

Research related to Western U.S. resource planning and adequacy

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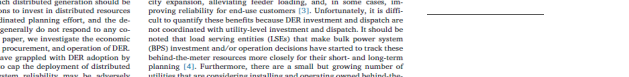
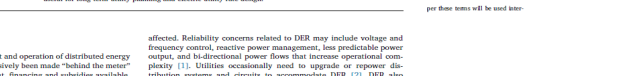
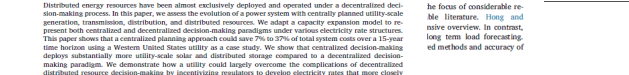
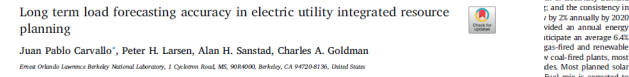
Electricity Advisory Committee

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Background

- Berkeley Lab has conducted research and provided technical assistance to Western U.S. stakeholders on long-term electric utility resource adequacy and planning-related topics since the mid-1980s



Western Interstate
Energy Board



WECC

HIGHLIGHTS

- First whole-system comparison of centralized vs decentralized electricity planning.
- Coordinated planning could save between 7% and 37% of system costs over 15 years.
- Decentralized decision-making leads to suboptimal adoption of renewable solar.
- Inefficiencies solved by setting rates close to the hourly locational marginal cost.

ARTICLE INFO

Keywords: Distributed energy resources; Decentralized decision-making; Electricity rate structure; Power systems; Resource planning; Resilient solar.

ABSTRACT

Distributed energy resources have been almost exclusively deployed and operated under a decentralized decision-making process. In this paper, we assess the evolution of a power system with centrally planned utility-scale generation, transmission, distribution, and distributed resources. We adapt a capacity expansion model to represent both centralized and decentralized decision-making paradigms under various electricity rate structures. This paper shows that a centralized planning approach could save 7% to 37% of total system costs over a 15-year time horizon using a Western United States utility as a case study. We show that centralized decision-making enables substantially more utility-scale solar and distributed storage compared to a decentralized decision-making paradigm. We demonstrate how a utility could largely overcome the complications of decentralized distributed resource decision-making by incentivizing regulators to develop electricity rates that more closely reflect time- and location-specific, long-run marginal costs. The results from this analysis yield insights that are useful for long-term utility planning and electric utility rate design.

1. Introduction

Decisions about the deployment and operation of distributed energy resources (DER) have almost exclusively been made "behind the meter" and based on the cost of equipment, financing and subsidies available, and electricity rates. Utility planners have generally not been involved in determining where and how much distributed generation should be installed. It follows that the decisions to invest in distributed resources have not stemmed from any coordinated planning effort, and the decisions to operate these resources generally do not respond to any coordinated dispatch process. In this paper, we investigate the economic value of coordinating the planning, procurement, and operation of DER. To date, distribution utilities have grappled with DER adoption by using the feeder hosting capacity to cap the deployment of distributed generation in locations where system reliability may be adversely

affected. Reliability concerns related to DER may include voltage and frequency control, reactive power management, less predictable power output, and bi-directional power flows that increase operational complexity [1]. Utilities occasionally need to upgrade or rewire distribution systems and circuits to accommodate DER [2]. DER also benefit distribution systems by reducing losses, deferring system capacity expansion, alleviating feeder loading, and, in some cases, improving reliability for end-use customers [3]. Unfortunately, it is difficult to quantify these benefits because DER investment and dispatch are not coordinated with utility-level investment and dispatch. It should be noted that load serving entities (LSEs) that make bulk power system (BPS) investment and/or operation decisions have started to track these behind-the-meter resources more closely for their short- and long-term planning [4]. Furthermore, there are a small but growing number of utilities that are considering installing and operating owned behind-the-

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in the Western U.S. and 1% of electricity demand [5] and the consistency in [6] and the consistency in [7] annually by 2020. Most planned solar fuel mix is expected to be on future demand, fuel consistency within and next the issue.

ing process involves nally intensive. Many sected their integrated lvoates, Public Utility are planning content sts of LSEs operating ouncil (WECC) region, tion for nearly 40 of the electricity in more than a year old, ure planning staff to f load and resource information, including e results presented in available information

per these terms will be used later.

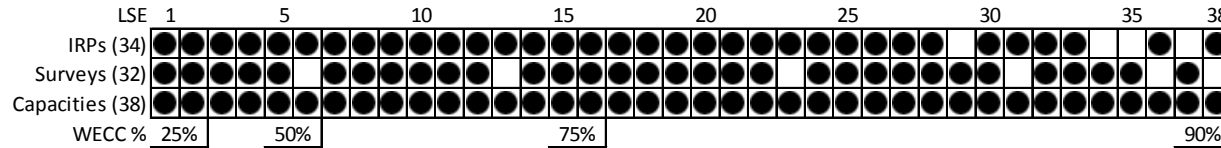


Overarching research questions

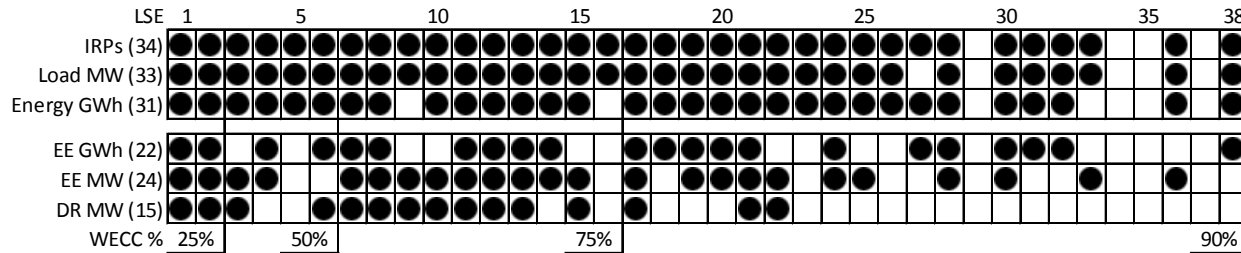
1. How are long-term planning assumptions reported and disseminated?
2. How do long-term planning assumptions compare to actual outcomes?
3. How much are electric utilities relying on the market to supply future resources?
4. What is the value of integrated planning and centralized coordination of distributed energy resources?
5. How might utility planning need to change to integrate with regional resource adequacy assessments?

How are planning assumptions reported and disseminated?

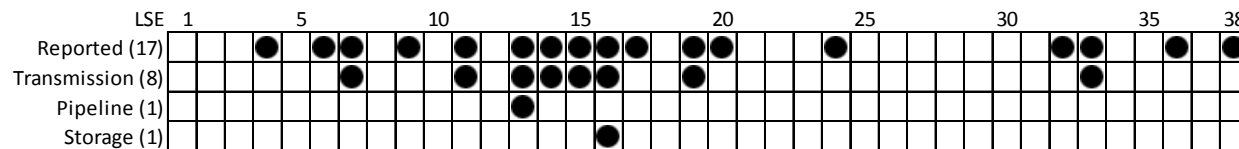
LSEs with publicly-released IRPs, responded to follow-up survey, and reported supply-side capacity information



Load, energy, and DSM forecast data availability

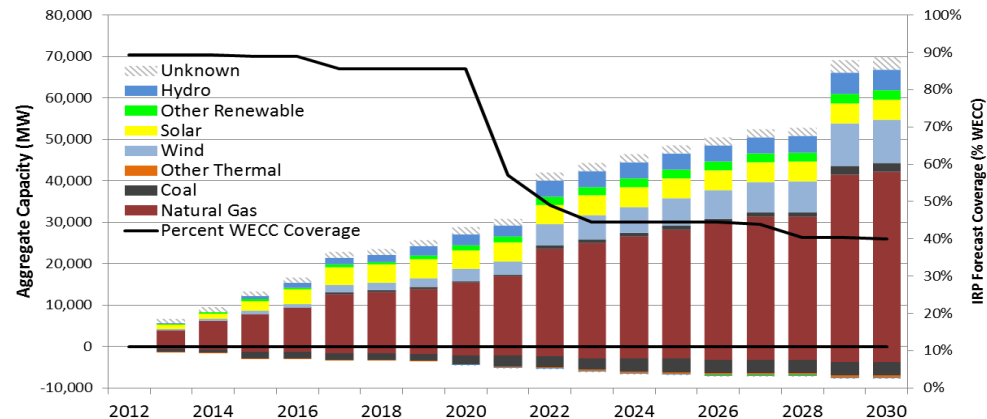


Transmission interconnections, fuel pipelines, and energy storage data availability



How are planning assumptions reported and disseminated?

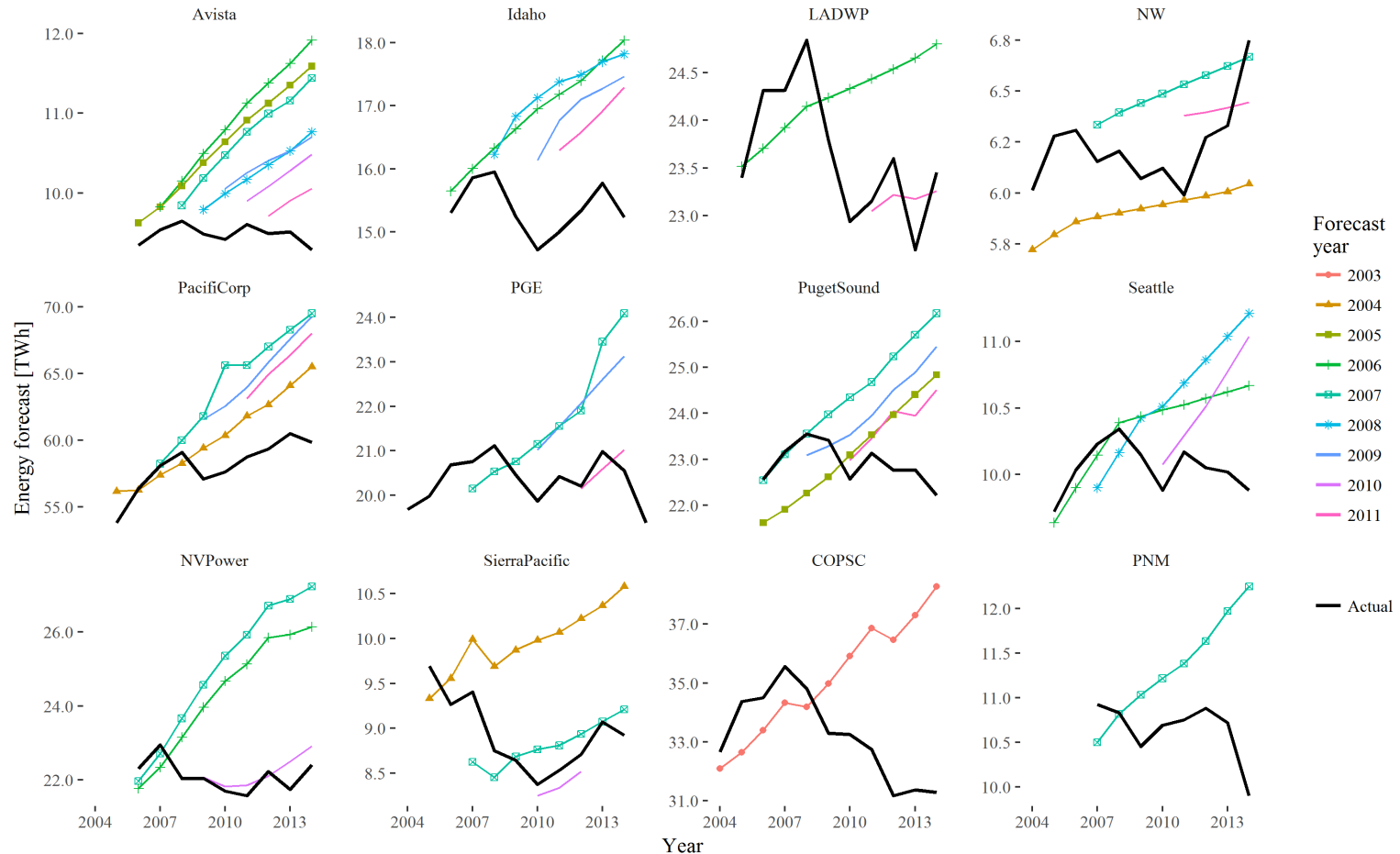
- Berkeley Lab's Resource Planning Portal is an open-source data platform containing long-term planning assumptions from over 130 IRPs filed by 45 utilities



1. Input electric utility planning information in a consistent format
2. Benchmark planning assumptions across jurisdictions
3. Output results in a standardized format for deeper analysis

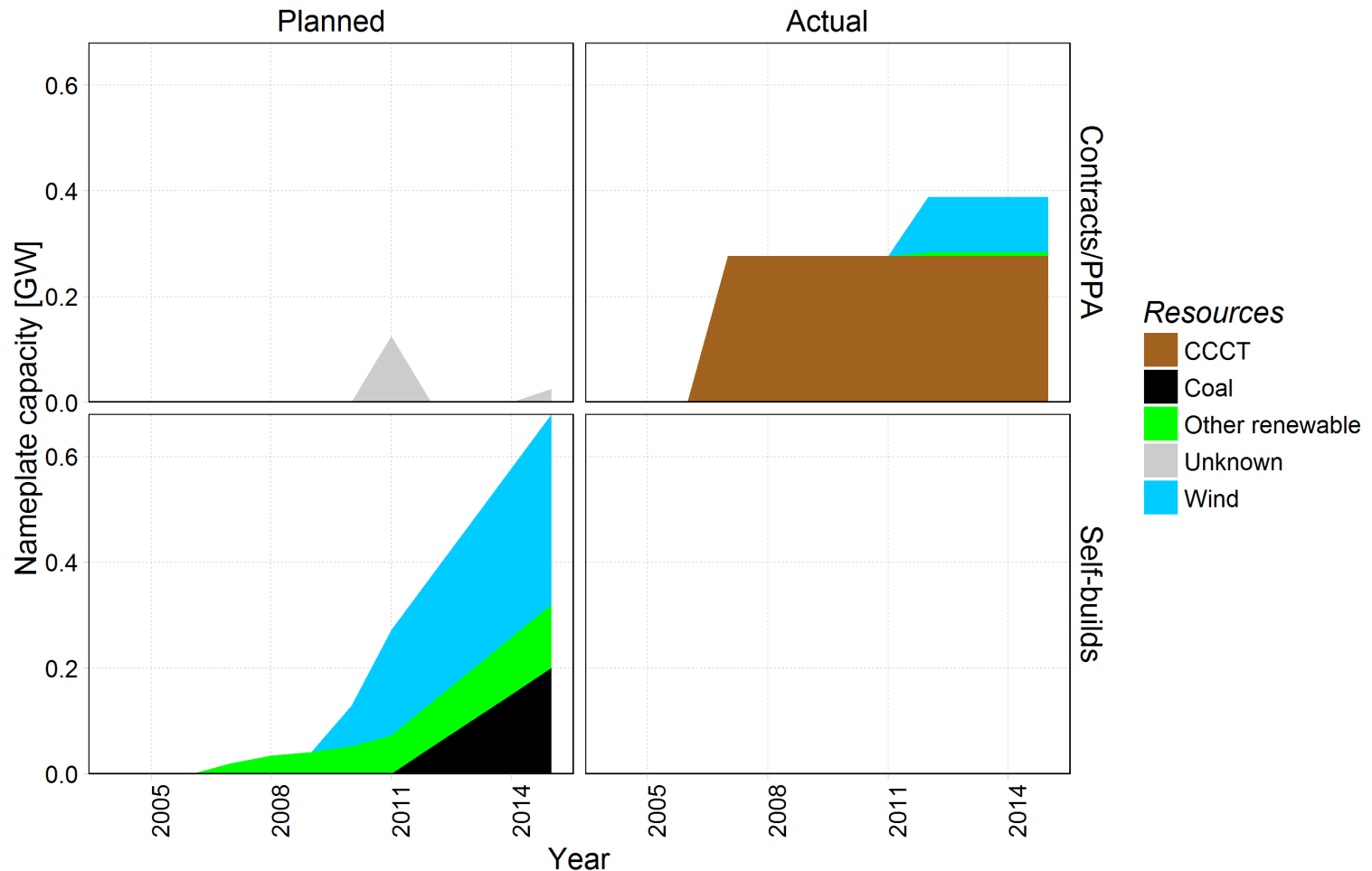
How do planning assumptions compare to actual outcomes?

Western U.S. electric utility energy forecasts versus actual energy consumed



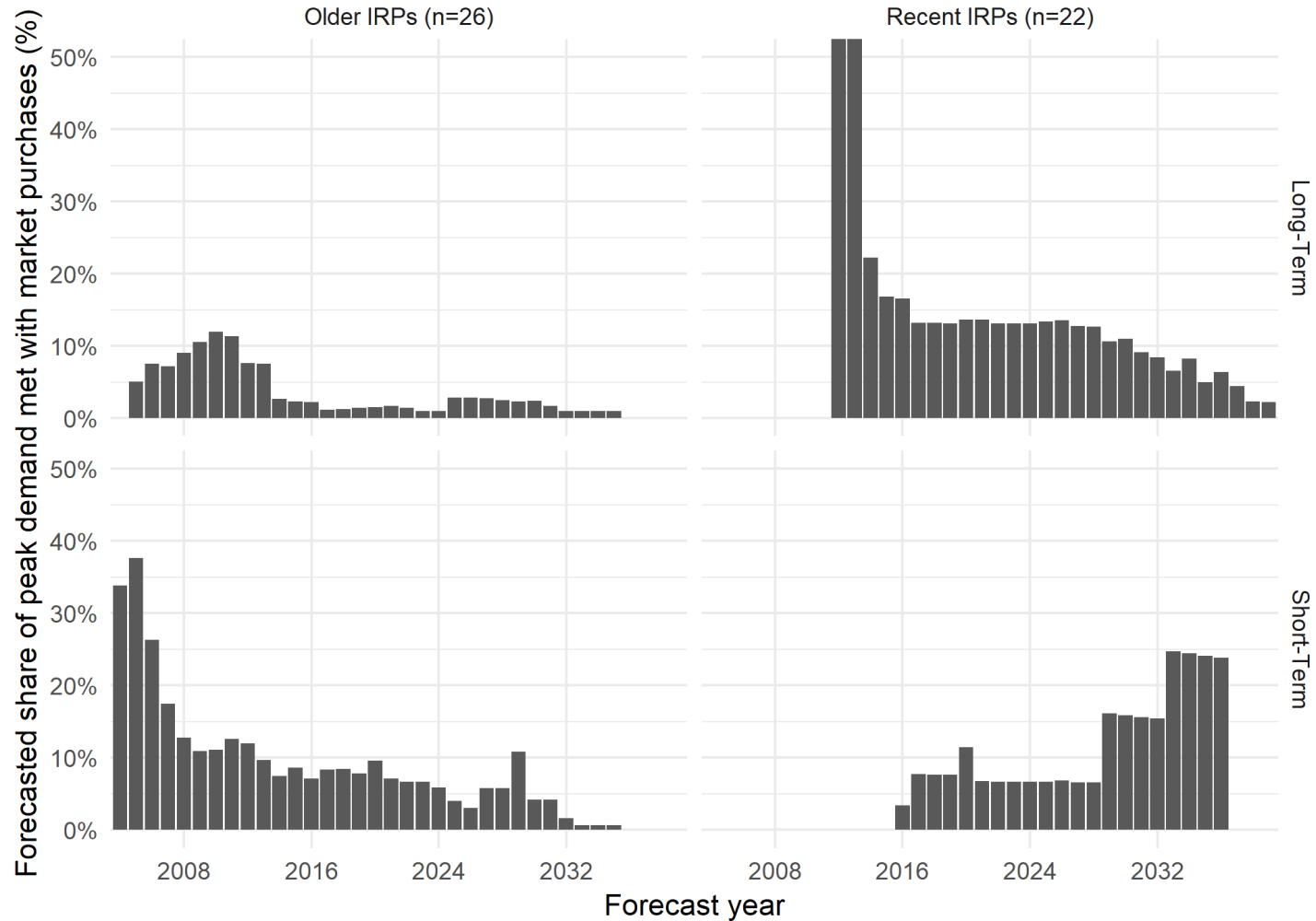
How do planning assumptions compare to actual outcomes?

Comparison of planning and procurement outcomes for a Western utilities



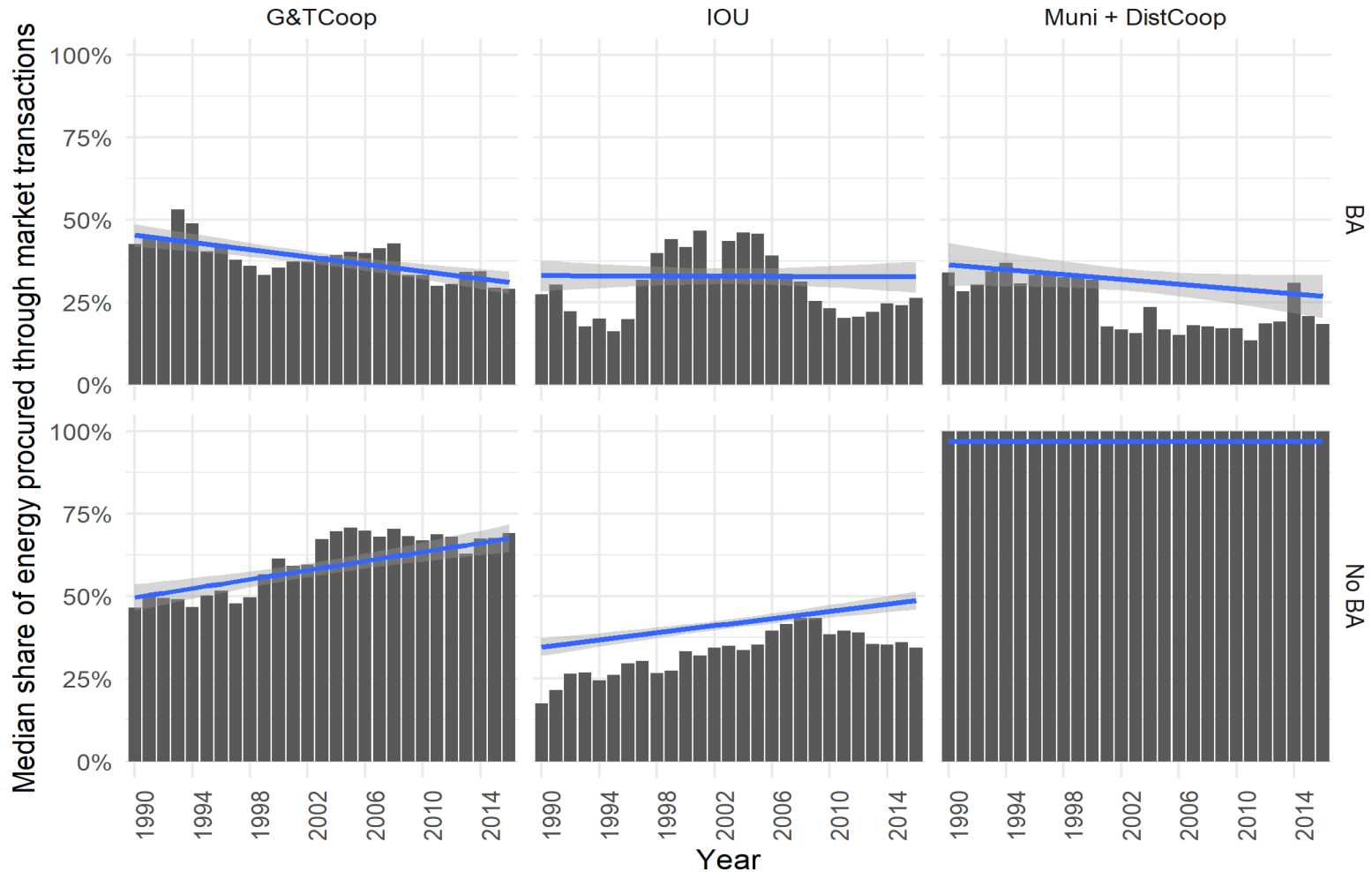
How much are utilities relying on the market to supply future resources?

Forecasted share of peak demand met with market purchases—older versus more recent IRPs



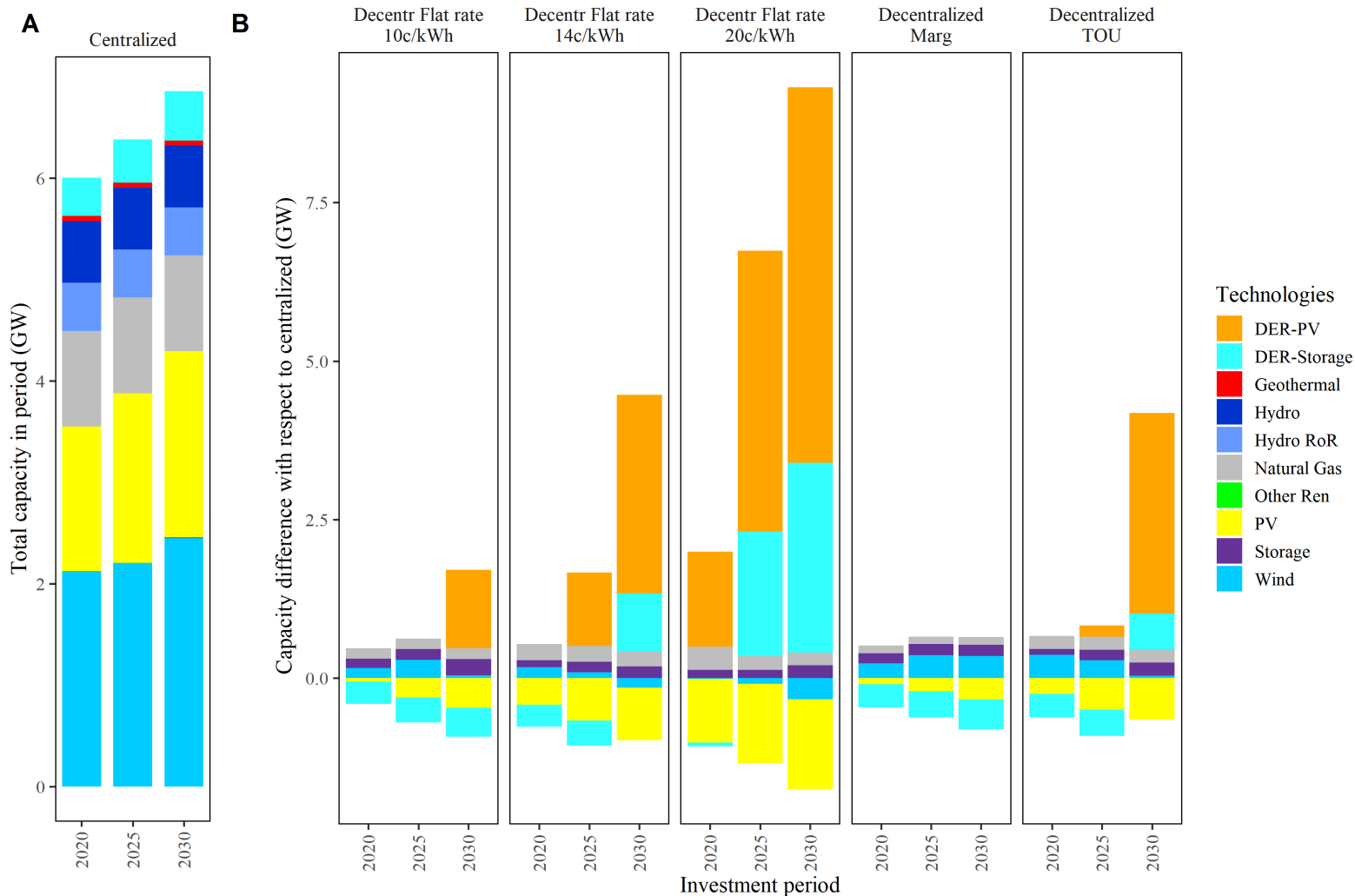
How much are utilities relying on the market to supply future resources?

Share of energy procured through market transactions by utility type and balancing authority participation



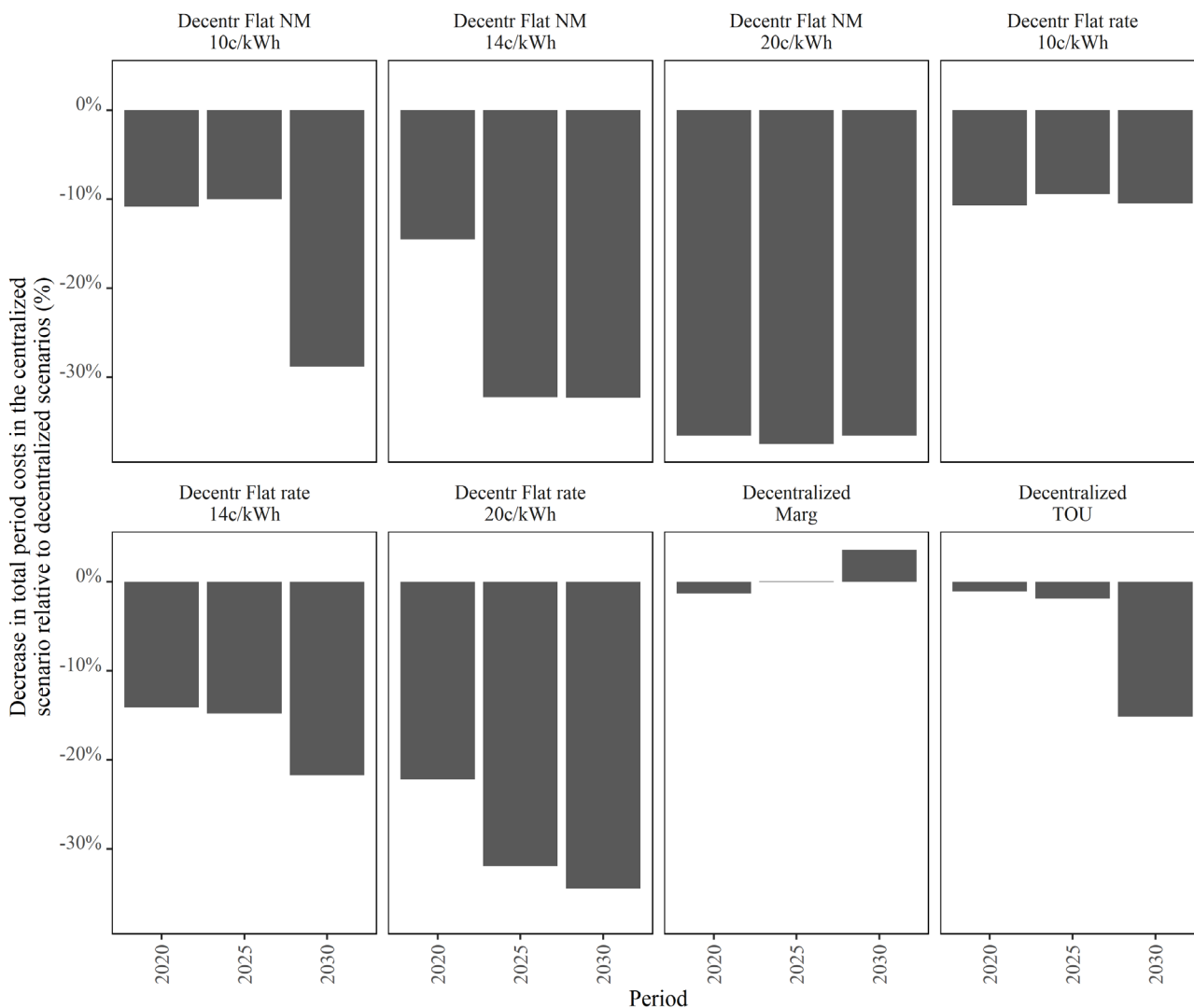
What is the value of integrated planning and centralized coordination of distributed energy resources?

Mix of capacity in the centralized scenario and differences that emerge in selected decentralized scenarios



What is the value of integrated planning and centralized coordination of distributed energy resources?

Percentage decrease in total period costs in the centralized scenario relative to decentralized scenarios



How might utility planning need to change to integrate with regional resource adequacy assessments?

- New DOE-funded research effort that explores the following questions:
 1. *What resource adequacy-related policies and practices are identified in electric utility integrated resource planning?*
 2. *What changes are needed in IRP processes and methods to coincide with regional resource adequacy programs in the Western U.S.?*



- Western Interstate Energy Board (WIEB) and University of Texas-Austin are key research partners

Additional research opportunities

Topic	Challenge
<i>Regional resource adequacy assessment</i>	Can the Resource Planning Portal be upgraded to estimate resource adequacy across the Western U.S.?
<i>Resilience oriented planning</i>	Existing long-term planning methods, models, and processes <i>do not</i> consider resilience of the capacity expansion portfolios. Applied research and development activities are needed to enhance IRPs by including metrics for resilience

Additional research opportunities

Topic	Challenge
<i>Contribution of DER to distribution system reliability and resilience</i>	Limited research into how DER—especially solar PV and battery storage—can improve or hinder reliability and resilience, how these outcomes depend on who owns and operates these resources, and how these impacts should be incentivized or penalized
<i>DER integration with bulk power system planning</i>	DERs, including centralized control of these resources, are not currently integrated into bulk power system planning models and frameworks

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