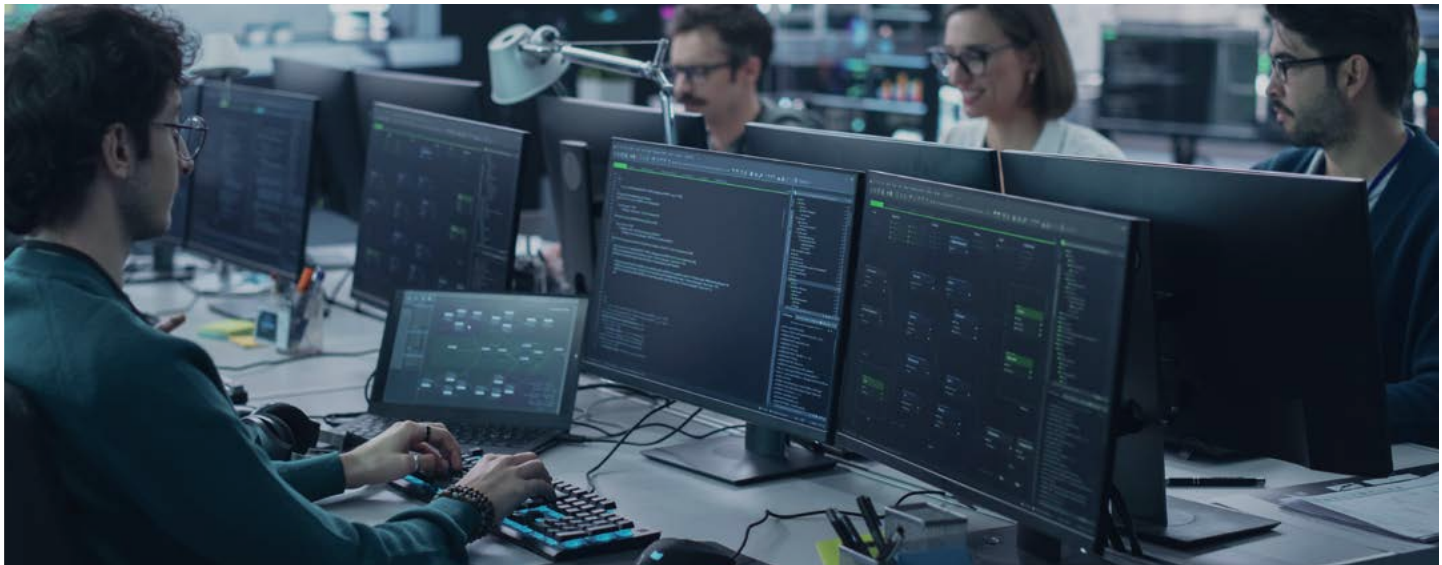
Electric utility resource adequacy planning:

Introducing HERO – ICF's integrated platform to accelerate portfolio optimization, improve decision quality, and better engage stakeholders

Introduction

Rapid changes in electricity demand growth, technology, operating environments, and policy outlooks are forcing the utility industry to modernize its resource adequacy and planning processes to be more comprehensive, efficient, and transparent. Stakeholders are concluding they need an integrated and timely approach that permits simultaneous optimization of a broad range of energy supply and demand options. Since traditional planning methods are often siloed, expensive, time-consuming, and hard to understand, a new approach is needed.



This paper provides insight into these planning challenges and outlines a new approach to scenario evaluation, system planning, and decision support. It then introduces ICF's Holistic Energy Resource Optimization (HERO) platform, which allows for rapid comparison of generation, transmission, distribution, demand-side, and policy alternatives based on their reliability, cost, risk, capital requirements, rate impact, emissions, employment, and other factors.

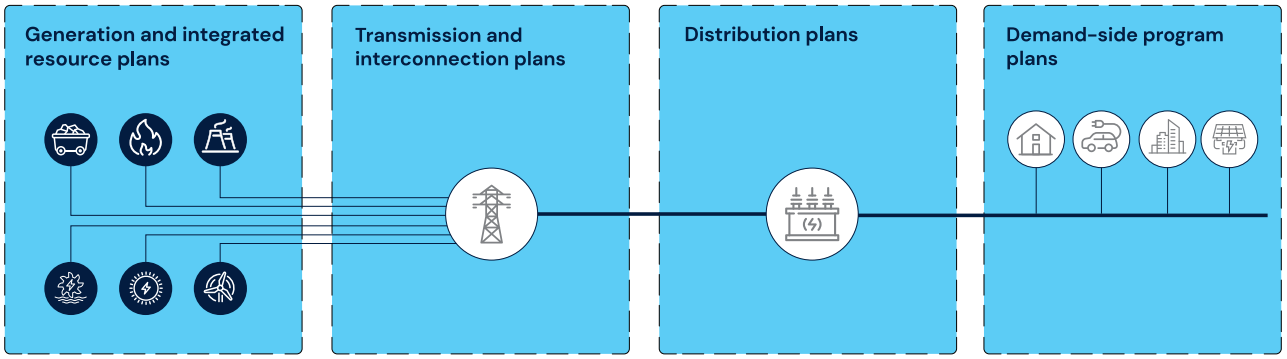
Finally, a case study demonstrates how planners can use the HERO platform to explore the impact of different scenarios and resource portfolios, and how HERO's decision-support features can be used to engage and build support with stakeholders. Insights delivered by HERO for the case study utility include:

- A broad mix of resources—including wind generation, gas generation, and transmission and distribution upgrades—and demand-side programs are necessary to meet reliability objectives.
- The resource mix is affordable from a rate and economic development perspective.
- The resource mix mitigates risks associated with uncertainty in the load forecast and the potential for stranded assets.

The problem with traditional planning

As shown in Figure 1, traditional planning typically has (at least) four general workstreams: 1) load forecasting, generation expansion, and integrated resource planning; 2) transmission and interconnection planning; 3) distribution system planning; and 4) demand-side program planning. While there are variations for utilities that are not vertically integrated, and demand-side planning may be split into components, the workstreams in most states are on different cycles, with different time horizons, using different assumptions, and are all resource intensive.

Figure 1: The challenge — Siloed, expensive, and time-consuming planning



Frequency	**2–5 years**	**3–5 years**	**3–5 years**	**3–5 years**
Timeline	**1–2 years**	**1–2 years**	**1–2 years**	**6–12 months**
Planning horizon	**15 years**	**10 years**	**5–10 years**	**3–5 years**

*Additional planning and capital approvals occur during rate cases and other regulatory proceedings.

Although these traditional processes were well-designed for their historic purposes, and are typically prescribed by administrative rule and regulatory process, they do not fully address three of today's key challenges, namely:

1. **Growing concern about rates and affordability.** Collective pressures to maintain reliability, modernize the grid, decarbonize, electrify, accommodate AI loads, promote equity, and ensure resilience all require capital investment. To properly understand the cumulative impact on rates and affordability and to allocate increasingly scarce capital efficiently, these categories of investment should be evaluated simultaneously and consistently.

2. **The need for speed.** With the sudden increase in load growth, some utilities are scrambling to meet capacity needs in as few as 2-3 years. While it may be tempting to rely on a generation-focused strategy to meet that load, demand-side options should be given serious consideration due to concerns about supply chain lead times, rising costs, and interconnection challenges—along with a desire to realize locational, temporal, cost, and other benefits that non-generation alternatives can provide. However, unless all the options can be compared quickly enough to meet looming needs for capacity, it seems likely that some otherwise attractive options may receive short shrift.

3. **Accommodating uncertainty and interactions.** Given the computational intensity of many traditional planning models, planners' ability to explore uncertainty is often limited to a "base case" and perhaps a "high" and "low" sensitivity. However, even slight changes in fuel price forecasts, carbon goals, interest rates, technology costs, and load forecasts can have enormous impacts on the composition of a least-cost portfolio. And in many cases, there are other near-least-cost portfolios that have preferable risk, emissions, or capital characteristics that should be considered. Compounding the complexity are interactions between issues such as transmission capacity and siting limitations on renewables, and the ability of demand-side programs to eliminate or defer distribution system investments. Such uncertainty and complexity, and the associated risk, can best be explored through the use of many (often hundreds) different scenarios.

Integrated planning with ICF's Holistic Energy Resource Optimization platform

To address these challenges, ICF developed the Holistic Energy Resource Optimization (HERO) platform. HERO allows efficient prioritization of policy and resource alternatives by performing key elements of traditional planning workflows, but does so in an integrated manner.

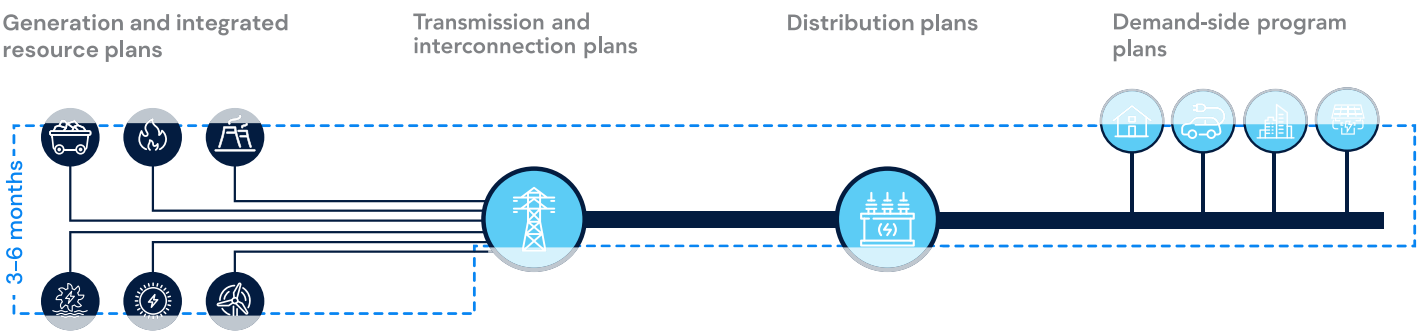
The granularity and geographic scope of the analysis is scaled to meet the specific planning needs, using heuristic techniques where appropriate to speed execution while maintaining the detail necessary for resource prioritization.

This approach is designed to take 3-5 months to complete and to cost a small fraction of the amount typically spent (both internally and externally) on traditional planning studies.

HERO is not a replacement for all elements of the traditional planning tools and workflows. It is, however, a means to explore, prioritize, and justify resource alternatives quickly and to prioritize the ongoing application and alignment of traditional tools where appropriate.

ICF's HERO modeling framework

Figure 2: HERO delivers integrated priorities faster, cheaper, and more transparently

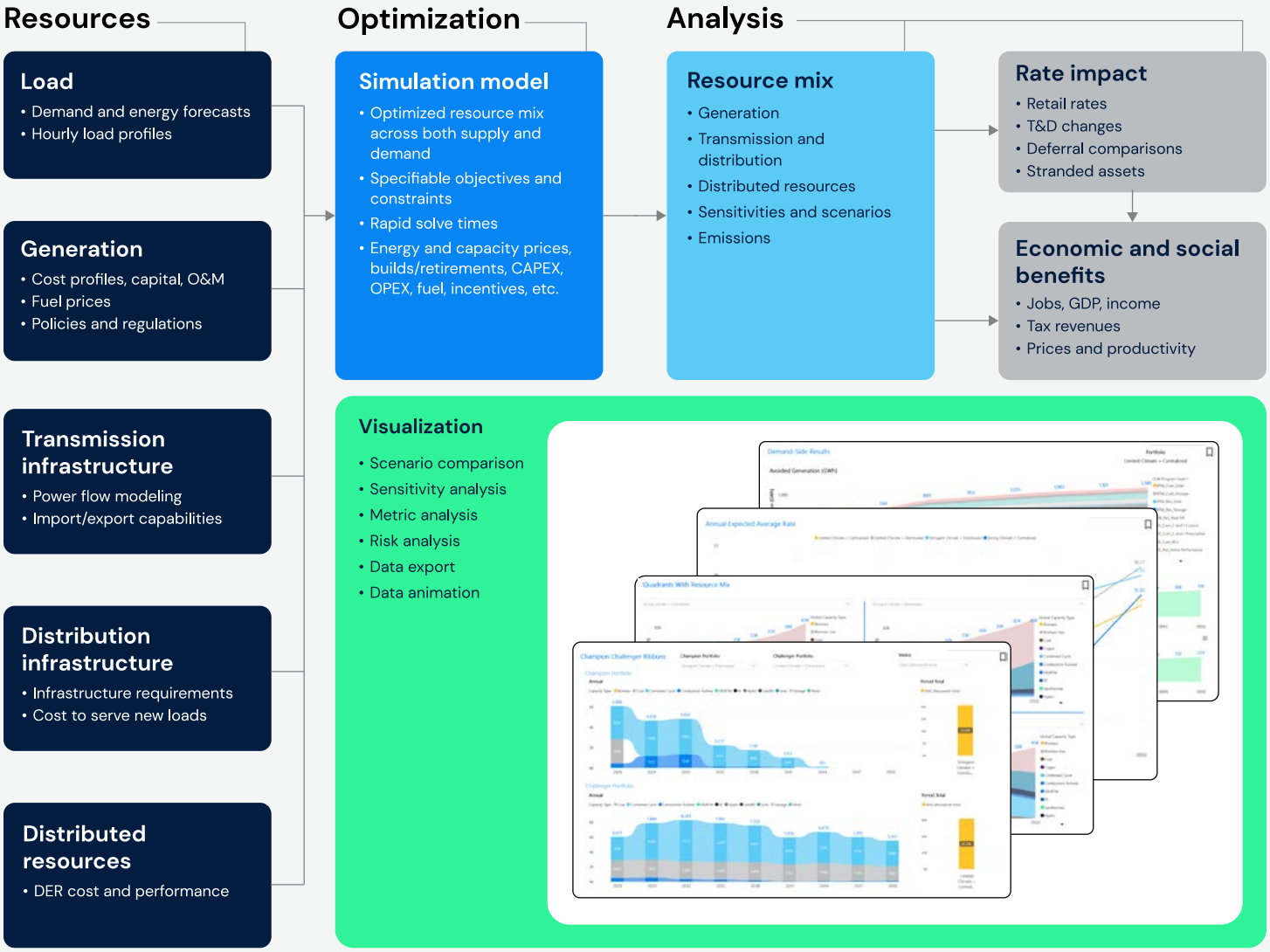


As illustrated in Figure 2, HERO is a combination of sophisticated resource planning tools, incorporating[1]:

- Characterizations of the utility's customer base, load forecast, and associated sensitivities
- Production costing and operating models simulating the utility's generation, transmission, and distribution system and associated constraints
- Supply curves and lead-times for resource alternatives, including traditional generation, renewables, energy efficiency, electrification programs, T&D upgrades, virtual power plants (VPPs), time-based rate designs, demand response, and other programs
- Optimization models to generate resource portfolios meeting certain objectives (e.g., cost minimization) subject to user specifiable constraints (e.g., minimum reliability threshold, emissions ceilings, capital investment ceilings)
- Analysis modules that provide further insight into rate impacts by class, timing of capital requirements, and economic impacts, such as jobs by type, gross state product, taxes, and other metrics
- Sophisticated decision-support dashboards providing data exploration and visualization, which facilitate understanding and communication of potentially hundreds of different scenarios and sensitivities to different audiences

[1] Where a client wishes to use its existing tools as elements of the HERO analysis, such tools can typically be substituted into the process in place of ICF provided tools.

Figure 3: HERO accelerates portfolio optimization and improves decision making



Source: ICF

HERO in action

Prototypical Power Company (PPC) is a hypothetical medium-sized, vertically integrated electric utility with approximately one million customers, 25 TWh of annual power demand, and 5 GW of annual peak demand. This would place PPC in the top 20th percentile of investor-owned utilities based on peak demand. PPC is facing a shifting landscape within its service territory, including:

- Rapid and significant (but uncertain) load growth, driven by a combination of data centers, electrification, and economic expansion
- An aging and constrained transmission and distribution system subject to reliability concerns in the absence of significant additional investment
- Growing pressure associated with rate affordability
- Concerns about local economic conditions and job growth
- Potentially changing state policies regarding the role of gas generation, transmission availability, decarbonization, and demand-side management

In order to maintain safe, reliable, and affordable service, PPC will have to invest in its infrastructure and resource portfolio. PPC's leadership has indicated it plans to adopt an "all-of-the-above" resource strategy to meet its objectives. However, there are divergent opinions both internally and externally regarding how much of each resource is appropriate, and when.

PPC's requirements for the analysis included:

- Identify, analyze, and prioritize the most appropriate portfolio of supply, demand, and policy resources—considering cost, risk, uncertainty, objectives of regulators, and the fair treatment of shareholders.
- Evaluate how the most appropriate portfolio changes under different scenarios regarding emissions and generation technology availability.
- Build support for the business case for a preferred portfolio among customers, regulators, legislators, and other stakeholders.
- Identify key uncertainties, analyses, policies, technologies, and other drivers that must be addressed before committing to the preferred portfolio, as well as any "no regrets strategies" that should be pursued in the near term.

ICF's approach leveraging the HERO platform for PPC included:

- Use of a traditional capacity expansion model used for integrated resource analysis together with a representation of the utility's grid developed from its distribution system topology, capacity, and needs.
- Incorporation of behind-the-meter resources represented by 14 customer-based program types that included energy efficiency, demand response, VPPs, managed charging, and solar and storage DERs.
- Implementation of an optimization function to allow supply-side (including traditional and emerging technologies, such as small modular nuclear reactors) and demand-side resources to directly compete to meet load. The function considered each respective resource's contribution to meeting reserve margin, as well as its impact on costs to upgrade the transmission and distribution systems.
- Evaluation of the alternative resource plans within the platform using a specially developed rate impact model that analyzed the impact of the various scenarios on retail rates. These results were subsequently used in a macroeconomic modeling platform to evaluate impacts on jobs, GDP, income, and tax revenues.

Further, using HERO, ICF analyzed approximately 100 individual scenarios addressing key drivers to inform legislative and regulatory consideration of policy changes that might shape utility strategy. These drivers included carbon policies ranging from non-existent to stringent, support of central-station generation versus support of DERs and customer programs, different levels of load growth—especially growth associated with demand from new data centers, and different assumptions regarding fuel price escalation and generation technology availability and cost.

A sampling of findings that were critical to PPC's decision-making process included:

- Under any scenario, gas generation remains an important contributor to the resource mix, varying between 15% and 20% of new capacity builds.
- Energy efficiency is cost-effective and significant in all scenarios (at 1.9-2.7% of energy sales), with some programs having more reach than others.
- Demand response and DERs can reduce system peak by as much as 10% and have the potential to avoid as much as $3 billion, or 30%, of planned distribution system upgrades.

- A stringent climate policy achieves net zero by 2047, but at a cost premium of $4.6 billion (+15%) relative to no carbon goals.
- Rates are forecast to increase the most under a stringent climate policy, DER-focused scenario—an average of 1.6 cents/kWh, or $157/year per customer, relative to the limited climate policy, centralized generation-focused scenario.
- Average rates, jobs, and economic impacts vary by up to plus or minus 14% across the scenarios.
- If forecasted load growth does not occur and stranded assets result, customers may see an additional $40/month cost for overbuilt generation. Use of demand-side resources instead of generation resources significantly lowers this risk.

Conclusion

To date, traditional utility resource adequacy planning methods have been unable to keep pace with evolving needs to simultaneously allocate capital and minimize rate impacts, make decisions quickly given short-term capacity needs, and address uncertainty related to planning assumptions and resource choices.

To address these needs, ICF's HERO framework incorporates key elements of traditional supply- and demand-side planning methods in a consistent manner but with a much lower burden and expense than typically associated with such methods. It enables rapid exploration of potential resource pathways and scenarios in a newly flexible, timely, and transparent manner. Along with its ability to quickly and thoroughly prioritize and explain different resource portfolios, these features make HERO ideal for any planner or policymaker seeking to explore their options, communicate with stakeholders, and manage risk.