Moving from Coal to Efficiency: An Analysis of State-Level Employment Impacts

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Abstract

Coal production in the Central Appalachian basin is projected to decline by 74 percent over the next decade, signaling a need for greater diversification in the region's economy. Can investment in energy efficiency programs compensate for projected job losses in coal-dependent regions? Selecting Kentucky as a case study, this research models the statewide employment impacts associated with energy efficiency programs. An economic impact assessment model known as IMPLAN is used to trace spending on energy efficiency programs and estimate the cumulative effects on employment. The goal of this research is to assess whether and to what extent energy efficiency programs can compensate for inevitable coal industry job losses. Analysis indicates that robust support for home weatherization and energy services can create nearly 4,000 direct job-years through 2017, reduce household expenses for poor populations, and offset regional declines in coal mining-related employment.

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Moving from Coal to Efficiency: An Analysis of State-Level Employment Impacts

Introduction

Coal-fired power plants accounted for 48 percent of electricity generation and 81 percent of electricity-sector greenhouse gas emissions in the United States in 2010. (U.S. Energy Information Administration, 2011a) Renowned climate scientist James Hansen has described the future of coal bluntly: “coal emissions must be phased out as rapidly as possible or global climate disaster will be a dead certainty.”(Hansen, 2009) Hansen and colleagues published one of the seminal works addressing climate change tipping points in 2008. Titled, “Target Atmospheric CO2: Where Should Humanity Aim?” the paper notes that current atmospheric concentrations of greenhouse gases are already too high to maintain the climate to which the biosphere has adapted. The authors designate 325-350 ppm as an initial target and the safe upper limit for carbon dioxide concentrations (pending additional studies and evidence from arctic ice sheet mass). The paper suggests rapid replacement of coal-fired power generation, since a phase-out of coal emissions by 2030 will keep atmospheric greenhouse gas concentrations close to 400 ppm. (Hansen et al., 2008) Hansen suggests replacing coal-fired electric power with energy efficiency measures, substitution with renewables, and smart grid technology. (Hansen, 2009)

The U.S. Energy Information Administration projects that electric power supplied by coal plants will increase by 20 percent compared with 2007 levels by 2030. (Watson & Freme, 2006) Hansen’s pronouncement is thus provocative, since it calls into question the status quo of energy production in the United States and has far-reaching technological, economic, and political implications.

Hansen’s assertions are perhaps most controversial in regions of the country historically dependent on coal production. Yet, as Hansen is quick to point out, in addition to contributing to climate change, coal is a nonrenewable resource that will eventually become uneconomically recoverable. Communities in formerly coal-rich states will begin to feel the pinch as coal production continues to decline. The focus of this research is thus the inevitable decline of coal, and the examination of energy efficiency as an alternative strategy for economic development that may also reduce greenhouse gas emissions.

Selecting Kentucky as a case study, this research models the economic impacts of energy efficiency-related employment in sectors such as construction, weatherization, and energy services. The first chapter examines coal industry production trends across the United States and Appalachia. The Kentucky coal industry is profiled and employment declines are explained in the second chapter. The third chapter details Kentucky’s electricity sector and makes the case for energy efficiency, noting that energy efficiency will decrease the need for additional generation capacity. The fourth chapter models employment impacts of energy efficiency programs and answers the research question: Can energy efficiency programs compensate for projected job losses in coal-dependent states?

Chapter 1: Coal in the United States and Appalachia

Coal began to replace wood and biomass as the primary source of energy in the late 19th century, and was a key fuel in the industrial revolution. Between 1845 and 1900, coal use increased from nearly zero to just under 200 million tons of oil equivalents (Mtoe). Coal dominated the energy consumption landscape from the industrial revolution until the late 1950s, when it was surpassed by petroleum and natural gas. (Höök & Aleklett, 2009) Coal-fired power plants accounted for 48 percent of electricity generation and 81 percent of electricity-sector greenhouse gas emissions in the United States in 2010. (U.S. Energy Information Administration, 2011a)

The Appalachian region has produced coal since the 1800s and is defined by the Appalachian Regional Commission to include counties in parts of Pennsylvania, Ohio, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, and Alabama. (Abrahmson, 2006) Three key U.S. coal basins fall within the Appalachian region: the Northern, Central, and Southern Appalachia basins. Figure 1 shows a map of the primary coal basins in the country, according to the U.S. Energy Information Administration.

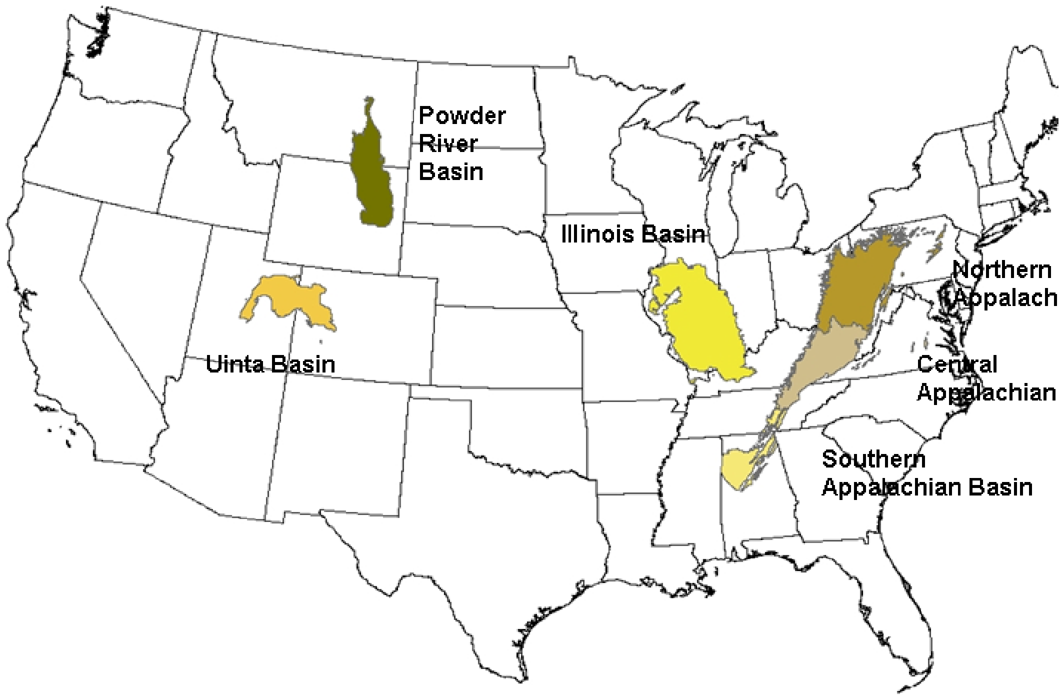

Figure 1. Map of Primary U.S. Coal Basins. *Source*: U.S. Energy Information Administration. Retrieved 4/19/2012 from http://205.254.135.7/coal/transportationrates/coal_trends_rates.cfm

Most mining activity has been concentrated in the Central and Northern Appalachian coal basins, which includes eastern Kentucky, southern Virginia, West Virginia, and western Pennsylvania. The three Appalachian coal basins differ materially from other parts of the country in two key ways: coal sulfur content and levels of estimated coal reserves. The Appalachian region contains nearly 100 percent of reserves of lower-sulfur anthracite coal, and about 40 percent of bituminous coal reserves. Bituminous coal tends to have higher sulfur content and lower heat content per unit mass, which means it burns less cleanly and efficiently than anthracite. (Höök & Aleklett, 2009)

Coal reserves in Appalachian states tend to be lower than in western states. For example, Kentucky was estimated to have 13,413 million metric tons of recoverable coal reserves in 2006, and West Virginia had 16,161 million metric tons, compared with 36,418 million metric tons of estimated reserves in Wyoming. (Höök & Aleklett, 2009) "Estimated reserves" exclude coal that is unavailable due to regulatory or land use restrictions and coal that is not considered economically recoverable.

Coal production is declining in the key coal-producing states in Appalachia. Eastern Kentucky coal production peaked in the 1980s. Pennsylvania coal production peaked in 1917 and has been declining ever since. Declines often result because the highest quality and thickest coal seams have been fully developed. Coal production declines in Appalachia can also be partly explained by productivity declines in small-scale surface mining. More than a thousand small mines, most of which were inefficient or seasonal operations, have been closed since the 1970s. Tightening permitting regulations of surface mines, increased environmental standards, and growing public opposition to mountaintop removal are also cited as factors affecting closure of some of these mines. (Watson & Freme, 2006)

Figure 2 offers a short-term snapshot of coal production in the Appalachian region that indicates continued annual decline in most regions. Eastern Kentucky, which, along with West Virginia, Tennessee, and Virginia, comprises the Central

Appalachian coal basin, reached its lowest production level since the 1970s, seeing a 9.7 percent decrease in 2010 relative to 2009 production levels. Western Kentucky alone has had six straight years of production growth, and saw a 13.3 percent increase in 2010 compared to 2009 production levels. (Watson, Paduano, Raghuveer, & Thapa, 2010)

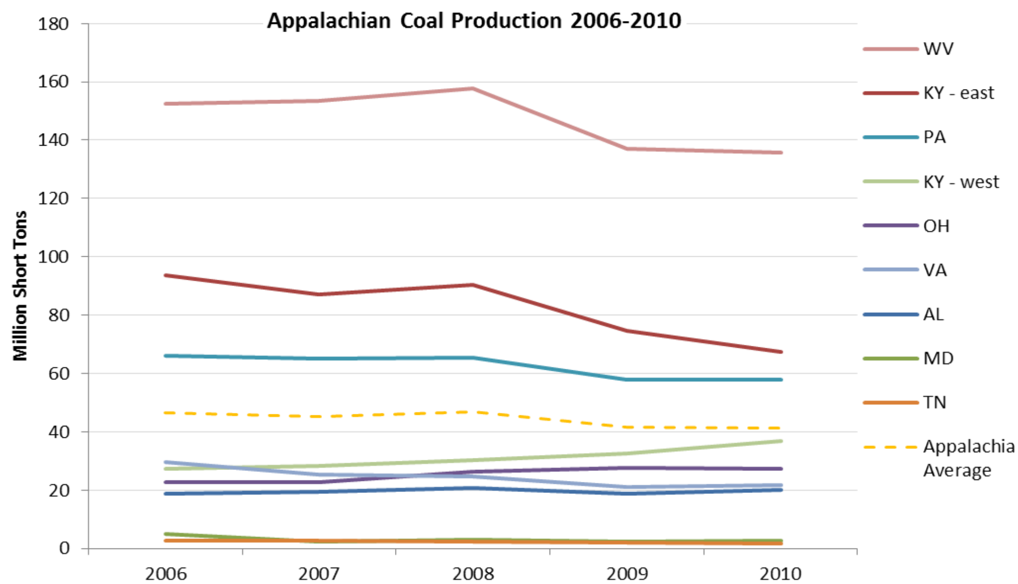

Figure 2. Appalachian Coal Production, 2006-2010. *Source*: Raw data derived from U.S. Energy Information Administration, 2010a

Even with these regional declines, recoverable resources in West Virginia are high enough to keep coal output from the Appalachian region fairly constant until 2050. Beyond 2050, coal from Montana and Wyoming is projected to account for the largest share of U.S. coal production, but federal and state policies such as land use restrictions, pollution regulations, and carbon legislation will have an important impact on production in those regions. In the absence of a vast scaling-up of coal production in Montana, in particular, coal production in the United

States is projected to peak around 2030. According to Höök and Aleklett, "The geological coal supply might be vast, but the important question is how large the share that can be extracted under present restrictions are and how those restrictions will develop in the future." (Höök & Aleklett, 2009, pg. 214)

Section 1.1: Mining Technology, Productivity, and Employment in Appalachia

Underground Mining

Coal is extracted underground in tunnels below the surface. Conventional mining involves undercutting and blasting exposed coal, and loading it into shuttle cars. Automated forms of underground mining include "continuous mining" – which involves the use of machines that gouge coal from the underground rockface – and longwall mining, which involves an automated application of the same machines that are used in continuous mining and requires relatively flat terrain. The longwall method typically has the highest efficiency and coal extraction rates. (Watson & Freme, 2006)

Surface Mining

There are several types of surface mining, including contour mining, area mining, and mountaintop removal mining. Surface mining has also been known as strip mining. In general, surface mining involves removing overlying rock and soil (known as overburden) and extracting coal from the coal seams that lie beneath. Contour mining is simply surface mining of sloping terrain. Area mining is characterized by the long pits (known as "box cuts") created during coal extraction. Overburden from the box being mined is deposited in previously used and mined box cuts. This method is common in the Powder River coal basin of Wyoming. Mountaintop removal is one adaptation of area mining that is common in the mountainous terrain of Appalachia. This method is controversial because it reduces the peaks of mountains by 250 to 600 feet, and overburden from excavation is typically placed in nearby valleys (as “valley fill”), which frequently contain streams. (Watson & Freme, 2006)

Surface mining has emerged as a dominant technology in coal mining since the 1970s. Figure 2 shows the percentage of underground mines versus surface mines over time. Note that in 1973, surface and underground coal mining each accounted for 50 percent of total coal production. Surface mining accounted for 67 percent of total production in 2003. (Watson & Freme, 2006) Due to relatively higher levels of mechanization, surface mines typically employ fewer workers than underground mines.

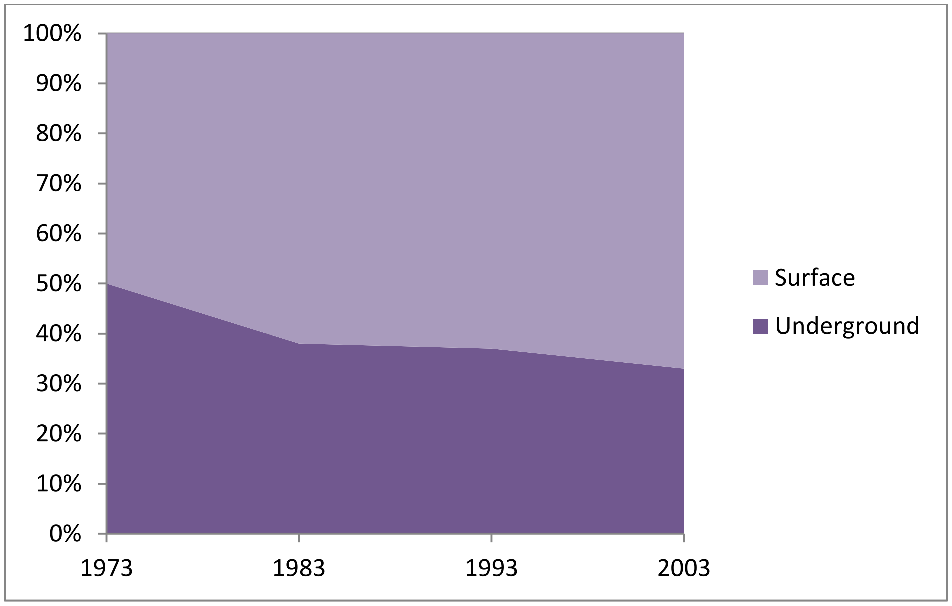

Figure 3. Mining Technology Trends in the United States. *Source*: Raw data retrieved from “Coal Production in the United States”. U.S. Energy Information Administration. 2006

Technological improvements since the 1970s have changed the mining industry as well. Conversions to belt conveyors to move coal out of mines, increasingly powerful longwall cutting machinery, and automation of equipment have improved productivity rates (defined as total coal production divided by total labor hours worked) of mines across the United States. These advances also serve to distance mine workers from areas of underground mines that may be dangerous, noisy, or contain moving machinery, which has increased occupational safety. (Watson & Freme, 2006)

The prevalence of surface mining – a lower-cost extraction method that employs relatively fewer miners – and technological improvements in both the underground and surface mining sector have led to a decrease in coal employment trends over time. Figure 3 illustrates these trends for selected years from 1973 to

2009. Rising global demand for coal along with expedited permitting processes for surface mines led to an uptick in Appalachian production beginning in 2004, but the boom has not negated decades of falling employment. (Mountain Association for Community Economic Development, 2009)

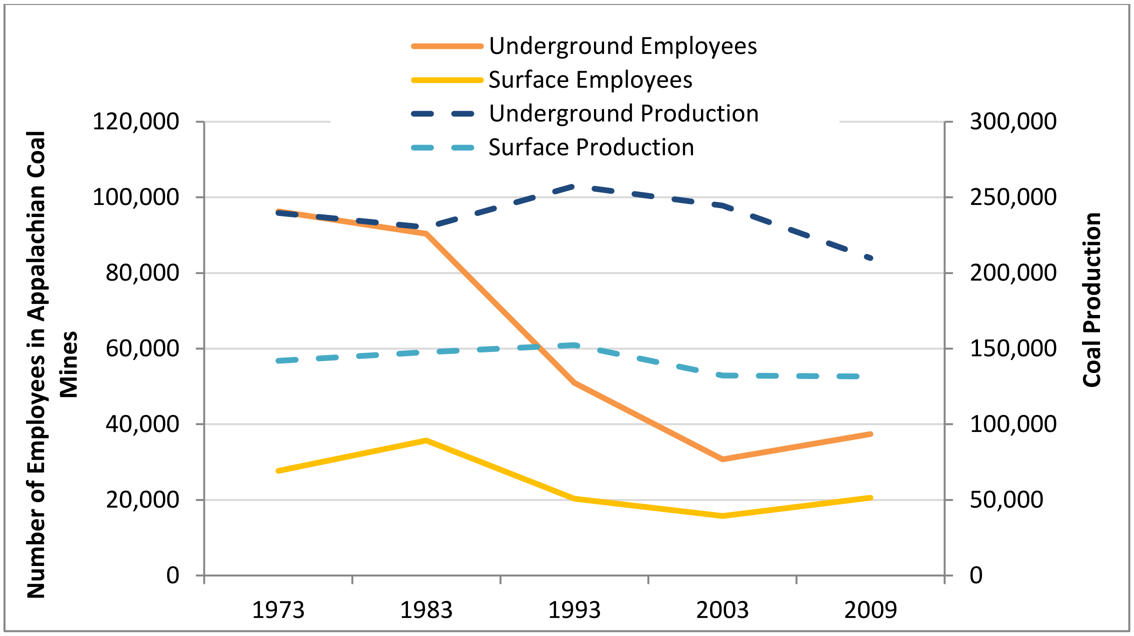

Figure 4. Employment Trends in Appalachia. *Source*: Raw data retrieved from "Coal Production in the United States". U.S. Energy Information Administration, 2010 and Watson et al., 2006.

Chapter 2: Kentucky Coal, Energy and Employment Profile

The “War on Poverty” was declared in a small town of Kentucky in 1964. President Johnson visited the area to make the announcement, and declared Kentucky part of the special economic zones of Appalachia under the Appalachian Regional Development Act. Like many other parts of Appalachia, economic opportunities in Kentucky have been historically scarce, beyond professions involving extraction of resources like timber and coal. By the end of the 1970s, Kentucky was producing more coal than any other state in the country. (Perry, 1982, Pg. 196) This chapter provides an overview of the dominance of coal from both a sociological and technical perspective. The following sections outline Kentucky’s historic dependence on coal, discuss employment and production trends, and provide an introduction to the complex factors contributing to coal industry employment declines.

Section 2.1 Conceptualizing Coal Dependence in Kentucky

Coal plays a key role in Kentucky’s electricity sector. Data from the U.S. Environmental Protection Agency’s Emissions & Generation Resource Integrated Database (eGRID) suggests that over 93 percent of electricity generated in Kentucky comes from coal. Of the coal burned to generate electricity in Kentucky, 67 percent was coal produced in Kentucky. Biomass and conventional hydropower make up just over 2 percent. Nearly 3 percent comes from oil, and approximately 2 percent from natural gas. (U.S. Environmental Protection Agency, 2007)

The Appalachian region of the country is a notoriously underdeveloped area that has been the focus of academic research in economic development and industrial diversity. Currently in Appalachia, population is increasing after years of decline, and per capita income is reaching parity with national averages. Some credit for improvements goes to the Appalachian Regional Commission, which has been active in regional economic development in the area since 1965, with the passage of the Appalachian Regional Development Act. (Bollinger, Ziliak, & Troske, 2011) Still, according to Bollinger, et al., "The Appalachian region has historically had lower levels of skilled labor and income relative to the rest of the country, which some researchers claim has resulted in a 'poverty trap'." (Bollinger et al., 2011, Pg. 820) Indeed, the Appalachian region has seen billions of federal and state dollars allocated to economic development, but economic growth in the heart of Appalachia is stagnant compared with the rest of the nation and more urbanized areas in the Appalachian region. In 1960, 44 of 49 Kentucky counties were documented on the Appalachian Regional Commission's list of distressed counties. In 1990, 38 counties still remained on the list.[1] (Glasmeier & Farrigan, 2003) The number of distressed counties has climbed again during the

[1] Distressed is defined as "poverty rates of at least 150 percent of the U.S. average, unemployment rates of at least 150 percent of the U.S. average, and per-capita market income (income less transfer payments) not more than two-thirds of the U.S. average." (Glasmeier & Farrigan, 2003)

economic recession, reaching 41 of 49 counties in 2012. (Appalachian Regional Commission, 2012)

Contemporary research cites the region's dependence on coal extraction and external control of land as a key source of socioeconomic disempowerment and stagnation. More than 50 percent of state lands in Kentucky are owned by outside interests. According to research by Amy K. Glasmeier and Tracey Farrigan, "the historical legacy of resource extraction in the region, coupled with the effects of outside ownership, produced an economy heavily dependent on a few sectors and a citizenry deeply suspicious of outside interests and fearful of the local power structure."(Glasmeier & Farrigan, 2003, Pg. 141) Glasmeier and Farrigan also document the fact that poor Appalachian counties lack basic municipal services, including waste pick-up, sewer systems, and sanitation. The lack of services is in part related to low land values and a small local tax base. There are two sources of tax revenue from coal companies: taxes paid on in-situ coal deposits and a coal severance tax.[2] However, rampant evasion of taxes on in-situ coal deposits serves to limit the local tax base. In addition, revenue from coal severance taxes is primarily used in the construction of roads rather than municipal services. When the coal severance tax was enacted in 1972, 50 percent of tax revenue was to be returned to Kentucky counties. In practice, tax revenue is split between the state of Kentucky general fund (50%), a Local Government Economic Development Fund (35%), which is divided according to county needs and total contribution to

[2] The severance tax is a tax imposed by the state of Kentucky on the extraction (severance) of coal. (Kentuckians for the Commonwealth, n.d.)

the severance fund, and a Local Government Economic Assistance Fund (15%). The Local Government Economic Assistance Fund dedicates 30% of revenue to a Coal-Haul Road Fund. (Kentuckians for the Commonwealth, n.d.) Finally, according to Glasmeier and Farrigan, “Horror stories also abound of how corrupt political officials siphon off millions from the severance tax funds for their own personal use.” (Glasmeier & Farrigan, 2003, Pg. 137)

Perry suggests that efforts to develop regions of Appalachia that are highly dependent on coal will face special difficulties. He argues that dependence on coal has reduced industrial diversification, and that the “boom and bust” economic pattern of coal development throughout the past century resembles that of Third World nations also dependent on primary resources. Even during “boom” times, Perry notes, counties dependent on coal have income level below those of areas not economically dependent on coal. Thus, Perry concludes, “It appears that the region resists development for reasons that lie in its socioeconomic structure, not merely in the attitudes of its residents or its lack of resources. Attempts to encourage industrialization must recognize the evident structural unattractiveness of the coal areas.” (Perry, 1982, Pg. 202)

In March of 2012, I visited Harlan County, Kentucky and was struck by the dominance of the coal narrative. Cars and trucks throughout the state display “Friends of Coal”, and “If You Don’t like Coal, Don’t Use Electricity” stickers. The local department of motor vehicles offers “Friends of Coal” license plates to all of its patrons, and similar t-shirts are available at local banks. Discussions of alternative forms of economic development take place only in limited enclaves, including some parts of Letcher County, which is known for its art and music community, and the urban center of Louisville. Contradicting the coal narrative in places like Harlan is met with significant resentment and resistance from locals, and often results in ostracization. Conversations with the Mountain Association for Community Economic Development about my research also made it clear that it is important to tread lightly around coal if you want to be heard. The strength of the coal narrative and the notion – however outdated – that coal creates economic opportunities contributes to the challenge of moving beyond a coal-based economy in Kentucky.

Section 2.2. Employment in Kentucky's Coal Industry

The U.S. Energy Information Administration makes data on coal mine locations, ownership, production and employment publicly available from 1991-2009. Analysis of available data shows that there were 358 active coal mines in Kentucky in 2009 that employed between one and 437 workers, with an average of 43 workers employed per mine. Eight mines have union affiliations. Most mining operations were strictly coal mines, while just fewer than 25% of the coal mining operations listed were processing plants. (U.S. Energy Information Administration, n.d.) Figure 5 shows the number of employees by mine type in 2009.

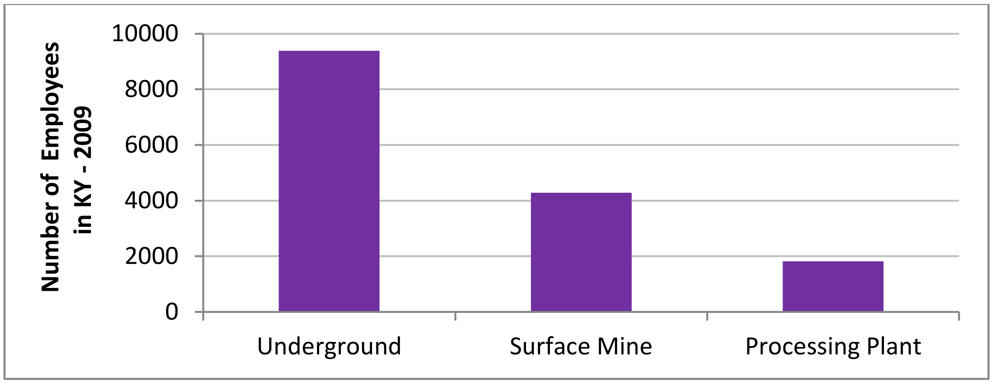

Figure 5. Employment by Mine Type in Kentucky. *Source*: U.S. Energy Information Administration Coal Production Data Files. Accessed 3/16/2012

Despite Kentucky's recognition as part of "coal country" within popular culture, the coal industry employs a small portion of the population. Kentucky coal mines employed a total of 17,699 workers in 2010, accounting for less than one percent of total jobs in the state that year. ("Workforce Kentucky," 2010) Figure 6 shows coal mining employment compared to other key industries in Kentucky, such as construction and manufacturing.

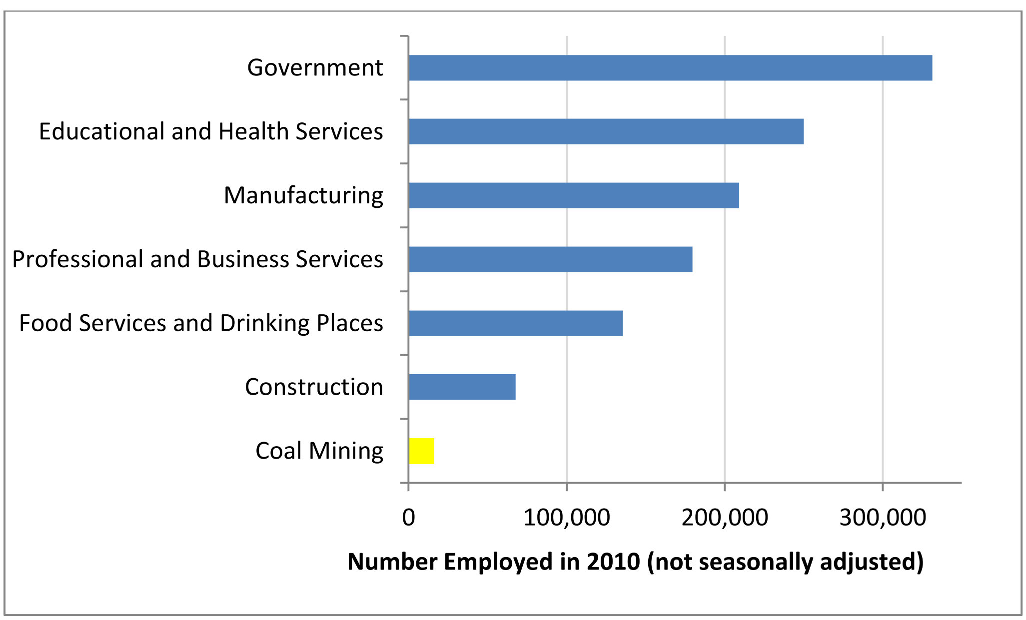

Figure 6. Employment in Selected Kentucky Industries Compared with Coal Mining. *Source*: Workforce Kentucky Current Employment Statistics, Annual 2010 data

Coal industry employment levels have steadily declined in Kentucky from 1979-2010. Figure 7 shows historic employment data.

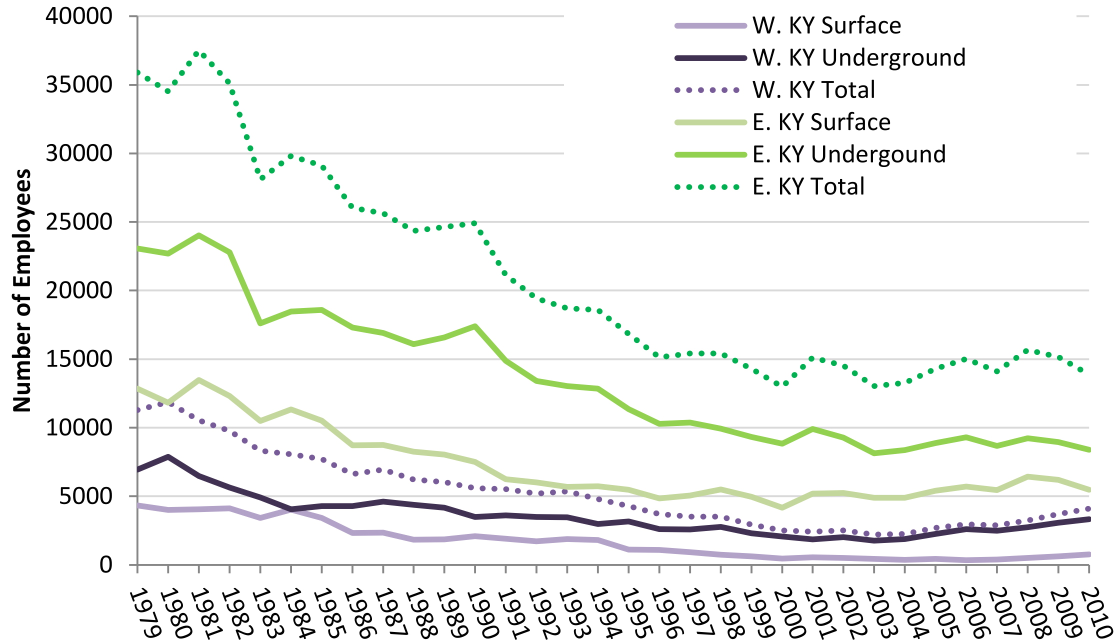

Figure 7. Kentucky Coal Historical Employment Trends by Mine Type and Region, 1979-2010. *Source*: Raw data retrieved from Kentucky Coal Association, U.S. Energy Information Administration Annual Coal Report, 2010. Accessed 3/16/2012.

Section 2.3 Coal Production Trends in Kentucky

In addition to observed declines in coal industry employment, the U.S. Energy Information Administration projects that coal production will also decline in Kentucky's historic coal country. Kentucky will face significant economic development challenges as coal production shifts from the Central Appalachia coal basin to the Illinois and Powder River coal basins. Central Appalachian coal tends to have lower sulfur content than coal from other regions, which as explained below, is one reason for shifting production trends. Figure 6 shows that the inflection point for this change is within the next two years, with projected increases in Wyoming and the Illinois basin outstripping projected production in eastern Kentucky.

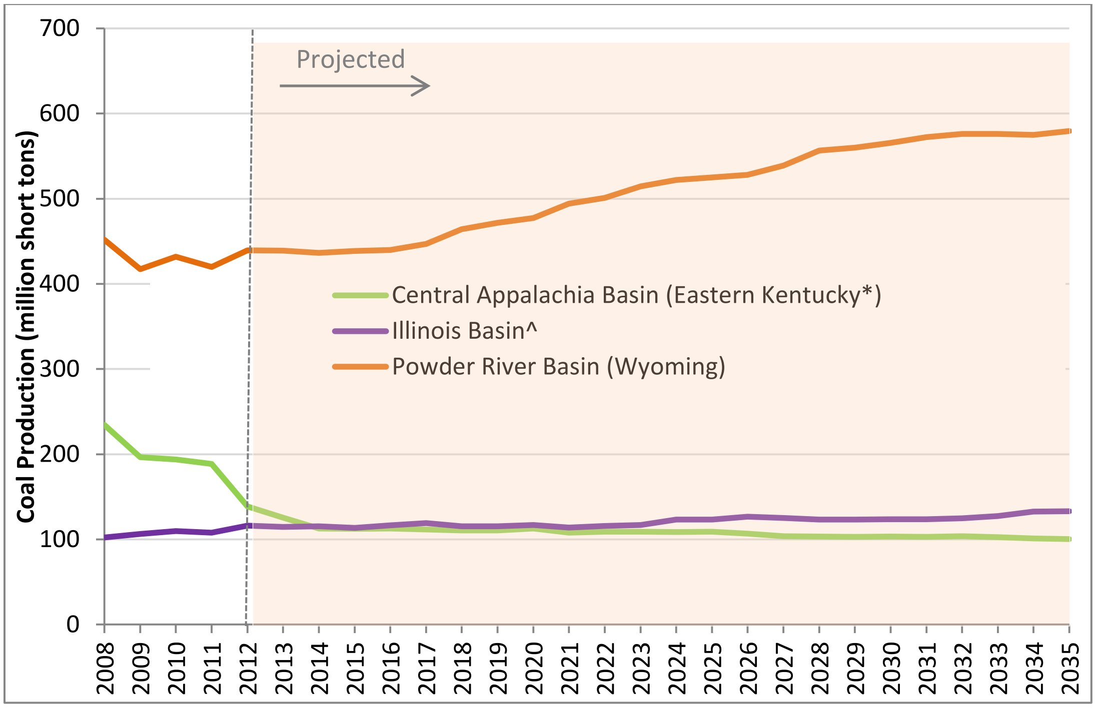

Figure 8. Eastern Kentucky v. Illinois & Wyoming Coal Production Trends, 2008-2035. *Source*: Raw data retrieved from U.S. Energy Information Administration, *Annual Energy Outlook* 2011, Reference Case.
*Basin also includes southern West Virginia, northern Tennessee, and Virginia
^Basin also includes Indiana, parts of western Kentucky, and Mississippi

Section 2.4 Explaining Coal Production and Employment Declines

The anticipated and observed decline in both coal industry employment and production can be explained by several factors affecting the coal industry. Reductions in coal production can be attributed to 1) changes in Clean Air Act compliance strategies, 2) proposed new EPA standards for new power plants, and 3) substitution of coal-fired power generation with natural gas. Declines in employment, while related to overall coal production declines, can also be explained by the contemporary prevalence of surface mines as opposed to underground mine sites.

Title IV of the 1990 Clean Air Act amendments set emissions allowances for sulfur dioxide (SO_2), a byproduct of coal combustion that causes acid rain. In the first phase of the program, emissions allowances were calculated according to an electric utility's historic baseline from 1985 to 1987, multiplied by 2.5lbs SO_2 per million Btu of heat produced. The year 2000 marked the beginning of tighter emissions regulations and lowering of emissions caps, as historic baseline levels were multiplied by only 1.2lbs SO_2 per million Btu. In this phase (Phase II) of regulation, new power plants were not allocated emissions allowances. In order to comply with regulations, utilities could purchase additional allowances, switch to lower sulfur coal, or install desulfurization units (known as "scrubbers"). (Milici & Dennen, 2009)

The Energy Information Administration predicted that burning low-sulfur coal – found in the eastern part of the country and in states like Kentucky – would be the compliance method of choice in the beginning stages of SO_2 regulation. For most coal plants, this would be the least expensive option. Correspondingly, production of low-sulfur Central Appalachian Basin coal increased steadily from 1985 to the mid-1990s.

However, the implementation of the stricter second phase of SO_2 regulations would change the economics of coal production and therefore the compliance method of choice. For example, the least expensive compliance strategy for most utilities during Phase II of the regulations was to install scrubbers. The new technology allows coal plants to burn high-sulfur coal and still comply with emissions standards. High-sulfur coal from the Eastern Interior basin, which includes states like Illinois and Ohio, is less expensive than low-sulfur coal from Kentucky. The installation of emissions control technology has served to increase demand for higher-sulfur coal over the past decade, and thus partly explains the decline in eastern Kentucky coal production. (Milici & Dennen, 2009)

The second factor contributing to contemporary declines in Kentucky coal production is the impact of low natural gas prices on the energy industry. Increased domestic production of natural gas from shale in the United States has served to dramatically lower the price of natural gas-fired power generation. According to the EIA, power sector demand for natural gas is expected to increase by 9% in 2012, whereas demand for coal will drop by 5% to its lowest levels since 1996. (U.S. Energy Information Administration, 2012a) According to a webinar on the topic hosted by IHS Cambridge Energy Research Associates (CERA), power sector demand for natural gas has risen by 3.5 Bcf per day, and is expected to reach 4 Bcf per day by the end of 2012. CERA anticipates that the natural gas “shale gale” will serve to further reduce coal production in the Central Appalachian basin. (IHS Cambridge Energy Research Associates, 2012)

New regulations promulgated by the Environmental Protection Agency may also contribute to future declines in coal production. On March 27, 2012, EPA published a draft ruling on new source performance standards for power plants that would limit plant carbon dioxide emissions to 1,000 pounds per megawatt-hour. Since most coal plants produce 1,800 pounds of CO2 per megawatt-hour, the rule would effectively limit the construction of new plants without carbon capture and sequestration (CCS) technology. (Natural gas plants, on the other hand, have no trouble meeting the standard.) (Barringer, 2012) Analysis of EIA data shows that most of Kentucky's coal fleet is approaching retirement age, as the majority of plants were built in the early 1960s. The new EPA rules will serve to limit construction of new coal plants in Kentucky as well as the rest of the nation. The impact of the performance standards on Kentucky coal production has yet to be studied in depth. However, one can assume that the rules will serve to decrease demand for coal nationwide and limit Kentucky coal production in the near-term, since Kentucky currently exports most of its coal within the United States.

A final contemporary change in coal production trends can be explained by the increase in the number of surface mines and mountaintop removal sites in Appalachia. While this trend does not cause coal production declines, it does contribute to losses in employment. The nature of mountaintop removal makes it inherently more productive – mountaintop removal requires fewer man-hours per ton of coal produced. Advances in technology, including using GPS to dispatch trucks that haul overburden and to pinpoint drilling locations, has also served to limit the number of employees required to achieve similar extraction rates. (Watson & Freme, 2006) The increase in mountaintop removal mining stems from a 2007 "parting gift" to the coal industry at the end of the Bush administration that allowed mining waste from mountaintop removal to be deposited in valleys and streams. (Broder, 2007)

It is important to note that despite low overall state-level employment in the coal-mining sector, mining jobs make up a significant percentage of employment in several historical coal counties. Since each of these counties is in the eastern Kentucky coal basin, alternative forms of economic development will become essential if eastern coal production continues to decline. Mining employed more than ten percent of the workforce in eight counties in eastern Kentucky in 2006, as shown in Figure 8.

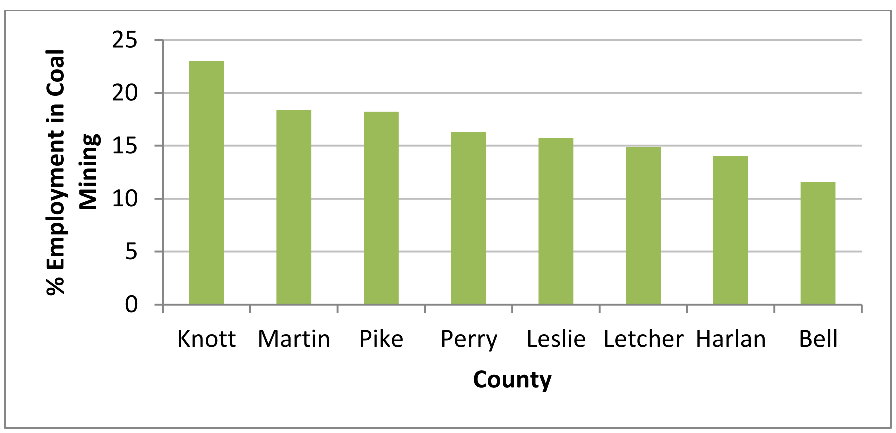

Figure 9. Coal Mining Employment as Percent of Total Employed by County, 2006. *Source:* Mountain Association for Community Economic Development, 2009. (2009). "The Economics of Coal in Kentucky: Current Impacts and Future Prospects"

Chapter 3: Energy Efficiency: Current Support and Opportunities

The Harlan County Community Action Agency (CAA) sits between a railroad crossing and an old industrial site in eastern Kentucky. A sign on the front door lets passersby know that the county has run out of this year's funds for the local Low Income Heating and Electric Assistance program. The CAA began its work in the late 1960s, and expanded its home weatherization efforts with the recent American Recovery and Reinvestment Act. The status of poverty in Kentucky – where 38 of 44 counties are classified as economically distressed by the Appalachian Regional Commission – keeps the weatherization work performed by the CAA in high demand. The work becomes even more critical when one considers that per capita residential electricity demand in Kentucky is among the highest in the nation, since over 40 percent of households use electricity for home-heating.

At the head of the CAA desk is Dennis Daniels, a former coal miner who now serves as Weatherization Director for the county. Employment in the coal industry is declining in Harlan County, and many talk of layoffs and shortened hours. Competition from natural gas, increasingly competitive coal from other regions, industry mechanization, and declining recoverable eastern Kentucky coal reserves are the primary contributors to the decline. The Central Appalachian coal basin, which includes Harlan County, once produced more coal than any other region in the United States. By 2014, however, the U.S. Energy Information Administration projects that Central Appalachian coal production will fall below that of the nearby Eastern Interior coal basin for the first time. Coal production in the Central Appalachian basin is projected to continue to decline over the next decade – dropping 74 percent by 2020, signaling a need for greater diversification in the region's energy sector and economy. (U.S. Energy Information Administration, 2011b) The following sections make the case for scaling up energy efficiency programs in Kentucky as a means of economic development. The electricity sector in Kentucky is profiled in order to provide background information and add context to the need for increased energy efficiency programs. Current incentives and state policy support are then discussed. The final section outlines the case for energy efficiency. Energy efficiency programs have local demand and room for growth because of current inefficiencies, overlapping skills with coal mining, and the likelihood that improved efficiency will decrease household electricity expenses.

Section 3.1 Kentucky Electricity Profile

The U.S. Energy Information Administration notes that per capita residential electricity demand in Kentucky is among the highest in the nation, since over 40 percent of households use electricity for home-heating. (An additional 44 percent use natural gas for heating.) Low electricity prices also influence this trend. Retail electricity prices in Kentucky averaged approximately $0.07/kWh in 2010, compared with a national average of approximately $0.10, a minimum of

$0.06/kWh (Idaho), and a maximum of $0.32/kWh (Hawaii). (U.S. Energy Information Administration, 2010)

In addition, energy consumption in Kentucky's industrial sector exceeds the national average, with industry accounting for 45 percent of annual electricity consumption in 2010, compared with less than 33 percent nationally, on average. The substantial demands of the sector are associated with the steel, aluminum, and manufacturing industries. (Kentucky Energy & Environment Cabinet & Kentucky Department for Energy Development and Independence, 2010)

It is important to note that increasing energy efficiency will reduce the need for new generation capacity to come online. Presently, 20 coal-fired power plants operate in Kentucky, and all but three were commissioned before 1980 – most were built in the early 1960s, making them over 50 years old. One plant burns sub-bituminous coal, while the primary fuel in the other 19 plants is bituminous coal, according to 2010 data. The number of coal-fired power plant units has increased steadily in Kentucky since the early 1950s, with a new unit being added nearly every year for a cumulative total of 57 coal-fired electricity units. New plants were added less frequently – approximately every two years. The average age of coal plants in Kentucky is 47, and many are approaching retirement. (U.S. Energy Information Administration, n.d.)

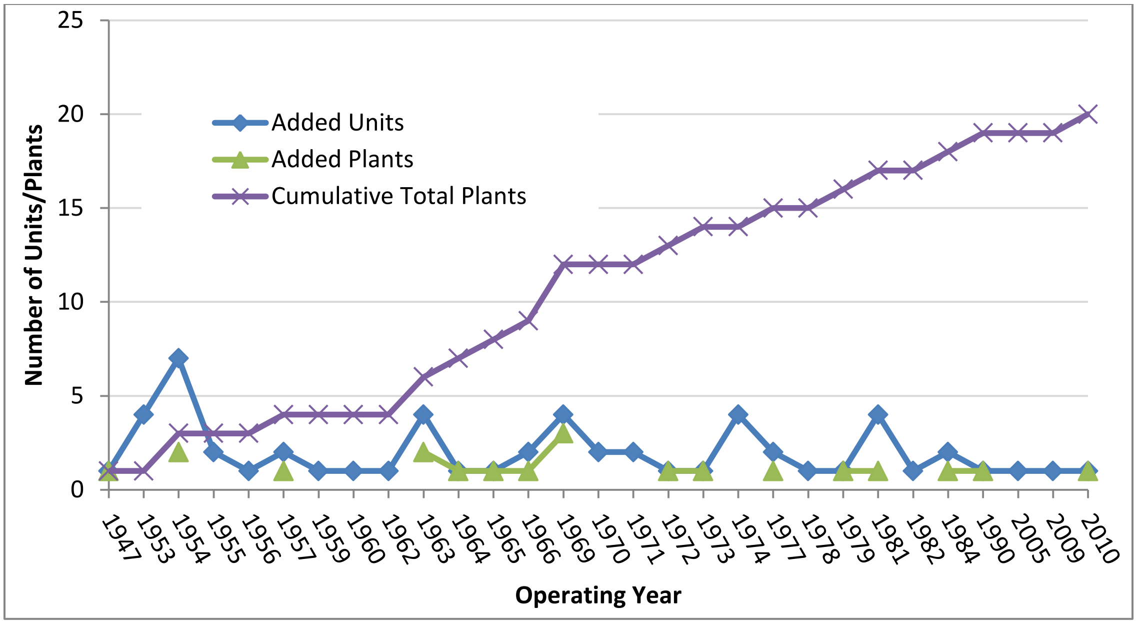

Figure 10. Kentucky Coal Plant Additions and Cumulative Totals. *Source*: Raw data retrieved from U.S. Energy Information Administration Coal Production Data Files. Accessed 3/16/2012.

Electric utilities in Kentucky consist of rural electric cooperatives, municipal utilities, and retail electric providers. Most utilities are not members of wholesale electricity markets. This is significant because participation in competitive markets tends to leave states better-positioned to influence electricity policy. (Hornby, White, Vitolo, Comings, & Takahashi, 2012) The state's two largest utilities, Louisville Gas & Electric and Kentucky Utilities Company, were granted approval to withdraw from the Midwest Independent Transmission System Operator (MISO) in 2006. (Commission, 2006) MISO is a regional transmission organization that provides transmission services and helps to coordinate the use of the electric grid by electric utilities and generators. However, Duke Energy Kentucky and a subsidiary of American Electric Power, Kentucky Power Company, are integrated into the Pennsylvania-New Jersey-Maryland (PJM) regional transmission organization. Duke Energy Kentucky, Inc. joined PJM as of

January 1, 2012 and will now participate in its competitive wholesale electricity market. ("Duke Energy to move Ohio, Kentucky arms to PJM from MISO," 2010)

A number of Kentucky utilities offer energy efficiency and weatherization rebates to residential and commercial customers. A review of the incentives listed in the Database of State Incentives for Renewables & Efficiency (DSIRE) shows that most residential efficiency rebate programs are offered by rural electric cooperatives, with the most common incentives being replacement of heat pumps, HVAC systems, and insulation. Larger utilities, including Duke Energy, Louisville Gas & Electric, and Kentucky Utilities Company notably do not offer programs targeting the residential sector, but provide rebates to commercial customers for a wide range of building upgrades, including lighting, HVAC, heat pumps, and windows. (DSIRE, 2012)

Section 3.2 Current Energy Efficiency Support

In addition to support for energy efficiency measures from electric utilities, a variety of state agencies in Kentucky are devoted to research and energy planning, with a focus on energy efficiency and in-state renewable energy development. Sources of support include:

- The state's first comprehensive Energy Plan, commissioned by Governor Beshear in 2008, which includes assessments of energy efficiency, renewable energy, sustainable biofuels production, coal-to-liquids industry

development, increased gas supplies, carbon capture and storage, and nuclear
- The state Office of Energy Policy
- Division of Renewable Energy within the Department for Energy Development and Independence (DEDI), which is charged with implementing the state's renewable energy strategy
- The Kentucky Renewable Energy Consortium, created by the state in 1984 to serve as a technical assistance resource center
- Conn Center for Renewable Energy Research at the University of Louisville
- The Task Force on Energy Efficient Housing and Construction, commissioned in 2008 within the Department of Public Protection

According to research completed by Synapse Energy Economics, the Kentucky legislature is also presently considering a renewable energy portfolio standard, which would require 12.5 percent of retail electricity load to be met by renewable energy and 10.2 percent to be met by energy efficiency in 2022. (Hornby et al., 2012)

A 2008 report produced by the Kentucky Rural Energy Consortium (KREC), supported by the Governor's Office of Energy Policy and the University of Kentucky, outlines a "roadmap" for Kentucky that would allow the state to obtain 25 percent of its electricity from renewable energy and energy efficiency projects by 2025. The KREC report is significant because it represents a general consensus among state government agencies regarding the future of energy in Kentucky. The report was completed over a number of years and features input from town hall-style events held across the state. The purpose of the report is to "advance comprehensive research on renewable energy and energy efficiency, and to highlight the importance of these research efforts to Kentucky's agriculture, rural communities, and related industries." (Kentucky Rural Energy Consortium, 2008, pg. 4)

The KREC report places the greatest emphasis on energy efficiency, noting that up to 19 percent of the KREC "roadmap" plan could be achieved through energy efficiency alone if programs are widely deployed over the next decade. Suggestions include increasing support for research and training at state universities, establishing statewide outreach programs that bring together relevant stakeholders, and by requiring all public buildings to meet Energy Star certification requirements. The report's final recommendations include increasing funding for biofuels research and creating public awareness and education campaigns around energy efficiency.

Additional agencies have examined the benefits of increased energy efficiency support in Kentucky. The Kentucky Pollution Prevention Center at the University of Louisville and the American Council for an Energy Efficient Economy prepared a report for the Governor's Office of Energy Policy in 2007 that quantified the state's potential savings from energy efficiency programs. The report's key conclusion is that energy efficiency can meet all future demand growth through 2017. This means that no additional power generation capacity would be needed in the short term. The report analyzed both minimally and moderately aggressive energy efficiency scenarios, and found that energy savings in the residential sector would range from $459 million to $1.6 billion. Commercial and industrial sector energy savings would range from $211 million to $950 million and $3 billion to $4.2 billion, respectively. (Ilyer, Sieglinde, Douglass, Monis Shipley, & Prindle, 2007)

Section 3.3 The Case for Energy Efficiency

The need for new economic opportunities in Kentucky is widely recognized by governments, advocacy groups, and citizens. Declining employment in the coal industry is one factor motivating the search for new opportunities. Energy efficiency programs represent a viable form of potential economic development due to 1) current inefficient use of electricity, 2) overlap with coal mining skill-sets, and 3) the fact that high percentages of dollars spent or saved due to energy efficiency programs remain in the local economy. The Kentucky Pollution Prevention Center at the University of Louisville and Synapse Energy Economics have independently estimated that the state of Kentucky can achieve 5.4-8.2% reductions in energy use with investments from $292-$634 million. (Hornby, et al., 2012; Ilyer et al., 2007)

As discussed previously, the potential for energy efficiency savings in Kentucky is large because low electricity prices have created limited incentive to conserve energy. Residential electricity consumption is among the highest in the nation. (U.S. Energy Information Administration, 2012b) Zinga and McDonald prepared a report for the Kentucky Environmental Foundation and Kentuckians for the Commonwealth in 2008 that outlines a number of options for fulfilling projected electricity demand increases with renewable energy and energy efficiency resources. Kentucky's technical potential – if efficiency measures were applied to the extent possible from an engineering perspective, regardless of cost – for energy efficiency is as high as 30%. (The authors note that technical potential differs from achievable potential, which is typically lower.) Zinga and McDonald show that significant energy savings can be realized through scaling up preexisting programs in space heating and cooling, water heating, and lighting. The authors provide specific recommendations based on other successful programs nationwide. These include a refrigerator, residential water heater, and air conditioner replacement program, along with solutions for industrial and commercial energy users. (Zinga & Mcdonald, 2008)

Significant percentages of workers in the coal mining sector already have the skills needed in the home weatherization and energy efficiency sector. National industry-occupation matrix data, available from the Bureau of Labor Statistics, sheds light on relationships between industry occupations and indicate that there is some skill overlap. As shown in Table 1, significant portions of those employed in the coal industry have occupations in the construction and extraction sector, which includes jobs such as worker supervision (5.7% of the industry), construction trades like carpentry and electrician work (16.7%), and construction equipment operators (10.9%). Many coal mining employees also occupy jobs related to installation, maintenance and repair, as well as transportation of equipment by rail, truck, or physical labor.

Table 1. National Coal Mining Industry Employment Breakdown

Occupation	Employees (in thousands) - 2010	Percent of Industry – 2010
Construction and Extraction Occupations	42.5	52.70%
Transportation and Material Moving Occupations	14.8	18.30%
Installation, Maintenance, and Repair Occupations	10.8	13.40%

Source: U.S. Bureau of Labor Statistics, Table 1.9, "Industry-occupation matrix data by industry", Coal Mining. http://www.bls.gov/emp/ep_table_109.htm. Accessed 4/5/2012

Energy efficiency programs will reduce basic monthly expenses for households, which will have an important impact on low-income families. Savings that accrue to lower income households are more likely to be spent on goods and services locally than are savings that accrue to wealthier individuals, who may invest the money instead of spending it. According to U.S. Census 2010 one-year estimates, median household income in Kentucky was $40,062, compared with $50,046 nationally. Furthermore, according to the same data set, 19% of Kentuckians reported living below the poverty rate in the 2010. (U.S. Census Bureau, 2010)

Spending on energy efficiency programs is also likely to have a greater impact on the local economy than equivalent spending on new power plants. According to Synapse Energy Economics, a higher percentage of total dollars spent on energy efficiency and renewable energy remain in the local economy than those spent on other sources of electricity. In addition, "[E]nergy efficiency and renewable energy projects tend to be more labor-intensive than traditional generation, and thus create more jobs per dollar spent." (Hornby et al., 2012, pg. 34)

Chapter 4: Modeling the Impacts of Energy Efficiency in Kentucky

Section 4.1 About Economic Impact Assessment and IMPLAN

Broadly speaking, an economic impact analysis traces spending caused by an event or policy change throughout an economy and measures the cumulative effects of that spending. A common method for conducting economic impact assessments is the use of input-output models, including a model developed by MIG, Inc. called Impact Analysis for Planning (IMPLAN). Input-output models might be used to show, for example, how the purchase of solar panels affects employment and earnings in solar component manufacturing, as well as other local industries like retail stores and restaurants.

IMPLAN is often used to model economic impacts of new power generation plants, scenarios in environmental impact statements, and in cost-benefit analysis of resource management plans. The input-output model is appropriate to use here because it is able to account for losses or gains in one sector (e.g., coal mining) created by growth in another sector, such as the energy efficiency industry. (Wei, Patadia, & Kammen, 2010)

Section 4.2 Background on Modeling Approaches

There is a sizeable body of research – predominately contributed by environmental and economic consulting firms – dedicated to modeling the employment impacts of investments in renewable energy and energy efficiency. The majority of the studies reviewed used IMPLAN to model economic and/or employment impacts. Most studies reviewed have found that a shift to renewables and energy efficiency has a positive net impact on employment.

A 2010 meta-study conducted by researchers at the University of California at Berkeley consisted of a review of 15 recent studies on the job creation potential of energy efficiency, renewable energy, carbon capture and storage, and nuclear power. One challenge for the authors was defining a common metric – lifetime average employment per unit of energy – with which to compare the studies they reviewed. The objective of the paper was to create a model to assist policymakers who are interested in the outcomes of adopting various clean energy development approaches. The authors summarize the advantages and disadvantages of the types of models found in their literature review. The models they encountered most frequently were: 1) input-output models, such as IMPLAN (considered "top-down" models), and 2) spreadsheet-based analytical models ("bottom-up" models). The authors found that overall, renewable energy sources generate more jobs than the fossil fuel sector per unit of energy delivered, regardless of modeling approach. (Wei et al., 2010)

A number of previous research endeavors have focused on the growth in employment associated with development in the renewable energy sector. For example, Ratliff, et al., used IMPLAN to estimate the impacts of building a wind farm on employment in San Juan County, Utah. The authors found that construction and maintenance of one 100-MW installation would create over 500 jobs. Hansen, et al., of the West Virginia-based firm Downstream Strategies, used the same model and found that developing the local wind industry would create more jobs and tax revenue than mountaintop removal after 2033. The authors analyzed the local economic benefits of three future scenarios for West Virginia's Coal River Mountain: 1) mountaintop removal, 2) siting of 164 wind turbines on top of Coal River Mountain, and 3) wind turbine siting and development of a local wind industry. County-level data from 2007 and the IMPLAN model were used for scenario 1. A spreadsheet-based model, known as the Jobs and Economic Development Impact (JEDI) model, created by NREL, was used for scenarios 2 and 3.

Research increasingly focuses on the employment impacts of the renewable energy and energy efficiency (REEE) "industry", which has tasked researchers with defining REEE. Currently, models like IMPLAN do not have a designated renewable energy or energy efficiency industry. In a 2010 doctoral dissertation, Heidi Garrett-Peltier sought to overcome this limitation of IMPLAN. The author used both literature and primary data to determine which industries constitute the REEE industry. She concludes, for example, that energy efficiency can be grouped into Energy Services and Green Building sectors and further defines these sectors so that they can be applied to models like IMPLAN. For example, green building can be defined as 28.53% construction, 43.93% nonmetallic mineral products, and 22.9% miscellaneous professional, scientific and technical services. (Garrett-Peltier, 2010, pg. 161)

Communities are understandably apprehensive when coal mine closures or plant decommissions are announced. However, local economic impacts – particularly indirect impacts – are difficult to measure without modeling software, and communities may occasionally overestimate the negative consequences of plant closures. (Black, Mckinnish, & Sanders, 2005) In "The Economic Impact of the Coal Boom and Bust", Dan Black and colleagues reviewed studies that determined that closures of military bases throughout the 1980s had "surprisingly modest" and "sometimes positive" impacts. Through an econometric assessment of coal plant openings and closures from 1970 to 1983 in Kentucky, Ohio, Pennsylvania and West Virginia, Black and colleagues concluded that coal busts destroy more jobs in local goods sectors (construction, retail, and services) than coal booms create. Every mining job created during a coal boom produces 0.174 local sector jobs, while one mining job lost during a coal bust destroys 0.349 local sector jobs. (Black et al., 2005)

Several studies have examined the impact that energy projects have on local economies and employment. Synapse Energy Economics created an analytical cash-flow model in order to estimate the economic impacts of replacing Ontario's coal plants with natural gas plants. The model's outputs included the levelized cost of electricity generation under a base-case scenario (continued coal generation) or a natural gas substitution scenario. The Synapse Energy Economics report concluded that conversion to natural gas would add three to five percent to a typical Ontarian's utility bill. Another report published by the Mountain Association for Community Economic Development sought to estimate the effects of the coal industry on the Kentucky state budget. The report concludes that the net effect of the coal industry is that it costs the state $115 million a year in subsidies to the industry and expenditures on roads and infrastructure. (Konty & Bailey, 2009)

Economic impact models have also been used to assess the impact of regulatory changes on employment. Authors affiliated with the University of Massachusetts Political Economy Research Institute (PERI) used IMPLAN to estimate employment effects under proposed changes to EPA regulations affecting coal-fired power plants. The report concluded that over the next five years, jobs related to pollution controls and new generation capacity would offset job losses from increased regulatory standards. (Heintz & Garrett-Peltier, 2011) Finally, Frank Ackerman at the Stockholm Environment Institute tested an industry claim that EPA regulation of coal ash would harm the economy and destroy jobs. Ackerman conducted a jobs-impact analysis for the United States using IMPLAN. The report concluded that new spending associated with coal ash regulation would support 28,000 jobs. (Ackerman, 2011)

Section 4.3 Methodology

This research uses IMPLAN and models three scenarios: (1) A "business-as-usual" scenario (BAU), which estimates statewide employment impacts in light of projected coal production declines, (2) A mid-case energy efficiency scenario, in which the state achieves 2.7% reductions in residential energy use over 2008 levels by 2017 and invests $292 million in the energy efficiency industry, and (3) a high-case scenario, in which the state achieves an 8.2% reduction in residential energy use over 2008 levels by 2017 with an investment of $634 million in weatherization and energy services. Energy use reduction figures for the mid-case and high case scenarios are based on estimates from the Kentucky Pollution Prevention Center and University of Louisville.

A ten percent reduction in coal industry employment through 2017 was assumed under the Business-as-Usual scenario. A ten percent reduction is on par with historic declines due to natural gas substitution. For example, in 1996, when coal-fired generation accounted for a historically small proportion of electricity generation due to low natural gas prices, total coal industry employment in the Kentucky declined 10.8% compared with the previous year. (U.S. Energy Information Administration, 2008) An additional assumption in the BAU scenario was that current state spending on energy efficiency programs would stay at the level of $21.4 million per year.

Two sources of income flows are estimated for the energy efficiency scenarios. These include 1) household savings from energy efficiency upgrades and 2) investments in weatherization and energy services. The IMPLAN model traces the effects of the increase in household income and direct spending in the weatherization and construction sectors. Household energy savings were assumed to accrue to households earning less than $50,000 annually. Spending on weatherization was assumed to take place locally, and assumed to impact the industry sector dedicated to maintaining and repairing residential structures.[3] Spending on energy services was allocated according to the definition of the industry proposed by Garrett-Peltier (2010). Spending was assumed to accrue to sectors such as professional, technical and scientific services, government program administration, and waste management and remediation services, for example. The full allocation of energy services and weatherization sector spending is outlined in Appendix A for the mid- and high-case scenarios.

The energy use reductions and corresponding household income increases in these scenarios are based on energy efficiency potential estimates developed by the Kentucky Pollution Prevention Center at the University of Louisville. High-case projected investment in weatherization is based on a study of the achievable potential for energy efficiency in the Eastern Kentucky Cooperative conducted by the Ochs Center for Metropolitan Studies. Mid-case projected investment in weatherization is based on a 2012 Synapse Energy Economics Study, "Potential Impacts of a Renewable Energy and Energy Efficiency Standard in Kentucky". Assumptions and sources are further defined in Table 2.

[3] IMPLAN code 3040.

Table 2. Scenario Assumptions and Input Sources.

Scenario	Input/Income Flow	2012 dollars	Projected Energy Use Reduction	Source
BAU	Industry Change – 10% Decline in Employment	-	-	Author's assumptions based on EIA production data
Mid-	Household Income Increase	50,400,000	2.70%	Kentucky Pollution Prevention Center & University of Louisville, 2007
Mid-	Commodity Change – Weatherization & Energy Services Spending	292,000,000	5.40%*	Garrett-Peltier, 2010, pg. 177, & Synapse Energy Economics (Table 5-1, pg. 35)
High	Household Income Increase	1,756,810,000	8.20%	Kentucky Pollution Prevention Center & University of Louisville, 2007
High	Commodity Change - Weatherization & Energy Services Spending	634,200,000	>10%*	Garrett-Peltier, 2010, pg. 177, & Ochs Center for Metropolitan Studies, 2009

*Author's calculations

Section 4.4 Scope

This research focuses on the statewide employment impacts of increasing energy efficiency in Kentucky as well as the employment impacts of projected reductions in coal mining. The IMPLAN model is designed to capture these types of impacts through its estimation of inter-industry flows. Examination of the economic feasibility of increased spending on energy services and weatherization is outside the scope of this study, but should be pursued in future research on utility rate structures in Kentucky.

Section 4.5 Results

Results from the IMPLAN analysis are reported in job-years according to direct, indirect, and induced impacts on employment. Job-years represent full and part-time annual average jobs supported over the course of a project's lifetime. For example, if 15,000 jobs are supported in total over a ten-year project, an average of 1,500 people will be employed each year of the project. This is an appropriate metric to use in analysis of energy efficiency programs because some jobs will be short-term (e.g. construction) while others will last longer (e.g. program implementation).

Direct effects represent jobs in the energy efficiency industry that are created by additional spending. Indirect jobs are those created indirectly by sector purchases – when money is spent by the energy efficiency industry on supplies, services, and labor. Induced effects are the result of the spending of the wages earned by workers in the energy efficiency and indirectly-affected industries on, for example, restaurants, rent or groceries. One rule of thumb for understanding the difference between indirect and induced impacts is that worker spending on local businesses creates induced effects, while industry spending creates indirect effects. Effects of the BAU, Mid-Case, and High Case scenarios are summarized in Table 3 and discussed in greater detail in the sections following.

Table 3. Summary of IMPLAN-estimated Employment Impacts.

Employment Impacts of Energy Efficiency Investment by 2017 (Job-Years)			
	Business-as-Usual	Mid-Case	High Case
Direct	-1,770	1,825.2	3,961.2
Indirect	-567.3	428.9	929.9
Induced	-1,432.4	1,139.2	15,791.1
TOTAL	-3,769.7	3,393.3	20,682.1

Section 4.5.1 Business as Usual Scenario

The BAU scenario incorporates a ten percent decline in coal mining employment compared to 2012 levels. A ten percent decrease in coal mining jobs in 2017 would represent a reduction of 1,770 direct job-years in the coal industry and reduce industry sales by over $379 million. Where indirect and induced effects are accounted for, the BAU scenario shows a net loss of 3,770 job-years.

Section 4.5.2 Mid-case Scenario

An investment of $292 million in the energy efficiency industry and a 2.7% reduction in residential electricity usage would produce 3,393 job-years, including 1,825 direct employment opportunities. Table 4 shows the top ten industries affected.

Table 4. Mid-case Energy Efficiency Scenario: Top Ten Industries Experiencing Job Growth.

Sector	Total Employment (Job-Years)
Maintenance and repair construction of residential structures	1,325.8
Waste management and remediation services	303.1
Environmental and other technical consulting services	155.6
Food services and drinking places	149.7
Private junior colleges, colleges, universities, and professional schools	85.6
Real estate establishments	73.4
Private hospitals	65.3
Offices of physicians, dentists, and other health practitioners	64.0
Employment services	58.6
Retail Stores - General merchandise	53.6

Section 4.5.3 High Case Scenario

The High Case scenario represents $634.2 million in direct investment coupled with reducing state residential electricity consumption by 8.2%. Results show this scenario would support a total of 20,682 job-years in a variety of sectors. With the exception of 3,961 direct job-years created – mostly in the maintenance and repair construction of residential structures sector – the majority of jobs created represent indirect and induced effects. The top ten industries affected are shown in the table below.

Table 5. High Case Energy Efficiency Scenario: Top Ten Industries Experiencing Job Growth.

Sector	Total Employment (Job-Years)
Maintenance and repair construction of residential structures	5,766.7
Food services and drinking places	1,211.5
Private hospitals	651.2
Real estate establishments	638.4
Offices of physicians, dentists, and other health practitioners	616.9
Nursing and residential care facilities	418.8
Retail Stores - General merchandise	406.1
Retail Stores - Food and beverage	404.2
Nondepository credit intermediation and related activities	302.7
Wholesale trade businesses	298.9

Section 4.6 Discussion & Analysis Limitations

Results indicate that coal production declines will reduce direct employment in the coal industry by 1,770 job-years. Development of a local energy efficiency industry is one strategy for economic development that Kentucky could pursue. Energy efficiency programs could support 1,825- 3,961 direct job-years, depending on the level of spending on weatherization programs. At the higher level of investment, energy efficiency would offset loss of jobs in the coal industry and create additional employment opportunities. At the lower level of investment, direct job losses in the coal industry are offset; however, indirect and induced coal industry jobs are not.

In a similar study of economic impacts associated with a proposed Kentucky renewable energy and energy efficiency standard, Synapse Energy Economics found that investment in both energy efficiency and renewable energy projects would support a net increase of over 28,000 job-years through 2022 (including direct, indirect and induced impacts). (Hornby et al., 2012) These results are similar in magnitude and direction to the high-case scenario outlined in this research, which examined the impact of energy efficiency programs exclusively and found that 20,682 job-years could be supported in 2017.

Declining employment in the coal industry under the BAU scenario is reported according to direct job impacts in order to emphasize the need to shift coal-related jobs to other sectors. It is important to note that when indirect and induced impacts are included, production declines in the coal industry could produce total losses on the order of over 3,700 job-years.

While the use of input-output models tends to be the standard methodological approach to economic impact research, models like IMPLAN have several key limitations. First, IMPLAN is only able to make future projections based on how the economy has performed in the past. It is not able to anticipate factors such as future prices of commodities, future inter-industry flows, or economic downturns. Second, the tool's standardization makes it difficult for the novice user to disaggregate certain sectors of employment. In analyzing newer or niche industries such as renewable energy and energy efficiency, the user must determine which available IMPLAN sector best fits "energy efficiency industry" tasks, for example. In this case, that sector is "Maintenance and repair of residential structures", but it is not an exact match and could produce relatively higher estimated impacts.

These limitations aside, the core purpose of this research is to estimate a magnitude and direction of energy efficiency employment impacts in order to help inform a dialogue about alternative forms of economic development.

Conclusion

Is Kentucky still "coal country"? In 2010, the Kentucky coal industry employed fewer than 18,000 people, accounting for less than one percent of total employment in the state. ("Workforce Kentucky," n.d.) Due to a combination of factors, including increasingly cheap natural gas, environmental regulations and price competition from other coal basins, coal production in the Central Appalachian coal basin is expected to decline 74 percent by 2020. (U.S. Energy Information Administration, 2011b) Eastern Kentucky – the state's historic "coal country" – comprises nearly 40 percent of this coal basin, and significant job losses in the region are inevitable. These factors signal a need for energy and economic diversification in Kentucky, and new options for job creation.

Since per-capita residential electricity demand in Kentucky is among the highest in the nation, this research shows that energy efficiency may be a key area for economic growth in the state. In addition to significant technical potential, energy efficiency programs will serve to boost the local economy by reducing monthly expenses for low-income residents and others who are likely to spend locally. Energy efficiency jobs also have overlap with skill sets already held by coal industry workers such as construction, electrical work, and machine operation.

Results of this study show that if energy efficiency programs are scaled up over the next five years, projected job losses in the coal industry could be mitigated by employment in an energy efficiency industry dedicated to home weatherization and energy services. Higher investment levels produce greater impacts. Investment levels of $292 million would support a total of 3,393 job-years.[*] Investment levels of $634.2 million would support 20,682 job-years.[*] Under a

[*] "Total" impacts include direct, indirect, and induced impacts

business-as-usual scenario, job losses in the coal mining sector as well as indirectly related sectors total 3,769.* Results therefore indicate that government investment between $292 and $634 million would produce energy efficiency industry employment impacts that could compensate for job losses caused by coal's inevitable decline in eastern Kentucky.

Many strategies are available to increase investment in energy efficiency, including electric utility decoupling and systems benefits charges. A potential area for further research is thus the appropriate policy structure to encourage utility investment in energy efficiency in Kentucky. An additional area for research includes a more detailed examination of the impact of energy efficiency programs on low-income populations, particularly in the Kentucky counties with large populations living in poverty. Ultimately, a key area for future research will involve the dominance of coal culture, and how the Kentucky coal narrative will evolve over the next century in the face of climate change. If we as a nation are to follow James Hansen's advice and eliminate emissions from coal-fired power plants, we must be willing to confront coal culture head-on. Research related to the most appropriate and effective ways of reimagining coal country will thus be critically important. In the meantime, this research offers concrete support for scaling up energy efficiency programs in Kentucky, and it is my hope that it will be used to enact change.

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Appendix A: Energy Efficiency Industry Investment & Scenario-based Inputs

Mid-Case Assumptions

Mid-Case	$292 million, for 5.37% reduction through Energy Efficiency Industry Upgrades		
TOTAL mid-case investment in EE			292,000,000
Energy Services			
Sector spending			*146,000,000*
	Energy Services Sub-Sector	**Percent of "Energy Services" Industry**	**Total Spending in Sub-Sector ($)**
	Construction	0.08%	116800
	Wood Products	0.54%	788400
	Chemical Products	0.02%	29200
	Plastics and Rubber Products	0.09%	131400
	Miscellaneous Manufacturing	1.85%	2701000
	Publishing industries (includes software)	0.14%	204400
	Misc. Professional, Scientific and Technical Services	30.09%	43931400
	Waste Management and Remediation Services	53.16%	77613600
	Educational Services	13.77%	20104200
	Federal General Government	0.11%	160600
	State and Local General Government	0.14%	204400
Weatherization			
Sector spending			*146,000,000*
	Construction	100%	146000000

High-Case Assumptions

High-Case	$634 million in Energy Efficiency Industry Upgrades		
TOTAL high-case investment in EE			634,200,000
Energy Services			
Sector spending			*317,100,000*
	Energy Services Sub-Sector	**Percent of "Energy Services" Industry**	**Total Spending in Sub-Sector ($)**
	Construction	0.08%	253680
	Wood Products	0.54%	1712340
	Chemical Products	0.02%	63420
	Plastics and Rubber Products	0.09%	285390
	Miscellaneous Manufacturing	1.85%	5866350
	Publishing industries (includes software)	0.14%	443940
	Misc. Professional, Scientific and	30.09%	95415390

	Technical Services		
	Waste Management and Remediation Services	53.16%	168570360
	Educational Services	13.77%	43664670
	Federal General Government	0.11%	348810
	State and Local General Government	0.14%	443940
Weatherization			
Sector spending			*317,100,000*
	Construction	100%	317100000