

AEIC Center for Operational Excellence: Workshop #2: Topic 1 – Load Forecasting and Interconnection

Workstream: Integrated Distribution System Planning (IDSP)



Association of Edison Illuminating Companies
607 14th Street NW, Suite 560
Washington, DC 20005
www.aeic.org

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Critical Action Forum Workshop #2: IDSP

AEIC Center for Operational Excellence Overview

The mission of AEIC's Center for Operational Excellence is to provide the electricity industry with authoritative information as a basis for decision-making on local, state, and federal infrastructure investments. The Center facilitates industry workshops that address critical issues impacting power generation, power delivery, metering, engineering, and more recently, the transformation required to enable new energy resources and the impacts of electrification. By creating environments that foster powerful lessons learned, AEIC ensures that all industry stakeholders have access to trusted, actionable information. This workshop exemplifies AEIC's unique ability to bring together diverse voices to share knowledge and drive progress in the electricity sector.

Workshop Details

Workshop Name: AEIC's IDSP Critical Issues Forum Workshop #2: Topic 1 – Interconnection and Load Forecasting, via Workstream: Integrated Distribution System Planning

Date: June 4-5, 2024

Overview: AEIC organized this workshop to share and gain insights on best practices for Integrated Distribution System Planning (IDSP), focusing on interconnection and load forecasting. Multiple utilities participated in the workshop to discuss planning outcomes, data exchange, and decision-making processes.

Purpose

This workshop aimed to facilitate a robust dialogue on operational excellence, share insights from leading organizations, and identify current practices and gaps in utility planning. AEIC pulled together a workshop summary to provide valuable insights and actionable takeaways for its members.

Attendees at a Glance

- Represented Member Utilities: Alabama Power Co., Ameren Illinois, Commonwealth Edison Co., Duke Energy, Duquesne Light Company, Electric Power Research Institute, Eversource, Georgia Power Co., LG&E & KU Energy LLC, Minnesota Power, National Grid, North Carolina Electric Member Corporation, Oklahoma Gas & Electric Co., Omaha Public Power District, Oncor, Salt River Project, Southern California Edison Co., Southern Company, Southern Company Services, Tampa Electric Company
- Other Attendees: National Rural Electric Cooperatives Association (NRECA), National Renewable Energy Laboratory, United States Department of Energy
- Total Attendees: 34

Attendee List

- **AEIC:** Steve Hauser, Elizabeth Cook
- **Alabama Power:** Justin Harrison
- **Ameren Illinois:** Eddie Creighton
- **ComEd:** Marina Mondello
- **Duke Energy:** Jay Oliver
- **Duquesne Light Company:** Sam Levinson, Wesley Terek
- **EPRI:** Nadav Enbar
- **Eversource Energy:** Juan Martinez
- **Georgia Power Company:** Pooja Shah, Josh Stallings
- **LG&E and KU Energy:** Karmen Powell
- **Minnesota Power:** Eric Clement, Katie Frye
- **National Grid:** Elton Prifti
- **NRECA:** Venkat Banunarayanan
- **NCEMC:** Chris Walton
- **NREL:** Jeremy Keen, Lawryn Kiboma, David Narang
- **Oklahoma Gas and Electric:** Brian Huckabay
- **Omaha Public Power District:** Mark Gibilisco
- **Oncor Electric Delivery:** Kyle Malone
- **Salt River Project:** Jed Cohen, Melissa Martinez
- **Southern California Edison:** Devin Rauss
- **Southern Company:** Carley Goff, Jim Heilbron, Elaine Kwarcinski, Carey Holland, Melodie Welch
- **Tampa Electric:** Vianeybert Toussaint
- **US Department of Energy:** Joe Paladino

Key Discussions

Voices and Opinions

During the workshop, several important points and perspectives were shared by the attendees:

- **IDSP Workshop Context:** Discussions focused on interconnection and load forecasting, planning outcomes, data exchange, and decision-making processes.
- **Pre-Workshop Survey Results:** The survey identified existing planning practices, gaps, and opportunities in achieving an ideal IDSP, as well as key interactions and workflows within and between utilities and external organizations.
- **Industry Presentations:** Presentations covered leveraging grid edge resources, incorporating DER flexibility into interconnection review processes, DER interconnection process and load forecasting, long-range electric demand assessment, transitioning from static to dynamic planning, and distribution planning capabilities.

Additional Information

The workshop also covered topics that may interest the broader AEIC community, such as the importance of data exchange and decision-making processes in utility planning and the need for standardized practices across different utilities.

Conclusion and Key Takeaways

Summary of Findings:

The workshop concluded with several key takeaways and recommendations:

- **Integration and Load Forecasting:** Emphasis on the importance of accurate load forecasting and effective integration of distributed energy resources (DERs) to enhance grid reliability and efficiency.
- **Data Exchange and Decision-Making:** Highlighting the need for standardized data exchange protocols and collaborative decision-making processes to improve planning outcomes.
- **Gaps in Utility Planning:** Identification of gaps in current utility planning practices and the need for continuous improvement and adaptation to emerging technologies and regulatory requirements.
- **Collaborative Efforts:** Encouragement of collaborative efforts among utilities, national labs, and regulatory bodies to share best practices and drive innovation in IDSP.

For members who attended and others on a similar journey, these insights are invaluable for further investigation and addressing the challenges and gaps identified during the workshop.

List of Presentations and Presenters

Day 1: Tuesday, June 4, 2024

1. **Department of Energy:** IDSP Considerations and Challenges
(Presented By: Joe Paladino, Department of Energy)
2. **Duke Energy:** Leveraging Grid Edge Resources at Scale for Both Local and Bulk Power Capacity
(Presented By: Jay Oliver, Duke Energy)
3. **EPRI:** Incorporating DER Flexibility into the Utility Interconnection Review Process
(Presented By: Nadav Enbar, EPRI)
4. **ComEd (Exelon):** DER Interconnection Process and Load Forecasting Methods
(Presented By: Marina Mondello, ComEd)
5. **NRECA:** Integrated Distributed Resource Planning for Electric Cooperatives
(Presented By: Venkat Banunarayanan, NRECA)

Day 2: Wednesday, June 5, 2024

6. **SCE:** From Static to Dynamic, a CA Case Study
(Presented By: Devin Rauss, Southern California Edison)
7. **Southern Company (Georgia Power):** Distribution Hosting Capacity Capabilities (with a focus on load forecast input)
(Presented By: Josh Stallings, Georgia Power)
8. **Eversource / National Grid:** Long-Range Electric Demand Assessment of Statewide Decarbonization Goals
(Presented By: Juan Martinez, Eversource)
9. **Duquesne Light Co. (DLC):** Multi-objective Decision-Making, Scenario Forecasting/Probabilistic Forecasting
(Presented By: Sam Levinson, Duquesne Light Company (DLC))

Load Forecasting and Interconnections

AEIC's Center for Operational Excellence

Executive Summary

1. Interconnections: Develop and maintain accurate hosting capacity maps to aid in planning and reduce backlogs. Streamline and automate interconnection evaluations to expedite the decision-making process and increase transparency. Implement flexible interconnection agreements with dynamic hosting capacity when possible.
2. Load Forecasting: Refresh load profiles, ensuring detailed and diverse modeling based on socio-economic factors of customer classes for 8760-hour studies. Integrate AMI-level data to ensure the accuracy of load models and update demand predictions. Harmonize forecasting approaches between top-down and bottom-up load modeling.
3. Data Integration: Create opportunities to consolidate disparate data sources into a unified interface or “single pane of glass” for system planners to enhance decision-making. Foster alignment between organization departments with integrated workflows and centralized modeling sources.
4. Stakeholder Coordination: Ensure a formal approach for communicating with PUCs and ratepayers, aligning on common goals and the importance of active participation in demand-response programs.
5. Comprehensive Planning Framework: Enterprise-level solutions incorporating resilience, reliability, safety, affordability, and equity into the distribution system planning process.

Background

The Integrated Distribution System Planning (IDSP) workshop aimed to facilitate insights into best practices around IDSP, focusing on interconnections and load forecasting. Additionally, participants aimed to discuss planning outcomes, data exchange, and decision-making processes to understand the current state of practice and identify gaps in utility planning. This summary report will highlight key points from knowledge sharing, conclusions from the pre-workshop survey, and actionable takeaways.

The following summary report will present:

- Challenges and actionable takeaways for interconnection, load forecasting, and IDSP

- Appendix of quick links for useful references related to IDSP, in general
- Appendix with a detailed description of the pre-workshop survey results and workshop discussion

Interconnections

Challenges

During the workshop discussion and in the pre-workshop survey, attendees voiced several challenges with interconnection. Coordinating between utilities, distributed energy resource (DER) owners, regulatory bodies, third parties, and aggregators creates complexity for making interconnections, as does the need for significant infrastructure upgrades to handle bi-directional power flows. Accurate hosting capacity maps, whether publicly available or for internal use, are useful for planning. However, they often need more detailed, granular data. While public versions can enhance transparency and stakeholder engagement, utilities may prefer to use detailed load flow data or peak load information for their internal planning processes. They often provide information at the feeder level but may include less specific data at the sub-feeder or individual segment level. In certain areas of high DER deployment activity, the interconnection queue can become backlogged, creating delays. In contrast, the cost burden of processing interconnections can penalize both the utility and the applicant.

On average, utility attendees were reluctant to pursue third-party solutions, disclose grid needs, and make hosting capacity maps publicly available. Attendees voiced wariness about how these capabilities could create vulnerabilities to malicious attacks and prioritized other capabilities more highly, such as situational awareness and improved forecasting. While NWAs were deemed necessary, utility attendees also expressed concerns about their economic viability. More guidelines addressing utility concerns on these topics and educational content are needed.

The following table (Table 1) presents potential systems, data, and tools that may help address these challenges.

Table 1 Enabling Technology for Improving Interconnections

Systems, Data, Tools	Description
DER Operating Profile Matrix	Formal and standard collection of operating characteristics and requirements to evaluate a DER interconnection. It may include capacity, import/export limits, response time, controllability, target state of charge (SOC), and use case priority.

Systems, Data, Tools	Description
Hosting Capacity Analysis	Create GIS-based tools with a visual capacity of DER on each feeder, considering multiple types of DERs, including Electric Vehicles (EV), Solar, Wind, and Energy Storage Systems (ESS), and the advanced functions of smart inverters as applicable to those DER systems. This requires coordination with distribution planning, power flow analysis, and defined voltage / thermal limits.
Interconnect Evaluation Process	Develop a clear interconnection evaluation process, including automated decision-making, at least for the initial evaluation of project viability.
ERP / Interconnection Project Tracker and Reports	Create systems to provide a comprehensive overview of the interconnection queue, facilitating transparency, accountability, and effective management of the interconnection process.
Post-Interconnection Evaluation Metrics	<ul style="list-style-type: none"> • <i>Timing</i>: application process time, internal cost of studies/ approvals • <i>Cost</i>: cost incurred by the applicant, cost incurred by the utility to complete studies/approvals • <i>Performance</i>: SAIDI/SAIFI impact, power quality metrics, load factor of average load to peak load of each DER • <i>Operations</i>: frequency and duration of curtailment from interconnected systems • <i>Other</i>: contribution towards decarbonization goals, alignment with regulatory incentive or mandate
Advanced Data Analytics Tools	Advanced data analytics tools help process and analyze large volumes of data from various grid components, including time-series load forecasts, the generation interconnection queue, etc.
IEEE 1547-2018 Adoption	This standard provides specifications for the interconnection and interoperability of DERs.

Path Forward

Develop flexible interconnection agreements for dynamic hosting capacity. Certain loads and DER resources can adjust their power imports and/or exports in support of real-time distribution system needs. By limiting the peak power drawn from or injected into the grid, flexible interconnection agreements enable better load management and lead to an increase in the grid's hosting capacity. This can create opportunities such as faster and cheaper interconnection and a reduced socialized portion of the upgrade cost. However, this does present challenges, such as revision of existing interconnection methods, financial impact due to increased risk of curtailment, and modified rules on payment, compensation, and tariffs.

New forward-looking planning techniques to handle uncertainty. New forward-looking planning techniques are needed to help utilities handle uncertainty in the interconnection process. These may include:

1. Batch interconnection processes that account for customer changes.
2. Considerations for future conditions when analyzing interconnection requests.
3. N-1 contingency analysis that includes DER.

Integrated processes. Integrated work and data flows between interconnection, hosting capacity, and distribution planning processes could help improve post-interconnection evaluation metrics.

Load Forecasting

Challenges

During the workshop discussion and in the pre-workshop survey, attendees voiced challenges with load forecasting. In the modern energy landscape, these challenges include the evolving nature of customer classes such as electric vehicle (EV) load, building electrification, DER adoption propensity, data centers, and digital currency mining. These elements are not uniformly adopted across service territories, complicating accurate demand predictions. Additionally, integrating forecast modeling across an organization requires overcoming structural and procedural barriers. The complexity of this task is heightened by the necessity for a specialized team with diverse skill sets, including statistical analysis, managing multiple datasets, and leveraging new software solutions.

The pre-workshop survey showed a clear difference between the priority utility attendees placed on improving their load forecasts and the perceived manageability of making necessary changes. For example, utility attendees showed an interest in extra long-term load forecasts (e.g., up to 30 years) to help plan for long-term asset investments and policies. However, few techniques exist for long-term forecasts, and many utilities are grappling with the timing and location of new short-term load growth, especially for load drivers at the early stages of adoption.

Path Forward

Table 2 provides an overview of various enabling technologies that can support the development of a roadmap for improving load studies. These technologies encompass essential systems, data, and tools to enhance forecasting accuracy and operational efficiency.

Table 2 Enabling Technology for Improving Load Studies

Systems, Data, Tools	Description
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Robust and Diverse Load Profiles	Create robust and diverse load profiles to build accurate models rather than only seasonal peaks or static profiles. Use socio-economic modeling and considerations for new customer classes with a high load factor, such as data centers, digital currency mining operations, and EV loads. Also, carry out a detailed and comprehensive analysis, including an 8760 (hours) study, to detail load profiles for every hour of the year.
Utilize AMI (Advanced Metering Infrastructure) Data	Better integration of meter-level forecasting enables the identification of specific trends and patterns that might be missed in more aggregated forecasts.
Scenario or Probabilistic Analysis	Move from deterministic to probabilistic load models based on multiple factors, including weather, dynamic loads, vegetation management, asset health, and storm outages.
Distributed Energy Resources Management System (DERMS)	Implementing DERMS solutions can unlock the ability to control customer devices to shape demand.
Advanced Data Analytics Tools	Machine learning (ML) and artificial intelligence (AI) techniques enable the analysis of large datasets, enhancing the accuracy of load forecasts by identifying patterns and trends in historical data.
Data Collection: Adoption Rates	Adoption Rates and modeling for EV, PV, ESS, heat pumps, energy efficiency, and building electrification.
Data Collection: Demand Metrics	Demand (TWh), Electric Vehicles (% of vehicle stock), building electrification (% of appliance stock), Availability (%) of DER
Backcasting	Evaluating the correctness of past forecasts using actual data once the forecasted period is complete.
Spatial Load Forecasting	Uses granular geospatial data to predict load at high (e.g., below feeder) resolutions. While inaccuracies may exist, at high resolutions, spatial load forecasting generally achieves high-accuracy feeder and substation forecasts.

Harmonizing load forecasting. Top-down and bottom-up load forecasting is critical to integrated distribution systems planning by combining broad, system-wide perspectives with detailed, localized insights. Top-down forecasting provides a macro-level view of overall energy demand trends and patterns, drawing from historical data, economic indicators, and demographic shifts. Conversely, bottom-up forecasting aggregates data from individual consumers, devices, and specific geographical areas, capturing variations and emerging trends such as electric vehicle adoption and distributed energy resource integration. Utilities can achieve a more accurate and comprehensive understanding of future load requirements by integrating these approaches. Additionally, distribution load forecasts can be a valuable input to transmission load forecasts. However, guidelines must be developed to reconcile different T&D utility risk tolerances.

Load Flow Analysis. Combining load forecasts with power flow analysis is crucial, as considering operational impacts from Distributed Energy Resource Management Systems (DERMS) will enhance decision-making processes. As the systems mature, the eventual goal

will be to develop tools that integrate real-time data from SCADA telemetry and AMI operational data into distribution management systems (DMS), which will enable power system analysis applications to continually enhance and provide informed decisions within complex distribution networks.

Load forecasting tool benchmarks. Utilities have many options for improving load forecasts but little neutral guidance. Benchmarking studies for load forecasting tools could provide valuable advice to utility forecasters.

Integrated Distribution Systems Planning (IDSP)

According to the Department of Energy’s Next-Generation Distribution System Platform Initiative (DSPx), Vol.IV, Integrated Distribution Systems Planning “...provides a systematic approach to **satisfy customer service expectations** and the specific grid planning and design objectives related to **reliability and resilience, safety and operational efficiency, and DER and microgrid integration and utilization**. These three focus areas of modern distribution planning require a unified process integrated with system forecasts and corresponding resource and transmission planning.”¹

Challenges

During the workshop discussion and in the pre-workshop survey, attendees voiced challenges with IDSP. Utility attendees were more interested in internal integrated planning than external integrated planning. For example, relatively high importance was placed on integrated inter-departmental planning workflows to reduce interconnection queues, improve hosting capacity, and improve T&D coordination. One utility attendee observed that they now had enough DER in their service territory to affect transmission disturbances and are paying more attention to DER ride-through settings. Other specific challenges include:

- How do we combine disparate data sources into consolidated workflows for system planners?
- How do we coordinate and communicate investment prioritization between various stakeholder groups?
- How do we ensure that distribution planning includes inputs from numerous enterprise systems?
- How can we better integrate external and internal planning workflows?

¹ Department of Energy. Next-Generation Distribution System Platform Initiative (DSPx), Vol. IV: Integrated Distribution Systems Planning. U.S. Department of Energy, [2020].

- How do we fairly value the benefits and account for the risk of using DER in planning processes?
- How can we better define new customer objectives, such as resilience and equity?

Path Forward

- **Load Shaping Programs.** Several planned and current implementations of non-wire alternatives were shared, including distribution technology and customer engagement programs to shape load. As much as possible, utilities should consider load-shaping programs such as Volt/VAR Optimization, Vehicle-to-Grid (V2G), managed vehicle charging, incentivizing customer efficiencies, and dynamic / Time of Use (TOU) Pricing.
- **Stakeholder Engagement.** Evaluate approaches to stakeholder engagement within the utility through customer outreach and proactive communication with the public utility commissions (PUCs).
- **Enterprise-level solutions.** Organizations can no longer exist with siloed departmental structures. To properly execute IDSP, there must be internal alignment from Finance, Distribution, Transmission, and Corporate Strategy. Centralized modeling, collective forecasts, and common data sets should be shared between these groups as much as possible, creating inherent alignment and integrated workflows.
- **Customer Involvement.** Demand response programs play a key role by encouraging customers to shift their energy usage to off-peak times. By offering incentives and providing real-time feedback on energy consumption, utilities can motivate customers to participate actively in energy-saving practices in addition to a sense of collective responsibility for attaining climate goals.
- **Formal approach to communicating with PUCs.** Develop a formal approach to transparency with the utility commissions by providing clear, comprehensive, and accurate information about projects and their impacts. As clear alignment on carbon reduction goals exists between all organizations and stakeholders, utilizing a formal plan to communicate utilities' capabilities for meeting those goals solidifies this alignment. The Electric Sector Modernization Plan (ESMP) required in Massachusetts is a prime example.
- Follow a **framework for executing grid modernization** vision by integrating multiple applications, disparate data sources, and disaggregated systems into coherent methods to produce deliverables that address complex challenges of the distribution grid (Figure 1 DOE Framework of Integrated Planning Process).

- **Increase data governance and interoperability.** Data governance was determined to be a fundamental first step to IDSP practices regardless of maturity in the area. Interoperability of data allows different departments within a utility to access different data stores to make better planning decisions. This includes both new and legacy systems. There was a consensus among workshop attendees that there were challenges with data governance and interoperability, especially considering integrating new and legacy systems. Therefore, efficiently integrating such systems will aid in more successful IDSP practices.
- **Non-monetary objectives.** Historically, when optimizing and prioritizing power system investments, decisions were largely determined by monetary costs and benefits. However, a project can serve several tradeoffs and objectives (e.g., safety, reliability, cost, decarbonization, or equity). Therefore, there is a challenge in combining these objectives into traditional decision-making processes. One key takeaway from the workshop was that more guidance is needed to quantify energy justice and equity decisions properly. Workshop attendees mentioned the challenge of reconciling between neighborhood boundaries and grid boundaries. They also noted that grid planning has historically been neutral and should not introduce inequities. However, they also recognized that some customers have different vulnerabilities (e.g., access to critical services during long-duration outages) that grid planning processes do not always consider.
- **Automate Planning Processes.** Certain planning processes should be automated to enable better and quicker decision-making. Examples include T&D load forecasting, distribution planning tools like CYME, interconnection analysis, hosting capacity, asset management, corporate systems like GIS, investment tools like Copperleaf, and customer management tools like Salesforce.
- **Strengthen workforce.** Some utilities are reporting a 10-fold increase in distribution builds and legacy systems (e.g., paper maps) requiring rapid change management. Hiring and retaining an excellent workforce is essential to successful IDSP. Due to these plans being highly integrated, a unique skillset is required. Non-conventional hires like data analysis and computer engineers may be particularly valuable to utilities.

Figure 7. Integrated Planning Process

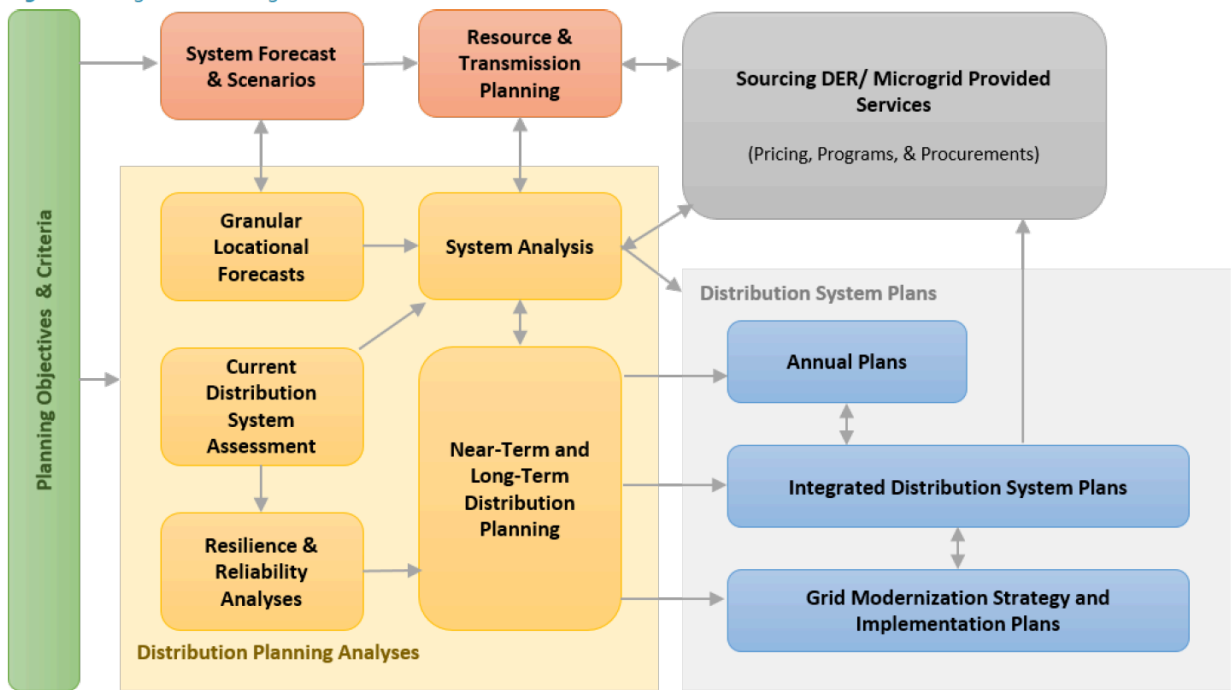


Figure 1 DOE Framework of Integrated Planning Process

Overall Summary

1. **Interconnections:** Develop and maintain accurate hosting capacity maps to aid in planning and reduce backlogs. Streamline and automate interconnection evaluations to expedite the decision-making process and increase transparency. Implement flexible interconnection agreements with dynamic hosting capacity when possible.
2. **Load Forecasting:** For 8760-hour studies, refresh load profiles, ensuring detailed and diverse modeling based on socio-economic factors of customer classes. Integrate AMI-level data to ensure the accuracy of load models and update demand predictions. Harmonize forecasting approaches between top-down and bottom-up load modeling.
3. **Data Integration:** Create opportunities to consolidate disparate data sources into a unified interface or “single pane of glass” for system planners to enhance decision-making. Foster alignment between organizational departments with integrated workflows and centralized modeling sources.

4. Stakeholder Coordination: Ensure a formal approach for communicating with PUCs and ratepayers, aligning on common goals and the importance of active participation in demand-response programs.
5. Comprehensive Planning Framework: Enterprise-level solutions incorporating resilience, reliability, safety, affordability, and equity into the distribution system planning process.

Appendix A: Quick Links Guide

This section serves as a quick reference guide establishing connections between the AEIC white paper on the Integrated Distribution System Planning (IDSP) workshop and related documents available on the U.S. Department of Energy's (DOE) IDSP website. The guide provides direct links and brief descriptions of the related sections to facilitate easy access and cross-referencing.

Related DOE IDSP resources

The following table provides a list of all resources on the DOE's as well as Berkley Lab's IDSP websites that have been linked so far.

Resource #	Resource Topic/Title	Description
[1]	Distribution System Evolution	Outlines the three-stage progression of the distribution system to accommodate ever-increasing levels of DER and electrification, including technical and institutional considerations.
[2]	Distribution Grid Code Framework	Provides an introduction to a distribution grid code framework that encompasses the various institutional, business, and technical activities associated with integrating and utilizing DER, microgrids, and electrification into a structured set of best practices and associated technical standards.
[3]	Operational Coordination across Bulk Power, Distribution and Customer Systems	Provides a comparative summary of the status of leading global discussions through 2018 regarding transmission-distribution-customer frameworks to reliably manage the integration and utilization of DER.

Quick Links Table

#	IDSP White Paper Section	Related DOE Resource #	Related DOE Resource Topic/Title	Text (in IDSP)	Text (in Resource)	Comment
[1]	Interconnections	[1]	Distribution System Evolution	Coordinating between utilities, DER owners, and regulatory bodies creates complexity for making interconnections, as does the need for significant infrastructure upgrades to handle	Implement foundational grid infrastructure and technologies necessary to enable deep decarbonization and climate adaptation	Both texts emphasize the complexity and the need for foundational infrastructure to support DER integration.

#	IDSP White Paper Section	Related DOE Resource #	Related DOE Resource Topic/Title	Text (in IDSP)	Text (in Resource)	Comment
				bi-directional power flows.		
[2]	Interconnections	[1]	Distribution System Evolution	Accurate and publicly available hosting capacity maps are essential for planning but are often lacking.	Identify and implement hosting-capacity analysis and related public information-sharing platforms with increasing sophistication, as needed.	Both texts highlight the importance of hosting capacity maps for effective planning and integration.
[3]	Interconnections	[1]	Distribution System Evolution	The interconnection queue can become backlogged, creating delays, while the cost burden of processing interconnections can be penalizing to both the utility and the applicant.	Establish a cost-effectiveness evaluation and cost-recovery framework for grid modernization investments.	Both texts address the challenges in managing interconnection queues and the need for effective evaluation frameworks.
[4]	Enablers	[2]	Distribution Grid Code Framework	Formal and standard collection of operating characteristics and requirements to evaluate a DER interconnection.	The “DER and Microgrid Integration” code family captures functions and technologies required to support grid resilience and practices to enable system safety and reliability at all levels of DER penetration.	Both texts focus on the need for standardized operating characteristics and requirements for DER interconnection.
[5]	Enablers	[1]	Distribution System Evolution	Create GIS based tools with visual capacity of DER on each feeder, considering multiple types of DERs, including Electric Vehicle	Identify and implement hosting-capacity analysis and related public information-sharing platforms with increasing	Both texts emphasize the importance of GIS-based tools and hosting capacity analysis for

#	IDSP White Paper Section	Related DOE Resource #	Related DOE Resource Topic/Title	Text (in IDSP)	Text (in Resource)	Comment
				(EV), Solar, Wind, Energy Storage Systems (ESS).	sophistication, as needed.	effective planning.
[6]	Enablers	[1]	Distribution System Evolution	Develop flexible interconnection agreements for dynamic hosting capacity.	Implement foundational grid infrastructure and technologies necessary to enable deep decarbonization and climate adaptation	Both texts highlight the need for flexible agreements and foundational infrastructure to support dynamic hosting capacity.
[7]	Enablers	[3]	Operational Coordination across Bulk Power, Distribution and Customer Systems	Create GIS based tools with visual capacity of DER on each feeder, considering multiple types of DERs, including Electric Vehicle (EV), Solar, Wind, Energy Storage Systems (ESS).	Develop detailed guidelines related to recommended information sharing and data collection for necessary information to flow across the transmission-distribution interface effectively to support BPS [Bulk Power System] reliability needs.	Both texts emphasize the importance of GIS-based tools and hosting capacity analysis for effective planning.
[8]	Enablers	[3]	Operational Coordination across Bulk Power, Distribution and Customer Systems	Develop a clear interconnection evaluation process, including automated decision-making, at least for initial evaluation of project viability.	An evaluation process based on comparative analysis of grid architectures and operational risk that can be used by individual states and regions to address evolving needs for greater TDC coordination is needed.	Both texts highlight the need for a clear and automated interconnection evaluation process.
[9]	Enablers	[3]	Operational Coordination across	Create systems to provide a comprehensive	Provide guidance for distribution-level	Both texts stress the importance of

#	IDSP White Paper Section	Related DOE Resource #	Related DOE Resource Topic/Title	Text (in IDSP)	Text (in Resource)	Comment
			Bulk Power, Distribution and Customer Systems	overview of interconnection queue, facilitating transparency, accountability, and effective management of the interconnection process.	monitoring to improve steady-state and dynamic modeling of aggregate DER, including the use of smart meters, dynamic disturbance recorders (DDR), phasor measurement units (PMUs), and other recording devices.	transparency and effective management of the interconnection process.
[10]	Enablers	[3]	Operational Coordination across Bulk Power, Distribution and Customer Systems	Post-Interconnection Evaluation Metrics	Reliable measurement and verification for DER services is needed.	Both texts discuss the need for detailed evaluation metrics post-interconnection to ensure performance and reliability.
[11]	Load Forecasting	[1]	Distribution System Evolution	Load forecasting in the modern energy landscape faces several challenges, particularly with the evolving nature of customer classes such as electric vehicle (EV) load, building electrification, data centers, and digital currency mining.	Apply Integrated Distribution System Planning ^{23,24} to understand the evolution of consumer resources and their interaction with the grid and to align foundational grid investments.	Both texts address the challenges in load forecasting and the need for integrated planning to manage evolving customer classes.
[12]	Load Forecasting	[2]	Distribution Grid Code Framework	Create robust and diverse load profiles to build accurate models,	Development of system data portals or websites to provide	Both texts emphasize the need for comprehensive

#	IDSP White Paper Section	Related DOE Resource #	Related DOE Resource Topic/Title	Text (in IDSP)	Text (in Resource)	Comment
				rather than only seasonal peaks or static profiles.		le load profiles to build accurate forecasting models.
[13]	Load Forecasting	[2]	Distribution Grid Code Framework	Real-time data analyzed from SCADA telemetry, distribution management system (DMS), and power analysis applications are foundational to make informed decisions for complicated distribution networks.	(ADMS/DERMS/S CADA)	Both texts stress the importance of real-time data analysis for informed decision-making in complex distribution networks.
[14]	Key Examples	[2]	Distribution Grid Code Framework	Several planned and current implementations of non-wire alternatives were shared, including distribution technology and customer engagement programs to shape load.	DERs—individually and in aggregations—are increasingly used as load-modifying resources for both distribution non-wire alternatives (NWAs) and wholesale capacity and ancillary services.	Both texts provide examples of non-wire alternatives and their implementations for effective grid management.

Appendix B: Survey and Discussion Synthesis

[PDF linkup of NREL-IDSP Workshop Synthesis]

Appendix C: Summary of Workshop Presentations

Notes / Key Concepts:

Background

The purpose of this document is to serve as a quick reference guide for those that attended, or are stakeholders of, AEIC's IDSP Critical Issues Forum Workshop 2 that took place in June 2024. Please refer to the source presentations for more details ([Member Access Only](#)). The following is intended for AEIC Internal Members only, as summarizations contained herein are referenced directly from participating organizations' presentations.

AEIC: IDSP Workshop Context and Purpose

- Share and gain insights on best practices around IDSP, focusing on interconnection and load forecasting.
- Engage with multiple utilities to discuss planning outcomes, data exchange, and decision-making processes.
- Understand the current state of practice and identify gaps in utility planning.

National Renewable Energy Laboratory: Pre-Workshop Survey & IDSP Roundtable

- Scope
 - 1) identify existing planning practices,
 - 2) identify gaps and opportunities in achieving an ideal IDSP and
 - 3) identify key interactions and workflows within utilities and between utilities and external organizations
- Scale: Important, Urgent, Team Fluency, Easy to Execute
- Interconnection, IDSP, Load Forecasting

Duke Energy: Leveraging Grid Edge Resources for Local and Bulk Power Capacity

- Load Shaping
- Carbon Reduction
- Growing customer participation in demand response
- Grid Enabled Devices in the home (shaping demand, two-way communication)

- Demand and Capacity Battery Programs
- Reducing and managing load at the grid edge can be one of the most cost-effective means to reduce carbon.
 - This can be accomplished through pairing customer programs, customer assets and grid assets together to shape the load profile
- Peak load is expected from residential
- key question: Is it more cost effective to implement a traditional Distribution capacity upgrade or to leverage Grid Edge programs to shape load?
- Customer Energy Control System (Downstream of ADMS, EMS)

Electric Power Research Institute (EPRI): Incorporating DER Flexibility into the Utility Interconnection Review Process

- Flexibility = certain loads and DER resources can adjust their power imports and/or exports in support of distribution system needs.
- Distribution applications:
 - Avoid, defer, and/or reduce infrastructure investments
 - Reduce operating costs
- Flexible Interconnection Agreement
 - Opp: Faster and cheaper interconnection, Reduce socialized portion of upgrade cost
 - Challenges: Revised interconnection method, curtailment / financial risk, rules on payment, compensation, tariffs
- Scheduled Interconnection
 - Determinants:
 - Customer – hosting capacity self-proposed, then screened,
 - Utility – Determines schedule based on system constraints,
 - Utility – Schedules projects in service area based on thermal / voltage constraints
 - Price Signal – Utility designs dynamic rate schedules
 - Operating Profile Matrix
 - Delimiting the scope and priority of what needs to be communicated about a proposed interconnection

ComEd (Exelon): DER Interconnection Process and Load Forecasting

- Pre-application & payment (Customer) – pre-application assessment (ComEd) – Interconnection application & Payment (Customer) – Application Review (ComEd) –

Technical Review (ComEd) – Approval (ComEd) – Interconnection Agreement (Shared)
– Engineering, Construction, Inspection (Shared) – Certificate of Completion (Shared)

- Evolving Tools
 - Connect the Grid (CTG) Interconnections Project Tracker
 - Solar Calculator / Digital Solar Tool
 - Hosting Capacity Maps
 - PV Hosting Capacity, EV Load Capacity, ESS Hosting Capacity
 - Interconnection Queue Report
 - Level 1 Interconnection Application Automation – automatic analysis of applications = ~1000/month
 - 57% have been approved via automation
- Dynamic Hosting Capacity and Flexible Interconnections
 - Dynamic Hosting Capacity – amount of DER MW that can be injected by real-time, active management
 - Flexible Interconnection – DER Control options to manage system constraints, that would otherwise require system upgrades (What are examples???)
 - Enablers: DERMS
- Capacity Planning (Short and Long-Term)
 - Once system with diverse customer needs (rural, suburban, urban, w/ diverse load profiles)
 - Probability analysis of weather and load
 - SCADA Feeder Head readings allocated to loads
 - AMI is seldomly used but requires manual data collection
 - RCI (Residential, Commercial, Industrial)

Duquesne Light Co. (DLC): Incorporating Forecasts into Decision Making

- Top-Down Forecasting
 - PJM Load Forecast Report
 - Zonal 10/15 Year Load Growth by Season
 - Load Peak and new load forecast
- Bottom-Up Forecasting
 - AMI Metering
 - Aggregated Transformers
 - 10-Year Circuit Forecasting
- Challenges
 - PJM did not include EV and other electrification into load forecasting, initially
 - DLC to create programs that meet PJM Forecast

- o EV and other electrification is not adopted uniformly and is specific to location
- Internal Consensus within the org
 - o Finance, Distribution Planning, Transmission Planning, Corporate Strategy
- Developing bottom-up forecasting using power flow studies
 - o ODMS – (Denodo) Transformer Loading – CYME (w/ input from GIS)
- Forecasting in the Future
 - o Improved adoption modeling
 - o Stochastic Demand modeling
 - o Probabilistic Forecasting & Risk Assessment
 - Storm Outage, Veg Mgmt Prioritization, Asset Health Model
 - o NRL C2C Program
 - Advanced Building Modeling, Non-Wire Solutions Analysis
 - IDP Criteria Dev.
 - Identify community goals / weighting, city-wide modeling, specific feeder modeling, real-time simulation (NWA/SEED validation)
- Key Themes
 - o Forecasts are more valuable when the entire organization adopts them
 - o Bottom-Up Forecasting presents a wide array of opportunities around adoption, behavior, and impact modelling.
 - o Forecasting efforts should not be limited to ‘Load Forecasting’, and should encompass risk and decision analysis.

Eversource / National Grid: Long-Range Electric Demand Assessment of Statewide Decarbonization Goals

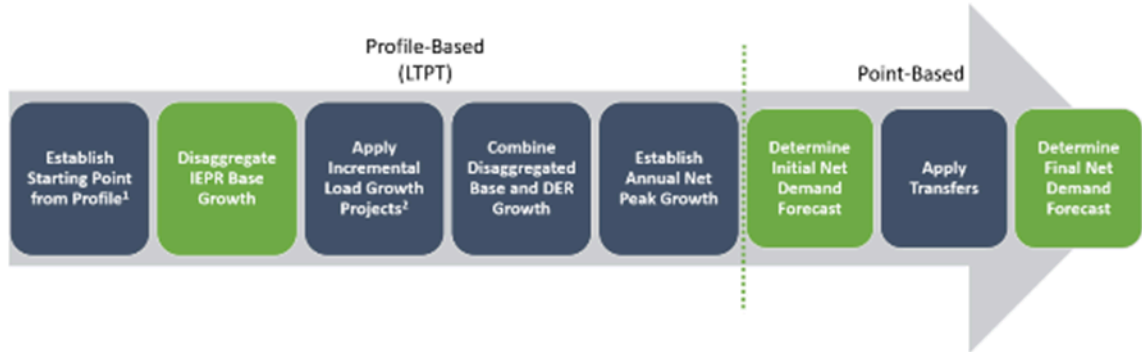
- Clean Energy & Climate Plan (CECP) – Emission limits and carbon neutral goals
 - o Net Zero by 2050
- Electric Sector Modernization Plan (ESMP)
 - o Comprehensive plan to ensure electric system is capable of meeting climate goals
 - o All 3 state IOUs are required by Massachusetts General Law to submit ESMP
 - o Current state of the distribution grid, utilities’ current and proposed investments; future of reliability; forecasted future power needs; strategies to support renewable energy resources, EVs, building electrification, etc.
 - o Eversource: ESMP Delivers
 - environmental, health and economic benefits of reduced carbon emissions
 - Improves resiliency of the grid
 - Minimizes infrastructure costs through proactive planning and using technology platforms to make the grid smarter

- Proposes robust stakeholder engagement process and community engagement framework
- Distribution Planning Horizon (Today to +10 Years)
 - Top-Down: ISO, State Level, Company Forecast, EVs, Solar Adoption, Energy Efficiency
 - Bottom-Up: New Business Step Loads, Economic Load Model
 - Result: Peak Load Forecast
- Long Range Electric Demand Assessment (+10 Years to 2050)
 - Top-Down: State Policy Objectives / Pathways, Federal Policy Objectives
 - Bottom-Up: EV / PV / ESS / Electric Heating Adoption Propensity, Socio-Economic Modeling based on customer reference classes
 - Result: Electric Demand Assessment
- Lessons Learned
 - Advanced Forecasting Team to transition from load centric, single value forecasts to advanced forecasting with multiple variables based on policy objectives.
 - New software solutions and datasets
 - Distribution Modeling Function to allow incorporation of forecasts into models and planning scenarios for transition to 8760 analysis
 - Centralized model management to ensure consistent model quality and to provide models as a service to all departments
 - Planning Models represent the build-out state of the system through 2050, including all forecasts and planned projects
 - Advanced Analytic Processes to assess load/DER impact across yearly load cycle and translating demand to identify transmission constraints
 - Automated tools and probabilistic power flow capabilities for 8760 analysis
 - Cross-functional planning teams to proactively assess DER and electrification impacts

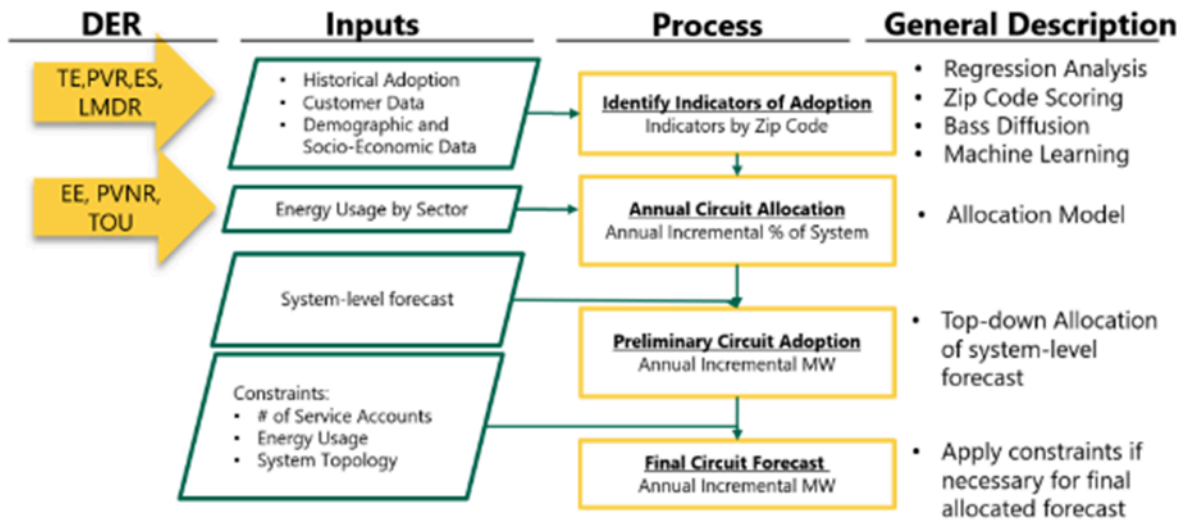
Southern California Edison (SCE): From Static to Dynamic, a CA Case Study

- Distribution Resources Plan with vision for DER planning (forecasting and deferrals), integrated capacity analysis / portals, and grid modernization investments – 2015
- Rule 21 (Limited generation profile) for DER interconnections – 2017
- DRP 2.0 initiated in 2021: bottom-up forecasting, scenario planning, demand flexibility
- Planning Process

SCE's End-to-end Distribution Forecast Process



¹ Starting Point derived from cleansed historical 8700 profiles reflect the weather-normalized peak, which typically occurs during Summer for the majority of SCE's system.
 ² SCE consults with the CEC to determine which projects are considered incremental to the IEPB.



TE: Transportation Electrification includes both light duty and non-light duty EVs (Medium & Heavy duty, Bus, Forklift and Transport Refrigeration Units)
 ES: Energy Storage
 EE: Energy Efficiency
 PVR: Residential Solar PV
 PVNR: Non-Residential Solar PV
 LMDR: Load Modifying Demand Response
 TOU: Time of Use Rates

Transforming System Planning Process and Technology - Vision



Taking an integrated approach and scaling it to create the right, cost effective grid solutions for a High DER Future



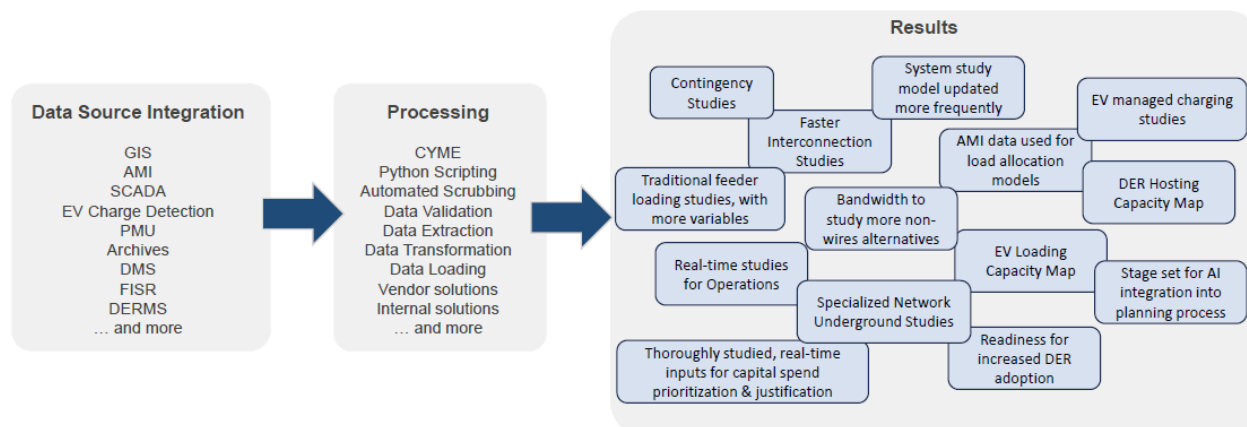
¹Refer to Acronym slide for all acronyms in the presentation

The capabilities will be enabled by the System Planning, Evaluation, and Execution Dashboard (SPEED) tool

- SPEED (System Planning, Evaluation, and Execution Dashboard)
 - Single user interface to all system planning processes, load growth scenarios, and Integrated Grid Planning Process (IGPP) for capacity and non-capacity driven
 - Hosting capacity maps, interconnection engineering studies, structure level forecast, 8760 timeseries system modeling
- System planning shifting from deterministic to more probabilistic
- Generation interconnection and load energization becoming more flexible
- Demand Metrics: Demand (TWh), Electric Vehicles (% of vehicle stock), building electrification (% of appliance stock)
 - Winter peak is comparable to summer evening load with heat pump proliferation
- Generation Metrics: capacity needed for load growth □ Solar, On/Offshore Wind, Storage
- Reliability – availability of DERs
- Grid Expansion – T&D investments required to meet load growth
- Affordability - Barriers to electrification must be addressed so all consumers can access savings
- Calls to Action:
 - Reimagine system planning, advance emerging generation technologies, accelerate transmission buildout, evolve distribution grid
- Case Study

Georgia Power (Southern Company): GPC Distribution Planning

- Dynamic Planning System (DPS)
 - Mission: Provide customers & commissions information they require, Modernize Grid Planning, Enterprise Level Solution
 - Framework to integrate many sources of data in newer, faster ways leveraging multiple solutions



- Generator Hosting Capacity Tool
 - To improve interconnection guidance for DG projects, state regulator approved development of GIS-based hosting capacity tool
 - Visual representation of available feeder capacity for solar generation on each feeder that can be safely and reliably added
- DERMS Strategy
 - Roadmap: Visibility of Distribution connected DER, Visibility of existing Customer Program DR/DSM Devices, System DER and Load Forecasting, Configuration of Company owned DER, System optimization with Company owned DER
 - Grid Optimization Capabilities (i.e., VVO, Economic Dispatch, Resiliency, Outage Support, etc.), Integration with 3rd Party Aggregators, DR/DSM Programs, Arbitrage & Settlement, EV charging and V2G (Vehicle to Grid)

