Demand Response Fundamentals, Evolution, and Industry Leaders

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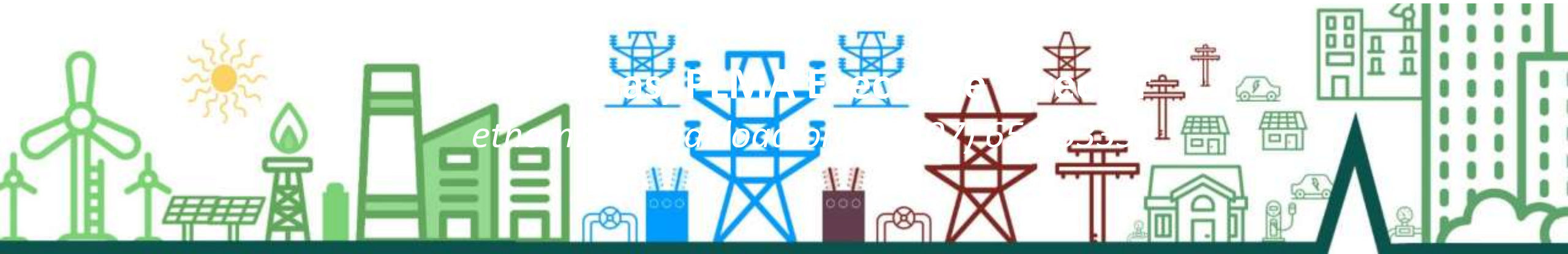


PLMA™
Load Management Leadership

LEADERSHIP IN SHARING LOAD MANAGEMENT EXPERTISE

Introduced refreshed PLMA logo and tagline with article posted viewed by over 900 people in Utility Dive

Published industry reports

- Produced joint webinars with AESP, SEPA, Parks Associates, Greentech Media
- Placed speakers at Distributech, Edison Electric Institute, AESP, US Energy Association, Parks Associates and 5 other industry events
- Utility Load Management Exchange achieved record-breaking attendance at in-person, multi-day events in Coronado, Calif. and Austin, Texas adjacent to PLMA Conferences

Voice of Load Management Practitioner

1. Accenture
2. Advanced Energy
3. Alectra Utilities
4. Ally Energy Solutions
5. AESC
6. Ameren
7. American Public Power
8. Apogee Interactive
9. Applied Energy Group
10. Arizona Public Service
11. Aquanta
12. Austin Energy
13. AutoGrid Systems
14. BGE, an Exelon Company
15. Berkshire Hathaway Energy
16. Bidgely
17. Blackhawk Network
18. Bonneville Power Admin.
19. BPL Global
20. BTES
21. Buffalo Niagara Medical Ctr
22. Carina Technology
23. Central Hudson G&E
24. Centrica Business Solutions
25. Chelen PUD
26. City of Tallahassee Utilities
27. CLEAResult
28. COI Energy Services
29. Commonwealth Edison
30. Con Edison
31. Connected Energy
32. Consumers Energy Co.
33. Cpower
34. CPS Energy
35. Crius Energy
36. Customized Energy Solutions
37. Dairyland Power Co-op
38. DTE Energy
39. Duke Energy
40. E Source
41. E4TheFuture
42. Eaton
43. Ecobee
44. EcoFactor
45. Ecotagious
46. Edison Electric Institute
47. Efficiency Vermont
48. Electric Ireland
49. Emerson Climate Tech.
50. Enbala
51. Encycle
52. Enel X
53. Energy Datametrics
54. Energy Federation
55. EnergyHub
56. Energy Solutions
57. EnerVision
58. Engie
59. Entergy
60. EPRI
61. ERS
62. Eversource
63. Extensible Energy
64. Fairbanks Morse
65. FleetCarma
66. Franklin Energy
67. Georgia Power
68. Google (Nest)
69. Great River Energy
70. GridOptimize
71. Hawaiian Electric
72. High West Energy
73. Honeywell Smart Energy
74. ICF
75. Idaho Power
76. IGS
77. Illume Advising
78. Indianapolis Power & Light
79. Integral Analytics
80. IPKeys Power Partners
81. Itron
82. Jackson EMC
83. JouleSmart Solutions
84. KCP&L
85. Landis & Gyr
86. Leap
87. Lockheed Martin
88. Message Broadcast
89. Modesto Irrigation District
90. Mosaic Power
91. National Grid
92. NRECA
93. Navigant
94. NB Power
95. New Hampshire Electric Coop.
96. Nexant
97. Next Energy Party
98. New Braunfels Utilities
99. North Carolina EMC
100. Northwestern REC
101. NRG Curtailment Solutions
102. NTC Corporate
103. Oglethorpe Power Corp
104. Okla. Gas & Electric
105. Olivine
106. Omnetric
107. Oncor Energy Delivery
108. Opinion Dynamics
109. Orange & Rockland Utilities
110. Pacific Gas and Electric
111. PECO, an Exelon Company
112. Pepco, an Exelon Company
113. Portland General Electric
114. Powerley
115. Rappahannock Electric
116. Research into Action
117. RF Demand Solutions
118. SMUD
119. Salt River Project
120. San Diego Gas & Electric
121. Schneider Electric
122. Scope Services
123. Sensus USA
124. Simple Energy
125. Skipping Stone
126. SEPA
127. Snohomish PUD
128. Southern Calif. Edison
129. SoCal Gas
130. Steffes Corporation
131. Tacoma Power
132. Tantalus
133. Tendril
134. Tenn Muni Electric Pwr Assn
135. Tenn. Valley Authority
136. The Brattle Group
137. Threshold
138. Tierra Resource Consultants
139. Tokyo Electric Power
140. Tri-State G&T Assoc.
141. Tucson Electric Power
142. United Illuminating
143. Utility Load Mgmt Exchange
144. Vectren
145. Virtical Peaker
146. Waseda University
147. WaterFurnace
148. Westar Energy
149. West Monroe Partners
150. Whisker Labs
151. Xcel Energy
152. Zen Ecosystems
153. Zeuthen Mgmt Solutions
154. ZOME Energy Networks

PRACTITIONER ENGAGEMENT

Education Planning Group produced

- Week-long training presented in Phoenix co-hosted by Arizona Public Service and Salt River Project on: DR Market Fundamentals, DR Program Design and Implementation
- Demand Response Fundamentals and Evolution courses presented in Coronado, Calif and Austin Texas adjacent to PLMA Conferences, and in Washington, DC adjacent to SEPA event and full-day course presented
- First interactive on-line training course with Enerdynamics called Demand Response Fundamentals

Demand Response Fundamentals

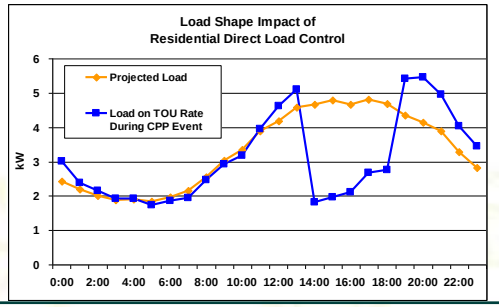
Demand Side Management

Conservation

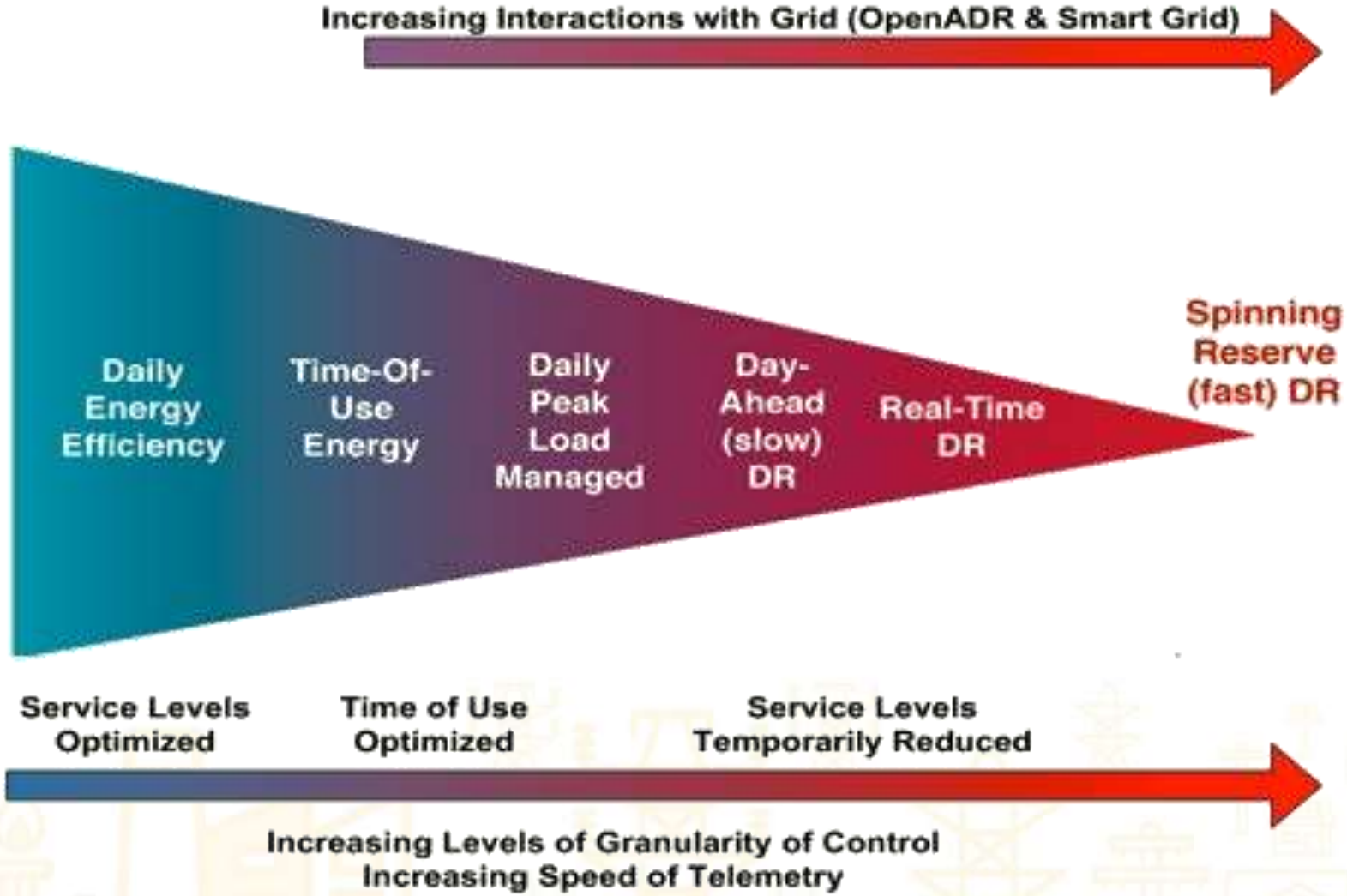
Energy Efficiency

ENERGY STAR

Demand Response

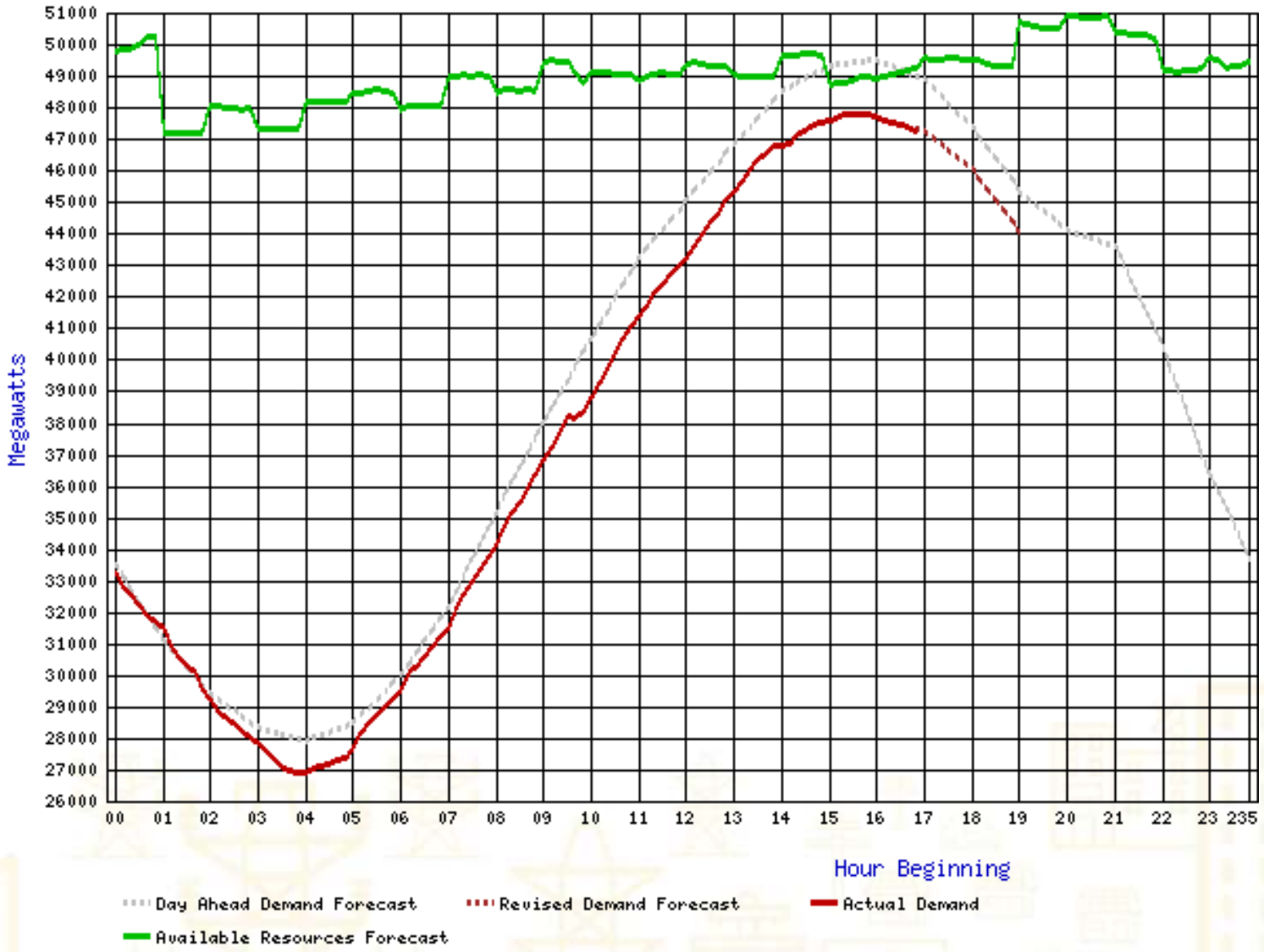


Demand Response – its "Fast EE" for the Grid



Why Utilities Need Demand Response

- Supply has to always meet demand
- Must be available *immediately*
- When demand may exceed supply
- DR is needed to reduce demand



The Economic Definition of DR

The “response” is based on a payment for either:

- the willingness to change behavior (capacity), or
- the actual change (performance)

in the “demand” level of electric energy

Payment can be based on the actual reduction

controlled by:

- the electricity customer, or
- programmed into the customer’s equipment

responding to either:

- a grid system operator reliability request, or
- a price signal, or
- on the availability to be on call

Demand Response in the Airline Industry

80 People show up for a flight on a day of high travel **demand**

Bombardier CRJ-700
Only Has **Capacity** for 70 People

Airline pays 10 people to take a later flight (e.g. provide an **incentive** in the form of ticket vouchers)

Source: Skipping Stone

Demand Response in the Utility Industry

Power Grid needs 80 MW

Power Grid only has 70 MW

Power Grid pays consumers to reduce 10 MW to balance supply & demand

Source: Skipping Stone

Policy Drivers of DR Programs

Capacity Deferral	• Delaying investments in new generation capacity to meet reserve requirements
Improved Reliability	• Developing curtailment capability to address short-term/emergency supply shortfalls
Deferral of T&D Upgrades	• Delaying investment in specific, localized substations and feeders using DR as a demand side resource
Operational Cost Savings (Economic Dispatch)	• Reduction of system operating costs through fewer starts of peaking units, reduced need for spinning reserve from generators, and economic dispatch of DR resources
Integration of Intermittent Renewable Resources	• A possible alternative to new generation or a more economical way to provide ancillary services
Regulatory requirements	• Commission rulings to have ESPs fund and operate DR programs or achieve DR curtailment goals

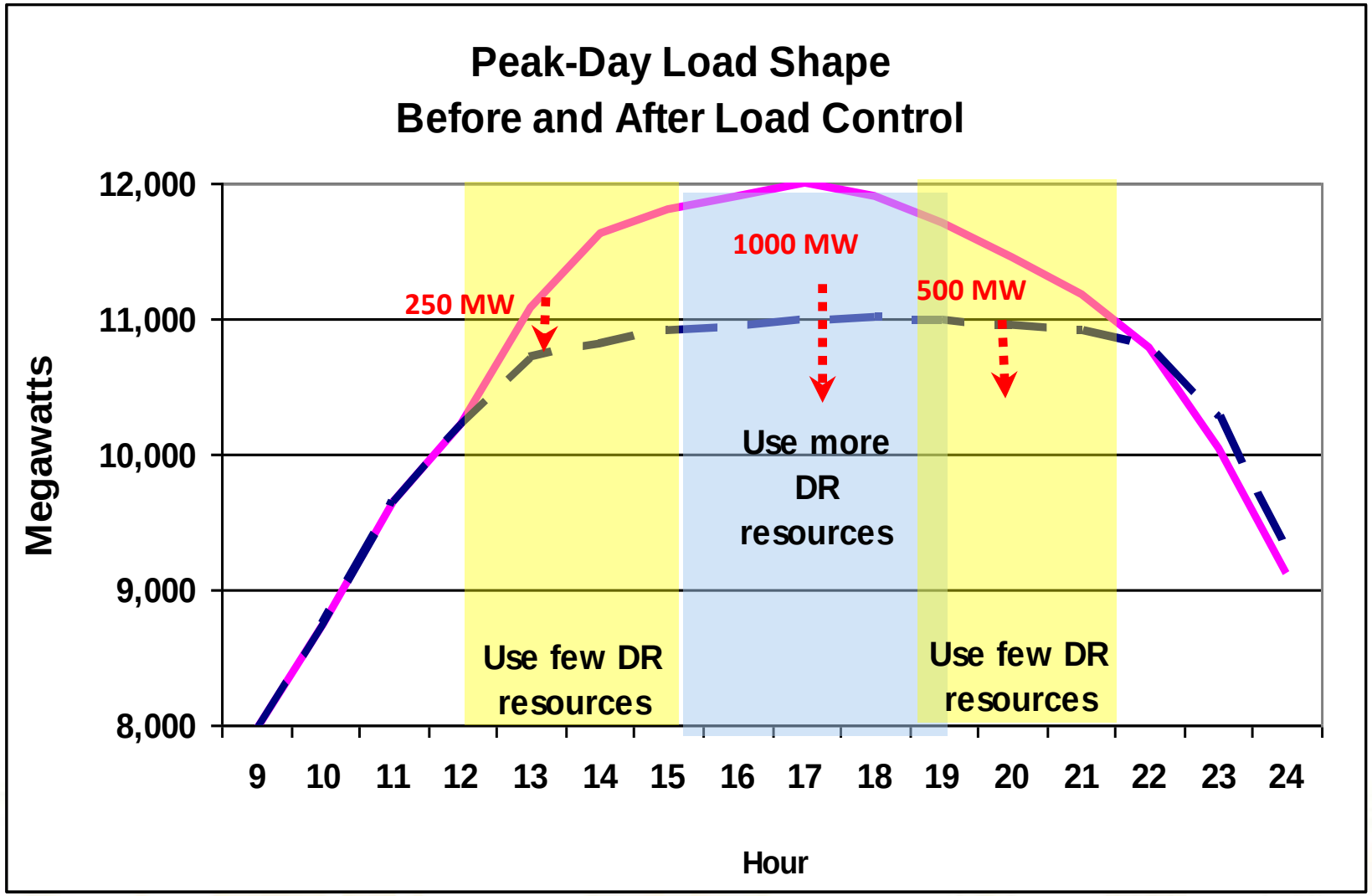
Source: Navigant

Types of DR programs

- **Dispatchable = call or control or bid in advance**
  - Wholesale market directed economic programs
  - Wholesale market directed reliability programs
  - Direct Load Control, e.g. automatic appliance shut-off
  - Interruptible Rates, i.e. lower rates for directed reductions

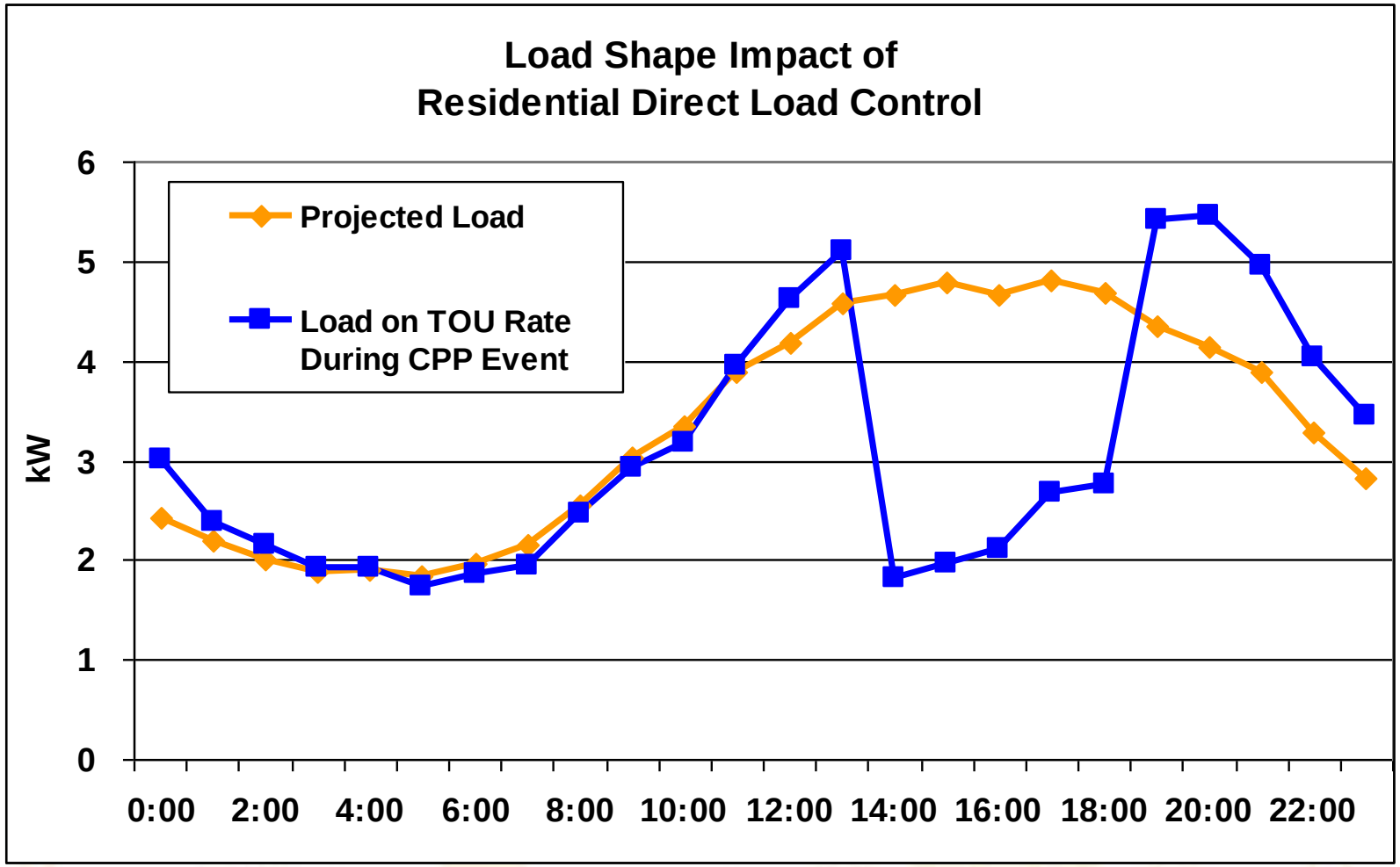
- **Non-Dispatchable / Price-Responsive Demand = pre-set**
  - Critical Peak Pricing – scheduled
  - Peak Time Rebate – built into a rate
  - Time-Of-Use Pricing – annual schedule
  - Dynamic Pricing – all of the above

Call on DR when it is needed



Source: Navigant

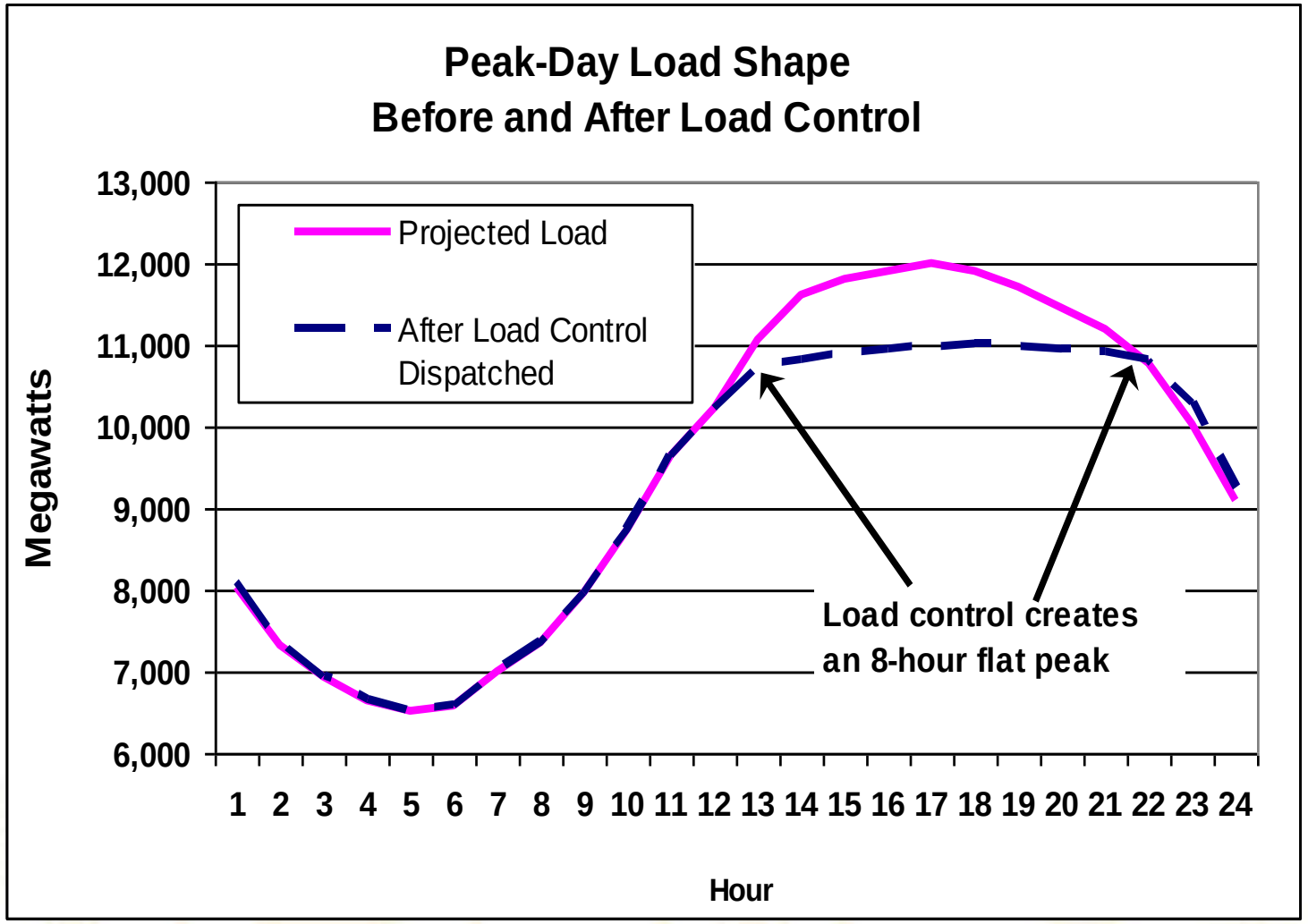
DR Impact on the System Load Can be Nuanced



- Manage pre-event load to get more during event
- Manage post-event snapback to avoid new peak
- Smooth out load reduction to give steady MW that operators can count on
- Monitor indoor temperatures (for HVAC loads) to ensure customer comfort

Source: Navigant

Optimizing Multiple DR Resources Maximizes System Peak Reduction



- Smooth load shape during control event
- Like a bull pen, different loads can be called when needed
- Its all about the load impact, not what is controlled

Source: Navigant

Demand Response Evolution

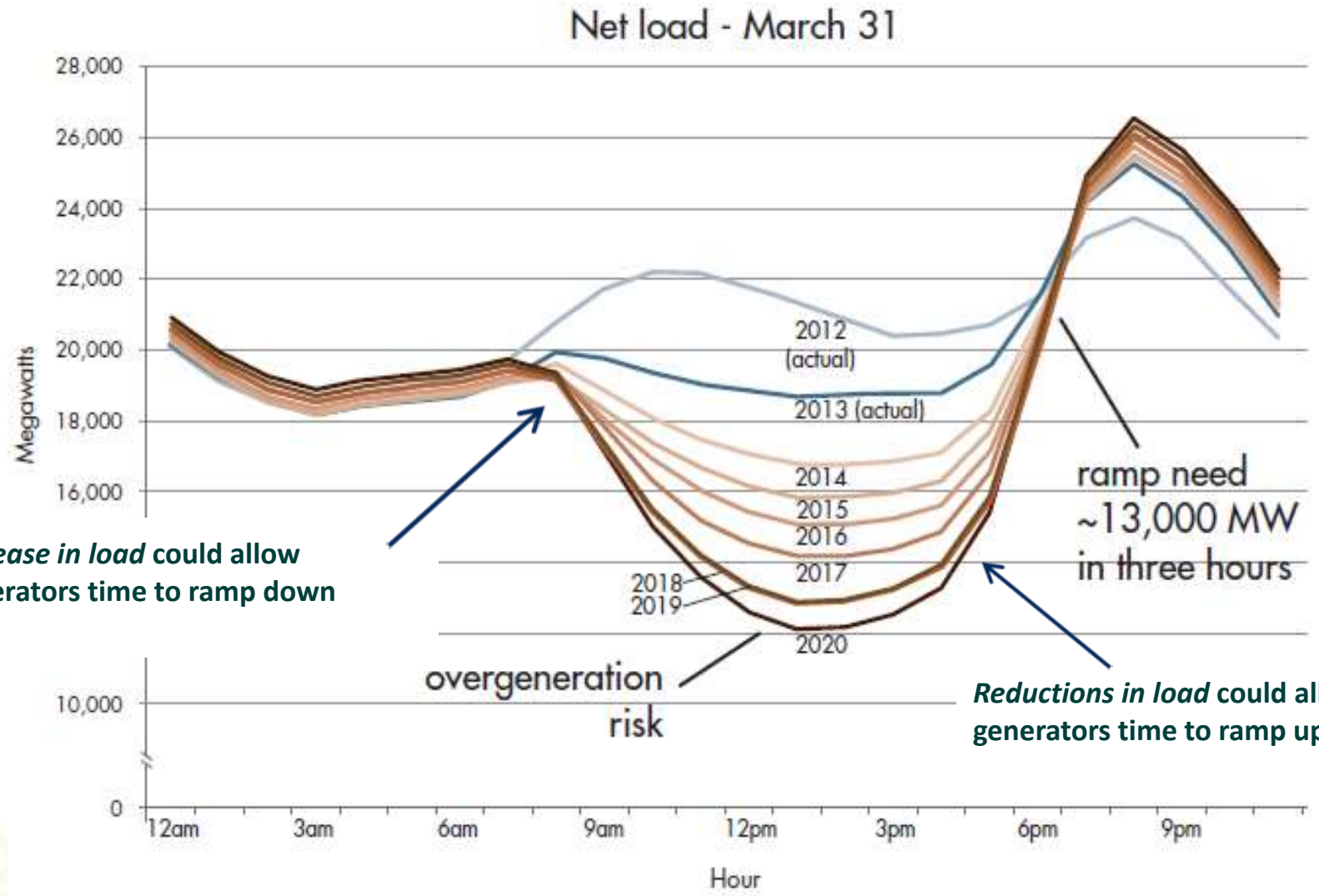
Demand Response Evolution

- Largely manual control
- Interruptible tariffs for large C&I
- 1-way Direct Load Control for Residential
- Used for Capacity Planning & Emergencies

- Introduced To Wholesale Markets
- Increased automation
- Increased Precision
- Eventually Ancillary Services
- Behavioral/voluntary Options
- Smarter Equipment
- 2-way communications
- Some Near Real-Time Visibility

- Provide Multiple Grid Services
- Respond to Controls and/or Price Signals
- Distribution & Transmission Relief
- Introduction of Storage
- Migration to DER

Renewables Growth Creates DR Opportunities

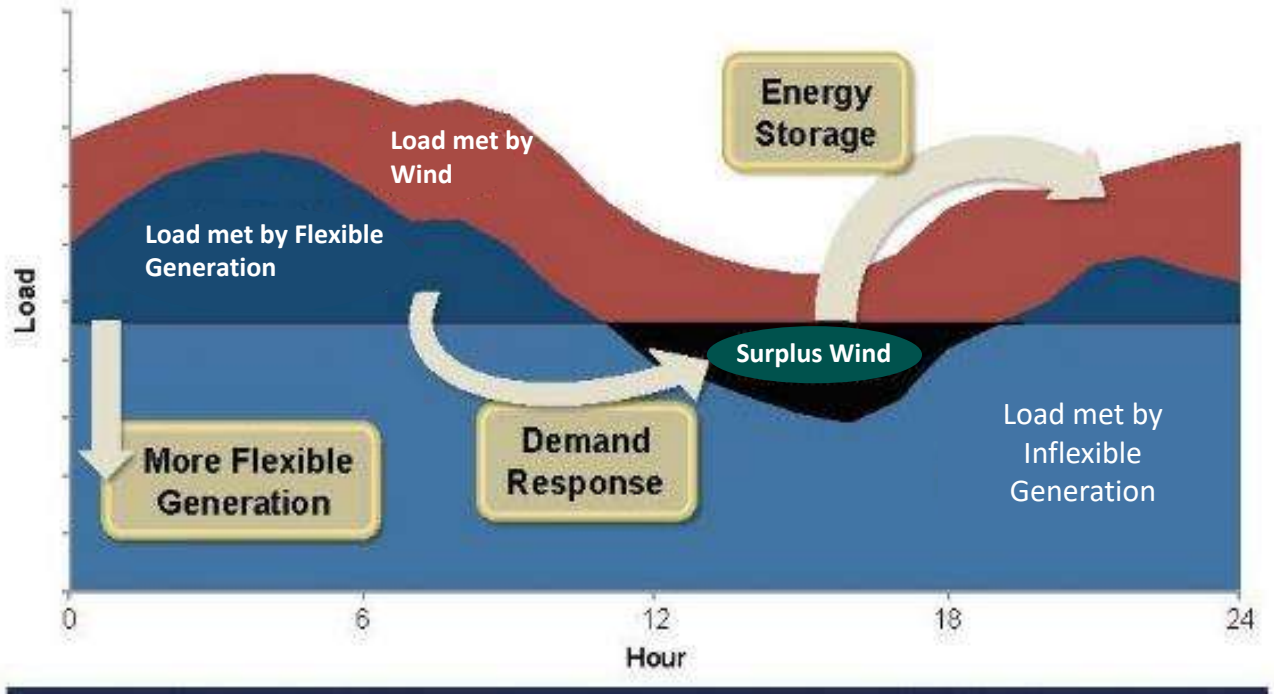


Increase in load **could allow generators time to ramp down**

Reductions in load **could allow generators time to ramp up**

Source: California Independent System Operator

DR, Storage and Renewables Integration



This figure also shows how more flexible generation could accommodate increased RE penetration and can provide an alternative or supplement to DR and storage.

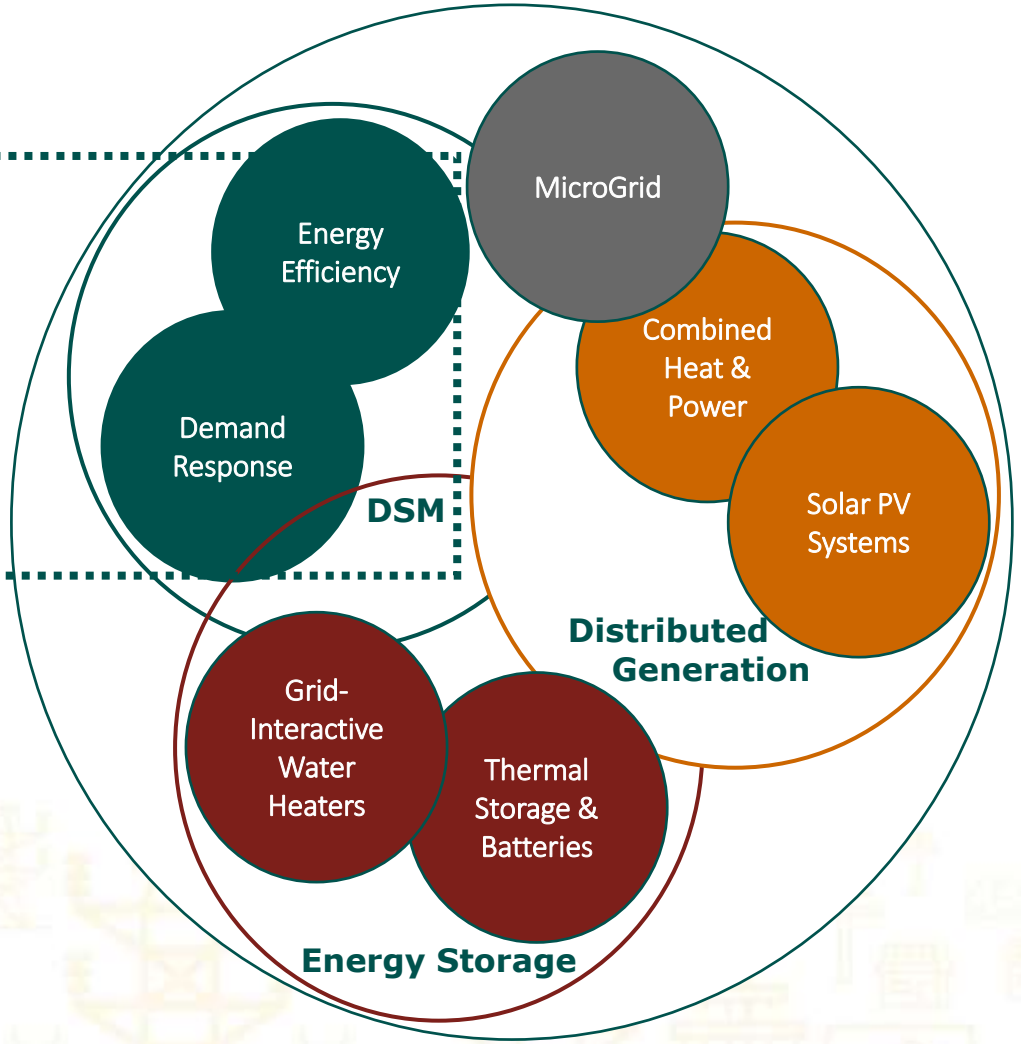
Demand response and energy storage are sources of power system flexibility that increase the alignment between renewable energy generation and demand.

- ***Demand Response*** provides a means to shift demand to times of relatively high wind generation and low load
- ***Storage Technologies*** can store excess wind generation for use in times of relatively low wind generation and high load

Source: GreeningtheGrid.org/ National Renewable Energy Laboratory Sept. 2015

DR is Part of Integrated Demand Side Management (IDSM)

A program design type that delivers the benefits of EE to customers and DR to the grid using the same technology intervention and/or a linked incentive while leveraging the same program delivery resources and infrastructure.



Thought Leadership

Thought Leadership Group
published 5 industry reports
and produced 30 webcasts
with over 5,000 registrant

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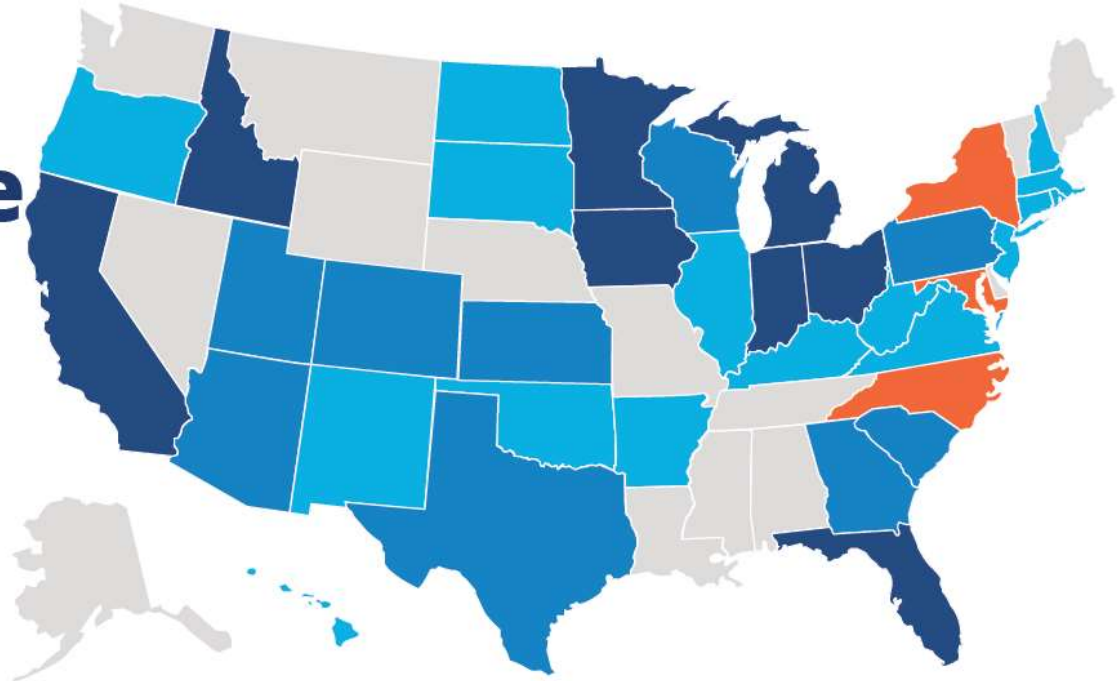
Smart Electric Power Alliance

2017 Utility Demand Response Market Snapshot

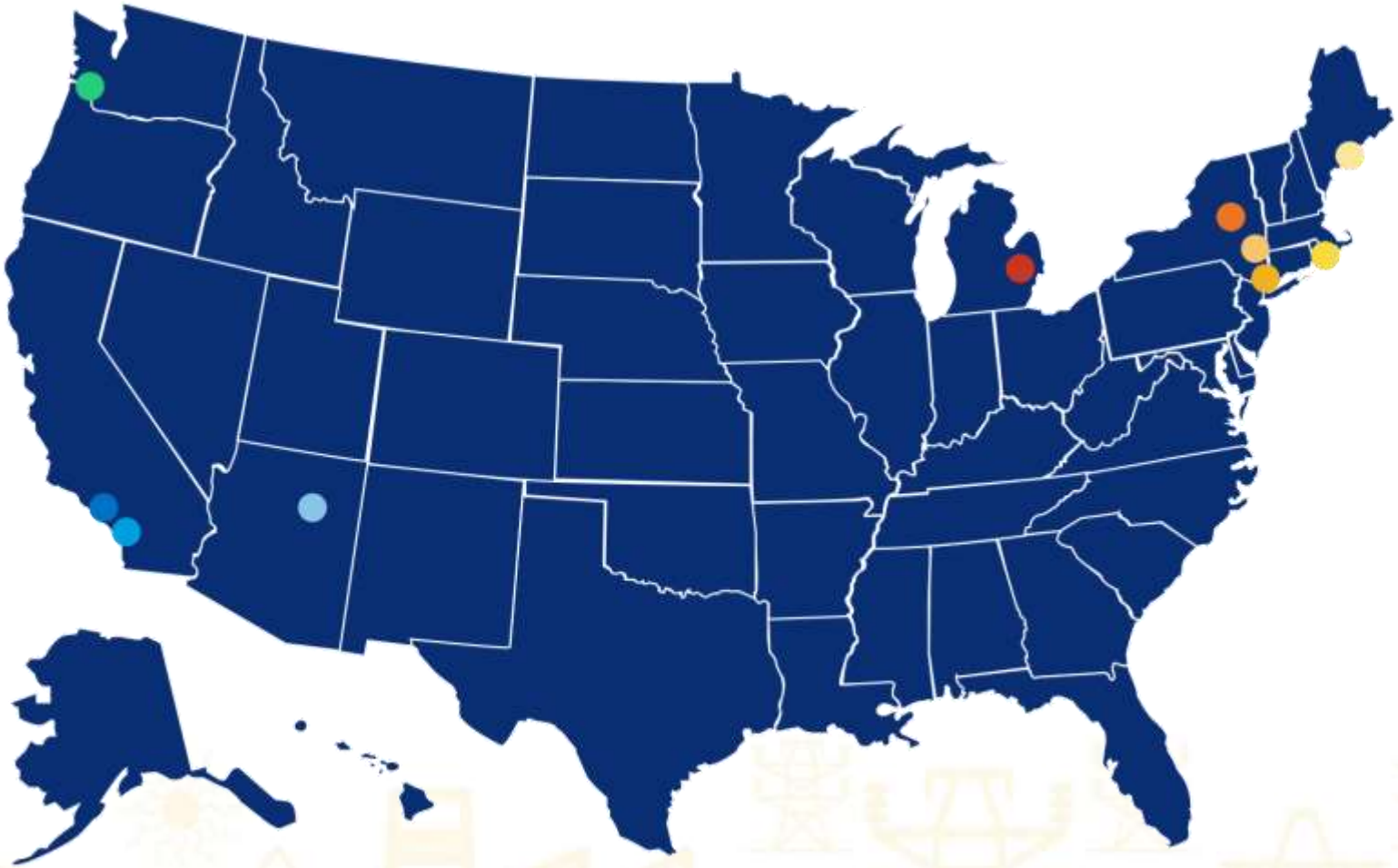


IN PARTNERSHIP WITH

NAVIGANT

OCTOBER 2017

Featured Case Studies



- **BPA—SOUTH OF ALLSTON**
  ALLSTON, WA
- **SCE—VIRTUAL POWER PLANT**
  LOS ANGELES, CA
- **SCE—DESI 1**
  ORANGE, CA
- **APS—PUNKIN CENTER**
  PUNKIN CENTER, AZ
- **CONSUMERS ENERGY—SWARTZ CREEK ENERGY SAVERS**
  SWARTZ CREEK, MI
- **NATIONAL GRID—OLD FORGE**
  OLD FORGE, NY
- **CENTRAL HUDSON GAS & ELECTRIC—PEAK PERKS PROGRAM**
  MID-HUDSON RIVER, NY
- **CON ED—BROOKLYN QUEENS DEMAND MANAGEMENT**
  BROOKLYN, NY
- **NATIONAL GRID—TIVERTON NWA PILOT**
  TIVERTON/LITTLE COMPTON, RI
- **GRIDSOLAR—BOOTHBAY PILOT**
  BOOTHBAY PENINSULA, ME

Source: SEPA, PLMA, and E4TheFuture, 2018.

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Learn more at www.peakload.org

Demand Response Fundamentals, Evolution, and Industry Trends

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