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Load as a Resource: Examples from Field Tests

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FESC Workshop: Integration of Renewable Energy into the GRID

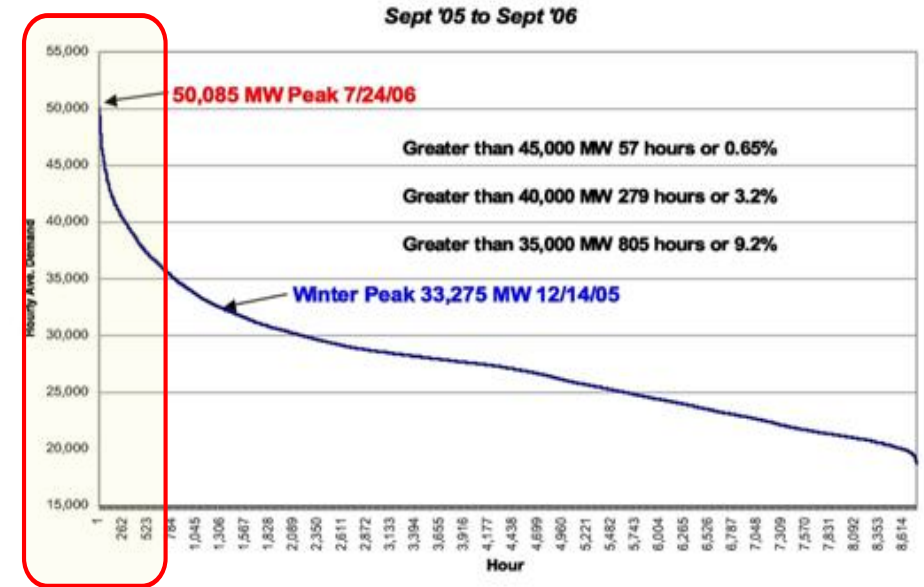
Presentation outline

- **Background on R&D activities on DR**
 - Buildings
 - Communication
 - ISO signals
 - **Field Tests**
 - Intermittent Resource Management Pilot 2: Santa Rita Jail
 - Synchronous Reserves: Walmart
 - Regulation: Los Angeles Air Force Base
 - **Conclusions**
-

DR Research Motivation

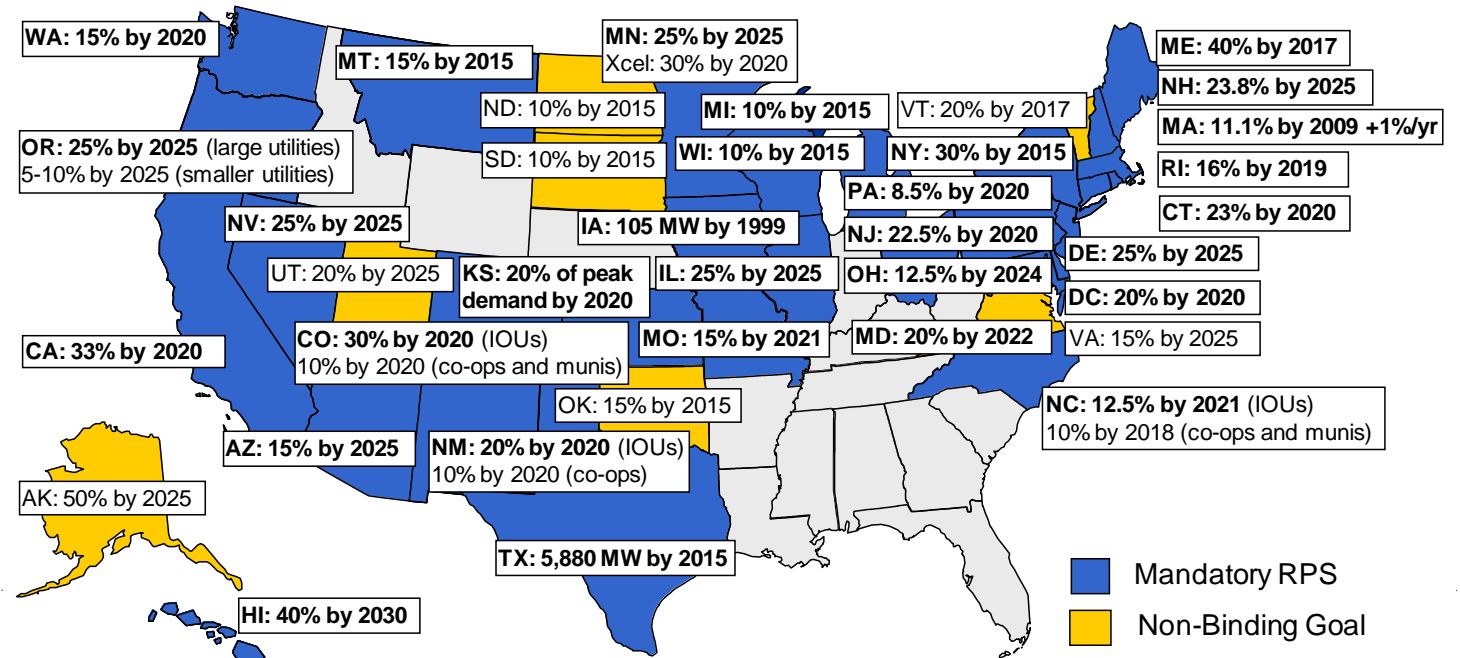
Early on...

- Peak load growing faster
- Load duration curve



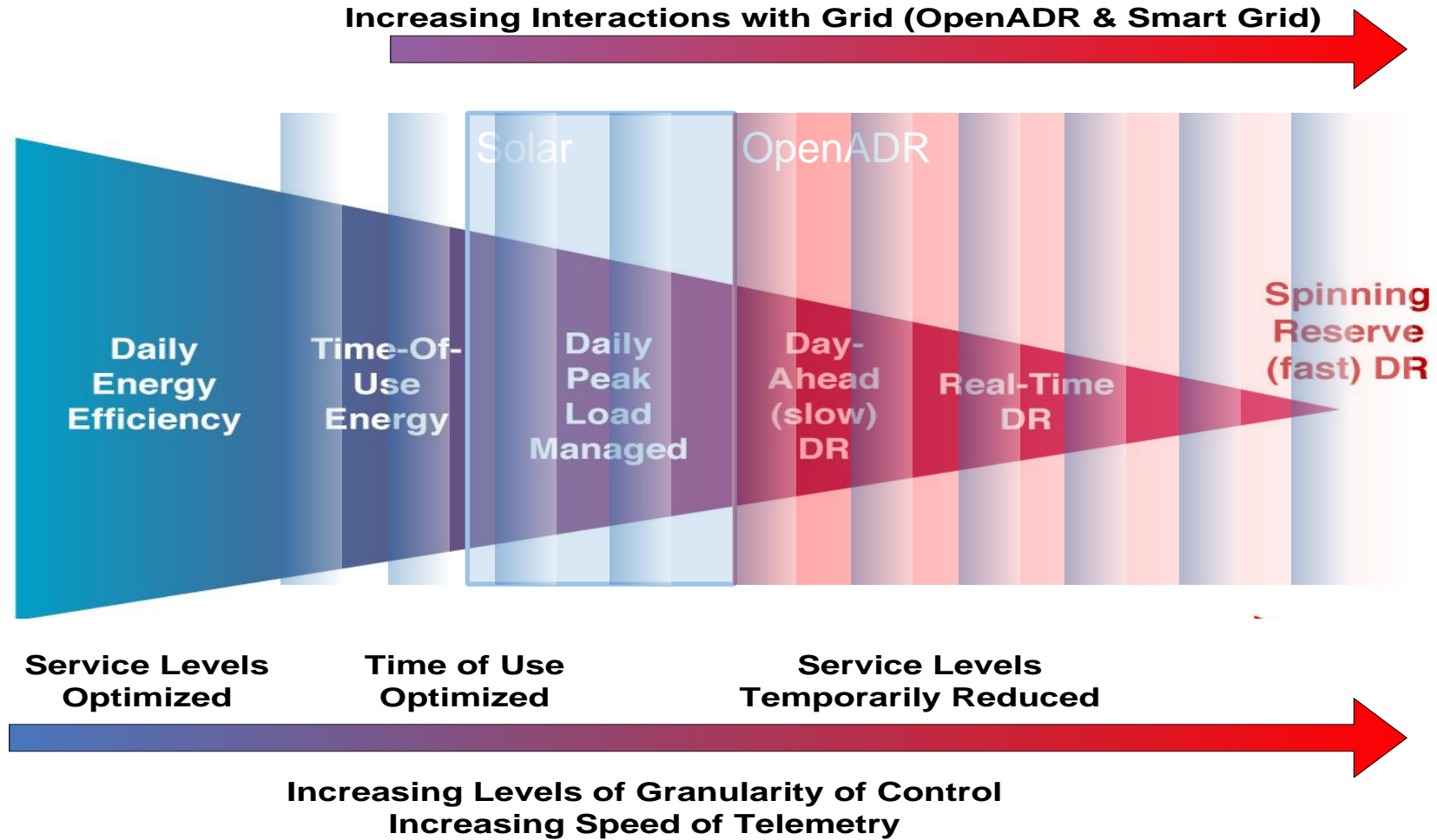
Later...

- Integration of renewable generation



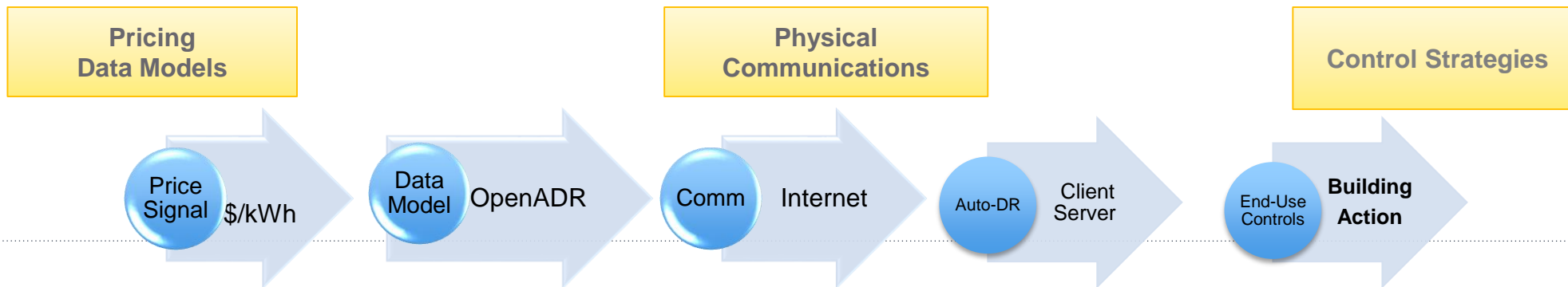
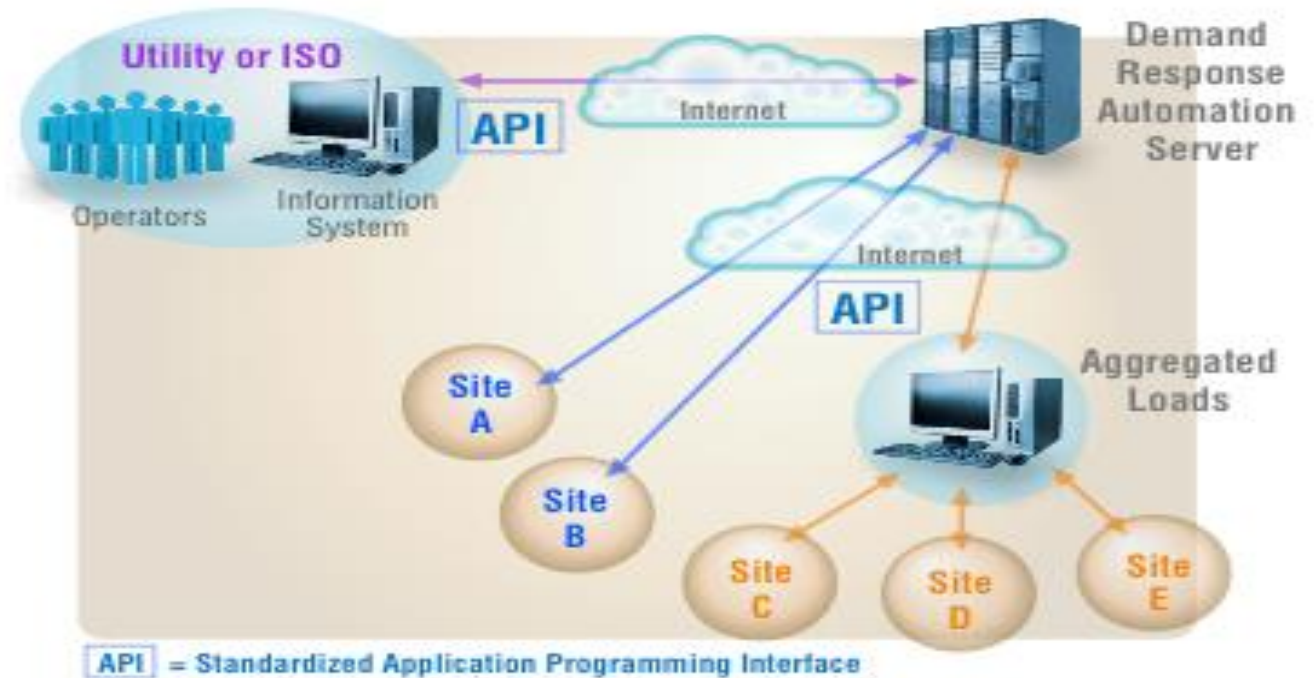
Source: Berkeley Lab

Demand-side activities



OpenADR (Open Automated DR) Has Been Developed and Deployed

Provides open standardized interface to allow electricity providers to communicate DR signals directly to customers using a common language and existing communications such as Internet.



DR Strategies Evaluated for Commercial Buildings

	Building use	HVAC											Lighting					Other
		Global temp. adjustment	Duct static pres.	SAT Increase	Fan VFD limit	CHW temp. Increase	Fan qty. reduction	Pre-cooling	Cooling valve limit	Boiler lockout	Slow recovery	Extended shed period	Common area light dim	Office area light dim	Turn off light	Dimmable ballast	Bi-level switching	Non-critical process shed
ACWD	Office, lab	X	X	X		X			X	X		X						
B of A	Office, data center		X	X	X	X			X									
Chabot	Museum	X						X										
2530 Arnold	Office	X									X							
50 Douglas	Office	X									X							
MDF	Detention facility	X																
Echelon	Hi-tech office	X	X	X			X					X	X	X	X			
Centerville	Junior Highschool	X						X										
Irvington	Highschool	X						X										
Gilead 300	Office			X														
Gilead 342	Office, Lab	X		X														
Gilead 357	Office, Lab	X		X														
IKEA EPaloAlto	Furniture retail	X																
IKEA Emeryville	Furniture retail	X																
IKEA WSacto	Furniture retail																	
Oracle Rocklin	Office	X	X															
Safeway Stockton	Supermarket																X	
Solectron	Office, Manufacture	X												X				
Svenhard's	Bakery																	X
Sybase	Hi-tech office													X				
Target Antioch	Retail	X					X											
Target Bakersfield	Retail	X					X											
Target Hayward	Retail	X					X					X					X	
Walmart Fresno	Retail	X															X	

Global temperature reset migrated to State Energy Code

Evaluated Baseline Methodologies

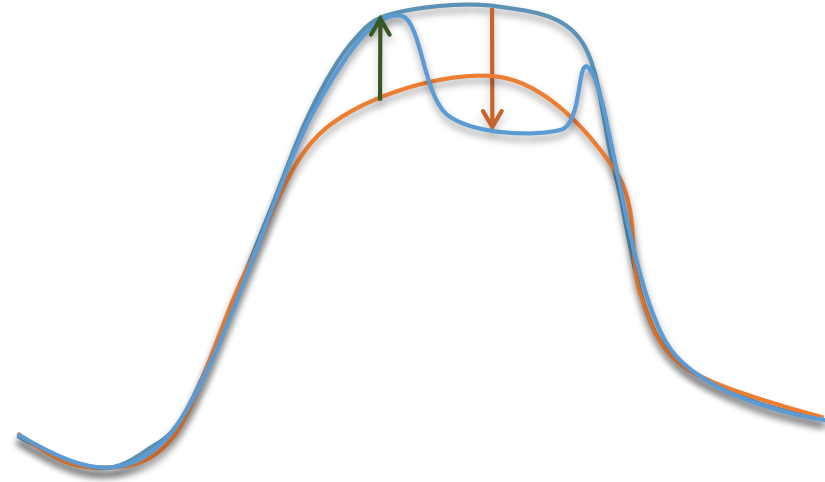
“x over y” baselines:

Go back y representative days, select x days (top x peak days, etc.) and average every hour.

Adjustments:

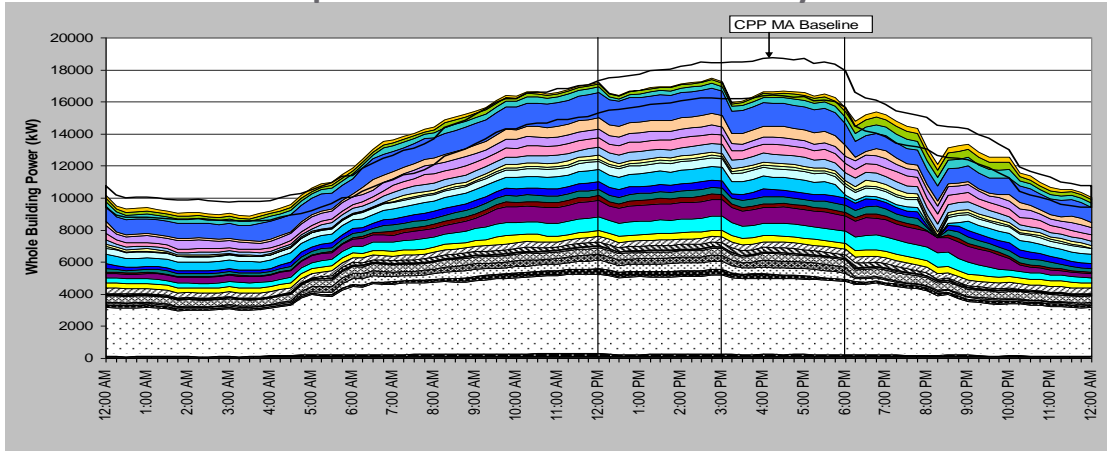
multiplier calculated based on ratio of measured and calculated data during a representative time period

Ex: 10/10 baseline with morning adjustment

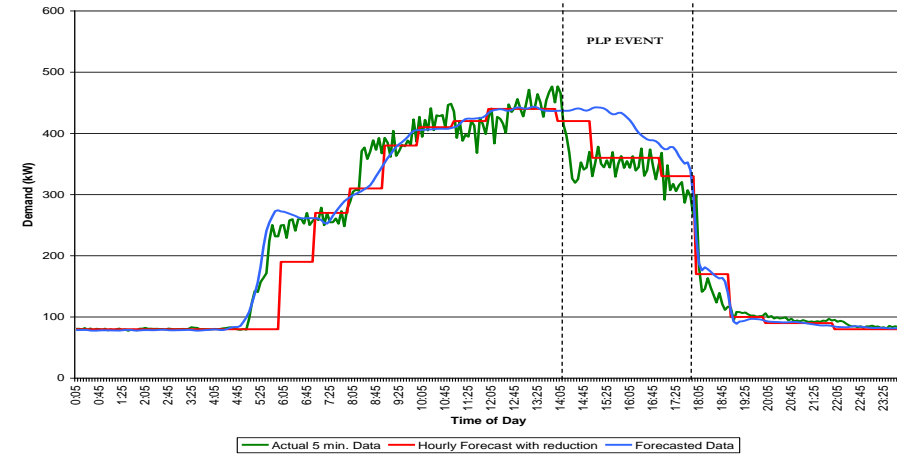


OpenADR in DR Programs in California and Beyond

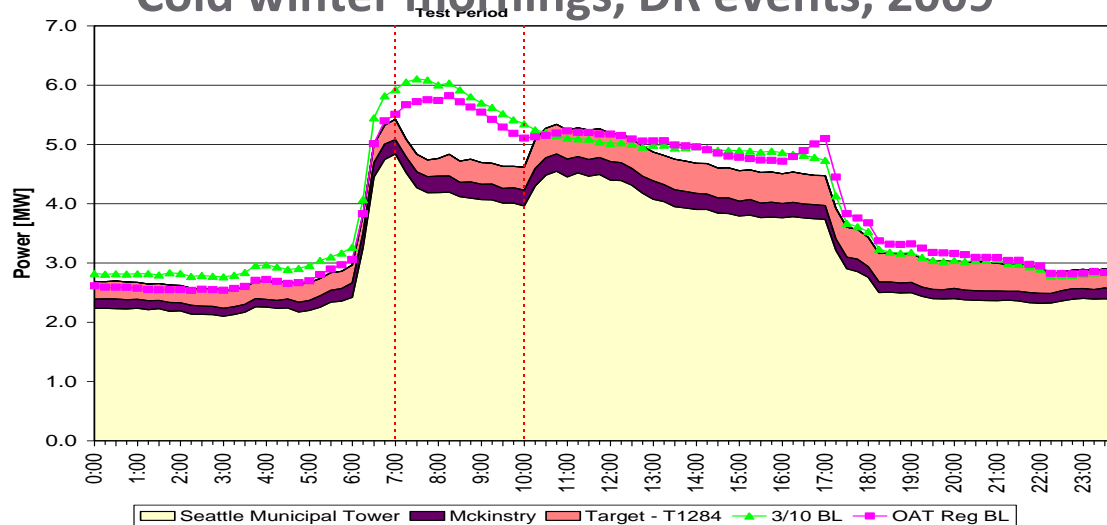
Hot summer afternoons
day-ahead price response
OpenADR Cumulative Shed in July 2008



DR and Ancillary Services
non-spinning reserves, 2010



Cold winter mornings, DR events, 2009

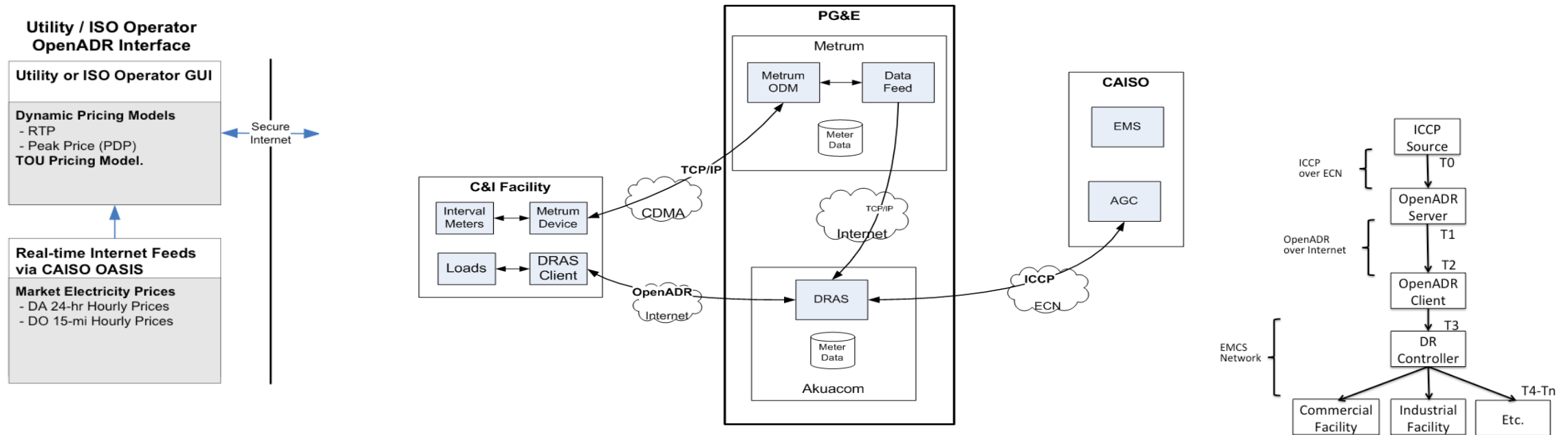


- OpenADR is one of the NIST Smart Grid Standards.
- Over 260 MW of OpenADR in CA
- 8 Countries including China, India, Korea, Australia, Scotland, Ireland, Netherlands, Canada
- 70+ companies with products!

End-to-end Grid Integration for Electricity Reliability

Fast Demand Response – Can loads act like generators?

- Development of architecture communication, control and telemetry (e.g., latency)
- Understanding markets and market participation rules
- Research concepts supported with field tests



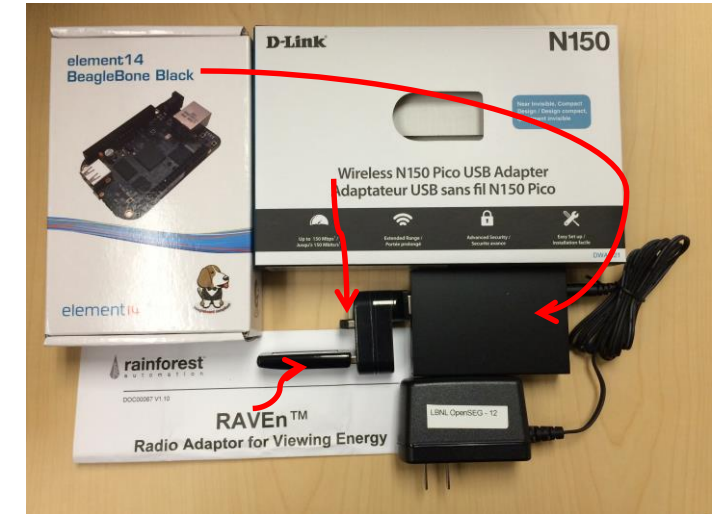
Open Smart Energy Gateway

Purpose – enable greater use of both near real-time and high resolution (10 sec) meter data

Methods – Gateway translates SEP 1.x to more secure protocol (e.g. WiFi)

Use Cases

- 1. Energy monitoring** - Consumers can collect near real time energy consumption data
- 2. Enable near real time DR aggregation**- Time stamped energy data can be aggregated to develop controllable loads for advanced DR programs that need kW feedback
- 3. Fast DR** – May provide lowest-cost telemetry for Fast DR
- 4. Load disaggregation** – 10 sec data provides information to identify end-use loads



LBNL's Wholesale DR Pilots

Regulation with Electric Vehicles (on going)

- Funded by DoD and CEC
- Partners: Akuacom/Honeywell, Kisensum, SCE, CPUC, CAISO

Integrating Renewable Resources - Phase 2 (ending in December)

- Funded by PG&E
- Partners: Olivine

Synchronous Reserves – PJM (completed)

- Funded by DoE
- Partners: IPKeys

LA Air Force Base



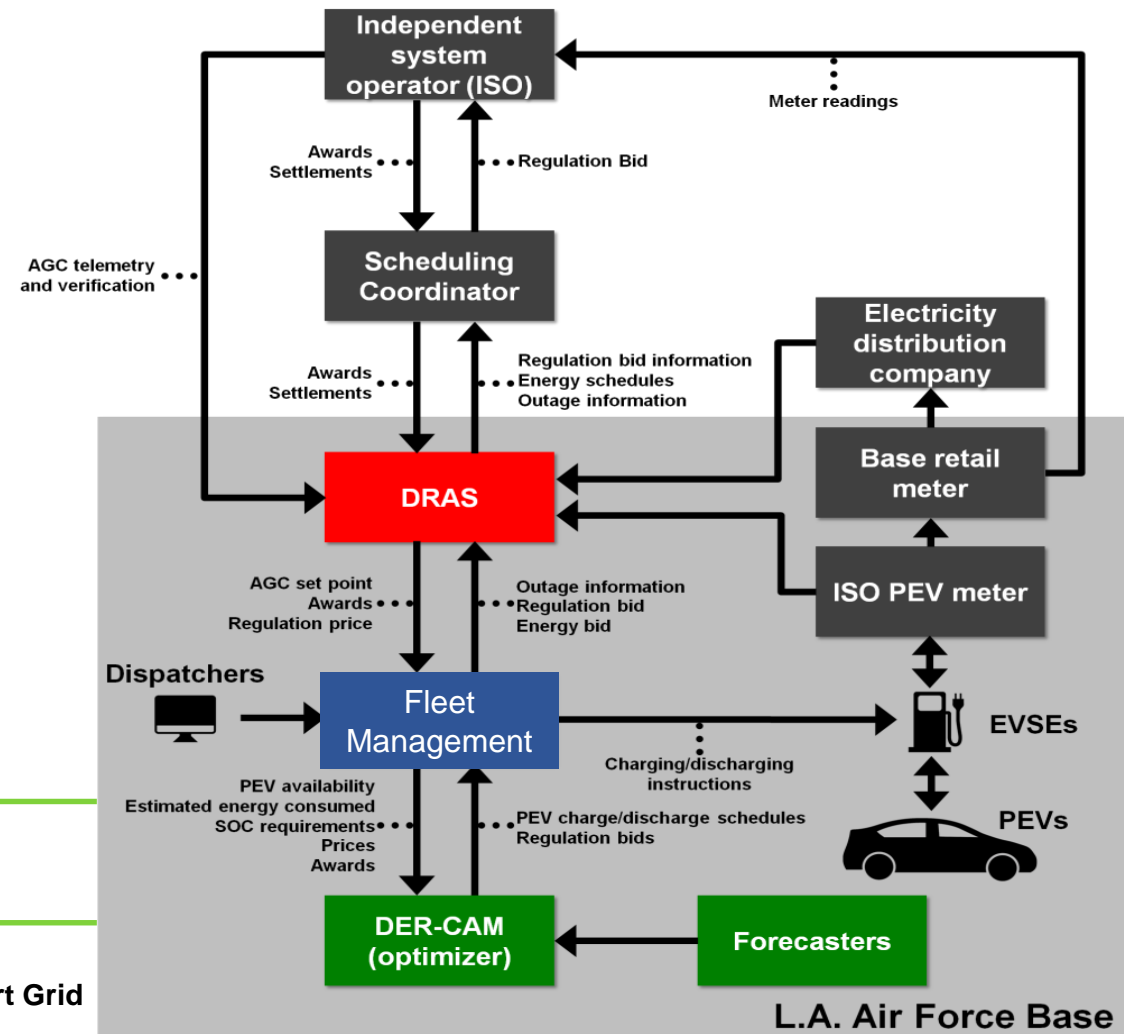
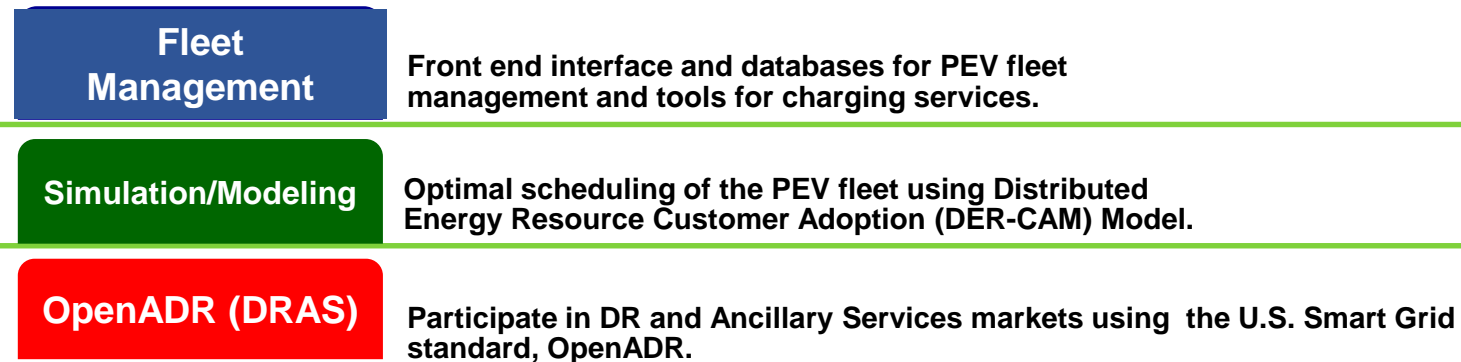
Los Angeles Air Force Base
90,000 m² office complex
4 MW peak electrical load



Applying DR experience: Vehicle-to-Grid Integration

V2G integration adds key capabilities to demonstrate V2G the full electric grid integration of all-electric fleets.

- Optimal charging and bidding into wholesale regulation markets of a fleet of 100% plug-in electric vehicle (PEV)
- PEVs will be given additional fleet management capabilities and enabled for OpenADR
- Optimization to schedule charging and discharging of PEVs to minimize energy costs and maximize benefits from DR and ancillary services markets
- Integration of PEVs into energy system to examine their potential role in base microgrids



Integrating Renewable Management Pilot Fundamentals

- IRM Phase 2 is a monthly program with ISO bidding requirements:
 - 3 or 6-hour commitment with Day-Ahead notification
 - Pay \$10 / kW-month for capacity
 - Settles in ISO market
 - CAISO market participation fees covered by PG&E
 - Requires 6-month customer commitment

7 participants active in the market today.

- **3 HVAC (one of which is also using Lighting)**
- **Rest is using batteries, EVs, Fuel cell.**

Alameda County - Santa Rita Jail (SRJ)

- 3 MW peak load facility
- CERTS microgrid functionality

DER On-site:

- photovoltaic: 1.2 MW peak
- fuel cell: 1 MW molten carbonate
- electric storage: 2 MW 2MWh Li-ion



Alameda County – Santa Rita Jail

Enrolled in January

HVAC, Lighting and Fuel Cell

Monthly Bid:

- Three hours 24 days
- At or above Net Benefits Test price
- 450 kW in Feb, 810 kW starting in March
- Total payments to date:
 $\$69,161 + \$649 = \$69,810$

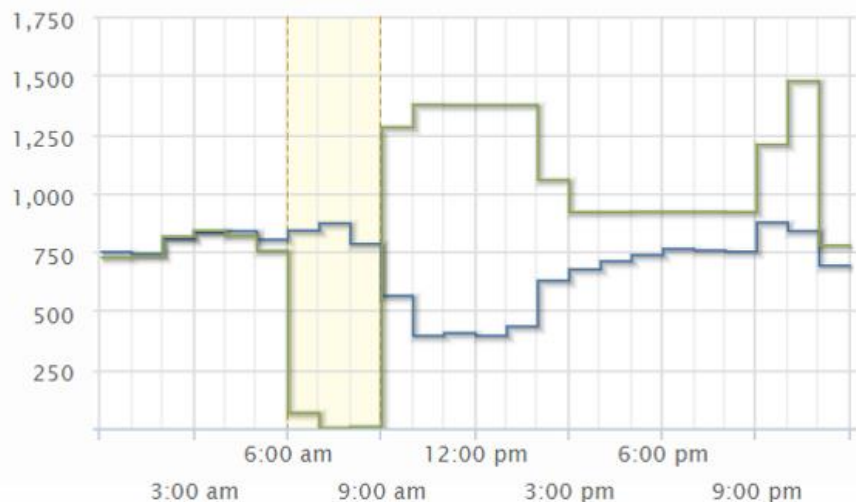
Date	Bid and Award Start	Capacity payment	Energy payment
Feb 3	8 am	\$4,361	\$536
Feb 4	8 am		
Feb 5	7 am		
Feb 7	7 am		
Feb 10	8 am		
Feb 11	8 am		
April 10	10 am	\$8,100	\$68
July 14	11 am	\$8,100	\$45

Performance

Performance

Settlements

Aggregate Performance Data



— Baseline
— Target
— Load

Time	Baseline	Expected Reduction	Target	Load	Reduction
04:00 am	830.54			837.96	-7.43
05:00 am	836.00			817.98	18.03
06:00 am	801.34			753.54	47.80
07:00 am	839.31			66.06	773.25
08:00 am	869.67			2.25	867.42
09:00 am	783.34			6.84	776.50
10:00 am	562.41			1,278.64	-716.23
11:00 am	391.43			1,374.41	-982.98

[? Help](#) [Baseline Details](#) [Native Intervals](#) [Show Reduction](#) [Expand](#)

[Individual Location Data](#) [Download Data](#)

Background - PJM

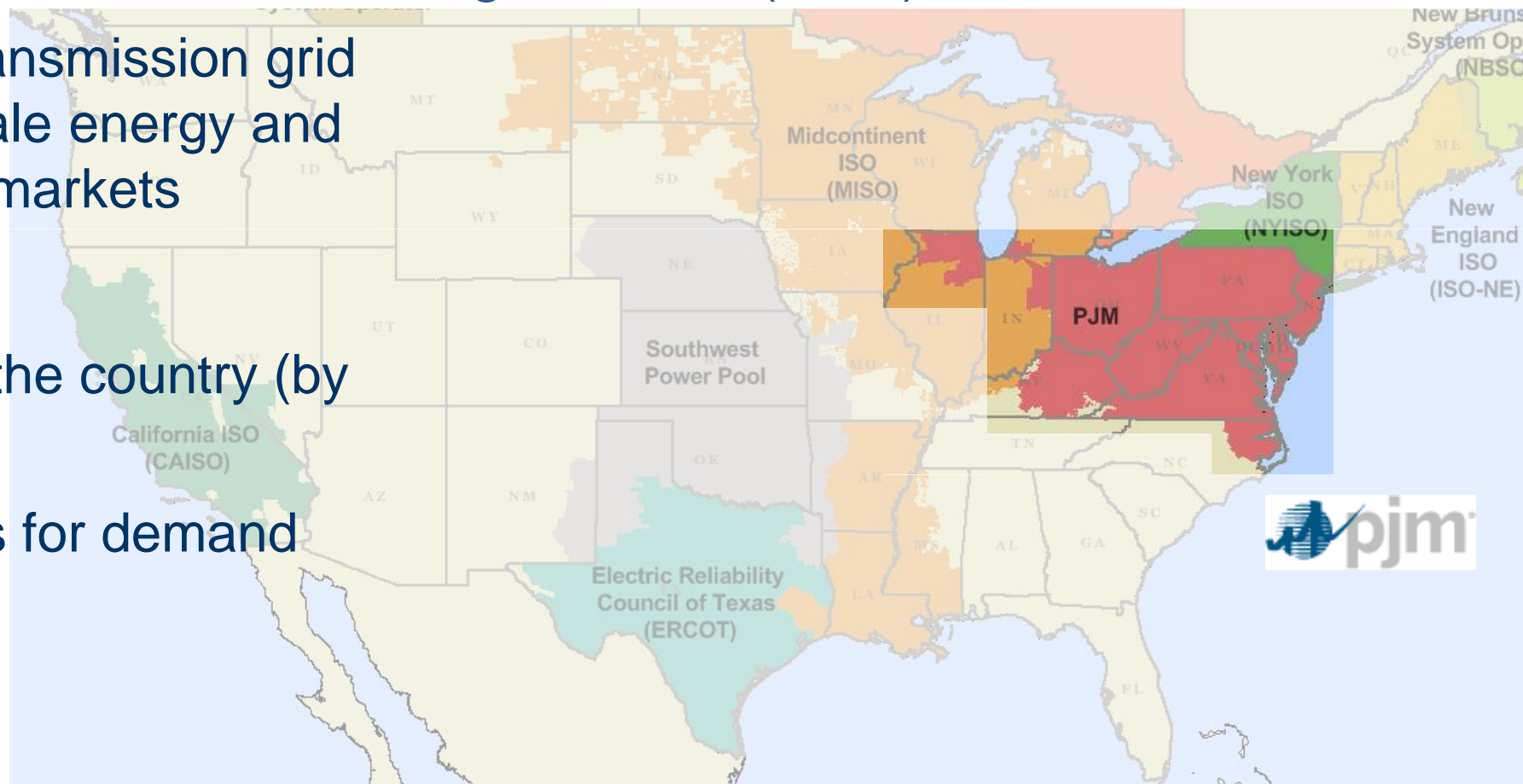
- PJM is a Regional Transmission Organization (RTO)

Operates regional transmission grid as well as wholesale energy and ancillary services markets

In 13 states and DC

Largest ISO/RTO in the country (by load)

Most conducive rules for demand response for AS



Source: FERC.gov



Synchronous Reserve Demo - Site

HVAC and Lighting in a big box retail through central building energy management system control

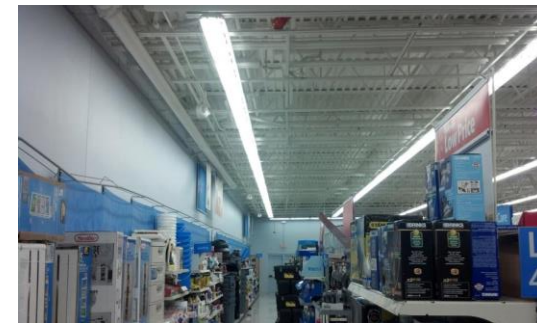
Walmart Store in Quakertown, PA

BMS – Honeywell Novar

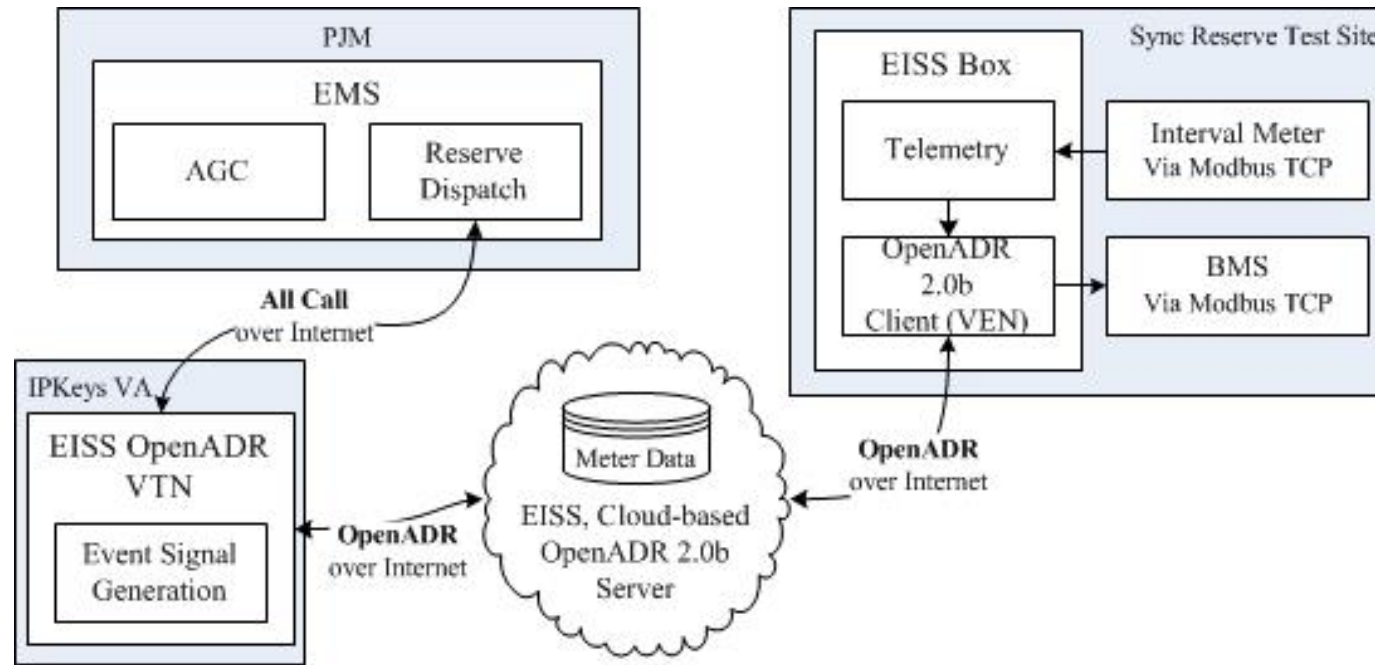
Metering – Schneider M820

Control actions:

- HVAC thru setpoint adjustment
- Lighting thru 1/3 shed of perimeter lights

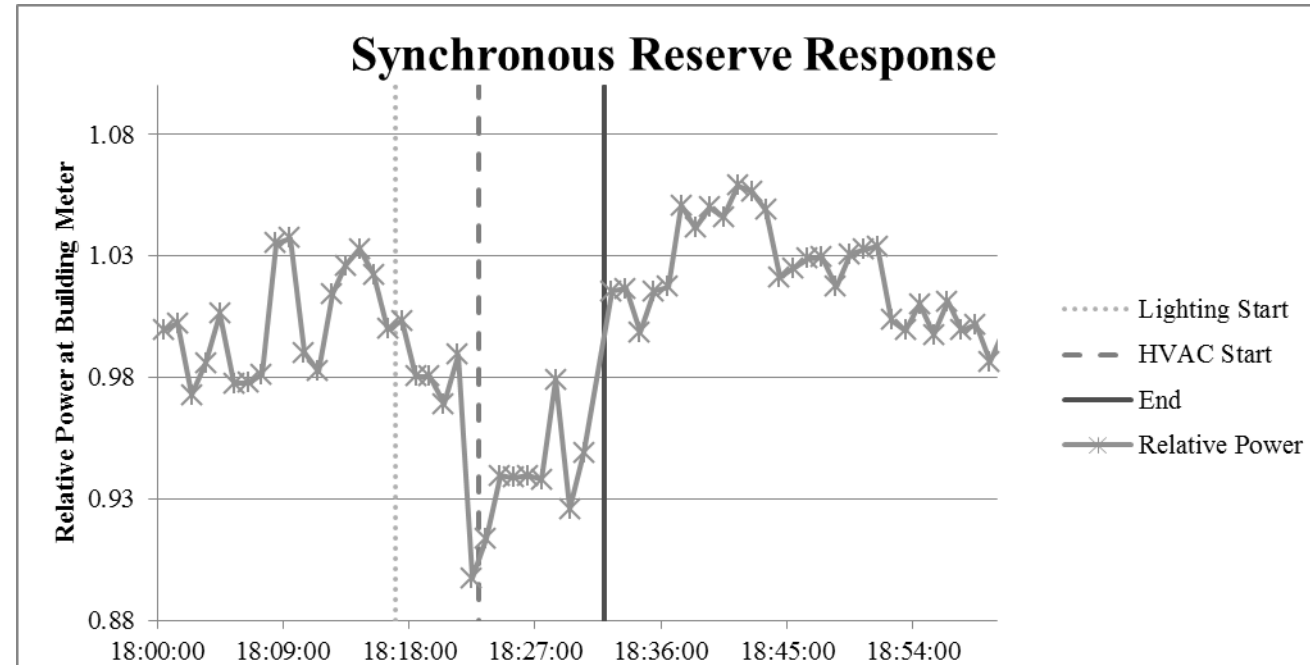


Synchronous Reserve Demo – Comm. Architecture



- Client polled using http every 20 seconds
- Client connected via cellular network
- Testing with new PJM automated M2M signaling next month

Synchronous Reserve Demo - Response



Loads successfully responded to synchronous reserve tests

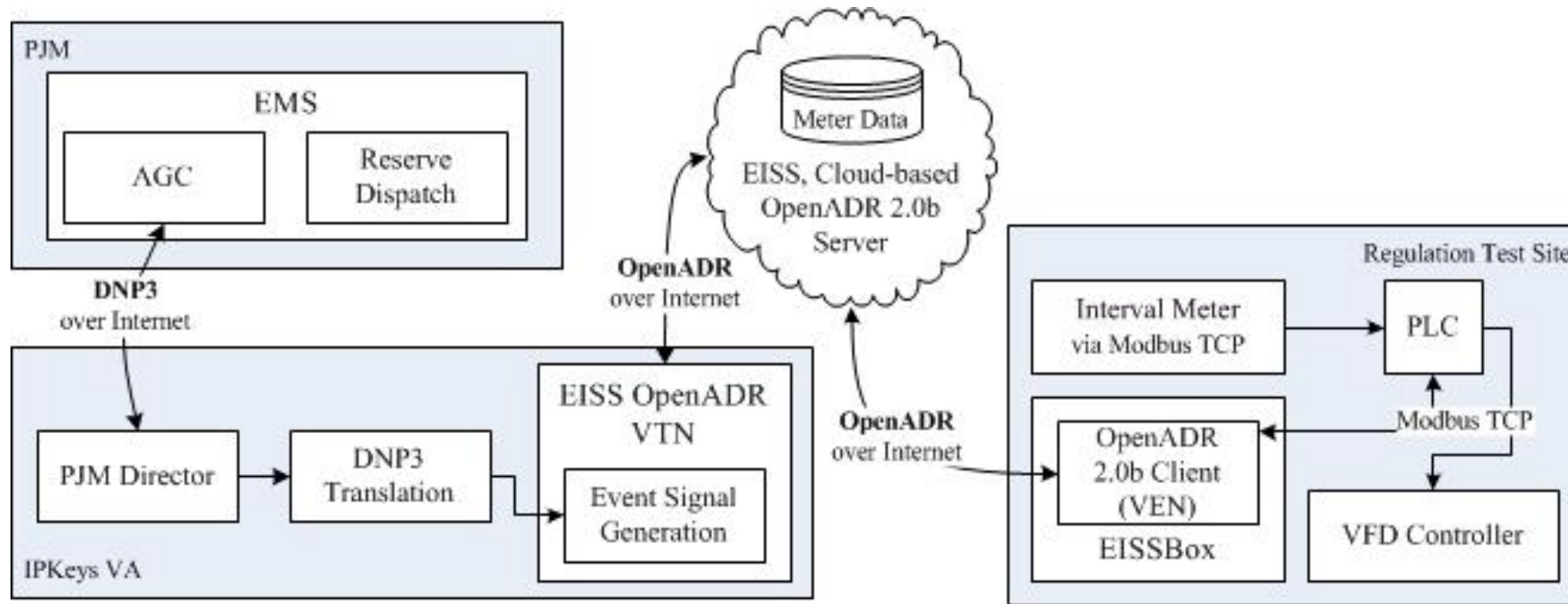
- Lighting response ~2% within 2 minutes
- HVAC response ~ 4% immediately or preemptively (?)
- Load response achieved without noticeable rebound

Regulation Demonstration - Site

- A heat pump cooling a small laboratory space was retrofitted with a VFD on supply fan
- Schneider Electric's VFD laboratory in Knightdale, NC
- Connected to VFD through PLC
- Telemetry – Schneider M820
- Controls:
 - 0.5 Hz frequency adjustments
 - Frequency range: 55 and 65 Hz.



Regulation Demonstration – Comm. Architecture



- Signals pushed to client via XMPP
- Wired internet connection
- At the time of tests, connection with PJM not established

Conclusion

System operators insist that DR looks like a generator

Technology for fast DR is available.

Challenges include:

- Uncertain value
- Lack of standards/streamlined integration platforms
- Cost and availability of telemetry
- Measurement and verification issues - baselines
- Regulatory barriers

Thank you!

