HIGHLIGHTING UNIVERSITY SPONSORED ENERGY INNOVATION CENTERS

NARUC CENTER FOR PARTNERSHIPS & INNOVATION WEBINAR SERIES
MAY 18, 2022
ABOUT NARUC

• The National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization founded in 1889.

• Our Members are the state utility regulatory Commissioners in all 50 states & the territories. FERC & FCC Commissioners are also members. NARUC has Associate Members in over 20 other countries.

• NARUC member agencies regulate electricity, natural gas, telecommunications, and water utilities.
ABOUT NARUC’S CENTER FOR PARTNERSHIPS & INNOVATION

- Grant-funded team dedicated to providing technical assistance to members.
- CPI identifies emerging challenges and connects state commissions with expertise and strategies to inform their decision making.
- CPI builds relationships, develops resources, and delivers trainings.

Regularly updated CPI fact sheet with recent publications & upcoming events under Quick Links at:

https://www.naruc.org/cpi-1/
PANELISTS

JOHN MORRISON
MODERATOR
President and Chief Executive Officer
E4 Carolinas

ROBERT COX
Associate Director
Energy Production and Infrastructure Center (EPIC), University of North Carolina Charlotte

KEN DULANEY
Director of Industry and Innovation
FREEDM Systems Center, North Carolina State University

JAY WHITACRE
Director
Wilton E. Scott Institute for Energy Innovation, Carnegie Mellon University
UNIVERSITY ENERGY INSTITUTE COLLABORATIVE

UEIC is a partnership of U.S. university-based energy institutes formed to address the critical challenges facing America’s energy systems.

Vision
To support a low carbon and just energy future.

Mission
To work together as energy institutes to inspire meaningful research, engage scholarship, inform regional and national policy, impact decision-making, and re-imagine energy education to be ready to create the future of energy systems.

Panelists are all members of the University Energy Institute Collaborative
https://www.ueic.org/
The Energy Production and Infrastructure Center (EPIC) at UNC Charlotte

Wednesday, May 18, 2022
Dr. Robert Cox
EPIC Associate Director
Founding Mission

EPIC was founded with the support of the energy industry
- Industry needs new energy talent for the future
- Average age of professionals is 55+
- To execute the energy transition, the power industry needs new skills

Professional development and life-long learning of employees

Applied research needs for a safe, reliable, and sustainable energy future

Bottom Line:
Educating future engineering professionals for the energy sector
An Additive Research Center

Typical EPIC Project Structure
- Faculty involvement / faculty PIs
- Day-to-day execution led / supported by professional research staff
- Student involvement in all aspects of projects

Currently ~ $20MM in total awards under management

Major focus on private / public partnerships
Major Research Thrusts

- **Power Management**
  - Advanced Motor Drives
  - High Power Density Power Converters
  - Transportation Electrification
  - Digital Engineering – Digital Twins

- **Energy Management**
  - Grid Resiliency & Modernization
  - Inclusive Approaches in Planning

- **Energy Infrastructure**
  - Advanced Construction
  - Energy Supply Chain
Energy Infrastructure

Vision: “Advanced Construction”
Apply advanced manufacturing strategies to the overall NPP construction, fabrication, assembly process.

- New nuclear > $12,000/kW in US
- “More than 50% of costs are civil works”
Transportation Electrification & Public Sector Partnership

Successful product development partnership

Requires interesting regulatory innovation
Grid Resilience & Digital Twin for Planning

Integrated Planning for the Future
- Detailed hourly analysis
- Outage & vulnerability prediction
- Reconfiguration
- Advanced protection
Valuing Resilience

Power System Impact  Community Impact

Inclusive Planning

Benefits of Shelter With Resilient Power
2 Day Use, 1X per year

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food damage</td>
<td>$64,000 / event</td>
</tr>
<tr>
<td>Sheltering cost</td>
<td>$23,800 / event</td>
</tr>
<tr>
<td>Self food preparation</td>
<td>$4,800 / event</td>
</tr>
<tr>
<td>Total Annual Benefit</td>
<td>$92,680 / event</td>
</tr>
<tr>
<td>20-Year Benefit</td>
<td>$1.85M</td>
</tr>
</tbody>
</table>
EPIC Workforce

- EPIC creates unique workforce development opportunities
- EPIC leads “energy concentrations” in all of the engineering disciplines & and in the MBA program
- About 1/3 of recent graduates have been going to the energy industry in the past several years
Thank You!

Robert Cox
Robert.Cox@uncc.edu
NC State

• 36,700 students
• #6 best value among US public universities (#1 in NC)
• $370 M in sponsored research in 2019
• 190+ Startup companies
• 1,500 active patents
• #5 in commercialization for universities w/o med school
• Top 10 in US for Undergraduate Entrepreneurship
• Centennial Campus
• 50 Research Centers
What is FREEDM?

Future
Renewable
Electric
Energy
Delivery and
Management
Systems
Center
Research Pillars

WBG Power Electronics
- WBG Devices
- SSTs
- MV Power Electronics
- Low-Voltage High-Performance Power Converters

Electric Transportation
- Electric Machines and Drives
- Fast Chargers
- Wireless Power Transfer
- Automotive & Aerospace Power Electronics

Modern Power Systems
- FREEDM Distribution System
- Distributed Grid Intelligence
- System Controls Stability and Cybersecurity
- Economic Modeling & Market Mechanisms

Renewable Energy Systems
- Distributed Energy Resources
- Microgrids
- Solar PV & Wind Systems
- Renewable Integration into Grid
Industry Members

Full
- Meta
- Duke Energy
- ABB
- New York State of Opportunity
- NY Power Authority

Associate
- FPL
- Schneider Electric
- Eaton
- Hitachi
- Typhoon HIL
- SAS
- NC Electric Cooperatives
- Hesse Mechatronics
- Danfoss
- Henkel
- Delta

Affiliate
- Triangle MicroWorks, Inc.
Wide Bandgap Materials

- Higher Voltages
- Higher Currents
- Higher Temperatures
- Higher Switching Frequencies
- Reduce Size of Passive Components

<table>
<thead>
<tr>
<th>Semiconductor properties (Electron Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon</td>
</tr>
<tr>
<td>Silicon Carbide</td>
</tr>
<tr>
<td>Gallium Nitride</td>
</tr>
</tbody>
</table>
DC Fast Charger
DC Fast Charger
Power Systems

- Impact of Demand Response Programs
- North Carolina Energy Storage Study
- Model Selection for Day Ahead Generation Scheduling
- Using PV to Enhance Grid Resilience
- Cybersecurity for Wide Area Control
- Advanced Magnetics for Transformer Design
Renewable Energy

- Solar PV
- Energy Storage
- Microgrids
Packaging
Electric Machines

- Switched Reluctance Motors
- Asymmetric Bar Windings
- 3D Airgaps
- FPGA Motor Emulator
- Model Predictive Current Control of PM Synchronous Motors
freedm.ncsu.edu

Ken Dulaney, PE
Director of Industry and Innovation
ken_dulaney@ncsu.edu
Enabling a sustainable energy future.
CMU Areas of Expertise in Energy

1. Energy Technologies – from current state to the future
   - High-Performance Renewables
   - Transportation Energy, EVs, Infrastructure, and Electrification
   - Energy Storage, Batteries, Fuel Cells, and Internet of Things
   - Decarbonization, Carbon Capture, Sequestration and Utilization

2. Resource Efficiency, Policy & Strategy, and Analysis
   - Efficiency of Traditional Fuels and Resource Recovery
   - Environmental Monitoring, Sensing and Treatment
   - Energy Policy, Economics and Community
   - Enhanced Water Resources

3. High-Tech Energy and Computational Solutions
   - Grid Modernization, Energy Planning, System Reliability, and Resiliency
   - Building Performance, Urban Planning, Design and Analytics
   - Machine Learning, AI, Autonomous Vehicles, and Robotics for Energy Systems
   - High-Performance Computing and Data Centers
What We Do

Support and Promote Faculty Research
- 150 Faculty
- CMU Energy Fellows program
- Fund Seed Grants & Faculty Fellowships

Foster Entrepreneurship
- CMU Energy + Cleantech Investor Forum & Startup Showcase
- DOE American-Made Solar Prize - Power Connector
- NREL IN2 Strategic Channel Partner
- CMU VentureWell Energy Hackathon

Form Strategic Partnerships
- CMU Energy Consortium for Industry
- Power Sector Carbon Index: emissionsindex.org

Host Energy Initiatives
- District-Scale Pilots
- Facilitate academic Centers for specific interest areas

Engage with Industry and the Public Sector
- CMU Energy Week – March 23-27, 2020
- Distinguished Lecture & Seminar Series, Workshop Events, and Programming
- Collaborations with NETL, NREL, City of Pittsburgh, DOE
CMU Core Strengths

• Key Technologies: Energy Storage, Fuel cells, smart sensing, machine learning
• Systems optimization approach to problem-solving and design
• Interdisciplinary collaboration
• Innovative and entrepreneurial faculty, staff, and community
• SW Pennsylvania location
• Proximity to start-up epicenter and ecosystem
Convergence of energy efforts across campus
NARUC Innovation Webinar series

One Thursday each month
All NARUC members and stakeholders are invited

Alleviating the Energy Burden: Regulatory Approaches to Supporting Affordability

• June 16, 2022 | 3:30 - 4:30 PM Eastern

Topics and more webinar information will be added soon!
https://www.naruc.org/cpi-1/innovation-webinars/

NARUC thanks the U.S. Department of Energy for its support of this series.