design practices. Their projections also account for the impacts of appliance and equipment standards. DOE updates its projections at least once a year and Evergy Missouri West uses the most recently available projections whenever we update our models.

Evergy Missouri West calibrates DOE appliance saturation projections to the saturation numbers that Evergy Missouri West obtains from our residential surveys. Evergy Missouri West also calibrate DOE's projections of unit energy consumption (UEC) for appliances to the results of our conditional demand study.

[40] 20 CSR 4240-22.030(5)
[41] 20 CSR 4240-22.030(5)(A)

Itron hosts an annual meeting for the Energy Forecasting Group (EFG), which supports utilities that use the SAE method to forecast their sales. DOE staff attends the meeting of the EFG (which we attend) to explain changes in the assumptions, data and methods that have occurred during the previous year. Their slide decks provided during these meetings for the past several years are included in our workpapers. On their website, DOE provides detailed documentation and computer code for their models and assumptions.

5.2 Long-Term Load Forecasts[42]

Evergy Missouri West believes that the SAE methodology is the best available for producing our load forecasts. DOE forecasts the impacts of all appliance and equipment standards, most of which will substantially increase efficiency.[i] DOE also models trends in appliance ownership and utilization.

The Annual Energy Outlook for 2023 (AEO2023) differed from the AEO2020 filed in the previous IRP forecast for both the residential and commercial outlooks. The residential outlook had changes for the following:

- Updated housing stock formation and decay
- End-use energy intensity projections
- End-use efficiency projections
- Impact of the federal efficiency investment tax incentives associated with the Inflation Reduction Act.

Total Residential intensity follows a growth trajectory very similar to the 2012 Annual Energy Outlook over the 20-year period 2023-2043, with both at -01%. A slightly sharper decline in Cooling intensity is offset by stronger growth in Base Miscellaneous consumption.

For the commercial outlook, changes were made for the following:

- End-use energy intensity projections

[42] 20 CSR 4240-22.030(5)(B)

- End-use efficiency projections
- Revised historical saturations and efficiencies

There was a slight increase in trajectory for total Commercial intensity in the 2023 outlook compared to the 2022 outlook, increasing -0.5% to -0.7%. This change is primarily due to ventilation and lighting end-uses.

5.3 Policy Analysis[43]

Evergy Missouri West believes that the SAE approach is the best available method to incorporate the impacts of appliance and equipment efficiency standards because the DOE is the best qualified institution to estimate these impacts. DOE will also incorporate any federal legal impacts into its forecasts. For example, DOE has incorporated CAFÉ regulations into its forecasts of electric vehicle unit sales, which in turn impacts kWh sales for recharging EVs.

Table 9: Residential Product Categories Covered by DOE Standards[ii]

Product Covered	Initial Legislation	Last Standard Published	Compliance Date	Issued By	Proposed Standards Due	New Final Standard Due	Potential Compliance Date	States With Standard
Battery Chargers	EPACT 2005	2016	2018	DOE	2022	2024	2026	CA OR
Bo lers	NAECA 1987	2016	2021	DOE	2022	2024	2029	
Cei ing Fans	EPACT 2005	2017	2020	DOE	2023	2025	2028	
Central Air Conditioners and Heat Pumps	NAECA 1987	2017	2023	DOE	2023	2025	2030	
Clothes Dryers	NAECA 1987	2011	2015	DOE	2017	2019	2022	
Clothes Washers	NAECA 1987	2012	2018	DOE	2018	2020	2024	
Compact Audio Equipment								CA CT OR
Computers and Computer Systems				N/A				CA CO HI VT WA
Cooking Products	NAECA 1987	2009	2012	DOE		2017	2020	
Dehumidifiers	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Direct Heating Equipment *	NAECA 1987	2010	2013	DOE	2019	2021	2024	
Dishwashers *	NAECA 1987	2012	2013	DOE	2019	2021	2024	
DVD Players and Recorders								CA CT OR
Electric Vehicle Supply Equipment								
External Power Supplies	EPACT 2005	2014	2016	DOE		2021		CA
Faucets	EPACT 1992	1992	1994	Congress				CA, CO, HI, NY, VT, WA
Furnace Fans	EPACT 2005	2014	2019	DOE	2020	2022	2025	
Furnaces	NAECA 1987	2007	2015	DOE		2016		
Game Consoles				N/A				
Hearth Products				N/A				
Lawn Spray Sprinklers								CA, CO, HI, VT, WA
Microwave Ovens	NAECA 1987	2013	2016	DOE	2019	2021	2024	
Misce laneous Refrigeration Products		2016	2019	DOE	2022	2024	2027	
Pool Heaters	NAECA 1987	2010	2013	DOE	2016	2018	2021	
Pool Pumps		2017	2021	DOE	2023	2025	2028	
Portable Air Conditioners	NAECA 1987	2020	2025	DOE	2026	2028	2031	CA CO VT WA
Portable Electric Spas								AZ, CA, CO, CT, OR, VT WA
Refrigerators and Freezers	NAECA 1987	2011	2014	DOE	2017	2019	2022	
Residential Ventilating Fans								CO, VT, WA
Room Air Conditioners	NAECA 1987	2011	2014	DOE	2017	2019	2022	
Set-top Boxes				N/A				
Showerheads	EPACT 1992	1992	1994	Congress				CA CO HI NY VT WA
Televisions	NAECA 1987			N/A				CA, CT, OR
Toilets	EPACT 1992	1992	1994	Congress				CA, CO, GA, NY, TX, WA
Water Heaters	NAECA 1987	2010	2015	DOE	2016	2018	2023	

43 20 CSR 4240-22.030(5)(C)

Table 10: Commercial/Industrial Product Categories Covered by DOE Standards[ii]

Commercial/Industrial								
Product Covered	Initial Legislati	Last Standa	Compliance D	Issued By	Proposed S	New Final S	Potential Com	States With Standard
Automatic Commercial Ice Makers	EPACT 2005	2015	2018	DOE	2021	2023	2026	
Beverage Vending Machines	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Commercial Boilers	EPACT 1992	2020	2023	DOE	2026	2028	2031	
Commercial CAC and HP (65,000 Btu/hr to 760,000 Btu/hr)	EPACT 1992	2016	2018	DOE	2022	2024	2029	
Commercial CAC and HP (<65,000 Btu/hr)	EPACT 1992	2015	2017	DOE	2021	2023	2026	
Commercial CAC and HP (Water- and Evaporatively-Cooled)	EPACT 1992	2012	2013	DOE	2018	2020	2023	
Commercial Clothes Washers	EPACT 2005	2014	2018	DOE	2020	2022	2025	
Commercial Dishwashers								CO, VT, WA
Commercial Fryers								CO, VT, WA
Commercial Ovens								
Commercial Refrigeration Equipment	EPACT 2005	2014	2017	DOE		2020	2023	
Commercial Steam Cookers								CO, VT, WA
Commercial Warm Air Furnaces	EPACT 1992	2016	2023	DOE	2022	2024	2029	
Commercial Water Heaters	EPACT 1992	2001	2003	DOE		2018	2021	
Compressors		2020	2025	DOE	2026	2028	2031	CA, CO, VT, WA
Computer Room Air Conditioners	EPACT 1992	2012	2013	DOE		2018	2021	
Distribution Transformers: Liquid-Immersed	EPACT 1992	2013	2016	DOE	2019	2021	2024	
Distribution Transformers: Low-Voltage Dry-Type	EPACT 2005	2013	2016	DOE	2019	2021	2024	
Distribution Transformers: Medium-Voltage Dry-Type	EPACT 1992	2013	2016	DOE	2019	2021	2024	
Electric Motors	EPACT 1992	2014	2016	DOE	2020	2022	2025	
Fans and Blowers	EPACT 1992			N/A				
Hot Food Holding Cabinets								CA, CO, CT, DC, MD, NH, OR, RI, VT, WA
Packaged Terminal AC and HP	EPACT 1992	2015	2017	DOE	2021	2023	2026	
Pre-Rinse Spray Valves	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Pumps, Commercial and Industrial	EPACT 1992	2016	2020	DOE	2022	2024	2027	
Single Package Vertical Air Conditioners and Heat Pumps	EPACT 1992	2015	2019	DOE	2021	2023	2026	
Small Electric Motors	EPACT 1992	2010	2015	DOE	2016	2018	2021	
Uninterruptible Power Supplies	EPACT 2005	2020	2020	DOE	2026	2028	2030	CO, VT, WA
Unit Heaters	EPACT 2005	2005	2008	Congress				
Urinals	EPACT 1992	1992	1994	Congress				CA, CO, NY, TX, VT, WA
Walk-In Coolers and Freezers	EISA 2007	2014	2017	DOE		2020	2023	
Water Dispensers								CA, CO, CT, DC, MD, NH, OR, RI, VT, WA
Water-Source Heat Pumps	EPACT 1992	2015	2015	DOE	2021	2023	2026	

Table 11: Lighting Product Categories Covered by DOE Standards[ii]

Product Covered	Initial Legislation	Last Standard Published	Compliance Date	Issued By	Proposed Standards Due	New Final Standard Due	Potential Compliance Date	States With Standard
Candelabra & Intermediate Base Incandescent Lamps		2007	2012	Congress				
Ceiling Fan Light Kits	EPACT 2005	2016	2019	DOE	2022	2024	2027	
Compact Fluorescent Lamps	EPACT 2005	2005	2006	Congress				
Deep-Dimming Fluorescent Ballasts								CA
Fluorescent Lamp Ballasts	NAECA 1988 1988	2011	2014	DOE	2017	2019	2022	
General Service Fluorescent Lamps	EPACT 1992	2015	2018	DOE	2021	2023	2026	
General Service Lamps	EISA 2007	2007	2012	Congress		2022	2025	CA, CO, NV, VT, WA
HID Lamps	EPACT 1992	2015		DOE	2018	2020	2023	
High Light Output Double-Ended Quartz Halogen Lamps								OR
High-CRI Linear Fluorescent Lamps								CO, HI, VT, WA
Illuminated Exit Signs	EPACT 2005	2005	2006	Congress				
Incandescent Reflector Lamps	EPACT 1992	2009	2012	DOE		2014	2017	
Incandescent Reflector Lamps (includes certain BR and Other Exempted IRLs)	EPACT 1992			N/A				
Luminaires	EPACT 1992			N/A				
Mercury Vapor Lamp Ballasts	EPACT 2005	2005	2008	Congress				
Metal Halide Lamp Fixtures	EISA 2007	2014	2017	DOE		2019	2022	CA
Small-Diameter Directional Lamps								CA
Torchiere Lighting Fixtures	EPACT 2005	2005	2006	Congress				
Traffic Signals	EPACT 2005	2005	2006	Congress				

Section 6: Load Forecasting Model Specifications[44]

6.1 Description and Documentation[45]

6.1.1 Determination of Independent Variables[46]

In the models of residential use per customer, the independent variables were appliance saturations, appliance UECs, the real price of electricity, real per capita income and persons per household. The appliance saturations and UEC forecasts were adopted from DOE's forecast for the west north central region. The critical assumptions influencing the forecasts of saturations and UECs are discussed in workpapers located in documentation/SAE/assumptions and describe the model assumptions, computational methodology, parameter estimation techniques. These forecasts incorporate appliance ownership trends, trends in efficiency, updated building standards and technological change.

The forecasts of real per capita income and persons per household were produced by Moody's analytics for the KC metro area. Moody's documents its methodology in *micromodel_methodology.pdf*, *State Model Methodology.pdf* and Metro_Model_Methodology.*pdf*, which are supplied in the workpapers. These independent variables were used to construct an end-use forecast of residential use per customer for three major end-uses: heating, cooling and other, and these were then calibrated to monthly billed sales per customer in a linear regression. This is described in *Appendix 3: Residential SAE Modeling Framework* in the file *Res2023SAEUpdate.pdf*.

In the models of commercial sales and use per customer, the independent variables were equipment saturations and EUIs, the real price of electricity and economic variables. Economic variables were non-manufacturing employment or non-manufacturing GMP. The forecasts from DOE incorporate trends in equipment saturations, equipment efficiencies, equipment standards, building standards and technological change. These independent variables were used to construct an end-use forecast of commercial use for

[44] 20 CSR 4240-22.030(6)
[45] 20 CSR 4240-22.030(6)(A)
[46] 20 CSR 4240-22.030(6)(A)(1)

three major end-uses: heating, cooling and other, and these were then calibrated to monthly billed sales or sales per customer in a linear regression. This is described in *Appendix 3: Commercial Statistically Adjusted End-Use Model* in the file *2023CommercialSAE.pdf*.

In the models of industrial sales, the independent variables were EUIs on an industry and employment basis, the real price of electricity and economic variables. Economic variables were manufacturing employment or manufacturing GMP.

The forecasts from DOE incorporate trends in equipment saturations, equipment efficiencies, equipment standards, building standards and technological change. These independent variables were used to construct an intensity forecast of aggregated across industrial segments and these were then calibrated to monthly billed sales or sales per customer in a linear regression. This is described in *Appendix 3: Commercial Statistically Adjusted End-Use Model* in the file *2023CommercialSAE.pdf*.

The explanatory variables used by Evergy Missouri West in its forecasting models incorporate the most important drivers of energy use. These drivers are energy standards, building standards, trends in saturations and equipment efficiency, economic growth at the sector level and existing company energy efficiency and DSM programs.[47]

Evergy Missouri West has used the SAE approach since 2004 to forecast its loads. The economic drivers for the residential sector have been the number of households in the KC metro areas during this time period. This is the fourth filling that Evergy Missouri West has modeled small commercial (SGS), big commercial (MGS, LGS, and LP) and industrial sales (SGS, MGS, LGS, and LP) using the statistically adjusted end-use method.

For this filing, Evergy Missouri West is using updated projections from DOE for 2023 and June 2023 vintage economic forecasts of the KC metro areas from Moody's Analytics.[48]

---

[47] 20 CSR 4240-22.030(6)(A)(1)(A)
[48] 20 CSR 4240-22.030(6)(A)(1)(B)

6.1.2 Development of Mathematical & Statistical Equations Comprising the Load Forecast Models[49]

Table 12: MO West Residential kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value
mStrucVars.XHeat55_RES	0.840	0.011	73.192	0.00%
mStrucVars.XCool65_RES	0.675	0.007	97.956	0.00%
mStrucVars.XOther_RES	1.027	0.078	13.177	0.00%
RES_AvgUse.Jan10	84.941	22.536	3.769	0.02%
RES_AvgUse.AprthruNov_2012	-35.540	11.443	-3.106	0.23%
RES_AvgUse.July_2013	-72.052	22.450	-3.209	0.16%
RES_AvgUse.JulAugSept_2017	44.878	16.758	2.678	0.82%
RES_AvgUse.Jan23	125.662	22.145	5.675	0.00%
mBinaryVars.Jun	-20.549	6.346	-3.238	0.15%
tGoogleMobility.MO_Residence_Cyc	4.589	2.039	2.250	2.58%
RES_AvgUse.calibCOVID	-71.949	21.947	-3.278	0.13%
mBinaryVars.CCB	0.002	0.001	1.580	11.61%
RES_AvgUse.CCBcalib	-21.037	10.187	-2.065	4.06%
MA(1)	0.359	0.079	4.578	0.00%

[49] 20 CSR 4240-22.030(6)(A)(2)

Table 13: MO West Small GS Commercial kWh per Customer

Variable	Coefficient	StdErr	T-Stat	P-Value
mStrucVars.XHeat50_SML	0.691	0.043	16.058	0.00%
mStrucVars.XCool60_SML	0.699	0.019	36.268	0.00%
mStrucVars.XOther_SML	1.611	0.017	97.335	0.00%
mBinary.Feb	144.135	36.064	3.997	0.01%
mBinary.Jun	-69.086	32.361	-2.135	3.44%
tGoogleMobility.SML_workplace	2.600	1.007	2.583	1.08%
mBinary.GMOConsolidation	-550.011	20.934	-26.273	0.00%
mBinary.calib0	-670.033	24.510	-27.337	0.00%
mBinary.CCBcalib2	-68.703	22.092	-3.110	0.23%
mBinary.calib3	164.711	25.810	6.382	0.00%
SML_AvgUse.FebMar09	171.967	55.046	3.124	0.22%
SML_AvgUse.May17	233.434	75.144	3.106	0.23%
SML_AvgUse.Jan23	224.090	85.297	2.627	0.95%
SML_AvgUse.Dec10	-200.080	75.413	-2.653	0.89%
SMA(1)	0.423	0.081	5.220	0.00%

Table 14: MO West Big GS Commercial kWh per Customer (SGS, LGS, & LP)

Variable	Coefficient	StdErr	T-Stat	P-Value
mStrucVars.XHeat45_BIG	211.593	21.763	9.722	0.00%
mStrucVars.XCool55_BIG	508.470	15.066	33.750	0.00%
mStrucVars.XOther_BIG	684.872	83.683	8.184	0.00%
mBinary.GMOConsolidation	7022993.634	1504166.505	4.669	0.00%
BIG_Sales.CalibCCB	21161565.478	1597659.050	13.245	0.00%
tGoogleMobility.BIG_workplace	254454.370	66401.741	3.832	0.02%
BIG_Sales.consol	34781212.162	1762628.018	19.733	0.00%
BIG_Sales.EarlyTrend	1510.973	255.771	5.908	0.00%
BIG_Sales.Yr09	-8039669.716	1841585.273	-4.366	0.00%
BIG_Sales.Jan10	-21877734.310	5202693.227	-4.205	0.00%
BIG_Sales.Feb10	17676046.478	5070911.341	3.486	0.06%
BIG_Sales.Jul21	-13967269.290	5056325.702	-2.762	0.64%
SMA(1)	0.266	0.081	3.276	0.13%

Table 15: MO West Industrial Sales

Variable	Coefficient	StdErr	T-Stat	P-Value
CONST	73552076.528	7758378.568	9.480	0.00%
mStrucVars.XCool60_IND	12018.500	597.505	20.114	0.00%
mStrucVars.XOther_IND	6678.866	2043.017	3.269	0.13%
tGoogleMobility.MO_AvgWorkRec	300007.960	76080.955	3.943	0.01%
IND_Sales.CalibConsolid	6900231.408	2681679.168	2.573	1.10%
IND_Sales.CalibCCB	5912010.494	2142655.380	2.759	0.65%
IND_Sales.Apr18_CCB	15384660.507	3403507.926	4.520	0.00%
IND_Sales.Feb10	18753950.863	3277362.753	5.722	0.00%
IND_Sales.Jun21	-20875108.288	3215112.486	-6.493	0.00%
IND_Sales.Jun12	9657437.067	3212782.276	3.006	0.31%
IND_Sales.Jul09	-12498095.671	3249583.342	-3.846	0.02%
IND_Sales.Jan10	-11860655.680	3235187.841	-3.666	0.03%
IND_Sales.Aug18	8120717.039	3255079.377	2.495	1.36%
IND_Sales.May19	8304386.033	3198909.552	2.596	1.03%
AR(1)	0.973	0.025	38.882	0.00%
MA(1)	-0.770	0.067	-11.554	0.00%

The load forecasting models rely on a forecast of economic activity for the KC metro areas that was produced by Moody's Analytics. The metro areas are the same as the Metropolitan Statistical Area (MSA) defined by the US Census Bureau and it includes some counties in both states that are not served by Evergy Missouri West. Also, Evergy Missouri West's service area includes some counties that are not included in the MSA. Despite these inconsistencies in geographic areas, there are reasons why this forecast is representative of our service areas. Many people live on one side of the state line and work on the other side. Many people shop on both sides of the state line. And many companies each year move from one side of the state line to the other. Documentation for Moody's forecast of economic activity is provided in the workpapers in the folder \ Evergy West\Models\GMOBase Case\Data\Economics.

The load forecasting models also rely on saturation and appliance and equipment utilization forecasts from the DOE. The advantages of the projections from these models are 1) DOE's Forecasting and Analyst staff includes dozens of experts and maintains a large budget for data collection and consultants, 2) DOE has a focus on measuring the impacts of appliance and equipment standards and legal mandates and 3) DOE is very transparent, making available its work and computer code on its website.[iii] Evergy

Missouri West also relies on the staff that developed and maintained some of EPRI's end-use models recommended and developed the SAE approach for Evergy Missouri West and many other utilities. EPRI no longer maintains its end-use forecasting models.

A potential downside of these projections for Evergy Missouri West is that the data and models developed by DOE are developed at a regional level rather than specifically for Evergy Missouri West, although this can be an advantage when one service area or region has insufficient variation to measure the impact of a variable such as electric price. Cross sectional variation in the data can be an advantage in situations where price or income elasticities are being modeled.[50]

6.2 Documentation of Deviations in Load Forecast Models[51]

There are no deviations in the independent variables or functional forms of the equations from those derived from load analysis in sections (3) and (4).

6.3 Development and Documentation of Load Forecasting Historical Database[52]

6.3.1 Historical Data Collection and Maintenance for Accurate Forecasting[53]

The independent variables acquired from Moody's are available back to 1990. Historical economic and demographic data are updated each time Evergy Missouri West acquires a new forecast as revisions are common.

The independent variables acquired from DOE are available for 10 years or more; as in the case of economic data, these historical estimates are subject to revision and are updated each time Evergy Missouri West receives data with an updated forecast. New studies or data can revise historical estimates of efficiencies and saturations.

Temperature data is maintained back to 1971 for the Kansas City International Airport.

[50] 20 CSR 4240-22.030(6)(A)(3)
[51] 20 CSR 4240-22.030(6)(B)
[52] 20 CSR 4240-22.030(6)(C)
[53] 20 CSR 4240-22.030(6)(C)(1)

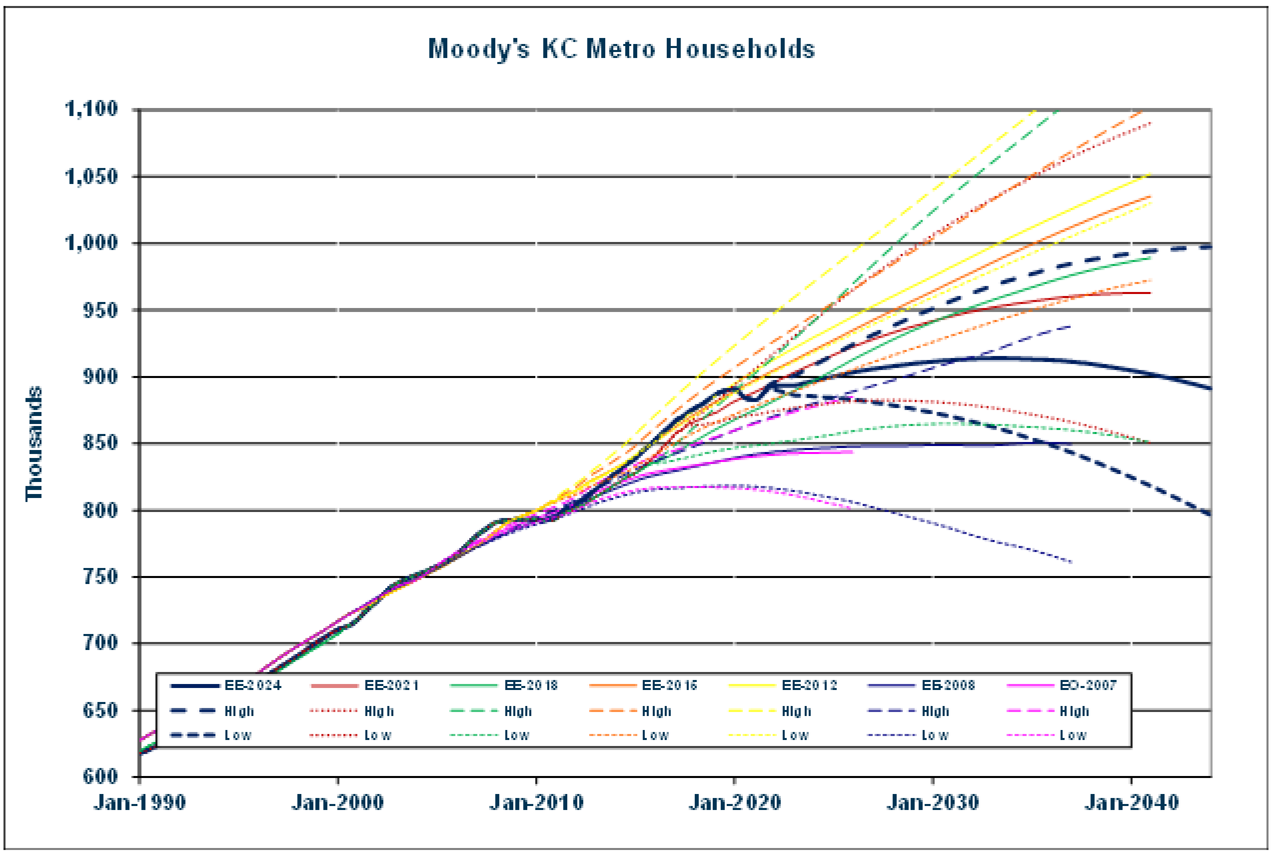
6.3.2 Independent Variable Adjustments[54]

Evergy Missouri West staff is not aware of any adjustments made to independent variables used in its load forecasting models.

6.3.3 Comparison of Historical Projected and Actual Energy Usage and Peak Load Forecasts, Including the Independent Data Sets Used to Produce the Forecasts[55]

Evergy Missouri West still possesses the electronic files that it received with the independent variables used in producing energy and peak forecasts during the last ten years. Below Evergy Missouri West plots the base, high and low bands for the most important economic and demographic independent variables used in the current and two previous IRP filings.

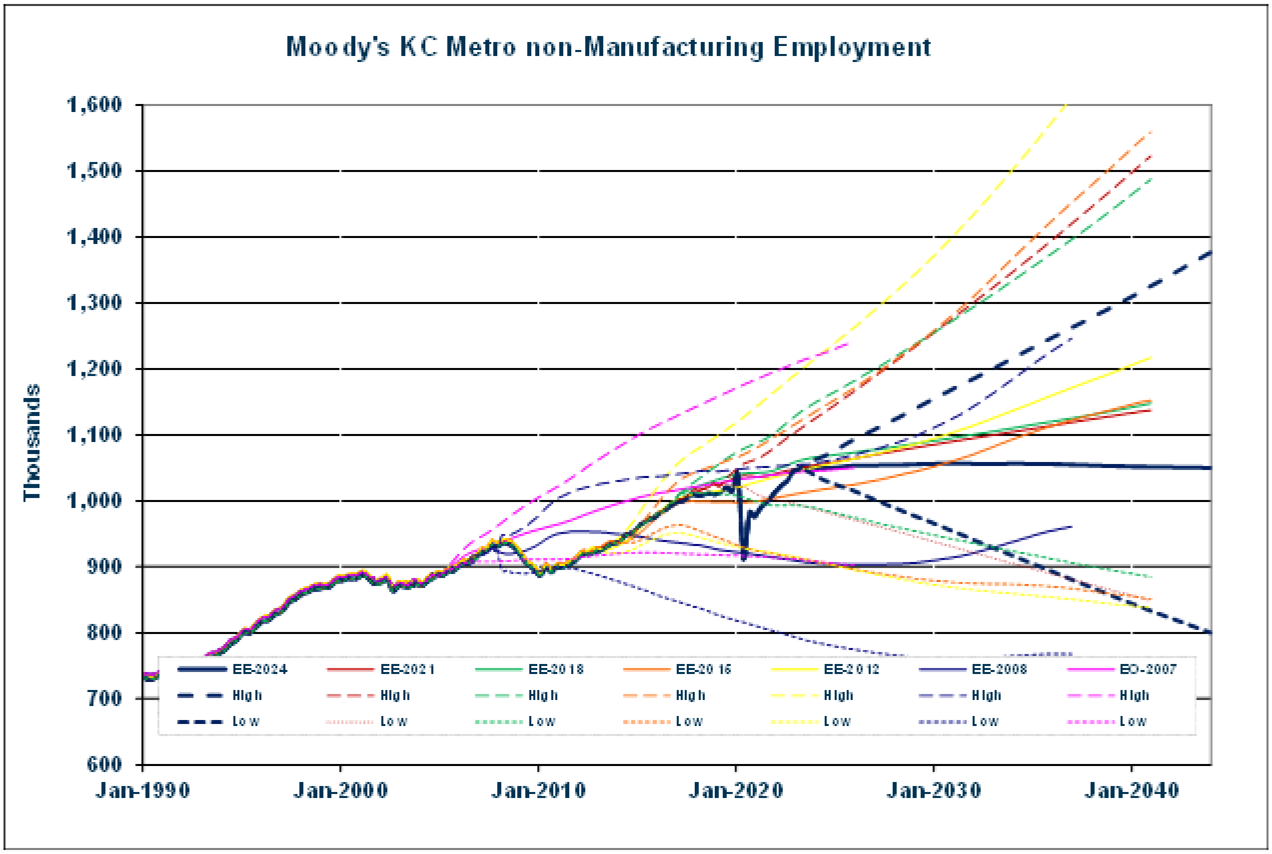
Figure 11: Households



[54] 20 CSR 4240-22.030(6)(C)(2)
[55] 20 CSR 4240-22.030(6)(C)(3)

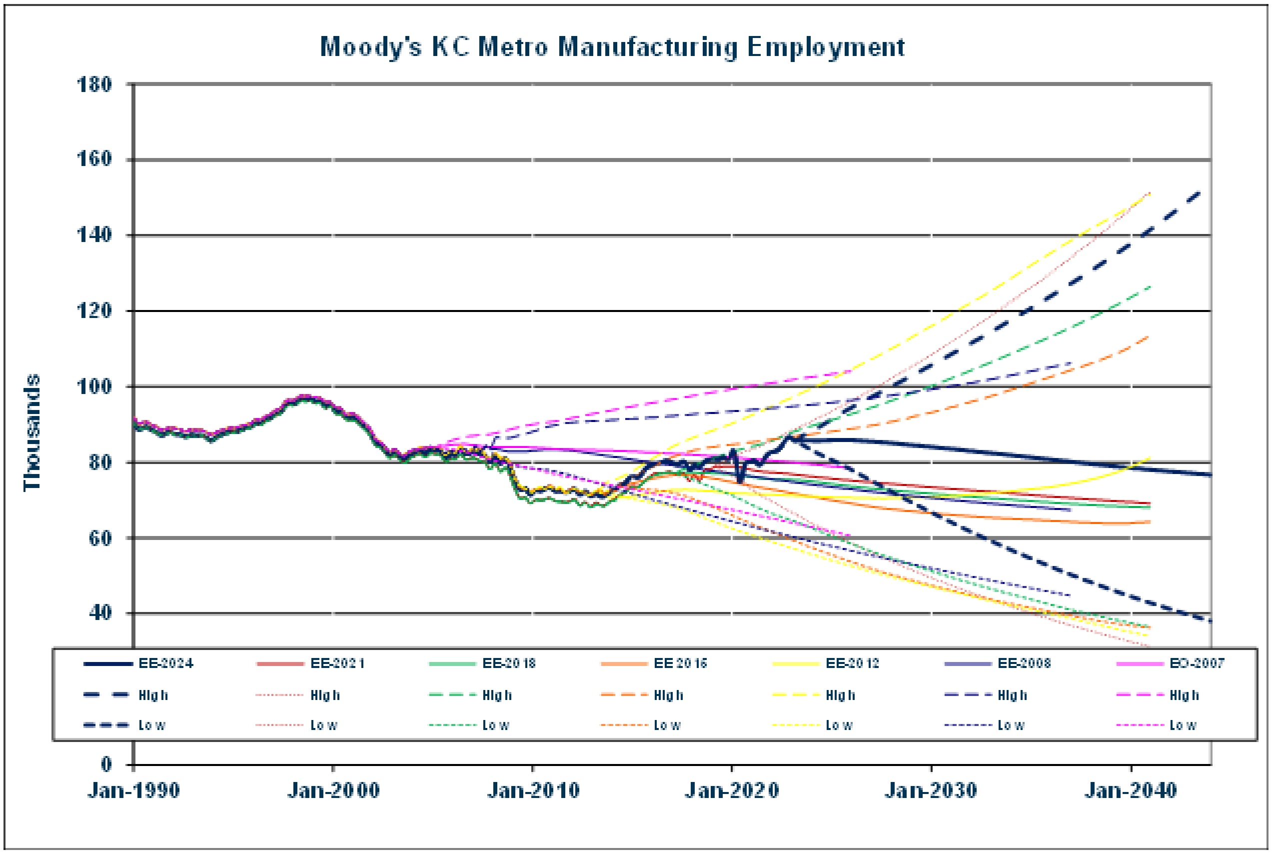
The current forecast for households has a slower long-term growth rate than the prior forecast after recent years has been higher than the last forecast.

Figure 12: Employment Non-Manufacturing



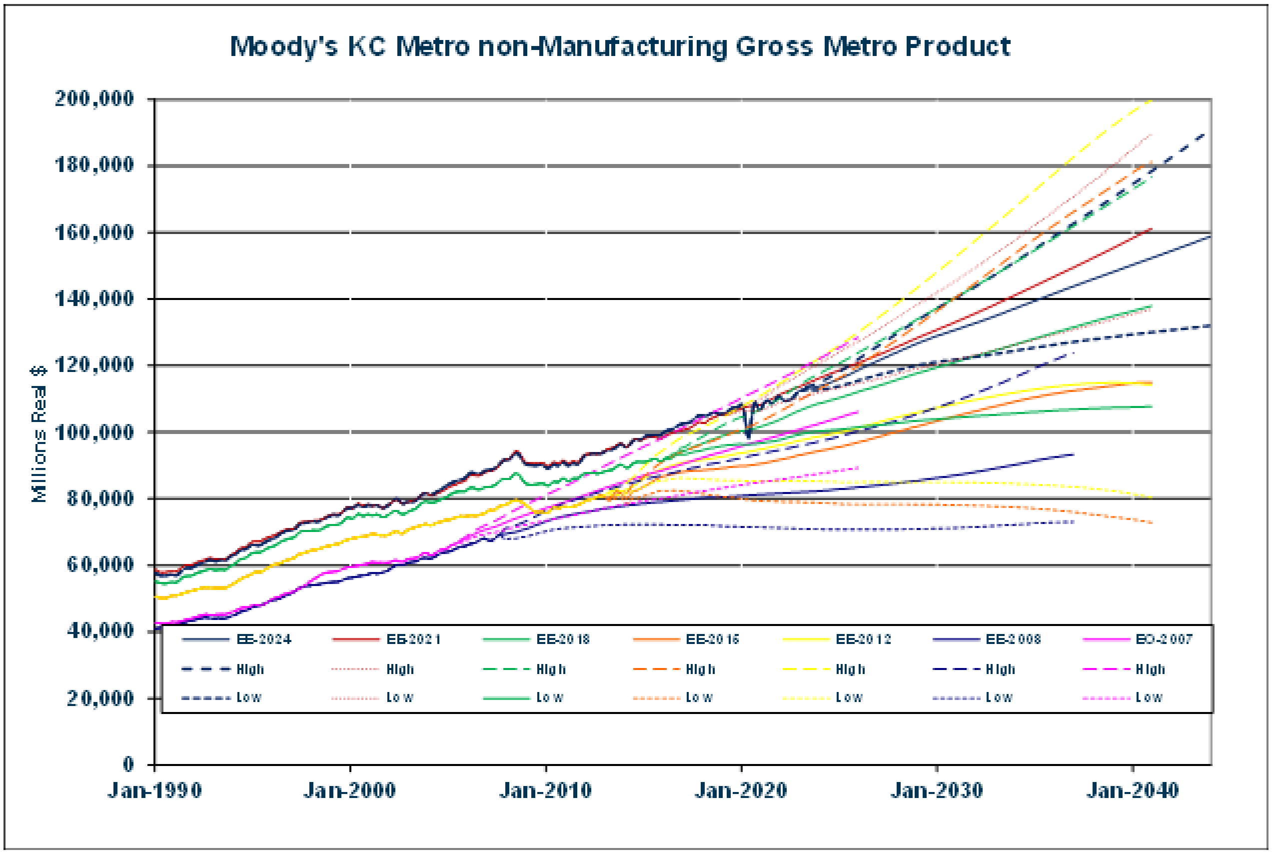
The 2024 forecast of non-manufacturing employment shows growth very similar to the 2021 forecast.

Figure 13: Employment Manufacturing



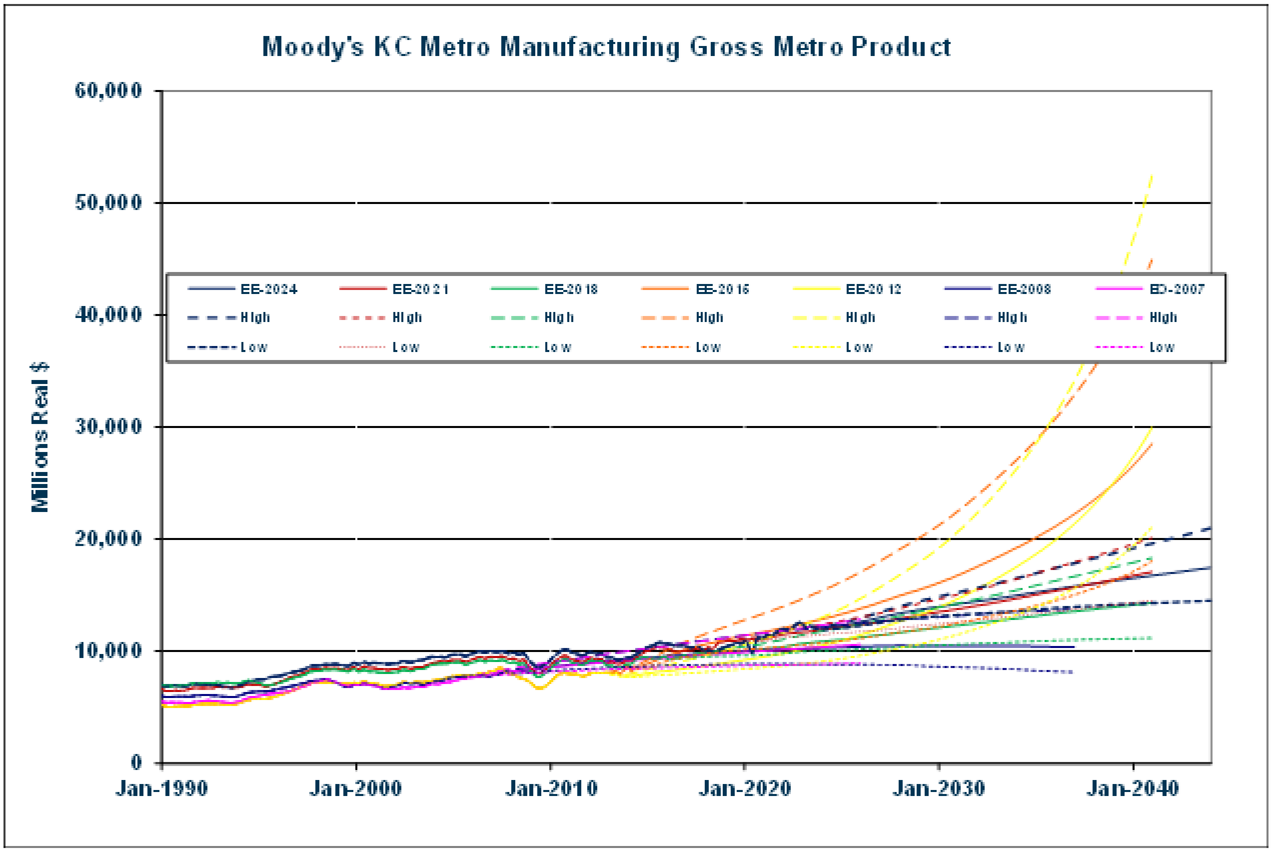
Manufacturing employment shows a large decline following the 2008 recession. It has climbed from a 2013 low and is projected to slowly decline throughout the forecast period very similar to the 2018 and 2021 forecasts despite the last couple years being higher than forecasted. Moody's indicates that the decline in employment for manufacturing workers is due to increased productivity from the workers, as manufacturing becomes more automated. The decline in manufacturing employment for the forecast horizon is also consistent with the observed downward trend dating back to the 1990s.

Figure 14: Gross Metro Product Non-Manufacturing



Real non-manufacturing GMP is growing much faster than employment in the forecast. The current forecasted growth trajectory is slightly lower than previously forecasted.

Figure 15: Gross Metro Product Manufacturing

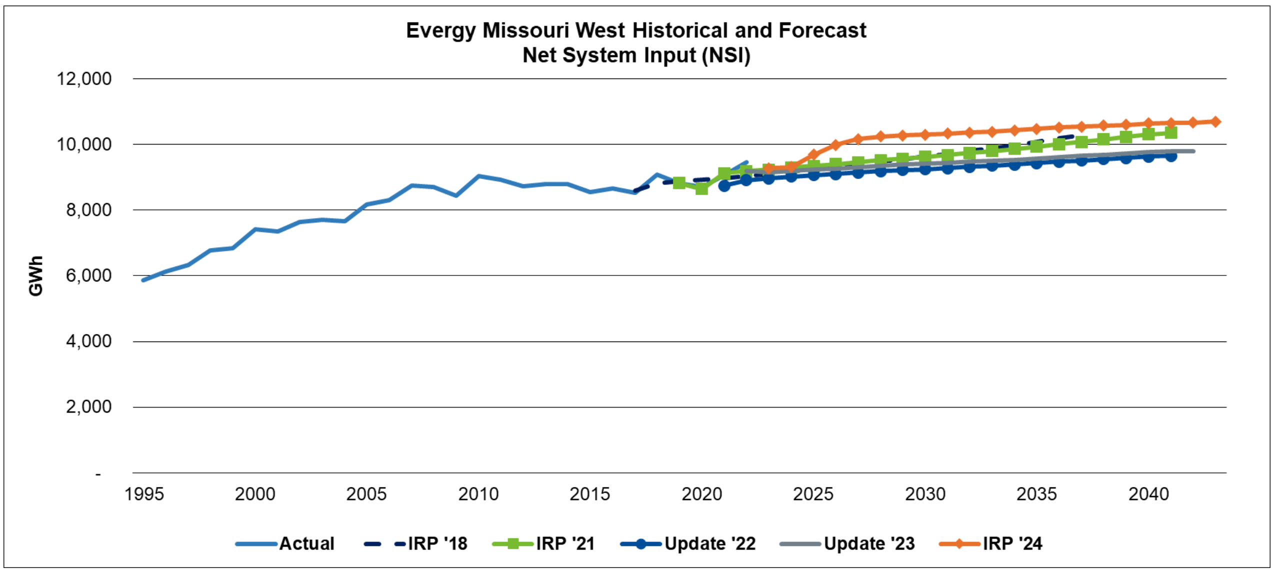


The current forecast for Manufacturing Gross Metro Product shows modest growth throughout the forecast period, similar to the 2021 forecast. Some previous Economic forecasts showed rapid growth for two reasons: (1) growth in manufacturing employment in the long run and (2) a competitive advantage for the area in manufacturing leading to faster growth compared to the national average. In contrast, the current forecast has a continuous decline in manufacturing employment and a production growth trajectory are similar to the US as a whole. These assumptions lead to modest growth throughout the forecast period for real manufacturing GMP, as opposed to the previous rapid growth in the long-term.

6.3.4 Comparison of Final Forecasts to Actual Energy and Peak Demand and the Current Forecast[56]

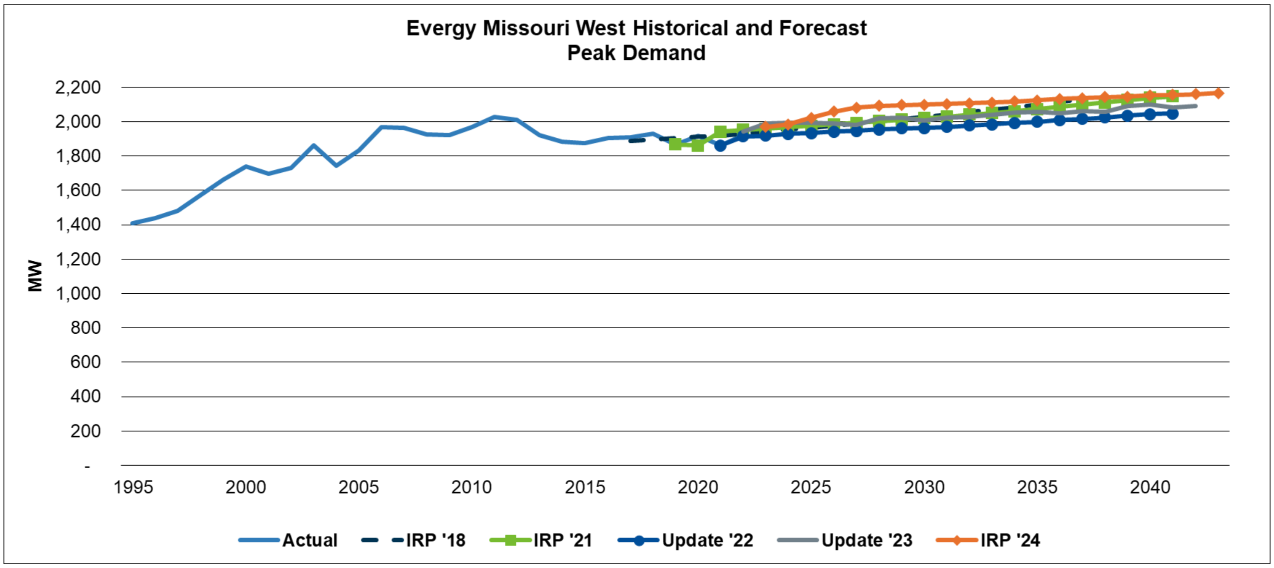
Evergy Missouri West maintains an archive of the electronic files associated with our previous forecasts of energy use and peak demand for at least the last ten years. The graphs below compare our previous long-run forecasts for NSI and peak demand. The most recent forecast reflects a significant slowdown in economic growth that in 2008, expectations for modest economic growth, the impact of currently enforced energy efficiency standards and the anticipated impact of recently enacted energy efficiency standards.

Figure 16: Net System Input (NSI) Historical and Forecasts



[56] 20 CSR 4240-22.030(6)(C)(4)

Figure 17: Peak Demand Historical and Forecasts



Section 7: Base-Case Load Forecast[57]

Evergy Missouri West's base-case forecast was produced with a base-case economic forecast from Moody's Analytics obtained in June 2023. The forecast included the impacts of Evergy Missouri West's implemented energy efficiency and DSM programs on NSI and peak load. The forecast was produced using normal weather.

7.1 Major Class and Total Load Detail[58]

7.1.1 Describe and Document Relevant Economic and Demographics[59]

Evergy Missouri West accounted for the effects of real electricity prices in two ways. First, the prices of electricity and natural gas were used in the models that forecast the saturations of electric space heating for residential and commercial customers. These models are described in the section of this document for rule 7.B.1. Second, Evergy Missouri West assumes a price elasticity of between -0.02 and -0.22 (elasticities vary by customer class and end use) in each model of sales or sales per customer. These elasticities are close to the default values in the ERPI models REEPS and COMEND, which ITRON used in the original SAE models that they delivered to Evergy Missouri West in 2004. Since then, Evergy Missouri West has made some small changes to these values to improve the fit of the models.

In the residential models of kWh per customer, Evergy Missouri West assumes an income elasticity of 0.41 a person's-per-household elasticity of 0.2. Moody's forecast of households for the KC metro areas was used in the models of residential customers as was described previously in the section for rule 3.B.

[57] 20 CSR 4240-22.030(7)
[58] 20 CSR 4240-22.030(7)(A)
[59] 20 CSR 4240-22.030(7)(A)(1)

7.1.2 Describe and Document Effects of Legal Mandates[60]

Evergy Missouri West uses the SAE methodology to forecast kWh sales for residential, commercial, and industrial sales. This methodology relies on DOE forecasts of UECs and EUIs, which account for appliance efficiency standards and building codes.[iv]

7.1.3 Describe and Document Consistency[61]

Evergy Missouri West forecasts incorporate and thus are consistent with the following trends:

- Electric space heating models explain the rapid rise of electric space heating saturations in the residential and commercial sector as a function of the relative costs of using electricity and natural gas. These costs depend on electricity and natural gas prices and the efficiencies of heat pumps and natural gas furnaces.
- Forecasts of UECs and EUIs used in our models reflect the impacts of energy standards in both the past and the future.
- Forecasts of appliance and equipment saturations reflect the penetration of new devices such as CFL/LED Light Bulbs, HDTVs and the limitations of further increases for appliances that are reaching equilibrium such as dishwashers and central air conditioners.

7.1.4 Describe and Document Weather Normalized Class Loads[62]

The estimates are shown below. Details for the full 20 years can be found in the WEST_SystemLoad and WEST_SystemLoadWN in the ENDUse_Energy Frequency Transforms.

[60] 20 CSR 4240-22.030(7)(A)(2)
[61] 20 CSR 4240-22.030(7)(A)(3)
[62] 20 CSR 4240-22.030(7)(A)(4)

Figure 18: Estimates of MO West Residential Monthly Cooling, Heating, and Base

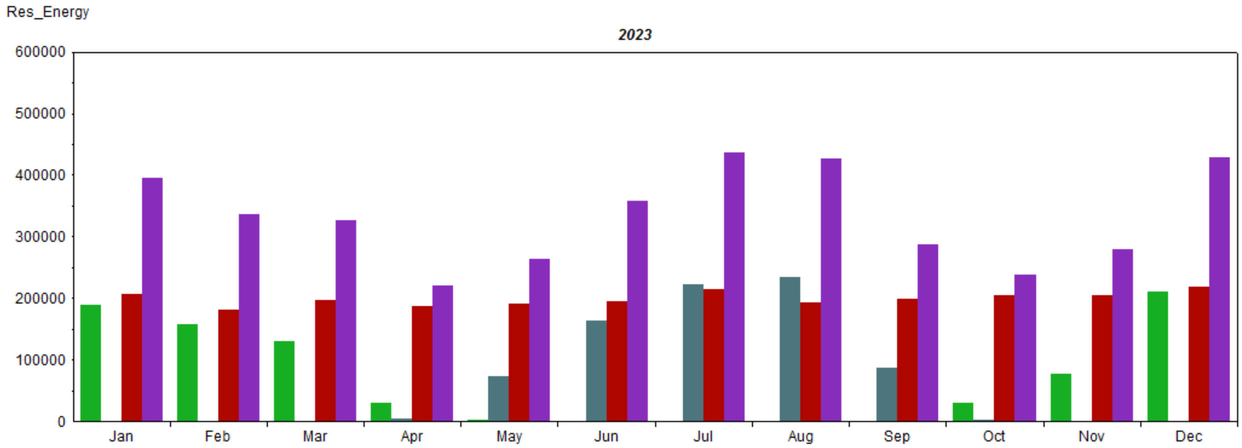


Table 16: Data Table of MO West Residential Monthly Cooling, Heating, and Base

Date	ResHeat	ResCool	ResBase	ResTotal
Jan-2023	187,953.52	0.00	206,930.50	394,884.03
Feb-2023	156,774.20	0.00	180,105.59	336,879.79
Mar-2023	130,360.82	0.00	196,261.32	326,622.14
Apr-2023	28,925.53	4,308.42	187,322.08	220,556.03
May-2023	1,788.40	72,486.38	190,266.17	264,540.95
Jun-2023	0.00	163,148.77	194,219.21	357,367.98
Jul-2023	0.00	221,797.32	215,335.70	437,133.03
Aug-2023	0.00	233,196.13	193,194.79	426,390.93
Sep-2023	0.00	87,537.59	198,840.48	286,378.06
Oct-2023	29,910.23	2,751.18	205,370.81	238,032.22
Nov-2023	76,549.90	0.00	203,580.70	280,130.60
Dec-2023	211,458.65	0.00	217,462.13	428,920.77

Figure 19: Estimates of MO West Commercial Small General Service Monthly Cooling, Heating, and Base

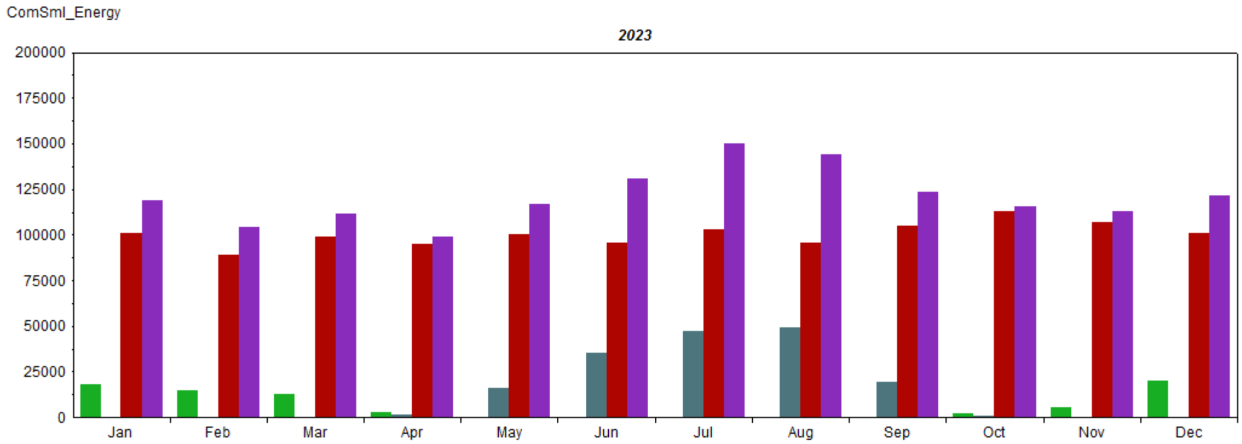


Table 17: Data Table of MO West Small General Service Monthly Cooling, Heating, and Base

Date	ComSmlHeat	ComSmlCool	ComSmlBase	ComSmlTotal
Jan-2023	17,838.51	0.00	100,680.48	118,518.99
Feb-2023	14,988.10	0.00	88,937.84	103,925.94
Mar-2023	12,408.98	0.00	98,820.45	111,229.43
Apr-2023	2,740.58	1,393.35	94,814.55	98,948.48
May-2023	175.66	15,859.57	100,575.40	116,610.62
Jun-2023	0.00	35,050.94	95,408.45	130,459.39
Jul-2023	0.00	47,141.28	103,019.69	150,160.97
Aug-2023	0.00	48,999.23	95,302.78	144,302.00
Sep-2023	0.00	19,059.00	104,698.73	123,757.73
Oct-2023	2,119.46	592.34	112,569.78	115,281.59
Nov-2023	5,665.15	0.00	107,119.78	112,784.93
Dec-2023	20,126.63	0.00	101,132.23	121,258.86

Figure 20: Estimates of MO West Big Commercial (SGS, LGS, & LP) Monthly Cooling, Heating, and Base

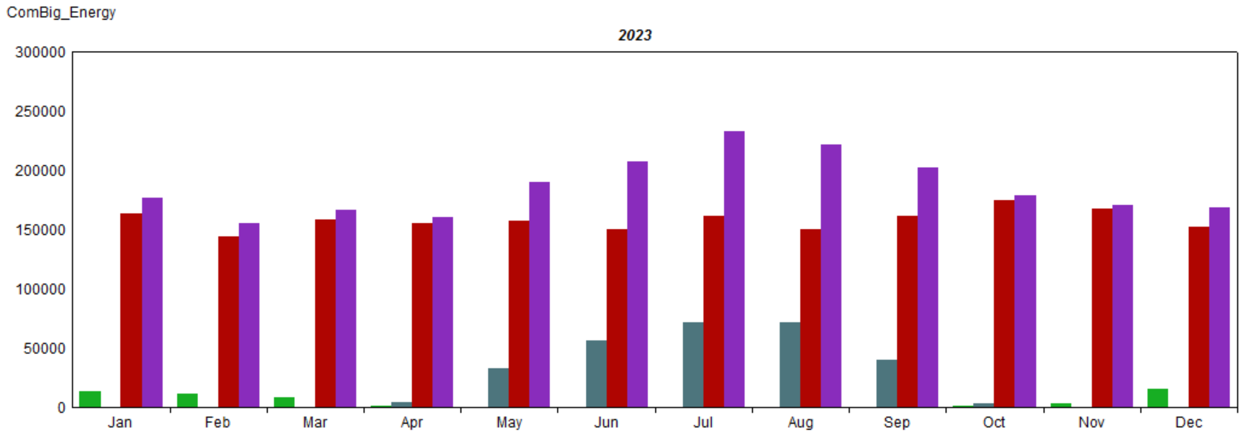


Table 18: Data Table of MO West Big Commercial (SGS, LGS, & LP) Monthly Cooling, Heating, and Base

Date	ComBigHeat	ComBigCool	ComBigBase	ComBigTotal
Jan-2023	13,461.92	0.00	163,664.25	177,126.18
Feb-2023	11,277.76	0.00	144,153.85	155,431.60
Mar-2023	8,330.69	0.00	158,401.57	166,732.26
Apr-2023	1,108.99	4,736.45	154,932.77	160,778.22
May-2023	0.00	33,128.11	156,959.81	190,087.92
Jun-2023	0.00	56,689.15	150,501.27	207,190.42
Jul-2023	0.00	71,666.33	161,433.23	233,099.57
Aug-2023	0.00	71,434.42	150,641.15	222,075.56
Sep-2023	0.00	40,155.22	162,004.75	202,159.97
Oct-2023	869.19	3,402.49	174,381.20	178,652.88
Nov-2023	2,823.43	0.00	167,549.17	170,372.60
Dec-2023	15,869.19	0.00	152,439.43	168,308.62

Figure 21: Estimates of MO West Industrial Monthly Cooling, Heating, and Base

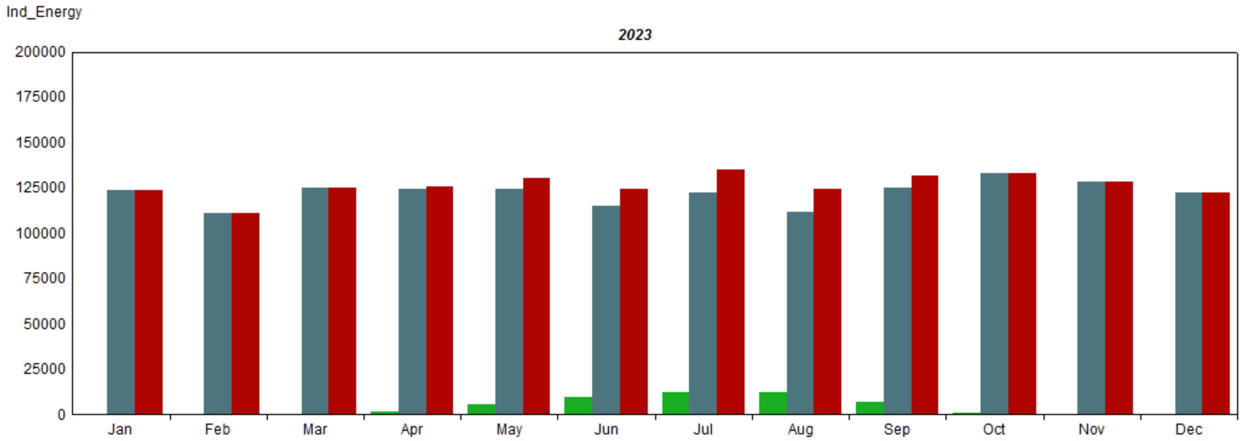


Table 19: Data Table of MO West Industrial Monthly Cooling, Heating, and Base

Date	IndCool	IndBase	IndTotal
Jan-2023	0.00	123,579.62	123,579.62
Feb-2023	0.00	110,925.50	110,925.50
Mar-2023	0.00	125,064.55	125,064.55
Apr-2023	1,188.06	124,175.56	125,363.62
May-2023	5,737.58	124,338.22	130,075.80
Jun-2023	9,780.61	114,703.55	124,484.16
Jul-2023	12,302.91	122,526.50	134,829.41
Aug-2023	12,291.96	111,864.04	124,156.00
Sep-2023	6,874.57	124,656.50	131,531.07
Oct-2023	578.57	132,710.00	133,288.56
Nov-2023	0.00	128,044.87	128,044.87
Dec-2023	0.00	122,296.94	122,296.94

Figure 22: Other MO West Load (SFR & Lighting)

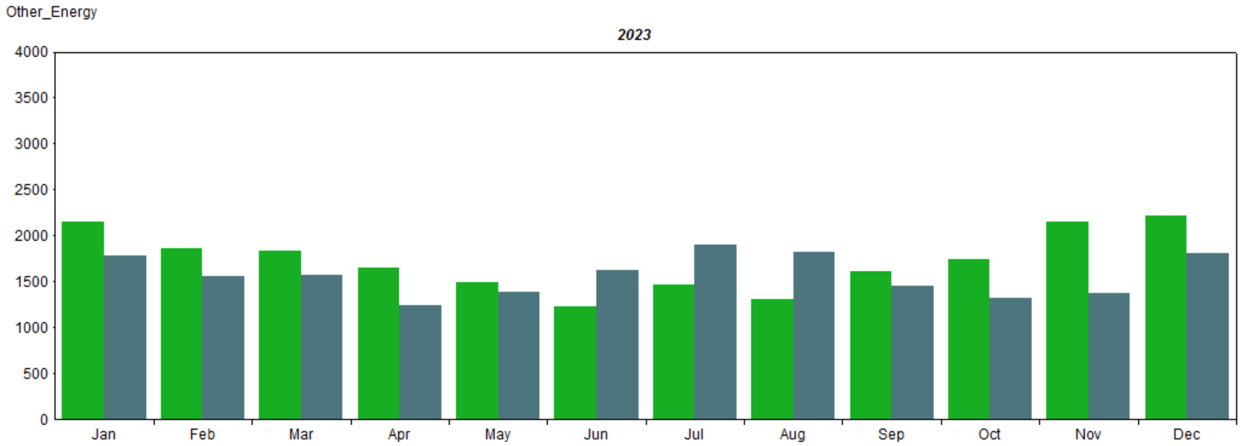


Table 20: Data Table Other MO West Load (SFR & Lighting)

Date	Lighting	SFR
Jan-2023	2,152.75	1,786.44
Feb-2023	1,861.80	1,556.36
Mar-2023	1,840.48	1,570.14
Apr-2023	1,652.62	1,241.03
May-2023	1,492.59	1,382.12
Jun-2023	1,227.91	1,619.14
Jul-2023	1,461.64	1,903.39
Aug-2023	1,311.43	1,813.68
Sep-2023	1,606.77	1,450.32
Oct-2023	1,741.95	1,322.45
Nov-2023	2,147.78	1,373.69
Dec-2023	2,218.43	1,804.96

7.1.5 Describe and Document Modification of Models[63]

No outside-the-model modifications were made to the forecasted values resulting from the energy and peak forecast models.

7.1.6 Plots of Class Monthly Energy and Coincident Peak Demand[64]

Plots for class monthly energy and coincident peak demand at the time of summer and winter system loads are provided in *Appendix 3B*. Energy plots by jurisdiction and system are provided in the file *IRP_7.1.6_West_MWh.xlsx* and peak plots are in the file *IRP_7.1.6_West_Peaks.xlsx*.

7.1.7 Plots of Net System Load Profiles[65]

The figures below show the load profiles for the base, fifth, tenth, and twentieth years broken out by summer and winter peak days for each major class of Evergy Missouri West and for the system. The plots with data tables are provided in *Appendix 3C*. Plots for additional years can be found in the MetrixLT files (*WEST_SystemLoad* and *SysShape*) included in the workpapers.

[63] 20 CSR 4240-22.030(7)(A)(5)
[64] 20 CSR 4240-22.030(7)(A)(6)
[65] 20 CSR 4240-22.030(7)(A)(7)

Figure 23: Base Year (2023) Net System Summer Peak Day Load Profiles

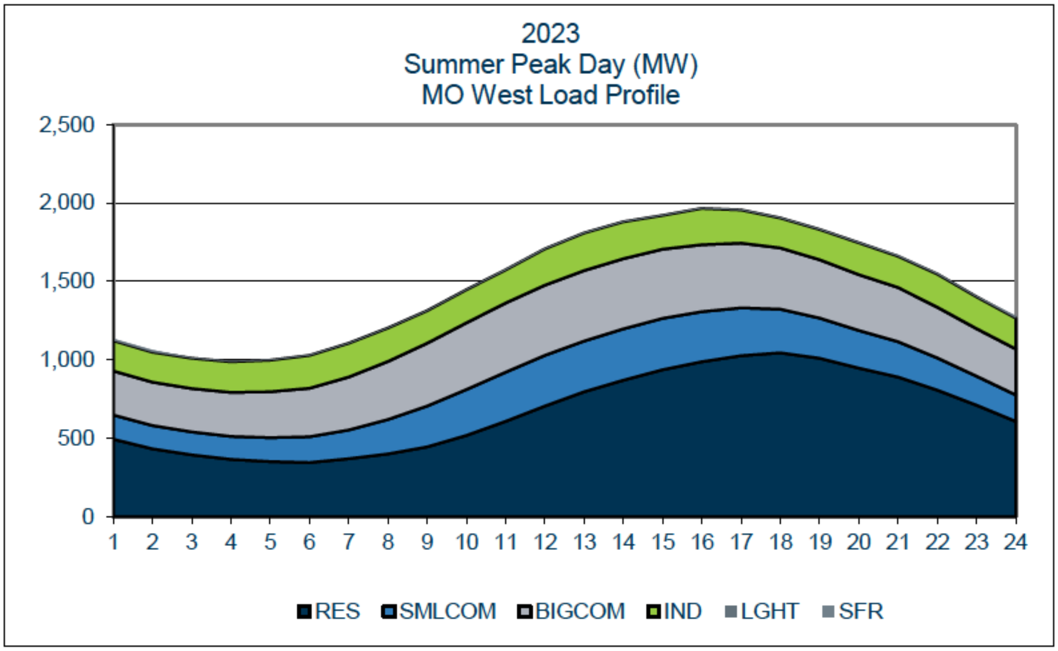


Figure 24: Base Year (2023) Net System Winter Peak Day Load Profiles

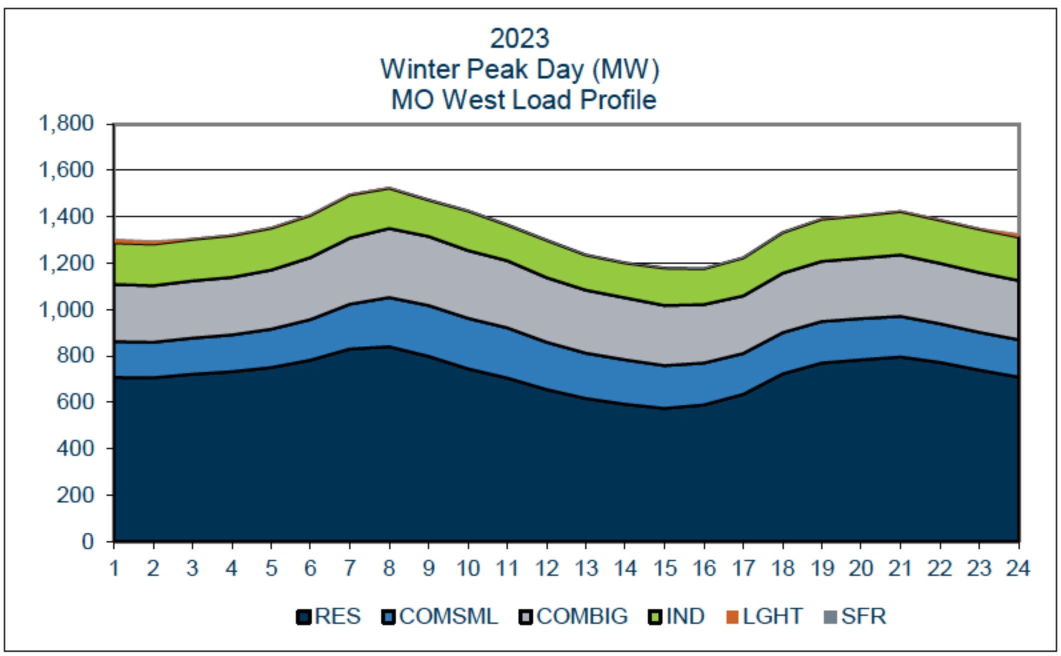


Figure 25: Fifth Year (2028) Net System Summer Peak Day Load Profiles

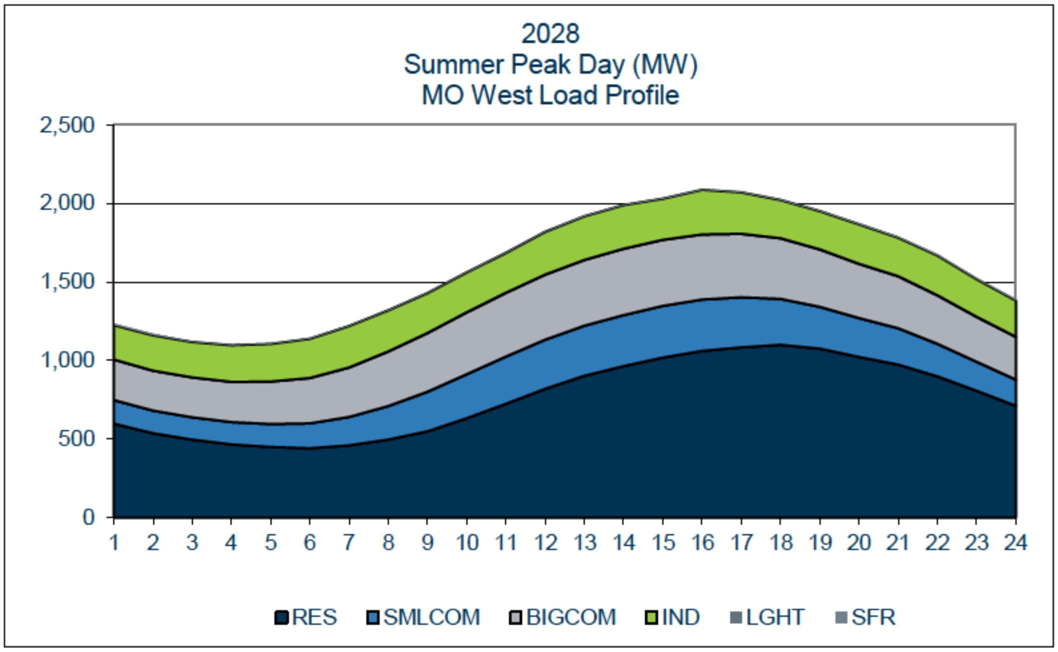


Figure 26: Fifth Year (2028) Net System Winter Peak Day Load Profiles

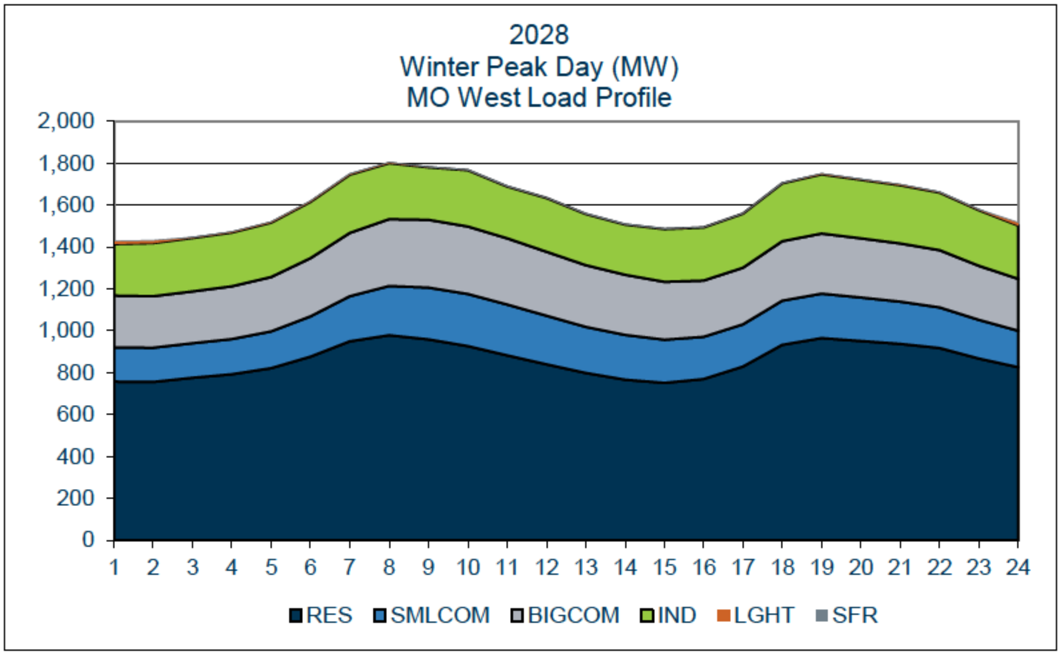


Figure 27: Tenth Year (2033) Net System Summer Peak Day Load Profiles

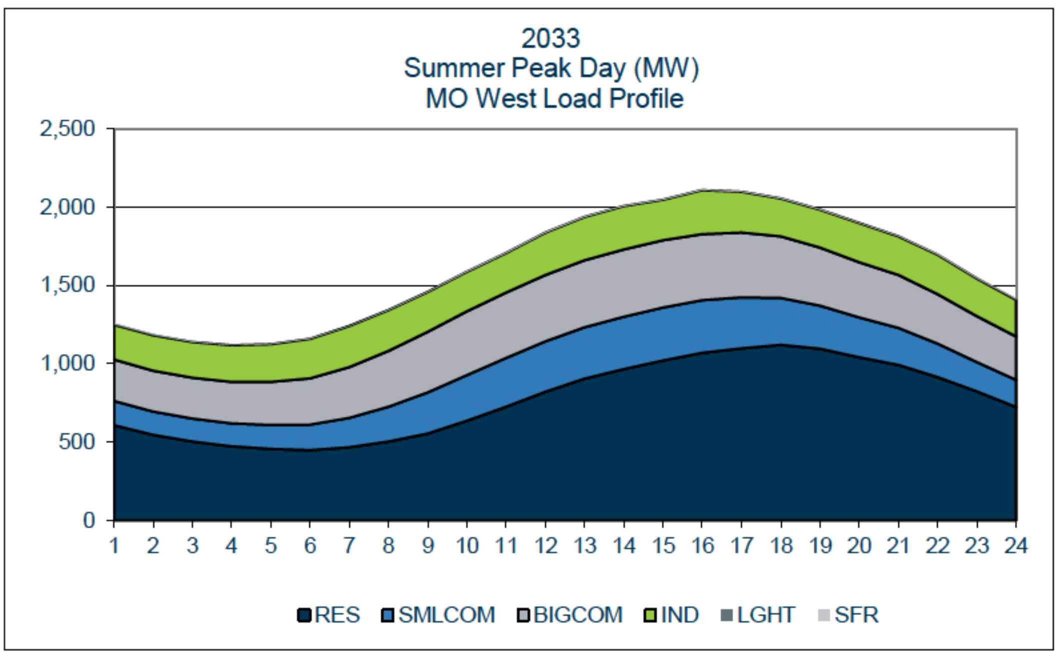


Figure 28: Tenth Year (2033) Net System Winter Peak Day Load Profiles

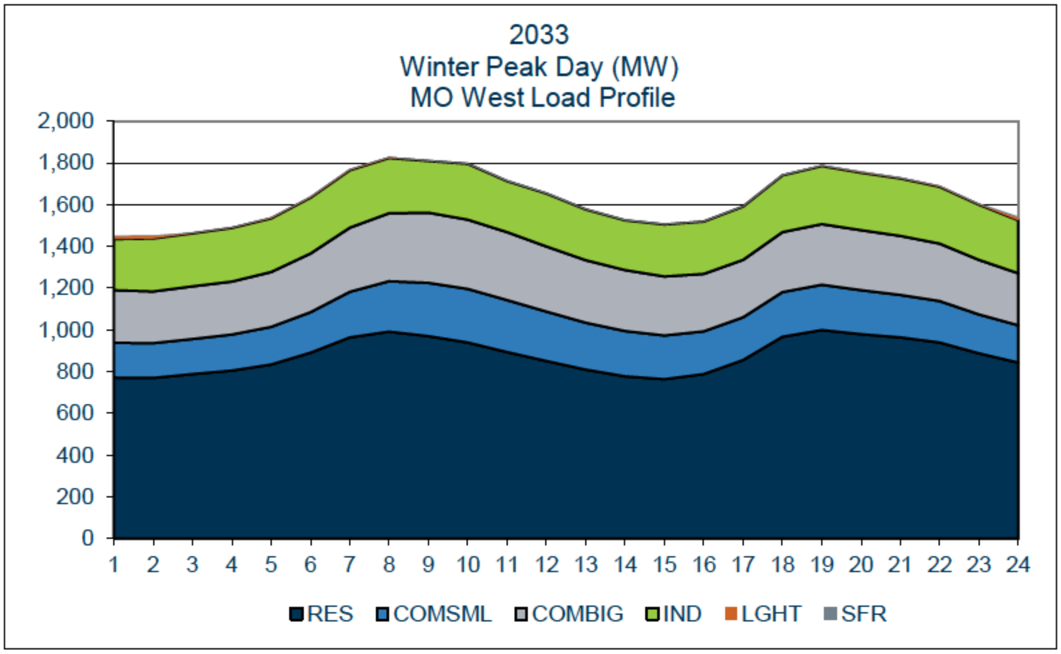


Figure 29: Twentieth Year (2043) Net System Summer Peak Day Load Profiles

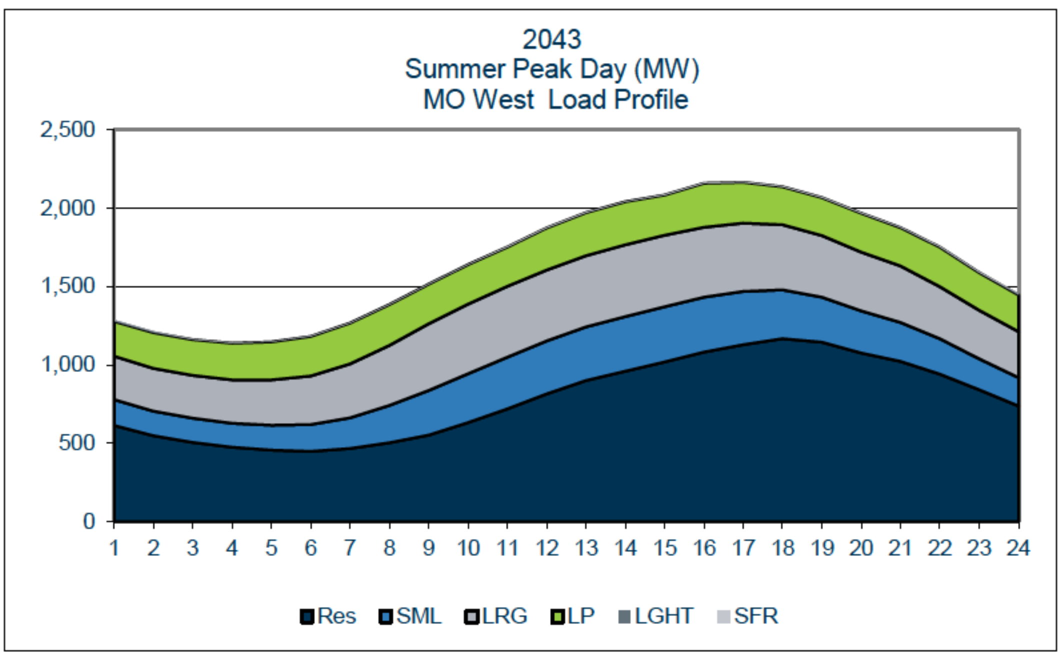
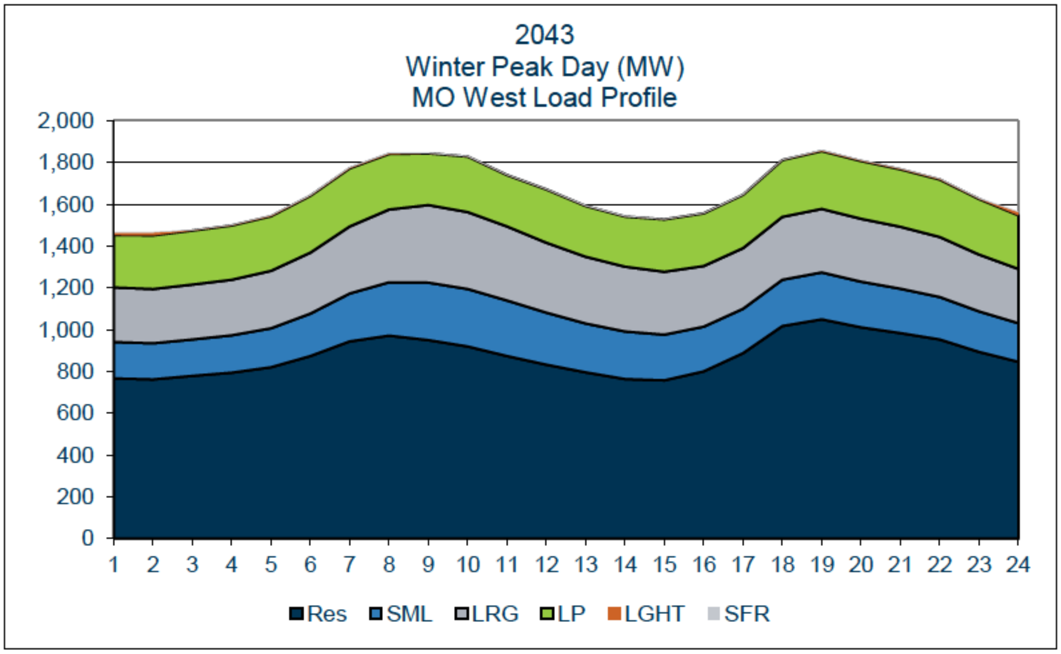


Figure 30: Twentieth Year (2043) Net System Winter Peak Day Load Profiles



7.2 Describe and Document Forecasts of Independent Variables[66]

The forecasts of independent variables were described above in the section for rule 20 CSR 4240-22.030(6)(C)(3) and below in the section for rule for 20 CSR 4240-22.030(7)(B)(3)

7.2.1 Documentation of Mathematical Models Developed by the Utility[67]

No mathematical models were developed by the utility to forecast the independent variables.

7.2.3 Documentation of Adopted Forecasts Developed by Another Entity[68]

Evergy Missouri West used a forecast of economic and demographic variables for the KC metro area that was developed by Moody's Analytics. The reasons for using this forecast, the applicability to Evergy Missouri West's service areas and documentation for the forecast were discussed in the sections for Rules 22.030(3)(A) and 22.030(6)(A)3.

[66] 20 CSR 4240-22.030(7)(B)
[67] 20 CSR 4240-22.030(7)(B)(1)
[68] 20 CSR 4240-22.030(7)(B)(2)

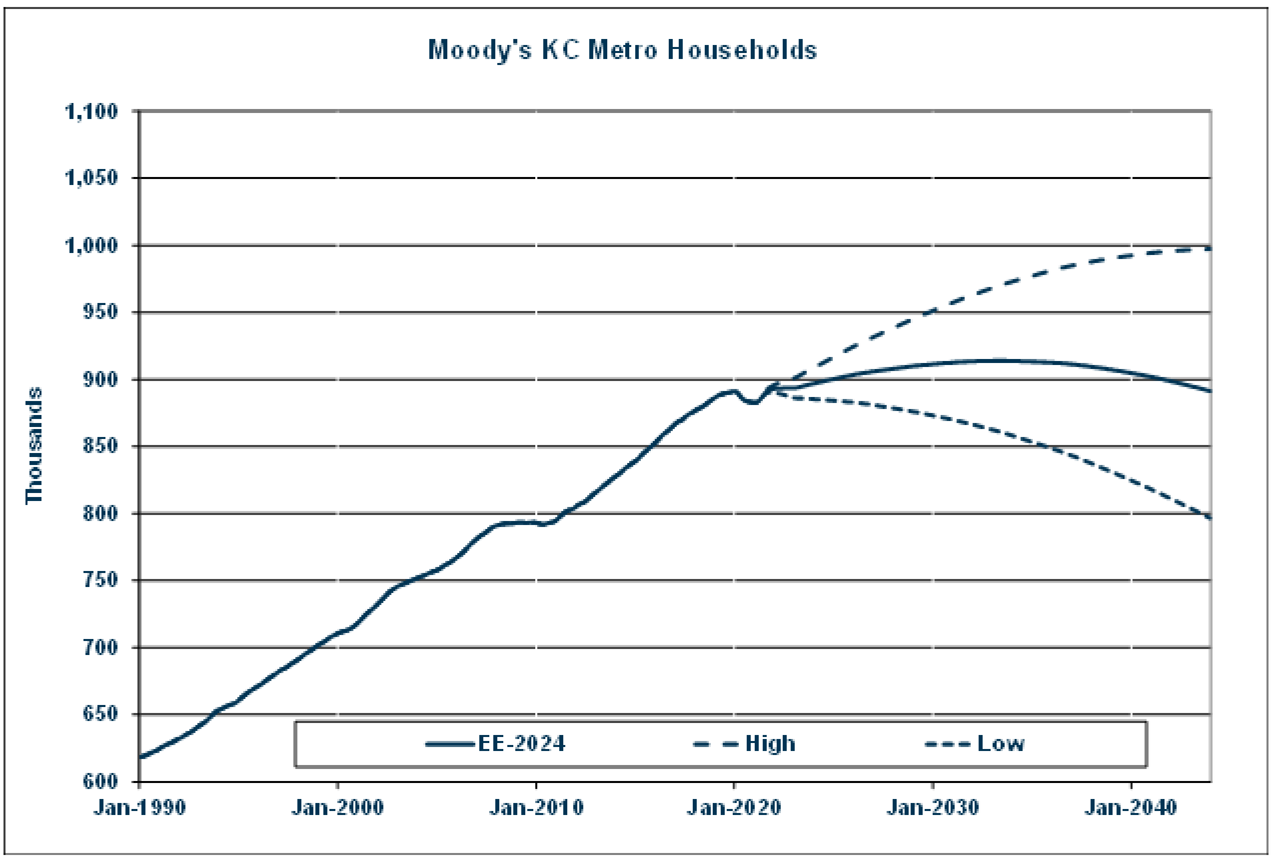
Evergy Missouri West used forecasts of saturations, UECs, EUIs and building efficiencies from DOE. The reasons for using these forecasts, the applicability to Evergy Missouri West's service area and documentation for the forecast were discussed in the sections for Rules 22.030(3)(A), (4)(A)1. 22.030(B), 22.030(5)(A), 22.030(5)(B) and 22.030(6)(A)3.

7.2.4 Comparison of Forecast from Independent Variables to Historical Trends[69]

Table 21: Economic Growth Rates for KC Metro Area **Confidential**

[redacted]

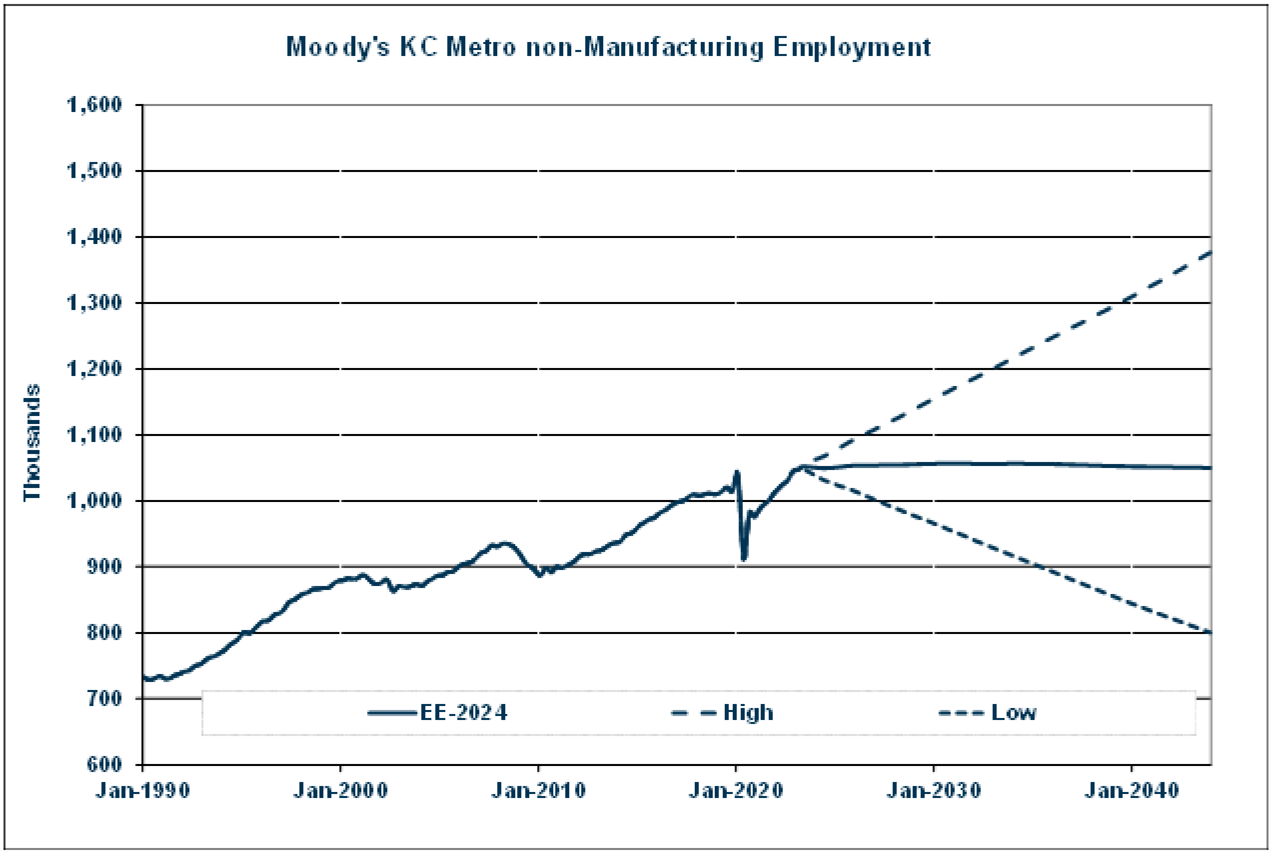
Figure 31: KC Metro Households



[69] 20 CSR 4240-22.030(7)(B)(3)

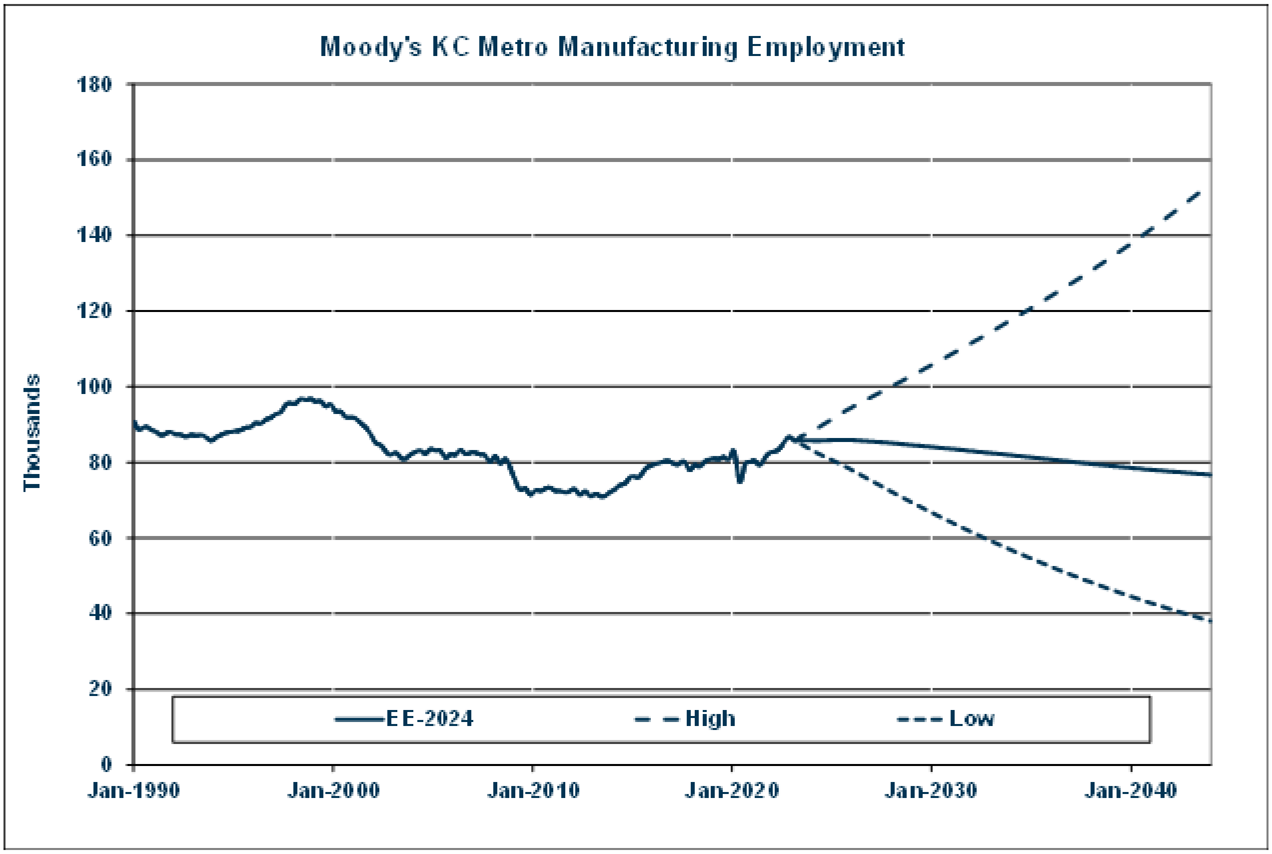
The household data and projection show robust growth from 1990 until the beginning of the last recession at the end of 2007, at which time growth slowed substantially. Housing stock has expanded since 2012 and the growth is expected to continue at a slowly decelerating pace until 2030 when the pace begins to decelerate more rapidly.

Figure 32: KC Metro Employment Non-Manufacturing



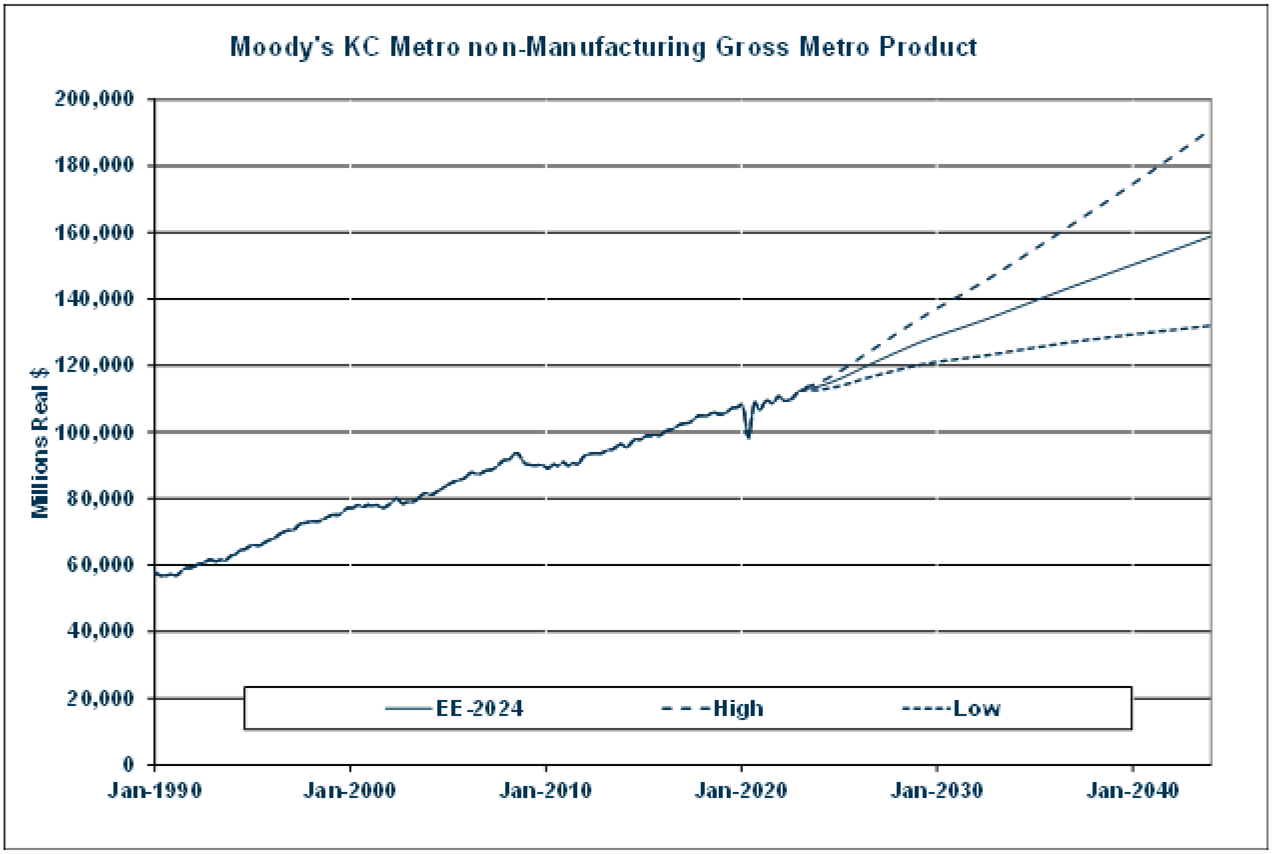
Non-manufacturing employment showed very strong growth in the 1990s, 1.9% per year, then stalled after the 2001 recession, picked up strongly in 2004 and then turned negative during the last recession. Growth returned in 2012 and grew stronger starting in 2015. Moody's expects very little growth throughout the forecast period, due in part to a slowdown and eventual decline in population.

Figure 33: KC Metro Employment Manufacturing



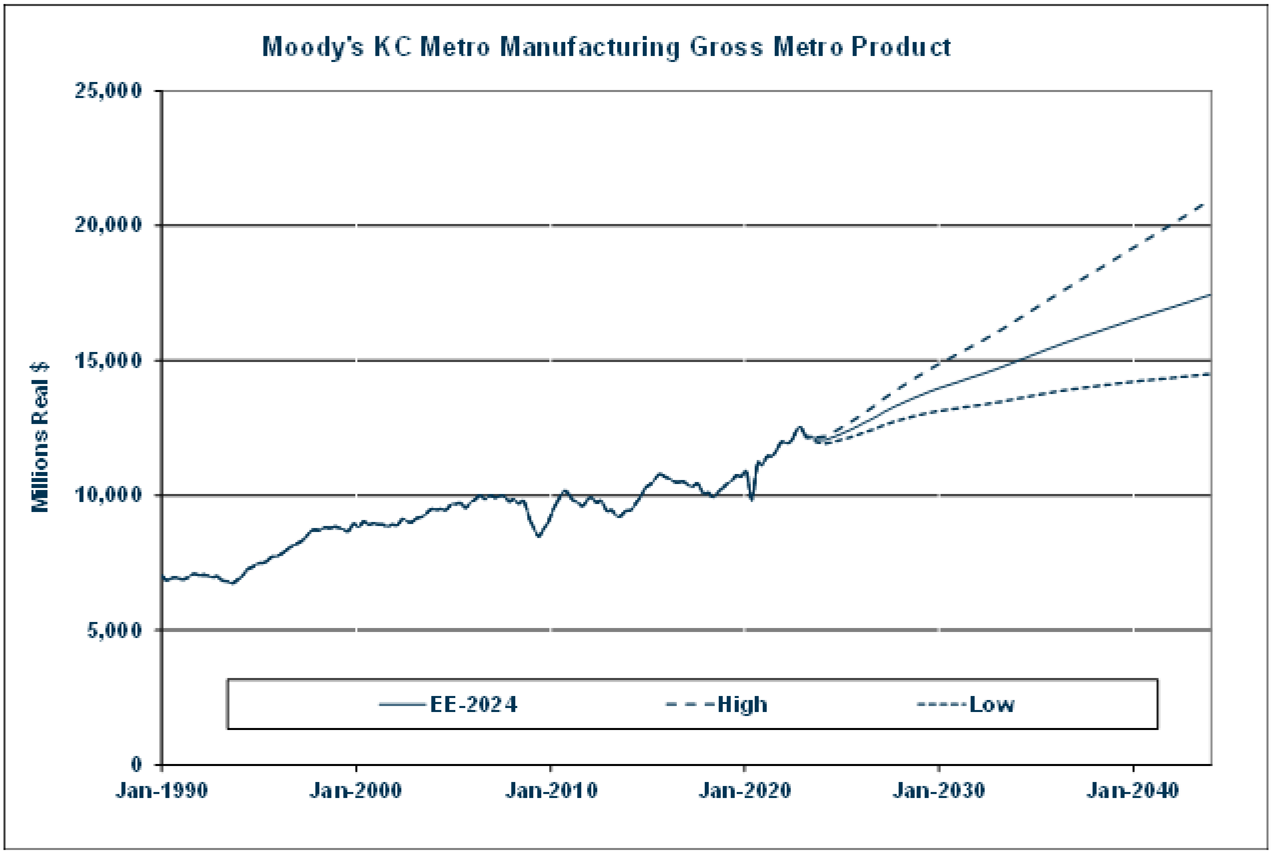
Manufacturing employment peaked in the late 1990s and has fallen since. It fell precipitously between 1999 and 2003 and again during the last recession. After regaining some of the jobs lost in the aftermath of the last recession, Moody's expects employment to resume its historical decline.

Figure 34: KC Metro Gross Metro Product Non-Manufacturing



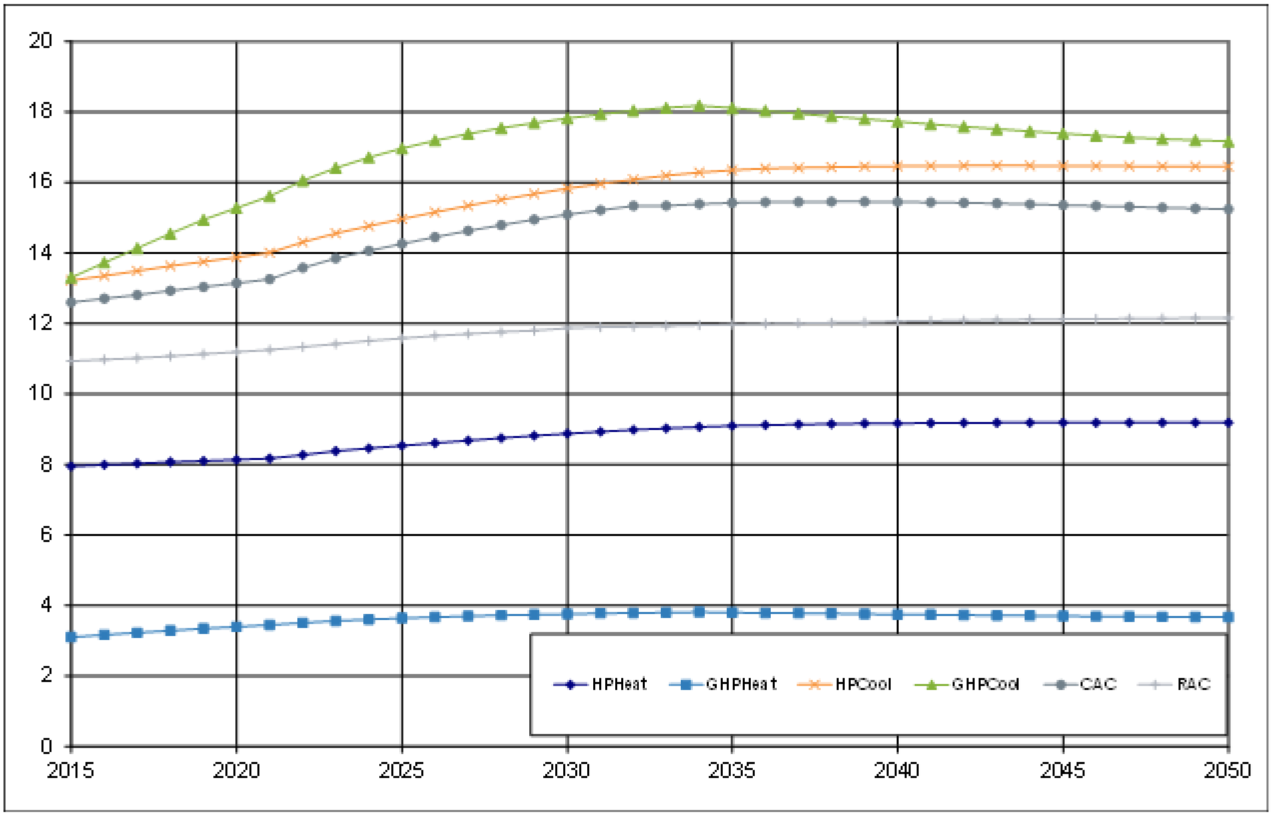
Real non-manufacturing gross metro product grew 3% per year during the 1990s, slowed down a bit after that and then declined during the last recession. GMP is growing faster than employment because of increasing productivity, a trend seen nationally and across many service sectors. Moody's expects strong growth over the next two decades.

Figure 35: Gross Metro Product Manufacturing



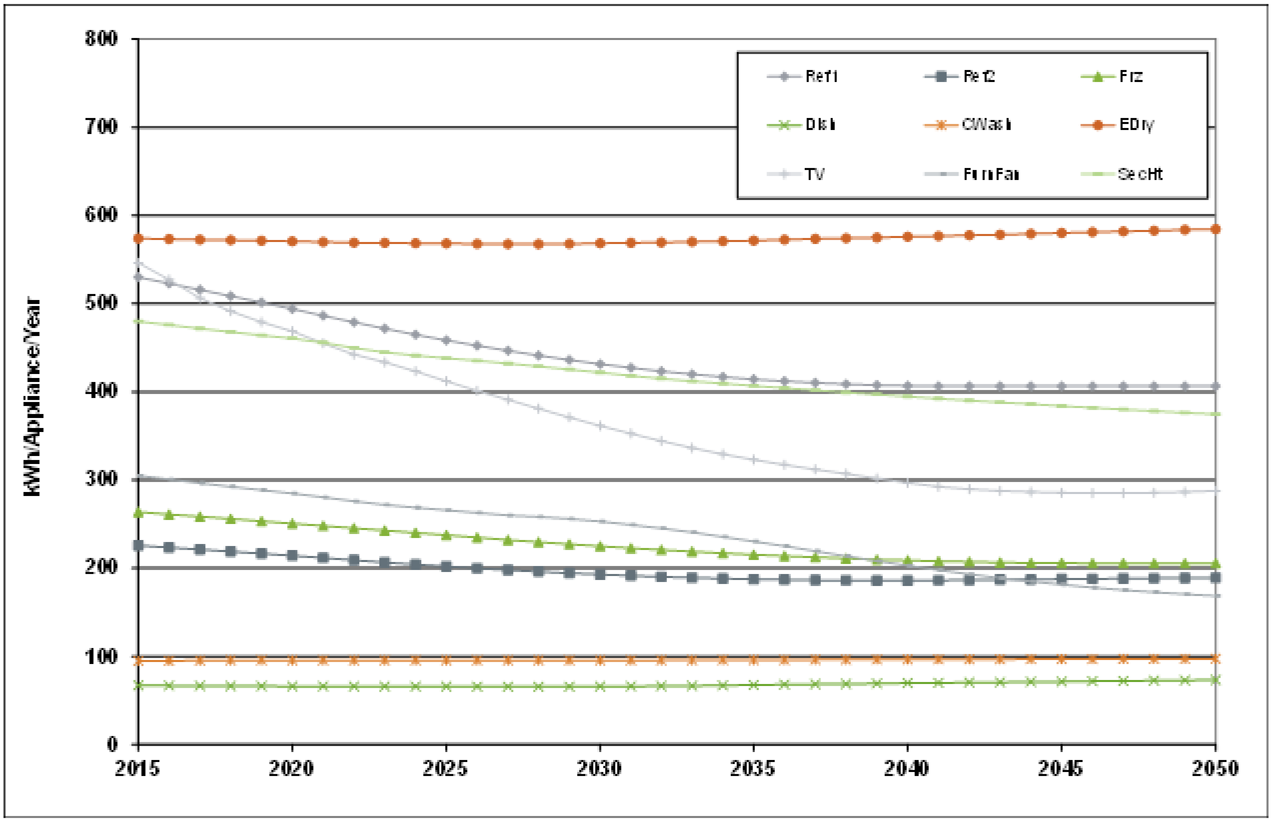
Real gross metro product from the manufacturing sector grew strongly during the 1990s and then fell flat until it plunged during the last recession. Growth has been somewhat volatile since 2008, but positive in total. Moody's expects strong growth in the forecast period. GMP for this sector is growing while employment is flat or declining because of increasing productivity, automation of the manufacturing processes and because many of the labor-intensive portions of production have moved overseas where labor cost is lower.

Figure 36: DOE Stock Average Appliance Efficiency Projections



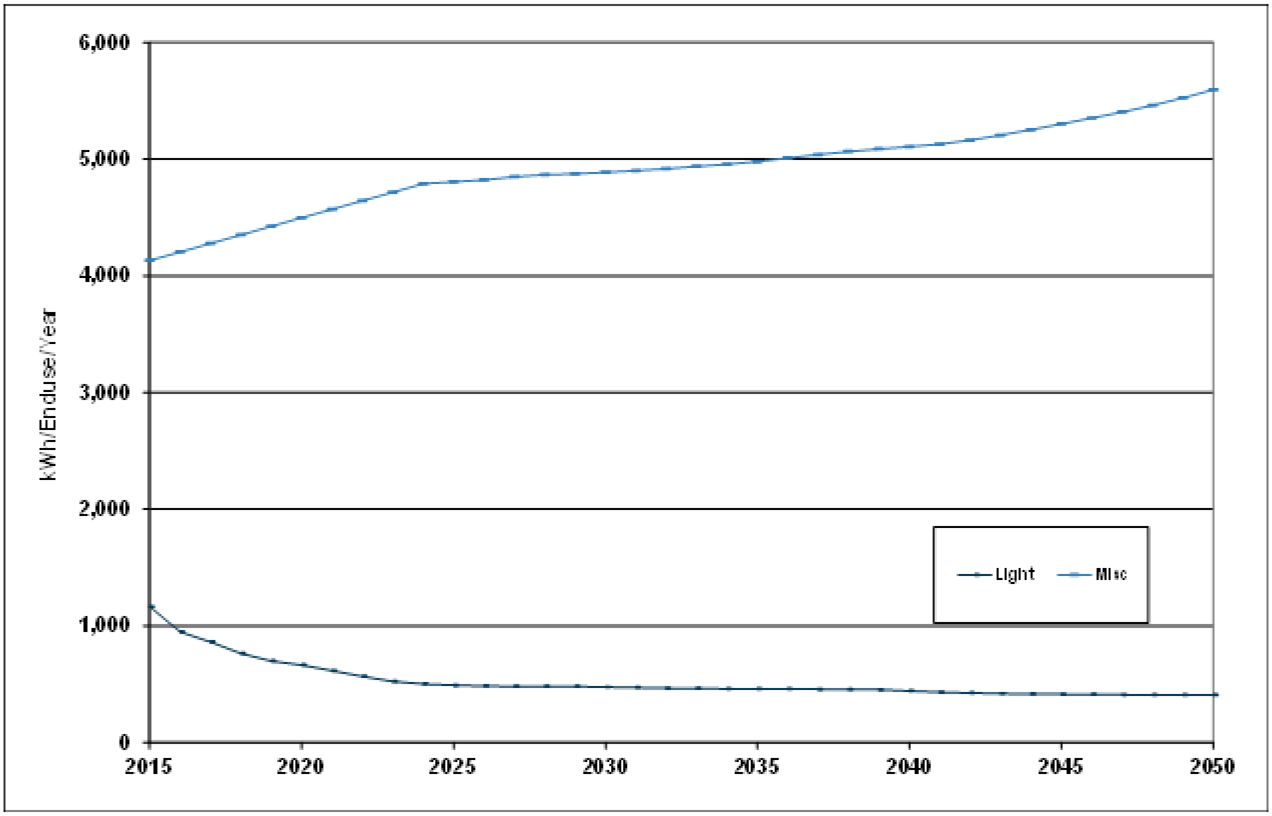
DOE is expecting increases in the stock average appliance efficiencies for residential heating and cooling equipment, resulting from appliance standards. The standards impact the stock average efficiency both due to new construction and replacement units.

Figure 37: DOE UEC Projections (<1000 kWh/year)



The decline in UEC for refrigerators and freezers is expected to continue for another decade before beginning to level. TV UEC has fallen sharply in recent years and is expected to continue. Furnace fans are expected to continue to see a decline in UEC. Dishwashers and electric dryers are expected to see flat UEC due to slightly increasing saturation levels offsetting efficiency gains.

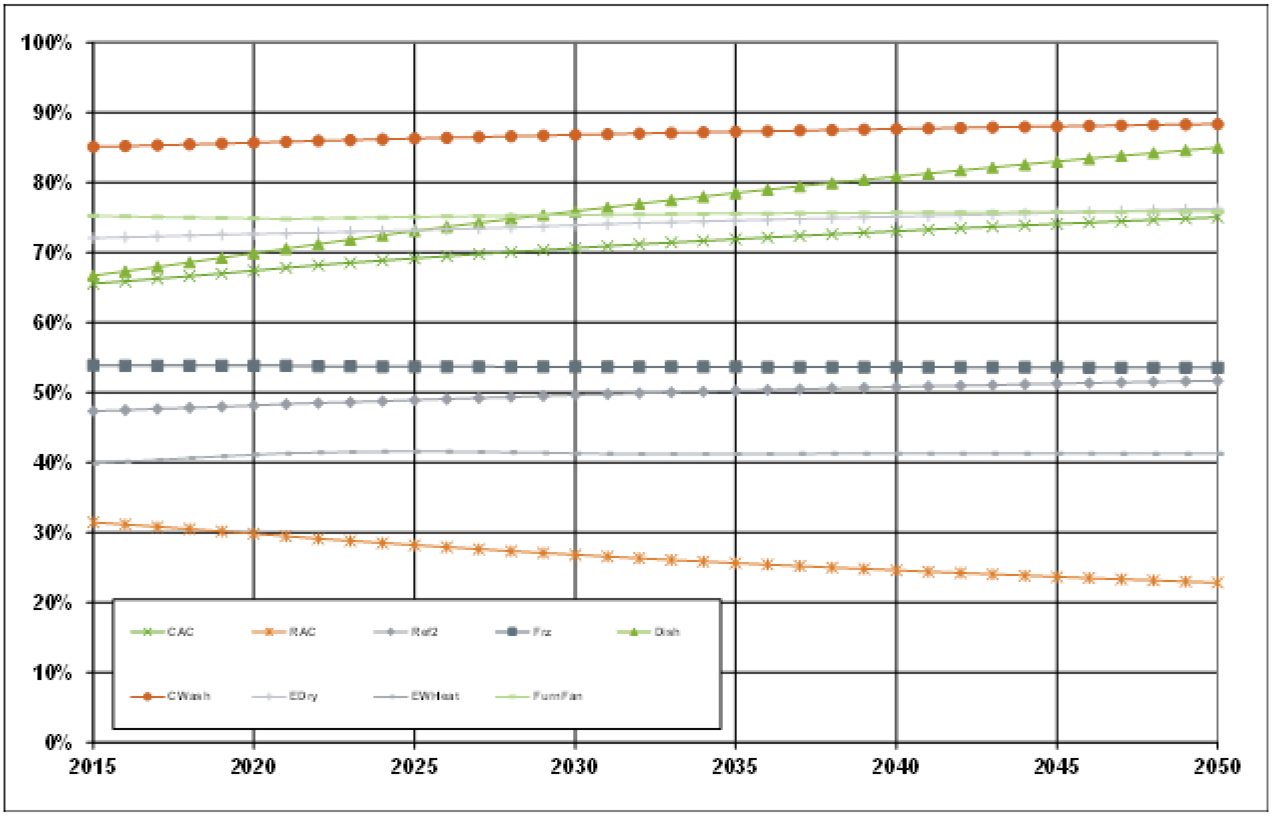
Figure 38: DOE UEC Projections (>1000 kWh/year)



Much of the decline in Lighting UEC has been realized through the adoption of LED and fluorescent lighting over incandescent. Lighting standards, many of which began in 2007 through 2015, will continue to impact consumption, though to a lesser degree, as less efficient incandescent and fluorescent lights are replaced with LED.

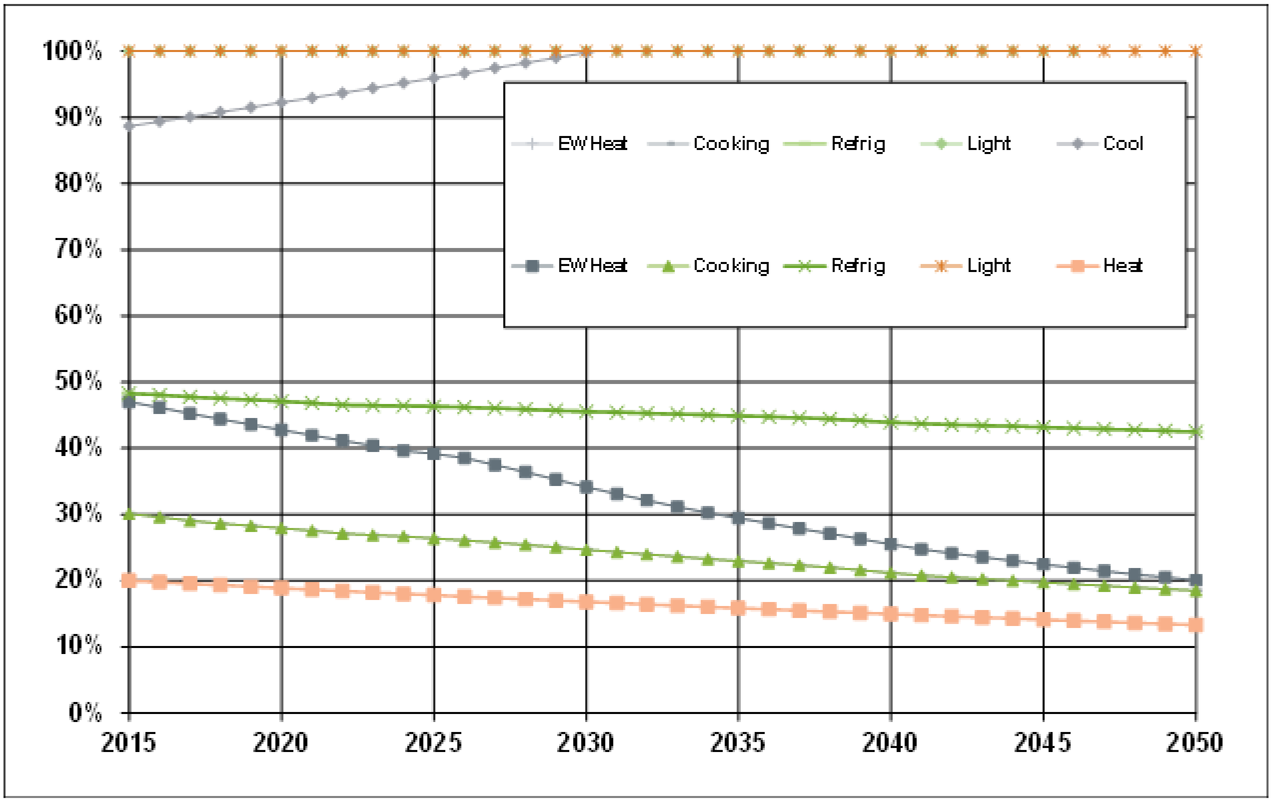
Miscellaneous UEC grew rapidly in the late 1990s and early 2000s before decelerating (from 5% to 3%) in 2006 and then again decelerating in 2016. The EIA expects miscellaneous UEC to grow through the forecast period.

Figure 39: DOE Electric Appliance Saturation Projections (< 100%)



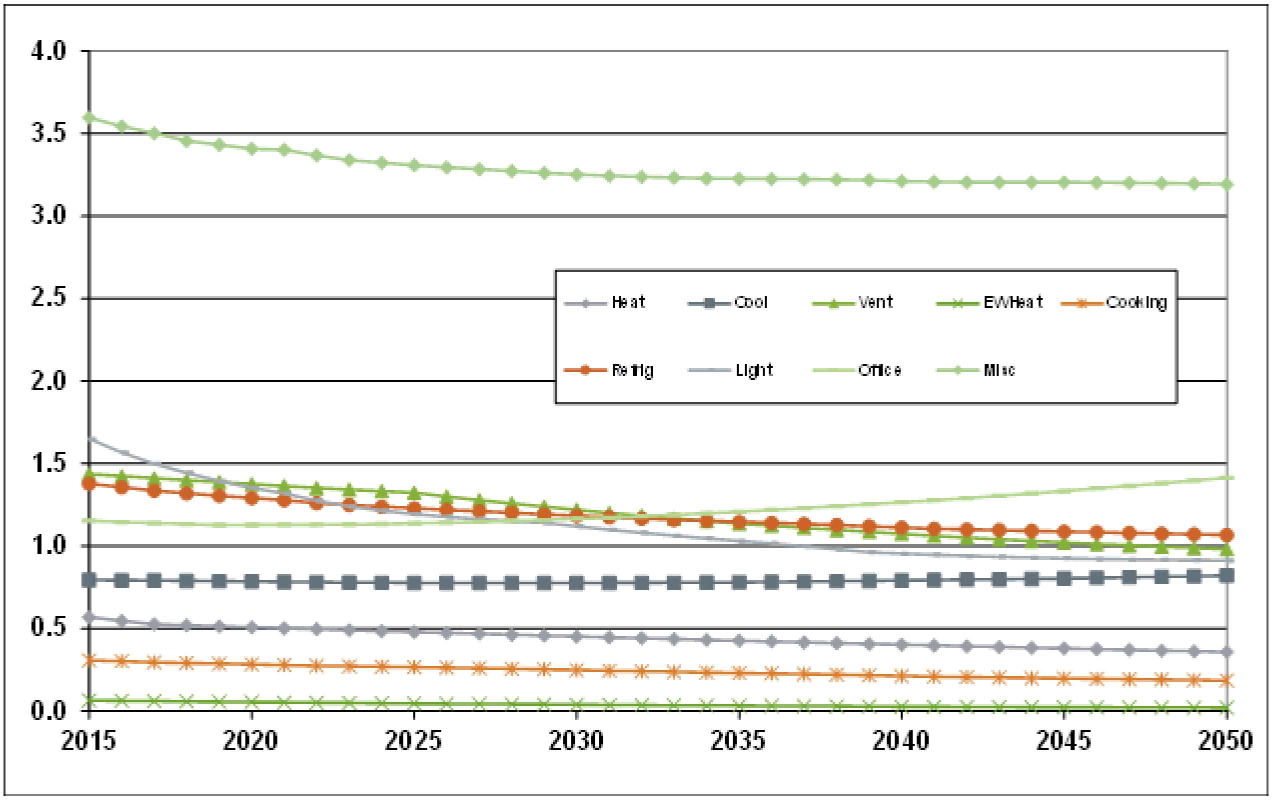
DOE saturation projections shown above are in line with recent historical trends.

Figure 40: DOE Equipment Saturation Projections (Average over all Commercial Building Types)



DOE commercial sector saturations are mostly in line with trends in recent historical data. Electric water heat saturation is projected to experience a slightly sharper decline starting near the late 20s.

Figure 41: DOE Commercial EUI Projections
(Average over all Commercial Building Types)



DOE estimates of the EUI for lighting have been declining since 1995 and started falling more rapidly in 2012, due to CFLs and LEDs, especially for lodging and in recessed fixtures in offices. New refrigeration standards became effective in 2017.[v] The heating EUI is declining and expected to further decline. A new standard for commercial heating and cooling equipment became effective in 2017.[vi] The EUI for miscellaneous equipment was revised lower than previous outlooks due to the incorporation of the 2012 CBECS.

Specification And Quantification of Factors[70]

Evergy Missouri West used the forecasts of economic and demographic variables as is from Moody's Analytics.

[70] 20 CSR 4240-22.030(7)(B)(4)

The projections of appliance saturations from DOE were calibrated to the results of our Residential appliance saturation survey and Commercial & Industrial equipment saturation survey. An additional calibration was made to lighting to account for the Evergy Missouri West lighting program that had been in place prior to the implementation of the 2013 federal lighting standard. The adjustment shows a stronger increase in lighting efficiency in the historical period and a slower rate of increase in efficiency in the forecast period.

7.3 Net System Load Forecast[71]

Evergy Missouri West has produced an hourly forecast for each major class and the sum of these forecasts is the hourly forecast of NSI.

[71] 20 CSR 4240-22.030(7)(C)

Section 8: Load Forecast Sensitivity Analysis[72]

To perform a sensitivity analysis, Evergy Missouri West utilized a method that was suggested by the Missouri Public Service Commission Staff for Evergy Missouri West's IRP. For each customer class, MWh sales were regressed on important driver variables and degree days and the standardized variables are used to show the relative importance of each explanatory variable. We also show the elasticity for each driver variable as measured by the statistical regression. The sensitivity analysis was run using the revenue class groups as opposed to the class cost of service groups in order to use a longer historical data set. Class cost of service historical data is available back to mid-2005. The analysis was repeated using revenue classes, residential, commercial, and industrial with monthly data available from 2001 to 2023.

The table below displays the results for Evergy Missouri West residential customers. Among the driving variables, the cooling degree days' variable has the largest standardized coefficient, followed by billing days and the heating degree days variables. Note that the base temperature for the cooling degree days' variable was 650 F and the base temperature for the heating degree days variable was 550 F. The variable hddPriceRatio variable is heating degree days with a base temperature of 55 F times the price of natural gas for the West North Central Region. The purpose of this variable is to measure the impact of gas and electric prices on electric space heating loads. The trends in heating degree day and cooling degree day responses are significant too. The variable BDays is the number of billing days averaged over each billing cycle. The regression periods used for these regressions are monthly. The regression periods used for these regressions are monthly from January 2001 to June 2023, or January 2002 to June 2023.

[72] 20 CSR 4240-22.030(8)

Table 22: MO West Residential

VARIABLE	Standardized Coefficient	t- Statistic	Elasticity
BDays	4,077,321	7.725	0.41
resCus	4,167,513	3.990	0.27
hddPriceRatio	9,925,287	2.130	0.03
resCusCDD65	79,966,987	80.753	0.21
resCusHdd55	40,653,888	5.400	0.12
hddTrend	22,469,396	5.423	0.06
res.Jan05	3,185,952	5.558	0.00
res.Sep06	1,659,595	2.898	0.00
EffTrend	-5,665,696	-3.280	-0.09

The table below provides the results for Evergy Missouri West commercial customers. The variable with the largest standardized coefficient is cooling degree days. The heating degree day base temperature for the commercial model is 500 F and cooling degree day base temperature was 600 F. Heating degree days, trend in heating degree days and the HDDpriceRatio variable all had similar impact for commercial customers. Several economic drivers were tested and were significant, including Non-Manufacturing Gross Product and Households.

Table 23: MO West Commercial

VARIABLE	Standardized Coefficient	t- Statistic	Elasticity
Population	10,315,587	58.661	0.62
HDDpriceRatio	8,097,502	2.840	0.02
comCusCDD60	34,077,432	50.763	0.10
comCusHdd50	2,766,565	0.787	0.01
hddTrend	6,039,862	4.605	0.01
comCalib	11,362,599	16.112	0.14
COVID	-3,219,573	-5.310	0.00
comCCB	15,425,389	25.961	0.10
com.Nov01	1,875,405	3.619	0.00
com.May20	-1,951,028	-3.709	0.00
com.Dec20	1,312,931	2.499	0.00
com.Jan23	1,622,739	3.069	0.00

The Missouri industrial model results are shown in the table below. The cooling degree variable has the largest standardized coefficient, followed by gross product manufacturing of the economic variables and industrial customers.

Table 24: MO West Industrial

VARIABLE	Standardized Coefficient	t- Statistic	Elasticity
GP_Man	5,932,967	13.655	0.63
indCus	2,523,321	7.454	0.42
prElecCus	-2,984,566	-5.304	-0.14
indCusCDD60	7,039,938	11.551	0.06
ind.Mar05	-1,479,664	-5.583	0.00
ind.Feb10	1,122,000	4.228	0.00
ind.binary	1,494,200	3.681	0.00
ind.calib	2,055,798	2.889	0.02
ind.Apr18	798,043	2.864	0.00
ind.May18	-695,241	-2.475	0.00
ind.May20	-566,012	-2.141	0.00

8.1 Two Additional Normal Weather Load Forecasts[73]

Evergy Missouri West used two additional economic forecasts from Moody's Analytics to produce high-growth and low-growth load forecast scenarios. These additional scenarios represent economic growth two standard deviation above and below the base case forecast.

In addition to these two scenarios, Evergy Missouri West produced an additional scenario representing significant loss of customer.

Evergy Missouri West constructed this scenario by subtracting the energy and peak demand from the largest customer from the results for the base case scenario. The most recent 12 billing records from each customer were used, and the energy and peak from each month was used for that month in the forecast. Losses were added to the energy and peak demands.

[73] 20 CSR 4240-22.030(8)(A)

The corresponding figures below show the base-case, low-case, high-case, and significant loss forecasts for energy and demand. The impact of the last recession and the economic malaise since then are evident in the plot for energy. Growth in the forecast is lower than it was prior to the last recession, and this is primarily because U.S. growth prior to the recession was fueled by circumstances that will not be repeated in the forecast horizon such as extremely lax lending standards.

Figure 42: MO West Base, Low, High, Significant Loss and Electrification Net System Input Forecast

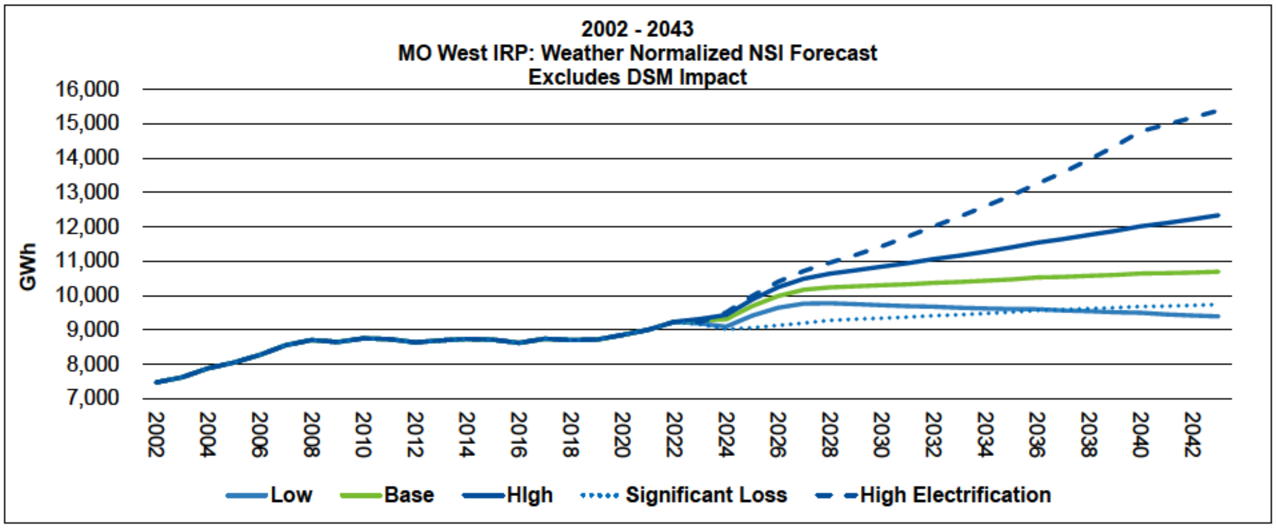
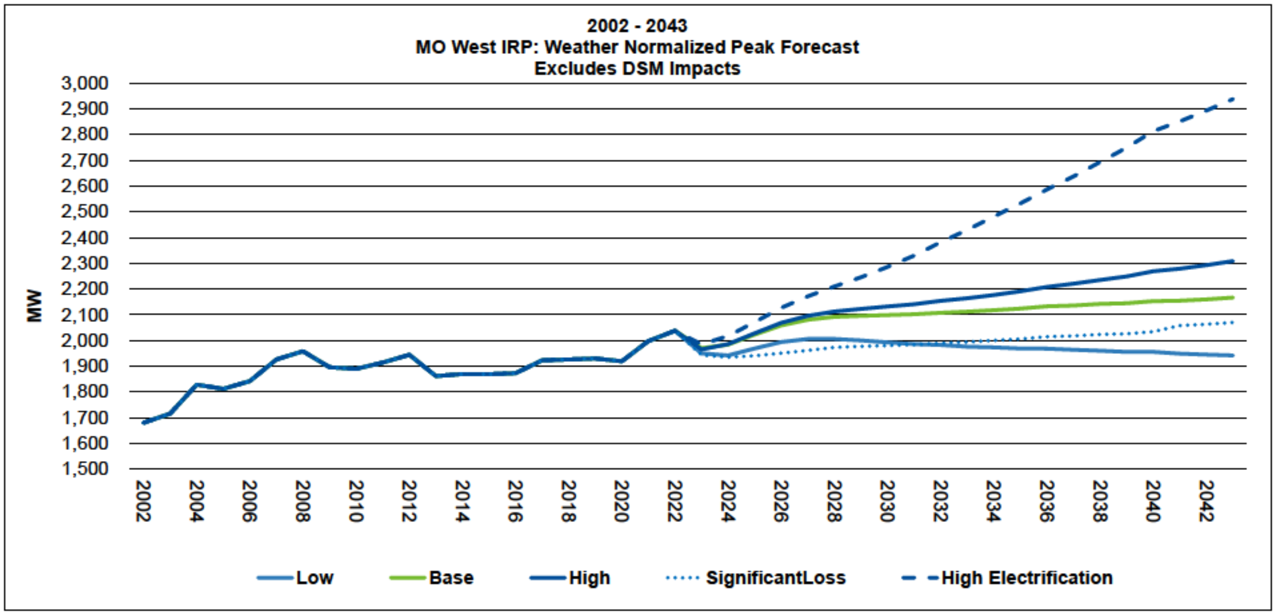


Figure 43: MO West Base, Low, High, Significant Loss and Electrification Peak Demand Forecast



8.2 Estimate of Sensitivity of System Peak Load Forecasts to Extreme-Weather[74]

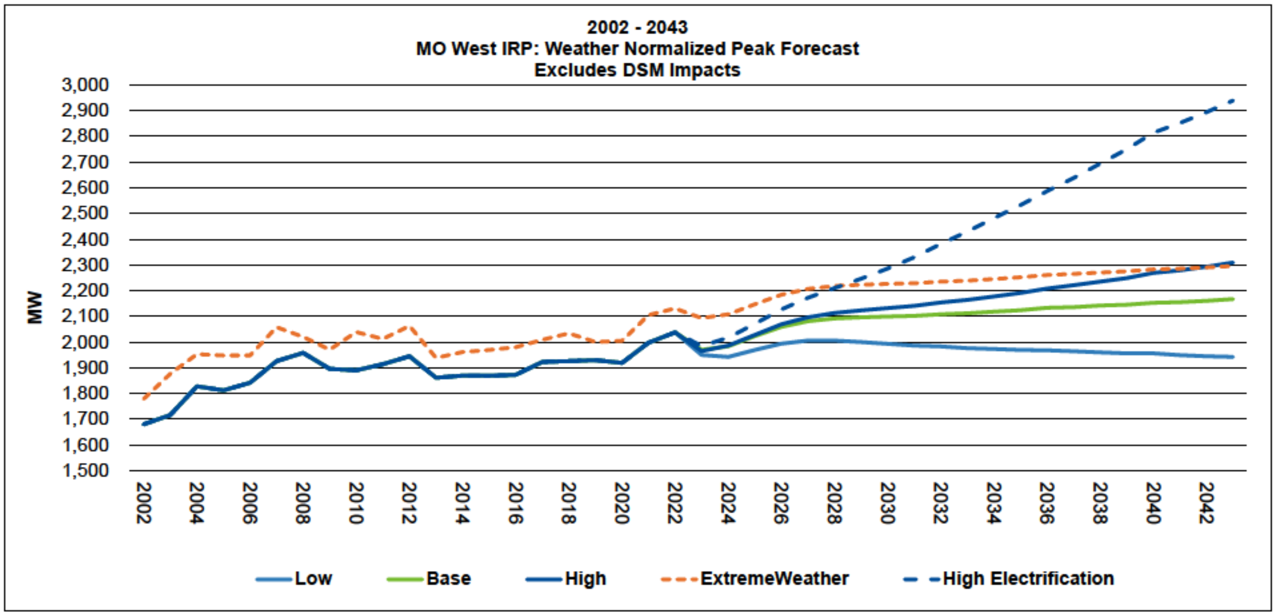
Evergy Missouri West created a forecast scenario using the base case economic scenario and weather from the 4 warmest years in terms of cooling degree days at KCI. These years were 1980, 1988, 2006 and 2012. The number of cooling degree days those years were 1,746, 1,724, 1,724 and 1,839. The scenario was created by running our computer programs with normal weather computed with those four years instead of with 30 years.

In 2023, the peak rose from 1,970 MW in the base case scenario to 2,093 MW in the extreme weather scenario. In 2028, the peak net of DSM increased from 2,092 (base case) to 2,218 extreme weather scenarios. The complete set of results is in a file, *West_NSI_Peak Monthly_Annual.xls*. This file contains monthly NSI and peak load for all forecast scenarios.

The corresponding figures below show the base-case, low-case, high-case, and extreme weather forecasts for energy and demand.

[74] 20 CSR 4240-22.030(8)(B)

Figure 44: MO West Base, Low, High, and Extreme Weather Peak Demand Forecast



8.3 Energy Usage and Peak Demand Plots[75]

The figures below represent actual, and weather normalized Net System Input (Energy) for summer, non-summer, and total year for the base case forecast. Corresponding tables can be found in *Appendix 3D* and in the file *IRP_8C_GMO_NSI_Peak.xls*. Weather normalization significantly smooths out the energy plots.

[75] 20 CSR 4240-22.030(8)(C); 20 CSR 4240-22.030(8)(C)(1); 20 CSR 4240-22.030(8)(C)(2)

Figure 45: MO West Base Case Actual and Weather Normalized Summer Energy Plots

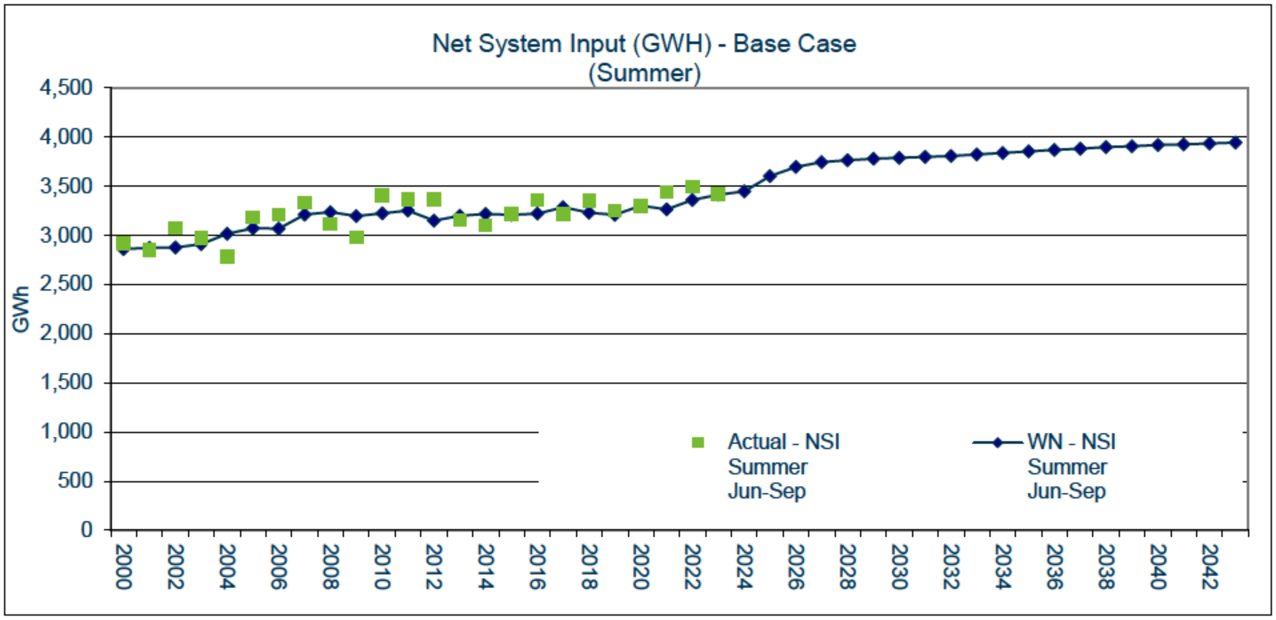


Figure 46: MO West Base Case Actual and Weather Normalized Non-Summer Energy Plots

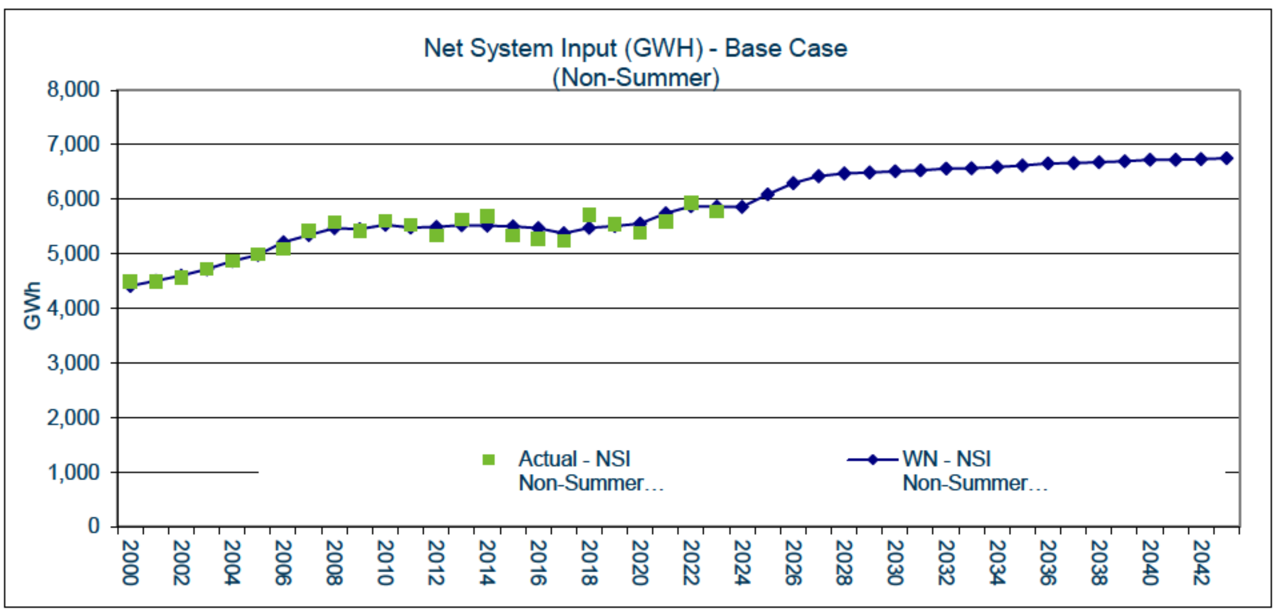
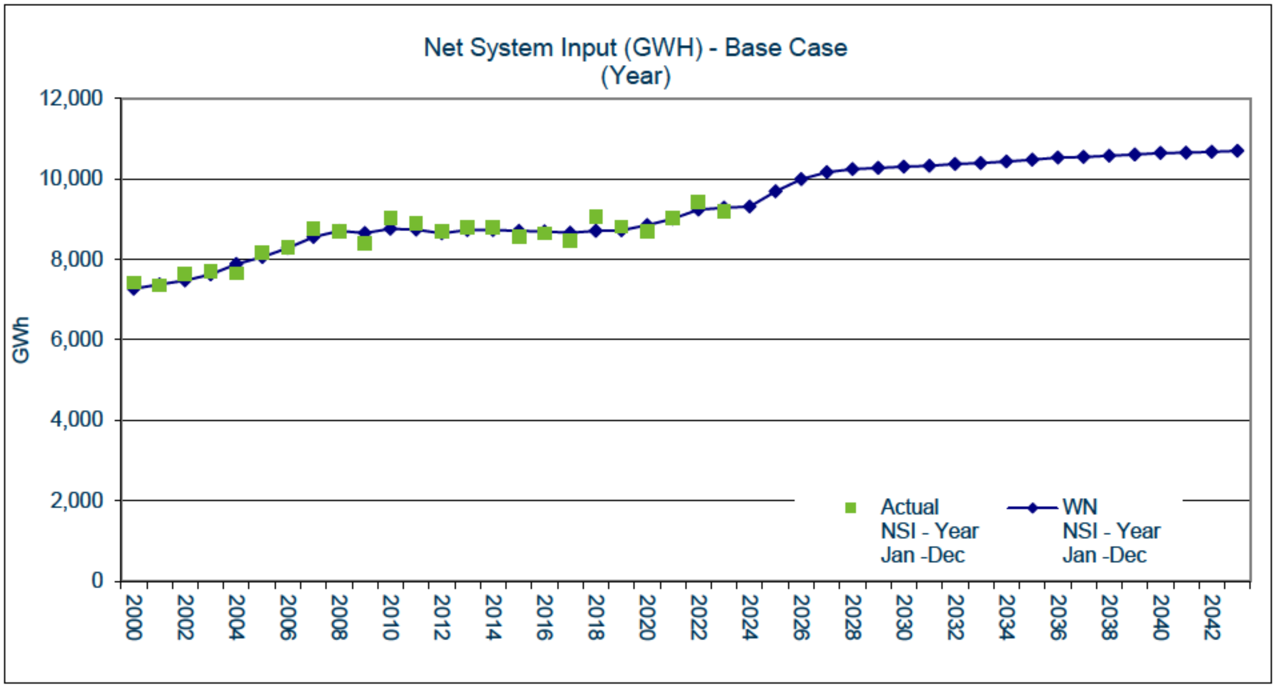


Figure 47: MO West Base Case Actual and Weather Normalized Total Energy Plots



The figures below represent actual, and weather normalized peak demand for summer and non-summer for the base case forecast. Annual demand charts are not shown since they are the same as summer demand charts. Corresponding tables can be found in *Appendix 3D* and the file *IRP_8C_West_NSI_Peak.xls*.

Figure 48: MO West Base Case Actual and Weather Normalized Summer Peak Demand Plots

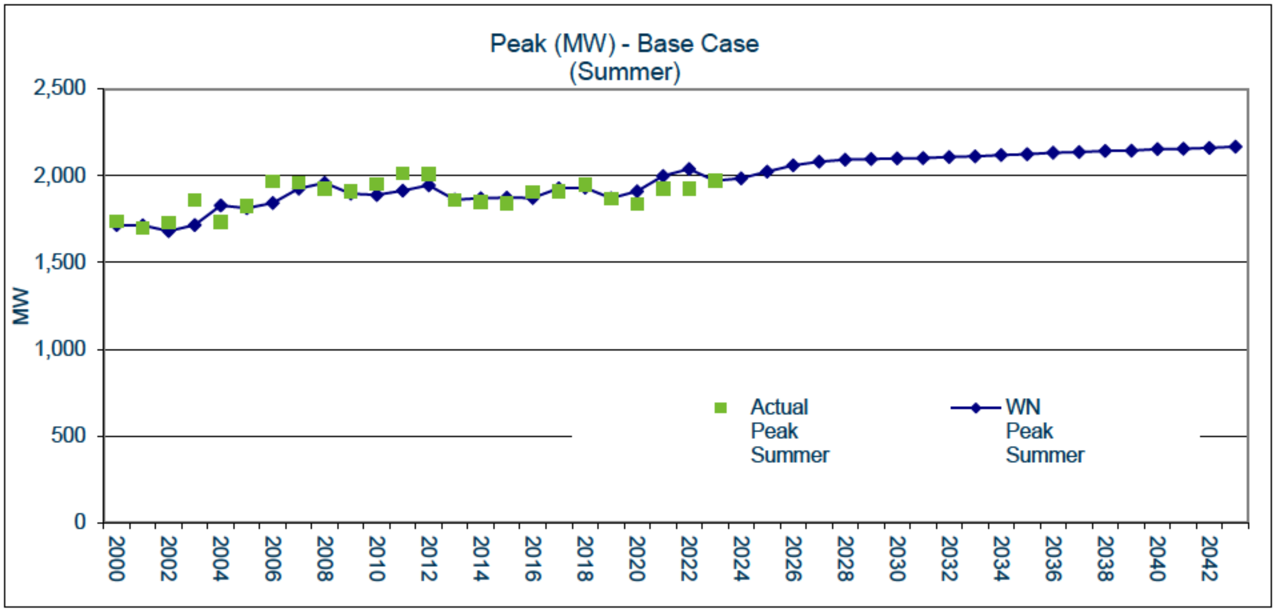


Figure 49: MO West Base Case Actual and Weather Normalized Winter Peak Demand Plots

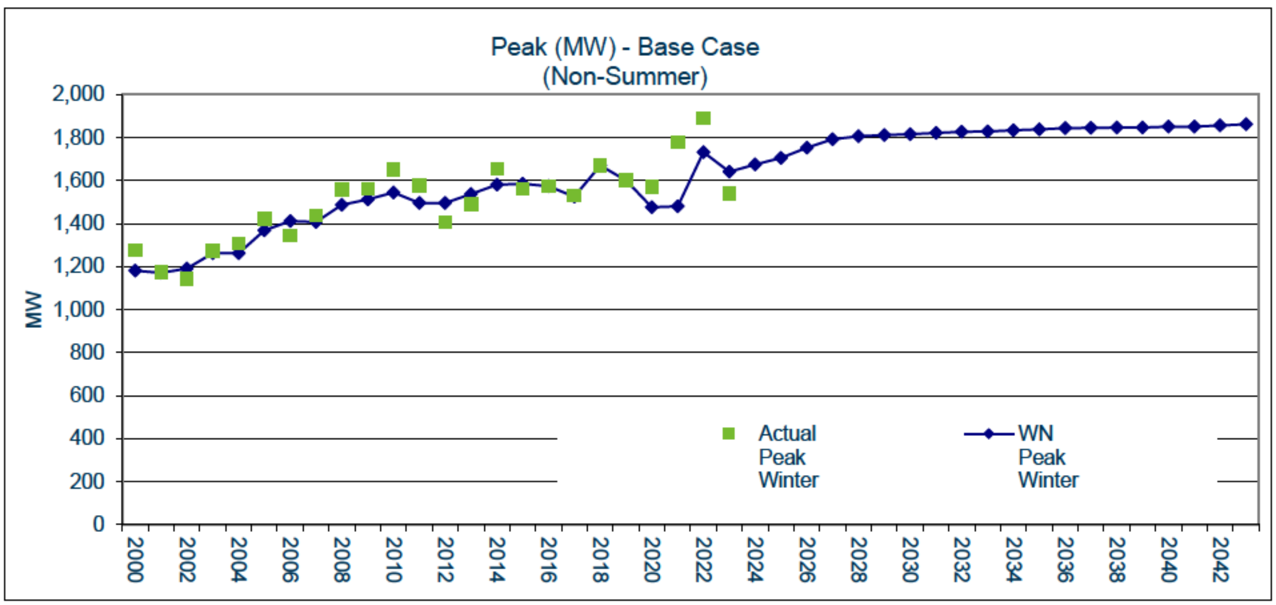
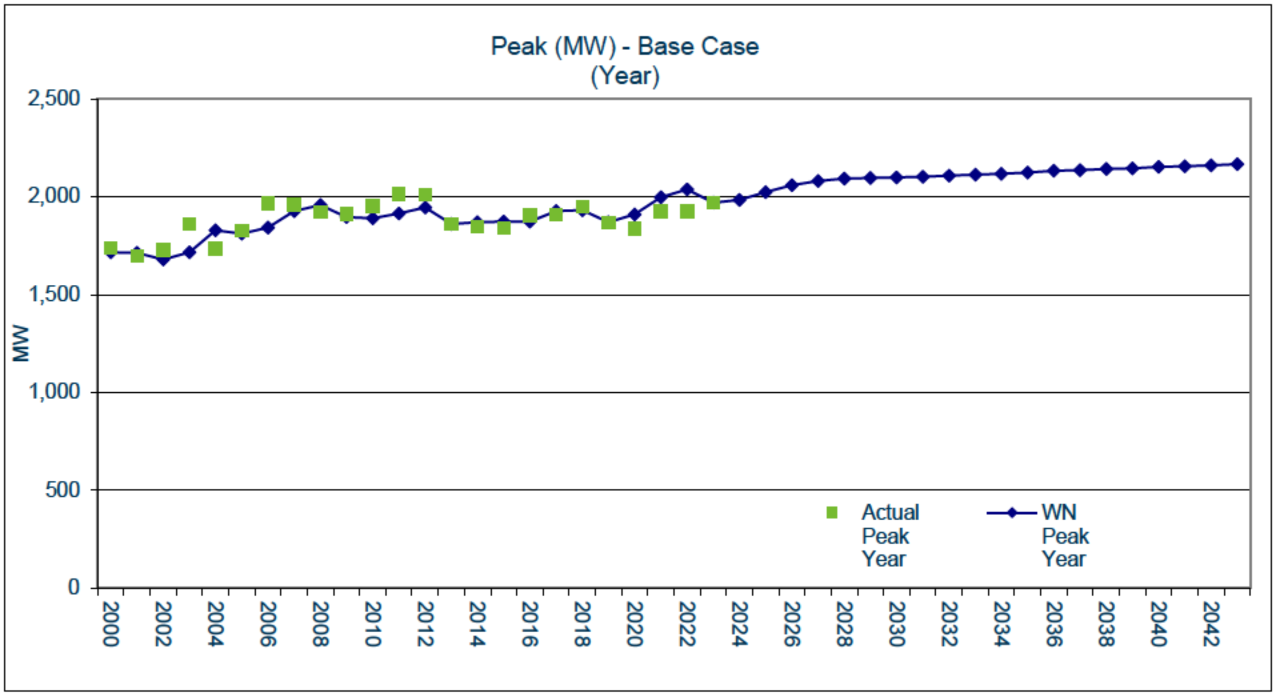


Figure 50: MO West Base Case Actual and Weather Normalized Total Peak Demand Plots



The figures below represent Net System Input (energy) for summer, non-summer, and the whole year for the base, low and high scenario forecasts. Corresponding tables can be found in *Appendix 3D* and the file *IRP_8C_West_NSI_Peak.xls*.

Figure 51: MO West Base-Case, Low-Case, and High-Case Summer Energy Plots

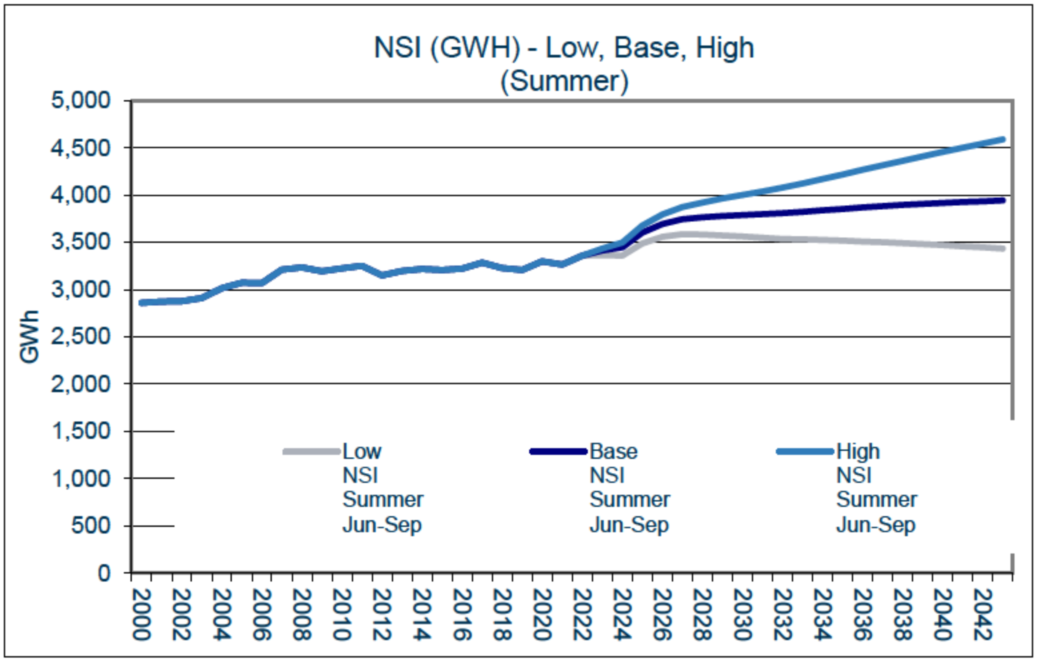


Figure 52: MO West Base-Case, Low-Case, and High-Case Non-Summer Energy Plots

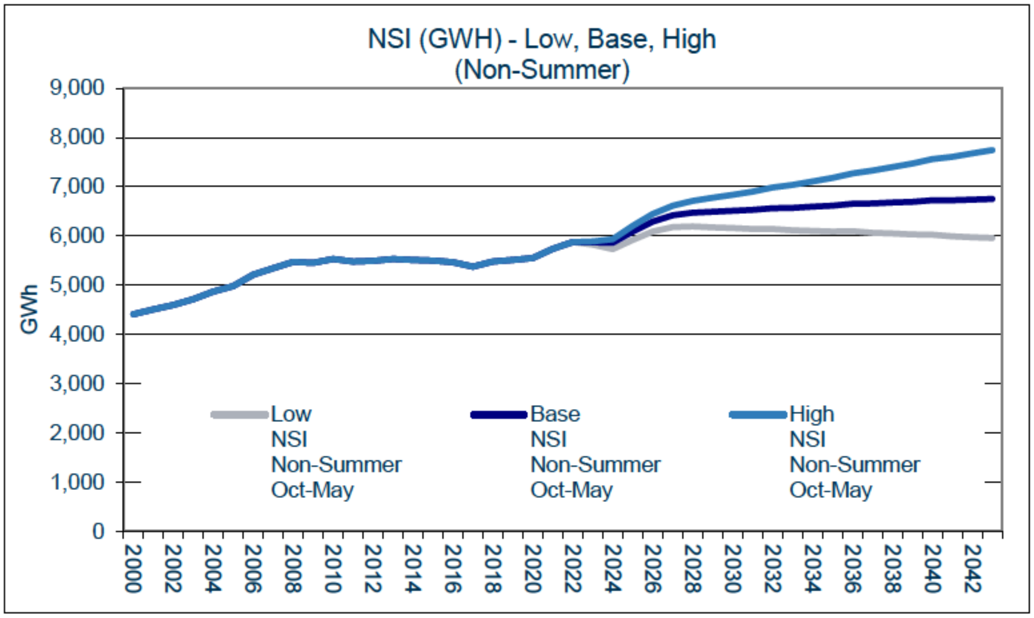
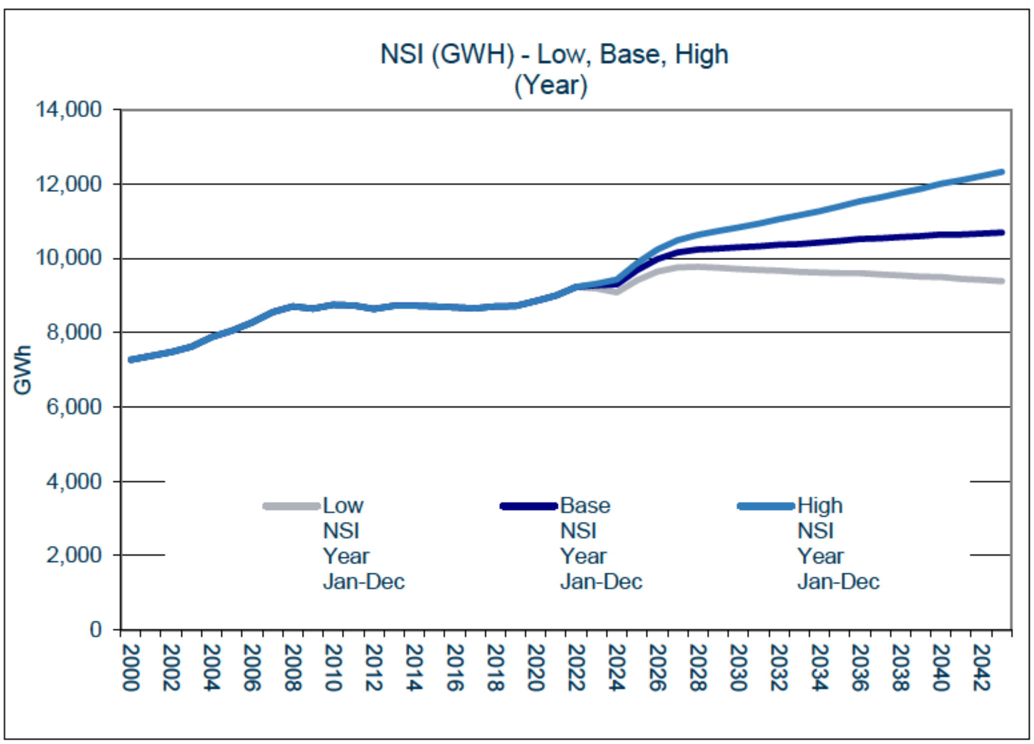


Figure 53: MO Metro Base-Case, Low-Case, and High-Case Total Energy Plots



The figures below represent peak demand for summer and non-summer for the base, low, and high scenario forecasts. Annual demand charts are not shown, since they are the same as summer demand charts. Corresponding tables can be found in *Appendix 3D* and in the file *IRP_8C_West_NSI_Peak.xls*.

Figure 54: MO West Base-Case, Low-Case, and High-Case Summer Peak Demand Plots

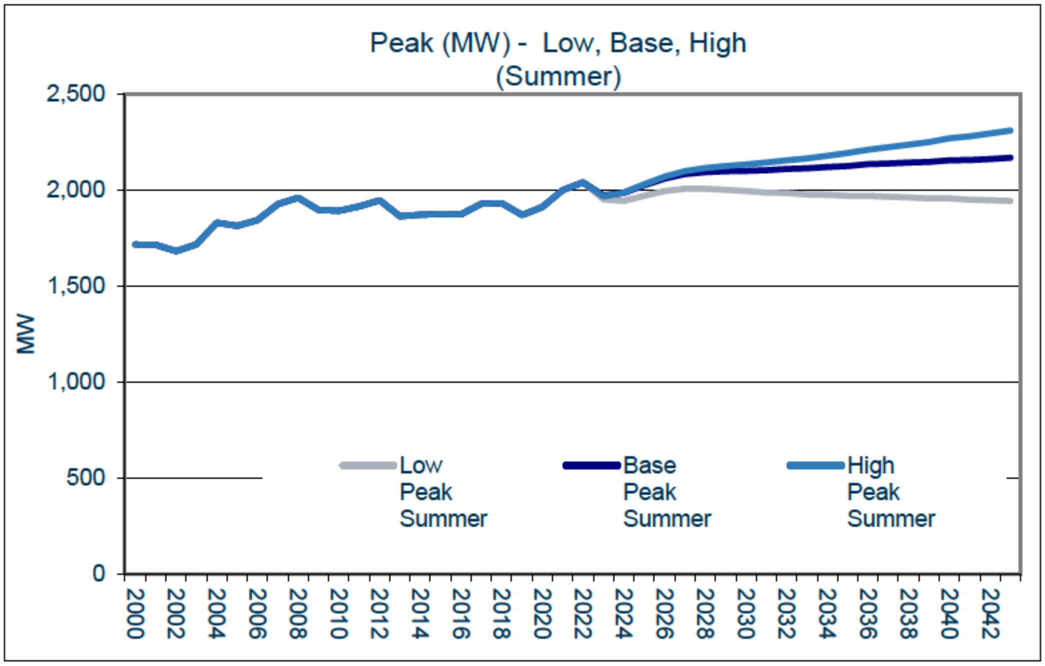


Figure 55: MO West Base-Case, Low-Case, and High-Case Winter Peak Demand Plots

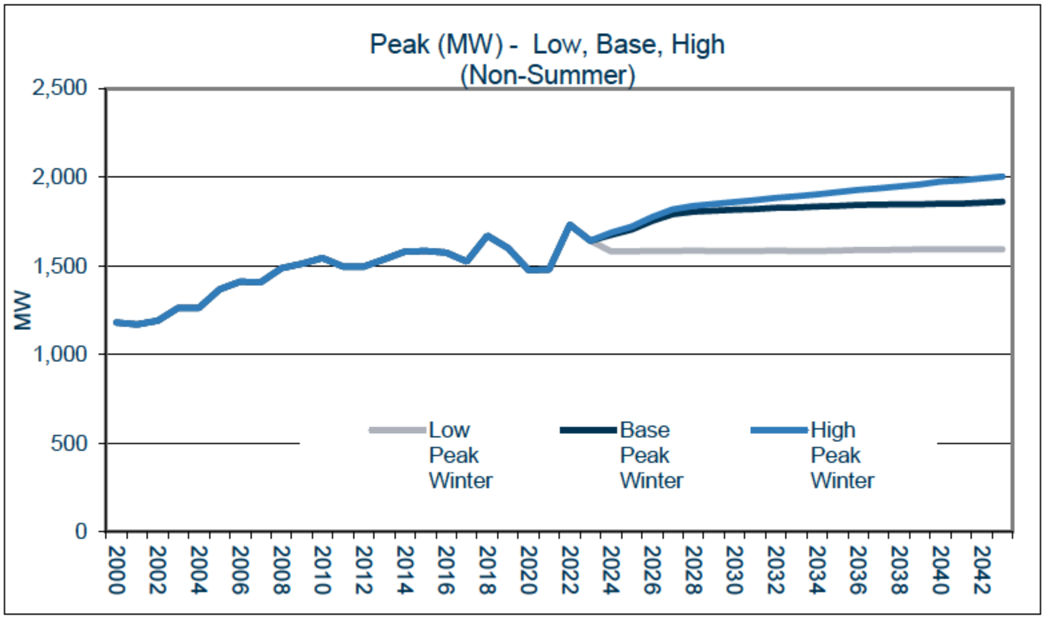
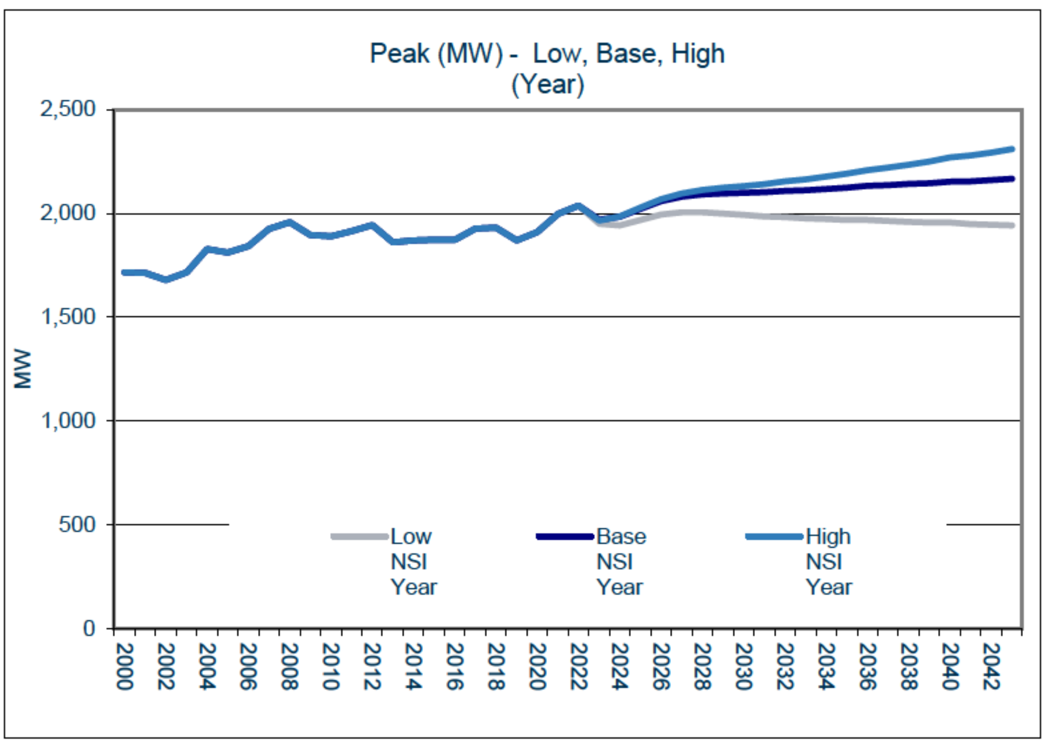


Figure 56: MO West Base-Case, Low-Case, and High-Case Total Peak Demand Plots



[i] http://www1.eere.energy.gov/buildings/appliance_standards/residential/residential_cac_hp.html

[ii] Appliance and Equipment Standards Program, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://appliance-standards.org/products-and-links.

[iii] Appliance and Equipment Standards Program, U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. https://appliance-standards.org/products-and-links.

[iv] See regulatory_programs_mypp.pdf .

[v] www1.eere.energy.gov/buildings/appliance_standards/commercial/refrig_equip_final_rule.html and www1.eere.energy.gov/buildings/appliance_standards/commercial/automatic_ice_making_equipment.html

[vi] https://www.regulations.gov/document?D=EERE-2014-BT-STD-0048-0102