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Load Forecasting in Electric Utility Integrated Resource Planning

EXECUTIVE SUMMARY

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Executive Summary

Integrated resource planning (IRP) is a process used by many vertically-integrated U.S. electric utilities to determine least-cost and risk-managed portfolios of supply and demand-side resources that meet future electricity needs of customers, comply with regulatory requirements and government policy objectives and, in many cases, fulfill obligations to shareholders. Integrated Resource Planning evolved in the late 1980s and 1990s from least-cost planning (LCP), which was developed to ensure that demand-side measures to reduce electricity consumption—especially end-use energy efficiency—were considered by utilities in addition to supply-side (generation) resources. Forecasts of energy and peak demand are a critical component of the IRP process. There have been few, if any, quantitative studies of IRP load forecast performance and its relationship to resource planning and actual procurement decisions.

In this study, we conduct a retrospective analysis of energy and peak demand forecasts for a set of integrated resource plans published by electric utilities operating in the Western United States. We analyze energy and peak demand forecasts from utility IRP plans filed in the early- and mid-2000s and compare these forecasts to subsequent actual observed loads. We also examine load forecasting techniques and sensitivity analyses; performance over time; the relationships among load forecasting, resource planning, and procurement; and strategies that utilities used to manage uncertainties in future load forecasts.

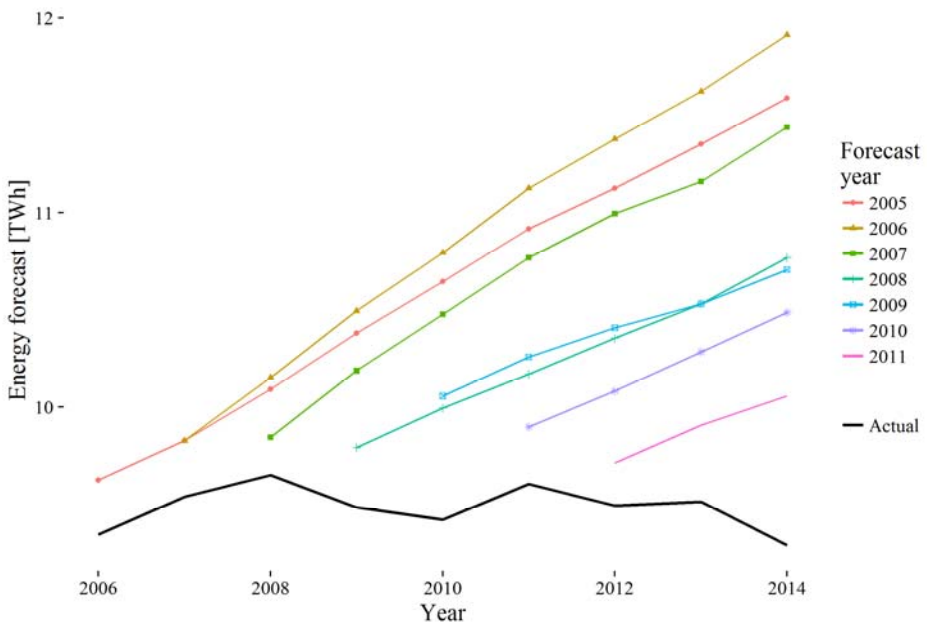

Figure ES-1 Load forecasts from seven subsequent IRPs and actual load for a Western U.S. utility.

A comparison of load forecasts to actual energy use and peak demand reveals that energy consumption growth was overestimated by all but one utility over planning periods beginning in the mid-2000s and ending in 2014. Moreover, peak demand growth was also overestimated in eight of the eleven cases we examined (those utilities that reported their peak forecasts). Utilities that projected the highest growth rates in energy and peak demand also experienced the lowest actual growth, especially for observed energy consumption.

Furthermore, examination of forecasts from more recent IRPs indicates a persistent overestimation of demand growth over planning periods up to year 2014, even in the presence of much slower-than-anticipated actual growth (see Figure ES-1 for an example from one utility). A number of the utilities highlighted the effects of the national recession that began in 2008-2009 to explain this phenomenon. Over time, the utilities did adjust their forecasts of projected load growth downward in response to lower-than-expected demand, but continued to overestimate future loads. Most of the utilities indicated that they expected national and regional economies would follow a historical pattern of relatively quick recovery from the recession, which influenced their load forecasts in more recent plans. Accordingly, the slower-than-expected economic recovery contributed to over-estimates of future load in more recent IRPs.

We find some correlation between forecasting methods—and their relative complexity—and forecast accuracy. In addition, utilities that had the most accurate peak demand forecasts were also among the most conservative in terms of their expected peak demand growth. Utilities with relatively more complex models had less forecast error than those that employed simpler models. There are structural reasons that may also explain the relative accuracy of load forecasts. For example, we find that utilities with a larger share of industrial load in their mix generally had larger forecast error. We believe that this may be caused by the highly elastic and “lumpy” nature of industrial customer load as well as the difficulty in predicting entry and exit of industrial customers from a utility service territory. These results suggest that, among the utilities we studied, there may be small marginal benefits to the planning process of greater model complexity.

Load forecast sensitivity analysis is an important component of risk assessment and management within IRP process. In the context of our study, sensitivity analyses are especially important because strategies derived from load forecast sensitivity analysis may allow the resource plans to adjust as new information comes in. Over time, we find that utilities have improved the breadth and sophistication of their load forecast sensitivity analyses. However, we find that both older and more recent IRPs generally lack an adaptive component that details how utilities would respond in practice were subsequent actual values of critical input variables—like load — to correspond to those studied in these sensitivity analyses rather than to those assumed in "base cases." We also find that load variation from the base case produces differences in projected revenue requirements for utilities that are much larger than the differences in revenue requirements from the resource portfolios that are designed and compared to select the “preferred” one.

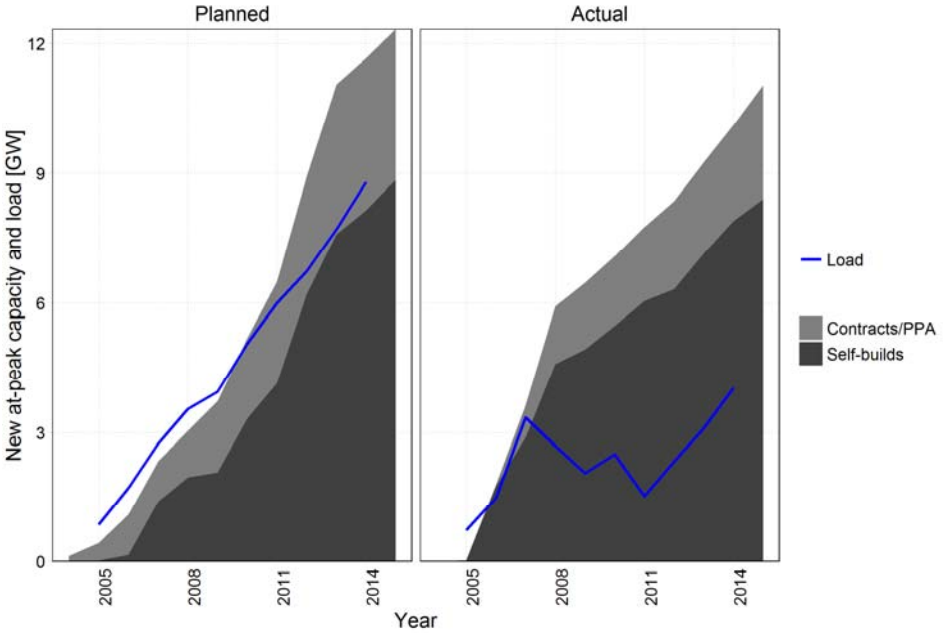

Figure ES-2 Planned and actual (procured) at-peak capacity with forecasted and observed peak demand.

For this sample of utilities, we find that aggregate planned and actual capacity expansion levels were generally consistent over the time period of our study. However, in aggregate, actual resource procurement decisions were not closely aligned with observed changes in load (see Figure ES-2). Actual incremental capacity additions were partially attributable to retirements of existing plants, which accounted for about 2.5 GW among our sample of utilities.

We find that load forecast methodologies have not changed significantly in the past 15 years, although there is evidence in more recent plans of the inclusion of potential structural change drivers such as distributed energy resources and electric vehicles. We did find that utilities which fundamentally changed their forecasting techniques had relatively larger forecast errors in earlier periods. This suggests an active effort to by the utilities to react to forecast error, although we do not have evidence that these changes led to reduced forecast error in subsequent periods. In general, we believe that our findings of load forecast performance and their relationship to procurement are applicable to current resource planning and procurement processes.

Our findings suggest that (1) load forecast accuracy may not be as important for resource procurement as previously believed, (2) load forecast sensitivities could be used to improve the procurement process, and (3) comprehensively addressing load uncertainty should be prioritized over developing more complex forecasting techniques. To the best of our knowledge, this is the first comparative and retrospective study of long-range energy and peak demand forecasts for electric utilities. We identify several key topics for further research to better understand the results and inform industry stakeholders about the role that load forecasts play in electricity sector infrastructure investments.