Demand Charge Management for Transit Fleets

CA Air Resources Board **Feb 8, 2016**

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Transit EV TCO and Year 1 Operating Costs

56% Cleaner, 2% Cheaper,
and No upfront Capital

	Electric (incl charger)	Diesel
MSRP	$750K	$450K
Miles (year / Life)	40,000 / 500,000	40,000 / 500,000
Fuel Efficiency (MPGe)	13	4
Maintenance ($/Mile)	$0.5	$0.9
Midlife Overhaul Cost****	$105K	$45K
Clean Air Cash Incentive	$115K	-
Total GHG Emissions (Kg/Mile)	1.1	2.5
Annual Cost of Ownership	**$138,000**	**$141,000**
Annual Operating Cost*	$45,000	$75,000
Annual Lease Cost**	$93,000	$66,000
Annual GHG Emission (mTons)***	44	100

* Fuel and Maintenance – assuming $3.5/Gallon for Diesel and $0.16/kWh for electricity

** 12 Year Lease with no upfront payment and 40,000 miles per year limit. Additional miles at $1.5/mile. Federal, State, and Local funding will lower the cost of ownership for both types.

*** The emissions of electric buses will decrease even further as the Renewable Standards increase.

**** Midlife Overhaul includes replacement of battery packs.

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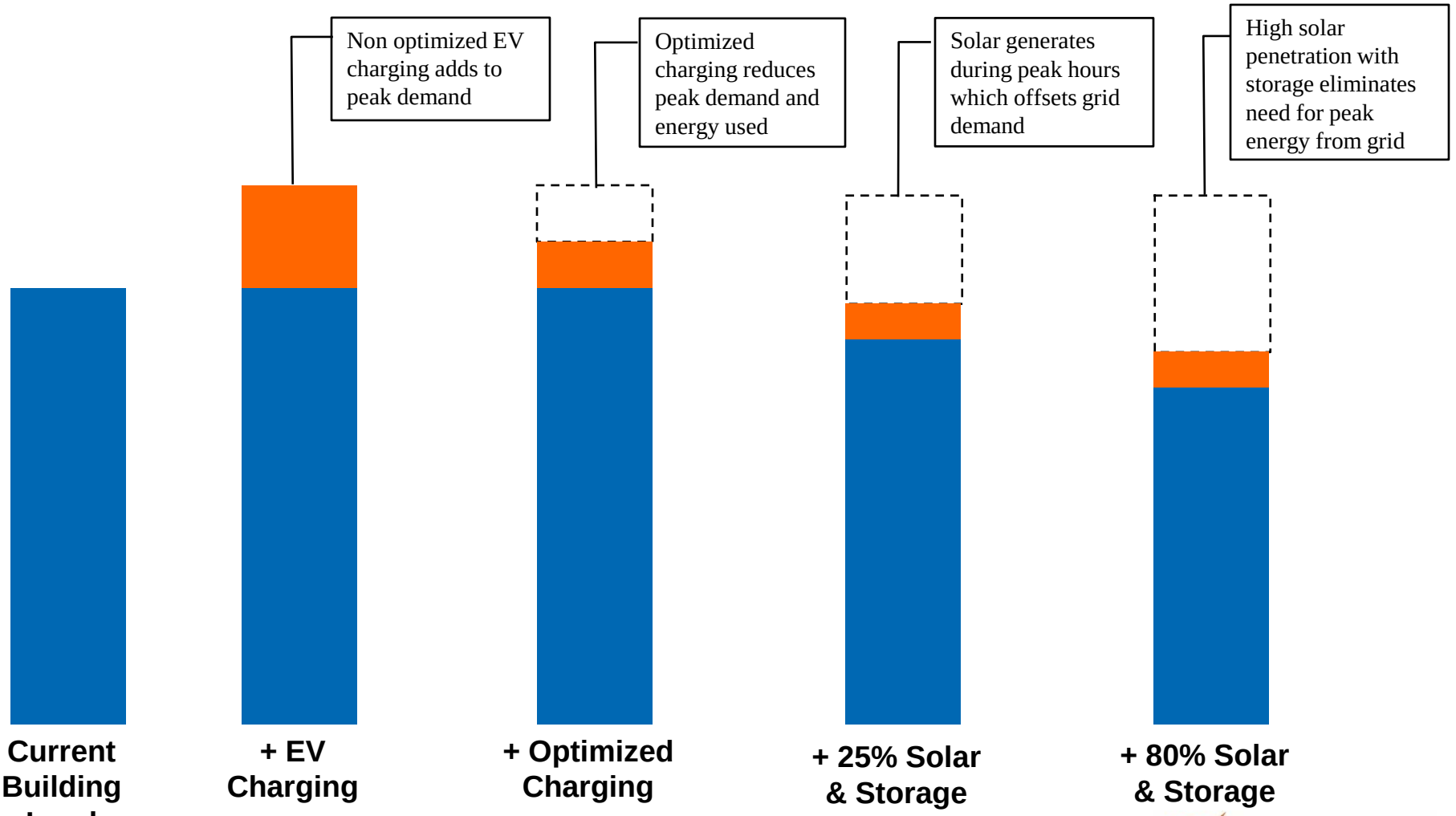
Building and Vehicle Fleet Electricity Cost

Options to achieve the lowest total electricity cost



Note : Based on average loads. Exact savings will vary

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Types of Charging

There are two types of charging options available:

1. In-Depot Charger
   a. Up to 100kW charger installed at the depot
   b. Charge time is typically between two to six hours, once a day
   c. Bus will have a larger battery pack >200kWh
   d. 'Top-Up' charging can be done mid day based on schedule
   e. Can operate 8 to 10 hours a day
2. On-Route Charger
   a. >300kW charger size, and are installed on route
   b. Charge time is typically between 2-10 minutes, every hour
   c. Bus will have a smaller battery pack <150kWh
   d. Can operate up to 24 hours continuously

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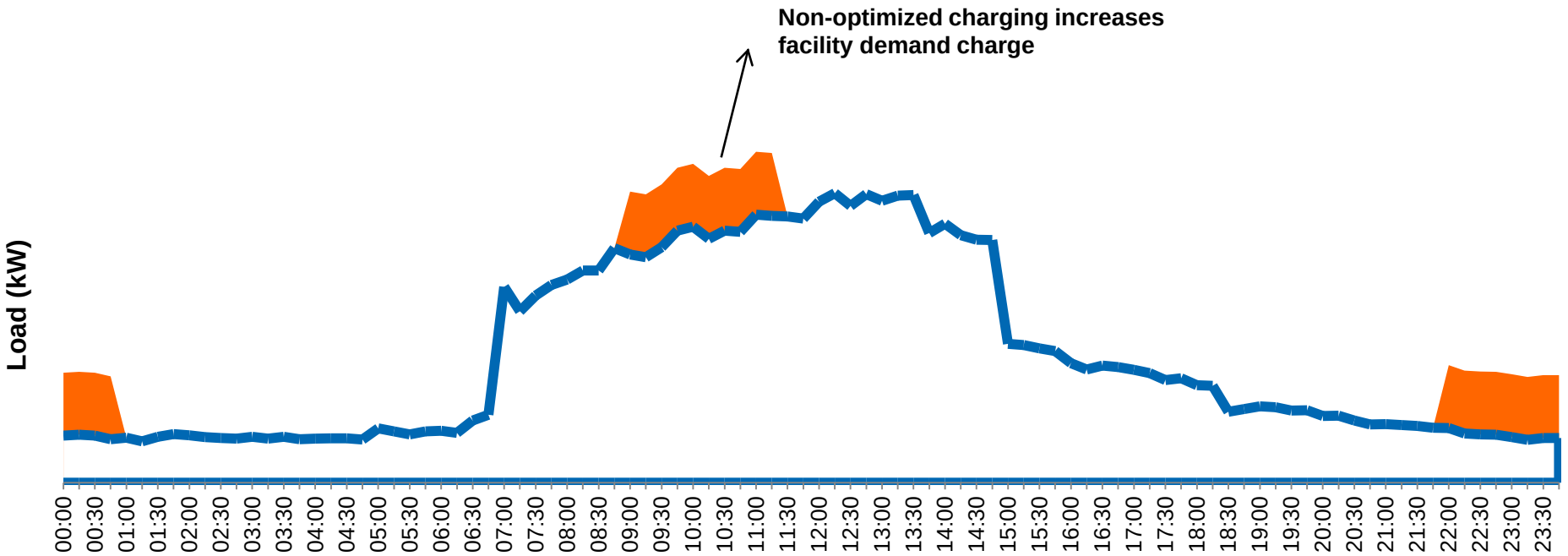
Demand Charges for In-Depot Charging

Case Study – Bus Fleet

FIVE EV buses added to facility load



Charging during day time hours, we need to understand:

- Effect of charging on the facility load
- Utility tariff structure
- Run time availability for the bus evening trips

Note : Tariff used is TOU GS-3 Option B from SCE. EV is charged based on run time requirements and cost of energy and demand. 50kW charger per bus

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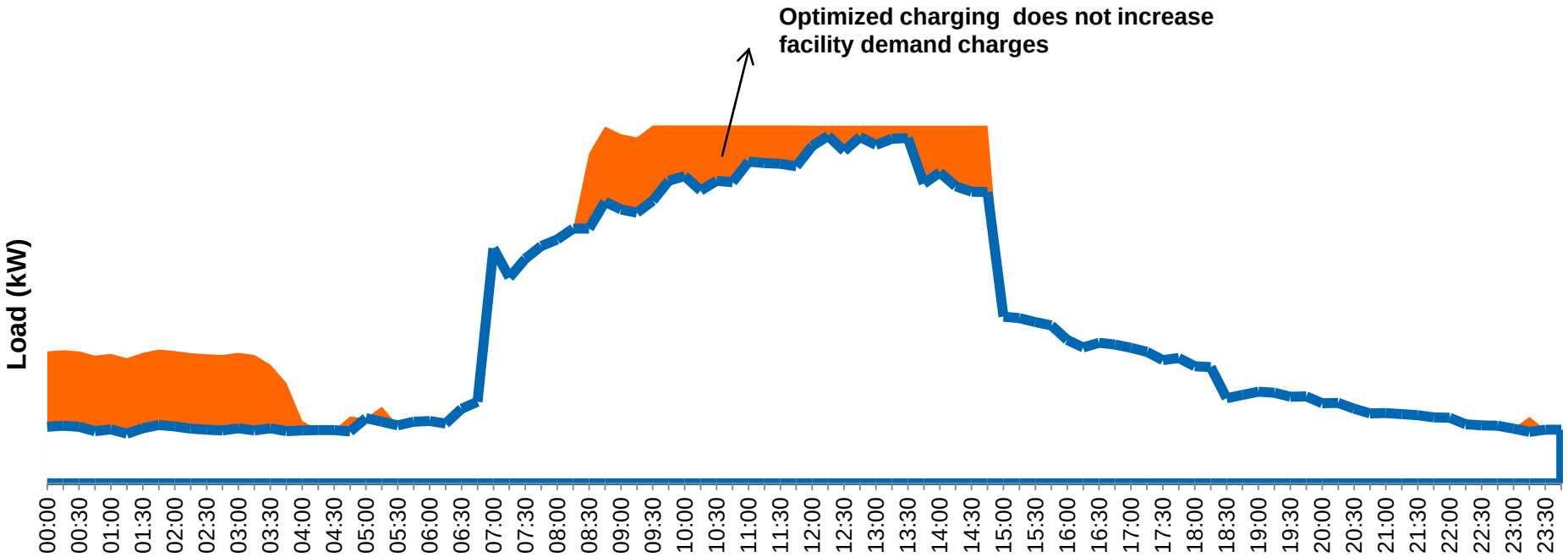
Case Study – Bus Fleet w/ Optimized Charging

FIVE EV buses added to facility load



Optimized fleet charging reduces demand charges by:

- Automatically stage all connected EVs to reduce peak load
- Charge during lower tariff rate
- Charge based on routing profile of the bus

Note : Tariff used is TOU GS-3 Option B from SCE. EV is charged based on run time requirements and cost of energy and demand. 50kW charger per bus

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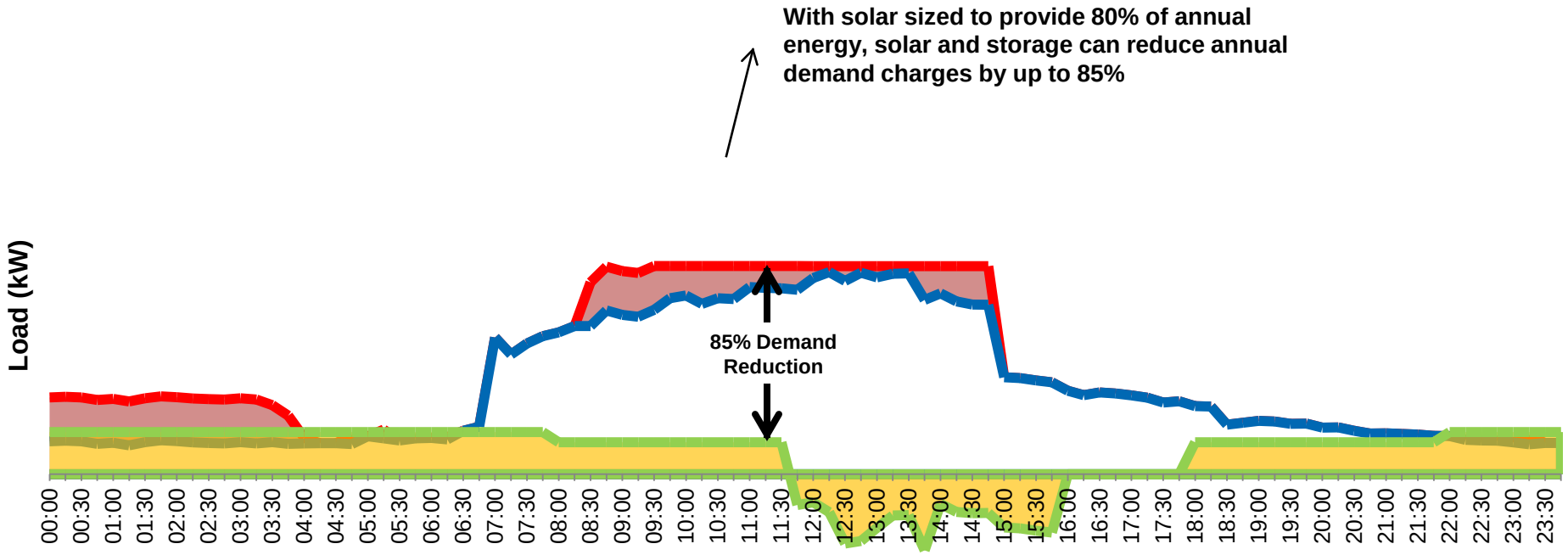
Bus Fleet w/ Optimized Charging, Solar, & Storage

FIVE EV buses added to facility load



Solar PV with energy storage sized to provide up to 80% of annual demand can:

- Reduce utility demand charges by up to 85% in summer
- Move tariff to 'Option R' lowering demand charges further
- Bank solar production for non solar hour usage

Note : Tariff used is TOU GS-3 Option B from SCE. EV is charged based on run time requirements and cost of energy and demand. 50kW charger per bus

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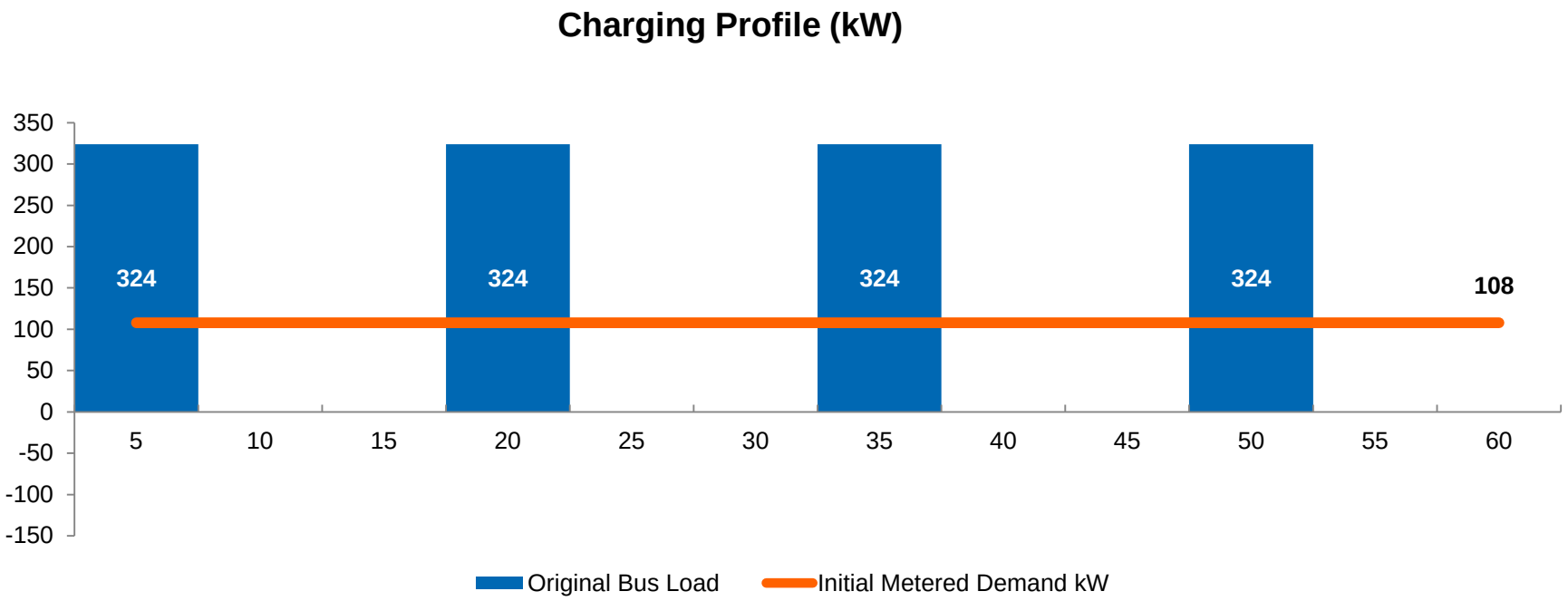
Demand Charges for On-Route Charging

Case Study – Four Bus Ideal Scenario

An Ideal Charging Scenario with **FOUR** buses:



- One bus is charged every 15 minutes; Pattern to occur all hours in the month
- Demand charge incurred is an average over 15 minutes
- With a peak charge of 324kW for 5 minutes, the metered demand is 108kW
- With a monthly demand charge of $20/kW, the annual demand charge is $25,920

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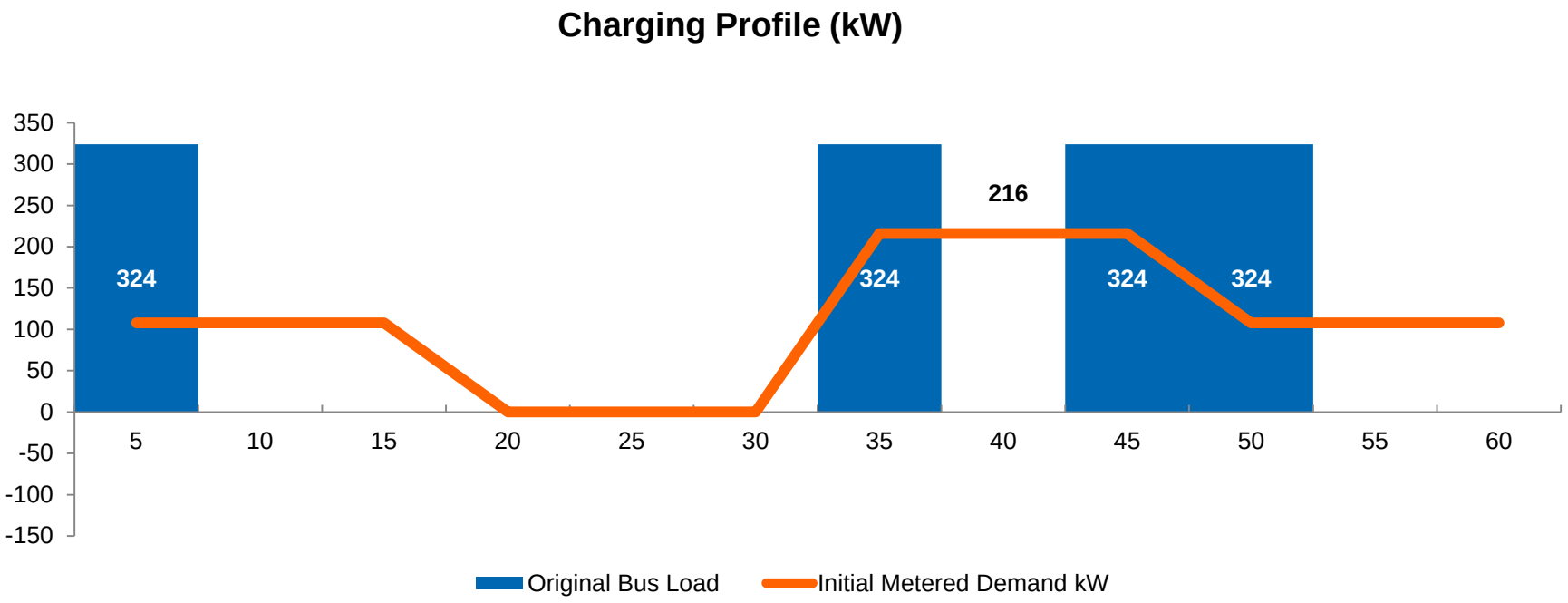
Case Study – Four Bus Charging Overlap

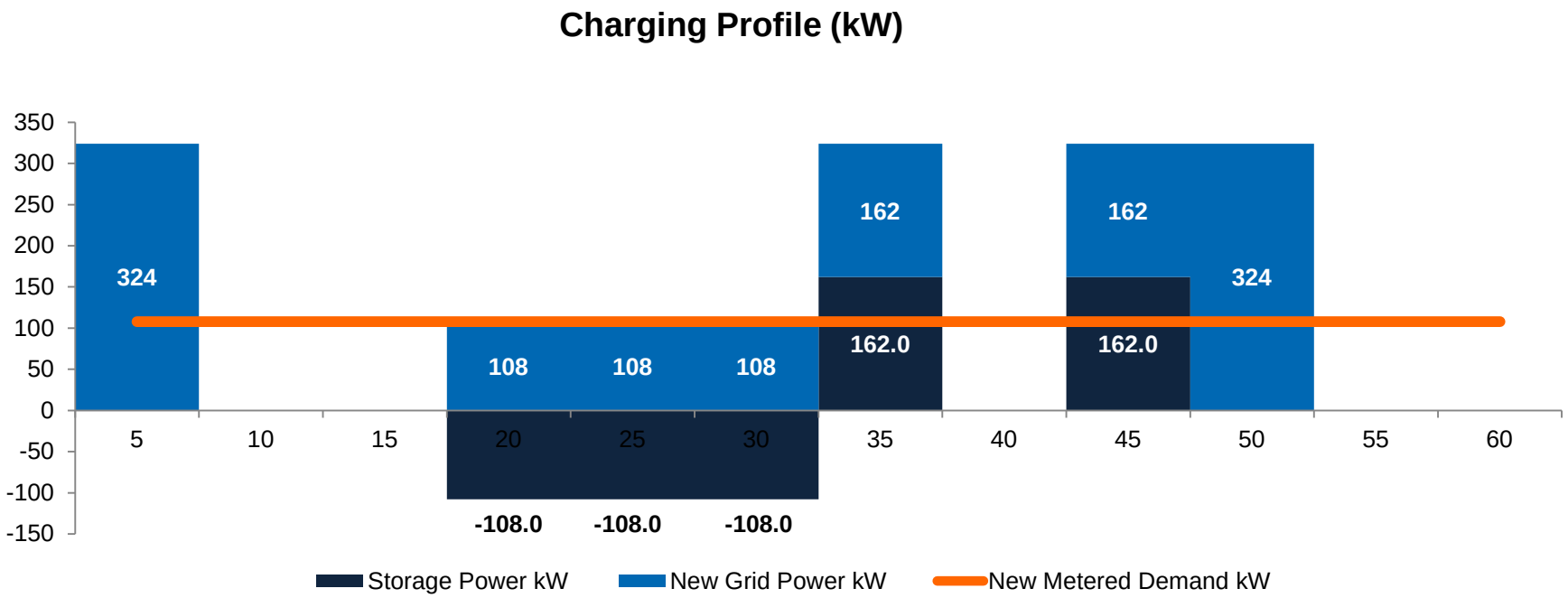
Concurrent Charging Scenario with **FOUR** buses:



- Two buses charged in one 15 minute interval; Occurs 40% of hours based on actual data
- Demand charge incurred is average over 15 minutes
- With a peak charge of 324kW for 10 minutes, the metered demand is 216kW
- With a monthly demand charge of $20/kW, the annual demand charge is $51,840

Case Study – Four Bus Charging Overlap w/ Storage

Storage Charging Scenario with **FOUR** buses:



- Storage system will average the total energy consumed to reduce demand in a 15 minute interval
- Integrated EMS algorithm will charge and discharge the battery to follow demand
- Storage SOC% will be maintained between start and end of hour
- With a monthly demand charge of $20/kW, the annual demand charge is $25,920, a total savings of 50%

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