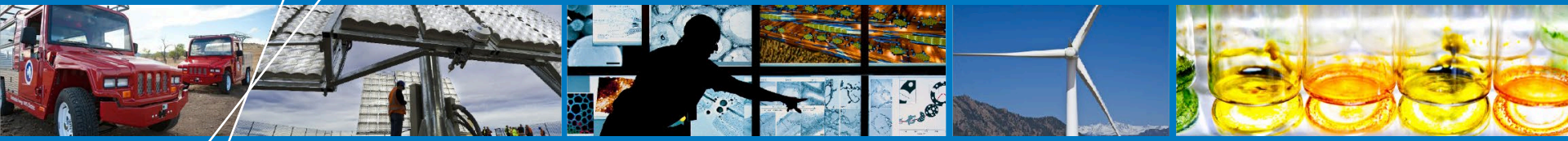
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

The Domestic Wind Energy Workforce



Suzanne Tegen

2015 IEEE PES General Meeting

Denver, Colorado

July 30, 2015

NREL/PR-5000-64760

Background for NREL's Wind Workforce Study

A robust workforce is essential to growing domestic wind manufacturing capabilities. The purpose of this research is to better understand today's domestic wind workforce, projected needs for the future, and how existing and new education and training programs can meet future needs.

Two Projects in One

Education and Training Database

Community college outreach

University outreach

- Number of current students
- Number of graduates
- Percentage in the wind industry.

Industry Survey

A survey of more than 400 wind industry companies

- Number of workers
- Categories of jobs
- Employee skills
- Employee training.

National Wind Energy Skills Assessment Analysis and Report

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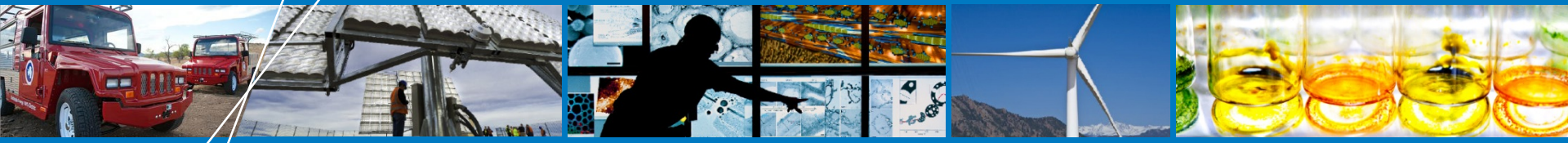

Industry Survey

Result: Level of Difficulty in Finding Qualified Applicants by Occupation

Occupation	Some Difficulty	Great Difficulty	Some or Great Difficulty
Professors & teachers	41%	43%	84%
Product designers	40%	35%	75%
Trade workers	40%	31%	71%
Manufacturing salespeople	33%	31%	64%
Wind technicians	50%	29%	79%
Construction managers	44%	28%	72%
Professional trainers	50%	27%	77%
Development technical specialists	47%	26%	74%
Engineers	42%	25%	66%
Scientists	48%	24%	71%
Research engineers	47%	22%	69%
Managers of sales, operations and training	40%	22%	61%
Attorneys	26%	18%	44%
Transportation/logistics workers	24%	18%	41%
Land-leasing agents	31%	15%	46%
Development managers	37%	15%	52%
Paralegals	33%	11%	44%
Supply chain & purchasing managers	44%	10%	54%
Construction laborers	67%	7%	73%
Resource assessors & surveyors	39%	6%	44%
Development finance	35%	5%	40%
Admin/clerical	31%	4%	35%
Manufacturing managers	72%	2%	74%
Government regulatory workers	73%	0%	73%
O&M Accountants & bookkeepers	60%	0%	60%
Assembly workers	67%	0%	67%

- Responses greater than 25% for “Great Difficulty” are highlighted in green, while 70% responses for the sum of “Some or Great Difficulty” are highlighted in yellow.
- The seven occupations highlighted in orange are those exceeding the threshold on both 25% “Great Difficulty” and 70% “Some Difficulty” or “Great Difficulty.”

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Development finance	35%	5%	40%
Admin/clerical	31%	4%	35%
Manufacturing managers	72%	2%	74%
Government regulatory workers	73%	0%	73%
O&M Accountants & bookkeepers	60%	0%	60%
Assembly workers	67%	0%	67%

Response Scale	No Difficulty	Some Difficulty	Great Difficulty

- Responses greater than 25% for “Great Difficulty” are highlighted in green, while 70% responses for the sum of “Some or Great Difficulty” are highlighted in yellow.
- The seven occupations highlighted in orange are those exceeding the threshold on both 25% “Great Difficulty” and 70% “Some Difficulty” or “Great Difficulty.”

Result: Preferred Educational Attainment for New Hires

	High School Diploma or Less	Post Secondary Professional Certificate (Journeyman, Trade/Technical Programs)	Associate Degree	Bachelor Degree	Post Bachelor Professional Certification (Examples: CPA, PE, LEED)	Master Degree, PhD or Law
Attorneys	0%	0%	0%	6%	21%	74%
Research engineers	0%	0%	0%	17%	11%	71%
Scientists	0%	0%	0%	19%	10%	71%
Government regulatory workers	0%	0%	0%	42%	0%	58%
Professors & teachers	0%	5%	15%	10%	7%	63%
Development managers	0%	3%	0%	39%	29%	29%
Engineers	0%	2%	0%	54%	15%	29%
Managers of sales, operations and training	1%	2%	5%	42%	16%	34%
Development finance	0%	0%	5%	50%	23%	23%
Development technical specialists	5%	5%	0%	47%	11%	32%
Product designers	3%	3%	0%	63%	10%	23%
Resource assessors & surveyors	6%	6%	22%	33%	0%	33%
Professional trainers	3%	16%	10%	32%	10%	29%
O&M Accountants & bookkeepers	7%	0%	13%	60%	13%	7%
Manufacturing salespeople	3%	3%	10%	79%	3%	3%
Construction managers	4%	12%	8%	58%	12%	8%
Manufacturing managers	2%	9%	13%	69%	7%	0%
Supply chain & purchasing managers	2%	4%	25%	68%	2%	0%
Paralegals	0%	0%	38%	63%	0%	0%
Land-leasing agents	0%	21%	7%	71%	0%	0%
Admin/clerical	18%	13%	28%	36%	1%	4%
Transportation/logistics workers	28%	11%	22%	33%	6%	0%
Trade workers	27%	62%	7%	5%	0%	0%
Wind technicians	25%	58%	17%	0%	0%	0%
Assembly workers	33%	44%	22%	0%	0%	0%
Construction laborers	56%	44%	0%	0%	0%	0%

- Green highlighting represents most common response per occupation. Yellow represents a second response that reached levels of 20%.
- Wind industry employers require a wide range of educational levels for their new hires.
- Most common educational achievement required was a bachelor's degree; several occupations required an advanced degree.
- Trade workers and technicians required some form of post high school professional training.

Result: Preferred Educational Attainment for New Hires

	High School Diploma or Less	Post Secondary Professional Certificate (Journeyman, Trade/Technical Programs)	Associate Degree	Bachelor Degree	Post Bachelor Professional Certification (Examples: CPA, PE, LEED)	Master Degree, PhD or Law
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Scientists	0%	0%	0%	19%	10%	71%
Government regulatory workers	0%	0%	0%	42%	0%	58%
Professors & teachers	0%	5%	15%	10%	7%	63%
Development managers	0%	3%	0%	39%	29%	29%
Engineers	0%	2%	0%	54%	15%	29%
Managers of sales, operations and training	1%	2%	5%	42%	16%	34%
Development finance	0%	0%	5%	50%	23%	23%
Development technical specialists	5%	5%	0%	47%	11%	32%
Product designers	3%	3%	0%	63%	10%	23%
Resource assessors & surveyors	6%	6%	22%	33%	0%	33%
Professional trainers	3%	16%	10%	32%	10%	29%
O&M Accountants & bookkeepers	7%	0%	13%	60%	13%	7%
Manufacturing salespeople	3%	3%	10%	79%	3%	3%
Construction managers	4%	12%	8%	58%	12%	8%
Manufacturing managers	2%	9%	13%	69%	7%	0%
Supply chain & purchasing managers	2%	4%	25%	68%	2%	0%
Paralegals	0%	0%	38%	63%	0%	0%
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Wind technicians	25%	58%	17%	0%	0%	0%
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Construction laborers	56%	44%	0%	0%	0%	0%

- Green highlighting represents most common response per occupation. Yellow represents a second response that reached levels of 20%.
- Wind industry employers require a wide range of educational levels for their new hires.
- Most common educational achievement required was a bachelor's degree; several occupations required an advanced degree.
- **Over half of employers prefer that engineers have a Bachelor's; and one third of employers preferred a Master's or higher.**

Result: Importance of Wind-Specific Degree

% Rating "Very" or "Somewhat" Important	College Degree	Wind Energy-Specific College Degree	Ratio of Importance of Wind Energy-Specific College Degree vs. Degree Not Specific to Wind
Assembly workers	29%	29%	100%
Wind technicians	40%	40%	100%
Development technical specialists	84%	47%	56%
Research engineers	97%	48%	50%
Professors & teachers	100%	47%	47%
Trade workers	19%	7%	38%
Engineers	100%	36%	36%
Development managers	94%	28%	30%
Resource assessors & surveyors	88%	24%	27%
Managers of sales, operations, & training	95%	24%	25%
Transportation/logistics workers	53%	13%	25%
Land-leasing agents	62%	15%	25%
Professional trainers	91%	22%	24%
Construction managers	77%	18%	24%
Scientists	100%	20%	20%
Paralegals	100%	17%	17%
Product designers	93%	15%	16%
Manufacturing salespeople	86%	11%	13%
Admin/clerical	61%	8%	13%
Manufacturing managers	80%	10%	13%
O&M accountants & bookkeepers	93%	7%	8%
Supply chain & purchasing managers	79%	6%	7%
Attorneys	100%	7%	7%
Development finance	85%	5%	6%
Construction laborers	9%	0%	0%
Government regulatory workers	100%	0%	0%
Average	**77%**	**19%**	**28%**

Response scale:	Not Needed	Somewhat Important	Very Important

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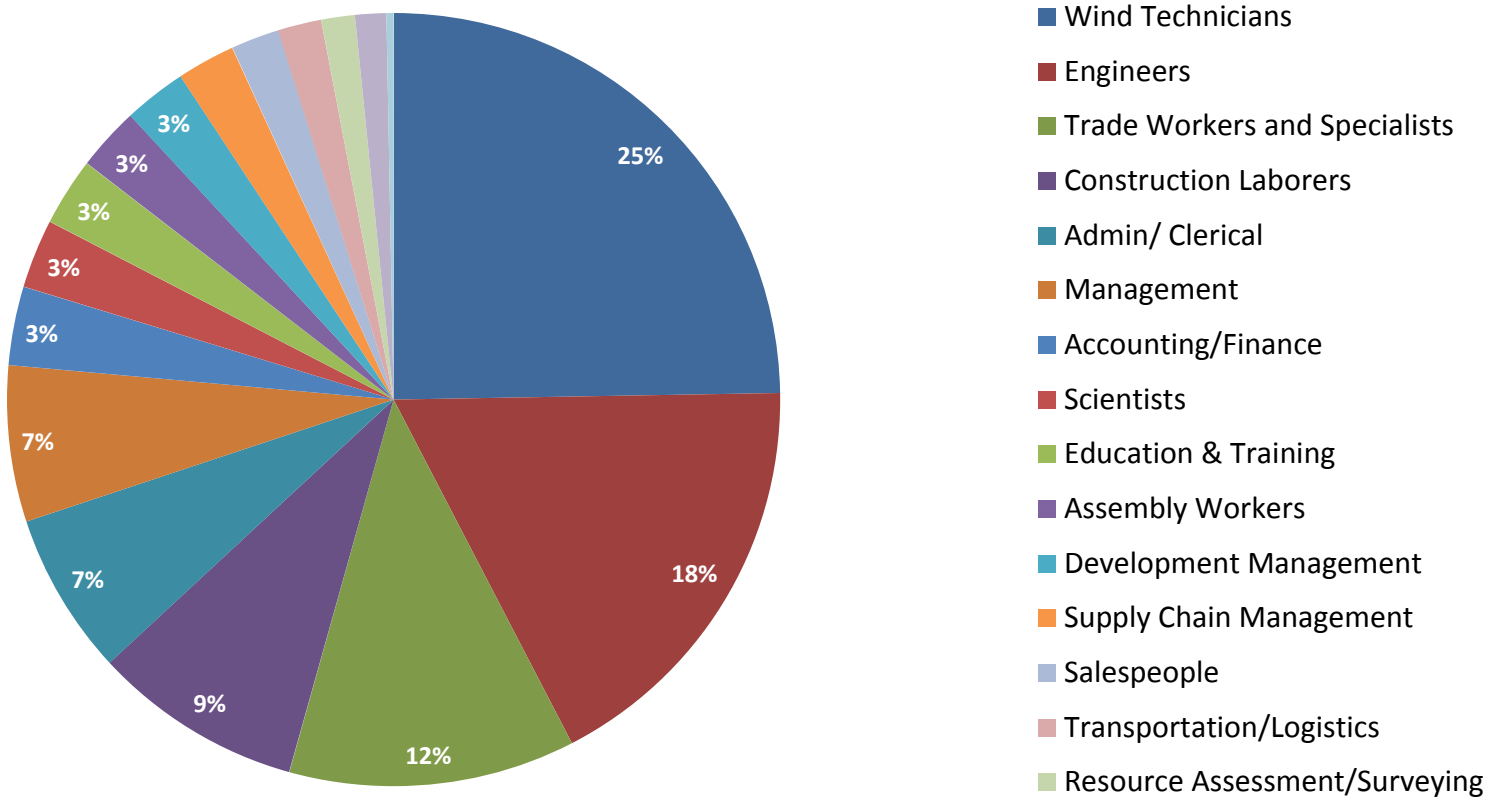
Manufacturing managers	80%	10%	13%
O&M accountants & bookkeepers	93%	7%	8%
Supply chain & purchasing managers	79%	6%	7%
Attorneys	100%	7%	7%
Development finance	85%	5%	6%
Construction laborers	9%	0%	0%
Government regulatory workers	100%	0%	0%
Average	**77%**	**19%**	**28%**

Response scale:	Not Needed	Somewhat Important	Very Important

Survey Results: A Segment of Today's Wind Industry Jobs

Subset of the Workforce Captured in Our Survey

(~46,000 Workers)



Manufacturing jobs include some from the following categories: trade workers, assembly workers, supply chain management, salespeople, transportation, and some admin/ clerical (approximately 25%).

Wind Workforce Projection

For our research, we:

- **Used primary survey data to assess current employment**
- **Anchored employment results to report: *20% Wind Energy by 2030*** (U.S. Department of Energy 2008) **which estimated industry growth rates.**
  - Anchored O&M jobs to cumulative installed capacity
  - Anchored construction and development jobs to annual installed capacity.
- **Built in:**
  - Retirement rates
  - Labor efficiency gains.

Results: Estimate of Education & Training Gap

To meet predicted wind industry growth over the next 20 years, we need to increase the number of *wind-energy-specific* education and training programs offered at the community college and university levels.

Degree/ Certificate	Maximum New Hires Needed with Wind-Specific Degrees/ Certificates	Type of Institution Offering	Estimated Percent of Graduates Entering Wind Industry	Number Needed to Graduate in Max Year	Estimated Graduates Per Program Per Year	Number of Programs Needed in US	Number of Programs Currently Available	Difference
Post-secondary professional certificate (journeyman, trade/technical programs)	2,750	Community & tech colleges	83%	3,310	21	160	70	**90**
Associate's degree	1,000	Community & tech colleges		1,200		60	90	**0**
Bachelor's degree	800	University	48%	1,660	34	50	20	**30**
Post-bachelor's professional certification (e.g., CPA, PE, LEED)	210	University		440		10	NA	**0-10**
Master's degree, Ph.D., or Law	550	University		1,150		30	20	**10**

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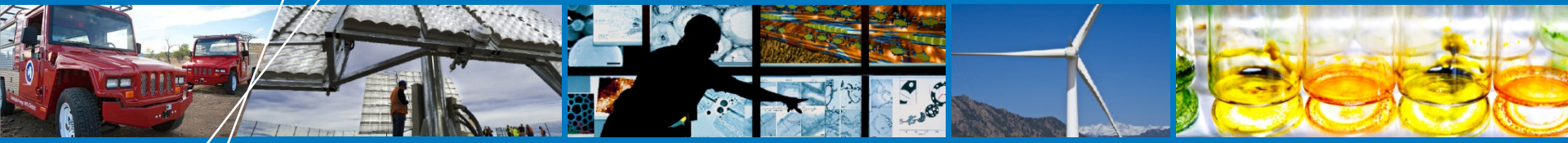
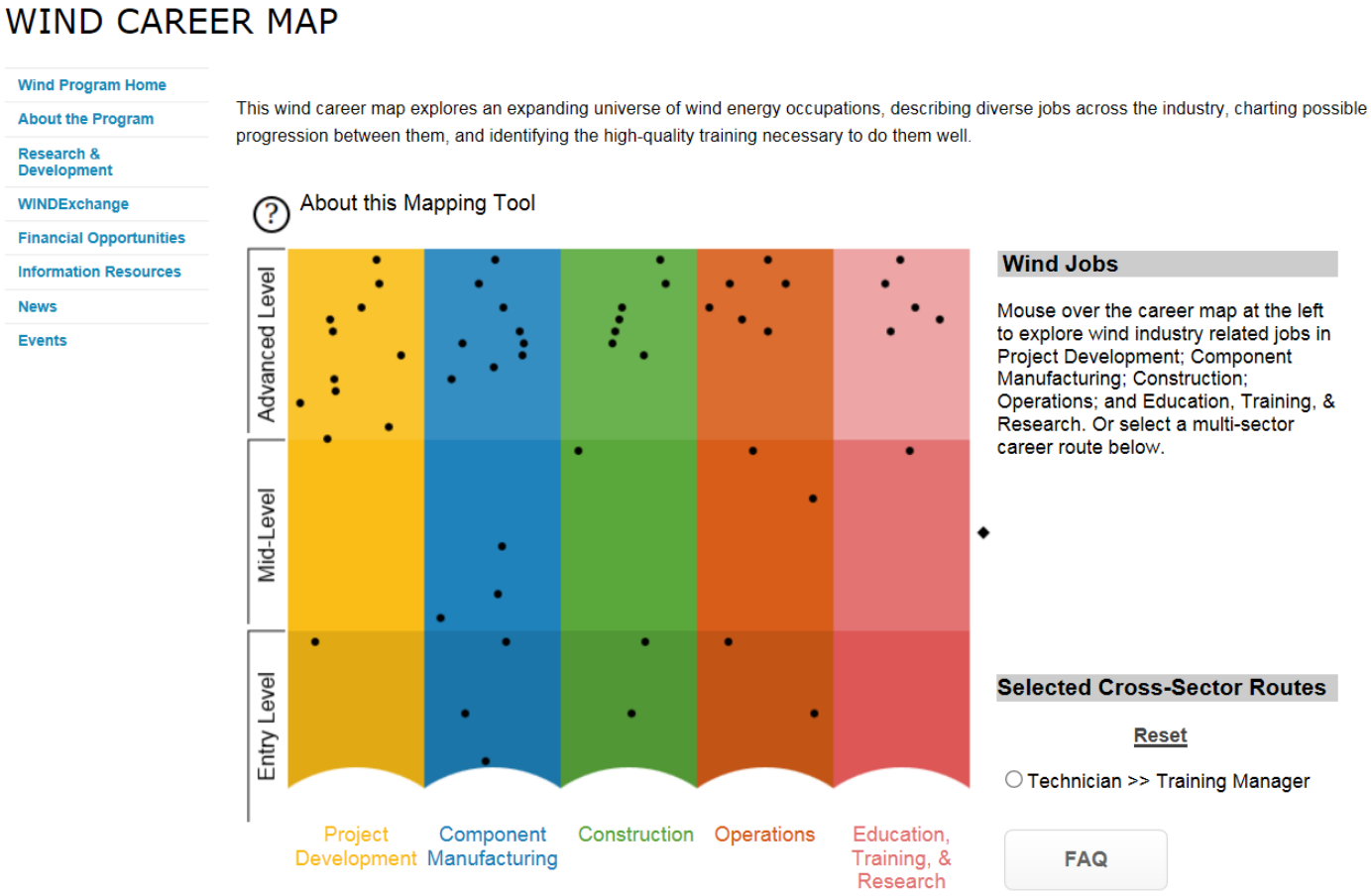


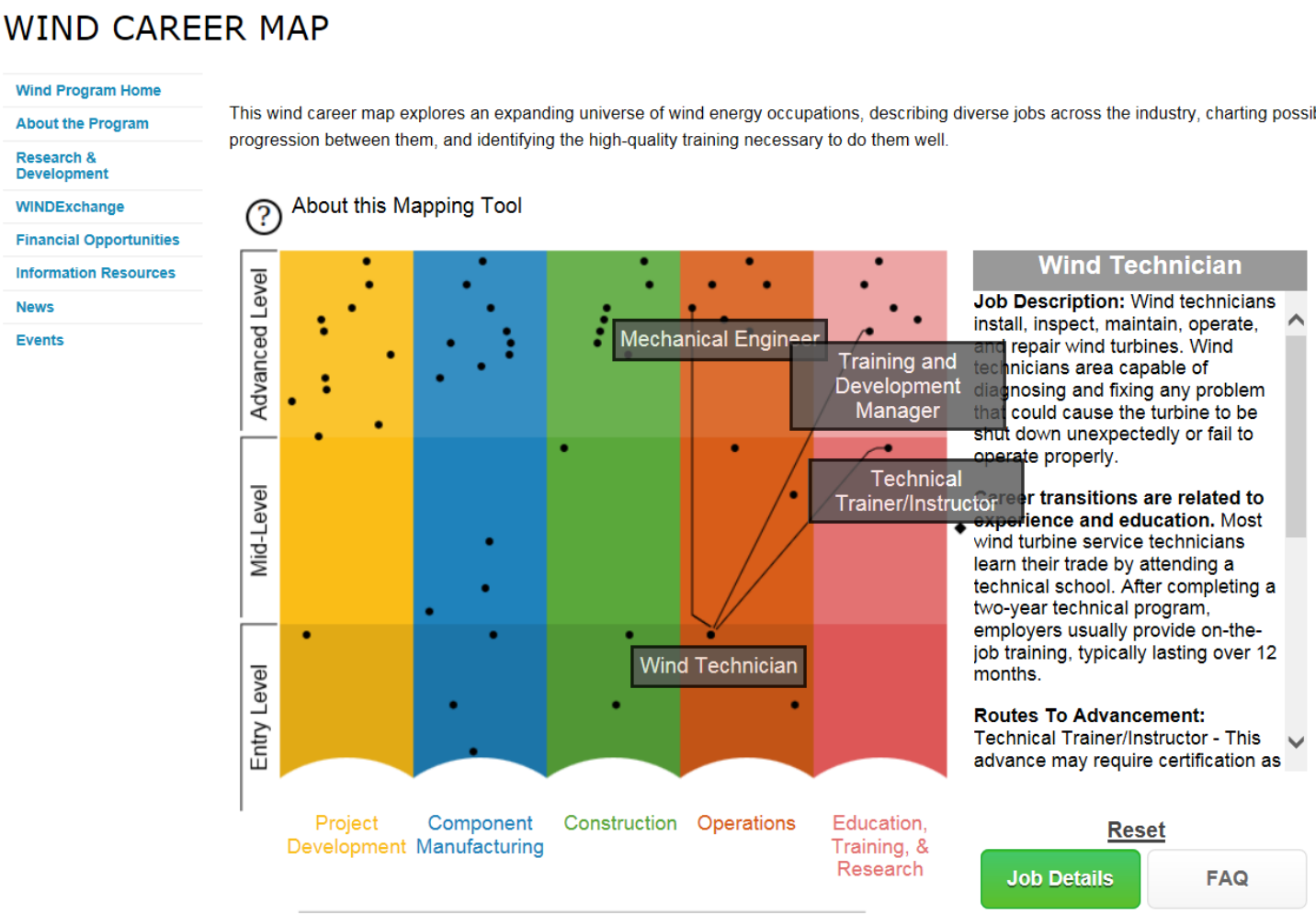
Domestic Renewable Energy Workforce

Renewable Energy Career Maps

Wind: energy.gov/eere/wind/wind-career-map
Solar: See the Sunshot Initiative: eere.energy.gov/solar/careermap/



Wind Career Map



Collegiate Wind Competition

Stimulate student interest and industry awareness of a highly qualified next-gen workforce and new wind power education and training programs

2014 Inaugural Competition

- **10 undergraduate university teams**
- **3-day event held in conjunction with WINDPOWER 2014.**

2015 Follow-up Technical Competition

- **3-day event at NREL's National Wind Technology Center**
- **Seven undergraduate university teams.**

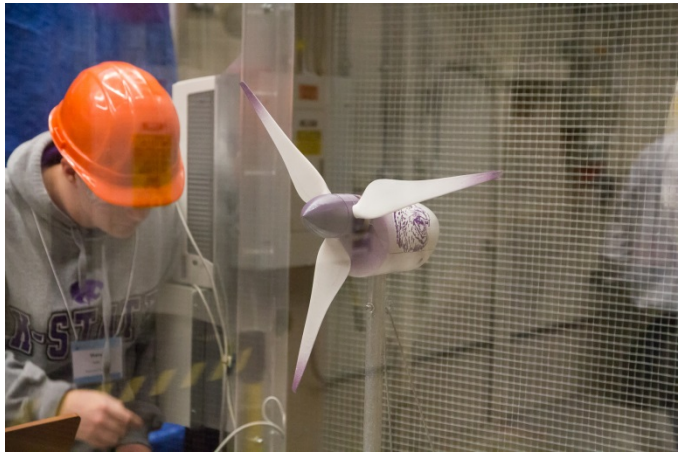


Photo by Lee Jay Fingersh, NREL

Photo by Dennis Schroeder, NREL

DOE Wind Program Director with the CWC winning team Boise State

COLLEGIATE WIND COMPETITION
U.S. DEPARTMENT OF ENERGY

- **Design, build, and test a wind turbine**
- **Present on wind energy topics**
- **Deliver a cohesive business plan.**

Wind for Schools

- K-12: Introduce wind energy concepts into our school's science curricula
- University level: provide juniors and seniors with real-world skills/experience in wind energy applications
- Engage communities to consider wind energy benefits and costs
- Through Wind Application Centers, develop centers for excellence.

Photo from South Dakota Wind Application Center, NREL 18283

Photo from Joe Jacobs, NREL17945

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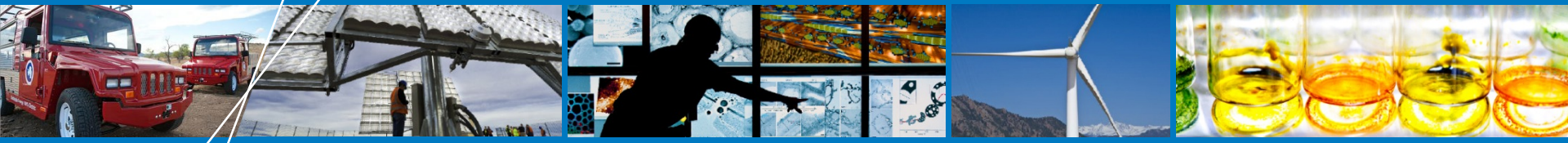


Jobs in Renewable Energy: NREL's Jobs and Economic Development Model

Which Technologies Have JEDI Models?

- **Current JEDI models**
  - Land-based wind (distributed and utility)
  - Offshore wind – fixed platform
  - Natural gas (combined cycle)
  - Coal (pulverized coal)
  - Marine and hydrokinetic
  - Concentrating solar power
  - Dry mill corn ethanol
  - Lignocellulosic ethanol
  - Solar photovoltaic
  - Conventional hydropower
  - Transmission
  - Geothermal
  - Biopower
  - Petroleum refining.
- **JEDI models under development**
  - Offshore wind – floating platform

Photo from Sally Wright, Renewable Energy Research Lab - Umass, NREL/PIX15160

Jobs and Economic Development Impacts

Wind energy's economic "ripple effect"

Project Development & On-site Labor Impacts

- Construction workers
- Cement truck drivers
- Vessel operators
- Maintenance workers
- Legal and siting
- Management
- Administrative support

Local Revenue, Turbine, & Supply Chain Impacts

- Blades, towers, gearboxes
  - Platforms, crane & truck operators, gas and gas station workers;
  - Supporting businesses, such as bankers financing the construction, contractors, manufacturers, and equipment suppliers;
  - Utilities;
- Hardware store purchases and workers, spare parts and their suppliers

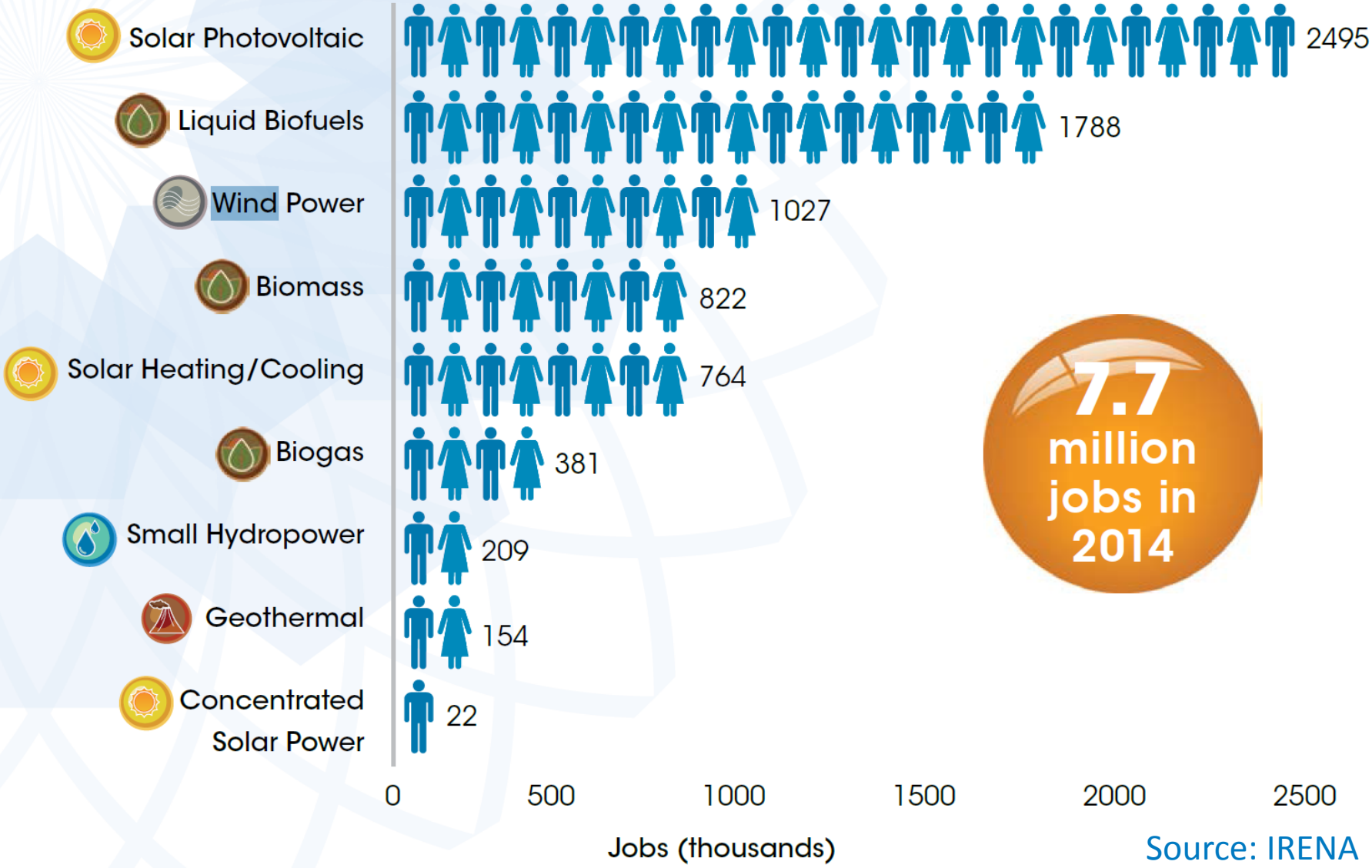
Induced Impacts

Jobs and earnings that result from the spending supported by the project workers, including benefits to grocery store clerks, retail salespeople, and restaurant workers

Source: National Renewable Energy Laboratory

The International RE Jobs Picture

FIGURE 1. RENEWABLE ENERGY EMPLOYMENT BY TECHNOLOGY



Source: IRENA

A National Skills Assessment of the U.S. Wind Industry in 2012

-Leventhal and Tegen

www.nrel.gov/docs/fy13osti/57512.pdf

JEDI Model: www.nrel.gov/analysis/jedi

Thank you.

Questions?

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