IACMI Overview / Project Focus

1. IACMI history
2. IACMI structure
3. Technical project levels
4. IACMI goals and objectives
5. Wind industry challenges
6. Potential IACMI project topics
Prior to the President’s Announcement

- Concept paper submitted: April 21
- FOA released: Feb. 25
- Full application submitted: June 23
- Response to reviewers’ comments submitted: July 24
- Response to additional clarifying questions submitted: Sept. 16
- Pre-selection interview: Sept. 18

2014-2015
January 9, 2015: President Obama Announces New Composite Institute

“...and today, we’re proud to announce our latest manufacturing hub, and it is right here in Tennessee. Led by the University of Tennessee–Knoxville, the hub will be home to 122 public and private partners who are teaming up to develop materials that are lighter and stronger than steel.”
After the President’s Announcement

- President’s announcement: Jan. 9, 2015
- Negotiation of the Cooperative Agreement: Jan.–June
- DOE issues award to IACMI: June 15
- IACMI startup: July – Aug.
- IACMI request for proposals issued: ~Sept./Oct.
- Next budget period requirements due: Nov. 1, 2016
IACMI Kick-off Meeting / Agreement Signing

Wednesday, June 17th, 2015
Shared RD&D facilities will support industry

- Vehicles
  - Michigan

- Wind Turbines
  - Colorado

- Composite Materials & Process Technology
  - Tennessee

- Compressed Gas Storage
  - Ohio

- Innovative Design, Predictive Modeling & Simulation
  - Indiana
Core partners are capable and strategically located

- >70% of automotive production occurs in IACMI states
- >70% of US auto R&D in Michigan alone
- Colorado has more blade facilities (factories plus technical centers) than any other state
- >60% of compressed gas fueled vehicle manufacturers with in half-day drive from IACMI Focus Areas
Core partners are capable and strategically located

Colorado has more blade facilities (factories plus technical centers) than any other state.

The State of Colorado has

- 22 wind industry manufacturing plants
- 29 operating wind farms
- 3 wind research and workforce development institutions

Source: Winds of Change, E2 Environmental Entrepreneurs
Wind Technology Area

• 30 year history of collaboration with every major wind turbine OEM and US blade manufacturer

• Extensive university-based composite material and manufacturing research at Colorado School of Mines, Colorado State University, and University of Colorado-Boulder

• Largest US university-based turbine blade manufacturing prototyping facility at Iowa State University

• Wind composite manufacturing scale-up facility

Automation (Viper)
• Fast resin infusion and curing

Models for
• Preforming
  • Infusion
• Cure kinetics
• Performance

Automation
• Fast resin infusion and curing

Low-cost carbon fiber
• Pultrusion
  • Nondestructive Evaluation
• Blade recyclability
### Vehicles
Global #1, 3, 5, 7; mainstream OEM’s with >30% global and >45% US production share

- **Toyota**
- **Volkswagen of America**
- **Ford**
- **Honda**

### Wind
Top 3 US OEM’s with >70% share of installed US wind generation capacity, US #1 blade manufacturer

- **GE**
- **Vestas**
- **Siemens Wind Power**
- **3M**
- **Honeywell**

### CGS
US #1 composite tank fabricator; 2 innovative new entrants; truck and auto OEM’s

- **Hexagon Lincoln**
- **Xperion**
- **OSHKOSH**
- **TPI**
- **Delivering Composite Solutions**
Members

Charter:
11 members

Premium:
18 members

Colorado  Indiana  Michigan  Ohio  Tennessee

Dow  Ford  Volkswagen  Dassault Systèmes  Lockheed Martin  Dow Aksa

Dow  Ford  Volkswagen  Dassault Systèmes  Lockheed Martin  Dow Aksa

American Chemistry Council  BASF  Continental Structural Plastics

Cytec  DuPont  fives  Evonik Industries  General Electric

Heil Trailer  Honda  Huntsman  Local Motors  Boeing  PolyOne  PPG  Sabic  Xperion
## Project Types

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Project Total Budget</th>
<th>Cost Share Requirement</th>
<th>Duration</th>
<th>Other Requirements</th>
<th>Intent</th>
</tr>
</thead>
</table>
| Enterprise           | $600K                | Minimum 1:1 with 50% being cash | Up to 5 years | • A small number of value-chain members can jointly submit  
• Must involve team collaboration and potential large economic and commercial impact | Bigger projects with multiple partners that significantly contributes to achieving IACMI goals. |
| Technical Collaborations | $20K-$600K         | Minimum 1:1 (large entities: 50% being cash) | Up to 2 years | Awarded in 2 phases:  
• Phase 1 is <6 months and $150K total costs  
• Optional Phase 2 is <18 months and $450K total costs | Smaller investigatory efforts that can be started up quickly. |
| Topic Specific       | $20K                | Minimum 1:1            | Up to 1 year | Only accept white papers that address specific IACMI-issued topics                  | Address topics of interest to our Members                              |
Initial IACMI Projects Launched in BP1

- **Vehicles**
  - Focus on overcoming the barriers to high speed, low cost fabrication of carbon fiber composites
  - Will develop automotive-specific carbon fiber, fast curing resins, and target high volume vehicle platforms
  - Industrial partners: Ford, Dow Chemical, DowAksa, Harper

- **Wind Turbines**
  - Exploration of reactive infusion thermoplastic resins for improved cycle time, durability, recyclability
  - Overcome concerns with fiber-matrix adhesion, high temperature processing and characterization
  - Industrial partners: Johns Manville, TPI Composites

- **Compressed Gas Storage**
  - Innovative method to rapidly fabricate impact resistant, medium and large CNG Type-IV pressure vessels using braided fabric
  - Reduce cycle time, improve damage tolerance and meet pressure requirements
  - Industrial partners: xperion E&E USA, A&P Technologies
IACMI Goals As Stated in the Funding Opportunity Announcement

Focus Areas
- Vehicles
- Wind turbine blades
- Compressed gas storage

Five Year Technical Goals
- 25% lower carbon fiber-reinforced polymer cost
- 50% reduction in CFRP embodied energy
- 80% composite recyclability into useful products

Impact Goals
- Enhanced energy productivity
- Reduced life cycle energy consumption
- Increased domestic production capacity
- Job growth and economic development

Path to commercialization
1. Industry led projects
2. Bridge from early development to prototype
3. Shared risk
4. Path to commercialization
Partnering Opportunities Between DWEA SMART Wind Consortium and IACMI

Sustainable Manufacturing, Advanced Research and Technology

Institute for Advanced Composites Manufacturing Innovation

Composites
- Blades
- Nacelle housing
- Nosecone
- Tower

Electrical Systems
- Inverter
- Controller
- Alternator
- Power electronics
- Generator
- Magnets
- Bus bars
- Slip rings
- Interconnection
- System monitoring

Distributed wind energy turbine systems, subsystems, components and piece parts divided into four subgroups

Mechanical Systems
- Shafts
- Bearings
- Braking system
- Gearbox
- Pitching system
- Furling system
- Yaw system

Support Structures
- Tower
- Access ladder
- Foundation
- Anchoring System
- Permitting

Institute for Advanced Composites Manufacturing Innovation
Drivers for Composites in the Wind Industry

- Wind blade molding cycle time
- Labor content
- Material costs
- Light-weighting of wind turbine components
- Recyclability
- Quality/reliability of structural components

Courtesy of TPI Composites
Shared Goals for Turbine Composite Structures

- Improve the manufacturing quality of structural composite components
- Decrease the cost of composite raw materials
- Increase the recyclability of composite wind turbine components at the end of life
- Decrease the embodied energy of the manufacturing process for blades, towers, nacelles, and nose cones
- Reduce the production cycle time of turbine composite components
- Enhance the lifetime reliability of composite parts
Wind Blade Challenges and Opportunities

- Reduction in hands-on labor
  - Automated fabric laying
  - Automated tape laying

- Transportation logistics
  - Segmented blades

- Recyclability
  - Thermoplastics

- Field reliability of blades
  - In-process nondestructive evaluation
  - Structural testing

- Blade structural properties
  - Pultruded spar caps

- Time to market
  - Additive manufacturing—molds
Potential Project Areas for Wind Technology Composite Components

- Thermoset/thermoplastic matrix development
- Automated fabric placement during laminate layup
- Automated nondestructive evaluation during the composite production process
- Pultruded blade and tower sections
- Pultruded structural spar caps
- Segmented blades
- Additive manufacturing of composite tooling and components
- Possible overlap with the automotive technology area of IACMI in the area of compression molding, resin transfer molding, and injection molding
Federal investment will catalyze a composites ecosystem in the heart of US manufacturing

- $70M - DOE
- $189M - Other
- 122 - Member Consortium
- 6 States
- Strong Leadership
- 5 Focus Areas

- CFRP Production Cost - 50%
- CFRP Embodied Energy Savings - 75%
- GHG Avoidance - 75%
- FRP Recycled and/or Reused - 95%
- Jobs
- Production Capacity

5 Years
10 Years

- 75%
- 50%
- 50%
- 50%
- 25%
- 80%
- 95%
- 80%
Questions

• Contact Derek Berry: derek.berry@nrel.gov

• Visit IACMI.org to sign up for updates