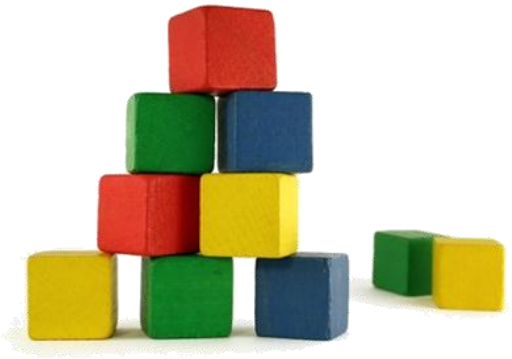
Opportunities in the Energy Industry - Microgrids



John Westerman, Vice President

Horizon Energy Group

OSIsoft. USERS CONFERENCE 2011

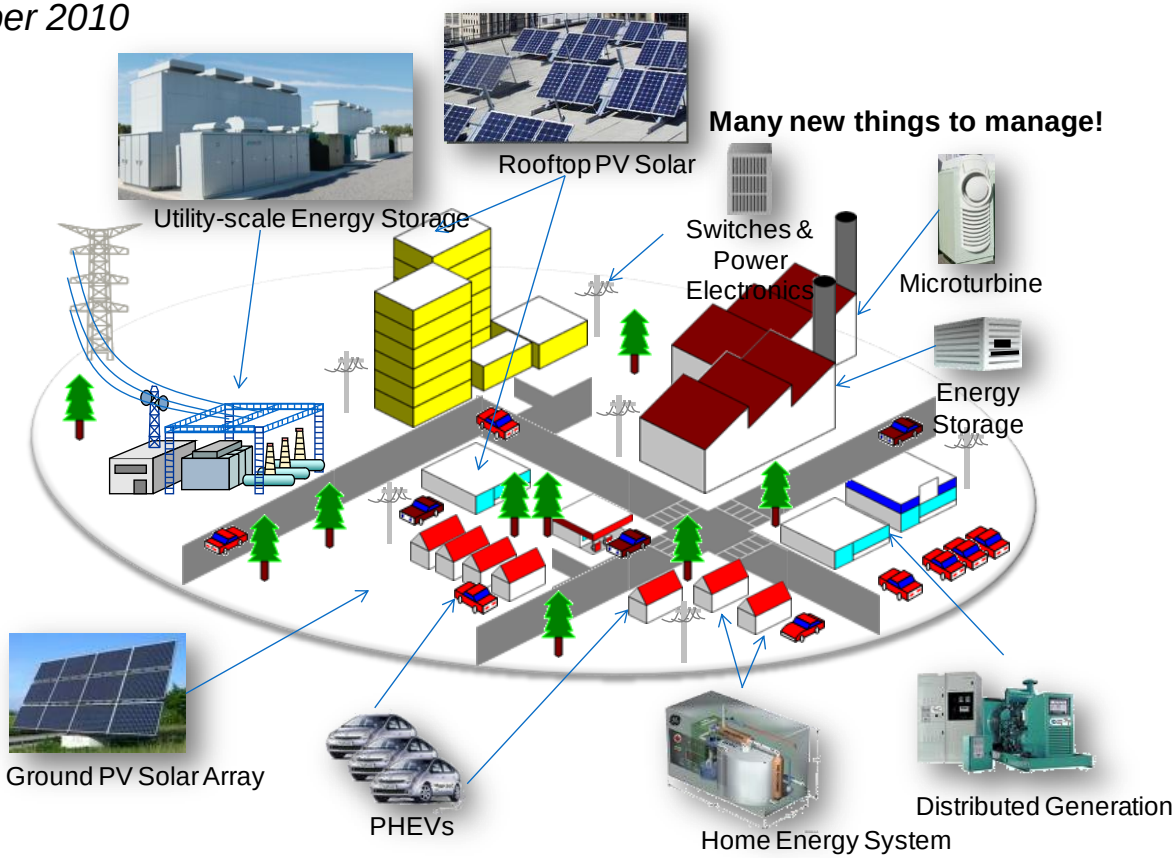
MARCH 28-30, 2011
HILTON SAN FRANCISCO UNION SQUARE
SAN FRANCISCO, CA

What is a Microgrid?

"A **microgrid** is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode."

Microgrid Exchange Group, October 2010

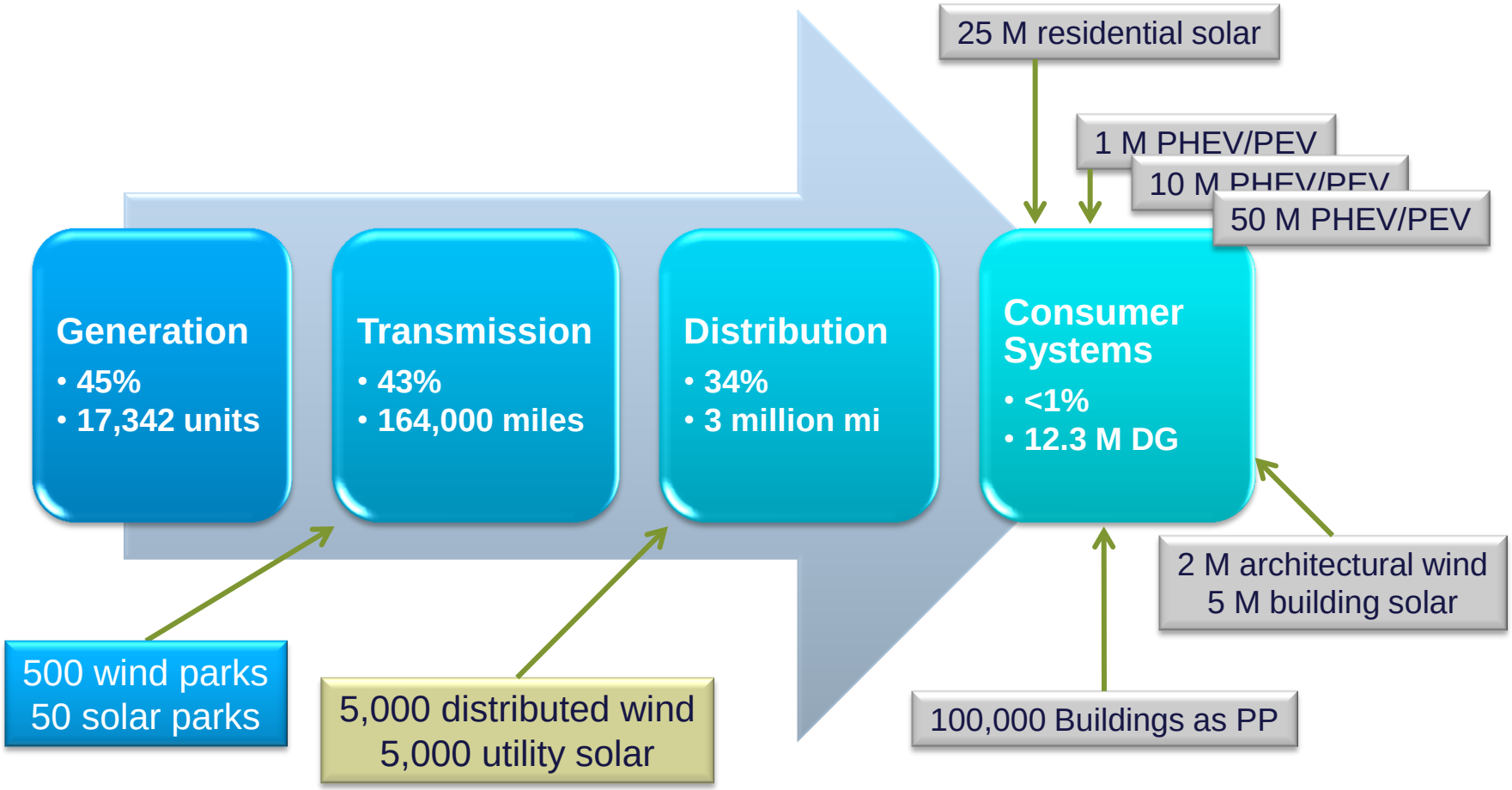
There are federal and state incentives and tax credits for microgrids.



What to expect in the future

THE CASE FOR MICROGRIDS

From the 20th to the 21st Century



Continued increase in energy intensity

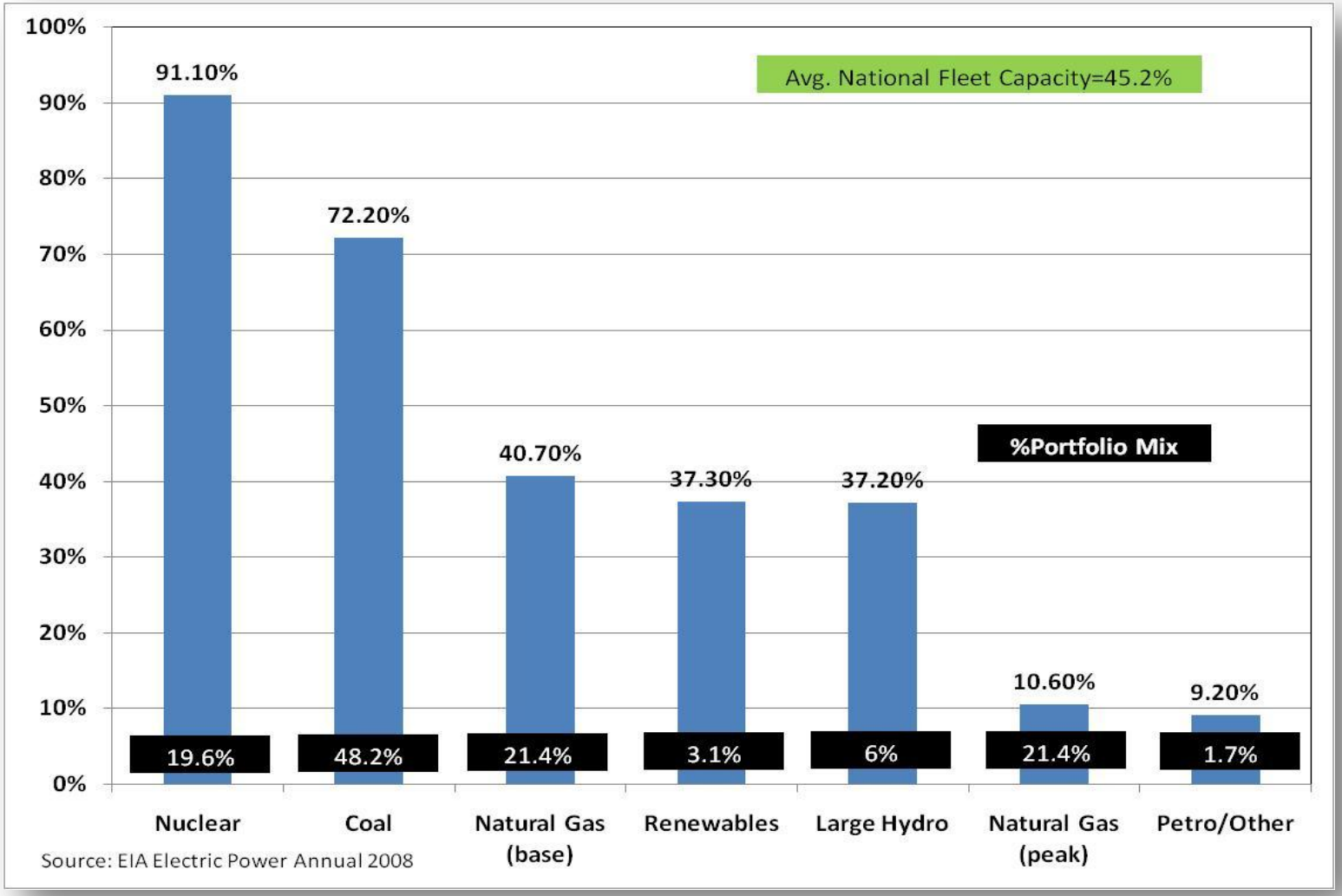
Prices increasing, in some regions faster than gasoline at the pump

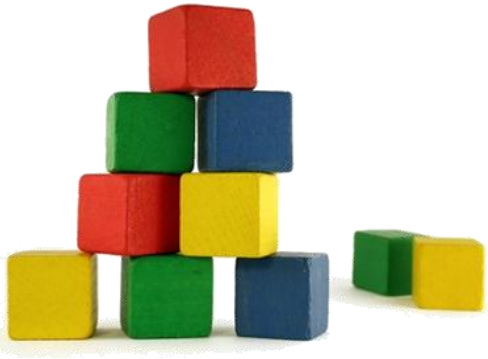
Changeover to more and more digital loads

Consumer choices

Horizon Energy Group

Business As Usual Results





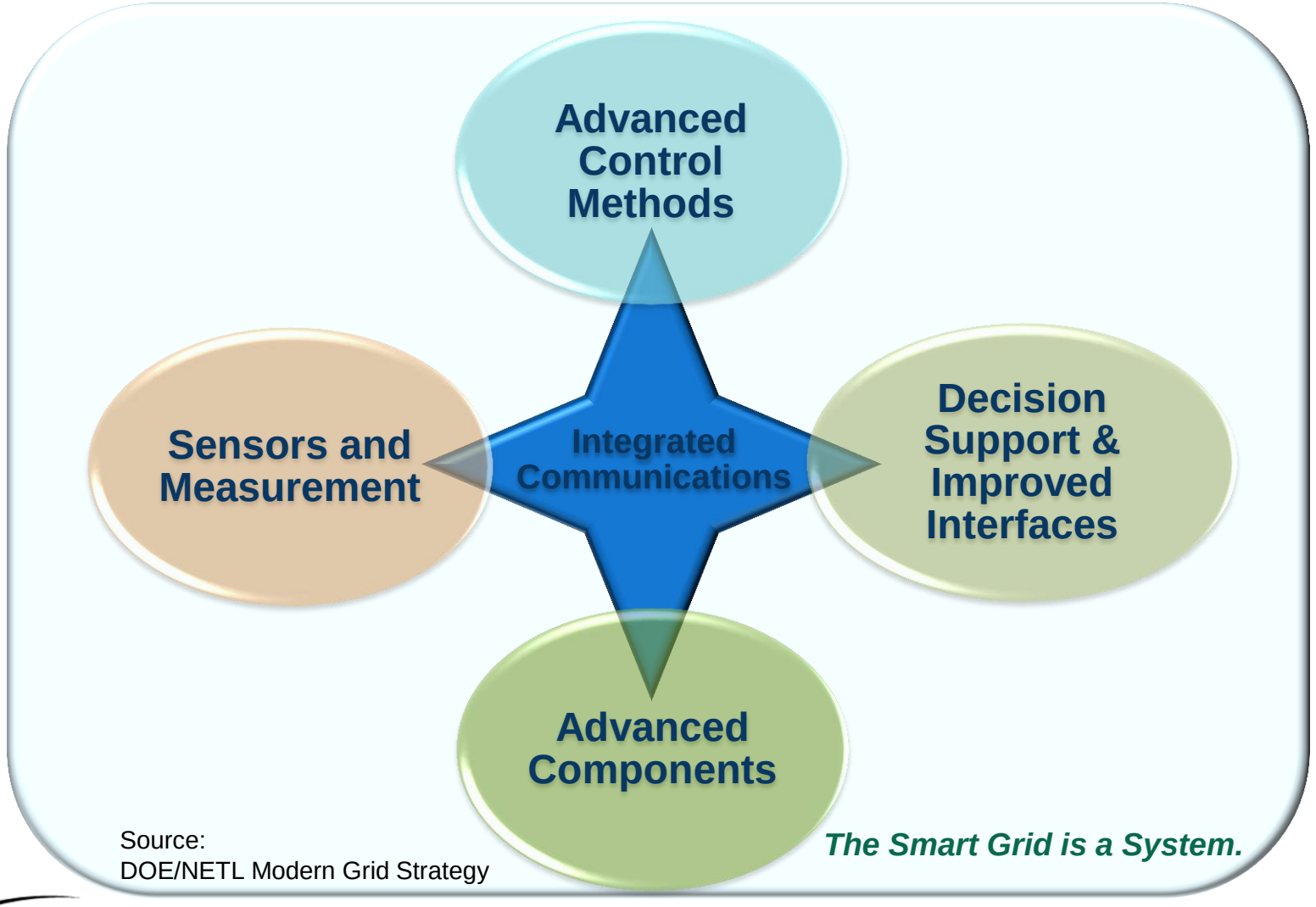
Design and engineering

CONSIDERATIONS

Why Microgrids?

- **Savings**: The microgrid portfolio of resources is tuned to the campus to provide economic savings
- **Sustainability**: The microgrid portfolio enables a hedge against fuel cost increases
- **Stewardship**: The microgrid enables deep penetration of renewables
  - Emissions reduction
  - Green marketing
- **Reliability**: The microgrid actively controls the network for better reliability

Microgrids and the 5 Key Technology Areas



Microgrid Objectives

Utility Network Management

Microgrid Objectives
Take action to improve reliability
Take action to improve economics
Take action to manage renewables

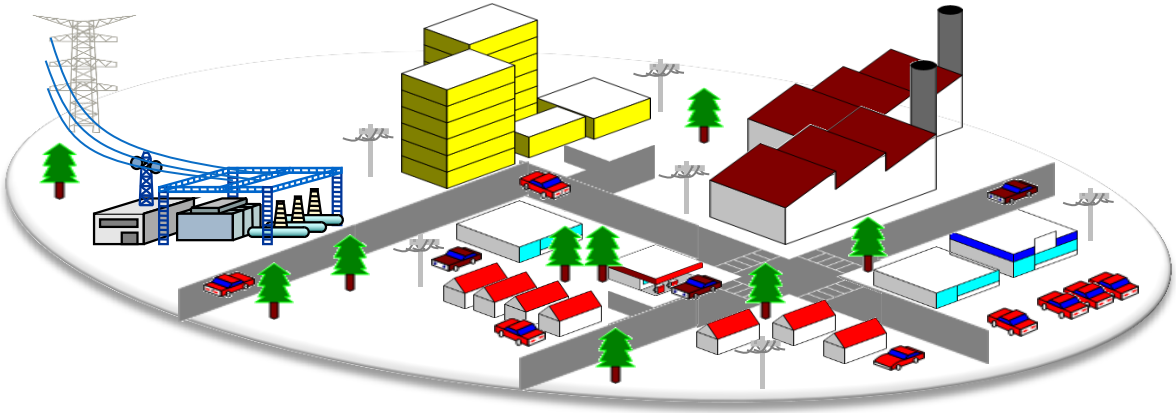
Microgrid Master Controller

SCADA System

Distributed Energy Resources
Utility-scale Energy Storage
Rooftop PV Solar
Micro-turbines
Building Energy Storage
Community Energy Storage
Distributed Generation
Home Energy System
PHEVs
Ground PV Solar Array

Information
Electricity Pricing
DER status
Demand Response Programs
Network status
Community Objectives
Load and Resource Profiles

Grid Resources
Capacitor Banks
Voltage Regulators
Automated Switches
Power Electronics
Communications



SDG&E Microgrid Overview

Demonstration Project

•Contract with DOE (NETL) $12M

•Contract with California Energy Commission (CEC) $2.8M

•Duration: 3 years

Site Selection

•Borrego Springs

•Circuit #170:

- 4 MW peak demand
- ~4 circuit miles.
- ~3000 customers,
- 560 kW PV (existing customer-owned)

Microgrid Elements

- Distributed Generation
- Volt/VAR Management
- FAST*
- Advanced Energy Storage
- OMS/DMS Integration
- Price Driven Load Mgmt
- Customer DER Integration

Microgrid Team

San Diego Gas & Electric, Horizon Energy Group, Oracle, IBM, Lockheed Martin, Motorola, Gridpoint, Xanthus Consulting, PNNL, USD

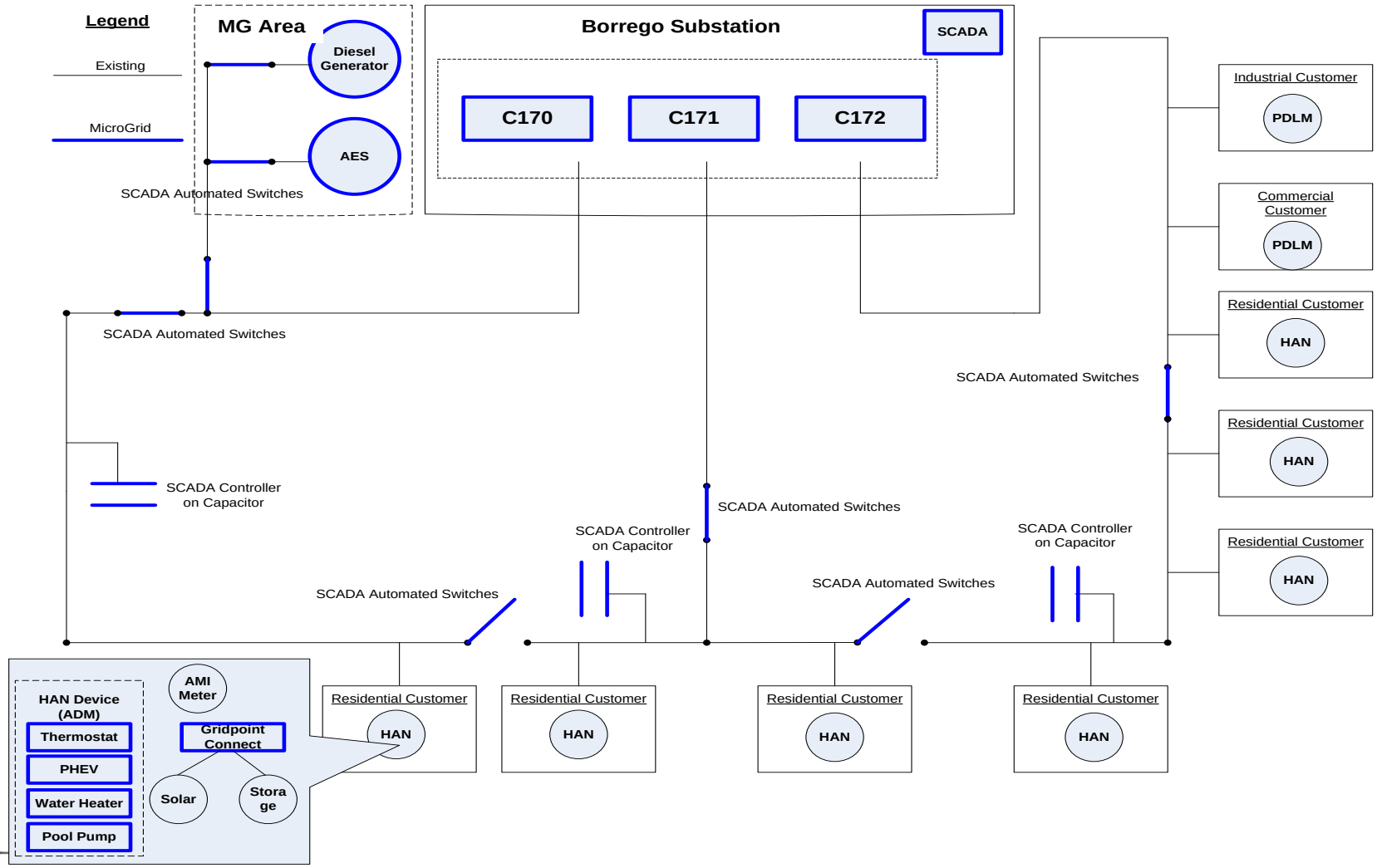
*Feeder Automation System Technologies

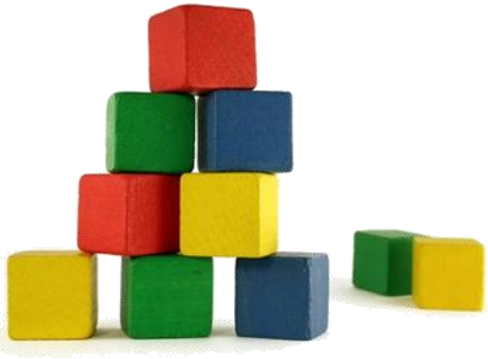
Project Location

Key Strengths:

- Potential to realize advanced reliability improvements
- High concentration of customer-owned solar
- Opportunity to develop self-sufficient circuit
- Great learning environment
- Extendable to service territory

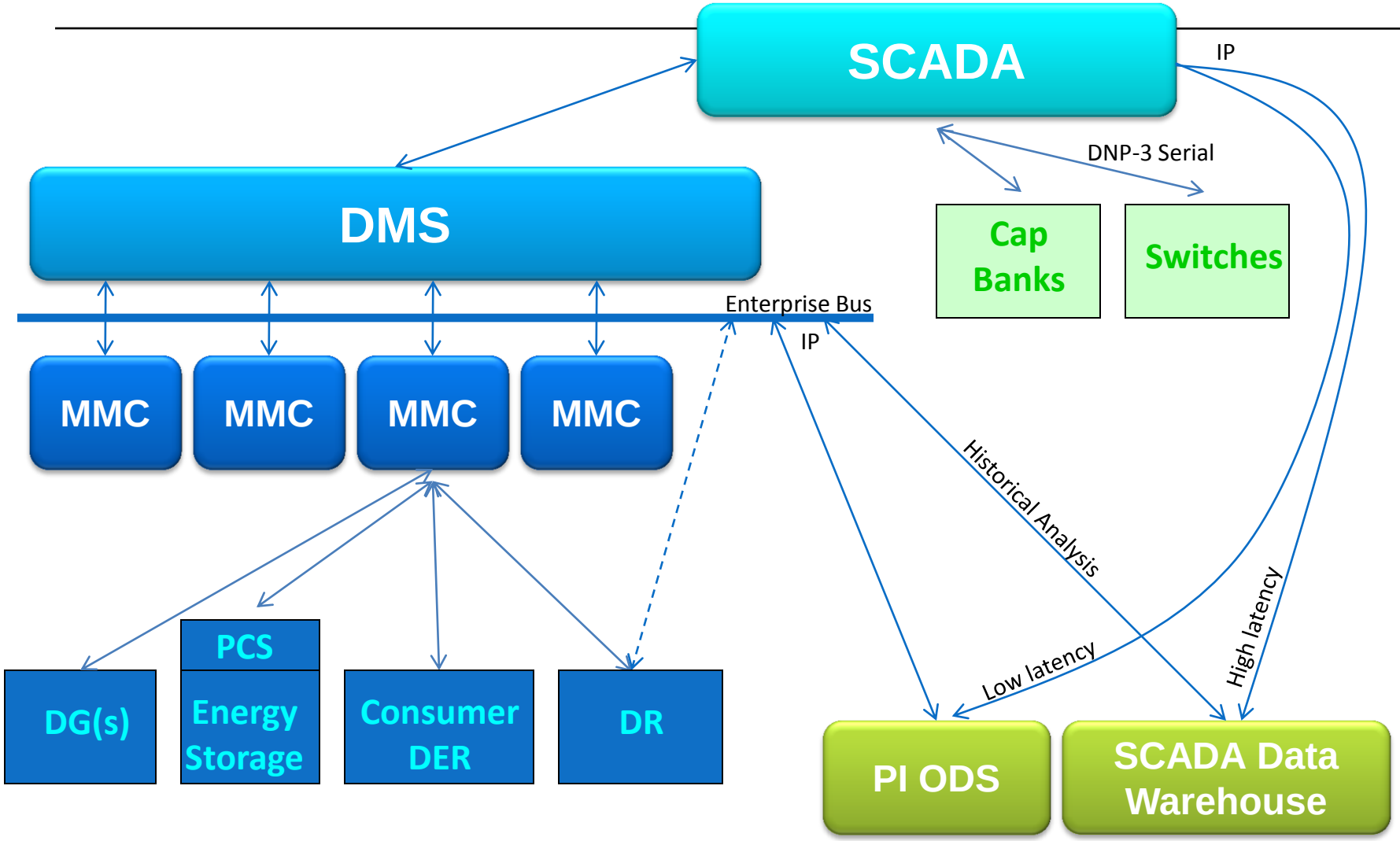
Borrego Substation Circuit Diagram



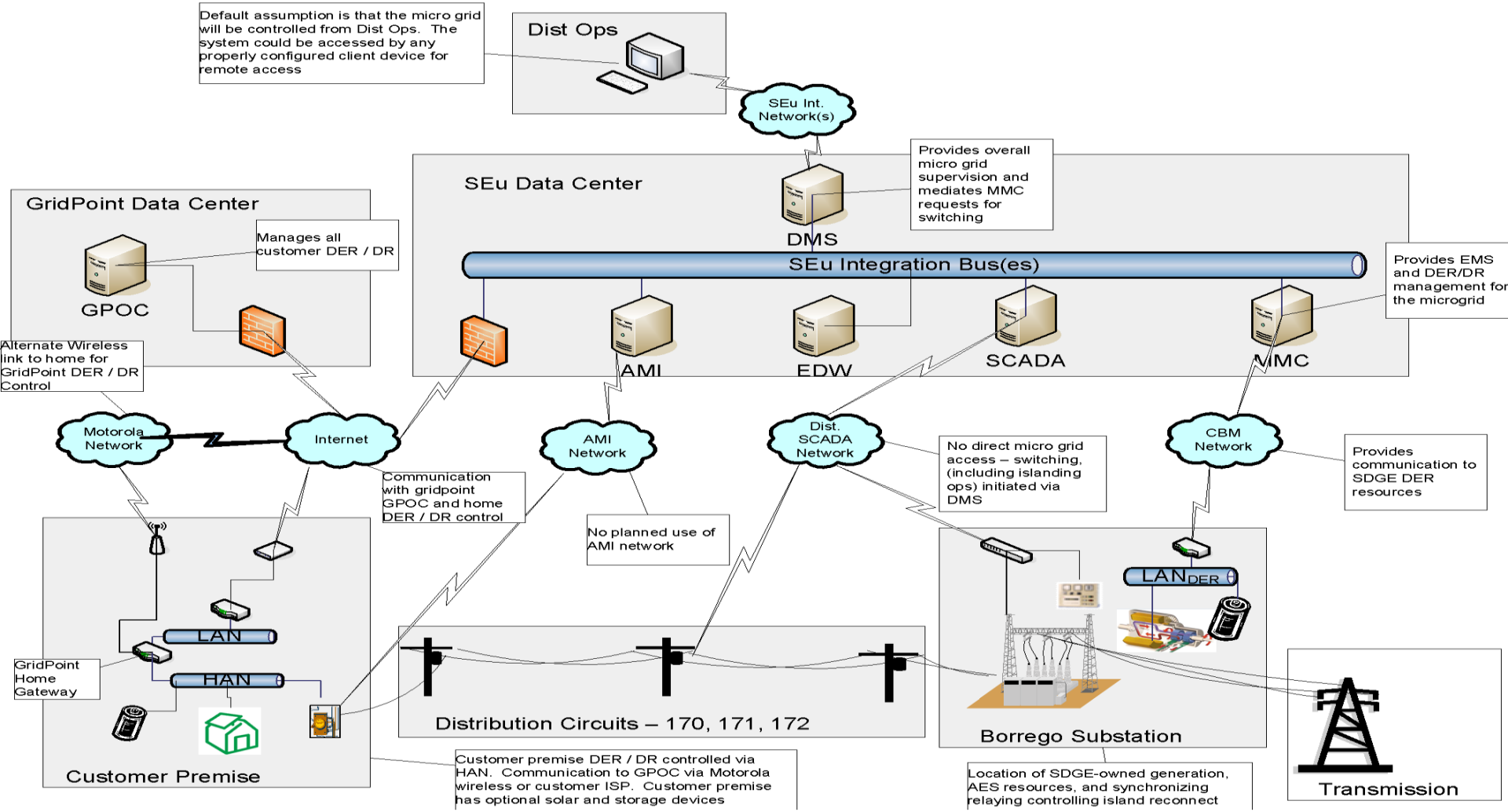


MICROGRID USE CASES

Microgrid Architecture Overview



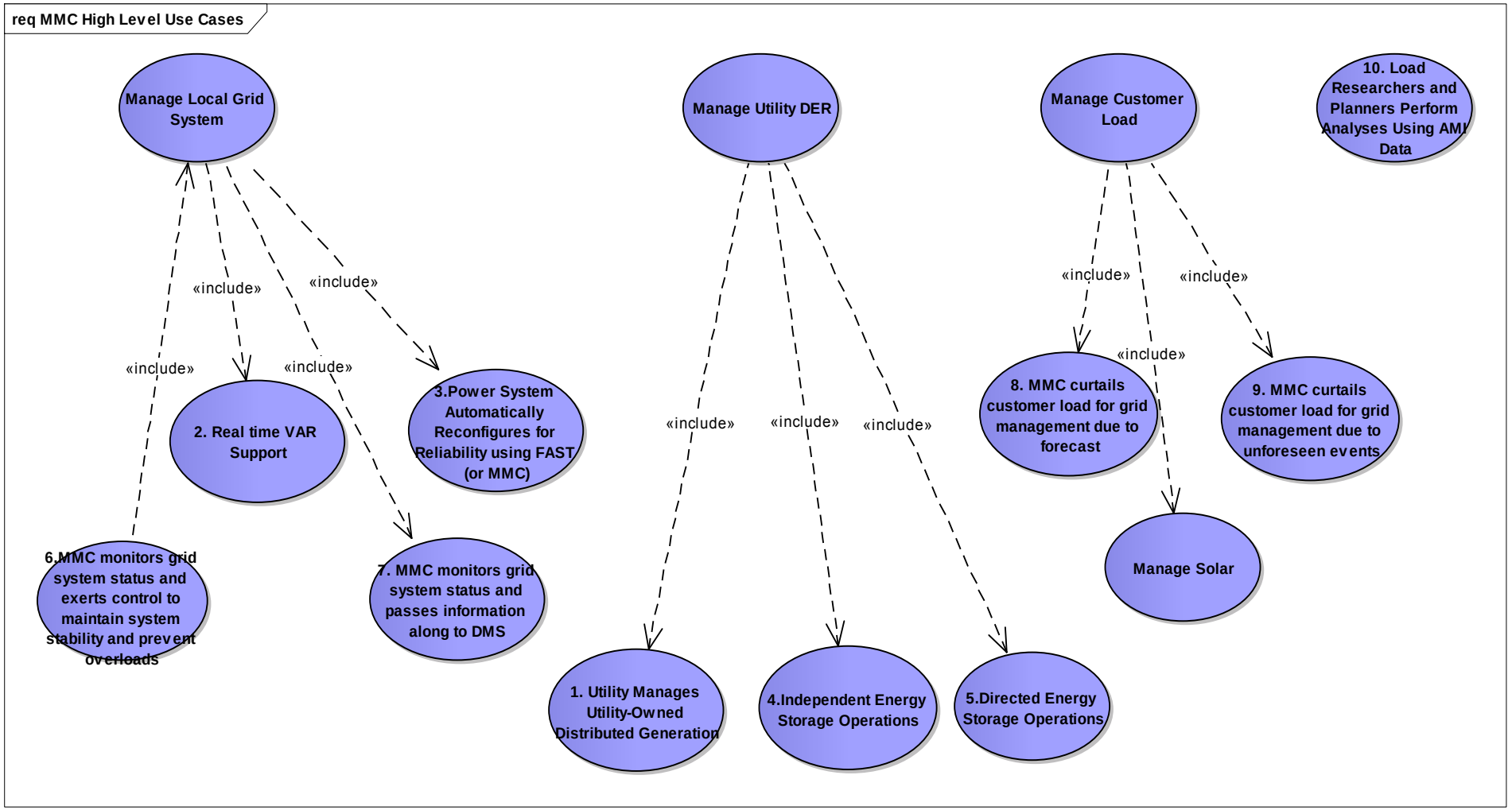
Microgrid Conceptual Architecture



Functional Description (Use Cases)

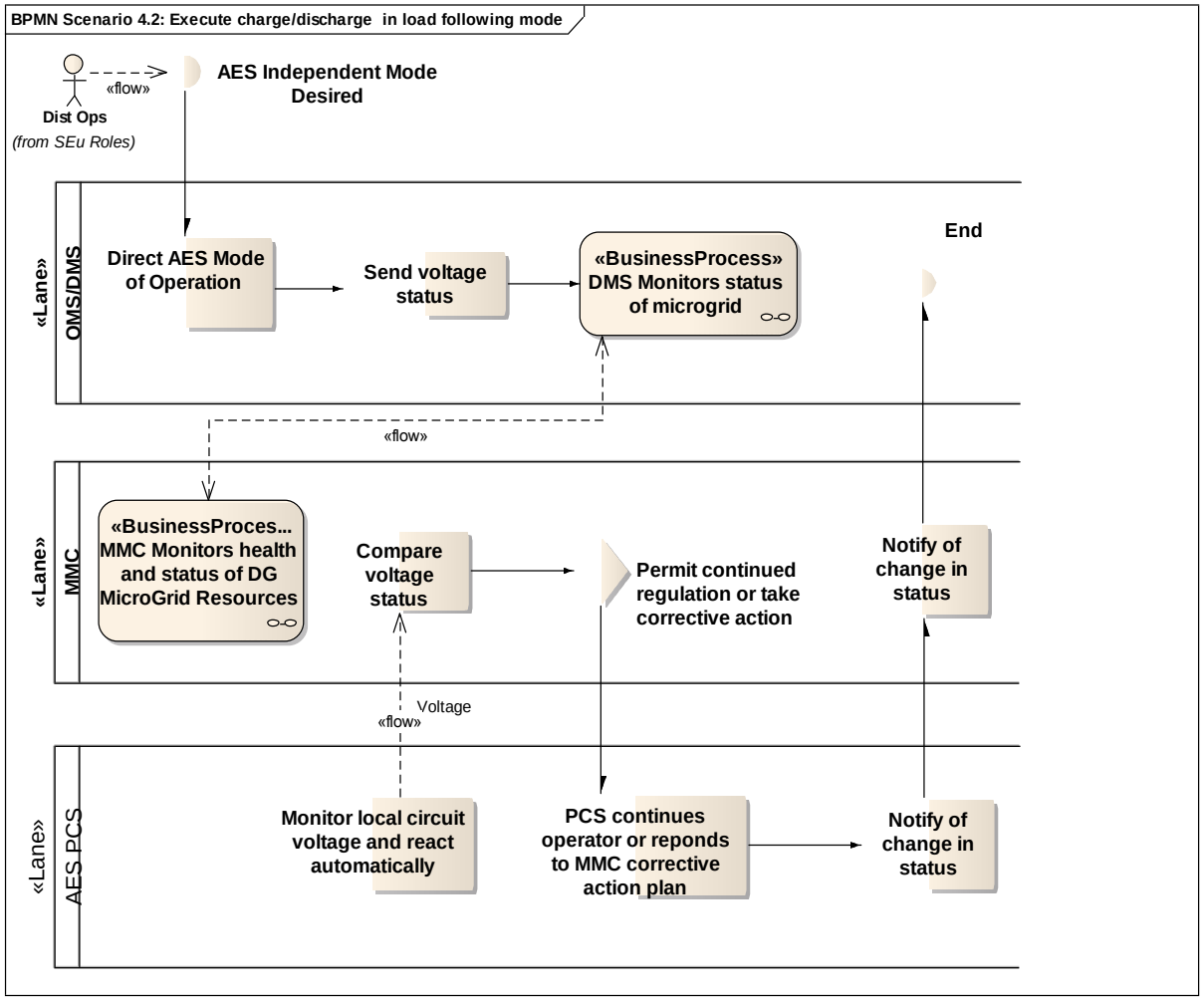
- Utility Manages Utility-Owned Distributed Generation
- Real-time VAR Support
- Power System Automatically Reconfigures for Reliability using FAST
- Independent Energy Storage Operations
- Directed Energy Storage Operations
- MMC monitors grid system status and exerts control to maintain system stability and prevent overloads
- MMC monitors grid system status and passes information along to DMS
- MMC curtails customer load for grid management due to forecast
- MMC curtails customer load for grid management due to unforeseen events
- Planners Perform Analyses Using Multiple Data Sources

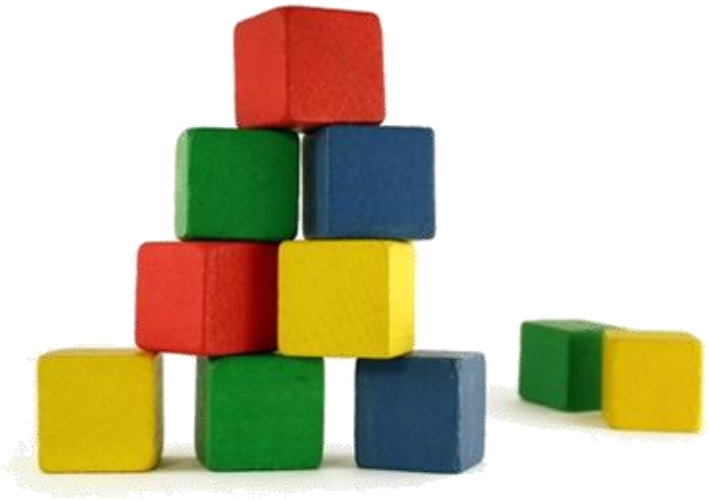
Microgrid Use Cases



Example:
Sparx EA Business Process Diagrams

Use Case 4.2: Independent Energy Storage Operations



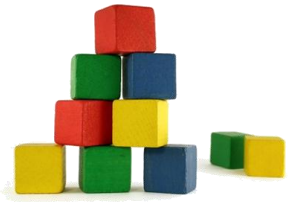


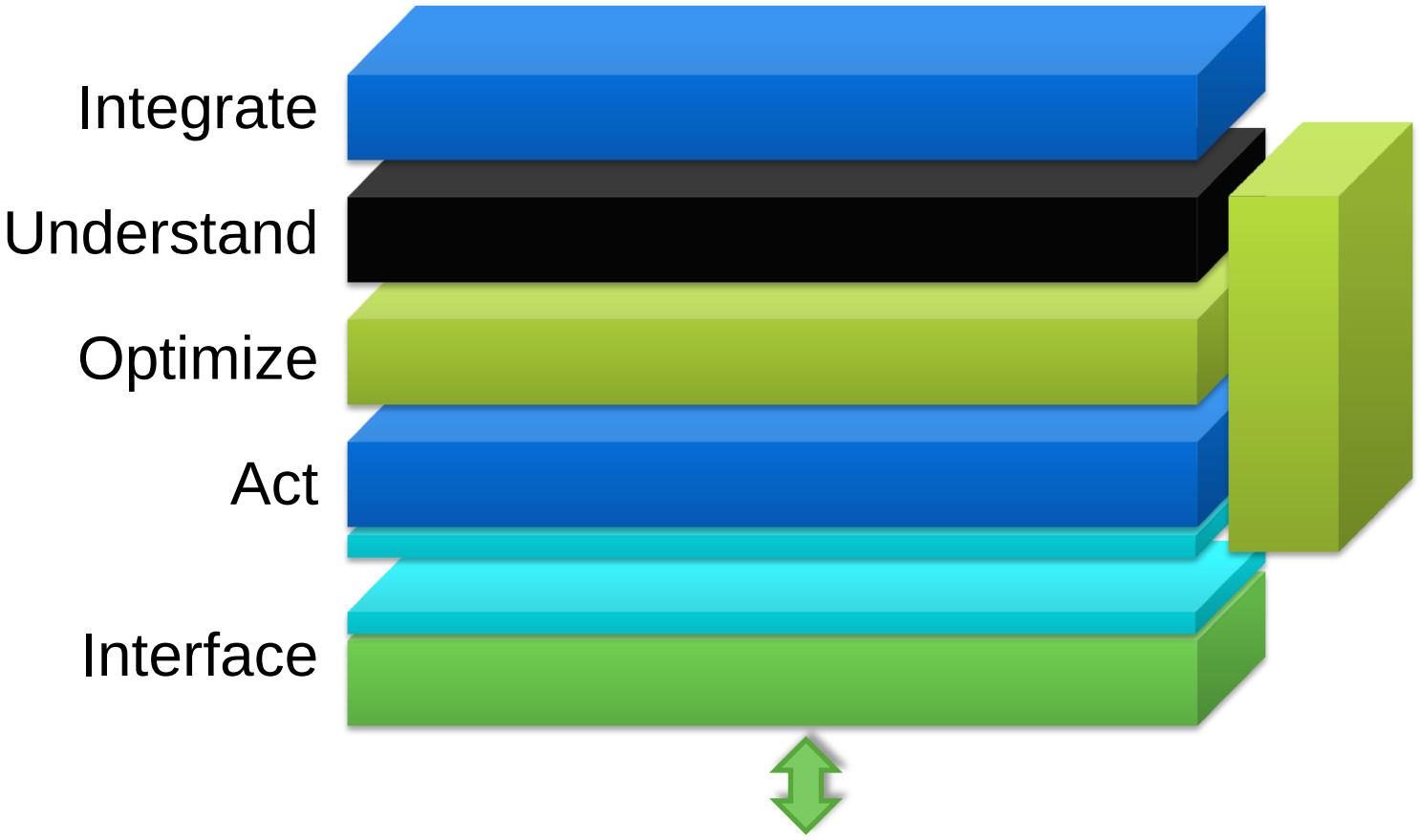
MICROGRID MASTER CONTROLLER DESIGN

Active Monitor and Control

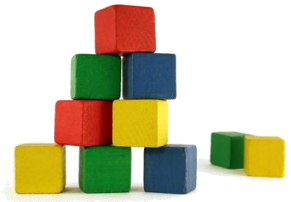
- Optimize variable aspects: load, wind, solar, storage
- Continuously monitor and trend health of all system components
- Base the energy market purchases and sales on hourly forecasts
- Leverage resources into the energy market on local non-peak days
- Island (i.e. disconnected or zero net electric import) when needed or advantageous

Successful Microgrid Design

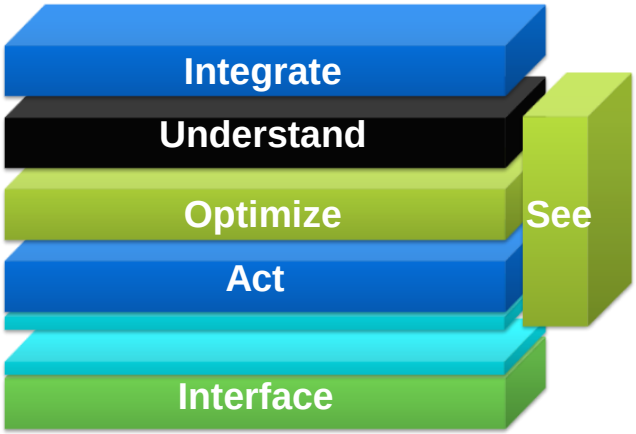




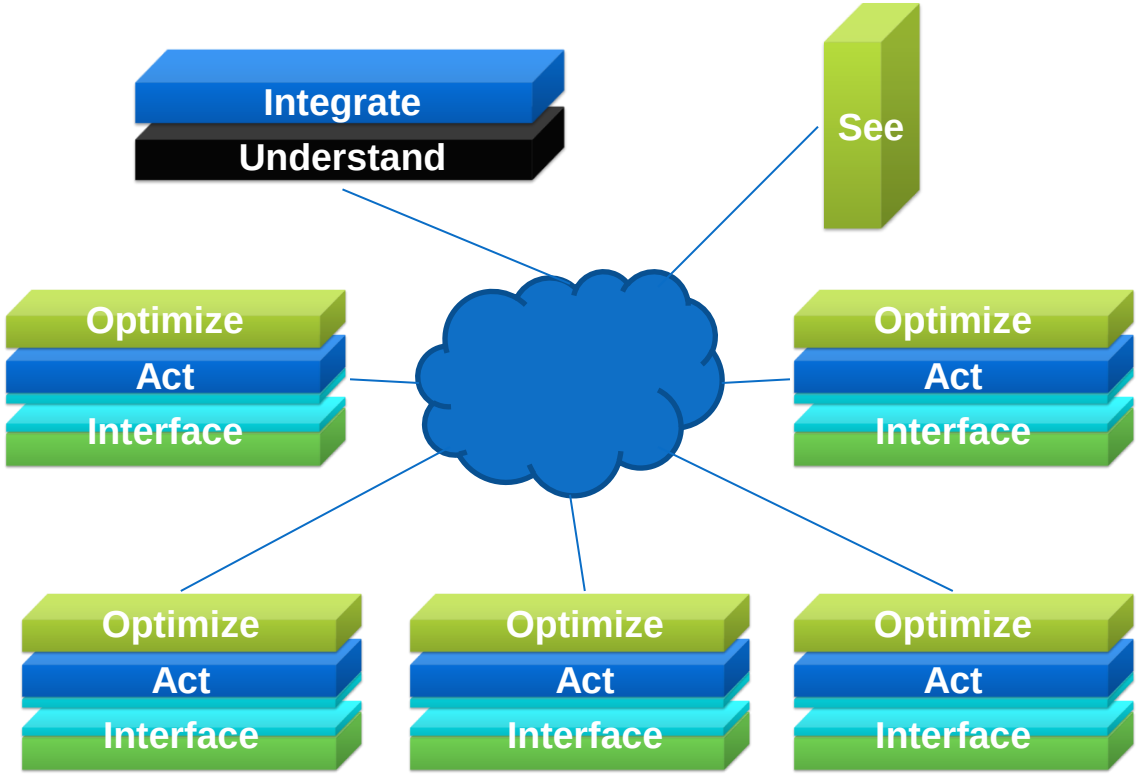
MMC – Two Designs



MMC Brain



Agent Community



MMC Design - Embedded

- There are several key elements embedded in multiple areas of the design
  - Interoperability standards
  - Common information model
  - Cyber security
  - Service-oriented architecture

Algorithm Map

Integrate

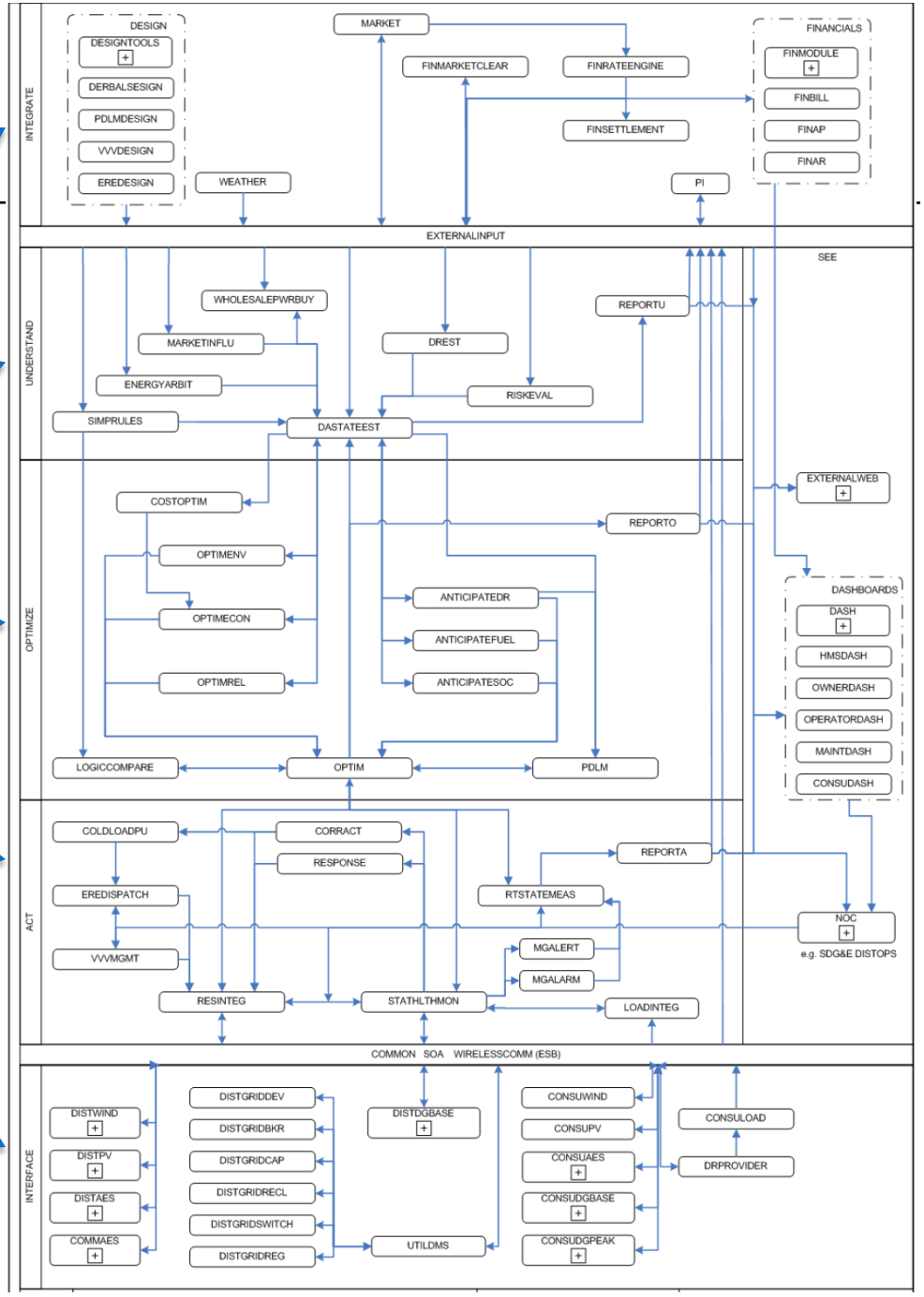
Understand

Optimize

Act

Interface

See



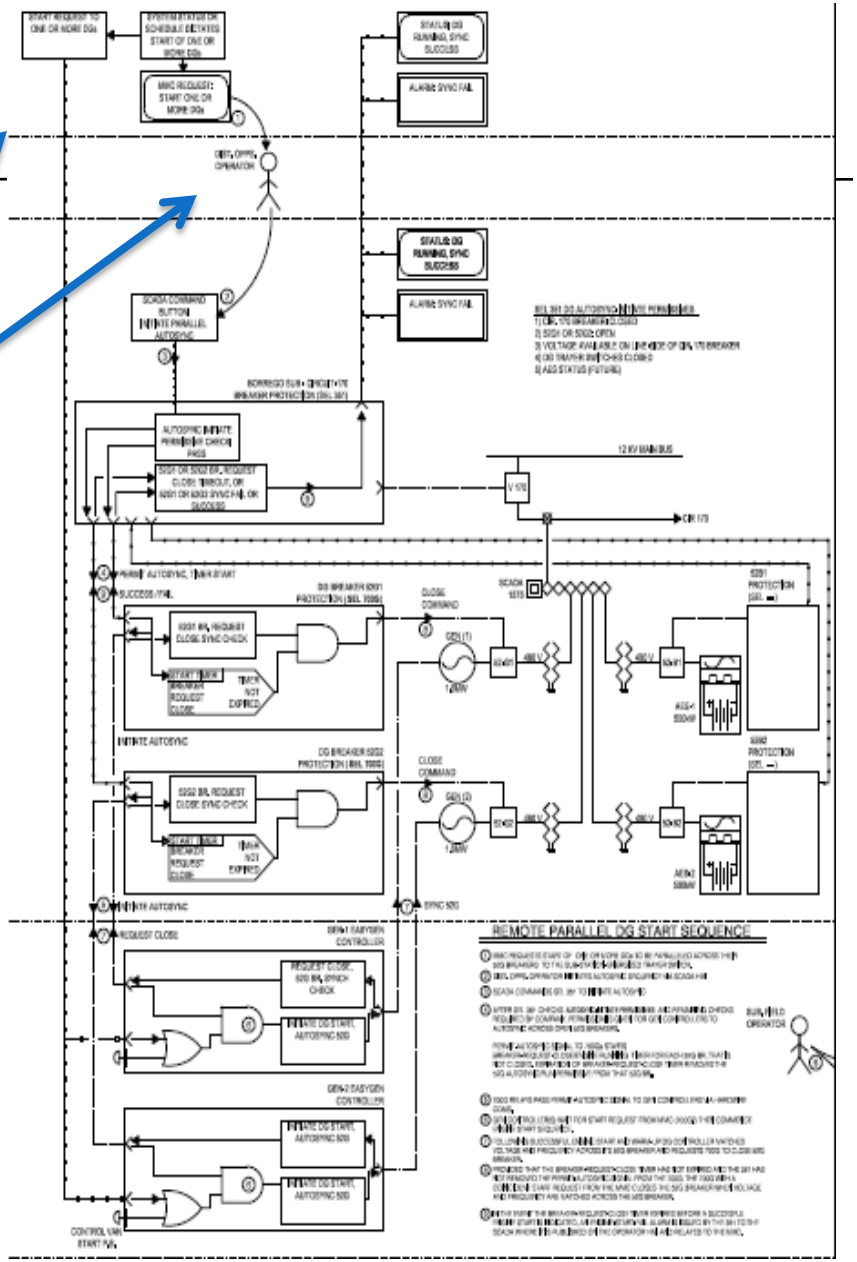
DG Start Sequence

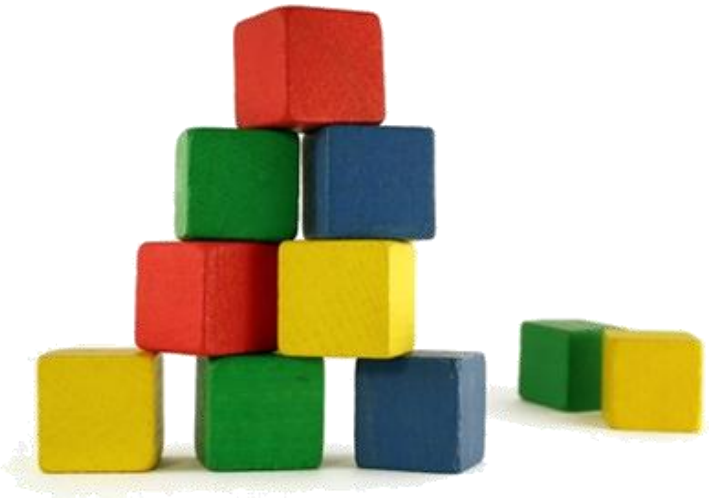
MMC Request Start

Operator Authorizes Operation

Safety Check and Synchronization

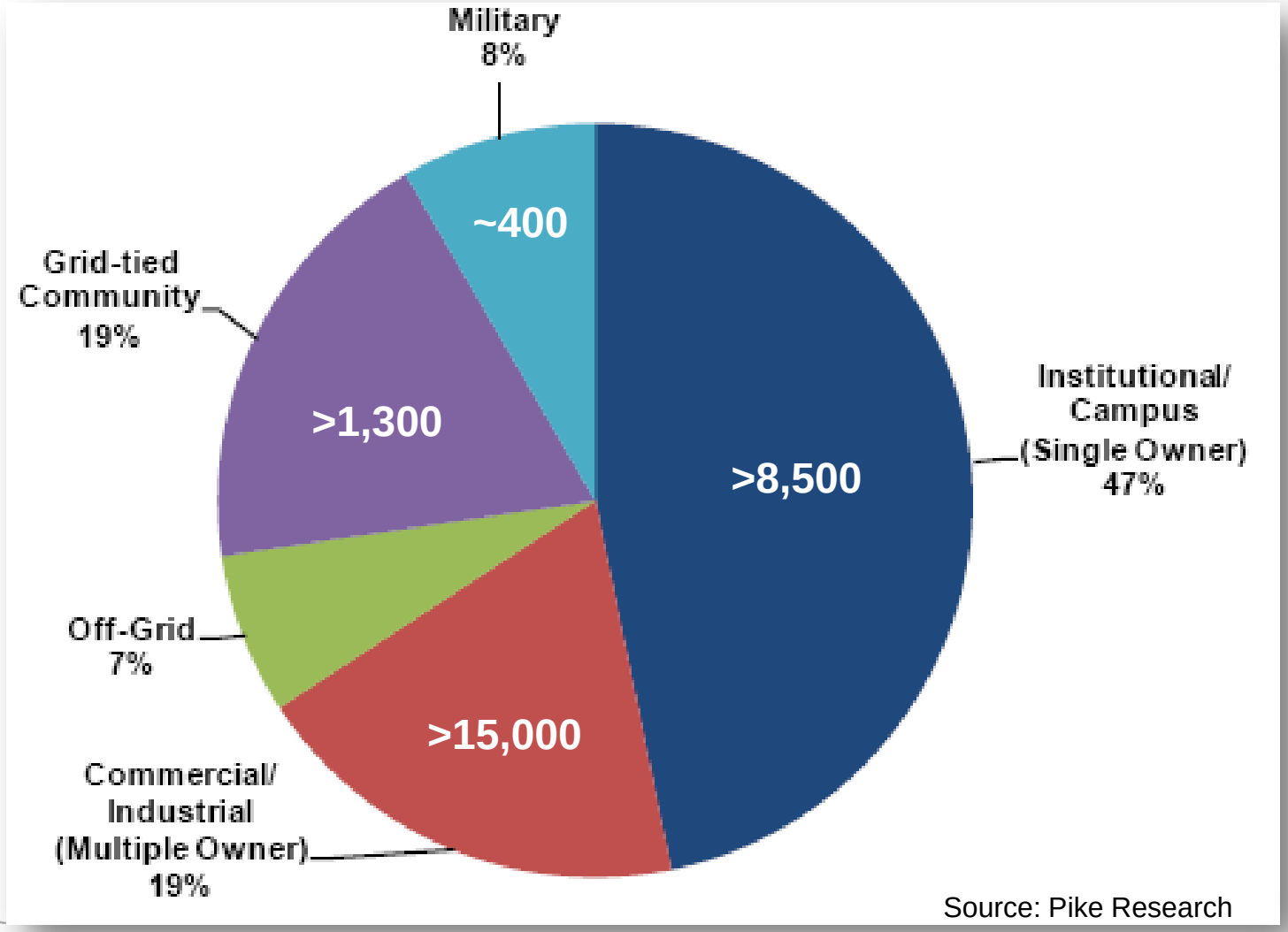
Local DG Controls





MICROGRID MARKETPLACE

North American Microgrid Market 2015



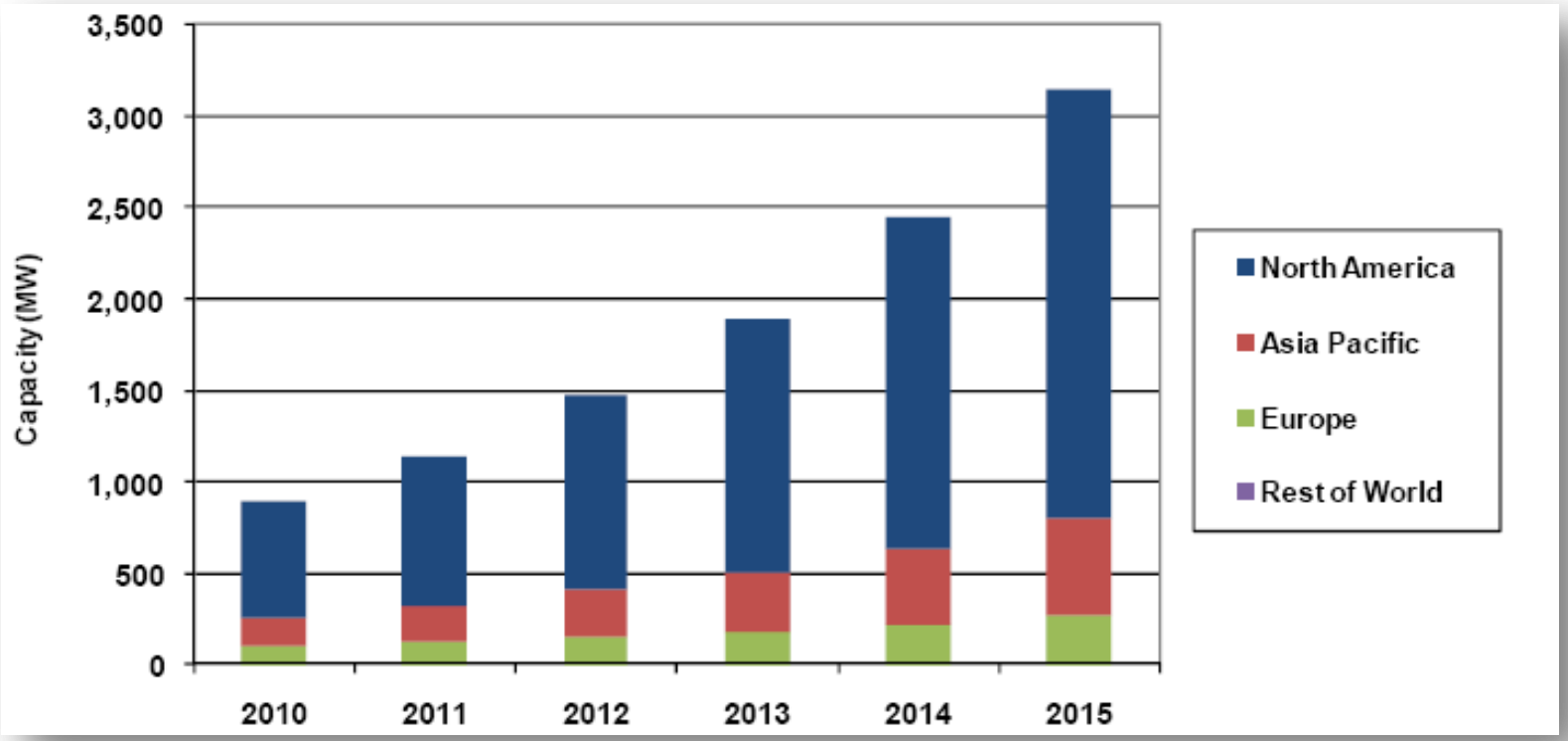
Source: Pike Research

Market Size

2,000 US microgrids by 2015

- Pike Research, Dec 2009

Microgrid Capacity, World Markets: 2010-2015



Source: Pike Research

~$2B annual US market by 2015

- Pike Research, Dec 2009

PROPOSED PROJECT

1.5 MW average demand

750,000 sq ft

3,200 engineers

Executive Summary

- Microgrid – sustainable, reliable active 24/7 control of supply and load
- Sustainability Objectives
  - Reduce annual energy cost by 15% for the long-term
  - Reduce carbon footprint by 18,750 Tons over 10 yrs
  - Increase reliability and reduce the risk of an outage
  - Sustainability leadership among peers
- Not replacing the utility grid (still connected), but replacing much of the utility supply to be more cost effective & reliable
- Increase “green energy” capacity from 0% to 100%
  - Tremendous green marketing opportunity
  - LEED Certification
  - Following the White House call for 25% renewables in the federal sector

Resources Modeled

Resource	Capacity (kW)	Hours / Year
PV	1369	1579
Wind	102	5840
DG Base	24	2088
DG Peak	88	200
Fuel Cell	0	8322
Energy Storage	422	1564

Horizon has also modeled a 11,200 ft^2 Solar Thermal system to offset space and water heating. This would be co-located with the roof PV arrays.

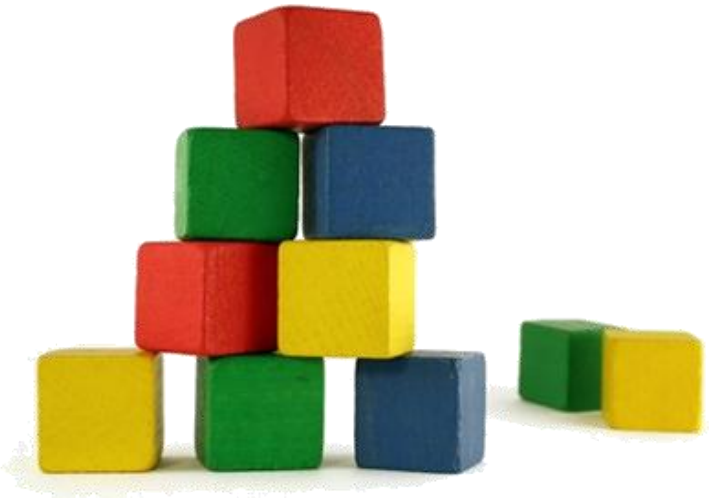
Keys to Success

- Portfolio mix of resources (high level of renewables)
- ISO-NE DR market participant
- Integration of resources
- Gaining approval for State and Utility Incentives
- MMC Control to optimize operations (economics, reliability, and environmental considerations)

The Project

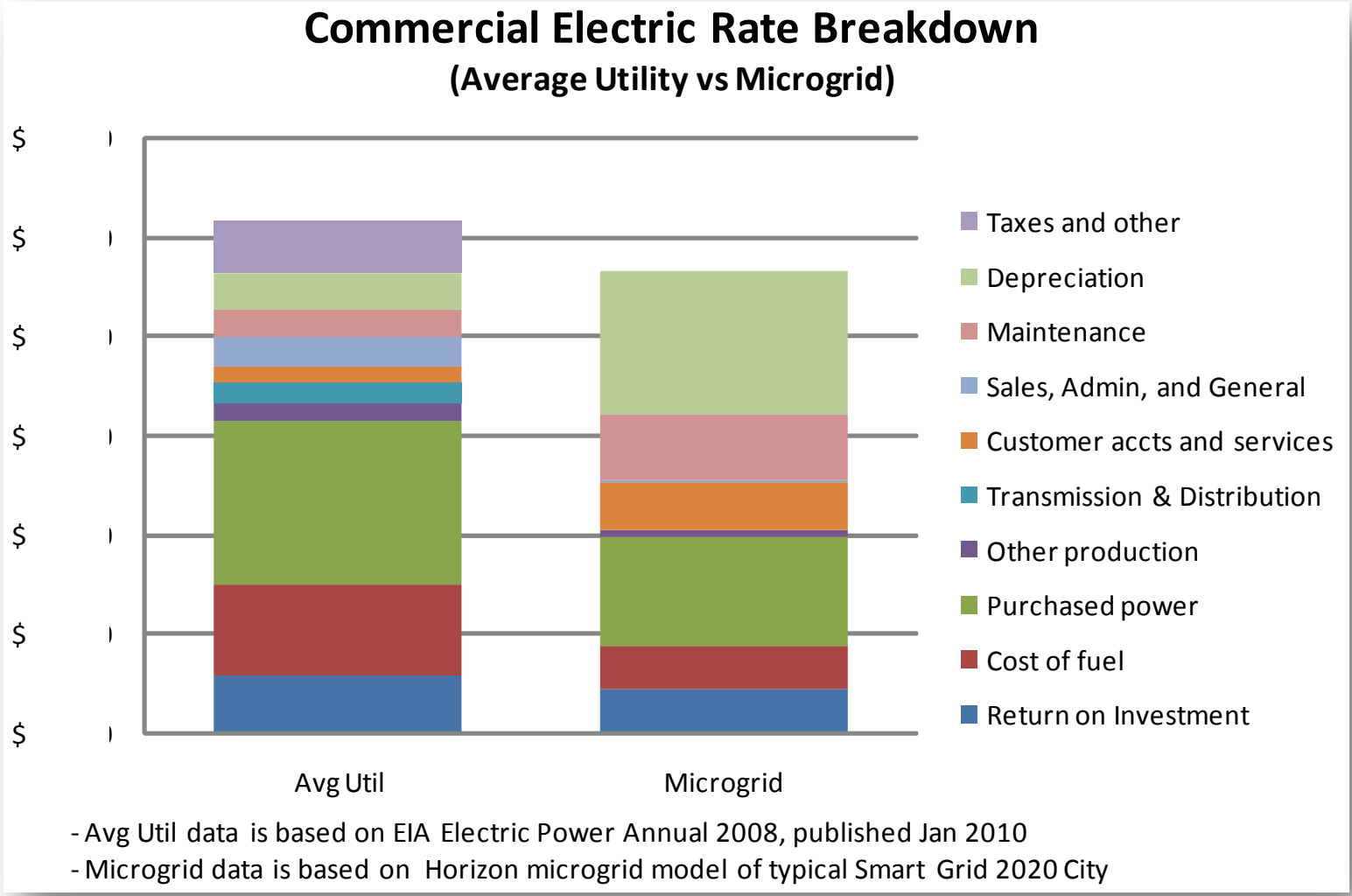
- Estimated $5.33M total development cost after incentives and tax credits
  - Before Incentives and Tax Credits: $11.39M
  - Equity: $0.40M
  - Total Incentives: $6.06M
    - Federal ITC: $2.11M
    - State Incentives: $3.32M
    - Utility Incentives: $0.63M
  - Financing: $6.22M @ 3.25%

Where does the microgrid revolution lead?



CONCLUSIONS

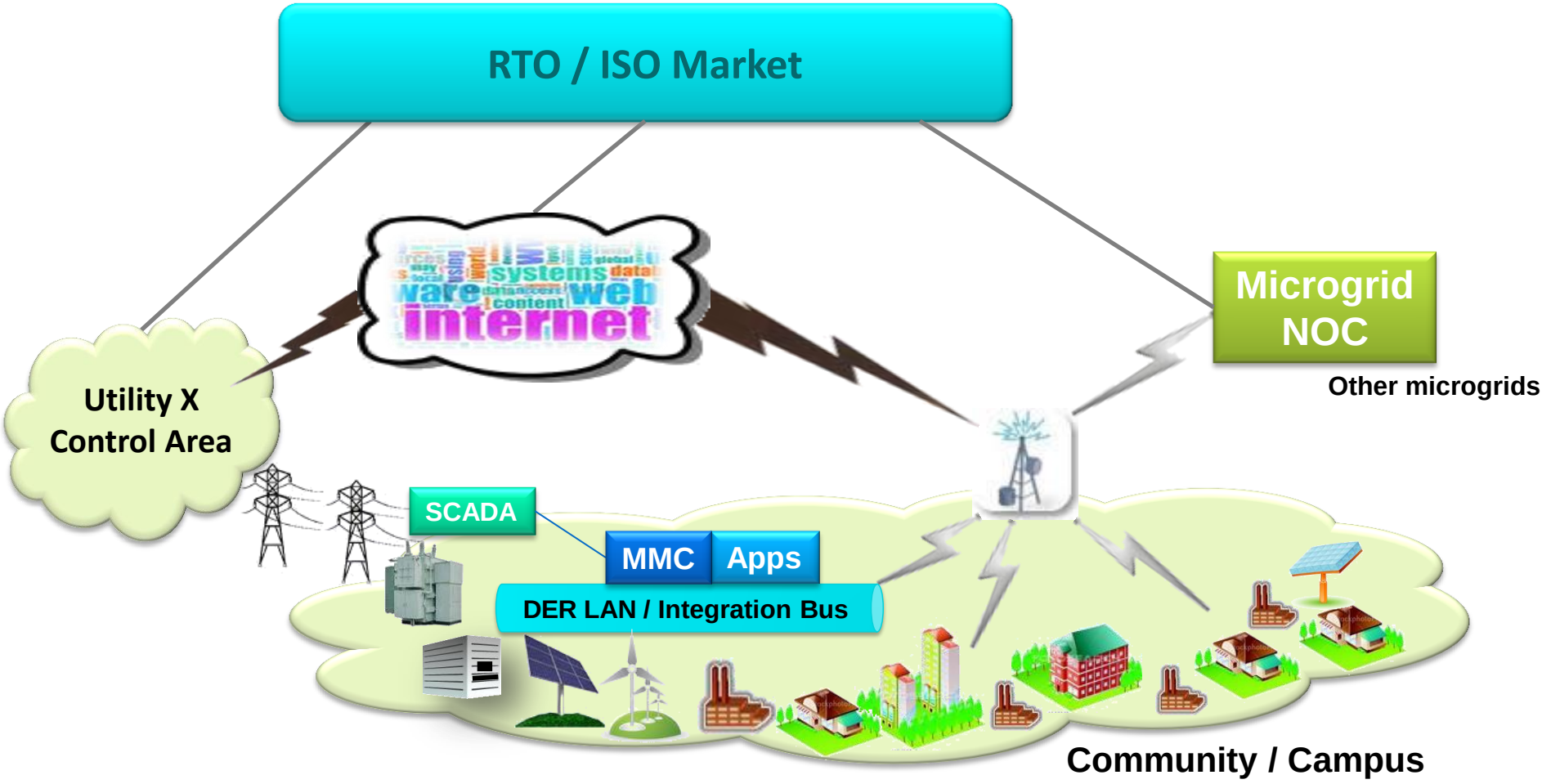
Rate Comparison – Avg Utility vs Microgrid



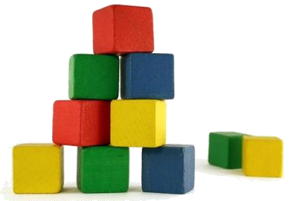
Emerging Design Elements

- State estimation (day ahead)
- State measurement (real-time)
- Economic, reliability, environment (ERE) dispatch tools
- Objective functions and algorithms for most of the design (Design Overview)
- Anticipatory and response/corrective algorithms
- Energy arbitrage algorithms
- MMC – enterprise vs distributed; brain vs agent community

Microgrid Future Vision



MMC Development Partners



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PRIMARY INTEGRATION

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Horizon Energy Group is a key contractor on the DOE Smart Grid Implementation Strategy Team

Horizon Energy Group Principals are Certified Navigators for Carnegie Mellon's Software Engineering Institute's Smart Grid Maturity Model

Horizon Energy Group named in 2008 as a Company to Watch in the book, "Perfect Power" by former Motorola Chairman, Bob Galvin, and former EPRI CEO, Kurt Yeager.

Horizon listed in 2009 as one of the "Top 100 Movers and Shakers in the Smart Grid Movement" by GreenTech Media.