Distribution Grid Electrification Model

Supplemental Analysis

Our mission is to advocate for the lowest possible bills for customers of California's regulated utilities consistent with safety, reliability, and the state's climate goals.

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The Public Advocates Office
California Public Utilities Commission
505 Van Ness Avenue, San Francisco, CA 94102-3298
www.publicadvocates.cpuc.ca.gov

1 Introduction and Summary

In August 2023, the Public Advocates Office at the California Public Utilities Commission (CPUC) published its *Distribution Grid Electrification Model – Study and Report* (DGEM).[1] The DGEM assessed the costs of upgrading California's three large investor-owned utilities'[2] (IOU) distribution grids to meet demand growth due to California's transportation electrification (TE) goals. The focus of the DGEM is similar to a study entitled *Electrification Impacts Study Part 1* (EIS) published in May 2023 by a consultant, Kevala, hired by the CPUC's Energy Division.[3] The DGEM contains many comparisons between itself and the EIS.[4]

The primary differences between the DGEM and the EIS inputs are higher per-unit costs and lower on-peak charging in the DGEM.[5] Based upon this observation, the DGEM makes a "first-order" estimate that cost outcomes in the EIS could be reduced by 70 percent – $35 billion – with less on-peak charging.[6] The analysis contained herein incorporates the EIS's load shape into the DGEM to observe the resulting impact on total costs through 2035. This document supplements the DGEM by presenting the new load shape analysis and results to highlight the significance of load shapes to grid impacts. Overall, the inclusion of the EIS's load shape resulted in a $10.1 billion increase compared to original load shape used in the DGEM.[7]

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[1] The DGEM is attached to *Motion of the Public Advocates Office to Admit Its Distribution Grid Electrification Model Study and Report into the Record*, September 8, 2023; filed in Rulemaking (R.) 21-06-017, *Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future*. Available here: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M520/K423/520423681.PDF. The October 17, 2023 *Administrative Law Judge's Ruling Soliciting Comments on Cal Advocates' Distribution Grid Electrification Model Study and Report* grants the motion and admits the DGEM into the record of R.21-06-017; filed in R.21-06-017. Available here: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M520/K563/520563683.PDF.

[2] Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison Company.

[3] Kevala, *Electrification Impacts Study Part 1: Bottom-Up Load Forecasting and System-Level Electrification Impacts Cost Estimates*, May 9, 2023 (EIS); filed in R.21-06-017. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M508/K423/508423247.PDF.

[4] DGEM at 31.

[5] DGEM at 34.

[6] DGEM at 43-44.

[7] The DGEM uses the California Energy Commission's 2022 Integrated Energy Policy Report load shapes.

2 Background on the 2023 DGEM

The 2023 DGEM uses an EV adoption propensity model to distribute the EV load growth forecasted by the 2022 Integrated Energy Policy Report (IEPR) to the distribution feeders within the three IOUs' service territories. This propensity model relies on Department of Motor Vehicle (DMV) vehicle registration data.[8] After placing EVs to DMV registration addresses based on the propensity model, the DGEM combines EV load growth with non-EV load growth to determine where and when distribution grid infrastructure will be overloaded and require upgrading.[9] Using IOU-provided infrastructure cost data, the DGEM then calculates the total cost to upgrade the IOUs' distribution grid infrastructure to accommodate load growth through 2035.[10] The DGEM estimates the need for $26 billion in investment across the three large IOUs through 2035. This is substantially less than the EIS's total cost of $51 billion.[11] The DGEM also includes an assessment of potential impact on electric rates.

The DGEM included several infrastructure unit cost scenarios to capture uncertainty in the IOU-provided infrastructure asset upgrade costs. One of these scenarios, the "Replicate" scenario, uses the cost assumptions made by Kevala in the EIS. The Replicate scenario was included to highlight the differences between the two models that are not due to unit cost assumptions.

2.1 Load Management Analysis in DGEM

The EIS uses an "unmitigated" load shape, which assumes lower customer participation in EV time-of-use (TOU) rates than the 2022 IEPR; the DGEM relies on the load shapes provided in the 2022 IEPR. These load shapes are shown below in Figure 1.

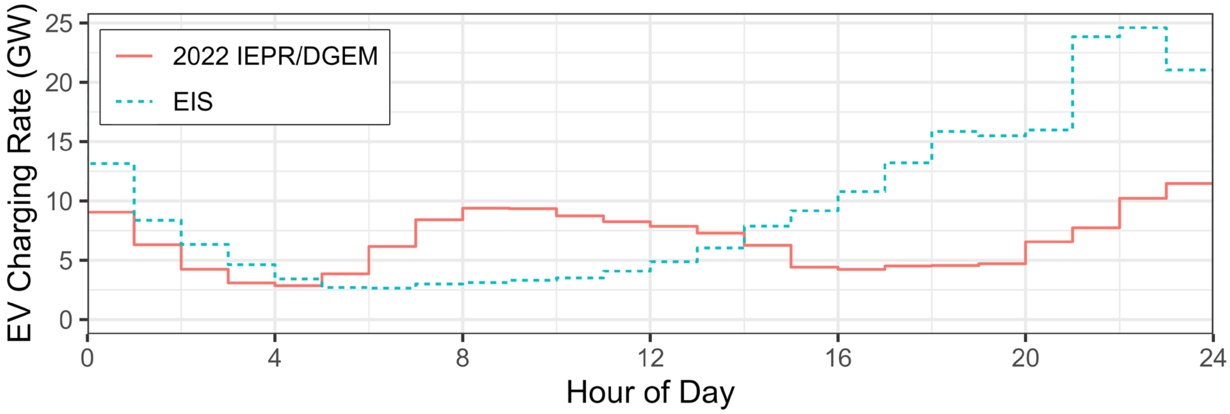
[8] DGEM at 19.

[9] DGEM at 16.

[10] DGEM at 17.

[11] DGEM at 30 and EIS at 20.

Figure 1. Comparison of peak day charging load shapes across the 2022 IEPR (used in DGEM), and the EIS.



As seen in Figure 1, the EIS's load shape includes a large peak at 9pm, which is the start of the current non-EV low price period for the large IOUs. Additionally, the EIS assumes 43% more energy consumed on the peak day than the 2022 IEPR.[12] The analysis presented in the DGEM eliminated the unit cost differences between the EIS and DGEM in the Replicate cost scenario. The Replicate scenario resulted in a total cost for DGEM through 2035 of $15.7 billion across the three IOUs compared to the EIS's $51 billion.[13] The DGEM then infers that the difference between these two numbers is driven primarily by peak load growth resulting from the differing load shape assumptions between EIS and DGEM.[14]

However, the influence of charging load shape alone was not directly assessed in DGEM, only inferred based on the results of the Replicate scenario. The 43% difference in total energy served no doubt plays a role in this difference. The conclusion that the difference in costs ($16 billion vs. $51 billion) is driven by the differences in charging load shape and, therefore the approximate value of load management, is only a first-order estimate.

3 Supplemental Load Management Analysis

This supplemental analysis provides a more precise assessment of the impact of charging load shape by comparing the Replicate scenario to a scenario which uses the EIS's load shape. This allows for a direct assessment of the impact of load shape on the total infrastructure cost, thereby providing an estimate of the potential of load management to avoid distribution infrastructure costs.

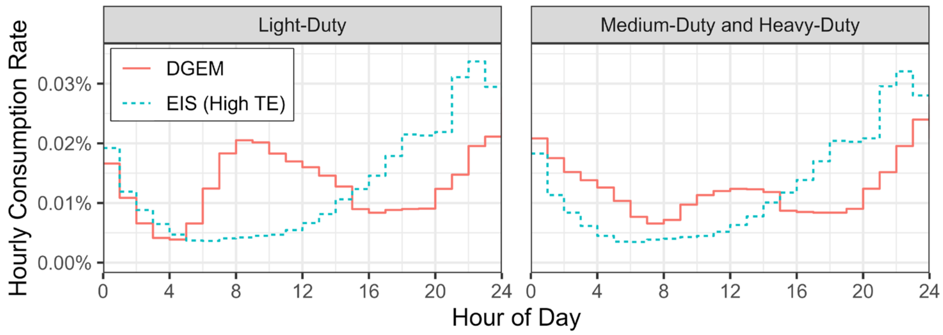
[12] DGEM at 33.

[13] DGEM at 31.

[14] DGEM at 32.

We accomplished this by replacing the DGEM's load shape with the EIS's High Transportation Electrification (TE) scenario's peak day load shape[15] in the DGEM and recalculating the subsequent results. Figure 2 provides a comparison of these load shapes.

Figure 2: Charging rate (percent of annual total energy) for the peak day used in this analysis.



The total cost in 2035 resulting from the inclusion of the EIS's load shape is shown below in Table 1.

Table 1. Comparison of the Replicate scenario (EIS's unit costs and DGEM's load shape) and the New Supplemental scenario (EIS's unit costs and EIS's load shape). All figures are in $billion.

Scenario	Unit Cost	Load Shape	PG&E	SCE	SDG&E	Total Cost
New Supplemental scenario	EIS	EIS	$16.2	$7.1	$2.6	$25.8
Replicate scenario	EIS	DGEM	$11.4	$3.1	$1.3	$15.7
Percent decrease			30%	56%	50%	39%
Approximate savings			$4.8	$4.0	$1.3	$10.1

The resulting total savings by replacing the EIS's load shape with the DGEM's load shape is $10.1 billion. This is $10.1 billion of infrastructure investments that can be avoided through a charging profile that is consistent with managed charging.[16] This $10.1 was calculated using the EIS's unit costs, which are lower than the unit costs assumed in the DGEM. Replacing the EIS's unit costs with the DGEM's unit costs would increase the savings by 68%[17] to $16.9 billion.

[15] EIS data provided by Energy Division Staff and Kevala as an informal response to Cal Advocates' June 12, 2023 email *R2106017 EIS Ruling Data Request*, Question 5. See also *Administrative Law Judge's Ruling Setting Deadline to Receive Data Requests on Electrification Study*, June 9, 2023; filed in R.21-06-017.

[16] Managed charging or load management refers to any strategy to move load away from peak times to avoid infrastructure overloads.

[17] 60% = the DGEM's central estimate of $26.3 billion divided by the Replicate scenario's estimate of $15.7 billion.

The first-order estimate in the DGEM report assumes that the difference between the $51 billion EIS result and the $16 billion DGEM-Replicate result is driven by the differences in EV charging load shape. However, the new results show that only a portion of this cost is due to differences in charging load shape. The EIS's load shape brings the DGEM-Replicate cost up to $26 billion; the remaining $25 billion (to get to the EIS's estimate) is due to other modelling differences between the two studies. These may include the EIS's inclusion of public charging and, and higher peak day energy consumption.

4 Conclusions

The conclusion that managed charging strategies that work to move EV load away from peak charging times will reduce the infrastructure investments needed to accommodate EVs still stands with this new analysis. The difference due to this new analysis is the scale of the value of load management. Previously, it was concluded that the difference between the Replicate scenario ($16 billion) and the EIS ($51 billion) could be contributed primarily to load shape. However, the incorporation of the EIS's load shape shows an overall $10.1 billion increase in total costs across the three IOUs compared to a $35 billion increase.

Overall, managed charging has the capacity to greatly reduce the cost to build out the distribution grid and, ultimately, the burden on ratepayers.