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WECC 20-year Demand Response Forecast

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Outline of presentation

- Introduction
- Modeling Assumptions
- State-level DR projections

Introduction

Our purpose

- **Previously, Brattle created 10-year potential estimates for SPSC's 10-year High DSM/DR case, which we have now extended to 2032**
  - Our forecast for years 1 through 10 remains unchanged from our previous forecast; in this task, we have developed a forecast for the second decade based on expected long-run DR trends

- **The specific scenario we are modeling is the "high DR" scenario, which represents aggressive yet plausible assumptions about future DR impacts and embeds assumptions about the likely willingness of utilities and regulators to pursue DR**
  - This is based on the "Achievable Participation" scenario for California and "Expanded BAU" for the other WECC states

- **DR projections are based on five DR programs: pricing with and without enabling technology, automated or direct control DR, interruptible tariffs, and other DR.**

The modeling assumptions

Key assumptions that were modified for 2032 include

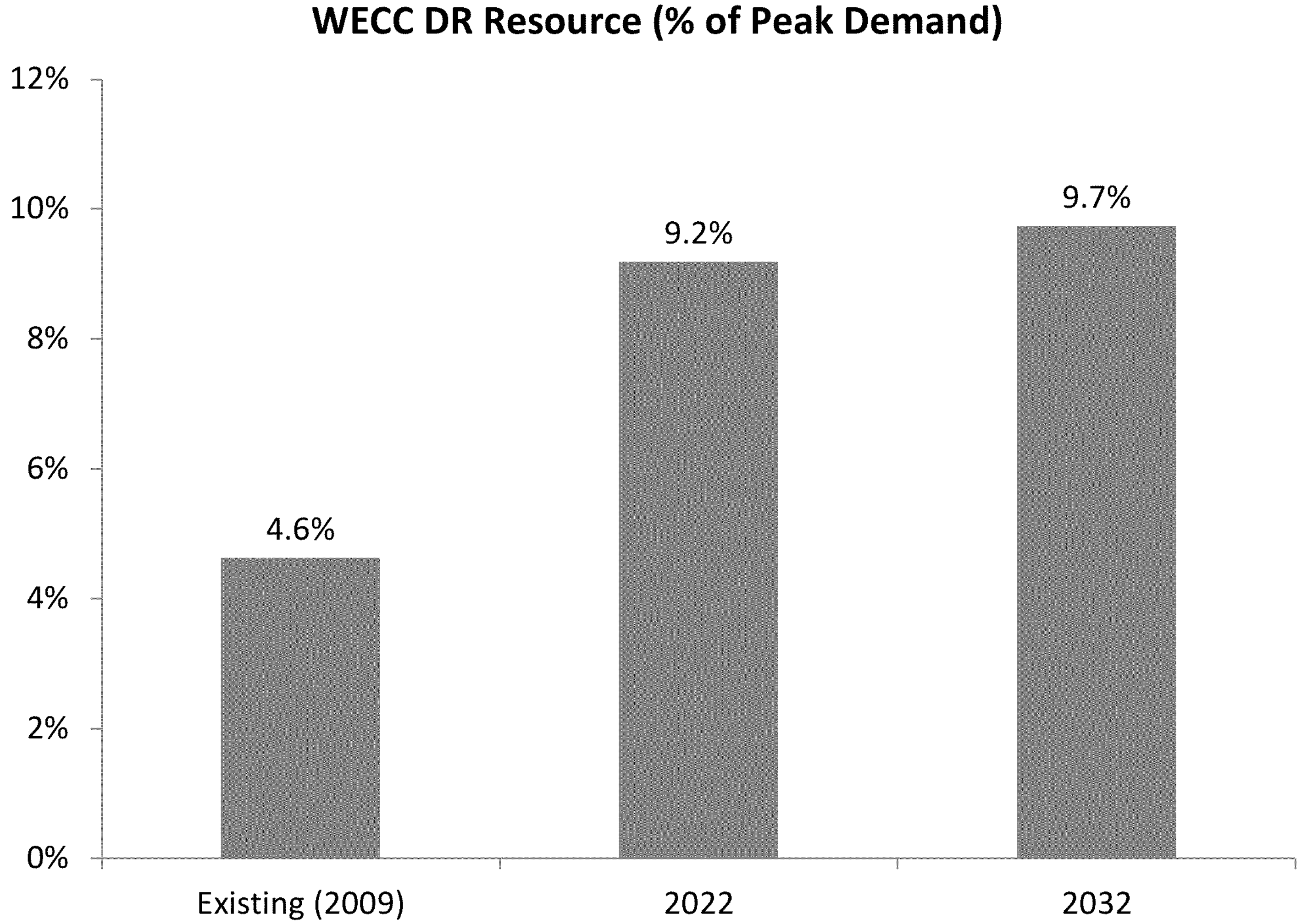
- AMI market penetration
- Residential central air-conditioning saturation
- Direct load control participation
- Dynamic pricing participation

Key assumptions that were not modified include

- C&I DR participation (other than dynamic pricing)
- Average per-customer impacts from DR programs

Other assumptions, such as load growth and customer growth, were linearly extrapolated

Across WECC, DR is projected to reduce peak demand by nearly 10% over the next two decades



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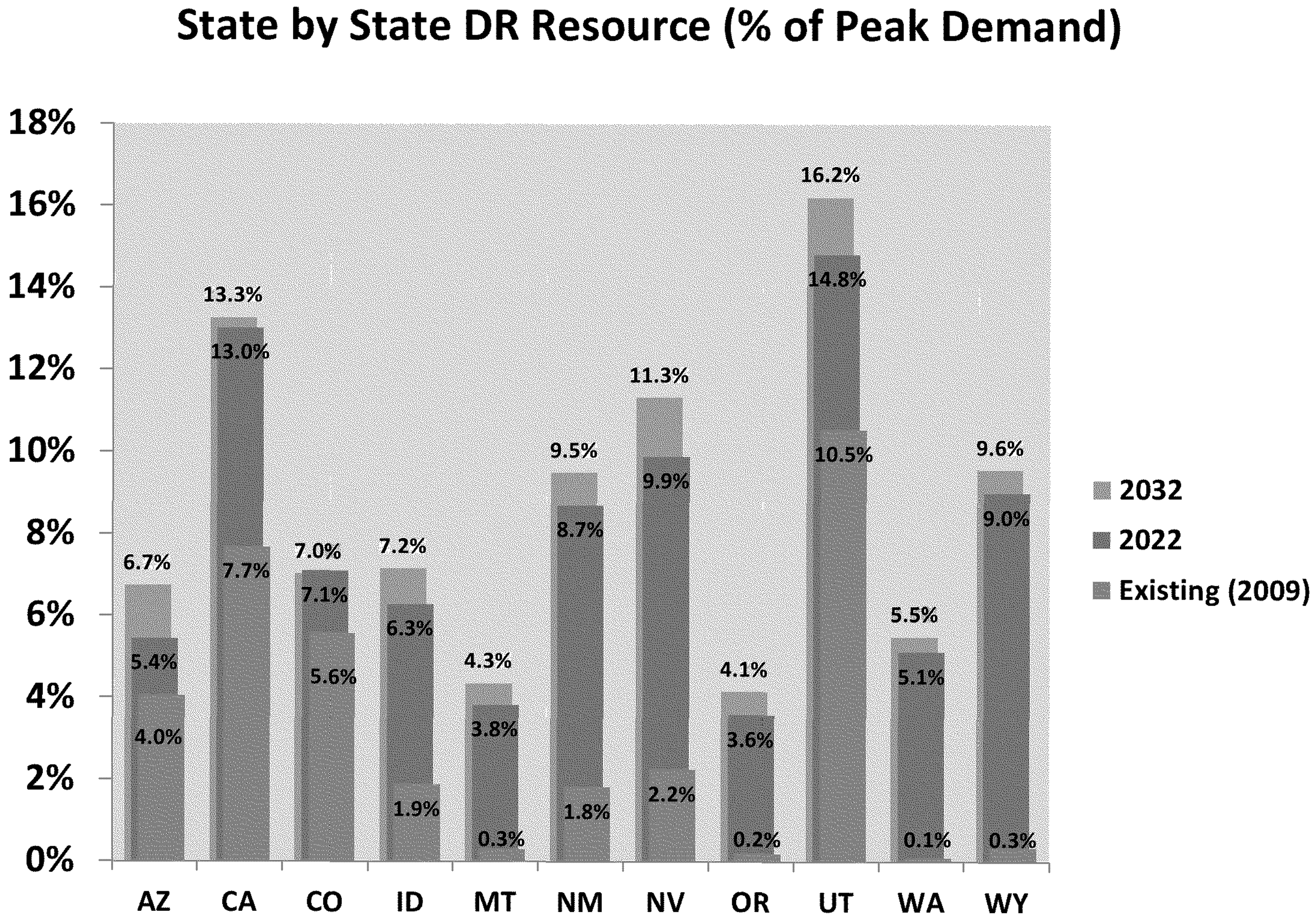
The impact of DR is expected to vary by state



Note: Existing DR is included here as it was reported by utilities to FERC for its 2008 and 2010 Assessment of Advanced Metering and Demand Response.

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Policy and regulatory drivers contribute to the variation in DR impacts

- Possibly the single most influential driver of DR market penetration is the extent to which state regulators support its development
- For example, California's Energy Action Plan prioritizes demand-side resources in the state's energy mix, and the California IOUs have built significant DR portfolios as a result
- Even a general policy focus on demand-side participation, such as Arizona's DSM energy reduction goal of 22% by 2020, has been shown to correlate with greater impacts from DR programs (Smith and Hledik, 2012)
- Support for innovative pricing schemes can also act as an indicator of future DR and dynamic pricing efforts; the Colorado PUC requires that the state's utilities offer an inclining block rate to residential customers
- States without policy support for demand-side initiatives, such as Montana and Wyoming, have demonstrated little DR market penetration

Market drivers also cause DR impacts to vary by state

The generation mix influences the economic attractiveness of DR

- In the Pacific Northwest, reliance on hydropower has limited the need for peaking capacity, since the system is energy constrained
- However, this could change as operational constraints on hydro units increase and new resources are needed to integrate intermittent generation that is coming online

Service territory characteristics also play an important role

- Hot, peaky service territories – such as those in California and the Southwest - are more attractive locations for DR programs, where load reductions in a limited window of hours can lead to a significant drop in system peak demand
- Regions with customers that are more "energy conscious" and have a longer history of experience with DR programs (such as California) are candidates for larger future DR impacts

Technology also contributes to the variation in impacts

- Advanced metering infrastructure (AMI) will allow time-varying rates and new energy management technologies to be deployed to the mass market

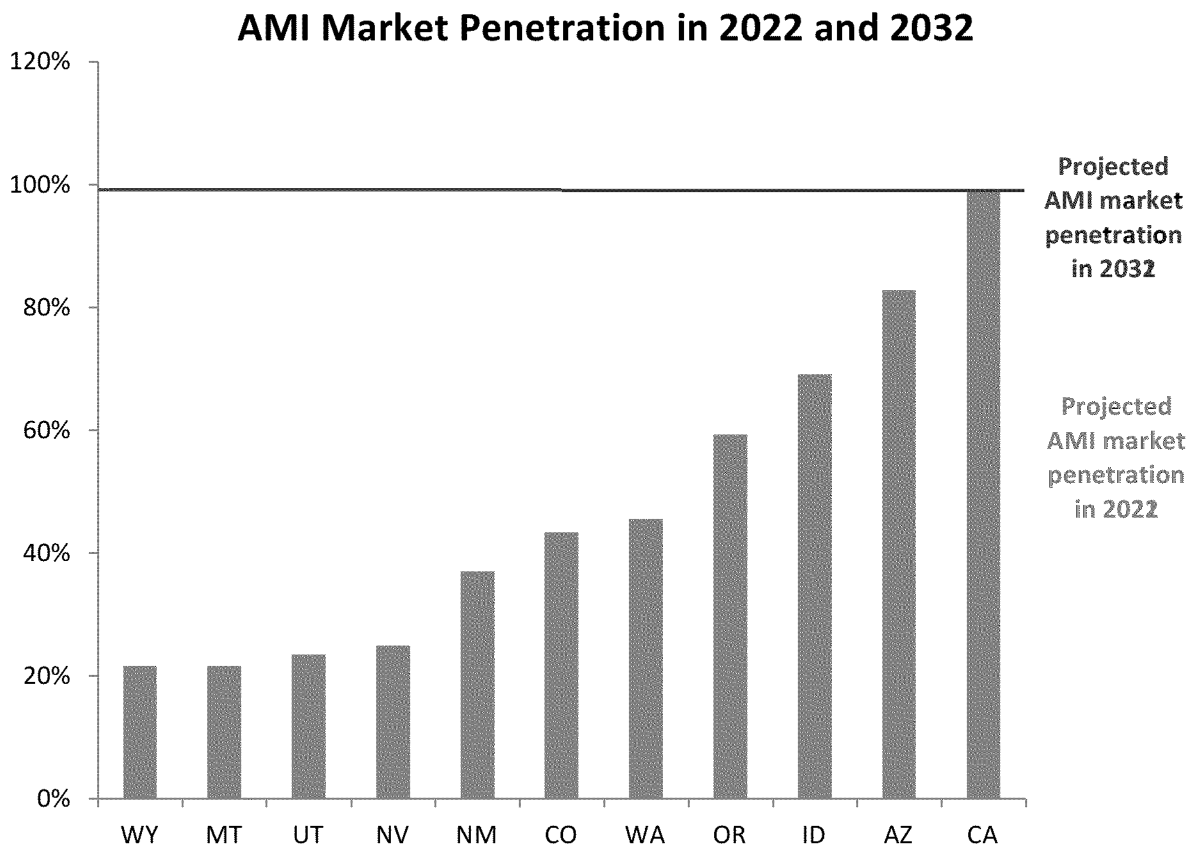
- In the long run, it is assumed that all utilities will eventually transition to AMI; however, some states are more likely to make this transition sooner than others

- Large full-scale deployments of AMI are already completed or significantly underway in Arizona, California, Nevada, and Oregon

- Additionally, service territories with peak demand that is driven by easily-controlled (and large) sources of load, such as air-conditioning and irrigation, are also more likely to have significant DR programs; for example, Utah has a significant amount of existing DR in an irrigation load control program

Modeling Assumptions

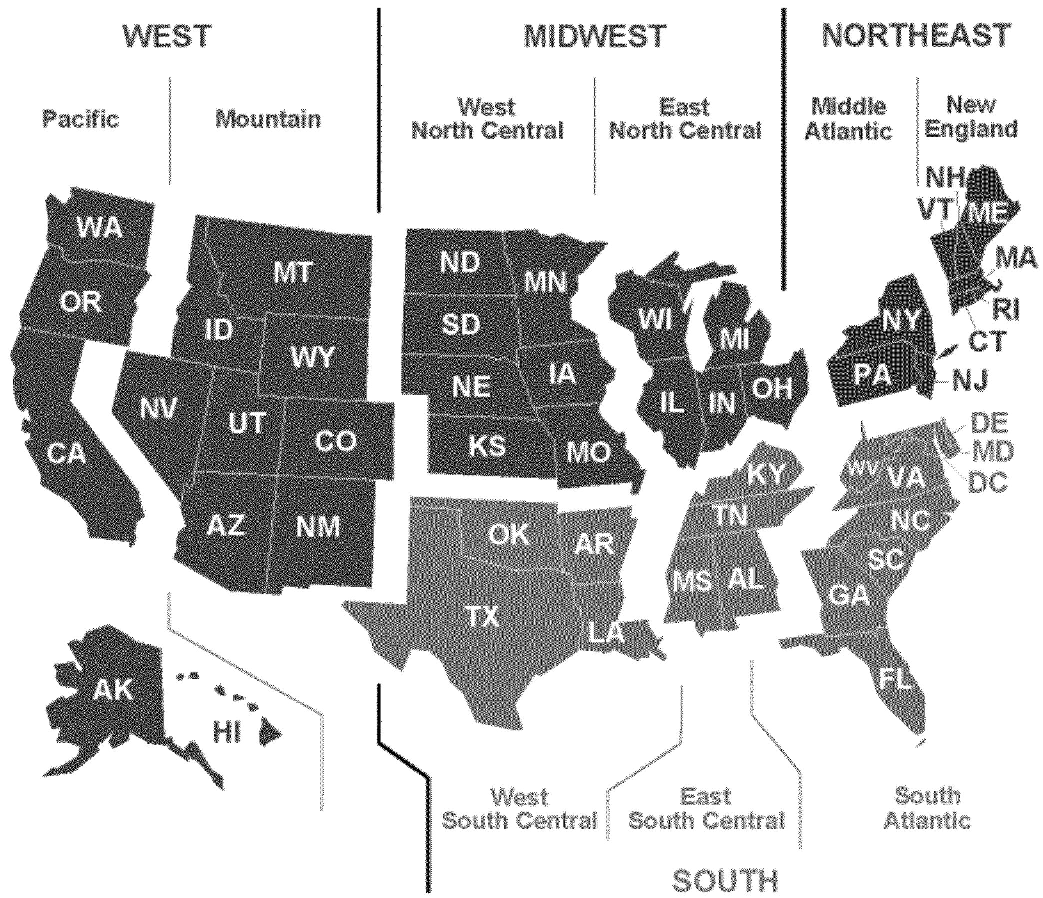
AMI market penetration



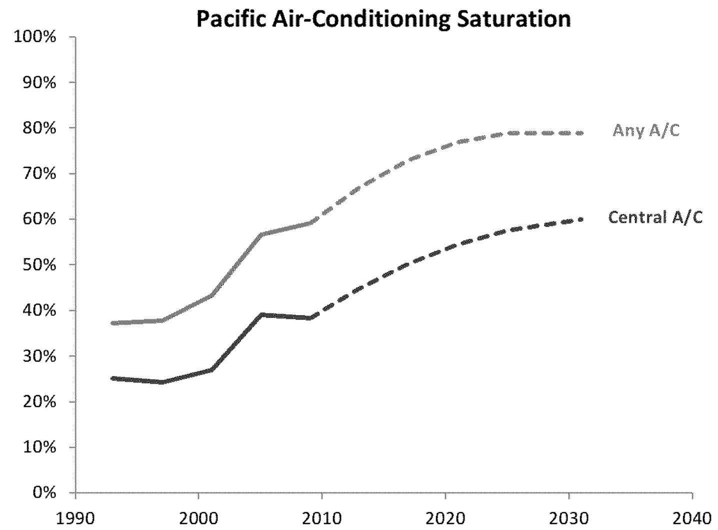
- AMI is assumed to reach full market penetration (99%) in all states by 2032
- We assume 99% penetration to account for opt-out policies and minor technical limitations
- This assumption is driven by the likelihood that technological risk (e.g., the "beta-max problem") and customer backlash concerns will lessen over the next two decades as experience with smart meters increases
- Additionally, we assume that technology costs will come down, and that it will become increasingly expensive to maintain electromechanical meters as metering companies shift the focus of their operations to digital meters

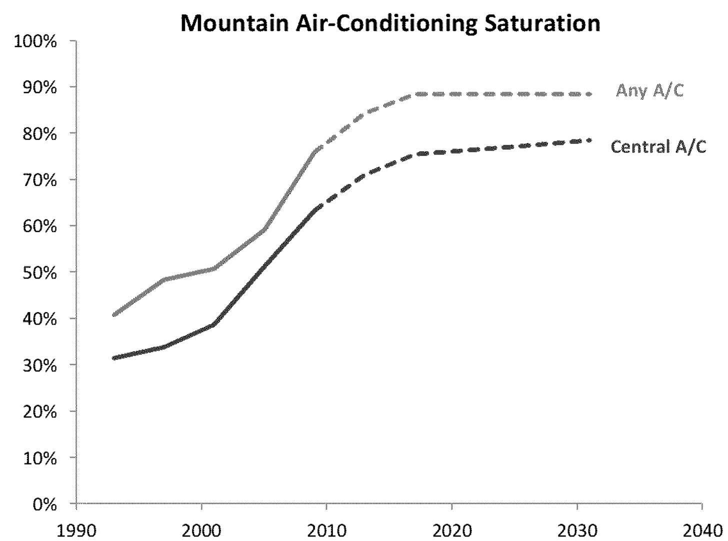
Residential Central Air-Conditioning (CAC) saturation

- Several utilities in the Pacific Northwest expect that the market penetration of CAC will increase significantly over the next two decades
- This is an important assumption, because it influences the number of customers who are eligible to participate in direct load control programs
- It also influences customer responsiveness to dynamic pricing
- To develop the forecast, we relied on historical EIA RECS data, which is available at the Census Division level
- As shown in the map at right, the West is divided into two Divisions, Pacific and Mountain



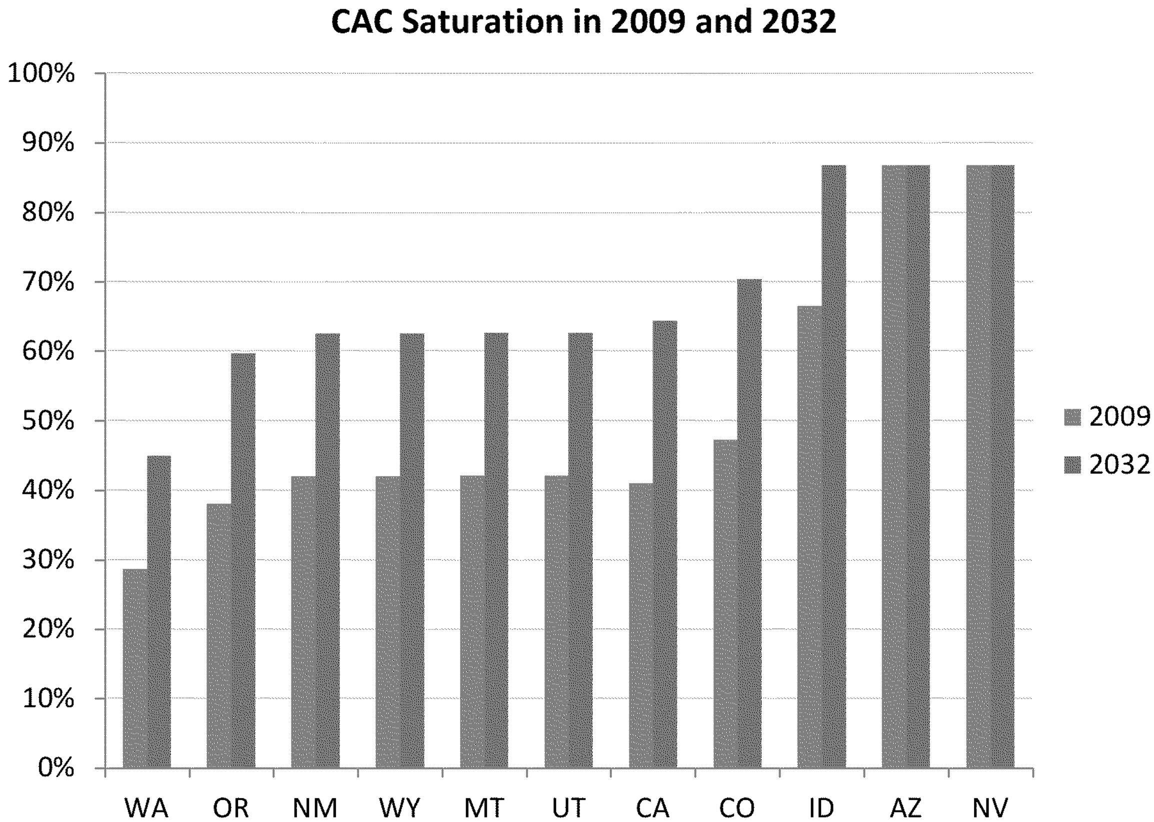
Central air-conditioning saturation (cont'd)





- For the two Census Divisions, we assumed that historical growth in air-conditioning adoption would slowly level off as it approaches full saturation
- CAC share of all A/C is assumed to slowly increase, as housing stock turns over and older homes with window A/C are replaced by new homes with CAC
- Note that the Mountain Division includes the Southwest, which is already at or near full saturation (roughly 90% CAC in AZ and NV), so future growth in the other Mountain states is higher than is represented by the Division average

Central air-conditioning saturation (concluded)



- AZ and NV are already nearly fully saturated and therefore are assumed to remain at 87%
- Pacific states are assumed to grow roughly at the rate of their Census Division's forecast
- Mountain states other than AZ and NV are assumed to grow at 2x the forecasted Mountain growth rate (to offset the lack of growth in the Southwest)
- Idaho's CAC penetration is capped at 87%, which is assumed to be full saturation for the West

Direct load control (DLC) participation

We expect residential DLC participation to increase over the next two decades

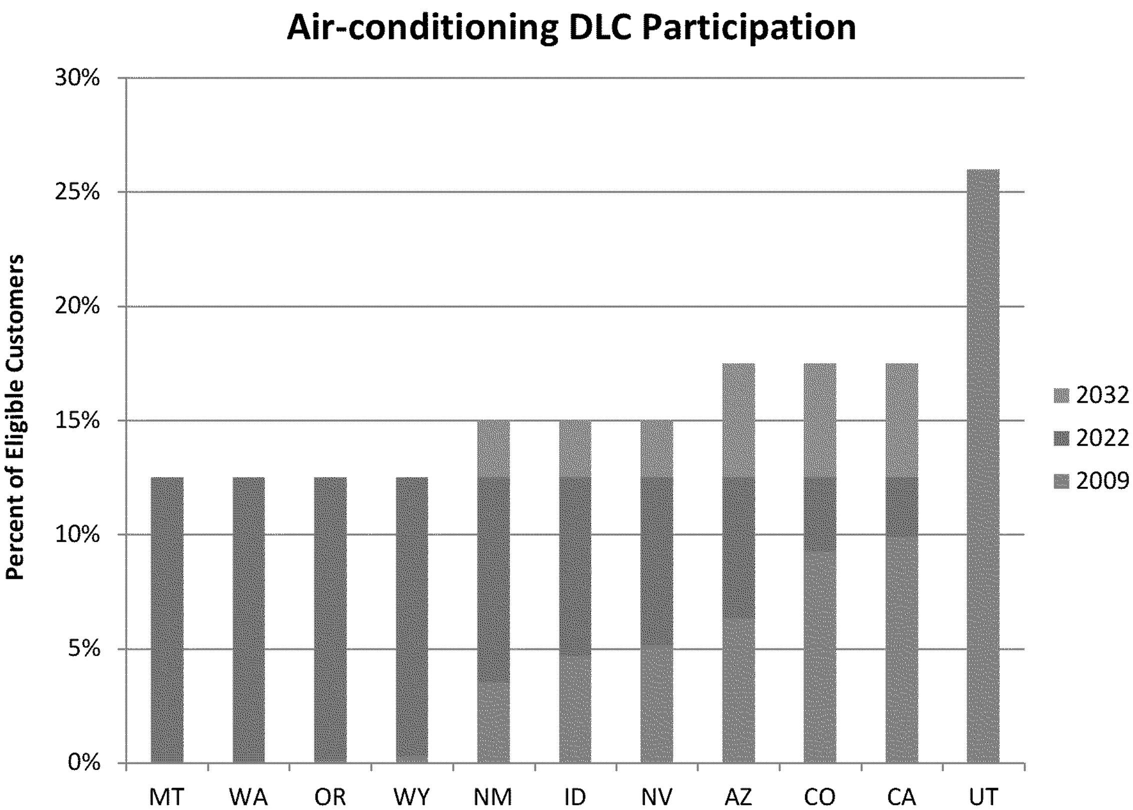
This expectation is supported by a trend toward new appliances being wired with communications technology

A few examples include

- ThinkEco's "modlet" for remotely controlling window A/C (which is currently being tested in New York by ConEd)
- Smart phone apps for remotely managing appliances
- The Nest Learning Thermostat, which improves A/C efficiency and comes with remote control capability

To roughly capture the potential impact of this trend, we have assumed that air-conditioning DLC participation will increase in varying degrees across the Western states over the next two decades

DLC participation (concluded)



- In the 10-year forecast, all states except for Utah are projected to reach EBAU "best practices" participation of 12.5%
- In the 20-year forecast, participation is modified using today's participation as an indication of potential interest in future DLC programs
- States with low current participation (<2%) remain at 12.5% in 2032
- States with moderate current participation (2% to 6%) will grow to 15% in 2032
- States with significant current participation (6% to 10%) will grow to 17.5% in 2032
- Utah, the outlier, remains at 26% due to its already very high participation rate

Dynamic pricing participation

There is lack of industry consensus on the level of enrollment in dynamic pricing programs two decades out

However, it is difficult to ignore the increase in dynamic pricing offerings that have materialized across the U.S. over the past decade (e.g. plans for opt-out dynamic pricing in California, Maryland, and Washington DC, as well as plans for opt-in dynamic pricing in many other states)

Based on this trend it is plausible that, two decades from now, dynamic pricing participation will exceed the 5% to 14% opt-in estimate that was used as the Expanded BAU scenario in the updated 10-year DR forecast, even if most dynamic pricing rate plans are still offered on an opt-in basis

The question is: what will be the new rate of dynamic pricing participation?

Dynamic pricing participation (cont'd)

For each state except for California, we continue to use the "Expanded BAU" assumption that dynamic pricing will be offered on an opt-in basis to all customer classes, but we modify the opt-in participation rate on a regional basis

For California, we continue to use the "Achievable Participation" assumption that dynamic pricing will be offered on an opt-out basis to all customer classes, but we modify the opt-out participation rate

Our four Western regions are defined as follows

- Northwest: OR, WA, ID, MT, WY
- Southwest: AZ, NV, NM, UT
- Colorado
- California

Dynamic pricing participation (concluded)

Region	2022 assumed participation	Factors suggesting higher participation rate in 2032	Factors suggesting lower participation rate in 2032	2032 assumed participation
Northwest	**Res = 5%** **C&I = 5%**	- PGE has deployed AMI and is currently conducting a CPP pilot - Renewables integration challenge and constraints on hydro operations may lead to increased need for flexible demand	- Hydro-based system means low energy prices with limited volatility - Very limited historical interest/experience in DR in the region; focus is on EE	**Res = 5%** **C&I = 5%**
Southwest	**Res = 13.75%** **C&I = 20%**	- 40% opt-in residential participation in TOU rates in Arizona - Needle peak means significant load concentrated in a few top hours; ideal candidate for dynamic pricing		**Res = 20%** **C&I = 30%**
Colorado	**Res = 13.75%** **C&I = 20%**	- Regulators have demonstrated progressive views on retail ratemaking through recent adoption of IBR - Legislation mandates peak reduction goals for IOUs	- Boulder Smart City pilot debacle may have soured CO policy-makers on smart grid programs - Little to no activity related specifically to time-varying rates	**Res = 15%** **C&I = 20%**
California	**Res & Small C&I = 75%** **Med/Large C&I = 65%**		- Recent negative public reaction to smart metering rollout - Lower-than-expected enrollment in C&I opt-out dynamic pricing - Utility opposition to residential PTR as default rate	**Res & Small C&I = 60%** **Med/Large C&I = 60%**

Commercial & industrial (C&I) DR participation

Other than changes to C&I dynamic pricing enrollment, we assume that participation in other C&I programs will remain unchanged in the second decade (on a percentage basis)

Programs such as interruptible rates and demand bidding have been offered to C&I customers for decades

Unless there is a significant change to the incentives offered to participate in these programs, there is little justification for assuming that enrollment will increase beyond the "best practices" participation rates that are already embedded in the Expanded BAU scenario

	Small C&I	Medium C&I	Large C&I
Automated/Direct Load Control	1.2%	7.2%	NA
Interruptible/Curtailable Tariffs	NA	1.7%	9.0%
Other DR Programs	NA	0.1%	20.0%

Per-customer DR impacts

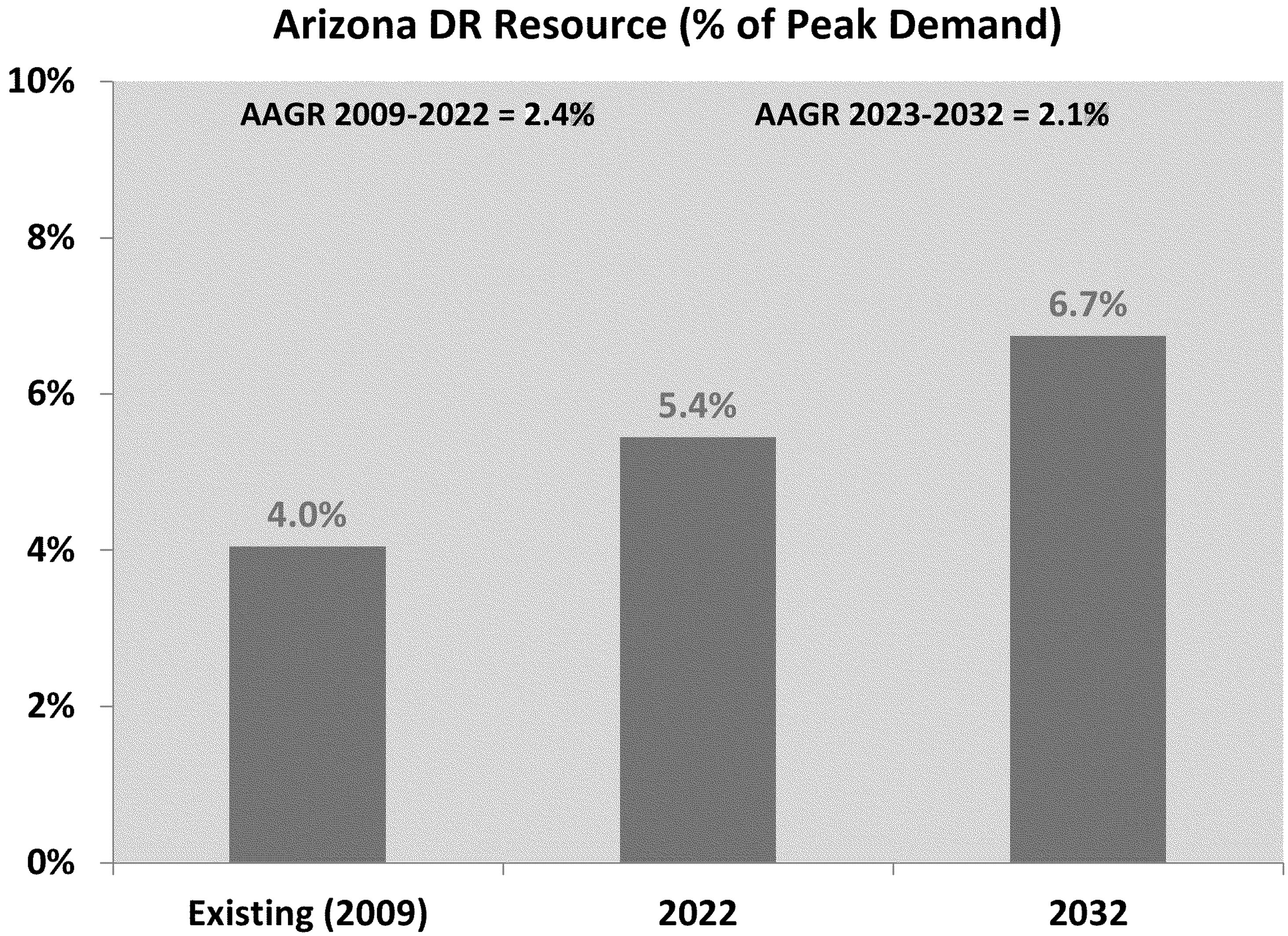
The per-customer impact of DR programs is assumed to remain constant through the 20-year forecast horizon

These impacts have been carefully estimated using the most recent available information on customer price responsiveness and willingness to curtail

- FERC's 2010 survey of utility DR programs
- Brattle's 2011 survey of DSM experts
- Brattle's 2012 survey of dynamic pricing pilots

State-level DR Projections

Arizona



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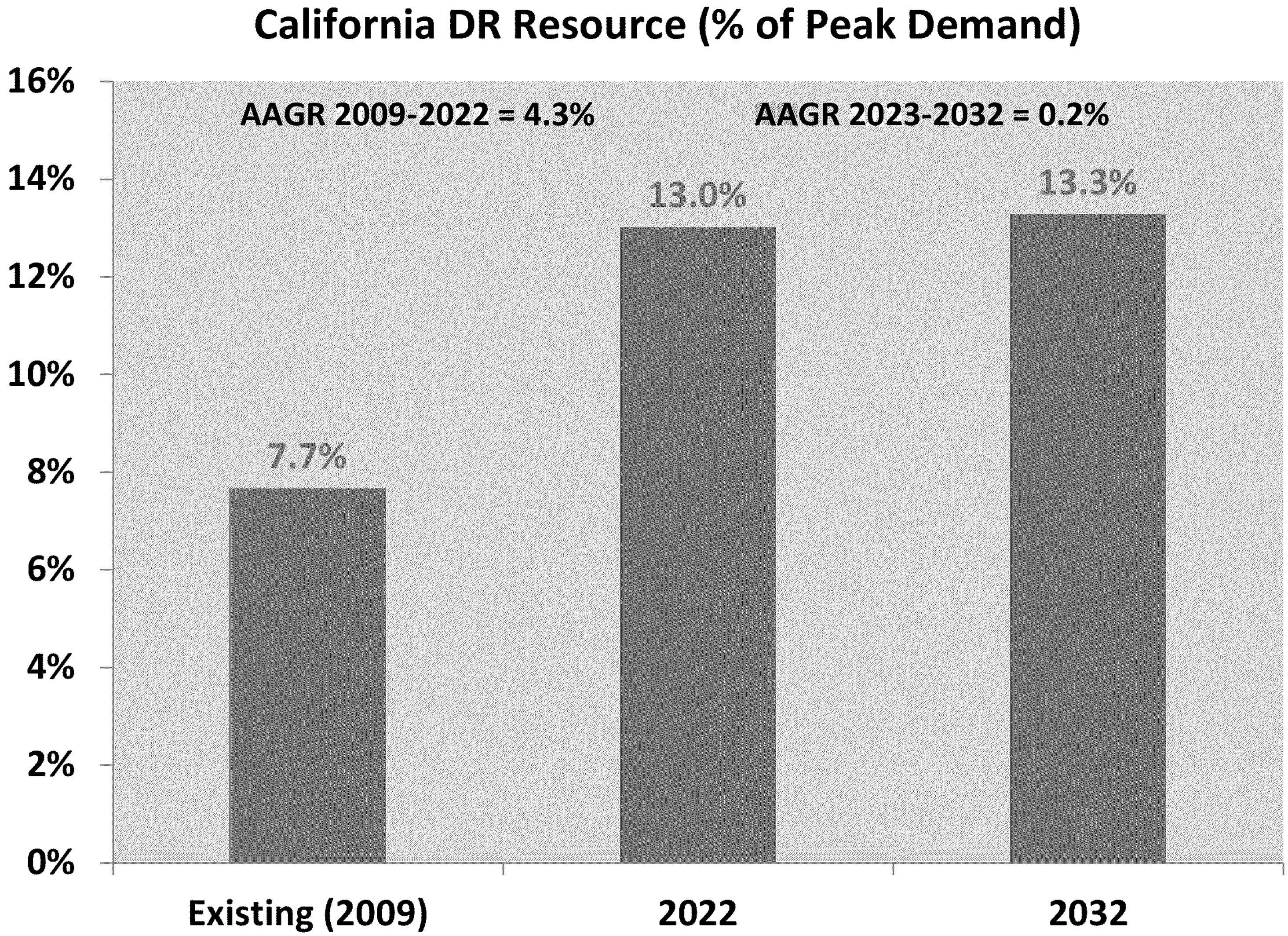
California



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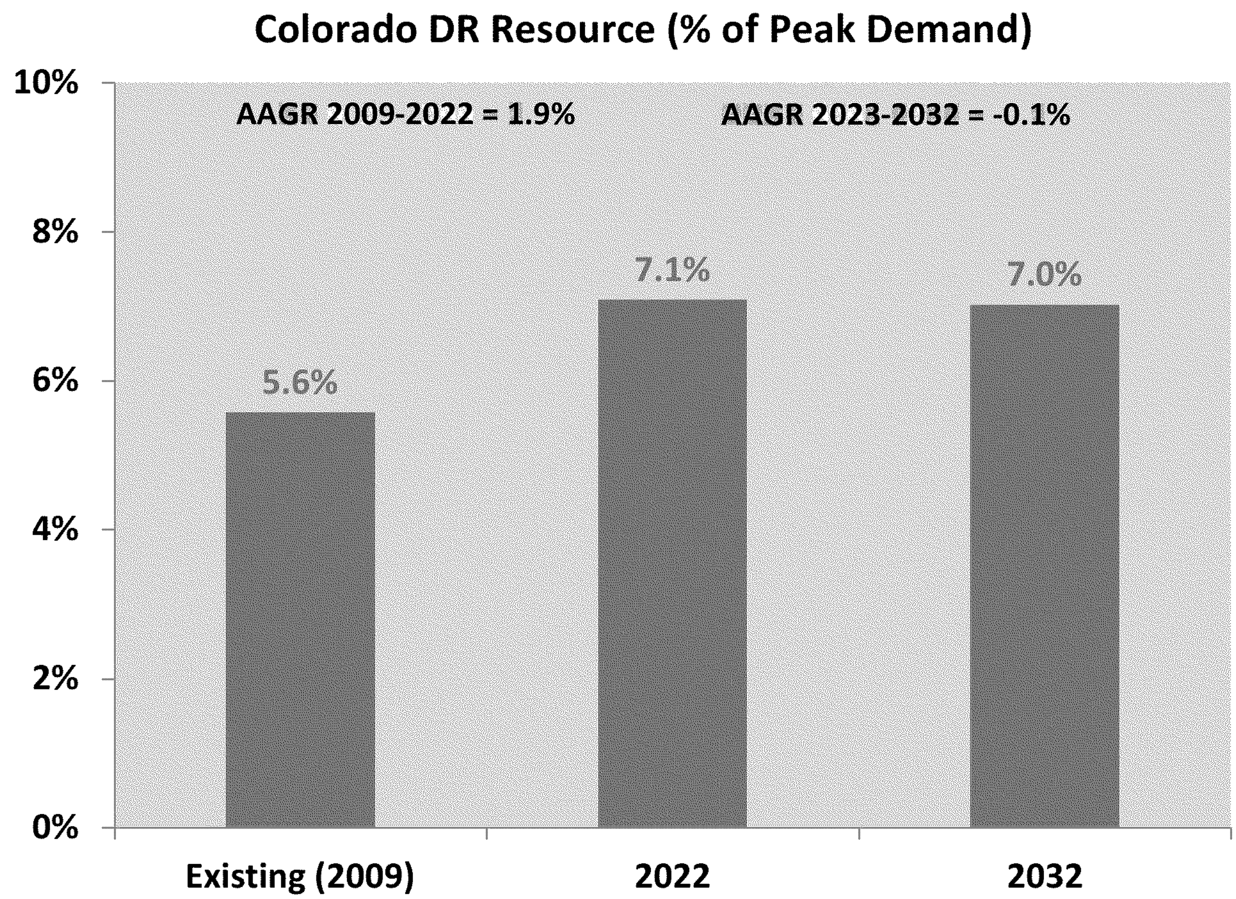
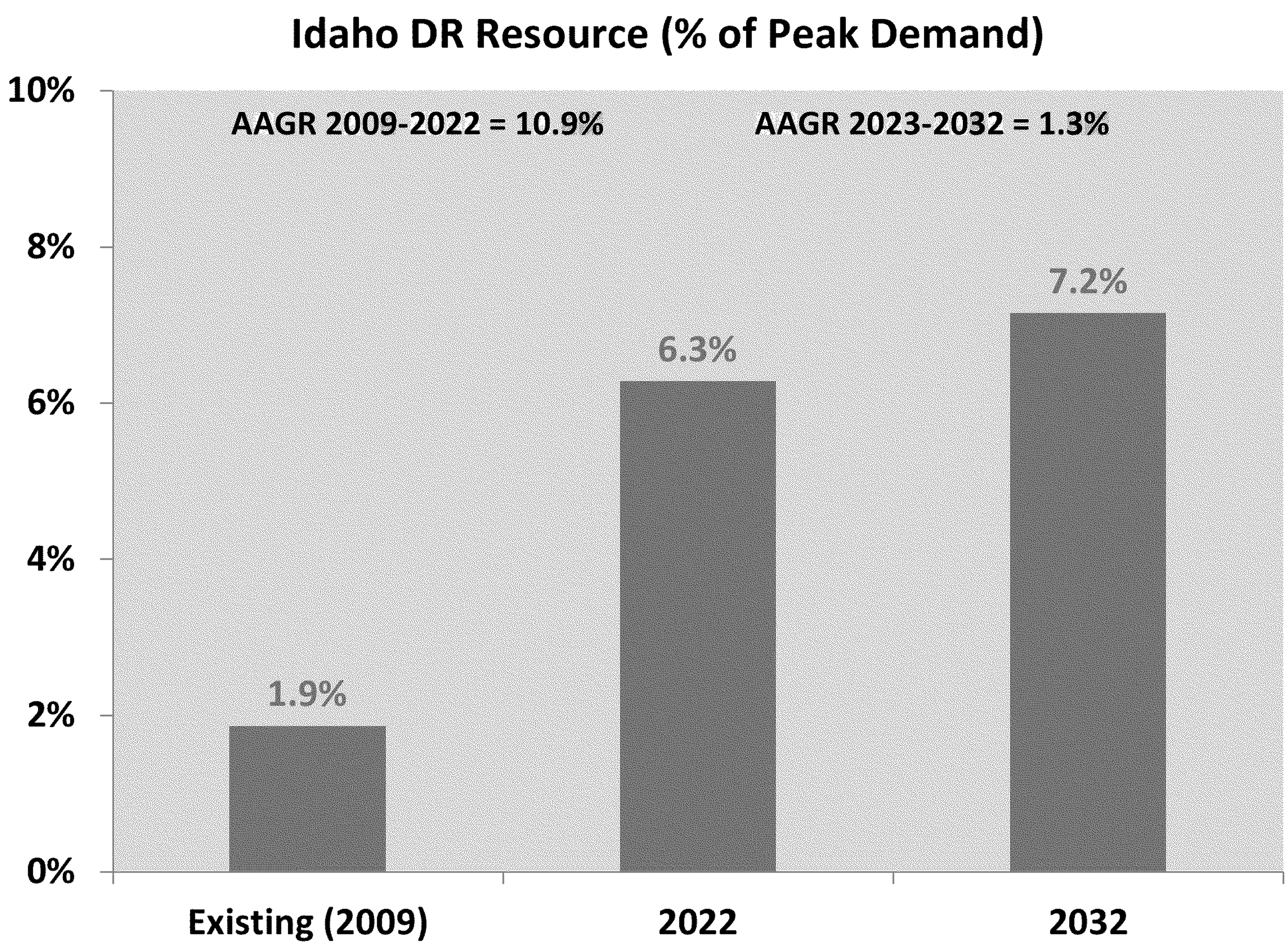
Colorado



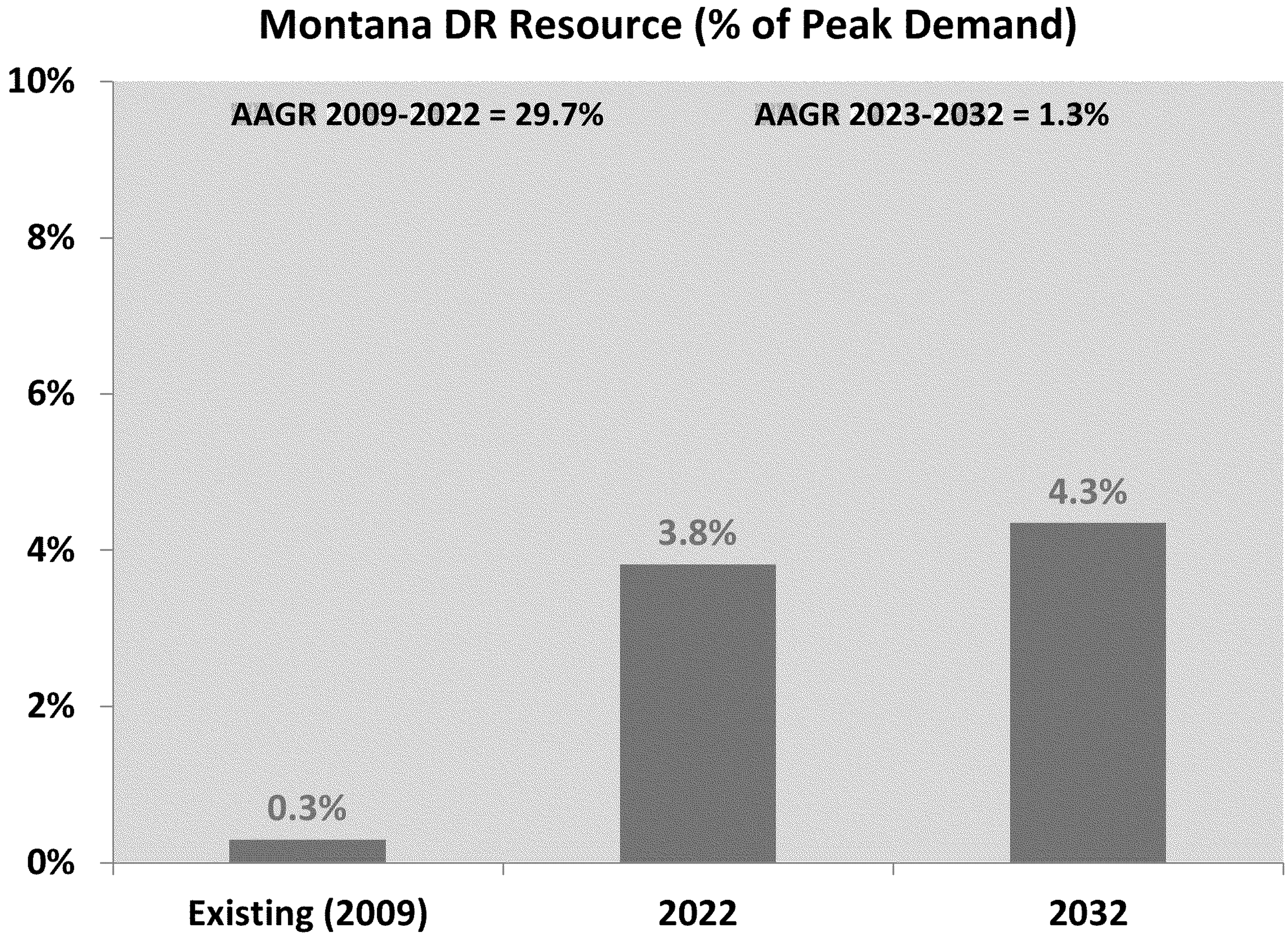
Note: Colorado's DR impact is projected to decrease from 2022 to 2032 as a percent of peak demand, but it grows in absolute terms. This is due primarily by peak demand that is projected to grow at a faster rate than the state's customer base

Idaho

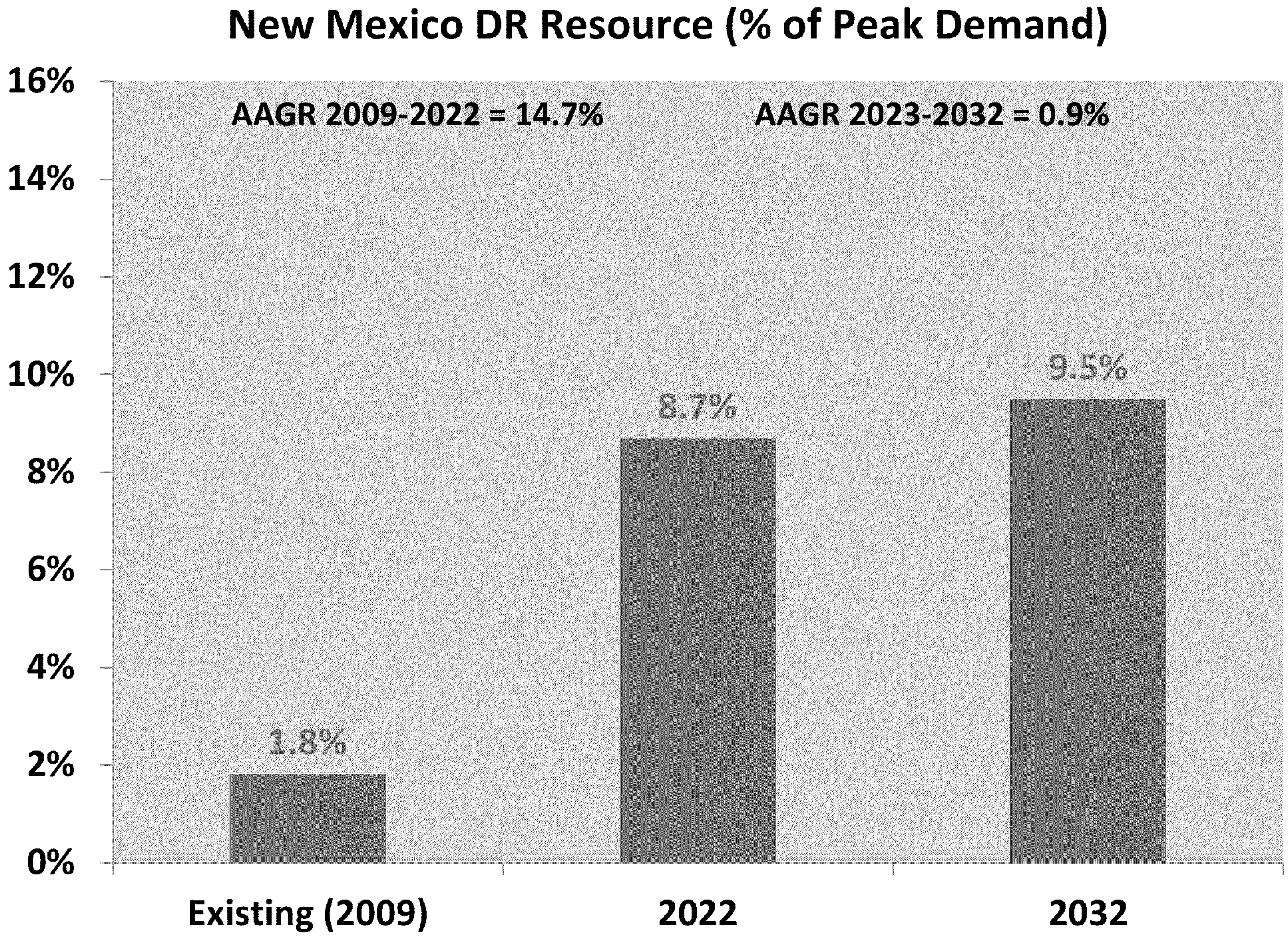


Idaho DR Resource (% of Peak Demand)
10%
8%
6%
4%
2%
0%
AAGR 2009-2022 = 10.9%
AAGR 2023-2032 = 1.3%
1.9%
6.3%
7.2%
Existing (2009)
2022
2032

Montana


Montana DR Resource (% of Peak Demand)
10%
8%
6%
4%
2%
0%
AAGR 2009-2022 = 29.7%
AAGR 2023-2032 = 1.3%
0.3%
3.8%
4.3%
Existing (2009)
2022
2032

New Mexico



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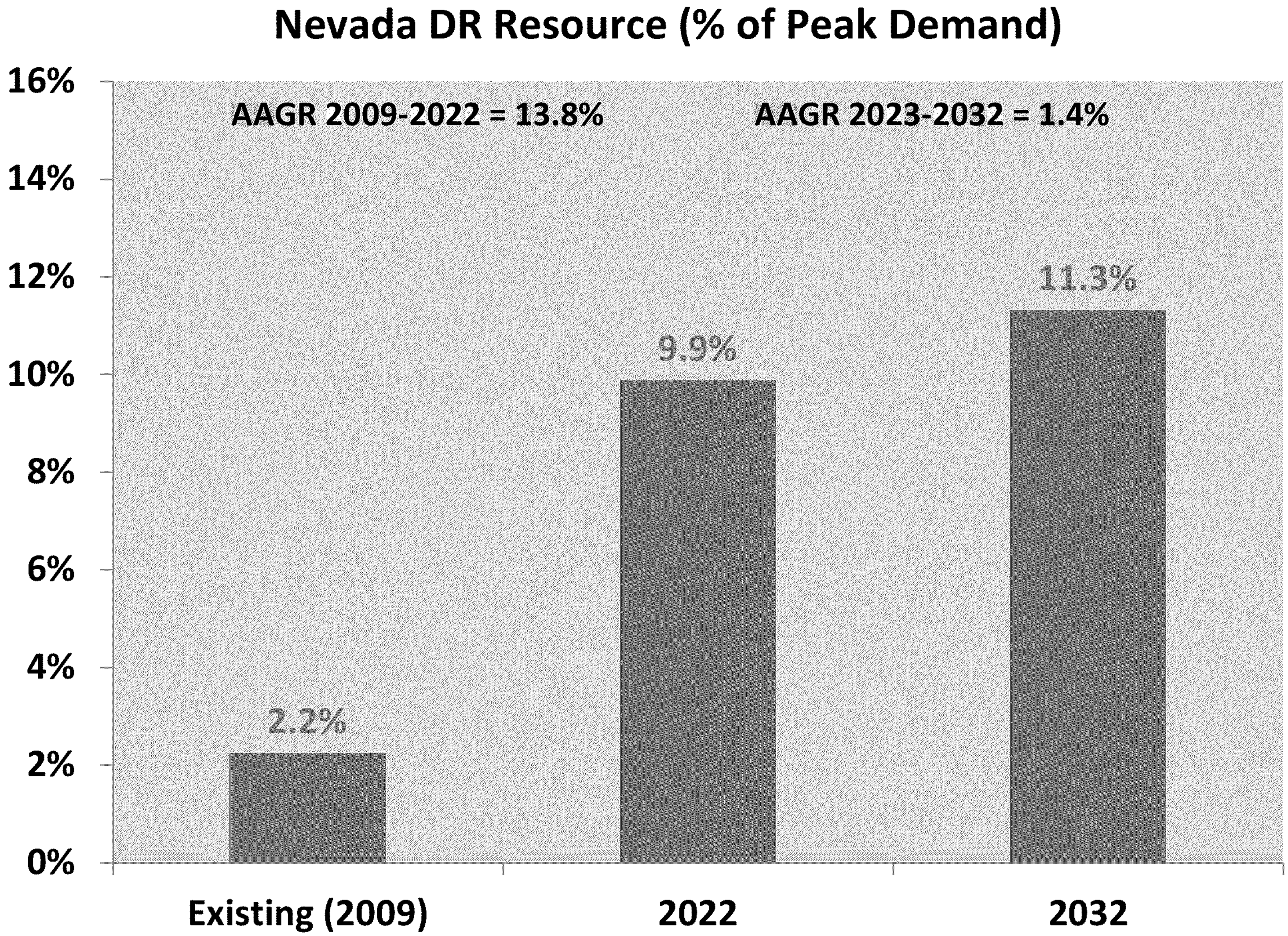
Nevada



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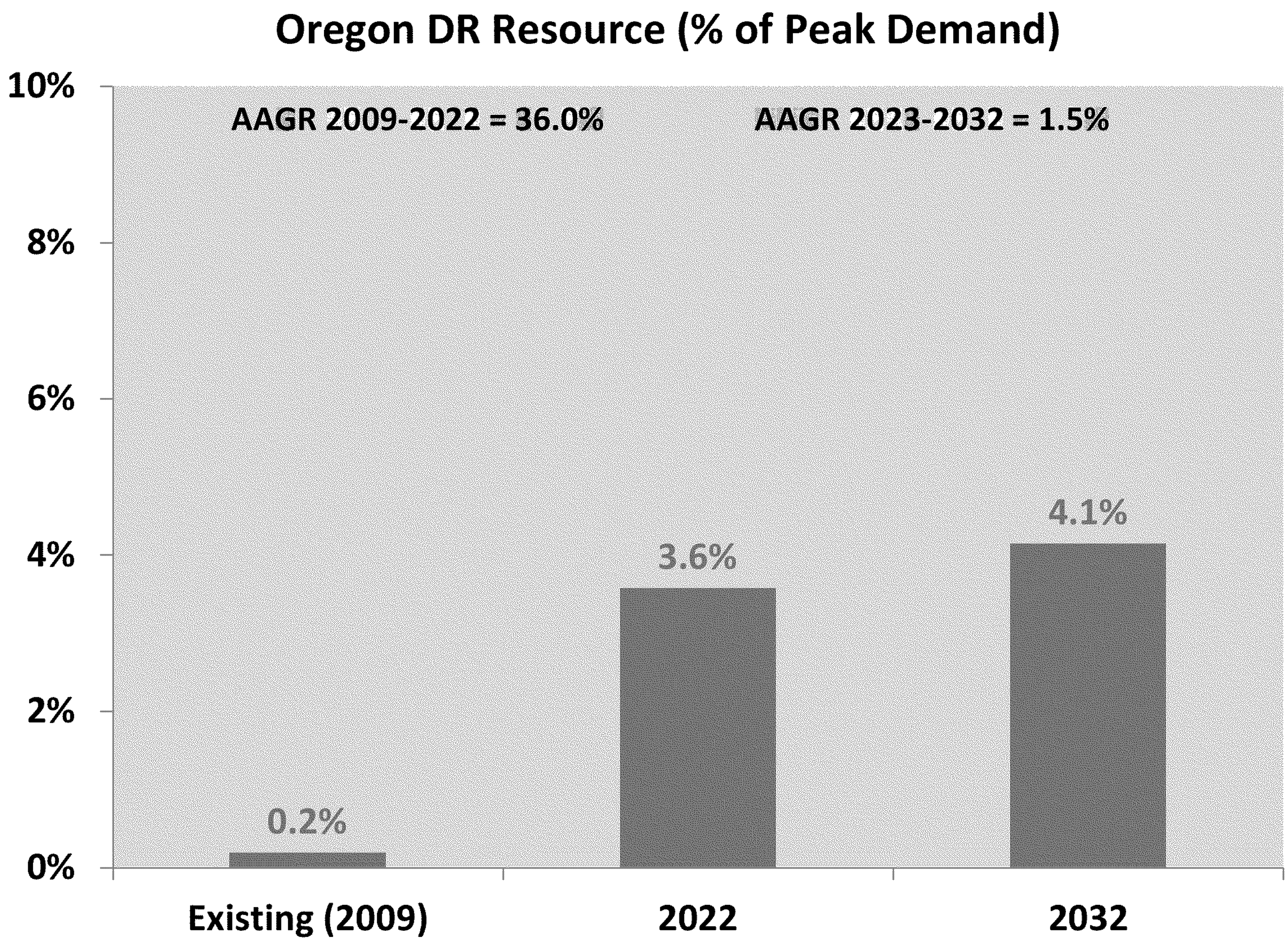
Oregon



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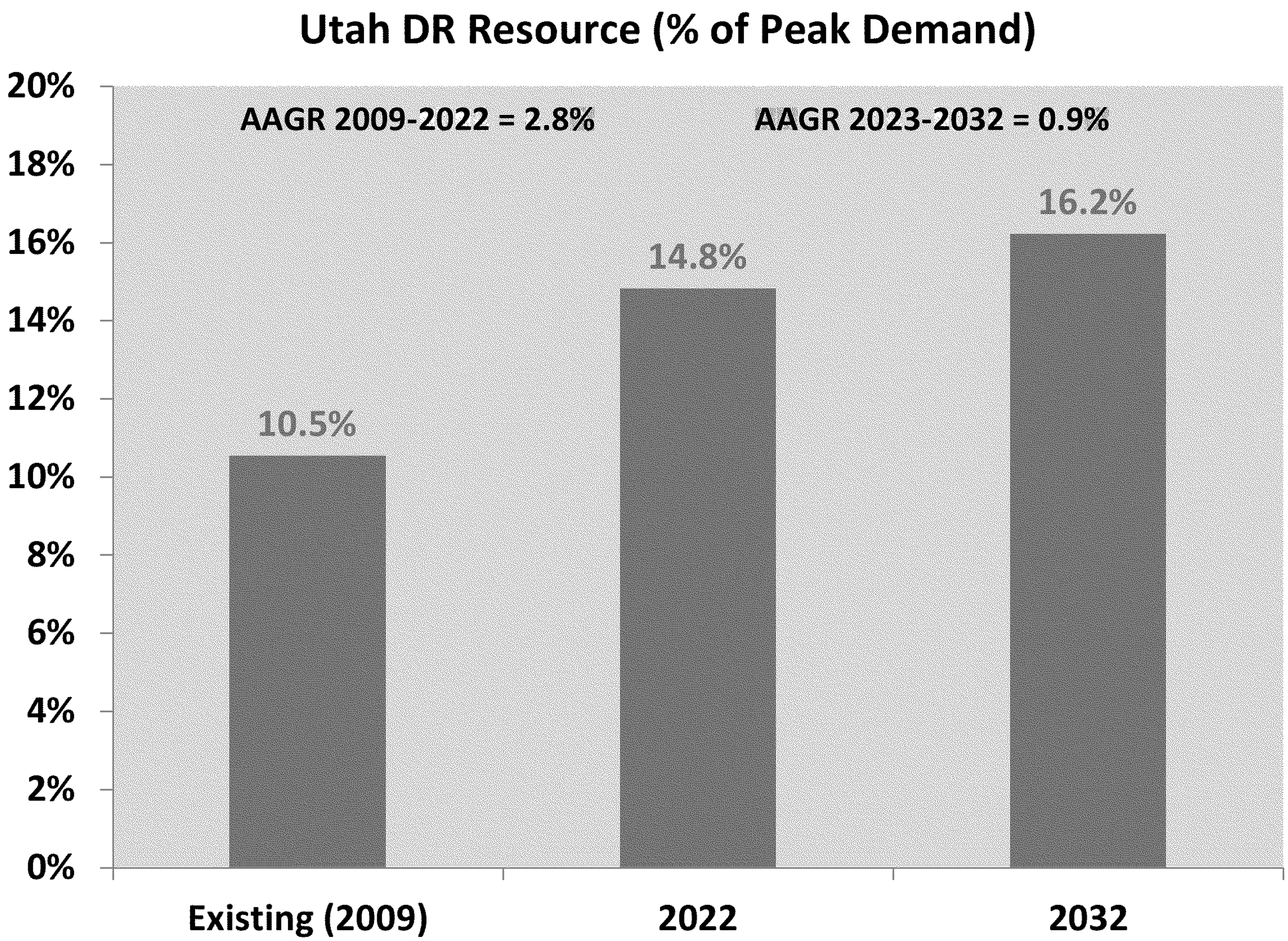
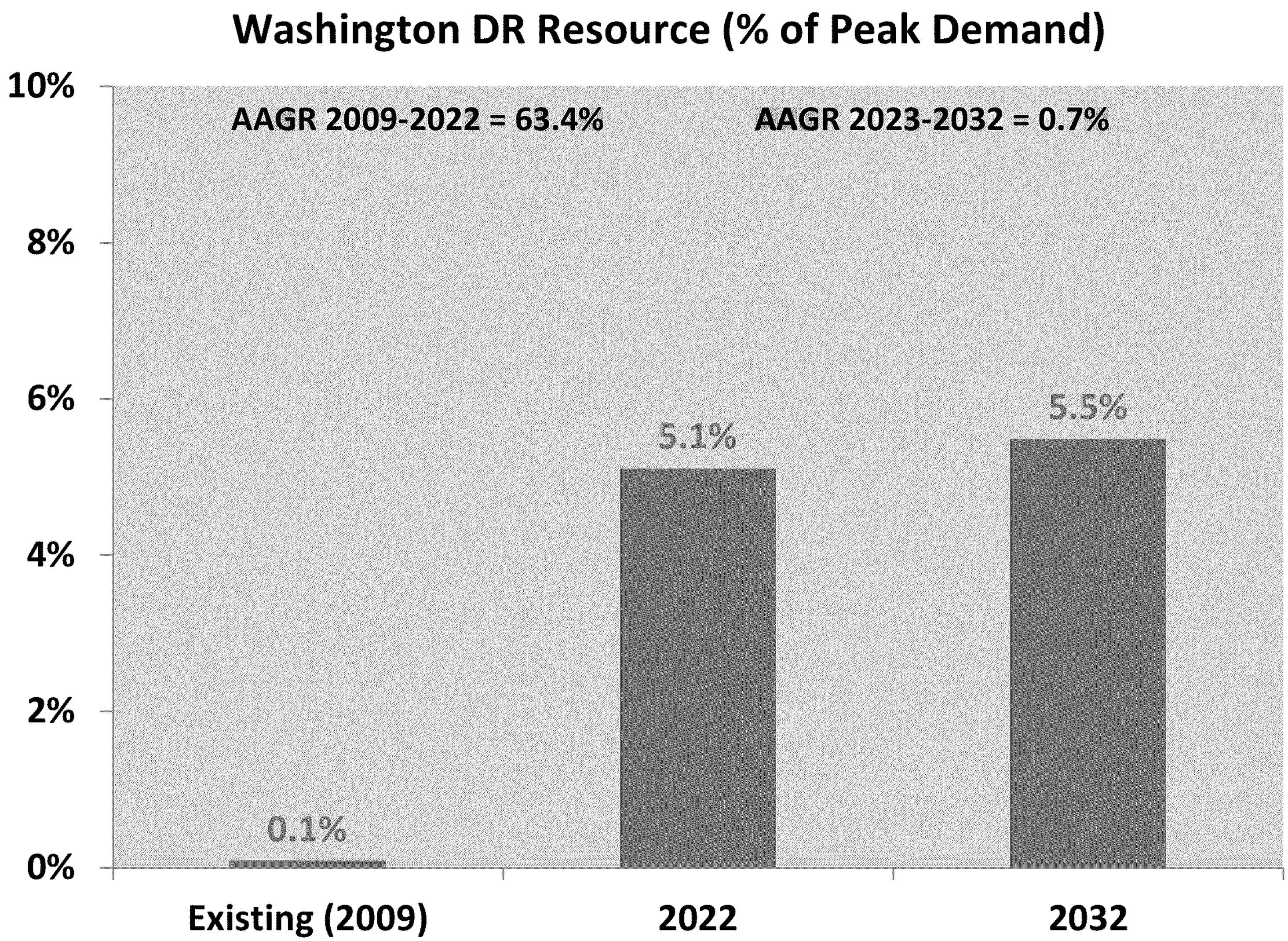
Utah

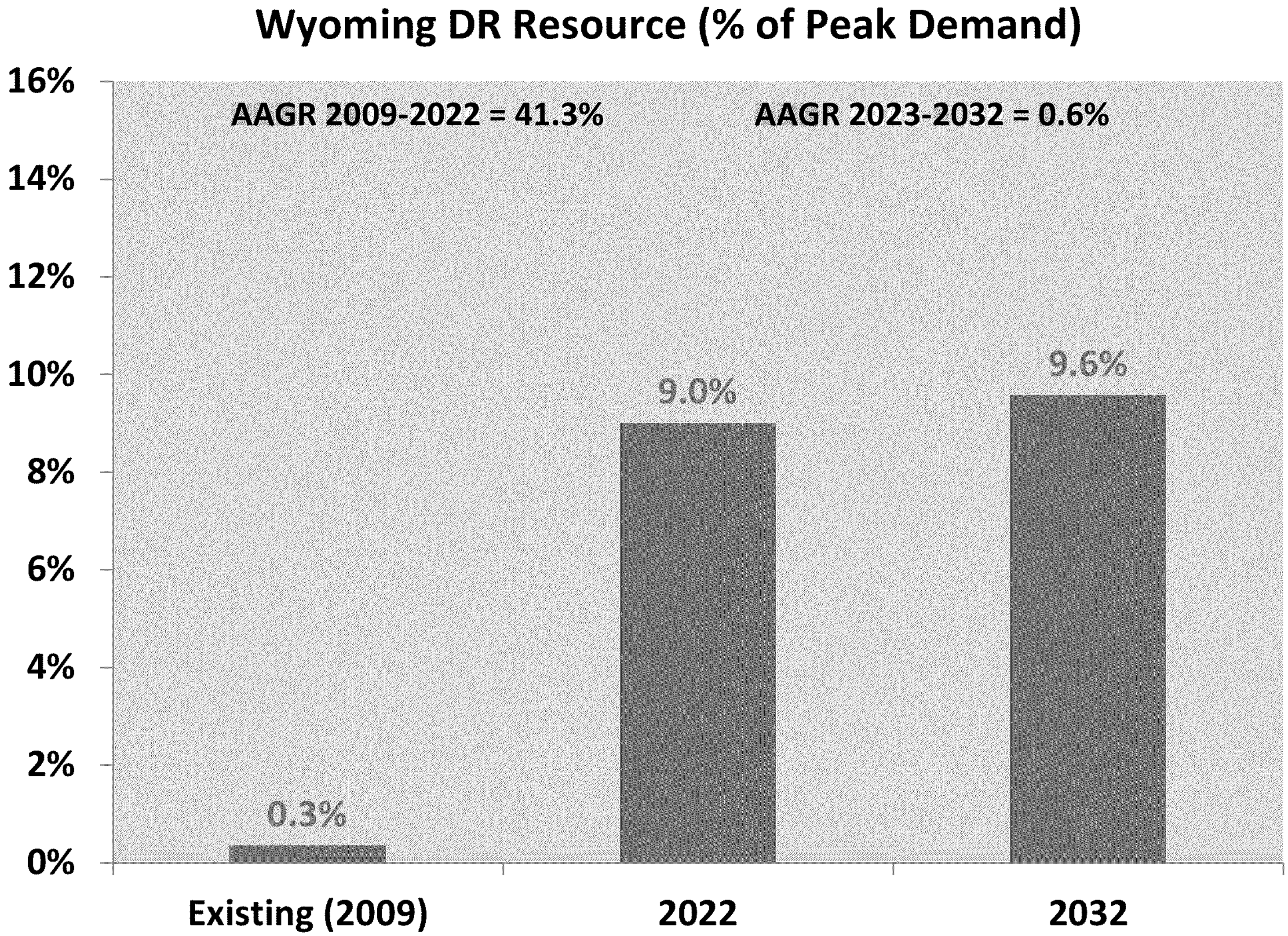


Utah DR Resource (% of Peak Demand)
AAGR 2009-2022 = 2.8%
AAGR 2023-2032 = 0.9%
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
10.5%
14.8%
16.2%
Existing (2009)
2022
2032

Washington


Washington DR Resource (% of Peak Demand)
10%
8%
6%
4%
2%
0%
AAGR 2009-2022 = 63.4%
AAGR 2023-2032 = 0.7%
0.1%
5.1%
5.5%
Existing (2009)
2022
2032

Wyoming


Wyoming DR Resource (% of Peak Demand)
16%
14%
12%
10%
8%
6%
4%
2%
0%
AAGR 2009-2022 = 41.3%
AAGR 2023-2032 = 0.6%
0.3%
9.0%
9.6%
Existing (2009)
2022
2032

Resources

- Faruqui, Ahmad and Jenny Palmer, "The Discovery of Price Responsiveness – A Survey of Experiments Involving Dynamic Pricing of Electricity," *EDI Quarterly*, 4:1, April 2012. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2020587
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