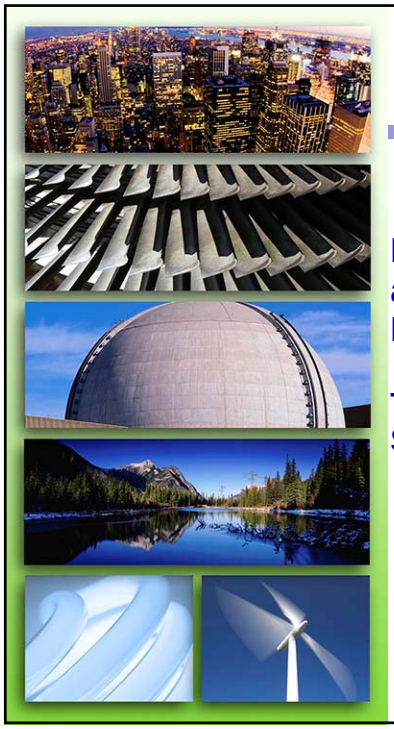

Regional Profiles, Framework, and Aggregation Methods for Distributed Resource Integration

Tasks 1.1, 1.2, and 2.4 of Smart Grid Demonstration Initiative

Angela Chuang
Senior Project Manager

October 13, 2009

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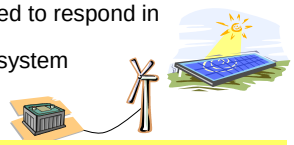
Regional Profiles Task

Clarify regional drivers, challenges, activities, and methods to integrate distributed resources

- **Deliverables**
  - Workshops/webcast
  - Reports
- **Scope emphasizes Distributed Resources:**
  - Connected on the distribution system or customer-side of the meter
  - curtailable/interruptible load (demand response resource)
  - distributed energy resource (DER)
    - distributed generation, storage, PHEV, etc. integrated to respond in coordinated fashion
    - renewable resources located along the distribution system



Clarify regional activities and their relationships to support collaboration, enhance leverage, and identify demonstration needs within regional contexts

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Project Tasks

- **Literature Review**
  - Regional drivers for distributed resource integration
  - What types of resources qualify as “renewable resource” by state
  - What opportunities exist for distributed resources to participate in
  - What are the associated market requirements
- **Primary Research**
  - Online Survey
  - Regional Workshops
    - Working group feedback via “grid” exercises
    - Activity surveys
- **Analyses**
  - Characterize findings per region
  - Compare regional findings
- **Integration Framework**
  - Relate utility programs, retail tariffs, and pilot implementations
  - Identify trends and gaps
  - Identify characteristics of other implementations enabled by smart grids towards overcoming integration barriers

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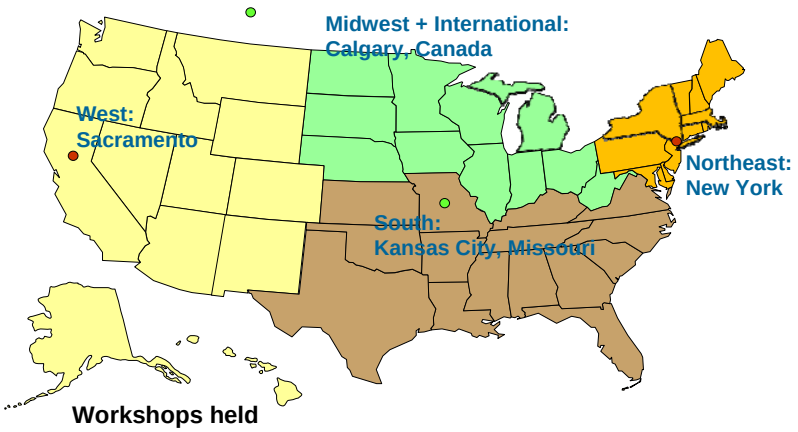
Workshop and Survey Invitations by Region



Workshops held

- **West, May 15th (CEC)**
- **Northeast, June 29th (EPRI PQA Conference)**
- **Midwest & International, July 29th (IEEE PES General Meeting)**
- **South, August 25th (SPP)**

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Objectives for Distributed Resource Integration: What utilities are using distributed resources for?

Objectives

- Market Economics **NE, Midwest, South**
- Low Carbon Future **South**
- Reliability **NE**
- Dynamic Security & Protection
- Power Quality
- Enhanced Innovation and Customer Choice
- Defer capital expansion **Midwest, South**
- Meet regulatory requirement **West, Int'l**
- Serve isolated remote load

Additional Objectives?

- Congestion Management
- Energy Security & Independence
- Distribution System Efficiency
- Private Investor

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Enablers that are Lacking for Distributed Resource Integration

Barriers

- Automation
- System operator confidence
- Wholesale market structures

} **Next for International**

- Economic justification — **Top for all Regions**
- Retail rates — **Next for all U.S. Regions**
- Customer convenience
- Aggregation
- Measurement & billing
- Safety & monitoring
- Building codes & permits
- Planning & engineering

Additional Barriers?

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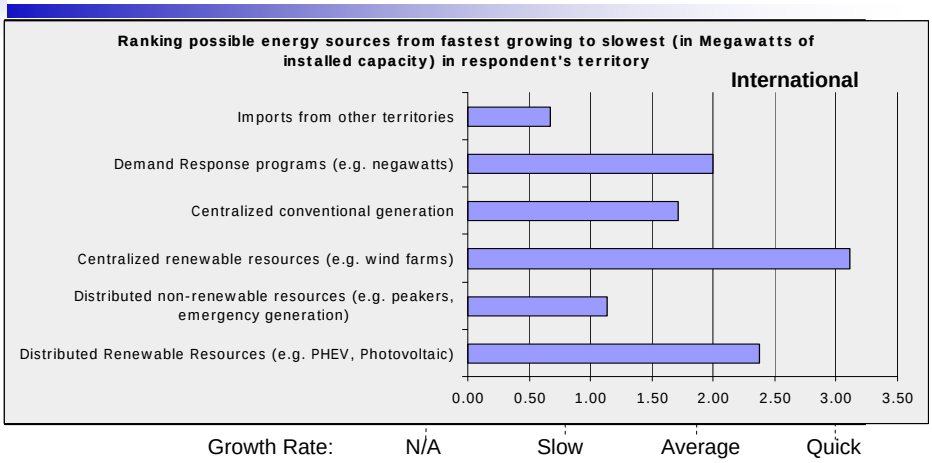
Relative Growth Rate of Distributed Resources



Centralized renewable resources has above average growth rate in all but NE, and quickest growth rate Internationally. Demand response has at least average growth rate. Distributed renewable at least at average growth, except slow in South and Midwest. Imports are at best at slow growth rate, except at average growth in the Northeast.

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Lessons Learned from Regional Profiles Task

- Regions have own reasons and relative growth rates for distributed resources.
- Drivers influencing differences in reasons and growth rates include:
  - Regulatory requirements (e.g., status of mandates towards low carbon future, policy drivers, etc.)
  - Market economics (e.g., heightened wholesale electricity costs)
  - Resource constraints leading to reliability concerns (e.g., NIMBY)
- Economic justification is the top enabler that is lacking in all regions
- Next top enabler that is lacking include
  - Retail rates for integrating distributed resources (U.S. Regions)
  - Wholesale market structures, automation, and system operator confidence (International)

The top reasons, barriers, and growth rates for distributed resources are regulatory and economically driven. Technical issues are secondary.

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Distributed Resource Integration - Objectives

• **Improve System Economics**	• Reduce Peak Demand • Reduce Technical Losses • Serve Isolated Remote Load • Defer Capital Projects
• **Environmental Compliance**	• Meet Renewable Portfolio Standards • Reduce Greenhouse Gas Emissions • Meet other regulatory requirement
• **Improve Reliability**	• Provide Emergency Support / Ancillary Services • Reduce Facility/Equipment Loading • Support System Protection / Dynamic Security
• **Improve Power Quality**	• Improve Voltage Profile/Regulation • Reduce Harmonics and Other PQ Issues
• **Enhance Customer Choice**	• Support Interconnection Requests • Enhanced Innovation/Customer Choice

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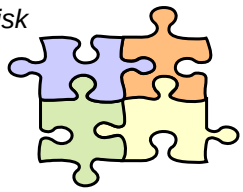
Recap from Feb '09 Advisory:
Demand-side Implementation Framework Parameters

Implementation methods can be related by

- Time Horizon - *Timeframe to address imbalance risk*
  - Resource Planning (year)
  - Operational Planning (months)
  - Day-ahead Operations (day)
  - Day-of Operations (<day)



- Implementation Type - *Motivation for participant engagement*
  - Alternative Pricing: pricing structures determine what customers pay
  - Direct Incentives: financial incentives determine rewards to participants
  - Outreach and Cooperation*: information exchange to engage customers or encourage voluntary behavior
  - Regional Codes & Standards*: dictate minimum regional requirements

* Chuang and Gellings (CIGRE paper, 2008)

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Findings on Regional Commonalities:
Implementation Types Used

- Directive Incentives and Outreach & Cooperation are used more than Alternative Pricing in all U.S. regions. However, Alternative Pricing is used more internationally than Direct Incentives.
- Alternative Pricing is not as widely used for integrating distributed resources, yet is most critical to pursue in every region.
- Outreach & Cooperation is used more than Regional Codes & Standards by respondents in each region, except the Northeast uses the former slightly more.
- "Other" distributed resource efforts that are most critical to pursue
  - "De-coupling and proper regulation treatment to get rate of return on the assets"
  - "Regulatory approval for DER deployment with a standard rate of return"
  - "Getting distributed resources integrated into wholesale market"

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Types of contracts customers willing to accept?

- Subscriptions for demand limiting services (e.g. breaker settings in the meter)
- Subscriptions for matching demand to generation (e.g. zero net usage)
- Subscriptions for emergency demand only (e.g. the customer makes all their own power, except for emergency circumstances)
- Subscription for demand limiting on critical days (e.g. a limit of 20 days per year with a demand limit set in the meter)
- Subscription for direct load control (e.g. the customer agrees to let you control their equipment directly to limit load)
- Subscriptions to control variable generation (e.g. the customer allows you to stop their variable generation when needed to balance the system)
- Pre-payment for power (e.g. credits loaded into the meter)
- Subscription for premium power (e.g. the utility offers N+1 or better service for the customer to prevent the loss of power from a single failure)
- Subscription for priority service (e.g. if the power goes out, the customer has first call on getting it restored)
- Load matching (e.g. the customer agrees to allow their load to be remotely managed based on the production of an off-site variable resource)
- Real-time market pricing (e.g., the customer agrees to pay for energy at rates that can change hourly based on fluctuating wholesale market price conditions)

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Regional Commonalities on Contract Acceptability:
Top responses per category of acceptability

- U.S. regions uncertain about acceptability of pre-payment for power, except the South and International region are more uncertain about priority service.
- "Subscriptions for demand limiting on critical days" is acceptable now or with customer education in all U.S. regions, except "subscription for emergency demand" in South and "premium power" in Int'l regions are acceptable now.
- Real-time market pricing would be acceptable with customer education in the NE and South, but would have low acceptability or no acceptability in the West and International regions, even with customer education.

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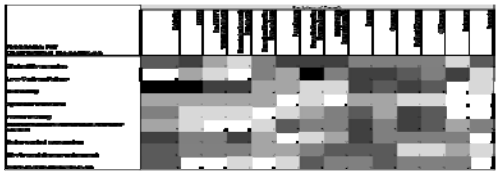
Observations from Session #1 of Workshops (Reasons)

- There was some agreement that the regulator and the distribution utility would gain the largest number of benefits from distributed resources
- Combinations of Low Carbon Future, Reliability, and Market Economics were cited as top reasons for integrating distributed resources.
- Deferral of capital expansion was a reason across the utility value chain in the South and Midwest, and seems to devolve to the distribution utility in the NE.



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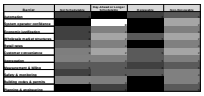
Observations from Session #2 of Workshops (Enablers that are lacking)

- There are clear concerns around renewables and non-schedulable resources and the enablers that are in place.
- Economic justification for all distributed resources seems to need further clarification and support.
- Automation across the board is seen as lacking in the grid to support distributed resources
- In general the participants were more comfortable that the integration of schedulable and non-renewable resources would be easier than renewables and non-schedulable resources.



Respondents on the workshop activity survey reported the greatest number of projects involved renewable resource integration.

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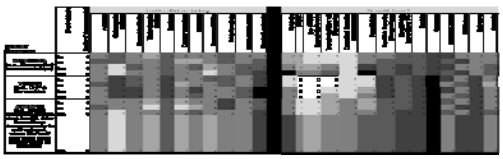
Observations from Session #3 of Workshops (by physical considerations)

- Participants were resigned to using always on resources and did not expect that they would be an issue to integrate
- Variable resources are seen as the hardest to integrate. They are also seen as the least desirable, except in the West.
- There is more concern about devices that can not be remotely actuated and even more concern if they are connected only to a single phase of the grid (NE and International workshops).



Technical considerations are also important including resource variability, number of phases of power connected, and remote actuator presence.

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Public Advisory Webcast and Online Survey:
Insights from addressing respondent comments

- Other contract types acceptable to customers:
  - "Feed-in tariff … for environmentally friendly power" (West)
  - Net-metering and standby rates (Public advisory group)

- Energy Efficiency vs. Demand Response
  - Measured in Energy (MWh) vs. in Demand for Power (MW) during events
  - Conservation across time vs. resource responsiveness in daily system operations

Net metering and Feed-in tariffs measure total energy produced/ consumed, whereas smart grid-enabled contracts may also have provisions for coordinated operation of distributed resources.

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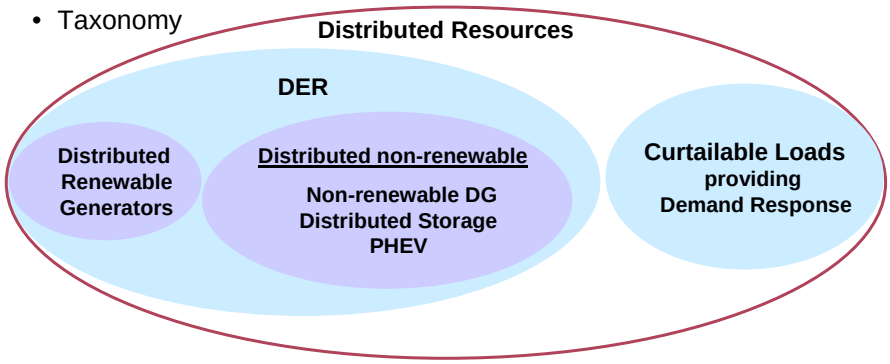
Regional Terminology Differences

- DER vs. DR Terminology
  - U.S.: DER distinct from curtailable loads providing demand response
  - Europe: DER includes curtailable loads providing demand response
  - EPRI Smart Grid Demo: "Distributed resource" includes both

- Taxonomy



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Integration Framework

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Distributed Resource Integration Framework

- **Regulatory: Domain of decisions made by regulators**
  - Regulatory Policies, Guidelines, Decisions and Tariffs
- **Commercial: Factors influencing economic justification and viability of new capabilities**
  - Ownership, Costs, Financial Paybacks
- **Physical: Technical and infrastructure requirements and constraints**
  - Interconnection, Metering, Monitoring & Control, and T&D Capacity related issues
- **Operational: Operating procedures and practices of utilizing physical infrastructure and resources**
  - Resource Operations, Markets and Programs

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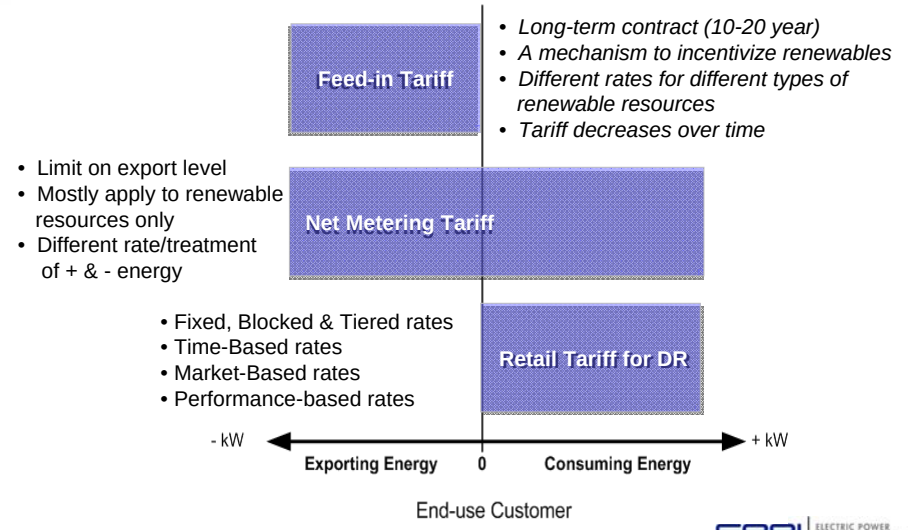
Tariff Types for Customer-owned Distributed Resources



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Recap from Feb '09 Advisory Meeting:
Demand-Side Implementation Framework

Implementation Horizon & Type →	Alternative Pricing	Direct Incentive	Outreach & Cooperation	Regional Codes & Standards
Planning				
Resource Planning (years)	**Alternative Pricing & Rate Structures**	**Paid for Adoption** Cash grant Rebate Low-interest loan subsidized installation	**Trade Ally Cooperation** **Direct Customer Contact** **Ads and Promotions** **Customer Education**	**Energy Efficiency Standards** Building codes Appliance efficiency
Operational Planning (months)	**Time of Use (Seasonal)**	**Paid for Performance** Seasonal Conservation Cr. Installed Capacity Aggregator Economic DR Demand Bidding of forward energy Emergency DR & Ancillary Services Interruptible Load Direct Load Control	**Public Conservation Appeal**	**Variable Service Subscription** **Demand Subscription Service**
Operations				
Day-ahead Operations (days)	**Dynamic Pricing** CPP RTP		**Public Appeal for Voluntary DR** Flex Alert	Demand Limiting Premium Power Priority Service OBMC
Day-of Operations (<day)	**Discounted Rate** Interruptible Load Direct Load Control			**Rolling Blackout**

DR Programs can be related by Time Horizon (operability of distributed resources) and Implementation Type (motivation for participation engagement)

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Extended for Renewable and DER Programs

Implementation Horizon & Type	Alternative Pricing	Direct Incentive	Outreach & Cooperation	Regional Codes & Standards
Planning				
Resource Planning (years)	**Alternative Pricing & Rate Structures** Net Metering Standby Rate	**Paid for Adoption** Cash grant & Rebate Tax incentive Low-interest loan Subsidized installation	**Trade Ally Cooperation** **Direct Customer Contact** **Ads and Promotions** **Customer Education**	**Energy Efficiency Standards** **Renewable Port-folio Standards**
Operational Planning (months)	**Time of Use (Seasonal)**	**Paid for Performance** **Feed-in Tariff** Seasonal Conservation Cr. Installed Capacity Economic DR Demand Bidding of forward energy Emergency DR & Ancillary Services Interruptible Load Direct Load Control	**Public Conservation Appeal**	**Variable Service Subscription** **Demand Subscription Service**
Operations				
Day-ahead Operations (days)	**Dynamic Pricing** CPP RTP		**Public Appeal for Voluntary DR** Flex Alert	Demand Limiting Premium Power Priority Service OBMC
Day-of Operations (<day)	**Discounted Rate** Interruptible Load Direct Load Control			**Rolling Blackout**

Net metering and Feed-in tariffs measure total energy produced/consumed. Other types provide for coordinated operation of distributed resources.

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Comparing Implementation Methods:
Distributed Resource Program Types supporting Operations

Alternative Pricing and Rates *(customer pays more for lack of DR)*	**Paid for Performance** *(customer paid for DR)*	**Outreach & Cooperation** *(no financial exchange for DR)*	**Variable Service Subscription** *(more customer choice using DR)*
TOU **Demand Rates** **Standby Rates** **Dynamic Pricing (CPP, RTP, VPP)**	**Regional Operator Economic DR Program** **Demand Bidding for:** Forward Energy Ancillary Service	**Public Appeal for:** Peak Demand Conservation Voluntary Demand Response (Day-ahead)	**Demand Subscription Service** **Demand Limiting**
Discounted Rate for: Direct Load Control Interruptible Load Curtailable Load (FSL, GLD) Dispatchable Standby Generation	**Regional Operator Emergency DR Programs:** Interruptible Load Curtailable Load Dispatchable Standby Generation Direct Load Control	Voluntary emergency demand Response Voluntary emergency standby generation Pre-planned voluntary interruptible/ curtailable load **Rolling Blackout**	**Premium Power** **Better-Served-for-Performance (OBMC, PAP)** **Priority Service**

A sweet spot for smart grid-enabled tariffs: provisions for coordinated operation of distributed resources.

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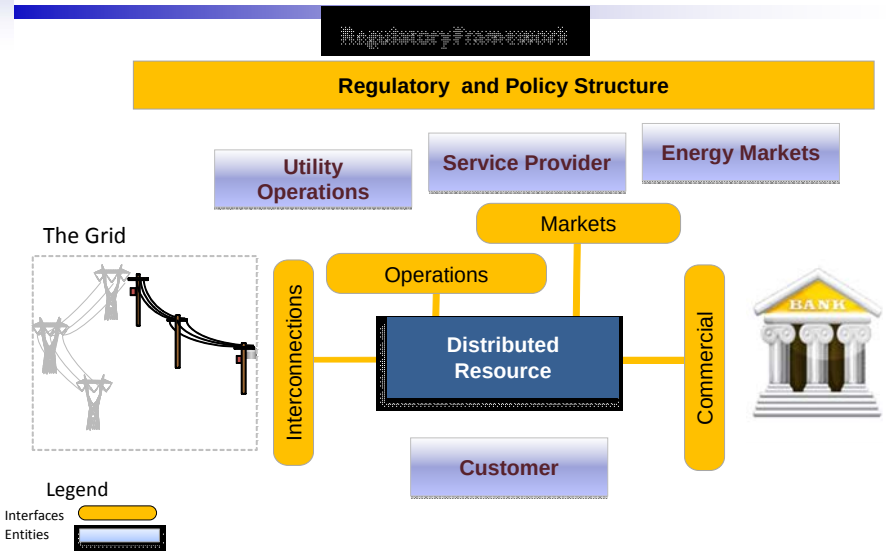
Distributed Resource Integration Framework: Collective view includes dimensions of interactions



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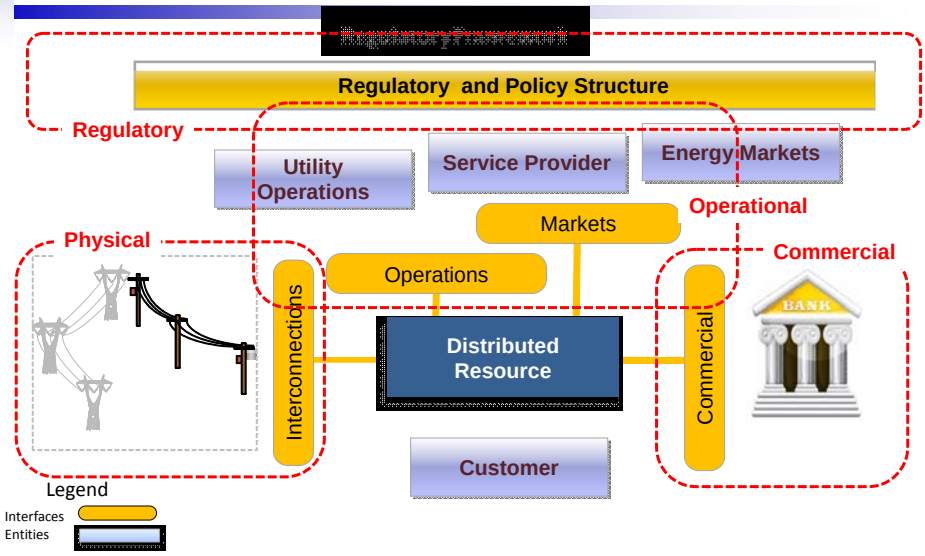
Dimensions of Distributed Resource Integration Framework



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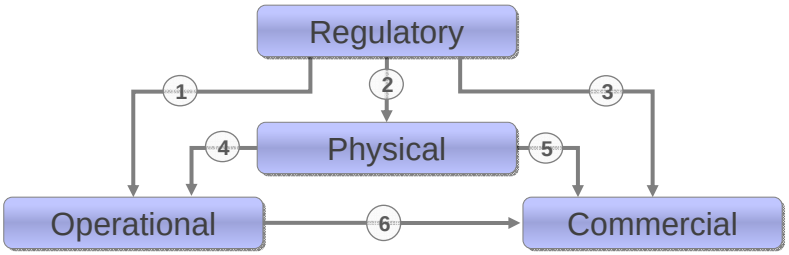
Examples of the Hierarchy of Influences between Framework Dimensions



1. Market Structure and Rules, Tariff Structure, RPS/GHG Requirements
2. Interconnection Policy, Regional Codes & Standards
3. Rates, Incentives, Penalties
4. Dispatch, Measurement , Verification & Control Capabilities, Limitations
5. Infrastructure and System Capabilities & Limitations
6. Utilization, Operational Capabilities and Limitations

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Elements under Regulatory Dimension

Elements	Sub-Elements	
Rates & Tariff	Retail Tariff for DR	Residential
		C&I
	Net Metering	
	Feed-in Tariff	
Direct Incentives and Penalties	Renewable Incentive (Tax Credit, Rebate, etc.)	
	Greenhouse Gas Emission Penalties	
	Performance-based incentives	
Outreach and Cooperation	Ads and Promotions, Direct Customer Contact	
	Public Appeal	
Regional Codes & Standards	Interconnection Policy	Renewable Resources
		Non-Renewable
	Building/Civil Codes	Safety
		Fire
		Aesthetics
	Permitting and Licensing Process	
Environmental Policies	Renewables Portfolio Standards (RPS)	Generation
		Storage
	Greenhouse Gas Emissions	Cap & Trade
Market Structure / Retail Competition	Direct Access/Retail Competition	Residential
		C&I
	Curtailment Service Providers	Residential
		C&I
	Retail Market Structure and Mechanics	
	Wholesale Market Structure and Mechanics	Energy
		Ancillaries
		Capacity

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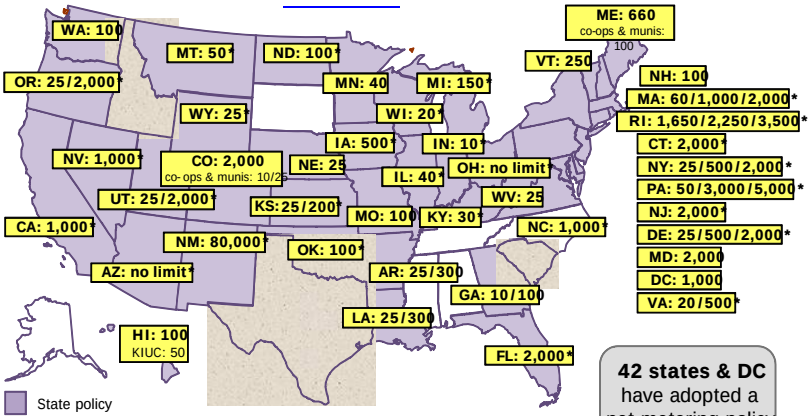
Net Metering Policies



Source: dsireusa, August 2009

42 states & DC have adopted a net metering policy

* State policy applies to certain utility types only (e.g., investor-owned utilities)

Note: Numbers indicate system capacity limit in kW. Some state limits vary by customer type, technology and/or system application
Other limits might also apply X/Y: X= residential, Y/non-residential

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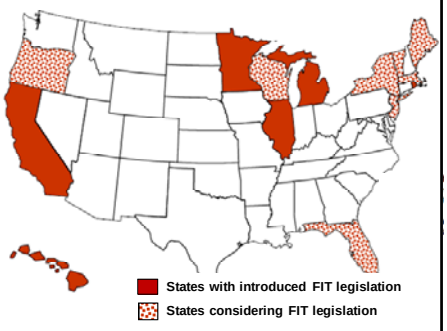
Feed-in Tariff - FIT

- Feed-in tariff policies have driven rapid renewable energy growth for electricity in Europe, but have not been widely adopted in North America to date.
- Long-term contract (10-20 year) - A mechanism to incentivize renewables
- Examples:
  - **California** – CPUC 8/27/2009 Ruling
    - Expanding FIT from 1.5 MW to 10 MW per customer
    - Limit to 1,000 MW statewide
    - Several proposed pricing models – mostly cost based
  - **Michigan** HB 5218
  - **20 Year Contracts**

Hydro less than 500 kW:	$0.10 kWh
Biogas less than 150 kW:	$0.145 kWh
Geothermal less than 5 MW:	$0.19 kWh
Wind turbine:	$0.105 kWh
Wind energy from small wind turbines:	$0.25 kWh
Rooftop solar less than 30 kW:	$0.65 kWh
Solar façade cladding less than 30 kW:	$0.71 kWh



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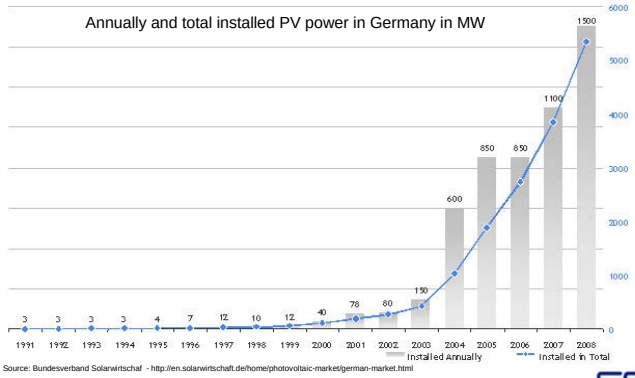
Feed-in Tariff - Germany

- The 2000 Policy, established a 20-year fixed price feed-in tariff for specific renewable generation technology types. The Policy has been adjusted in 2004 and 2008 to reflect changes in technology and adaptation rates.
- FITs are why Germany has 53% of the world's total installed solar PV; currently getting 15% of electricity from Renewable Energy sources



Source: Bundesverband Solarwirtschaf - http://en.solarwirtschaft.de/home/photovoltaic-market/german-market.html

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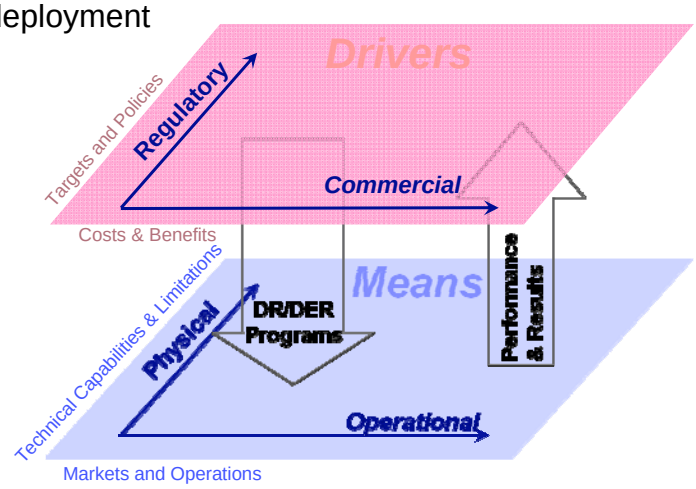
Interaction between "Planes" of Framework

- Role of programs in distributed resource operation and deployment



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Elements under Physical Dimension

	Elements	Sub-Elements	Applicable Interconnection Standards
System Plannin	System Studies	Capacity Assessment and Planning	N/A
	Infrastructure Availability	Deliverability	N/A
Interconnections	General Electrical Interconnection	Voltage Regulation	IEEE 1547, IEC TC8
		Grounding	IEEE 1547, IEC TC8
		Synchronization	IEEE 1547, IEC TC8
		Electric Protection	IEEE 1547, IEC TC8, IEC 61850
		Transient Response	IEEE 1547, IEC TC8
		Inadvertent Energization	IEEE 1547, IEC TC8
		Monitoring	IEEE 1547, IEC TC8
	Response to Abnormal Conditions	Area Fault	IEEE 1547, IEC TC8
		Voltage & Frequency	IEEE 1547, IEC TC8
		Loss of synchronization	IEEE 1547, IEC TC8
		Reconnection	IEEE 1547, IEC TC8
	Power Quality	Limitation of DC Injection	IEEE1547
		Limitation of Voltage Flicker Induced	
		Harmonics	
	Islanding	Unintentional Islanding	IEEE1547
		Intentional Islanding - MicroGrid	
	Conformance Test	Abnormal voltage and frequency; Synchronization; Interconnection integrity; Unintentional islanding; Limitation of DC injection; Harmonics	P1547.1 standard for test procedures
Operational Support	Phase Balancing		
	Monitoring	Metering	IEEE 1547.3 IEC 61850-7-420
		Telemetry	
	Control	Local	IEEE 1547.3 IEC 61850-7-420
		Remote	

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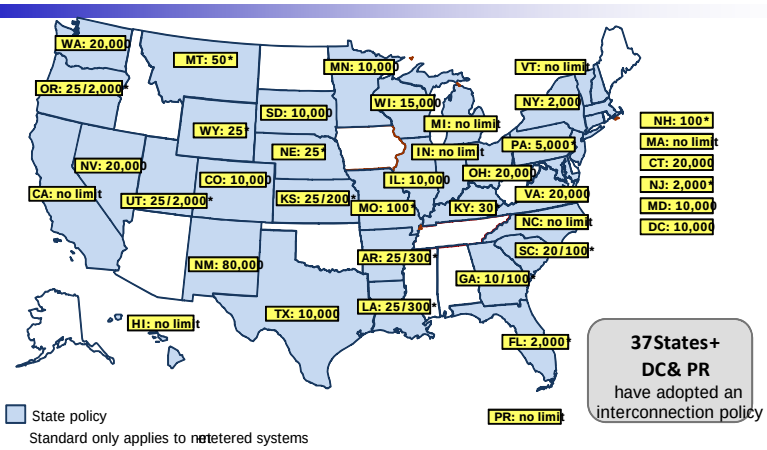
States with DER Interconnection Policy



Notes: Numbers indicate system capacity limit in kW. Some state limits vary by customer type (e.g., residential/non-residential).“No limit” means that there is no stated maximum size for individual systems. Other limits may apply. Generally, state interconnection standards apply only to investor-owned utilities. X/Y: X= residential, Y/non-residential

Source: dsireusa, July 2009

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Elements under Operational Dimension

Elements		Sub-Elements
Planning		Capacity Planning
		Forecasting
		Maintenance
Aggregation		By Resource Type
		By Program
		By Network Location
Scheduling & Operation	**Capacity**	Capacity Market / Resource Adequacy
	Energy	Day-Ahead
		Hour Ahead
	Reserves	Spin/Non spin
		Replacement Reserve
	Regulation	Regulation Up/Down
	Other Ancillary Services	Imbalance Energy Voltage/VAR Support
	Emergency Support	Emergency Operation Outage Management & Restoration
		Emergency Maintenance
Billing and Settlements		Market Settlement
		Settlement Allocation

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Elements under Commercial Domain

Elements	Sub-Elements	
Ownership	Utility	
	Customer	
	IPP	
	Service Providers	
Project Cost	Capital Cost	
	Deployment & Integration Costs	
	O&M Cost	
Financial Payback	Life Span	
	Project Cost	
	Deployment Incentives	Renewables
		Performance
		Other
	Customer Contracts	Power Purchase Agreement / Feed-in Tariff
		Capacity Payment
		Performance Payment
		Renewable Energy Credits
		Other Rates & Tariffs

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Sample DER Programs

- California Self Generation Incentive Program
  - Adaptation incentive for adaptation of small DER – extended through 2011
- PGE Dispatchable Standby Generation Program
  - Utility takes responsibility for regular maintenance and fuel cost of DGs – up to 400 dispatch hours per year
- SDG&E Rolling Blackout Reduction Program
  - for DER Greater than 50 kW, Customer is compensated at $0.35/kWhr when SDG&E dispatches the resource
- Duke Energy Solar PV Distributed Generation
  - Utility rents customer's roof-top or land, installs utility owned and maintained PV, customer receives rental payment.
- NYSERDA Solar and Wind Incentives
  - Qualified installations receive adaptation incentives
- Various Net Metering Programs
- Feed-in Tariff

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DER Program Descriptions

Primary Characteristic
Other Characteristics
Enabled

	REGULATORY														COMMERCIAL			
	Environmental Policie		Rates & Tariff						Incentives & Penalties			Regional Codes & Standards			Ownership			
			Retail Tariff		Net Metering		Feed-in Tariff					Inter-connection Policy						
	RPS	GHG Emissions	Residential	C&I	Renewable	Non-Renewable	Renewable	Non-Renewable	Renewables	Greenhouse Gases	Other	Renewable	Non-Renewables	Building & Civil Codes	Utility	IPP	Service Providers	Customer
CA Self Gen Incentive Program																		
CA Solar Initiative Program																		
CA Net Energy Metering Program																		
MN Net Metering Program																		
CA Feed-in Traiff																		
SDG&E Rolling Blackout Reduction Program																		
CA PHEV Tariff (pending)																		
Standby Rate																		
PGE Dispatchable Stanby Generation Program																		
Duke Energy Solar PV DG Program																		
Duke Energy Parallel Generation Program																		
NY Net Metering Program																		
NY ICAP																		
NY DADRP																		
NY EDRP																		
NYSERDA Solar & Wind Incentive Programs																		

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Mapping of DER Integration projects against Framework Elements

Region	Project	Name	Physical	Operational	Commercial
US	DOE RDSI	Detroit Edison DER Integration	X	X	X
US	DOE RDSI	SDG&E Beach Cities Microgrid	X	X	
US	DOE RDSI	CERTS/Chevron Microgrid	X		
US	DOE RDSI	IIT MIcroGrid	X	X	
US	DOE RDSI	FortColins Zero Energy Zone	X	X	X
US	DOE RDSI	Maui Grid Modernization		X	
Europe	EC	FENIX - Virtual Power Plant	X	X	X
Germany	E-Energy	e-DeMa		Home Automation	
Germany	E-Energy	Mannheim model city		X	X
Germany	E-Energy	eTelligence	X	X	X
Germany	E-Energy	MEREGIO - Low Emissions		X	
Germany	E-Energy	RegModHarz	X	X	
Germany	E-Energy	SmartW@tts		X	X

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Description of EPRI Smart Grid Demonstration Projects using Framework Elements (Draft)

Project Involving Elements

EPRI Smart Grid Demonstration Project	BUSINESS OBJECTIVES					REGULATORY			PHYSICAL						COMMERCIAL				OPERATIONAL					
						Environmental Policies			System Planning			Operational Support			Ownership				Planning			Scheduling & Operation		
	Improve System Economics	Environmental Compliance	Improve Reliability	Improve Power Quality	Enhance Customer Choice	RPS	GHG Emissions	Energy Efficiency & DR (Rates and Tariff)	System Studies	T&D Infrastructure	Interconnections	Feeder Management	Monitoring	Control	Utility	IPP	Service Providers	Customer	Capacity Planning	Forecasting	Maintenance	Energy	Reserves	Regulation
AEP	■								■	■	■	■	■	■	■	■	■	■				■	■	■
ConEd	■		■		■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
EdF		■	■	■			■		■				■	■		■	■	■				■		
First Energy	■		■					■					■	■		■	■	■		■		■	■	
PNM		■	■			■			■	■		■	■	■		■	■	■		■	■	■		

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Request: Project Survey Participation

- Who:
  - Project managers (or delegated assistant) of actual deployments or pilots demonstrating distributed resource integration
- Benefit:
  - Adopt broader perspective through application of framework and inclusion in study
- Goal:
  - Compare existing projects towards revealing gaps and identifying other critical scopes for demonstration
- Alternative contact to participate: aeldredge@epri.com
- Dates:
  - Submit survey by November 1 (report deadline)
  - Before December 1 (future update)

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Aggregation Methods

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Current ISO/RTO Opportunities for DR: All Paid-for-Performance Type Programs

Product	ISO-NE	NYISO	PJM	MISO	ERCOT	CAISO	SPP
Capacity	RTDPR, RTEG, OP and SP	Installed Capacity Special Case Resources (Capacity Component)	Full Emergency Load Response (Capacity Component)	Load Modifying Resource	Emergency Interruptible Load Service		
Day Ahead Energy	Day-Ahead Load Response Program for RTDRP & RTPR	Day-Ahead Demand Response Program	Economic Load Response	DRR-I, DRR-II		Participating Load Program	Variable Dispatch Demand Response
Real Time Imbalance Energy	Real Time Price Response Program	Emergency Demand Response Program, SCR	Emergency Load Response - Energy Only	Emergency Demand Response			
Reserves	Demand Response Reserves Pilot	Demand Side Ancillary Services Program	Economic Load Response	DRR-I, DRR-II	LaaR / NSRS, RRS, CLR, UFR	Participating Load Program	
Regulation		Demand Side Ancillary Services Program	Economic Load Response	Demand Response Resource Type-II	Controllable Load Resources providing Regulation Service		

This mapping scoped under the SG Demo was also contributed to NAESB through the Smart Grid Task Force.

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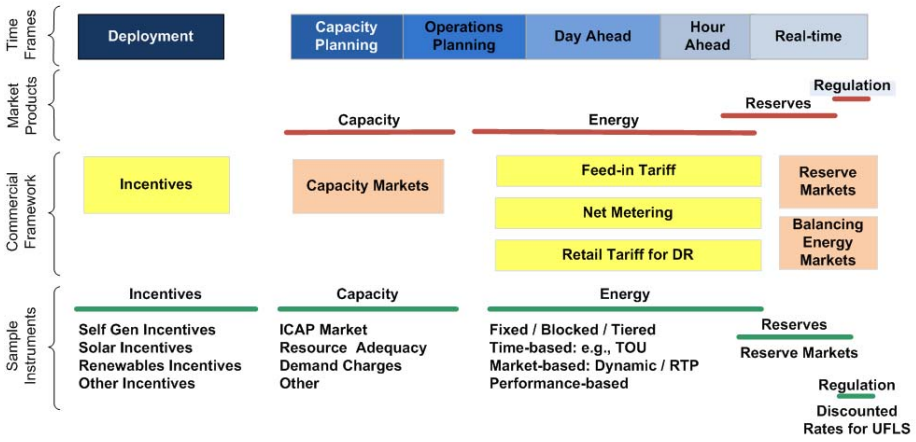
Sample Instruments Supportive of Defined Market Products



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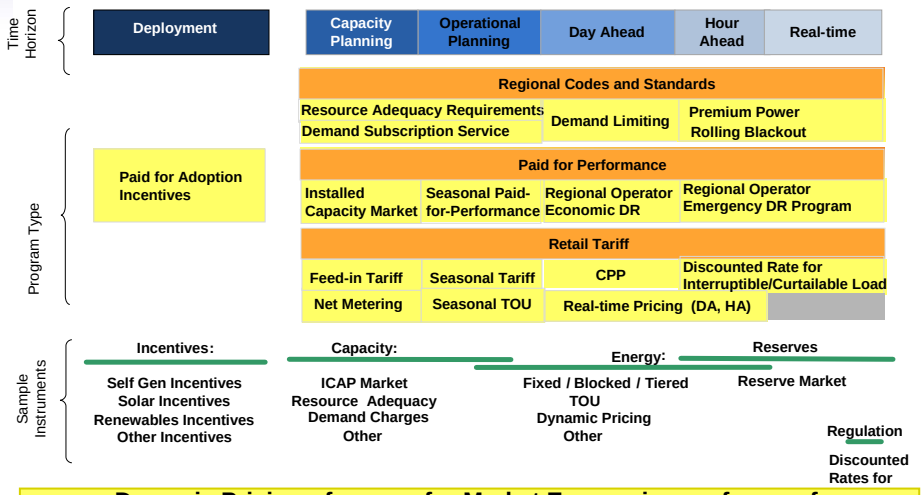
Program Types and their respective Time Horizons for balancing Supply/Demand using Distributed Resources



Dynamic Pricing of energy for Market Economics vs. forms of Paid for Performance and Variable Service Subscription for Reliability

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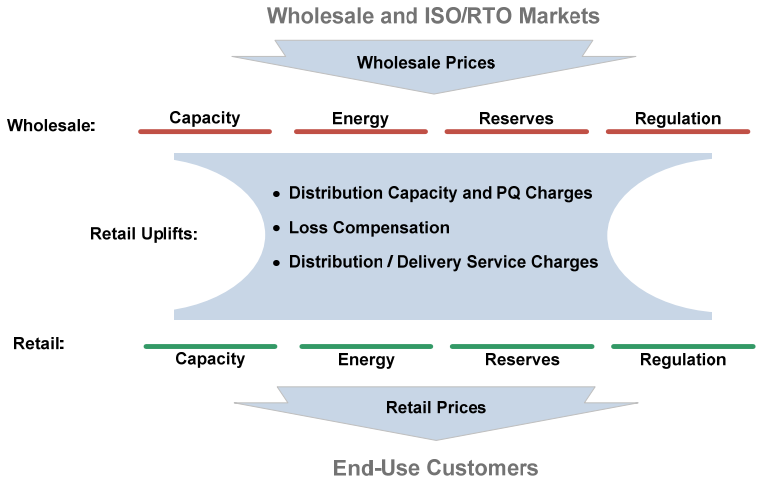
Relationship of wholesale and retail market prices



Question for pause: Real-time pricing for what?
Actual cost-impacting situation can vary (e.g., overloads from fast charging PHEVs).

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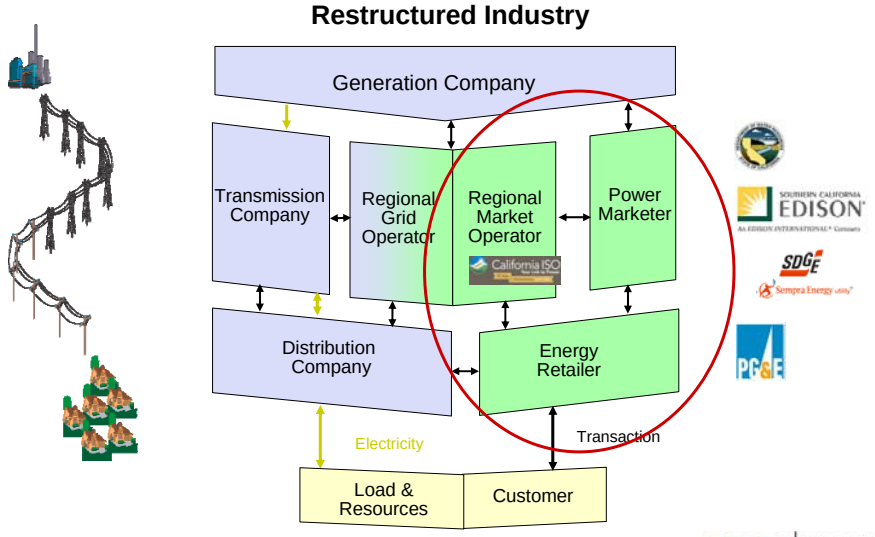
EPRI-led DR Triggers Collaboration:
Crossing traditional boundaries to bridge industry gap

Restructured Industry



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Resource Types and Charges Relevant to Demand Response

- Generators
- Pump Storage Gen
- Dispatchable participating load
- Non-participating load
- Import
- Dynamic Import
- Export
- INTER-SC Trade
- Metered Subsystem
- Participating Transmission Owner
- UDC
- FTR/CRR
- Transmission Ownership Rights

* MD02 Charge Code Number	MD02 Charge Code Name	Group	MD02 Status	MRTU Status	Billable Quantity	Dispatchable-Participating Load: - Pump Storage Load - Single Pump - Aggregated Pump	Non-Dispatchable / Non-Participating LOAD	Prior Charge Code	Start	End
2	Day Ahead Non-Spinning Reserve due SC	AS	Active	Replaced	Day Ahead Non Spin Capacity Awarded	X			4/1/1998	Open
4	Day Ahead Replacement Reserve due SC	AS	Active	Retired	Replacement Reserve Accepted Bid Quantity	X			4/1/1998	Open
24	Dispatched Replacement Reserve (Bid-In) Capacity Withheld	AS	Active	Retired	Amount of 'bid-in' Replacement Reserve capacity that has been dispatched by ISO	X			8/1/2001	Open
52	Hour Ahead Non-Spinning Reserve due SC	AS	Active	Replaced	Hour Ahead Awarded NonSpinBid Capacity	X			4/1/1998	Open
54	Hour Ahead Replacement Reserve	AS	Active	Retired	Hour-Ahead additional Replacement Reserve accepted Bid Quantity	X			4/1/1998	Open
111	Spinning Reserve due ISO	AS	Active	Replaced	Spinning Reserve Obligation MW	X	X	101	8/18/1998	Open
112	Non-Spinning Reserve due ISO	AS	Active	Replaced	Non-Spinning Reserve Obligation MW	X	X	102	8/18/1998	Open
114	Replacement Reserve due ISO	AS	Active	Retired	Replacement Reserve Obligation	X	X	103	8/18/1998	Open
115	Regulation Up Due ISO	AS	Active	Replaced	Regulation Up Oblig MW	X	X	103	8/18/1998	Open
116	Regulation Down Due ISO	AS	Active	Replaced	Regulation Down Obligation MW	X	X		8/18/1998	Open
124	Dispatched Replacement Reserve (Self-Provided) Capacity Withheld	AS	Active	Retired	Amount of Excess Self-Provided Replacement Reserve capacity that has been dispatched by ISO	X	X		8/1/2001	Open

75 Charge Codes out of 183 reviewed found relevant to DR (before transition)

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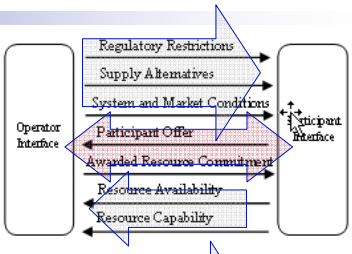
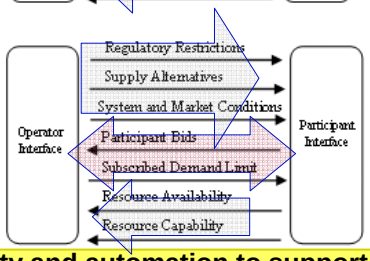
Information Exchange Comparison:
Demand Bidding (Status Quo) vs. Demand Limiting

- Demand Bidding (offers to sell)
  - Status quo: Participant offers to sell (e.g., ISO Ancillary Service Participating Load Program)
  - ISO/RTO procures and allocates resulting costs to electricity buyers (e.g., reserves)
  - Procure reliability reserves at any cost



- Demand Limiting (bids to buy)
  - Configurable limit by customer subscription
  - Automation of response
  - enabled by smart grid infrastructure
  - *Potential of avoiding excess procurements and resulting costs allocable to buyers*



Smart grids can enhance configurability and automation to support new uses and emerging applications for distributed resources. Can help bridge the disconnect between wholesale and retail markets.

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Conclusions

- Important to identify & prioritize objectives for use of distributed resources before picking methods, technologies, and "standards"
  - An objective implies time horizon for addressing system imbalance risk
  - Implications on actuation requirements
    - response time, communications and coordination requirements
- Structure incentives and programs to support objectives
  - Deployment incentives: Customer adoption of enabling technologies
  - vs. Operational provisions: Coordination of resource response to support grid or market operations
- Inform standards activities at national level
  - Guiding principles needed (from industry that operates the power system)
  - Industry objectives and priorities for integrating distributed resources
  - Scope of implementation methods to consider in use case and standards consensus efforts (e.g., NIST PAP9 focus: just dynamic pricing or also other smart grid-enabled retail contracts?)

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Together…Shaping the Future of Electricity

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