AN OVERVIEW OF KENTUCKY'S ENERGY CONSUMPTION AND ENERGY EFFICIENCY POTENTIAL

KENTUCKY POLLUTION PREVENTION CENTER
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EXECUTIVE SUMMARY

The Kentucky Governor's Office of Energy Policy commissioned the Kentucky Pollution Prevention Center at the University of Louisville to conduct a preliminary study of the potential for energy efficiency in Kentucky. A growing demand for electricity, increasing strains on electric transmission infrastructure, spiking natural gas and crude oil prices, concerns about global climate change and the need to achieve energy independence have prompted a renewed focus on energy efficiency. Energy efficiency has emerged as a viable resource and the least-cost alternative to reduce these energy vulnerabilities.

Kentucky's 2005 Comprehensive Energy Strategy Report[1] identified energy efficiency as a key resource to maintain low energy costs and help address environmental concerns. Recent studies conducted by other states also conclude that energy efficiency can play a significant role in meeting future energy needs without adversely affecting the economy.[2,3,4] Given Kentucky's relatively high per capita energy consumption, similar opportunities for energy efficiency are likely to exist, but a formal evaluation of the potential offered by energy efficiency has not been made until now.

This report analyzes energy consumption in Kentucky's residential, commercial and industrial sectors and estimates the impact that energy efficiency could play in reducing future energy demand. It is intended as a starting point for discussion; additional efforts will need to address specific actions or incentives necessary to improve energy efficiency in the Commonwealth. While the methodologies differ among the sectors, the objectives are similar:

- Quantify current energy consumption and energy expenditures;
- Forecast energy consumption under a base case scenario for the 10-year period 2008 – 2017; and
- Estimate the potential for energy savings under a minimally aggressive and moderately aggressive scenario, and compare against this base case.

There is significant opportunity and value for energy efficiency in Kentucky. **Improved energy efficiency could meet all of the growth in energy demand predicted by 2017**. Under the moderately aggressive scenario, energy consumption in 2017 would be less than in 2008 by 30 trillion British thermal units (tBtu). The annual energy savings would represent more energy than 300,000[5] households use each year. Over the 10-year period, the cumulative potential from improved energy efficiency would save Kentucky 449 tBtu and $6.8 billion. This amount of energy is equivalent to the power that three 500-megawatt power plants would generate over a 10-year period.

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[1] Commonwealth Energy Policy Task Force, *Kentucky's Energy Opportunities for our Future – A Comprehensive Energy Strategy*, February 2005
[2] American Council for an Energy-Efficient Economy, *Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands*, February 2007
[3] American Council for an Energy-Efficient Economy, *Potential for Energy Efficiency, Demand Response, and Onsite Renewable Energy to Meet Texas's Growing Electricity Needs*, March 2007
[4] ICF Consulting, *Assessment of Energy Efficiency Potential in Georgia*, May 2005
[5] Annual energy use for 10,000 homes is equivalent to 1 tBtu

Residential Sector

The residential sector consumed nearly 354 tBtu of energy in 2003 at a cost of $2.2 billion (2003 dollars). Electricity and natural gas comprised the majority of delivered energy at 51% and 38%, respectively (excluding electricity related losses). The primary end use for energy was space heating (42%), followed by lighting and miscellaneous equipment (32%).

From 2008 to 2017, residential consumption is expected to increase 7.8% to 458 tBtu. Under the minimally aggressive scenario, delivered energy consumption would decline by 5 tBtu in 2017 and save 23 tBtu, which represents $459 million in savings over the 10-year period. Under the moderately aggressive scenario, delivered energy consumption would decline by 15 tBtu in 2017 and save 81 tBtu, which represents a savings of $1.6 billion over the 10-year period.

Commercial Sector

The commercial sector consumed nearly 249 tBtu of energy in 2003, while total expenditures were approximately $1.4 billion. Electricity (54%) and natural gas (35%) were the dominant forms of delivered energy. Energy use for space heating (17%) and lighting (12%) was significant, however half of the energy was attributed to the "all other" category.

Energy consumption in Kentucky's commercial sector is expected to grow 22% between 2008 and 2017 – three times the increase predicted for the residential sector. Without changes, consumption is predicted to reach 382 tBtu in 2017 due, in part, to an increase in the use of electrical equipment.

Under the minimally aggressive scenario, energy consumption would decline by 2 tBtu in 2017 and save 14 tBtu representing $211 million in savings over the 10-year period. Under the moderately aggressive scenario, energy consumption would decline by 10 tBtu in 2017 and save 62 tBtu representing a savings of $950 million over the 10-year period.

Industrial Sector

Kentucky's industrial sector consumed nearly 830 tBtu of energy in 2003 at a cost of approximately $3.2 billion. Petroleum (36%), electricity (30%) and natural gas (21%) were the main forms of delivered energy consumed by the industrial sector. One-half of all electricity was used by motors; 17% was used for process heating applications. The vast majority of natural gas is used in process heating (54%) and boilers (36%).

Energy consumption in the industrial sector is expected to reach 989 tBtu in 2017, a 6.5% increase over the forecast for 2008. Under the minimally aggressive scenario, delivered energy consumption would decrease by 39 tBtu in 2017 and save 208 tBtu, which represents $3 billion in savings over the 10-year period. For the moderately aggressive scenario, delivered energy consumption would decline by 57 tBtu and save 306 tBu which represents $4.2 billion over the 10-year period. A summary of energy efficiency potential for Kentucky is provided in **Table 1**.

Table 1: Summary of Energy Efficiency Potential in Kentucky

	Annual Energy Consumption and Cost				Cumulative Delivered Energy and Cost Savings 2008 – 2017	
	*Source		Delivered		Minimally Aggressive	Moderately Aggressive
	2003	2017	2003	2017		
Residential	354 tBtu	458 tBtu	167 tBtu $2.2 billion	185 tBtu $3.9 billion	23 tBtu $459 million	81 tBtu $1.6 billion
Commercial	249 tBtu	382 tBtu	113 tBtu $1.4 billion	148 tBtu $2.4 billion	14 tBtu $211 million	62 tBtu $950 million
Industrial	830 tBtu	989 tBtu	507 tBtu $3.2 billion	580 tBtu $8.8 billion	208 tBtu $3 billion	306 tBtu $4.2 billion
Total	**1,433 tBtu**	**1,829 tBtu**	**787 tBtu $6.8 billion**	**913 tBtu $15.1 billion**	**245 tBtu $3.7 billion**	**449 tBtu $6.8 billion**

*Source is defined as total energy consumption including electricity generation and transmission losses

Conclusions

Overall, the savings potential from energy efficiency in Kentucky is large, achievable and significant – it has the promise of "supplying" the energy needs that will fuel Kentucky's growth and prosperity over the next decade.

The benefits offered from energy efficiency have a positive impact on the economy and the environment which reflect us as individuals and as a society. These benefits include:

- Reduced energy expenditures keep money in Kentucky's communities, towns and homes; money not spent for imported energy can be used to meet Kentucky's needs.
- Reduced emissions of greenhouse gasses improve the global environment while reductions in regulated pollutants, such as particulates, sulfur oxides (SO_x) and nitrous oxides (NO_x), improve local air quality.
- Creation of new markets for jobs and economic development, while helping existing Kentucky businesses and manufacturers remain profitable through improved efficiency.
- Reduced impact of higher energy prices and costs on families throughout the Commonwealth.
- Reduced energy demand slows the need for additional power generation facilities, transmission lines and pipelines.
- Reduced dependence on imported energy – much of which comes from nations that occasionally have strained relations with the United States. This decreased dependence on foreign sources of energy will increase our national security.

Energy efficiency is the fastest, cheapest and cleanest source of "new" energy. It can help reduce the strain on existing energy infrastructure and offer new solutions to slowing energy demand growth.

Seizing the opportunity that energy efficiency provides will require dedicated efforts from multiple stakeholders that must be sustained over many years. The challenge presented to the Commonwealth is how best to develop the right policies, procedures and incentives that will afford all Kentuckians the benefits of energy efficiency.

1.0 INTRODUCTION AND SCOPE

The rising cost of energy affects all facets of American society, and there are no indications that prices will decrease in the near future. In 2003, Kentuckians enjoyed one of the lowest combined utility rates throughout the nation, and the lowest retail electricity rates nationwide.[6,7] However, these low rates do not necessarily mean lower utility costs. According to the Kentucky Comprehensive Energy Strategy Report[8], released in 2005:

- Kentucky residents actually paid 1% more on their electric bills than West Virginia residents (even though our electricity rates are 9% lower).
- Although our electricity rates are 18% lower than Indiana's, our residents paid only 6% less on their electric bills.
- On an average monthly electric bill, Kentucky's schools spend 7% more per student than the national average.
- The average Kentucky industrial bill is 123% higher than the national average.
- Kentucky's average residential electric rate is 33% less than the national average but the average residential bill is only 17% below the national average.

As concluded in the Kentucky Comprehensive Energy Strategy Report, "… Kentucky's low electricity rates have encouraged energy-intensive practices, processes and procedures. This historic energy intensity provides a great opportunity for energy efficiency to help lower consumption, reduce energy bills, and improve the environment."

The purpose of this report is to provide a general indication of the energy consumption and forecasting as well as energy efficiency potential that exists within residential, commercial and industrial sectors of Kentucky. It is not designed to represent an exhaustive analysis, but rather to be viewed as a tool to identify opportunities for additional evaluation. The majority of data within this document is based on 2003 data that was available at the time this report was prepared. In some cases, older data was used, but still represents the most recent and pertinent information available.

2.0 RESIDENTIAL SECTOR

The residential sector consists of occupied housing units, including mobile homes, single-family housing units (attached and detached), and apartments.

2.1 Residential Energy Consumption

In 2003, Kentucky's residential sector consumed 353.9[9] trillion British thermal units (tBtu) of total energy, ranking the state 23rd nationwide in energy consumption.[10] The residential per

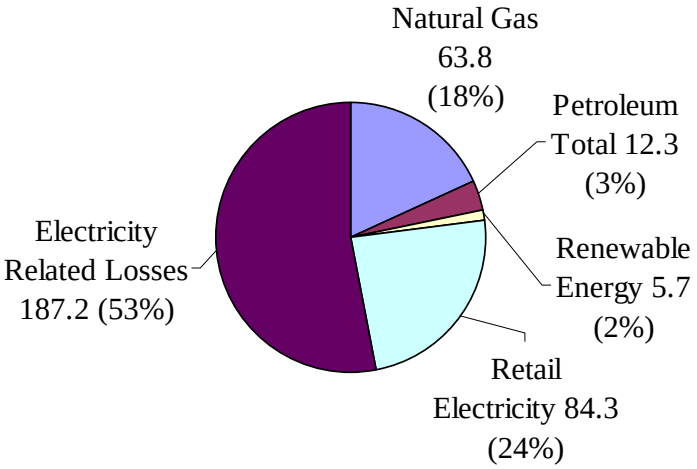
[6] Energy Information Administration (EIA), *Table R1. Energy Prices and Expenditures Ranked by State, 2003*
[7] EIA, *Table R4. Coal and Retail Electricity Prices and Expenditures Ranked by State, 2003*
[8] Commonwealth Energy Policy Task Force, *Kentucky's Energy Opportunities for our Future – A Comprehensive Energy Strategy*, February 2005
[9] EIA, *Table 8. Residential Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*

capita energy consumption was estimated at 86 million Btu (MMBtu) in 2003, ranking the state 9th in the nation; this is approximately 18% above the nation's per capita use of 73 MMBtu. The total energy expenditures were $2.186 billion (2003 dollars).[11]

In 2003, per capita income for Kentuckians was $25,840[12], while per capita residential energy expenditure was estimated to be $531 or 2% of their income. For the same year, the nationwide per capita income was $31,466[13], and the energy expenditure was $615 or approximately 2% of their income. Despite Kentucky's low energy prices, Kentuckians spend the same portion of their salary on energy compared to the national average.

Kentucky's 2003 total energy consumption by energy components is provided in **Figure 1**. Over three-fourths of the energy consumed is attributed to purchased electricity and electricity-related losses. Excluding electricity losses, the majority of energy used in Kentucky homes is electricity and natural gas at 51% and 38%, respectively.

Figure 1: 2003 Kentucky Residential Sector Total Energy Consumption
353.3 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.
Coal consumption of 0.6 tBtu is not shown resulting in a total of 353.3 tBtu.
Electricity Related Losses – the amount of energy lost during generation, transmission and distribution of electricity.

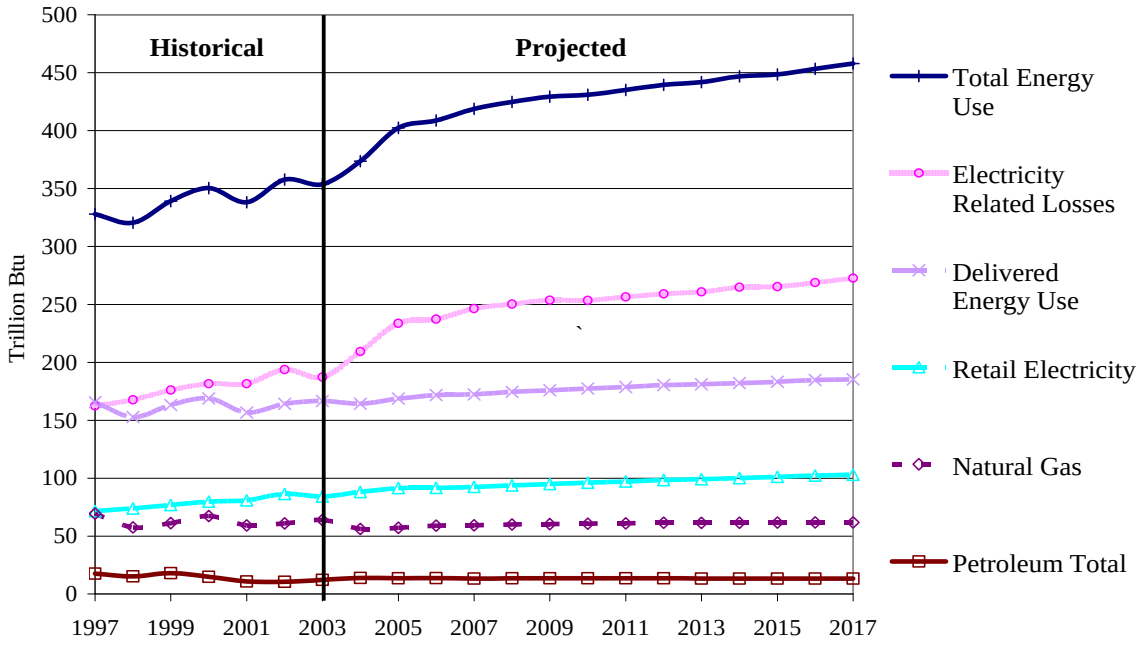
[10] EIA, *Table R1. Energy Consumption by Sector, Ranked by State, 2003*
[11] EIA, *Table S2b. Residential Sector Energy Expenditure Estimates by Source, 2003*
[12] U.S. Bureau of Economic Analysis, Regional Economic Accounts, *Bearfacts 1993-2003, Kentucky*
[13] U.S. Bureau of Economic Analysis, Regional Economic Accounts, *Personal Income and Per Capita Personal Income by BEA Economic Area, 2003-2005*

2.2 Residential Energy Forecast

Kentucky's historical and projected residential sector energy consumption trends for major energy sources are shown in **Figure 2**. Total energy consumption is expected to increase 7.8% from 425 tBtu in 2008 to 458 tBtu in 2017. This represents an annual average increase of 0.9%.

The energy profile from 1997 through 2003 is historical data for Kentucky[14] gathered from the U.S. Department of Energy, Energy Information Administration (EIA). Projected energy consumption for the residential sector is estimated by adjusting the forecasted energy consumption in the Annual Energy Outlook (AEO) 2006 using the National Energy Modeling System[15] (NEMS) for the East South Central region for Kentucky's household population[16] and climatic conditions (based on degree days).[17]

Figure 2: Kentucky Residential Sector Projected Energy Consumption



Note: "Total Energy Use" also includes coal and renewable energy.

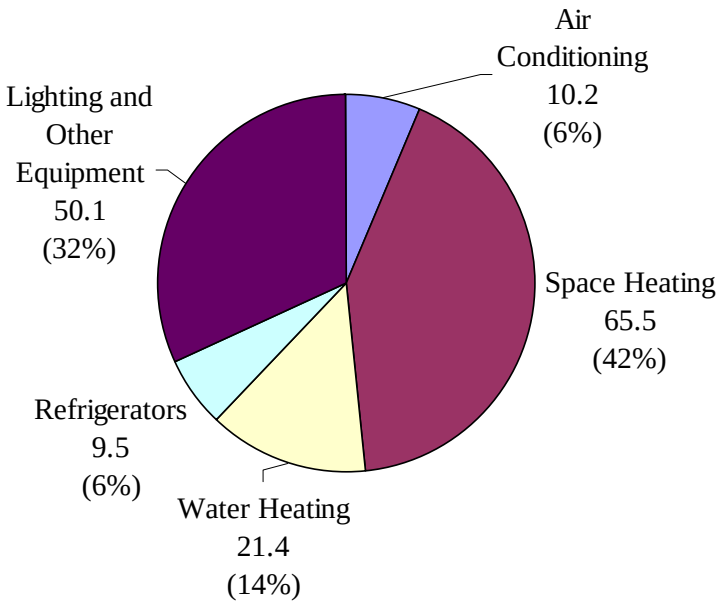
2.3 Residential End Use Analysis

The majority of energy use (42%) is consumed for space heating. Lighting and other miscellaneous equipment, such as televisions and home appliances, are the second largest, consuming 32% of the total energy. A summary of end use energy consumption is provided in **Figure 3**.

[14] EIA, *Table 8. Residential Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*
[15] EIA, *Table 6. Energy Consumption by Sector and Source – East South Central, February 2006*
[16] U.S. Census Bureau, *American Community Survey – Household Population*
[17] National Oceanic & Atmospheric Administration, *Population-Weighted Monthly Normals, 1971-2000*

Data from the 2001 Residential Energy Consumption Survey (RECS) for the East South Central region was adjusted for Kentucky's household population and climate to estimate end use energy consumption.[18] This 2001 survey is the most recent year for which information is available for this sector.

Figure 3: 2001 Kentucky Residential Sector Delivered Energy by End Use
156.7 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.

2.4 Potential for Residential Energy Savings

The residential sector was analyzed using a minimally aggressive scenario and a moderately aggressive scenario from 2008 to 2017. Assuming a minimally aggressive scenario, a 2.7% decrease in energy usage would be achieved in 2017. For the moderately aggressive scenario, an 8.2% savings would be achieved for this same period.

For the moderately aggressive scenario, the energy savings that could be achieved by 2017 are approximately 15 tBtu annually; cumulative energy savings over the same period would be approximately 81 tBtu. This is equivalent to a cumulative cost savings of $1.6 billion. A summary of the projected energy efficiency potential for the residential sector is provided in **Table 2**.

[18] EIA, *Residential Energy Consumption Survey 2001 Consumption and Expenditure Data Tables*

Table 2: Summary of Kentucky's Energy Efficiency Potential – Residential Sector

Projected Scenario	Usage/Estimated Savings
2008 Base Case Energy Usage – Delivered Energy	173 tBtu
2017 Base Case Energy Usage – Delivered Energy	183 tBtu
Percent Increase in Delivered Energy Consumption from 2008 to 2017	5.8%
2017 Minimally Aggressive Delivered Energy Savings over 2017 Base Case	5 tBtu
2017 Moderately Aggressive Delivered Energy Savings over 2017 Base Case	15 tBtu
2017 Minimally Aggressive Cumulative Delivered Energy Savings	23 tBtu
2017 Moderately Aggressive Cumulative Delivered Energy Savings	81 tBtu
2017 Minimally Aggressive Cumulative Energy Cost Savings	$459 million
2017 Moderately Aggressive Cumulative Energy Cost Savings	$1.6 billion

In AEO 2006, "Reference Case" average national residential energy intensities are forecasted until 2030. These national trends in energy intensities from 2003 to 2017 are applied to Kentucky's 2003 energy intensity estimated from EIA and U.S. Census Bureau data to forecast Kentucky's energy intensity through 2017. Kentucky's Base Case energy use is estimated from the forecasted energy intensities and projected trends in the number of households in Kentucky obtained from the University of Louisville's Kentucky State Data Center (KSDC).[19]

Energy savings for the Minimally Aggressive and Moderately Aggressive scenarios are estimated by applying, respectively, AEO 2006 "High Technology" and "Best Available Technology" energy intensity data to Base Case energy consumption. Consistent with AEO 2006 definitions, the Minimally Aggressive scenario assumes earlier availability of the most energy efficient technologies with lower costs and higher efficiencies, but does not constrain consumer choices. The Moderately Aggressive scenario assumes that the most energy efficient technology is always chosen, regardless of cost. Future energy prices are estimated by applying an average rate of increase in prices for each fuel type during the period from 1997-2003 to 2003 respective energy prices.

3.0 COMMERCIAL SECTOR

The commercial sector includes non-manufacturing businesses, such as office buildings, warehouses, retail outlets, schools and other similar types of facilities.

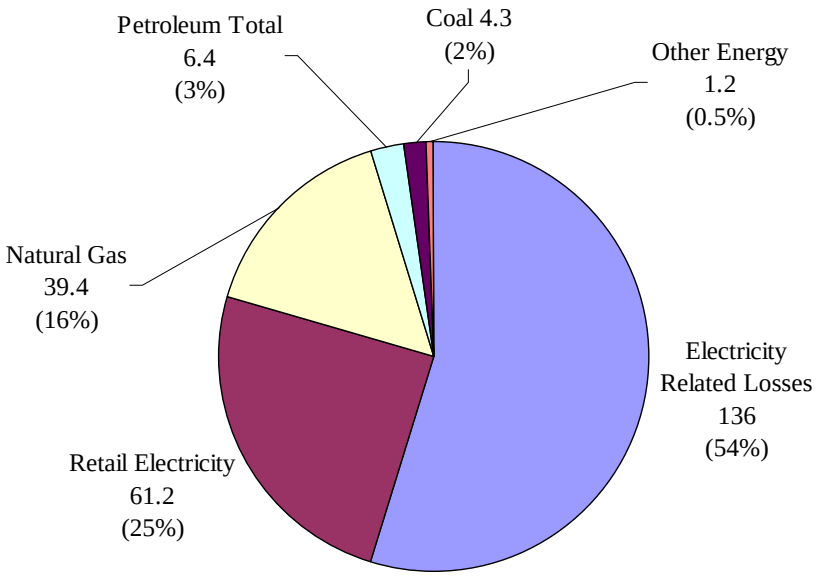
3.1 Commercial Energy Consumption

In 2003, Kentucky's commercial sector consumed 248.6[20] tBtu of total energy ranking the state 25th nationwide in energy consumption.[21] The total energy expenditures were $1.356 million (2003 dollars).[22]

[19]KSDC, *Historical and Projected Household Populations, Number of Households, and Average Household Size, State of Kentucky, Area Development Districts, and Counties*
[20] EIA, *Table 9. Commercial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*

Kentucky's total energy consumption by energy components for 2003 is provided in **Figure 4**. Over three-fourths of energy is from purchased electricity and electricity related losses. Approximately 54% of total energy was lost in electricity related losses. Excluding electricity losses, the energy used in commercial buildings is predominantly electricity (54%) and natural gas (35%).

Figure 4: 2003 Kentucky Commercial Sector Total Energy Consumption
248.5 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.
"Other Energy" includes biomass and geothermal.

3.2 Commercial Energy Forecast

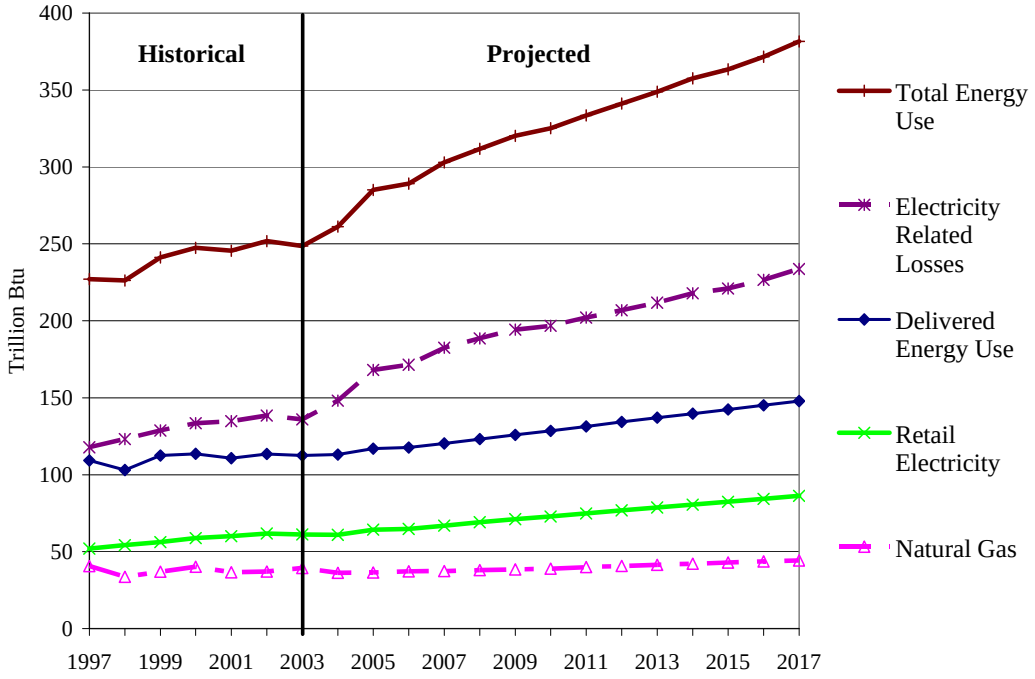
Figure 5 illustrates Kentucky historical and projected commercial sector trends for major energy sources. From 2008 to 2017, total energy consumption is expected to increase 22.4% from 312 tBtu to 382 tBtu. This represents a 2.5% annual average increase and is approximately three times greater than the rate of increase for the residential sector.

[21] EIA, *Table R1. Energy Consumption by Sector, Ranked by State, 2003*
[22] EIA, *Table S3b. Commercial Sector Energy Expenditure Estimates by Source, 2003*

The profile from 1997 through 2003 is based on historical data for Kentucky gathered from EIA.[23] The trends from 2004 through 2017 are forecasts derived from the NEMS model.[24] Applying the NEMS model, Kentucky's delivered energy intensity (kBtu/ft^2/yr) for the commercial sector is expected to increase from 135 kBtu/ft^2/yr in 2008 to 151.3 kBtu/ft^2/yr by 2017 due to increased use of electronic equipment (despite anticipated improved efficiencies in modern equipment).

The methodology to forecast commercial sector energy consumption is based first on applying Kentucky's historic (1997-2003) energy components (as a percentage) to the forecasted energy consumption in the AEO 2006 for the East South Central region. Then, the 2003 EIA Commercial Buildings Energy Consumption Survey (CBECS) data[25] for the East South Central region was adjusted for Kentucky's 2003 population. Finally, the growth in commercial space was assumed to increase at the same rate as the state's population as estimated by KSDC.[19] Forecasted energy usages and square footages are used to estimate energy intensities.

Figure 5: Kentucky Commercial Sector Projected Energy Consumption



Note: "Total Energy Use" also includes petroleum, coal, biomass and geothermal.

3.3 Commercial Energy Consumption: Sub-Sector and End Use Analysis

In 2003, Kentucky had approximately 85,300 commercial structures, which accounted for an estimated 881 million square feet.[26] **Table 3** provides the 2003 energy intensity for various commercial buildings on a national basis. Food Service is the most energy intensive sub-sector

[23] EIA, *Table 9. Commercial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*
[24] EIA, *Table 6. Energy Consumption by Sector and Source – East South Central, February 2006*
[25] CBECS, *Table A3. Census Region and Division, Number of Buildings for All Buildings (Including Malls), 2003, East South Central*

using approximately 227 kBtu/ft^2/yr, followed by the Health Care and Food Sales sectors. The variation in energy intensity observed among the sub-sectors is likely attributed to several factors, particularly the number of hours of daily activity and the type and prevalence of specialized equipment.

Figure 6 shows 2003 commercial sector delivered energy by end use. The majority of energy use (50%) is consumed by the category "All Other," which may include specialized equipment for hospitals, laboratories, and other similar facilities that have not been specified in AEO 2006. Space heating is the second largest, consuming 17% of the total energy.

National energy intensities for buildings with various principal building activities are estimated from AEO 2006 and presented in **Table 3**. National energy intensity percentages for specific end uses were estimated from AEO 2006 and applied to Kentucky's 2003 delivered energy consumption to estimate energy consumption by end uses.

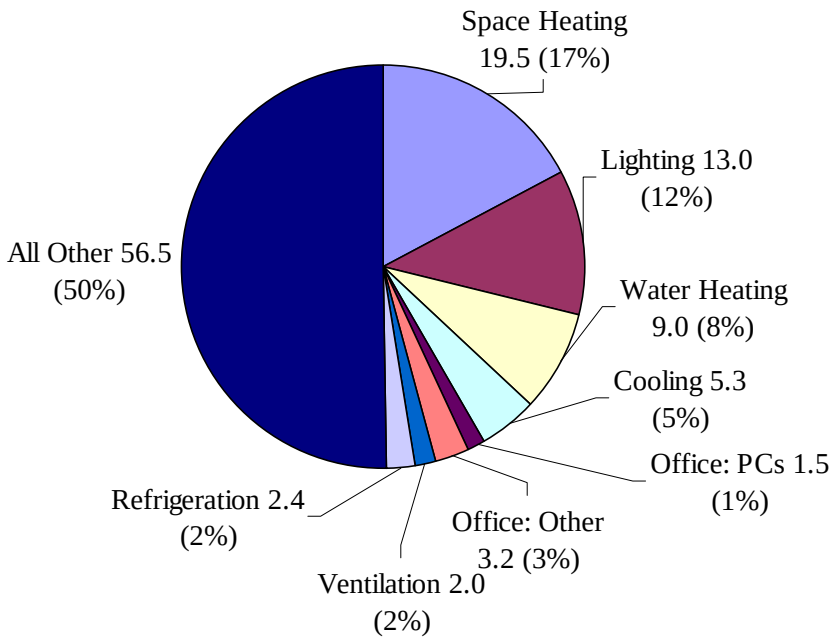
Table 3: 2003 National Commercial Building Energy Intensity (delivered energy)

Commercial Building Types	Energy Intensity (kBtu/ft^2/yr)
Food Service	226.5
Health Care	209.1
Food Sales	195.0
Office – Large	91.7
Lodging	90.6
Mercantile/Service	81.4
Education	74.1
Office – Small	66.5
Public Assembly	59.4
Warehouse	42.9
Other	78.8

Source: AEO 2006, *Table 22. Commercial Sector Energy Consumption, Floorspace, and Equipment Efficiency*

[26] CBECS, *Table A4. Census Region and Division, Floorspace for All Buildings (Including Malls), 2003, East South Central*

Figure 6: 2003 Kentucky Commercial Sector Delivered Energy by End Use
112.4 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.

3.4 Potential for Commercial Energy Savings

The commercial sector was analyzed using the minimally aggressive and moderately aggressive scenarios from 2008 to 2017. Assuming a minimally aggressive scenario, a 1.5% savings in energy usage would be achieved by 2017. For the moderately aggressive scenario, a 6.8% savings would be achievable in the same period. For the moderately aggressive scenario, the annual energy savings that could be achieved by 2017 are approximately 10 tBtu, and the cumulative savings over the same period are approximately 62 tBtu. The results suggest that up to $950 million in cumulative potential savings is achievable under a moderately aggressive scenario. A summary of the projected energy efficiency potential for the commercial sector is provided in **Table 4**.

Table 4: Summary of Kentucky's Energy Efficiency Potential – Commercial Sector

Projected Scenario	Usage/Estimated Savings
2008 Base Case Energy Usage – Delivered Energy	123 tBtu
2017 Base Case Energy Usage – Delivered Energy	148 tBtu
Percent Increase in Delivered Energy from 2008 to 2017	20.3%
2017 Minimally Aggressive Delivered Energy Savings over 2017 Base Case	2 tBtu
2017 Moderately Aggressive Delivered Energy Savings over 2017 Base Case	10 tBtu
2017 Minimally Aggressive Cumulative Delivered Energy Savings	14 tBtu
2017 Moderately Aggressive Cumulative Delivered Energy Savings	62 tBtu
2017 Minimally Aggressive Cumulative Energy Cost Savings	$211 million
2017 Moderately Aggressive Cumulative Energy Cost Savings	$950 million

Energy savings for the Minimally Aggressive and Moderately Aggressive scenarios are estimated by applying, respectively, AEO 2006 "High Technology" and "Best Available Technology" commercial building energy intensity data to Base Case energy consumption (see **Section 3.2**). Future energy prices are estimated by applying an average rate of increase in prices for each fuel type during the period from 1997-2003 to 2003 respective energy prices.

4.0 INDUSTRIAL SECTOR

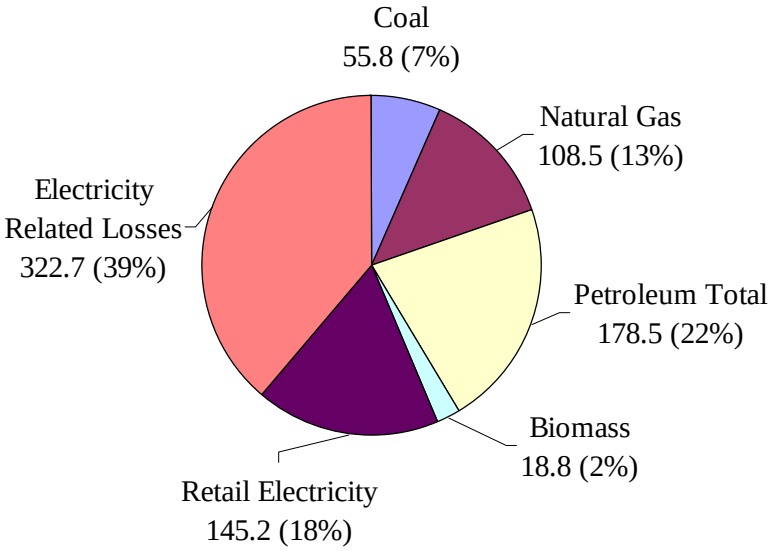
The Kentucky industrial sector is expansive and includes many different sub-sectors. However, not all sub-sectors are as energy intensive as others. Consequently, this report targeted only key industrial sub-sectors that consumed the majority of energy (electricity and natural gas).

4.1 Industrial Energy Consumption

In 2003, Kentucky's industrial sector consumed 829.5[27] tBtu of energy, ranking the state 11th nationwide in industrial consumption.[28] Total energy expenditures were $3.182 billion (2003 dollars).[29] **Figure 7** illustrates Kentucky's total energy consumption for the industrial sector by energy source for 2003 (this includes electrical system losses). Excluding electricity related losses, petroleum (36%), electricity (30%) and natural gas (21%) were the main forms of delivered energy consumed by the industrial sector.

[27] EIA, *Table 10. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*
[28] EIA, *Table R1. Energy Consumption by Sector, Ranked by State, 2003*
[29] EIA, *Table 4. Industrial Sector Energy Price and Expenditure Estimates, Selected Years, 1970-2003, Kentucky*

Figure 7: 2003 Kentucky Industrial Sector Total Energy Consumption
829.5 Total tBtu



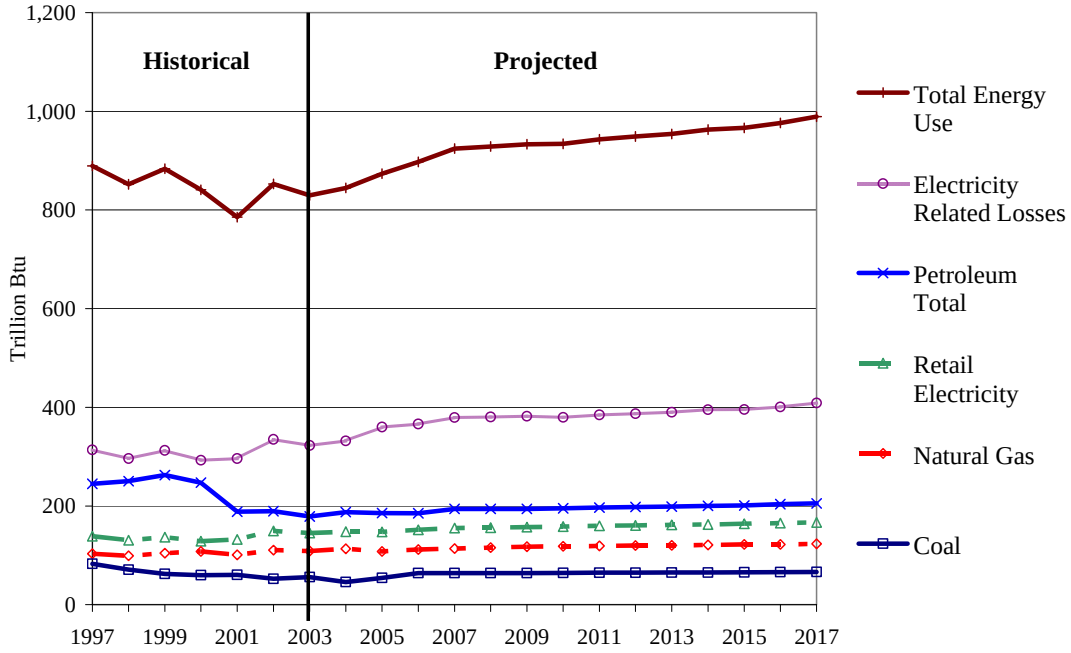
Note: Summary of percentages may not equal 100% due to rounding.

4.2 Industrial Energy Forecast

Kentucky's historical and projected industrial sector energy trends for major energy sources are provided in **Figure 8**. Based on this energy forecast, total energy consumption is expected to increase approximately 6.5%, from 929 tBtu in 2008 to 989 tBtu by 2017. This represents a 0.7% average increase each year. Historical data (from 1997 through 2003) was obtained from EIA.[30] AEO's projected increases are provided for each energy source except biomass, which is assumed to be constant at the 2003 level of 18.8 tBtu.

[30] EIA, *Table 10. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*

Figure 8: Kentucky Industrial Sector Projected Energy Consumption



Note: "Total Energy Use" also includes biomass.

4.3 Industrial Electricity Consumption: Sub-Sector and End Use Analysis

Primary metal manufacturers purchased the largest portion of electricity consumption, estimated to represent 36% of the industrial total. The chemical sector represented the second greatest electricity consumption at 13%. A summary of electricity consumption for the top seven industrial sub-sectors in Kentucky is provided in **Table 5**.

Approximately one-half of electricity consumption was attributed to motors for all sub-sectors. Process heating, which includes heat treating, melting and casting, represented approximately 17% of end uses for electricity. A summary of weighted average industrial end uses is provided in **Figure 9**. The "Total Motors" category includes pumps, fans and blowers, compressed air, material handling, material processing, refrigeration and other motors. The category "Other" includes miscellaneous equipment, such as office equipment and specialty process equipment. Although lighting and HVAC represent a relatively small percentage of the industrial sector electricity consumption, they are important in some of the key industries found in the region, such as transportation equipment manufacturers.

Data on industrial electricity consumption is not available for individual industrial sub-sectors. To estimate electricity sub-sector usage in Kentucky, the national electric intensity estimates provided in the 2002 EIA Manufacturing Energy Consumption Survey[31] (MECS) and the 2002 U.S. Census Bureau (USCB) national value of shipments[32] were applied to the USCB 2002

[31] EIA, *2002 MECS, Energy Consumption as a Fuel, Table 3.1. By Manufacturing Industry and Region (physical units)*

[32] U.S. Census Bureau, *2002 Economic Census Manufacturing Subject Series; Report Number EC02-31SG-1*

Kentucky value of shipments.[33] These were adjusted for electric intensity (defined as kilowatt-hour consumption per dollar of value of shipments) in the south census region from the 2002 MECS. The results were then calibrated to match the actual consumption for 2003. Only sub-sectors with electricity consumption greater than 4% of the total industrial electricity were included in the analysis.

The end uses of electricity in the industrial sector were estimated by using information collected in a study for the New York State Energy Research and Development Authority (NYSERDA) on industrial end uses.[34] Again, only the top seven industrial sub-sectors were considered when evaluating electricity consumption by end use.

Table 5: 2003 Estimated Electricity Consumption - Top Seven Sub-Sectors in Kentucky

NAICS Code	Industry Name	Estimated Electricity Consumption Million kWh (tBtu)	Percent of Total Industrial Electricity Consumption	Estimated Sub-Sector Costs (Million /yr)
331	Primary Metal Manufacturers	15,395 (53)	36%	$481
325	Chemical	5,414 (18)	13%	$169
336	Transportation Equipment	4,230 (14)	10%	$132
322	Paper	3,431 (12)	8%	$107
326	Plastics & Rubber Products	2,080 (7)	5%	$65
212	Mining (except oil & gas)	1,831 (6)	4%	$57
311	Food Manufacturers	1,731 (6)	4%	$54
Sub-Sector Total		**34,112 (116)**	**80%**	**$1,065**
Industrial Total		**42,570 (145)**[35]	**100%**	**$1,329**[36]

NAICS – North American Industry Classification System

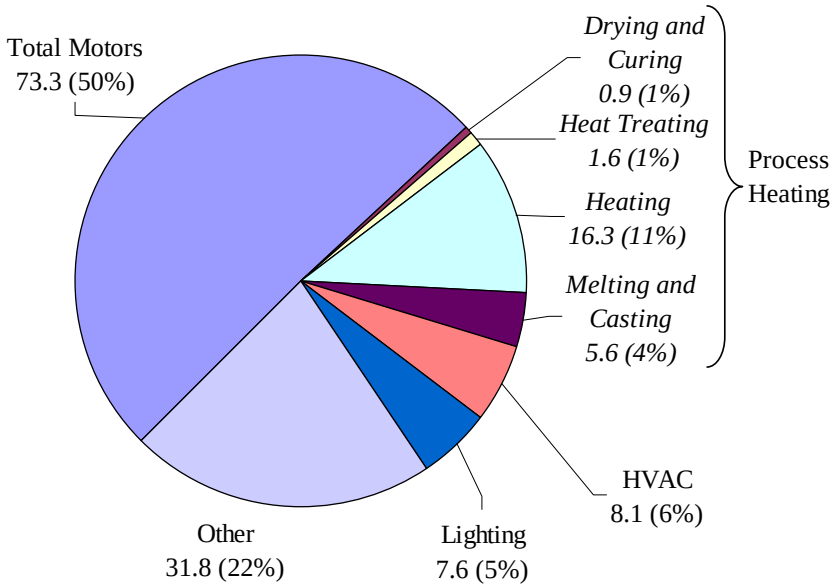
[33] U.S. Census Bureau, *2002 Economic Census Manufacturing Geographic Area Series; Report Number EC02-31A-KY (RV)*

[34] New York State Energy Research and Development Authority, *Energy Efficiency and Renewable Energy Resource Development Potential in New York State, Final Report*, May 2004

[35] EIA, *Table 10. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*

[36] EIA, *Table 4. Industrial Sector Energy Price and Expenditure Estimates, Selected Years 1970-2003, Kentucky*

Figure 9: 2003 Kentucky Weighted Average Industrial Electricity by End Use
145.2 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.

4.3.1 Potential for Industrial Electricity Savings

An analysis of 19 distinct measures for reducing electricity consumption was conducted for the Kentucky industrial sector. The savings potential for electricity as shown in **Table 6** was calculated based on the study of industrial electricity use for NYSERDA.[34] Future energy prices were estimated by applying an average rate of increase in electricity prices during the period from 1997-2003 to 2003 prices and forecasted to 2017.

The findings of this report reveal that cost-effective (minimally aggressive) investments in energy efficiency can save Kentucky industries an estimated 15.5% of electricity use by 2017, resulting in a cumulative cost savings of up to $1.7 billion. The energy savings that could be achieved with these minimally aggressive energy efficient cost-effective investments are approximately 26 tBtu annually, with a cumulative energy savings of 139 tBtu by 2017. A summary of Kentucky's electricity efficiency potential for the industrial sector is provided in **Table 7**.

The eight cost-intensive (moderately aggressive) measures would also improve efficiency, but existing technology is more expensive relative to the energy saved. These measures may become cost-effective when the cost of energy rises and the cost of the technologies fall. The energy savings that could be achieved through a moderately aggressive scenario are approximately 44 tBtu, with a cumulative energy savings of 237 tBtu by 2017. When considering all measures (cost effective and cost intensive), the total savings potential for electricity savings is over 26% by 2017, resulting in a cumulative cost savings of $2.9 billion.

Table 6: Electricity Savings Measures

Measure	Cost of Saved Energy ($/kWh saved)	Technical Savings Potential (% of Total Industrial Electricity)
Cost-Effective Measures (Minimally Aggressive)		
Pumps	0.010	3.1%
Sensors/controls	0.021	3.0%
Electric supply improvements	0.010	3.0%
Compressed air management	-	2.1%
Lighting	0.030	1.5%
Motor management	0.020	0.7%
Fans	0.030	0.7%
Lubricants	-	0.6%
Motor System Optimization	0.012	0.4%
Compressed air - advanced	-	0.1%
Refrigeration	0.004	0.4%
Subtotal		**15.5%**
Cost-Intensive Measures (Moderately Aggressive)		
Energy Information Systems	0.090	5.0%
Motor design	0.040	2.3%
Pipe insulation	0.090	1.3%
Microwave processing	0.450	1.0%
Energy Management Systems	0.450	0.6%
Transformers	0.188	0.3%
Cooling/storage – food	0.530	0.3%
HVAC	0.650	0.1%
Subtotal		**10.9%**

Source: New York State Energy Research and Development Authority, *Energy Efficiency and Renewable Energy Resource Development Potential in New York State*, *Final Report*, May 2004

Note: The retail industrial electricity price in 2003 in Kentucky was $0.032 per kWh. Cost-effectiveness is defined as all measures that cost less than $0.032/kWh saved over the life of the measure.
Summary of percentages may not equal subtotal due to rounding.

Table 7: Summary of Kentucky's Electricity Efficiency Potential – Industrial Sector

Projected Scenario	Usage/Estimated Savings
2008 Base Case Electricity Usage	157 tBtu
2017 Base Case Electricity Usage	167 tBtu
Percent Increase in Electricity Usage from 2008 to 2017	6.4%
2017 Minimally Aggressive Electricity Savings over 2017 Base Case	26 tBtu
2017 Moderately Aggressive Electricity Savings over 2017 Base Case	44 tBtu
2017 Minimally Aggressive Cumulative Electricity Savings	139 tBtu
2017 Moderately Aggressive Cumulative Electricity Savings	237 tBtu
2017 Minimally Aggressive Cumulative Electricity Cost Savings	$1.7 billion
2017 Moderately Aggressive Cumulative Electricity Cost Savings	$2.9 billion

4.4 Industrial Natural Gas Consumption: Sub-Sector and End Use Analysis

Primary metal manufacturing is the largest consumer of natural gas in Kentucky's industrial sector, estimated at 25% of the total natural gas consumption. Chemical manufacturing is the second largest user, estimated at 21% of the total. A summary of natural gas consumption for the top seven industrial sub-sectors is provided in **Table 8**.

Within the industrial sector, direct process heating and boilers consume the greatest natural gas, estimated at 54% and 36%, respectively (**Figure 10**). Boilers in industrial facilities are primarily used to generate steam and hot water used in manufacturing processes; direct process heat refers to usage by other process equipment, such as ovens and driers.

Data on industrial natural gas usage by sub-sector and end use consumption of natural gas is not available for Kentucky. Similar to the electricity analysis, the 2002 national energy intensities of the sub-sectors, estimated from MECS and value of shipments, were applied to the 2002 Kentucky value of shipments to estimate natural gas usage in the sub-sectors. The results were calibrated to match the actual consumption for 2003.[37] Only seven sub-sectors with gas consumption greater than 6% of the total industrial gas (representing 88% of industrial natural gas consumption in Kentucky) were evaluated in the analysis.

National end use data for sub-sectors, available in the 1998 MECS survey[38], was used in conjunction with data in **Table 8** to estimate the weighted average end use energy consumption presented in **Figure 10**.

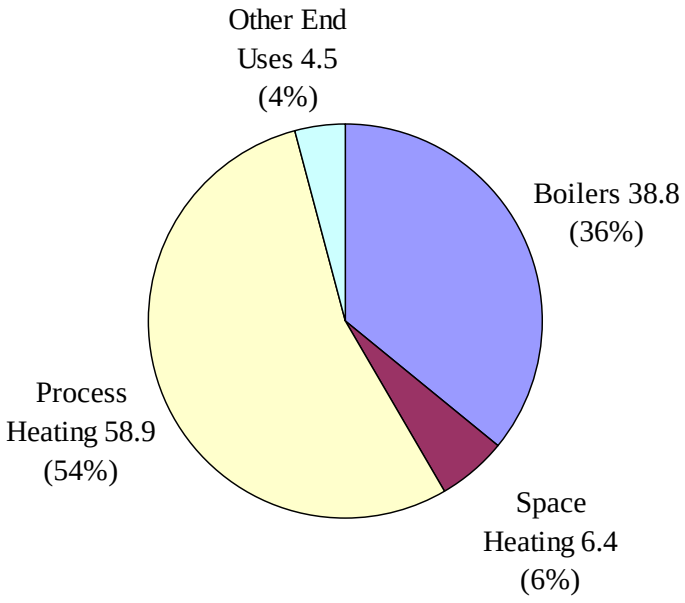
[37] EIA, *Table 10. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*
[38] EIA, MECS, *Table N6.1. End Uses of Fuel Consumption, 1998*

Table 8: 2003 Estimated Natural Gas Consumption - Top Seven Sub-Sectors in Kentucky

NAICS Code	Industry Name	Estimated Natural Gas Consumption (tBtu)	Percent of Total Industrial Consumption	Estimated Sub-Sector Costs (Million /yr)
331	Primary Metal Manufacturers	26.9	25%	$157.0
325	Chemical	22.5	21%	$131.2
322	Paper	12.5	12%	$73.2
324	Petroleum and Coal Products	10.5	10%	$61.3
336	Transportation Equipment	8.8	8%	$51.3
311	Food Manufacturers	7.2	7%	$42.3
327	Nonmetallic Mineral Products	7.1	7%	$41.6
Sub-Sector Total		**95.5**	**88%**	**$558**
Industrial Total		**108.5**[39]	**100%**	**$633.7**[40]

Note: Summary of columns may not equal sub-sector totals due to rounding.
NAICS – North American Industry Classification System

Figure 10: 2003 Kentucky Weighted Average Industrial Natural Gas by End Use
108.6 Total tBtu



Note: Summary of percentages may not equal 100% due to rounding.

[39] EIA, *Table 10. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2003, Kentucky*
[40] EIA, *Table 4. Industrial Sector Energy Price and Expenditure Estimates, Selected Years 1970-2003, Kentucky*

4.4.1 Potential for Industrial Natural Gas Savings

The savings potential for natural gas was calculated based on a study of industrial gas use in California.[41] The study calculated the 10-year achievable potential for natural gas savings in the California industrial sector. The study found that 12% of boilers, 10% of process heating, and 10% of space heating gas use could be saved in 10 years. These totals do not include estimates of how much natural gas can be saved by fuel switching. When applied to the industrial natural gas consumption in Kentucky, it is estimated that gas savings of approximately 10.3% could be achieved from 2008 to 2017 resulting in a cumulative cost savings of up to $1.3 billion. The annual energy savings that could be achieved by 2017 is approximately 13 tBtu, and the cumulative savings over the same period is approximately 69 tBtu. A summary of the natural gas efficiency potential for the industrial sector is provided in **Table 9**.

Future energy prices are estimated by applying an average rate of increase in gas prices during the period from 1997-2003 to 2003 prices and then projected to 2017.

Table 9: Summary of Kentucky's Natural Gas Efficiency Potential – Industrial Sector

Projected Scenario	Usage/Estimated Savings
2008 Base Case Natural Gas Usage	116 tBtu
2017 Base Case Natural Gas Usage	123 tBtu
Percent Increase in Natural Gas Usage from 2008 to 2017	6%
2017 Natural Gas Savings over 2017 Base Case	13 tBtu
2017 Cumulative Natural Gas Savings	69 tBtu
2017 Cumulative Natural Gas Cost Savings	$1.3 billion

5.0 SUMMARY AND CONCLUSION

Results from this report suggest that the residential, commercial and industrial sectors in Kentucky have the potential to achieve significant cost savings by implementing energy efficiency practices. Conservative estimates for implementing energy efficiency measures indicate that by 2017 Kentucky could save the following:

- Residential Sector - $459 million in savings
- Commercial Sector - $211 million in savings
- Industrial Sector - $3 billion in savings

In 2003, Kentucky was fortunate to have one of the lowest combined utility rate structures and the lowest electricity rates in the nation. According to Kentucky's Comprehensive Energy Strategy Report, these low rates encourage "… energy-intensive practices, policies and

[41] Pacific Gas and Electric Company, *California Industrial Energy Efficiency Market Characterization Study*, December 2001

procedures." Clearly, energy efficiency opportunities exist within the state. Significant improvements in energy efficiency can be achieved by implementing currently available and cost-effective technologies.

Kentucky has many options on how to achieve these potential savings. Many states have implemented or are considering implementing various incentive programs to promote energy efficiency. For example, in July 2007 Florida's Governor signed Executive Orders concerning the state's energy policy. Specifically, future state building construction will be energy efficient and include solar panels whenever possible. Office space leased in the future must be in energy efficient buildings. Additionally, the Governor requested the Public Service Commission to adopt a 20% Renewable Portfolio Standard by 2020, with a strong focus on solar and wind energy.

Overall, the savings potential from energy efficiency in Kentucky is large, achievable and significant – it has the promise of "supplying" the energy needs that will fuel Kentucky's growth and prosperity over the next decade.

The benefits offered from energy efficiency have a positive impact on the economy and the environment which reflect us as individuals and as a society. These benefits include:

- Reduced energy expenditures keep money in Kentucky's communities, towns and homes; money not spent for imported energy can be used to meet Kentucky's needs.
- Reduced emissions of greenhouse gasses improve the global environment while reductions in regulated pollutants, such as particulates, sulfur oxides (SO_x) and nitrous oxides (NO_x), improve local air quality.
- Creation of new markets for jobs and economic development, while helping existing Kentucky businesses and manufacturers remain profitable through improved efficiency.
- Reduced impact of higher energy prices and costs on families throughout the Commonwealth.
- Reduced energy demand slows the need for additional power generation facilities, transmission lines and pipelines.
- Reduced dependence on imported energy – much of which comes from nations that occasionally have strained relations with the United States. This decreased dependence on foreign sources of energy will increase our national security.

Energy efficiency is the fastest, cheapest and cleanest source of "new" energy. It can help reduce the strain on existing energy infrastructure and offer new solutions to slowing energy demand growth.

Seizing the opportunity that energy efficiency provides will require dedicated efforts from multiple stakeholders that must be sustained over many years. The challenge presented to the Commonwealth is how best to develop the right policies, procedures and incentives that will afford all Kentuckians the benefits of energy efficiency.