Valuation of Transactive Systems

GWAC Transactive Systems Valuation Technical Meeting

Paul De Martini
Newport Consulting

July 7, 2015

NEWPORT
CONSULTING GROUP

Topics

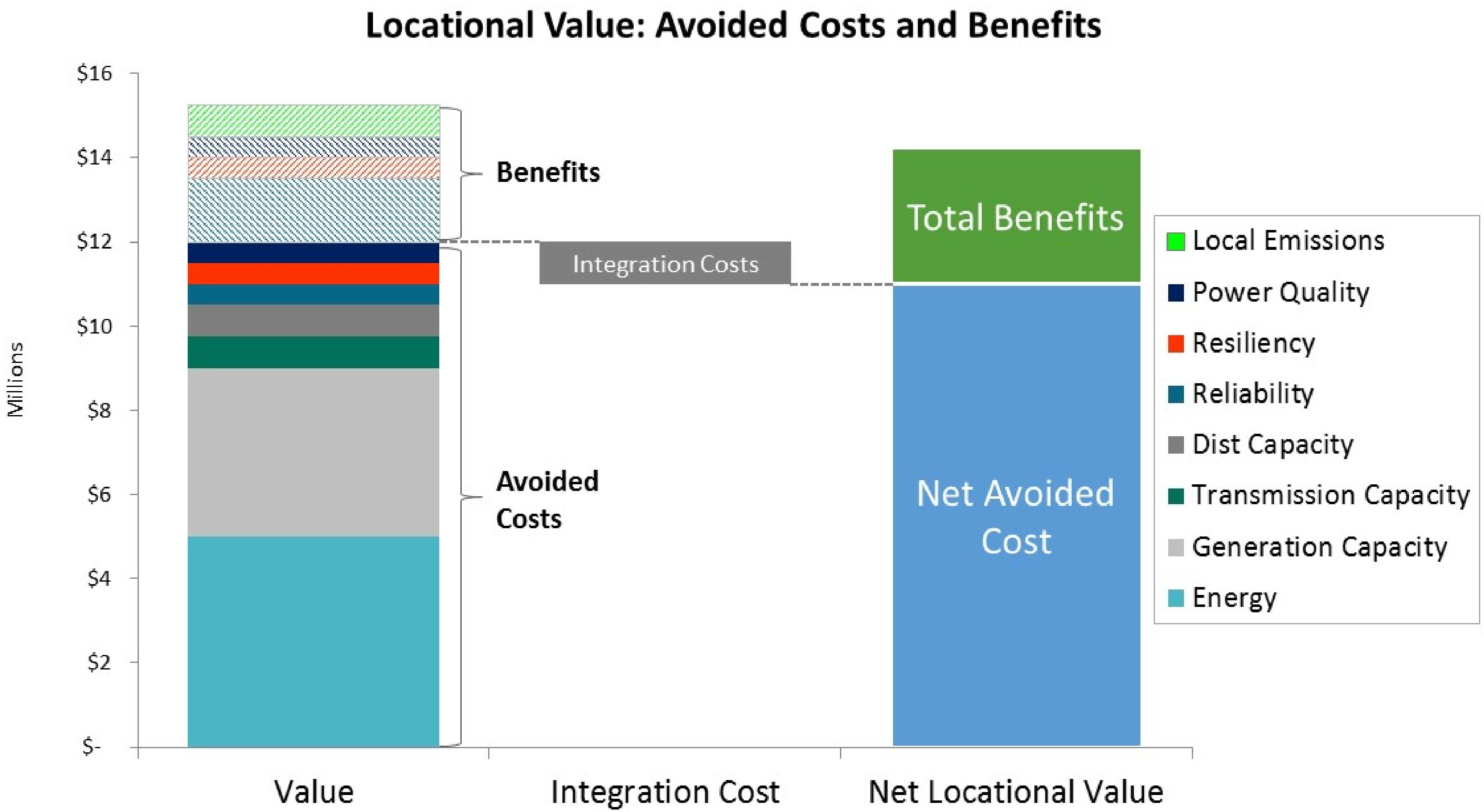
- DER Net Value in a California Context
- Value is Directly Related to Time & Location
- Diminishing Net Value in Terms of Time & Location Granularity
- TE System is a composition of people, processes & technology implemented incrementally over time based on discrete value realization
- TE System Valuation is basically a 5 step process

DER Value Components

	Value Component	Definition
Wholesale	Regional Bulk Power System Benefits	Regional BPS benefits not reflected in System Energy Price or LMP
	System Energy Price	Estimate of marginal wholesale system-wide value of energy
	Wholesale Energy	Reduced quantity of energy produced based on net load
	Resource Adequacy	Reduction in capacity required to meet Local RA and/or System RA
	Flexible Capacity	Reduced need for resources for system balancing
	Wholesale Ancillary Services	Reduced system operational requirements for electricity grid reliability
	RPS Generation & Interconnection Costs	Reduced RPS energy prices, integration costs, quantities of energy & capacity
	Transmission Capacity	Reduced need for system & local area transmission capacity
	Transmission Congestion + Losses	Avoided locational transmission losses and congestion
	Wholesale Market Charges	LSE specific reduced wholesale market & transmission access charges
Distribution	Subtransmission, Substation & Feeder Capacity	Reduced need for local distribution upgrades
	Distribution Losses	Value of energy due to losses bet. BPS and distribution points of delivery
	Distribution Power Quality + Reactive Power	Improved transient & steady-state voltage, harmonics & reactive power
	Distribution Reliability + Resiliency	Reduced frequency and duration of outages & ability to withstand and recover from external threats
	Distribution Safety	Improved public safety and reduced potential for property damage
Customer & Societal	Customer Choice	Customer & societal value from robust market for customer alternatives
	Emissions (CO_2, Criteria Pollutants & Health Impacts)	Reduction in state and local emissions and public and private health costs
	Energy Security	Reduced risks derived from greater supply diversity
	Water & Land Use	Synergies with water management, environmental benefits & property value
	Economic Impact	State or local net economic impact (e.g., jobs, investment, GDP, tax income)

Source: CA More Than Smart

Locational Net Value



Source: CA More Than Smart

DER Value in Context

- **Value realization** is a function of **specific locations and temporal requirements** related to each specific value
- Bulk power system has distinctly different values from distribution – ***energy is a bulk power system product and value***
- The **marginal price of energy** on the **distribution** system is the **LMP + D**istribution constraints & losses between the LMP node and the distribution take-out/injection point
- Distribution **constraints are included in distribution capacity deferral**/avoidance as well as distribution reliability value and need parsing out to avoid double counting
- The value of **Distribution Losses can be estimated** using historical data (as is done today) **or measured in short time cycles** such as 5 minutes – but there are pre-requisite capabilities and complexities in practice
- Individual **values may be mutually exclusive** regarding the number of values that may be provided by a single DER solution (aggregated or individual)
- The vast **majority of DER being installed** and planned over the next 5 years are **load-modifying, not supply-side**

NEWPORT CONSULTING GROUP

Value in Relation to Time

Note that **most of these values have time dimensions in hours – not minutes or seconds**

Several distribution level values like power quality are special cases and not clear when (given need for IEEE 1547 change) and how DER (based on installed inverter capability) will address transient response – let alone a market construct other than a reservation fee

Distribution reliability related to outage restoration - Not clear yet how DER shortens restoration given that nearly all DER is load modifying. But, likely any mechanism would be a reservation fee structure

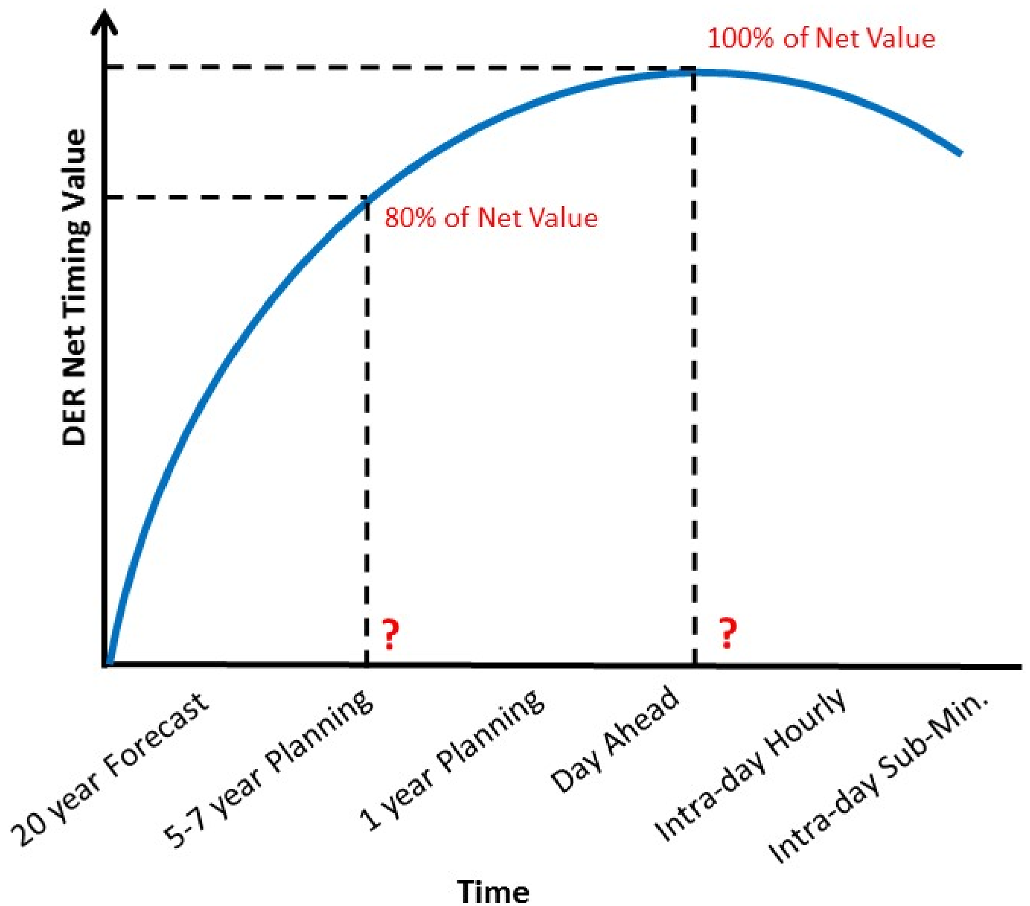
		Discharge Duration*		
#	Type	Low	High	Note
1	Electric Energy Time-shift	2	8	Depends on energy price differential, storage efficiency, and storage variable operating cost.
2	Electric Supply Capacity	4	6	Peak demand hours
3	Load Following	2	4	Assume: 1 hour of discharge duration provides approximately 2 hours of load following.
4	Area Regulation	15 min.	30 min.	Based on demonstration of Beacon Flywheel.
5	Electric Supply Reserve Capacity	1	2	Allow time for generation-based reserves to come on-line.
6	Voltage Support	15 min.	1	Time needed for a) system stabilization or b) orderly load shedding.
7	Transmission Support	2 sec.	5 sec.	Per EPRI-DOE Handbook of Energy Storage for Transmission and Distribution Applications.[17]
8	Transmission Congestion Relief	3	6	Peak demand hours. Low value is for "peaky" loads, high value is for "flatter" load profiles.
9.1	T&D Upgrade Deferral 50th percentile	3	6	Same as Above
9.2	T&D Upgrade Deferral 90th percentile	3	6	Same as Above
10	Substation On-site Power	8	16	Per EPRI/DOE Substation Battery Survey.
11	Time-of-use Energy Cost Management	4	6	Peak demand hours.
12	Demand Charge Management	5	11	Maximum daily demand charge hours, per utility tariff.
13	Electric Service Reliability	5 min.	1	Time needed for a) shorter duration outages or b) orderly load shutdown.
14	Electric Service Power Quality	10 sec.	1 min.	Time needed for events ridethrough depends on the type of PQ challenges addressed.
15	Renewables Energy Time-shift	3	5	Depends on energy cost/price differential and storage efficiency and variable operating cost.
16	Renewables Capacity Firming	2	4	Low & high values for Renewable Gen./Peak Load correlation (>6 hours) of 85% & 50%.
17.1	Wind Generation Grid Integration, Short Duration	10 sec.	15 min.	For a) Power Quality (depends on type of challenge addressed) and b) Wind Intermittency.
17.2	Wind Generation Grid Integration, Long Duration	1	6	Backup, Time Shift, Congestion Relief.

*Hours unless indicated otherwise. Min. = minutes. Sec. = Seconds.

Time-Value Diminishing Net Value Curve

Q: What is the time cycle by which the maximum **net value** at distribution can be achieved?

Net Value = Timing Value – (System Costs + Operational Risks)



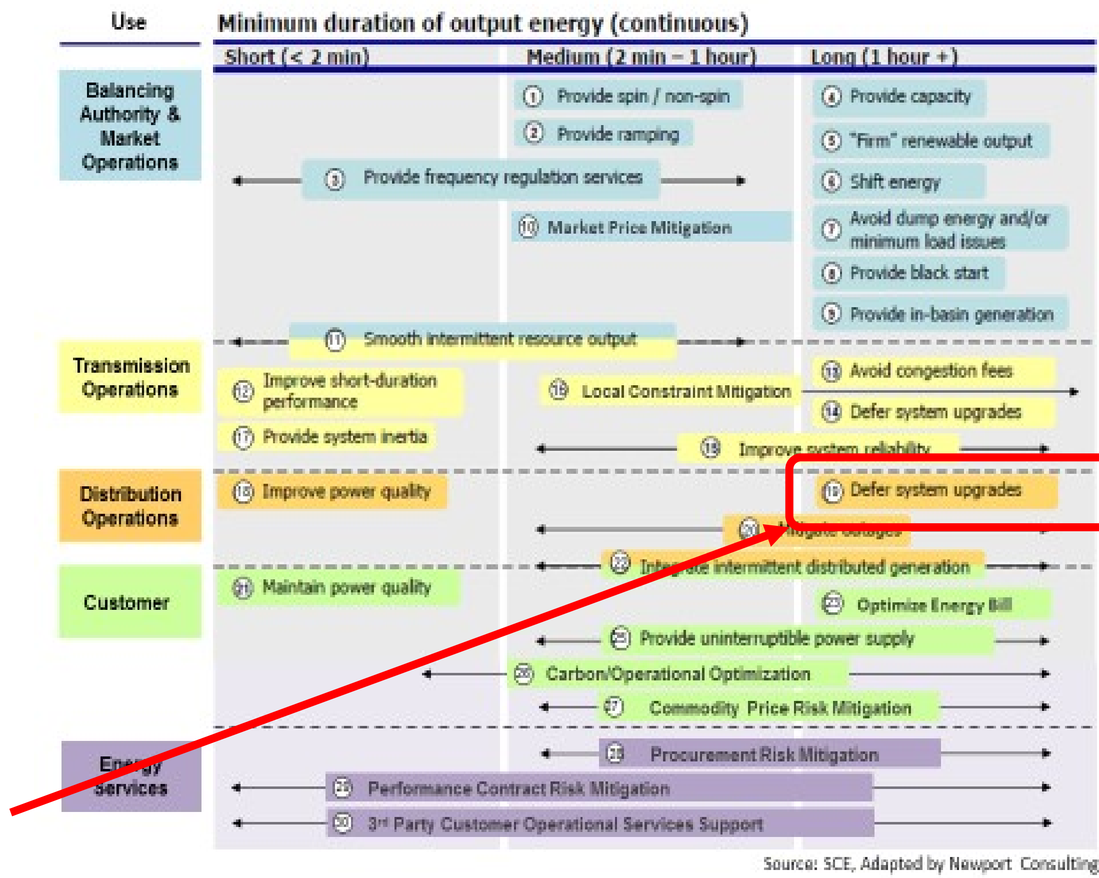
Value in Relation to Location

A **value** is associated with a **specific location on the power system** (including market participants) **or** in a **customer premise**

Most **monetizable value** is related to **avoided costs** associated with **energy** prices and/or volume, **transmission capital** + operational costs and **distribution capital** + operational costs

For **distribution, a significant amount of potential value is associated with infrastructure upgrade capital deferral**…

…this **potential value is highest at the distribution substation including all the aggregated feeders'** breaker, poles, wires, transformers and apparatus

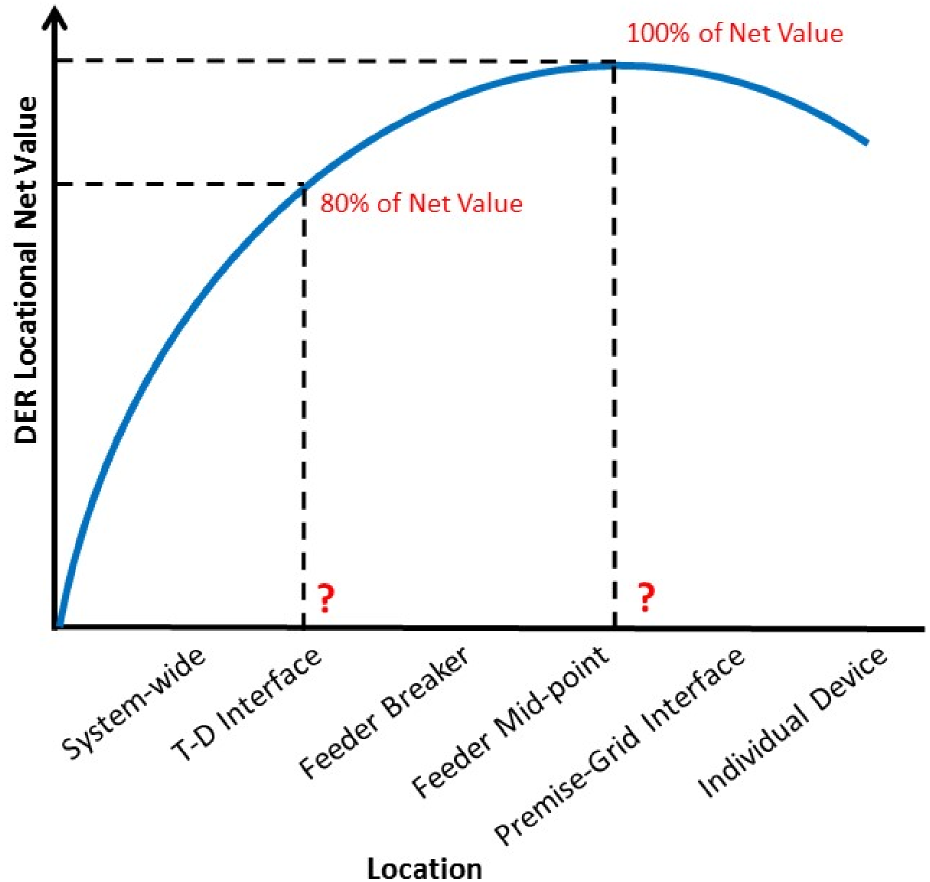


NEWPORT CONSULTING GROUP

Location-Value Diminishing Net Value Curve

Q: Where is the location by which the maximum **net value** at distribution can be achieved?

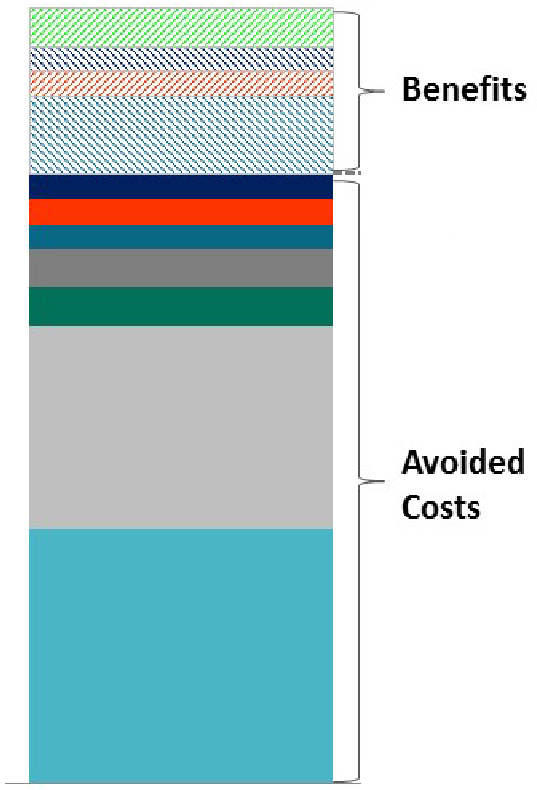
Net Value = Locational Value – (System Costs + Operational Risks)



Value of a Transactive System

"Transactive energy refers to the use of a ***combination of economic and control techniques*** *to improve grid reliability and efficiency."* **GWAC TE Framework**

- **Each value component** requires **specific TE System functionality** to monetize and operationalize the associate value
- Such a **TE System** will include both **people, process and technology** to enable monetization mechanisms and related layered controls, measurement and settlement
- **This is the "System Integration"** cost in the MTS diagram on slide 4 that is **subtracted to yield the net locational value**
- In practice this is **not a single one-time cost** as a **TE system will evolve over time** in terms of **functional richness and reach**



Gross Value Based on Location & Time

TE Economic & Control Combinations

Transaction Energy **encompass several different potential combinations** of economic signaling and controls systems that are designed to enable realization of specific value/s

Time-Varying Rates W/Indirect Control	**Event Driven 1-way Direct Load Control Program**	**BPS or Dist. Load-side DER**	**BPS or Dist. Grid-Side DER**	**PJM Freq. Response w/Bldg HVAC**	**PNW - TE Demonstration**

Examples of TE Systems

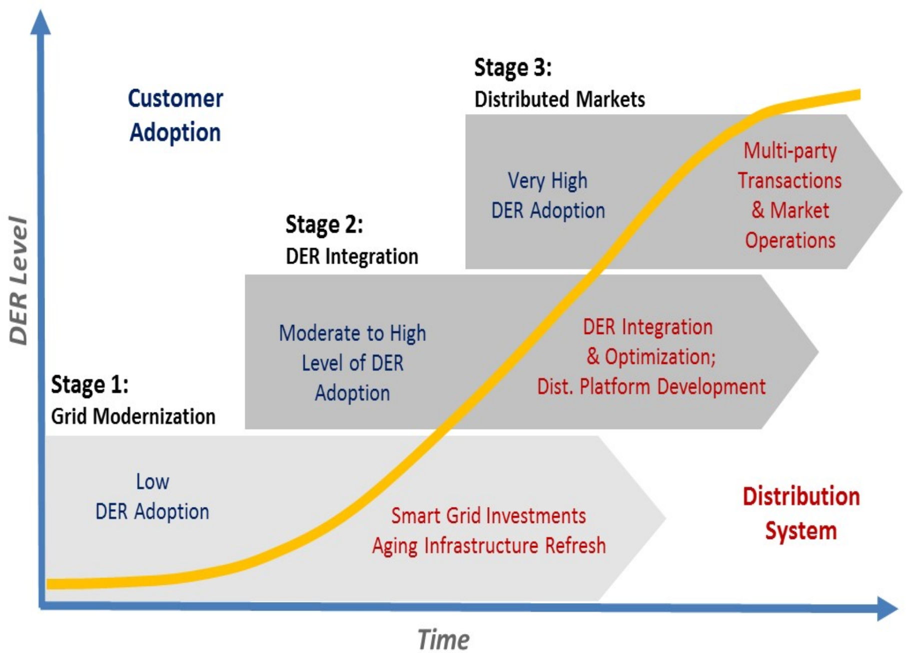
Each **TE System design needs** to address **overall operational cost effectiveness for desired use** and the **grid architecture** considerations identified by PNNL* and others. This drives **different system functional requirements** for components such as pricing, settlement, controls, communications and measurement.

* J. Taft, and A. Becker-Dippmann, Grid Architecture, PNNL, 2015

NEWPORT CONSULTING GROUP

When & What TE System Capability is Needed?

TE System is a composition of **people, processes & technology** functionality that **over time** enables **increasingly more granular locational and time** based value realization **as needed**



Transactive DER Roadmap		
Stage 1 **Wholesale Energy Capacity Reserves + Ancillary Services**	**Stage 2** **Ramping Services + Distribution Svcs**	**Stage 3** **Full Market + T&D Grid Services**
Expansion of DER supplying Energy, Capacity Reserves and Ancillary Services including pilots for ramping from flexible customer resources. Formalization of bulk power system differentiated services and performance requirements. Resolution of cost effective measurement and verification requirements Pilots of distribution services using DER	Ramping services provided by DER and launch of distribution grid services Use of DER to manage LMP & distribution asset optimization Formalization of distribution level differentiated services and performance requirements Creation of sourcing mechanisms for distribution services	Expansion of DER to support bulk power system and distribution operations to full potential Continued creation and refinement of differentiated services, market access rules and transaction methods to achieve market participation potential Integration of supply-side distribution DER with evolution of customer and community microgrids

TE System Valuation Method & Roadmap

1. Identify Value Components
2. Determine the associated Value based on requisite location and timing parameters
3. Identify the TE System functionality necessary to realize the value on both locational and timing considerations including any intermediate functional capability increments for both monetization and controls aspects
4. Identify diminishing value curve for net location-time value for all relevant value components and related TE System functionality costs
5. Select the point on the curve that yields the desired net value also considering any operational risks

Then:

A. Identify the implementation sequence for each value components based on any prerequisites

B. Develop a TE system functionality implementation roadmap

NEWPORT
CONSULTING GROUP

paul@newportcg.com
714.856.7742