NCREPT
National Center for Reliable Electric Power Transmission

Research in Advanced Power Electronics: Status and Vision

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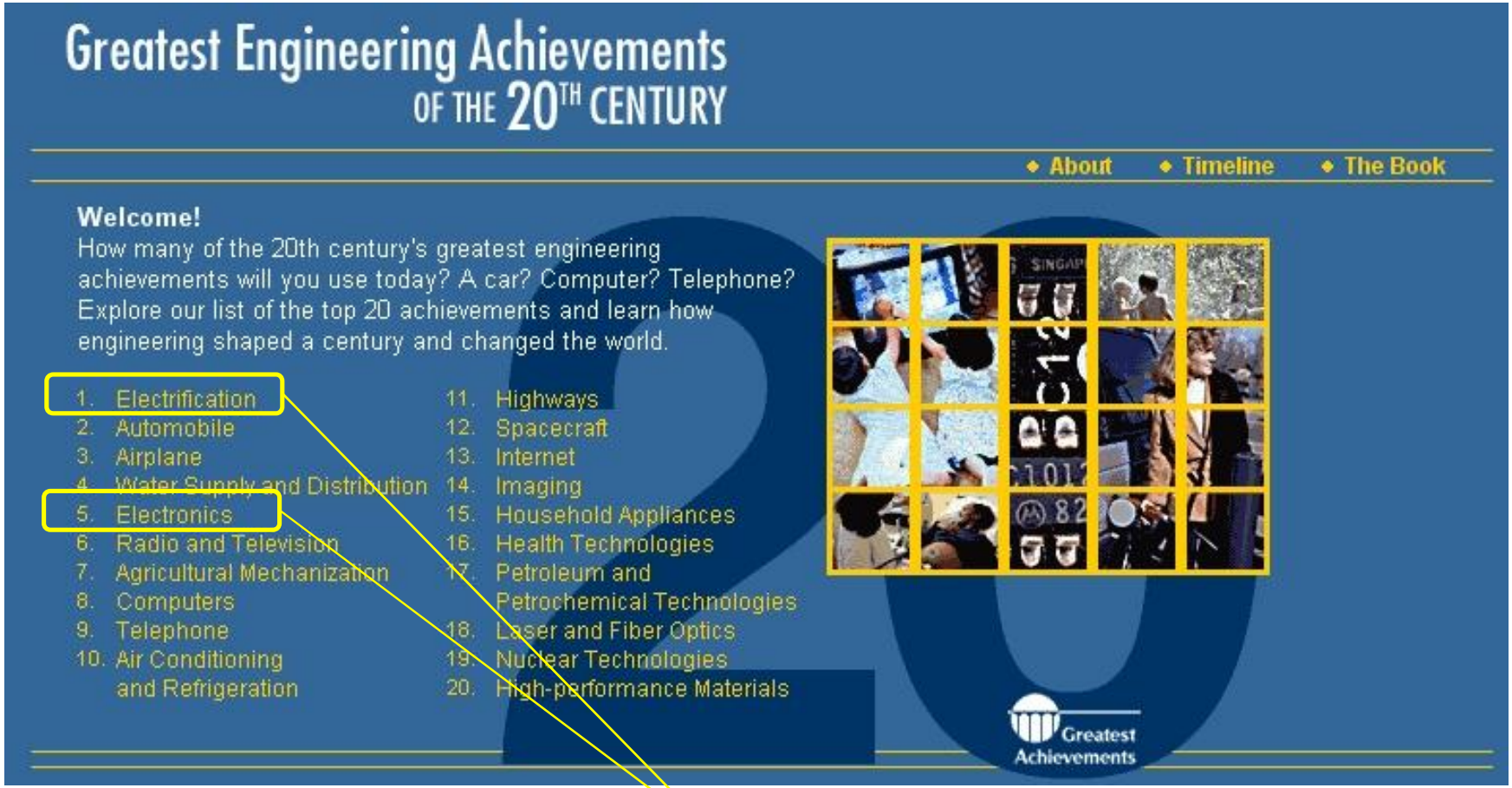
Building the Arkansas Innovation Economy

Defining Power Electronics



Electrification + Electronics = Power Electronics

NCREPT's Mission and Research

Mission:

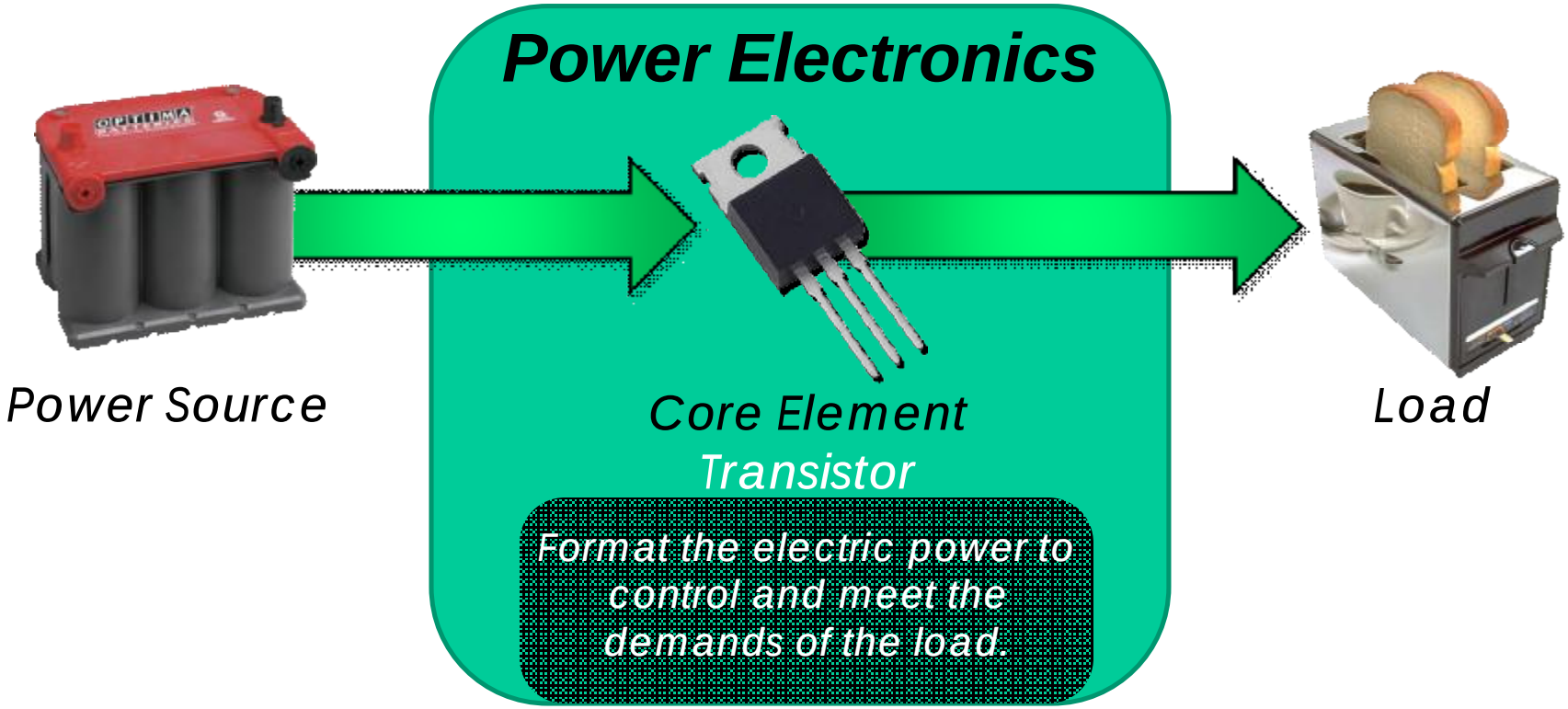
To impact the lives of Americans through industrially-relevant research and education in future energy systems involving *advanced power electronics*

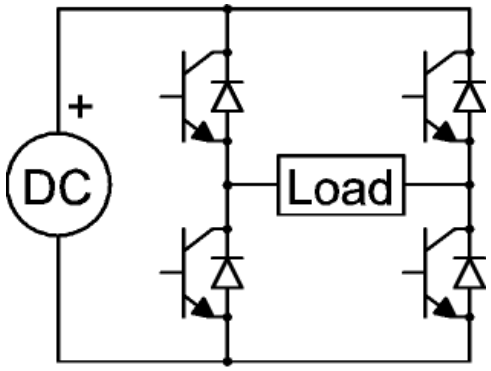
Research Focus:

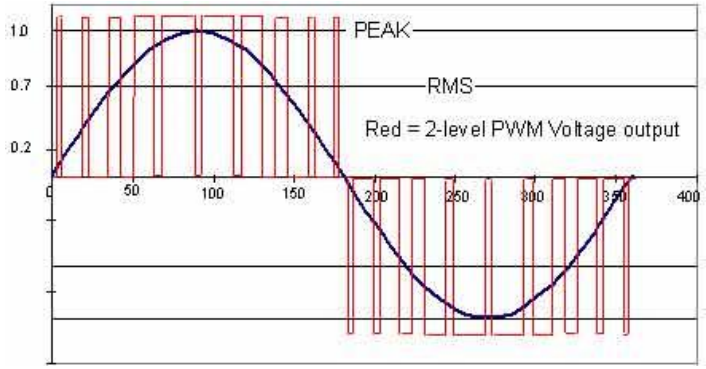
Design and test of advanced, solid-state solutions applicable to:

- **Control technologies for the nation's power grid with a focus on grid reliability**
- **Power interface applications that allow diversification of power sources to the grid**
- **Transportation (automotive, aerospace, traction) and other extreme-temperature power electronics applications "under the hood"**
- **Energy exploration and geo-thermal applications (down-hole electronics)**

What IS Power Electronics?







State of the U.S. Energy Industry

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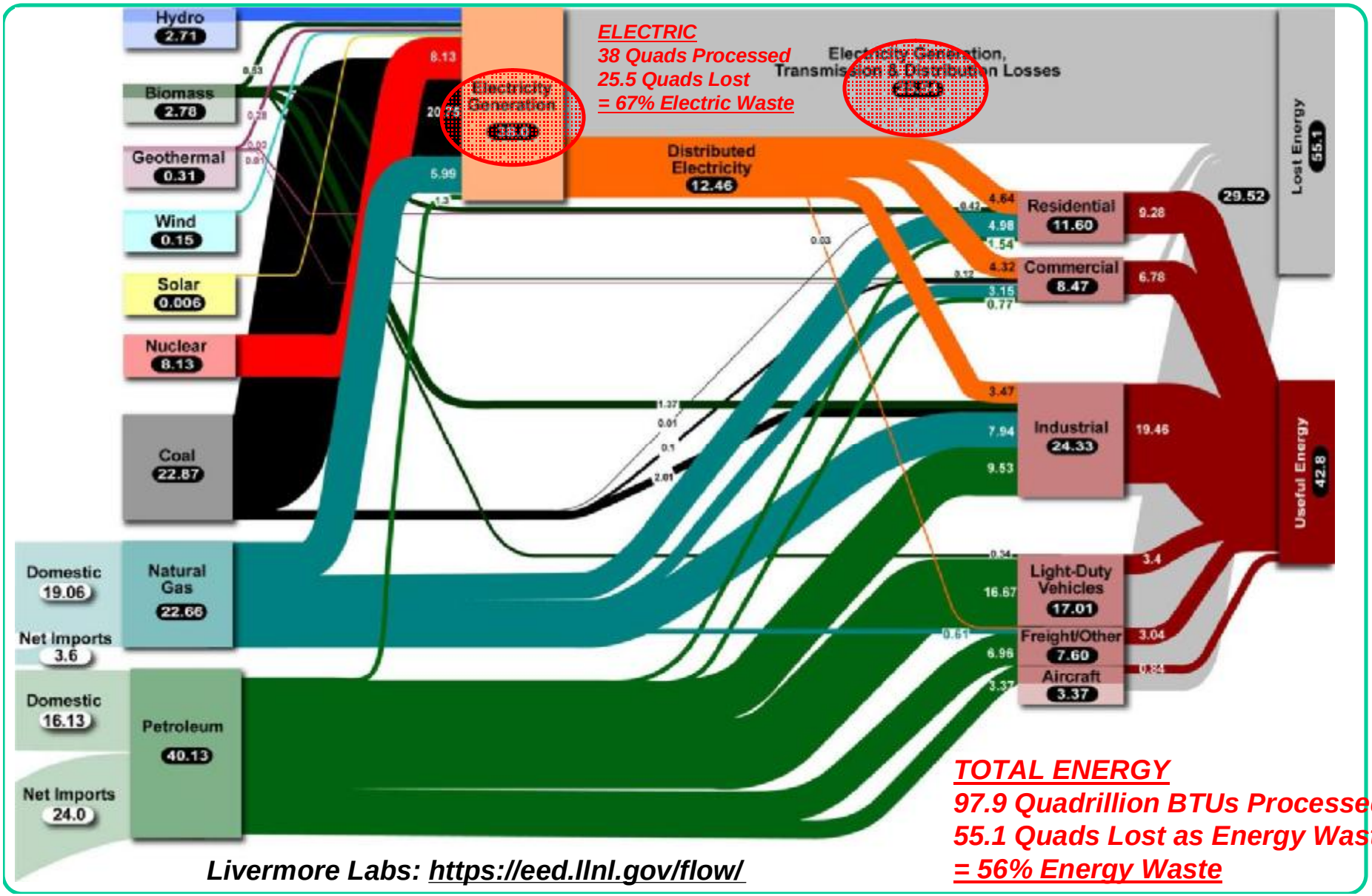

Livermore Labs: https://eed.llnl.gov/flow/

State of the U.S. Energy Industry

- Greater than 30% of all electricity generated is processed by power electronics…and growing to over 80% by 2030
- This 30% equates to $300 billion in energy that is processed by power electronics annually
- Average power electronics system is 70-90% efficient (i.e. up to $60 billion in wasted energy annually).

Power Electronic Applications

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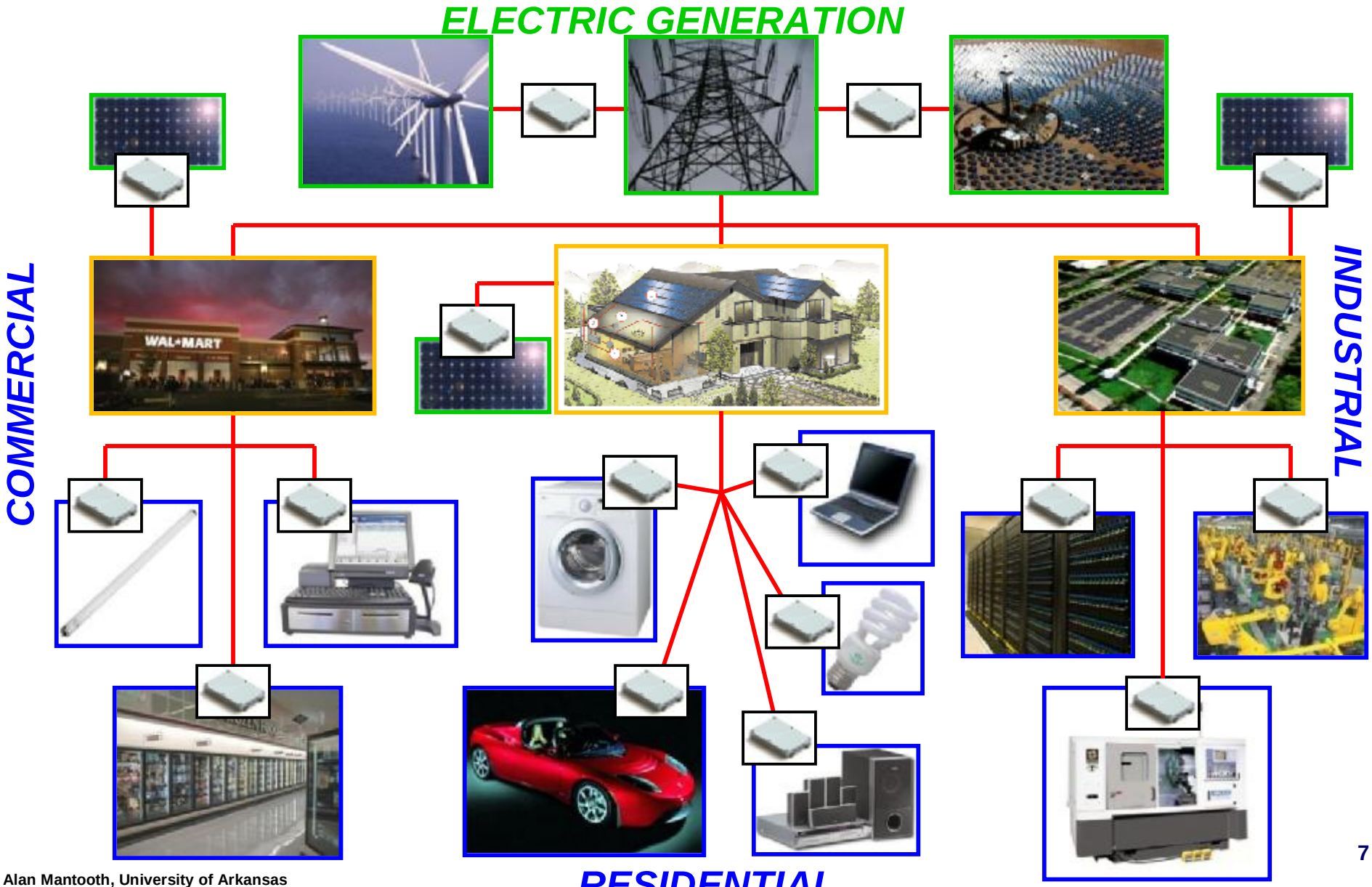

Research Activity at NCREPT

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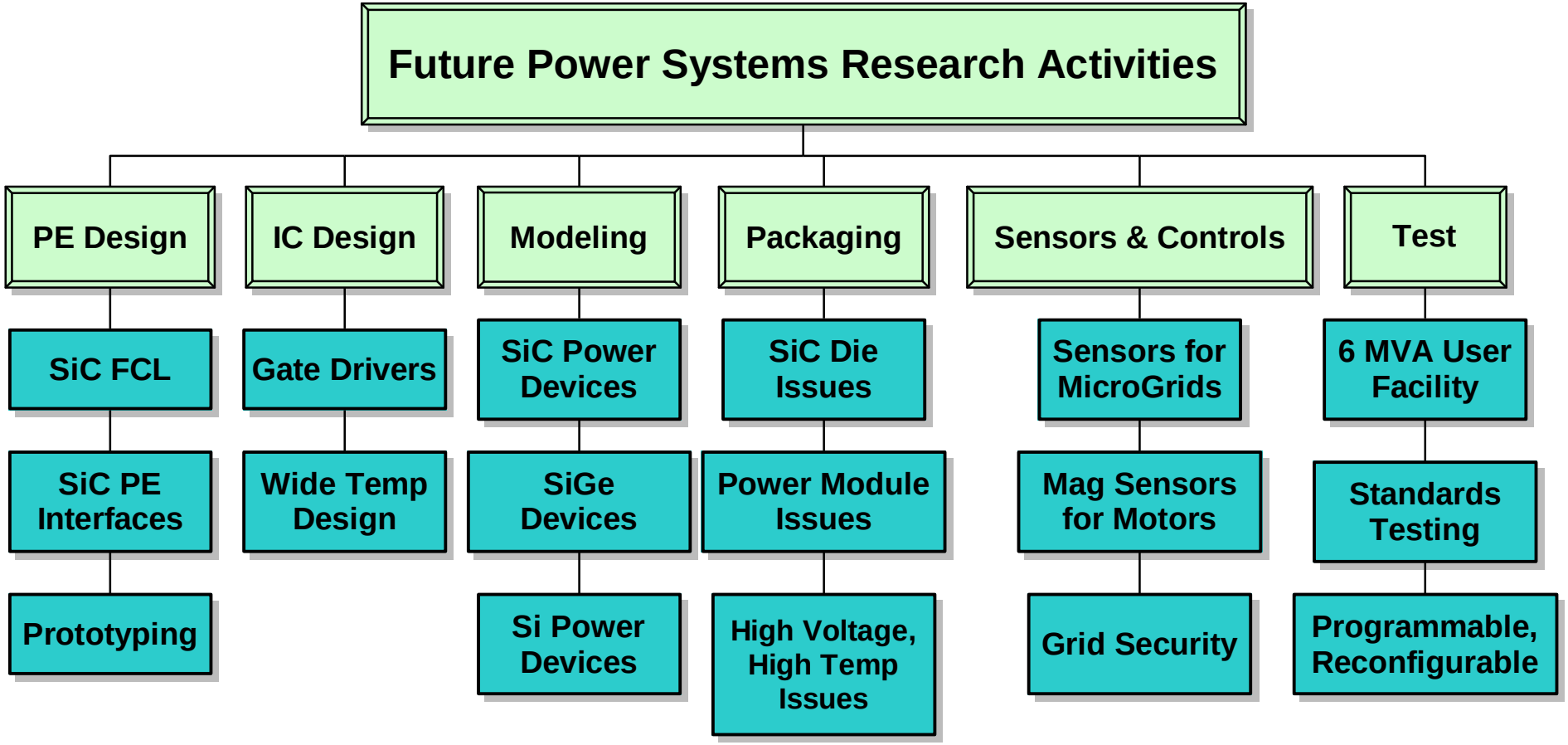


"Materials to the Grid"

NCREPT's Research and Value

What Makes NCREPT Unique:

- Currently, NCREPT is the only user test facility to offer programmability and reconfiguration options at 6 MW.
- Vertically integrated services from basic research through application prototype development and testing (modeling, design, materials and packaging, prototyping, testing, industrial collaboration)
- High quality collaborations with partner institutions
  - UALR – Alex Biris, Jing Zhang
  - ASU – Robert Engelken, Paul Mixon
  - UAFS – Kevin Woolverton
  - UAPB – Monsour Mortazavi
- Students at all degree levels

Prototype Test & Evaluation Facility

National Center for Reliable Electric Power Transmission

- 7000 ft^2 building
- $4.5 million test facility
- One-of-a-kind
- Cost-effective facility for businesses, national labs, and universities
- Ribbon-cutting Oct. 31, 2008!
- First commercial customer began testing 1.6 MW device Feb. 2, 2009
- Purpose: Acceleration of advances to the grid

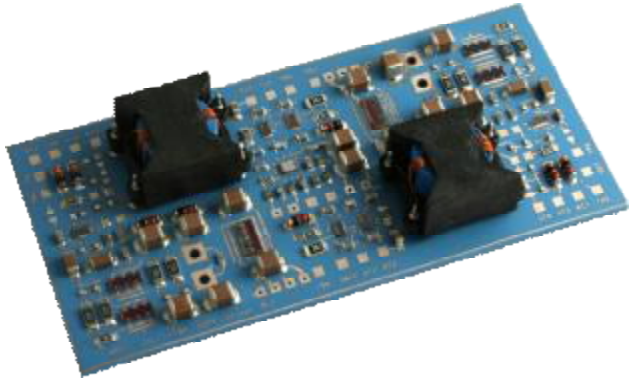
UA Test Facility

National Center for Reliable Electric Power Transmission

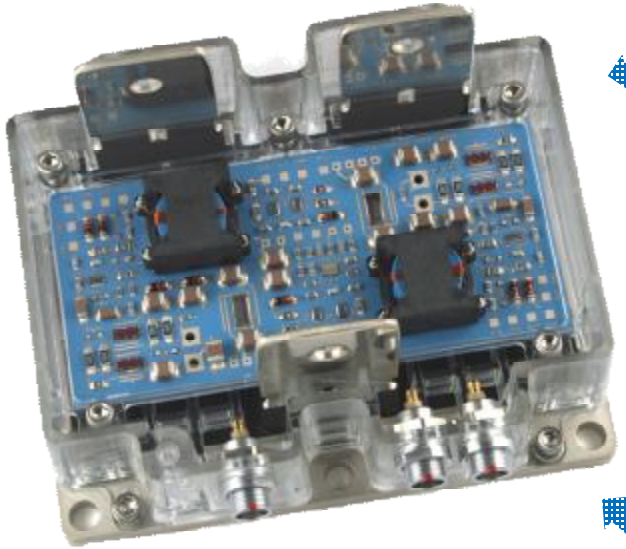
Example Power Electronic Module

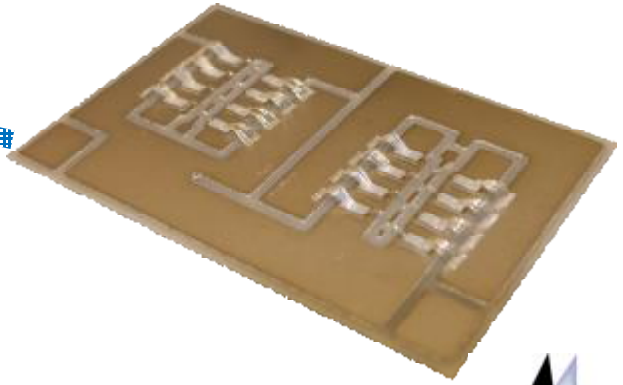
SiC Power Modules (actual photos)

- Collaboration with APEI, Rohm, Sandia
- Built and tested
- Demonstrations
- Recorded data
- R&D 100 Award Winner (2009)



LTCC Driver Boards





DBA Power Board

MMC Baseplate

NSF Industry/University Cooperative Research Center

GRid-connected Advanced Power Electronic Systems (GRAPES)

The GRAPES Solution

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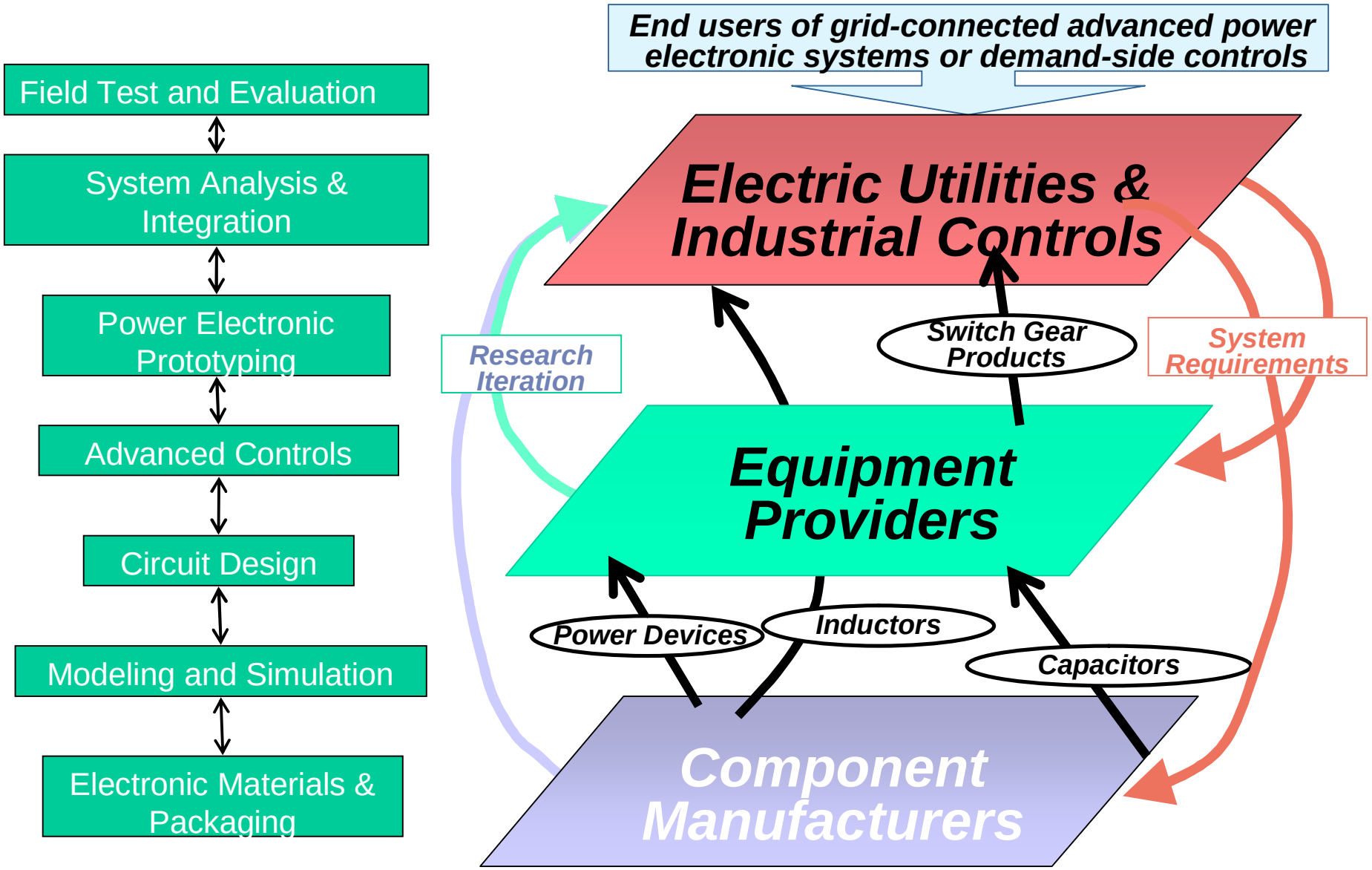


Alan Mantooth, University of Arkansas

VICTER: Vertically Integrated Center for Transformative Energy Research

Dr. H. Alan Mantooth, PI - UAF

Dr. Alexandru Biris, Co-PI - UALR

Dr. Robert Engelken, Co-PI - ASU

Dr. Mansour Mortazavi, Co-PI - UAPB

Dr. Ajay Malshe, Co-PI - UAF

Arkansas Can Address this National Problem Based on 4 Areas of Strength

The Only Center in the U.S. with reconfigurable power to emulate Connecting Alternative Energy Sources to the Grid

- Unique 6 MVA Test & Training Facility
- Accelerates Technology Transfer
- Equipment funded by DoE, NSF, & UA
- User facility for low-cost research prototype test and evaluation

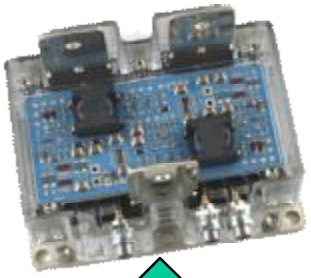
In 2008-09:
Ribbon-cutting Oct. 31, 2008
First commercial user Feb. 2009
U.S. Navy all-electric ship

The Best Design and Fabrication of High Power Electronics in the Country. This is Needed to Connect New Photonic sources to the Grid

- Delivers power electronics for use now
- Symbiotic relationship with industry (Arkansas and beyond)
- Involved in next generation defense systems

In 2008:
Texas Instruments Engibous Prize
25 Refereed papers
5 patent disclosures
1 IEEE Fellow

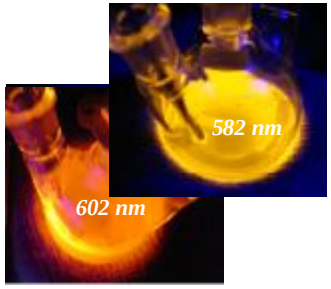
Unique Electronic Packaging Center Which Produces High Density Electronic Packaged Devices



- One of only two Packaging Facilities at a University in the country
- Complete design, fabrication, test, reliability, and inspection capability
- World recognized leadership

In 2008-09:
R&D 100 Awardee
1 Society Fellow
1 patent disclosure
New key industrial partnerships

One of the Most Productive Nanostructure Growth and Imaging Facilities in the Country



- Largest supplier of nanostructures to other research institutions in the country
- About 200 Publications/yr
- Over 4000 Citations/yr
- Hold over 10 Patents
- 4 spin-off companies with over 40 employees
- 10 NSF/DoE grants in place

In 2008:
Most Outstanding DoE Project
32 Applied Physics Letters (APL)
12 Physical Review Letters (PRL)
1 Nature
5 Nano Letters (NL)
11 Journal American Chemical Society (JACS)
7 Optics Letters (OL)

VICTER's Unique Approach

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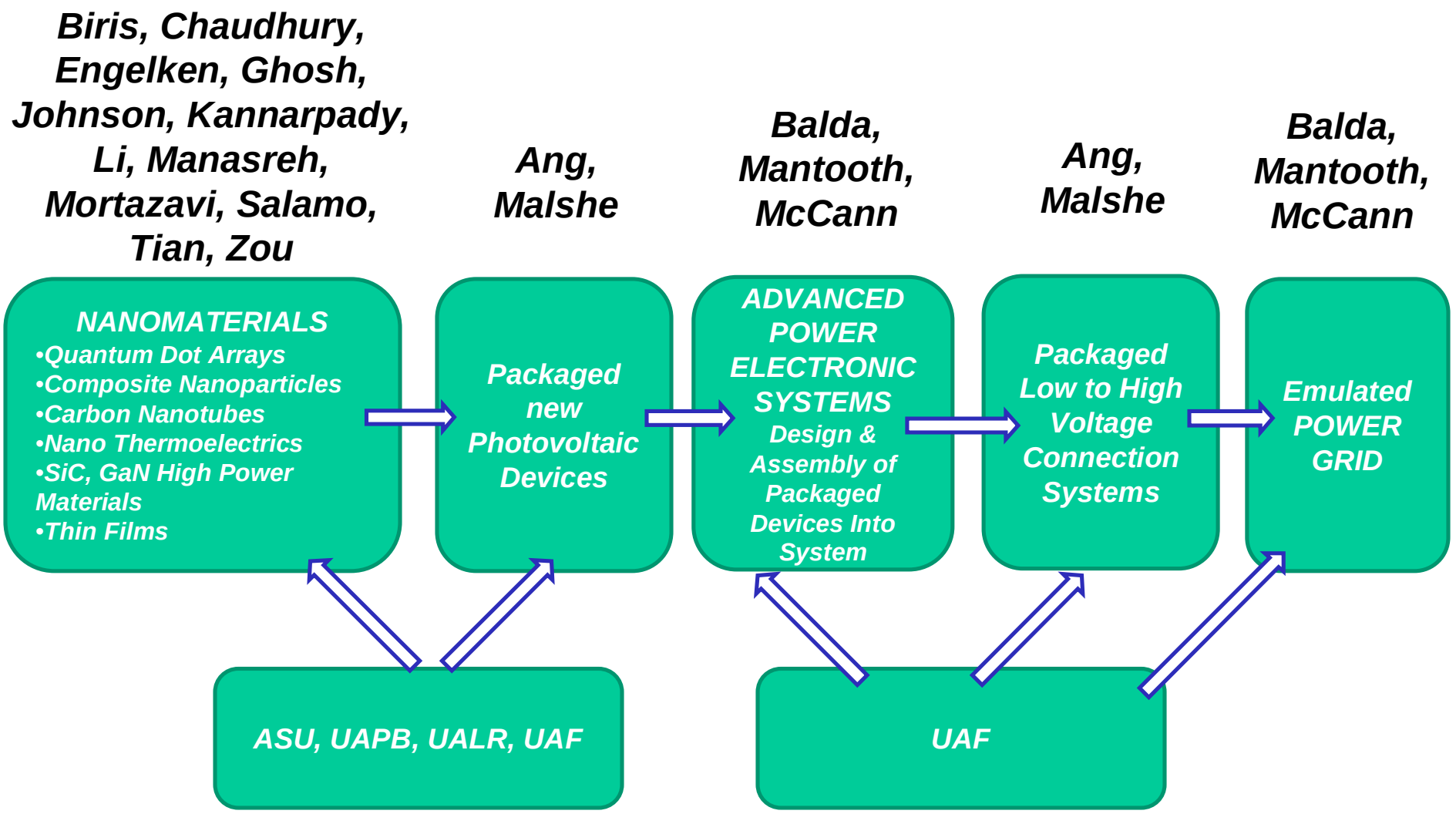

Acknowledgements

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- Collis Geren, Don Pederson, John White as the earliest supporters of our vision
- Phil Stafford and Alex Lostetter for helping shape the vision and supporting us as we execute
- Our great students for commitment, dedication and work ethic to achieve!