Missouri Statewide DSM Potential Study.

Input Report.

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Burlington, Massachusetts, October 27, 2010

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1. Introduction

This report documents the inputs that have been developed for the Missouri Statewide DSM Potential Study. These inputs are provided as Microsoft Excel workbooks that accompany this document. This report provides KEMA's deliverable under Tasks 003- 005 of this project.

The following inputs are discussed in order:

- Technology or Measure Inputs
- Economic Inputs
- Baseline Inputs

In addition, we provide in Appendix A descriptions of the input files. The input files are provided in three separate compressed directories, file names "MO-Bld2010.zip", "MO-Eco2010.zip", and "MO-Meas2010.zip."

2. Technology or Measure Inputs

KEMA worked to develop measure data assumptions relevant to the Missouri region. Utilizing data supplied by the utilities and other regional market characterization studies when possible, KEMA has developed measure files for all three sectors: residential, commercial, and industrial, and for two fuels: gas and electric. These assumptions will be used in conjunction with the economic data and baseline data to populate KEMA's DSM Assyst™ model and estimate the technical and economic energy savings potential. While the assumptions in these files are considered final from a research perspective, they may change as needed based on comments from the PSC or during a review of the technical and economic potential.

The main sources used to derive assumptions for the measure files were as follows:

- Ameren UE DSM Market Potential Study
- RLW Missouri Statewide Residential Lighting and Appliance Efficiency Saturation Study
- RLW KCP&L Single-Family Residential Potential Analysis
- LBNL Industrial Studies
- Utility program filings
- LBNL Home Energy Savers Calculator set for Springfield, MO
- Energy Information Agency Residential, Commercial Building, and Manufacturing End Use Studies (RECS, CBECS, MECS)
- Ohio Technical Resource Manual

- Past KEMA implemented residential and commercial building surveys for gas and electric in Indiana, Rhode Island, and Colorado
- DEER databases
- Energy Star Calculators
- Manufacturer cost and savings estimates

Measure data assumptions have been reviewed and accepted where appropriate based on professional experience and findings from other potential studies. Numbers have been calibrated as necessary to be as Missouri specific as possible. Several additional files were included in data provided to KEMA and were carefully reviewed. We relied extensively on the IRPs from the Missouri IOUs in developing the economic data for the analysis. These inputs included discount rates, inflation rates, and avoided costs.. A more detailed breakdown of the sources used for each assumption can be found in the measure files, located to the far right of the data in each file.

3. Economic Inputs

The DSM ASSYST® model requires a number of economic inputs including

- Time-of-use definitions (peak-off peak, summer/winter)
- Avoided costs (demand and energy)
- Rates (demand and energy)
- Discount rates (for both the utility and the customer)
- Inflation rate
- Line loss rate

This section describes the approach used to gather this data for the state of Missouri.

3.1 Time-of-use periods

We reviewed rate schedules for the four IOUs to determine how each defined peak periods for their rates. Ameren UE and KCP&L-GMO (GMO) define summer as June to September, while KCP&L and Empire define it from mid-May to mid-September. Because our peak load calculations are greatly simplified when based on complete months, we defined summer as June to September.

Peak periods also varied by utility: 10 am to 10 pm for Ameren (year round) and for GMO's summer period. KCP&L had a shorter peak period, running from 11 am to 7 pm. Empire did not

appear to have time-of-use rates, but their interruptible rate schedule describes typical interruption periods as noon to 7 pm, and that was taken as their peak period. For winter peak, GMO used 7 am to 10 pm. For the summer and winter period we weighted these start and end times, then rounded the results. We estimated an 11 hour summer peak running from 10 am to 9 pm, and a slightly longer winter peak running from 10 am to 10 pm.

The following table summarizes the four time-of-use periods we propose for this study.

Figure 1 - Time of Use Periods

Rate/Time Periods	**1**	**2**	**3**	**4**	
Name	**Summer On-Peak**	**Summer Off-Peak**	**Winter On-Peak**	**Winter Off-Peak**	
Definition	June-September 10:00-21:00 weekdays	June-September 21:00-10:00 weekdays and 24 hrs weekends	September-May 10:00-22:00 weekdays	September-May 22:00-10:00 weekdays and 24 hrs weekends	
Abbreviation	SON	SOFF	WON	WOFF	TOTAL
Hours	1342	1586	2916	2916	8760

3.2 Avoided Costs

We found partial avoided cost data in the IRPs for the investor-owned utilities. We found capacity costs (based on the cost of a combined-turbine plant) for KCP&L and GMO, and found energy avoided cost forecasts for KCP&L and Ameren.

We weighted this data by utility sales for use in the model, using Ameren's business-as-usual forecast. Because of the uncertainty in avoided costs, the multiplicity of scenarios analyzed by the utilities, and because we were not able to obtain data for all utilities, we plan to use this forecast as a base case, and create high and low avoided cost forecasts to be used for scenario analysis. We believe that this approach will allow the Missouri PSC to choose the scenario most appropriate to their expectations of avoided costs.

3.3 Rates

We used the Energy Information Administration's Form F826 to obtain utility sales and revenue by sector. The data included all Missouri's investor-owned utilities and some of the publicly-owned utilities. The revenue and sales data were estimate average rates for 2008. Rates were forecasted by tying the rate increases to the avoided cost forecast using the following formula:

$$Rate_t = (Rate_{t-1} – AC_{t-1}) * (1 + Inf) + AC_t$$

where t is the year, AC is the avoided cost, and Inf is the inflation rate or some other price escalator.

3.4 Discount Rates

Discount rates were obtained for each IOU from their IRPs and weighted by sales to obtain a statewide average.

The model also requires a customer discount rate to use in customer cost/benefit calculations. While Ameren reports that they use their internal discount rate as the customer discount rate, we believe that such a low rate is inappropriate. Studies have found consumer discount rates to be quite high; they do not make decisions the same way that businesses do. We will use a 15 percent customer discount rate in the model, which is what we have used for past studies.

3.5 Inflation Rates

Inflation rates were obtained for each IOU from their IRPs and weighted by sales to obtain a statewide average.

3.6 Line Loss Rate

The PSC provided line loss rates for the four IOUs. We weighted these values by sales and estimated an average line loss rate of 5.5 percent.

4. Baseline Inputs

To develop Missouri statewide energy use by sector, we started with breakouts from the Energy Information Administration's State Energy Data System (EIA's SEDS, found at http://www.eia.doe.gov/states/_seds.html). The following table shows the SEDS data by fuel and sector, with subtotals for the commercial and industrial (C&I) sectors combined. For natural gas, consumption is further broken out into sales and transport, a distinction which may be important for program design. For this study, we have been directed to consider both natural gas sales and transport for savings potential.

Figure 2 - SEDS Energy Consumption Data

	NG Trillion Btu	Electricity Million kWh
Residential consumption	114.6	35,390
Commercial consumption	65.3	31,118
Industrial consumption	67.1	17,850
Subtotal C&I	*132.4*	*48,968*
Commercial sales (excludes transport)	50.6	
Industrial sales (excludes transport)	9.3	
Subtotal C&I	*59.9*	
Coml Transport	14.7	
Ind transport	57.8	
Subtotal C&I	72.5	

It is our understanding that the SEDS sector breakouts are determined by assigning rate classes to one sector or another in their entirety. Utilities typically have a residential rate class that applies to residential customers, so this approach should result in accurate estimates for the residential sector. However, because commercial and industrial rates are typically broken out by customer demand rather than by sector, we did not want to rely on SEDS for the commercial and industrial breakouts. Instead, we relied on SEDS for overall C&I consumption, but based the allocation of energy use between the sectors based on other data sources.

We found that Ameren, KCP&L and KCP&L/GMO each had detailed commercial and industrial baseline electricity analyses, which were provided to us through the PSC. These three utilities represent a majority of Missouri's electricity consumption. While we had concerns extrapolating the data to Missouri as a whole, we felt this approach was more reliable than SEDS' rate-class approach. In the absence of detailed sector breakouts from Empire and the state's publicly

owned utilities, we believe that this is the best approach. The following table shows the adjusted electricity consumption by sector.

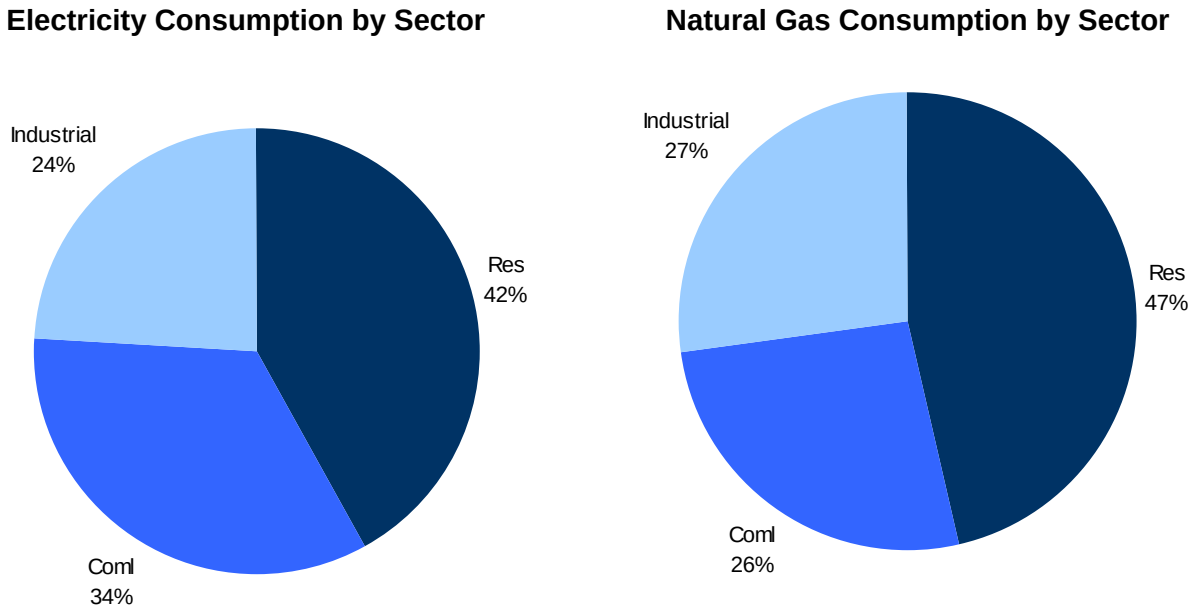
Figure 3 - Adjusted Energy Consumption data

	Electricity Million kWh
Commercial consumption	28,577
Industrial consumption	20,391
Subtotal C&I	48,968

There were no similar baseline studies available from the natural gas utilities detailing the natural gas market. The variation between energy use profiles in different utilities, combined with the variation in industrial customers between utilities, regions, and states, limited our ability to leverage data from other studies. In the absence of a better approach, we adopted the SEDS splits for natural gas.

The resulting breakdown of energy use by sector are shown in the charts below.

Figure 4 - Energy Consumption by Sector



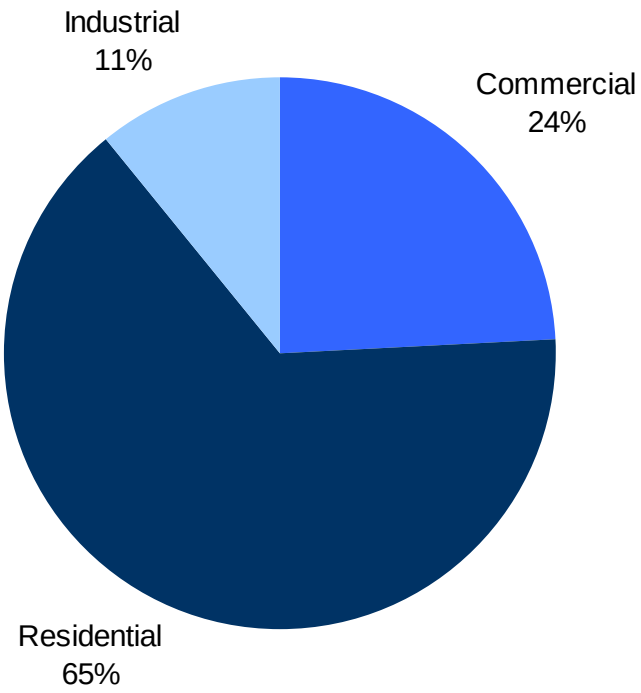
The following sections discuss how usage was broken out further by building type and end use.

4.1 Peak Demand Summary

Peak demand estimates were calibrated to a forecast of Missouri's peak demand for 2011 from the Federal Energy Regulatory Commission's National Assessment of Demand Response Potential, which estimates peak at 18,102 MW.

The following figure shows our estimate of how system peak breaks out by sectors, which was based on our energy use estimates by building type and end-use (discussed below), and load shape data from the IOUs.

Figure 5 - Contribution to Peak Demand by Sector



4.2 Residential Sector

4.2.1 Residential Building Types

The residential customer class in Missouri was disaggregated into four building types for our analysis:

- Single family (SF)
- Multifamily (MF)
- Single family low income (SF LI)
- Multifamily low income (MF LI)

While low income is not really a "building type," it represents a customer segment that is frequently targeted with specialized programs. For modeling program impacts, it is useful to split these customers out.

We prefer to break out energy use by building type using a billing data analysis, but billing data was not available. Instead, we turned to a variety of secondary sources. The most recent figure available from the EIA of the total number of residential electricity customers in Missouri is 2,686,746.[1] The total number of low income households (683,461) was taken from the "LIHEAP [Low Income Home Energy Assistance Program] Home Energy Notebook for Fiscal Year 2008."[2] This approach may understate the total number of low income households, as the figure is an average of the 2006 through 2008 state-level estimates. The ratio of low income single family and low income multi family households was approximated using the American Community Survey 2009 dataset accessed through the Missouri Census Data Center's Data Extraction Web Utility "Dexter,"[3] which allowed Missouri to be disaggregated into 41 regions. This dataset was also used to estimate the fraction of households in each customer class with utility natural gas, though this data was only complete at the Congressional district level. The total number of residential natural gas customers was given by EIA's SEDS as 1,352,015, or 50.32% of electricity customers. To inflate the energy consumption and customer counts from 2008 to 2011, ten year average growth rates of Missouri's residential electricity and natural gas

[1] http://www.eia.gov/cneaf/electricity/esr/esr_sum.html

[2] Table B-1, http://www.acf.hhs.gov/programs/ocs/liheap/guidance/information_memoranda/2008_notebook1.pdf

[3] Available from [http://mcdc2.missouri.edu/].

consumption and customer base from various EIA datasets[4] were applied to the above quoted figures to arrive at the final table below:

Figure 6-Number of Residential Customers by Class and Fuel (2011)

	SF	MF	SF-LI	MF-LI	Total
Electric	1,659,427	429,606	542,690	158,151	2,789,874
Gas	954,605	72,294	312,188	26,614	1,365,701

Figure 7 - Residential Baseline and Forecast

	Baseline	Source	Forecast 2011
Electric Customers	2,686,746	EIA 2008	2,789,874
Natural Gas Customers	1,352,015	SEDS 2008	1,365,701
Natural Gas Consumption (Dth)	114,600,000	SEDS 2008	105,001,999
Electric Consumption (MWh)	35,389,941	EIA 2008	38,554,849
Customer Accounts	2,686,746	EIA 2008	2,789,874
Accounts Eligible for LIHEAP	683,461	2008 LIHEAP	700,840

4.2.2 The Residential Energy Consumption Dataset

The RECS dataset is typically disaggregated by regions and further into census divisions. Missouri falls into the “Midwest” region and the southernmost corner of the “West North Central” census division. As can be seen from the EIA maps below, these census divisions span disparate climate zones. Because of this, to analyze weather sensitive end uses such as HVAC and water heating, RECS microdata was sorted by census divisions, heating degree days (HDD) and cooling degree days (CDD). To approximate the climate in Missouri, microdata within divisions 3, 4, and 6 with the characteristics of climate zone 3 (less than 2,000 CDD and between 4,000 and 5,499 HDD) were selected. This dataset spans Missouri, Kansas, Kentucky,

[4] Available from: [http://www.eia.doe.gov/cneaf/electricity/epa/customers_state.xls], [http://www.eia.doe.gov/cneaf/electricity/epa/sales_state.xls], [http://www.eia.gov/dnav/ng/hist/n3010mo2m.htm], [http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_smo_m.htm]

and the southern ends of Illinois and Indiana. For non-weather sensitive measures, we used the West North Central census division.

Figure 8 - Census Divisions

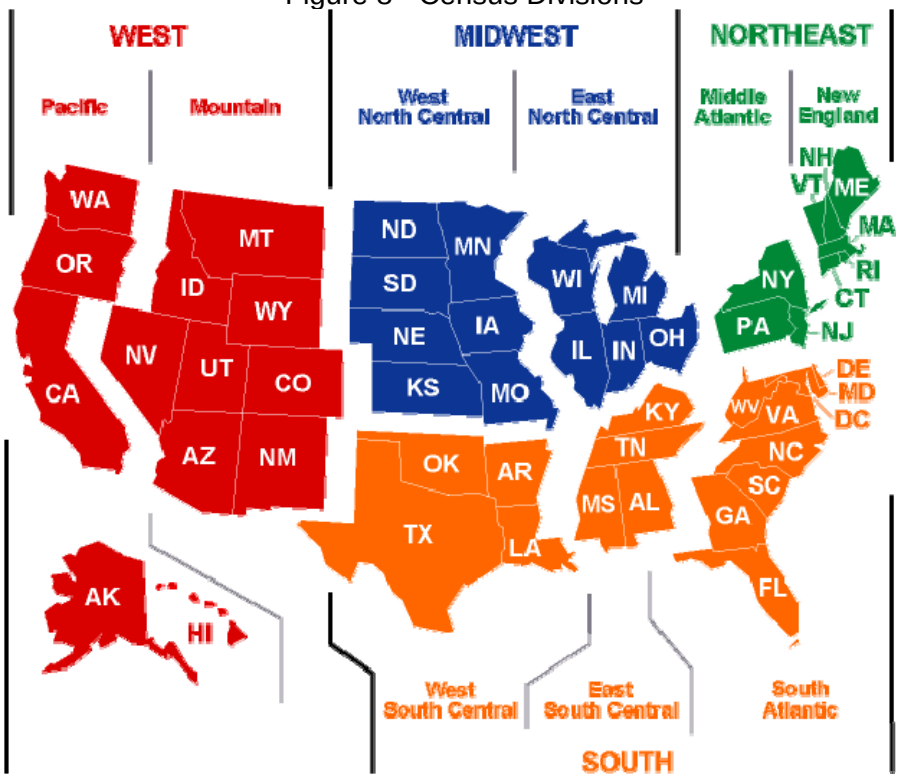
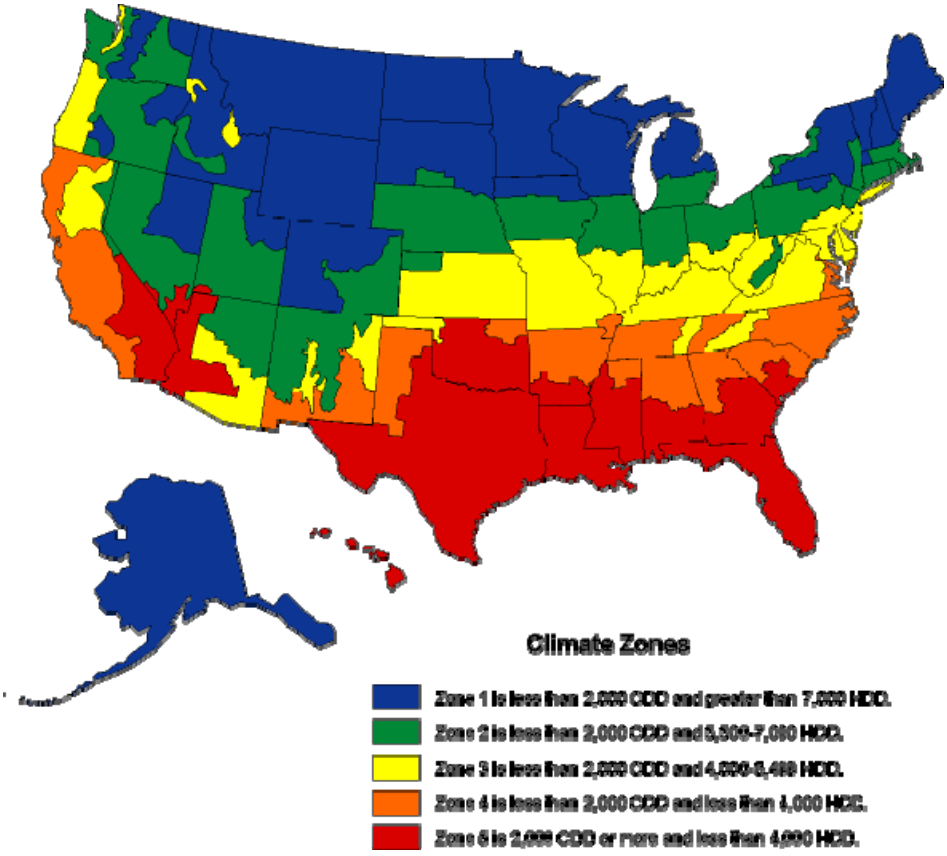


Figure 9 - Climate Zones



4.2.3 Residential End-use Saturations

The residential gas saturation estimates (the percentages of homes with the base measure installed) were calculated based on the 2006 “Missouri Statewide Residential Lighting and Appliance Efficiency Saturation Study” by KEMA (formerly RLW Analytics) and RECS 2005 microdata.

Figure 10- Residential Natural Gas End-Use Saturations

	SF	MF	SF LI	MF LI	
Furnace	0.765	0.765	0.765	0.765	RLW 2006
Boiler	0.008	0.008	0.008	0.008	RLW 2006
Room Heat	0.020	0.020	0.020	0.020	RLW 2006
Water Heating	0.765	0.765	0.765	0.765	RLW 2006
Clothes Dryer	0.119	0.119	0.119	0.119	RLW 2006
Cooking	0.356	0.344	0.456	0.391	RECS microdata, Region 2
Other	0.047	0.015	0.025	0.010	RECS microdata, Region 2

Residential electric saturations were calculated based on RLW 2006, the 2010 Ameren UE "Demand Side Management Market Potential Study" by Global Energy Partners, and the Energy Information Administration's most recent Residential Energy Consumption Survey (RECS) microdata from 2005.

Figure 11 - Residential Electric End-Use Saturation

	SF	MF	SF LI	MF LI	Sources & Notes
10.7 SEER Split-System Air Conditioner	74.0%	73.1%	74.0%	73.1%	Ameren 2010 and RLW 2006 - 85% percentage of respondents with CAC.
Early Replace 10 SEER Split-Sys AC	13.1%	15.5%	13.1%	15.5%	Ameren 2010 and RLW 2006 - 15% respondents with CAC.
Room Air Conditioner - EER 9.7	5.1%	7.7%	5.1%	7.7%	Ameren 2010 and RLW 2006 - 85% percentage of respondents with RAC.
Early Replacement RAC- EER 9.0	0.9%	1.4%	0.9%	1.4%	Ameren 2010 and RLW 2006 - 15% of respondents with RAC.
Dehumidifier (EF =1.20)	27%	13%	27.0%	13.0%	Ameren 2010 --> all respondents with dehumidifier
Furnace Fans	87.0%	87.0%	87.0%	87.0%	RLW 2006
Resistance Space Heating	3.9%	3.9%	3.9%	3.9%	RLW 2006
Electric Furnace	15.0%	15.0%	15.0%	15.0%	RLW 2006
Ltg 60-Watt incandescent, 1.8 hr/day	100.0%	100.0%	100.0%	100.0%	RLW 2006
Lighting 15 Watt CFL, 1.8 hours/day	100.0%	100.0%	100.0%	100.0%	RLW 2006
Lighting Fluorescent Tube, 1.8 hrs/day	100.0%	100.0%	100.0%	100.0%	RLW 2006
Ltg: HID, Halogen, Fluor, 1.8 hrs/day	100.0%	100.0%	100.0%	100.0%	RLW 2006
Refrigerator (18 cf top-mount no TTD)	44.6%	44.6%	44.6%	44.6%	RLW 2006 --> 85% of 15-18.99 cf fridge with TF
Early Replacement of18 cf top mount	7.9%	7.9%	7.9%	7.9%	RLW 2006 --> 15% of 15-18.99 cf fridge with TF
Refrigerator (21 cf SS, no TTD)	40.4%	40.4%	40.4%	40.4%	RLW 2006 --> 85% of 19-21.99 cf fridge with SS
Early Replacement 21 cf SS	7.1%	7.1%	7.1%	7.1%	RLW 2006 --> 15% of 19-21.99 cf fridge with SS
Second Refrigerator	32.7%	12.0%	16.4%	6.0%	RLW 2006 for SF, Ameren 2010 for MF; LI estimated based on Ameren 2010
Freezer	45.9%	16.8%	38.3%	10.5%	RLW 2006 for SF, ratio to derive MF taken from SF/MF secondary fridge ownership --> 85% respondents with freezer; ; LI from ratios of SF LI/ SF and MF LI/ MF from RECS CZ 3, Division 3, 4 & 6
Early Replacement Freezer	8.1%	3.0%	8.1%	3.0%	RLW 2006 for SF, ratio to MF taken from SF/MF secondary fridge ownership -->15% respondents with freezer
40 gal. Water Heating (EF=0.88)	24.6%	33.4%	26.8%	28.9%	SF based on RLW 2006, assuming SF/MF ratio from Ameren, minus 5% from both for ER; LI from ratios of SF LI/ SF and MF LI/ MF from RECS CZ 3, Division 3, 4 & 6
Early Replacement Water Heating to Heat Pump Water Heater	1.3%	1.8%	1.4%	1.5%	SF based on RLW 2006, assuming SF/MF ratio from Ameren 2010, 5% from both for ER; LI from ratios of SF LI/ SF and MF LI/ MF from RECS CZ 3, Division 3, 4 & 6
Clothes washer (MEF=1.26)	98.0%	68.0%	98.0%	68.0%	Ameren 2010
Clothes Dryer (EF=3.01)	87.7%	63.8%	79.7%	57.8%	SF from RLW 2006, MF derived from ratio of SF/MF from Ameren 2010; LI from ratios of SF LI/ SF and MF LI/ MF from RECS CZ 3, Division 3, 4 & 6
Dishwasher (EF=0.65)	77.0%	75.0%	52.9%	31.5%	SF and MF from Ameren 2010, multiplied by the % of electric WH; LI from ratios of SF LI/ SF and MF LI/ MF from RECS CZ 3, Division 3, 4 & 6
Single Speed Pool Pump (RET)	0.4%	0.4%	0.0%	0.0%	RLW 2006; LI assumed to be 10%
Two Speed Pool Pump (1.5 hp) (ROB)	0.4%	0.4%	0.0%	0.0%	RLW 2006; LI assumed to be 10%

	SF	MF	SF LI	MF LI	Sources & Notes
Plasma Screen TV	11.0%	8.0%	1.1%	0.8%	Ameren 2010 for SF/MF, assumption for LI
LCD Screen TV	42.0%	35.0%	4.2%	3.5%	Ameren 2010 for SF/MF, assumption for LI
Other TV	87.0%	78.0%	87.0%	78.0%	Ameren 2010 for SF/MF, assumption for LI
Laptop Computer	46.0%	56.0%	46.0%	56.0%	Ameren 2010
Desktop Computer	47.0%	35.0%	47.0%	35.0%	Ameren 2010
Cooking	81.4%	81.4%	81.4%	81.4%	RECS microdata, CZ 3 in Division 3, 4 & 6
Miscellaneous	100.0%	100.0%	100.0%	100.0%	By definition

4.2.4 Residential Energy Intensities

End-use energy intensities for the residential electricity sector were estimated from a variety of source, as noted in the table below.

Figure 12 - Residential Electric End-Use Energy Intensities (kWh/home with the installed measure)

	SF	MF	SF LI	MF LI	Sources & Notes
10.7 SEER Split-System Air Conditioner	3415	2433	3415	2433	ENERGYSTAR Calculator - SEER 10.7 (RLW 2006); St. Louis, MO; weighted average of 2.5 and 3 ton EUI for SF (RLW 2006 average tonnage is 2.84 ton), ratio of SF/MF floorspace for MF from Ameren 2010 Volume 3 Appendix B. Calibrated.
Early Replace 10 SEER Split-Sys AC	3638	2592	3638	2592	ENERGYSTAR Calculator- 3 ton for SF 2.5 ton for MF. 10 SEER, used ENERGYSTAR calculator for St. Louis, MO; Calibrated.
Room Air Conditioner - EER 9.7	1785	2293	1730	1441	ENERGYSTAR Calculator, 9.7 EER, St. Louis, MO; Units/ home from RECS microdata, CZ3 in Division 3, 4 & 6 Calibrated.
Early Replacement RAC-EER 9.0	1923	2470	1864	1553	ENERGYSTAR Calculator, 9.0 EER, St. Louis, MO; Units/ home from RECS microdata, CZ3 in Division 3, 4 & 6 Calibrated.
Dehumidifier (EF =1.20)	1064	1064	1064	1064	ENERGYSTAR Calculator- 35-45 pints, 1.2 EF
Furnace Fans	983	983	983	983	Assumed 350 watts, 1997 full load heating hours and 1178 cooling hours (ENERGYSTAR Calculator ASHP); Calibrated.
Resistance Space Heating	14,805	10,048	17,729	7,612	RECS microdata, CZ 3 in Division 3, 4 & 6. Note that LBNL "Home Energy Saver" gave preliminary heating estimates of 18,230 kWh/ yr for baseboard heat, using SF housing characteristics from Ameren 2010 Vol 3 Appendix B, St. Louis. Calibrated.
Electric Furnace	11,694	8,308	9,348	6,293	RECS microdata, CZ 3 in Division 3, 4 & 6. Note that LBNL "Home Energy Saver" gave preliminary heating estimates of 18,553 kWh/ yr for electric furnace heat, using SF housing characteristics from Ameren 2010 Vol 3 Appendix B, St. Louis. Calibrated.
Lighting 60-Watt incandescent, 1.8 hr/day	1528	860	1528	860	Hours of use (1.8 hrs/day) from CA Upstream Lighting Evaluation Program; lamps/HH and average watts/bulb from RLW 2006, updated to account for Ameren's findings that CFL and Halogen penetration has increased; incandescent is 37.22 bulbs/HH (63%) and 62.5 watts. MF diminished to account for Ameren's findings that MF averages 27/48 as many bulbs/HH as SF
Lighting 20 Watt CFL, 1.8 hours/day	172	97	172	97	Hours of use (1.8 hrs/day) from CA Upstream Lighting Evaluation Program; lamps/HH and average watts/bulb from RLW 2006, updated to account for Ameren's findings that CFL and Halogen penetration has increased; CFLs average 12.44 bulbs/HH (21%) and 21 watts. MF diminished to account for Ameren's findings that MF averages 27/48 as many bulbs/HH as SF
Lighting Fluorescent Tube, 1.8 hrs/day	83	46	83	46	Hours of use (1.8 hrs/day) from CA Upstream Lighting Evaluation Program; lamps/HH and average watts/bulb from RLW 2006, updated to account for Ameren's findings that CFL and Halogen penetration has increased; Fluorescent is 21.05W and 5.97 bulbs/home. MF diminished to account for Ameren's findings that MF averages 27/48 as many bulbs/HH as SF

	SF	MF	SF LI	MF LI	Sources & Notes
Lighting HID, Halogen, 1.8 hrs/day	116	65	116	65	Hours of use (1.8 hrs/day) from CA Upstream Lighting Evaluation Program; lamps/HH and average watts/bulb from RLW 2006, updated to account for Ameren's findings that CFL and Halogen penetration has increased; Halogen is 45.6W and 3.55 bulbs/home; HID is 251.9W and 0.06 bulbs/home. MF diminished to account for Ameren's findings that MF averages 27/48 as many bulbs/HH as SF
Refrigerator (18 cf top-mount no TTD)	878	777	878	777	RLW 2006, multiplied by fridges/home, taking into account fridges for recycling
Early Replacement of18 cf top mount	878	777	878	777	RLW 2006, multiplied by fridges/home, taking into account fridges for recycling
Refrigerator (21 cf SS, no TTD)	1,156	1,023	1,156	1,023	RLW 2006, multiplied by fridges/home, taking into account fridges for recycling
Early Replacement 21 cf SS	1,156	1,023	1,156	1,023	RLW 2006, multiplied by fridges/home, taking into account fridges for recycling
Second Refrigerator	791.4	791.4	791.4	791.4	RLW 2006
Freezer	549	549	549	549	RLW 2006
Early Replacement Freezer	549	549	549	549	RLW 2006
40 gal. Water Heating (EF=0.88)	4,516	3447	4516	3447	DOE/LBNL Water Heater calculator; EF .89 (RLW 2006); gallons per day based on 21.78 gallons daily recovery load per person (PG&E 2007) multiplied by average people/ home 2.7 for SF and 1.9 for MF (Ameren 2010).
Early Replacement Water Heating to Heat Pump Water Heater	4,516	3,447	4,516	3,447	DOE Water calculator; EF .89 (RLW 2006); gallons per day based on 21.78 gallons daily recovery load per person (PG&E 2007) multiplied by average people/ home 2.7 for SF and 1.9 for MF (Ameren 2010).
Clothes washer (MEF=1.26)	80.7	81	81	81	ENERGYSTAR Calculator- Energy used with beyond water heating
Clothes Dryer (EF=3.01)	969	583	776	583	Assumptions from [http://www.energy.ca.gov/2008publications/CEC-400-2008-013/CEC-400-2008-013-D.PDF] (653); [http://www.calmac.org/events/Final_DEER_Presentation_-_Complete_.ppt#347,29,Non-Weather Sensitive Measures; LBNL:Residential Measures; [http://enduse.lbl.gov/SharedData/standards/resstds.DOC]. Based on 416 cycles/yr SF and 250 cycles/yr MF; SF LI is average of SF and MF
Dishwasher (EF=0.65)	162	162	162	162	ENERGYSTAR Calculator
Single Speed Pool Pump (RET)	822	822	822	822	Used CEC HERS EUI, then divided by 3.25 to account for less run time in MO than CA
Two Speed Pool Pump (1.5 hp) (ROB)	357	357	357	357	Using pump affinity law: [http://clubp.info/media/1.Pool%20Pump%20Energy%20Savings%20Calculator.xls], then divided by 3.25 to account for less run time in MO
Plasma Screen TV	931	1118	946	946	Calculated from LBNL 4/2008 UEC for all TV types
LCD Screen TV	450	500	460	460	Calculated from LBNL 4/2008 UEC for all TV types

	SF	MF	SF LI	MF LI	Sources & Notes
Other TV	127	111	118	118	LBNL4/2007 UEC, adjusted by average number of laptops per home
Laptop Computer	192	168	170	170	LBNL4/2007 UEC, adjusted by average number of desktops/home
Desktop Computer	730	572	685	1129	CA HERS Topic Report 2008 - [http://www.energy.ca.gov/2008publications/CEC-400-2008-013/CEC-400-2008-013-D.PDF]
Cooking	316	316	316	316	Assumed 10%, calibrated to intensity targets
Miscellaneous	1536	1132	1434	1033	ENERGYSTAR Calculator - SEER 10.7 (RLW 2006); St. Louis, MO; weighted average of 2.5 and 3 ton EUI for SF (RLW 2006 average tonnage is 2.84 ton), ratio of SF/MF floorspace for MF from Ameren 2010 Volume 3 Appendix B.

Residential gas end-use energy intensities were taken from RECS microdata. For weather-sensitive measures we used data from climate zone 3 in census divisions 3, 4 and 6. For non-weather sensitive measures, we used the West North Central census division.

Figure 13 – Residential Natural Gas Energy Intensity (kBtu/end-use sq ft)

EUI	SF	MF	SF LI	MF LI	
Furnace	64	61	63	75	RECS microdata, CZ 3 in Division 3, 4 & 6, calibrated
Boiler	113	56	117	63	RECS microdata, CZ 3 in Division 3, 4 & 7, calibrated
Room Heat	57	22	89	22	RECS microdata, CZ 3 in Division 3, 4 & 8
Water Heating	31	15	28	23	RECS microdata, CZ 3 in Division 3, 4 & 8
Clothes Dryer	10	10	4	4	RECS microdata, West North Central Midwest
Cooking	6	5	5	6	RECS microdata, West North Central Midwest
Other	14	14	1	1	RECS microdata, West North Central Midwest
Total (kBtu/sq ft)	79	62	75	79	

4.2.5 Residential Energy Use

The following tables and figures show the number of households by building type and energy consumption by building type and end-use for electricity and natural gas. Energy use is calculated by multiplying together the saturations, EUIs, and number of households.

Figure 14- Residential Electric Housing Stock and Energy Use by Building Type and End-Use

	SF	MF	SF LI	MF LI	Total
Households	1,659,427	429,606	542,690	158,151	2,789,874
Energy Consumption (MWh)					
10.7 SEER Split-System Air Conditioner	4,190,376	764,090	1,370,397	281,284	6,606,146
Early Replace 10 SEER Split-Sys AC	787,747	172,369	257,620	63,454	1,281,190
Room Air Conditioner - EER 9.7	151,039	75,349	47,894	17,435	291,717
Early Replacement RAC- EER 9.0	28,717	14,326	9,106	3,315	55,465
Dehumidifier (EF =1.20)	476,720	59,423	155,904	21,875	713,923
Furnace Fans	1,419,121	367,394	464,101	135,248	2,385,865
Resistance Space Heating	948,768	166,710	371,563	46,491	1,533,532
Electric Furnace	2,902,788	533,874	758,882	148,872	4,344,415
Ltg 60-Watt incandescent, 1.8 hr/day	2,535,853	369,283	829,311	135,944	3,870,390
Lighting 20 Watt CFL, 1.8 hours/day	284,824	41,477	93,147	15,269	434,718
Lighting Fluorescent Tube, 1.8 hrs/day	137,009	19,952	44,807	7,345	209,113
Ltg: HID, Halogen 1.8 hrs/day	193,185	28,133	63,178	10,356	294,853
Refrigerator (18 cf top-mount no TTD)	649,886	148,873	212,535	54,805	1,066,100
Early Replacement of 18 cf top mount	114,686	26,272	37,506	9,671	188,135
Refrigerator (21 cf SS, no TTD)	775,226	177,586	253,525	65,375	1,271,711
Early Replacement 21 cf SS	136,805	31,339	44,740	11,537	224,420
Second Refrigerator	429,440	40,799	70,221	7,510	547,969
Freezer	418,465	39,756	114,132	9,083	581,436
Early Replacement Freezer	73,847	7,016	24,150	2,583	107,596
40 gal. Water Heating (EF=0.88)	1,844,903	493,972	656,806	157,821	3,153,503
Early Replacement Water Heating to Heat Pump Water Heater	97,100	25,999	34,569	8,306	165,974
Clothes washer (MEF=1.26)	131,237	23,575	42,919	8,679	206,410
Clothes Dryer (EF=3.01)	1,410,203	159,611	335,707	53,282	1,958,803
Dishwasher (EF=0.65)	206,997	52,197	46,536	8,059	313,789
Single Speed Pool Pump (RET)	5,246	1,358	-	-	6,604
Two Speed Pool Pump (1.5 hp) (ROB)	2,280	590	-	-	2,870
Plasma Screen TV	169,942	38,407	5,648	1,197	215,194
LCD Screen TV	313,318	75,106	10,474	2,544	401,442
Other TV	182,989	37,028	55,854	14,593	290,464
Laptop Computer	146,511	40,528	42,484	15,072	244,596
Desktop Computer	568,989	85,982	174,628	62,467	892,066
Cooking	427,028	110,553	139,653	40,698	717,931
Miscellaneous	2,548,543	486,326	778,320	163,320	3,976,509

Figure 15- Residential Electricity Use by End Use

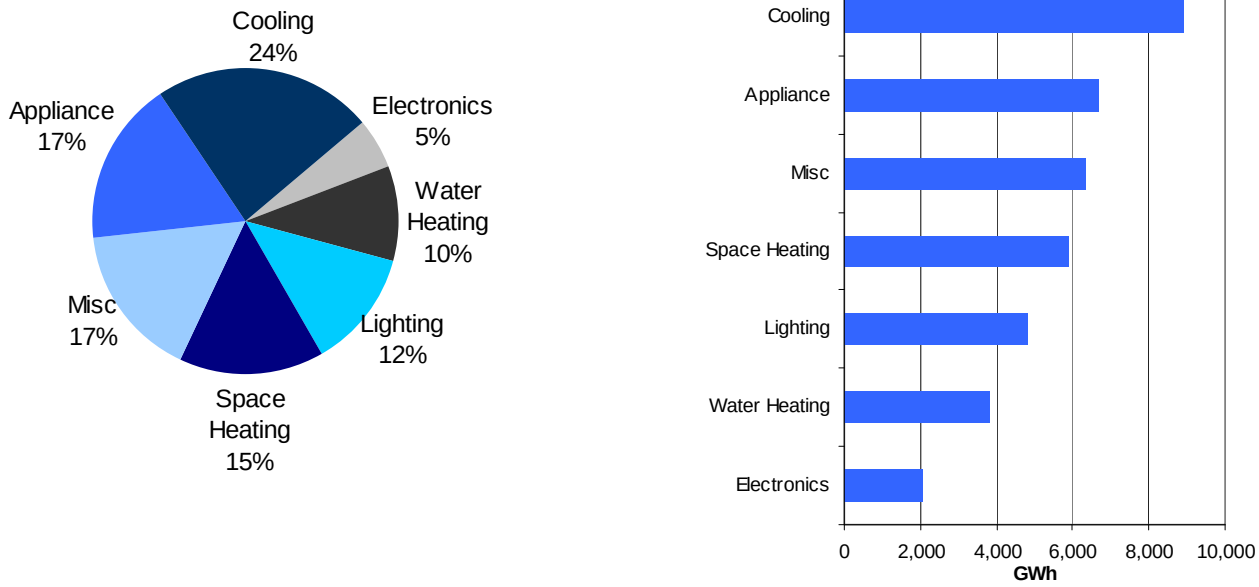


Figure 16- Residential Electricity Use by Building Type

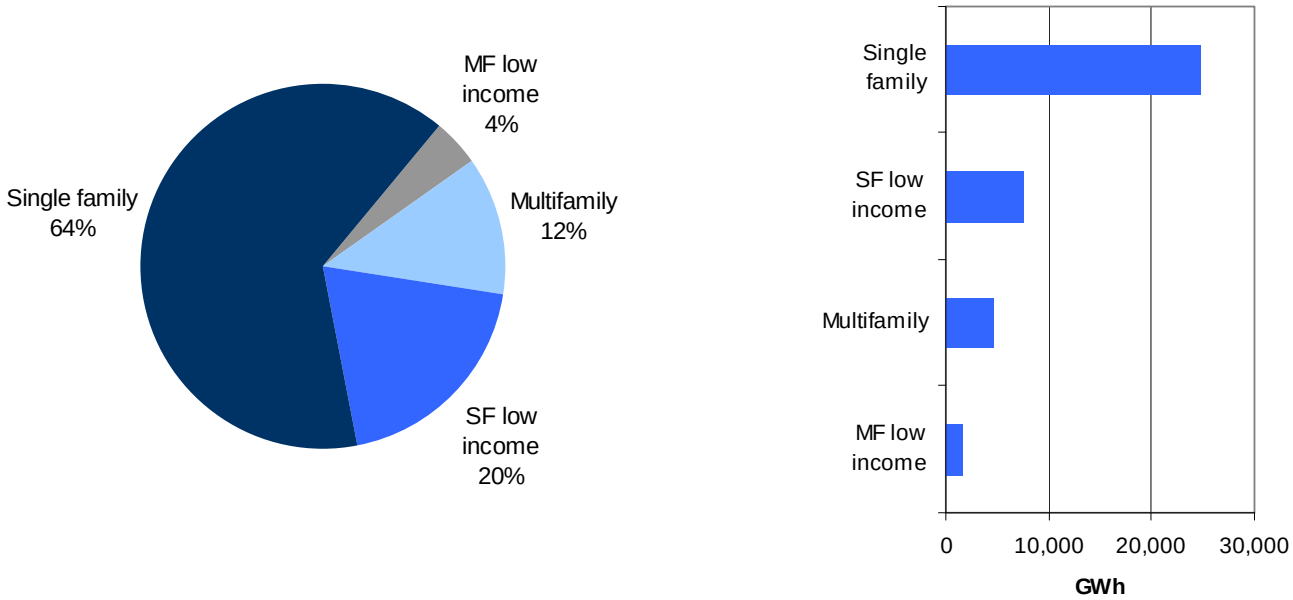


Figure 17 - Residential Natural Gas Housing Stock and Energy Use by Building Type and End-Use

	Single Family	Multifamily	Single Family Low Income	Multifamily Low Income	Total
Homes	954,605	72,294	312,188	26,614	1,339,087
Energy Consumption (Dth)					
Furnace	40,284,286	2,899,250	13,003,042	1,319,331	57,505,910
Boiler	698,242	26,249	236,275	10,839	971,605
Room Heat	916,059	27,138	466,164	9,990	1,419,352
Water Heating	19,540,709	724,428	5,696,333	411,754	26,373,224
Clothes Dryer	1,086,837	82,308	146,601	12,498	1,328,245
Cooking	2,006,944	125,108	696,707	64,328	2,893,088
Other	13,082,738	990,782	402,723	34,332	14,510,575
Total	77,615,818	4,875,264	20,647,846	1,863,072	105,001,999

Figure 18 - Residential Natural Gas Use by End Use

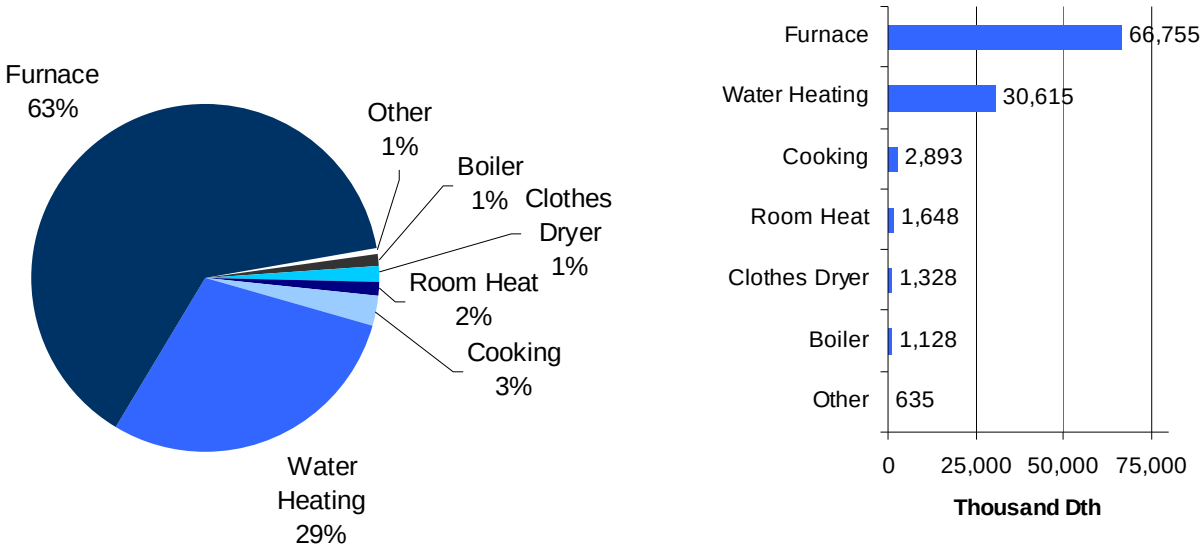
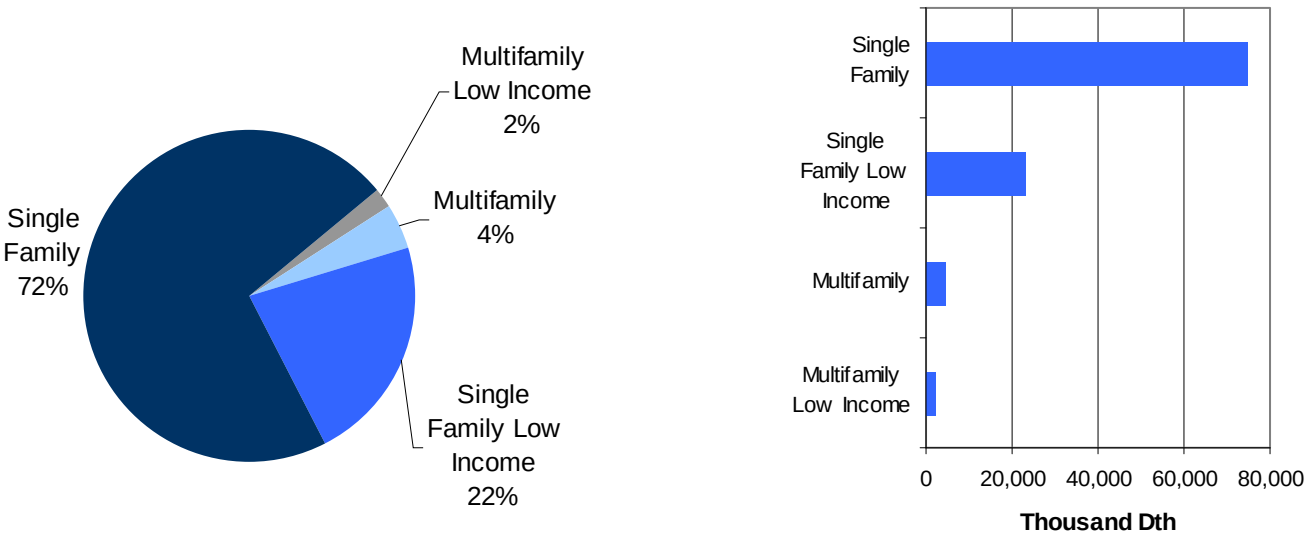


Figure 19 - Residential Natural Gas Use by Building Type



4.2.6 Residential Peak Demand

Residential load shape data from KEMA's end-use databases was utilized to allocate annual energy usage to time-of-use (TOU) periods. Peak period usage, developed on a sector-specific and end-use basis, were calibrated across all sectors to equal the Missouri summer peak. Residential peak demand was estimated to be 11,761 MW. The following table shows the contribution to residential peak demand by building type and end use.

Figure 20 - Residential Peak Demand by Building Type and Sector (MW)

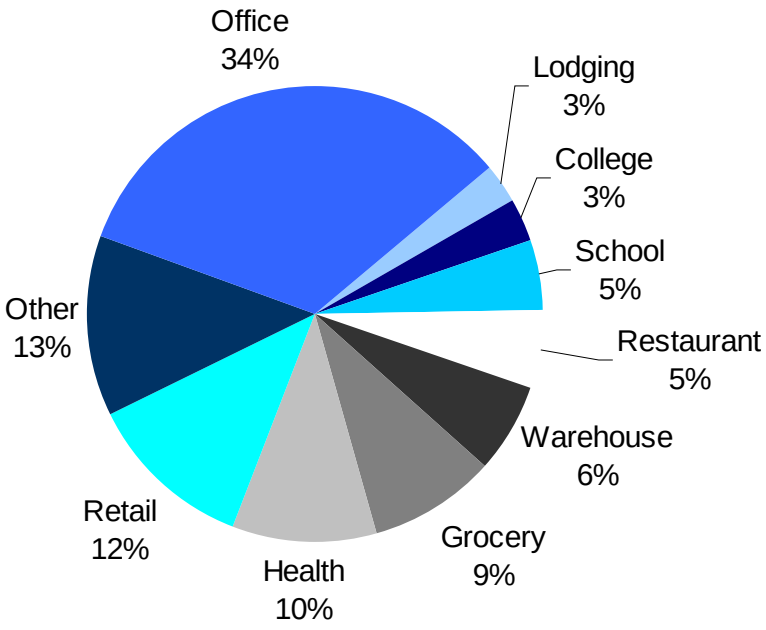
Peak demand estimates	SF	MF	SF LI	MF LI	Total
10.7 SEER Split-System Air Conditioner	4,032	735	1,319	271	6,086
Early Replace 10 SEER Split-Sys AC	758	166	248	61	1,172
Room Air Conditioner - EER 9.7	145	72	46	17	264
Early Replacement RAC- EER 9.0	28	14	9	3	50
Dehumidifier (EF =1.20)	149	19	49	7	217
Furnace Fans	1,365	353	447	130	2,165
Resistance Space Heating	0	0	0	0	0
Electric Furnace	0	0	0	0	0
Ltg 60-Watt incandescent, 1.8 hr/day	170	25	56	9	251
Lighting 20 Watt CFL, 1.8 hours/day	19	3	6	1	28
Lighting Fluorescent Tube, 1.8 hrs/day	9	1	3	0	14
Ltg: HID, Halogen, 1.8 hrs/day	13	2	4	1	19
Refrigerator (18 cf top-mount no TTD)	70	16	23	6	110
Early Replacement of18 cf top mount	12	3	4	1	19
Refrigerator (21 cf SS, no TTD)	84	19	27	7	131
Early Replacement 21 cf SS	15	3	5	1	23
Second Refrigerator	47	4	8	1	59
Freezer	46	4	13	1	63
Early Replacement Freezer	8	1	3	0	12
40 gal. Water Heating (EF=0.88)	136	36	48	12	221
Early Replacement WH to Heat Pump WH	7	2	3	1	12
Clothes washer (MEF=1.26)	13	2	4	1	20
Clothes Dryer (EF=3.01)	134	15	32	5	181
Dishwasher (EF=0.65)	22	6	5	1	33
Single Speed Pool Pump (RET)	0	0	0	0	1
Two Speed Pool Pump (1.5 hp) (ROB)	0	0	0	0	0
Plasma Screen TV	16	4	1	0	20
LCD Screen TV	29	7	1	0	37
Other TV	17	3	5	1	26
Laptop Computer	12	3	3	1	19
Desktop Computer	46	7	14	5	67
Cooking	84	22	27	8	133
Miscellaneous	207	39	63	13	310
Total	7,697	1,589	2,476	566	11,761

4.3 Commercial Sector

4.3.1 Commercial Building Types

For the commercial electricity breakdown, we turned to the baseline studies performed by Ameren, KCP&L and KCP&L-GMO. The sales data by building type for the three utilities was combined and the resulting distribution of commercial electricity use by building type was applied to total Missouri consumption, developed as discussed above. The following chart shows the breakdown of commercial electricity use by building type.

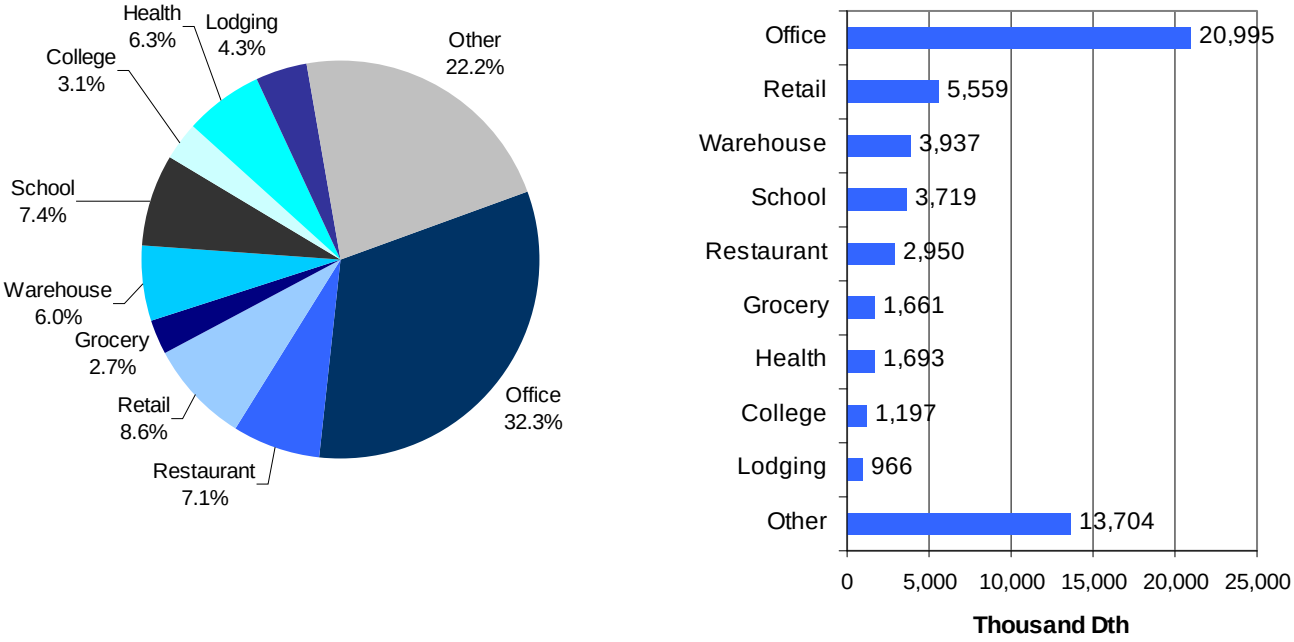
Figure 21 - Commercial Electricity Use by Building Type



Lacking both natural gas billing data and a detailed gas market analysis, we looked to other gas studies we did for which we had access to utility billing data by NAICS (North American Industry Classification System) code. We have found the distribution of energy use across building types to be very similar across different regions. We took the energy use distribution by building type for Xcel Energy's Colorado service territory and for the state of Connecticut and reweighted them to reflect the distribution of floorspace by building type in Missouri (for example, if offices

represented 36 percent of Xcel's floorspace compared to 24 percent of Missouri floorspace, we scaled back Xcel's office energy use by a third before calculating the distribution of energy use). The distributions for Xcel and Connecticut were averaged and applied to Missouri commercial natural gas use, developed as discussed above. The following chart shows commercial natural gas use by building type.

Figure 22 - Commercial Natural Gas Use by Building Type



4.3.2 Commercial End-Use Definitions

Commercial sector electricity and natural gas consumption was disaggregated into end-use consumption of the following base measures:

Commercial Electric Base Measures
Lighting 4 Lamp 4' T12
Lighting 2 Lamp 4' T12
Lighting 2 Lamp 8' T12
Lighting Incand-CFL Screw-in
Lighting CFL-LED Screw-in
Lighting Incand-CFL Hardwire
Lighting CFL-LED Hardwire
Lighting High Bay
Lighting 4 Lamp 4' T8
Lighting 2 Lamp 4' T8
Lighting Exit Signs
Outdoor Lighting
Street Lighting
Chillers
DX Packaged Systems
Ventilation Motors 5 hp
Ventilation Motors 15 hp
Ventilation Motors 40 hp
Non-commercial refrigerators
Refrigeration System
Desktop PC
Monitor, 17" CRT
Monitor, 17" LCD
Copier
Laser Printer
Data Centers
Water Heating
Vending Machines
Cooking - Convection Oven
Cooking - Fryer
Cooking - Steamer
Cooking - Hot Food Holding Cabinets
Miscellaneous

Commercial Gas Base Measures
Heating
Water Heating
Cooking - Fryer
Cooking - Steamer
Cooking - Convection Oven
Cooking - Griddle
Cooking - Range
Other

4.3.3 Commercial End-use Saturations

For the commercial sector electricity saturations, we again turned to the commercial baseline estimates done for Ameren, KCP&L and KCP&L-GMO. Each study broke out energy use by major end use (lighting, cooling, etc.). These end-use splits were weighted and used as the basis for the base measure saturations.

Because some end uses have several base measures, we needed to break out the end-use saturations developed from the utility studies into the detailed base measures. To do this, we turned to detailed on-site data from a recent Rhode Island study. This allowed us to break up the overall cooling saturation, for example, into chillers and DX systems. No Missouri data was found to inform these splits at the necessary level of detail. For some measures, the utility data was not available or useable (for example, outdoor lighting could not be disaggregated from indoor lighting). We turned to the U.S. DOE's Commercial Building Energy Consumption Survey (CBECS) for some measures that fell outside the definitions of the utility studies, and used saturations from previous studies for outdoor lighting. Exit signs and miscellaneous were assumed to have 100 percent saturation.

For the natural gas baselines we relied on the U.S. DOE Commercial Building Energy Consumption Survey (CBECS) for end use saturation estimates.

Figure 23 - Commercial Saturations for Electric Base Measures

	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other
Lighting 4 Lamp 4' T12	5.9%	4.7%	4.1%	0.0%	21.8%	0.0%	0.6%	0.3%	0.0%	3.4%
Lighting 2 Lamp 4' T12	9.9%	1.9%	8.3%	12.5%	13.8%	0.0%	1.0%	1.2%	1.9%	2.3%
Lighting 2 Lamp 8' T12	4.8%	4.0%	5.6%	47.5%	7.6%	0.0%	0.0%	0.0%	0.0%	1.0%
Lighting Incand-CFL Screw-in	15.8%	24.5%	10.7%	5.0%	1.1%	4.8%	0.6%	3.8%	4.7%	32.9%
Lighting CFL-LED Screw-in	5.5%	13.3%	0.5%	0.0%	1.8%	0.3%	0.0%	6.0%	8.7%	5.3%
Lighting Incand-CFL Hardwire	7.1%	5.8%	3.1%	1.1%	0.1%	0.3%	3.7%	10.5%	23.6%	7.2%
Lighting CFL-LED Hardwire	19.6%	7.5%	0.2%	0.7%	0.1%	0.2%	6.2%	17.2%	61.0%	5.7%
Lighting High Bay	0.6%	0.0%	9.1%	9.3%	13.8%	16.0%	2.8%	0.2%	0.0%	14.7%
Lighting 4 Lamp 4' T8	12.6%	13.1%	18.7%	0.0%	31.0%	42.9%	35.1%	26.9%	0.0%	18.9%
Lighting 2 Lamp 4' T8	18.2%	25.1%	39.6%	24.0%	9.0%	35.5%	49.9%	33.9%	0.0%	8.6%
Lighting Exit Signs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Outdoor Lighting	67.0%	100.0%	81.5%	47.3%	88.7%	79.2%	100.0%	96.7%	100.0%	88.4%
Street Lighting										100.0%
Chillers	35.4%	4.6%	12.3%	0.0%	7.2%	21.4%	74.7%	76.7%	27.9%	14.6%
DX Packaged Systems	57.2%	88.2%	73.8%	94.3%	72.8%	62.6%	9.3%	18.0%	67.9%	69.9%
Ventilation Motors 5 hp	86.0%	72.8%	73.3%	49.3%	68.3%	77.7%	100.0%	47.7%	100.0%	83.6%
Ventilation Motors 15 hp	5.5%	12.1%	9.0%	0.0%	0.0%	42.0%	37.1%	14.3%	0.0%	12.2%
Ventilation Motors 40 hp	20.2%	0.0%	13.6%	0.0%	5.7%	0.0%	22.3%	0.0%	0.0%	52.0%
Non-commercial refrigerators	67.3%	44.0%	53.1%	43.4%	49.0%	60.3%	73.1%	89.7%	61.1%	60.0%
Refrigeration System	67.8%	87.7%	70.1%	96.7%	67.1%	86.4%	97.2%	96.6%	86.1%	63.5%
Desktop PC	91.0%	72.8%	84.4%	67.0%	68.1%	93.0%	37.1%	94.9%	96.4%	79.1%
Monitor, 17" CRT	38.9%	31.5%	54.9%	37.4%	71.2%	69.2%	37.1%	42.2%	4.9%	63.5%
Monitor, 17" LCD	16.7%	47.0%	12.8%	61.7%	15.6%	84.0%	37.1%	24.8%	63.5%	22.8%
Copier	94.2%	14.2%	59.0%	45.7%	68.1%	85.7%	93.0%	94.9%	42.4%	49.2%
Laser Printer	94.2%	72.6%	85.8%	87.6%	68.1%	93.0%	93.0%	94.9%	86.0%	65.7%
Data Centers	0.7%	0.1%	0.0%	0.1%	0.2%	0.3%	1.3%	1.1%	0.1%	0.1%
Water Heating	36.1%	21.2%	35.2%	8.1%	30.9%	27.0%	27.0%	9.2%	8.0%	34.7%
Vending Machines	62.3%	25.0%	48.5%	53.6%	52.0%	71.7%	96.6%	95.9%	84.0%	36.9%
Convection Oven	0.0%	67.9%	12.8%	38.6%	0.0%	84.0%	84.0%	0.0%	63.5%	22.8%
Fryer	1.4%	21.4%	0.0%	38.6%	0.0%	0.0%	0.0%	0.0%	0.0%	22.8%
Steamer	1.4%	38.1%	0.0%	61.7%	0.0%	0.0%	0.0%	24.8%	0.0%	22.8%
Hot Food Holding Cabinets	1.4%	67.9%	6.4%	51.0%	0.0%	65.5%	65.5%	24.8%	49.7%	22.8%
Heating	20.9%	17.0%	19.6%	11.6%	14.9%	9.0%	9.0%	6.1%	56.6%	22.8%
Miscellaneous	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 24 - Commercial Natural Gas Saturations

End Use	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other
Heating	71%	74%	74%	98%	88%	79%	89%	83%	39%	82%
Water Heating - high standby applications	51%	79%	57%	75%	55%	77%	85%	80%	94%	69%
Water Heating - low standby applications	51%	79%	57%	75%	55%	77%	85%	80%	94%	69%
Cooking - Fryer	21%	88%	0%	66%	0%	48%	0%	34%	36%	6%
Cooking - Steamer	0%	17%	0%	33%	0%	69%	0%	80%	36%	1%
Cooking - Convection Oven	31%	31%	28%	33%	0%	69%	0%	80%	36%	16%
Cooking - Griddle	21%	73%	0%	0%	0%	42%	0%	34%	36%	8%
Cooking - Range	23%	87%	0%	0%	0%	2%	0%	67%	36%	29%
Other	0%	6%	0%	0%	11%	6%	10%	10%	6%	1%

4.3.4 Commercial Energy Intensity

The Ameren, KCP&L and KCP&L-GMO studies provided both energy intensities (energy per total building square foot) and end-use energy intensities (EUI, which is energy use per end-use square foot) only for electricity. As with saturations, these were provided for major end-uses (such as lighting) rather than at the detailed base-measure level required for ASSYST. We therefore started with the detailed base-measure level EUIs from a recent Colorado study, then adjusted within each major end-use category to match the Missouri data. Once that was done, we calculated the overall energy intensity by building type implied by the EUIs and saturation we had just developed. A second calibration was applied to bring the overall energy intensity in line with that found by the utility studies. We compared the results to the California Commercial End-Use Survey (CEUS)[5] as a cross-check, and found, as expected, that energy use by non-weather-sensitive measures (such as lighting and cooking) were similar, while weather sensitive measures such as cooling and heating were higher in Missouri, which has more extreme weather than the mild California climate.

For natural gas, we began with California Commercial End-Use Survey data as a starting point for EUI estimates. These values were adjusted to account for Missouri's climate differences.

[5] http://www.energy.ca.gov/ceus/

Figure 25 - Commercial Electric EUIs (kWh/end-use square foot)

	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other
Lighting 4 Lamp 4' T12	6.2	6.5	6.0	21.2	4.0	6.5	8.1	12.6	6.6	2.8
Lighting 2 Lamp 4' T12	6.2	6.5	6.0	21.2	4.0	6.5	8.1	12.6	6.6	2.8
Lighting 2 Lamp 8' T12	6.2	6.5	6.0	21.2	4.0	6.5	8.1	12.6	6.6	2.8
Lighting Incand-CFL Screw-in	20.4	21.6	19.8	70.2	13.3	21.7	27.0	41.8	21.8	9.3
Lighting CFL-LED Screw-in	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lighting Incand-CFL Hardwire	20.4	21.6	19.8	70.2	13.3	21.7	27.0	41.8	21.8	9.3
Lighting CFL-LED Hardwire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
High Bay Lighting	6.3	6.7	6.1	21.8	4.1	6.7	8.4	13.0	6.8	2.9
Lighting 4 Lamp 4' T8	3.5	3.8	3.4	12.2	2.3	3.8	4.7	7.2	3.8	1.6
Lighting 2 Lamp 4' T8	3.5	3.8	3.4	12.2	2.3	3.8	4.7	7.2	3.8	1.6
Exit Signs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Outdoor lighting	0.8	8.3	1.5	4.3	0.5	1.0	0.4	0.5	1.1	0.5
Street Lighting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Chillers	1.6	3.6	1.4	4.5	1.5	0.9	1.1	2.2	0.5	0.6
DX Packaged Systems	2.7	6.2	2.4	7.8	2.6	1.5	2.0	3.8	0.9	1.0
Ventilation Motors 5 hp	0.7	1.8	0.5	3.0	0.3	0.5	0.5	1.7	0.4	0.3
Ventilation Motors 15 hp	0.6	1.7	0.5	2.7	0.3	0.5	0.5	1.6	0.4	0.3
Ventilation Motors 40 hp	0.6	1.6	0.5	2.7	0.3	0.5	0.5	1.6	0.4	0.3
Non-commercial refrigerators	0.1	0.0	0.2	0.0	0.0	0.1	0.0	0.2	0.2	0.0
Refrigeration System	0.1	8.3	0.2	21.1	1.0	0.3	0.3	0.2	0.2	0.2
Desktop PC	2.6	0.1	0.1	0.1	0.1	0.2	0.0	0.2	0.0	0.1
Monitor, 17" CRT	2.6	0.1	0.1	0.1	0.1	0.2	0.0	0.2	0.0	0.1
Monitor, 17" LCD	0.010	0.001	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.000
Copier	0.9	0.1	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.1
Laser Printer	1.7	0.2	0.2	0.2	0.0	0.1	0.0	0.2	0.0	0.1
Data Centers	80.8	82.6	53.1	98.2	41.6	58.2	44.8	67.5	58.6	50.1
Water Heating	0.2	4.7	0.4	1.0	0.3	0.3	0.2	1.3	1.7	0.2
Vending Machines	0.4	0.3	0.0	0.1	0.8	0.3	0.2	0.1	0.1	0.0
Convection Oven	0.0	0.6	1.8	1.4	0.0	0.0	0.0	0.0	0.0	0.1
Fryer	0.6	17.6	0.0	12.3	0.0	0.0	0.0	0.0	0.0	0.9
Steamer	0.3	6.1	0.0	4.7	0.0	0.0	0.0	1.3	0.0	0.6
Hot Food Holding Cabinets	0.1	1.0	5.5	1.6	0.0	0.1	0.0	0.4	0.1	0.2
Heating	3.6	4.4	2.5	7.6	0.8	3.6	3.4	5.2	1.4	1.3
Miscellaneous	2.3	3.1	1.5	3.8	0.4	0.21	0.20	6.3	1.7	1.2
Overall Energy Intensity (kWh/total sq ft)	20.42	43.84	13.36	67.57	7.97	9.42	9.42	23.49	11.85	9.45

Figure 26 – Commercial Natural Gas EUIs (kBtu/ sq ft)

End Use	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other
Heating	63.4	15.3	29.1	28.7	18.9	33.7	15.1	15.0	35.9	21.6
Water Heating - high standby applications	9.0	22.5	4.8	20.9	2.1	0.0	0.0	0.0	0.0	33.0
Water Heating - low standby applications	0.0	28.3	0.0	0.0	0.0	10.2	11.8	24.6	28.8	0.0
Cooking - Fryer	0.60	69.34	3.30	8.14	2.81	0.62	1.37	1.55	3.40	1.50
Cooking - Steamer	0.35	40.46	1.93	4.75	1.64	0.36	0.80	0.90	1.98	0.87
Cooking - Convection Oven	0.09	10.46	0.50	1.23	0.42	0.09	0.21	0.23	0.51	0.23
Cooking - Griddle	0.24	27.63	1.31	3.24	1.12	0.25	0.55	0.62	1.35	0.60
Cooking - Range	0.30	35.18	1.67	4.13	1.43	0.32	0.69	0.79	1.72	0.76
Other	27.8	43.8	12.2	10.0	11.3	3.7	11.1	21.2	3.9	75.4

4.3.5 Commercial Floorspace

Floorspace was calculated for electricity customers based on the saturations, EUIs and usage by building type already developed. Data on floorspace is hard to acquire and we have typically found this data to be the least reliable of the inputs to the ASSYST baseline analysis. We therefore derived floorspace estimates from other more reliable data, calibrated against other inputs.

Because of the uncertainty in natural gas EUIs, this process is not possible for gas. We therefore used the floorspace determined for the electric analysis as a starting point, and scaled it back 10 percent to account for electric-only customers.Floorspace is shown with energy consumption in the tables below.

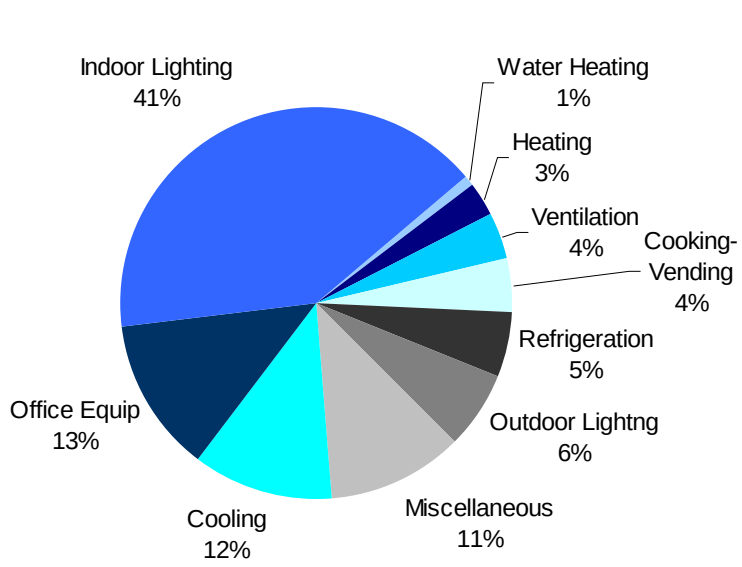
4.3.6 Commercial Energy Consumption

The following tables and figures show commercial floorspace by building type and energy consumption by end-use and building type for electricity and natural gas.

Figure 27 - Commercial Floorspace (thousand sq ft) and Electricity Consumption (MWh) by Building Type and End Use

	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other	Total
Floorspace (thousand sq ft)	468,278,172	35,263,778	255,598,429	37,661,950	230,078,993	151,685,023	91,134,393	125,189,814	69,432,623	365,471,734	1,819,508,828
Energy Consumption (MWh)											
Lighting 4 Lamp 4' T12	171,260	10,888	62,156	0	201,395	0	4,570	4,927	0	35,097	490,293
Lighting 2 Lamp 4' T12	285,426	4,326	126,041	100,098	127,913	0	7,409	18,769	8,698	23,518	702,197
Lighting 2 Lamp 8' T12	137,108	9,298	85,194	378,549	70,089	0	0	0	0	10,015	690,254
Lighting Incand-CFL Screw-in	1,504,101	187,137	541,690	131,298	33,252	156,393	15,938	199,754	71,581	1,119,174	3,960,320
Lighting CFL-LED Screw-in	0	0	0	0	0	0	0	0	0	0	0
Lighting Incand-CFL Hardwire	679,381	44,097	157,362	28,298	2,475	10,526	91,598	550,375	357,904	245,784	2,167,799
Lighting CFL-LED Hardwire	0	0	0	0	0	0	0	0	0	0	0
High Bay Lighting	19,154	0	142,459	76,187	130,812	163,403	21,460	3,387	0	155,389	712,251
Lighting 4 Lamp 4' T8	208,736	17,355	164,012	0	164,635	244,951	149,824	243,698	0	111,918	1,305,131
Lighting 2 Lamp 4' T8	301,941	33,276	347,387	110,048	47,877	202,917	212,893	307,529	0	50,883	1,614,751
Exit Signs	10,270	1,316	2,904	244	563	1,159	1,030	4,850	1,259	3,314	26,910
Outdoor lighting	252,461	291,786	310,597	76,864	95,480	115,097	35,077	66,092	77,237	168,842	1,489,532
Street Lighting	0	0	0	0	0	0	0	0	0	351,323	351,323
Chillers	261,190	5,731	42,906	0	24,873	27,679	78,108	210,467	10,564	32,053	693,572
DX Packaged Systems	730,931	192,374	445,887	276,377	437,899	140,661	16,765	85,673	44,556	266,551	2,637,673
Ventilation Motors 5 hp	275,242	45,755	96,838	54,789	49,984	62,370	45,421	101,727	29,234	90,214	851,574
Ventilation Motors 15 hp	16,372	7,049	10,996	0	0	31,281	15,625	28,302	0	12,163	121,787
Ventilation Motors 40 hp	58,969	0	16,444	0	3,803	0	9,229	0	0	51,208	139,653
Non-commercial refrigerators	24,644	478	23,881	353	366	6,740	235	17,716	9,246	7,918	91,576
Refrigeration System	22,507	255,989	31,932	769,847	160,896	35,450	23,543	21,113	13,260	38,113	1,372,650
Desktop PC	1,128,303	3,564	29,932	3,328	9,272	28,754	1,140	24,046	1,136	35,297	1,264,770
Monitor, 17" CRT	471,490	1,508	19,052	1,821	9,491	20,940	1,117	10,464	57	27,740	563,679
Monitor, 17" LCD	789	9	17	12	8	99	4	24	3	39	1,003
Copier	384,981	432	13,973	4,258	3,563	5,896	570	15,191	241	11,436	440,541
Laser Printer	749,013	5,728	40,210	5,143	6,718	17,898	1,904	27,172	1,227	24,121	879,134
Data Centers	273,507	3,012	3,404	4,699	16,944	27,495	52,232	92,785	2,969	19,356	496,403
Water Heating	38,126	34,871	39,342	3,018	20,026	10,442	5,885	14,838	9,254	30,942	206,743
Vending Machines	127,632	2,623	5,664	1,308	97,523	28,777	20,805	10,876	8,101	5,811	309,119
Convection Oven	0	14,952	57,519	20,098	0	3,173	0	0	1,513	8,739	105,994
Fryer	3,741	133,148	0	178,975	0	0	0	0	0	77,827	393,692
Steamer	2,299	81,825	0	109,987	0	0	0	39,762	0	47,828	281,700
Hot Food Holding Cabinets	658	23,404	90,035	31,459	0	4,967	0	11,373	2,369	13,680	177,943
Heating	354,360	26,316	124,395	33,356	26,164	49,284	27,775	39,730	55,741	111,649	848,770
Miscellaneous	1,067,987	107,776	381,458	144,319	92,745	32,522	18,329	789,562	116,342	436,529	3,187,571
Total	9,562,578	1,546,022	3,413,686	2,544,730	1,834,769	1,428,873	858,486	2,940,201	822,491	3,624,470	28,576,306

Figure 28 - Commercial Electricity Consumption by End Use



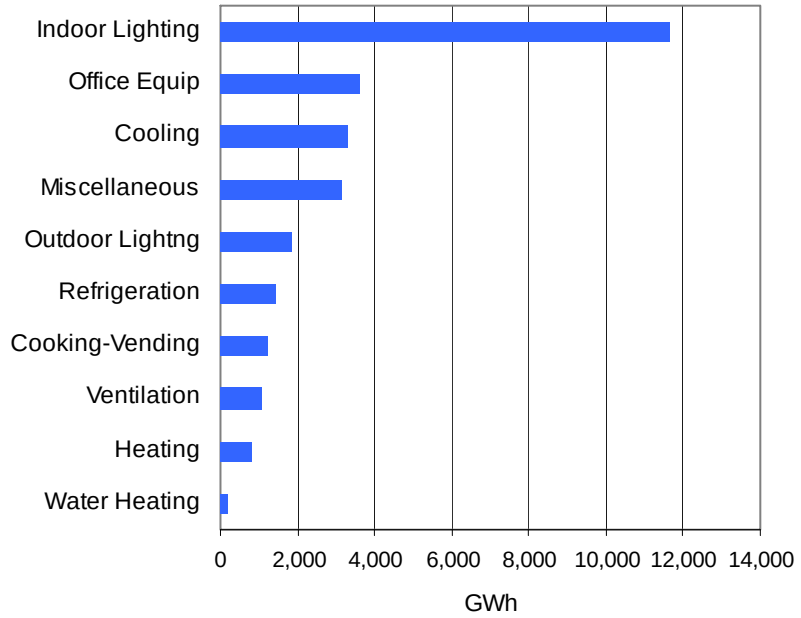
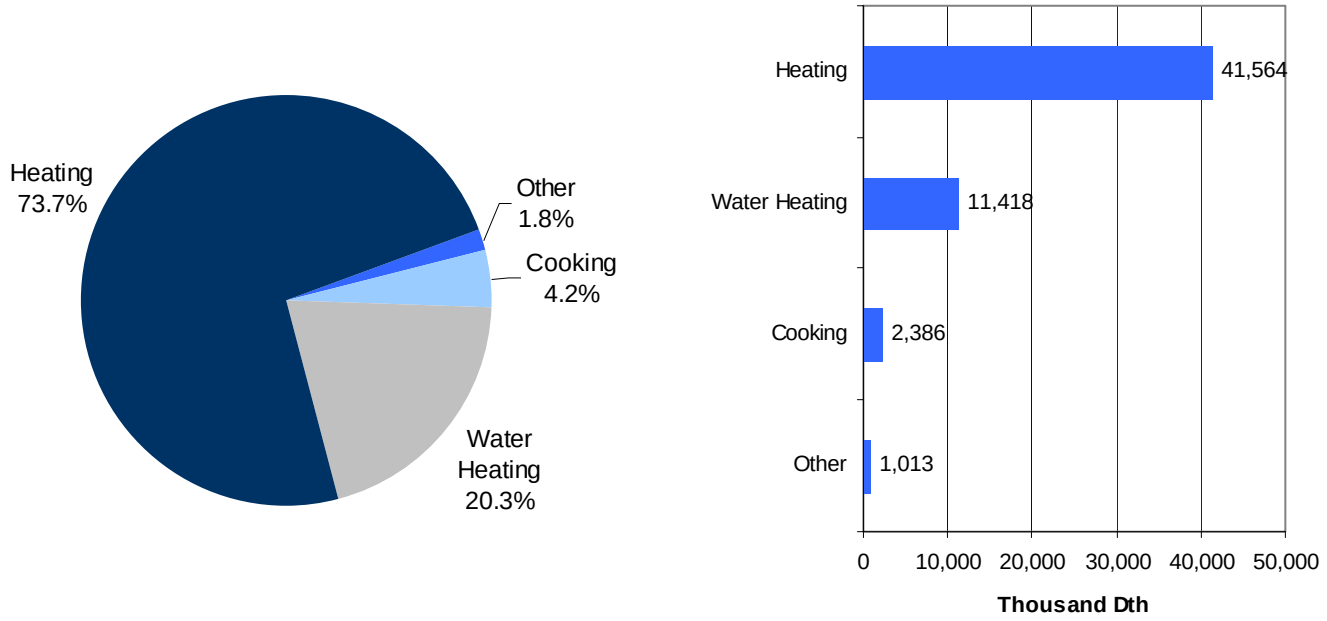


Figure 29 - Commercial Natural Gas Floorspace (thousand sq ft) and Energy Consumption (Dekatherms) by Building Type and End Use

	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other	Total
Floorspace (thous. sq ft)	421,450	31,737	230,039	33,896	207,071	136,517	82,021	112,671	62,489	328,925	1,646,815
Energy Consumption											
Heating	19,008,497	360,064	4,928,467	952,394	3,447,866	3,647,005	1,101,963	1,397,426	875,462	5,845,292	41,564,436
Water Heating - high standby applications	1,933,891	565,188	630,324	528,056	234,073	0	0	0	0	7,526,663	11,418,195
Water Heating - low standby applications	0	709,396	0	0	0	1,075,783	825,274	2,223,952	1,700,235	0	6,534,640
Cooking – Fryer	52,444	1,944,374	0	181,035	0	41,032	0	59,187	76,316	31,422	2,385,810
Cooking - Steamer	0	212,156	0	52,817	0	34,065	0	81,080	44,529	1,589	426,236
Cooking - Convection Oven	11,619	104,414	31,759	13,652	0	8,866	0	20,957	11,510	11,935	214,712
Cooking - Griddle	20,897	643,768	0	0	0	14,182	0	23,583	30,408	14,958	747,797
Cooking - Range	29,456	976,682	0	0	0	649	0	59,492	38,720	72,593	1,177,591
Other	0	80,647	0	0	255,283	31,428	94,954	236,305	13,977	300,600	1,013,192
Total	21,056,804	5,596,688	5,590,550	1,727,954	3,937,222	4,853,010	2,022,191	4,101,982	2,791,156	13,805,050	65,482,610

Figure 30 - Commercial Natural Gas Consumption by End Use



4.3.7 Commercial Peak Demand

Commercial load shape data from KEMA's end-use databases was utilized to allocate annual energy usage to time-of-use (TOU) periods. Peak period usage, developed on a sector-specific and end-use basis, were calibrated across all sectors to equal the Missouri summer peak. Commercial peak demand was estimated to be 4,383 MW. The table below shows the contribution to commercial peak demand by building type and end use.

Figure 31 - Commercial Peak Demand by Building Type and End Use (MW)

	Office	Restaurant	Retail	Grocery	Warehouse	School	College	Health	Lodging	Other	Total
Lighting 4 Lamp 4' T12	20.5	1.4	7.2	0.0	22.9	0.0	0.6	0.5	0.0	3.8	56.9
Lighting 2 Lamp 4' T12	34.1	0.5	14.6	9.8	14.5	0.0	1.0	1.8	0.8	2.6	79.8
Lighting 2 Lamp 8' T12	16.4	1.2	9.9	37.0	8.0	0.0	0.0	0.0	0.0	1.1	73.5
Lighting Incand-CFL Screw-in	179.8	23.6	62.8	12.8	3.8	13.8	2.2	19.5	6.5	122.3	447.1
Lighting CFL-LED Screw-in	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lighting Incand-CFL Hardwire	81.2	5.6	18.2	2.8	0.3	0.9	12.5	53.7	32.5	26.9	234.5
Lighting CFL-LED Hardwire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
High Bay Lighting	2.3	0.0	16.5	7.4	14.9	14.4	2.9	0.3	0.0	17.0	75.7
Lighting 4 Lamp 4' T8	25.0	2.2	19.0	0.0	18.7	21.5	20.4	23.8	0.0	12.2	142.8
Lighting 2 Lamp 4' T8	36.1	4.2	40.3	10.8	5.4	17.8	29.0	30.0	0.0	5.6	179.1
Exit Signs	1.2	0.2	0.3	0.0	0.1	0.1	0.1	0.6	0.1	0.4	3.1
Outdoor lighting	2.2	12.4	13.0	1.2	0.8	2.9	0.1	0.4	0.4	8.4	41.8
Street Lighting	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	17.5
Chillers	141.5	2.7	26.3	0.0	17.9	10.5	35.4	87.4	4.7	19.5	345.8
DX Packaged Systems	396.0	89.1	273.7	135.8	315.1	53.4	7.6	35.6	19.9	161.9	1,488.1
Ventilation Motors 5 hp	62.4	8.8	20.2	8.7	11.5	9.0	9.4	15.3	4.6	19.4	169.4
Ventilation Motors 15 hp	3.7	1.4	2.3	0.0	0.0	4.5	3.2	4.3	0.0	2.6	22.0
Ventilation Motors 40 hp	13.4	0.0	3.4	0.0	0.9	0.0	1.9	0.0	0.0	11.0	30.6
Non-commercial refrigerators	2.3	0.0	2.4	0.0	0.0	0.6	0.0	1.7	0.9	0.8	8.7
Refrigeration System	2.1	25.0	3.2	81.0	20.0	3.2	2.3	2.0	1.3	3.7	143.8
Desktop PC	100.4	0.4	3.4	0.4	1.0	1.6	0.1	2.2	0.1	3.5	113.2
Monitor, 17" CRT	42.0	0.2	2.2	0.2	1.0	1.2	0.1	1.0	0.0	2.7	50.5
Monitor, 17" LCD	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Copier	34.3	0.1	1.6	0.5	0.4	0.3	0.1	1.4	0.0	1.1	39.7
Laser Printer	66.7	0.7	4.6	0.6	0.7	1.0	0.2	2.5	0.1	2.4	79.5
Data Centers	24.3	0.4	0.4	0.5	1.8	1.5	6.0	8.5	0.3	1.9	45.6
Water Heating	3.3	3.8	4.1	0.3	2.0	0.5	0.7	1.2	0.8	3.0	19.7
Vending Machines	11.9	0.3	0.6	0.1	11.8	1.7	2.5	1.0	0.8	0.6	31.4
Convection Oven	0.0	2.0	6.7	1.8	0.0	0.2	0.0	0.0	0.2	0.9	11.7
Fryer	0.4	17.5	0.0	16.0	0.0	0.0	0.0	0.0	0.0	8.2	42.1
Steamer	0.2	10.8	0.0	9.8	0.0	0.0	0.0	4.9	0.0	5.1	30.7
Hot Food Holding Cabinets	0.1	3.1	10.4	2.8	0.0	0.2	0.0	1.4	0.3	1.4	19.7
Heating	15.5	0.0	0.5	0.0	0.0	0.6	1.5	1.4	1.0	1.9	22.6
Miscellaneous	99.8	13.5	43.7	14.7	11.2	1.9	2.2	70.4	12.1	46.8	316.2
Total	1,418.9	231.0	611.6	355.1	484.7	163.4	142.0	372.6	87.4	516.1	4,383

4.4 Industrial Sector

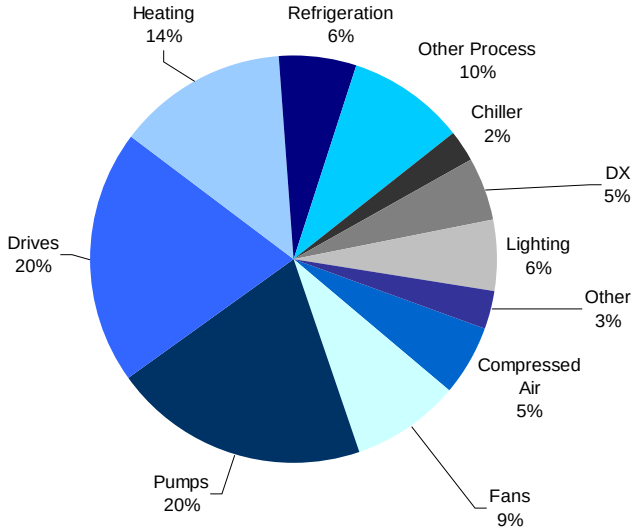
4.4.1 Industrial Building Types

We used a different approach for the industrial sector. The available data on energy use by industry was not very detailed. The Ameren potential study treated all industries together to protect the confidentiality of Ameren's largest customers. The KCP&L and KCP&L-GMO studies broke out a limited number of industries (for example, printing and petroleum), while presenting all manufacturing industries together. Since we typically break out 16 different industries, this data was inadequate, although it did act as a cross-check against numbers developed through other methods. As noted above, the distribution of industries varies greatly by region, making it impossible to apply distributions from other studies as we did with commercial gas.

We adopted an approach based on employment data by industry. The Bureau of the Census' 2007 Economic Census[6] provides state-level employment by NAICS code, which we combined with energy use per employee by industry from the Department of Energy's Manufacturing Energy Consumption Survey[7] to estimate distributions of electricity and gas use by industry for Missouri. These were then normalized to the consumption estimates developed above. The following figures show the breakdown of electricity and natural gas by industry.

[6] http://www.census.gov/econ/census07/
[7] http://www.eia.doe.gov/emeu/mecs/contents.html

Figure 32 - Industrial Sector Electricity Consumption by Industry



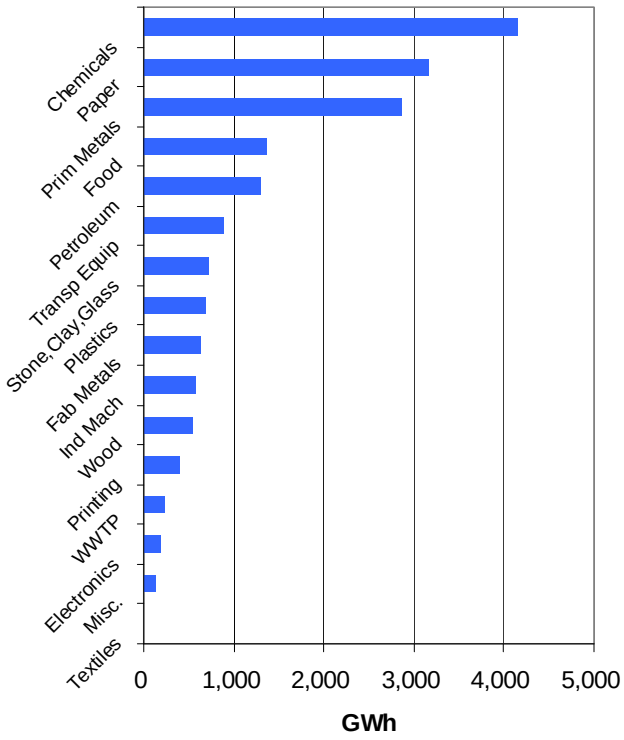
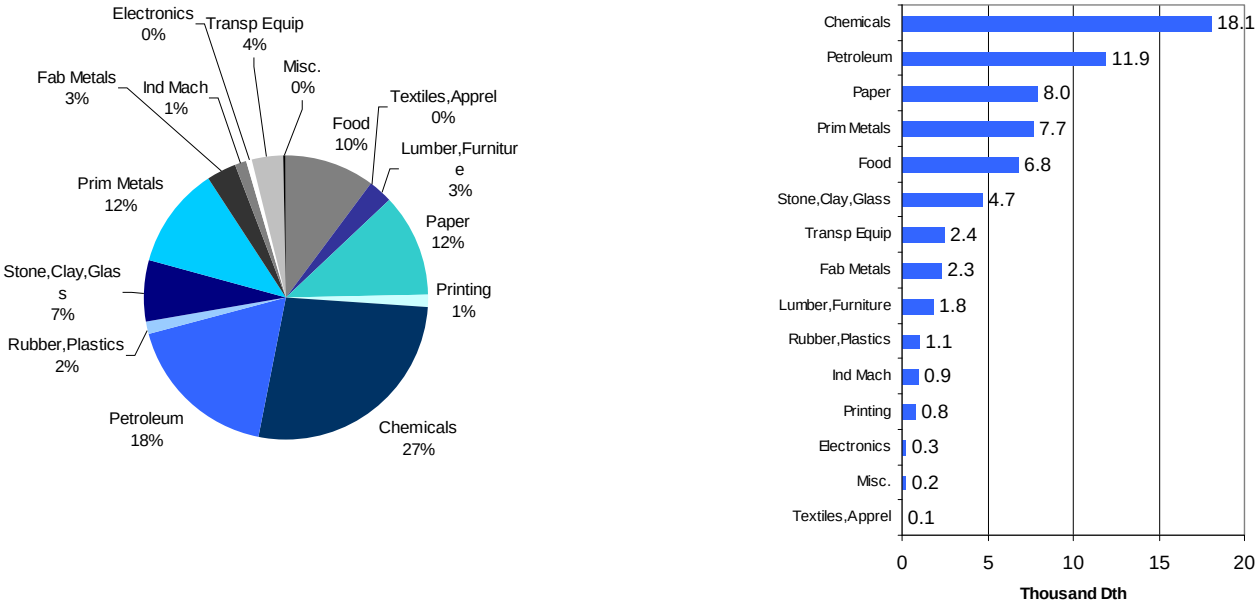


Figure 33 - Industrial Sector Natural Gas Consumption by Industry



4.4.2 Industrial Sector End Use Consumption

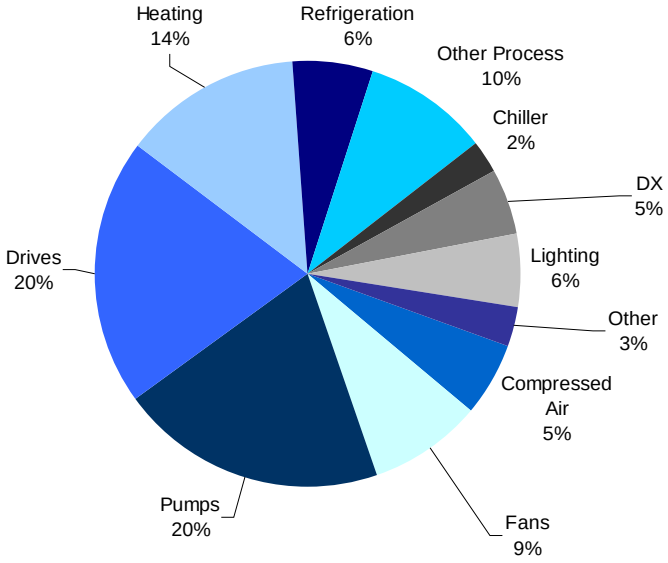
Energy use was disaggregated into end-use consumption percentages based mainly on the Department of Energy's Manufacturing Energy Consumption Survey (MECS). Where possible, the most current end-use by industry splits were used. A minority of end use splits were withheld in the 2006 version due to sampling errors, and were informed by applying ratios derived from 2002 MECS end-use data. Further disaggregation of the motor end uses (into pumps, fans, drives, and compressed air) by industry were based on the 1998 study "United States Industrial Electric Motor Systems Market Opportunities Assessment." Water and wastewater treatment plant electric end-use splits are not included in MECS and were based on a number of surveys conducted during the course of KEMA's potential studies for Xcel Energy (Colorado) in 2004 and Rhode Island in 2010.

Figure 34 - Industrial Electric End-Use Consumption Splits (fraction of energy)

	Proc Heat	Proc Cool	Pumps	Fans	Comp Air	Proc Drives	Proc Other	HVAC	Lighting	Other	Boiler Use	CHP Proc	Total
Food	0.06	0.26	0.15	0.08	0.08	0.14	0.01	0.08	0.07	0.04	0.03	0.00	1.00
Textiles	0.10	0.12	0.09	0.07	0.04	0.30	0.01	0.14	0.10	0.03	0.01	0.00	1.00
Wood	0.07	0.01	0.11	0.09	0.05	0.41	0.01	0.07	0.08	0.09	0.02	0.00	1.00
Paper	0.04	0.02	0.24	0.15	0.04	0.32	0.02	0.04	0.04	0.02	0.07	0.00	1.00
Printing	0.03	0.06	0.09	0.07	0.04	0.32	0.01	0.19	0.12	0.07	0.01	0.00	1.00
Chemicals	0.05	0.08	0.26	0.06	0.03	0.21	0.14	0.06	0.04	0.03	0.04	0.00	1.00
Petroleum	0.04	0.05	0.49	0.07	0.12	0.13	0.01	0.04	0.02	0.01	0.01	0.00	1.00
Plastics	0.15	0.09	0.09	0.07	0.04	0.31	0.02	0.11	0.09	0.04	0.01	0.00	1.00
Stone,Clay,Glass	0.22	0.03	0.18	0.14	0.06	0.20	0.03	0.06	0.05	0.03	0.00	0.00	1.00
Prim Metals	0.28	0.01	0.10	0.08	0.03	0.11	0.31	0.03	0.03	0.01	0.00	0.00	1.00
Fab Metals	0.20	0.04	0.09	0.07	0.12	0.22	0.05	0.10	0.09	0.03	0.00	0.00	1.00
Ind Mach	0.07	0.03	0.07	0.05	0.14	0.18	0.02	0.22	0.15	0.06	0.00	0.00	1.00
Electronics	0.15	0.09	0.04	0.03	0.10	0.09	0.08	0.24	0.12	0.07	0.01	0.00	1.00
Transp Equip	0.14	0.06	0.07	0.05	0.12	0.12	0.03	0.19	0.15	0.05	0.01	0.00	1.00
Misc.	0.10	0.06	0.04	0.03	0.09	0.16	0.02	0.25	0.17	0.08	0.00	0.00	1.00
WWTP	0.01	0.00	0.62	0.30	0.00	0.00	0.00	0.02	0.04	0.00	0.00	0.00	1.00

Sources: DOE 2006 & 2003 MECS, KEMA 1998 Motors Assessment

Figure 35 - Industrial Electricity Consumption by End Use



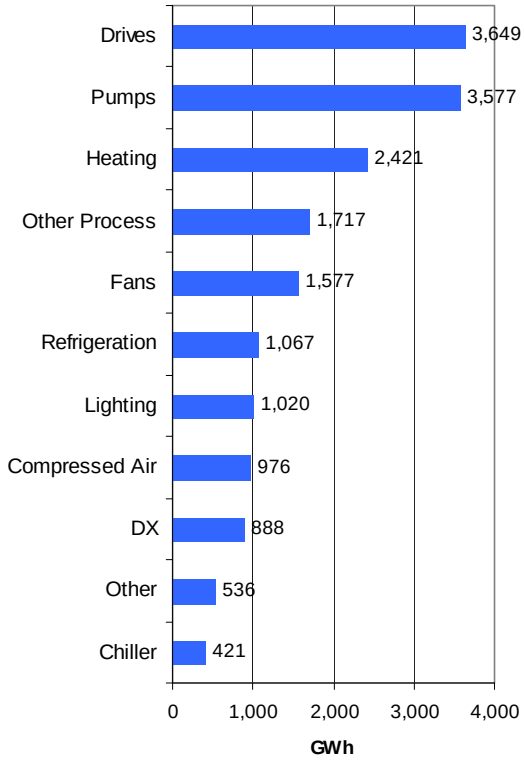


Figure 36 - Industrial Electricity Consumption by Industry and End Use

	Compressed Air	Fans	Pumps	Drives	Heating	Refrigeration	Other Process	Chiller	DX	Lighting	Other
Food	104,793	114,696	201,829	193,927	113,119	357,270	13,761	14,928	101,526	101,576	58,345
Textiles	685	1,297	1,736	5,939	2,043	2,276	291	1,424	1,225	2,040	590
Wood	24,224	45,853	60,128	216,288	49,563	7,170	4,296	19,106	16,438	45,029	45,783
Paper	113,718	461,764	768,459	1,009,679	369,567	50,098	65,759	17,571	119,504	124,817	71,940
Printing	14,599	27,633	36,236	130,345	14,627	23,770	3,099	40,530	34,870	48,655	28,666
Chemicals	106,083	269,088	1,091,877	871,949	386,494	332,581	598,147	31,422	213,708	152,677	107,625
Petroleum	160,135	96,081	640,539	170,810	65,453	70,431	7,251	5,937	40,382	30,302	14,567
Plastics	24,251	45,903	60,194	216,525	110,184	62,045	11,670	39,811	34,252	59,098	26,467
Stone,Clay,Glass	42,157	99,069	125,769	142,632	155,528	19,165	23,608	5,692	38,715	36,649	21,513
Prim Metals	91,302	214,560	272,385	308,906	818,433	26,046	899,308	12,318	83,776	98,484	34,095
Fab Metals	74,991	41,769	54,772	138,733	126,362	22,282	30,193	34,103	29,340	59,443	20,933
Ind Mach	81,529	29,520	38,710	103,810	39,617	15,923	14,086	67,783	58,317	82,455	35,387
Electronics	18,320	5,551	7,280	15,572	27,705	15,713	14,091	23,228	19,984	21,035	13,160
Transp Equip	107,556	48,153	63,144	103,715	126,984	54,728	29,564	89,959	77,396	127,758	46,820
Misc.	11,036	4,099	5,375	20,032	12,552	7,329	1,890	16,391	14,102	20,648	10,113
WWTP	600	71,826	148,817	0	2,998	600	0	692	4,704	9,581	0

Figure 37 - Industrial Natural Gas End-Use Shares

Industry	Proc Heat	HVAC	Conventional Boiler Use	CHP and/or Cogen	Other	Total
Food	0.31	0.05	0.52	0.04	0.07	1.00
Textiles,Apparel	0.30	0.06	0.35	0.12	0.17	1.00
Lumber,Furniture	0.53	0.13	0.16	0.00	0.18	1.00
Paper	0.26	0.03	0.25	0.33	0.13	1.00
Printing	0.66	0.18	0.13	0.00	0.03	1.00
Chemicals	0.28	0.02	0.28	0.32	0.11	1.00
Petroleum	0.59	0.01	0.14	0.19	0.07	1.00
Rubber,Plastics	0.25	0.19	0.45	0.00	0.10	1.00
Stone,Clay,Glass	0.78	0.04	0.04	0.00	0.14	1.00
Prim Metals	0.78	0.07	0.05	0.05	0.05	1.00
Fab Metals	0.64	0.15	0.15	0.01	0.06	1.00
Ind Mach	0.29	0.37	0.20	0.05	0.10	1.00
Electronics	0.30	0.29	0.31	0.00	0.10	1.00
Transp Equip	0.30	0.34	0.15	0.02	0.19	1.00
Misc.	0.24	0.48	0.16	0.00	0.12	1.00

Source: DOE 2002 and 2006 MECS

Figure 38 - Industrial Natural Gas Consumption by End Use

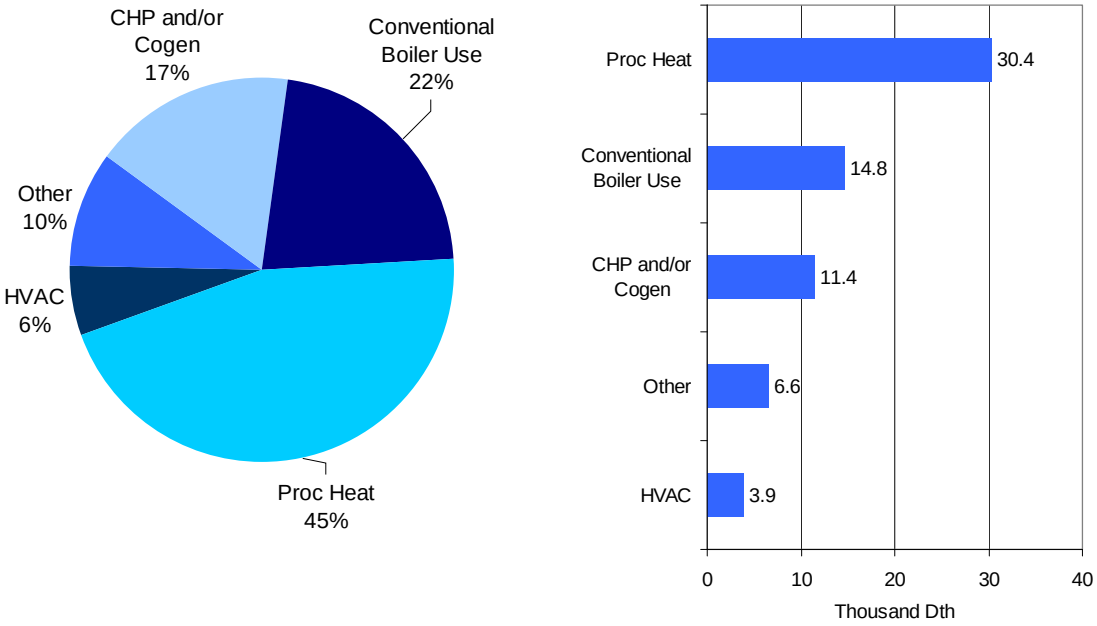


Figure 39 - Industrial Natural Gas Consumption by Industry and End Use (Therms)

Industry	Proc Heat	HVAC	Conventional Boiler Use	CHP and/or Cogen	Other	Total
Food	21,490	3,426	35,817	3,011	4,568	68,312
Textiles, Apparel	229	43	264	93	125	754
Lumber, Furniture	9,635	2,363	2,909	73	3,200	18,180
Paper	20,701	2,243	20,184	26,394	10,006	79,528
Printing	5,182	1,451	1,036	0	207	7,877
Chemicals	50,342	2,938	49,808	57,286	20,564	180,939
Petroleum	70,614	1,009	16,717	22,481	8,070	118,891
Rubber, Plastics	2,656	2,056	4,798	17	1,097	10,623
Stone, Clay, Glass	36,568	1,792	2,108	105	6,428	47,001
Prim Metals	60,460	5,027	3,940	3,668	4,076	77,172
Fab Metals	14,911	3,380	3,380	199	1,392	23,261
Ind Mach	2,745	3,431	1,830	458	915	9,379
Electronics	764	733	794	6	269	2,567
Transp Equip	7,363	8,372	3,631	403	4,640	24,409
Misc.	500	1,000	333	0	250	2,084
Total	304,162	39,264	147,550	114,194	65,806	670,976

4.4.3 Industrial Peak Demand

Industrial load shape data from KEMA's end-use databases were utilized to allocate annual energy usage to Missouri's peak electricity use periods. Given limited information on industrial end use load shapes, typical whole-facility shapes were applied to each end use. Peak period usage, developed on a sector-specific and end-use basis, were calibrated to equal Missouri's summer peak. Peak demands for the process cooling/refrigeration and HVAC end uses were adjusted upward to account for temperature sensitivity on peak days. Industrial peak demand was estimated to be 1,958 MW. The following shows the contribution to peak by industry and end use.

Figure 40 - Industrial Electric Peak Demand by Industry and End Use – MW – 2011

Peak demand estimates	Proc Heat	Proc Cool	Pumps	Fans	Comp Air	Proc Drives	Proc Other	HVAC	Lighting	Other	Boiler Use	CHP Proc	Total
Food	8.2	49.8	21.1	12.0	10.9	20.3	1.4	16.2	10.6	6.1	3.6	0.0	160.2
Textiles	0.7	1.1	0.6	0.5	0.2	2.1	0.1	1.3	0.7	0.2	0.1	0.0	7.6
Lumber	4.9	1.2	7.7	5.9	3.1	27.8	0.6	6.1	5.8	5.9	1.4	0.0	70.5
Paper	9.2	4.6	53.2	32.0	7.9	69.9	4.6	12.6	8.6	5.0	16.3	0.0	223.9
Printing	1.3	3.6	4.1	3.1	1.7	14.8	0.4	11.4	5.5	3.3	0.3	0.0	49.5
Chemicals	20.5	43.7	107.5	26.5	10.4	85.9	58.9	32.2	15.0	10.6	17.6	0.0	428.8
Petroleum	4.7	9.2	63.1	9.5	15.8	16.8	0.7	6.1	3.0	1.4	1.7	0.0	132.0
Plastics	12.6	9.9	7.2	5.5	2.9	25.8	1.4	11.8	7.0	3.2	0.5	0.0	87.7
Stone-clay-glass	14.8	2.5	12.2	9.6	4.1	13.8	2.3	5.7	3.5	2.1	0.2	0.0	70.7
Primary Metals	100.0	4.3	33.6	26.5	11.3	38.1	111.0	15.8	12.2	4.2	1.0	0.0	357.9
Fab Metals	14.8	3.6	6.6	5.0	9.0	16.6	3.6	10.1	7.1	2.5	0.3	0.0	79.1
Ind Machinery	7.3	4.1	7.4	5.7	15.6	19.9	2.7	32.2	15.8	6.8	0.3	0.0	117.7
Electronics	2.9	2.3	0.8	0.6	2.0	1.7	1.5	6.3	2.3	1.4	0.1	0.0	22.1
Transp Equip	14.1	8.7	7.5	5.7	12.8	12.3	3.5	26.5	15.2	5.6	1.0	0.0	112.9
Misc	1.2	1.0	0.5	0.4	1.1	2.0	0.2	4.0	2.0	1.0	0.0	0.0	13.3
WWT	0.3	0.1	14.5	7.0	0.1	0.0	0.0	0.7	0.9	0.0	0.0	0.0	23.6
Total	217.7	149.5	347.6	155.3	108.8	367.7	192.8	199.1	115.4	59.2	44.5	0.0	1,958

Appendix A - Input File Description

The files accompanying this report are the primary inputs DSM Assyst™ uses to estimate technical and economic potential for savings from energy efficiency. This appendix provides information on the structure of these files and field definitions.

These files fall into the following categories and follow a consistent naming convention.

- **Building Files:** These files contain the Building Tables, Load Shape Tables, and Peak to Load Shape Tables. The naming convention is "Bld_<Sector>_<State or Utility>_<Fuel>.xls"
- **Economic Parameters Files:** These files contain economic parameters for the geographic study area including discount rates, inflation rates, technology implementation rates, avoided cost tables, and customer rates. The naming conventions is "Eco_<Sector>_<State or Utility>_<fuel>.xls"
- **Technology Input Files, also known as "Measure Files":** These files contain sets of worksheets with technology based input data disaggregated by sector and fuel. M_B*.XLS files contain data for the Basic Analysis and M_S*.XLS files contain data for the Supply Analysis. The naming convention is "M_<B or S><A><E or G><R or C or I><N or E><#>_<State or Utility>.xls" where

  <A> - incorporates all end uses (a placeholder for future analyses)
  <E or G> - gas or electric
  <R or C or I> - sector (residential, commercial, industrial)
  <N or E> - whether the measure will be installed a "new" or "existing" location.
  <#> - revision number.

Building Files (BLD_*.XLS)

The following inputs are contained in the the Building Files.

Building Stock Table Worksheet

The Building Stock Table allows the user to specify up to 20 building segments and up to 20 different types of buildings in each segment. Units used for the analysis of the

residential sector are number of households. Units used for the analysis of the commercial or industrial sectors are square feet or square meters.

Building Type Definition Table Worksheet

This table allows users to provide definitions for the building types in each market segment. Building types are the types of homes, commercial facilities, or industries to be reviewed in the study.

Segment Definition Table Worksheet

This table allows users to label the market segments that will be used in the analysis. Market segments are typically existing construction or new construction.

End Use Definition Table Worksheet

This table allows users to label the End Uses that will be used in the analysis.

End Use Load Shape Table

The End Use Load Shape Table specifies what portion of energy is used in each rate time period, by building type and end use. The proportional energy use must sum to 1 for each building type within each end use.

The end use order is typically set as shown below in Table 1, though users may specify whatever order they prefer, so long as there is consistency between the order and the numbering of end uses in the Technology Input Table.

Table 1: Typical End Use Order

Order	Commercial/Industrial	Residential
1	Lighting	Space Cooling
2	Exterior Lighting	Lighting
3	Cooling	Refrigeration
4	Heating	Freezer
5	Ventilation	Water Heating
6	Refrigeration	Clothes Washer
7	DHW	Clothes Dryer
8	Process	Dishwashers
9		Pool Pump
10		Furnace Fan
11		Space Heating
12		Cooking
13		Home Electronics
14		Miscellaneous

Utility Coincidence Table Worksheet

The Utility Coincidence Table is comprised of factors that associate the average demand, as can be calculated from the load shape, to the actual demand for each market segment or building type, for each rate time period, for each end use, coincident with the utility's peak.

To calculate the values, we average the demand for each market segment, for each rate-time period, and for each end use. Next, we divide the actual demand during the utility's peak time period for the end-use for the market segment by the average demand of the same end-use, market segment, and time period. For example, if average demand for office cooling during the hours that constitutes the summer peak rate-time period is 0.80 kW/Sq. Ft. and the actual demand for high-rise office cooling is 1.20 kW/Sq/ Ft., then the Peak-to-Energy factor is 1.20 divided by 0.80, or 1.5.

End uses are listed in the same order as in the Load Shape Table above.

Customer Coincident Relationship Table Worksheet

The Customer Coincident Relationship Table is comprised of factors that associate the average demand, as can be calculated from the load shape, to the actual demand coincident with the customer's peak usage for each market segment or building type, for each rate time period, for each end use.

End uses are listed in the same order as in the Load Shape Table.

Economic Inputs Files (ECO_*.XLS)

The following inputs are found in the economic input files.

Economic Parameters Worksheet

Utility Name: This cell is informational.

Sector: This cell is informational.

Batch #: This cell is informational.

Utility Discount Rate (UTIL_DISC_RATE): This is the discount rate that the utility uses to do net present value analysis when considering cost streams over the life of projects.

Customer Discount Rate (CUST_DISC_RATE): This is the discount rate that utility customers would use when calculating the net present value of savings from reduced energy bills resulting from energy conservation.

General Inflation Rate (INFLATION_RATE): Projected inflation rate.

Base Year (BASE_YEAR): This is the year to which all cost and benefits are normalized. It is also the first year for data in the Avoided Cost and Rate Tables.

Start Year (START_YEAR): This is the first year of the analysis. Changing the Start Year changes the 20-year period over which the cost and benefit streams are calculated. The Start Year can not be earlier than the Base Year.

Difference: This is the calculated difference between the Start Year and the Base Year.

Utility Line Loss Rate: The percentage of energy lost through line losses.

TOU Definitions Worksheet

Rate/Time Periods: Name of rate/time period. There are 6 available for use. The analysis should use as many as the Utility or State uses.

Name Abbreviation: Abbreviation for Rate/Time Period

Hours: Number of hours per year in Rate/Time Period. These should sum to 8760.

Monthly Adjustment for rates: Number of months the Rate/Time period is applicable.

Energy Costs and Rates # Worksheets

These worksheets are used to store 40 years of rates and avoided cost data. The worksheet # should correspond with the market segment defined in the Bld_ file. Rates should change by market segment but avoided cost information is typically the same on all worksheets. Header information is informational.

Technology-Based Inputs (M_*.XLS)

The following technology-based input tables operate as a set and are referenced by the same Measure Numbers. The Measure Numbers, including the Base Technology Measure Numbers, must all be in progressive sequential order for the "look-up" functions to operate properly.

Header Worksheet

This worksheet contains information that helps identify analytic parameters.

Measure Input Table (M) Worksheet

This table contains the following data.

Segment: This number identifies the market segment. (See building files BLD_.XLS.)

Measure Number: Contains the number by which the measure or base case will be referred.

Measure: A brief description or title of the DSM technology or base case technology.

Savings Units: The engineering units with which energy savings are associated.

Cost Units: The units by which the technology is priced.

Unit Equipment Cost: The cost of the DSM technology. This can either be wholesale or retail but the user should know which it is and it should be consistent in the application of costs.

Unit Labor Cost: This is the cost of installing the technology.

Incremental Lifetime O&M Cost: These values are used to account for the discrepancies between the O&M cost of the DSM technology relative to the base case technology. This value can be positive (if the measure costs more to operate and maintain than the base technology) or negative (if the measure costs less to operate and maintain than the base technology). Although O&M is generally accounted for on an annual basis, this value should reflect the discounted sum of the annual incremental O&M cost over the life of the technology.

Cost Multiplier: This factor allows the user to increase the cost of a measure without changing the cost in the cost fields. This factor can be used for scenario analysis. The default value should be "1".

Cost Units Per Savings Units: This factor reconciles the differences between cost units and savings units, should they be different thereby making them multiplicative. The default value for this factor is "1."

Service Life: This is the expected life of the measure. If the Service Life is less than 100, the model assumes that the units are years. If the Service Life is over 100, the model assumes that the units are hours. All measures are analyzed over a 20-year period.

Initial Cost (Full = 1, Incremental = 0): This is a toggle switch that tells ASSYST whether to consider the measure a retrofit or replace-on-burnout measure. The toggle should be set to "1" for retrofit measures and the full cost of the measure will be used. The toggle may be set to "0" if the measure is a replace-on-burnout measure and the user wants the initial cost to be the incremental cost between the measure and the base case.

Replacement Cost (Full = 1, Incremental = 0): When a measure has a service life of less than 20 years and needs to be replaced one or more times over the 20-year period of analysis, this toggle switch tells DSM ASSYST whether to apply the full cost of replacing the measure or the incremental cost of replacing the measure. The toggle is usually set to the same value as it is in the Initial Cost.

Full Unit Cost: This is the sum of the Unit Equipment Cost, the Unit Labor Cost, and the Incremental Lifetime O&M Cost and is automatically calculated.

Relative Energy Reduction Factors (by rate time period): These five columns allow the user to allocate each measure's incremental energy and demand savings to the appropriate rate time period thus affecting load shifting. The default value equals "1" indicating that energy savings resulting from the measure occur in the same pattern as base case energy use (e.g., a value of "1" would mean that a 20% energy savings would yield a savings of 20% of the base case energy for the time covered in the rate-time period). If the marginal savings are to occur in a different pattern than the base energy use pattern, then these factors allow the user to change the proportional savings. For example, if the energy savings in a particular rate-time period are 90% of what would be expected (e.g. 18% instead of 20%), then the factor should be "0.9".

These factors are closely tied to the definition of energy savings found in the ENERGY_SAVINGS table because they can potentially alter the weighted average savings for the measure.

End Use: This is a numerical value corresponding to the end use for each measure. Numbers should correspond to the end uses as numbered in the load shape portion of the Building Table BLD_.XLS.

Implementation Type 1= 1 time, 2= turnover: This informs the model how to treat the implementation of the technology in the achievable potential analysis. Generally "1" is used for retrofit applications such as shell measures and "2" is used for replace-on-burnout applications.

Base Tech EUI Worksheet

The Base Technology EUIs table contains the energy consumption of each base technology by market segment or building type. Commercial units are kWh/ square foot. Residential units are UEC or kWh/ per household.

Energy Saving Worksheet

The Energy Savings table contains the estimated annual energy savings for each measure by market segment or building type. In the Basic Analysis the energy savings are in relation to the base case.

EUI Adjustment Factors Worksheet

The Standards Adjustment Factors table allows the user to adjust EUIs or UECs to account for efficiency improvements due to existing or anticipated regulations. These factors can also be used to adjust base EUIs and UECs to account for changing market conditions that would result in higher base technology energy efficiencies. The Standards Adjustment Factors are arranged by measure and market segment or building type. This factor should be used for measures where the currently installed base measure is of a lower efficiency level than the current base measure available for purchase. This situation may be the result of recent changes to federal standards.

Applicable Factors Worksheet

The % Applicable Factors table contains the fraction of the floorspace or households that is applicable for conversion to the DSM technology for each market segment or building type. It generally corresponds to the saturation of the base case technology.

Not Complete Factors Worksheet

The % Not Complete Factors table contains the fraction of the applicable floorspace or households that has not yet been converted to the particular energy-efficiency technology. The % Not Complete Factors are arranged by measure and market segment or building type.

Feasible Factors Worksheet

The % Feasible Factors table contains the fraction of the applicable floorspace or households that is technically feasible for conversion to the DSM technology from an engineering perspective. The % Feasible Factors are arranged by measure and market segment or building type.

Technology Saturation Worksheet

The Technology Saturation table contains information about how many measure costing units are found in each applicable square foot or household of each market segment or building type (e.g. tons/sq. ft.). The measure units are the same as those specified in Cost Units in the Measure Input Table.

Light Worksheet

The Light table gives estimates of the annual hours of operation for measures whose service lives are expressed in hours.