



Distributed Energy Resource Services and Pricing

Caltech Resnick Institute
Grid 2020 Seminar

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VP, Smart Grid and Green Power

February 21, 2013



Trade Secret

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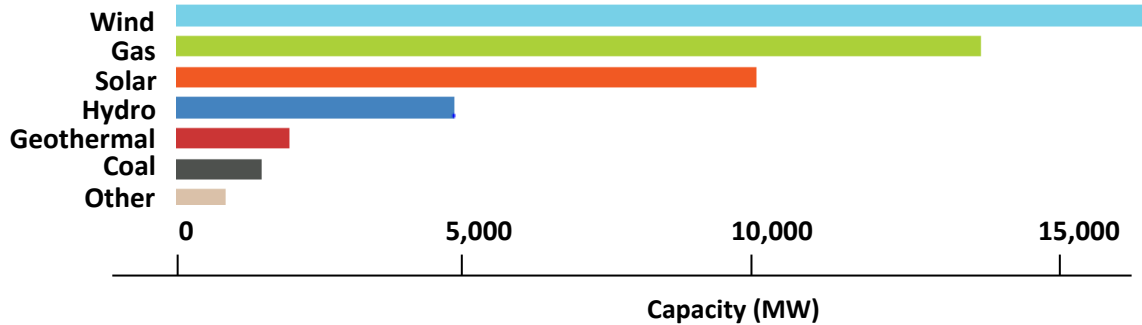
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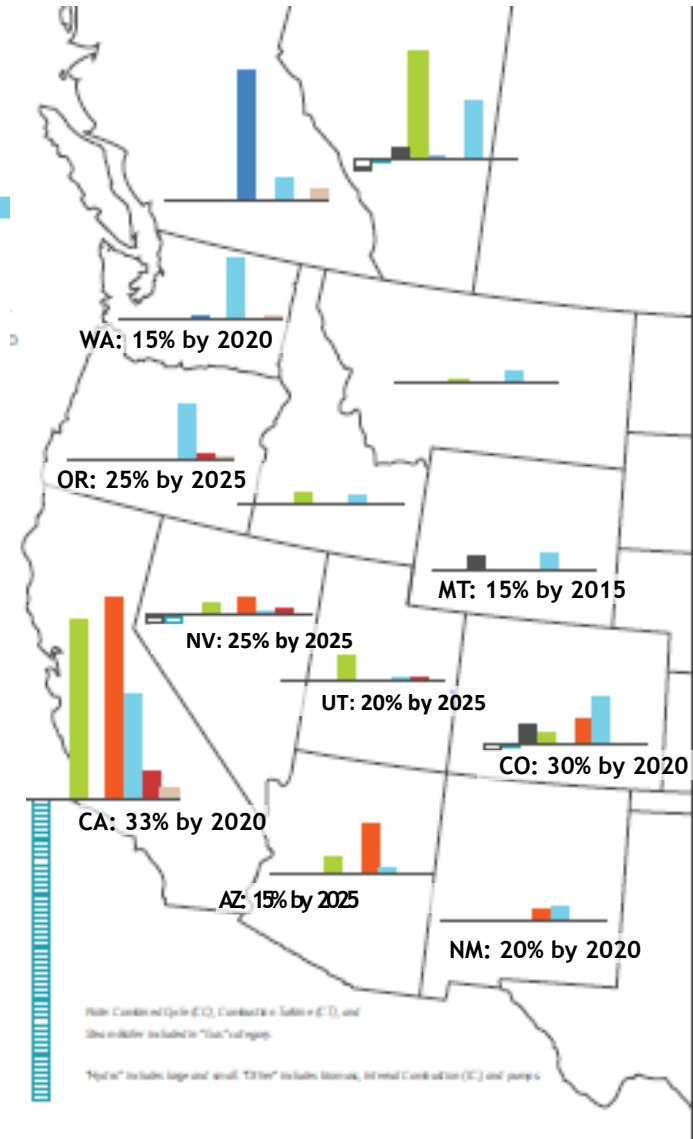
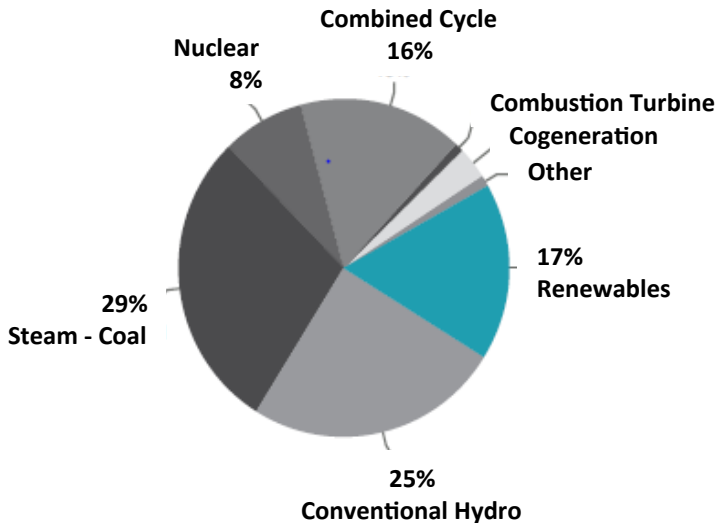


WECC Generation Additions and Retirements 2010-2020

WECC Generation Capacity Additions By Resource Type 2010-2020



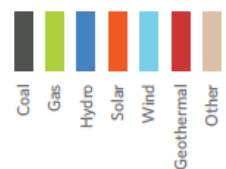
WECC 2020 Annual Energy Generation Type



RETIRED RESOURCES



INSTALLED RESOURCES



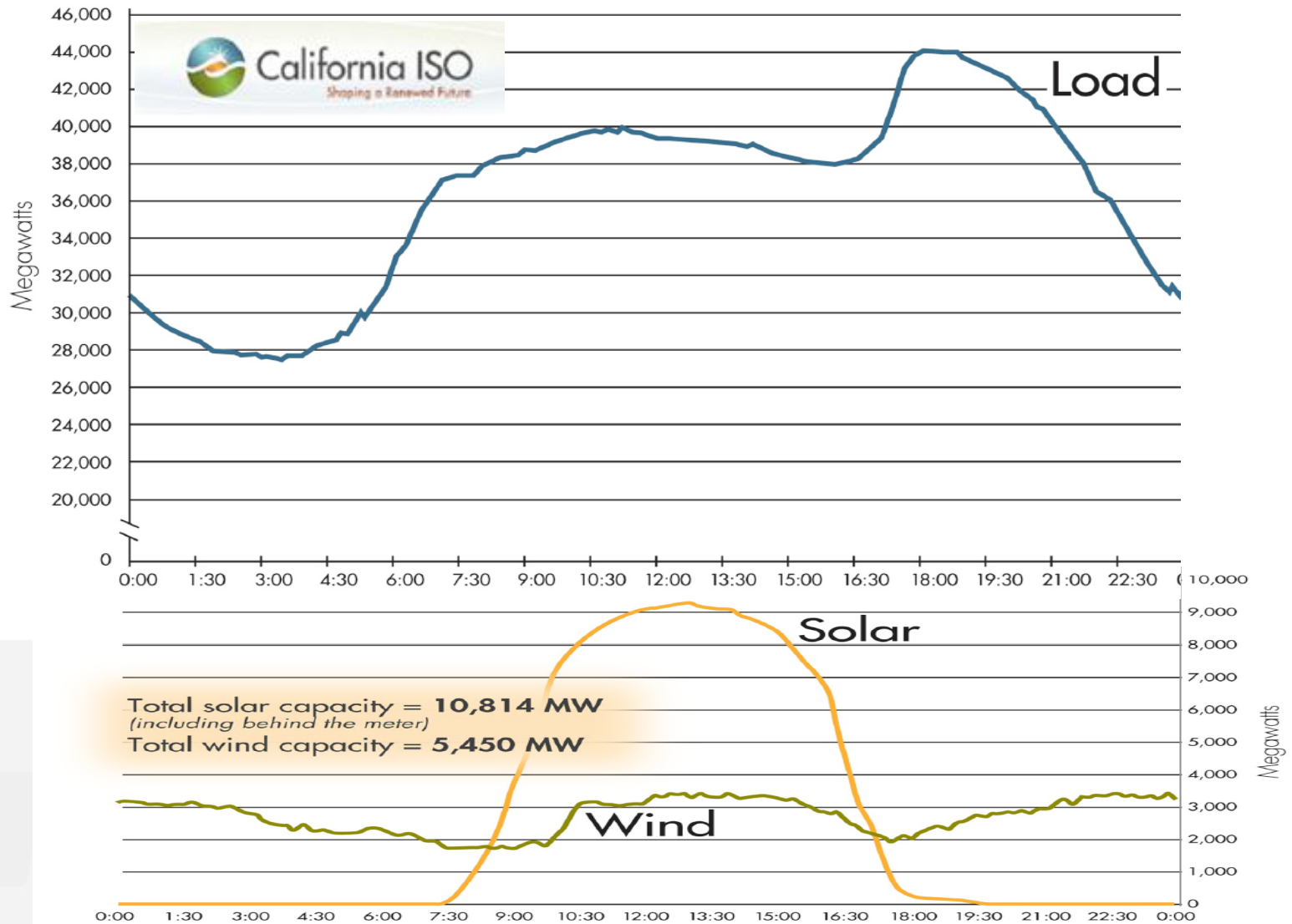
Note: Combined Cycle (CC), Combustion Turbine (CT), and Cogeneration included in "Gas" category.
Hydro includes large and small. Other includes biomass, internal combustion (IC) and pumps.

Source: 2011 WECC 10-Year Regional Transmission Plan - Executive Summary - Sept. 22, 2011

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A Sample CAISO Winter Day in 2020

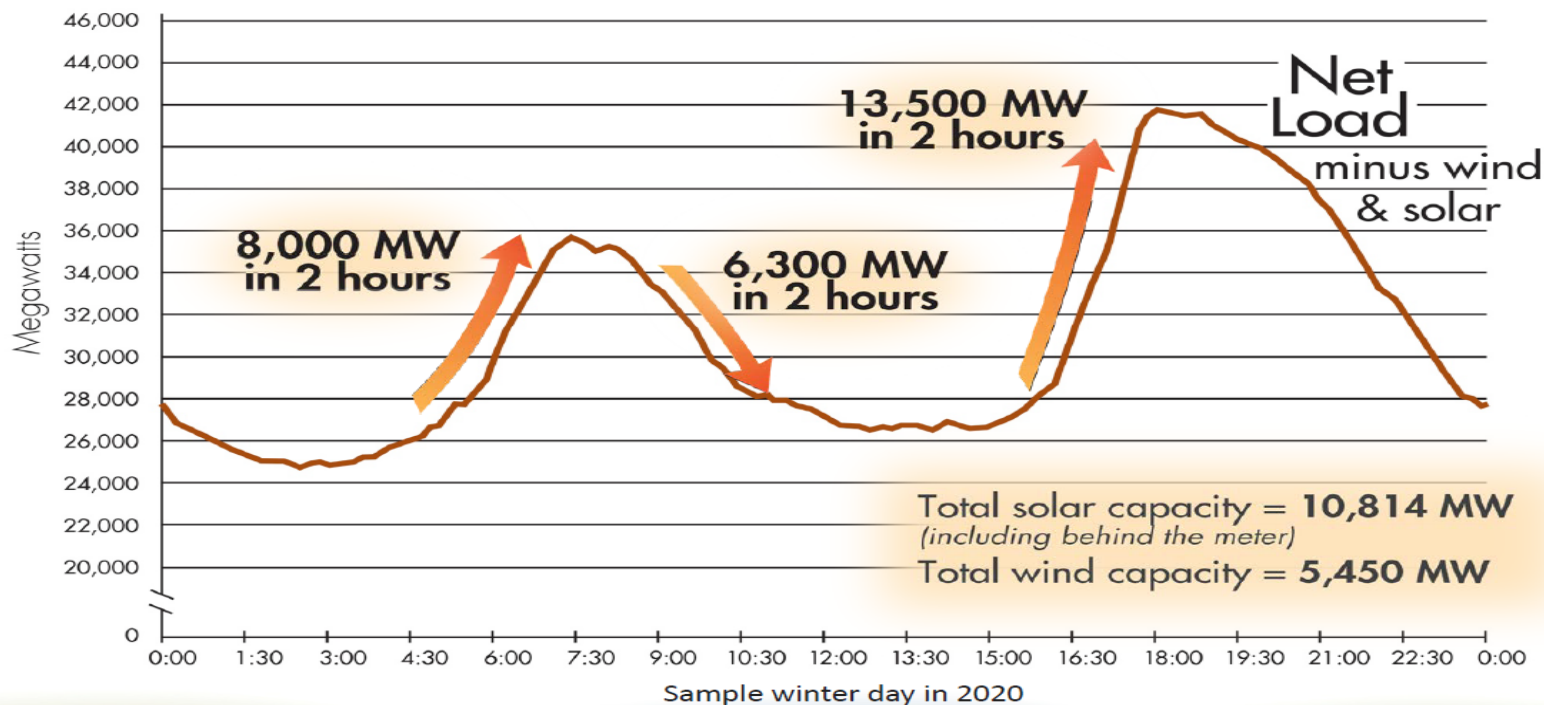


Source: CA ISO

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Flexible Resources will be Essential to Meeting the Net Load Demand Curve

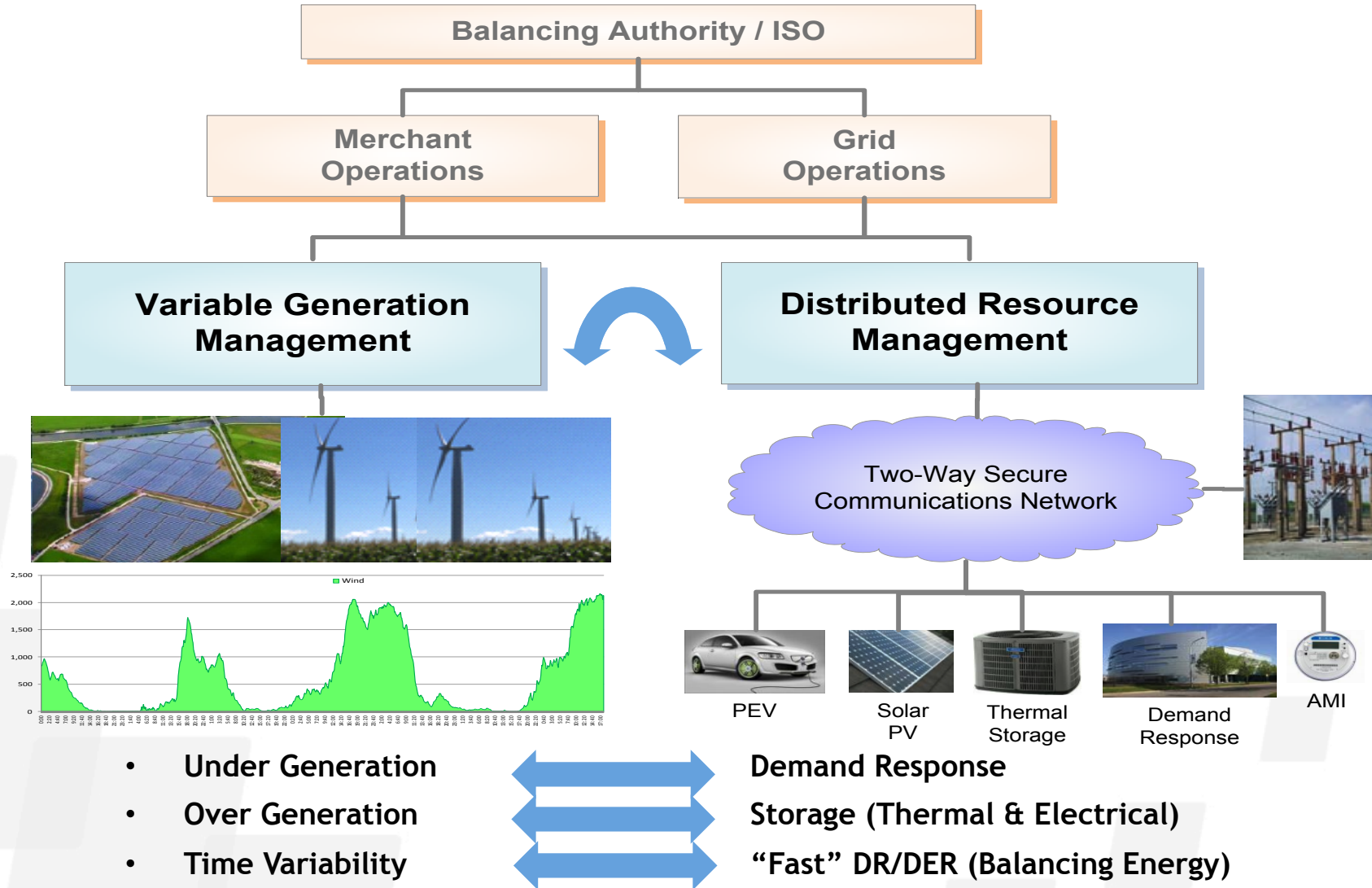


Source: CA ISO

- Flexible Generation
- Demand Response (DR), Storage (electric & thermal), Distributed Generation
- Flexible Ramp-Up and Flexible Ramp-Down Products/Markets

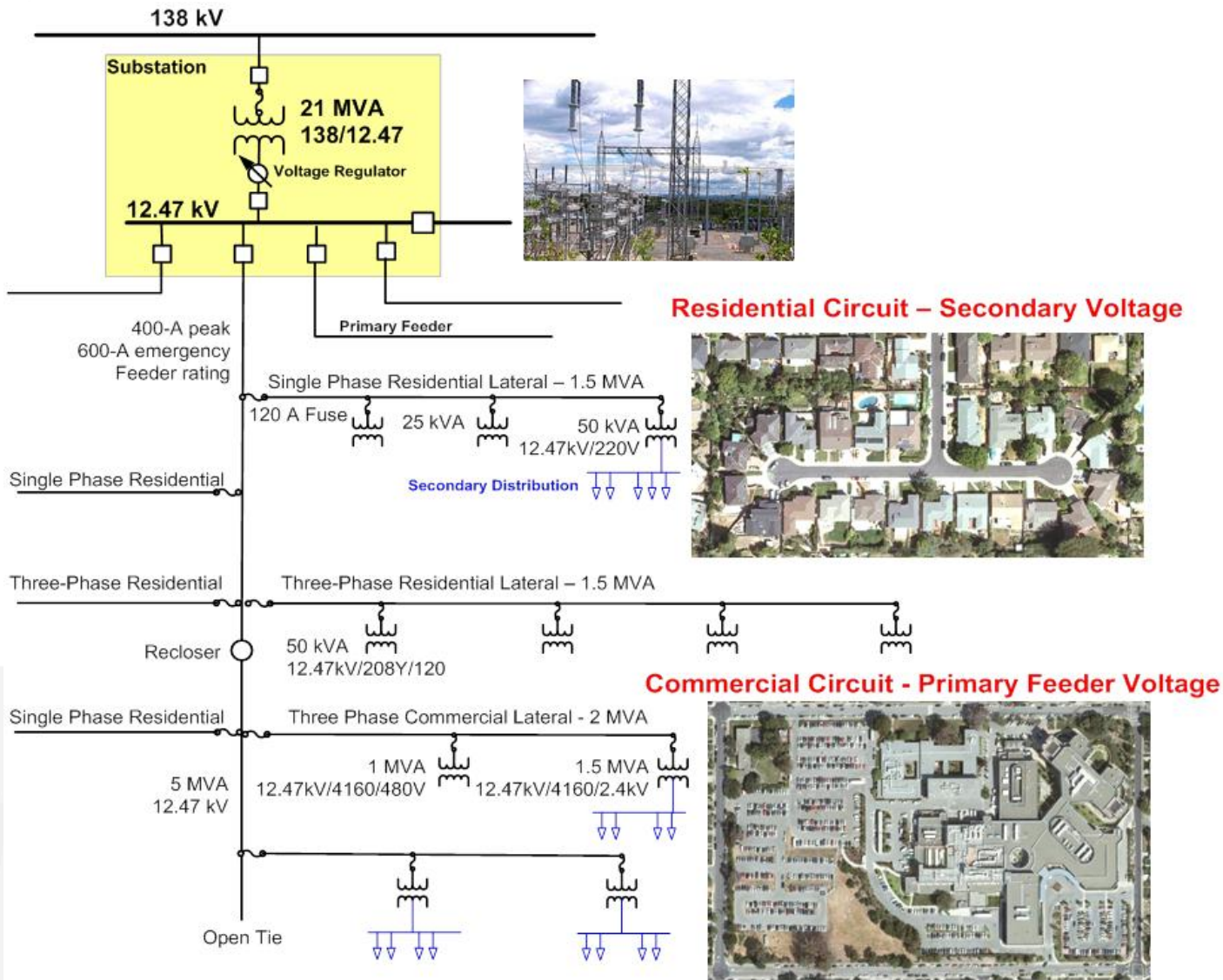


DR/DER: “Dancing Partner” of VER



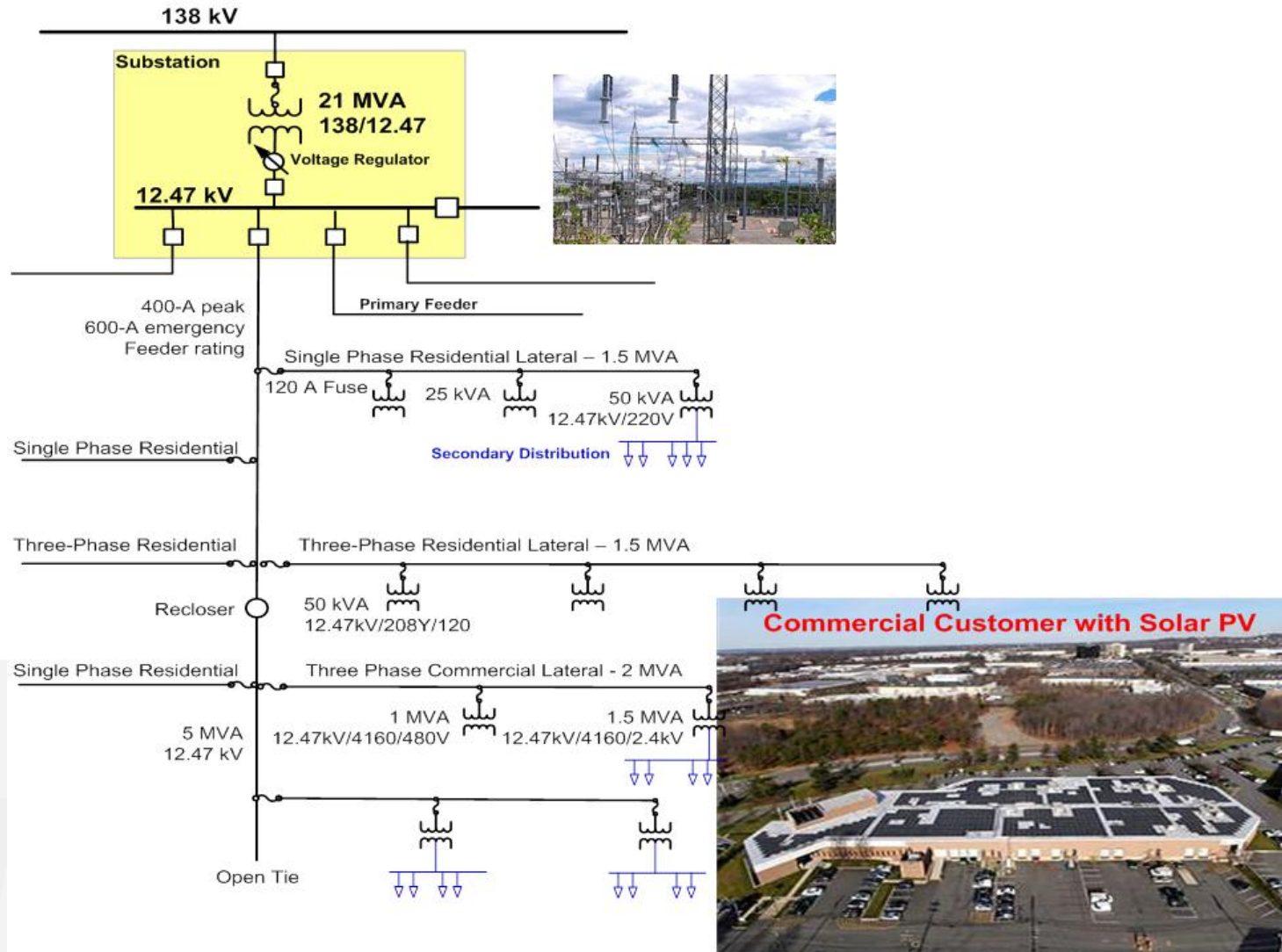


A Typical Distribution Feeder





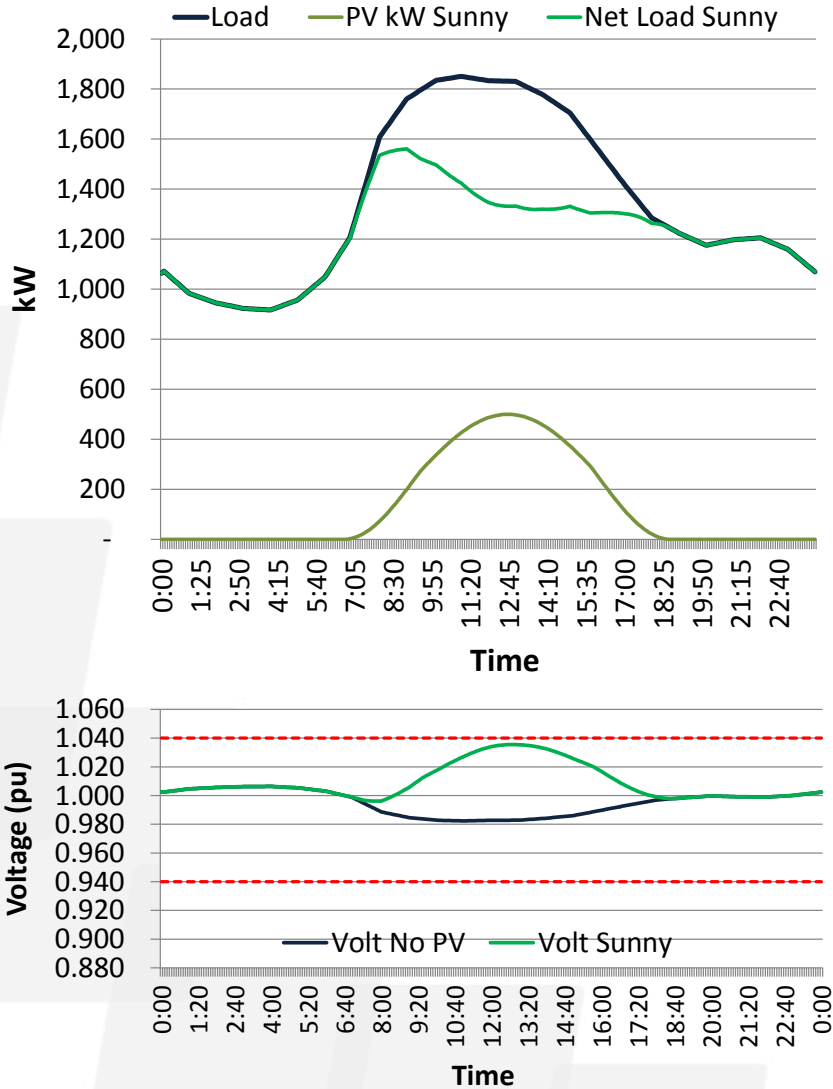
Distribution Grid with High Penetration Solar PV



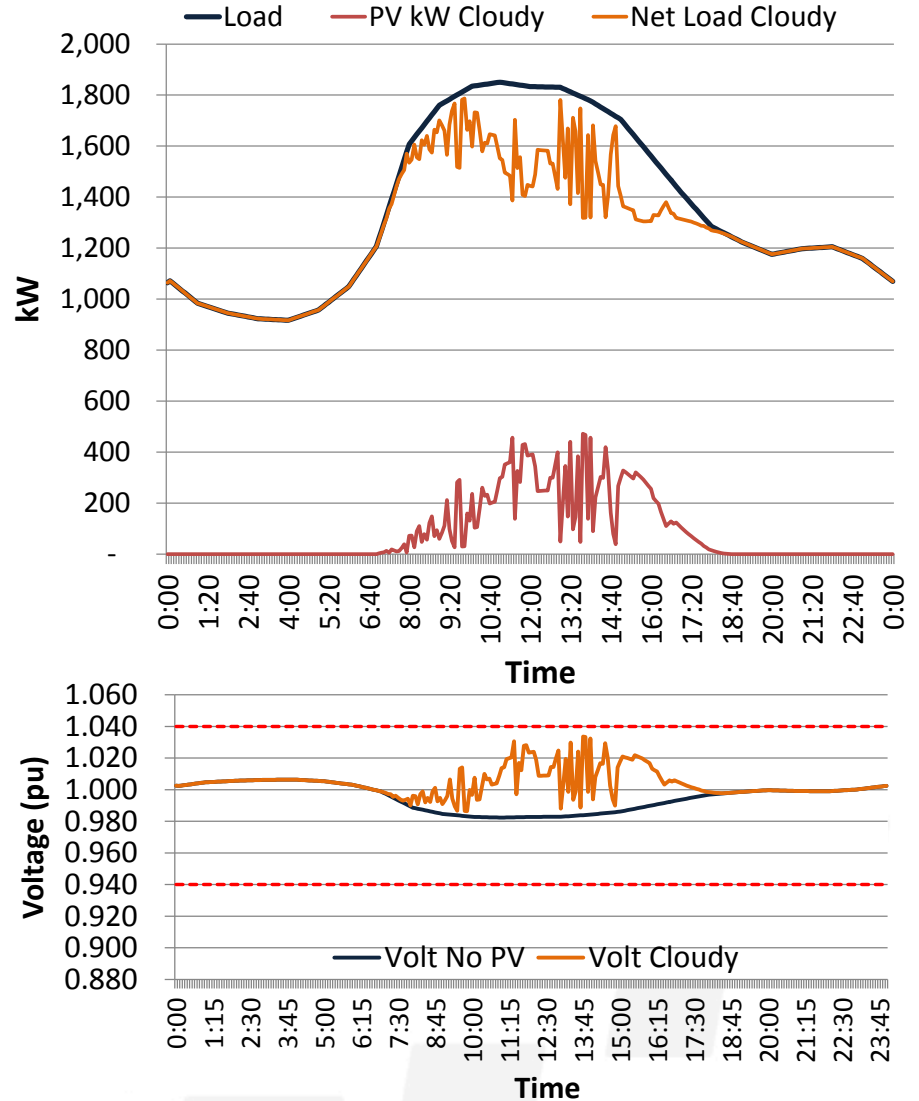


Impact of PV Generation on Load and Voltage

Sunny Day

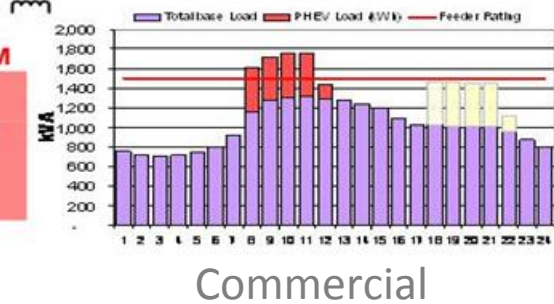
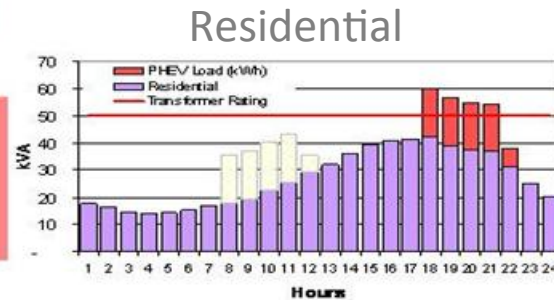
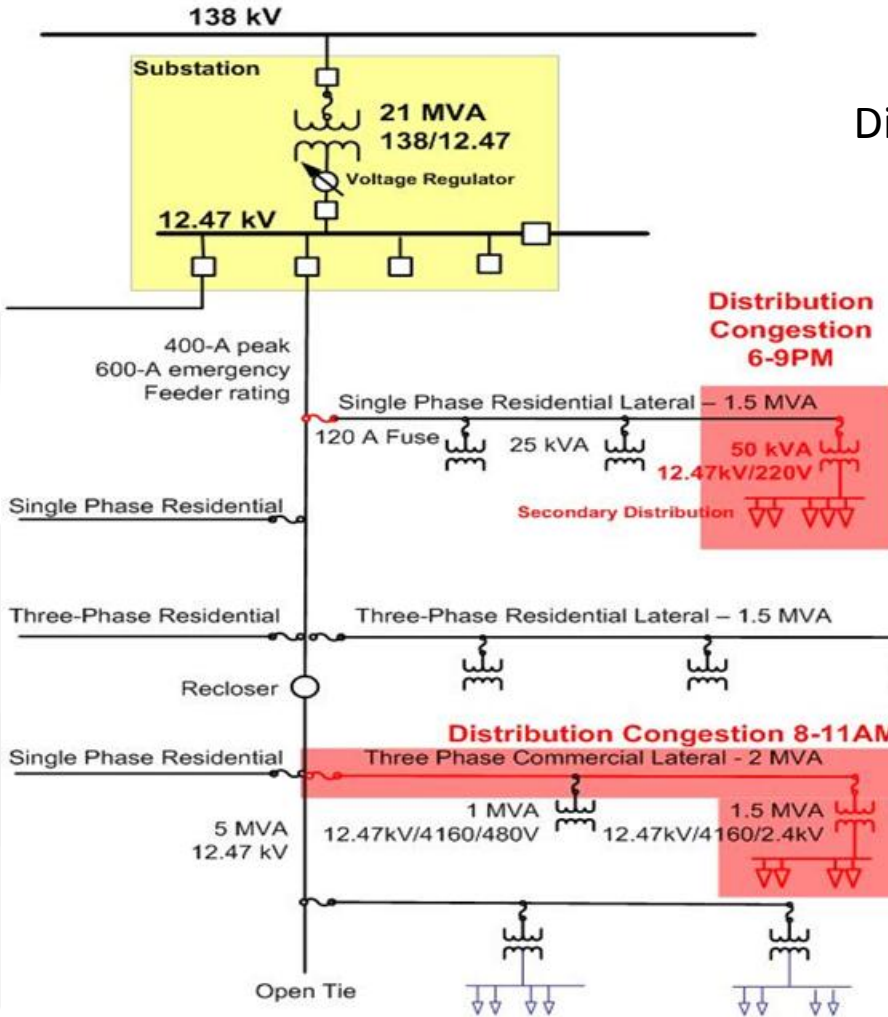


Cloudy Day



Impact of Plug-in Electric Vehicles (PEV): Another Potential for Distribution “Congestion”

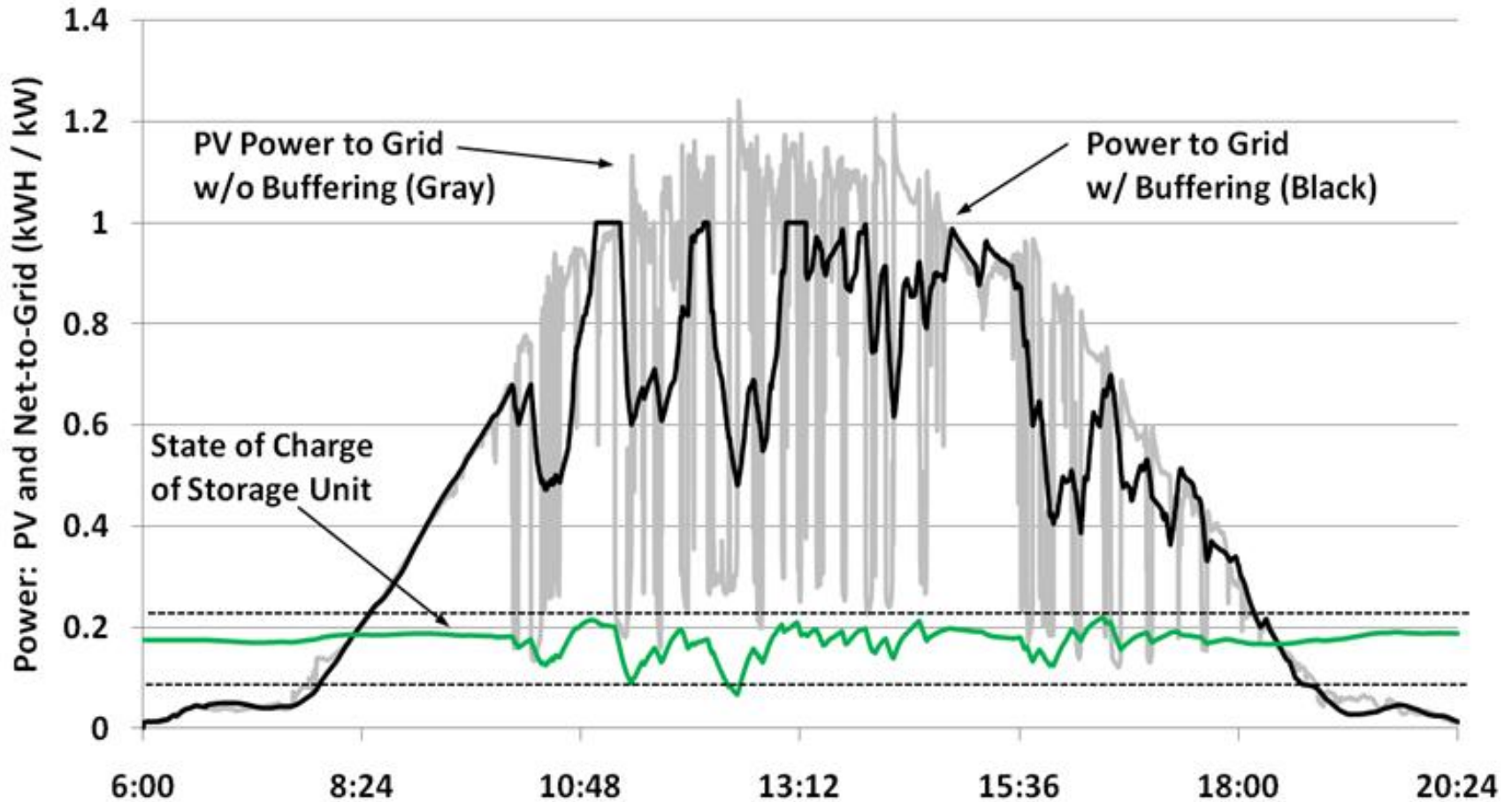
Different distribution circuits may peak at different Times





Solar PV with Coordinated Storage

tenK PI Storage Loop Control - June 24, 2012 - Minneapolis, MN
Example of Intermittent Cloud Buffering With Minimum Storage (0.25 Hours)



Source: tenK Solar

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Technical Requirements for Electricity Products

Product		Response Time / Notice	Baseline Estimation	Telemetry	Real-Time Metering	
Conventional	Capacity	Seasonal	Yes	No	No	
	Energy	Day-Ahead Energy	A day	Yes	No	No
		Real-Time Energy	1 hour	Yes	No	No
		Interruptible Load	10-30 minutes	Maybe	No	Maybe
	Ancillary Services	Reliability Capacity	30 minutes to 2 hrs	Maybe	Maybe	No
		30 minute Non-Spin	30 minutes	No	Maybe	Maybe
		10 minute Non-Spin	10 minutes	No	Yes	Yes
		10 minute Spin	10 minutes	No	Yes	Yes
		Regulation	4 sec to 5 min	No	Yes	Yes
New	Ramping	5 minutes	No	?	Yes	
	Balancing Energy	5-15 Minutes	No	?	Yes	

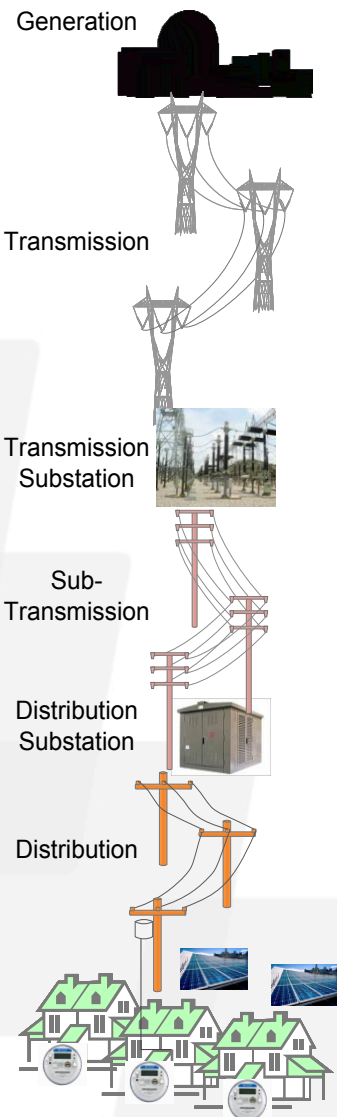


Demand-Side Programs to Wholesale Products

Demand Resoponse

Wholesale Products

		Non-Dispatchable		Dispatchable					
		Voluntary	Noti- fication	Demand-limiting Control	Notification	Firm Commit- ment	Direct Load Control (DLC)	Conservation Voltage Regulation	
									May
Capacity	Seasonal		May	Yes	Yes	Yes	Yes	Yes	Yes
	Energy	Day Ahead			Yes	Yes	Yes	Yes	Yes
		Real-time			Yes	Yes	Yes	Yes	Yes
Ancillary Services	30 Min Non-Spin				May	Yes	Yes	Yes	Yes
	10 Min Non-Spin				May	Yes	Yes	Yes	Yes
	10 Min Spin						Yes	Yes	Yes
	Regulation						May	Yes	May
New	Ramping						May	Yes	May
	Balancing Energy						May	Yes	May



Wholesale Market Prices

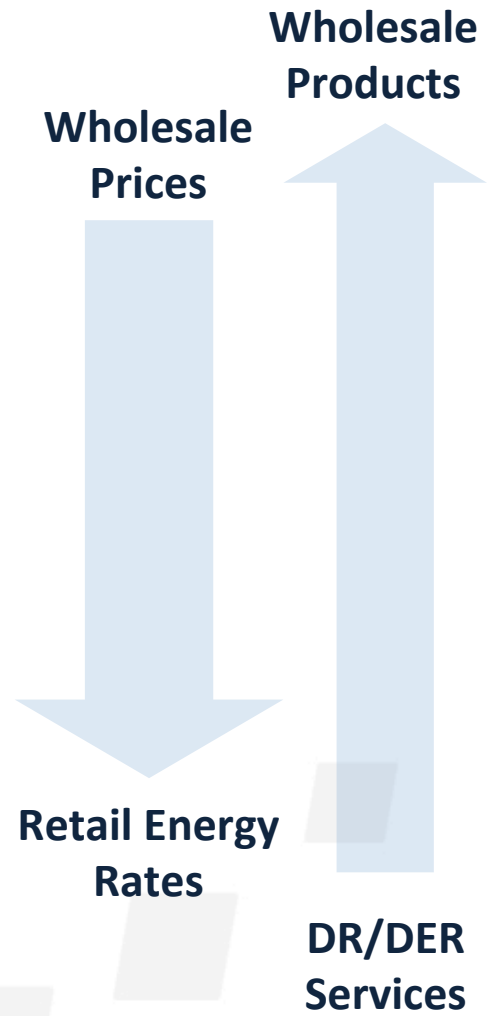
<u>Capacity</u>	<u>Energy</u>	<u>Reserves</u>	<u>Regulation</u>
Seasonal Cap- Zones	Day-Ahead Real-Time Locational	Day-Ahead Real-Time Zonal	Day-Ahead Real-Time Zonal

+ Uplifts:

- Delivery Services Charges
- Distribution Capacity Charges
 - Power Quality Charges
 - Loss Compensations
- Incentives & Penalties
 - Etc.

Fixed Tired	TOU	CPP/ PTR	RTP	Net- Metering	Feed-in
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End-Use Consumers





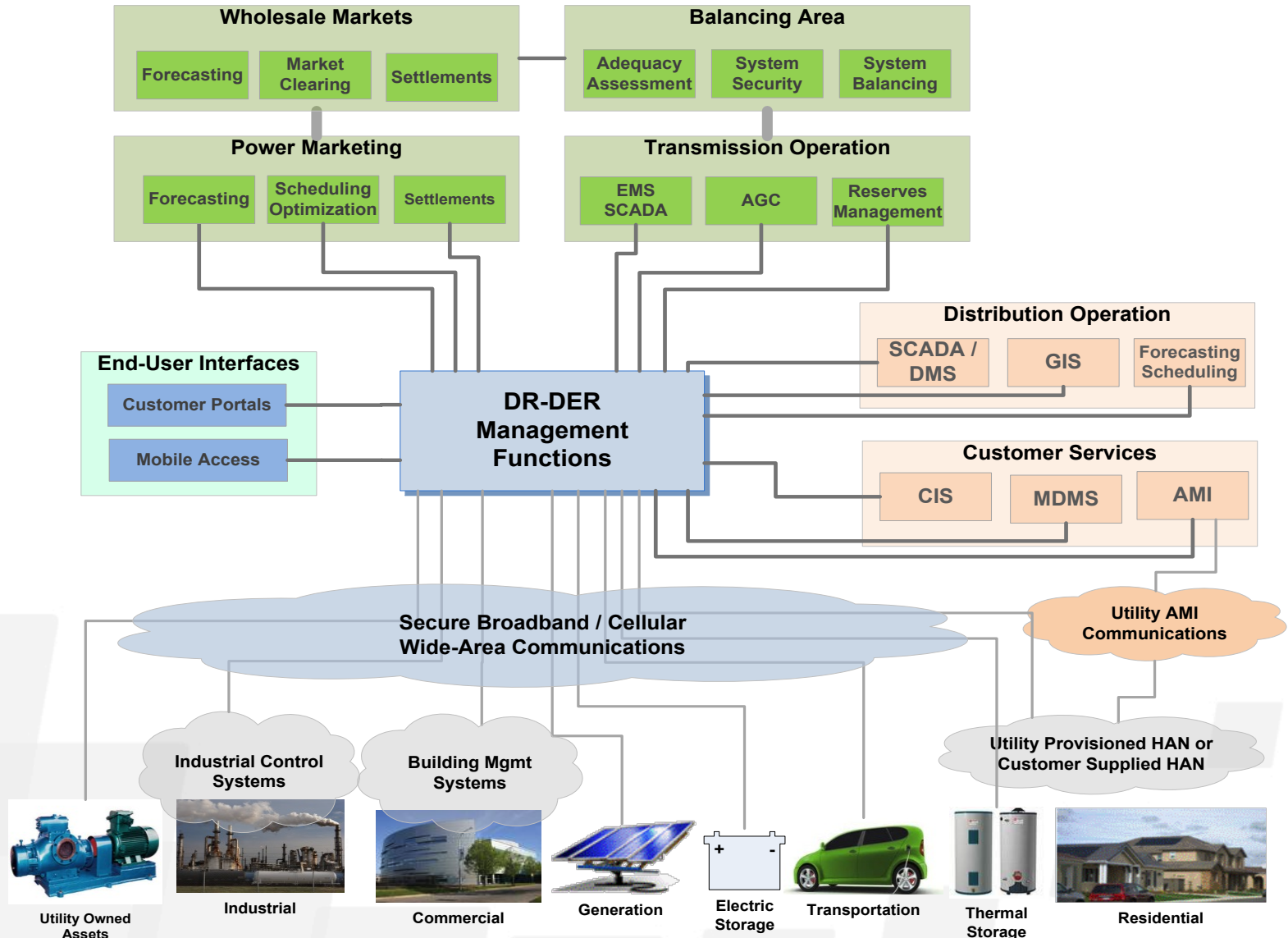
Demand-Side (DR-DER) Integration - Price Signals

- Need for unbundling

Price / Tariff	Type	Characteristics
Energy Usage Charges	Fixed / Tired	<ul style="list-style-type: none">- Energy Usage- Energy Efficiency- Non-Dispatchable Resources
	TOU, CPP, PTR	
	RTP	
	Net Metering	
	Feed-In	
Demand Charges	Demand	<ul style="list-style-type: none">- Scheduling & Facility Loading- Operational Reliability
	Demand Shape	
Supply of Grid Services (Payments/Credits)	Resource Adequacy	<ul style="list-style-type: none">- Dispatchable Services- Pay-for-Performance- Fixed Incentive / Contract-Based- Distribution vs. Transmission Services- Response Time / Sustained Duration- Measurement & Verification, Settlement Rules
	DA/DO Energy	
	Balancing Energy	
	Ancillary Services	
	Ramping	



Need for the End-to-End Integration Transactive Operations Across the Operations





Thank You

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