# Smart Charge Management

An overview of how fleets can benefit from managed charging

Jesse Bennett

March 2024

# Smart Charge Management (SCM)

## Value Proposition

Why consider managed charging?

## Next Steps

What other work is under development?

## SCM Overview

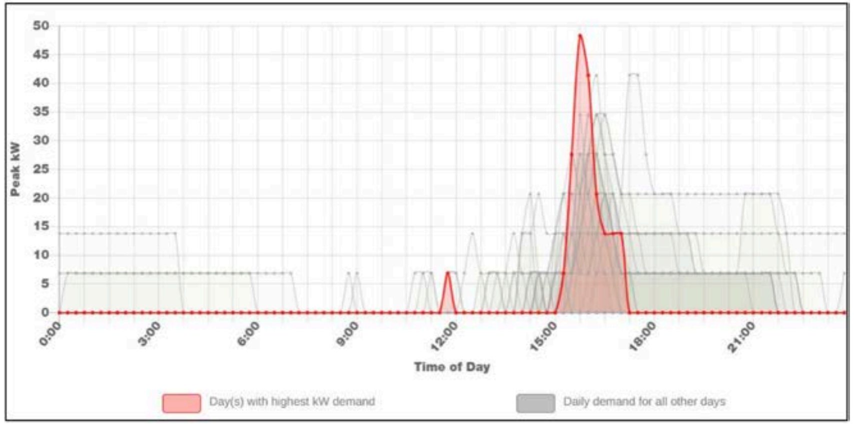
How does SCM fit in fleet operations?

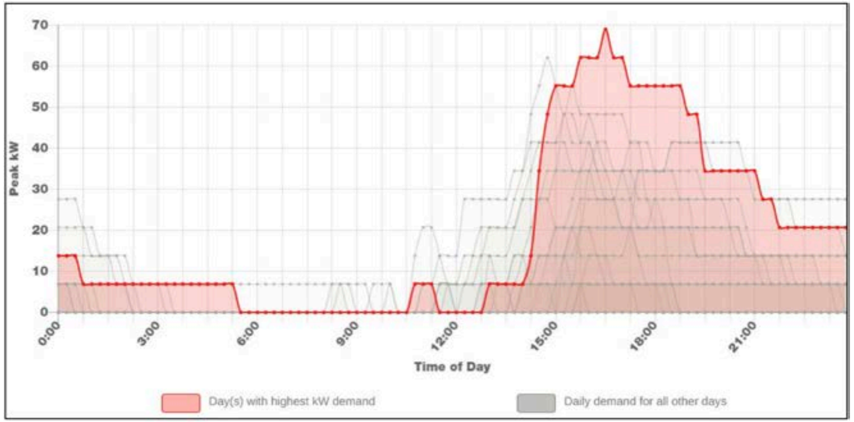

## Example Solutions

What examples of SCM currently exist?

# EV Charging and Temporal Flexibility

- Daily driving needs (VMT) indicate energy needs (kWh)
- EV charging (kW) will typically occur at parking locations with long dwell periods (hr)
- EV charge sessions will typically be shorter than vehicle dwell periods (overnight)
    - Temporal Flexibility = Charge Shifting

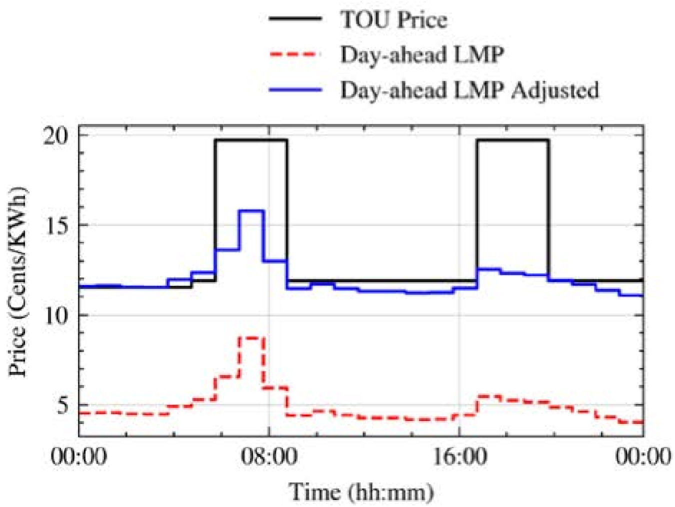


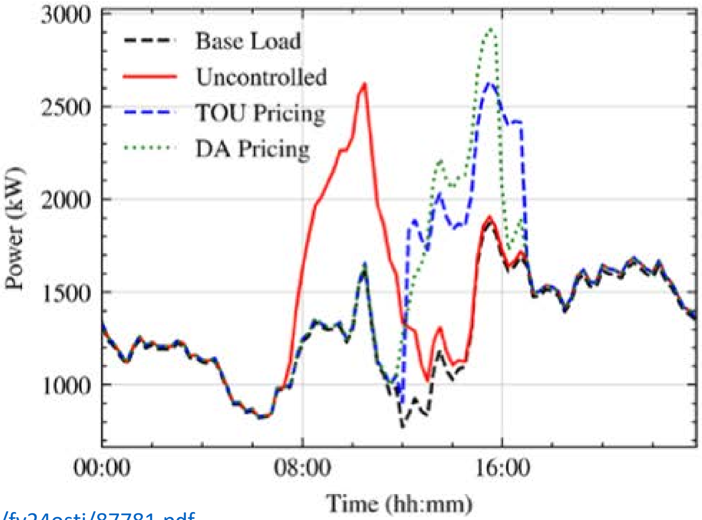




https://www.nrel.gov/docs/fy22osti/81595.pdf

# Optimizing the cost of electricity

- Some rates include dynamic prices to support bulk system needs
  - Time-of-use (TOU): peak/off-peak pricing, seasonally scheduled, utility-wide
  - Day-ahead pricing: changes every hour/day based on transmission congestion from load and generation forecasts for each transmission node, (e.g. PJM's LMP wholesale rates)
- Optimizing the use of these rates can reduce the cost of energy

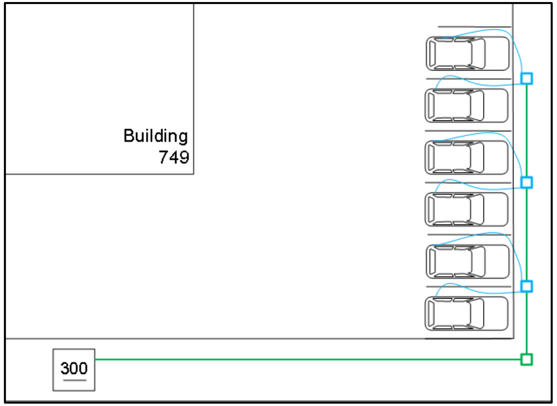


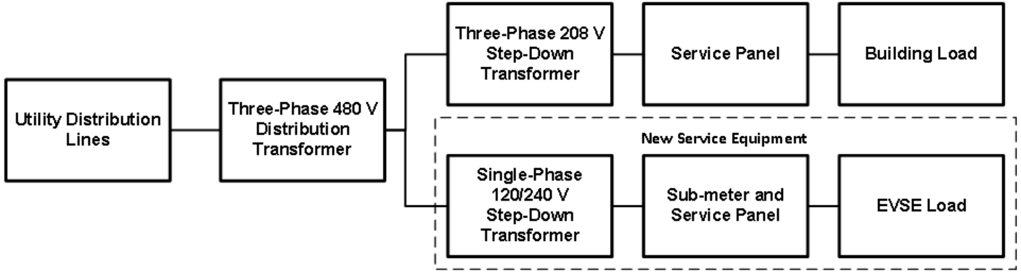




https://www.nrel.gov/docs/fy24osti/87781.pdf

# Mitigating Equipment Upgrades

- The installation of EVSE may trigger the need to upgrade service equipment
  - Service panels, distribution transformers…
- SCM can mitigate these upgrades by maintaining a power ceiling
  - EVSE can reduce power in response to peak demand and avoid overloading

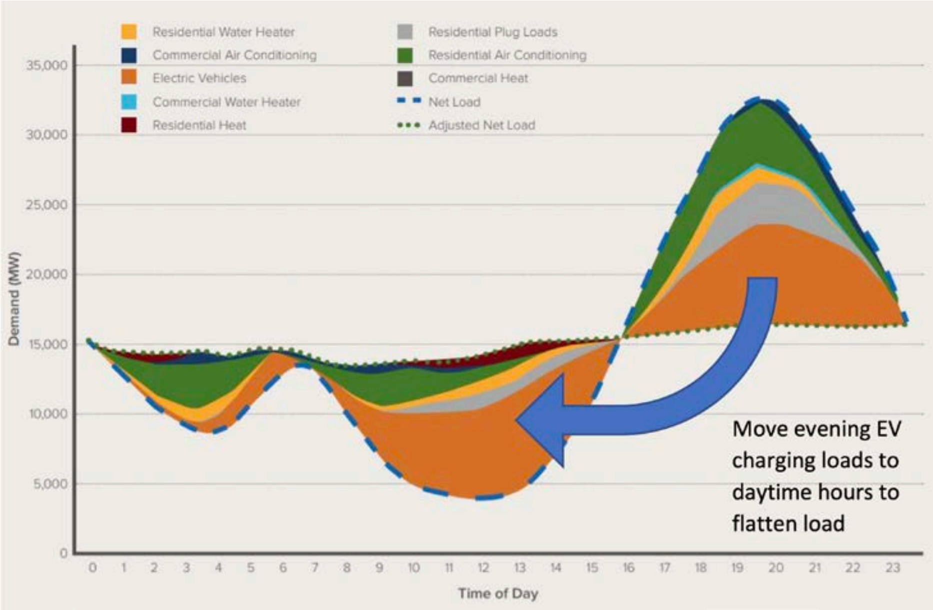



# Managed Charging Opportunities

- Charge session flexibility can be leveraged to avoid installation upgrades, reduce energy costs, and mitigate grid impacts

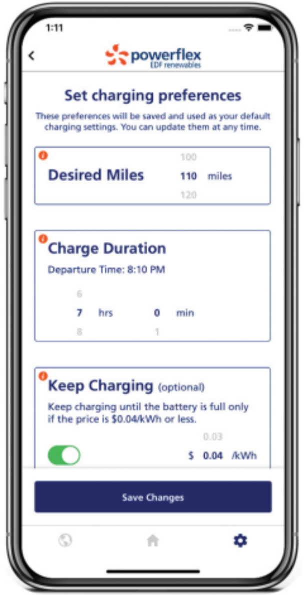
- Capacity Limitations
  - Power ceiling, dynamic loads
- Energy costs
  - TOU, Demand charges
- Utility Services
  - Demand Response, Dynamic Pricing



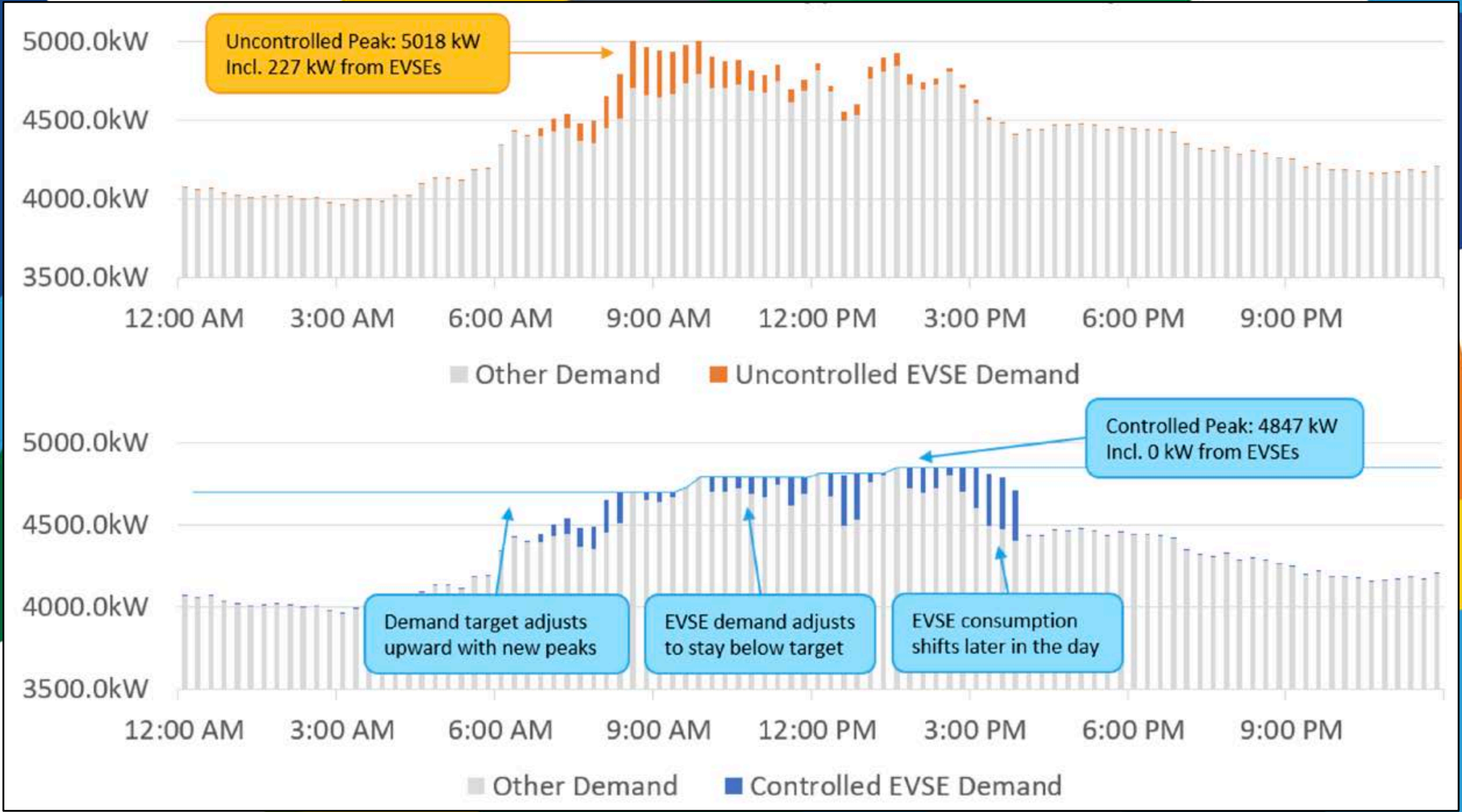

https://www.nrel.gov/docs/fy20osti/77438.pdf

# NREL’s Workplace Charging SCM

- Managed charging solution
  - Employees input desired mileage and dwell period
  - Limit max garage load to less than transformer rating
  - Limit specific service panel circuits to avoid overloads
  - Schedule charging to meet requirements and limit facility peak demand
- Mitigating upgrade costs and demand charges, while meeting the energy needs of all users

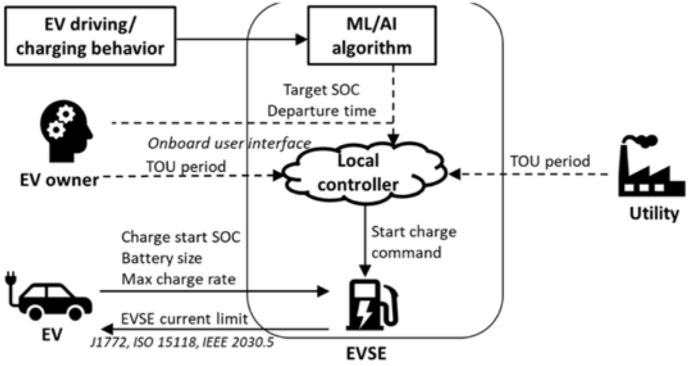

# NREL's SCM Solution at the South Table Mountain Garage in Golden, CO




https://www.nrel.gov/docs/fy20osti/77438.pdf

# Federal Fleet Considerations*

- SCM Objective Function
  - Capacity limitations, energy cost
- OCPP capability/EVSE compatibility
  - OCPP power set point send/receive
- Load Coordination/UL approval
  - UL Considerations: 2594, 916, and 60730
  - For both equipment and controls
- Fleet management
  - Manage/coordinate vehicle dwell times




https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10186998

*FEMP/NREL is investigating specific SCM requirements with additional details under development

# Current Research and Next Steps

- EVs@Scale SCM/VGI Pillar (FUSE)
  - Consortium Website / Year in Review Report
- Field Demonstrations
  - Some utilities are beginning to develop SCM programs, but more pilots are underway
- FEMP One-pager
  - Outline SCM capabilities/procurement needs
- FEMP Pilot Projects
  - Partner with FEMP and NREL to pilot SCM technologies at your site!

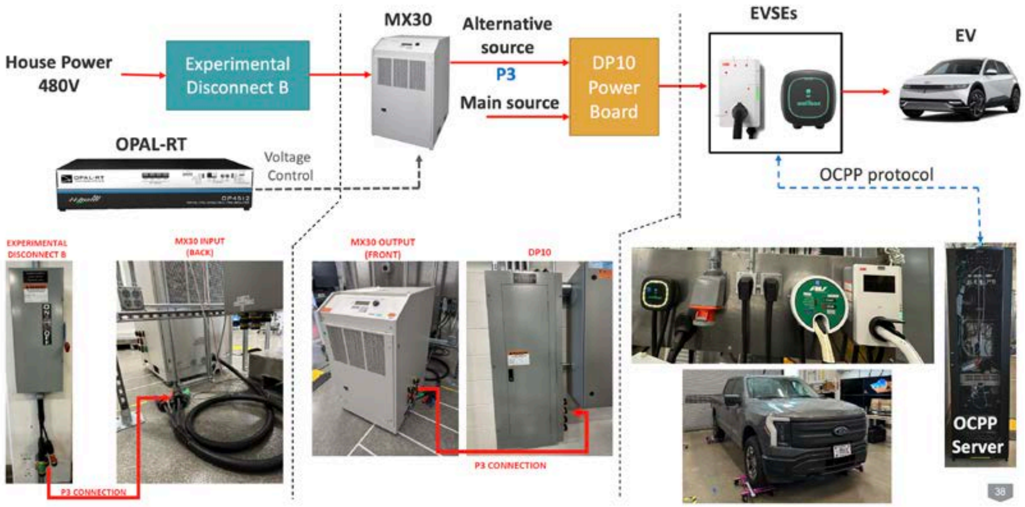
# SCM Objective Functions Under Investigation

- In addition to site benefits, SCM may also create value for utility companies by mitigating the grid impacts of EV charging at scale
- EVs@Scale is assessing multiple SCM objective functions and their ability to:
  - Mitigate transformer overloading
  - Improve local voltage quality
  - Optimize use of renewables
  - Reduce feeder peak demand
- Although few utility SCM programs currently exist, many are under development

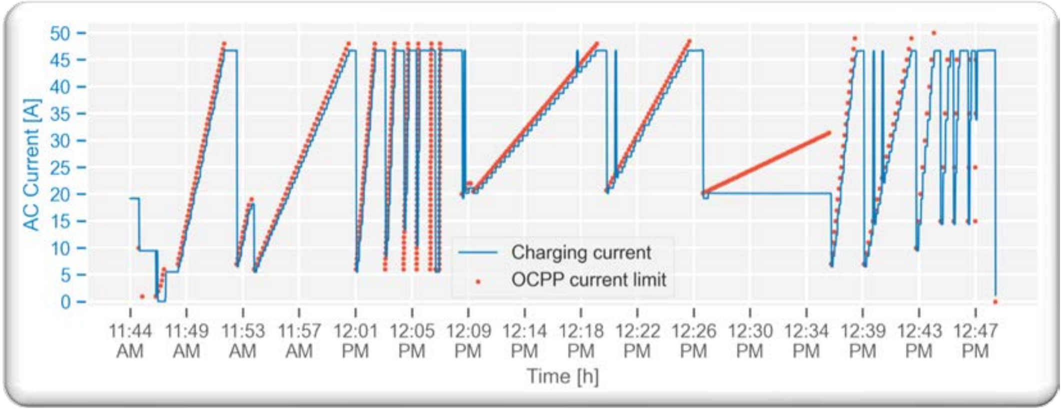
| Strategy Name | Objective Function: PEV Charging… |
|---|---|
| TOU Immediate | begins immediately at start of TOU in dwell |
| TOU Random | randomly distributed within dwell/TOU |
| Random Start | randomly distributed within dwell |
| Feeder Peak | distributed within dwell to limit feeder peak |
| Volt/VAR | provides reactive power support |
| Volt/Watt | Charging limits to support local voltage |
| BTM/DER | reduce PV/home/ESS net demand |
| Day-ahead Pricing | minimize costs per PJM LMP |

# NREL SCM Testbed

- Testbed designed to characterize OCPP performance for SCM
- Multiple L2 EVSE with SCM signals sent from an OCPP server
- Leveraging the signal: “SetChargingProfile.req” per the OCPP protocol to manage the charging current of the EVSE




OCPP Control Characterization Tests (Ioniq 5)




Per EVs@Scale Semi-Annual Stakeholder FUSE presentation from 2/28/24

Energy Exchange℠

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Federal Energy Management Program Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes

NREL/PR-5400-89220