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Economic Development Impacts of Wind Power: A Comparative Analysis of Impacts within the Western Governors' Association States

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Economic Development Impacts of Wind Power: A Comparative Analysis of Impacts within the Western Governors' Association States

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Abstract

As wind power development continues at a rapid pace in the United States, there is increasing interest in its economic impacts. Because good wind resources are typically far from electrical loads, wind power plants are often built in rural areas. The economic impacts that arise from building and operating a power plant can be significant but are often not considered by public utility commission processes. Although these impacts vary from state to state because of the differences in wind resource and state infrastructure, economic development from new wind provides important impacts from necessary power system expansion and should play a more prominent role in decision-making processes. This paper uses the National Renewable Energy Laboratory's (NREL's) newest Jobs and Economic Development Impacts (JEDI II) model to assess economic impacts from alternative power technologies for a variety of states. Because of the significant interest in the recent Clean and Diverse Energy Advisory Committee (CDEAC) report to the Western Governors' Association, we focus on the CDEAC states for this comparative analysis.

Introduction

Jobs and rural economic development have become increasingly important factors for decision-makers. As the Montana Republican House Majority Leader, Michael Lange, stated "The promise of jobs is what I want. I want jobs for my kids. I want jobs for your kids."[1] The creation of new wind generation creates jobs, increases rural America's tax base, and provides land-lease revenue to landowners. In addition to the more direct impacts, the economic benefits to a region can increase substantially when wind component manufacturing facilities are located in rural or urban areas. The best wind resources are typically far from electrical loads, so wind power plants are usually built in rural areas.

[1] Associated Press. Helena, Montana. Feb 27, 2007. Matt Gouras, Associated Press Writer

Economic development that arises from building and operating a wind power plant can be significant and should play a prominent role in decision-making processes. Although these impacts vary from state to state because of the differences in wind resource and state infrastructure, they are often not considered by public utility commission processes.

This paper uses the National Renewable Energy Laboratory's (NREL's) newest Jobs and Economic Development Impacts (JEDI II) model to assess economic impacts from wind power technologies for a variety of states. Because of the significant interest in the recent Clean and Diverse Energy Advisory Committee (CDEAC) report to the Western Governors' Association (WGA), we focus on the WGA states for this comparative analysis. An explanation of CDEAC is followed by the Methodology and Results sections. This paper presents the preliminary results from research on WGA states, and will be followed by an NREL technical report providing more detail on states and scenarios.

Western Governors' Association Clean and Diversified Energy Advisory Committee

In 2004, WGA adopted a resolution to add 30,000 megawatts (MW) of clean and diversified energy and to implement energy efficiency improvements in the West by 2015. The WGA established the Clean and Diversified Energy Advisory Committee (CDEAC) to provide the groundwork to move forward on the WGA resolution. The CDEAC then formed a series of task forces to inform the CDEAC of the characteristics of advanced coal, biomass, energy efficiency, geothermal, solar, wind energy and transmission. The focus of the task forces' work was to assess the viability of each technology along with any potential technical and policy barriers that might hinder the implementation of the WGA goal. The task forces are made up of representatives from business, government, environmental groups and academia.

"Western North America is blessed with an abundance of natural energy resources that have been critical to accommodating substantial population growth and fueling a dynamic economy….Western Governors also believe there is long-term wind energy potential in the western plains and mountain states but that a more aggressive effort to develop this energy resource is needed."
--WGA Policy Resolution 04-14

Each task force developed a set of supply curves for the respective generation technology that showed the capacity, location, and cost of that resource. The Wind Task Force developed a set of supply curves for two alternative scenarios that were based on the availability of transmission capacity to deliver wind to load. The Wind Task Force also suggested that wind development will not necessarily coincide with the supply curve analysis, and showed evidence from utility Integrated Resource Plans (IRP) and several subregional and regional transmission analyses that posited significant wind generation within the WGA footprint. The Wind Task Force developed three scenarios of plausible future wind development based on varying assumptions regarding the physical transmission capability and the ability to tap existing transmission potential in a way to increase the utilization and efficiency of the transmission system. One of the key recommendations made by the Wind Task Force was the development of a flexible-firm transmission tariff. The Federal Energy Regulatory Commission (FERC) recently adopted a standard tariff product (Order 890) that is now part of the standard Open Access Transmission Tariff. Since the Wind Task Force developed its scenarios approximately two years ago, significant wind capacity additions have been announced and installed.

Scenario 1 was developed under the assumption that no significant transmission expansion would occur to enable wind to be delivered to load and that no new flexible transmission tariff products would be developed. Scenario 2 was based on the potential development of new transmission tariff products and some limited transmission expansion. This represented a mid-range of possible build-outs. Finally, Scenario 3 was a high-range estimate based on the ability to build new transmission and develop new transmission tariff products. Table 1 shows each of these scenarios.

Table 1. CDEAC Wind Task Force Wind Development Scenarios

	WGA Wind Task Force Scenarios Wind Capacity (MW)		
	1	2	3
Arizona	156	2,800	3,300
California	3,300	7,535	9,303
Colorado	500	1,000	1,750
Idaho	125	125	635
Kansas	250	2,500	2,500
Montana	470	470	2,100
Nebraska	0	100	1,000
Nevada	679	1,150	2,770
New Mexico	150	200	6,000
North Dakota	125	500	2,900
Oregon	625	1,405	2,735
South Dakota	250	750	2,900
Texas	1,000	3,641	8,641
Utah	100	100	570
Washington	1,090	1,090	2,247
Wyoming	355	1,900	5,355
Total	9,175	25,266	54,706

This paper estimates the economic development benefits of wind capacity additions based on the CDEAC Wind Task Force Scenario 3; the high-range build-out case. See Figure 1.

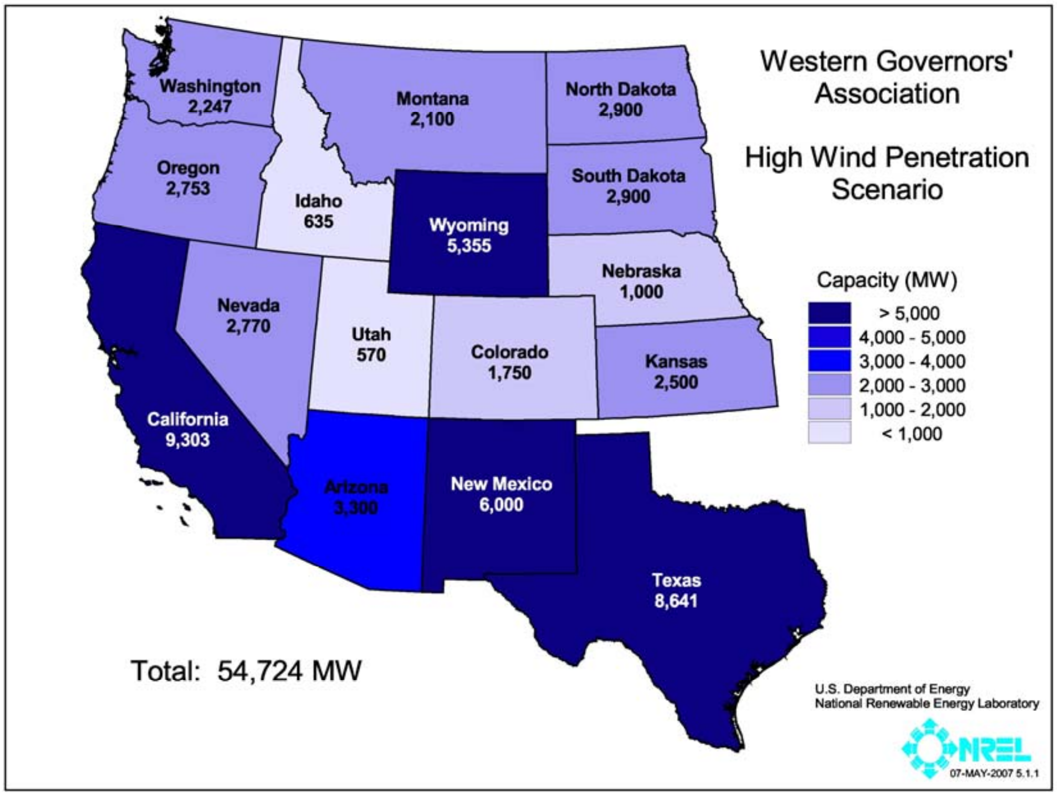

Figure 1. WGA Scenario 3: High Wind Penetration

Today's installed wind capacity, as seen on the map in Figure 2, shows significant wind development progress had already been made by December 2006 since the CDEAC scenario development in 2005.

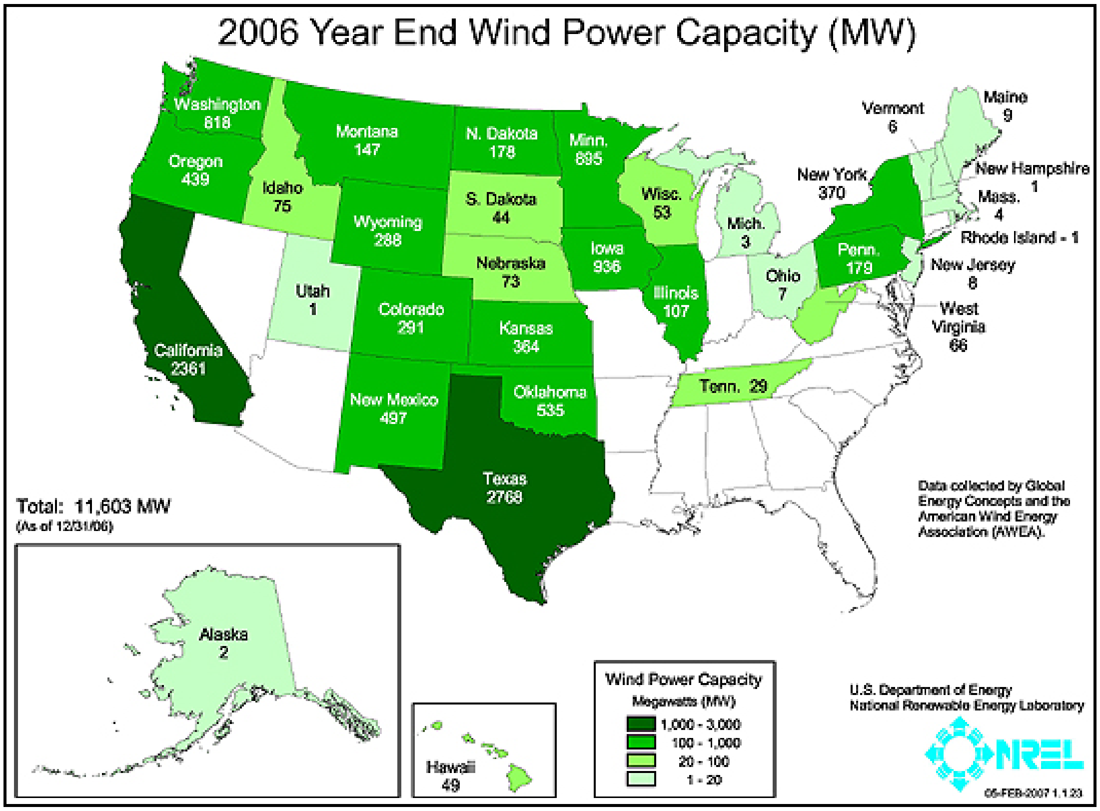

Figure 2. U.S. installed capacity in 2006.

Figure 3 shows a map of U.S. new wind capacity planned or under development. By combining the planned capacity to the installed capacity shown in Figure 2, there are some cases in which the CDEAC Scenario 3 capacity addition will already be surpassed (See Idaho and Utah).

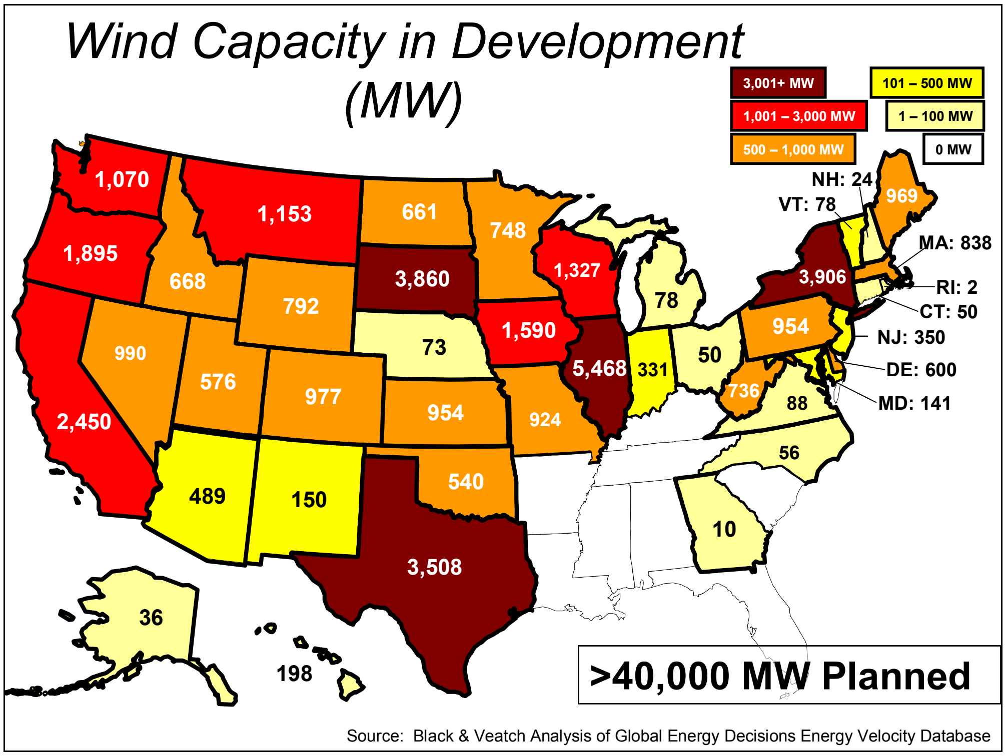

Figure 3. Wind capacity still in development, January 2007.

Methodology

For this paper, we used the Jobs and Economic Development Impacts model (JEDI II) to project economic impacts. State specifics, such as property taxes and landowner revenues, were obtained through research and interviews with project developers and assessors' offices in the WGA region.

JEDI Model Description

The Jobs and Economic Development Impact (JEDI) model was developed in 2002 for NREL to demonstrate the economic development impacts associated with developing wind power plants in the United States. Economic development impacts include jobs created, wages and salaries earned, and increases in overall economic activity in the community in which the wind power project is located.

JEDI was designed as a state-specific model and shows the economic impacts resulting from new wind power development in each state. JEDI can be adjusted to perform county, regional and national analyses as well. This particular analysis focuses on the economic benefits for individual states within the WGA region.

To calculate economic impacts, the spreadsheet-based model relies on input-output or "multiplier" data to trace supply linkages in the economy. For example, the analysis shows how purchases of wind turbines not only benefit turbine manufacturers, but also the fabricated metal industries and others businesses that supply those manufacturers.

The benefits that are ultimately generated by expenditures for wind plants depend upon the extent to which those expenditures are spent locally (i.e., in the specific state, region, county or nation.) and on the structure of the economy. For example, the wind turbine blades could be manufactured in the Colorado, but they could also be imported from Denmark. In this analysis, imported blades provide no economic benefit for the state in which the wind plant is located.

The model analyzes the economic impacts of developing a wind power project by evaluating three separate impacts: direct, indirect and induced impacts.

- Direct impacts are the on-site or immediate effects created by spending money for a new wind project. For example, constructing a wind plant includes the on-site jobs of the contractors and crews hired to construct the plant as well as their managers and staffs. It also includes the jobs at the manufacturing plants that build the turbines and the jobs at the factories that produce the towers and blades.

- Indirect impacts refer to the increase in economic activity that occurs when a contractor, vendor or manufacturer receives payment for goods or services and, in turn, pay others who support their business. This includes the banker who finances the contractor, the accountant who keeps the contractor's books, and the steel mills and electrical manufacturers and other suppliers that provide the necessary materials.

- Induced impacts are the changes in wealth that occur as a result of the spending by people directly and indirectly employed by the project. For example, when workers/households receive income, they may purchase higher quality food, more expensive clothes and other goods and services from local business.

The sum of these three impacts yields a total impact. For this analysis, JEDI relies on U.S.-specific multipliers and personal expenditure patterns. These multipliers, for employment, wage and salary income and output (economic activity), and personal expenditure patterns are adapted from the IMPLAN Professional model[2] based on real U.S. data. The spending (and expenditure patterns) from new investments in developing

[2]See Minnesota IMPLAN Group (MIG, Inc), Stillwater, Minnesota, 651/439-4421, www.IMPLAN.com. IMPLAN (IMpact Analysis for PLANning) Professional is a social accounting and impact analysis tool.

and operating wind power plants are matched with their appropriate multipliers for each industry sector (e.g., manufacturing and services) affected by the change in expenditure. For example, the manufacturing of a generator part may create a greater local economic benefit in Detroit, Michigan than in Kenai, Alaska, due to their in-state manufacturing infrastructure.

JEDI Inputs

The following table lists the detailed categories JEDI uses to determine economic impacts. For each category, the expenditure is tracked along with the part of the expenditure that goes to the local area. In this case, the "local" area is the whole United States.

Project Cost Data
Construction Costs
- Materials
  - Construction (concrete, rebar, equip, roads and site prep)
  - Transformer
  - Electrical (drop cable, wire,)
  - HV line extension
- Labor
  - Foundation
  - Erection
  - Electrical
  - Management/supervision

Equipment Costs
- Turbines (excluding blades and towers)
- Blades
- Towers

Other Costs
- HV Sub/Interconnection
- Engineering
- Legal Services
- Land Easements
- Site Certificate/Permitting

Wind Plant Annual Operating and Maintenance Costs
Personnel
- Field Salaries
- Administrative
- Management

Materials and Services
- Vehicles
- Fees, Permits, Licenses
- Utilities
- Insurance
- Tools and Misc. Supplies
- Spare Parts Inventory

Financial Parameters

Debt Financing

Percentage financed

Years financed (term)

Interest rate

Equity Financing/Repayment

Percentage equity

Individual and Corporate Investors (percent of total equity)

Return on equity (annual interest rate)

Repayment term (years)

Property Tax Parameters

Land Lease

Payroll Parameters - Field Salaries, Administrative, Management

JEDI Outputs

JEDI has two output categories: construction and operations. The construction period numbers are reported for the entire time of the construction (typically one year for a utility-scale wind project). The operations numbers are reported per year. First, the number of jobs created and the earnings for those jobs during the construction period are reported. The "economic output," which is the sum of the direct, indirect and induced payments for work, and other expenditures (such as money spent on parts, e.g., blades and services, e.g., boom truck rental) is also reported. For the operations output, jobs, earnings and economic output are also reported. In the operations category, economic output is hourly wages, annual salaries and other expenditures such as new part purchases for turbine maintenance and payments for accounting services. This category also includes property taxes and landowner royalties.

Caveats

Before noting the specific data assumptions used in modeling, it is important to underscore several important caveats about JEDI: the static model, a reasonable profile, gross analysis and sufficient revenues.

First, the JEDI model is considered a *static model*. As such, it relies on inter-industry relationships and personal consumption patterns existing at the time of the analysis. The analyses does not account for feedback through demand increases or reductions that could result from price changes. The model output has two categories: construction phase and operational phase. The construction phase for a wind project typically lasts about one year, depending on the wind project size and other variables. The operational phase results are presented for one year. The model does not account for feedback from inflation or potential constraints on labor and money supplies. The model assumes there are adequate local resources and production and service capabilities to meet the level of local demand identified in the modeling assumptions (e.g., availability of workers, service providers, and businesses, such as hardware stores and other suppliers for necessary parts and tools). Similarly, the model does not automatically account for industry productivity improvements that may occur over time[3] or changes that may occur in the construction or operation and maintenance (O&M) processes (e.g., production recipe for labor, materials, and service cost ratios) for new power plants.[4]

Second, the intent of using the JEDI model is to construct a *reasonable profile of investments* (i.e., wind power plant construction and operating costs) to demonstrate the economic impacts that will *likely* result during the construction and operating periods. Given the potential for future changes in wind power plant costs beyond those identified and potential changes in industry and personal consumption patterns in the economy noted earlier, the analysis is not intended to provide a precise forecast, but rather an approximate estimate of overall impacts.

Third, the analysis and results are specific to developing new land-based and offshore wind power plants only, and thus, is considered a *gross analysis*. That is, it does not reflect net impacts associated with alternate spending of the money (to construct and operate other types of electricity generating power plants) or replacement of existing power generation resources to meet growing needs.

Fourth, the analysis assumes the output from the wind power plants and the specific terms of the power purchase agreements generate *sufficient revenues* to accommodate the equity and debt repayment and annual operating expenditures. Additional revenues (i.e., profits and/or tax advantages above actual costs) accrued by plant owners result in additional benefits. These benefits are not included in the analysis.

Results

The map in Figure 4 shows the total (direct, indirect and induced) economic impacts from construction and operation of the 54,700 megawatts (MW) of wind power in the WGA states by 2015. The brown bar represents the number of new jobs created during the construction phase of the new wind projects. The blue bar represents the job-years over 20 years of operations. Job-years refer to a full-time job in one year; for example, if a worker is hired to do maintenance on the wind turbines and her jobs lasts 20 years; this is counted as 20 job-years. The green bar represents the economic impact, or the dollar flow, into the state from construction and operation of these new wind projects. Bars of the same color can be compared from state to state (e.g., New Mexico stands to gain a projected $4.5 billion from now until 2015, whereas Arizona is predicted to gain by $6.4 billion).

[3] While the model does not directly account for these changes in process and material improvements over time, these are in part reflected in declining technology and operating costs during the period of analysis, in this national impact work.

[4] Due to the uncertainties associated with technology and material changes the model maintains the same detailed cost ratios for construction and operations during the entire period being analyzed.

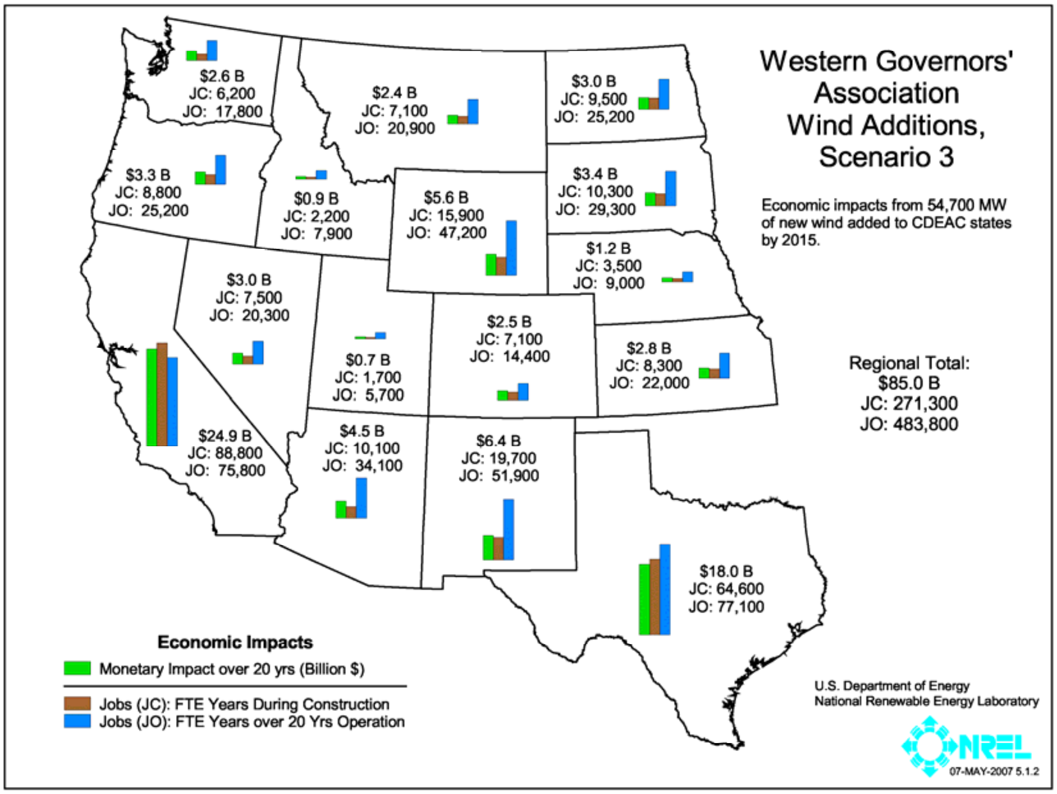

Figure 4. Economic impacts from CDEAC Scenario 3.

The chart in Figure 5 separates the direct, indirect and induced jobs and economic impacts from the creation of new wind power in the WGA states. The impacts are based on state-specific analyses. For example, the 1,750 MW of new wind in Colorado creates specific benefits for the state of Colorado (new jobs and new economic activity). It does not include the benefits that the new wind in Colorado provides to the rest of the region (e.g., not included: Colorado wind project on the border of Colorado and Wyoming creates jobs for Wyoming residents). The forthcoming NREL technical paper will consider the benefits for the entire WGA region. This paper gives only state-specific jobs and impacts sums. When the entire region is considered, benefits from the wind projects will be higher.

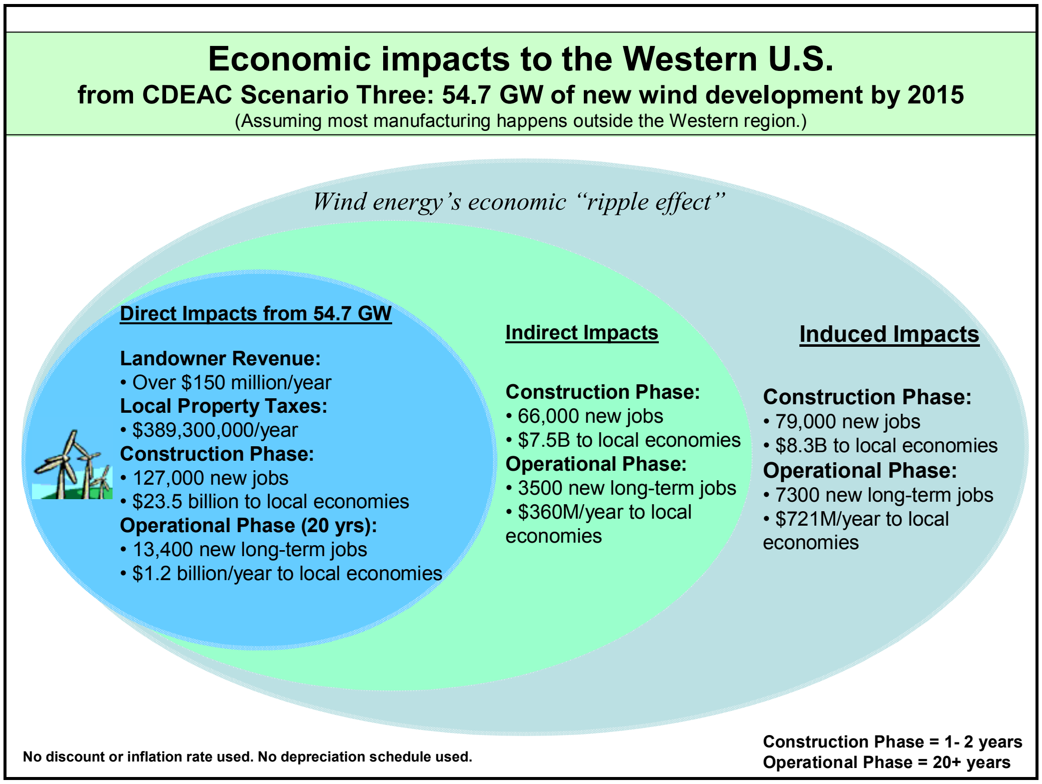

Figure 5. Direct, indirect and induced economic impacts from CDEAC Scenario 3.

Job Creation

The jobs created by adding 54,700 MW (or 54.7 gigawatts, GW) of wind by 2015 will provide a significant boost to the economy. The JEDI model shows that Scenario 3 would create over 270,000 new jobs during the construction phases and almost 145,000 permanent jobs during the operational phase of the wind projects. This analysis assumes that most of the major manufacturing of wind turbine parts takes place outside of the WGA region. If there is local manufacturing of turbines and turbine components, economic benefits will be notably larger. (See figures 7 and 8 below.)

Figure 6 shows a chart of the jobs created from construction and 20 years of operations of new wind projects in the WGA states. Each construction job for a wind project typically lasts up to one year, and the operations jobs are reported in job-years,[5] assuming there will be a job associated with the O&M phase of the new wind projects for at least 20 years. The blue bars indicated jobs created during the construction phase and red bars are job-years during operating years.

[5] The job is counted each year it exists, so one job that lasts for 20 years appears as 20.

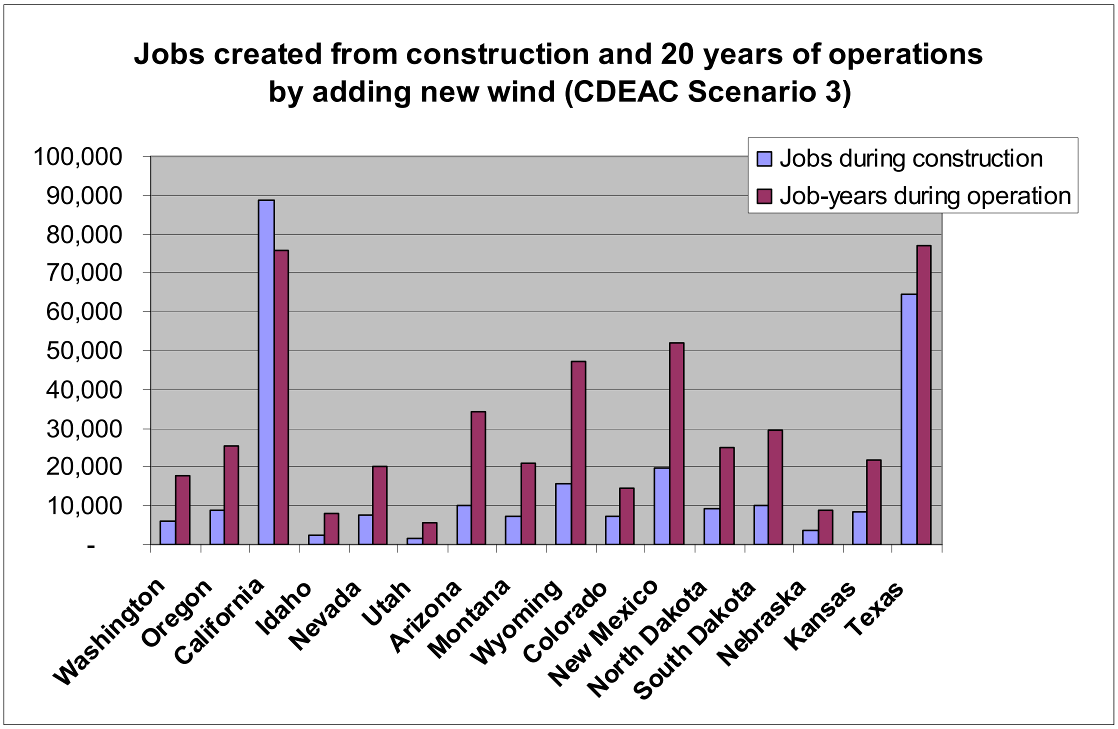

Figure 6. State-specific job creation from CDEAC Scenario 3.

Local Manufacturing

The overall analysis assumes that most wind turbine components (e.g., generators, blades, towers) are made outside the WGA region. The analysis did not look at existing or potential manufacturing facilities. With increased local manufacturing, there will be a greater economic benefit to the local area, state and region. Figure 7 shows that under a scenario in which Colorado produced no wind turbine blades for its projects, almost 6,000 new jobs (construction and long-term) are created. However, if Colorado could produce 100% of its wind blades within the state, the jobs created during construction would increase significantly to more than 10,000. In reality, even with the new blade facility opening in 2008, in Windsor, Colorado, it is likely that Colorado will produce some of its blades but probably not all of them.

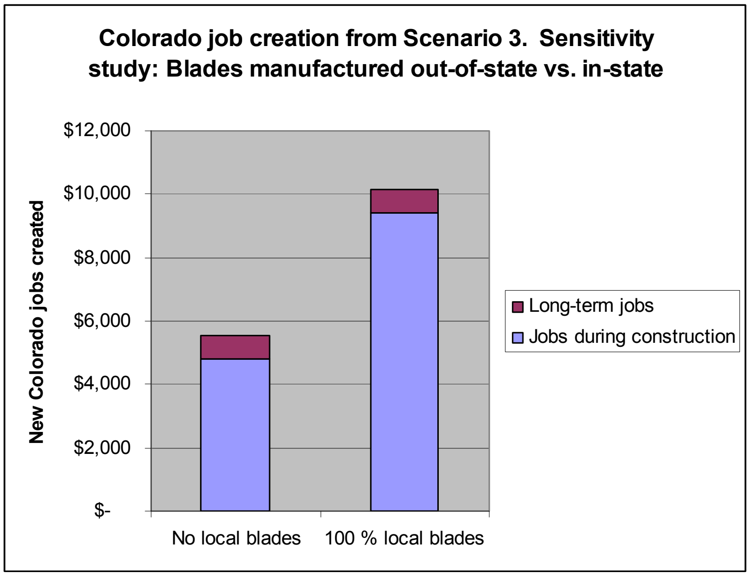

Figure 7. Number of jobs created in Colorado from Scenario 3. Sensitivity scenario: with and without local blade production.

Figure 8 shows the direct, indirect and induced economic impacts from Scenario 3 to Colorado with and without local blade production. Under the no in-state blades scenario, there will be an impact of just over $2 billion. With local blade production, the total impact increases to almost $3 billion. This is a very large increase in economic activity for the state that also influences the entire region.

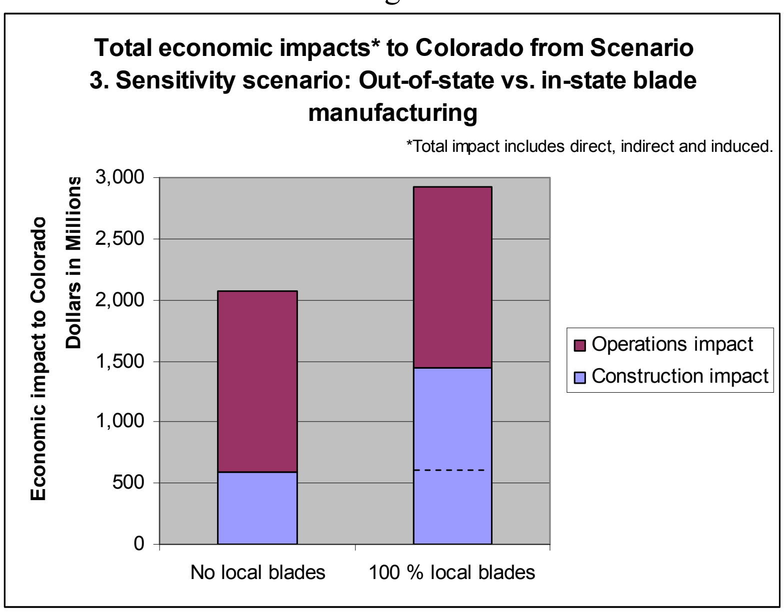

Figure 8. Total economic impacts in Colorado from Scenario 3. Sensitivity scenario: with and without local blade production.

Clearly, the Scenario's economic impacts will create the most jobs and the largest economic benefit to the states in which the most wind installed. Figure 9 shows a breakdown of the economic benefits to states from Scenario 3.

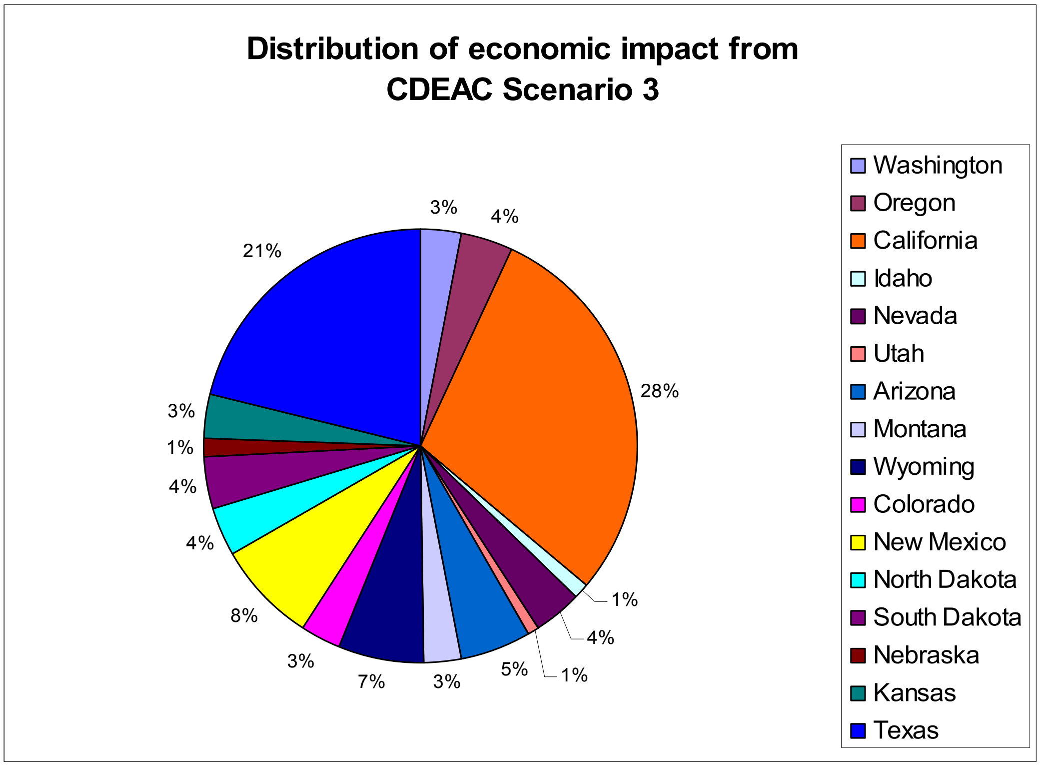

Figure 9. Economic impact distribution to states from CDEAC Scenario 3.

The 20% Wind Vision

The American Wind Energy Association (AWEA), the U.S. Department of Energy (DOE) and NREL have agreed to develop an action plan for optimizing wind's contributions to the U.S. energy needs. The 20% wind vision plans new wind installments through 2030 to help the U.S. meet 20% of its electricity needs from wind. Though their projections are through 2030, we have taken their projections of wind installment up until 2014 to compare to the CDEAC Scenarios in WGA states. The projects tend to follow similar trends of high and low installment in different states, with Scenario 3 usually predicting the most installed wind, followed by the 20% vision and then Scenario 2. Figure 10 is a comparison of the installed capacities in each state by 2014 (in the case of the 20% Vision, because they use even numbered years for their analysis) and 2015 (for CDEAC states). This chart uses the 20% wind vision data from February of 2007. In the upcoming NREL technical report, the 20% wind vision numbers will be updated to their most recent projections.

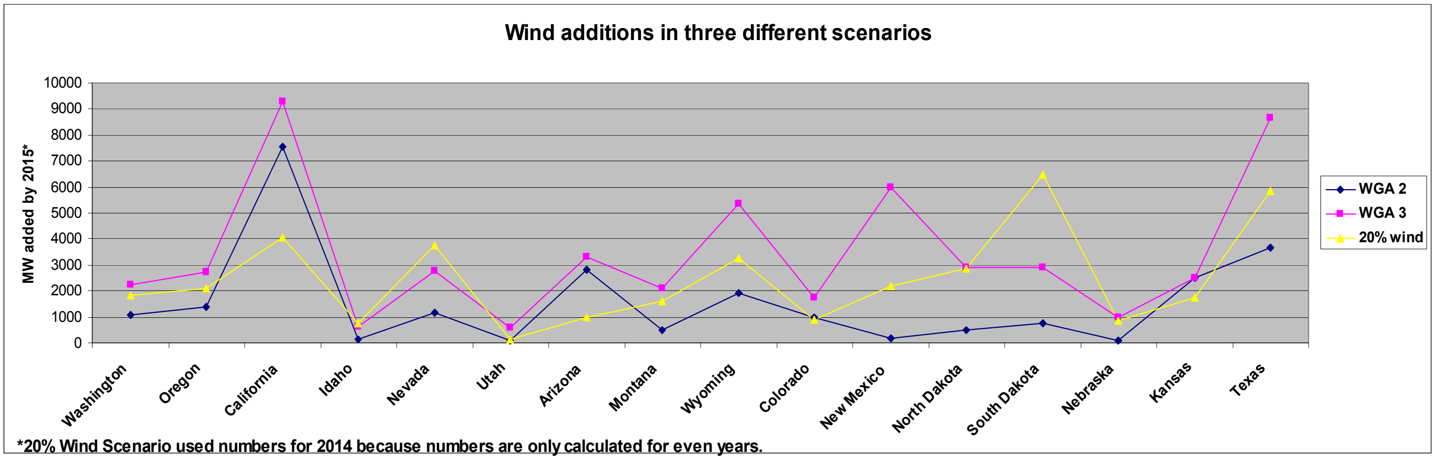

Figure 10. Comparisons of CDEAC Scenario 3 to Scenario 2 and the 20% vision.

Conclusion

The WGA goal of 30,000 MW by 2015 is possible and in some states, will likely be surpassed. New wind energy will bring significant economic benefits to the states in the WGA region. These benefits will be further enhanced as local wind components manufacturing expands in these states. This point helps illustrate the advantage that states have when they are able to attract wind component manufacturing or related industries. The JEDI model shows that the CDEAC Wind Task Force Scenario 3 would create over 270,000 new jobs during the construction phases and almost 145,000 permanent jobs during the operational phase of the wind projects. The forthcoming NREL technical report will examine states and scenarios in more detail and will provide more information on existing and potential manufacturing capabilities.

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