NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Energy Systems Integration

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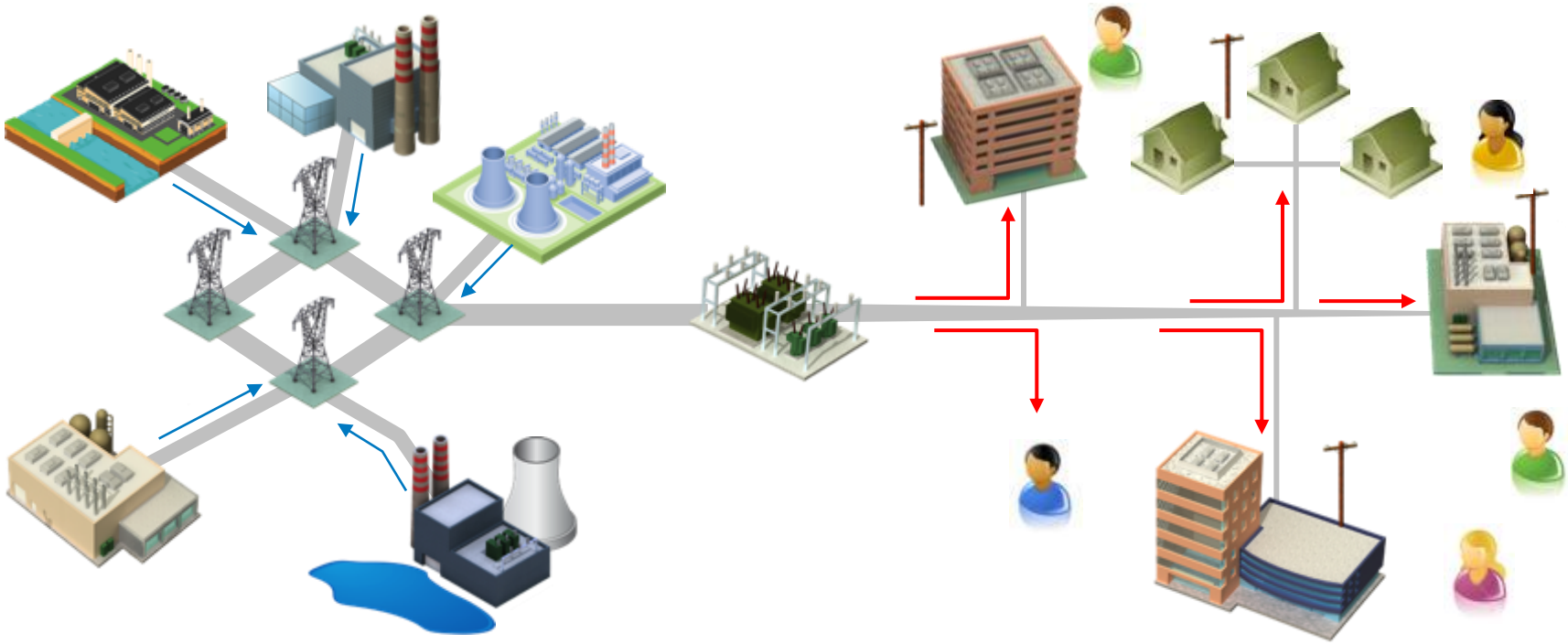
Why Energy Systems Integration?

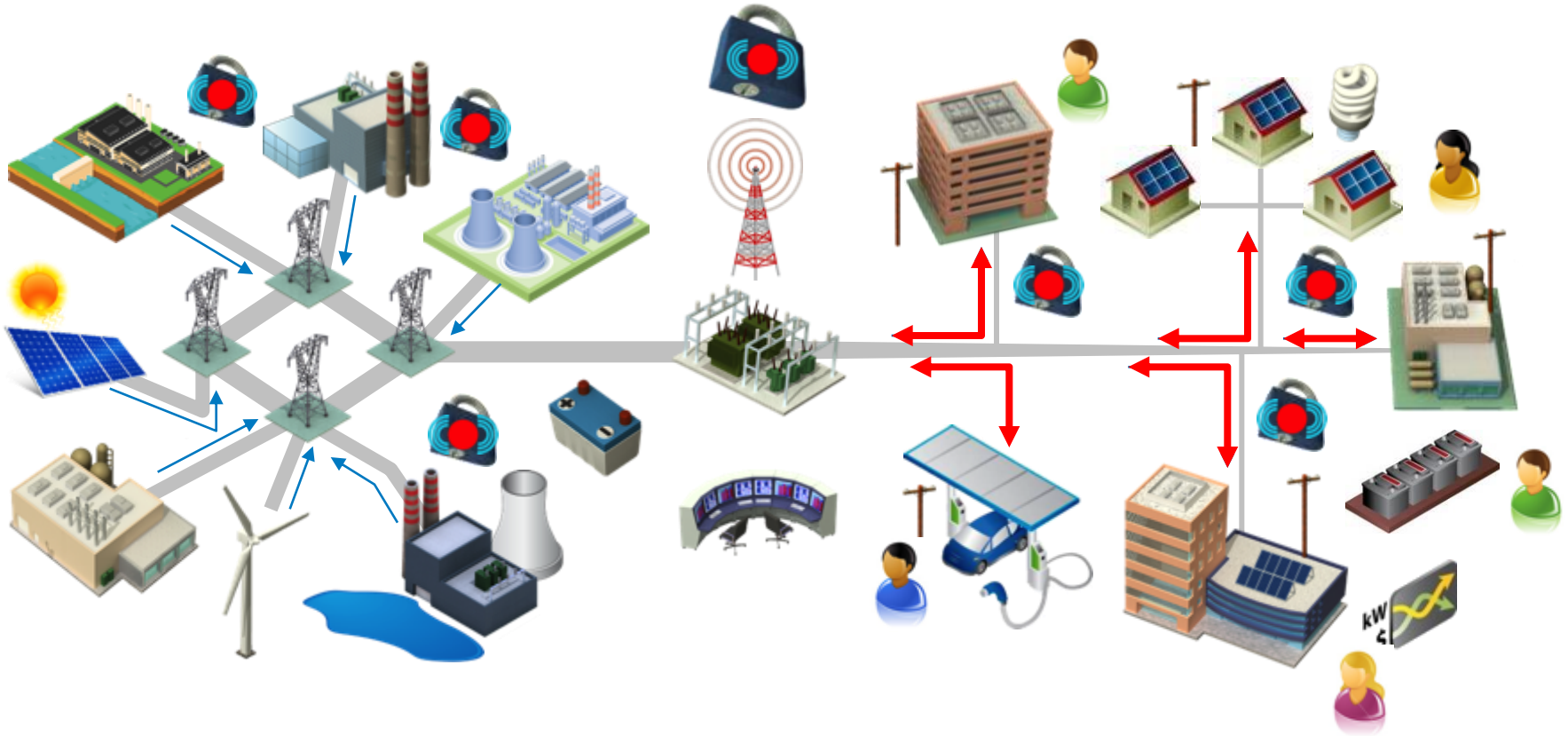
Existing energy systems have served us well… but a clean energy future needs a modernized and integrated infrastructure.

Today's Electricity Grid

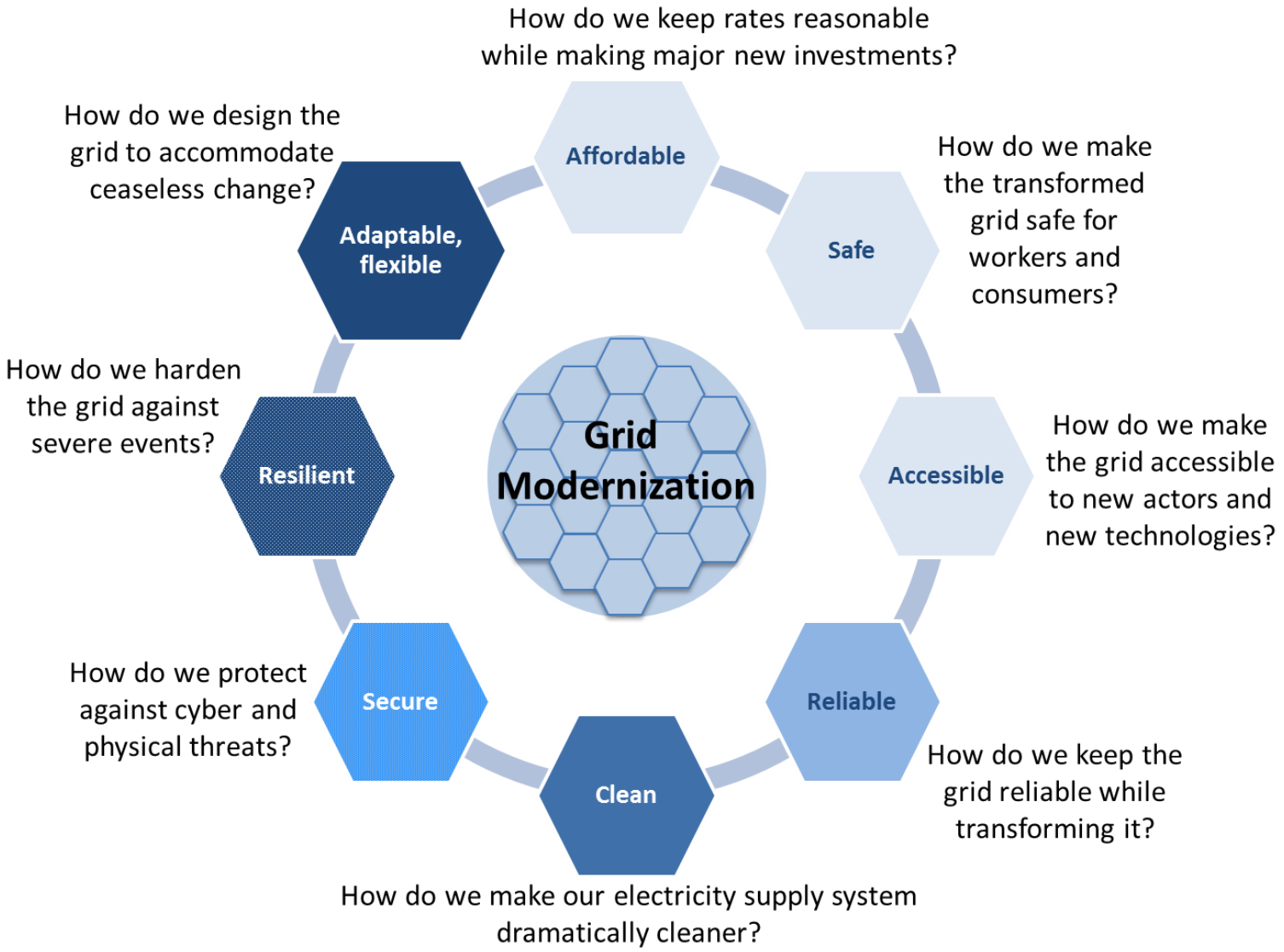


Generation Delivery Customer

Tomorrow's Power System



Key Grid Modernization Challenges



U.S. DOE Grid Modernization Initiative

System Control and Power Flow

Design and Planning Tools

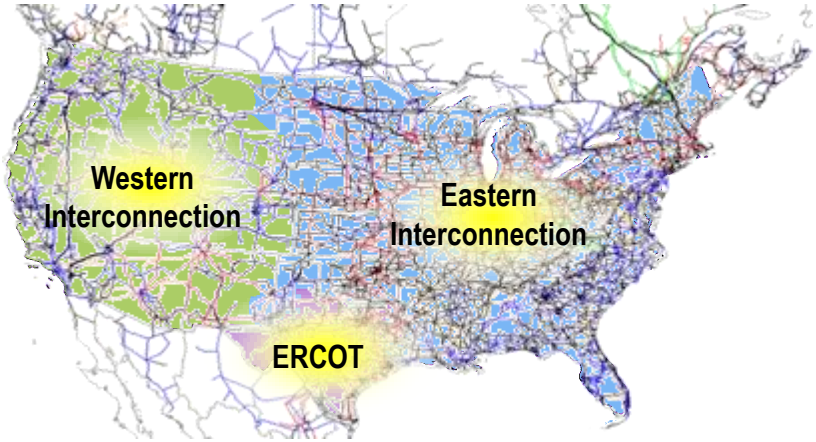
Sensing and Measurements

Devices and Integrated System Testing

Institutional Support

Security and Emergency Response

Regional Partnerships



Challenges

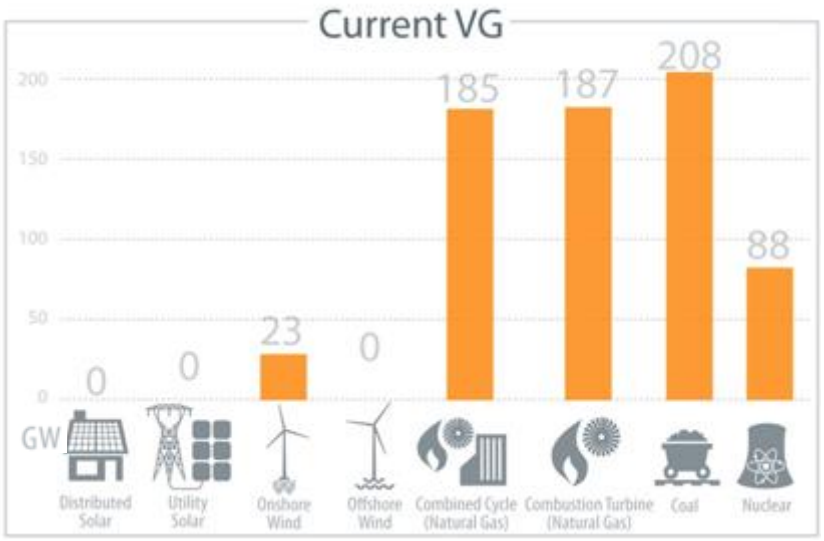
- Aging infrastructure
- Increased asset stress
- Fuel mix changes
- Increase variability and uncertainty
- More information and potential control points

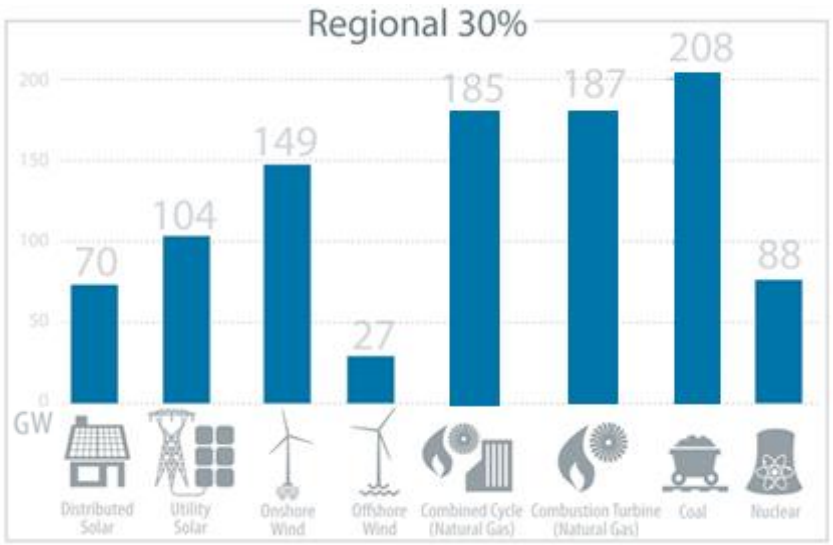
Goals

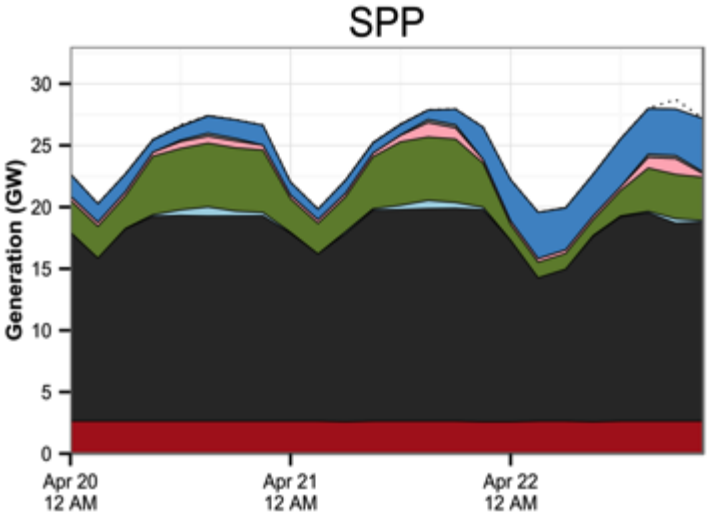
- Maintain reliability, safety, affordability
- Increase security and resilience
- Double installed renewables by 2020
- 80% clean electricity by 2035

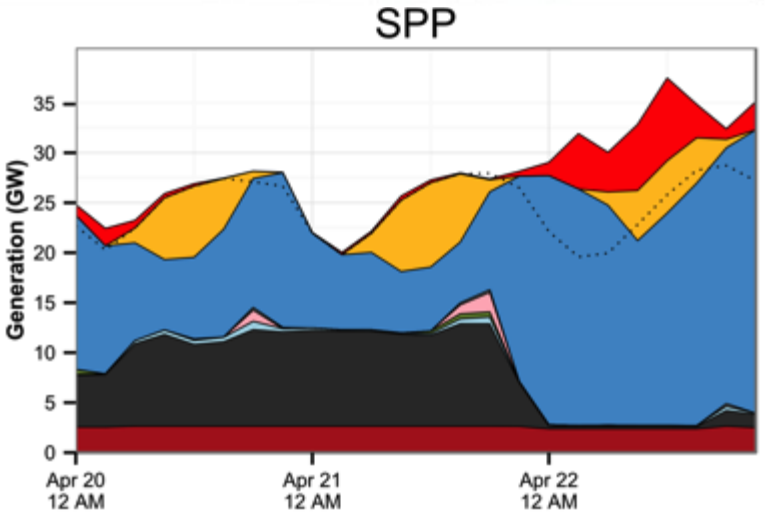
A Look Into the Clean Energy Future?

Eastern Renewable Generation Study (ERGIS), study forthcoming

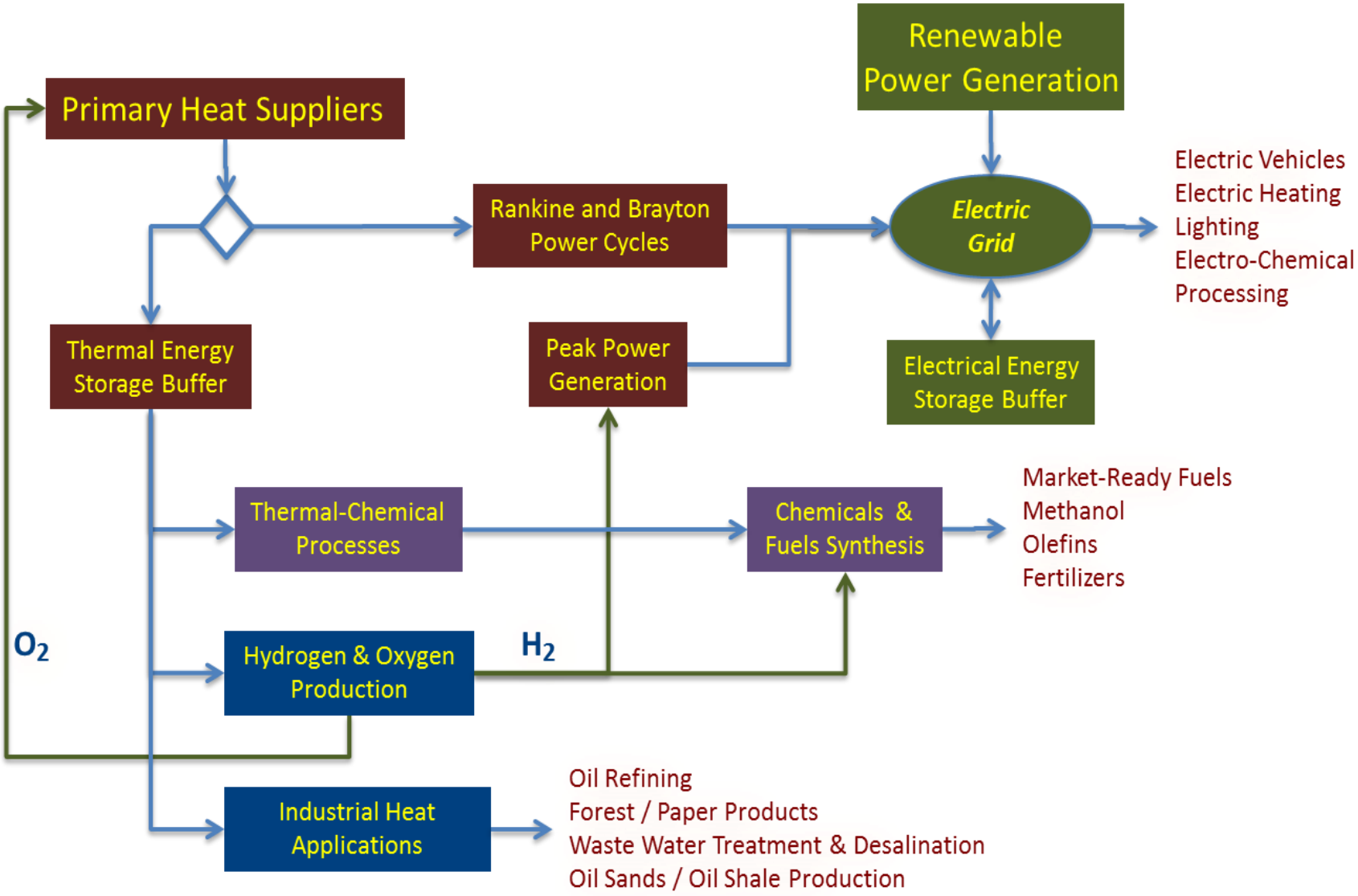




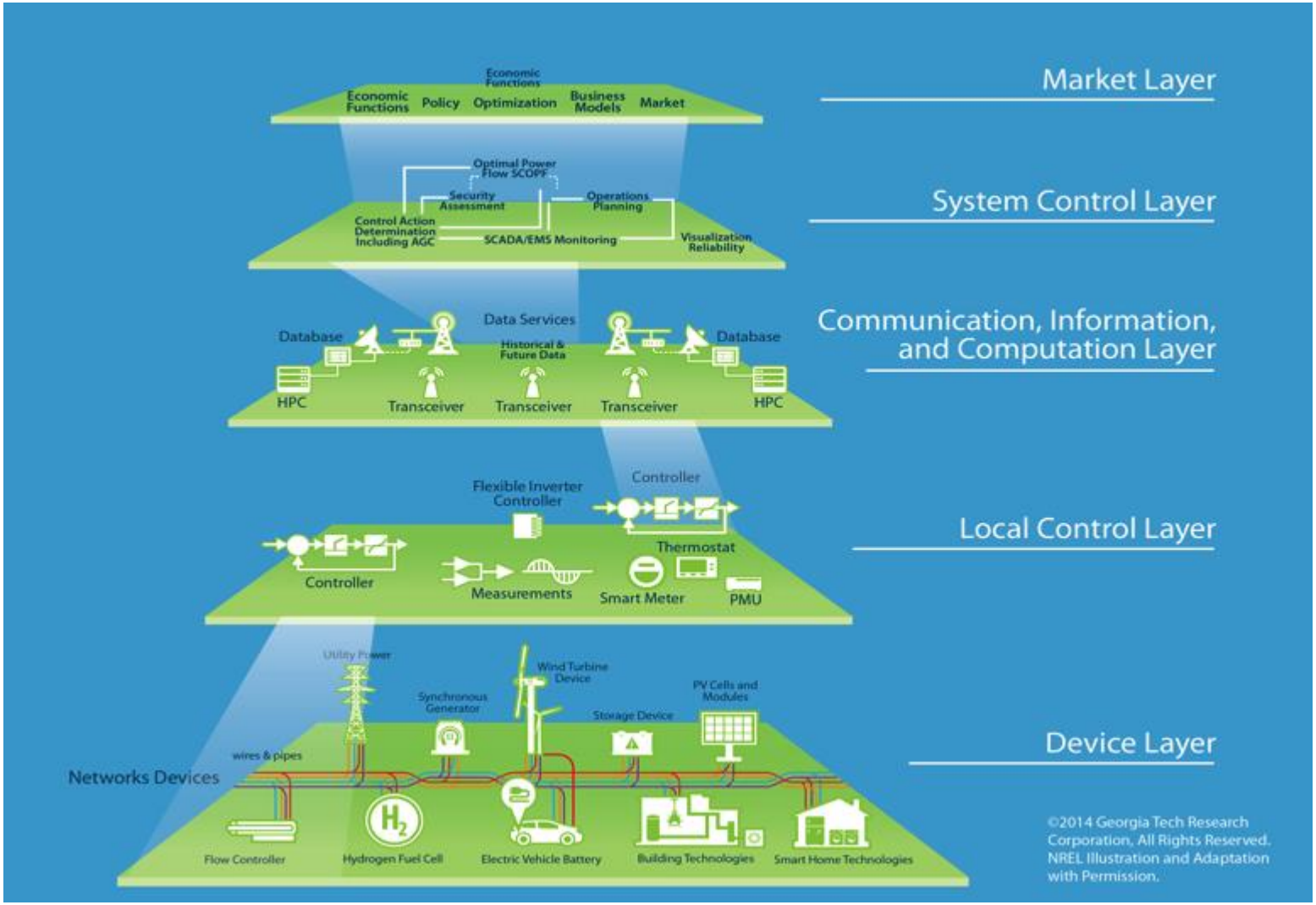




Thinking "Beyond the Grid"



Future Energy System Architecture

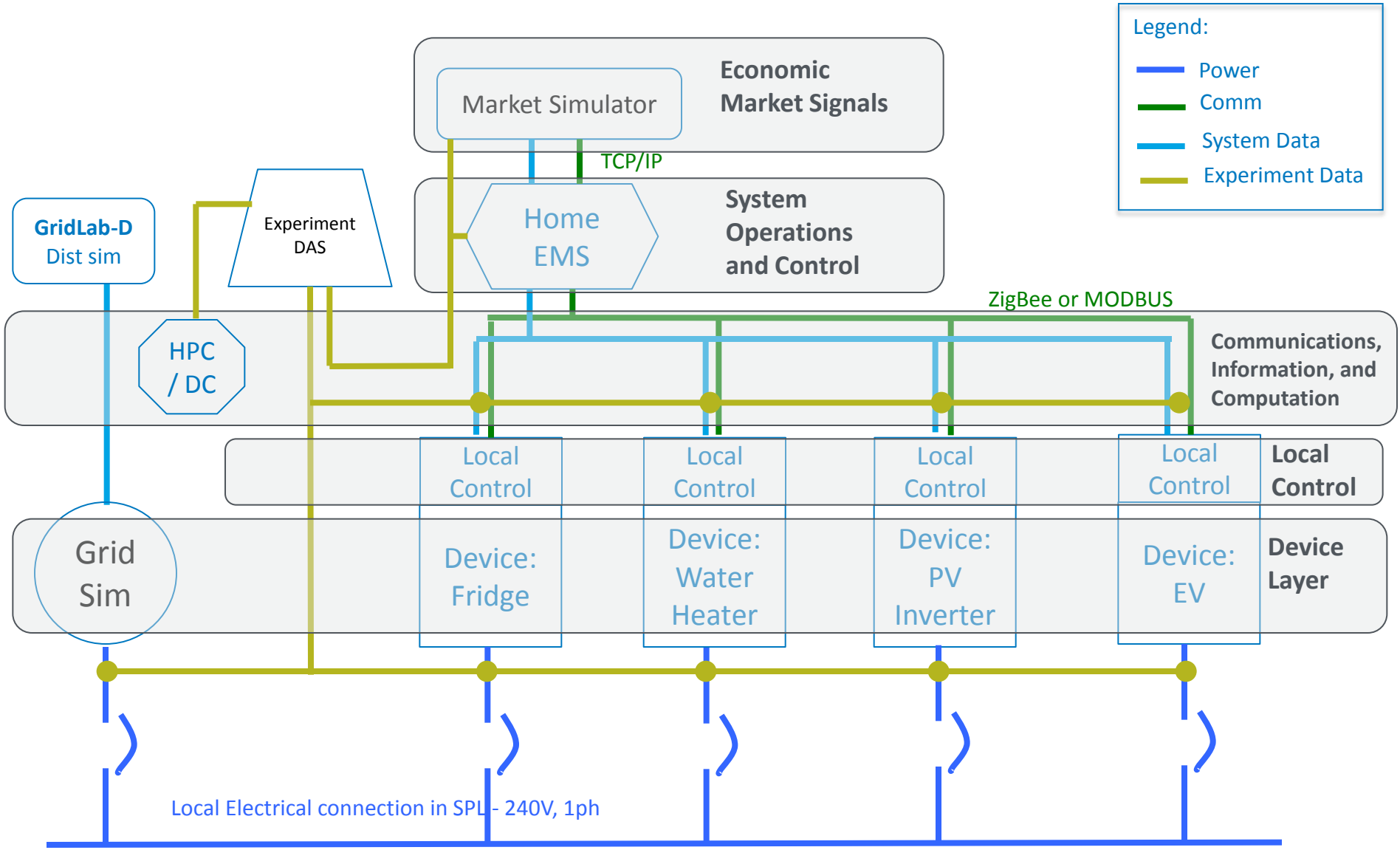


Energy Systems Integration Facility (ESIF)

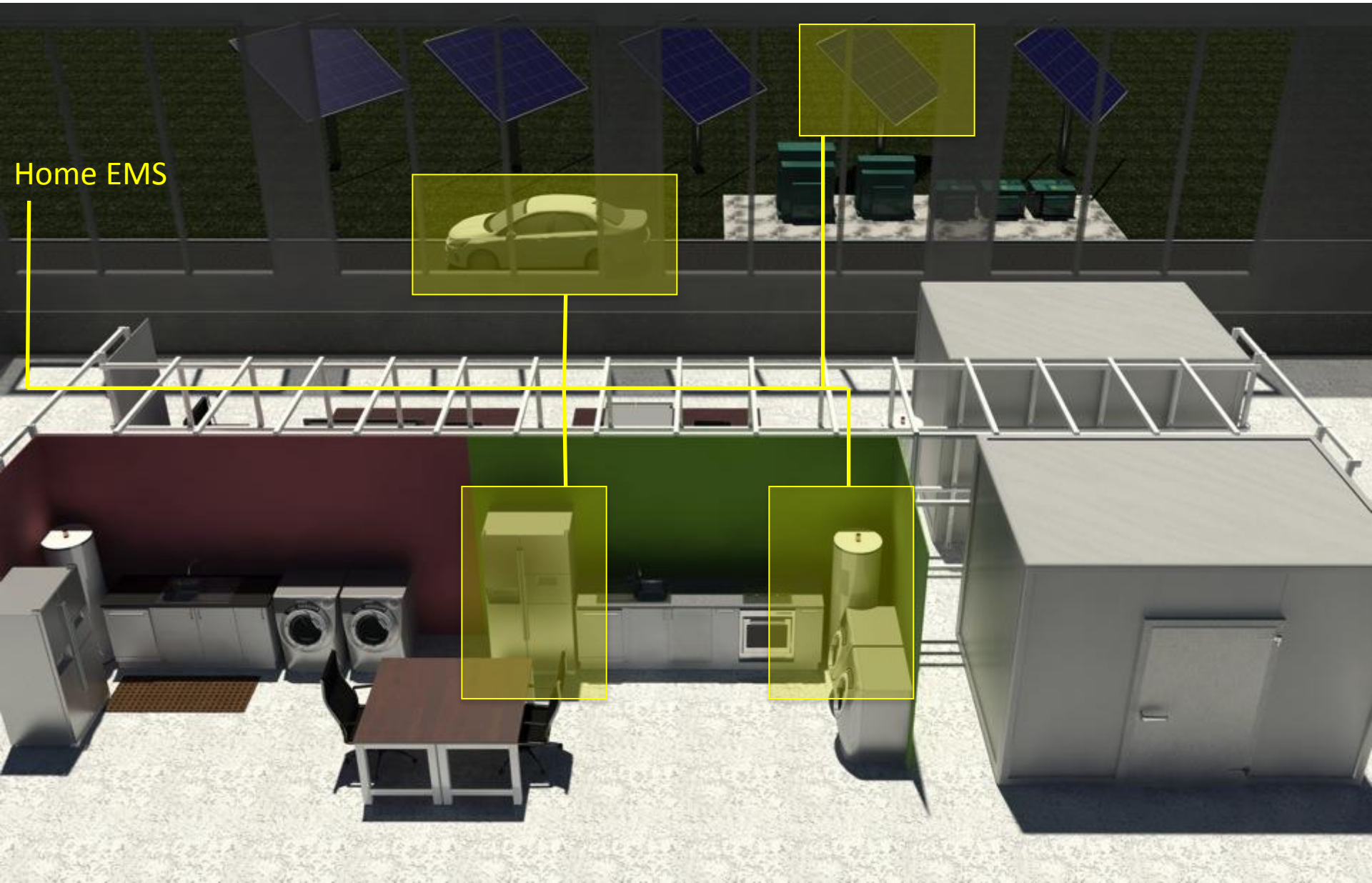
- NREL's largest R&D facility (182,500 ft^2 /20,000 m^2)
- Space for 200 NREL staff and research partners
- 15 state-of-the-art hardware laboratories
- Integrated megawatt-scale electrical, thermal and fuel infrastructure
- High performance computation and data analysis capabilities
- 2-D/3-D advanced visualization

http://www.nrel.gov/esi/esif.html

“Smart Home” Example



ESIF Smart Power Lab



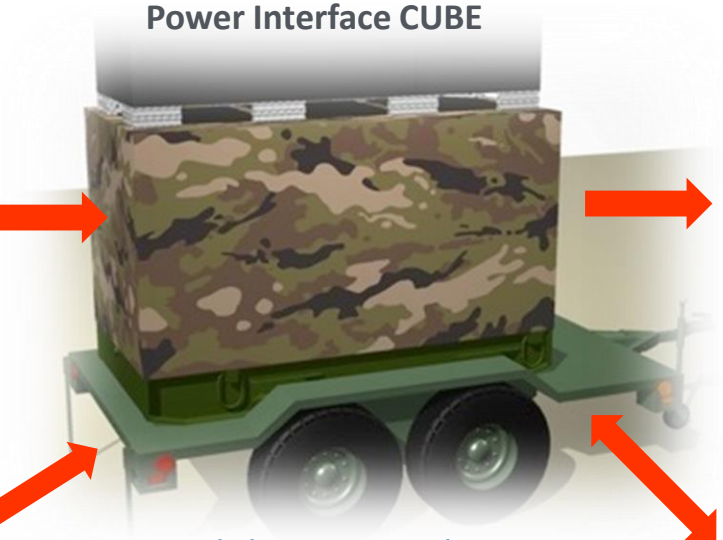
The “CUBE” – A Mobile Microgrid

Integrated power electronic platform for 60 kW PV-Battery-Diesel hybrid power system developed for the U.S. Army

TQG

Two 30 kW Gensets

Power Interface CUBE



Modular Power Electronic Building Blocks

AC and DC Loads

60 kW Load

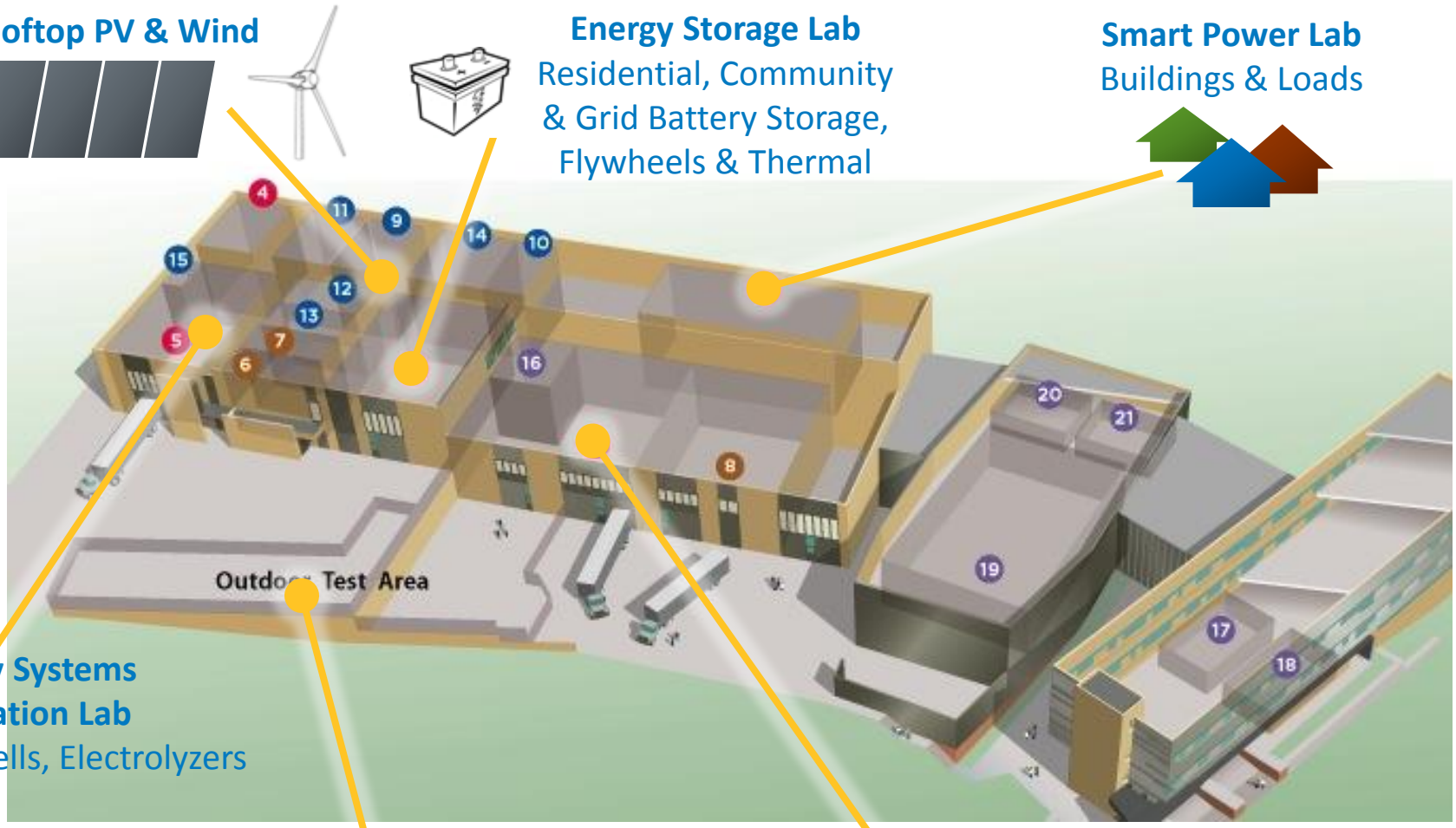
Solar

Four 5 kW PV Arrays

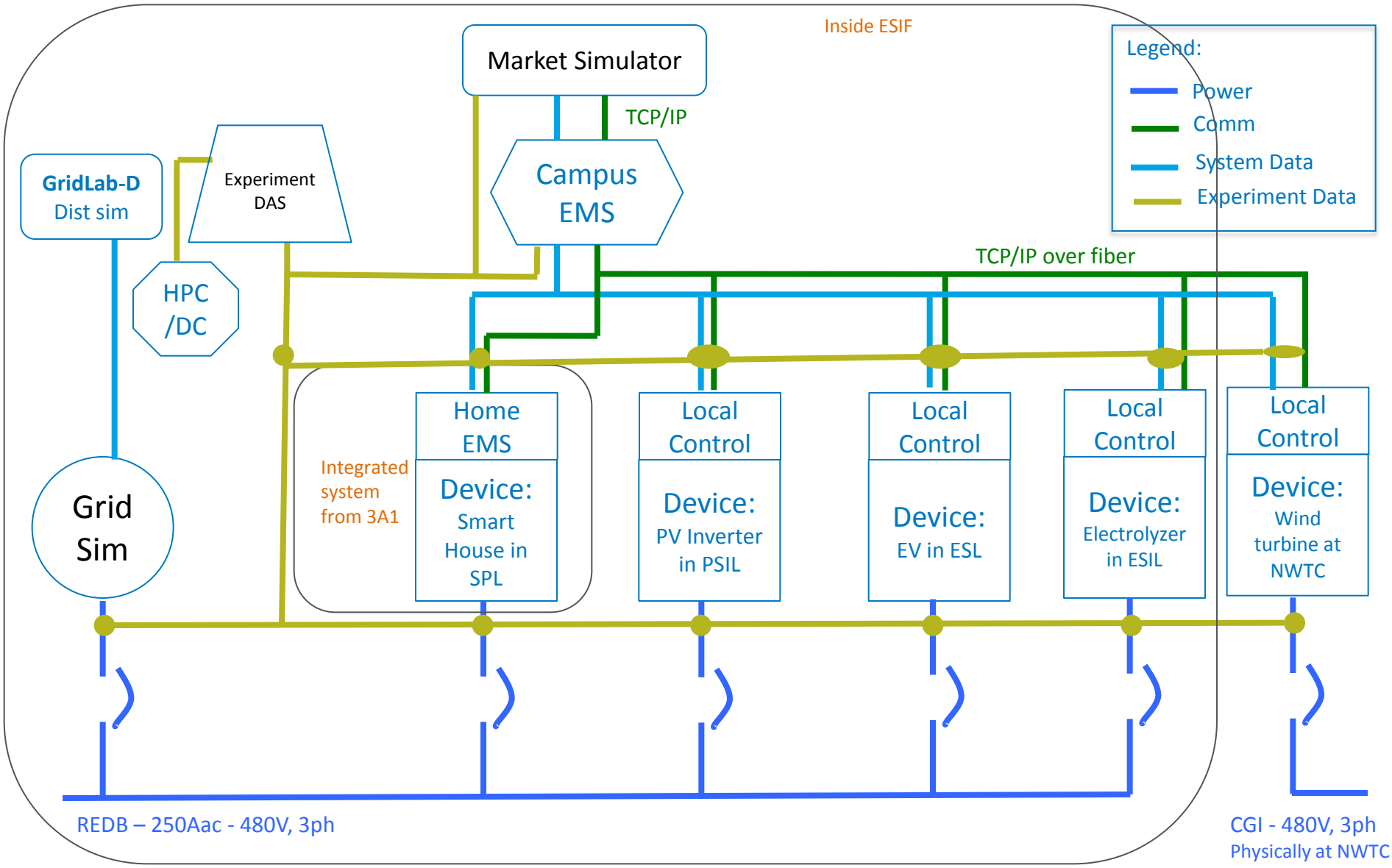
Batteries

One 30 kW Battery Bank

ESIF Laboratories



“Smart Campus” Example



iiESI International Institute for Energy Systems Integration

Addressing energy challenges through global collaboration www.iiESI.org

Vision

A global community of scholars and practitioners from leading institutes engaged in efforts to enable highly integrated, flexible, clean, and efficient energy systems

Objectives

- Share ESI knowledge and Experience
- Coordination of R&D activities
- Education and Training Resources

Activities

- Feb 18-19 Workshop (Washington DC)
- May 28-29 Workshop (Copenhagen)

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Pacific Northwest NATIONAL LABORATORY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

UCD DUBLIN

DTU

KU LEUVEN

A Design Process for Clean Energy

Hardware Testing

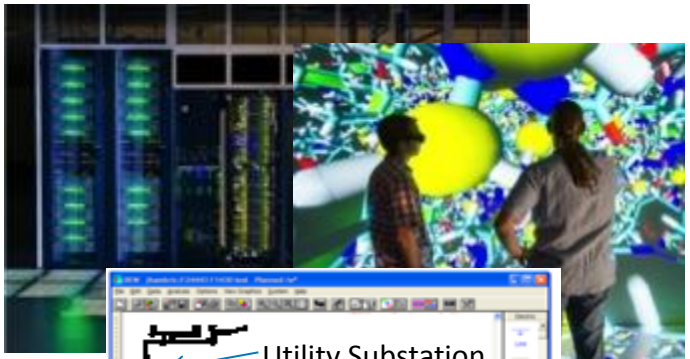
PV Simulator

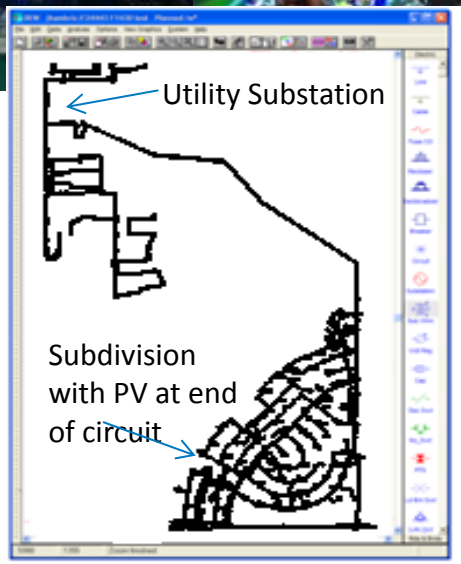
Devices Under Test (e.g. inverter, energy storage, EV, loads)

Load Banks

Grid Simulator

Modeling & Simulation





Field Deployment

Continuous Learning and Improvement

For More Information

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Energy Systems Integration

Accelerating the Clean Energy Future