Standard LSE Plan

Silicon Valley Clean Energy

2020 INTEGRATED RESOURCE PLAN

September 1, 2020

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I. Executive Summary

Silicon Valley Clean Energy (SVCE) is pleased to present herein its 2020 Integrated Resource Plan (IRP). SVCE is a community choice aggregation program (CCA) operated by the Silicon Valley Clean Energy Authority (SVCEA), a California joint powers authority (JPA) composed of twelve cities plus the unincorporated areas of Santa Clara County. As a JPA, SVCEA is a local government agency that operates on a not-for-profit basis and is controlled by, and accountable to, the communities it serves.

SVCE is focused on helping its member communities advance their greenhouse gas (GHG) reduction goals by providing a clean source of energy while maintaining cost competitive rates and furthering system reliability. SVCE appreciates this opportunity to highlight its progress so far and to contribute to the statewide IRP planning exercise.

SVCE's accomplishments since its launch in 2017 include achieving an annual carbon-free[1] content which includes an aggressive Renewable Portfolio Standard (RPS) of approximately 50% since its inception; successfully offering a voluntary 100% RPS product to approximately 3.7% of its load; demonstrable progress towards meeting SB 350 long-term RPS procurement mandates through the successful execution of seven long-term power purchase agreements; strong performance in meeting California's Resource Adequacy mandates (almost 100% compliance with no penalties); and an expansive list of program offerings to promote decarbonization and electrification within SVCE's service territory. All this was achieved while maintaining competitive rates relative to the incumbent investor-owned utility (IOU) and building a financially stable organization. In July 2020, SVCE became the third CCA to earn an investment grade credit rating by Moody's of Baa2. This rating was awarded because of SVCE's ability to meet all procurement mandates, demonstration of strong leadership, and ability to understand and manage risk and build a financially viable organization.

The 2021-2030 IRP is SVCE's second IRP. In the process of creating it, SVCE engaged its community, stakeholders, and Board of Directors to establish high-level goals, objectives, and a vision for where SVCE needs to be in 2030. SVCE's planning and electricity procurement efforts will help meet California's aggressive and necessary GHG reduction goals while charting a path towards providing SVCE's customers carbon-free electricity to promote electrification in an affordable and reliable manner. To this end, SVCE has identified three key goals: GHG reductions, affordability and reliability. It is not sustainable or responsible to present a portfolio which merely looks at one of these goals without considering the consequences for the others. This is demonstrated through SVCE's current procurement efforts, which balance aggressive deployment of solar PV with paired storage at all facilities and additional long-term purchases of new and existing geothermal resources. Additionally, while SVCE's energy portfolio is carbon-free on an annual basis, SVCE recognizes the ongoing role of natural gas in grid reliability and the challenges that decarbonizing California's grid has raised. Through consistent investments in resource adequacy products, its plan to self-procure to meet the IRP Procurement Track

[1] SVCE voluntary tracks and reports greenhouse gas emissions to The Climate Registry under its Electric Power Sector protocol. In 2017, 2018 and 2019 SVCE reported 0.25, 4.32 and 2.34 lbs of CO_2e/MWh, respectively.

mandate[2] and current efforts to deploy long-duration storage through collaborative procurement, SVCE is committed to doing its part to maintain grid reliability and contribute more than its share of statewide renewable integration resources.

In this IRP, SVCE presents two Conforming Portfolios in accordance with the two scenarios examined in this IRP cycle: 46 MMT by 2030 and 38 MMT by 2030. The 38 MMT Conforming Portfolio represents SVCE's current procurement approach, which is carbon-free on an annual basis with a 50% RPS (plus 2% buffer) through 2026, the mandated RPS percentage through 2030, and the remainder of annual demand in all years supplied with large hydro. The 38 MMT Conforming Portfolio emissions are below SVCE's assigned GHG emissions benchmark for the 38 MMT scenario. The 46 MMT portfolio is the same as the 38 MMT portfolio, but with reduced large hydro reliance in 2030 such that it meets SVCE's GHG emissions benchmark for the 46 MMT scenario. Both portfolios meet the reliability standards tested in the resource template.

This IRP also presents one Alternative Portfolio under the 38 MMT scenario. The Alternative Portfolio increases the RPS mandate to 75% of retail sales while filling in the remainder of annual need with large hydro. While this alternative portfolio does not represent current SVCE procurement policy, it was modeled and included as a representation of how SVCE could adapt to a tightening market for large hydro and other carbon-free non-RPS resources in the future while still meeting all GHG reduction milestones. Notably, both the 38 MMT scenario Conforming Portfolio and Alternative Portfolio have 2030 emissions below not only SVCE's 38 MMT scenario GHG benchmark, but also SVCE's forecasted benchmark in a theoretical 30 MMT Scenario.

The modeling approach for this IRP uses the PowerSIMM model to simulate reliability, cost, and GHG metrics for each portfolio. In the coming years SVCE's procurement activity will focus on additionality of new renewable procurement, diversifying our renewable portfolio in order to better match our renewable generation profile to our demand curve, and planning for potential changes in the large hydro market as environmental conditions evolve and more retail suppliers are interested in carbon-free power. SVCE is also investing heavily in programs to help its communities decarbonize their building and transportation sectors by facilitating building electrification, access to electric vehicle charging infrastructure, and decarbonization-related workforce development as shown in Figure 1.

[2] D.19-11-016.

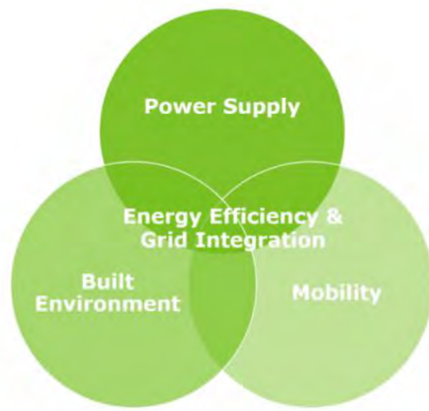

Figure 1. SVCE's approach to deep decarbonization is to impact all four elements

II. Study Design

a. Objectives

SVCE’s purpose in undertaking this modeling exercise was twofold. First and foremost, SVCE sought to produce an IRP that would represent SVCE’s procurement policies as comprehensively as possible and contribute meaningfully to the statewide IRP process. Second, SVCE sought to undertake an outreach and modeling process that would be internally useful for planning purposes and instructive on how SVCE might wish to modify its procurement strategy in the future should market conditions make the current approach less feasible or more expensive.

In order to achieve these goals, SVCE took a three-phase approach spanning a full year between August 2019 and August 2020. The first phase involved conversations with SVCE’s Board of Directors and the public about key procurement decisions and aspects of SVCE’s procurement strategy. SVCE held two community workshops in the fall of 2019, one in September and one in October. These workshops had two purposes. First, SVCE used the workshops to provide the public with an overview of and the opportunity to provide feedback on SVCE’s overarching carbon-free policy and procurement strategy. Second, SVCE used the workshops to gather customer feedback to guide several major procurement decisions SVCE would have to make between when the workshops were held and when the IRP was due. These included whether to accept allocations of large hydro and nuclear energy available to SVCE either on an interim basis or through the Working Group 3 portion of the ongoing PCIA reform proceeding (R.17-06-026), although CPUC staff have since clarified that these resources should not be shown in the 2020 IRPs. The workshops and subsequent Board follow-ups in February, March, and June 2020 also spanned and influenced the implementation of SVCE’s 2019 RFP for long-term PCC1 renewable resources, resulting in the selection and execution of five of SVCE’s seven current long-term PPAs.

Table 1. SVCE Long-term Renewable Power Purchase Agreements Executed to Date

Project	Technology	Location	Term (years)	Expected On-line Date	RFP
EDF BigBeau	Solar + Storage	Kern County, CA	20	December 2021	2017
Recurrent Energy Slate	Solar + Storage	King County, CA	17	June 2021	2017
Ormat Casa Diablo	Binary Geothermal	Mono County, CA	10	December 2021	2019
Coso Geothermal	Geothermal	Inyo County, CA	15	January 2022	2019
First Solar Rabbitbrush	Solar + Storage	Kern County, CA	15	June 2022	2019
Nextera Yellow Pine	Solar + Storage	Clark County, NV	20	December 2022	2019
8ME Aratina	Solar + Storage	Kern County, CA	20	June 2023	2019

The early workshops focused on improvements to SVCE's original GHG reduction goals: being carbon-free on an annual energy basis for forecasted future grid needs and transitioning to a carbon-neutral energy system by 2045. The workshops recognized that being carbon-free on an annual basis is not sufficient for ensuring grid reliability in a decarbonizing world, and sought to identify ways for SVCE to evolve its portfolio in accordance with changing grid needs while maintaining that original standard. The main strategy that emerged from these conversations was to pursue renewable energy PPAs whose generation profile was better matched to both SVCE's hourly load profile and to the Availability Assessment Hours (AAH), the times of greatest energy need on the grid. One component of this is renewable baseload, which SVCE secured in the form of two geothermal PPAs in January and March 2020, one of which will be the first new geothermal plant to schedule into the CAISO in 30 years. Another component is heavier reliance on battery storage to move solar output to the AAH, and SVCE has paired all new solar resources with storage equal to at least 40% of the solar capacity. Apart from applying this rule to the new solar PPAs signed in 2020, SVCE also amended one of its two 2018 PPAs in February 2020, expanding the battery capacity from roughly 30% to 50% the size of the solar nameplate capacity. Figure 2 summarizes SVCE's approach to planning and procurement in the context of IRPs, the state's clean energy mandates and goals and SVCE's own clean energy goals.

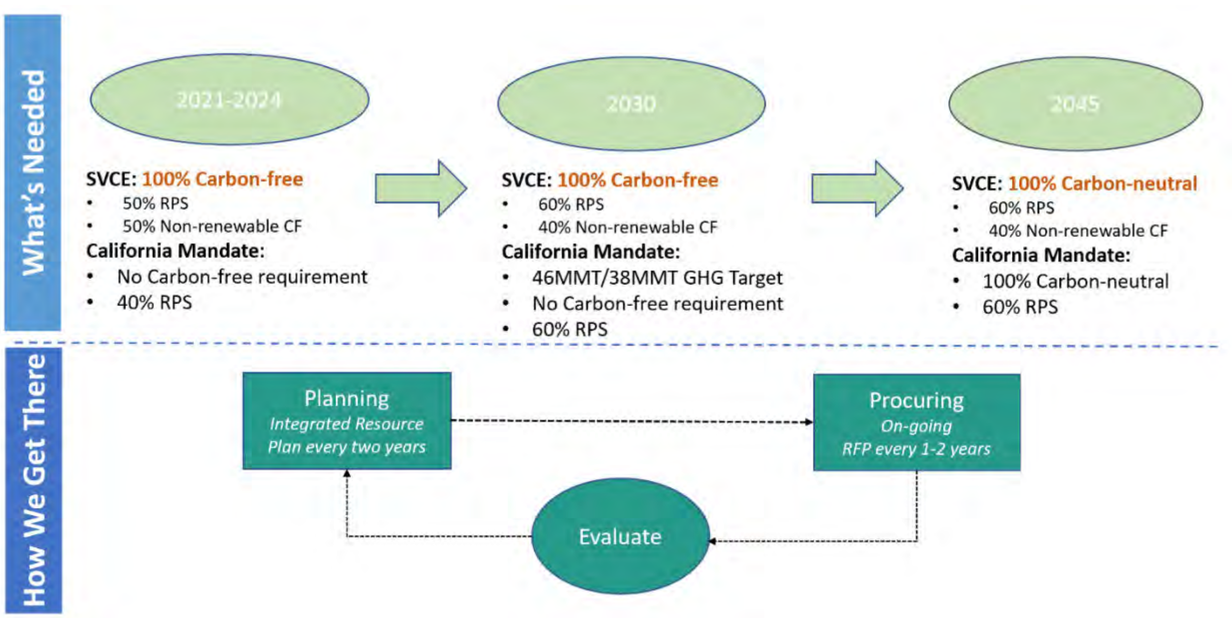

Figure 2: SVCE's Planning and Procurement Process

Core to SVCE's mission is the deployment of programs to reduce dependence on fossil fuels. The need to identify distributed energy resources (DER) and electrification measures was another focus of SVCE's IRP discussions. Since SVCE's conforming load represents a pro rata share of PG&E's TAC area load and is not representative of SVCE's specific service territory load, SVCE has made it a priority to understand its own load and how it may be modified. Specifically, SVCE assessed the potential to deploy DERs incremental to those already accounted for in the state's long-term planning and load forecasts. While incremental DERs are not a part of SVCE's Conforming Portfolios, they are presented in the Alternative Portfolio and SVCE will continue to pursue cost-effective DERs and electrification measures.

The second phase of the IRP process was the modeling described below, but it happened on an iterative basis alongside the conversations in the first phase of the IRP. The portfolios presented in this IRP are a final version reflecting both procurement decisions made by SVCE as well as changing compliance requirements and guidance from the Energy Division over the past year. However, it should be noted that there were a number of portfolios modeled along the way that are not included in the list of portfolios for IRP compliance. This is because the IRP cycle has been long enough that the marginal portfolio changes these portfolios were designed to assess, such as inclusion/exclusion of the carbon-free allocations, the geothermal PPAs, and theoretical biomass PPAs, have either already been decided or been rendered superfluous by updated IRP guidance (exclusion of carbon-free allocations) or lack of feasible market options for implementation (biomass contracts).

The final phase of SVCE's IRP process was selecting the portfolios that would be included in the IRP itself, which include two Conforming Portfolios and one Alternative Portfolio. These and SVCE's reasons for selecting them are detailed further in Section II.b below.

b. Methodology

i. Modeling Tool(s)

For IRP portfolio development, SVCE relied on PowerSIMM, an industry leading market simulation, capacity expansion, and production cost model developed by Ascend Analytics ("Ascend"). PowerSIMM captures and quantifies elements of risk through the simulation of meaningful uncertainty with weather as a fundamental driver. PowerSIMM is a "hybrid model," meaning it uses both market data and long-term fundamentals to simulate load, renewables, and CAISO spot market prices against which resources are dispatched and valued.

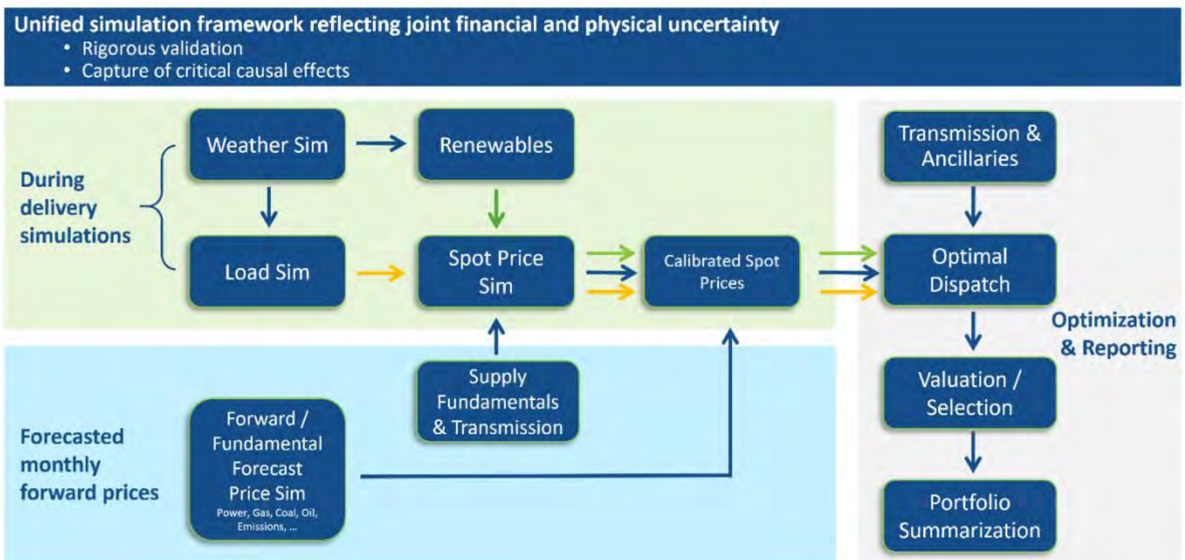

Figure 3. Schematic diagram of PowerSIMM modeling framework.

Figure 3 shows PowerSIMM's modeling framework. PowerSIMM simulates hourly spot price conditions (i.e. "during delivery simulations") as a function of weather, system load, and renewables. The simulated spot prices are scaled so that the average of all spot prices equals the simulated on-peak/off-peak monthly forward price. Market forward data in the near term (next 5 years) is blended with Ascend's long-term fundamental forecasts of gas and power prices driven by supply fundamentals in the WECC.

PowerSIMM captures a meaningful range of uncertainty driven by the factors that create price risk in power markets, including variability in weather, load, renewable output, congestion risk, and forward price volatility. PowerSIMM trains its econometric "sim engine" model with up to 30 years of historical weather to model the relationships between weather, load, and renewables. Ascend parameterizes its weather uncertainty using both time (month, day, hour) and autoregressive terms to create discrete chronological weather simulation. Weather serves as an input to load and renewable simulation for both SVCE load and CAISO system load. For this study each portfolio was put through 50 "sim-reps," which are simulation processes of 8760 hours across the planning time horizon. Results were summarized across the sim-reps to capture the full distribution of outcomes, including summarization of mean, median, P5, and P95 states.

SVCE selected PowerSIMM as the primary production cost and valuation tool for this IRP because it provides deeper insight and precision in valuation relative to a sector-wide capacity expansion model like RESOLVE.[3] PowerSIMM was used as a simulation model to valuate SVCE's load and resources within the context of both CAISO hubs (NP-15) and specific LMPs (for PPA resources).

One aspect to note is that SVCE opted not to use the capacity expansion function of PowerSIMM for this exercise. This was largely for two reasons. First, after layering SVCE's existing contracts and the priorities of its member communities on top of statewide compliance requirements, there were significantly more constraints on the composition of SVCE's future portfolio than there are with the Reference System Plan. This makes capacity expansion less marginally useful, because the optimization process has a narrower solution space in which to work from the start. Secondly, SVCE staff wished to avoid projecting an air of greater certainty around SVCE's future procurement than actually exists. While there are certain resource categories such as RPS-eligible renewables whose quantities have hard percentage requirements, within those categories SVCE's selection between various resources will depend heavily on the responses received in future RFPs. Changing markets and financing conditions, the granular characteristics and varying quality of individual offers, and changing regulatory requirements around reliability all add uncertainty to the selection of future resources. SVCE staff indicate clearly in this document the places where the estimation of the percentage of each resource type is a proxy representing flexibility within a category rather than a set-in-stone commitment. However, SVCE staff did not feel that capacity expansion would convey that uncertainty as clearly, and so opted for the scenario analysis approach documented below.

For DER modeling, E3 used the RESTORE and IDSM Models for DER valuation and to determine optimal dispatch. The consumer adoption model was informed by the PATHWAYS stock rollover model and the NREL Bass Diffusion model.

ii. Modeling Approach

Initial Analysis

As discussed above, the second phase of SVCE's IRP involved significant analytical work to lay the foundation for the assumptions used to form the portfolios presented in this IRP ("Initial Analysis"). That modeling work was comprised of two separate efforts: DER potential modeling by E3 and resource portfolio scenario modeling by Ascend Analytics. Each is described in turn below.

[3] RESOLVE is a high-level capacity expansion optimization model that selects system level (i.e. WECC or California wide) resources to meet a set of load, emissions, and reliability constraints at minimum cost using a "typical week" simplification.

E3 Consulting DER Modeling

SVCE hired E3 Consulting to run a scenario analysis of DER adoption and load in SVCE territory through 2030. Customers were segmented into 15 groups based on building type, building vintage, square footage, and energy use. The following technologies were considered:

- Rooftop solar PV
- EV charging
- BTM storage
- Water heating
- HVAC/Space heating
- Energy Efficiency
- Cooking
- Clothes drying

E3 conducted seven sensitivities and three reference scenarios for each technology and each customer segment. More detail on E3's modeling can be found in the slides in Appendix A attached to the IRP.

Based on the results of this analysis SVCE selected a scenario to incorporate into the baseline assumptions in further resource planning modeling, including the work by Ascend Analytics described below. This scenario included the following set of assumptions:

- Building electrification (water heating [EE embedded], HVAC/space heating [EE embedded], clothes drying, cooking): Natural gas moratorium in new construction and remodels by the 2022 code cycle
- BTM PV: Assume full economic potential of BTM PV under an SVCE NEM rate from 2020-2030
- BTM storage: Assume full economic potential and a 4-hour battery duration under a continuing SGIP program from 2020-2030
- Residential EV charging: Assume level 2 charging load and full economic potential, 250-mile range, and identical customer driving profiles under an SVCE EV rate from 2020-2030

E3 ran the above scenario and forecasted through 2030 the incremental load change due to these technologies in the residential and commercial customer sectors. Using the 8760 results for each technology, SVCE calculated the incremental change in load due to the technology through 2030. As discussed further below, since such load modifications were not permitted in Conforming Portfolios in this cycle, these changes were shown only in the 38 MMT scenario Alternative Plan.

Ascend Analytics PowerSIMM Modeling

SVCE took the approach of designing candidate portfolios, as summarized in the table below, based on the intersection of Board procurement priorities and the type and quantity of resources available on the market.

Each portfolio had to meet all regulatory requirements for long-term contracted resources, RA, GHG reduction, and renewable energy along with SVCE's aggressive RPS targets and its internal goal of being 100% carbon free on an annual basis. In addition, SVCE used the same load forecast for each portfolio in Table 2. The load forecast was based on SVCE's IEPR forecast, with modifications to account for the load modifiers from E3's results described above. To avoid double counting the E3 incremental load change with the embedded DER assumptions in the SVCE IEPR forecast, SVCE computed the difference between the IEPR DER assumptions and E3's incremental load change for each technology. This difference is what is deemed as SVCE's load change due to incremental DERs/electrification, and it was applied as a load reduction resource in PowerSIMM.

Table 2. Initial list of portfolios modeled in PowerSIMM.

Portfolio Name	Description and Motivation
A-Business as Usual	SVCE's existing portfolio in fall 2019. The remainder of SVCE's long-term contracting obligations under SB 350 were filled in with generic long-term wind and solar PPAs at a 30%/70% ratio, with the balance of RPS credits coming from Index+ REC short-term contracts. SVCE conservatively estimates 50 MW of imported large hydro can be reliably procured, with the rest of load served by Index+ GHG-free short-term contracts. No long-term geothermal or bioX resources are included.
B-RFP	This plan includes existing contracts plus contracts that were under negotiation through SVCE's 2018 RFP process, which includes two geothermal resources (Ormat and Coso). A small amount of generic long-term PPAs for solar and wind in a 70%/30% ratio were backfilled into the portfolio to meet the SVCE long-term contract requirements, with the balance of RPS credits coming from Index+ REC short-term contracts. SVCE conservatively estimates 50 MW of imported large hydro can be procured on a bundled energy and RA basis, with the rest of load served by Index+ GHG-free short-term contracts.
C-RFP No Coso Geo	Identical to portfolio B, but without the Coso geothermal PPA. This was a sensitivity to evaluate the marginal impact of that contract on evaluated metrics.
D-PG&E RPS + Hydro	Identical to portfolio B but with added allocations of large hydro and RPS resources from the PCIA Working Group 3 process unfolding in R.17-06-026.

E-PG&E Nuclear	Identical to portfolio D but with the addition of nuclear from PG&E's carbon-free allocations
F-BioX with PG&E RPS & Hydro	Identical to portfolio D but with added long-term biomass PPAs. This portfolio was designed to complement SVCE's investment in geothermal, as biomass could serve as another form of renewable baseload.

As the table indicates, the analysis was set up to analyze the following questions:

- Should SVCE execute contracts under negotiation in the RFP process?
- Should SVCE include geothermal in its portfolio?
- What benefits would allocations from PG&E's PCIA resources provide?
- Should biomass and/or biogas ("bioX") resources be included?

To answer these questions, Ascend Analytics modeled each portfolio in PowerSIMM to quantify the performance of each portfolio on various metrics in three categories: Decarbonization, Reliability, and Affordability. More detailed descriptions of the metrics and results are provided in the slides attached to the IRP as Appendix B. SVCE staff ranked the portfolios against the metrics and based on the results made the following recommendations:

- Use Portfolio B as the preferred portfolio to guide future procurement as it represents the best balance of reduced emissions, reliability, and affordability of all portfolios modeled
- Execute contracts for geothermal resources to capture their reliability and emissions-reduction benefits
- Explore taking allocations of PCIA resources from PG&E to reduce cost should the CPUC approve such allocations in the future

IRP Compliance Analysis

Because Portfolio B was selected as the preferred portfolio from the PowerSIMM modeling, SVCE intended it to be the basis for its Conforming Portfolio for the IRP. However, the IRP requirements specify two Conforming Portfolios, one for each of two emissions reduction scenarios (38 MMT and 46 MMT), and provided emissions benchmarks for each LSE associated with each scenario. Each LSE is required to submit at least one Conforming Portfolio for each scenario. In subsequent guidance, the Energy Division informed LSEs that for the 38 MMT scenario, the portfolio emissions may be at or below the emissions benchmark, while for the 46 MMT scenario emissions must be equal to, but not less than, the benchmark level. Because Portfolio B was constructed to achieve the SVCE procurement goal of 100% carbon free energy on an annual basis, it falls below the emissions benchmarks, and thus was selected as the basis for the 38 MMT Conforming Portfolio.

The 38 MMT Scenario Conforming Portfolio was built from Portfolio B and thus includes the following requirements:

1. Be carbon-free on an annual basis, meaning procuring enough RPS-eligible renewable and carbon-free energy to cover the GWh of SVCE's total annual load each year.
2. Achieve a 50% RPS target every year though 2026 followed by the state RPS target in 2027 – 2030, plus an additional 2% in each year's target for buffer.
3. Fill in remaining annual energy need with large hydro and carbon-free ACS.
4. Meet RA requirements and the RPS long-term contracting requirements associated with SB 350.
5. In order to promote grid reliability and help address the duck curve, pair all future new solar resources with 4-hour battery storage equal to 40% of the capacity of the solar facility.

Beyond these concrete requirements, SVCE adopted several assumptions as placeholders representing uncertainty in future procurement:

1. Future RPS-eligible PPAs and short-term contracts were assumed to be a mix of 70% solar and 30% wind. This mirrors the larger role of solar in the Reference System Plan fleet and is also an approximation of the relative frequency with which each resource appears in responses to SVCE's renewable RFPs so far.
2. Future long-term wind PPAs would include 150 GWh of existing wind based on responses to RFPs received so far, and the rest would be new.
3. All new solar + storage PPAs would be assumed to be from new facilities.
4. All Index+ transactions for RPS compliance would be from existing facilities.

To become the 38 MMT Conforming Portfolio, Portfolio B also had to be updated to reflect the results of ongoing procurement and needed some modification to meet the CPUC's requirements to be a conforming portfolio. The following changes were made:

- The contract for the Duran Mesa wind facility was removed, as this contract was terminated. (For more detail, please see Section III.i. on Out-Of-State Wind Development)
- The contract for the Aratina solar+storage facility was executed and accordingly added to the portfolio.
- Generic long-term PPAs had been modeled starting in 2021 in Portfolio B. These were delayed to 2023 to reflect SVCE's updated expectations of its procurement through its ongoing RFP.
- The load forecast was modified to reflect expectations of expanded Direct Access consistent implementation of SB 237.[4]

[4] Per Commission instructions, SVCE submitted this updated load forecast for approval via Comments on Administrative Law Judge Fitch's Ruling Allowing Updated Load Forecasts on February 28, 2020. The Commission approved SVCE's updated forecast on May 20, 2020 in the Administrative Law Judge's Ruling Finalizing Load Forecasts and Greenhouse Gas Benchmarks for Individual 2020 Integrated Resource Plan Filings and Assigning Procurement Obligations Pursuant to Decision 19-11-016.

- A shed demand response (DR) resource was added as a proxy for the ongoing resiliency RFP procurement. (For more detail, see Section III.f on System Reliability Analysis.)
- The load modifier assumptions from the E3 analysis were removed, as they are not allowed for conforming portfolios.

In addition to the 38 MMT Conforming Portfolio, SVCE is required to submit a second conforming portfolio for the 46 MMT emissions reduction scenario. SVCE's 46 MMT Conforming Portfolio is based on the 38 MMT Conforming Portfolio, but includes a reduced amount of large hydro energy in 2030, such that GHG emissions reach but do not drop below the benchmark. This portfolio does not meet SVCE's Board-approved procurement objective of being 100% carbon free on an annual basis, so it is only being provided for IRP compliance purposes and does not reflect SVCE's planned future procurement strategy. [5] SVCE urges the Commission to use its 38 MMT Conforming Portfolio for all portfolio consolidation and planning purposes regardless of whether the Commission selects the 46 MMT scenario or the 38 MMT scenario.

Finally, SVCE added one portfolio that was not part of the initial PowerSIMM portfolio modeling effort. Because of concerns over the reliance on large hydro in the 38 MMT Conforming Portfolio, which is discussed further in the Hydro Generation Risk section of the IRP, SVCE developed an the 75% RPS Alternative Portfolio. This portfolio uses similar assumptions as the 38 MMT Conforming Portfolio, except for the following:

- Reduces the reliance on large hydro by targeting SVCE's portfolio to be 75% renewable under California's RPS by 2030.
- Includes more aggressive RPS procurement targets for long-term contracting, as shown in Section III below.
- Because it is an alternative portfolio and not a conforming portfolio per CPUC IRP requirements, load modifiers are allowed. Thus, it includes the load modifications from the E3 modeling.

All three portfolios are submitted for IRP compliance, and thus are modeled in the CPUC's Clean System Power (CSP) calculator to estimate their emissions. SVCE has also prepared CPUC resource data templates for each portfolio, which includes an RA tracking table. Earlier versions of two of the IRP portfolios (38 MMT Conforming and the 75% RPS Alternative Portfolio) were modeled in PowerSIMM. Due to a lack of time between receiving final IRP requirements from the CPUC (June 15, 2020) and the filing date (September 1, 2020), SVCE

[5] The Energy Division's instruction that 46 MMT portfolios include emissions equal to, but not less than, each LSE's assigned share of the 46 MMT target does not have a basis in SB 350 and was neither considered nor adopted in any Commission Decision or ALJ ruling. SVCE does not believe that this instruction is consistent with the letter or spirit of SB 350 or the Commission's IRP program, both of which are intended to set a floor, not a ceiling, on GHG reductions and are designed to encourage the greatest amount of GHG reduction possible, consistent with cost, safety, and reliability considerations. In submitting a 46 MMT portfolio consistent with the Energy Division's guidance, SVCE does not waive the right to object to this guidance or the use of this portfolio as the basis for statewide planning, procurement mandates, or non-bypassable charges.

was unable to model the final versions of the three portfolios listed in the IRP document. SVCE will continue modeling efforts in the next IRP cycle. A summary of the PowerSIMM analysis is included in Appendix C[6].

CSP Calculator Assumptions

The CSP Calculator was customized using the following assumptions:

- Load reflects the annual managed retail sales forecast assigned to SVCE in the April 15, 2020 Ruling.
- The load shape reflects a mix of the default commercial and industrial (C&I) and non-C&I load shapes provided in the calculator. SVCE assumes a mix of 66% C&I load and 34% non-C&I load in each modeled year.
- Hourly generation profiles for all resources for which SVCE has executed long-term contracts were summed and entered as annual custom GHG-free generation profiles in the calculator. This includes dispatch of the battery storage for SVCE's hybrid resource PPAs.
- Resources under short-term contract and generic resources, for which SVCE has planned but not yet contracted for, were entered using the default generation profiles by resource type that are embedded in the calculator.

RA Tracking Table Assumptions

The following table summarizes the assumptions used to build the RA tracking tables in the CPUC's resource data templates.

[6] Portfolios A, C, D, E, and F were modeled in PowerSIMM but ultimately not selected as part of SVCE's IRP

Table 3. Summary of RA modeling assumptions.

	RA Tracking Table
Annual System RA Obligation Forecast	The ratio of LSE 2021 peak demand and CAISO 2021 peak demand is multiplied by the annual forecasted CAISO peak demand and then reduced by each LSE's proportional share of the resource adequacy capacity value of the resources reflected in the year-ahead cost-allocation mechanism (CAM) list.
Hybrid Resource RA Contribution	Methodology from D.20-06-031; Solar generator RA portion is de-rated to that portion not needed to charge the battery
Effective Load Carrying Capability (ELCC) Curves	Monthly ELCC curves are provided in resource data template and change over time; Different for 46 MMT and 38 MMT portfolios

III. Study Results

a. Conforming and Alternative Portfolios

SVCE has chosen to submit three portfolios for this IRP:

- **38 MMT Conforming Portfolio:** based on the preferred portfolio from the initial Analysis, with updates to conform to CPUC requirements for IRP compliance
- **46 MMT Conforming Portfolio:** based on the 38 MMT Conforming Portfolio, but with emissions increased by 0.449 MMT to conform to the Energy Division's "equal to" requirement. Emissions increases were achieved by replacing large hydro procurement in 2030 with unspecified system power
- **75% RPS Alternative Portfolio:** based on the 38 MMT Conforming Portfolio but with more aggressive renewable procurement and additional DER development. This portfolio represents a potential future response to a tightening market for large hydro that would allow SVCE to uphold its commitment to being carbon-free on an annual basis.

SVCE's governing board has selected its 38 MMT Conforming Portfolio as its preferred portfolio and the portfolio that most accurately reflects SVCE's intended procurement strategy going forward. SVCE's 38 MMT Conforming Portfolio reflects the needs and values of the communities SVCE serves, is fully consistent with SVCE's mandatory Board-adopted procurement requirements, and provides a diverse and balanced portfolio that achieves results consistent with SB 350's reliability, GHG-reduction, RPS, disadvantaged communities, renewables integration, and other requirements.

i. Resources Included in All Portfolios

All portfolios include SVCE's current portfolio of short-term index+ transactions. The following two tables summarize SVCE's current portfolio used in IRP modeling for 2020 and 2021. Contracts for multiple types of RPS resources may include a mix of biomass, geothermal, small hydro, wind, and solar.

Table 4. SVCE RPS Index+ Transactions by Resource Type (GWh).

Resource Type	2020	2021
Multiple Types		1,350
Biomass	40	0
Geothermal	152	0
Small Hydro	327	0
Solar	730	0
Wind	723	0
Total	**1,973**	**1,350**

The carbon-free index+ transactions below are backed by a mix of in-state and imported large hydro. The mix changes year to year. For 2020, SVCE estimates a mix of 35% in-state hydro.

Table 5. SVCE Carbon-Free Index+ Transactions by Resource Type (GWh).

Resource Type	2020	2021
Nuclear	23	0
Large Hydro	1,893	1,507
Total	**1,915**	**1,507**

In addition to short-term procurement, the table below summarizes the long-term PPA resources that are included in all portfolios:

Table 6. Long-term PPA Resources included in all portfolios.

Resource Type	Resource Name	Nameplate Capacity (MW) (Solar/Battery)	Contract Status	Development Status	Delivery Start Date	Energy & RA?
Solar plus Storage	Big Beau	70/22	Executed	New	12/1/2021	Yes
	Slate	93/46.5			6/30/2021	
	Rabbitbrush	40/8			6/30/2022	
	Yellow Pine	50/26			12/1/2022	
	Aratina	80/20			6/30/2023	
Geothermal	Ormat	7	Executed	New	12/31/2021	Yes
	Coso	33.3		Existing	1/1/2022	

Large Hydro	Western Base Resource	1,900 – SVCE's share 0.325%	Planned	Existing	1/1/2025	Energy Only
Demand Response	SunRun resiliency RFP	6	Planned	New	1/1/2022	Yes

In addition to the resources listed in the table above, each portfolio also includes 50 MW of generic imported large hydro/ACS that provides energy and RA from 2021-2030. Historically, SVCE has received over 100 MW of allocated annual import allocation rights on the major interties and believes that assuming 50 MW of generic imported large hydro/ACS and its bundled energy delivery is a conservative estimate. SVCE plans on executing long-term import RA and bundled energy contracts as soon as the CAISO Maximum Import Capability Stabilization and Multi-Year Allocation Initiative is implemented in Q3 2021.

ii. Additional Generic Resources

The portfolios also include resources from the following resource types. All these resources are planned resources that have not been procured. The assumed resource mix is an estimate, and the final ratios will depend on evaluation of responses received to future resource solicitations.

Backfill Long-Term PPAs

All scenarios were targeted to procure enough energy under long-term PPA to exceed minimum RPS contract requirements. The 75% RPS Portfolio included especially aggressive long-term contracting targets for compliance periods (CP) 5 and 6. These targets are summarized in Table 7.

Table 7. Long-term PPA contracting targets for each compliance period (CP). Targets are based on percent of retail sales.

	CP4	CP5	CP6
Minimum Long-term RPS Requirement	25.9%	32.1%	37.3%
SVCE's Current Long-term RPS Resources	25%	36%	33%
38 MMT and 46 MMT Portfolios	31%	37%	42%
75% RPS Portfolio	31%	45%	55%

Table 8 summarizes the backfill PPA resources that were added to each portfolio to meet long-term RPS compliance requirements. Contracts were modeled to begin in 2023, with additional PPAs starting in 2028 for the 75% RPS portfolio to meet the more aggressive RPS requirements.

Table 8. Backfill PPA resource summary. Generic storage resources are modeled as 4-hour battery storage.

		38 MMT Portfolio & 46 MMT Portfolio	**75% RPS Portfolio**
New Resources	**Solar + Storage**	171.5 MW solar + 68.6 MW storage starting 2023	171.5 MW solar + 68.6 MW storage starting 2023 143.5 MW solar + 57.4 MW storage starting 2028
	Wind	16.5 MW starting 2023	16.5 MW starting 2023 61.5 MW starting 2028
Existing Resources	**Wind**	57 MW starting 2023	57 MW starting 2023

<u>Index + RPS Transactions</u>

These resources were added above long-term RPS contracts to meet SVCE renewable procurement goals from 2021-2030. The procurement goals exceed minimum RPS standards as shown in Table 9.

Table 9. Annual RPS procurement targets for each portfolio. Targets are based on percent of retail sales.

	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
RPS Minimum Requirement	36%	39%	41%	44%	47%	49%	52%	55%	57%	60%
38 MMT and 46 MMT Portfolio RPS Procurement Target	52%	52%	52%	52%	52%	52%	54%	57%	59%	62%
75% RPS Portfolio RPS Procurement Target	52%	52%	52%	52%	52%	52%	58%	64%	69%	75%

The quantities of short-term RPS purchases needed to meet the above targets for each portfolio are summarized in Figure 4 below. The resources were modeled as a mix of 70% existing solar and 30% existing wind resources. Short-term resource needs are expected to decline between 2022 and 2023 as SVCE's portfolio of resources under long-term contract come online, then increase again after 2026 as RPS requirements increase. For the 75% RPS portfolio, the short-term procurement need declines from 2027 to 2028 as Backfill PPAs are assumed to begin in 2028 to meet CP6 targets.

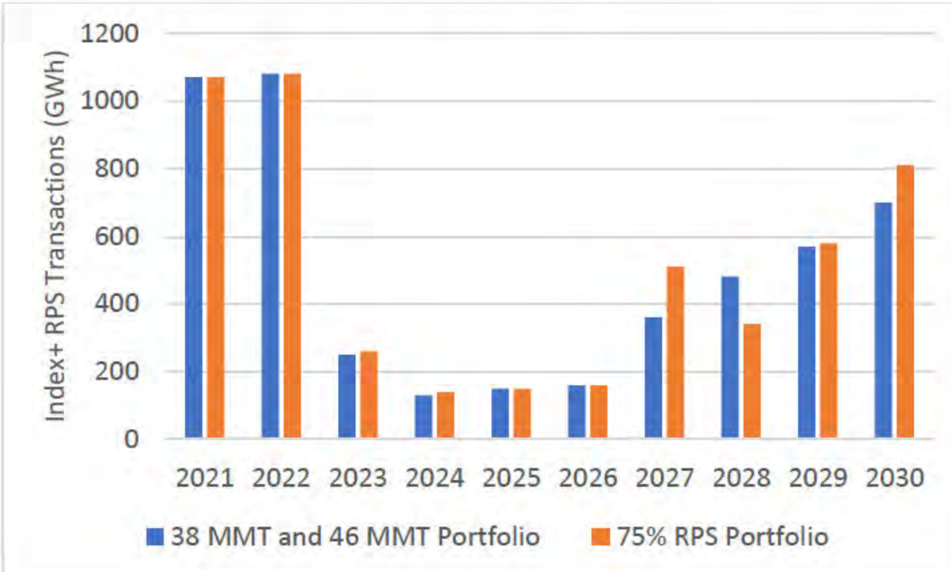

Figure 4. Index+ RPS transaction quantities included in each portfolio.

Index+ GHG-Free Transactions

These resources were added to meet the Board's approved procurement goal of being 100% carbon-free on an annual basis. Currently, SVCE contracts for supply from existing large hydro resources to meet this need, and this is assumed to continue through 2030 in the IRP portfolios. The differences in the amounts of Index+ GHG free energy in each portfolio reflect the following:

- The reduced hydro necessary to meet the 46 MMT portfolio GHG emissions benchmark in 2030
- The lower amount of hydro necessary in the 75% RPS portfolio because it includes more renewable energy as described above
- The additional hydro needed to meet the assumed incremental electrification load in the 75% RPS portfolio

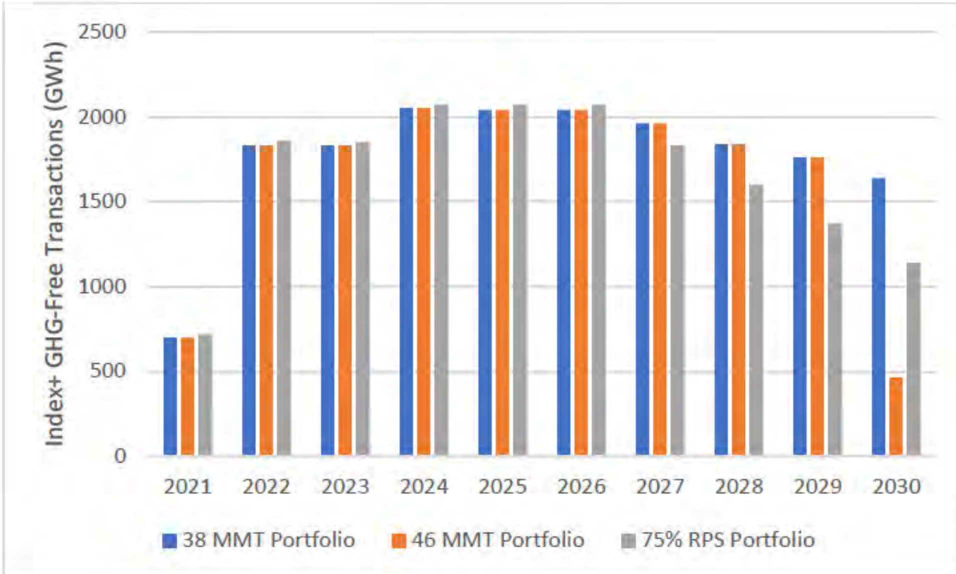

Figure 5. Index+ GHG-free transaction quantities included in each portfolio.

iii. Portfolio Energy Balance

Figures 6, 7, and 8 graphically summarize the composition of each portfolio.

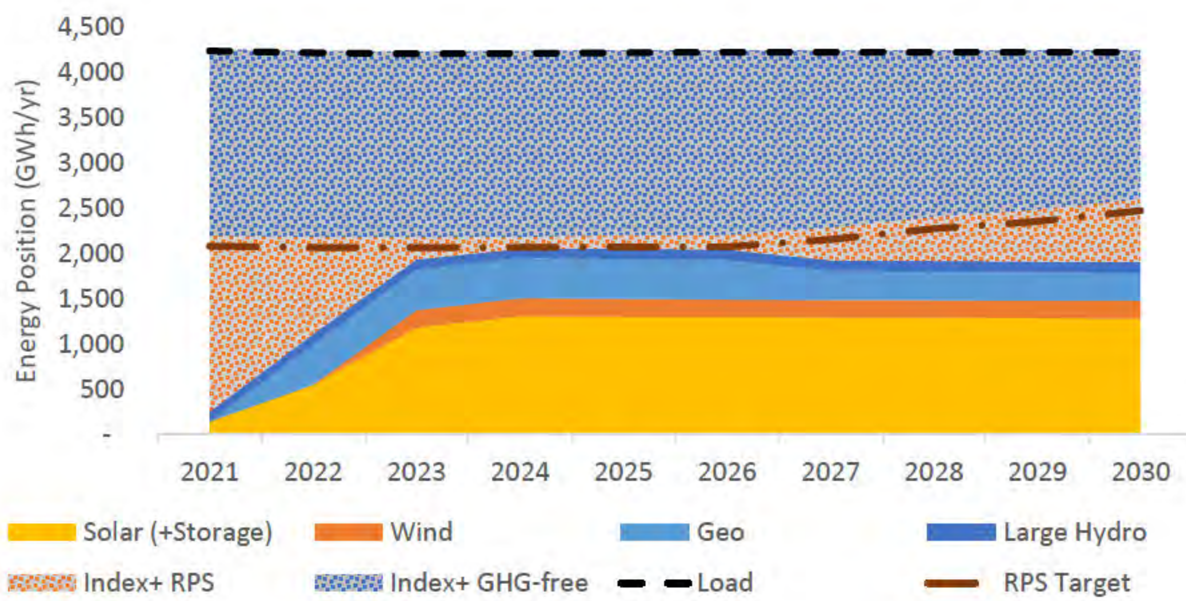

Figure 6. 38 MMT Conforming Portfolio Energy Expansion Chart.

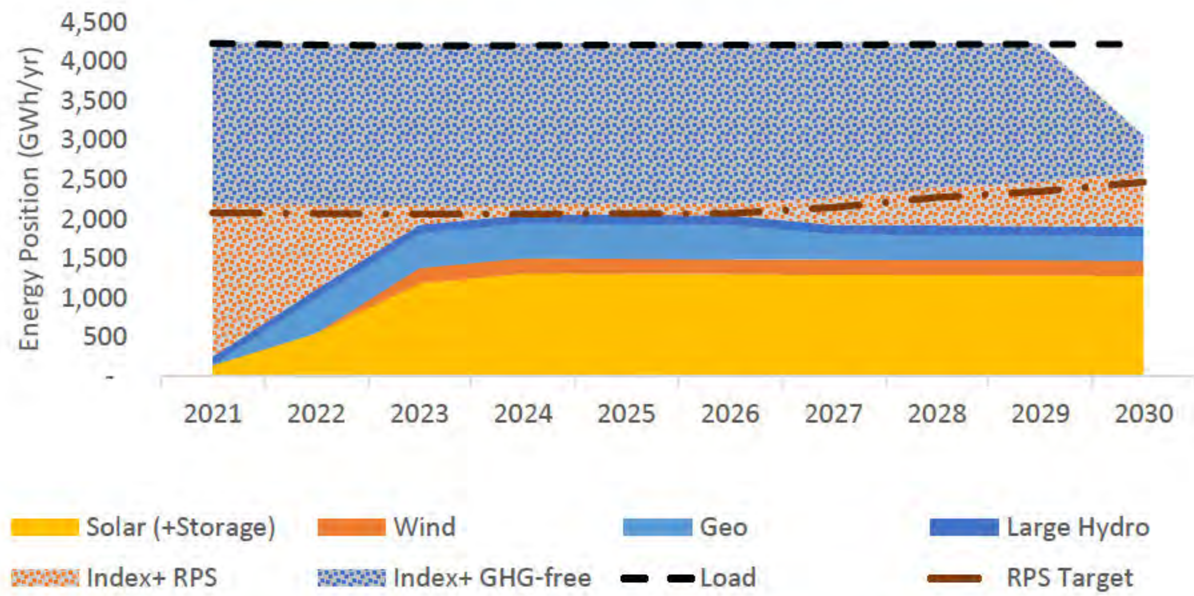

Figure 7. 46 MMT Conforming Portfolio Energy Expansion Chart. Gap In 2030 to be filled by system power.

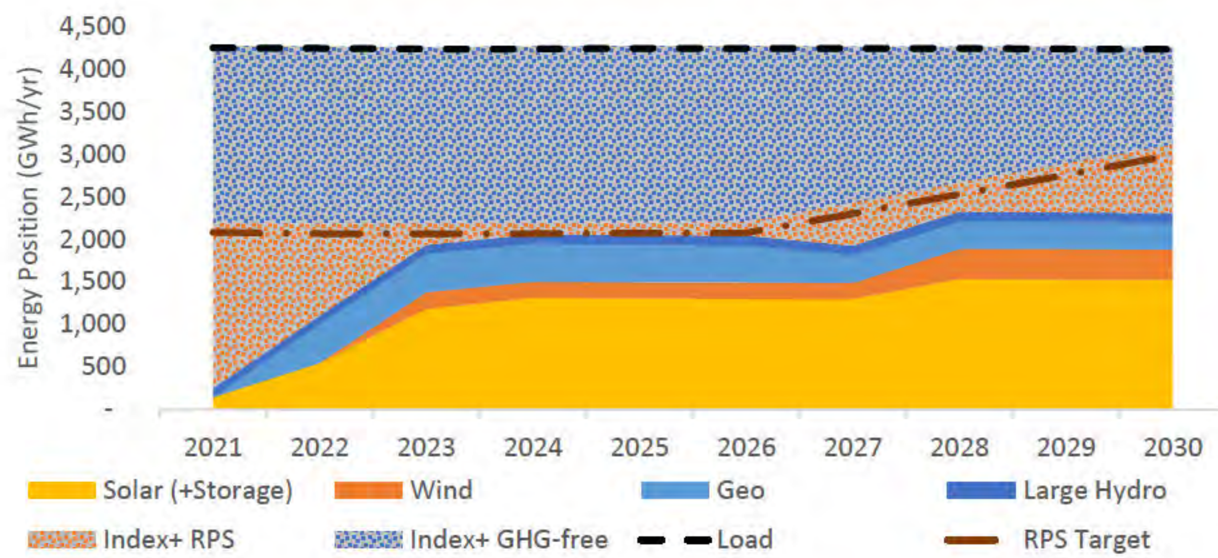

Figure 8. 75% RPS Alternative Portfolio Energy Expansion Chart.

iv. Comparison to Reference System Portfolios

Under D.20-03-028, "LSEs are not required to adhere directly to the exact proportion of resources selected by RESOLVE in the 46 MMT or 38 MMT portfolios, in developing their own portfolios" and "specific resources may be used as proxies for similar resources."[7] The Decision requires that LSEs procure resources in five broad categories defined by their attributes: long-duration storage (8-12 hours); short-duration storage (4 hours or less); hybrid resources; renewable resources; and other resources.[8] Similarly, the Energy Division has stated that "The RSP is meant to guide planning, but LSEs do not have to procure an amount of resources that aligns with their proportional share of resources selected in the RSP. LSEs may submit portfolios that include more or less resources than their share of the RSP as long as those portfolios achieve their emissions goals."[9] Consistent with this guidance the table below compares SVCEs 38 MMT and 46 MMT Portfolios for general consistency with the Commission's RSPs.

Table 10. Comparison of new resources in SVCE portfolios to SVCE's load ratio share of new resources in RSPs in 2030.

	Load Ratio Share of Reference System Portfolios		**SVCE Portfolios**	
	38 MMT	**46 MMT**	**38 MMT and 46 MMT Portfolios**	**75% RPS Portfolio**
Short-Duration Storage (MW/MWh Capacity)	194/644	177/523	191/732	249/962
Long-Duration Storage (MW/MWh Capacity)	32/385	19/234	-	-
Total Storage (MW/MWh Capacity)	226/1,029	197/756	191/732	249/962
Renewable Energy (GWh)	1,161	803	1,408	1,821
Renewable Energy Mix	Solar: 57% In-State Wind: 24% Out-of-State Wind: 19%	Solar: 76% In-State Wind: 19% Out-of-State Wind: 5%	Geothermal: 4% Solar: 93% In-State Wind: 3%	Geothermal: 3% Solar: 85% In-State Wind: 11%
Other Resources (Shed Demand	4.4	4.4	6	6

7 D.20-03-028 at 63

8 Id.

9 *See* "Filing Requirements Questions and Answers," Version 8/11/2020, at 19-20 (Answer to Question 34).

Response) (MW)				

As the table shows, the total quantities of short-duration storage, renewable energy, and shed demand response are comparable to or greater than SVCE's load ratio share of the RSPs. The two major differences are the lack of long-duration storage, the inclusion of new geothermal, and the heavier reliance on solar energy. Though not included in its portfolio modeling, SVCE is actively exploring procurement of long duration storage. Further information on this topic is discussed Section III.h on Long-Duration Storage Development. As a baseload renewable resource, the addition of new geothermal energy is expected to contribute to grid reliability. Finally, although SVCE relies more on solar energy than the RSPs, all new solar energy is assumed to be paired with 4-hour battery storage to ensure operation of the resource. In addition, as SVCE's Resource Data Templates demonstrate, the timing of SVCE's planned procurement under both portfolios is generally consistent with the Commission's identified new resource need timing under the 38 MMT and 46 MMT scenarios.

b. Preferred Conforming Portfolios

As SVCE has only presented one Conforming Portfolio for each GHG emissions reduction scenario, each is technically considered a Preferred Conforming Portfolio for IRP compliance purposes. However, the 38 MMT Conforming Portfolio is SVCE's is the one that represents SVCE's current procurement plans and is a blueprint for future procurement. Conversely, the 46 MMT Conforming Portfolio was developed exclusively to comply with the explicit instruction from Commission staff that it must hit but not go below SVCE's 46 MMT scenario GHG benchmark. The 46 MMT Conforming Portfolio is **not** consistent with SVCE's planned procurement strategy, and only the 38 MMT Conforming Portfolio should be used for aggregation and Preferred System Plan development.

The 38 MMT Conforming Portfolio is preferred over the 46 MMT Conforming Portfolio because it conforms to the Board's procurement goal of being 100% carbon free on an annual basis through 2030. The 38 MMT Conforming Portfolio is currently preferred over the 75% RPS Alternative Portfolio for the following reasons:

- The SVCE Board has not approved a procurement strategy for a 75% RPS target;
- Staff is still assessing the cost, benefits, risk, and viability of accelerating RPS procurement;
- Reliability, resource adequacy, and grid integration requirements are still in flux and highly uncertain and may impact the value of additional RPS resources;
- Moving to a higher RPS will likely be achieved with solar plus storage resources, which may have an adverse impact on SVCE's hourly GHG emissions and electrification goals; and
- The expansion of Direct Access could pose significant risk to SVCE if it procures large amounts of long-term resources beyond those necessary to meet existing mandates.

However, SVCE will continue to analyze the need for additional procurement of alternatives to energy from large hydro that may become scarce over time as more LSEs are required to meet the state's decarbonization goals. SVCE will report on this topic in the next IRP.

As shown in the next section, the GHG emissions for the 38 MMT conforming portfolio are significantly below the required GHG emissions benchmark. SVCE expects this portfolio would operate similarly regardless of what emissions target other LSEs use to set their own procurement goals. The excess emissions reduction is largely a result of the dependence on large hydro resources. Though aggressive large hydro procurement by other LSEs could make large hydro more difficult to procure in the future, it is not expected to significantly impact hydro operations or SVCE's ability to procure in the near term. SVCE has addressed the risk of lack of hydro availability in the longer term through analysis of the 75% RPS Alternative Portfolio, which is more thoroughly discussed in Section III.g on Hydro Generation Risk Management.

SVCE's aggressive procurement of renewable resources, including large amounts of new solar development, could contribute to lower Effective Load Carrying Capacity for all solar resources under the current Resource Adequacy framework. However, all new solar in SVCE's portfolio is backed by battery storage to reduce risk of curtailment and ensure its operation. Within executed PPAs, SVCE has negotiated buyer curtailment and buyer curtailment caps to help mitigate CAISO negative price risk. Additionally, with the exception of one solar plus storage resource, SVCE along with MBCP will be responsible for the scheduling coordination function, thus ensuring optimal dispatch to the two CCAs' portfolio objectives. Finally, any future reform to the RA program that recognizes the value of energy generation in all hours rather than just the peak should improve the value proposition for storage paired with solar, minimizing disruptions in the planned development of these resources.

Last, SVCE expects to continue to rely on natural gas generation for resource adequacy and hedging of its cost to meet load through the CAISO (see Section III.f), and supports expansion of the CAISO's Energy Imbalance Market (EIM) and regionalization efforts as an effective means to manage curtailment risk on a macro level. Additionally, SVCE is current exploring options for entering into tolling agreements and other longer-term contracts for gas capacity that are within the limitations placed by SB 1368.

c. GHG Emissions Results

Both of SVCE's conforming portfolios achieve GHG reductions at or below the level required by our assigned GHG benchmarks. The emissions from each portfolio are shown in the table below alongside the appropriate benchmark.

Table 11. GHG Emissions in 2030

		46 MMT Conforming Portfolio				38 MMT Conforming Portfolio (Preferred)				75% RPS Alternative Portfolio			
Pollutant	Unit	2020	2022	2026	2030	2020	2022	2026	2030	2020	2022	2026	2030

CO2	MMT/yr	0.216	0.128	0.125	0.704	0.215	0.132	0.129	0.255	0.215	0.130	0.127	0.297
Benchmark*	MMT/yr				0.704				0.562				0.562

**Benchmark is shown net of BTM CHP emissions.*

These emissions are the result of inputting each portfolio into the final version of the CSP calculator. The assumptions used in the CSP calculator are described in Section II.b above.

d. Local Air Pollutant Minimization and Disadvantaged Communities

i. Local Air Pollutants

Local air pollutant emissions were calculated in the CSP calculator and for each portfolio and are summarized in the table below.

Table 12. Local Air Pollutant Results

		46 MMT Conforming Portfolio				38 MMT Conforming Portfolio (Preferred)				75% RPS Alternative Portfolio			
Pollutant	Unit	2020	2022	2026	2030	2020	2022	2026	2030	2020	2022	2026	2030
PM 2.5	Tonnes/yr	26	7	7	31	26	7	7	13	26	7	7	14
SO2	Tonnes/yr	7	1	1	3	7	1	1	1	7	1	1	1
NOx	Tonnes/yr	73	24	24	60	73	24	25	28	73	24	25	29

For all portfolios, the only local air pollutants are due to system power. The Action Plan section of the IRP discusses various strategies SVCE intends to employ for reducing reliance on system power over time.

ii. Focus on Disadvantaged Communities

In order to identify disadvantaged communities (DACs) that are located within its service territory, SVCE used CalEnviroScreen 3.0 to identify the top 25% of impacted census tracts on a statewide basis and the top 5% of census tracts without an overall score but with highest pollution burden. This analysis indicates that SVCE serves 5,719 customers residing in 6 census tracts identified as DACs: 6085504602, 6085505202, 6085512310, 6085512602, 6085512603, and 6085503214. The map below, excerpted from the CalEnviroScreen 3.0 website, shows each of these census tracts. The population of these DAC areas is listed as 26,006 per 2010 census figures, which is estimated to comprise approximately 4% of the population of SVCE service territory.

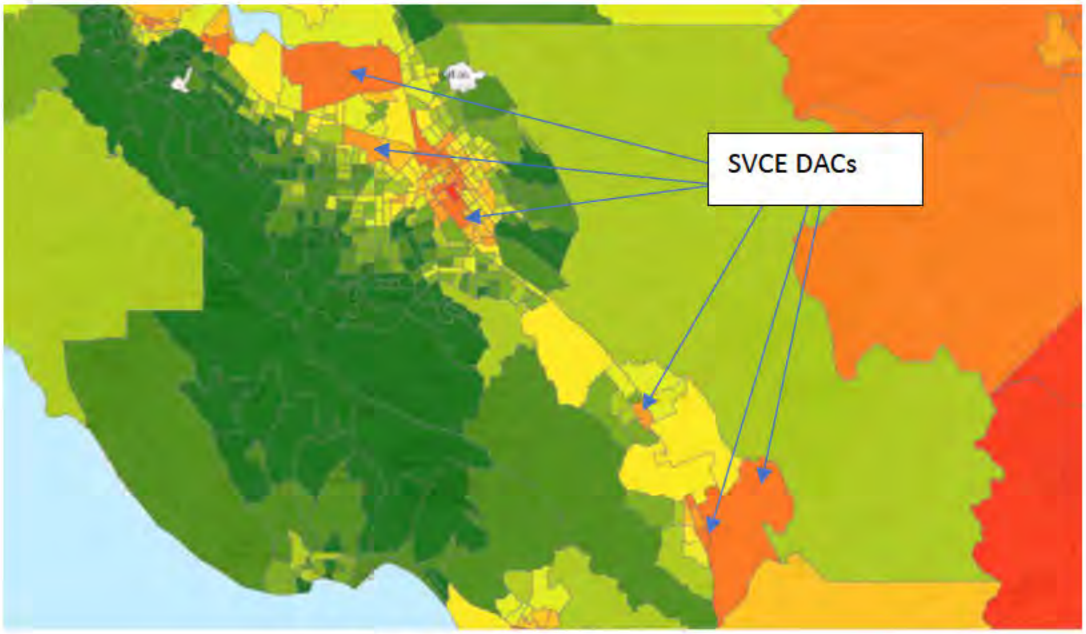

Figure 9. Map of SVCE DAC Census Tracts.10

SVCE's primary strategy for reducing emissions and contributing to the economic development of DACs is the aggressive procurement of zero-emissions renewable resources. When selecting green power projects, SVCE considers whether proposed facilities are located within DACs or otherwise contribute to DAC economic development (for instance, by increasing employment opportunities for DAC residents). Currently, SVCE has signed one PPA for a solar plus storage facility within a DAC census tract: RE Slate in Kings County.

SVCE does not have any energy contracts with gas generators located in or next to DACs. SVCE does not have any energy contracts with renewable generation that may have local emissions impacts (such as biogas or biomass) located within or next to DACs. SVCE's preferred 38 MMT Conforming Portfolio significantly reduces SVCE's reliance on system power, which may include some power dispatched in certain hours of the day from generators that have emissions impacts on DACs. SVCE's existing and future RA contracts are primarily from natural gas units which may be located in or near a DAC area. To the extent compatible with RA program requirements and cost-effectiveness, SVCE prefers capacity contracts from generators that do not have emissions impacts on DACs such as those from DER, renewable and carbon-free resources.

SVCE's community outreach and programs are designed to be especially sensitive to the needs of DACs. In 2018, SVCE awarded $75,000 in grant funds to six local nonprofits to collaborate on outreach to traditionally hard-to-reach and underserved residential customers. The purpose of this small grant pilot program was to provide accurate information to SVCE

[10] CalEnviroScreen 3.0 Mapping Tool, https://oehha.ca.gov/calenviroscreen/maps-data.

customers about SVCE's mission and benefits, as well as build relationships in disadvantaged communities for future program development and deployment.

The grants were offered to trusted, local nonprofits that serve underrepresented communities and harder-to-reach audiences in the SVCE service territory. These communities and audiences include low-income residents; seniors; customers eligible for Medical Baseline discounts; customers with low English language proficiency; and customers living in the south county, unincorporated Santa Clara County, and Milpitas. In total, the grants facilitated outreach to over 310,000 residents.[11] This collaboration has helped SVCE promote social equity by ensuring that customers in target communities are aware of how they can benefit from SVCE programs and rates, which is a shared priority among state regulators. SVCE plans to launch a second Community Engagement Grant cycle in the future.

Through the Innovation Onramp program, SVCE provided grant funding to launch two innovative pilots to provide reliable and affordable charging access to apartment and condo residents. The pilot with EVmatch is to test their reservation-based software platform for shared charging for multi-unit dwelling tenants. The pilot with Ecology Action is to demonstrate a low power charging technology and business model designed specifically for affordable housing communities.

SVCE is conducting ongoing analyses to better understand and measure equity in its service territory. This includes tracking customer adoption of behind-the-meter (BTM) solar, BTM storage, electric vehicles, and home electrification on a census tract-level. Tracking these adoption metrics alongside equity metrics such as CalEnviroScreen 3.0 will allow SVCE to ensure that its programs and initiatives reach its disadvantaged and underserved communities.

Per SVCE's Electric Vehicle Infrastructure Joint Action Plan, SVCE is currently offering two programs focused on deployment of EV charging to serve multi-family properties in lower-income communities. The 'Priority Zone DC Fast Charging' program offers additional financial incentives for new fast charging stations located near concentrations of lower-income multifamily properties. SVCE's FutureFit Assist EV Charging program offers a full suite of free technical assistance to multi-family properties for design and deployment of onsite Level 2 charging.

Lastly, through SVCE's Resiliency RFP, described in other sections, SVCE contracted with Sunrun for capacity and resilience from behind-the-meter battery storage and solar installations. Half of the capacity is targeted to come from installations at multi-family properties to benefit customers living in disadvantaged communities or enrolled on low income assistance (CARE, FERA) or medical baseline programs. The installations will take place in 2020 through 2022. The program is expected to benefit thousands of customers,

[11] Over 3,000 total engagement and over 308,000 total reach.

particularly during future iterations of the Public Safety Power Shutoff events that began in 2019.

e. Cost and Rate Analysis

As a California CCA operating in an in environment where customers have choice, whether it's returning to the incumbent utility, participating in direct access or bypassing SVCE with behind-the-meter solar, SVCE is acutely aware of the need to manage cost and maintain competitive rates. SVCE's value proposition since its inception has been to provide affordable and annually carbon-free product offerings to its customers. GreenStart is SVCE's default product offering, comprised of a mix of RPS and other carbon-free resources, which since inception has been offered at a discount to PG&E's bundled generation rates of four percent on average. GreenPrime is SVCE's opt-up product which is made up of 100% RPS eligible resources and is offered at a slight premium to GreenStart.

Fundamental to achieving SVCE's product and rate objectives is SVCE's ability to procure cost-effective electric supply resources and manage the cost and risk associated with its load and supply portfolio. This starts with the proper evaluation and selection of resources acquired to meet SVCE's long-term renewable needs, which make up a large portion of the supply portfolio. In evaluating the addition of new or existing resources to the SVCE generation portfolio, SVCE utilizes both quantitative and qualitative metrics. SVCE evaluates the resource value as determined by its net energy (including congestion), ancillary service (A/S), resource adequacy (RA) and RPS/REC value and compares it to the contract cost. In addition, SVCE assigns qualitative metrics including a resource's generation profile, location, workforce development and technology type. SVCE then measures the resource's benefits against its costs to determine whether it is cost-effective and to assess an implied REC cost.

After a resource has been analyzed to be cost-effective, it is then incorporated and modeled with SVCE's existing portfolio to determine the overall portfolio's return/risk ratio. The return/risk ratio analysis will account for portfolio dynamics including:

- Resource performance against SVCE's hourly load obligation;
- Basis locational price differential between the resource and SVCE DLAP; and
- Variability in production from resources and forward and spot price uncertainty

Resources that increase the portfolio's gross margin net present value (NPV) while decreasing the gross margin at risk (as measured by the mean gross margin NPV minus the fifth percentile probability [P5] gross margin NPV) are considered resources for further consideration.

Aside from the process describe above, SVCE also assesses the strategic value a resource may provide. Resources are evaluated on their ability to:

- Meet SVCE's vision of a true carbon-free portfolio where the resource can provide clean energy on a 24x7 basis or in the hours where carbon emissions are the highest;
- Provide local benefits to its member communities;
- Mitigate portfolio concentration risk (price, technology, counterparty and/or location); and
- Provide for overall grid reliability.

SVCE is subject to significant cost volatility and uncertainty in meeting its energy load obligations within the CAISO. To manage this cost, SVCE's governing board has adopted an Energy Risk Management Policy. Included in the Policy are tolerance bands for minimum and maximum amount of load to be met through forward purchases of fixed-price energy. These transactions are carried out with Board-approved counterparties and for the most part are sourced through generic resources priced at the PG&E EZ-Gen Hub or NP15 delivery point.

Table 13. SVCE Board Approved Energy Risk Management Tolerance Bands (Fixed Price Supply as a % of Load)

Period	**Minimum**	**Maximum**
Prompt Quarter	85%	105%
Current Balance of Year	80%	105%
Year 2	70%	90%
Year 3	55%	75%
Year 4	40%	60%
Year 5	0%	50%

Taking a portfolio approach of varying new and existing projects, technology, location, contract tenor, counterparties and contract pricing structures in its pursuit of long-term RPS resources along with having a rigorous energy risk management program to manage load obligations and supply portfolio cost and risk ensures that SVCE can meet its near and long-term cost, rate, and financial objectives. Over time short-term index plus REC and/or carbon-free resources will be replaced with less expensive and more valuable long-term PPAs delivering energy, RECs, carbon-free, and RA attributes. As such, SVCE's cost for clean energy is expected to decrease or remain stable over time; however cost to meet RA requirements are expected to increase. Overall SVCE's expected cost through 2030 are relatively flat as shown in Figure 10.

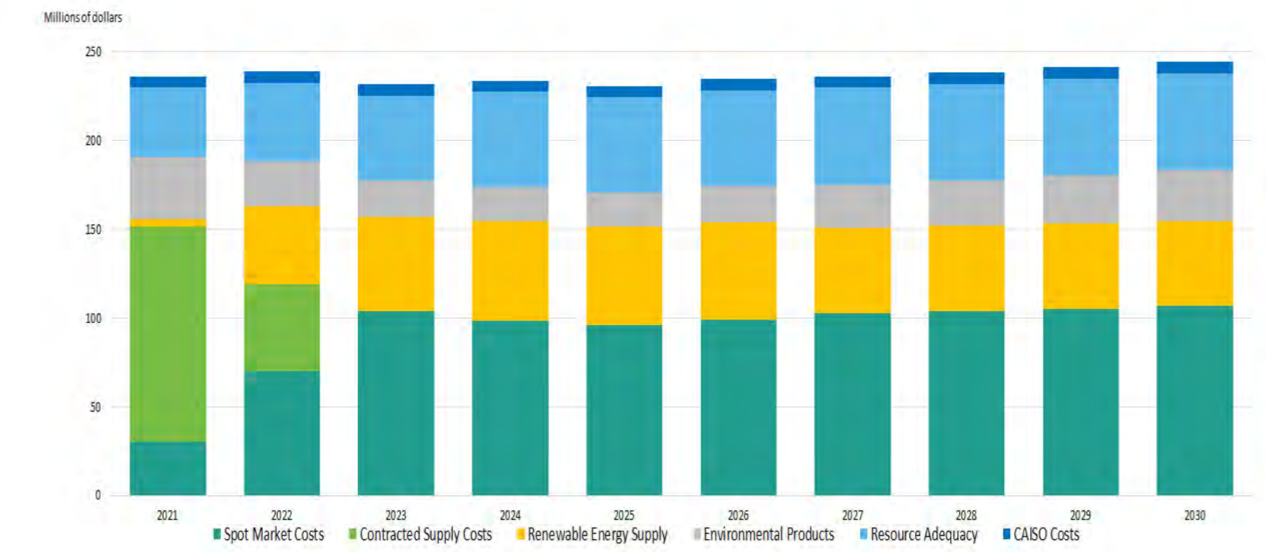

Figure 10. SVCE Expected Cost to Meet Load 2021-2030 $MM/year.

f. System Reliability Analysis

SVCE is fully committed to maintaining a portfolio that not only meets our decarbonization goals but fulfills our commitment to the Resource Adequacy (RA) program and broader system reliability. Reliability has emerged as the major technical challenge in the process of decarbonizing California's grid, and SVCE's procurement strategy and priorities bring several types of innovative solutions to the table.

The reliability challenge California faces is that unlike natural gas, which the state has historically and continues to rely on for the majority of our energy needs, many renewable energy sources cannot generate electricity on a 24/7 basis. A gas-based system can maintain system reliability as long as there is enough capacity available to meet peak demand, and that is what California's current RA program is designed to do. However, as the fleet is increasingly dominated by variable renewables, planning for peak demand is not enough because there is no guarantee that resources available to meet the peak can contribute in other hours as well. RA tracking table results are summarized in the tables below. RA contributions from the following resources are included:

- Existing short-term RA contracts
- Executed long-term PPAs for RPS resources and associated storage, if applicable
- Planned long-term PPAs for additional RPS resources (existing wind, new wind, and new solar + storage hybrid resources)
- Planned shed DR resources from SVCE's resiliency RFP

After these resources are accounted for, 50 MW of the remaining RA obligation each year is assumed to be met with large hydro imports, which is in line with current short-term RA contracts, and the remaining RA obligation is met with existing gas resources via short-term RA-only contracts. This is consistent with SVCE's current RA procurement, which relies on RA-only contracts with natural gas generating units.

For purposes of estimating RA from solar + storage PPAs, all PPAs, both executed contracts and backfill generic resources, are modeled as hybrid resources. This means that they have charging restrictions such that most energy for the battery is supplied by attached solar, making the resource eligible for investment tax credits. The calculation of the amount of RA for these resources is described in D.20-06-031. Per this decision, the amount of RA contribution from the solar resource must be limited to that which is not used to charge the battery. SVCE estimated this derate for each PPA, and then multiplied the resulting solar capacity by the solar ELCC curves in the CPUC resource data template, which vary for the 38 MMT and 46 MMT scenarios. The battery ELCC curves in the resource data template were also multiplied by the battery capacities to estimate the RA contribution from the battery resources.

Table 14. September RA tracking table for 38 MMT Conforming Portfolio.

[redacted]

Table 15. September RA tracking table for 46 MMT Conforming Portfolio.

[redacted]

Table 16. September RA tracking table for 75% RPS Alternative Portfolio.

[redacted]

The RA tracking table includes new shed DR resources in all portfolios. (Shed DR is an unknown ELCC type in the tables.) In response to Pacific Gas and Electric Public Safety Power Shutoffs and to invest in resiliency for our customers, SVCE along with three other LSEs conducted a Request for Proposals ("RFP") to provide RA capacity and resilience to its residential and commercial customers through the development of customer-sited Distributed Energy Resources ("DERs"). SVCE signed a 10-year contract with SunRun to provide capacity and resiliency in the form of a load modification approach. SunRun is contracted to provide up to 7.5 MWs through the installation of solar plus storage DERs to single family and multi-family homes no later than 2022. The RA tracking tables reflects 6 MW of generic shed DR as a proxy for these resources. Although each tracking table represents a reasonable approach to RA procurement for each IRP portfolio, there is significant uncertainty regarding future RA requirements and procurement. Therefore, SVCE's actual RA portfolio in the future may be significantly different than what is reported here. Current Commission proceedings, once resolved, may result in SVCE taking RA allocations from PCIA resources, and the new central procurement framework may result in substantial RA procurement outside SVCE's direct control.

g. Hydro Generation Risk Management

Electrical generation from hydroelectric facilities depends on the volume of water available to flow through turbine generators. A lack of precipitation in drought years creates low water availability and hence lower hydro generation output. Hydro systems without large reservoirs that can store water for multiple years and that can average out generation over time are at particular risk. California's hydro generation system is vulnerable to drought and has experienced lower than average hydro generation during several major droughts over the past two decades.

Drought risk can impact generation system reliability. For hydro generation systems with at least some water storage and dispatch flexibility, the risk primarily manifests as an energy constraint as opposed to a capacity constraint. During droughts, such systems can generate up to their maximum capacity for short periods of time, but cannot do so for long periods because of a lack of water due to the drought. Hydro systems with no effective water storage will be energy and capacity limited in a drought.

Currently, SVCE relies on a significant amount of purchases of GHG-free energy from hydro generators to maintain its Board-approved goal of being carbon-free on an annual basis. SVCE manages its hydrological risk by contracting with both Pacific Northwest (PNW) and California suppliers. In addition, SVCE attempts to execute firm contracts to provide certainty on hydro deliveries from suppliers who will only sell excess resources versus a unit contingent contract that is subject to the vagaries of hydrological conditions. For example, in 2020 hydro conditions in the PNW are at or above average while California conditions are more challenging. SVCE is able to mitigate its hydrological delivery risk by diversifying the regions from which it procures large hydro. In addition, SVCE is inserting language in contracts that specify that the supplier provide hydrological statistics (storage levels and acre/ft conversions) at certain times of the year in order for SVCE to better forecast future deliveries.

SVCE contracts for hydro resources through a mix of counterparties and for varying terms to manage risk associated with counterparty default on hydro resources. SVCE's goal is to secure a large portion of its large hydro needs under contract of three- to five-year tenures; however, it continues to explore longer-term contracting for small hydro facilities.

SVCE is actively working to reduce its reliance on short-term purchases of GHG-free energy through its growing portfolio of long-term contracts for renewable resources. This portfolio includes geothermal resources that can deliver baseload generation. Further, SVCE is exploring long-term contracts for hydro resources. In 2018, SVCE was awarded a small allocation of large hydro from the Central Valley Project (CVP) as provided for under Western Area Power Administration's 2025 Power Marketing Plan. The contract is 30 years in term, structured as a run-of-river for which SVCE will be responsible for its share of project cost. The contract is expected to be executed by the end of 2020 for deliveries starting in 2025.

Figure 11 below compares the amount of hydro generation in 2030 for both the RSPs and SVCE's IRP portfolios. Since it is not known how much hydro in SVCE's portfolio will be in-state or imported, total hydro generation is shown as a percent of retail sales.

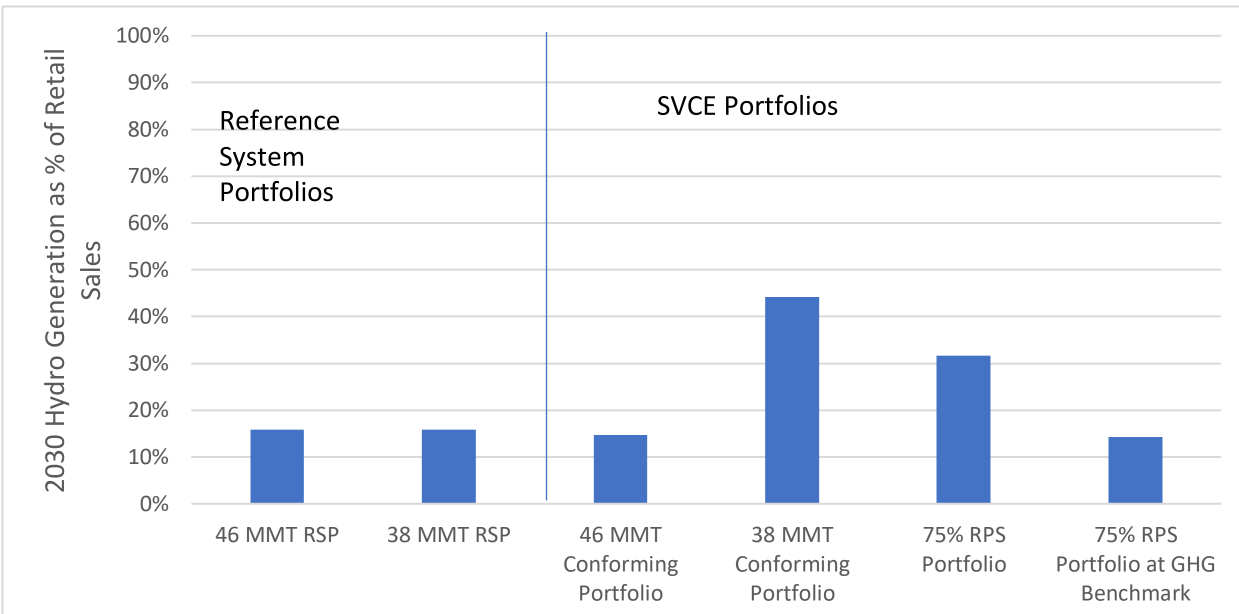

Figure 11. Comparison of 2030 hydro generation as percent of retail sales. For RSPs, CAISO large, small, and imported hydro generation is shown as a percent of CAISO retail sales. For SVCE portfolios, SVCE hydro purchases are shown as a percent of SVCE retail sales.

As the figure shows, the 38 MMT Conforming Portfolio and 75% RPS Alternative Portfolio are far more heavily dependent on hydro than the RSPs. However, they also have emissions much lower than the assigned benchmark. When the amount of large hydro in the 38 MMT Conforming Portfolio is reduced to meet the 46 MMT emissions benchmark, the result is the 46 MMT Conforming Portfolio. And as the chart shows, the amount of hydro in this portfolio is somewhat lower than that from the Reference System Plan (RSP) portfolios.

In addition, SVCE performed a sensitivity analysis with the 75% RPS Alternative Portfolio. The amount of large hydro in the portfolio was lowered until emissions increased to equal SVCE's 38 MMT scenario benchmark. The resulting quantity of hydro is shown in the rightmost column of

Figure 11, and is lower than the hydro reliance in the 38 MMT Scenario RSP portfolio. Therefore, SVCE concludes that the additional hydro reliance in the 75% RPS portfolio compared to the RSP is not necessary to meet the emissions benchmark, but only needed to meet the Board-approved goal of being 100% carbon free on an annual basis. Should hydro purchases become difficult over time due to drought or competition with other LSEs seeking lower-carbon portfolios to meet GHG emissions targets, the 75% RPS portfolio represents an alternative path to meeting SVCE's procurement objectives, including being 100% carbon-free on an annual basis. And should hydro resources become even more scarce, SVCE could still meet its 38 MMT Scenario GHG benchmark with a pro rata share of the hydro in the Reference System Plan. SVCE will monitor hydro availability and the cost of renewable energy to determine which path it will take, and will report back on this issue in future IRPs.

h. Long-Duration Storage Development

SVCE does not currently hold any contracts for long-duration storage resources and thus does not include them in any of the three portfolios in this IRP. However, SVCE is aware of the potential value of long-duration storage for reliability and is actively exploring options for procuring long-duration storage in the future.

Along with 12 other CCAs, SVCE issued a joint request for information (RFI) on long-duration storage on June 3, 2020. The goal of the RFI was two-fold. First, to inform upcoming efforts to issue a Request for Offers for long-duration storage resources. Second, to assess the viability of long-duration storage and inform the CCAs' individual and collective efforts in developing their IRPs, specifically as it relates to meeting long-duration storage capacity needs identified in the CPUC's Reference System Portfolio (RSP). Under the 38 MMT scenario, the RSP identified a need to add 1,605 MW of new long-duration storage (minimum of eight-hour discharge duration, though modeled by the CPUC as twelve hour duration) by 2026. Taking a pro rata share of the CCA's portion of the capacity represents 450 MW in 2026, assuming CCAs are 28% of state load. For SVCE alone, the needed capacity is 48 MW assuming an eight-hour duration.[12]

The RFI is an attempt to reflect the results from the RSP in that it sought information for resources to be grid charged, have a minimum discharge duration of 8 hours, and to begin commercial operation by 2026. The RFI was open to multiple technologies including battery storage, mechanical storage, thermal storage, and chemical storage. RFI responses were due July 1, 2020 and over 30 submissions were received for 25 distinct projects. While SVCE and the group of CCAs are still reviewing results, the general observation is that the amount of capacity identified in the RSP can be technically developed by 2026. The following is a summary of key information gathered:

- A total of 9,183 MW of 8-hour duration project capacity was submitted;
- Offers varied in tenor, battery discharge duration (8, 12, or 16-hour) and available attributes (e.g., RA only, tolling, A/S);

[12] SVCE's straight load-ratio share of the 1,605 MW is 32 MW. However, since the 1,605 MW was modeled as a 12-hour duration resource, SVCE multiplies 32 by 12/8 to get 48 MW equivalent at 8-hour duration.

- 14 types of technologies were submitted including lithium-ion, chemical flow, compressed air, pumped storage hydro, thermal storage, gravity-based, hydrogen, and 2nd life EV batteries;
- Prices ranged from $10 - $51.26 per kW-month; and
- Projects are able to meet an on-line date of 2026 or earlier.

Additionally, no developer expressed specific concerns with respect to contracting with a single CCA or with multiple CCAs through a joint buying arrangement.

SVCE along with a sub-set of the CCAs that participated in the RFI intend to issue a joint RFP later this year. These same CCAs are exploring the formation of a new joint powers authority to enable the procurement of long-duration storage resulting from the RFP. Joint procurement for long-duration storage will allow for better economies of scale while reducing project development, technology, and regulatory risk. While the results from the RFI appear promising from a technical potential basis, SVCE and the other CCAs remain concerned about the costs, benefits, and regulatory risk. SVCE will look to the results of the future RFO and discussions with developers and the CPUC to inform future procurement decisions about long-duration storage.

As mentioned earlier, SVCE has not included any long-duration storage in its three 2020 IRP portfolios because at this time no such resources are under contract. However, SVCE hopes that the above demonstration of recent but rapid and substantial progress demonstrates SVCE's recognition of the role long-duration storage could play in grid reliability and its commitment to exploring potential development of this resource.

i. Out-of-State Wind Development

The Commission's 38 MMT RSP calls for 3,000 MW of new out-of-state wind generation ("OOS Wind") to be developed and operational by 2030, while the 46 MMT RSP calls for 606 MW of new OOS Wind to be operational by 2030. SVCE understands that the transmission projects needed to connect OOS wind to the CAISO grid require significant lead times. However, given the fact that OOS wind is not needed until 2030, SVCE believes that a careful and considered approach to potential OOS wind projects is best. SVCE remains open to OOS wind proposals in response to its Requests for Offers. Such proposals are evaluated alongside others and are not penalized for being out-of-state as long as they can deliver to the CAISO. However, SVCE recently had to terminate an out-of-state wind PPA. In June 2018, SVCE's Board of Directors approved a 15-year PPA with Duran Mesa LLC for 110 MW of wind power from the Corona Wind Farm in Torrance and Lincoln Counties, New Mexico.[13] The project was to supply portfolio content category one renewable energy credits from a new wind facility and transmitted to California via a new transmission path. Unfortunately, on April 16, 2020 SVCE and Pattern Energy, Duran Mesa LLC's parent company, mutually terminated the PPA due to unanticipated delays in development outside the control of the supplier. The project had a scheduled COD of December 31, 2020 and was expected to meet 10% of SVCE's RPS.

[13] The PPA resulted from a joint procurement with Monterey Bay Community Power.

The RSP calls for a large amount of out-of-state wind on new transmission paths for delivery in 2030. Through its current RFP for long-term renewables, SVCE received multiple offers for in-state resources but none for out-of-state. Additionally, SVCE has had bilateral discussions with developers for out-of-state wind resources, however transmission and cost continue to be a major barrier. SVCE will continue to seek cost-effective and viable wind resources consistent with its 38 MMT Conforming Portfolio and its desire to achieve a diversification of technologies in its RPS procurement.

j. Transmission Development

Resources for which SVCE has already executed contracts are in all IRP portfolios. The table below summarizes the location information for new resources under long-term contract.

Table 17. New SVCE Resource Location Information. SVCE has executed contracts with these resources.

Project Name	Resource Type	Location	Queue Position	Station or Transmission Line	Interconnection Agreement?	RESOLVE Area	Coordinates
Big Beau	Solar + Storage	Kern County, CA	602 (18MWs solar) 1329 (110MWs solar, 40 MWs storage)	Whirlwind Substation 230kV	Yes	Tehachapi	34.933767 N 118.341933 W
RE Slate	Solar + Storage	Kings County, CA	1158	Mustang Switching Station 230kV	Yes	Westlands	36.24095 N 119.914801 W
Ormat	Geothermal	Mono County, CA	315	115 kV bus at SCE Control Substation	Yes	Northern California	37.65187 N 118.91686W
Rabbit-brush	Solar + Storage	Kern County, CA	1215	Whirlwind Substation 230kV	Yes	Tehachapi	34.8775 N 118.3595 W
Yellow Pine	Solar + Storage	Clark County, NV	1341	GridLiance Trout Canyon 230 kV substation on the Pahrump Sloan Canyon 230 kV line	Yes	Southern Nevada	36.0514 N 115.7519 W
Aratina	Solar + Storage	Kern County, CA	1604	Kramer Substation 230 kV	Yes	Kern Greater Carrizo	34.987952 N 117.68 W

Each of the portfolios also includes new solar, wind, and storage resources that are modeled as planned backfill PPAs but not yet under contract. SVCE's only location requirement for these resources is that they must qualify as PCC1 resources for RPS compliance purposes, meaning they have a first point of interconnection with a California balancing authority. For resources with CODs on or before December 31, 2026, the CPUC requires LSEs indicate which transmission zone the resources will be located in. Because SVCE does not have any strong preferences for resource location, it followed the RSP distribution of wind and solar resources.[14] This spreads the resources in many zones throughout California. For resources with CODs after December 31, 2026, SVCE does not specify a location. Ultimately, SVCE will select resources with the best overall characteristics for cost and reliability, including the cost of any new transmission for interconnection. Risk of interconnection delays due to the need for new transmission construction are also considered in reviewing all offers in SVCE's procurement process.

SVCE also includes a new shed DR resource in all IRP portfolios, that is planned to come from its resiliency RFP, as described in more detail in the section of the IRP on System Reliability Analysis. This resource is expected to be located within SVCE's service territory.

k. Geothermal Resources

In 2019 SVCE signed two long-term geothermal PPAs. One is with an existing facility and one is with a new project that utilizes an air-cooled binary system and will have no CO2 emissions. Both projects are located in California and will deliver PCC1 energy meeting about 11% of SVCE's retail sales along with resource adequacy and ancillary services. The geothermal resources will help SVCE meet its decarbonization and electrification goals by providing a 24x7 source of carbon-free energy.

Both resources were selected through a competitive solicitation process which evaluated offers to assess an expected levelized net benefit value under various market and regulatory conditions. While the geothermal resources were offered in at significantly higher PPA cost on a per-MWh basis versus the solar plus storage and wind projects, the expected value and therefore net benefit was deemed competitive and cost-effective. Specifically, the projects demonstrated strong energy, REC and resource adequacy value. And, from a reliability perspective, SVCE finds geothermal to be a good substitute to capacity from natural gas resources and Diablo Canyon. It is a proven technology and is not susceptible to grid integration issues such as those with intermittent resources.

SVCE recognizes that the CPUC's RSP does not include new geothermal capacity. However, given SVCE's own experience and valuation of these resources, SVCE is excited to include them as part of its IRP portfolios.

[14] Energy was apportioned using the RSP capacity by aggregated zone for year 2022 as provided in the CSP calculators. For the Resource Data Template, the resources were placed in one RESOLVE zone per aggregated CSP zone. For simplicity, the RESOLVE zone with the most development in 2022 was selected as a proxy.

IV. Action Plan

a. Proposed Activities

As a community-driven LSE, SVCE works with its governing board to set policy, strategies, and directives. At a high level, in 2018 SVCE's board approved a Decarbonization Roadmap[15] which sets a path for achieving deep decarbonization goals. The Decarbonization Roadmap promotes electrification in the built environment and transportation sectors, grid integration, and a carbon-free electricity grid.

SVCE's decarbonization approach consists of four central tenets that are all necessary to achieving deep decarbonization: procure and maintain a sustainable, affordable and carbon-free power supply; electrify the built environment; electrify mobility; and promote energy efficiency and successful grid integration. Figure 1 shows how SVCE holistically considered all these pieces when developing a decarbonization portfolio.

The following subsections summarize key activities by focus area.

i. Built Environment

Buildings are responsible for approximately one third of GHG emissions in our communities. As SVCE's electricity supply is carbon-free on an annual basis, these emissions are driven by the consumption of natural gas as an on-site fuel source. In early 2019 SVCE and its member communities embarked on an ambitious project: adopting reach codes that would provide decarbonization benefits above and beyond the state code. [16] Reach codes can be adopted to impact both the built environment through banning gas or encouraging all-electric construction and mobility through requirements around installing EV chargers or laying EV-ready wiring to parking spaces.

Each city was able to consider its own reach codes with SVCE serving as a facilitator and technical advisor. The reach code effort was a major success, and as of July 2020 twelve of SVCE's thirteen member communities have approved or are working towards some type of reach code. Figure 12 shows the details of each city's code.

To continue to spur adoption of electrified technologies and building on the momentum and success of the reach code effort, SVCE is completing a Building Decarbonization Joint Action Plan (Building Decarb Plan)[17] to identify a portfolio of programs to pursue. The plan will be finalized in Fall 2020. SVCE's goal in this effort is to help customers understand and transition to "FutureFit" buildings, as shown in Figure 13.

[15] Available at https://www.svcleanenergy.org/wp-content/uploads/2019/03/Decarbonization-Strategy-Programs-Roadmap_Dec-2018.pdf.
[16] For more details, see https://www.svcleanenergy.org/reach-codes/.
[17] See RFP submitted in January 2020, available at https://www.svcleanenergy.org/wp-content/uploads/2020/01/20191203_SVCE-Building-Decarb-Joint-Action-Plan-RFP.pdf.

					Building Reach			EV Reach
Member Agency	Status	Next Meeting	Date of Next Meeting	Code Language	Encourage Gas Reduction (1 + 2 + 2A)	Limit Gas (1 + 2A)	Ban Gas (1 only)	Higher than CalGREEN
Mountain View		Approved		Begins on pg. 23			X	X
Morgan Hill		Approved		Begins on pg. 45			X	
Milpitas		Approved		Begins on pg. 1132	X			X
Monte Sereno		Approved		Begins on pg. 3	X[1]			X
Saratoga		Approved		Begins on pg. 33		X		X
Los Gatos		Approved		Begins on pg. 93			X	X
Cupertino		Approved		Ordinance			X	X
Los Altos Hills		Approved		Ordinance		X		X
Campbell		Approved		Begins on pg. 41		X		
Los Altos		1st Reading					X	
Santa Clara County		Staff Proposal			X			
Sunnyvale		Staff Proposal				X		
Gilroy	-	Declined						

[1]Reach code proposes wiring all homes for electric appliances and battery storage

Figure 12. Building Reach Code Progress in SVCE's Territory.

The programs and budget committed to tackling building decarbonization will allow SVCE to address the challenging problems and demonstrate scalable solutions. The Building Decarb Plan portfolio will be complimentary to other ongoing SVCE initiatives including a heat pump water heater rebate,[18] city permitting streamlining support and continued support for reach code implementation.

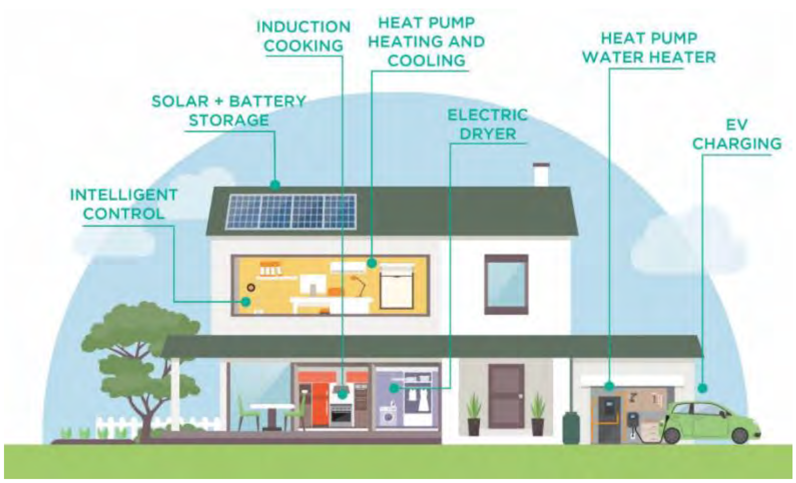

Figure 13. SVCE's presentation of a "FutureFit" home that embraces intelligent decarbonization.

[18] For more details, see https://www.svcleanenergy.org/water-heating/.

ii. Mobility

Emissions from transportation comprise the largest source of GHGs in SVCE's territory, and SVCE's Board has taken this sector seriously by authorizing $8 million in expenditure through 2023 to run the set of programs outlined in SVCE's EV Infrastructure Joint Action Plan (EVI Plan).[19] SVCE also worked with four other LSEs across San Mateo and Santa Clara Counties (both CCAs and municipal utilities) to attract the California Electric Vehicle Infrastructure Project (CALeVIP) to the region. Qualification for CALeVIP funding saw an additional $6 million in co-funding for EV charging incentives committed to SVCE territory from the California Energy Commission.

SVCE's programs tackle some of the hardest challenges in the electric vehicle sector: soft costs, multifamily properties, and fleets. As one example, SVCE launched a working group in 2019 to share knowledge among cities, installers, manufacturers, and employers and have been working on reducing soft costs and other installation barriers. SVCE also launched a program in July 2020 that is helping multifamily and small or medium business properties understand EV charger options and go through the process of installing them. The programs in SVCE's EVI Plan are both helping customers transition to electric vehicles now and providing insights for SVCE as it considers additional programmatic efforts.

Community Resiliency: Public Safety Power Shutoffs & COVID-19

In response to the 2019 Public Safety Power Shutoff (PSPS) events and desire from SVCE's customers to be able to enhance their home and business resilience, SVCE partnered with three other Bay Area LSEs to issue a competitive solicitation for a capacity product made from aggregated solar and storage installations (aka "Resiliency RFO").[20] SVCE expects to pay a premium for this capacity product in order to help more customers receive a resiliency cobenefit. SVCE has signed a 10-year contract with SunRun to provide up to 7.5 MW of capacity from DERs installed on single-family and multi-family homes no later than 2022. Negotiations are still underway with developers for commercial and industrial customers but SVCE is planning to provide additional capacity to be better prepared for additional PSPS events.

SVCE's Resiliency RFO in response to PSPS events will also help minimize local pollutants. By incentivizing resiliency provided by solar and storage installations, SVCE is ensuring that participating customers do not need to turn to diesel or gas backups that result in local emissions during outage events.

In response to COVID-19 and the corresponding economic impact on our customers, SVCE's Board approved $10M in customer relief and community resilience funds in Spring 2020.[21] Approximately $2.5M of the total funds are being used to provide $100 in bill credits to SVCE customers on CARE/FERA rates. These are customers with demonstrated economic or medical hardships. Our relief program will help these customers be able to afford to keep using electricity for their needs and comfort. On top of the bill credits for CARE/FERA customers, SVCE is issuing $250 in bill credits

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[19] Available at https://www.svcleanenergy.org/wp-content/uploads/2019/09/EVI-Joint-Action-Plan_Sept-2019.pdf.

[20] Original RFP documentation available at https://www.svcleanenergy.org/wp-content/uploads/2019/11/Joint_LSE-Distributed_RA-RFP-FINAL_11_05_2019.pdf.

[21] For more details on SVCE's COVID-19 response, see https://www.svcleanenergy.org/covid-19/.

to qualifying/interested small business customers with the total expenditure targeted at $1 million and approximately 4,000 customers.

Of the $10M total in relief, $5M is reserved for SVCE's thirteen member agencies to consider and install resiliency infrastructure in their communities. Resiliency projects will vary, but keeping facilities operational during PSPS events or other outages is critical SVCE's member agencies' ability to serve all customers and particularly those in disadvantaged communities. SVCE's $5M investment in its member agencies to support them in pursuing resiliency projects includes stipulations and encouragement around clean resiliency options like storage systems. While some operational constraints may require diesel or gas backups, SVCE's involvement will help ensure that the goal of minimizing local pollutants is considered and incorporated to the greatest extent possible.

iii. Large Commercial & Industrial Initiatives

SVCE has a close relationship with many of its large C&I customers, and SVCE has begun discussions to understand how it can continue to best serve their needs. This has led SVCE to begin constructing some custom power offerings built on its C&I customer's interests. One approach is SVCE's "Eco-Invest" offering, which will provide a lower rate whose discount goes into a fund for reinvestment into a decarbonization project at the customer site. Another approach is SVCE's "GreenPrime Direct", which offers a dedicated renewable resource to a customer through a virtual power purchase agreement. Third and finally, SVCE is also in the process of developing a "GreenPrime 24x7" offer that will match a customer's load with carbon -free electricity at all hours of the year.

iv. Grid Integration

SVCE worked with Gridworks and a group of industry stakeholders to create a whitepaper outlining options for running a virtual power plant (VPP) in its service territory. VPPs aggregate DERs to provide various value streams to SVCE (such as providing capacity or reacting to real-time pricing surges), which are then monetized by aggregators or DER providers and passed on to the end customer in the form of cheaper up-front costs or ongoing payments. Improving the economics of intelligent, electric technologies has the potential to spur an increase in widespread DER adoption by making electrified technologies even more economically attractive than their gas counterparts. A summary of key takeaways from this whitepaper can be found in Figure 14, and SVCE has already begun to test out different approaches. The Resiliency RFO is one example, following the "DRAM" option listed in the table (i.e. the LSE enters into a capacity agreement with a DER aggregator). SVCE is also piloting multiple dynamic pricing offers through Innovation Onramp (details below) that follow the described "LSE – Grid Responsive" approach (i.e. proactively shaping SVCE's load to lower capacity and energy costs).

5. EVALUATION MATRIX AND DISCUSSION

Virtual power plant options are evaluated to indicate how well they align with criteria. **LOWEST SCORE** **HIGHEST SCORE**

OPTION	CUSTOMER, COMMUNITY, AND PUBLIC VALUE	EMISSIONS IMPACT	SCALABLE & TRANSFERABLE	EQUITY IN SERVICE	CORE ROLE FOR SVCE	VIABILITY
REAL TIME PRICING *rates based on hourly wholesale market prices*	Can lower customer bills but change in demand is not certain. Value increases and extends to community and public if significant response to price signals. Indirect impact on grid services.	Emissions are correlated with wholesale prices, so response to price signals increase emissions reductions.	Theoretically replicable but technical challenges for CCA to offer real time pricing exist, as introduced herein.	Available to all customers and is not dependent on special equipment. Exposure to real time prices limits cross-subsidy.	Sophisticated C&I customers already requesting dynamic pricing rate options. CCA could engage closely with its customers to offer technical assistance and guidance for customers to shift load.	Substantial, but addressable, technical barriers and deterrents to CCA implementation exist, as introduced herein.
PEAK DAY PRICING *commercial and industrial (C&I) rate structure that targets summer peak load reduction*	Year-round customer bill savings possible. Provides RA value. Decline in summer peak can improve grid stability and provide grid services but impacts limited to the season.	Reductions are limited to summer season. May lead to more consumption overall.	As an existing program, easily replicable, scalable, and transferrable.	Only available to C&I customers. Limited cross subsidy from non-participants.	Same as RTP.	If program design fits within utility billing structure, program could launch quickly.
DRAM *demand response aggregation for resource adequacy (RA)*	Direct impact on grid services, providing RA. Grid services such as capacity and load smoothing benefit the community.	Potential to reduce peak emissions but depends on when resources are scheduled.	Aggregation approach and auction design could be replicated and transferred to other load serving entities.	Accessible to all customer classes with controllable DERs. Limited cross subsidy from non-participants.	CCA's role in the community can engage participants closely and solicit innovative bids to meet RA requirements.	CCA could design and implement auction in short-term. Market nascence may make it challenging to keep customers engaged throughout CAISO integration process and realize total program potential; this challenge is not specific to a CCA.
LSR — GRID-RESPONSIVE *load shift from targeted dispatch signals, customer can opt out*	Customers can earn value on provision of grid services. Community and public benefit from grid services, increased DER integration, and avoided renewable curtailment.	Broad DER eligibility and grid-related dispatch signals can maximize emissions reductions.	Relatively easily scalable and transferable; depends on local DER adoption rates.	Accessible to all customers with communicating DERs. Non-participants benefit from optimized load management.	CCA's understanding of local DER adoption rates and grid needs are critical to success. CCA can leverage close customer relationships to target participants and ensure responses.	Program could launch relatively quickly but delayed access to customer meter data might impact operations.
LSR — MARKET- INTEGRATED *load shift to take advantage of low to negative prices, requires storage*	Customers can access low or negative energy prices. Community and public benefit from avoided renewable curtailment and local grid management.	Uses only emission-free electricity and avoids curtailment of renewable resources.	Limited scalability since currently only storage is eligible. Transferability is possible.	Only available to storage resources. DERs. Non-participants benefit from optimized load management.	CCA engagement would diversify market actors. Close customer relationships needed to engage participants.	Limited to storage resources. CAISO market is not open until Fall 2020.
DISTRIBUTION SERVICE MODEL *proactive, independent non-profit distribution system operator (DSO) optimizes DERs to provide grid services*	Customers earn on monetized grid services and contribution to local grid management. Community and public benefit from optimized operation of distribution grid, renewable integration, and avoided renewable curtailment	Assumes DERs replace conventional resources.	Dependence on DSO limits ability to scale or transfer.	All DERs could participate. Non-participants benefit from optimized distribution grid and load management.	CCA leverages close customer relationships and detailed understanding of local DER adoption rates to engage participants and liaise with DSO.	Lack of independent DSO, optimization tools, and access to grid and customer data are significant barriers.

Figure 14. Table from SVCE's review of VPP options.

v. Innovation

SVCE's location in the Silicon Valley gives it a unique opportunity to engage with top innovators and startups. Since achieving deep decarbonization will necessitate overcoming major hurdles in cost-effective ways, SVCE developed its Innovation Onramp program to attract innovative companies to propose pilots that demonstrate or test potential solutions. [22] These pilots are bigger swings that SVCE is taking to make not only incremental change but possibly unlock paradigm-shifting technologies or approaches. To that end, each pilot is accompanied by a robust evaluation plan to be sure that learnings are captured and can be shared with the rest of the industry.

SVCE runs a semi-annual application cycle and is currently supporting six active pilots – these range from the Data Hive[23] that offers authorized, instant access of customer electricity data for DER providers to several pilots focused on new models for EV charging deployment at multifamily properties. SVCE is currently evaluating five more pilots for its next cohort with a focus on resiliency.

vi. Carbon Free Power Supply

California's goal to be carbon neutral by 2045 along with SVCE's efforts to promote electrification through a carbon-free source of electricity necessitate a closer look at SVCE's ability to provide a clean source of energy on an annual basis. Additionally, there is a desire by some to move SVCE to be carbon-free in all hours of the day in support of its goals. These aspirational goals must be balanced with the need to be cost competitive and promote the use of resources which support grid reliability.

Through this IRP exercise, SVCE tested several portfolio scenarios including the more aggressive RPS depicted in the Alternative Portfolio. The Alternative Portfolio allows SVCE to achieve its clean goals while reducing its reliance on large hydro resources, most notably out-of-state. The cost of achieving SVCE's carbon-free goals has increased over time and is expected to continue to rise as competition for large hydro, both in-state and out-of-state, increases. Over the next year, SVCE intends to explore the procurement policies depicted in the Alternative Portfolio further. Specifically, SVCE will evaluate options to secure a long-term source of large hydroelectricity, use of Asset Controlling Supplier (ACS) resources, use of carbon-offsets, and renewable energy products which guarantee delivery of energy in specified hours including non-solar producing hours such as 4 to 9 pm (otherwise known as "sundown" products).

In the future SVCE will explore its ability to deliver a 24x7 carbon-free product, or at least one which better matches SVCE's unique load and/or customer specific characteristics and needs. A key focus of this assessment will be how to reduce emissions during certain months and/or hours of the day when SVCE may be most reliant on system power and therefore subject to high levels of emissions. SVCE will explore supply and demand-side measures to reduce hourly system emissions and develop a plan to transition to a carbon-free portfolio with reduced hourly emissions.

Lastly, SVCE is committed to reducing all GHG emissions including those within its own community through the implementation of its Decarbonization Roadmap and local pollutants identified in the Minimization of Local Air Pollutants in Disadvantaged Communities (Table 12). Aside from evaluation of a more aggressive RPS and consideration of a 24x7 carbon-free policy to displace emissions from natural gas resources, SVCE will explore alternatives to further reduce Local Air Pollutants.

[22] For more details, see https://www.svcleanenergy.org/innovation/.
[23] For more details, see http://data.svcleanenergy.org/.

Resource Adequacy and Preferred Resources

SVCE is committed to meeting its RA requirements and overall reliability needs in a cost-effective manner while recognizing a desire to reduce dependence on RA supported by natural gas resources. With the exception of small portions of DR RA, SVCE currently sources all of its RA compliance capacity contracts from natural gas resources. By 2030, SVCE's executed PPAs will contribute approximately 25-30% of SVCE's needed RA capacity through preferred resources. Further, SVCE recognizes the value and need to bundle out-of-state clean energy when procuring import RA. SVCE intends to fully utilize its import allocation rights received for 2020 and 2021 and will seek opportunities to procure bundled imported energy and RA beyond 2020 consistent with the CPUC's new import RA rules. To this end, SVCE fully supports efforts by the CAISO to expand allocations of import allocation rights to a multi-year process.

With the expected retirement of once-through-cooling units and the Diablo Canyon Nuclear Power Plant, the cost of meeting RA through short-term transactions is expected to increase and become more volatile. Procuring the majority of RA needs through short-term contracts is not a viable strategy to manage cost. SVCE plans to procure longer-term RA resources but is mindful of the risk of stranding assets due to load loss and/or regulatory change. SVCE plans to issue the aforementioned RFP for long-duration storage by fall of 2020 and will also issue an RFP for stand-alone storage in 2021. Both resources will be evaluated on their cost and benefits and overall ability to manage portfolio risk and mitigate regulatory uncertainty related to grid reliability. Additionally, SVCE currently procures energy hedge products which may or may not be tied to a physical source of electricity. SVCE intends to evaluate its hedging strategy and products available to meet financial hedging goals while also ensuring physical delivery of energy in the hours hedged.

Last, SVCE will evaluate the merits of adopting an internal clean RA policy and setting a minimum standard of RA to be met via preferred resources including shed DR, large hydro, bundled clean energy imports with RA, and RPS resources with and without storage.

b. Procurement Activities –

i. Clean Energy Procurement

SVCE takes a multi-pronged approach to meeting its annual and long-term clean energy goals for RPS and carbon-free non-RPS eligible resources. This includes issuing request for proposals, participating in other entities' RFPs, and pursuing bilateral negotiations and partnerships to develop clean resources. SVCE ladders its clean energy procurement to ensure a diversification of counterparties, prices and term and to meet short-term needs based on actual load.

All of SVCE's long-term RPS procurement to date has been conducted jointly with Monterey Bay Community Power Authority (MBCP). Together the two agencies have completed two RFPs and executed eight PPAs. Through joint procurement SVCE and MBCP are able to attract a larger set of diverse and competitive offers, use resources cost-effectively, and spread risks related to execution, development and performance.

SVCE and MBCP issued their latest joint RFP in April 2020 with submissions received in June 2020 for long-term RPS PCC1 resources. A variety of diverse proposals were submitted, meeting the objectives set out by the RFP. SVCE is confident it will be able to execute PPAs in support of its long-term RPS targets and 38 MMT Conforming Portfolio. The specific resources to be procured have not been decided, so SVCE included generic backfill PPA resources including wind and solar with storage in its resource portfolios beginning in 2023 as substitutes for these planned PPAs. SVCE plans to bring three to four new PPAs to its governing board in early 2021 for consideration.

SVCE has completed procurement of Index+ RPS and Index+ carbon-free resources for 2020 and part of 2021, which are included in SVCE's IRP portfolios. Beyond this timeframe, SVCE included generic existing RPS and large hydro resources in its portfolios beginning in 2021 as a substitute for planned Index+ transactions. These transactions will be carried out consistent with SVCE's laddering strategy and to meet its actual load obligations.

SVCE is exploring several short and mid-term bundled clean energy and RA resources and longer-term contracts for large hydroelectricity. Some contracts are intended to start as early as 2021.

ii. DER Procurement

SVCE successfully executed one PPA from long-term DR RA through its Resiliency RFP and is in negotiations for a second PPA. Through these efforts, SVCE will direct the installation of BTM solar plus storage throughout its service territory. Additional DER procurement is expected through the efforts of it Decarbonization Roadmap as described above.

iii. Resource Adequacy Procurement

SVCE works with a group of four other CCAs to pool and procure RA. In 2019 this joint-RA group enlisted the support of ACES to administer request for RA offers and manage intra-pool transactions. For the upcoming RA compliance period 2021-23, SVCE has procured a significant portion of its 2021 and 2022 system and flex RA needs and much of its local RA needs through 2022. SVCE anticipates procuring additional RA for the upcoming compliance period through the joint-CCA effort, its own RFPs and bilateral negotiations and through participation in other load serving entities, including PG&E's, solicitations. Consistent with the CPUC's central procurement entity decision, SVCE does not plan to procure local RA products beyond 2023 unless it is a preferred resource such as DER or local renewables.

iv. Procurement Summary

Summarized below is a summary of SVCE's procurement activities for the balance of 2020 through 2021 related to meeting its RPS, carbon-free and resource adequacy goals.

Table 18. Summary of SCVE Procurement Activity

Procurement Activity	Portfolio Need	Goal	Status
2020 RFP for long-term PCC1 RPS .	Long-term RPS Resources PCC1 resources for minimum of ten years with delivery starting in CP#4	Procure sufficient to meet 31% long-term and contribute towards CP#5 and CP#5 targets.	In process of shortlisting proposals.
Other LSE's RFPs for RPS and/or RPS Offerings	PCC1 index plus REC purchases to meet annual and long-term RPS targets	Annually meet 50% RPS target or state min RPS, whichever is greatest. Procure a small portion of long-term RPS needs	In June 2020, submitted offer into SDG&E's to meet a small % of load. Awaiting shortlist status. Waiting on release of other RFPs and PCIA Working Group #3 resolution
Carbon-free resources	2021-2025 carbon-free (non-RPS) Resources bundled with and without RA	Procure 50 to 100 MW of firm large hydro with RA	Expect to issue in fall 2020
Western Base Resource Contract (30 year contract starting in January 2025)	Carbon-free	Contract for an allocation of Central Valley Project run-of-river large hydro to meet small portion of load.	Seek Board approval at the end of CY 2020
Joint CCA RA Procurement (ACES)	2021-2023 System, flex and local RA	Meet all RA compliance obligations by October 31, 2020	On-going
Other LSE's RFPs for RA	2021-2023 System, flex and local RA	Meet all RA compliance obligations by October 31, 2020	Waiting on PG&E's RFP release
Long-duration Storage RFP (minimum 8 hours)	RA, reliability and energy toll with 2026 on-line date	Jointly procure to meet pro rata share of LDS capacity per 38 MMT Conforming Portfolio	Issue joint RFP early fall 2020 Procurement dependent on RFP results, economics, mandates, and CPE
Stand-alone Storage RFP	RA, reliability and energy toll with 2023 on-line date	Dependent on hybrid resources procured through current RPS RFP	Issue by mid-2021
DER	Shed DR, RA and load shifting	Procure clean sources of RA, promote resiliency, reduce hourly system emissions, help customers meet climate goals	Complete Resiliency RFP DR RA negotiations On-going custom product offerings

c. Potential Barriers

Though SVCE has made tremendous progress to effectuate its internal decarbonization goals and meet all state requirements, there remain several barriers to achieving the 38 MMT Conforming Portfolio. The most important barriers include the following:

- As more LSEs decarbonize their portfolios over time, SVCE expects increased competition for a fixed amount of existing large hydro generation. Therefore, as detailed, SVCE is exploring alternative paths to meet its decarbonization goals and developed the 75% RPS Alternative Portfolio.
- SVCE has had challenges procuring wind resources, and recently had to cancel a contract for out-of-state wind. However, SVCE remains committed to procuring wind in the future and is in negotiations for wind resource PPAs.
- SVCE must do significant procurement through long-term contracts during a time of considerable regulatory uncertainty, especially with regard to the RA market. Although the CPUC recently approved a methodology for calculating the RA contributions of hybrid resources, this methodology may change in the future, and the contributions made by batteries could decline over time. In addition, the ongoing conversation over the role of a central procurement entity has created uncertainty over how much of SVCE's own RA needs it will be responsible to procure. It is not known how the changes in the RA market will change future IRP requirements in such a way as may require changes to SVCE's long-term procurement strategy.
- SVCE faces competition from Direct Access, which has recently been allowed to expand, and may expand further in future years. This leaves SVCE with the risk of stranded assets in its long-term portfolio should load migrate to Direct Access without institution of an exit fee for CCAs.
- As directed by CPUC staff, SVCE has not incorporated any expected long-term effect of the COVID-19 pandemic into the load forecast for this IRP. At this time, SVCE does not anticipate the pandemic producing significant load reduction in 2030. However, future iterations of the IEPR load forecast will capture any changes that do occur, and a sustained and significant loss of load could prompt reevaluation of planned resource development.
- At this time, SVCE has not received notice that the CODs of any of the projects with which SVCE holds PPAs will be delayed. However, depending on the future length and severity of the pandemic, it is possible that such delays could arise. If they do, SVCE will take appropriate actions to replace these resources and detail these efforts in the 2022 IRP.

d. Commission Direction or Actions

SVCE intends to exert all reasonable effort to procure the resources detailed in the 38 MMT Conforming Portfolio, but there are certain actions on the Commission's part that could make that substantially easier or more difficult.

PG&E Interim Allocations & PCIA Working Group #3

SVCE is paying for the above market costs of PG&E's carbon-free portfolio via the Power Charge Indifference Adjustment ("PCIA") while receiving none of the carbon-free attributes associated with the carbon-free portfolio. After being pushed on the issue, PG&E offered all PCIA paying load serving entities allocations of GHG-free resources for 2020. SVCE participated by taking its load share of the large hydro and nuclear resources, creating savings for its ratepayers by avoiding procurement of additional carbon-free resources.

As part of its initial IRP analysis, SVCE looked at the merits of taking its full pro rata allocation of PG&E's carbon-free portfolio (large hydro and nuclear) through 2030. The savings to SVCE's ratepayers from avoiding procuring large hydroelectricity to meet its carbon-free goals are significant (see Appendix B). SVCE is similarly paying for the above market costs of PG&E's RA and RPS portfolio without receiving any of the associated attributes.

The CPUC asked stakeholders to address the issue of excess resources in IOU portfolio pursuant to the Phase 2 Scoping Memo of CPUC Rulemaking 17-06-026, PCIA Working Group Three: Portfolio Optimization and Cost Reduction, and Allocation and Auction ("WG 3"). The Final Report submitted by the co-chairs (Southern California Edison, Commercial Energy and CalCCA) addresses the appropriate treatment of excess GHG-free, RA and RPS in the IOU portfolios. The report was developed in a 10-month stakeholder process and outlines the consensus and non-consensus areas. SVCE urges the CPUC to accept the proposal in the final report and issue a Proposed Decision as soon as possible so that the eligible LSE can claim the attributes that they are already paying for through the PCIA. Delays by the CPUC in making a decision could result in over procurement of RPS, carbon-free, and RA resources.

e. Diablo Canyon Power Plant Replacement

All of SVCE's IRP portfolios contribute new resources to meet system needs after Diablo Canyon's planned retirement in 2024 and 2025, including a new geothermal resource. As a low-carbon baseload resource, geothermal power is an excellent replacement for nuclear power.

The incremental build in the Reference System Plan (RSP) incorporates resources needed to replace DCPP, so it is instructive to compare SVCE's incremental resources to its pro rata share of the RSP incremental build. The table below compares the new resources in SVCE's portfolios compared to its load ratio share of the RSP portfolios in 2026. The table shows that SVCE's planned procurement of new renewable energy, short-term battery storage, and DR covers more than its load ratio share of such new resources the year after DCPP retires. Though SVCE's portfolios currently do not include long-duration storage, SVCE is pursuing such resources through a joint RFP as described in the Long-Duration Storage Development section of the IRP.

Table 19. SVCE portfolios compared to SVCE's load ratio share of RSP portfolios in 2026.

	Load Ratio Share of Reference System Portfolios		SVCE Portfolios	
	38 MMT	46 MMT	38 MMT and 46 MMT Portfolio	75% RPS
Short-Duration Storage (MW/MWh Capacity)	101/435	123/523	191/732	191/732
Long-Duration Storage (MW/MWh Capacity)	32/385	19/234	-	-

Total Storage (MW/MWh Capacity)	133/820	142/756	191/732	191/732
Renewable Energy (GWh)[24]	683	588	1,427	1,427
Renewable Energy Mix	Solar: 70% In-State Wind: 30%	Solar: 75% In-State Wind: 25%	Geothermal: 4% Solar: 93% In-State Wind: 3%	Geothermal: 4% Solar: 93% In-State Wind: 3%
Shed Demand Response (MW)	4.4	4.4	6	6

f. Incremental Procurement Progress Report

As demonstrated in SVCE's resource data templates and the following table, SVCE has fully procured all resources needed to meet SVCE's incremental procurement requirement specified in D.19-11-016 for years 2021-2023. The table below shows the resources SVCE has procured that will contribute to this requirement. The total expected contribution of these resources is greater than SVCE's procurement obligation each year, giving SVCE confidence that it will meet this requirement successfully.

Table 20. Resources planned to meet SVCE's incremental procurement requirement.25

Project Name	Expected RA Initial Delivery Date	Expected Qualifying Capacity (MW)	Term (years)	% Contribution to 2021 Obligation	% Contribution to 2022 Obligation	% Contribution to 2023 Obligation
Sutter Energy Center	1/1/2021	33.6	3	100%	66%	49%
Slate Battery Expansion	6/30/2021	46.5	17	138%	92%	69%
Big Beau Battery	12/1/2021	22	20	0%	43%	33%

[24] For the two Conforming Portfolios, the amount of energy from incremental renewables is slightly lower (19 GWh) in 2030 than in 2026 due to solar panel and geothermal production tapering. All of the incremental solar and geothermal in these portfolios is operating by 2023 and declines slightly between 2023 and 2030. This effect happens in the Alternative Portfolio resources as well, but is not as visible because the higher RPS targets between 2027-2030 compared to the Conforming Portfolios require the addition of new incremental resources between 2026 and 2030 that boost the total 2030 output above that in 2026.

[25] Pursuant to D.19-11-016, this table calculates the RA value of hybrid solar plus storage resources being used for compliance using the interim methodology created by D.20-01-004. SVCE Is aware that on 8/24/20 a Proposed Decision was released in R.16-02-007 that would substitute the Interim methodology with the permanent version created by D.20-06-031. However, given that this Proposed Decision cannot be voted on until after the submission date for the IRP, SVCE has not changed the methodology used for these resources. If the Proposed Decision passes the Commission vote, SVCE will update the methodology used in future progress reports. Since the Interim methodology Is more conservative than the D.20-06-031 version, updating the methodology will not reduce SVCE's success In self-procuring sufficient resources to meet the requirements of D.19-11-016

Ormat Geothermal	12/31/2021	7	10	0%	14%	10%
SVCE Procurement Requirement (MW)				**33.6**	**50.4**	**67.2**
SVCE Total Procurement (MW)				**80.1**	**108.6**	**108.6**
% of Requirement Procured				**238%**	**215%**	**162%**

V. Lessons Learned

SVCE has learned a great deal in the process of producing this IRP and expects its long-term strategy to continue evolving as new information presents itself. For the next IRP cycle, SVCE recommends the CPUC consider some changes.

First, demand-side resource planning is extremely important to SVCE, and SVCE actively supports electrification activities to meet its decarbonization goals. SVCE is disappointed that it cannot include the impact of these activities in its load forecast for conforming portfolios for IRP compliance. SVCE recommends the CPUC revise its process in future IRP cycles to allow LSEs to reflect load modification resources beyond DR in their conforming portfolios, as long as such resources do not duplicate what is already accounted for in the IEPR forecast. This would put such resources on an equal footing with supply-side resources for meeting state decarbonization goals. This is also in accordance with Public Utility Code 454.52(a)(1)(G), which lists "enhance distribution systems and demand-side energy management" as a goal of the IRP process.

Second, SVCE is concerned by the CPUC directive to include portfolios with a minimum amount of GHG emissions. SVCE believes this is not in accordance with the primary objective of the IRP, which is to reduce GHG emissions. In its decision setting the requirements for this IRP (D.20-03-028), the CPUC states that "we note the comments of the Joint CCAs that request the ability to file portfolios containing 100 percent GHG-free resources. While we applaud these LSEs for their forward thinking, they will still need to address how such portfolios will be reliable without further technological or fuel development. It is not sufficient for LSEs to assume that the reliability, renewable integration, and ramping needs associated with their portfolios will be met by resources in the portfolios of other LSEs." However, the CPUC failed to provide any standards by which LSEs could show such 100% carbon free portfolios adequately (supply reliability, renewable integration, and ramping needs), and instead required LSEs to include a fixed amount of emissions in their portfolios under the 46 MMT scenario. This inappropriately conflates emissions reduction with protection of reliability, renewable integration, and ramping. In the next IRP cycle, the CPUC should define standards for these other metrics more clearly so 100% carbon-free portfolios can be conforming for all scenarios.

Third, it is difficult to value the contributions of resources that are not included in the RSP. This was a problem for SVCE this cycle as it has signed a PPA for a new geothermal resource, and there were no new geothermal resources selected in the RSPs this IRP cycle. In its decision setting the requirements for this IRP (D.20-03-028), the CPUC discusses certain resources acting as proxies for other resources, including geothermal as a proxy for baseload renewables, but the term "baseload renewables" was not specifically defined or listed in the broad categories of resources the LSEs are expected to procure. It would be much more useful for the CPUC to define a set of objectively identifiable standards required to create a reliable portfolio. LSEs can then compare the contributions of such resources to such a set of standards and procure the set that best meets CPUC requirements and internal Board directives. Traditional resource planning standards of total capacity plus a reserve margin in peak load hours are insufficient with renewable resources for which energy availability varies significantly year-to-year (hydro), hour-to-hour (wind and solar), and/or season-to-season (hydro, wind, and solar). The CPUC's own RESOLVE modeling showed this to be the case when portfolios selected to meet planning reserve margin standards could not meet loss of load expectation standards in SERVM. New standards beyond a planning reserve margin must be defined.

Fourth, as discussed in the IRP, SVCE has analyzed adding allocations from PG&E's portfolio of PCIA resources. A set method of allocating such resources to all LSEs is under discussion by stakeholders through Working Group Three in R.17-06-026. Since a final method of such allocations has not been defined, the CPUC directed LSEs not to use such allocations for building IRP portfolios this cycle. SVCE recommends the CPUC adopt a standard method to allocate these resources to all LSEs since all LSEs pay for these resources. This would also help PG&E optimize its portfolio and avoid over procurement. Then, in future IRP cycles, SVCE recommends reliance on such allocations be an option for building IRP portfolios.

Fifth, SVCE suggests inclusion of 2025 as one of the focus interim years in the 2021 Reference System Plan. In this IRP cycle, LSEs are asked to comment specifically on how they plan to contribute to the replacement of Diablo Canyon Power Plant. Individual LSEs and the sector as a whole would have an easier time answering this question if the Reference System Plan were structured to emphasize this concern by presenting the year of DCPP retirement as an interim focus year the way 2022 and 2026 are presented in this cycle's RSP. Doing so would make the impact of DCPP's removal clearer and facilitate more granular understanding of the type and quantity of resources needed by the year of retirement in order to maintain system integrity.

Finally, SVCE encourages the CPUC to undertake further integration and complementarity between the IRP and RPS Procurement Plan processes and timelines. Many of the same fundamental questions addressed in the RPS Procurement Plan are of interest in the IRP exercise, including future resource selection and impacts of resource selection on grid reliability. Developing internal CPUC infrastructure that would allow LSEs to avoid duplicating this information would reduce administrative burden and allow for more focus on substantive consideration of key policy issues.

Glossary of Terms

Alternative Portfolio: *LSEs are permitted to submit "Alternative Portfolios" developed from scenarios using different assumptions from those used in the Reference System Plan. Any deviations from the "Conforming Portfolio" must be explained and justified.*

Approve (Plan)*: the CPUC's obligation to approve an LSE's integrated resource plan derives from Public Utilities Code Section 454.52(b)(2) and the procurement planning process described in Public Utilities Code Section 454.5, in addition to the CPUC obligation to ensure safe and reliable service at just and reasonable rates under Public Utilities Code Section 451.*

Balancing Authority Area (CAISO): *the collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains load-resource balance within this area.*

Baseline resources: *Those resources assumed to be fixed as a capacity expansion model input, as opposed to Candidate resources, which are selected by the model and are incremental to the Baseline. Baseline resources are existing (already online) or owned or contracted to come online within the planning horizon. Existing resources with announced retirements are excluded from the Baseline for the applicable years. Being "contracted" refers to a resource holding signed contract/s with an LSE/s for much of its energy and capacity, as applicable, for a significant portion of its useful life. The contracts refer to those approved by the CPUC and/or the LSE's governing board, as applicable. These criteria indicate the resource is relatively certain to come online. Baseline resources that are not online at the time of modeling may have a failure rate applied to their nameplate capacity to allow for the risk of them failing to come online.*

Candidate resource: *those resources, such as renewables, energy storage, natural gas generation, and demand response, available for selection in IRP capacity expansion modeling, incremental to the Baseline resources.*

Capacity Expansion Model: *a capacity expansion model is a computer model that simulates generation and transmission investment to meet forecast electric load over many years, usually with the objective of minimizing the total cost of owning and operating the electrical system. Capacity expansion models can also be configured to only allow solutions that meet specific requirements, such as providing a minimum amount of capacity to ensure the reliability of the system or maintaining GHG emissions below an established level.*

Certify (a Community Choice Aggregator Plan)*: Public Utilities Code 454.52(b)(3) requires the CPUC to certify the integrated resource plans of CCAs. "Certify" requires a formal act of the Commission to determine that the CCA's Plan complies with the requirements of the statute and the process established via Public Utilities Code 454.51(a). In addition, the Commission must review the CCA Plans to determine any potential impacts on public utility bundled customers under Public Utilities Code Sections 451 and 454, among others.*

Clean System Power (CSP, formerly "Clean Net Short") methodology*: the methodology used to estimate GHG emissions associated with an LSE's Portfolio based on how the LSE will expect to rely on system power on an hourly basis.*

***Community Choice Aggregator**: a governmental entity formed by a city or county to procure electricity for its residents, businesses, and municipal facilities.*

***Conforming Portfolio**: the LSE portfolio that conforms to IRP Planning Standards, the 2030 LSE-specific GHG Emissions Benchmark, use of the LSE's assigned load forecast, use of inputs and assumptions matching those used in developing the Reference System Portfolio, as well as other IRP requirements including the filing of a complete Narrative Template, a Resource Data Template and Clean System Power Calculator*.

***Effective Load Carrying Capacity**: a percentage that expresses how well a resource is able avoid loss-of-load events (considering availability and use limitations). The percentage is relative to a reference resource, for example a resource that is always available with no use limitations. It is calculated via probabilistic reliability modeling, and yields a single percentage value for a given resource or grouping of resources.*

***Electric Service Provider**: an entity that offers electric service to a retail or end-use customer, but which does not fall within the definition of an electrical corporation under Public Utilities Code Section 218.*

***Filing Entity**: an entity required by statute to file an integrated resource plan with CPUC.*

***Future**: a set of assumptions about future conditions, such as load or gas prices.*

***GHG Benchmark (or LSE-specific 2030 GHG Benchmark)**: the mass-based GHG emission planning targets calculated by staff for each LSE based on the methodology established by the California Air Resources Board and required for use in LSE Portfolio development in IRP.*

***GHG Planning Price:** the systemwide marginal GHG abatement cost associated with achieving a specific electric sector 2030 GHG planning target.*

***Integrated Resources Planning Standards (Planning Standards)**: the set of CPUC IRP rules, guidelines, formulas and metrics that LSEs must include in their LSE Plans.*

***Integrated Resource Planning (IRP) process**: integrated resource planning process; the repeating cycle through which integrated resource plans are prepared, submitted, and reviewed by the CPUC*

***Long term**: more than 5 years unless otherwise specified.*

***Load Serving Entity**: an electrical corporation, electric service provider, community choice aggregator, or electric cooperative.*

***Load Serving Entity (LSE) Plan**: an LSE's integrated resource plan; the full set of documents and information submitted by an LSE to the CPUC as part of the IRP process.*

***Load Serving Entity (LSE) Portfolio**: a set of supply- and/or demand-side resources with certain attributes that together serve the LSE's assigned load over the IRP planning horizon.*

***Loss of Load Expectation (LOLE):** a metric that quantifies the expected frequency of loss-of-load events per year. Loss-of-load is any instance where available generating capacity is insufficient to serve electric demand. If one or more instances of loss-of-load occurring within the same day regardless of duration are counted as one loss-of-load event, then the LOLE metric can be compared to a reference point such as the industry probabilistic reliability standard of "one expected day in 10 years," i.e. an LOLE of 0.1.*

Net Qualifying Capacity: *Qualifying Capacity reduced, as applicable, based on: (1) testing and verification; (2) application of performance criteria; and (3) deliverability restrictions. The Net Qualifying Capacity determination shall be made by the California ISO pursuant to the provisions of this California ISO Tariff and the applicable Business Practice Manual.*

Non-modeled costs*: embedded fixed costs in today's energy system (e.g., existing distribution revenue requirement, existing transmission revenue requirement, and energy efficiency program cost).*

Nonstandard LSE Plan*: type of integrated resource plan that an LSE may be eligible to file if it serves load outside the CAISO balancing authority area.*

Optimization*: an exercise undertaken in the CPUC's Integrated Resource Planning (IRP) process using a capacity expansion model to identify a least-cost portfolio of electricity resources for meeting specific policy constraints, such as GHG reduction or RPS targets, while maintaining reliability given a set of assumptions about the future. Optimization in IRP considers resources assumed to be online over the planning horizon (baseline resources), some of which the model may choose not to retain, and additional resources (candidate resources) that the model is able to select to meet future grid needs.*

Planned resource: *any resource included in an LSE portfolio, whether already online or not, that is yet to be procured. Relating this to capacity expansion modeling terms, planned resources can be baseline resources (needing contract renewal, or currently owned/contracted by another LSE), candidate resources, or possibly resources that were not considered by the modeling, e.g., due to the passage of time between the modeling taking place and LSEs developing their plans. Planned resources can be specific (e.g., with a CAISO ID) or generic, with only the type, size and some geographic information identified.*

Qualifying capacity*: the maximum amount of Resource Adequacy Benefits a generating facility could provide before an assessment of its net qualifying capacity.*

Preferred Conforming Portfolio*: the conforming portfolio preferred by an LSE as the most suitable to its own needs; submitted to CPUC for review as one element of the LSE's overall IRP plan.*

Preferred System Plan: *the Commission's integrated resource plan composed of both the aggregation of LSE portfolios (i.e., Preferred System Portfolio) and the set of actions necessary to implement that portfolio (i.e., Preferred System Action Plan).*

Preferred System Portfolio: *the combined portfolios of individual LSEs within the CAISO, aggregated, reviewed and possibly modified by Commission staff as a proposal to the Commission, and adopted by the Commission as most responsive to statutory requirements per Pub. Util. Code 454.51; part of the Preferred System Plan.*

Reference System Plan: *the Commission's integrated resource plan that includes an optimal portfolio (Reference System Portfolio) of resources for serving load in the CAISO balancing authority area and meeting multiple state goals, including meeting GHG reduction and reliability targets at least cost.*

Reference System Portfolio*: the multi-LSE portfolio identified by staff for Commission review and adopted/modified by the Commission as most responsive to statutory requirements per Pub. Util. Code 454.51; part of the Reference System Plan.*

Short term*: 1 to 3 years (unless otherwise specified).*

Staff*: CPUC Energy Division staff (unless otherwise specified).*

Standard LSE Plan*: type of integrated resource plan that an LSE is required to file if it serves load within the CAISO balancing authority area (unless the LSE demonstrates exemption from the IRP process).*

APPENDIX A

Energy+Environmental Economics

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SVCE DER Electrification Adoption Potential

Results

2/21/2020

SILICON VALLEY CLEAN ENERGY

Agenda

- **Executive Summary**
- **Modeling**
  - Building Electrification Model
  - RESTORE-IDSM
  - Adoption Model
- **Analysis Setup**
  - Customer Segmentation
  - Technologies
  - Scenarios
- **Results**
  - Building Electrification
  - DER Adoption

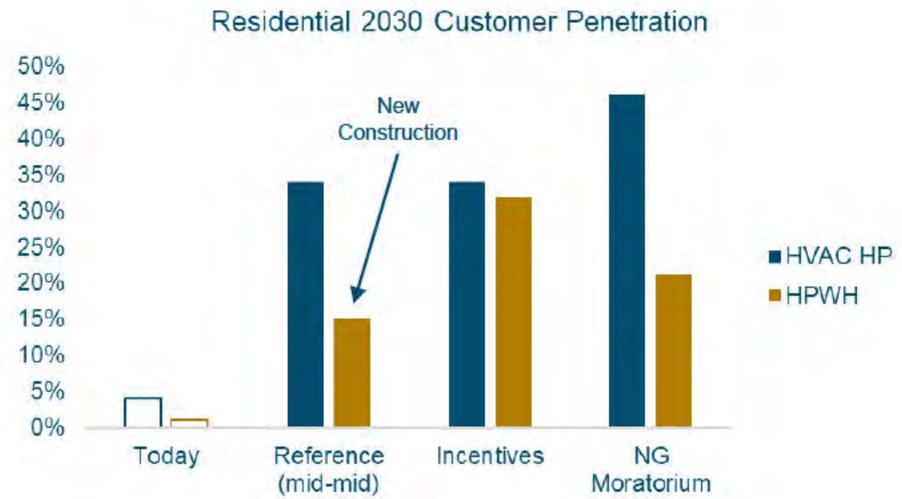
Executive Summary: Analysis

- **Adoption forecast of DER technologies: Rooftop solar PV, Electric vehicles, BTM storage, Water heating, HVAC/Space heating, and Energy Efficiency**
- **Scenarios/Sensitivities:**
  - Base cases based on electric and gas rates: Low Elec & High Gas, Mid Electric & High Gas, High Electric & High Gas
  - Rates: Real-time Pricing, SVCE Net Energy Metering 2.0, and SVCE EV rates
  - Incentives to match payback periods of 3, 5, and 10 years and SGIP continuation
  - Codes and Standards: Natural gas moratorium beginning in 2002 for new construction and remodel
- **Customer Segmentation:**
  - Building type: Residential single-family home, residential multi-family home, small commercial, medium commercial, large commercial
  - Vintages:
    - Residential: 1978 and prior, 1978-2019, New Construction
    - Commercial: Existing and New Construction
- **Building Electrification Adoption Model: 624 Unique Scenario Runs**
- **RESTORE-IDSM Model: 804 Unique Scenario Runs**

Executive Summary: Results Building Electrification

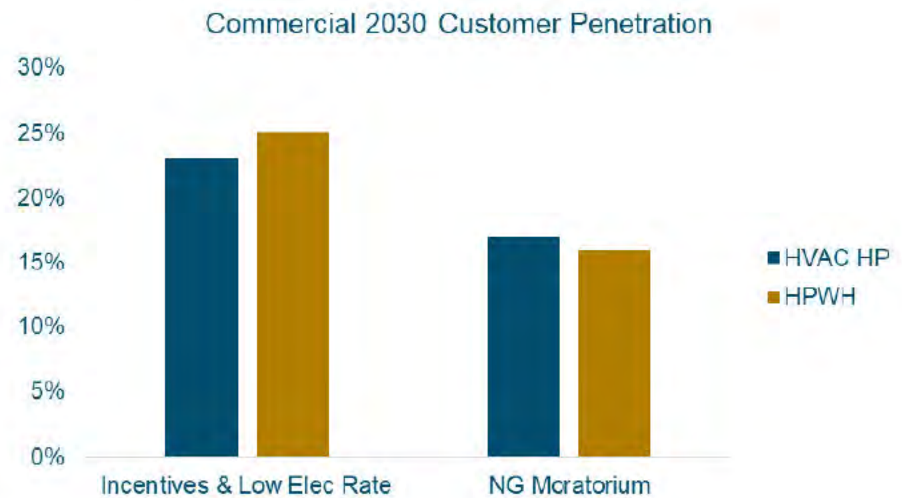
+ Residential:

- Whole building electrification (retrofit) will not occur without intervention
- HVAC Heat Pumps are economical but are low on the adoption curve, meaning incented adoption will remain slow in the near term



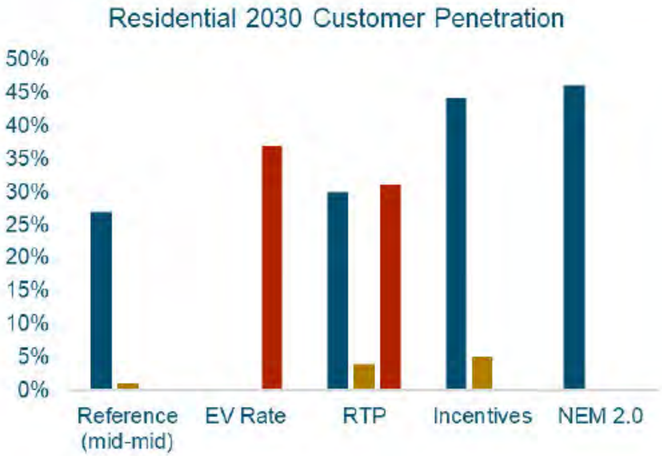
+ Commercial

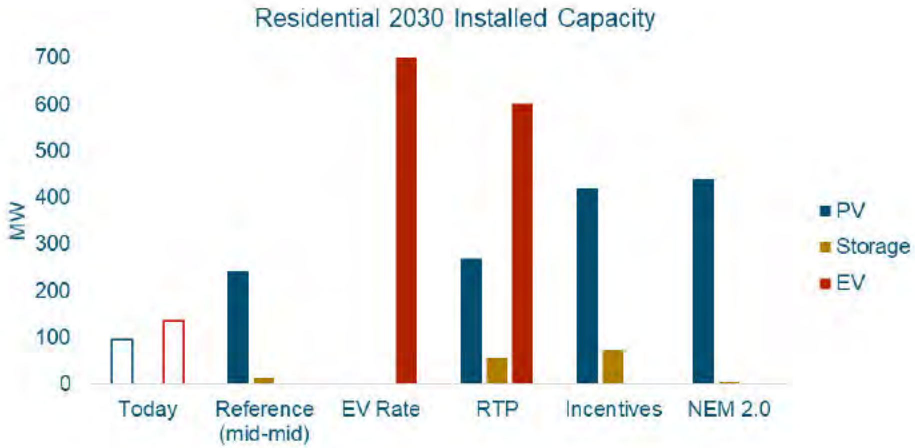
- Neither HVAC Heat Pumps nor HPWHs are cost effective enough in commercial buildings to encourage adoption in the Reference case
- HPWHs increase bills and incentives offset lifecycle costs



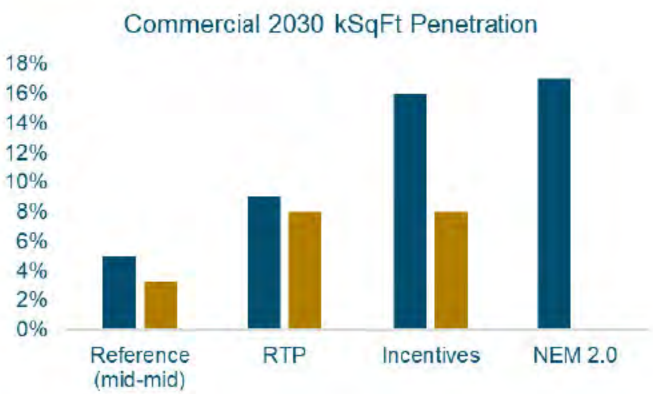
Executive Summary cont. Results DER

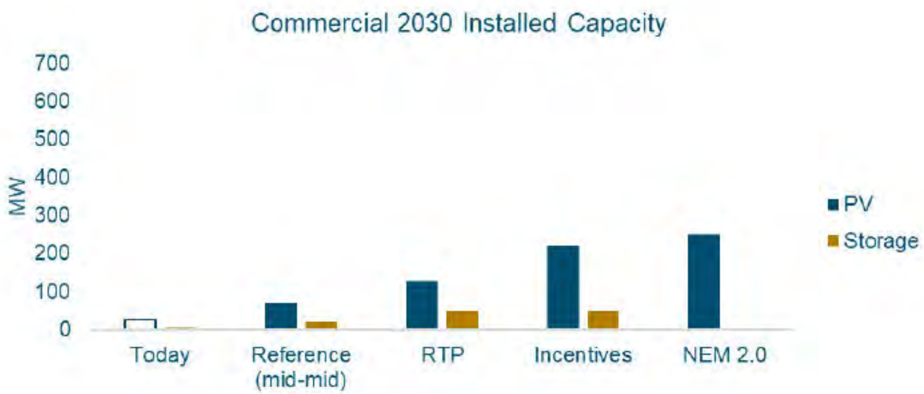
+ Residential:

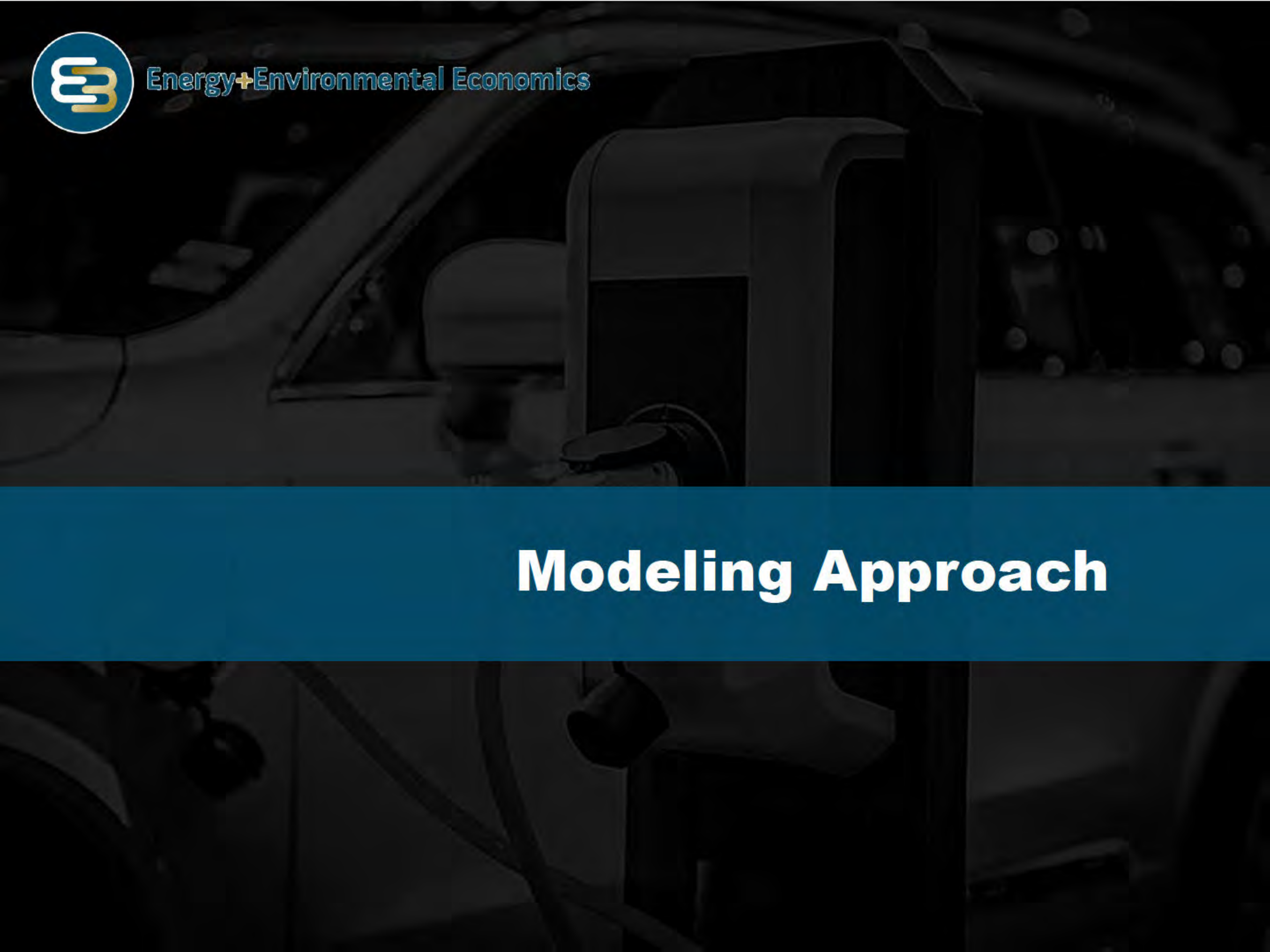




+ Commercial

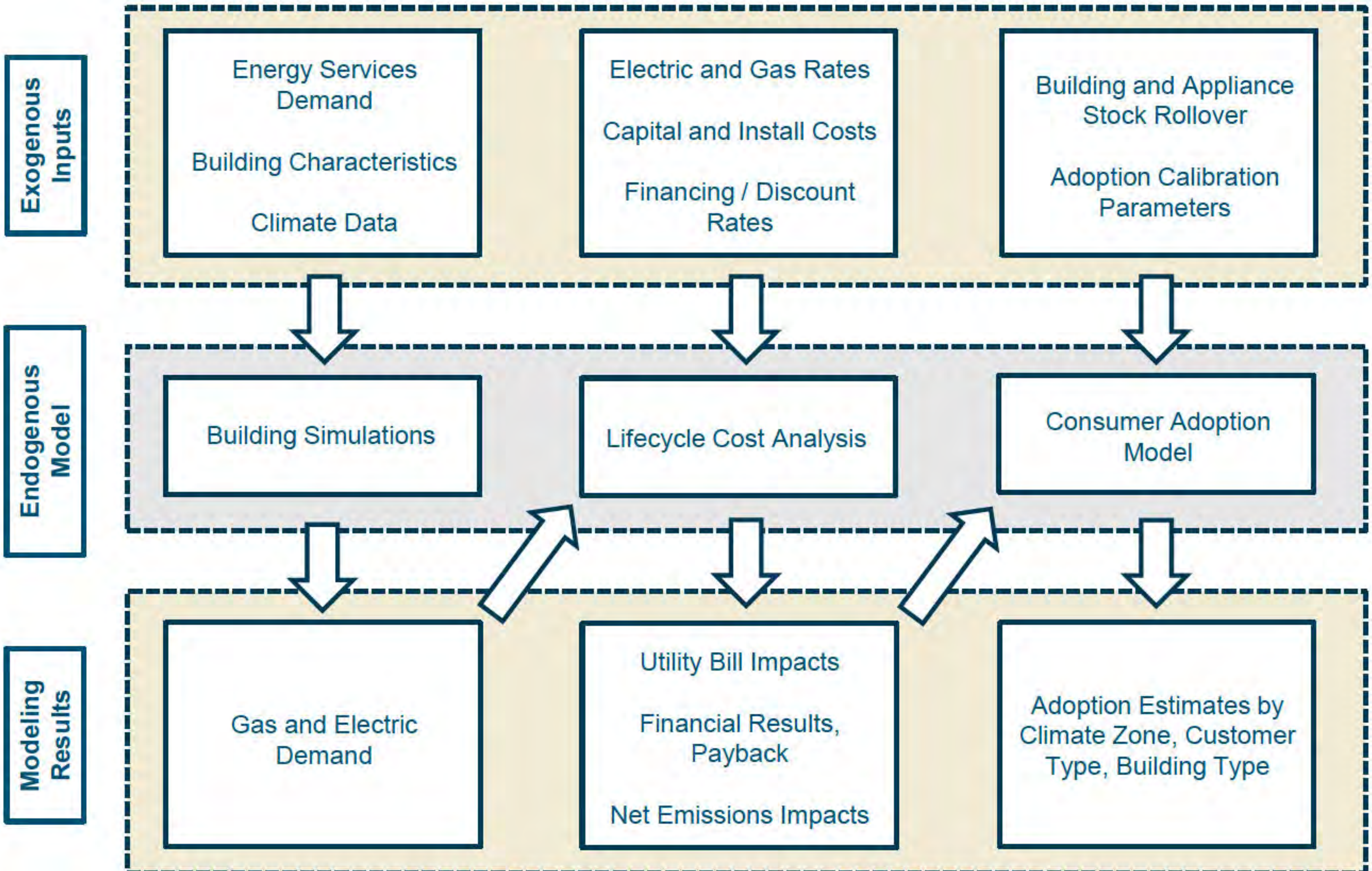




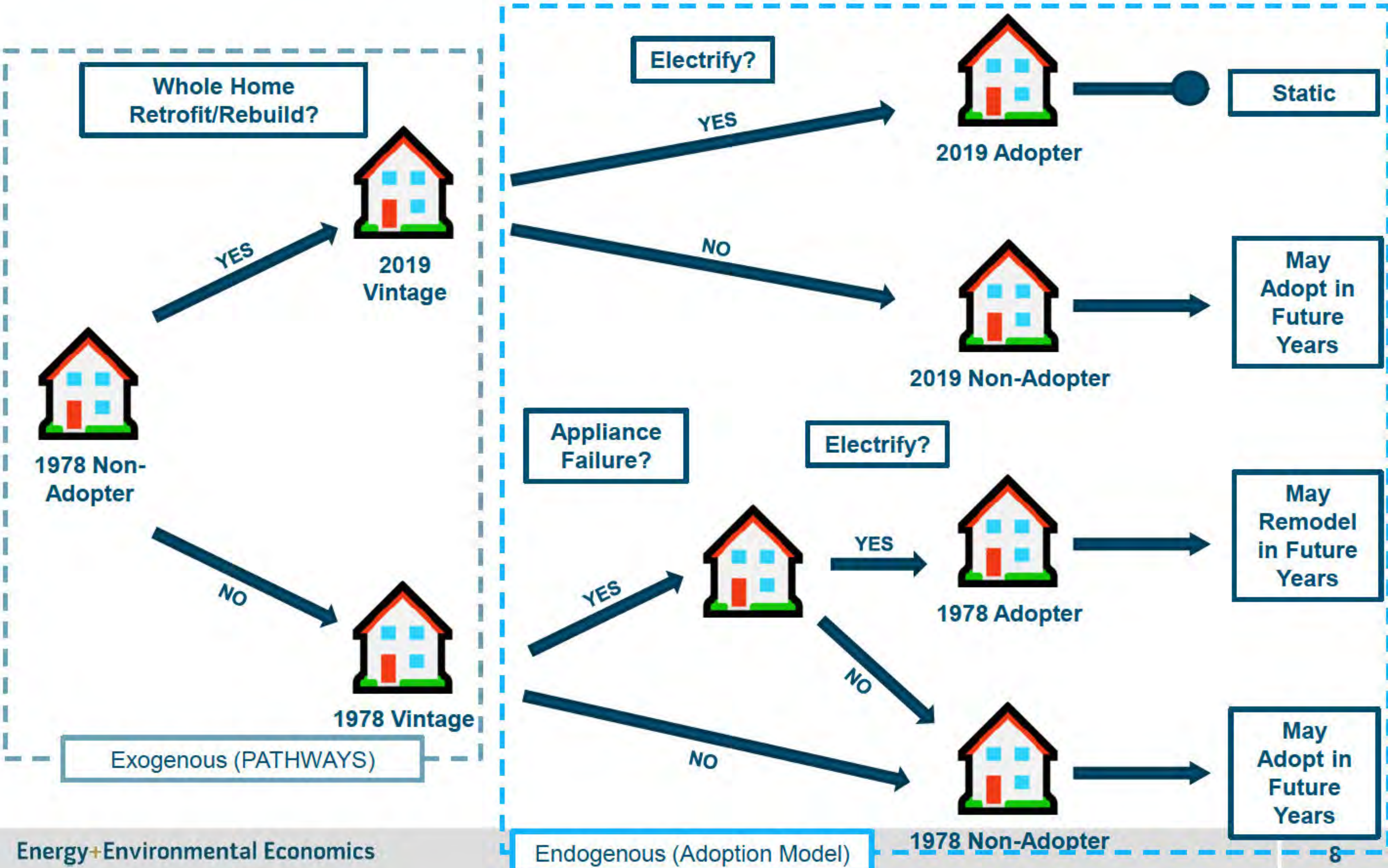


Modeling Approach

Building Electrification Model Flow



Homeowner Decision Matrix



RESTORE: DER Shapes

+ Dispatchable

- Objective function: minimizing net costs
- Subject to technology, market, and incentive (e.g. ITC) constraints
- Co-optimization across multiple technologies with perfect foresight
- Price taker

+ Partial Dispatchable

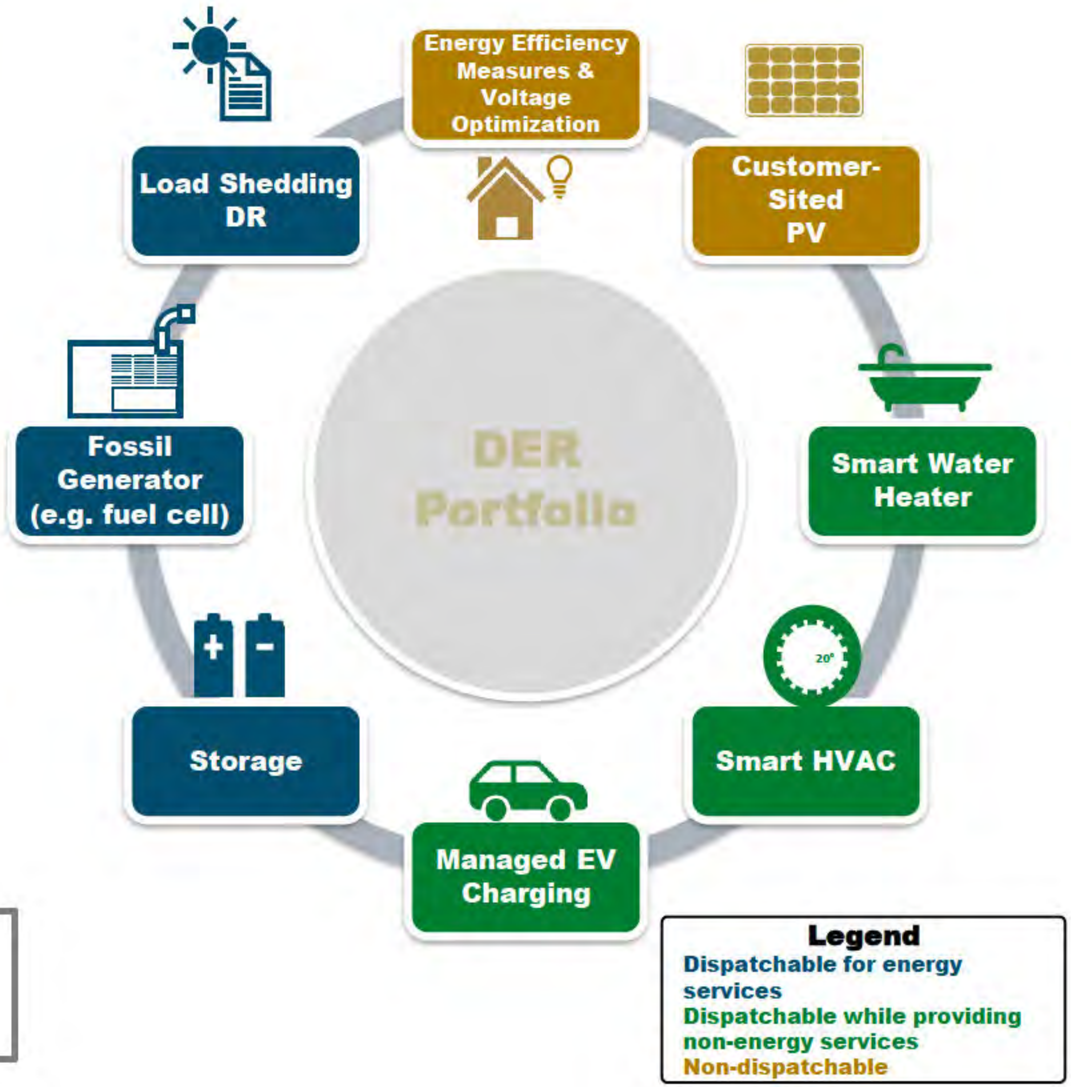
- Dispatch with the consideration of customer comfort level
- Co-optimize with both dispatchable and partial dispatchable technologies

+ Fixed shapes

- User input based on the specific project or customer
- Default PV shapes pre-loaded for each climate zone

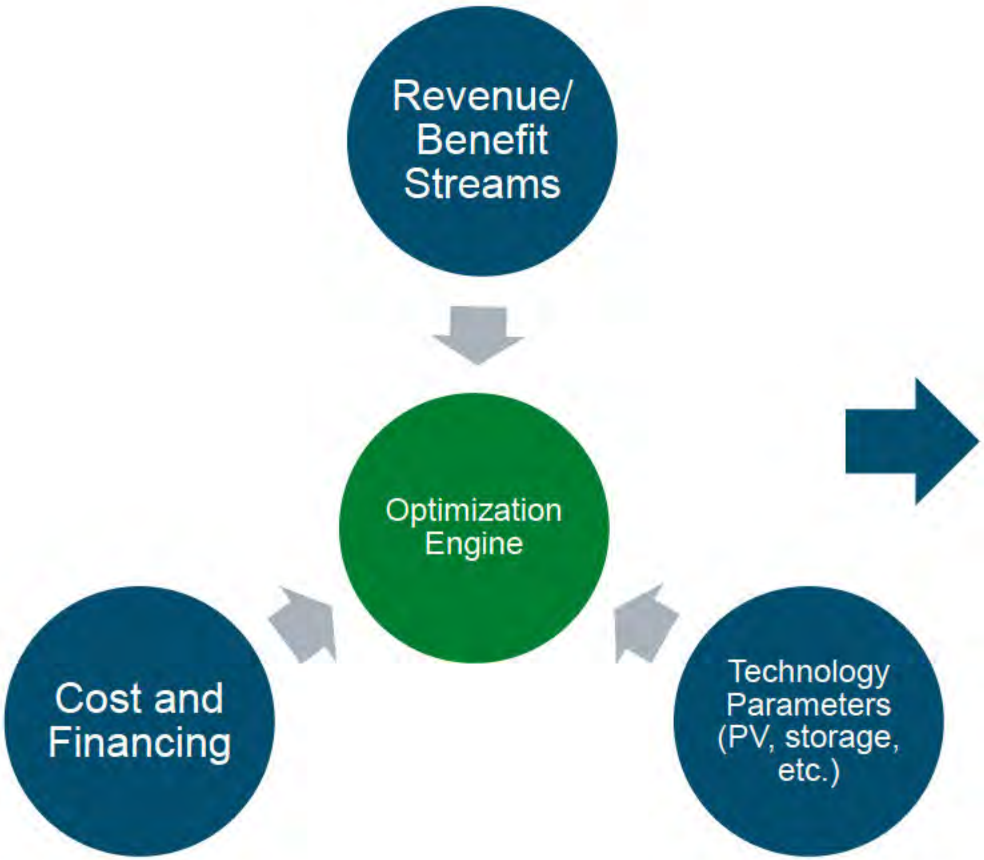
Other highlights

- Temperature-based day mapping
- Flexible Optimization Window (Daily, Monthly, Annual) and Intervals (Hourly, 15mins, 5mins)



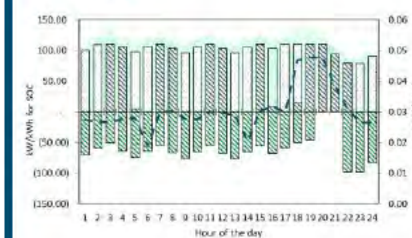
RESTORE-IDSM Tool

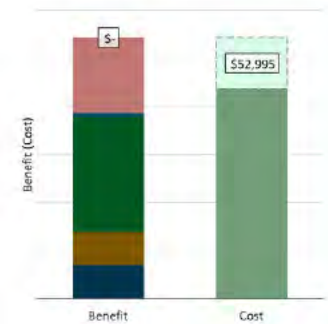
+ **A DER valuation tool with an optimization engine for dispatch**

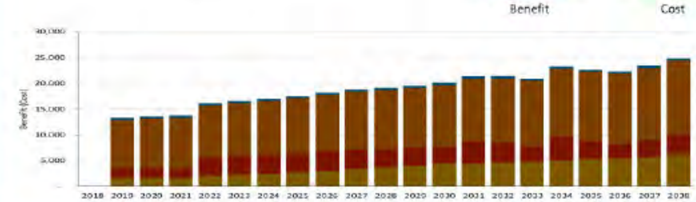


Results:

- NPV and annual benefits and costs
- Cost tests
- DER optimal dispatch
- …







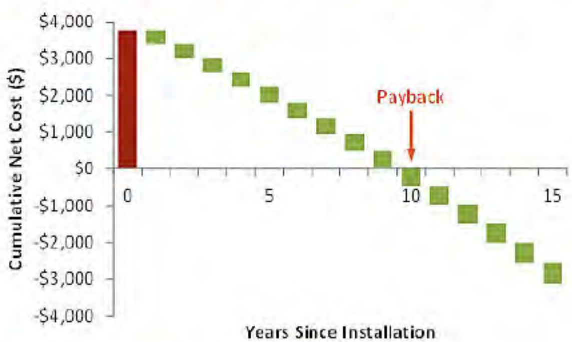
RESTORE: Costs

- **A Pro Forma is integrated into the model to calculate the all-in project costs, including:**
  - Capital costs
  - Operating and maintenances costs
  - Financing costs
  - Incentives
    - Self-Generation Incentive Program (SGIP)
    - Investment Tax Credit (ITC)
    - Other
  - Taxes
- **Financing options:**
  - Self-financing (ability to specify a debt and equity ratio)
  - Third-Party
- **E3 developed cost estimates**
  - Updated in 2019-2020

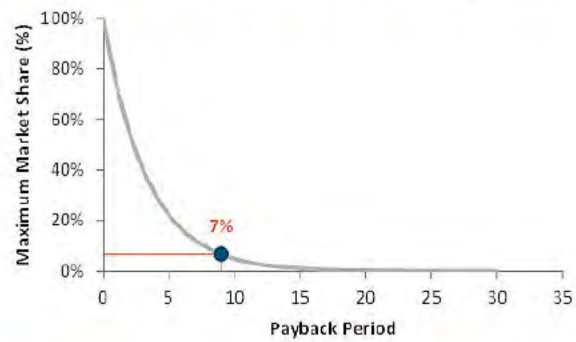
Consumer Adoption Model Overview

+ The Consumer Adoption Model estimates the percent of consumers, by vintage and type, that decide to purchase DERs based on the lifecycle cost of ownership
+ It consists of two key elements: PATHWAYS stock rollover and an NREL adoption model

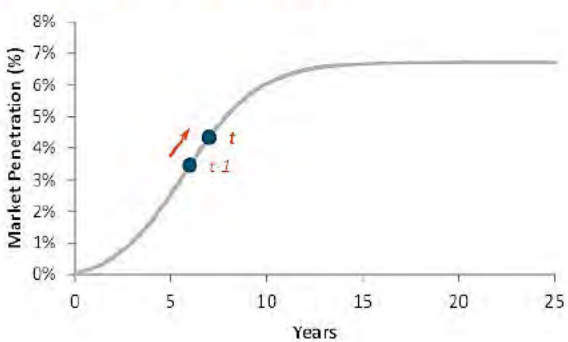
1. Determine payback period



2. Determine max market share



3. Fit logistic curve

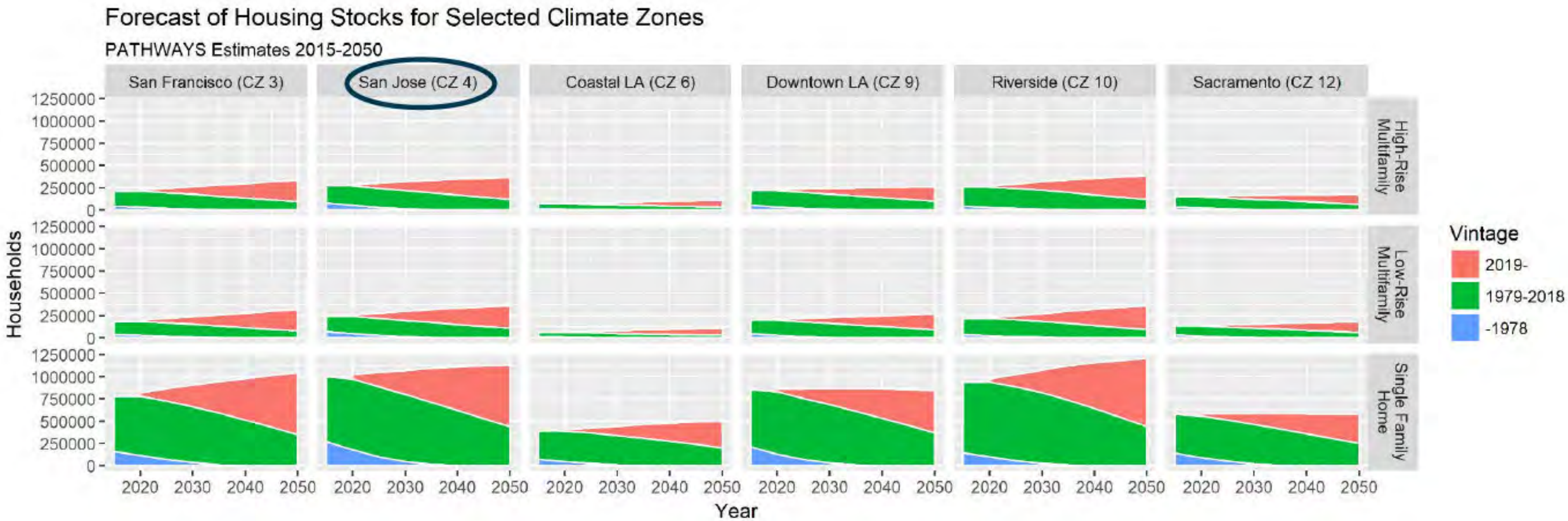


4. Apply to technical potential

	Technical potential	MW
x	Market penetration at *t*	%
=	**Installed capacity at *t***	**MW**

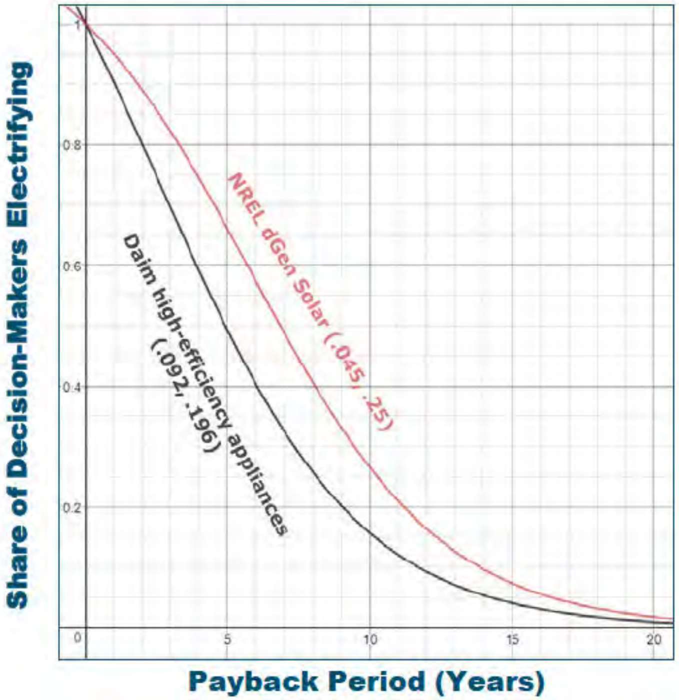
Stock Rollover Model

+ Stock rollover is an accounting model populated with PATHWAYS data which provides households by type, climate zone, and vintage
+ Homes are characterized by building envelope useful life, not original construction. Consequently, PATHWAYS does not differentiate between home rebuilds and whole-home retrofits.
+ Stock is assumed to keep pace with California population growth



Adoption Decision Logic

+ Decision logic based on NREL bass diffusion methodology to estimate rooftop solar adoption, and is modified for high efficiency appliance adoption
+ S-curve differentiation between customer types: Residential and Commercial
+ Decisions are made based on payback period e.g.: If payback time decreases from 10 to 5 years, market share of *new sales* rises from 15.7% to 49.3% for EE appliances.



$$Decision\ Share = \left(\frac{1 - \left(e^{-(p+q)PB}\right)}{1 + \frac{q}{p}\left(e^{-(p+q)PB}\right)} \right) \times \mathrm{M}$$

p,q = Adoption Parameters (.045, .25)
PB = Payback Time (e.g. 12 years)
M = Maximum Feasible Market Share (e.g. 100%)

Payback Period	% of New Sales PV
20	1.7%
15	7.4%
10	26.6%
7.5	44.6%
5	66.0%
2.5	85.7%
1	95.0%

Factors Affecting Adoption

- Upfront cost
- Lifetime cost
- Knowledge
- Income, debt
- Family size, location
- Convenience
- Social influence
- "Irresistible" technology
- Housing stock
- Policy & regulation
- Many other factors…

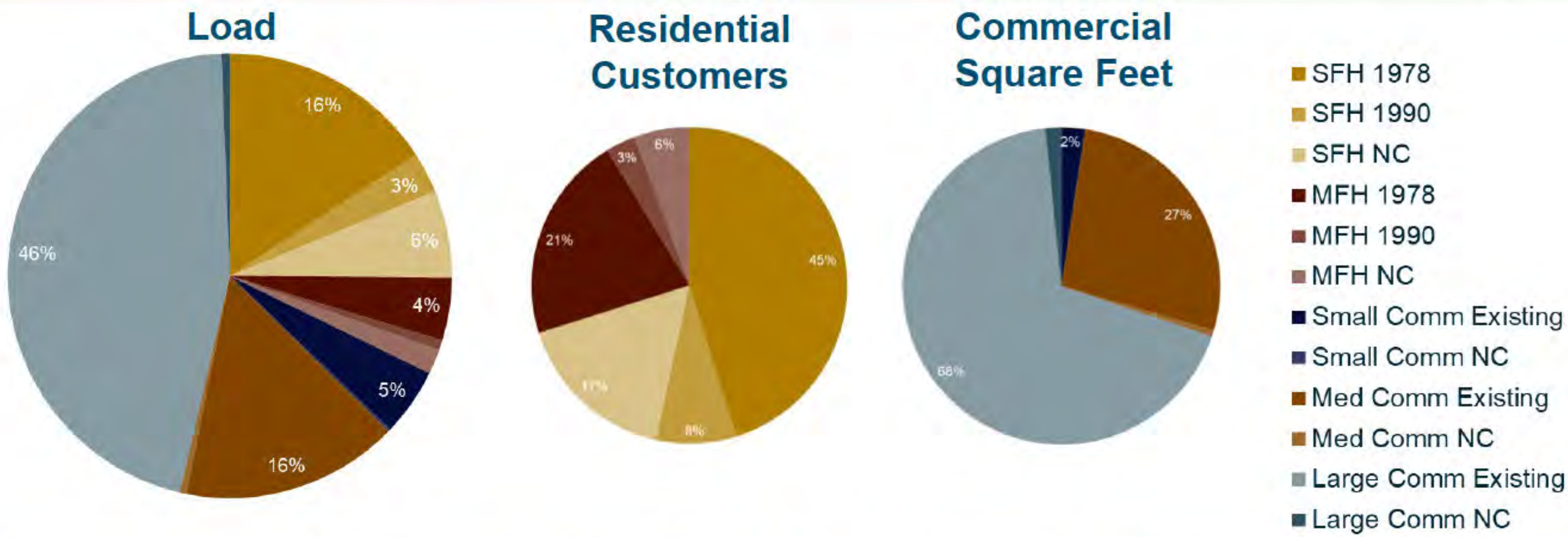
Complex consumer decisions have been modeled since 1970s using the Bass Diffusion model/logistics / "S-curve" adoption model, which uses 3 parameters to model adoption:

1. Total market size
2. p ="coefficient of innovation" rate or probability of innovators adopting new product
3. q = "coefficient of imitation" the rate or probability of imitators adopting new product

Energy+Environmental Economics

Analysis Setup

Customer Segmentation



Vintages	Single Family	Low-rise Multi-family	Small Commercial	Medium Commercial	Large Commercial
Pre-1978 (No insulation, single pane windows)	**1,800 sf**	**8 units** (780 sf/unit and 960 sf/unit)	**2,000 sf**	**16,700 sf**	**100,000 sf**
1990s (T24 building code 1992 construction)	**2,100 sf**	**6 units** (1,500 sf/unit)			
New Construction (2019 T24 building code)	**2,400 sf**	**8 units** (780 sf/unit and 960 sf/unit)	**2,300 sf**	**18,000 sf**	**206,000 sf**

Technology: Building Electrification

	Gas Baseline	Electric Home
HVAC	Gas Furnace + AC	Packaged Terminal Heat Pump OR Mini-split Heat Pump OR Ducted Split Heat Pump
Water Heating	Gas Storage WH (retrofits) OR Gas Tankless WH (new)	Heat Pump Water Heater
Cooking and Clothes Drying	Gas Stove OR Gas Dryer	Electric OR Induction; Electric OR Heat Pump

Technology: RESTORE

	Tech Specs
BTM Storage	4-hour storage. Sized to customer load. *Assume customers will adopt storage only when they already/plan to have BTM PV
BTM Solar PV	Sized to customer annual load
EV	BEV, 250-mile range using level 2 charging with uniform driving behaviors and charging availability

Scenarios: Reference

	Generation Rate	Electric Delivery Charges (T&D)	PCIA	Natural Gas Rate
Best: Low Elec & High Gas	2020 SVCE TOU	High Building Electrification	$0.03/kWh	High Building Electrification
Ok: Mid Elec & Mid Gas	2020 SVCE TOU	Multi-prong with Slow electrification	$0.04/kWh	Multi-prong with Slow electrification
Worst: High Elec & Low Gas	2020 SVCE TOU	Current Policy Reference scenario + Plus wildfire costs	$0.05/kWh	Current Policy Reference scenario

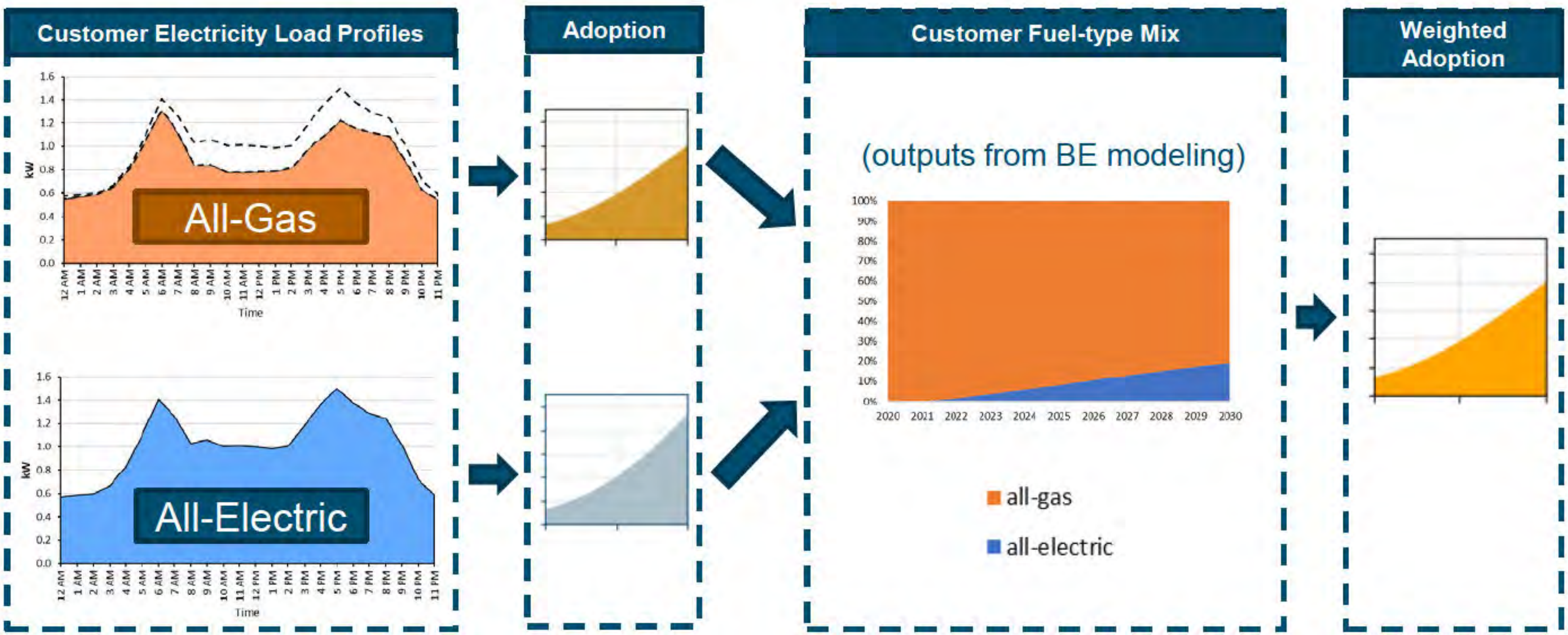
+ **TOU Rates**
  - Residential: E-TOU-C
  - Commercial: B1
+ **T&D and Natural Gas Rate Assumptions**
  - High Building Electrification - Achieves CA GHG goals. Includes high electrification of buildings and LDVs
  - Current Policy Reference - Does not meet California's 2030 and 2050 GHG goals
+ **Wildfire Costs –** Based on PG&E GRC filing forecast forward and fed through the Future of Natural Gas Revenue Requirement Tool
+ **PCIA –** From E3 Market Forecasting team
+ **No NEM (including T&D) in Base Case**

Scenarios: Sensitivities

+ **Rates**
  - Real-time Pricing
    - System capacity price
    - Avoided energy price
    - Avoided emission cost
    - Avoided RPS
    - Avoided Ancillary services cost
  - SVCE NEM
  - SVCE EV Rates
+ **2022 Reach Code: Natural Gas Moratorium**
  - Applied to New Construction and Remodels
+ **Incentives**
  - 3-yr, 5-yr, and 10-yr Target Payback
  - SGIP to 2030
  - ITC included in baseline

Impact of Building Electrification on DER Adoption

- Progress of building electrification could affect economics of DER adoption by changing customer electricity load profiles
- E3 captures the building stock rollover by modeling the same representative customer under two fuel type scenarios, and weight adoption results by fuel type mix within this customer group



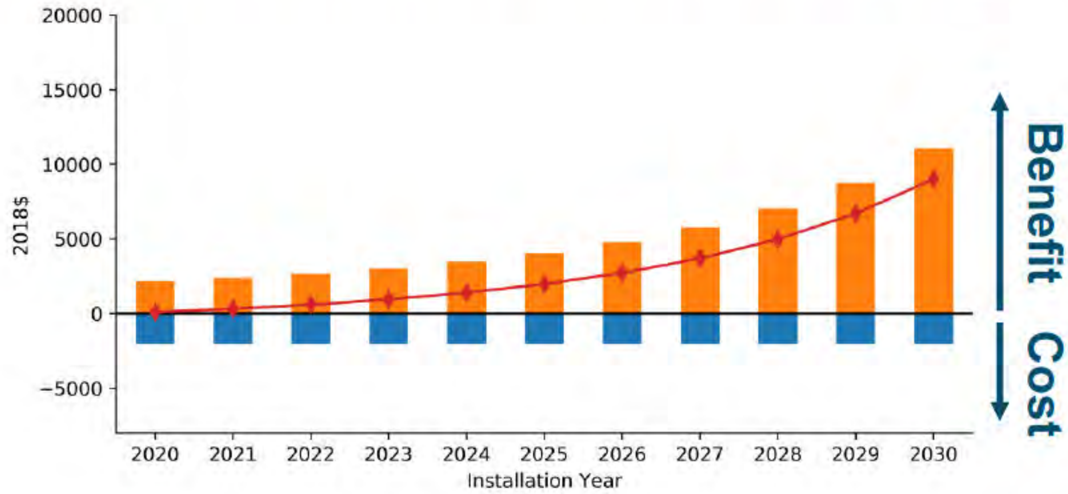
Energy+Environmental Economics

Building Electrification Results

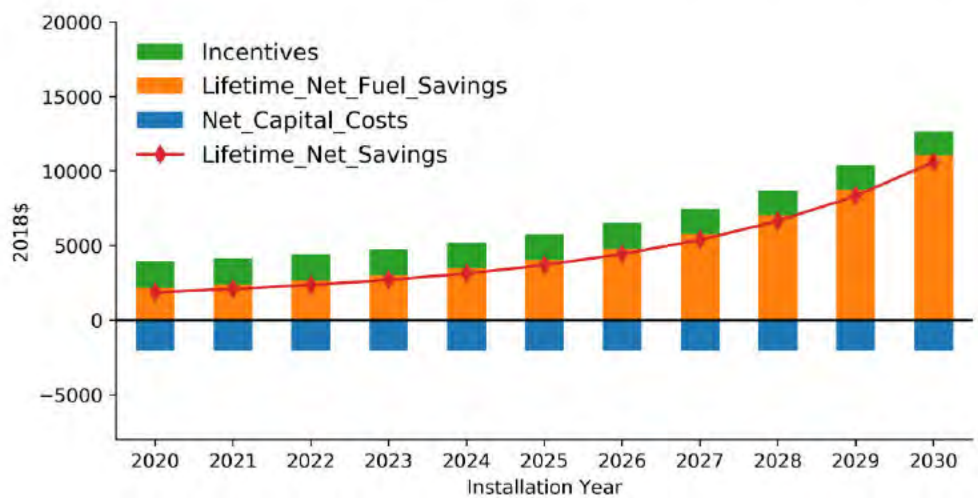
Residential All-Electric Retrofit

Lifetime Benefit / Cost of All-electric Homes (Single Family, 1990s)

Base, OK



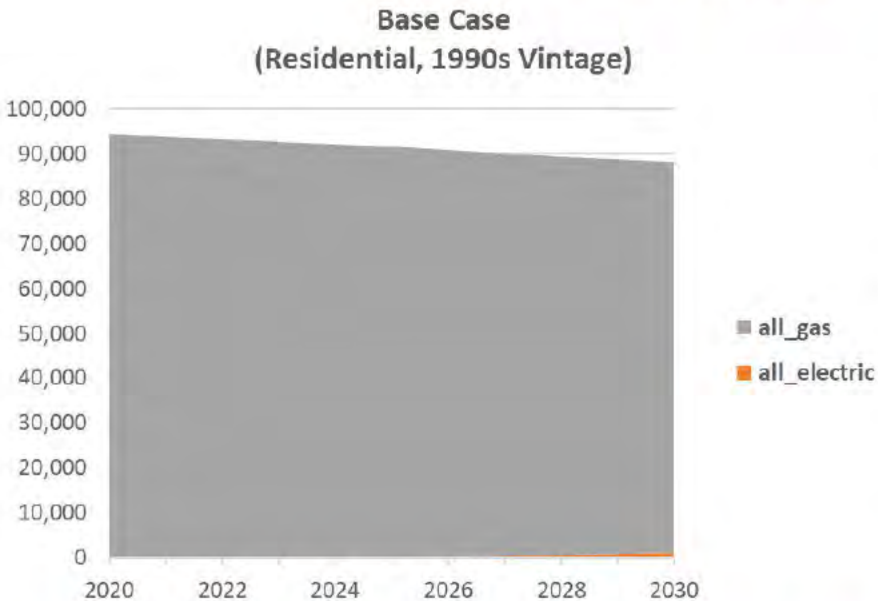
Inctv3, OK

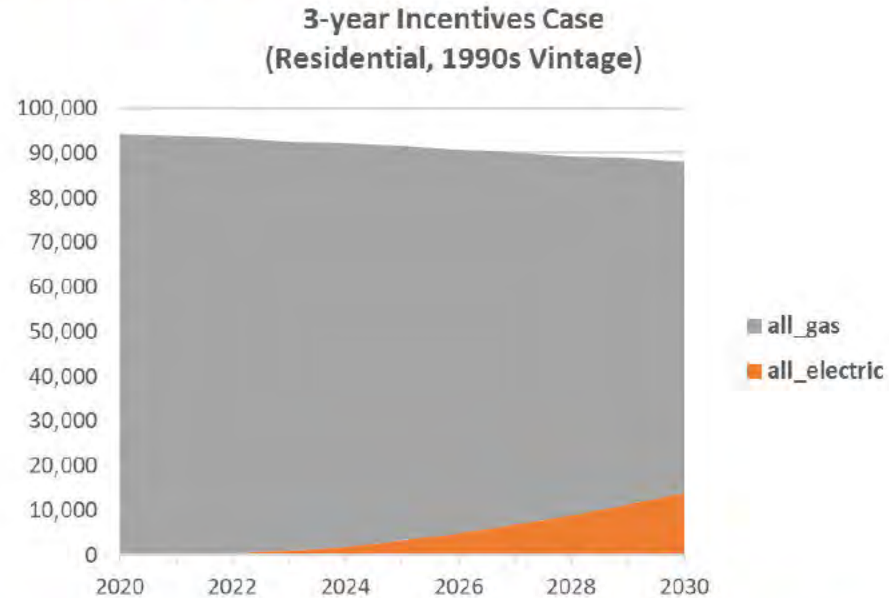


- Net costs and savings are relative to a mixed-fuel home
- Lifetime is assumed to be 20 years

Residential All-Electric Retrofit

Adoption of all-electric RESIDENTIAL 1990s homes





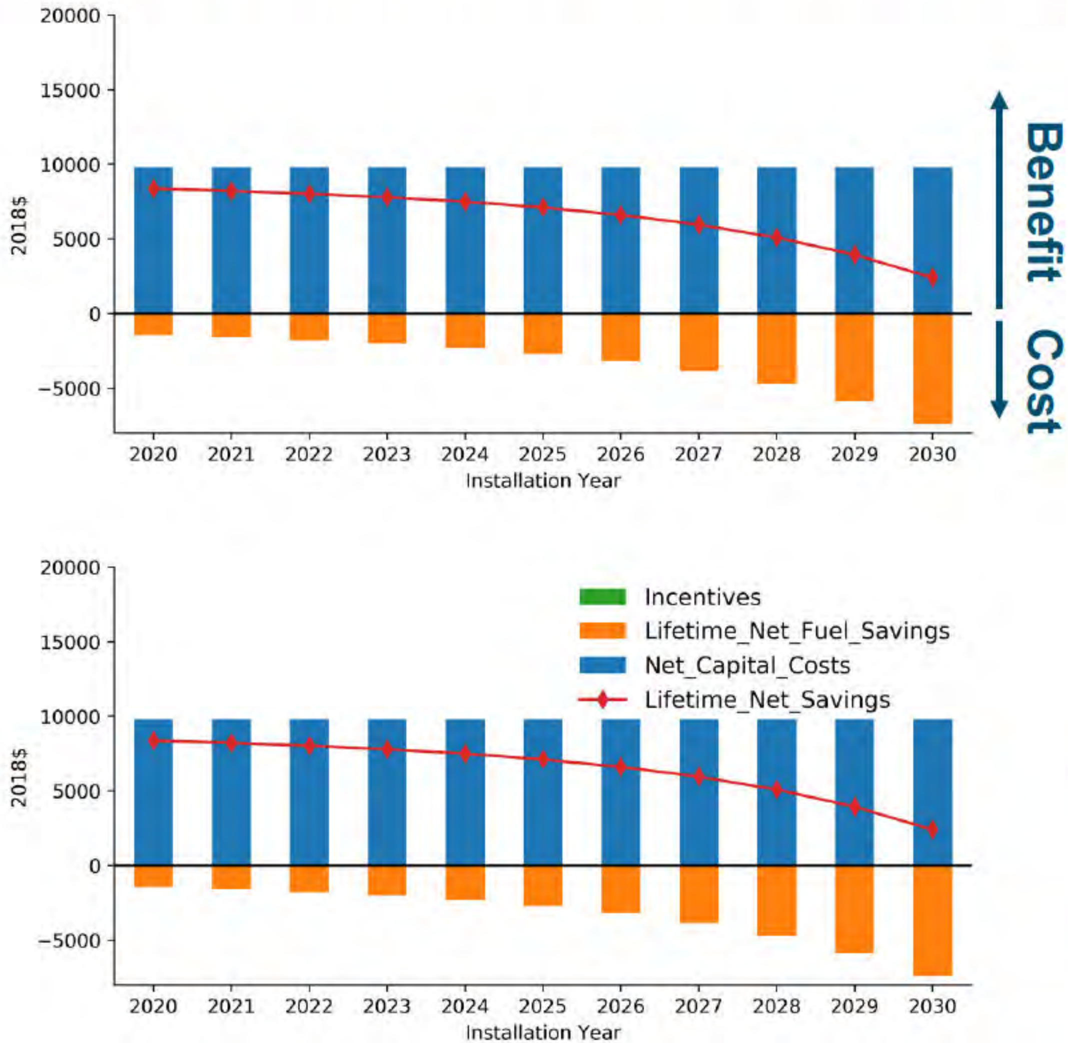
+ A 1990s vintage home is defined as one that was built between 1978 and 2019. The charts above show both single-family and multi-family homes combined.
+ Retrofitting an existing home to be all-electric is expensive; there is almost no adoption of all-electric retrofits in the Base Case.
+ With an incentive that improves payback period to 3 years, adoption of all-electric retrofits is projected to reach ~15% by 2030.
+ Homes without AC are excluded from adopting heat pump HVAC and all-electric homes due to significantly higher costs (details in Appendix)

Residential All-Electric New Construction

Lifetime Benefit / Cost of All-electric Homes (Single Family, NC)

Base, OK

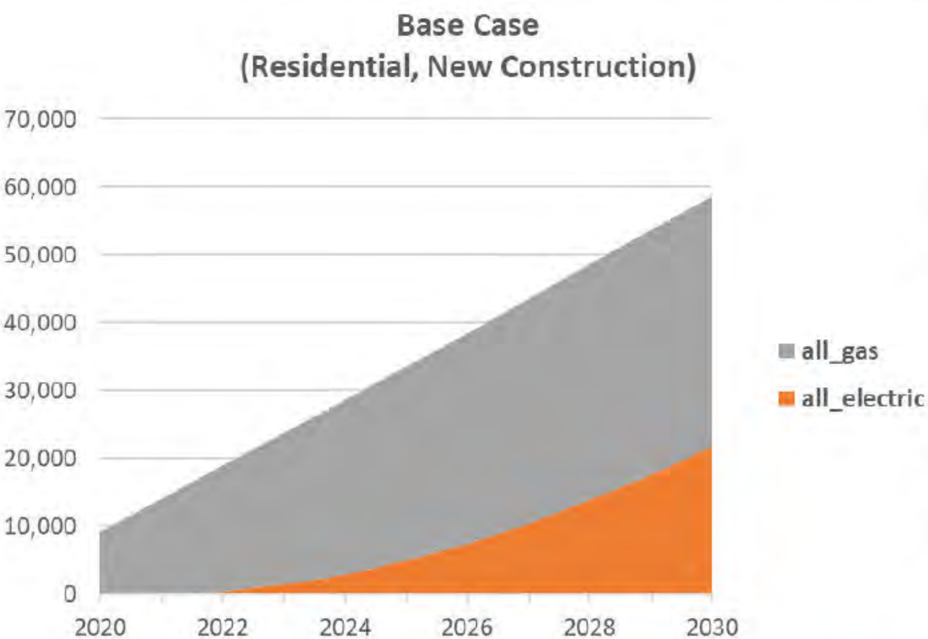
Inctv3, OK

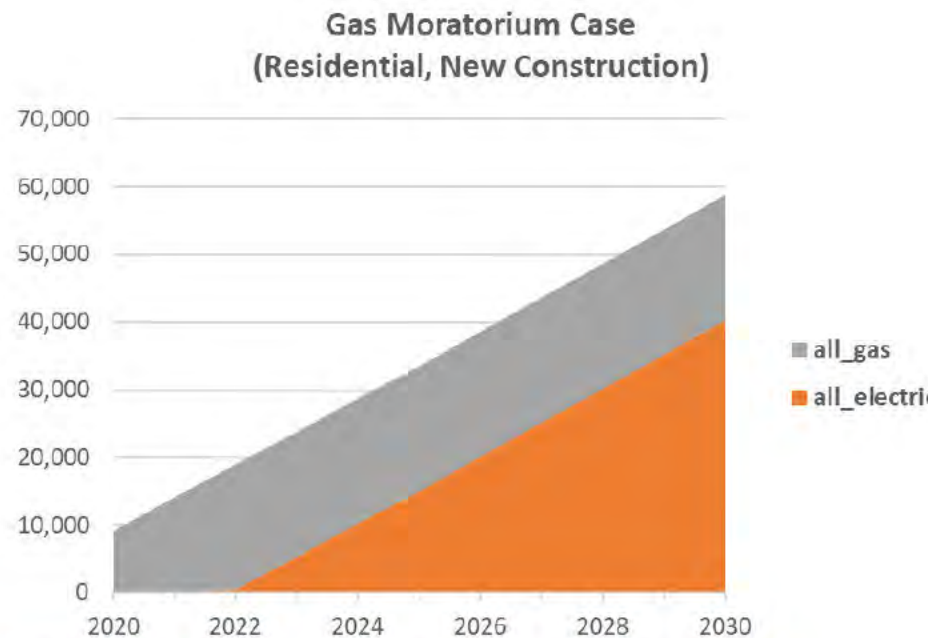


- Note that blue bars are positive indicating capital cost savings, and orange bars are negative indicating increases in bills
- Although customers will pay higher bills, the capital cost savings cover more than the extra bills over the lifetime of the appliances.
- Net costs and savings are relative to a mixed-fuel home
- Lifetime is assumed to be 20 years

Residential All-Electric New Construction

Adoption of all-electric RESIDENTIAL new construction homes



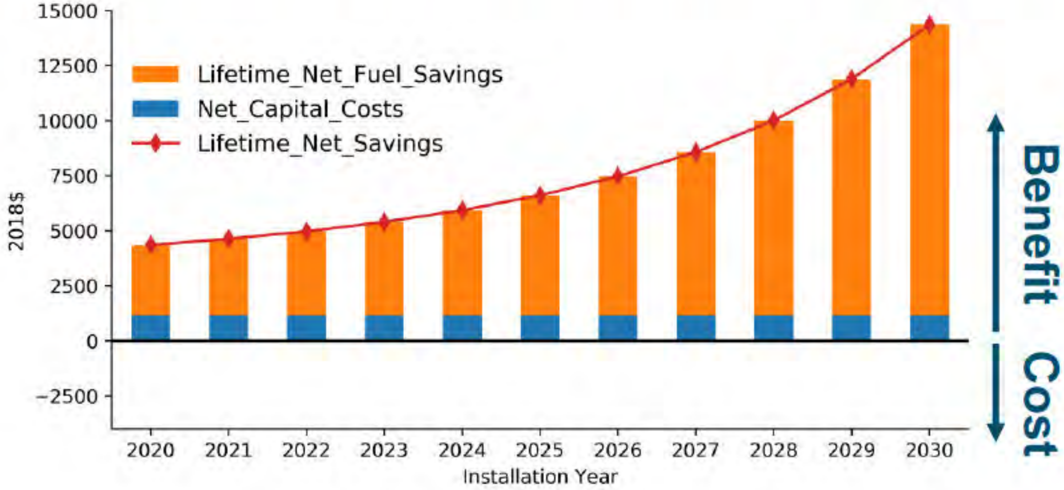


- A new construction home is defined as one that will be built in 2020 and beyond. The rate of new construction is assumed to be the same as population growth rate forecasted by the California Department of Finance
- All-electric new construction homes already reach cost parity with mixed-fuel homes; adoption of all-electric new construction is projected to reach 1/3 of total stock by 2030
- Gas moratorium would double the adoption of all-electric new construction than in the Base Case

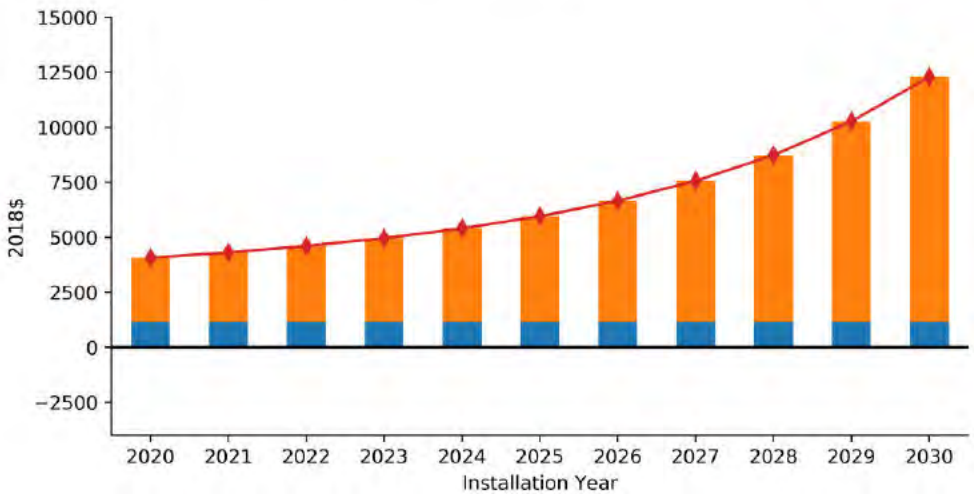
Residential HVAC Heat Pumps

Lifetime Benefit / Cost of HVAC Heat Pumps (Single Family, 1990s)

Base, OK



Base, Worst



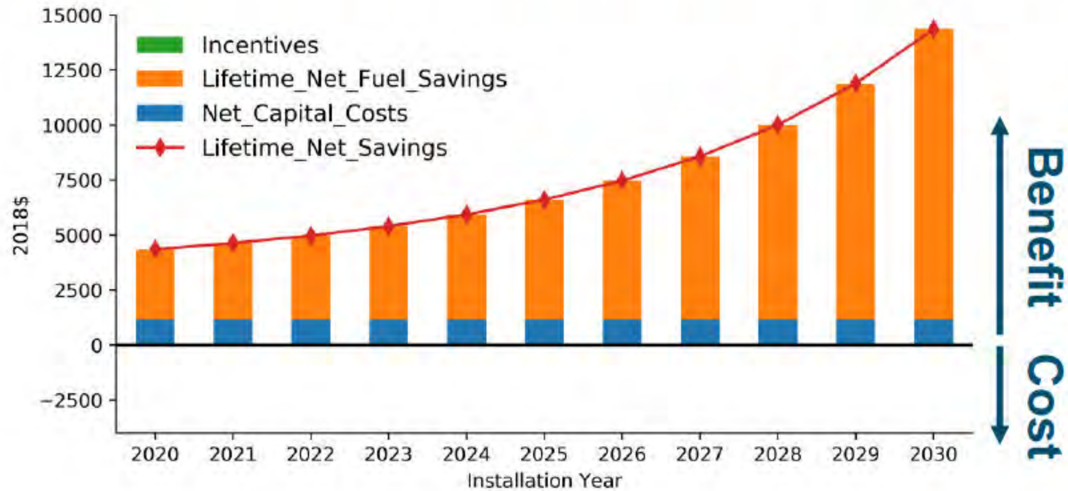
- The different electricity and gas rate scenarios have very little impact on B/C of heat pumps

Net costs and savings are relative to gas furnace+ AC

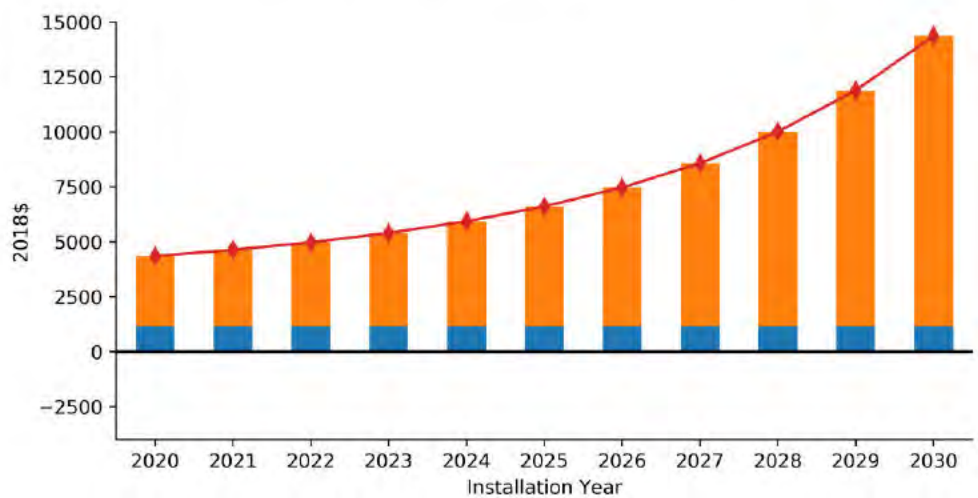
Residential HVAC Heat Pumps

Lifetime Benefit / Cost of HVAC Heat Pumps (Single Family, 1990s)

Base, OK



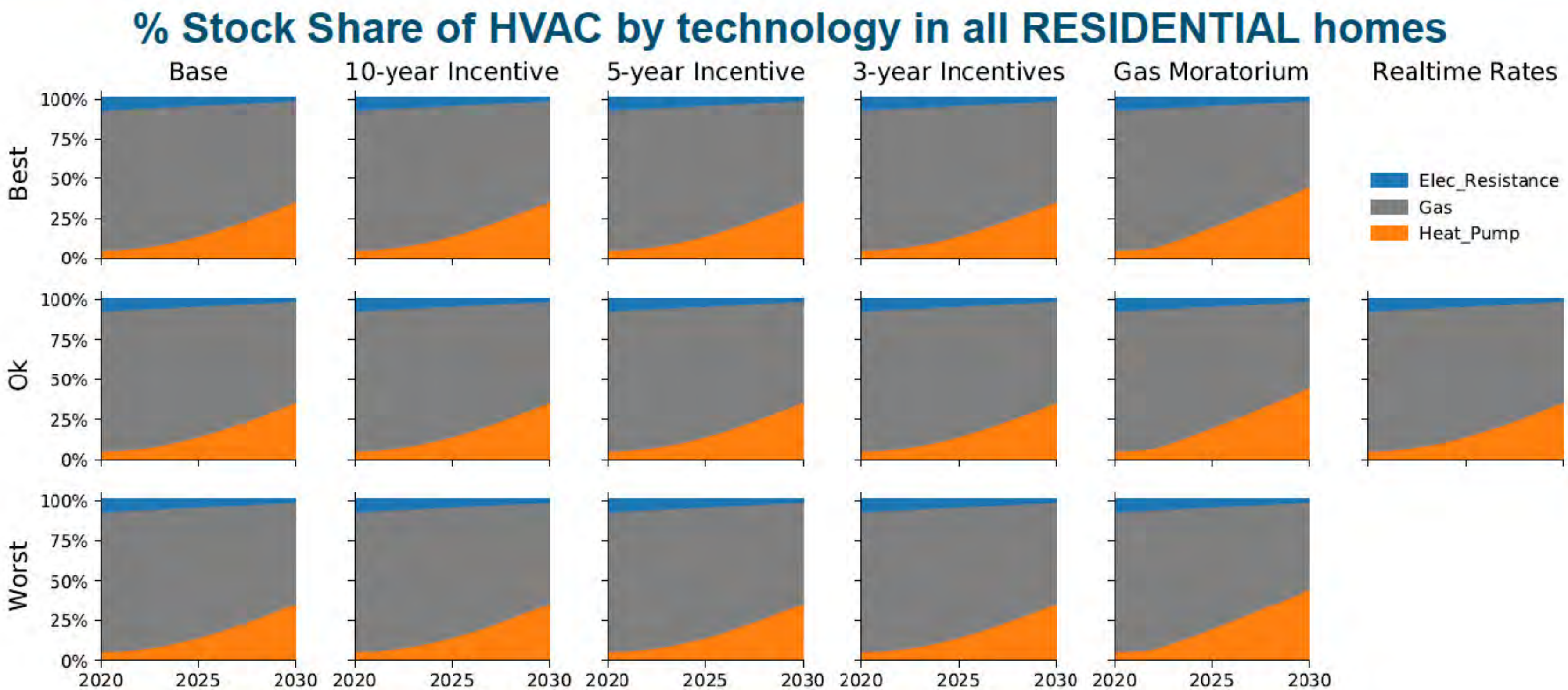
Inctv3, OK



- No incentives needed, because heat pump HVACs immediately pays back with capital cost savings

Net costs and savings are relative to gas furnace+ AC

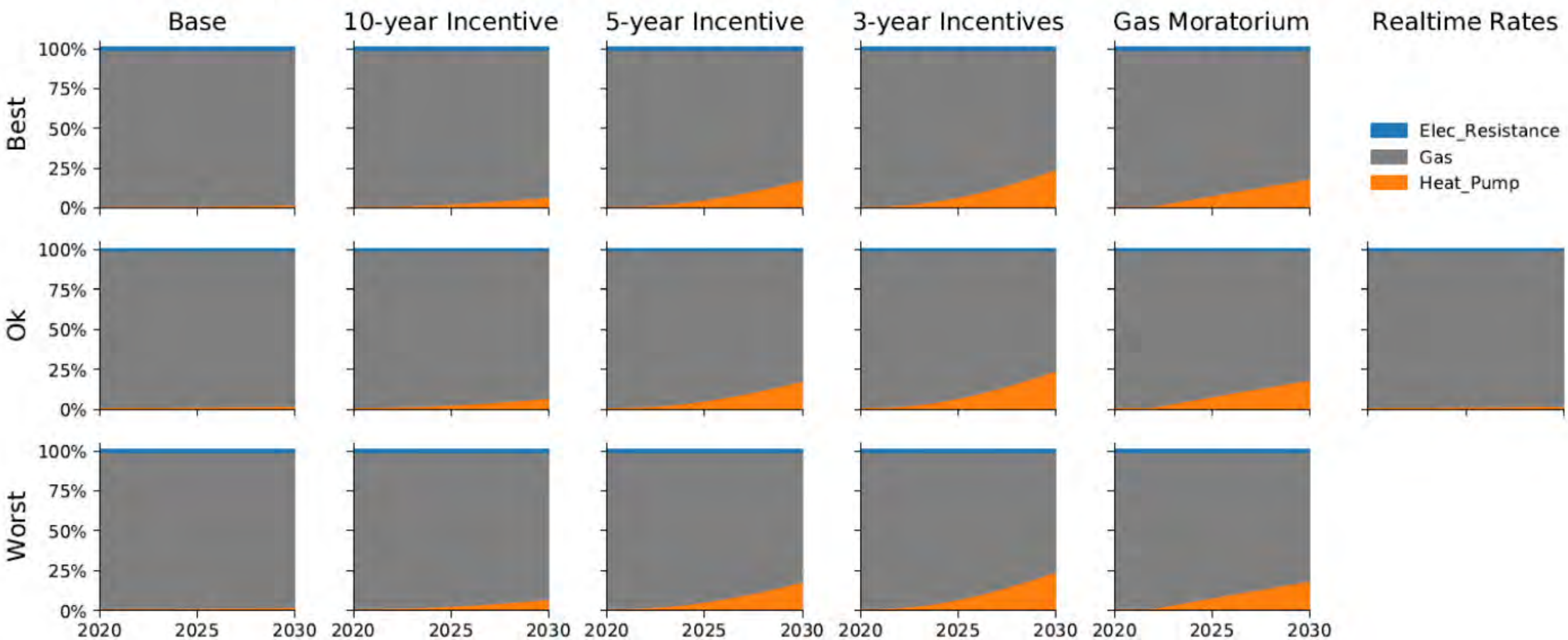
Residential HVAC Heat Pumps



- Heat pump penetration is projected to increase from 4% currently to 34% by 2030
- Because heat pumps already have payback period less than 3 years, the incentive cases all show same adoption trajectory as the Base case.
- Gas moratorium would result in heat pump penetration of 46%.
- Homes without AC are excluded from adoption of heat pump HVAC and all-electric homes (details explained in Appendix)

Commercial HVAC Heat Pumps

% Stock Share of HVAC by technology in all COMMERCIAL buildings



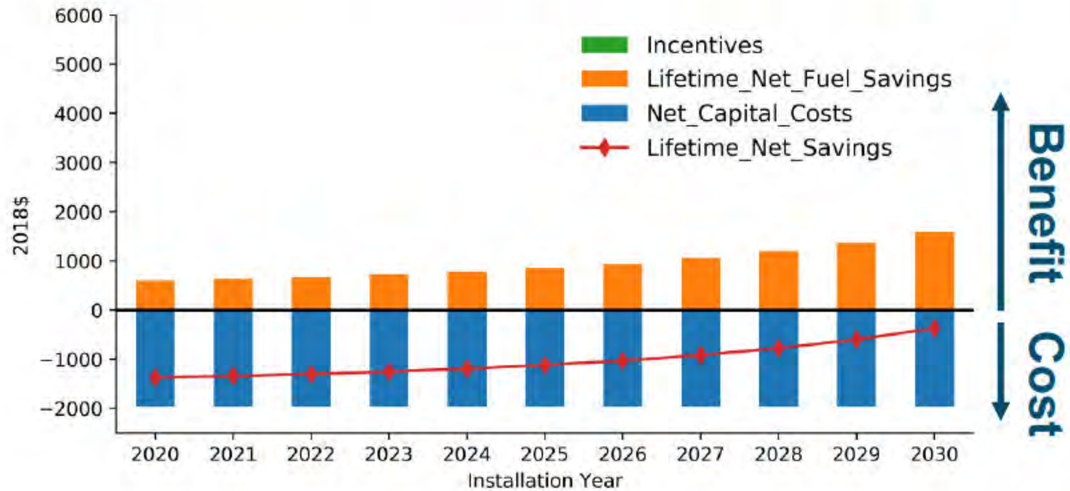
* Note that we assume Variable Refrigerant Flow (VRF) systems in the medium and large commercial buildings. These are expensive systems, but the only known heat pump systems for large buildings based on E3's internal research. Further work is needed on optimal system to electrify space heating for large commercial spaces.

+ Heat pump HVAC systems are not cost effective enough in commercial buildings to encourage adoption in the Base Case based on E3's internal research.
+ With incentives, heat pumps can reach up to 23% of all HVAC stock by 2030
+ Gas moratorium would result in heat pump penetration of 17%.

Residential Heat Pump Water Heaters

Lifetime Benefit / Cost of Heat Pump Water Heaters (Single Family, 1990s)

Base, OK



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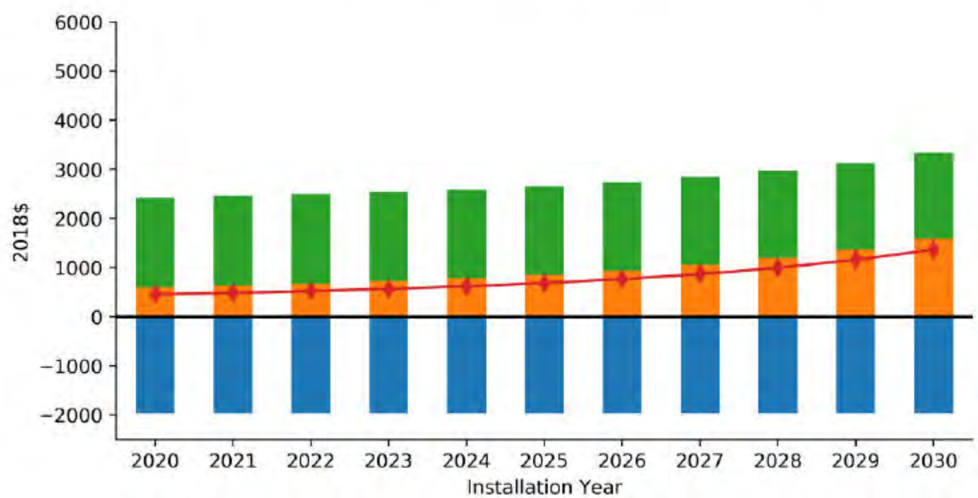
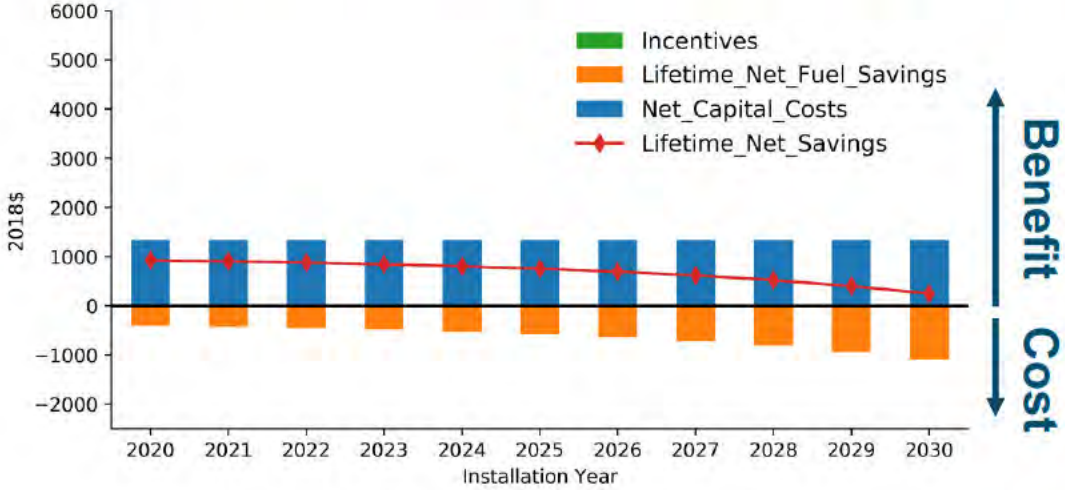


Net costs and savings are relative to a gas storage water heater

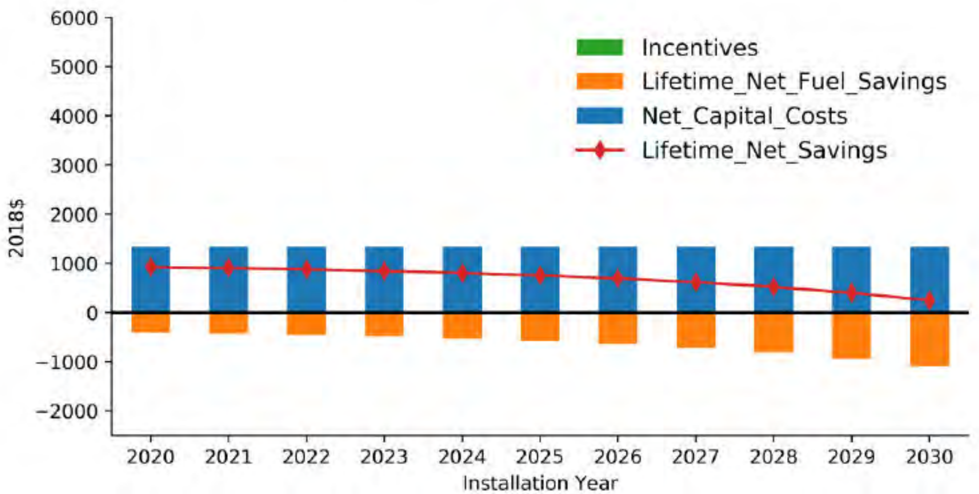
Residential Heat Pump Water Heater

Lifetime Benefit / Cost of Heat Pump Water Heaters (Single Family, NC)

Base, OK



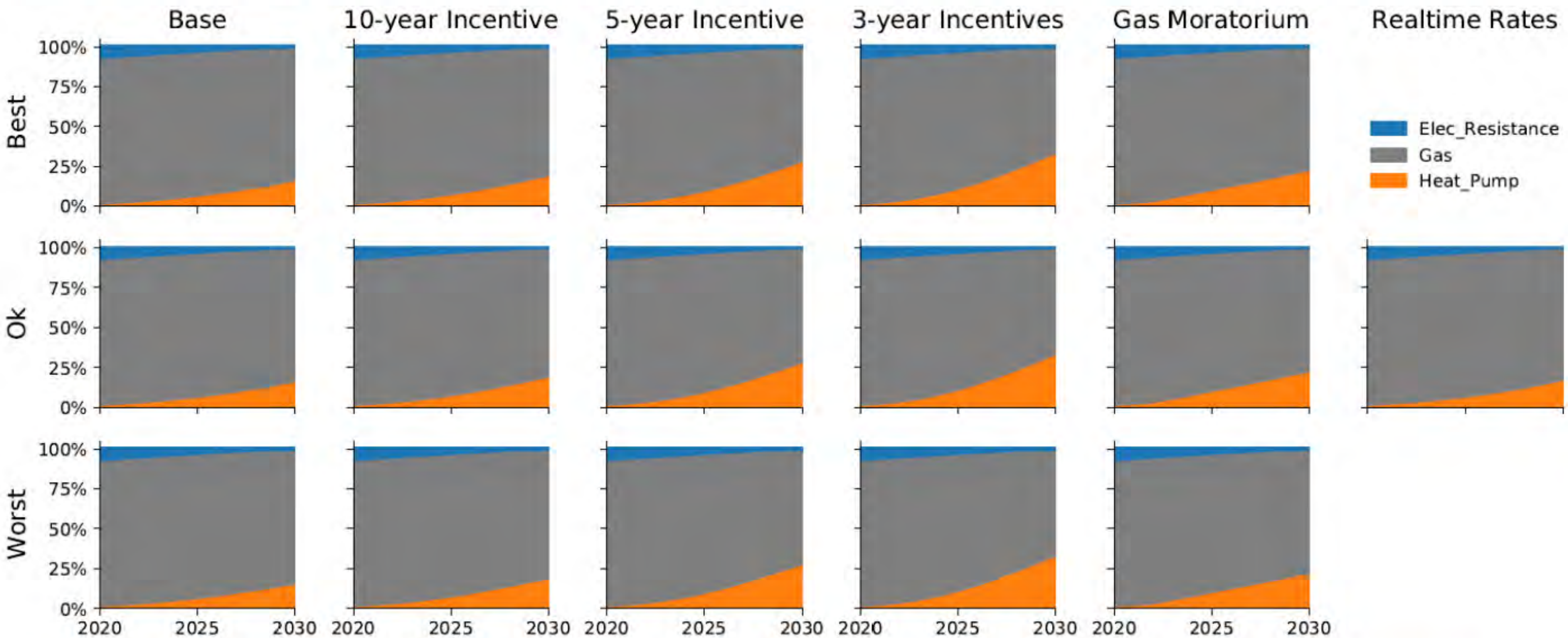
Inctv3, OK



Net costs and savings are relative to a gas tankless water heater

Residential Heat Pump Water Heaters

% Stock Share of Water Heaters by technology in all RESIDENTIAL homes

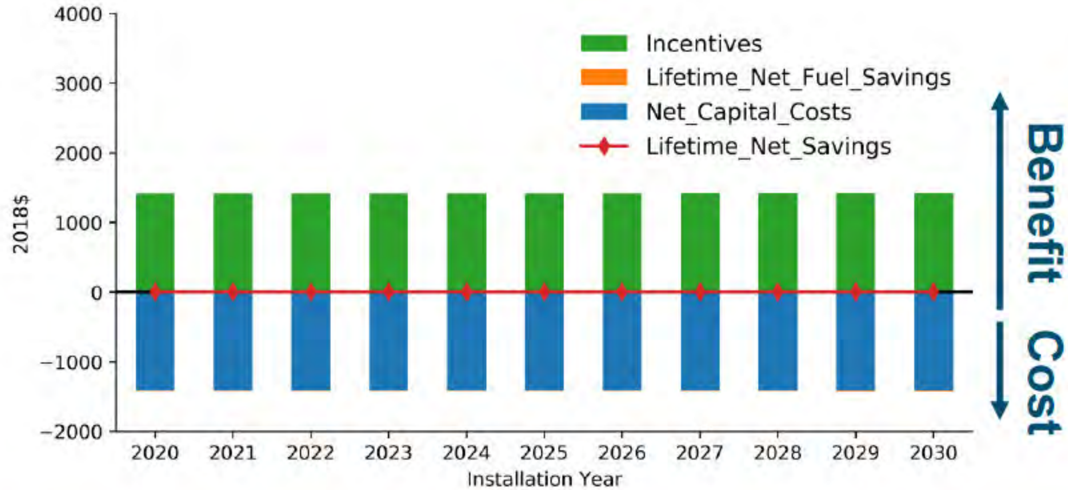


- Heat pump water heater (HPWH) penetration is projected to increase from less than 1% currently to 15% by 2030, mainly driven by adoption in new construction homes.
- With incentives, heat pump water heaters can reach up to 32% of all stock by 2030.
- Gas moratorium would result in heat pump penetration of 21%.

Commercial Heat Pump Water Heaters

Lifetime Benefit / Cost of Heat Pump Water Heaters (Medium Commercial, retrofit)

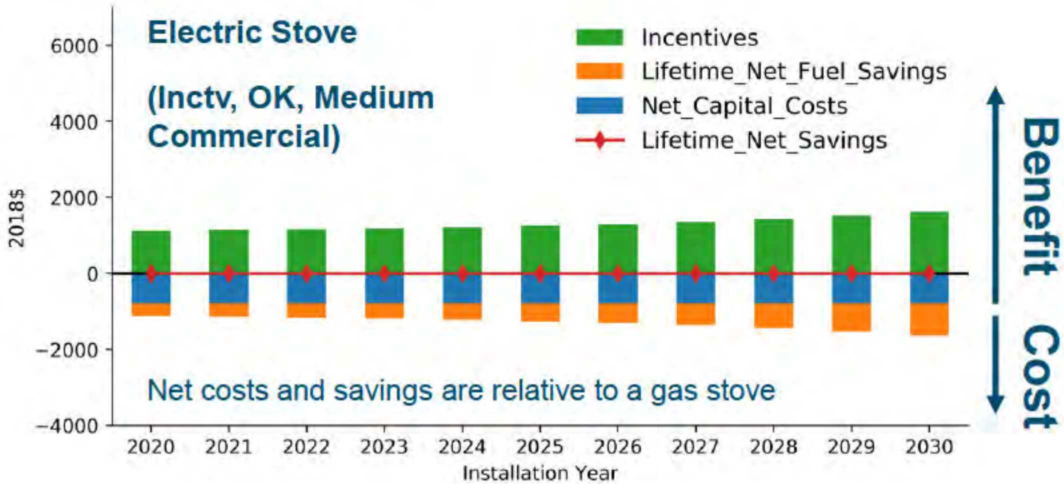
Inctv, OK

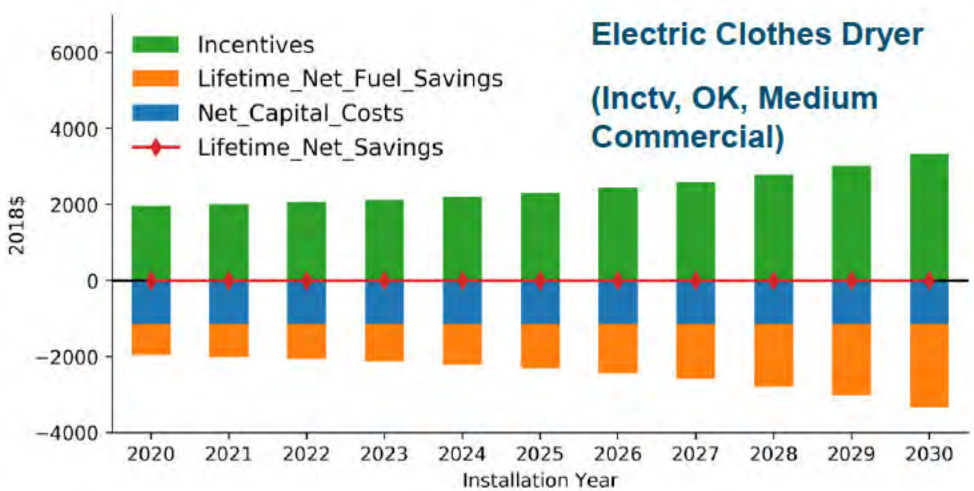


Net costs and savings are relative to a gas storage water heater

- Heat pump water heaters (HPWHs) slightly increases bills for commercial buildings in the Ok and Worst scenarios.
- Since commercial customers would spend more money both upfront for capital costs and monthly on bills, Investment on HPWHs would never pay itself back.
- In these cases, we assume that incentives are set to make the investment break even over the lifetime of HPWHs.
- Therefore, the actual payback period equals appliance lifetime. e.g. 13 years for a HPWH. There is no difference in actual payback among the Inctv3, Inctv5 and Inctv10 cases (labeled as Inctv).

Commercial Electric Stove & Clothes Dryer

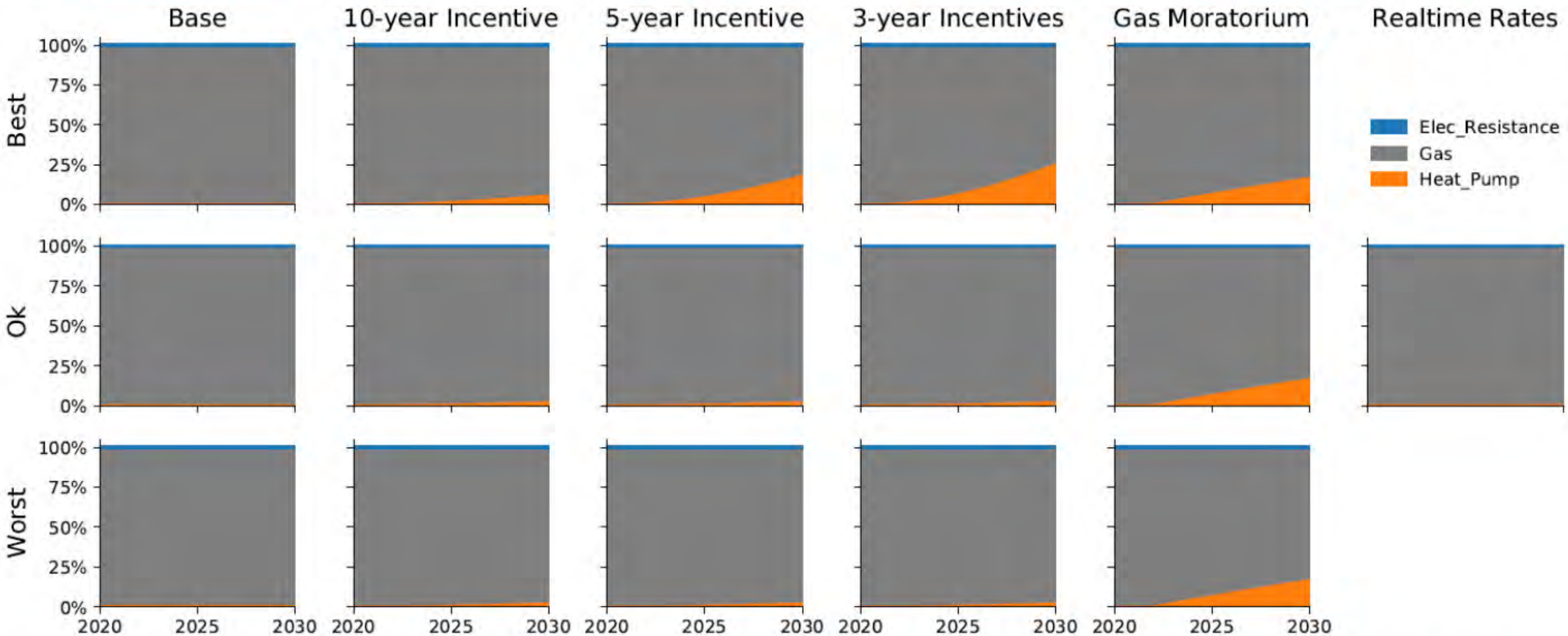




- Similar situation of increase in both upfront and bill costs also happen to cookstoves and clothes dryers.
- Likewise, incentive levels are set to cover the lifetime cost of the appliances.
- The actual payback period equals the appliance lifetime, i.e. 12 years for a cookstove and 13 years for a clothes dryer. There is no difference in actual payback between the Inctv3, Inctv5 and Inctv10 cases (labeled at Inctv).

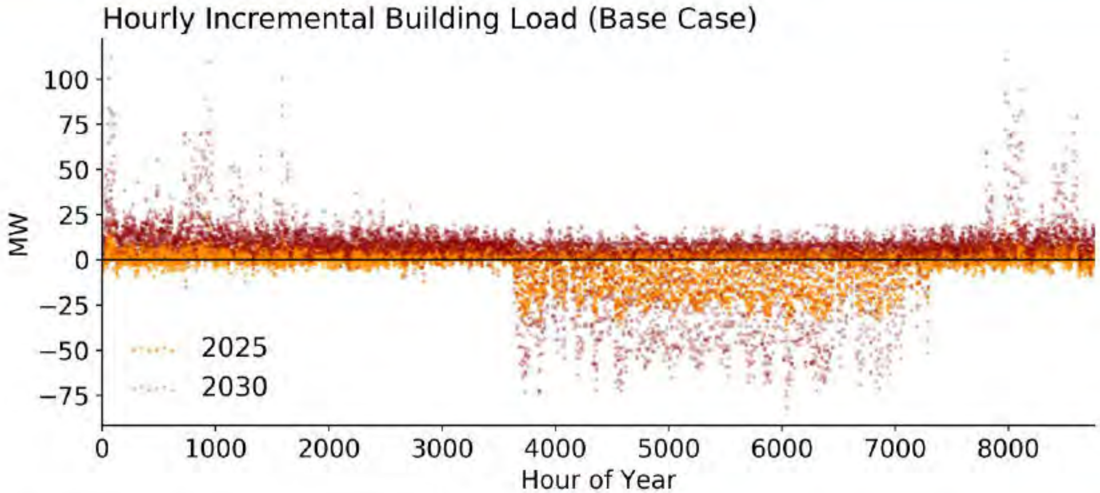
Commercial Heat Pump Water Heaters

% Stock Share of Water Heaters by technology in all COMMERCIAL buildings

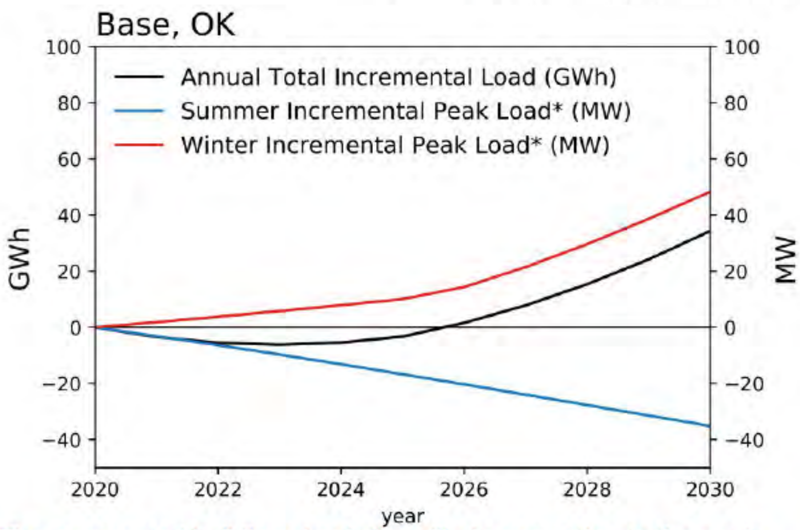


- Heat pump water heaters (HPWHs) are not cost effective enough in commercial buildings. In the Ok and Worst scenarios, HPWHs would increase bills and thus incentives are only set to cover lifetime costs. The equivalent payback of 13 years are not high enough to encourage adoptions.
- In the Best scenarios, HPWHs would get bill savings and thus incentives can reduce payback period. HPWH reaches up to 25% of all stock by 2030. Gas moratorium would get HPWH penetration to 16%.

Building Electrification Load Impacts 2025 vs 2030



All appliances in both residential and commercial buildings

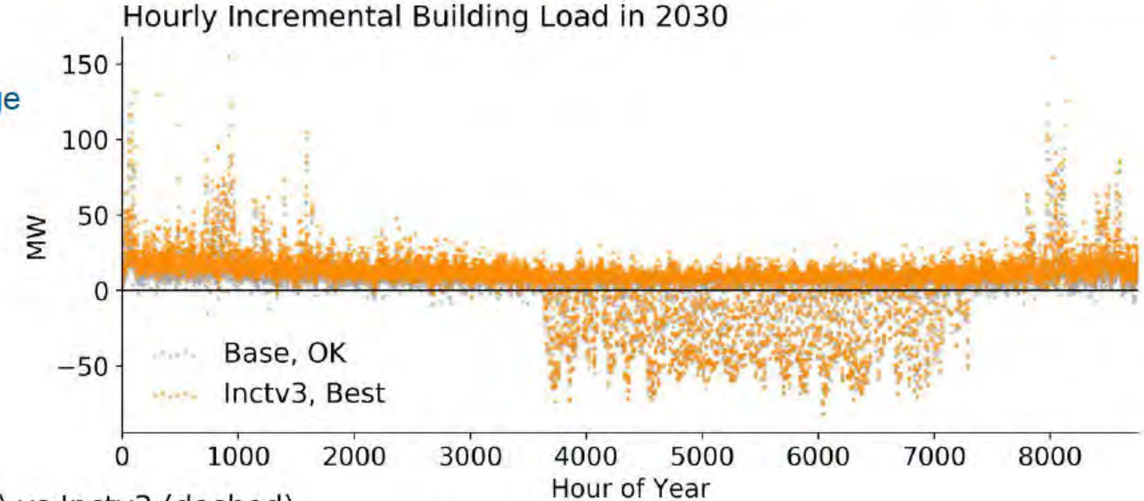


* The aggregated building simulations likely overestimate the peak impact. A diversity factor of 0.43 is applied to the aggregated peak load. The factor is from the paper linked below and represents diversity in occupancy schedule and customer behaviors.
https://www.sciencedirect.com/science/article/pii/S0306261917308954

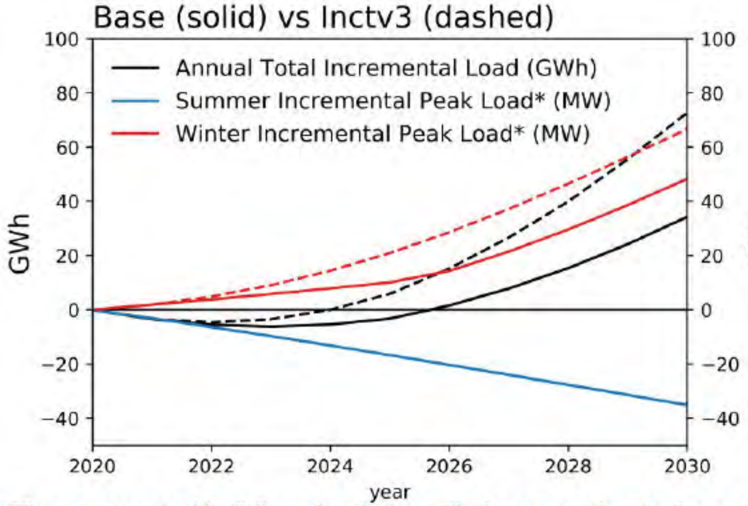
+ Electrification of space heating reduces annual loads in the near term due to switching from electric resistance heating to the much more efficient heat pumps
+ In the long term, electrification increases winter loads because of fuel switching and reduces summer load due to more efficient heat pumps than existing AC units.
+ The reduction in summer peaks is because heat pumps are assumed to replace only furnaces paired with AC in this analysis. Homes without AC may adopt heat pumps, which could result in summer load increase.
+ The question is whether the system will become winter peaking at any point?

Building Electrification Load Impacts Base vs. 3-year Incentive Case

Note change of scale



All appliances in both residential and commercial buildings



* The aggregated building simulations likely overestimate the peak impact. A diversity factor of 0.43 is applied to the aggregated peak load. The factor is from the paper linked below and represents diversity in occupancy schedule and customer behaviors.
https://www.sciencedirect.com/science/article/pii/S0306261917308954

- The major difference between the Base and Inctv3 cases is the adoption of heat pump water heaters.
- More electrification of water heating results in greater increase in annual loads and winter peaks, but little effect on reducing summer peaks which are mainly driven by space cooling.
- CAVEAT: Water heating load may slightly affect the summer peak if more load diversity is included.

DER Adoption Results

Results Overview

+ Adoption

- impacts of rate scenarios and sensitivities on cumulative adoption (MW installed capacity)

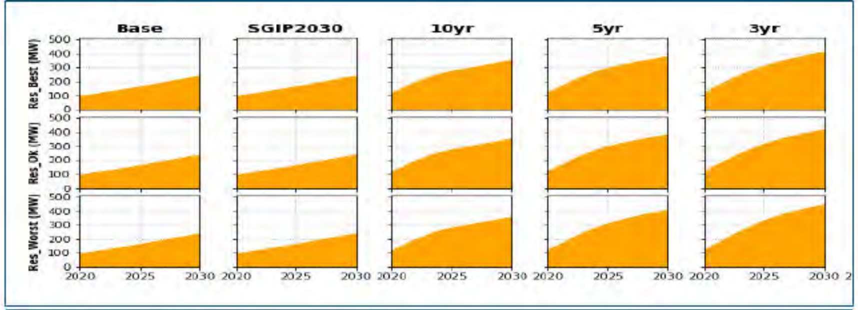
+ Costs & Benefits

- detailed costs & benefits shedding lights on how economics affect consumer adoption

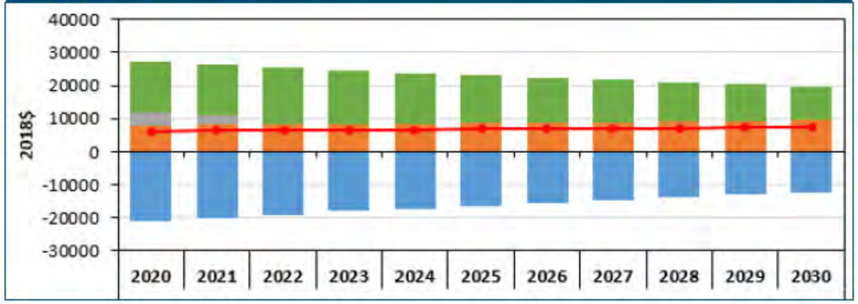
+ Customer Load Impact

- how DER affects BTM customer net load under different cases

Adoption



Costs & Benefits



Customer Load Impact

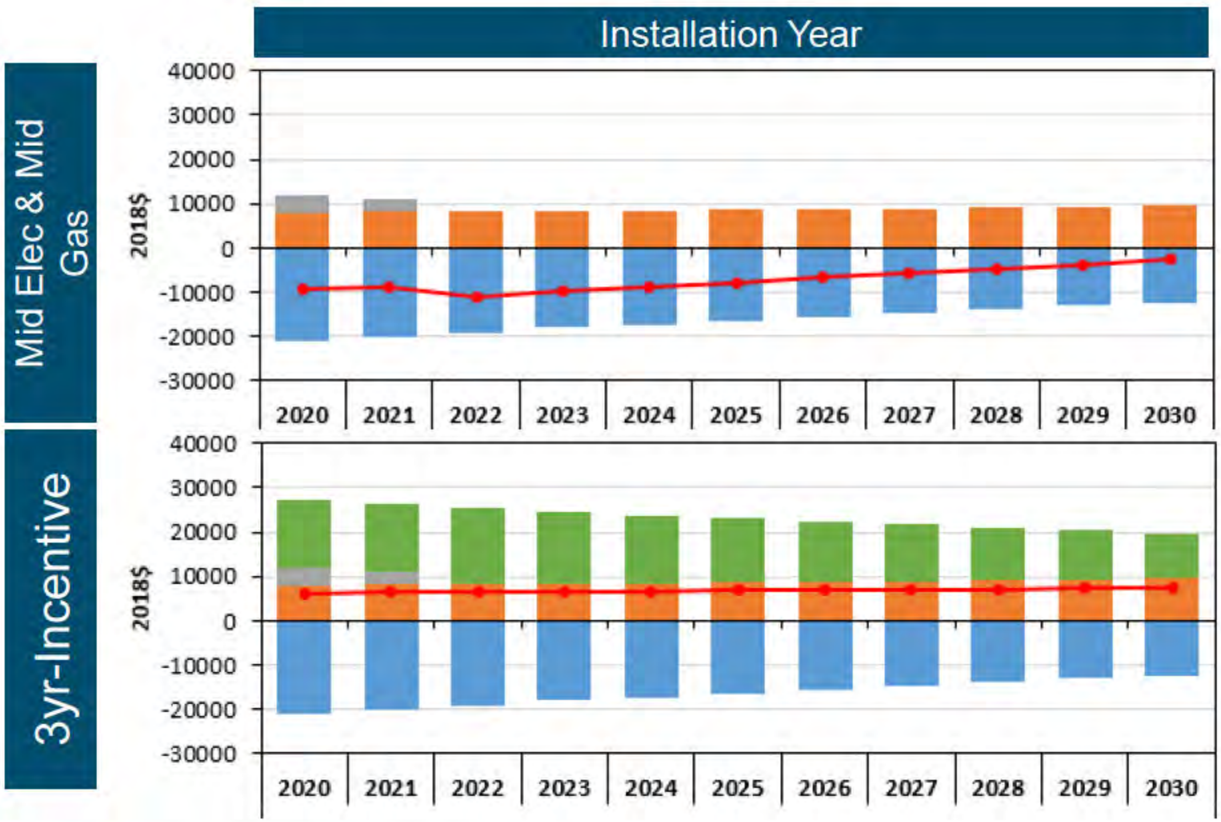
Key DER Adoption Modeling Updates

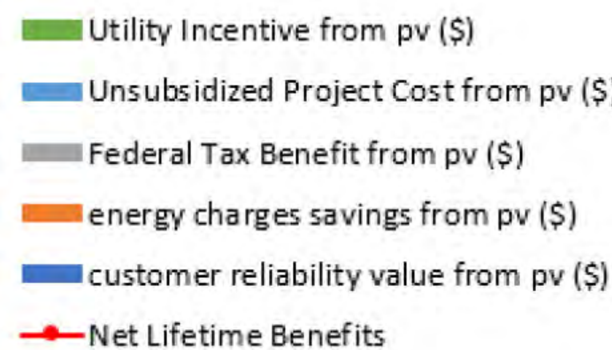
+ All residential customers size storage kW capacity to their peak load
+ Updated PV and storage cost assumptions for residential
  - update to E3 2020 internal resource cost pro forma analysis
+ Modeled California PV Mandate better
+ Updated SGIP Incentive assumptions

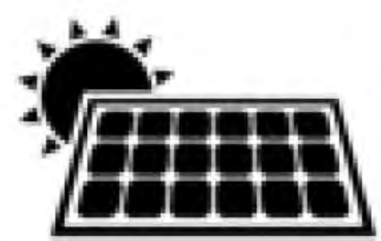
Incentive Rates ($/Wh) when < 500 kW Assuming 0-4 hour battery operating 0-2 MWh Expire after 2025	
Residential <= 10 kW	0.26
Large > 10 kW when claiming ITC	0.20
Large > 10 kW	0.26

Costs & Benefits BTM PV Residential, Single Family, NC

- Base Case: residential BTM PV is not cost-effective by 2030 as the bill savings without NEM and ITC tax benefit together are not enough to offset project costs
- 3-year Target Payback Period Incentive: residential BTM PV becomes cost-effective and the incentive level could decrease in future because of declining capital costs

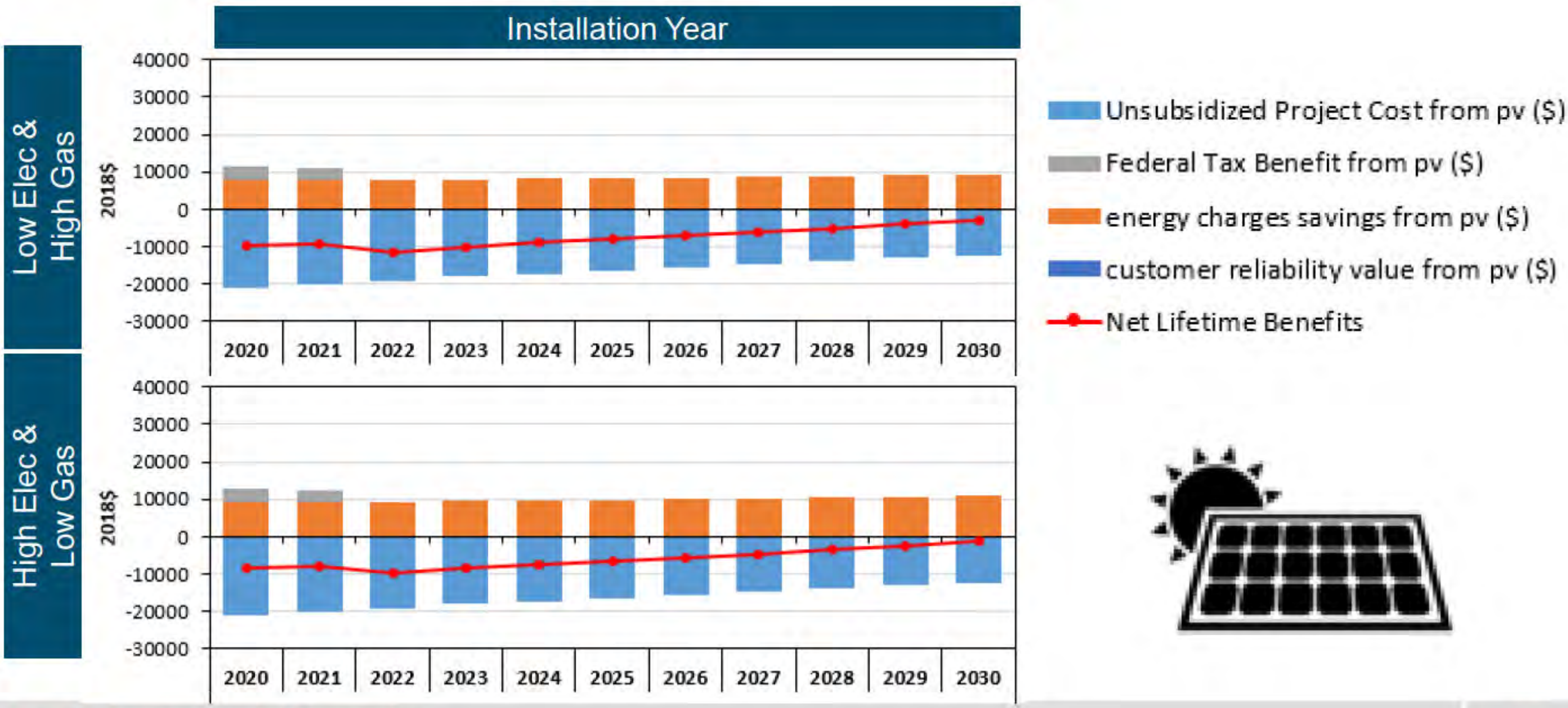






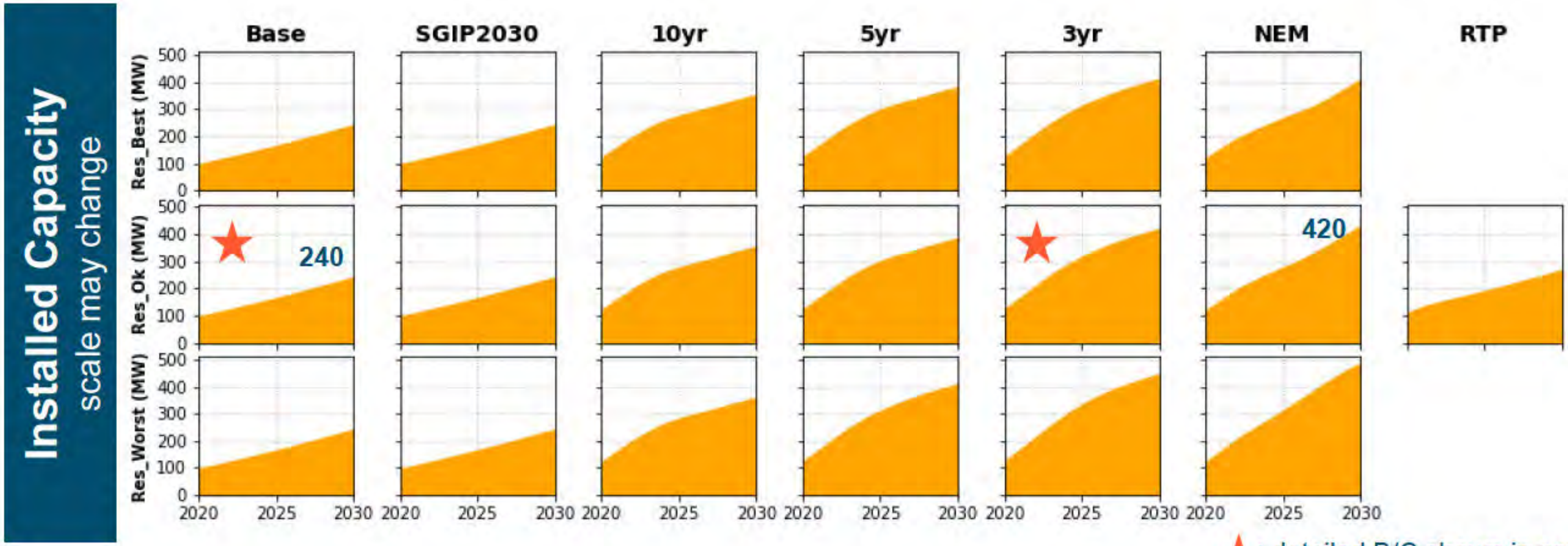
Costs & Benefits BTM PV Residential, Single Family, NC

+ **Different electricity rate scenarios have very little impact on B/C of PV**
  - cost-effectiveness follows the same trends
  - higher electricity rate leads to higher bill savings



Adoption Residential BTM PV

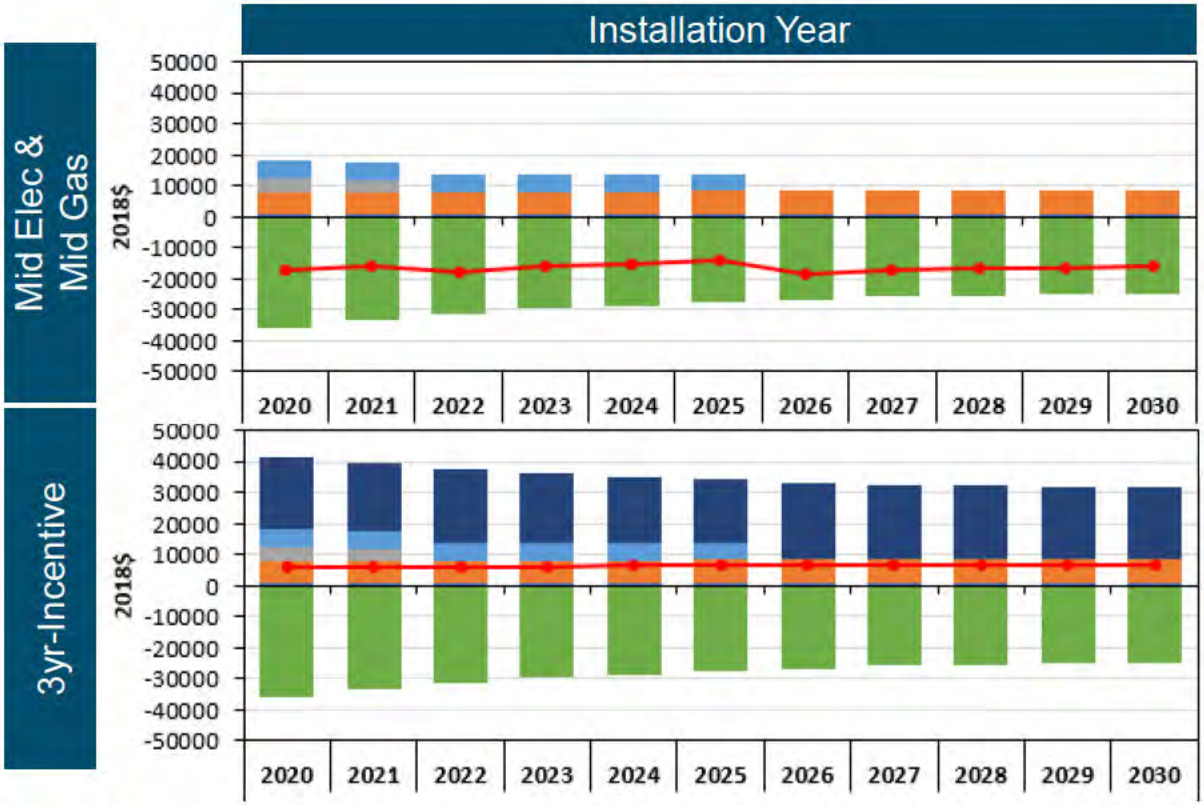
- PV is projected to increase from 96 MW to 242 MW by 2030, being installed by 27% of residential customers within SVCE service territory
- RTP could facilitate PV adoption to 268 MW by 2030, with a customer penetration of 30%
- With Target Payback Period Incentives, PV can reach up to 420 MW by 2030, with a customer penetration of 44%
- NEM could result in PV penetration of 46% by 2030



★: detailed B/C shown in previous slides

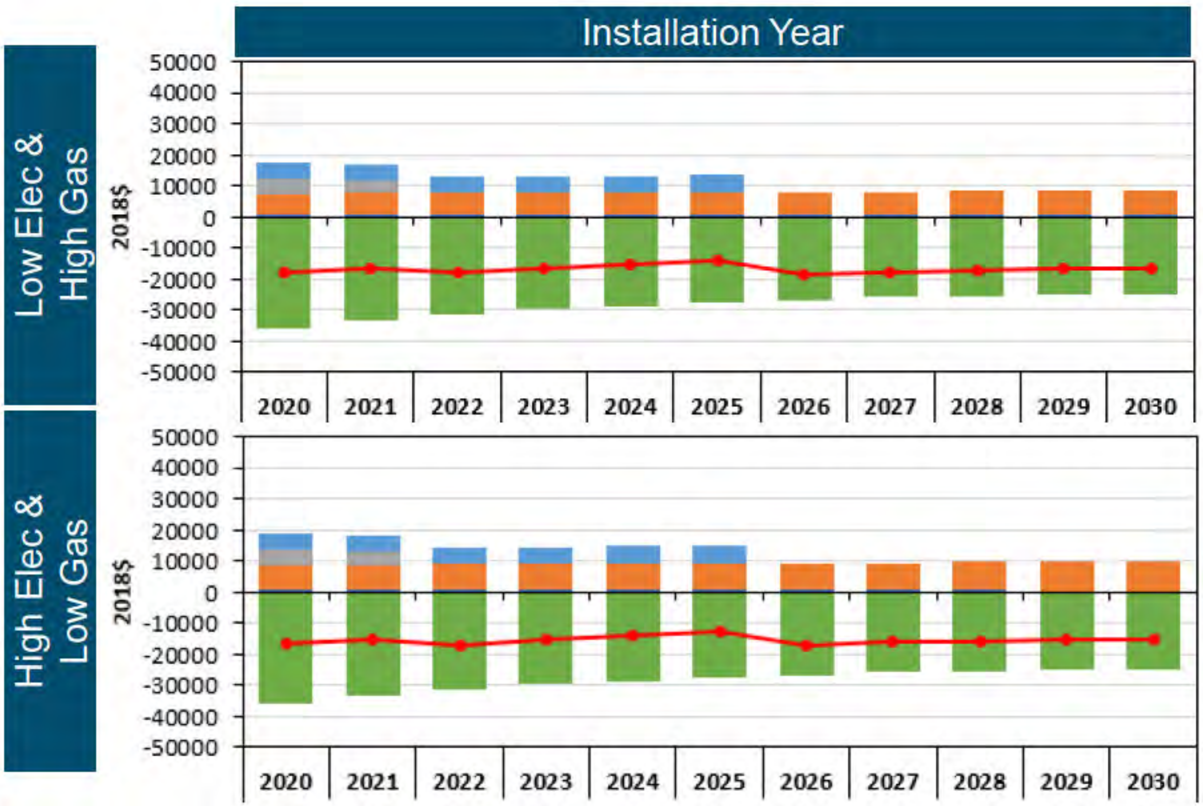
Costs & Benefits BTM Storage Residential, Single Family, NC

- Base Case: residential BTM storage is not cost-effective as the bill saving is too low when dispatching against TOU rates, and gets worse after ITC and SGIP expire
- 3-year Target Payback Period Incentive: incentive level to achieve 3-year payback target would increase due to the expiration of federal and state incentives



Costs & Benefits BTM Storage Residential, Single Family, NC

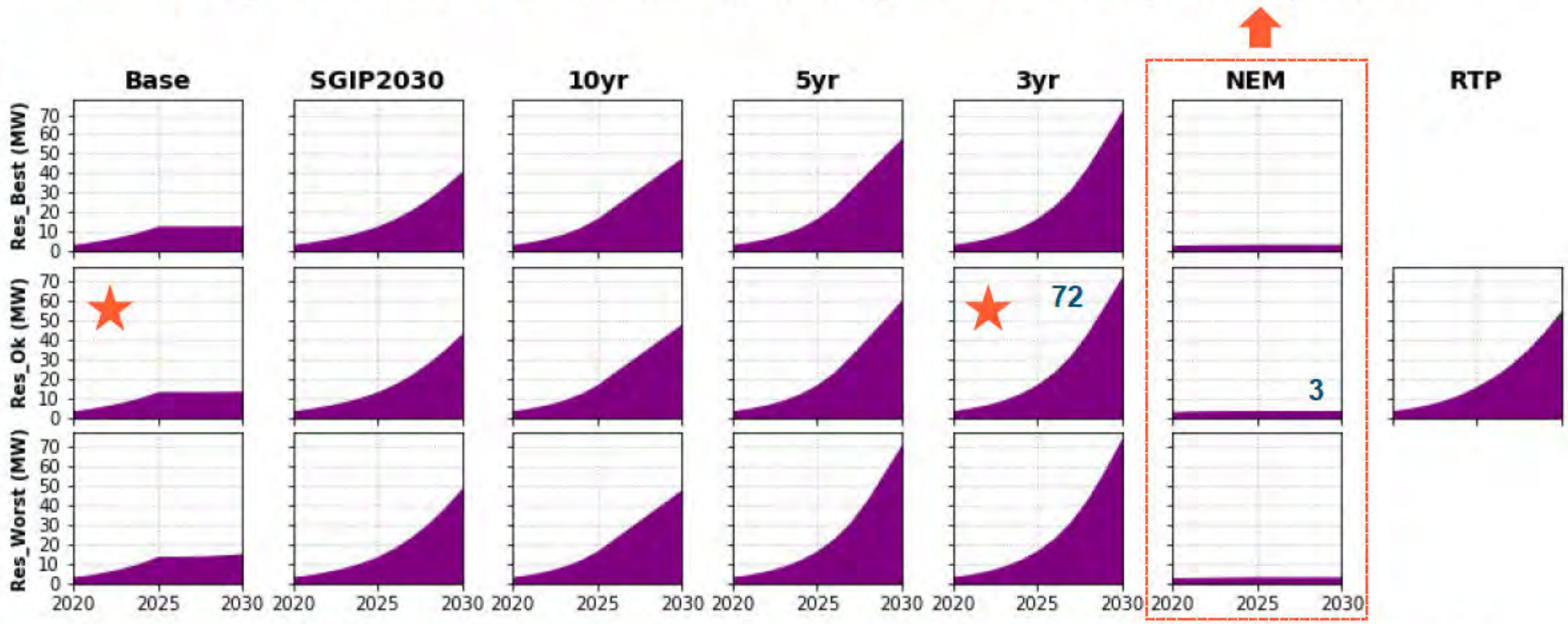
+ **Different electricity rate scenarios have very little impact on B/C of storage**
  - Cost-effectiveness follows the same trends
  - Higher electricity rate leads to higher bill savings from energy arbitrage



Adoption Residential BTM Storage

- Storage is projected to increase from 3 MW to 13 MW by 2030, but only installed by about 1% of residential customers within SVCE service territory
- RTP could result in storage penetration of 4%, 55 MW by 2030
- With utility incentives or extend SGIP, storage can reach up to 72 MW by 2030, with a customer penetration around 5%
- Under NEM, residential customers will adopt less storage out of pure economic preference as most of the energy charge saving benefits are claimed by PV under NEM, leading to only 3.2 MW adoption by 2030

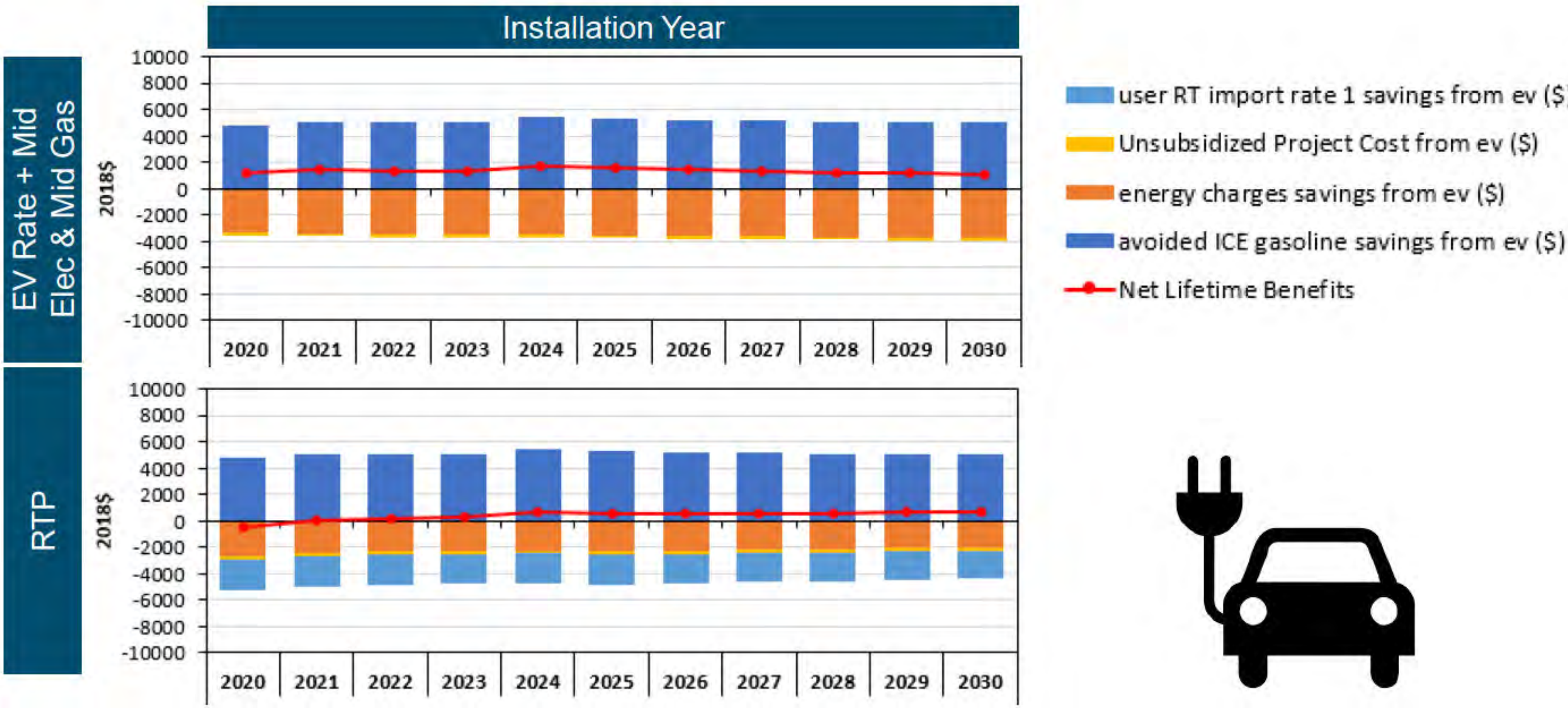
Installed Capacity
scale may change



★: detailed B/C shown in previous slides

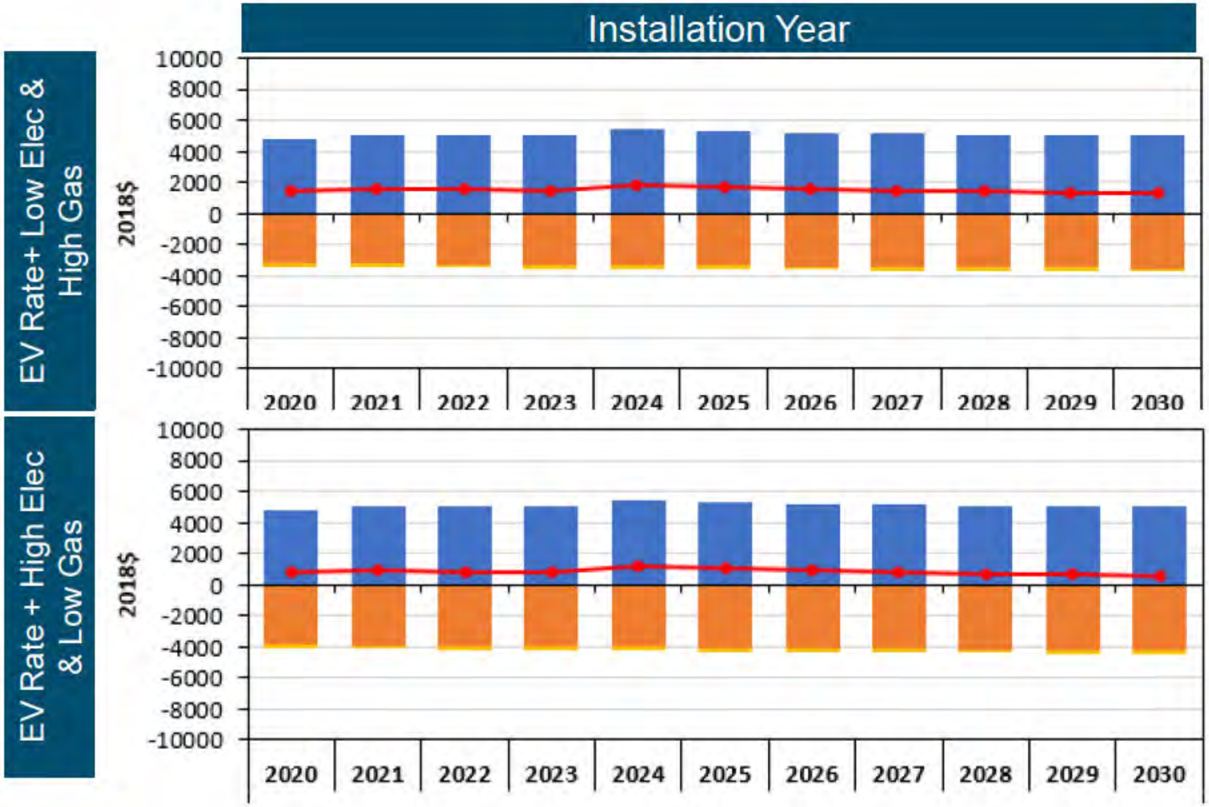
Costs & Benefits EV Residential, Single Family, NC

+ **Mid Elec & Mid Gas: Residential EV is cost-effective because of high gasoline savings**
+ **With RTP, higher charging costs makes residential EV less economic, but still cost-effective**



Costs & Benefits EV Residential, Single Family, NC

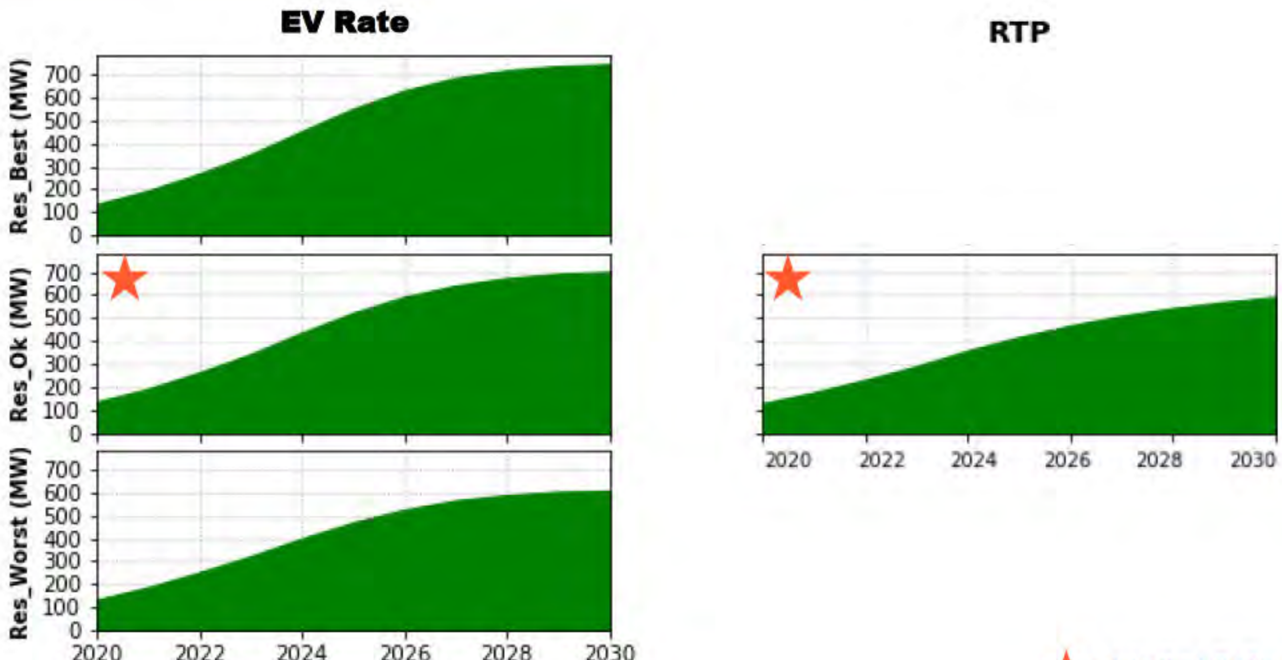
+ **Different electricity rate scenarios have very little impact on B/C of EV**
  - Cost-effectiveness follows the same trends
  - Higher electricity rate leads to higher charging costs



Adoption Residential EV (simplified)

- Simplified EV adoption analysis assuming all EVs are BEV250 with L2 chargers and same driving and charging behaviors
- EV capacity is projected to increase from 135 MW to 700 MW by 2030, being adopted by 37% of residential customers within SVCE service territory
- Under RTP, EV adoption could drop 16%, ending up around 600 MW by 2030, with a penetration of 31%

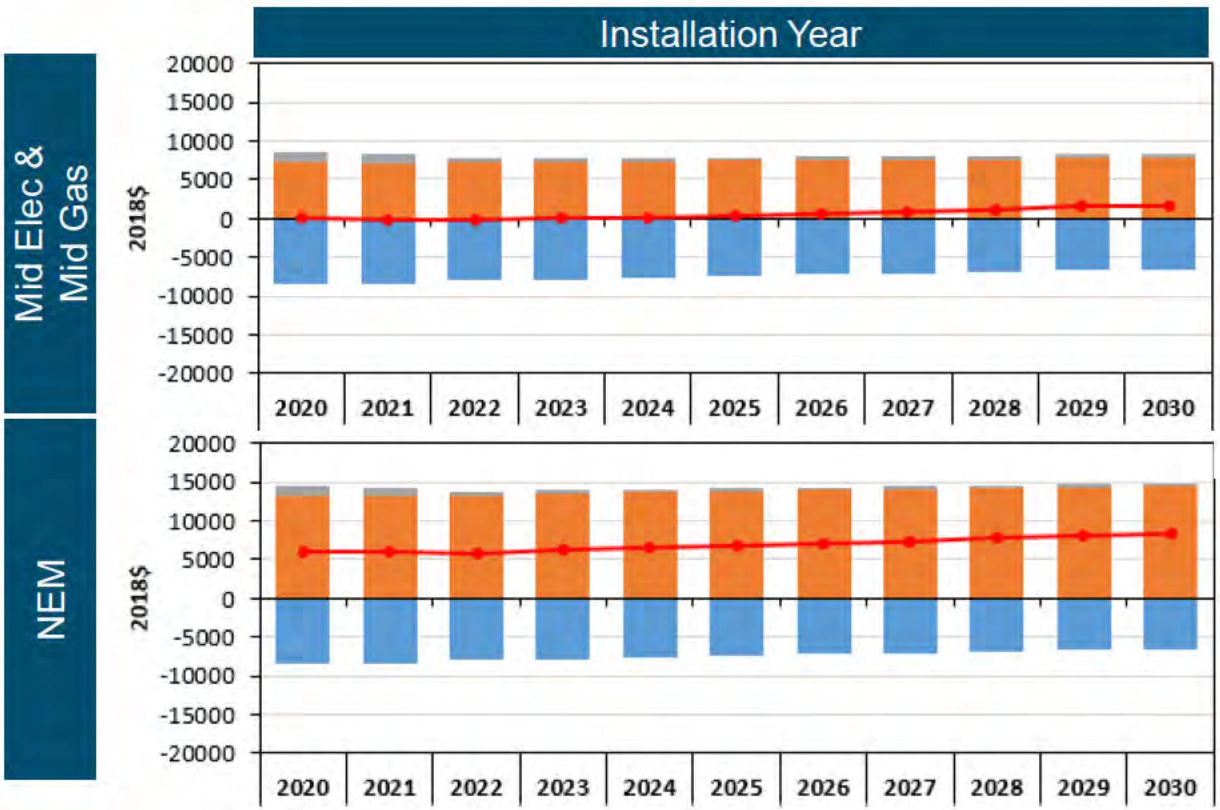
Installed Capacity
scale may change

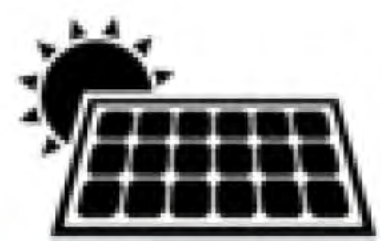


★: detailed B/C shown in previous slides

Costs & Benefits BTM PV Large Commercial, 1990s

- Mid Elec & Mid Gas - The payback period for commercial BTM PV is around its lifetime – 25 years as the net lifetime benefits is around 0
- With NEM 2.0, PV becomes very cost-effective with bill savings/revenues from selling back excess solar electricity at retail rate



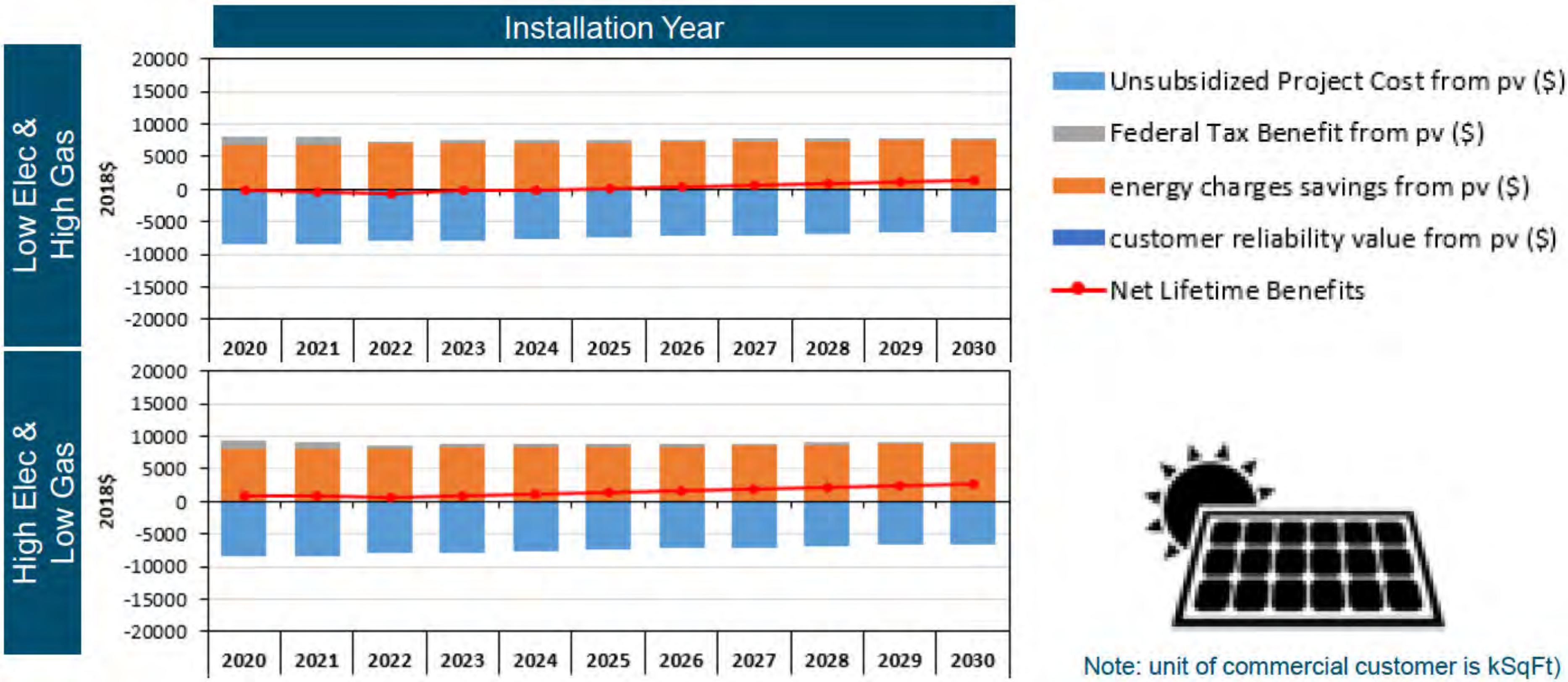


Note: unit of commercial customer is kSqFt)

Costs & Benefits BTM PV Large Commercial, 1990s

+ Different electricity rate scenarios have very little impact on B/C of PV

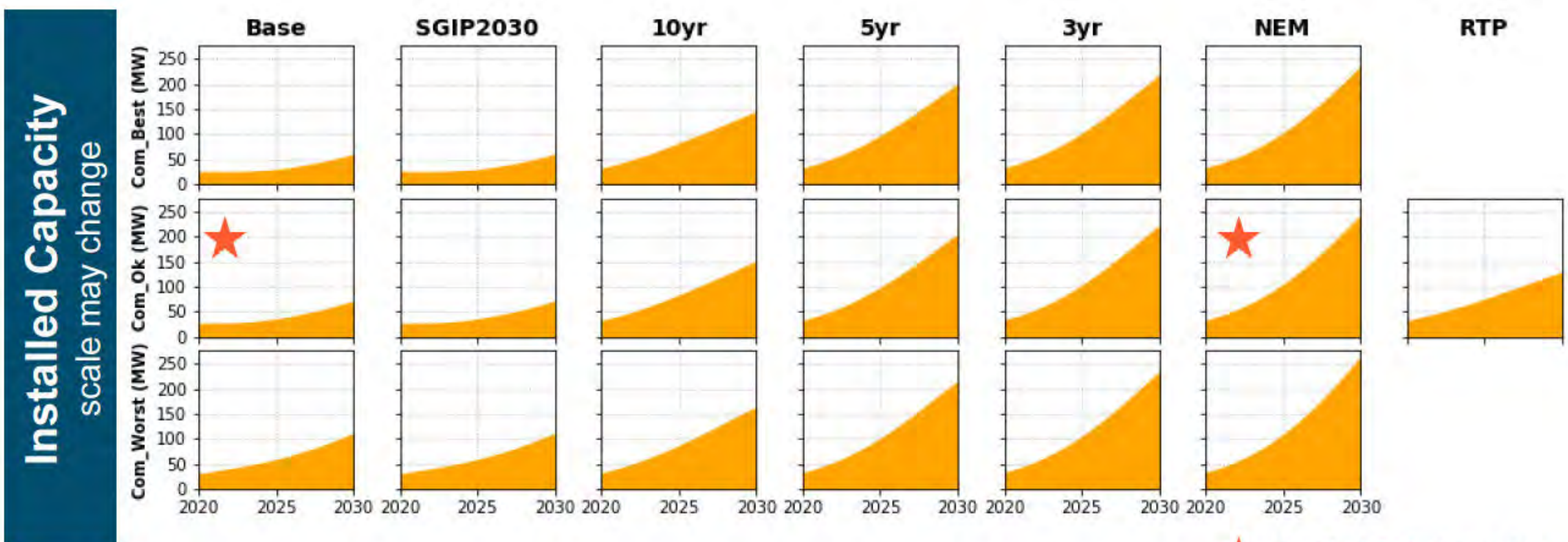
- Cost-effectiveness follows the same trends
- Higher electricity rate leads to higher bill savings



Note: unit of commercial customer is kSqFt)

Adoption Commercial BTM PV

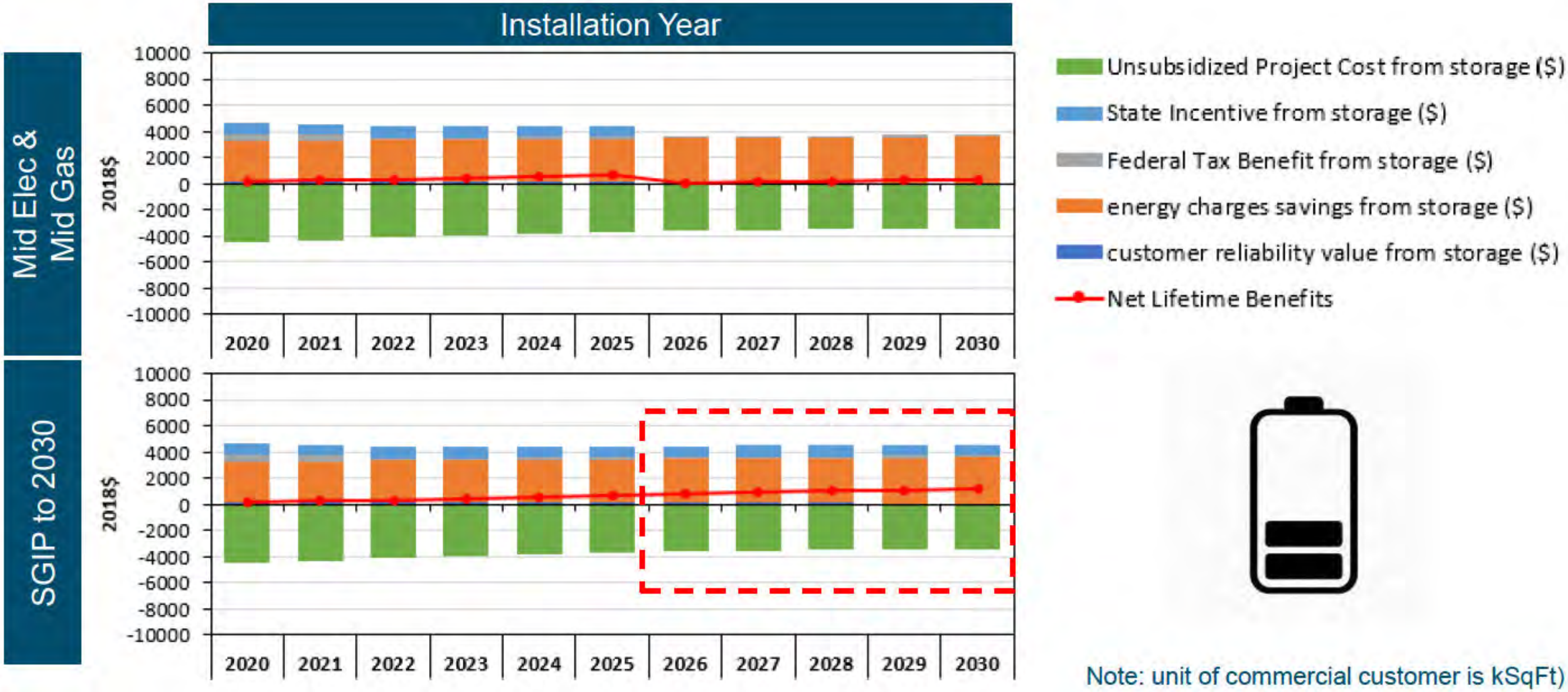
- PV is projected to increase from 25 MW to 70 MW by 2030, being installed by only 5% of commercial customers (in kSqFt) within SVCE service territory
- RTP could facilitate PV adoption to 127 MW by 2030, with a customer penetration of 9%
- With incentives, PV can reach up to 221 MW by 2030, with a customer penetration of 16%
- NEM could result in PV penetration of 17% by 2030



★: detailed B/C shown in previous slides

Costs & Benefits BTM Storage Large Commercial, 1990s

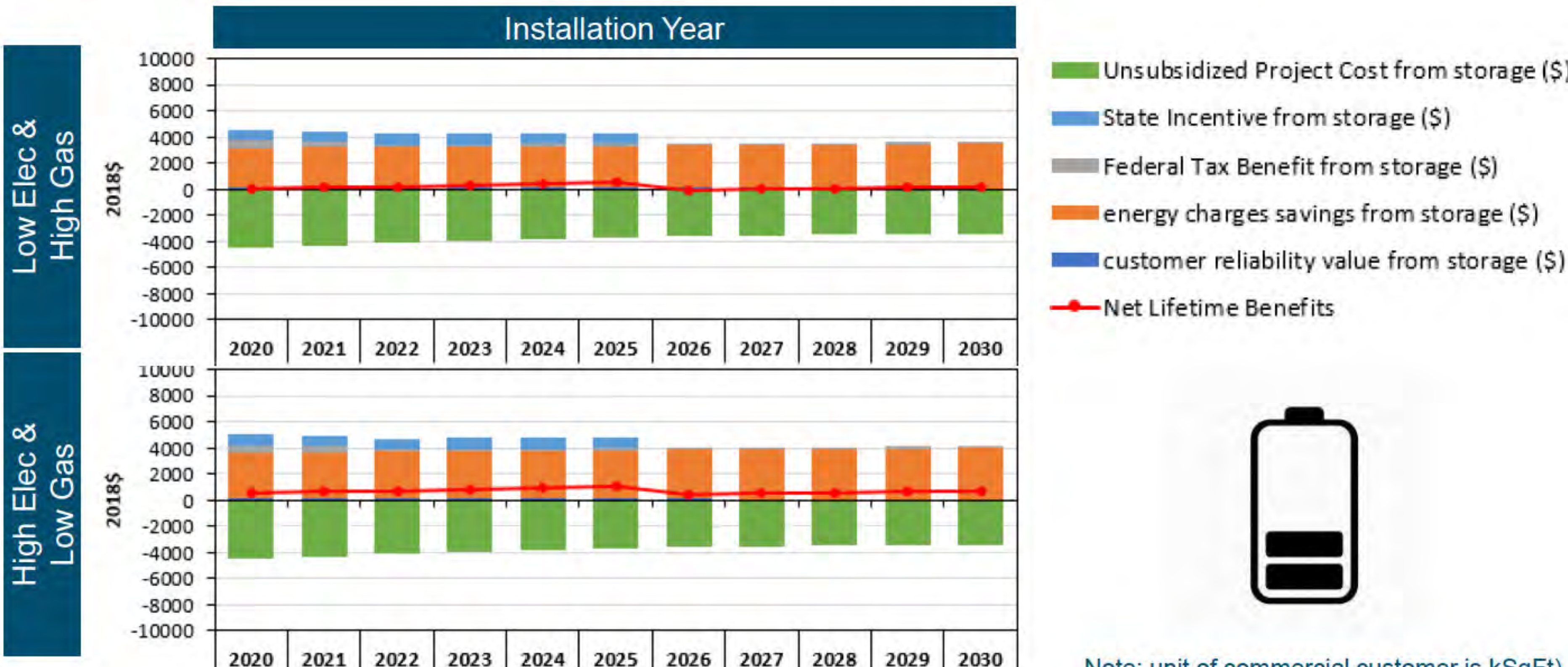
- Base Case, commercial BTM storage is slightly cost-effective with lower capital costs compared with residential and long-lasting ITC tax benefits
- With SGIP extended to 2030, B/C ratio of installing BTM storage after 2026 improves



Note: unit of commercial customer is kSqFt)

Costs & Benefits BTM Storage Large Commercial, 1990s

+ **Different electricity rate scenarios have very little impact on B/C of storage**
  - Cost-effectiveness follows the same trends
  - Higher electricity rate leads to higher bill savings from energy arbitrage

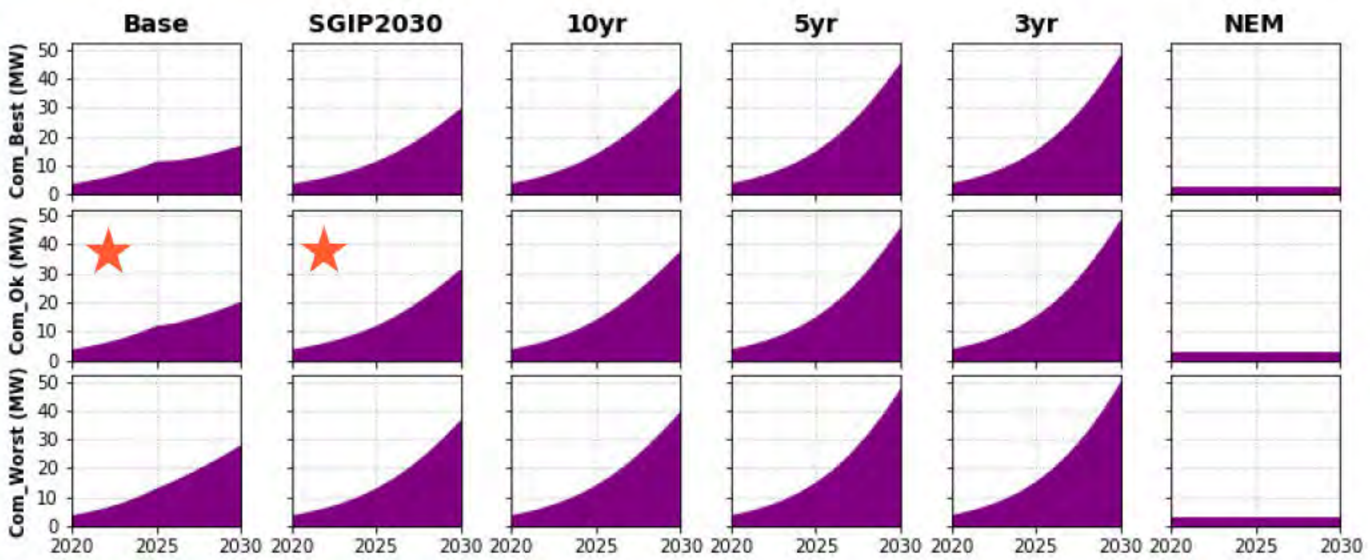


Note: unit of commercial customer is kSqFt)

Adoption Commercial BTM Storage

- Storage is projected to increase from 3.7 MW to 20 MW by 2030, being installed by only 3.3% of commercial customers (kSqFt) within SVCE service territory
- Extended SGIP could facilitate storage adoption to 32 MW by 2030, penetrating 5.2% of customers
- With utility incentives or RTP, storage can reach up to 49 MW by 2030, with a customer penetration around 8%
- No adoption happened under NEM

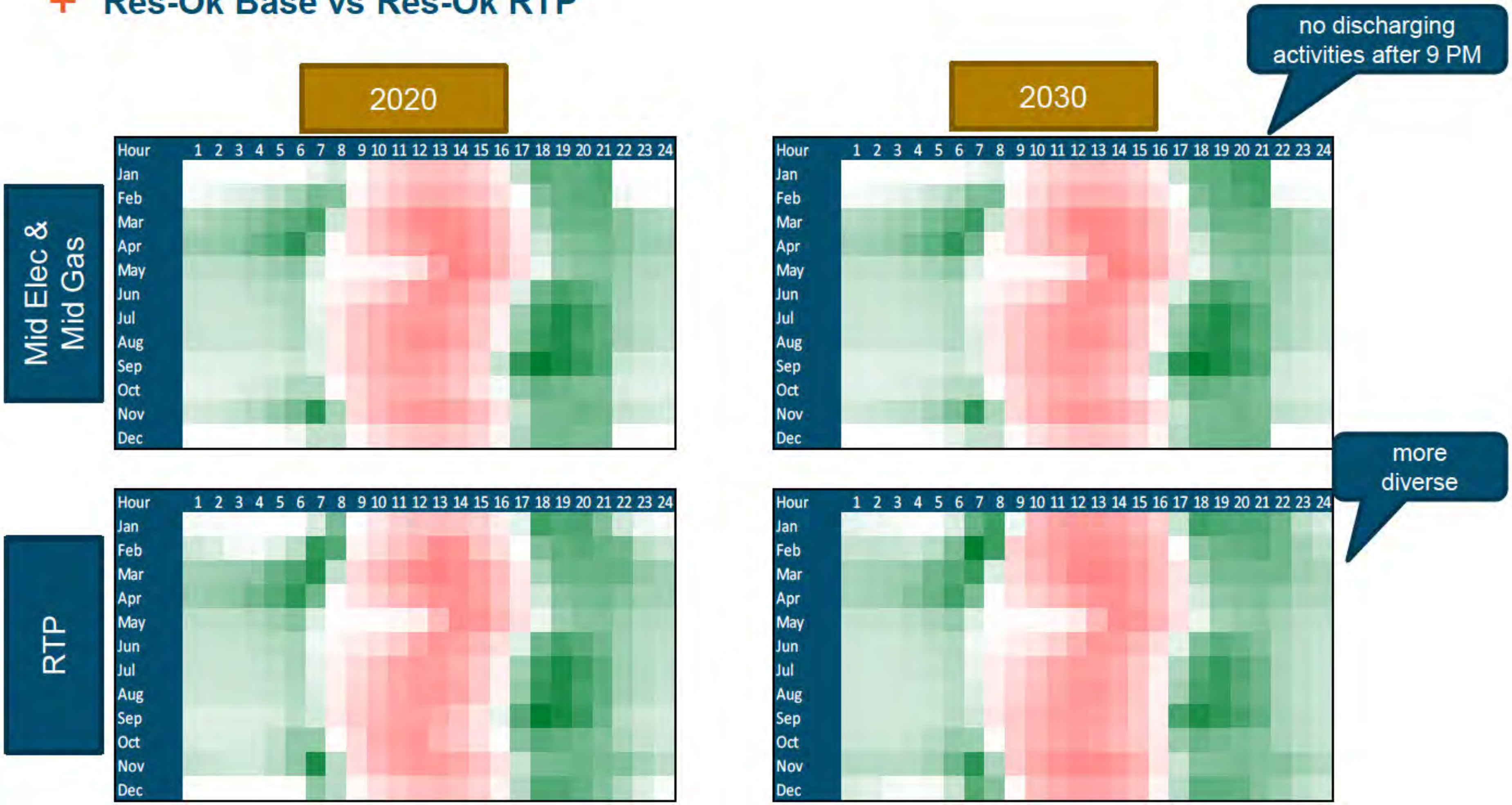
Installed Capacity scale may change



★: detailed B/C shown in previous slides

Load Impact Residential BTM Storage

+ Residential storage dispatch
+ Res-Ok Base vs Res-Ok RTP



Energy+Environmental Economics

Key Takeaways

DER Key Takeaways

+ **Rate scenarios have minor impacts on cost-effectiveness of DER adoption for both residential and commercial customers over the modeling horizon**
  - Higher rate would encourage PV and storage adoption, as it increases bill savings/energy charge revenue
  - Higher rate would, in opposite, inhibits EV adoption (assume only allow V1G) because of higher charging costs

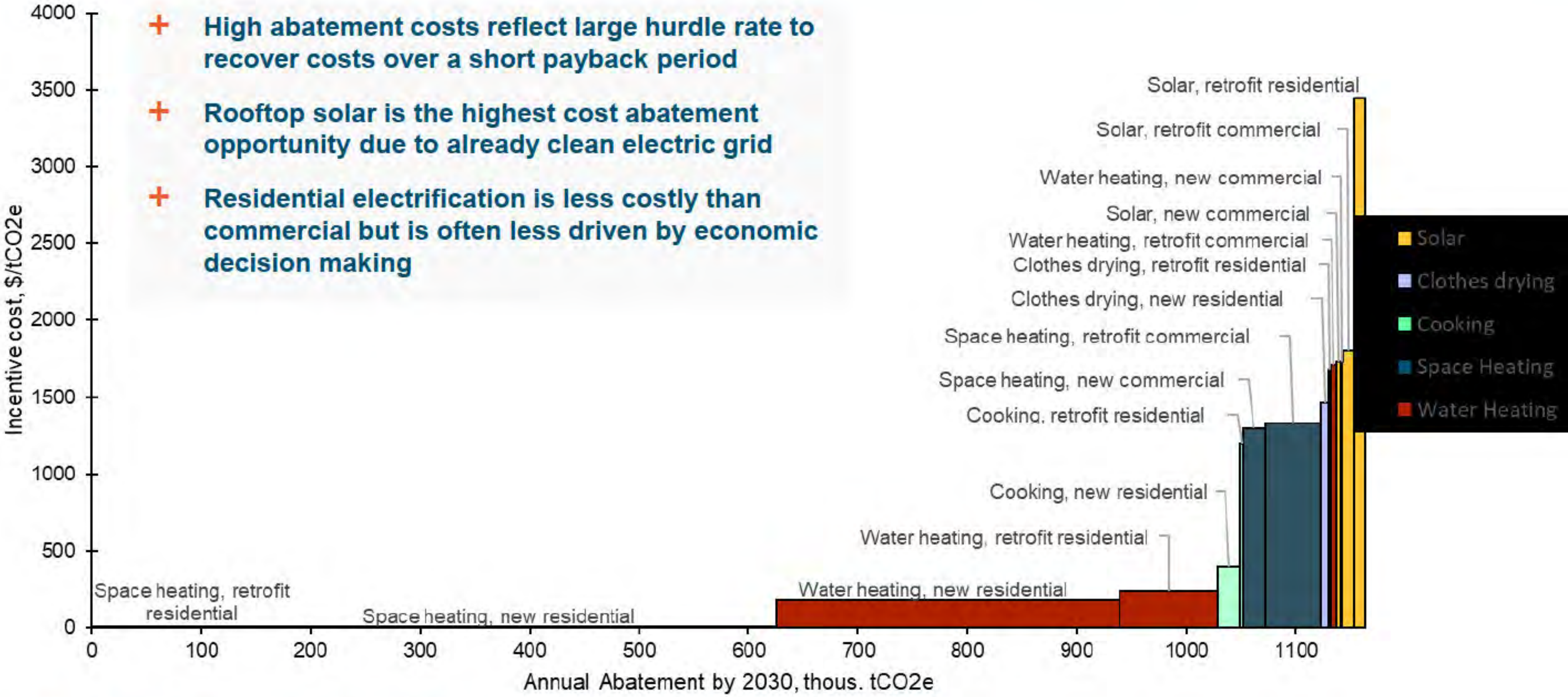
+ **Sensitivities, including federal, state, and utility incentives, as well as various rate structures, could have noticeable impacts on customer's economics**

Building Electrification Key Takeaways

+ **SVCE has near-term opportunities for building electrification**
  - **Heat pump HVAC in replacement of gas furnace + AC**
    - Customers can save costs today!
    - SVCE could focus on consumer education, workforce training and providing incentives to contractors to better market heat pump technology
  - **New construction**
    - Customers can save costs on all-electric new construction today!
    - SVCE could work with local government on reach code
  - **Heat pump water heater (HPWH)**
    - HPWHs are cheaper than gas tankless water heaters, but still more expensive than gas storage water heaters.
    - SVCE could provide incentives to bring down capital costs and encourage market transformation
+ **Building electrification will increase winter peaks and likely decrease summer peaks of SVCE**
  - Our results show that both space heating and water heating will be contributing to the increasing winter peaks.
  - Further study is needed to understand the grid impact (whether the system will be shifting to winter peaking).

Residential space and water heating electrification lead in building decarbonization

- High abatement costs reflect large hurdle rate to recover costs over a short payback period
- Rooftop solar is the highest cost abatement opportunity due to already clean electric grid
- Residential electrification is less costly than commercial but is often less driven by economic decision making



- X-axis represents annual abatement of equipment adopted by 2030
- Y-axis represents levelized abatement costs through the lifetime of the equipment to incent adoption assuming a 5-year payback and mid rates.
- Approximate GHG abatement calculated through annual average emissions factors

Further Research Needed

- **Non-economic factors driving consumer adoption** – The analysis provides an economic adoption forecast with some additional reductions made to better reflect market adoption via the adoption curve assumptions. However, more accurate non-economic inputs to better reflect SVCE's customers (e.g. a tailored adoption curve) would provide a more accurate forecast.
- **Impacts to 2045/2050** – The analysis covers adoption to 2030, but further analysis is required to look at the critical climate goal years of 2045 and 2050.
- **Increased AC need/adoption** – AC penetration was assumed to mimic that of the state and to remain constant, however we expect to see increased AC penetration due to the effects from climate change. This will change the economics of the technologies analyzed.
- **GHG emissions impacts** – Additional analysis is required to understand the GHG emissions impacts of each of the scenarios/sensitivities.
- **Air quality impacts** – Additional analysis is required to understand the air quality impacts of each of the scenarios/sensitivities.
- **Coupling sensitivities** – For this analysis, each sensitivity and technology (ex solar + storage) was analyzed independently. Further research is required to understand the implications of layering interventions.
- **Detailed EV adoption** – A simplified EV adoption analysis was conducted for this analysis. Further research is required to include all technology types and driving behaviors.
- **Storage for reliability** – This analysis analyzed economic storage adoption, but further analysis is required to understand storage adoption for reliability.

Appendix

Payback Period and Internal Rate of Return

+ A targeted payback period can be converted into an internal rate of return (IRR) by considering all the post-incentive benefits and costs over the lifetime of an appliance.
+ Appliances with different lifetime have different IRR even with the same targeted payback period.
+ Below is a conversion between the targeted payback modeled in this study and IRR equivalents for all appliances.

Payback (Year)	IRR Equivalent	
	HVAC	Water Heater, Clothes Dryer and Cookstove
3	40%	39%
5	25%	23%
10	12%	9%

Based on 5% real discount rate

Literature on Bass Diffusion Residential EE Consumer Adoption

+ **"Technology forecasting for residential energy management devices". Daim, Iskin, and Ho (2011).**
    - Creates scenarios of consumer adoption using data from Mahajan (2000)
+ **"Modelling intervention options to reduce GHG emissions in housing stock – A diffusion approach." Higgins, Foliente, and McNamara (2011).**
    - a case study of seven suburbs in Brisbane, Australia, comprising of 25,000 houses/units with a mixture of demographics, new and old suburbs.
+ ***New-Product Diffusion Models*, Mahajan, V., Muller, E. and Wind, Y. (2000).**
    - p and q data is based on empirical observation of appliance adoption collected in the years from 1921 to 1996; the average study period was about ten years
+ **"A Study on Economic Analysis Corresponding to Enhancement of Energy Efficiency for Residential Air Conditioners". Lee, Baek, and Won (2009).**

Stock Rollover – Decision-Makers

- **The stock rollover model estimates the number of consumer decision-makers in each year:**
  - **New home builds:** All incremental 2019- vintage housing is considered as a new build and utilizes new build decision inputs.
    - Example: If post-2019 vintage homes rise from 100 to 120 between 2020 and 2021, all 20 incremental homes will decide between gas and electric using new build economics.
    - This is only performed for new homes, all of which are post-2019 vintage.
  - **Retrofits:** Retrofit decision-makers are equivalent to the estimated number of appliance failures in each pool. This is represented as the number of remaining non-electrified customers divided by the appliance lifetime.
    - Example: If there are 100 non-electrified pre-1978 homes in 2020 and HPWH lifetimes are estimated at 25 years, 4 customers will decide between gas and electric using retrofit economics.
    - This is performed for all vintages.

PATHWAYS Residential Building Stock & Rollover in High Electrification Scenario

Table 2-1. Share of low-rise residential existing housing (as of 2020) assumed by climate zone and utility in the modeled study area

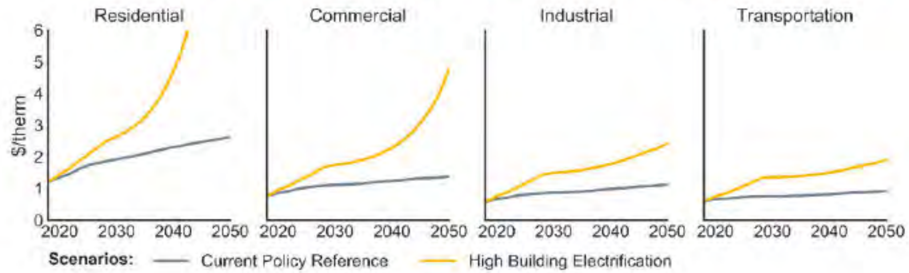
Climate Zone	Major City	Utility	Retrofits	
			Single Family	Low-rise Multifamily
CZ03	San Francisco	PG&E	17%	4%
CZ04	San Jose	PG&E	8%	2%
CZ12	Sacramento	SMUD	7%	2%
CZ06	Coastal LA	SCE	10%	3%
CZ06	Coastal LA	LADWP	2%	1%
CZ09	Downtown LA	SCE	12%	3%
CZ09	Downtown LA	LADWP	13%	3%
CZ10	Riverside	SCE	11%	3%
		Total	**80%**	**20%**

Table 2-2. Share of low-rise residential new construction housing (as of 2020) assumed by climate zone and utility in the modeled study area

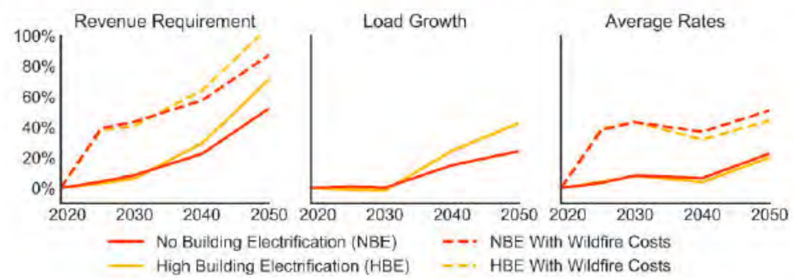
Climate Zone	Major City	Utility	New Construction	
			Single Family	Low-rise Multifamily
CZ03	San Francisco	PG&E	14%	9%
CZ04	San Jose	PG&E	6%	4%
CZ12	Sacramento	SMUD	6%	4%
CZ06	Coastal LA	SCE	7%	5%
CZ06	Coastal LA	LADWP	1%	1%
CZ09	Downtown LA	SCE	8%	5%
CZ09	Downtown LA	LADWP	9%	6%
CZ10	Riverside	SCE	9%	6%
		Total	**61%**	**39%**

Reference Rate Scenario Tables

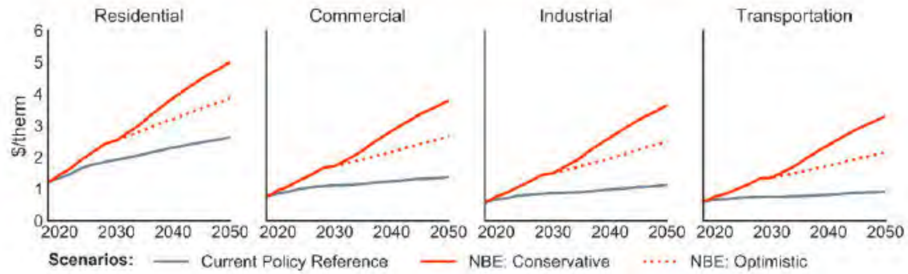
Gas Rates by Sector in the High Building Electrification Scenario



Percentage Increase in Electric Sector Revenue Requirement, On-Grid Loads and Average Rates



Gas Rates by Sector in the No Building Electrification Scenario



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Building Electrification Adoption Assumptions

Special Considerations

- For HVAC and water heating, we assume that **all electric resistance** appliances will be replaced by heat pumps upon burnt-out due to much more favorable consumer economics
- **Homes with air conditioning (AC) and those without AC are modeled separately for heat pump HVAC adoption**
  - We assume that homes without AC will not consider heat pump HVACs because they are much more expensive than a counterfactual of gas furnace only.
  - The following AC share is applied to each modeled home type:

Single Family Detached	Townhouse Duplex or Row House	Apartment or Condo (2-4 Units)	Apartment or Condo (5+ Units)
60%	68%	48%	72%

Derived from the 2009 California Residential Appliance Saturation Study (RASS) for the entire building climate zone 4.

  - CAVEAT: more homeowners will consider installing space cooling even though their houses currently do not have AC. This could be due to the rising temperature and more frequent heat waves in summer as a result of climate change, or rising living standard and income level that makes AC more affordable for more homeowners in SVCE's service territory.

Homeowners vs. Landlord-Tenant

- **Homeowners are modeled to consider both capital costs and bills when making decision based on payback period**
- **In the landlord-tenant case, we assume that a landlord will make decision based on capital cost only**
  - Utility bills are usually paid by renters and thus are not factored in landlord's decision
- **We applied the following share of renting homes by home type for SVCE's service territory**

	Single-family	Multi-family
Owner	77%	73%
Renter	23%	27%

Derived from the American Community Survey 2018 for SVCE's service territory

Equipment Lifetime Assumptions & Discount Rate

	Equipment lifetime
Heat Pump	18
Gas Fired Furnace	
Central AC	
Gas Water Heater	13
Heat Pump Water Heater	13
Cookstove	12
Clothes Dryer	13
All-Electric Home / Building	30

Data source: EIA Annual Energy Outlook 2019

+ Discount rate:
  - 5% for the residential sector, and 7% for the commercial sector
  - Benchmarked to industry standard practice based on commonly used residential nominal discount rate of 7%, and commonly used unleveraged discount rate of 6-12% for commercial real estate.
+ Benchmarked to industry standard practice based on commonly used unleveraged discount rate (6-12%) for commercial real estate.
+ Assume one lifetime for HVAC systems to simplify lifecycle cost calculations
+ Assume 30-year lifetime for all-electric homes and buildings, assuming houses will remain all-electric. CEC T24 uses 30-year lifetime to evaluate cost-effectiveness of residential building code.

Energy+Environmental Economics

DER Adoption Assumptions

DER Adoption Assumptions

+ DER Adoption

- **PV & storage sizing:** might oversize MFH customer's installed capacity
- **Customer Load Profiles**: fixed customer load profiles over the entire modeling horizon without load growth for each representative customers
- **SGIP**: took a simplified approach SGIP incentives to represent its average effects considering various types of customers
- **CA PV mandate**: assume all new homes built in 2019 will also comply with CA PV mandate for modeling simplicity
- **EV**: EV analysis focuses more on the impacts of different factors (rates, incentives, etc) on EV adoption with less robust modeling assumptions due to the budget constraint. For IRP impact shapes, we would recommend use IEPR forecast with NREL EV charging load.
- **Customer Reliability**: this study assumes 10 $/kWh VoLL for both residential and commercial customers as it's not focused on reliability-driven adoption. Cost-effectiveness of commercial PV and storage might be dominated by customer reliability if we apply assumptions from ICE (Interruption Cost Estimates from NREL)
- **Adoption**: this study assumes all customers are eligible for adopting PV, EV, and storage because of data availability issue
- **Home Ownership**: RESTORE/IDSM does not differentiate renters/home-owners

Payback Period and Internal Rate of Return

+ A targeted discounted payback period can be converted into an internal rate of return (IRR) by considering all the post-incentive benefits and costs over the lifetime of DER.
+ DER technologies with different lifetime have different IRR even with the same targeted payback period.
+ Below is a conversion between the targeted payback modeled in this study and IRR equivalents for all appliances.

	IRR Equivalent	
Discounted Payback (Year)	PV	Storage
3	43%	40%
5	28%	23%
10	16%	7%

Based on 7% real discount rate for PV and storage

DER Adoption Assumptions - Data

+ California Bulk System

- avoided cost: PG&E Climate Zone 04 (PGE-CZ04) from 2019 CPUC Avoided Cost Calculator
- only used in sensitivity analysis for real-time pricing (RTP)

+ Distribution System

- distribution system data including peak deferral value and corresponding distribution upgrade costs are not used in this consumer adoption analysis because customers are usually not able to claim this benefit

+ Utility Tariff

- rate scenarios: the same as building electrification analysis
- rate escalation: assume 3% annual rate escalation for all rate scenarios except RTP to account for inflation and rate increase
- RTP: include avoided system capacity, energy, emissions, RPS, ancillary services, and PCIA and T&D costs

DER Adoption Assumptions - Data

+ Customer

- Customer Load Profiles
  - residential:
  - commercial:
- Customer Reliability
  - normal-level VoLL for both residential and commercial customers– 10 $/kWh

+ DER Technology

- DG PV
  - characteristics: fixed normalized PV shapes and PV characteristics from 2018 CPUC Avoided Cost Calculator
  - costs: E3 2020 internal resource cost pro forma analysis
  - sizes: assume both residential and commercial customer size their PV capacity to cover 100% of annual electricity consumption (net-zero on-site electricity consumption)
  - lifetime: 25 years

DER Adoption Assumptions - Data

+ DER Technology

- Energy Storage
  - characteristics: E3 generic storage inputs for BTM 10kW-4h battery storage
  - costs: E3 2020 internal resource cost pro forma analysis
  - sizes: assume both residential and commercial customer size their storage capacity to their annual peak demand to comply with ITC and/or SGIP requirements, and their storage energy to ensure 4-hour duration
  - lifetime: 10 years
  - SGIP incentives: incentive rates may vary by sizes and duration for every single customer. Initial results show that typical residential storage is <= 10kW/customer and commercial storage is within 5-150 kW/customer, which means the majority of residential and commercial customers will not go above 500 kW. In this case E3 has taken a simplified approach to apply averaged incentive rates to residential and commercial customers respectively (values below have accounted for all incentive discounts):

Incentive Rates ($/Wh) when < 500 kW Assuming 0-4 hour battery operating 0-2 MWh Expire after 2025	
Residential <= 10 kW	0.26
Large > 10 kW when claiming ITC	0.20
Large > 10 kW	0.26

used for residential storage

used for commercial storage

DER Adoption Assumptions - Data

+ DER Technology

- Electric Vehicles (EV)
  - characteristics: E3 generic BEV250 inputs based on NREL EVI-Pro Lite Tool
  - costs: assume EV has 0 incremental cost compared with equivalent ICE vehicle. It's because 1) EV incentive; 2) although the average cost of EV is higher than equivalent ICE, customers will not have additional budget when choosing between EV and equivalent ICE, not to mention
  - sizes: assume residential customer only adopt one BEV250 per customer, and commercial customer only adopt one BEV250 per kSqFt
  - lifetime: 10 years
  - driving behavior & charging availability: compiled from NHTS database
  - charging behavior: managed charging (V1G) with L2 chargers. The tool will determine the optimal charging schedule based on rates
  - customer reliability is 0 as EV could not serve as energy sources under managed charging (V1G)
  - **As we discussed before, the EV consumer adoption analysis focuses more on the impacts of different factors (rates, incentives, etc) on EV adoption. For IRP impact shapes, we would recommend use IEPR forecast with NREL EV charging load at this moment**

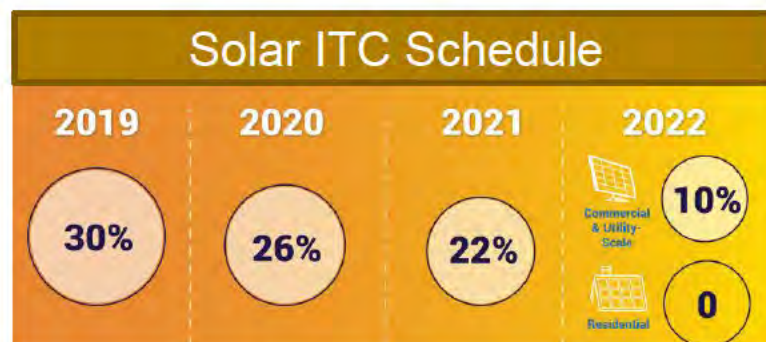
DER Adoption Assumptions - Data

+ Financing Assumptions

- California-base-BTM (default data in CEC Solar + Storage Tool)
  - financing options: third party leasing as we assume BTM customers are more likely to purchase from a third party.
  - Third-party lease fee is the payment that an operator who is leasing a DER portfolio must pay to a third party for the right to operate the fleet of technologies. The third-party lease fee is also displayed as the project cost and can be thought of the cost to operate the group of DER's if the user does not own the devices.
  - Note: customer discount rate: 9%

Basic Financing Parameters

Attribute	Value
Inflation rate	2.00%
Nominal utility discount rate	7.00%
Nominal societal discount rate	3.00%
Financing Option	third_party_lease_fee
Percent upfront state incentive for storage > 30 kW	50%
Property Tax	1%
Federal Tax Rate	21.00%
State Tax Rate	8.84%
Debt interest rate	8%
Weighted Average Cost of Capital	11.00%
Third Party Lease Escalator	0%

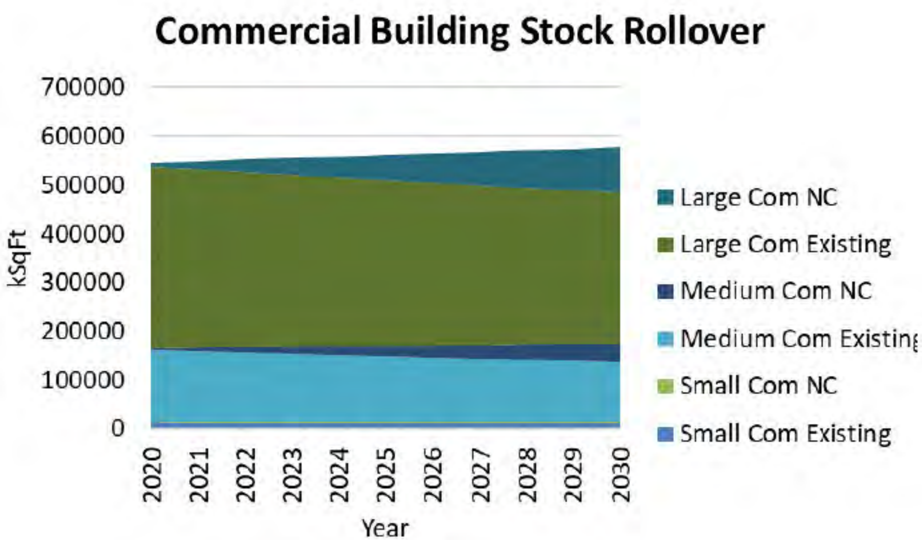


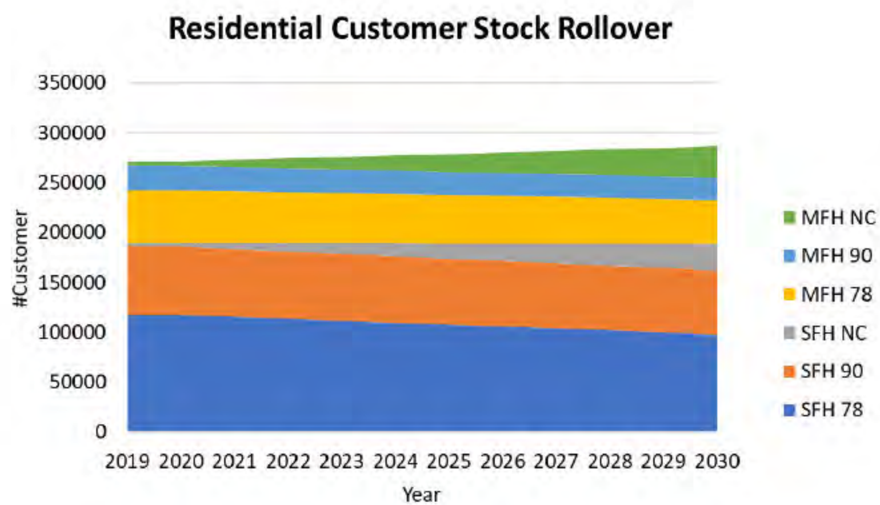
solar ITC schedule chart: https://www.seia.org/initiatives/solar-investment-tax-credit-itc

DER Adoption Assumptions - Data

+ Adoption Parameters

- Technical Potential
  - assume both residential and commercial customer have full technical potential for PV, storage, and EV
  - residential: equal to total customer number based on the customer segmentation from SVCE customer data, adjusted by building stock rollover
  - commercial: equal to total kSqFt, adjusted by building stock rollover

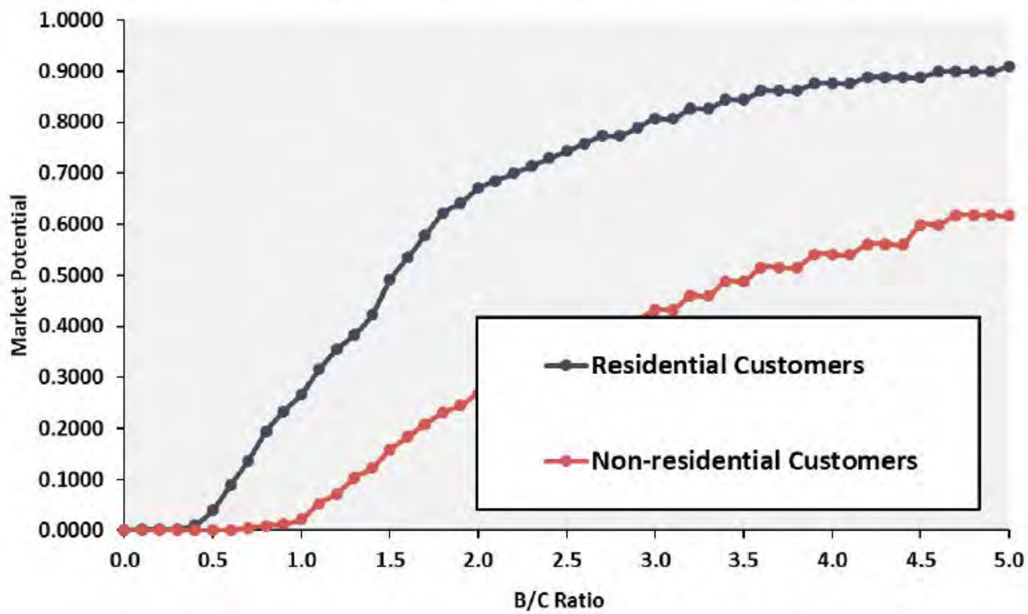




DER Adoption Assumptions - Data

+ Adoption Parameters

- Achievable Market Curve
  - The achievable market curve and bass diffusion curve reflect the customers' willingness-to-pay and the rate of market adoption changes for a certain product in a certain region. Both parameters for achievable market and bass diffusion curves used in this study is based on the analysis done worldwide.
  - the curve is from this report (page 10) by converting payback period to B/C ratio assuming the simple payback assuming a 10-year project lifetime as a proxy

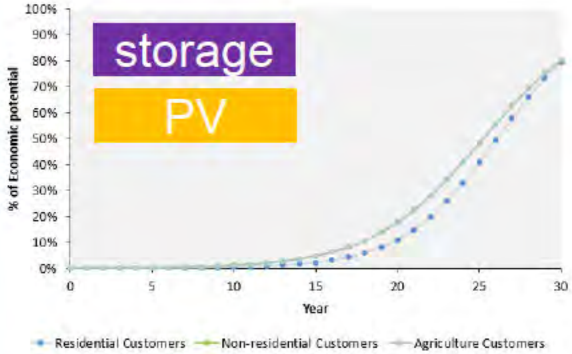


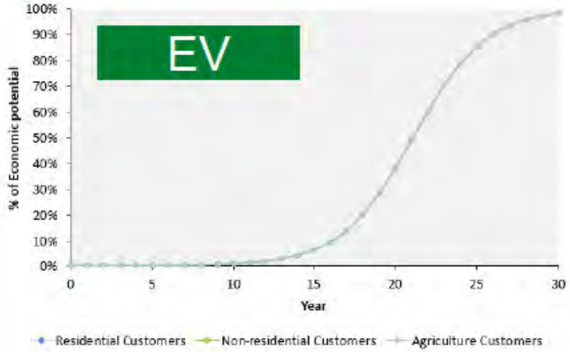
DER Adoption Assumptions - Data

+ Adoption Parameters

- Bass Diffusion Curve

Technology	Scenario	Customer Type	Innovation parameter: p	Imitation parameter: q	Sources & Notes
PV & Storage	Less Favorable	Domestic	0.0000039	0.332	**Source:** Sigrin (2016): The Distributed Generation Market Demand Model (dGen): Documentation **Notes:** p, q numbers for three scenarios are based on the p, q number studied for the state of Idaho, Oregon, and New York in the U.S. Three states have similar PV capacity factor as Delhi and have varies renewable policy to reflect a less, moderately, and more aggressive renewable policy support
		Non-domestic	0.000033	0.243	
	Moderately Favorable	Domestic	0.000044	0.344	
		Non-domestic	0.00018	0.293	
	High Favorable	Domestic	0.00000035	0.739	
		Non-domestic	0.000022	0.518	
EV	All	All	0.0000365	0.447	**Source:** Li, G.. (nd). Power forecasting for plug-in electric vehicles with statistic simulations. **Notes:** E3 compares EV adoption studies from multiple academic papers, and pick the parameters that reflects the similar adoption pattern as forecasted by different groups (Energy Policy Simulator, BNEF, Navigant, Barclays, Edison Electric Institute, and AEO)





DER Adoption Assumptions - Data

+ Adoption Parameters

- Baseline Adoption
  - residential: based on Task 1 results, rematch to E3 customer segmentation, assume EV only includes L2
  - commercial: based on Task 1 results and customer average kSqFt information from SVCE customer data, rematch to E3 customer segmentation
  - assume all new homes built in 2019 will also comply with CA PV mandate for modeling simplicity (see Policy Assumptions section)

Residential, in #customer

Building Type	Vintaga	PV	Storage	EV
SFH	78	10525	232	7625
SFH	90	7670	197	5468
SFH	NC	2024	0	0
MFH	78	93	2	640
MFH	90	34	0	345
MFH	NC	2356	0	0

Commercial, in kSqFt

Building Type	Vintaga	PV	Storage	EV
SCOM	Existing	69	2	0
SCOM	NC	0	0	0
MCOM	Existing	1429	70	0
MCOM	NC	0	0	0
LCOM	Existing	8602	2670	0
LCOM	NC	0	0	0

DER Adoption Assumptions - Data

+ Policy Assumptions

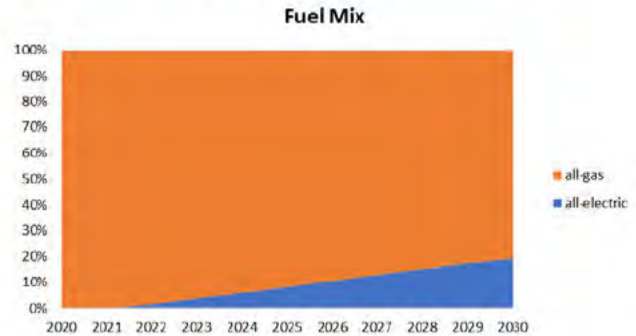
- California PV Mandate
  - this analysis fixes annual adoption of SFH-NC and MFH-NC customer to be equal to the annual increase of #customer starting from 2020 to represent the fact that all new homes will comply with CA PV mandate
  - also assume all new homes built in 2019 will comply with CA PV Mandate for modeling simplicity
- ITC & SGIP Compliance
  - assume that only the customers who adopt PV will consider adopting storage in order to get ITC and SGIP incentives. In this case, PV is included in the customer's system when calculating the BC ratio of installing battery storage

DER Adoption Assumptions – Others

+ Notes

- all timeseries outputs (if any) are in 2009 days and hours based on the customer load profiles
- DER adoption analysis also captures the impacts of building electrification (reflected on customer load profiles) on DER adoption by modeling representative customers in two scenarios: all-gas & all-electric. Results are the weighted sum of customer adoption under these two fuel-type scenarios using the fuel mix outputs from BE tool. The fuel mix is by customer, year, rate, and by sensitivities.

Example:
- 5yr-Payback-Period-Incentive
- Com-Worst
- SCOM
- NC

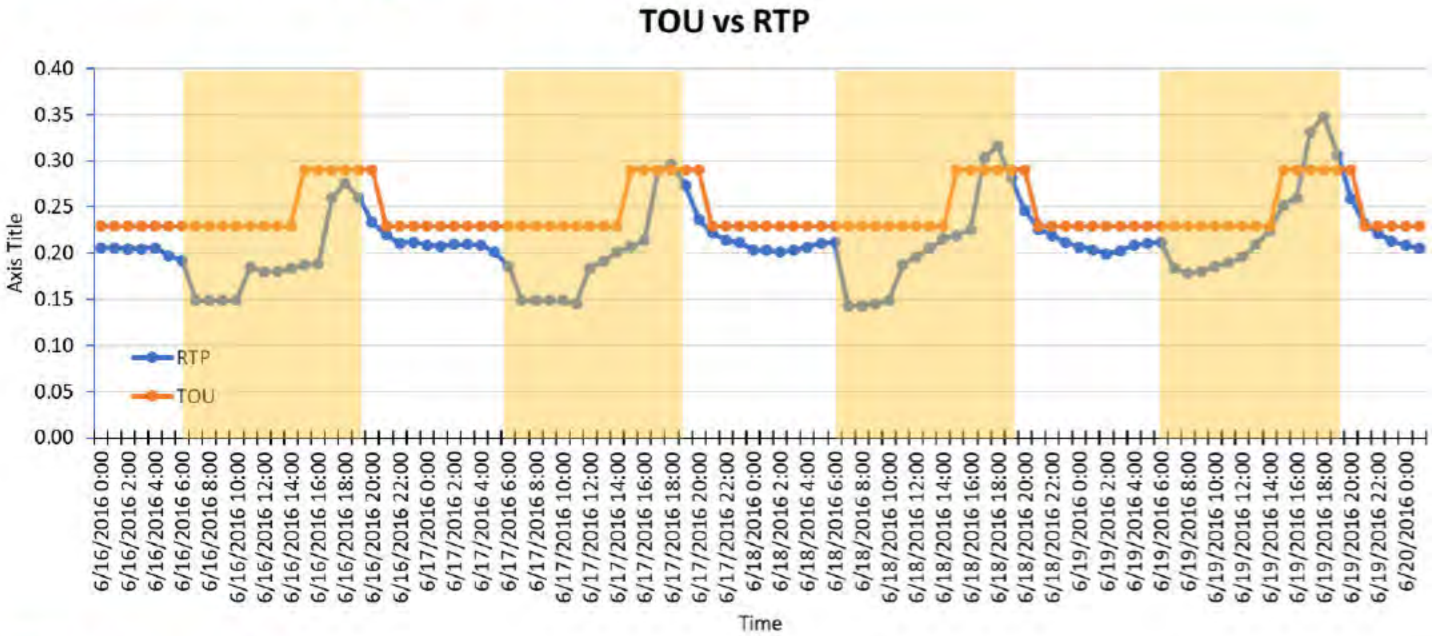


- commercial customers only differentiate vintage by new-construction and existing, due to the limit of commercial building electrification modeling
- peak load reduction is ignored in the model as this is a consumer adoption analysis

Q: Why PV adoption is higher under RTP?

+ Why PV adoption is higher under RTP?

- Sometimes RTP is higher than TOU



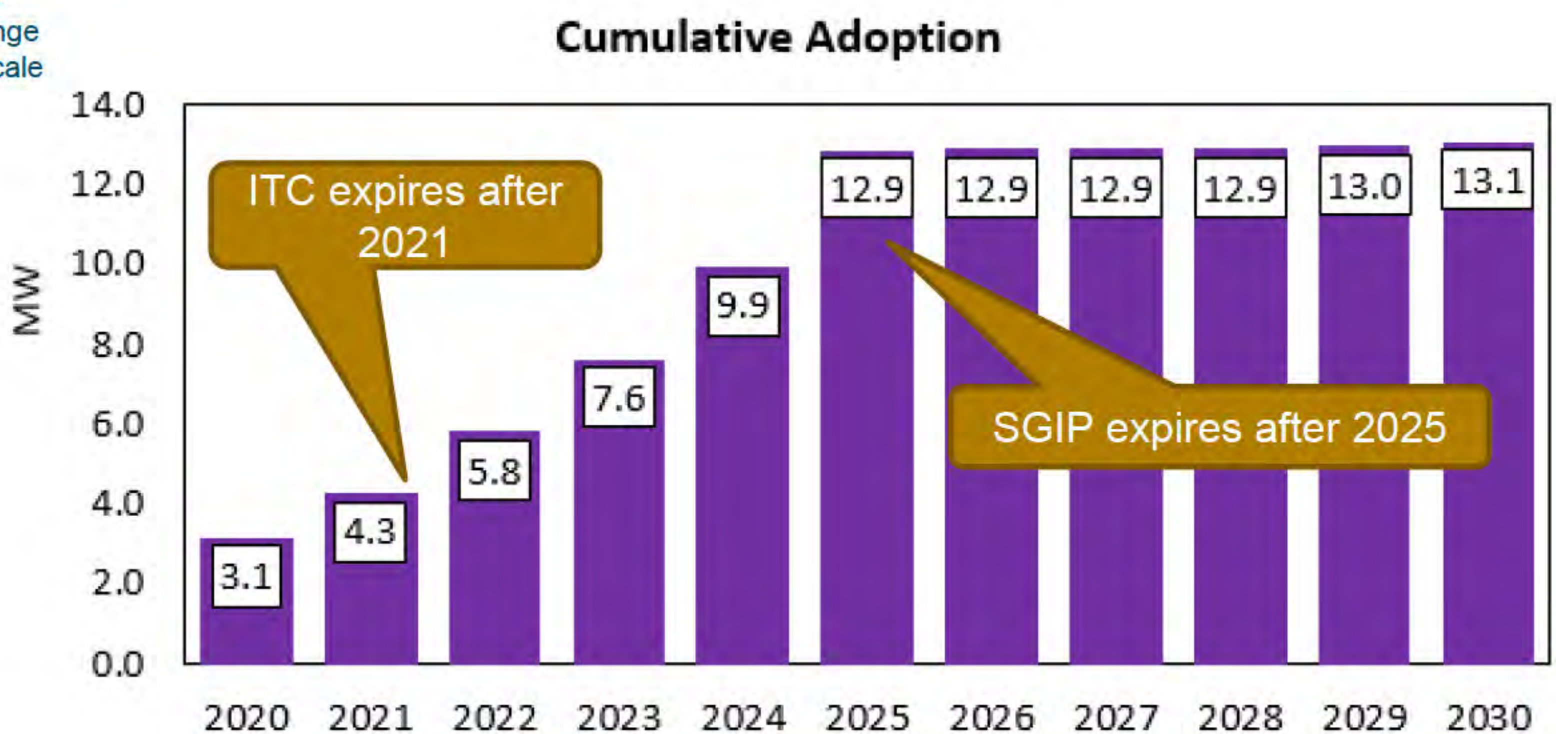
- RTP price spike
  - if PV electricity generation overlaps with the price spike period, even an hour could result in noticeable customer bill savings

Q: Why annual adoption changes?

+ Res-Ok, Base Case, Storage

- 2021 is a tipping point because ITC expires after this year
- 2025 is a tipping point because SGIP expires after this year

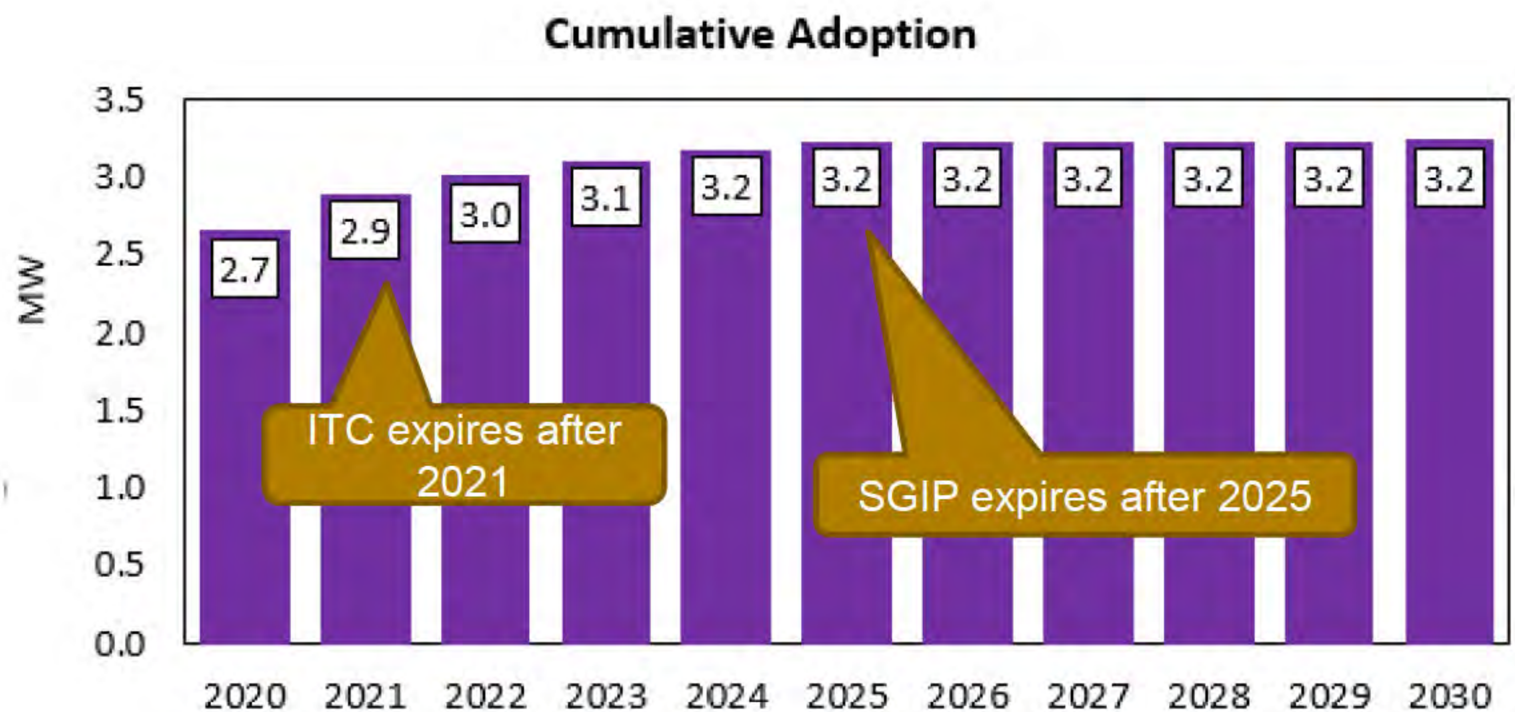
note
change
of scale



Q: Why annual adoption changes?

+ **Res-Ok, NEM Case, Storage**
  - Energy charge savings are claimed by PV under NEM, so the adoption slope before 2025 is smaller than the base case
  - After 2025, because of the expiration of SGIP the BC ratio drops dramatically, so there is no headroom left for storage adoption to increase

note change of scale

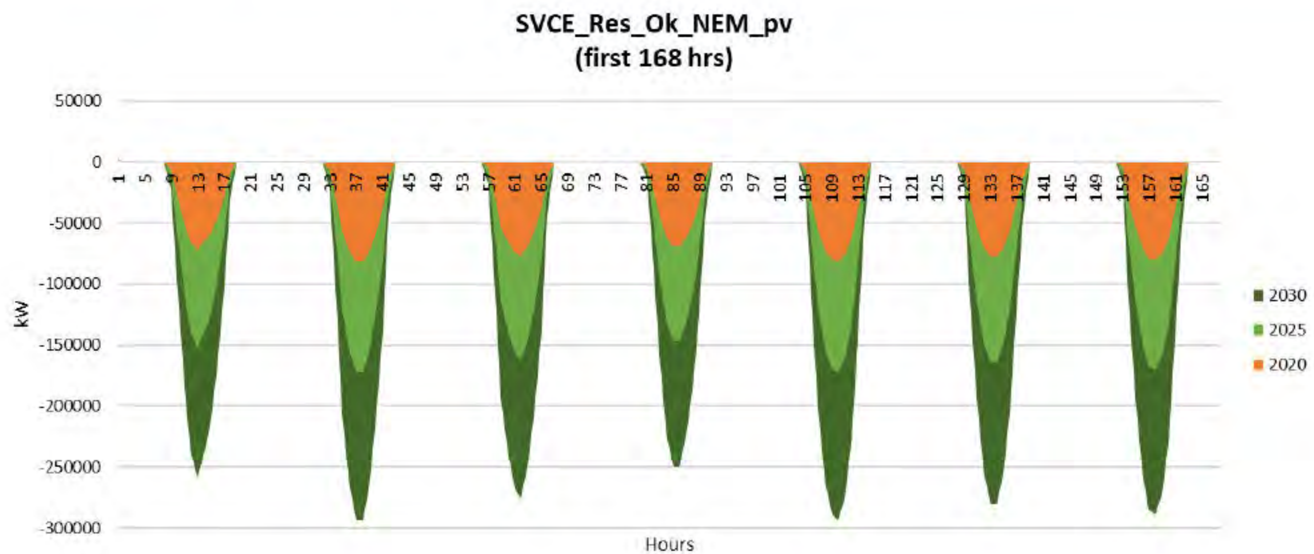


Q: How fixed adoption impacts others?

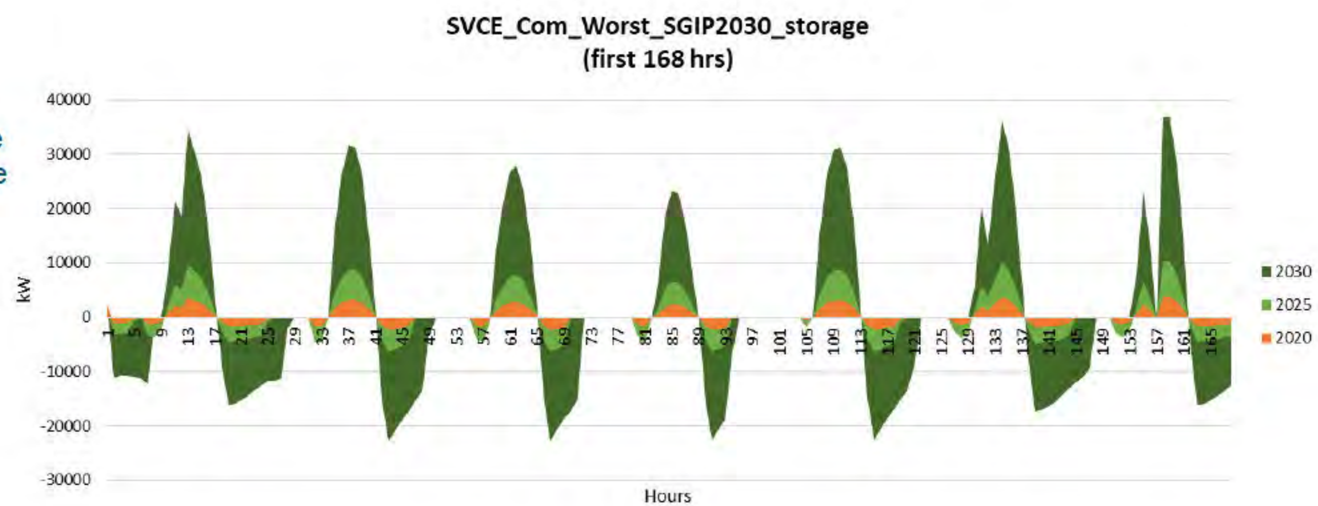
+ RESTORE calculates adoption by s-curve-sharing-group and adoption calculation is made at the group-level and them allocate back to each customer. This means the adoption of one customer will impact the others -- this is related to our CA PV mandate implementations.
+ Example – Res-Ok, Base
  - because of the fixed adoption from new homes every year, it reduces the natural adoption from other customers

	annual	annual	annual	cum		
Row Labels	Sum of predicted_adoption	Sum of baseline_adoption	Sum of fixed_adoption	Sum of cum_adoption	Sum of headroom	Sum of eco_poten
2020	4549	0	4853	32104	35359	53681
2021	3451	0	4853	40408	29429	52300
2022	1682	0	4853	46943	25292	51614
2023	0	0	4853	51796	10886	38889
2024	0	0	4852	56648	12420	40424
2025	0	0	4854	61502	20193	48197
2026	0	0	5039	66541	21498	49502
2027	0	0	5040	71581	26294	54298
2028	0	0	5040	76621	28100	56104
2029	0	0	5039	81660	33807	61811
2030	0	0	5040	86700	38037	66040
Grand Total	9682	0	54316	672502	281316	572861

Q: Impact shapes



note change of scale



Q: Benchmark PV forecast

- **Compare with 2019 CEC BTM PV Forecast**
  - down-scale to SVCE territory level by annual end-use energy deliveries data from IEPR
  - include both residential and commercial customer

Author	Scenario	2020 (MW)	2030 (MW)
E3	Base	117	312
	NEM	151	672
CEC	Mid	136	374
	High	160	435

APPENDIX B

SILICON VALLEY CLEAN ENERGY

2020 Integrated Resource Plan – Ascend's Preliminary Model Results & Selection of Preferred Portfolio

Board Direction on Integrated Resource Plan (IRP)

10 Year IRP (2020 IRP) – 2021 to 2030

- RPS, GHG and Reliability to be balanced with Affordability

Board direction on IRP modeling in October 2019

- Exceed RPS mandate ~50% through 2026 and 60% by 2030
- Consider PG&E Allocations
- Shopping Cart of Resources – Portfolios
- Consider Geothermal & BioX Resources with a strategy to neutralize GHG

Plan for how to close Clean Energy Net Open Position!

SILICON VALLEY CLEAN ENERGY

IRP Modeling Directives

1. 100% clean annually
2. Include incremental Distributed Energy Resources
3. 2021-2026 50% minimum RPS; 60% RPS by 2030
4. Must meet minimum long-term RPS mandates (65% of RPS)
5. RPS Portfolio Category Content 1 (PCC1) only
6. Limit long-term procurement
7. Did not model Resource Adequacy alternatives

Key Planning Objective - Metrics

1. Decarbonization

a. Annual Accounting of Emissions – ***SVCE Policy and PCL reportable***

b. Clean Net Short – emissions for the sum of all hours not covered - ***possible future requirement***

2. Reliability

a. Annual Resource Adequacy Net Open Position based on 2020 system RA obligations – ***current requirement***

b. Availability of Resource During Assessment Hours (4 pm to 9 pm) - ***most likely future requirement***

3. Affordability

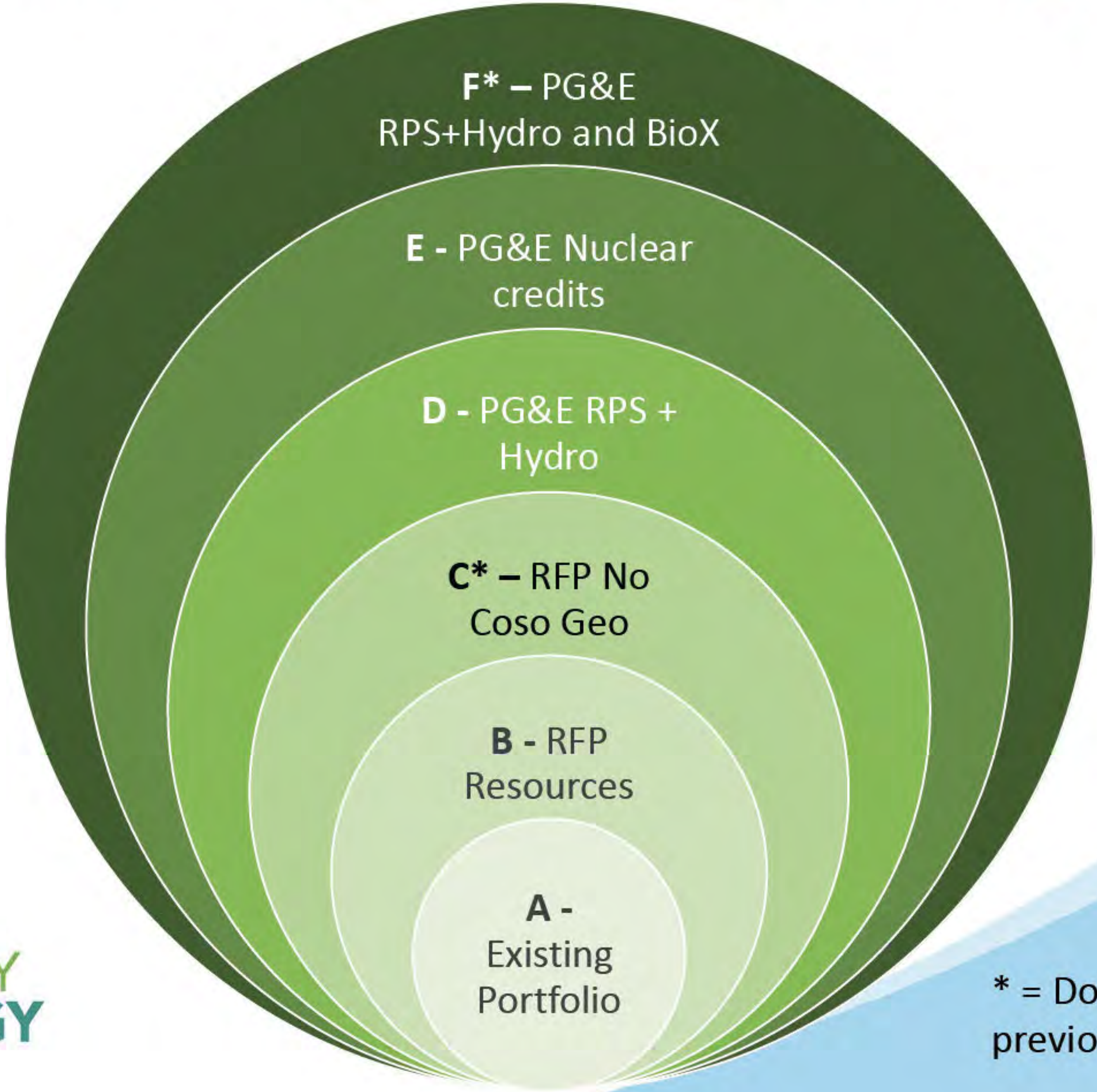
a. 10 Year Levelized Net Cost & Risk (PPA and/or resource cost net of energy, A/S & RA value)

SILICON VALLEY CLEAN ENERGY

Alternative Portfolios to Meet Clean Energy Goals

#	Portfolio Name	Description
A	**Business as Usual**	No new resources. All energy and clean credit needs purchased from markets.
B	**Business as Usual (A) + PPA resources from RPS RFP**	Resources that are in final stages of contract negotiation from RPS RFP process last fall and long-term federal hydro contract from WAPA are included. All remaining needs are purchases from markets (as is done in all other portfolios).
C	**RPS RFP (B) minus Coso Geo**	All resources in portfolio B plus minus Coso Geothermal.
D	**RPS RFP (B) + PG&E RPS and hydro Allocation**	All resources in portfolio B plus all PCC1 and carbon-free credit from PG&E resources.
E	**RFP (B) PG&E RPS+hydro (D) + Nuclear**	All resources in portfolio D plus nuclear allocation.
F	**RPS RFP (B) + PG&E(D) RPS+Hydro + BioX**	All resources in portfolio B plus BioX biogas and all PG&E RPS and hydro allocations (no nuclear).

Alternative Portfolios to Meet Clean Energy Goals



SILICON VALLEY CLEAN ENERGY

* = Does not include entirety of previous portfolio, as indicated

Annual Power Supply Mix per Portfolio (% of Retail Sales): Levelized

All portfolios have significant renewable penetration and minimal GHG emissions intensity. For reference, PG&E had a GHG emissions intensity of 210 lb CO_2/MWh in 2017 and the CAISO Reference System averages 375 lb CO_2/MWh from 2020-2030. [A CSP dispatchable gas generator emits ~947 lb CO_2/MWh.]

Portfolio	A – BaU	B - RFP	C – RFP No Coso Geo	D – PG&E RPS + Hydro	E – PG&E Nuclear*	F- BioX with PG&E RPS & Hydro
RPS Eligible Resources	**51%**	**50%**	**50%**	**63%**	**63%**	**64%**
Biomass/Biowaste	0%	0%	0%	0.2%	0.2%	0.7%
Geothermal	0%	7%	1.4%	7%	7%	7%
Eligible Hydro	0%	0%	0%	0.9%	0.9%	0.9%
Solar	30%	29%	33%	39%	39%	39%
Wind	21%	14%	16%	16%	16%	16%
Large Hydro	**41%**	**45%**	**45%**	**34%**	**26%**	**33%**
Nuclear	**0%**	**0%**	**0%**	**0%**	**10%**	**0%**
GHG Emission Intensity (lb CO_2/MWh)	**0**	**5**	**0**	**14**	**14**	**15**

*nuclear allocation ends mid-2025

Key Findings

1. Incremental DERs reduces underlying load by 16% in 2030, primarily driven by solar and offset by increases in EV charging.
2. Annual emissions can be avoided by excluding BioX and geothermal resources but increases Clean Net Short position (and associated emissions).
3. Taking PG&E RPS allocation increases Clean Net Short emissions due to heavy reliance on solar (and resulting lack of evening clean energy).
4. Geothermal resources minimize Clean Net Short but carry annual emissions. Wind resources help reduce Clean Net Short and do not carry emissions. Both are more expensive than Solar+Storage.
5. Portfolios with geo PPAs best help meet Reliability needs and reduces Resource Adequacy costs.
6. Taking the PG&E Allocations greatly reduces costs.

SILICON VALLEY CLEAN ENERGY

Portfolio Performance Dashboard

Ability to meet objective: Least Middle Best

	[A] BaU	[B] RFP	[C] RFP No Coso Geo	[D] PG&E RPS + Hydro	[E] PG&E Nuclear	[F] BioX with PG&E RPS & Hydro
Minimizes Annual Emissions	Middle	Best	Middle	Least	Least	Least
Helps meet Carbon-free 24x7	Middle	Best	Middle	Least	Middle	Least
Meets RA Needs	Least	Best	Middle	Best	Best	Best
Covers 4 -9 pm	Least	Best	Best	Best	Best	Middle
Minimize Net Cost	Least	Middle	Middle	Best	Best	Best
Minimize Risk	Middle	Middle	Best	Middle	Middle	Middle

Recommended Preferred Portfolio

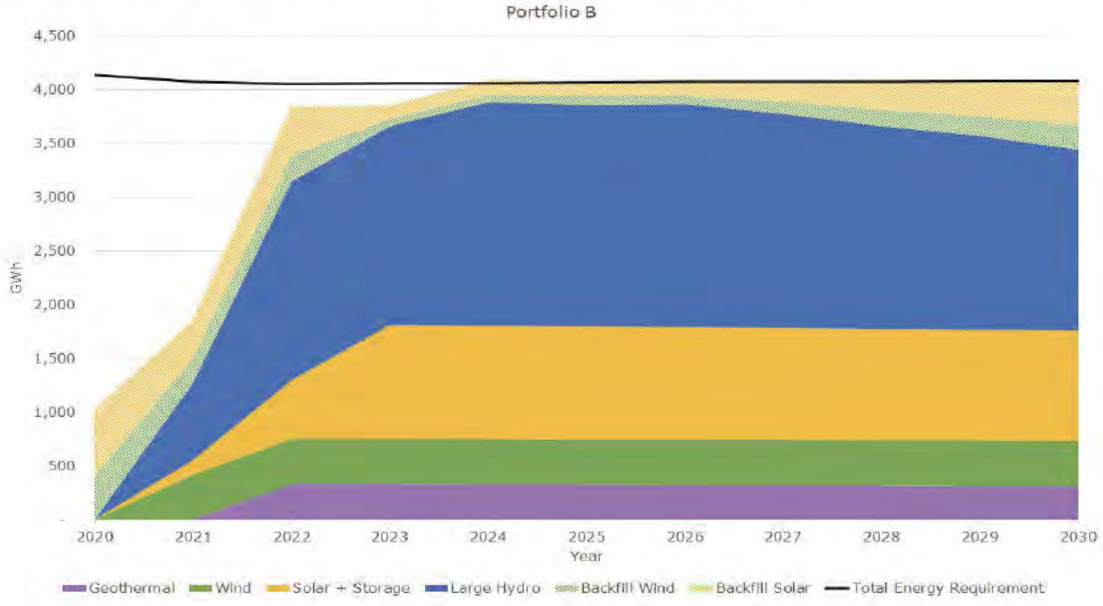
1. ***For 2020 IRP*** - **Portfolio B**

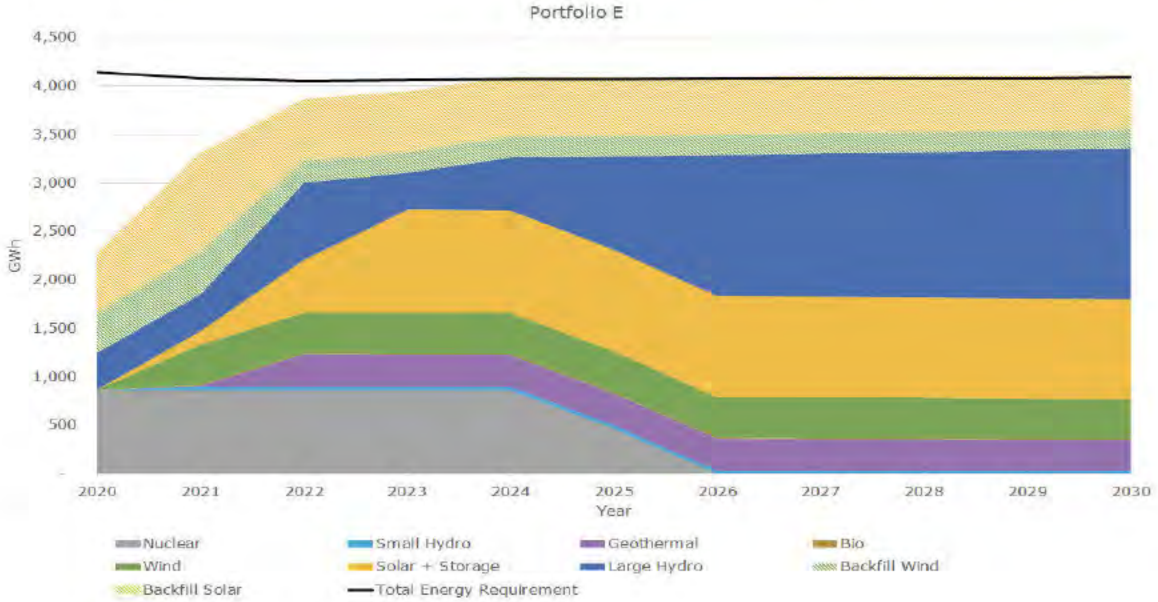
Existing Long-term PPAs

- 2 solar + storage
- 1 Wind
- 1 Geo

New Long-term PPAs

- 4 solar + storage
- 1 Geo
- 1 Large Hydro





2. Pursue PG&E Allocations – RPS, large hydro and Nuclear (Portfolio E)

2020 IRP Next Steps

1. Model supply variations and ability to meet Clean & RPS goals for Preferred Portfolio (B)
2. Benchmark Portfolio B to CPUC's Reference System Plan
3. Assess the ratepayer impact due to changes in PCIA from taking PG&E RPS Allocations
4. Complete 2020 IRP Report and submittals
5. Board approval of IRP
6. File IRP with CPUC

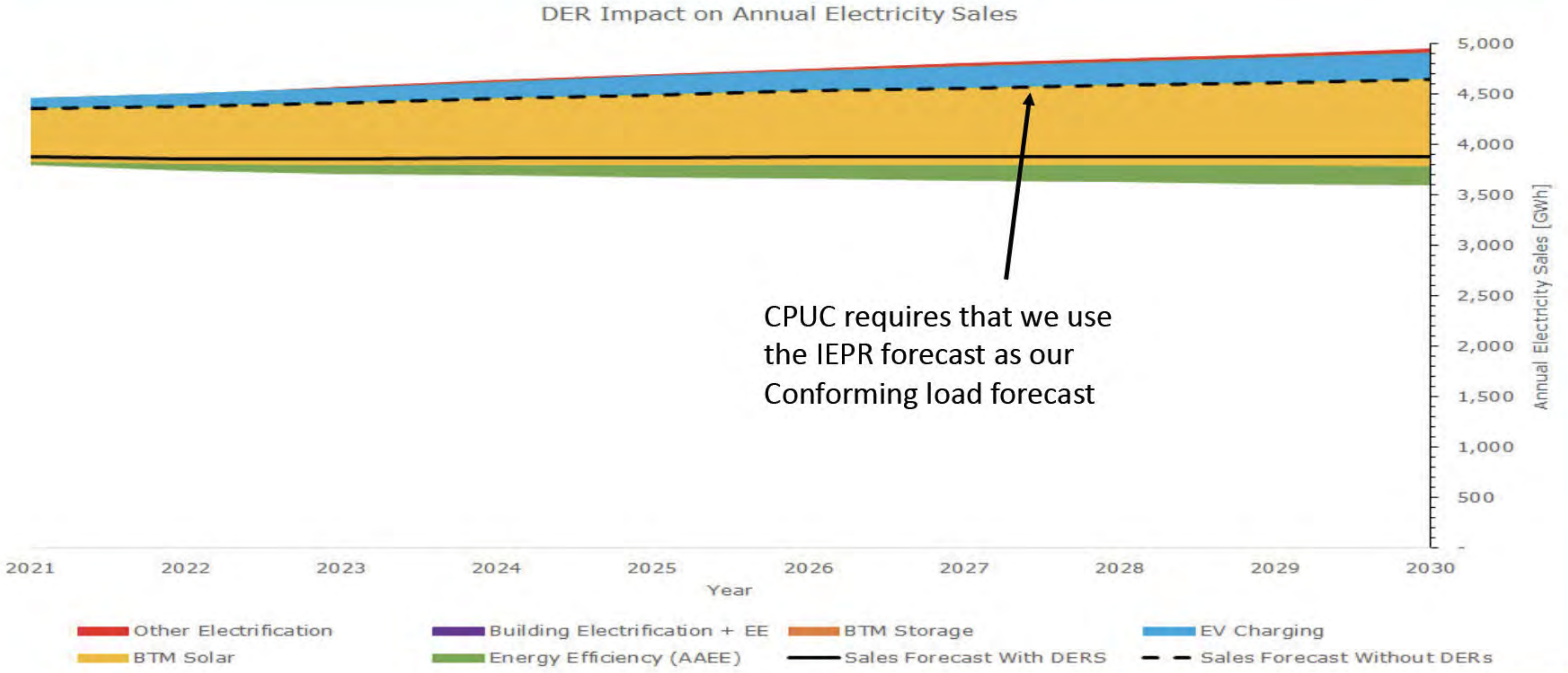
SILICON VALLEY CLEAN ENERGY

Ascend Analytics PowerSimm Modeling Output

SILICON VALLEY CLEAN ENERGY

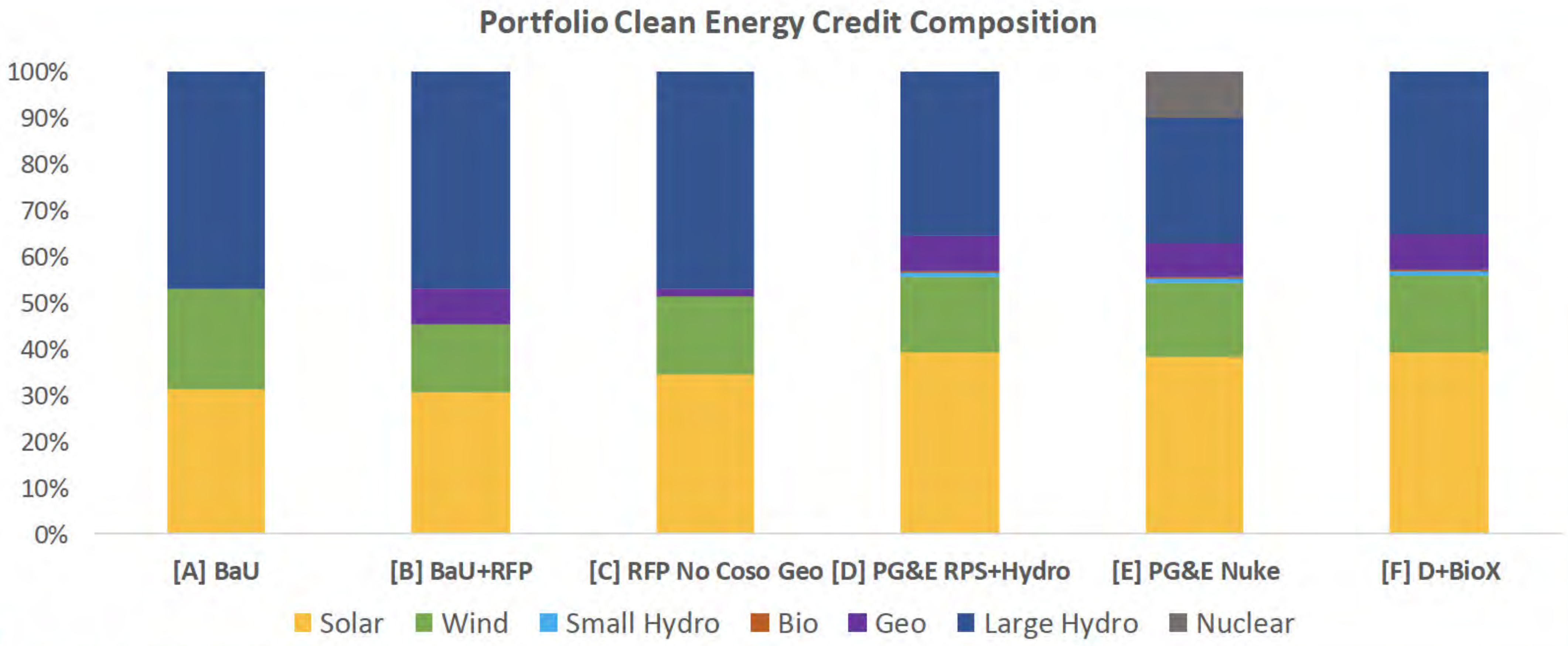
Long-term Load Forecast and Load Modifiers

By 2030, sales forecast is **16% lower** according to California Energy Commission's 2019 IEPR load forecast + incremental DERs. Primarily drivers include: behind-the-meter solar: -18%; energy efficiency: -4%; electric vehicle charging: +5%. Includes small DA adjustment.



Resource Composition

All portfolios meet all RPS and Carbon-Free targets, but portfolios that have a lower percentage of solar energy (A, B, C) have lower Clean Net Short positions and hence lower effective total emissions.



SILICON VALLEY CLEAN ENERGY

1a. Decarbonization – Annual & Hourly Emissions

All portfolios are long in annual clean energy credits, so the only Annual Net Emissions are those associated with emissive resources (geothermal and biogas). When accounting for hourly emissions, portfolios with a higher percentage of solar energy (D, E, F) have larger shortages during evening hours, and hence have increased total emissions.

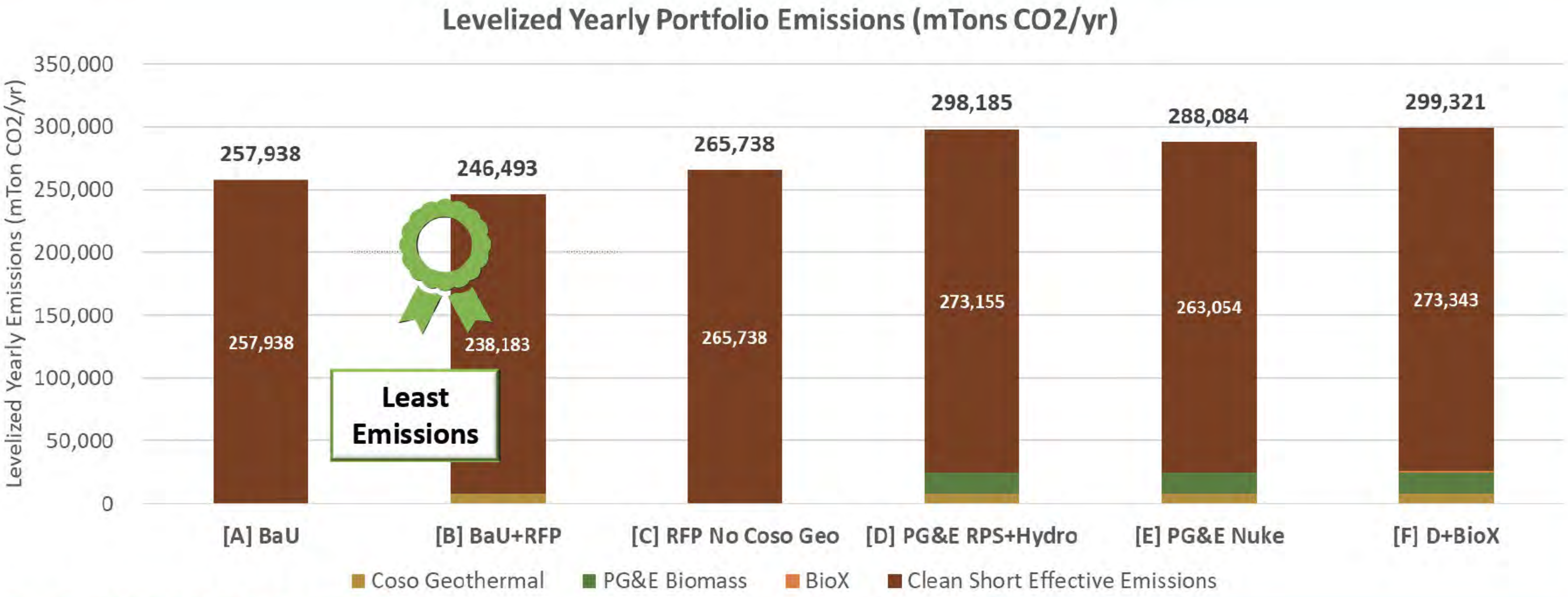
Emissions (levelized mTon CO2/yr)	[A] BaU	[B] BaU+RFP	[C] RFP No Coso Geo	[D] PG&E RPS+Hydro	[E] PG&E Nuke	[F] D+BioX
Annual Net Emissions (with surplus)	0	8,310	0	25,030	25,030	25,977
Hourly Accounting Total Emissions (no surplus)	257,938	246,493	265,738	298,185	288,084	299,321

The IRP Clean Net Short Calculator allows for inclusion of hourly surpluses.

SILICON VALLEY CLEAN ENERGY

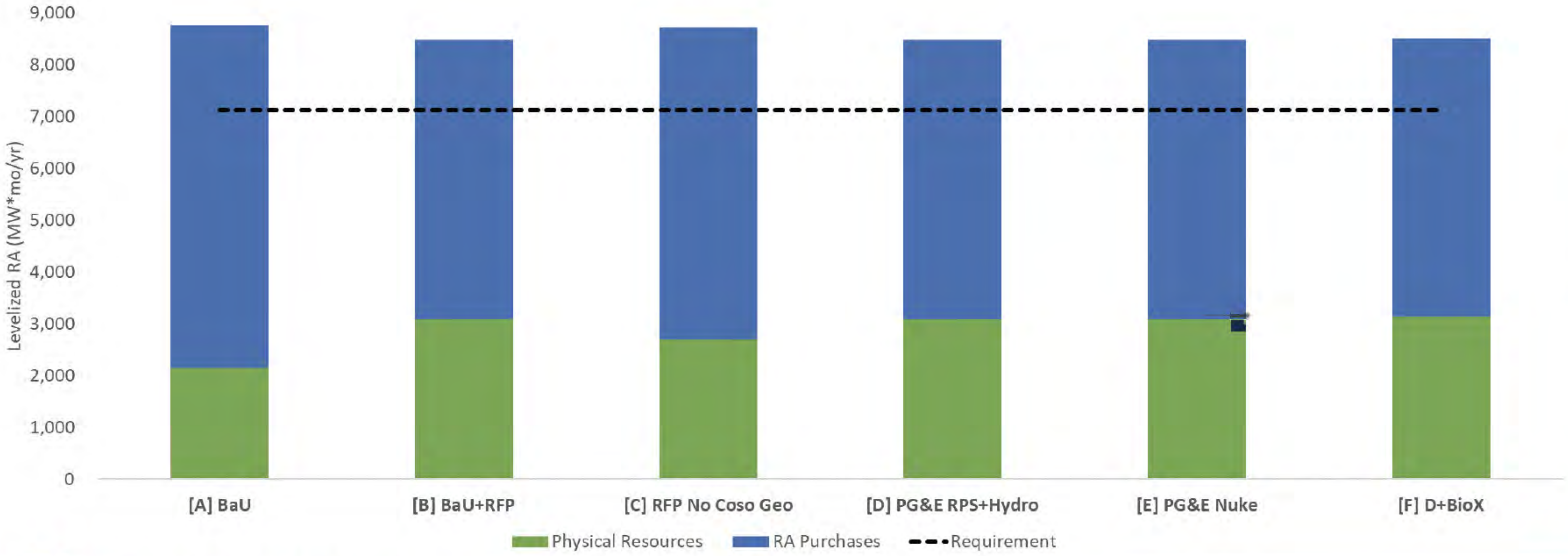
1b. Decarbonization – Annual Emissions

Portfolio B has the smallest Clean Net Short position (calculated hourly) and the least emissions. Portfolios D, E, and F have higher levels of solar penetration, decreasing the amount of clean energy available during the evening and hence increasing hourly effective emissions.



2a. Reliability – Resource Adequacy Position

All portfolios meet RA requirements. RFP resources significantly help reduce RA purchases. RA surplus is due to purchasing RA in 100 MW increments; this can be fine-tuned during actual procurement to minimize costs.



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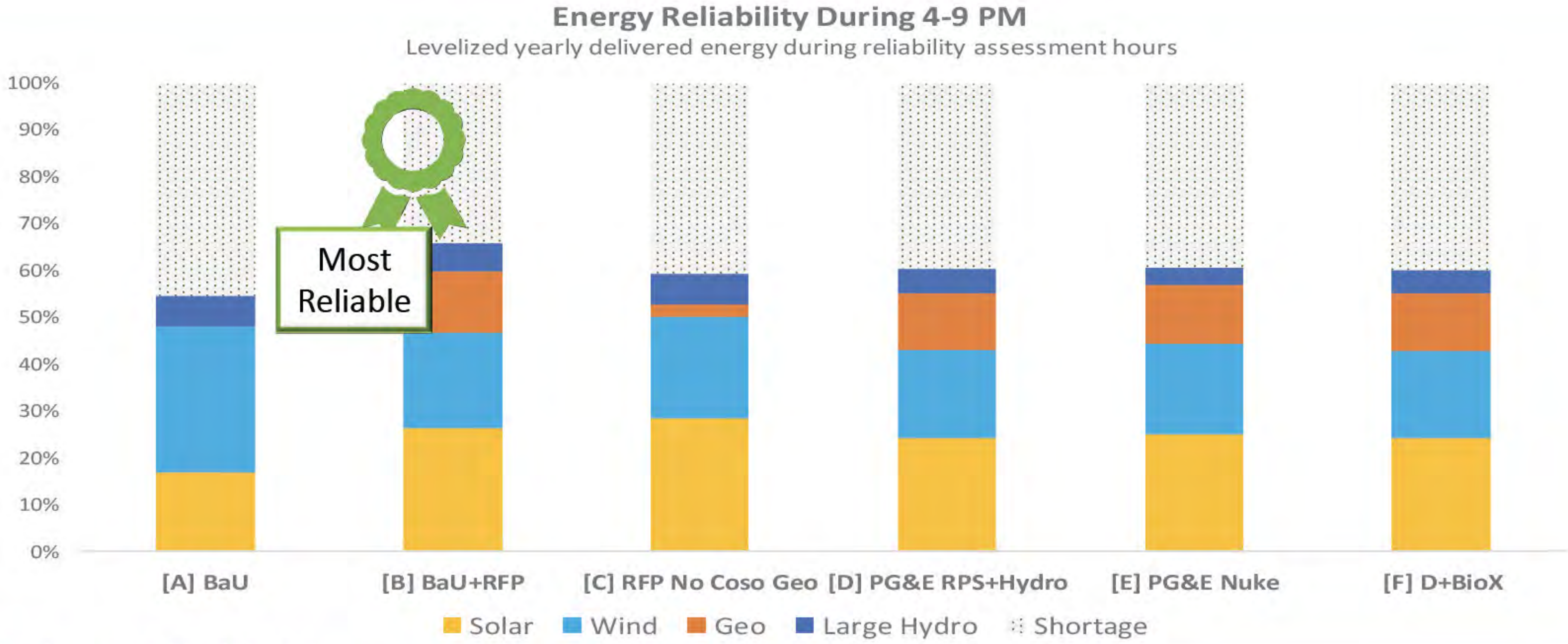
2b. Reliability – Availability Assessment Hours (4 to 9 pm)

Portfolio B, which includes additional solar + storage and Coso Geothermal is best able to deliver energy in the new "Net Peak" hours – thus helping with the Duck Curve.



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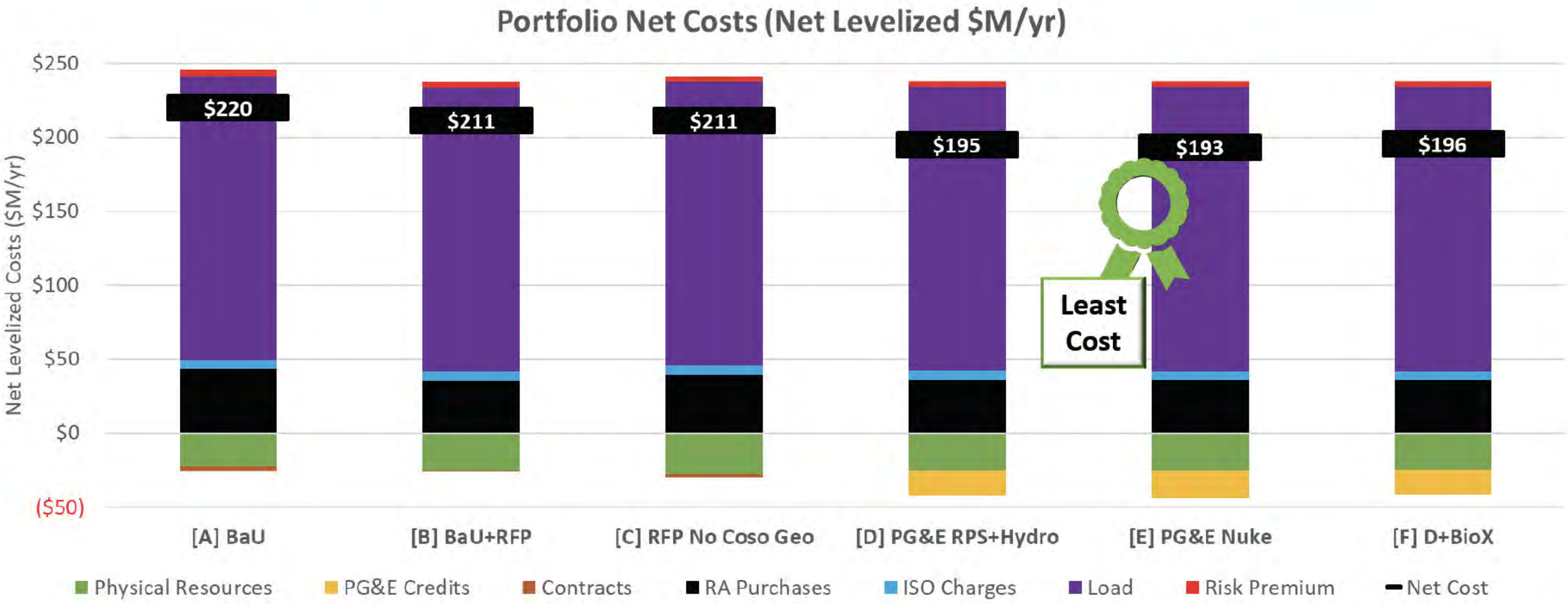
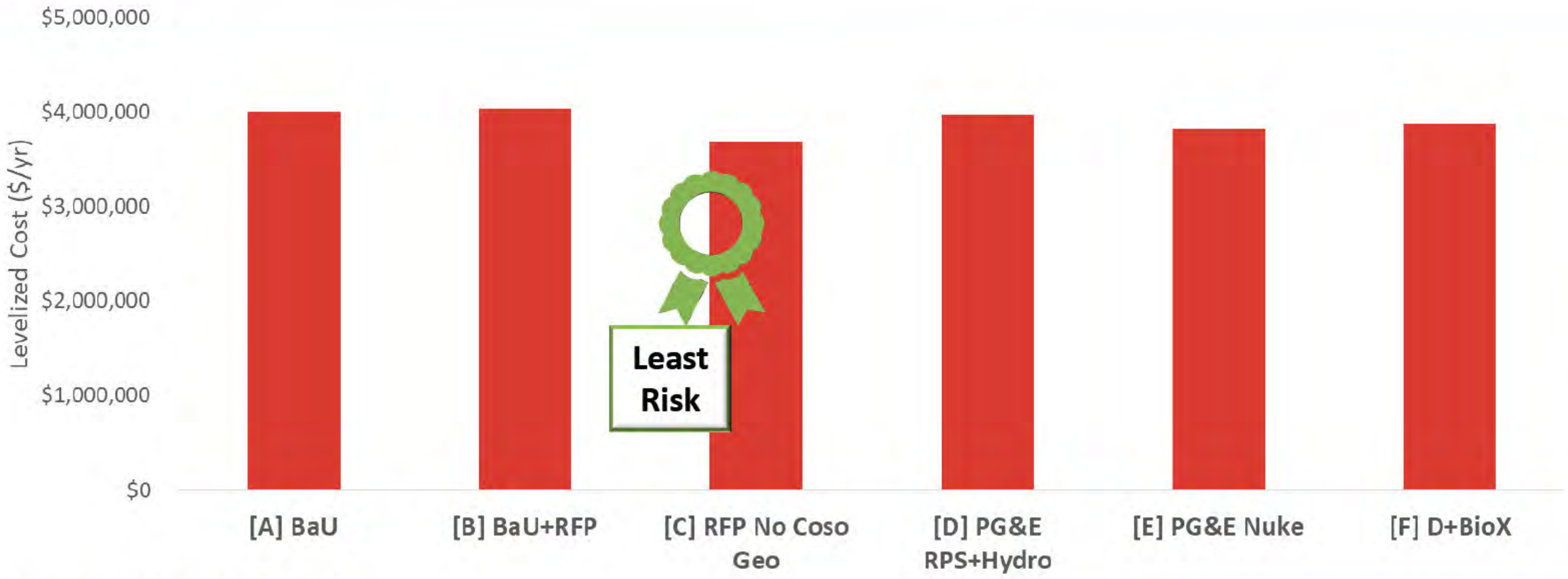
3a. Affordability – Levelized Portfolio Supply Cost

Solar and PG&E RPS+Hydro credits bring the most value to all portfolios while load and RA purchases are the largest expenses. Portfolio E (All PPAs + PG&E RPS, Hydro, and Nuclear credits) is the most cost-effective portfolio.



3a. Affordability – Risk

The Risk Premium represents the cost of all financial risks in a portfolio, providing an estimate of how much costs could potentially exceed expectations in that portfolio. All portfolios present similar levels of risk premium. Portfolio C has a slightly reduced risk premium since it has less energy from physical PPAs and hence lower exposure to market price risk.



SILICON VALLEY CLEAN ENERGY

Recommended Preferred Portfolio

1. ***For 2020 IRP*** - **<u>Portfolio B</u>**,

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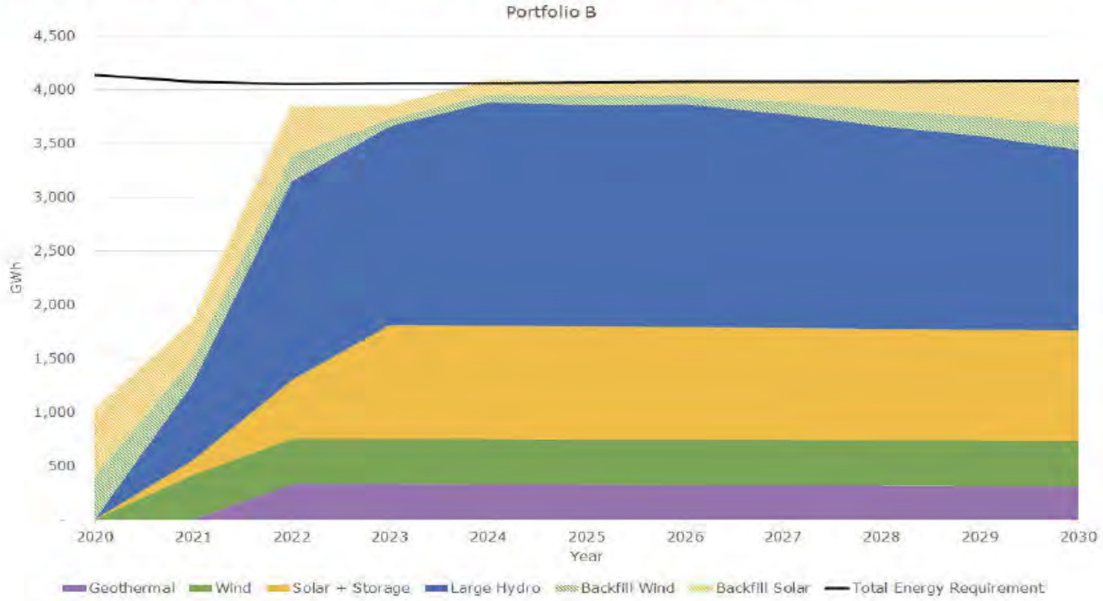
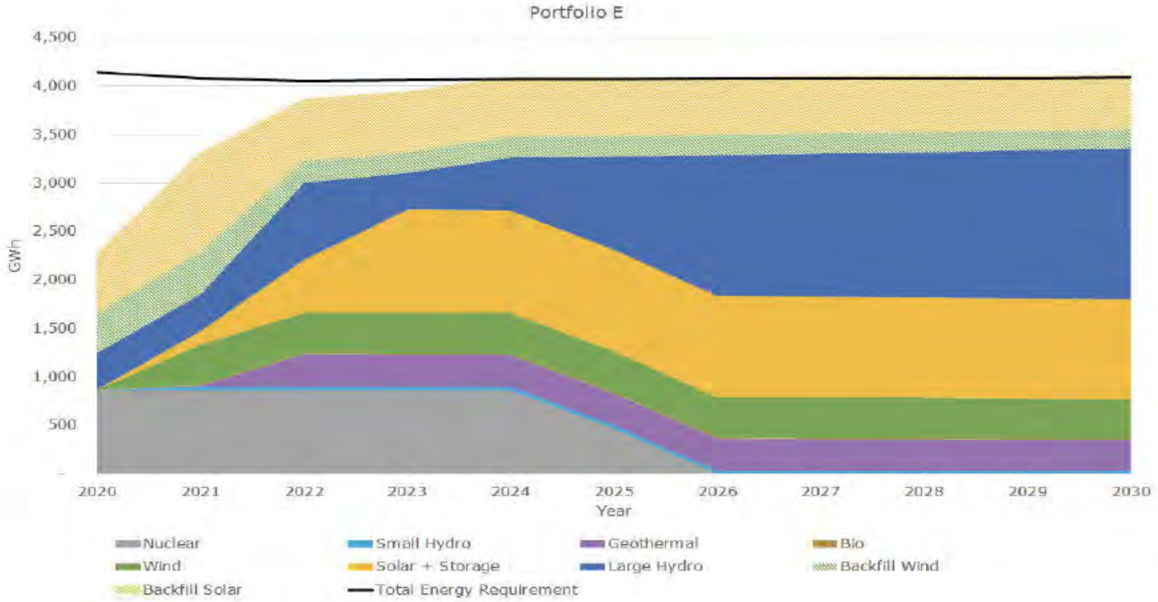
2. Pursue PG&E Allocations – RPS, large hydro and Nuclear (Portfolio E)





1a. Decarbonization – Annual & Hourly Emissions

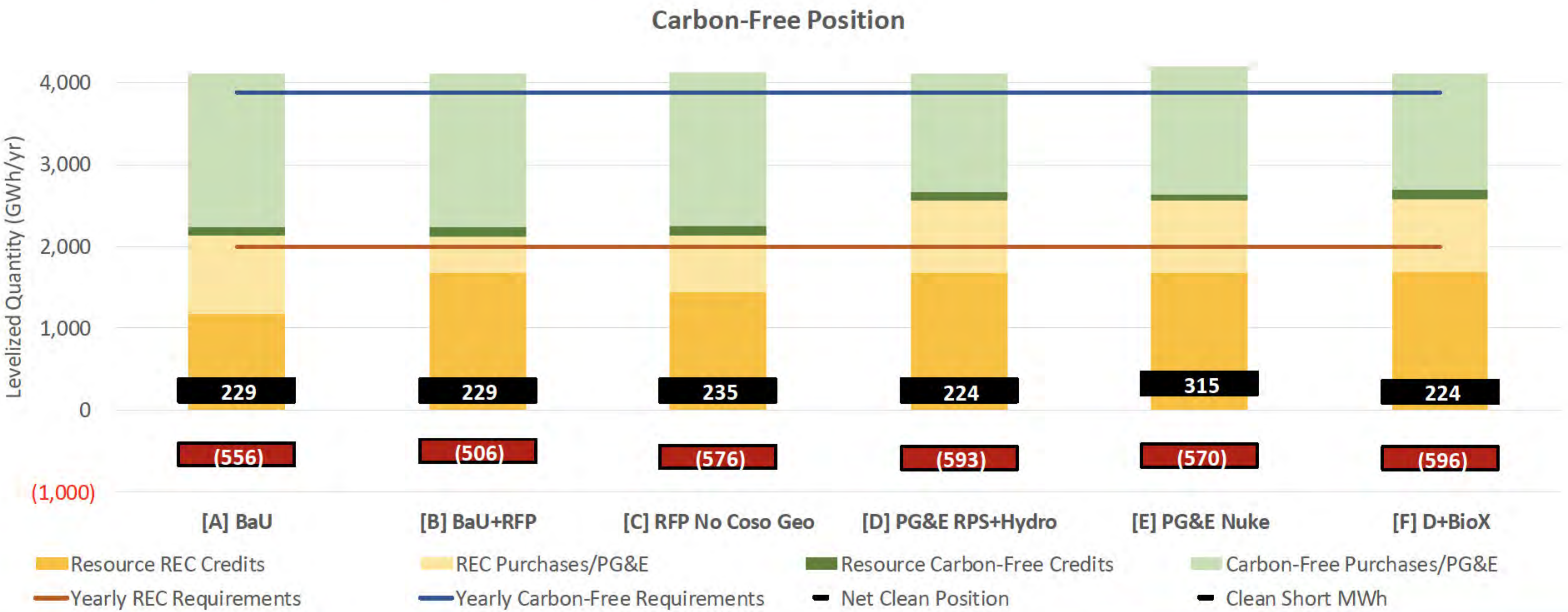
Portfolio A has no Annual emissions as only Solar and Wind resources are assumed to be added.
All Portfolios have hourly emissions and PG&E credits bring a strong boost to Net Clean position. Taking PG&E credits for only RPS+Hydro leaves a larger number of Clean Net Short MWh/year (portfolios C, F in red boxes) due to hourly shape of credits poorly complementing remaining net load. Portfolio B (with Coso) has lowest hourly emissions due to baseload nature of resources.

Portfolio	Annual Accounting [metric tons CO2]	Hourly Accounting (without surplus) [metric tons CO2]
[A] BaU	0	257938
[B] BaU+RFP	8310	246493
[C] RFP No Coso Geo	0	265738
[D] PG&E RPS+Hydro	25030	298185
[E] PG&E Nuke	25030	288084
[F] D+BioX	25977	299321

The IRP Clean Net Short Calculator allows for inclusion of hourly surpluses

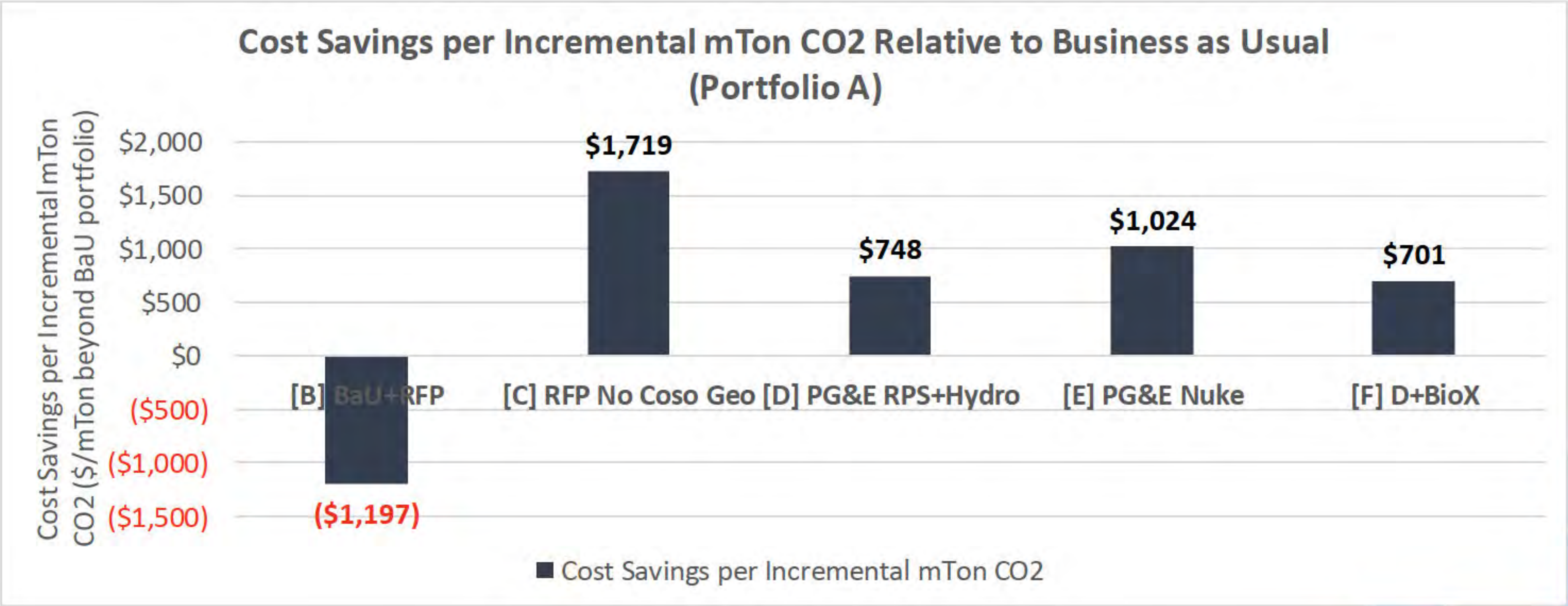
SILICON VALLEY CLEAN ENERGY

1b. Carbon Free Position



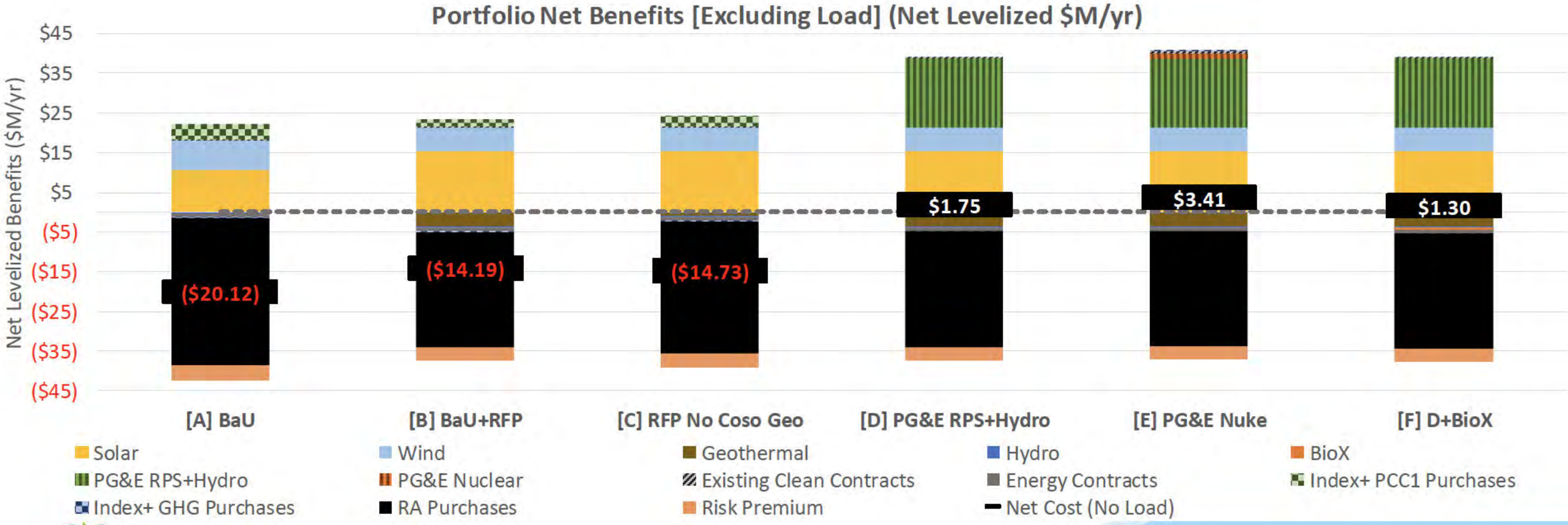
SILICON VALLEY CLEAN ENERGY

1b. Decarbonization – Hourly Emissions



SILICON VALLEY CLEAN ENERGY

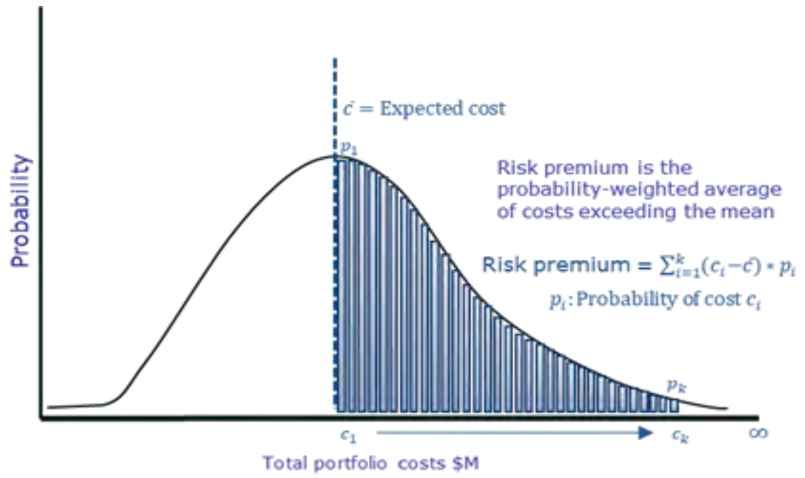
3a. Affordability – 10 Year Levelized Net Benefits

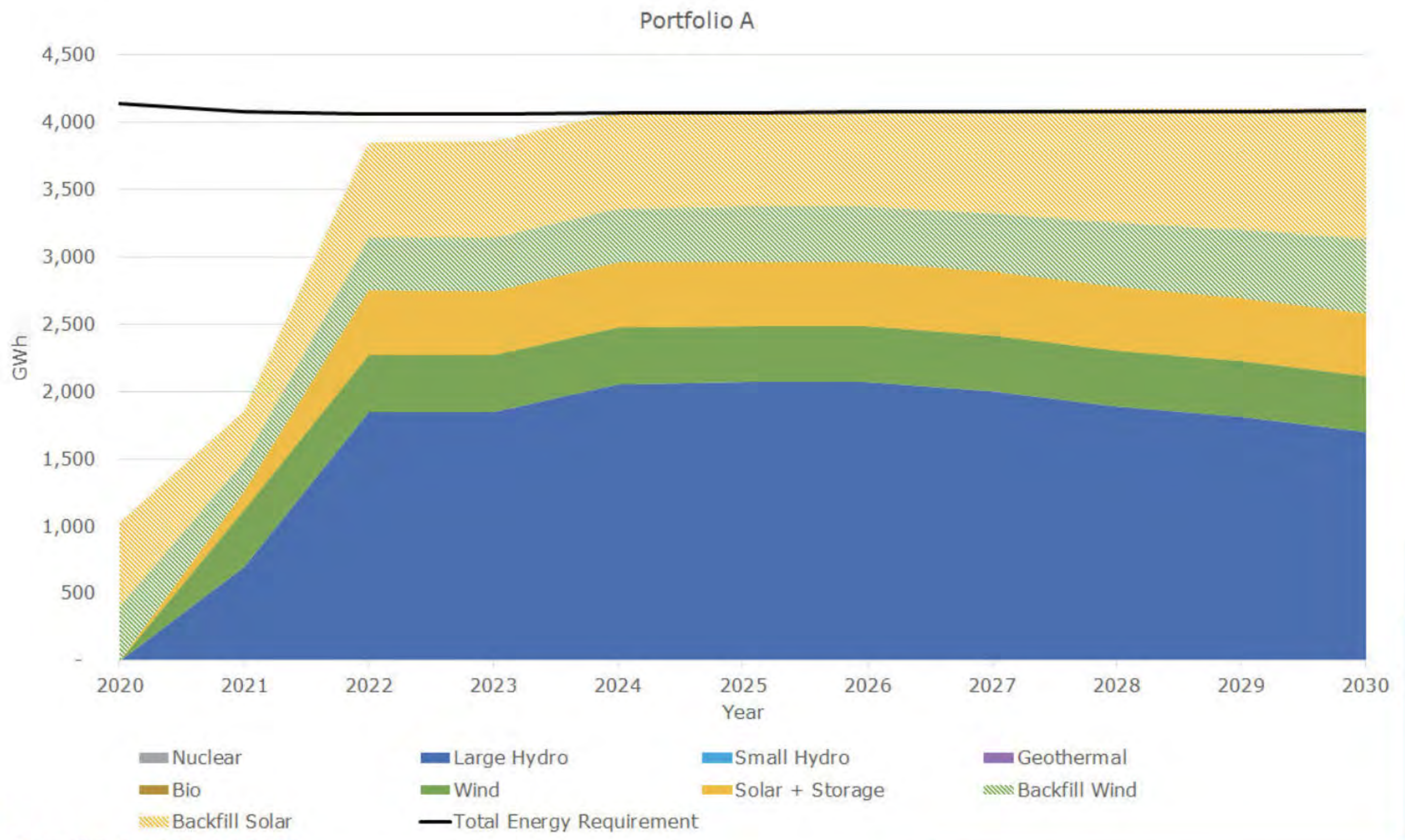


SILICON VALLEY CLEAN ENERGY

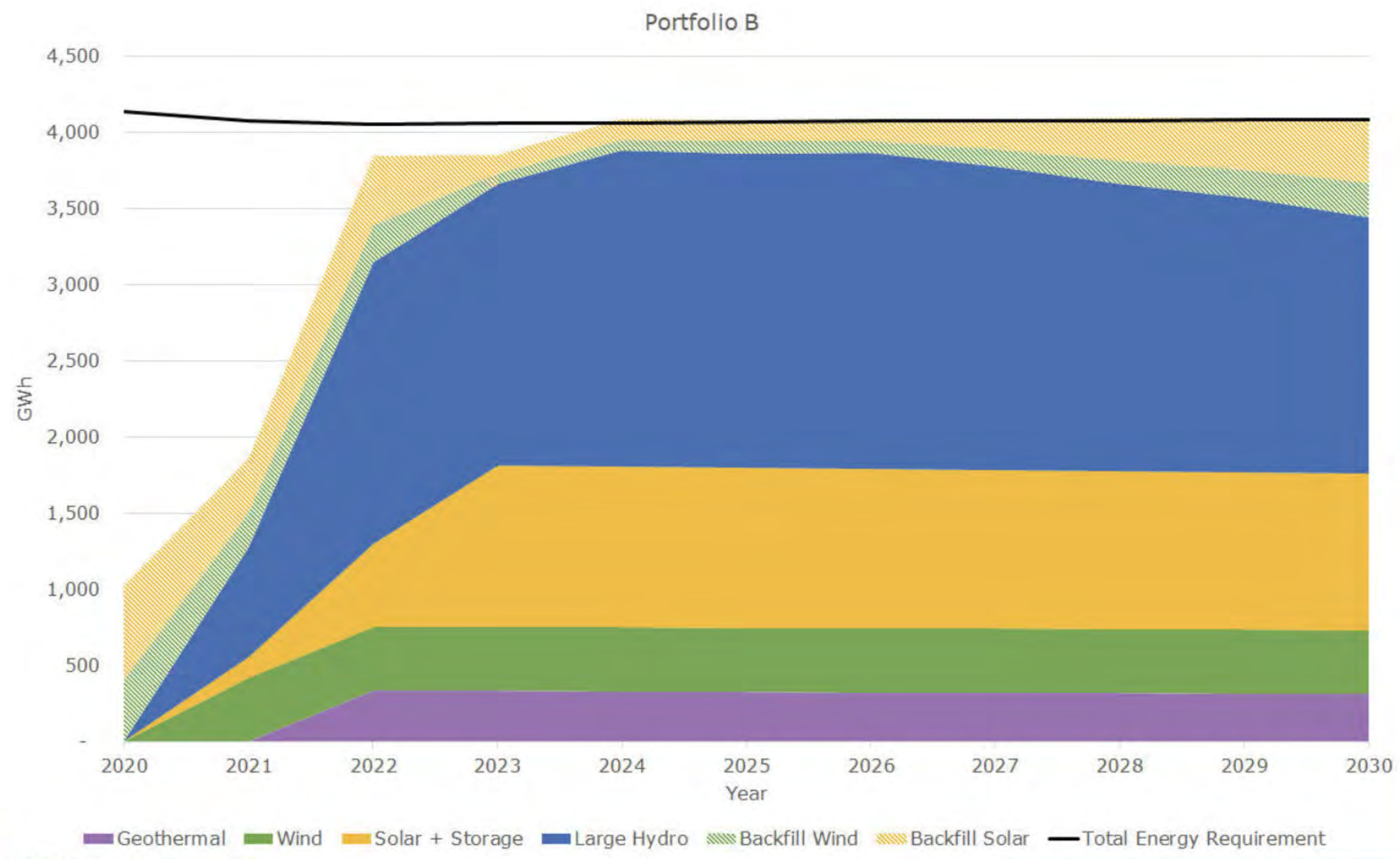
3a. Affordability – 10 Year Levelized Net Benefits – Risk Premium

- The risk premium is calculated similarly to an insurance premium calculation, deriving from the difference between the P95 and median portfolio costs (see diagram at right).
- For example, we simulate market electricity price volatility which exposes load purchases to price risk. This price risk is captured in modeling and allows PowerSimm to quantitatively assess the upside cost risk of a given resource portfolio and compare that risk between portfolios via a Risk Premium

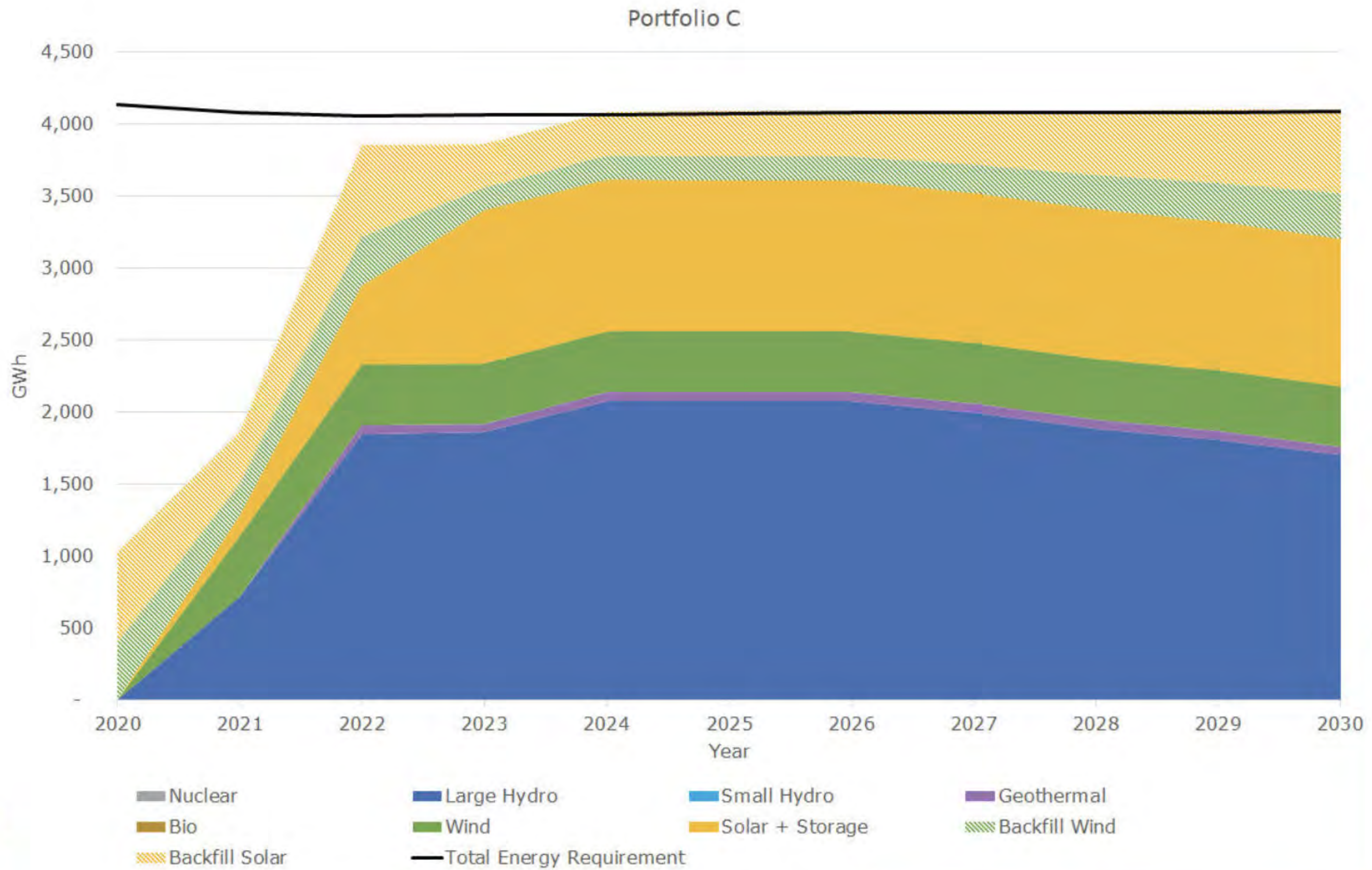


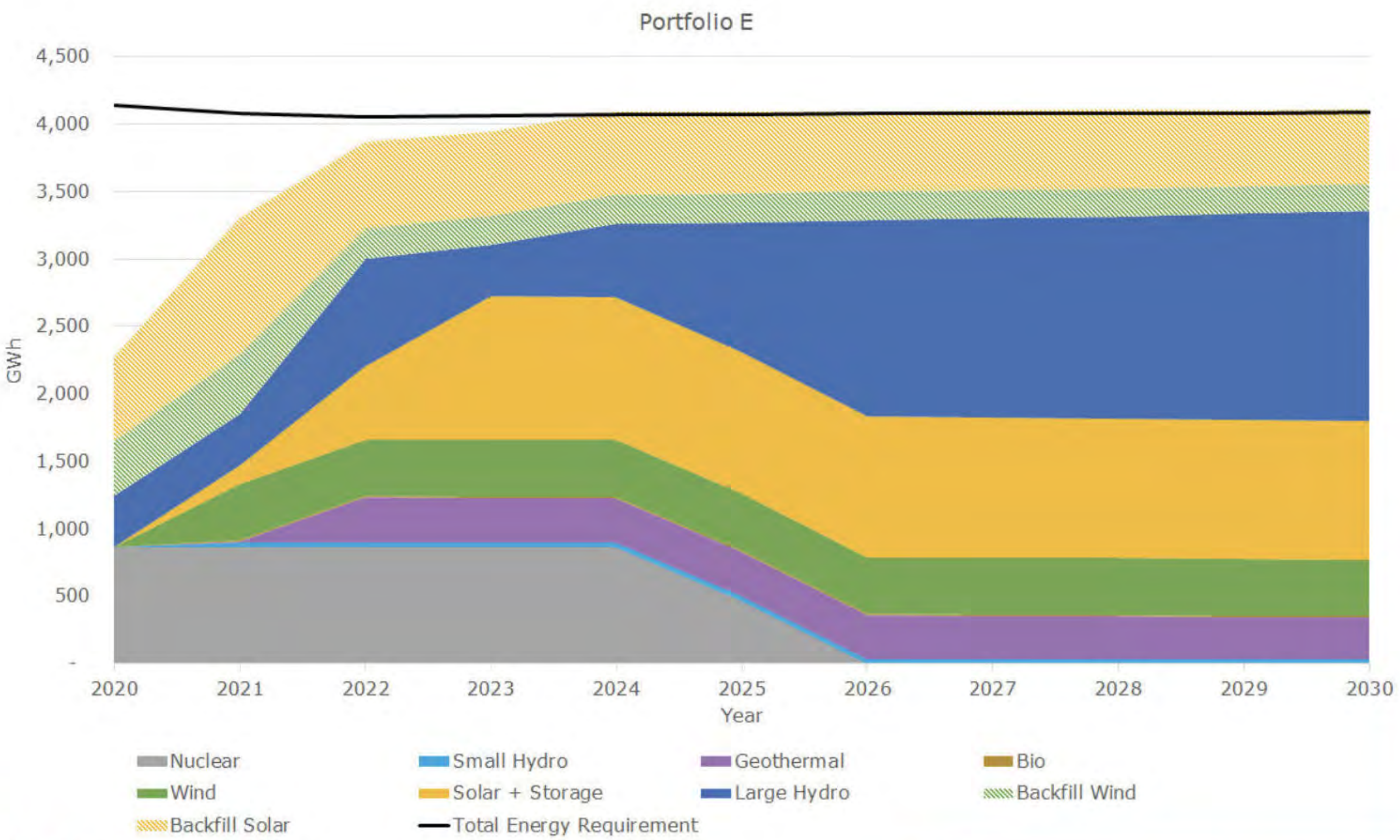


SI CLEAN ENERGY

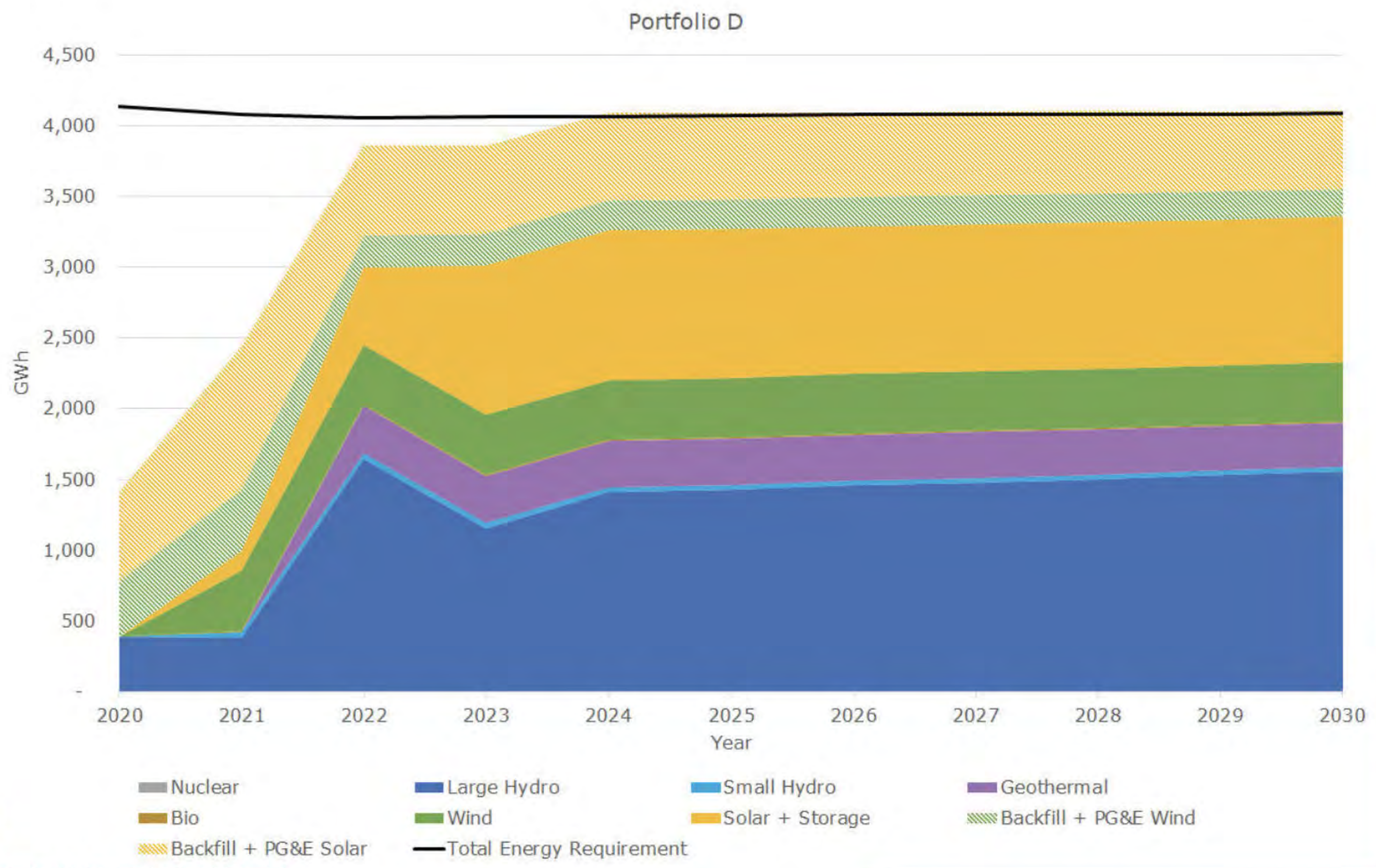


SILICON VALLEY CLEAN ENERGY

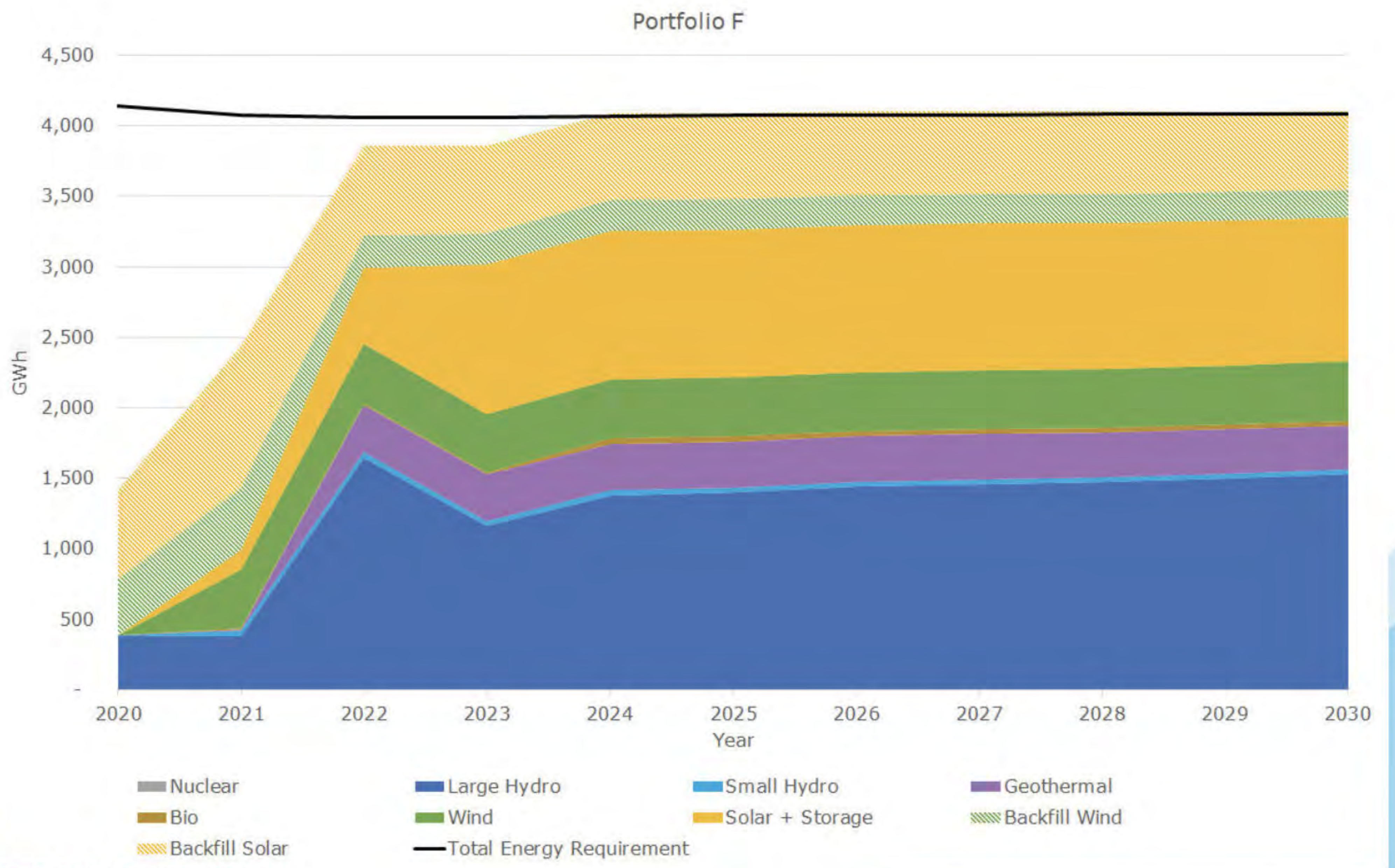

Portfolio C
GWh
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Year
Nuclear
Large Hydro
Small Hydro
Geothermal
Bio
Wind
Solar + Storage
Backfill Wind
Backfill Solar
Total Energy Requirement



SIL CLEAN ENERGY



Portfolio D
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
GWh
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Year
Nuclear
Large Hydro
Small Hydro
Geothermal
Bio
Wind
Solar + Storage
Backfill + PG&E Wind
Backfill + PG&E Solar
Total Energy Requirement


Portfolio F
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-
GWh
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Year
Nuclear
Large Hydro
Small Hydro
Geothermal
Bio
Wind
Solar + Storage
Backfill Wind
Backfill Solar
Total Energy Requirement

APPENDIX C

Ascend Analytics

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IRP Portfolio Modeling Results

Summary of PowerSimm results for all IRP modeling portfolios.

Daniel Weingarten
Dave Millar
7/1/2020

Analysis Summary

- Five portfolios were built to achieve distinct RPS, carbon-free, and CPUC reference system targets.
- All portfolios were modeled in PowerSimm to simulate the cost, energy position, and risk dimensions of each portfolio under the dynamic conditions of CAISO's renewable-heavy system.
- PowerSimm also modeled portfolio emissions from dynamically modeled hourly market purchases to cover Clean Net Short position, providing a more accurate calculation than the average hourly shapes used in the CPUC's Clean Power Calculator tool.
    - For IRP purposes, submitted emission values are calculated using the CPUC calculator tool.

Results Summary

- All portfolios assessed for total cost (A – Preferred, B – RPS-Only, C – 75% RPS) all have similar net costs.
- Portfolios A and C serve all of load with clean energy on a net yearly basis and, as a result, have dramatically lower emissions and hourly Clean Net Short positions.
- While portfolio C is slightly less costly than portfolio A, it has slightly more emissions and hourly clean net short position due to an increased reliance on solar resources.
  - Portfolio C also has more long-term PPA contracts than A as a result of increased long-term RPS targets. As a result, portfolio diverges slightly from SVCE's historical strategy of relying on short-term purchases as much as possible.
- Portfolio "A – IRP Preferred" best serves SVCE's needs across RPS, carbon-free, clean net short, cost, and emissions metrics.

Planning Portfolio Composition Strategy

- All portfolios contain all existing and in-process contracts and BTM load modifier resources
  - **Physical PPAs:** Big Beau (solar+storage), RE Slate (solar+storage), Rabbitbrush (solar+storage), Ormat (geo), Coso (geo), Yellow Pine (solar+storage), Aratina (solar+storage), and WAPA WBR (large hydro).
  - Existing RPS (2021) and GHG-free contracts (2021-2023)
  - BTM load modifier resources account for Residential+Commercia Electrification, Energy Efficiency, and BTM storage as forecasted by E3
- Internal portfolios (IRP Preferred, RPS-Only, 75% RPS)
  - Portfolios were "backfilled" with solar and wind physical PPAs to achieve long-term targets.
    - Solar and wind were added in a 70/30 ratio by nameplate capacity until each Compliance Period Long-Term RPS target was met
    - All backfill solar included a 4-hour storage component sized at 40% of the project's nameplate solar capacity
    - All backfill resources are assumed to be 10-year PPA contracts for all energy and attributes
  - For IRP Preferred and 75% RPS portfolios, GHG-free targets were met using 50 MW of large hydro PPA contracts plus sufficient short-term Index+ Carbon-free credit purchases to meet targets.
    - Large hydro PPA is assumed to include energy and attributes.
    - Index+ carbon-free credits were purchases until portfolio met 106% of net yearly forecasted load with RPS or carbon-free credits (to account for T&D losses)
    - RPS-Only portfolio meets all RPS targets but ignores additional carbon-free targets.
- RPS/GHG Targets
  - IRP Preferred and RPS-Only have identical RPS and GHG-free targets, while 75% RPS portfolio has increased Long-Term RPS requirements as well as increased RPS targets (linearly scaling up from 52% in 2026 to 75% in 2030).

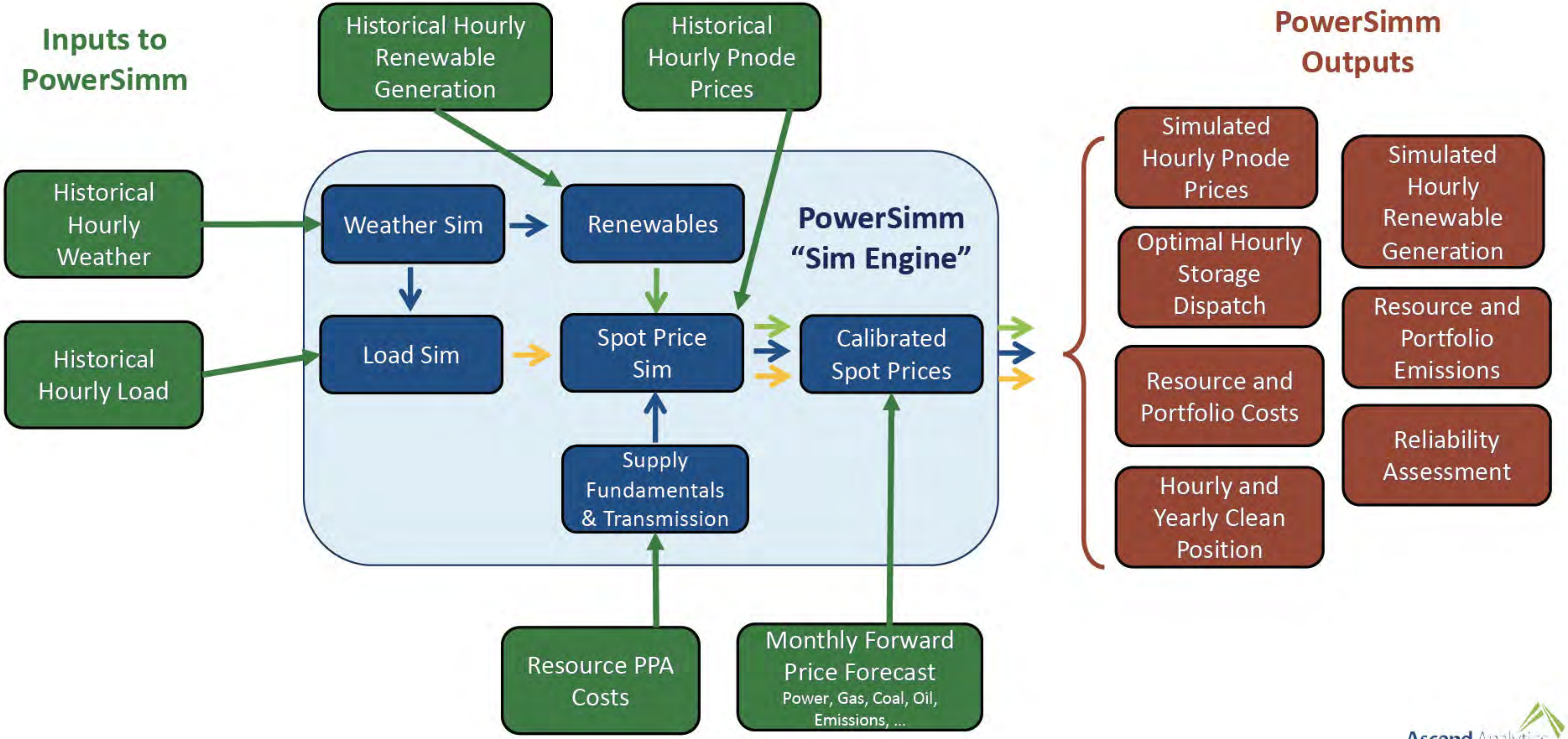
Reference System Portfolio Composition Strategy

- All portfolios contain all existing and in-process contracts and BTM load modifier resources
  - **Physical PPAs:** Big Beau (solar+storage), RE Slate (solar+storage), Rabbitbrush (solar+storage), Ormat (geo), Coso (geo), Yellow Pine (solar+storage), Aratina (solar+storage), and WAPA WBR (large hydro).
  - Existing RPS (2021) and GHG-free contracts (2021-2023)
  - BTM load modifier resources account for Residential+Commercia Electrification, Energy Efficiency, and BTM storage as forecasted by E3
- Reference System Portfolios
  - SVCE's pro rata share of the CPUC Reference System Portfolio was calculated and then reduced by the amount of resources already under contract by SVCE in 2030 (physical PPAs listed at the top of this slide)
  - All remaining resources in the pro rata portfolio were added at the latest possible date that still achieved long-term RPS targets
    - Solar and Wind was introduced in 2021
    - Additional solar(+storage) and wind plus large hydro, small hydro, biogas/biomass, and Shed DR were added in 2027.
    - Standalone 2hr and 8hr storage was added in 2030.
  - All reference system portfolio resources are assumed to be 10+ year PPA contracts for energy and attributes
  - Additional Index+ RPS short-term purchases were made as necessary
- RPS/GHG Targets
  - Both Reference System Portfolios have the same RPS and GHG targets as the IRP Preferred and RPS-Only portfolios
    - SB 100 RPS targets through 2030 and remainder of yearly energy needs covered by GHG-free up to 106% of load (to cover T&D losses)

Summary of Portfolios

	[A] – IRP Preferred	[B] – RPS-Only	[C] – 75% RPS	[D] – 38 MMT RefSys	[E] – 46 MMT RefSys
Existing and In-Process PPA Contracts	✓	✓	✓	✓	✓
BTM Load Modifier Resources	✓	✓	✓	✓	✓
RPS Backfill *Solar/Wind at 70/30 ratio by capacity plus 4hr storage @ 40% of solar capacity*	✓	✓	✓	✗	✗
Large Hydro (50 MW)	✓	✗	✓	✗	✗
Index+ RPS Purchases	✓	✓	✓	✓	✓
Index+ GHG-Free Purchases	✓	✗	✓	✗	✗
Reference System Pro Rata Share	✗	✗	✗	✓	✓
Elevated RPS Targets	✗	✗	✓	✗	✗

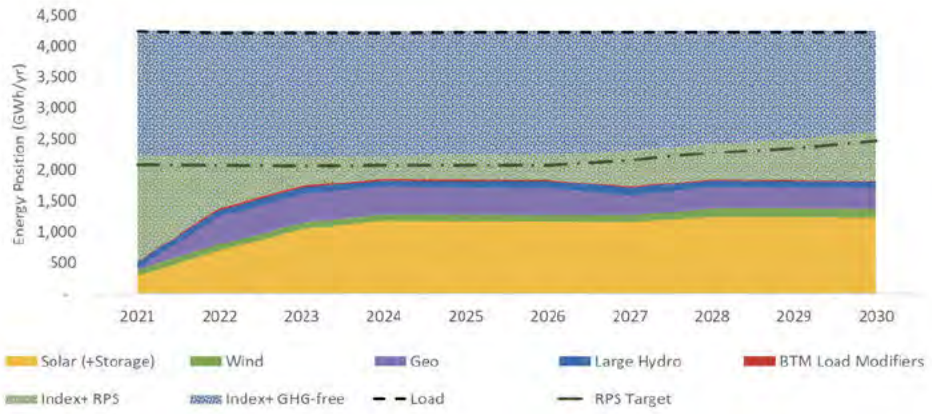
PowerSimm Modeling Framework



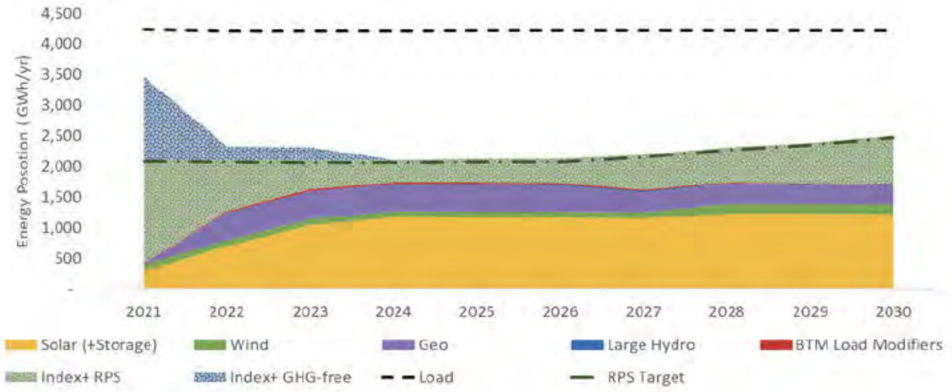
Energy Balance

- All portfolios meet RPS targets (dashed green line)
- [A] and [C] meet 100% of service load with GHG-free resources
    - [B] does not include GHG-free targets and so has a significant clean short position
- Portfolio [C] includes significantly more PPA physical resources due to increased Long-Term RPS targets.

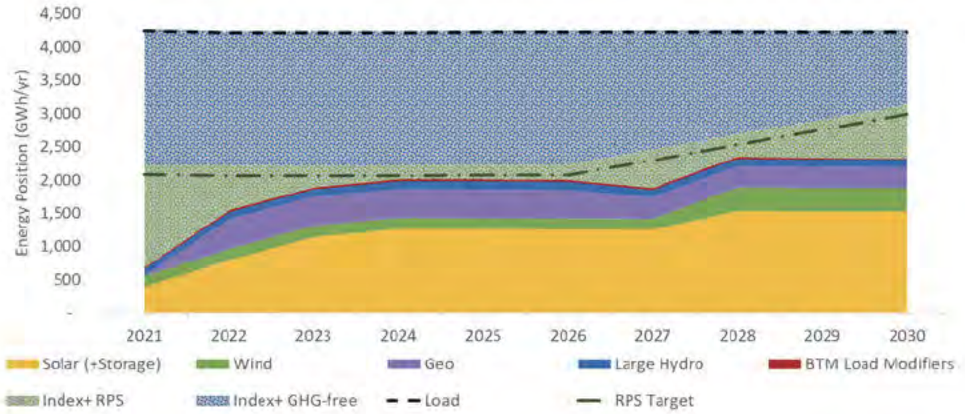
[A]
IRP Preferred



[B]
RPS-Only



[C]
75% RPS



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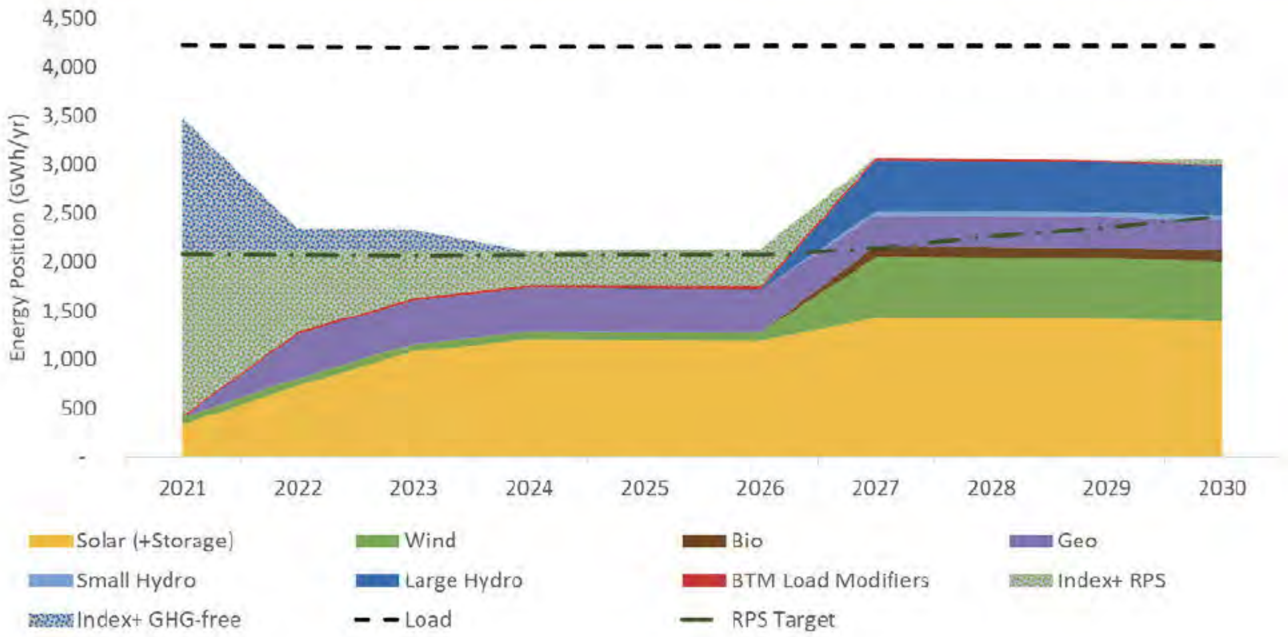
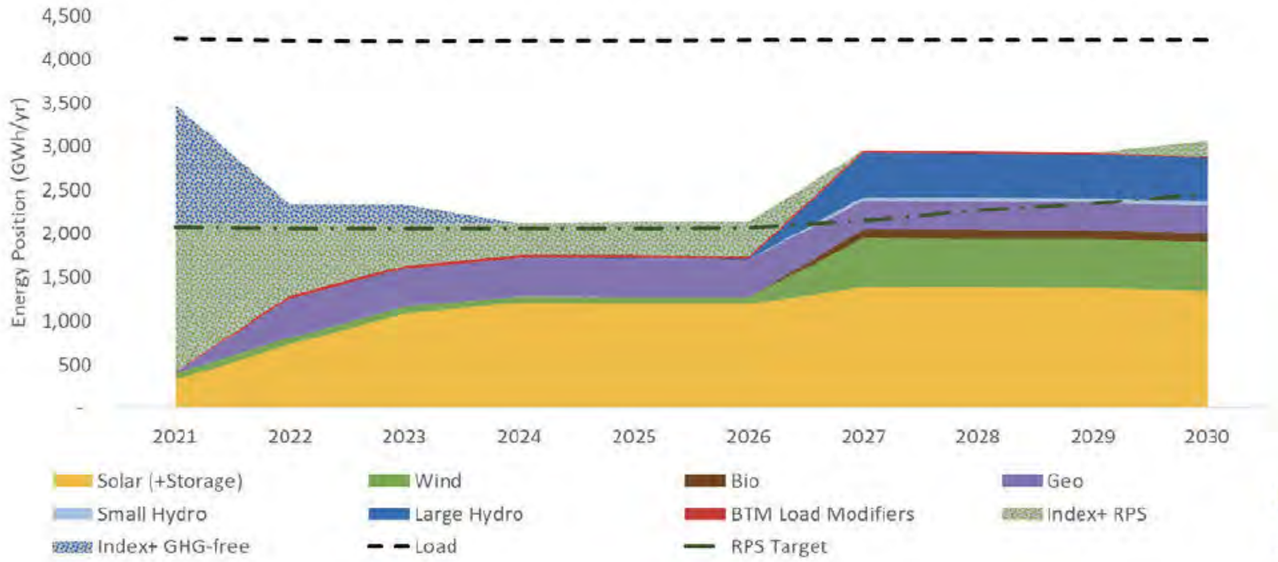
Energy Balance

- Composition of both Reference System portfolios are very similar
- Primary differences are slightly increased solar/wind and additional storage [D]

[D]
38 MMT RefSys

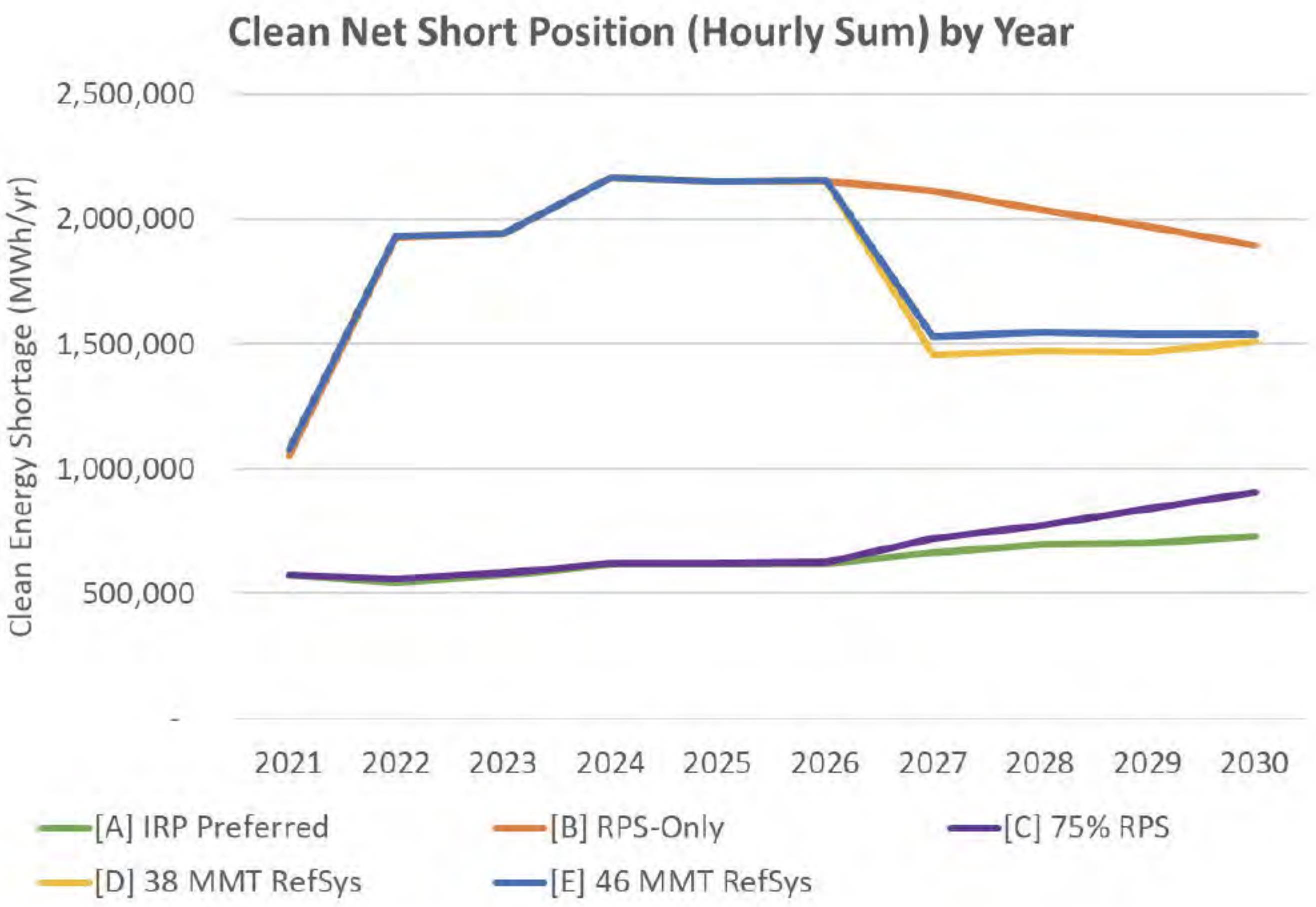


[E]
46 MMT RefSys



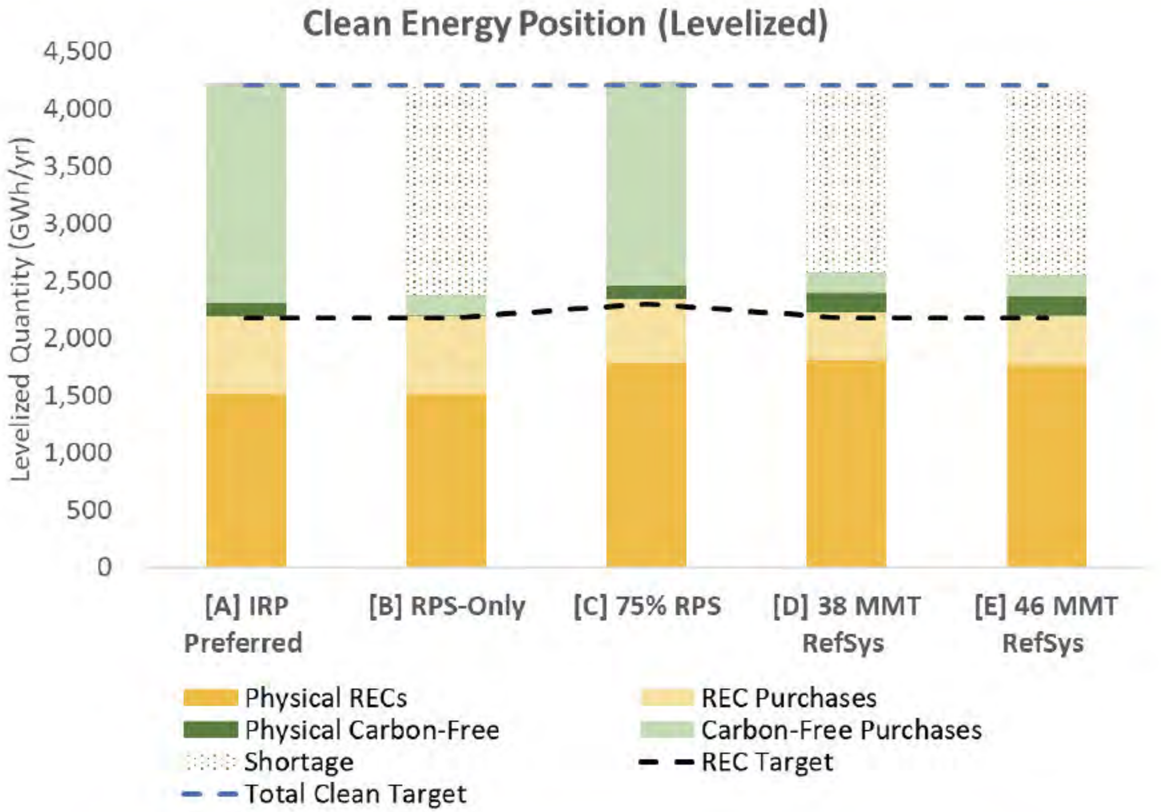
Hourly Clean Short Position

- Portfolios [A] and [C] were built to achieve SVCE's 100%-clean targets, resulting in significantly lower hourly clean shortages.
  - All other portfolios have no Index+ GHG-free purchases to cover Clean Short position.
- Clean Short position increases sharply between 2021-22 for [B], [D], [E] due to the expiration of 1357 MW of existing GHG-free short-term contracts that are not replaced.
- [C] has a slightly higher shortage position than [A] after RPS requirements increase in 2027, largely due to replacing Index+ GHG purchases with the less-desirable hourly shape of solar resources.



Average Clean Position

- Achieve RPS targets in each year from 2021-2030.
  - [C] has a higher RPS target in 2027-2030, which is why the average REC target line is slightly higher for [C] in the graph to the right.
- Portfolio [A] is largely similar to the Reference System portfolios with the addition of significant Index+ GHG purchases to meet all of load with clean energy.
  - As long as [A] can purchase at least 100 GWh of Index+ GHG credits on average (out of ~1,900 GWh/yr planned purchases) then it will be able to achieve RefSys 38 MMT emissions targets.
  - Any Index+ GHG procured after that will contribute towards further reducing hourly Clean Net Short position.
- Reference system portfolios [D] and [E] both achieve smaller yearly Net Clean positions than [B] due to increased biogas and hydro resources.

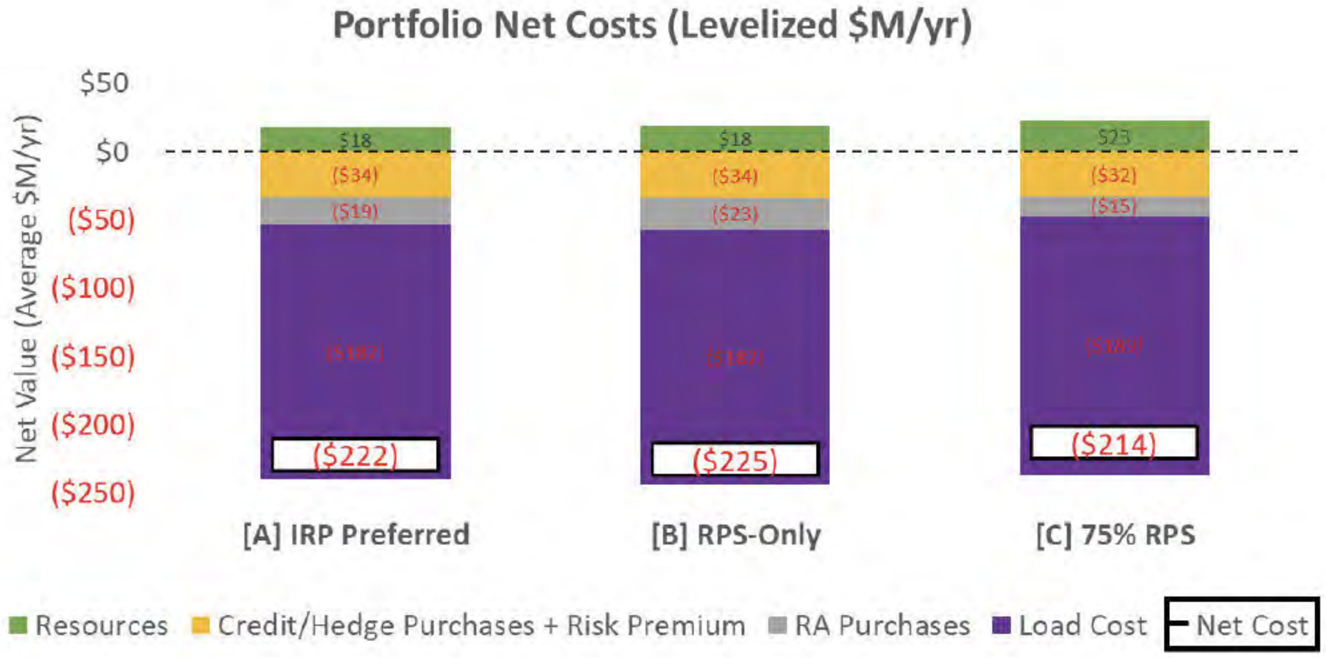


	Net Clean Position (Yearly)	Clean Net Short (Hourly)
[A] IRP Preferred	23,258	-633,489
[B] RPS-Only	-1,830,735	-1,939,651
[C] 75% RPS	34,634	-682,521
[D] 38 MMT RefSys	-1,583,383	-1,732,516
[E] 46 MMT RefSys	-1,613,935	-1,757,607

Portfolio Net Costs

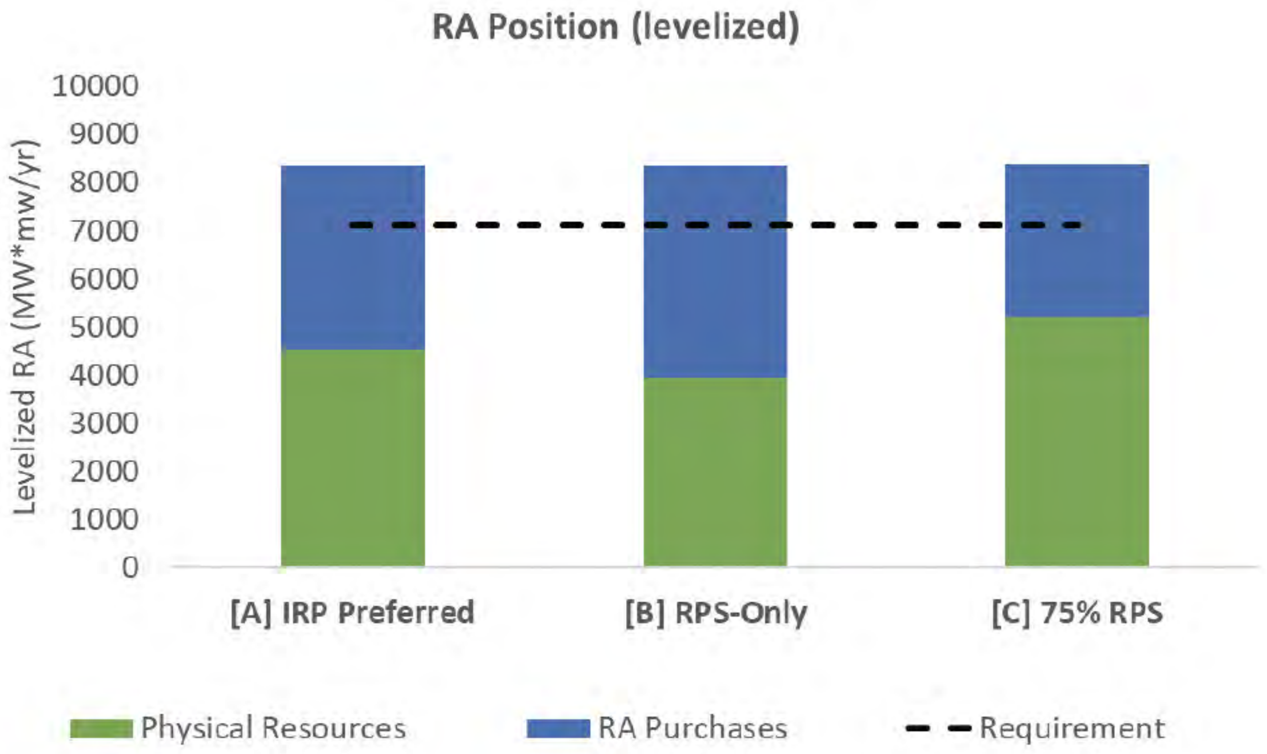
Note: positive values imply net revenue for that category, negative values imply net cost.

- PPA resources – especially solar and wind – tend to provide net value to the portfolios due to their PPA costs being competitive against market energy prices plus the added value of RA and PCC1 attributes.
- Short-term purchases (Index+ PCC1/GHG-free credits, energy hedge IST purchases) are comparable across all planning portfolios, on average.
- The increased quantity of physical PPAs in [A] and [C] (especially the 50 MW hydro) provide significantly more RA, reducing RA purchase costs compared to [B].
- Load is slightly more expensive in [C] due to the increased RPS target.
    - Some GWh of load that are served by cheaper GHG-free resources/credits in [A]/[B] must now be served by more expensive RPS resources/credits in [C].
- NOTE: Reference System portfolios [D] and [E] were not modeled for cost due to cost assumptions for those resources not being made available when modeling began.



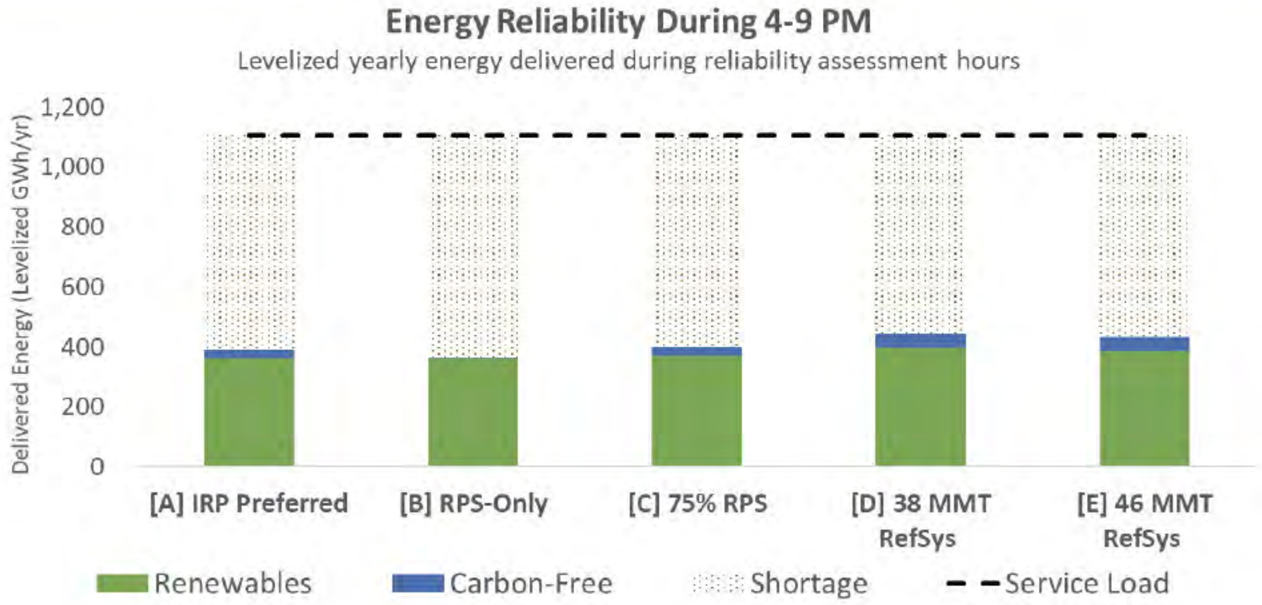
RA Position

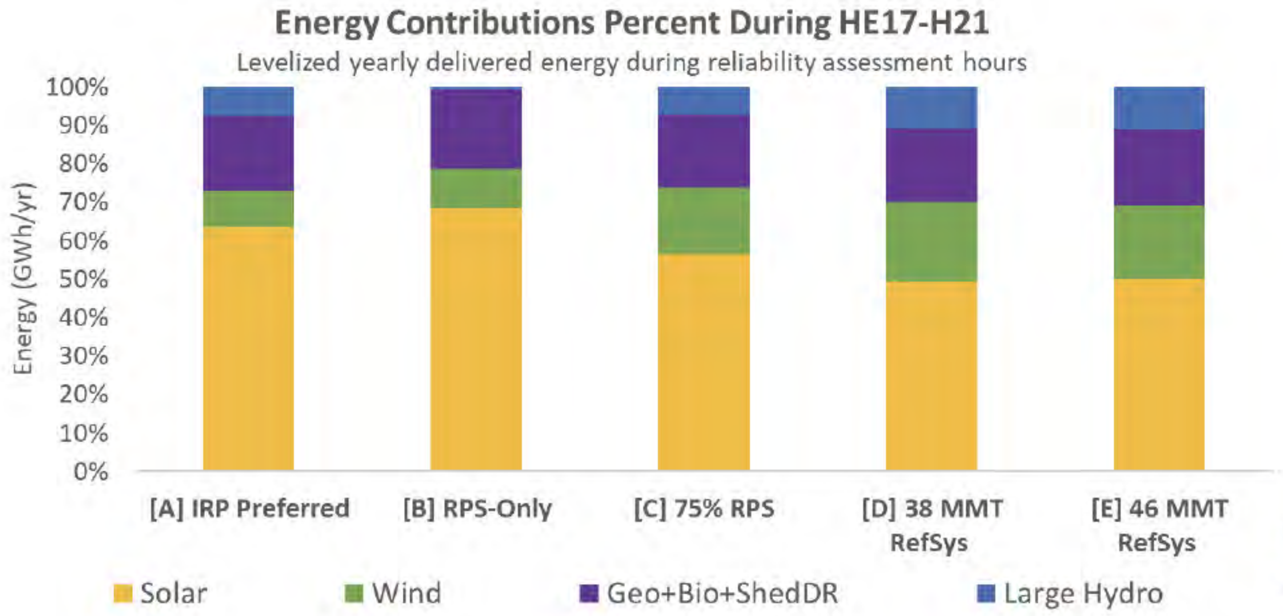
- RA purchases are targeted to exceed monthly targets by >20 MW in each month, resulting in a yearly RA surplus.
  - RA purchases are assumed to be short-term monthly contracts.
- RA monthly targets are set by 2019 targets and kept constant throughout 2021-2030
  - Actual RA targets will vary by year
  - Yearly load forecast is flat, so actual RA targets not expected to change significantly
- ELCC values of renewable resources are kept constant through study period at 2019 CPUC values
  - ELCC values are expected to reduce over time, reducing the amount of RA provided by physical resources
  - This model accounts for this reduction through over-procurement of RA purchases.



Energy Reliability: 4-9 PM

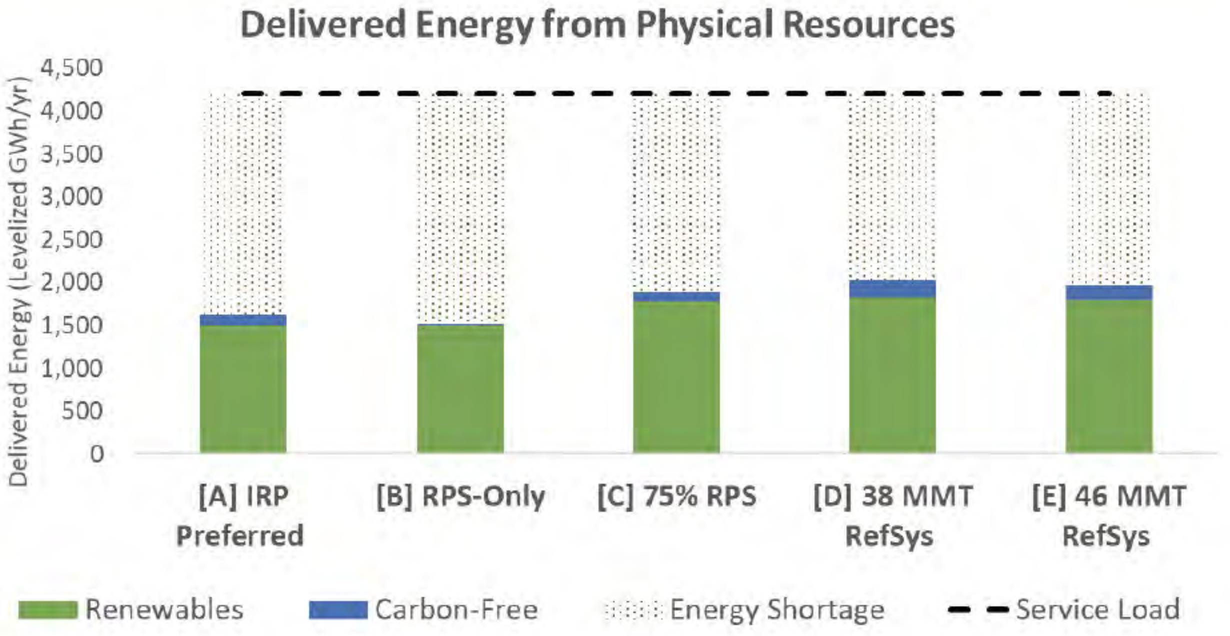
- Between 4-9 pm SVCE is supplying ~1/3 of load with energy from physical PPA resources.
  - All remaining energy needs are forced market exposure.
- Energy from physical PPA resources is primarily supplied by PCC1 resources between 4-9 pm, with batteries helping extend the availability of solar energy.
- Coso geothermal provides significant energy value during these hours due to few other PCC1 resources that can provide reliable evening energy.

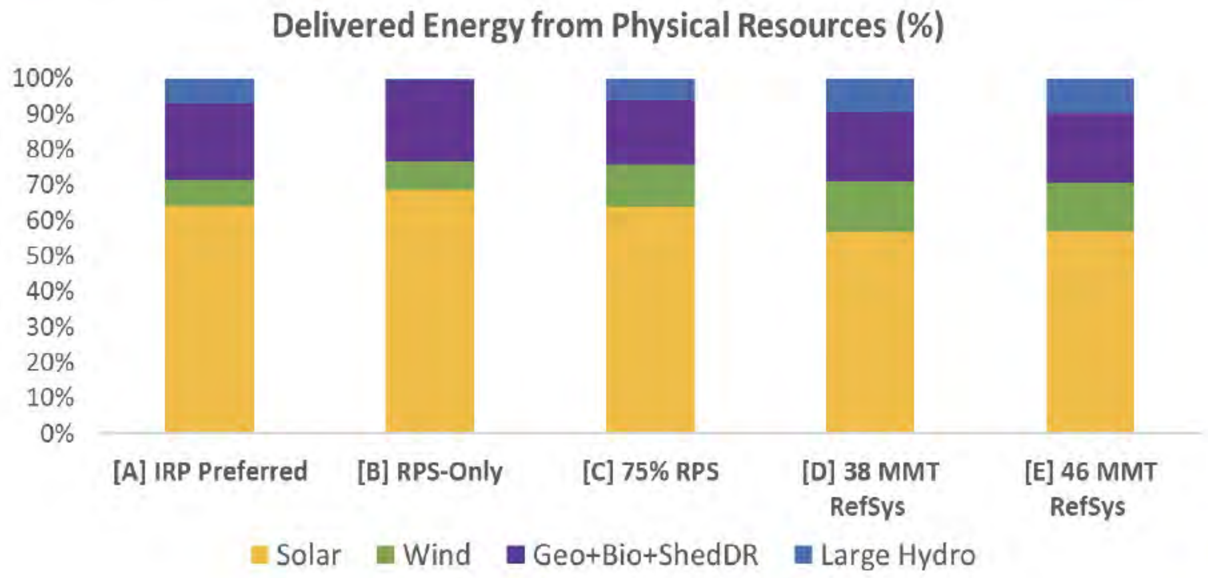




Energy Reliability: All Hours

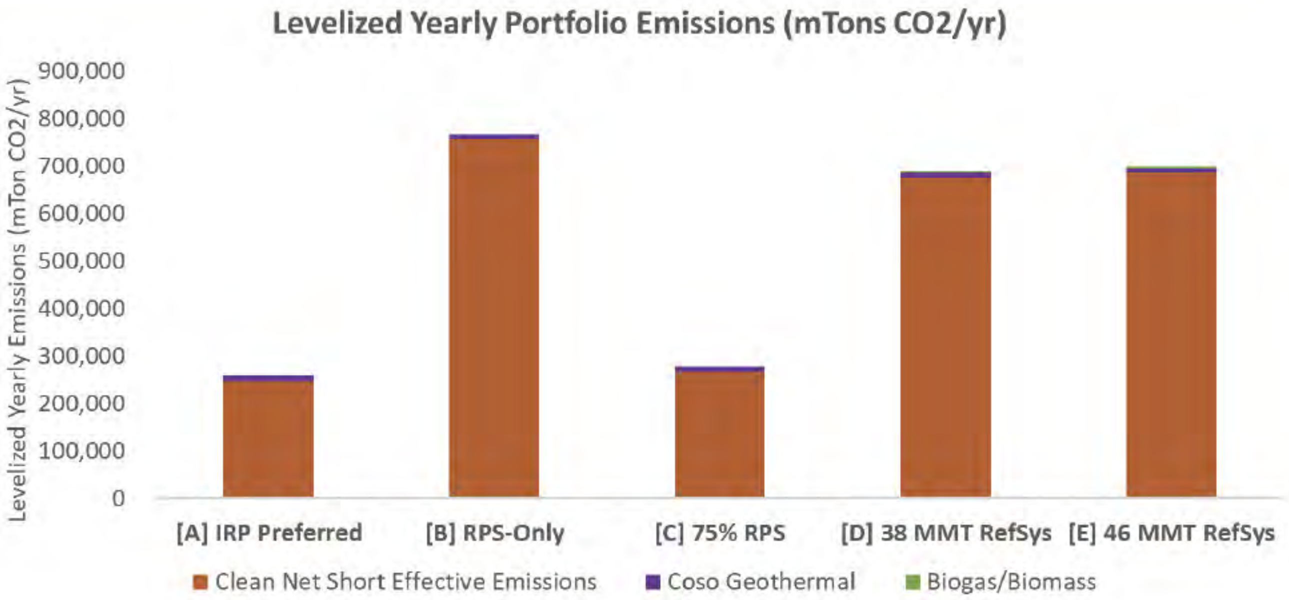
- All portfolios receive most of their physical energy from PCC1 resources across all hours.
- All portfolios supply an average of ~1/3 of energy needed to serve load.
  - [C], [D], and [E] furnish slightly more energy due to increased procurement of long-term physical PPAs
- Wind resources provide slightly more energy relative to other resources when viewed across all hours vs 4-9 pm.
  - Other resource types are roughly similar in portion of energy provision.

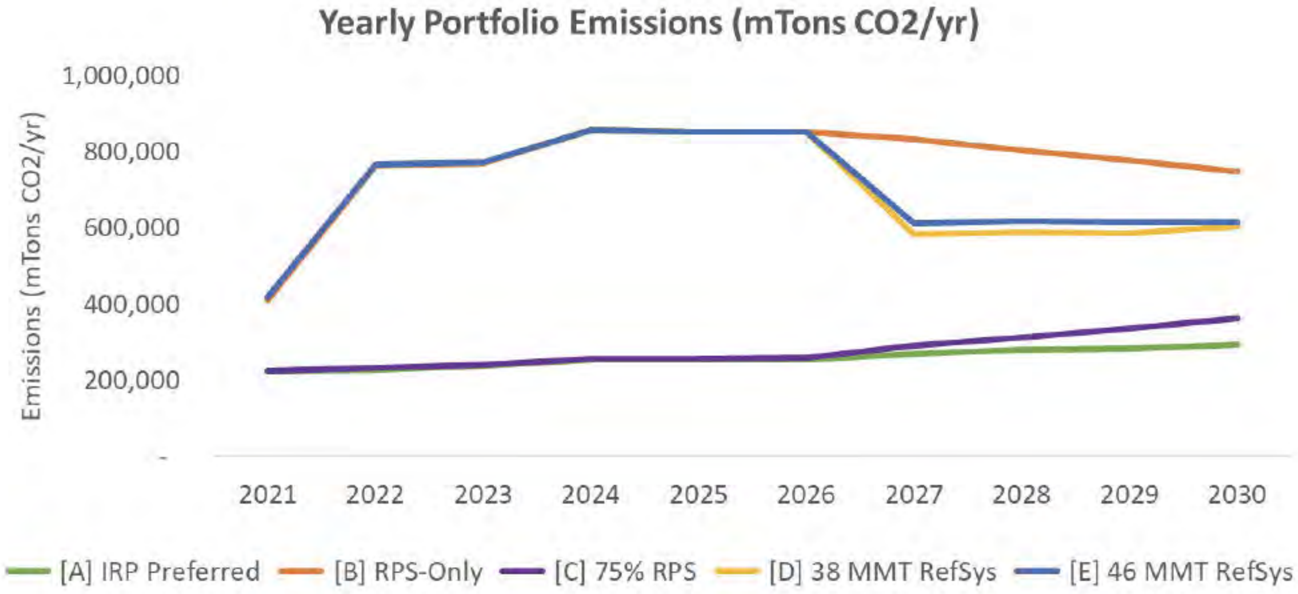




Emissions

- Nearly all emissions are due to effective emissions from market purchases.
  - Portfolios [A] and [C] cover all of load with REC or GHG-free energy/credits, resulting in significantly reduced emissions.
- [C] has slightly more emissions than [A] due to replacing some Index+ GHG purchases with the less-desirable shape of solar PPA resources.
- IRP emissions submitted values were calculated using the CPUC Clean Power System calculator tool and may differ from PowerSimm values.
  - PowerSimm calculates hourly energy position and assigns emissions only to market purchases made to cover Clean Net Short position (i.e. hours when load > resources).
  - PowerSimm calculations are more accurate and responsive to weather/market/load conditions than CPUC's calculator which uses averaged hourly shapes for all resources.





Portfolio Performance Summary

- All portfolios assessed for total cost (A – Preferred, B – RPS-Only, C – 75% RPS) all have similar net costs.
- Portfolios A and C serve all of load with clean energy on a net yearly basis and, as a result, have dramatically lower emissions and hourly Clean Net Short positions.
- While portfolio C is slightly less costly than portfolio A, it has slightly more emissions and hourly clean net short position due to an increased reliance on solar resources.
  - Portfolio C also has more long-term PPA contracts than A as a result of increased long-term RPS targets. As a result, portfolio diverges slightly from SVCE's historical strategy of relying on short-term purchases as much as possible.
- Portfolio A – IRP Preferred best serves SVCE's needs across RPS, clean, clean net short, cost, and emissions metrics.

	[A] - Preferred	[B] - RPS-Only	[C] - 75% RPS	[D] - 38 MMT RefSys	[E] - 46 MMT RefSys
Net Cost ($M)	$221.9	$225.4	$213.5	-	-
RA Costs ($M)	$19.0	$22.8	$14.5	-	-
Cost Risk Premium ($M)	$2.6	$2.6	$2.6	-	-
Emissions (mTons)	257,310	766,812	276,436	688,355	698,143
Net Carbon-Free Position (GWh)	23	-1,831	35	-1,583	-1,614
Hourly Carbon-Free Shortage (GWh)	-633	-1,940	-683	-1,733	-1,758
Energy Reliability 4-9 PM (GWh)	-716	-744	-706	-661	-673
Energy Reliability ATC (GWh)	-2,574	-2,682	-2,304	-2,181	-2,223

Portfolio Performance Summary

- Portfolio Recommendation: [A] – Preferred
  - Emissions
    - The Preferred portfolio has the lowest emissions out of all portfolios considered portfolios (primarily due to 100% clean composition and lower reliance on solar than other portfolio).
  - Cost
    - Cost is comparable to other portfolios analyzed
    - While more costly than the 75% RPS portfolio, the Preferred portfolio has lower emissions, a smaller hourly clean short position, and less dependence on long-term PPA contracts (which better matches SVCE's current strategy of maximizing short-term purchases).
  - Reliability
    - All portfolios analyzed are comparably reliable. The 75% RPS portfolio is slightly more reliable but does so at the cost of increased hourly clean short position.
    - The Preferred portfolio commits to a smaller amount of long-term PPA contracts than the 75% RPS portfolio, leaving room to contract additional reliability increasing clean-energy PPAs (geo, hydro, etc) as pricing and technology improves.

	[A] - Preferred	[B] - RPS-Only	[C] - 75% RPS	[D] - 38 MMT RefSys	[E] - 46 MMT RefSys
Net Cost ($M)	$221.9	$225.4	$213.5	-	-
RA Costs ($M)	$19.0	$22.8	$14.5	-	-
Cost Risk Premium ($M)	$2.6	$2.6	$2.6	-	-
Emissions (mTons)	257,310	766,812	276,436	688,355	698,143
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Energy Reliability ATC (GWh)	-2,574	-2,682	-2,304	-2,181	-2,223

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APPENDIX D

Appendix D

IEPR template table for 38 MMT Scenario Alternative Portfolio[1]

Year	Retail Sales (MWh)[2]	Peak Demand (MW)[3]	Residential Retail Sales (MWh)[4]	Residential Peak Demand (MW)	Non-Residential Retail Sales (MWh)	Non-Residential Peak Demand (MW)	Residential Customer Counts[5]	Nonresidential Customer Counts
2020	4,061,236	873	1,380,820	297	2,680,416	576	240,543	27,881
2022	3,995,036	880	1,358,312	299	2,636,724	581	242,954	28,161
2026	4,001,388	878	1,360,472	299	2,640,916	580	247,850	28,728
2030	3,988,015	869	1,355,925	295	2,632,090	574	252,844	29,307

[1] All information pulled from the CSP calculator for the 38 MMT Scenario Alternative Portfolio
[2] Retail load forecast plus custom-input building electrification, with 8% losses removed from electrification inputs
[3] Peak demand pulled from Columns AG-AJ on the Demand Calc tab
[4] Retail sales multiplied by the 0.66 Custom C&I Percentage of Total on the Demand Inputs tab