Future City: Powering Our Future Educator Workshop

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Purdue University Fort Wayne
Panelists:
Carol Dostal, Director of Outreach, College of ETCS
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Powering Our Future

- **Your Challenges**
- **Research Questions**
- **Today's Electrical Grids**
  1. **USAGES**
     - **Customers/Users: Industrial, Commercial, Residential types)**
     - **Usage patterns: day, month, season**
     - **Electrical safety,**
     - **Critical systems that rely on electricity**
     - **Electric grid blackouts, power outages and consequences**
  2. **GENERATION**
  3. **TRANSMISSION & DISTRIBUTION**
  4. **MONITORING**
  5. **STORAGE**

Powering Our Future

- Today's Electrical Grids
  1. USAGES
  2. GENERATION
     - Bulk Generation (conventional): Hydroelectic generation, Fossil Fuel, Natural gas, Nuclear power
     - Power Plants Locations
     - Environmental Impacts
     - Advances and Innovation on Non-Bulk Generation (distributed energy resources): wind, solar, microgrids, electric or hybrid vehicles, geothermal, wasted heat, Energy storages
     - Smart Grid Technologies: Digital, Computer, Control and Information Technology; and Energy Management Systems
     - Microgrids? Advantages, Disadvantages
       - https://smartgrid.ieee.org/resources/news/906-the-power-of-microgrids

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YouTube Videos (Electric Power Generation, Transmission & Distribution)

** Annimation Videos from Tennessee Valley Authority: How Hydroelectric Power works, How a Pumped-Storage Plants Work,

** How a Coal Power Station Works, https://www.youtube.com/watch?v=SeXG8K5_UvU

** I&M Power Company, https://www.indianamichiganpower.com/info/educational/

** Fundamentals of Electricity: I&M (Generation, Delivery, Rates & Calculations, Basics, Safety, Circuit):

** The Anatomy of an Electric System, 23 minute video, https://www.indianamichiganpower.com/safety/HowElectricityWorks/Anatomy.aspx

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- **Microgrid? Advantages, Disadvantages**
  - Utility and other Energy Company Business Case Issues Related to Microgrids and Distributed Generation (DG), Especially Roofttop Photovoltaics, https://smartgrid.ieee.org/images/files/pdf/IEEE_QER_Microgrids_October_3_2014.pdf
    - Microgrid Definition:
      - "A Microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect the grid."
      - "A microgrid can connect from the grid to enable it to operate in both grid-connected or island mode."
  - The Power of Microgrids, 2016, Webinars, https://smartgrid.ieee.org/resources/news/906-the-power-of-microgrids

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1. USAGES
2. GENERATION
3. TRANSMISSION & DISTRIBUTION (Delivery Infrastructure)
   - Transmission & Distribution Wire:
     - Placement options
     - System Protection
   - Geographic challenges to transmission & distribution
   - Transmission & Distribution systems' vulnerability: natural disasters
4. MONITORING
5. STORAGE

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1. USAGES
2. GENERATION
3. TRANSMISSION & DISTRIBUTION (Delivery Infrastructure)
4. MONITORING
   - Smart Grid? How does it affect monitoring and electricity delivery?
   - Grid operators: how to make sure the grid operating properly?
   - How is the electricity supply controlled?
   - How are transmission and distribution controlled?
   - What aspects of an electric grid can't be controlled by technology
5. STORAGE

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1. USAGES
2. GENERATION
3. TRANSMISSION & DISTRIBUTION
4. MONITORING
5. STORAGE
   - Why don't cities store electricity?
   - How can electricity be stored with existing technology?
   - What are cutting-edge idea in energy storage?

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U.S. Smart Grid Development References

- Energy Independence and Security Act of 2007, https://www.congress.gov/bill/110th-congress/house-bill/6
  - "… Title XIII: .. to support the modernization of the Nation's electricity system to maintain a reliable and secure infrastructure that can meet future load growth and achieve the characteristics of a smart-grid. .."
  - Involved government agencies: Dept. of Energy (DOE), Federal Energy Regulatory Commission (FERC), National Institute of Standards and Technology (NIST), U.S. Dept. of Homeland Security, U.S. Environmental Protection Agencies (EPA), etc
- American Recovery and Reinvestment Act of 2009, https://www.congress.gov/bill/111th-congress/house-bill/1/text

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U.S. Smart Grid Development References

- Smart Grid System Report, U.S. Department of Energy, July 2009
  - Smart Grid Definitions: "A Smart Grid uses digital technology to improve reliability, surety and efficiency of the electric system."
  - Scope of Smart-Grid Concerns:
    - Transmission Automation
    - System Coordination Situation Assessment
    - Distribution Automation
    - System Operators
    - Renewable Integration
    - Energy Efficiency
    - Demand Participation Signals & Options
    - Distributed Generation & Storage
    - Smart Appliances PHEVs and Storage

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U.S. Smart Grid Development References

- Smart Grid System Report, U.S. Department of Energy, July 2009
  - Smart Grid Definitions
  - Scope of Smart-Grid Concerns:
  - Modern Grid Initiative's characteristics
    - a) Self-Heals
    - b) Resist Attack
  - Smart Grid's Characteristics
    - 1) Enabling informed participation by customers
    - 2) Accommodating all generation and storage options
    - 3) Enabling new products, services, and markets
    - 4) Providing the power quality for the range of needs
    - 5) Optimizing asset utilization and operating efficiency
    - Operating resiliently: disturbances, attack, and natural disasters

- Smart Grid System Report, U.S. Department of Energy, July 2009
  - Scope of Smart-Grid Concerns (page 2):

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- Smart Grid System Report, U.S. Department of Energy, July 2009
  - Smart Grid Definitions
  - Scope of Smart-Grid Concerns:
  - Modern Grid Initiative's characteristics
  - Smart Grid's Characteristics
  - Stakeholder Landscape
    - Gen/Load Wholesalers
    - Wholesale Market Operators
    - Transmission Providers
    - Reliability Coordination
    - Reliability Coordinators
    - Distribution Providers
    - Energy Service Retailers
    - End Users: industrial, Commercial, Residential

A Natural Disaster that is Relevant

- What are the immediate and long-term effect of natural disasters?
- How can natural disasters affect a city's electrical grids?
- In what ways can an electric grid be protected against natural disasters?
- How can a city be prepared to repair its grid quickly after a natural disaster?
- What innovations for grids are being tested or implemented to improved resiliency?
- What role does engineering and technology play in making an electrical grid more resilient?

Conclusion

Thank you!