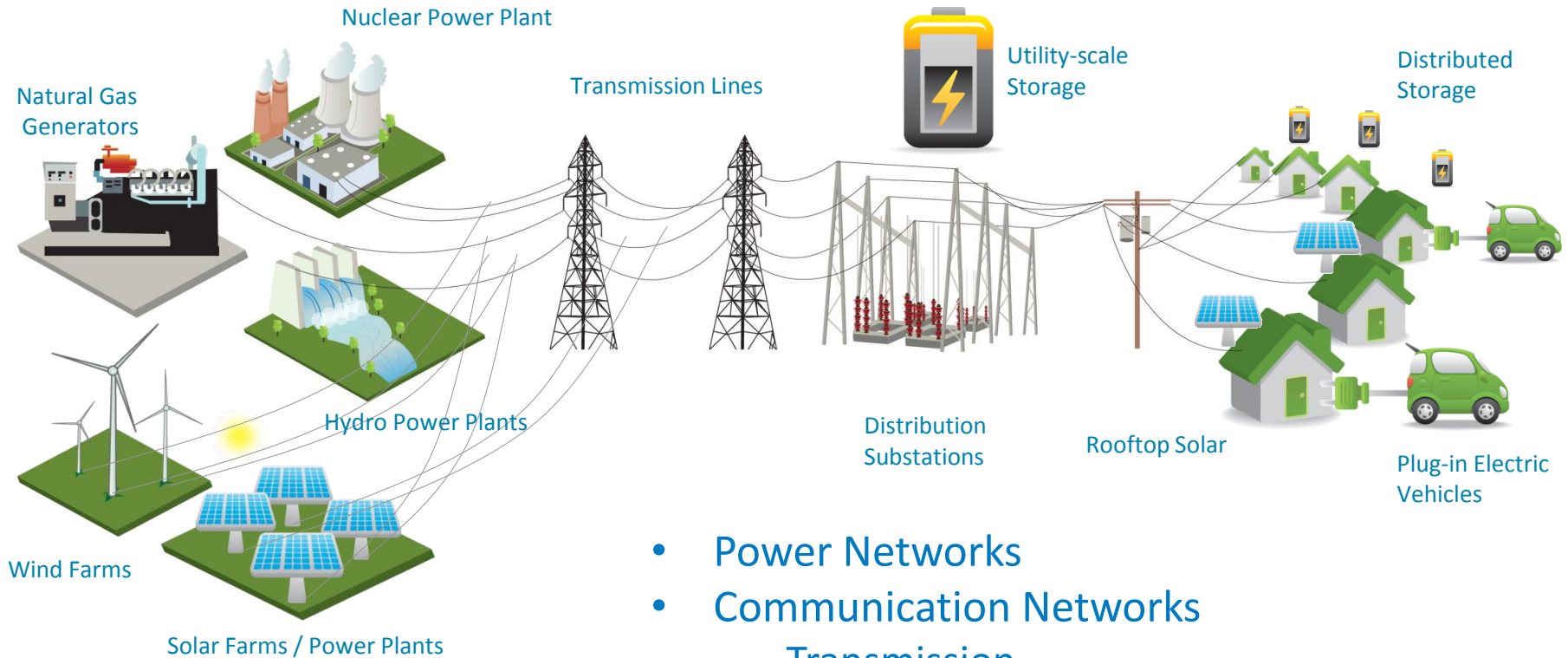# Grid Modernization – Bringing New Technology to the Industry

Art Anderson
NREL Grid Integration Program Manager

Grid Integration – New Technology

Utility Environments

Nuclear Power Plant

Natural Gas Generators

Transmission Lines

Utility-scale Storage

Distributed Storage

Hydro Power Plants

Distribution Substations

Rooftop Solar

Plug-in Electric Vehicles

Wind Farms

Solar Farms / Power Plants

- Power Networks
- Communication Networks
  - o Transmission
  - o Distribution
  - o Control Systems
  - o Outage Management

Utility Communication Networks

Field Area Networks

- Fiber

- Cellular

- Legacy Network Solutions

Residential & Commercial Networks

- Cellular

- WiFi

- Radio Frequency Mesh
  - Meter Networks
  - Home Energy Management

Utility Infrastructure

Example: California Utility:

- 70,000 square miles

- 5.2 million Electric Customers

- 1,008,186 Transformers

- 6,833 MW of Generation

- 18,616 miles of electric transmission

- 120,000 miles of electric distribution circuits

Innovation to Production

Grid Integration - Establish a Path

Solutions Rarely go form Design to Production
- o Too Many Moving Parts

- Products need to be evaluated in a test environment
  - o Power Solution Characteristics
  - o Communication Capability
  - o Utility Requirements

- Evaluate Business Processes and Systems
  - o Transmission Systems
  - o Distribution Systems
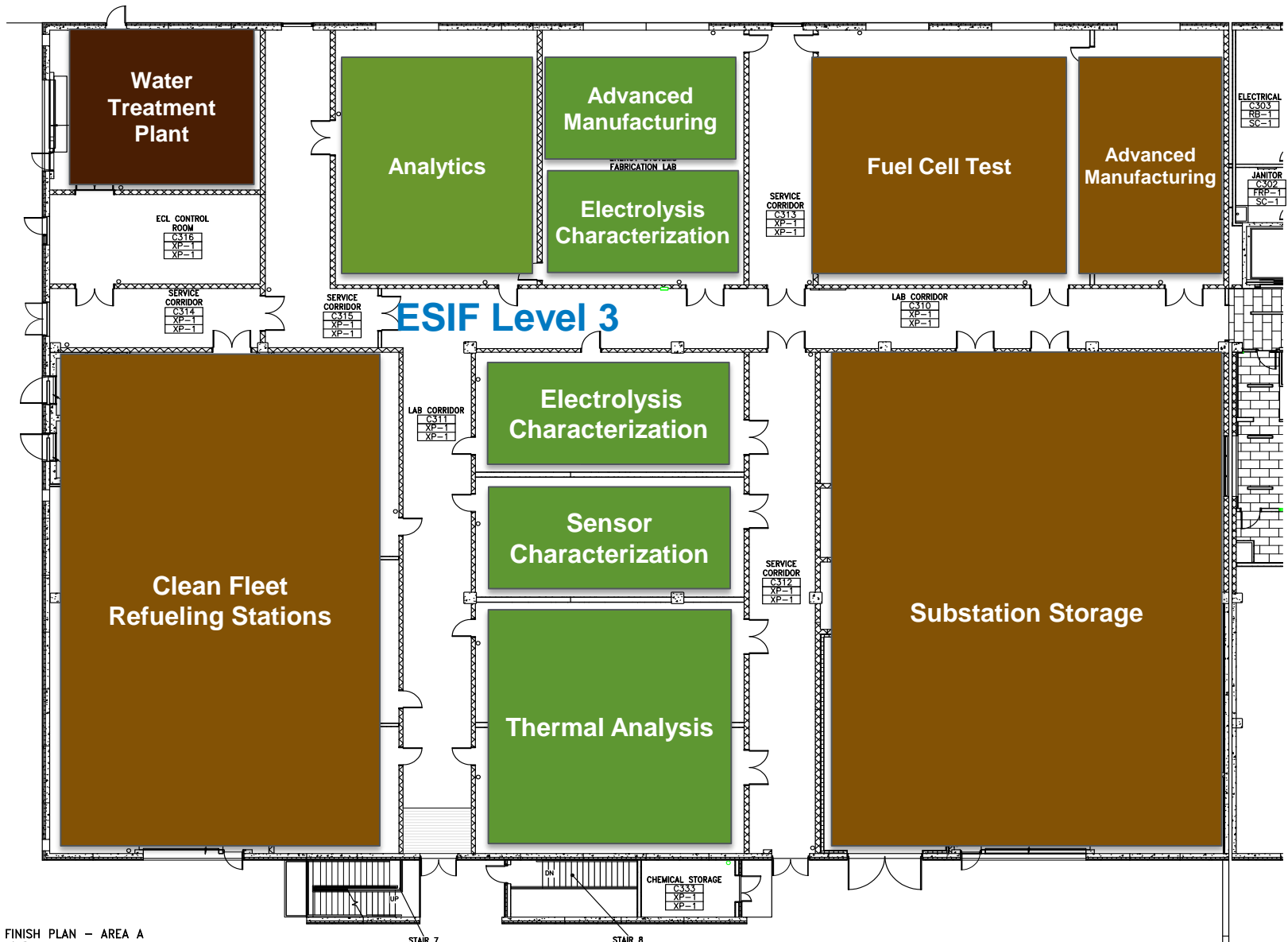   - – SCADA
    - – Outage Management
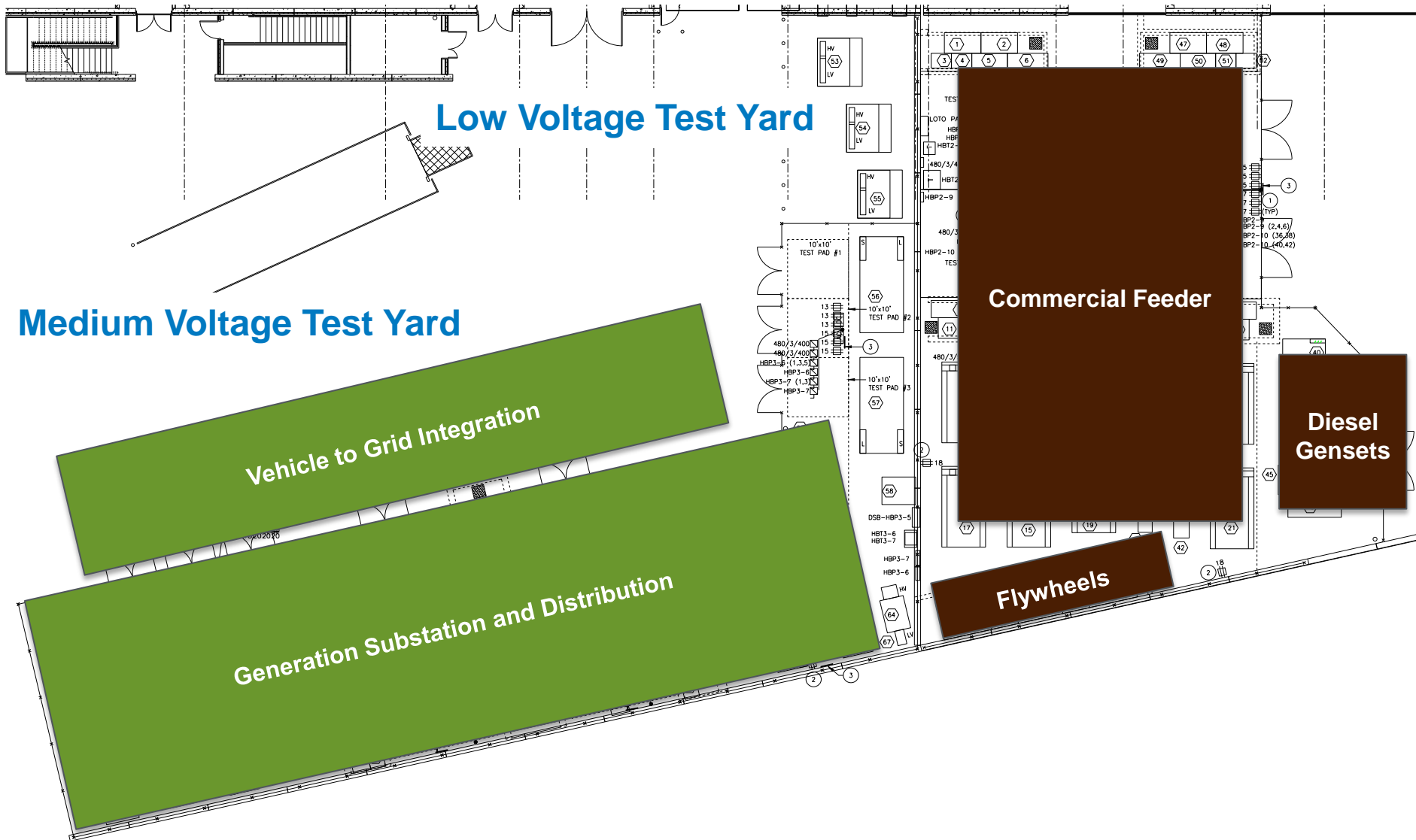
Electric System Integration Facility

- **Designated by DOE March 2013**
- **Federally sponsored facility available for external use**
  1. Open to all potential users
  2. Allocation of resources determined by merit review
  3. User fees are not charged for non-proprietary work if results are published in open literature
  4. Full cost recovery is required for proprietary work
  5. Facility provides resources sufficient for users to conduct work safely and efficiently
  6. Facility supports a formal users organization
  7. Facility is governed by a steering committee made up of DOE, NREL, Industry, Academia, and Users
  8. Facility does not compete with any available private sector capability

ESIF – Integrated Distribution Capability

Small Commercial

Multi Inverter

Commercial PV

Cyber Security

Commercial Systems

Home Energy Management

Feeder Level Technology

ESIF Level 2

DMS Control Room

Distributed Energy Resources

PV Simulation

Grid Simulation

Solar Farm Large Inverter Testing

Distributed Energy Resource Management

Industrial Demand

Microgrids Large Commercial Loads

Solar Thermal Calibration

Environmental Characterization

ESIF – Generation and Storage

ESIF Level 3

LEVEL 3 FINISH PLAN – AREA A

ESIF – On Site Integration

Low Voltage Test Yard

Medium Voltage Test Yard

Vehicle to Grid Integration

Generation Substation and Distribution

Commercial Feeder

Diesel Gensets

Flywheels

High Performance Computing

Grid Integration – Show solutions at utility scale

HPC for Advanced Manufacturing

- The *High Performance Computing for Manufacturing (HPC4MFG)*

The HPC tools can provide simulation capability to provide new understanding of energy and materials efficiency in manufacturing processes, particularly for energy intensive and energy dependent applications.

- The *Next Generation Electric Machines (NGEM)*

This program connects AMO investments in power electronics with the large scale electric motors used in manufacturing, providing a technical pathway to cost-effective energy efficiency in a range of applications.

Thank you

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www.nrel.gov/ESIF