SOUTHERN INDIANA GAS AND ELECTRIC COMP

D/B/A

VECTREN ENERGY DELIVERY OF INDIANA, INC.

CAUSE NO. 45052

VERIFIED DIRECT TESTIMONY

OF

MICHAEL J. HICKS

THE GEORGE AND FRANCES BALL DISTINGUISHED PROFESSOR OF ECONOMICS AND BUSINESS RESEARCH AND DIRECTOR

SPONSORING PETITIONER'S EXHIBIT NO. 14,

ATTACHMENT MJH-1

VERIFIED DIRECT TESTIMONY

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MICHAEL J. HICKS

THE GEORGE AND FRANCES BALL DISTINGUISHED PROFESSOR

OF ECONOMICS AND BUSINESS RESEARCH AND DIRECTOR

Q. Please state your name and business address.

A. Michael Joseph Hicks, and I work at the Center for Business and Economic Research (the "Center") at Ball State University.

Q. Please describe Ball State University.

A. Ball State is a public research university located in Muncie, Indiana.

Q. Please describe your educational and professional experience.

A. I hold a bachelor's degree in economics from Virginia Military Institute (1984), and a Master's and Ph.D. in economics from the University of Tennessee (1997 and 1998). Between undergraduate and graduate school I served as an infantry officer in the United States Army (1984-1992). Since finishing my Ph.D. I worked in the Center for Business and Economic Research at University of Tennessee as a visiting research assistant professor, at Marshall University's Center for Business and Economic Research as Director of Research and Assistant/Associate Professor. I worked for three years as an assistant and associate professor of economics at the Air Force Institute of Technology, and have been director of the Center at Ball State University since summer of 2007. I've also held positions as associate professor, then professor and now distinguished professor at Ball State.

Q. Are you a member of any professional organizations?

A. I am a member of the American Economic Association, National Tax Association, Midcontinent Regional Science Association, and an institutional member of the Association of University Business and Economic Research, University Economic Development Association, International Economic Development Council and the Indiana Economic Development Association.

Q. Have you previously testified before the Indiana Utility Regulatory Commission ("Commission")?

A. No

Q. Are you sponsoring any exhibits in support of your testimony?

A. Yes. I am sponsoring the following exhibit:

Exhibit	Description
Petitioner's Exhibit No. 14, Attachment MJH-1	Economic Impact of Closing Coal-Fired Power Plants

Q. Were the exhibits identified above prepared or assembled by you or under your direction or supervision?

A. Yes.

Q. What is the purpose of your Direct Testimony in this proceeding?

A. My testimony discusses analysis the Center performed of the estimated economic effects of coal fired power plant closings in Indiana.

Q. What experience do you have with conducting economic modeling?

A. I've written three books which extensively used econometric modeling, authored more than 50 published papers and several hundred technical studies on economic modeling. I've presented economic models used in analysis for the U.S. Senate, House and four state legislatures and in litigation before state and federal courts. I have taught classes on econometric modeling at a number of universities.

Q. Please describe the analysis you performed on behalf of the Company.

A. Vectren South commissioned the Center to provide an assessment of the potential economic effects of closing some coal fired power plant operations in Indiana, and replacing them with a combined cycle gas turbine facility. The results of this analysis are reflected in a written report which I have attached to my testimony as Petitioner's Exhibit No. 14, Attachment MJH-1.

Q. What type of study did the Center perform?

A. The availability of information and historical data on coal fired power plant closings from the Energy Information Administration ("EIA") enabled the performance of an econometric study of the economic impact of coal-fired generation plant closings.

Q. What is an econometric study?

A. An econometric study uses statistical and mathematical theories in economics for the purpose of testing hypotheses and forecasting future trends. It takes economic models, tests them through statistical trials and then compares and contrasts the results against real-life examples. This is a very standard approach in economics.

Q. Please explain your approach to developing an econometric study of the impacts of closing coal-fired generation plants.

A. I began by reviewing some existing studies of impacts of the opening or closing of industrial facilities. I then constructed an econometric model that accounted for gas-fired

generation plant closings and tested the effect on county employment as a result of the facility closing. The Report outlines this study in more detail.

Q. What conclusions did the study reach about the economic benefits resulting to Vectren South's service territory as a result of the construction of the combined cycle gas turbine ("CCGT")?

A. I focused only on the negative effects of closing the coal fired power plants, ignoring any benefits that would accrue to Posey County because of new employment or infrastructure investment attributable to the CCGT.

Q. What were the conclusions of your study?

A. Based on the econometric modeling I performed, I found that closing a coal-fired generation facility does not have a statistically significant change in employment of the county and adjacent counties in which the coal fired power plant is located.

Q. Is the approach you used widely accepted by economists?

A. Yes, this is the standard approach to the vast majority of published research.

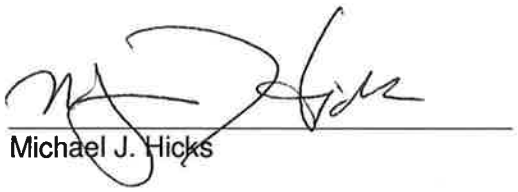
I. Conclusion

Q. Does this conclude your prepared direct testimony?

A. Yes, at this time.

VERIFICATION

The undersigned, Michael J. Hicks, affirms under the penalties of perjury that the answers in the foregoing Direct Testimony in Cause No. 45052 are true to the best of his knowledge, information and belief.



Michael J. Hicks

Jobs Impact of Closing Coal Fired Power Plants: Evidence from Indiana's Experience

March 11, 2018

Michael J. Hicks, Ph.D.
George & Frances Ball Distinguished Professor of Economics
Director, Center for Business and Economic Research
Ball State University

Executive Summary

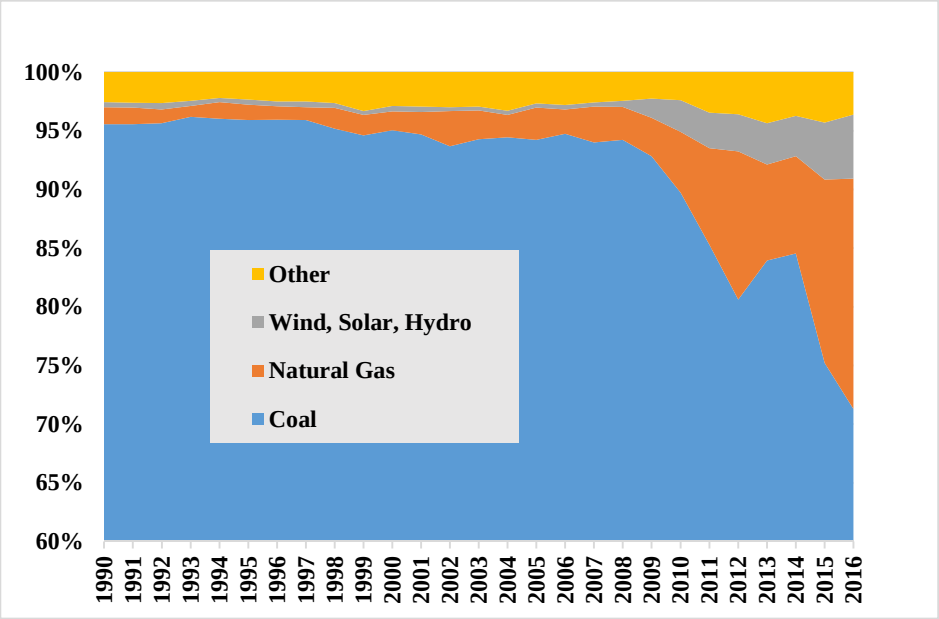
- Vectren has proposed retiring three coal fired power-generating units in two plant locations, while adding additional environmental controls in order to retain a fourth coal fired unit, and constructing a new combined cycle gas turbine plant.
- Historically communities, which have experienced closure of coal-fired plants, have not experienced statistically significant changes in employment. That is the most likely outcome in this case.
- This study did not evaluate the potential positive effects of new construction and employment associated with construction of a new CCGT plant in the region.

Introduction

This study analyzes the effect of the closing of a coal fired power plant on employment in a host county and on contiguous counties in Indiana from 1993 through 2016. To complete this work, we review research on power plant closures, and the recent nationwide shift from coal to natural gas for electricity production. We then outline our modeling approach, the data we use and outline results from our model. This is followed by a summary. We begin the analysis with a background on electric power generation in the region.

Indiana currently has 41 coal fired generators in 15 plants located in 13 counties (EIA, 2016). As late as 2008, almost 95 percent of electrical generation in Indiana was provided by coal fired power plants. Today, the coal share is 70 percent and declining quickly. Despite a large relative growth of wind and solar production, the majority of the shift of production away from coal has come from the expansion of natural gas use. Moreover, the substitution of gas for coal as a source of turbine power is unlikely to be impacted by renewables because the large subsidies for wind and solar are phasing out and their natural expansion limits .

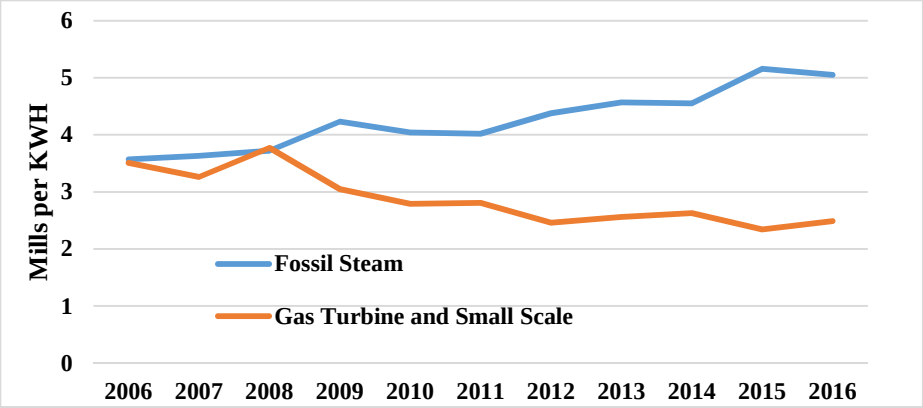
Figure 1, Fuel Use for Power Generation in Indiana



Source: Energy Information Administration, U.S. Department of Energy

Not surprisingly, the decline in coal share of electrical power production in Indiana is due to the relative cost difference between coal and natural gas. Indeed, the U.S. Energy Information Administration estimates the operating costs per unit of energy produced has grown from a 1.7 percent gap to a 102.8 percent gap from 2006 through 2016 (EIA, 2017). Similar cost growth in maintenance has also occurred, thus the economic efficiency of coal has dipped significantly relative to natural gas as a fuel for electric power generation in Indiana.

Figure 2, Operating Costs of Electric Power Generation by Fuel Type



Source: Energy Information Administration

A share of that cost difference is obvious in the price differential between coal and natural gas in recent years. As a consequence, a total of 27 coal fired generators in Indiana have been retired, in 11 plants across 11 counties. The bulk of these closures have occurred since natural gas price reductions over the past decade, and the resulting relative inefficiency of coal fired power plants. The average age of the retired generators was 36 years old, while the average age of the currently operating coal fired plant is 47 years.

Figure 3, Nominal Price as reported to the Energy Information Administration (short ton of coal and 1,000CF of NG; Illinois Basin and Citygate respectively)
Source: Energy Information Administration

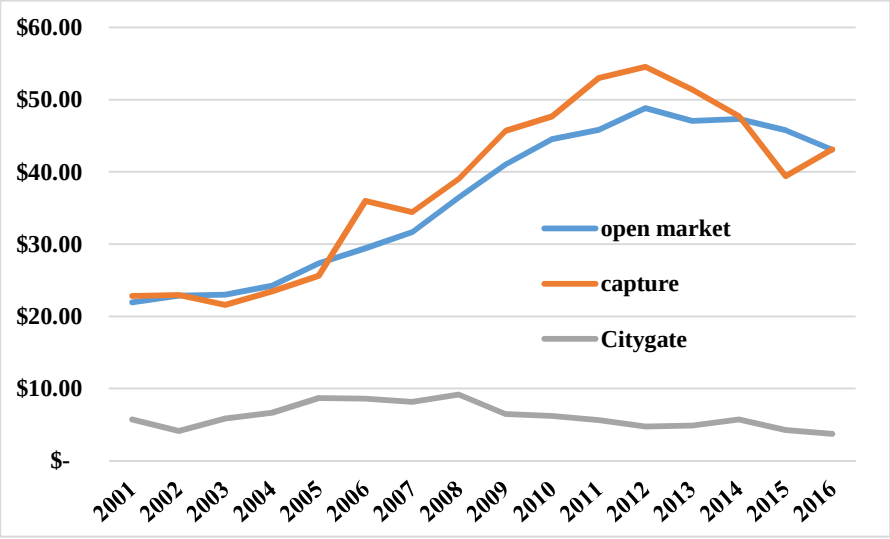
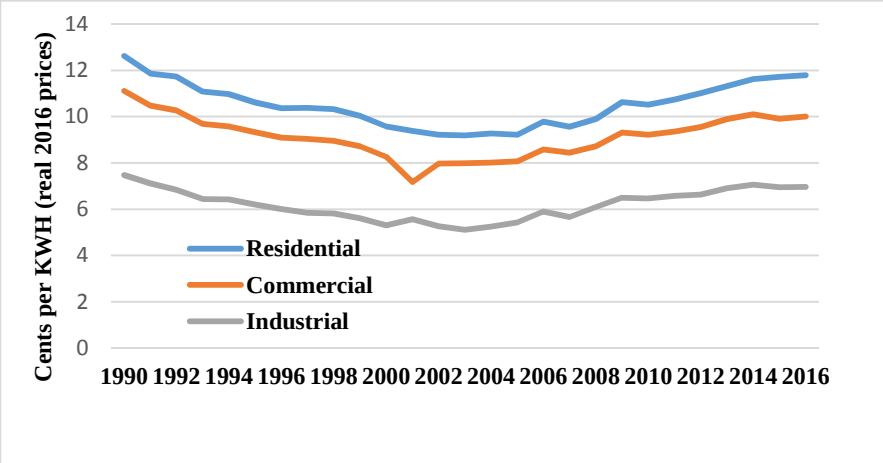


Figure 4, Real Average Retail Price by End Use in Indiana



Source: Energy Information Administration

This shift in fuel usage has slowed a price increase in electric power generation experienced by households and businesses in recent years. Consumers, businesses and policymakers should expect this trend to continue. This continued adjustment will reduce the cost of electric power production, reduce the price to the end use from baseline expectations, and result in other market adjustments. Before providing our estimates of some of these effects in the study region, we first review other research on these matters, and outline how those studies inform our approach to this analysis.

The Impacts of Changing Fuel Markets for Electricity Production

Economic research has focused on the causes and effects of power plant closings. Much of this research has focused on nuclear power plant closings, given the size and environmental effects of such facilities. The most recent of these studies examined private generation costs and NOX emissions, not local employment impacts (see Davis and Hausman, 2016). That approach is most common in the literature, since total employment within a single power generation facility is typically a modest share of local jobs.

Holladay and LaRiviere (2015) studied the effect of reduction in natural gas prices on electricity production, reported a large reduction of the use of coal fired generation. Linn, Muehlenbachs, and Wange (2014) examined the effect of recent natural gas price declines, finding that the bulk of effects flow to consumers in the form of lower energy prices. These researchers linked the price of coal to declines in the open market price of natural gas as a prime source of fuel substitution during this period. Overall, they report that a 10 percent decrease in natural gas prices, reduced peak energy prices by 7.67 percent, and off peak prices by 6.72 percent. They also found that the same 10 percent price drop increased the share of natural gas production of electricity by 1.42 percent and reduced emissions of Carbon Dioxide, Sulphur Dioxide and Nitrogen Dioxide by between 0.93 percent and 1.83 percent.

Few additional useful peer reviewed studies have been conducted on the effects of plant closings in recent years, but analysis of coal mining and shocks to other types of industrial facilities offer some useful insight to this analysis.

Studies on local effects include case studies by Gordus (1981) from the 1970's and a review of worker dislocation by Hammermesh (1989). More recent studies have examined the global automotive sector during the Great Recession (Pavlinek, 2015) and larger scale loss of factory employment in the past generation (Rodwin and Hidehiko, 2017). Connolly, et. al. (2010) reviewed the local effects of plant closings in a multidisciplinary book. These studies provide evidence that disruptions in labor markets and in overall regional economic activity accompany larger scale disruptions of commerce due to plant closings. They vary dramatically on the scale and persistence of estimated effects.

Among the best known of these was a review of the coal mining boom and bust in the 1970's and 1980's (Black, McKinnish and Sanders, 2005). This study reviews the effects of declining coal employment in Appalachia that accompanied a price increase and decline over this period. They report a much weaker link between coal mining and non-coal mining employment than is commonly believed. They find that for each 10 mining jobs in a county, only about 2 non-mining jobs were created.

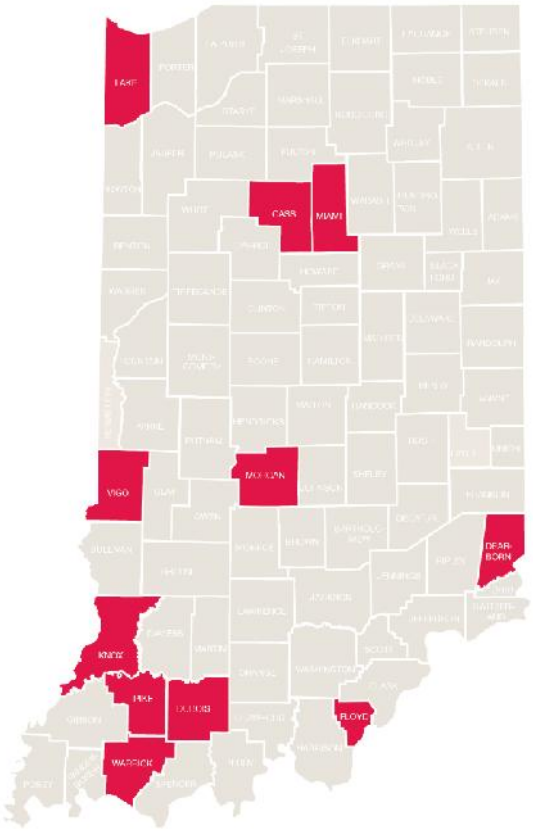
The Black, McKinnish and Sanders study was important, and heavily cited because it implies an actual employment multiplier of roughly 0.2 for coal mining. This is much lower than the 1.5 to 2.5 county multiplier often used in input-output model estimates of industrial job losses. This study, which was heavily cited and has become one of the more critical elements in the analysis of economic disruption, provides a key insight into the modeling in this study. It suggests, that in addition to deploying traditional economic simulation models, where possible, empirical assessment of similar historical events is warranted.

Modeling Approach

To estimate the impact of the shift from coal to CCGT production in Southwest Indiana, an empirical model of employment and employment growth was constructed, which accounts for spatial and temporal factors and electric power plant closings. This offers a historical perspective on the actual effects in counties following a plant closure. This approach does not just examine what occurred with regard to the plant itself, but what happened holistically in the county.

Indiana has experienced power plant closings in 11 counties over the past two decades. We know the year they closed, and using existing data on total employment and population, can test the impact of their closure on this measure of economic activity. These closed facilities are depicted in the Figure below.

Figure 5, Location of Retired Coal Fired Power Plants in Indiana



To conduct this empirical test, we use existing data on total employment, and create a binary variable (1,0) to depict the closing of a plant (including all subsequent years). This is motivated by the research of Black, McKinnish and Sanders (2005) and the availability of historical data on electric power plant closings in Indiana. The first plant to close was in Lake County, in 1999; the most recent are in Morgan, Cass, Vigo and Dubois in 2016.

We also wish to examine the relationship between employment and plant closings in the broader geographic region, so a spatial variable was created, which is the average of employment or plant closings in the contiguous counties. Summary statistics of these data are depicted in the table below.

Table 1: Summary Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.
Total Employment	**39,003**	**17,166**	**744,516**	**1,263**	**81,229**
Total Employment (average of surrounding counties)	**53,076**	**28,641**	**240,245**	**5,790**	**51,679**

Mean Closing of a Coal Fired Power Plant	**0.021808**	**0**	**1.0**	**0**	**0.146090**
Mean Closing of a Coal Fired Power Plant in the average of surrounding counties	**0.014943**	**0**	**0.6**	**0**	**0.063576**

Note: employment and population data derived from the Bureau of Economic Analysis, coal fired plant closings from the Energy Information Administration.

The models we test posits that change in total employment in a county, and in a labor market area, are a function of last year's change in employment, and measures of the closure of a coal fired power plant power plant in the county or in an adjacent county. The use of the distributed lag value, $B_{t+1,\ldots t-n}\gamma_{i,t+1,\ldots t-n}$, is motivated by the possibility of a phased closing of power plants. So, the impacts of closure could begin prior to, and linger after the formally reported termination of electricity generation. In its specific form, the model is:

$$\boldsymbol{N_{i,t} = \alpha + \alpha_i + B_{t+1,\ldots t-n}\gamma_{i,t+1,\ldots t-n} + \rho\widehat{W}Y_{j,t} + \theta_{t-n}\delta_{i,t-n} + e_{i,t}}$$

This model is then a time series cross sectional model of Indiana's 92 counties from 1993 to 2016. The closing of a power plant can be assessed in this model, and tested for its contribution to a change in employment (**N**) growth and levels in county ***i***, in year ***t***. I estimated two variations of each model, one in which we assume there is no fixed effects, α_i, (that is a common set of conditions which do not vary across the county during the period 1993 to 2016) and one in which we relax that assumption. These models use a similar approach to Black, McKinnish and Sanders (2005) treating the closing shocks as persistent regional effects. The results appear in the following table.

Table 2: Estimation Results (t-statistics in parentheses)

	***d*(log(Employment))**		**log(Employment)**	
Variable	**Model 1**	**Model 1a**	**Model 2**	**Model 2a**
α	-0.000808 (-1.44)	-0.0017** (-2.49)	9.40*** (245.20)	13.10*** (3.09)
CFPP closing +1 year (*B*)	-0.000691 (-0.15)	0.0019 (0.51)	0.000914 (0.25)	0.003802 (1.24)
CFPP closing (*B*)	-0.003628 (-0.72)	-0.00238 (-0.47)	-0.000594 (-0.11)	0.0001984 (0.68)
CFPP closing –1 year (*B*)	0.0017 (0.20)	0.0039 (0.42)	0.00084 (0.96)	0.008360 (0.89)
CFPP closing –2 years (*B*)	-0.000292 (-0.03)	-0.0019 (-0.23)	-0.0011 (-0.24)	0.000451 (0.10)
Spatial Autoregressive (*ρ*)	0.65*** (21.98)	0.59*** (20.86)	8.21E-06*** (13.30)	8.57E-06*** (16.35)
Autoregressive AR(1) (*θ*)	0.152*** (6.09)	0.27*** (10.75)	1.12*** (44.65)	1.29*** (52.80)
Autoregressive AR(2) (*θ*)	-0.09*** (-4.4)	0.005 (-0.56)	-0.22*** (-9.16)	-0.28*** (-11.71)
Fixed Effects (α_i)	yes	no	yes	no
Adjusted R-squared	0.39	0.33	0.99	0.99
S.E. of regression	0.029	0.03	0.029	0.030
F-statistic	12.26***	122.35***	58,807***	776,442.9***
Durbin-Watson Statistic	2.06	2.04	2.02	2.03

Note: * denotes statistical significance at the 0.10 level, ** denotes statistical significance at the 0.05 and *** denotes statistical significance at the 0.01 level. All models treated with Whites (1980) heteroskedasticity invariant, variance covariance matrix and are estimated using GLM.

These models of employment change, suggest that the impact of a power plant closing imposes a statistically insignificant, and in magnitude small effect on local employment in Indiana. In our model of employment without fixed effects (model 1) the closing of a plant in an adjacent county reduces employment, but the level of change is very modest and statistically weak. In model 1a, which includes county fixed effects there is no statistically significant impact of the power plant closing on employment in the county. Model's 2 and 2a conduct the same tests on employment levels (log (N)). These models explain between 33 and nearly 100 percent of employment growth in Indiana counties. Taken together, these empirical results suggest that the closing of a coal fired power plant in a county or adjacent counties does not have a statically noticeable effect on employment in the county, or adjacent counties in Indiana.

The reasons for this are not fully known. The infrequency of plant closings, the relatively low level of employment of individual plants in a county, and the composition of employment may all contribute to smaller impacts. Whatever the cause, these empirical estimates suggest a minimal impact to a county's economy or that of the surrounding region following the closure of facilities and the net loss of employment in power generation. This results mimics the findings of Black, McKinnish and Sanders (2005) study of Appalachian coal fields.

Summary

The proposed changes to fuel use for electric power generation described in this document are part of a national trend which will continue for the forecastable future. These changes in fuel sources improve the efficiency and environmental impact of delivering electricity to residential and commercial customers. They also require changes to capital and labor, which have local impacts on employment, production, earnings population and tax revenues. This document models the impact of efficiency gains, capital investment and labor changes in an eleven county study region of southern Indiana.

Our modeling approach is designed to account for the negative economic impact on counties of plant closures, using historical experience with power plant closings in Indiana. This model suggests that the negative shocks to the closing of a plant on local employment are effectively zero. This finding echoes other recent studies, which suggest employment may be decreasingly sensitive to modest economic shocks.

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