High Tech Inverter Research & Development: A Five-Year Strategy

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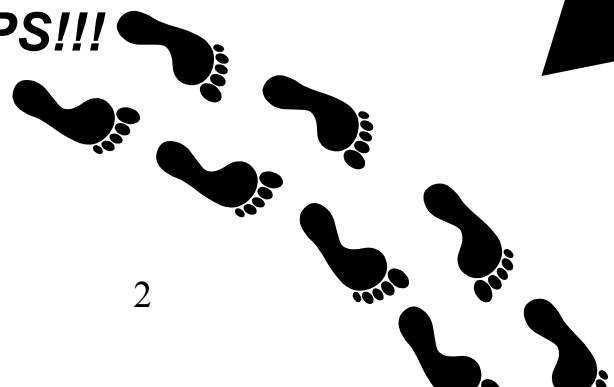
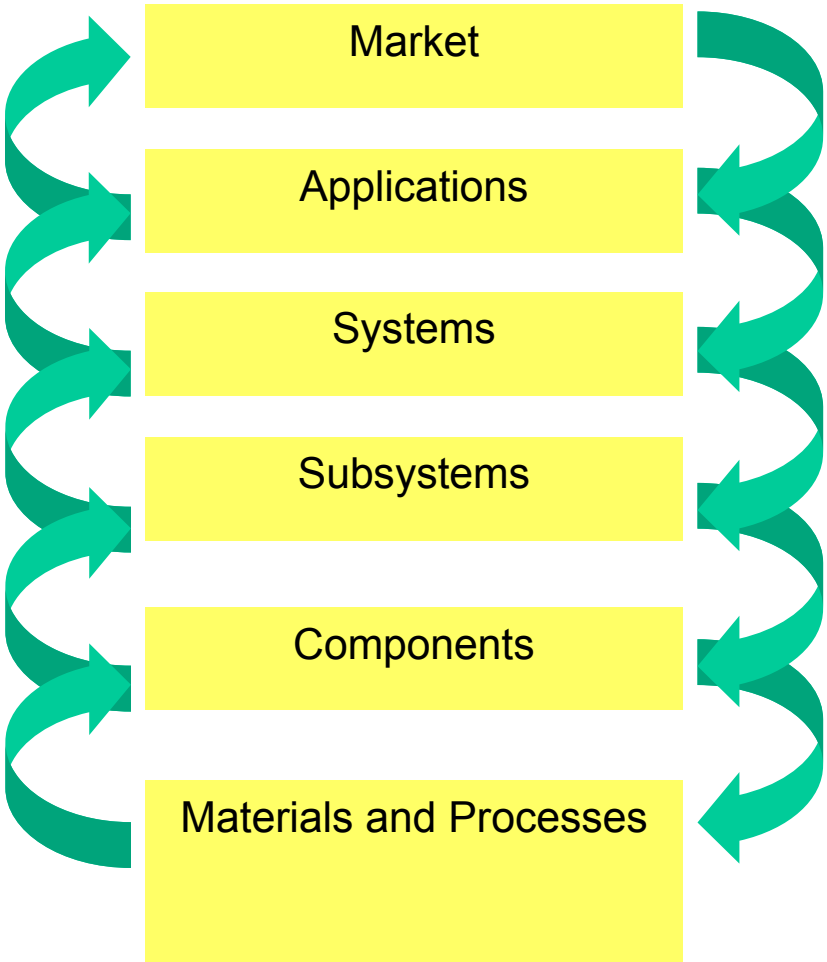
Introduction

- *The Systems-driven Approach (SDA)*
- *Benefits of a Strategy for Galvanizing Research and Development of Inverters*
- *Current Status and Key Elements of the Strategy*
- *What is Needed from this Meeting???*
- *Anticipated IMPACTS of the RESULTS/FOLLOW On*
- *NEXT STEPS!!!*



Inverters and The Systems Driven Approach to R&D



What are the highest-value applications for inverters?

What are the performance and cost characteristics of an inverter for the largest markets?

What are key factors in an inverter development? Components? Mounting? Subsystems? Thermal management? Packaging?

How does a component like inverter software impact costs for interconnection? The reliability?

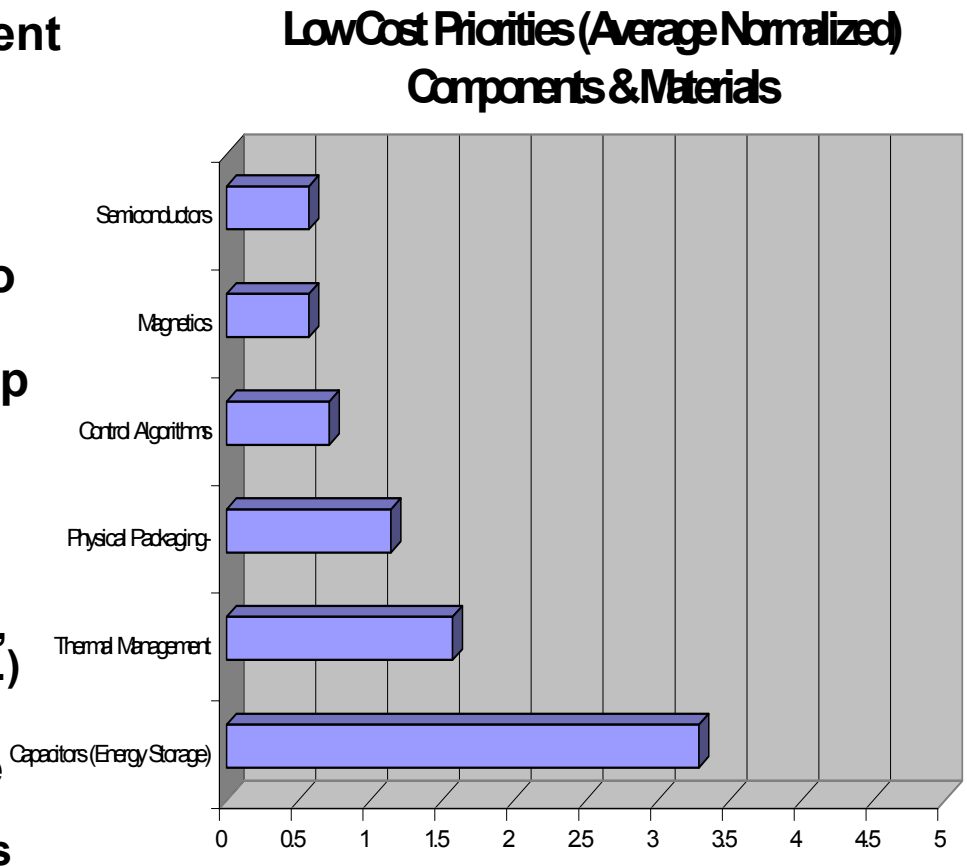
How do monolithic components affect the reliability & cost of inverters? Disposable inverters??

Advantages Of A Strategy For Galvanizing R&D

- **Provides a Platform for Collaborative Work that Affects Multiple Technologies**
- **Focuses and Leverages (VERY) Scarce Funding Resources**
- **Provides a Set of Targets and Goals for the Benefit of the US Industry**
- **Introduces Communication Among the Technologies and Inverter Manufacturers**
- **Satisfies the New "Cross-technology" Collaborative Research Guidelines of DOE**

Current Status of the Strategy

- A 5-year "Strategy" document based in part on the 1st inverter workshop is being developed for DOE
- Strategy WILL use the systems-driven approach to determine priorities
- The results of this workshop will help prioritize R&D
- The evolving strategy encompasses:
  - Device needs (technology advances, cost reductions, reliability, synergisms, etc.)
  - Modeling needs
  - The "Strategy" will Include industry, academia, end users and funding partners
- The "Strategy" will be included the revised "Solar MYTP"



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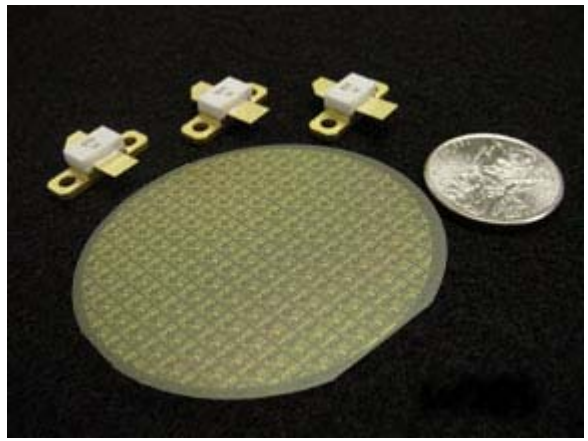
Device Needs for the High Tech Inverter R&D Strategy

- **New and Advanced Semiconductor Devices**
  - SiC diodes and wide bandgap switching devices
  - Smart drivers and switching
  - Higher temperature printed wiring boards
- **Advanced, Long-life Capacitors**
  - New and higher temperature metal-film capacitors
  - High-temperature multilayer ceramic capacitors
  - Integrated thick-film capacitors
  - Self-healing capacitors
  - Longer lived electrolytic capacitors



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Device Needs for the High Tech Inverter R&D Strategy

- **Surge Suppression**
  - Advanced surge suppression devices for both ac and dc circuits
  - Advanced circuit layouts to mitigate surge potentials
  - Maintenance free devices, diagnostics, transient management, peak current requirements
- **Magnetic Materials Applications**
  - Lower cost, higher performing magnetic materials for inductors and transformers
  - Nano-crystal materials

Technology Needs for the High Tech Inverter R&D Strategy

- **Hybridization of Sensors, Controls, Drivers**
  - **Hybrid integrated circuits to reduce the use of solder joints**
  - **Isolated sensors for improved reliability**
  - **Hybridized protection sensors**
  - **Thin- and thick-film hybridization utilizing advanced metal bonds in place of solder**
  - **Integrated controls on power modules**

Technology Needs for the High-Tech Inverter R&D Strategy

- **Innovative Thermal Management**
  - Combine high-temperature electronics with thermal management, high-temp components to eliminate fans and possibly heat sinks
  - Advanced coatings and hardware such as insulated metal substrates
- **Advanced Control Methodologies**
  - Feed-forward controls to reduce energy storage requirements
  - Innovative control algorithms for cross-technology synergistic applications
- **Automated Manufacturing and Hardware Synergism**
  - Combine packaging and layout to minimize labor intensive tasks
  - Standardize selected packaging to allow more standard inverter packages to be used in multiple applications
  - Graduate to full system designs

Logistics Needs for the High-Tech Inverter R&D Strategy

- **Communications Standardization**
  - Standardize I/O protocol for interrogating, analyzing and controlling the inverters
  - Standardize high-reliability I/O hardware and ports
  - Develop dependable wireless communications
- **Value-added Communications for Improving Utility Acceptance**
  - Focus on "VALUE ADDED" for the utilities
  - Standardize and collaborate on communications interconnection devices and methodologies

Logistics Needs for the High-Tech Inverter R&D Strategy

- **Device and System Self-protection**
  - **Hardware and software advances to protect the inverter and its sensitive components**
  - **Advanced control algorithms to protect the system**
- **Customer Friendly Placement, Aesthetics, Mounting**
- **Improved Inverter AND System Modeling to Facilitate Performance Predictions and Advanced Adaptive Controls**

Packaging Needs for the High-Tech Inverter R&D Strategy

- **Low-cost and Innovative Cabinetry**
- **Standardized I/O Power Termination Methodologies**
- **Innovative Internal Interconnects**
- **Emphasis on Higher Reliability, Lower Costs and Improved Performance**

Review of the Ongoing High-Reliability Inverter Initiative

- **Goals and Objectives**
  - **Achieve High Reliability to Improve Public Perceptions**
  - **Require Corporate Buy-in Through Significant Cost Sharing & Commitment**
  - **Focus on Identifying and Formulating Solutions for Today's Issues and Problems**
  - **Design for a High Volume Production Expectation**

Schedule of the High-Reliability Inverter Initiative (Review)

Multi-Year Product Development Effort

- **Phase I (3-month effort)**
  - 3 awards
- **Phase II (12-month effort)**
  - 3 awards
- **Phase III (9-month effort)**
  - 2 awards (funding dependent)

This effort is continuing with each contractor (GE, SatCon and Xantrex) in the last quarter of Phase II.

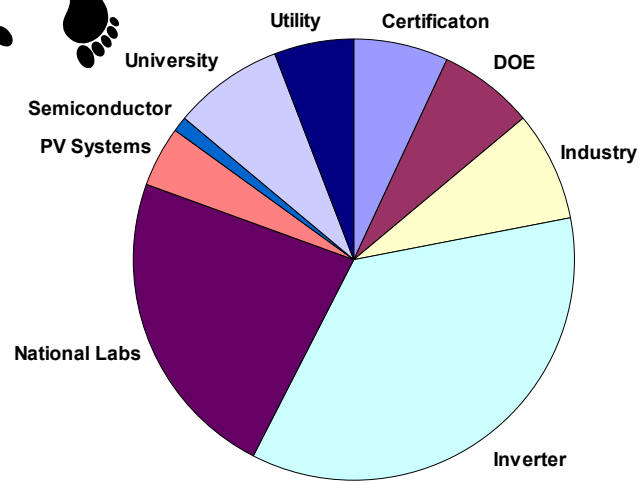
Phase III will likely be scaled down to two contractors after evaluation of final Phase II reports and prototype performance.

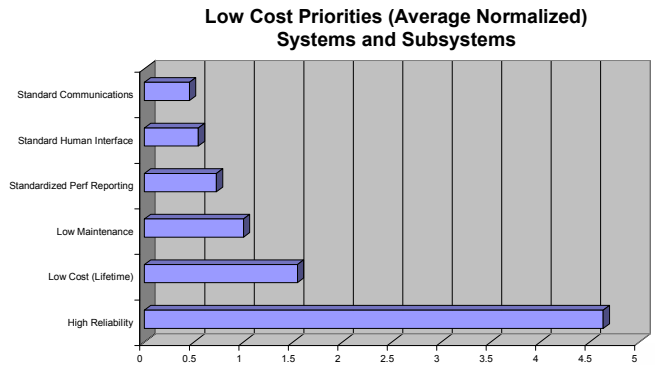
Summary

- **5-year "High-tech Inverter R&D Strategy" Will Use the Systems-Driven Approach to Help Determine Priorities**
- **The Results of This Workshop Will Help Prioritize**
  - **Program directions**
  - **Device needs (technology, costs, reliability, synergisms, etc.)**
  - **Modeling strategies and needs**
  - **Systems integration and applications**
- **Strategies Will Involve Industry, Academia, End Users and Funding Partners**
- **The 5-year High-tech Inverter Strategy Will be Submitted to The Revised DOE Solar Multi-year Technical Plan**

Next Steps

- Ask Participants to Review and Comment on the Final Report for This Workshop
- Use the Results of The Previous/This Workshop to Complete a 5-Yr High-tech Inverter R&D Strategy
- Submit the 5-year Strategy to the DOE MYTP
- Continue With Workshops to Refine the Strategy





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A Successful Workshop and Inverter R&D Strategy Can Avoid This!!