Unlocking Grid Data

Enabling Data Access and Transparency to Drive Innovation in the Electric Grid

A white paper jointly authored by TechNet, SunSpec Alliance, and DBL Partners

Endorsements

The following companies support the concepts put forth in this document

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Data access and transparency are foundational to unlocking innovation in the design and optimization of the modern electricity grid. The authors and supporters of this paper are committed to increasing data sharing across all aspects of grid design, planning, operations, and markets, with the goal of enabling the transformation of how energy is produced, transported and consumed.

With the increasing democratization of the energy industry, electrification of industries, and creation of new energy markets, the underlying electric grid is fundamentally evolving. Traditional grid planning and operations are being reimagined in ways that take advantage of the increasing deployments of renewables, distributed energy resources, and customer-centric technologies. These market-based solutions can reduce energy costs and minimize infrastructure spend, lowering rates for all utility customers. This new reality presents a unique opportunity to modernize our aging grid and support the decarbonization of our electricity supply. We can and should seize this opportunity to reform the grid while maximizing customer choice, increasing reliability, and maintaining public safety.

In order to realize the promise of a modernized grid, the underlying data associated with the grid must be made available to a wide group of industry stakeholders and market participants. Increasingly, the practice of grid design and planning is no longer the sole expertise of industry incumbents. Broader engagement promises innovation and new thinking. This paper puts forth the following set of guiding principles and detailed recommendations to advance the data access and transparency needed to increase innovation in grid design, planning, and customer engagement.

Benefits of Grid Data Transparency and Access

DRIVES INDUSTRY INNOVATION | Data democratization unlocks third party engagement, dramatically increasing the pace of innovation.

IMPROVES GRID DESIGN | Broad industry participation improves grid design, driving a more efficient, reliable, and cost effective grid.

INFORMS CUSTOMER CHOICE | Data access improves customers' ability to make informed decisions about their energy management.

REINFORCES ACCOUNTABILITY | Transparency increases accountability of all industry participants, improving outcomes for all customers.

Guiding Principles to Unlock Grid Data

SHARE BROADLY | Share data broadly as a standard practice, while recognizing appropriate access qualifications. The electric grid is a public good; its underlying data is also a public good that should be made available in the interest of driving innovation for all stakeholders.

SHARE PROACTIVELY | Proactively share underlying grid data sets to foster experimentation, even before specific use cases are defined.

DEFAULT TO MACHINE-READABLE FORMATS | Provide online access to bulk data sets in standard machine-readable data formats.

MAINTAIN PRIVACY | Adamantly protect customer privacy, giving customers control over the collection and use of their personal data.

ENSURE SAFETY AND SECURITY | Utilize best-in-class tools to protect critical data and assets, fostering continued security advancement.

Introduction

Today's electrical grid is undergoing an unprecedented evolution, driven by the need to decarbonize our energy supply and supported by increasing deployments of renewables and distributed energy resources (DERs), including distributed solar, energy storage, electric vehicles, controllable loads, and energy efficiency. Traditional grid planning and operational processes are likewise being reimagined to leverage this wave of innovative solutions being deployed on the grid. This new reality presents the unique opportunity to modernize our aging grid and support our electricity supply, while also improving customer choice, increasing reliability, and maintaining public safety, all at an affordable cost.

Unlocking the underlying grid data – making the data transparent and accessible to a wide group of industry stakeholders and market participants – is a necessary step to realize the promise of a modernized grid. The practice of grid design and planning is no longer the sole expertise of utilities, and with broader stakeholder engagement comes the potential for increased innovation and new solutions to meet grid needs. While the grid operator is still responsible for the planning and operation of the grid, broad qualified access to underlying grid data will facilitate improved grid design, planning, and customer engagement. Data transparency and access are fundamental enablers for achieving a modernized electric grid.

Data sharing to support a changing grid has been limited and segmented to date. The groundbreaking *Green Button* initiative enables customers to access and share their energy usage data, increasing customer engagement and choice. *Orange Button*, a U.S. Department of Energy SunShot initiative, streamlines data interchange within the solar sector of the energy industry. In California, the introduction of solar plus storage into the distributed grid has brought communication standards such as IEEE 2030.5 to facilitate utility-to-DER interactions. The development of these programs represent steps along the path to a much wider future of grid data transparency, but more is needed.

This paper looks beyond discussions about customer usage or technology-specific data to consider broader grid, utility, and DER provider data sets that will foster increased innovation if more widely accessible. While some initial progress has begun in making underlying grid data available for industry stakeholders and market participants,[1] significantly more access and transparency is necessary in order to facilitate the amount of innovation required to support the grid evolution underway today. In this paper, we identify the rationale for increased data sharing, briefly review the developing consensus on the need for additional data sharing, discuss dissemination tools, recommend specific data to be shared, and propose a standard machine-readable data sharing format.

Recommended Initial Step

To accelerate delivery of innovative customer and DER solutions to offset and/or defer grid investments, granular data on grid needs and planned investments is critical. Regulators should require grid operators and utilities to share their holistic grid needs data from their distribution planning processes through a machine readable, standard data format. In most cases, this data is readily available to utilities, but must also be made accessible to third parties.

The Need for Data Transparency

Data pertaining to the planning, operations, and maintenance of electric grids can be successfully leveraged by the broader industry only if it is made fully transparent. Simply publishing the outcomes of utility analysis, rather than the underlying data, is not sufficient to drive industry stakeholder engagement and innovation. There are a number of foundational reasons to actively promote data transparency of grid planning and operations:

- *Data transparency informs customer choice and economic development*
    - Customers and DER providers can investment in projects with full understanding of relevant grid needs
    - Customers have greater ability to control their energy futures and adjust their impact on the grid
- *Data transparency supports industry innovation*
    - Additional industry stakeholder engagement unlocks new and different perspectives on grid design and operations, dramatically increasing the pace of innovation
    - Third parties offer expertise to improve grid planning and operations, particularly in areas that are not

[1] "In order to support third party participation in determination of optimization [DER] locations, there should be the necessary policy

traditional utility strengths (e.g. data science, software development, distributed control)
  - DER providers can more intelligently tailor the capabilities of DER technologies to support grid needs
  - Data transparency allows for better allocation of risk to match the differing appetites of customers, technology providers, and utilities

- *Data transparency enables credible auditing of grid infrastructure investment plans*
  - Industry stakeholders can suggest alternative means to meet grid investment needs
  - Underlying data, beyond the publishing of finalized analyses (e.g. deferrable investments) shines a light on the grid investment methodology and decision-making
  - Data transparency is the foundation of ratepayer advocacy and should extend into grid planning

- *Data transparency improves accountability for the safe and reliable operation of the electric grid*
  - Industry stakeholder and consumers can clearly assess and engage in how ratepayer funds are utilized to ensure a safer grid and increased reliability

The Need for Data Access

Data transparency alone is not adequate for market animation. The data must be available *and* in a readily utilized set format. Online access to bulk, machine-readable, downloadable data is critical for third parties to perform analyses independently, using the underlying data to develop insights. Simply making data viewable but not downloadable is not sufficient to spur innovation.

Data access best practices are emerging as a result of regulator and utility leadership. For example, California utilities are currently developing online data portals to make hosting capacity and locational value data accessible to third parties, an example of which is shown below.[2] In addition to viewable information, these portals are expected to eventually provide the underlying data in downloadable format. This work sets the stage for fully functional data sharing platforms that offer comprehensive grid data transparency.

Example Grid Data Access Portal

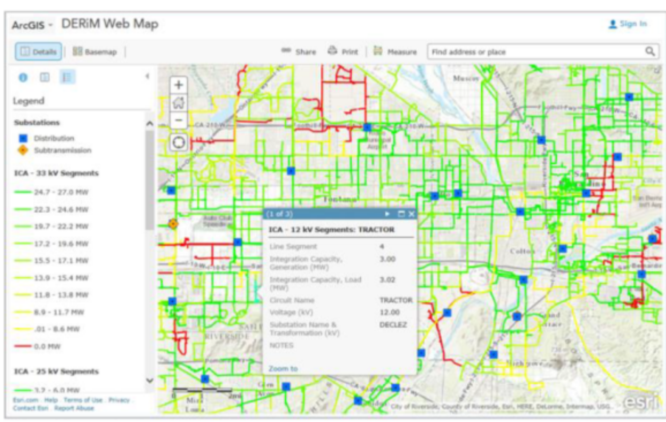


Image Source: Southern California Edison

[2] Southern California Edison Renewable Auction Mechanism (RAM) Map

Concerns regarding Data Access

While data access is often readily accepted as required to enable market innovation, lingering concerns regarding grid data access remain. Commonly raised concerns regarding grid data access are described below, along with potential approaches to addressing the issues raised:

- *Grid security could be threatened*
  Maintaining grid security, both physical and cyber, is of upmost importance. A common concern voiced in regards to enabling grid data access is that such sharing would put grid security at risk. For example, the location of many grid assets, such as circuit models and equipment, is commonly cited as a data risk that could enable physical attacks on the grid. And yet, this equipment information is already widely available through common online mapping engines. Not all grid data is of equal importance in assuring a secure electric grid. Sharing the data types outlined in this paper does not pose any additional security risk than the status quo. The security concern of sharing this same data, while highly relevant, is inflated.

- *Customer privacy could be violated*
  Customer privacy is of significant importance, and must be maintained. The data types outlined in this paper, therefore, do not include any customer-specific data. This paper instead identifies non-customer or aggregated grid data, which are adequate for all industry stakeholders to perform the type of grid planning and operations analyses envisioned. The need to protect customer data is not forfeited by data transparency and access.[3]

- *Sharing data could be cost-prohibitive*
  It is true that the breadth and amount of data outlined in this paper goes beyond what utilities have shared to date. As such, there are some concerns that the burden and cost of sharing this data is prohibitive. However, all of the data outlined is *already* readily available and used internally by utilities – it is simply not shared beyond the utility. While there will be some costs in making this data accessible to outside parties, this moderate cost is worth the increased innovation that this data will drive in the market.

- *Irresponsible data access could be a cyber security risk*
  Some parties have called for any stakeholder accessing grid data to sign confidentiality agreements and have cyber security protocols in place that equal utility standards. Responsible grid data access is indeed critical, and data access standards should be utilized. However, such standards should not be so strict as to reduce potential innovation by reducing stakeholders' abilities to share insight gained from analyzing grid data, nor so burdensome that they would prevent smaller stakeholders' access to such data. The grid security concerns can be remedied through collaborative conversations and by implementing agreeable protective measures. For useful data sharing standards, examples from the wholesale energy markets can inform protocols and agreements which should be in place in order to access qualified grid data.

- *Proprietary information could be shared*
  The electric grid is a public good; its underlying data is also a public good that should be made available unless a compelling reason exists otherwise. While it is true that, in some jurisdictions, system operating cost data or other data held by the grid operator has only been partially released to approved intervenors, there is no particular reason that this data should be considered "proprietary" or that its release would be harmful to the grid operators' efforts. In contrast, jurisdictions which have more open data transparency systems and deregulated markets publish system cost data publically with limited if any negative impact to customers or other stakeholders.

The Imperative for Data Sharing

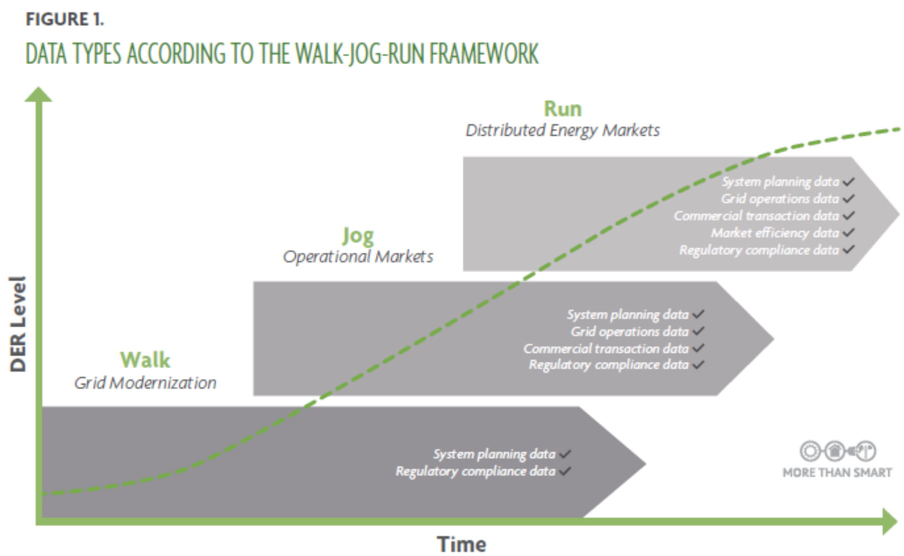
This paper offers a contribution to the current dialogue underway in the energy industry today on the need for significantly increased data sharing. Many voices within the industry – including utilities, third-party providers, customer advocates, state and federal regulators, and technical coalitions – are stressing that a modernized grid planning and operations process must feature significantly increased data sharing across all parties. With the accelerating deployment of innovative customer and

[3] This paper recognizes the concern that large or isolated customers on the grid may be identifiable when certain data sets are shared. This is a special circumstance that should trigger additional measures to ensure customer privacy is maintained.

DER solutions, an imperative exists to also accelerate the availability of granular grid data to ensure that deployed assets are able to best meet grid, customer, and societal needs.

In particular, this paper explores in detail the data categories necessary to modernize grid planning. While developed separately, we see our paper as dovetailing well with the recently released More than Smart paper entitled "Data and the Electricity Grid".[4] More than Smart's Walk-Jog-Run framework, depicted in the figure below, articulates how the sharing of different data categories becomes necessary as grid modernization advances to embrace increasingly higher levels of DERs.

Data Sharing Framework from More Than Smart[5]



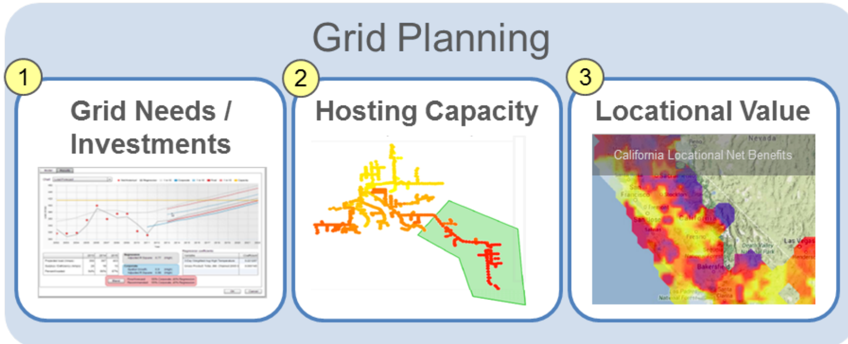
Within our paper, we expand upon the "System Planning" data category, which More Than Smart also features as its most urgent data category to address in its 'Walk' phase. We dive deeper into the actual System Planning data that should be made transparent and accessible, with the aim of providing a practical blueprint for regulators, utilities, and industry stakeholders to consider when designing their own data transparency and access approaches.

Unlocking the Grid Planning and Investment Data

The data that needs to be shared between grid operators and industry stakeholders spans grid planning, operations and market functions, as identified by the More than Smart framework. This paper, however, dives into detail on the specific grid planning data that should be transparent and accessible. This paper breaks down needed grid planning data into three categories: 1) Grid Needs and Planned Investments, 2) Hosting Capacity, and 3) Locational Value. Specifics on the exact data that need to be shared are included, with additional details provided in the Appendix. As the grid continues to evolve into operational markets where large-scale renewables and distributed energy resources play a critical role, additional data categories will likely be required.

[4] http://morethansmart.org/resources/

[5] Printed with permission from More than Smart



1. Grid Needs and Planned Investments

The critical first step in grid planning is identifying the underlying grid investment needs. Data transparency efforts, therefore, should focus first on communicating the exhaustive list of grid needs that grid operators and utilities already identify as part of their planning process, along with any accompanying planned investment to meet that need. While high-level summaries of grid needs are often included within utility general rate cases, the data contained in these filings is not sufficiently complete for other stakeholders to effectively participate in solution identification. A standard set of comprehensive data on each grid need and planned investment should be shared so that stakeholders can proactively develop and propose solutions to meet those needs. This data sharing will broaden the set of innovative solutions available to utilities, and guards against an insular approach to deploying grid investments. The table below presents an initial set of the minimum amount of data required to foster true stakeholder engagement in regards to specific, utility-identified grid needs and planned investment. See the Appendix for more details.

Data Required to Foster Engagement in Grid Needs and Planned Investments

DATA NEED	DESCRIPTION
Grid Need Type	The type of grid need (e.g. capacity, reactive power, voltage, reliability, resiliency, etc.)
Location	The geographic (e.g. GPS, address) and the system location (e.g. planning area, substation, feeder) of the grid need
Scale of Deficiency	The scale of the grid need (e.g. MW, kVAR, CAIDI/SAIDI deficiency)
Planned Investment	The traditional investment to be deployed in the absence of an alternative solution (e.g. 40 MVA transformer, 12 kV reconductor, line recloser, line regulator), and the dollar investment required
Reserve Margin	Additional capacity embedded within the planned investment to provide buffer contingency scenarios (e.g. 20% margin above expected deficiency embedded within equipment ratings to ensure available capacity during contingency scenarios)
Historical Data	Time series data used to inform identification of grid need (e.g. loading data, voltage profile, loading versus equipment rating)
Forecast Data	Time series data used to inform identification of grid need and specification of planned investment (e.g. loading, voltage, and reliability data). Forecast to include prompt year deficiency (i.e. near-term deficiency driver) as well as long-term forecast (i.e. long-term deficiency driver)
Expected Forecast Error	Historical data that includes forecasts relative to actual demands for relevant grid need type in similar projects. Data to be used to evaluate uncertainty of needs and corresponding value of resources with greater optionality (e.g. lead times, sizing)

The immediate use cases that would be enabled by increasing the transparency of grid needs and planned investments data include:

- Allowing third parties to more effectively engage in utility General Rate Cases
- Opening up the potential for additional grid services solicitations by allowing all stakeholders to consider the potential grid investments and develop alternative solutions

2. Hosting Capacity

A subset of the overall grid needs is related to enabling consumers to install DERs as desired in order to manage their own energy profiles. To quantify this need, grid planners first calculate the capacity of the grid to accommodate additional technologies, whether DERs or large-scale renewables, in various combinations. This capacity is called the *hosting capacity* or *integrated capacity*. Grid planners then compare the available hosting capacity with forecasts of DER and large-scale renewables growth in order to identify whether the available hosting capacity is sufficient to accommodate all consumers' desire to install energy technologies.

As DER penetrations and large-scale renewables continue to increase, hosting capacities will play a fundamental role in whether these systems can readily interconnect to the grid and provide value to grid operators. Due to the critical nature of this hosting capacity information for every energy technology provider and customer, the underlying data used to calculate hosting capacities should be easily accessible to all parties. Simply publishing hosting capacity values themselves is inadequate, as it limits the ability of third parties to interpret and apply the results, as well as reducing the potential for innovation. The table below identifies and introduces the key data that are needed to quantify hosting capacity. See the Appendix for detailed description of the data required to calculate circuit-level hosting capacities.

List of Necessary Data to Evaluate Hosting Capacities

CATEGORY	TYPE	DESCRIPTION
Circuit Model	Circuit Models	The digital representation of the key attributes of a utility distribution circuit, which is necessary to perform power flow and hosting capacity analyses.
Loading	Loading	Time series data for the loading of distribution circuits, which is necessary to evaluate the behavior of a circuit over the course of a year. Data provided at circuit level and node level.
	Customer Types	Customer demographics, such as residential vs. commercial vs. industrial, are important to understand the loading characteristics of an individual circuit.
	Existing DER Capacity	In addition to load, existing installed DERs are important to model on any individual circuit. DER type and capacity is necessary.
Equipment Ratings and Settings	Thermal Ratings	Equipment ratings for assets such as transformers and conductors indicate the amount of power that can safely be transported on any individual circuit.
	Voltage Equipment	Ratings of voltage regulating equipment by location inform the ability of the circuit to manage voltage fluctuations, an important consideration in hosting capacity analyses.
	Protection Equipment	Ratings and settings of protection equipment inform the typical operational characteristics of an individual circuit, and are important when considering events like faults, over-current and over-voltage.

The immediate use cases that would be enabled by increasing the transparency of hosting capacity data include:

- Providing proactive feedback to developers seeking to interconnect onto the grid
- Adding transparency and accountability for the interconnection costs cited by the grid operator

3. Locational Value

DERs' and renewables' locational value reflects the costs and benefits accrued to society of locating these energy assets in a specific location. Articulation of locational value components already exists in the energy industry in other venues: for example, in most wholesale markets, locational marginal prices (LMPs) reflecting the cost of wholesale energy are specified by geography or *node*. While LMPs convey only wholesale value components, all other benefits and costs can also be articulated by location.

A standard method used within the energy industry to quantify the costs and benefits of deploying assets is the *net benefit* approach, which considers the net benefits or cost of a particular investment by quantifying the reduction in costs (or avoided costs) that would otherwise be incurred in a business-as-usual trajectory. Net benefit calculations underpin many cost/benefit analyses conducted to evaluate energy policy considerations, and the impacts of these analyses have far-ranging implications on utilities, third parties, and customers. Therefore, transparency in the underlying data feeding these analyses is critical to fostering robust discussions on policy and grid design. A non-exhaustive list of benefit and cost categories associated with quantifying the locational value of renewables and DERs is provided in the table below.

Net benefit analyses using avoided costs that are performed at local levels, rather than at the system level, are called *locational net benefit analyses*. These analyses are increasingly used to quantify the net benefit of DERs and renewables on the grid; however, the underlying data to perform these calculations are rarely made available. Given the importance of these analyses on policy and operational decisions, it is imperative that the underlying data is available to industry stakeholders.

Non-Exhaustive List of Benefit and Cost Categories for Renewables and DERs

AVOIDED COST	DESCRIPTION
Energy + Losses	The value of wholesale energy that would otherwise be generated in the absence of DERs or renewables, adjusted for losses that would occur
Generation Capacity	The value of avoiding the need for system generation capacity resources to meet peak load and planning reserve requirements
Transmission Capacity	The value of avoiding the need to expand transmission capacity to meet peak loads
Distribution Capacity	The value of avoiding the need to expand distribution capacity to meet peak loads
Ancillary Services	The value of reduced need for ancillary services based on its provision through DERs or renewables
Renewable Energy Compliance	The value of reducing procurement requirements for renewable energy credits (where applicable), due to retail energy on which RPS compliance levels are based
Societal Benefits	The value of benefits that accrue to society, and are not costs directly avoided by the utility
Voltage and Power Quality	The value of avoiding or reducing the cost required to maintain voltage and frequency within acceptable ranges for customer service
Conservation Voltage Reduction	The value of enabling conservation voltage reduction benefits by providing localized voltage support
Equipment Life Extension	The value of extending the useful life and improving the efficiency of grid infrastructure by reducing load and thermal stress equipment
Reliability and Resiliency	The value of avoiding or reducing the impact outages have on customers
Market Price Suppression	The value of reducing the electric demand in the market, hence reducing market clearing prices for all consumers of electricity

The immediate use cases that would be enabled by increasing the transparency of locational value include:

- Informing the development of tariffs and rates
- Adding transparency, accountability, and documentation on the underlying assumptions in “avoided cost” or costs of service studies used by grid operators

Data Standardization, Delivery, and Machine-Readable Formats

While providing any information on the grid is useful, in order to truly spur third party engagement, grid operators and utilities must make grid data easily accessible to industry stakeholders via a digital, machine-readable format in an appropriately secure manner. Information that *is* made available on grid needs and planned investments today is rarely provided in an accessible format. Often, information is provided in the form of photocopied images of spreadsheet tables within utility General Rate Case (GRC) filings, a format that does not readily enable streamlined analysis. This provision of information requires stakeholders to manually recreate entire data sets into electronic version in order to carry out any meaningful analysis, a time-intensive and needless exercise. Many would-be stakeholders never attempt to engage due to the barrier to data access.

The use of standard, machine-readable data formats is prevalent in many industries and within the utility industry itself; organizations like the Energy Information Agency (EIA), and National Renewable Energy Laboratory (NREL) foster such broad access to electronic, standardized data sets, and wholesale markets run on standardized data sets and data access protocols. Grid needs and planned investments should follow suit.

To illustrate a potential path forward, below on the left is an example of traditional grid capacity needs and corresponding capacity investments as communicated via Pacific Gas & Electric Company's 2017 General Rate Case Phase 1 filing,[6] which was made available in PDF format. To the right is an image of an illustrative digital text file that shows how those same grid needs and planned investments could be translated into a digital, machine-readable format.

General Rate Case Worksheet PDF *Standard Grid Needs Data Format Text File (e.g. JSON)*

In addition to ensuring the data is presented in a way that allows for meaningful analysis, it is important that the data is released through an appropriately secure and accessible manner. The data-interchange format should satisfy the following key principles:

- Easy set up: it should be relatively easy for the data host (for example, utility personnel) to set up a data transfer transaction and accounts (when secured access is necessary) for the requesting parties.
- Secured connection: the data interchange should be secured as appropriate to ensure data access will only be granted to authorized parties.
- Easy access: it should be simple for the requesting parties to go through the authorization process, if appropriate, and access the data provided.
- Flexible access: any significant stream of data should be able to be queried via an API (Application Program Interface) in order to provide flexible data access.

A candidate data-interchange format is JSON, which could satisfy all of the above principles in a secured fashion if implemented appropriately.

Conclusion

Data transparency and access is the foundational enabler required to foster innovation in electric grid design and operation. Without data sharing, key stakeholders are sidelined from proactively proposing solutions that could increase the reliability, safety, affordability, and consumer choice of the 21st century grid.

[6] https://www.pge.com/en_US/about-pge/company-information/regulation/general-rate-case/materials.page

Key Takeaways

- Granular grid planning data is critical to modernizing the electric grid and leveraging emerging energy technologies such as renewables and distributed energy resources.

- Regulators should consider requiring utilities to share their holistic grid data developed from their integrated planning processes through a machine-readable standard data format in an easily accessible manner.

Appendix

Details on Grid Needs / Planned Investments

CATEGORY	DATA TYPE	DATA REQUEST	INTENDED USE	CURRENTLY AVAILABLE TO UTILITIES	CURRENT PUBLIC AVAILABILITY
Project Identification	Project name	Individual identifying name or serial number for each planned investment project	Ensure each individual project planned by utility is accounted for and readily identifiable for third party consideration of alternative investments	IOUs maintain project names and tracking systems for planned investment projects as part of their periodic distribution investment planning process. This data is readily available.	Data for major projects are individually discussed within each utility GRC; numerous smaller projects are often summarized under one listing or heading
	Location/ geography	GPS coordinates, city, zip code, and electrical configuration (node location by: substation, feeder, node, line section, downstream Line Recloser (SCADA switch)	Allow for geographical mapping of each project	IOUs maintain planned projects by location as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but data is presented at district level. Data is not made available by node location (i.e. circuit/substation)
Project Requirements	Deployment timelines	Planned start of project deployment (e.g. start of installment of equipment), planned start of project operation, and required start of project to meet identified grid need	Assess whether DERs or renewables can be deployed to offset investments	IOUs maintain planned projects installation and operation schedules as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but detailed timelines are not made available for the majority of planned projects
	Planned asset life	Expected operating life of planned investment	Assess whether DERs or renewables can be deployed to offset investments	IOUs determine planned asset life as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but detailed assessments of planned asset life are not made available for all planned projects
	Primary grid need served	Grid need or needs that have been identified as the underlying requirement for the planned project: capacity, power quality (VARs, voltage regulation), frequency regulation, reliability, resiliency, other (specified)	Assess whether DERs or renewables can be deployed to offset investments	IOUs determine grid needs as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but detailed assessments of primary grid need are not made available for all planned projects
	Secondary grid need served	Grid need or needs that are not required or motivating the planned project, but which are valuable secondary impacts or benefits the planned project could provide: capacity, power quality (VARs, voltage regulation), frequency regulation, reliability, resiliency, other (specified)	Assess whether DERs or renewables can be deployed to offset investments	IOUs determine grid needs as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but detailed assessments of secondary grid need are not made available for the majority of planned projects
Performance Requirements	Performance requirements	Planned required operation of the project including: operation window (e.g. 24/7, HE 7 – HE 20, summer afternoon hours, etc.), operation duration (e.g. 24 hours, 2 hours, 5 minutes, etc.), required response time following trigger (e.g. 24 hours, 2 hours, 4 seconds, etc.),	Assess whether DERs or renewables can be deployed to offset investments	IOUs determine grid needs as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but detailed assessments of performance requirements are not made available for the majority of planned projects
Estimate Investment	Projected cost of planned investment	The dollar investments required for deployment of the planned investment and their timing	Assess potential cost-effectiveness of DERs or renewables alternatives to planned investments	IOUs estimate the costs to address grid needs as part of their periodic distribution investment planning and GRC processes. This data is readily available.	Data for major projects are individually discussed within each utility GRC; numerous smaller projects are often summarized under one listing or heading

Details on Hosting Capacity Data

CATEGORY	DATA TYPE	DATA REQUEST	INTENDED USE	CURRENTLY AVAILABLE TO UTILITIES	CURRENT PUBLIC AVAILABILITY
Circuit Model	Circuit Models	GIS or distribution analysis software model; line equipment; length of lines; latitude and longitude coordinates; updated models made available as projects are implemented; existing models made available ongoing	Model individual circuits	Electronic circuit models are readily available within IOU's GIS systems in standardized format.	Circuit locations are provided in IOU RAM maps, but RAM maps do not include the required details to perform power flow modeling. Furthermore, not all circuit data is downloadable (only viewable online).
Loading	Feeder-Level Loading	MW load; VARs; Amps; Volts; 15 minute granularity; node location by: substation, feeder; updated data made available monthly; historical data made available ongoing	Perform steady state integrated hosting capacity analysis	Electronic feeder-level loading is readily available within IOU's data historian databases.	Substation and circuit peak loads are communicated in RAM maps, but granular data such as feeder load curves are not made available.
	Customer Type Breakdown	Number of customers by rate type; customer type: i.e. residential, commercial, industrial; agricultural; household income levels; number of demand response (DR) customers; DR device types; DR event participation statistics; node location by: substation, feeder, node, line section, downstream Line Recloser (SCADA switch); updated data made available monthly; historical data made available ongoing	Estimate load curve based on typical customer loading	Electronic customer demographic data is readily available. Utilities would need to aggregate this data by circuit node in order to make anonymous data available.	Data is not made available in any manner.
	Circuit Node Loading	MW load; VARs; Amps; Volts; 15 minute granularity; node location by: node, line section, downstream Line Recloser (SCADA switch); updated data made available monthly; historical data made available ongoing	Allocate loading along circuit	Data may be available based on utility SCADA equipment. Data quality is lower than feeder-level data. Can be approximated based on customer breakdowns by circuit node.	Data is not made available in any manner.
	Existing DER Capacity	DER capacity MW; node location by: substation, feeder, node, line section, downstream Line Recloser (SCADA switch); updated data made available monthly; historical data made available ongoing	Incorporate existing DER capacity into hosting analysis	This data is readily available within utility interconnection databases.	Circuit-level existing and queued distributed generation is communicated via RAM maps, but more granular locations of systems by circuit nodes are not made available.
Equipment Ratings and Settings	Equipment Thermal Ratings	Thermal equipment ratings for conductor and line equipment by location (switches, breakers, transformers, voltage regulating equipment, voltage protection equipment, etc.); updated lists made available as changes are implemented.	Evaluate thermal loading limits	Data is readily available in IOU GIS databases.	Substation bank and circuit thermal limits are communicated via RAM maps, but distribution equipment ratings are not available.
	Voltage Regulating Equipment	Ratings of voltage regulating equipment by location; Voltage equipment settings (unique or typical settings) including bidirectional capability; updated lists made available as changes are implemented; existing equipment lists and settings made available ongoing	Evaluate voltage equipment performance	Data is readily available in IOU GIS databases; however, data quality is lower than thermal ratings.	Nominal circuit voltage is available, but equipment settings are not made available in any manner.
	Protection Equipment	Ratings of protection equipment by location; Protection equipment settings (unique or typical settings); updated lists made available as changes are implemented; existing equipment lists and settings made available ongoing	Evaluate protection criteria	Data is readily available in IOU GIS databases; however, data may be of lower quality than thermal ratings.	Data is not made available in any manner.

Details on Locational Value Data

CATEGORY	DATA TYPE	DATA REQUEST	INTENDED USE	CURRENTLY AVAILABLE TO UTILITIES	CURRENT PUBLIC AVAILABILITY
Capacity	Planned capacity projects	Project details planned w/in 10 years; MW capacity; node location; updated data made available at time of planning; historical data made available ongoing	Assess where DERs or renewables can be deployed to offset investment	IOUs maintain planned capacity projects by location as part of their periodic distribution investment planning process. This data is readily available.	Data is periodically delivered to PUC to support avoided cost analysis and GRCs, but data is presented at district level. Data is not made available by node location (i.e. circuit/substation)
	DER and load growth forecasts vs. integrated capacity	DER growth forecast MW; load growth forecast MW; integrated DER MW capacity; node location; updated data made available monthly; historical data made available ongoing	Assess when DERs, renewables, and load growth will surpass integrated capacity; compare timing against planned projects	Load growth data is readily available but DER growth and hosting capacity analyses are largely new analyses. As these analyses are completed, this data will be readily available.	System-level growth forecasts are available, yet substation/ circuit-level growth data is not. Hosting capacities are listed by some utilities, but they are often static and not comparable to DER growth.
Voltage / Power Quality	Planned voltage / power quality projects	Project details planned w/in 10 years; voltage and power quality results expected; node location; updated data made available at time of planning; historical data made available ongoing	Assess where DERs and renewables can be deployed to offset investments	IOUs maintain planned voltage and power quality project as part of their periodic distribution investment planning process. This data is readily available.	The largest projects are often shared within IOU GRCs, but projects by node location (i.e. substation/circuit) are not made available.
	Observed violations statistics	SCADA voltage violation data: i.e. overvoltage, undervoltage, voltage flicker, voltage imbalance, etc.; violation time stamp; violation remedy; node location; updated data made available monthly; historical data made available ongoing	Assess whether investment plan matches needs, and identify areas to target DERs or renewables	IOUs have access to power quality violation data which are monitored by power quality engineering groups within distribution operations.	System-level power quality statistics are made available but statistics by node location (i.e. substation/circuit) are not made available.
	Customer complaints	Complaint type; complaint time stamp; violation verification; violation type; remedy; node location; updated data made available monthly; historical data made available ongoing	Assess whether investment plan matches needs, and identify areas to target DERs or renewables	IOUs have access to power quality violation data which are monitored by power quality engineering groups within distribution operations	System-level power quality statistics are made available but statistics by node location are not made available.
Reliability / Resiliency / Security	Planned reliability / resiliency / security projects	Project details; node location; updated data made available at time of planning; historical data made available ongoing	Assess where DERs or renewables can be deployed to offset investments	IOUs maintain reliability and resiliency projects as part of their periodic distribution investment planning process. This data is readily available	The largest projects are shared within IOU GRCs but projects by node location are not made available.
	Reliability Statistics <u>*excluding*</u> and <u>*including*</u> major events	Reliability statistics: CAIDI, SAIDI, SAIFI, CESO, DEMI; worst performing circuits; major event days; automated restoration operation; updated monthly; historical data made available ongoing	Assess whether investment plan matches needs, and identify areas to target DERs or renewables	Utilities maintain and track this data within electronic Outage Management Systems (OMS).	Data is shared via periodic PUC reports at system- and regional/district levels, but data is not made available by node location.
	Existing supply redundancy level	Redundancy MW capacity; # of supply feeds (use as proxy for resiliency); node location; updated data made available yearly; historical data made available ongoing	Assess whether investment plan matches needs, and identify areas to target DERs or renewables	The data to calculate this metric is available, but this metric is not currently calculated or examined internally. Data can readily be shared.	Data is not made available in any manner.
	Probability of major event	Probability of major event by geographic area; node location; updated data made available yearly; historical data made available ongoing	Assess whether investment plan matches needs, and identify areas to target DERs or renewables	Utilities Emergency Management and Risk organizations are quantifying the risk of catastrophic events.	Data is not made available in any manner.

About TechNet

TechNet is the national, bipartisan network of technology CEOs and senior executives that promotes the growth of the innovation economy by advocating a targeted policy agenda at the federal and 50-state level. TechNet's diverse membership includes dynamic startups to the most iconic companies on the planet and represents more than two million employees in the fields of information technology, e-commerce, advanced energy, biotechnology, venture capital, and finance. TechNet has offices in Washington, D.C., Silicon Valley, San Francisco, Sacramento, Austin, Boston, Seattle, Albany, and Tallahassee.

About SunSpec Alliance

The SunSpec Alliance is a coalition of developers, manufacturers, and service providers, together pursuing information standards for the distributed energy industry. SunSpec standards address most operational and financial aspects of PV and other distributed energy systems on the smart grid—including residential, commercial, and utility-scale—thus reducing cost, promoting innovation, and accelerating industry growth. More than 100 organizations are members or business partners of the SunSpec Alliance, including global leaders from Asia, Europe, and North America. Membership is open to corporations, non-profits, and individuals. For more information about the SunSpec Alliance, or to download SunSpec specifications free of charge, please visit www.sunspec.org.

About DBL Partners

DBL Partners was formed in 2015 from the combination of DBL Investors and the Cleantech practice of Technology Partners. Our Double Bottom Line investment strategy is to invest in companies that can deliver top-tier venture capital returns (First Bottom Line), while working with our companies to enable social, environmental and economic improvement in the regions in which they operate (Second Bottom Line).

DBL Partners uses venture capital to accelerate innovation in a way that positively affects an organization's social impact, as well as its financial success. We strongly believe these two drivers –positive social change and a healthy financial performance– are inherently connected. DBL invests in and helps nurture outstanding entrepreneurs and companies in Cleantech, Information Technology, Sustainable Products and Services, and Healthcare.