

# EVS26

**GREAT MINDS THINK ELECTRIC**

GRANDES MENTES PENSAM ELETRICAMENTE  
LAS MENTES BRILLANTES TIENEN IDEAS ELÉCTRICAS

LES GRANDS ESPRITS S'ILLUMINENT

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*26th International Electric Vehicle Symposium*

## Mitigation of Vehicle Fast Charge Grid Impacts with Renewables and Energy Storage

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ORGANIZED BY THE WORLD ELECTRIC VEHICLE ASSOCIATION, WEVA

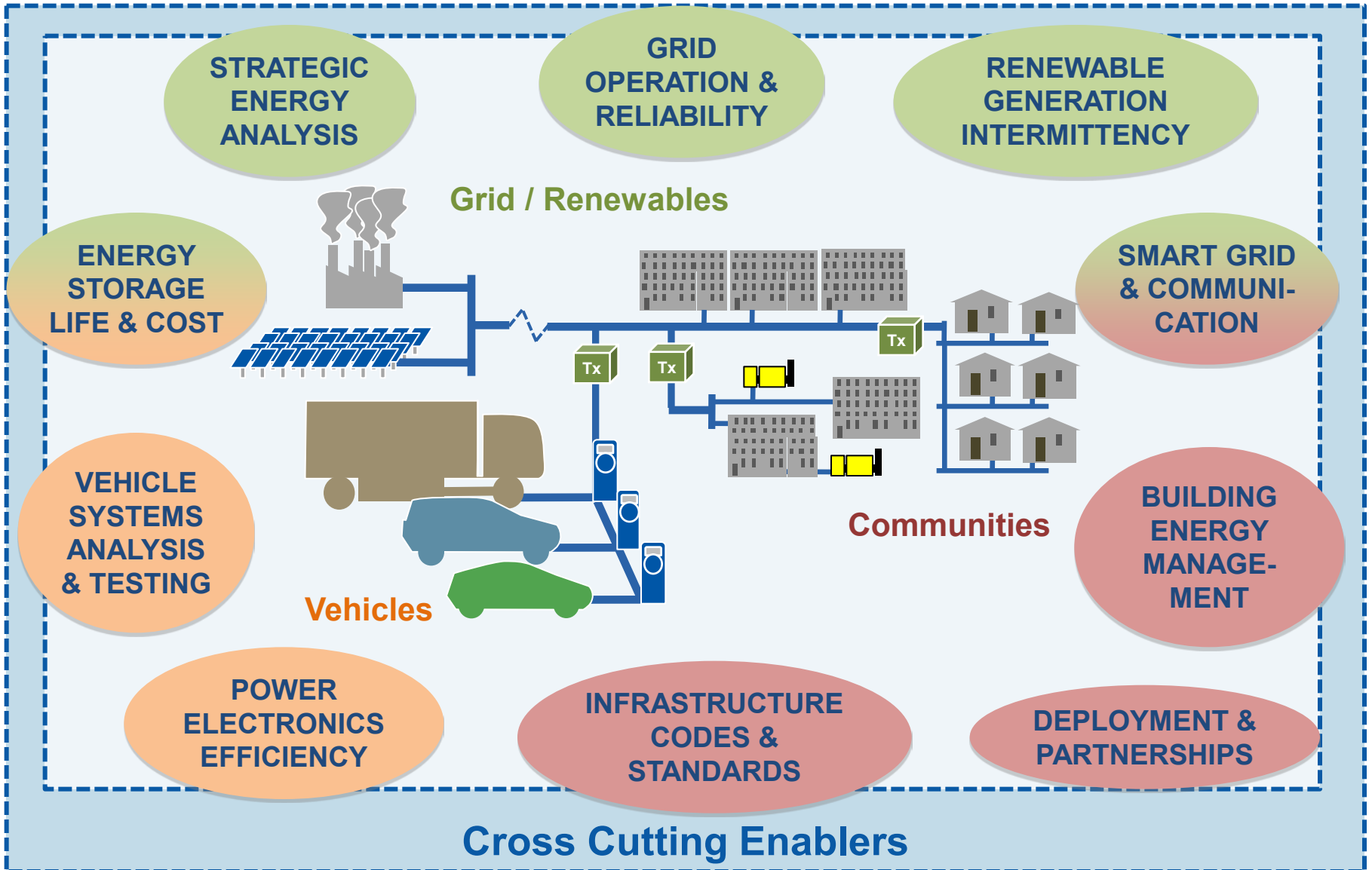
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# Vehicle Test Facilities at NREL



Photo by Dennis Schroeder, NREL/PIX 19757



Photo by Dennis Schroeder, NREL/PIX 20045



Photo by Dennis Schroeder, NREL/PIX 19699



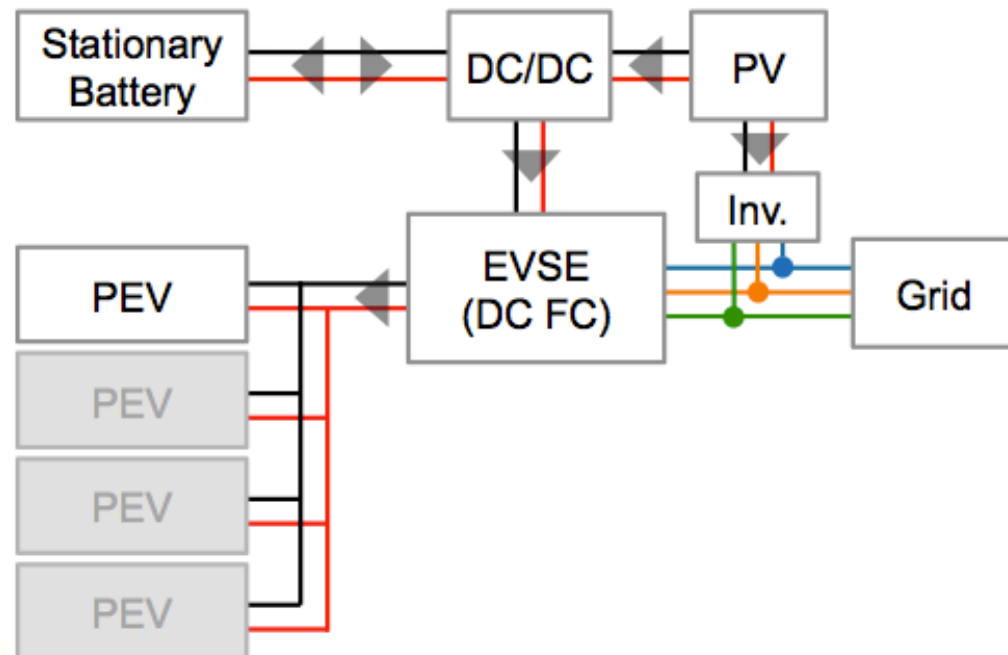
Photo by Dennis Schroeder, NREL/PIX 20040

# How Will Fast Chargers Impact the Grid?

- How will drivers use fast chargers?
- What does the time-dependent demand look like?
- How does the aggregate fast charge demand correlate with grid peaks?
- How can photovoltaics (PV) and energy storage reduce the impact and thus the cost of fast charging?

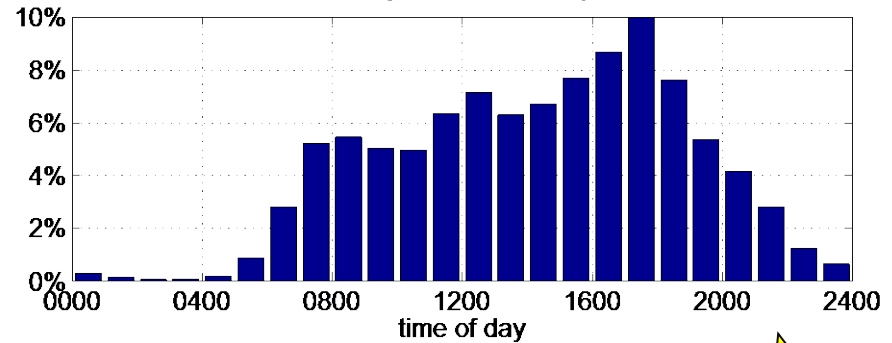
# Fast Charge Grid Impact Mitigation

- Identify system benefits
  - Add efficient, electric transportation miles cost effectively
  - Enable competitive performance from all-electric vehicles
    - long-distance travel fueled with renewables
- Address fast charging concerns / barriers
  - Minimize power spikes on the local grid
  - Avoid exacerbating peak demand
  - Reduce system costs
  - Quantify battery utilization

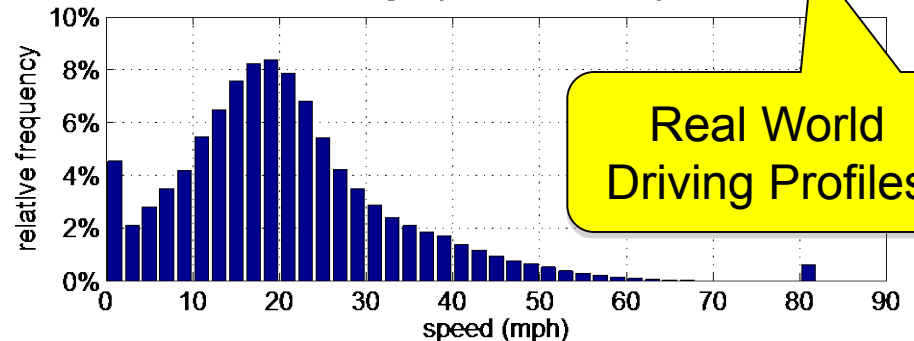


- Multiple fast charges of both CHAdeMO compliant vehicles
- Real-world traffic patterns [*Puget Sound Regional Council Traffic Choices Study*] and solar data incorporated
- Simulation assesses impacts of multiple vehicle adoption rates and station configurations
- PV and storage sizing conducted to mitigate impact

Time of Day that Vehicle Trips Start

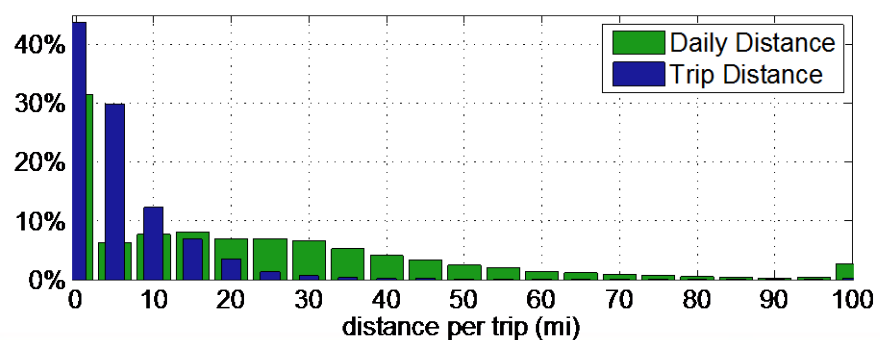


Average Speed of Vehicle Trips



Real World Driving Profiles

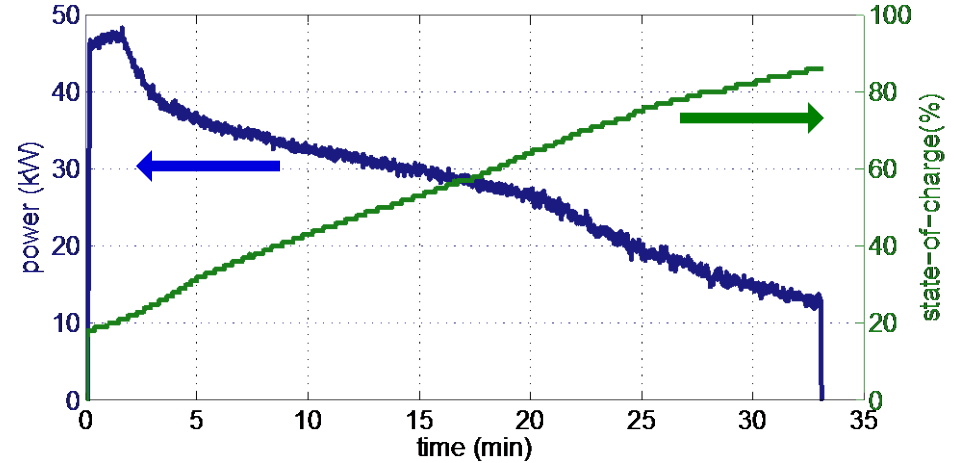
Average Distance of Vehicle Trips



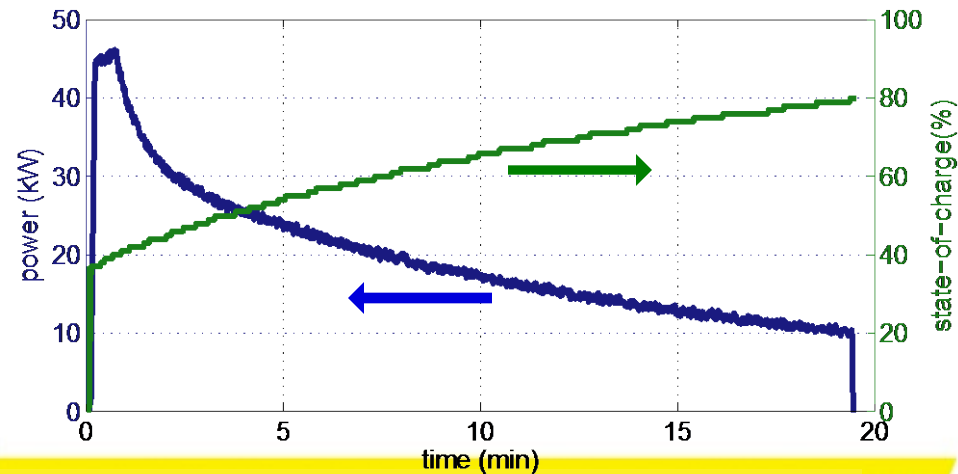


NREL PIX #20144

### Leaf Fast Charge Profile



### i-MiEV Fast Charge Profile



## Model Assumptions

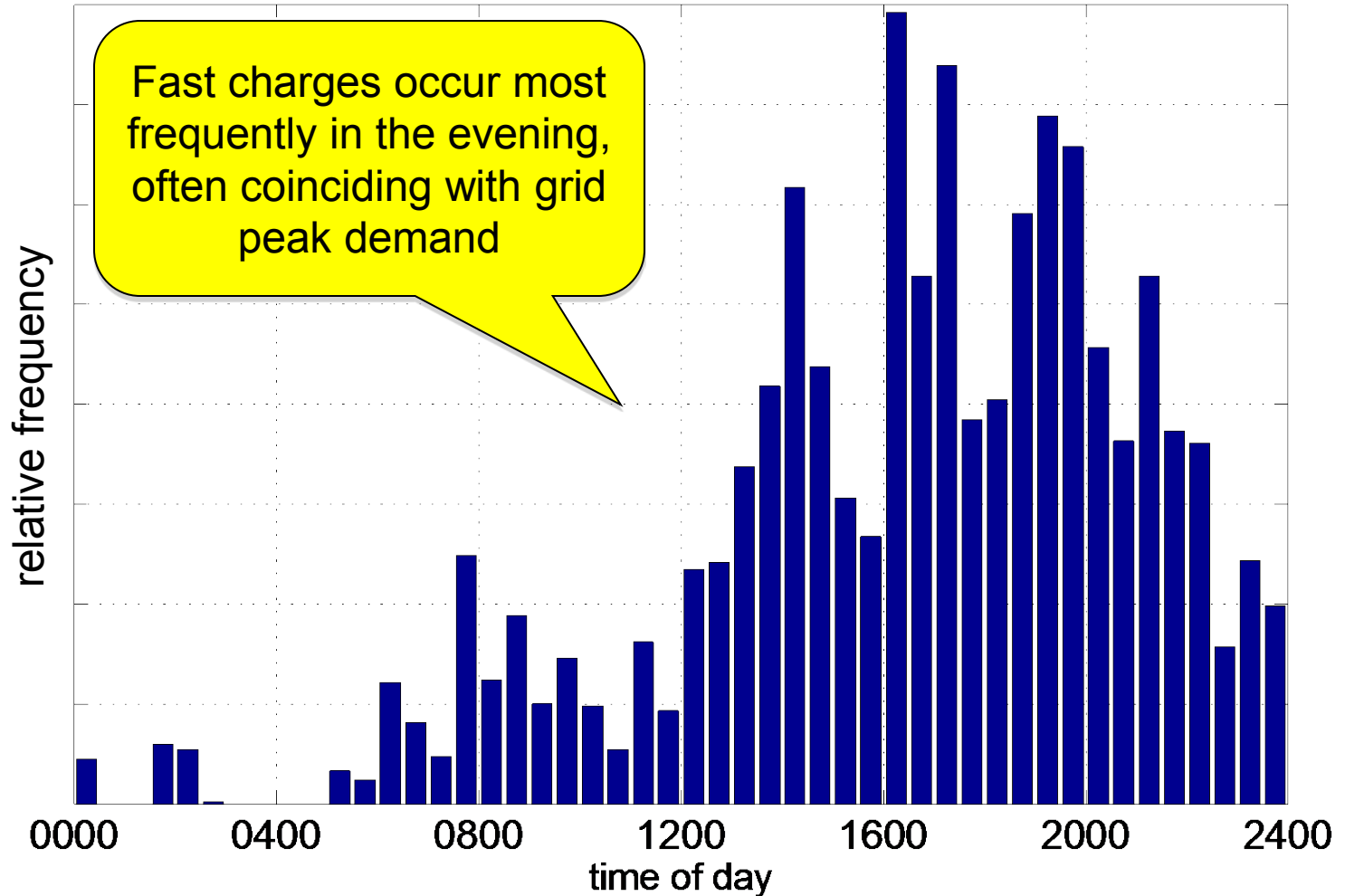
Assumption	Value	Units/Notes
Vehicle State-of-Charge Window	80%	<i>Min: 10%, Max: 90%</i>
Vehicle Energy Consumption Rate	300	Wh/mi
Forgetfulness Factor	10%	<i>User forgets to plug-in roughly 1 in every 10 days of driving</i>
Home Charge Power	3.3	kW
Fast Charger Efficiency	85%	<i>Source-to-Battery</i>
Fast Charger Power (max)	50	kW
Fast Charger Max SOC	80%	<i>Charger cuts off at 80% SOC</i>
Stationary Battery SOC Window	75%	<i>Min: 15%, Max: 90%</i>

- Home charging begins at midnight if the car is stationary and the driver doesn't forget
- Fast charges occur only secondary to home charging when, in the middle of a trip, the battery approaches minimum SOC

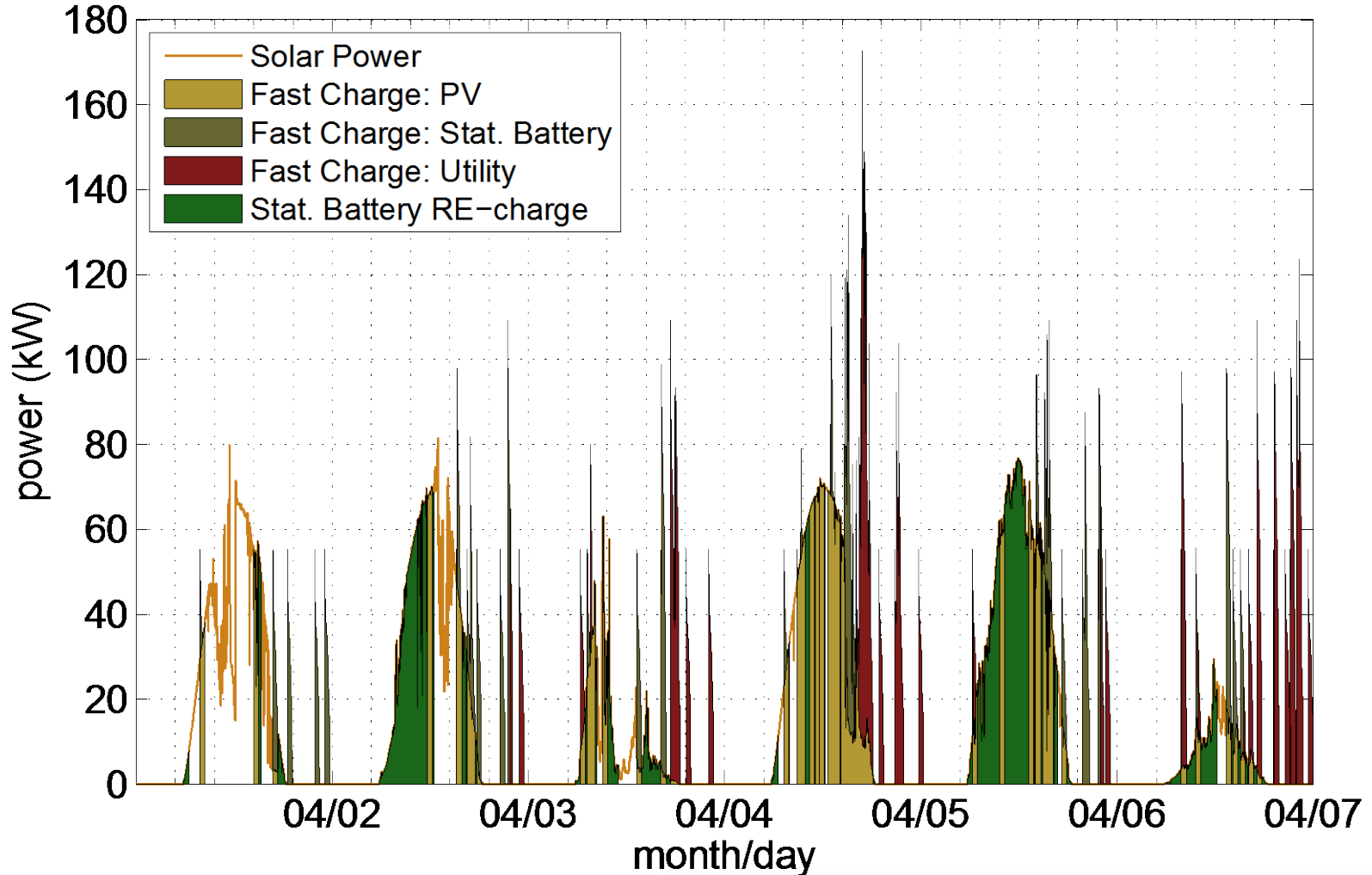


## Simulations Indicate High Potential Utilization

### Times of Day when Fast Charges Occur



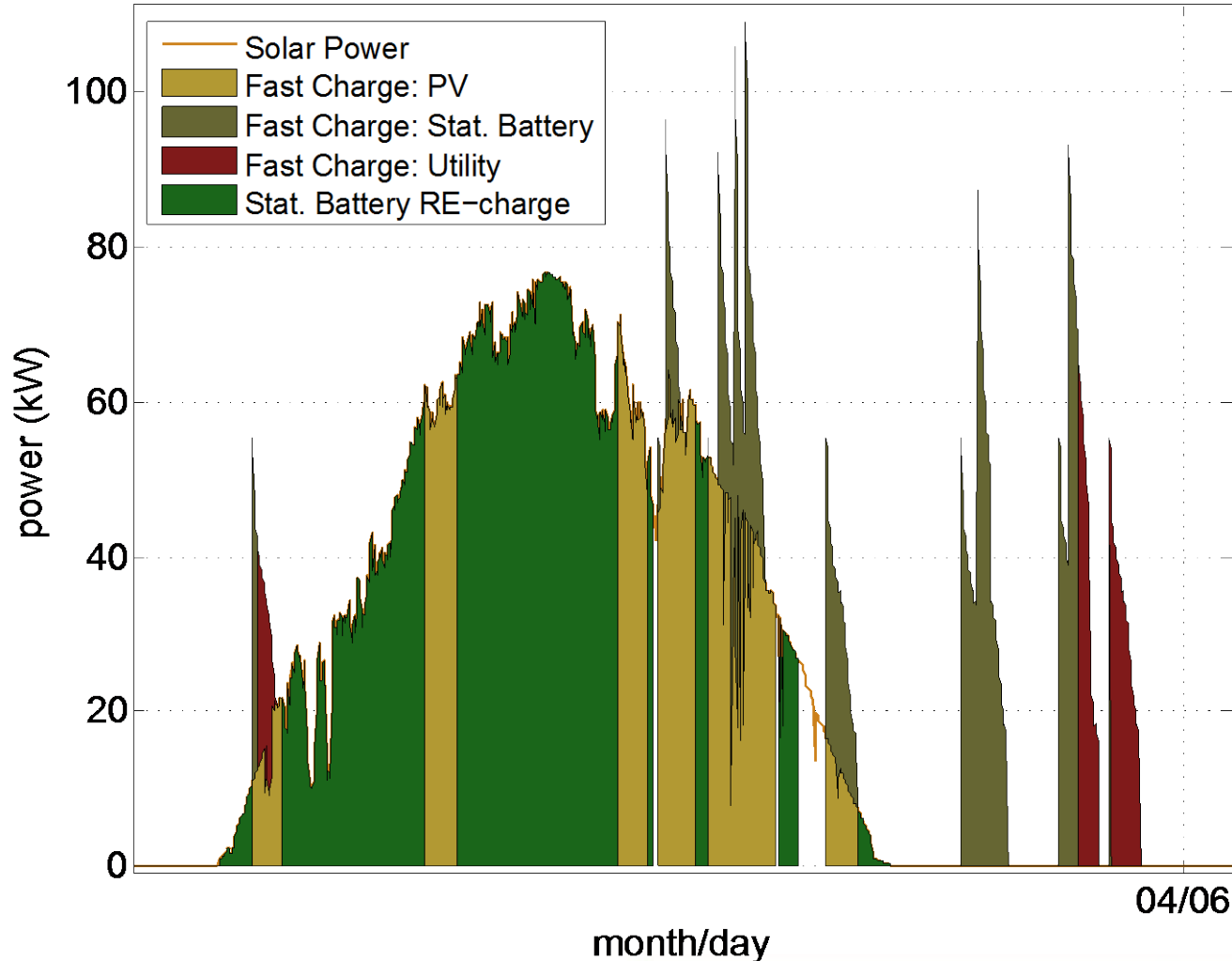
### PV and Battery Required to Renewably Fast Charge



Assuming 4 ports, 200 vehicles, 24 kWh per vehicle, 100-kW PV, 100-kW stationary battery

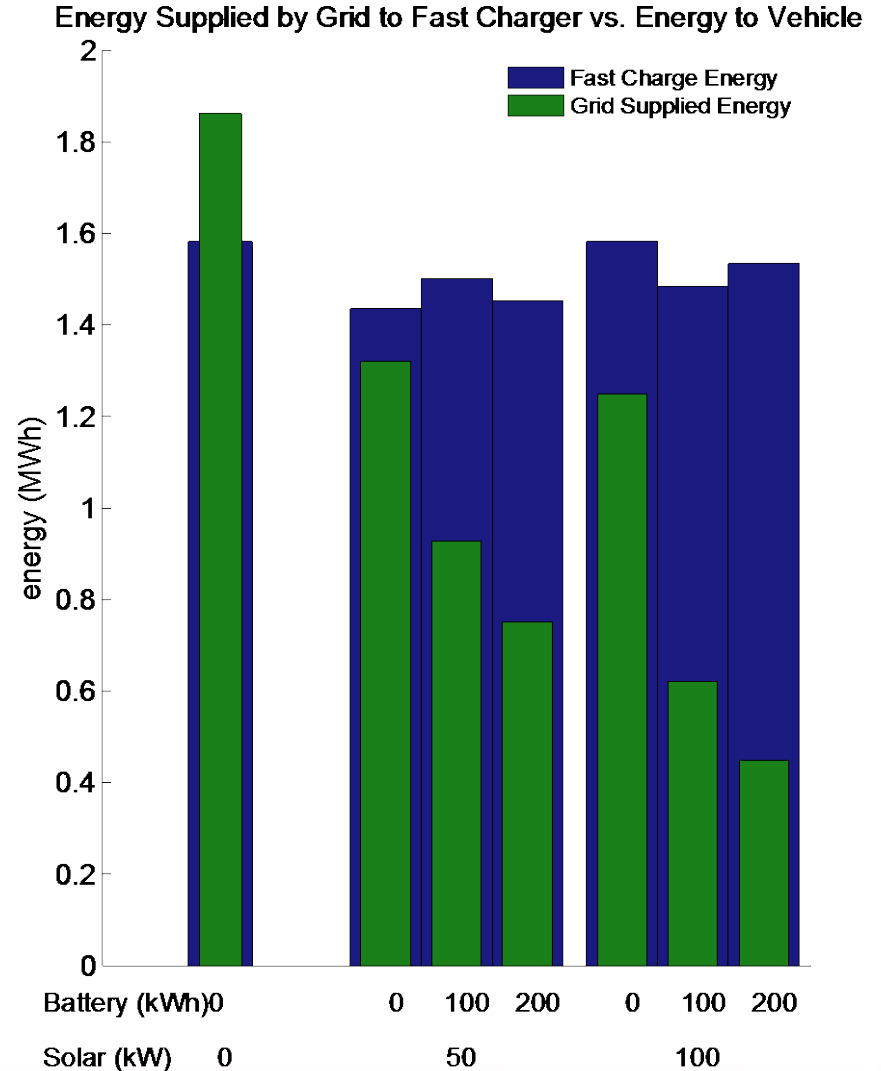
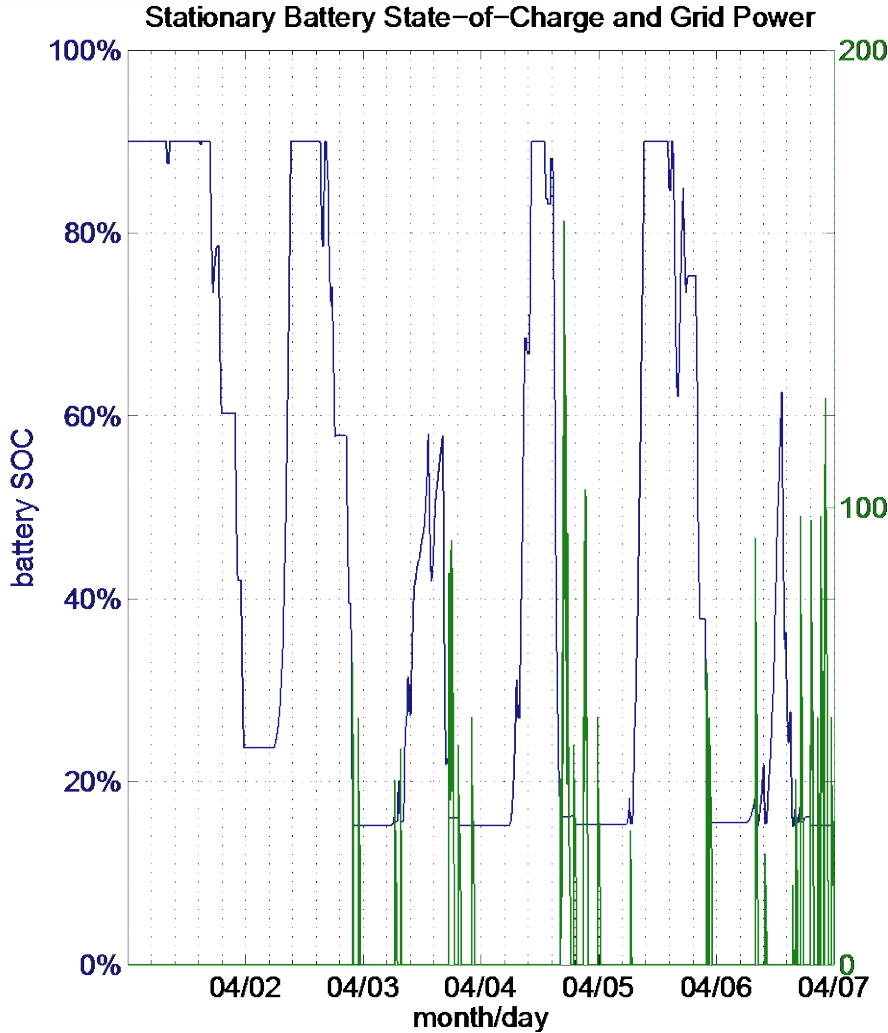
## Single Day System Operation 200 PEVs, 100-kW PV, 100-kWh Battery

### PV and Battery Required to Renewably Fast Charge



Assuming 4 ports, 200 vehicles, 24 kWh per vehicle, 100-kW PV, 100-kWh stationary battery

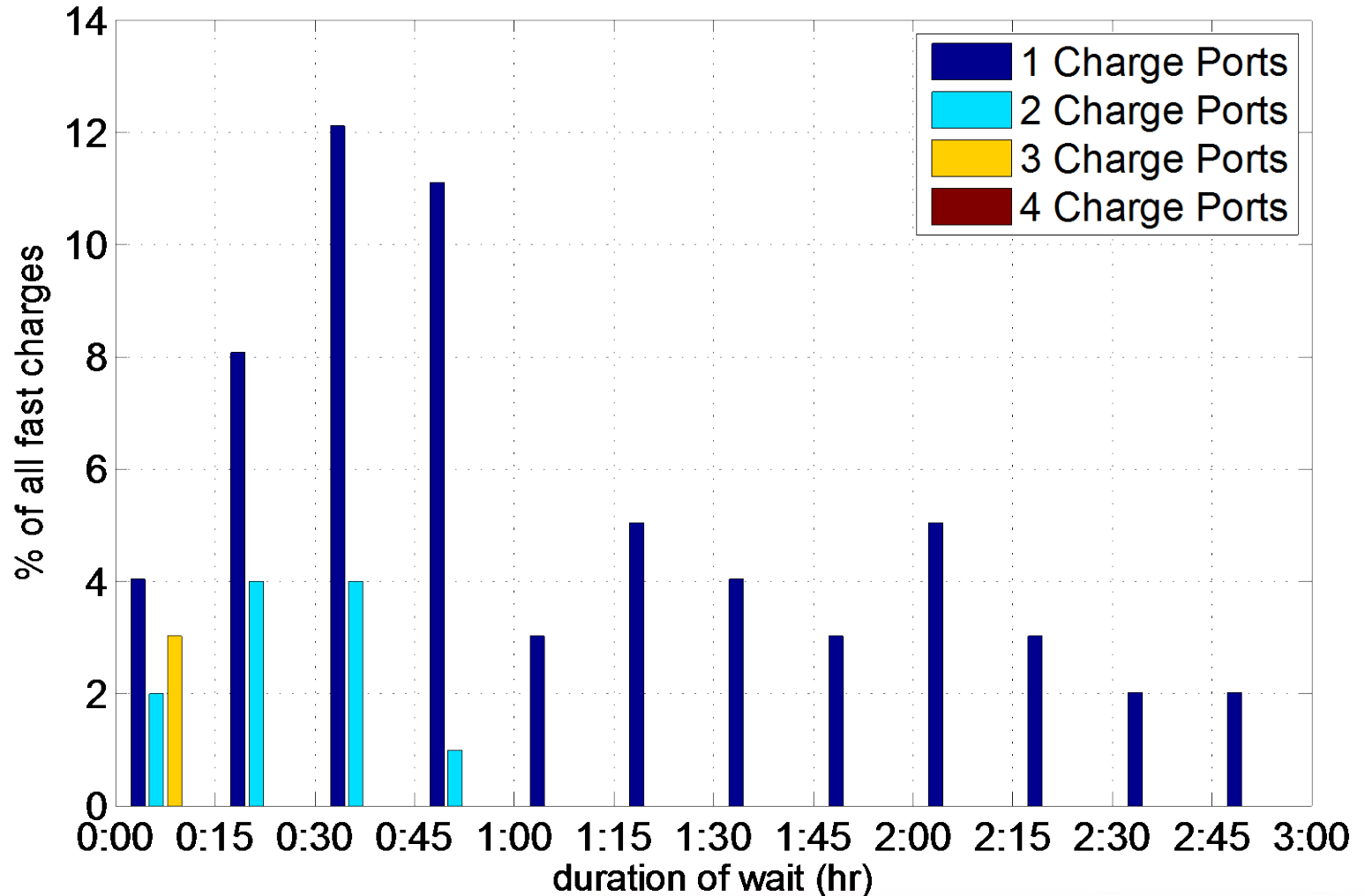
## Avoiding expensive energy and demand charges on your bill...



Assuming 4 ports, 200 vehicles, 24 kWh per vehicle, 100-kW PV, 100-kW stationary battery

## Reduced Wait Times with More Installed Ports

Fast Charge Wait Times for Fleet of 400, 24kWh Vehicles



- Fast charge utilization simulation developed
- Grid impact options identified
- Next steps:
  - Include economics in design of experiments

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## 26th International Electric Vehicle Symposium

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U.S. Department of Energy

### Questions?

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