NATIONAL RENEWABLE ENERGY LABORATORY

Electric Vehicle Grid Integration for Sustainable Military Installations

NDIA Joint Service Power Expo

Mike Simpson
Mike.Simpson@NREL.gov

5 May 2011

NREL/PR-5400-51519

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Agenda

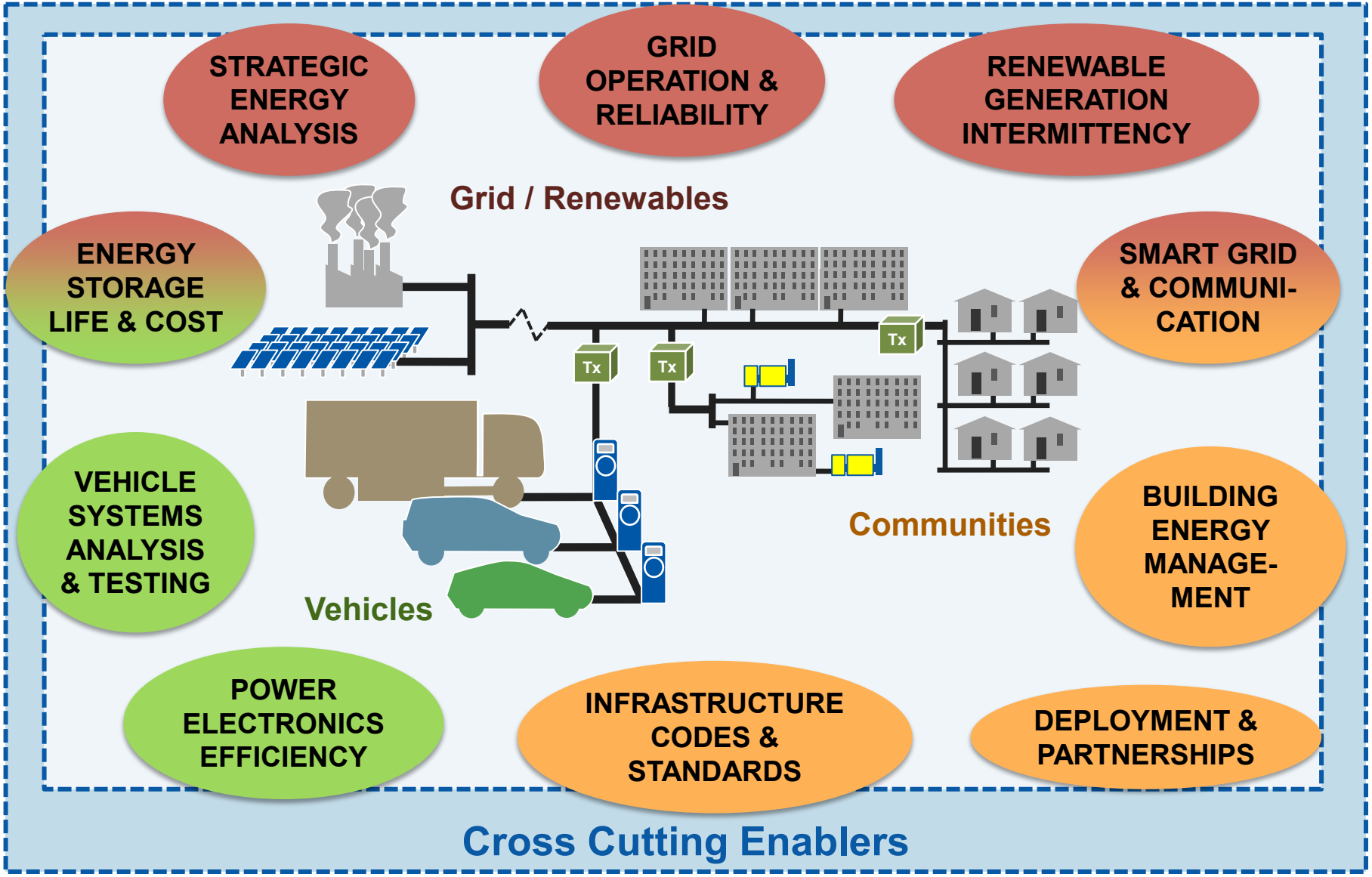
1. NREL Transportation Research
2. Net Zero Energy Installations (NZEI)
3. Fort Carson as a Case Study
   - Vehicles On-Site
   - Utility Operations
   - Vehicle Charge Management
4. Full Fleet Simulation
5. Continuing Work

NREL is the only national laboratory solely dedicated to advancing renewable energy and energy efficiency.

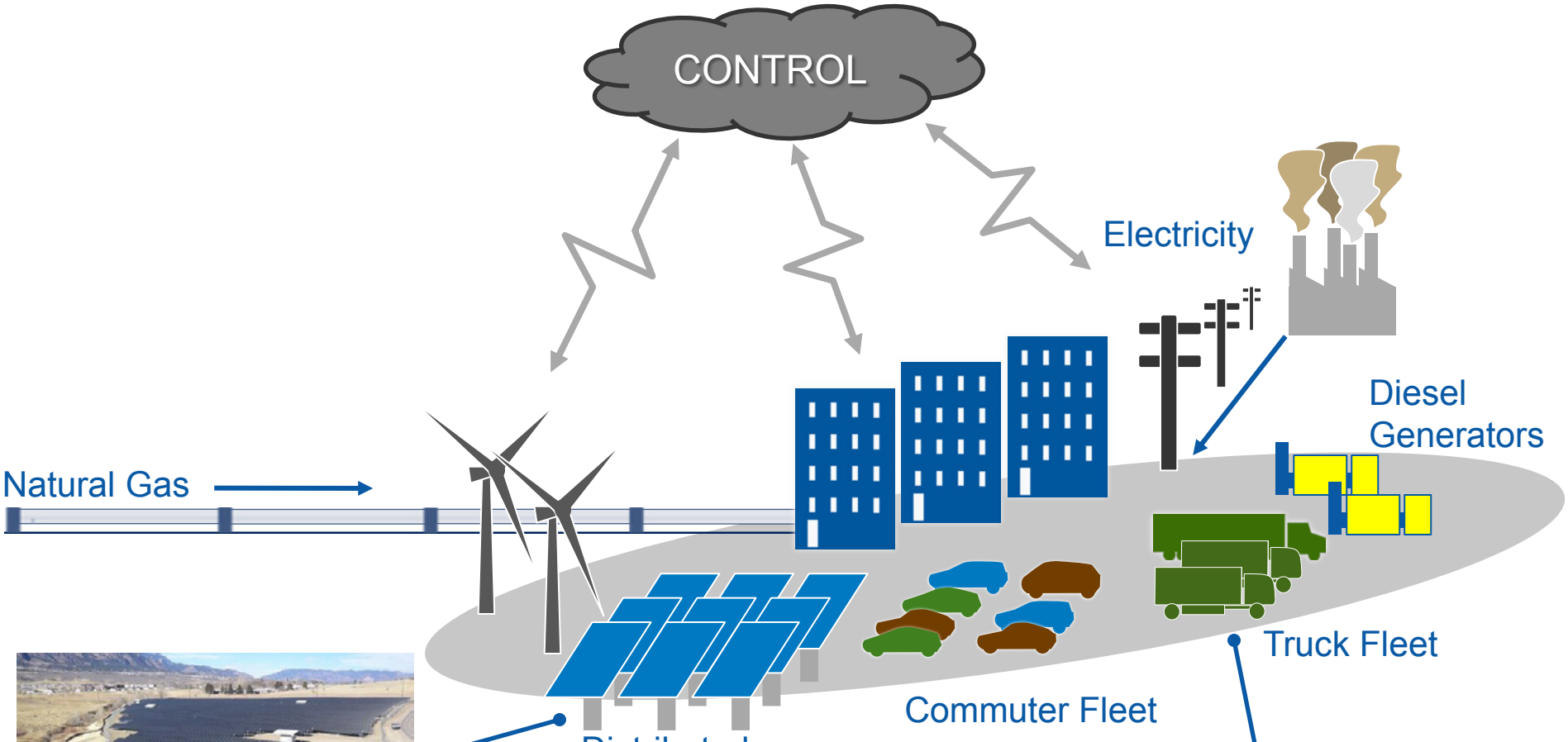
Our employees are committed to building a cleaner, sustainable world.

Photo Credits: NREL

What is Electric Vehicle Grid Integration (EVGI)?



Large multi-purpose campuses benefit from reduced energy consumption and renewable resources.



Fort Carson 2MW PV Array
NREL PIX 17394

Smith Newton EV NREL PIX 17631

Fort Carson Commuters

Hundreds of Thousands of Person-Miles Each Day…

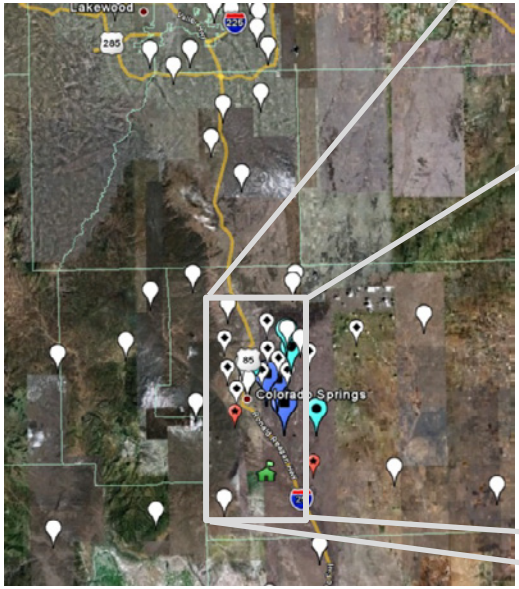
Commercially available PEVs are here…

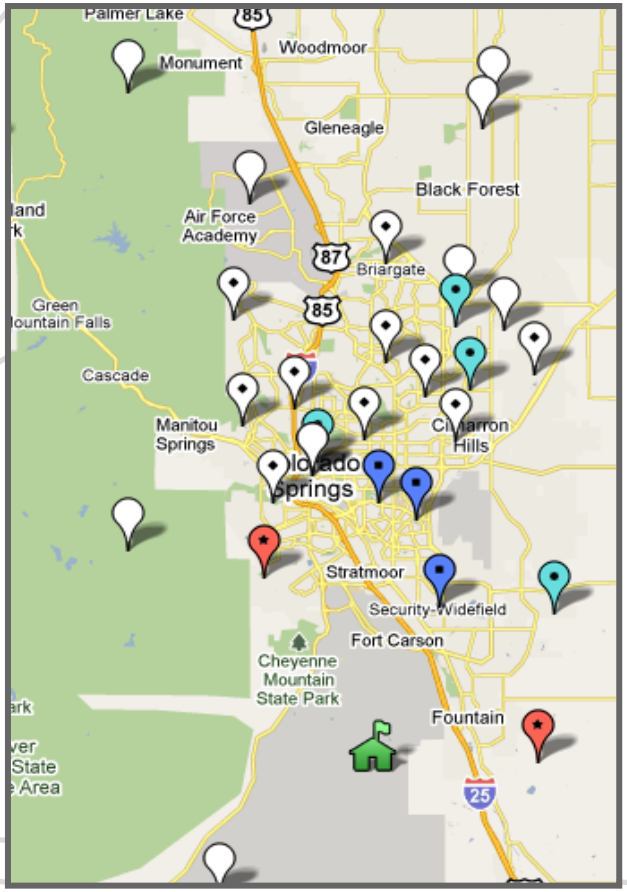
Nissan Leaf
NREL PIX 18215

Chevy Volt
NREL PIX 18215

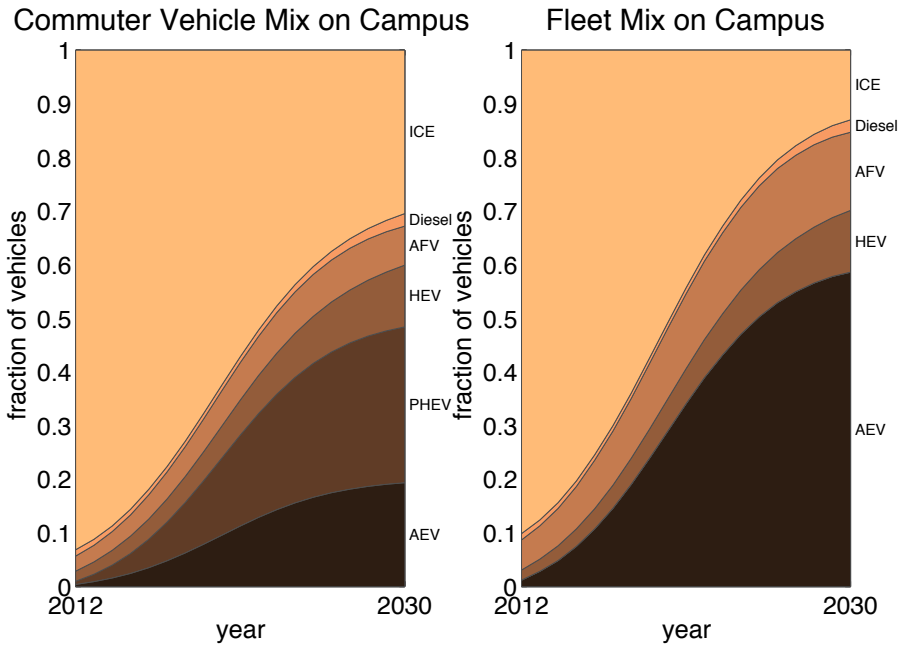
Commuters from Local Zip Codes

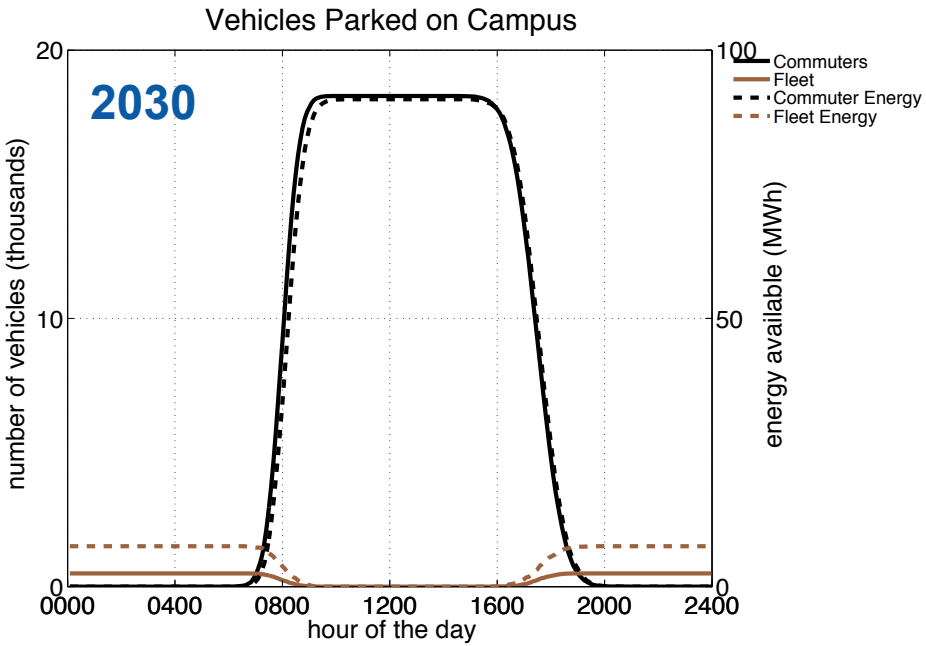
- Fort Carson
- Over 2,000
- 1,000 to 2,000
- 500 to 1,000
- 100 to 500
- 10 to 100





Fleet Energy Opportunities



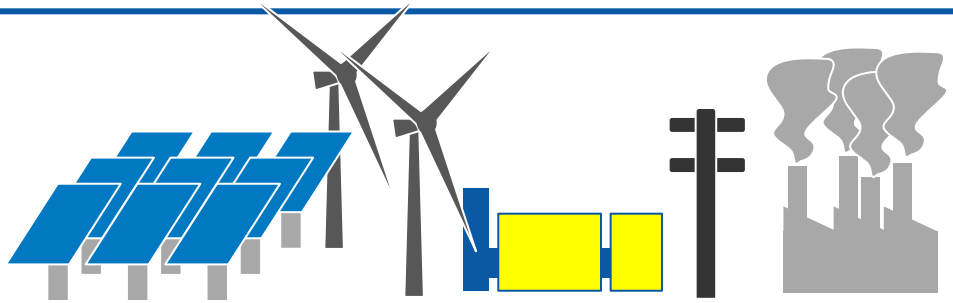


Dotted line is energy in PEVs only.

GSA-Approved Vehicles	Smith Newton	Zero Truck ZT	Enova Ze
GVWR Class	4 to 6	3 to 5	3 to 4
GSA Item Number	571E.1	95E	134E.1
Maximum Range (mi)	100	75	150
Maximum Speed (mph)	50	60	65
GSA Base Price	$167,000	$142,100	$109,500
Incremental Cost	$109,548	$119,573	$80,309

Example Power Exchange Scenarios

PEV



Normal Grid / Microgrid

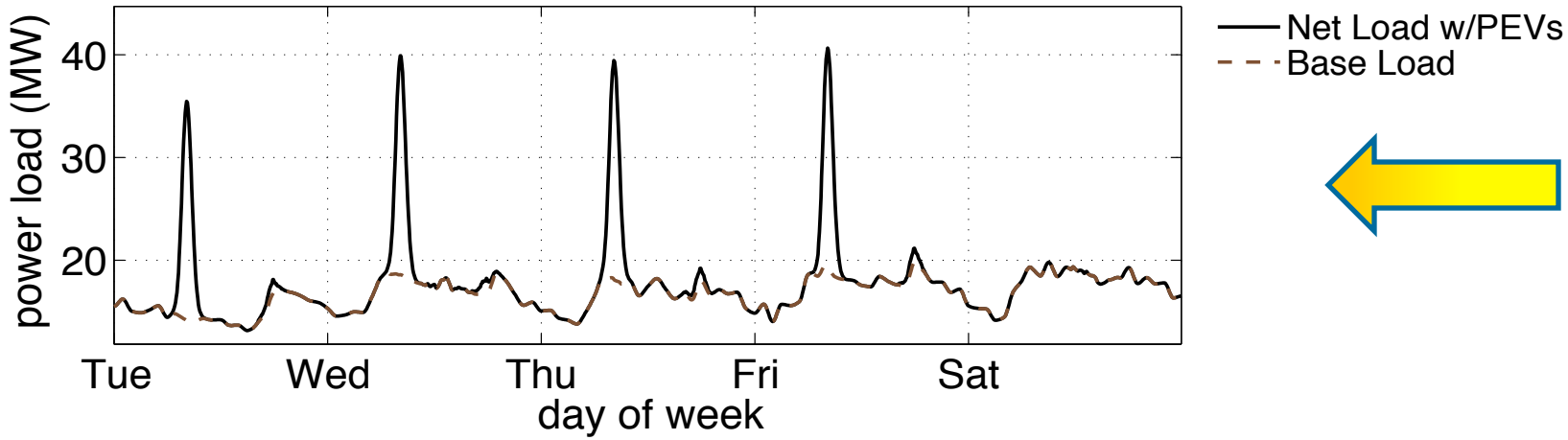
1 Opportunity Charging

2 Managed Charging

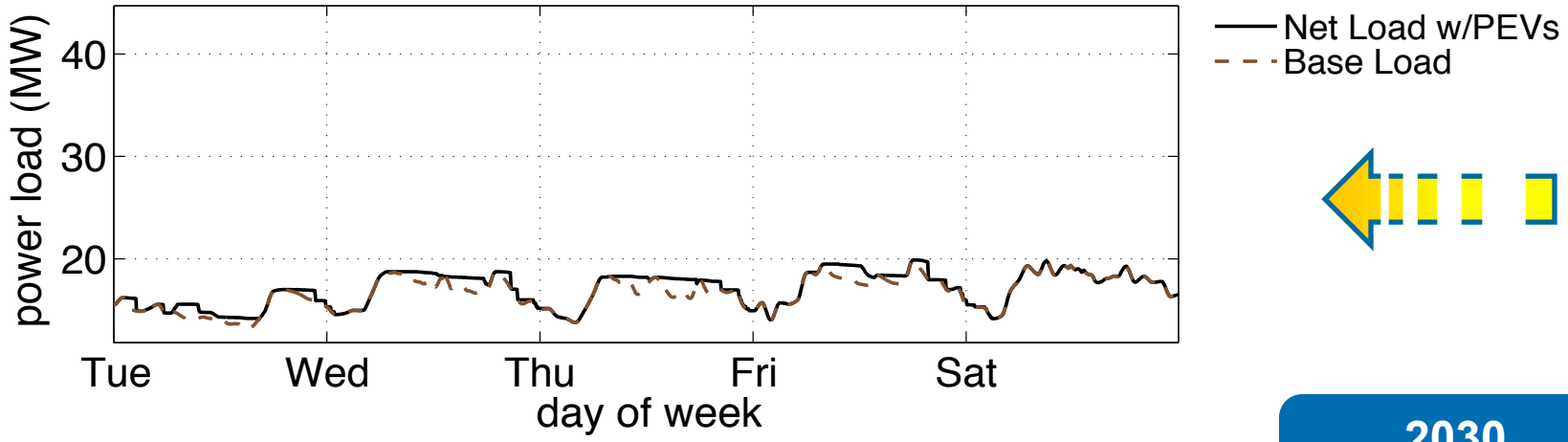
3 Managed Bi-directional Charging

PEV Charge Management

Campus Base Load with Electric Vehicle Opportunity Charging

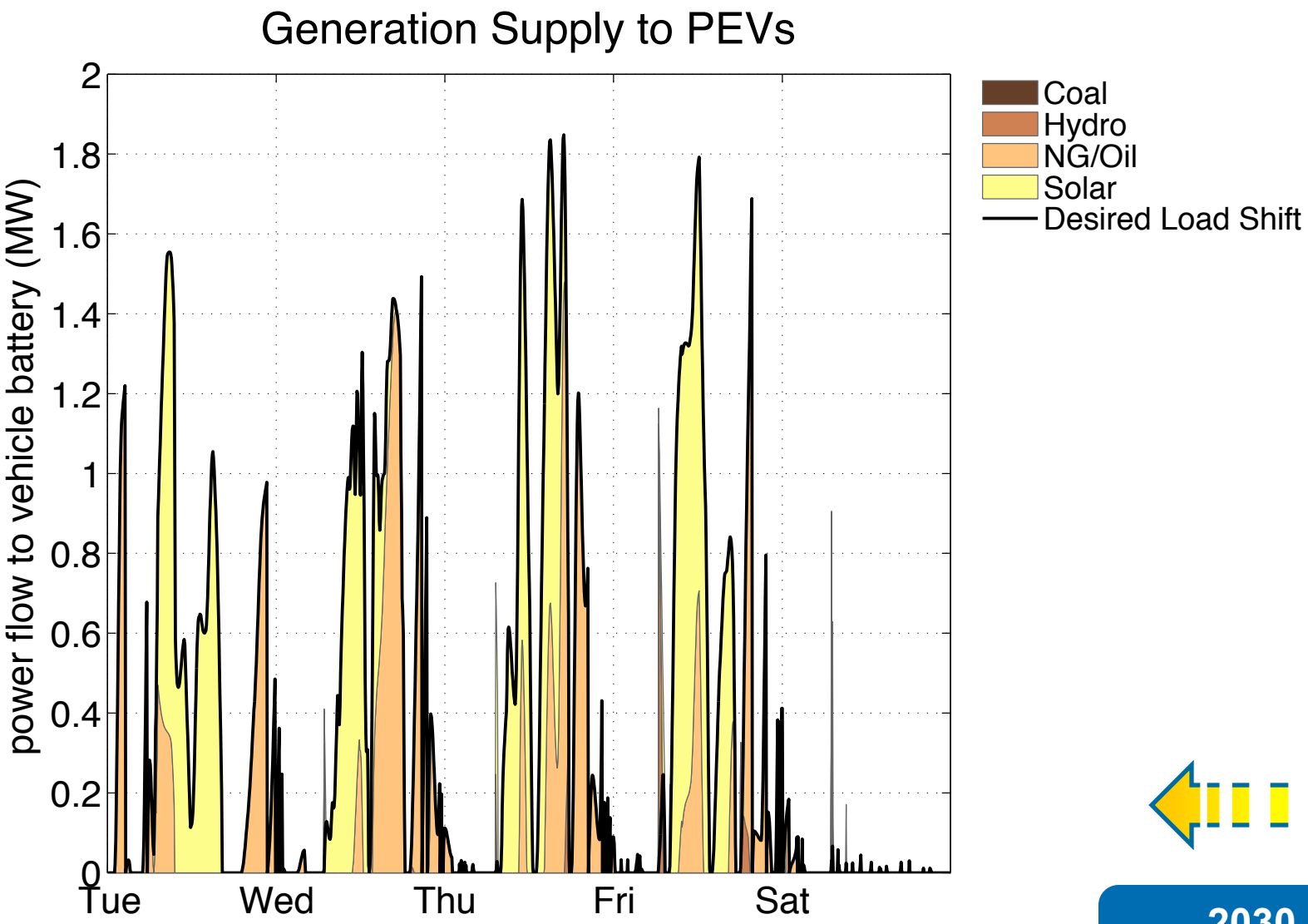


Campus Base Load with Electric Vehicle Managed Charging



2030 Normal Grid

Enable greater resource stability



2030 Normal Grid

Load Leveling with PEVs

Determine which vehicles are available based on day of the week (commuters only M-F) **and situation** (fleet vehicles alternate between parked and mission driving during emergency)

Time-step through simulation:

Identify recent peak.
Avoid exacerbating demand charges

Determine which vehicles need power.
Order vehicles by greatest difference between range remaining and range needed (commute distance)

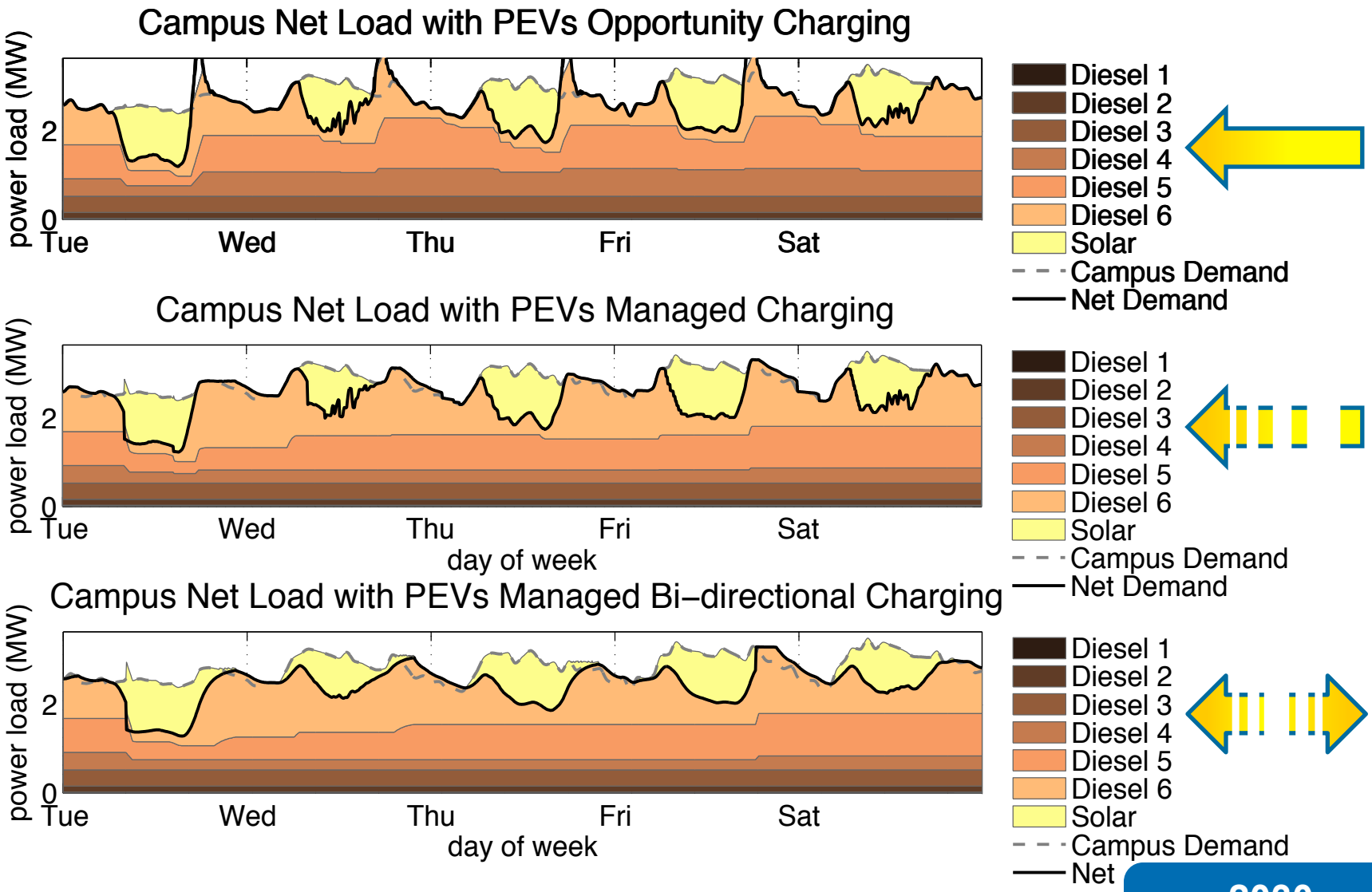
Calculate amount to charge (+/-). *NREL-developed Algorithm*

Iteratively solve for vehicles that are ready to share the load.

Add power to total demand from those in need of charge.

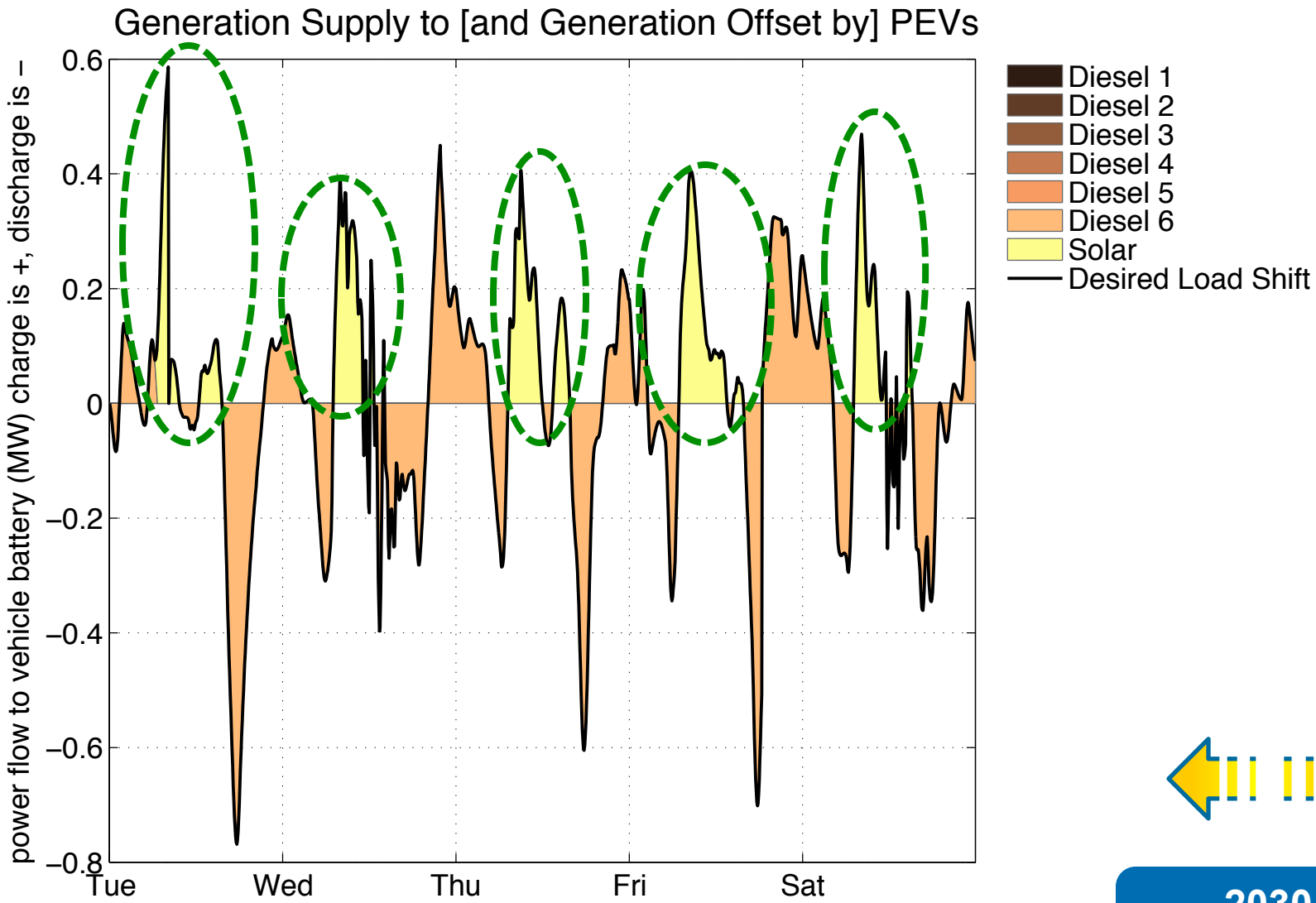
Calculate miles remaining from SoC of each vehicle.

75 electric trucks "buffer" the demand profile ...



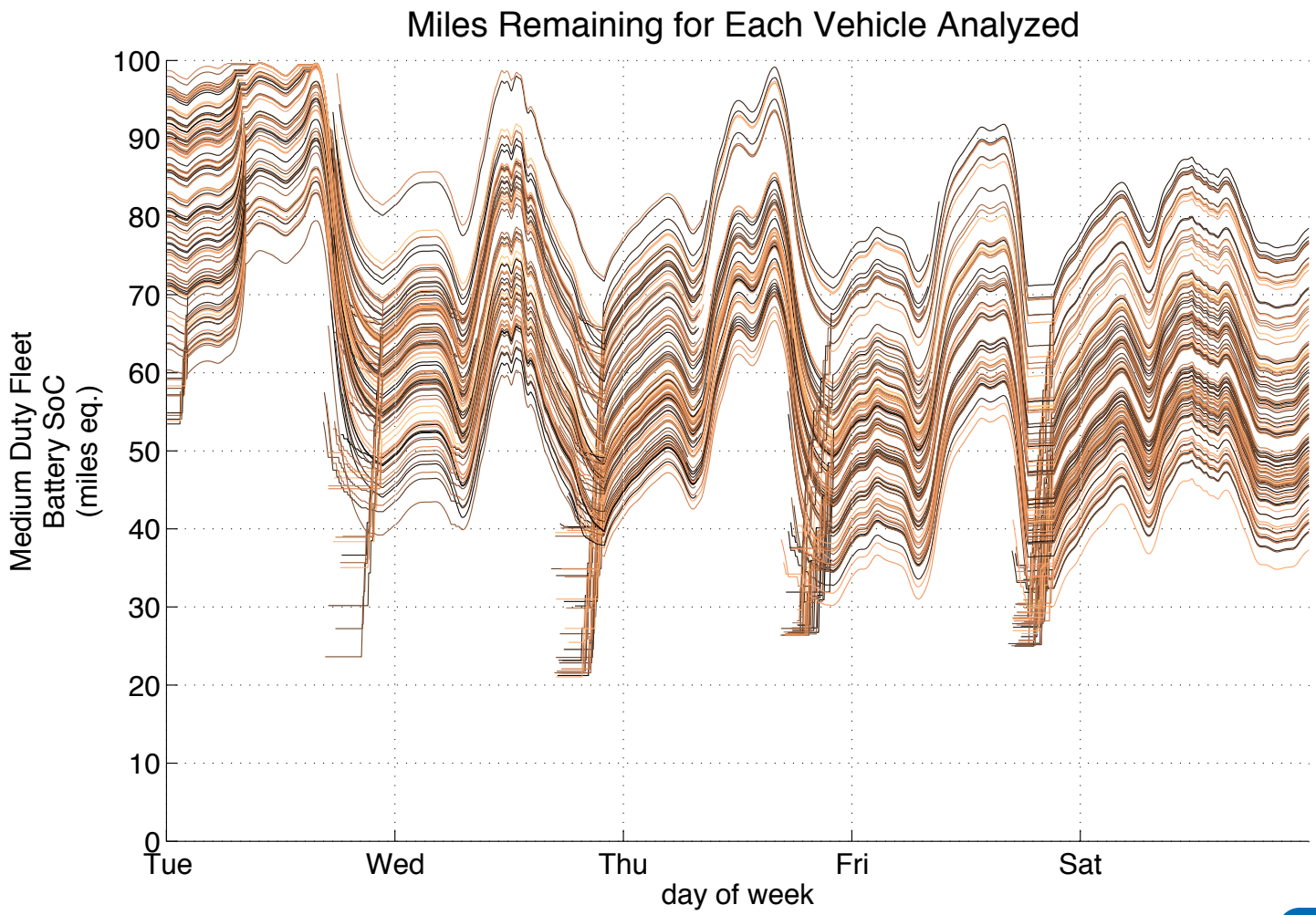
2030 Microgrid

… and ensures maximum renewable energy utilization.



2030 Microgrid

Algorithms intelligently match vehicles with grid needs while ensuring mobility

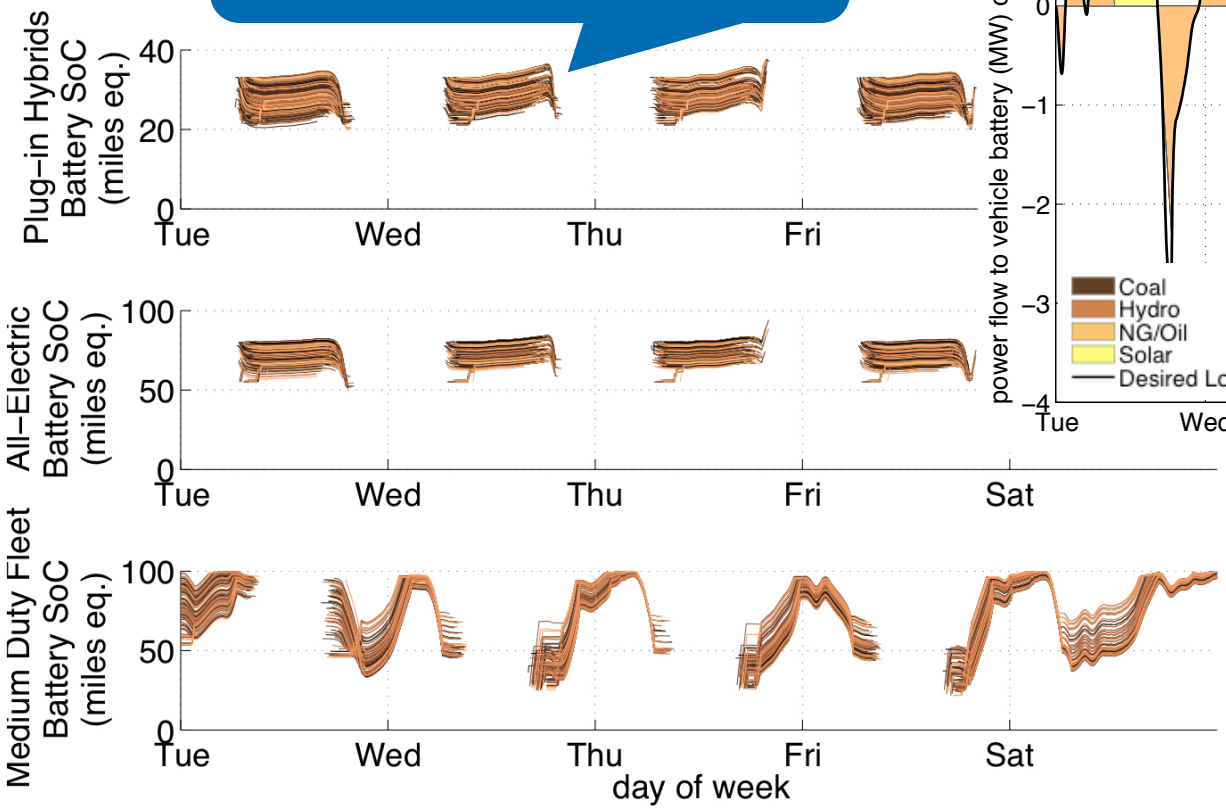


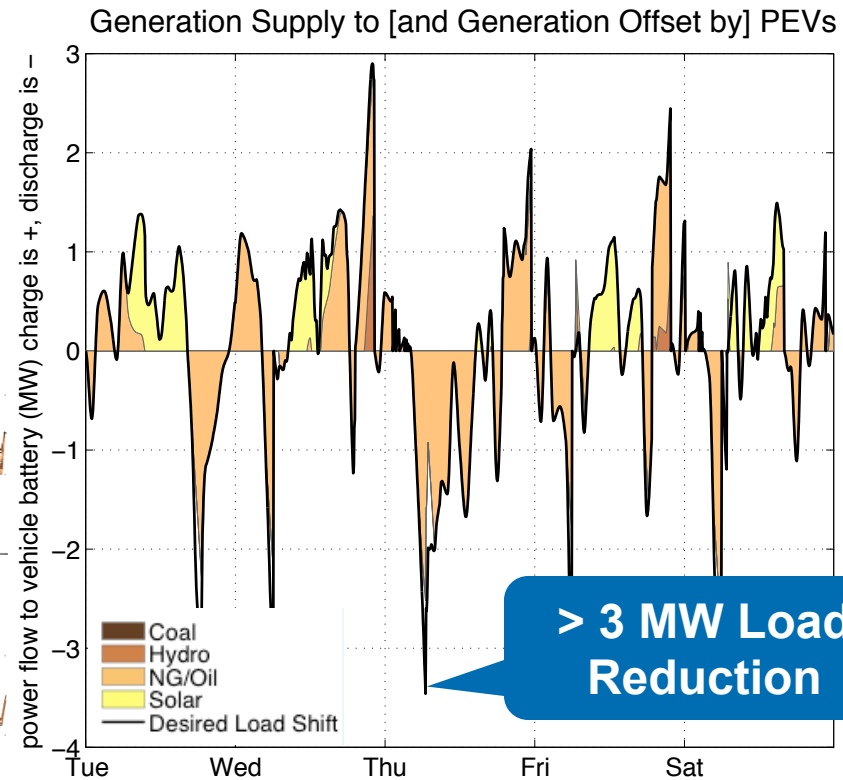
2030 Microgrid

Commuters add large benefit with little effect on each.

Frequent Solar Energy Uptake

< 25% SoC Window Used in Commuter Fleet

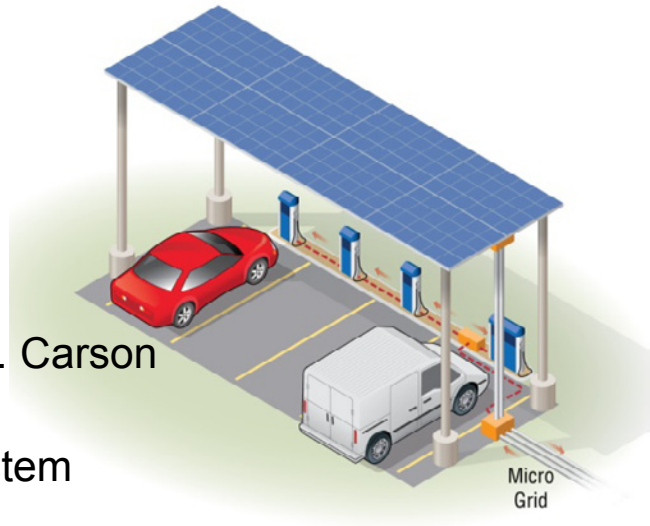




> 3 MW Load Reduction

2030 Normal Grid

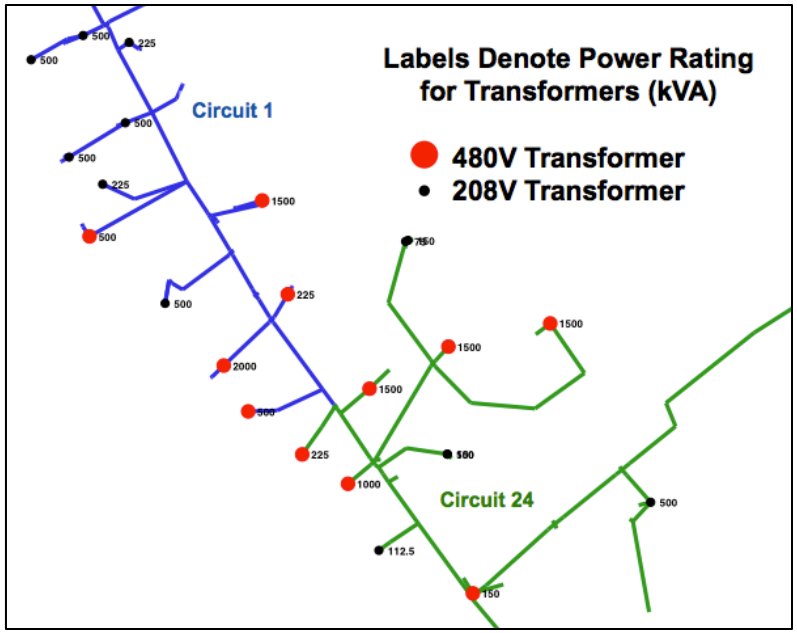
Grid-Vehicle Interface Component Requirements Definition Through DOD ECIP in FY11

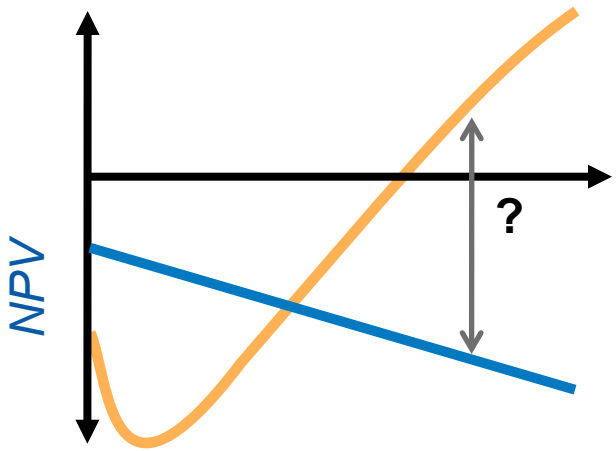


- US Army sponsored ECIP project
  - **E**nergy **C**onservation **I**nvestment **P**rogram
- Programmatic Goals:
  - Develop models, complete analysis specific to Ft. Carson for a RE and transportation microgrid node
  - Use that information to create an RFP for the system construction
- US Army Corp of Engineers collaboration
- Supports the development of parameterized models that can be used with optimization catered to each installation

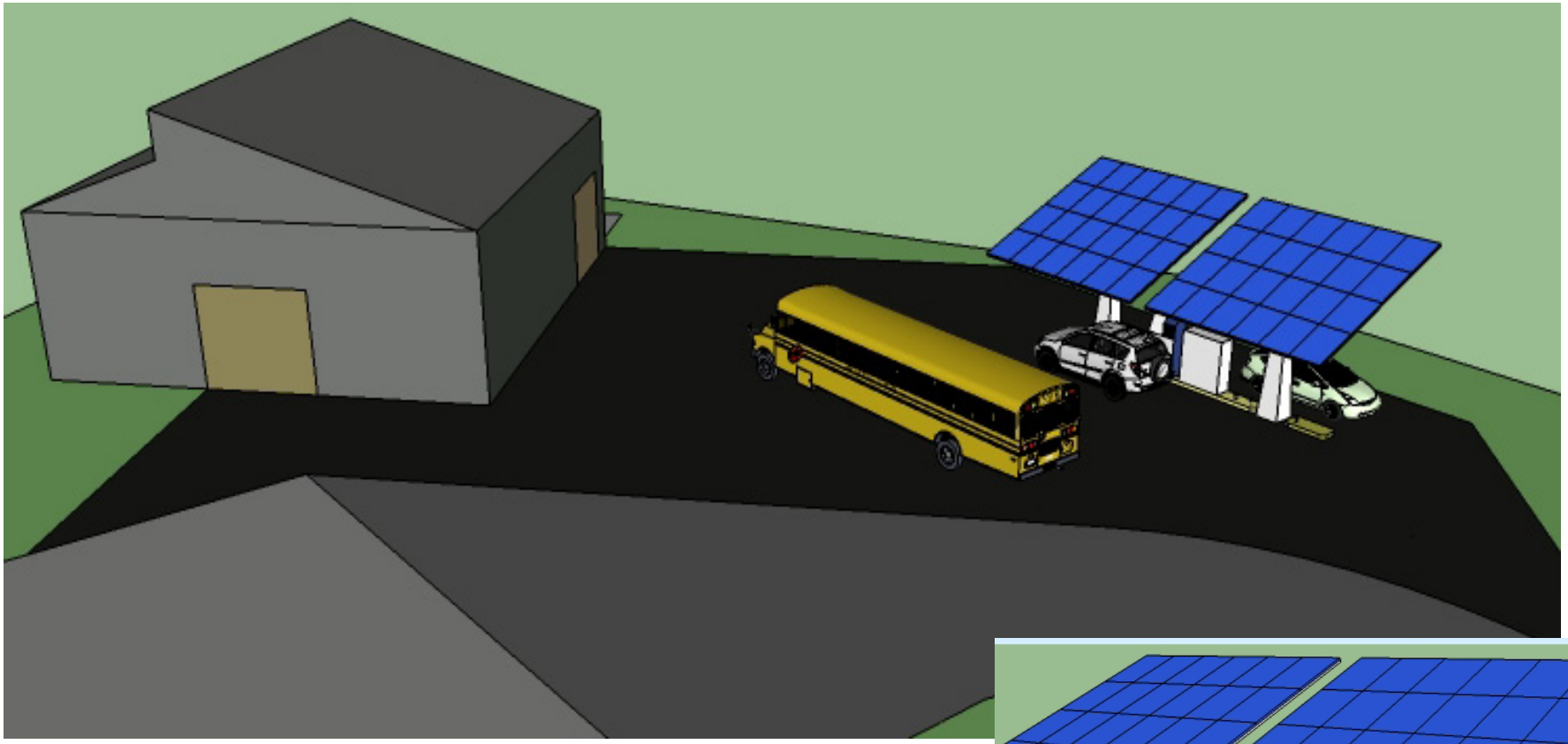
ECIP: Current Status

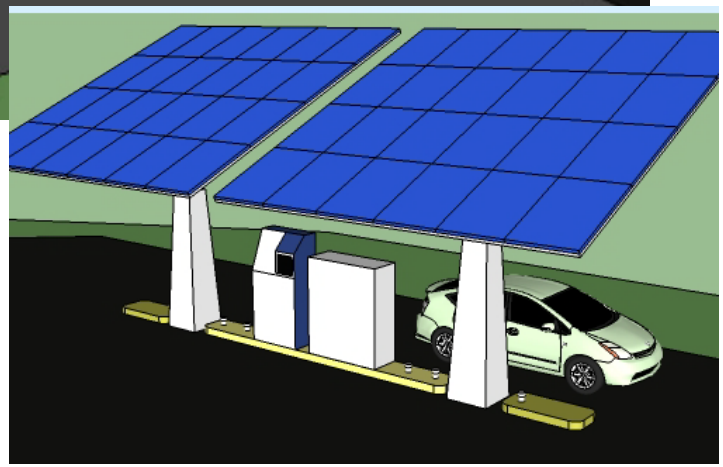
- Microgrid Model Complete
  - OpenDSS (EPRI) open source platform used
- Node component models started
- Cost model for Colorado Springs Utility initialized
- On track to integrate models and begin optimization





RECharge Integrated Demonstration Site





Garage + Vehicle-Grid-Renewables Testbed at NREL Campus FY11

NATIONAL RENEWABLE ENERGY LABORATORY

Thank you.

Mike Simpson
Mike.Simpson@NREL.gov
1-303-275-3209