Effect of EV charging on need for LDES

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How might EV charging choices affect the need for storage?

Farzan ZareAfifi; under the supervision of Prof. Sarah Kurtz

Overview of EV charging study

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- **Motivation:** what is the value of daytime charging?
- **Inputs**:
  - Three *profiles* for charging light-duty Zero Electric Vehicles (ZEVs)
  - *Energy demand* forecast of ZEVs
- **Results:**
  - Daytime charging requires less storage but more charging infrastructure.
  - How much could be saved?
- **Practicality:**
  - What is net cost savings?
  - Is savings for storage bigger than cost of required charging infrastructure?

How will EV charging load affect the need for storage?
What is the value of daytime charging?

Let's see the analyzed alternative futures first.

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California Energy Commission

COMMISSION REPORT

Assembly Bill 2127
Electric Vehicle Charging Infrastructure Assessment

Analyzing Charging Needs to Support Zero-Emission Vehicles in 2030

Gavin Newsom, Governor
July 2021 | CEC-600-2021-001-CMR

Unconstrained (no incentive) light-duty ZEVs charging profile

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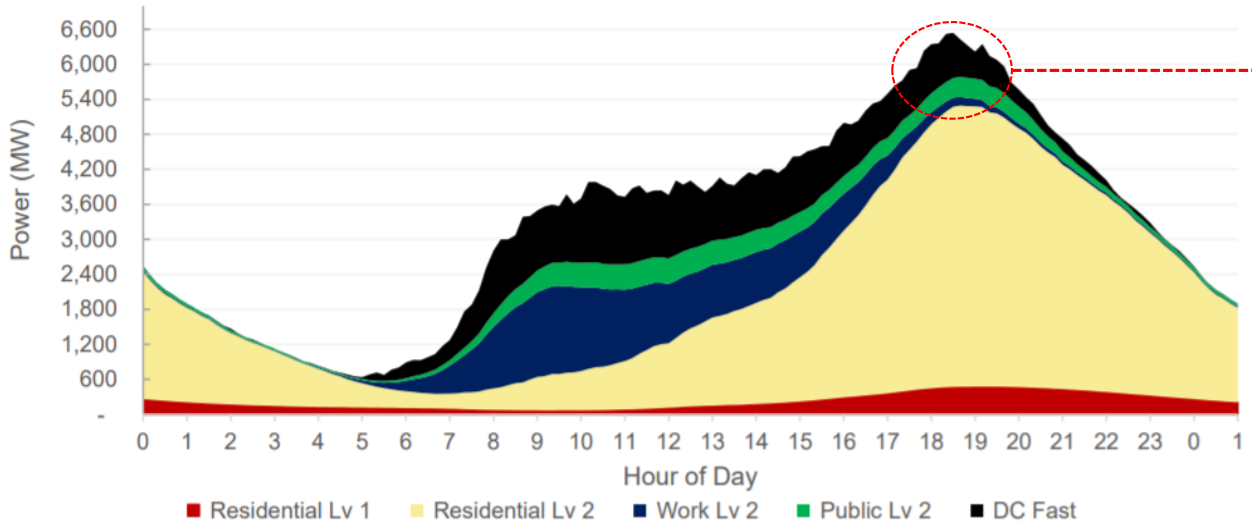
According to the CEC assessment of the AB 2127:

Figure D-1: Projected 2030 Weekday Load Curve for the Unconstrained Alternative Future



Peak load happens when people come back to their homes; NO policy

https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127

Residential (current TOU) light-duty ZEVs charging profile

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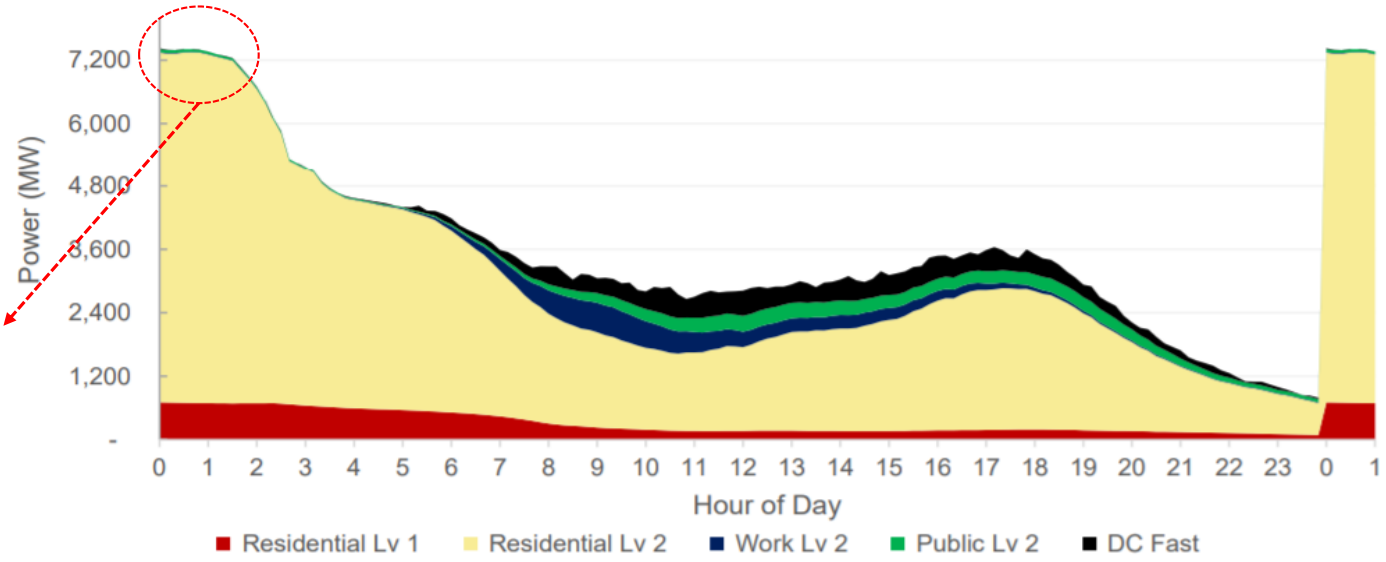
According to the CEC assessment of the AB 2127:

Figure D-3: Projected 2030 Weekday Load Curve for the High Residential Access Alternative Future



Current incentive program: lower electricity rates for charging EVs

https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127

Daytime (e.g. workplace) light-duty ZEVs charging profile

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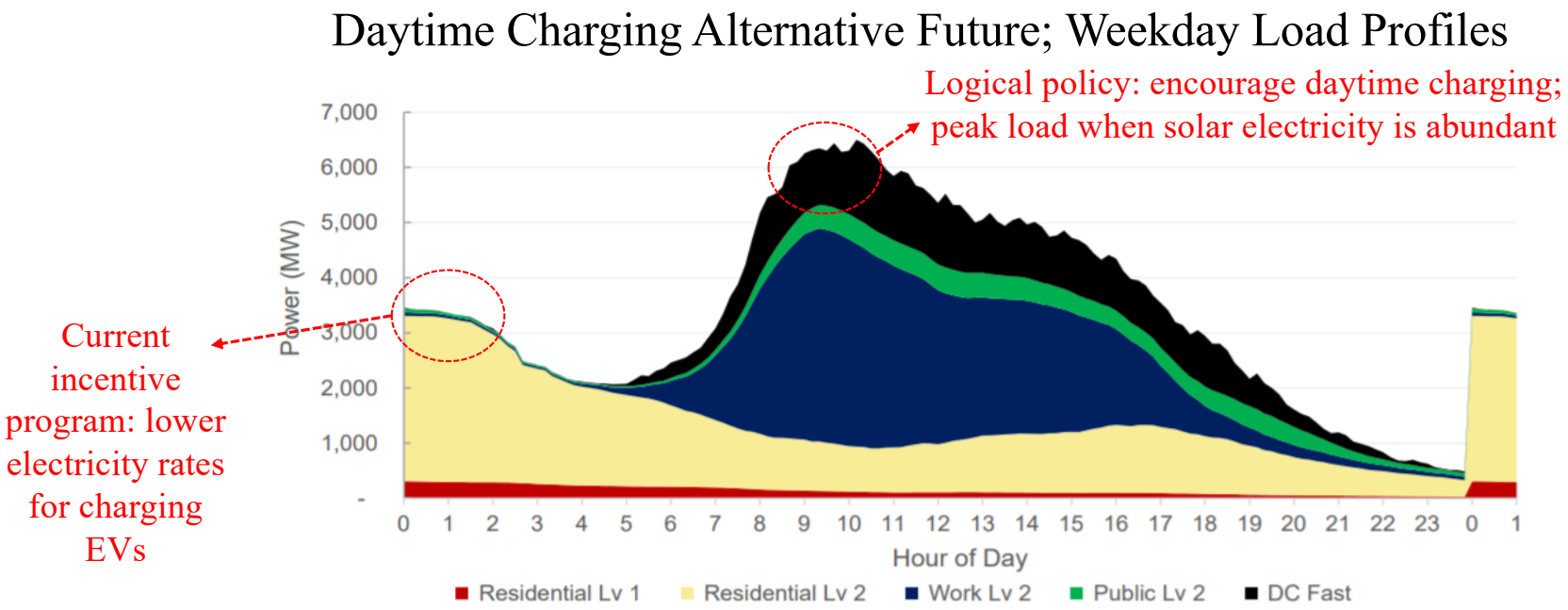
According to the CEC assessment of the AB 2127:



- The weakness of this study → The weekends are not considered.

https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127

Energy demand forecast for 2045:

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IEPR 2021[1]

- **Projected energy demand using in RESOLVE: 55,000 GWh/y**
- **15M ZEVs**
- **46% ZEVs penetration**
- **40 miles/day/vehicle on average**

[1] https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2021-integrated-energy-policy-report

Three profiles scaled for energy demand (2045)

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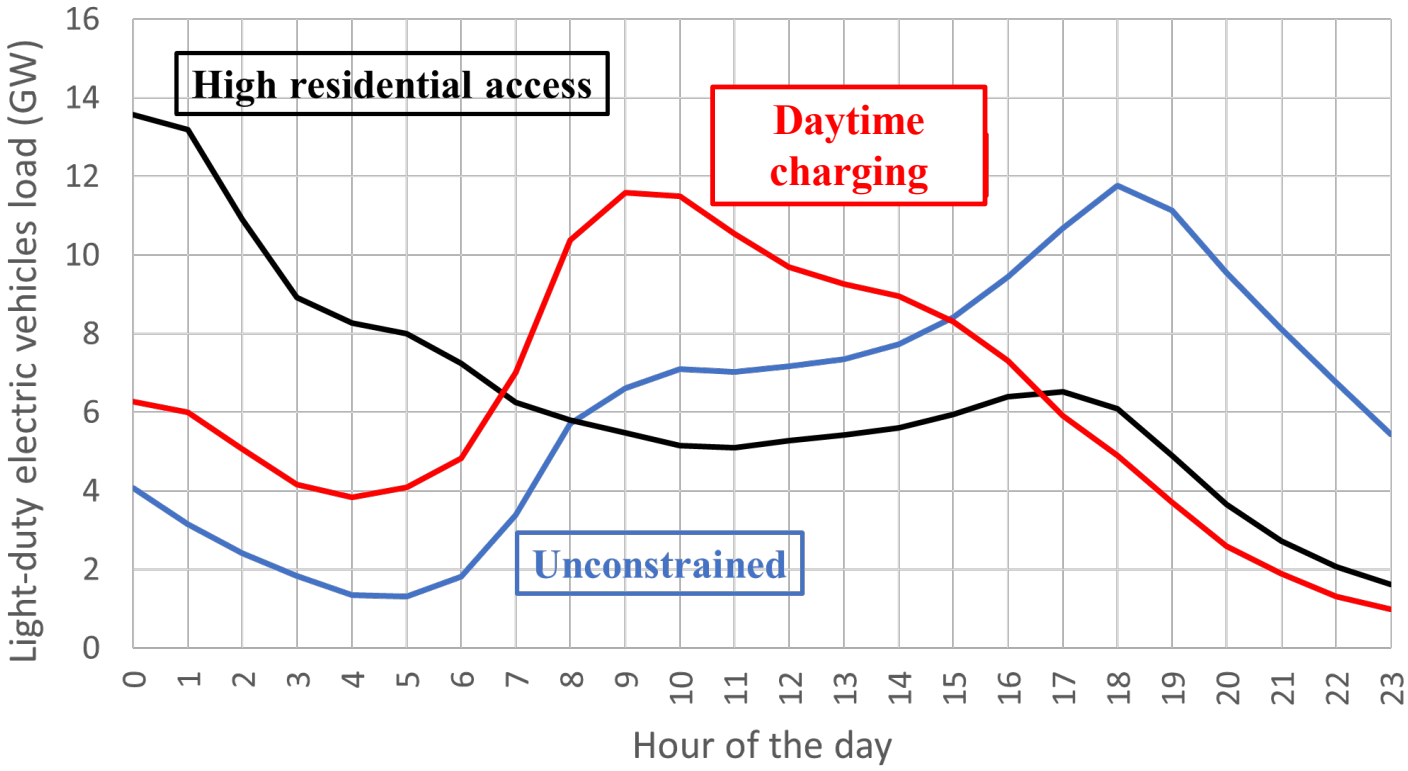

Direct use of solar power is maximum for the daytime charging profile

How much does the daytime charging reduce the need for storage?

Comparison of the operational capacities for the three profiles

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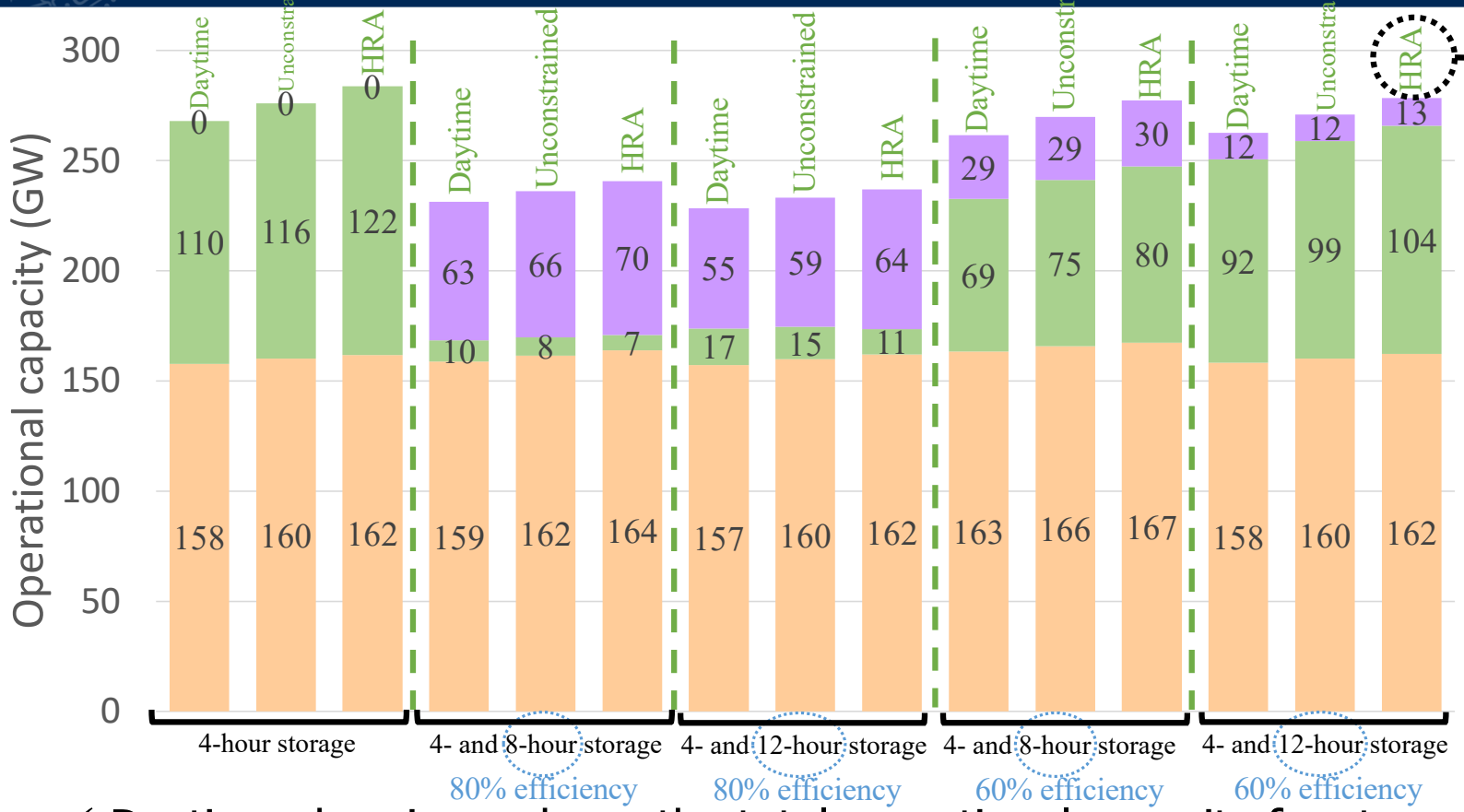

High Residential Access

Assumption:

$$\frac{\textbf{8-h storage cost } (\frac{\$}{kW})}{\textbf{4-h storage cost } (\frac{\$}{kW})} = \mathbf{1.2}$$

$$\frac{\textbf{12-h storage cost } (\frac{\$}{kW})}{\textbf{4-h storage cost } (\frac{\$}{kW})} = \mathbf{1.4}$$

LDES
Lithium-ion battery
Solar PV

✓ Daytime charging reduces the total operational capacity for storage.

Storage capital cost

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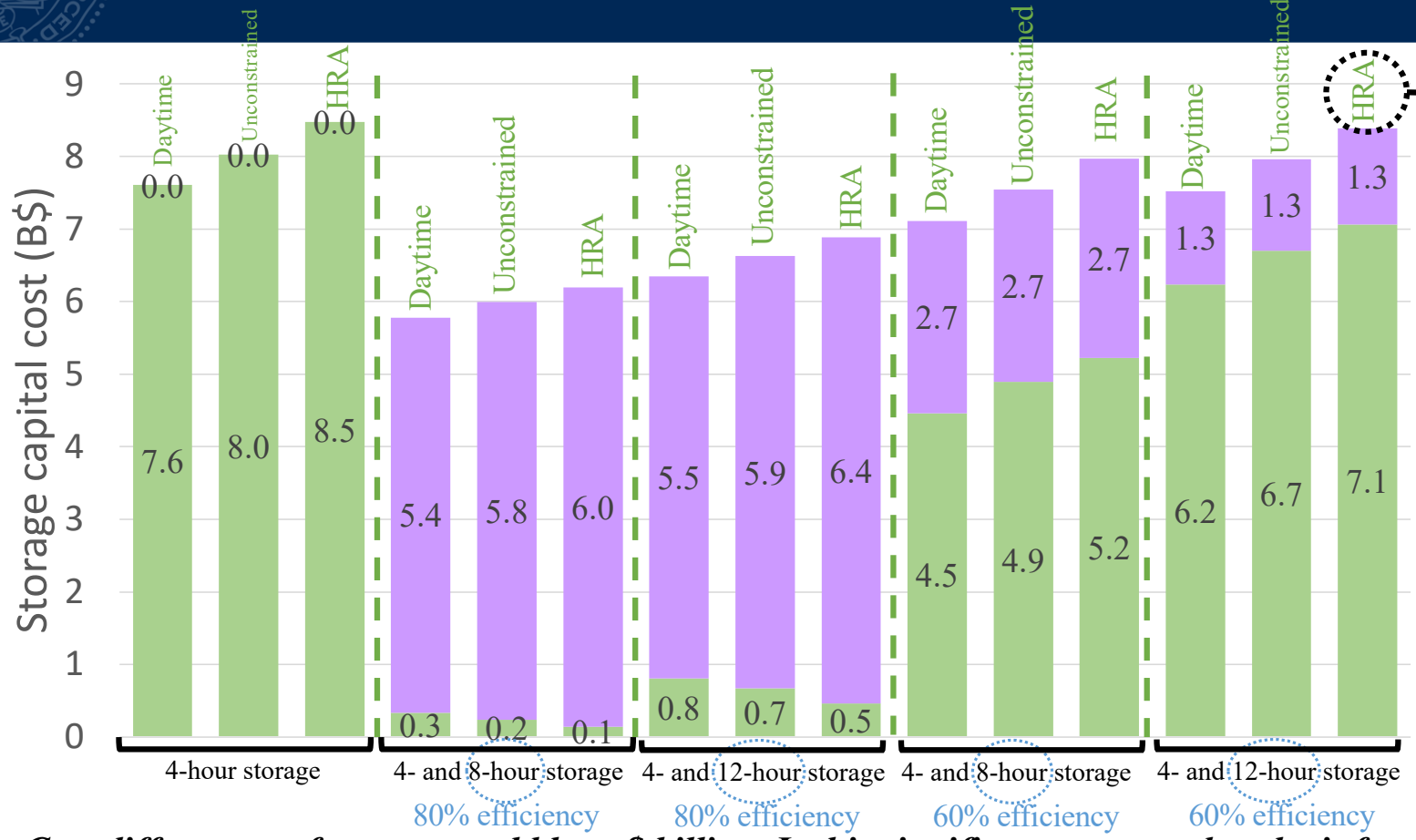

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LDES

Lithium-ion battery

➢ ***Cost differences of storage could be ~ $ billion. Is this significant compared to the infrastructure cost?***

Daytime charging requires more non-residential charging infrastructure. How much is this added cost?

Projected number of chargers for 2045

Profile	Number of chargers for 15M light-duty ZEVs				
	Workplace (LV2)	Public (LV2)	Multi-Unit (LV2)	DC Fast	Total
Unconstrained	599,500	861,667	605,000	67,833	2,134,000
High residential access	242,000	504,167	1,906,667	40,333	2,693,167
Daytime charging	1,442,833	898,333	605,000	67,833	3,014,000

*Note: these values do not include chargers at single-family homes.

Assumptions:
-Level 2 chargers for public and workplace charging
-Large amount of level 1 charging is replaced with level 2 for residential charging
-NO level 1 chargers considered in this study (is this reasonable?)

➢ ***How much does each charger cost?***

https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127

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WHITE PAPER

JULY 2021

CHARGING UP AMERICA: ASSESSING THE GROWING NEED FOR U.S. CHARGING INFRASTRUCTURE THROUGH 2030

Gordon Bauer, Chih-Wei Hsu, Mike Nicholas, and Nic Lutsey

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ZEVs charging infrastructure cost projections until 2030

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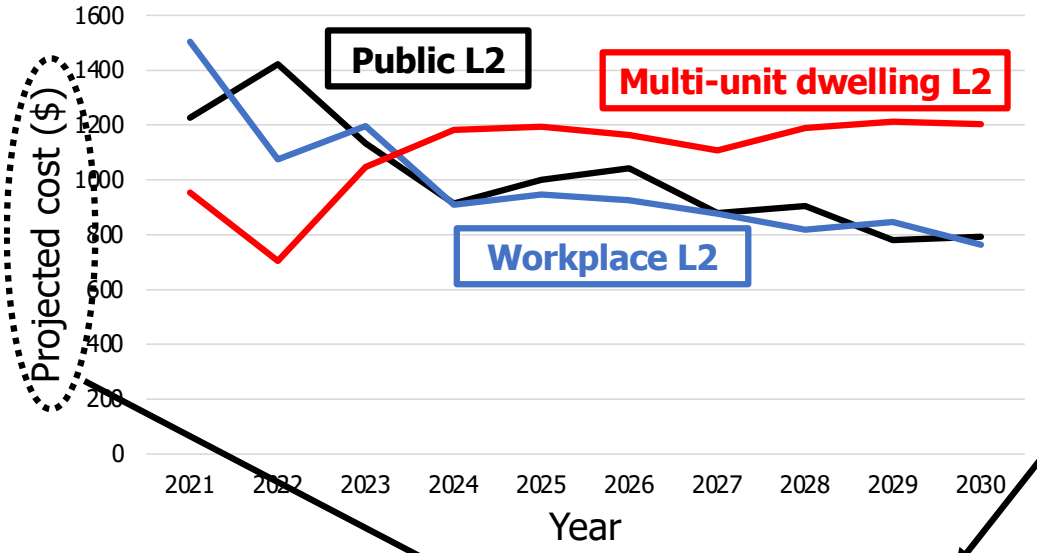

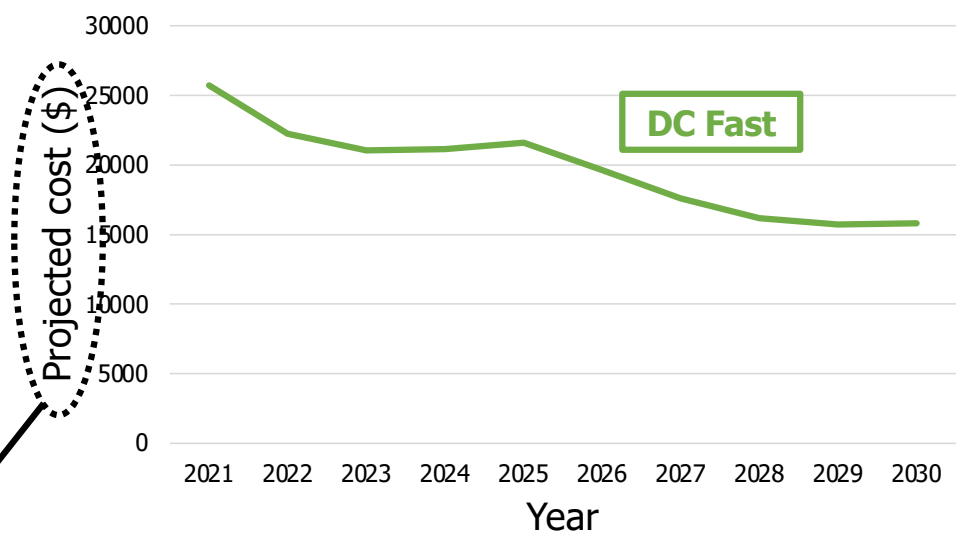

Annual charging infrastructure investment per charger (about half of which is for installation labor)

- ***What about the cost in 2045?***

Data from: Charging up America: Assessing the growing need for U.S. charging infrastructure through 2030 ; Gordon Bauer, Chih-Wei Hsu, Mike Nicholas, and Nic Lutsey

Scenarios for ZEVs charging infrastructure cost projections in 2045

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- **Small Technological Progress (STP) Scenario:** average of the projected costs from 2021 to 2030 is considered for 2045*.
- **Medium Technological Progress (MTP) Scenario:** 2030 projected cost is considered for 2045
- **High Technological Progress (HTP) Scenario:** the predicted cost drop from 2026 to 2030 happens for the next 15 years in 2045*

Scenario	Cost of different chargers ($/charger)			
	Public	Workplace	Multi-unit dwelling*	DC Fast
STP	1000	1000	1200	20000
MTP	800	800	1200	16000
HTP	600	600	700	12000

***Note: for multi-unit dwelling, the cost is considered to be $1200 for MTP and STP, and is $700 for HTP, which is the minimum projected cost from 2021 to 2030.**

Is it practical to charge California's ZEVs with solar-covered parking lots?

Mounting solar panels over the parking lots: solar parking canopy legislation

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Los Angeles County alone has 101 square miles of parking lots (about 25% of the state's population).

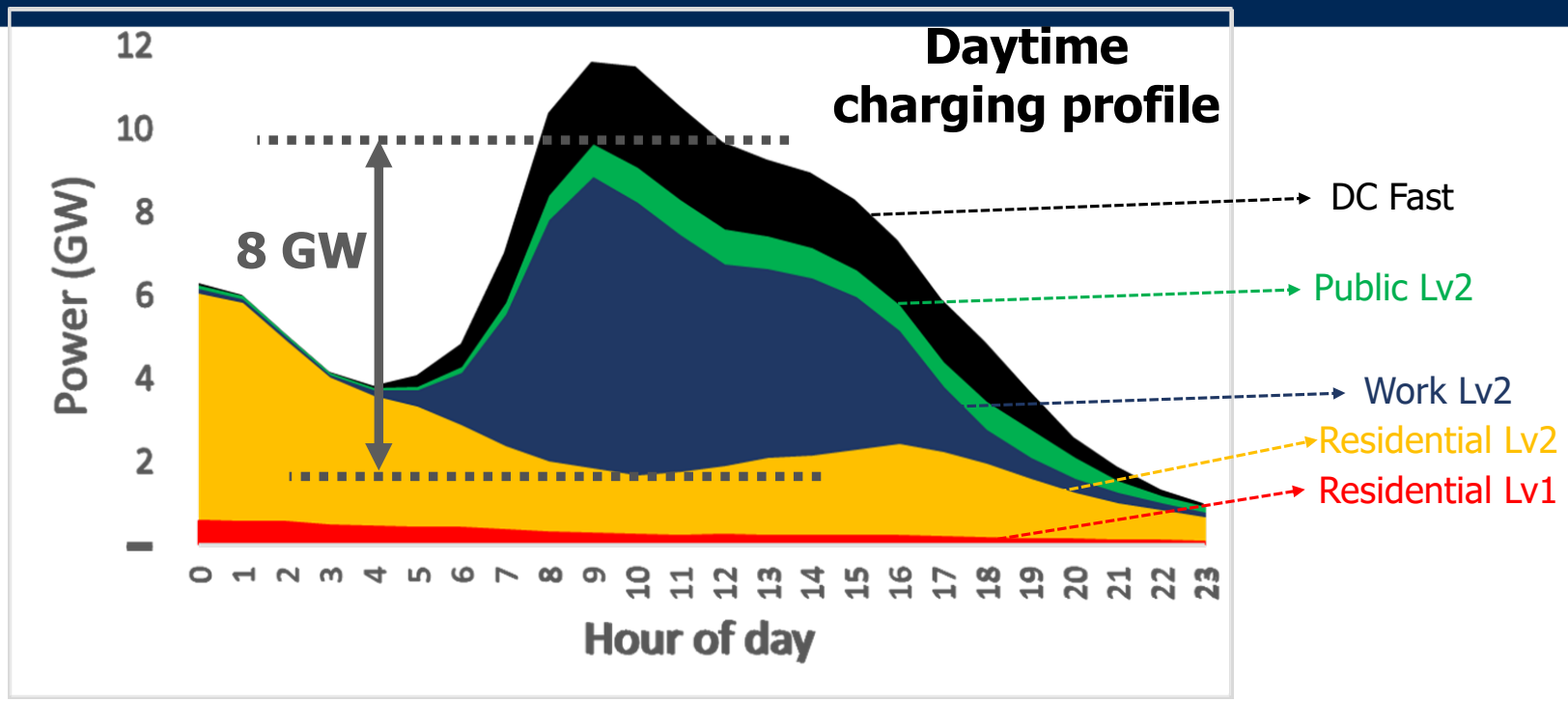
A press release by Senator Becker extrapolates these numbers by population, inferring that there should be approximately 400 square miles of parking lots in the state, equivalent to 26 GW of solar canopies.

- ***Is 26 GW sufficient to meet the daytime charging?***

https://pv-magazine-usa.com/2023/04/12/california-senate-transport-committee-passes-solar-parking-canopy-and-highwayside-law/

19

Can we meet the ZEVs load with 26 GW solar canopies?



- ✓ **By using 30% of the parking lots, the peak load of 8 GW for work and public charging could be met.**
- ✓ **1000 hours generation/y →26,000 GWh energy generation < 55,000 GWh projected energy demand → energy for chargers other than workplace and public ones should come from somewhere else.**

Takeaways

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- ✓Daytime charging of light-duty ZEVs adds the non-residential charging infrastructure cost, but the decrease in the total energy system cost is more significant.

- ✓With all the parking lots covered by solar panels, using around 30% of them meets public and workplace charging demand for daytime charging.

Appendix: Alternative Futures

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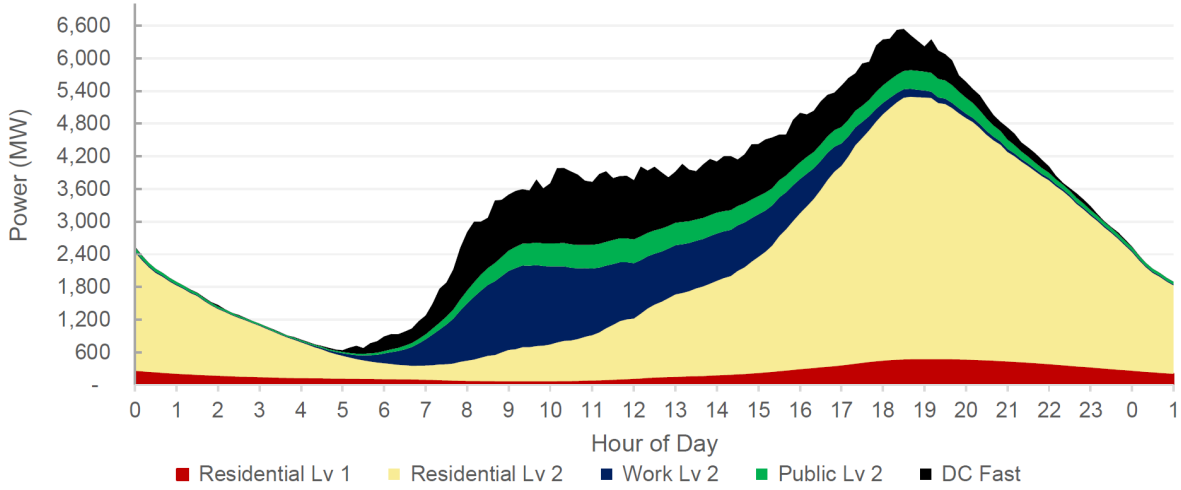
Figure D-1: Projected 2030 Weekday Load Curve for the Unconstrained Alternative Future



Appendix: Alternative Futures

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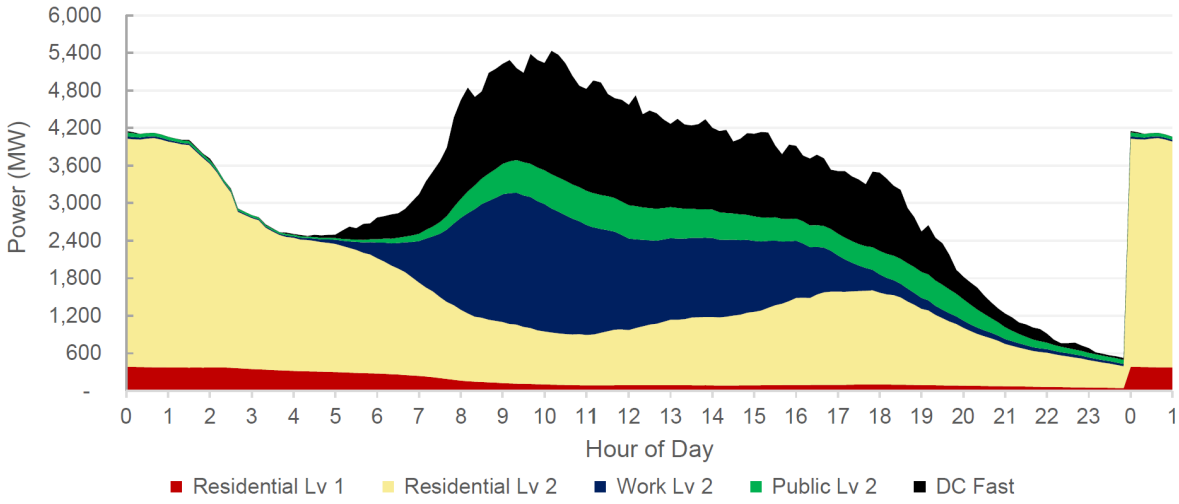
Figure D-2: Projected 2030 Weekday Load Curve for the Low Residential Access Alternative Future



Appendix: Alternative Futures

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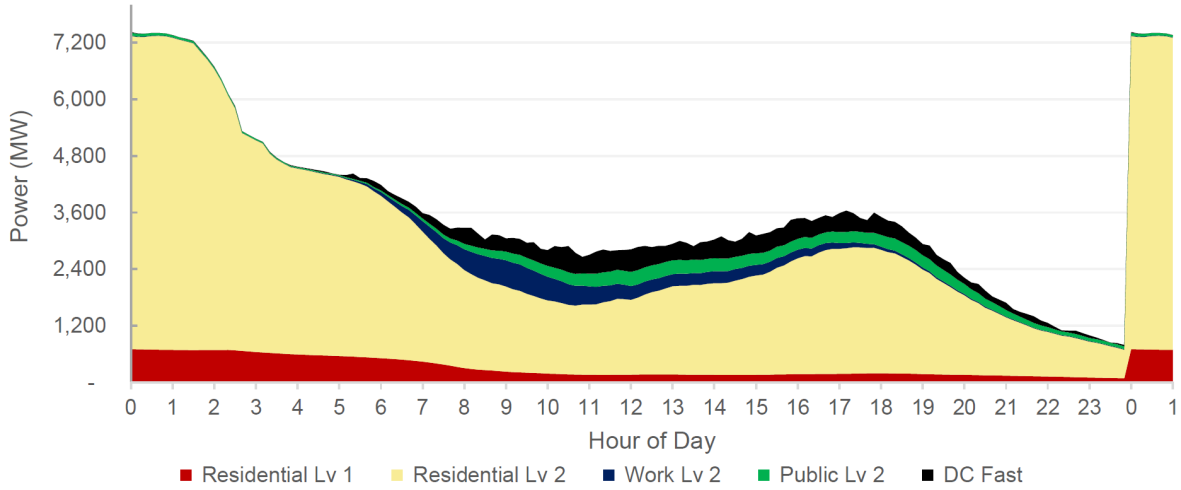
Figure D-3: Projected 2030 Weekday Load Curve for the High Residential Access Alternative Future



Appendix: Alternative Futures

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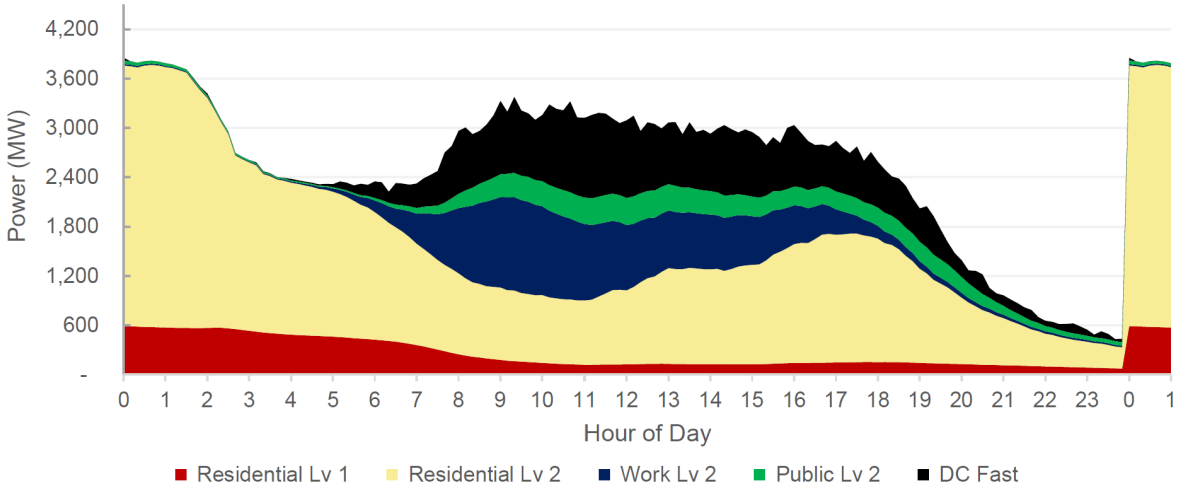
Figure D-4: Projected 2030 Weekday Load Curve for the Low Energy Demand Alternative Future



Appendix: Alternative Futures

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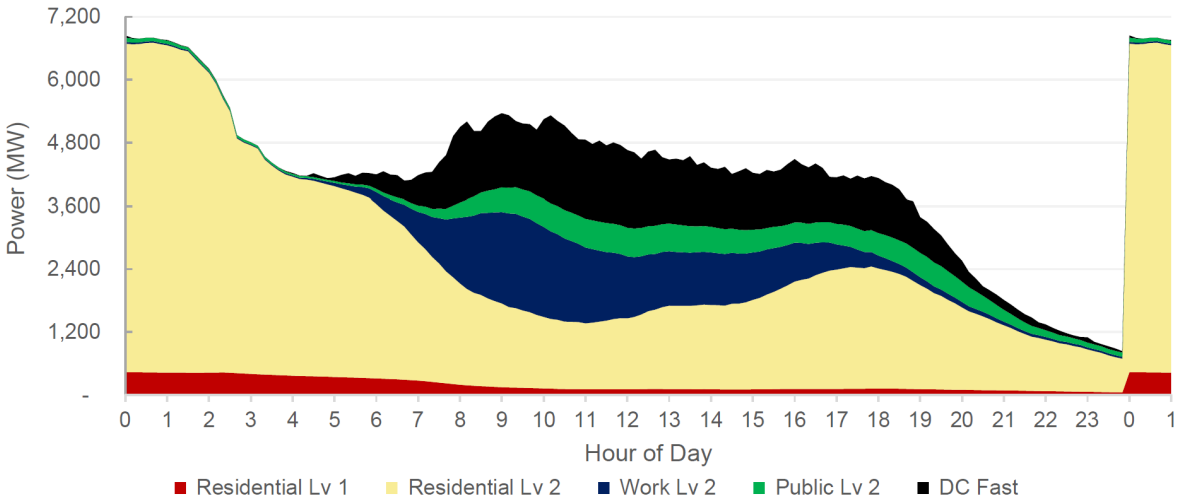
Figure D-5: Projected 2030 Weekday Load Curve for the High Energy Demand Alternative Future



Appendix: Alternative Futures

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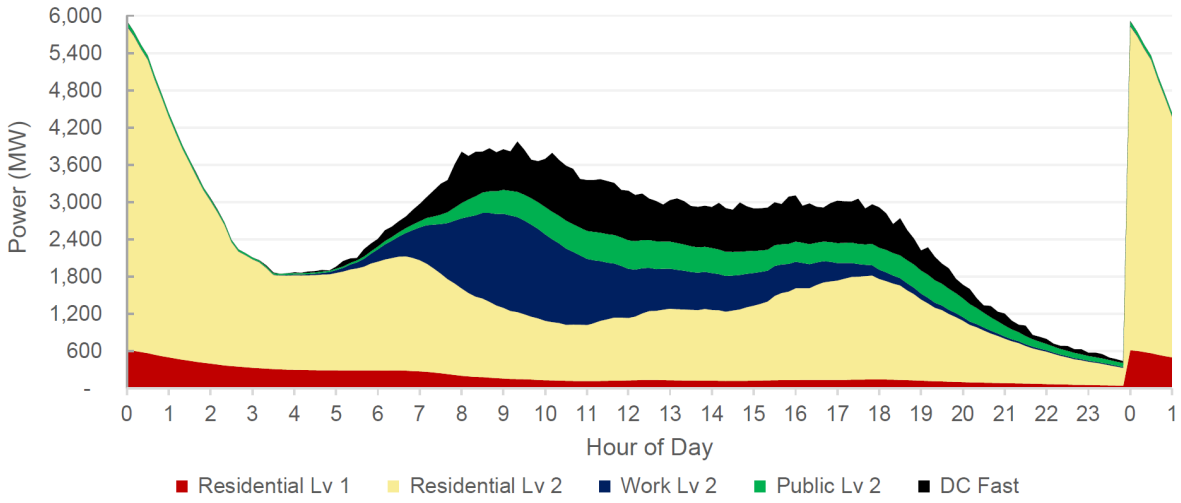
Figure D-6: Projected 2030 Weekday Load Curve for the Low Range PEVs Alternative Future



Appendix: Alternative Futures

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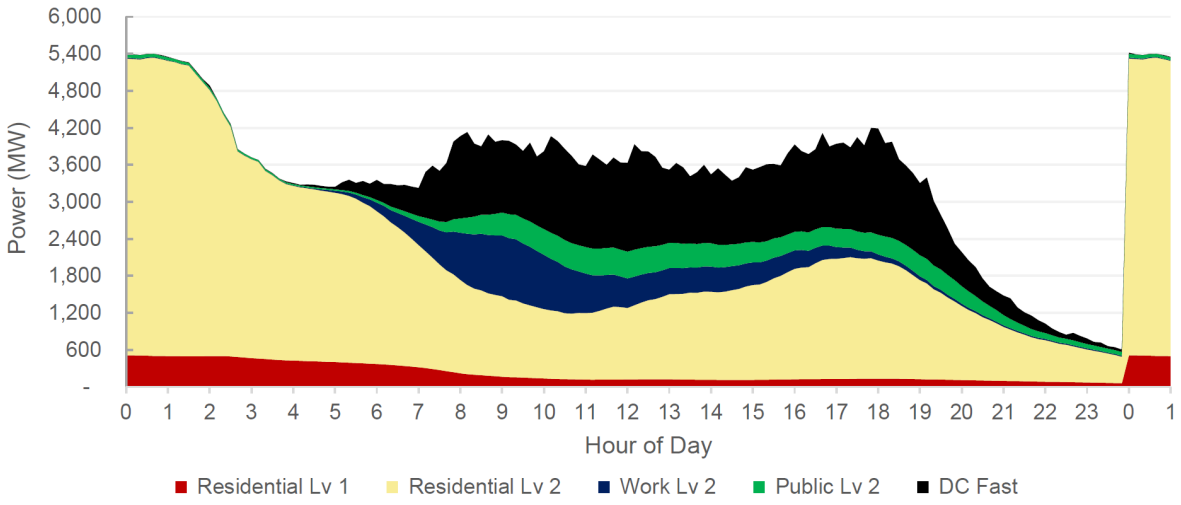
Figure D-7: Projected 2030 Weekday Load Curve for the Gas Station Model Alternative Future



Appendix: Alternative Futures

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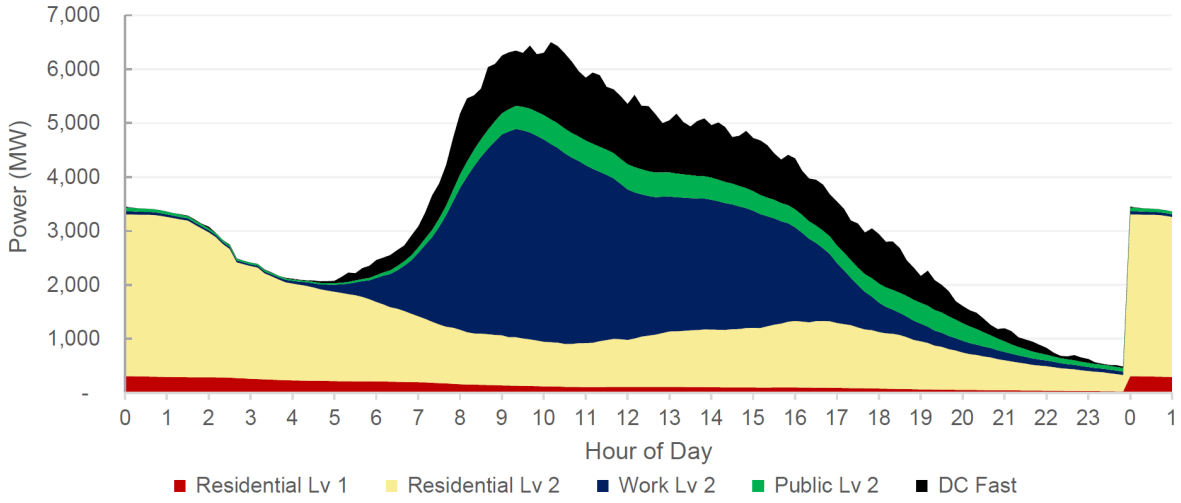
Figure D-8: Projected 2030 Weekday Load Curve for the EV Happy Hour Alternative Future



Appendix: Alternative Futures

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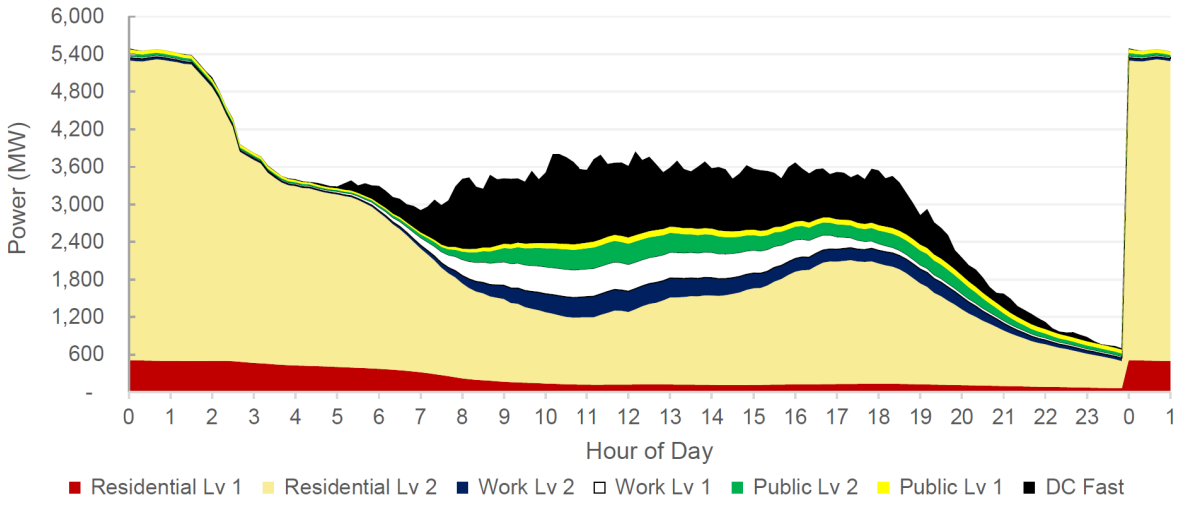
Figure D-9: Projected 2030 Weekday Load Curve for the Level 1 Charging Alternative Future



Appendix: Alternative Futures

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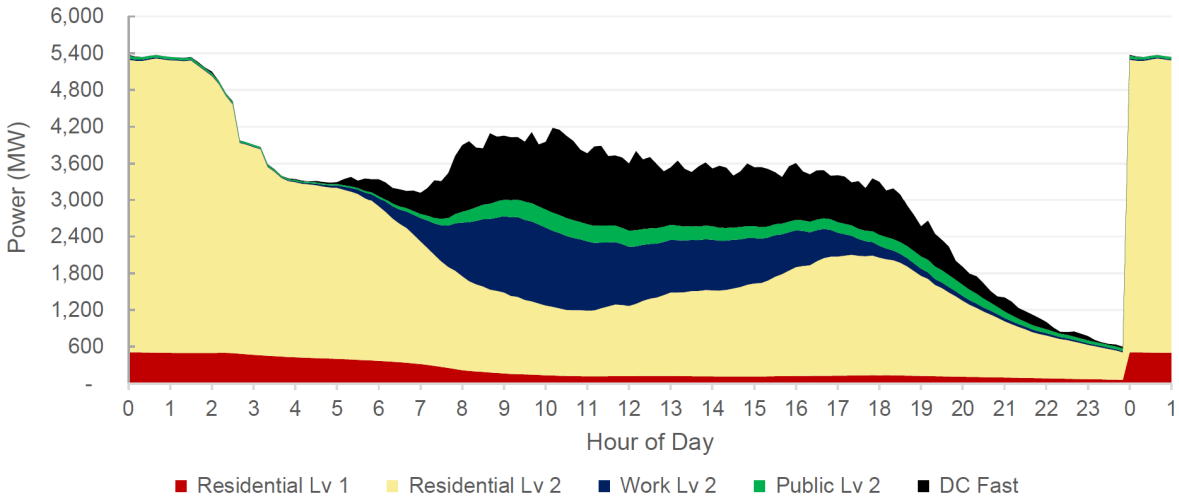
Figure D-10: Projected 2030 Weekday Load Curve for the Lazy PHEVs Alternative Future



Appendix: Alternative Futures

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Figure D-11: Projected 2030 Weekday Load Curve for the Widespread Topping Off Alternative Future