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User-Friendly Tool to Calculate Economic Impacts from Coal, Natural Gas, and Wind: The Expanded Jobs and Economic Development Impact Model (JEDI II)

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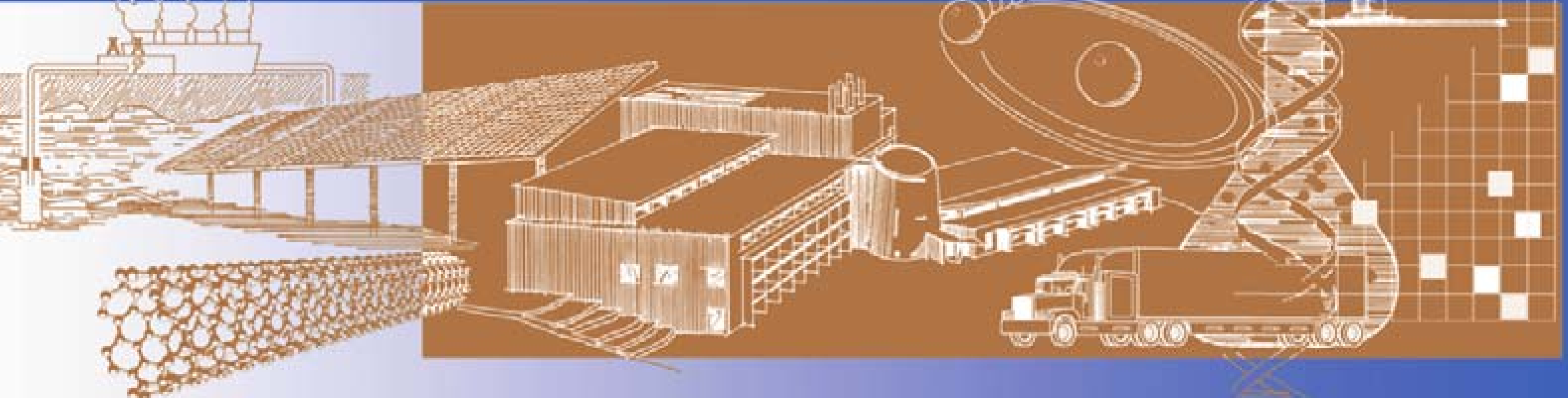

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A User-Friendly Tool to Calculate Economic Impacts from Coal, Natural Gas, and Wind: The Expanded Jobs and Economic Development Impact Model (JEDI II)

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Abstract
The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) has developed new and expanded economic impact models to compare coal, natural gas, and wind power (Jobs and Economic Development Impact II, or JEDI II). The models include multipliers for jobs, income, and other impacts. Developed for statewide parameters, they can also be used to conduct a regional analysis.

Executive Summary

Policymakers today are faced with decisions about how utilities in their region should provide electricity to their service territories. Each type of generating technology has geographic, technological, economic, and political advantages and limitations. To help address the need for quantitative tools that can help evaluate the economic benefit of alternative fuel choices, the original Jobs and Economic Development Impacts (JEDI) model has been expanded so it can be used to assess impacts of coal and gas plants in addition to wind plants.

In this paper, we examine the impacts of building new coal, gas, or wind plants in three states: Colorado, Michigan, and Virginia. The technologies are compared based on generation of an equivalent amount of electricity over the 20-year periods of our analysis. Our findings indicate that local/state economic impacts are directly related to the availability and utilization of local industries and services to build and operate the power plant. For gas and coal plants, the economic benefit depends on whether the fuel is obtained from within the state, out of state, or some combination. We also find that the taxes generated by power plants can have a significant impact on local economies via increased expenditures on public goods. Because of significant differences in the way taxes are assessed and because payments in lieu of taxes are sometimes substituted for actual tax payments, there is significant variation in this aspect of the economic impacts.

In Colorado, building a new wind plant will have a greater economic impact than building a new coal plant, even if 40% of the power plant coal is from within the state. In Michigan and Colorado, new natural gas plants utilizing in-state gas bring the largest economic benefit to the states due to high gas prices (Virginia does not produce its own natural gas). However, high gas prices may make new natural gas plants cost-prohibitive. In Virginia, coal plants need to purchase more than 25% in-state coal for the economic benefits from coal to be greater than those from new wind power.

Introduction

Policymakers today are faced with decisions about how utilities in their region should provide electricity to their service territories. This complicated question includes choosing a resource from which the electricity will be generated. Each resource has geographic, technological, and political advantages and limitations. This research focuses on calculating the economic impacts to a state of new electricity generation from a coal, natural gas, or wind power plant. The comparison of fuel types is done on a per-megawatt-hour (MWh) basis, meaning that each new plant will produce the same annual amount of electricity. Although these three resources are not the only resource options available, they are the most common in the United States today for grid-connected, utility-scale power.

The primary goal of the original JEDI model was first to provide a tool for wind developers, renewable energy advocates, government officials, decision makers, and other potential users who might not have the resources to develop their own economic development model; and second, to easily identify the local economic impacts associated with constructing and operating wind power plants. The second goal was to facilitate broad access and usage of the model by making it electronically available through NREL's Wind Powering America program. The goal of this current version, JEDI II, is to expand the usefulness of this tool by addressing additional electricity resources: coal and natural gas.

To accommodate a broad user base with varying experience, JEDI II was designed in a user-friendly format that can be easily modified. This insures the greatest flexibility for inexperienced spreadsheet users, those unfamiliar with economic impact analysis, and more experienced users who need this type of analysis. Cautions and reminders have been added to make sure users enter as much context-specific information as possible. Especially when comparing the three very different resources, it is important to gather as much local resource-specific data to enter into the model as possible (e.g., state and county property tax percentages or tax breaks for certain resources).

The new JEDI II model structure is nearly identical across technologies, and only basic information is needed to describe each power option. Each model has default values for all 50 states, but each can also be applied to smaller regions or counties with the appropriate adjustments and additional data. Because local and state economies have different characteristics, the economic impacts of a given power plant will not be the same in different parts of the United States.

Methodology

Basic (minimum) information about the new coal, natural gas, or wind plant must be entered into the model to calculate project cost as well as the number of jobs, income (e.g., wages and salary), and economic activity that will accrue to the area analyzed. This includes state, county, or region to be analyzed; the construction year; and the size of the facility. The more specific the information is to the project, the more accurate the model's output will be. To evaluate these impacts, input-output (also commonly referred to as multiplier) analysis is used.

Input-output models were originally developed to trace supply linkages in the economy. For example, they show how purchases of wind turbines not only benefit turbine manufacturers but also the fabricated metal industries and other businesses supplying materials to those manufacturers. The benefits that are ultimately generated by expenditures for power plants depend on the extent to which those expenditures are spent locally and the structure of the local economy. Consistent with the spending pattern and state-specific economic structure, different expenditures support a different level of employment, income, and output.

Direct effect: Direct effects are the on-site or immediate effects created by an expenditure. In constructing a wind plant, for example, it refers to the on-site jobs of the contractors and crews hired to construct the plant. It also includes the jobs at the turbine manufacturing plants and the jobs at the tower and blade factories.

Indirect effect: Indirect effects refer to the increase in economic activity that occurs when a contractor, vendor, or manufacturer receives payment for goods or services and in turn is able to pay others who support their business. For instance, this impact includes the banker who finances the contractor, the accountant who keeps the contractor's books, and the steel mills and electrical equipment manufacturers and other suppliers that provide necessary materials to the natural gas or other plant.

Induced effect: Indirect effects are changes in spending that are caused by, for example, the increased wealth and income of those persons directly and indirectly employed by the power plant project. This includes spending on food, clothing, or day care by those directly or indirectly employed by the project, retail services, public transit, cars, income taxes, medical services and insurance, and much more.

The sum of these three effects yields a total effect that results from a single expenditure. To accomplish this analysis, state-specific multipliers and personal expenditure patterns are used to derive the results. These state-by-state multipliers for employment, wage, and salary income and output (economic activity), and personal expenditure patterns are adapted from the IMPLAN Professional model. The changes in expenditures brought about by investments are matched with their appropriate multipliers for each sector affected by the change in expenditure.

Inputs

For each state analysis, we included as much local information as possible. As stated above, to achieve the most localized results, it is important to enter as much site-specific information as possible. Figure 1 is an example of a JEDI II input screen and identifies some of the model inputs available to more accurately describe the specific plant. If no site-specific details are provided, JEDI II will use default values. The default values are based on state data and national averages (in the case of power generation data).

Construction or capital cost
The cost per kilowatt (kW) to construct a new coal, gas, or wind plant can vary greatly across the United States. Some state utility boards require stricter or more lenient environmental standards, which will change the capital cost of the plant. For example, a new coal plant in South Dakota (Big Stone II) is priced at approximately $1900/kW, whereas a new coal plant in Colorado (Comanche III) is estimated to cost less than $1500/kW. These distinctions will make a significant difference in the economic impact during construction years.

Operations and maintenance
For natural gas and coal, operations and maintenance (O&M) costs are entered in dollars per kilowatt for fixed costs as well as in dollars per MWh for variable costs. Wind power O&M is measured only in dollars/kW. Although there is no national consensus on O&M costs, for this study we assumed the same costs in each state: $22/kW for wind, $1.90/MWh for coal variable and $20kW for coal fixed, $2.30 for natural gas variable and $10 for natural gas fixed. These O&M costs can be easily adjusted in the model.

Fuel price and fuel origin
The relatively high and volatile cost of natural gas can make the option to build a new gas plant prohibitively expensive. JEDI II does not account for the associated costs to the electricity ratepayer. However, electricity planners and decision-makers will. Therefore, even though new natural gas plants with local natural gas may contribute the largest dollar flow to the state economy, coal, wind, or another option may be chosen over gas due to its fuel price risks.

If natural gas comes from within the state, impacts from natural gas purchases will be significant due primarily to the high cost of fuel—usually topping that from wind and coal. On the other hand, if coal is from within the state, economic benefits from coal may not top those of gas or wind because coal still costs significantly less than gas. This is highly dependent on the type and price of coal, as results show.

Percentage of local labor used
If contractors building and operating the power plants are from out of state, they will often bring in construction crews from outside the state. In contrast, plants typically don't import workers into the state to perform annual maintenance activities. Most O&M labor comes from within the state, and for most power resources, the local labor percentage is very high.

Default values for JEDI II construction labor are 50% for coal and 50% for natural gas. For wind, JEDI breaks down the labor into several parts. For example, the default for supervision is 0% while the default for foundation labor is 100%. For the annual O&M impacts, default values are also broken down for specific technologies. Because these parameters are critical to the results, we recommend that model users obtain current, local information that is appropriate for the analysis.

Landowner revenue
This is a vital issue for rural economic development. Rural landowners are often in difficult economic situations, and the land lease payments they may receive from wind developers are significant. Landowners typically receive between $3,000 to $6,000 per turbine per year, depending on the size of the turbine and the contract agreement. The JEDI II model calculates its default value by using a base value of $4,000 per 1.5-MW turbine. This number can, of course, be adjusted to match specific contract agreements or state averages. One advantage to building new wind farms versus coal and gas plants is that farmers and ranchers can continue to grow crops or graze livestock, while also gaining revenue from land leases.

Property taxes
Property taxes can greatly impact the overall economic outlook of the project. States typically use one specific number with which to assess power plants. For example, a percentage of the "real property" value is taken (typically about 80% to 90% of installed plant cost). Then, states apply their assessment rate – usually around 30%. From this number, each local jurisdiction (usually the county) applies its mill levy (typically around 1%). The examples in this paper show that local mill levies make a big difference. In fact, high property taxes or mandatory payments in lieu of taxes can drive developers out of the state to a location with more favorable tax rules. Table 1 details property taxes in Colorado, Michigan, and Virginia. This information was obtained from Offices of Taxation or Treasury in the respective states.

Table 1. Approximate State-Specific and JEDI Default Property Tax Values

State	% of Capital Cost Taxed	Assessed Value	Mill or Local %	Comment
CO	85%	29%	1%	Coal and gas plants often receive sales and property tax breaks during the first 10 years
MI	100%	50%	1%	Wind farms are typically exempt for a specific time, during which they make lesser payments in lieu of taxes
VA	84%	73%	0.1%	Assessed and local values are variable and determined by individual localities
JEDI	85%	33%	1%	Default model assumptions

In some cases, if exemptions from property taxes are given to encourage economic development (in the case of gas and coal) or cleaner technology (in the case of wind), payments in lieu of taxes are often made instead.

Discount rate
For this analysis, we did not apply a discount rate or use depreciation values. These numbers are highly variable, depending on user assumptions. Discount rates and depreciation values, along with specific funding and repayment mechanisms, can be applied to the results from JEDI II.

System Descriptive Data

Project Location	VIRGINIA
Year Construction Starts	2006
Project Size - Nameplate Capacity (MW)	276
Capacity Factor (Percentage)	85%
Heat Rate (Btu per kWh)	12,000
Construction Period (Months)	48
Plant Construction Cost ($/KW)	$1,540
Cost of Fuel ($/mmbtu)	$1.96
Produced Locally (Percent)	40%
Fixed Operations and Maintenance Cost ($/kW)	$20.00
Variable Operations and Maintenance Cost ($/MWh)	$1.75
Money Value - Current or Constant (Dollar Year)	2005

Utilize Model Default Values (below)? (Y or N) n Review/Edit Values below

Go To Summary Impacts

Project Cost Data - Default Values

Construction Costs	Cost	Cost Per KW	Percent of Total Cost	Local Share
Facility and Equipment				
Power Generation	$62,991,218	$228	14.8%	0%
General facilities	$48,135,349	$174	11.3%	75%
Plant Equipment	$134,994,512	$489	31.8%	0%
Facility and Equipment Subtotal	$246,121,079	$892	57.9%	
Labor				
Construction Labor	$137,129,968	$497	32.3%	50%
Project management	$7,383,632	$27	1.7%	0%
Labor Subtotal	$144,513,600	$524	34.0%	
Construction Subtotal	$390,634,679	$1,415	91.9%	
Other Costs				
Engineering	$26,991,067	$98	6.4%	0%
Construction insurance	$4,152,472	$15	1.0%	0%
Land	$56,530	$0	0.0%	100%
Catalysts & chemicals	$463,888	$2	0.1%	10%
Grid intertie	$1,392,656	$5	0.3%	100%
Spare Parts	$1,348,708	$5	0.3%	2%
Other Subtotal	$34,405,321	$125	8.1%	
Total	$425,040,000	$1,540	100.0%	

Figure 1. Sample JEDI II input screen

Results

To demonstrate the JEDI II model and show some representative results, we applied the model to three states with different economic characteristics: Colorado, Michigan, and Virginia. All results were obtained using the default JEDI II assumptions, unless otherwise noted. The research for this work began in 2005, but construction was assumed to begin in 2006. As a result, the monetary values (and results) are reported in 2005 dollars.

We expect that coal plants will take 4 years to construct, gas plants 2 years to construct, and wind turbine installations 1 year to construct. In all three states, we assume that wind will be installed in various locations (i.e., not one large wind farm).

As stated above, power plants are compared on a per-MWh or "energy equivalent" basis. The following table illustrates this concept and shows values for each technology. States have different assumed capacity factors for coal and wind plants.

Table 2. Equivalent Generation

	Capacity Factor	Equivalent MW Needed	MWh Produced Per Year
Coal	80%-85%	276 - 300	~ 2,084,880
Gas	87%	270	2,057,724
Wind	25%-35%	680 – 900	~ 2,084,880

Below are the results and assumptions specific to three states: Colorado, Michigan, and Virginia. Each section details the state-specific inputs and individualized JEDI II outputs.

Colorado

In Colorado, new coal plants are currently being proposed and approved, so we used current available data wherever possible. The construction cost for a coal plant is estimated to be $1450/kW, so we entered this amount into JEDI II instead of accepting the default value. For most new coal plants proposed, the coal will come from Wyoming's Powder River Basin. However, we performed a sensitivity analysis to show the impacts of coal from Colorado. We found that local coal provides a greater economic benefit to the state (Figure 3). Based on interviews with plant developers and power plant contractors, the percentage of in-state labor used for the construction of the project was set at 20%. This local percentage change from the JEDI II default of 50% in-state labor can make a significant difference. For the Michigan and Virginia analyses, we used the JEDI II default of 50% in-state labor because no more localized information was available. Unfortunately, this type of information is often considered proprietary, so it is difficult to obtain.

It is likely that some of the natural gas used for the new power plant will come from within the state's borders. Estimates for local natural gas (i.e., produced within the state) purchases vary greatly, from 25% to 66%. For this research, we assumed that 40% of the natural gas will be from Colorado gas wells. Gas prices have fluctuated greatly, and JEDI II users may want to use a range of prices for their projects. At the time of this report, $7/MMBtu was the current Energy Information Administration price estimate, based on current prices.

The capacity value for wind plants in Colorado is 35%. Construction of a Colorado wind plant is assumed to be $1400/kW. Both of these values were user inputs into the model. Of course, these values can be easily adjusted, as was done for Michigan and Virginia.

Property taxes in Colorado are determined by taking the value of the "real and personal" property – about 85% of the construction cost. The assessed value is 29% of the construction cost, to which the local mill levy must be applied. Taxes make a big difference in the outcome of the impact assessment, and tax inputs should therefore be as precise as possible. In Colorado, recent coal and gas plants have received property tax breaks for the first 10 years of operation. For example, in Pueblo, Colorado, the newly proposed Comanche 3 coal plant will receive a 50% reduction in property taxes for the first 10 years of operation. This comparative analysis assumes that coal and gas plants in Colorado are given this same tax break. We have no examples of tax breaks for wind in Colorado. However, below we will describe one such example in Michigan.

Table 3 shows in-state economic impacts to Colorado from new power generation. ***Jobs*** are the full-time equivalent in-state jobs created by the new power plant. ***Earnings*** are salaries and wages earned by workers. ***Output*** is the *total* economic output, including all economic activity relating to the new power plant (salary earnings, machine parts, electricity used, rental equipment, etc.).

Figure 4. JEDI II results for Colorado – statewide economic impacts

Colorado coal	Jobs	Earnings	Output
During construction period			
Direct Impacts	465	$17.17	$57.19
Construction Sector Only	465	$17.14	$57.07
Indirect Impacts	189	$6.87	$18.47
Induced Impacts	202	$6.51	$20.49
Total Impacts (Direct, Indirect, Induced)	**857**	**$30.55**	**$96.15**
During operating years (annual)			
Direct Impacts	72	$3.74	$6.76
Plant Workers Only	27	$2.01	
Indirect Impacts	19	$0.69	$2.07
Induced Impacts	29	$0.94	$2.97
Total Impacts (Direct, Indirect, Induced)	**120**	**$5.36**	**$11.80**

Colorado natural gas	Jobs	Earnings	Output
During construction period			
Direct Impacts	322	$11.87	$39.67
Construction Sector Only	320	$11.80	$39.28
Indirect Impacts	131	$4.76	$12.83
Induced Impacts	140	$4.51	$14.18
Total Impacts (Direct, Indirect, Induced)	**593**	**$21.14**	**$66.68**
During operating years (annual)			
Direct Impacts	138	$9.02	$43.03
Plant Workers Only	14	$1.61	$1.61
Indirect Impacts	116	$4.42	$14.08
Induced Impacts	115	$3.72	$11.71
Total Impacts (Direct, Indirect, Induced)	**369**	**$17.17**	**$68.81**

Colorado wind	Jobs	Earnings	Output
During construction period			
Direct Impacts	866	$32.85	$108.79
Construction Sector Only	830	$30.64	$101.98
Indirect Impacts	356	$12.96	$35.01
Induced Impacts	395	$12.74	$40.10
Total Impacts (Direct, Indirect, Induced)	**1,618**	**$58.55**	**$183.90**
During operating years (annual)			
Direct Impacts	152	$9.06	$15.12
Plant Workers Only	88	$6.73	
Indirect Impacts	43	$1.56	$4.95
Induced Impacts	64	$2.07	$6.53
Total Impacts (Direct, Indirect, Induced)	**259**	**$12.69**	**$26.60**

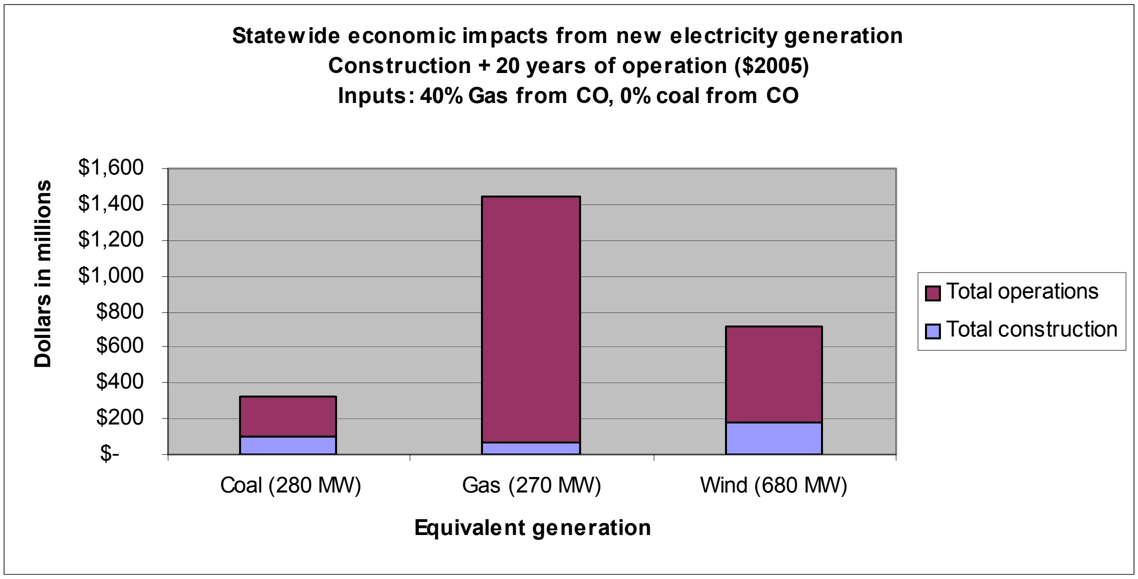
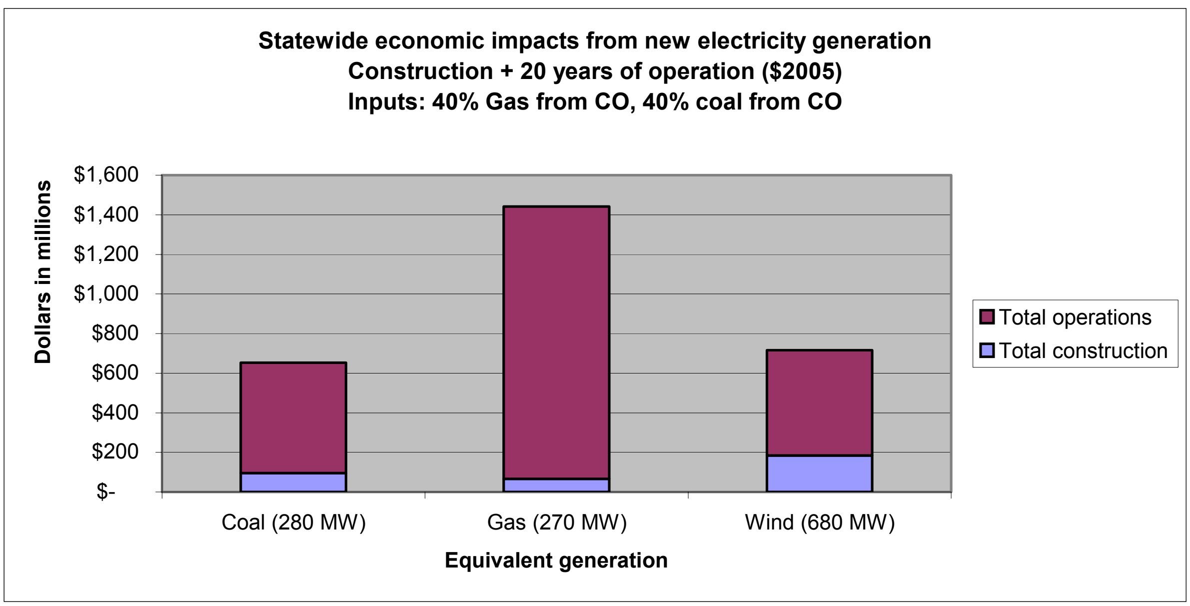


Figure 6. Sensitivity analysis: JEDI II results for Colorado with 40% in-state coal



Note that the above chart shows that Colorado will receive greater economic benefit from wind over coal, even if 40% of the coal is from Colorado. This is due in part to the Rocky Mountain region's inexpensive coal with a low heat rate.

Michigan
Table 4 and Figure 4 show in-state economic impacts for Michigan from new power generation resources. We assumed that 25% of the natural gas would come from within Michigan's borders and that all of the coal will be brought in from out-of-state by ship and rail. Construction costs for the coal plant in Michigan is higher than in Colorado, based on current plant information. Michigan's coal plant construction cost is $1800/kW. Due to the lower capacity factor for the Michigan coal plant, it will require 300 MW to reach the equivalent energy generation of the benchmark natural gas plant.

JEDI II results from Michigan's wind-generated electricity are based on the assumption that the wind farms will be exempt from property taxes for the first 6 years of the project. Instead, the wind farms will be required to make annual payments in lieu of taxes, amounting to $5,000 per turbine. After the sixth year, the wind farm will be expected to pay property taxes. This assumption is based on a number of possible scenarios suggested by a Michigan wind developer. The 6 years of payments in lieu of taxes have been added to the 14 years of regular Michigan taxes, which are relatively high due to the assessed rate of 50%, but also dependent on the local taxation rate or mill levy.

Table 4. JEDI results for Michigan: Statewide Economic Impacts

Michigan Coal	Jobs	Earnings	Output
During construction period			
Direct Impacts	1,123	$43.85	$134.91
Construction Sector Only	1,123	$43.81	$134.74
Indirect Impacts	429	$15.16	$38.27
Induced Impacts	629	$19.81	$58.58
Total Impacts (Direct, Indirect, Induced)	**2,181**	**$78.82**	**$231.76**
During operating years (annual)			
Direct Impacts	74	$4.08	$7.04
Plant Workers Only	31	$2.26	
Indirect Impacts	20	$0.73	$2.08
Induced Impacts	52	$1.65	$4.88
Total Impacts (Direct, Indirect, Induced)	**146**	**$6.47**	**$14.00**

Michigan Natural Gas	Jobs	Earnings	Output
During construction period			
Direct Impacts	364	$14.19	$43.84
Construction Sector Only	362	$14.12	$43.44
Indirect Impacts	139	$4.92	$12.45
Induced Impacts	204	$6.42	$18.98
Total Impacts (Direct, Indirect, Induced)	**707**	**$25.52**	**$75.26**
During operating years (annual)			
Direct Impacts	133	$7.38	$28.48
Plant Workers Only	14	$1.61	
Indirect Impacts	81	$3.01	$8.38
Induced Impacts	108	$3.41	$10.09
Total Impacts (Direct, Indirect, Induced)	**323**	**$13.80**	**$46.95**

Michigan Wind	Jobs	Earnings	Output
During construction period			
Direct Impacts	1,167	$46.75	$143.98
Construction Sector Only	1,125	$43.88	$134.97
Indirect Impacts	453	$16.09	$40.73
Induced Impacts	689	$21.69	$64.14
Total Impacts (Direct, Indirect, Induced)	**2,308**	**$84.52**	**$248.85**
During operating years (annual)			
Direct Impacts	203	$11.60	$19.25
Plant Workers Only	117	$8.52	
Indirect Impacts	52	$1.87	$5.55
Induced Impacts	91	$2.87	$8.48
Total Impacts (Direct, Indirect, Induced)	**346**	**$16.34**	**$33.27**

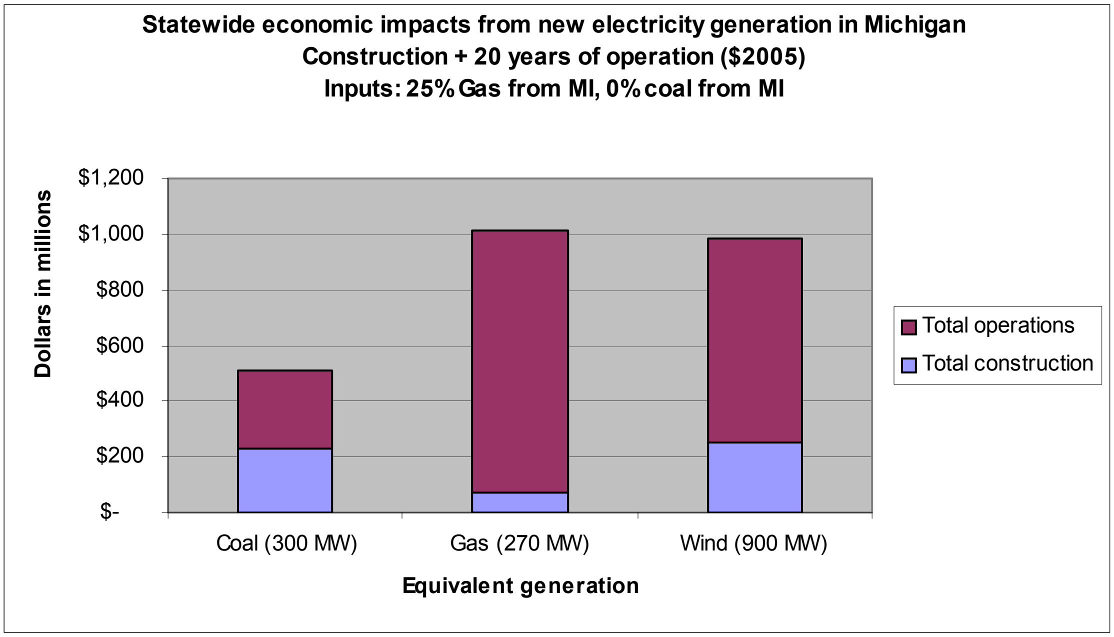
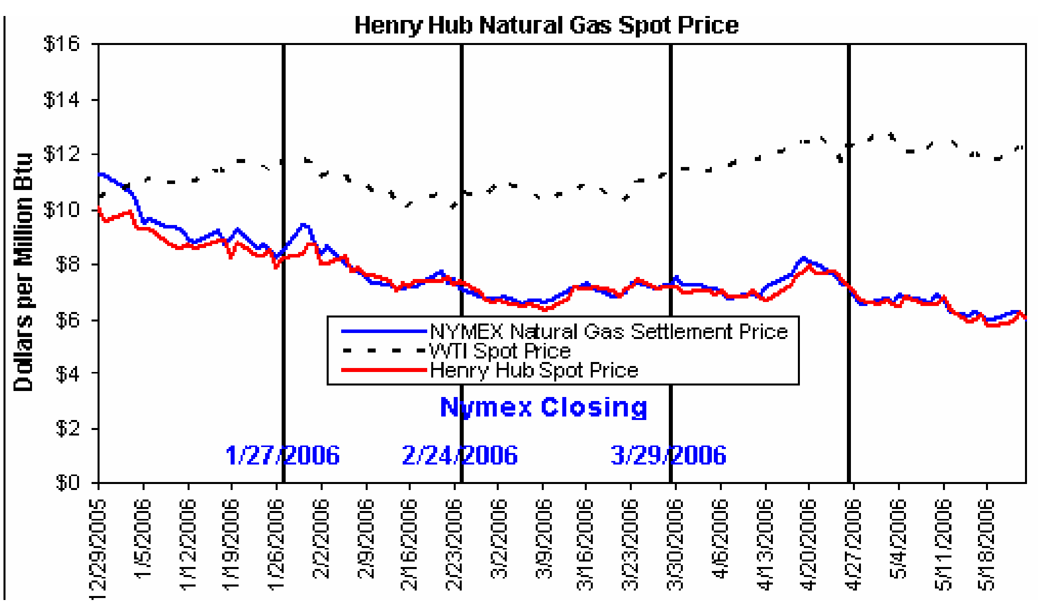


Figure 4. Michigan's local economic impacts

As the following figure illustrates, natural gas prices in the United States have been fluctuating over the past few years. Though prices reached over $12/MMBtu, they have since decreased, depending on their origin and contract term length. For this analysis, we assumed $7 per MMBtu.



Source: Energy Administration Information's Natural Gas Index

Figure 5. Price of natural gas, May 2006

As this report was being finalized in late May 2006, gas prices dropped to around $6/MMBtu (according to the Energy Administration). Figure 6 shows Michigan results with this most recent gas price.

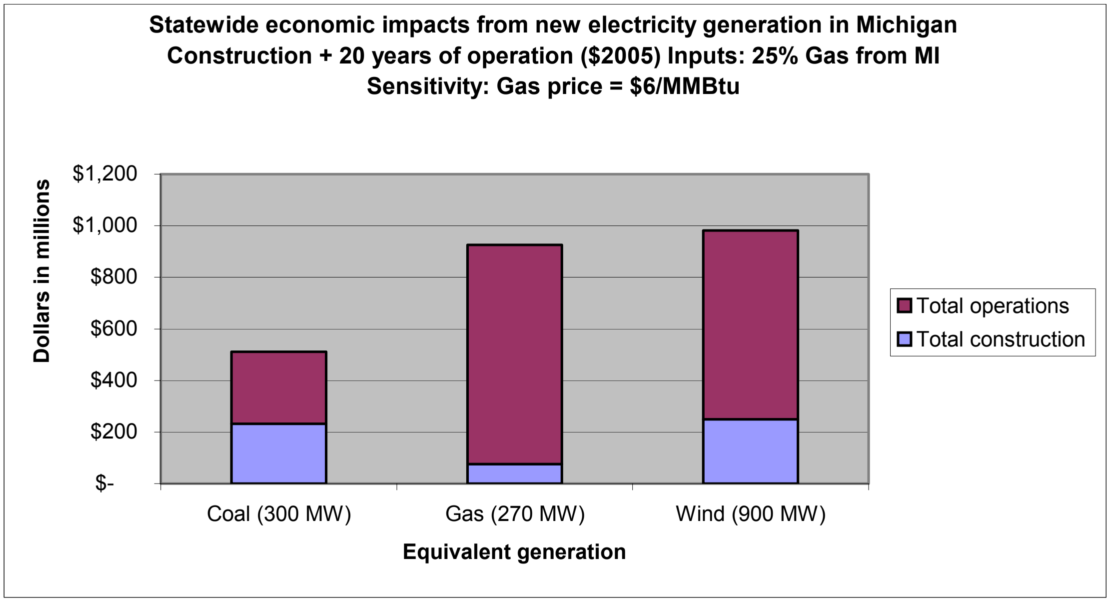


Figure 6. Sensitivity Analysis for Michigan with Gas Price at $6/MMBtu[1]

Virginia

It is assumed that Virginia's in-state coal producers will supply 40% of the coal (based on an analysis of 2003 Energy Information Administration data) to this new power plant.[2] No natural gas will come from within the state. Construction costs for the coal plant in Virginia are higher than in Colorado and lower than in Michigan, based on current available data. The Virginia coal plant construction cost is $1540/kW. Due to the capacity factor for the Michigan coal plant, it will be 276 MW to reach the equivalent generation to the 270 MW natural gas plant. The capacity factor for wind in Virginia is assumed to be 30%.

Virginia property taxes are highly variable due to local control over assessed and "stated ratios" which are similar to mill rates. The State Corporation Commission performs assessments for utilities. The property tax is determined by a valuation process, which takes the sum of the original cost of the power plant, less depreciation for non-land inventory within each municipality. To that value, the Department of Taxation applies the "local ratio" according to the Code of Virginia.[3] Then the annual Tax Rate from the locality is applied to the new assessed number. The local tax rate is determined by the locality. For this analysis we used average rates from examples provided by the State

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[1] http://tonto.eia.doe.gov/oog/info/ngw/ngupdate.asp

[2] Virginia produced 5,669 short tons of coal in 2003, according to the Energy Information Administration. http://www.eia.doe.gov/cneaf/coal/page/coaldistrib/d_va.html

[3] Code of Virginia Title 58.1 Taxation – 58.1-2604.

Corporation Commission. As shown in Table 1, although the assessed value is high, the local tax rate is only approximately one-tenth of average mill rates, so the property tax liability to utilities ends up on the low end of the spectrum of average property taxes.

Table 5 identifies the in-state economic impacts for Virginia from new power generation. Figure 7 shows the output information. And Figure 8 is the result of a sensitivity model run, in which only 20% of the coal comes from within Virginia's borders.

Table 5. JEDI II Results for Virginia: Statewide Economic Impacts

Virginia Coal	Jobs	Earnings	Output
During construction period			
Direct Impacts	922	$32.31	$106.19
Construction Sector Only	921	$32.28	$106.06
Indirect Impacts	339	$12.65	$31.16
Induced Impacts	407	$14.01	$40.15
Total Impacts (Direct, Indirect, Induced)	**1,668**	**$58.97**	**$177.50**
During operating years (annual)			
Direct Impacts	150	$8.24	$25.94
Plant Workers Only	28	$2.08	
Indirect Impacts	66	$2.75	$7.42
Induced Impacts	88	$3.02	$8.66
Total Impacts (Direct, Indirect, Induced)	**304**	**$14.01**	**$42.03**

Virginia Natural Gas	Jobs	Earnings	Output
During construction period			
Direct Impacts	379	$13.30	$43.84
Construction Sector Only	377	$13.22	$43.44
Indirect Impacts	140	$5.21	$12.87
Induced Impacts	168	$5.77	$16.54
Total Impacts (Direct, Indirect, Induced)	**686**	**$24.28**	**$73.24**
During operating years (annual)			
Direct Impacts	23	$2.15	$3.27
Plant Workers Only	14	$1.61	
Indirect Impacts	8	$0.32	$0.89
Induced Impacts	13	$0.44	$1.26
Total Impacts (Direct, Indirect, Induced)	**44**	**$2.90**	**$5.42**

Virginia Wind	Jobs	Earnings	Output
During construction period			
Direct Impacts	1,057	$38.07	$124.79
Construction Sector Only	1,016	$35.60	$116.97
Indirect Impacts	392	$14.70	$36.33
Induced Impacts	494	$16.99	$48.71
Total Impacts (Direct, Indirect, Induced)	**1,943**	**$69.77**	**$209.83**
During operating years (annual)			
Direct Impacts	175	$10.20	$16.68
Plant Workers Only	101	$7.38	
Indirect Impacts	41	$1.63	$4.61
Induced Impacts	71	$2.43	$6.96
Total Impacts (Direct, Indirect, Induced)	**286**	**$14.26**	**$28.25**

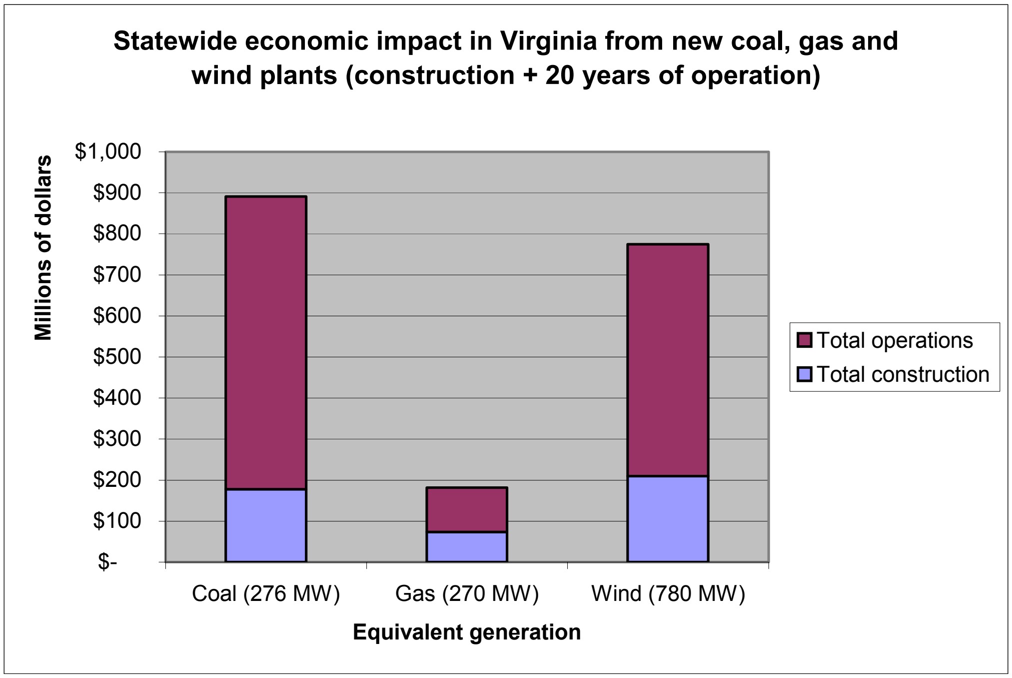

Figure 7. JEDI II results for Virginia

It is noteworthy that if both Colorado and Virginia supply 40% of their own coal, Virginia sees much greater reward. This is primarily due to the higher price of coal as well as the higher heat rate (>12,000 in Virginia vs. <9,000 Btu in Colorado) in the Eastern United States.

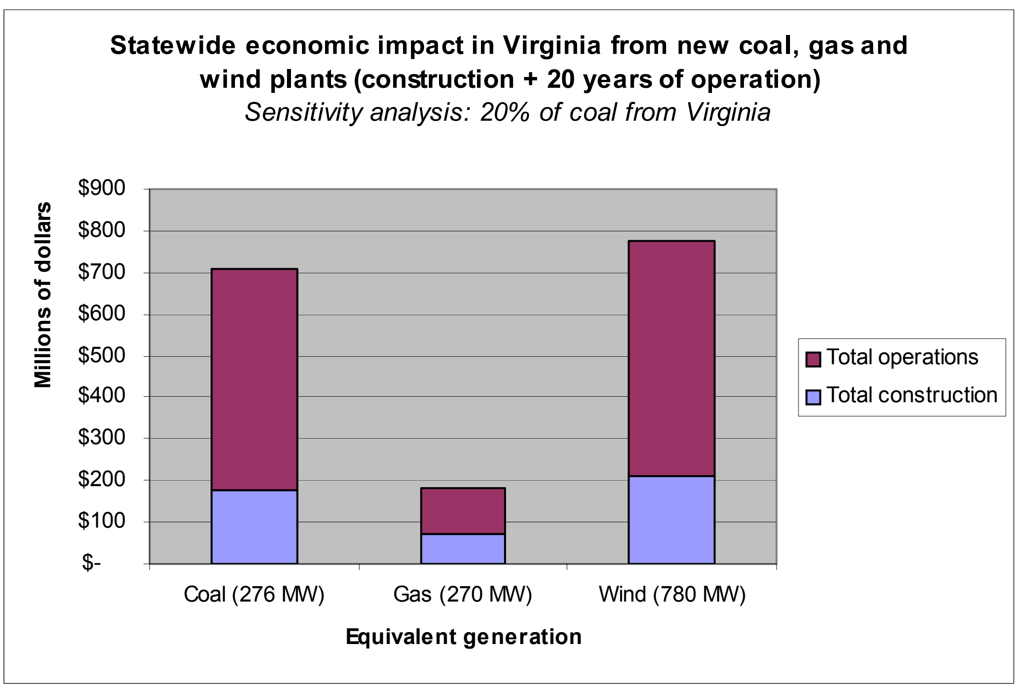

Figure 8. Sensitivity analysis results: 20% of the coal from Virginia

In the above sensitivity analysis (Figure 8), we ran the model with all values constant, except for the origin of fuel. We assumed, based on an interview with a professor of Integrated Science and Technology at Virginia's James Madison University, that the use of in-state coal in utility power plants will decrease in the future. Because it is uncertain exactly how much less in-state coal may be used, we assumed that 20% of the coal would still come from Virginia. The results indicate that this will be a significant change for Virginia. Compared to Figure 6, wind power may bring higher economic benefits to the state if only 20% (or less) Virginia coal is used. Again, this emphasizes the importance of obtaining and using accurate inputs based on project location.

Results Interpretation

Regardless of the amount of project-specific data entered by the user, as long as the minimum data are entered, JEDI II will provide sufficient information to help users better understand the magnitude of the economic impacts associated with potential projects. The model provides basic project information to identify the magnitude of the construction-related spending and ongoing O&M expenditures, as well as a portion of local spending. As noted above, these outputs should not be interpreted as precise values but should be used as an indication of the magnitude of the potential economic development impacts.

In addition to basic project information, JEDI II provides analysis (divided into the above direct, indirect, and induced impacts) of the local jobs, earnings and output (economic activity) generated as a result of the project. This includes the one-time impacts from construction as well as ongoing impacts from annual operations.

User Add-in Location Feature

The initial design for JEDI provided for state-level impact analysis only. After its introduction, it was apparent that many potential users might also wish to perform a similar level of analysis for a smaller or more localized region (such as an individual county or group of counties) or for a larger region (such as a group of neighboring states) to better capture the regional benefits. The high cost of including multiplier and expenditure data in the model for every county in the United States and the complexities associated with designing the model to analyze the endless number of possibilities for combining counties and states made this impractical.

To accommodate those users who desire to do this level of analysis, a User Add-in Location feature is provided in the model. This feature allows users with the capability to derive or obtain the necessary data inputs to complete analysis for a specific region of interest other than the state level included with the base model. The necessary inputs include direct, indirect, and induced multipliers for employment, earnings, and output (per million dollars change in final demand) and personal consumption expenditures (i.e., average consumer expenditures on goods and services, calculated as a percentage for each industry and totaling 100% combined), for the 14 aggregated industries analyzed in the model. More detail on the sectors contained in each industry can be found as an appendix to the model, which is made available to all JEDI and JEDI II users.

The aggregated industries include:

1. Agriculture
2. Construction
3. Electrical Equipment
4. Fabricated Metals
5. Finance, Insurance, and Real Estate
6. Government
7. Machinery
8. Mining
9. Other Manufacturing
10. Other Services
11. Professional Services
12. Retail Trade
13. Transportation, Communication, and Public Utilities
14. Wholesale Trade.

After the user's new location data are entered into the model, the user need only identify the location of the power plant (in the project description section of the ProjectData worksheet) as "MyCounty" or "MyRegion," depending on where the data are entered (in the User Add-in Location worksheet) and proceed with the analysis.

We emphasize that the use of the User Add-in Feature ("MyCounty" or "MyRegion" options) in any of the JEDI models requires additional economic multiplier data that has been customized for the appropriate area. Without this custom data set, the results from the model will be invalid.

Important Considerations
The considerations mentioned in the first version of JEDI (wind only) also hold true for this version. This model constructs a reasonable profile of dollar flows and demonstrates the economic impacts that are likely to result, assuming the projects have default or user-defined inputs. However, given future price volatility and changes in technology and policy, as well as changes in consumption patterns, the analysis does not provide a precise forecast.

This analysis does not account for any potential rate changes for electricity consumers associated with the new generation facilities. Although natural gas plants currently have the lowest construction costs of the resources analyzed, rising fuel costs make them very expensive to operate, and few new plants are being proposed based on increases in ratepayer prices.

Additionally, the analysis assumes the output from power plants and specific terms of the power purchase agreements generate sufficient revenues to accommodate the equity and debt repayment and annual operating expenditures. To the extent additional revenues (e.g., profits or tax advantages) accrue to the project owners, there will be additional benefits. If the project owner is local, these additional benefits may contribute to the local economy. Although these benefits are not included in our analysis because it is unlikely in these scenarios, JEDI II is capable of evaluating these contributions to the local economic impacts.

Conclusion

Based on our experience, the economic benefits of alternative power generation technologies can be calculated on a statewide or more local basis with appropriate adjustments to the model. The JEDI II economic development models have been developed to provide a tool for policy makers and other interested parties so that the economic benefits can be analyzed and compared. Users can also evaluate alternative assumptions regarding the potential projects. It is clear from our results that localized inputs make a significant difference in the overall economic impacts from new power plants (e.g., 40% local coal in Colorado vs. 40% local coal in Virginia). The JEDI II models are not general equilibrium models and therefore are limited in scope. They do not capture the impact of project cost on electricity rates, nor do they estimate power production costs or actual generation for the projects.

We found a range of outcomes in the few states that we analyzed and strongly suspect that nearly all states have characteristics that are unique enough that there is no one-size-fits-all economic outcome. Some of the key drivers are:

- Percent of fuel that is obtained locally/within the state
- Makeup of the local/state labor force and relationship to the needs of the power technology that is under analysis
- Availability of local (within the state or region being analyzed) equipment (components of the power plant) and services
- State and local tax characteristics, and whether there are payments in lieu of taxes
- Fuel prices
- Localization of the model (providing specific data that override model default values
- Share of the power plant that is owned locally.

Based on our analysis, the biggest economic impacts to a state's economy from new electricity generation are directly related to fuel purchases (in the case of natural gas and coal), property taxes, and the cost of O&M.

Decision-makers may choose to use a combination of coal, gas, or wind to fit their electricity needs.

Data Sources

Analyzing the economic impacts of constructing and operating power plants requires a large amount of project-specific data, state-specific input-output multipliers and personal expenditure patterns, and price deflators. The project-specific data include a bill of goods (costs associated with actual construction of the facility, roads, etc., as well as costs for equipment, fuel, and other services and fees required), annual operating and maintenance costs and data on the portion of expenditures spent locally, financing terms, and tax rates. More specifically, the model utilizes the following project inputs:

- ☐ Construction Costs (materials and labor)
- ☐ Equipment Costs (turbines, rotors, towers, etc.)
- ☐ Other Costs (utility interconnection, engineering, land easements, permitting, etc.)
- ☐ Fuel Costs
- ☐ Annual Operating and Maintenance Costs (personnel, materials, and services)
- ☐ Other Parameters (financial: debt and equity, taxes, and land lease).

Unfortunately, many developers consider this type of information proprietary due to competitive forces in the marketplace. Similarly, project-specific differences can and do significantly impact costs. As a result, it is near impossible to identify one-price-fits-all situations. Nevertheless, the model provides reasonable default values for each of the inputs noted above and all those necessary for the analysis. These values represent average costs and spending patterns derived from a number of sources (project-specific data contained in reports and studies) and research and analysis of renewable resources undertaken by the model developer during the past 10 years. Among other sources (including personal communications and anecdotal evidence gathered to complete previous renewable studies), the model incorporates specific project-related data from the following sources:

BBC Research and Consulting. *Potential Economic Benefits from Commercial Wind Power Facilities in Quay County.* New Mexico Energy, Minerals and Natural Resources Department, Santa Fe, New Mexico. July 15, 2000.

DanMar and Associates. *Economic Impact Analysis of WINDPOWER DEVELOPMENT in Southwest Minnesota.* Southwest Regional Development Commission, Slayton, Minnesota. September 1996.

Energy Information Administration Web site
http://tonto.eia.doe.gov/oog/info/ngw/ngupdate.asp

Goldberg, M.; Sinclair, K; Milligan, M. "Job and Economic Development Impact (JEDI) Model: A User-friendly tool to Calculate Economic Impacts from Wind Projects." Presented at Global WINDPOWER 2004, March 28-31, 2004, Chicago, Illinois.

Office of Utility Technologies, Energy Efficiency and Renewable Energy. *Renewable Energy Technology Characterizations.* Electric Power Research Institute and U.S. Department of Energy. December 1997. TR-109496.

Tegen, Suzanne. *A comparison of statewide economic impacts of new generation from wind, coal and natural gas in Colorado*. Presented at the American Wind Energy Association's WINDPOWER 2004. Chicago, Illinois. May 2004.

Wind, Thomas A. *Wind Farm Feasibility Study.* Iowa Association of Municipal Utilities, Ankeny, Iowa. April 1996.

Personal communications with Lee House, State Corporation Commission of Virginia. Colorado, 2006.

Personal communications with Rich VanderVeen, developer in Michigan, 2005.

Personal communications with Andy Wyatt, Prowers County Assessor. Prowers County, Colorado, 2005.

Personal communications with Dan Juhl, a wind project developer in Minnesota, 2003.

Personal communications with Steve Clemmer, senior energy analyst, Union of Concerned Scientists, Cambridge, Massachusetts, 2003.

The state-by-state input-output multipliers and household commodity demand/personal consumption expenditure patterns were derived from IMPLAN Professional™ Version 2.0, using 2001 state data files for the respective states. Minnesota IMPLAN Group, Inc., Stillwater, Minnesota.

The U.S. price deflators were derived from Current Dollar and "Real" Gross Domestic Product data downloaded from the Bureau of Economic Analysis Web site, http://www.bea.doc.gov.

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14. ABSTRACT *(Maximum 200 Words)*

Policymakers today are faced with decisions about how utilities in their region should provide electricity to their service territories. There are geographic, technological, economic, and political advantages and limitations to each type of generating technology. To help address the need for quantitative tools that can help evaluate the economic benefit of alternative fuel choices, the original Jobs and Economic Development Impacts (JEDI) model has been expanded so it can be used to assess impacts of coal and gas plants in addition to wind plants.

In this paper we examine the impacts of building new coal, gas, or wind plants in three states: Colorado, Michigan, and Virginia. Our findings indicate that local/state economic impacts are directly related to the availability and utilization of local industries and services to build and operate the power plant. For gas and coal plants, the economic benefit depends significantly on whether the fuel is obtained from within the state, out of state, or some combination. We also find that the taxes generated by power plants can have a significant impact on local economies via increased expenditures on public goods.

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