The Revolution Will Be Distributed

Vote Solar Webinar
With
Ryan Hanley – SolarCity

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From Pearl Street to Rooftop PV

» **The Past**: Power is centrally generated, then is delivered to customers via the distribution grid. Utility-centric, customers passive consumers.

» **The Present**: Mostly large, central station generation, but with an increasing mix of distributed generation and demand side management. Utility centric with limited 3rd party providers, customers have more choices.

» **The Future**: More distributed resources, more consumer choice and participation, smaller mix of central station generation, microgrids, data sharing and transparency, new procurement structures and revenue models. Utility, customer and 3rd party provider shared responsibility.

The Revolution is Coming…

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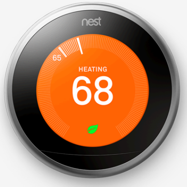
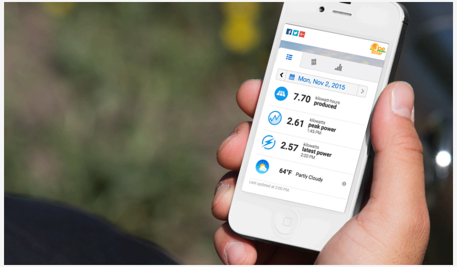
» What's Driving Change?

- Advances in technology – including at the consumer level
- Emergence of the "prosumer"
- Non-traditional market entrants
- Policy shifts and regulatory reforms
- Awareness of environmental and climate impacts of energy choices





The Revolution is Coming…

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» Who's Leading the Charge?

- New York: Reforming the Energy Vision – a top-down approach to reforming the utility business model (in part a response to Sandy)
- California: Distributed Resources Planning & Integration of Distributed Energy Resources (response to climate change policies and rapid adoption of rooftop PV, electric vehicles, energy storage)
- Hawaii: Investigation of Distributed Energy Resources (driven by high rates, rapid consumer uptake of PV)
- Minnesota/others: DER/Utility Business Model investigations (proactive regulatory policies)

The Revolution is Coming…

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» Key California Regulatory Proceedings

> Distributed Resources Planning (R.14-08-013) – focus on grid needs, identifying "hosting capacity" for DER (shared online), identifying locational net benefits and assigning values, demonstration programs for modeling the grid.

> Integration of DER (R.14-10-003) – focus on provision of DER to meet needs identified in DRP process, develop procurement framework for DER, ensure customer choice and participation.

Integrated Distribution Planning:

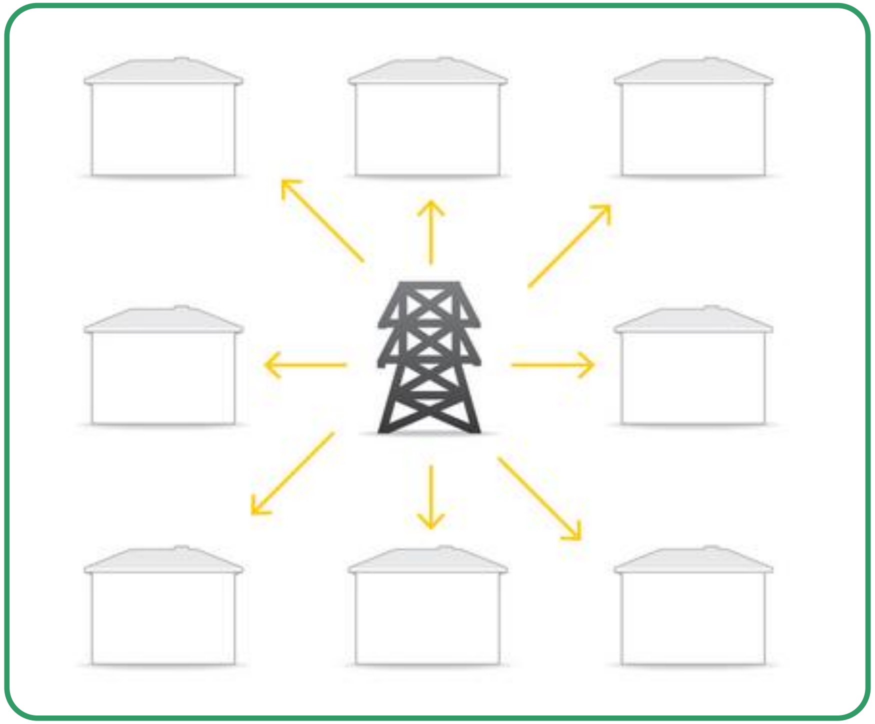
A holistic approach to meeting grid needs and expanding customer choice by unlocking the benefits of distributed energy resources

Ryan Hanley
Senior Director
Grid Engineering Solutions

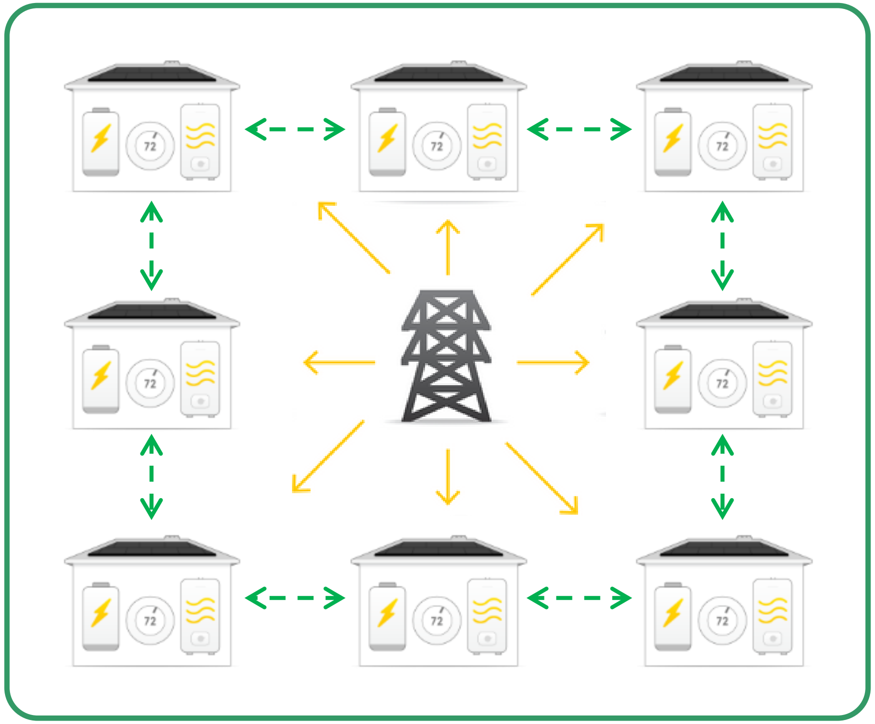
December 16th, 2015

Designing the Distributed Grid of Tomorrow

Today

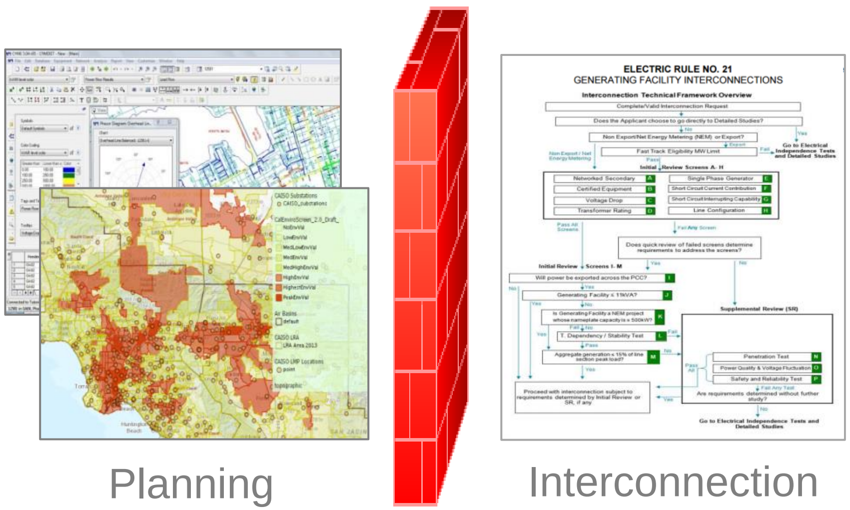


Tomorrow



Modernization in grid planning is needed

Traditional Planning



Integrated Distribution Planning

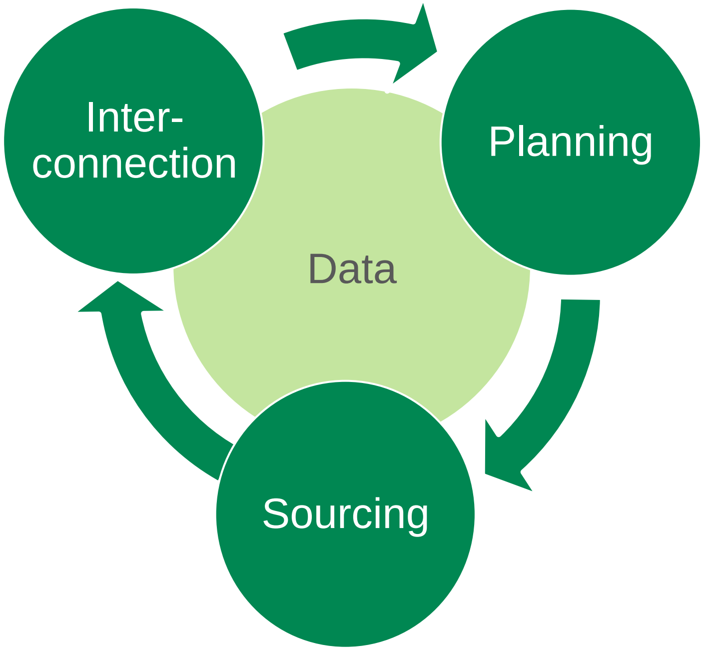
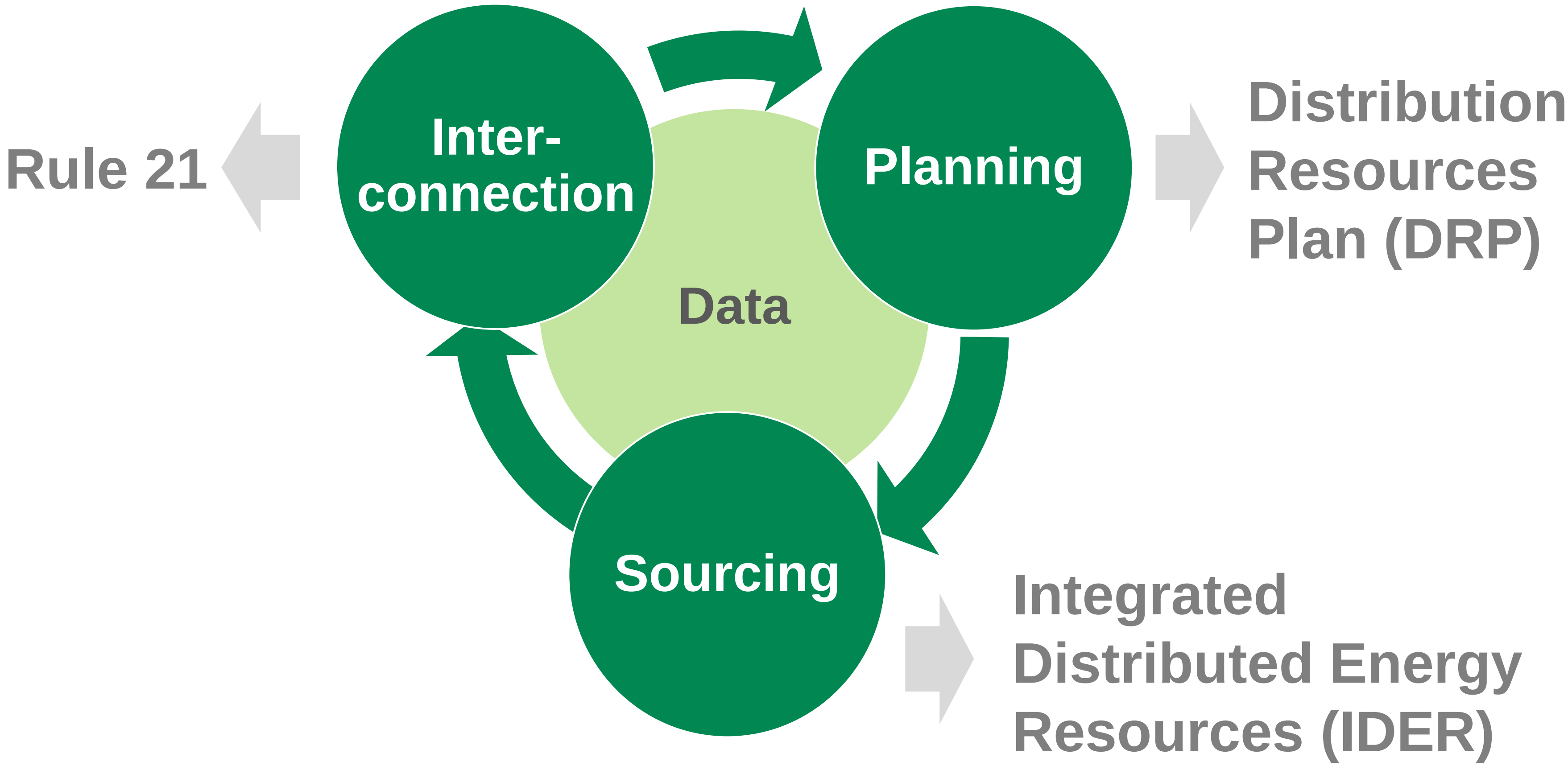


Image Sources: CYME, Kevala, PG&E

A holistic approach to meeting grid needs and expanding customer choice by unlocking the benefits of distributed energy resources

IDP In Action: California regulatory proceedings already align with *Integrated Distribution Planning* framework



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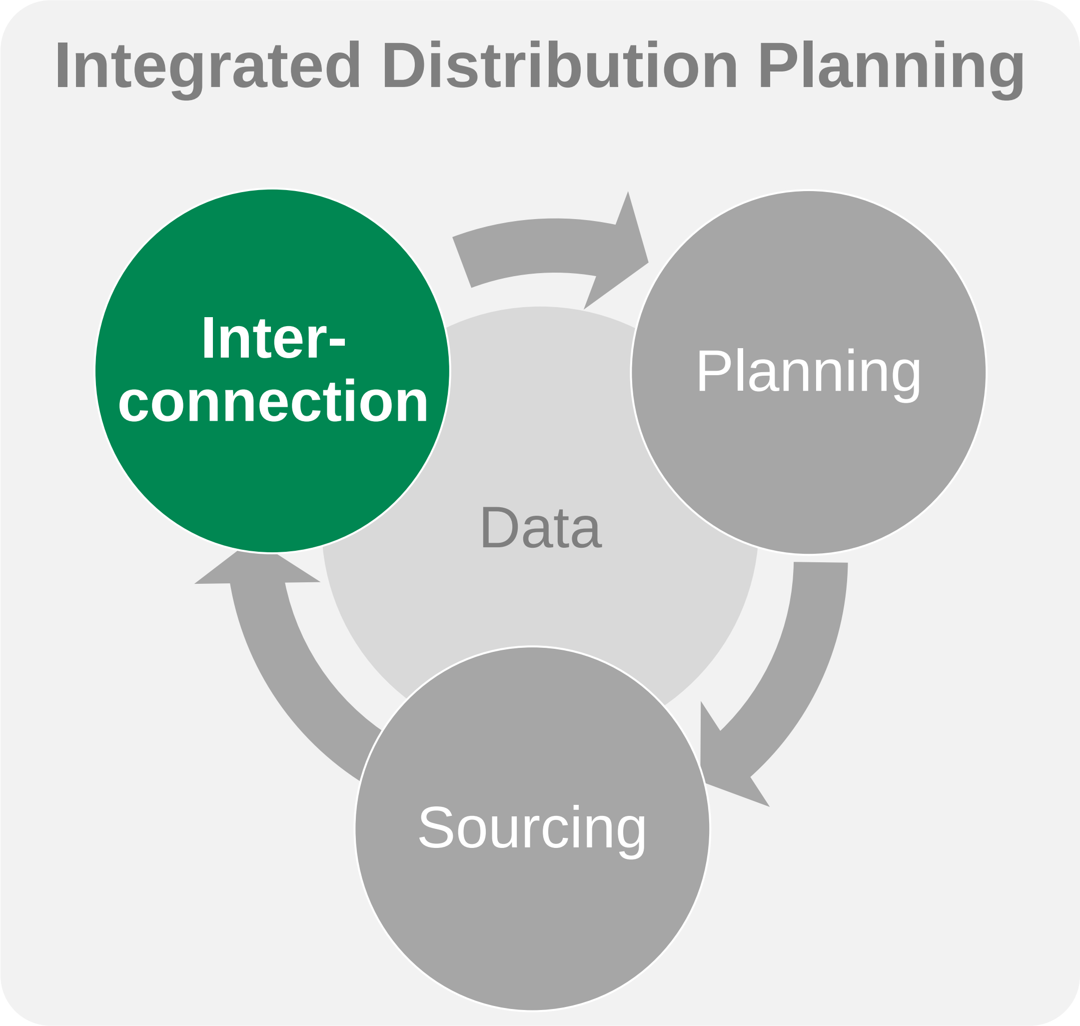
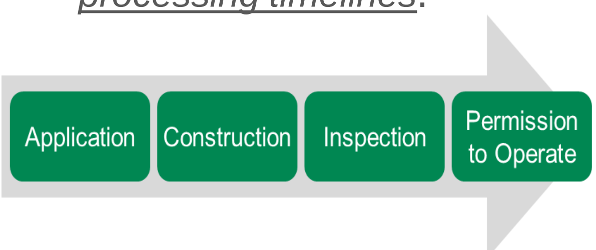

Integrated Distribution Planning
Inter-
connection
Planning
Data
Sourcing

Challenge: Interconnection processes can be avoidably slow, include unwarranted costs, and unnecessarily limit DER interconnections

Approach: Streamline DER interconnection process, eliminate unwarranted costs, and expand allowable interconnection approvals

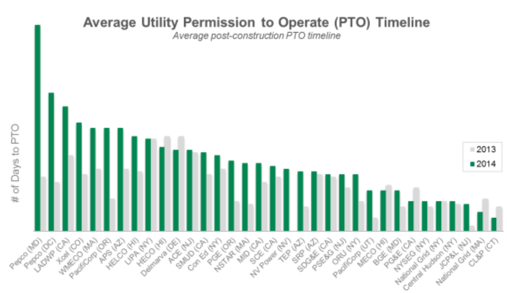
Streamline Process

- While many states establish timeline requirements for utilities to complete interconnection, *timelines are often not met*.
- Best-in-class utilities standardize their interconnection process and have *drastically reduced their processing timelines*.



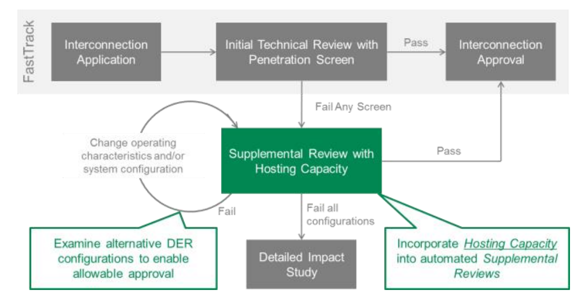
Eliminate Costs

- *Cost certainty* is a critical component of successful interconnection. Upgrade costs to DER owners vary significantly by project.
- Upgrade requirements are frequently based on outdated technical information, resulting in *undue DER integration costs*

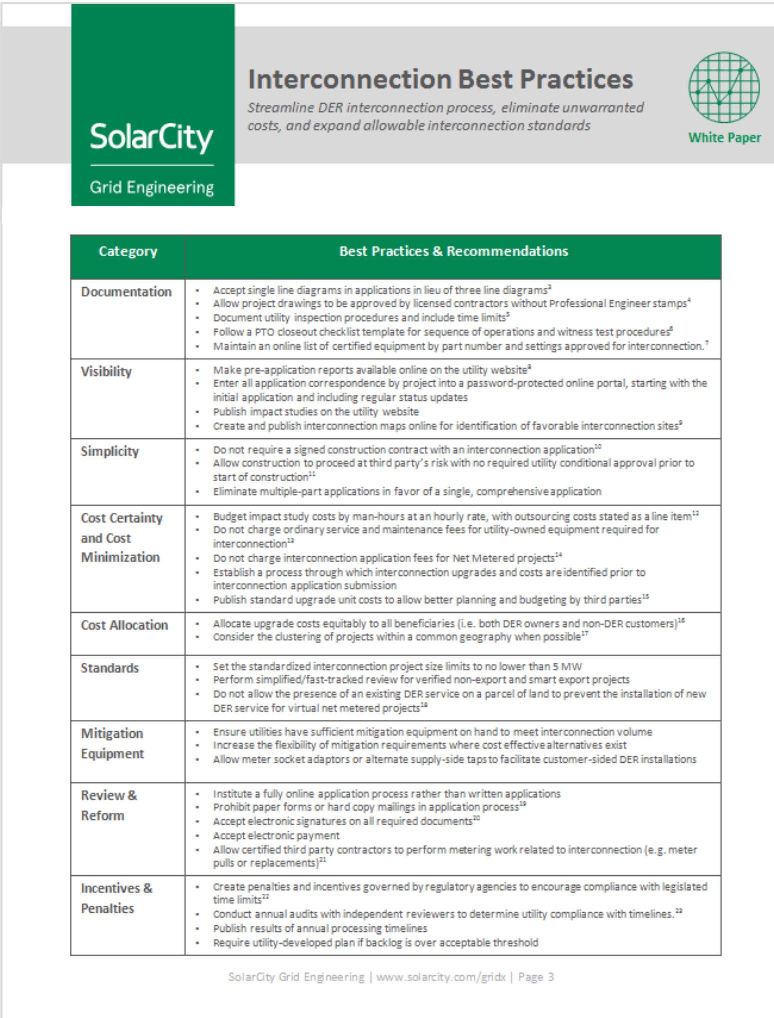


Expand Approvals

- Outdated interconnection technical standards unnecessarily *limit the amount of DERs* that are allowed to interconnect
- Utilize automated *hosting capacity analyses* to increase allowable interconnections.



Streamline Process: Best practices and recommendations



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Interconnection Best Practices

Streamline DER interconnection process, eliminate unwarranted costs, and expand allowable interconnection standards

White Paper

Category	Best Practices & Recommendations
Documentation	• Accept single line diagrams in applications in lieu of three line diagrams[3] • Allow project drawings to be approved by licensed contractors without Professional Engineer stamps[4] • Document utility inspection procedures and include time limits[5] • Follow a PTO closeout checklist template for sequence of operations and witness test procedures[6] • Maintain an online list of certified equipment by part number and settings approved for interconnection.[7]
Visibility	• Make pre-application reports available online on the utility website[8] • Enter all application correspondence by project into a password-protected online portal, starting with the initial application and including regular status updates • Publish impact studies on the utility website • Create and publish interconnection maps online for identification of favorable interconnection sites[9]
Simplicity	• Do not require a signed construction contract with an interconnection application[10] • Allow construction to proceed at third party's risk with no required utility conditional approval prior to start of construction[11] • Eliminate multiple-part applications in favor of a single, comprehensive application
Cost Certainty and Cost Minimization	• Budget impact study costs by man-hours at an hourly rate, with outsourcing costs stated as a line item[12] • Do not charge ordinary service and maintenance fees for utility-owned equipment required for interconnection[13] • Do not charge interconnection application fees for Net Metered projects[14] • Establish a process through which interconnection upgrades and costs are identified prior to interconnection application submission • Publish standard upgrade unit costs to allow better planning and budgeting by third parties[15]
Cost Allocation	• Allocate upgrade costs equitably to all beneficiaries (i.e. both DER owners and non-DER customers)[16] • Consider the clustering of projects within a common geography when possible[17]
Standards	• Set the standardized interconnection project size limits to no lower than 5 MW • Perform simplified/fast-tracked review for verified non-export and smart export projects • Do not allow the presence of an existing DER service on a parcel of land to prevent the installation of new DER service for virtual net metered projects[18]
Mitigation Equipment	• Ensure utilities have sufficient mitigation equipment on hand to meet interconnection volume • Increase the flexibility of mitigation requirements where cost effective alternatives exist • Allow meter socket adaptors or alternate supply-side taps to facilitate customer-sided DER installations
Review & Reform	• Institute a fully online application process rather than written applications • Prohibit paper forms or hard copy mailings in application process[19] • Accept electronic signatures on all required documents[20] • Accept electronic payment • Allow certified third party contractors to perform metering work related to interconnection (e.g. meter pulls or replacements)[21]
Incentives & Penalties	• Create penalties and incentives governed by regulatory agencies to encourage compliance with legislated time limits[22] • Conduct annual audits with independent reviewers to determine utility compliance with timelines.[23] • Publish results of annual processing timelines • Require utility-developed plan if backlog is over acceptable threshold

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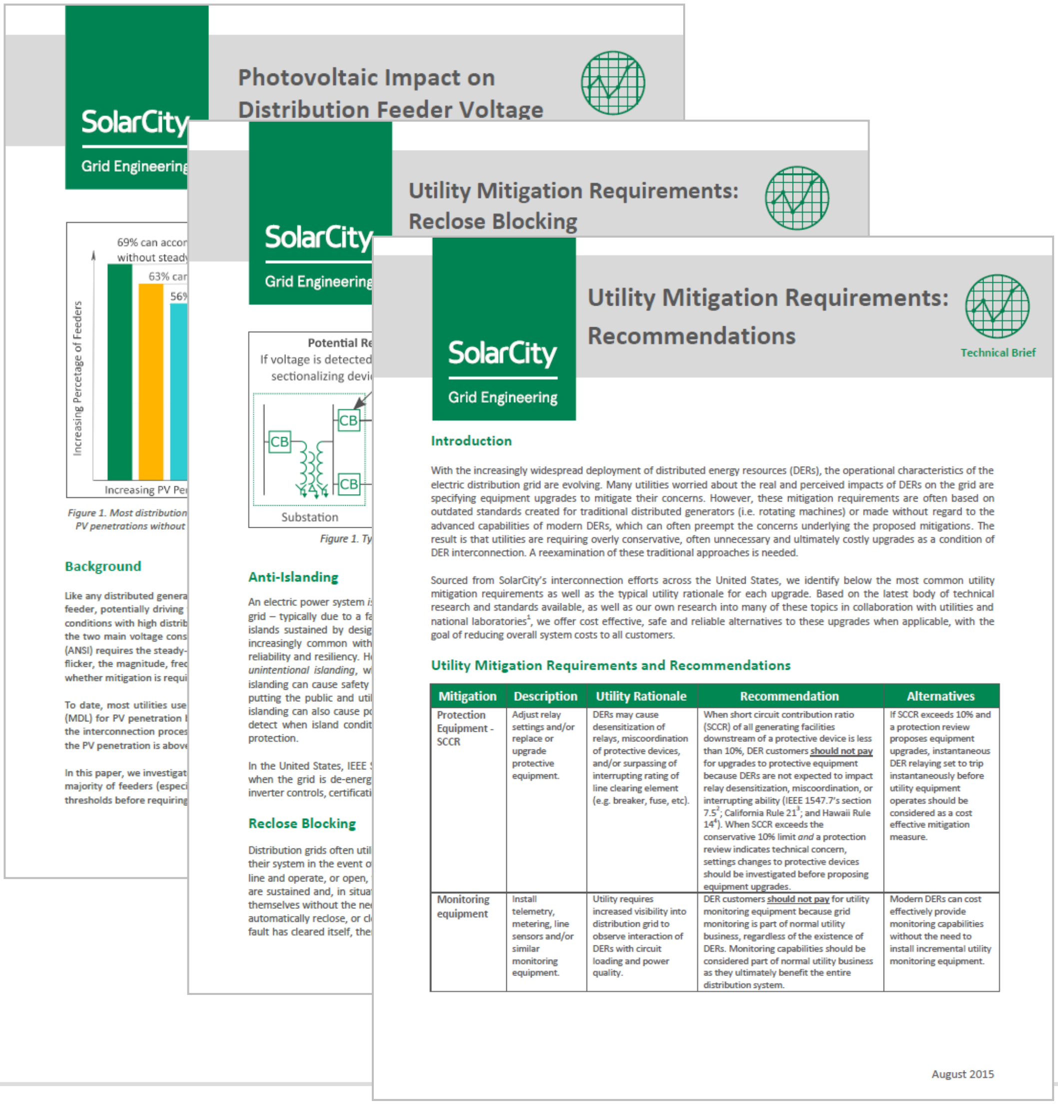
Streamline process in following areas:

Documentation	Visibility	Simplicity
Cost Certainty / Minimization	Cost Allocation	Standards
Penalties	Review / Reform	Equipment

Eliminate Costs: Many mitigation requirements are overly conservative and can be avoided with cheaper alternatives



Photovoltaic Impact on Distribution Feeder Voltage

Utility Mitigation Requirements: Reclose Blocking

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Utility Mitigation Requirements: Recommendations

Technical Brief

Introduction

With the increasingly widespread deployment of distributed energy resources (DERs), the operational characteristics of the electric distribution grid are evolving. Many utilities worried about the real and perceived impacts of DERs on the grid are specifying equipment upgrades to mitigate their concerns. However, these mitigation requirements are often based on outdated standards created for traditional distributed generators (i.e. rotating machines) or made without regard to the advanced capabilities of modern DERs, which can often preempt the concerns underlying the proposed mitigations. The result is that utilities are requiring overly conservative, often unnecessary and ultimately costly upgrades as a condition of DER interconnection. A reexamination of these traditional approaches is needed.

Sourced from SolarCity's interconnection efforts across the United States, we identify below the most common utility mitigation requirements as well as the typical utility rationale for each upgrade. Based on the latest body of technical research and standards available, as well as our own research into many of these topics in collaboration with utilities and national laboratories[1], we offer cost effective, safe and reliable alternatives to these upgrades when applicable, with the goal of reducing overall system costs to all customers.

Utility Mitigation Requirements and Recommendations

Mitigation	Description	Utility Rationale	Recommendation	Alternatives
Protection Equipment - SCCR	Adjust relay settings and/or replace or upgrade protective equipment.	DERs may cause desensitization of relays, miscoordination of protective devices, and/or surpassing of interrupting rating of line clearing element (e.g. breaker, fuse, etc).	When short circuit contribution ratio (SCCR) of all generating facilities downstream of a protective device is less than 10%, DER customers **should not pay** for upgrades to protective equipment because DERs are not expected to impact relay desensitization, miscoordination, or interrupting ability (IEEE 1547.7's section 7.5[2]; California Rule 21[3]; and Hawaii Rule 14[4]). When SCCR exceeds the conservative 10% limit *and* a protection review indicates technical concern, settings changes to protective devices should be investigated before proposing equipment upgrades.	If SCCR exceeds 10% and a protection review proposes equipment upgrades, instantaneous DER relaying set to trip instantaneously before utility equipment operates should be considered as a cost effective mitigation measure.
Monitoring equipment	Install telemetry, metering, line sensors and/or similar monitoring equipment.	Utility requires increased visibility into distribution grid to observe interaction of DERs with circuit loading and power quality.	DER customers **should not pay** for utility monitoring equipment because grid monitoring is part of normal utility business, regardless of the existence of DERs. Monitoring capabilities should be considered part of normal utility business as they ultimately benefit the entire distribution system.	Modern DERs can cost effectively provide monitoring capabilities without the need to install incremental utility monitoring equipment.

August 2015

- Interconnection process best practices identified in the following categories:
  - Documentation
  - Visibility
  - Simplicity
  - Cost Certainty / Minimization
  - Cost Allocation
  - Standards
  - Penalties
  - Review / Reform
  - Equipment
- Alternatives to common utility mitigations identified in the following categories:
  - Protection Equipment - SCCR
  - Reclose Blocking
  - Direct Transfer Trip (DTT)
  - Reconductor
  - Transformer replacement
  - Grounding transformer
  - SCADA Recloser
  - Monitoring equipment
  - Voltage Equipment – Variability
  - Voltage Equipment – Reverse Flow

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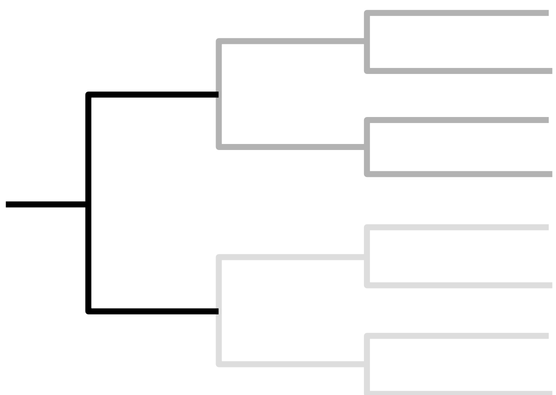
Expand Approvals: Phase out universal screens in favor of hosting capacity analyses

Screen-Based



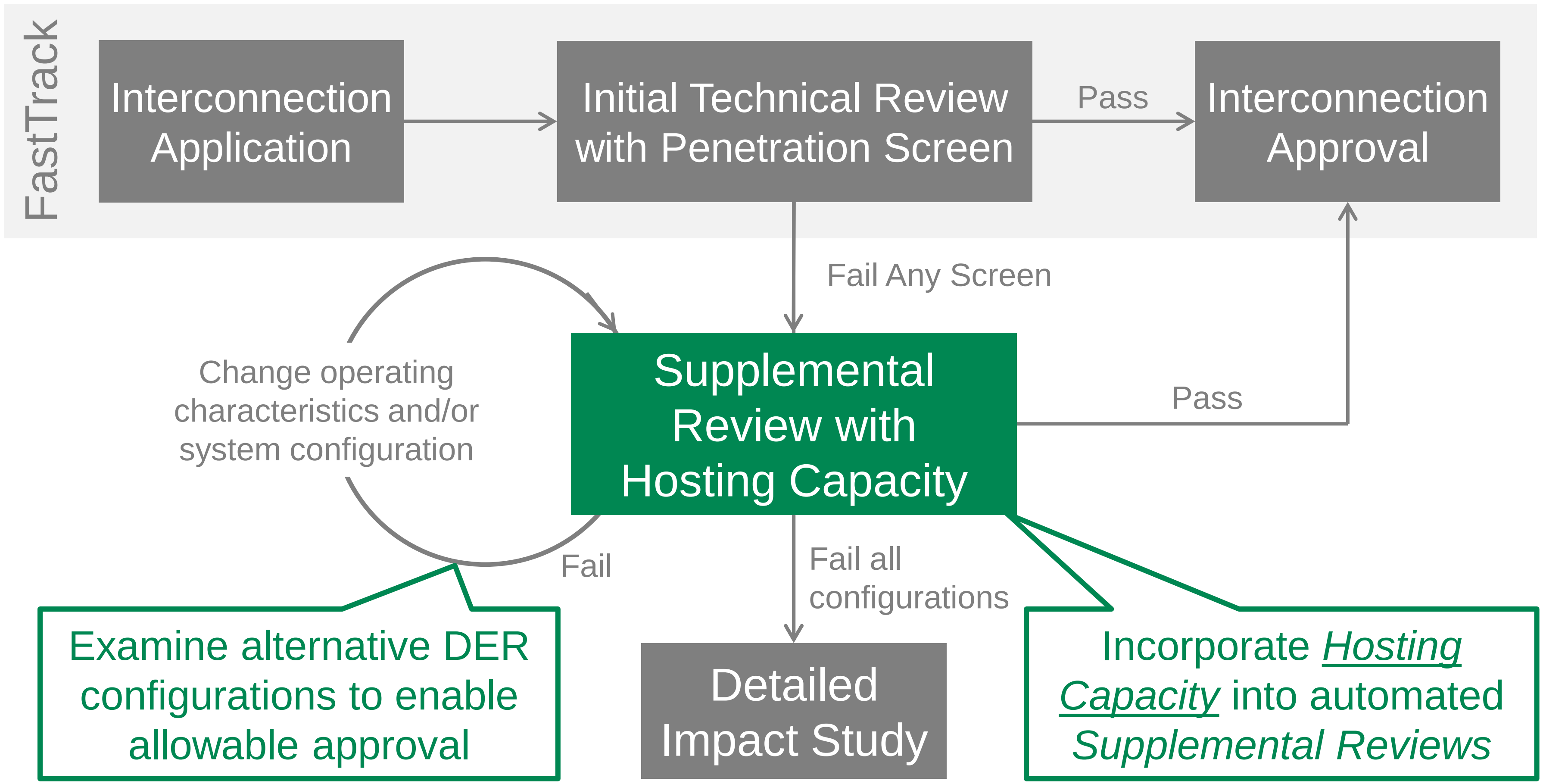
At low PV penetration levels, screening methods can enable timely decisions

Hosting Capacity

At high PV penetration levels, circuits need to be individually assessed for DER hosting capacity

Image Sources: EPRI

Expand Approvals: Incorporate automated *Hosting Capacity* analyses into interconnection process



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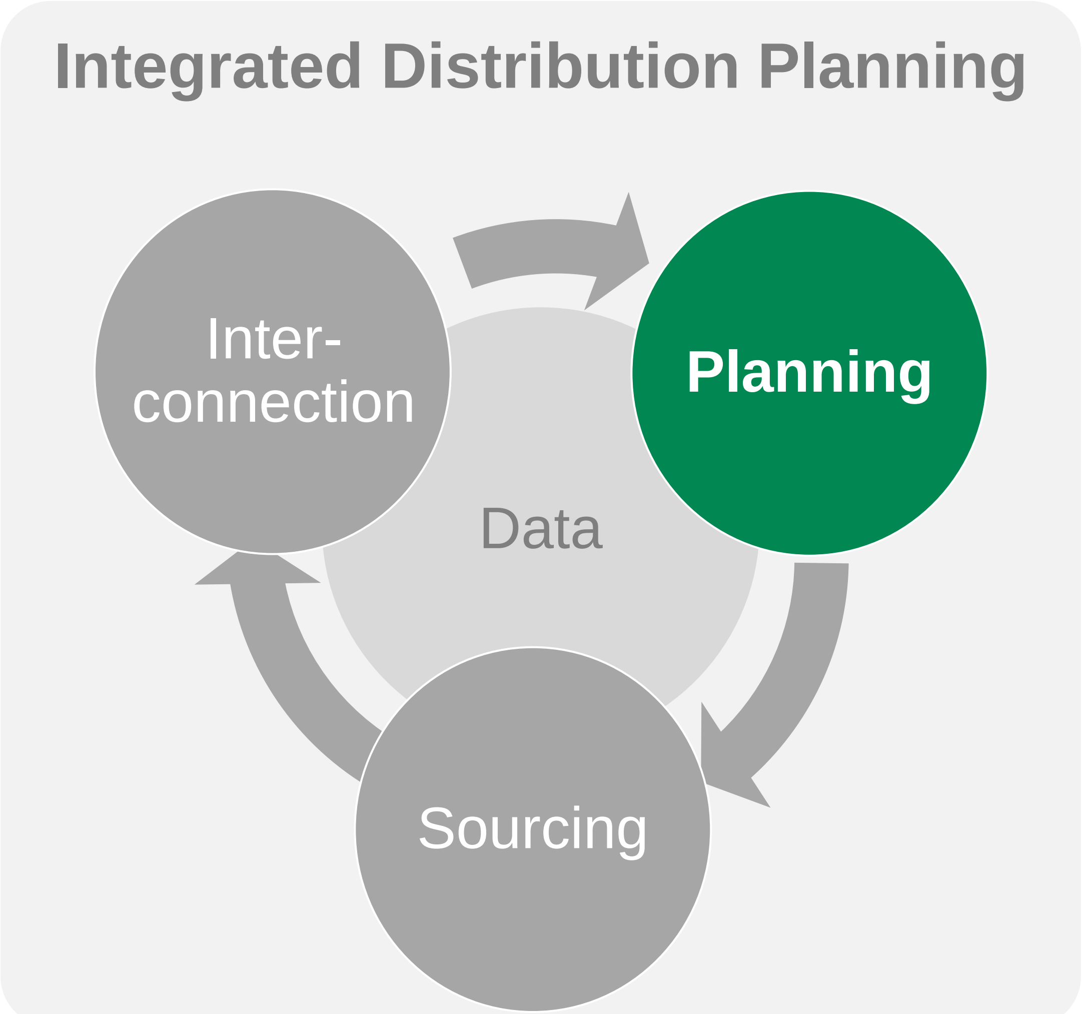

Integrated Distribution Planning
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Challenge: Utility planning processes do not leverage DERs to provide grid services, lower system costs, and increase resiliency

Approach: Modernize distribution planning to leverage DERs

1 Forecast Growth & Maintenance

Forecast load and DER growth and required equipment maintenance

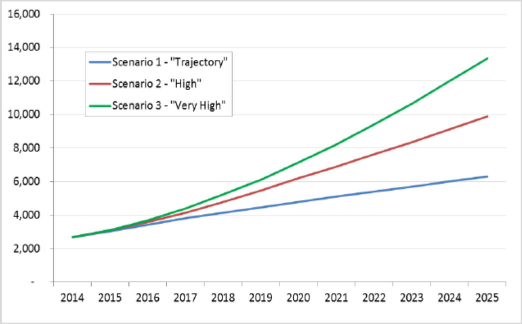
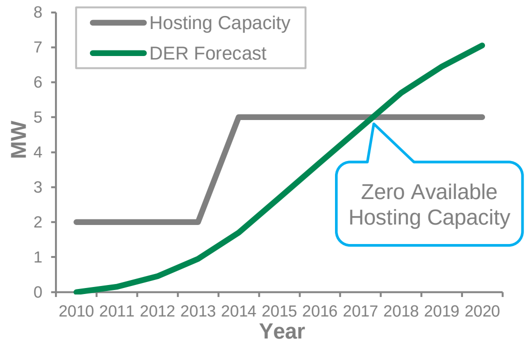


Image Source: Pacific Gas & Electric

2 Identify Needs

Compare growth to available hosting and circuit capacities



3 Develop Plan

Evaluate solutions to meet identified needs, including the use of DER portfolios

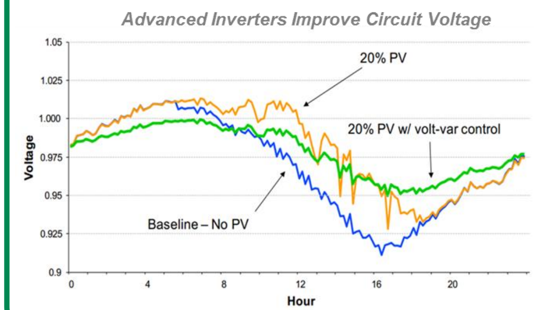


Image Source: EPRI

Incorporate DER growth in addition to load growth forecasts

Include DERs as an option to proactively meet grid needs

Develop Plan: Transmission Planning Process provides a useful example for distribution-specific processes

Transmission Planning Process

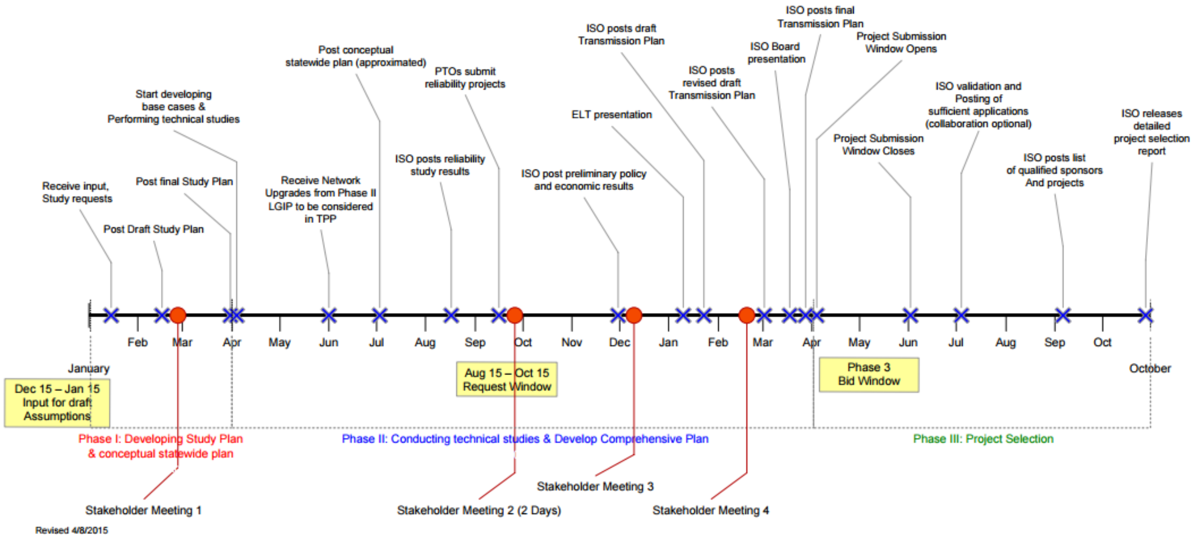
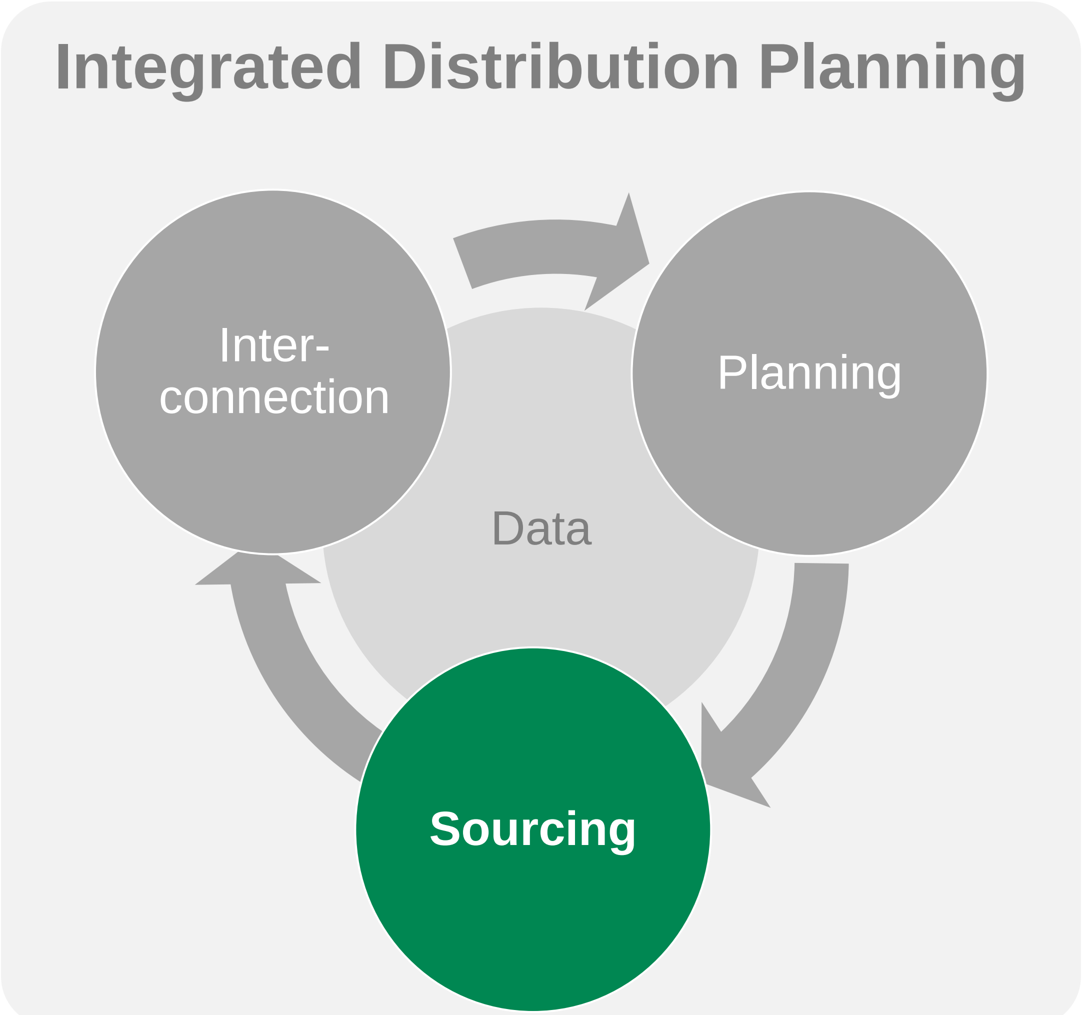


Image Source: California Independent System Operator (CAISO)

Agenda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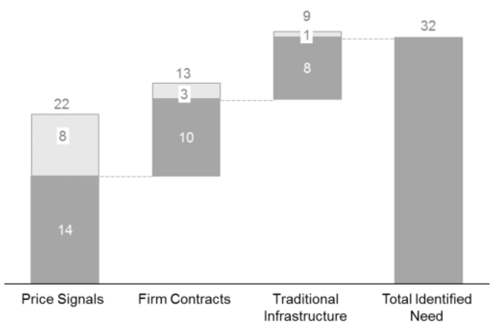
Challenge: Utility distribution sourcing does not leverage DERs to provide grid services, lower system costs, and increase grid resiliency

Approach: Modernize distribution sourcing to evaluate, select, and deploy DERs to meet grid needs

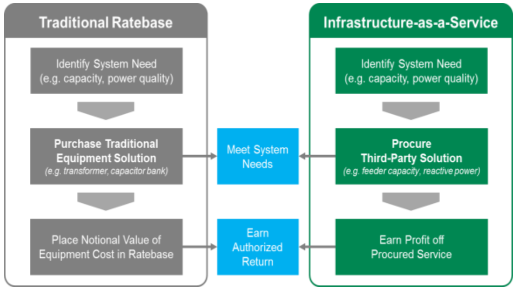
1 Select Least Cost / Best Fit

Identify least cost / best fit portfolio of DER and traditional assets



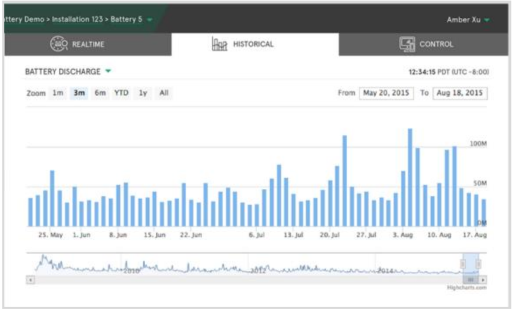
2 Deploy Resources

Conduct pricing, program and procurement efforts to obtain needed assets



3 Monitor Performance

Monitor, measure and verify performance, adjusting portfolio as needed



Select least cost / best fit portfolio, including DERs rather than solely traditional infrastructure

Select Least Cost / Best Fit: Distribution Loading Order

A policy to encourage the utilization of DER portfolios to meet grid needs

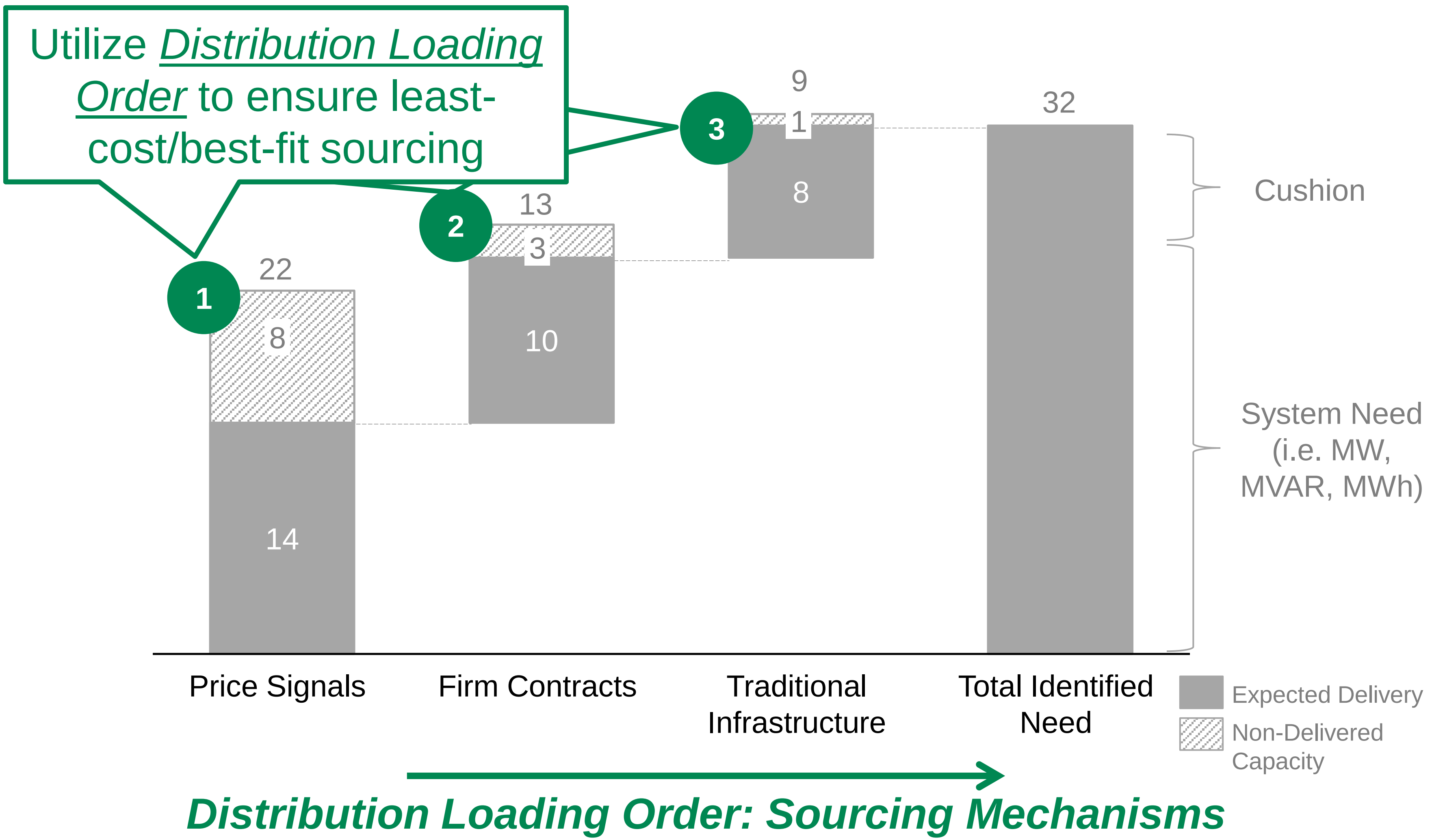
Procurement Solutions

Proposed Distribution Loading Order	Selection of Resource Examples
1. **Distributed Energy Resources** (DERs)	Energy efficiency, controllable loads/demand response, renewable generation, advanced inverters, energy storage, electric vehicles
2. **Conventional Distribution Infrastructure**	Transformers, reconductoring, capacitors, voltage regulators, sectionalizers

Procurement Mechanisms

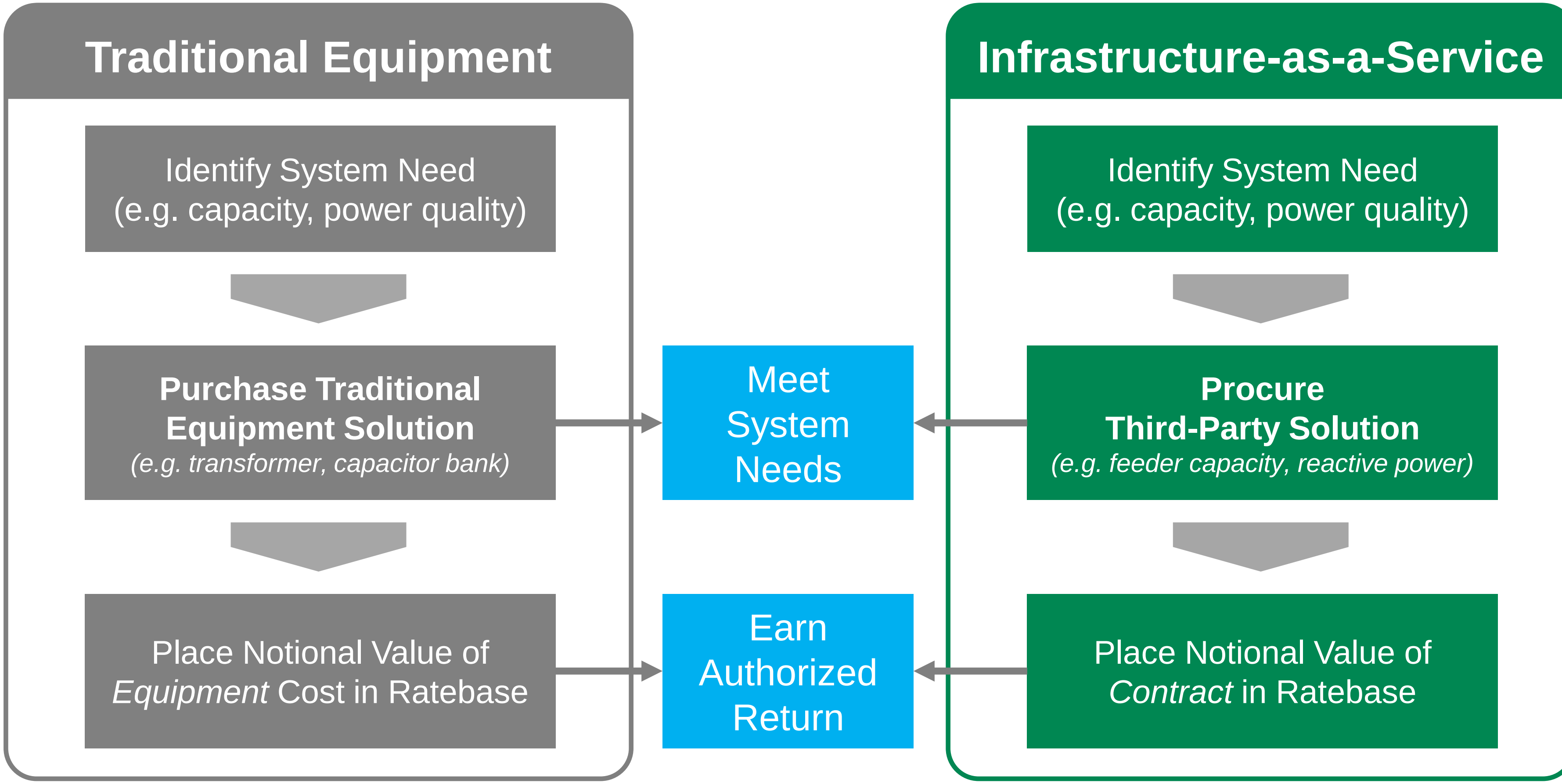
Rank Order	Procurement Mechanism	Description	Selection of Practical Examples
1	**Price Signals** (DERs)	DER portfolios that voluntarily respond to price signals sent from the utility that incent the desired behavior to meet grid needs.	• Voluntary Critical Peak Power / TOU Pricing • Voluntary Distributed Marginal Pricing (DMP) • Voluntary Voltage Support Pricing
2	**Firm Contracts** (DERs)	DER portfolios that are contractually obligated to deliver grid services based on contracted prices.	• Week-Ahead Reactive Power Payments • 1-10 year ahead availability contracts for peak substation real power capacity
3	**Traditional Utility Infrastructure**	Traditional utility infrastructure self-supplied through General Rate Case capital budgets.	• Utility investment in Substation transformer • Utility investment in feeder reconducturing

Select Least Cost / Best Fit: Utilize Distribution Loading Order Mechanisms to source solution to grid need



Source: SolarCity illustrative Loading Order analysis

Deploy Solutions: Examine *Infrastructure-as-a-Service* investments in lieu of traditional infrastructure



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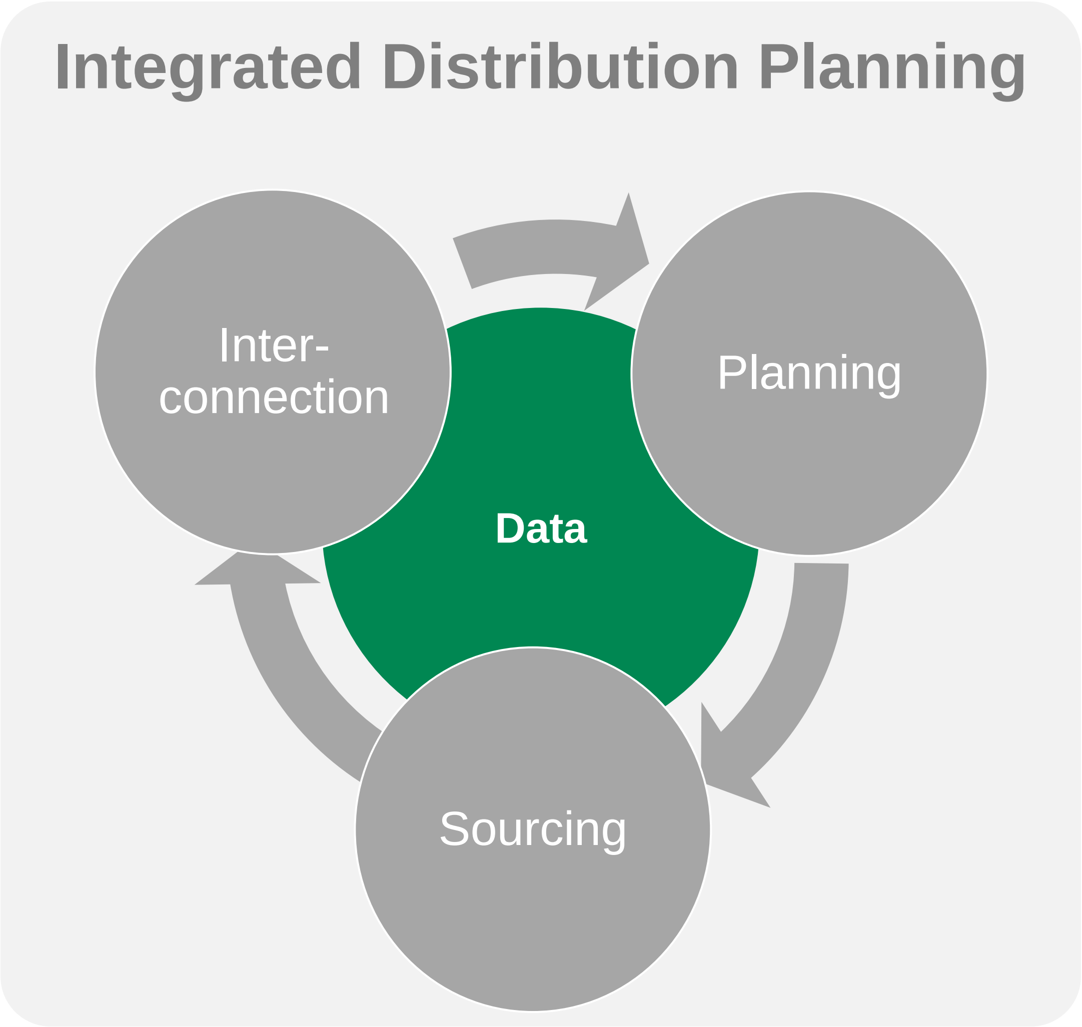

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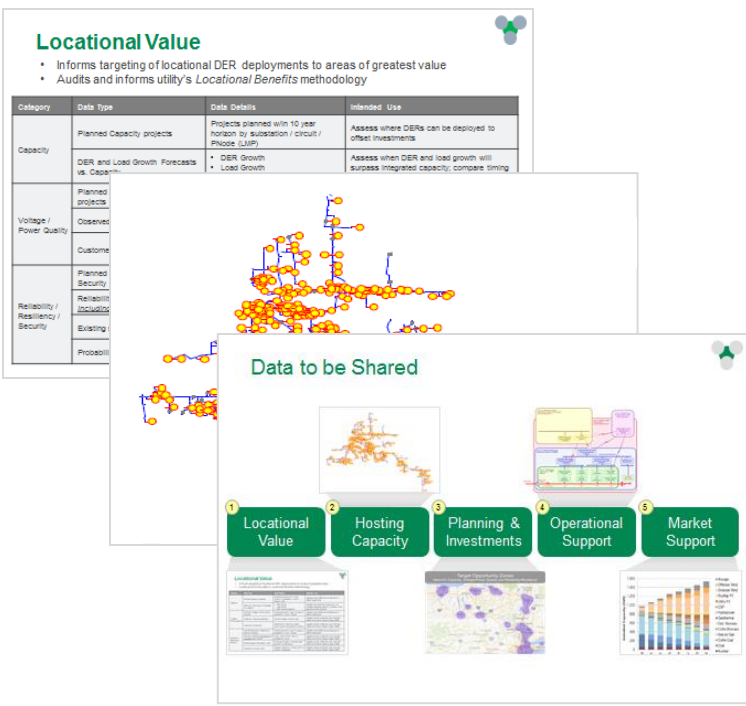
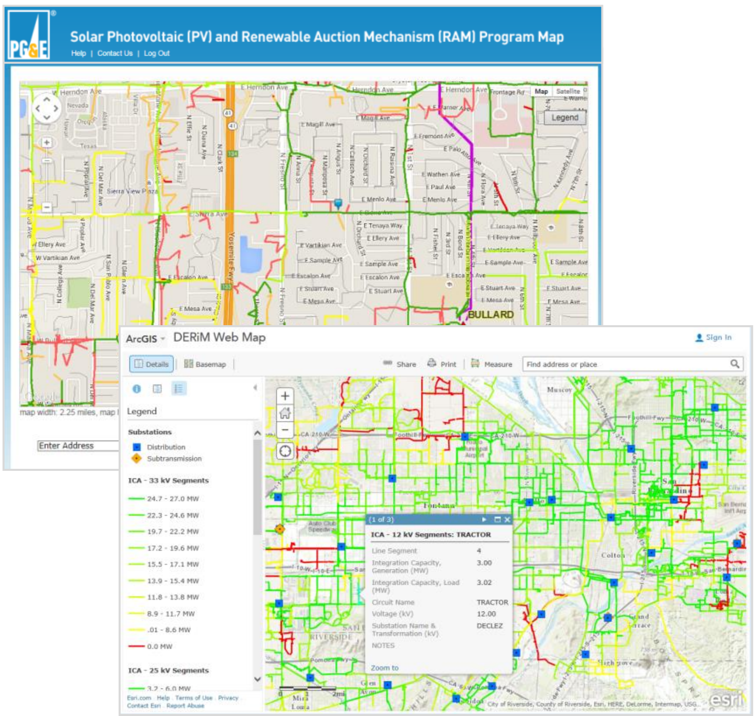
Challenge: Utility data critical for driving innovation is not accessible by broader industry

Approach: Utilities must commit to data transparency and access to enable industry innovation

Data Transparency



Data Access



Thank you!

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Integrated Distribution Planning

A holistic approach to meeting grid needs and expanding customer choice by unlocking the benefits of distributed energy resources

White Paper

Key takeaways

Takeaway 1
Integrated Distribution Planning is a holistic approach to meeting distribution needs and expanding customer choice by modernizing utility *interconnection*, *planning*, *sourcing*, and *data* sharing processes.

Takeaway 2
Hosting Capacity analyses should be incorporated into the interconnection of distributed energy resources to streamline and eventually automate interconnection

Takeaway 3
Adopting *Distribution Loading Order* policies will encourage the sourcing of cost effective distributed energy resources before conventional distribution equipment

Background

Designing the electrical grid for the 21st century is one of today's most important and exciting challenges. In the face of evolving electricity needs and an aging electrical grid that relies on centralized and polluting sources of power, it is imperative to transition to a grid that actively leverages the wave of renewable distributed energy resources proliferating across the industry. Distributed energy resources offer tremendous benefits to this new grid by actively engaging customers in their energy management, increasing the use of clean renewable energy, improving grid resiliency, and making the grid more affordable by reducing system costs. Designing a grid that fully harnesses these assets is a key undertaking for all industry stakeholders, including utilities, regulators, legislatures, and DER developers.

Current efforts to utilize DERs to support the broader electric system, however, are hampered by the systemic failure of the industry to integrate DERs into distribution planning efforts. As the figure to the right depicts, traditional distribution planning is highly siloed and planning efforts are considered independently of interconnection efforts. To fully leverage DERs to benefit the grid, utility interconnection, planning, sourcing, and data sharing efforts must be modernized.

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Visit our webpage at www.solarcity.com/gridx for full report and additional materials

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Questions & Answers