BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF NEW YORK

PROCEEDING ON MOTION OF THE COMMISSION IN REGARD TO REFORMING THE ENERGY VISION. **Case 14-M-0101**

CLEAN COALITION COMMENTS ON DEVELOPING THE REV MARKET IN NEW YORK: DPS STAFF STRAW PROPOSAL ON TRACK ONE ISSUES

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I. INTRODUCTION

On August 22, 2014, the New York Public Service Commission Staff ("Staff") released Developing the REV Market in New York: DPS Staff Straw Proposal on Track One Issues ("Proposal") in response to the New York Public Service Commission's ("Commission") Order Instituting Proceeding, regarding Case 14-M-0101, otherwise known as Reforming the Energy Vision ("REV"). In the Proposal, PSC submitted several recommendations to the Commission that would implement the basic elements of REV. Staff invited parties to submit comments on the Proposal by September 22, 2014.

The Clean Coalition supports many aspects of the Proposal, subject to a number of refinements reflected in these and the Clean Energy Advocates' joint comments.[1] As noted in the comments, the Proposal fails to take significant steps towards initiating the requisite distribution grid planning process. The Clean Coalition offers these comments reflecting our expertise in distribution grid planning projects and the statewide Distribution Resource Plans ("DRPs") actively being developed in California specifically addressing Distributed Energy Resources ("DER"). We respectfully urge the Commission to draw upon this work in order to effectively begin readying New York's distribution grid for the significant changes envisioned by REV.

II. CLEAN COALITION BACKGROUND

The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise. The Clean Coalition drives policy innovation to remove barriers to procurement, interconnection, and realizing the full potential of integrated distributed energy resources, such as distributed generation, advanced inverters, demand response, and energy storage. The Clean Coalition also works with utilities to develop Community Microgrid projects that demonstrate that local renewables can cost-effectively provide at

[1] Clean Energy Advocates Joint Comments in Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Case 14-M-0101 (Sept. 22, 2014).

least 25% of the total electric energy consumed within the distribution grid, while maintaining or improving grid reliability. The Clean Coalition actively supported the establishment of the 150 MW of Feed-In Tariff programs for Long Island and is active in numerous energy-related proceedings throughout the United States.

III. DISTRIBUTION GRID PLANNING

The Proposal indicates that utilities acting as distributed system providers ("DSPs")—or utilities acting in conjunction with DSPs—will soon need to coordinate distribution system planning and construction.[2] Much of the planning process will be performed during the creation of Distributed System Implementation Plans ("DSIPs"), which will indicate how each utility proposes to implement REV actions during the next five years.

In order to develop the DSIPs, the Proposal recommends that a methodology first be established through a stakeholder process, and that the Commission approve the final DSIP methodology.[3] The Clean Coalition supports the Proposal's general goal that the DSIP development and associated distribution grid planning process be subject to open review and provide information needed by market participants. However, the Proposal currently lacks sufficient details to enable a proactive distribution grid planning process.

The Clean Coalition respectfully urges the Commission to promptly initiate the distribution grid planning process and DSIP development. The Commission's decision-making may be informed by the Clean Coalition's involvement in the planning processes currently underway in California.

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[2] N.Y. DEP'T OF PUB. SERV., DEVELOPING THE REV MARKET IN NEW YORK: DPS STAFF STRAW PROPOSAL ON TRACK ONE ISSUES 14 (Aug. 22, 2014) [hereinafter Proposal].

[3] *Id.* at 65.

a. Developing DSIPs

Under AB 327, California requires investor-owned utilities to develop Distribution Resources Plan Proposals by July 1, 2015.[4] The California Public Utilities Commission initiated a rulemaking to establish policies, procedures, and rules that will guide Investor Owned Utilities through the process of creating DRPs, which are similar to the DSIPs described in REV.[5]

The DRPs will focus on identifying "optimal locations" for the deployment of DER. From a distribution grid system locational value perspective, optimal locations for DER are those locations that avoid or defer alternative investments to meet projected demand for power and needs for grid services, such as investments in transmission, congestion mitigation, flexible capacity, central generation, local peak resources, and voltage control or conservation. The Clean Coalition recommends that the DSIPs place a similar emphasis on optimal locations for the placement of DER to help site resources where they will be effective and provide the greatest operational value at the lowest net total

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[4] Assembly Bill ("AB") 327 added Section 769 to the Public Utilities Code, which concerns Distribution Resources Plans. Section 769 requires:

> Not later than July 1, 2015, each electrical corporation shall submit to the commission a distribution resources plan proposal to identify optimal locations for the deployment of distributed resources. Each proposal shall do all of the following:
> (1) Evaluate locational benefits and costs of distributed resources located on the distribution system. This evaluation shall be based on reductions or increases in local generation capacity needs, avoided or increased investments in distribution infrastructure, safety benefits, reliability benefits, and any other savings the distributed resources provides to the electric grid or costs to ratepayers of the electrical corporation.
> (2) Propose or identify standard tariffs, contracts, or other mechanisms for the deployment of cost-effective distributed resources that satisfy distribution planning objectives.
> (3) Propose cost-effective methods of effectively coordinating existing commission-approved programs, incentives, and tariffs to maximize the locational benefits and minimize the incremental costs of distributed resources.
> (4) Identify any additional utility spending necessary to integrate cost-effective distributed resources into distribution planning consistent with the goal of yielding net benefits to ratepayers.
> (5) Identify barriers to the deployment of distributed resources, including, but not limited to, safety standards related to technology or operation of the distribution circuit in a manner that ensures reliable service.

Cal. Stats. 2013, ch. 611.

[5] Pub. Utilities Comm'n of the State of Cal., Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Development of Distribution Resources Plans, Rulemaking 14-08-013 (filed Aug. 14, 2014).

cost for ratepayers and both public and private investors providing the energy resources and services.

Further, the Clean Coalition recommends consideration of the following optimization criteria to guide development of the DSIPs:

- Maintain or increase grid reliability and resilience.
- Encourage the development of clean DER that cost-effectively avoid or defer alternative investments to meet projected demand for power and needs for grid services, such as investments in transmission, central generation, congestion mitigation, local peak resources, or flexible capacity.
- Leverage clean DER to improve distribution system operational efficiency.
- Meet New York's clean energy and climate goals and mandates, including the state Renewable Portfolio Standard and the 2014 Draft New York State Energy Plan, which calls for a 50% reduction in carbon emissions by 2030 and an 80% reduction by 2050.
- Include all DER—both those that are projected to successfully bid into NYISO markets and future DSP procurement programs and markets and non-market participant installations that are likely to influence grid operation.

b. DSIP requirements

The Clean Coalition recommends dividing the development of the DSIPs into the three stages described below.

The utilities should first be required to propose the following for Commission approval:

- Methodology for developing optimal portfolios of DER capacity and services;
- Methodology for determining optimal and preferred locations;
- Methodology for calculating locational values;
- Methodology for evaluating and proposing distribution grid upgrades for approval in General Rate Case proceeding;

- Demonstration of application of all of the methodologies described above to at least one substation;
- Proposals for effectively coordinating existing and pending programs, incentives, and tariffs to maximize the incremental costs of DER;
- Reasonable timeline for implementing the DSIP for the entire distribution grid, including implementation of the methodologies described above, performance grid upgrades, and deployment of DER consistent with optimal portfolios;
- Roadmap for continued improvement of planning, optimization and modeling of distribution systems; and
- For the utilities entire territory, publish information regarding where locational value will influence the economic value of DER projects and associated interconnection costs.

Second, the utilities should be required to submit an application to the Commission with detailed DSIPs that include the following:

- Proposed optimal portfolios of DER for each substation to meet the DSIP criteria;
- Publicly provide preferred locations for 125% of targeted amounts of DER through searchable grid maps and databases;
- Location, description, and cost of distribution grid investments that will be proposed for approval in the General Rate Case;
- Projected net load shapes per substation in each season, and as modified by target amounts of DER; and
- Status report on implementation of DSIPs.

Finally, the utilities should be required to have implemented and deployed the DSIP and associated DER for at least one substation as a pilot project. The utilities should be required to submit a report to the Commission by a specified date regarding the planning and implementation of the DSIP at the pilot substation, including a description of the major barriers and solutions discovered by the pilot.

c. *Pilot projects*

In order to provide a testing ground for distribution grid planning processes, the Clean Coalition recommends that utilities promptly design and implement pilot projects. Below we discuss two pilot projects that are in different stages of development.

1. *Hunters Point Community Microgrid*

In collaboration with Pacific Gas & Electric ("PG&E") and in support of the city of San Francisco's goal to achieve a 100% renewable electricity supply, the Clean Coalition is spearheading a groundbreaking project in the Bayview and Hunters Point areas of San Francisco. The Hunters Point Project, part of the Clean Coalition's Community Microgrids Initiative, will prove that local renewables can fulfill at least 25% of total electric energy consumption for the 20,000 customers served by the Hunters Point substation while maintaining or improving power quality, reliability, and resilience. Policymakers and utility executives need to see real-world solutions in action to gain confidence in accelerating the transition to local renewables. The Hunters Point Project, which is named after the substation serving the Bayview and Hunters Point areas of San Francisco, is designed to provide a world-class example that facilitates San Francisco, and communities around the globe, to reap the benefits from significant levels of local renewables—including economic, environmental, and resilience benefits.

Phase 1 of the Hunters Point Project, to be completed by yearend-2014, will result in a replicable model that any community can use to evaluate Community Microgrid opportunities. Ultimately, the modeling platform will expedite the creation of Community Microgrids by efficiently simulating the ability of local renewables to balance vital grid services (power, voltage, and frequency) locally and cost-effectively. Phase 2 of the Project, which is anticipated to be substantially completed by yearend-2015, will result in the actual deployment of the Hunters Point Community Microgrid. Additional information about the Project is attached as Exhibit 1.

The Clean Coalition uses sophisticated powerflow modeling and cost-benefit analysis tools to reveal how—and precisely where—local renewable energy can be supported in the distribution grid by intelligent grid solutions. The Clean Coalition team works with utilities and modeling tools providers to improve methods for distribution grid planning. For the Hunters Point project, we're working with PG&E's modeling tool provider Cyme and its cost-analysis tool provider Integral Analytics. Our team has experience with a broad range of powerflow modeling tools, but we've found that it's important to be able to show that utilities' favored tools can meet these new challenges once they have the right specifications to move forward. We're also developing standard specifications for modeling tools providers, so that our lessons learned from this experience can be applied to any other powerflow tool. More information about the Clean Coalition's grid planning and modeling methodology is attached as Exhibit 2.

2. South Fork Community Microgrid

The Clean Coalition has also provided recommendations on the Utility 2.0 Long Range Plan of PSEG Long Island concerning development and implementation of a cost-effective and scalable Community Microgrid project in the South Fork.[6] This pilot project will demonstrate the simultaneous deployment of significant renewables and enhanced grid resilience.

Informed by our work with the Hunters Point Community Microgrid, the Clean Coalition provided the following recommendations to the Commission for developing and implementing a cost-effective and scalable South Fork Community Microgrid project: (1) select a single substation for the project, (2) consider substations in the South Fork with at least several thousand customers, (3) island only a few truly critical loads rather than the entire substation grid area, and (4) achieve the fully deployed Community Microgrid project by yearend-2016 before generous Federal tax benefits are set to expire.

[6] PSEG LONG ISLAND, UTILITY 2.0 LONG RANGE PLAN at 3-34 to 3-35 (July 1, 2014).

If promptly deployed, the South Fork Community Microgrid would have the opportunity to ground truth many of the principles involved with distribution grid planning in New York. This pilot project could cost-effectively increase resilience, serve as a testing ground for REV, and provide a replicable model for increasing resilience across the state.

IV. CONCLUSION

The Straw Proposal recommends that utilities file Proposals for Interim Actions in order to summarize how each utility intends to achieve near-term and transitional recommendations.[7] As part of this process, utilities and the Commission should begin to develop both the methodology for the DSIPs and the associated distribution grid planning process. Utilities should further begin developing and implementing pilot projects to provide a testing ground for distribution grid planning processes.

The Clean Coalition appreciates the opportunity to comment on the Proposal.

Respectfully submitted,

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[7] Proposal at 65.

EXHIBIT 1

Hunters Point Project Overview

(See attached)

The Hunters Point Project: A Model for Clean Community Power

In collaboration with Pacific Gas & Electric and in support of the city of San Francisco's goal to achieve a 100% renewable electricity supply, the Clean Coalition is spearheading a groundbreaking project in the Bayview and Hunters Point areas of San Francisco. The Hunters Point Project, part of the Clean Coalition's Community Microgrids Initiative, will prove that local renewables can fulfill at least 25% of total electric energy consumption while maintaining or improving power quality, reliability, and resilience. Policymakers and utility executives need to see real-world solutions in action to gain confidence in accelerating the transition to local renewables. The Hunters Point Project, which is named after the substation that serves the Bayview and Hunters Point areas of San Francisco, is designed to provide a world-class example that facilitates San Francisco, and communities around the globe, to reap the benefits from significant levels of local renewables – including economic, environmental, and resilience benefits.

Bayview-Hunters Point Community

Bayview-Hunters Point is a disadvantaged community within the City of San Francisco – a community that lacks economic opportunities and healthy environmental conditions. Hunters Point suffers one of the highest poverty rates in San Francisco with thirty percent of the families there earning less than $10,000 per year, and 72% of its African Americans living below the federal poverty level. Overall, the community's median annual household income is only $29,640 compared to San Francisco's average of $55,221.[1] One third of San Francisco's hazardous waste sites are located in this community, and the neighborhood was downwind from one of California's dirtiest power plants until community activism forced the plant's closure in 2010. One in six children in Hunters Point still suffer from asthma, and the occurrence of chronic illnesses is more than four times the statewide average.[2]

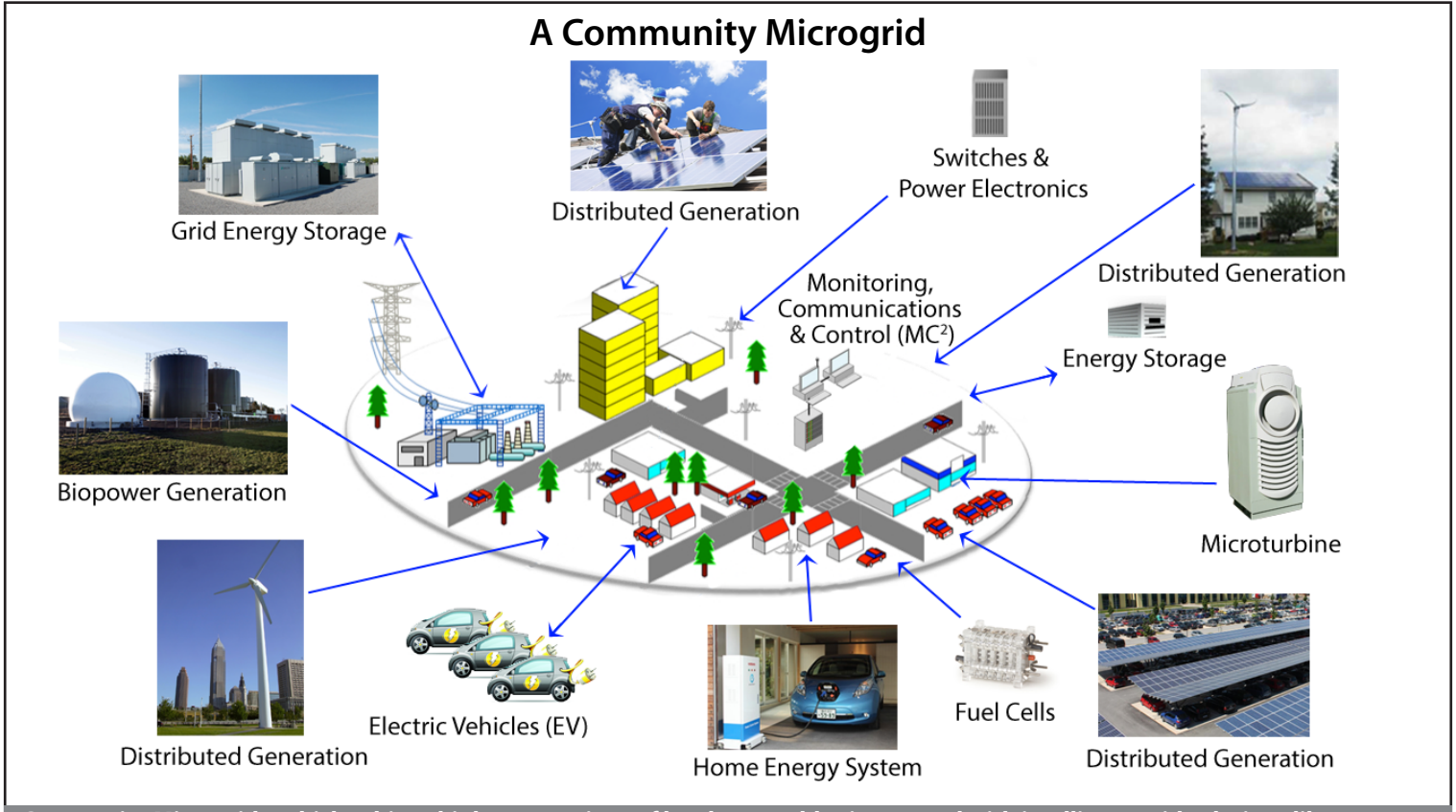
Project Overview

The City of San Francisco has targeted Hunters Point for significant economic and community redevelopment. The Hunters Point Project will advance the redevelopment goals by boosting the local economy through robust job creation and significant private investment in clean local energy.

Distributed generation refers to generating energy close to where it is consumed. Intelligent grid solutions – such as energy storage, advanced inverters, and demand response – enable high levels of local renewables by balancing the supply and demand of power and other vital grid services. Combining distributed generation with intelligent grid solutions enables 'Community Microgrids' that result in smarter, cleaner, and more resilient power systems.

The Hunters Point Project will demonstrate that local renewables can power communities with clean, affordable, and reliable energy. Importantly, this replicable Project will show how communities anywhere can stimulate their economies by embracing clean local energy. Community Microgrids strengthen local economies by attracting private investment, creating jobs, stabilizing energy prices, and keeping energy spend close to home. Early projects, like Hunters Point, will provide policymakers and utility executives with the empirical evidence needed to embrace clean local power systems with confidence.

[1] Hunters Point Family, Web, 30 August 2013, <http://hunterspointfamily.org/who-we-are/our-history/>
[2] Grid Alternatives. Web, 22 August 2013, <http://www.gridalternatives.org/planet/>



Community Microgrids, which achieve high penetrations of local renewables integrated with intelligent grid solutions like energy storage and advanced inverters, enable smarter, cleaner, and more resilient power systems.

Project Goals and Objectives

The Hunters Point Project is designed to prove the technical and economic feasibility of high penetrations of local renewables. Overall, the Project will serve as a model to modernize power systems with significant adoption of local renewables and intelligent grid solutions that bring the new energy economy to communities everywhere – along with improved environmental conditions and enhanced grid resilience.

Phase 1 of the Project, to be completed in 2014, will result in a replicable modeling platform that any community can use to evaluate Community Microgrid opportunities. Ultimately, the modeling platform will expedite the creation of Community Microgrids by efficiently simulating the ability of local renewables and intelligent grid solutions to balance the vital grid services (power, voltage, and frequency) locally and cost-effectively. Key Phase 1 activities include:

- Modeling and simulating the existing distribution grid
- Identifying sites for local renewables and intelligent grid solutions
- Modeling and simulating optimal scenarios for distributed resources
- Assessing benefits in terms of economics, environment, and grid resilience
- Engaging community stakeholders
- Providing recommendations for a cost and benefits optimized deployment

Phase 2 of the project, anticipated to be substantially completed by yearend 2015, will result in the actual deployment of the Hunters Point Community Microgrid recommended in Phase 1. Key Phase 2 activities include:

- Bringing approximately 50 megawatts of new local renewable capacity online in Hunters Point (for comparison, the entire County of San Francisco only has about 25 megawatts of local renewables deployed as of October 2013)
- Generating $233M in regional economic stimulation, including $100M in local wages, 1,270 near term job-years in construction and installation, and 520 job-years in ongoing regional employment
- Avoiding $80 million in transmission-related costs over 20 years
- Reducing GHG emissions by 78 million pounds and saving 15 million gallons of water annually
- Substantiating the business case that distributed generation boosts local economies by attracting significant private investment, stabilizing energy prices, and keeping energy spend local

The Hunters Point Project will create a Community Microgrid that is smarter, cleaner, more resilient; and will help San Francisco take the lead in the fast-growing clean energy economy.

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Exhibit 2:

Optimizing Distributed Energy Resources in a Community Microgrid:

Methodology and Case Study

***DRAFT**: September 21, 2014*

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Introduction

Distributed Energy Resources – local generation from solar, wind, geothermal and biopower, combined with demand response, energy efficiency, electric vehicle charging, and energy storage – provide an opportunity to meet evolving electric system needs in a manner that is fundamentally different from the existing centralized model. Traditional system planning assumes that centralized generation and bulk transmission is the most efficient method for delivering energy to customers. While certain economies of scale exist for centralized generation, Distributed Energy Resources, or "DER," offer a cost-effective alternative while also providing substantial societal benefits, including reduced greenhouse gas emissions and improved system-wide efficiencies.

This paper provides a framework and methodology such that any utility, utility commission, or community can achieve DER deployments in an optimized, cost-effective and scalable manner using tools readily available today. This approach enables high penetrations of local renewable energy, combined with other DER solutions, while maintaining grid reliability and power quality. In sum, this methodology will accelerate a substantial, existing asset – the distribution grid – towards a more highly utilized, cost-effective, and sustainable electric system.

This approach is somewhat unique. It starts from the necessary foundation: measuring the existing, available capacity in the distribution grid to satisfy local load with locally produced electricity, or Distributed Generation (DG). This is the logical first step, as it leverages the existing asset as is, without major changes or upgrades. Historically, distribution grids were not designed to accommodate locally produced electricity. However, the distribution grid is a collection of lines, poles, transformers, voltage regulators, and other equipment, all capable of unlocking a certain amount of local generation with little or no modification, at minimal cost in terms of grid upgrades. This existing, or Baseline Capacity, offers the lowest-cost option for incorporating large amounts of local renewables into our electrical system. Using the Baseline Capacity as the foundation, we can then calculate the additional impacts in terms of increased capacity, costs, or savings that result from including other DER solutions such as demand response, energy efficiency, electric vehicle (EV) charging, energy storage, and local reserves (or baseload generation) from combined heat and power (CHP) or fuel cells. The result is an optimized DER portfolio that cost-effectively supports higher penetrations of local renewable resources. At the same time, an optimized DER portfolio provides valuable ancillary services. These include deferring distribution grid equipment upgrades, such as transformers; decreasing the amount of (and thus cost) for transmission-delivered electricity; flattening peaks, which reduces the complexities (and thus costs) of transmission system operations; and maintaining essential services during outages.

This study and its results focus on the most cost effective and optimized opportunities for utilities to realize the benefits of DER portfolios. To compare against transmission and central generation investments on a level playing field, and to fully comply with state and federal clean

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energy goals, the full value of DER should be incorporated into cost-effectiveness calculations. DER provide a number of significant and quantifiable benefits to ratepayers, including:

- Increasing independence from transmission system energy services
- Deferring or avoiding distribution and transmission investments
- Reducing system-wide volatility and the need for contingency reserves
- Meeting clean energy goals
- Improving local resiliency and power quality
- Hedging against fossil fuel price volatility
- Accelerating electric vehicle adoption (while avoiding grid impacts)

The costs of DER include:

- Physical costs of DER
- Network upgrade and interconnection costs
- Telemetry and infrastructure to manage DER

The impacts of DER largely depend on their location. Therefore, accurate estimation of DER costs and benefits requires a detailed understanding of distribution grid dynamics and the manner in which these resources impact those dynamics on a locational basis. A recent report evaluating the costs and benefits of DER concluded that the "…wide variation in analysis approaches and quantitative tools used by different parties in different jurisdictions is inconsistent, confusing, and frequently lacks transparency."[1] Any attempt to realistically evaluate DER costs and benefits must therefore be transparent, vetted by a large cross section of stakeholders, and include the necessary granularity required to establish the locational value of these resources.

Traditional system planners views DER as "alternatives" to transmission and central generation, beyond their operational visibility and control, and rarely prioritize DER solutions to meet system needs. At the same time, distribution planners generally fail to account for the value of DER in avoiding investments in the distribution grid as well as in transmission and central generation. An integrated approach to transmission and distribution planning is necessary to move beyond the current view of DER as Non-Transmission Alternatives (NTA), uncounted resources, or even a potential system burden. Instead, DER must be proactively evaluated as a primary means of addressing system needs.

While the distribution grid – in principle – can supply power to the transmission grid, the methodology described herein causes zero backflow to the transmission grid while also preserving voltage stability. This zero backflow parameter minimizes impacts to the infrastructure and operation of the transmission grid resulting from increased DER penetration. In fact, optimizing DER at the substation level provides better local balancing of load and

[1] A Review of Solar PV Benefit and Cost Studies, Electricity Innovation Lab, Rocky Mountain Institute, September 2013

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generation, thereby maintaining a flatter load shape overall. This added benefits simplifies transmission grid operations and results in reduced costs.

In California, Assembly Bill 327 (AB-327) is a major step forward for smarter grid planning. This law requires utilities to develop Distribution Resources Plans by July 2015 to guide DER to optimal locations on the grid, while allowing utilities to rate-base any distribution grid investments that yield net ratepayer benefits.[2] One objective of this paper is to provide a detailed framework for distribution resource planning requirements in California under AB 327, as well as for other states seeking to develop similar requirements. As a blueprint for planning DER in an optimized and cost-effective manner, this paper offers a replicable and scalable approach for achieving these plans, vastly accelerating our transition to higher levels of renewable energy and a modern grid.

The Community Microgrid Opportunity

The existing power grid was designed primarily to deliver electricity in a one-way fashion: from large, centralized generating facilities across many miles to the cities and towns where it is used. Due to decreasing costs and improved operations, Distributed Energy Resources are now increasingly competitive economically, and these technologies offer great opportunity to transform our power system. Yet, both utilities and policymakers are concerned that the current, one-way power grid will become unreliable if local renewable generation provides more than 15% of peak power in a community. Due in part to this perceived limitation, solar energy today provides less than 1% of the total energy consumed in the United States, according to the Institute for Energy Research. Without evidence that local renewables can be reliably and cost-effectively integrated into the grid, this limit will continue to impede the nation's transition towards a modern and sustainable electric system.

To overcome this barrier, the Clean Coalition established the Community Microgrid Initiative. In partnership with electric utilities, community stakeholders, and energy developers, this Initiative proves that local renewables connected to the distribution grid can provide at least 25% of the total electric energy consumed while maintaining or improving grid reliability. Our Community Microgrid Initiative builds upon the existing utility infrastructure to enable more local renewable generation as part of a broader, cost-effective, and optimized portfolio of DER. This provides the following benefits:

- *Accelerates clean energy & sustainability*: Achieves higher amounts of sustainable energy, targeting at least 25% of the total electricity consumed in a community as local renewables

- *Improves grid performance, reliability & resilience*: Includes a portfolio of DER – such as advanced inverters, demand response, energy efficiency, EV charging, energy storage,

[2] California Public Utilities Code, Section 769, added by California Assembly Bill 327 (2013)

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and local reserves (e.g. fuel cells, CHP) – to achieve better grid performance by increasing the balance of load and generation locally.

- *Optimizes for cost-effectiveness*: Analyzes DER portfolios in partnership with utilities to determine the most cost-effective resource mix

- *Stabilizes energy prices while distributing investments locally*: Results in more predictable and stable energy prices, reduced transmission and distribution system costs, and more investment in local economies

The Clean Coalition's Community Microgrid Initiative accelerates and scales local renewable energy and a modern grid in two important ways:

1. Planning: Via a replicable and standardized modeling solution, or "planning blueprint," based on existing tools and technology. The methodology and results are validated first using Cyme's CYMDIST power flow modeling tool and Integral Analytics software tools using the Hunters Point Project, a Clean Coalition collaboration with PG&E, as a single, substation-wide model. The resulting blueprint will be available to anyone in the industry including other tool vendors, utilities, and utility commissions, in order to help replicate, scale and accelerate DER optimization and deployments.

2. Deployment: Via identifying large-scale procurement and interconnection solutions that utilities and communities can embrace, including a wholesale model (e.g. feed-in-tariff) for larger DG systems and capitalized grid upgrades. In addition, the Capacity Planning approach enables a "plug-and-play" interconnection opportunity featuring pre-approved local generation capacity in bulk amounts and specified locations. This will further speed widespread deployment of local renewables and reduce overall costs.

The Community Microgrid Initiative brings a top-down, system-wide, scalable solution that can be implemented across utility substations – vastly different to the project-by–project method used to bring local renewables online today. Using the Community Microgrid Initiative, grid operators can quickly and accurately plan for specific and beneficial amounts of renewable capacity that can be integrated in months rather than years, as part of any substation area. This approach enables grid operators to choose from a suite of scenarios such as:

1. Low Cost: the amount of local renewable generation supported by a substation area and its existing equipment, requiring no upgrades; often this will utilizes existing voltage regulation equipment and/or smart inverter functionality to help stabilize voltage as needed.

2. Medium Cost: the amount of local renewable generation supported by a substation area that builds on the Low Cost Scenario by including an optimal and cost-effective mix of other DER, such as demand response, energy efficiency, EV charging, and lower-cost energy storage; may require minimal upgrades to existing grid infrastructure.

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3. Higher Cost: the amount of local renewable generation supported by a substation area that builds on the Medium Cost Scenario by increasing storage and/or including local reserves such as CHP to achieve specific performance goals such as flattening peaks and/or maintaining essential services in case of outages; may require significant upgrades to existing grid infrastructure.

These scenarios enable grid operators to cost-effectively and rapidly meet local renewable energy and grid performance goals. The result is an efficient, reliable distribution grid based on local generation targets – achieving an operationally predictable and financially viable solution – and analogous to how the transmission grid is operated today using capacity targets and peak demand levels.

Today, solar in communities is added to the grid extremely slowly, often one rooftop at a time. This piecemeal approach causes unknown impacts to the grid, which unnecessarily restricts adoption and is a primary reason solar PV meets less than 1% of our total electric needs today. Using the Community Microgrid Initiative methodology, utilities and their regulators can establish specific, operational targets for local renewable capacity within communities, and then cost-effectively upgrade the grid to support those targets. Using these capacity targets, utilities can rapidly add substantial amounts of local renewable capacity to their distribution grids.

A Case Study: The Hunters Point Community Microgrid Project

In collaboration with Pacific Gas & Electric (PG&E), and in support of achieving at least 25% of total electric energy needs from local renewables, the Clean Coalition is developing a Community Microgrid in the Bayview-Hunters Point area of San Francisco. The Hunters Point Community Microgrid Project, named after the Hunters Point substation that serves the area, encompasses an entire substation area serving 20,000 residential, commercial and industrial customers. The Project showcases how any community and utility can reap significant economic, energy and environmental benefits – including a stronger and more resilient grid – from deploying an optimized and cost-effective mix of local renewables integrated with other DER. The Hunters Point Community Microgrid Project demonstrates that the technologies required to plan and deploy these advanced energy solutions are readily available today (for example, the Clean Coalition is using Cyme's CYMDIST tool, v5.04 r10, for dynamic distribution grid modeling.)

To reach at least 25% of total electric energy needs from local renewables, approximately 50 megawatts (MW) of new solar photovoltaic (PV) capacity must be installed. These 50 MW of new PV will be added to an existing 8 MW (PV-equivalent) already installed in the area (1.5 MW of existing solar plus 6.5 MW PV-equivalent of biopower produced by the local wastewater treatment plant). In total, the 50 MW of new PV and the 8 MW of existing PV-equivalent local renewable energy achieves 91,000 megawatt-hours MWh of annual renewable electricity generation, or 28% of the total annual load of 320,000 MWh in the substation plan. Note that

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this analysis is focused primarily on adding solar PV simply because other renewable resources such as wind and geothermal are not readily available in the Bayview-Hunters Point area.

Note that Hunters Point, a naval shipyard, is undergoing a multi-year redevelopment effort by the City of San Francisco, which requires a portion of this analysis to be forward-looking. Through a comprehensive evaluation of the City's redevelopment plan, including likely rooftop square footage and projected electricity demand, we have determined that 20 MW of new PV in the Hunters Point redevelopment area is conservative estimate. With the 20 MW of new PV estimated for the redevelopment area, 30 MW of new PV must be sited in the existing area served by the substation – known as the Bayview – that will not undergo redevelopment. This near-term opportunity is the basis for this study. Thus, our modeling effort adds 30 MW of new PV and optimizes DER on the feeders serving the Bayview community. These 30 MW of new PV, plus the 8 MW of existing (PV-equivalent) local renewable energy already located in that area, will provide 60,000 MWh of annual renewable electricity generation, which is 25% of the total annual load of 236,000 MWh needed to serve the Bayview area (the non-redevelopment zone).

While establishing a replicable methodology for power system planners and operators, the Hunters Point Community Microgrid Project also strengthens the local economy by increasing private investment, creating jobs, stabilizing energy prices, and keeping energy dollars close to home. Starting with the 30 MW of new PV in the Bayview area, then reaching a total 50 MW of new PV once the redevelopment zone is completed, achieves many community benefits. Using industry-accepted assumptions from sources such as the National Renewable Energy Lab (JEDI tool and emissions calculator), the California Energy Commission (cost of generation calculator), the California Independent System Operator (transmission charges and infrastructure projections), PG&E (local outage estimates), and the Department of Energy (water savings), 50 MW of new PV added to the San Francisco Bay Area would generate the following benefits over twenty years:

Local Economic Benefits:

- $200 million added to the local economy
- $100 million in increased community wages
- Over 1,700 new local job-years created

Energy Cost Benefits:

- Cost parity with new, centralized, natural gas generation: 14.9¢/kWh for new solar vs. $15.3¢/kWh for new combined cycle natural gas
- $80 million in avoided transmission-related costs ($38 million in avoided transmission access charges, $30 million in avoided costs for new transmission capacity, and $12 million in avoided costs from transmission line losses)
- $30 million saved by local businesses and homes by reduced power outages

Environmental Benefits:

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- Annual greenhouse gas emission reductions of 78 million pounds
- Annual water savings of 15 million gallons
- More than 375 acres of land preserved by using rooftops and parking lots to generate energy rather than pristine land

The Clean Coalition's Hunters Point Community Microgrid Project underscores the technical and economic viability of achieving higher penetrations of local renewables and optimized DER portfolios, helping reduce system-wide electrical energy costs and complexities. Once deployed, this project will serve as a cutting-edge model for modernizing America's electrical system in the most cost-effective and beneficial manner.

Optimization Methodology for Distributed Energy Resources (DER)

As stated, the goal of this study is to establish a replicable and scalable solution for optimizing DER in a cost-effective manner. The focus is our Hunters Point Community Microgrid Project, which covers an entire substation area. Conventionally, utilities have modeled the distribution grid only to manage peak loads with all power arriving from the transmission grid to the substation transformer, and then unidirectional distribution occurring across substation feeders. Optimizing DER requires modeling in a dynamic, bidirectional way, balancing power, voltage and frequency across the distribution grid. Generation must be blended across local and substation transformer sources and analyzed regularly, such as in 15-minute increments. For the most part, this approach to grid modeling is entirely new to utility operations. In other words, the existing DG capacity for any substation, or group of substations, is currently an "unknown" quantity. Our Community Microgrid Initiative demonstrates how to use existing tools to make this a "known" quantity, helping utilities, utility commissions, and communities make informed decisions about energy system goals and costs on the path towards achieving smarter, integrated distribution grid planning.

Optimizing DER requires recognizing the complementary benefits of DER portfolios, rather than analyzing the value of individual resources in isolation. Synergistic relationships between different DER can lead to substantial improvements in efficiencies and costs. Several examples are worth mentioning. It is expected that high levels of distributed PV, peaking during mid-day, will lead to lower daytime energy prices, depending on rate design. Low mid-day energy prices, when communicated to end users through time-of-use or dynamic pricing, may spur behaviors that mitigate any potential over-generation issues. For example, low mid-day energy prices may cause customers to precool (e.g. summer weekdays) or preheat (e.g. winter weekdays) their homes when energy is cheaper – relying less on more expensive energy at other times during the day and early evenings. Also, peak PV generation impacts can be mitigated with demand response to increase daytime loads and daytime electric vehicle (EV) charging.[3]

[3] See the Clean Coalition's presentation to the California Energy Commission, Flattening the Duck (February 2014), available at http://www.clean-coalition.org/resources/february-2014-cec-presentationflattening-the-duck/

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Similarly, the value of distributed PV and storage are both enhanced by turning on advanced capabilities of inverters. Advanced inverters effectively manage any over-voltage issues that occur due to high levels of distributed solar, prevent blackouts by providing reactive power close to loads, and enable conservation voltage efficiencies.[4] Understanding storage performance characteristics and its effect on a Levelized Cost of Electricity (LCOE) is required while evaluating distributed energy storage options. Curtailment of DG resources is not specifically a DER resource but rather a complementary tool for controlling the output of these resources. Given the objective to increase local renewable generation as much as operationally and financially feasible, curtailment is used as a last resort. Keep in mind that we are diligently evaluating the most cost-effective mix of DER, given the combination of local load and generation opportunities.

In examining cost effective and optimized DER in support of increasing levels of distributed PV, for simplicity's sake we'll evaluate a single substation as the basic building block. A single substation can integrate a certain amount of distributed PV at an extremely low cost from the perspective of utility infrastructure upgrades. Utility customers are paying distributed PV costs, and for net energy metered systems interconnection costs are essentially zero. Furthermore, small wholesale DG facilities – generating facilities that sell all power produced to the utility – pay their own interconnection costs. As a result, these systems cost the utility nothing, assuming we can define the amount and locations that require no upgrades to existing grid infrastructure. Thus, we can measure the maximum amount of PV resources that can be reliably integrated within a single substation at the lowest possible cost, subject to required voltage regulation and zero backflow to the transmission system. This is known as the Baseline Capacity of a given substation.

Distribution resources planning should require utilities to correctly and accurately define and publish this existing Baseline Capacity, including optimal locations and generation amounts along the feeders within a substation area. This will enable the most cost-effective and optimal amount of local renewable energy. The Baseline Capacity is also used to determine which additional DER solutions further optimize the performance of the grid in a cost-effective manner. This DER Optimization Methodology, comprised of the four steps below, is based on Capacity Planning – a more operationally and financially stable method to integrate DER:

Step 1: Baseline Powerflow. This provides the foundation and must be completed first in order to understand the quantity and dynamics of how electricity moves on the distribution grid. Without this step, we cannot understand how additional amounts of local renewables may cause grid impacts. Note that this step requires incorporating key utility data sets, including customer and transformer loads and the network model. The circuit map, including schematic, connections, wire and cable types, and equipment settings, is also crucial. Voltage, power flows, voltage regulation (e.g. load tap changers), capacitor bank operations, and the effect of series reactors will all be measured during this step. The model must run consistently and with

[4] Craig Lewis, Advanced Inverters – Recovering Costs and Compensating Benefits (October 2013), available at http://www.clean-coalition.org/site/wpcontent/uploads/2013/10/October2013_SolarServer.pdf

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stability, including ongoing validation of data across load allocation, load flow, and time-based scenarios.

Step 2: Baseline Capacity ("Low Cost" scenario). The Baseline Capacity defines the potential amounts of local renewable generation that can be supported by the existing substation circuits – by individual feeder lines as well as by the entire system of connected feeders that make up a substation area. The Baseline Capacity is based largely on the current physical nature of the circuit, such as wire thickness and the capabilities of existing voltage regulation mechanisms. Maximizing the Baseline Capacity is also based on matching local generation types to local loads. For example, in the case of solar, robust feeder locations and customers with large daytime loads offer the most optimal locations. Guiding deployment to optimal locations maximizes the amount of local renewables that can be supported by a substation system with no changes or upgrades needed. This is critical information in order to design the most cost-effective solution possible. And, without this step, the next two steps have an unsteady foundation to build upon. Note that one can also find optimal locations in different combinations, such as less robust feeder locations with larger customer daytime loads, or more robust feeder locations with lower customer daytime loads. The diagram below illustrates achieving this step using resistance, or ohms, in combination with daytime load sizes.

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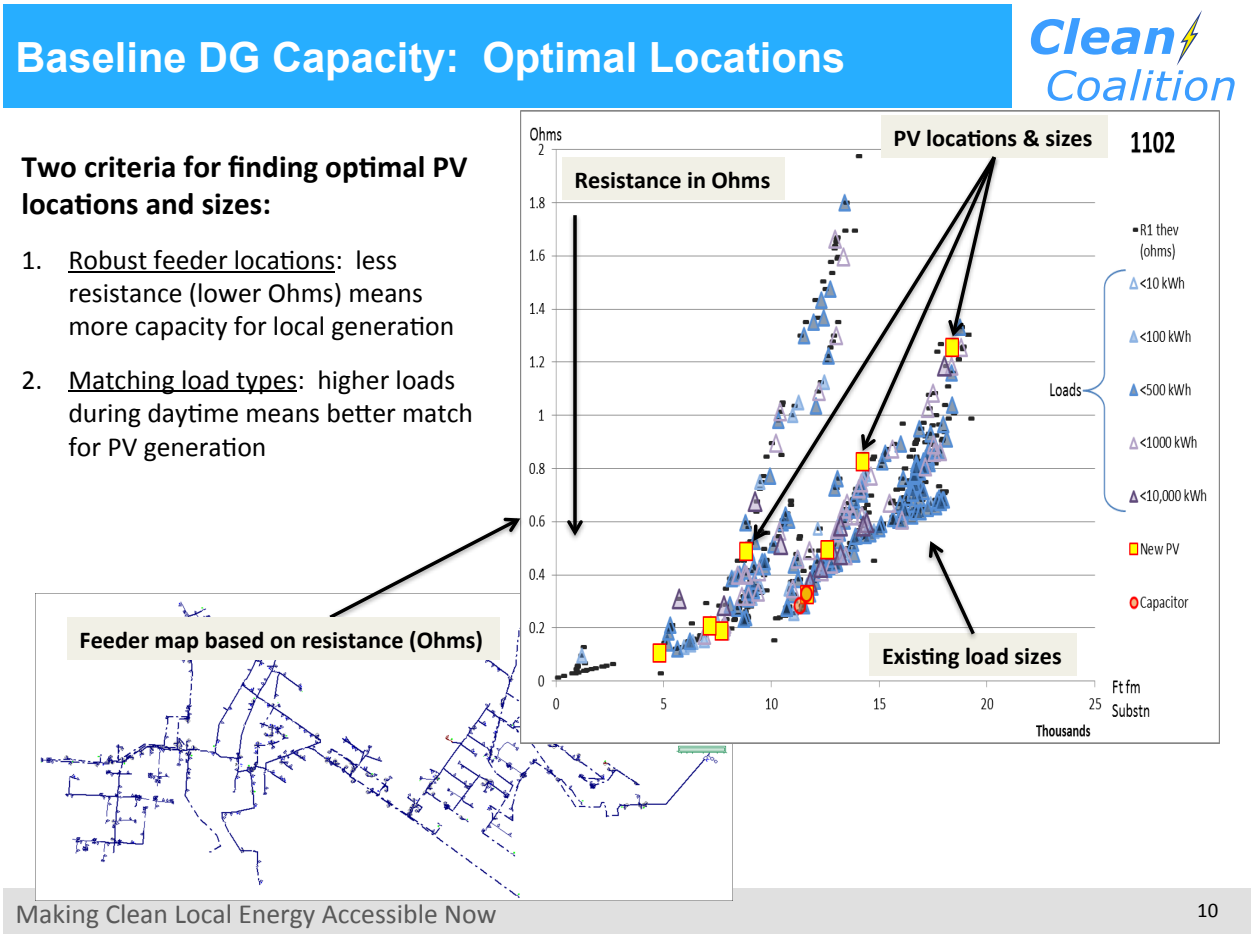

Determining Baseline Capacity Using Optimal Locations

The above diagram visually highlights an important fact: this enormous asset – the distribution grid – is currently underutilized. There is substantial existing potential within substation areas to supplement one-way power with two way, local generation. This capacity, and capability, should be realized in order to get the most out of our distribution grid investment.

Another method achieving further optimizations is connecting the feeders across a substation so they work as a single system, downstream from the substation transformer. This "Substation as-a-System" approach delivers additional efficiencies as follows:

1. **Local Balancing**: Over-generation on certain feeders can be consumed by load on other feeders connected at the substation. For example, weekend PV generation on large commercial rooftops, normally consumed locally during weekdays either onsite or on that feeder segment, can be consumed by residential customers within that substation area, during weekends when residential loads increase
2. **Optimizing Settings**: E.g. load tap changers across the substation feeders
3. **Optimizing DER:** E.g. storage and demand response across the substation feeders (see

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steps 3 & 4)

As stated, defining the Baseline Capacity for DG means finding the optimal locations in a substation area by determining the most robust feeder locations and optimal customer load types that match local renewable generation profiles. This requires analyzing load shapes per customer type – e.g. residential, and commercial & industrial (C&I) loads, during both weekdays and weekends, and using minimum daytime loads to test for the "worst-case" scenario. In the case of potential voltage issues, advanced inverters can be used to maintain acceptable voltage levels through reactive power provisioning. Additional data sets required to complete the Baseline Capacity and additional capacity measurements (see Steps 3 and 4 below) include solar insolation data; weather forecasting data to reach more granular results; performance characteristic assumptions for demand response, energy efficiency, and EV charging; and performance specifications for energy storage solutions.

In addition, utilizing equipment lists, upgrade plans, and operations and maintenance schedules from utilities is critical in order to complete the Baseline Capacity and additional capacity measurements (See Steps 3 and 4 below). Equipment-related data helps identify opportunities to reduce costs by deferring equipment upgrades, such as substation transformers. Local generation reduces equipment use by reducing the electrical load delivered through the substation transformer (i.e. delivered by the transmission system). At the same time, where demand for electricity is starting to exceed local grid capacity, satisfying onsite load with some portion of onsite generation can help defer future equipment upgrade costs, such as by extending the life of customer-level (pole) transformers. Other significant cost-savings can come from reduced reliance on transmission. Each Megawatt hour produced and consumed locally reduces the amount of electricity delivered over long-distance transmission lines by an equivalent amount, achieving further system-wide savings and efficiencies.

As two examples supporting the above, Greentech Media reported in September 2014 that two leading U.K utilities – Scottish and Southern Energy and U.K. Power Networks – forecast savings of more than €300 million [$387 million] in avoidable capital expenditures by pinpointing specific "hot spots" that needed to be upgraded or addressed through distributed resources. Also in September 2014, Greentech Media reported that New York's *Reforming the Energy Vision* proceeding, known as REV, includes utility commission staff identifying a number of near-term actions for immediate implementation by utilities – starting with using DER opportunities to help defer the $30 billion the state has planned for transmission and distribution system upgrades over the next ten years. And, Consolidated Edison is already proving that this is a successful approach. The utility is seeking approval to manage electricity demand – using demand response, storage and energy efficiency – rather than building a new $1 billion dollar substation to meet unmanaged demand. This move alone is expected to save customers around $500 million.

As with Step 1, Baseline Powerflow, the metrics measured to achieve the Baseline Capacity include voltage, power flows, voltage regulation (e.g. load tap changers), capacitor bank operations, and the effect of series reactors. The model must run consistently and with stability,

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including ongoing validation of data across load allocation, load flow, and time-based scenarios.

Step 3: Medium Capacity ("Medium Cost" scenario). Step 3 builds on the Baseline Capacity by adding cost-effective DER options such as demand response, energy efficiency, and EV charging, along with lower-cost energy storage. These DER solutions can lower demand and/or peak loads at critical times and/or add load during daytime generation of solar if needed. The result is increased grid performance, as well as a greater amount of DG supported by a substation area. Step 3 requires optimizing the DER portfolio based on locations, sizes, types and costs to achieve preferred DER penetration and cost targets. Modeling lowest-cost approaches like demand response, energy efficiency, and EV charging will result in a more cost-effective DER portfolio, and this should be done prior to including storage options such as combined PV/storage solutions located at customer sites. The result of Step 3 is the optimal mix of local generation and lowest-cost DER for a given substation.

Demand response and energy efficiency programs should be time-optimized to match the distributed generation assets. For example, in the Clean Coalition's Hunters Point Community Microgrid Project, solar irradiance is the primary driver of the distributed generation profile. In this case, a targeted demand response program would structure time-based incentives (kW-based or kWh-based) for participants across Residential and Commercial & Industrial (C&I) load categories to:

- Consume more electricity (e.g. preheating/precooling) on weekdays between 11am and 2pm,when solar generation is maximal
- Consume less electricity (e.g. reschedule laundry load) weekdays between 4pm and 9pm when solar generation is minimal or non-existent
- Consume less electricity weekdays between 6am and 8am when solar generation is minimal (if needed)

Weekend incentives would increase for residential segments to offset the expected shortfall in demand response participation by C&I customers on weekends. As needed, energy storage can take up any remaining weekend excess generation. (Note: Programmable Thermostats, Smart Appliances, low-cost home energy management systems, and utility incentives for businesses to acquire Automated Demand Response/ADR equipment would all be all enablers for program efficacy. Obligatory backup generator tests for critical facilities, e.g. hospitals, wastewater treatment facilities, police, and fire departments can also correspond to weekday afternoon/evening Demand Response participation).

To the extent possible, energy efficiency measures should also be time-optimized to match the mix of DER in a substation area. In general, energy efficiency measures can be categorized into four groups:

1. <u>Energy efficiency with a focused time interval impact on the weekday 4-9pm window, such as:</u>
    - High efficiency OLED television

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- Heat pump condensing electric drier

2. Energy efficiency with longer time interval impacts to substantially overlap with the weekday 4-9pm window, such as:
   - LED street lighting retrofits
   - LED traffic lights retrofits
   - High efficiency Xerox machines

3. Energy efficiency with 24x7 impacts
   - Advanced refrigeration
   - High efficiency water pumps
   - Server/power supply upgrades
   - Vampire load mitigation, e.g. TV set top boxes manufactured prior to 2010
   - High COP CO2 Heat Pump Water Heater

4. Energy efficiency with important winter and summer benefits, such as:
   - High efficiency window retrofits
   - IndoWindow inserts

As stated, solar is the primary distributed generation resource for the Hunters Point substation. Therefore, demand response and energy efficiency programs for Hunters Point – and other solar-dominated areas – should align with daytime generation and reduce load at night. Different substation, however, are likely have a unique mix of local renewable energy sources. For example, some communities may have a large geothermal or biopower resource. In this case, the optimal demand response and energy efficiency programs may need to achieve very different load modification objectives than a substation with a large solar resource, such as shifting loads to late night in order to satisfy a constant renewable energy generation resource when the larger, normal daytime and early evening loads start to fall off.

As with Step 2, the results can be optimized to achieve specific distribution grid equipment upgrade deferrals and savings in transmission costs.

Step 4: Higher Capacity ("Higher Cost" scenario). Step 4 builds on the previous steps to achieve further levels of system-wide efficiencies. In Step 4, a utility can determine the optimal and most cost-effective mix of additional energy storage (such as substation-wide flow batteries) and local, non-variable generation (such as CHP or fuel cells). Additional storage increases the amount of DG supported by the substation area without impacting grid operations. For example, with storage, any potential over-generation from local renewables can be stored and used later to satisfy evening peaks. This flattens the load shape locally, which simplifies transmission needs and operations, resulting in lower overall system costs. In addition, both the energy storage and local non-variable reserves like CHP enable essential services to be maintained during grid outages. As with DER in previous steps, energy storage and local reserves can be optimized by location, size, type and cost within a substation area, or even across substations. Step 4 results in a higher-cost deployment of local renewables and DER, however, this DER portfolio also

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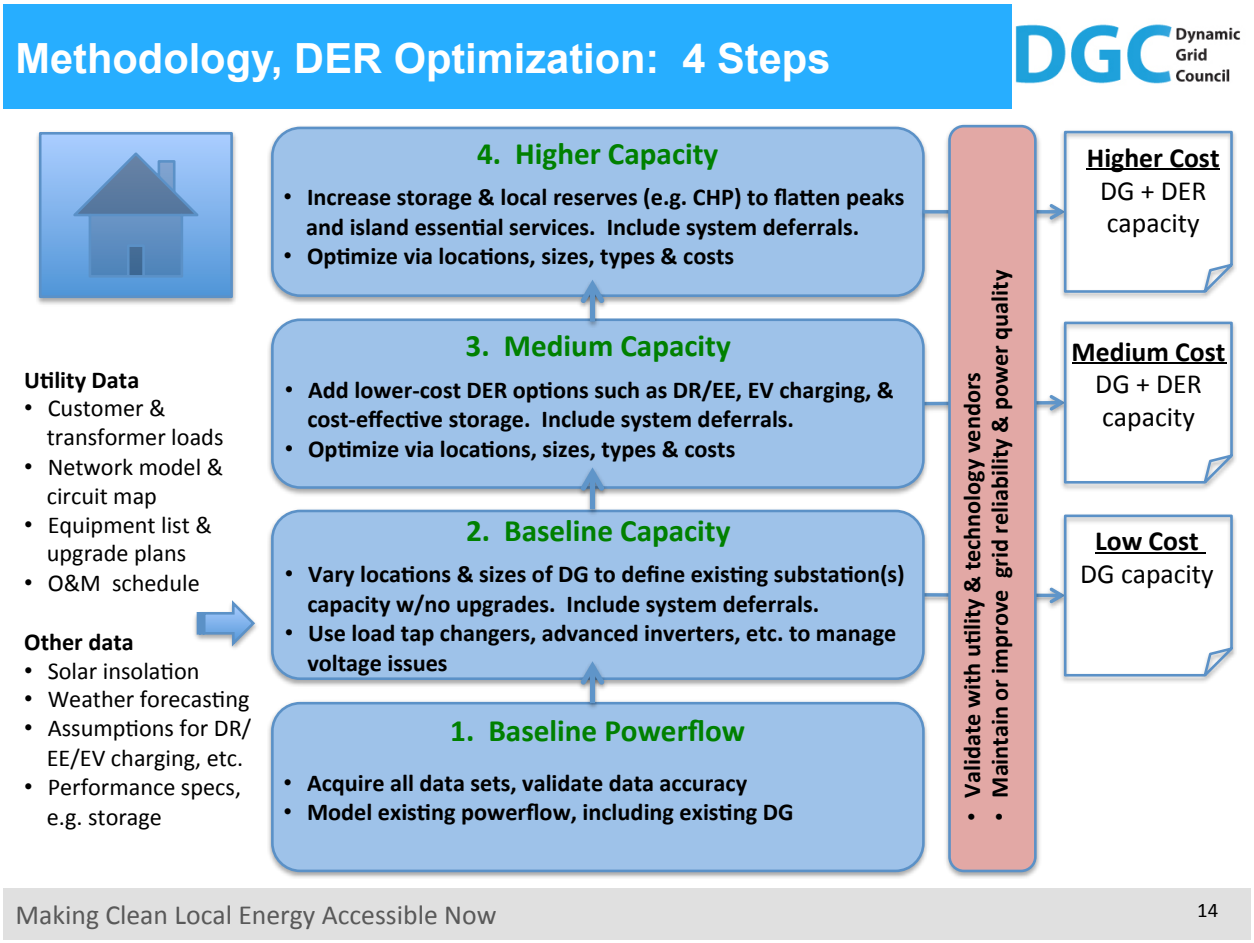
provides a more reliable, resilient and efficient distribution grid.

As with Steps 2 and 3, Step 4 results in an optimized DER portfolio that can achieve specific distribution grid equipment upgrade deferrals and savings in transmission costs.

The diagram below illustrates this four-step methodology. Working through the steps is like building a house. One must start with a solid foundation to build upon – Step 1, or Baseline Powerflow. The Clean Coalition is employing this methodology for our Hunters Point Community Microgrid Project, in collaboration with PG&E. For our modeling, we use the commercial version of PG&E's distribution modeling tool, Cyme (specifically, CYMDIST v5.04 r10) and Integral Analytics LoadSEER, DSMore and IDROP software tools.



DER Optimization Methodology

By starting with the Baseline Capacity and then modeling DER portfolio combinations that leverage this baseline, a utility can determine the optimal mix of local renewables and other DER that result in the most cost-effective and resilient deployment for any given substation. In the

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case that a utility or community is already planning to target the higher capacity scenario – e.g. to maintain essential services in the case of outages – one option is to bypass Step 3, the Medium Capacity scenario, and go directly from the Baseline Capacity to Step 4, the Higher Capacity scenario. This is recommended only if the lower-cost DER options outlined in Step 3 are also included in Step 4. Through this methodology, the resulting DER portfolio will achieve the highest value and most cost effective outcome.

Identifying and prioritizing DG deployment at optimal locations in substation areas highlights an important fact for utility distribution planning: C&I customers are often an ideal match for DG programs, and especially PV, in these important ways:

- **Maximum Generation Potential:** C&I customers have larger rooftop and parking lot spaces that can generate larger amounts of energy.
- **Lower Costs:** Larger PV systems at C&I locations are more cost-effective to deploy than smaller residential rooftop systems, reducing overall system costs.
- **Best Locations:** C&I customers typically use much larger loads and thus are connected to more robust feeder segments. These more robust feeder segments are capable of handling more DG without grid upgrades.
- **Matching Loads:** C&I customers typically have larger daytime loads that match solar generation profiles.
- **Financial Motivation:** C&I customer typically have much larger electricity bills, thus they are more motivated to stabilize and reduce their long-term energy costs, including reducing demand response charges, through use of DG.

Given these five advantages, C&I customers offer the lowest hanging fruit to achieve scalable and cost-effective DER deployments. Utilities seeking to achieve distributed generation goals quickly and cost-effectively should design DG programs to leverage this C&I opportunity. The diagram below helps illustrate the value of a utility or community DER program focused on C&I customers. Note the load shape for the C&I customer segment, which is the red line in the diagram. As a general rule, the load requirements of the C&I customer segment reach an extended peak during the daytime, matching the generation profile of PV much more closely than the residential customer segment.

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Example Load Profiles: C&I Match for PV

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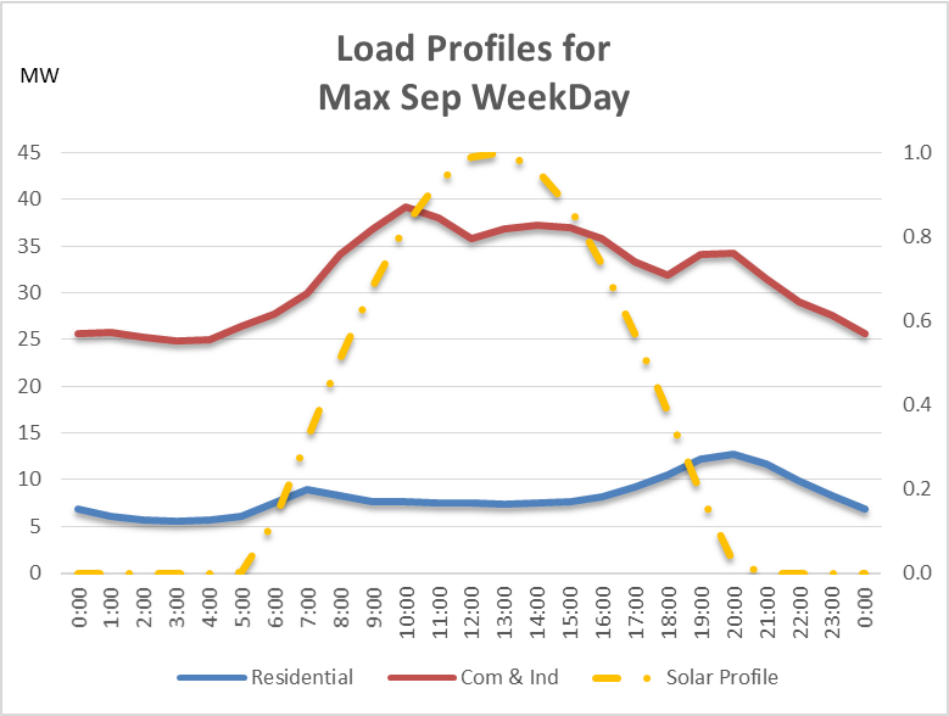

Hunters Point substation area load shapes: Commercial & Industrial vs. Residential

Note these considerations when evaluating the advantages of C&I DG programs:

- Feeders are connected within each substation. This enables sharing energy across feeders and thus across customers and customer types.
- Each urban/suburban substation or set of substations can determine the optimal mix of DER to accommodate balancing the generation and load across that substation's customer types: e.g. Commercial, Industrial, Residential.
- Both weekday and weekend load profiles must be considered.
- In general, during weekday daytimes when residential load is low and C&I load is high, a good portion or all of the C&I daytime PV generation can be consumed "hyper-locally" by C&I customers, either directly or via sharing energy across those customers.
- During the weekends, C&I customers may use less daytime load which can then be shared more broadly with local residential customers who often use more load mid-day on weekends than weekdays.
- Multi-dwelling units can be bundled with C&I given the larger rooftops and loads; however, the load profiles will match typical residential, not C&I customers.

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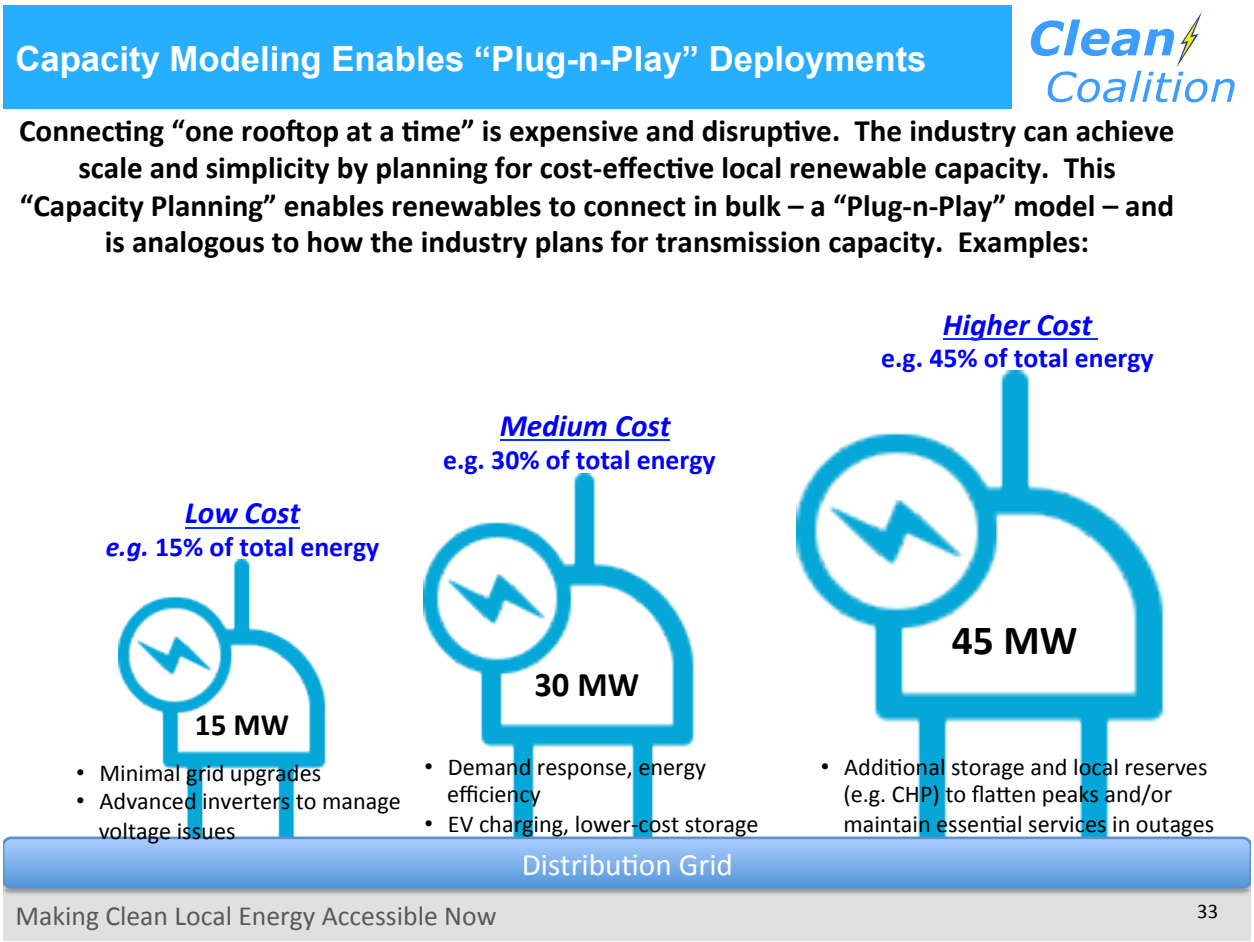
As detailed above, the industry can achieve scale and operational simplicity, which reduces costs, by planning for the optimal mix of local renewable capacity and other DER. Once this planning process is in place, DER and supporting grid upgrades can connect in bulk – a "Plug-n-Play" model – rather than one project at a time, which is more expensive and operationally disruptive. This is similar to how the electric industry plans for transmission capacity or peak load on the distribution grid. As a simplified illustration, the diagram below proposes three generic distribution grid examples of "Plug-n-Play" deployment:



Examples of "Plug-n-Play" DG Interconnection based on Capacity Planning

This DER Optimization methodology, based on Capacity Planning, enables a bulk, Plug-n-Play model for bringing DER online, which achieves both scale and simplicity across the industry. The result is accelerating deployment timelines while substantially reducing operational costs.

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Results: The Hunters Point Project

[Note: The Hunters Point Community Microgrid study is currently in process. Specific results will be provided in a subsequent version of this document]

Conclusion

As a leading and lower cost DG opportunity, solar power provides less than 1% of the total electric energy consumed in the U.S today. Even though renewables – specifically solar – have experience rapid growth over the past few years, there is a long way to go until renewables are providing a significant portion of our national electric energy needs.

The strength of our electrical system is its breadth: power lines reach to almost every corner of the country. Until now, distribution grids have solely been used simply for unidirectional delivery of electricity – from a substation transformer to homes and businesses where the power is used. Technological advances now enable us to leverage the vast miles of distribution grid infrastructure (wires, utility poles and other equipment like load tap changers) to enable a bidirectional, dynamic grid that can integrate large amounts of local renewables and other DER.

This paper has detailed an approach to distribution grid planning that will result in cost-effective, optimized, and standardized deployments of local renewables and other DER. Every utility should develop distribution grid Capacity Planning using this methodology. And, it is consistent with a statement in a leading industry paper, the *More Than Smart* report – co-published by the Greentech Leadership Group, the Energy Foundation, and the Resnick Institute – to help establish a framework that modernizes the distribution grid:

> "…utilities continue to make significant investment in grid modernization. (One utility), for example, has incorporated fundamental changes to enable integration of DER at scale. These changes include larger distribution wire sizes and transformers that also improve safety and reliability. Given these grid modernization investments, distribution planning should start by establishing a common understanding of the capabilities of the existing system as a "baseline"."

Capacity Planning for DER, which includes evaluating the economic advantages of various DER portfolios, are indeed possible using existing commercial tools. In the case of the Hunters Point Community Microgrid Project, Cyme (CYMDIST) is used in concert with Integral Analytics software tools to help complete the picture for DER Optimization and distribution grid Capacity Planning. Note that both of these tools are already being utilized by investor owned utilities in California.

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In addition, DER should be leveraged to maximize local balancing, as is economically and operationally feasible, to reduce the complexity between utilities and the transmission system operator. Too much operational complexity between utilities and transmission system operators will likely result in delayed implementation of a DER-optimized distribution grid. The more we can use DER to balance load and demand locally – e.g. on a substation basis, or across substations within a utility – the less complex the interface between utilities and the transmission system operator, which improves system-wide efficiencies and costs.

Transitioning towards a renewables-based electrical system is possible today. A road map that defines realistic deployment opportunities in the near-term, medium-term, and longer-term will guide us to an eventual ideal grid architecture. In the near-term, however, we can leverage existing, proven technologies and methodologies to achieve electrical system goals. The Hunters Point Community Microgrid Project, for example, proves that we can optimize a DER portfolio to achieve enhanced sustainability and reliability. We should move forward with these near-term deployment opportunities without delay.

Benjamin Franklin captured the imagination of the world in 1750 when he used a kite to "harness" electricity from lightning. This invention eventually led to the creation of the lightning rod. Franklin became famous for this accomplishment, giving demonstrations in Europe while the colonies were still debating whether or not to become an independent "United States."

Over a century later, in 1886, George Westinghouse founded a new company that pioneered long-distance and high-voltage alternating-current transmission, ushering in an era of centralized generation distributed over long distances. This brought lower-cost and highly available electricity service to the U.S. that is essentially unchanged today – a model we've lived with and benefitted from for over 100 years.

Now, over 125 years later, a third major wave of electricity innovation is upon us. Utilities can now plan for and deploy an optimized DER portfolio within and across substations. To begin, we can focus initially on the smaller subset of urban and suburban substations as they offer the biggest gains. With a little focus and training, we can unlock the potential of these substations and achieve a modern, more distributed energy system, wringing the most value out of this large, existing asset. The result is a truly sustainable energy solution – more sustainable financially, with predictable and stable long-term energy prices; more sustainable operationally, offering a highly resilient and simplified system-wide architecture; and of course, more sustainable for the environment. The U.S has pioneered electric revolutions twice before. We can certainly do it again – for industry, and for good. Let's get started!

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EXHIBIT A: Methodology Comparisons

Two recent California studies have looked at how to increase reliable levels of distributed solar subject to various limitations. These two cases are both conceptually similar to the low cost case described above. The first study, commissioned by the CPUC, examines the technical potential for increasing levels of distributed solar within California, and also assessed the associated costs and benefits.[5] The CPUC paper was able to show that up to 15,000 MW of distributed PV can be deployed across all CA distribution networks by 2020. The central constraint used to identify this distributed PV potential is that it be consumed by local load, and not backflow from the distribution system onto the transmission system. This work uses detailed location dependent hourly generation and load profiles to assess distributed PV potential, but does not use engineering models to examine technical performance metrics of the distribution grid. One of the main conclusions of this study is that PV generation must be distributed throughout the state in rough proportion to load in order to achieve significant penetration. Substations with greater load can accommodate larger levels of PV without backflow. Sorting distributed PV projects by Least Net Cost (minimizing total system cost plus interconnection cost - avoided cost) identifies the most cost effective opportunities to locate DG in areas with high avoided costs. Interestingly, this study finds that the benefits of this approach carry through to about 2016, but disappear by 2020, when all ideal locations for distributed PV have been realized regardless of cost. Note that this CPUC study does not look at how any other DER approaches such as smart inverters, demand response, energy storage, or energy efficiency, or local reserves such as CHP can be used to increase the amounts of distributed PV that can be deployed across distribution networks while maintaining grid reliability and power quality.

The second study, commissioned by the CEC, evaluates the costs for SCE to comply with Governor Brown's *Clean Energy Jobs Plan* goal of 12,000 megawatts of distributed PV in California by 2020. SCE's share of this is 4800 MW. The study consists of a detailed engineering study of the entire SCE service territory using power flow modeling tools to evaluate the technical capabilities of their distribution networks to support distributed PV resources.[6] The CEC study looked at 3 base cases with 70% DPV in urban areas and 30% in rural areas; 30% in urban areas and 70% in rural areas; and 50% in both urban and rural areas. DG integration costs for the three base cases ranged from a low of just above $0.9 million for the urban centric case, to more than $1.3 billion for the most rural centric case. Notably, fewer system upgrades are required for DG installed in urban areas. Most costs are for interconnection to the distribution grid. In contrast, the mostly rural scenario has system upgrades that cost roughly the same as interconnection. Total integration costs from DG range from $190/kilowatt (kW) to $270/kW for the distribution system.

The CEC study takes a conservative approach for deploying distributed PV resources by limiting DG penetration to less than 15% of the feeder annual-peak load, as specified by Rule 21

[5] E3, Technical Potential for Local Distributed Photovoltaics in California, Preliminary Assessment, March, 2012
[6] The study utilizes a clustering technique to group feeders across the service territory, comparing feeder metrics and grouping similar feeder types to simplify the engineering analysis.

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interconnection limits.[7] The study further constrained DG penetration by not allowing load to be offset by DG output. For example, with this constraint, a feeder rated 10 MW with 5 MW of load cannot accommodate 15 MW of DG. PV inverter power factors were also fixed in this study, limiting the ability of the DG installation to provide reactive power to the grid, and limiting its ability to manage voltage stability. This CEC study also does not take into account other DER approaches including smart inverters, demand response, energy storage, energy efficiency, or local reserves such as CHP.

Despite these limitations, the CEC study comes to some useful conclusions:

- The cost of DG integration depends highly upon locational factors, for both the distribution and transmission systems.
- Integration impacts and costs are lower when DG is installed in urban areas, where feeders are shorter and often equipped with larger conductor or cable along the entire length of the circuit.
- Integration costs increase significantly as greater amounts of DG are clustered and/or installed near the end of distribution lines.
- Distribution planning and operational criteria and practices that ensure minimal impact to reliability and system operability can limit DG integration, even on feeders where DG does not create loading or voltage violations.
- High penetrations of DG may require sophisticated communications and control systems to better manage impacts and reduce integration costs.

Exhibit B: Future Requirements for Tool Providers

Following is a summary of feature requests for utility tool vendors. These features, if incorporated, will further simplify and accelerate the human effort needed to achieve the described methodology and results.

To be added in Q4 2014

EXHIBIT C: Modeling Specification

Complete and Detailed Modeling Spec

To be added in Q4 2014

[7] Rule 21 is the California specific distribution interconnection tariff. More precisely, exceeding the 15% limit triggers a supplemental interconnection study.

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