CEED
Center for Energy and
Economic Development

August 30, 2007

Environmental Commission
State of Nevada
c/o John B. Walker, Executive Secretary
901 South Stewart Street, Suite 4001
Carson City, NV 89701-5249
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Re: Petition No. P2007-03 – Western Resource Advocates (WRA) Petition for Initiation of Rulemaking Regarding Suspension of Permitting Process for New Coal-Fired Electric Generating Plants

Dear Commissioners:

The Center for Energy and Economic Development (CEED) respectfully submits these comments on the Petition for Initiation of Rulemaking, filed by the Western Resource Advocates ("WRA") on July 31, 2007 (the "Petition"). The Petition requests that the Nevada State Environmental Commission ("SEC") adopt a rule suspending its statutorily defined air pollution control permitting process for any coal-fired electric generating plants to be located in the State of Nevada, until such time in the future when the SEC or Nevada Department of Environmental Protection ("NDEP") promulgates regulations enacting the particular greenhouse gas emission standard advocated by WRA in the Petition. WRA believes that SEC and NDEP should adopt an emissions limit for "new electricity generating facilities" of 1,100 lbs of carbon dioxide per megawatt hour of electricity generated.

CEED is a non-profit organization formed by the nation's coal-producing companies, railroads, a number of electric utilities, equipment manufacturers, and related organizations for the purpose of educating the public, including public-sector decision-makers, about the benefits of affordable, reliable and environmentally compatible coal-fueled electricity. As an active participant in state, regional, and national air quality issues, CEED has long advocated the development of air quality regulations based upon sound science so as to achieve state and federal goals in a rational and cost-effective manner. CEED has several members doing business in the State of Nevada that would be directly impacted by the relief requested in the Petition.

I. INTRODUCTION

The WRA Petition asks the SEC to suspend its air pollution control permitting process in anticipation of a greenhouse gas emissions standard that the State of Nevada has not yet considered or enacted. If granted, the approach proposed by WRA would create irreconcilable legal problems for the State of Nevada, including a) acting without an express statutory direction,

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b) impairing existing contracts in violation of the U.S Constitution, and, c) by prohibiting certain purchases of electricity, violating the Commerce Clause of the U.S. Constitution. Further, granting the WRA proposal would result in the SEC unlawfully taking an important public policy decision away from the Nevada electorate and the legislature of the State of Nevada, in excess of the SEC's statutorily defined rulemaking authority. CEED encourages the SEC to carefully consider the serious flaws in the Petition before choosing to suspend its air pollution control permitting process or establishing a greenhouse gas emissions performance standard.

In addition to, and in support of these Comments, CEED refers to and incorporates by reference the following documents:

1. An article by Professor M. Harvey Brenner, "Health Benefits of Low-Cost Energy: An Econometric Case Study," Journal of the Air & Waste Management Association, Nov. 2005 ("Brenner Article") (Attachment 2), together with a summary of Dr. Brenner's research (Attachment 1);

2. A paper by Professor Adam Z. Rose and Dan Wei, "The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015," ("Rose & Wei Paper") (Attachment 4), together with a summary of Dr. Rose's and Mr. Wei's research (Attachment 3) and additional supporting calculations (Attachment 5); and

3. An article published by Americans for Balanced Energy Choices, "Energy Cost Burdens on American Families," ("Balanced Energy Report") (Attachment 6).

As further discussed below, WRA's assertion that Nevada's current air pollution control permitting process will result in harm to Nevada and its citizens is erroneous. Granting the Petition, rather, would likely result in serious harm to the State of Nevada and its citizens by a) narrowing its options in developing future, lower-cost energy supplies, b) encouraging business to leave the state, and c) increasing the price of electricity in the State of Nevada.

Moreover, as a perquisite to its proposal, WRA simply assumes that Nevada would enact a greenhouse gas emissions limit, and that the limit would be 1,100 lbs CO_2/megawatt hour, without any analysis of why such a standard would be appropriate (and without presenting any alternatives thereto for consideration). The Petition should therefore be denied.

II. THE WRA PROPOSAL CITES NO LEGAL AUTHORITY FOR THE PROPOSITION THAT THE SEC HAS AUTHORITY TO ACT "AS A SURROGATE" FOR THE EPA UNDER THE CLEAN AIR ACT

The Petition itself concedes that "NDEP does not currently regulate carbon dioxide or other GHGs [sic] emissions pursuant to the state air pollution requirements established in NRS 445B.100 through 445B.825 and 486A.010 through 468A.180." Petition at 15. Nevada law currently does not currently permit the SEC to regulate in the manner which WRA requests. As such, the law in Nevada must first be changed (only by Nevada's democratic institutions) before SEC may proceed in a manner similar to that requested by WRA.

The Petition cites no specific affirmative statutory grant of authority beyond the general citation of the federal Clean Air Act and analogous Nevada implementing statutes. Thus, WRA appears to be asserting that Nevada has "implied authority" to regulate GHG emissions based upon the recent Supreme Court ruling in *Massachusetts v. EPA*, 127 S.Ct. 1438 (2007). Such implied authority does not exist in Nevada unless and until existing statutes are amended, or the EPA directs regulation under the Clean Air Act. Neither of these circumstances has occurred.

The authority to promulgate such dramatic statutory amendments lies exclusively with the Nevada Legislature and Governor, not with the Commission. The Petition further concedes that the law is currently unsettled regarding EPA's authority to regulate carbon dioxide and other greenhouse gas emissions from power plants under the Clean Air Act, noting that very question is pending before the United States Court of Appeals for the District of Columbia Circuit in the case captioned *State of New York v. EPA*. Given this status, WRA's contention that Nevada may "act as a surrogate" for the EPA and may currently regulate greenhouse gases under the Clean Air Act stands in direct contradiction with the unsettled status of the law in this regard. Moreover, even if the federal court later determines that EPA may regulate such greenhouse gas emissions, it does not follow that Nevada may act as EPA's surrogate in any event.

III. THE WRA PROPOSAL UNLAWFULLY IMPAIRS EXISTING CONTRACTUAL OBLIGATIONS THAT HAVE ARISEN REGARDING NEW CONSTRUCTION OF COAL-FUELED POWER PLANTS.

The Contracts Clause of the United States Constitution provides an unqualified guarantee that "No State shall . . . pass any . . . law impairing the obligation of Contracts." U.S. Const. art. I, § 10; *see also* Nevada Const. art. I, § 15. The Contract Clause of the U.S. Constitution imposes limits on a state's power to impair existing contracts. The clause applies where the challenged law "... invade[s] an area never before subject to regulation by the State." *Allied Structural Steel Co. v. Spannaus*, 439 U.S. 234, 242, (1978). It additionally applies where the law works a "severe, permanent, and immediate change in relationships . . . ." *Id.*

WPA cites in its Petition three projects currently under development in Nevada. Petition at 4 n.2 and 5 (referring to the Ely, White Pine, and Sithe projects). WRA specifically states that it requests the SEC to suspend the air permitting process for these ongoing projects – that is, to immediately change the law in order to work an immediate change in the relationships regarding the ongoing projects. The summary action WRA requests is impermissible, and WRA's Petition should be denied for this reason.

IV. THE WRA PROPOSAL FAILS TO ANALYZE THE COSTS ASSOCIATED WITH ITS REQUIREMENTS, AND LACKS AN ADEQUATE BASIS OR RECORD TO PROVIDE SUCH ANALYSIS

WRA cites, as "avoided costs" of its proposal, costs associated with a non-existent federal program imposing carbon emissions costs. Such a federal program has not been imposed. The details of such a program are therefore speculative, and cannot be considered by the SEC in determining the costs associated with WRA's Petition. Moreover, the Petition gives

short shrift to any analysis or discussion of costs imposed on ratepayers resulting from the WRA Proposal, noting only that "[i]t is possible that rate payers would experience a slight increase in their bills in the short term, as the utilities invest in new, cleaner technologies." Petition at 29.

Further, the Proposal does not contain any analysis of the reliability concerns raised by homogenizing Nevada's energy supply to rely upon natural gas.[1] The Petition also misses the much larger policy issue created by eliminating most new resource options and forcing Nevada to become increasingly dependent upon natural gas. At a minimum, the Petition must contain, and the SEC should only consider a) the anticipated compliance costs, b) reliability impacts and c) how (if at all) the proposed approach minimizes ratepayer costs and risks.

A. The Petition Will Not Minimize the Costs of the to Nevada Ratepayers.

Despite representations to the contrary, the WRA Petition lacks both cost containment provisions and analysis of the costs associated with implementing the WRA Proposal. By eliminating all cost containment provisions, and in failing to address the costs to ratepayers, the WRA Petition fails to protect ratepayers from the costs of the proposal. The WRA proposal is legally-defective because it fails to provide any cost containment methods.

B. The Displacement of Coal-Fueled Electric Generation Will Harm Nevada's Economy, and Will Disproportionately Harm Lower-Income Nevada Families.

The higher electricity rates resulting from the Petition's stated goal of displacing coal fueled electric generation will have the same effect as a regressive tax. Higher energy prices disproportionately harm families living on lower and fixed incomes.[2] Thus, the State of Nevada has a compelling governmental interest in keeping energy costs affordable. More money spent on electricity means less money is available for housing, food, education, and other necessities that maintain and improve the quality of life of Nevada citizens. Therefore, it is an unwise and unjust policy to raise energy prices so that consumers use less energy.

C. Rose & Wei Research: The Displacement of Coal-Fueled Electric Generation Will Damage Nevada's Economic Output, Household Income, and Jobs.

Adam Z. Rose, Ph.D., and Dan Wei conducted research to estimate the economic impacts of displacing coal-fueled electricity generation. *See* Rose & Wei Paper (Attachment 4); *see also* Summary of same (Attachment 3); Supporting Data (Attachment 5); and Balanced Energy

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[1] Although WRA suggests an ultimate goal of encouraging renewable generation, the short-term effects of its Petition would likely be a shift of development to natural gas fueled electric generation. The Petition recognizes that "the owner(s) of any proposed facilities could meet this emission standard through the construction of natural gas combined cycle plants or renewable sources." Petition at 25.

[2] In 2005, energy costs accounted for only 5% of the gross incomes of families with household incomes of greater than $50,000. In the same year, energy costs consumed 48% of the budgets of U.S. families with incomes of less than $10,000. *See* Balanced Energy Report (Attachment 6) at 1-6.

Report (Attachment 6). Dr. Rose and Mr. Wei calculated that U.S. coal-fueled electric generation will contribute $1.05 trillion in gross economic output, $362 billion in annual household incomes, and 6.8 million jobs in 2015. *See* Rose & Wei Paper at 4. Based upon these calculations, Dr. Rose and Mr. Wei concluded that displacement of 33% of coal-fueled electric generation (nationwide) would result in a loss of $166 billion in gross economic output, a $64 billion reduction in annual household incomes, and 1.2 million job losses. *Id*. at 5. But the report further calculated the net economic losses of such displacement of coal-fueled electric generation in Nevada alone. *See* Summary of Rose & Wei Paper at 8-9 (Attachment 3). A 33% displacement of coal-fueled electric generation would result in a $1 billion net loss in economic output (not including the specific loss of the pending projects WPA cites in its Petition, Ely, White Pine, and Sithe), $500 million in lost household income, and 2,200 lost jobs in Nevada. A 66% displacement would cost Nevada $2.5 billion in lost economic output, $1.1 billion in lost household income, and 18,000 lost jobs. These losses illustrate the interdependence of major segments of the economy, and show that the Petition cannot be judged in terms of expected environmental effects alone. The additional effects of the Petition must be assessed by the SEC before taking any action on WRA's proposal.

D. Brenner Research: Higher-Cost Energy Results in Reduced Household Income, Increased Unemployment, and Premature Deaths.

M. Harvey Brenner, Ph.D.,[3] conducted research regarding the relationship between energy, the environment, and health. *See* Brenner Article (Attachment 2); *see also* Summary of same (Attachment 1). After applying his econometric model of public health to a hypothetical scenario in which higher-cost fuels displace U.S. coal to generate electricity, Dr. Brenner discovered that such displacement will result in staggering adverse impacts, including reduced household income, increased unemployment, and premature deaths. *See* Brenner Article at 30 (Table 1). Such premature deaths are directly attributable to "decreased household income and increased unemployment associated with a shift to higher cost energy supply options, absent any direct mitigation programs that effectively prevented or offset these effects." *Id*. at 32. By increasing the costs of goods and services such as electricity, and, in doing so, reducing disposable income, government regulation can inadvertently harm individuals' socioeconomic status and contribute to poor health and premature death. *Id*. at 28.

Dr. Brenner's caution to public policy makers applies directly to the SEC here: "Governmental programs intended to protect public health and the environment should take into account potential income and employment effects of required compliance measures." *Id*. In short,

> [t]he economic growth that continuously improves human life expectancy requires access to affordable energy. In this fundamental sense, any policy change that reduces growth or raises

[3] Dr. Brenner is Professor of Health and Policy Management at the Johns Hopkins University Bloomberg School of Public Health and Senior Professor of Epidemiology at the Berlin University of Technology.

> the level of unemployment should therefore be defined and addressed as a public health issue requiring an economic policy response that limits or offsets these results.

Id. at 33. Dr. Brenner's research cautions the SEC to recognize the costs and potential unintended consequences that the Petition will have on employment, income, and public health.

V. THE PETITION PRECLUDES COAL-FUELED POWER PLANTS FROM SUPPLYING BASELOAD GENERATION TO NEVADA, AND INCREASES NEVADA'S DEPENDENCE ON NATURAL GAS TO SUPPLY ITS POWER NEEDS

The Petition seeks to expressly exclude coal-fueled electric generation from Nevada during an indefinite "interim" period. Advanced technologies may be able to meet the Petition's proposed greenhouse gas limit in the future; however, by excluding coal from the Nevada market entirely, the Petition creates no incentive to develop such technologies.

A. The Petition Would Result in Greater Vulnerability to Natural Gas Market Reliability Risks.

Power plants that use oil, clean coal, petroleum coke, and most waste fuels would be precluded from supplying baseload power to Nevada investor-owned utilities under the WRA proposal. By limiting baseload generation competition in this way, the Petition leaves Nevada with fewer and higher-cost baseload generation options. Moreover, the Petition expressly excludes unspecified resources from electric purchases, meaning that net system power could not be used to satisfy baseload demands. When coal and unspecified generation options are excluded from baseload Nevada power contracts, utilities must depend upon additional new CCGT plants, nuclear units, and renewable resources to meet Nevada's growing energy demand. If Nevada is reluctant to support nuclear power, it is left with little diversity in its energy portfolio – only natural gas and renewable energy options.

The North American Electric Reliability Council ("NERC") 2006 Long-Term Reliability Assessment[4] recognizes this fact, and also notes that "[a]s with other areas within WECC, the future adequacy of the generation supply over the next ten years in this area [the Arizona-New Mexico-Southern Nevada Power Area] will depend on how much new capacity is actually constructed." NERC Report at 117.

A portfolio of limited energy sources is intrinsically a high-risk portfolio, and the Petition creates unjustifiably high supply and market risks for Nevada ratepayers. Given the volatility of natural gas prices, as well as the higher cost of natural gas, the WRA Proposal would place

[4] NERC 2006 Long-Term Reliability Assessment, October 16, 2006, at 120, *available at* ftp://www.nerc.com/pub/sys/all_updl/docs/pubs/LTRA2006.pdf.

Nevada ratepayers in an inherently risky position. *See* Balanced Energy Report (Attachment 6) at 3-4 (Charts 1 and 2 – electricity fuel cost indices by energy source).

NERC's 2006 Long-Term Reliability Assessment Report analyzes the adequacy of electricity supply and transmission reliability in North America through 2015, and the report calls for actions to improve system reliability. NERC 2006 Long-Term Reliability Assessment at 6-10. NERC expects demand for electricity to increase over the next ten years by nineteen percent in the U.S., but expects confirmed power capacity to increase by only six percent. *Id*. at 11-14. Accordingly, capacity margins are projected to drop below minimum target levels in the western U.S. *Id*. In Western Electricity Coordinating Council ("WECC") territory specifically, "[d]ue to a slight decrease in existing generating capacity and a significant decrease in reported generation additions, capacity margins . . . are reported as declining throughout the ten-year assessment period." *Id*. at 19. NERC predicts summer electricity supply shortages relative to study planning margins as early as 2009, assuming no resource additions beyond those presently under active construction. *Id*. Such drops alert NERC to the increased potential for shortages in electricity due to fuel disruptions, particularly for natural gas: "The supply and delivery of gas to electric generators can be disrupted when electric generation demands for gas coincide with high gas demands for other customers. In some cases, even firm gas contracts for electric generation can be curtailed in favor of residential heating needs during extreme cold weather." *Id*. at 9. By shifting Nevada's energy portfolio to natural gas – the reallocation of resources that the Petition would cause, if granted – Nevada places itself in a position of increased system reliability risk. Instead of increasing system capacity as NERC recommends, Nevada would be taking action which would reduce available system capacity.

Further, heavy reliance upon renewable energy options is currently a high-risk and unrealistic option for Nevada. First, it is unlikely that renewable energy can meet this large demand without a significant price impacts. Renewable power has been and continues to be far more expensive than conventional generation options. Four western states (Arizona, Colorado, New Mexico, and California) have also adopted renewable portfolio requirements that plan to draw upon these same renewable resources. Other western states are also considering adopting similar standards that would push demand for renewables above 140 TWh. How much renewable resources can be developed, when, and at what cost? These are critical substantive questions the SEC must answer before considering whether to grant the Petition.

B. <u>The Petition Would Hinder Advanced Clean Coal Technology Development.</u>

The Petition works against the goal of encouraging future clean coal technology development in Nevada. An outright ban on coal-fueled electric generation would only discourage investment in such new technologies, as no project using advanced technologies that may meet a future greenhouse gas emissions standard could be considered based upon the language of WRA's proposal.

VI. THE PETITION'S SUGGESTION OF PROHIBITING POWER PURCHASES THAT DO NOT MEET WRA'S PROPOSED STANDARD VIOLATES THE COMMERCE CLAUSE OF THE U.S. CONSTITUTION

The Petition would preclude coal generation from competition in Nevada power markets. The proposal plainly "blocks the flow" of such generation at the Nevada border, and in doing so, would violate the Commerce Clause of the U.S. Constitution.

A. The Petition Will Preclude Out-of-State Suppliers from Competing in Nevada's Markets.

The reality of the Petition's proposed language dictates that it will preclude out-of-state suppliers from competing in Nevada markets. The Supreme Court of the United States has stated that "where simple economic protectionism is effected by state legislation, a virtually *per se* rule of invalidity has been erected. The clearest example of such legislation is a law that overtly blocks the flow of interstate commerce at a State's borders." *City of Philadelphia v. New Jersey*, 437 U.S. 617, 624 (1978) (internal citations omitted) (state may not ban importation of solid waste while allowing disposal of in-state waste). The Supreme Court has found it to be equally clear that electric power raises interstate commerce concerns: "it is difficult to conceive of a more basic element of interstate commerce than electric energy, a product used in virtually every home and commercial or manufacturing facility."[5] "A state cannot block imports from other states, nor exports from within its boundaries, without offending the Constitution."[6] WRA's proposal will necessarily prohibit coal-fueled electricity from being imported into Nevada.[7]

In *Pike v. Bruce Church*, 397 U.S. 137 (1970), the Supreme Court articulated the balancing test used to determine whether state laws and regulations are valid under the Commerce Clause:

> Where the statute regulates evenhandedly to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits…. If a legitimate local purpose is found, then the question becomes one of degree. And the extent of the burden that will be tolerated will of course depend on the nature of the local interest

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[5] *Federal Energy Regulatory Comm'n v. Mississippi*, 456 U.S. 742, 757 (1982).

[6] *City of Philadelphia v. New Jersey*, *supra*, 437 U.S. at 620.

[7] Yvonne Gross, "Kyoto, Congress, or Bust: The Constitutional Invalidity of State CO2 Cap-and-Trade Programs," manuscript at 19, Thomas Jefferson Law Review, Vol. 28, No. 205, 2005 Available at SSRN: http://ssrn.com/abstract=883687.

> involved, and on whether it could be promoted as well with a lesser impact on interstate activities.

Id. at 142 (internal citations omitted).

To meet the requirements of the Commerce Clause, a regulation must satisfy the *Pike* test. *Pike,* 397 U.S. at 142, discussed *supra* at 15. Under the *Pike* test, even if a regulation is evenhanded, it must effectuate a *legitimate local public interest*. *Id*. The plain fact is, however, that Nevada's potential enactment of WRA's proposal will itself achieve little, if any, climate change. *See, e.g.*, Benjamin Zycher, PhD, *California Focus: Another Enviro-Scare Campaign*, California Republic & Orange County Register, August 29, 2006 (noting that if California were to achieve 1990 CO_2 emissions levels under its proposed greenhouse gas emissions program, "the predicted decline in world temperatures in the year 2100 would be thirteen one-thousandths of a degree Celsius," and that if the entire United States achieved such reductions, "the decline would be sixteen one-hundredths of a degree Celsius.").

1. The Interim Ban on Construction of Coal Fueled Generation and the Suggested Emissions Performance Standard Would Have a Discriminatory Effect on Interstate Commerce.

Various Supreme Court decisions have struck down regulatory enactments that required particular economic activity to be performed within the jurisdiction.[8] The discrimination in each of these cases was based on geographic origin. In each case, the regulating jurisdiction (state, county, or city) drew a line around itself and treated those inside the line more favorably than those outside the line. These arrangements are protectionist, either in purpose or practical effect, and amount to virtually *per se* discrimination.

The ability of out-of-state coal-fueled generation plants to export their electricity into Nevada would be foreclosed altogether – as the limitation in the WRA Petition precludes in-state utilities and other load-serving entities from the purchase and importation of coal-fueled generation. Petition at 2-3. The Petition's proposal discriminates against coal-fueled energy in interstate commerce, and accordingly, offends the Commerce Clause of the U.S. Constitution.

For example, in *United States v. Wrightwood Dairy Co.*, 315 U.S. 110 (1942), the Supreme Court held that, because milk produced and sold wholly within a state competes with and impacts the price of milk shipped in from out-of-state, the U.S. Department of Agriculture

[8] *See*, *e.g.*, *Dean Milk Co. v. Madison*, 340 U.S. 349 (1951) (unconstitutional for city to require milk to be pasteurized within five miles of the city); *Fort Gratiot Sanitary Landfill, Inc. v. Michigan Dept. of Natural Resources*, 504 U.S. 353 (1992) (unconstitutional for county to prevent a landfill owner from accepting for disposal solid waste produced outside of the county); *Minnesota v. Barber*, 136 U.S. 313 (1890) (unconstitutional for state to require meat sold within the state to be examined by state inspector); *Foster- Fountain Packing Co. v. Haydel*, 278 U.S. 1 (1928) (unconstitutional for state to require that shrimp heads and hulls must be removed before shrimp can be removed from the state); *South-Central Timber Development, Inc. v. Wunnicke*, 467 U.S. 82 (1984) (unconstitutional for state to require all timber to be processed within the state prior to export).

properly regulates the pricing of milk produced and sold wholly within a state. Like the milk at issue in *Wrightwood Dairy*, electricity generated in other states competes with electricity generated in Nevada. Limiting Nevada's ability to include coal-fueled generation in energy procurement discriminates against the interstate trade of electric generation, and in doing so, depresses the price of electricity in the exporting state by reducing the level of demand it might otherwise satisfy, thereby imposing an unconstitutional burden on out-of-state generators.[9]

2. The Interim Ban on Construction of Coal Fueled Generation and the Suggested Emissions Performance Standard Would Have an Extraterritorial Effect on Interstate Commerce

The Supreme Court has also ruled that it is a *per se* violation for one state to regulate conduct in another state. For example, the Supreme Court found in a series of cases that States cannot adopt regulations that tie in-state liquor prices to out-of-state liquor prices.[10] The WRA proposal precludes access to the Nevada market, and its proposed regulations would have a negative effect on out-of-state generators. The Supreme Court has held that a law may have an impermissible extraterritorial scope even when, technically, it applies only to conduct within the state: "The critical inquiry is whether the practical effect of the regulation is to control conduct beyond the boundaries of the State."[11] Here, the Petition's proposed action cannot avoid having the practical and actual effect of regulating the "greenhouse gas" emissions of out-of-state generators selling into the Nevada market, thus unlawfully controlling commercial conduct beyond the borders of Nevada.

VII. CONCLUSION

The WRA Petition proposes, and is based upon, an unrealistically low greenhouse gas emissions standard. The Petition lacks any cost containment information necessary to protect ratepayers, and denies Nevada the means necessary to provide for its growing need for additional electric generation. The Petition, if granted, would increase Nevada's dependence on natural gas to supply its power needs, would prohibit out-of-state power suppliers from competing in baseload Nevada power markets, and would eliminate or create disincentives for continued development of cleaner coal-fueled electric generation, thereby harming the State of Nevada and its citizens. Moreover, because SEC risks violating the laws of the State of Nevada and the U.S. Constitution if it were to grant the Petition, CEED respectfully urges the SEC to deny the WRA Petition.

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[9] Gross, *supra* note 12, manuscript at 20.

[10] *Healy v. Beer Inst.*, 491 U.S. 324, 332 (1989); *Brown-Forman Distillers Corp. v. N.Y. State Liquor Auth.*, 476 U.S. 573 (1986).

[11] *Healy*, 491 U.S. 336; *accord Brown-Forman*, 476 U.S. 583.

Sincerely,

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The Linkage of Economic Prosperity and Low-cost Energy to Improved Public Health

Federal, state, and local policymakers concerned about the relationship between energy, the environment, and health should become familiar with the work of M. Harvey Brenner, PhD., an internationally noted expert in the fields of economics and public health. Dr Brenner's research demonstrates that macroeconomic factors—and energy costs—play a leading role in human health. In 2005, Dr. Brenner published two important articles based on his update of research he originally conducted for the Congressional Joint Economic Committee. These articles are summarized below.

International Journal of Epidemiology, July 2005

In his article, "Economic Growth Is the Basis of Mortality Rate Decline in the 20th Century," Dr. Brenner noted, "It is now among the firmest of epidemiological findings, across industrial societies, that socioeconomic status is inversely related to health status." In other words, higher income reduces the odds of premature death; lower income increases morbidity and mortality.

Since 1984, at least seventeen European and U.S. studies have found higher income, employment security, and improved "socioeconomic status" can reduce an individual's risk of disease and premature death. Brenner's work contributes significantly to this body of research. According to Brenner, "Economic growth, cumulatively over at least a decade, is the central factor in mortality rate decline in the U.S. over the 20th century."

However, he noted, "volatility of changes in that growth was – in the very short-term – a source of increased mortality." Such volatility, which can lead to longer-term unemployment and place the unemployed at risk for a downturn in socioeconomic status, introduces significant risk to health and life expectancy through "increased exposure to alcoholism and use of other psychotropic substances such as tobacco and less expensive/nutritious foods."

Brenner concluded, "It is crucial to place the health impact of the small oscillations represented by annual changes in economic growth into the broader context of the

principal…trends of economic development," however, "…the net effect of increased unemployment is a substantial increase in mortality."

EM, November 2005

EM (the Air and Waste Management Association's journal for environmental managers) published a case study relating Dr. Brenner's work to the cost of energy. In "Health Benefits of Low-Cost Energy: An Econometric Case Study." Dr. Brenner stated that key economic factors leading to improvements in the national economy mean longer life and reduced rates of mortality. Conversely, he found strong evidence that decreased per capita income and greater unemployment contribute to increased mortality. The key macro-economic factors Brenner identified in his research are 1) real GDP per capita, 2) the employment ratio, 3) unemployment rate, and 4) the interaction between GDP and unemployment as coincident and lagging business cycle indicators.

In particular, Brenner stated "the damaging effects of increased unemployment and acute business cycle disturbances" are key drivers of overall mortality trends and are as robust and statistically significant as the benefits of higher income and stable employment.

Brenner acknowledged that health-risk factors (such as obesity, tobacco consumption, cholesterol levels, and family history) are also important predictors of human health and mortality. He found, however, that "while known risk factors to health, such as high consumption of tobacco, alcohol, and fatty foods, are additionally significant predictors of mortality, they are subordinate to the main economic predictors [the four macro-economic factors above] that routinely influence mortality."

As a consequence, when Brenner applied his econometric model to a hypothetical regulatory case study in which higher-cost fuels displace U.S. coal to generate electricity, he discovered the adverse impact on household income and unemployment could result in 195,000 additional premature deaths annually. That figure is on the low end of a range between 171,000 and 369,000 deaths.

According to Brenner, his case study results can be applied to specific policies affecting coal-fueled electricity generation. For example, the U.S. Department of Energy estimated that certain climate change policies proposed in the U.S. Congress could result in

up to 78% of U.S. coal-based generation being replaced by higher-cost energy sources. In that instance, Brenner believes that "increased mortality rates would result from decreased household income and increased unemployment associated with a shift to higher cost energy supply options, absent any direct mitigation programs that effectively prevented or offset these effects."

Brenner added, "The technological bases of long-term economic growth continue to involve the harnessing of energy supplies to enable humans to produce more per unit of labor or capital investment. The economic growth that continuously improves human life expectancy requires access to affordable energy. In this fundamental sense, any policy change that reduces economic growth or raises the level of unemployment should be defined and addressed as a public health issue requiring an economic policy response that limits or offsets these results."

This led Dr. Brenner to conclude that "growth in real per capita income is the backbone of declines in the U.S. mortality rate." His research showed that, by increasing the costs of goods and services such as energy - and decreasing disposable income, government regulation can inadvertently harm individuals' socioeconomic status "and thereby contribute to poor health and premature death." Therefore, according to Brenner, "Governmental programs intended to protect public health and the environment should take into account potential income and employment effects of required compliance measures."

Implications for Policy Makers

Brenner's work shows that a combination of smart individual health practices, along with changes in regulatory standards for air and water quality, are not necessarily sufficient to maintain or improve individual health. Public policy makers must recognize the costs and potential unintended consequences that regulatory programs can have on employment and income. These costs and unintended consequences particularly affect the health of lower income Americans.

In this context, public policy makers should focus clearly on the importance of low-cost energy. "Energy is among the most indispensable ingredients of human existence," Brenner writes. Making energy more expensive decreases per-capita income and

employment, and might, in effect, bring about a net increase in population mortality, according to Brenner.

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M. Harvey Brenner is Professor of Health Policy and Management at the Johns Hopkins University Bloomberg School of Public Health (Baltimore, Maryland) and Senior Professor of Epidemiology at the Berlin University of Technology (Berlin, Germany).

Dr. Brenner's coal case study reported in *EM* was supported by a research grant from the Center for Energy and Economic Development (CEED). The research and conclusions referenced above are his own. CEED is a national, non-profit organization dedicated to providing information and research to policy makers and opinion leaders about the importance of affordable, reliable, and environmentally compatible coal-fueled electricity.

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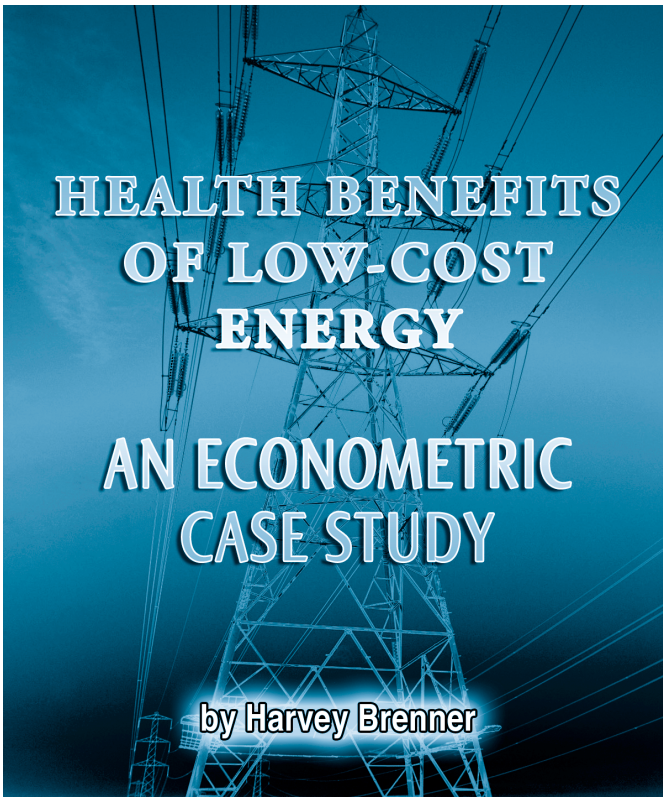

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Disclaimer: The research described in this article was supported by a grant from the Center for Energy & Economic Development Inc. The author accepts sole responsibility for the findings, conclusions, and opinions expressed herein.

Numerous studies conducted in the past 10–15 years have indicated that economic factors, such as income, employment, and socioeconomic status, affect disease and death.[1] The case study research described in this article shows how a large-scale econometric model—the application of statistical methods to the study of economic data and problems—can accurately predict long-term U.S. mortality trends based on variables such as per-capita income and unemployment rates (see Figure 1). In addition, it demonstrates that even short-term, year-to-year fluctuations in economic indicators can accurately predict year-to-year fluctuations in population mortality rates (see Figure 2). These results leave little doubt that the statistically significant relationships between socioeconomic indicators and population mortality rates identify principal risk factors to a population's health.

AN ECONOMETRIC MODEL

An econometric model was applied to a hypothetical regulatory case study, whereby U.S. coal was replaced by alternative higher-cost fuels such as natural gas for the purpose of electricity generation. The model was used to estimate the premature mortality associated with increased unemployment and reduced personal income. The adverse impacts on household income and unemployment due to the substitution of higher-cost energy sources were estimated to result in 195,000 additional premature deaths annually (see Table 1).

The results from this hypothetical case study may be scaled to apply to specific policy initiatives affecting the U.S. coal-based electricity generation sector. For example, the U.S. Department of Energy's Energy Information Administration (EIA) estimates that climate change bills currently before the U.S. Congress—such as Senate Amendment No. 2028, rejected by the Senate in 2003 and again in June 2005—could result in the displacement of up to 78% of U.S. coal-based electricity generation with higher-cost energy sources.[2] The methodology employed here suggests that, absent any direct mitigation measures to offset expected decreases in employment and income,[3] implementation of such measures could result in an annual increase of premature mortality rates by more than 150,000.

> Governmental programs intended to protect public health and the environment should take into account potential income and employment effects of required compliance measures.

These predicted mortality trends are an order of magnitude greater than recent estimates of the premature mortality benefits associated with implementation of the U.S. Environmental Protection Agency's 8-hr ozone standard (approximately 1000–3000 premature deaths avoided annually)[4] and fine particulate ($PM_{2.5}$) standard (approximately 15,000 premature deaths avoided annually).[5] In this context, a major implication of this research is that governmental programs intended to protect public health should take into account potential income and employment effects of required compliance measures. By increasing the costs of goods and services such as energy, and decreasing disposable incomes, regulation can inadvertently harm the socioeconomic status of individuals and, thereby, contribute to poor health and premature death.

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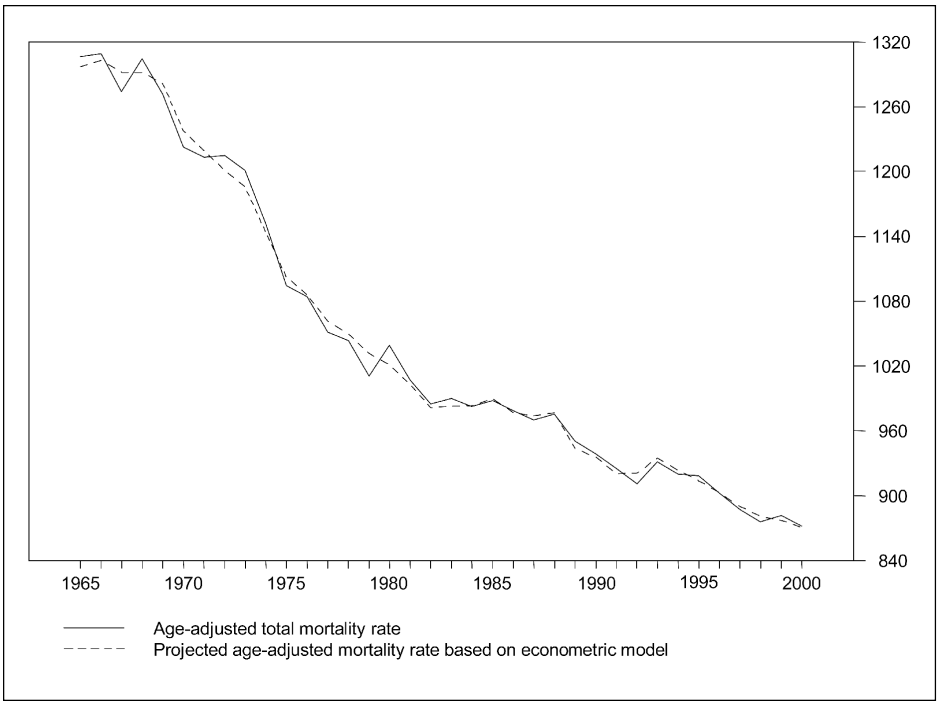

Figure 1. U.S. total mortality rate, real and projected, 1965–2000 (Level model; age-adjusted per 100,000 population).

ENERGY AND HEALTH

Energy is among the most indispensable ingredients of human existence. Like most advanced industrial economies, the United States depends primarily on carbon-based (and carbon-emitting) energy. In 2003, U.S. energy users consumed a total of 98 quadrillion British Thermal Units (quads) of energy, including 39 quads of petroleum, 23 quads of natural gas, and 23 quads of coal. Nuclear, hydro, and other non-carbon-emitting energy sources supplied the remaining 14 quads, or 15% of total energy consumption.[6] Emissions from coal-based electricity generation plants alone represented one-third of U.S. carbon dioxide (CO_2) emissions in 2002.[7]

A substantial body of literature has developed examining the potential impacts of proposed restrictions on greenhouse gas emissions on the national gross domestic product (GDP), energy prices, income, and employment.[8] It has been estimated, for example, that global climate change initiatives requiring expanded use of high-cost, lower-carbon energy alternatives such as natural gas 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,[1,3,9-11] it follows that these proposed policies might, in effect, bring about a net increase in population mortality.

LINKS BETWEEN HEALTH AND INCOME

The socioeconomic-status findings show that changes in the economic status of individuals produce subsequent changes in the health and life span of those individuals. Unfortunately, traditional epidemiological literature has not dealt with the issue of change in socioeconomic status in relation to changes in health status. However, another body of research shows that decreased real income per capita and increased unemployment have consequences that lead to increased mortality in U.S. and European populations.[3,9-11] This literature uses econometric analyses of time-series data to measure the relationship between changes in the economy and changes in health outcomes.

The econometric approach to health impact assessments was developed initially in two studies for the Joint Economic Committee (JEC) of the U.S. Congress in 1979[9] and 1984.[10]

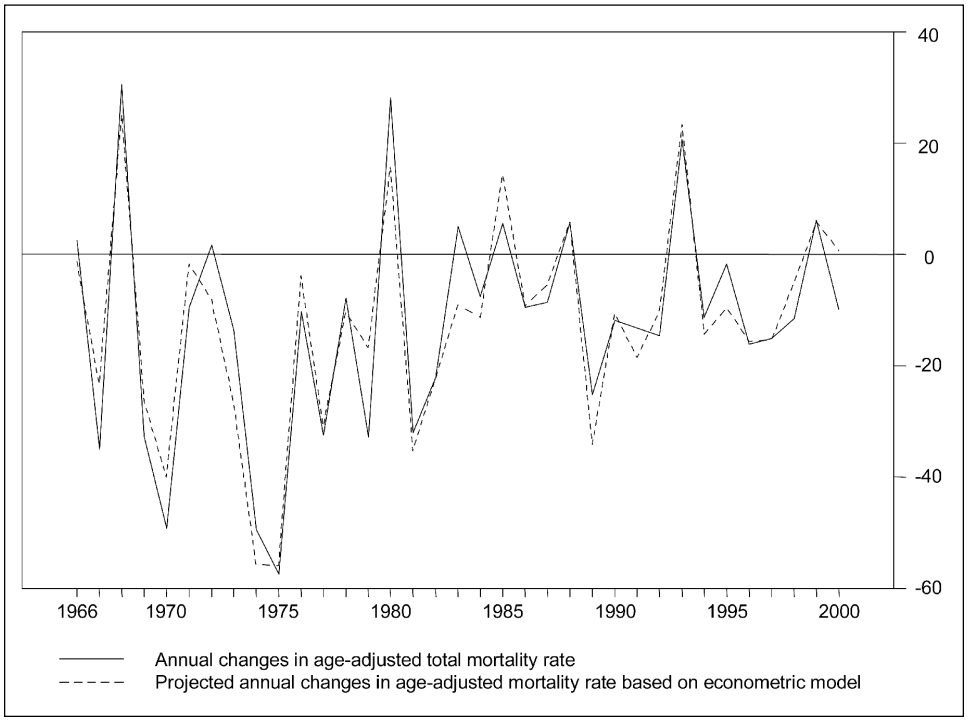

Figure 2. Annual changes of U.S. total mortality rate, real and projected, 1966–2000 (First difference model using error correction method [ECM]; age-adjusted per 100,000 population).

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Table 1. Estimates of premature mortality impacts in 2010 of hypothesized elimination of coal utilization for electricity generation.

Year	U.S. Population	Annual Growth
2000	282,125,000	
2010	310,013,000	0.95%

Model Types		Base (2010)	Mortality Rates[a] Final	Delta	Number of Deaths Base	Final	Low SD (95% confidence)[b]	Delta	High SD (95% confidence)[b]	Delta Growth (%)[c]
Model 1 – Unemployment Rate (UR)	Level model	797	852	55	2,470,804	2,641,311	166,505	170,507	174,510	6.9
	First difference model	811	870	59	2,514,205	2,697,113	178,282	182,908	187,533	7.3
Model 2 – Employment Rate (ER)	Level model	885	947	62	2,743,615	2,935,823	188,555	192,208	195,861	7
	First difference model	915	976	61	2,836,619	3,025,727	185,620	189,108	192,596	6.7
Model 3 – GDP per capita (GDPP)	Level model	1392	1,504	112	4,315,381	4,662,596	342,597	347,215	351,832	8
	First difference model	1463	1,582	119	4,535,490	4,904,406	364,252	368,915	373,579	8.1
Model 4 – Model # 3 level with Model #2 first difference	First difference model	1406	1469	63	4,358,783	4,554,091	193,181	195,308	197,435	4.5
Average		**1096**	**1171**	**76**	**3,396,414**	**3,631,581**	**231,285**	**235,167**	**239,049**	**6.9**

Model Type	Mortality Rate	Weights[d]	Number of Deaths
Model 4	**Delta**		
First difference model	195,308		
UR		0.246	48,079
ER		0.266	52,037
GDPP		0.487	95,192
Total		**1.000**	**195,308**

[a]Base = 2010 forecast; Final = 2010 forecast with coal utilization impact. The impact on UR is the average of the DRI[14] and Rose and Yang[15] estimates for job loss % change from the 4% assumed 2010 base level. The impact on ER is assumed to be a minus 2% change from the 2010 base level. The impact on GDPP is the average of the DRI[14] and Rose and Yang[15] estimates for personal income % change the 2010 base level; Delta = 2010 forecast, no population assumption needed. [B]Error forecast standard deviation (SD). [c]Delta mortality rate divided by the 2010 base forecast. [d]Weights calculation = Step 1: GDPP weight is estimated as 1 minus Delta from Model 2 first difference divided by Delta from Model 3 first difference; Step 2: UR weight is estimated as 1 minus GDPP weight divided by 2 multiplied by Delta from Model 1 first difference divided by Delta from Model 2 first difference; Step 3: ER weight is estimated as 1 minus GDPP weight minus UR weight; by definition weights sum to 1.

These studies demonstrated 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, the 1984 JEC study found that a one-percentage-point increase in the unemployment rate (e.g., from 5% to 6%) would lead to a 2% increase in the age-adjusted mortality rate. 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. Over the past four years, the European Commission has supported similar research showing comparable results throughout the European Union.[11]

UPDATED MODEL RESULTS

The research described in this article updates the 1984 JEC analysis. U.S. data for the period 1965–2000 were employed to estimate mortality rates and other health effects of changes in economic conditions. The econometric model combined four predictive factors in the explanation of U.S. mortality trends and fluctuations:

1. real GDP per capita (beneficial impact on mortality);
2. employment ratio (beneficial impact);
3. unemployment rate (harmful impact); and
4. the interaction between GDP and unemployment as coincident and lagging business-cycle indicators (harmful impact).

At the national level, the findings confirmed that the

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hypothesized benefits of real income per capita and employment were strong and statistically significant, while the damaging effects of increased unemployment and acute business-cycle disturbances were similarly robust and statistically significant. Figure 1 demonstrates the model's projection of U.S. mortality rates.

As in the 1984 JEC study, the upward trends in real income per capita represented the most important factor in decreased U.S. mortality rates since the 1960s. Also, the unemployment rate continued to bear a significant correlation to increased mortality rates, such that an increase of 1% in the unemployment rate eventuates in an approximately 2% increase in the age-adjusted mortality rate, estimated cumulatively over at least the subsequent decade.

> In sum, growth in real income per capita is the backbone of decreases in the U.S. mortality rate.

In sum, growth in real income per capita is the backbone of decreases in the U.S. mortality rate. There are several reasons for this. First, with respect to physical health, economic growth is fundamental in meeting basic population needs, such as nutrition, housing, health insurance,[12] medical care, sanitation, electricity, transportation, and climate control. In addition, economic growth enables increased industrial investment in pollution control technologies and safer work environments, with minimal adverse workplace exposures to chemicals, noise, and unsanitary conditions.

Year-to-year fluctuations in mortality rates are largely explained by annual changes in the behavior of variables in the model (see Figure 2). This means that a decline in the mortality rate from one year to the next (e.g., between 1981 and 1982) is related to increased real income per capita and declining unemployment rates during that same year's change (1981–1982) and the (approximately) 10 years prior to that same year's mortality decline.

State and Regional Analyses

If the economic model explaining mortality changes in the overall United States applied to all of its regions, or to a large number of states, then it would necessarily follow that the historical pattern of mortality rate changes in the regions and states would resemble one another. If true, this would be remarkable, in that there is no existing literature indicating that the trends and fluctuations in mortality rates are similar among the major regions of the United States.

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Regional and state modeling to test the robustness of the national model constituted a major effort of the present analysis.

The U.S. national-level model was applied to the explanation of mortality rate changes in five populous and geographically diverse states: California, Texas, New York, Florida, and Illinois. The results were remarkably similar in that the overall U.S. model applied quite precisely to each of those five states. The model's principal predictive variables all showed statistically robust relations to the age-adjusted mortality rate. It should be pointed out that the coefficients, representing the extent of change in mortality related to changes in the economic variables, were not identical from state to state. Nevertheless, it is important to note that the same economic model described historical changes in mortality rates of states thousands of miles from one another, with vastly different economies, patterns of urbanization, and a host of lifestyle, social, and environmental factors. Similar findings resulted from application of the model to regional data for the United States.

All statistical tests traditionally used in time-series analysis, as well as the forecasting capacity of the model, demonstrate that each of the variables in the model plays a highly significant role and that the entire model is of great statistical significance. The overall results, prevalent throughout the United States, demonstrate (1) long-term declining mortality rates related to patterns of economic growth, and (2) short-term fluctuations in mortality rates associated with recessions, structural unemployment rates, and the lag of unemployment rates behind changes in real GDP per capita (a standard feature of the business cycle).

CASE STUDY: MORTALITY EFFECTS OF ENERGY SUPPLY CHANGES

The national econometric model was applied to a case study to quantify the increased mortality rate that could result from potential decreased real income per capita and increased unemployment rates due to regulatory constraints on U.S. coal utilization. Numerous policy proposals to reduce greenhouse gas emissions have called for restrictions of carbon emissions by the U.S. electricity-generating sector.[13]

Under the hypothetical scenario that coal production and related electricity generation were eliminated in favor of lower-carbon, higher-cost alternatives such as natural gas combined-cycle generation, an additional 195,000 premature deaths were estimated to occur by the year 2010 (see Table 1). This is a conservative estimate based on a tight construction of the assumptions of the future behavior of the study variables (e.g., real income per capita, unemployment rates) to 2010.

The case study used inputs from two analyses of the impacts of reduced coal utilization on U.S. income and employment data, each offering disaggregated state-level estimates of income and employment effects. Standard & Poor's DRI (1998)[14] and Rose and Yang of The Pennsylvania State University (2001)[15] used alternative macroeconomic and input–output models, respectively, to estimate the reductions of income and employment associated with large-scale displacement of coal use. The findings from these studies were scaled to approximate the effects of a hypothetical 100% replacement of coal. Thus adjusted, the estimated increased unemployment in 2010 ranged from 3.2 million (Rose and Yang) to 4.6 million jobs (DRI). The reduction in household income was estimated in a range of $166 billion (Rose and Yang, 1999$) to $363 billion (DRI, 1992$).

This upward scaling provided the basis for an assessment of policy proposals that could result in specific energy supply changes. For example, in a recent study, EIA estimates that the climate change proposals currently before the U.S. Congress could lead to the displacement of 59–78% of U.S. coal-based electricity generation by higher-cost natural gas and other alternative generation sources.[2]

The results from this hypothetical case study demonstrate that increased mortality rates would result from decreased household income and increased unemployment associated with a shift to higher cost energy supply options, absent any direct mitigation programs that effectively prevented or offset these effects. The estimated increased mortality in the year 2010, based on four different variations of the econometric model, ranges from an additional 170,507 to 368,915 deaths for the displacement of 100% of coal-based generation. A moderately conservative estimate based on an annual change model would be an additional 195,308 deaths. This point estimate has a 95% confidence interval of 193,181–197,435 individual deaths.

Given an estimated potential displacement of 78% of U.S. coal generation based on EIA's study of proposed climate

REFERENCES

1. See Wildavsky, A. *Searching for Safety*; Transaction Books (Rutgers University): New Brunswick, NJ, 1988; Keeney, R. Mortality Risks Induced by Economic Expenditures; *Risk Analysis* **1990**, *10* (1); 147-59; Adler, N. Ostrove, J. Socioeconomic Status and Health: What We Know and What We Don't; *Ann. NY Acad. Sci.* **1999**, *896*; 3-15.
2. *Analysis of Senate Amendment, 2028*; U.S. Department of Energy's Energy Information Administration: Washington, DC, May 2004; Table 2.
3. See *Employment in Europe 2000, Recent Trends and Prospects*; European Commission Dir.-Gen. for Employment and Social Affairs, Unit A.1: Luxembourg, 2003; *Employment Policies in the EU and in the Member States—Joint Report, 2002*; European Commission Dir.-Gen. for Employment and Social Affairs, Unit A.1: Luxembourg, 2003; *Human Capital in a Global and Knowledge-Based Economy, Part II: Assessment at the EU Country Level*; European Commission Dir.-Gen. for Employment and Social Affairs, Unit A.1: Luxembourg, 2003.
4. Hubbell, B.; Hallberg, A.; McCubbin, D.; Post, E. Health-Related Benefits of Attaining the 8-Hr Ozone Standard; *Environ. Hlth. Perspect.* **2005**, *113*; 83-82.
5. *Regulatory Impact Analysis for the Particulate Matter and Ozone National Ambient Air Quality Standards and Proposed Regional Haze Rule*; ES-18; U.S. Environmental Protection Agency: Washington, DC, July 15, 1997.
6. *Short-Term Energy Outlook, 2004*; U.S. Department of Energy's Energy Information Administration: Washington, DC, 2004.
7. *Annual Energy Outlook, 2004*; U.S. Department of Energy's Energy Information Administration: Washington, DC, 2004.
8. See *Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity*; U.S. Department of Energy's Energy Information Administration: Washington, DC, 1998; The High Costs of the Kyoto Protocol; Wharton Econometric Forecasting Associates Inc.: Philadelphia, PA, 1998; Manne, A.; Richels, R. *Economic Impacts of Alternative Emission Reduction Scenarios*; American Council for Capital Formation Center for Policy Research: Washington, DC, 1998.
9. Brenner, M.H. *Estimating the Social Costs of National Economic Policy: Implications for Mental and Physical Health and Criminal Aggression*; Joint Economic Committee, U.S. Congress: Washington, DC, 1979.
10. Brenner, M.H. *Estimating the Effects of Economic Change on National Health and Social Well-Being*; Joint Economic Committee, U.S. Congress: Washington, DC, 1984.

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change initiatives, the indicated premature mortality from reduced income and increased unemployment would exceed 150,000 deaths annually, absent any direct and effective mitigation programs.[3] The effects of other policy measures entailing significant, near-term disruption of energy supply markets could be estimated with a similar linear interpolation of these model results. However, the model does not reliably lend itself to estimation of mortality effects associated with relatively minor shifts in regional coal production or electricity generation (e.g., 10–15%). In many instances, such production shifts tend to be offsetting, as production decreases in one region are offset by gains elsewhere.

Effects of Lagged Relationships

The relationship between change in the economic circumstances of people's lives and their subsequent health status unfolds over time. In the case of sharp stress reactions to financial or employment catastrophes, the reaction patterns may be very rapid, that is, within a single year. This is clearly the case when suicide rates are factored in, as these rates typically rise sharply within several months of increases in national unemployment rates. Chronic diseases such as cardiovascular diseases, on the other hand, are known to respond to many different health risk factors within years, if not decades.

In addition to the potential health effects of income loss and unemployment, one has the problem of judging at what point to begin the estimation of the impact of increased unemployment. The difficulty here is that in classic analyses of business cycles, national income—specifically, GDP per capita—is a "coincident" business cycle indicator, meaning that changes in it tend to coincide with the timing of business cycles. Unemployment rates, on the other hand, are "lagging" business cycle indicators. This means that, despite even robust economic growth, during much of the initial year of recovery from a recession, unemployment rates may still remain high.

If one does not take into account these basic relationships between income and unemployment change on one hand and mortality on the other over at least a decade, it is possible to arrive at the misinterpretation that without lag there might be a negative relation between unemployment and mortality. This could imply that unemployment (in the very short term) is related to decreased mortality.[16] This type of error becomes more likely if one does not control for the usual impact of traditional risk factors on mortality, such as the effects of tobacco and saturated fat consumption on cardiovascular mortality rates over at least a decade.

In virtually all of the studies on unemployment and health, unemployment (especially long-term) is definitively associated with higher illness and mortality rates at the individual level of analysis.[17] But perhaps the most powerful evidence that economic growth is the fundamental source of life-span longevity improvement is that, as shown in the present study, the trends of decline in mortality rates across diverse states and regions of the United States are related to those in real GDP per capita cumulated for at least 10 years.

Influence of Other Health Factors

The model described here was evaluated to determine whether control for principal epidemiological risk factors to health would render the predictive variables insignificant. The result was that, while known risk factors to health, such as high consumption of tobacco, alcohol, and fatty foods, are additionally significant predictors of mortality, they are subordinate to the main economic predictors of the model that routinely influence mortality.

Since the late 1960s, increasing real income per capita in the United States is no longer positively related to consumption of tobacco, alcohol, and fatty foods. Indeed, after 1970, in the United States and much of Europe, these health risk factors ceased to be found more frequently in higher income segments of society and came to be linked instead to the lifestyles of lower socioeconomic groups. Thus, the population groups that generally have benefited least from economic growth and have been most vulnerable to problems of structural and cyclical losses of employment are most likely to suffer from the risks of dietary and addictive "lifestyle" health risks.

CONCLUSIONS

This study demonstrates the fundamental importance of sustained economic growth to health and improved life span for the U.S. population. The technological bases of long-term economic growth continue to involve the harnessing of energy supplies to enable humans to produce more per unit of labor or capital investment. The economic growth that continuously improves human life expectancy requires access to affordable energy. In this fundamental sense, any policy change that reduces growth or raises the level of unemployment should therefore be defined and addressed as a public health issue requiring an economic policy response that limits or offsets these results. The implication of the research described in this article provides an important basis for future studies of energy and health. **em**

11. See Brenner, M.H. *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; Brenner, M.H. *Unemployment and Public Health in Countries of the European Union*; European Commission Dir.-Gen. for Employment, Industrial Relations, and Social Affairs: Luxembourg, 2003.
12. See McWilliams, J.M.; Zaslavsky, A.; Meara, E.; Ayanian, J. Health Insurance Coverage and Mortality Among the Near-Elderly; *Health Affairs* **2004**, *23* (4); 223.
13. For example, S.139 calls for a two-phase reduction of U.S. carbon dioxide emissions, achieving stabilization of emissions at 2000 levels by 2010, and a return to 1990 emission levels by 2020. The scaled-down version of this bill (S.A. 2028) rejected by the U.S. Senate in 2003 sought to achieve stabilization of carbon emissions at 2000 levels by 2010.
14. The Impact of Meeting the Kyoto Protocol on Energy Markets and the Economy, Standard & Poor's DRI, New York, 1998.
15. Rose, A.; Yang, B. The Economic Impact of Coal Utilization in the Continental United States, The Pennsylvania State University, University Park, PA, 2001.
16. Ruhm, C.J. *Healthy Living in Hard Times*; Working Paper No. 9468; National Bureau of Economic Research: Cambridge, MA, 2003.
17. See Bjorklund, A.; Eriksson, T. (1998) Unemployment and Mental Health: Evidence from Research; *Work and Stress*, **2000**, *13*; 204-222; Kokko, K.; Pulkkinen, L.; Puustinen, M. Selection into Long-Term Unemployment and Psychological Consequence; *Int. J. Behavioral Develop.* **2000**, *24*; 310-320; Novo, M. Unemployment and Mental Health in Galicia, Spain; *Int. Arch. Occ. & Environ. Hlth.* **1999**, *72*; s14-s15; Tausig, M.; Fenwick, R. Recession and Well-Being; *J. Health and Soc. Behavior* **1999**, *40*; 1-16.

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Electricity from coal:
Powering our energy future

A report on research by Dr. Adam Rose,
Professor of Energy, Environment and Regional Economics
and Dan Wei, Graduate Research Assistant,
The Pennsylvania State University

Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015 (July 2006)

Electricity from coal:
Powering our energy future

For decades, Americans took affordable energy for granted. Recent energy price increases are now squeezing family budgets and reducing income available for food, medical care, and other necessities.

Today, over half of the electricity generated in the U.S. comes from coal. Coal is an abundant domestic energy resource, with enough proven reserves to last 250 years at current rates of usage. Even in an era of rising energy costs, coal-fueled electric power remains one of the lowest-cost sources of energy for consumers and industries.

Economic benefits of coal use

In their 2006 study, *Economic Impacts of Coal Utilization and Displacement in the Continental United States*, Professor Adam Rose and Dan Wei of Pennsylvania State University examine the prospective effects of coal-generated electricity on state economies. Their study estimates that coal will add more than $1 trillion to U.S. economic output in 2015, along with 4.6 to 9.0 million jobs.

Using coal to generate electricity provides affordable energy to millions of Americans. Coal will add more than $1 trillion to the U.S. economy in 2015.

The Penn State study also considers the potential adverse economic consequences of reduced coal utilization on state and regional economies. Policies restricting coal use, such as proposed government-mandated measures to reduce greenhouse gas emissions, could cost millions of jobs and reduce family incomes by billions of dollars annually as a direct result of higher energy costs. For the first time in a study of this type, the positive offsetting benefits of alternative investments in natural gas and renewable energy sources, such as wind and biomass, were factored into the calculations.

Using a range of future energy price projections, the economists estimated that U.S. coal-based electricity generation in 2015 will provide:

- ✓ $714 billion to $1.38 trillion in increased economic output;
- ✓ $242 to $482 billion in increased household earnings; and
- ✓ 4.6 to 9.0 million additional U.S. jobs.

These significant benefits reflect the close interdependence of major segments of the U.S. economy. Because virtually all businesses rely on electricity to produce and sell goods and services, the economic power of coal-based energy extends far beyond the generation and sale of electricity. The availability of low-cost electricity produces powerful ripple effects that benefit the American economy as a whole.

Because reliance on coal as a fuel source for generating electricity varies from region to region, the economic benefits are not evenly spread across the U.S.

Even though electricity costs vary from state to state, coal-generated electricity is among the lowest-cost power produced in the U.S. The consumer cost-savings realized from using coal to generate electricity increase the disposable incomes of working families. This income, when used to buy other goods and services, creates additional economic benefits.

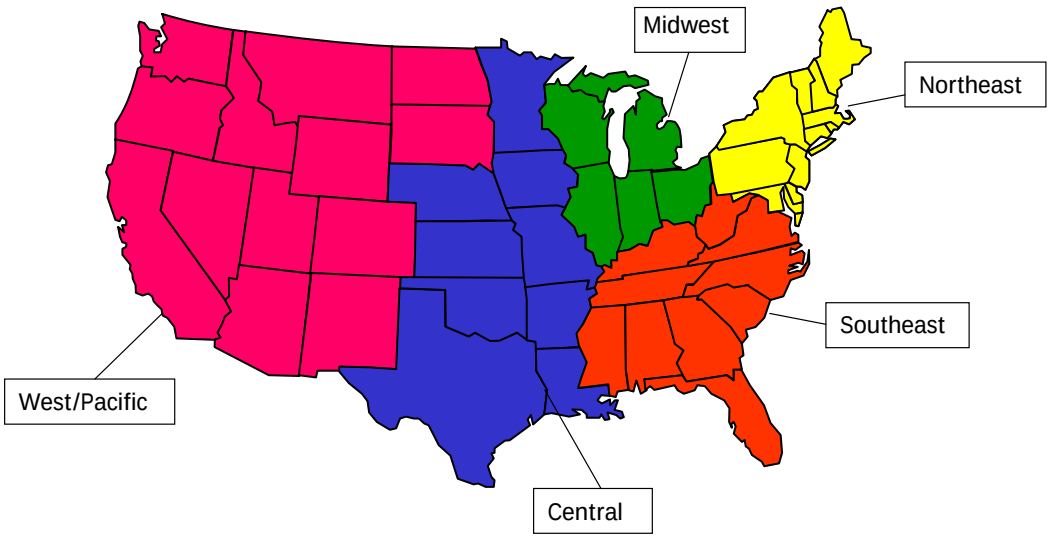
The study assessed three cases

Rose and Wei developed three cases to estimate the economic benefits of coal utilization and the potential costs of displacing coal using higher cost energy sources. The first case measures the overall "existence value" of coal by estimating the economic effects of completely replacing U.S. coal-based electric generation with higher-cost alternative fuels. The "existence value" case is intended to measure the aggregate economic and job benefits that the availability of coal-based electricity provides to the U.S. economy as a low-cost energy source.

Rose and Wei then simulated cases where alternative energy supplies (including natural gas, nuclear, and a 10 percent mix of renewables) displace coal-based electricity generation at levels of *66 percent* and *33 percent*. The two displacement scenarios utilize low, high, and average alternative energy cost projections.

They then divided the nation into five regions and calculated results for the three cases at state and regional levels. Rose and Wei found that, for all five regions – and for nearly every state individually – displacement of coal at these levels would have net negative economic impacts *even factoring in the positive offsetting multiplier impacts of replacement fuels and technologies*.

Penn State Study Regions



Regional results are summarized in the following table based on averages of the study's low and high energy price projections. These results show the overall <u>benefits</u> of the availability of coal as a low-cost electric energy resource along with the potential net <u>costs</u> of displacing coal-based power with higher-cost energy sources.

Summary of Penn State study results
(Billions of 2005 $ and millions of jobs)

Region	Overall coal generation benefits	Net costs of 33% coal displacement	Net costs of 66% coal displacement
Northeast			
Economic Output	$105	-$18	-$39
Household Income	$40	-$7	-$16
Jobs	0.6	-0.1	-0.3
Southeast			
Economic Output	$238	-$30	-$68
Household Income	$80	-$12	-$27
Jobs	1.6	-0.3	-0.6
Midwest			
Economic Output	$304	-$54	-$120
Household Income	$101	-$19	-$43
Jobs	1.8	-0.3	-0.7
Central			
Economic Output	$227	-$39	-$85
Household Income	$78	-$15	-$32
Jobs	1.5	-0.3	-0.6
West			
Economic Output	$174	-$25	-$59
Household Income	$63	-$10	-$24
Jobs	1.2	-0.2	-0.5
48 States			
Economic Output	$1,047	-$166	-$371
Household Income	$362	-$64	-$142
Jobs	6.8	-1.2	-2.8

Tables 1, 2, and 3 (see pages 7-9) provide state-by-state results for the three cases, based on an average of the study's low and high energy price projections.

The study concludes that coal-based electricity provides substantial economic benefits for large and small states alike. For example, Illinois, Indiana, Ohio, Texas, and Pennsylvania *each* stand to benefit from $42 billion to $84 billion in increased economic output because of using coal-based electricity. Smaller states also share in the advantages: New Hampshire, Connecticut, South Carolina,

Oregon, and South Dakota are *each* projected to gain between $1 billion and $7 billion in expanded annual output.

In *all* states, there was a negative net effect from displacing coal-based electricity under the high-price scenario. In nearly all states, the net effect was negative even under the low-price scenario.

The Penn State research also demonstrates that states that rely on coal for a substantial portion of electric generation, but do not produce coal, obtain significant benefits. For example, North Carolina and Georgia stand to realize $31 billion and $39 billion in higher state economic output, respectively, because of coal-based generation. California, which relies on "coal-by-wire" (imported electricity generated in other western states) for about 20% of its electricity, will gain $58 billion in increased state output. These results largely reflect the beneficial price differential effects of low-cost coal generation on state economies.

The study provides empirical proof of substantial economic advantages created by coal-based electricity, and the potential costs of displacing coal with higher-cost energy supplies.

Coal provides a balanced energy future

The Penn State study provides empirical proof of the substantial economic advantages created by the coal-fueled electricity industry. Low-cost electricity from coal is a mighty economic engine that powers a growing American economy and empowers millions of American consumers and businesses.

The Penn State research was supported by a grant from the Center for Energy and Economic Development (CEED). CEED believes that the lesson from this research is simple: *electricity from coal is the key to a balanced energy portfolio*. Thanks to advances in technology, CEED also believes that Americans will not have to choose between affordable and reliable electricity or a clean environment. When it comes to electricity from coal, America can have both.

Study methodology

In *The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015*, Pennsylvania State University's Adam Z. Rose and Dan Wei use the IMPLAN input-output model to estimate the direct and indirect economic multiplier effects of coal-based electricity generation. Projecting to the year 2015, the study provides state-by-state estimates of the economic output, household income, and jobs attributable to electricity generated using coal.

The study also estimates the effect of higher electricity prices on state economies in the event that utilities switch from coal to more costly alternatives, such as natural gas or renewables. In examining these impacts, the study's authors examine two scenarios, one in which alternative fuels displace 33 percent of projected production and utility consumption of coal. Another assumes 66 percent displacement. The mix of replacement energy sources varies by region, reflecting projected patterns of electricity generation. All cases assume that renewable energy alternatives such as wind and biomass account for 10 percent of state generation portfolios. Summary results are displayed in Tables 1-3, based on an average of the study's low and high energy price projections. The high and low price results for all three cases are reported in the full study.

Rose and Wei's model is based on *minimum backward linkages* plus *price differential impacts*.

A demand-side multiplier provides the backward linkage. It encompasses all direct and indirect inputs of materials, labor, and equipment for coal-based generation, coal production, and coal transportation. It also takes into account increased government expenditures that result from growing tax revenues which, in turn, further enhance the multiplier effect of coal-based electricity.

The price differential impacts measure the effects of higher electricity prices on state economies based on a conservative estimate of the price elasticity of demand for electricity.

A copy of the full Penn State study is available online at:
http://www.ceednet.org/ceed/index.cfm?cid=7505

Table 1.
Economic benefits due to coal-based generation, 2015
(Mid-range estimates in billions of 2005 $ and thousands of jobs)

State	Economic output ($Bil.)	Household income ($Bil.)	Jobs (000)
Alabama	$16.3	$5.2	101.2
Arizona	$12.8	$4.4	86.0
Arkansas	$5.2	$1.6	35.6
California	$58.4	$21.9	338.8
Colorado	$19.0	$6.9	109.4
Connecticut	$2.8	$1.1	15.2
Delaware	$4.6	$1.5	27.9
Florida	$26.6	$9.8	218.7
Georgia	$38.9	$13.6	242.6
Illinois	$66.5	$25.4	328.5
Indiana	$66.3	$20.0	410.3
Iowa	$21.7	$6.6	157.4
Kansas	$26.3	$8.6	194.0
Kentucky	$49.3	$16.2	340.3
Louisiana	$11.3	$4.4	99.2
Maine	$0.4	$0.1	3.4
Maryland	$18.9	$8.4	132.1
Massachusetts	$8.7	$3.4	47.2
Michigan	$54.8	$17.6	292.9
Minnesota	$32.6	$11.4	201.0
Mississippi	$5.5	$1.9	45.7
Missouri	$47.0	$16.6	317.1
Montana	$4.5	$1.5	44.1
Nebraska	$19.6	$6.9	95.0
Nevada	$7.7	$3.0	69.2
New Hampshire	$1.3	$0.4	8.3
New Jersey	$10.1	$3.9	53.0
New Mexico	$14.4	$5.5	131.6
New York	$16.3	$6.4	81.6
North Carolina	$30.8	$10.0	217.4
North Dakota	$8.5	$2.7	64.2
Ohio	$83.7	$27.1	528.0
Oklahoma	$16.9	$5.8	132.4
Oregon	$1.5	$0.5	11.7
Pennsylvania	$42.0	$14.3	263.9
South Carolina	$7.2	$2.3	49.1
South Dakota	$2.6	$0.8	18.5
Tennessee	$27.7	$9.2	172.7
Texas	$46.4	$16.4	289.5
Utah	$32.4	$11.8	245.6
Virginia	$14.3	$5.6	90.3
Washington	$4.8	$1.8	28.9
West Virginia	$20.9	$6.8	160.6
Wisconsin	$32.6	$10.6	216.8
Wyoming	$7.1	$2.5	55.5
Total	$1,047	$362	6,800

Table 2.
Net economic costs of 33% coal generation displacement, 2015
(Mid-range estimates in billions of 2005 $ and thousands of jobs)

State	Economic output ($Bil.)	Household income ($Bil.)	Job losses (000)
Alabama	-$1.6	-$0.6	-14.7
Arizona	-$0.6	-$0.4	-7.5
Arkansas	-$0.2	-$0.1	-3.0
California	-$10.0	-$4.1	-65.3
Colorado	-$4.0	-$1.7	-27.5
Connecticut	-$0.5	-$0.2	-2.7
Delaware	-$0.7	-$0.2	-4.6
Florida	-$2.6	-$1.2	-32.6
Georgia	-$5.6	-$2.2	-41.3
Illinois	-$14.5	-$6.0	-73.0
Indiana	-$8.2	-$2.7	-55.9
Iowa	-$3.3	-$1.1	-27.7
Kansas	-$5.2	-$1.8	-43.6
Kentucky	-$3.9	-$1.6	-35.2
Louisiana	-$1.5	-$0.7	-17.1
Maine	-$0.1	Negl.	-0.4
Maryland	-$3.8	-$1.9	-30.6
Massachusetts	-$1.0	-$0.4	-6.0
Michigan	-$11.6	-$3.8	-64.4
Minnesota	-$8.5	-$3.1	-54.5
Mississippi	-$0.6	-$0.3	-6.9
Missouri	-$8.7	-$3.4	-63.2
Montana	-$0.4	-$0.2	-6.2
Nebraska	-$5.1	-$1.9	-24.9
Nevada	-$1.0	-$0.5	-2.2
New Hampshire	-$0.1	Negl.	-0.9
New Jersey	-$2.1	-$0.8	-11.5
New Mexico	-$1.3	-$0.6	-17.2
New York	-$2.4	-$1.1	-13.2
North Carolina	-$5.2	-$1.9	-44.0
North Dakota	Negl.	Negl.	-10.6
Ohio	-$14.2	-$4.8	-95.1
Oklahoma	-$0.5	-$0.3	-9.6
Oregon	-$0.2	-$0.1	-1.9
Pennsylvania	-$7.0	-$2.6	-50.3
South Carolina	-$0.7	-$0.3	-7.0
South Dakota	-$0.3	$163	-1.9
Tennessee	-$6.7	-$2.3	-43.9
Texas	-$6.2	-$2.5	-47.5
Utah	-$5.8	-$2.2	-45.8
Virginia	-$2.8	-$1.3	-21.0
Washington	-$1.0	-$0.4	-6.4
West Virginia	-$0.1	-$0.1	-5.5
Wisconsin	-$5.7	-$1.9	-40.4
Wyoming	-$0.3	-$0.3	-6.1
Total	-$166	-$64	-1,200

Table 3.
Net economic costs of 66% coal generation displacement, 2015
(Mid-range estimates in billions of 2005 $ and thousands of jobs)

State	Economic output ($Bil.)	Household income ($Bil.)	Job losses (000)
Alabama	-$3.6	-$1.5	-33.4
Arizona	-$1.7	-$0.9	-18.6
Arkansas	-$0.3	-$0.2	-5.4
California	-$22.9	-$9.3	-148.3
Colorado	-$6.4	-$2.8	-45.8
Connecticut	-$1.0	-$0.4	-6.3
Delaware	-$1.7	-$0.6	-11.2
Florida	-$5.4	-$2.6	-69.4
Georgia	-$12.7	-$5.0	-93.4
Illinois	-$31.0	-$12.8	-156.2
Indiana	-$19.9	-$6.5	-135.1
Iowa	-$7.6	-$2.4	-62.6
Kansas	-$10.9	-$3.8	-90.8
Kentucky	-$10.4	-$4.2	-90.6
Louisiana	-$3.3	-$1.6	-38.4
Maine	-$0.1	Negl.	-1.1
Maryland	-$8.3	-$4.1	-65.8
Massachusetts	-$2.6	-$1.1	-15.6
Michigan	-$25.0	-$8.3	-138.1
Minnesota	-$17.3	-$6.3	-111.0
Mississippi	-$1.3	-$0.6	-14.9
Missouri	-$19.0	-$7.3	-137.1
Montana	-$1.3	-$0.5	-16.6
Nebraska	-$10.7	-$4.0	-52.2
Nevada	-$2.5	-$1.1	-18.0
New Hampshire	-$0.3	-$0.1	-2.3
New Jersey	-$4.6	-$1.8	-25.4
New Mexico	-$3.4	-$1.6	-43.7
New York	-$5.7	-$2.5	-30.9
North Carolina	-$11.1	-$4.0	-93.2
North Dakota	-$1.7	-$0.6	-26.0
Ohio	-$31.4	-$10.7	-210.3
Oklahoma	-$1.9	-$1.1	-27.4
Oregon	-$0.5	-$0.2	-4.6
Pennsylvania	-$15.1	-$5.6	-108.3
South Carolina	-$1.3	-$0.5	-13.5
South Dakota	-$0.7	-$0.2	-5.1
Tennessee	-$13.3	-$4.7	-88.0
Texas	-$13.6	-$5.5	-105.8
Utah	-$14.1	-$5.3	-111.7
Virginia	-$5.4	-$2.6	-40.8
Washington	-$2.1	-$0.9	-13.9
West Virginia	-$3.0	127.3	-32.6
Wisconsin	-$12.8	-$4.4	-91.1
Wyoming	-$1.8	-$0.9	-19.8
Total	-$371	-$142	-2,800

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The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015

by

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Report Prepared for
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The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015

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The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015

by

Adam Z. Rose, Ph.D., and Dan Wei[1]

Executive Summary

Our analysis shows that, in 2015, U.S. coal production, transportation and consumption for electric power generation will contribute more than $1 trillion (2005 $) of gross output directly and indirectly to the economy of the lower-48 United States. Based on an average of two energy price scenarios summarized below, we calculate that $362 billion of household income and 6.8 million U.S. jobs will be attributable to the production, transportation and use of domestic coal to meet the nation's electric generation needs.

The United States relies heavily on coal to produce electric power. Domestic coal production has expanded from 560 million tons in 1950 to 1.13 billion tons in 2005, while coal consumption for electric generation has increased from 92 million tons to 1.04 billion tons in this period. Historically, coal has provided the lowest cost source of fossil energy in the U.S. Electricity is one of the most prominent commodities traded in the United States, second only to food in annual sales volume.

We based our analysis on state-specific "IMPLAN" input-output tables -- a widely utilized source of data on the composition of state economic activity -- to estimate the basic direct and indirect "multiplier" effects of coal utilization for electric generation. These multiplier effects include the economic impacts of coal mining and of government spending of taxes paid by coal mining for electricity generation, by companies that transport coal, and by coal-fueled electricity generation companies. We calculated results at the state level and compiled regional summaries by dividing the nation into five geographic regions (see Figure S1, below).

The study first presents estimates of the positive economic output, household income, and jobs attributable to projected levels of coal production and utilization in 2015. We used a 2015 base case because electric generation and other projections for this year were readily available from U.S. DOE and U.S. EPA. These estimates measure the "existence" value of coal as the key fuel input into U.S. electricity generation. The analysis includes estimates of the impact of higher electricity rates on individual state economies if utilities were required to utilize fuel sources and generating technologies more costly than coal-based electricity.

[1] Professor of Energy, Environmental and Regional Economics, and graduate research assistant, respectively, Department of Geography, The Pennsylvania State University, University Park, PA 16802.

Two Basic Scenarios

Our first scenario includes backward linkage, or demand-side multiplier, effects for coal-fueled electricity generation. Tax payments from coal production, utilization, and transportation subsequently result in government expenditures, which also generate multiplier effects. The analysis also includes the impacts of the favorable price differential attributable to coal-based electricity. This calculation measures the economic activity attributable to relatively cheaper coal in contrast to more expensive alternatives at upper-range ("high") prices for alternative generation sources.

Our second scenario is the same as the first in terms of backward linkages, but we calculated the price differential effects on the basis of lower-range estimates of the prices of alternative fuels and technologies.

The study relied on U.S. DOE Energy Information Administration (DOE/EIA) and other projections of electric generation and delivered coal prices to estimate the impact on energy prices of replacing 100% of projected coal-fueled electricity generation. We estimated the impact of higher energy prices on state economies using a price elasticity estimate of 0.10, meaning that a 10% change in energy costs would induce a 1.0% change in state economic output.

Regional results of the basic "Coal Existence" scenarios are summarized in Table S1 below. Assigning equal weight to each of the two energy price scenarios, we estimate that U.S. coal-fueled electric generation in 2015 will contribute:

- **$1.05 trillion (2005 $) in gross economic output;**
- **$362 billion in annual household incomes, and**
- **6.8 million jobs.**

We also estimated the prospective net economic impacts of the "displacement" of coal-fueled electricity generation at assumed levels of 66% and 33% from a projected 2015 base. These levels of displacement are consistent with some of the potential impacts of major environmental policy initiatives in climate change or other areas. In these cases, we again calculated backward linkage and price differential effects to determine potential negative impacts on each state's economy. Additionally, we calculated potential positive economic benefits due to the operation of replacement electricity generation of various types. In all states, the net effect of displacing coal-based electricity was negative for the "high-price" scenarios, and in nearly all states, the net effect was negative for the "low-price" scenarios.

Regional results of the "Displacement/Replacement" scenarios are presented in Tables S2 and S3. Assigning equal weight to the high- and low-price scenarios, we estimate the average impacts of displacing 66% of coal-fueled generation in 2015 at:

- **$371 billion (2005 $) reduction in gross economic output;**

- **$142 billion reduction of annual household incomes; and**

- **2.7 million job losses.**

Assigning equal weight to the high- and low-price scenarios, we estimate the average impacts of displacing 33% of coal-based generation in 2015 at:

- **$166 billion (2005 $) reduction in gross economic output;**

- **$64 billion reduction of annual household incomes; and**

- **1.2 million job losses.**

These findings are discussed in more detail in the state and regional analyses of the main report. Appendix C contains detailed state and regional results for each of the three displacement cases, including alternative impact estimates for the low and high energy price scenarios.

Figure S1
U.S. Regions Analyzed

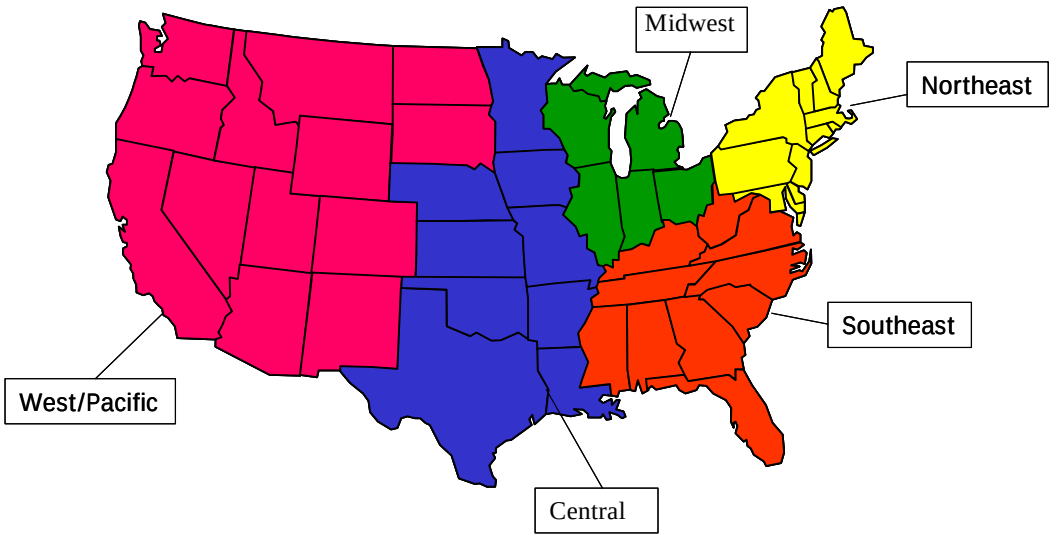


Table S1
Regional Summary of the "Existence" Value of U.S. Coal Utilization in Electric Generation, 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$309	$166	$238
Earnings	$106	$55	$80
Jobs	2.2	1.1	1.6
Northeast			
Output	$145	$65	$105
Earnings	$56	$24	$40
Jobs	0.9	0.4	0.6
Midwest			
Output	$409	$199	$304
Earnings	$137	$65	$101
Jobs	2.4	1.2	1.8
Central			
Output	$305	$149	$227
Earnings	$106	$50	$78
Jobs	2.1	1.0	1.5
West			
Output	$213	$135	$174
Earnings	$78	$48	$63
Jobs	1.5	0.9	1.2
48 States			
Output	$1,381	$714	$1047
Earnings	$482	$242	$362
Jobs	9.0	4.6	6.8

Table S2
Regional Summary of the Net Economic Costs of 66% Displacement of Coal-fueled Electric Generation in the U.S., 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$116	$20	$68
Earnings	$44	$10	$27
Jobs	0.9	0.2	0.6
Northeast			
Output	$66	$13	$39
Earnings	$27	$6	$16
Jobs	0.4	0.1	0.3
Midwest			
Output	$189	$51	$120
Earnings	$67	$19	$43
Jobs	1.1	0.3	0.7
Central			
Output	$136	$33	$85
Earnings	$51	$14	$32
Jobs	1.0	0.3	0.6
West			
Output	$86	$33	$59
Earnings	$34	$14	$24
Jobs	0.7	0.3	0.5
48 States			
Output	$594	$148	$371
Earnings	$223	$62	$142
Jobs	4.2	1.2	2.8

Table S3
Regional Summary of the Net Economic Costs of 33% Displacement of Coal-fueled Electric Generation in the U.S., 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$55	$5	$30
Earnings	$21	$3	$12
Jobs	0.4	0.07	0.3
Northeast			
Output	$31	$4	$18
Earnings	$13	$2	$7
Jobs	0.2	0.03	0.1
Midwest			
Output	$89	$19	$54
Earnings	$31	$7	$19
Jobs	0.5	0.1	0.3
Central			
Output	$66	$13	$39
Earnings	$24	$5	$15
Jobs	0.5	0.1	0.3
West			
Output	$39	$11	$25
Earnings	$16	$5	$10
Jobs	0.3	0.1	0.2
48 States			
Output	$279	$52	$166
Earnings	$105	$23	$64
Jobs	2.0	0.4	1.2

The Economic Impacts of Coal Utilization and Displacement in the Continental United States, 2015

by

Adam Z. Rose, Ph.D. and Dan Wei*

I. Introduction

This study projects the extent of the likely impacts of coal utilization for electricity generation on the economies of the forty-eight contiguous states in the year 2015. The projection period covers both current coal-related economic benefits and those that may result from the construction of new coal-fueled electric generating capacity.

We first estimate the overall economic benefits associated with the availability of coal as a relatively low-cost fuel resource. This "existence" value reflects the increased economic output, earnings, and employment associated with projected coal utilization for electric generation in 2015. We also estimate the net economic impacts of displacing 33% and 66% of projected coal generation by alternative energy resources, taking into account the positive economic effects associated with alternative investments in oil/gas, nuclear, and renewable energy supplies.

We performed our analysis with the aid of an interindustry, or input-output, model. Specifically, we analyzed how coal-based electric generation affects production (output), household income, and employment in other sectors of each state and the continental U.S. as a whole under three alternative displacement scenarios. Our results indicate that the combination "multiplier" and "price-differential" effects are sizeable, amounting to $1.05 trillion ($2005) in total 48-state economic output for the "existence" of coal as a relatively inexpensive fuel for electricity generation. The results illustrate that government policies and private industry decisions affecting coal-based electric generation potentially can affect every major aspect of the American economy.

The methodology underlying the study is summarized in Section II below, as well as in Appendix A, which also presents major assumptions and some basic computations underlying the analysis. The results for the five regions analyzed are summarized in Section III, with tables of basic data presented in Appendix B and simulation results presented in Appendix C.

We simulated cases where coal-based electricity generation is displaced at levels of 66% and 33% by alternative energy supplies, including natural gas, nuclear, and a 10% mix of renewables, reflecting potential Renewable Portfolio Standards (RPS) that could be in place by 2015. The results indicate that for the nation, and for nearly every state individually, this displacement -- even factoring in positive offsetting multiplier impacts of replacement fuels and technologies -- would have a net negative economic impact. We project that national gross output would decline by $371 billion for the 66% case, and by $166 billion for the 33% case.

II. Methodology

A. Measuring Economic Interdependence

With a broad base and high level of technological advancement, the U.S. economy exhibits a great deal of interdependence. Each business enterprise relies on many others for inputs into its production process and provides inputs to them in return. This means that the coal and coal-based electric utility industries' contributions to the nation's economy extend beyond their own production to include demand arising from a succession of "upstream" inputs from their suppliers and "downstream" deliveries to their customers. The economic value of these many rounds of derived demands and commodity allocations is some multiple of the value of direct production itself. Hence, the coal and coal-based electric utility industries generate "multiplier" effects throughout the U.S. economy.

The first round of demand impacts is obvious--the direct inputs to electricity generation, including coal and primary factors (labor and capital). Subsequent rounds, or indirect demands for goods and services used by the providers of these inputs, however, thread their way through the economy in subtle ways, eventually stimulating every other sector in some way. Likewise, they generate income that is transformed into consumer spending on still more products. All of this economic activity also generates local, state, and federal tax revenues, which, when spent by all three levels of government, creates still more multiplier effects.[1]

B. Measuring Locational Attractiveness

We omitted forward linkages, or supply-side multipliers, from our analysis in this study in contrast to the one performed by Rose and Yang (2002). The premise of the supply-side multiplier is that economic activity is stimulated by "locational attractiveness" characteristics for a state or region, such as the availability of relativity inexpensive coal-fueled electricity. This effect has been documented for electricity and other key inputs (see Blair and Premus, 1987). However, the supply-side multiplier has received significant criticism (cf. Oosterhaven, 1988; Rose and Allison, 1989). The main criticism is that this form of multiplier represents a further extension of a discredited economic theory called Say's Law, which states that supply creates its own demand.[2] Therefore, we omitted supply-side impacts from this study.

Another way to capture the locational attractiveness of a good or service is not to claim the entirety of output of its direct and indirect users, but only an amount relating to the price advantage of the input over its competitors. In this case, we calculate a "price differential" between coal and alternative fuels in electricity production, and then calculate how much economic activity is attributable to this cost saving. For this purpose, we use an economy-wide elasticity of output with respect to energy prices. This measures the percentage change in economic activity with respect to

a 1.0 percent change in price. We analyzed a variety of sources of information to arrive at a value of 0.10, meaning that the availability of coal-fueled electricity at a price 10 percent lower than that of its nearest competitor is responsible for increasing total state or regional economic activity by 1.0 percent (see, e.g., Anderson 1982; Hewson and Stamberg, 1996).[3]

III. Economic Impacts of Coal on State and Regional Economies, 2015

To assess the importance of coal to state and regional economies in 2015, we first estimated the level of coal-based electricity generation in each state in 2015 based on projections by DOE/EIA (2006) and EPA (2005). We also assumed that the technological structure of the economy, embodied in individual state input-output tables, would remain unchanged over the projection period to 2015.

We evaluated coal-related impacts according to various assumptions embodied in our scenarios (see Appendix B for further explanation of assumptions).

Scenario Set 1: "Coal Existence" Scenarios

This set of scenarios calculates the positive regional economic output, household income, and jobs attributable to the projected levels of coal-fueled electricity in 2015. These scenarios estimate the "existence" value of coal as the key fuel input into electricity generation in the U.S. The economic impacts of coal that we calculated include two components: 1) the backward linkage, or demand-side multiplier, effects for coal-fueled electricity generation, and 2) the effects of the favorable price differential attributable to the relatively cheaper cost of coal-based electricity.

We first use the 2002 IMPLAN input-output tables to estimate the direct and indirect (multiplier) economic output, household income, and jobs created by coal-fueled electricity generation in each state. In this study, we measure only the minimum backward linkage effects for the "multiplier" effects. This method excludes all forward linkages (all the production that uses

coal-fueled electricity directly or indirectly) and focuses only on the factor inputs of coal-based electricity generation, such as fuel and electric generating equipment.

Tax payments from coal mining, coal transportation services, and coal-fueled electricity generation result in government expenditures, which also generate multiplier effects of the conventional demand-driven type. We calculated total personal income and employment impacts of government expenditures by multiplying these total sectoral output changes by their corresponding income and employment coefficients, rather than by direct application of multipliers.

We then evaluated the impacts of a favorable price differential attributable to coal-based electricity. Essentially, we are measuring the economic activity attributable to relatively cheaper coal in contrast to what would take place if a state were dependent on more expensive alternatives, which we assume would be a combination of oil/gas, renewable, and nuclear electricity. Here we perform two calculations: 1) an upper-range ("high") price scenario, and 2) a lower-range ("low") price scenario. These two scenarios have the same backward linkages effects, but different price differential effects based on their different energy price assumptions. We estimated the impact of higher electricity prices on state economies using a price elasticity estimate of 0.10, meaning that a 10% differential in electricity prices causes a 1.0% change in regional economic activity.

Finally, we assigned equal weight to each of the two price scenarios to obtain the average "existence" impacts of coal-fueled electricity generation in 2015. The results of this set of scenarios for each state and region in the year 2015 are presented in the summary tables in Appendix C. An example of the detailed derivation of the price differential effect is presented in Appendix Table B2.

Table 1 summarizes our regional findings for the "existence" value of coal in 2015 for the low and high energy price scenarios, as well as an average of the two price scenarios.

Table 1
Regional Summary of the "Existence" Value of U.S. Coal Utilization in Electric Generation, 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$309	$166	$238
Earnings	$106	$55	$80
Jobs	2.2	1.1	1.6
Northeast			
Output	$145	$65	$105
Earnings	$56	$24	$40
Jobs	0.9	0.4	0.6
Midwest			
Output	$409	$199	$304
Earnings	$137	$65	$101
Jobs	2.4	1.2	1.8
Central			
Output	$305	$149	$227
Earnings	$106	$50	$78
Jobs	2.1	1.0	1.5
West			
Output	$213	$135	$174
Earnings	$78	$48	$63
Jobs	1.5	0.9	1.2
48 States			
Output	$1,381	$714	$1047
Earnings	$482	$242	$362
Jobs	9.0	4.6	6.8

Scenario Set 2: <u>66% "Coal Displacement/Replacement" Scenarios</u>

In this set of scenarios, we calculate the net economic impacts of "displacement" of coal-based electricity generation at a level of 66% from the projected 2015 level, and "replacement" by alternative fuel sources and generating technologies. We calculated both the backward linkage and price differential effects as in the "Coal Existence" scenarios. However, in contrast to the first set of scenarios, which only calculate the backward linkage multiplier effects of coal-fueled generation, we include the positive economic impacts due to the operation of replacement electricity generation of various types, i.e., gas/oil-fueled electricity, nuclear electricity, and an electricity generation mix from renewables.

For the 66% coal displacement/replacement level, we perform one scenario that calculates the price differential effects based on upper-range price assumptions. The second scenario has the same backward linkage multiplier effects on both the displacement and replacement sides, but price differential effects based on lower-range price assumptions.

We again assign equal weight to each of these two scenarios. The detailed state and regional results of this set of scenarios for the year 2015 are presented in Appendix C. Table 2 summarizes regional results for the 66% displacement cases.

Table 2
Regional Summary of the Net Economic Costs of 66% Displacement of Coal-fueled Electric Generation in the U.S., 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$116	$20	$68
Earnings	$44	$10	$27
Jobs	0.9	0.2	0.6
Northeast			
Output	$66	$13	$39
Earnings	$27	$6	$16
Jobs	0.4	0.1	0.3
Midwest			
Output	$189	$51	$120
Earnings	$67	$19	$43
Jobs	1.1	0.3	0.7
Central			
Output	$136	$33	$85
Earnings	$51	$14	$32
Jobs	1.0	0.3	0.6
West			
Output	$86	$33	$59
Earnings	$34	$14	$24
Jobs	0.7	0.3	0.5
48 States			
Output	$594	$148	$371
Earnings	$223	$62	$142
Jobs	4.2	1.2	2.8

Scenario Set 3: <u>33% "Coal Displacement/Replacement" Scenarios</u>

In this set of scenarios, we calculate the impacts of "displacement" of coal-based electricity generation by 33% from the projected 2015 level, and its "replacement" by alternative generating technologies. The methodologies of calculating the backward linkage multiplier effects and the

price differential effects (again, one scenario for the high-price case and one scenario for the lower-price case) are similar to the 66% "Coal Displacement/Replacement" scenarios.

The state and regional results of this set of scenarios are presented in Appendix C. Summary results for the five U.S. regions are shown in Table 3.

Table 3
Regional Summary of the Net Economic Costs of 33% Displacement of Coal-fueled Electric Generation in the U.S., 2015
(in billions of 2005 dollars and millions of jobs)

Region	*High-Price Alternatives*	*Low-Price Alternatives*	*Average*
Southeast			
Output	$55	$5	$30
Earnings	$21	$3	$12
Jobs	0.4	0.07	0.3
Northeast			
Output	$31	$4	$18
Earnings	$13	$2	$7
Jobs	0.2	0.03	0.1
Midwest			
Output	$89	$19	$54
Earnings	$31	$7	$19
Jobs	0.5	0.1	0.3
Central			
Output	$66	$13	$39
Earnings	$24	$5	$15
Jobs	0.5	0.1	0.3
West			
Output	$39	$11	$25
Earnings	$16	$5	$10
Jobs	0.3	0.1	0.2
48 States			
Output	$279	$52	$166
Earnings	$105	$23	$64
Jobs	2.0	0.4	1.2

IV. Conclusion

Coal-based electricity generation provides a significant stimulus to the U.S. economy by increasing output, income, and employment in all sectors through direct and indirect (multiplier) effects. It also increases the purchasing power of the consumer, and enhances the competitiveness of U.S. exports, by avoiding increased reliance on higher-priced fuels and electricity-generating technologies. Even when we take into account the positive economic effects of capital investments and operation of alternative energy generation sources, the replacement of coal-based electricity by relatively more expensive fuels or generating technologies would have a net negative economic impact on every region and on nearly every state. In general, these results reflect the large economic benefits associated with coal's favorable price differential effect relative to alternative fuels.

Note on Study Scope and Limitations

Our analysis is not intended to measure the impacts of any specific policy that could result in decreased coal production or utilization. The impacts of specific policy proposals on coal production and related electric generation should be determined on a case-by-case basis. However, the findings of our coal displacement scenarios provide preliminary insights into the potential magnitude of state, regional and national economic impacts of policy initiatives that could result in significant decreases in coal production and utilization.

This study has not addressed the several important "externalities" associated with coal used in electricity generation. On the down-side are various types of environmental pollution and the emissions of greenhouse gases. On the up-side are the creation of saleable by-products of combustion, and coal's major contribution to lowering our dependence on foreign oil. Public health

benefits also may result from increased employment and higher levels of personal income associated with lower energy costs (see, e.g., Brenner, 2005). All of these external impacts are, however, beyond the scope of this study.

Endnotes

*The authors are, respectively, Professor of Energy, Environmental and Regional Economics, and Graduate Assistant in the Department of Geography at the Pennsylvania State University. The authors wish to acknowledge the funding of the Center for Energy and Economic Development (CEED). We are most grateful to Eugene Trisko for providing the data and feedback on various earlier drafts. The methodology employed in this report is an extension of that developed in an analysis by Adam Rose and Ram Ranjan in the "The Economic Impacts of Coal Production and Utilization in the Southern Appalachian Mountain Region" (June 2001), and by Adam Rose and Bo Yang in the "The Economic Impact of Coal Utilization in the Continental U.S. (January 2002) also prepared with the support of the Center for Energy and Economic Development. Dr. William Schaffer of Georgia Tech served as a consultant to and reviewer of the 2002 study. The methodology employed in the current study reflects in principle Dr. Schaffer's constructive comments on this previous work, including the suggested elimination of more speculative "forward-linkage" calculations.

[1] Note that this and subsequent multipliers used in this study are Type II multipliers, which include the stimulus from household income and spending (see Appendix A for further discussion of multipliers). Tax multiplier effects are calculated separately.

[2] Thus, supply-side multipliers do not have the solid footing of demand-side multipliers. In the latter, production definitely requires material inputs; hence the analogy of pulling an object with a rope will guarantee that the object will come forth. The supply-side analysis suggests that just the attractiveness of an input will cause it to be used; the analogy here is that pushing on a rope doesn't necessarily move the object.

[3] A 0.14 estimate first appeared in an unpublished National Economic Research Associates report by K. P. Anderson in 1982. More recent studies for the state of Georgia and the United Kingdom yield similar results. Also, the output elasticity is directly related to the ordinary price elasticity of demand for electricity, which more studies indicate to be in the range of 0.05 to 0.25. Under normal conditions, the output elasticity and price elasticity of demand are equivalent. We chose to use the more conservative value of 0.10 in this study to place our results on as solid a footing as possible

References

Anderson, K. P., 1982. "Industrial Location and Electric Utility Price Competition," (unpublished report) National Economic Research Associates, Inc., New York, NY.

Blair, J. P. and R. Premus. 1987. "Major Factors in Industrial Location: A Review," *Economic Development Quarterly* 1: 72-85.

Brenner, M. H. 2005 "Commentary: Economic growth is the basis of mortality rate decline in the 20th century – experience in the United States 1901-2000," *International Journal of Epidemiology*, 34:1214-1221.

(EIA) Energy Information Administration. Various titles listed in figures and tables in this Report.

(EPA) Environmental Protection Agency. Various titles listed in figures and tables in this Report.

Hewson, T. and J. Stamberg. 1996. *At What Cost? Manufacturing Employment Impacts from Higher Electricity Prices*, Energy Ventures Analysis, Arlington, VA.

Leontief, W. 1986. *Input-Output Economics (2nd ed.)*, New York: Wiley.

(MIG) Minnesota IMPLAN Group. 2005. *Impact Analysis for Planning (IMPLAN) Users' Guide*, Stillwater, MN.

(MIG) Minnesota IMPLAN Group. 2005. *Data for States of the U.S.* (electronic file), Stillwater, MN.

Miller, R. and P. Blair, 1985. *Input-Output Analysis: Foundations and Extensions*, Englewood Cliffs, NJ: Prentice-Hall.

Oosterhaven, J. 1988. "On the Plausibility of the Supply-Driven Input-Output Model," *Journal of Regional Science* 28: 203-17.

Rose, A. and T. Allison. 1989. "On the Plausibility of the Supply-Driven Input-Output Model: Empirical Evidence on Joint Stability," *Journal of Regional Science* 29: 451-58.

Rose, A. and O. Frias. 1994. "The Impact of Coal on the U.S. Economy," Report to the National Coal Association, Department of Mineral Economics, The Pennsylvania State University.

Rose, A. and W. Miernyk, 1989. "Input-Output Analysis: The First Fifty Years," *Economic Systems Research* 1: 229-271.

Appendix A

Input-Output Analysis

An input-output (I-O) table is a valuable tool that provides insights into economic interdependence. The table is composed of a set of accounts representing purchases and sales between all of the sectors of an economy. Official versions of this table at the national level, prepared by the U.S. Department of Commerce, are based on an extensive collection of data from nearly all of the business establishments in the United States.

I-O accounts can serve as the foundation for more formal models, the most basic of which assumes a linear relationship between inputs and the outputs they are used to produce. This structural model enables analysts to trace linkages between sectors and to estimate the economy-wide effects of changes in activity in any one sector.

Input-output analysis was pioneered in the 1930s by Professor Wassily Leontief. Since that time, Leontief and hundreds of other researchers have extended I-O theory, constructed tables for countries and regions around the world, and used these tables to perform a broad range of economic impact analysis. I-O analysis is considered to be such an important achievement that Leontief was awarded the Nobel Prize in economics in 1973. (For further insight into input-output analysis, see Leontief, 1986; Miller and Blair, 1985; and Rose and Miernyk, 1989.)

In addition to the national I-O table, based on a census of business establishments, tables have been constructed for many regions of the U.S., based on adjustments of national data and/or a regional sample of firms. One of the preeminent sets of regional input-output tables are those of the Impact Analysis for Planning System, or IMPLAN, developed and maintained by the U.S. Forest Service in conjunction with several other government agencies. IMPLAN consists of national and regional economic databases and methodologies to construct, update, and modify I-O tables, and to apply them in impact studies (MIG, 2005). In this study, we used the latest IMPLAN I-O Tables for the forty-eight contiguous states, which are updated to 2002 (MIG, 2005).

Due to the enormous amount of data collection and reconciliation that goes into constructing the official U.S. Table, a considerable lag typically exists between the year in which data are gathered and the date of availability of the table. It is therefore standard practice to use an I-O table that is somewhat dated and this is, of course, inevitable when making future projections as in this report. We have satisfied ourselves that we are utilizing the best available model, and that any errors in estimating coal-related impacts are likely to be small. For example, although the Florida economy has grown and changed since 1998, and will continue to do so, the structural relationships (ratios of input to outputs), upon which the model is based, have been found to be relatively stable over short time periods (around 10 years).

The standard IMPLAN multipliers are now Type II multipliers. In general, a multiplier is a ratio of total impacts divided by direct impacts. Versions of multipliers differ according to the calculation of total impacts. Type I multipliers only include indirect impacts (interindustry demands) and are rarely used because they omit a major component of economic interdependence. Type II multipliers include indirect effects and induced effects (those stemming from income payments and their expenditure). Type III multipliers also include both indirect and induced effects, but are based on marginal propensities to consume (spend) out of additional income, instead of average propensities to consume. Since marginal propensities are slightly lower than average propensities, Type III multipliers are a bit more conservative than standard Type II multipliers. We used Type II multipliers in our analysis because IMPLAN recently ceased the calculation of Type III multipliers.

Appendix B

Key Assumptions

We have embodied several key assumptions in our analysis. These assumptions are needed due to limitations of data, and for computational manageability. We have taken special care, however, to ensure that the assumptions are as realistic as possible.

A. General Assumptions

1. Economic growth is proportional across all sectors and is the same in 2015 as in 2002.
2. Intraregional trade patterns are constant over time.
3. Interregional trade patterns are constant over time.
4. Technology (except for electricity generation) is constant over time.
5. Relative prices (except for fuels and electricity) are constant over time.
6. Coal heat rate is 10,250 btu/kwh and natural gas heat rate is 7,200 btu/kwh in 2015.

B. Energy-Specific Assumptions

1. We based costs of fuels and prices of electricity generation on estimates from U.S. EIA or EPA as presented in Table B1.

a. We assumed a 10-percent minimum renewable target in each state. In states, where this target was exceeded (primarily due to the presence of extensive hydroelectricity), we based our projections on actual values.

b. We used our best judgment in determining low and high price ranges for different fuels and technologies. Specifically, for nuclear and renewable electricity generation, high price estimates were 25% above the average in Table B1, and low price estimates were 25% below Table B1 estimates for all 3 cases.

For delivered natural gas prices:

33% displacement scenario -- $5/mcf for low and $9/mcf for high

66% displacement scenario -- $6/mcf and $10/mcf

100% “existence” case -- $8/mcf and $12/mcf

2. Projected electricity generation in each state is based on estimates from U.S. DOE/EIA and EPA. Specifically, we used EIA's 2015 regional electricity generation projections as control totals, and used EPA's projections of state to regional proportions for 2015 to calculate the projected electricity generation for each state.

C. Other Assumptions

1. The 100% Displacement ("Coal Existence") case does not include the impacts of replacement fuels or technologies.

2. The 66% and 33% Displacement cases do include the impacts of replacement fuels and technologies.

We made an adjustment in these simulations in the price differential effect of exporting coal-fueled electricity. The price differential effect is applied in each state to the amount of coal-fueled electricity generated and used in that state. We were not able to compute the effect of this relatively lower-priced generation on the economies of the states that import it (to do so, we would ideally need to know the origin and destination of all coal-fueled electricity exports).

For the 66% and 33% coal "Replacement" cases, the situation differs. If coal were replaced by higher-priced generation, the alternative replacement electricity could not compete in regional markets (if each state unilaterally replaced coal-fueled generation with alternatives). We assumed this would cut coal-fueled electricity generation exports to zero from each state. We then adjusted the coal displacement and coal replacement columns for each state accordingly. However, it is not appropriate to also include the price differential effect on importing states, since these states are no longer importing coal-fueled electricity (because those quantities have been replaced by higher-price alternative generation that is not competitive), nor is it appropriate to add the price differential effect of coal exports to the exporting states (since it would not impact their economies even if the exports were maintained).

Appendix Table B1. Prices of Electricity by Various Technologies and Fuels in Pennsylvania, Example Projected to 2015
(in 2003 cents per kwh)

Technology		COM TRB[1]	Nuclear[2]	Wind Turbines	Solar Thermal	Solar PV	Hydro	Geothermal	Biomass	Average Mix Price
Energy Source	Coal	Gas	Uranium	Wind	Sunlight	Sunlight	Water	Brine/Steam	Landfill or Wood	
Existing Capacity in 2015[3]										
Generation	2.24									
Transmission	0.41									
Distribution	2.36									
Total	5.01									
New Capacity in 2015[4]										
Generation and Transmission		8.34[5]	6.19	6.03		22.43	4.88[6]		5.72	5.33
Distribution		2.36	2.36	2.40	n.a.[7]	2.40	2.40	n.a.[7]	2.40	2.36
Total		10.70	8.55	8.43		24.83	7.28		8.12	7.69

Sources:

EIA. 2005a. *EIA Annual Energy Outlook 2005*. Tables 60-72. Electricity Power Projections for Electricity Market Module Regions.

EIA. 2005b. *EIA Annual Energy Outlook 2005*. Unpublished Diagnostic File "LevCost" From National Energy Modeling System (NEMS) Reference Case Run aeo2005.d102004a.

EPA. 2005. Average *Costs of Generation for Existing Coal Units in 2015 Under CAIR/CAMR/CAVR*.

(NCOE) North Carolina Office of Energy. 2005. *North Carolina Energy Impact Model*. Raleigh, NC.

[1] COM TRB: Combustion turbine, including both conventional and advanced combustion turbine (pollution control equipment unspecified).
[2] Listed as "Advanced Nuclear" for year 2015 from EIA (2005b).
[3] The projected generating cost is from EPA (2005) for the MACW Region. The total projected electricity price is computed by adding the EPA generating cost and the projected transmission and distribution costs from EIA (2005a) for the Mid-Atlantic Region.
[4] All entries are projections from EIA (2005a and 2005b) for the Mid-Atlantic Region in Year 2015 unless otherwise noted. The total projected electricity prices are computed by adding the electricity levelized costs (including generation and transmission costs) from EIA (2005b) and the distribution costs from EIA (2005a).
[5] Average cost of "conventional combustion turbine" and "advanced combustion turbine" technologies.
[6] Data from NCOE (2005) for Year 2000 U.S. dollars adjusted to 2003 U.S. dollars.
[7] There is no solar thermal generation or geothermal electricity generation in EIA 2015 projections for the Mid-Atlantic Region.

Appendix Table B2. Example Calculation of Price Differential Effect (Pennsylvania)

Row				
	Basic fuel price			
1	Price of coal ($/million BTU)		1.73	1
2	Price of gas ($/thousand cubic feet)		12.00	2
3	Price of gas ($/million BTU)		11.70	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	1,046,733,435.57	4
5	Total amount of electricity coal displaced by gas (million BTU)	[Calculated by the authors][b]	279,410,551.74	5
6	Total cost of coal displaced by gas (million $)	[Row 5 X Row 1]	482.65	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	195,587,386.22	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	2,287.57	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	1,804.92	9
	Electricity price differential			
10	Displaced coal-fired electricity (excluding the part displaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	74,137.85	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.35	11
12	Total value of displaced coal-fired elec (excluding part displaced by gas) (million $)	[Row 10 X Row 11]	3,969.02	12
13	Displacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	13,589.94	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	10.52	14
15	Total value of displacement renewable electricity (million $)	[Row 13 X Row 14]	1,429.40	15
16	Displacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	60,547.91	16
17	Price of nuclear electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	11.44	17
18	Total value of displacement nuclear electricity (million $)	[Row 16 X Row 17]	6,924.77	18
19	Total value of the displacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	8,354.17	19
20	Total value differential of electricity with displacement (million $)	[Row 19 - Row 12 + Row 9]	6,190.07	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	205,050.91	21
22	Average mix price of electricity after displacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	7.59	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	15,561.27	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	39.78	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	-0.10	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-3.98	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	1,184,626.90	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-47,122.95	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	423,310.39	29
30	Income change (million $)	[Row 26 X Row 29]	-16,838.75	30
	Employment			
31	Total employment	[Calculated by the Authors]	7,946,201.85	31
32	Employment change (person years)	[Row 26 X Row 31]	-316,089.82	32

Notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired
b. This is calculated by multiplying the number in Row 4 by the percentage of gas-fired electricity in total displacement electricity.

Appendix C

State and Regional Summary Tables

SUMMARY TABLES FOR SOUTHEAST REGION

Southeast Table 1A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-$20,844	-$11,832	-$16,338
Florida	-$34,134	-$19,080	-$26,607
Georgia	-$51,674	-$26,160	-$38,917
Kentucky	-$60,222	-$38,444	-$49,333
Mississippi	-$7,118	-$3,950	-$5,534
North Carolina	-$44,661	-$17,028	-$30,845
South Carolina	-$8,625	-$5,763	-$7,194
Tennessee	-$40,188	-$15,182	-$27,685
Virginia	-$17,527	-$11,166	-$14,346
West Virginia	-$24,140	-$17,687	-$20,913
Total	-$309,134	-$166,292	-$237,713

Southeast Table 1B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-$6,740	-$3,642	-$5,191
Florida	-$12,786	-$6,813	-$9,800
Georgia	-$18,184	-$8,941	-$13,563
Kentucky	-$19,877	-$12,472	-$16,174
Mississippi	-$2,449	-$1,300	-$1,875
North Carolina	-$14,648	-$5,330	-$9,989
South Carolina	-$2,759	-$1,777	-$2,268
Tennessee	-$13,406	-$4,916	-$9,161
Virginia	-$6,996	-$4,295	-$5,646
West Virginia	-$7,897	-$5,615	-$6,756
Total	-$105,742	-$55,102	-$80,422

Southeast Table 1C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

(jobs)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-133,263	-69,100	-101,182
Florida	-289,553	-147,923	-218,738
Georgia	-326,643	-158,495	-242,569
Kentucky	-418,442	-262,106	-340,274
Mississippi	-60,110	-31,290	-45,700
North Carolina	-323,124	-111,687	-217,406
South Carolina	-60,351	-37,886	-49,119
Tennessee	-252,608	-92,739	-172,673
Virginia	-111,876	-68,710	-90,293
West Virginia	-190,125	-130,984	-160,554
Total	-2,166,094	-1,110,920	-1,638,507

Southeast Table 2A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-$6,629	-$668	-$3,649	-$3,063	-$64	-$1,564
Florida	-$10,511	-$228	-$5,370	-$5,447	$204	-$2,622
Georgia	-$21,133	-$4,245	-$12,689	-$9,822	-$1,306	-$5,564
Kentucky	-$17,693	-$3,191	-$10,442	-$7,596	-$155	-$3,876
Mississippi	-$2,376	-$252	-$1,314	-$1,189	-$80	-$635
North Carolina	-$20,213	-$2,033	-$11,123	-$9,749	-$744	-$5,246
South Carolina	-$2,463	-$224	-$1,343	-$1,349	-$71	-$710
Tennessee	-$21,628	-$5,124	-$13,376	-$10,802	-$2,550	-$6,676
Virginia	-$8,107	-$2,789	-$5,448	-$4,389	-$1,225	-$2,807
West Virginia	-$5,112	-$788	-$2,950	-$1,187	$1,071	-$58
Total	-$115,863	-$19,542	-$67,702	-$54,593	-$4,921	-$29,757

Southeast Table 2B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-$2,491	-$442	-$1,467	-$1,155	-$124	-$640
Florida	-$4,683	-$603	-$2,643	-$2,369	-$127	-$1,248
Georgia	-$8,038	-$1,920	-$4,979	-$3,738	-$653	-$2,196
Kentucky	-$6,637	-$1,705	-$4,171	-$2,874	-$344	-$1,609
Mississippi	-$945	-$175	-$560	-$463	-$61	-$262
North Carolina	-$7,037	-$906	-$3,972	-$3,389	-$353	-$1,871
South Carolina	-$938	-$170	-$554	-$509	-$70	-$289
Tennessee	-$7,501	-$1,898	-$4,700	-$3,747	-$945	-$2,346
Virginia	-$3,688	-$1,430	-$2,559	-$1,986	-$643	-$1,315
West Virginia	-$1,949	-$420	-$1,185	-$547	$251	-$148
Total	-$43,906	-$9,670	-$26,788	-$20,778	-$3,069	-$11,923

Southeast Table 2C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

(jobs)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Alabama	-54,666	-12,230	-33,448	-25,402	-4,054	-14,728
Florida	-117,734	-20,997	-69,365	-59,213	-6,049	-32,631
Georgia	-149,000	-37,700	-93,350	-69,315	-13,192	-41,254
Kentucky	-142,623	-38,514	-90,568	-61,874	-8,457	-35,165
Mississippi	-24,568	-5,253	-14,911	-11,960	-1,870	-6,915
North Carolina	-162,747	-23,643	-93,195	-78,418	-9,520	-43,969
South Carolina	-22,290	-4,714	-13,502	-12,042	-2,003	-7,022
Tennessee	-140,742	-35,229	-87,985	-70,293	-17,537	-43,915
Virginia	-58,850	-22,768	-40,809	-31,704	-10,235	-20,969
West Virginia	-52,375	-12,749	-32,562	-15,858	4,828	-5,515
Total	-925,596	-213,797	-569,696	-436,079	-68,088	-252,084

SUMMARY TABLES FOR NORTHEAST REGION

Northeast Table 1A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-$4,337	-$1,291	-$2,814
Delaware	-$5,890	-$3,358	-$4,624
Maryland	-$27,103	-$10,767	-$18,935
Massachusetts	-$11,128	-$6,244	-$8,686
Maine	-$503	-$316	-$409
New Hampshire	-$1,641	-$952	-$1,297
New Jersey	-$14,964	-$5,185	-$10,074
New York	-$22,321	-$10,243	-$16,282
Pennsylvania	-$57,580	-$26,337	-$41,959
Total	-$145,467	-$64,692	-$105,080

Northeast Table 1B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-$1,718	-$462	-$1,090
Delaware	-$1,968	-$1,112	-$1,540
Maryland	-$12,174	-$4,579	-$8,376
Massachusetts	-$4,403	-$2,387	-$3,395
Maine	-$175	-$107	-$141
New Hampshire	-$575	-$313	-$444
New Jersey	-$5,787	-$1,935	-$3,861
New York	-$8,955	-$3,911	-$6,433
Pennsylvania	-$19,909	-$8,744	-$14,327
Total	-$55,664	-$23,551	-$39,607

Northeast Table 1C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

(jobs)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-23,935	-6,408	-15,171
Delaware	-35,807	-20,010	-27,909
Maryland	-192,852	-71,418	-132,135
Massachusetts	-61,119	-33,359	-47,239
Maine	-4,221	-2,506	-3,363
New Hampshire	-10,941	-5,719	-8,330
New Jersey	-79,520	-26,566	-53,043
New York	-112,861	-50,345	-81,603
Pennsylvania	-368,645	-159,069	-263,857
Total	-889,901	-375,400	-632,650

Northeast Table 2A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-$2,076	-$15	-$1,045	-$1,014	$92	-$461
Delaware	-$2,567	-$840	-$1,703	-$1,168	-$222	-$695
Maryland	-$13,677	-$2,889	-$8,283	-$6,541	-$1,139	-$3,840
Massachusetts	-$4,198	-$950	-$2,574	-$1,805	-$145	-$975
Maine	-$176	-$52	-$114	-$72	-$10	-$41
New Hampshire	-$490	-$35	-$263	-$202	$26	-$88
New Jersey	-$7,860	-$1,294	-$4,577	-$3,759	-$391	-$2,075
New York	-$9,723	-$1,751	-$5,737	-$4,421	-$435	-$2,428
Pennsylvania	-$25,488	-$4,807	-$15,148	-$12,253	-$1,824	-$7,039
Total	-$66,254	-$12,632	-$39,443	-$31,235	-$4,047	-$17,641

Northeast Table 2B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-$874	-$24	-$449	-$425	$31	-$197
Delaware	-$883	-$299	-$591	-$402	-$82	-$242
Maryland	-$6,575	-$1,560	-$4,068	-$3,148	-$636	-$1,892
Massachusetts	-$1,813	-$473	-$1,143	-$785	-$99	-$442
Maine	-$66	-$21	-$44	-$27	-$5	-$16
New Hampshire	-$196	-$23	-$109	-$83	$4	-$40
New Jersey	-$3,139	-$552	-$1,845	-$1,499	-$172	-$835
New York	-$4,188	-$859	-$2,524	-$1,910	-$246	-$1,078
Pennsylvania	-$9,367	-$1,976	-$5,672	-$4,496	-$769	-$2,632
Total	-$27,101	-$5,787	-$16,444	-$12,774	-$1,974	-$7,374

Northeast Table 2C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

(jobs)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Connecticut	-12,246	-383	-6,314	-5,945	420	-2,762
Delaware	-16,601	-5,824	-11,213	-7,545	-1,639	-4,592
Maryland	-105,876	-25,687	-65,781	-50,701	-10,543	-30,622
Massachusetts	-24,849	-6,386	-15,617	-10,745	-1,306	-6,026
Maine	-1,723	-591	-1,157	-716	-150	-433
New Hampshire	-4,001	-555	-2,278	-1,719	4	-857
New Jersey	-43,222	-7,665	-25,444	-20,629	-2,393	-11,511
New York	-51,565	-10,305	-30,935	-23,501	-2,871	-13,186
Pennsylvania	-177,621	-38,894	-108,257	-85,246	-15,285	-50,265
Total	-437,704	-96,289	-266,996	-206,746	-33,762	-120,254

SUMMARY TABLES FOR MIDWEST REGION

Midwest Table 1A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-$95,392	-$37,686	-$66,539
Indiana	-$82,113	-$50,407	-$66,260
Michigan	-$75,140	-$34,452	-$54,796
Ohio	-$112,434	-$55,018	-$83,726
Wisconsin	-$43,485	-$21,719	-$32,602
Total	-$408,564	-$199,282	-$303,923

Midwest Table 1B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-$36,956	-$13,941	-$25,449
Indiana	-$24,932	-$15,182	-$20,057
Michigan	-$24,212	-$10,997	-$17,605
Ohio	-$36,538	-$17,603	-$27,071
Wisconsin	-$14,194	-$6,990	-$10,592
Total	-$136,833	-$64,713	-$100,773

Midwest Table 1C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

(jobs)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-472,111	-184,972	-328,541
Indiana	-511,683	-308,906	-410,294
Michigan	-403,210	-182,568	-292,889
Ohio	-713,994	-341,917	-527,956
Wisconsin	-291,017	-142,659	-216,838
Total	-2,392,015	-1,161,021	-1,776,518

Midwest Table 2A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-$49,946	-$12,025	-$30,986	-$23,853	-$5,137	-$14,495
Indiana	-$30,565	-$9,251	-$19,908	-$13,791	-$2,565	-$8,178
Michigan	-$38,409	-$11,547	-$24,978	-$18,357	-$4,913	-$11,635
Ohio	-$50,482	-$12,389	-$31,436	-$23,830	-$4,492	-$14,161
Wisconsin	-$19,998	-$5,595	-$12,797	-$9,293	-$2,037	-$5,665
Total	-$189,400	-$50,808	-$120,104	-$89,124	-$19,143	-$54,134

Midwest Table 2B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-$20,369	-$5,246	-$12,808	-$9,717	-$2,252	-$5,984
Indiana	-$9,826	-$3,272	-$6,549	-$4,425	-$973	-$2,699
Michigan	-$12,630	-$3,904	-$8,267	-$6,037	-$1,670	-$3,853
Ohio	-$17,018	-$4,455	-$10,736	-$8,029	-$1,651	-$4,840
Wisconsin	-$6,773	-$2,006	-$4,389	-$3,149	-$747	-$1,948
Total	-$66,616	-$18,883	-$42,750	-$31,356	-$7,294	-$19,325

Midwest Table 2C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

(jobs)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Illinois	-250,522	-61,834	-156,178	-119,582	-26,449	-73,015
Indiana	-203,241	-66,933	-135,087	-91,806	-20,010	-55,908
Michigan	-210,979	-65,309	-138,144	-100,873	-27,971	-64,422
Ohio	-333,726	-86,869	-210,297	-157,760	-32,441	-95,100
Wisconsin	-140,143	-41,973	-91,058	-65,165	-15,707	-40,436
Total	-1,138,612	-322,918	-730,765	-535,186	-122,578	-328,882

SUMMARY TABLES FOR CENTRAL REGION

Central Table 1A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-$5,787	-$4,541	-$5,164
Iowa	-$28,434	-$14,894	-$21,664
Kansas	-$36,552	-$16,146	-$26,349
Louisiana	-$14,349	-$8,154	-$11,251
Minnesota	-$48,120	-$17,154	-$32,637
Missouri	-$63,824	-$30,163	-$46,994
Nebraska	-$29,741	-$9,505	-$19,623
Oklahoma	-$19,943	-$13,780	-$16,861
Texas	-$58,320	-$34,517	-$46,418
Total	-$305,070	-$148,854	-$226,962

Central Table 1B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-$1,782	-$1,375	-$1,579
Iowa	-$8,655	-$4,472	-$6,564
Kansas	-$11,990	-$5,134	-$8,562
Louisiana	-$5,655	-$3,067	-$4,361
Minnesota	-$16,881	-$5,887	-$11,384
Missouri	-$22,680	-$10,462	-$16,571
Nebraska	-$10,617	-$3,277	-$6,947
Oklahoma	-$6,995	-$4,704	-$5,849
Texas	-$20,766	-$11,950	-$16,358
Total	-$106,020	-$50,328	-$78,174

Central Table 1C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

(jobs)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-40,347	-30,892	-35,619
Iowa	-208,837	-105,890	-157,363
Kansas	-273,630	-114,374	-194,002
Louisiana	-129,606	-68,828	-99,217
Minnesota	-298,349	-103,699	-201,024
Missouri	-433,836	-200,399	-317,118
Nebraska	-144,287	-45,783	-95,035
Oklahoma	-158,953	-105,794	-132,373
Texas	-369,816	-209,171	-289,494
Total	-2,057,661	-984,830	-1,521,246

Central Table 2A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-$878	$265	-$307	-$566	$163	-$202
Iowa	-$12,028	-$3,073	-$7,551	-$5,564	-$1,058	-$3,311
Kansas	-$17,601	-$4,165	-$10,883	-$8,565	-$1,893	-$5,229
Louisiana	-$5,349	-$1,220	-$3,285	-$2,530	-$406	-$1,468
Minnesota	-$27,513	-$7,076	-$17,295	-$13,604	-$3,385	-$8,494
Missouri	-$30,131	-$7,883	-$19,007	-$14,331	-$3,161	-$8,746
Nebraska	-$17,324	-$4,054	-$10,689	-$8,342	-$1,834	-$5,088
Oklahoma	-$3,921	$157	-$1,882	-$1,497	$556	-$470
Texas	-$21,739	-$5,517	-$13,628	-$10,600	-$1,735	-$6,167
Total	-$136,484	-$32,567	-$84,525	-$65,598	-$12,753	-$39,176

Central Table 2B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-$390	-$17	-$204	-$235	$3	-$116
Iowa	-$3,818	-$1,052	-$2,435	-$1,768	-$376	-$1,072
Kansas	-$6,086	-$1,572	-$3,829	-$2,960	-$719	-$1,839
Louisiana	-$2,434	-$709	-$1,572	-$1,144	-$256	-$700
Minnesota	-$9,883	-$2,628	-$6,255	-$4,887	-$1,260	-$3,073
Missouri	-$11,358	-$3,282	-$7,320	-$5,400	-$1,346	-$3,373
Nebraska	-$6,364	-$1,551	-$3,957	-$3,064	-$703	-$1,883
Oklahoma	-$1,811	-$296	-$1,053	-$731	$32	-$349
Texas	-$8,552	-$2,544	-$5,548	-$4,140	-$857	-$2,499
Total	-$50,696	-$13,649	-$32,173	-$24,329	-$5,481	-$14,905

Central Table 2C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

(jobs)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arkansas	-9,754	-1,091	-5,423	-5,799	-274	-3,037
Iowa	-96,719	-28,630	-62,675	-44,836	-10,578	-27,707
Kansas	-143,214	-38,353	-90,784	-69,689	-17,622	-43,656
Louisiana	-58,667	-18,153	-38,410	-27,501	-6,655	-17,078
Minnesota	-175,242	-46,772	-111,007	-86,659	-22,425	-54,542
Missouri	-214,264	-59,976	-137,120	-101,951	-24,484	-63,218
Nebraska	-84,531	-19,939	-52,235	-40,708	-9,032	-24,870
Oklahoma	-45,015	-9,844	-27,429	-18,438	-726	-9,582
Texas	-160,540	-51,058	-105,799	-77,460	-17,638	-47,549
Total	-987,945	-273,816	-630,881	-473,042	-109,434	-291,238

SUMMARY TABLES FOR WESTERN/PACIFIC REGION

Western Table 1A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-$15,373	-$10,242	-$12,807
California	-$74,935	-$41,882	-$58,408
Colorado	-$20,758	-$17,183	-$18,971
Montana	-$5,317	-$3,614	-$4,466
Nevada	-$9,382	-$6,103	-$7,743
New Mexico	-$17,166	-$11,714	-$14,440
North Dakota	-$9,881	-$7,028	-$8,454
Oregon	-$1,808	-$1,185	-$1,497
South Dakota	-$3,151	-$2,030	-$2,591
Utah	-$40,038	-$24,796	-$32,417
Washington	-$6,307	-$3,287	-$4,797
Wyoming	-$8,470	-$5,814	-$7,142
Total	-$212,585	-$134,879	-$173,732

Western Table 1B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

($2005 million)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-$5,314	-$3,428	-$4,371
California	-$28,259	-$15,540	-$21,900
Colorado	-$7,540	-$6,191	-$6,866
Montana	-$1,840	-$1,228	-$1,534
Nevada	-$3,682	-$2,359	-$3,021
New Mexico	-$6,637	-$4,391	-$5,514
North Dakota	-$3,160	-$2,215	-$2,687
Oregon	-$620	-$403	-$512
South Dakota	-$913	-$587	-$750
Utah	-$14,639	-$9,012	-$11,825
Washington	-$2,366	-$1,209	-$1,788
Wyoming	-$2,979	-$1,925	-$2,452
Total	-$77,950	-$48,488	-$63,219

Western Table 1C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the 100% Displacement (Existence) Case

(jobs)

State	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-105,323	-66,600	-85,962
California	-438,164	-239,492	-338,828
Colorado	-120,198	-98,649	-109,424
Montana	-53,467	-34,798	-44,133
Nevada	-78,607	-49,759	-69,215
New Mexico	-159,775	-103,413	-131,594
North Dakota	-82,479	-55,952	-64,183
Oregon	-14,319	-9,163	-11,741
South Dakota	-22,545	-14,400	-18,473
Utah	-304,341	-186,933	-245,637
Washington	-38,285	-19,477	-28,881
Wyoming	-67,423	-43,659	-55,541
Total	-1,484,929	-922,295	-1,203,612

Western Table 2A. Estimates of the Statewide Output Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-$3,409	-$5	-$1,707	-$1,501	$227	-$637
California	-$33,815	-$12,000	-$22,907	-$15,435	-$4,527	-$9,981
Colorado	-$8,553	-$4,319	-$6,436	-$5,743	-$2,253	-$3,998
Montana	-$1,831	-$707	-$1,269	-$681	-$119	-$400
Nevada	-$3,626	-$1,461	-$2,544	-$1,542	-$460	-$1,001
New Mexico	-$5,228	-$1,583	-$3,406	-$2,212	-$321	-$1,266
North Dakota	-$2,663	-$780	-$1,721	-$503	$439	-$32
Oregon	-$700	-$288	-$494	-$298	-$93	-$196
South Dakota	-$1,099	-$360	-$730	-$457	-$88	-$272
Utah	-$19,177	-$9,068	-$14,122	-$8,325	-$3,197	-$5,761
Washington	-$3,133	-$1,140	-$2,137	-$1,471	-$475	-$973
Wyoming	-$2,690	-$929	-$1,809	-$746	$146	-$300
Total	-$85,923	-$32,641	-$59,282	-$38,915	-$10,720	-$24,818

Western Table 2B. Estimates of the Statewide Personal Income Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

($2005 million)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-$1,511	-$260	-$885	-$671	-$36	-$353
California	-$13,517	-$5,122	-$9,319	-$6,192	-$1,994	-$4,093
Colorado	-$3,606	-$2,009	-$2,807	-$2,349	-$1,032	-$1,690
Montana	-$700	-$296	-$498	-$273	-$72	-$173
Nevada	-$1,567	-$694	-$1,130	-$674	-$238	-$456
New Mexico	-$2,388	-$887	-$1,637	-$1,027	-$248	-$637
North Dakota	-$893	-$269	-$581	-$177	$135	-$21
Oregon	-$256	-$113	-$184	-$110	-$38	-$74
South Dakota	-$312	-$97	-$205	-$129	-$22	-$75
Utah	-$7,185	-$3,452	-$5,319	-$3,127	-$1,233	-$2,180
Washington	-$1,234	-$470	-$852	-$581	-$199	-$390
Wyoming	-$1,218	-$520	-$869	-$438	-$84	-$261
Total	-$34,387	-$14,187	-$24,287	-$15,747	-$5,059	-$10,403

Western Table 2C. Estimates of the Statewide Employment Impact of Coal-Fueled Electricity Generation for the Displacement/Replacement Cases

(jobs)

State	66% Displacement/Replacement			33% Displacement/Replacement		
	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average	High Alternative-Price Scenario	Low Alternative-Price Scenario	Average
Arizona	-31,451	-5,759	-18,605	-13,988	-943	-7,465
California	-213,835	-82,712	-148,274	-98,065	-32,503	-65,284
Colorado	-58,565	-33,046	-45,806	-37,989	-16,949	-27,469
Montana	-22,739	-10,418	-16,578	-9,296	-3,135	-6,216
Nevada	-35,506	-9,232	-17,986	-15,373	2,123	-2,254
New Mexico	-62,516	-24,832	-43,674	-26,994	-7,439	-17,216
North Dakota	-26,740	-16,466	-25,986	-6,631	-5,853	-10,613
Oregon	-6,344	-2,941	-4,642	-2,747	-1,045	-1,896
South Dakota	-7,838	-2,462	-5,150	-3,247	-559	-1,903
Utah	-150,590	-72,715	-111,652	-65,580	-26,076	-45,828
Washington	-20,116	-7,703	-13,909	-9,464	-3,258	-6,361
Wyoming	-27,713	-11,959	-19,836	-10,098	-2,118	-6,108
Total	-663,954	-280,243	-472,099	-299,472	-97,754	-198,613

CA Table 3A. Backward Linkage Impacts of 100% Coal-Fired Electricity Displacement, 2015
(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
Coal			
1. Direct Coal-Fired Electricity Generation Displacement[a]	-$3,920	-$825	-4,390
Electricity Demand Multiplier	1.916	2.663	6.694
Subtotal	-$7,512	-$2,196	-29,383
2. Indirect Business Taxes[b]	-$481	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	-$928	-$474	-9,092
Displacement Grand Total	-$8,440	-$2,670	-38,475

Notes:

a. Value computed by multiplying average price of coal-fired generation in surrounding region in 2015 (from EPA, 2005b) by projection of coal-fired generation in 2015 (from EPA, 2005a).

b. Includes taxes paid by all coal-fired electricity generation, by coal mining for electricity generation, and by railroad transportation of coal (to the electricity generation sector).

c. Total impacts determined by special calculation (see text).

CA Table 3B. Backward Linkage Impacts of 66% Coal-Fired Electricity Replacement, 2015

(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
Coal			
1. Direct Coal-Fired Electricity Generation Displacement[a]	-$2,587	-$544	-2,897
Electricity Demand Multiplier	1.916	2.663	6.694
Subtotal	-$4,958	-$1,449	-19,393
2. Indirect Business Taxes[b]	-$317	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	-$612	-$313	-6,001
Displacement Grand Total	-$5,570	-$1,763	-25,394
Oil/Gas			
1. Direct Oil/Gas Electricity Generation Replacement[d]	$4,419	$930	4,949
Electricity Demand Multiplier	1.466	1.819	4.232
Subtotal	$6,477	$1,691	20,941
2. Indirect Business Taxes[e]	$512	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$988	$505	9,687
Total	$7,465	$2,196	30,628
Nuclear			
1. Direct Nuclear Electricity Generation Replacement[d]	$1,385	$291	1,551
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$1,979	$514	6,305
2. Indirect Business Taxes[e]	$159	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$307	$157	3,009
Total	$2,286	$671	9,314

Biomass			
1. Direct Biomass Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.916	2.663	6.694
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Hydro			
1. Direct Hydro Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Wind			
1. Direct Wind Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Solar			
1. Direct Solar Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Replacement Grand Total	$9,751	$2,867	39,942

Notes:

a. Value computed by multiplying average price of coal-fired generation in surrounding region in 2015 (from EPA, 2005b) by projection of coal-fired generation in 2015 (from EPA, 2005a).

b. Includes taxes paid by all coal-fired electricity generation, by coal mining for electricity generation, and by railroad transportation of coal (to the electricity generation sector).

c. Total impacts determined by special calculation (see text).

d. Value computed by multiplying average price of the corresponding electricity generation in surrounding region in 2015 (from EIA, 2005b) by projection of the corresponding electricity generation in 2015 (from EPA, 2005a and EIA, 2005c).

e. Includes taxes paid by all corresponding electricity generation, by mining or processing (where applicable), and by transportation or distribution (where applicable).

CA Table 3C. Backward Linkage Impacts of 33% Coal-Fired Electricity Replacement, 2015
(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
Coal			
1. Direct Coal-Fired Electricity Generation Displacement[a]	-$1,293	-$272	-1,449
Electricity Demand Multiplier	1.916	2.663	6.694
Subtotal	-$2,479	-$725	-9,696
2. Indirect Business Taxes[b]	-$159	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	-$306	-$157	-3,000
Displacement Grand Total	-$2,785	-$881	-12,697
Oil/Gas			
1. Direct Oil/Gas Electricity Generation Replacement[d]	$2,209	$465	2,474
Electricity Demand Multiplier	1.466	1.819	4.232
Subtotal	$3,238	$845	10,471
2. Indirect Business Taxes[e]	$256	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$494	$253	4,843
Total	$3,732	$1,098	15,314
Nuclear			
1. Direct Nuclear Electricity Generation Replacement[d]	$692	$146	776
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$989	$257	3,152
2. Indirect Business Taxes[e]	$80	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$154	$78	1,505
Total	$1,143	$336	4,657

Biomass			
1. Direct Biomass Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.916	2.663	6.694
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Hydro			
1. Direct Hydro Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Wind			
1. Direct Wind Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Solar			
1. Direct Solar Electricity Generation Replacement[d]	$0	$0	0
Electricity Demand Multiplier	1.429	1.765	4.065
Subtotal	$0	$0	0
2. Indirect Business Taxes[e]	$0	c	c
Government Expenditure Multiplier	1.928	c	c
Subtotal	$0	$0	0
Total	$0	$0	0
Replacement Grand Total	$4,875	$1,434	19,971

Notes:

a. Value computed by multiplying average price of coal-fired generation in surrounding region in 2015 (from EPA, 2005b) by projection of coal-fired generation in 2015 (from EPA, 2005a).

b. Includes taxes paid by all coal-fired electricity generation, by coal mining for electricity generation, and by railroad transportation of coal (to the electricity generation sector).

c. Total impacts determined by special calculation (see text).

d. Value computed by multiplying average price of the corresponding electricity generation in surrounding region in 2015 (from EIA, 2005b) by projection of the corresponding electricity generation in 2015 (from EPA, 2005a and EIA, 2005c).

e. Includes taxes paid by all corresponding electricity generation, by mining or processing (where applicable), and by transportation or distribution (where applicable).

Economic Impacts Tables of High Price Scenario

CA Table 4A. Economic Impacts of 100% Coal-Fired Electricity Displacement, 2015

(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$8,440	-$2,670	-38,475
2. Price Differential Effect	-$66,495	-$25,589	-399,689
Net Grand Total	-$74,935	-$28,259	-438,164

CA Table 4B. Economic Impacts of 66% Coal-Fired Electricity Replacement, 2015

(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$5,570	-$1,763	-25,394
2. Coal Replacement Grand Total	$9,751	$2,867	39,942
3. Price Differential Effect	-$37,995	-$14,621	-228,384
Net Grand Total	-$33,815	-$13,517	-213,835

CA Table 4C. Economic Impacts of 33% Coal-Fired Electricity Replacement, 2015
(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$2,785	-$881	-12,697
2. Coal Replacement Grand Total	$4,875	$1,434	19,971
3. Price Differential Effect	-$17,525	-$6,744	-105,339
Net Grand Total	-$15,435	-$6,192	-98,065

Economic Impacts Tables of Low Price Scenario

CA Table 4D. Economic Impacts of 100% Coal-Fired Electricity Displacement, 2015

(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$8,440	-$2,670	-38,475
2. Price Differential Effect	-$33,443	-$12,869	-201,017
Net Grand Total	-$41,882	-$15,540	-239,492

CA Table 4E. Economic Impacts of 66% Coal-Fired Electricity Replacement, 2015

(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$5,570	-$1,763	-25,394
2. Coal Replacement Grand Total	$9,751	$2,867	39,942
3. Price Differential Effect	-$16,181	-$6,227	-97,260
Net Grand Total	-$12,000	-$5,122	-82,712

CA Table 4F. Economic Impacts of 33% Coal-Fired Electricity Replacement, 2015
(in millions of 2005 dollars, and in person-years)

Impact Components	Output	Personal Income	Employment
1. Coal Displacement Grand Total	-$2,785	-$881	-12,697
2. Coal Replacement Grand Total	$4,875	$1,434	19,971
3. Price Differential Effect	-$6,618	-$2,547	-39,777
Net Grand Total	-$4,527	-$1,994	-32,503

Price Differential Impacts Analysis of CA - High Price Scenario (2015) (in 2005 dollars)

Level 1: 100% displacement coal-fired generation case

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		12.00	2
3	Price of gas ($/million BTU)		11.70	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal displaced by gas (million BTU)	[Calculated by the authors][b]	449,259,673.16	5
6	Total cost of coal displaced by gas (million $)	[Row 5 X Row 1]	558.94	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	314,481,771.21	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	3,678.15	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	3,119.21	9
	Electricity price differential			
10	Displaced coal-fired electricity (excluding the part displaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	20,465.23	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of displaced coal-fired electricity (excluding the part displaced by gas) (million $)	[Row 10 X Row 11]	1,162.29	12
13	Displacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	9.88	14
15	Total value of displacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Displacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	20,465.23	16
17	Price of nuclear electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	12.75	17
18	Total value of displacement nuclear electricity (million $)	[Row 16 X Row 17]	2,609.82	18
19	Total value of the displacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	2,609.82	19
20	Total value differential of electricity with displacement (million $)	[Row 19 - Row 12 + Row 9]	4,566.74	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after displacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	16.15	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-1.61	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076.03	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-66,494.95	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,726.83	29
30	Income change (million $)	[Row 26 X Row 29]	-25,588.73	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,029.91	31
32	Employment change (person years)	[Row 26 X Row 31]	-399,689.46	32

notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by the percentage of gas-fired electricity in total displacement electricity.

Level 2: 66% replacement of coal-fired generation

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		10.00	2
3	Price of gas ($/million BTU)		9.75	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal replaced by gas (million BTU)	[Calculated by the authors][b]	296,511,384.29	5
6	Total cost of coal replaced by gas (million $)	[Row 5 X Row 1]	368.90	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	207,557,969.00	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	2,022.98	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	1,654.08	9
	Electricity price differential			
10	Replaced coal-fired electricity (excluding the part replaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	13,507.06	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of replaced coal-fired electricity (excluding the part replaced by gas) (million $)	[Row 10 X Row 11]	767.11	12
13	Replacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	9.88	14
15	Total value of replacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Replacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	13,507.06	16
17	Price of nuclear electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	12.75	17
18	Total value of replacement nuclear electricity (million $)	[Row 16 X Row 17]	1,722.48	18
19	Total value of the replacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	1,722.48	19
20	Total value differential of electricity with replacement (million $)	[Row 19 - Row 12 + Row 9]	2,609.45	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after replacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	9.23	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-0.9227	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-37,995	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,727	29
30	Income change (million $)	[Row 26 X Row 29]	-14,621	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,030	31
32	Employment change (person years)	[Row 26 X Row 31]	-228,384	32

notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by 66% and by the percentage of gas-fired electricity in total replacement electricity.

Level 3: 33% replacement of coal-fired generation

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		9.00	2
3	Price of gas ($/million BTU)		8.77	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal replaced by gas (million BTU)	[Calculated by the authors][b]	148,255,692.14	5
6	Total cost of coal replaced by gas (million $)	[Row 5 X Row 1]	184.45	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	103,778,984.50	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	910.34	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	725.89	9
	Electricity price differential			
10	Replaced coal-fired electricity (excluding the part replaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	6,753.53	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of replaced coal-fired electricity (excluding the part replaced by gas) (million $)	[Row 10 X Row 11]	383.55	12
13	Replacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	9.88	14
15	Total value of replacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Replacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	6,753.53	16
17	Price of nuclear electricity (2005cents/kwh)	[25% higher than the price from "APPENDIX A" Table 4]	12.75	17
18	Total value of replacement nuclear electricity (million $)	[Row 16 X Row 17]	861.24	18
19	Total value of the replacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	861.24	19
20	Total value differential of electricity with replacement (million $)	[Row 19 - Row 12 + Row 9]	1,203.58	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after replacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	4.26	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-0.4256	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-17,525	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,727	29
30	Income change (million $)	[Row 26 X Row 29]	-6,744	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,030	31
32	Employment change (person years)	[Row 26 X Row 31]	-105,339	32

notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by 33% and by the percentage of gas-fired electricity in total replacement electricity.

Price Differential Impacts Analysis of CA - Low Price Scenario (2015) (in 2005 dollars)

Level 1: 100% displacement coal-fired generation case

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		8.00	2
3	Price of gas ($/million BTU)		7.80	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal displaced by gas (million BTU)	[Calculated by the authors][b]	449,259,673.16	5
6	Total cost of coal displaced by gas (million $)	[Row 5 X Row 1]	558.94	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	314,481,771.21	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	2,452.10	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	1,893.16	9
	Electricity price differential			
10	Displaced coal-fired electricity (excluding the part displaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	20,465.23	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of displaced coal-fired electricity (excluding the part displaced by gas) (million $)	[Row 10 X Row 11]	1,162.29	12
13	Displacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	5.93	14
15	Total value of displacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Displacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	20,465.23	16
17	Price of nuclear electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	7.65	17
18	Total value of displacement nuclear electricity (million $)	[Row 16 X Row 17]	1,565.89	18
19	Total value of the displacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	1,565.89	19
20	Total value differential of electricity with displacement (million $)	[Row 19 - Row 12 + Row 9]	2,296.77	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after displacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	8.12	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-0.81	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076.03	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-33,442.52	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,726.83	29
30	Income change (million $)	[Row 26 X Row 29]	-12,869.42	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,029.91	31
32	Employment change (person years)	[Row 26 X Row 31]	-201,017.08	32

notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by the percentage of gas-fired electricity in total displacement electricity.

Level 2: 66% replacement of coal-fired generation

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		6.00	2
3	Price of gas ($/million BTU)		5.85	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal replaced by gas (million BTU)	[Calculated by the authors][b]	296,511,384.29	5
6	Total cost of coal replaced by gas (million $)	[Row 5 X Row 1]	368.90	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	207,557,969.00	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	1,213.79	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	844.89	9
	Electricity price differential			
10	Replaced coal-fired electricity (excluding the part replaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	13,507.06	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of replaced coal-fired electricity (excluding the part replaced by gas) (million $)	[Row 10 X Row 11]	767.11	12
13	Replacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	5.93	14
15	Total value of replacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Replacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	13,507.06	16
17	Price of nuclear electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	7.65	17
18	Total value of replacement nuclear electricity (million $)	[Row 16 X Row 17]	1,033.49	18
19	Total value of the replacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	1,033.49	19
20	Total value differential of electricity with replacement (million $)	[Row 19 - Row 12 + Row 9]	1,111.27	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after replacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	3.93	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-0.3929	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-16,181	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,727	29
30	Income change (million $)	[Row 26 X Row 29]	-6,227	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,030	31
32	Employment change (person years)	[Row 26 X Row 31]	-97,260	32

notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by 66% and by the percentage of gas-fired electricity in total replacement electricity.

Level 3: 33% replacement of coal-fired generation

	Basic fuel price			
1	Price of coal ($/million BTU)		1.24	1
2	Price of gas ($/thousand cubic feet)		5.00	2
3	Price of gas ($/million BTU)		4.87	3
	Fuel cost differential			
4	Total amount of coal consumed in electric power sector (million BTU)	[Calculated by the authors][a]	640,000,000.00	4
5	Total amount of electricity coal replaced by gas (million BTU)	[Calculated by the authors][b]	148,255,692.14	5
6	Total cost of coal replaced by gas (million $)	[Row 5 X Row 1]	184.45	6
7	Total physical amount when gas is used (million BTU)	[Row 5 X 0.70 (Conversion Factor)]	103,778,984.50	7
8	Total cost of gas (million $)	[Row 7 X Row 3]	505.75	8
9	Cost differential of coal and gas (million $)	[Row 8 - Row 6]	321.30	9
	Electricity price differential			
10	Replaced coal-fired electricity (excluding the part replaced by gas) (million kwh)	[From "APPENDIX A" Table 1]	6,753.53	10
11	Price of coal-fired electricity (2005cents/kwh)	[From "APPENDIX A" Table 4]	5.68	11
12	Total value of replaced coal-fired electricity (excluding the part replaced by gas) (million $)	[Row 10 X Row 11]	383.55	12
13	Replacement generation by renewables (million kwh)	[From "APPENDIX A" Table 1]	0.00	13
14	Weighted average price of renewable electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	5.93	14
15	Total value of replacement renewable electricity (million $)	[Row 13 X Row 14]	0.00	15
16	Replacement generation by nuclear (million kwh)	[From "APPENDIX A" Table 1]	6,753.53	16
17	Price of nuclear electricity (2005cents/kwh)	[25% lower than the price from "APPENDIX A" Table 4]	7.65	17
18	Total value of replacement nuclear electricity (million $)	[Row 16 X Row 17]	516.74	18
19	Total value of the replacement renewable and nuclear electricity (million $)	[Row 15 + Row 18]	516.74	19
20	Total value differential of electricity with replacement (million $)	[Row 19 - Row 12 + Row 9]	454.49	20
21	Total electricity generation (million kwh)	[From "APPENDIX A" Table 1]	289,331.31	21
22	Average mix price of electricity after replacement (2005cents/kwh)	[From "APPENDIX A" Table 4]	9.78	22
23	Total value of electricity generation (million $)	[Row 21 X Row 22]	28,282.14	23
24	Price differential averaged over all electricity in the state (%)	[(Row 20 / Row 21) X 100]	1.61	24
	Impact Differential			
25	Elasticity of regional economic activity	[From Text]	**-0.10**	25
26	Impact differential factor (%)	[Row 24 X Row 25]	-0.1607	26
	Impact Results			
	Output			
27	Total base gross output (million $)	[Calculated by the Authors]	4,118,076	27
28	Gross output change induced by price differential (million $)	[Row 26 X Row 27]	-6,618	28
	Income			
29	Total base income generated (million $)	[Calculated by the Authors]	1,584,727	29
30	Income change (million $)	[Row 26 X Row 29]	-2,547	30
	Employment			
31	Total employment	[Calculated by the Authors]	24,753,030	31
32	Employment change (person years)	[Row 26 X Row 31]	-39,777	32

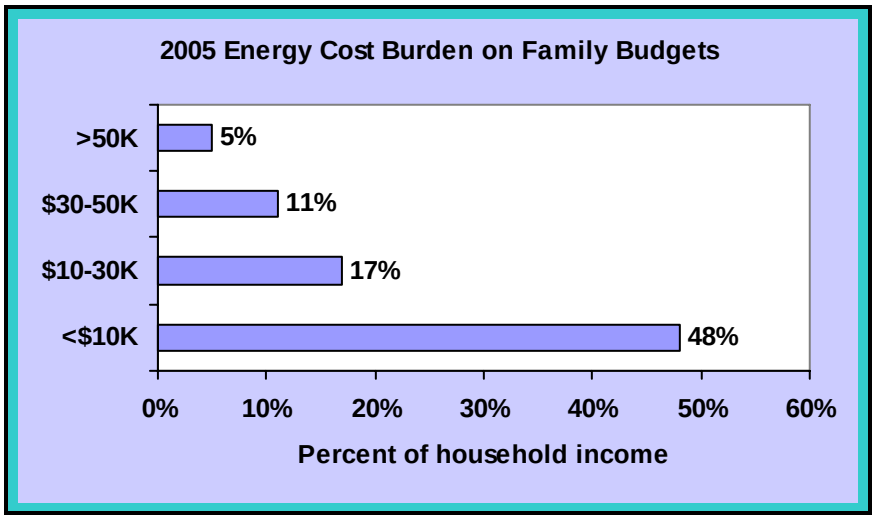
notes: a. This is calculated by multiplying the EIA regional projection of electricity coal consumption in 2015 by the EPA projected ratio of state coal-fired electricity to regional coal-fired electricity in 2015.
b. This is calculated by multiplying the number in Row 4 by 33% and by the percentage of gas-fired electricity in total replacement electricity.

balanced energy

AMERICANS FOR BALANCED ENERGY CHOICES

Energy Cost Burdens on American Families

AMERICANS ARE FEELING THE PINCH OF SKYROCKETING ENERGY PRICES



"Overall, the 56 percent of American households with annual incomes of $50,000 or less, totaling 63 million families, will spend 20 percent of their pre-tax income on energy in 2005."

By: Eugene M. Trisko
Attorney at Law

October 2005

Energy Cost Burdens on American Families

This paper analyzes the effects of 2005 prices for residential and transportation energy based on data from the U.S. Department of Energy's Energy Information Administration (EIA)[1], the U.S. Bureau of the Census,[2] and the U.S. Department of Transportation (DOT).[3]

Key findings of this report include:

- In 2005, energy costs will consume 48 percent of the budgets of U.S. families with incomes of less than $10,000.

- The 29 million U.S. households with incomes of $10,000 to $30,000 (averaging $19,700) will spend 17 percent of their pre-tax income on energy products and services in 2005.

- Overall, the 56 percent of American families with incomes of $50,000 or less (totaling 63 million families) will spend 20 percent of their pre-tax income on energy in 2005.

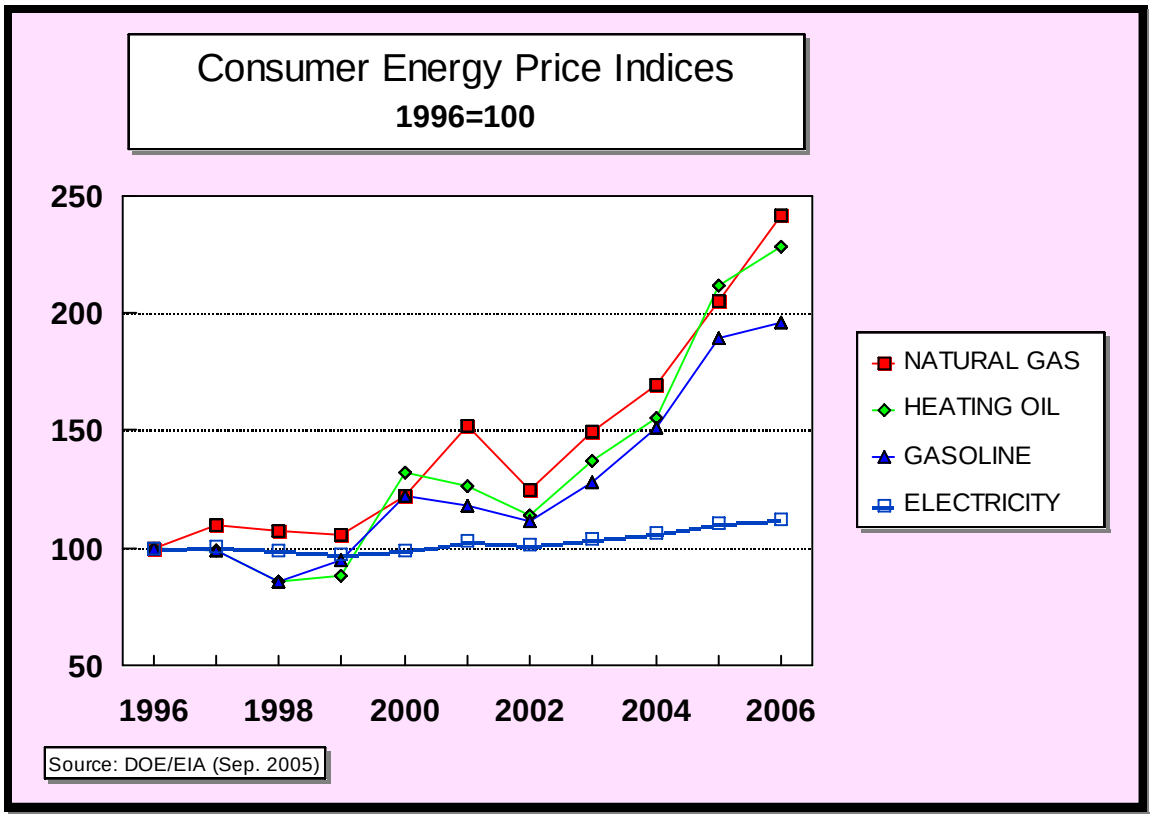
- Households with family incomes greater than $50,000 will spend five percent of their gross incomes for residential and transportation energy.

Among consumer energy purchases, only residential electric services have maintained a low rate of price increase over the past decade. Compared to gasoline, home heating oil, natural gas, and other petroleum-based products, residential electricity prices have remained stable.

Relative Fuel Price Increases

Chart 1 summarizes consumer energy price trends for the period 1996 to 2005, including EIA's projections for 2006, indexed to the year 1996. Prices for residential natural gas and home heating oil will more than triple by 2006, while gasoline prices will nearly double. Residential electricity is projected to increase by 10 percent from 1996 to 2005, and by 12 percent from 1996 to 2006.

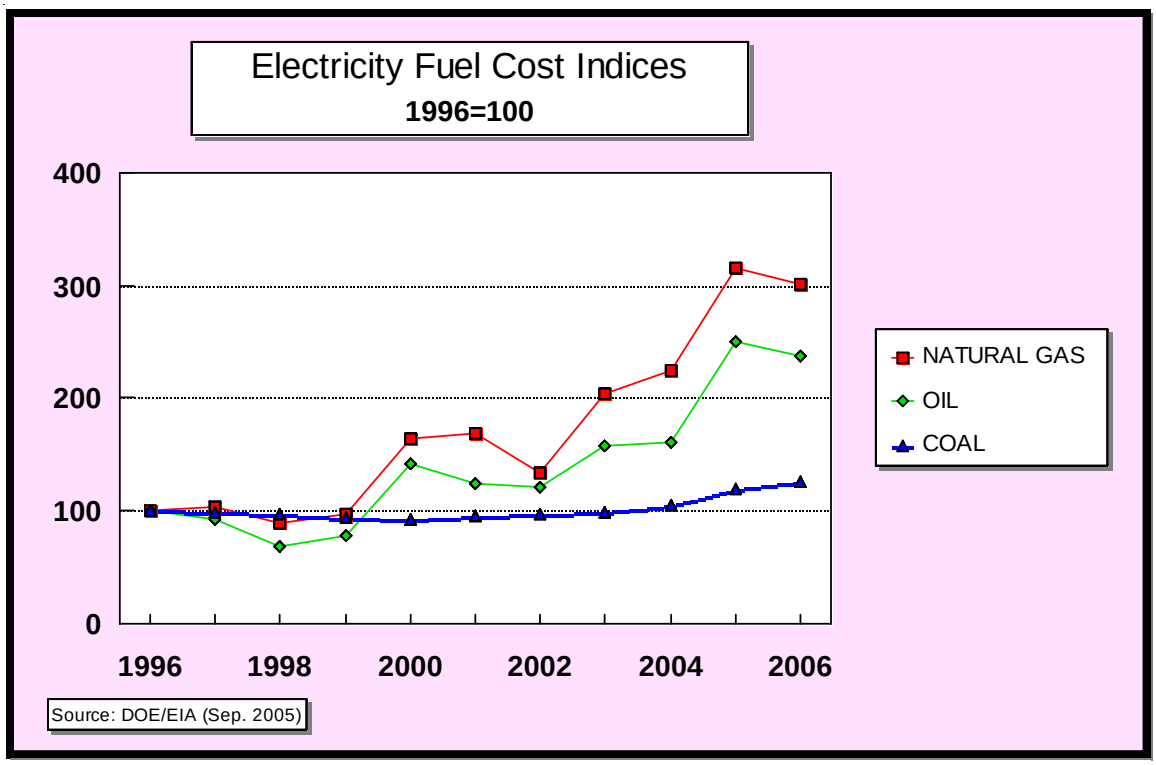
Chart 1



The modest rate of price increase for residential electric services reflects, in part, the electric utility industry's historic reliance on low-cost coal for more than 50 percent of its energy inputs. The price trends of fuels used for electric generation are shown in Chart 2, also indexed to 1996.

The price of natural gas for electric generation has tripled since 1996, similar to the trend for residential natural gas. Oil used for electric generation will cost 150 percent more in 2005 than in 1996. EIA projects that coal prices in 2005 will be only 20 percent above their 1996 level.

Chart 2



Total Energy Expenditures

The distribution of American households by income category in 2003 provides the basis for estimating the effect of current energy prices on consumers. Census data indicate that average household incomes have fallen slightly in recent years, except for gains among the highest-earning families. The 2003 Census data are representative of the current distribution of incomes among low- and middle-income families.

EIA's 2001 Survey of Residential Energy Consumption (updated to 2005 with EIA's September 2005 forecast of residential energy prices) is the source for estimating energy expenditures for residential heating, cooling, electricity, and other energy services.

The Department of Transportation's 2001 National Household Travel Survey provides information for estimating transportation energy costs. These transportation costs have been updated using EIA's 2005 projected national average retail gasoline price of $2.37 per gallon.

Household Incomes

Median family incomes peaked in 1999 and have declined slightly since that time. Mean, or average family incomes, peaked in 2000. The fraction of high-income families with incomes greater than $100,000 annually has grown recently, while the share of families in relatively low ($15-25K) incomes has remained stable.

U.S. income trends, 1997-2003

Year	Average income	Median income	Pct. $15-$25K	Pct. >$100K
2003	$59,067	$43,318	13.1%	15.1%
2002	$59,177	$43,381	12.9%	14.7%
2001	$60,488	$43,883	12.9%	14.9%
2000	$61,031	$44,853	12.5%	15.2%
1999	$60,420	$44,922	13.0%	15.0%
1998	$58,433	$43,825	13.1%	13.9%
1997	$58,795	$42,294	13.4%	12.9%

In 2003, more than one-third of American families had incomes of $30,000 or less, while 44 percent of families enjoyed incomes greater than $50,000 annually. Overall, U.S. families had an average income of $59,067 in 2003. Median family income was $43,318, meaning that one-half of families had incomes below this amount, and one-half had incomes of more than $43,318.

Distribution of U.S. households by income, 2003

Annual income	<$10K	$10-$30K	$30-$50K	>$50K	Total
No. of households (millions)	10.1	29.1	23.4	49.3	111.9
Pct. Of households	9%	26%	21%	44%	100%
Average income	$5,700	$19,700	$39,200	$107,700	$59,067

Residential Energy Expenses

The principal residential energy expenses are for electricity and natural gas, followed by home heating oil. Propane gas and kerosene are used by a relatively small number of households.

Since 2001, total residential energy expenditures have increased from $160 billion to more than $200 billion annually. The largest share of household income spent for residential energy falls disproportionately on poor and lower-income families. While some very low-income consumers may qualify for energy assistance through state or federal programs, these government programs will struggle to keep pace with the rapid escalation of energy prices. It is primarily the poor, fixed income, and other relatively low-income families who will bear the greatest burden of recent energy price increases. Only a massive increase in the amount of funds available to energy assistance programs - made possible by tax increases or by a redistribution of government spending - would soften the blow of rising costs for residential heating and cooling.

The following table shows the changing pattern of residential energy costs from 2001 to 2005, reflecting major increases in fuel oil and natural gas prices. Electricity prices have remained relatively stable, reducing the overall increase of residential energy prices.

Household energy expenses by fuel, 2001 and 2005

	2001	2005	Pct. Change
Electricity	$938	$1,050	12%
Natural gas	$702	$950	35%
Fuel oil	$737	$1,232	67%
Propane gas	$605	$979	62%
Total*	$1,493	$1,834	23%

**Columns do not add to totals because some households use more than one type of fuel. Costs by fuel are averages for households using that type of fuel.*

The effect of higher residential energy prices on low- and middle-income families is illustrated in the table below. Residential energy costs represent 23 percent of the household earnings of the lowest income families, less than $10,000, and eight percent of the pre-tax incomes of families with incomes of $10,000 to $30,000. These calculations do not include the effects of Federal and state income taxes, or contributions to Social Security and other programs that reduce “take-home” pay.

Residential energy costs by income category, 2005

2005 income:	<$10K	$10-30K	$30-$50K	>$50K	Total
Electricity	$703	$864	$1,032	$1,311	$1,050
Natural gas	$751	$858	$916	$1,089	$950
Fuel oil	$966	$1,083	$1,159	$1,433	$1,232
Propane gas	$683	$972	$984	$1,071	$979
Total*	$1,285	$1,554	$1,791	$2,247	$1,834
Pct. of average h/h income	23%	8%	5%	2%	3%

**Columns do not add to totals because some households use more than one type of fuel. Costs by fuel are averages for households using that type of fuel.*

Transportation Costs

Gasoline prices account for the largest single increase in consumer energy costs since 2001. Pump prices currently exceed $2.75 per gallon in most areas, and are $3.00 or more in major markets such as New York and California. EIA projects 2005 average retail gasoline costs at $2.37 per gallon, a 61 percent increase from the $1.47 per gallon price prevailing in 2001.

The rapid increase in gas prices follows a decade-long trend of increased use of motor vehicles, measured in millions of vehicle miles driven annually, increased market shares of pickup trucks and SUVs, and an increase in the average number of vehicles owned per household.[4]

EIA estimates that 181 million American vehicles – cars, vans, SUVs, pickup trucks, and motorcycles – consumed 107 billion gallons of gasoline and traveled 2.2 trillion miles in 2001. The total bill for these fuel purchases was $142 billion in 2001. In 2005, gasoline costs will exceed $250 billion.

Adjusting the most recent EIA fuel consumption data by projected increases in gasoline costs indicates that American families will spend more than $2,200 per family on gasoline in 2005. Based on DOT and EIA surveys of fuel use, low- and middle-income families will bear the greatest burden of these price increases.

Projected 2005 energy costs for personal vehicles

Household income:	$0-10K	$10K-$30K	$30K-$50K	>$50K	Total
Fuel costs per h/h	$1,433	$1,891	$2,447	$3,019	$2,264
Avg. h/h income	$5,700	$19,700	$39,200	$107,700	$59,067
Pct. of avg. income	25%	10%	6%	3%	4%

Total Household Energy Costs

Soaring residential energy costs (for natural gas, heating oil, and other fuels) and gasoline prices approaching $3 per gallon are imposing severe strains on low- and middle-income family budgets. Heating, cooling, and transportation are necessities of life, and the rapid increase in consumer energy costs is diverting low- and middle-income family budgets from other necessary goods and services such as improved health care, housing, and nutrition.

In 2005, the average American family will spend $4,100 on energy. This is seven percent of average pre-tax household income, and nine percent of the $43,318 median household income. The 63 million households earning less than $50,000, representing 56 percent of the population, will devote 20 percent of their pre-tax income to energy.

Total consumer energy expenditures, 2005

2005 income:	<$10K	$10-30K	$30-$50K	>$50K	Total
Residential energy	$1,285	$1,554	$1,791	$2,247	$1,834
Transportation	$1,433	$1,891	$2,447	$3,019	$2,264
Total energy	$2,718	$3,445	$4,238	$5,266	$4,098
Avg. h/h income	$5,700	$19,700	$39,200	$107,700	$59,067
Pct. of average h/h income	48%	17%	11%	5%	7%

Disproportionate Impacts on Minorities

The costs of residential and transportation energy represent even larger fractions of household expenditures for minority citizens. The Bureau of the Census finds that the median incomes of Hispanic and African American families in 2001 were $33,575 and $29,470, respectively, or 27 percent to 36 percent below the $46,305 median income of non-Hispanic Caucasian families.[5]

The U.S. Government does not publish data on household energy consumption by ethnic background, so it is impossible to estimate with precision the potentially greater burdens that energy costs are imposing on minority families. However, the lower median family incomes of these groups make it apparent that they may be disproportionately represented among the income categories with the highest energy cost burdens as a percentage of household income.

Conclusion

International market conditions (such as increased oil demand by China and other developing nations) affect all of the fuel price trends for petroleum: gasoline, home heating oil, natural gas, and propane. These fuels have experienced the fastest rate of price increase in this decade because they are subject to both international market demand pressures and supply uncertainties.

The prices of petroleum-based fuels have increased significantly above the rate of inflation in the past five years, while the residential cost of electricity has barely kept pace with inflation. The moderating influence of coal-based electric generation on overall energy price trends should be a key consideration for state and federal policymakers in decisions affecting the electric utility industry for the foreseeable future.

The rapid escalation of U.S. consumer energy prices, together with sluggish growth of income among lower- and middle-income households, underscores the need to find ways to slow these surging costs. Expanding the use of our abundant domestic coal resources - a primary source of low-cost electric energy generation, and a potential source of ultra-clean fuel products for industry and consumer uses - is an immediate, common sense policy response available to the United States Government.

Gene Trisko is an environmental attorney and energy economist who represents labor and industry clients. Mr. Trisko concentrates on issues surrounding the Clean Air Act and the continued use of coal as part of America's fuel mix.

End Notes

[1] Data on residential energy consumption patterns are from U.S. Department of Energy, Energy Information Administration, 2001 Survey of Residential Energy Consumption (RECS), http://www.eia.doe.gov/emeu/recs/contents.html. Data for 2001 energy consumption by fuel type were updated to estimated 2005 values based on consumer energy cost projections in EIA's Short Term Energy Outlook (September 2005, Hurricane Katrina "middle recovery" case), http://www.eia.doe.gov/emeu/steo/pub/contents.html.

[2] The most recent data on U.S. household income by income categories (2003) are from U.S. Bureau of the Census, "Income, Poverty, and Health Insurance Coverage in the United States, 2003," http://www.census.gov/hhes/www/income/income.html. Total and average household incomes by income category and race are from the distribution of household income in U.S. Bureau of the Census, "Money Income in the United States, 2001," (September 2002), http://www.census.gov/prod/2002pubs/p60-218.pdf.

[3] Data on consumer transportation expenditures were obtained from the U.S. Department of Transportation's 2001 National Household Travel Survey, http://www.fhwa.dot.gov/policy/ohpi/nhts/, with supplemental data by DOE/EIA in "Appendix K. Documentation On Estimation Methodologies For Fuel Economy And Fuel Cost," http://www.eia.doe.gov/emeu/rtecs/nhts_survey/2001/. Fuel costs for 2001 were updated to 2005 based on EIA's 2005 gasoline price projection in the Short-Term Energy Outlook (September 2005), n. 1, *supra*. The distribution of fuel costs by household income category was estimated from 1997 and 1994 DOT survey data.

[4] U.S. DOT, 2001 National Household Travel Survey, "Summary of Travel Trends," (December 2004).

[5] U.S. Bureau of the Census, "Money Income in the United States, 2001," (September 2002), http://www.census.gov/prod/2002pubs/p60-218.pdf.

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