Scaling and Forecasting Reliable Demand Side Load Flexibility

Tom Hines

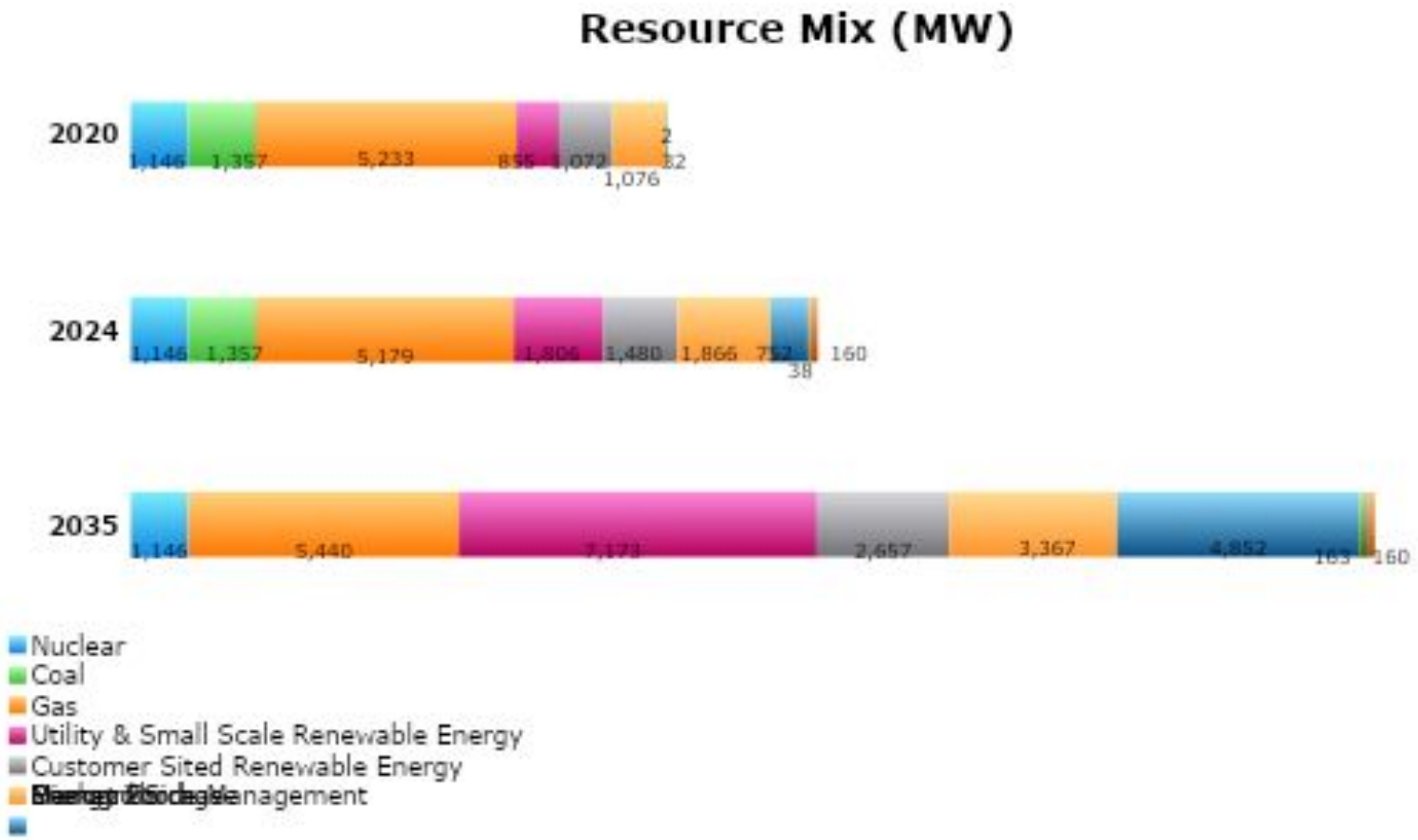
ESIG Workshop

June 13, 2023

Current State

- Increasing customer and investor demand for clean energy
- Retirement of coal plants
- Supply chain constraints
- Unprecedented growth
- Rapidly changing technology

Customers as Part of the Solution



Source: 2020 IRP

Approaches to Drive Customer Load Flexibility

Awareness/Behavior

Manual voluntary customer actions encouraged by messages of clean/reliable/affordable

Direct Dispatch

A connected customer-sited technology responds to a utility dispatch signal

Customer manually responds to a dispatch call

Rate Responsiveness

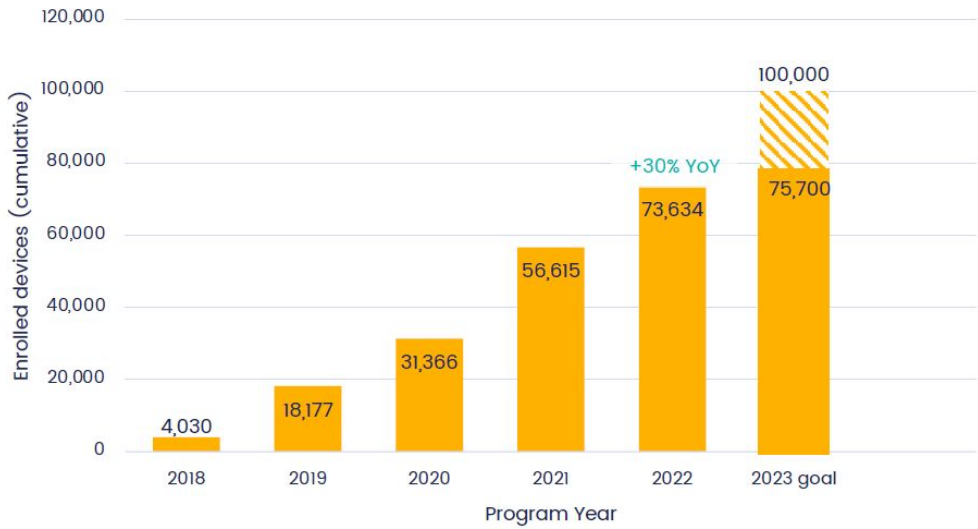
Automated rate optimized technologies and/or manual customer actions

APS Has One of the Largest Aggregated DER Device Programs in the Nation

- **Cool Rewards Smart T-Stat DR**
  - Nearly 80K thermostats enrolled
  - Forecasting over 120 MWs in 2023
- **Residential Battery Pilot**
  - ~4 MWs currently online in pilot
- **Peak Solutions C&I DR**
  - Forecasting up to 50 MWs in 2023
- **Connected Water Heating Control Pilot**
  - Water heating timed around TOU rates
  - Daily load shifting with MF households

Rapid Cool Rewards Growth Continues

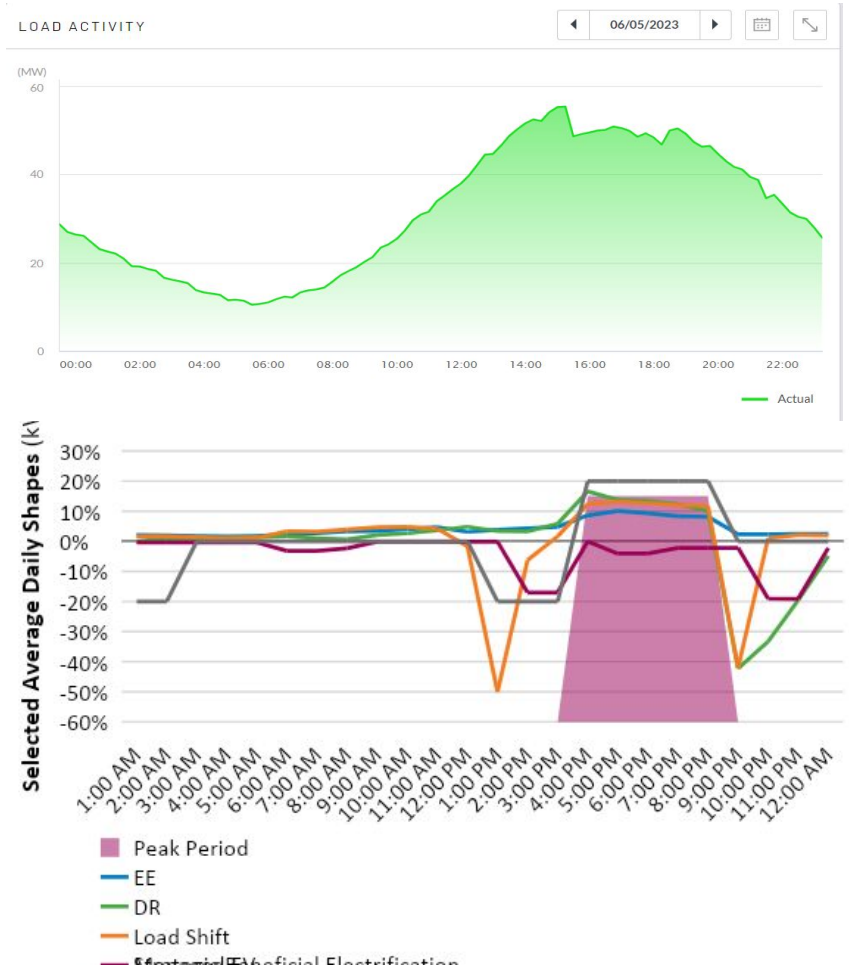
30% YoY enrollment growth in 2022



DER Savings Profiles: 8760 Hourly Load Shapes

Forecasted impacts for each DSM technology in APS's portfolio are supported by extensive data collection, research and analysis

- **AMI Data**
  - Hourly/15 min interval
- **End-Use Metering**
  - Egauge sub-metering study
  - Residential Hot Water, HVAC, Appliances, Pools
  - Commercial Lighting, VFDs, EMS
- **Device Telemetry Data**
  - Smart Thermostats
  - Connected Water Heating
  - Residential Batteries
  - EVs
- **Energy Modeling**
  - Thermal Energy Storage



Datasets, Tools, and Metrics

APS has several resources to model DSM programs to optimize future design and customer value

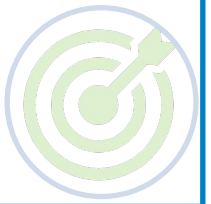
- Hourly DSM Load Impacts by Technologies
- APS dispatch/load forecast
- Emission Factors
- Avoided energy/capacity costs
- Customer Retail Rates
- Tech/Program Costs

Datasets

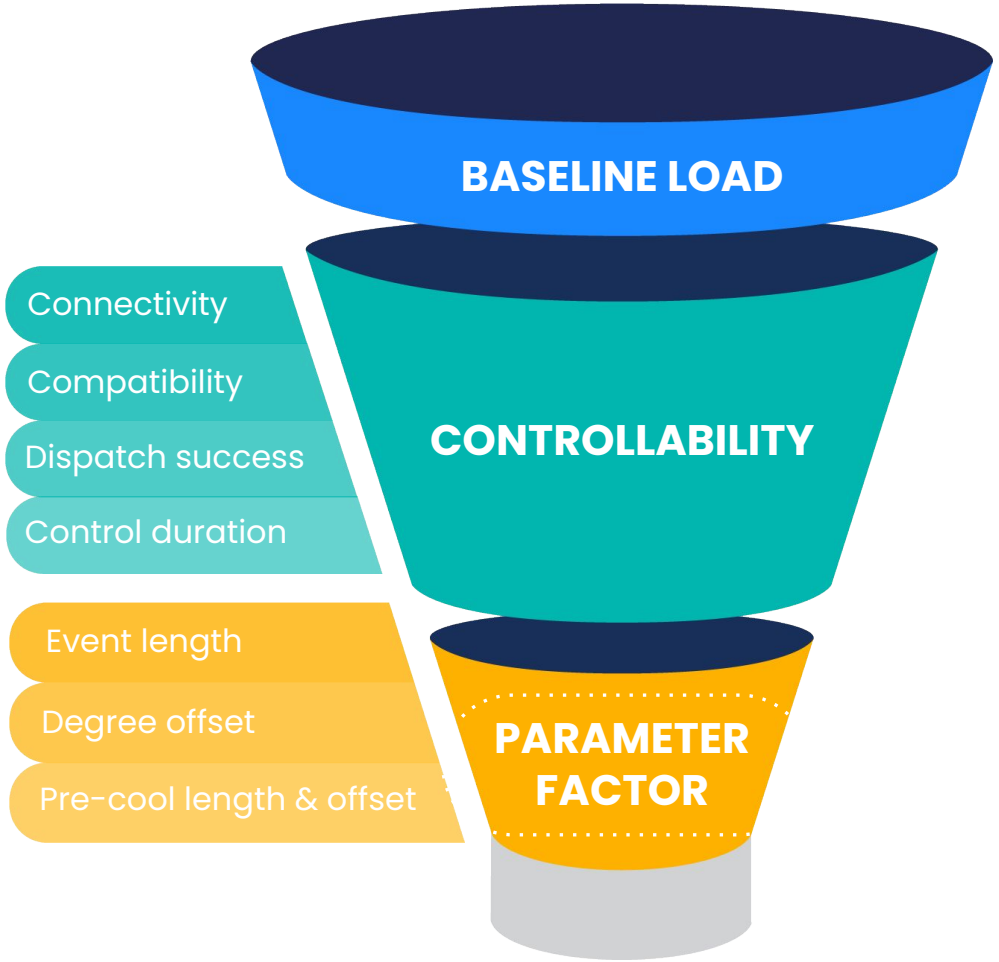
- Load shape Viewer
- Program Planning and Potential model
- Customer Surveys

Tools

- Hourly energy impacts and peak reductions
- Cost Effectiveness
- Emissions Reductions
- Customer Satisfaction

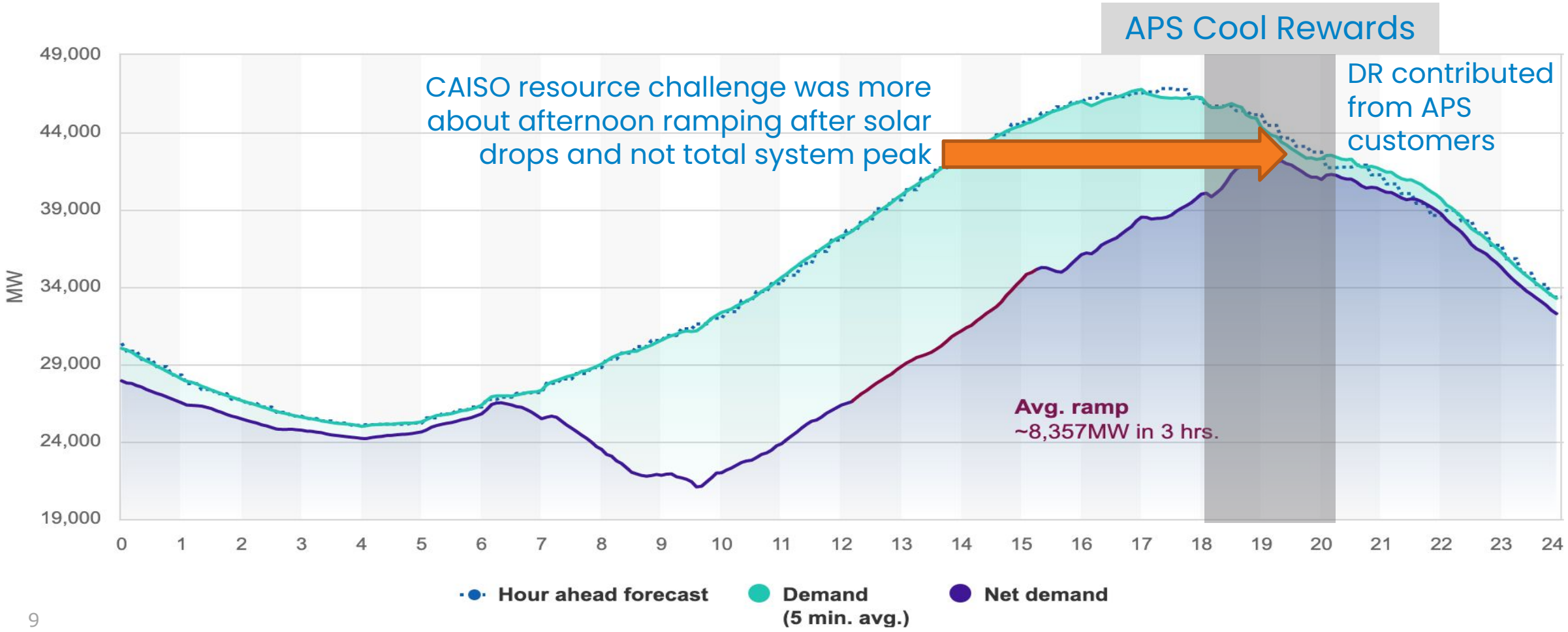


Metrics



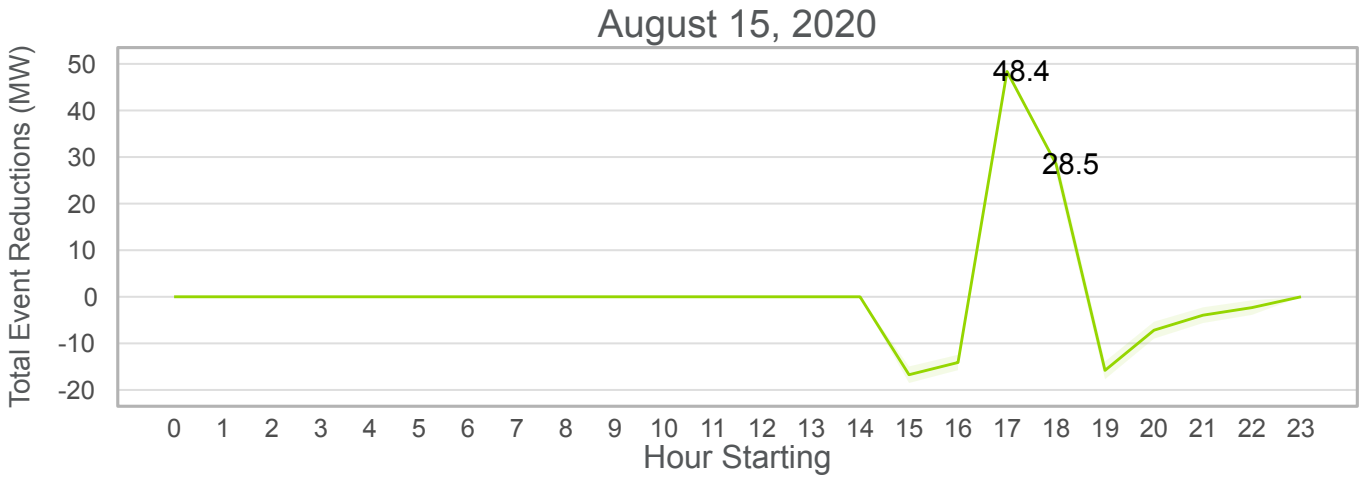
‘Load Shed Funnel’ from theoretical maximum to actual impact

Using DR to Address Regional Net Peak Supply Challenges (August 2020)



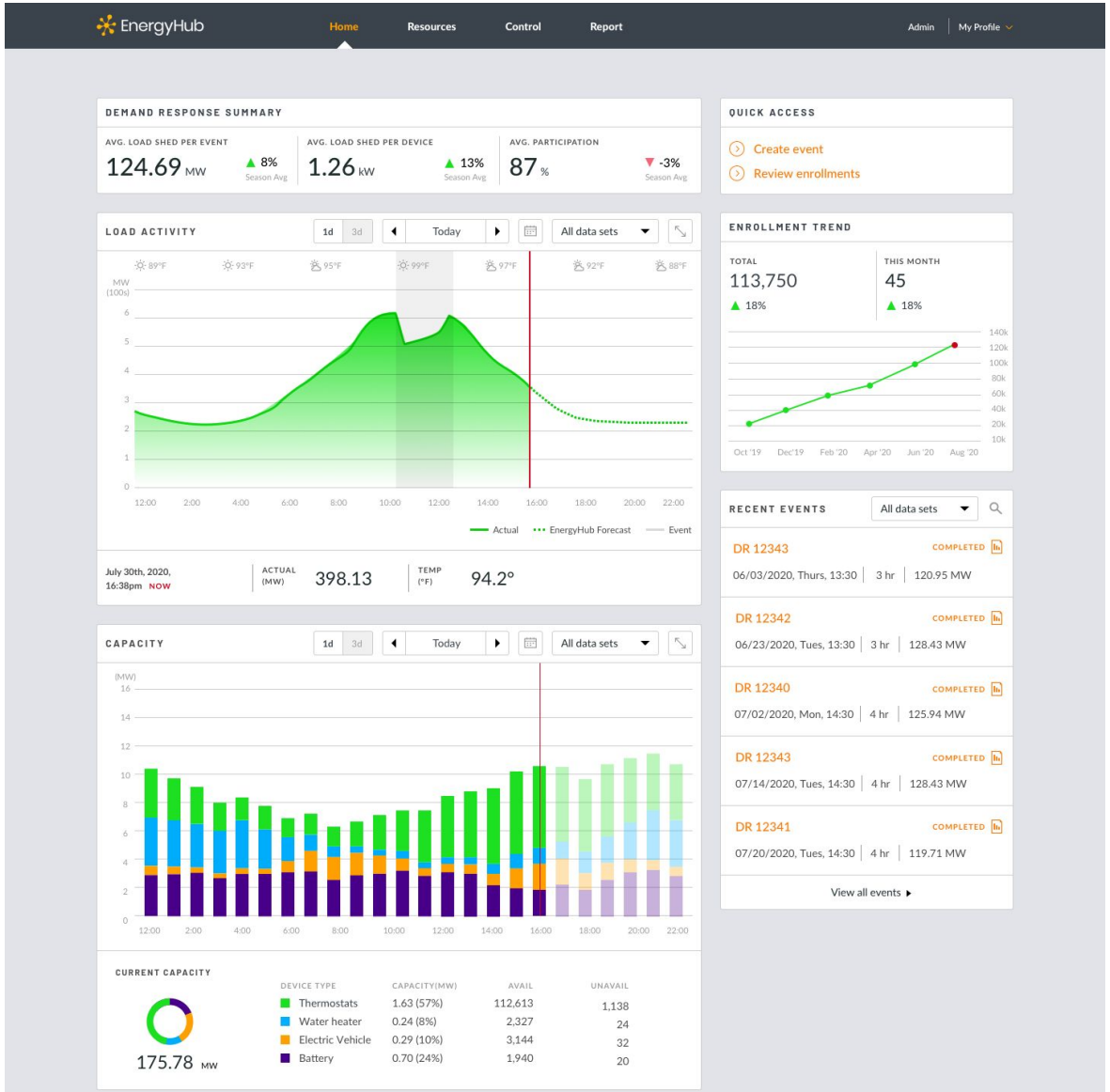
Cool Rewards Reliable Load Reductions

- *The reductions presented here reflect actual impacts observed at the generator from four events held over five days in August 2020.*



Event Date	Average per Device Reductions Over the Event Period	Total Average Event Period Reductions	Total Peak Hour Reductions
14-Aug-20	1.25 kW	29.9 MW	37.9 MW
15-Aug-20	1.61 kW	38.6 MW	48.4 MW
17-Aug-20	1.19 kW	28.7 MW	35.8 MW
18-Aug-20	1.17 kW	28.2 MW	34.9 MW

Future Improved flexibility forecasting for better resource planning



Demand Response Potential Assessment Approach

Step 1: Market Characterization	Characterize market for DR estimates (number of customers and coincident peak load estimates by customer class-residential, small/med/large C&I and by building type).
Step 2: Develop Count and Peak Demand Projections	Define peak and develop baseline peak demand projections by customer class, building type, and end use; additionally develop account count forecasts.
Step 3: Define DR Options	Define and characterize DR options (plus sub-options, which represent technology choices for controlling load) and map applicable options/sub-options to relevant customer classes.
Step 4: Develop Key Assumptions for DR and Cost Estimates	Develop participation and unit load reduction assumptions under each DR option and sub-option; develop itemized cost assumptions.
Step 5: Estimate DR Potential and Costs and Develop Supply Curves and B/C Ratios	Apply participation, unit impacts, and cost assumptions to characterized options by applicable market segment and develop "achievable" DR and cost estimates; undertake cost-effectiveness analysis.

DR Options and Sub-Options

DR Options	Sub-Options	Eligible Customer Classes	Targeted/Controlled End Uses
Direct Load Control (DLC)	• CAC/Heat Pump control via thermostats • Window AC control • Ductless Minisplit AC/HP control • Water Heating Control • HVAC (manual and Auto-DR enabled) • Lighting (standard and advanced controls)	Residential	HVAC, Water Heating, Pool Pump
C&I Curtailment	• Water Heating Control • Refrigeration control • "Other" end-use curtailment • Total Facility (for segments that do not have end-use disaggregation)	Small C&I, Medium C&I, Large C&I, XL – Excluding Mines C&I, XL – Mines C&I, XLHF C&I	HVAC, Lighting, Water Heating, Refrigeration, Total Facility, Other
C&I Load Shift to BUGs	• Load shift to Back Up Generators (BUGs)	All C&I with BUGs	Total Facility
Dynamic Pricing	• Dynamic Pricing with enabling tech • Dynamic Pricing without enabling tech	Res_Standard, Res_TOU, Res_Demand XS C&I, Small C&I, Medium C&I, Large C&I, XL – Excluding Mines C&I, XL – Mines C&I, XLHF C&I	Total Facility
BTM Battery Dispatch	• Res BTM Battery Dispatch • Com BTM Battery Dispatch	Res Battery, Com Battery	Batteries
EV Managed Charging	• EV Managed Charging	EV	EVs
EV Behavioral	• EV Behavioral	EV	EVs
EV V2G	• EV V2G	EV	EVs
Behavioral DR	• Behavioral DR	Res_Standard, Res_TOU, Res_Demand	Total Facility

Participation hierarchy ensures that impacts are not double counted among overlapping options offered to the same customer class

Peak Solutions Characterization (C&I Curtailment)

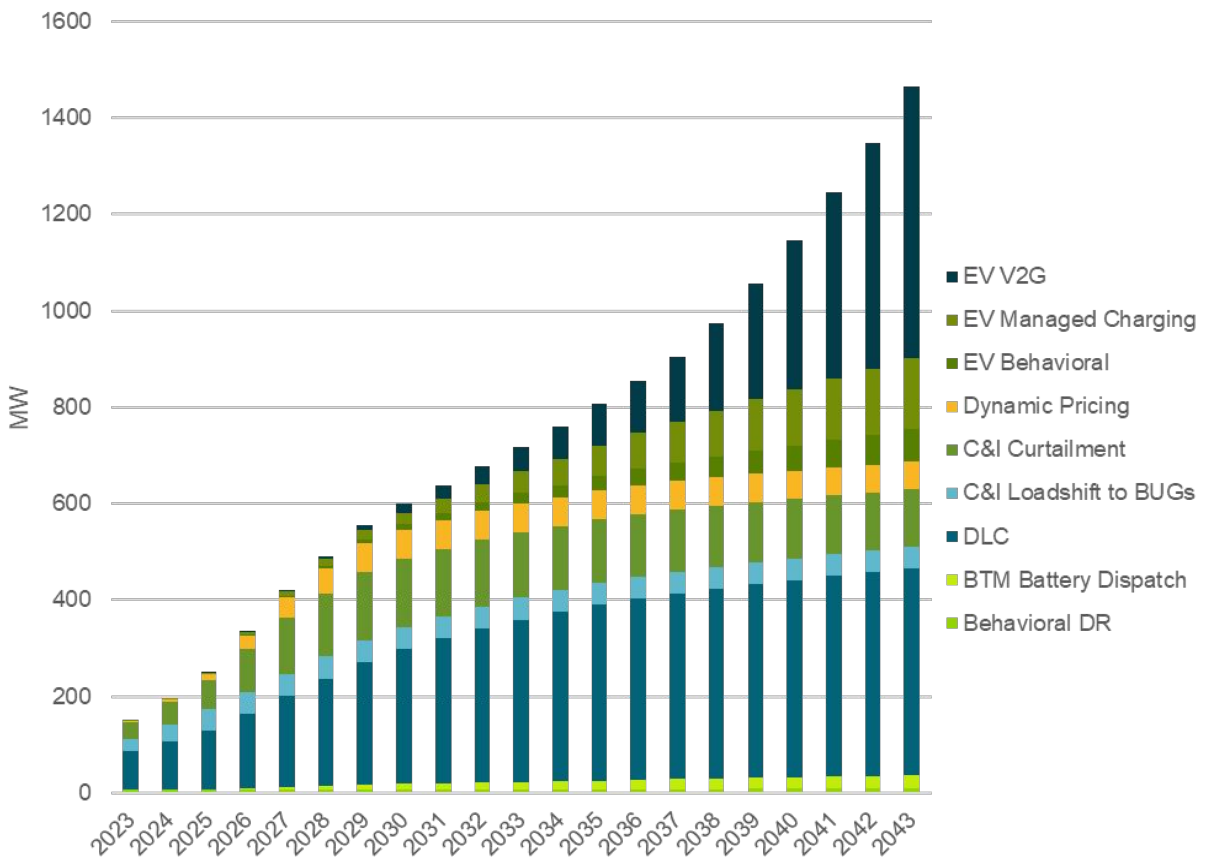
Participation Assumptions

- **Participation** is defined as the percent of total segment peak demand enrolled in the program
  - e.g., 2022 Participation (C) = B ÷ A
- The **Steady State Participation Rate** represents the maximum proportion of peak demand that could participate in the program
  - The Steady State rate is informed by existing participation, survey results, and benchmarking with other jurisdictions
  - A **Participation Ramp Factor** defines the trajectory of growth from current (2022 and 2023) participation up to the Steady State rate

Building Type	A. 2022 Baseline Peak Demand (MW)	B. 2022 Participants Estimated Peak Demand (MW)	C. 2022 Existing Participation Rate (% of Peak Demand)	D. Steady State Participation Rate (% of Peak Demand)
Agriculture	0.6	-	0%	30%
Communications	17.1	-	0%	5%
Data Centers	39.8	-	0%	5%
Education	114.8	28.9	25%	Up to 53% (varies by class)
Entertainment/Recreation	6.5	2.5	38%	Up to 55% (varies by class)
Food Service	111.5	0.1	0%	5%
Government	160.5	16.6	10%	25%
Grocery	67.5	0.8	1%	40%
Healthcare	117.1	-	0%	5%
Lodging	71.7	1.0	1%	10%
Manufacturing/Industrial	333.3	16.0	5%	25%
Miscellaneous/Other	622.4	80.9	13%	25%
Office	363.4	3.0	1%	30%
Retail	302.3	61.4	20%	Up to 80% (varies by class)
Warehouse	27.1	0.2	1%	5%
Wholesale Trade	5.3	0.0	1%	5%
Total	**2,360**	**211.5**	**9%**	

Preliminary DRAFT DR Projections: All Options (MW)*

APS's overall DR portfolio could potentially grow to 250 MW in 2025, 600 MW in 2030 and to 1145 MW in 2040



*Values shown here are estimated at the meter.

- **250 MW from all DR options in 2025** (~3.99% reduction in peak demand)
  - ✔ DLC: 121 MW
  - ✔ C&I Curtailment: 59 MW
  - ✔ C&I Loadshift: 45 MW
- **600 MW from all DR options in 2030** (~9.03% reduction in peak demand)
  - ✔ DLC: 279 MW
  - ✔ C&I Curtailment: 142 MW
  - ✔ Dynamic Pricing: 60 MW
- **808 MW from all DR options in 2035** (~12.4% reduction in peak demand)
  - ✔ DLC: 364 MW
  - ✔ C&I Curtailment: 133 MW
  - ✔ *EV V2G*: *87 MW*
- **1145 MW from all DR options in 2040** (~17.8% reduction in peak demand)
  - ✔ DLC: 409 MW
  - ✔ *EV V2G: 308 MW*
  - ✔ C&I Curtailment: 123 MW

Note: Only top 3 contributing options in each respective year are shown, non cost-effective sub-options are italicized

Guidehouse Outwit Complexity

Current/On the Horizon

- Closer coordination with EIM on load adjustments
- Stronger contract SLAs with aggregation partners
- Better predictive forecasting in the aggregation platform
- Better orchestration across DER types
- Lower latency/quicker data transfer from device OEMs
- Approaches for addressing changing distributed resource flexibility needs

Thank You!

Tom Hines
Tom.hines@aps.com
Tom.hines@tierrarc.com