# Staff Subcommittee on Energy Resources and the Environment

NARUC Summer Policy Summit

# Staff Subcommittees on Energy Resources

## Preparing for a Future with Abundant DER

NARUC Summer Policy Summit

# Preparing for a Future Grid with Abundant Distributed Energy Resources

**Subcommittee on Energy Resources and the Environment**
**NARUC Summer Policy Summit, San Diego**
**July 16, 2017**

Scott Murtishaw, Interim Supervisor
Customer Generation Section
CPUC Energy Division

# Cornerstones of the Distribution Resources Plan

1. *Identify* Available DER Hosting Capacity across the Distribution Grid
   - Replace rules-of-thumb with more sophisticated analytics
2. *Facilitate* Interconnection for DERs with Capacity below Available Hosting Capacity
3. *Identify* Where DERs can Provide the Most Locational Value
4. *Direct* DERs to High-Value Locations
   - Use various procurement and incentive mechanisms

# Integration Capacity Analysis Methodology Development and Working Group Coordination

## 2017 NARUC Summer Policy Summit

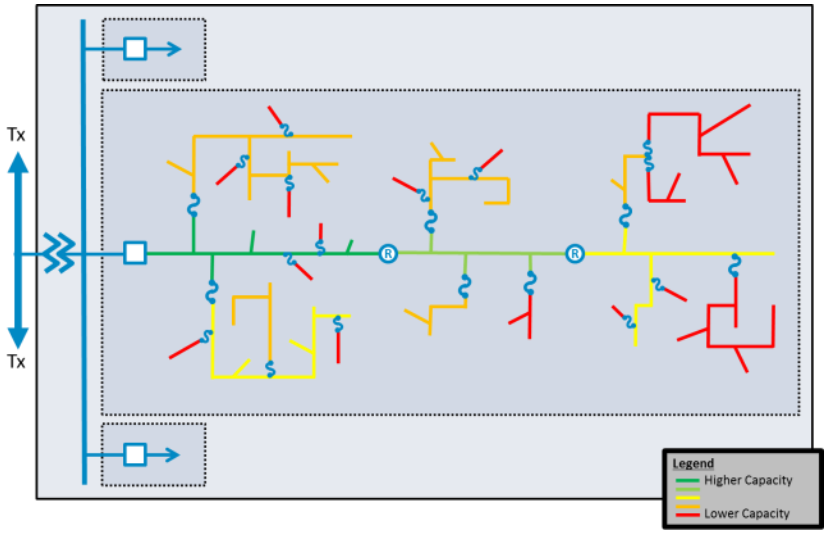
**Mark Esguerra, PE**
Pacific Gas and Electric Company
Grid Integration and Innovation

July 16, 2017

# What does Integration Capacity Analysis (ICA) Evaluate?

## Distribution Resources Plan (DRP) Guidance on ICA

- Specify available hosting capacity on distribution grid
- Results down to line section or node level
- Ability to improve efficiency of interconnection process




## Key Characteristics Required for ICA

- Establish common methodology among utilities
- Avoid ”rule of thumb” approaches
- Incorporate new technologies and DER capabilities (i.e. Smart Inverters)
- Publish results via online maps for customers
- Can be performed on regular intervals system wide

# California DRP Working Groups

## Collaborative Innovation

- Industry working group has been established to get feedback and input to help improve the methodologies
- The working group is public and free to participate
- Information can be found at the two websites below

Pacific Gas and Electric Company
SDGE
Southern California Edison
An Edison International Company
EDF Environmental Defense Fund
Finding the ways that work
A Sempra Energy utility
IREC Interstate Renewable Energy Council
VOTE SOLAR
EPRI Electric Power Research Institute
SolarCity
Clean Coalition

### ICA Working Group Timeline

| 2016 | | | | 2017 | | | |
|---|---|---|---|---|---|---|---|
| Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |

- ACR on ICA Demo
- Ruling on Short Term
- Demo A
- Revised Demo A Plan
- Final Demo A Report
- Short Term (Monthly Meetings)
- ICA Criterion Report
- Status Report on Long Term ICA
- Short Term ICAWG Report
- Long Term Mtgs.
- Long Term ICAWG Report

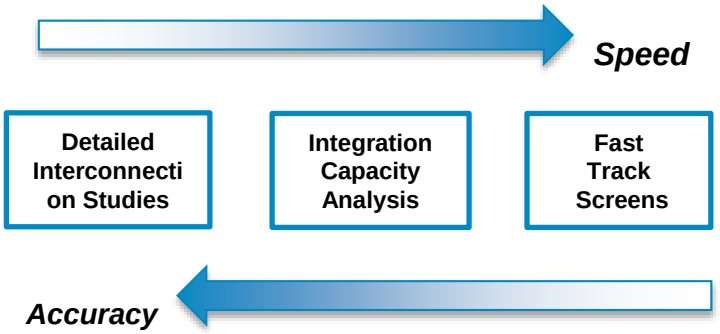
http://www.cpuc.ca.gov/General.aspx?id=5071


MORE THAN SMART

http://drpwg.org/

# Integration Capacity Framework and Principles

## Development of new methodology was required in order to calculate DER Integration Capacity




**Establish Granularity**

**Determine Level of Granularity**
*(e.g., Substation, Feeder, Line Section)*

**Determine Capability of Planning Tools**
*(e.g., Load Profiles, Simulations)*

**Model and Extract Data**

**Model Circuits and Load Profiles**
*(e.g., Weekly Circuit Model Update from GIS Maps, SCADA, AMI)*

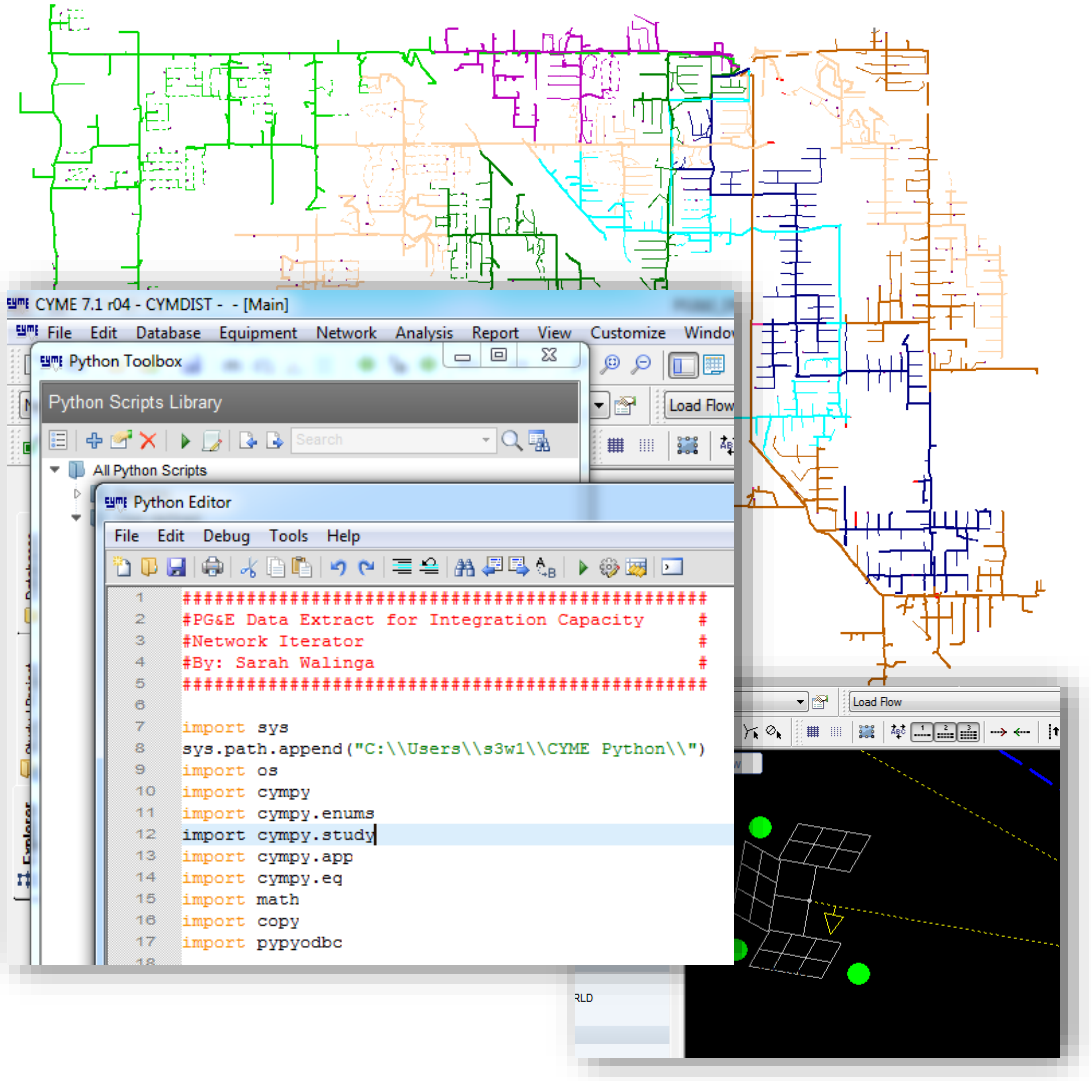
**Extract Power Flow and Electrical Parameters**
*(e.g., Load/Voltage Profiles, Impedance, Fault Duties)*

**Evaluate Criteria**

**Evaluate Criteria**
(*e.g., Thermal, Power Quality, Protection, Safety/Reliability*)

**Publish/Utilize ICA results**
*(e.g., Interconnection Map, DER Planning)*

# Distribution Grid Modeling and Software Tools




## Modeling geospatial distribution circuits is extremely helpful

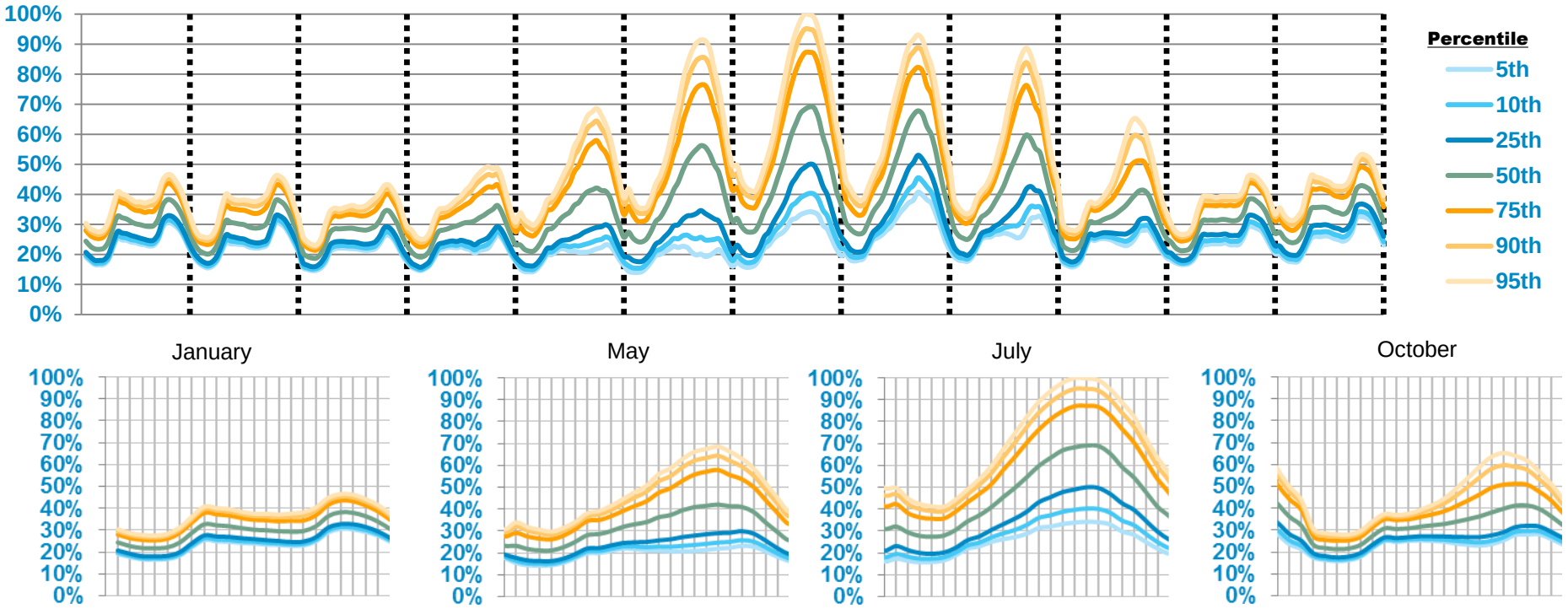
- Customer loading and forecast data downloaded from SmartMeters
- Granular modeling is critical

## Software Tools

- Batch automated power flow is necessary for an efficient ICA
- Scripts needed to properly analyze and extract large amounts of data relevant for ICA

# Analyzing and Understanding Hourly Profiles

- SCADA can be useful, but it's not everywhere
- Smart Meters are useful, but it doesn't tell the whole story
- Raw historical data is useful, but isn't the future
- PG&E utilizes software to provide enhanced load shapes based on metered data and locational variation between customer types and statistical occurrence




Establish Granularity | **Model and Extract Data** | Evaluate Criteria

# Evaluation of Important Power System Criteria

## Various aspects of the power system must be analyzed to determine possible impacts

### Thermal

- Determines limits based on equipment thermal ratings

### Power Quality / Voltage

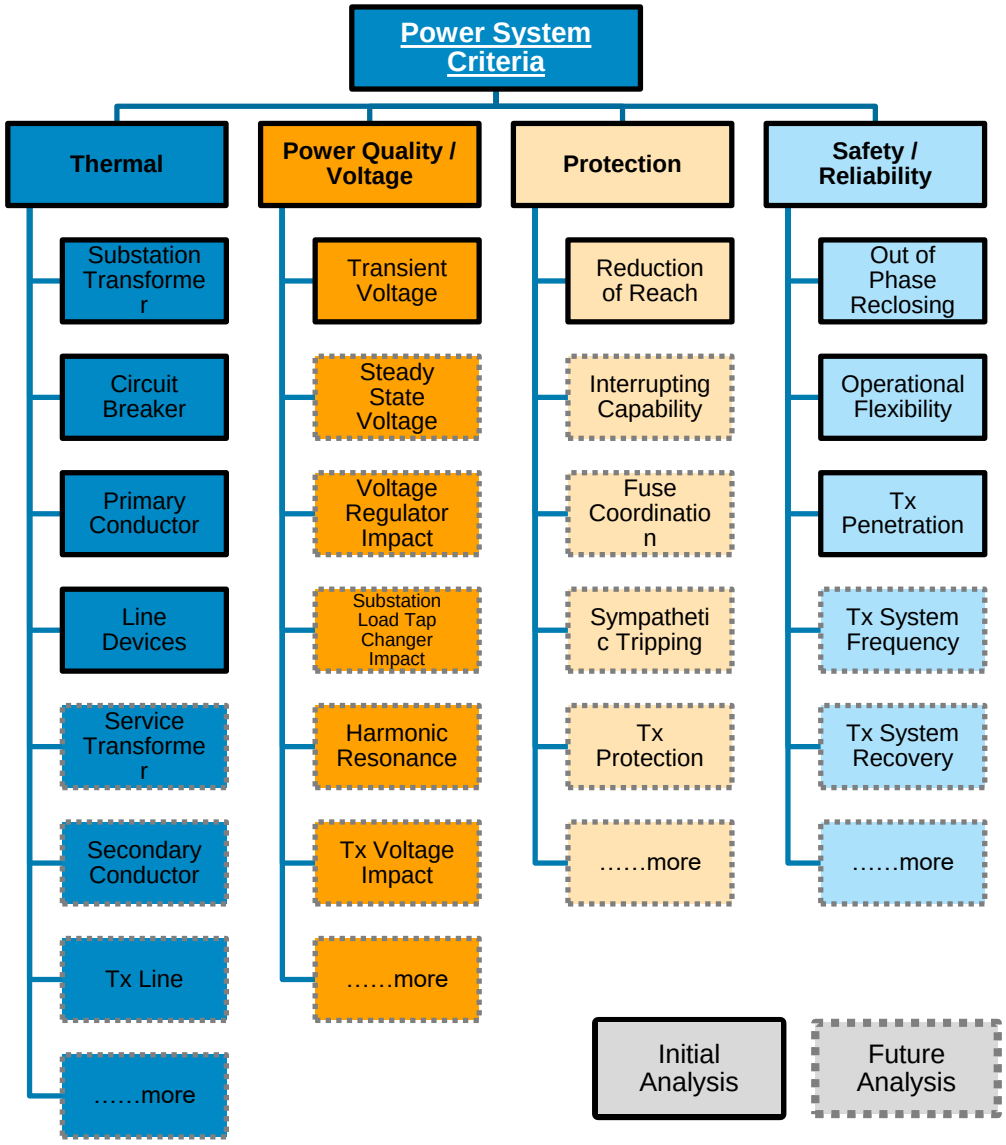
- Determines limits that do not create power quality to operate outside prescribed thresholds

### Protection

- Determines limits that ensure protection equipment can still operate as designed

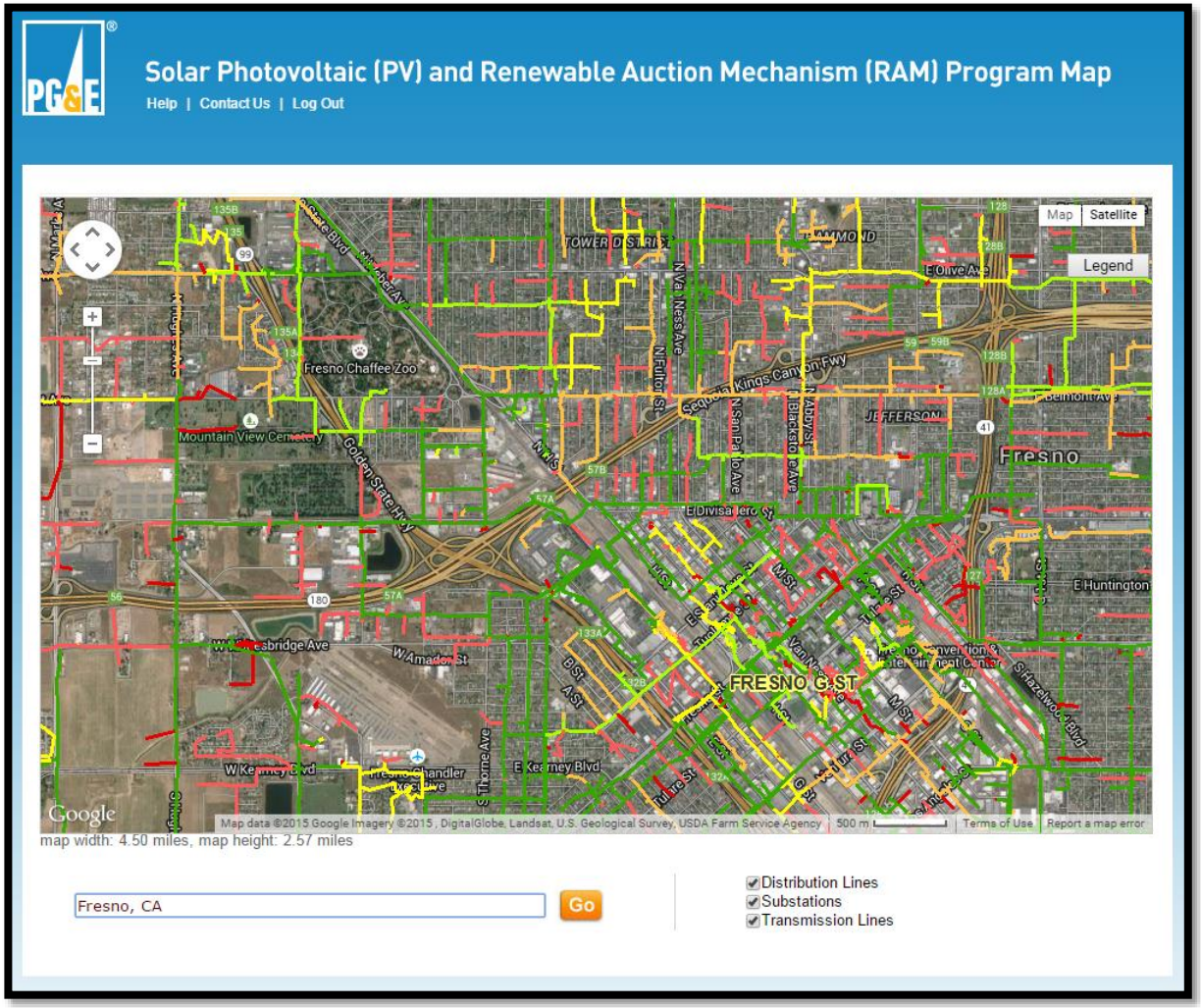
### Safety / Reliability

- Determines limits that reduce impacts to safe and reliable operation of the grid during abnormal conditions




Establish Granularity → Model and Extract Data → Evaluate Criteria

# Integration Capacity Analysis Results

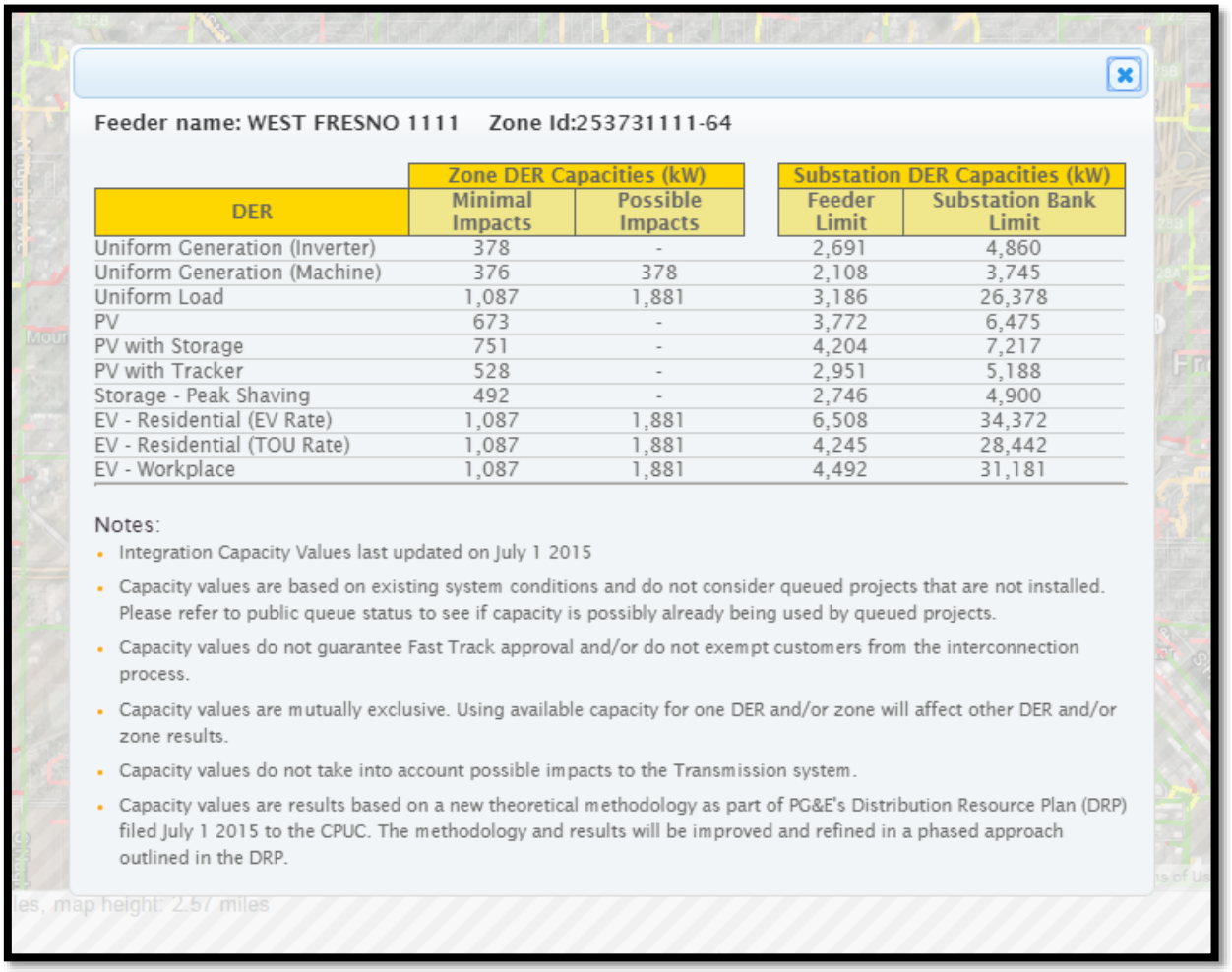



**PG&E analyzed all three phase line sections for about 3,000+ distribution circuits**

- Helps customers and developers in optimally locating DER
- Initially colored by PV Results
- Exploration of new interfaces and data sharing techniques will occur in DRP discussions

***PG&E***: *http://www.pge.com/en/b2b/energysupply/wholesaleelectricsuppliersolicitation/PVRFO/pvmap/index.page*

# Locational Integration Capacity on PG&E Website



Feeder name: WEST FRESNO 1111  Zone Id:253731111-64

| DER | Zone DER Capacities (kW) | | Substation DER Capacities (kW) | |
|---|---|---|---|---|
| | Minimal Impacts | Possible Impacts | Feeder Limit | Substation Bank Limit |
| Uniform Generation (Inverter) | 378 | - | 2,691 | 4,860 |
| Uniform Generation (Machine) | 376 | 378 | 2,108 | 3,745 |
| Uniform Load | 1,087 | 1,881 | 3,186 | 26,378 |
| PV | 673 | - | 3,772 | 6,475 |
| PV with Storage | 751 | - | 4,204 | 7,217 |
| PV with Tracker | 528 | - | 2,951 | 5,188 |
| Storage - Peak Shaving | 492 | - | 2,746 | 4,900 |
| EV - Residential (EV Rate) | 1,087 | 1,881 | 6,508 | 34,372 |
| EV - Residential (TOU Rate) | 1,087 | 1,881 | 4,245 | 28,442 |
| EV - Workplace | 1,087 | 1,881 | 4,492 | 31,181 |

Notes:

- Integration Capacity Values last updated on July 1 2015
- Capacity values are based on existing system conditions and do not consider queued projects that are not installed. Please refer to public queue status to see if capacity is possibly already being used by queued projects.
- Capacity values do not guarantee Fast Track approval and/or do not exempt customers from the interconnection process.
- Capacity values are mutually exclusive. Using available capacity for one DER and/or zone will affect other DER and/or zone results.
- Capacity values do not take into account possible impacts to the Transmission system.
- Capacity values are results based on a new theoretical methodology as part of PG&E's Distribution Resource Plan (DRP) filed July 1 2015 to the CPUC. The methodology and results will be improved and refined in a phased approach outlined in the DRP.

## Provide capacities for 10 different types of DER

- Substation (Bank and Feeder) limits are provided
- Line Section Level results provide a range indicating different capacities based on where interconnection on line section.
- IOU coordination with ICA Working Group will determine best consistent method for result publication this year

***CPUC DRP Page with ICA tabulated Results***: http://www.cpuc.ca.gov/General.aspx?id=5071

# Next Steps for ICA Working Group

Long term work is to create path forward for how ICA progresses in methodology and utilization

- Enhancements of online maps displaying ICA results
- Improve data sharing of ICA (e.g. more accessible and user friendly)
- Incorporation of Smart Inverters and other voltage regulation devices
- Expand methodology to incorporate load modifying resources (e.g. Non generation DER such as EE and DR)
- Improve modeling of DER load profile shapes
- Engage non IOU validation and comparison of hosting capacity results
- Planning Use Case - Establish how ICA is used in the planning context

# Locational Value of DERs

Presentation to:

NARUC Summer Policy Summit,

Staff Subcommittee on Energy Resources and the Environment

July 16, 2017

By:

Dhaval Dagli, Regulatory Affairs, SCE

# Distribution Resources Plan (DRP)

- 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**
  - Other demos
- Policy issues

# Locational Net Benefits Analysis (LNBA) Tool

- Optimal location for DERs = available hosting capacity + locational benefits greater than costs
- LNBA Tool calculates locational benefits on an indicative basis
  - Distribution investment deferral value + locational avoided costs
- 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 Tool – Project Deferral Value Calculation

| | |
|---|---|
| First load forecast year (e.g.: 2016) | 2017 |
| Discount Rate (%/yr) | 7.00% |
| Generic default inflation rate (%/yr) | 2.00% |
| Case to use for allocated hourly costs (Base, Low, High): | Base |
| Deferral Yrs indicated by DER Dashboard | 3 |

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% |
| Cost Information | Base |
| Capital Cost ($000) | $2,000.0 |
| Incremental O&M Cost ($000) | $240.0 |
| Cost yr basis | 2015 |
| Project install/commitment year | 2017 |

User input: Project specific details (equipment type defines project financial assumptions)

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

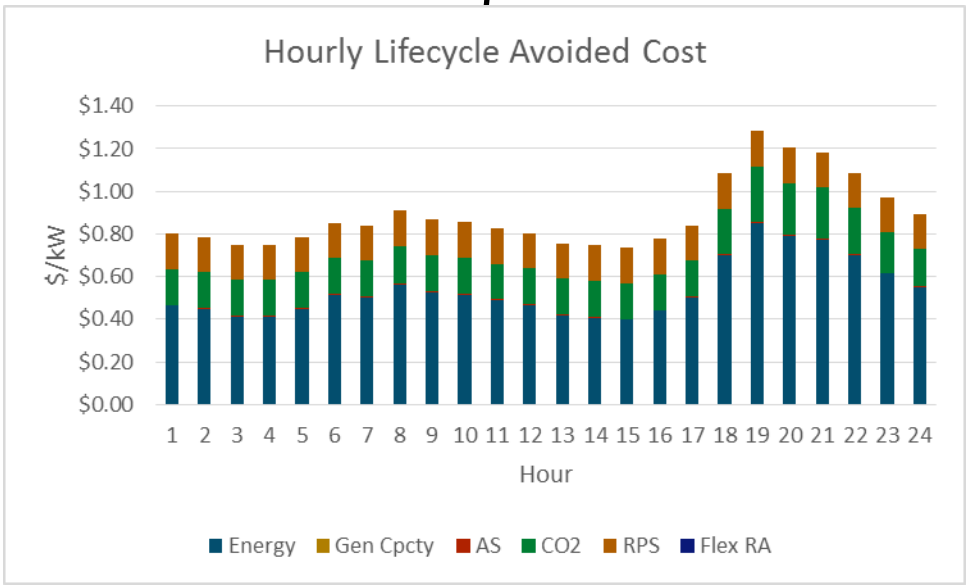
Yearly peak need summarized from user input hourly project need

# LNBA Tool: Other Avoided Costs Calculation

User inputted hourly DER solution profile

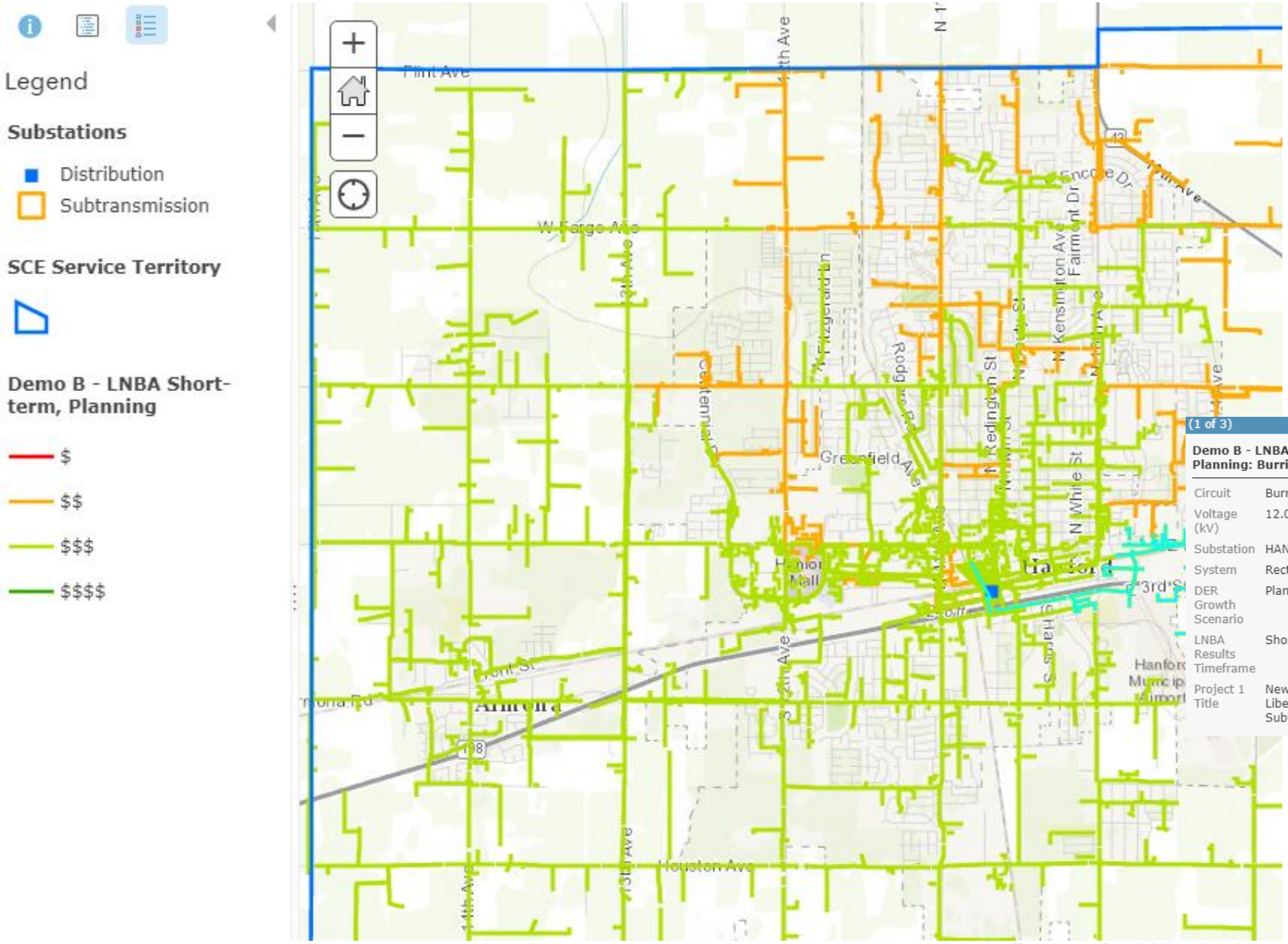
Calculated lifetime hourly avoided cost values

| 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 |




| 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 |

# Heatmap of LNBA Results



# Questions?

Clean Coalition

Making Clean Local Energy Accessible Now

# Locational Net Benefits Assessment & Distribution Infrastructure Deferral

## Limitations, Opportunities & Next Steps

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Clean Coalition
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# LNBA Value Components

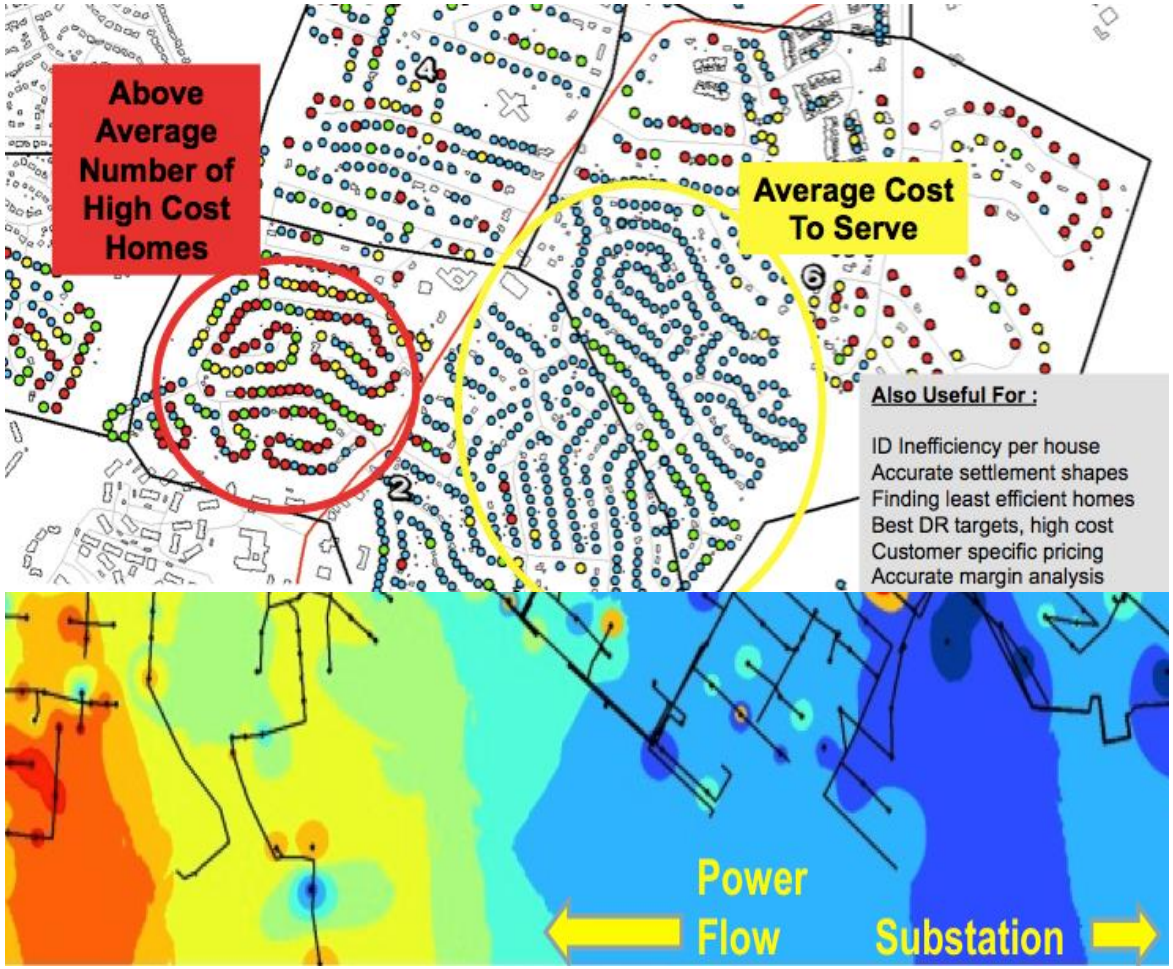
*Value categories are refined and adjusted for local variation*

**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**

# LNBA Value Components

*Value categories are refined and adjusted for local variation*




| | |
|---|---|
| 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 - Distribution Marginal Cost Impacts

Clean Coalition

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

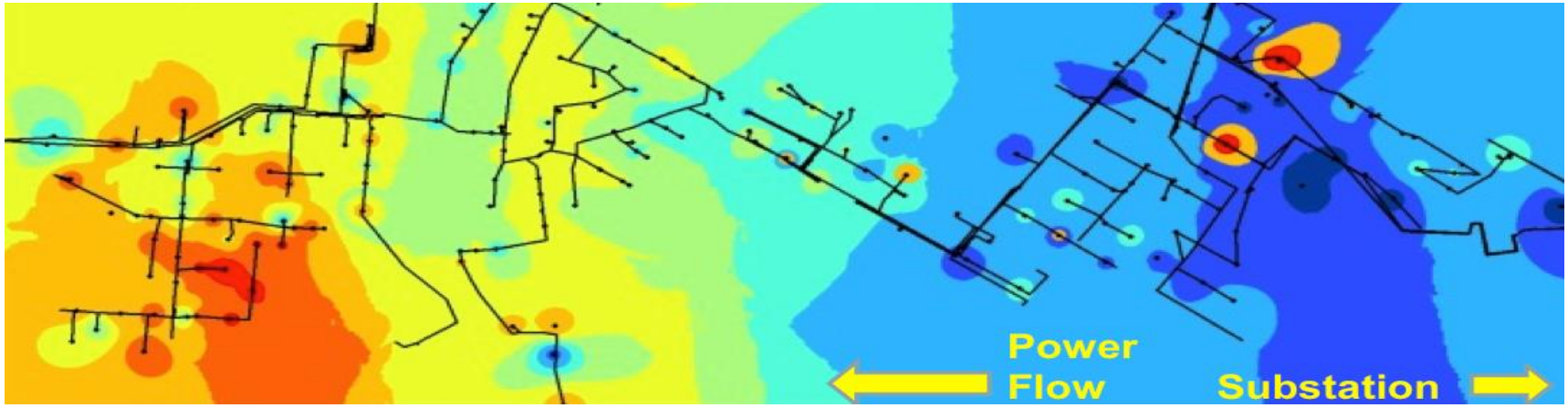
**Time**

*Minutes*

*Hours*

*Months*

*Years*



# Distribution Infrastructure Deferral Evaluation

Clean Coalition

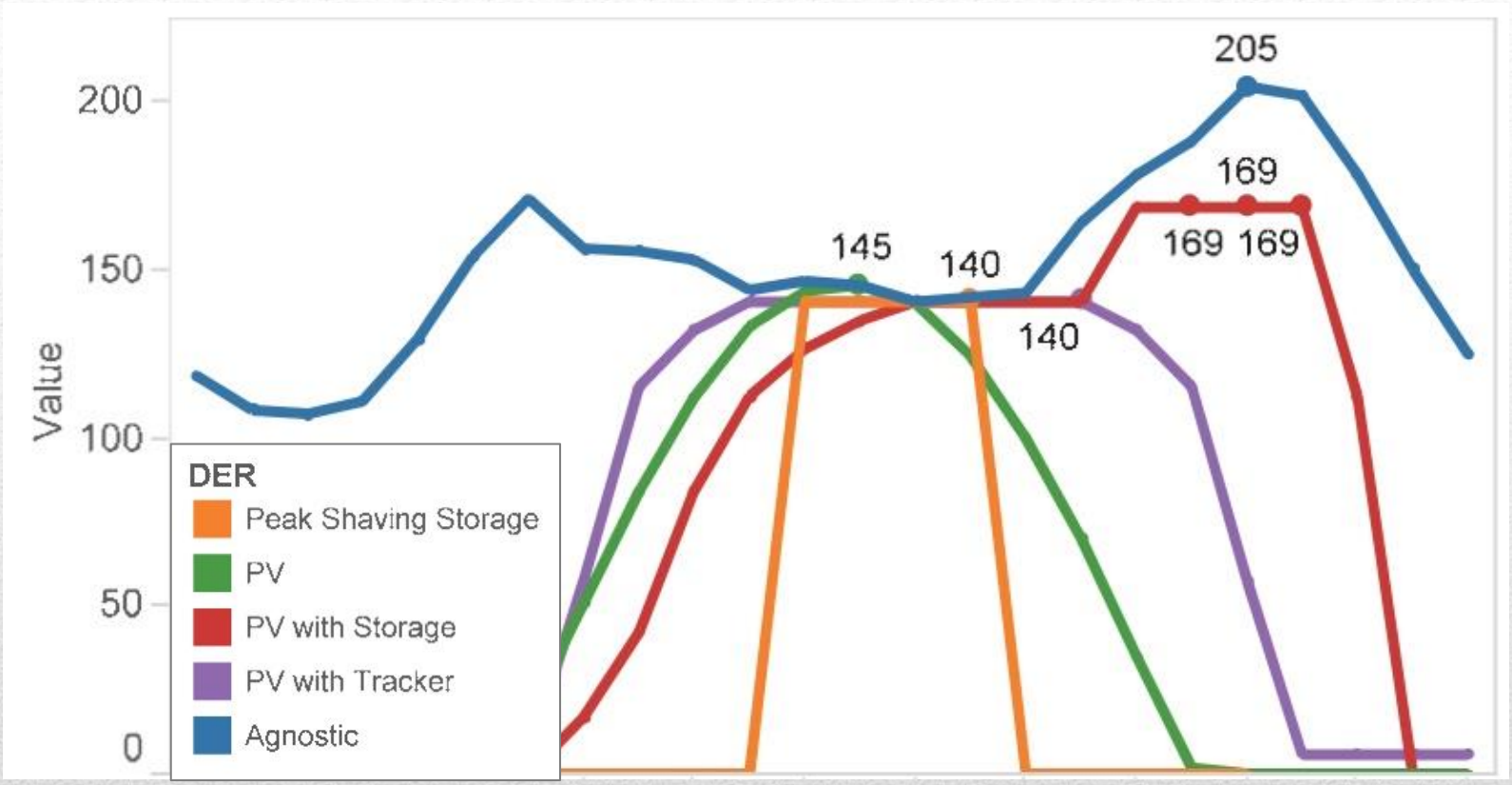
## Project Screening & Selection Process

| Scoring Metrics | Features | Higher Viability |
|---|---|---|
| Screen 1: Technical<br>(Which projects have DER options) | Four DER services: Capacity, Voltage, Reliability, Micro-grid | Thermal mitigation service |
| Screen 2: Project Timing<br>(rules out many potential projects) | Sufficient lead time within planning cycle | 3-5 years<br>Allows for procurement & Contingency options |
| DER Attribute Requirements | DER capacity to deferral ratio (MW/MWh reduction, duration, & timing profile) | Lower DER capacity requirement & Higher siting potential |
| Project Timing Certainty | volatility in historic and forecast load growth | Nearer term need &<br>Low volatility |
| Financial Assessment | Higher deferral value | Expensive projects/DER capacity |
| Customer Composition<br>(Market Assessment) | High load reduction to participant ratio | Customers with large loads |
| Distribution Topology | Geographic and customer range | Larger area & number of potential participants (substation needs) |

# Distribution Resources Planning in California

CALIFORNIA SOLAR ENERGY INDUSTRIES ASSOCIATION

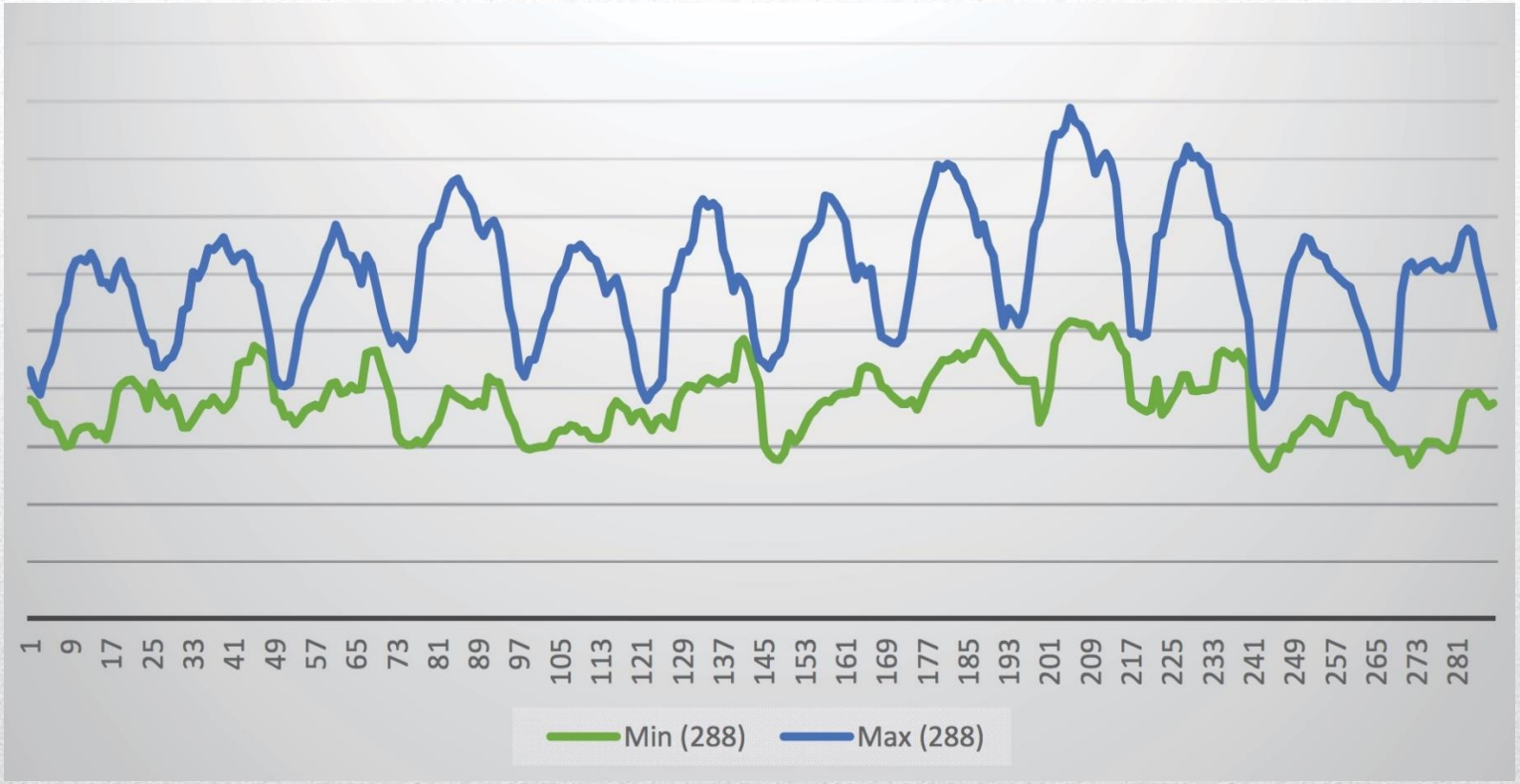
Brad Heavner
Policy Director, CALSEIA
July 16, 2017




# Integration Capacity Analysis Values



Source: PG&E ICA Report Dec 2016




# Circuit Load Profile – 576 Hours Per Year



Source: SCE ICA Report Dec 2016

# Measuring Locational Value

| Date & time (Hour Beg) | 2025 | 2026 | | | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3/1/13 21:00 | 3,676 | 3,750 | | | 438 | 500 | 564 | 630 | 696 | 764 | 833 | 904 | 976 | 1,050 |
| 3/1/13 22:00 | 3,529 | 3,600 | | | 312 | 372 | 434 | 497 | 561 | 626 | 692 | 760 | 829 | 900 |
| 3/1/13 23:00 | 3,376 | 3,443 | | | 181 | 239 | 298 | 357 | 419 | 481 | 545 | 609 | 676 | 743 |
| 3/2/13 0:00 | 3,243 | 3,308 | | | 68 | 123 | 179 | 237 | 296 | 356 | 417 | 479 | 543 | 608 |
| 3/2/13 1:00 | 3,072 | 3,133 | | | - | - | 28 | 82 | 138 | 195 | 252 | 311 | 372 | 433 |
| 3/2/13 2:00 | 2,889 | 2,946 | | | - | - | - | - | - | 22 | 76 | 132 | 189 | 246 |
| 3/2/13 3:00 | 2,736 | 2,791 | | | - | - | - | - | - | - | - | - | 36 | 91 |
| 3/2/13 4:00 | 2,624 | 2,676 | | | - | - | - | - | - | - | - | - | - | - |
| 3/2/13 5:00 | 2,533 | 2,584 | | | - | - | - | - | - | - | - | - | - | - |
| 3/2/13 6:00 | 2,480 | 2,530 | | | - | - | - | - | - | - | - | - | - | - |
| 3/2/13 7:00 | 2,572 | 2,623 | | | - | - | - | - | - | - | - | - | - | - |
| 3/2/13 8:00 | 2,857 | 2,914 | | | - | - | - | - | - | - | 46 | 101 | 157 | 214 |
| 3/2/13 9:00 | 3,241 | 3,306 | | | 66 | 122 | 178 | 236 | 295 | 354 | 415 | 478 | 541 | 606 |
| 3/2/13 10:00 | 3,631 | 3,703 | | | 399 | 461 | 524 | 588 | 654 | 721 | 790 | 860 | 931 | 1,003 |
| 3/2/13 11:00 | 3,971 | 4,050 | | | 689 | 757 | 826 | 896 | 968 | 1,042 | 1,117 | 1,193 | 1,271 | 1,350 |
| 3/2/13 12:00 | 4,228 | 4,313 | | | 909 | 981 | 1,055 | 1,130 | 1,206 | 1,284 | 1,364 | 1,445 | 1,528 | 1,613 |
| 3/2/13 13:00 | 4,412 | 4,501 | | | 1,066 | 1,141 | 1,218 | 1,296 | 1,376 | 1,458 | 1,541 | 1,626 | 1,712 | 1,801 |
| 3/2/13 14:00 | 4,554 | 4,645 | | | 1,187 | 1,265 | 1,344 | 1,425 | 1,507 | 1,592 | 1,677 | 1,765 | 1,854 | 1,945 |
| 3/2/13 15:00 | 4,628 | 4,721 | | | 1,250 | 1,329 | 1,410 | 1,492 | 1,576 | 1,661 | 1,748 | 1,837 | 1,928 | 2,021 |
| 3/2/13 16:00 | 4,567 | 4,658 | | | 1,198 | 1,276 | 1,355 | 1,436 | 1,519 | 1,603 | 1,689 | 1,777 | 1,867 | 1,958 |
| 3/2/13 17:00 | 4,328 | 4,415 | | | 994 | 1,068 | 1,143 | 1,220 | 1,299 | 1,378 | 1,460 | 1,543 | 1,628 | 1,715 |
| 3/2/13 18:00 | 3,986 | 4,066 | | | 702 | 770 | 840 | 911 | 983 | 1,056 | 1,132 | 1,208 | 1,286 | 1,366 |
| 3/2/13 19:00 | 3,679 | 3,753 | | | 440 | 503 | 567 | 632 | 699 | 767 | 836 | 907 | 979 | 1,053 |
| 3/2/13 20:00 | 3,460 | 3,529 | | | 253 | 312 | 372 | 434 | 496 | 560 | 625 | 692 | 760 | 829 |
| 3/2/13 21:00 | 3,312 | 3,378 | | | 127 | 183 | 241 | 300 | 360 | 421 | 483 | 547 | 612 | 678 |
| 3/2/13 22:00 | 3,174 | 3,237 | | | 9 | 63 | 118 | 175 | 232 | 291 | 350 | 411 | 474 | 537 |
| 3/2/13 23:00 | 3,075 | 3,136 | | | - | - | 30 | 85 | 140 | 197 | 255 | 314 | 375 | 436 |
| 3/3/13 0:00 | 3,011 | 3,071 | | | - | - | - | 27 | 81 | 137 | 194 | 252 | 311 | 371 |
| 3/3/13 1:00 | 2,897 | 2,955 | | | - | - | - | - | - | 30 | 85 | 141 | 197 | 255 |
| 3/3/13 2:00 | 2,774 | 2,829 | | | - | - | - | - | - | - | - | 19 | 74 | 129 |
| 3/3/13 3:00 | 2,634 | 2,687 | | | - | - | - | - | - | - | - | - | - | - |
| 3/3/13 4:00 | 2,519 | 2,569 | | | - | - | - | - | - | - | - | - | - | - |

# Load Reduction Need in LNBA Tool

- Where are there constraints that are difficult to surmount?
- Where will capacity additions be more expensive?
- Where is long-term load growth expected?
- In which areas would DER grid services be most effective?

# Regional Considerations

# Thank you!

CALSEIA
CALIFORNIA SOLAR ENERGY INDUSTRIES ASSOCIATION

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# Staff Subcommittee on Energy Resources and the Environment

NARUC Summer Policy Summit