



# JISEA

Joint Institute for  
Strategic Energy Analysis

## The State of Clean Energy Manufacturing and Trade

2017 JISEA Annual Meeting  
22 March 2017

Moderator: Jill Engel-Cox, Director, CEMAC

# Objective Analysis Supports Manufacturing Innovation



## Information for Business and Investors

**Bloomberg Technology** Markets Tech Pursuits Politics Opinion Businessweek

### Tesla Flips the Switch on the Gigafactory

Batteries are the limiting factor for electric cars, but few automakers have made a similar commitment to produce them, choosing instead to let suppliers like LG Chem and Samsung shoulder the risk. <sup>9</sup> In 2015, 88 percent of the global lithium ion cell manufacturing took place in China, Japan, and South Korea, according to a report by the Clean Energy Manufacturing Analysis Center.

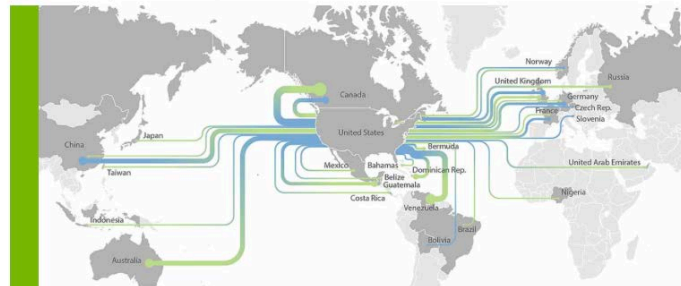
### Manufacturing Clean Energy Blog

*Manufacturing Clean Energy* is the official blog of the Clean Energy Manufacturing Analysis Center (CEMAC). It features insights from CEMAC staff, partners, and guests. To contribute to *Manufacturing Clean Energy*, contact us.

### Hydropower Turbine Market and Trade Values: A closer look at small hydro turbines in the U.S.

December 14, 2016

By Parthiv Kurup, NREL, and Megan Johnson, ORNL



## Objective Analysis for Policymakers and R&D Managers



## Advanced Supply Chain Analysis

### The present and future silver cost component in crystalline silicon PV module manufacturing

Michael Redlinger<sup>1</sup>, Michael Woodhouse<sup>2</sup> & Roderick G. Eggert<sup>1</sup>

<sup>1</sup>Division of Economics and Business, Colorado School of Mines (CSM), Golden, Colorado; <sup>2</sup>Strategic Energy Analysis Center, National Renewable Energy Laboratory (NREL), Golden, Colorado, USA

#### ABSTRACT

The purpose of this paper is to determine how increased c-Si PV module production might affect future silver demand and prices, as well as the impacts on total c-Si module manufacturing costs. A bottom-up estimation of the current and potential material intensity (tonnes of silver per GW) for silver in c-Si PV cell fabrication is presented. Partly because of concerns about material intensity, and also because of the changing economics of manufacturing, there is some interest in shifting away from the traditionally higher material intensity approach of screen printing with silver paste to alternative metallization techniques, such as electroplating, which uses substantially less silver. To evaluate how PV's changing demand for silver might affect future silver prices, and the impact in terms of manufacturing costs, some scenarios of silver's contribution to c-Si PV cell manufacturing costs are compiled on the basis of projected changes in demand and price as a result of changes in material intensity. The analysis indicates that an expansion of c-Si production from 55GW/year to 250GW/year results in a 0.05–0.7¢/W increase in manufacturing costs because of higher silver prices. As an illustration of this, the current estimates of the manufacturing costs for the two contrasting methods – silver screen printing and nickel-copper-silver electroplating – are presented.



### Global Carbon Fiber Composites Supply Chain Competitiveness Analysis

Sujit Das, Josh Warren, and Devin West  
Energy and Transportation Science Division,  
Oak Ridge National Laboratory

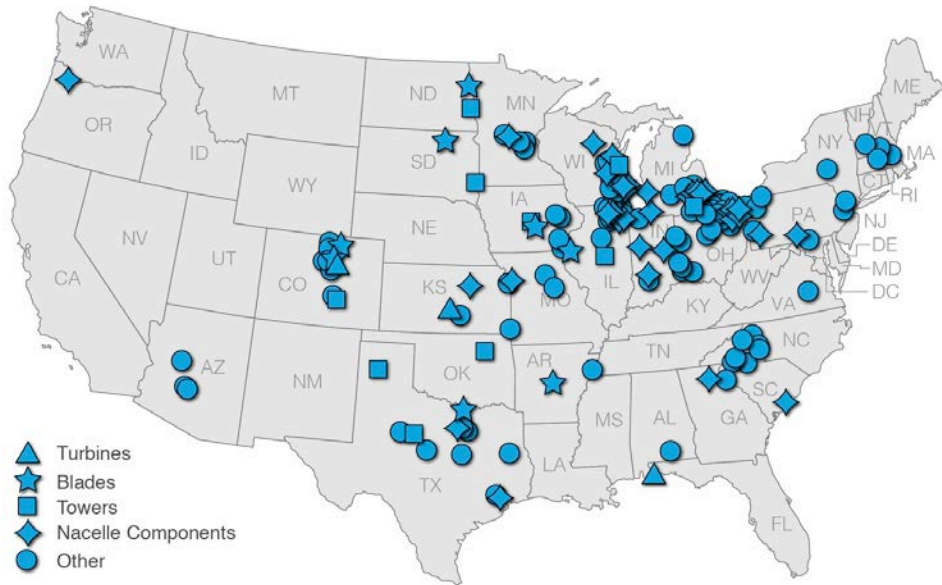
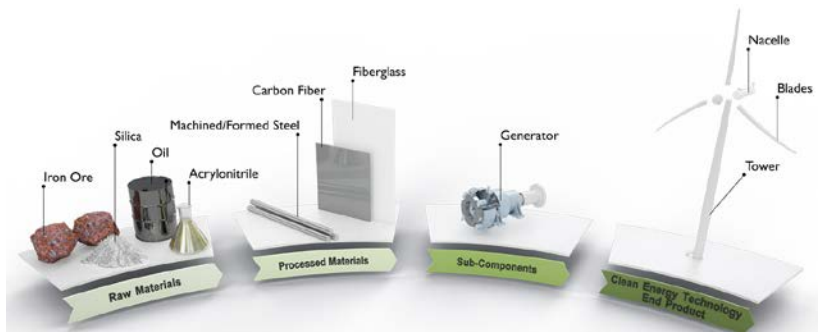
Susan M. Schexnayder  
The University of Tennessee, Knoxville



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# Wind Power: A Manufacturing Case Study



## Wind power developed from public & private support

- **Research.** Technology validated and improved through research labs and industry partnerships
- **Policy.** Early government policies encouraged domestic market deployment
- **Manufacturing.** Domestic market enabled establishment of supply chains and manufacturing at scale
- **More Manufacturing.** Resulting price declines encouraged manufacturing innovations and enabled expansion
- **Trade.** Trade agreements enabled exports
- **Innovation.** New innovations still being developed, such as onsite manufacturing



**More than 145 major wind turbine manufacturing and assembly facilities operate in the U.S.**

Sources: Benchmarks of Global Clean Energy Manufacturing, CEMAC, 2017; Wind Turbines Made in the USA, CEMAC Blog, 2017.

# THE STATE OF CLEAN ENERGY MANUFACTURING AND TRADE

## SPEAKERS

**Steve Kukoda**, Executive Director, International Copper Association

**Paul Kaleta**, Executive Vice President & General Counsel, First Solar

**William McElnea**, Director for Environment and Natural Resources,  
Office of the United States Trade Representative

**Swami Venkataraman**, Senior Vice President, Global Project &  
Infrastructure Finance, Moody's Investors Service

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Thank you!

# Questions and Discussion

