Powered Together
Tapping the Water–Energy Nexus

130th NARUC Annual Meeting and Education Conference

Staff Subcommittee on Energy Resources and the Environment

I have a Hosting Capacity Analysis. Now What?

I Have a Hosting Capacity Analysis. Now What?

Sky Stanfield

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IREC

November 11, 2018

NARUC – Staff Subcommittee on Energy Resources and the Environment

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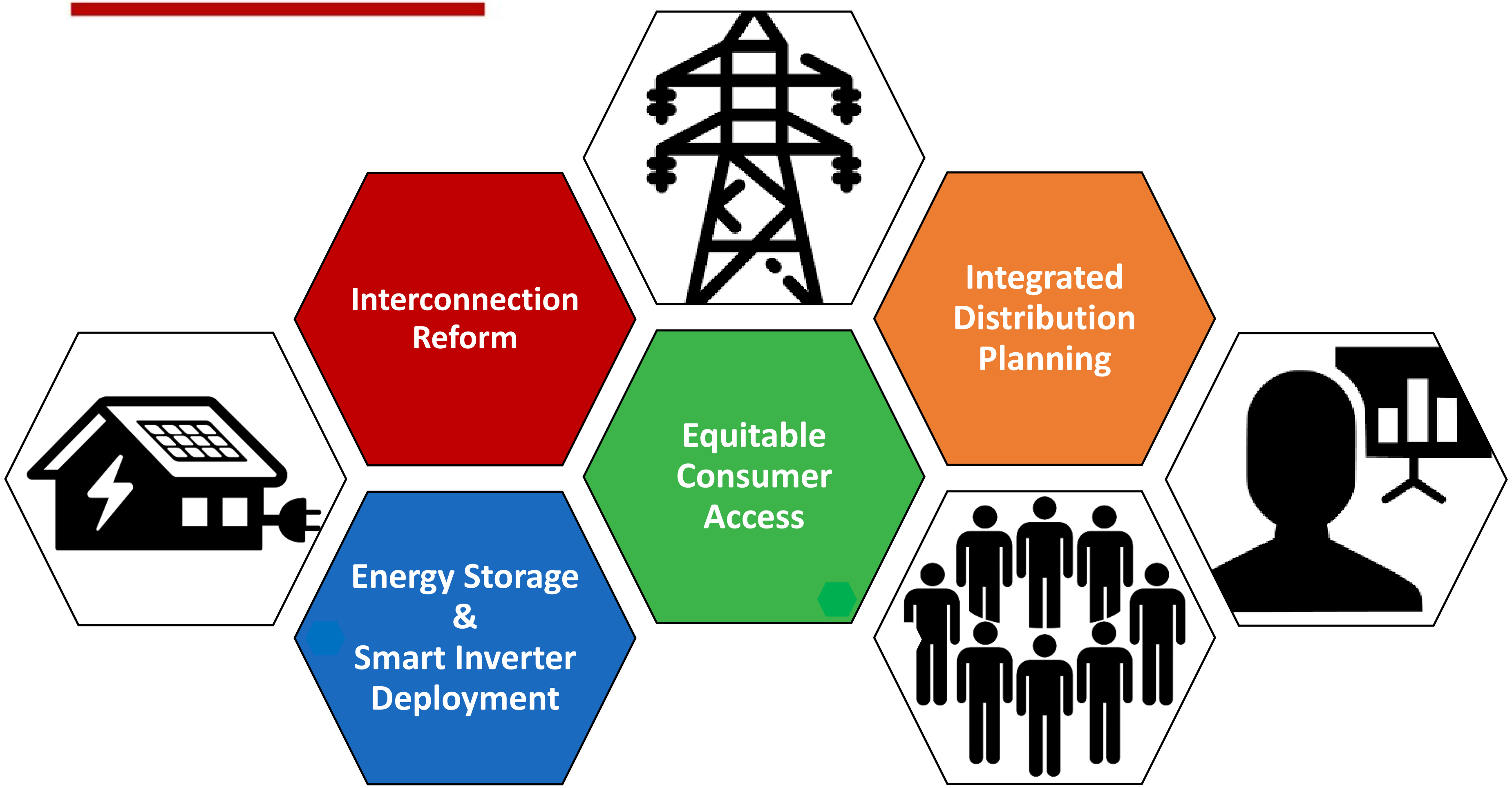
Regulatory Reform

Quality Workforce

Consumer Empowerment

Independent, national non-profit | Est. 1982



Independent, national non-profit | Est. 1982 | www.irecusa.org

OPTIMIZING THE GRID

A REGULATOR'S GUIDE TO

Hosting Capacity Analyses for Distributed Energy Resources

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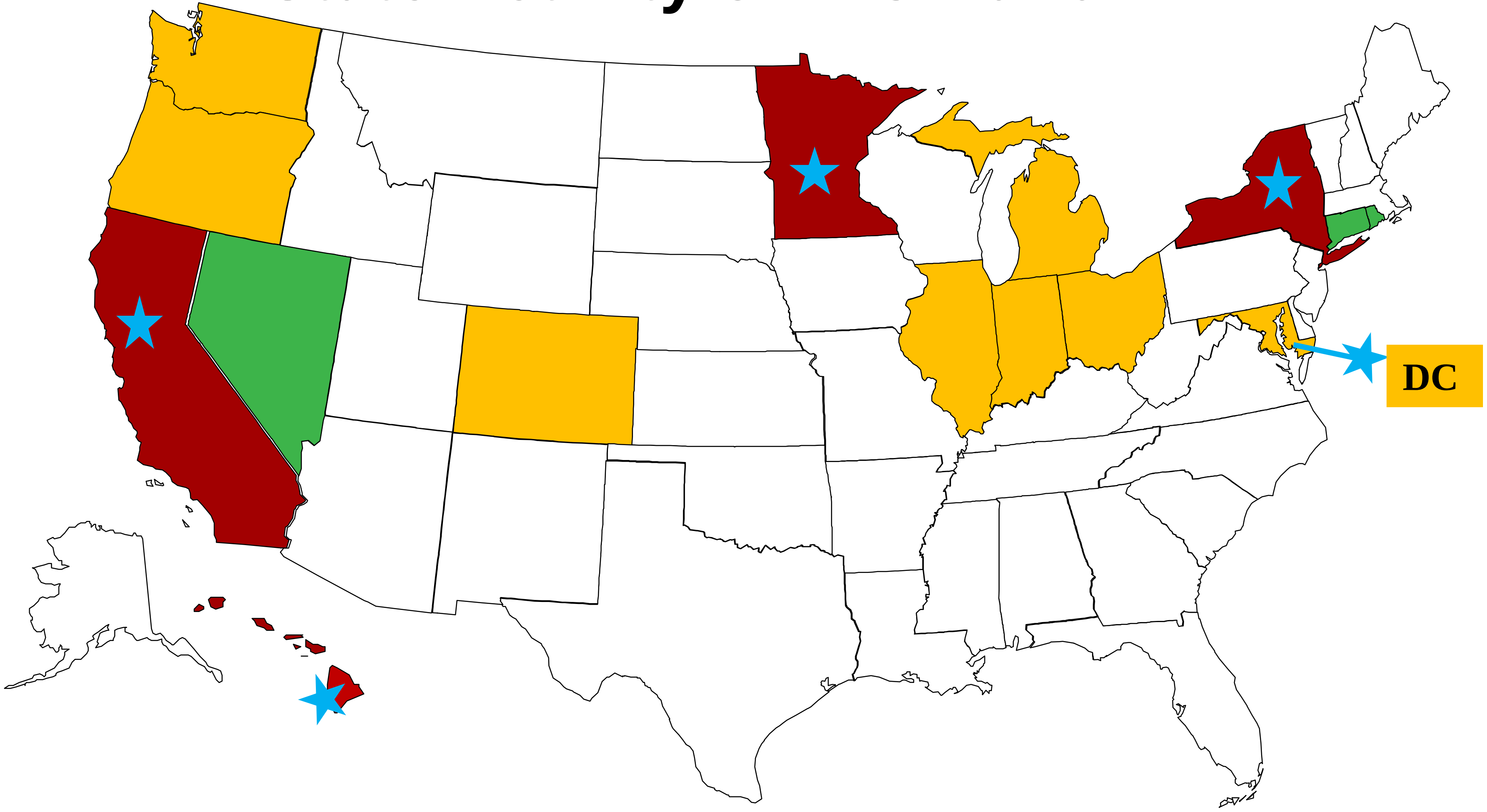
Interstate Renewable Energy Council

December 2017

State Activity on HCA and IDP



Advanced activity on HCA and IDP

Early stages of activity on HCA and IDP

Investigative stages on HCA and IDP

★ **Featured case studies and examples in IREC's *Optimizing the Grid***

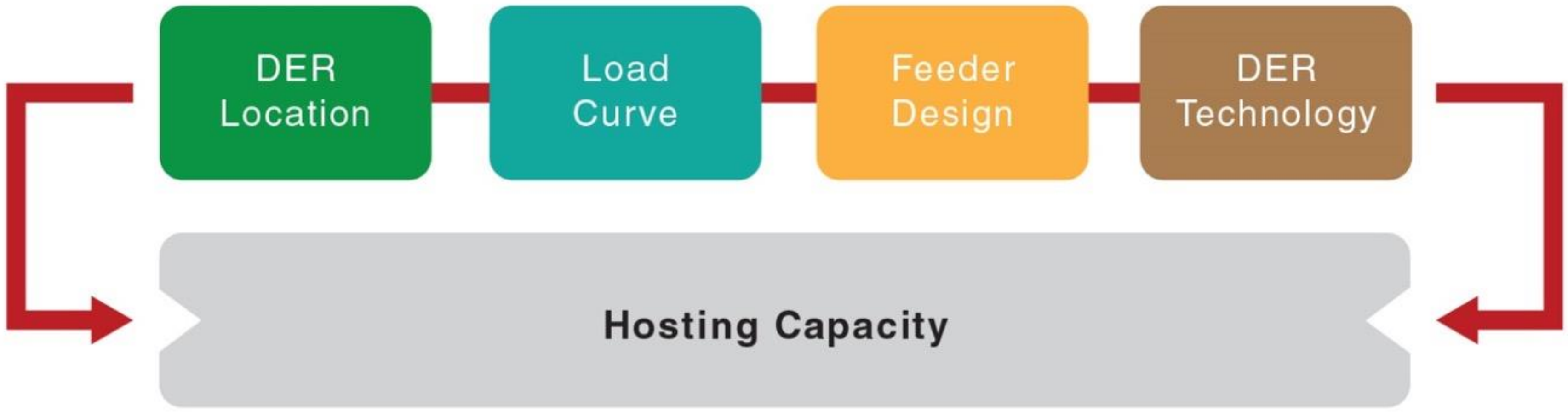
Today’s discussion

- What is ‘Hosting Capacity’?
- Why does it matter and how is it used?
- What are the key process steps to develop a hosting capacity analysis?
- What are some of the key technical issues to be aware of?

What is Hosting Capacity?

The amount of distributed energy resources that can be accommodated on the distribution system under existing grid conditions and operations without adversely impacting operational criteria or requiring significant infrastructure upgrades.

Hosting Capacity Components



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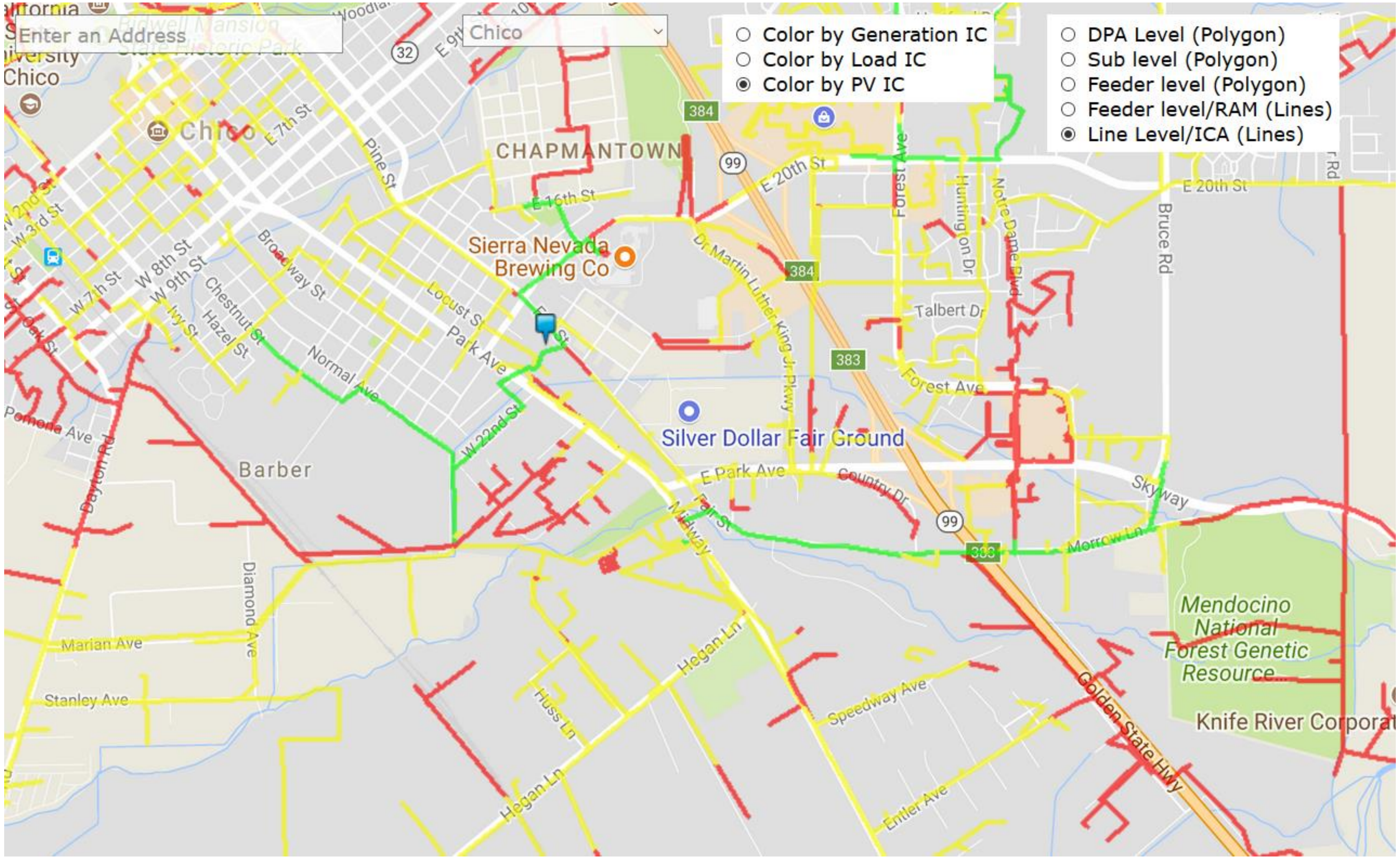
Hosting Capacity Maps



From PG&E Demonstration A ICA Map, available at:
https://www.pge.com/b2b/energysupply/wholesaleelectricsuppliersolicitation/PVRFO/DemoAMap/DemoA.html

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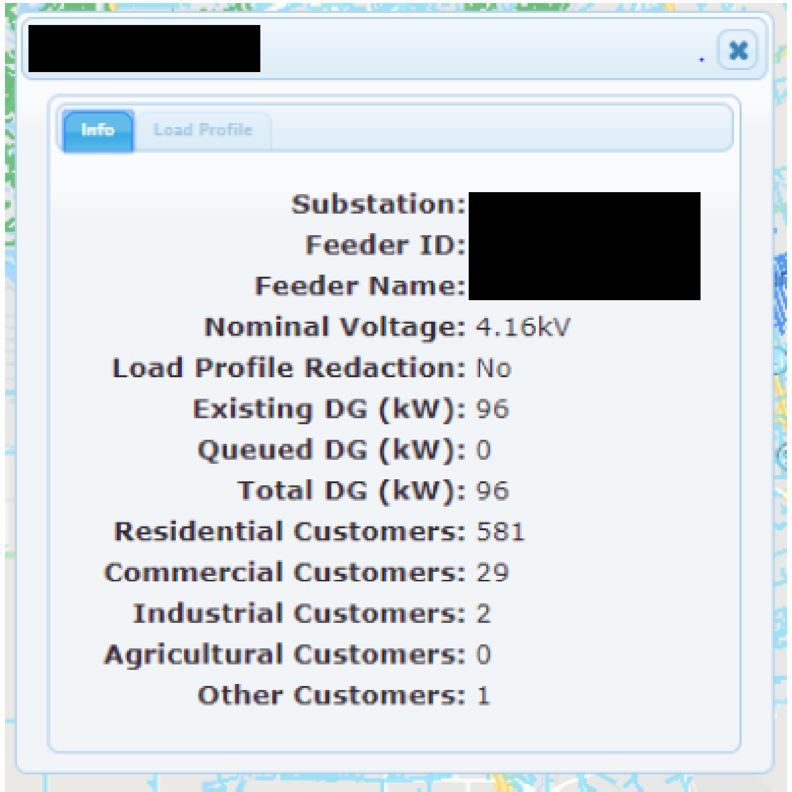
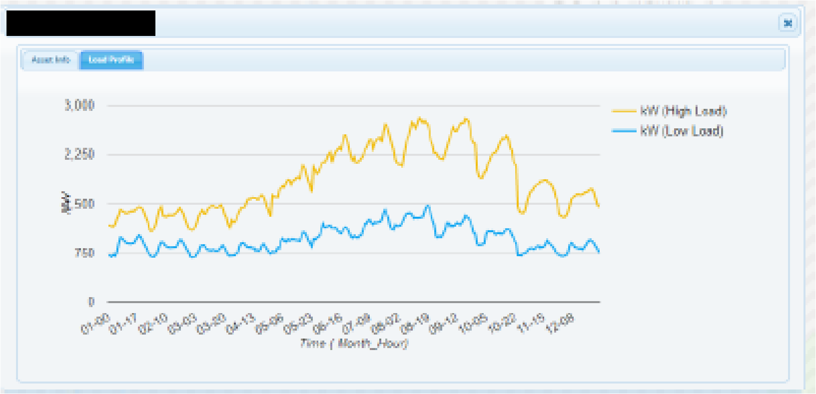
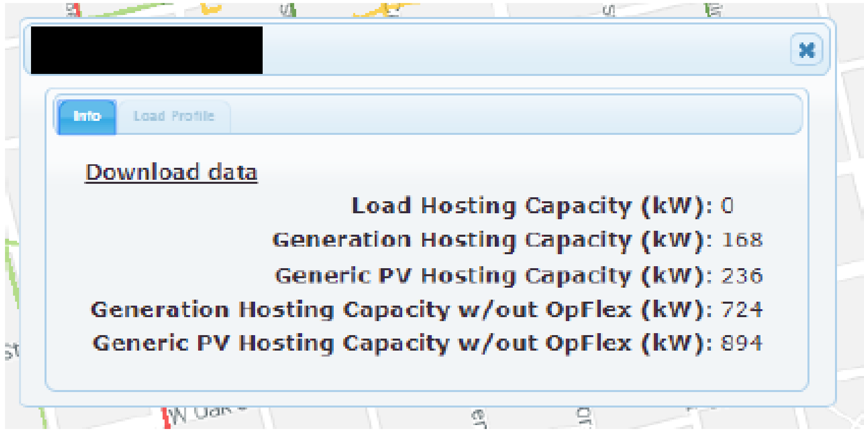
Hosting Capacity Maps (Cont.)







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Downloadable Data Files

	Network	Line_Segment_Number	Month	Hour	Percentile	ICA_Thermal	ICA_Voltage_PQ	ICA_Safety	ICA_Protection	Final_ICA	BankReverseFlowLimitKW	DistanceFromSub
2	102171102	200118744	Dec	2300	P10	1999	532	70	2167	70	2536.0549	26442
3	102171102	200118744	Jan	300	P10	1999	534	70	2167	70	2557.9351	26442
4	102171102	200118744	Apr	100	P10	1999	533	70	2167	70	2623.939	26442
5	102171102	200118744	Feb	0	P10	1999	523	69	2167	69	2524.731	26442
6	102171102	200118744	Nov	0	P10	1999	521	68	2167	68	2497.083	26442
7	102171102	200118744	Nov	100	P10	1999	527	69	2167	69	2536.917	26442
8	102171102	200118744	Nov	200	P10	1999	522	69	2167	69	2504.834	26442
9	102171102	200118744	Nov	2300	P10	1999	527	69	2167	69	2537.522	26442
10	102171102	200118744	Dec	0	P10	1999	524	69	2167	69	2503.8201	26442
11	102171102	200118744	Dec	400	P10	1999	525	69	2167	69	2533.9141	26442
12	102171102	200118744	Mar	2200	P10	1999	527	69	2167	69	2574.626	26442
13	102171102	200118744	Apr	0	P10	1999	531	70	2167	70	2610.925	26442
14	102171102	200118776	Dec	2300	P10	1977	118	450	500	118	2536.0549	73371
15	102171102	200134428	Dec	2300	P10	1983	137	450	583	137	2536.0549	65350
16	102171102	200118776	Jan	300	P10	1977	118	451	500	118	2557.9351	73371
17	102171102	200129169	Jan	300	P10	2009	114	451	500	114	2557.9351	74115
18	102171102	200129639	Jan	300	P10	2009	114	451	500	114	2557.9351	74388
19	102171102	200118776	Apr	100	P10	1977	118	451	500	118	2623.939	73371
20	102171102	200129169	Apr	100	P10	2009	114	451	500	114	2623.939	74115
21	102171102	200129639	Apr	100	P10	2009	114	451	500	114	2623.939	74388

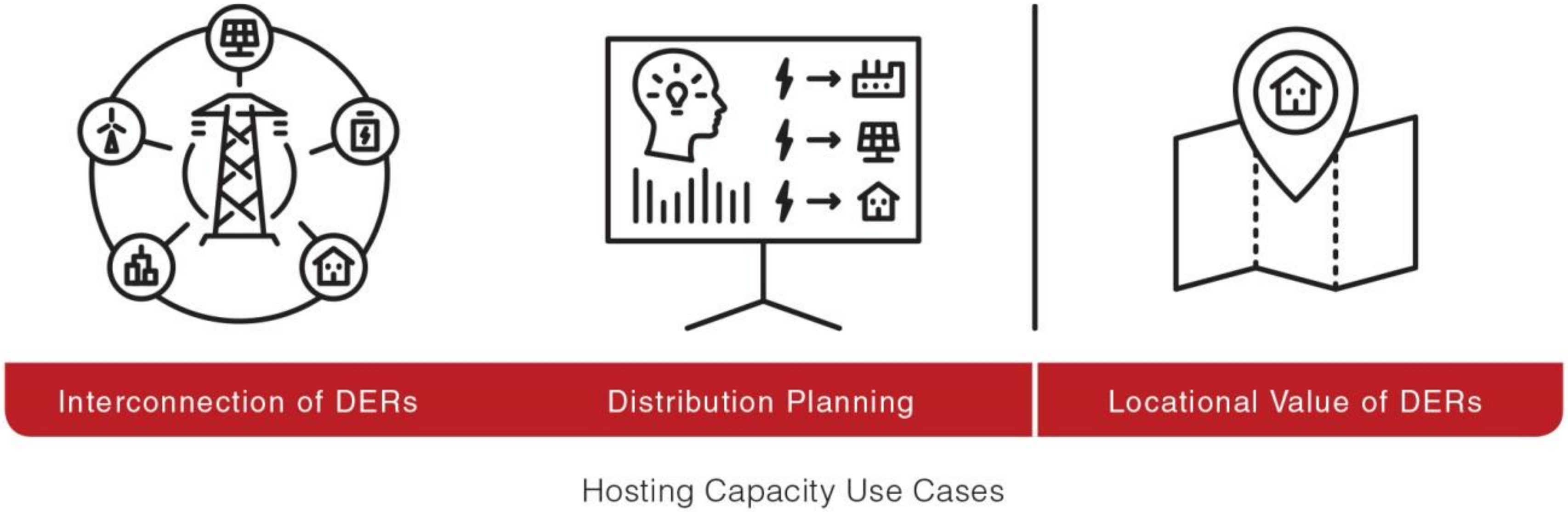
From SDG&E's Demonstration A Downloadable data, available at: https://www.sdge.com/generation-interconnections/enhanced-integration-capacity-analysis-ica

Key HCA Process Steps

- Establish a stakeholder process
- Select and define use cases
- Identify criteria to guide HCA implementation
- Develop HCA methodology
- Validate results
- Share and Use HCA data
- Track, Learn & Evolve

Download Optimizing the Grid report at:
https://irecusa.org/publications/

HCA Use Cases



Select & Refine Methodology

- **Streamlined**
  - Fewer Computations
  - Insufficient accuracy for interconnection
- **DRIVE/Hybrid**
  - Replicable
  - Accuracy uncertain
- **Iterative**
  - Mimics a full power flow
  - Computational intensity
- **Stochastic**
  - Fewer Computations
  - Random/ Probabilistic

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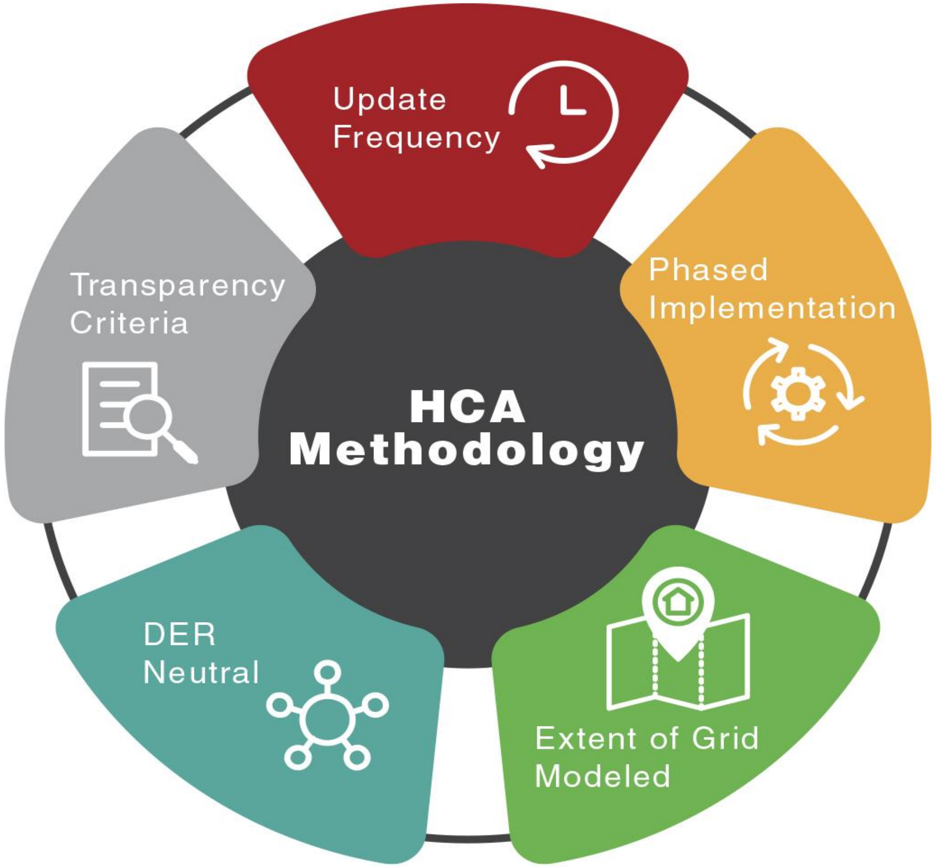
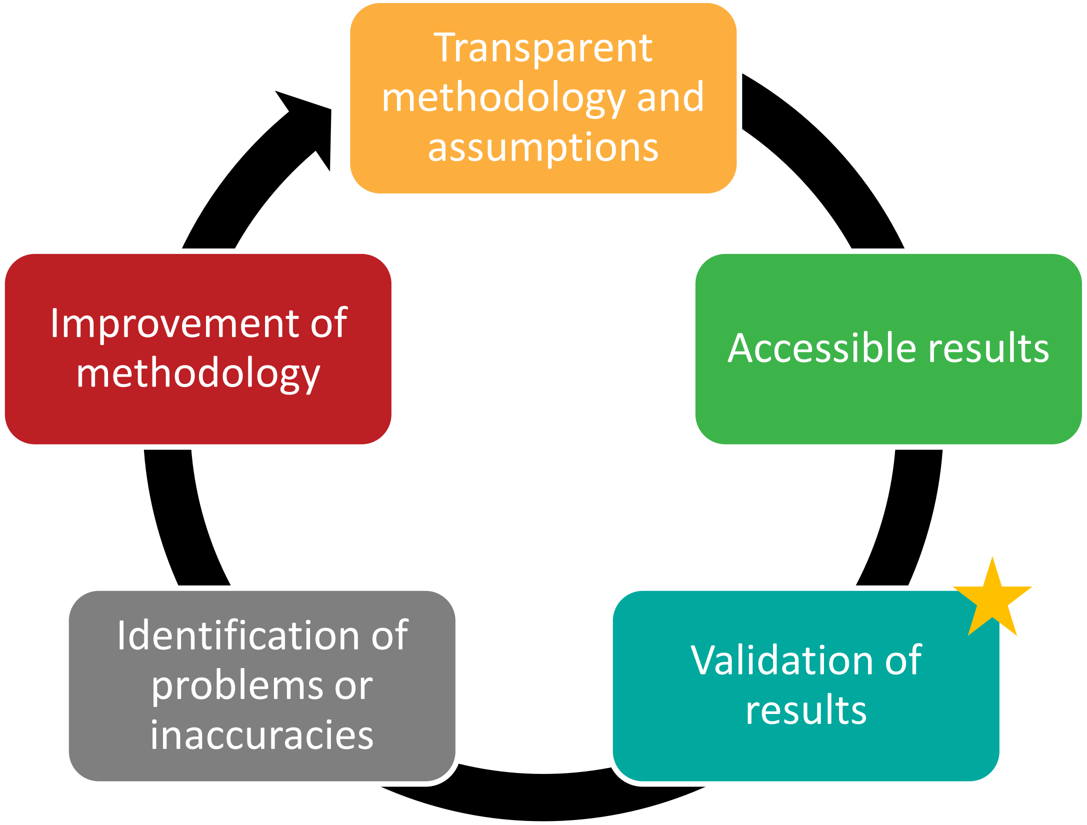
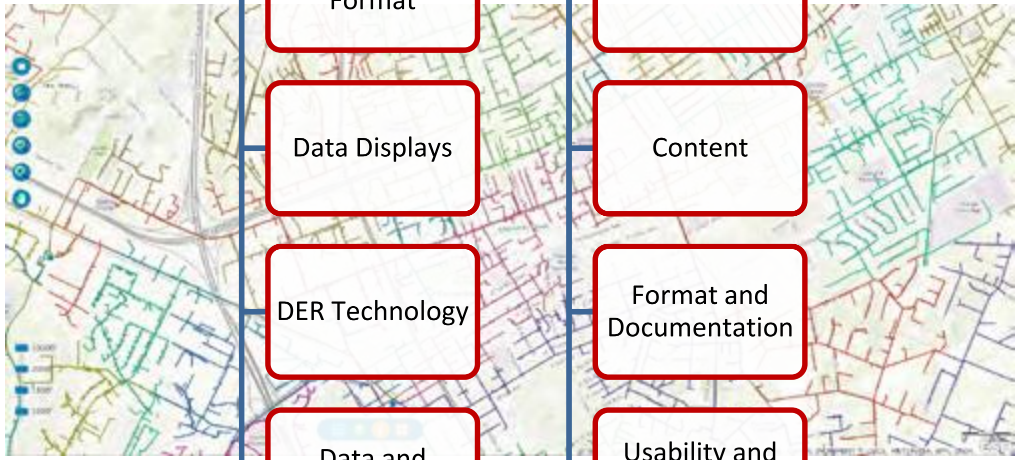
Criteria to Guide Methodology



Validate Results



Share Hosting Capacity Data



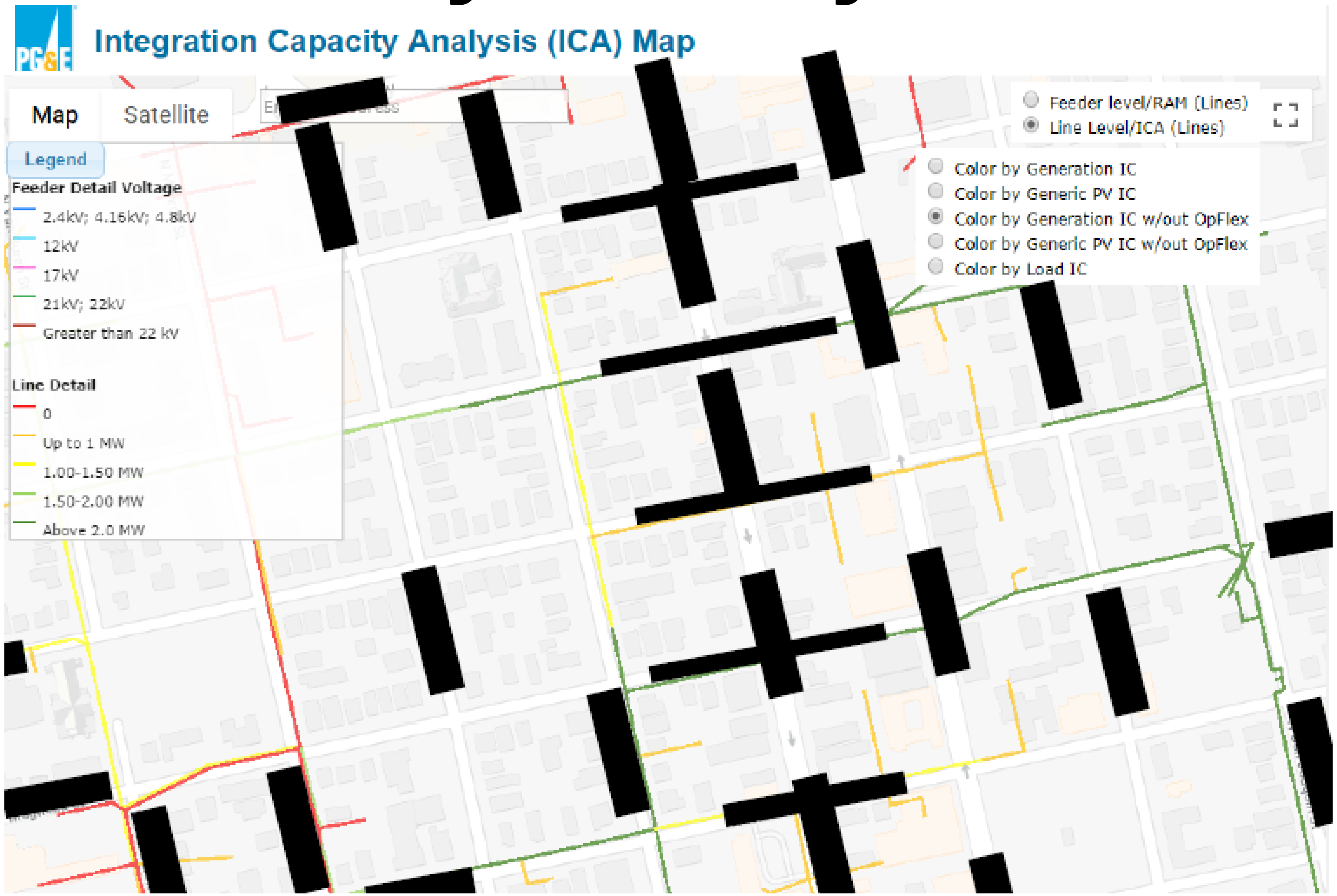
Maps

- Visual Display Format
- Data Displays
- DER Technology
- Data and Format

Data Files

- Access
- Content
- Format and Documentation
- Usability and Granularity
- Privacy and Security

HCA and Physical/Cyber Security



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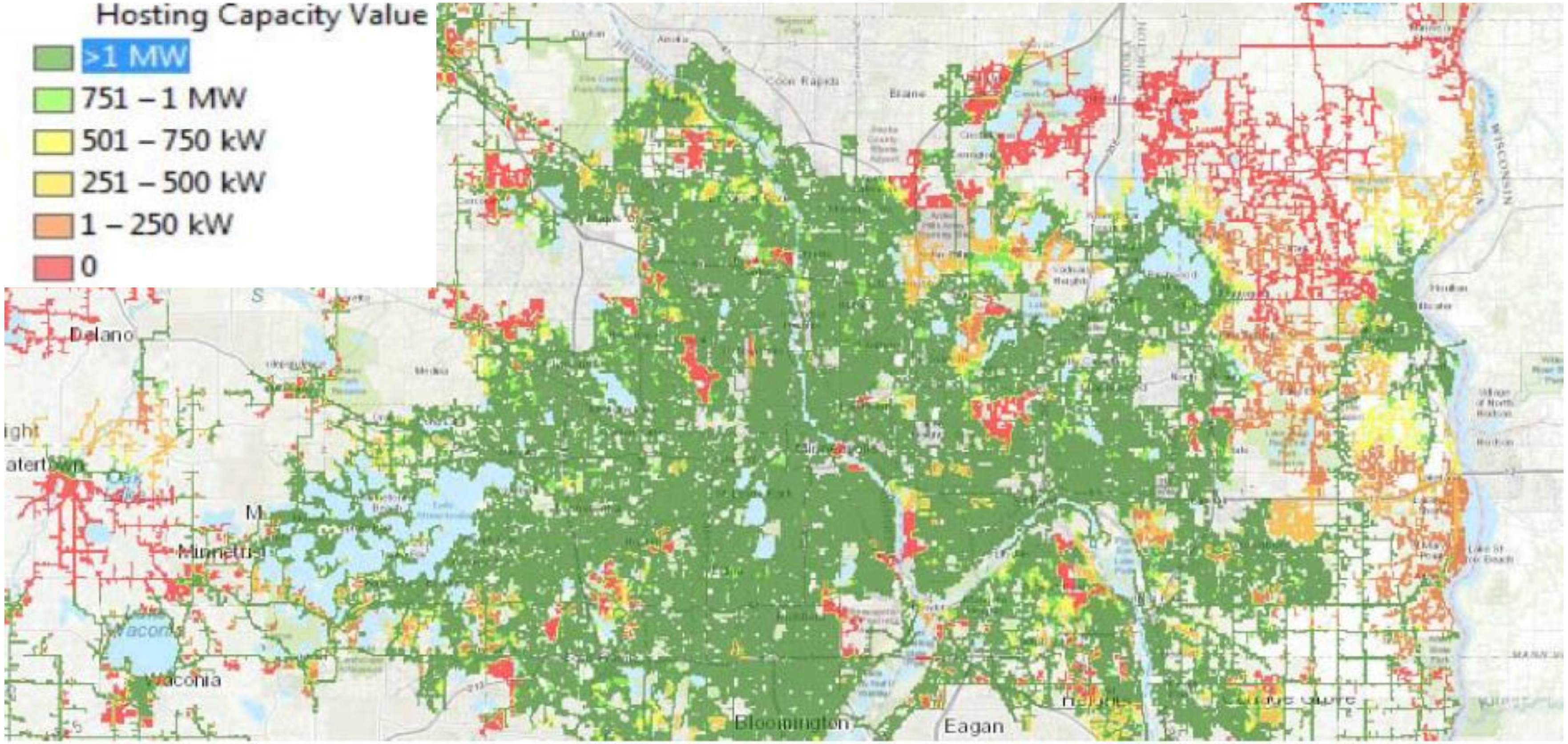
Deploy and Evolve

Xcel MN Hosting Capacity Maps



https://www.xcelenergy.com/working_with_us/how_to_interconnect

Xcel MN Hosting Capacity Data Files

Substation	Feeder	Minimum Hosting Capacity (MW)	Min Limiting Factor	Maximum Hosting Capacity (MW)	Max Limiting Factor
Hadley	HAD022	0	Additional Element Fault Current - min	0	Additional Element Fault Current - max
Hastings	HAS021	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hastings	HAS022	0.6	Primary Over-Voltage - min	4.05	Breaker Relay Reduction of Reach - max
Hastings	HAS023	1.8	Primary Over-Voltage - min	10	Primary Over-Voltage - max
Hastings	HAS031	1.5	Primary Over-Voltage - min	10	Primary Over-Voltage - max
Hastings	HAS032	0.6	Primary Over-Voltage - min	6.45	Breaker Relay Reduction of Reach - max
Hastings	HAS033	1.4	Primary Over-Voltage - min	6.92	Breaker Relay Reduction of Reach - max
Hector	HEC001	0.1	Primary Over-Voltage - min	0.93	Breaker Relay Reduction of Reach - max
Henderson	HEN021	0.4	Primary Over-Voltage - min	1.31	Thermal for Gen - max
Hollydale	HOL061	0.8	Primary Over-Voltage - min	8.38	Breaker Relay Reduction of Reach - max
Hollydale	HOL062	0.7	Primary Over-Voltage - min	7.11	Breaker Relay Reduction of Reach - max
Howard Lake	HOW061	0.4	Primary Over-Voltage - min	5.3	Breaker Relay Reduction of Reach - max
Hassan	HSN311	0.2	Primary Over-Voltage - min	2.86	Breaker Relay Reduction of Reach - max
Hassan	HSN312	0.08	Breaker Relay Reduction of Reach - min	0.08	Breaker Relay Reduction of Reach - max
Hassan	HSN321	0	Additional Element Fault Current - min	0	Breaker Relay Reduction of Reach - max
Hassan	HSN322	1.7	Primary Over-Voltage - min	15.99	Breaker Relay Reduction of Reach - max
Hugo	HUG311	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hugo	HUG312	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hugo	HUG321	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hugo	HUG322	0	Primary Over-Voltage - min	0	Primary Over-Voltage - max
Hiawatha West	HWW061	0.3	Primary Over-Voltage - min	1.74	Breaker Relay Reduction of Reach - max
Hiawatha West	HWW062	1.6	Primary Over-Voltage - min	8.9	Breaker Relay Reduction of Reach - max
Hiawatha West	HWW071	1.21	Thermal for Gen - min	10	Primary Over-Voltage - max
Hiawatha West	HWW072	3.28	Thermal for Gen - min	10	Primary Over-Voltage - max
Hiawatha West	HWW073	2.7	Primary Over-Voltage - min	10	Primary Over-Voltage - max
Hiawatha West	HWW074	2.5	Primary Over-Voltage - min	10	Primary Over-Voltage - max
Hiawatha West	HWW075	1.17	Thermal for Gen - min	10	Primary Over-Voltage - max
Hyland Lake	HYL061	1.2	Primary Over-Voltage - min	6.32	Breaker Relay Reduction of Reach - max
Hyland Lake	HYL062	1.5	Primary Over-Voltage - min	9.47	Breaker Relay Reduction of Reach - max
Hyland Lake	HYL063	0.4	Primary Over-Voltage - min	4.75	Breaker Relay Reduction of Reach - max

Thank you! Questions?

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Staff Subcommittee on Energy Resources and the Environment

Hosting Capacity – Lessons Learned

Pepco Holdings
An Exelon Company

Presented by: Steve Steffel
Pepco Holdings, an Exelon Company

Nov 11, 2018

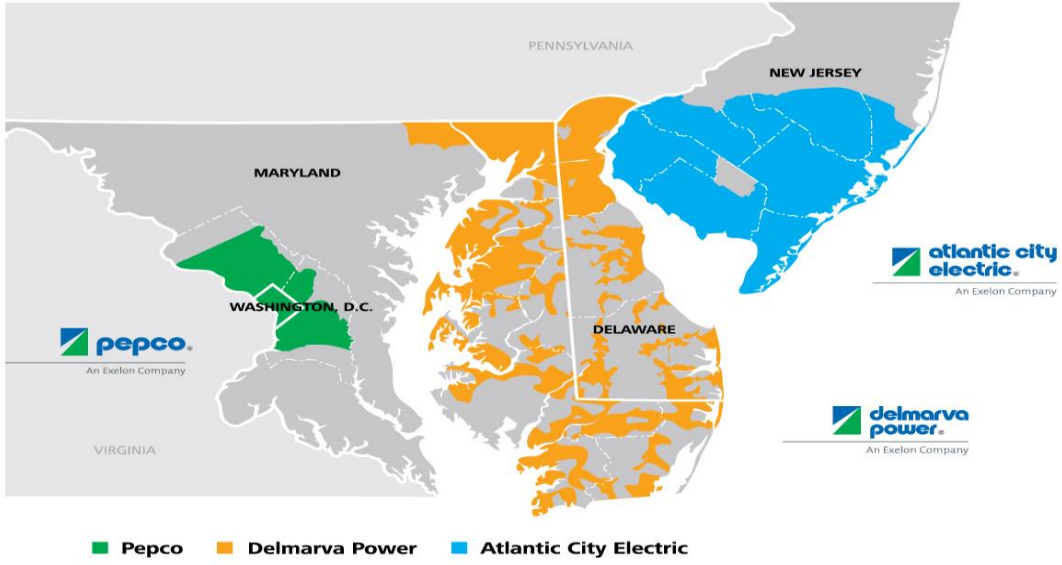
o Holdings
An Exelon Company

Agenda

- DER Stats
- Hosting Capacity Introduction
- Hosting Capacity at Pepco Holdings, an Exelon Company
- Interactive Maps
- Methods of Increasing Hosting Capacity
- Privacy, Future Plans for Hosting Capacity and Non-Wires Alternatives
- Questions

Pepco Holdings, an Exelon Company

- Service territory of 8,340 square miles
- 5.4M people served
- PHI includes three subsidiary utility companies:
  - Atlantic City Electric:
    - 547K – electric customers
  - Delmarva Power:
    - 515K – electric customers
    - 130K – natural gas customers
  - Potomac Electric Power Company (PEPCO):
    - 842K – electric customers



Pepco Holdings.
An Exelon Company

Exelon Utilities at a Glance

Exelon

Commonwealth Edison	
Customers (electric):	3,800,000
Service Territory:	11,400 sq. miles
Peak Load:	20,162 MW

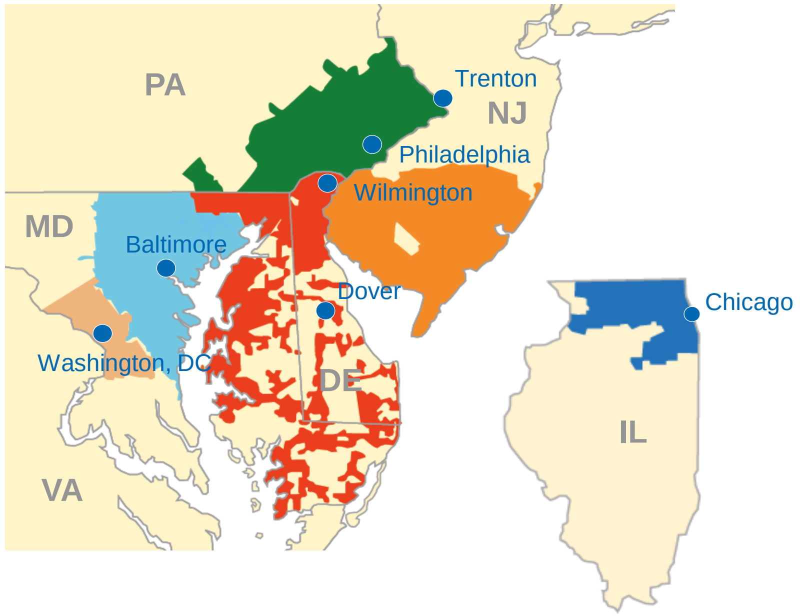
Potomac Electric Power	
Customers (electric):	852,000
Service Territory:	640 sq. miles
Peak Load:	6,584 MW

PECO Energy	
Customers (electric):	1,612,000
Customers (gas):	506,000
Service Territory:	2,100 sq. miles
Peak Load:	8,364 MW

Delmarva Power & Light	
Customers (electric):	632,000
Customers (gas):	126,000
Service Territory:	5,000 sq. miles
Peak Load:	4,127 MW

Baltimore Gas & Electric	
Customers (electric):	1,250,000
Customers (gas):	650,000
Service Territory:	2,300 sq. miles
Peak Load:	6,601 MW

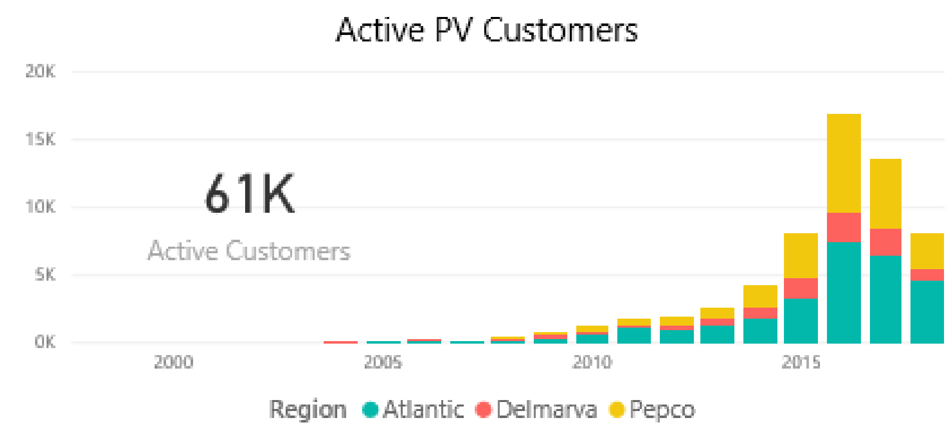
Atlantic City Electric Co.	
Customers:	545,000
Service Territory:	2,700 sq. miles
Peak Load:	2,673 MW

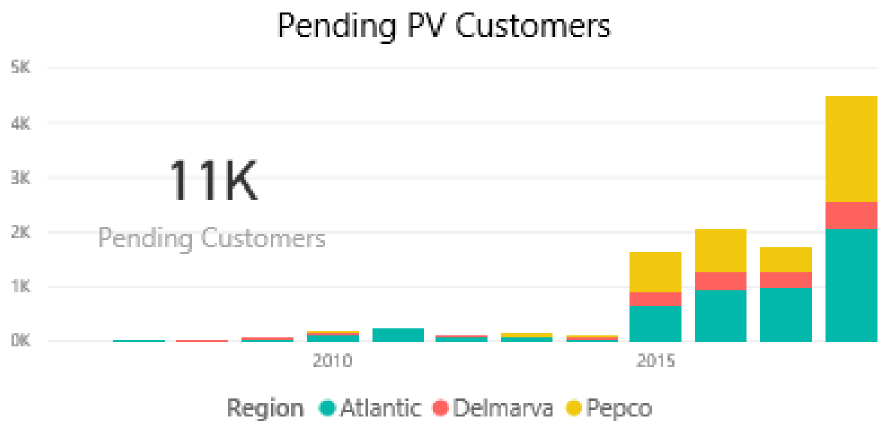


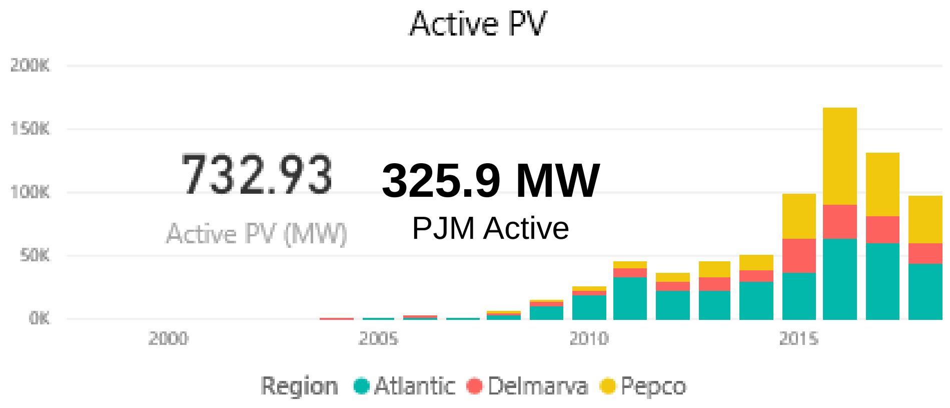
- Atlantic City Electric Co. Service Territory
- Baltimore Gas and Electric Co. Service Territory
- ComEd Service Territory
- Delmarva Power & Light Service Territory
- PECO Energy Service Territory
- Potomac Electric Power Service Territory

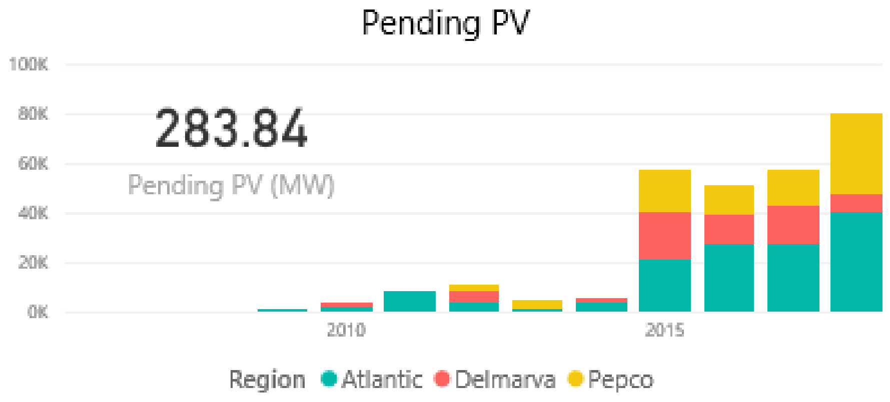
Pepco Holdings
An Exelon Company

PHI NEM Statistics









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Hosting Capacity Methods Overview

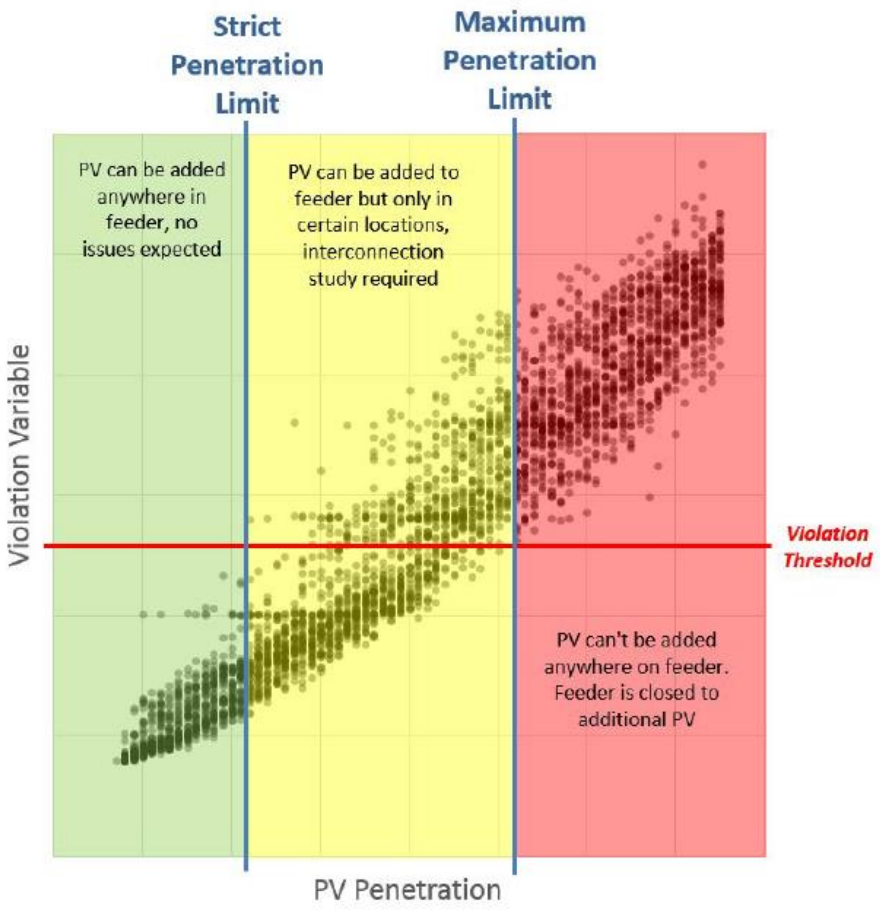
Method	Approach	Advantages	Disadvantages	Computation Time	Use Case
Stochastic	+Increase DER randomly +Run power flow each time	+Well understood technique +Performed in vendor tools	+Computationally intensive +Limited scenarios	Long	+DER Planning
Iterative	+Increase DER at specific location +Run power flow each time	+Well understood technique +Performed in vendor tools	+Computationally intensive +Limited scenarios	Long	+Screening +Informing Developers
Streamlined	+Limited number of power flows +Power flow not ran each time	+Computationally efficient +Not vendor tool specific	+Not well understood method +Limited scenarios	Short	+Screening +Informing Developers
DRIVE	+Limited number of power flows +Power flow not ran each time	+Computationally efficient +Many DER scenarios considered +Not vendor tool specific	+Not well understood method	Moderate	+DER Planning +Screening +Informing Developers

These methods generally don’t take into consideration substation transformers, transmission system, secondary voltage rise, distribution automation, arc flash, and detailed fuse and protective device coordination.

Image: EPRI, Matthew Rylander

Strict Penetration Limit vs Maximum Penetration Limit

- Each point on the plot below represents one tested random placement of PV sites, satisfying the PV penetration value



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PHI Hosting Capacity Criticism

- *HCA may limit projects by underestimating the hosting capacity*
  - PHI does not use the HCA when evaluating applications so it has no impact on limiting larger projects on feeders
  - It is possible for the HCA displayed on the PHI maps to be lower or higher than the final amount that may be able to be installed
- *PHI's methodology has not gone thru any public vetting*
  - PHI developed this proactively, before being required, and won a DOE grant that included development of HCA. Similar methodology was used by EPRI prior to their adopting the streamlined / DRIVE approach.
  - PHI publishes its DER Criteria online and has provided information on the HCA methodology to any interested parties in an attempt to be transparent.
  - PSC staff and developers have had positive comments on the HCA and map.

Key Takeaways

- Hosting Capacity is a proactive step utilities can take to support customer interconnections
- Hosting Capacity depends heavily on location and size of PV
- Hosting Capacity is unique to each circuit and is time varying.
- Hosting Capacities need to be updated as circuit conditions change over time.
- There are varying methods to calculating hosting capacity, but a stochastic placement model is optimal
- A consistent and repeatable methodology is required to better understand how feeder characteristic impact hosting capacity
- Voltage regulator and capacitor bank settings can have a big impact on hosting capacity

Interactive Maps

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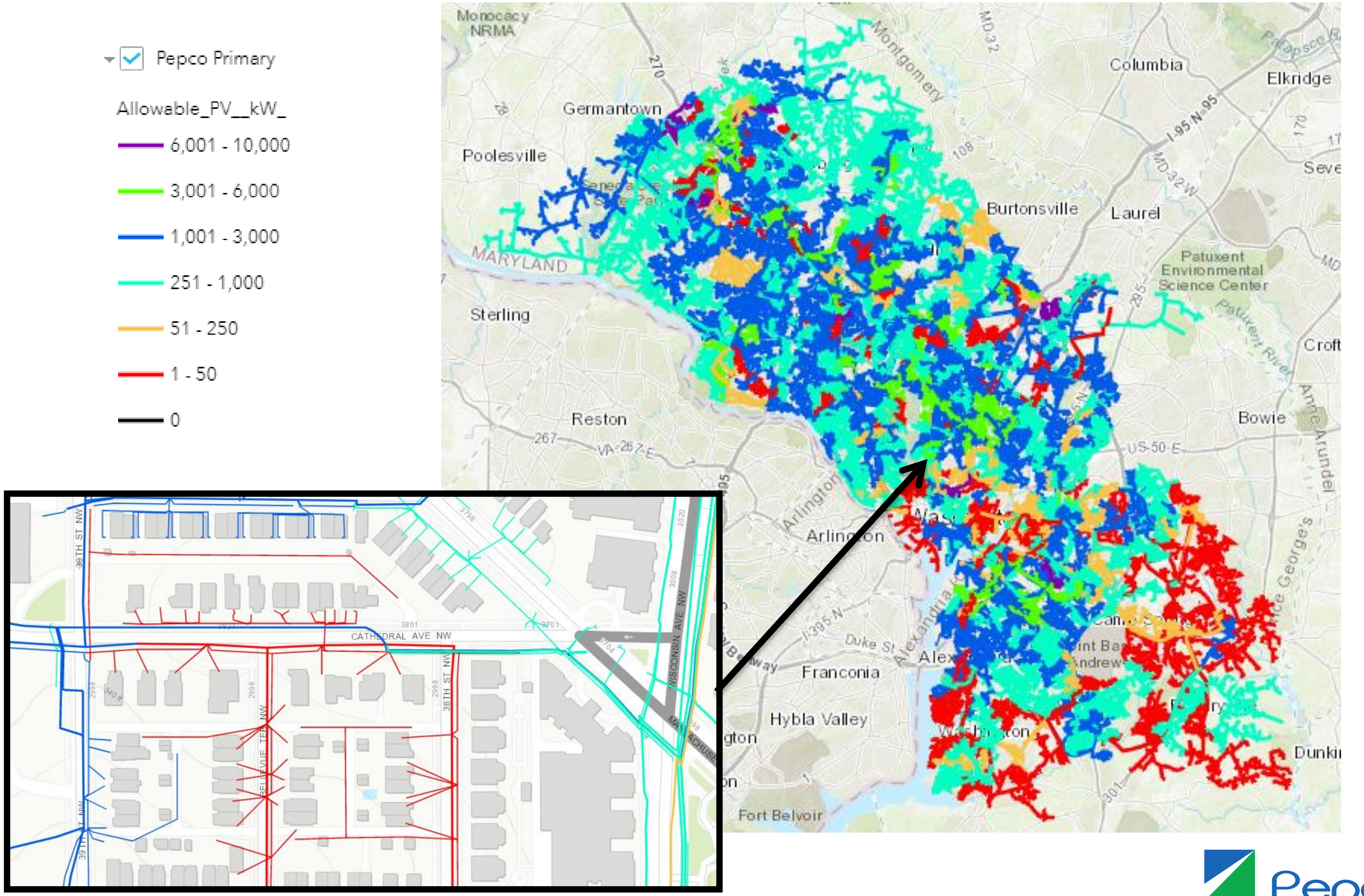
Hosting Capacity Visualization

- For hosting capacity studies to be utilized effectively, their results must be visualized
  - A report is generated on a monthly basis, showing those feeders that require an updated hosting capacity (due to a change of 500 kW in generation on that feeder)
  - PHI stores the results of each hosting capacity study in a central database
  - This database is tied to our online ArcGIS tool to create a visual representation of hosting capacity per feeder
- Hosting Capacities are shared with the public to provide the greatest benefit.
  - Helps developers find suitable areas for large installations

Hosting Capacity (Radial)



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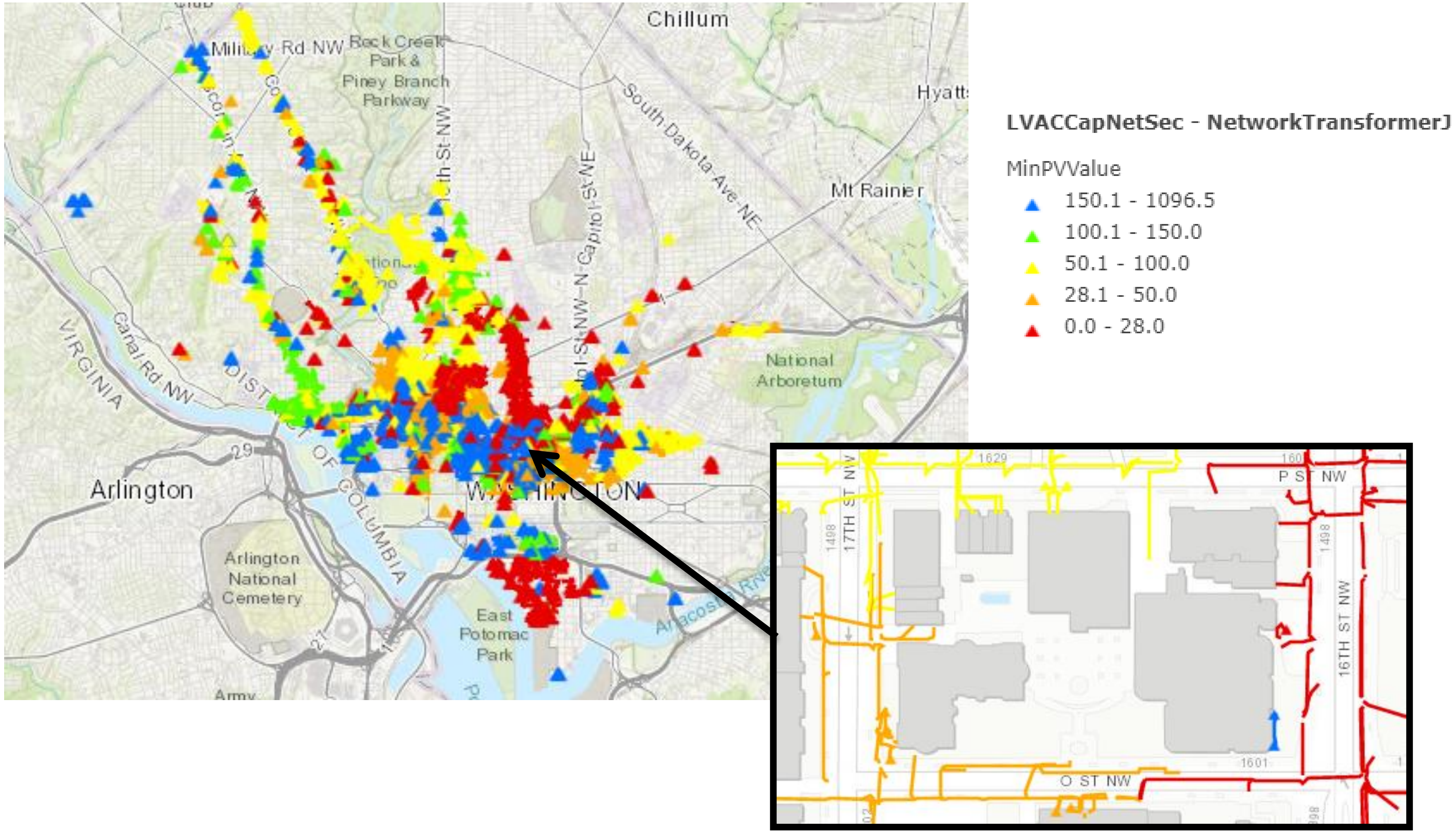
Hosting Capacity (Network)



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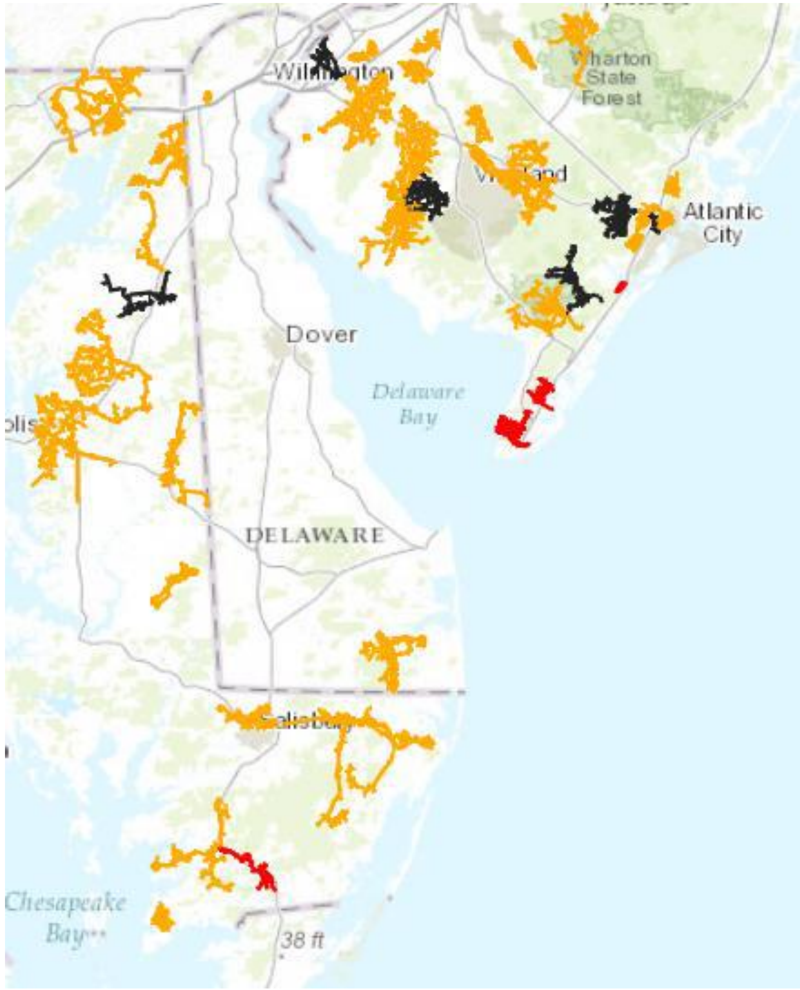
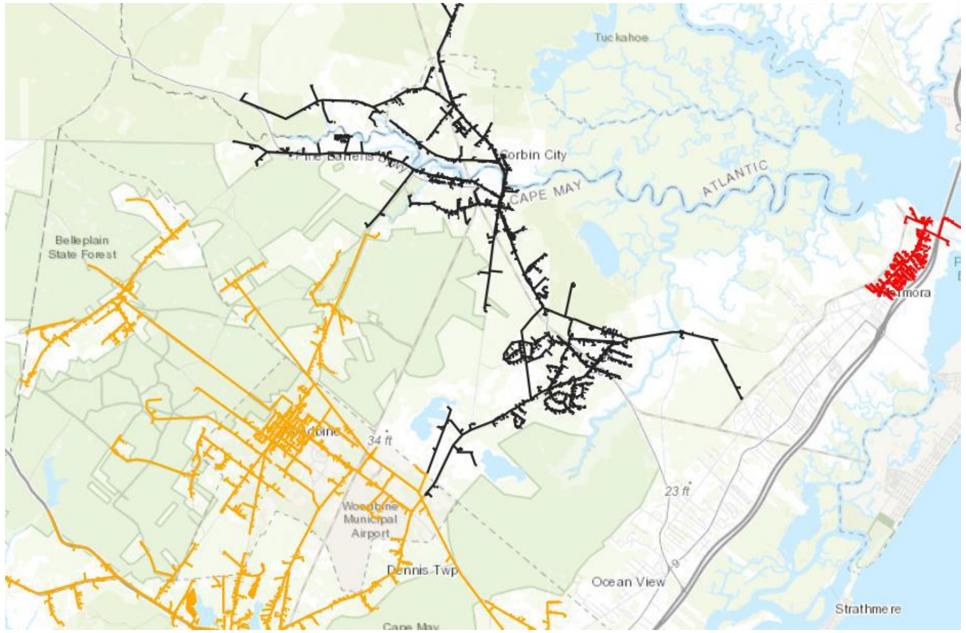
Restricted Circuit



Maximum System Size of 250kW

Maximum System Size of 50kW

Maximum System Size of 0kW



An Exelon Company

Heat Map

Total PV - 4kV

Total PV
- 0 to 125 kW
- 125 to 250 kW
- 250 to 500 kW
- 500 to 1,000 kW
- 1,000 kW

Total PV - 23-25kV

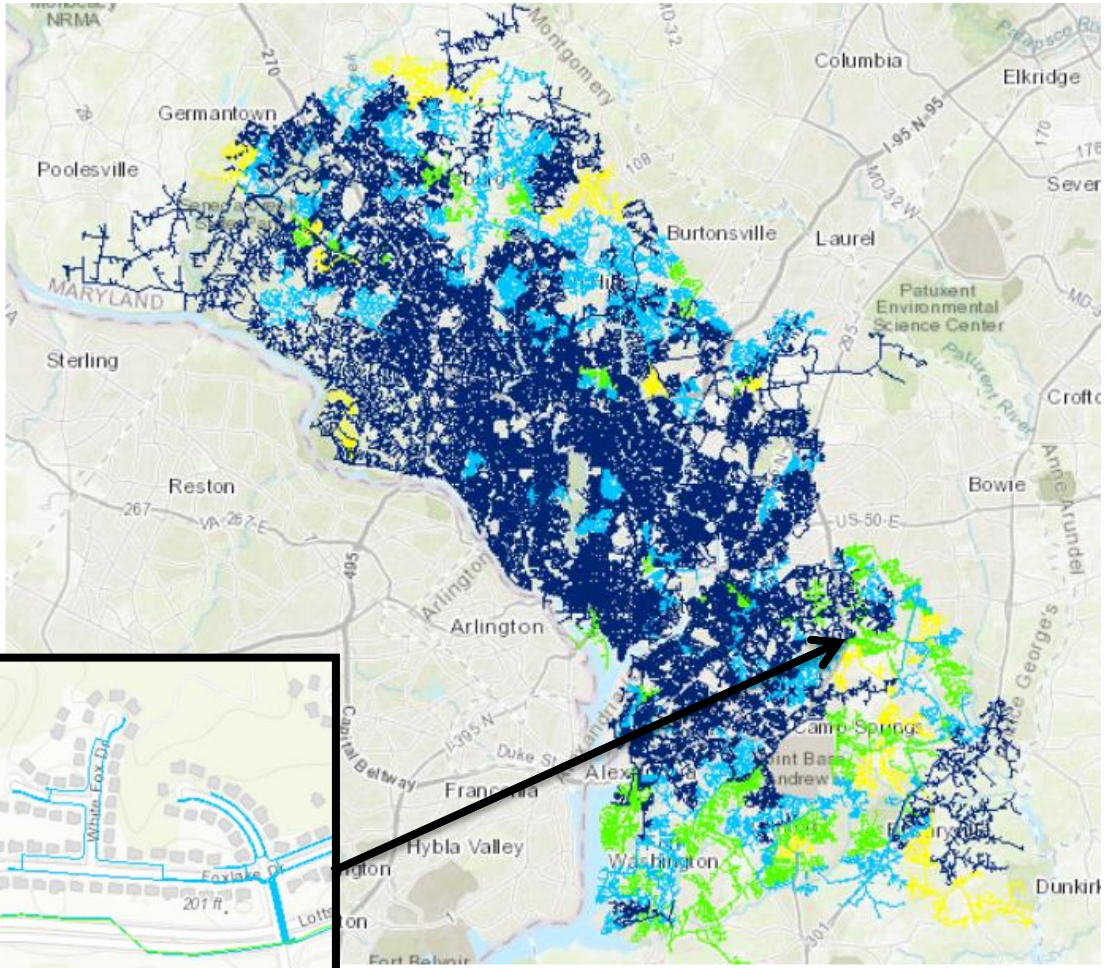
Total PV
- 0 to 1,000 kW
- 1,000 to 2,000 kW
- 2,000 to 4,000 kW
- 4,000 to 8,000 kW
- 8,000 kW

Total PV - 12-13kV

Total PV
- 0 to 500 kW
- 500 to 1,000 kW
- 1,000 to 2,000 kW
- 2,000 to 4,000 kW
- 4,000 kW

Total PV - 34kV

Total PV
- 0 to 1,750 kW
- 1,750 to 3,500 kW
- 3,500 to 7,000 kW
- 7,000 to 14,000 kW
- 14,000 kW



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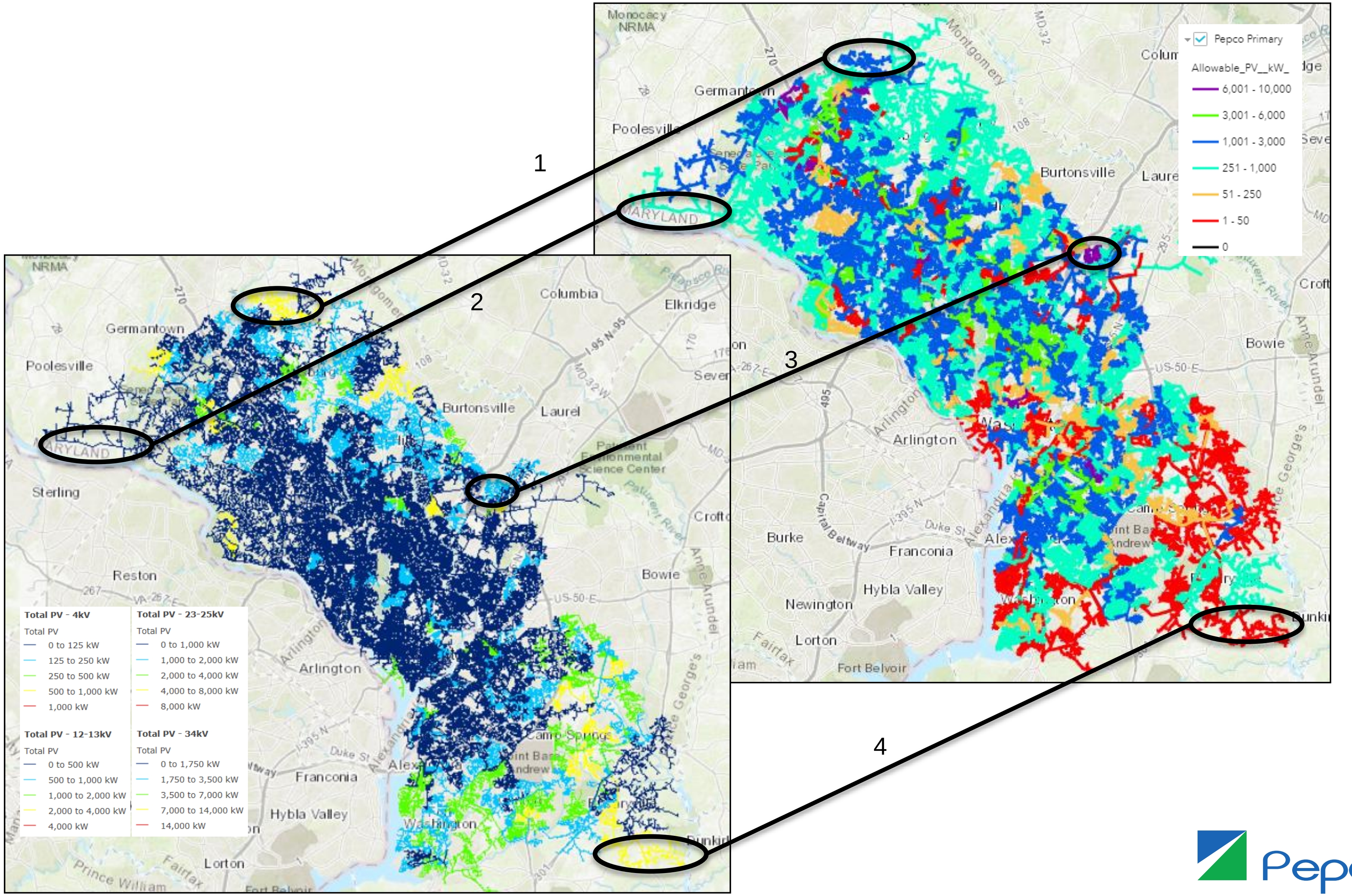
Solar Heat Map vs Hosting Capacity



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Key Takeaways

- Although hosting capacity is a beneficial internal tool, external parties and customers can also benefit from this information
- By providing both a hosting capacity map and heat map, we allow customers to truly understand their feeder and whether there may be potential issues with a large interconnection.
- For hosting capacity to provide the most benefit, it must be updated whenever major changes occur on the circuit.

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Increasing Hosting Capacity

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Circuit Improvements to Increase Hosting Capacity

- As part of the U.S. Department of Energy SunShot Initiative, PHI worked with EDD, CPR, and Rutgers University on PHI Hosting Capacity studies
- A number of methods were utilized to implemented with the objective of increasing hosting capacity. These include:
  - Phase Balancing
  - Dynamic Voltage Regulator Control
  - Equipment Voltage Settings
  - Capacitor Redesign
  - Voltage Regulator Set Point Reduction
  - Inverter Fixed Power Factor
  - Battery Storage
  - Combination of Multiple Efforts

SunShot U.S. Department of Energy

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Cost for Upgrades

Strict Penetration Limit (Before and After)						
Feeder	Base Case			Max. Penetration w/ Upgrades		
	PV (%)	PV (MW)	Cost (k$)	PV(%)	PV(MW)	Cost(k$)
1	29.7	1.0	0.0	167.9	5.9	60.2
2	29.7	1.5	0.0	197.1	10.4	32.5
3	53.6	2.2	67.9	264.7	10.9	149.3
4	34.9	1.2	0.0	134.5	4.8	22.0
5	43.7	2.0	67.3	193.7	8.7	96.8
6	38.9	2.6	0.0	219.6	14.5	78.5
7	36.9	1.9	0.0	92.7	4.7	131.4
8	23.8	1.4	0.0	129.2	7.6	2.0
9	1.9	0.1	0.0	161.3	8.1	21.0
10	12.8	0.3	0.0	62.9	1.6	27.5
11	39.0	2.0	37.2	61.0	3.1	178.3
12	8.0	0.7	37.2	11.9	1.0	118.7
13	2.9	0.2	0.0	104.9	5.8	150.2
14	15.9	1.5	0.0	18.0	1.7	33.0
15	20.0	1.6	0.0	76.0	6.2	21.5
16	5.9	0.5	59.7	63.9	5.2	167.1
17	17.0	2.0	0.0	104.9	12.1	31.0
18	42.9	2.8	0.0	336.7	22.2	25.0
19	25.9	1.6	74.0	67.8	4.1	80.0
20	44.9	2.7	0.0	184.6	11.0	2.5
AVERAGE	**26.4**	**1.5**	**17.2**	**132.7**	**7.5**	**71.4**

← Minimum (feeder 14)

← Maximum (feeder 18)

The above does not include battery deployment and it represents different voltage levels

Other system upgrades may be necessary as overall penetration increases.

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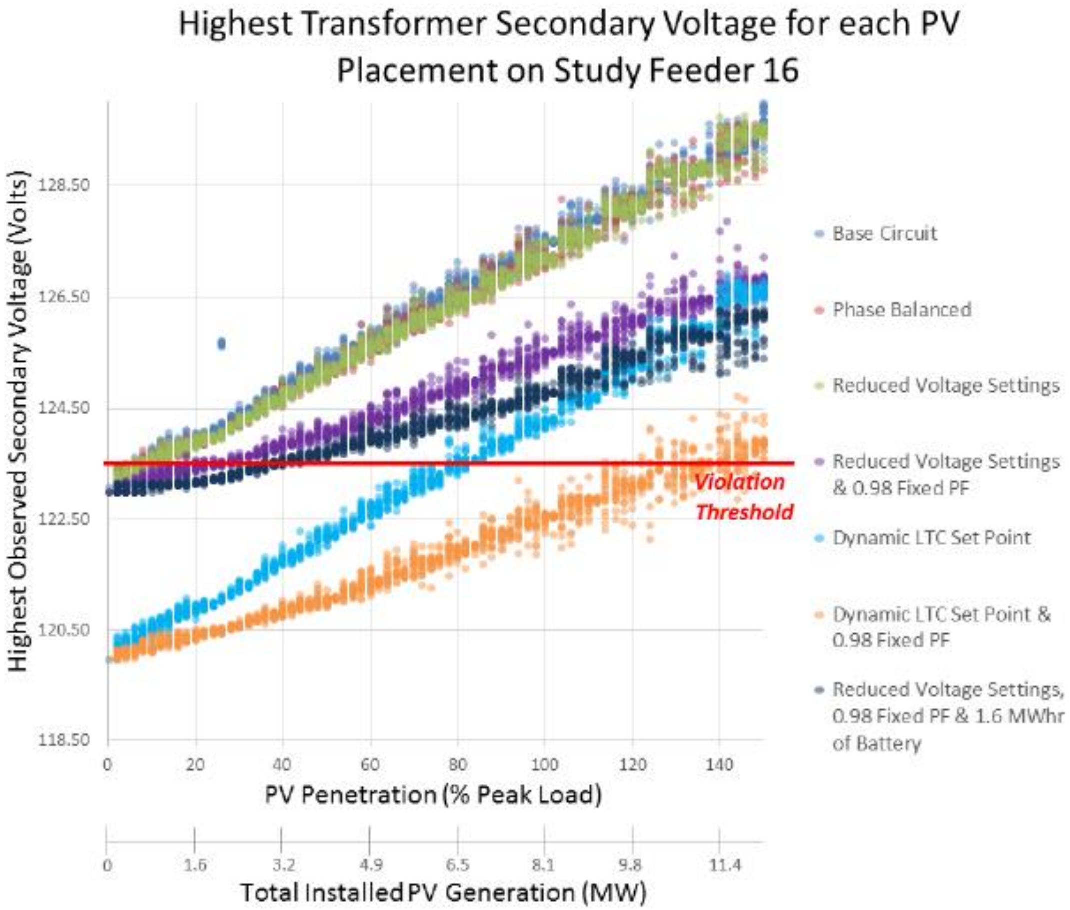
Study Feeder 16

- Choosing a violation threshold is vital



Peak Load 8.1 MW

15 kW Active PV
(Approximate <1% Penetration)

Min. Daytime Load 2.4 MW

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Key Takeaways

- Hosting Capacity can be used to help redesign and reconfigure circuits to accommodate additional DER
- A variety of methods, including low cost methods, can be used to increase hosting capacity.
- These improvements do not include the application of controllable smart inverters which could significantly improve hosting capacity on feeders. This needs to be studied further.
- The concept of voltage headroom that allows customers to export power without causing overvoltage would help to increase hosting capacity and potentially reducing losses

Privacy & Update Policy

- Privacy
  - HCA - Distribution circuits represented as a colored line without any equipment shown. The colored line extends to premises which are just depicted as grey blocks.
  - Heat Maps – Individual projects and installed solar are not depicted, just the aggregate active and pending system capacity so as to maintain the privacy of any single installation.

- Update Policy
  - HCA – Circuits are flagged to be updated if 500kW of additional solar is approved, or if load on the feeder increases or drops significantly or if the feeder configuration changes. Once per month any flagged feeder has HCA rerun.
  - Heat Maps - - are updated each night based on the systems that went active and the additional systems approved and are now pending

Future Plans

- Iterative Hosting Capacity – PHI has plans to post this type hosting capacity when updates can be done automatically each evening. This will depict the Hosting Capacity at each node.
- EV Fast Charge Siting - - a reverse type of HCA is being used to identify sections of circuits that could host a 10 car fast charge station without significant upgrades.
- Use of smart inverters and battery systems to avoid upgrades and increase hosting capacity
- Long term plans for deploying ADMS will help to increase hosting capacity
- Low cost secure communication will enable higher penetration without compromising DA scheme operation, reducing reliability

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Non-Wires Alternative Analysis

- PHI has created a Load/DER database with customer native load, customer net load, and generation with hourly values for each.
- Disaggregated load/DER at each customer is the base upon which Non-wires Alternative studies can be done
- LIDAR data for each customer provides solar potential, and building envelope data
- Infrared data can provide loss information
- High frequency sampling at the meter can determine appliance health and efficiency
- Demand response can be layered on
- Statistical cleansing will be added with weather normalization of all weather dependent load
- Data compression will reduce enormous data sizes so program loading and execution will be acceptable

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Staff Subcommittee on Energy Resources and the Environment

BORREGO SOLAR

HOSTING CAPACITY ANALYSIS

Developer’s Perspective

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Borrego Solar Systems, Inc.

Utility Electrical Engineer

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AGENDA

- Introduction
- Interconnection Cost Estimating
  - Current Methods
- Hosting Capacity Analysis
  - Experience and Lessons Learned
- Future Tool Improvements and Suggestions

INTRODUCTION

- ## Borrego Solar
- Established in 1980 in Borrego Springs, California
  - Started with strictly rooftop residential systems
- In 2001, we shifted our focus towards grid-tied, ground-mount solar installations
- In 2007, opened the New England Branch
- Few years later, strategic direction changed to focus 100% on commercial utility markets

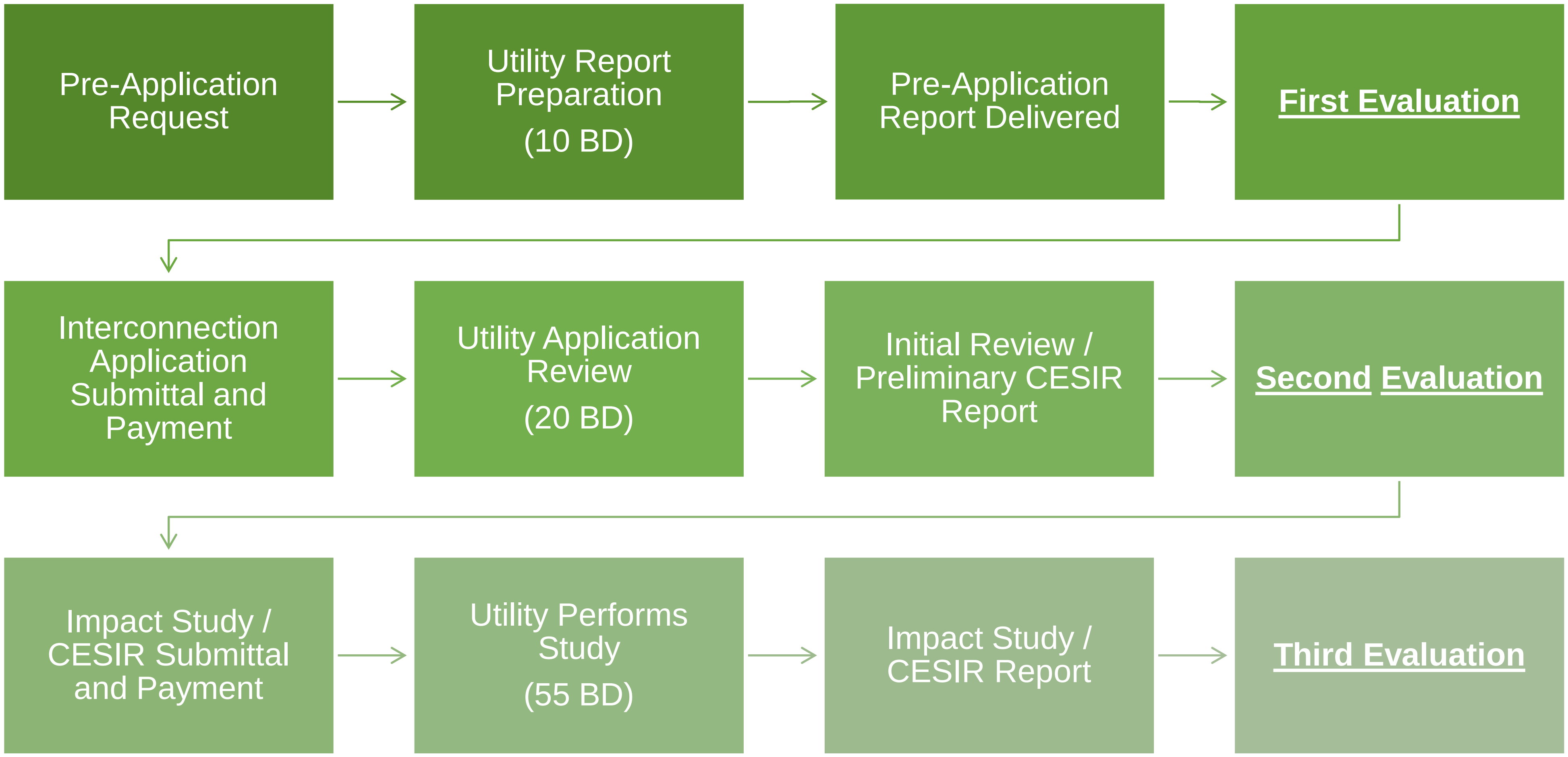
- ## Shay Banton, E.I.T.
- Utility Electrical Engineer (Jan. 2017 – Present)
- Experience in Substation Design at NiSource in Indiana
- Graduate of Washington University in St. Louis, 2015
  - Bachelor of Science in Systems Science & Engineering
  - Concentration in Electrical Engineering
- Contact Information:
  - Email: sbanton@borregosolar.com

INTERCONNECTION ESTIMATING

CURRENT METHODS

INTERCONNECTION ESTIMATING

Typical Interconnection Application Process



INTERCONNECTION ESTIMATING

Reviewing the Data Provided by Utilities

Pre-Application Stage – “EPS Snapshot”

Report Requirement:	MA	NY	IL	What does this reveal about the electric power system?
Circuit Name/ID	✓	✓	✓	Allows comparison to previous projects on same circuit
Voltage at Proposed Site	✓	✓	✓	Determines protective requirements and helps estimate circuit capacity
Voltage at Substation	✓	✓	X	Difference between sub and site indicates line transformer or split-phase
Number of Phases at Site	✓	✓	✓	Whether or not we require a 3Ø line extension
Distance to 3-Phase	✓	✓	✓	Estimating cost of reconductoring
Aggregate Connected DG	✓	✓	✓	Estimate circuit capacity and what upgrades have been installed
Aggregate in Queue DG	✓	✓	✓	Helps determine what upgrades will be triggered by queued projects
Type of Circuit	✓	✓	✓	Estimate how much distribution protection upgrades will cost
Other Feeders in Area?	✓	X	✓	Allows us to estimate for different feeders with different characteristics
Est. Circuit Capacity	X	?	✓	How much DG can fit on circuit without excessive upgrades
Circuit Peak/Min Load	X	✓	✓	Further insight into circuit capacity
Substation Name	?	X	X	Allows comparison to previous projects on same substation
Substation Bank Capacity	X	✓	X	Insight into whether or not future projects can be placed in the area
Substation Peak/Min Load	X	✓	X	Bi-directional control threshold
Distance to Substation	X	✓	✓	Estimating cost of extensive reconductoring

INTERCONNECTION ESTIMATING

Reviewing the Data Provided by Utilities

Initial Review / Preliminary Screening – Final Review before Impact Study

Report Requirement:	MA	NY	IL	What does this reveal about the electric power system?
Pre-Application Data	?	?	X	Determine if anything has changed from previous evaluation
Preliminary Study Results	X	✓	✓	Assist in determining what major issues might come up during study
Circuit Peak/Min Load	✓	?	X	Further insight into circuit capacity
Limiting Equipment	X	?	X	Allows comparison to previous projects on same substation
Fault Current at POI	X	?	X	Stiffness Factor estimation or used to satisfy design requirements for pre-study submittal

Impact Study / CESIR Results

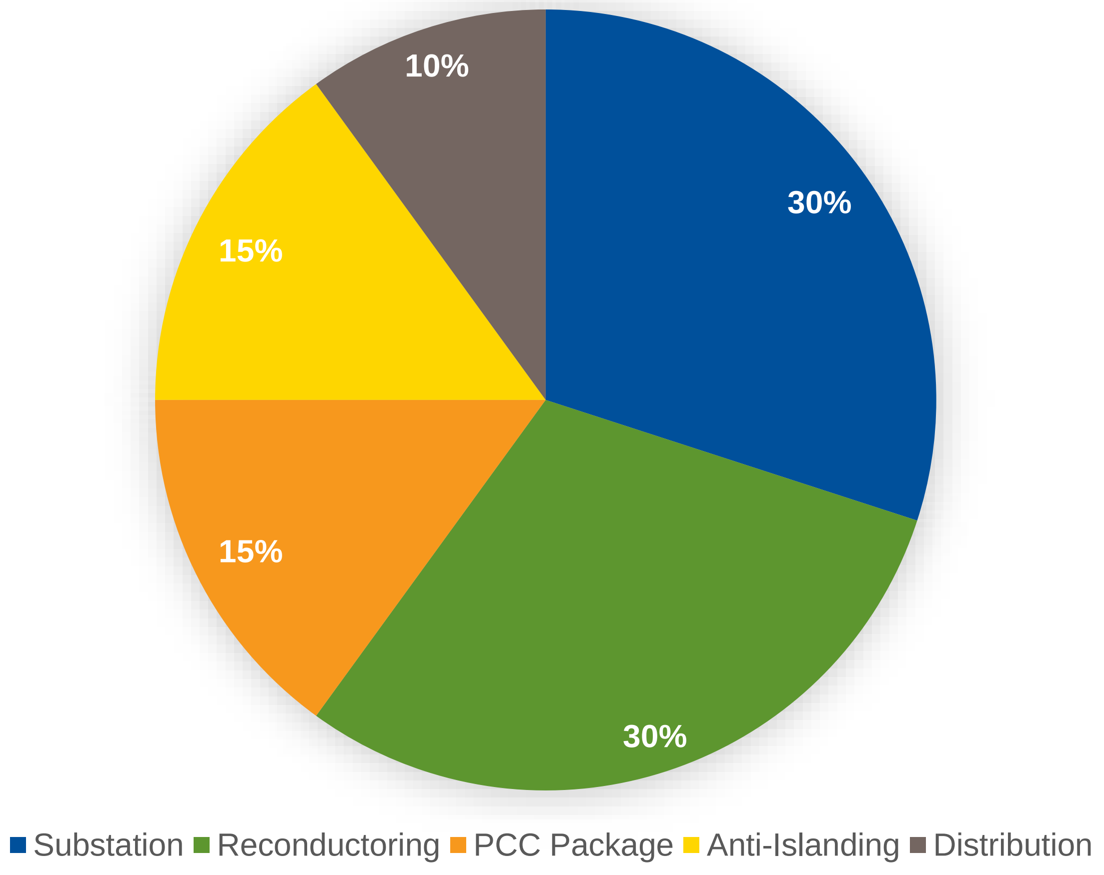
Report Requirement:	MA	NY	IL	What does this reveal about the electric power system?
Circuit Characteristics	✓	✓	X	Provides transparency into study parameters and assist in future development in the area
Substation Characteristics	✓	✓	X	Provides transparency into study parameters and assist in future development in the area
Study Results	✓	✓	✓	Tells developers whether or not they failed the utility's analysis
Study Result Details	✓	✓	X	Transparency allows developers to address specific utility concerns with system modifications
Cost Estimate	✓	✓	✓	Tells developers what it will cost them to mitigate reliability concerns found during the study
Line Item Cost Estimate	✓	✓	X	Transparency allows developers to better estimate future interconnection cost

INTERCONNECTION ESTIMATING

Identify System Upgrade Cost Barriers Based on Data

- Distribution Upgrades:
  - Reconductoring
    - Line Extensions to 3-Phase
    - Thermal Rating of Conductor
    - Voltage Change and Flicker Concerns
  - Protection Upgrades (i.e. Coordination)
  - Regulation Upgrades (i.e. Bi-Directional)
- Substation Upgrades:
  - Thermal Limitations of the Transformer
  - Protection Upgrades (e.g. $3V_0$, Coordination, etc.)
  - Regulation Upgrades (i.e. Bi-Directional)

Typical Upgrade Distribution



BORREGO SOLAR

HOSTING CAPACITY ANALYSIS

EXPERIENCE AND LESSONS LEARNED

HOSTING CAPACITY ANALYSIS

Utility Versus Developer Perspective

- Utility
  - Definition:
    - *"The amount of distributed energy resources that can be accommodated on the distribution system under existing grid conditions and operations without adversely impacting operational criteria or requiring significant infrastructure upgrades."* - IREC
  - Benefits:
    - Streamline the interconnection process
    - Focus development in areas that would most benefit the grid
    - Reduce utility resources needed to review and study applications that end up not moving forward

- Developer
  - Definition:
    - *"Tool that shows where distributed generation can be interconnected for the least amount of Utility upgrades."* - Developers
  - Benefits:
    - Streamline the interconnection process
    - Focus development in areas with a high capacity for DG where interconnection will yield low upgrade costs
    - Reduce developer resources and engineering on applications that end up being too expensive to build

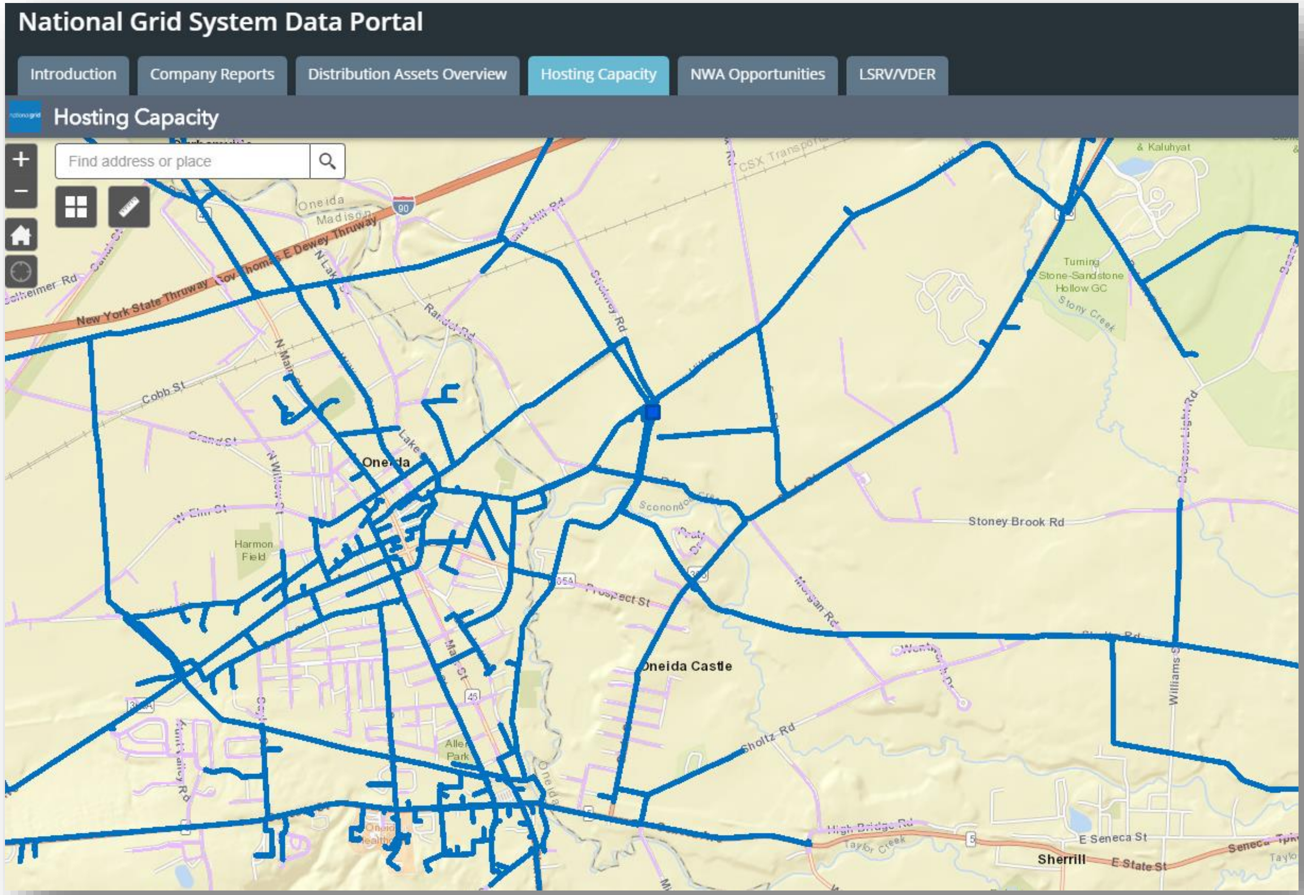
HOSTING CAPACITY ANALYSIS

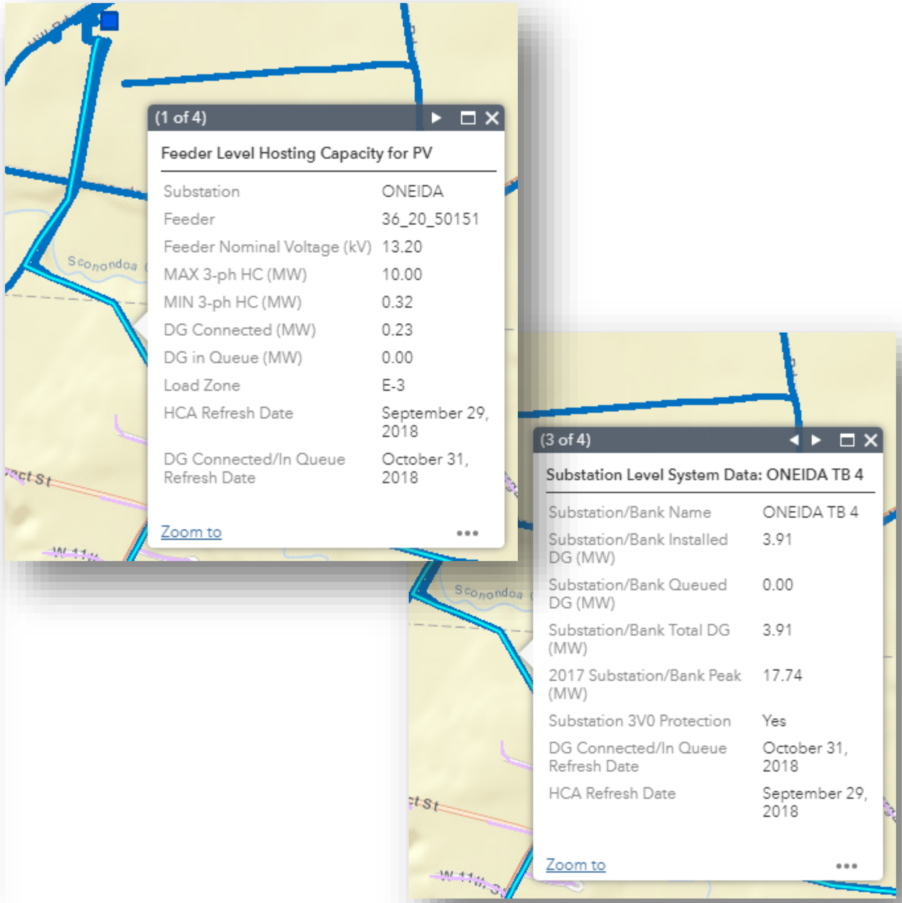
Borrego's Experience with New York Utilities

- **Completed Stages**
- Stage 1 (December 2016)
  - Published red-zone maps which indicate locations with higher interconnection costs.
  - Enhanced indicator maps with additional data and more consistent representation across the Joint Utilities
- Stage 2 (October 2017)
  - Heat maps of the gross hosting capacity by feeder calculated using large centralized solar PV scenarios
  - Data pop-ups for each feeder will provide information in tabular format.
- Stage 2.1 (February 2018)
  - Additional values to be included in the data pop-up
  - Current stage of HCA in New York

HOSTING CAPACITY ANALYSIS

Borrego's Experience with New York Utilities





HOSTING CAPACITY ANALYSIS

Borrego's Experience with New York Utilities

- Future Development
- Stage 3 (TBD)
  - Increase the spatial granularity of the hosting capacity values provided
  - Substation level hosting capacity
  - Model existing DER
- Stage 4 (TBD)
  - Perform fully integrated value assessments

HOSTING CAPACITY ANALYSIS

Borrego's Experience with New York Utilities

- ## Stakeholder Input
  - Conferences and webinars held a handful of times throughout development
  - Discussions and updates at bi-monthly Interconnection Technical Working Group (ITWG) meetings
  - Developer feedback during sessions are responsible for the modifications to data tables in Stage 2.1
  - Developers hope to have direct input into the next series of features implemented in Stages 3 and 4
- ## Developer Concerns
  - No Developer input into HCA study methodologies
  - Slower than expected tool development

HOSTING CAPACITY ANALYSIS

Changes to the Development Process

Pre-Application Reports

- Developers:
  - Many developers have opted to skip the pre-app report process entirely
  - Major reduction in interconnection timeline (~30 BD)
- Utilities:
  - Major reduction in utility resource allotment to producing these reports
  - Has allowed for more focus on application automation efforts

Submitted Applications

- Developers:
  - Nearly all applications submitted are on circuits and substations with capacity remaining for projects
  - Nearly all applications proceed to Impact Study / CESIR with little doubt into utility upgrades
  - Can anticipate where they might run into grid limitations and can modify system characteristics to avoid restudies
- Utilities:
  - Lower number of failed applications
  - Reduced number of restudies and more productive preliminary screening discussions prior to CESIR

FUTURE TOOL IMPROVEMENTS AND SUGGESTIONS

FUTURE TOOL IMPROVEMENTS AND SUGGESTIONS

Changes to the Development Process

- Developer Engagement in HCA Methodology Decisions
- Process Flexibility for Updating HCA for Emerging DG
  - Examples: Advanced Inverter Functions, Storage, Electric Vehicles, Combined Heat and Power, etc.
- Coupled with Utility Upgrade Cost Standardization Efforts
- Increased Frequency of Queue and Capacity Calculation Updates

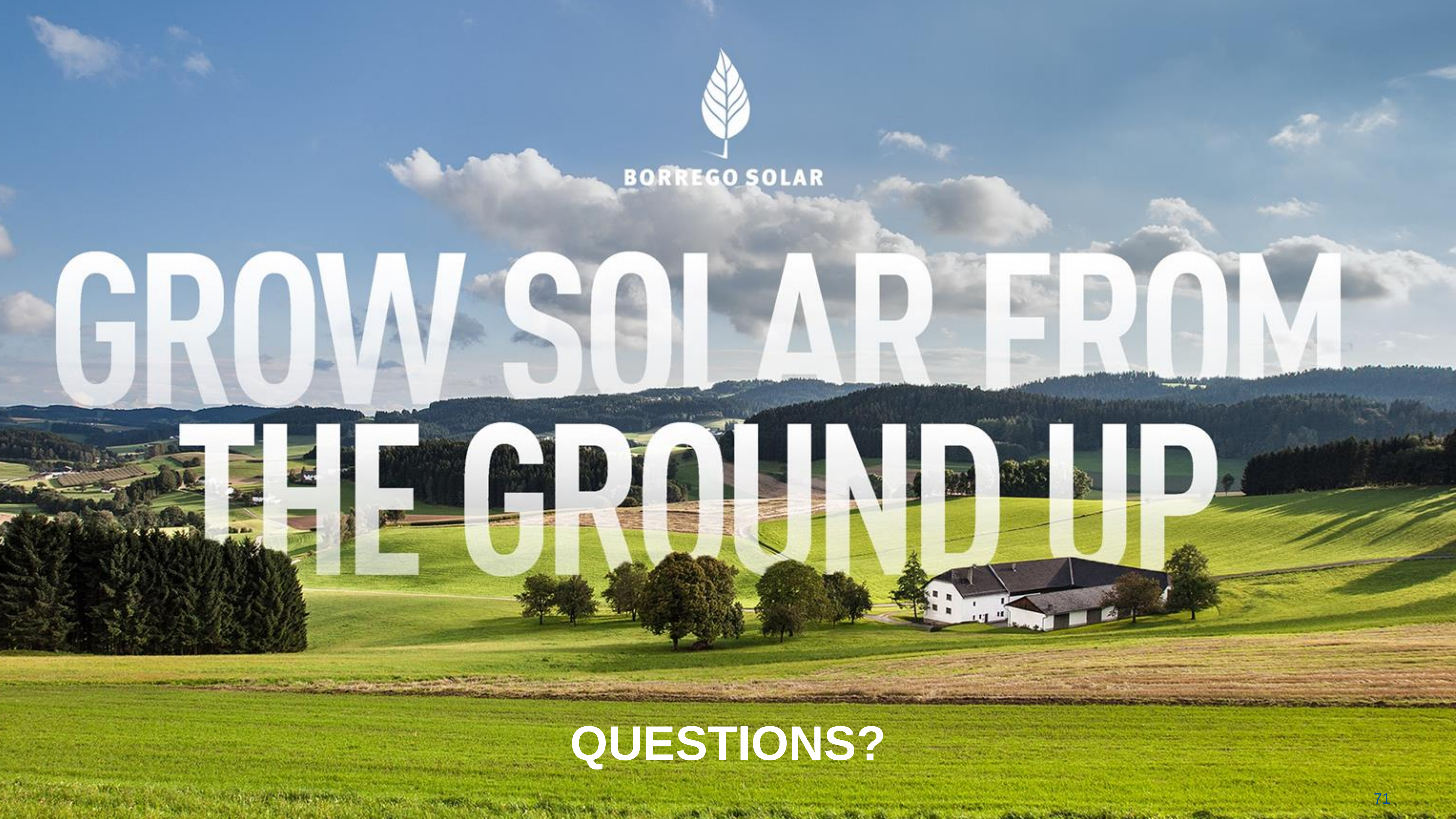
FUTURE TOOL IMPROVEMENTS AND SUGGESTIONS

Keep the End Goal in Mind While Developing Your Tool

- Map Capable of Running Fully Automated Impact Studies at Designated Nodes Along a Circuit
- Automated Interconnection Cost Estimate
- Ability to Filter Map to Isolate Low Upgrade Areas for Different Types of DG

Resources and References

- New York Hosting Capacity Maps: https://jointutilitiesofny.org/utility-specific-pages/hosting-capacity/
- JU Hosting Capacity Stakeholder Session 2017-11-02: https://jointutilitiesofny.org/joint-utilities-of-new-york-engagement-groups/
- Estimating Interconnection Cost for Utility-Scale Distributed Generation: https://www.nrel.gov/solar/distribution-grid-integration-costs-workshop.html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GROW SOLAR FROM
THE GROUND UP
QUESTIONS?

Staff Subcommittee on Energy Resources and the Environment