The Public ADVOCATES OFFICE

Distribution Grid Electrification Model 2025

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The Public Advocates Office | Distribution Planning & Policy

Background

Background: Our Model

- We developed a model which **estimates the costs of electric grid upgrades to support electrification out to 2040**, under a variety of scenarios.
- We use this model to help us understand several elements of electrification:
  - How will load growth impact the grid?
  - How much will electrification-related upgrades cost?
  - How will electrification impact electric rates?
  - How will different possibilities, like adoption rates and consumption behaviors, affect all these outcomes?
- These findings can help inform advocacy, regulation, and policy.

DGEM 2025

- Our previous **Distribution Grid Electrification Model** (DGEM 2023) was published August 2023.
- We are now presenting the results of DGEM 2025.
- DGEM 2025 uses the same basic model as DGEM 2023, but updates and expands it in several ways:
  - We use updated data.
  - We have made many small improvements to the model.
  - We have developed new modeling to more accurately allocate **building electrification** (BE) loads.
  - We have developed new modeling to investigate the impact of different **electric vehicle** (EV) **charging behaviors**.

DGEM 2025: Methodology and Model Details

Phases of Analysis

Phase 1: Estimate building electrification load on each feeder for each year out to 2040.

Phase 2: Estimate electric vehicle load on each feeder for each year out to 2040.

Phase 3: Estimate annual peak load on each feeder for each year out to 2040.

Phase 4: Estimate the cumulative cost of mitigations for overloads for each year out to 2040.

Phase 5: Estimate the impact on rates due to mitigation costs balanced by additional electricity sales for each year out to 2040.

Major data inputs:

- Feeder locations, historic loads, and feeder and substation capacities, provided by the IOUs.
- IEPR load forecasts provided by the CEC.
- Vehicle registration data provided by the DMV.

Scenarios

- DGEM 2025 uses **nine scenarios** to investigate uncertainties in the way electrification will occur.
- These scenarios are not intended to span the total range of possible outcomes. Instead, they are intended to demonstrate the comparative impacts of different electrification adoption possibilities.
- DGEM 2025 uses three BE adoption scenarios and three EV charging behavior scenarios. In all combinations, this produces nine total scenarios.

BE Scenarios

- We use CEC IEPR Additional Achievable Fuel Substitution (AAFS) scenarios, which model varying paces of the adoption of electric appliances (such as heat pump water heaters and HVACs) to replace fossil fuel appliances.

Scenario	AAFS 2.5	AAFS 3	AAFS 4
Adoption rate	Lower rate of BE adoption	Moderate rate of BE adoption	Higher rate of BE adoption
Grid strain	Lower	Moderate	Higher
Policy goals	Lags behind short-term regional/local policy goals	Meets state, local, and regional policy goals	Exceeds state, local, and regional policy goals
CEC usage scenario	Gradual Transformation	Planning	Local Reliability

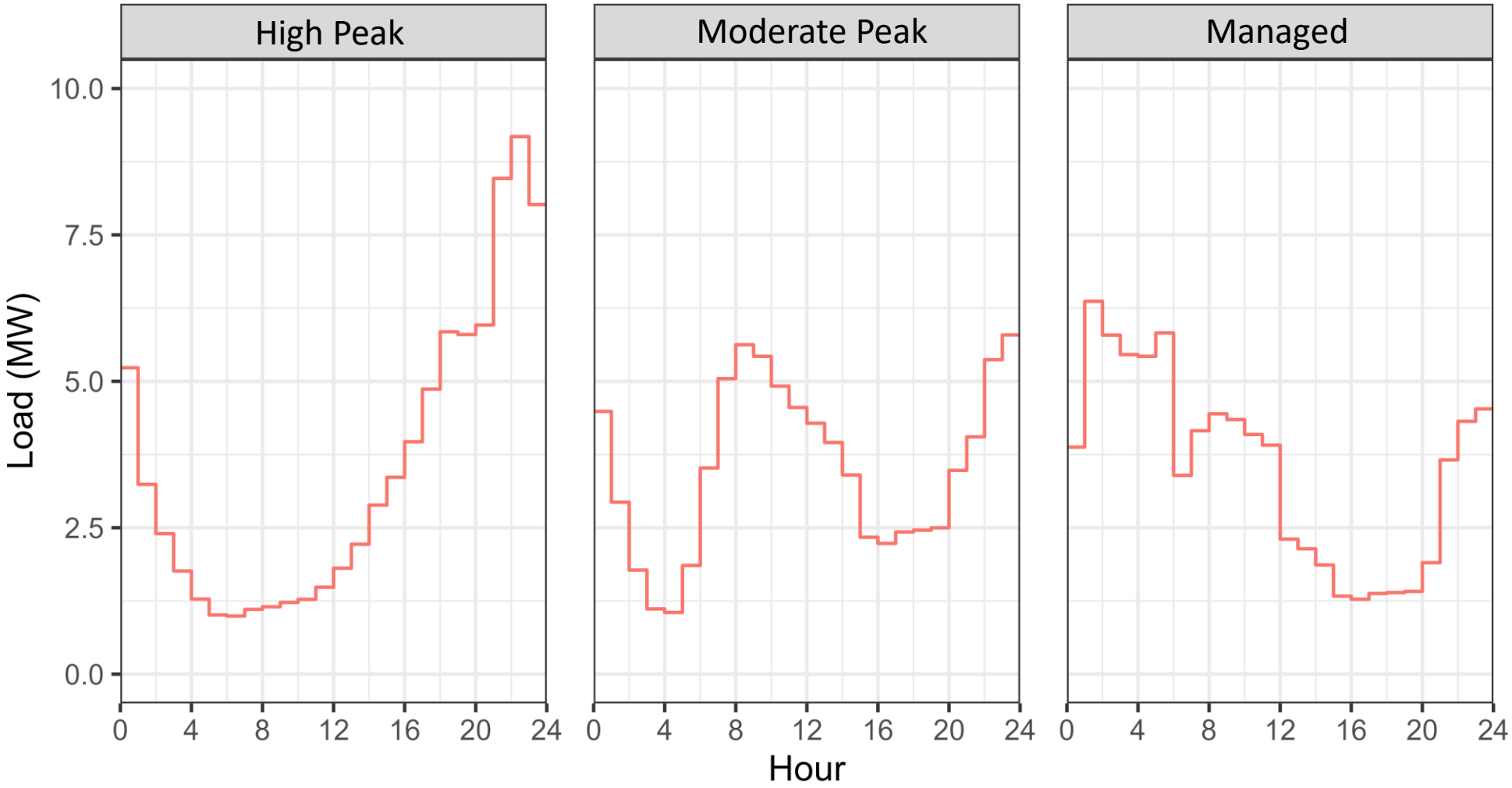
EV Scenarios

- We use different electric vehicle charging load shapes to model varying possibilities for electric vehicle charging behavior, with varying strain on the grid.

Scenario	High Peak	Moderate Peak	Managed
Load shape source	Electrification Impact Study Part 1, published 2023 by Kevala	2023 IEPR, AATE[1] Scenario 3	Constructed in our own modeling. Also uses 2023 IEPR load shape
Grid strain	Higher	Moderate	Lower
EV TOU[2] enrollment	Low	High	High
Active EV charging management	No	No	Yes (50% of LD[3] and 20% of MDHD[4])
Variability	Same load shape for all vehicles on all feeders	LD and MDHD vehicles use different load shapes	Unique load shape for each feeder

[1]AATE: Additional Achievable Transportation Electrification.
[2]TOU: Time of use. [3]LD: Light duty. [4]MDHD: Medium duty and heavy duty.

EV Load Shapes Example



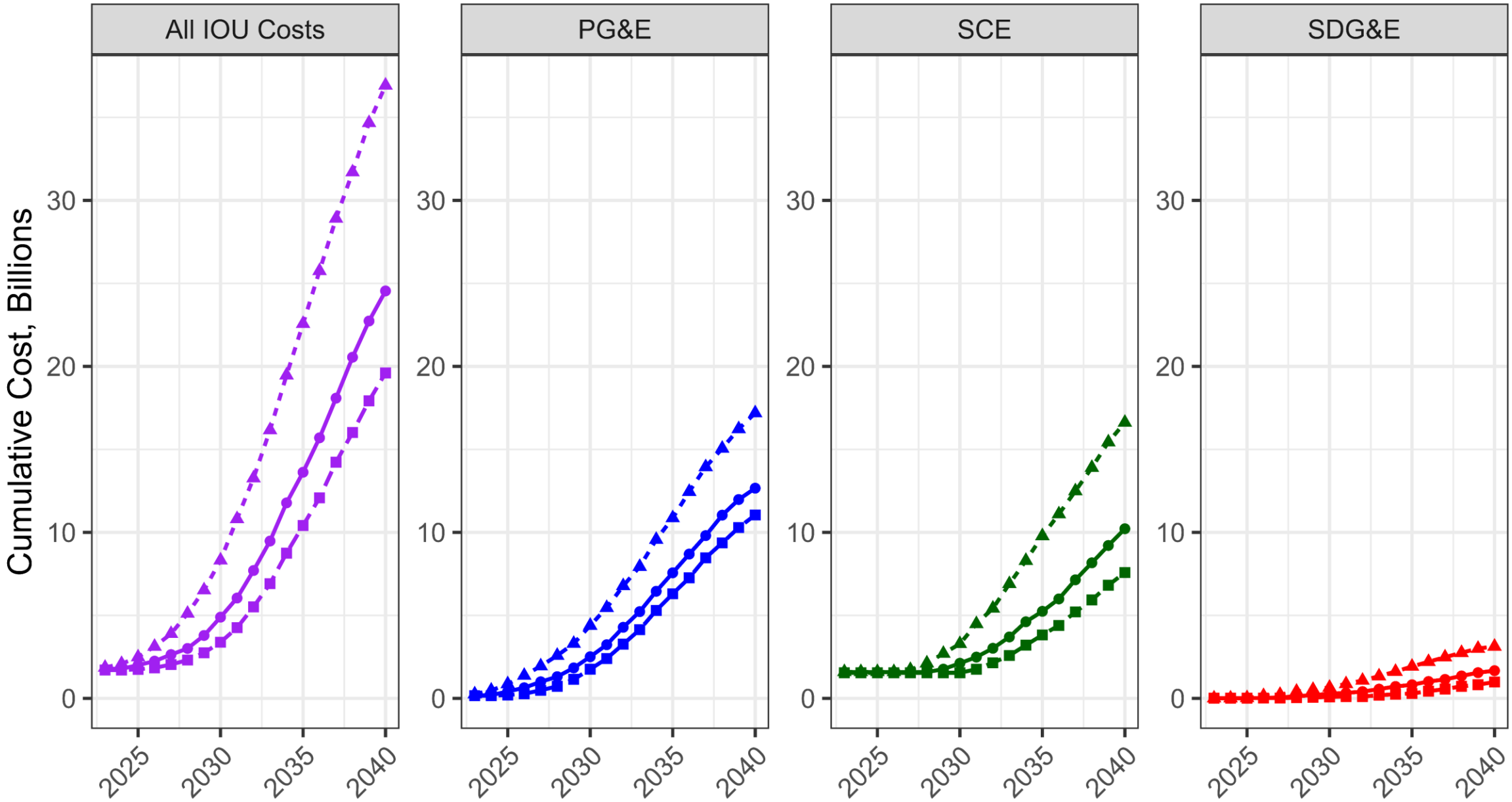
Light duty EV load shapes on an example feeder in 2040.

Results

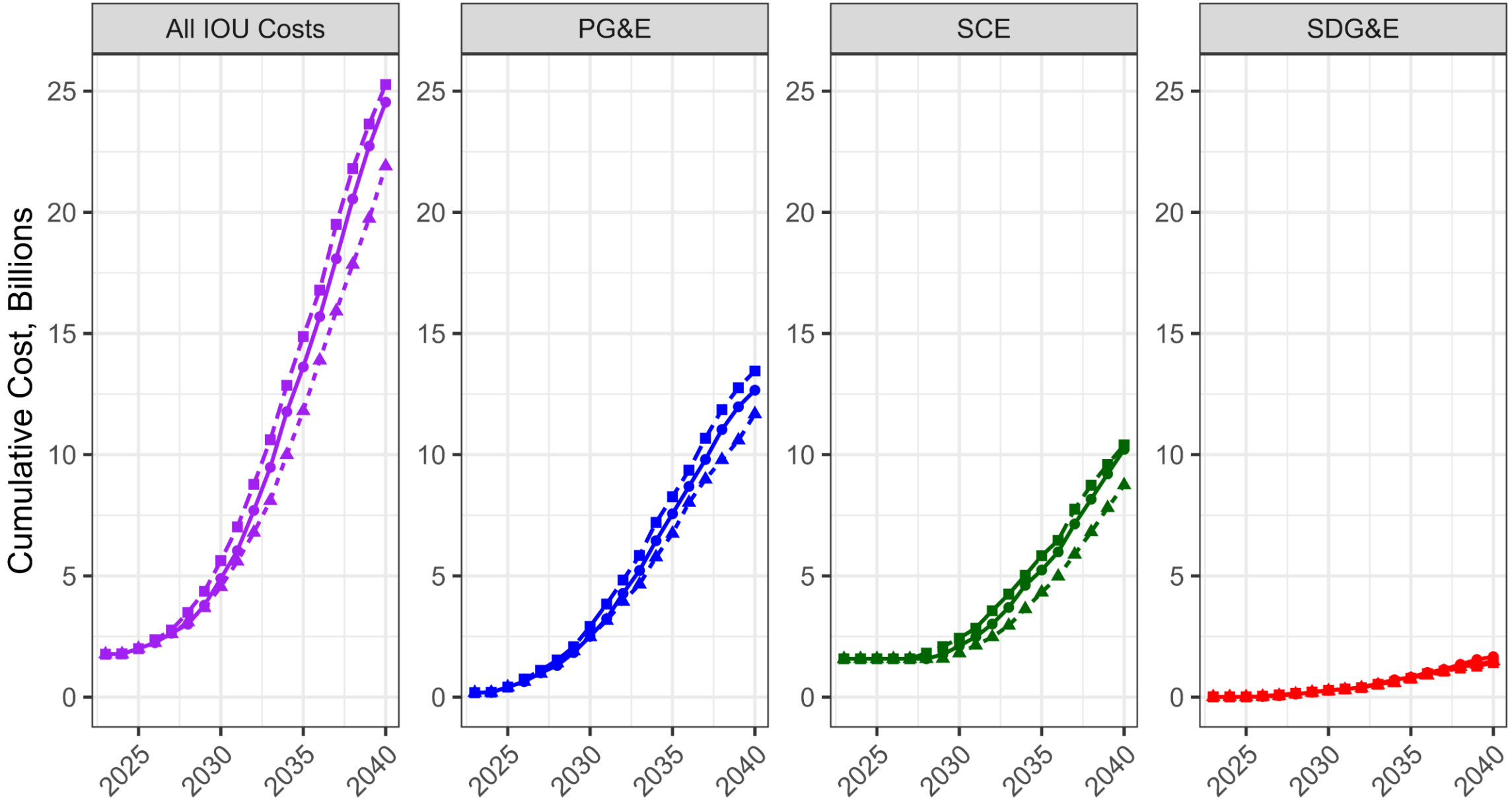
Results: Cost Summary

Cumulative 2040 Upgrade Costs for All 3 IOUs Combined in 2025 $billion			
	AAFS 2.5	AAFS 3	AAFS 4
High Peak Shape	34.8	36.9	37.5
Moderate Peak Shape	21.9	24.6	25.3
Managed Shape	17.0	19.6	20.4

EV charging management has a significant impact on costs



BE adoption has a moderate impact on costs



Key Takeaways: Costs

- More BE adoption leads to higher grid costs, varying by up to $3.4 billion between our considered scenarios in 2040.

- More EV charging management leads to lower costs, varying by up to $17.8 billion between our considered scenarios in 2040.
  - The value of active managed charging depends heavily on assumptions around default, unmanaged charging behavior.
  - The value of active managed charging varies significantly *by feeder*. Some feeders overload in all scenarios, decreasing the value of managed charging for those feeders.

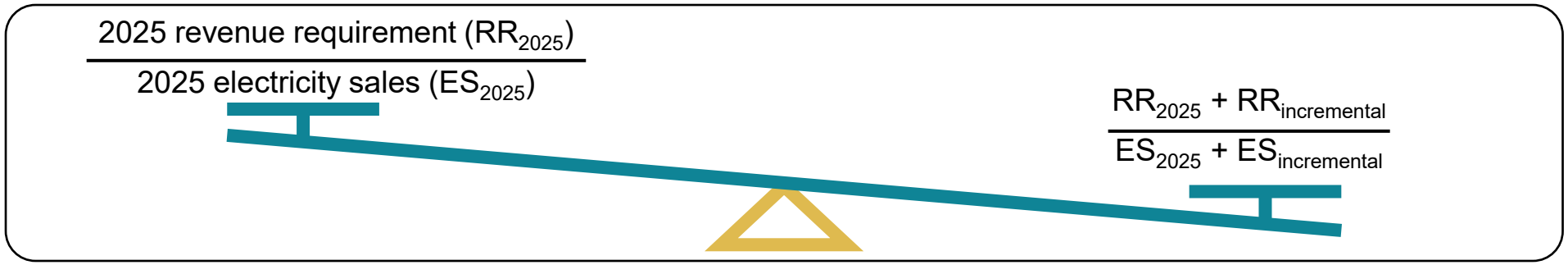
- PG&E's costs react more strongly to BE load growth. SDG&E and SCE's costs react more strongly to EV load growth.

- Costs are lower than in DGEM 2023, largely due to changes in input data and our assumptions around unit costs of upgrades.

Results: Rates Summary

Rate Impact in 2040, in cents per kWh, relative to 2025 rates									
	PG&E			SCE			SDG&E		
	AAFS 2.5	AAFS 4	AAFS 4	AAFS 2.5	AAFS 4	AAFS 4	AAFS 2.5	AAFS 4	AAFS 4
High Peak Shape	-2.7	-3.0	-2.9	-0.7	-1.0	-0.4	-2.6	-2.8	-2.1
Moderate Peak Shape	-3.5	-3.7	-3.6	-2.2	-2.3	-1.7	-3.8	-4.0	-3.3
Managed Shape	-3.8	-3.9	-3.8	-2.7	-2.9	-2.2	-4.3	-4.5	-3.8

Downward Pressure on Rates



- Electrification will have two impacts on rates:
  1. Electrification will require costly grid upgrades, causing upward pressure on rates.
  2. Electrification will result in increased consumption of electricity, which will divide costs across more units of electricity sold, resulting in downward pressure on rates.

- DGEM 2025 finds that the overall effect of electrification is a **downward pressure on rates**. This does not mean rates will fall; other factors could cause an increase in rates over the same period.

- Rates have increased over 10 cents per kWh over the past 10 years for all three IOUs. A downward pressure of a few cents per kWh will not be a solution to the rates crisis.

Key Takeaways: Rates

- Varying degrees of BE have very little impact on rates. We predict that overall downward pressure on rates will be driven more by electric vehicles than BE.

- Rate pressure is negative overall in all scenarios. This finding is robust to large changes (such as doubling unit costs or halving load growth in the central scenario). The highest degree of downward pressure comes with AAFS 3 and the Managed charging scenario.

- The benefits of downward pressure on rates could be reduced or even reversed if:
  1. Expected load growth due to electrification does not appear.
  2. Utilities build more infrastructure than is needed or build infrastructure in the wrong places.
  3. Overload mitigations are more expensive than DGEM 2025 estimates.
  4. Electric rates rise to cover additional electrification programs.
  5. Rate designs pass the majority of savings to a small number of customers.
  6. Electrification puts more strain on the grid than any of our policy scenarios suggest.

DGEM 2025 Key Findings

1. Grid upgrades to support electrification are estimated to cost $25 billion by 2040 in our central scenario.
   - In the near term, grid upgrades will cost $5 billion by 2030, $14 billion by 2035 in our central scenario.

2. Increased sales due to electrification may put downward pressure on rates of up to a few cents per kWh, but electrification will not be a solution to the rates crisis.

3. Mass shifting of peak EV load away from the peak could save between $5 billion and $18 billion in distribution costs by 2040. The benefits of this load-shifting vary greatly by feeder.

4. Marginal changes in BE adoption have almost no effect on electric rates.