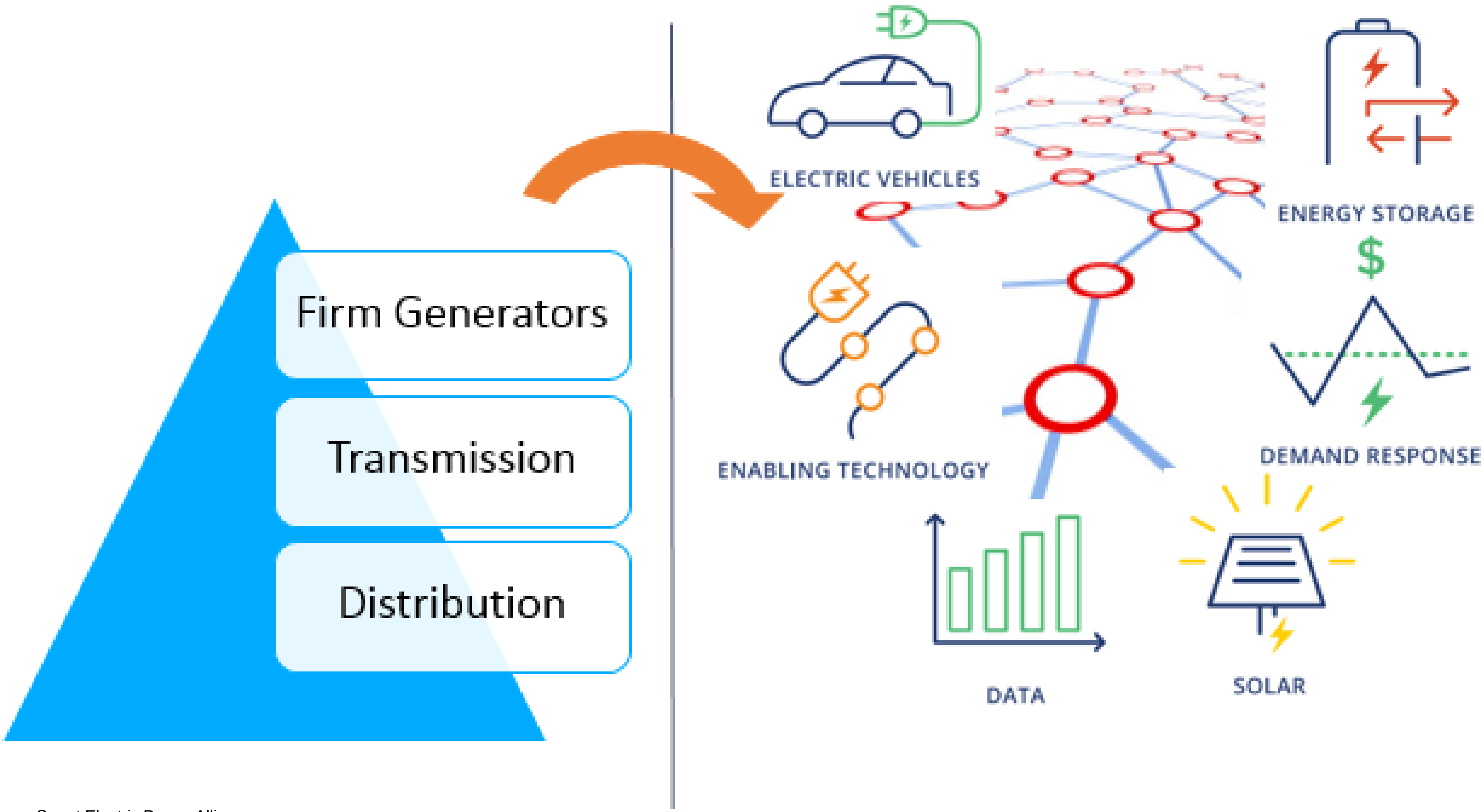
EE and DR as a DER

National Symposium on Market Transformation, April 3, 2017

Vazken Kassakhian, SEPA Research Analyst

Smart Electric Power Alliance

Context of Changes & Challenges in Sector



Source: Smart Electric Power Alliance

DER Capabilities - 1

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TABLE 1: ENERGY AND GRID RELATED CAPABILITIES THAT CAN BE PROVIDED BY DERS

IMPACT	DER CAPABILITIES / SERVICES	KEY FUNCTION	EXISTING COMPETITIVE MECHANISMS AND PRODUCTS
BULK LEVEL IMPACT	Energy production	What mix of resources can produce electricity at lowest cost?	▪ Bilateral contracts ▪ ISO Day-Ahead Auctions ▪ ISO Real-Time Auctions
	Generation Capacity	Is the system able to meet extreme[32] peak demand levels?	▪ ISO capacity markets ▪ Utility Tariffs
	Frequency regulation / Load following / Balancing	Can the bulk system respond quickly enough to balance supply and demand?	▪ Regulation ▪ Utility OATTs[33]
	Spinning reserve / Non-spinning reserve	Does the grid have the ability to withstand system shocks (e.g. forced outages and unforecasted changes in loads)?	▪ 10 Minute Spinning Reserve ▪ 10 Minute Non-Synchronous Reserve ▪ 30 Minute Operating Reserve[34]
LOCATIONAL IMPACT	Locational (T&D) Capacity	Is the distribution system able to accommodate local peak loads?	▪ Utility program tariffs RFI/RFP's
	Voltage regulation	Are voltage levels stable and reliable? Can line losses be reduced?	▪ No market ▪ Some tariffs

Source: Nexant & SEPA

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

DER Capabilities - 2

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TECHNOLOGIES	ENERGY	GENERATING CAPACITY	DISTRIBUTION CAPACITY	VOLTAGE REGULATION	FREQUENCY REGULATION	LOAD FOLLOWING	BALANCING	SPINNING RESERVES	NON-SPINNING RESERVES	BLACKSTART
DISTRIBUTED SOLAR	Energy Generator	◑	◑	●	●	●	●	No	No	No
DISTRIBUTED SOLAR + ADVANCED INVERTER FUNCTIONALITY	Energy Generator	◑	◑	◉	◉	◑	●	No	No	No
BATTERY STORAGE	Energy Storage	◉	◉	◉	◉	◉	◉	Yes	Yes	Yes
INTERRUPTIBLE LOAD	Load Shaping	◐	●	●	●	●	◉	Yes	Yes	No
DIRECT LOAD CONTROL	Load Shaping	◐	◐	●	◐	◉	◉	Yes	Yes	No
BEHAVIORAL LOAD SHAPING	Load Shaping	◑	◑	●	●	◑	◑	No	No	No
ENERGY EFFICIENCY	Reduce Load	◐	◑	●	●	●	●	No	No	No

● Unsuitable for reliably performing the specified service.

◑ May be able to perform a service, but is not well suited or can provide partial support.

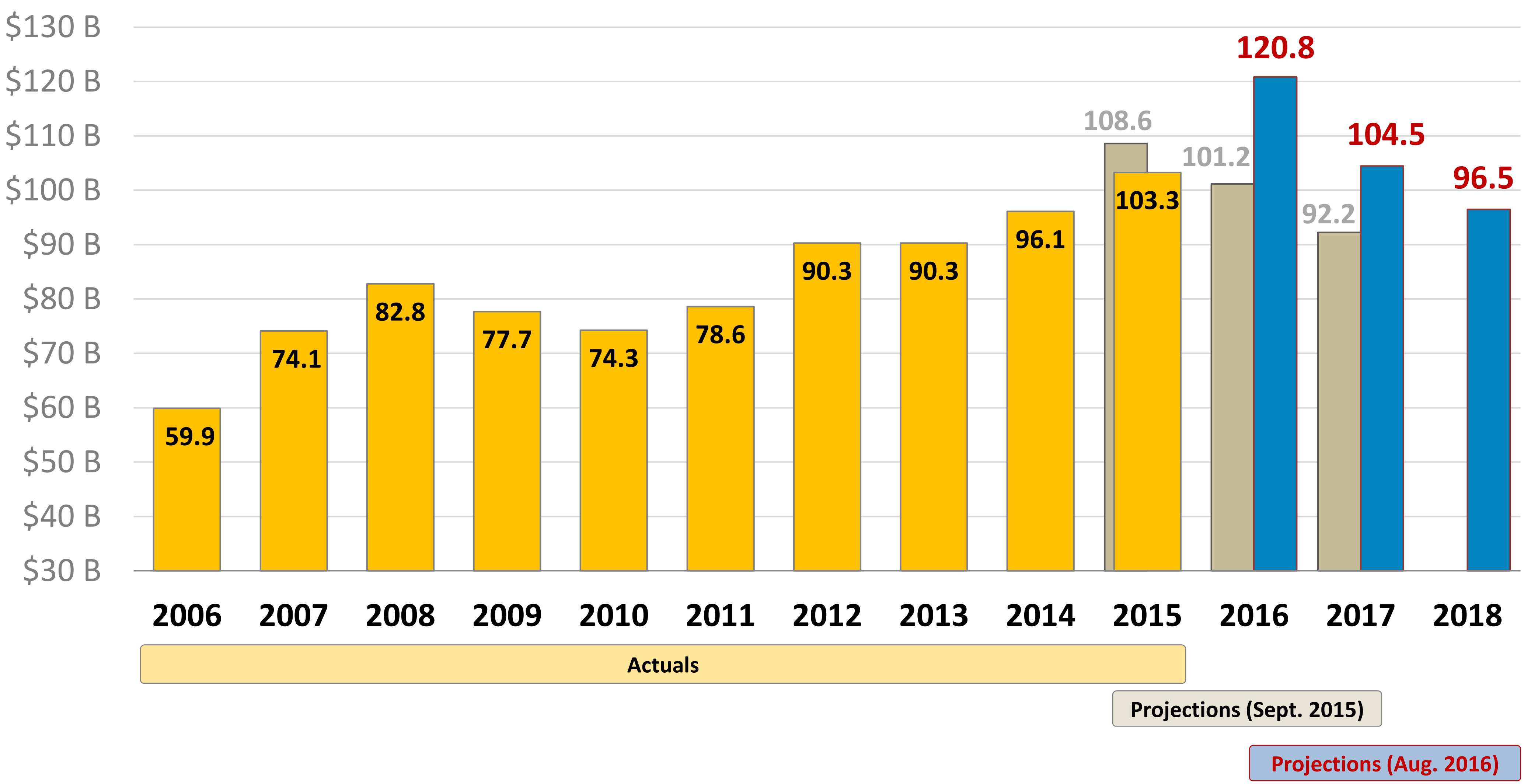
◐ Able to perform a service, but may be limited by factors such as availability or customer behavior.

◉ Well suited to perform a service; may exceed legacy technologies for providing the service.

Source: Smart Electric Power Alliance, Beyond the Meter | Distributed Energy Resources Capabilities Guide, 2016
https://sepa.force.com/CPBase__item?id=a12o000000SjefkAAB

Electric Power Industry Capital Expenditures

Smart Electric Power Alliance



Source: EEI Finance Department, company reports, S&P Global Market Intelligence (August 2016).

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Projected Functional CapEx

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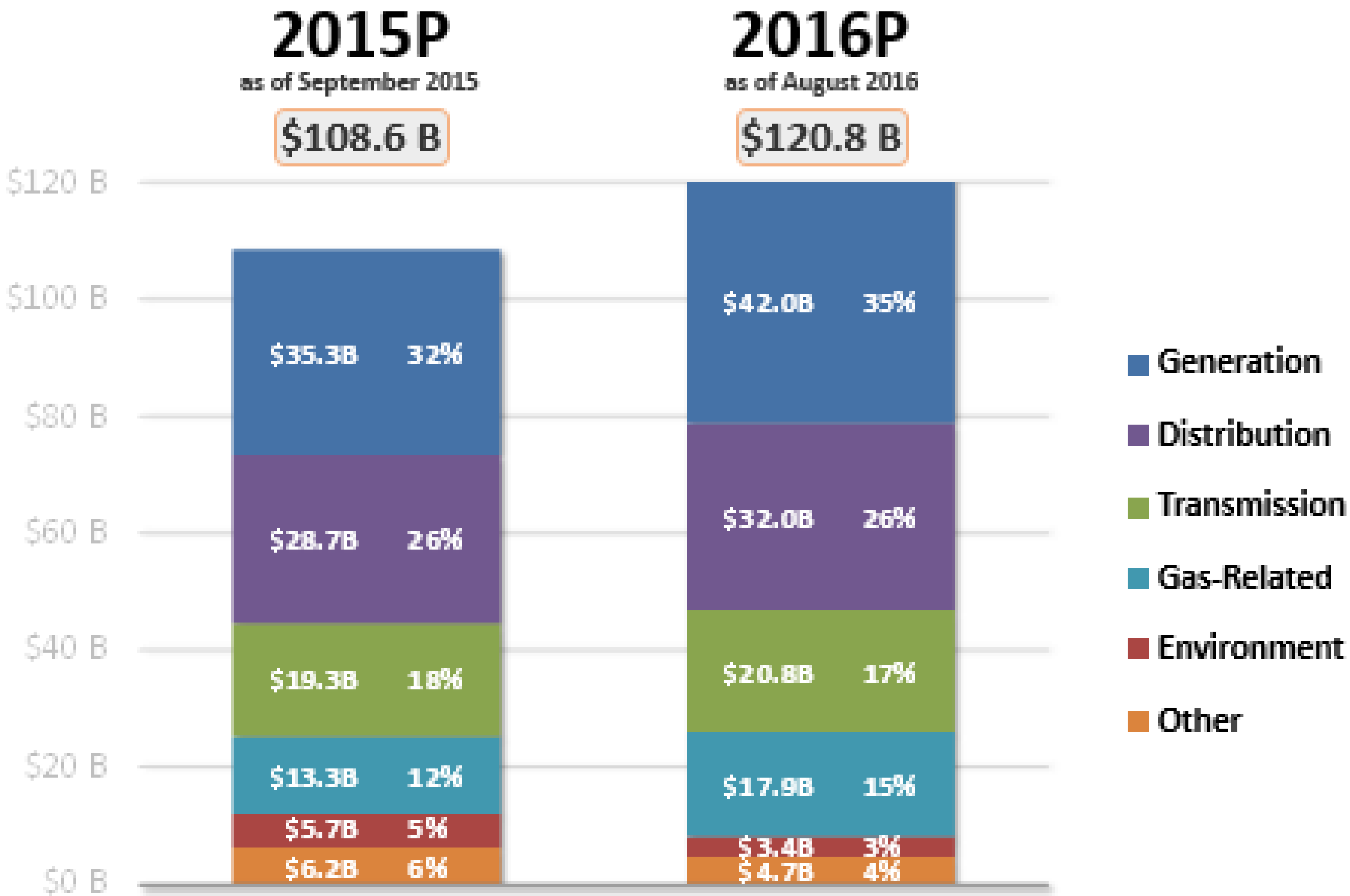

Source: EEI Finance Department, company reports , S&P Global Market Intelligence (August 2016).

Distribution Capacity Investments

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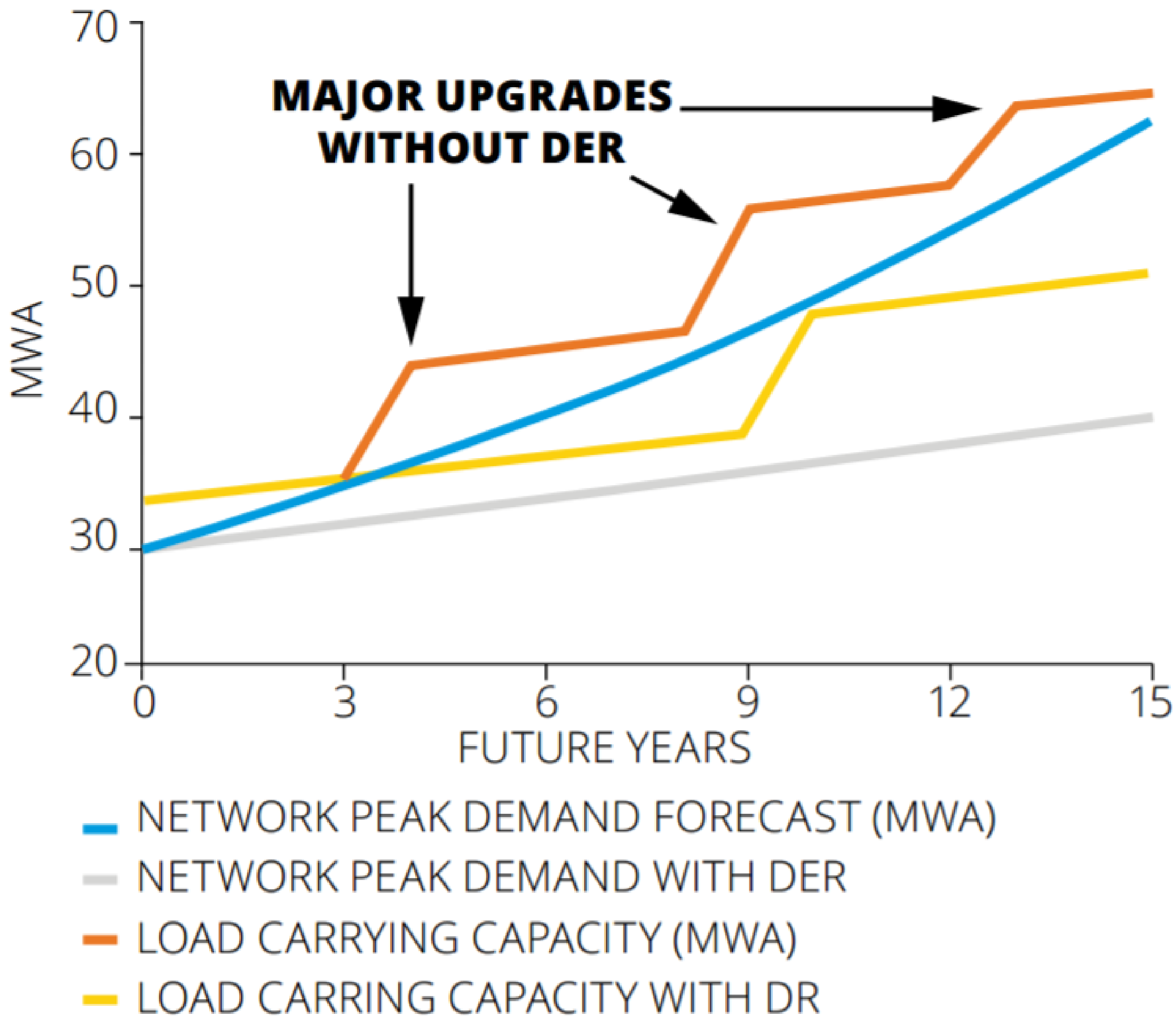
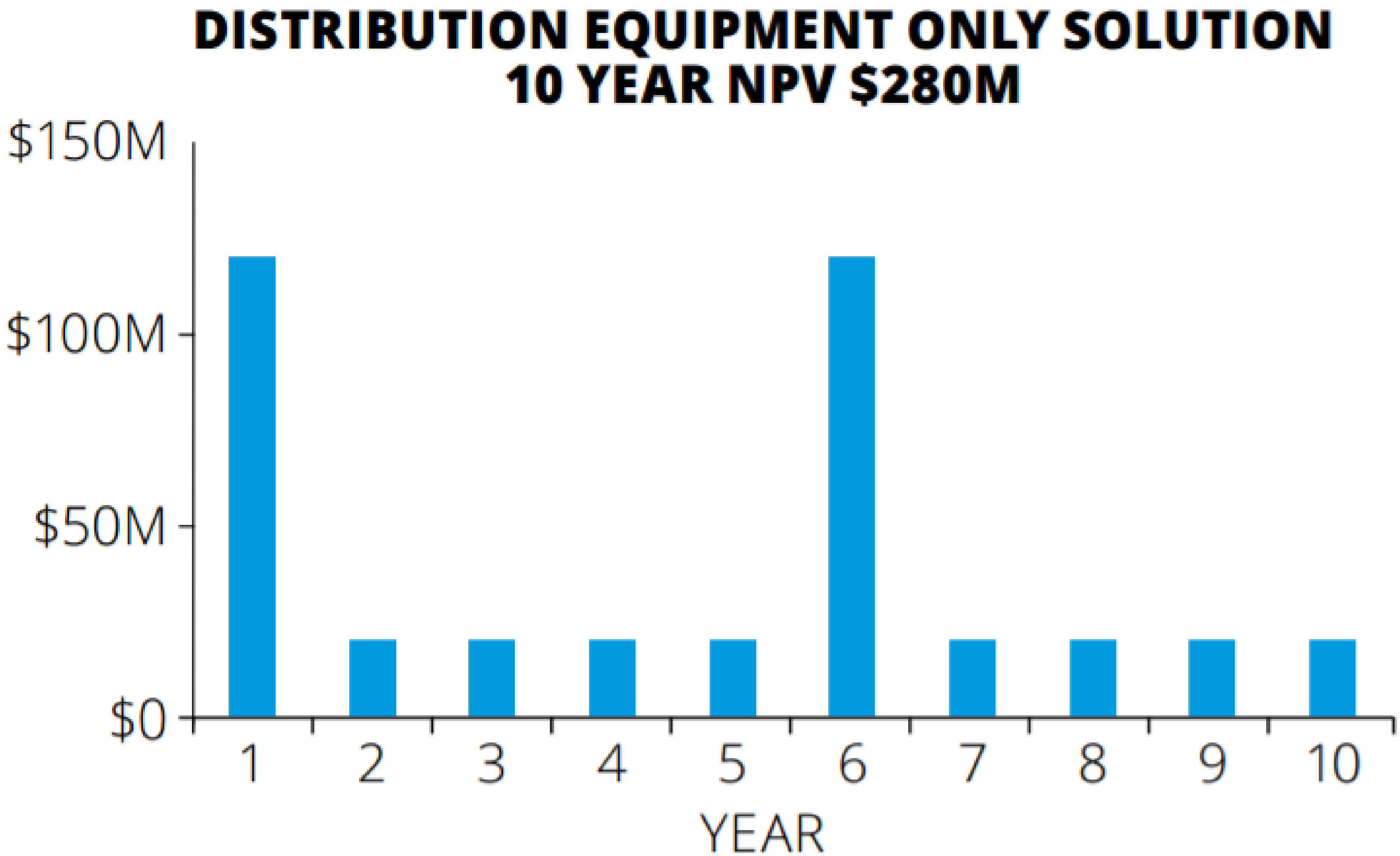


Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

Effect of DER on Expenditures - 1



Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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Effect of DER on Expenditures - 2

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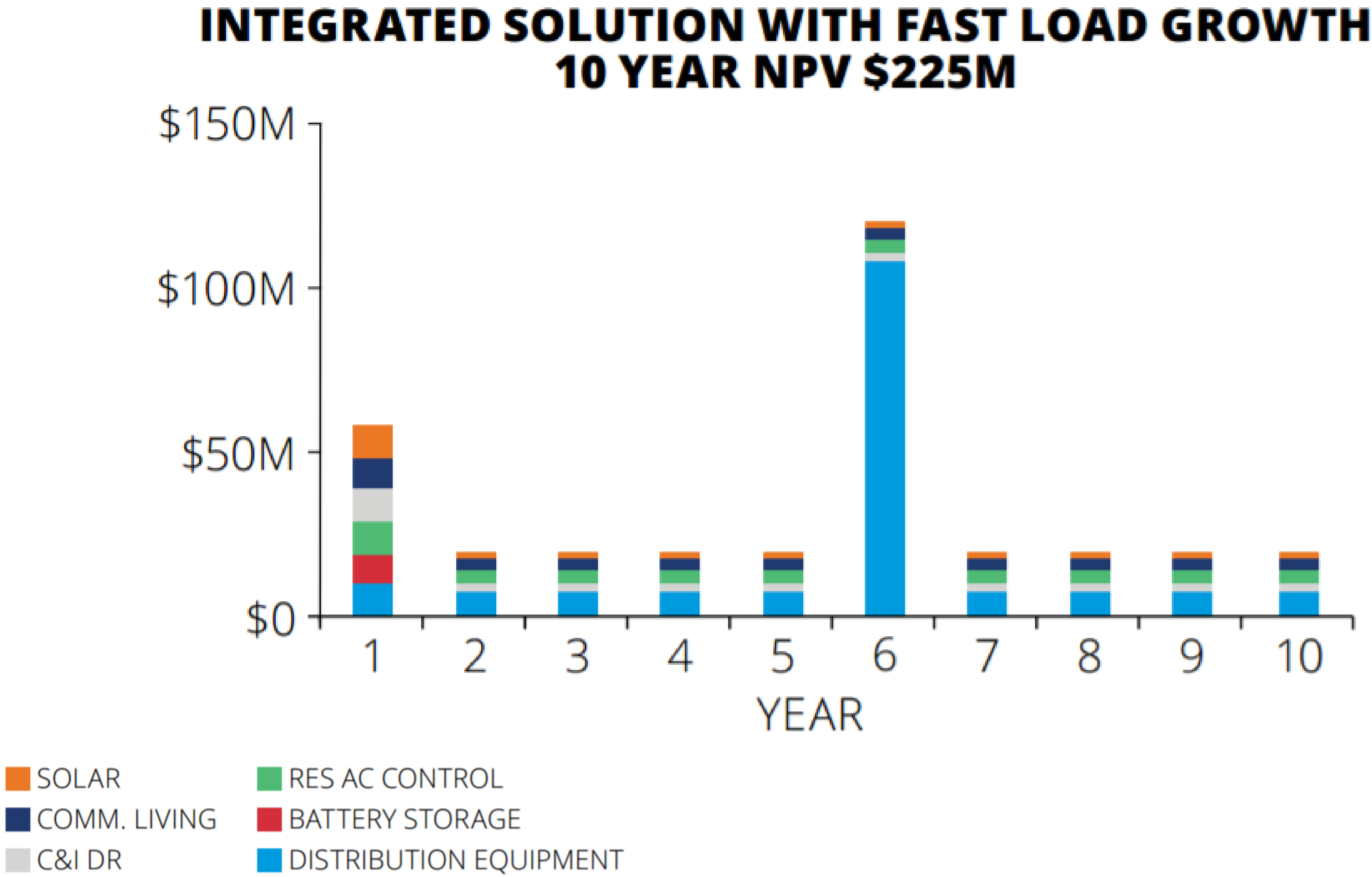

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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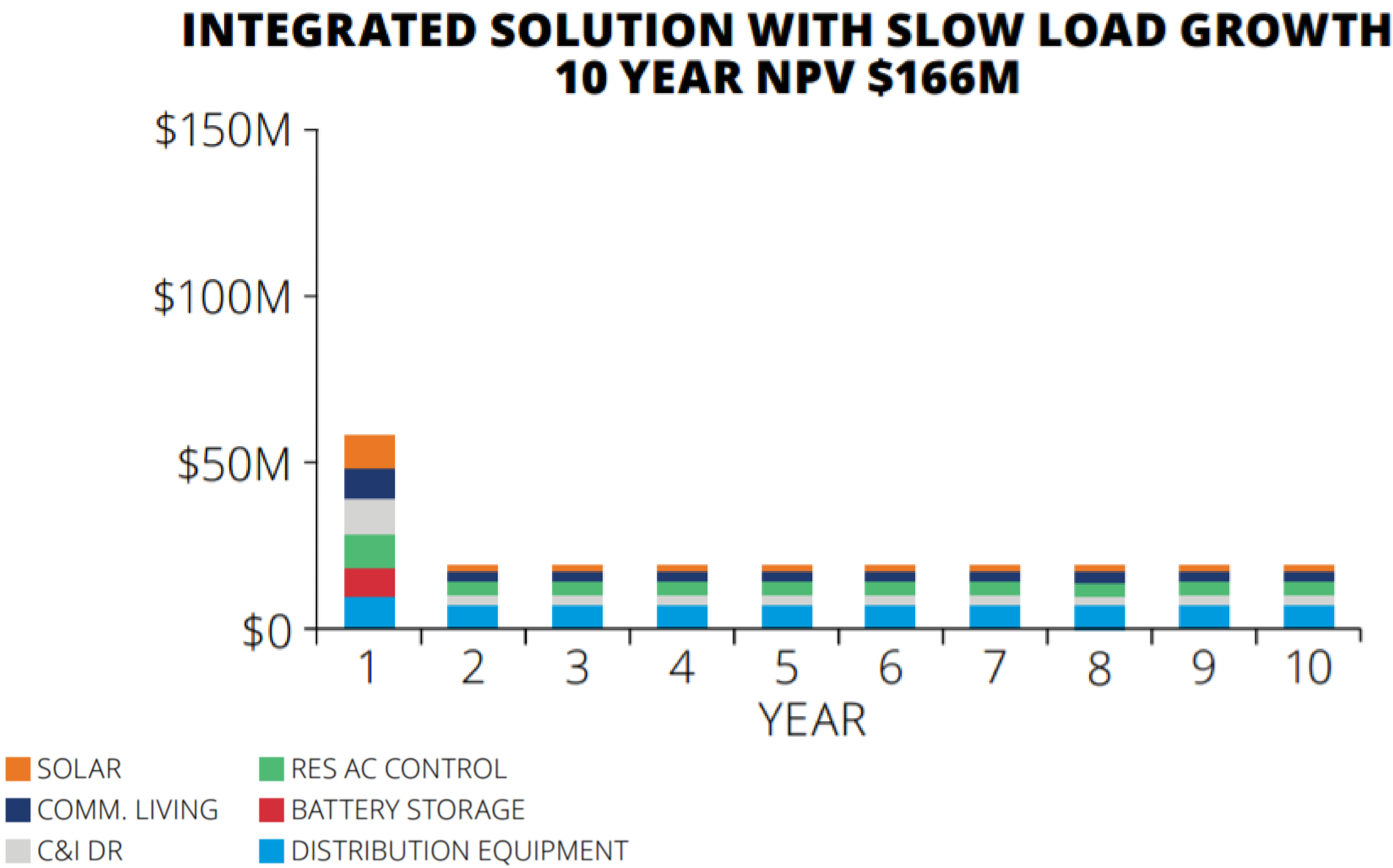
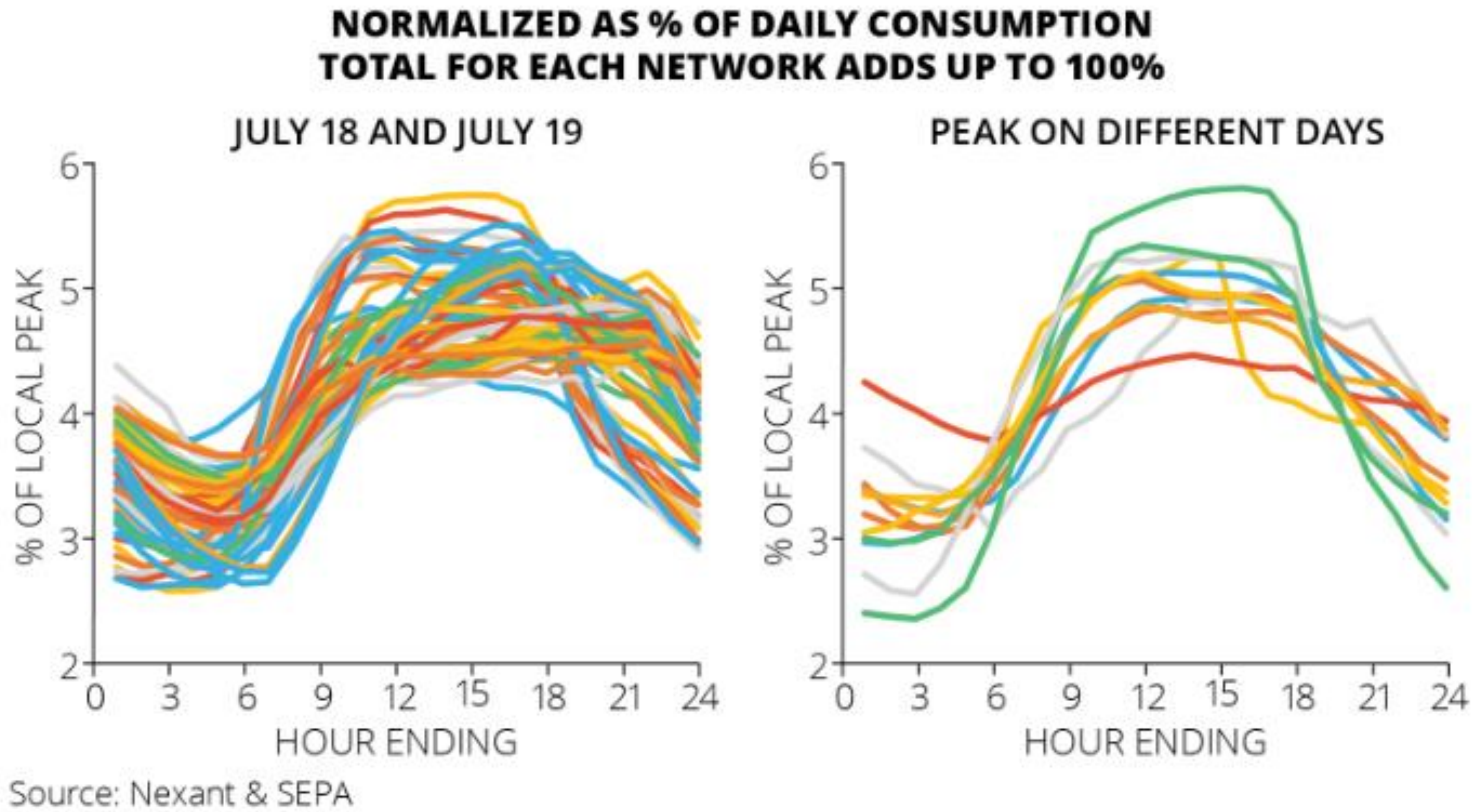
Effect of DER on Expenditures - 3



Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

Local Peaks Vary



Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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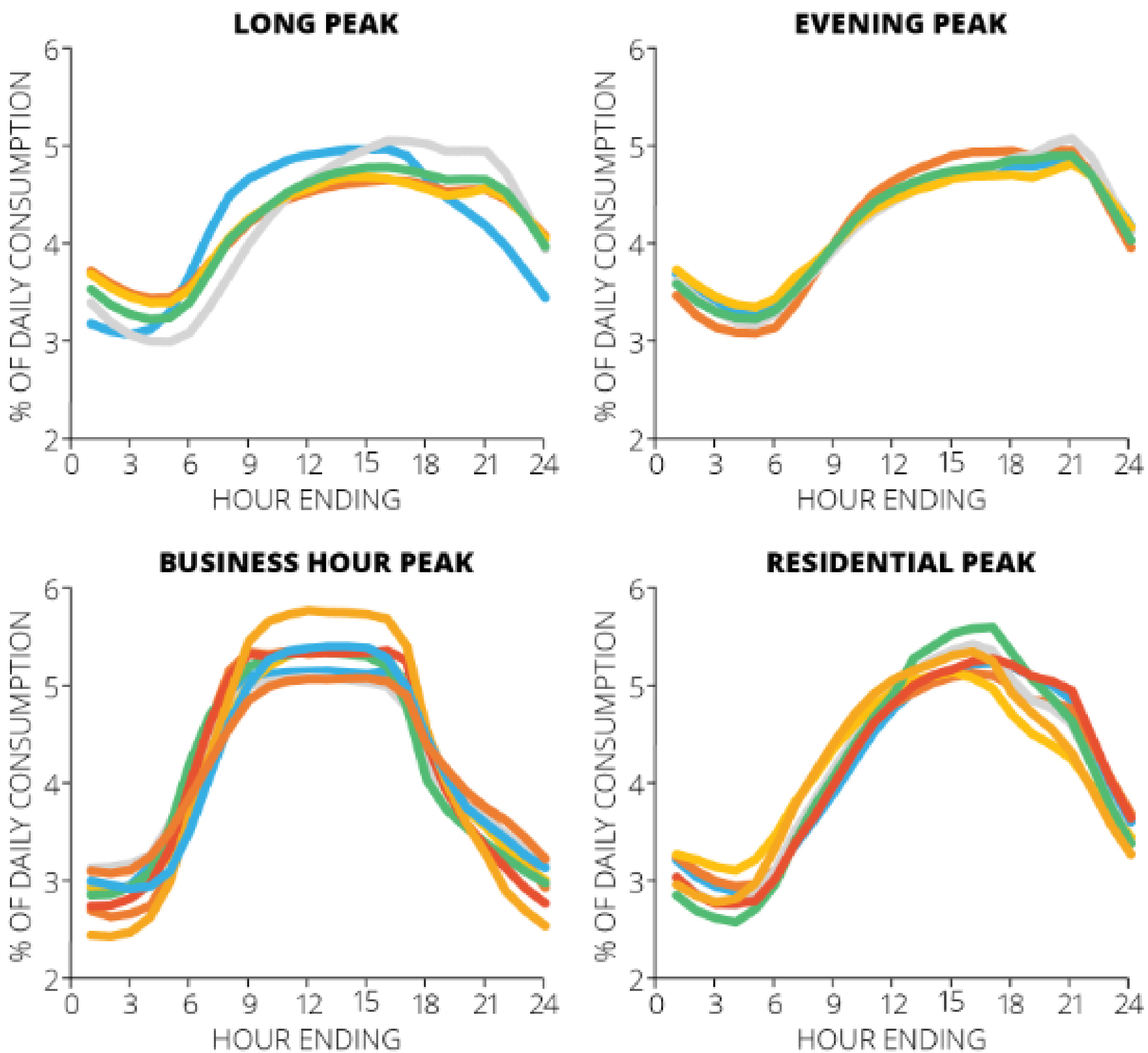
Local Areas by Peak Load Shape



Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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Right DER, Right Location, Right Time

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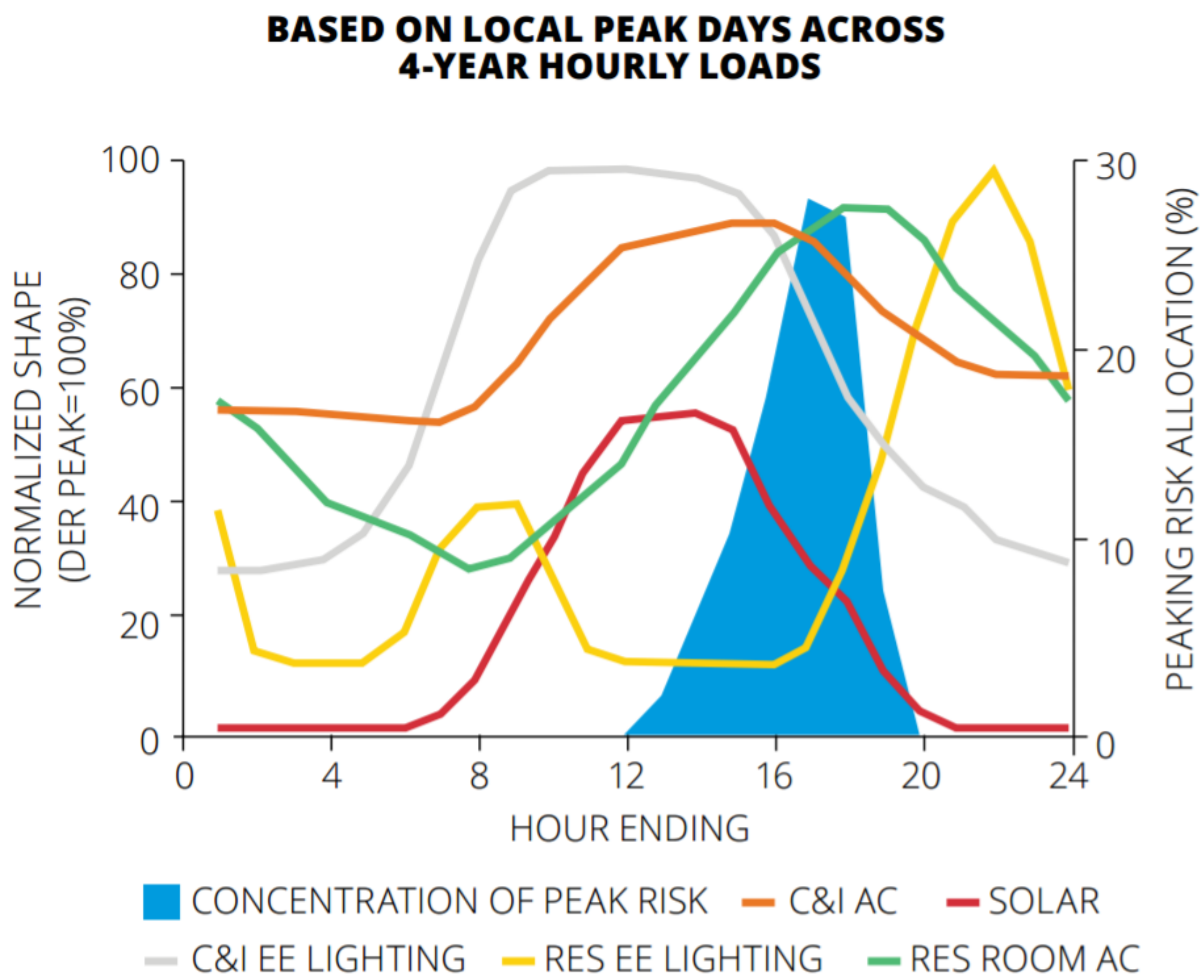

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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DER Constraints on Dispatch

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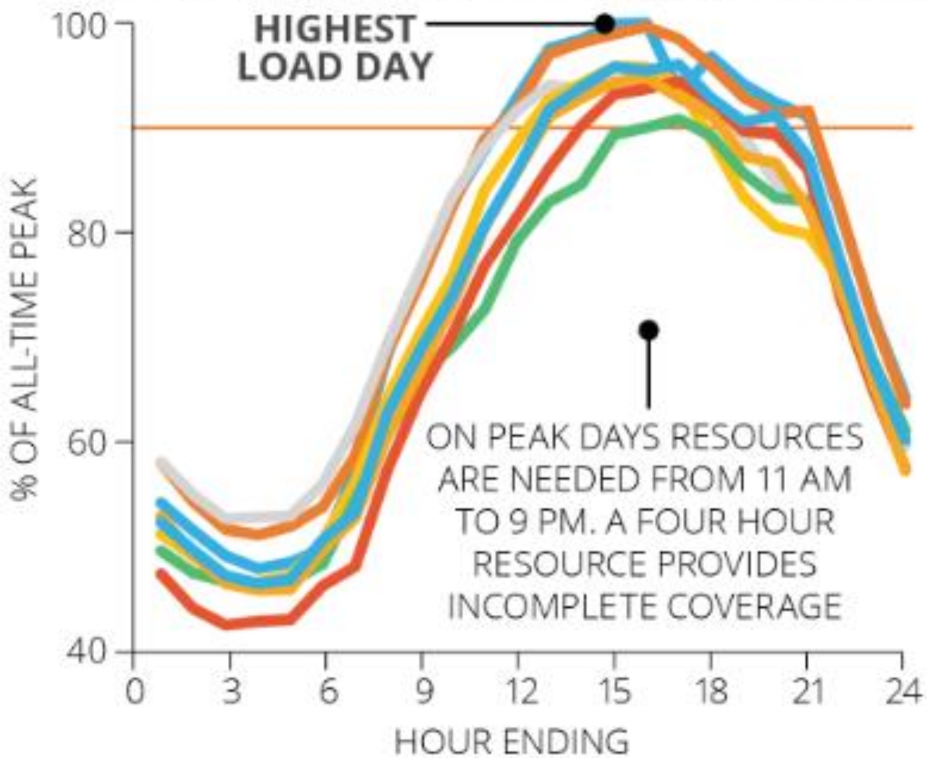
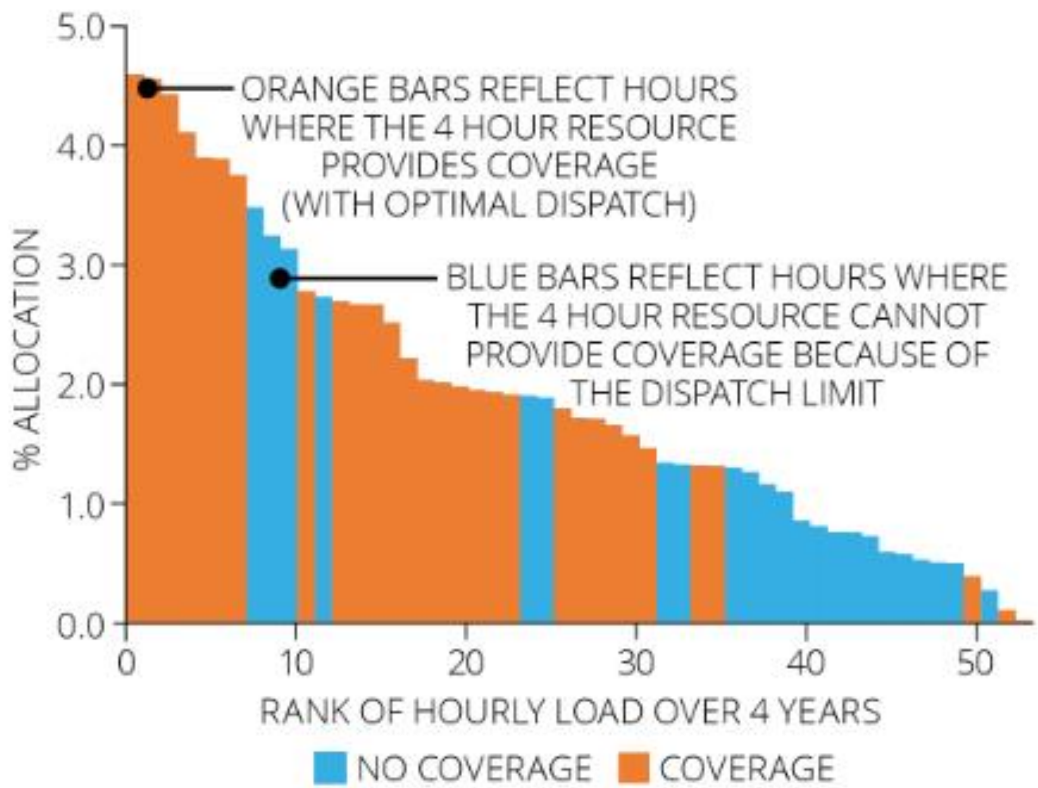
HOURLY LOADS ON DAYS SURPASSING CUTOFF



ALLOCATION OF MWh OVER 90% OF ALL TIME PEAK



Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
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Operating Constraints on Locational Value

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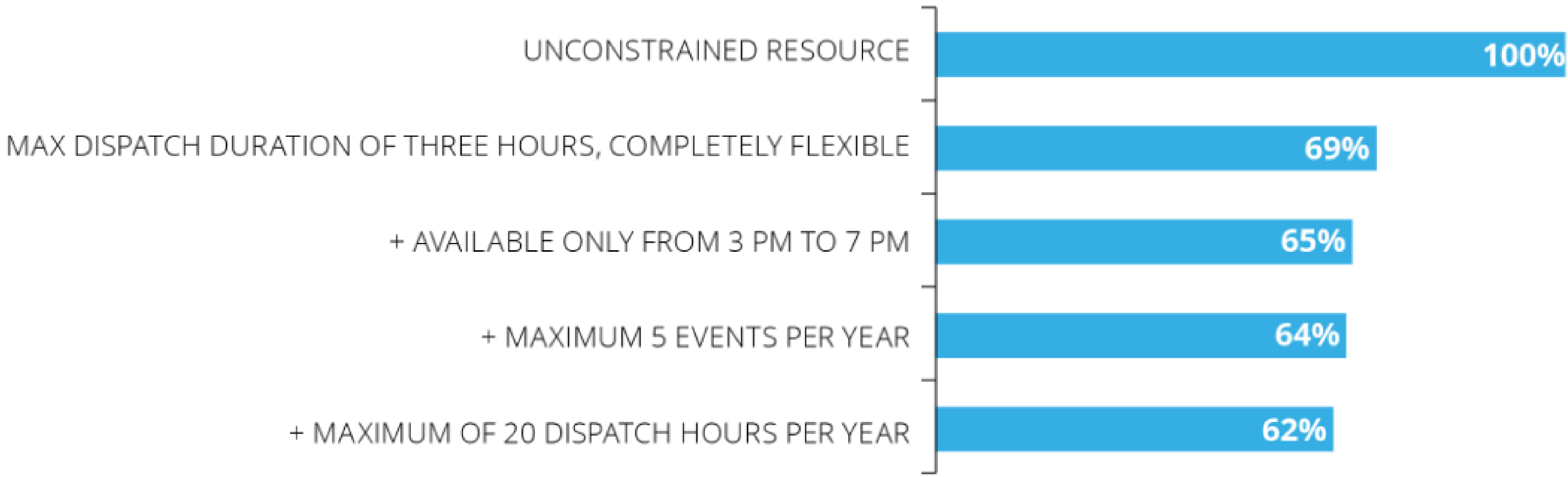

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

DER Constraints

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TABLE 2: SUMMARY OF DER CHARACTERISTICS THAT CAN LIMIT THEIR ABILITY TO DELIVER PEAK LOAD REDUCTION

KEY QUESTION	CONSTRAINT	DEFINITION
Is the DER tied to a specific load shape?	Load profile	Structural shape of load reductions deliverable by a resource. For example, energy efficiency will deliver loads aligned with underlying consumption patterns (e.g., lighting or HVAC); solar PV will deliver loads varying by time of day, peaking in early afternoon; batteries of fuel based generation have no such limits.
	Seasonal availability	Availability year round versus summer only.
Is the resource flexible?	Availability window (start and end hours)	Hours of the day during which the resource is available. May be longer than the duration category. If duration category is shorter than the availability window, optimal window is used (e.g., the window with the most peak load).
	Ramp speed	Length of time it takes for resource to achieve maximum load reduction.
	Dispatch delay	Advance notice which must be given for resource to be dispatched.
Are there specific operating constraints?	Dispatch duration	Maximum number of consecutive hours during which a resource is able to deliver load reduction. May be limited by technology constraints (battery discharge time) or program limits (demand response event window).
	Max dispatch hours per year	Limit to total number of dispatchable hours in a year.
	Max events per year	Limit to total number of dispatch events (days) in a year.
	Max consecutive	Limit to total number of consecutive dispatch events (days) in a year.
	Events per year	(Days) in a year.

Source: Nexant & SEPA

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

Criteria for Resource Flexibility

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CRITERIA	EXAMPLE		EXPLANATION AND CAVEATS
Can it be dispatched with different start and end hours?	☑	AC load control	Load control programs can be designed to allow flexible dispatch between a range of hours.
	☒	Solar	Except for curtailment, generation occurs when the sun shines.
Can the magnitude of output be controlled (ramping)?	☑	Adaptive AC load control	If only what is needed is dispatched when it is needed (different amounts in different hours rather than all at once).
	☒	Energy efficiency	Energy efficiency is "always on" and cannot be ramped up or down.
How far ahead must it be scheduled?	☑	Batteries	As long as they are charged ahead of time, batteries can respond almost immediately.
	☒	Day ahead Demand response	DR contracts specify advance notice requirements (can be Day ahead, hours ahead, etc.).

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

SCE Using DER to offset 300 MW of Peak Load

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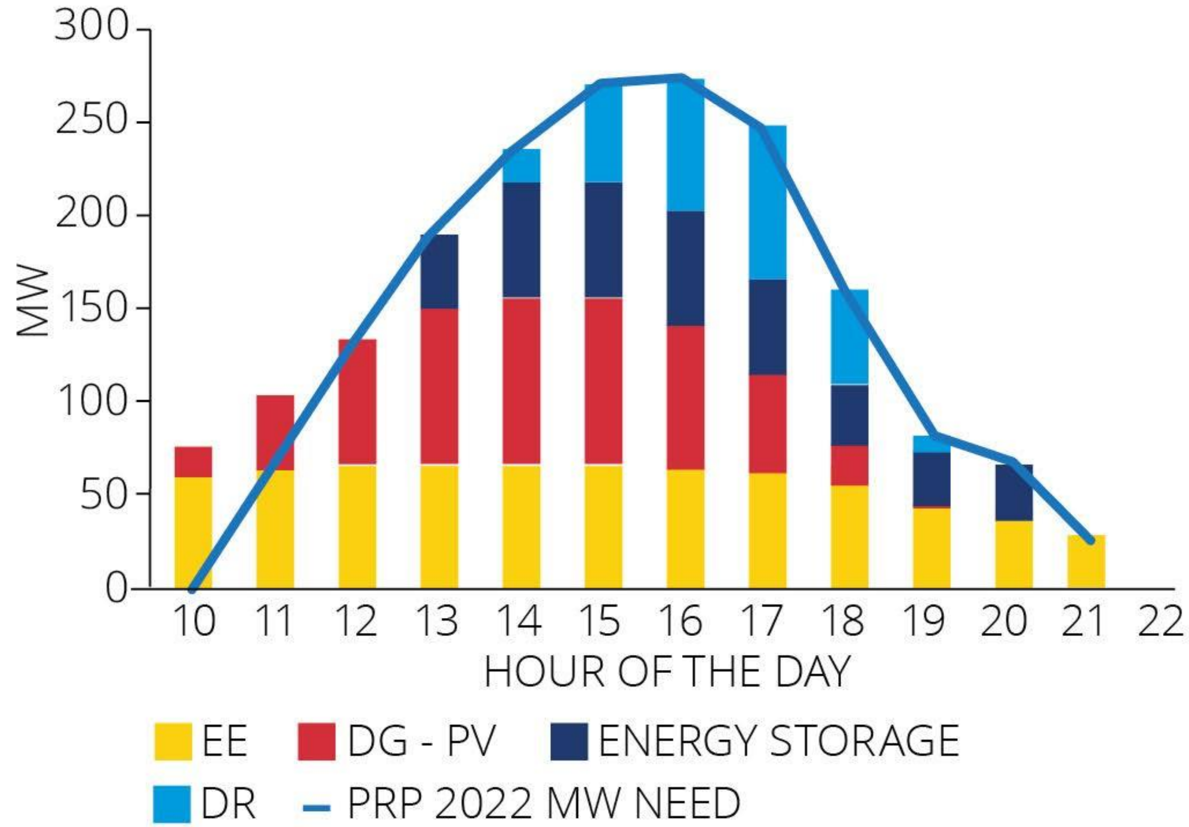
FIGURE 1: EXAMPLE PORTFOLIO OF DER RESOURCES TO OFFSET PEAK LOAD



Source: Southern California Edison, 2016

Source: Smart Electric Power Alliance, Beyond the Meter | The Potential for a New Customer-Grid Dynamic, 2016
https://sepa.force.com/CPBase__item?id=a12o000000QuxopAAB

Key Publications

Beyond the Meter: Addressing the Locational Valuation Challenge for Distributed Energy Resources

URL: https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

Beyond The Meter: The Potential for a New Customer-Grid Dynamic

URL: https://sepa.force.com/CPBase__item?id=a12o000000QuxopAAB

Distributed Energy Resources Capabilities Guide

URL: https://sepa.force.com/CPBase__item?id=a12o000000SjefkAAB

51st State Perspectives | Distributed Energy Resources Integration: Policy, Technical, and Regulatory Perspectives from New York and California

URL: https://sepa.force.com/CPBase__item?id=a12o000000Vd348AAB

Contact Me

Vazken Kassakhian

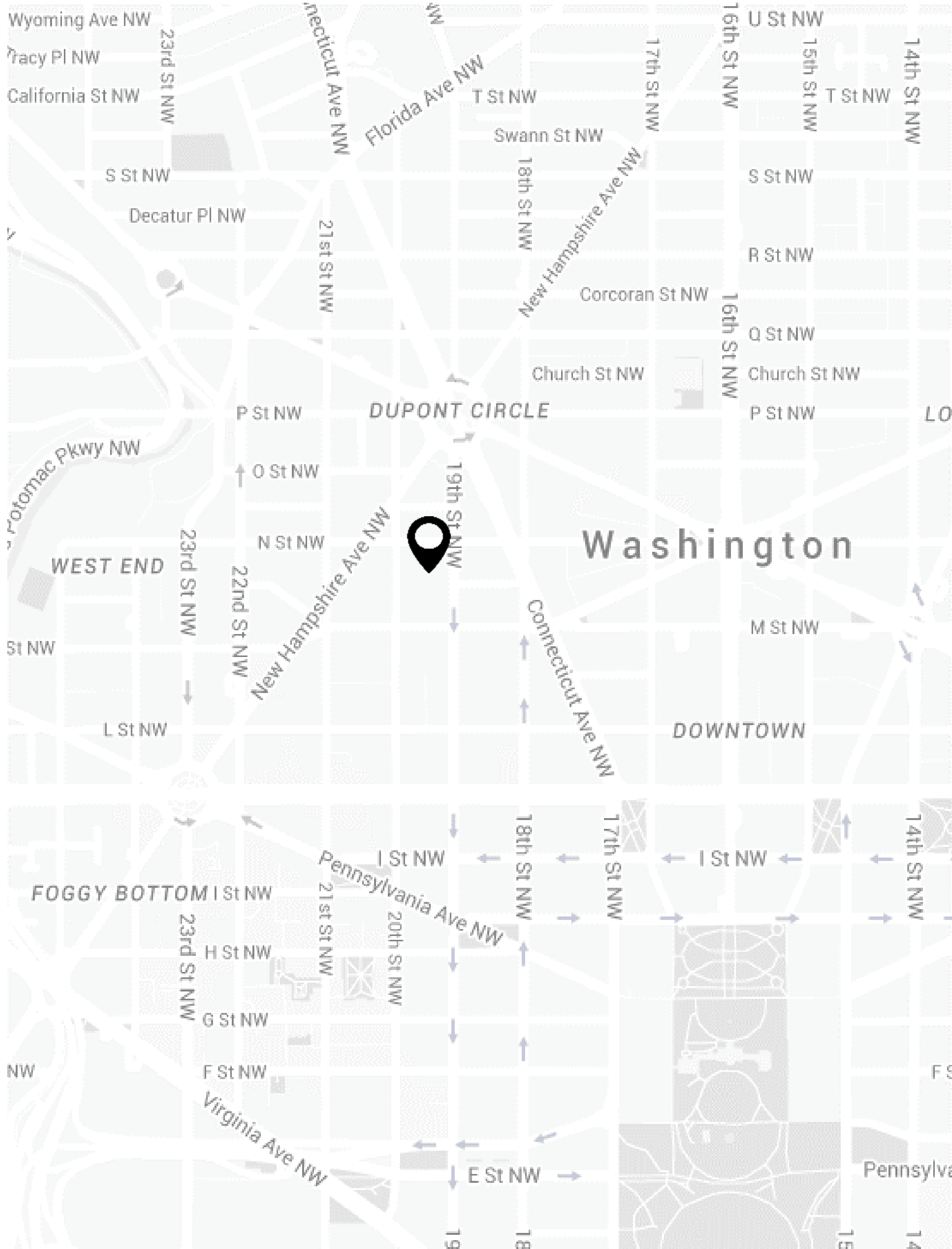
Research Analyst

vkassakhian@sepapower.org

Smart Electric Power Alliance

1220 19th St NW, Suite 800

Washington, DC 20036

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About SEPA

Smart Electric Power Alliance

SEPA's mission is to facilitate the utility industry's smart transition to a clean energy future through education, research, and collaboration.

COMMUNITY

Members, Events, USC, Fact Finding Missions, Partnership Opportunities, Power Player Awards

DATA

USD, Solar Calculators, Mapping Tools, Research Reports, Project and RFP News, Custom Research Solutions

INSIGHTS

Advisory Services, Webinars, Workshops, Case Studies, SEPA Publications, Blog, Expert Commentary

Cost Tests Summary

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Name	Perspective	Description
Total Resource Cost (TRC)	Utility + Participant	Combines the costs and benefits of the program administrator (usually the utility) and the participants
Program Administrator Cost (PAC)	Utility	Includes costs and benefits experienced by the program administrator (usually the utility)
Ratepayer Impact Measure (RIM)	Impact on rates	Includes all PAC costs and benefits, plus changes in revenues
Participant Test (PCT)	Participant	Includes costs and benefits experienced by the participants
Societal Cost Test (SCT)	Society	Includes all TRC costs and benefits, plus several environmental benefits and a lower discount rate

Source: CA Standard Practice Manual & Navigant

CA: Myriad of tests for DERs

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Resource	Specific Program	Use of SPM Test	Non-energy impacts (NEIs) included
Energy Efficiency (EE)	Core programs	Funding approval	Not included*
	Energy Services Assistance Program (Low Income EE)	Funding approval, measure add -back	Cost-effectiveness tests designed specifically for this program include specific participant and utility NEIs. **Does not include societal NEIs.**
	Water/Energy	Incorporated into EE tests	Includes estimates of the avoided environmental costs of water that accrue to water users.
Demand Response (DR)	All DR programs, including Permanent Load Shifting	Funding approval	**Includes social NEIs in the TRC**, utility NEIs in the TRC, PAC and RIM, and participant NEIs in the PT. Quantification of NEIs is optional, but utilities are required to provide a qualitative analysis.
Customer Generation**	Self-Generation Incentive Program (SGIP)	Evaluation study, tech eligibility	**2015 study included a "Social TRC," with a lower discount rate.** D.16-06-055 adopts the "STRC" as "soft" criteria in screening technologies for SGIP eligibility.[30]
	California Solar Initiative (CSI)	Evaluation study only	**2011 study used a social test which included a value of $0.01 per kWh for health effects and national security impacts**
	Net Energy Metering (NEM)	Evaluation study only	Not included in 2013 ratepayer impacts study
	MASH/SASH (low income solar)	Evaluation study only	Includes participant and utility NEIs. Does not include social NEIs, except it used the **EPA GHG value for GHG costs, instead of the predicted avoided cost of GHG in the avoided cost calculator.**

Source: CA PUC

CA: Myriad of tests for DERs

Electric Vehicles (EV)		TBD	SB 350 defines a set of "ratepayer interests," which are a set of NEIs that may accrue to ratepayers as the result of electric vehicle adoption.
Storage		TBD	AB 2514 says to **consider the "co-benefits from reduced emissions of criteria pollutants"** for storage technologies.
Distributed Resource Planning		TBD	**Feb 2015 Guidance Ruling directs utilities to include societal avoided costs** which can be clearly linked to the deployment of DERs in their net benefits analysis.

Source: CA PUC

New York's BCA

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Benefits

- Bulk
  - Avoided Generation Capacity Costs, including Reserve Margin
  - Avoided Energy
  - Avoided Transmission Capacity
- Infrastructure and O&M
  - Avoided Transmission Losses
  - Avoided Ancillary Services
- Distribution System
  - Avoiding Distribution Capacity Infrastructure
  - Avoided O&M Costs
  - Avoided Distribution Losses
- Reliability/Resiliency
  - Net Avoided Restoration Costs
  - Net Avoided Outage Costs
- External
  - Net Avoided Greenhouse Gases
  - Net Avoided Criteria Air Pollutants
  - Avoided Water Impacts
  - Avoided Land Impacts
  - Net Non-Energy Benefits related to utility or grid operations (e.g., avoided service terminations, avoided uncollectible bills, avoided noise and odor impacts, to the extent not already included above)

Costs

- Program Administration Costs
- Added Ancillary Service Costs
- Incremental T&D and DSP Costs
- Participant DER Costs
- Net Non-Energy Costs

(Not included directly in the methodology but calculated elsewhere for consideration: Wholesale Market Price Impacts in benefits and Lost Utility Revenues and Shareholder Incentives in costs)

Source: SEPA & ScottMadden

CA's LNBA

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- Avoided T&D
  - Sub-Transmission/Substation/Feeder
  - Distribution Voltage/Power Quality
  - Distribution Reliability/Resiliency
  - Transmission
- Avoided Generation Capacity
  - System and Local Resource Adequacy
  - Flexible Resource Adequacy
- Avoided Energy
- Avoided GHG
- Avoided RPS
- Avoided Ancillary Services
- Renewable Integration Costs
- Societal Avoided Costs
- Public Safety Costs

Source: SEPA & ScottMadden

A Continuum of Approaches

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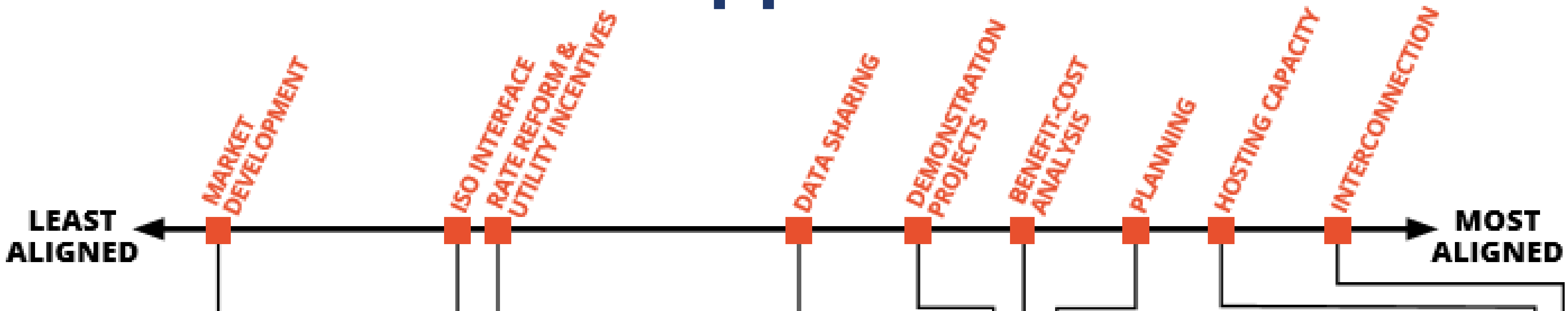

MARKET DEVELOPMENT

NY has an explicit goal of "market animation." CA does not.

ISO INTERFACE

NYISO's DER roadmap focuses on integration of dispatchable resources only. CAISO has implemented the aggregation of dispatchable and non-dispatchable DERs.

RATE REFORM & UTILITY INCENTIVES

NY's Track Two is more focused on Earning Adjustment Mechanisms and Platform Service Revenues than residential rate design. CA has initiated an entire proceeding regarding residential rate design.

DATA SHARING

Both states focused on providing customer and system data. CA is ahead in both.

USE OF DEMONSTRATION PROJECTS

Demos in NY test both business model changes and technical integration of DERs; in CA, the focus is on testing out concepts in Distribution Resources Plans (mainly technical integration).

BENEFIT-COST ANALYSIS

NY has adopted the Societal Cost Test; CA is considering the SCT. CA is focusing on valuing benefits with locational granularity. In NY, the focus will first be on analyzing hosting capacity. CA is doing both concurrently.

PLANNING

Comprehensive plans for the integration of DERs, including hosting capacity and identifying beneficial locations for DER deployment. Both looking at DERs to offset utility Capex. DER penetration rates, particularly solar PV, is a notable difference.

HOSTING CAPACITY

Similar efforts to assess hosting capacity and make it available to DER providers.

INTERCONNECTION

Focus on speeding up the process and automating technical screening.

Source: SEPA & ScottMadden, 2016

LCCF - 1

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Equation 4-1: Calculation of load carrying capacity factor

$$LCCF_{Resource} = \sum A_i \times B_i$$

Where

A = Peaking risk allocation[64] *and*

B = Resource production on peak risk days (including all constraints, load profile, etc.)[65]

Equation 4-2: Calculation of cost per effective MW

$$\frac{\$\ NPV}{effective\ MW} = \frac{NPV\ (costs)}{nameplate\ MW * LCCF}$$

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL

LCCF - 2

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TABLE 4: EXAMPLE CALCULATIONS FOR ESTIMATING LOAD CARRYING CAPACITY FACTOR

HOUR (END)	SOLAR PANELS			RESIDENTIAL LIGHTING ENERGY EFFICIENCY		
	PEAKING RISK ALLOCATION	RESOURCE PRODUCTION (PER NAMEPLATE kW)	LCCF INTERIM CALCULATION	PEAKING RISK ALLOCATION	RESOURCE PRODUCTION (PER NAMEPLATE kW)	LCCF INTERIM CALCULATION
	(A)	(B)	(A X B)	(A)	(B)	(A X B)
1:00	0.0%	0.00	0.00	0.0%	0.38	0.00
2:00	0.0%	0.00	0.00	0.0%	0.14	0.00
3:00	0.0%	0.00	0.00	0.0%	0.12	0.00
4:00	0.0%	0.00	0.00	0.0%	0.12	0.00
5:00	0.0%	0.00	0.00	0.0%	0.12	0.00
6:00	0.0%	0.00	0.00	0.0%	0.17	0.00
7:00	0.0%	0.02	0.00	0.0%	0.32	0.00
8:00	0.0%	0.10	0.00	0.0%	0.39	0.00
9:00	0.0%	0.23	0.00	0.0%	0.39	0.00
10:00	0.0%	0.35	0.00	0.0%	0.27	0.00
11:00	0.0%	0.48	0.00	0.0%	0.14	0.00
12:00	0.0%	0.56	0.00	0.0%	0.11	0.00
13:00	1.9%	0.57	0.01	1.9%	0.11	0.00
14:00	7.2%	0.58	0.04	7.2%	0.11	0.01
15:00	11.1%	0.55	0.06	11.1%	0.11	0.01
16:00	17.9%	0.42	0.07	17.9%	0.11	0.02
17:00	27.0%	0.30	0.08	27.0%	0.15	0.04
18:00	26.0%	0.24	0.06	26.0%	0.29	0.08
19:00	8.9%	0.11	0.01	8.9%	0.49	0.04
20:00	0.0%	0.03	0.00	0.0%	0.72	0.00
21:00	0.0%	0.00	0.00	0.0%	0.90	0.00
22:00	0.0%	0.00	0.00	0.0%	0.99	0.00
23:00	0.0%	0.00	0.00	0.0%	0.87	0.00
24:00	0.0%	0.00	0.00	0.0%	0.60	0.00
		Max average hourly production	**0.08**		**Max average hourly production**	**0.08**
		LCCF	**0.34**		**LCCF**	**0.20**

Source: Nexant & SEPA

Source: Smart Electric Power Alliance & Nexant, Beyond the Meter | Addressing the Locational Valuation Challenge for Distributed Energy Resources, 2016
https://sepa.force.com/CPBase__item?id=a12o000000RNvYdAAL