Clean Coalition
Making Clean Local Energy Accessible Now

Peninsula Advanced Energy Community (PAEC)
Streamlining the interconnection of advanced energy solutions to the grid

Sahm White, Clean Coalition

June 5, 2018

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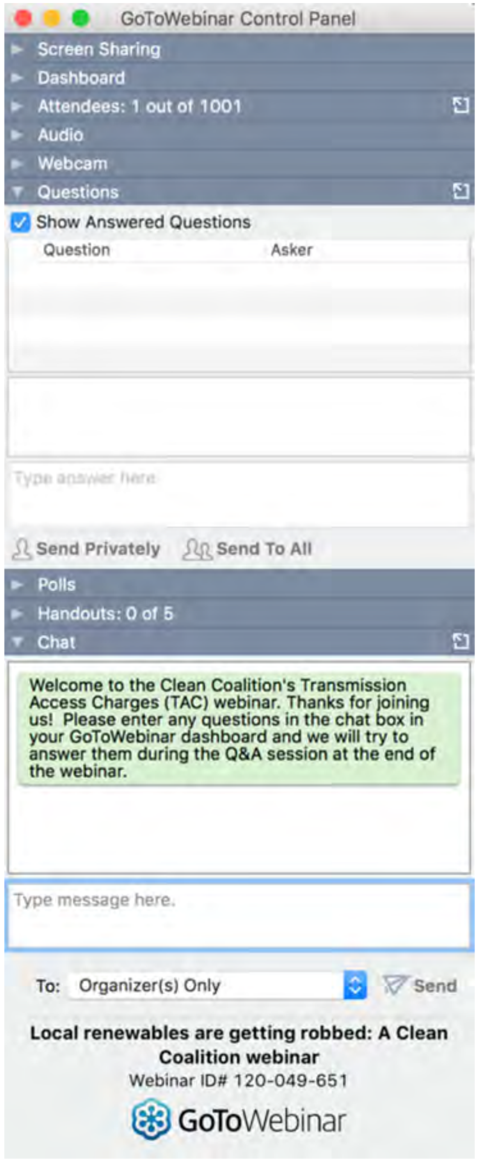

Today's presenter

Sahm White is Economics & Policy Analysis Director for the Clean Coalition. He brings over 20 years experience in economic and environmental policy, with over 200 filings before public utility and energy commissions. Prior to joining the Clean Coalition, Sahm held positions as a Senior Research Consultant to the Center for Ecoliteracy, Technical and Policy Analyst in the development of the Ecological Footprint, and Associate Director of Progressive Secretary, a leading web source of legislative constituent engagement.

Questions?

For questions and assistance about today's webinar, contact:

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Clean Coalition Mission

Clean Coalition

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

The Clean Coalition is a nonprofit organization representing ratepayer's environmental interests

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PENINSULA ADVANCED ENERGY COMMUNITY (PAEC)

TASK 4: FINAL BEST PRACTICES: INTERCONNECTION FOR LOCAL, COMMERCIAL-SCALE, RENEWABLE ENERGY PROJECTS

STREAMLINING THE INTERCONNECTION OF ADVANCED ENERGY SOLUTIONS TO THE GRID

PAEC Interconnection Best Practices Report

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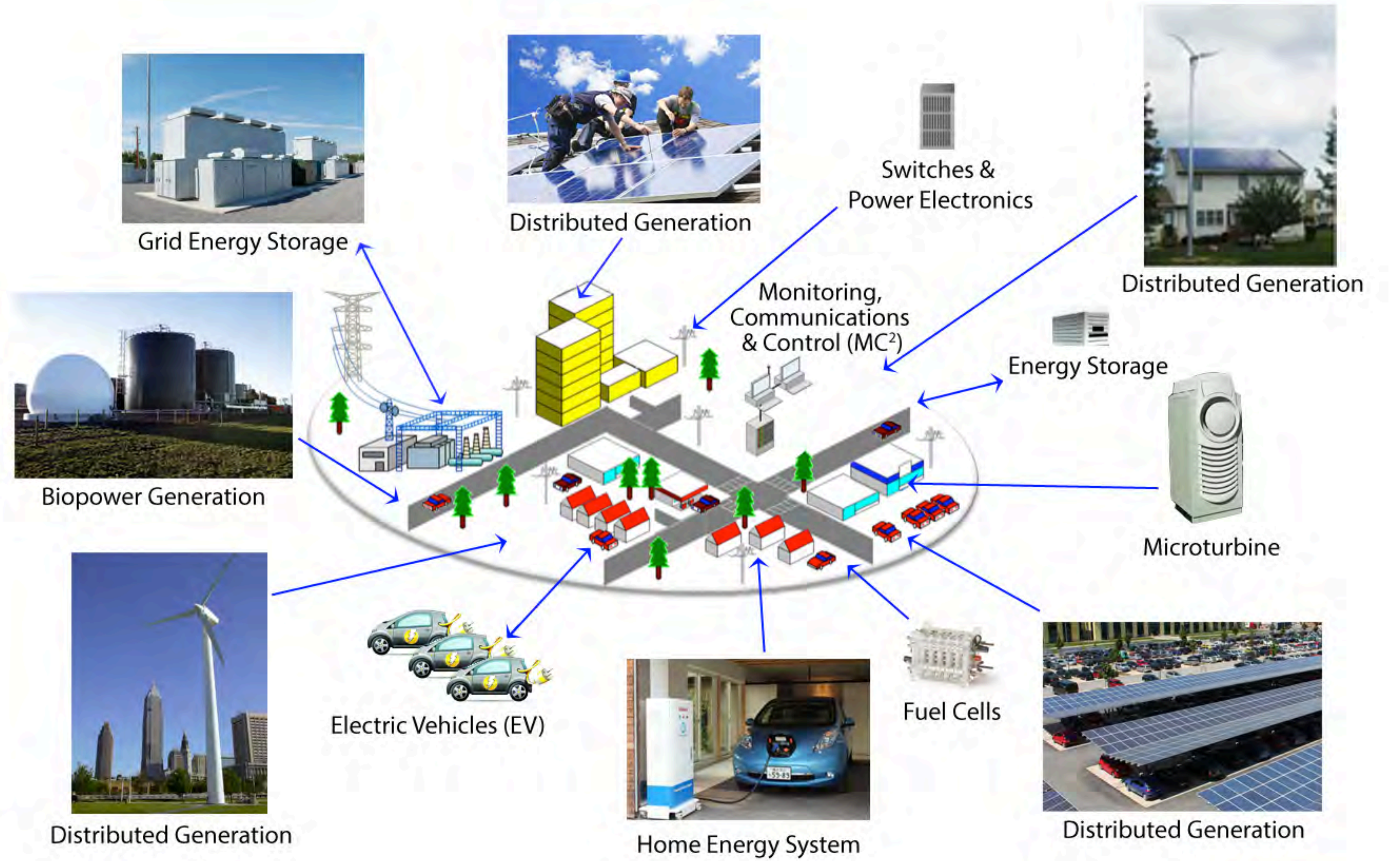
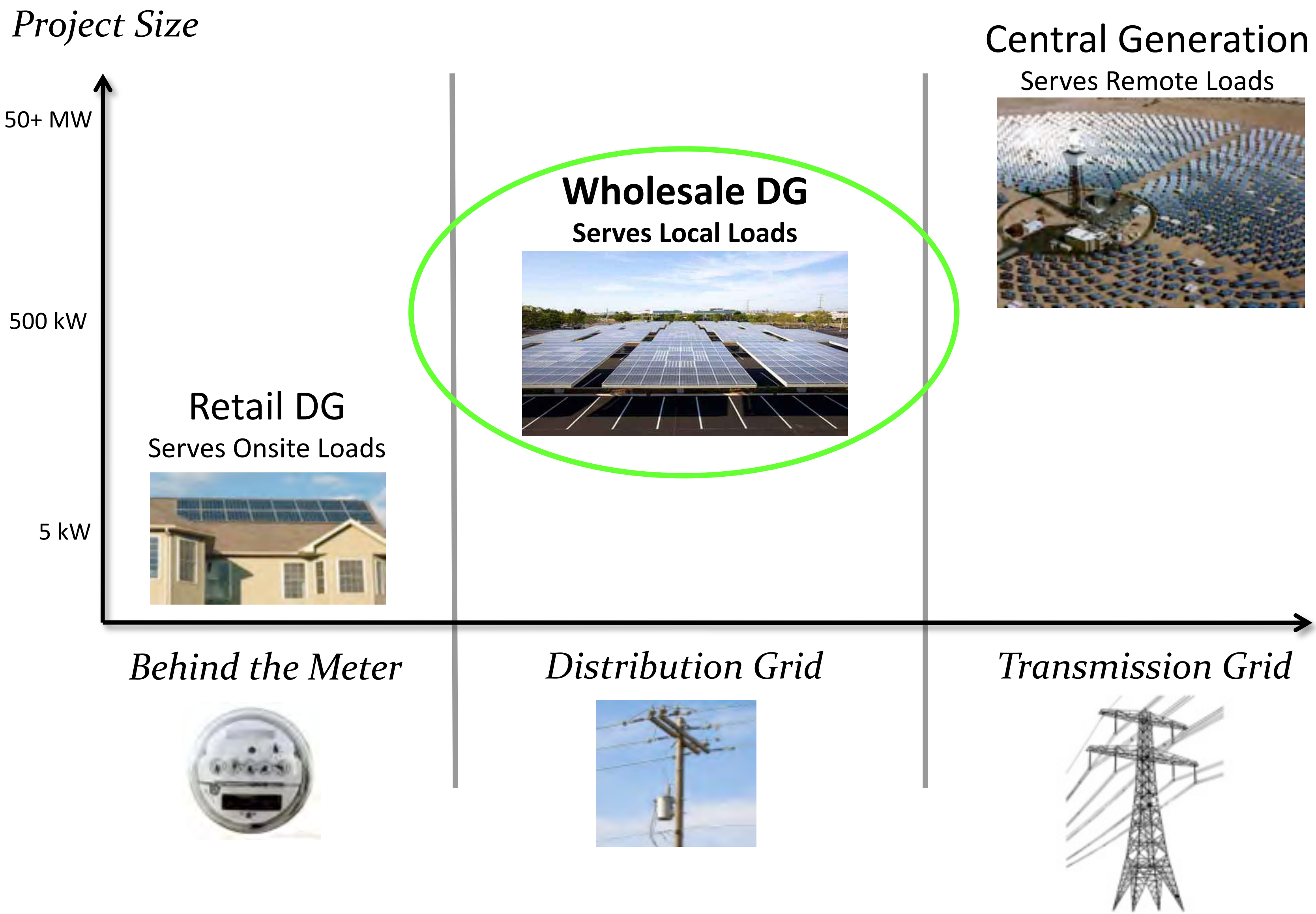
Topics Covered -

- Opportunity for faster cheaper development of renewables
- Importance of streamlining interconnection
- Review: Best practices for interconnecting small WDG
    - Information sharing processes
    - Transparent application and review processes
    - Predictable and Reasonable Timelines
    - Queue management
    - Dispute resolution procedures
    - Cost-certainty
    - Cost-sharing for Electrically Related Projects
    - Automation and online interconnection portals
- Model Interconnection Process for small WDG
- Recommendations not yet implemented

Distributed Energy Resources (DER)



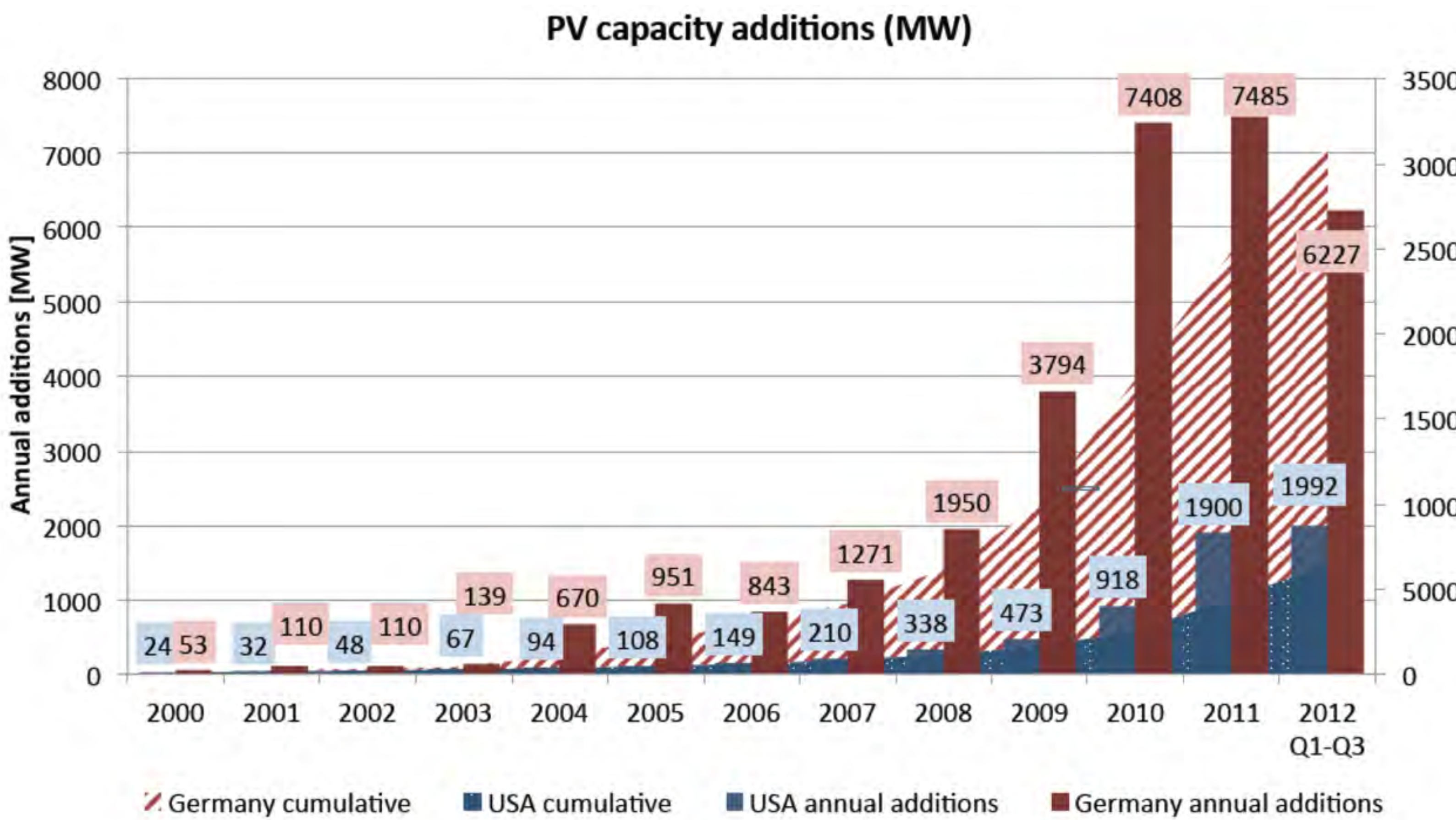
Wholesale DG market segment



Germany Demonstrates Opportunity

Germany's annual additions were consistently 4x greater than US additions

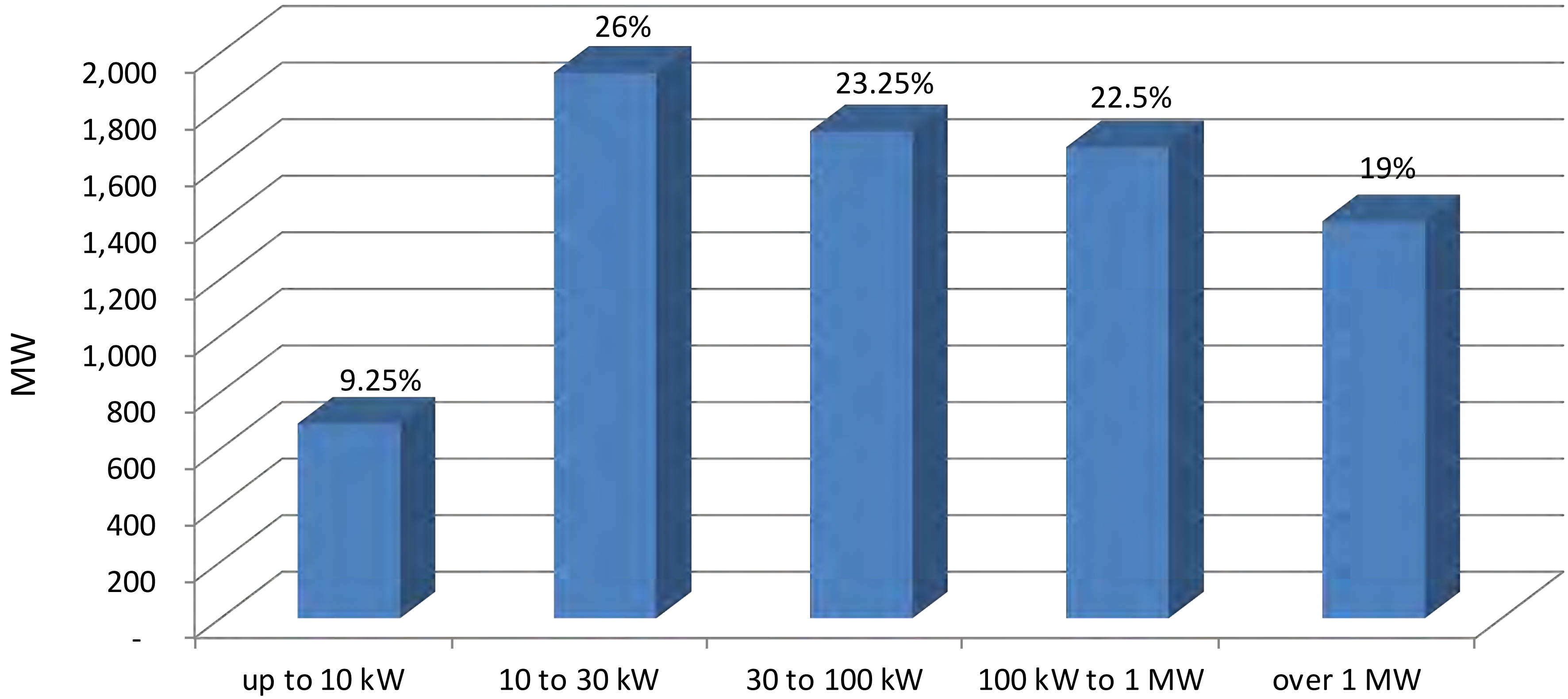
(Due to dramatically lower soft costs, including rapid interconnection and cost certainty, in response to comparable compensation offers)



Source: DOE SunShot

German solar is mostly local (on rooftops)

German Solar Capacity Installed through 2012



Source: Paul Gipe, March 2011

Germany's solar deployments are almost entirely sub-2 MW projects on built environments and interconnected to the distribution grid (not behind-the-meter)

German rooftop solar is 4 to 6 cents/kWh today

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Project Size	Euros/kWh	USD/kWh	California Effective Rate $/kWh
Under 10 kW	0.1270	0.1359	0.0628
10 kW to 40 kW	0.1236	0.1323	0.0611
40.1 kW to 750 kW	0.1109	0.1187	0.0548
Other projects up to 750 kW*	0.0891	0.0953	0.0440

- Conversion rate for euros to dollars is €1:$1.07
- California's effective rate is reduced 40% due to tax incentives and then an additional 33% due to the superior solar resource

Replicating German scale and efficiencies would yield rooftop solar today at only between 4 and 6 cents/kWh to California ratepayers

* For projects that are not sited on residential structures or sound barriers.

Wholesale DG has Superior Value

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Total Ratepayer Cost of Solar

	Distribution Grid					T-Grid
PV Project size and type	100 kW roof	500 kW roof	1 MW roof	1 MW ground	5 MW ground	50 MW ground
Required PPA Rate	12-15¢	9-12¢	8-10¢	6-8¢	4-7¢	3-6¢
T&D costs	0¢	0¢	0¢	0¢	0¢	2-4¢
Ratepayer cost per kWh	12-15¢	9-12¢	8-10¢	6-8¢	4-7¢	5-10¢

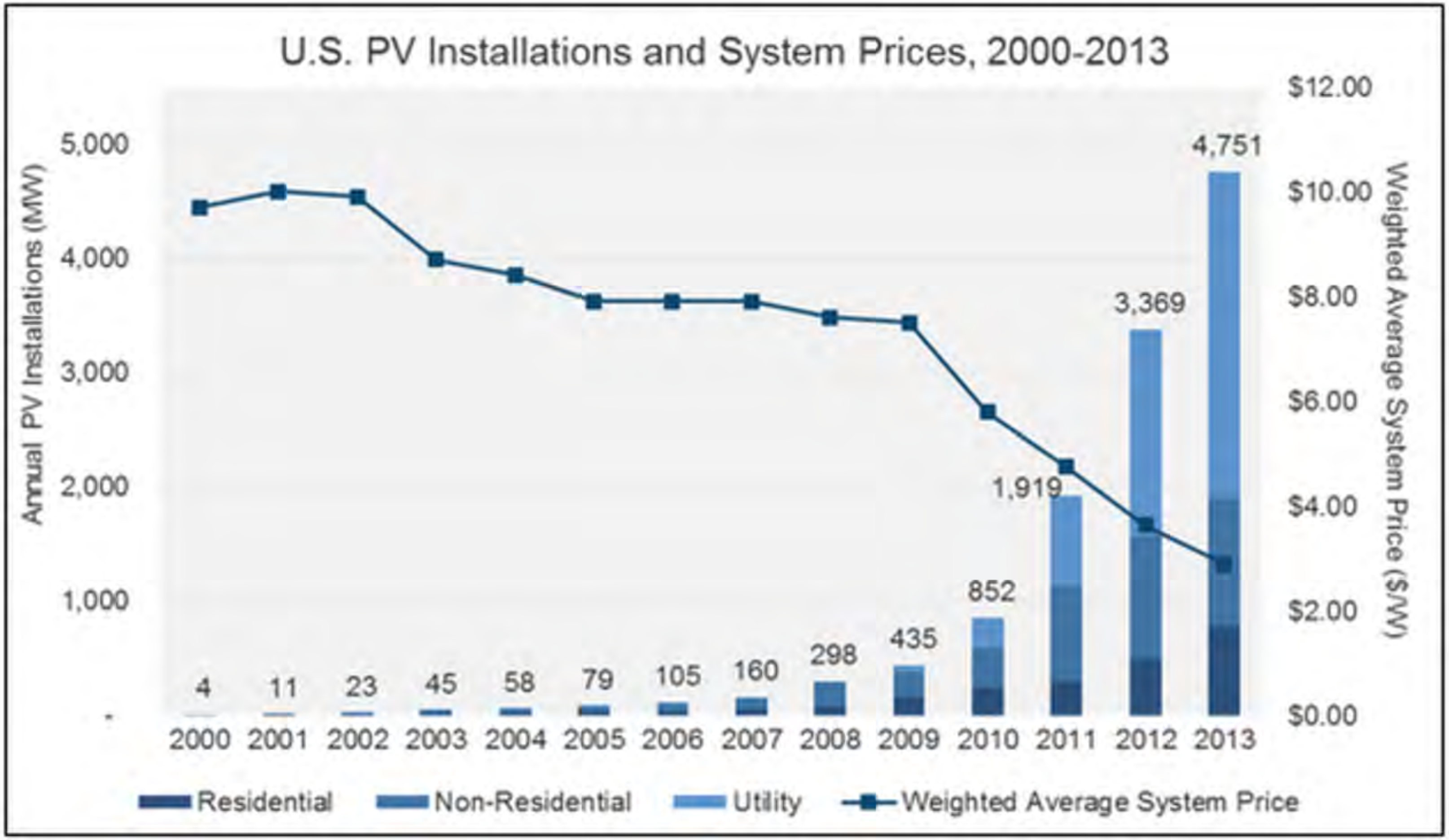
Sources: CAISO, CEC, CPUC and Clean Coalition

The most cost-effective solar is large WDG, not central station due to significant hidden T&D costs

Why Interconnection Matters

Addressing growing demand

- 245,358 solar projects in California as of Oct 8, 2014



Source: CSI, SIEA US Solar Market Insight: 2013 Year-in-Review

Why Interconnection Matters

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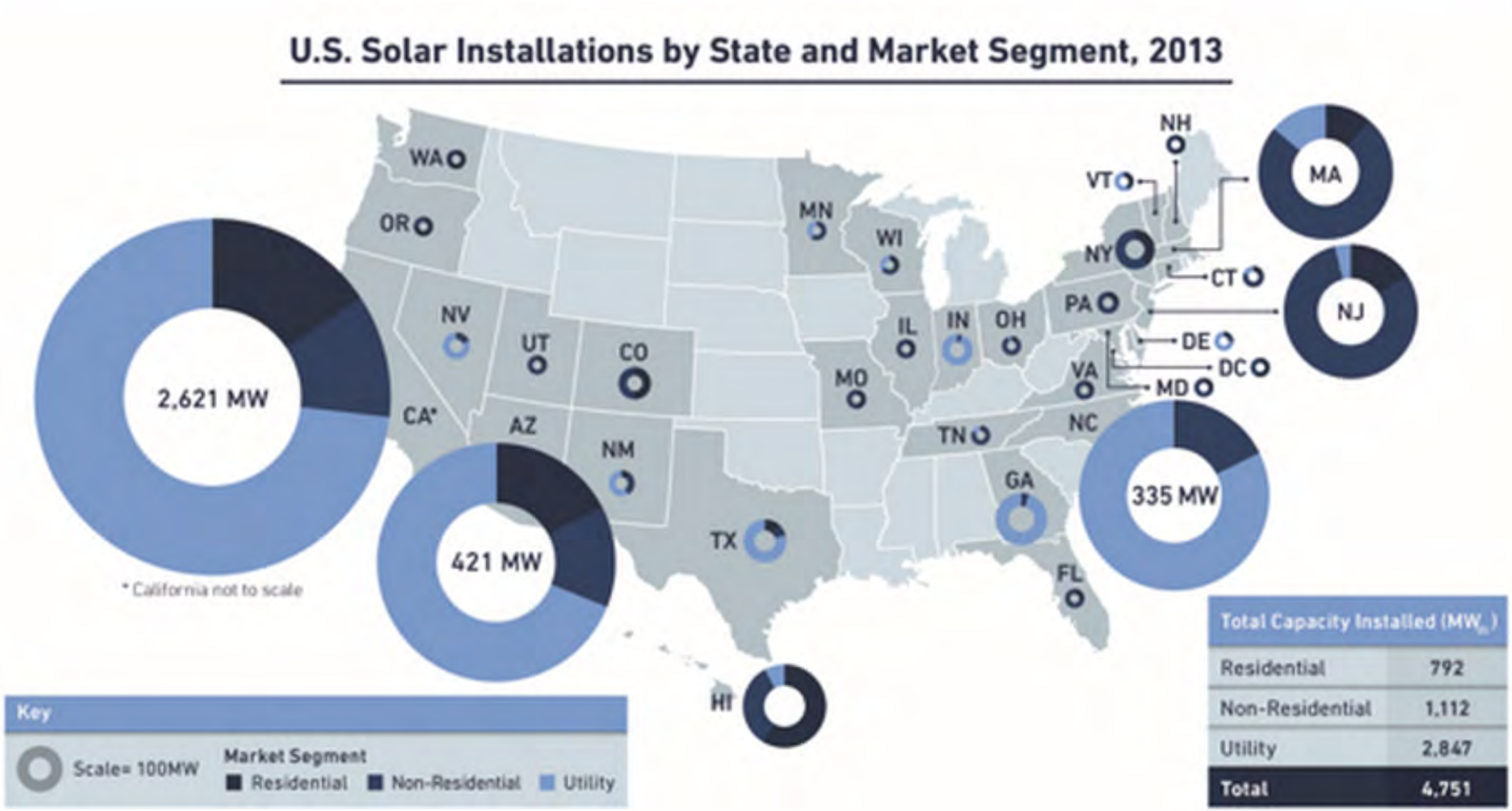
Some states are leading the curve but all states are on a similar curve
Commercial and residential scale PV represent similar total capacity



WDG Market awaits: Top 25 Roofs in LA = 75 MW

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Rank	Potential Size (kW)	Address	Description
1	6,987	300 WESTMONT DR	Warehousing, Distribution, Storage
2	6,296	3880 N MISSION RD	Warehousing, Distribution, Storage
3	4,797	400 WESTMONT DR	Warehousing, Distribution, Storage
4	4,524	20525 NORDHOFF ST	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
5	4,402	2501 S ALAMEDA ST	Warehousing, Distribution, Storage
6	3,771	4544 COLORADO BLVD	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
7	3,629	1800 N MAIN ST	Warehousing, Distribution, Storage
8	3,597	5500 CANOGA AVE	Heavy Manufacturing
9	3,596	20333 NORMANDIE AVE	Food Processing Plants
10	3,366	8500 BALBOA BLVD	Heavy Manufacturing
11	3,351	6600 TOPANGA CANYON BLVD	Shopping Centers (Regional)
12	3,313	401 WESTMONT DR	Warehousing, Distribution, Storage
13	3,052	9301 TAMPA AVE	Shopping Centers (Regional)
14	2,806	11428 SHERMAN WAY	Warehousing, Distribution, Storage
15	2,703	3820 UNION PACIFIC AVE	Heavy Manufacturing
16	2,693	1601 E OLYMPIC BLVD	Warehousing, Distribution, Storage
17	2,673	9120 MASON AVE	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
18	2,672	12745 ARROYO ST	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
19	2,431	5525 W IMPERIAL HWY	Heavy Manufacturing
20	2,430	8201 WOODLEY AVE	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
21	2,404	8900 DE SOTO AVE	Heavy Manufacturing
22	2,201	3410 N SAN FERNANDO RD	Lgt Manf.Sm. EQPT. Manuf Sm.Shps Instr.Manuf. Prnt Plnts
23	2,171	12820 PIERCE ST	Warehousing, Distribution, Storage
24	2,149	4024 RADFORD AVE	Motion Picture, Radio & Television
25	2,126	3020 E WASHINGTON BLVD	Heavy Manufacturing

100+ GW of built environment solar potential in California vs 60 gw of peak load

A peek of the future

Ecoplexus project at the Valencia Gardens Apartments in SF. ~800 kW meeting ~80% of the total annual load.

This section of the circuit is now at maximum capacity, but coordinated DER will allow even higher PV penetration when standards are adopted.

Why Interconnection Matters

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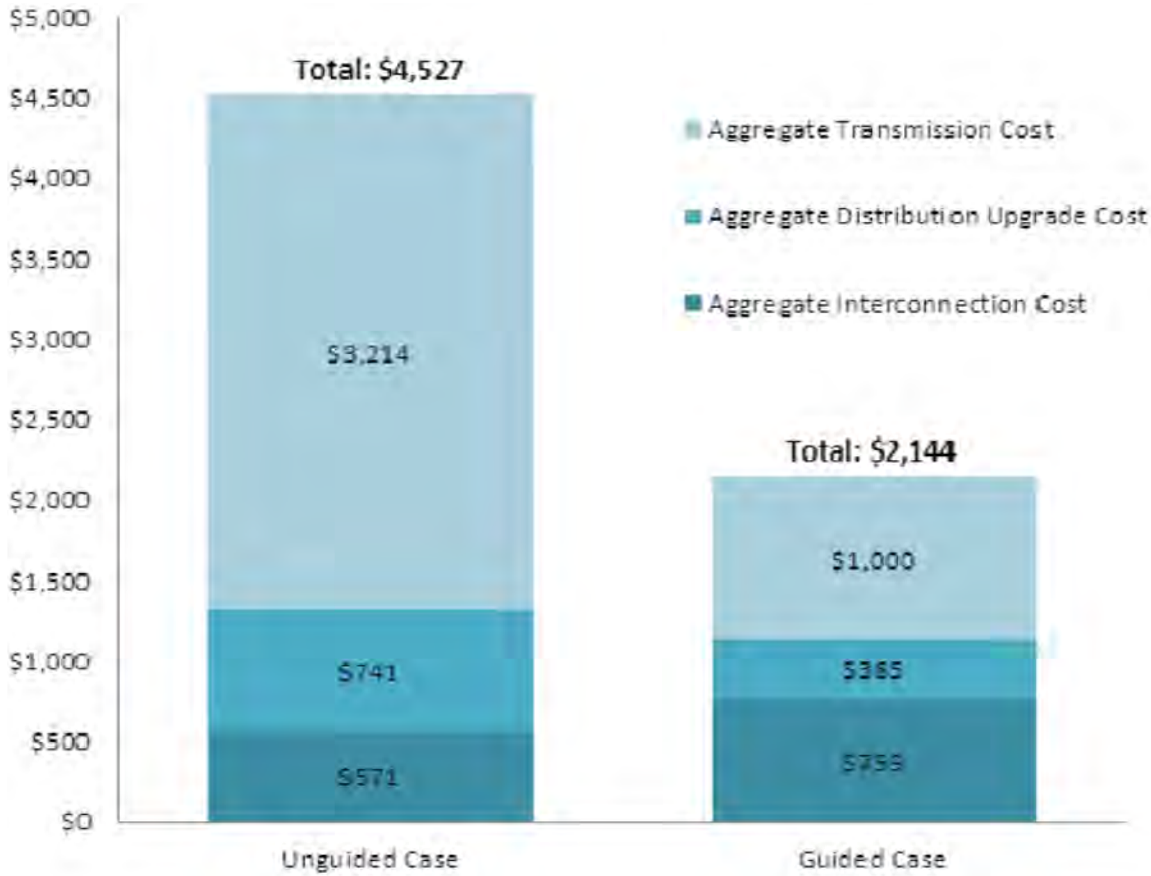
Location Matters for Applicants & Ratepayers

- Southern California Edison found that siting renewables projects closer to consumers could reduce their T&D upgrade costs by over $2 billion

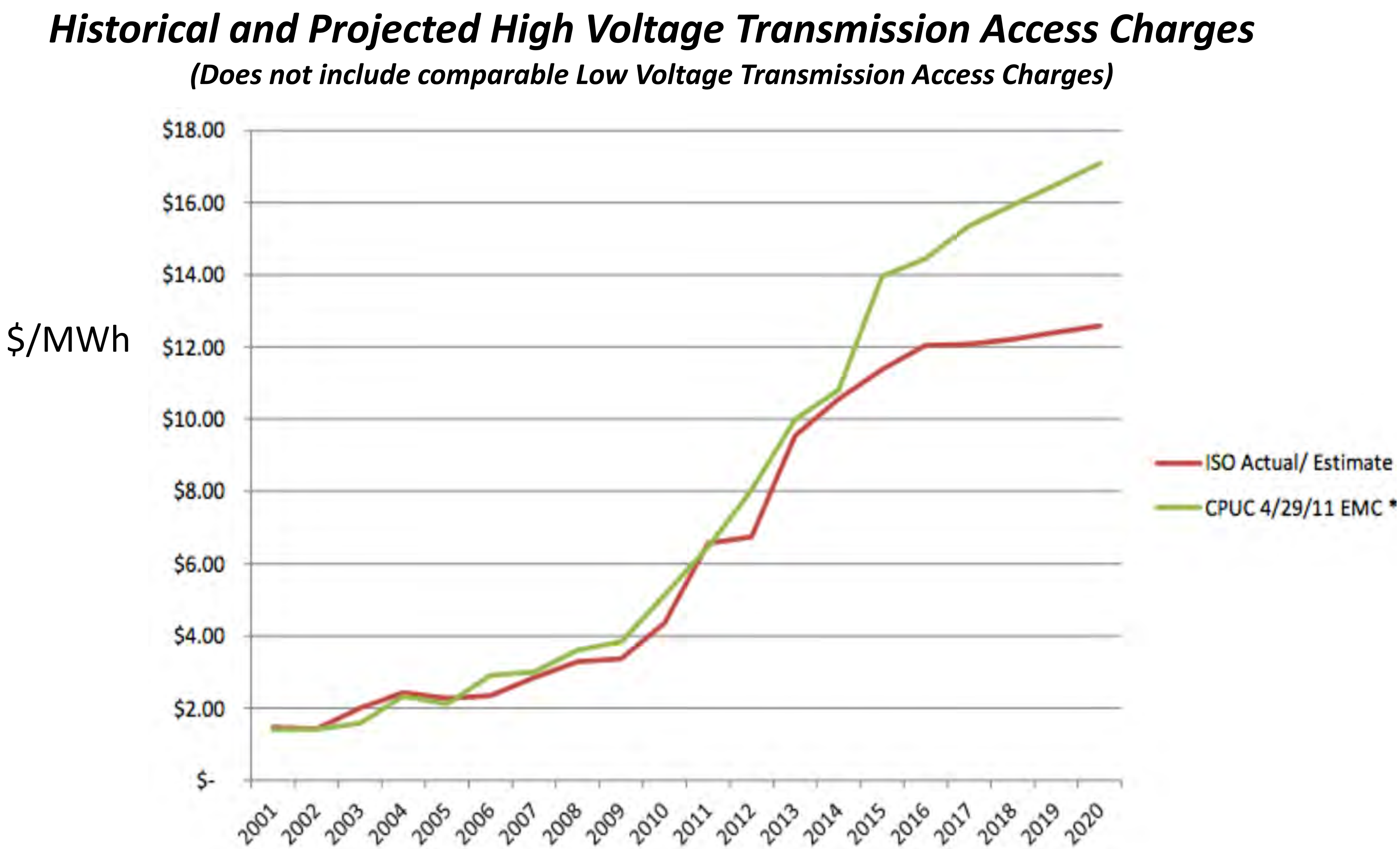


Source: Southern California Edison (2012)

Transmission costs would be borne by ratepayers

Why Interconnection Matters

Opportunity to reduce transmission costs



Interconnection Policies Vary Nationwide

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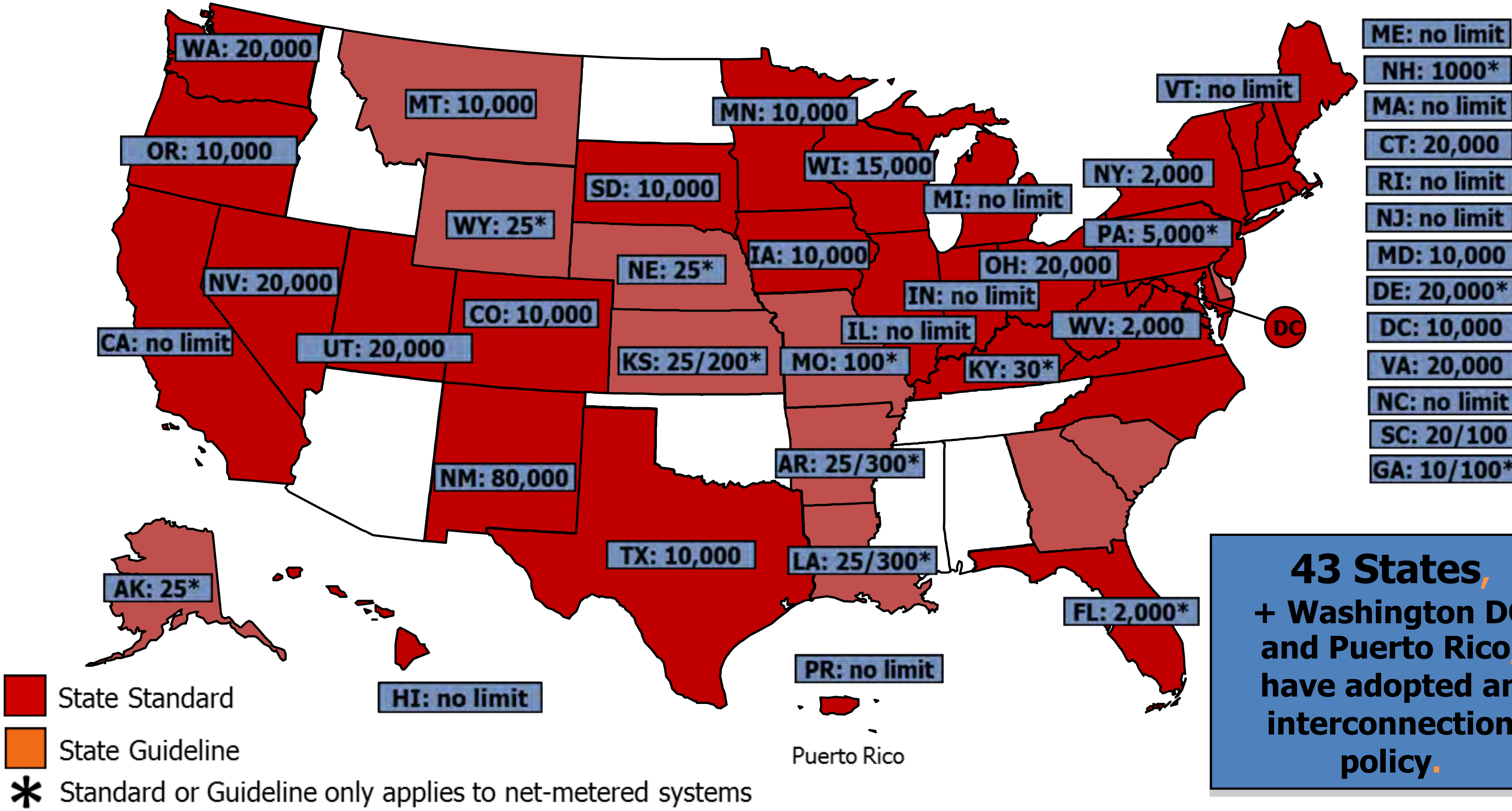

43 States, + Washington DC and Puerto Rico, have adopted an interconnection policy.

Notes: Numbers indicate system capacity limit in kW. Some state limits vary by customer type (e.g., residential versus non-residential). "No limit" means that there is no stated maximum size for individual systems. Other limits may apply. Generally, state interconnection standards apply only to investor-owned utilities.

From www.dsireusa.org, 2013

Interconnection Goals + Principles

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Goals:

- Efficiently incorporate appropriately sited DG as a major clean energy source in a secure, resilient and cost effective electric grid
- Help customers make timely decisions about where to apply, whether to apply, and to commit to interconnect.

Mechanisms:

- Transparency
- Accessibility
- Simplicity
- Speed
- Certainty

What to avoid

Interconnection processes and cost determinations that are:

- Unpredictable
- Unwieldy
- Untimely

  and ultimately….
- Uncertain

Interconnection Barriers

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Customer hurdles in applying for interconnection:

- Information about the application process, requirements, costs, and timelines
- Access to grid information for siting and system design
- Utility response time
- Consistency among utility personnel
- Schedule delays – application review, site visits, studies, inspection, installation
- Excessive requirements – equipment and upgrades
- Complex contracts and agreements
- Dispute resolution

Utility hurdles in applications for interconnection:

- Errors in application materials
- Excessive application submission and subsequent withdrawal rates
- Utility access to accurate grid information
- Performing grid impact studies
- Coordinating electrically related applications
- Inappropriate system designs triggering additional study
- Scheduling field work – site review, inspection, installation
- Customer negotiation and dispute resolution

Proven Strategies

Plan, prepare and communicate

Utilities can:

- Anticipate future interconnection demand
- Provide clear usable information to support submittal of viable interconnection requests
- Make information highly accessible
- Standardize processing and evaluation of requests to provide efficient, rapid, consistent and predictable results
- Plan integrated solutions to capture benefits of local distributed resources

Proven Strategies

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Offer Clear Information

Help customers make a decision quickly about where to build, what to build, and when to commit *before submitting an application*. This can be achieved through:

- Accountable standards and processes

  All parties rely upon known rules, commitments, and timelines.

- Clear review processes

  Review processes should emphasize predictability, flexibility and objectivity, including screening and solution options

- Certainty in costs and responsibilities

  Clear cost determination means less risk and lower costs for developers, utilities, and consumers alike. Earlier cost determination means faster decisions.

- Transparent and accessible information

  Too often, interconnection information is hard to come by

Principles for Interconnection Processes

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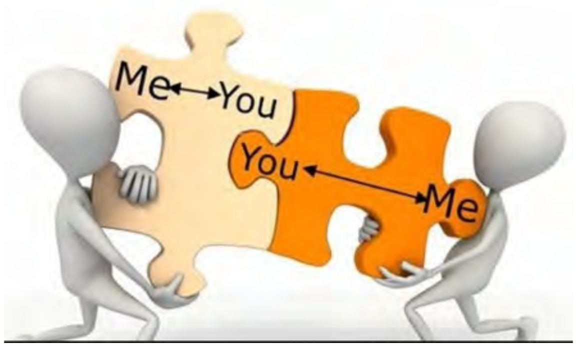
Accountable standards and processes

- Common statewide and national standards, practices, procedures, and contracts.
- Interconnection procedures designed to handle the expected scale of requests across all categories of distribution level interconnection.
- A standard application, review, and timelines, including any necessary studies.



Principles for Interconnection Processes

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Clear Review Processes

Review processes should emphasize predictability, flexibility and objectivity, including screening and solution options:

1. Simplified review of appropriate projects
2. Default approval of conforming projects
3. Rapid resolution of most common issues
4. Identification of issues that will require further study if they cannot be addressed through supplemental review or simple project modification
5. Determination of specific technical study requirements where needed.

Principles for Interconnection Processes

Certainty in costs and responsibilities

Clear cost determination is the overriding issue for customer decisions and for a successful interconnection process.

Address the needs of both customer and utility toward an Interconnection Agreement.

Adopted standards, requirements, and planning should be forward looking.

Reasonable fees, schedules, milestones and enforcement penalties for all parties support timely responses

Effective Interconnection is Simple and Transparent

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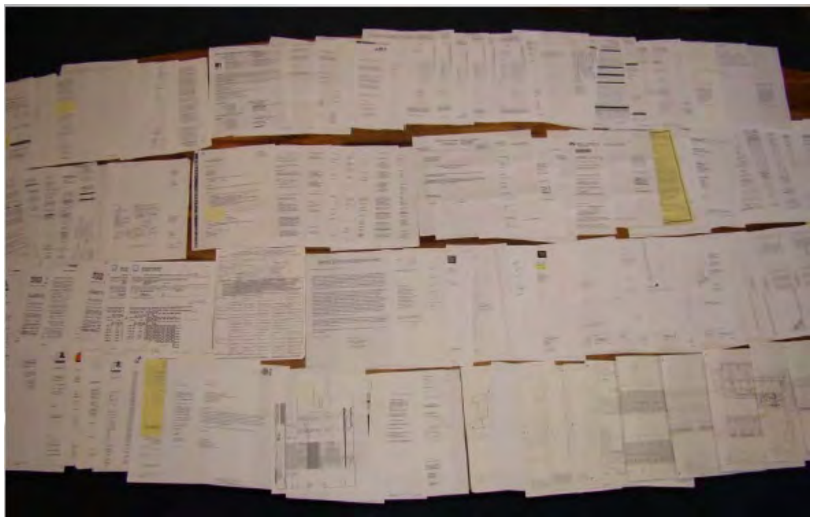
Typical California paperwork for one project



Could be a 1kW-sized project, but maximum 1MW (via CSI program). Even more paperwork for California projects larger than 1MW (via RPS program).

Typical Germany paperwork for one project

Could be a 1kW or 20MW-sized project, or bigger.

Reducing bureaucracy alone can shave costs by 20%

Source: Gary Gerber, President of CalSEIA and Sun Light & Power, June 2009

Available Solutions – Online Forms

Benefits of Online Forms & Agreements

Online forms:

- Ensure applications are fully completed
- Efficient and accurate utility data capture
- Accessible application status tracking for utility and customer schedules
- Automated communications for customers and utility staff
- Verification of receipt
- Faster turnaround times

Principles for Interconnection Processes

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Transparent and accessible information

Identifying "what can go where" with little or no modification or customer cost.

Current grid information should be maintained and readily available to generation interconnection staff and customers in order to:

- Address qualification screens, predict costs, reduce potential redesign and restudy, and generally know "what can go where" early in the project development process
- Efficiently process interconnection requests
- Track the progress and outcomes of interconnection requests

Current grid information can be made available through:

- Maps, databases, and/or Pre-Application Reports regarding existing and planned system capacities.
- Application queue status and results.

Pre-Application Reports

Standard Report: ($300)

- Available Capacity
- Voltage
- Distance from Substation
- Line Section peak load estimate, and minimum load data, when available.
- Number of protective devices and number of voltage regulating devices
- Whether or not three-phase power is available at the site
- Limiting conductor rating
- known constraints such as, but not limited to:
  - electrical dependencies at that location, short circuit interrupting capacity issues, power quality or stability issues on the circuit, capacity constraints, or secondary networks

Pre-Application Reports

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Primary Service Package: ($225)

- Line section configuration
- Absolute minimum load, and minimum load during the 10 AM – 4 PM period
- Existing upstream protection details:
  - (a) Device type (Fuse Breaker, Recloser)
  - (b) Device controller (device make/model ex: 50E/50T)
  - (c) Phase settings [IEEE Curve, Lever, Min Trip (A), Inst Trip(A)]
  - (d) Ground settings [IEEE Curve, Lever, Min Trip (A), Inst Trip(A)]
  - (e) Rated continuous current
  - (f) Short Circuit interrupting capability
  - (g) Confirm if the device is capable of bi-directional operation
- Available Fault Current

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Secondary/Behind The Meter Package: ($800)

- Transformer data
  - (a) Existing service transformer kVA rating
  - (b) Primary Voltage and secondary Voltage rating
  - (c) Configuration on both Primary and Secondary Side (i.e., Delta, Wye, Grounded Wye, etc.)
  - (d) Characteristic impedance (%Z)
  - (e) Confirm if the transformer is serving only one customer or multiple customers
  - (f) Provide the Available Fault Current on both the Primary and Secondary Side
- Primary & Secondary Service Characteristics
  - (a) Conductor type (AL or CU) and size (AWG)
  - (b) Conductor insulation type
  - (c) Number of parallel runs
  - (d) Confirm if the existing secondary service is 3-wire or 4-wire

The Future

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Interconnection 3.0

A roadmap to the Future

- Guiding generation to where it's most useful
- Recognizing locational benefits,
- Integration with ADR, EVs, Storage, D-grid upgrades and Smart Grid development
- Eventual goal is “1 click” instant study results – fully automated, or largely automated, interconnection review.

The next major step toward this future is Hosting Capacity Analysis

New ICA 2.0 Map & Data

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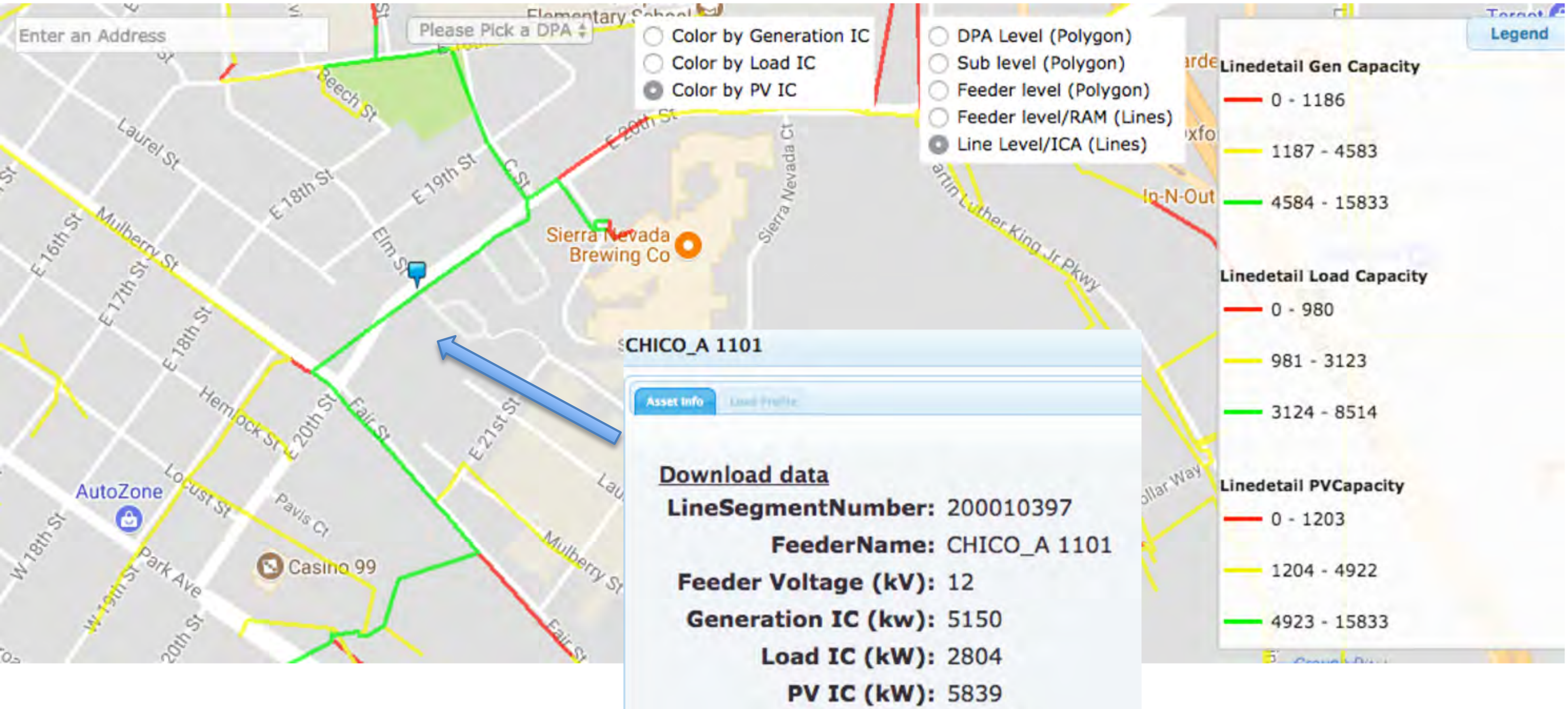

- Highly location specific
- Detailed hourly data on any operational constraints factors
- Capacity values for specific technologies (PV, storage, fuel cell…)
- Identification of constraints and upgrade costs

Typical Fixed PV ICA Value

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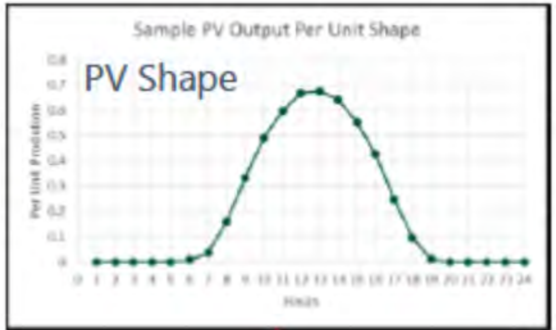

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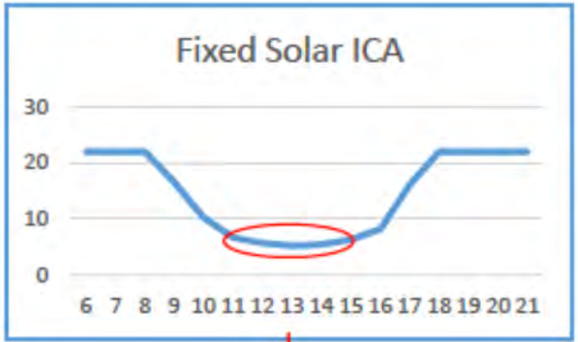


ICA Value – From

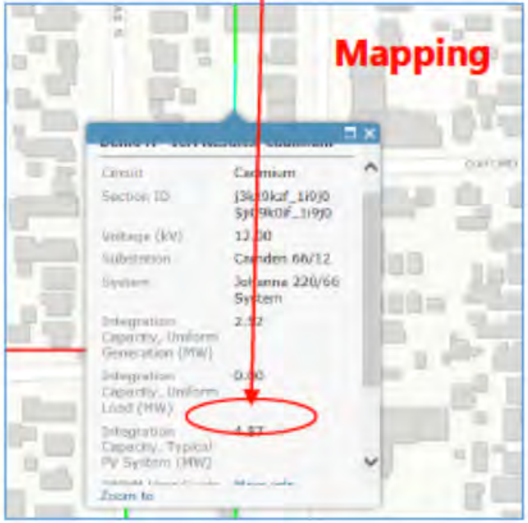
- Thermal
- Voltage
- PQ/Voltage Fluctuations
- Protection
- System Flexibility

- Typical PV shape from PV-Watts Tool
- 95th percentile curve

PW Watts Parameters

- DC size = Normalized to 1.0
- Module Type = Standard
- System Losses = 14%
- Tilt = 18 Degrees
- DC-AC ratio = 1.0
- Inverter Efficiency = 96%

THESE PARAMENTERS MUST BE CONSIDERED



What is Integration Capacity Analysis*

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Not all hosting capacity is created the same

- The methodology used in California will specify how much DER hosting capacity may be available on the distribution network down to the line section or node level
- This analysis quantifies the capability of the distribution system to integrate DER within thermal ratings, protection system limits and power quality and safety standards
- Perform an analysis using dynamic modeling methods using power flow modeling software tools

Example for Southern California Edison

Approximately average of 600 nodes per feeder, 576 hours and several categories

= Approximately 10 billion data points

- Customers may use the uniform ICA values with translator to develop technology specific ICA values
  - PV+ storage, PV with trackers, peak shaving storage, etc.

*Also known or referred to as "Hosting Capacity Analysis" in several forums and research work activities

What is Considered/Included in ICA Calculations

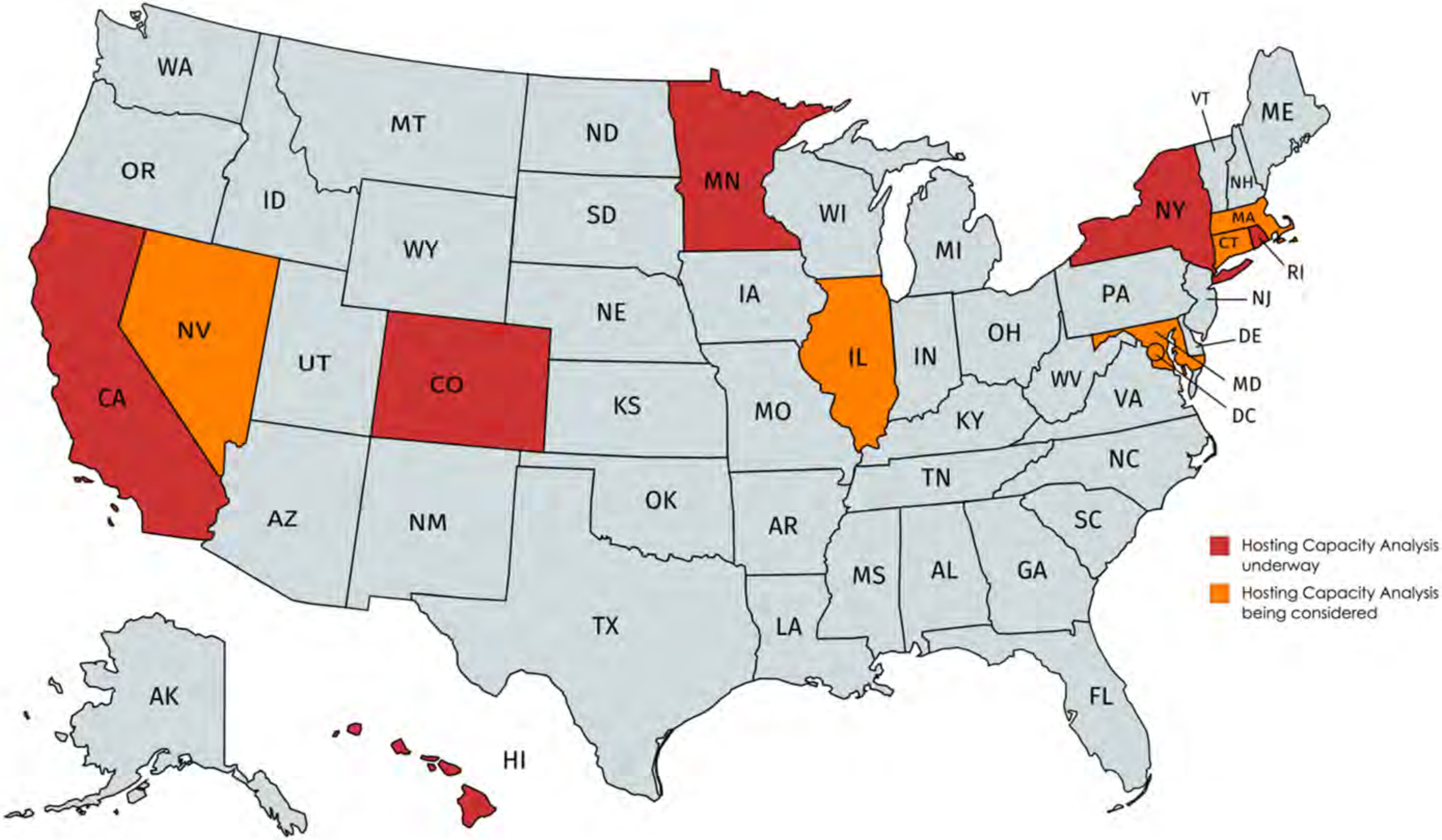
1. Calculated for all 3-phase nodes and line sections of radial distribution feeders (circuits)
2. Account for feeder's electrical components Thermal Loading limitations
3. Account for deviations is Steady State Voltage (SSV) throughout the feeder.
   Injecting real power at one node must not overvoltage other ports of the circuit(s)
4. Impacts of DER to Protection systems.
   Adding DER at one node must not desensitize the relay to a point that it cannot effectively protect the system
5. Impacts of DER to Voltage Fluctuations and Power Quality(PQ).
   Must not create significant voltage changes in system voltage
6. Impacts of DER to Operational Flexibility.
   The ability to reconfigure the distribution system as necessary for operations

Future ICA Calculations

Future ICA Calculations will look to include:

1. Substation Level limitations (Transformer Banks, busses…)
2. Transmission Limitations
3. Networked systems
4. Secondary systems, service drops, service transformers
5. ICA values for rotating machine (Synchronous or Induction Generation)
6. Single Phase radials
7. Smart Inverter functionality –Volt/Var with reactive power priority
8. All PV system configurations
   - –PV ICA only addresses PV installation equivalent to what was used in PV-Watts® when determining regional PV profiles Does not address tracking systems, inverters limit output, etc.

The current "state" of HCA in the U.S.



PAEC Streamlined Interconnection Pilot

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- Goal: Replicate the streamlined NEM interconnection review and pricing process for qualified wholesale applicants
- Pilot: Expedited Review & Pre-determined Fixed Interconnection Fee
  - Pending PG&E approval
- Core Pilot Components
  - Eligibility: ICA Qualifying Projects Below 1 MW
  - Guaranteed Fast Track Review
  - Standardized Interconnection Fee
- Additional Components (Phase II)
  - Automate the Interconnection Approval Process for ICA Compliant Projects
  - Explore Enhanced ICA Data & Modeling Access
  - Allow Combined Interconnection Applications for DER Aggregations
  - Upgrades: Utility Ownership (without transfer)
  - Qualified Third Party Upgrade Bid and Construction

Q&A

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Further reading:

- Peninsula Advanced Energy Community (PAEC) initiative http://www.clean-coalition.org/our-work/peninsula-advanced-energy-community/
- Clean Coalition's *Model Interconnection Tariff and Procedures* http://www.clean-coalition.org/resource/the-resource-hub/single-utility-resources/model-tariffs-and-contracts/
- Resource Hub http://www.clean-coalition.org/resource/the-resource-hub/state-level-resources/interconnection/

Thanks for listening

Questions, thoughts, ideas?

Note to California applicants: New April 2018 inverter standards require Reactive Power Priority after July 26 – *Make sure your equipment is certified.*

Extra Slides

Solar Siting Survey – sample site detail

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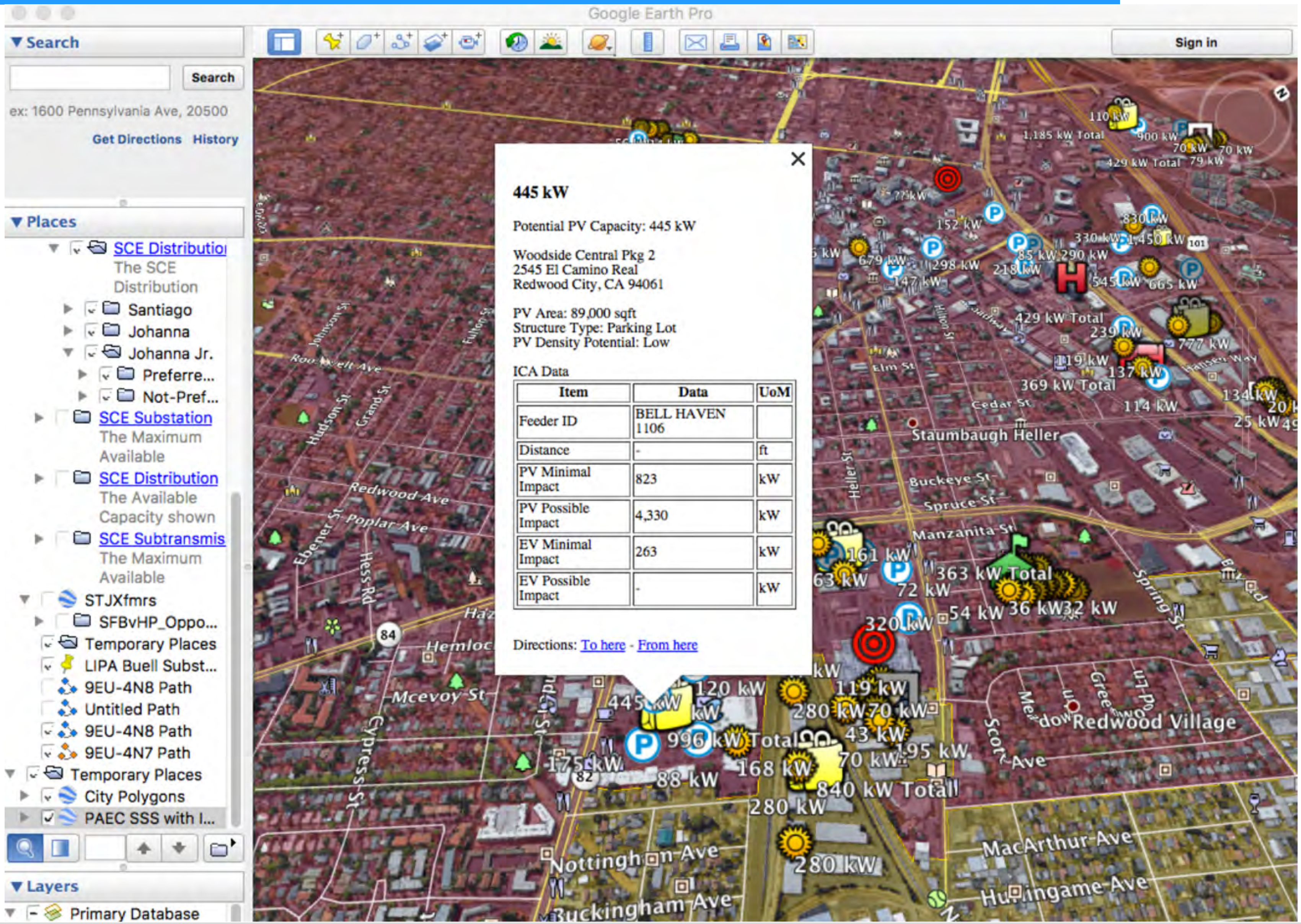

Local Capacity Optimization

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Utility Data

- Customer & transformer loads
- Network model & circuit map
- Equipment list & upgrade plans
- O&M schedule

Other data

- Solar insolation
- Weather forecasting
- Assumptions for DR/EE/EV charging, etc.
- Product performance specs, e.g. storage

Baseline Powerflow

- Acquire all data sets, validate accuracy
- Model existing powerflow

Baseline Capacity

- Vary location & size of local generation to define existing capacity
- Use advanced inverter features, e.g. for voltage (VAr) control

Medium Capacity

- Add low-cost options such as DR/EE, EV charging, & cost-effective storage
- Optimize via locations & costs, etc.

Higher Capacity

- Add higher-cost solutions such as major upgrades, more storage, outage performance goals, etc.
- Optimize via locations & costs, etc.

- **Validate with utility & technology vendors**
- **Maintain or improve grid reliability and power quality**

No Cost local renewable capacity

Low Cost local renewable capacity

More Cost local renewable capacity

Define "optimal locations" for DER

Optimal locations = highest **net value** to the grid over relevant time period

- Lowest cost
  - Grid upgrade costs
  - Interconnection costs, regardless of who directly pays these costs
- Highest value
  - Avoided/deferred distribution upgrades
  - Avoided/deferred transmission investments
  - Avoided T&D line and congestion losses
  - Avoided transmission access charges
  - Improved grid reliability and power quality
  - Local capacity value

	Lowest costs	**Medium costs**	**High costs**
Highest value	Best locations	Good locations	Subprime locations
Medium value	Good locations	Average locations	Poor locations
Lowest value	Subprime locations	Poor locations	Worst locations