POTENTIAL ECONOMIC IMPACTS IN TENNESSEE OF REDUCED TVA RELIANCE ON COAL

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ABSTRACT

TVA is proposing to reduce reliance on coal and increase use of other energy sources. However, TVA's proposal to prematurely retire coal plants will leave it unable to meet its reliability requirements.

Tennessee has an attractive business environment due to its reliable electricity and low, stable rates, since coal provides nearly half of the state's electric power. Notably, the state emphasizes the affordability and reliability of TVA electricity as a key economic advantage. However, this competitive advantage is at risk: Less coal is being used to generate electricity in the state, and this has been accompanied by higher electricity prices. Tennessee has the fourth largest automotive manufacturing sector in the U.S., but competitive pressures are intense and Tennessee is no longer a low-wage state for the automotive industry. Other competitive factors such as reliable, high quality, low-cost electricity are increasingly more important and electricity is critical in the future as vehicle manufacturing becomes ever more electricity intensive and dependent on emerging electro-technologies.

Under the TVA plan, average electric rates in Tennessee will be more than 20 percent higher than otherwise, and Tennessee rates would then be higher than the U.S. average. As shown in Figure AB-1, by 2025 the impact on the Tennessee economy would be devastating: 1) Tennessee gross state product would be reduced by more than $7 billion; 2) Tennessee manufacturing output would be reduced by more than $900 million; 3) Tennessee state and local government tax revenues would be reduced by nearly $700 million. The impact on the Tennessee automotive sector will be especially severe, and it will lose an important competitive advantage it currently possesses. As shown in Figure EX-9, the jobs impact would be substantial, and by 2025 more than 65,000 jobs would be lost annually -- the job losses would exceed the total number of jobs lost in the state economy in 2012 and 2013 *combined*. A disproportionately large share of the job losses would be in the automotive sector. Low income households, the working poor, Blacks, Hispanics, and seniors on fixed incomes will be especially harmed.

Figure AB-1: Annual 2025 Losses in Tennessee GSP, State & Local Govt. Revenues, and Mfg. Output Resulting From TVA Proposal

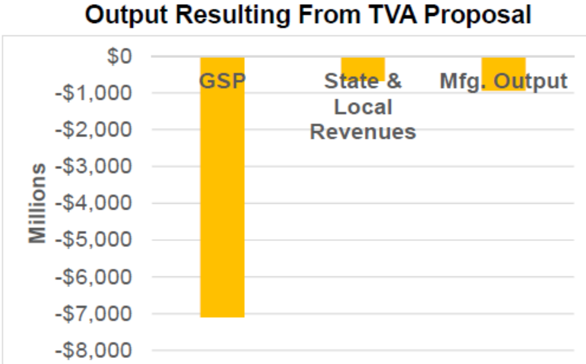
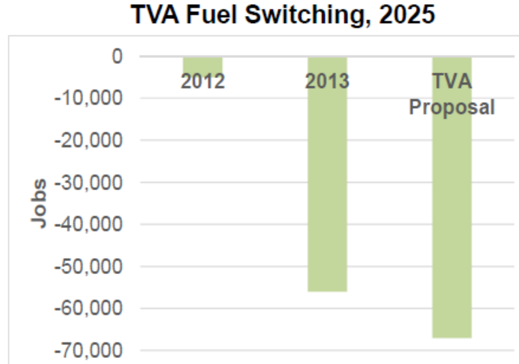


Figure AB-2: Magnitude of Tennessee Job Losses Resulting From Proposed TVA Fuel Switching, 2025



<u>**Therefore, TVA's decision to close 3,900 MW of coal generation at Colbert, Widows Creek, and Paradise 1 & 2 must be reversed, and the potential retirement of additional coal generation at Shawnee, Allen, and Widows Creek must be prevented. Further, TVA's IRP must be revised to facilitate timely upgrades of TVA's existing coal facilities and the**</u>

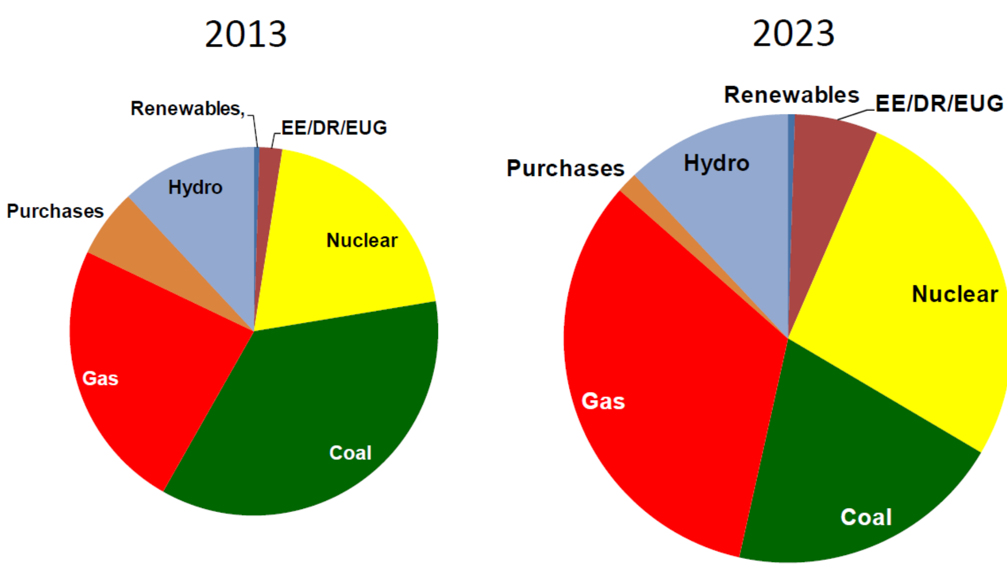
construction of new supercritical coal power stations, thus permitting TVA to lead in the deployment of clean coal technologies.

EXECUTIVE SUMMARY

TVA

For the past decade, coal has provided about 50 percent of the Tennessee Valley Authority's electricity, and coal currently represents about 40 percent of TVA generating capacity. This heavy reliance on coal has helped keep TVA's electricity reliable and affordable. Despite these contributions and the potential of clean coal-based electricity, TVA proposes to prematurely retire a number of coal units: TVA's 2011 IRP recommended increasing reliance on nuclear, natural gas, and renewable energy and reducing reliance on coal, and by retiring as many as 7,000 MW TVA plans to reduce coal to 20 percent of capacity – Figure EX-1

Figure EX-1: TVA Generating Capacity Plan



This policy will place TVA in a potential "high regrets" position of being unable to meet its reliability requirements.

Tennessee Electricity

TVA and Tennessee are increasing dependency on risky natural gas -- the fuel with a history of the most volatile prices and a questionable balance of future supply and demand. Increased use of natural gas makes Tennessee vulnerable to price spikes (Figure EX-2) and, according to the latest EIA forecasts, natural gas prices will remain higher than coal as coal's price advantage increases every year – Figure EX-3. TVA's recent decision to prematurely retire Paradise 1 & 2 and potentially close additional coal plants creates serious reliability concerns for serving TVA customers in Tennessee.

Figure EX-2: Natural Gas Price Volatility in Tennessee

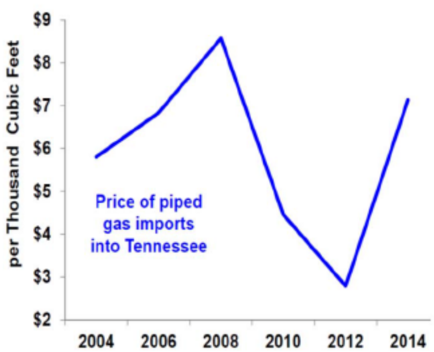
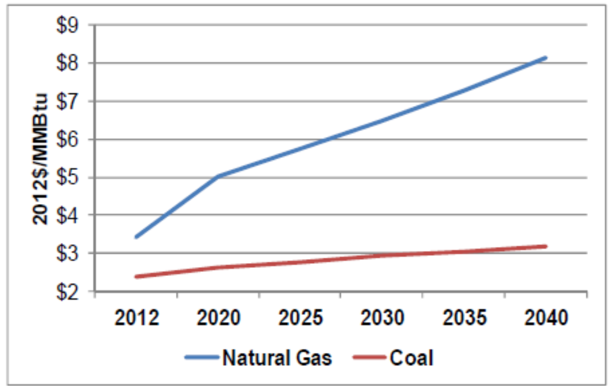


Figure EX-3: Forecast Natural Gas and Coal Prices for Electric Power Producers



One of the major reasons Tennessee has an attractive business environment is its stable, low electricity rates, since coal provides nearly half of the state's electric power – Figure EX-4, and both TVA and the State of Tennessee emphasize the affordability, stability, and reliability of TVA's electricity as a key economic advantage. Tennessee has benefited greatly from reliance on dependable, low-cost coal: The state's industrial electricity rates are relatively low and provide it with a key competitive advantage. However, Tennessee's competitive advantage is at risk because less coal is being used to generate electricity in the state. Tennessee's reduction in coal power has been accompanied by higher electricity prices: In 2000 Tennessee's rates were 18 percent below the U.S. average; at present they are just eight percent lower – Figure EX-5.

Figure EX-4: 2012 Tennessee Generation (mWh)

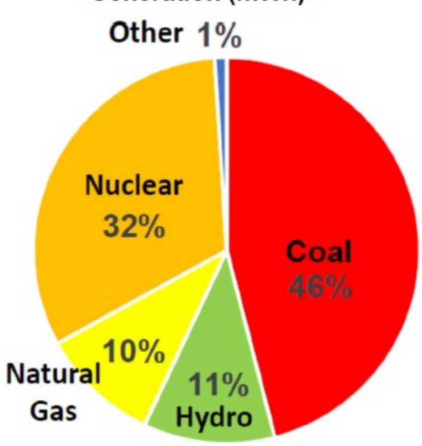
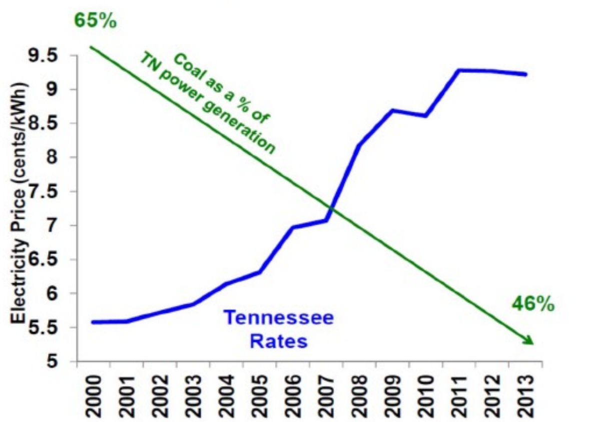


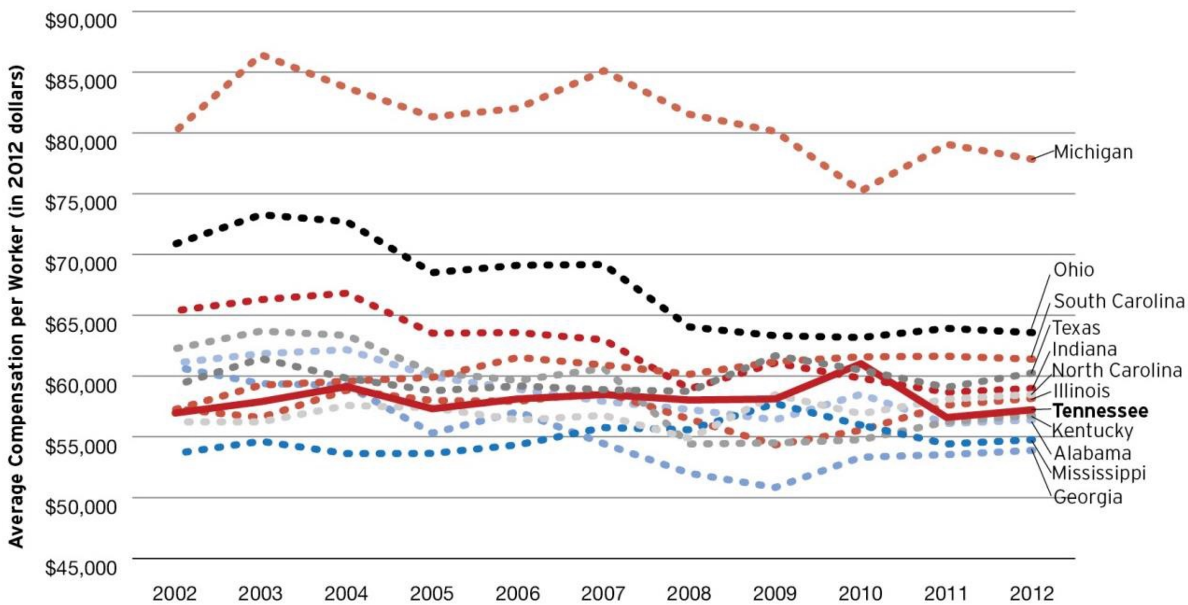
Figure EX-5: Tennessee's Reduced Use of Coal for Electricity Generation = Increased Rates



The Tennessee Automotive Sector

Since 1979, Tennessee has developed the fourth largest automotive manufacturing sector in the U.S. (behind Michigan, Indiana, and Ohio), and Nissan, Volkswagen, GM, and other firms create about 400,000 jobs in every region of the state. This has allowed Tennessee to vastly upgrade its economy, and the state has emerged as one of the auto industry's most important supplier hubs. However, the industry is in flux, competitive pressures are intense, and Tennessee is no longer a low wage state for the industry (Figure EX-6). As wage convergence proceeds, other competitive factors such as reliable, high quality, low-cost electricity, will become ever more important.

Figure EX-6: Compensation Compression in the U.S. Automotive Sector



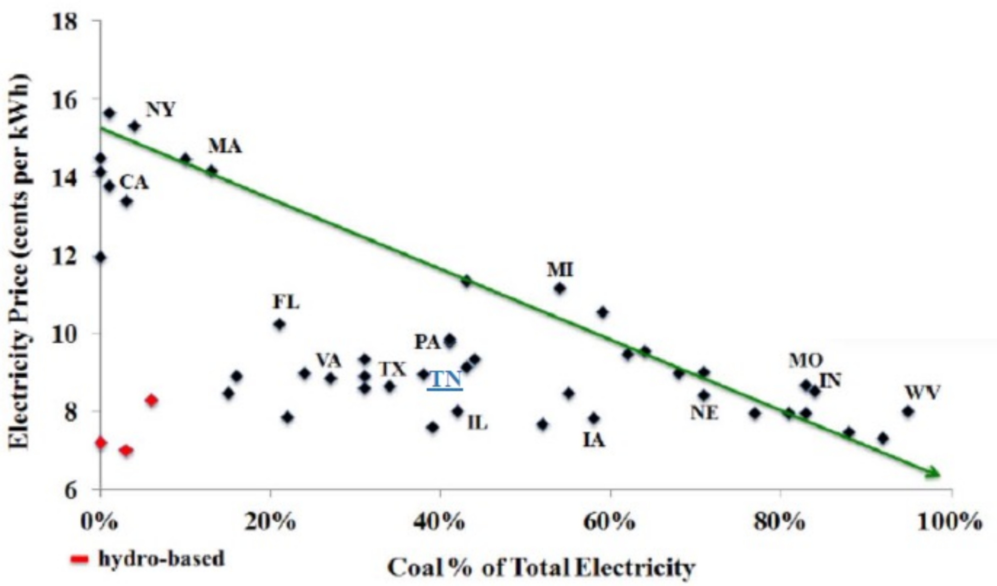
The Tennessee auto industry is undergoing critical changes and cost pressures are affecting its competitiveness, but it has one important advantage over most of its competitors: The reliable, high quality, low-cost electricity provided by TVA. Tennessee's electricity will be even more important in the future: Automotive manufacturing is becoming more electricity intensive and dependent on emerging electro-technologies. However, this competitive advantage is at risk under the TVA plan.

Electricity and the Economy

There is a negative relationship between energy prices and economic activity: Increases in energy and electricity prices harm the economy and decreases in energy and electricity prices benefit the economy. This relationship is important because coal is currently the low-cost option for generating electricity and is forecast to remain so. There is a negative relationship between electricity prices and a state's use of coal to generate electricity: The higher percentage of coal used to generate electricity, the lower the electricity rate – Figure EX-7.

Energy costs have Keynesian economic effects similar to those of taxes: Increased energy and utility costs act as a "hidden tax" that have deflationary, economically constrictive impacts; e.g., they decrease sales, GDP, jobs, etc.; conversely, decreased energy and utility costs have the effect of a "tax cut" and have economically stimulating effects by putting more money in the hands of consumers and businesses, thus increasing sales, creating jobs, etc. Policies that increase electricity prices will have adverse effects on the economy and jobs. Review of the literature revealed numerous studies that estimated the energy price/GDP elasticities, and we determined that a reasonable electricity elasticity estimate is -0.1, which implies that a 10 percent increase in electricity prices will result in a one percent decrease in GDP.

Figure EX-7: Relationship Between Coal Generation & Electricity Prices by State



Economic Impact in Tennessee

There will be adverse effects on the Tennessee economy and jobs from the rate increases associated with TVA fuel switching: 1) Tennessee businesses (including those in the automotive industry) will face increased competitive disadvantages; 2) some businesses will leave the state; 3) new businesses will hesitate to locate in Tennessee; 4) Tennessee electric customers will have less money to spend. There is a quantifiable relationship between economic activity and jobs – between the level of GDP/GSP and jobs. Basically, GDP and jobs are closely, positively correlated.

Under the proposed TVA policy, average electric rates in Tennessee will be more than 20 percent higher than they would otherwise be. Tennessee would change from having electric rates that are about five percent lower than the U.S. average to having rates that are more than 15 higher than the U.S. average, and from having industrial electric rates that are 10 percent lower than the national average to more than 10 percent higher than the national average. This increase in industrial rates means that one of Tennessee's major competitive advantages will be eliminated. As shown in Figure EX-8, by 2025 the impact on the Tennessee economy would be devastating: 1) Tennessee gross state product would be reduced by more than $7 billion; 2)

Manufacturing output would be reduced by more than $900 million; 3) Tennessee state and local government tax revenues would be reduced by nearly $700 million. The impact on the Tennessee automotive sector will be severe: 1) TVA's policy will result in a "tax" on this sector from which it will receive no benefits; 2) this sector is especially vulnerable to energy costs; 3) its future health depends critically on electricity-based technologies, processes, and innovation; 4) this sector will lose an important Tennessee competitive advantage it currently possesses over other states and nations.

As shown in Figure EX-9, the jobs impact on Tennessee from fuel switching would be substantial, and by 2025: 1) More than 65,000 jobs would be lost annually; 2) The jobs losses would total more than 13 times the number of jobs lost in Tennessee in 2012, would exceed the jobs lost in Tennessee in 2012, and would exceed all of the jobs lost in the state in 2012 and 2013 *combined*. A disproportionately large share of the job losses would be related to the automotive sector in Tennessee. The Tennessee unemployment rate could increase by nearly 40 percent – from 6.4 percent to nearly nine percent.

Figure EX-8: Annual 2025 Losses in Tennessee GSP, State & Local Govt. Revenues, and Mfg. Output Resulting From TVA Proposal

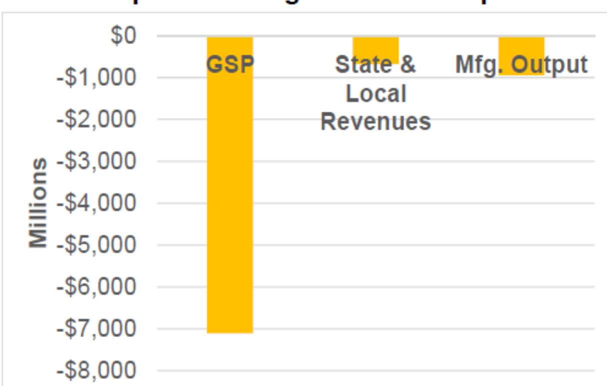
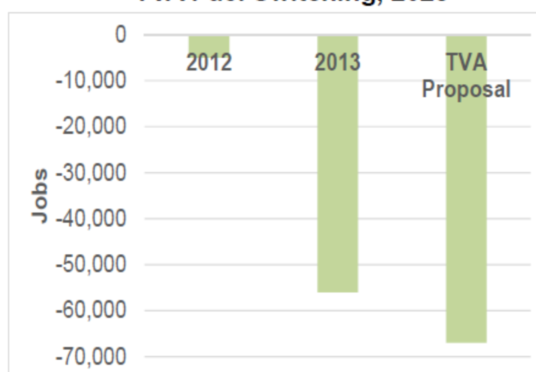


Figure EX-9: Magnitude of Tennessee Job Losses Resulting From Proposed TVA Fuel Switching, 2025



Demographic Impacts

The energy burdens of low-income households are much higher than those of higher-income families, and high burden households are those with the lowest incomes and highest energy expenditures. Households in the lowest-income classes spend the largest shares of their disposable income to meet their energy needs. The portion of U.S. household incomes expended on energy costs has increased significantly over the past decade, especially for lower-income groups. In 2013 the poorest households were paying, in percentage terms, nearly nine times as much for energy as the most affluent households – and more than 11 times as much for residential energy. High energy prices have a detrimental effect on the lives of those with limited incomes, and people purchase less medicine when their utility bills are too high (Figure EX-10). Temperature extremes can be damaging to vulnerable populations, including the elderly, the disabled, and small children. High energy prices compromise the safety of low-income households, and inability to pay utility bills often leads to the use of risky alternatives. Older consumers with the lowest incomes experience the greatest cost burdens -- low income seniors dependent primarily on retirement income.

Tennessee is the 7th poorest U.S. state and its citizens are vulnerable to higher electricity prices: 1) Tennessee per capita income is 17 percent below the U.S. average, and the gap is widening – Figure EX-11; 2) 57 percent of Tennessee families have an average annual after-tax income of $23,700 -- less than $2,000/month; 3) in Tennessee, 120,000 seniors live in poverty, over 400,000 children live in poverty, over 660,000 homes are on food stamps, and nearly 770,000 families live in poverty – Figure EX-12; 4) Tennessee household income is 20 percent below the U.S. average; 5) the median value of houses in the state is 1/3 less than the U.S. average; 6) nearly 1/5th of Tennesseans live in poverty – 1.25 million; 7) in Tennessee, 38 percent of Blacks are impoverished and 35 percent of Hispanics are impoverished; 8) the poverty level for children is 26 percent, and over 400,000 Tennessee children are impoverished; 9) There are 800,000 households of Social Security recipients; 10) nearly 1/3 of Tennessee households receive Social Security, and these recipients have an average annual SS income of $16,700. Over 700,000 Tennessee households are eligible for LIHEAP, about 1/3 of all households in state – but only 1/5 of Tennessee households eligible receive any LIHEAP assistance.

Figure EX-10: Potential Health Impacts of Increased Energy Costs on Low Income Persons

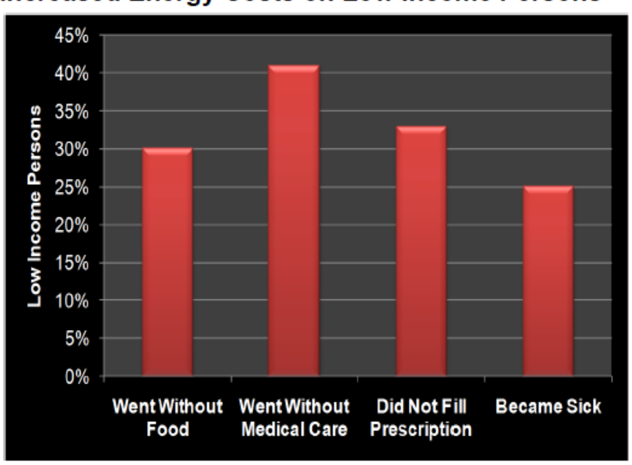
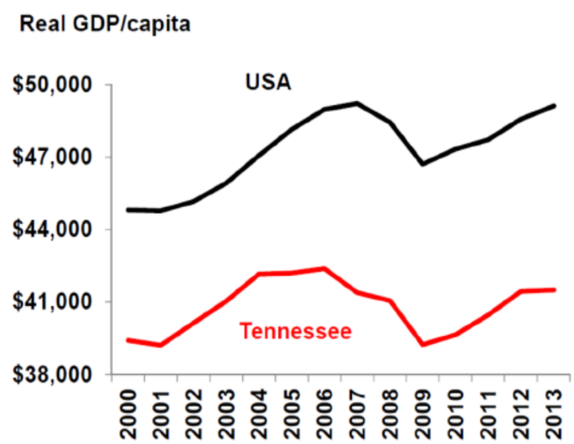


Figure EX-11: Per Capita GDP, U.S. and Tennessee



The energy burdens of low-income Tennessee households are much higher than those of higher-income families, and households with the lowest incomes spend the largest shares of their income to meet their energy needs – Figure EX-13. High energy prices harm those with limited incomes, and they suffer from home energy arrearages and shut-offs, cutbacks on necessities, risks to health and safety, and housing instability. Low-income families are often forced to limit the amount of money they spend on necessities to manage their energy costs and must reduce food purchases. The electricity rate increases and negative economic and job effects of the TVA proposal in Tennessee will thus especially harm low income households, the working poor, Blacks, Hispanics, and seniors on fixed incomes.

Figure EX-12: Tennessee Poverty Indicators

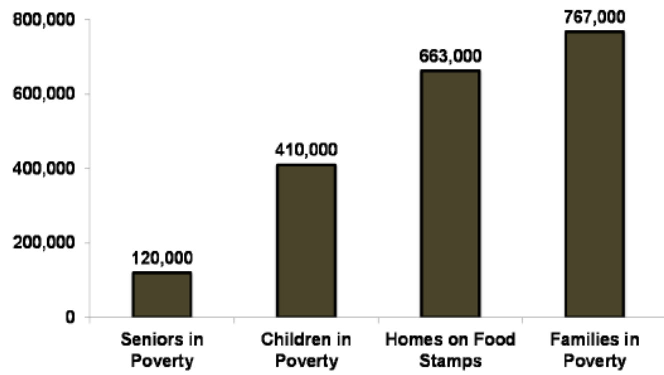
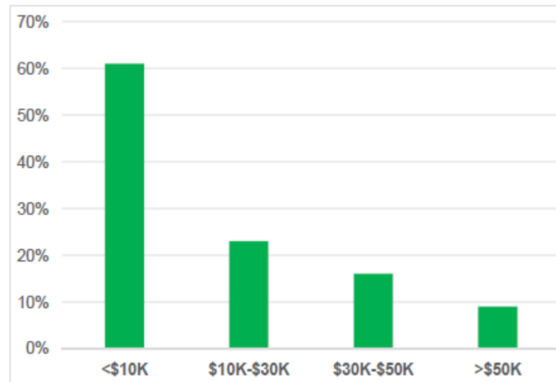


Figure EX-13: Tennessee Family Energy Costs as Percent of After-Tax Income



The major conclusions derived here are summarized below.

TVA

1. Heavy reliance on coal has kept TVA's electricity reliable and affordable.
2. However, TVA's premature retirement of a number of coal plants will leave TVA unable to meet its reliability requirements – and these retirements may only be the beginning, since additional coal-fired retirements may result from ongoing revisions of the 2011 IRP.
3. TVA and Tennessee are increasing dependency on risky natural gas -- the fuel with the most volatile prices and a questionable balance of future supply and demand.
4. TVA's 2014 decision to close 3,900 MW of coal generation at Colbert, Widows Creek, and Paradise 1 & 2 must be reversed, and the potential retirement of additional coal generation at Shawnee, Allen, and Widows Creek must be prevented.
5. TVA's IRP must be revised to facilitate timely upgrades of TVA's existing coal facilities and the construction of new supercritical coal power stations, thus permitting TVA to lead in the deployment of clean coal technologies.

Tennessee

1. One of the reasons Tennessee maintains an attractive business environment is its low electricity rates, since coal provides nearly half of the state's electric power.
2. Tennessee has benefited greatly from reliance on dependable, low-cost coal: The state's industrial electricity rates are low and provide it with a key competitive

advantage, and Tennessee emphasizes the affordability, stability, and reliability of TVA's electricity as a key state economic advantage.

3. However, Tennessee's competitive advantage is at risk because less coal is being used to generate electricity, and Tennessee's reduction in coal power has been accompanied by higher electricity prices.
4. Tennessee has developed the fourth largest automotive manufacturing sector in the U.S., and this has allowed Tennessee to vastly upgrade its economy.
5. Competitive pressures are intense, and Tennessee is no longer a low wage state for the automotive industry: As wage convergence among the states proceeds, other competitive factors such as reliable, high quality, low-cost electricity, become ever more important.
6. Cost pressures are affecting the Tennessee auto industry's competitiveness, but it has a major advantage: Reliable, high quality, low-cost electricity, and Tennessee's electricity will be critical in the future as vehicle manufacturing becomes ever more electricity intensive and dependent on emerging electro-technologies.

Electricity and the Economy

1. There is a negative relationship between energy prices and economic activity: Increases in energy and electricity prices harm the economy and decreases in these prices benefit the economy.
2. There is a negative relationship between electricity prices and a state's use of coal to generate electricity: The higher percentage of coal used to generate electricity, the lower the state's electricity rate.
3. Energy costs have Keynesian economic effects similar to those of taxes: Increased energy and utility costs act as a "hidden tax" that have deflationary, economically constrictive impacts, and policies that increase electricity prices will have adverse effects on the economy and jobs.

Economic and Job Impacts

1. There will be adverse effects on the Tennessee economy and jobs from the rate increases associated with TVA fuel switching, and with the TVA proposal average Tennessee electric rates will be more than 20 percent higher than otherwise.
2. Tennessee would change from having electric rates that are about five percent lower than the U.S. average to having rates that are more than 15 percent higher, and increased industrial rates means that one of Tennessee's major economic competitive advantages among the states will be eliminated.
3. By 2025 the impact on the Tennessee economy of the TVA proposal would be devastating: i) Tennessee gross state product would decrease by more than $7 billion; ii) manufacturing output would decrease by more than $900 million: iii) state and local government tax revenues would decrease by $700 million.

4. The impact on the Tennessee automotive sector will be severe: Its future health depends critically on electricity-based technologies, and it will lose an important competitive advantage it currently possesses over other states and nations.
5. The jobs impact on Tennessee from fuel switching would be substantial, and by 2025: i) More than 65,000 jobs would be lost annually; ii) the job losses would exceed the total number of jobs lost in the state economy in 2012 and 2013 *combined*.
6. A disproportionately large share of the job losses would be in the Tennessee automotive sector.
7. The Tennessee unemployment rate could increase by nearly 40 percent – from 6.4 percent to nearly nine percent.

Demographic Impacts

1. Tennessee is the 7th poorest U.S. state and its citizens are vulnerable to higher electricity prices.
2. The energy burdens of low-income Tennessee households are much higher than those of higher-income families, and households with the lowest incomes spend the largest shares of their income to meet their energy needs.
3. High energy prices have a detrimental effect on the lives of those with limited incomes, and they suffer from home energy arrearages and shut-offs, cutbacks on necessities and other items, risks to health and safety, and housing instability.
4. Low-income families are often forced to limit the amount of money they spend on necessities to manage their energy costs and must reduce food purchases.
5. People purchase less medicine when their utility bills are too high, and temperature extremes can be damaging to vulnerable populations, including the elderly, the disabled, and small children.
6. The electricity rate increases and negative economic and job effects of the TVA proposal in Tennessee will especially harm low income households, the working poor, Blacks, Hispanics, and seniors on fixed incomes.

I. INTRODUCTION

For the past decade, coal has reliably and affordably provided about 50 percent of the Tennessee Valley Authority's electricity, and coal currently represents about 40 percent of TVA generating capacity. TVA's 2011 IRP recommended increasing reliance on nuclear, natural gas, and renewable energy and reducing reliance on coal.[1] More recently, Credit Suisse recommended that TVA close nine of its 11 coal-fired plants and finish three incomplete nuclear reactors.[2] Within a decade, these types of actions could reduce TVA coal generation from about 50 percent of total generation to about 20 percent.

However, coal is TVA's most important, reliable, and affordable power source and TVA's plan to reduce coal capacity in favor of gas, nuclear, and renewable generating capacity is risky and will increase future costs and decrease reliability in Tennessee:

- Coal provides nearly half of the electricity in Tennessee
- Electric rates in the state are below the national average and provide an important competitive advantage for Tennessee.
- Natural gas has the most volatile energy prices and a questionable balance of future supply and demand.
- The cost to construct nuclear power stations has escalated dramatically in recent years and now exceeds $10,000/KW.
- Renewable energy costs are orders of magnitude higher than coal generation costs.

Thus, the net result of TVA's planned actions would be to significantly increase system electricity costs – including those in Tennessee. These increased costs would harm the Tennessee economy, harm businesses in the state (including the state's automotive industry), and destroy jobs. The most seriously impacted would be those who are the most vulnerable and least able to afford it: Lower-income persons, the elderly, minorities, and those on fixed incomes.

The goal of this project is to provide rigorous analysis of the energy, economic, job, and related demographic impacts on Tennessee of the proposed TVA actions. Specifically:

- Chapter II discusses recent proposed changes in TVA electricity generation sources, the Tennessee electricity sector, and the critical role of electricity in the Tennessee automotive sector.
- Chapter III discusses the relationship between electricity and the economy.

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[1] "TVA 2015 Integrated Resource Plan," Integrated Resource Plan Working Group, November 2013.
[2] Dave Flessner, "TVA Urged To Cut Coal Power, Finish Nuclear Plants," September 13, 2013, http://timesfreepress.com/news/2013/sep/13/tva-urged-to-cut-coal-power/.

- Chapter IV estimates the impacts of the proposed changes in TVA electricity generation on the Tennessee economy and job market.

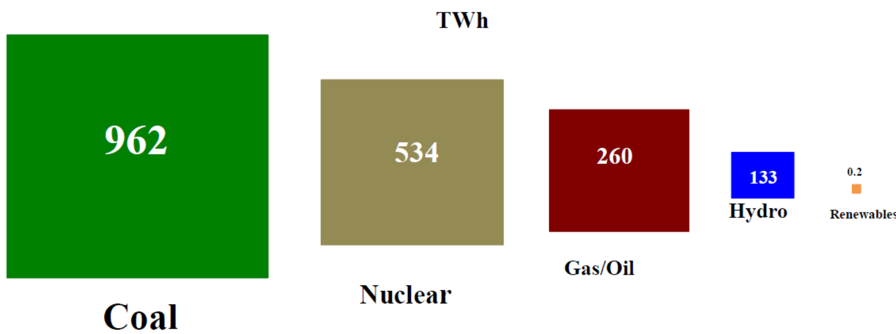
- Chapter V discuss the implications for energy poverty in Tennessee.
- Chapter VI present the findings and conclusions derived from this research.

II. TVA AND TENNESSEE ELECTRICITY

II.A. TVA

For decades, coal has reliably and affordably provided over 50 percent of the electricity for TVA's consumers – Figure II-1. Further, clean coal technology is working throughout the TVA service area, which includes all of Tennessee, and TVA currently has 14,000 MW of coal-fired generation.[3]

Figure II-1
Cumulative TVA Power Generation, Terawatt Hours
(2002-2012)



Source: TVA generation data, 2002-2012.

This heavy reliance on coal has helped keep TVA's electricity reliable and affordable – Figure II-2.

Despite these contributions and the potential of clean coal-based electricity, TVA is proposing to prematurely retire a number of coal units, including two of the least expensive but most reliable - Paradise 1 & 2 in Kentucky, and replace them with a gas plant – Figure II-3.[4] Further, by retiring as many as 7,000 MW, TVA plans to reduce coal to 20 percent of capacity while increasing generation from natural gas, nuclear, and renewables -- Figure II-4. However, TVA's proposed path is not least cost and the consequences will harm ratepayers and the region it has served so importantly and ably since its founding.[5]

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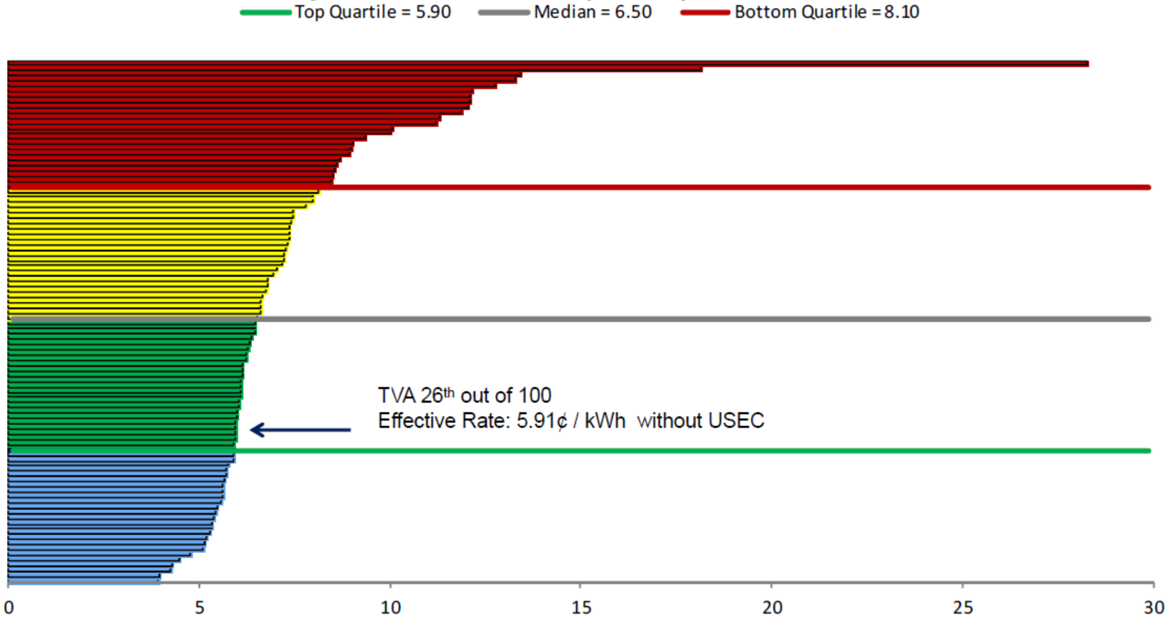
[3]John Malone, "TVA Overview," Tennessee Valley Authority, December 2012.
[4]John Malone, "TVA Overview, FCA, & Interruptible Products, MLGW Key Customer Meeting," December 2012
[5]Frank Clemente and Roger A. Babb, "Comments on Tennessee Valley Authority Integrated Resource Plan -- Scoping: Eliminating Coal is Adverse to Human Health and Welfare, November, 2013.

Figure II-2
12-month Average Industrial Rate (¢/kwh) of the Top 100 U.S. Utilities



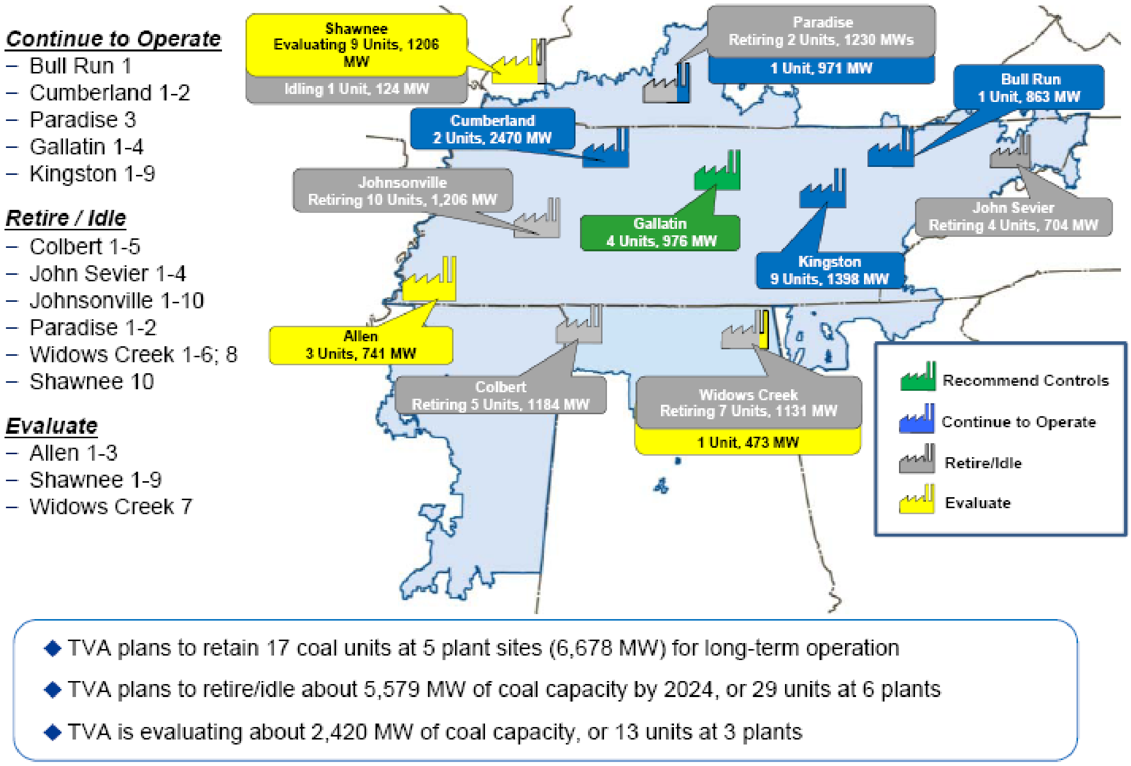
Source: EIA and TVW 2015 IRP.

TVA's Integrated Resource Plan (IRP) process is designed to identify the least cost alternative to reliably provide electricity to the TVA's customers and do so in an environmentally sound manner.[6] The Plan should be robust enough to be relatively least cost under a variety of scenarios. The goal, according to TVA's 2011 IRP process, is to develop a "no-regrets" strategy that is relatively insensitive to uncertainty. However, TVA's management recommendation to the Board to prematurely close Paradise 1 & 2, the lowest cost coal plants in TVA's fleet, is not least cost and does not represent a "no-regrets" strategy. It will cost TVA's customers over $600 million in extra Net Present Value (NPV) costs using only current environmental regulations and forward natural gas prices. It exposes TVA's customers – including those in Tennessee -- to significantly higher costs of almost $1.7 billion in NPV cost if gas prices are 70 percent higher than TVA expects.[7]

[6]TVA performs a periodic revision of its generation portfolio adapting it to changing market conditions. The objective is to maximize customer's value while maintaining a balanced approach that minimizes risks, and the results of the work of the IRPWG will help define the plan for the next 20 years. See "TVA 2015 Integrated Resource Plan," op. cit.

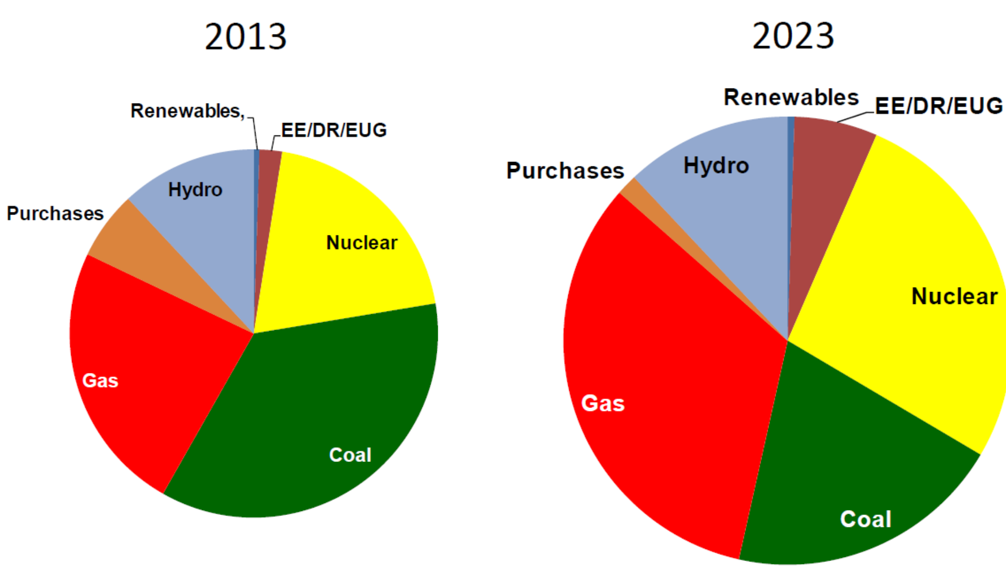
[7]It appears TVA assumes CO_2 regulations are approved and takes the quite likely "high-regrets" decision to prematurely retire some of the most CO_2 efficient coal units in the TVA system, Paradise 1 & 2 and replace the units at the site with natural gas generation. Such a decision forever seals the fate of the most reliable coal units in the TVA fleet and is done so on the assumption CO_2 rules will be finalized and brought into law, which is clearly not the case. See Clemente and Rabb, op. cit.

Figure II-3
TVA's Coal Fleet: Current Status



Source: "TVA Overview, December 2012.

Figure II-4
TVA Generating Capacity Plan Moves Away From Low Cost and Reliability



Source: "TVA Overview," December 2012.

TVA's 2014 decision to close 3,900 MW of coal generation at Colbert, Widows Creek and Paradise 1 & 2, coupled with the potential retirement of an additional 3,000 MW of coal generation at Shawnee, Allen, and Widows Creek leaves TVA in a potential "high regrets" position of being unable to meet reliability requirements as many utilities retire coal plants that are not able to meet EPA's Mercury rules (MATS).[8] Such an out-of-cycle decision is questionable given the array of uncertainties that will likely have much more clarity in 2016. The decision to prematurely retire Paradise 1 & 2, which are the most reliable plants in the TVA system, as well as potentially retire Allen, Shawnee, and the remaining Widows Creek unit and other units seems to have little upside gain to the TVA customers but enormous downside loss potential, i.e. "high-regrets." Even third party studies that are not supportive of coal in general noted that Paradise 1 - 3 are the most cost effective coal units in the TVA fleet across a range of market and regulatory scenarios.[9]

II.B. Tennessee

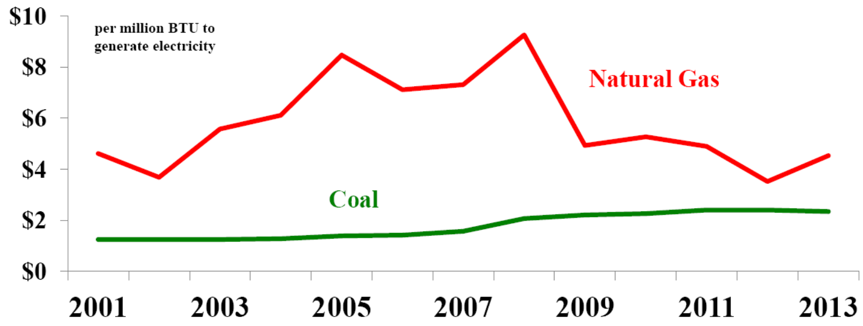
II.B.1. Warning Signs

TVA is proceeding down a path that will impose significant adverse economic and service reliability impacts on Tennessee. This approach is adverse to "human health and welfare" in the words of the Clean Air Act, and not "least cost" for five reasons.[10] First, the risk to its customers in Tennessee is adversely asymmetric. Gas prices are relatively low at present, but the accepted probability is that they will significantly increase over the next decade. The American Power Association has found that replacement of gas reserves could cost $10 per million Btu -- double the price projected in 2020 by the EIA.[11] If the APPA is correct, the additional cost to TVA consumers – including Tennessee ratepayers -- would total $2 billion a year for decades to come.

Second, the U.S., and now potentially TVA and Tennessee, are treading a dangerous path of increased dependency on risky natural gas -- the fuel with a history of the most volatile prices in the nation (Figure II-5) and a questionable balance of future supply and demand. PIRA Energy Group indicated that by 2025, incremental demand for gas could exceed EIA's projected incremental supply by 9 Tcf, -- the production of Texas plus the Gulf of Mexico.

[8]See Clemente and Rabb, op. cit.
[9]Synapse Energy Economics published a study recommending increased energy efficiency. However, it noted that TVA's Paradise 1 - 3 was the most cost effective plant under a full regulatory compliance of EPA regulations including CSPAPR, MATS, ozone, and SO_2 NAAQS, water intake rules and Coal Combustion Residue (CCR) Rule, and effluent limitation and was one of the most cost effective plants under an EPA Consent Decree scenario. See Jeremy Fisher and Kenji Takahashi, "TVA Coal in Crisis: Using Energy Efficiency to Replace TVA's Highly Non-Economic Coal Units," Synapse Energy Economics, Inc., August 12, 2012.
[10]See Clemente and Rabb, op. cit.
[11]American Public Power Association, "Implications of Greater Reliance on Natural Gas For Electricity Generation," 2010.

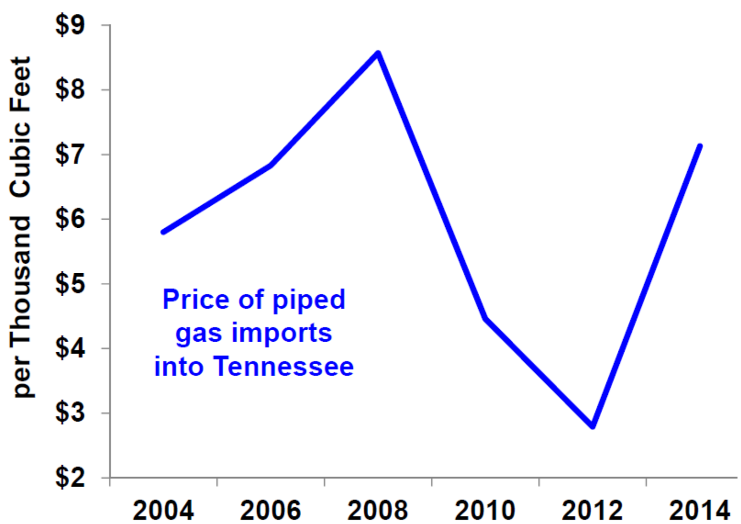
Figure II-5
Volatility of Natural Gas Prices Compared to Coal Prices



Source: U.S. Energy Information Administration.

Increased use of natural gas makes Tennessee vulnerable to price spikes – as illustrated in Figure II-6. As a recent study warned, "Overdependence on natural gas could expose Americans to soaring electricity prices, as natural gas has a history of price volatility."[12]

Figure II-6
Natural Gas Price Volatility in Tennessee



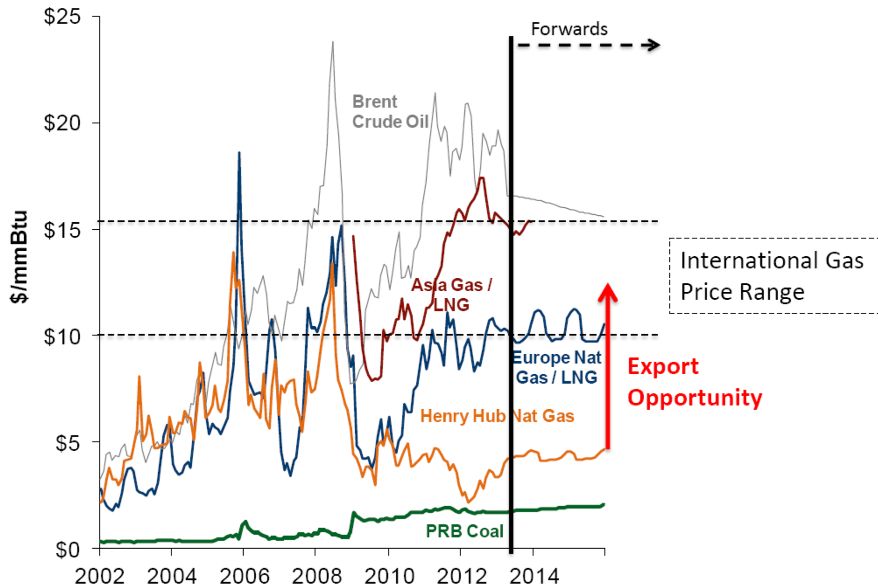
Source: U.S. Energy Information Administration and Georgia Public Policy Foundation.

Third, the ongoing globalization of the gas trade will reach the U.S. through LNG exports, and costs to gas and electric consumers will escalate. LNG prices are indexed to oil in most of the world, and the cost of U.S. gas production is not relevant to the

[12]Georgia Public Policy Foundation, January 24, 2014, www.georgiapolicy.org/friday-facts-january-24-2014/#t4QEV.

market price once the gas is exported – Figure II-7. For example, Saudi Arabia produces oil for below $10/bbl, but prices are over $100 per barrel and projected by EIA to escalate to $180 in 2030. The cost of gas in Japan is over $15 per unit, three times the U.S. price.

Figure II-7
U.S. and International Natural Gas Prices

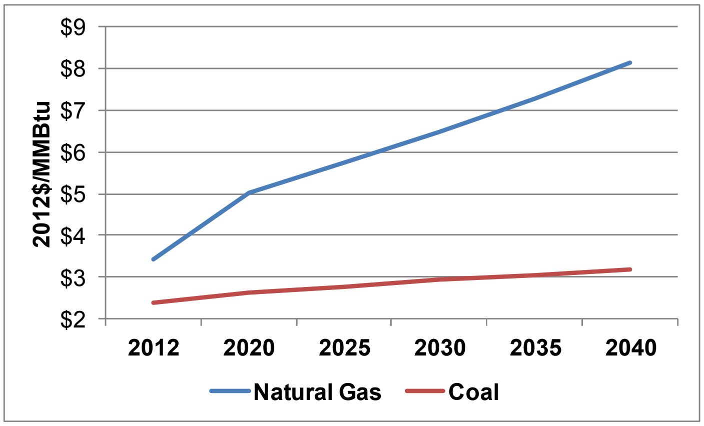


Source: U.S. Energy Information Administration.

As noted, natural gas has historically been subject to greater price volatility than coal – Figure II-5. And while new supplies and infrastructure are helping to stabilize that situation, the bottom line is that while the future price of natural gas is unknown, price volatility will likely continue due to its numerous uses and sectors that demand it. This is only exacerbated by government policies that increase demand for natural gas. In addition, according to the latest EIA forecasts, natural gas prices will remain higher than coal, and coal's price advantage is expected to increase every year – Figure II-8.[13]

[13] U.S. Energy Information Administration, *Annual Energy Outlook 2014*, 2014.

Figure II-8
Forecast Natural Gas and Coal Prices for Electric Power Producers



Source: U.S. Energy Information Administration.

Fourth, allowing for a 15 percent reserve factor, TVA load carrying ability will be only 28,369 MW by the summer of 2015 – but TVA peak loads have exceeded that level many times in both summer and winter. By 2015, TVA will require 32,000 MW plus 15 percent reserves, or 36,800 MW, of dependable capacity, and this is likely to increase going forward, as discussed in Section II.B.2.

Finally, the "retirement" of reliable coal plants such as the Paradise units is not benign idleness, but rather results in permanent loss of license and removal from the grid. Thus, these productive assets would not be available when, once again, gas prices spike as supply falters. Nor would they be available if the current version of TVA's ever optimistic nuclear plan falls short. The cost to construct nuclear power stations has escalated dramatically in the past five years and has now reached over $10,000 per Kilowatt.[14] For example, the proposed 2,200 MW Levy nuclear plant in Florida was projected to come online in 2016, but was cancelled in 2013 after cost estimates increased fivefold in just seven years -- Figure II-9.

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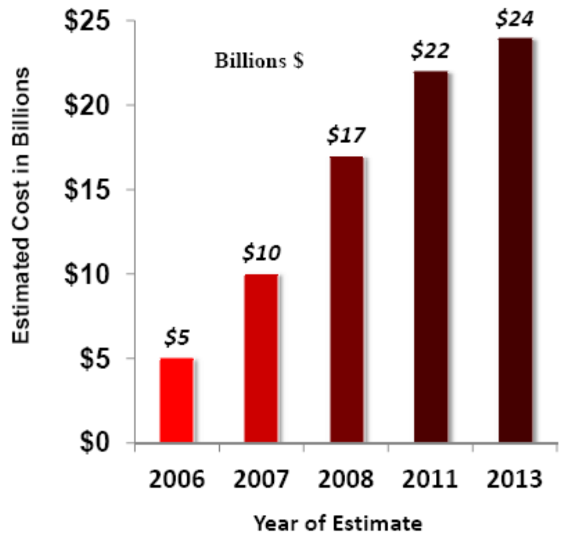
[14]"The likelihood of someone else going ahead with a new nuclear plant today is very low indeed," Jonathan Arnold, Utility Analyst, Deutsche Bank, August 2013.

Figure II-9
Cost Escalation for the Levy Nuclear Plant in Florida



Source: Clemente and Rabb.

In sum, such wide ranging cumulative costs and risks make the TVA plan adverse to the human health and welfare of the people in Tennessee. A secure route to reliable electricity supply, lower rates, economic growth and environmental progress is to pursue timely upgrades of TVA's existing coal facilities (e.g., the Paradise units) as well as the construction of new supercritical coal power stations. TVA should take the lead in the continuing deployment of clean coal technologies.

II.B.2. Reliability Concerns

TVA's recent decision to prematurely retire Paradise 1 & 2 and other coal plants creates serious reliability concerns for serving TVA customers in Tennessee as EPA's Mercury (MATS) rules takes hold. Utilities throughout the U.S. are looking at retiring coal plants, which may create capacity shortages in the regional markets. TVA announced on November 14, 2013 that 3,900 MW of coal would not be invested in for MATS compliance and closed in the 2015 – 2016 timeframe.[15] TVA has about 2,000 MW of coal generation at Shawnee 1-10 and Allen 1-3 not yet set for retirement that does not meet MATS standards, with no plan to upgrade in time for MATS. TVA's coal capacity could be reduced from the 12,901 MW reported for 2013 to 6,808 MW, and the net summer capability reduced from the 2013 reported 36,594 MW to only 30,501 MW. If Watts Bar Nuclear #2 is completed and the 1,000 MW combined cycle plant completed at Paradise, the net summer capability will be 32,624 MW.[16]

[15]Clemente and Rabb, op. cit.
[16]See Clemente and Rabb, op. cit.

Allowing for the 15 percent reserve factor, the TVA load carrying ability will be only 28,369 MW by the summer of 2015. However, TVA peak loads have exceeded 28,369 MW many times in both summer and winter. With a return of normal temperatures and rainfall, it can be expected that TVA peak loads will exceed 30,000 MW even with zero load growth. It is not unreasonable to expect a 32,000 mw peak load by 2015. TVA will then require 32,000 plus 15 percent reserves, or 36,800 MW of net capability in 2015, and this is likely to increase going forward. The proposed TVA plan will result in a capacity deficit which could be as much as 8,000 MW by 2015, just as the regional markets are also deficient extra capacity. This could lead to significant reliability problems, potential rolling blackouts and much higher electricity prices.[17]

II.B.3. Tennessee's Electricity Advantage

One of the major reasons Tennessee currently maintains an attractive economic and business environment is its reliable electricity and low rates. Notably, both TVA and the State of Tennessee emphasize the affordability, stability, and reliability of TVA's electricity as a key economic advantage. For example, TVA emphasizes its key role in meeting the region's needs through low rates, a balanced portfolio, and well-operated systems.[18] TVA also stresses how important its industrial rate competitiveness for industry in the Valley, noting that:[19]

- Electricity is a significant cost for industry in the Valley.
- Many industrial customers within the Valley compete with sister facilities and competitors outside the Valley.
- TVA supports 10,000 manufacturing companies, 527,000 direct jobs, and $32 billion direct wages.

Tennessee is aggressive and forthright in using TVA and its low-cost, reliable power in recruiting business to the state. The Tennessee Department of Economic and Community Development (DECD) notes that Tennessee is an ideal place to drive business success, offering resources that give businesses a winning edge in their growth and profitability, and the state is positioned to offer whatever a company needs to be successful. Specifically, DECD emphasizes that:[20]

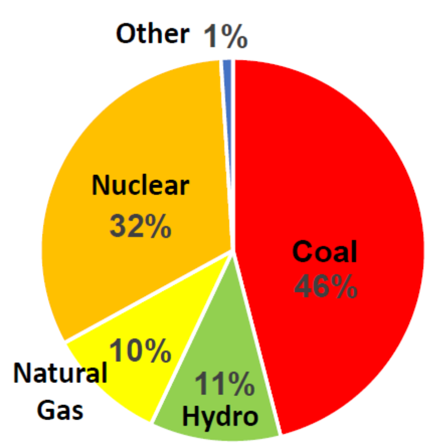
- The TVA serves virtually all of the 95 counties in Tennessee.
- TVA was named a 2013 Top Utilities in Economic Development by *Site Selection Magazine*. The analysis is based on several factors, including corporate end-user project activity, website tools and data, and job-creating infrastructure.

[17]Ibid.
[18]John Malone, "TVA Overview, FCA, & Interruptible Products," Tennessee Valley Authority MLGW Key Customer Meeting, December 6, 2012.
[19]Source: TVA Board Meeting, August 22, 2013.
[20]Tennessee Department of Economic and Community Development, "Why Tennessee?" http://www.tn.gov/ecd/.

- TVA's power rates are better than the national average.
- TVA ranks fifth in the U.S. in generating capacity.
- TVA's robust network in Tennessee, which includes 9,444 miles of transmission line and 263 substations and switchyards, is more than sufficient to supply its 42,000 square-mile service region in the state.
- The TVA service area in Tennessee covers 99.7 percent of Tennessee, about 49 percent of TVA's territory.
- Since 2000, the TVA system has delivered 99.999 percent transmission reliability.
- In Tennessee, TVA operates 19 hydroelectric dams, six coal-fired power plants, two nuclear power plants, seven combustion turbine sites, and a pumped-storage plant, with a combined generating capacity of more than 19,655 megawatts.
- TVA works with local power companies, directly served customers, and regional, state and community organizations to create economic development opportunities for the TVA region.
- During fiscal year 2013, over 32,550 jobs were created or retained in Tennessee and more than $2.9 billion was invested.

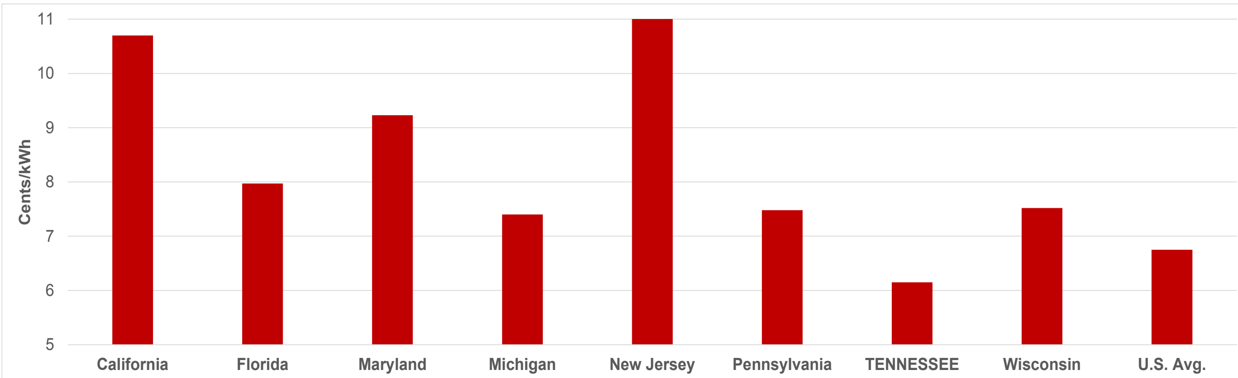
Tennessee has benefited greatly from reliance on dependable, low-cost coal-fueled electricity generation which provides nearly half of the state's electric power – Figure II-10. Accordingly, Tennessee's industrial electricity rates are relatively low and provide it with a key competitive advantage – Figure II-11. This advantage has been key in enabling Tennessee to become over the past several decades a major U.S. automotive manufacturing center, as discussed below. Electro-technologies will become increasingly important in the 21st century, and competitive electricity rates are critical to the state's maintaining its competitive edge.

Figure II-10
2012 Tennessee Generation, mWh



Source: U.S. Energy Information Administration.

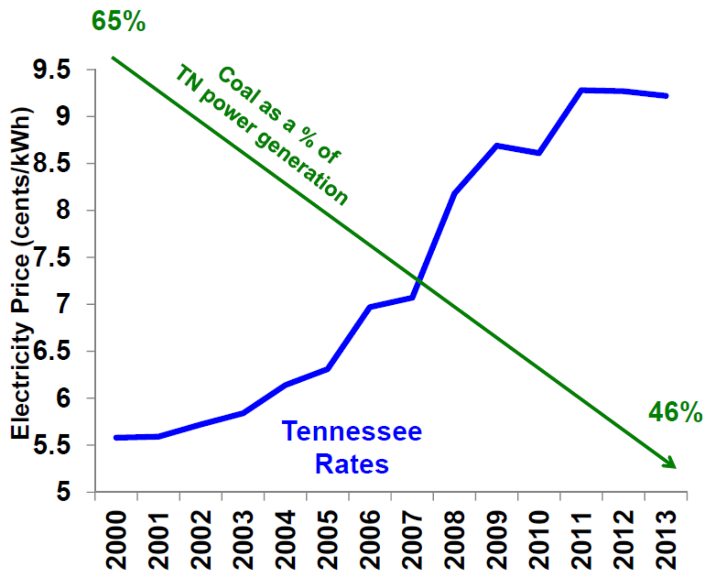
Figure II-11
Industrial Electricity Rates, 2014



Source: U.S. Energy Information Administration.

However, it must be realized that Tennessee's competitive advantage is at risk as less coal is being used to generate electricity in the state. It is no coincidence that Tennessee's reduction in coal power has been accompanied by higher electricity prices. As shown in Figure II-12, in 2000 Tennessee's rates were 18 percent below the U.S. average, whereas, at present, they are just eight percent lower.

Figure II-12
Tennessee's Reduced Use of Coal for
Electricity Generation Has Resulted in Increased Rates

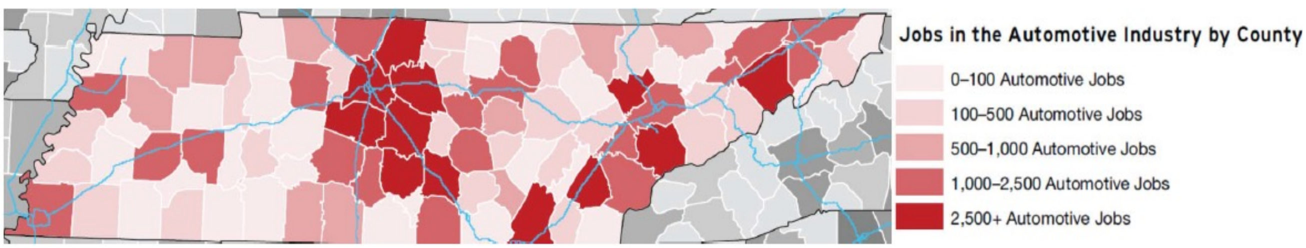


Source: U.S. Energy Information Administration.

II.B.4. The Critical Role of the Tennessee Automotive Sector

In 1979, Tennessee initiated the Southern automotive tier and brought the first foreign-owned auto assembly plant to the South: The Nissan plant at Smyrna. Since production of its first car in 1983, the Smyrna plant has been joined by additional Nissan assembly plants as well as new plants for General Motors and Volkswagen. Billions of dollars of other new investment has flowed into the state, especially supporting the hundreds of GM, Nissan, and VW suppliers and thousands of jobs throughout the state – Figure II-13. In total, approximately $30 billion of auto-related investment, procured through foresight and assertiveness, has allowed Tennessee to greatly upgrade its economy.[21]

Figure II-13
Impact of the Automotive Sector in Tennessee



Source: Dun & Bradstreet, ELM Analytics, and MarkLines.

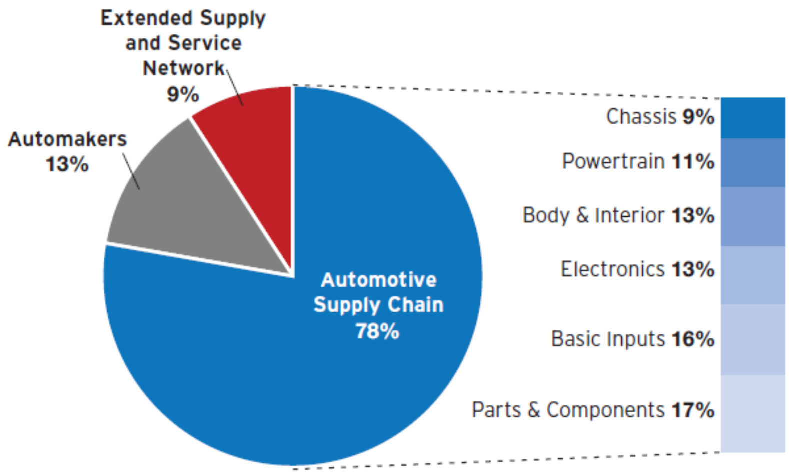
Tennessee's large auto sector encompasses an extended production network and supply chain. Nearly 650 firms comprise Tennessee's automotive economy and together employ almost 94,000 workers. Three large automakers – GM, Nissan, and Volkswagen -- have major operations in Tennessee and represent each major global auto-producing bloc. These original equipment manufacturers (OEMs) employ more than 12,000 Tennesseans. Nevertheless, notwithstanding the usual focus on the automakers themselves, suppliers actually constitute the bulk of establishments and employment in the industry.

About 73,500 jobs -- 78 percent of the sector total, reside in Tennessee's direct supplier network, while another 8,500 are in a more extended network of indirect suppliers and service providers, and Tennessee ranks first in the South and fifth among peer states in terms of its total supply chain employment. More than half of these jobs reside in the state's approximately 600 small and medium-sized establishments (SMEs), which together employ nearly 50,000 workers. The automotive supply chain accounts

[21]"Drive !: Moving Tennessee's Automotive Sector Up The Value Chain," Brookings Institution, Brookings Advanced Industries Series, Washington, D.C., 2013.

for more than three-quarters of industry jobs in Tennessee, building all systems of the car – Figure II-14. Tennessee has emerged as one of the industry's most important supplier hubs not just in the region, but nationally and globally.[22]

Figure II-14
The Tennessee Automotive Industry



Source: Dun & Bradstreet, ELM Analytics, and MarkLines

Tennessee is home to the fourth-largest concentration of automotive industry employment in the U.S. and, in terms of employment, is the fourth-ranked auto-producing state in the nation (behind Michigan, Indiana, and Ohio) and the first-ranked in the South (just ahead of Kentucky). The state's automotive industry contributed $2.8 billion in compensation in 2012, at an average disbursement of $57,000 per worker.[23]

Most significantly perhaps, manufacturing has a very large employment multiplier, and it has been estimated that every manufacturing job creates three other jobs indirectly.[24] For example, "If an auto plant opens up, a Wal-Mart can be expected to follow. But the converse does not hold: A Wal-Mart opening definitely does not bring an auto plant with it."[25] Thus, the total number of jobs created in Tennessee by the automotive sector is nearly 400,000.

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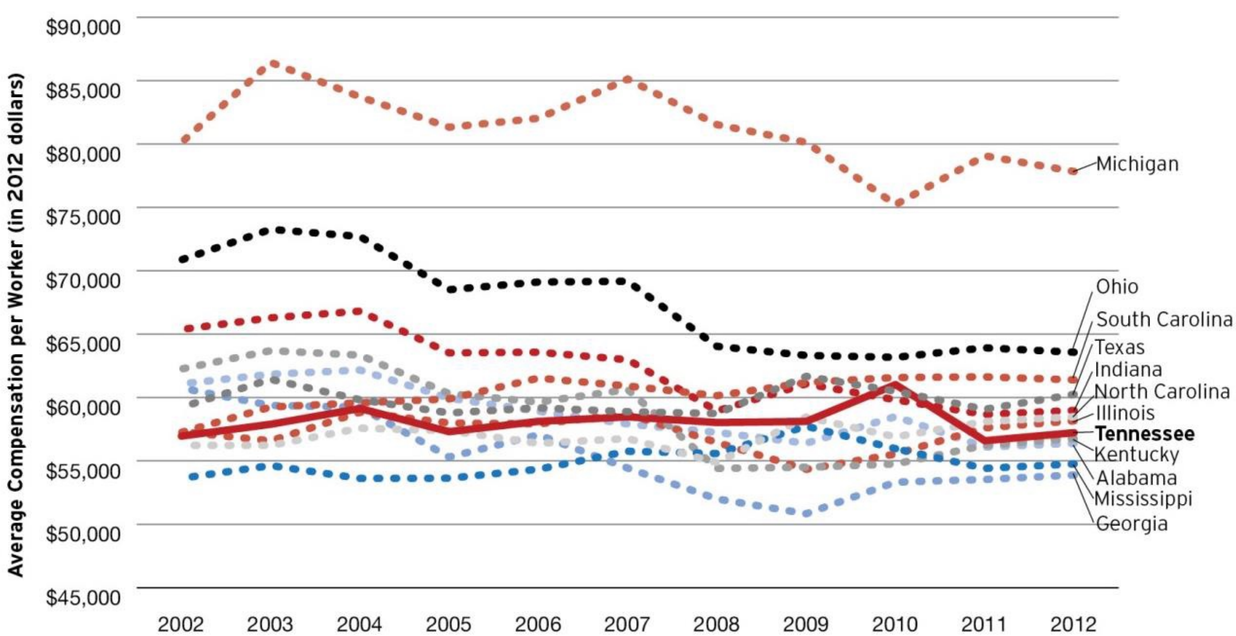
[22]Tennessee's auto industry has a strong international cast, with majority-owned foreign businesses from 14 different countries employing 46 percent of Tennessee's auto industry workforce.
[23]Brookings Institution, op. cit.
[24]Harold L. Sirkin, Michael Zinser, and Douglas Hohner, "BCG Perspectives," commentary on the BCG study *Made in America, Again: Why Manufacturing Will Return to the U.S.*. Boston Consulting Group, August 2011.
[25]Gene Sperling, Director, White House National Economic Council, March 2012. Further, "American manufacturers are creating new jobs. That's good for the companies, but it's also good up and down the supply chain, because if you're making this stuff here, that means that there are producers and suppliers

However, economies and industries are always in flux. Five years after the Great Recession, a leaner and more intensely competitive auto industry is emerging under new conditions. The transformed environment presents Tennessee with both opportunities and challenges as it considers how to maintain and expand its competitive advantage in what the state has recognized as a classic “advanced industry.” Tennessee – and other states -- will have to find new sources of competitive advantage other than relative wages, as compensation levels converge within a $10,000 band outside of Michigan – Figure II-15. As this figure illustrates, Tennessee’s wage advantage has eroded over the past decade as compensation per worker in all major auto states except Michigan converged around a band between $53,500 and $63,500 per year. To maintain the differential, historically low-wage states and their automakers increasingly rely on even lower-wage pools of flexible contract workers in favor of full-time employees. Post-recession, however, such flexible workforce models are becoming standard. This means that as wage convergence proceeds, other competitive factors such as reliable, high quality, low-cost electricity, will become ever more important.

Figure II-15
Compensation Compression in the U.S. Automotive Sector



Source: Brookings analysis of data from Moody’s Analytics

A major disruptive trend in the auto industry is the continuation of pervasive cost pressures as international competition, input price trends, and increased demand for

in and around the area who have a better chance of selling stuff here. Everybody benefits when manufacturing is going strong.” President Obama, April 2012.

consumer electronics increase costs for North American producers.[26] Input costs are rising steadily and it is forecast that in the coming decade global commodity prices will continue to rise.[27] For example, the prices of steel and petroleum -- two of the most important commodities for the auto industry -- increased by 30 and 250 percent, respectively, between 2001 and 2010. During that same time period content suppliers were forced to absorb input cost increases of 50 percent.[28]

II.B.5. The Tennessee Automotive Sector: Electricity's Importance

The Tennessee auto industry is thus undergoing critical changes, and cost pressures continue to affect its competitiveness. It faces increasing competition from Alabama, Georgia, Illinois, Kentucky, Mississippi and Texas, as well as from Mexico.[29] However, industry output, or value-added, in Tennessee has been consistently lower over the past decade than would be expected given employment numbers. For Tennessee to remain competitive going forward, value-added per worker will have to increase.

Tennessee does have one important advantage over most of its competitors: The reliable, high quality, low-cost electricity provided by TVA. As discussed, this has been critical in the past for developing the automotive industry in the state. However, Tennessee's electricity will be even more important in the future:

- It is currently an important competitive advantage – see Figure II-9, and it is one input cost over which the state has some control.
- Tennessee will no longer be able to rely on cheap labor as a competitive advantage – see Figure II-12.
- Most important perhaps, automotive manufacturing in the future will become even more electricity intensive and dependent on emerging electro-technologies.

In general, electricity is increasingly critical for all manufacturing:

- U.S. manufacturing is becoming ever more dependent on reliable, affordable, quality electricity.
- Lower energy costs facilitate superior performance of U.S. industrial firms.
- Electric technologies are replacing use of existing fuel-based technologies.

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[26]The changing composition of the modern automobile is also driving up input costs, particularly with regard to IT systems and new battery technologies for hybrid and electric cars.
[27]"U.S. Manufacturing on Track to Nearly Double Export Markets by End of 2015," Nissan North America, Irvine, California, 2013.
[28]International Trade Administration, "Trends in U.S. Vehicle Exports," Washington, D.C.: U.S. Department of Commerce, 2013, and "Video Report: Nissan U.S. Manufacturing on Track to Nearly Double Export Markets by End of 2015."
[29]Sean McAlinden and Yen Chen, "After the Bailout: Future Prospects for the U.S. Auto Industry," Ann Arbor, 2012, and Center for Automotive Research, "CAR 3rd Quarter U.S. Sales, Production, and Employment Outlook," Ann Arbor, 2013.

- Productivity is driven by technology, and new technology is increasingly electric – and reliable, affordable electricity facilitates this.
- Advanced manufacturing technologies (AMTs) require reliable uninterrupted electric power.
- Productivity growth is highest in electric-dominant industries.
- U.S. manufacturing is twice as productive as two decades ago, and electric technologies enabled by low-cost electricity facilitated this.
- Electric technologies are the primary source of new equipment.
- AMTs are more electricity intensive and more energy efficient.
- New AMTs will be electricity dependent and require more electricity.
- Electro-technologies will dominate new technology and productivity growth.

Specifically, advanced electro-technologies in automotive manufacturing include:[30]

- Materials with engineered properties created through the development of specialized process and synthesis technology.
- Nanotechnology, including materials, devices, or systems at the atomic, molecular, or macromolecular level, with a scale measured in nanometers.
- Micro-electromechanical systems, including devices and systems integrating microelectronics with mechanical parts and a scale measured in micrometers.
- New technology and systems that enhance and improve the manufacturing process.
- Advanced computing and electronic device technology related to advanced automotive, manufacturing materials, information, and processing technology.
- Design, engineering, testing, and diagnostics related to advanced automotive, manufacturing, information, and processing technology.

For example, the automotive industry is increasingly reliant on electronic solutions, electronics account for 40 percent of automotive production costs, and they will be increasingly important in the future.[31] If present trends continue, electronic component costs will soon comprise the majority of materials/components costs. The main factor behind the rapid increase in the proportion of electronic components used in motor vehicles is the crucial role that electronics plays in developing optimal technological solutions to the four main issues that automakers currently face: 1) improving drivability, 2) enhancing safety features, 3) lowering environmental burden, and 4) realizing greater operational reliability. The effective application of electronics technology is absolutely vital to the automotive industry as viable solutions to these four key issues.

Twenty-first century vehicle manufacturing will experience the "Third Industrial Revolution" and will increasingly require mass customization and individualized production, 3-D printing, additive manufacturing, digitalization of manufacturing,

[30]"Advanced Automotive, Manufacturing, Materials, Information," www.gvsu.edu/.
[31]TechnoAssociates, Nikkei Business Publications, Inc., 2013.

nanotechnology, continuing manufacturing processes, next generation ultra-precision production systems, emerging smart system products, new production chains that apply nano and micro scale features rapidly onto large (and continuous) multi-material substrates, fine feature generation processes for multi-material processing, including effective quality control, and related technologies.[32] All of these will be highly dependent on high quality, reliable, affordable electricity.[33] Coal is essential to provide this electricity – in Tennessee and elsewhere.

In particular, several electricity-dependent trends will affect production process and platform design in automotive manufacturing in the coming years, including digital modeling, simulation, and visualization; advances in industrial robotics; and additive manufacturing.[34] Adoption rates for these technologies vary widely, but the trend is clear.

Digital modeling, simulation, and visualization. Using inputs from product development and historical production data (such as order data and machine performance), vehicle manufacturers can apply advanced computational methods to create a digital model of the entire manufacturing process. A "digital factory," including all machinery, labor, and fixtures, can simulate the production systems. In addition, ubiquitous sensor technologies (such as cameras and transponder chips) help to "synchronize" simulation and reality at every point in the production timeline. Leading automobile manufacturers have used this technique to optimize the production layout of new plants, and companies have developed simulations to significantly improve the reliability of complex production lines[35]

Vehicle manufacturers can also use big data techniques and analytics to manage complex manufacturing processes and supply chains, and big data can facilitate greater experimentation at the product design stage. Toyota, Fiat, and Nissan have reduced new-model development time by 30 to 50 percent by allowing designers and manufacturing engineers to share data quickly and create simulations to test different designs and choice of parts and suppliers.

Advances in industrial robotics. Nearly 1.5 million industrial robots are currently in use worldwide, 150,000 are being sold annually, and the numbers and uses are increasing dramatically. Robot use is highly skewed by region and by industry, the automotive sector is one of the major users of robots, and robots are more concentrated in advanced economies where wages are higher and the workforce is more highly

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[32]Bill O'Neill, "An Exploration of Future Manufacturing Technologies in Response to the Increasing Demands and Complexity of Next Generation Smart Systems and Nanotechnology," Centre for Industrial Photonics Institute for Manufacturing, Department of Engineering, University of Cambridge, March 2012.
[33]"The manufacturing sector has a huge stake in ensuring that the U.S. has a dependable supply of affordable energy." National Association of Manufacturers, 2013.
[34]*Manufacturing the Future: The Next Era of Global Growth and Innovation*, McKinsey Global Institute. McKinsey & Company, 2012.
[35]*Improved Manufacturing Processes Save Company One Billion Dollars,* U.S. Department Energy, October 2011, www.energy.gov.

educated.[36] Across manufacturing industries, robots are used increasingly to reduce variability, increase speed in repetitive processes, get around ergonomic restrictions, and improve plant utilization and productivity. Rapid adoption is being driven largely by falling costs; average robot prices have declined by 40 to 50 percent relative to labor compensation since 1990 in many advanced economies. Another factor is the growing variety and complexity of tasks that robots can perform with the integration of machine learning and natural language processing. In addition, manufacturers are installing robots to meet demands for higher quality from customers and regulators and to match competitors. Robotics can also help manufacturers adapt to changes in the global labor market, such as the aging of working-age populations and rising labor costs in developing economies. The automotive industry is the most important customer of industrial robots and has substantially increased investments in industrial robots worldwide. In recent years it has accounted for about 40 percent of new industrial robot purchases.[37]

Additive manufacturing. Additive manufacturing (AM) refers to a wide set of technologies, including 3-D printing, that build up solid objects from small particles.[38] AM technologies -- selective laser sintering, fused deposition modeling, and tereolithography -- are key technologies for industrial AM today. These technologies are used over a range of products, materials, and sizes, with no single technology capable of covering the entire range. The automotive industry is one of the primary users and, while AM manufacturing consumes large amounts of electrical energy per unit of product, it mitigates the need for large amounts of raw material in the supply chain. AM can be a truly transformative force for manufacturing flexibility by reducing prototyping and development time, reducing material waste, eliminating tooling costs, enabling complex shapes and structures, and simplifying production runs. Some experts believe AM is nearing an inflection point, as new advances enable more applications, reduce costs, and increase adoption by downstream industries.[39]

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[36]International Federation of Robotics, *World Robotics 2013: Industrial Robots* 2013.
[37]Ibid.
[38]*Wohlers Report* 2012: *Additive manufacturing and* 3D *printing state of the industry.* Wohlers Associates. 2012.
[39]McKinsey Global Institute, op. cit.

III. ELECTRICITY AND THE ECONOMY

III.A. Energy Costs and the Economy

Virtually all economists agree that there is a negative relationship between energy price changes and economic activity, but there are significant differences of opinion on the economic mechanisms through which price impacts are felt.[40] Beginning with the oil supply shocks of the 1970's, analyses that have addressed the impact of energy price shocks on economic activity have produced, and continue to produce, a steady stream of reports and studies on the topic.

A number of studies have analyzed the long run impacts of changes in energy and electricity prices on the economy and jobs. For example:[41]

- In 2012 and 2013, Bildirici and Kayikci in several studies found causal relationships between electricity consumption and economic growth in the Commonwealth of Independent States countries and in transition countries in Europe.[42]
- In 2010, Lee and Lee analyzed the demand for energy and electricity in OECD countries and found a statistically valid relationship between electricity consumption and economic growth.[43]
- In 2010, Baumeister, Peersman, and Van Robays examined the economic consequences of oil shocks across a set of industrialized countries over time and found that energy costs and GDP are negatively correlated.[44]
- In 2010, Brown and Hunnington employ a welfare-analytic approach to quantify the security externalities associated with increased oil use, which derive from the expected economic losses associated with potential disruptions in world oil supply.[45]

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[40]See the discussion in Management Information Services, Inc. "The Social Costs of Carbon? No, the Social Benefits of Carbon," report prepared for the American Coalition for Clean Coal Electricity, Washington, D.C., January 2014.

[41]See also the discussion in Section II.H.2 and Appendices II and III.

[42]Melike Bildirici, Frazil Kayikci, "Economic Growth and Electricity Consumption in Former Soviet Republics" IDEAS, Federal Reserve Bank of St. Louis, 2012; Melike Bildirici, Frazil Kayikci, "Economic Growth and Electricity Consumption in Former Soviet Republics," *Energy Economics*, Volume 34, Issue 3 (May 2012), pp. 747–753; "Economic Growth And Electricity Consumption In Emerging Countries Of Europa: An ARDL Analysis," *Economic Research - Ekonomska Istrazivanja*, Vol. 25, No. 3 (2013), pp 538-559.

[43]Chien-Chaing Lee and Jun-De Lee, "A Panel Data Analysis of the Demand for Total Energy and Electricity in OECD Countries," *The Energy Journal*, Vol. 31, No 1 (2010), pp. 1-23.

[44]Christiane Baumeister, Gert Peersman and Ine Van Robays, "The Economic Consequences of Oil Shocks: Differences Across Countries and Time," Ghent University, Belgium, 2010.

[45]Stephen P.A. Brown and Hillard G. Huntington, "Estimating U.S. Oil Security Premiums," Resources for the Future, Washington, D.C., June 2010.

- In 2009, Blumel, Espinoza, and Domper used Chilean data to estimate the long run impact of increased electricity and energy prices on the nation's economy.[46]
- In 2008, in a study of the potential economic effects of peak oil, Kerschner and Hubacek reported significant correlations between energy and GDP – although they noted that sectoral impacts are more significant.[47]
- In 2008, Sparrow analyzed the impacts of coal utilization in Indiana, and estimated that electricity costs significantly affect economic growth in the state.[48]

Numerous studies have developed estimates of the elasticity of GDP with respect to energy and electricity prices.[49] Examples of these are summarized in Table III-1 and are discussed in more detail in the Appendix. The meaning and interpretation of these elasticities are discussed below.

As indicated in Table III-1, three decades of rigorous research support elasticity estimates factors of about:

- -0.17 for oil,
- -0.13 for electricity,
- -0.14 for energy, and
- -0.15 for every energy-related study (all of the above).

III.B. The Impact of Electricity Price Increases on the Economy and Jobs

We summarized above some of the major studies that estimated the relationship between the economy and jobs, on the one hand, and the price of energy and electricity on the other, and Appendix III cites over 60 references to studies published over the past three decades. These references pertain to studies published in peer-reviewed international professional and scientific journals, reports prepared by researchers at major universities and research institutes (such as the UK University of Leeds, the Colorado School of Mines, Citigroup Energy, Inc., Duke University, Pennsylvania State University, the National Science Foundation, the OECD, the Federal Reserve Bank, Statistics Norway, etc.), and papers presented at major international scientific conferences.

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[46]Gonzalo Blumel, Ricardo A. Espinoza, and G. M. de la Luz Domper, "Does Energy Cost Affect Long Run Economic Growth? Time Series Evidence Using Chilean Data," Instituto Libertad y Desarrollo Facultad de Ingenier´ıa, Universidad de los Andes, March 22, 2009.
[47]Christian Kerschnera and Klaus Hubacek, "Assessing the Suitability of Input-Output Analysis For Enhancing Our Understanding of Potential Economic Effects of Peak-Oil," Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK, 2008.
[48]F.T. Sparrow, Measuring the Contribution of Coal to Indiana's Economy," CCTR Briefing: Coal, Steel and the Industrial Economy, Hammond, Indiana, December 12, 2008.
[49]An elasticity of -0.1 implies that a 10 percent increase in the electricity price will result in a one percent decrease in GDP or – in the case of a state – Gross State Product (GSP).

Table III-1
Summary of Energy- and Electricity-GDP Elasticity Estimates

Year Analysis Published	Author	Elasticity Estimate
2010	Lee and Lee (energy and electricity)	-0.01 and -0.19
2010	Brown and Huntington (oil)	-0.01 to -0.08
2010	Baumeister, Peersman, and Robays (oil)	-0.35
2009	Blumel, Espinoza, and Domper (energy and electricity)	-0.085 to -0.16
2008	Kerschner and Hubacek (oil)	-0.03 to -0.17
2008	Sparrow (electricity)	-0.3
2007	Maeda (energy)	-0.03 to -0.075
2007	Citigroup (energy)	-0.3 to -0.37
2007	Lescaroux (oil)	-0.1 to -0.6
2006	Rose and Wei (electricity)	-0.1
2006	Oxford Economic Forecasting (energy)	-0.03 to -0.07
2006	Considine (electricity)	-0.3
2006	Global Insight (energy)	-0.04
2004	IEA (oil)	-0.08 to -0.13
2002	Rose and Young (electricity)	-0.14
2002	Klein and Kenny (electricity)	-0.06 to -0.13
2001	Rose and Ranjan (electricity)	-0.14
2001	Rose and Ranjan (energy)	-0.05 to -0.25
1999	Brown and Yucel (oil)	-0.05
1996	Hewson and Stamberg (electricity)	-0.14
1996	Rotemberg and Woodford (energy)	-0.25
1996	Gardner and Joutz (energy)	-0.072
1996	Hooker (energy)	-0.07 to -0.29
1995	Lee and Ratti (oil)	-0.14
1995	Hewson and Stamberg (electricity)	-0.5 and -0.7
1982	Anderson (electricity)	-0.14
1981	Rasche and Tatom (energy)	-0.05 to -0.11

Source: Management Information Services, Inc.

The sources cited include analyses of the economic and jobs effects of oil price increases, energy price increases, and electricity price increases in both developed and developing countries throughout the world. This breadth of coverage strengthens the analysis and findings.

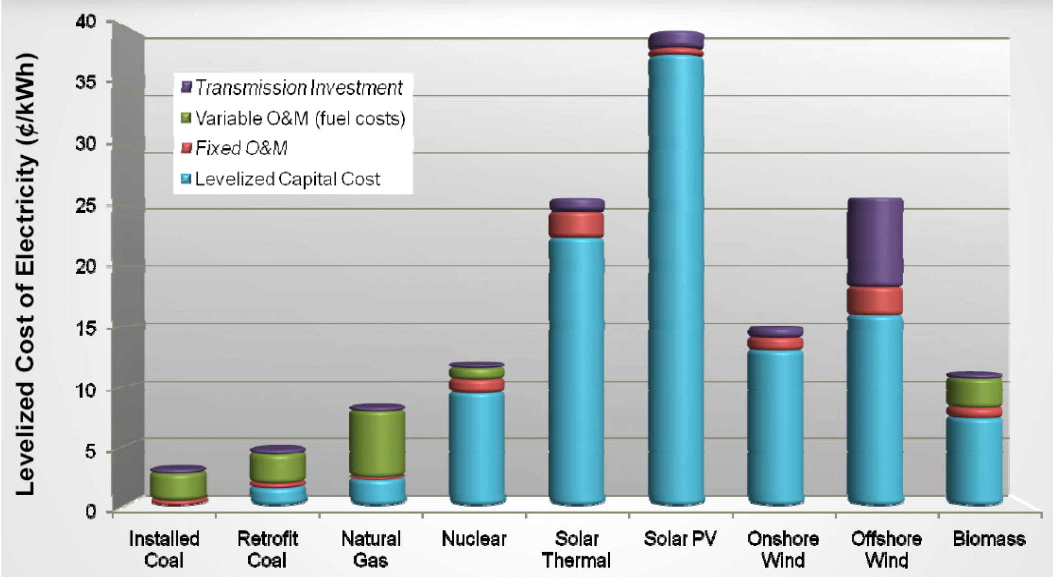
The research discussed here finds that virtually all economists who have analyzed the issue agree that there is a negative relationship between energy price changes and economic activity, but there are significant differences of opinion on the economic mechanisms through which price impacts are felt. Estimates of the impacts of oil shocks and other energy price perturbations have produced different results, with smaller time-series econometric models producing energy price change-output elasticities of -2.5 percent to -11 percent, while large disaggregated macro models estimate much smaller impacts – in the range of -0.2 percent to -1.0 percent.

Nevertheless, the salient point is that the relationship between energy prices and the economy is negative: Increases in energy and electricity prices harm the economy and decreases in energy and electricity prices benefit the economy. This relationship is important because coal is currently the low-cost option for generating electricity and is forecast to remain so – as discussed below. The mix of electric generating capacity – existing and new — among the various fossil, nuclear, and renewable sources will significantly affect electricity prices. Estimates of the levelized cost of electricity (LCOE) of existing and, especially, new electricity generating technologies vary by orders of magnitude – see Figure III-1.

Nevertheless, it seems clear that coal is the least expensive, followed by natural gas. New builds of nuclear and renewables are the most expensive and, among renewables, geothermal and biomass are the least expensive, followed by onshore wind, offshore wind, solar thermal, and PV.[50] As shown in Figure III-2, there is a negative relationship between electricity prices and a state's use of coal to generate electricity: The higher percentage of coal used to generate electricity, the lower the electricity rate.[51] Figure III-3 shows that it would be primarily the middle U.S. states that would be most negatively affected by a shift from coal for electricity generation.

Figure III-1
Levelized Costs of Electricity by Generation Sources

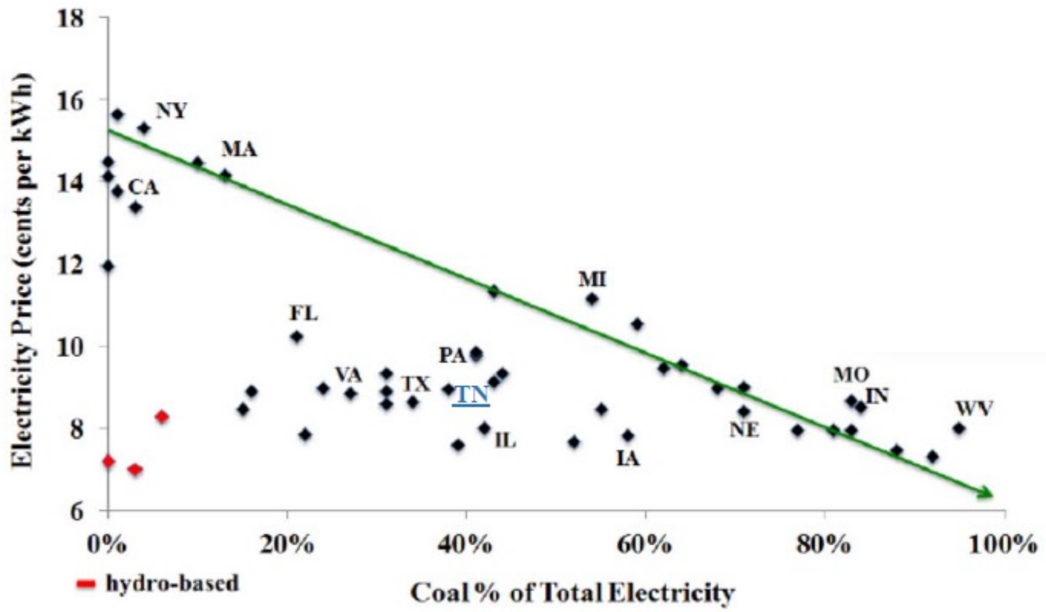
[50]No new builds of large hydro are assumed here.
[51]This figure compares estimated current and retrofit power plant costs. However, LCOEs underestimate the actual electricity production costs of intermittent, unreliable renewables; see "Meaningless LCOEs," *Power for USA*, July 22, 2014, http://dddusmma.wordpress.com/2014/07/22/meaningless-lcoes/.



1. All cost data from EIA 2010
2. Installed coal costs estimated from EIA projections for new generation less capital costs
3. Retrofit coal capital costs derived from Burns & McDonnell analysis December 2010

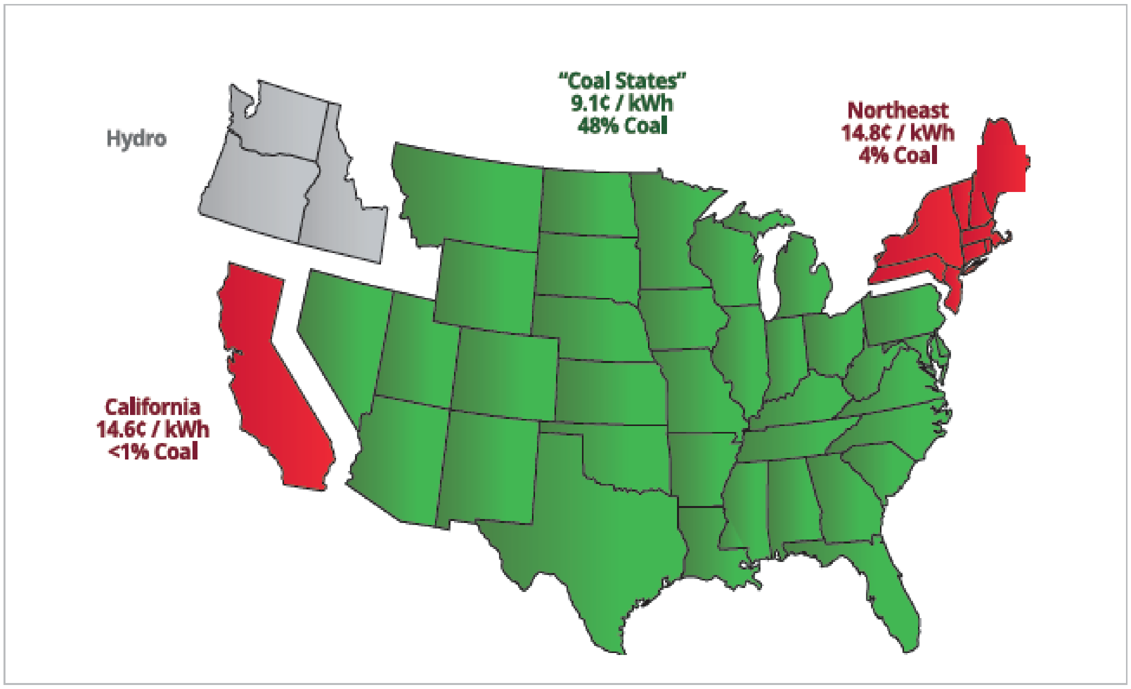
Source: Van Ness Feldman and Burns & McDonnell, 2011.

Figure III-2
Relationship Between Coal Generation and Electricity Prices by State



Source: U.S. Energy Information Administration, *Electric Power Monthly*, August 2013.

Figure III-3: U.S. Electricity Prices



Sources: U.S. EIA, 2013 data, Mar. 2014. Average retail electricity prices per kWh. Weighted average of CA and NE states equals 14.7 cents per kWh. ID, OR, WA excluded due to hydropower.

Thus, a large body of rigorous research conducted over the past three decades indicates that energy and electricity prices have significant economic and job impacts. All of these studies indicated that there is a negative correlation between energy and electricity prices and economic variables. That is, electricity price increases will harm the economy and jobs, whereas electricity price decreases will stimulate economic and job growth. Basically, energy price increases act like a tax increase on the economy, increasing the outflows of funds and reducing the incomes of energy consumers and ratepayers. In addition, the supply-side impacts from rate increases will depress business development and economic output. On the other hand, the consumer cost-savings realized from lower rates increase the disposable incomes of ratepayers and, this income, when used to buy other goods and services, creates additional economic benefits.

Energy costs have Keynesian economic effects similar to those of taxes:[52]

- Increased energy and utility costs act as a "hidden tax" that have deflationary, economically constrictive impacts; e.g., they decrease sales, GDP, jobs, etc.
- Conversely, decreased energy and utility costs have the effect of a "tax cut" and have economically stimulating effects by putting more

[52]See Roger H. Bezdek, "Energy Costs: The Unseen Tax? A Case Study of Arizona," presented at the National Taxpayers Conference, Chandler, Arizona, October 2013.

money in the hands of consumers and businesses, thus increasing sales, creating jobs, etc.

- Like tax increases and decreases, changes in energy costs have both direct and indirect effects on the economy.

Programs and policies that increase electricity prices – in a city, state, region, or nation — over what they would be otherwise will have adverse effects on the economy and jobs. Review of the literature revealed a number of studies that estimated the energy price/GDP elasticities – Table III-1 and the Appendix. On the basis of this review and an analysis of studies conducted to estimate the impact on GDP of changes in energy prices, we determined that a reasonable electricity elasticity estimate is -0.1, which implies that a 10 percent increase in electricity prices will result in a one percent decrease in GDP. The reported elasticity estimates ranged between -0.85 and -0.01, and most were in the range of about -0.1. This elasticity estimate has been used in rigorous, scholarly studies of these issues, and it is the estimate we use in our research. As noted in the preceding section, a reasonable average estimate of this elasticity is about -0.13. In our work, we use a conservative value of -0.1 and, thus, if anything, we understate the impact of electricity price changes on the economy and jobs.

An elasticity of -0.1 implies that a 10 percent increase in the electricity price will result in a one percent decrease in GDP or – in the case of a state – Gross State Product (GSP). Thus, for example, in a state such as Colorado where GSP is currently about $275 billion,[53] a 10 percent increase in the electricity price will (other things being equal) likely result in about a $2.75 billion decrease in Colorado GSP.

We do not imply here that this an exact estimate or that it implies a misleading level of precision. However, the overwhelming weight of scientific evidence shows that the relationship between electricity prices and the economy is negative; e.g., electricity price increases will harm the economy. And, as indicated, the metric of that relationship is not precise. While the elasticity used in our research, -0.1, is supported in the published literature and has been used by other researchers in related studies, the elasticity could be somewhat higher or lower – both in general and in specific jurisdictions. Thus, for example, in Colorado, the elasticity could range from -0.08 to -1.13. This would correspond to the estimates in the literature and would also support the -0.1 estimate used in the MISI research. Nevertheless, either of these alternative elasticity estimates would give only slightly different results. For example, if the elasticity is -0.08, then a 10 percent increase in electricity prices in Colorado would result in a decline of state GSP of about $2.2 billion. If the elasticity is -0.13, then a 10 percent increase in electricity prices in Colorado would result in a decline of state GSP of about $3.5 billion.[54]

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[53]U.S. Department of Commerce, Bureau of Economic Analysis, "GDP by State," 2014.

[54]See "Answering Testimony and Exhibits of Roger H. Bezdek on Behalf of the Colorado Mining Association in the Matter of Commission Consideration of Public Service Company of Colorado Plan in Compliance With House Bill 10-1365, 'Clean Air-Clean Jobs Act,'" before the Public Utilities Commission of the State of Colorado, Docket No. 10m-245e, September 17, 2010; Roger H. Bezdek, "Economic and Energy Impacts of Fuel Switching in Colorado," Presented at the 2010 North American Regional Science Association Meeting, Denver, Colorado, November 2010.

Thus, while the direction of the relationship between electricity prices and GSP is clear, the precise quantification of this relationship is less than exact. That is why in discussing our research results we are careful to give ranges of estimates, to qualify the findings, and to avoid imputing a misleading level of precision to the estimates.[55]

Energy and energy prices – specifically electricity and electricity prices -- matter to the economy and, in general, more abundant, efficient, and less expensive electricity is desirable and preferred and provides significant economic and jobs benefits[56]. Electricity is a mainstay of the U.S. economy -- and the Tennessee economy, and is a critical factor of production, so this is straightforward and noncontroversial[57]

[55]This approach has withstood the intense scrutiny of contentious PUC Hearings in Colorado; see Ibid.
[56]See the discussion in Roger Bezdek, Robert Wendling, and Robert Hirsch, *The Impending World Energy Mess*, Toronto, Canada: Apogee Prime Press, 2010.
[57]Management Information Services, Inc., *Literature Review of Employment Impact Studies of Power Generation Technologies,* DOE/NETL-2009/1381, September 14, 2009.

IV. ECONOMIC IMPACTS IN TENNESSEE

IV.A. Electricity Price Impacts

As discussed, one of the major reasons Tennessee currently maintains an attractive economic and business environment is its low electricity rates. However, as also discussed, electricity price increases act like a tax increase, reducing incomes of energy consumers and ratepayers[58] The supply-side impacts from price increases depress business development and economic output, and there will be adverse effects on the Tennessee economy and jobs from the rate increases associated with fuel switching:

- First, Tennessee businesses (including those in the automotive industry) will face increased competitive disadvantages.
- Second, some businesses in Tennessee will leave the state.
- Third, new businesses will hesitate to locate in Tennessee.
- Fourth, Tennessee electric customers will have less money to spend in the state.

Even worse, this represents a tax increase for which people receive no benefit: No road or infrastructure improvements are made, no technology improvements occur, no schools are built, no police or firefighters are hired, etc.

IV.B. Economic Effects in Tennessee

The basic economic parameters for Tennessee used here are summarized in Table IV-1.

To quantify the relationship between electricity prices and the economy, we utilized the elasticity of GDP with respect to electricity prices. Extensive review of the literature indicates that a reasonable long run value for this elasticity is about -0.10 – see the discussion in section III-A and the Appendix. This indicates that a ten percent increase in electricity prices will result in a decrease in GDP (or GSP) of about one percent. A value of -0.10 is credible and defensible and has been used in rigorous studies of the impact of energy and electricity on the economy[59] In fact, it is a conservative estimate[60]

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[58]See Roger H. Bezdek, "Energy Costs: The Unseen Tax? A Case Study of Arizona," op. cit.
[59]See the Appendix.
[60]Clearly, the higher the value used for the elasticity estimate the larger impact that changes in electricity prices will have, and vice-versa. However, using values significantly higher than -0.10 runs the risk of overestimating the impact of electricity prices on the economy, while using values significantly lower than -0.10 runs the risk of underestimating the impact of electricity prices on the economy. Nevertheless, as noted, the elasticity estimate in the literature for electricity is -0.13.

Table IV-1
Basic Economic Parameters for Tennessee, 2013

GSP (billions)	287.6
TN GSP percent of U.S. GDP	1.7 percent
Manufacturing (billions)	$41.4
Manufacturing percent of GSP	14 percent
TN mfg. percent of U.S. mfg.	2 percent
Labor force (thousands)	3,047
Employment (thousands)	2,853
Unemployment (thousands)	194
Unemployment rate	6.4 percent

Source: U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics, 2014.

There is a quantifiable relationship between economic activity and jobs – between the level of GDP/GSP and jobs. Basically, GDP and jobs are closely, positively correlated.[61]

The effects on other Tennessee economic parameters (tax revenues, manufacturing output, etc.) are estimated on the basis of the GSP impacts. Impacts on jobs and unemployment rates were estimated using Tennessee employment data; impacts on tax revenues were estimated using Tennessee tax and tax rate data; impacts on specific population groups (low-income, elderly, minorities) can be estimated using Tennessee demographic and income data; and so forth.[62]

The salient point is that existing coal plants produce inexpensive electricity and replacing them with much higher cost nuclear, natural gas, and renewable facilities will,

[61]This is relatively noncontroversial. We assume that the relationship is linear, but changes over time as productivity increases: Increasing the number of jobs created per billion dollars of GDP of GSP implies slower productivity growth, while decreasing the number of jobs created per billion dollar of GDP implies more rapid productivity growth. See Management Information Services, Inc., *Optimizing the Relationship Between Energy Productivity/Costs and Jobs Creation*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-402/110209, November 2009; Management Information Services, Inc., *GDP Impacts of Energy Costs*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL- DOE/NETL- 402/083109, October, 2009.
[62]For example, GSP data are obtained from the U.S. Bureau of Economic Analysis; demographic data are obtained from the U.S. Census Bureau; jobs, employment, labor force, and unemployment data are obtained from the U.S. Bureau of Labor Statistics; data on state, local, city, and municipal budgets, tax revenues, and tax burdens are obtained from the U.S. Department of the Treasury, the Federal Reserve Board, and the U.S. Census Bureau; data on the energy burdens of specific population groups (low-income, elderly, minorities) are obtained from the U.S. Department of Health and Human Services, the U.S. Energy Information Administration, and the U.S. Census Bureau; energy data are obtained from the U.S. Energy Information Administration.

inevitably, cause electricity costs and rates to increase significantly.[63] With TVA's current resource planning direction, it is likely that average electric rates in Tennessee will be more than 20 percent higher than they would otherwise be.

Overall, Tennessee would change from having average electric rates that are about five percent lower than the U.S. average to having average rates that are more than 15 higher than the U.S. average, and from having industrial electric rates that are 10 percent lower than the national average to industrial rates that are more than 10 percent higher than the national average. This increase in industrial rates means that one of Tennessee's major economic competitive advantages among the states will be lessened or eliminated.

As illustrated in Figure IV-1, by 2025 the net impact on the Tennessee economy would be devastating:[64]

- Tennessee gross state product (GSP) would be reduced by more than $7 billion.
- Tennessee manufacturing output would be reduced by more than $900 million.[65]
- Tennessee state and local government tax revenues would be reduced by nearly $700 million.

The impact on the Tennessee automotive manufacturing sector will be severe:

- TVA's fuel switching will result in a "tax" on this sector from which it will receive no benefits.
- This sector is especially vulnerable to energy costs, and will be even more so in the future.
- The future health of this sector depends critically on electricity-based technologies, processes, and innovation.
- This sector will lose an important economic competitive advantage it currently possesses over other states and foreign nations.

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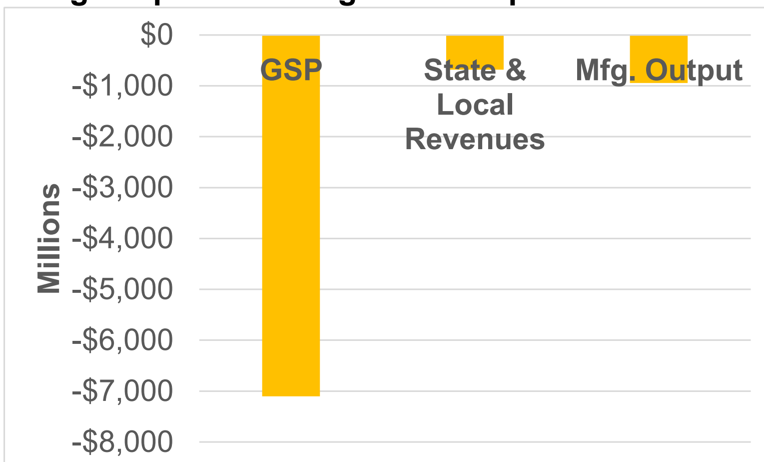
[63]All indications are that new builds will generate LCOEs that could be orders of magnitude higher than LCOEs from existing coal plants.

[64]This is the total economic impact net of gains and losses in all sectors of the economy.

[65]Manufacturing is especially vulnerable to electricity price increases, and the negative impacts on this sector are higher than average. See, for example, T. Hewson, and J. Stamberg, *At What Cost? Manufacturing Employment Impacts from Higher Electricity Prices,* Energy Ventures Analysis, Arlington, Virginia, 1996; Matthew E. Kahn and Erin T. Mansur, How Do Energy Prices, and Labor and Environmental Regulations Affect Local Manufacturing Employment Dynamics? A Regression Discontinuity Approach," Energy Institute at Haas and Haas School of Business, University of California, Berkeley, November 2010; Peter C. Balash, Natural Gas and Electricity Costs and Impacts on Industry, U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-2008/1320, April 28, 2008; Joel R. Hamilton and M. Henry Robison, "Economic Impacts from Rate Increases to Non-DSI Federal Power Customers Resulting from Concessional Rates to the DSIs," Submitted to the Public Power Council, Portland, Oregon, May 31, 2006.

Figure IV-1
Annual 2025 Losses in Tennessee GSP, State & Local Govt. Revenues, and Manufacturing Output Resulting From Proposed TVA Fuel Switching



Source: U.S. Bureau of Economic Analysis and Management Information Services, Inc.

IV.C. Impacts on Jobs and Unemployment

The jobs impact on Tennessee from fuel switching would be substantial. Figure IV-2 shows that, by 2025:[66]

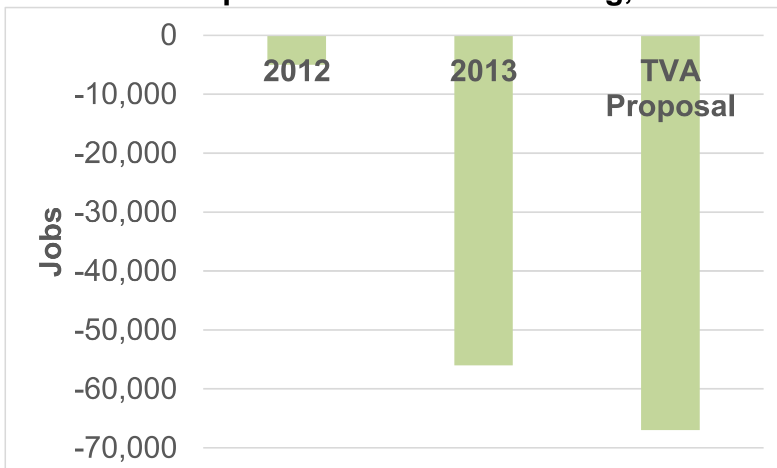
- More than 65,000 FTE jobs would be lost.[67]
- The jobs losses resulting would total more than 13 times the number of jobs lost in Tennessee in 2012.[68]
- The jobs losses resulting would exceed the number of jobs lost in Tennessee in 2012.[69]
- The jobs losses resulting would exceed the total number of jobs lost in the state economy in 2012 and 2013 *combined*.[70]

It is likely that a disproportionately large share of the job losses would be related, directly or indirectly, to the automotive sector in Tennessee.

---

[66]This is the total jobs impact net of gains and losses in all sectors of the economy.
[67]An FTE (full time equivalent) job is defined as 2,080 hours worked in a year's time, and adjusts for part time and seasonal employment and for labor turnover. Thus, for example, two workers each working six months of the year would be counted as one FTE job.
[68]Job losses in Tennessee in 2012 totaled about 5,000.
[69]Job losses in Tennessee in 2013 totaled about 56,000.
[70]Job losses in Tennessee in 2012 and 2013 combined totaled about 61,000.

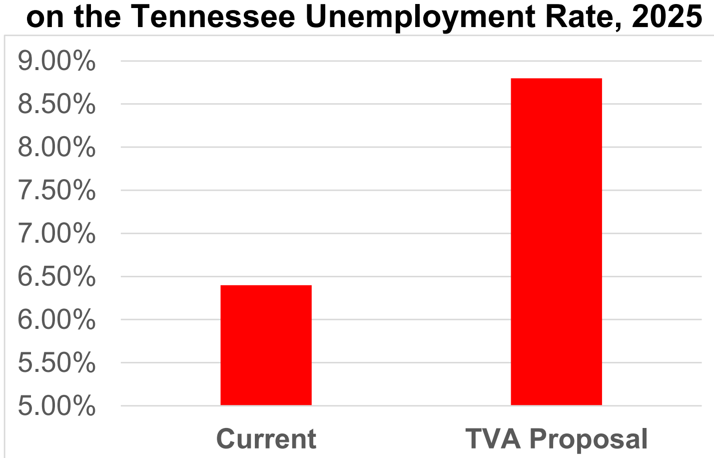
Figure IV-2
Magnitude of Tennessee Job Losses Resulting From Proposed TVA Fuel Switching, 2025



Source: U.S. Bureau of Labor Statistics and Management Information Services, Inc.

As illustrated in Figure IV-3, the Tennessee unemployment rate could increase by nearly 40 percent – from 6.4 percent to nearly nine percent.[71]

Figure IV-3
Impact of Proposed TVA Fuel Switching on the Tennessee Unemployment Rate, 2025



Source: U.S. Bureau of Labor Statistics and Management Information Services, Inc.

[71] Based on the actual 2014 unemployment rate in the state.

V. IMPACT ON ENERGY POVERTY IN TENNESSEE

V.A. The Regressive Burden of Energy Costs

V.A.1. The Energy Burden Defined

The "energy burden" is defined as the percentage of gross annual household income that is used to pay annual energy bills.[72] It is a widely used and accepted term and is officially defined in the *Code of Federal Regulations* and in numerous federal and state documents.[73] Energy burden is an important statistic widely used by policy-makers in assessing the need for energy assistance and can be defined broadly as the burden placed on household incomes by the cost of energy, or more simply, the ratio of energy expenditures to household income.[74]

The energy burden concept is used to compare energy expenditures among households and groups of households, and it is often used in the Low Income Home Energy Assistance Program (LIHEAP) and similar programs to estimate required payments. For example, consider the case where one household has an energy bill of $1,000 and an income of $10,000 and a second household has an energy bill of $1,200 and an income of $24,000. While the first household has a lower energy bill ($1,000 for the first household compared to $1,200 for the second), the first household has a much higher energy burden (10 percent of income for the first household compared to five percent of income for the second).

The energy burdens of low-income households are much higher than those of higher-income families, and energy burden is a function of income and energy expenditures. Since residential energy expenditures increase more slowly than income, lower income households have higher energy burdens. High burden households are those with the lowest incomes and highest energy expenditures. As shown in Figure V-1:

- Families earning more than $50,000 per year spent only four percent of their income to pay energy-related expenses.
- Families earning between $10,000 and $25,000 per year (29 percent of the U.S. population) spent 13 percent of income on energy.

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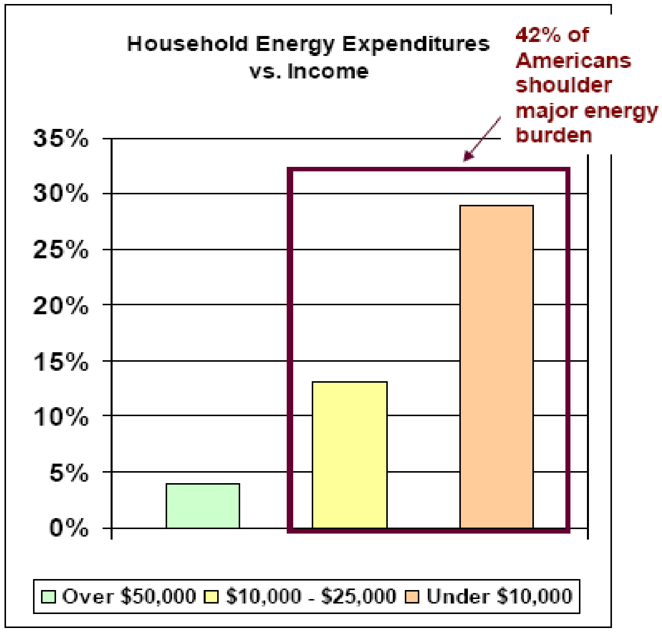
[72]The individual household energy burden is calculated for each household and then averaged within income/origin categories. See the discussion in Applied Public Policy Research Institute for Study and Evaluation, *LIHEAP Energy Burden Evaluation Study*, report prepared for the Office of Community Services, U.S. Department of Health and Human Services, July 2005.

[73]The CFR defines the residential energy burden as residential expenditures divided by the annual income of that household. See 10 CFR 440.3 - Definitions. - *Code of Federal Regulations* - Title 10: Energy - PART 440.

[74]U.S. Department of Energy, *Buildings Data Energy Book*, 2.9.2., "Energy Burden Definitions," March 2011.

- Those earning less than $10,000 per year (13 percent of population) spent 29 percent of income on energy costs.

Figure V-1



Source: American Association of Blacks in Energy.

Thus, for 42 percent of households – mostly senior citizens, single parents, and minorities – increased energy costs force hard decisions about what bills to pay: Housing, food, education, health care, and other necessities.[75] Cost increases for any basic necessity are regressive in nature, since expenditures for essentials such as energy consume larger shares of the budgets of low-income families than they do for those of higher-income families. Whereas higher-income families may be able to trade off luxury goods in order to afford the higher cost of consuming a necessity such as energy, low-income families will always be forced to trade off other necessities to afford the higher-cost good.

When families with income constraints are faced with rising costs of essential energy, they are increasingly forced to choose between paying for that energy use and other necessities (also often energy-sensitive) such as food, housing, or health care. Because all of these expenditures are necessities, families who must make such choices face sharply diminished standards of living. For example, of the 8.7 million American households earning less $10,000 per year in 2008, 60 percent of the average after-tax income was used to meet those households' energy needs. Among the highest earners, the 56 million households making more than $50,000 per year, only 10

[75]This is a national average, and the impacts vary by state. The specific Tennessee impacts are discussed in VI.D.

percent of the average after-tax income was spent on those households' energy needs. The national average for energy costs as a percentage of household income is in the range of about 10 - 12 percent.

V.A.2. The Regressive Nature of Energy Costs

Table V-1 shows that households in the lowest-income classes spend the largest shares of their disposable income to meet their energy needs. For example, for the nine million American households earning less $10,000 per year in 2013, more than 75 percent of their average after-tax income was used to meet those households' energy needs – and more than 1/3 of their income just for residential energy. Among the highest earners, the 56 million households making more than $50,000 per year, less than nine percent of the average after-tax income was spent on energy needs, and only three percent on residential energy. The national average for energy costs as a percentage of household income was 11.1 percent, and 4.1 percent for residential energy.[76]

Table V-1
Estimated U.S. Household Energy Expenditures as a Percentage of Income, 2013

Pre-tax Income	<$10K	$10K - $30K	$30K - $50K	>$50K	Average
Percent of households	7.6 percent	22.9 percent	19.4 percent	50.1 percent	
Residential energy	1,622	1,719	1,937	2,568	2,117
Transportation fuel	1,991	2,473	3,497	4,668	3,730
Total energy	3,613	4,192	5,434	7,256	5,907
Average after-tax income	4,726	18,261	33,297	84,828	53,092
Energy percent of after-tax income	76.5 percent	23.0 percent	16.3 percent	8.6 percent	11.1 percent
Residential energy percent of after-tax income	34.3 percent	9.4 percent	5.8 percent	3.0 percent	4.1

Sources: U.S. Bureau of Labor Statistics, *Consumer Expenditure Survey*; U.S. Bureau of the Census, *Current Population Survey*; U.S. Department of Energy, *Residential Energy Consumption Survey*; U.S. Energy Information Administration, *Annual Energy Review*, *Short Term Energy Outlook*, and *Household Vehicle Energy Use: Latest and Trends*; U.S. Congressional Budget Office, *Effective Federal Tax Rates Under Current Law, 2001-2014* and *Effective Federal Tax Rates, 1979-2006*.

The portion of U.S. household incomes expended on energy costs has increased significantly over the past decade, especially for lower-income groups -- as illustrated in Figure V-2. Energy costs as a percentage of after-tax income increased 85 percent between 2001 and 2013, from a national average of 6.0 percent to 11.1 percent – and for residential energy 40 percent, from less than three percent to 4.1 percent. However, this figure indicates that the increases for different income groups varied widely:

[76]U.S. Census Bureau and U.S. Energy information Administration, 2013.

- For households earning less than $10,000 per year, the percent of their after-tax income consumed by energy costs more than doubled, increasing from 36 percent to 77 percent – and for residential energy by more than 50 percent.
- For households earning between $10,000 and $30,000 per year, the percent of their after-tax income consumed by energy costs increased from 14 percent to 23 percent – and for residential energy by more than 40 percent to 9.4 percent of income.
- For households earning between $30,000 and $50,000 per year, the percent of their after-tax income consumed by energy costs increased from 10 percent to 16.3 percent – but to only 5.8 percent of income for residential energy.
- For households earning more than $50,000 per year, the percent of their after-tax income consumed by energy costs increased from five percent to 8.6 percent – but to only three percent of income for residential energy.

Thus, in 2013 the poorest households were paying, in percentage terms, nearly nine times as much for energy as the most affluent households – and more than 11 times as much for residential energy.[77] Even households earning between $10,000 and $30,000 per year were paying in percentage terms, nearly three times as much for energy as the most affluent households – and more than three times as much for residential energy.

Thus, energy costs as a percentage of annual after-tax income have increased significantly for household incomes under $50,000:

- Nearly 50 percent of U.S. households earn less than $50,000 per year, and they spend 20 percent or more of their income on energy – and more than eight percent on residential energy
- U.S. households earning less than $10,000 per year spend more than ¾ or more of their income on energy – and over 1/3 on residential energy

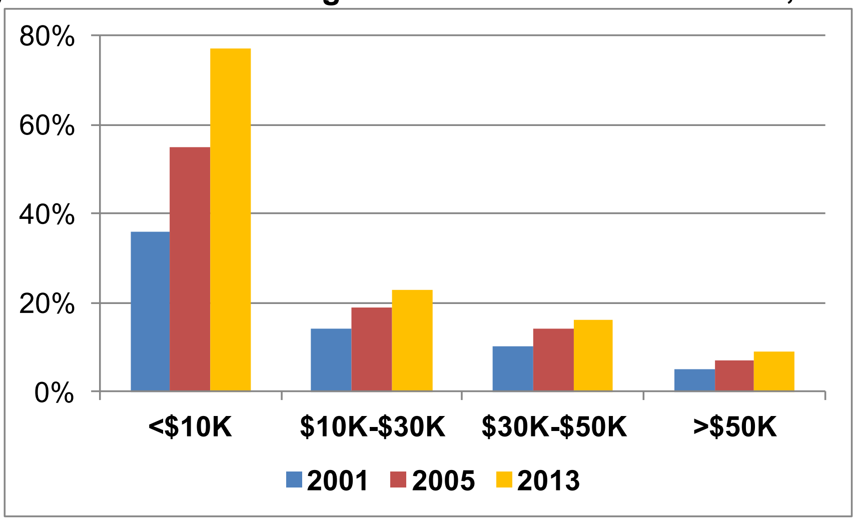
Table V-2 shows the average annual household expenditures for U.S. households earning $50,000 or less. Note that these households:

- Spend more on energy than on food
- Spend twice as much on energy than on healthcare
- Spend more than twice as much on energy as on clothing
- Spend more on energy than on anything else, except housing

[77]Many lower-income families qualify for federal or state energy assistance. However, these programs have been unable to keep up with the increase in household energy costs. In FY 2011, federal funding for the Low Income Home Energy Assistance Program (LIHEAP) was cut from $5.1 billion to $4.7 billion. In FY 2012, Congress again reduced annual funding for LIHEAP to $3.5 billion. Based on EIA's 2009 *Residential Energy Consumption Survey*, a $3.5 billion funding level for LIHEAP would offset less than six percent of residential energy bills for lower-income households with incomes below $30,000.

- Spend more than 1/4 of their income on housing – nearly 40 percent on housing if utilities are included.
- Have little discretionary income, and thus increased energy costs will displace spending on health, food, clothing, housing, and other necessities.

Figure V-2
Energy Costs as a Percentage of Annual After-Tax Income, 2001-2013



Source: Same as Table V-1.

Table V-2
Average Annual Household Expenditures, 2009

Pre-tax annual income (average)	$50,000 or Less	% of Total Expenditures
After-tax income (average)	$36,218	--
Clothing	$1,340	3.7%
Energy – residential & transportation	$5,396	14.9%
Healthcare	$2,861	7.9%
Food	$5,287	14.6%
Housing (ex. utilities)	$10,395	28.7%
Transportation (ex. fuel)	$5,179	14.3%
Entertainment	$1,920	5.3%
Insurance and pensions	$1,956	5.4%
Education and reading	$507	1.4%
Tobacco and alcohol	$761	2.1%
All other	$616	1.7%
Total expenditures	$36,218	100%

Source: U.S. Bureau of Labor Statistics, *Consumer Expenditure Survey 2009*, October 2010.

V.B. Impacts and Effects

High and Increasing energy prices have a detrimental effect on the lives of those with limited incomes, and they suffer from home energy arrearages and shut-offs, cutbacks on necessities and other items, risks to health and safety, and housing instability.[78] For example, in recent years, 15 – 20 million U.S households have been in arrears on their home energy bills, and more than 15 percent of all households were at least 30 days delinquent.[79] Unpaid utility bills harm home both energy suppliers and low-income families. For example, in 2008, suppliers were experiencing a loss of nearly $5 billion in unpaid household bills, costs that they pass on to other consumers.[80] Families unable to pay their bills face utility shut-offs that deprive them of the basics of living such as heating, cooling, lights, refrigeration, and the ability to cook food. A survey conducted by the Energy Programs Consortium (EPC) found that eight percent of low-income respondents (defined as those living at 150 percent of the federal poverty level) experienced a utility shut-off during the past year due to rising home energy and gasoline costs.[81]

In addition to experiencing threats of disruption to their energy services, low-income families are often forced to limit the amount of money they spend on necessities and other important items in order to help manage their energy costs. Of particular concern are reduced purchases of food. According to the EPC survey, 70 percent of those living at or below 150 percent of poverty reported that they were buying less food in response to increases in home energy and gasoline costs. Further, families that are slightly above this poverty marker (151 percent to 250 percent of poverty) and families across all other income levels also reported spending less on food -- although they were affected to a lesser degree than the lowest-income families. Thirty-one percent of the poorest families indicated that they purchased less medicine due to high energy costs.[82] They changed plans for education (19 percent), fell behind on credit card bills (18 percent), and reduced their contributions to savings (58 percent) -- Table V-3.[83] Thus, Americans of all income levels suffer financially from high energy costs, but those at the bottom of the economic spectrum are under the greatest strain – and those families at or below 150 percent of poverty are the most affected by increased energy prices.[84]

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[78]Joy Moses, *Generating Heat Around the Goal of Making Home Energy Affordable to Low Income Americans: Current Challenges and Proposed Solutions*, Center for American Progress, Washington, D.C., December 2008.
[79]National Energy Assistance Directors' Association, "NEADA Press Release: Consumers Continue to Fall Behind on Utility Bills, Arrearages Approach $5 billion, Up 14.8 percent From Last Year," May 2008.
[80]Ibid.
[81]Energy Programs Consortium and National Energy Assistance Directors' Association, "2008 Energy Costs Survey," June 2008.
[82]Ibid.
[83]Ibid.
[84]The energy burdens in the third world – and for many Native Americans -- are much higher and the implications of high energy prices more severe; see, for example, Gautam N. Yadama, *Fires, Fuel and the Fate of 3 Billion: The State of the Energy Impoverished*, Oxford University Press, 2013.

Table V-3
Actions Taken by U.S. Households as a Result of High Energy Prices

Actions taken	All respondents	≤150% of poverty	151%-250% of poverty
Reduced purchases of food	43%	70%	51%
Reduced purchases of medicine	18%	31%	23%
Changed plans for education or children's education	11%	19%	18%
Behind on credit card bills	11%	18%	15%
Reduced amount of money put into savings	55%	58%	58%

Source: 2008 Energy Costs Survey (NEADA).

V.C. The Health and Safety Benefits of Affordable, Reliable Energy

V.C.1. Health Risks

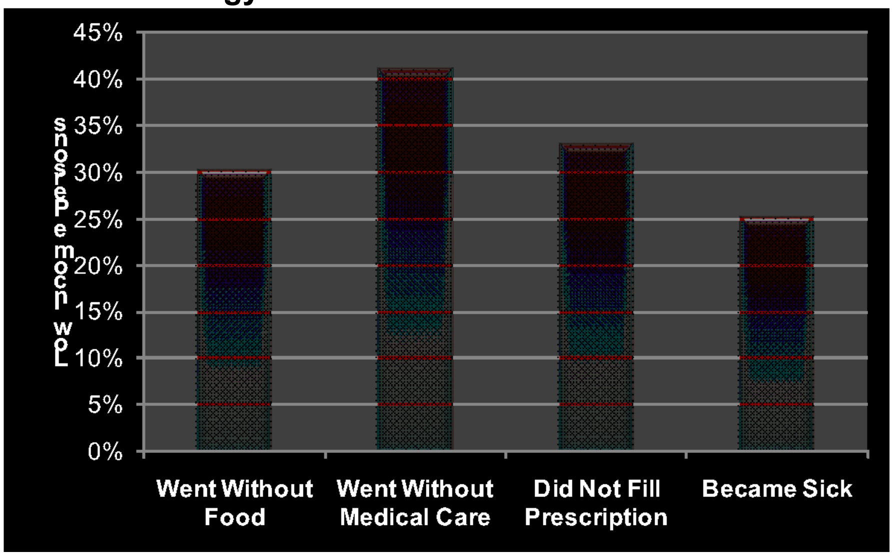
A major impact of restricting coal power generation will be to significantly increase U.S. electricity costs and rates. This will make electricity more expensive and less affordable, especially for those with limited incomes, and being unable to afford energy bills can be harmful to one's health – as illustrated in Figure V-3. Many people are forced to purchase less medicine when their utility bills increase. Other health hazards can occur if inside temperatures are too low or too high as a result of shut-offs or efforts to lower bills by reducing the use of heating and cooling equipment. Surveys have found that nearly one-third of households with incomes at or below 150 percent of poverty kept their homes at a temperature that was unsafe or unhealthy at some point during the year. Similarly, so also did 24 percent of those between 151 percent and 250 percent of poverty.[85]

Temperature extremes can be damaging to vulnerable populations, including the elderly, the disabled, and small children. These groups are particularly susceptible to hypothermia (cold stress or low body temperatures) and hyperthermia (heat stress or high body temperatures), conditions that can cause illness or death.[86] Young children are particularly at risk from extreme temperatures because their small size makes it difficult for them to maintain body heat.[87] Small children in households that are struggling to afford energy costs are more likely to be in poor health, have a history of hospitalizations, be at risk for developmental problems, and be food insecure. Compared with families receiving energy assistance, families who are eligible for such

[85]Energy Programs Consortium and National Energy Assistance Directors' Association, "2008 Energy Costs Survey," June 2008.
[86]U.S. Department of Health and Human Services, "Tips for Health and Safety," available at www.acf.hhs.gov/programs/ocs/liheap/consumer_info/health.html.
[87]Children's Sentinel Nutrition Assessment Program and Citizens Energy Corporation, "Fuel for Our Future: Impacts of Energy Insecurity on Children's Health, Nutrition, and Learning," September 2007.

benefits but not receiving them are more likely to have underweight babies and 32 percent more likely to have their children admitted to the hospital.[88]

Figure V-3
Potential Health Impacts of Increased Energy Costs on Low Income Persons



Source: National Energy Assistance Directors' Association.

High energy burdens among older, low-and moderate-income households, expose them to the risks of going without adequate heating or cooling, frequently resulting in adverse health and safety outcomes, including premature death. Unaffordable home energy undermines state and national priorities for seniors to age in place and avoid institutional care.[89] Households at the lowest income level are often on a fixed income from Social Security, disability, or retirement. When energy prices escalate, their incomes do not keep pace, and they have little flexibility in their budgets to address increases in energy costs.[90]

Further, the job losses and price increases resulting from the increased energy costs will reduce incomes as firms, households, and governments spend more of their budgets on electricity and less on other items, such as home goods and services. The loss of disposable income also reduces the amount families can spend on critical health care, especially among the poorest and least healthy.[91]

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[88] Ibid.
[89] "Home Energy Costs: The New Threat to Independent Living for the Nation's Low-Income Elderly," *Journal of Poverty Law and Policy*, January-February 2008.
[90] Ibid.
[91] Randall Lutter and John F. Morrall. "Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation", *Journal of Risk and Uncertainty*, 8 (1), 43-66 (1994); Ralph L. Keeney, "Mortality Risks Induced by Economic Expenditures", *Risk Analysis* 10(1), 147-159 (1990); Krister Hjalte et al. (2003). "Health -- Health Analysis -- an Alternative Method For Economic Appraisal of Health Policy and Safety

More generally, a substantial body of literature has developed examining the potential impacts of energy and environmental regulations on GDP, energy prices, income, and employment. It has been estimated, for example, that initiatives requiring expanded use of high cost energy alternatives such as natural gas and renewables would increase the cost of energy to the point that per-capita income and employment rates would decrease in a quantitatively predictable manner. Assuming these estimates to be approximately correct, and given the epidemiological findings on socioeconomic status and health, it follows that policies such as carbon restrictions would bring about a net increase in population mortality.[92] Thus, a major impact of restricting the use of coal and other fossil fuels will be to increase U.S. mortality rates.

Socioeconomic-status findings demonstrate that changes in the economic status of individuals produce subsequent changes in the health and life spans of those individuals. Research shows that decreased real income per capita and increased unemployment have consequences that lead to increased mortality in U.S. and European populations. The research uses econometric analyses of time-series data to measure the relationship between changes in the economy and changes in health outcomes. Studies have found that declines in real income per capita and increases in unemployment led to elevated mortality rates over a subsequent period of six years. For example, a 1984 study by the Joint Economic Committee of the U.S. Congress found that a one-percentage-point increase in the unemployment rate (e.g., from five percent to six percent) would lead to a two percent increase in the age-adjusted mortality rate.[93] The growth of real income per capita also showed a significant correlation to decreases in mortality rates (except for suicide and homicide), mental hospitalization, and property crimes.[94] The European Commission has supported similar research showing comparable results throughout the European Union.[95]

Upward trends in real income per capita represented the most important factor in decreased U.S. mortality rates over the past half-century. Also, the unemployment rate continued to bear a significant correlation to increased mortality rates, such that an increase of one percent in the unemployment rate eventuates in an approximately two percent increase in the age-adjusted mortality rate, estimated cumulatively over at least the subsequent decade.[96]

Regulation: Some Empirical Swedish Estimates," *Accident Analysis & Prevention* 35(1), 37-46; W. Kip Viscusi "Risk-Risk Analysis," *Journal of Risk and Uncertainty* 8(1), 5-17 (1994); see also Viscusi and Richard J. Zeckhauser, "The Fatality and Injury Costs of Expenditures", *Journal of Risk and Uncertainty* 8(1), 19-41 (1994).

[92] Harvey Brenner, "Health Benefits of Low-Cost Energy: An Econometric Study," *Environmental Management*, November 2005, pp 28 – 33.

[93] Harvey Brenner, *Estimating the Effects of Economic Change on National Health and Social Well-Being*; Joint Economic Committee, U.S. Congress: Washington, DC, 1984.

[94] Ibid.

[95] See Harvey Brenner, *Estimating the Social Cost of Unemployment and Employment Policies in the European Union and the United States*; European Commission Dir.-Gen. for Employment, Industrial Relations, and Social Affairs: Luxembourg, 2000; Harvey Brenner, *Unemployment and Public Health in Countries of the European Union*; European Commission Dir.-Gen. for Employment, Industrial Relations, and Social Affairs: Luxembourg, 2003.

[96] "Health Benefits of Low-Cost Energy: An Econometric Study," op. cit.

Being unable to afford energy bills can thus be harmful to one's health. As indicated above, some people purchase less medicine when their utility bills are too high. Other health hazards can occur if inside temperatures are too low or too high as a result of shut-offs or efforts to lower bills by reducing the use of heating and cooling equipment. Thirty-one percent of households with incomes at or below 150 percent of poverty kept their homes at a temperature that they thought was unsafe or unhealthy at some point during the year. Similarly, so also did 24 percent of those between 151 percent and 250 percent of poverty.[97]

Further, there are substantial health benefits of temperature control in warmer climates, and studies have analyzed the effect of temperature on mortality and morbidity and documented the effectiveness of air conditioners (ACs) as a mitigation strategy. For example, a recent study investigated the association between temperature and hospital admissions in California from 1999 to 2005 and also determined whether AC ownership and usage, assessed at the zip-code level, mitigated this association.[98] It found that ownership and usage of ACs significantly reduced the effects of temperature on adverse health outcomes, after controlling for potential confounding by family income and other socioeconomic factors. These results demonstrate important effects of temperature on public health and the potential for mitigation. That is, the research found significant associations between heat and several disease-specific hospital admissions in California, and concluded that the use of central AC significantly reduces the risk from higher temperatures. Thus, higher electricity costs that limit or prohibit the use of AC can be hazardous to one's health.

EPA has acknowledged that "People's wealth and health status, as measured by mortality, morbidity, and other metrics, are positively correlated. Hence, those who bear a regulation's compliance costs may also suffer a decline in their health status, and if the costs are large enough, these increased risks might be greater than the direct risk-reduction benefits of the regulation."[99] In addition to EPA, the Office of Management and Budget, the Food and Drug Administration, and the Occupational Safety and Health Administration use similar methodology to assess the degree to which their regulations induce premature death amongst those who bear the costs of federal mandates.[100] Further, OMB Circular A-4, which provides the procedures for federal regulatory impact analysis and benefit-cost analysis, states "the benefits of a regulation that reduces

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[97]Ibid.

[98]This study used temperature data during the warm season in California to estimate the impact on several disease-specific categories of hospitalizations. To limit exposure misclassification, the authors limited the study to buffer areas with individuals living in zip codes within 25 kilometers of a temperature monitor. They quantified the likely reduction in health impacts based on both ownership and use of ACs using individual-level data for each buffer, and examined the potential confounding effect that local measures of family income may have on their effect estimates. See Bart Ostro, Stephen Rauch, Rochelle Green, Brian Malig, and Rupa Basu, "The Effects of Temperature and Use of Air Conditioning on Hospitalizations," *American Journal of Epidemiology*, October 2010.

[99]U.S. Environmental Protection Agency, "On the Relevance of Risk-Risk Analysis to Policy Evaluation," August 16, 1995.

[100]Ibid.

emissions of air pollution might be quantified in terms of the number of premature deaths avoided each year; the number of prevented nonfatal illnesses and hospitalizations."[101]

V.C.2. Safety Risks

High energy prices also compromise the safety of low-income households. For example, the inability to pay utility bills often leads to the use of risky alternatives. In a survey of energy assistance recipients, eight percent of respondents indicated that at some point in the previous year they were unable to use a main heating source such as heating oil or propane because they could not pay for the delivery.[102] Six percent indicated that a utility company had shut off their main heating sources of natural gas or electricity during the previous year due to nonpayment.[103]

When households are cut off from their main heating source – such as natural gas, propane, or fuel oil, or are trying to save money by reducing use of a main heating source, they most commonly turn to heating alternatives such as electric space heaters. According to the National Fire Protection Agency, these devices are associated with a significant risk of fire, injury, and death. In 2005, space heaters accounted for 32 percent of home heating fires, totaling 19,904 fires and 73 percent of home heating fire deaths, which killed 489 people.[104] Researchers at the Johns Hopkins School of Medicine also noted this problem in a 2005 study in which they found that utility terminations were associated with a significant subset of fires involving children -- 15 percent of fires that brought patients to their hospital were rooted in utility shut-offs.[105]

V.C.3. Housing Instability

Families and individuals who cannot afford their energy bills are at risk of housing instability. They may have to move to locations with lower utility costs, or shut-offs can make homes uninhabitable, forcing household members into homelessness or alternative forms of shelter. Often, unaffordable housing compounds this problem as families experiencing difficulty paying mortgages or rent fall further behind due to energy bills that represent a higher-than-normal percentage of their income. This factor was particularly relevant during the recent subprime mortgage crisis, which resulted in excessively high mortgage payments for some families.

The connections between unmanageable home energy costs and homelessness have been well documented. For example, a Colorado study found that 16 percent of

[101] U.S. Office of Management and Budget, "Regulatory Impact Analysis: A Primer," Circular A-4, 1993.
[102] National Energy Assistance Directors' Association, "2005 National Energy Assistance Survey," September 2005.
[103] Ibid.
[104] National Fire Protection Association, "U.S. Home Heating Equipment Fires Fact Sheet," 2007.
[105] Johns Hopkins School of Medicine, "Burn Injuries and Deaths of Children Associated with Power Shut-offs," April 2005.

homeless people in the state cited their inability to pay utility bills as one of the causes of their homelessness.[106] A nationwide survey of individuals receiving energy assistance produced further evidence of this phenomenon. Twenty-five percent reported that within the previous five years, they had failed to make a full rent or mortgage payment due to their energy bills.[107] Difficulties with paying utilities resulted in other negative outcomes such as evictions (two percent of respondents), moving in with friends or family members (four percent of respondents), and moving into a shelter or homelessness (two percent).[108]

Housing instability disrupts lives, especially if individuals are forced to move between several different locations before regaining permanent housing. Household members may find themselves at a greater distance from work and/or school and face increased transportation costs and challenges. They can also be disconnected from familiar communities, neighbors, family members, and friends. For children, the outcomes can be devastating, with homelessness being associated with increased risk of physical illness, hunger, emotional and behavioral problems, developmental delays, negative educational outcomes, and exposure to violence.[109]

V.C.4. Energy-Related Risks to the Elderly

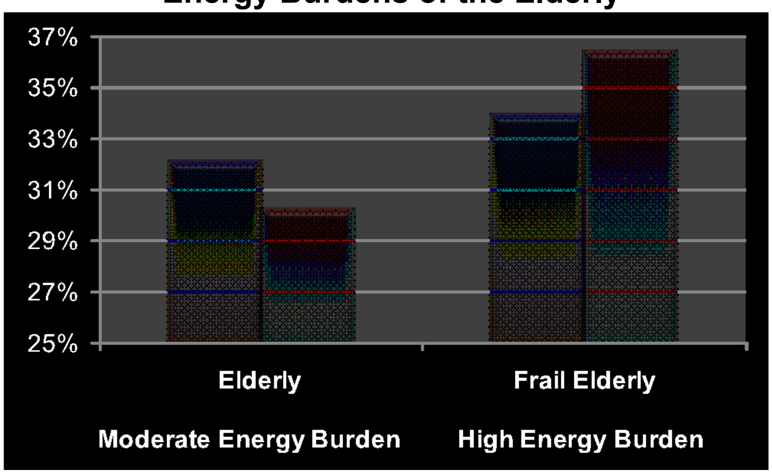
Between 2010 and 2050, the U.S. will experience rapid growth in its older population, and in 2050 the number of Americans aged 65 and older is forecast to be 88.5 million -- more than double its population of 40.2 million in 2010.[110] The baby boomers are largely responsible for this increase in the older population, as they began crossing into this category in 2011.[111] The aging of the population will have wide-ranging implications for the country,[112] and senior citizens are particularly vulnerable to energy price increases due to their relatively low incomes. The average basic Social Security retirement benefit is currently about $15,200.[113] The median gross income of senior households over 65 years is currently about $31,400, and seniors have the highest per capita residential energy consumption among all age categories.[114] For

[106]The Colorado Statewide Homeless Count, "Colorado Statewide Homeless Count, Summer 2006: Final Report," February 2007.
[107]National Energy Assistance Directors' Association, "2005 National Energy Assistance Survey," September 2005.
[108]Ibid.
[109]The National Center on Family Homelessness, "The Characteristics and Needs of Families Experiencing Homelessness," April 2008.
[110]See U.S. Census Bureau, *The Next Four Decades: The Older Population in the United States: 2010 to 2050*, May 2010. Here, the "older population" refers to those aged 65 and older.
[111]The baby boomer generation consists of people born between 1946 and 1964.
[112]Projecting the size and structure, in terms of age, sex, race, and Hispanic origin, of the older population is important to public and private interests, both socially and economically. The projected growth of the older population in the U.S. will present challenges to policy makers and programs, such as Social Security and Medicare, and it will also affect families, businesses, and health care providers.
[113]U.S. Social Security Administration, "Monthly Statistical Snapshot," August 2013, September 2013.
[114]U.S. Census Bureau, "American Community Survey – 2010 American Community Survey 1-Year Estimates," (2012).

many senior households, as with other households earning less than $50,000 annually, energy price increases can force difficult choices among energy, food, and other basic necessities of life, choices that would be made more difficult by higher energy costs resulting from restrictions on fossil fuels.

Older consumers with the lowest incomes will experience the greatest cost burdens: 35 percent of older households have total household incomes of less than $20,000, and they will experience the greatest energy burden. Although consumption data show that low-income older consumers tend to use less heating fuel than higher-income groups, higher winter heating costs are likely to be a greater burden on this group than on higher-income older consumers who have greater financial resources available to meet the increased costs. As shown in Figure V-4, large percentages of the elderly have high energy burdens, and nearly 34 percent of the elderly and more than 36 percent of the frail elderly have high energy burdens

Figure V-4
Energy Burdens of the Elderly



Source: Division of Energy Assistance, U.S. Department of Health and Human Services.

Low income senior citizens dependent primarily on retirement income have especially high energy burdens: About 45 percent of such individuals have high energy burdens, as compared to about 36 percent of all low income persons.[115] Thus, the greatest burdens of increased energy costs will fall on households of elderly Social Security recipients – 20 percent of all households -- who depend mainly on fixed incomes, with limited opportunity to increase earnings from employment. These households have an average Social Security income of about $15,000.

[115] APPRISE, "LIHEAP Energy Burden Evaluation Study Final Report," Prepared for Division of Energy Assistance, Office of Community Services, Administration for Children and Families, U.S. Department of Health and Human Services, PSC Order No. 03Y00471301D, July 2005.

Elderly individuals with low average annual incomes are more vulnerable to increasing energy costs even if their energy consumption levels are below those for households with similar annual incomes. Unlike young working families with the potential to increase incomes by taking on part-time work or increasing overtime, fixed income seniors are largely limited to cost-of-living increases that often do not keep pace with rising energy prices. Maintaining affordable energy costs is critical to the wellbeing of millions of the nation's elderly citizens.

For many senior households energy price increases represent a serious financial burden -- for example, the elderly relying on SSI spend nearly 20 percent of their incomes on utility bills. The diversion of increased shares of family incomes to energy costs implied by higher electricity bills will reduce available funds for other necessities, such as housing and healthcare, and diminish quality of life and the ability to save and invest for future needs.

The low-income elderly are particularly susceptible to weather-related illness, and a high energy burden can represent a life-threatening challenge. Given their susceptibility to temperature-related illnesses, elderly households tend to require more energy to keep their homes at a reasonable comfort level. However, despite this requirement, low-income elderly households spend 16 percent less on residential energy than all households. Higher utility bills would place many elderly households at serious risk by forcing them to heat and cool their homes at levels that are inadequate for maintenance of health. Finally, senior homeowners may be forced to sell their homes because they cannot afford their energy bills.

Elderly Americans' limited budgets are stretched even further by higher health care expenditures. Medical spending for those between the ages of 55 and 64 is almost twice the amount spent by those between the ages of 35 and 44, and the health care expenditures of those 65 and older are even larger. Health care costs have contributed to the rise in bankruptcy filings among the elderly. More serious, being unable to afford home energy can be harmful to the health of household members, and many persons are forced to purchase less medicine and health care when their utility bills are too high. A 2009 survey of low-income seniors[116] found that due to energy costs:

- 41 percent were forced to defer or forgo medical or dental care
- 33 percent were unable to afford their prescriptions
- 22 percent were unable to pay their energy bills due to medical expenses
- Nearly 30 percent became ill because their home was too cold or too hot
- 33 percent went without food for at least one day.

For the elderly, the impact of higher energy costs on food expenditures is an especially serious problem. Nearly 18 percent of low-income elderly (with incomes below 130 percent of the poverty line) who live with others are food insecure, as are more than 12 percent of low-income seniors who live alone. And although 65 percent of

[116] Jackie Berger, "2009 National Energy Assistance Survey," prepared for NEADA by APPRISE, June 15, 2010.

individuals who are eligible for food stamps receive benefits, the participation rate among the elderly is much lower at only 30 to 40 percent.[117]

Other health hazards can occur if inside temperatures are too low or too high as a result of shut-offs or household member efforts to lower bills by reducing their use of heating and cooling sources. Thirty-one percent of households with incomes at or below 150 percent of poverty kept their homes at a temperature that they thought was unsafe or unhealthy at some point during the past year. Similarly, so also did 24 percent of those between 151 percent to 250 percent of the poverty level.[118]

These temperature extremes can be dangerous to the elderly, who are particularly susceptible to hypothermia (cold stress or low body temperatures) and hyperthermia (heat stress or high body temperatures), conditions that can cause illness or death.[119] Of the approximately 600 people who die from hypothermia each year, half are typically 65 or older,[120] and this group accounts for 44 percent of those who die from weather-related heat exposure.[121] Senior citizens are at increased risk for these conditions because they do not adjust well to sudden changes in temperature and are more likely to have medical conditions or take medications that impair the body's response to hot and cold temperatures.[122] Thus, increased utility costs have serious implications for the health of many senior citizens.

V.D. Tennessee-Specific Impacts

While Tennessee has multiple Class I areas, it is not a wealthy state; for example:[123]

- Tennessee is the seventh poorest state in U.S. – Figure V-5.
- Tennessee is growing in population,[124] but it is a relatively poor state and its citizens are vulnerable to higher electricity prices – Figure V-6.

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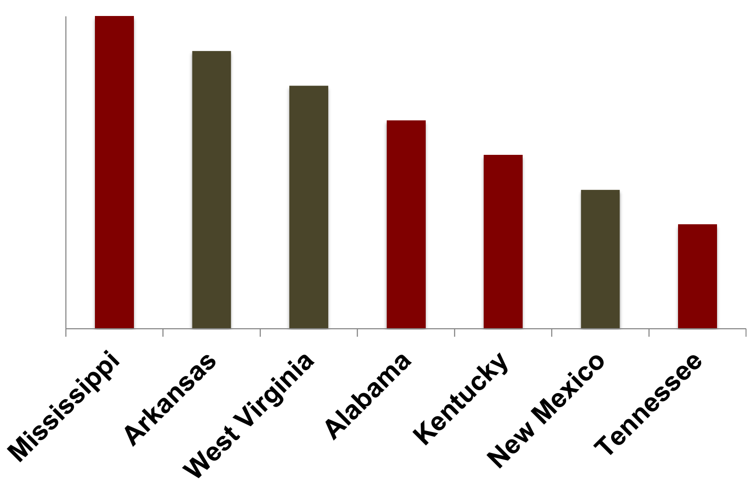
[117]Hawthorne, op. cit.
[118]Energy Programs Consortium and National Energy Assistance Directors' Association, "2008 Energy Costs Survey," June 2008.
[119]U.S. Department of Health and Human Services, "Tips for Health and Safety," available at www.acf.hhs.gov/programs/ocs/liheap/consumer_info/health.html.
[120]National Institutes of Health, "Staying Warm in the Winter Can Be a Matter of Life and Death for Older People," *NIH News*, January 2005.
[121]Centers for Disease Control, "Heat-Related Illnesses, Deaths, and Risk Factors -- Cincinnati and Dayton, Ohio, 1999, and United States, 1979-1997," *MMWR Weekly*, June 2, 2000.
[122]National Institutes of Health, "Staying Warm"; Centers for Disease Control, "Extreme Heat Fact Sheet" (August 2004).
[123]Sources include U.S. Census Bureau, "Tennessee Selected Economic Characteristics: 2012," 2013; U.S. Census Bureau www.census.gov/hhes/www/cpstables/032013/pov; U.S. Census Bureau, "American Fact Finder;" "Tennessee LIHEAP Facts," Campaign for Home Energy Assistance, 2013; *Poverty USA, 2013*; Kaiser Family Foundation; U.S. Department of Agriculture; U. S. Energy Information Administration; and U. S. Congressional Budget Office.
[124]Tennessee's population is forecast to increase from 6,468,000 in 2012 to 6,957,000 in 2020; see http://health.state.tn.us/statistics/PdfFiles/PopulationProj2010-2012.pdf.

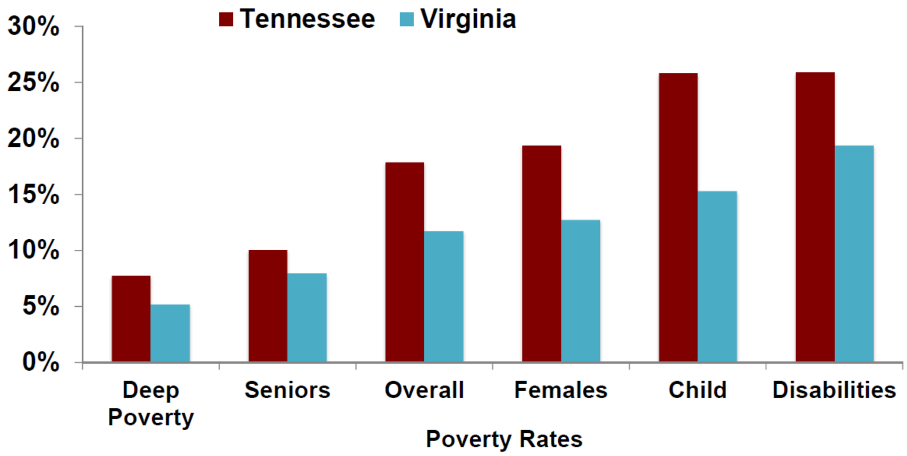
- Tennessee per capita income is 17 percent below the U.S. average, and the gap has widened since the Great Recession – Figure V-7.
- 57 percent of Tennessee families have gross annual incomes of $50,000 or less, with an average after-tax income of $23,700 -- less than $2,000 per month.
- In Tennessee: 120,000 seniors live in poverty, over 400,000 children live in poverty, there are over 660,000 homes on food stamps, and there are nearly 770,000 families living in poverty – Figure V-8.
- Tennessee household income is 20 percent below the U.S. average.
- The median value of owner-occupied houses in the state is one-third less than the U.S. average.
- Nearly one-fifth of Tennesseans live in poverty – 1.25 million.
- In Tennessee, 38 percent of Blacks are impoverished and 35 percent of Hispanics are impoverished.
- The poverty level for children under 18 is 26 percent, and over 400,000 Tennessee children are impoverished – Figure V-8.
- Tennessee has nearly 800,000 households of Social Security recipients
- Nearly one-third of households in Tennessee receive Social Security, and these recipients have an average annual household Social Security income of about $16,700.

Figure V-5
The Poorest U.S. States



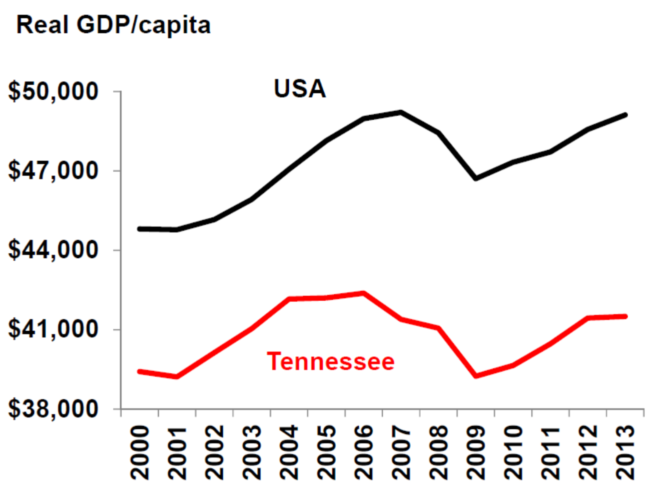
Source: 24/7 Wall St, September 2013; *Nashville Scene*, February 23, 2012

Figure V-6
Relative Poverty in Tennessee



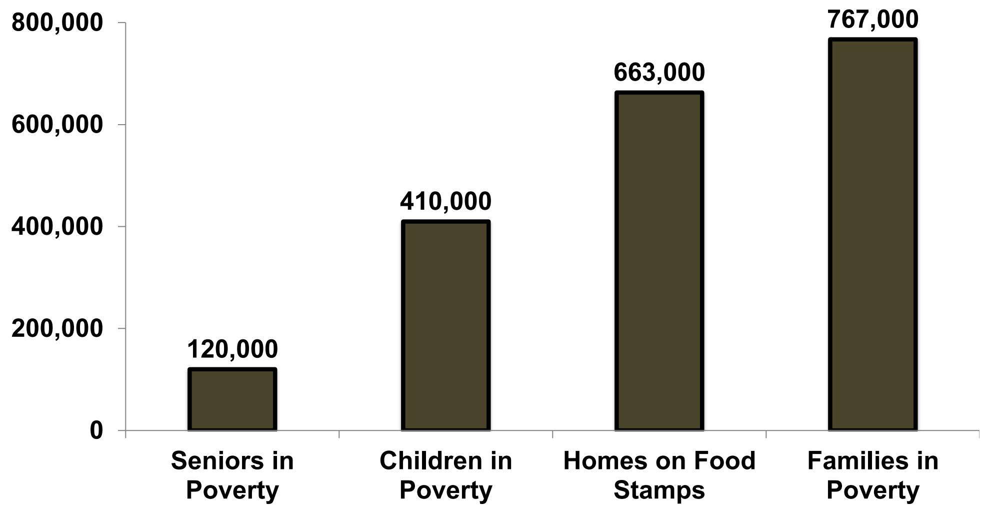
Source: *Poverty USA, 2013.*

Figure V-7
Per Capita GDP in the U.S. and Tennessee



Source: U.S. Bureau of Economic Analysis.

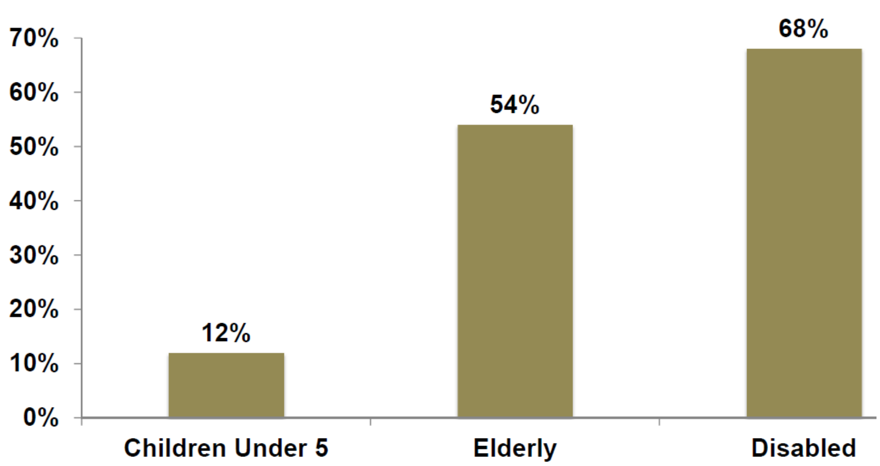
Figure V-8
Tennessee Poverty Indicators



Sources: U.S. Department of Agriculture; U.S. Census Bureau; Kaiser Family Foundation; National Center for Children in Poverty

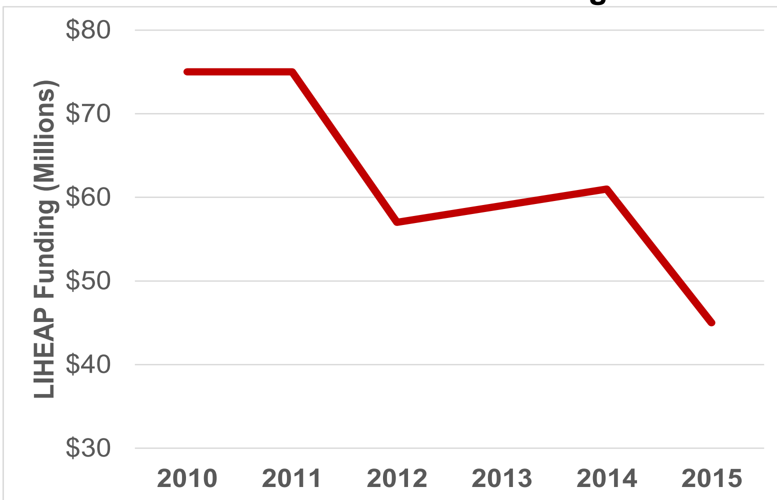
The major source of energy assistance for low income persons in the U.S. is LIHEAP. Over 700,000 Tennessee households are eligible for LIHEAP, which is about 30 percent of all households in state. However, even in the best years only one in five Tennessee households eligible for LIHEAP actually receive any assistance under the program. In the state, 12 percent of LIHEAP recipients are children under the age of five, over-half are elderly, and two-thirds are disabled – Figure V-9. Further, Tennessee LIHEAP funding has decreased 40 percent in recent years – figure V-10.

Figure V-9
Demographic Characteristics of People on LIHEAP in Tennessee



Source: *LIHEAP Facts*.

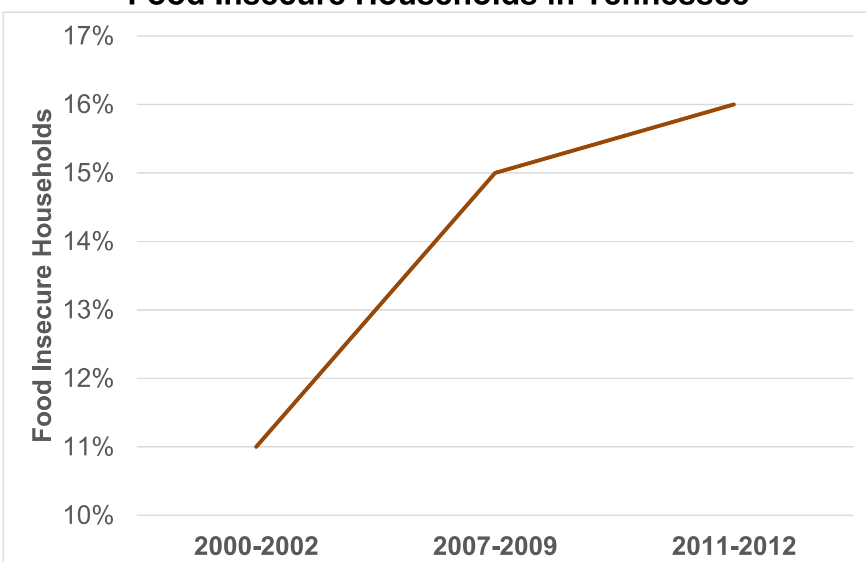
Figure V-10
Tennessee LIHEAP Funding



Source: *LIHEAP Facts*.

On average, food insecurity in Tennessee has increased 45 percent in the past decade – Figure V-11. Nearly 50 percent of those homes living in food insecurity report having to choose between paying for utilities, heating fuel, or food.

Figure V-11
Food Insecure Households in Tennessee



Source: U.S. Department of Agriculture; 2013; *Feeding America*, 2013

Table V-4 shows estimated 2012 after-tax incomes for Tennessee families in different income brackets.[125] Nearly 57 percent of Tennessee families had pre-tax incomes below $50,000 in 2012. After federal and state taxes, these families had average annual incomes of $23,374, equivalent to an average monthly take-home income of less than $2,000. In 2012, the median gross household income of Tennessee families was $42,704, 16 percent below the national median household income of $51,017.[126] The average gross income of Tennessee households was $59,547, 17 percent below the national average.

Table V-4
Tennessee Households by Pre-Tax and After-Tax Income, 2012

Pre-tax annual income:	<$10K	$10-<$30K	$30-<$50K	≥$50K	Total/avg.
Households (Mil.)	0.224	0.652	0.525	1.079	2.48
Pct. of total households	9.0%	26.3%	21.2%	43.5%	100.0%
Avg. pre-tax income	$5,925	$19,786	$39,542	$104,465	$59,547
Effec. fed tax rate %	1.0%	4.5%	10.6%	19.5%	12.0%
Est. state tax %	0.0%	0.0%	0.5%	1.0%	0.5%
Est. after-tax income	$5,866	$18,895	$35,153	$83,050	$52,077

Source: U.S. Census Bureau, U.S. Congressional Budget Office, and Tax Foundation.

As shown in Table V-5 and Figure V-12, the energy burden is already critical in Tennessee. Energy prices and stagnant incomes are straining the budgets of Tennessee families, and energy costs are consuming the incomes of Tennessee's low and middle-income families at levels comparable to other necessities such as housing, food, and health care. The share of household income spent for energy falls disproportionately on lower-and middle-income families earning less than $50,000 per year.[127] For example:

- Tennessee families spend an average of 11 percent of their after-tax incomes on energy, and four percent on residential energy.[128]
- About 1.4 million Tennessee households -- 57 percent of the total households in the state -- earn less than $50,000 annually and spend an average of 20 percent of their after-tax income on energy.

[125]The U.S. Congressional Budget Office has calculated effective total federal tax rates, including individual income taxes and payments for Social Security and other social welfare programs; see U.S. Congressional Budget Office, "Effective Federal Tax Rates Under Current Law, 2001 to 2014," August 2004. State income taxes were estimated from current Tennessee income tax rates.
[126]U.S. Census Bureau, "American Fact Finder, Tennessee Selected Economic Characteristics 2012," 2013.
[127]"Energy Cost Impacts on Tennessee Families," February 2014, www.americaspower.org.
[128]The principal residential energy expenses are for electricity and natural gas for home cooling, heating, and household appliances. Many Tennessee homes also use propane fuel and other heating sources such as wood.

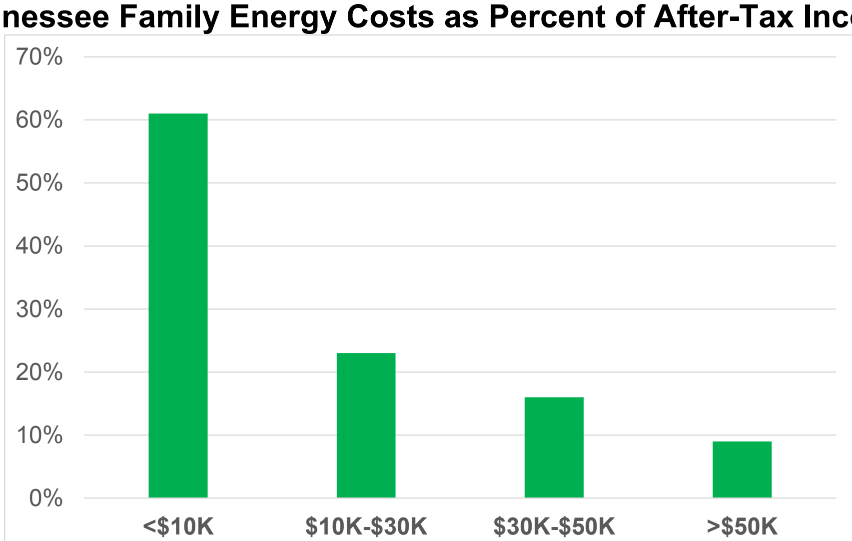
- Tennessee families with annual incomes of $10,000 to $30,000, nearly one-quarter of the state's population, spend an average of 23 percent of their after-tax family budgets on energy, and 10 percent on residential energy.
- Energy bills for the poorest households earning less than $10,000 annually consume 61 percent of family incomes, and residential energy expenditures consume 29 percent of family incomes
- For lower-income families and for 800,000 Tennessee households receiving Social Security (one-third of all Tennessee households) energy costs are especially burdensome.

Table V-5
Tennessee Household Energy Costs by Income Category

Pre-tax Income	<$10K	$10K - $30K	$30K - $50K	>$50K	Average
Residential Energy $	$1,716	$1,798	$2053	$2,779	$2281
Electric $	$1,416	$1,464	$1,699	$2272	$1,862
Natural gas $	$189	$211	$224	$323	$265
Other (LPG & wood) $	$110	$123	$130	$184	$154
Gasoline $	$1,871	$2,572	$3,490	$4,733	$3,644
Total Energy$	$3,587	$4,370	$5,543	$7512	$5,925
Energy percent of after-tax income	61%	23%	16%	6%	11%
Residential energy percent of after-tax income	29%	10%	6%	3%	4%

Source: U.S, Energy Information Administration

Figure V-12
Tennessee Family Energy Costs as Percent of After-Tax Income



Source: U.S. Energy Information Administration, U.S. Census Bureau, and U.S. Congressional Budget Office.

The large share of after-tax income devoted to energy by lower-income groups poses difficult budget choices among food, health care and other necessities. The

224,000 poorest families in Tennessee, living well below the federal poverty line and earning less than $10,000 per year, are being squeezed hardest by energy cost increases. While many lower-income consumers qualify for energy assistance, these government programs are hard pressed to keep pace with the escalation of energy prices – as noted, Tennessee's LIHEAP funding has decreased 40 percent in recent years – figure V-10. Thus, for most lower-income families and for 800,000 Tennessee households receiving Social Security – one-third of all Tennessee households – energy costs are competing with other basic necessities (such as food and medicine) for the family budget.

As discussed in Section V.C.4, energy costs have disproportionate impacts on senior citizens, and the impacts of increased energy costs are falling disproportionately on Tennessee's 820,000 households of Social Security recipients, representing 33 percent of the state's households. In 2012, Social Security recipients in Tennessee had an average household Social Security income of $16,700.[129] Unlike young working families with the potential to increase incomes by taking on part-time work or increasing overtime, many fixed income seniors are limited to cost-of-living increases that may not keep pace with energy prices. Maintaining the relative affordability of electricity and utilities is essential to the wellbeing of Tennessee's senior and lower-income citizens.

[129] U.S. Census Bureau, "Tennessee Selected Economic Characteristics: 2012," 2013.

VI. FINDINGS AND CONCLUSIONS

VI.A. Findings

The major findings derived here are summarized below.

TVA

- For the past decade, coal has provided about 50 percent of the Tennessee Valley Authority's electricity.
- Coal currently represents about 40 percent of TVA generating capacity.
- This heavy reliance on coal has helped keep TVA's electricity reliable and affordable.
- However, TVA's premature retirement of a number of coal plants will leave TVA unable to meet its reliability requirements – and these retirements may only be the beginning, since additional coal-fired retirements may result from ongoing revisions of the 2011 IRP.
- TVA and Tennessee are increasing dependency on risky natural gas -- the fuel with the most volatile prices and a questionable balance of future supply and demand.

Tennessee Electricity

- TVA and Tennessee are treading a dangerous path of increased dependency on risky natural gas -- the fuel with a history of the most volatile prices and a questionable balance of future supply and demand.
- Increased use of natural gas makes Tennessee vulnerable to price spikes.
- According to the latest EIA forecasts, natural gas prices will remain higher than coal, and coal's price advantage is expected to increase every year.
- TVA's recent decision to prematurely retire Paradise 1 & 2 and potential additional closures create real reliability concerns for serving TVA customers in Tennessee.
- One of the major reasons Tennessee currently maintains an attractive economic and business environment is its low electricity rates, since coal provides nearly half of the state's electric power
- Notably, both TVA and the State of Tennessee emphasize the affordability, stability, and reliability of TVA's electricity as a key economic advantage.
- Tennessee has benefited greatly from reliance on dependable, low-cost coal: The state's industrial electricity rates are relatively low and provide it with a key competitive advantage.
- However, Tennessee's competitive advantage is at risk as less coal is being used to generate electricity in the state.
- Tennessee's reduction in coal power has been accompanied by higher electricity prices: In 2000 Tennessee's rates were 18 percent below the U.S. average; at present they are just 8 percent lower.

Tennessee Automotive Sector

- Since 1979, Tennessee has developed the fourth largest automotive manufacturing sector in the U.S. (behind Michigan, Indiana, and Ohio), and Nissan, Volkswagen, GM and other firms create about 400,000 jobs in every region of the state.
- This has allowed Tennessee to vastly upgrade its economy, and the state has emerged as one of the auto industry's most important supplier hubs both nationally and globally.
- The industry is in flux, competitive pressures are intense, and Tennessee is no longer a low wage state for the industry: As wage convergence proceeds, other competitive factors such as reliable, high quality, low-cost electricity, will become ever more important.
- The Tennessee auto industry is undergoing critical changes and cost pressures are affecting its competitiveness, but it has one important advantage over most of its competitors: The reliable, high quality, low-cost electricity provided by TVA.
- Tennessee's electricity will be even more important in the future: Automotive manufacturing is becoming even more electricity intensive and dependent on emerging electro-technologies.

Electricity and the Economy

- There is a negative relationship between energy price changes and economic activity: Increases in energy and electricity prices harm the economy and decreases in energy and electricity prices benefit the economy.
- This relationship is important because coal is currently the low-cost option for generating electricity and is forecast to remain so.
- There is a negative relationship between electricity prices and a state's use of coal to generate electricity: The higher percentage of coal used to generate electricity, the lower the electricity rate.
- Energy costs have Keynesian economic effects similar to those of taxes: Increased energy and utility costs act as a "hidden tax" that have deflationary, economically constrictive impacts; e.g., they decrease sales, GDP, jobs, etc.; conversely, decreased energy and utility costs have the effect of a "tax cut" and have economically stimulating effects by putting more money in the hands of consumers and businesses, thus increasing sales, creating jobs, etc.
- Programs and policies that increase electricity prices – in a city, state, region, or nation — over what they would be otherwise will have adverse effects on the economy and jobs.
- Review of the literature revealed a number of studies that estimated the energy price/GDP elasticities, and we determined that a reasonable electricity elasticity estimate is -0.1, which implies that a 10 percent increase in electricity prices will result in a one percent decrease in GDP.

Economic Impact in Tennessee

- There will be adverse effects on the Tennessee economy and jobs from the rate increases associated with TVA fuel switching: 1) Tennessee businesses (including those in the automotive industry) will face increased competitive disadvantages; 2) some businesses will leave the state; 3) new businesses will hesitate to locate in Tennessee; 4) Tennessee electric customers will have less money to spend.
- There is a quantifiable relationship between economic activity and jobs – between the level of GDP/GSP and jobs. Basically, GDP and jobs are closely, positively correlated.
- Under the proposed TVA policy, average electric rates in Tennessee will be more than 20 percent higher than they would be in the absence of the mandate.
- Tennessee would change from having average electric rates that are about five percent lower than the U.S. average to having rates that are more than 15 higher than the U.S. average, and from having industrial electric rates that are 10 percent lower than the national average to more than 10 percent higher than the national average.
- This increase in industrial rates means that one of Tennessee's major economic competitive advantages among the states will be eliminated.
- By 2025 the impact on the Tennessee economy would be devastating: 1) Tennessee gross state product (GSP) would be reduced by more than $7 billion; 2) Tennessee manufacturing output would be reduced by more than $900 million: 3) Tennessee state and local government tax revenues would be reduced by nearly $700 million
- The impact on the Tennessee automotive sector will be severe: 1) TVA's policy will result in a "tax" on this sector from which it will receive no benefits; 2) This sector is especially vulnerable to energy costs, and will be increasingly vulnerable; 3) Its future health depends critically on electricity-based technologies, processes, and innovation; 4) This sector will lose an important economic competitive advantage it currently possesses over other states and nations.
- The jobs impact on Tennessee from fuel switching would be substantial, and by 2025: 1) More than 65,000 FTE jobs would be lost; 2) The jobs losses would total more than 13 times the number of jobs lost in Tennessee in 2012, would exceed the number of jobs lost in Tennessee in 2012, and would exceed the total number of jobs lost in the state economy in 2012 and 2013 *combined*.
- A disproportionately large share of the job losses would be related to the automotive sector in Tennessee.
- The Tennessee unemployment rate could increase by nearly 40 percent – from 6.4 percent to nearly nine percent.

Demographic Impacts

- The energy burdens of low-income households are much higher than those of higher-income families, and high burden households are those with the lowest incomes and highest energy expenditures.

- Households in the lowest-income classes spend the largest shares of their disposable income to meet their energy needs.
- The portion of U.S. household incomes expended on energy costs has increased significantly over the past decade, especially for lower-income groups
- In 2013 the poorest households were paying, in percentage terms, nearly nine times as much for energy as the most affluent households – and more than 11 times as much for residential energy.
- High energy prices have a detrimental effect on the lives of those with limited incomes, and they suffer from home energy arrearages and shut-offs, cutbacks on necessities and other items, risks to health and safety, and housing instability.
- Low-income families are often forced to limit the amount of money they spend on necessities to manage their energy costs, and must reduce food purchases.
- People purchase less medicine when their utility bills are too high, and temperature extremes can be damaging to vulnerable populations, including the elderly, the disabled, and small children.
- High energy prices compromise the safety of low-income households, and inability to pay utility bills often leads to the use of risky alternatives.
- Older consumers with the lowest incomes will experience the greatest cost burdens -- low income seniors dependent primarily on retirement income.
- Tennessee is the 7th poorest U.S. state: 1) Its citizens are vulnerable to higher electricity prices; 2) Tennessee per capita income is 17 percent below the U.S. average, and the gap is widening; 3) 57 percent of Tennessee families have an average annual after-tax income of $23,700 -- less than $2,000/month; 4) In Tennessee, 120,000 seniors live in poverty, over 400,000 children live in poverty, over 660,000 homes are on food stamps and nearly 770,000 families live in poverty; 5) Tennessee household income is 20 percent below the U.S. average; 6) The median value of houses in the state is 1/3 less than the U.S. average; 7) nearly 1/5th of Tennesseans live in poverty – 1.25 million; 8) In Tennessee, 38 percent of Blacks are impoverished and 35 percent of Hispanics are impoverished; 9) The poverty level for children is 26 percent, and over 400,000 Tennessee children are impoverished; 10) There are 800,000 households of Social Security recipients; 11) Nearly 1/3rd of Tennessee households receive Social Security, and these recipients have an average annual household SS income of $16,700.
- Over 700,000 Tennessee households are eligible for LIHEAP, about 1/3 of all households in state – but only 1/5 Tennessee households eligible receive any LIHEAP assistance.
- The energy burden is already critical in Tennessee: Energy prices and stagnant incomes are straining the budgets of Tennessee families, and energy costs are consuming the incomes of Tennessee's low and middle-income families at levels comparable to other necessities such as housing, food, and health care.
- The large share of after-tax income devoted to energy by lower-income groups poses difficult budget choices among food, health care and other necessities.
- The 224,000 poorest families in Tennessee, living well below the federal poverty line and earning less than $10,000 per year, are being squeezed hardest by

energy cost increases, and the impacts fall disproportionately on Tennessee's 820,000 households of Social Security recipients -- 1/3 of the state's households.

VI.B. Conclusions

The major conclusions derived here are summarized below.

TVA

1. Heavy reliance on coal has kept TVA's electricity reliable and affordable.
2. However, TVA's proposal to prematurely retire a number of coal plants will leave TVA unable to meet the reliability requirements.
3. TVA and Tennessee are increasing dependency on risky natural gas -- the fuel with a history of the most volatile prices and a questionable balance of future supply and demand.
4. TVA's 2014 decision to close 3,900 MW of coal generation at Colbert, Widows Creek, and Paradise 1 & 2 must be reversed, and the potential retirement of additional coal generation at Shawnee, Allen, and Widows Creek must be prevented.
5. TVA's IRP must be revised to facilitate timely upgrades of TVA's existing coal facilities and the construction of new supercritical coal power stations, thus permitting TVA to lead in the deployment of clean coal technologies.

Tennessee

7. One of the reasons Tennessee maintains an attractive business environment is its low electricity rates, since coal provides nearly half of the state's electric power
8. Tennessee has benefited greatly from reliance on dependable, low-cost coal: The state's industrial electricity rates are low and provide it with a key competitive advantage, and Tennessee emphasizes the affordability, stability, and reliability of TVA's electricity as a key state economic advantage.
9. However, Tennessee's competitive advantage is at risk as less coal is being used to generate electricity, and Tennessee's reduction in coal power has been accompanied by higher electricity prices.
10. Tennessee has developed the fourth largest automotive manufacturing sector in the U.S., and this has allowed Tennessee to vastly upgrade its economy.
11. Competitive pressures are intense, and Tennessee is no longer a low wage state for the automotive industry: As wage convergence among the states proceeds, other competitive factors such as reliable, high quality, low-cost electricity, become ever more important.
12. Cost pressures are affecting the Tennessee auto industry's competitiveness, but it has a major advantage: Reliable, high quality, low-cost electricity, and Tennessee's electricity will be critical in the future as vehicle manufacturing becomes ever more electricity intensive and dependent on emerging electro-technologies.

Electricity and the Economy

4. There is a negative relationship between energy prices and economic activity: Increases in energy and electricity prices harm the economy and decreases in these prices benefit the economy.
5. There is a negative relationship between electricity prices and a state's use of coal to generate electricity: The higher percentage of coal used to generate electricity, the lower the state's electricity rate.
6. Energy costs have Keynesian economic effects similar to those of taxes: Increased energy and utility costs act as a "hidden tax" that have deflationary, economically constrictive impacts, and policies that increase electricity prices will have adverse effects on the economy and jobs.

Economic and Job Impacts

8. There will be adverse effects on the Tennessee economy and jobs from the rate increases associated with TVA fuel switching, and under the proposed TVA policy average electric rates in Tennessee will be more than 20 percent higher than they would otherwise be.
9. Tennessee would change from having electric rates that are about five percent lower than the U.S. average to having rates that are more than 15 percent higher, and increased industrial rates means that one of Tennessee's major economic competitive advantages among the states will be eliminated.
10. By 2025 the impact on the Tennessee economy of the TVA proposal would be devastating: i) Tennessee gross state product would decrease by more than $7 billion; ii) manufacturing output would decrease by more than $900 million: iii) state and local government tax revenues would decrease by $700 million
11. The impact on the Tennessee automotive sector will be severe: Its future health depends critically on electricity-based technologies, and it will lose an important competitive advantage it currently possesses over other states and nations.
12. The jobs impact on Tennessee from fuel switching would be substantial, and by 2025: i) More than 65,000 jobs would be lost annually; ii) the job losses would exceed the total number of jobs lost in the state economy in 2012 and 2013 *combined*.
13. A disproportionately large share of the job losses would be in the Tennessee automotive sector.
14. The Tennessee unemployment rate could increase by nearly 40 percent – from 6.4 percent to nearly nine percent.

Demographic Impacts

7. Tennessee is the 7th poorest U.S. state and its citizens are vulnerable to higher electricity prices.
8. The energy burdens of low-income Tennessee households are much higher than those of higher-income families, and households with the lowest incomes spend the largest shares of their income to meet their energy needs.
9. High energy prices have a detrimental effect on the lives of those with limited incomes, and they suffer from home energy arrearages and shut-offs, cutbacks on necessities and other items, risks to health and safety, and housing instability.
10. Low-income families are often forced to limit the amount of money they spend on necessities to manage their energy costs and must reduce food purchases.
11. People purchase less medicine when their utility bills are too high, and temperature extremes can be damaging to vulnerable populations, including the elderly, the disabled, and small children.
12. The electricity rate increases and negative economic and job effects of the TVA proposal in Tennessee will especially harm low income households, the working poor, Blacks, Hispanics, and seniors on fixed incomes.

APPENDIX: ELECTRICITY-GDP ELASTICITY ESTIMATES

A number of studies have developed estimates of the elasticity of GDP with respect to energy and electricity prices. Examples of these are summarized in Table A.III-1, and include the following:

- In 2012 and 2013, Bildirici and Kayikci in several studies found causal relationships between electricity consumption and economic growth in the Commonwealth of Independent States countries and in transition countries in Europe.[130]
- In 2010, Lee and Lee analyzed the demand for energy and electricity in OECD countries. They estimated that the elasticities range between -0.01 and -0.19.[131]
- In 2010, Baumeister, Peersman, and Van Robays examined the economic consequences of oil shocks across a set of industrialized countries over time. They estimated that the elasticity was approximately -0.35.[132]
- In 2010, Brown and Hunnington employ a welfare-analytic approach to quantify the security externalities associated with increased oil use, which derive from the expected economic losses associated with potential disruptions in world oil supply. They estimated that the elasticity ranged between -0.01 and -0.08.[133]
- In 2009, Blumel, Espinoza, and Domper used Chilean data to estimate the long run impact of increased electricity and energy prices on the nation's economy.[134] They estimated that the elasticity ranged between -0.085 and -0.16.
- In 2008, in a study of the potential economic effects of peak oil, Kerschner and Hubacek reported elasticities in the range of -0.17 to -0.03 – although they noted that sectoral impacts are more significant.[135]

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[130] Melike Bildirici, Frazil Kayikci, "Economic Growth and Electricity Consumption in Former Soviet Republics" IDEAS, Federal Reserve Bank of St. Louis, 2012; Melike Bildirici, Frazil Kayikci, "Economic Growth and Electricity Consumption in Former Soviet Republics," *Energy Economics*, Volume 34, Issue 3 (May 2012), pp. 747–753; "Economic Growth And Electricity Consumption In Emerging Countries Of Europa: An ARDL Analysis," *Economic Research - Ekonomska Istrazivanja*, Vol. 25, No. 3 (2013), pp 538-559.

[131] Chien-Chaing Lee and Jun-De Lee, "A Panel Data Analysis of the Demand for Total Energy and Electricity in OECD Countries," *The Energy Journal*, Vol. 31, No 1 (2010), pp. 1-23.

[132] Christiane Baumeister, Gert Peersman and Ine Van Robays, "The Economic Consequences of Oil Shocks: Differences Across Countries and Time," Ghent University, Belgium, 2010.

[133] Stephen P.A. Brown and Hillard G. Huntington, "Estimating U.S. Oil Security Premiums," Resources for the Future, Washington, D.C., June 2010.

[134] Gonzalo Blumel, Ricardo A. Espinoza, and G. M. de la Luz Domper, "Does Energy Cost Affect Long Run Economic Growth? Time Series Evidence Using Chilean Data," Instituto Libertad y Desarrollo Facultad de Ingenier´ıa, Universidad de los Andes, March 22, 2009.

[135] Christian Kerschnera and Klaus Hubacek, "Assessing the Suitability of Input-Output Analysis For Enhancing Our Understanding of Potential Economic Effects of Peak-Oil," Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds, UK, 2008.

Table A.II-1
Summary of Energy- and Electricity-GDP Elasticity Estimates

Year Analysis Published	Author	Elasticity Estimate
2012 and 2013	Bildirici and Kayikci (energy)	Causal relationships between energy and growth varied by nation
2010	Lee and Lee (energy and electricity)	-0.01 and -0.19
2010	Brown and Huntington (oil)	-0.01 to -0.08
2010	Baumeister, Peersman, and Robays (oil)	-0.35
2010	Deschenes (electricity)	-0.16 to -0.10
2009	Blumel, Espinoza, and Domper (energy and electricity)	-0.085 to -0.16
2008	Kerschner and Hubacek (oil)	-0.03 to -0.17
2008	Sparrow (electricity)	-0.3
2007	Maeda (energy)	-0.03 to -0.075
2007	Citigroup (energy)	-0.3 to -0.37
2007	Lescaroux (oil)	-0.1 to -0.6
2006	Rose and Wei (electricity)	-0.1
2006	Oxford Economic Forecasting (energy)	-0.03 to -0.07
2006	Considine (electricity)	-0.3
2006	Global Insight (energy)	-0.04
2004	IEA (oil)	-0.08 to -0.13
2002	Rose and Young (electricity)	-0.14
2002	Klein and Kenny (electricity)	-0.06 to -0.13
2001	Rose and Ranjan (electricity)	-0.14
2001	Rose and Ranjan (energy)	-0.05 to -0.25
1999	Brown and Yucel (oil)	-0.05
1996	Hewson and Stamberg (electricity)	-0.14
1996	Rotemberg and Woodford (energy)	-0.25
1996	Gardner and Joutz (energy)	-0.072
1996	Hooker (energy)	-0.07 to -0.29
1995	Lee and Ratti (oil)	-0.14
1995	Hewson and Stamberg (electricity)	-0.5 and -0.7
1982	Anderson (electricity)	-0.14
1981	Rasche and Tatom (energy)	-0.05 to -0.11

Source: Management Information Services, Inc.

- In 2008, Sparrow analyzed the impacts of coal utilization in Indiana, and estimated electricity elasticities in the range of about -0.3 for the state.[136]
- In 2007, in a study of energy price GDP relationships, Maeda reported a range of elasticity estimates between -0.03 to -0.075.[137]
- In 2007, in a study of the relationship between energy prices and the U.S. economy, Citigroup found that in the long run, protracted high energy prices can have an economic impact and reported elasticities in the range of -0.3 to -0.37 between 1995 and 2005.[138]
- In 2007, in a study of oil-price GDP elasticities, Lescaroux reported a range of elasticities between -0.1 and -0.6.[139]
- In 2006, in an analysis of the likely impacts of coal utilization for electricity generation on the economies of the 48 contiguous states in the year 2015, Rose and Wei estimated the electricity elasticity to be -0.1[140] They also reported that more recent studies for the state of Georgia and the UK yield similar results.
- In 2006, in a study of energy price impacts in the UK, Oxford Economic Forecasting found elasticities to range between about -0.11 and -0.21.[141]
- In 2006, in a study that analyzed the economic impacts from coal Btu energy conversion, Considine estimated an electricity elasticity of -0.3.[142]
- In 2006, in a study of the impact of energy price increases in the UK, Global Insight estimated the elasticity to be -0.04.[143]
- In 2004, IEA employed energy-economic model simulation to calculate how much the increase in oil prices reduces GDPs in several countries. It found that the elasticity estimates ranged between -0.08 to -0.13.[144]

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[136]F.T. Sparrow, Measuring the Contribution of Coal to Indiana's Economy," CCTR Briefing: Coal, Steel and the Industrial Economy, Hammond, IN, December 12, 2008.

[137]Akira Maeda, On the World Energy Price-GDP Relationship, presented at the 27th USAEE/IAEE North American Conference, Houston, Texas, September 16-19, 2007.

[138]PV Krishna Rao, "Surviving in a World with High Energy Prices, Citigroup Energy Inc., September 19, 2007.

[139]F. Lescaroux, An Interpretative Survey of Oil Price-GDP Elasticities, Oil & Gas Science and Technology Vol. 62 (2007), No. 5, pp. 663-671.

[140]Adam Rose and Dan Wei, *The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015*. Report prepared for the Center for Energy and Economic Development, Inc., Alexandria, Virginia, the Pennsylvania State University, July 2006.

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- In 2002, in a study of the economic impact of coal utilization in the continental U.S. Rose and Yang estimated the GDP electricity price elasticity of at -0.14.[145]
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- In 2001, Rose and Ramjan analyzed the impact of coal utilization in Wisconsin. They calculated a price differential between coal and natural gas in electricity production, and then estimated how much economic activity is attributable to this cost saving. They used an economy-wide elasticity of output with respect to energy prices, which they estimated to be -0.14.[147]
- In 2001, Rose and Ranjan surveyed recent studies of the impacts of energy prices on GDP and reported elasticities in the range of -0.5 to -0.25.[148]
- In 1999, Brown and Yucel surveyed a number of studies and reported an average elasticity of about -0.05.[149]
- In 1996, Rotemberg and Woodford analyzed the effects of energy price increases on economic activity and reported an elasticity of -0.25.[150]
- In 1996, Gardner and Joutz analyzed the relationship between economic growth, energy prices, and technological innovation, found that the real price of energy is negatively related to output in the US , and estimated that the elasticity is -0.72.[151]
- In 1996, in a study of the impact of electricity prices on manufacturing, Hewson and Stamberg estimated an electricity elasticity of -0.14.[152]
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- In 1995, in a study of the impact of NO_x control programs in 37 states, Hewson and Stamberg estimated electricity elasticities ranging between -0.5 and -0.7.[155]
- In 1982, in a study of industrial location and electricity prices, Anderson estimated the elasticity to be -0.14.[156]
- In 1981, Rasche and Tatom found that an energy price shock modifies the optimal usage of the existing stock of capital, modifying the optimal capital-labor ratio and generating an upward shift on the aggregate supply curve and a decline in potential output. They estimated that the elasticity of output with respect to the real price of energy ranges between -0.05 and -0.11.[157]

In addition, numerous studies have examined the relationship between energy prices and GDP and found strong causality; for example:

- In 2008, Chontanawat found that the causality relationship is stronger in developed countries rather than developing countries.[158]
- In 2008, Bekhet and Yusop examined the long run relationship between oil prices, energy consumption, and macroeconomic performance in Malaysia over the period 1980-2005. Their findings indicated that there is a stable long-run relationship between oil prices, employment, economic growth, and the growth rate of energy consumption and also substantial short run interactions among them. The linkages and causal effects among prices, energy consumption and macroeconomic performance have important policy implications, and they found that the growth of energy consumption has significant impacts on employment growth.[159]

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- In 2006, Soytas and Sari analyzed the causal relationship between energy consumption and GDP in G-7 countries and found that causality runs from energy consumption to GDP in these countries. They argued that energy conservation in some countries could negatively impact economic growth.[160]
- In 2006, Chontanawat, Hunt, and Pierse tested for causality between energy and GDP using a consistent data set and methodology for 30 OECD and 78 non-OECD countries.[161] They found that causality from aggregate energy consumption to GDP and GDP to energy consumption is found to be more prevalent in the developed OECD countries compared to the developing non-OECD countries. This implies that a policy to reduce energy consumption aimed at reducing GHG emissions is likely to have greater impact on the GDP of the developed rather than the developing world.
- In 1995, Finn found that in the U.S. the Solow residual tends to fall when energy price rises, implying a direct link between energy and production.[162]
- In 1987, Erol and You found a causal relationship running from energy consumption to output in a large set of industrialized countries.[163]

Other studies that came to similar conclusions include Al-Faris,[164] Al-Iriani,[165] Apergis, and Payne,[166] Burniaux and Jean Chateau,[167] Chien-Chiang and Jun-De

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Lee,[168] Coffman,[169] Cournède,[170] Davis and Haltiwanger,[171] Gausden,[172] Gronwald,[173] Harris,[174] Lee,[175] Manjulika and Koshal,[176] Narayan and Smyth,[177] Oligney,[178] Soytas and Sari,[179] Stern,[180] Stern and Cleveland,[181] and Wolde-Rufael.[182]

Dahl has conducted extensive studies of NEMS elasticities and provided summaries of the elasticities within NEMS.[183] She noted that, since elasticities are a convenient way to summarize the responsiveness of demand to such things as own prices, cross prices, income, or other relevant variables, a substantial amount of resources have been devoted to estimating demand elasticities, at various levels of aggregation using a variety of models. Nevertheless, she found that considerable variation in the estimates at the aggregate and disaggregate levels remains.

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