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Abstract

- This paper presents a case study at the University of California, Riverside (UCR) that evaluates the effectiveness of different transportation-based microgrid configurations in reducing both carbon dioxide (CO₂) emissions and electricity costs
- Electric costs were also compared to determine the financial savings potential for the consumer
- The results demonstrate that a peak-shaving transportation-microgrid strategy can effectively reduce CO₂ emissions in the range of 24% to 38% and costs from \$27,000 to \$29,000 per year
- Careful consideration should be given to battery sizing, as peak-shaving has diminishing returns

Purpose and Contributions

- This research holds significant implications for the advancement of intelligent transportation systems, as it aims to address the economic needs of EV charging infrastructure owners and determine the optimal configuration that benefits both EV owners and the environment by minimizing greenhouse gas emissions
- This paper delves into the impacts of transportation-microgrids equipped with Level 2 and Level 3 charging on the behavior of microgrids, associated electricity costs, and CO₂ emissions within the context of southern California
- The simulations are conducted using OpenModelica, a dynamic modeling and simulation environment
- This study distinguishes itself from previous research in many ways, including employing a higher time resolution for calculating CO₂ emissions that is measured every 15 minutes

BESS Capacity Comparison

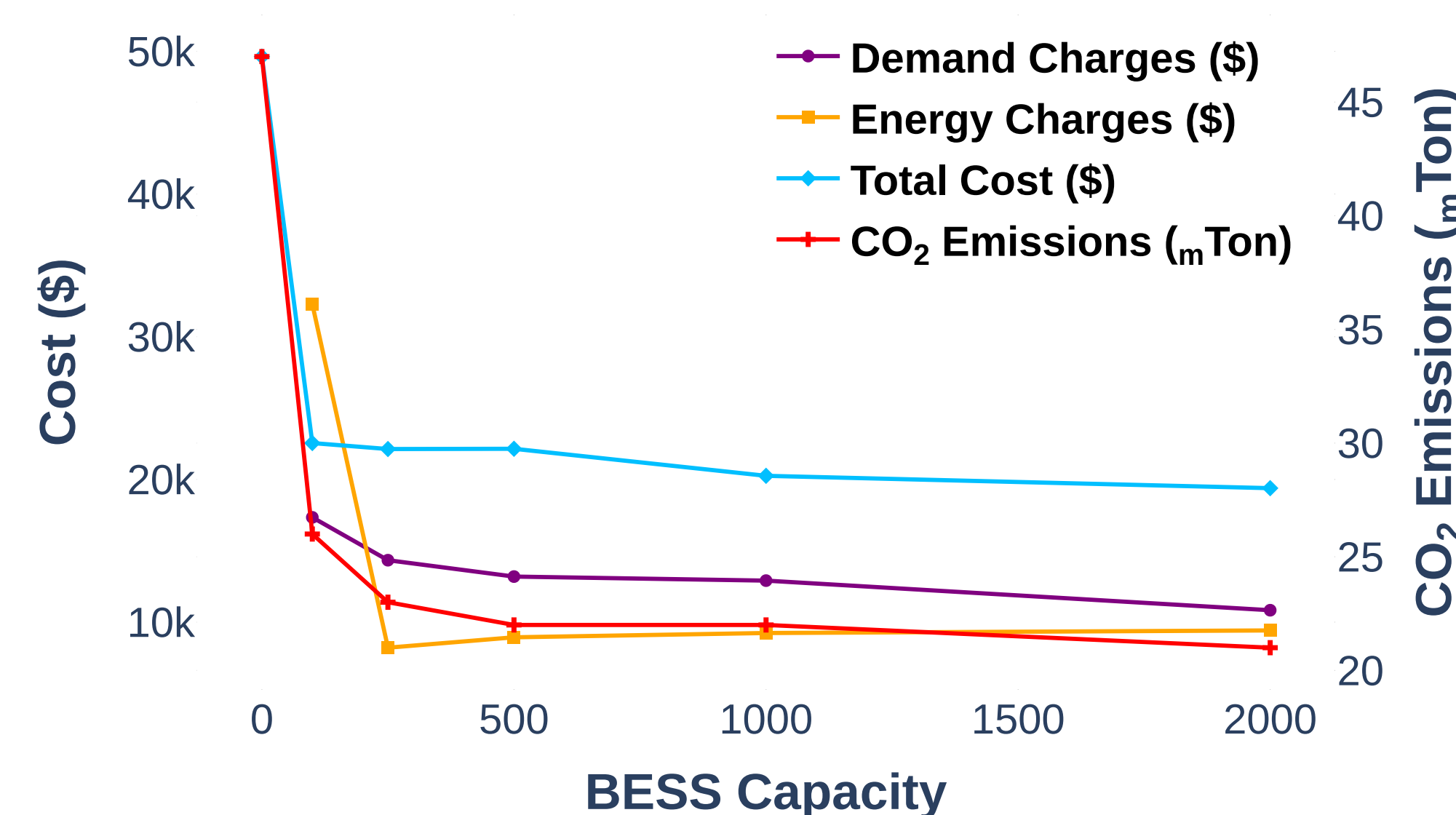


Figure 1: Cost and CO₂ Emissions for Different Battery Capacities. A BESS capacity of 250 -500 kWh is ideal for the lowering costs and CO₂ emissions without with less diminishing returns in savings.

Microgrid Architecture

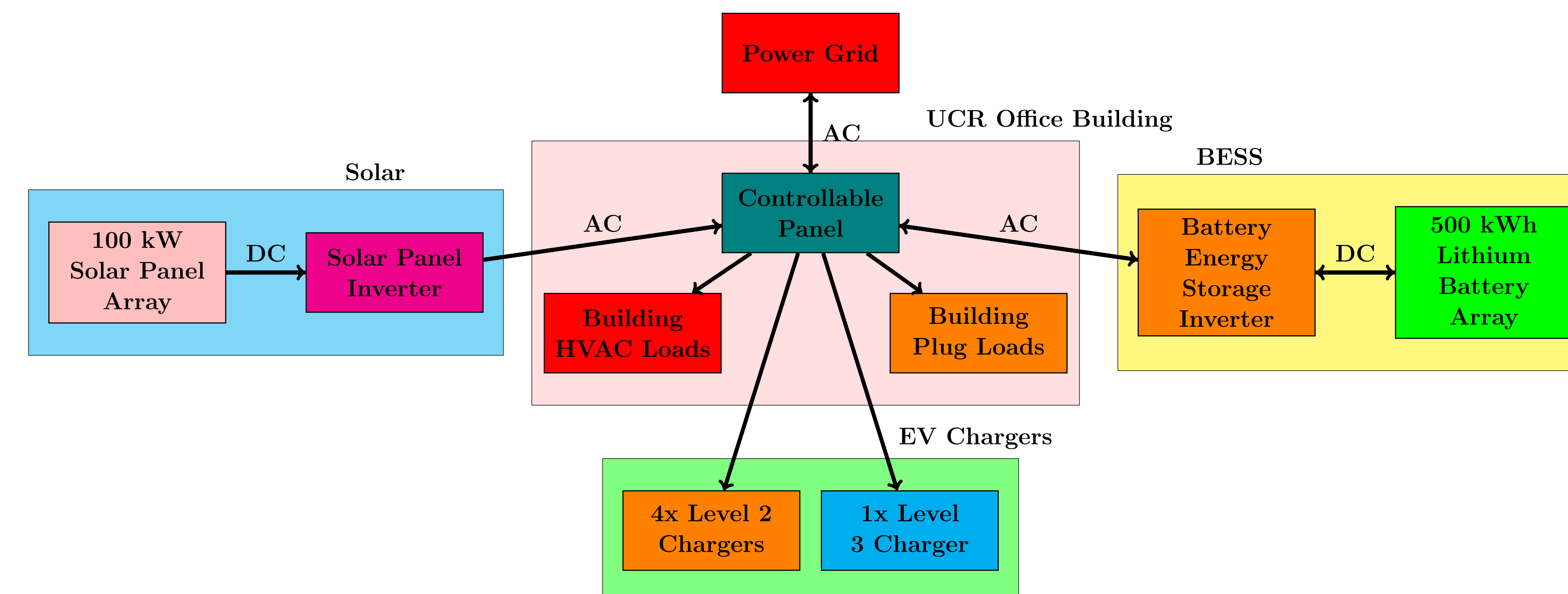


Figure 2: Microgrid Architecture of our Case Study Example BESS: Battery Energy Storage System

Simulated Scenarios of the UCR Microgrid using Different Layouts

Table 1

| Scenario | |
|----------|---|
| 1 | Standard Building with no EV Chargers |
| 2 | Standard Building with Level 2 and Level 3 Charging |
| 3 | Microgrid Building with 100 kW Solar, 500 kWh BESS, No EV Charging |
| 4 | Microgrid Building with 100 kW Solar, 100 kWh BESS, Level 2, and Level 3 Charging |
| 5 | Microgrid Building with 100 kW Solar, 250 kWh BESS, Level 2, and Level 3 Charging |
| 6 | Microgrid Building with 100 kW Solar, 500 kWh BESS, Level 2, and Level 3 Charging |
| 7 | Microgrid Building with 100 kW Solar, 1 MWh BESS, Level 2, and Level 3 Charging |
| 8 | Microgrid Building with 100 kW Solar, 1 MWh BESS, Level 2, and Level 3 Charging |

Microgrid Utility Electricity Prices and Associated CO₂ Emissions Output under Different Scenarios

Table 2

| Scenario | Demand Charges (\$) | Energy Charges (\$) | Total Cost (\$) | CO ₂ Emissions (mTons) |
|----------|---------------------|---------------------|-----------------|-----------------------------------|
| 1 | 7695 | 22736 | 30431 | 34 |
| 2 | 17343 | 32289 | 49632 | 47 |
| 3 | 3904 | 0 | 3904 | 18 |
| 4 | 14341 | 8209 | 22550 | 26 |
| 5 | 13193 | 8937 | 22130 | 23 |
| 6 | 12909 | 9239 | 22148 | 22 |
| 7 | 10835 | 9418 | 20253 | 22 |
| 8 | 9811 | 9577 | 19388 | 21 |

Scenario Comparison Emissions Output Average Day

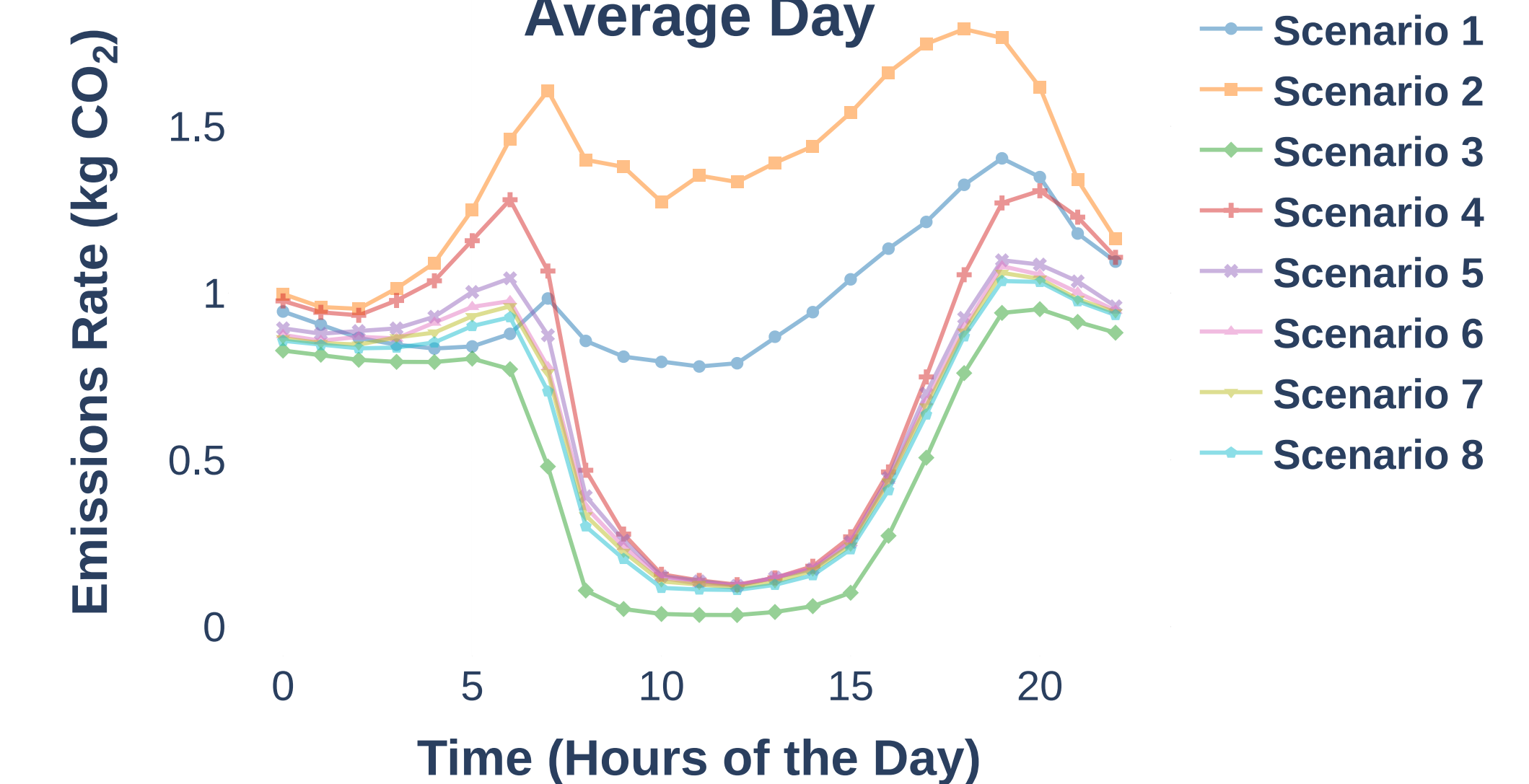


Figure 3: Microgrid CO₂ Emissions Outputs Averages During Times of Day. Adding a microgrid significantly reduces CO₂ Emissions compared to the non-microgrid scenarios 1 and 2.

Conclusions and Future Work

- Transportation-microgrids offer significant economic and environmental benefits
 - Estimated annual savings of \$8,000-\$10,000 compared to conventional systems
 - Annual savings of \$27,000-\$29,000 compared to buildings with EV chargers but no microgrid
 - 24% - 38% reduction in CO₂ emissions compared to conventional buildings
 - 45% - 55% reduction in CO₂ emissions compared to buildings with EV chargers and no microgrid
- Increased battery capacity does not guarantee improved performance
 - Increased capacity improves performance but not proportionally to the cost
 - Large capacity needed for challenging situations may not be cost-effective
- 15 kW demand price floor discourages zero net load
 - Discourages zero net load in peak shaving setups, increasing CO₂ emissions
- Future Work
 - Optimizing electric costs and CO₂ emissions through throttling charging, maximizing solar energy use, and minimizing grid draw during peak CO₂ emissions times
 - Assessing the impact of California's new net energy metering policy

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