President Obama announces new manufacturing institute at NC State
Developing advanced manufacturing processes to enable cost-competitive, large-scale production of wide bandgap semiconductor-based power electronics, which allow electronic systems to be smaller, faster and more efficient than power electronics made from silicon.
Each institute has unique Technology Focus
# Technology Readiness Levels and Manufacturing Readiness Levels

<table>
<thead>
<tr>
<th>TRL 1:</th>
<th>Basic principles observed and reported</th>
<th>MRL 1:</th>
<th>Manufacturing feasibility assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRL 2:</td>
<td>Technology concept and/or application formulated</td>
<td>MRL 2:</td>
<td>Manufacturing concepts defined</td>
</tr>
<tr>
<td>TRL 3:</td>
<td>Analytical and experimental critical function and/or characteristic proof of concept</td>
<td>MRL 3:</td>
<td>Manufacturing concepts developed</td>
</tr>
<tr>
<td>TRL 4:</td>
<td>Component and/or breadboard validation in a laboratory environment</td>
<td>MRL 4:</td>
<td>Capability to produce the technology in a laboratory environment</td>
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<tr>
<td>TRL 5:</td>
<td>Component or breadboard validation in a relevant environment</td>
<td>MRL 5:</td>
<td>Capability to produce prototype components in a production relevant environment</td>
</tr>
<tr>
<td>TRL 6:</td>
<td>System/subsystem model or prototype demonstration in a relevant environment</td>
<td>MRL 6:</td>
<td>Capability to produce prototype system or subsystem in a production relevant environment</td>
</tr>
<tr>
<td>TRL 7:</td>
<td>System prototype demonstration in an operational environment</td>
<td>MRL 7:</td>
<td>Capability to produce systems, subsystems or components in a production relevant environment</td>
</tr>
<tr>
<td>TRL 8:</td>
<td>Actual system completed and qualified through test and demonstrated</td>
<td>MRL 8:</td>
<td>Pilot line capability demonstrated; Ready to begin Low Rate Initial Production</td>
</tr>
<tr>
<td>TRL 9:</td>
<td>Actual system proven through successful mission operations</td>
<td>MRL 9:</td>
<td>Low rate production demonstrated; Capability in place to begin Full Rate Production</td>
</tr>
</tbody>
</table>

*Source: NNMI prelim design report.*
Wide Bandgap Materials

Operate above 300 °C compared to 150 °C for Silicon-based devices

Handle 10 times higher voltages

Produce bulbs with 10 times more light that last 30 times longer ...

Reduce losses during DC-to-AC electricity conversion

saving $250B by 2030
Applications
Wide Bandgap inverters convert DC to AC electricity while reducing losses by 50%
Wide Bandgap materials cut electricity losses during charging by 66%
Wide Bandgap Materials enable higher-efficiency, variable-speed drives. Motor systems use 69% of electricity consumed in U.S. manufacturing.
WBG Market – Power Electronics

Discrete power electronics market projected to ~ $15 B
Wide Band Gap Semiconductor portion ~ 22 % ..... ~ $3B

Today: 20% Power Electronics between point of Generation and Use
2030: 80 % of systems will have power electronics
Optimizing the Power Electronics Industry

Epitaxy Wafers
- Wafer Bowing
- Epi Thickness
- Defects
- Material Quality
- Wafer Optimization

Device Design Fabrication
- Device Optimization

Packaging
- Device Area, Voltage, Currents, Reliability
- Package Optimization

End User Req’ts
- Voice of the Customer
- Market Size
- Business Case

Market
- Seed the Market:
  - Technology Demonstrations
  - Proofs of Reliability
POWER AMERICA

Thriving Power Electronics Industry Ecosystem

- Commercial Product Acceleration
- Production & Packaging Foundries
- Comprehensive Education and Workforce Development Program
- Research, Development & Demonstration

PRODUCTS
TALENT
MARKET DEMAND
MANUFACTURING PROCESS
Low Voltage Devices (600V to 1700V) 3 years

Medium Voltage Devices (3300V to 6500V) 5 years

High Voltage Devices (> 10kV) 10 years

Limited Supply

Achieve last 50% cost reduction via Power Electronics Innovation

TARGET:
WBG Costs
Reach Parity with Silicon

PowerAmerica
POWERAMERICA
Developing Talented Workforce
Help solve our energy challenges.

NC STATE UNIVERSITY

POWERAMERICA

Next Generation Power Electronics Manufacturing Innovation Institute

Develop systems that are...

SMALLER
FASTER
MORE EFFICIENT
LESS EXPENSIVE
Centers & Institutes draw about 180 partners, including some of the top names in industry.
Questions?