June 12, 2024

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Managing Sempra's Costs & Risks from Electrification

Final Presentation Report

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Final Presentation Report

Managing Costs and Risks Instead

Meeting Overview

Agenda:

1. Problem Definition
2. Analytical Approach
3. Quick Summary of Insights
4. Historical Load Growth and Factors Affecting Future Demand
5. Modeling Future Load
6. Marginal Cost Model
7. Case Studies
8. Summarize Overall Recommendation

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The Problem

The costs of satisfying changing electricity loads requires more expenditures and higher customer prices, leading to **public backlash** against SDG&E.

The Anatomy of a Backlash

Price Increases

Service Reliability Issues

Environmental Concerns

Customer Service

Health/Safety Concerns

r/sandiego • 2 yr. ago
GreatOneLiners

Listen

How do we push back on SDGE?

What do we need to do to push back on pricesv

175 · 120 · Share

Ad

LOCAL NEWS

New filing reveals 1/4 of SDG&E customers are past-due on their monthly bills

More than 361,000 customers were at least one month behind on their energy bills as of January 2024, which represents 26% of their residential customer base.

San Diego Gas & Electric Company

1.2 (23 reviews)

Unclaimed • **Electricity Suppliers**

Open Open 24 hours See hours

Write a review · Add photo · Share · Save

SCIENCE/ENVIRONMENT

Ballot Measure Forming to Push Out SDG&E, Create Public Utility

One of San Diego's most prolific public power advocates is behind Power San Diego, an effort to put municipalization before voters in November.

y MacKenzie Elmer October 25, 2023

onomy

San Diego utility customers furious about SDG&E rate hike request

By Erik Anderson / Environment Reporter
Contributors: Matthew Bowler / Video Journalist
Published March 7, 2023 at 9:54 AM PST

This story was published more than 1 year ago.

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Analytical Approach

Our two-pronged analytical approach combines **demand and price optimization models** with **case study analysis** to provide recommendations.

Modeling

Model 1: Predicts **demand** (load) using policy and behavioral levers to assess potential changes in marginal cost.

Model 2: Calculates **marginal cost** using predicted demand and grid infrastructure.

Case Studies

Analyzes situations where LSEs have experienced similar problems, including strategies employed, levels of success, and applicability to Sempra.

Recommendations

To be derived from analysis of Modeling and Case Studies.

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Findings & Recommendations

Brief Overview

Question	Key Finding	Strategic Implications & Recommendations
Is load increasing?	**Dynamic load is slightly decreasing (but is vulnerable to shocks).**	• TOU and **other behavioral load-shifting initiatives**
How do technological advancements and political changes impact consumer behavior?	**Overall load may go up with rooftop solar, (NEM 3.0), new California fixed charge, EV incentives, and AI.**	• **Level 2 charging** • Solar, NEM, and the new fixed charge. • New data center demand is unlikely, **but there should be a best practice/policy for data centers to pay for or provide their own energy.**
How do we minimize system and marginal costs given consumer behavior?	**MC is highest at peak load at night, and solar generation is unavailable. Battery storage stabilizes MC during peak hours, which leads to lower rates.**	• IPPs to enter the battery storage market • Residential batteries vs. grid-installed batteries • Strategic rate design based on load distribution
How can we be proactive about managing potential risks of backlash? (high costs, consumer pushback, ROI)?	**Regulatory collaboration, technology deployment, and financial planning are helping other utilities manage potential risks from electrification.**	• Rate structure approaches • Engage private firms. • IRA

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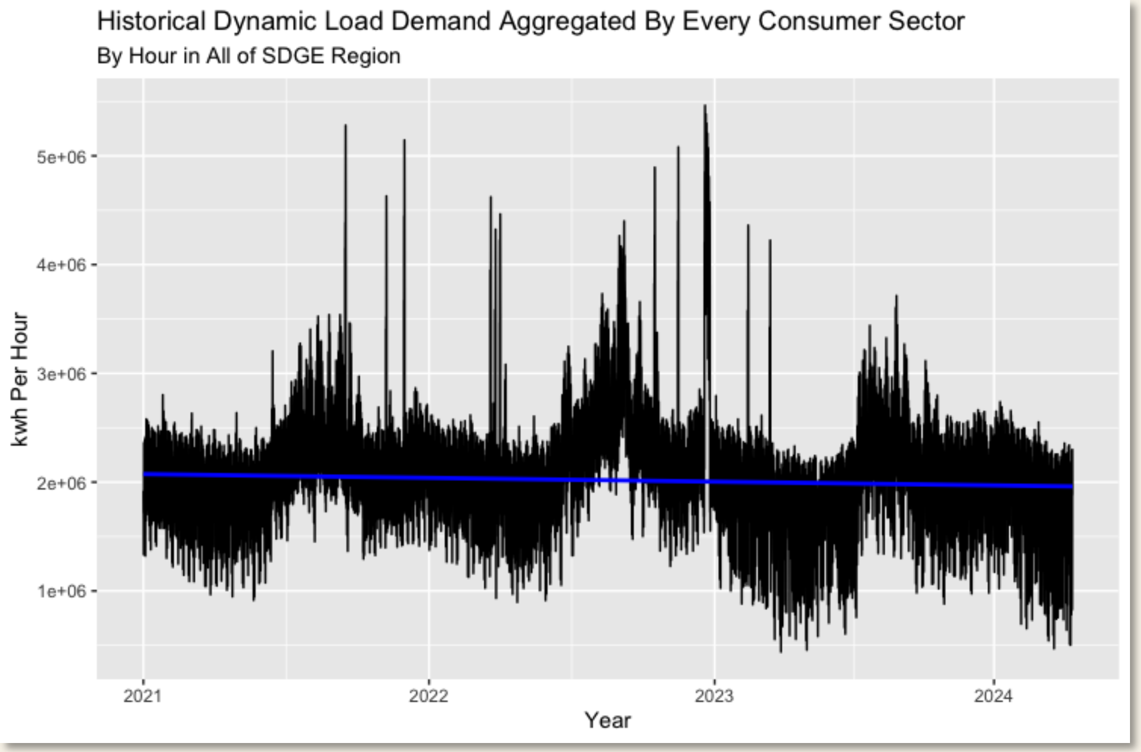
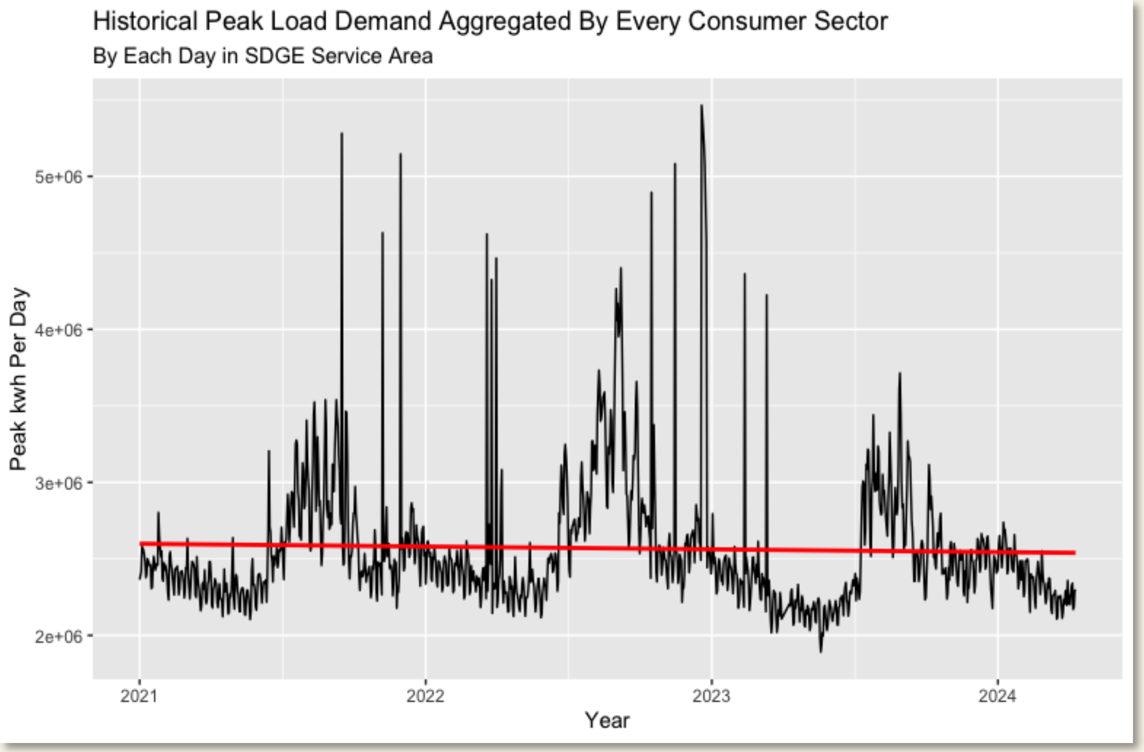
Dynamic load is trending slightly downwards in historical data.





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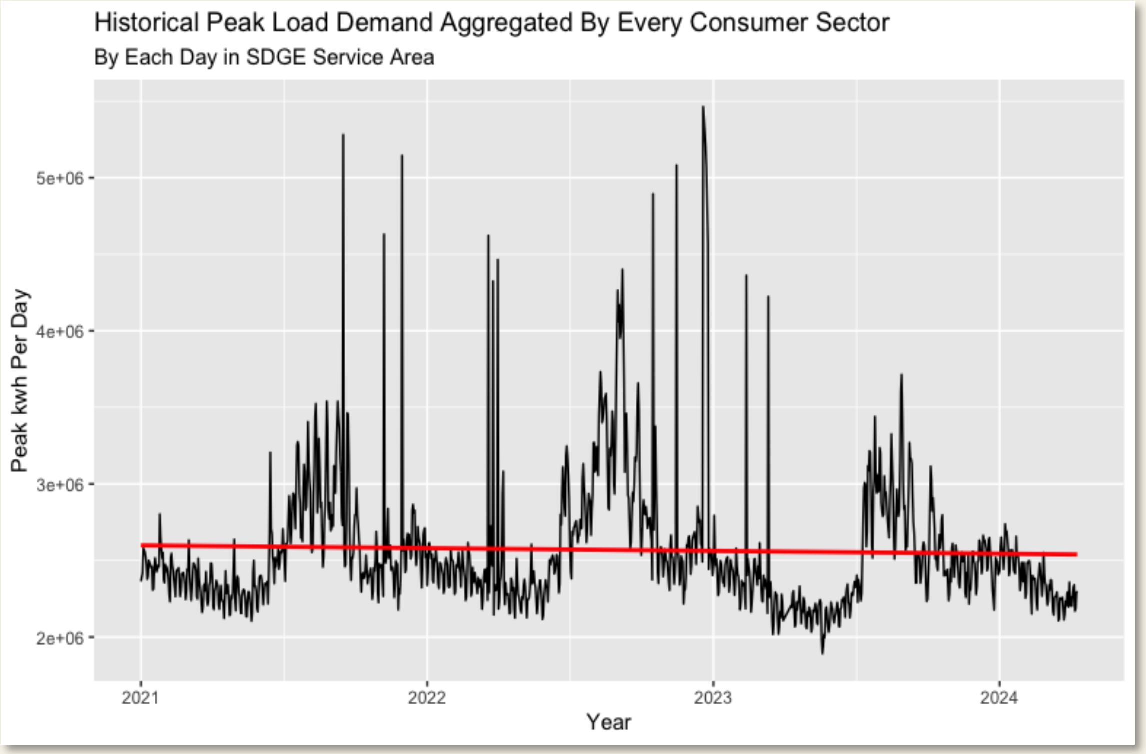
Dynamic load is trending slightly downwards in historical data.

- Population in 2022 decreased by 33,000 residents
- Load shifting with large industrial demand TOU + rooftop solar leads to a net lower load during the day



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We chose 5 political & technological factors to test their influence on load.

COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLAR GROWTH) NEM

RESIDENTIAL (FIXED CHARGE)

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Factors that Could Influence Load

Based on California Political and Technological Development

COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLAR GROWTH) NEM

RESIDENTIAL (FIXED CHARGE)

- Requires varying but significant levels of electricity
- Some level of load growth is guaranteed, by the nature of the technology
- Consumer-facing incentives and programs (federal, state, SDG&E)
- CA 2030 mandate

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Factors that Could Influence Load

Based on California Political and Technological Development

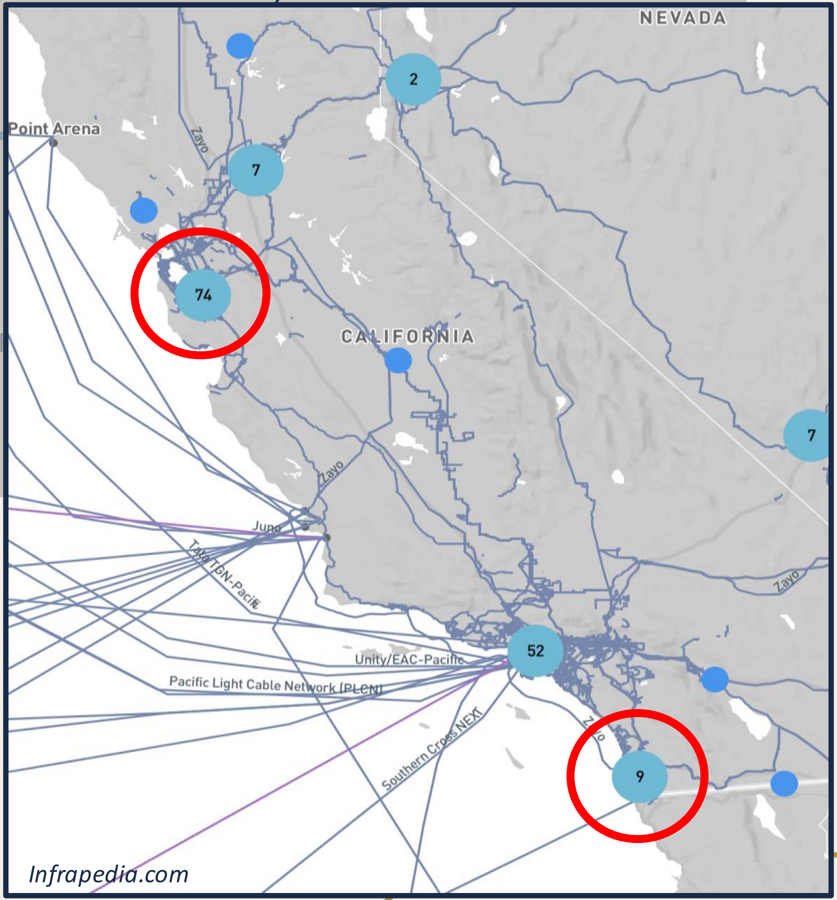
COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLA
NEM

Internet Infrastructure: Facilities, Undersea Cables, and Terrestrial Networks



- Would represent a high, relatively quick increase in load
- Unlikely, SDG&E is not a prime location

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Factors that Could Influence Load

Based on California Political and Technological Development

COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLAR GROWTH) NEM

RESIDENTIAL (FIXED CHARGE)

- TOU rate structure has been successful at managing peak demand

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Factors that Could Influence Load

Based on California Political and Technological Development

COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLAR GROWTH) NEM

RESIDENTIAL (FIXED CHARGE)

- Residential solar has, in the past, caused an "oversupply" of electricity in the middle of the day
- Sequence of NEM policies is decreasing residential solar adoption

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Factors that Could Influence Load

Based on California Political and Technological Development

COMMERCIAL (EV CHARGING)

INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)

SCHEDULE A6-TIME OF USE (PRICE) STRUCTURE

RESIDENTIAL (SOLAR GROWTH) NEM

RESIDENTIAL (FIXED CHARGE)

- New residential fixed charge changes the per kWh price of electricity, which may impact load (likely increase)

Modeling: Factors that Could Influence Load

Based on California Political and Technological Development

- COMMERCIAL (EV CHARGING)
- INDUSTRY (DATA CENTERS THAT COULD BE INFLUENCED BY AI GROWTH)
- RESIDENTIAL (SOLAR GROWTH) NEM
- SCHEDULE A6- INDUSTRIAL TIME OF USE (PRICE) STRUCTURE
- RESIDENTIAL (FIXED CHARGE)

Modeling: Demand Side

Assumptions and Output

Data Sources

- SDGE interconnection sites, SDGE Historic Dynamic Load, NOAA temperature data

General Model Structure (ARIMA forecast model):

- Demand at each hour (t) is a function of seasonal (S), time trends (T) and sector specific conditions (C).

$$\boxed{D_t = \beta_0 + \beta_1 S_t + \beta_2 T_t + \beta_3 C_t + \epsilon_t}$$

- To Assess the Impact of Influences on Load: Keep all other industries at low growth predictions and only change the sector of interest

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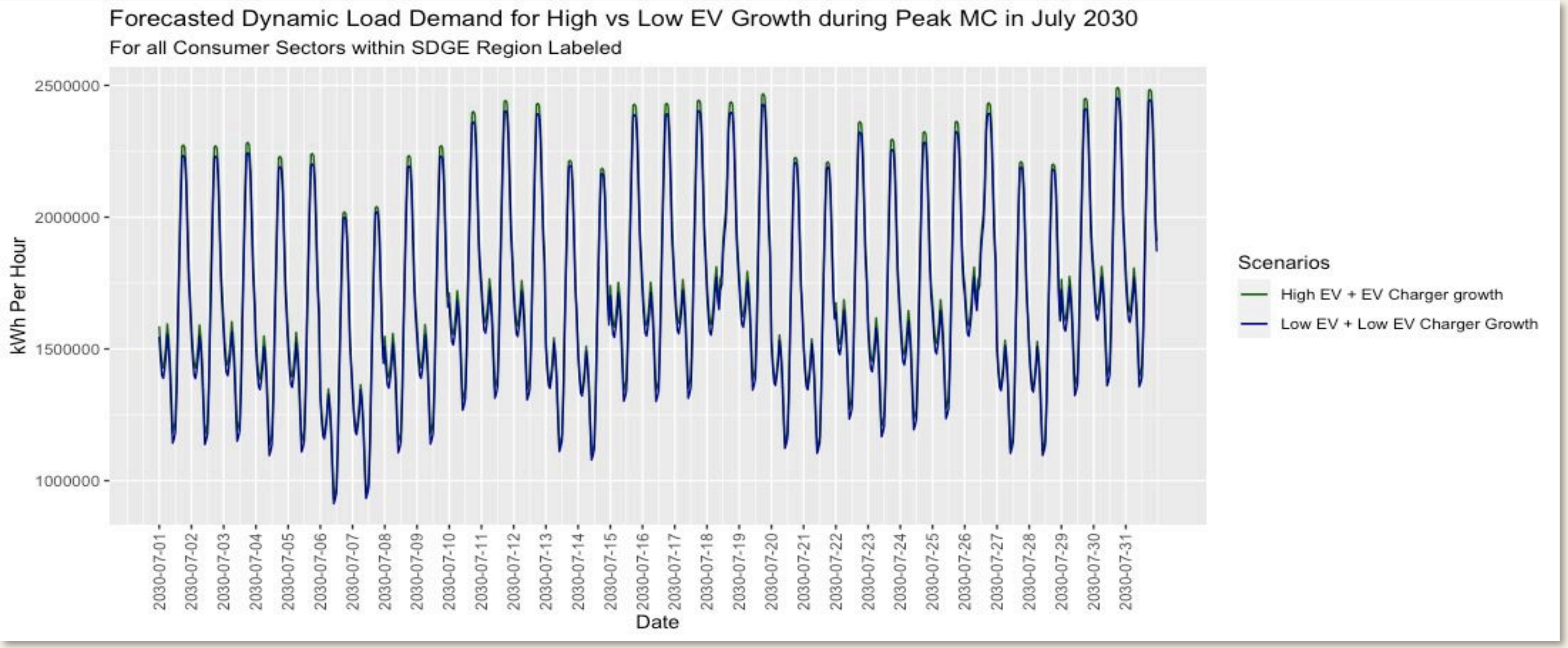
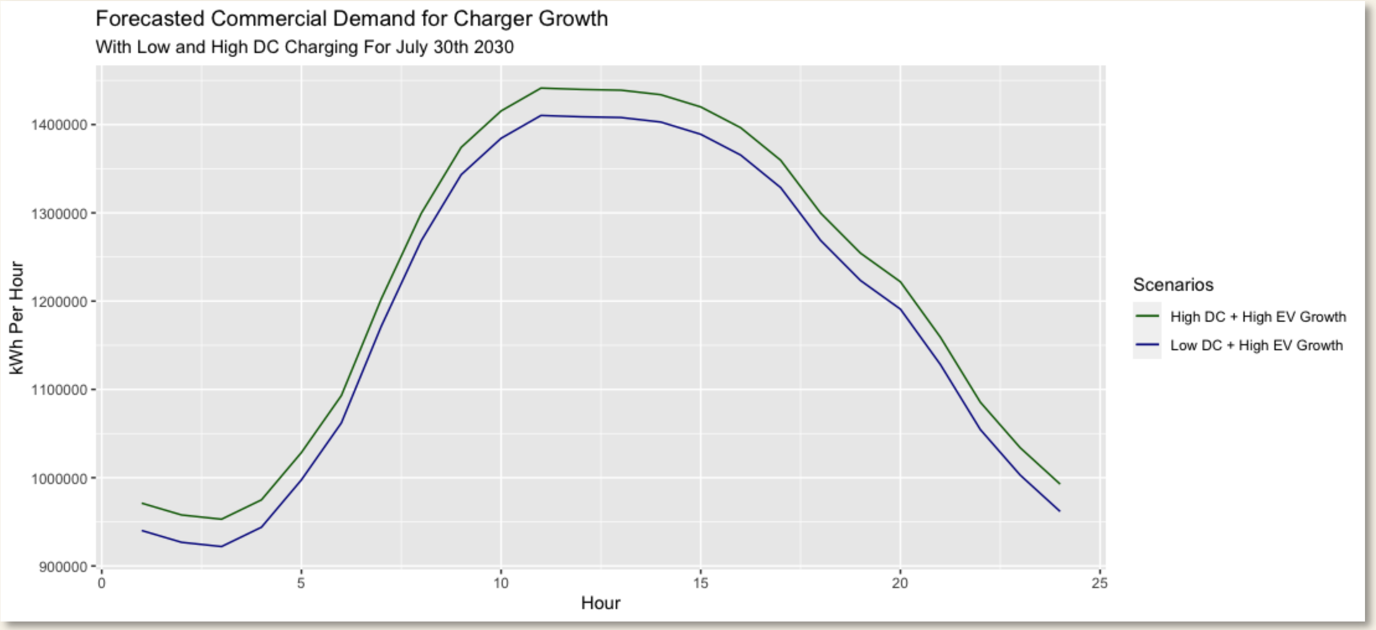
Commercial: EV Growth Does Not Lead to a Noticeable Growth in Overall Load

Largely Affects Peak Load



Commercial: EV load leads to greatest shock with growth in DC charging



- Higher DC charging adds a higher marginal unit of load
- Based on consumer behavior, this affects the load largely during the day

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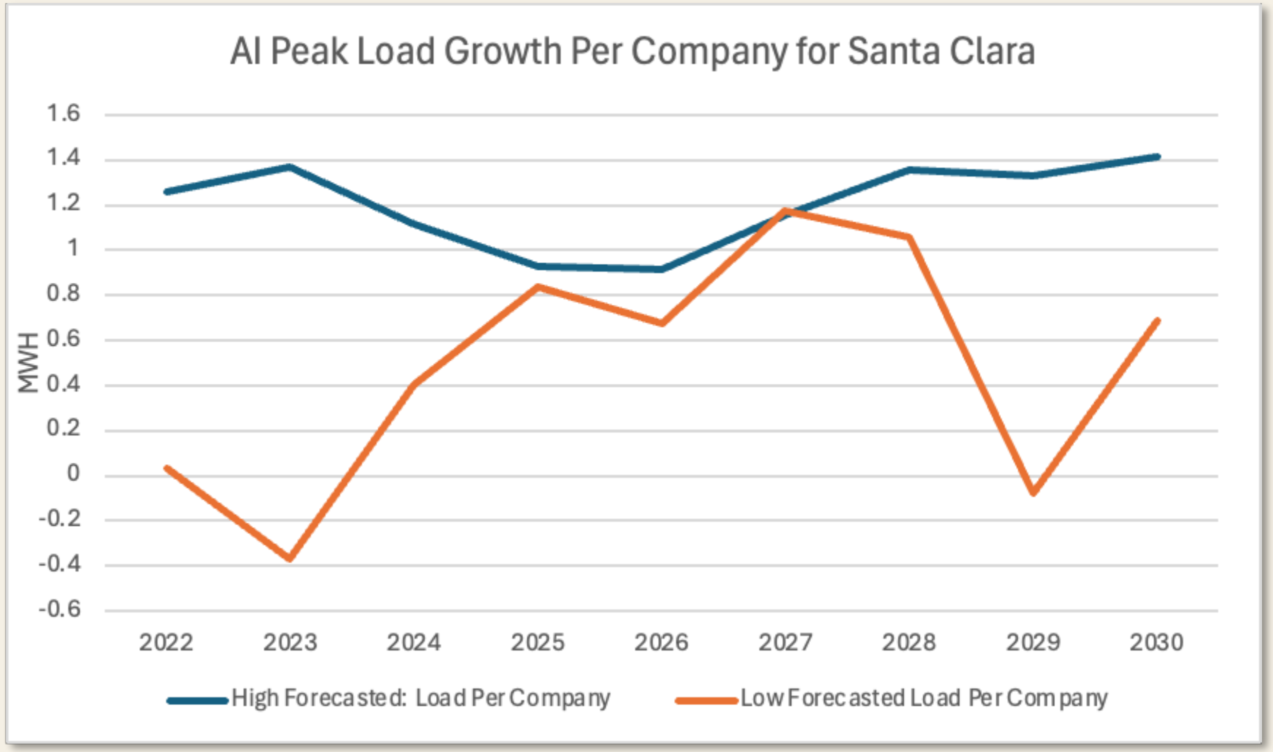
Industry: Data Center Growth Leads to High Load Growth

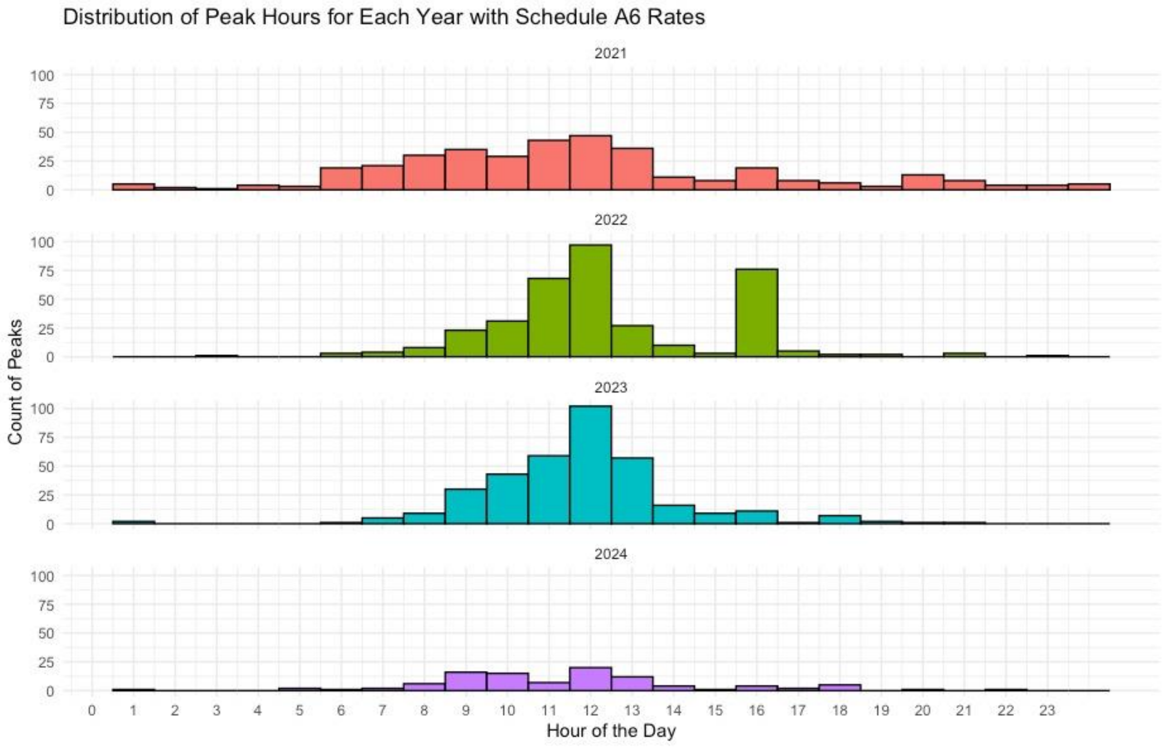
Not a risk for SDGE but it would contribute close to a megawatt hour every hour

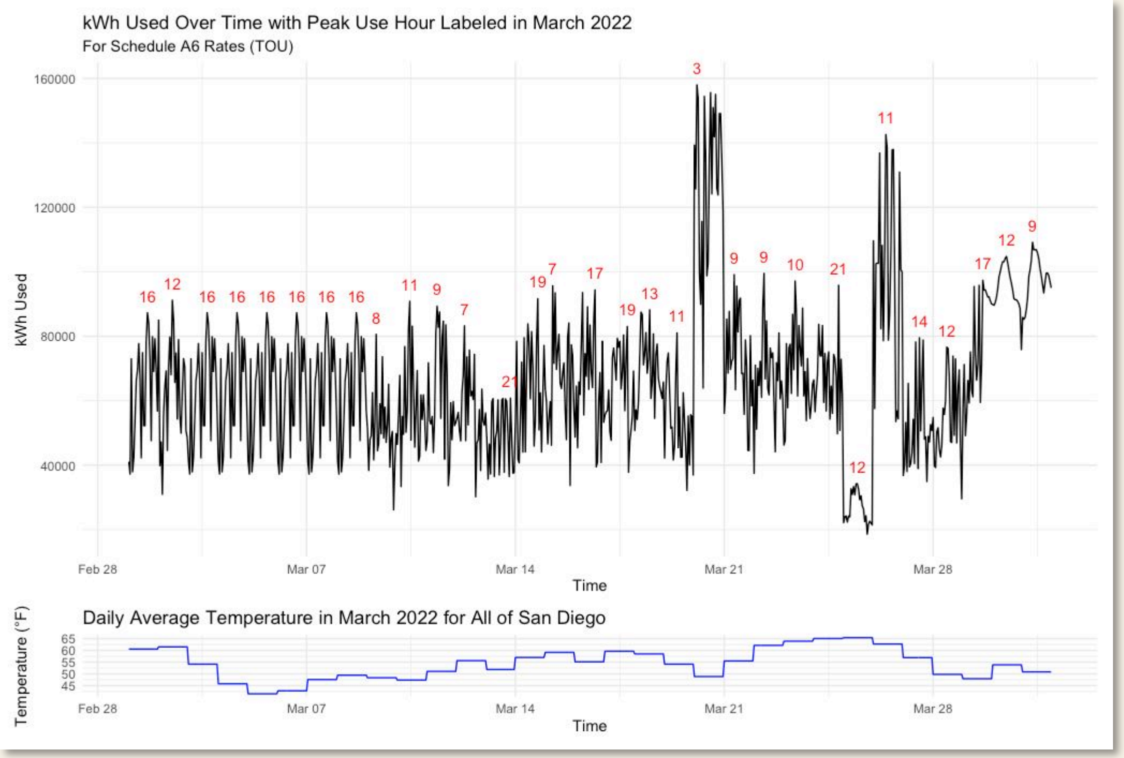
- Has a constant high energy load
  - Load factor of 80% of peak load



Schedule A6 (TOU): Price is Significant Determinant of Industrial Behavior but Sensitive to Shocks

TOU Industry Load has shifted to off-peak use, but is sensitive to extreme weather events (Cold Winter in 2022)





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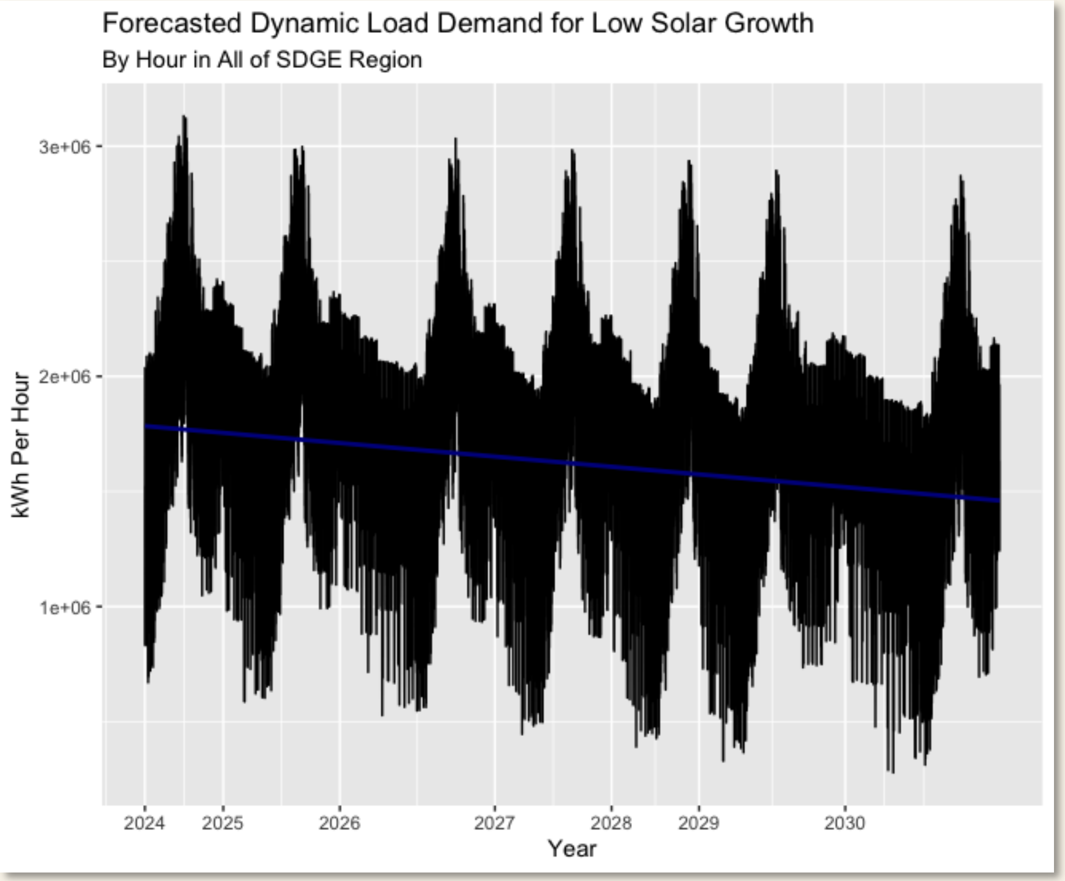
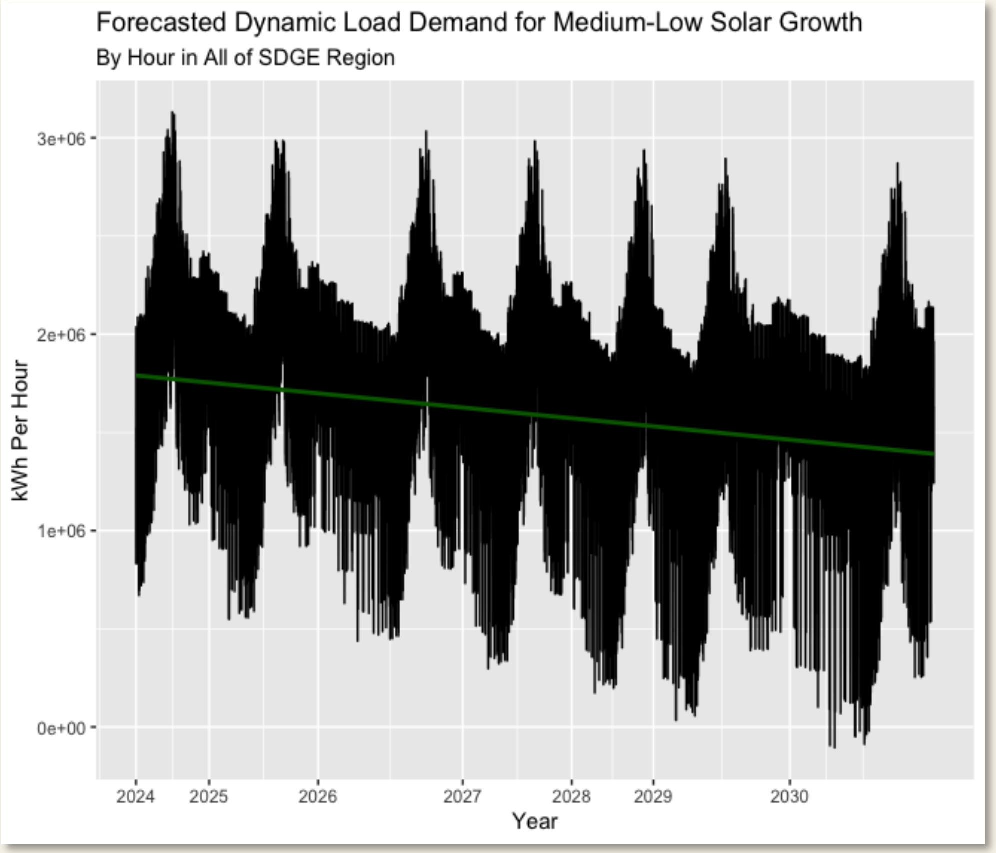
Residential: Solar Growth Has Not Addressed Peak Load

Consumers with forecasted solar growth into 2030 illustrate consistent on peak usage but illustrate overall lower load over time

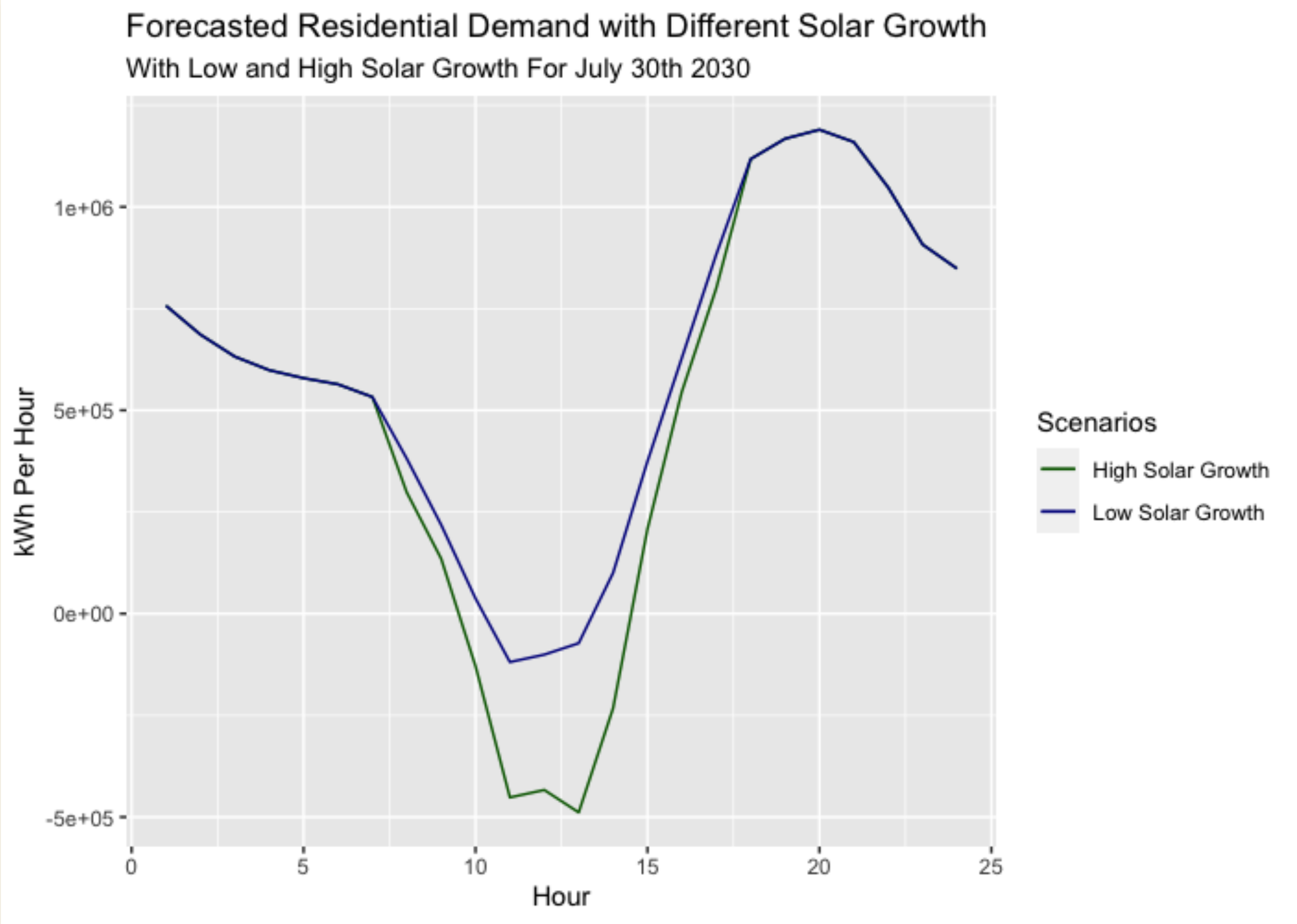




Dynamic Load: Across All Sectors

Residential: NEM's 3.0 Increases Dynamic Load During Solar Hours

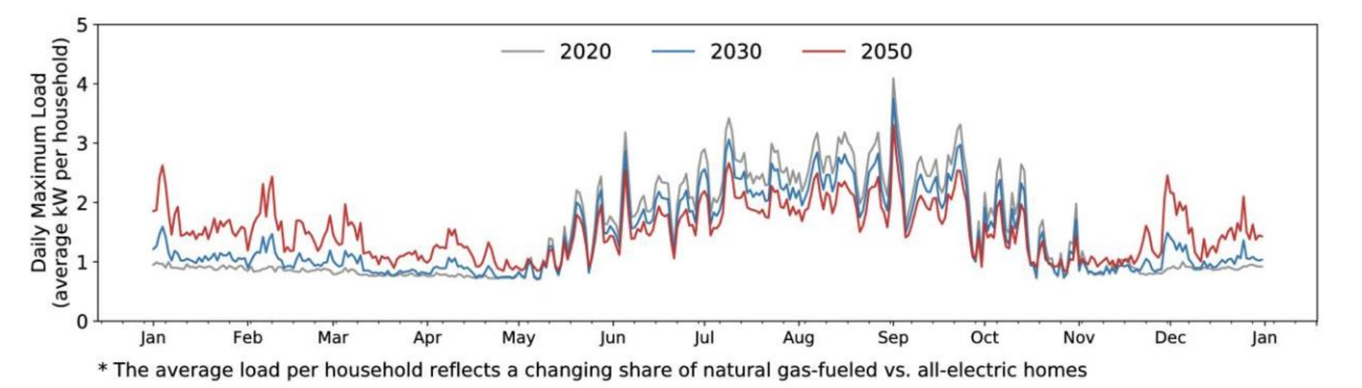
Without Addressing Peak Load



Fixed Charge Rate: New California Policy Could Impact TOU's Effectiveness

Rate is set to encourage electrification within buildings and switch residents away from gas

Daily Average Household Maximum Loads from Electrifying All End Uses in a High Building Electrification Scenario



The average load per household is weighted by the share of households in the home types and climate zones within the study area. Temperatures are based on the typical meteorological year data from the CEC Title 24 code.

Source: E3 Report

- Higher electrification of buildings could add to the peak demand particularly in non-summer months

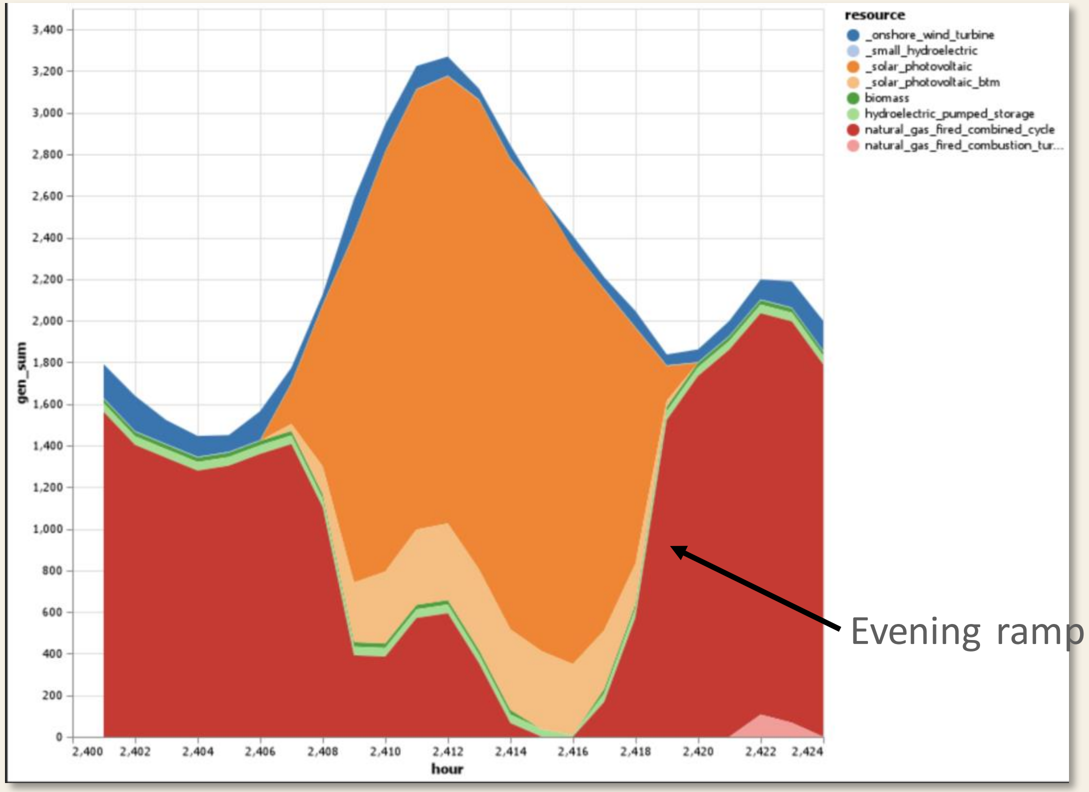
Marginal Cost Modeling

Why is this model important

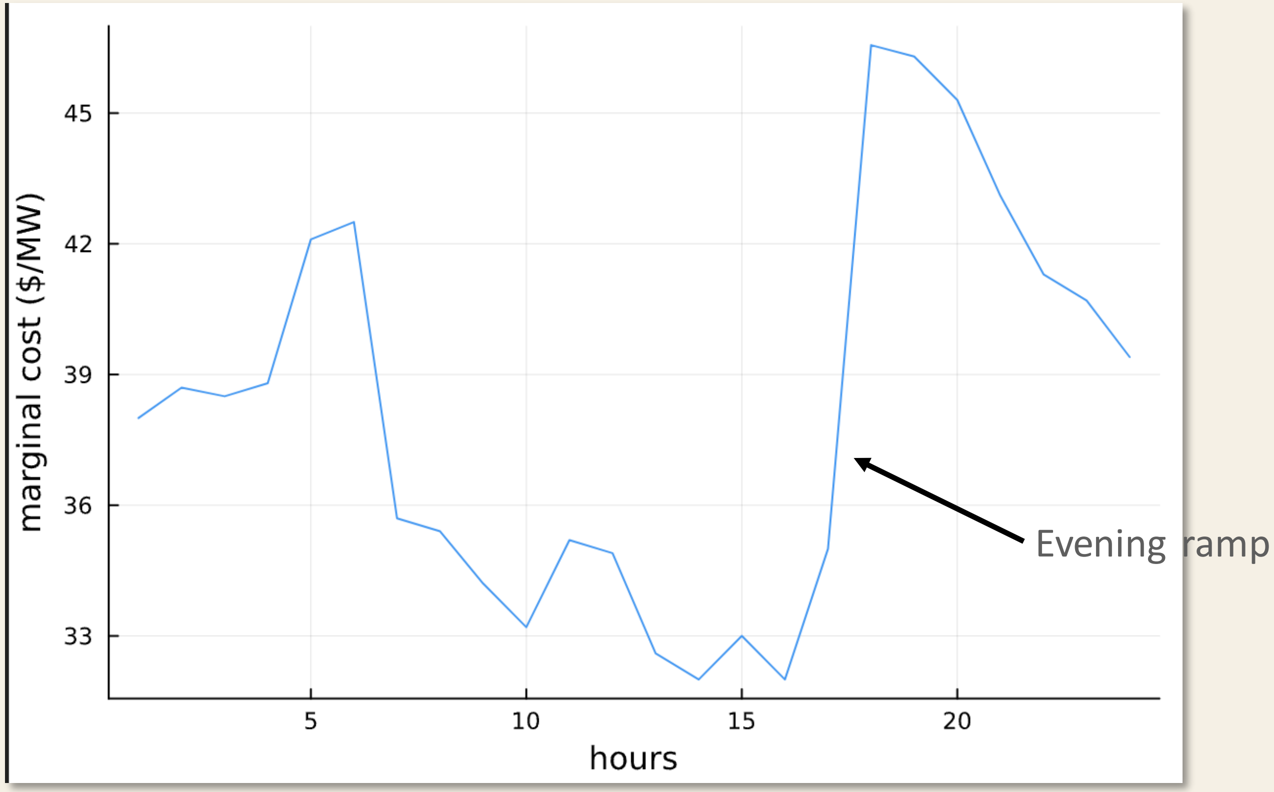
- Load is NOT proportional to Marginal Cost
- Key factors in deciding marginal cost: **Demand (load)** and **Cheapest Available Generator**
- **Switching from renewables to natural gas at night increases cost**
- A simple and modified Unit Commitment and Economic Dispatch informs us what the marginal cost will be at a certain time period
  - Similar to PLEXOS simulation and modeling

$$\min \sum_{g \in G, t \in T} VarCost_g \times GEN_{g,t} + \sum_{g \in G_{thermal}, t \in T} StartUpCost_g \times START_{g,t} + \sum_{g \in G_{NEW}} Investments_g$$

Peak Marginal Cost on July 7th, 2030



Generation Mix



Arbitrary Cost

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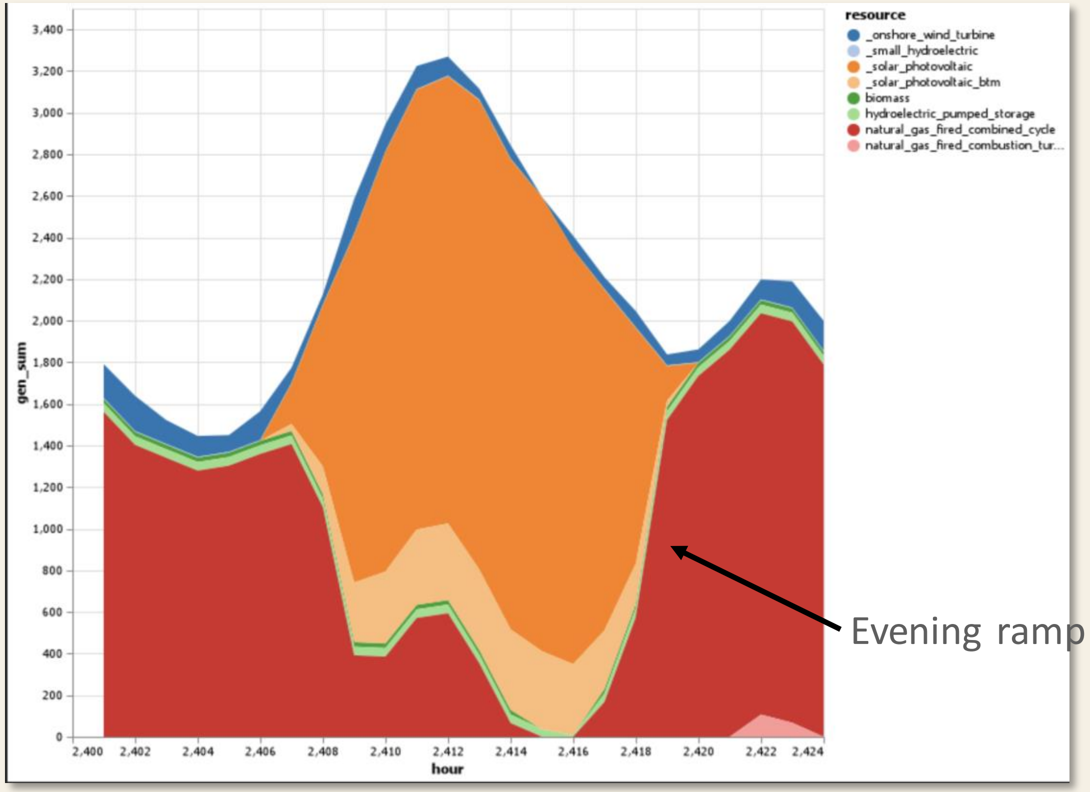
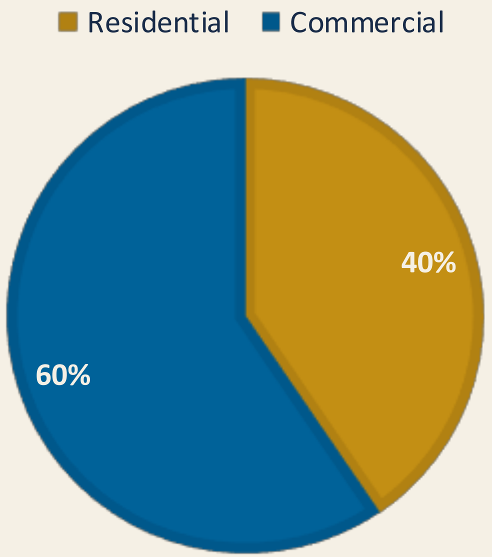
Distribution of Load



Generation Mix

Ratio Of Load In Residential And Commercial Sector



Load Distribution

Increasing Battery Storage Decreases Cost

Top-Level Finding

- **Increasing battery storage in the system stabilizes the evening ramp, decreasing the marginal cost**
  - More battery storage installation in industries might be beneficial for SDG&E in whole
  - Removes the frequency of bringing peaker plants online
- Prevents curtailment
  - May promote building more variable renewable energy (VRE) generators

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Increasing EVs May Cause an Issue

- Low EV penetration <u>does not cause a significant effect</u> on the cost
- High EV penetration is generally increases the marginal cost BUT
  - Marginal cost changes for EVs are highly dependent on consumer behavior
  - Charging during the daytime does push the demand high, but does not cause significant changes in the marginal cost
  - Rooftop solar might be beneficial if consumers decide to charge at home, but these behind-the-meter systems need to be coupled with adequate battery storage equipment

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AI is Not a Threat, But It is Good To Be Ready

- **High AI growth shifts the demand upwards, bringing more natural gas generators online, driving the marginal cost up, increasing rates**
  - Cogeneration/industrial generation brings the marginal cost down, which may decrease rates (new rate design required for cogeneration plants)
  - Higher renewable energy plants in the grid to account for the high load growth, batteries to stabilize evening ramp, which would increase rates in the short term and decrease in the long term
- AI growth can be beneficial with higher rooftop solar installations which would keep the grid stabilized but would drive the marginal cost up, increasing rates

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Is there a need for new investments?

- Our models suggest there is no need for additional investments as load is not increasing significantly BUT
- Diversifying generation mix increases marginal cost in the short term (5-10 years) but beneficial in the long term
- A sudden growth of AI could require new investments which will cause an increase in marginal costs

Case Study Justification

Utilities managing the clean energy transition, addressing public backlash, and balancing costs

Similar Challenges

- Load (Data centers)
- Cost (Energy transition)
- Rate (Residential)
- Service (Unstable)

Varied Strategies

- TOU
- Storage battery
- Bridge fuel
- Rate structure

Outcome &Insights

- Successful implementation
- Lessons for SDG&E

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Case Study Findings

Public backlash & Decarbonization cost management

- Public backlash results from **residential overexposure to revenue requirement increases, unreliable service**, and **poor customer service.**
- Negotiating **cost-spreading between consumer classes** and **accelerated depreciation of gas assets** can smooth **revenue requirement** over time, ensure ROI, and **limit public backlash.**
- Establishing **rules for big projects like data centers** can protect more exposed customers from higher system costs (reliability).
- Deploying storage battery programs incentivized by financial tools, and battery developers are significant in **stabilizing price** and **diversifying energy portfolio**.

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Case Study 1: Xcel Energy, CO

An extreme case of public pushback

- Regulatory decarbonization targets
- Phasing out coal, and using natural gas as bridge fuel
- Residential customers cover the most of cost of energy transition
- Adopting TOU and demand response programs as part of mitigation strategies
- Major public opposition, even after reducing rates in September, 2023

Colorado regulators set to slash Xcel's $262 million rate hike request

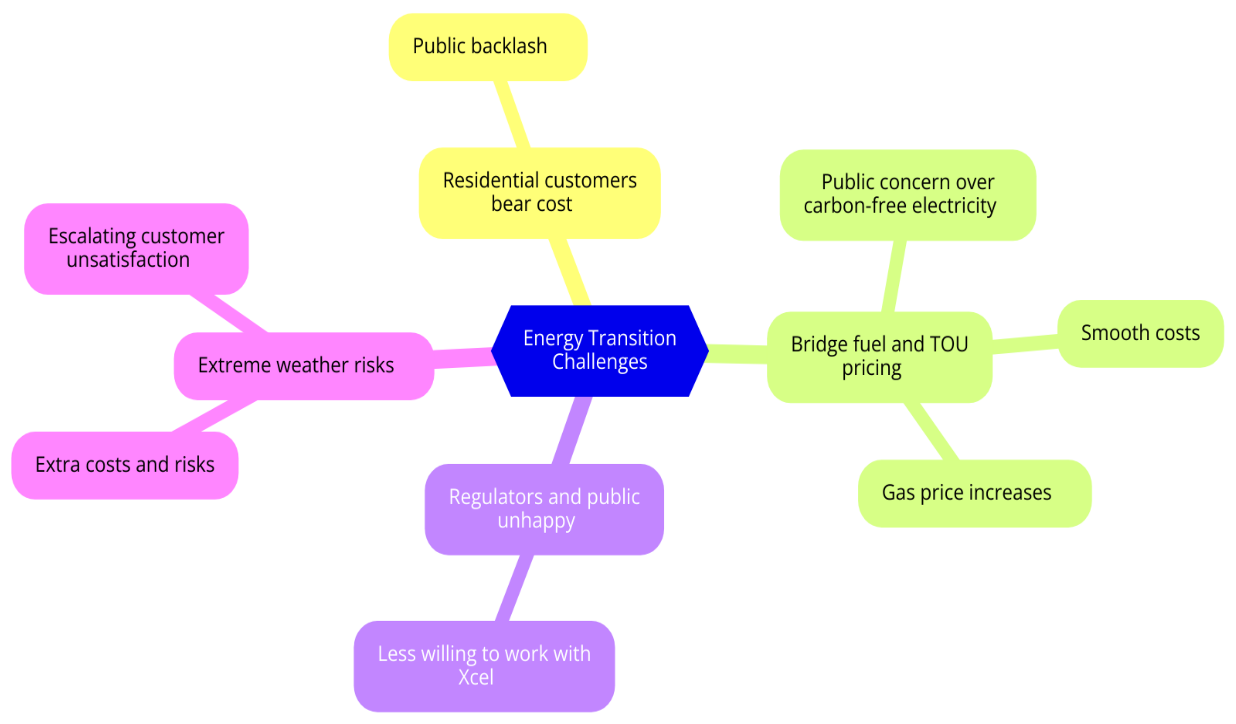
Scott Weiser scott.weiser@gazette.com Jun 28, 2023 Updated Oct 27, 2023

FILE PHOTO: A rally against high energy prices attracted scores of people to Colorado's state Capitol. The rally was organized by CoPIRG.
Scott Weiser/The Denver Gazette

Essence of public backlash is how to balance customer costs and utility returns

Case Study 1 Cont.: Xcel Energy

- Residential customers bear the cost of energy transition, leading to public backlash
- Bridge fuel smooth the costs of the transition, but the public still shows concern over the lack of carbon-free electricity and gas price increases
- TOU reduces peak use, avoiding build new "peaking" plants, which are often fueled by natural gas
- Regulators, in addition to the public, are unhappy with Xcel and less willing to work with them
- Extreme weather imposes extra costs/risks to the resilience of energy system, escalating unsatisfaction from customers



Case Study 2: Puget Sound Energy, WA

A successful regulatory negotiation

PSE is a gas and electricity provider
Gas use is declining; electricity use is increasing; hastened by regulatory goals
April 2024 state bill (HB 1549)

- **Speeds the depreciation of gas assets (increases short-term gas revenue requirements) → protects ROI through energy transition**
- **Allows costs of gas asset depreciation to be spread among both electricity and gas rate bases → lower prices over all consumers → less public pushback**

PUGET SOUND ENERGY

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Regulatory Negotiation for Effective Cost-Shifting

Case Study 2 Cont.: Puget Sound Energy, WA

PSE negotiated with regulators: to achieve emissions targets they needed some way to protect their assets

Protects ROI of gas assets through the electrification period while maintaining intermediary operation

Allows costs of accelerated depreciation to be (more) spread among both electricity and gas rate base → lower rates over combined rate base → less public pushback

More assistance programs → more credibility → less public pushback

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Utilities are using policy to protect exposed customers from data center demand.

Case Study 3: AEP Ohio

- Problem:
  - The obligation to serve the rising demand from data centers would require investments to improve reliability and increase revenue requirements
  - Residential customers are most exposed to price increases.
- Approach:
  - AEP's latest rate case provides justification that they are not obligated to serve data centers.
- Outcome:
  - The policy approach protects exposed residential customers by preventing undue rate increases, **preventing undue public pushback**.

Residential battery loan programs are successful in Vermont and Hawaii.

Case Study 4: GMP Vermont

- Problem:
  - Intensive clean energy targets and high electricity rates led by environmental characteristics and consumer base
  - Natural uncertainty imposes unforeseen risks to system resilience
- Approach:
  - GMP utilized IRA incentives and tax benefits to deploy home battery leasing program; Hawaii used cash incentives and bill credits to encourage combination of storage battery and rooftop solar
- Outcome:
  - Diverse ownership of battery storage **stabilizes peak demand and increases resilience**

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Review: Analytical Approach

Our two-pronged analytical approach will use demand/price optimization models and case study analysis to provide recommendations.

Modeling

Model 1: Predicts **demand** using policy and behavioral levers to assess potential changes in marginal cost.

Model 2: Calculates **marginal cost** using predicted demand and grid infrastructure.

Case Studies

Analyzes situations where LSEs have experienced similar problems, including strategies employed, levels of success, and applicability to Sempra.

Recommendations

To be derived from analysis of Modeling and Case Studies.

Findings & Recommendations

Question	Key Finding	Strategic Implications & Recommendations
Is load increasing?	Dynamic load is slightly decreasing (but is vulnerable to shocks).	• Aside from shock scenarios (i.e., extreme weather events), TOU is a successful way to reduce peak load in the industrial sector; however, it might have some limitations for the residential sector. → **Continue to expand TOU and other behavioral load-shifting initiatives.**
How do technological advancements and political changes impact consumer behavior?	Overall load may go up with rooftop solar, (NEM 3.0), new California fixed charge, EV incentives, and AI.	• DC EV charging causes the greatest spikes → **Continue to promote Level 2 charging.** • Rooftop solar destabilizes the grid and does not address peak load; NEM has slowed rooftop solar growth and lowered the MC → **Plan for solar to be less destabilizing in the future.** • **Plan for the new income-based fixed charge to increase load.** • New data center load is unlikely, **but there should be a best practice/policy for data centers to pay for or provide their energy.**
How do we minimize MC?	MC is highest at peak load at night, and solar generation is unavailable. Battery storage stabilizes MC during peak hours, which leads to lower prices.	• Make it easier for IPPs to enter the battery storage market → **Pursue faster permitting, capacity payments, and an ancillary services revenue sharing program.** • The MC of residential batteries is less than grid-installed batteries → **Explore programs like residential battery storage leasing; finance by rate-basing equipment, pursuing state funding, and using IRA tax incentives.** • **Consider load distribution when developing strategies.**
How do we manage the risks of electrification (high costs, consumer pushback, ROI)?	Regulatory collaboration, technology deployment, and financial planning are helping other utilities manage potential risks from electrification.	• **Collaborate and negotiate rate structure approaches with the CPUC.** • **Engage private firms to expand new technologies, like battery storage, to more residential customers.** • **Use IRA incentives to offset the cost of programs like residential battery leasing.**

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Lower Solar Growth – Not Accompanied by Higher Battery Growth

- Solar Growth with NEM 3.0 has decreased significantly

- Key Insight: **To increase battery storage**
    - California has responded with significant SGIP funding particularly for residents in high-risk areas.
        - SGIP is a rebate that can take up to 6 months to return to customers
        - Approval is not guaranteed
        - Assumes people can afford the up to $10,000-26,000 upfront cost
        - **Why not directly subsidize batteries?**

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Residential Energy Demand Increasing?

- San Diego population has decreased over time
  - Feeds into **slightly lower overall peak load** each year
    - This is also assuming that climate conditions remain constant!
- With Lower Solar Growth: Shorter U Dip in Dynamic Load
  - Concerning trend with higher energy use in all sectors

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AI: If it was a risk

- Has a significant impact on peak load, and with minute growth in data centers there is significant repercussions in peak
- Load Factor (Average Load Divided by Peak Load) is **80%**
    - **High Demand is constant**

Year	High Peak Load- Forecasted	Low Peak Load- Forecasted	Number of Companies- High	Number of Companies- Low
2021	615	615	79	79
2022	683	616.2406015	133	120
2023	779	602.4778325	203	157
2024	885	623.6577181	298	210
2025	963	670.5706806	382	266
2026	1028	698.9492274	453	308
2027	1058	720.0584551	479	326
2028	1077	727.4665314	493	333
2029	1093	727.2237624	505	336
2030	1110	729.9806576	517	340

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Appendix

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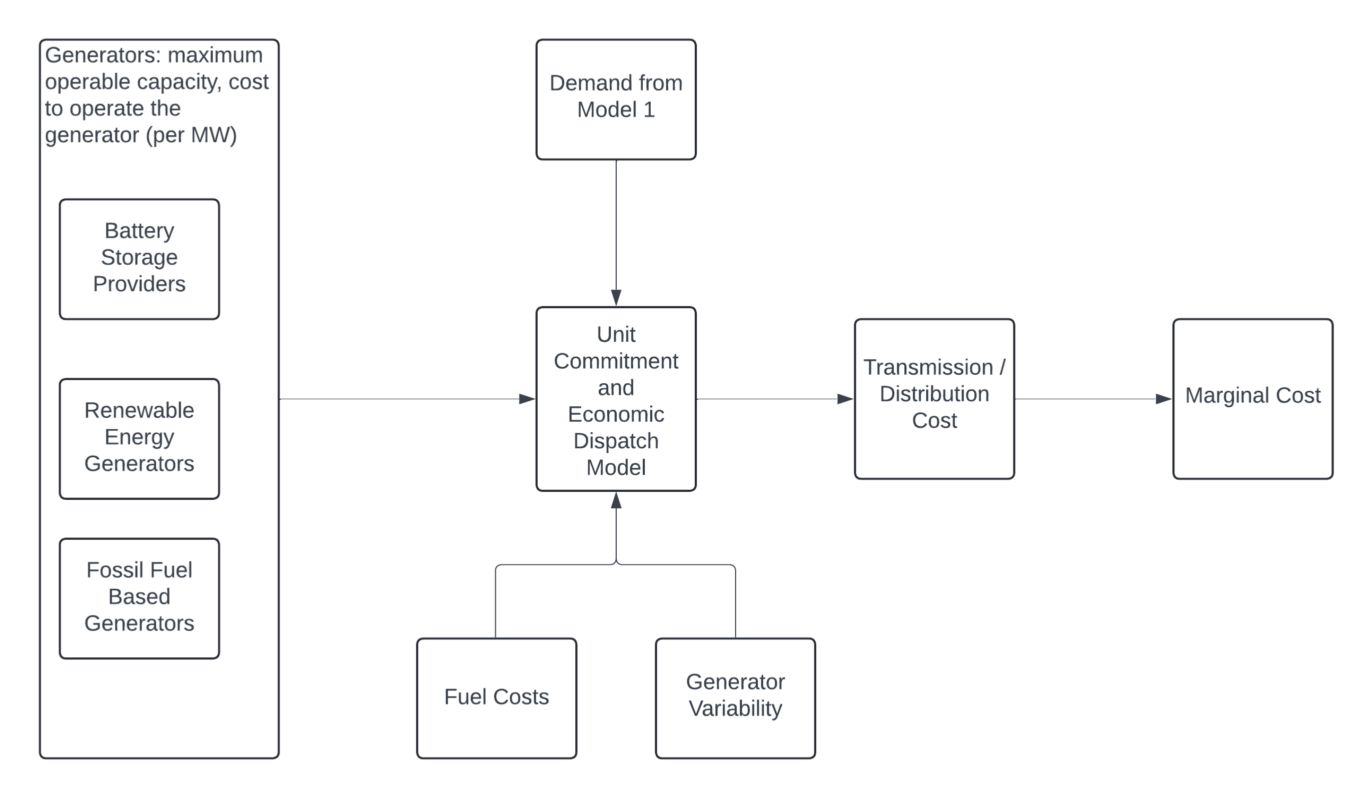
How Model 2 works



Critical Assumptions

- Battery storage investments – modeling was done under the assumption that Sempra/SDG&E would lease out batteries to residents, making it cheaper to install batteries.
  - We are addressing that installing any kind of infrastructure requires an upfront cost, which increases marginal cost at first but is better in the long-term.
- Transmission/distribution lines are arbitrary, but the best way to estimate system costs.

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Duality of the UCED Model

Convex Optimization Methods

- Convex optimization mathematical branch that drives the optimization model suggests that a primal problem (objective function of the UCED model) can be transformed into a dual problem (shifting the perspective of function) using the Lagrangian of the primal problem.
- The dual problem is always convex, and by Karush-Kuhn-Tucker (KKT) conditions, we can establish strong duality for this optimization problem, which determines the same optimal point for both primal and dual problems.
- This means that by adding a non-convex constraint (the transmission/distribution line constraint), the convexity of the problem is preserved, making it possible to solve and get the marginal price of the system.
- Findings are preserved by this model due to the strong duality of the model, but it increases the credibility of the model and assumptions and opens up the room for Sempra/SDG&E if they want to use their model with their own data

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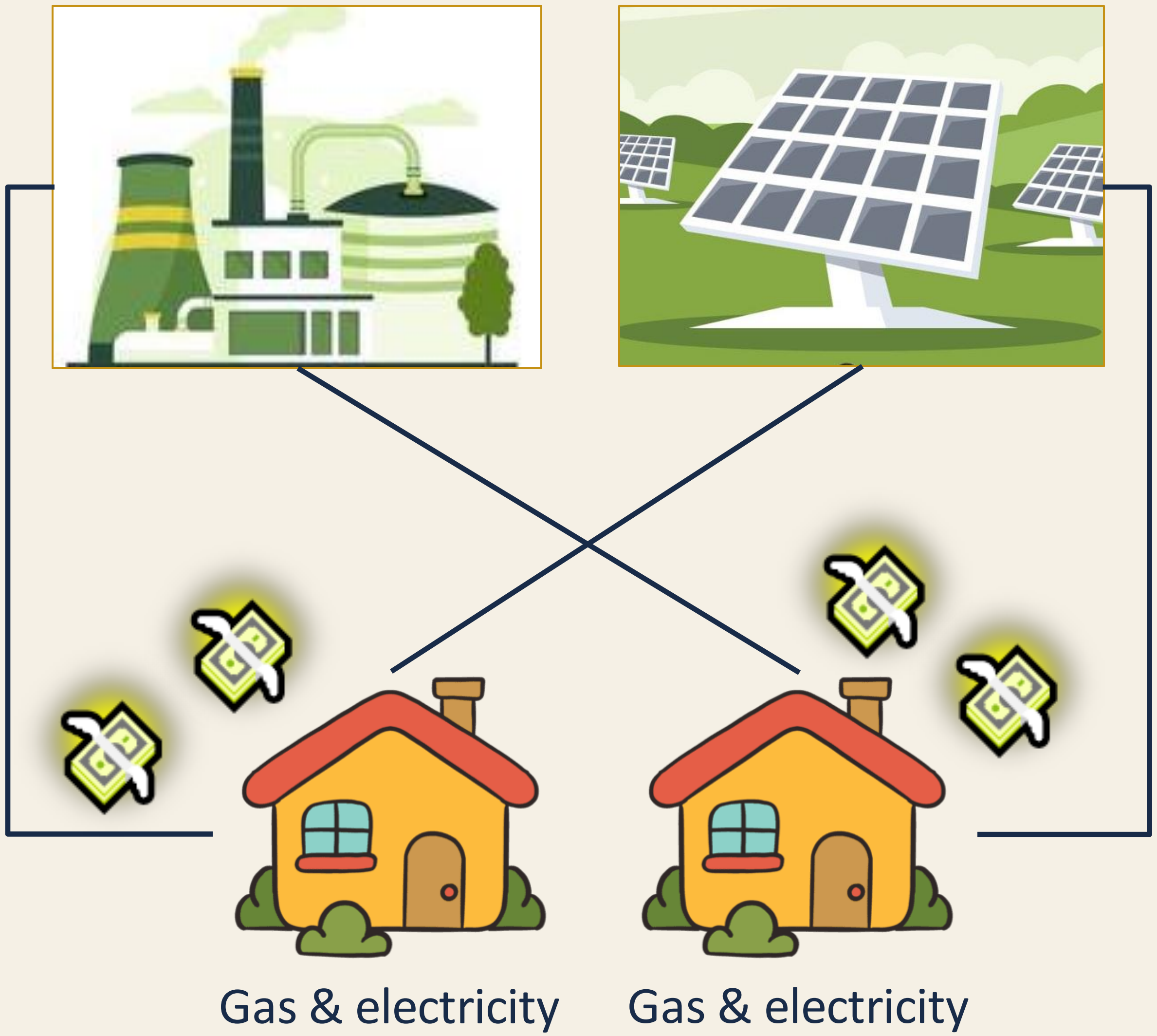
Why are batteries good for the system (A)

Visualizing the effect of EVs on the cost (A)

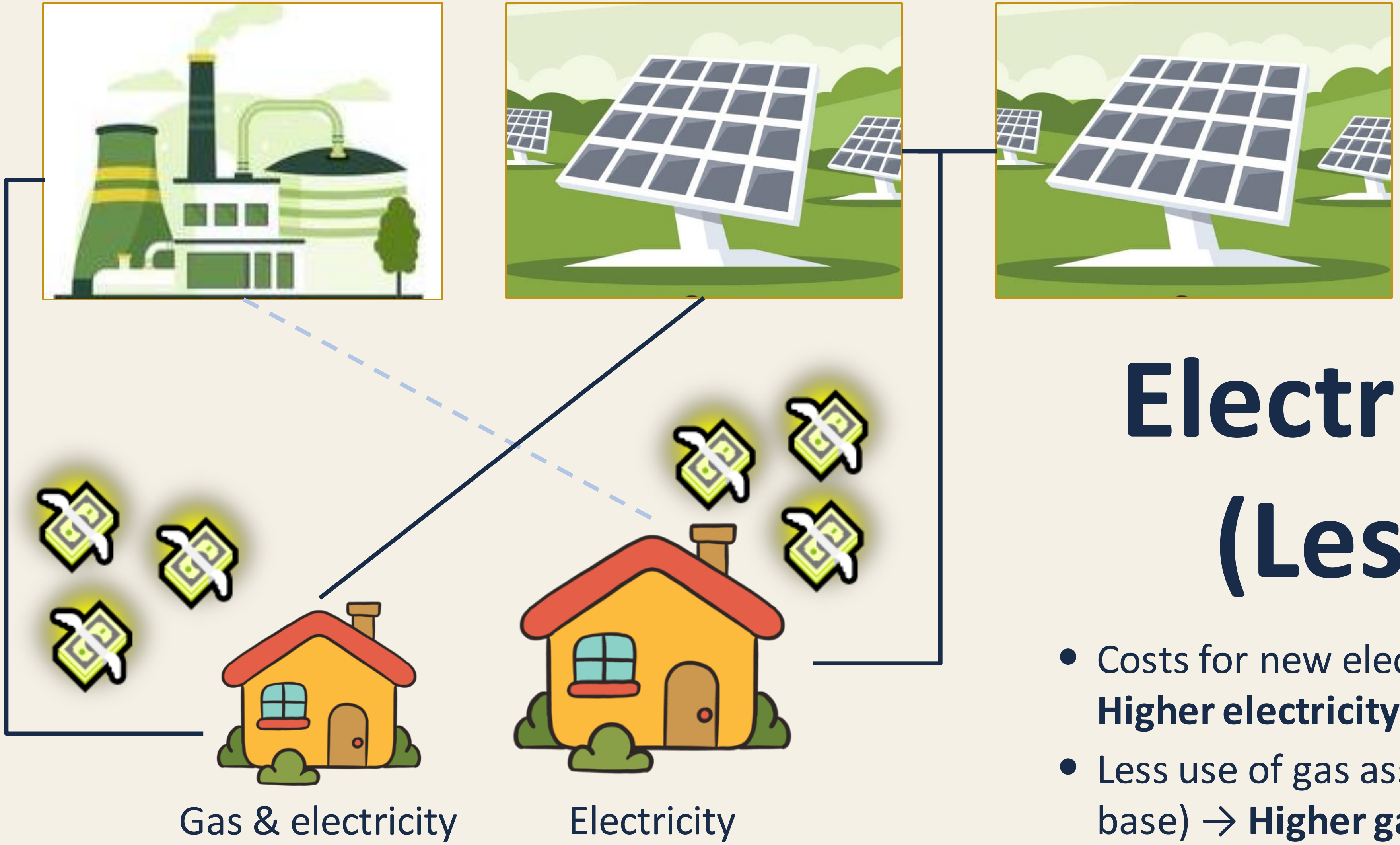
Being ready for AI (A)



Base Case

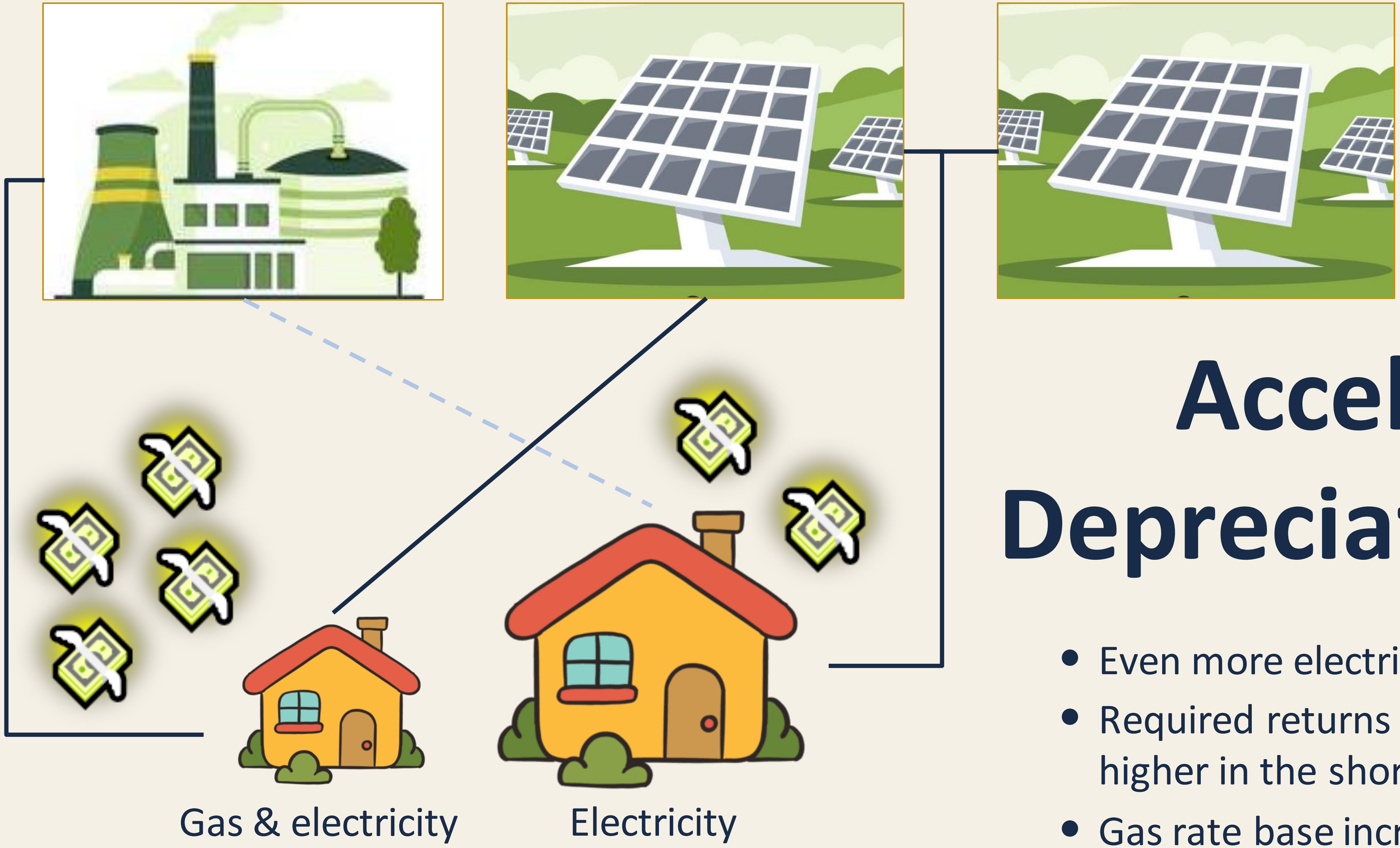
- Energy comes from mix of gas and electricity

Case Study 2 Cont.: Puget Sound Energy, WA



Electrification (Less Gas)

- Costs for new electric infrastructure → **Higher electricity rates**
- Less use of gas assets (smaller rate base) → **Higher gas rates**



Accelerated Depreciation of Gas

- Even more electrification
- Required returns for gas become higher in the short term
- Gas rate base increasingly shrinks

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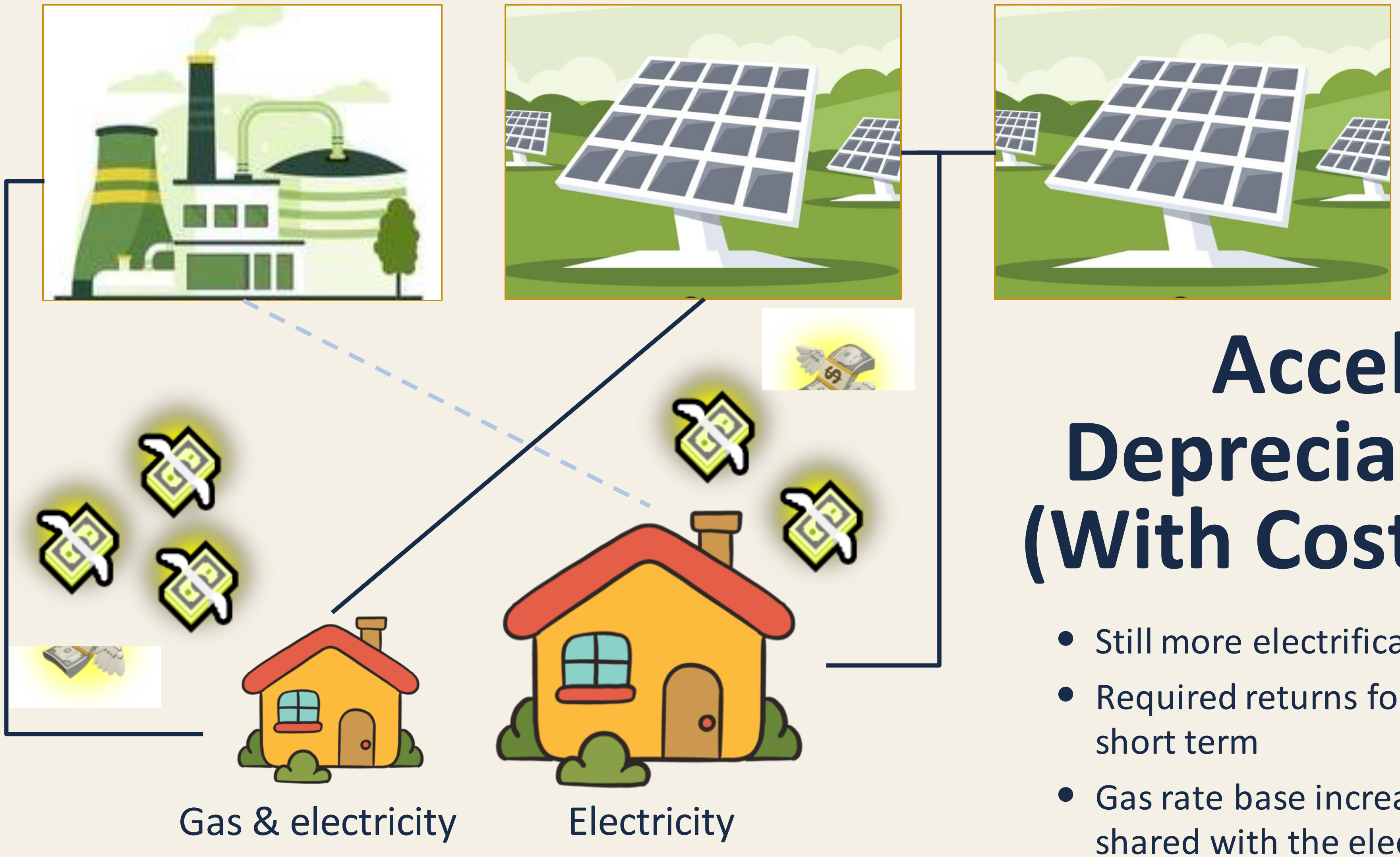

Accelerated Depreciation of Gas (With Cost-Spreading)

- Still more electrification
- Required returns for gas become higher in the short term
- Gas rate base increasingly shrinks, but costs are shared with the electric rate base

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