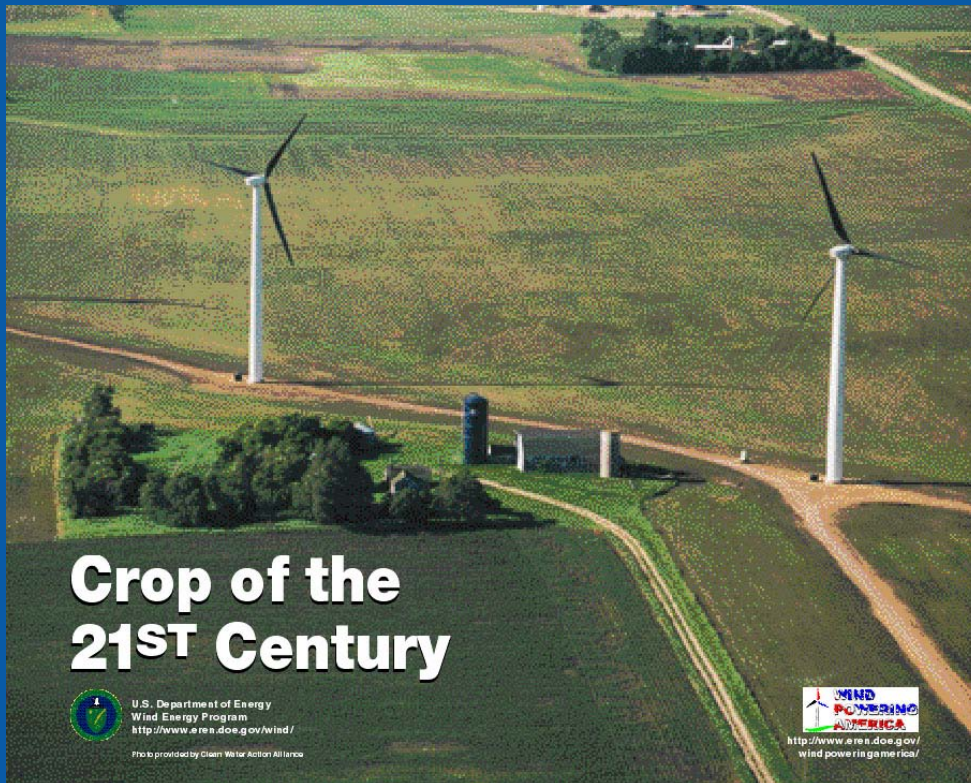# How to Estimate Economic Impacts from Renewable Energy

DOE Technical Assistance Program (TAP) Webcast

Eric Lantz and Gail Mosey

July 29, 2009

Overview

Purpose:

Educate State and Local Policymakers in analysis and assessment of economic development impacts (EDI) from Renewable Energy Projects

Relevant Questions

- How is EDI measured?
- How does NREL think about EDI?
- What can NREL's JEDI Suite Offer?

Outline

- Definitions and Background
- Accessing and Using NREL's JEDI models
- Interpreting Modeling Results
- Highlights and Examples from recent NREL Research
- Explaining variability in results

Measuring Economic Development Impacts

General Input Output Methodology

- Aggregated economic data is used to recreate inter-industry transactions throughout the economy
  - This data demonstrates how spending in one industry affects spending in other industries
- From inter-industry transaction data, industry specific multipliers are derived
- Multipliers are used to measure how changes in demand for goods and services in one industry result in changes in demand for goods and services throughout the economy

Input Output Models

- Tools that apply multiplier relationships to evaluate EDI
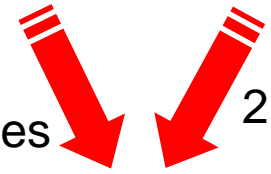- Examples: IMPLAN, RIMS II, REMI, IMSET, JEDI etc.

Defining Economic Development Impacts

1. On-site Labor and Professional services

2. Turbine Production and Supply Chain Impacts
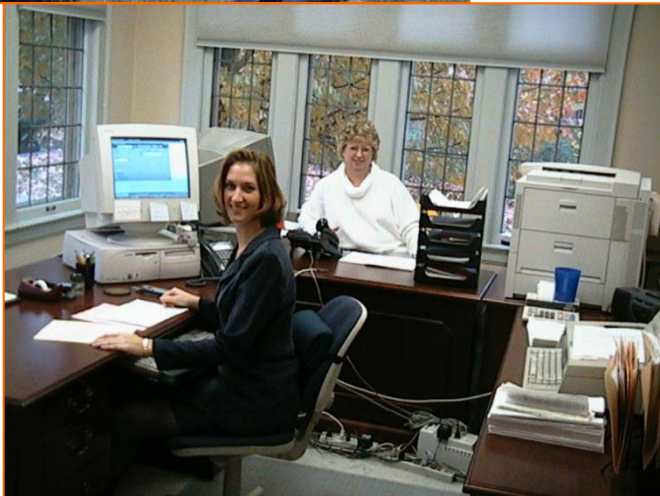

3. Induced Impacts (Household purchases due to injection of income)

On-site Labor and Professional Services

Truck drivers, crane operators

Earth moving, cement pouring

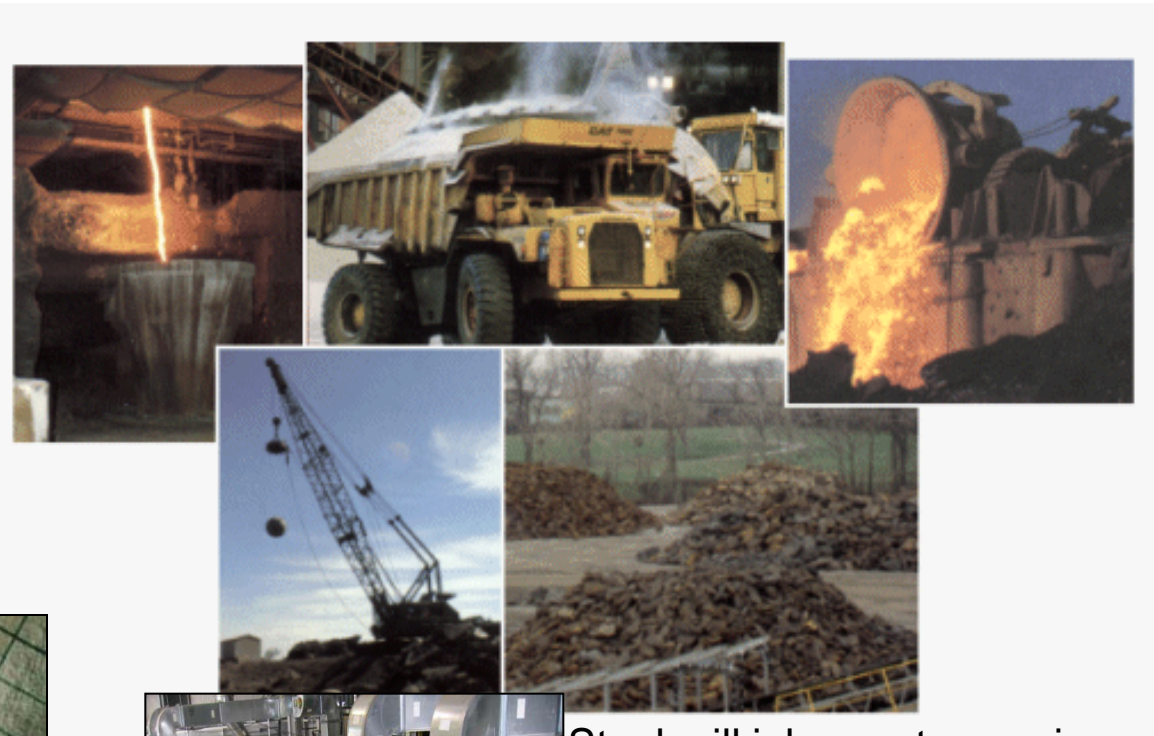**Management and support**

Construction

Equipment Production and Supply Chain Impacts

Property taxes

Financing, banking, accounting

Steel mill jobs, parts, services
Photos: E.C.Levy, Inc, Detroit, MI

Component manufacturing and sales

Induced Jobs, Services, Materials

Child care, grocery store, clothing, other retail, public transit, new cars, restaurants, medical services

Challenges to modeling Renewables

Renewables represents a new industry

- Not isolated as an industry in conventional I/O tables

Requires detailed knowledge of project costs and industry specific expenditures

- Equipment, Engineering, Labor, Permitting, O&M, etc.

Enter JEDI

- Provides a project basic project recipe for specific RE technologies
- Applies Industry Specific Multipliers derived from IMPLAN

JEDI Model Availability

Current JEDI Models

- Large Wind (>=Class 4)
- Concentrating Solar Power (CSP)
- Dry Mill Corn Ethanol
- Lignocellulosic Ethanol
- Natural Gas (Combined Cycle)
- Coal (Pulvervized Coal)

JEDI Under Development

- Photovoltaics (PV) – Residential New & Retrofit, Small and Large Commercial, Utility Scale
- JEDI Hydro – Conventional & MHK

The JEDI Suite

http://www.nrel.gov/analysis/jedi/

The JEDI Model

JEDI - WIND

Jobs and Economic Development Impact Model

This demonstration model is designed to estimate the statewide economic impacts associated with developing wind power electric generation facilities. The economic impacts identified include annual jobs, earnings, and output for the construction period and once the windfarm is up and running. A user defined "add-in" location (e.g., county or region) option is also available.

Steps to complete an economic impact analysis:

1. Enter project descriptive data
2. Choose to accept default project cost data (based on project description and average cost data for windfarms) or review and enter new project data.
3. If you accept default values go directly to SUMMARY RESULTS to view and/or print results.
4. If you choose to enter new values make sure to enter an "N" in the designated cell before proceeding.

To begin analysis press Start button

> **Start**
> Economic Impact Analysis

The models contain state multipliers, but county or regional multipliers can be acquired and input into the model to carry out analysis on entities other than states

Basic User Inputs

	A	B	C	D	E	F
1	**Wind Farm Project Data**					
2						
3	**INSTRUCTIONS:** Begin by entering Project Location (from pull-down list) and other Descriptive Data.					
4	After inserting required data press enter (or cursor to the next cell) to continue.					
5	Once Descriptive Data is complete, choose "Y" or "N" on Line 24 to continue.					
6	Choose "Y" to accept Project Cost and Local Share defaults or "N" to review/modify values.					
7	To utilize new values in analysis you must choose an "N" in "Utilize Model Default Values (below)?" - Line 24					
8	Additional information is available by pointing to the red triangles located in cell corners and in the *FAQ* tab.					
9	Only those cells with a white background can be changed (accept new values).					
10						
11						
12	**Project Descriptive Data**					
13	Project Location	COLORADO ▼				
14	Population (only required for County/Region analysis)					
15	Year of Construction	2009				
16	Total Project Size - Nameplate Capacity (MW)	100				
17	Number of Projects (included in Total Project Size)	1				
18	Turbine Size (KW)	1,500				
19	Number of Turbines	67				
20	Installed Project Cost ($/KW)	$2,043				
21	Operations and Maintenance Cost ($/kW)	$20.00				
22	Money Value - Current or Constant (Dollar Year)	2008				
23						
24	Utilize *Project Cost Data* default values in analysis?	Y ▼			**Press 'Go To Summary Impacts' Button**	
25	Choose "Y" to accept default values below or "N" to					
26	over-ride default values and utilize new user defined values as entered below. *See FAQ for related topics.*				Go To Summary Impacts	
27	If desired, default values (in cells below - based on *Project Descriptive Data* entered above) may be restored by pressing the 'Restore Default Values' button. *Note: it is not necessary to restore defaults to incorporate default Project Cost Data in system analysis - simply choose "Y" in cell B24 above.*					Restore Default Values

Basic User Inputs

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The user chooses the state where the project will be located from a drop down menu and provides basic project level information.

The user can then accept the default descriptive data or enter their own project specific data.

Detailed User Inputs

Project Cost Data				
Construction Costs	**Cost**	**Cost Per KW**	**Percent of Total Cost**	**Local Share**
Equipment Costs				
Turbines (excluding blades and towers)	$91,451,104	$915	44.8%	0%
Blades	$21,409,957	$214	10.5%	0%
Towers	$23,703,882	$237	11.6%	0%
Transportation	$16,363,325	$164	8.0%	0%
Equipment Total	$152,928,268	$1,529	74.8%	
Balance of Plant				
Materials				
Construction (concrete, rebar, equip, roads and site prep)	$22,098,135	$221	10.8%	90%
Transformer	$2,499,757	$25	1.2%	0%
Electrical (drop cable, wire,)	$2,634,913	$26	1.3%	100%
HV line extension	$4,813,107	$48	2.4%	70%
Materials Subtotal	$32,045,912	$320	15.7%	
Labor				
Foundation	$1,266,243	$13	0.6%	95%
Erection	$1,434,200	$14	0.7%	75%
Electrical	$2,090,061	$21	1.0%	70%
Management/Supervision	$1,084,537	$11	0.5%	0%
Misc.	$7,762,202	$78	3.8%	50%
Labor Subtotal	$13,637,243	$136	6.7%	
Development/Other Costs				
HV Sub/Interconnection				
Materials	$1,518,720	$15	0.7%	90%
Labor	$465,214	$5	0.2%	10%
Engineering	$2,066,598	$21	1.0%	0%
Legal Services	$1,126,296	$11	0.6%	100%
Land Easements	$0	$0	0.0%	100%
Site Certificate/Permitting	$526,983	$5	0.3%	100%
Development/Other Subtotal	$5,703,811	$57	2.8%	
Balance of Plant Total	$51,386,966	$514	25.2%	

Detailed User Inputs

Local share values allow the user to adjust the percentage of local labor that is used in the project

Construction Costs	Cost	Cost Per KW	Percent of Total Cost	Local Share
Equipment Costs				
Turbines (excluding blades and towers)	$91,451,104	$915	44.8%	0%
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Line item cost inputs are shown here. In addition to *construction* cost inputs, default values are provided for *operating and maintenance* and *financial* parameters or the user can choose to enter their own project specific data.

Results Summary

	A	B	C	D	E
1	**Wind Farm - Project Data Summary based on model default values**				
2	Project Location		COLORADO		
3	Year of Construction		2009		
4	Total Project Size - Nameplate Capacity (MW)		100		
5	Number of Projects (included in total)		1		
6	Turbine Size (KW)		1500		
7	Number of Turbines		67		
8	Installed Project Cost ($/KW)		$2,043		
9	Annual O&M Cost ($/KW)		$20.00		
10	Money Value (Dollar Year)		2008		
11	Installed Project Cost		$204,315,234		
12	Local Spending		$36,581,782		
13	Total Annual Operational Expenses		$33,598,101		
14	Direct Operating and Maintenance Costs		$2,000,000		
15	Local Spending		$697,527		
16	Other Annual Costs		$31,598,101		
17	Local Spending		$869,090		
18	Debt and Equity Payments		$0		
19	Property Taxes		$567,590		
20	Land Lease		$301,500		
21					
22	**Local Economic Impacts - Summary Results**				
23		**Jobs**	**Earnings**	**Output**	
24	**During construction period**				
25	Project Development and Onsite Labor Impacts	67	$4.2	$4.9	
26	Construction and Interconnection Labor	60	$3.8		
27	Construction Related Services	7	$0.5		
28	Turbine and Supply Chain Impacts	306	$12.0	$41.5	
29	Induced Impacts	122	$4.3	$14.6	
30	**Total Impacts**	**495**	**$20.5**	**$61.0**	
31					
32	**During operating years (annual)**				
33	Onsite Labor Impacts	6	$0.4	$0.4	
34	Local Revenue and Supply Chain Impacts	8	$0.3	$1.7	
35	Induced Impacts	7	$0.2	$0.8	

Print Project Data Summary and Summary Results

Print Detailed Project Data

Export All Project Data and Summary Results to a new spreadsheet file

Return to Project Description and Cost Data

Results Summary

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JEDI then estimates the annual economic impact on jobs earnings and output during facility construction and operation.

Print Project Data Summary and Summary Results

Print Detailed Project Data

Export All Project Data and Summary Results to a new spreadsheet file

Return to Project Description and Cost Data

Interpreting the Results

- JEDI reports jobs as *full time equivalents* or 2,080 hour units
  - Projects may take more or less than a year to complete, in these cases construction can be adjusted to reflect the impact during the actual period of construction
    - Example: JEDI reports 100 Construction period jobs. This could be 25 workers supported for 4 years or 200 workers supported for 6 months.
  - Operations period impacts are also FTE's but because they are reported as annual impacts you can interpret these as long-term jobs

- Earnings reflect the actual salaries acquired by laborers

- Output is the sum value of all goods and services provided at each layer of the supply chain
  - Example: For a wind turbine it is the cost of the iron ore, plus the cost of the rolled steel, plus the cost of the assembly, plus the cost of the final project
  - This is in contrast to metrics like GDP or GSP which reflect only the sum of the value added (i.e. sale price less material input prices) or the market value of *final goods and services*

- JEDI Analyses are a measure of Gross Economic Impacts

Jobs and Economic Impacts from the JEDI Model

1,000 MW of New Wind Power in Illinois

Wind energy's economic "ripple effect"

Direct and Indirect Impacts

Landowner Revenue:
- $3 million/year

Local Property Taxes:
- $6.9 million/year

Construction Phase:
- 3,577 jobs
- $471.5 million to local economies

Operational Phase:
- 120 jobs/year
- $21.9 million/yr to local economies

Induced Impacts

Construction Phase:
- 1,394 jobs
- $165.2 million to local economies

Operational Phase:
- 80 jobs/year
- $9.5 million/year to local economies
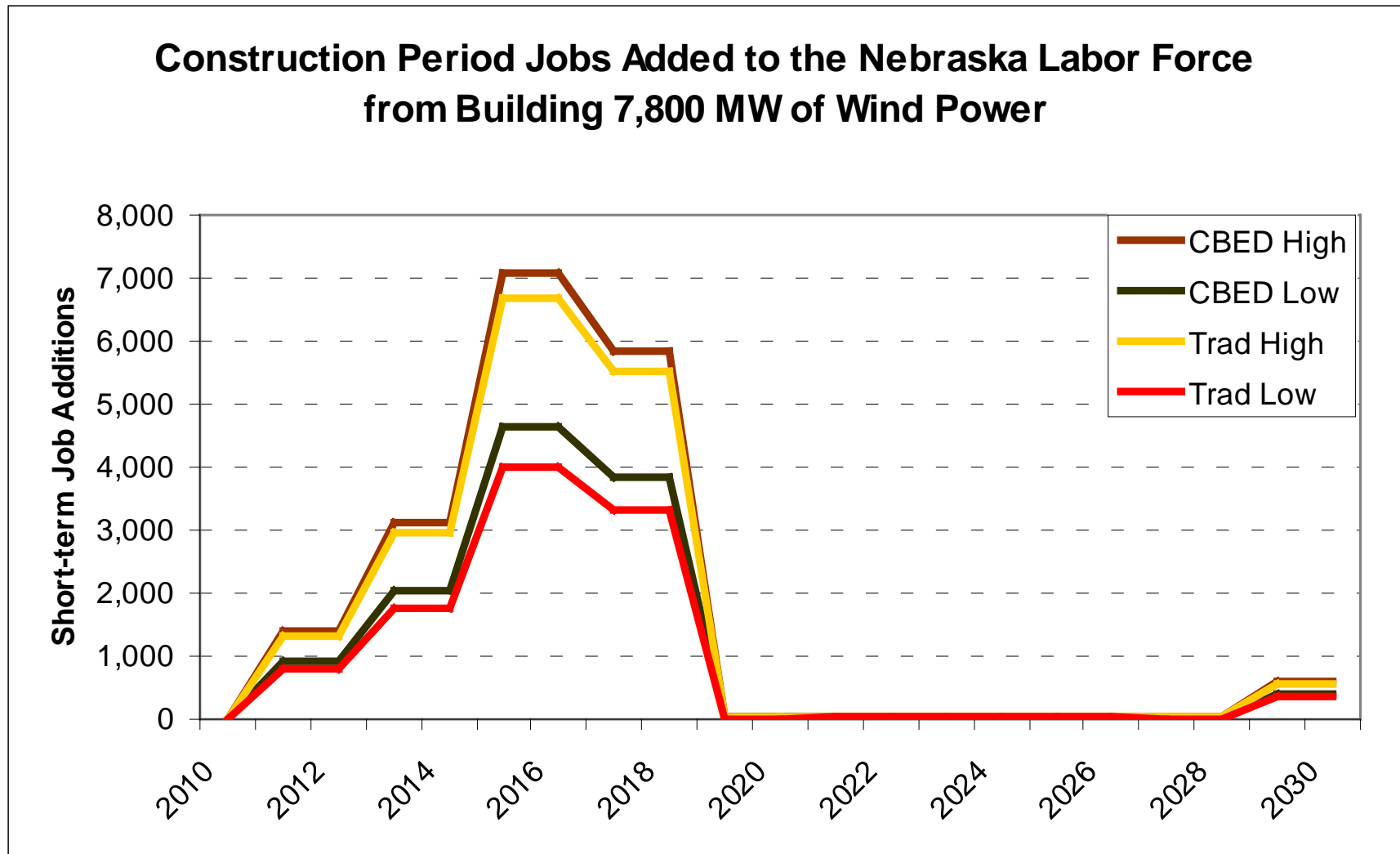
Totals

Construction Phase:
- 4971 jobs
- $636.7 million to local economies
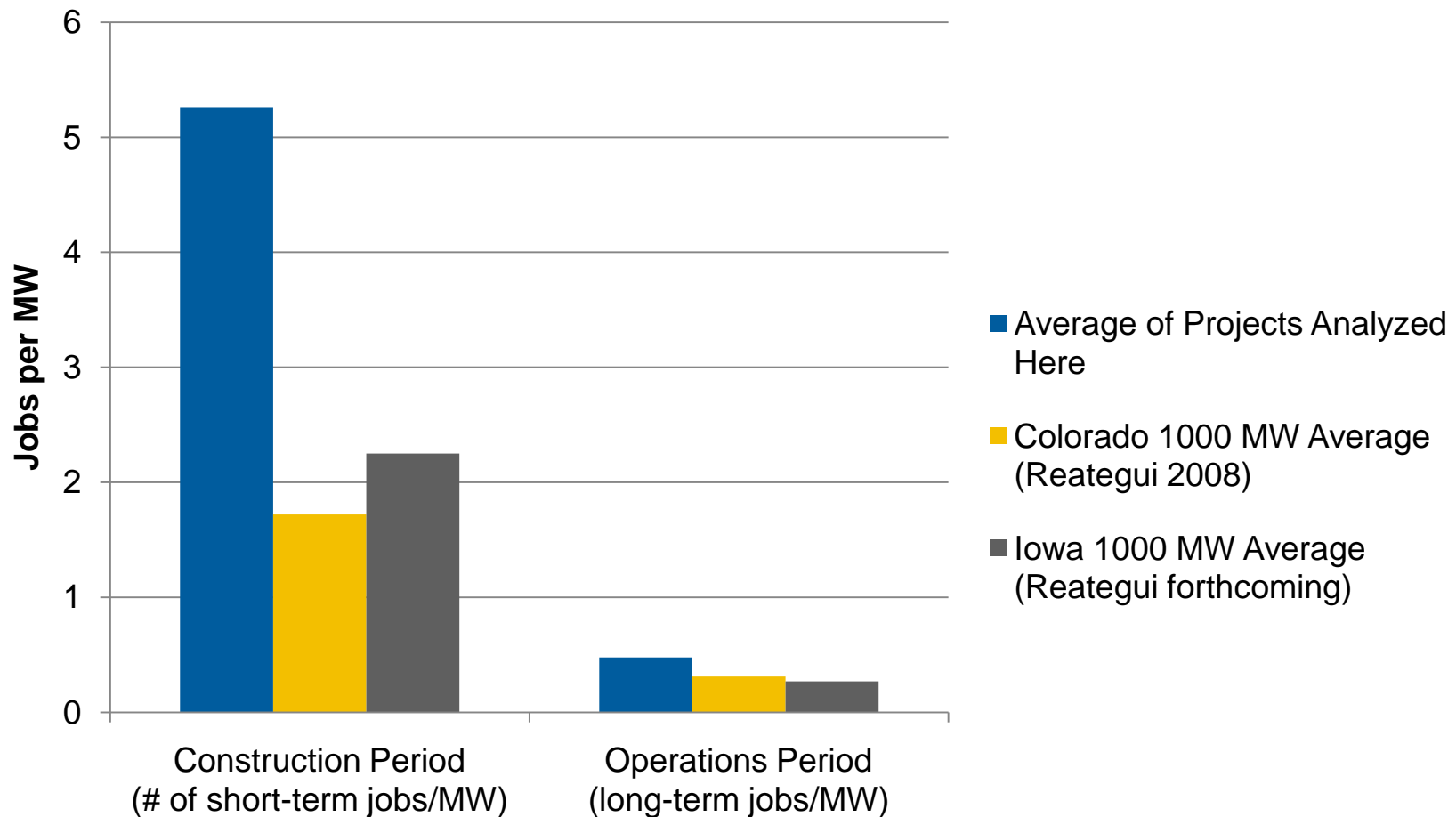
Operational Phase:
- 200 jobs/year
- $31.5 million/year to local economies

Construction Phase = 1-2 years
Operational Phase = 20+ years

# JEDI at Work: Employment Impacts from construction over time

Construction Period Jobs Added to the Nebraska Labor Force from Building 7,800 MW of Wind Power

JEDI at Work: Comparing Completed Community Wind Projects and other Retrospective Analyses

- Average of Projects Analyzed Here
- Colorado 1000 MW Average (Reategui 2008)
- Iowa 1000 MW Average (Reategui forthcoming)

- Ratio of Construction Period Impacts   2.3 – 3.1 : 1
- Ratio of Operations Period Impacts   1.5 – 1.8 : 1

JEDI at Work: Comparing Community Wind to Absentee Wind during Operations
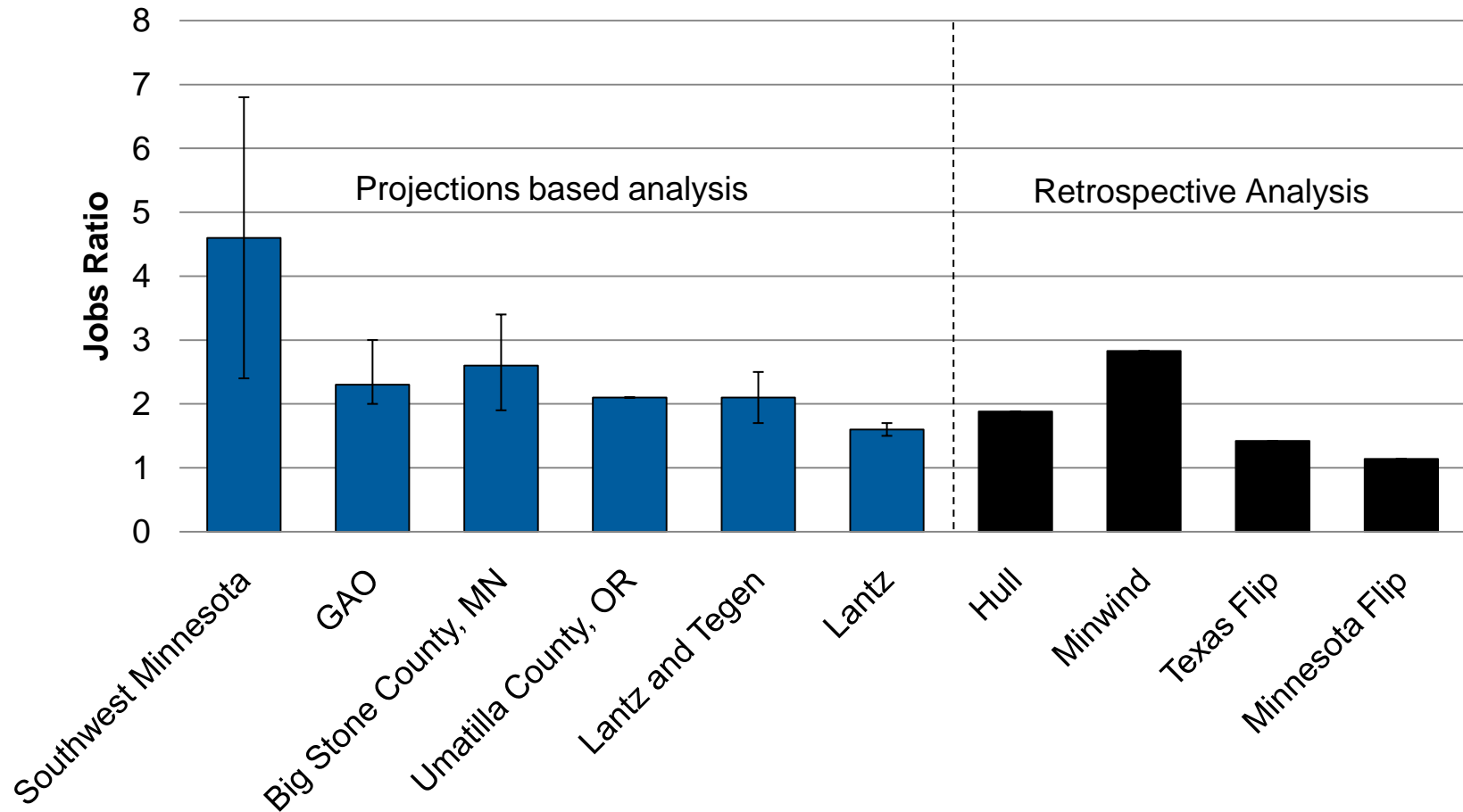
Note: Values shown here represent the ratio of community wind to a hypothetical "average" absentee wind project. The ratio of impacts is interpreted as the value shown to one (e.g., 2.8 : 1).
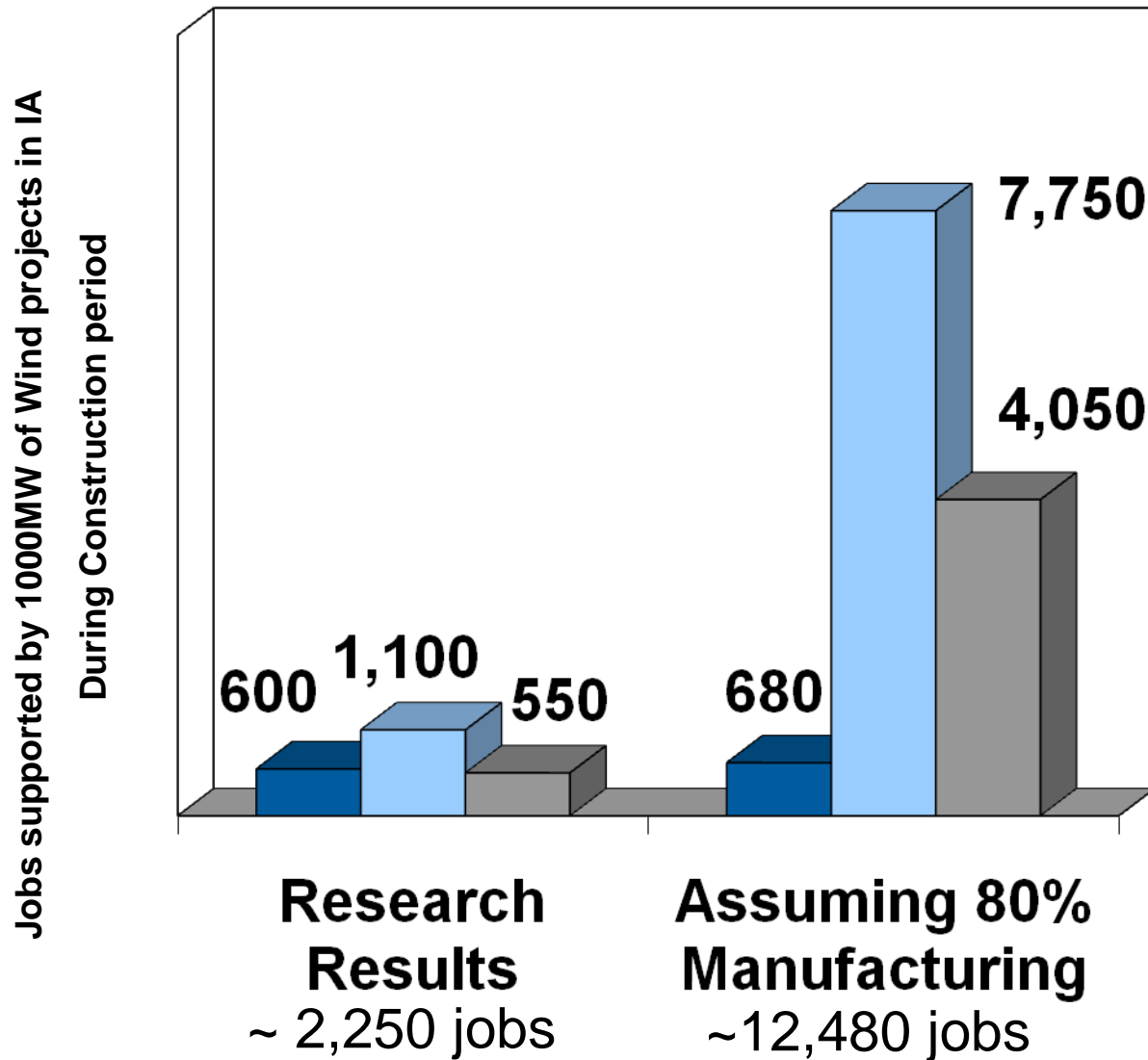
JEDI at Work: Comparing Between Power Generation Alternatives

Total economic impacts from energy equivalent wind and coal in Colorado
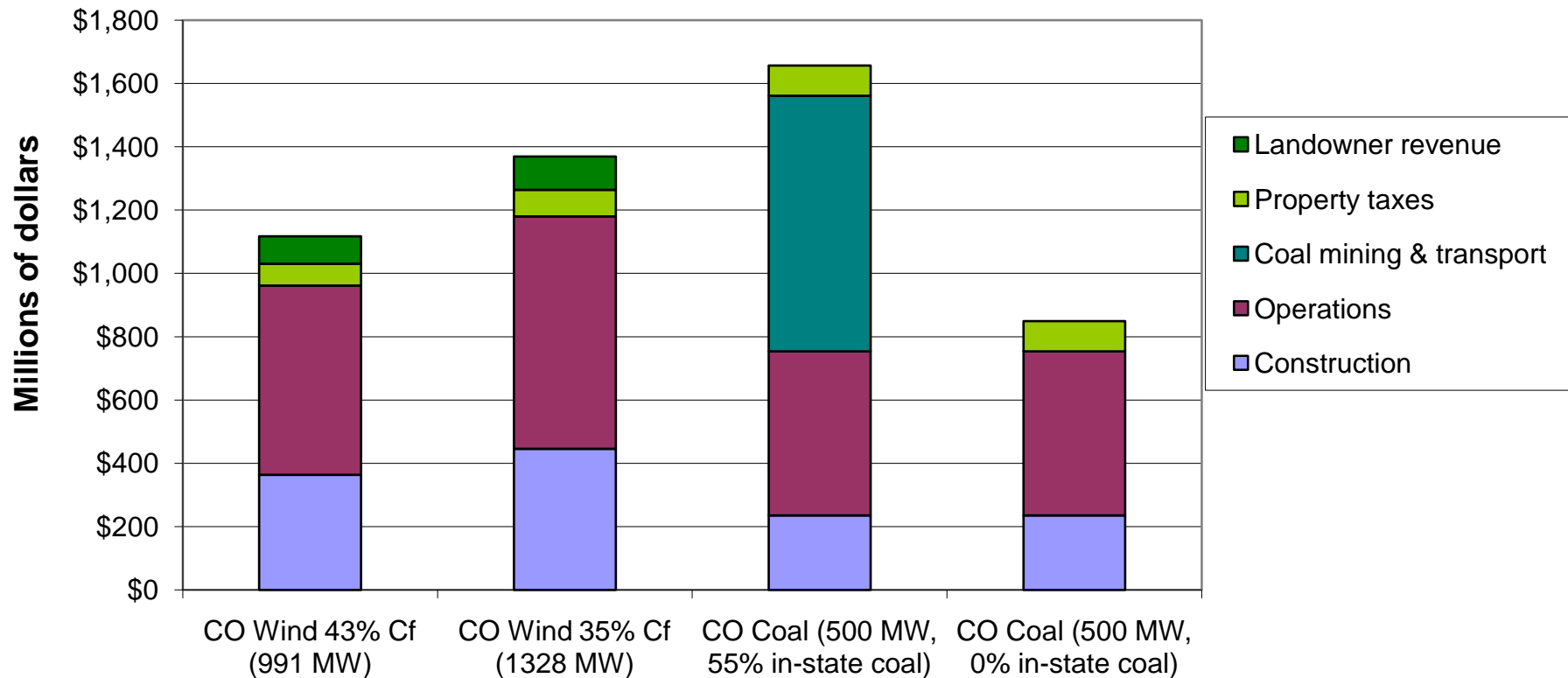
JEDI at Work: Potential Jobs Impacts During Construction Assuming 80% In-state Manufacturing

Preliminary Results

Explaining variability in economic development impacts

- Size and cost of the project
  - Higher costs often results in increased impact for both construction and O&M
- Size and diversity of the local economy
  - Level of analysis
  - Multiplier effect
- Developer preferences and contractor / equipment availability
  - Goods and services
  - *Turbine manufacturing*
- Magnitude and allocation of project revenues

Conclusions

- Analyzing Jobs and Economic Impacts is an important task, and even more so in today's economic and political climate
  - It is not however, the sole metric upon which we can/should evaluate renewable energy projects
- The JEDI tool provides a *user friendly* platform to carry out economic impacts analysis for renewable energy projects
- Individual projects vary in key aspects that affect economic development to state and local regions
  - In extreme cases (i.e. local turbine manufacturing) impacts to a state or local region may be 5 to 10 times different.
- Acquiring as much project specific information as possible is critical
- NREL can provide answers to general questions regarding the JEDI models at *jedisupport@nrel.gov*

Thank You

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