AABC Commissioning Group

AIA Provider Number 50111116

Incorporating Distributed Energy Generation Projects into Whole Building Commissioning

Course Number: CXENERGY1827

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Course Description

Distributed energy and power systems, including the integration of renewable energy generation sources, cogeneration, energy storage systems and traditional backup generators, are increasing in importance, due to both decreasing costs and a renewed emphasis on resiliency and community microgrids. This presentation discusses how Owner's Project Requirements and commissioning plans can be expanded to incorporate Distributed Energy Systems.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand why Distributed Energy Generation is making the leap beyond “Back-up Power.”

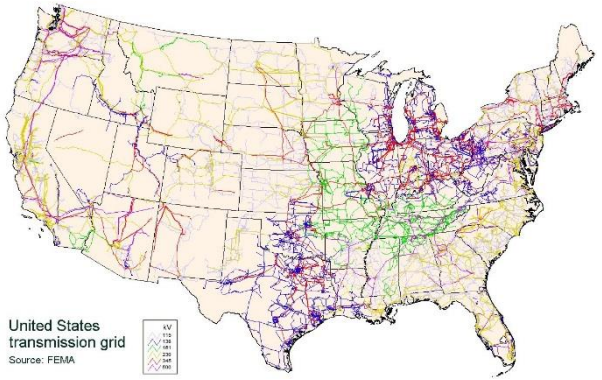
2. Understand the components required to make Distributed Energy Generation practical.

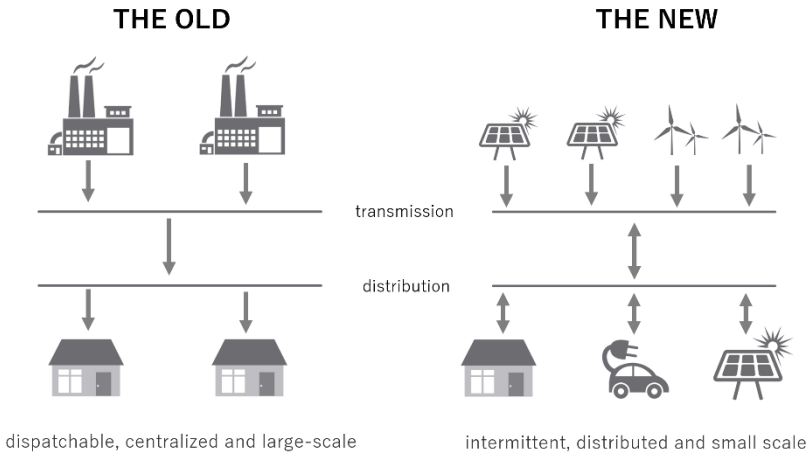
3. Understand the aspects of third party certifications, such as PEER.

4. Understand the role of the Commissioning Authority in projects with Distributed Energy Resources.

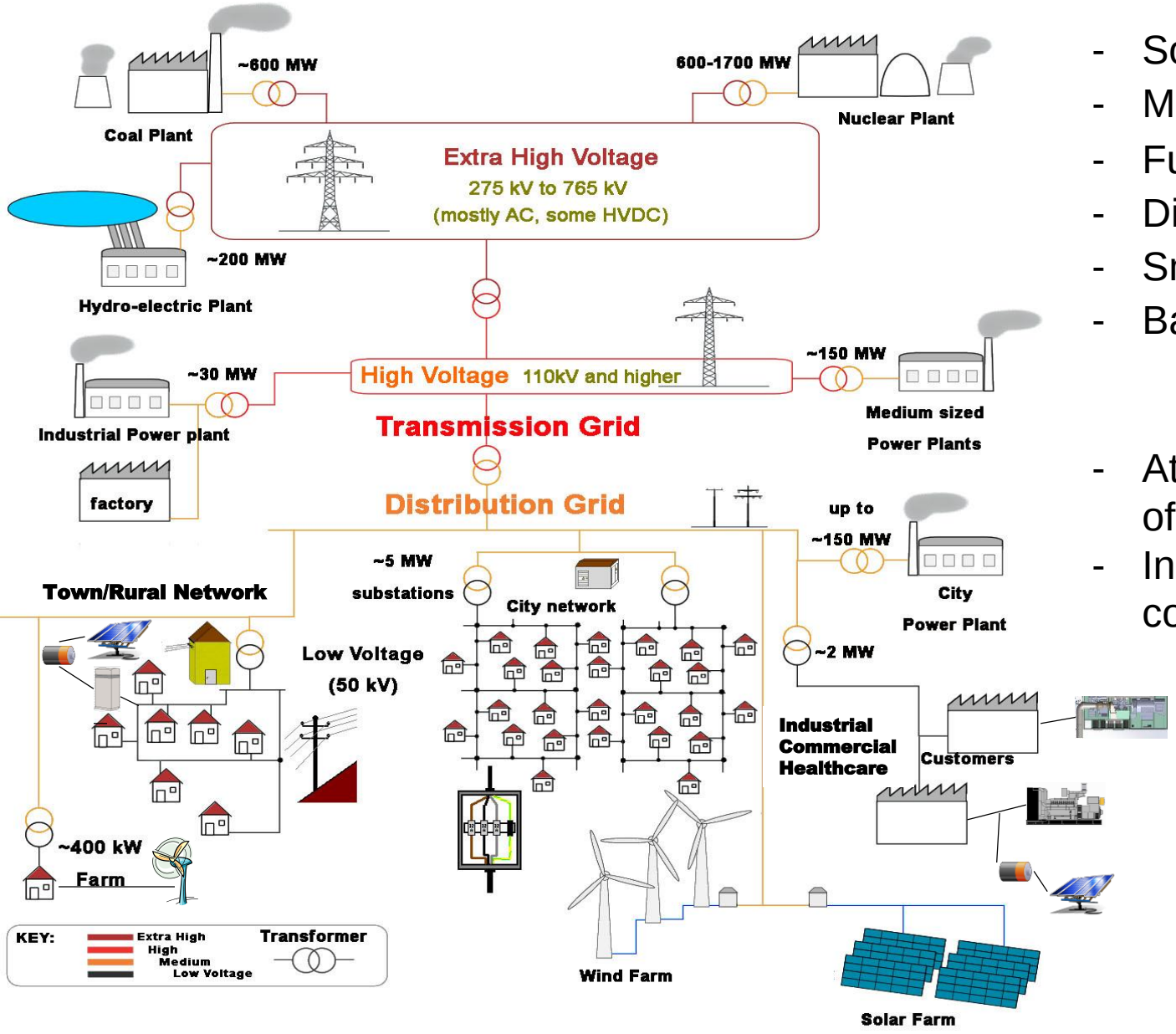
Witnessing the Evolution

- Fundamental shift in energy production and distribution
  - Aging distribution infrastructure
  - Increasing need for resiliency and reliability
  - Development of new production technologies
  - Shift from primary source to fleet of interconnected smaller ones





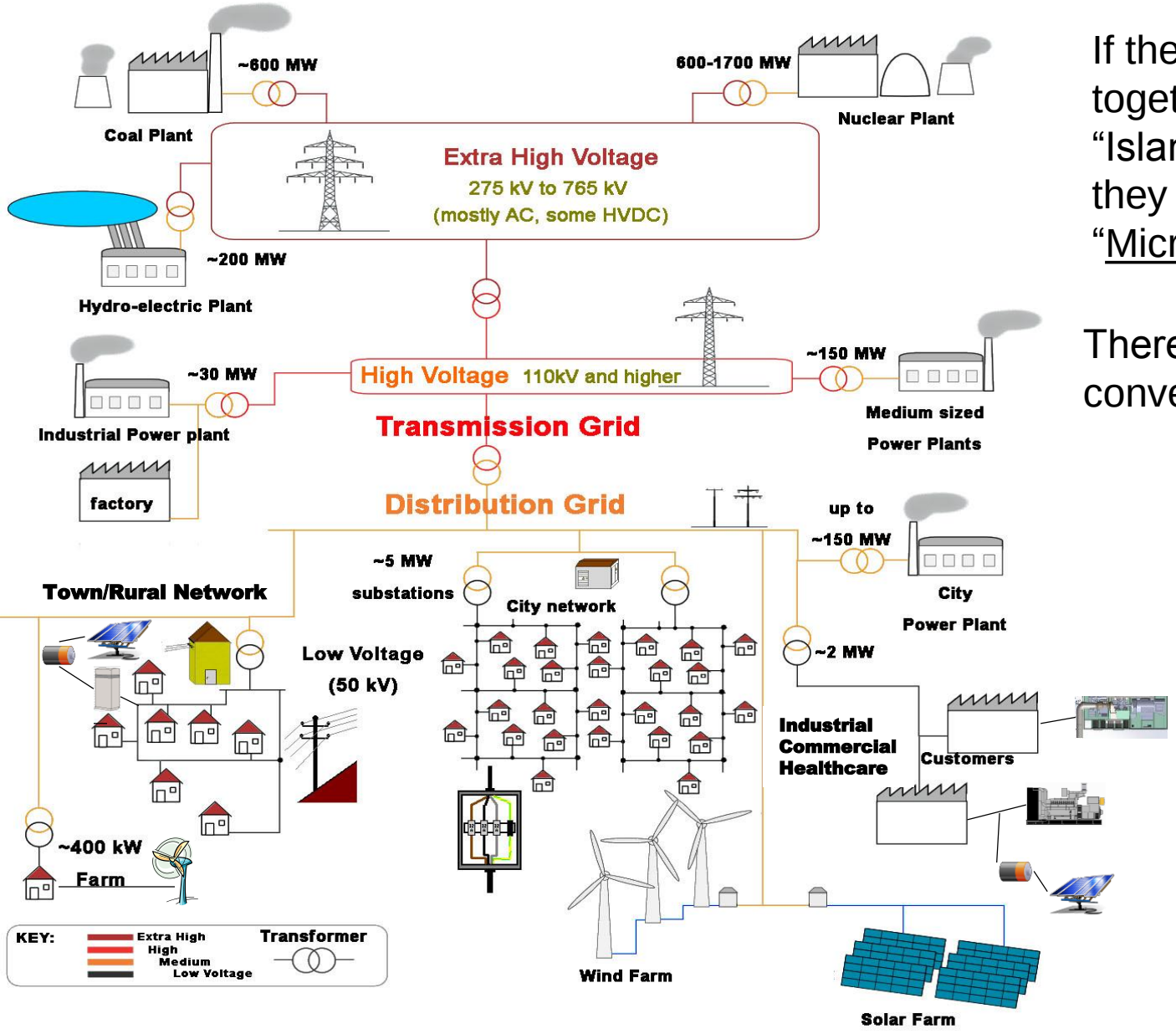
What do we mean by Distributed Energy Resources (DER)?



- Solar/PV
- Microturbines
- Fuel Cells
- Diesel/Gas Gensets
- Small Wind Turbines
- Battery Storage

- Attached to subset of Distribution Grid
- Independently-controlled

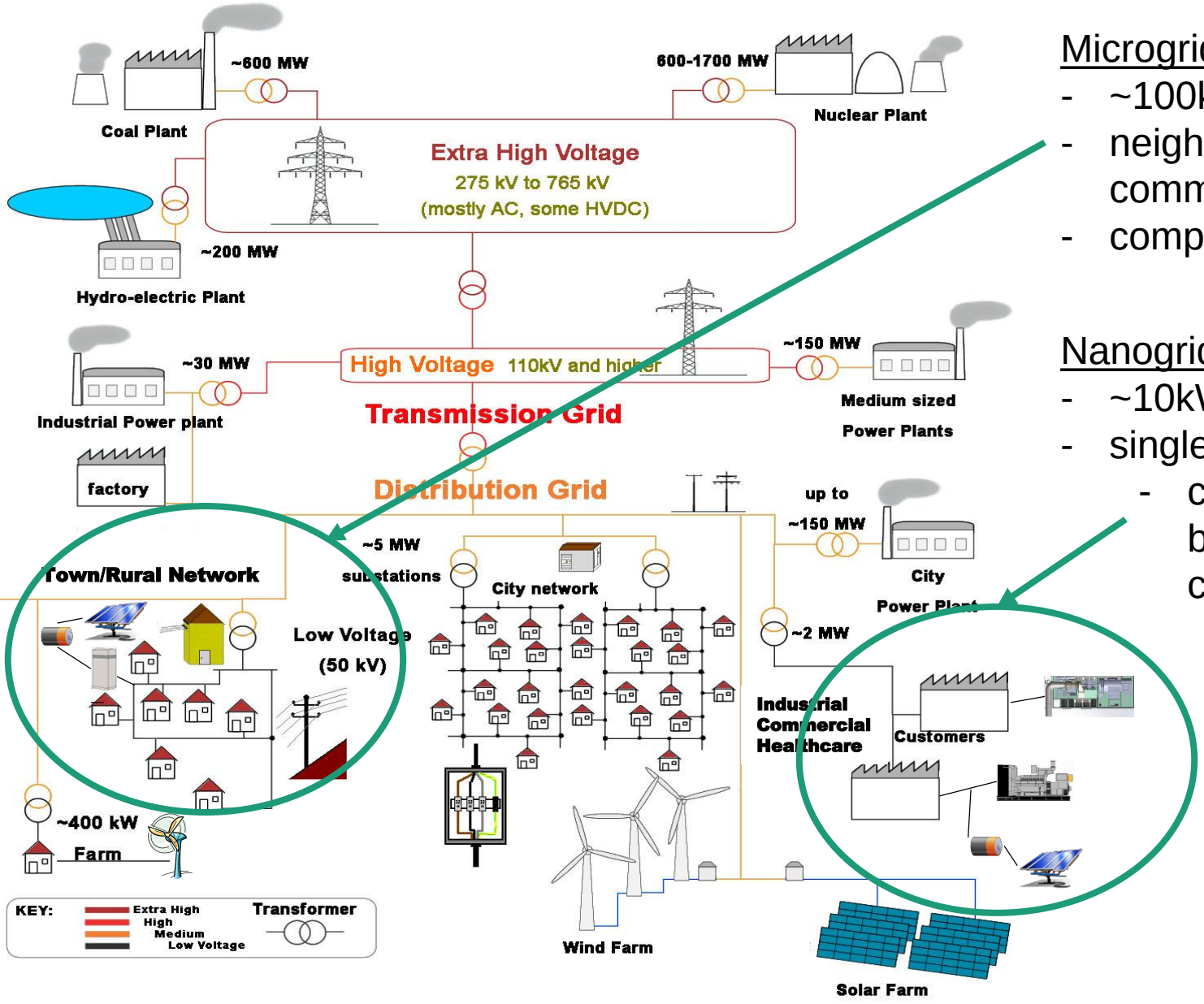
What do we mean by Distributed Energy Resources (DER)?



If the DERs are tied together and designed to "Island" from the Utility, they are termed a "Microgrid" or "Nanogrid"

There's no fixed convention, but in general:

What do we mean by Distributed Energy Resources (DER)?



Microgrids

- ~100kW to ~10MW
- neighborhoods or communities
- complex campuses

Nanogrids

- ~10kW to ~1000kW
- single owner
  - could be multiple buildings on one campus

Nanogrids & Whole Building Commissioning

Single Owner is the key (currently):

- Microgrid projects tend to be
  - Rare
  - Highly customized controls
  - Complex with numerous entities (many “bosses”)
- Nanogrid projects, with prices falling, are
  - Becoming more common
  - Still customized, but with more off the shelf systems
  - Driven by one owner (fewer “bosses”)
  - Typically include one, or at most a few, buildings

Advantages of Nanogrids

Resiliency - when the grid goes down, the building is still operational

If this was the only reason, we'd just use diesel gensets

Other advantages:

- Use DERs continuously – return on capital $$
- Extend backup generator fuel beyond 72 or 96 hours
- Energy efficiency
  - no transmission losses / cogeneration
- Peak shaving and load leveling
  - save money & equipment life
- Tax credits
- Own a buzzword
  - Net Zero Energy / Passive Building / LEED Kryptonium

Third-Party Certifications

USRC – United States Resiliency Council

- Focused on seismic events
- Ratings based on Life, Damage, and Recovery

Usefulness of Performance Metrics

USRC BUILDING RATING SYSTEM	SAFETY	DAMAGE	RECOVERY
★ ★ ★ ★ ★	Blocking exit paths unlikely	Minimal Damage (<5%)	Immediate to Days
★ ★ ★ ★	Serious injuries unlikely	Moderate Damage (<10%)	Within days to weeks
★ ★ ★	Loss of life unlikely	Significant Damage (<20%)	Within weeks to months
★ ★	Isolated loss of life	Substantial Damage (<40%)	Within months to a year
★	Loss of life likely	Severe Damage (40%+)	More than a year

Source: usrc.org/rating-definitions

Third-Party Certifications

PEER – Performance Excellence in Electricity Renewal

- Registered trademark of Green Building Certification, Inc.
- Modeled after LEED
  - Points awarded in four categories:

1) Reliability and Resiliency
2) Energy Efficiency and Environment
3) Operational Effectiveness
4) Customer Contribution

Unlike USRC, PEER has a strong sustainability aspect

Recent Real World "Nanogrids" – State of Oregon RFP

Resiliency Buildings - Continuity after "Cascadia"

- Normal 350,000 SF office building with parking garage
- Post-earthquake 24/7 operation at 150% normal occupancy
  - Low energy/carbon-neutral/passive designs aid both goals
- Assumes no utilities after disaster event
  - Must have off-grid water and wastewater systems
- Assumes portable communications devices (cell-on-light-truck)
- Includes some type of "energy plant" for multiple buildings
- Includes generator with fuel delivery every 96 hours
- Includes a photovoltaic (PV) system, i.e., solar array
- Design must mitigate flood risk
- USRC Platinum and USGBC LEED Gold certified

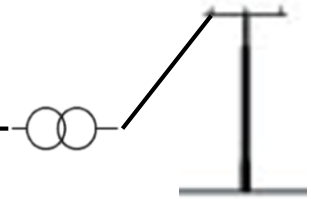
Recent Real World “Nanogrids” – Beaverton School District

Timberland MS - “Community Shelter” for 30+ days

- Seismic Risk Category III (code); designed for IV
- 500kW generator with 4000 gallons fuel (96 hours)
- 128 kW PV system – use to extend fuel storage
- Assumes no natural gas service
- Must power lighting, communications, security, “spider boxes”
- Minimize active ventilation and heating – no AC
- Some provisions for pumping/heating water to key areas

Recent Real World “Nanogrids” – Beaverton School District

Main Switchboard



PV Inverters

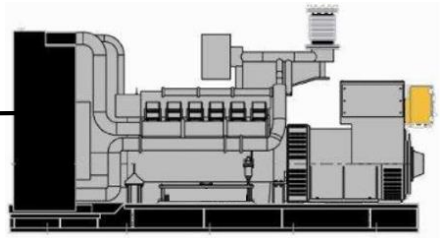
ATS

ATS

Emergency Load Panel

Standby Power Panel

Genset Panel



To School Resiliency Loads

Genset Loadbank

Recent Real World “Nanogrids” – Beaverton School District

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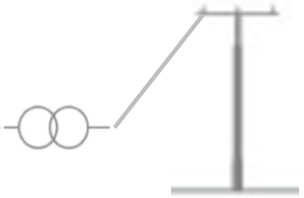

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Emergency Load Panel

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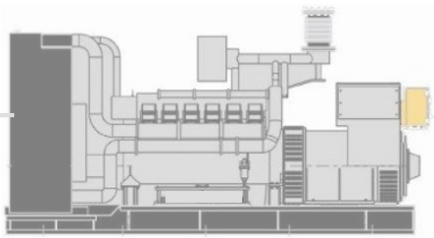


Resiliency Loads

Genset Loadbank

Alarm Bells for AHJs

- PV Panels NOT disconnected during grid outage
- Multiple Automatic Transfer Switches

Does the CxA *really* need to care about DER & Nanogrids?

Let's look at the Trends

- 2017 Global investments ~ $4 Billion/yr
- Market estimates by 2026 ~ $23.6 Billion/yr
- Buildings increasingly becoming sources of dispatchable power
- Oregon State Law ORS 279C.527
  - 1.5% of public bldg. cost to green energy technology
  - Many designers choosing photovoltaic

Integrating DER's into Building Cx

Commissioning providers

- Help building owners define their requirements
- Communicate through the OPR (Owners Project Requirements)
- Develop and execute an effective Cx Plan

OPR – Defining Owner Requirements

- Priorities
- Financial Goals
- Technical Requirements
  - Island Mode – Off Grid
  - Normal Mode – On Grid

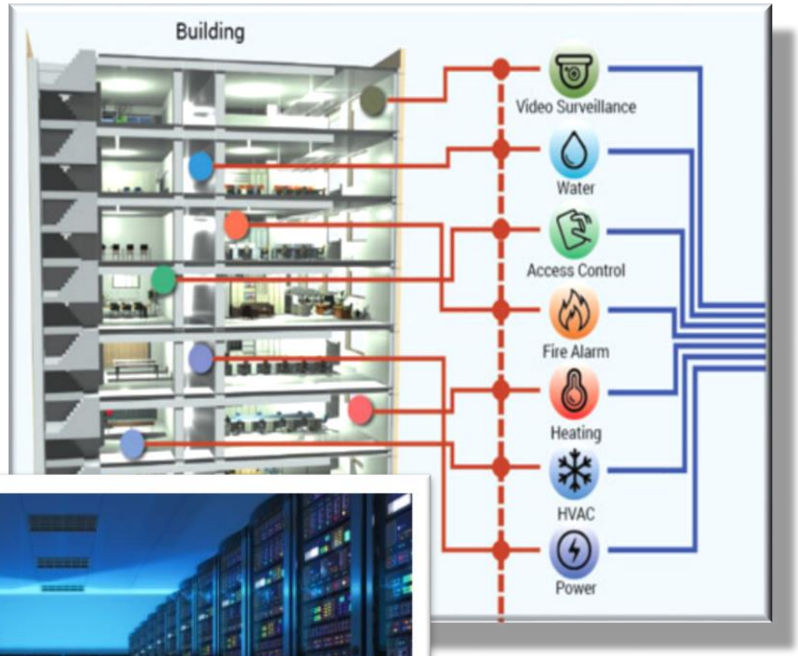
OPR – Defining Owner Requirements

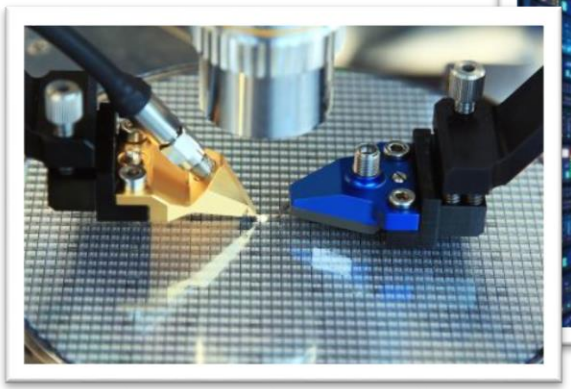
- Priorities
  - Reliability
  - Resiliency
  - Independence
  - Emergency Back-up
  - Cost Reduction
  - All of the above?
    - *In which order?*

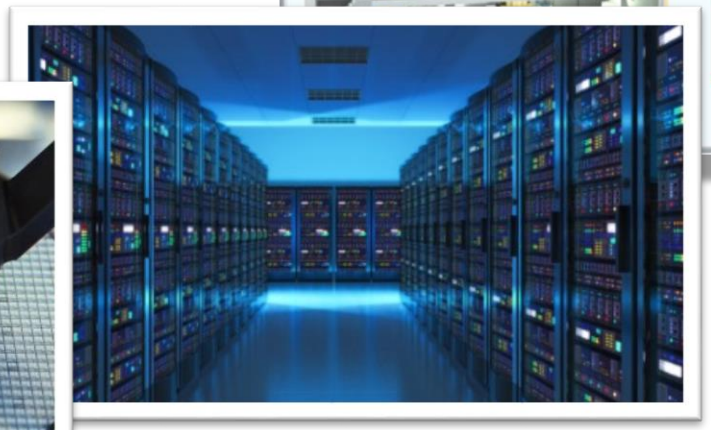
- Financial Goals
  - Target specific programs
  - Special Incentives
  - Rebates
  - Tax Breaks
  - Energy Efficiency
  - Each has specific criteria that must be met

OPR – Defining Owner Requirements

- Island Mode: Complete isolation from primary grid
  - Power- How much for how long?
    - Seconds, days, weeks, complete independence?
  - Define Load Requirements
    - Critical vs Non-Critical
    - Fire / Life / Safety
    - Process Equipment
    - Data Centers / Server Rooms
    - Communications
    - Access Control

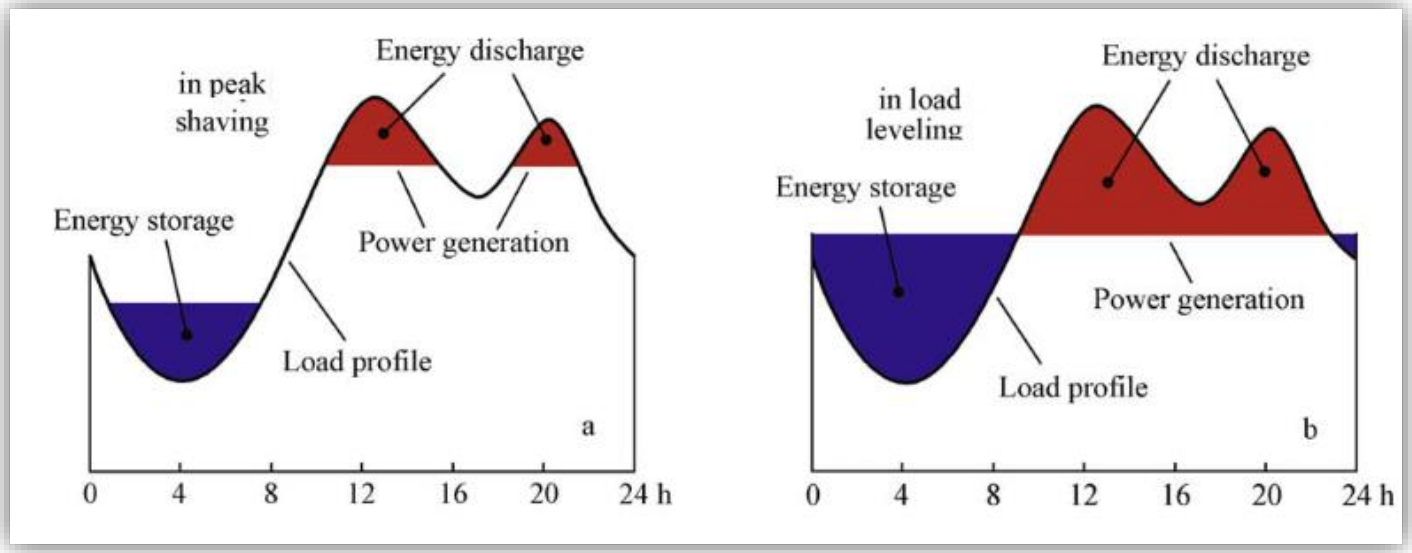






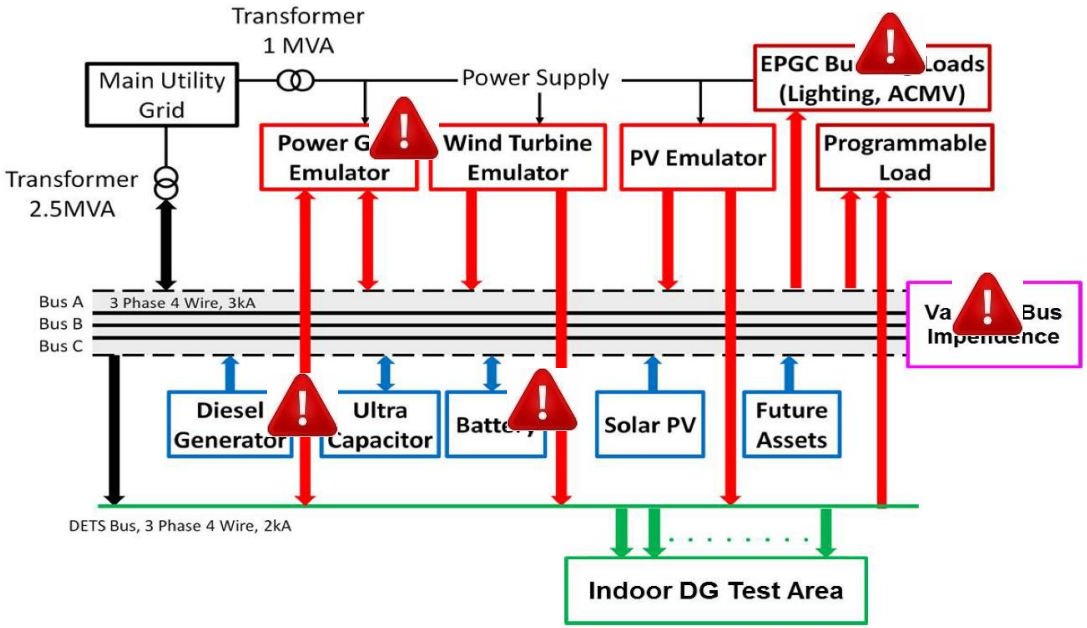
OPR – Defining Owner Requirements

- Normal Mode: Tied to primary grid
  - Define your role in the grid network
    - Load leveling / peak shaving capabilities
    - Localized incentives
    - PGE- Dispatchable Stdby Generation (DSG) program
    - Net Metering- Selling power back to utility provider
  - ***Just asking the right questions can have a significant impact on design requirements.***



Developing an Effective Cx Plan

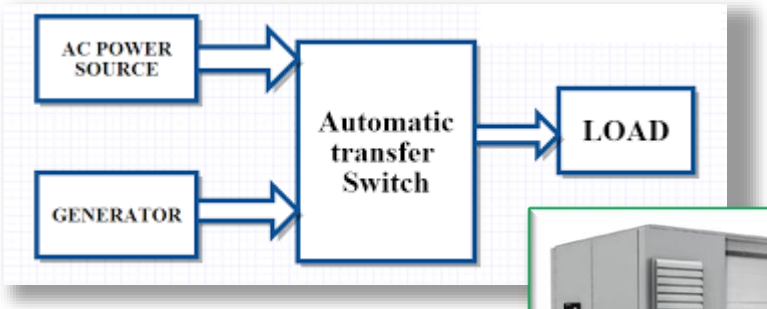
- Cx Team
  - Utility representatives
  - Specialized equipment providers
  - Level of participation depends on project complexity

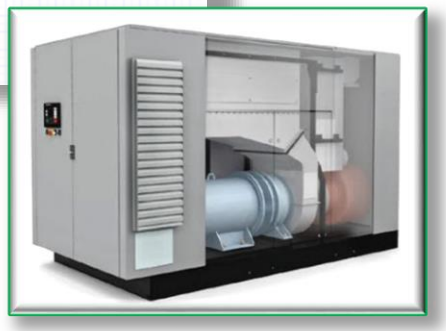


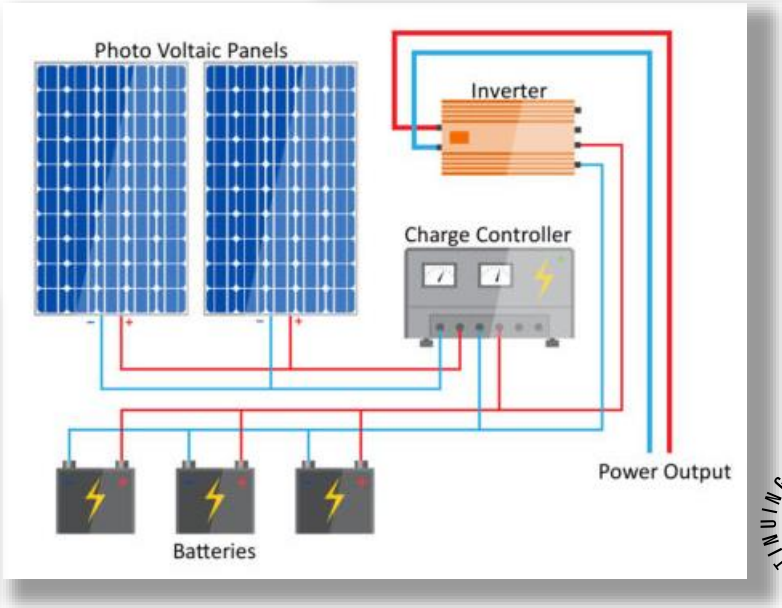
- Design and Specification
  - Integrate Utility design and spec requirements into project documents.
    - Equipment
    - SOO
    - Controls
    - Network
    - Verify compatibility
    - Submissions for Utility review

Developing an Effective Cx Plan

- Integrate new equipment
  - DER source (PV, Microturbines, Generators, etc.)
  - Inverters
  - Batteries
  - Automatic Transfer Switch(es)
  - Controller(s)
  - Breakers/Branch Panels
  - Load Shedding Devices/Load Banks
  - Heat rejection devices (for cogeneration)
  - . . .





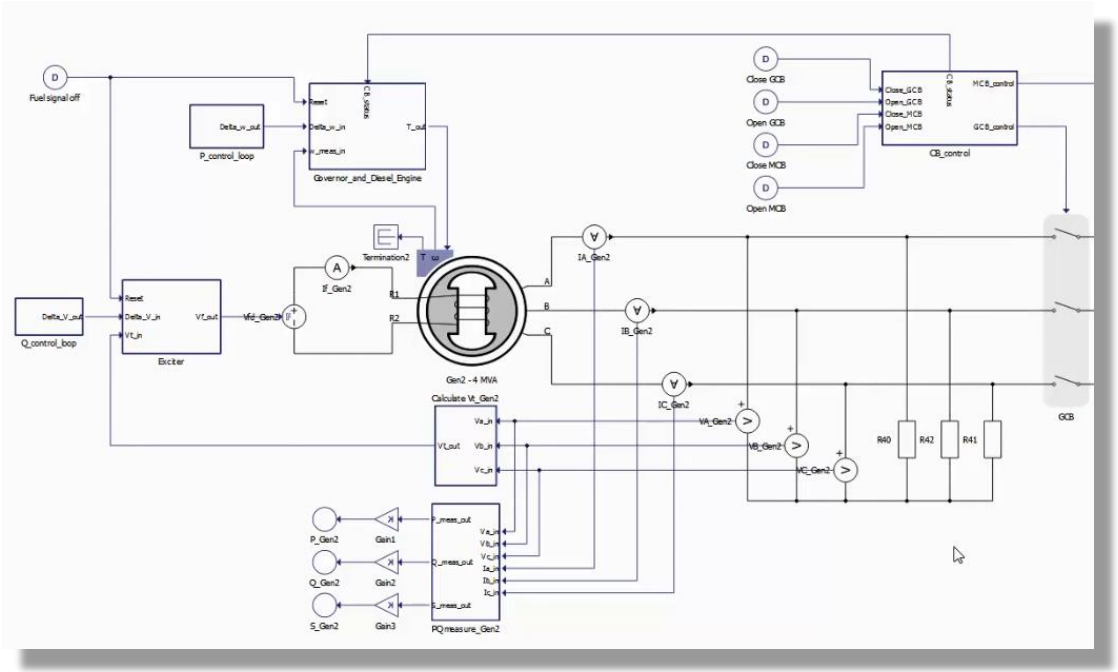


Developing an Effective Cx Plan

- Start-Up
  - Localized vs Collaborative equipment
    - Define Roles - Responsibility matrix
  - Results – Required submissions for Utility review
  - Verification of factory or 3rd party tests
- Pre-functional Checklists
  - Develop meaningful checklists for new and evolving equipment
- Testing
  - Challenges
    - New technologies & equipment
    - Testing requirements and techniques
    - Complex interactions
    - Escalating number of test conditions

Developing an Effective Cx Plan

- Testing
  - High fidelity simulations: Micro-grid testbed can test multiple DER controller interactions (Complete system testing)
  - Work out software bugs, compatibility and sequence issues
  - Reduced cost. Less risk.
- Failure Testing
  - Equipment, connections, network/comm, multi-component failures (disaster event), **single points of failure!**



Developing an Effective Cx Plan

- Testing
  - Transitions
    - DER enable/disable
    - Grid to Island and Island to Grid
  - Functional vs Performance Testing
    - Functional
      - ✓ Verification of basic operations
      - ✓ Component start/stop
      - ✓ Failures
      - ✓ System stability
      - ✓ Synchronization
    - Performance
      - ✓ Refined system testing
      - ✓ Analyze extended trend logs/data
      - ✓ Develop a benchmark
      - ✓ Optimization
      - ✓ Model verification
      - ✓ Finding your “system curve”

How much can be tested for real?

How much can you trust to simulations?

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand why Distributed Energy Generation is making the leap beyond “Back-up Power.”

2. Understand the components required to make Distributed Energy Generation practical.

3. Understand the aspects of third party certifications, such as PEER.

4. Understand the role of the Commissioning Authority in projects with Distributed Energy Resources.

Conclusions

- More DER's and nanogrids *will* show up on your projects
- Be prepared to encounter equipment not traditionally seen
- Owners will have a wide range of priorities
  - Energy efficiency?
  - Resiliency?
  - Certification?
  - Tax credits?

Talk to Owners early

Add these to the Cx Plan

This concludes The American Institute of Architects
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