

Oak Ridge National Laboratory Energy Storage Program

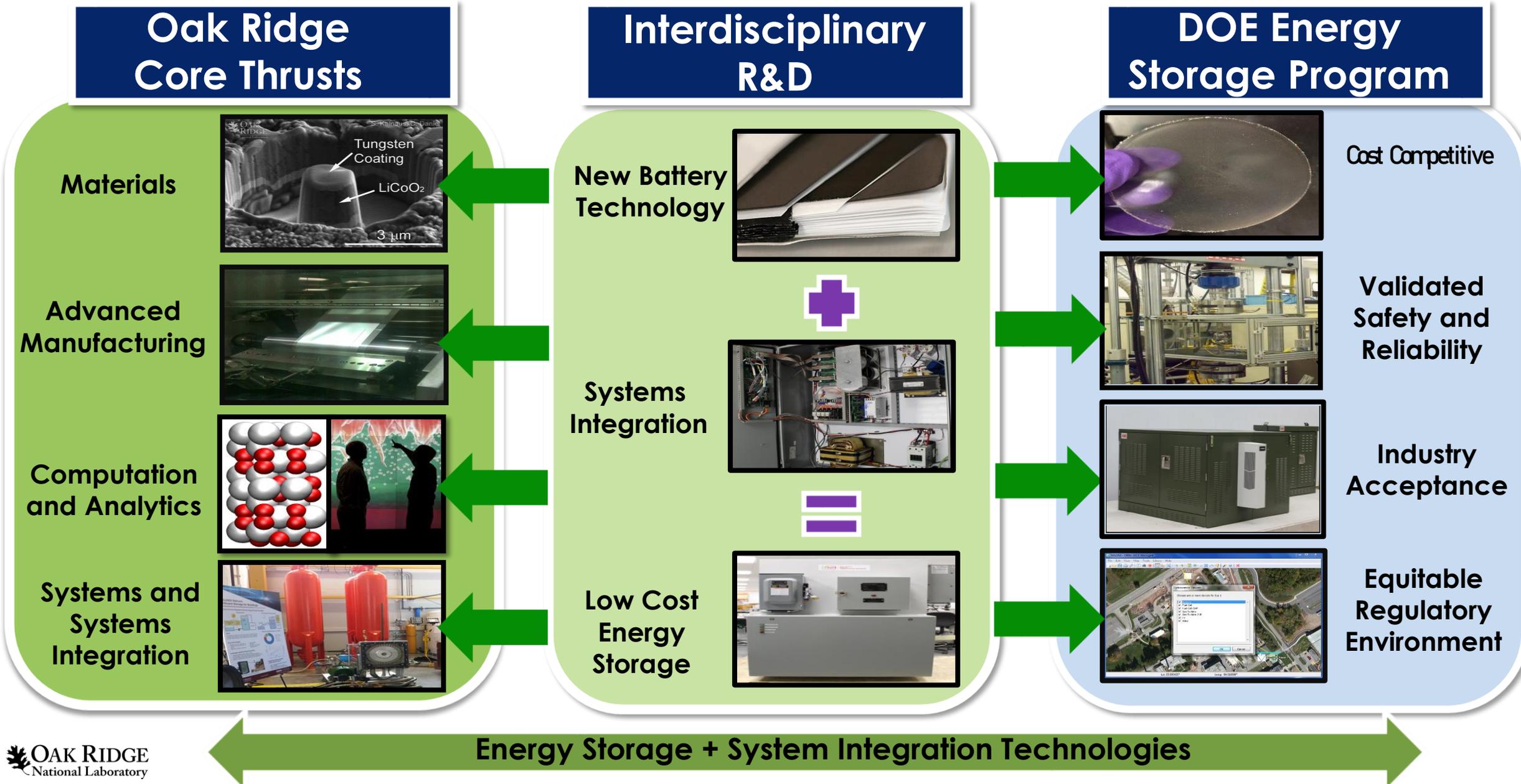
Michael Starke, PhD

Electric Energy Systems Integration Group

Oak Ridge National Laboratory

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

Energy Storage Research



Energy Storage System Technologies

Systems

Energy Storage System

Subsystems

Stack

Thermal
Management

Battery
Management
Systems

Components

*Cathode, Anode
Aqueous/Nonaqueous
chemistries*

*Interfaces & Packaging,
Passive Elements,
Active Elements*

*Logic Controllers,
Thermocouples
Auxiliary Circuits
Balancing Circuits
Analytics*

ORNL Research Going Forward

Systems Integration of Energy Storage Technologies

Systems

Application Specific Grid Interfacing System

Subsystems

Power Stage

Control & Protection

Thermal Management

Interface Integration

Components

Semiconductor Devices,
Capacitors,
Inductors & Transformers

Logic Controllers
Current & Voltage Sensors.
Contactors,
Circuit Breakers & Fuses,
Auxiliary Circuits

Interfaces & Packaging,
Passive Elements,
Active Elements

Agent Systems,
Communication Interfaces,
Computational Platform,
State Machines

ORNL Research (low -> high TRL)

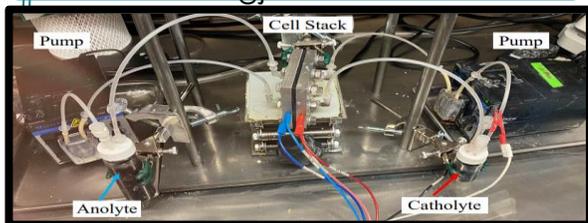
Energy Storage Projects Under DOE OE Energy Storage Program

Cost Competitive

Flow Battery:

Low Cost Membranes for High Energy Density Non-aqueous Redox Flow Batteries

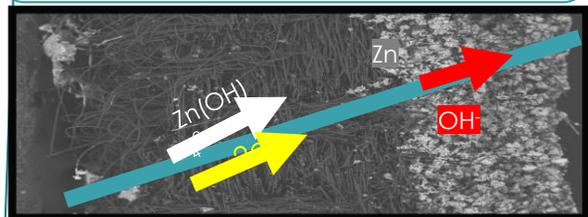
Jagjit Nanda



Metal Air Batteries:

Development Of Components and Cell Architectures for High Performance 'Open' Batteries for Grid Applications

- Tom Zawadinski



Compressed Air Hybrid:

A near-isothermal-isobaric compressed gas energy storage combined with ground-level pumped-hydro storage

- Ayyoub Momen

Industry Acceptance

Systems Integration:

Secondary Use Development of a Battery Chemistry Agnostic Secondary Use Energy Storage System

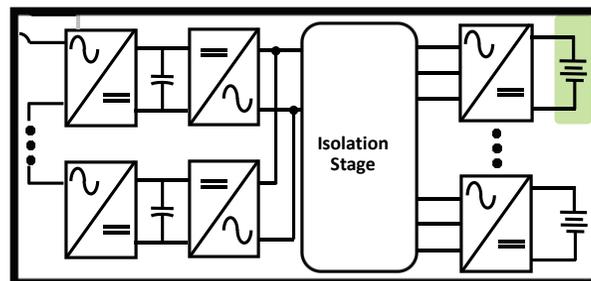
- Michael Starke



New Grid Interconnections:

Direct-Tied Medium Voltage Energy Storage System Development

- Madhu Chinthavali

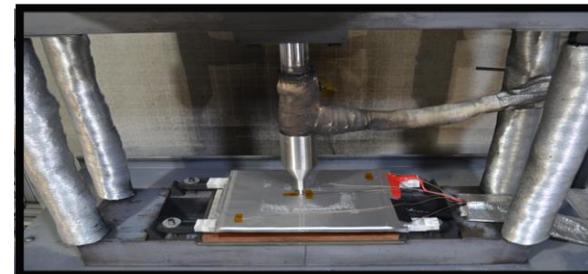


Validated Safety and Reliability

Establishing Safety Database:

Establishing Thermal Runaway Risk Test Protocols and Database – An ORNL and SNL Collaborative Research on Battery Safety

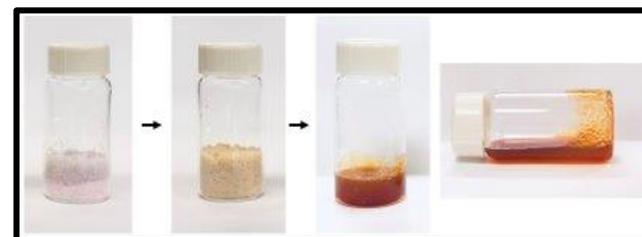
-Hsin Wang



Advanced Manufacturing:

Low-Cost, Durable Electrochemical Energy Storage for Electricity Grid Applications

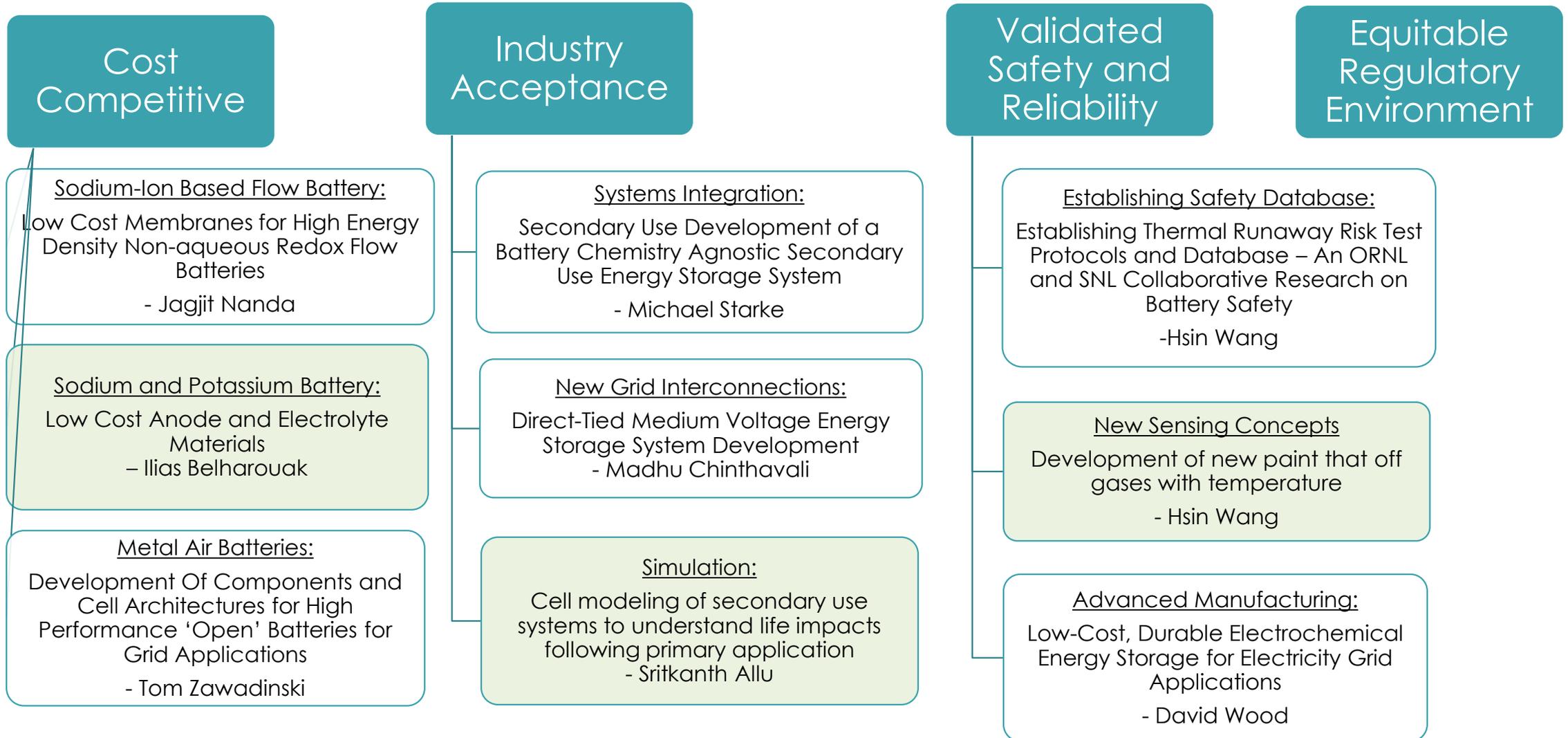
- David Wood



Equitable Regulatory Environment

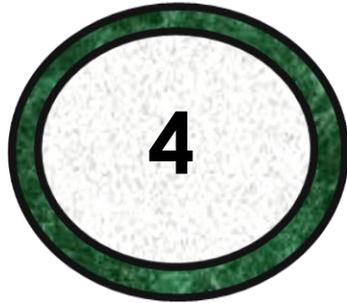
FY20: \$2.5M: 7 Projects

Energy Storage Projects Under DOE OE Energy Storage Program

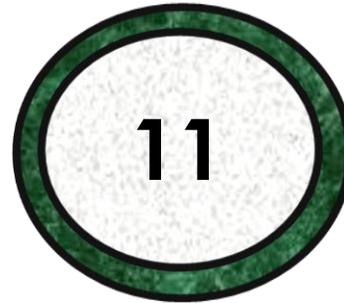


Program Output

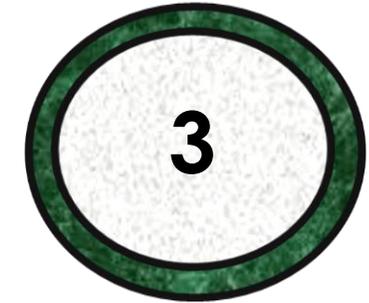
**Conference
Papers**



Journals



**Intellectual
Property**



GRID-C Facility Crosscutting Research

Vision: accelerate the transition and deployment of early stage components to systems R&D to enable autonomous operation of the grid

Cyber Security Research (DarkNet)

Secure, resilient communications architecture for the grid.

Advanced Component Development Lab

Sensors R&D platform, High voltage Semiconductors packaging and process development.

1+ MW Hybrid AC-DC 480V, 1.5 kV Grid Network

Future Substation ,network of Micro grids

All power electronics grid research, Distributed energy resources, and energy storage, HIL platforms

Grid Operations

Analytics Laboratory

Cyber-physical security, sensors, modeling, and data analytics test bed simulating a control room operation.

Battery Manufacturing Facility

Open-access DOE lab featuring materials synthesis, scale-up, roll-to-roll manufacturing, and prototyping vehicle and grid-level battery systems.

Electric Drive train Evaluation Facility

Open-access DOE lab for LD,MD,HD vehicle drivetrain evaluation

Advanced High voltage Component Characterization Lab

High voltage component evaluation and transmission and sub-transmission scale PE-HIL test beds

240/120 V Scale Grid

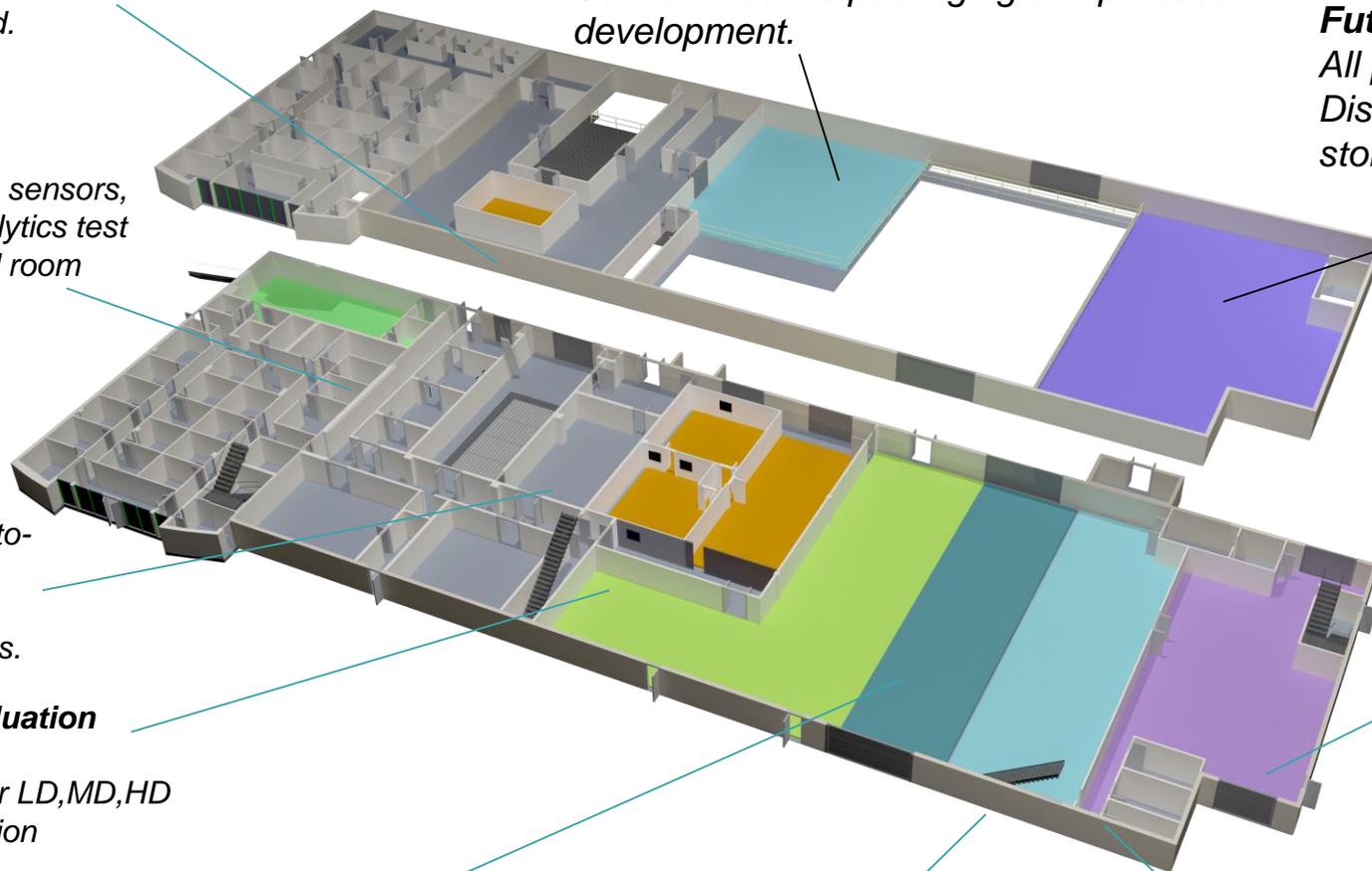
Home and neighborhood emulation, transactive controls, and grid integration test beds.

Extreme-fast Charging

Extreme-fast wired and wireless vehicle charging ecosystem and grid integration test bed.

Medium Voltage Distribution Scale Grid

Medium voltage PE interfaces, MV DC test beds



Acknowledgements

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