Clean Coalition

Making Clean Local Energy Accessible Now

Locational Net Benefits Assessment

Background, Summary & Next Steps

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Distributed energy resources (DER)

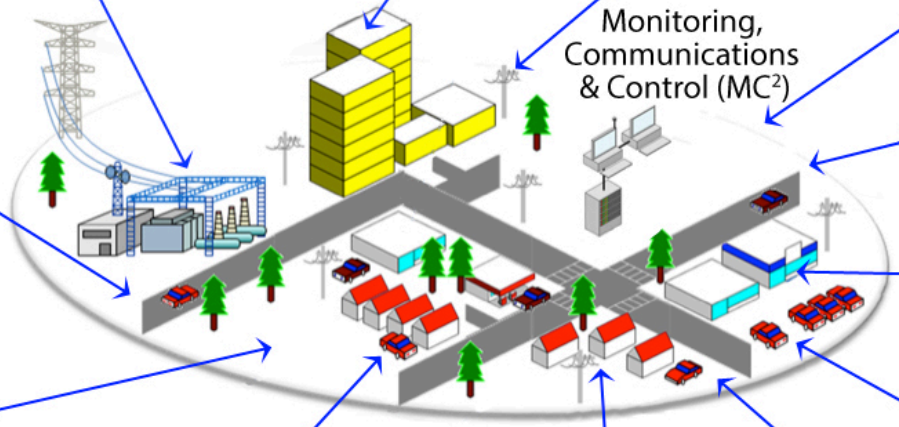
Grid Energy Storage

Distributed Generation

Switches & Power Electronics

Distributed Generation

Biopower Generation



Monitoring, Communications & Control (MC^2)

Energy Storage

Microturbine

Distributed Generation

Electric Vehicles (EV)

Home Energy System

Fuel Cells

Distributed Generation

Wholesale DG is a critical segment

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Project Size

50+ MW

500 kW

5 kW

Wholesale DG

Serves Local Loads

Central Generation

Serves Remote Loads

Retail DG

Serves Onsite Loads

Behind the Meter

Distribution Grid

Transmission Grid

Guided siting benefits (locational value)

SCE Share of 12,000 MW Goal

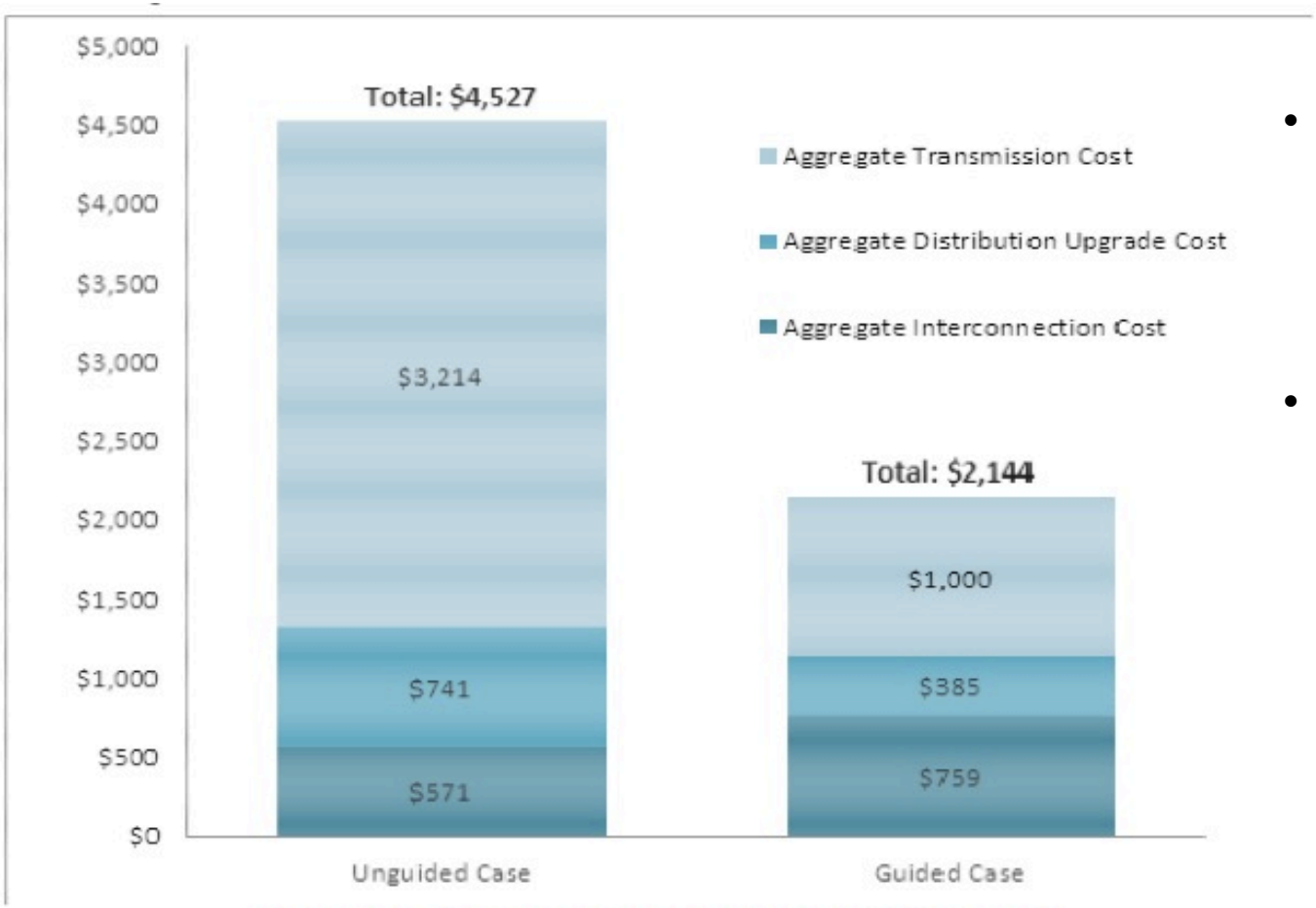

Figure 8: Total SCE System Costs of LER Proposal (Million USD)

Guided Siting Saves Ratepayers 50%

- **Locational value** methodology should include transmission costs.
- **Interconnection** policies should favor high value locations, and reduce cost uncertainty for developers.

Source: SCE Report May 2012

Distribution Resources Plan (DRP)

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- Analytical Frameworks
  - Grid Integration Capacity Analysis (ICA)
  - **Quantification of Distributed Energy Resources' (DER) locational value (aka locational net benefits analysis or LNBA)**
  - Growth scenarios forecast
- Demonstration Projects
  - ICA maps
  - **LNBA Calculator**
  - Field demos to test and verify DER value
- Policy issues

CA Distribution Resources Plans (AB 327)

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Optimal Location Benefit Analysis Requirements:

- Unified IOU Locational Net Benefits methodology
- Build upon E3's Distributed Energy Resources Avoided Cost Model (DERAC)

#	Minimum Value Components to include in Locational Net Benefit Methodology
1	Avoided Sub-Transmission, Substation and Feeder Capital and Operating Expenditures
2	Avoided Distribution Voltage and Power Quality Capital and Operating Expenditures
3	Avoided Distribution Reliability and Resiliency Capital and Operating Expenditures
4	Avoided Transmission Capital and Operating Expenditures
5	Avoided Flexible Resource Adequacy (RA) Procurement
6	Avoided Renewables Integration Costs
7	Any societal avoided costs which can be clearly linked to the deployment of DERs
8	Any avoided public safety costs which can be clearly linked to the deployment of DERs

DRP analysis process

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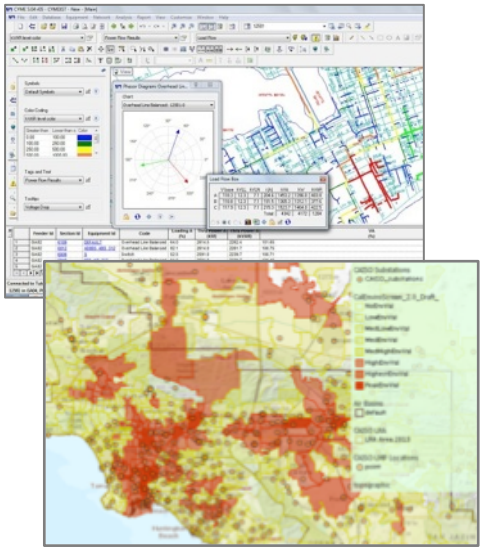
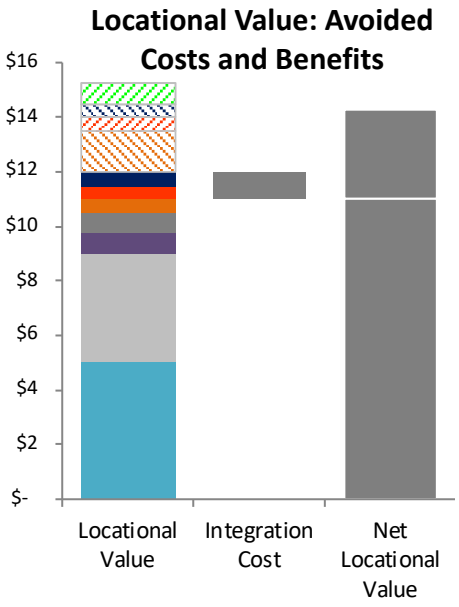
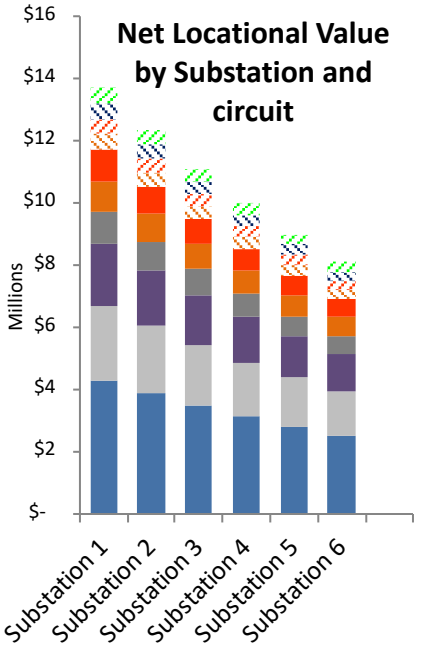
Identify DPA & Substations → **Perform Planning Analyses** → **Calculate Locational Value** → **Rank Locations by Value**







Stages of DRP optimal location implementation

Analysis & Planning	Grid Modeling & Optimization	Distribution Resource Plan Design	Distributed Energy Resource Deployment
Full cost and value accounting methods for DER	Siting analysis; powerflow modeling; DER optimization	Design and approval	Implementation: procurement and interconnection programs

(**LNBA for value**)

Locational Net Benefits Analysis (LNBA) Tool

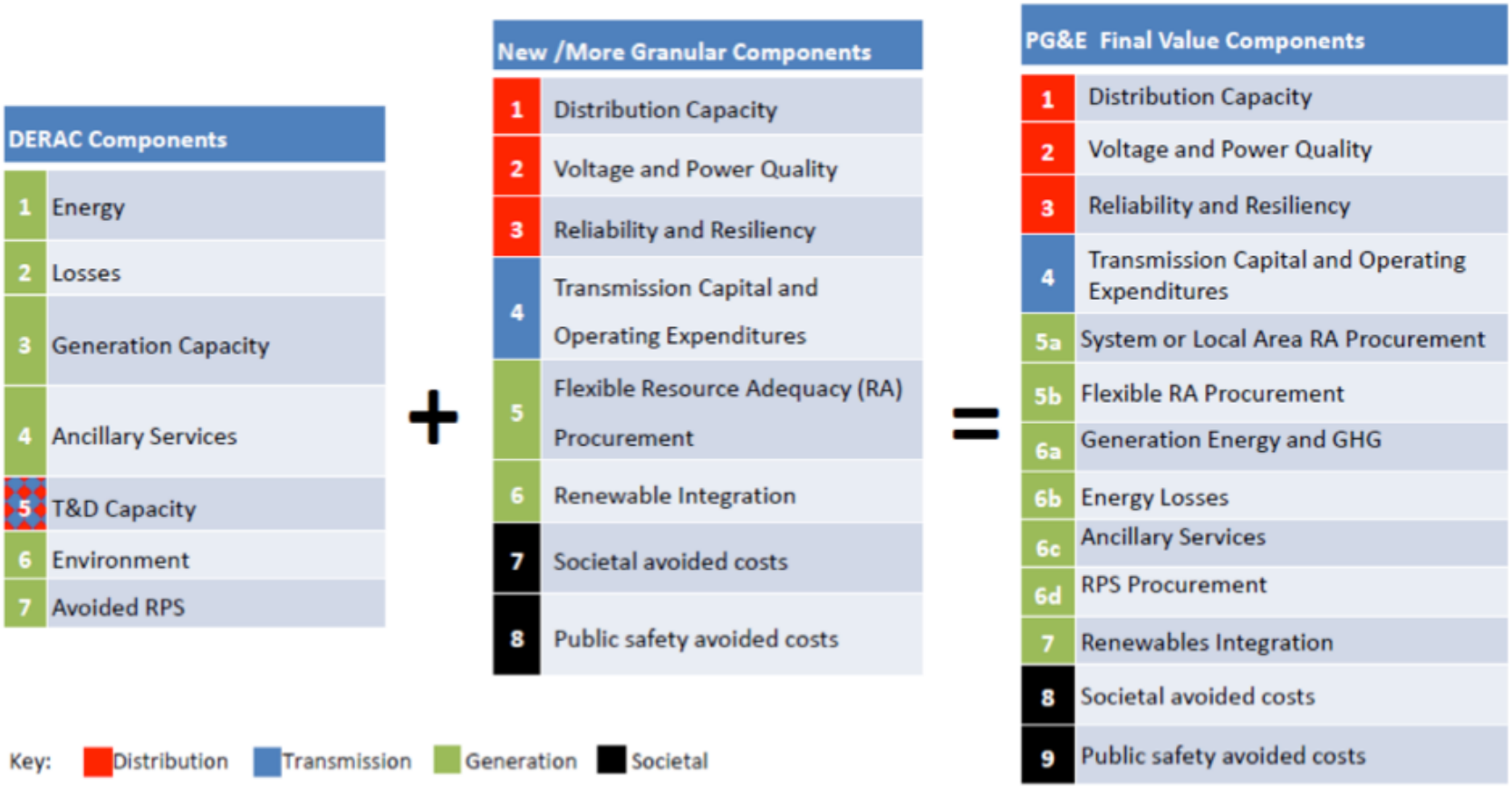
Optimal location for DERs =
available hosting capacity + locational benefits greater than costs

- LNBA Tool calculates locational benefits
  - Distribution investment deferral value + locational avoided costs
  - Indicative or confidential market values
- Distribution investment deferral value identified based on DER services
- Distribution capacity services
  - Voltage support services
  - Reliability (back-tie) services
  - Resiliency (microgrid) services
- Comparison with costs occurs outside of LNBA calculator
  - DER deployment, interconnection, integration costs

LNBA Value Components

Value categories are refined and adjusted for local variation

Starting with DERAC model and adding granularity and additional components



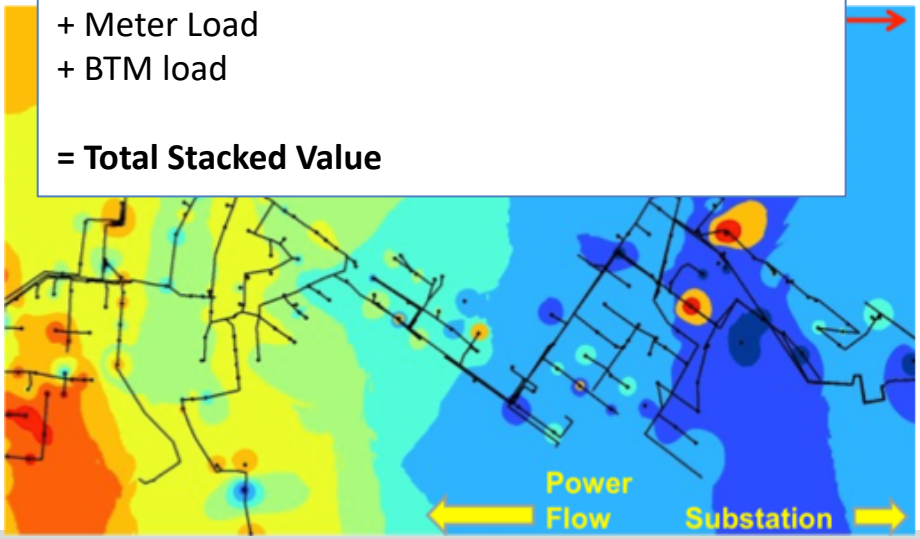
LNBA Value Components

Value categories are refined and adjusted for local variation

System-wide Average or
Location Specific Benefit Value layers
(Assessed as applicable to each layer)

HV System Transmission
+ LV Transmission Territory
+ Sub-transmission Area
+ Distribution Planning Area
+ Distribution substation
+ Circuit
+ Line section
+ Transformer
+ Meter Load
+ BTM load

= Total Stacked Value



Values accrue at various defined levels

ISO/ Market	1. Frequency regulation
	2. Spin
	3. Ramp
	4. Black start
	5. Real-time energy balancing
	6. Energy arbitrage
	7. Resource Adequacy
Generation	8. Intermittent resource integration: wind (ramp/voltage support)
	9. VER/ PV shifting, Voltage sag, rapid demand support
	10. Supply firming
Transmission / Distribution	11. Peak shaving: load shift
	12. Transmission peak capacity support (deferral)
	13. Transmission operation (short duration performance, inertia, system reliability)
	14. Transmission congestion relief
	15. Distribution peak capacity support (deferral)
	16. Distribution operation (volt/VAR support)
Customer	17. Outage mitigation
	18. Time-of-use (TOU) energy cost management
	19. Power quality
	20. Back-up Power

LNBA Use Cases

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Heat Map of Potential Optimal Locations

- **Public/Indicative values**
- **Generic OR DER Specific**
- **No DER Costs Included**
- Visual heat map to inform DER providers and stakeholder of locations where DERs may be most valuable.

Prioritization for DER Deferral Opportunities

- **Confidential values**
- **Generic OR DER Specific**
- **DER Costs May Be Included**
- Use LNBA to identify & prioritize locations for deploying DERs

Future Planning Use Cases?

Policy Planning

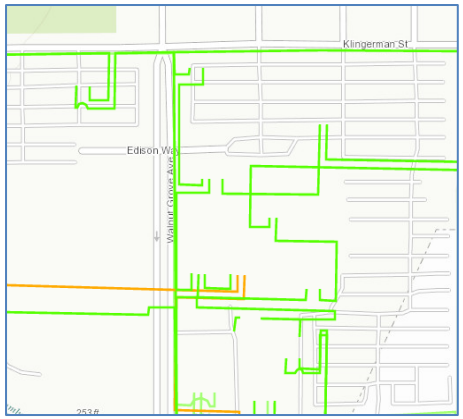
Heat map to inform policy makers of locations where DERs may be more valuable for targeted programs or incentives.

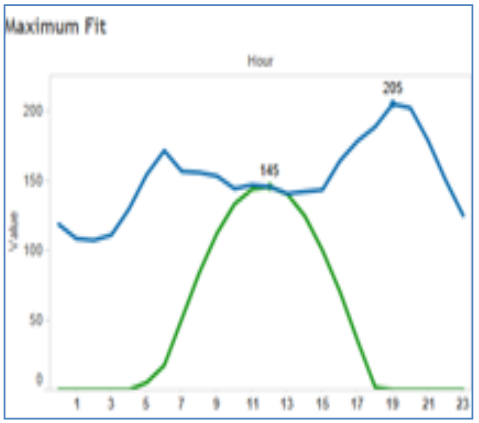
Utility Planning

- Combined with ICA Hosting Capacity map to evaluate and forecast potential DER grid impacts and net costs or savings.

LNBA Process Flow

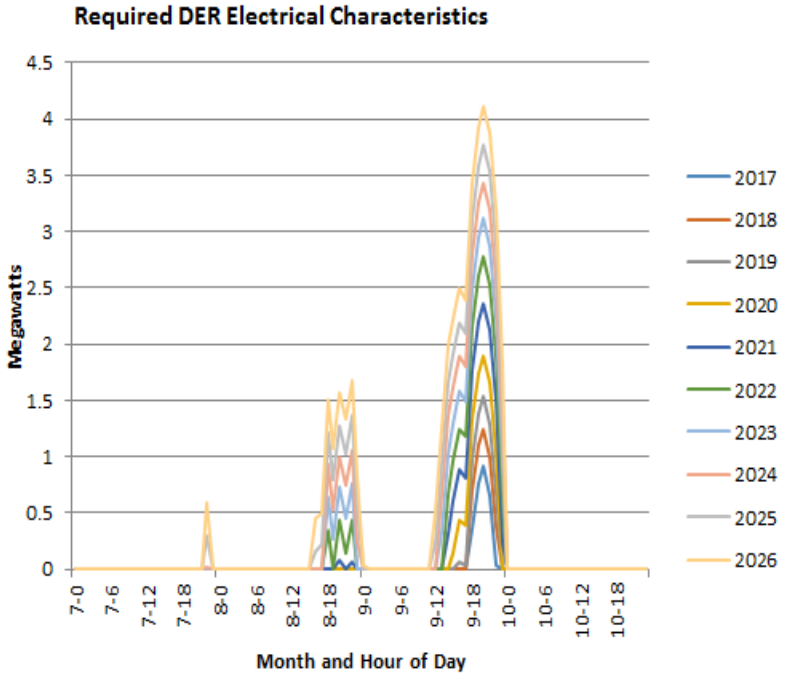
1. Access the LNBA mapping layer that identifies deferral opportunity locations
2. Select a project location to view its description and download distribution deferral datasets
3. Compile a DER profile that meets the required deferral electric characteristics
4. Upload DER profile in LNBA Tool to estimate avoided costs





Heatmap of DER shape

	Hour of the Year (hour starting PST)																					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Jan	0	0	0	0	0	0	0	0.08	3.02	7.17	9.19	11.4	12	12.4	11.4	8.78	2.2	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	0.81	4.21	7.61	9.77	11.7	11.6	11.6	8.37	6.8	5.17	0.39	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0.21	3.83	9.57	15	17.7	19.5	20.1	19.6	16.9	14	8.73	1.91	0	0	0	0	0	0
Apr	0	0	0	0	0	0.01	1.67	5.99	11.3	15.1	17.9	19.7	20.9	20.1	17.9	13.6	9.02	4.45	0.13	0	0	0	0	0
May	0	0	0	0	0	0.4	3.19	8.45	13.5	17.8	21.3	22.5	22.2	22	19.3	15.3	9.9	5.47	0.82	0	0	0	0	0
Jun	0	0	0	0	0	0.51	2.89	7.05	11.5	15.7	18.8	21	22.2	21.9	19.9	16.2	11.1	6.03	2.35	0	0	0	0	0
Jul	0	0	0	0	0	0.29	2.3	6.11	11.8	17.1	21.6	23.8	24.2	23.5	20.6	17.1	12	6.54	2.44	0	0	0	0	0
Aug	0	0	0	0	0	0.02	1.61	5.71	10.3	16.1	20.6	23.2	23.9	23.4	20.7	16.3	10.9	4.99	0.21	0	0	0	0	0
Sep	0	0	0	0	0	0	0.91	4.94	9.72	13.5	18.3	21.3	22	21	18.1	13.7	8.22	1.88	0	0	0	0	0	0
Oct	0	0	0	0	0	0	0.19	3.84	9.13	14	17.9	19.5	19.6	18.8	15.3	10.6	4.17	0.14	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	1.62	5.93	9.41	11.4	13.5	13.3	12.2	9.71	6.47	0.7	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	0.26	3.85	7	9.5	11.2	12	11.4	8.04	5.67	0.86	0	0	0	0	0	0	0



LNBA Tool: Project Deferral Value Calculation

First load forecast year (e.g.: 2016)	2017	
Discount Rate (%/yr)	7.00%	*disc*
Generic default inflation rate (%/yr)	2.00%	*inf*
Case to use for allocated hourly costs (Base, Low, High):	Base	
Deferral Yrs indicated by DER Dashboard	2	

User input: Tool wide financial data

Project cost and need information

Equipment Information	Item 1			
Location Identifier (user text)	DPA 1			
Location Mapping info (User text)	Location 1234			
Equipment type	Primary Feeder			
Equipment Inflation (%/yr)	2.0%			
Revenue Requirement Multiplier	165.0%			
O&M Inflation Rate (%/yr)	2.0%			
Book life (yrs)	25			
O&M Factor (Annual O&M$/Project Cost $)	12.0%	*0.12*	*0.12*	
Cost Information	Base	Low	High	
Capital Cost ($000)	$2,000.0	$1,800.0	$3,000.0	
Incremental O&M Cost ($000)	$240.0	$216.0	$360.0	
Cost yr basis	2015			
Project install/commitment year	2017			

	Cumulative MW reduction needed for deferral	Base
1	2017	0.26
2	2018	0.38
3	2019	0.51
4	2020	0.64

User input: Project specific details

LNBA Tool: Additional Avoided Cost Calculation

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User inputted hourly DER solution profile

User Input for DER Hourly Shape			
PST			
Hour Starting	Month	Hour	DER at meter (kW)
1/1/15 12:00 AM	1	0	0.00
1/1/15 1:00 AM	1	1	0.00
1/1/15 2:00 AM	1	2	0.00
1/1/15 3:00 AM	1	3	0.00
1/1/15 4:00 AM	1	4	0.00
1/1/15 5:00 AM	1	5	0.00
1/1/15 6:00 AM	1	6	0.00
1/1/15 7:00 AM	1	7	0.00
1/1/15 8:00 AM	1	8	105.30
1/1/15 9:00 AM	1	9	720.21
1/1/15 10:00 AM	1	10	154.16
1/1/15 11:00 AM	1	11	293.76
1/1/15 12:00 PM	1	12	315.30
1/1/15 1:00 PM	1	13	175.15
1/1/15 2:00 PM	1	14	940.02
1/1/15 3:00 PM	1	15	727.53
1/1/15 4:00 PM	1	16	174.38
1/1/15 5:00 PM	1	17	0.00
1/1/15 6:00 PM	1	18	0.00
1/1/15 7:00 PM	1	19	0.00
1/1/15 8:00 PM	1	20	0.00
1/1/15 9:00 PM	1	21	0.00
1/1/15 10:00 PM	1	22	0.00
1/1/15 11:00 PM	1	23	0.00

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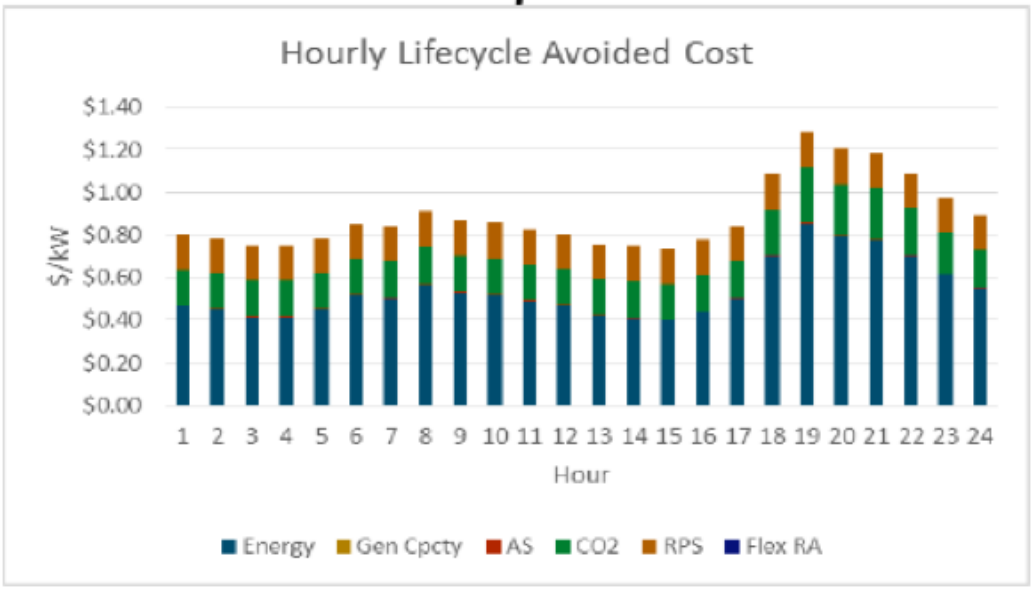
Calculated lifetime hourly avoided cost values



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Lifecycle Value from DER by Compon	Circuit 1102
Energy	$1,998,095
Gen Capacity	$362,696
Ancillary Services	$18,462
CO2	$794,182
RPS	$808,743
Flex RA	-$168,364

LNBA Calculation Example

- Deferral Value = (Full Cost of Asset * RECC) + Δ O&M
  - RECC Calculation
    - i = 2.5%, r = 7%, book life = 40 yrs.
    - RECC = 4.5%/1.07 *1.07^40/(1.07^40 - 1.025^40) = 5.12%
  - Full Cost = (Direct Capital * RRScaler) = ($8M * 150%) = $12M
- Deferral Value = ($12M * 5.12%) + $0.20M = $0.81M

Source: E3, http://drpwg.org/wp-content/uploads/2016/07/LNBA-Working-Group-072616_FINALVERSION.pptx

Deferral Value for one year

Item	Variable	Low
Investment Cost	TDCapital ($M)	$ 8.00
	RECC	5.12%
	RRScaler	150%
Incremental O&M	ΔO&M ($M/yr)	$ 0.20
One year Deferral	SavingsOne ($M)	$ 0.81

Value expressed in alternate metrics

Value	Variable	Low
Two year Deferral	SavingsTotal ($M)	$ 1.60
MW Need (Hi, Med, Lo)	MW Need (2 yr)	8
Discrete savings per kW	DiscreteperkW	$ 199

LNBA - Distribution Marginal Cost Impacts

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	Grid Side	Supply Side
Variable Costs	Voltage KVAR Power Factor Line Losses Limiting Factors	Ancillary Services Plant Following Wind/ Cloud Firming Current hour LMP
Fixed Costs / Capacity	Asset Protection Circuit Capacity Deferral Bank Capacity Deferral Future Congestion	Capacity Premium 10 Year LMP Forecasts Future Covariance

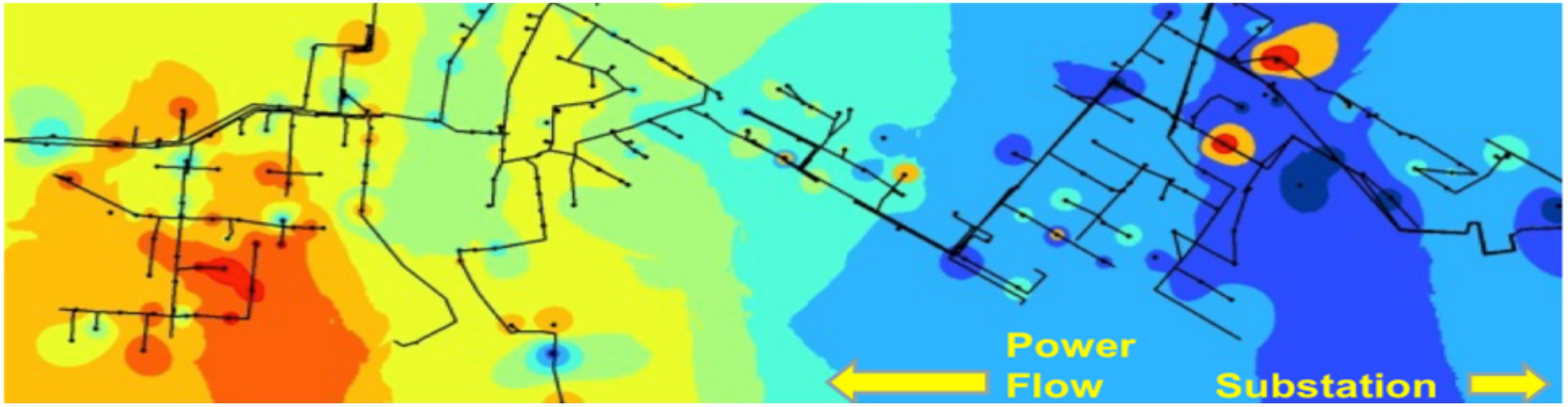
Time

Minutes

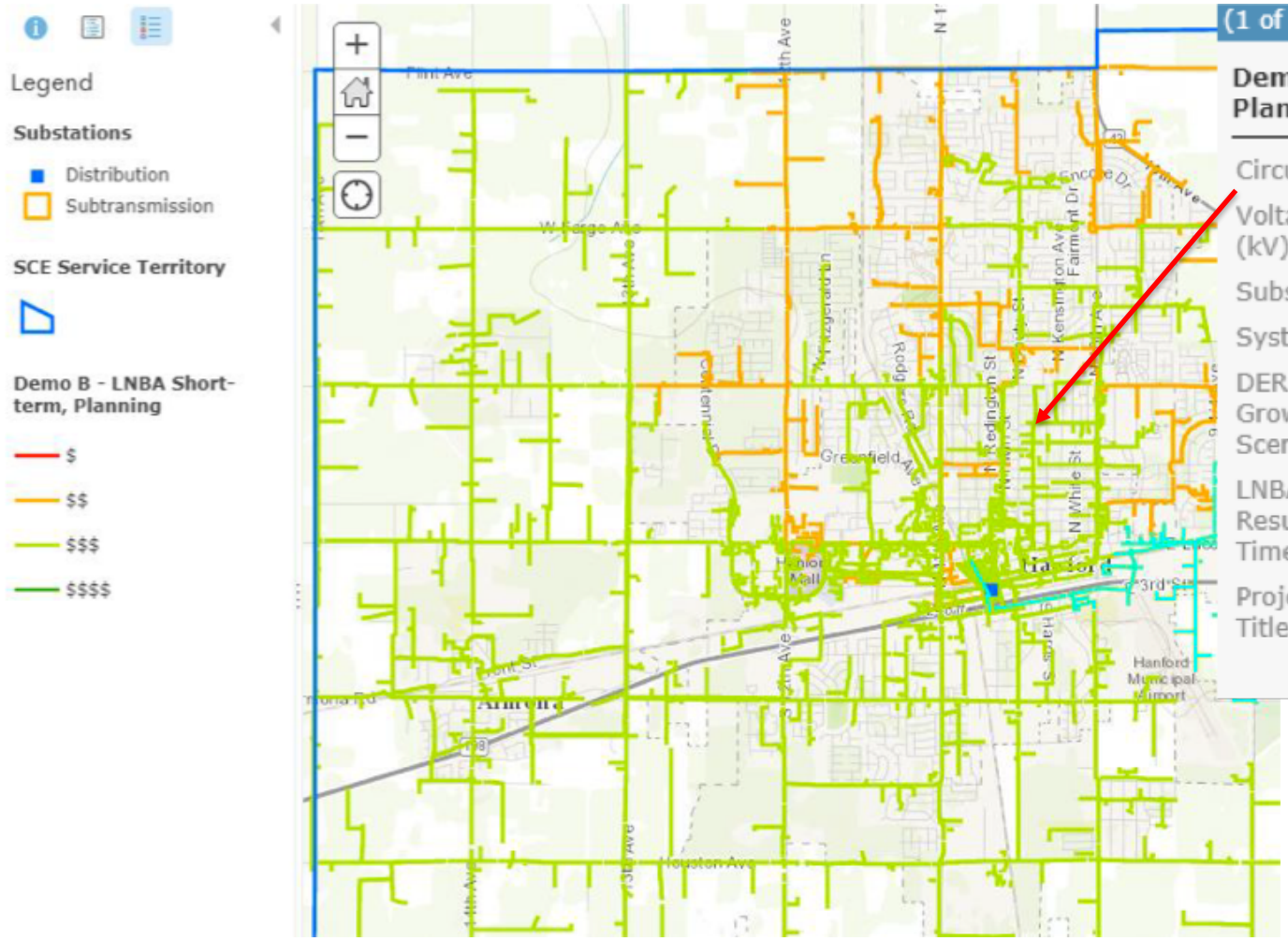
Hours

Months

Years



Heatmap of LNBA Results

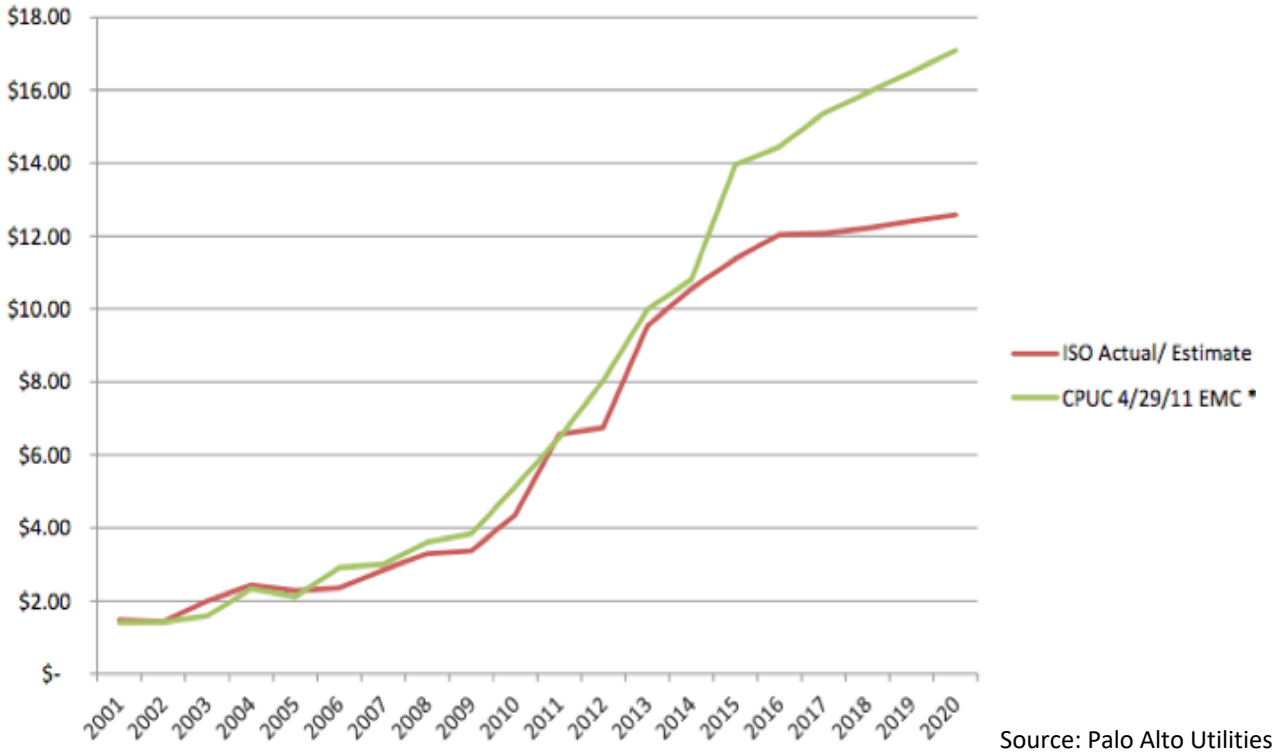


Shift transmission investments into the distribution grid

- Under a business as usual scenario, new incremental transmission investments are likely to reach **$80 billion** over the next 20 years for California ratepayers
- Levelized over 20 years, this approaches **3 cents/kWh** – or roughly 50% of the wholesale cost of electricity
- Avoiding half of these costs would **free up roughly $40 billion** for ratepayers or modernizing the distribution grid, including local renewables, storage, etc.

Historical and Projected High Voltage Transmission Access Charges ($/MWh).

Does not include Low Voltage Transmission Access Charges.



Source: Palo Alto Utilities

Questions?

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Mission

To accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

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