# SURVEY OF DISTRIBUTION PLANNERS ON CURRENT FORECASTING PRACTICES AND CONCERNS

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## *ABSTRACT*

*Load forecasting is a foundational component of distribution planning. Technology, resource, and policy changes pose challenges to traditional forecasting and planning assessments. To better understand current practices and future forecasting needs, a survey was developed asking distribution planners to provide information concerning their existing forecasting tools and practices in forecasting both load growth and Distributed Energy Resources (DER) adoption. The survey also posed questions seeking to understand specific areas of concern that distribution planners have regarding forecasting DER and other load changes. Survey results, along with analytical insights and identified areas of future research are summarized.*

## INTRODUCTION

Load forecasting is the foundational first step in planning any electrical distribution system. The forecast defines the future conditions that enable planners to identify the system upgrades and network additions necessary to adequately and reasonably meet future distribution system needs. Many forecasting methods and practices have been developed over the years. However, these typically assume traditional distribution system load characteristics and needs.

Technology, resource, and policy changes are resulting in dramatic changes in distribution system characteristics and planning needs. System loading is becoming more dynamic and uncertain with the adoption of variable and intermittent generation and other distributed resources. New technologies are also improving end-use efficiencies as well as how customers interact with the system. The ability to effectively forecast these, and other system changes is critical to the planning process.

To better understand the nature of current forecasting and research needs, a survey was conducted asking distribution planners to provide information concerning their existing forecasting tools and practices [1]. The survey also posed questions seeking to understand the level and specific areas of concern that distribution planners have regarding forecasting DER and other load changes. Twenty-eight distribution planners participated in the survey, and the results, along with analytical insights and identified areas of future research, are presented.

## SUMMARY OF SURVEY PARTICIPANTS

A broad spectrum of distribution utilities participated in the survey, as characterized by the summary statistics shown in Table 1. The survey was distributed to 71 distribution utilities, with 28 choosing to participate. While many of the participating utilities are North American, utilities located in Europe and Africa also participated in the survey.

*Table 1. General Statistics for the Participating Utilities Operating Footprint and Customer Characteristics*

| | Min | Average | Max |
|---|---|---|---|
| **Service territory (sq. miles)** | 132 | 27,683 | 110,000 |
| **Customers (thousands)** | 305 | 4,239 | 30,000 |
| **Number of substations** | 15 | 475 | 1,500 |
| **System peak (MW)** | 786 | 10,225 | 23,753 |

Participating utilities also provided past, current, and expected load growth percentages for their service territories. Survey results, shown in Figure 1, indicate a mix of changing load growth conditions when comparing the expected load growth to past and current conditions. While some utilities expect future load growth to increase compared to past or current levels, many are expecting relatively minimal load growth.

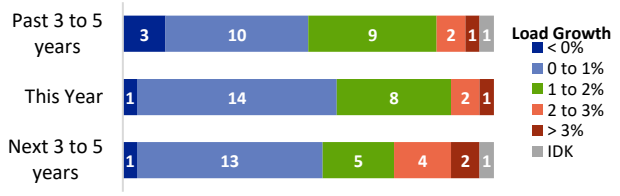


*Figure 1. Load growth levels in the past, present, and expected in the future*

The approximate penetration of DER and other load impacting technologies within each participant utility was also asked. Tabulated responses are provided in Figure 2 (note the number of survey response varied by technology type). While many participants did not provide or know these levels, the results do indicate diversity across the participants in the types and proliferation of DER and other load impacting technologies. Across these, solar and energy efficiency have the largest diversity and

penetration, with respondents indicating as much as 20% penetration in their systems.

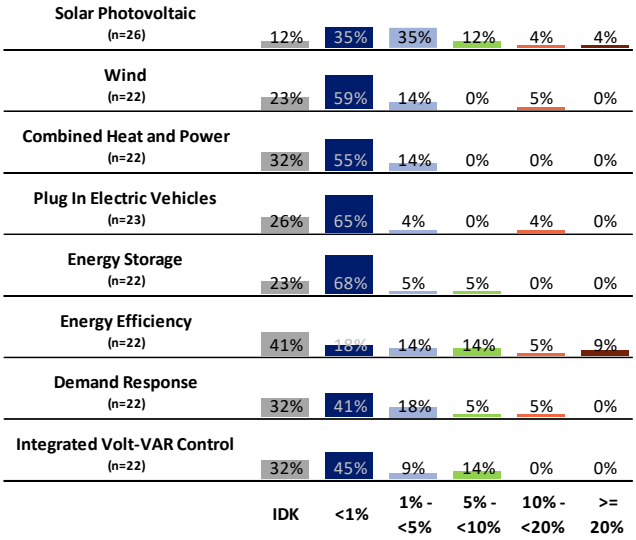


*Figure 2. Penetration level (ratio of total nameplate to system peak) of DER and load impacting technologies among utility respondents (the value "n" represents the number of respondents reporting each technology type)*

Correlating the results shown in Figures 1 and 2 revealed the three survey participants experiencing negative load growth also had at least 10% penetration of solar photovoltaics (PV) and at least 5% penetration of energy efficiency.

## SURVEY RESULTS

### Forecasting Tools

An important aspect in understanding future forecasting needs is to understand the tools currently being used to perform the forecasts. When asked about the tools being used to perform their load forecasts, in-house developed methods were the most common (see Figure 3). The methods were derived in house across a variety of computational platforms, such as Excel, SAS, or Matlab. However, a quarter of the respondents indicated using tools that were "dedicated" or specifically developed to perform load forecasts; either alone or in conjunction with in-house developed methods.

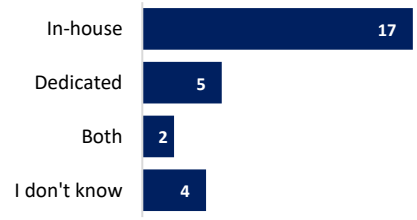


*Figure 3. Number of survey participants using dedicated or in-house software tools when performing load forecasts.*

The number of participants using computational tools to perform forecasts reflects the number of participants that also indicated they apply in-house developed methods and tools. This suggests the industry could benefit through increased collaboration and knowledge transfer of knowledge, experiences, and best practices. Furthermore, the variety of tools employed to perform forecasts also suggests that forecasting advancements will need to consider the multiple forecasting methods and approaches currently in use.

### Forecast Horizon

When considering future research needs, a relevant and important finding from the survey was how much the forecasting practices, data needs, and even objectives varied amongst the participating utilities. For example, when asked to provide the time frames for their forecasts, a wide variation was seen regarding the number of years considered as a mid-term forecast, as shown in Figure 4. While most participants who indicated they perform long-term forecasts use a 5 to 10-year horizon, larger time frames are also clearly common. Additionally, there is a significant amount of overlap in the 5 to 10-year time horizon between the two forecasts.

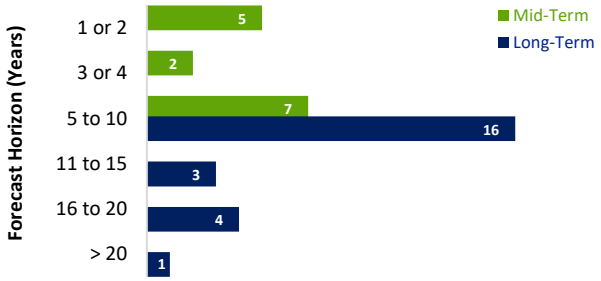


*Figure 4. Time horizon (years) for mid and long-term forecasts*

Many of the respondents perform forecasts for both mid- and long-term horizons. While some participants indicated they only perform forecast across long-term horizons, these utilities may be extrapolating these forecasts into time frames needed to support short-term planning.

### Forecast Reconciliation

When asked whether distribution forecasts are reconciled with higher-level forecasts, more than half of the respondents said they reconciled their forecasts with corporate or bulk system level forecasts (see Figure 5). Six of the 11 who do not reconcile forecasts, also responded that some form of higher level forecasts was used to inform their distribution planning forecasts.

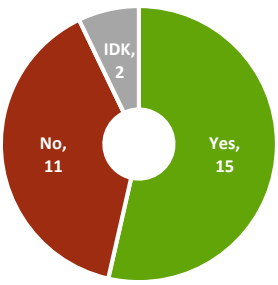


*Figure 5. Number of respondents that reconcile distribution load forecasts with corporate or bulk system forecasts*

The respondents who do reconcile forecasts were also asked to identify the associated challenges. A summary of the responses, grouped by the relative degree of indicated difficulty, is summarized in Figure 6. Variability of DER and the movement of loads between feeders appear to be common and important obstacles for all participants, regardless of the relative ease of reconciliation with the corporate/bulk forecasts. While only a third of respondents identified reconciliation of yearly 8760 data as an obstacle, this may become an increasing concern as system load profiles continue to change.

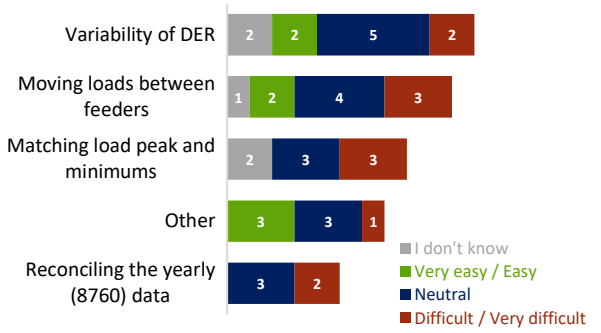


*Figure 6. Obstacles in reconciling distribution load forecasts with corporate or bulk system forecasts*

## Forecast Accuracy

While most respondents indicated they were satisfied or neutral on the subject of their forecast accuracy, the survey results indicate limited formal effort is taken to check the accuracy of their past forecasts. In fact, only two of the respondents that perform mid-term forecast confirmed that these steps were being taken.

These results indicate there may be potential benefits to reviewing the applications and methods employed in performing long-term forecasts amongst different utilities. For example, one participant stated that their "*forecasting methodology worked well when load growth was always positive, but it was not designed to handle negative load growth"*. Another respondent said that their tool was limited in its ability to provide a profile forecast.

Documenting best practices and engagement in collaborative forums where distribution planners can share how they overcome these and other obstacles could help address these issues and provide overall benefits to the industry. Additional investigation may be needed to identify deterrents to performing forecast model verification as well as to explore how changing load conditions may influence these practices.

## Data Requirements

A wide range of information and data can be used to perform load forecasts. Responses to survey questions indicate that historical peak, historical load growth, load profiles, and SCADA data are the dominant inputs in distribution load forecasts (see Figure 7). Other information is commonly used but by a lower percentage of respondents. Demographic and customer segmentation data is used least frequently in the distribution forecast. However, increasing levels of DER adoption and changing customer behaviors may be raising interest in using this information to improve planning forecasts.

Corporate forecasts are used to inform many of the participants' distribution planning forecasts. As such, the data sources used for these forecasting types are also plotted in Figure 7. One participant shared that their corporate forecasts considered DER, energy efficiency, and demand response, but these technologies were not included in their planning forecasts. Another participant stated that their utility was *"looking to move corporate forecasting to a more granular level so that all forecasts are from the same data and used for different purposes (planning, sales, etc.)."* These comments allude to potential benefits that could be derived from improving the coordination of using information at the distribution and corporate level.

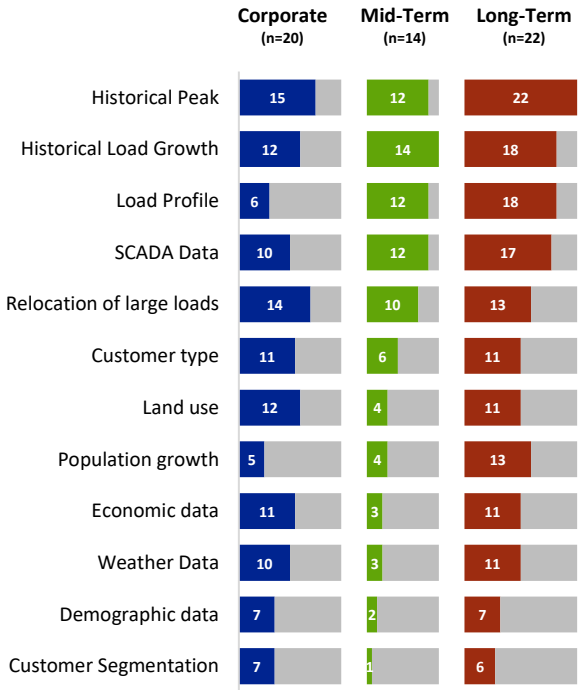


*Figure 7. Data types being used in survey participants' forecasts ("n" indicates the number of survey participants performing each forecast type)*

## Current DER Forecasting Practices

As discussed earlier in this paper, forecasting DER adoption and its characteristics poses a new and significant challenge for the electric utility industry. The percentage of survey respondents who account for existing DER or include forecasts of future DER in their load forecasts is provided in Table 2 for a variety of different DER types as well as other factors, such as energy efficiency. Note: while a utility may forecast a given DER type, this does not indicate how or the degree to which the DER is included in the utility's capacity planning.

*Table 2. Percentage of respondents who account for existing DER or forecast future DER levels*

| | Mid-term Forecasts (n=14) | | Long-term Forecasts (n=22) | |
|---|---|---|---|---|
| | Existing | Future | Existing | Future |
| **Photovoltaics** | 71% | 50% | 50% | 54% |
| **Demand Response** | 36% | 43% | 38% | 46% |
| **Energy Efficiency** | 36% | 29% | 38% | 42% |
| **Electric Vehicles** | 14% | 14% | 21% | 38% |
| **Energy Storage** | 14% | 14% | 17% | 21% |
| **Volt/var Control** | 7% | 14% | 17% | 17% |
| **CHP** | 29% | 14% | 21% | 8% |
| **Wind Generation** | 21% | 7% | 21% | 4% |

While the results in Table 2. indicate that many utilities include PV in their forecasts, there is still concern about the ability to forecast PV and other DER types. That said, existing or future DER is generally more likely to be included in mid-term forecasts rather than long term forecasts. This result is plausible considering the more immediate need for forecast accuracy in the mid-term compared to the long-term.

As there is no clear approach to incorporating DER into distribution planning forecasts, there could be an opportunity to advance the methods and approaches needed.

## Concern in Forecasting DER

Visibility of DER, especially residential customers sited DER, was a common challenge identified by participants and may likely be the main driver for the levels of concern shown in Figure 8. Comments include:

> *"We struggle to keep track of the native load absent of DER and worry that we may have isolated overloads if DER is not operational during a peak condition"*

> *"Increased penetration of co-gen and microgen where load is masked will decrease forecast accuracy of potential peak demand."*

While some of the surveyed utilities currently account for DER in their forecasts, it is important to gauge how concerned they are about forecasting each DER type and other technologies. As shown in Figure 8, technologies such as solar PV, energy storage, plug-in electric vehicles, and demand response are of great concern to respondents. While other technologies do not raise as much concern across the sample group, at least one participant indicated they were very concerned about these technologies. Furthermore, none of the distribution planners listed every technology as a concern.

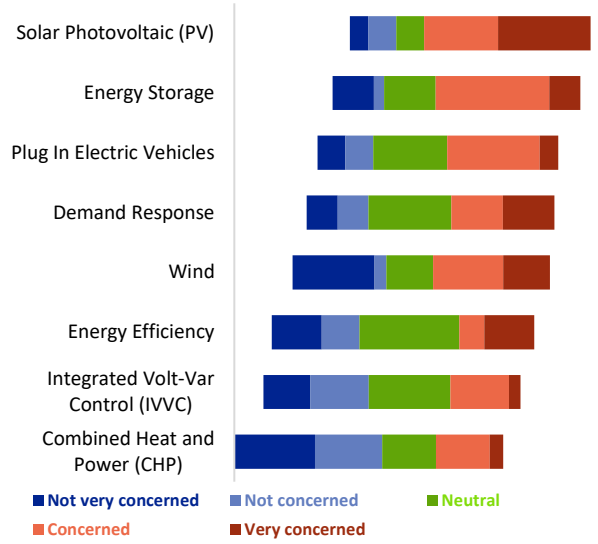


*Figure 8. Level of participant concern regarding the ability to forecast DER and other technologies. Results are centered around the neutral responses and the size of bars indicate the number of responses*

While the reported levels of concern are somewhat related to the existing penetration levels of each technology, no statistical correlation was determined. Most likely, the findings indicate that different utilities are facing different challenges in DER adoption drivers and policy. Nonetheless, research seeking to advance forecasting capabilities for all DER types are needed and could benefit the industry.

Survey participants were asked to characterize the impacts of DER adoption are influencing change in their planning processes, forecasting methods, forecasting tools, and approaches for assessing DER adoption and temporal load with system peak. Results are plotted in Figure 9. As shown, most participants are currently in the process of changing, or expect to see a change in, their planning and forecasting in the next five years. This signals a need to accelerate R&D efforts to address forecasting gaps.

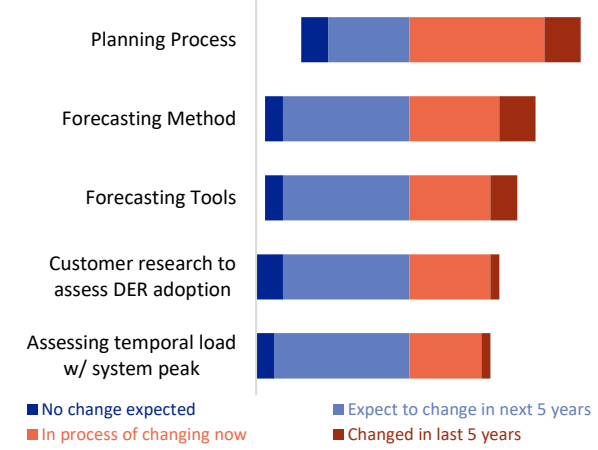


*Figure 9. The effect of DER on respondents' planning process, forecasting method, tools, etc.*

### Additional Challenges

Finally, participants were asked to comment on current challenges, their plans for addressing identified challenges, and to provide additional feedback. Two themes were repeatedly raised: the need for scenario or probabilistic forecasts, as well as the need to address data collection and utilization issues.

Given the increasing levels of uncertainty being brought about by DER and changing customer behaviors, several participants identified a need for methods that can provide probabilistic or scenario forecasts. Per one participant:

> *"DERs introduce a different risk level and intermittency in addition to the load shape. Understanding long term saturation levels of DERs is important too; a regression won't help in determining the inflection point. That said, any level of statistical analysis will be trumped by policy, which creates a significant challenge."*

This concern was echoed by others who expressed a desire for methods that provide statistical confidence intervals, scenario forecasts, and customer propensity to adopt specific technologies. Addressing the uncertainty resulting from the lack of visibility into residential sited PV resulted in one participant indicating a need for:

> *"A guideline for what inputs are needed to do a robust forecast/scenario plan along with some measures that could be taking if not all inputs are available."*

The availability of good data is another concern participants highlighted in their comments. This ranged from the "*integrity of data collection*" to data management issues affecting the data used to perform forecasts. Others mentioned challenges in forecasting large "*lumpy*" loads and the need to rely on stakeholders who often over-forecast these demands.

## IDENTIFIED R&D NEEDS

Review of the survey results lead to the identification of the following research and development needs:

### Collaborative sharing of industry best practices

The survey results clearly show a wide diversity in forecasting approaches and planning needs. While this diversity stems from many factors – data availability, planning needs, etc. – the transfer of technical knowledge through industry documentation of best practices and industry forums will benefit the industry overall.

### Advance DER forecasting methods and practices

While some of the surveyed utilities account for DER in their current forecasts, the survey results indicate that there are concerns about their capabilities to forecast these new technologies. However, there is currently no clear approach for incorporating DER into distribution planning forecasts, driving a need for new techniques and methods. Additionally, while some technologies are of concern to more utilities than others, forecasting advancements are needed for all DER types.

### Improved customer behavior models

Survey results indicate a clear utility interest in working closely with their customer research departments to obtain estimates of customer participation and adoption of new technologies. New technologies and program offerings are increasing the diversity and uncertainty of end-use customer loads. Given that half of the surveyed utilities plan to change their forecasting process in the next five years; a significant opportunity exists to collaborate on how best to incorporate these changes in standard modeling approaches.

### Evaluation of forecasting methods

Many utilities are changing or expect to change their forecasting practices and methods. The ability to evaluate different forecasting options or changes – in terms of quantified system planning benefits compared with the costs to adopt the forecast approach – would support the adoption of new approaches. Assessment tools could also be used to support research to improve forecasting practices, address questions concerning the necessary level of spatial granularity of accuracy, and evaluate the application of new forecasting approaches, such as the probabilistic methods.

### Address data gaps and DER visibility

The masking of the native load by DER is a clear concern among many survey participants. Masking of the native or true load is a concern as it may result in unexpected overloads if the DER is not operating as expected during peak loading conditions. The development of planning guidelines to generate robust forecast and scenario plans can help to overcome deficient visibility into behind-the-meter DER.

### Enable scenario and probabilistic planning

Respondents indicated that increasing levels of uncertainty due to increasing proliferation of variable and intermittent DER as well as macro-level issues, such as policy changes, are not accounted for in their current forecasting methods and tools. Research will need to address multiple areas – including data and model requirements, development of new forecasting techniques and industry guidance, and the identification of probabilistic and scenario-based planning requirements and best practices.

## REFERENCES

[1] Forecasting for Active Distribution Planning: Surveying the Current Load and DER Forecasting Landscape. EPRI, Palo Alto, CA: 2017. 3002010992.