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California Utility Vision and Roadmap for the Smart Grid of Year 2020

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Angela Chuang, EPRI
Kevin Dasso, PG&E
Mike Montoya, SCE
Lee Krevat, SDG&E

EPRI-IOU Team presentation at IEPR Workshop

Outline

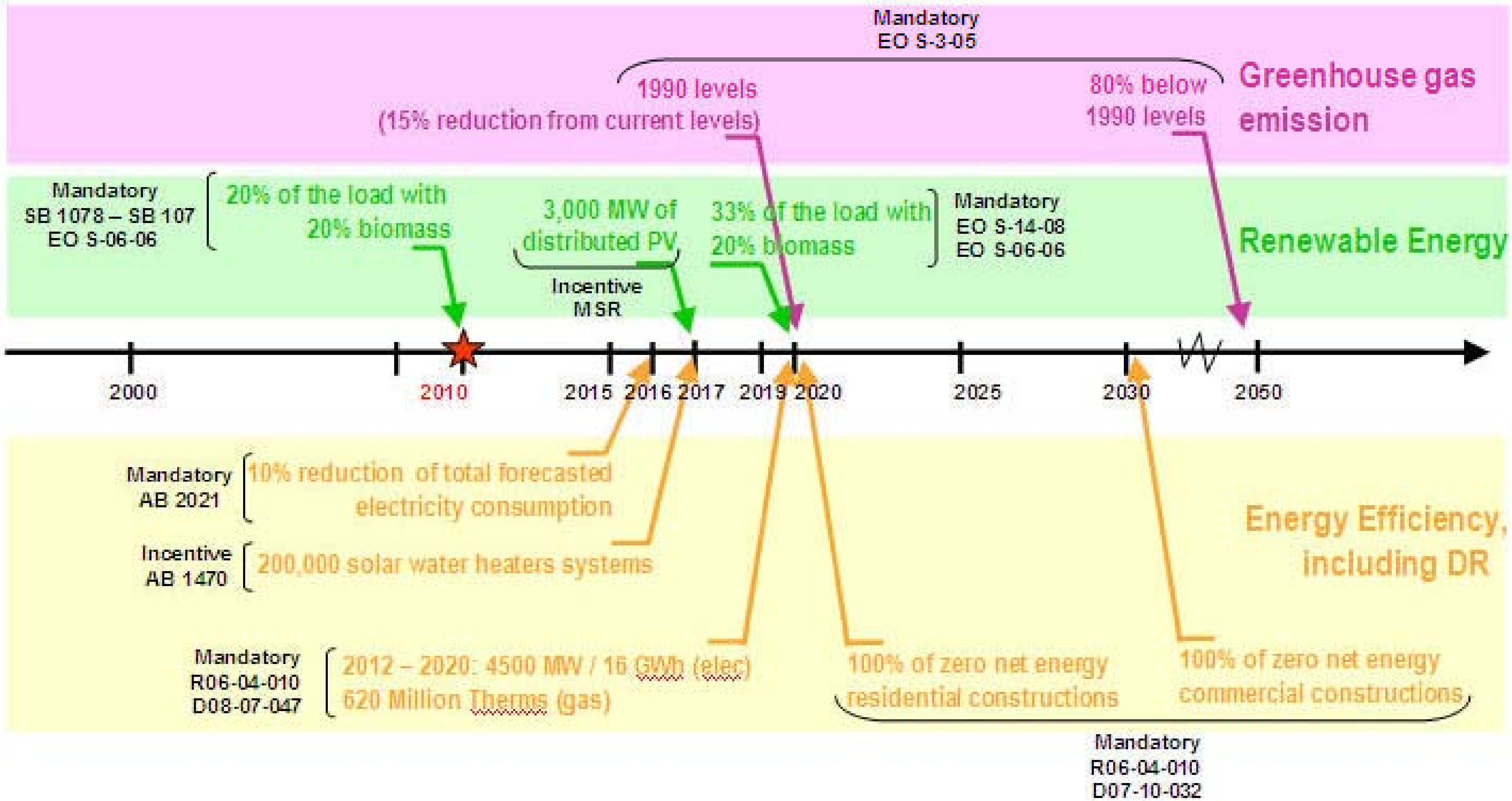
- Background
  - Drivers
  - Project Approach and Assumptions
- 2010 Baseline
- 2020 Vision
- Technology Readiness Roadmap Examples
- Policy Concerns
- Recommendations & Conclusions

Project Goals

- Synthesize utility perspectives to develop a CA Smart Grid vision in partnership with major California utilities
- Define the vision of the CA Smart Grid of Year 2020 and develop a roadmap to reach the vision, with Year 2010 as a baseline.
- Resulting vision and roadmap to support the state's energy policy targets
- Roadmap intended as a vehicle to identify key RD&D activities for CEC sponsorship in implementing the vision

Define California Utility Vision and Roadmap for the CA Smart Grid, which must support the state's energy policy targets

California Energy Policy Elements (2010)



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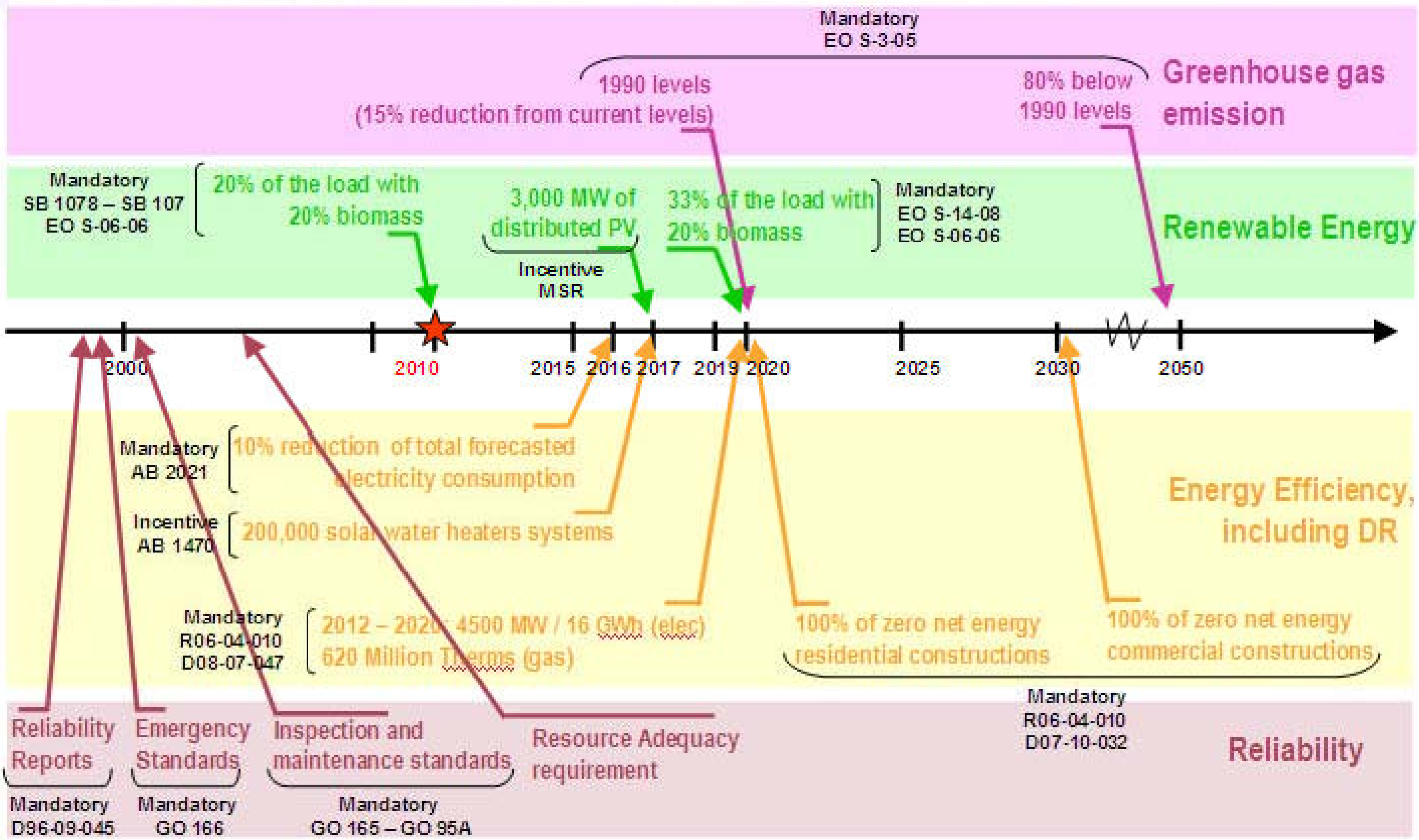

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Project Stages

2010

Feb — April — July — Nov –Dec — Jan

Define Guiding Principles and Frameworks

Workshop Series

Technology Ready Roadmaps
2020 Vision and 2010 Baseline
Gaps and Recommendations
Overall Recommendations

Integrate and Synthesize

Draft Final Report and Presentation

Revi ew and Publ ish

- Review publications and synthesize inputs
- Establish guiding principles and frameworks
- Depict 2010 baseline

- Vet and finalize 2010 Baseline
- Iterate to develop 2020 Vision and Roadmap
- Approve and integrate final work products of each domain team

- Assemble report
- Develop recommendations
- Steering Committee Approval

- CEC Review
- Final Edits
- Publication

Assumptions for Project

1. California Energy Policy Targets are met by Year 2020

2. Uncertainties affecting operations are handled logically
   - rules and controls assure gaming in market participation is thwarted
   - intermittency due to renewable fuel sources is managed
   - customers own distributed resources; other entities own resources too
   - infrastructure is aging and equipment failures will likely grow

3. Rates make sense to encourage fair behavior
   - Market and rate designs in place to effect behavior

4. Smart grid accommodates market enablement and customer-driven choices
   - customers will expect grid reliability to improve or at least stay the same
   - customers who want premium service will pay a premium (e.g., to the utility or on their own site), while others will not

5. Smart grid accommodates the integration of alternative resources
   - Integration of electric transportation, solar DG, and bulk renewables
   - energy storage will be integrated into the smart grid at the grid & customer level

Areas of Smart Grid Use:
Listed by Technical Areas of Expertise (Domains)

Communications Infrastructure & Architecture	Customer Systems	Grid Operations & Control	Renewable & DER Integration	Capital & Asset Efficiency	Workforce Effectiveness
Smart Grid Systems Architecture	Demand Response	Wide Area Situational Awareness & Control	Bulk Renewable Integration (Wind, Solar)	Grid Efficiency & Voltage Reduction	Workforce Management (distribution)
Communications Networks, Systems, and Data Integration	Customer Energy Management	Distribution Grid Management	Bulk Energy Storage Integration	Asset Management & Performance Optimization	Workforce Safety
Communications Protocols and Information Models	Electric Transportation Integration (inclusive of PEVs, Rail, Fleet, etc.)	Supporting Electric Transportation, DER, and Bulk Renewable Integration (All Types)	DER Integration (PV, CHP, Microturbine/Recip Engine/Fuel Cells, Distributed Storage)	Planning for Grid Growth (load, Elec Vehicles, PV systems, etc.)	
		Distribution Line Management			

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Objectives: What are we using Smart Grid to achieve?

Environmental Compliance	Meet Renewable Portfolio Standards
	Reduce GHG Emissions
Enhance Customer Choice	Meeting Customer Need
	Enhance Service Innovation
Improve System Economics	Reduce Peak Demand
	Reduce Losses
	Serve Isolated Remote Load
	Deferral of Capital Expansion
Maintain and/or Enhance System Reliability	Provide Emergency Support/Ancillary Service
	Reduce Facility Loading
	Provide for Micro-Grid Operation
	System Protection and Restoration
Improve Power Quality	Improve Voltage Regulation
	Reduce Harmonics and other PQ issues

Source: EPRI Report 2009

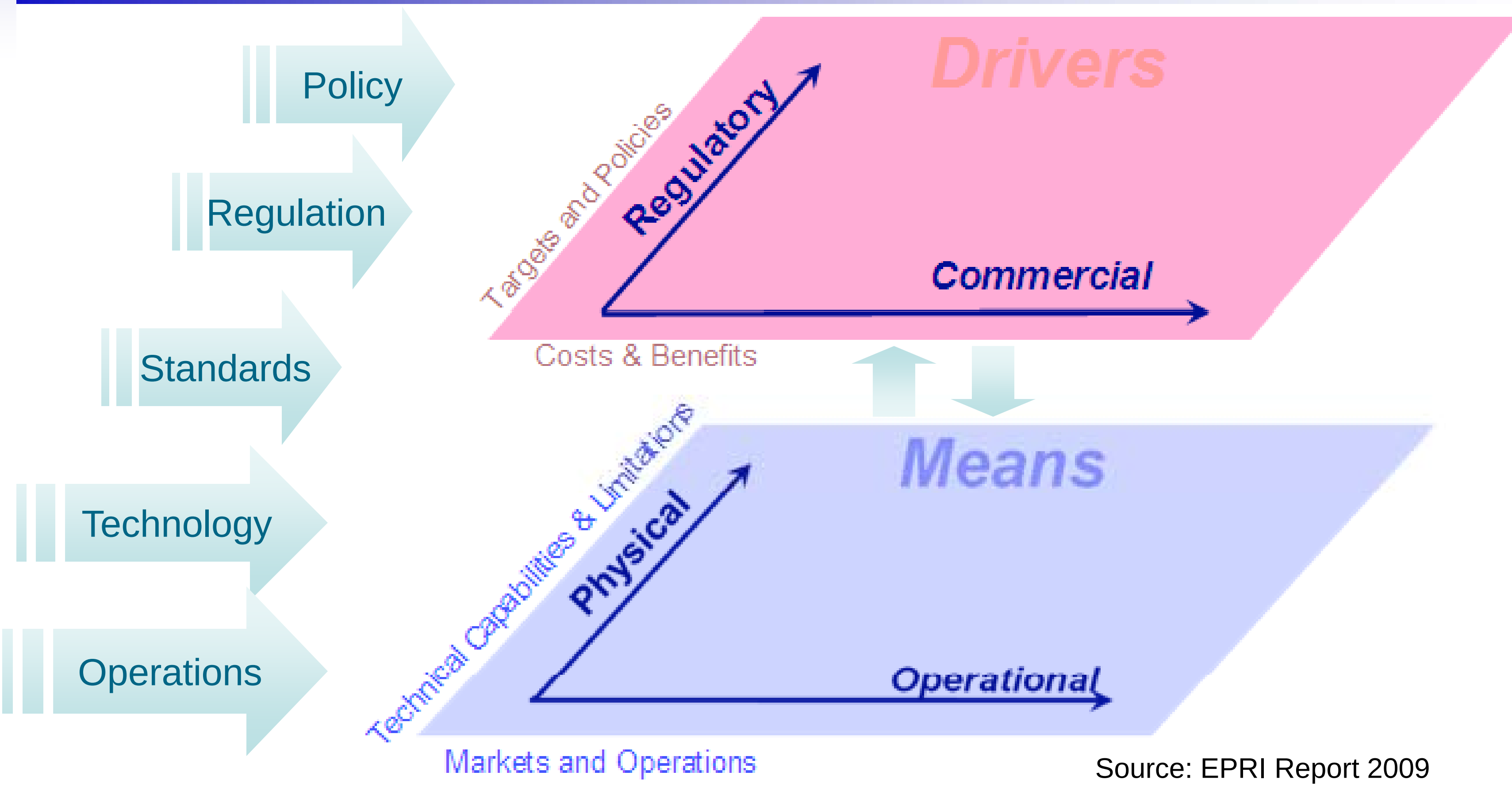
Top Priority Smart Grid Uses and Objectives

- Bulk wind and solar integration to meet RPS and reduce GHG emissions
- Wide area situational awareness and data integration for system protection & restoration
- PEV Integration to reduce GHG emissions and meet customer need
- Demand response to reduce peak demand
- Customer systems to enhance service innovation
- Grid efficiency & voltage reduction to reduce losses

High Priority Smart Grid Uses and Objectives

- Demand response for enhancing service innovation and deferral of capital expansion
- Customer systems for meeting customer need, reducing peak demand, and deferral of capital expansion
- Bulk electric storage for meeting RPS
- Data integration for enhancing customer choice and improving voltage regulation
- Customer Relationship Management for enhancing customer choice
- Electric rail system and integration of PV to reduce GHG emissions
- Distribution grid management for reducing peak demand or deferral of capital expansion

Dimensions of Evolving Considerations:
Policy, Economics, Technology & Operations

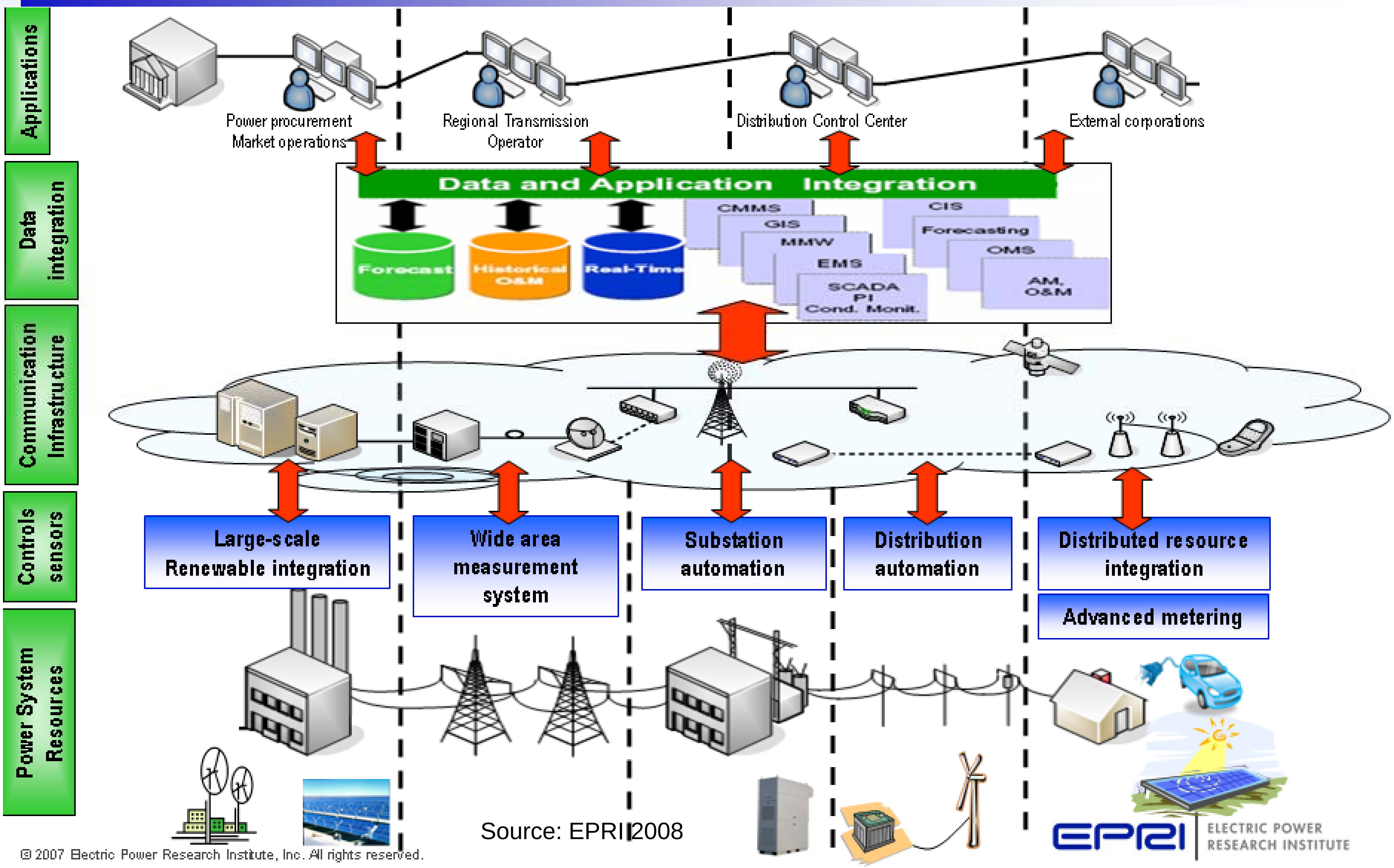


Source: EPRI Report 2009

Technology and operations determine what's possible (Enablers).
Policy and commercial viability determine what's probable (Drivers).
Standards drive consistency and support commercial viability.

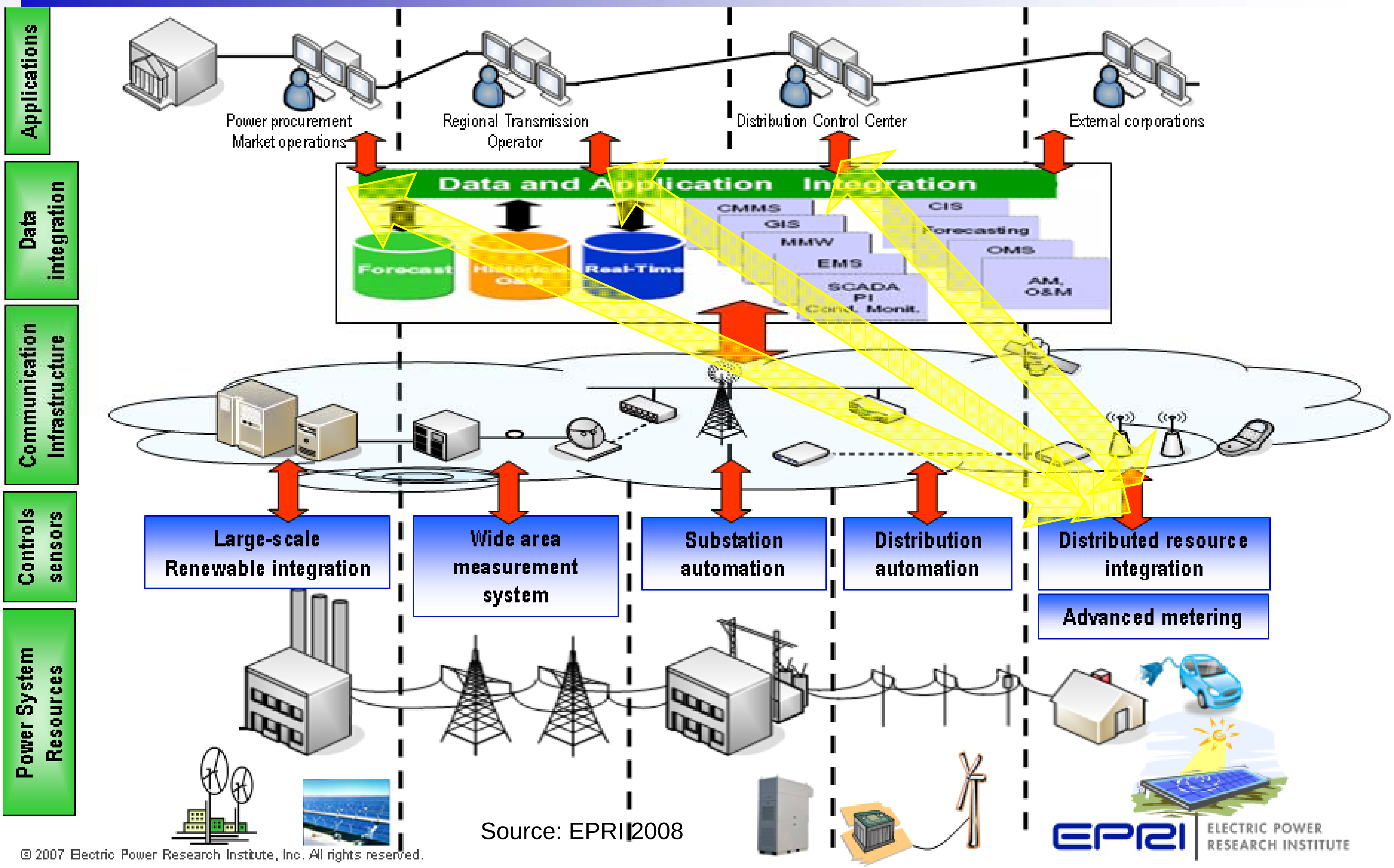
2010 Baseline

Smart Grid Technologies at Different Levels



Source: EPRI 2008

Intelligent Use of Information Across Traditional Boundaries



Source: EPRI 2008

2020 Vision

Smart Grid Characteristics … a starting point

Makes use of communications, computing & power electronics to create a system that is:

- *Self-Healing* and *Adaptive*
- *Interactive* with consumers and markets
- *Optimized* to make best use of resources and equipment
- *Predictive* rather than reactive, to prevent emergencies
- *Distributed* across geographical and organizational boundaries
- *Integrated*, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT
- *More Secure* from attack

MODERN GRID STRATEGY

- ***Self-heals***
- ***Motivates and includes the consumer***
- ***Enables markets***
- ***Optimizes assets and operates efficiently***
- ***Provides power quality for 21st-century needs***
- ***Accommodates all generation and storage options***
- ***Resists attack***

•Be self-healing and resilient

•Motivate consumers to actively participate in operations of the grid

•Enable electricity markets to flourish

•Run more efficiently

•Provide higher quality power that will save money wasted from outages

•Accommodate all generation and storage options

•Enable penetration of intermittent power generation sources

•Resist attack

2020 Vision Summary

"The smart grid will link electricity with communications and computer control to create a highly automated, responsive, and resilient power delivery system that will both optimize service and empower customers to make informed energy decisions."

Smart Grid Capabilities

The smart grid will:

- Empower consumers and open markets
- Facilitate the wide-spread presence of intermittent renewable generation
- Optimize grid reliability, resilience, security and efficiency in the face of increasing complexity to mitigate issues such as plug-in electric vehicles, intermittent renewable generation, and human caused and natural disasters
- Enable increased safety and productivity of the electric utility workforce.

Technology Readiness Roadmaps

PEV Technology Readiness Roadmap

Stage	Time Horizon	Applications	Key Enablers
Smart Charging	Short	Off-Peak Charging Demand Response and Load Control Critical Peak Pricing/Dynamic Pricing Down-Regulation	• Bidirectional Communications (Grid<-->Vehicle) • Standards Development (safety standards, metering) • OEM Implementation • Smart Grid Implementation
Vehicle to Home	Medium	Standby Power Rooftop solar integration Household load shifting	• Bidirectional Power Transfer on-board the vehicle • Proven Value Proposition
Vehicle to Grid	Long	Voltage and Frequency Regulation Utility Peak Shaving	• Proven reliability and robustness • Integration with grid operations • Proven Value Proposition
Renewables Integration	Long	Enabling more wind and solar generation	• Sufficiently high available installed base of PEVs • Proven Value Proposition • Mature standards • Upstream integration with bulk Generation

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DR Technology Readiness Roadmap

Stage	Time Horizon	Applications	Key Enablers
Reliability-Based Demand Response	Now	DR triggered during emergencies and other critical conditions (e.g., hottest summer days)	- Equipment retrofits with communications and remote control capability - Customer adoption and program participation
Energy Market Integration	Short	DR triggered based on wholesale energy market prices (e.g., day-ahead or day-of)	- Tariff approval for dynamic energy pricing - Smart end-use devices with one-way communications
Distribution Management System Integration	Medium	DR to reduce facility loading and extend asset life (e.g., PEV charging to avoid tranformer overloads)	- Localized event triggers - Smart end-use devices with two-way communications - Tariff approval for demand-based rates/pricing - Configurable demand limit (e.g., PEV charging)
Ancillary Service Market Integration	Medium	DR as operating reserves to support grid operations (e.g., Participating load or self-supply of reserves)	- Smart end-use devices with integrated communications & controls - Cost justification for telemetry or relaxed ISO telemetry requirements - Cost allocation method for avoided costs from self-supply of reserves
Renewable Integration	Long	DR to balance intermittent supply by providing regulation and other fast-response services	- Deep situational awareness - Smart end-use devices with integrated communications and rapid automated control

Supporting PEV, Renewable, and Storage Technology Readiness Roadmap

Stage	Time Horizon	Applications	Key Enablers
Integration Support	Short	Monitor DR, DER, PEV, and ES equipments Integrate it with SCADA and market systems Computing applications for information gathering, modeling, decision-making, and controlling actions operating in a coordinated manner and adaptive to the actual situations.	•Standards development •Proven reliability and robustness of supporting technologies •A set of computing tools for information gathering, modeling, decision-making, and controlling actions. •OEM Implementation of smart grid technologies •2 way communications •Cyber security
Advanced Protection and Operation	Short	Manage bi-directional power flow Low Voltage ride-thorough Technology (LVRT) and Anti-islanding (eg DER integration)	
Advanced Remote and Automated Control	Medium	Advanced remote and automated control of DR, DER, PEV, and ES equipment integrated with SCADA	•A combination of solutions for transient mitigation, intermittency handling, advances in forecasting (especially for wind) and coordination between the renewables and storage. •Customer acceptance of demand reduction through voltage optimization •Advanced real time voltage-VAR based software tools
Voltage/Var Control and Demand Control	Medium	Demand and energy reduction Voltage / Var optimization	

Policy Issues

Policy Concerns

Regulatory Role

Jurisdictional clarity needed on cyber security and interoperability standards; must prevent CA-only standards and requirements

Regulators should allow for IOU differences in progress of SG deployment

Varied consumer preferences create equity challenges

Investments to meet energy policy goals will be least-cost, best fit.

Deployment Pace

Regulators should avoid mandates and not "pick winners"

Methodology needed for treatment of emerging technology contingency costs

Ensure reliability is maintained while meeting aggressive policy goals

Customer Readiness

Stakeholders should carefully consider the appropriate outreach programs and rate structures to encourage customer participation in smart grid programs

The need for 3rd party access to customer information must be carefully evaluated in light of customer privacy issues.

Customer need to anticipate rising future electricity costs and understand the business as usual costs, absent a smarter grid.

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Summary Conclusions and Recommendations

Summary

- Energy policy goals are driving the adoption of smart grid technologies
  - Maintaining and/or improving reliability given these policy goals is a top priority
  - All IOUs have baseline activities in smart grid
  - Best fit, lowest cost solutions
- Developed common IOU vision for California smart grid
  - Empower consumers and open markets
  - Integrate and mitigate intermittent renewable generation
  - Maintain and enhance reliability, resilience, security, and efficiency
  - Increase worker safety and productivity
- Interdisciplinary opportunities and applications across domains
  - Holistic view of customers, grid planning, operations and workforce
  - Secure standards based approach
- Smart Grid Benefits
  - Utility technical efficiency (operational efficiency leads to society and/or cost impacts)
  - Demand reductions and environmental improvement
  - Service reliability and power quality
  - National security, economic prosperity, and worker safety

Recommendations

1. Advance DER and customer value strategies and technologies
2. Advance wide area monitoring & control for large scale renewable
3. Develop and demonstrate advanced technology assessment and integration
4. Advance standard model-based management of grid
5. Support research to advance the future operating environment and workforce development and management
6. Advance smart grid architecture development and specifications – system of systems
7. Develop integrated communication infrastructure plan and specification
8. Advance data management, analysis, and visualization approaches
9. Leverage experience from other industries

Conclusions

- Smart grid an enabler to achieving CA's energy policy targets
- Multiple dimensions considered in roadmap effort
  - Existing policy drivers and issues
  - Economic justification (cost/benefits)
  - Technology and operational readiness
- Hierarchy of considerations made
  - Technology readiness roadmap informs what's possible
  - Commercial filter further screens viable options
- 2020 Vision and roadmap with identified assumptions
  - Versus a prediction or forecast
  - Result may be useful for informing policy issues
- Three IOUs at various stages of deployment

Together…Shaping the Future of Electricity