SDGE
A Sempra Energy utility

Smart Green Grid

Smart Grid OIR Workshop 2

June 5, 2009

Distribution Level: Microgrid Overview

SDG&E

Microgrid Project Scopes

- DOE grant of $7.5M to demonstrate the theoretical microgrid concept
  - Utility scale demonstration of a smart grid alternative service delivery model
  - Leverages the existing Smart Meter/AMI, and smart substation, CBM
  - Chosen and vetted site is Borrego Springs
- CEC grant of $3M to demonstrate the theoretical microgrid concept
  - Residential, small commercial scale version of DOE project
  - Also leverages the existing smart meter and smart substation projects

Microgrid Project Objectives

Smart Green Grid SM

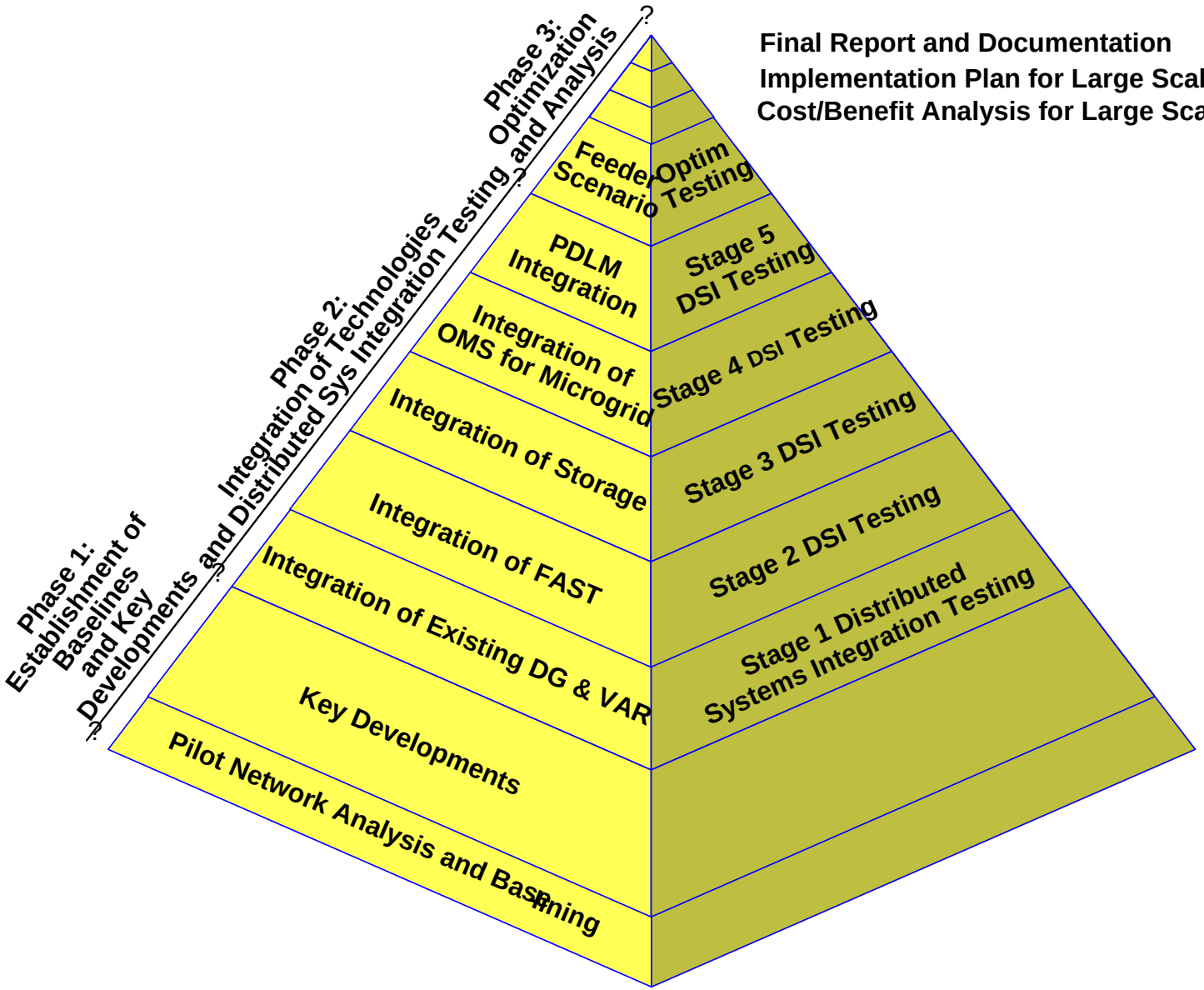
- Achieve > 15% reduction in feeder peak load
- Demonstrate capability of Volt-Amps-Reactive (VAr) management
- Develop a strategy and demonstrate:
  - Integration of Smart Meters/AMI into Microgrid operations
  - Self healing networks through the integration of Feeder Automation System Technologies (FAST)
  - Integration of an Outage Management System /Distribution Management System (OMS/DMS) into Microgrid operations
  - Intentionally island customers in response to system problems
  - Information/tools addressing the impact of multiple DER technologies

Microgrid Project Strategies

Smart Green Grid℠

- Design and demonstrate a smart electrical grid that incorporates sophisticated sensors, communications, and controls in the following ways:
  - Intelligently incorporate solar power generators on homes and businesses into the electrical delivery system.
  - Enable coordinated Demand Response (DR) programs whereby heavy electrical use during peak demand periods can be moderated to prevent electrical supply emergencies.
  - Integrate and control multiple distributed generation and electrical energy storage devices to operate the grid in a more cost-effective and reliable manner, benefiting customers and electrical rates.
- This project will proactively identify and apply leading-edge technologies to improve the security and reliability of electricity supply and to lower costs to consumers.

Microgrid Project Overview

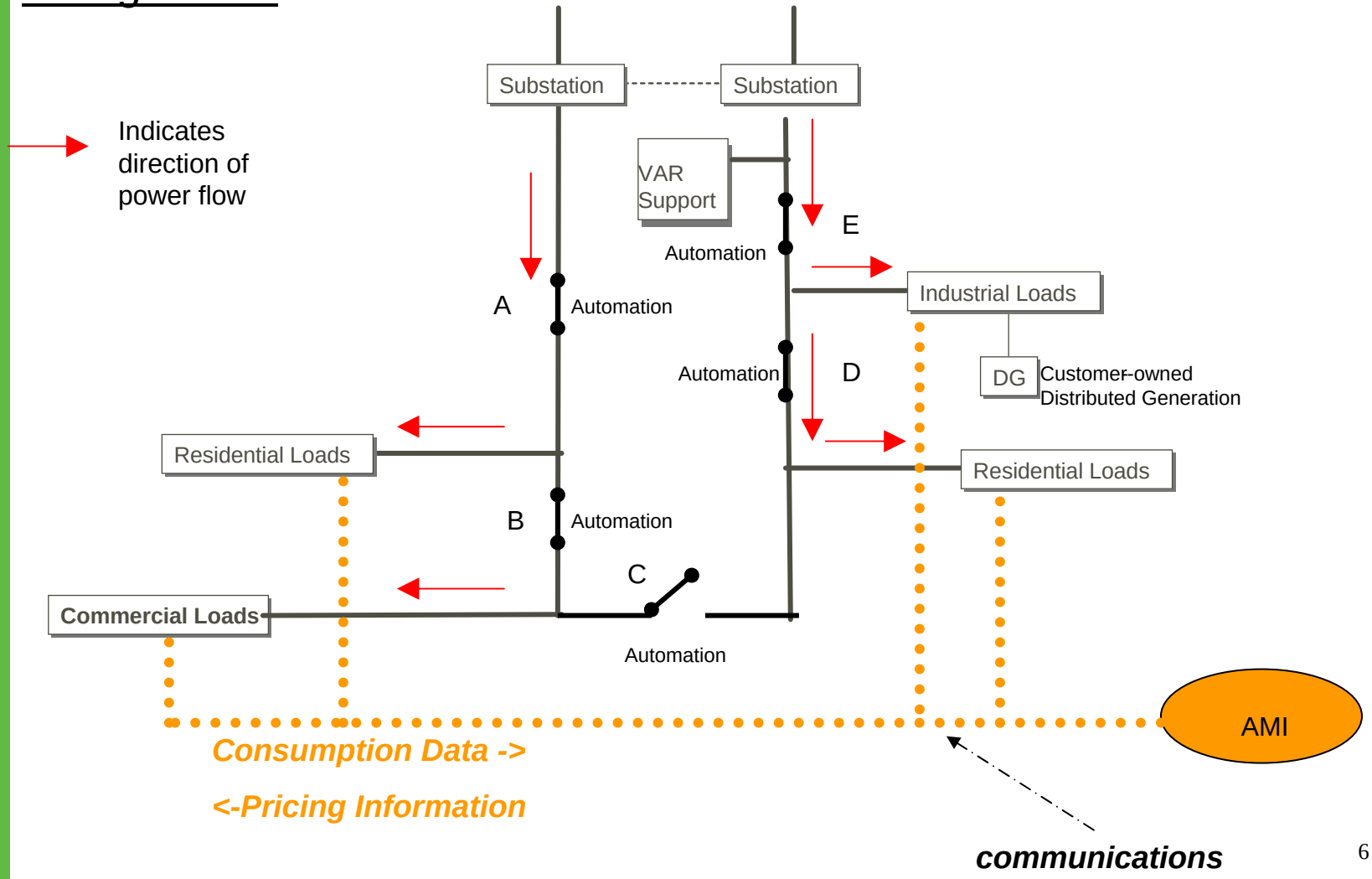


Final Report and Documentation
Implementation Plan for Large Scale Deployment
Cost/Benefit Analysis for Large Scale Deployment

Traditional Power Flow Model with AMI and Automated Switching

Smart Green Grid SM

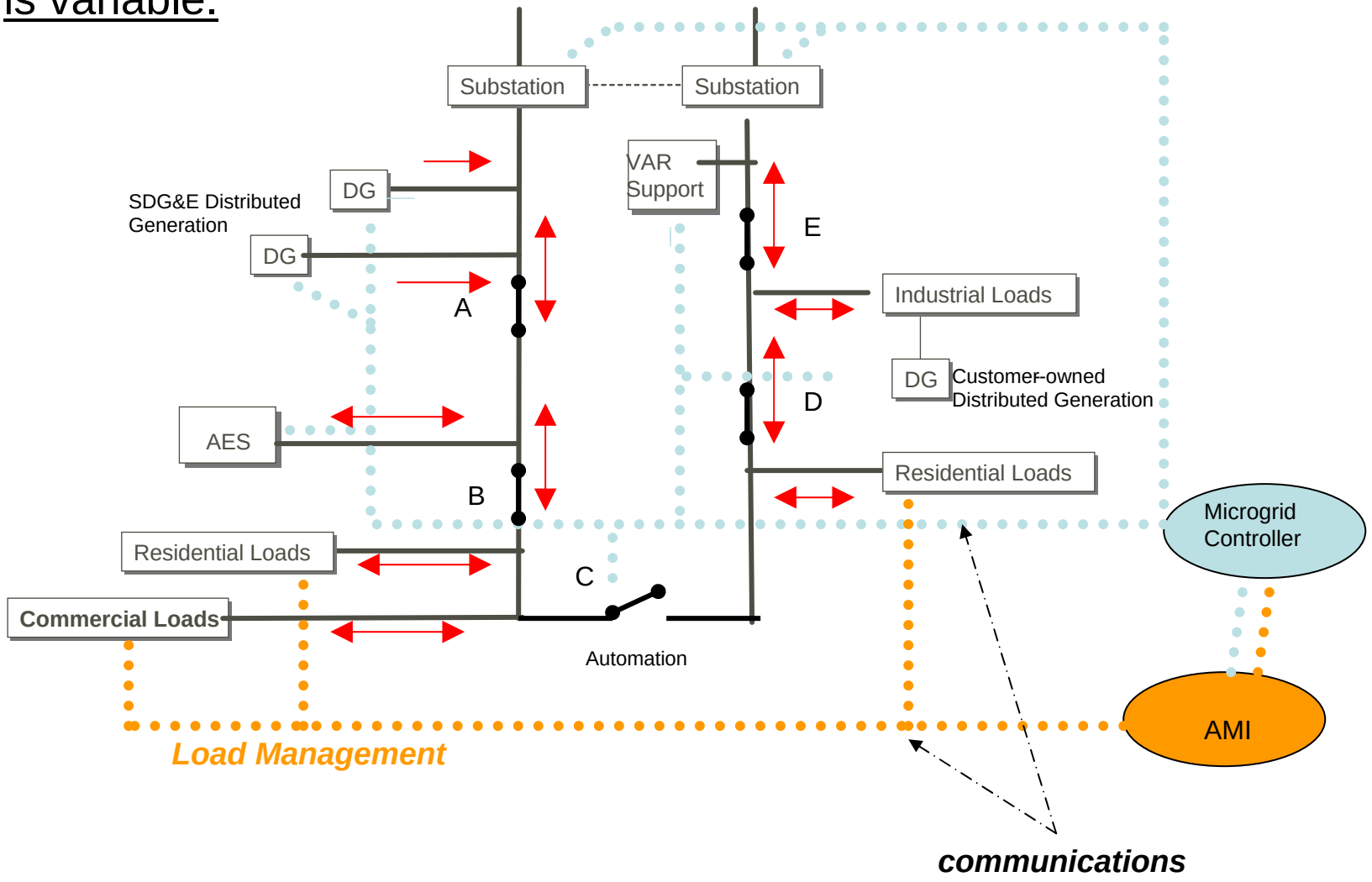
Only one switch may be open, and power always flows the same direction depending upon configuration



SDG&E Microgrid Concept

Smart Green Grid℠

More than one of switches A through E can be open simultaneously without outages due to distributed generation. Power flow direction is variable.



Microgrid Issues and Challenges

- Integration of Distribution Energy Resources
- Distribution Automation
- Asset Management
- Security – Cyber & Physical
- Tariff Development
- Customer Participation
- Cross-jurisdictional Issues

Appendix

Vision

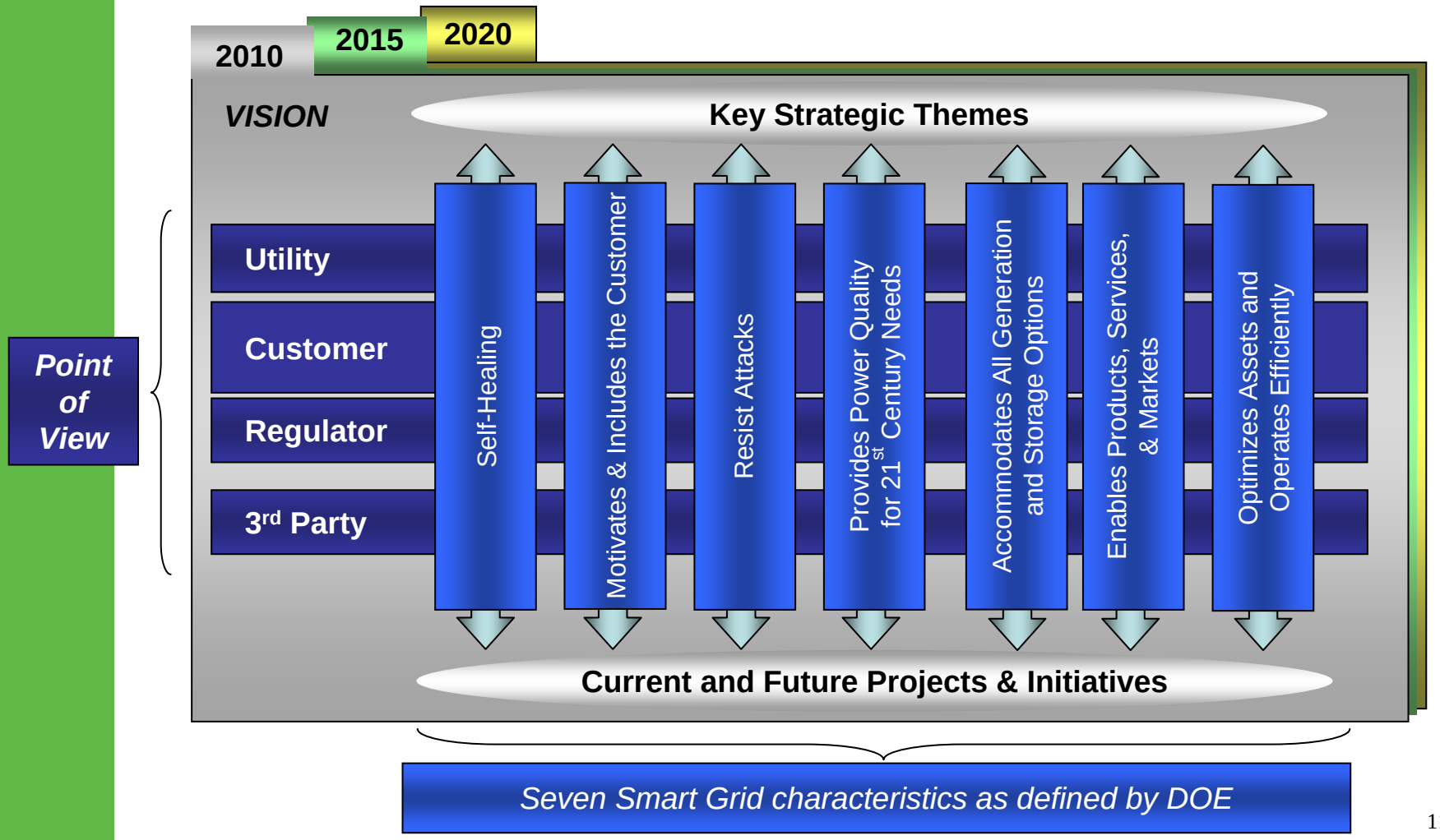
Smart Green Grid℠

- Intelligent
- Efficient
- Accommodating
- Motivating
- Opportunistic
- Quality-focused
- Resilient
- “Green”

- Smart Green Grid℠ will provide environmental and economic benefit by transforming the energy value chain via an evolving energy and information network that is resilient, open, and dynamic; enabling the active participation of customers, utilities, and suppliers in energy usage and supply decisions.

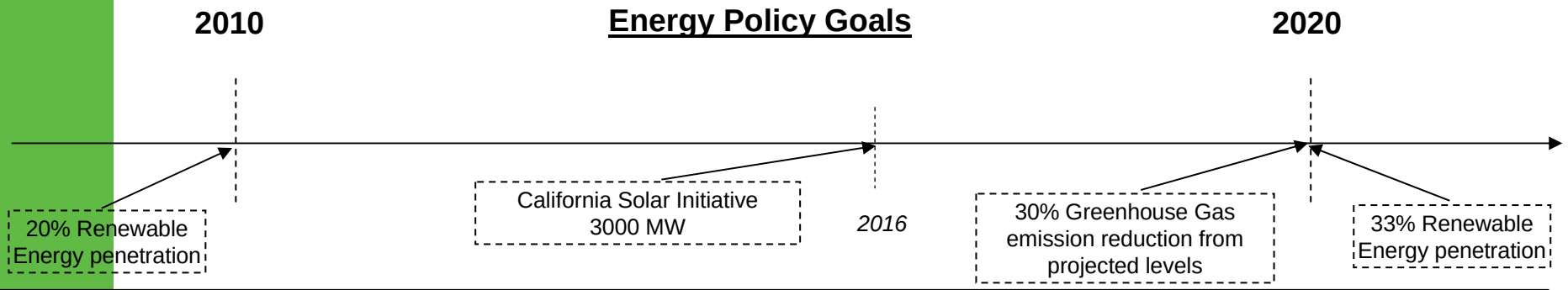
Approach

The Smart Green Grid is a **business transformation** that has **distinct key themes at different phase of development**.



Roadmap

Smart Green Grid℠



2009 - 2011

Deploy base technologies
- ✓Smart meters installed
- ✓OMS/DMS system
- ✓Microgrid Pilot

New Customer programs offered by Utilities
- ✓ Dynamic Pricing
- ✓ EE, Demand Response
- ✓ HAN, Energy Management

Many Smart Grid components are initially deployed
- ✓Self-healing-grid technologies in full deployment
- ✓Microgrid technology deployed and self sustaining community concept demonstrated
- ✓PHEV infrastructure pilots

2012 - 2015

Automated outage detection, restoration, and customer notification
- ✓Expanded SCADA & line devices
- ✓Self Healing Grid technologies in place

Traditional utility relationship with customer is changing due to more mature new services for customers
- ✓Load control with DR
- ✓Bundled services
- ✓DER Aggregation (including PHEV)

Major regulatory issues are solved
- ✓Data ownership and access
- ✓Cross jurisdictional conflicts
- ✓T&D renewables strategy

2016 - 2020

Customer supply side & storage decisions become the norm
- ✓Significant DER Penetration
- ✓Additional Microgrids where cost effective
- ✓"Customers as resources"

PHEV adoption rises- utility becomes "gas station of the future"
- ✓PHEV adoption emerges as a critical component of DER
- ✓Charging infrastructure in place
- ✓PHEV rates in place (charge & discharge)

Advanced grid technologies in place
- ✓CBM, Cable Diagnostics
- ✓Advance Energy Storage to support RPS goals
- ✓Self-healing grid is a reality

Microgrid Issues: Integration of Distribution Energy Resources

- Need to connect customer-owned DG to supply-demand decisions across grid
  - Must be customer choice
  - Storage, including PEV
  - DR—dispatchable and interoperable
  - DG
- Development of technology, tariffs, regulations, standards and controls to balance dynamic supply and demand
- More Investigation and pilots re: customers as supply resource
- Eventual “Plug and Play” Approach
- How can the Smart Grid help to integrate distributed energy resources, including generation and storage, into the distribution system?
  - Smart Grid can take enable the current distribution system by providing more control.
    - Peak Shaving
    - Better able to sense, transmit data, analyze and control

Microgrid Issues: Distribution Automation

- Fault detection with Smart Meter/AMI foundation will improve customer satisfaction
- As data becomes more real-time and better - CAIDI, SAIFI, SAIDI, MAIFI and reporting may initially appear to get worse
- Self-healing grid technologies rollout
- How can the Smart Grid help to integrate and maximize the benefits of distributed energy resources, including generation and storage, into the distribution system?
  - Smart Grid can take enable the current distribution system by providing more control.
  - Peak Shaving
  - Better able to sense, transmit data, analyze and control
  - Load profile levelizing
  - Voltage tolerance levels maintained
  - Capital expenditures may be deferred
  - Customer choice

Microgrid Issues: Asset Management

- Best in class policies and procedures implemented
- Movement towards condition-based maintenance continues
- Predictive analytics begin to develop and mature
- How can the Smart Grid increase the reliability and efficiency of the distribution system, for example, by improving situational awareness, achieving greater automation, and improving asset utilization?
  - Greater autonomy moving forward
  - More sensors
  - Better analytics and decision making tools
  - Improved visualization tools

Microgrid Issues: Cyber Security

- What cyber-security measures should be taken to protect the utility's systems and facilities?
  - Federal, state, and industry cybersecurity standards development should be coordinated
  - Cybersecurity must be an integral element, designed into systems from the start (rather than adding it on later)
  - Utilities should have structured cybersecurity programs for Smart Grid
    - Defense in depth security strategy
    - Physical, network, application, personnel
    - Common authentication mechanisms (reference White House report)
    - Authorized accesses for personnel and devices, logged for auditing
    - Controls and technologies to protect the privacy, confidentiality, and integrity of customer and utility data
    - Encryption
    - Digital signatures
  - Microgrids should use standards-based security processes and technologies, designed with a defense in depth strategy
    - Facilities, people, processes, technology
    - Cybersecurity as an integral element from the start
  - Must be designed to seamlessly integrate with the centralized utility computing systems, but also to operate autonomously
    - Systems must preserve system availability, security controls, and data integrity even while islanded

Recommended Metrics: Distribution Level

Objective Measures

- Reduction of Peak Usage
- MW of Aggregate Demand Response
- Increased Customer Participation in Dynamic Pricing Programs
- Availability of Energy Smart Products
- Reduction of Energy Usage
- Level of distribution automation
- Level of Smart Meter/AMI-enabled customers
- No. of outages/Outage duration
- Power Quality
- Peak load reduction

- Metrics may appear worse before improving due to enhanced monitoring
- DOE Metric workshop results

Strategy

Smart Green Grid℠

Strategic Components

- **Grid** – Enhancements to the grid to reduce customer disruptions, resists attack, and improve workforce and asset optimization

Large Scale Energy Storage, Phasor Measurement Units, Self Healing Grid, Network Communications

- **Customer** – Enable and motivate customer's energy management through smart energy devices, new products and services and adoption of PHEV and renewable resources at the premise

In-home/in-premise displays, control of individual appliances, Energy management systems/controllers

- **Environment** – Incorporate and enable all generation and storage options to support customer choice, improve grid stability and improve power supply options

PHEV Integration, Renewable Resource Integration