SMART Wind Consortium
Mechanical subgroup Event

Developing a Consensus-Based

Sustainable Manufacturing, Advanced Research & Technology

Roadmap for Distributed Wind

November 13, 2014

DWEA
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NIST
National Institute of Standards and Technology
U.S. Department of Commerce

- Overview of project vision, goals and objectives and likely evaluation for future funding
- Participant expectations, benefits
  - Decision points through out
- Plans for Subgroup Meetings
- AWEA Roadmap 2002
- SMART Wind Roadmap Table of Contents

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Con·sor·tium: *an agreement, combination, or group (as of companies) formed to undertake an enterprise beyond the resources of any one member*

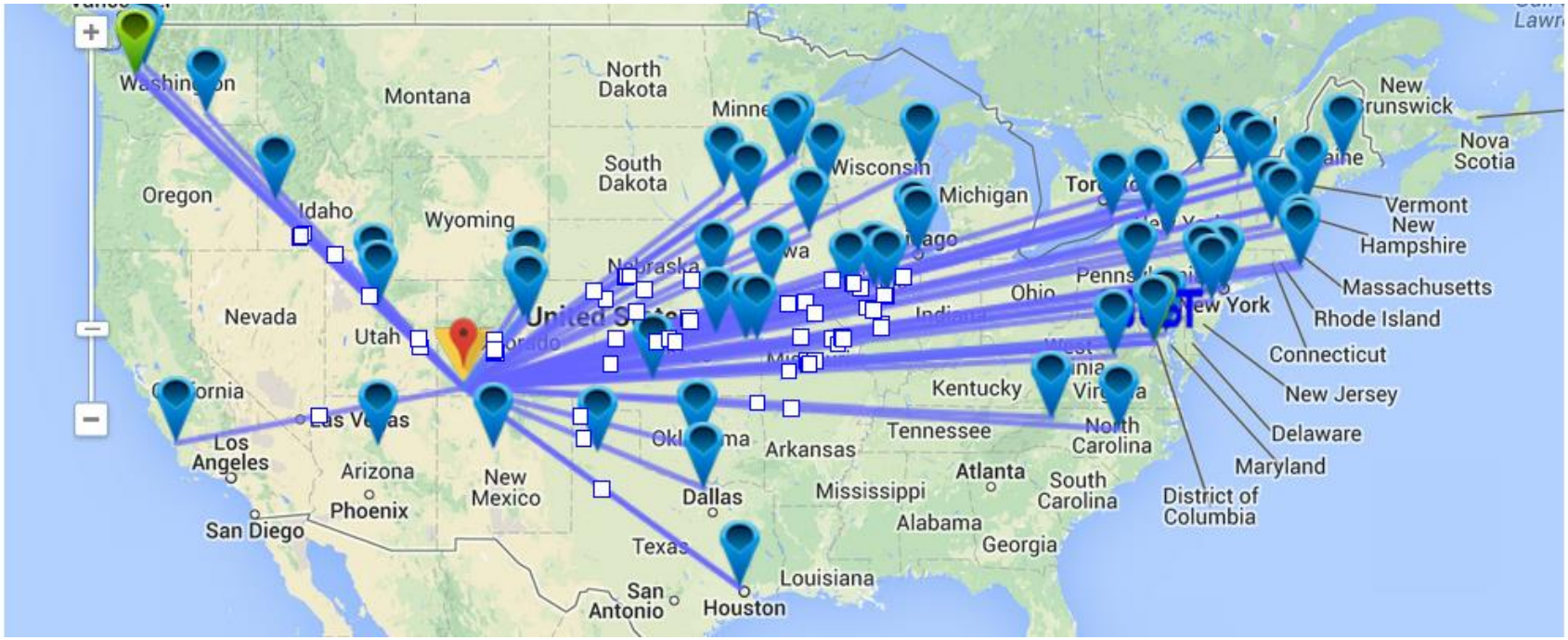

Image courtesy NIST

SMART Wind Consortium is connecting more than 80 collaborators to form consensus on near-term and mid-term plans needed to increase cost competitiveness through the use of advanced manufacturing techniques

www.distributedwind.org/smart-wind-sign-up/

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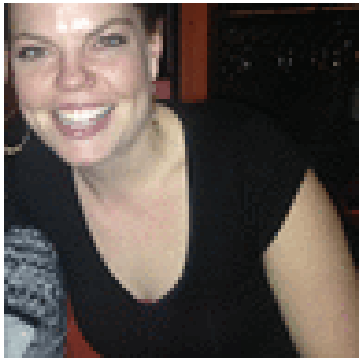
Core Team

DWEA Executive Director
Jennifer Jenkins

Project Manager
Heather Rhoads-Weaver
eFormative Options

Technical Lead
Trudy Forsyth
Wind Advisors Team



DWEA Business Manager
Christine Larsen

Technical Co-Lead
Brent Summerville
Summerville Wind & Sun

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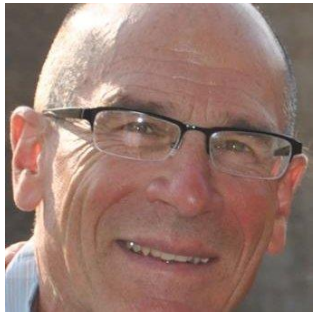
Support Team

Communications
Ruth Baranowski
Wind Advisors Team

jitasa
NUMBERS FOR GOOD

Bookkeeping & Accounting

Financial Operations
Mary Childress, CPA



Stakeholder Research
Kurt Sahl
eFormative Options

Market Analysis
Matthew Gagne
eFormative Options

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Why Distributed Wind: Benefits to America

- Promotes more energy choices for Americans
- Plays to American technology and manufacturing strengths
- Creates long-term sustainable jobs
- Strengthens exports
- Increases private sector investment in clean energy
- Places more wind energy in the public eye

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Distributed Wind's Diverse Market Potential

Residential

Schools

Commercial

Military

Farms

Public

Foreign Assistance

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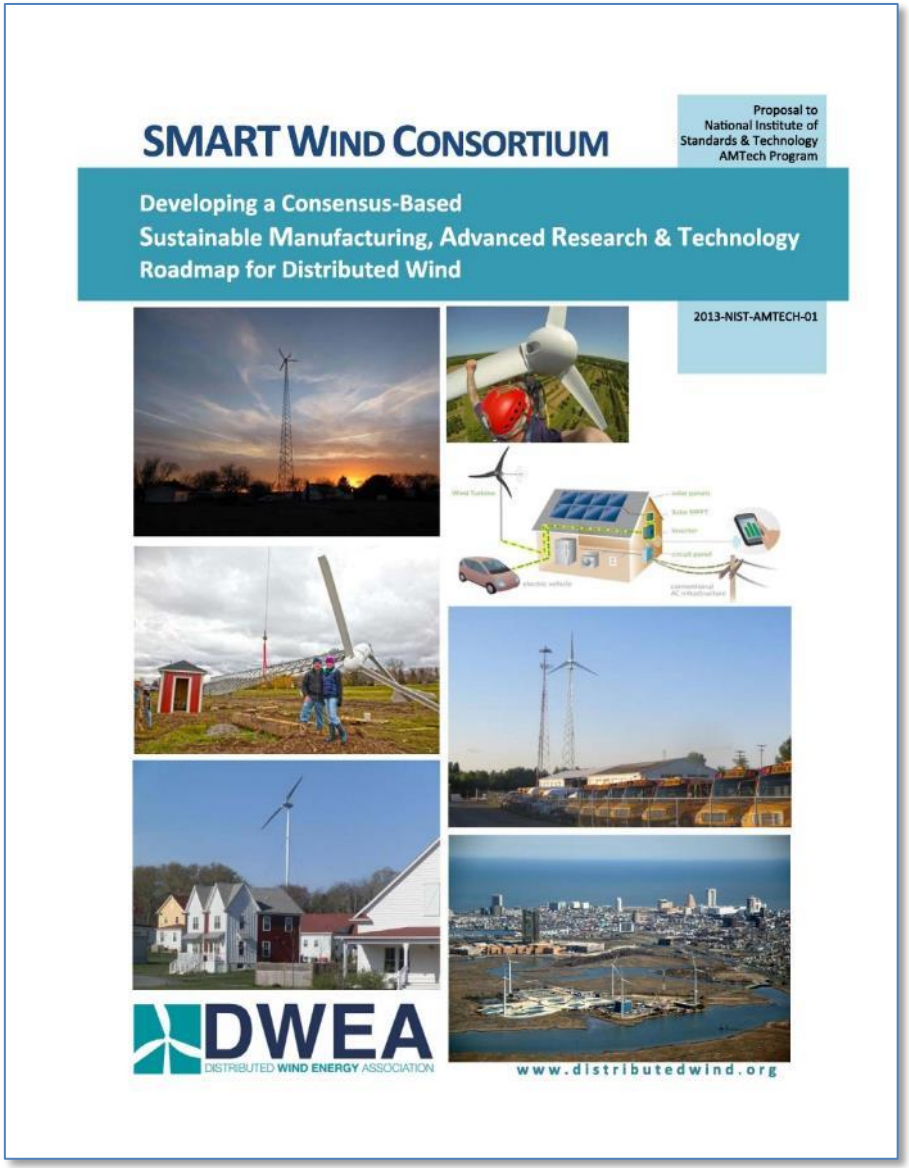
2-year grant awarded to DWEA, supported by eFormative Options and Wind Advisors Team to:

1) Form a **consortium** of DW manufacturers, suppliers, university researchers, manufacturing centers; and

2) Develop a **roadmap** to identify manufacturing gaps, prioritize actions, and foster solutions

Overall program aim:
Support OEMs by identifying areas to reduce technology and manufacturing costs.



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Industry Participation (partial)

DWEA speaks for all the Major Players

Northern POWER SYSTEMS

Endurance wind power

BERGEY WINDPOWER

JUHL WIND INC.

UL

RENEWABLE PNE ENERGY

Harvest THE WORLD NETWORK

FOUNDATION WINDPOWER

SED SUSTAINABLE ENERGY DEVELOPMENTS™

EWT

IOWA WIND TURBINES, LLC

SEMINOLE FINANCIAL SERVICES
RENEWABLE ENERGY FINANCE

Intertek

Wind Turbines of Vermont
Power is a breeze.

Pika

UNITEDWIND

CleanEnergy States Alliance

access america transport

COHN REZNICK
ACCOUNTING • TAX • ADVISORY

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Academic-Research University Participation in Consortium (partial)

Alternative Energy Institute

ADVANTAGE KENTUCKY ALLIANCE

Colorado State University
Wind Application Center
Department of Mechanical Engineering

PENNSTATE
1855

Appalachian State University

kwac
kansas wind applications center

BOISE STATE UNIVERSITY

CAL POLY WIND POWER

Virginia Center for Wind Energy

MAINE

WESTERN ILLINOIS UNIVERSITY

KANSAS STATE UNIVERSITY | Department of Civil Engineering

VMEC
VERMONT MANUFACTURING EXTENSION CENTER

UMASS University of Massachusetts Lowell

WindSTAR
Wind-Energy Science, Technology, and Research
Industry/University Cooperative Research Center

- **Overall Project Vision**

  Aid DW growth and adoption of innovative manufacturing techniques, increase production volumes and reduce costs throughout technology lifecycle, maintain high product quality and value

- **Project Goals**
  - U.S. distributed wind market is on track to grow from 2012 installed capacity of nearly 800 MW to >10 GW over next decade
  - DWEA is convening targeted SMART Wind Consortium to develop consensus-based ***Distributed Wind Technology Roadmap*** to:
    - Identify common distributed wind manufacturing gaps and barriers
    - Prioritize solutions/actions to gaps for today and for future scalability
    - Facilitate rapid transfer of innovation into American-manufactured wind turbines
  - Maintain U.S. global competitiveness and leadership

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Initial SMART Wind strategies

- Identify common distributed wind manufacturing gaps and barriers
- Prioritize solutions/actions to those gaps for today and for future scalability
- Facilitate a rapid transfer of innovation into American-manufactured wind turbines, open new market opportunities, expand distributed wind applications
- Reduce lifecycle costs, maintain high product quality and value
- Secure U.S. global competitiveness and leadership

photo courtesy Endurance Wind Power

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Consortium Meetings

- Bring together critical U.S. distributed wind turbine and component manufacturers to maintain edge in a growing global market
- Leverage industry-academic dialogue to develop strategies to aid distributed wind industry growth and advance innovative manufacturing techniques
- Share ideas and forge ahead as global leaders in the growing market of distributed wind

photo courtesy Northern Power Systems

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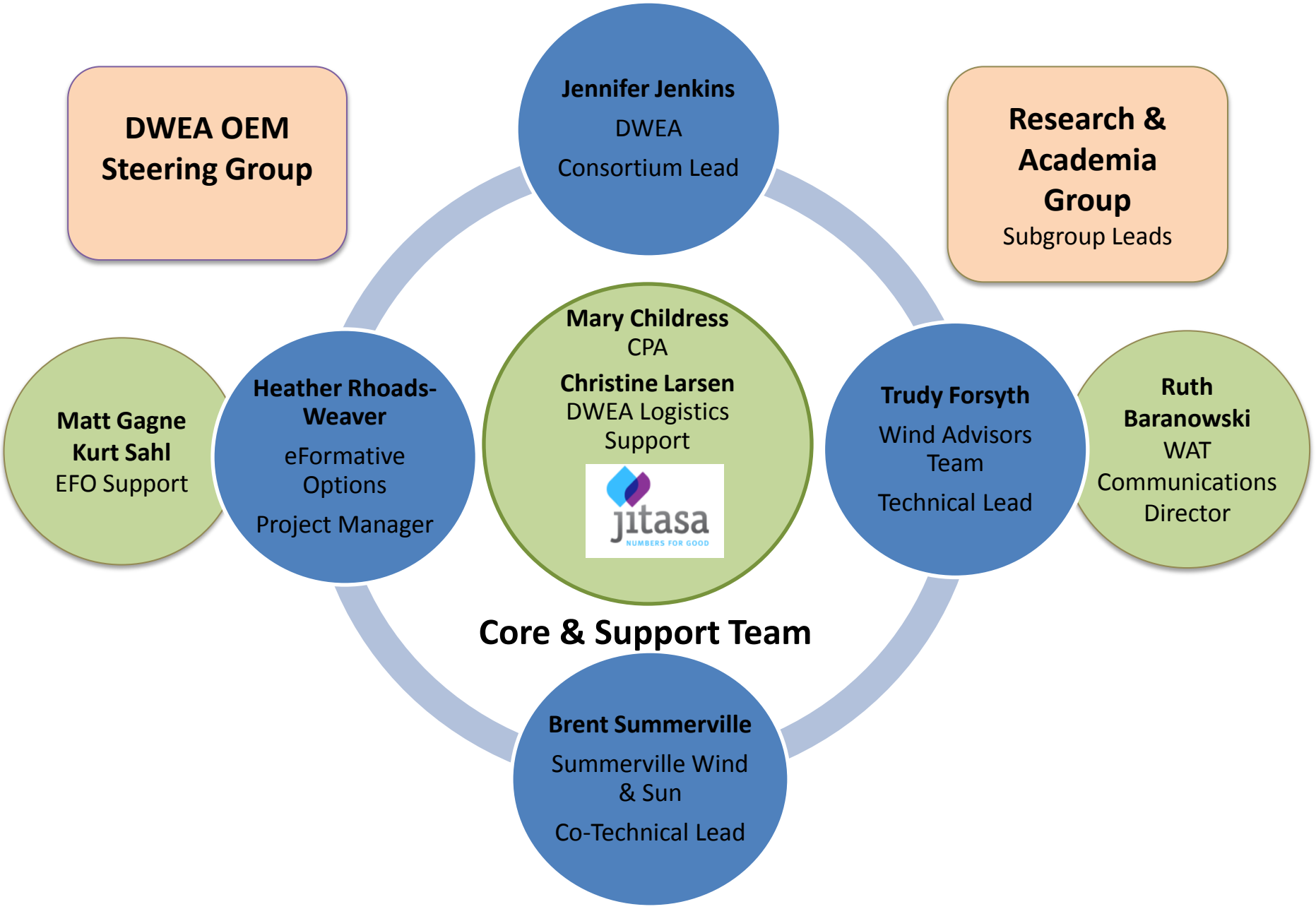
SMART Wind Consortium In-Person Meetings

	Meeting	Location	Date
	Project Meet & Greet, Initial Steering Meeting	Stevens Point, WI	June 17 and 19, 2014 In conjunction with Small Wind Conference
1	Consortium Launch	Albany, NY	October 15-16, 2014 In conjunction with DWEA All-States Summit
2	Mechanical Systems Subgroup	Denver, CO	November 12-14, 2014
3	Support Structures Subgroup	Denver, CO	January 13-14, 2015
4	Composites Subgroup	Denver, CO	February 16-18, 2015
5	Electrical Systems Subgroup	Washington, DC	March 25-27, 2015 In conjunction with DW15 Hill Event
6	Roadmap Prioritization	Washington, DC	February or March 2016
	Finalize, Produce & Distribute Roadmap		Project Completion: May 31, 2016

Register at www.distributedwind.org/smart-wind-consortium

Consortium Organization



DWEA OEM Steering Group (new and existing OEMs with slightly different needs)

- Expectations
  - Oversight advice and specific recommendations
  - Provide direct feedback on areas or partners to explore within SMART Wind project
    - Provide individual feedback directly to Technical team leads
    - Technical team may set up surveys to evaluate group priorities
  - Team together to develop overall Roadmap that helps technical development and manufacturing efforts
  - Participate in quarterly calls (early December, early March, ahead of face-to-face meetings)
  - Attend Steering Group meetings for direct feedback (November 13 dinner)
- Outcomes
  - Roadmap that represents opportunities for Steering Group companies
  - Keep any IP developed under project

- DWEA OEM Steering Group Requirements
  - Must be DWEA Industry-level members, meet domestic content & foreign participation criteria
  - One vote per company
  - Provide advice on SMART Wind project
  - Provide technical and manufacturing gaps (current and scale-up) & baseline and benchmark data


photo courtesy Endurance Wind Power

- **Project Objectives**
  - Address major technological and related barriers that inhibit growth of advanced DW manufacturing by building an industry-based Consortium with a wide variety of stakeholders to reach consensus on advanced manufacturing opportunities
  - Connect more than 80 existing and new collaborators to form consensus on near-term (low and high cost) and mid-term plans needed to increase cost competitiveness through the use of advanced manufacturing techniques as documented in the SMART Wind Roadmap

(continued)

- **Project Objectives (continued)**
  - Accelerate university-based research to develop innovative technology solutions and facilitate deployment to support advanced U.S. manufacturing, increasing number of American jobs throughout DW supply chain
  - Reduce levelized cost of energy (LCOE) of installed DW projects to achieve parity with U.S. retail electricity grid rates in more markets
  - Integrate NIST work with other federal and state government opportunities, namely to unite strategies and complement DW efforts of U.S. Department of Energy (DOE)

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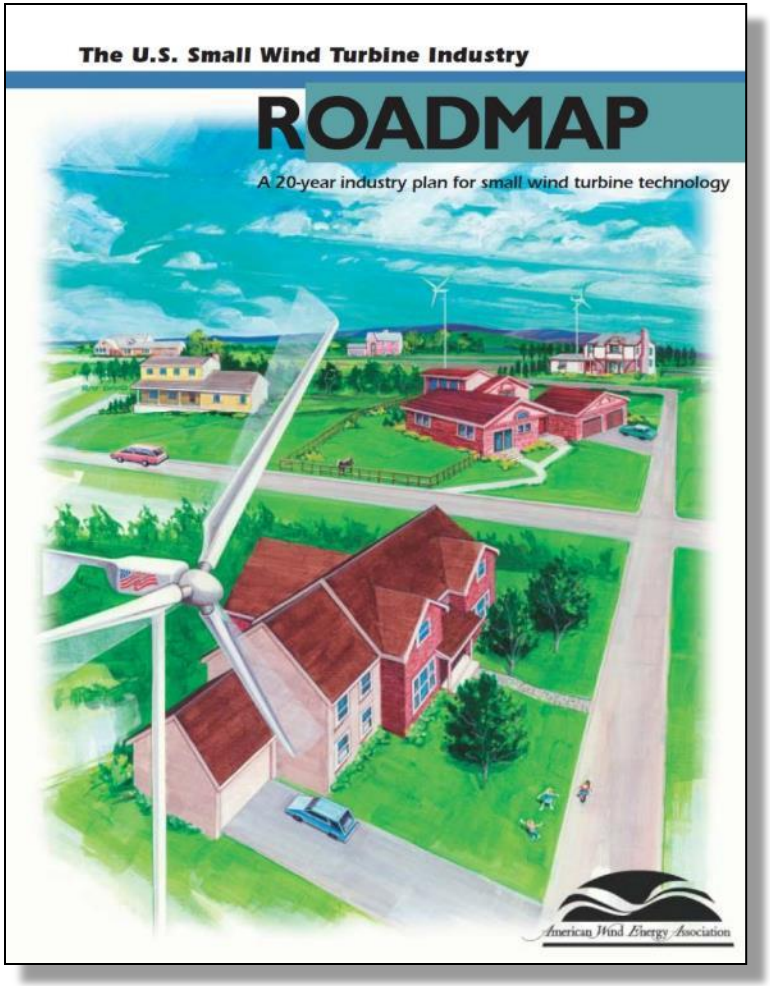

Last Small Wind Industry Roadmap was produced in 2002

SMART Wind project will identify and prioritize cost-effective solutions so U.S. distributed wind industry can claim its share of projected **potential global $2 trillion market**

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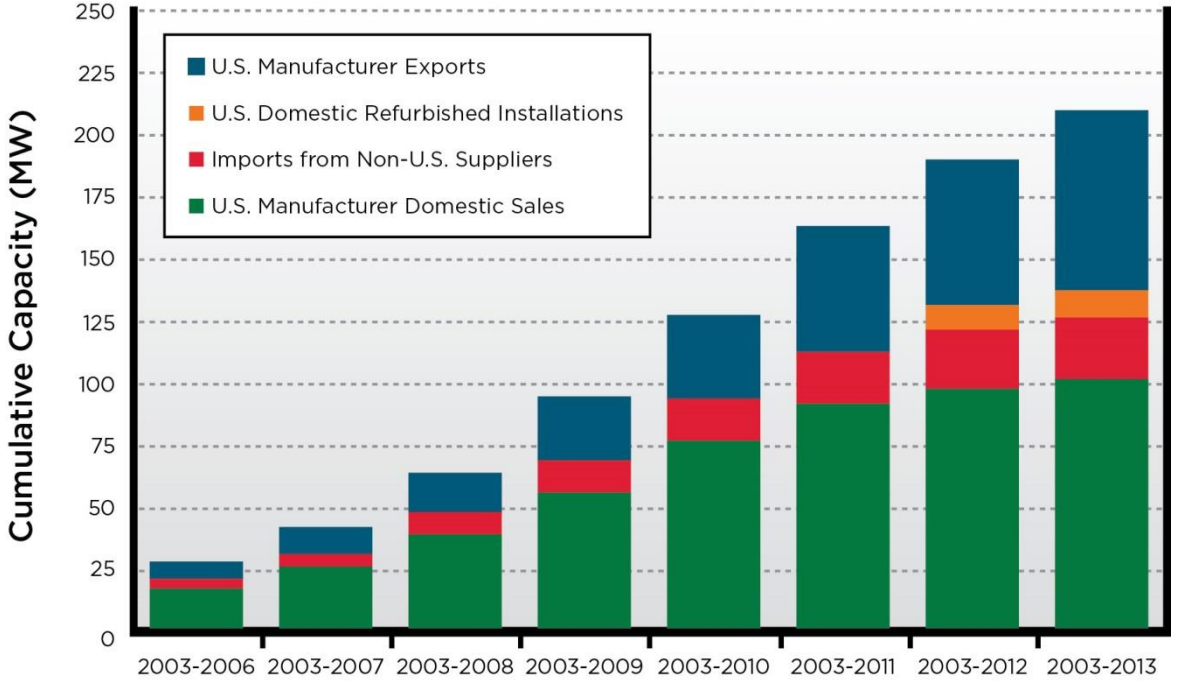
U.S. Small Wind Domestic, Imports, and Export Sales



Estimated Total Available Market

(2030 Theoretical Potential)

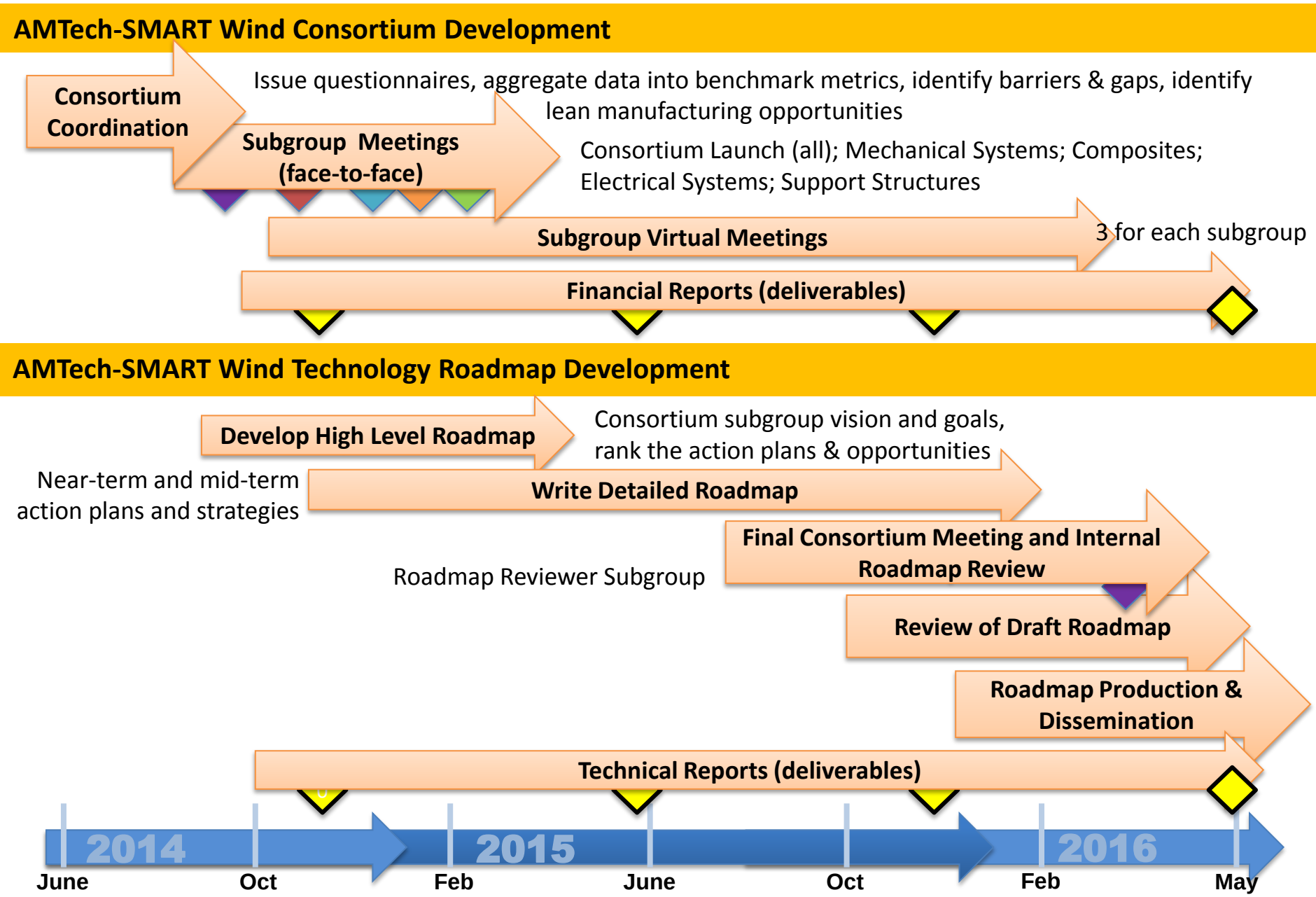
Market Segment	2013 Size, Units	Data Source	2030 Size, Units	Percent Suitable	2030 Potential Installed Units	Average Size (kW)	Potential (MW)
Businesses	8,900,000	Census, 2008	14,300,000	15%	2,145,000	350	750,750
Rural Residential	30,600,000	HUD, 2009	49,100,000	50%	24,550,000	10	245,500
Farm	2,200,000	USDA, 2007	2,200,000	60%	1,320,000	150	198,000
Public Buildings	1,200,000	DWEA Estimate	1,350,000	25%	337,500	250	84,375
Schools	140,000	NCES, 2010	165,000	40%	66,000	250	16,500

Total Potential (MW): 1,295,125

Proposed Roadmap Table of Contents

- Foreword – sets the vision
- Introduction to the SMART Wind project (DOC/AMTech and DWEA) and members
- Current Distributed Wind Turbine industry – baselines and benchmarks
- Current Distributed Wind Turbine Market – global and national
- Near-term Technology Barriers (relevant to DOE?)
- Manufacturing Barriers and Gaps (relevant to DOC)
  - Organized by Subgroup: Parts, processes, materials, quality, etc
- Action Plan
  - Organized by Subgroup
  - Evaluated near-term (0-3 years), mid-term (3-6 years), low & high cost
  - Prioritized at Roadmap Prioritization Meeting, March 2016
- Strategies for implementation
  - Rural development, maximum American jobs, maximum market growth, potential baseline and benchmark changes

Roadmapping SMART Wind Schedule



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Questions, discussion

http://distributedwind.org/smart-wind-faqs/

photo courtesy Endurance Wind Power

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To sign up for Subgroups or more information:

www.distributedwind.org/smart-wind-sign-up/

jjenkins@distributedwind.org

Back-up / Trudy & Brent

- Recommendations on future project evaluation*
  - Attainment of goals, quality of scientific results, published roadmaps
  - Demonstration of how research proposed to address gaps
  - Effectiveness of management in assuring goals are met
  - A vision that includes a “grand challenge”
  - Successful inclusion of small and mid-sized firms
  - Robust diffusion of technology and commercialization
  - Amount of resources leveraged with other government (including state)agencies, universities, others

** Based on NIST Visiting Committee on Advanced Technology, Recommended Design Principles for AMTech, February 7, 2012 (in response to PCAST Report, June 2011, which concluded “The PCAST researched the current state of manufacturing and concluded that U.S. leadership in manufacturing is declining, and this is detrimental to the well-being of the National overall.”*

Data provided in the proposal

	10 kW Wind Turbine, 31-Meter Guyed Tower	10 kW Wind Turbine, 31-Meter Lattice Tower
Tower	$ 14,145	$ 16,795
Foundation(s)	$ 3,280	$ 13,300
Setup/crane	$ 4,000	$ 6,000
Turbine (incl. dealer markup)	$ 31,770	$ 31,770
Wiring kit, wire run	$ 4,325	$ 4,325
Shipping & delivery	$ 1,800	$ 2,000
Electrical contractor	$ 6,375	$ 6,375
Permit & misc.	$ 2,500	$ 2,500
Total cost	$ 68,195	$ 83,065

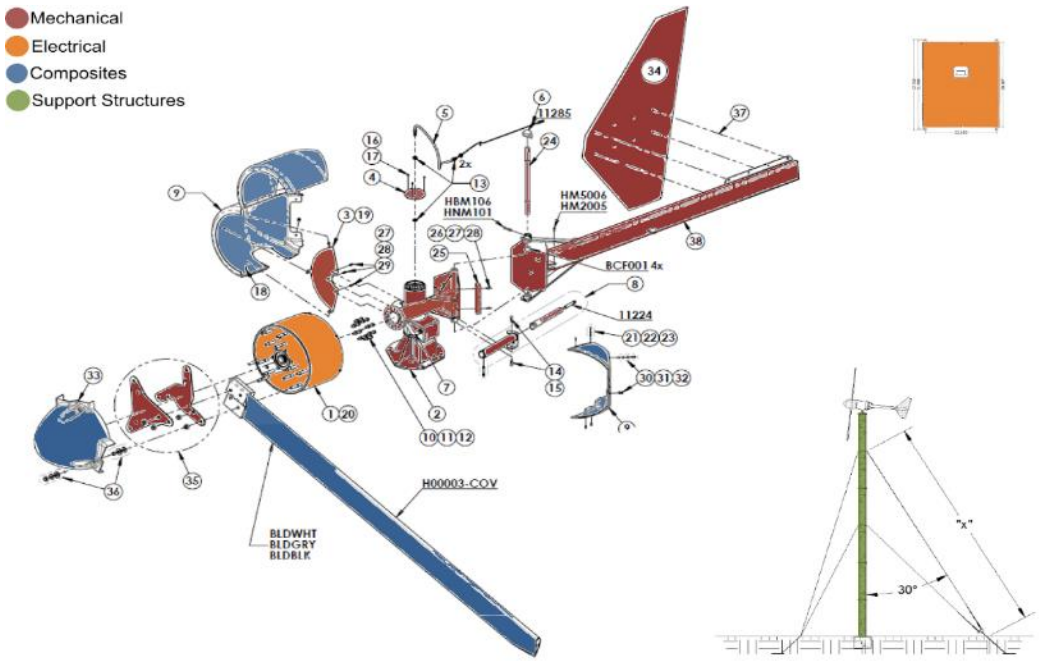
Consortium Subgroup	Component	Share of System Cost
Composites	Rotor	10%
Electrical	Alternator	22%
Electrical	Inverter	22%
Mechanical	Mainframe	12%
Mechanical	Tail	4%
Support Structure	Tower & Foundation	30%

- Requested DWEA SGA Information – for any component up for change
  - Baseline – Composite/Subsystem – available publically
    - exploded diagram with photo(s)
    - percentage of costs by piece parts or lower-tier supplies and location of manufacturing
    - Identification of hard to produce (manufacture or inspect for quality) or procure piece parts or assemblies
    - volume
  - Aggregated Benchmarks – System – not available publically

(These metrics will always be aggregated and never referenced with individual products.)

- Percentage of installed system cost per subsystem/component
- Percentage of raw material for the system
- LCOE, cost of goods sold
- BOM
- Jobs

Subgroup Boundaries



- **Mechanical subsystems - support structure subgroup & mechanical subsystems boundary is the tower top**
  - **Rotor, Hub, mainshaft, mainframe: Rotor connection to generator, generator support**
  - **Overspeed control/yaw mechanism (i.e pitching, furling, yawing)**
  - **Tower top/bed plate, tower adapter**
- **Electrical subsystems**
  - **Generator**
  - **Power Electronics**
  - **Balance of system electrical components (all the way up to the electrical service; transformer, bus bars, slip rings, etc.)**
- **Composite subsystems - Anything using fibre-reinforced or carbon resins including: blades, nose cones, nacelles, etc.**
- **Support structure subgroup includes: tower, bolts, foundation, rebar, guy wires, guy clamps, ground anchors, lifting device for tilt-down tower, etc.**

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Steering Group Advisors

- Brian Kuhn, Aeronautica
- Mike Bergey, Bergey Windpower
- Chris McKay, NPS
- Ben Polito, Pika
- David Laino, Endurance
- John McCoury, Xzeres
- Ken Kotalik, Primus
- Pat Quinlan, Black Island
- Keith Monson, Dakota Turbines
- David Blittersdorf, AllEarth

- OEM Subgroup Leadership
  - Mechanical (35)
    - Mike Bergey, Dave Laino, John McCoury, Chris McKay?, Ben Polito
    - Non-OEM Subgroup leaders – Gary Harcourt, Patrick Lemieux, Robert Preus
  - Support Structure (34)
    - Mike Bergey, John McCoury,
    - Non-OEM Subgroup leaders – Rick Damiani?, Roger Dixon, Asad Esmaeily?
  - Composites (35)
    - Mike Bergey, John McCoury, Pat Quinlan
    - Non-OEM Subgroup leaders – Pier Marzocca, Case vanDam?, Paul Williamson?
  - Electrical (36)
    - Mike Bergey, John McCoury, Chris McKay?, Keith Monson, Ken Portolese
    - Non-OEM Subgroup leaders – Ruth Douglas-Miller, Jerry Hudgins?, Rob Wills
  - Roadmap (Jennifer to select)
    - Mike Bergey, Dave Laino, John McCoury, Keith Monson,
    - Non-OEM Subgroup leaders –

- Technical team (Trudy, Brent and Ruth)
  - Facilitate dialogue (face-to-face and virtual meetings, other)
  - Search for new resources and experts to help DWT
  - Aggregate benchmark data and compile baseline data
  - Link to NIST MEP?
  - Provide technical input to government reporting
  - Produce the high-level, detailed and final Roadmaps

- Current challenges
  - Difficulty in engaging MEP/MEC
  - Opportunity to work with Great Lakes Wind Network – over 800 US component manufacturers interested in wind energy
- What is the best process to identify your near-term technology and manufacturing gaps?
  - Technology, skill sets, tooling, facilities, vendor relationships, quality assurance, etc.
- Exclusion of non-US manufacturers
- Include ISO 9000 work in this scope?