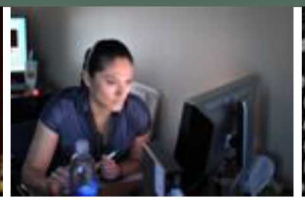
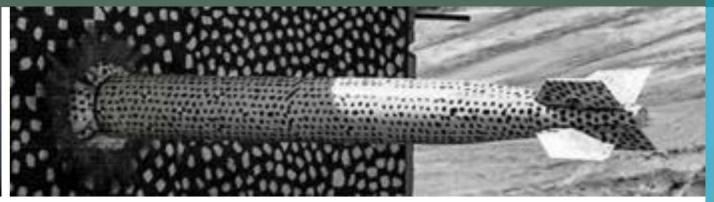
SAND2018-7078C

Sandia National Laboratories

Integrating XFC at Scale Into the Power System





Electrification Panel Discussion on High Power Charging

June 21, 2018

PRESENTED BY

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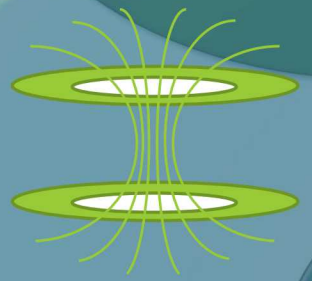
Outline

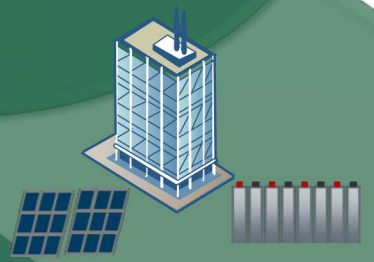
- Problem Statement
- Challenges and Gaps
- Technology Solutions
- Planned Work and Related Capabilities

XFC Multi-Lab Collaboration

ANL: Interoperability,
XFC test requirements and procedures,
networked communication and control

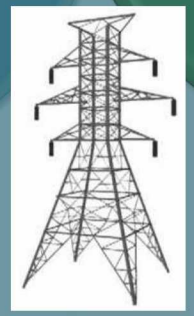
SNL: Integration of XFC with
DER in the context of Grid
Planning Operations





NREL: XFC Building,
Onsite Energy Resource,
and Grid integration

ORNL: High power charge system
power electronics
hardware and controls R&D



INL: XFC characterization, dynamic, and transient
analysis for grid reliability using power HIL real-time environment

Problem Statement

- Electric transportation and XFC infrastructure is coming to a grid near you… sooner than you think!
- Beyond the surface, grid and EV stakeholders are not yet ready for deployment at scale.
- XFC-grid integration issues should be addressed pro-actively.
  - Scale-up cost
  - Perceived risk and uncertainty
  - Pace of deployment

US' first 200 kW wireless charging system for a battery-electric transit bus fleet, BYD K9S bus at Link Transit in Wenatchee, Washington. Mar 2018

A Vision of XFC at Scale

- XFC integrated w/ local energy resources to manage demand variability and peak
  - Stationary storage, Building loads, Renewable generation (PV), Primary energy (natural gas)
- Grid-friendly XFC
  - Autonomous and supervisory control
  - Interface with utility systems and markets
- Challenging cybersecurity use case
  - Passenger safety, electrical capacity, IOT integration, EV-as-a-vector.

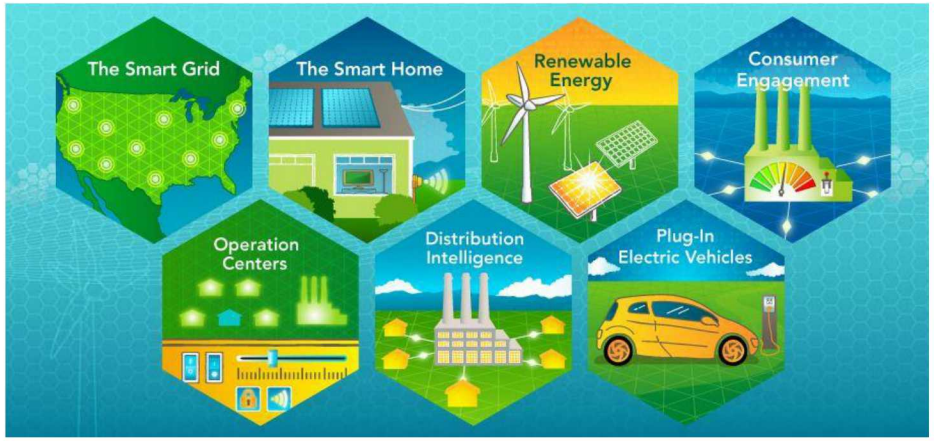
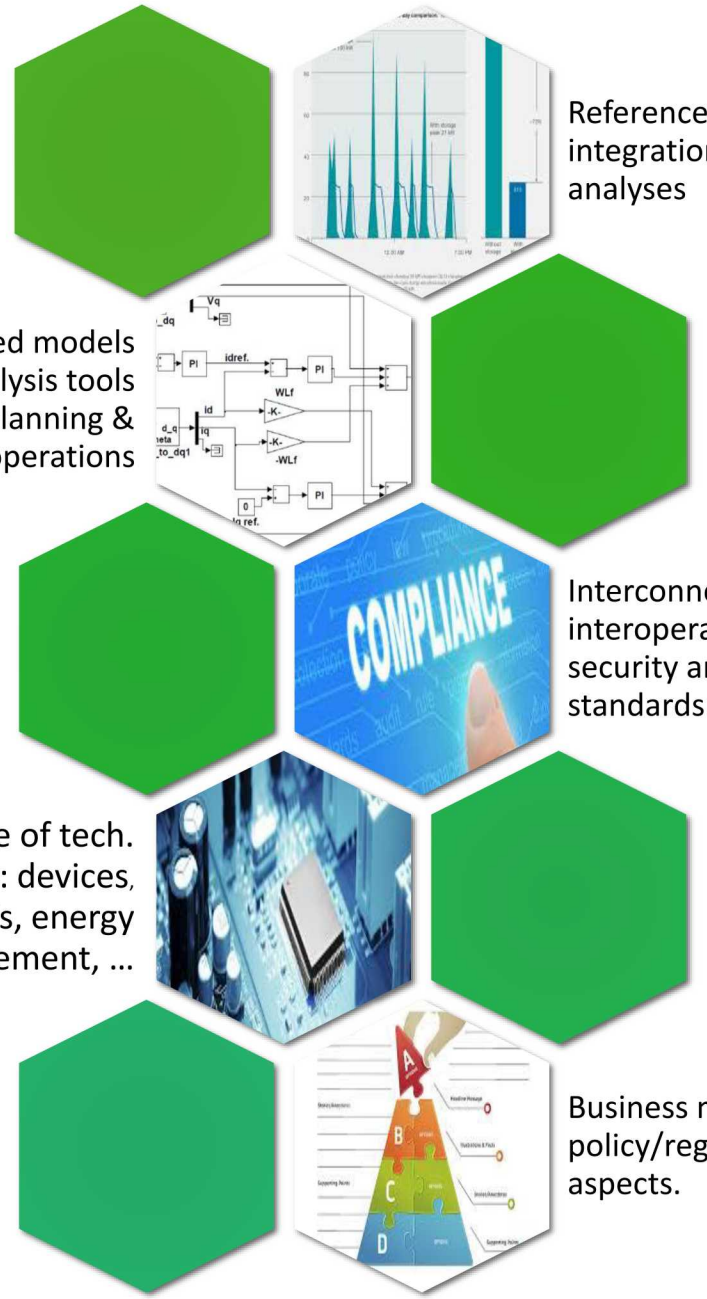


Image from Sound New Energy.
www.soundnewenergy.co.uk

Challenges and Gaps

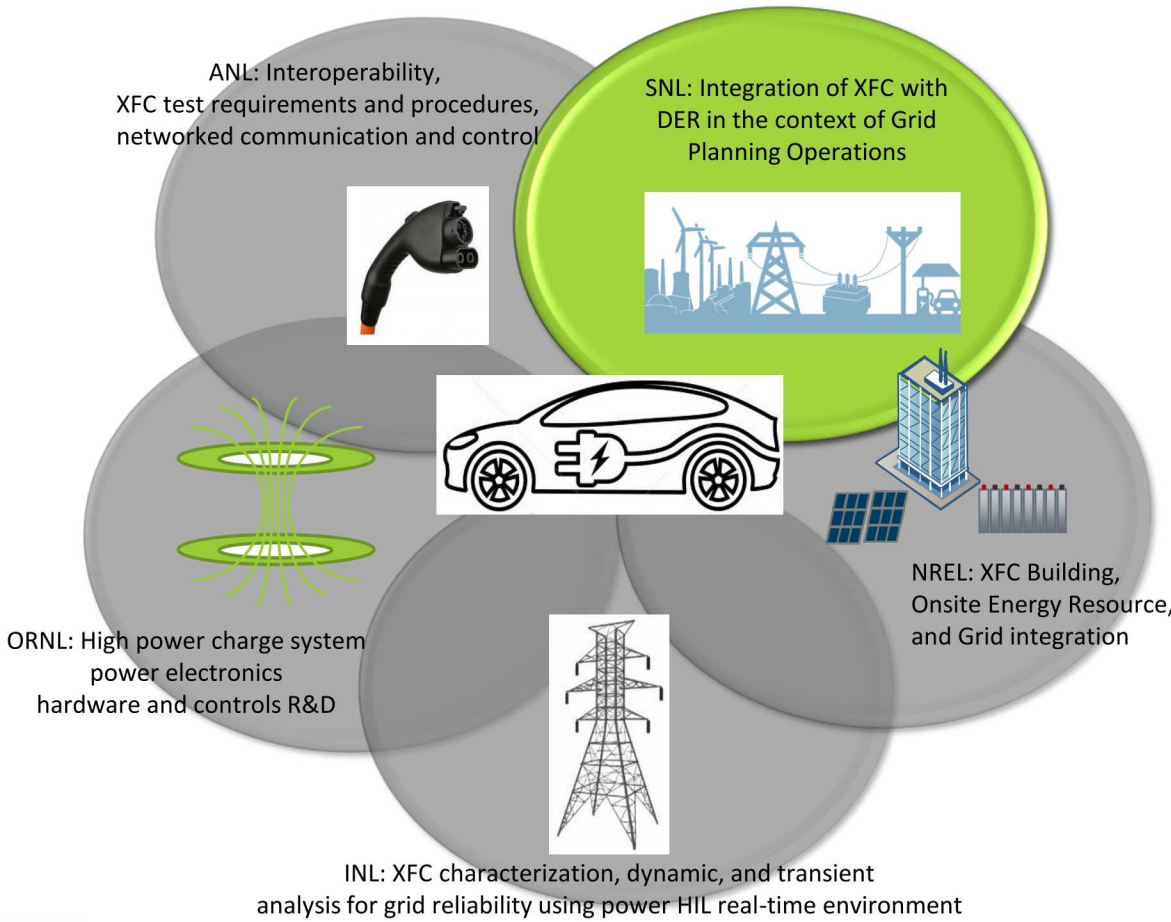
- XFC demand characteristics
  - Load profile; Dynamic and transient response
- Expected grid impacts, mitigation options, and their relative significance
- Technical requirements and standards
  - Interconnection, interoperability, safety, cyber, …
- Simulation models and analysis tools
- Value stack on the grid side
  - Deferral, reliability, market, resilience…
  - Relevant to business models, policy/regulatory

What is the role of Government & Natl. Labs?



Sandia Research to Address XFC Gaps

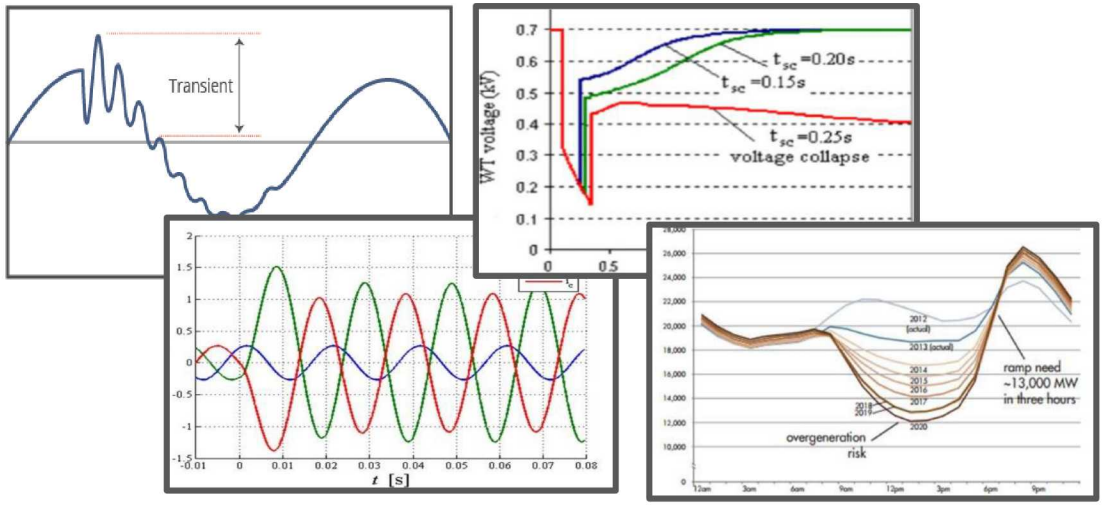
- Power electronics
  - Characterize current capability; charter next-generation XFC architecture and systems
- XFC control and operation
  - Optimal operation across time scales
- Models and Design/planning tools for grid planning and operations
  - Develop, validate and disseminate widely
- Cybersecurity
  - Assess vulnerability, develop technical solutions

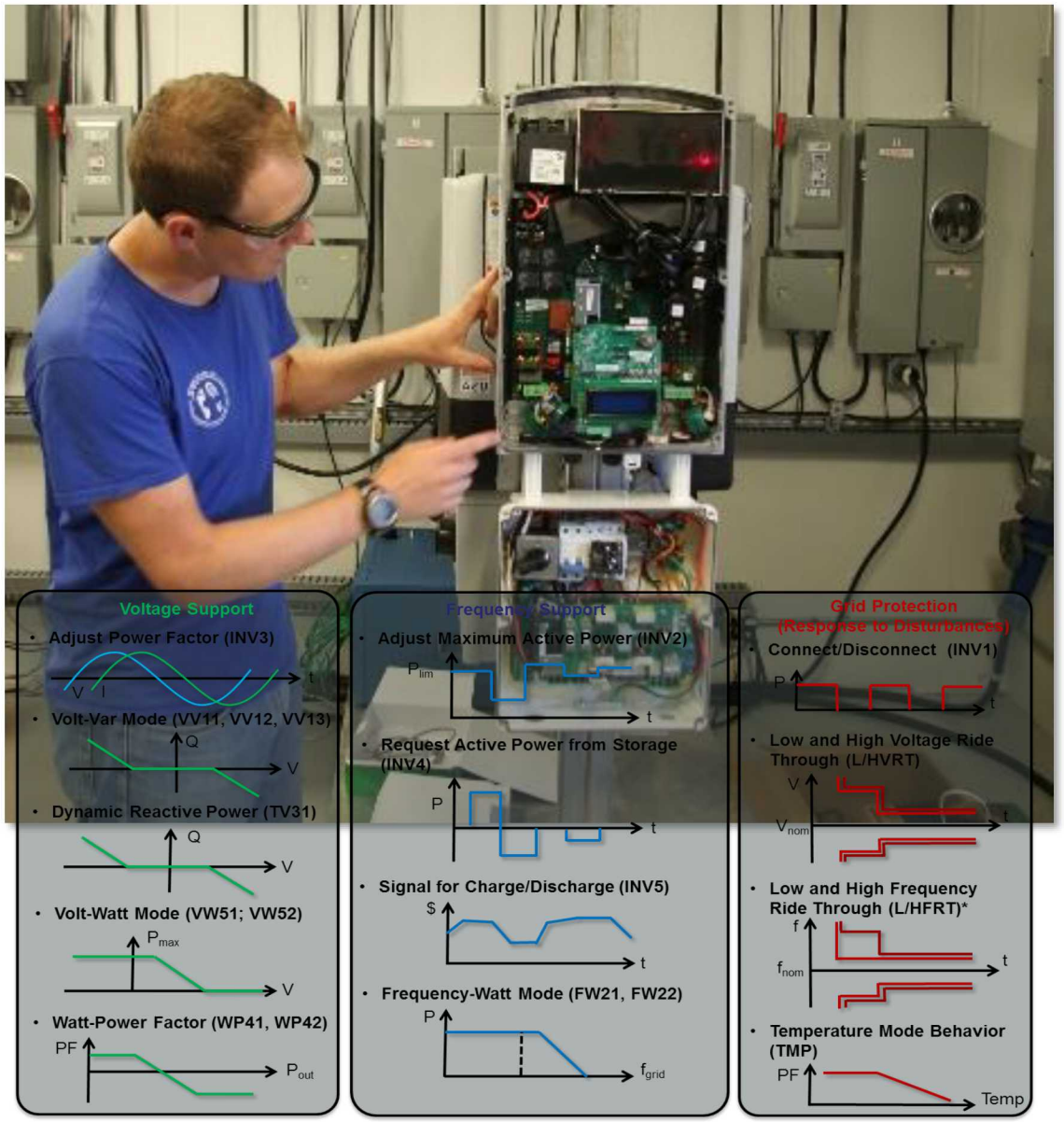


Leverage capabilities and prior/ongoing work across the VTO National Lab team.

Power Electronics (PE)

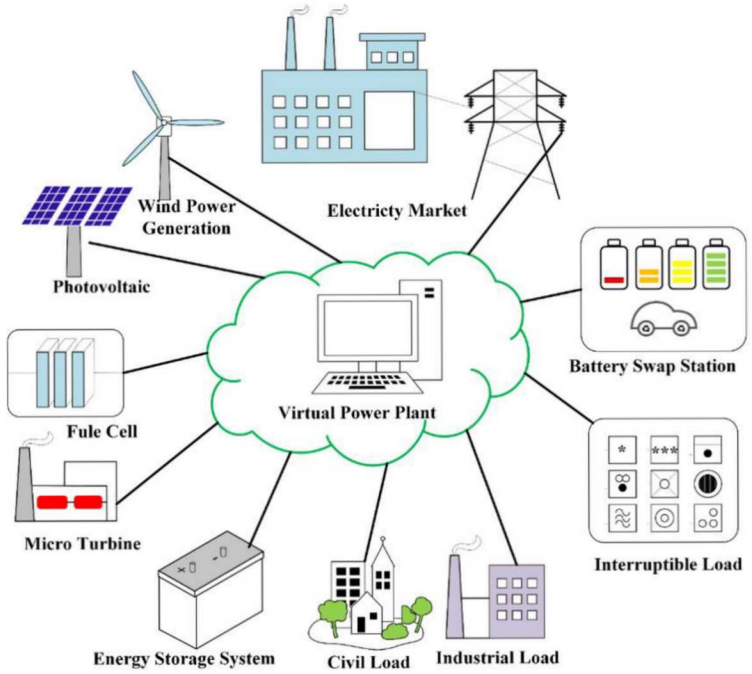
- Characterize performance and interoperability of XFC power electronics in a lab environment.
- Develop next-generation XFC power electronics concepts with advanced grid support functions.
  - Reactive power response, Active power response, Phase balancing, Fault detection, …
- Identify gaps to help inform technology development and grid-related standards.

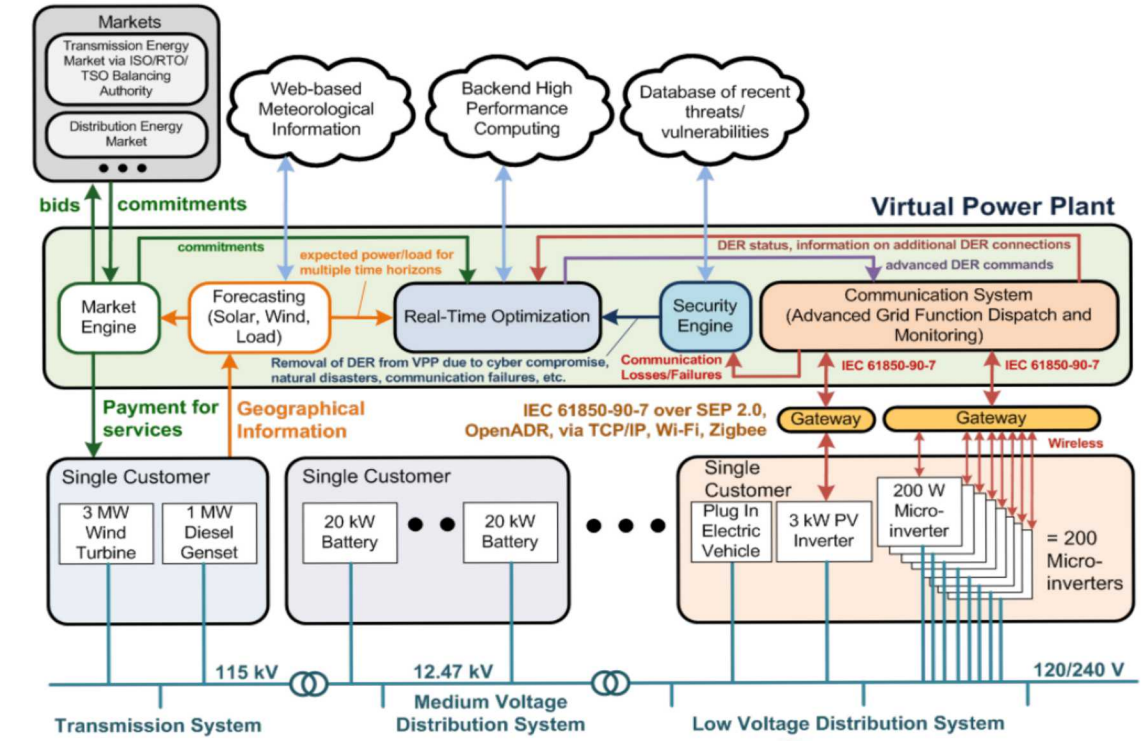


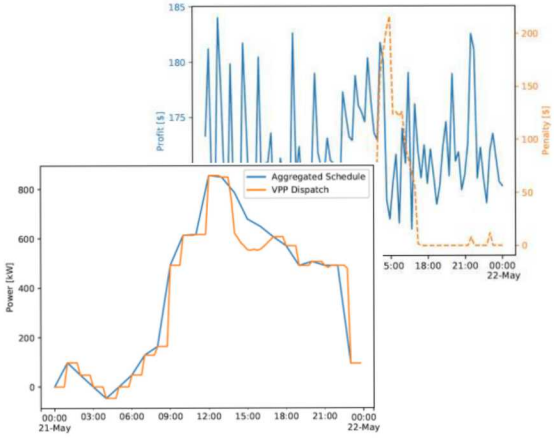


Optimal Control and Operations

- Develop controls to optimize the operation of XFC with other DER
  - Scalable, efficient, robust under high uncertainty
  - XFC integration with local, microgrid, distribution and bulk system controllers
- *Apply Sandia Virtual Power Plant platform*

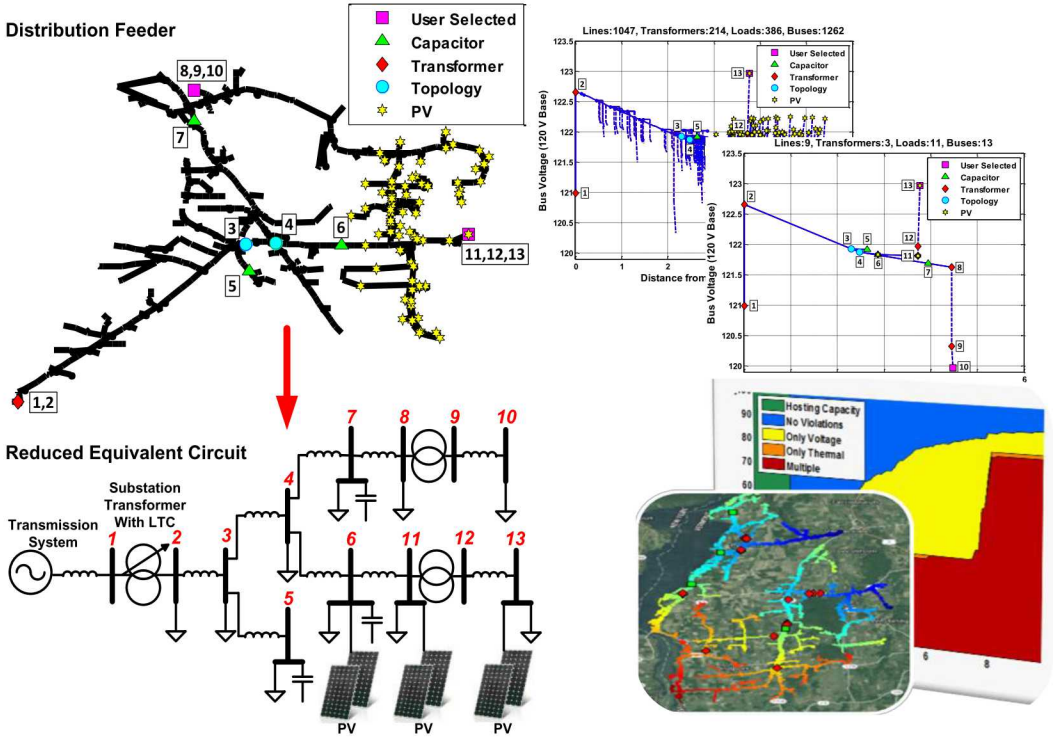


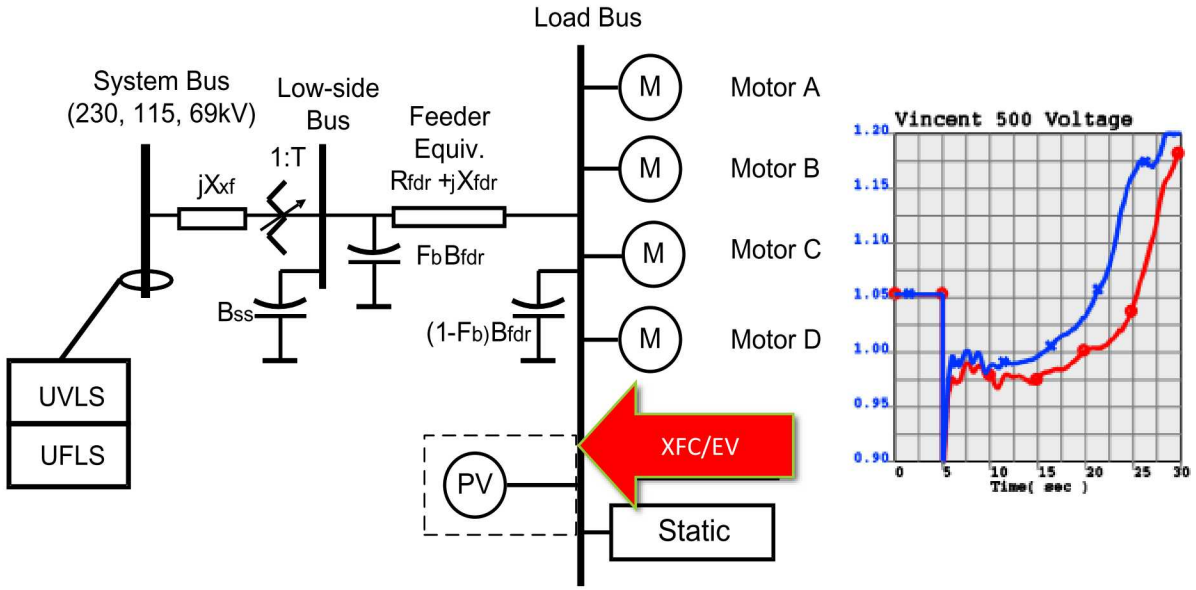




Models and Design/Planning Tools

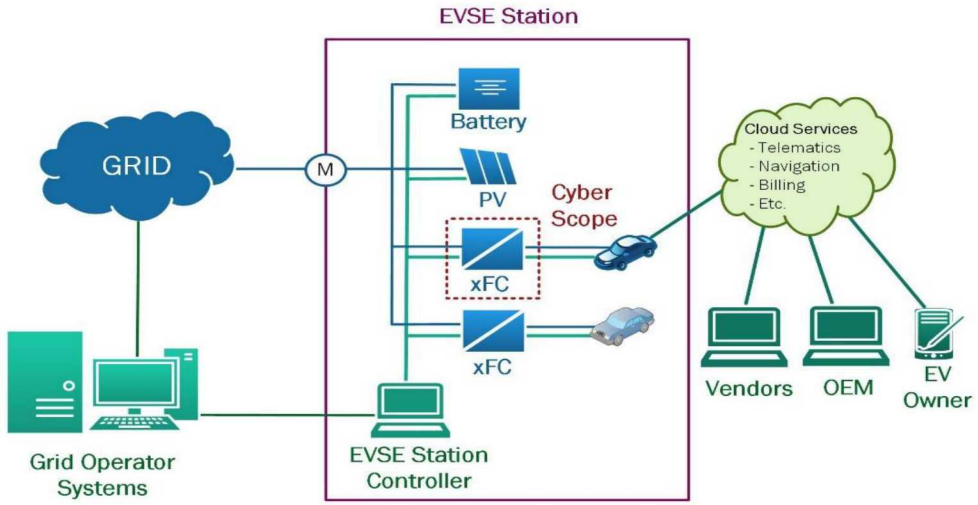
- Develop and validate models and methods to assess XFC impacts on distribution systems. *Apply to hosting capacity problem*.
- Focus on advanced quasi-static time-series (QSTS) methods. *Adapt existing DER analysis toolset to XFC.*
- Develop and validate standardized XFC models for transmission planning studies. *Analyze how grid stability relates to XFC capability.*
- *Focus on positive-sequence models, leveraging RE/DER modeling framework championed by Sandia under IEEE/WECC/NERC task forces.*

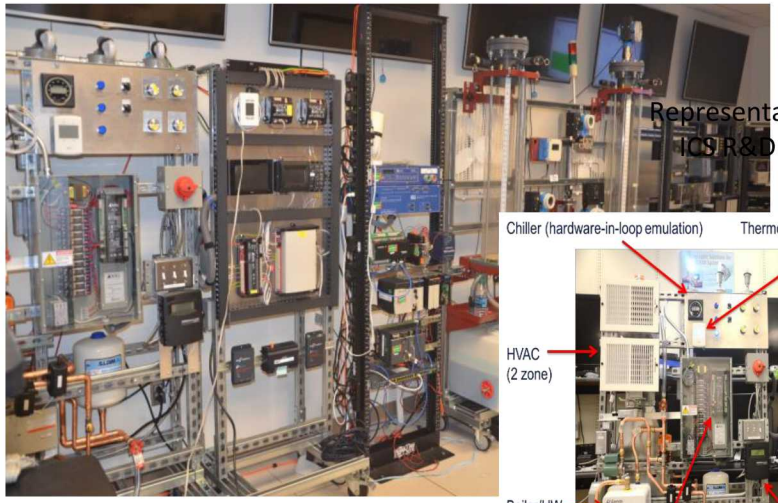




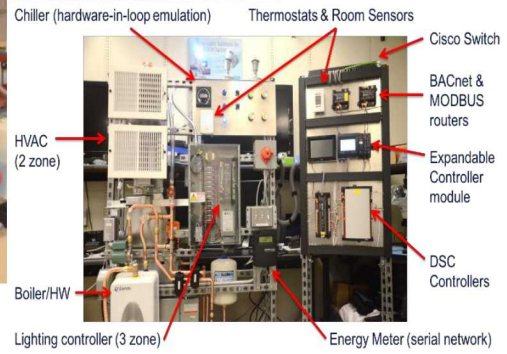
XFC Cybersecurity

- Quantify XFC vulnerability, grid effects, effectiveness of mitigation. *Focus on threat and risk assessment.*
- Extend XFC cyber emulation capability. *Focus on XFC ICS virtualization (e.g., SCEPTRE/HIL environments)*
- Cyber defense technologies. *Focus on cyber analytics, moving target defense, field device security.*
- Inform standards. *Leverage ongoing RE/DER/Cyber working groups.*

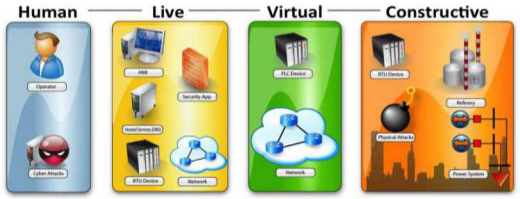


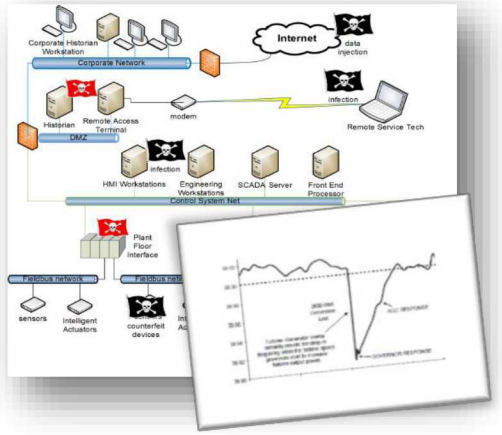


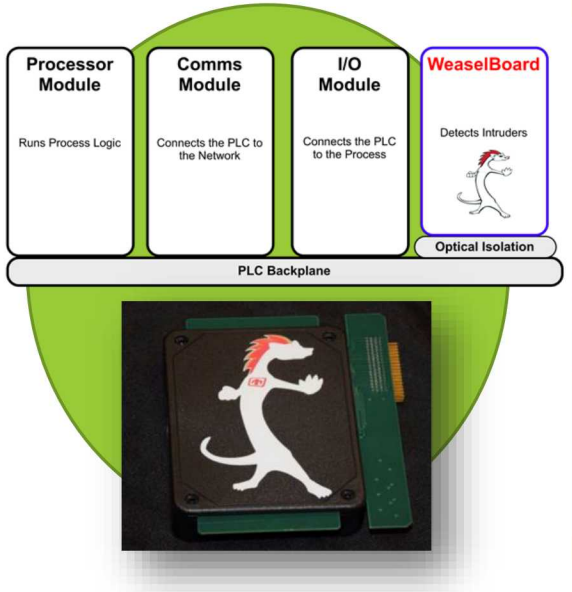
Representative Building/DER ICS R&D environments at Sandia



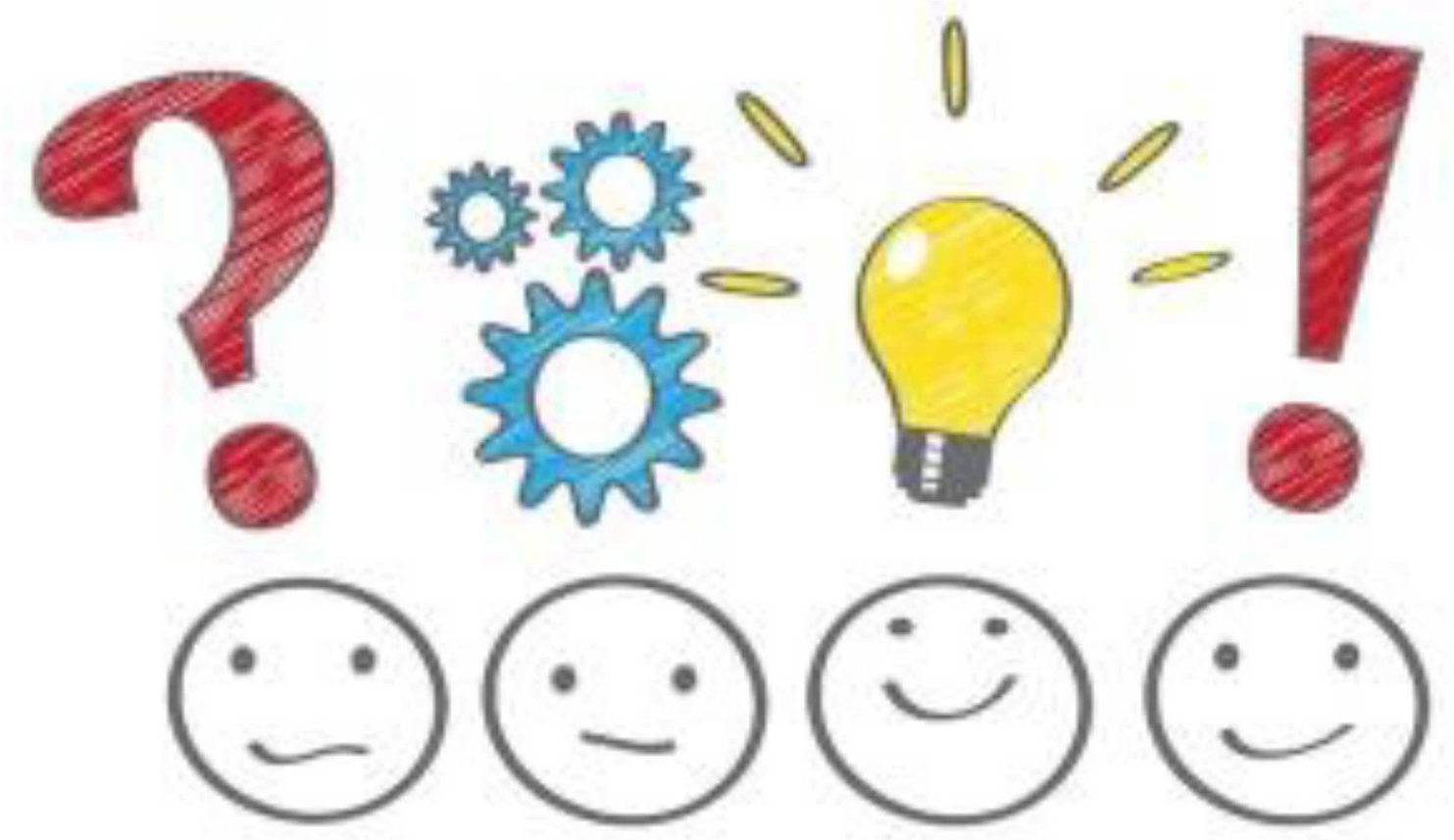
Emulytics™/SCEPTRE







Questions? Comments?



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