AEE – Nevada January Webinar

Grid-Interactive Efficient Buildings (GEB)

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Grid-Interactive Efficient Buildings (GEB)

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Learning Objectives

- Understand what Grid-Interactive Efficient Buildings are

- Understand electric demand in a building affects the grid as a whole

- Understand how Demand Flexibility relates to increased renewable generation

- Understand different strategies to make buildings grid-interactive

Important Terms

- DSM – Demand Side Management
  - Any management strategy on the customer side of a meter
- IDSM – Integrated Demand Side Management
  - Comprehensive suite of programs including efficiency and demand reduction
- EE – Energy Efficiency
  - Programs that save energy, usually measured in kWh
- DR – Demand Response
  - Programs that manage electric demand, usually measured in kW

Overview

- Grid-Interactive Efficient Buildings

  - Demand Flexibility
    - Controls provide automated energy efficiency as well as responsive load shed
  - Distributed Energy Resources
    - kW (as opposed to MW or GW) scale generation and energy storage
  - Connected Communities
    - Grid-Interactive buildings working together to meet energy needs

US Department of Energy Initiatives

The Building Technologies Office research is helping make buildings become smarter about the amount and timing of energy use through the Grid-interactive Efficient Buildings (GEB) Initiative. In addition to improving the energy efficiency of the overall building, this research focuses on making equipment more intelligent through next-generation sensors, controls, connectivity and communication. These capabilities give building occupants more control in managing building comfort and productivity while saving money on energy bills, plus they can benefit the electric grid by enhancing grid reliability and resilience, deferring capital expenditures, and helping balance the supply of renewable generation.

Source: https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings

Demand Flexibility - Supply and Demand

- Energy supply, on the utility side of the meter, is planned based on projected demand on individual circuits
  - Planning uses historical data for an area to provide the necessary supply capacity
  - Too much capacity is expensive in additional equipment
  - Too little capacity leads to supply failures
  - Properly sized capacity provides reliable power at low rates

Demand Flexibility - Transmission

Transmission lines can cost $1,000,000 per mile or more to build

Demand Flexibility - Supply and Demand
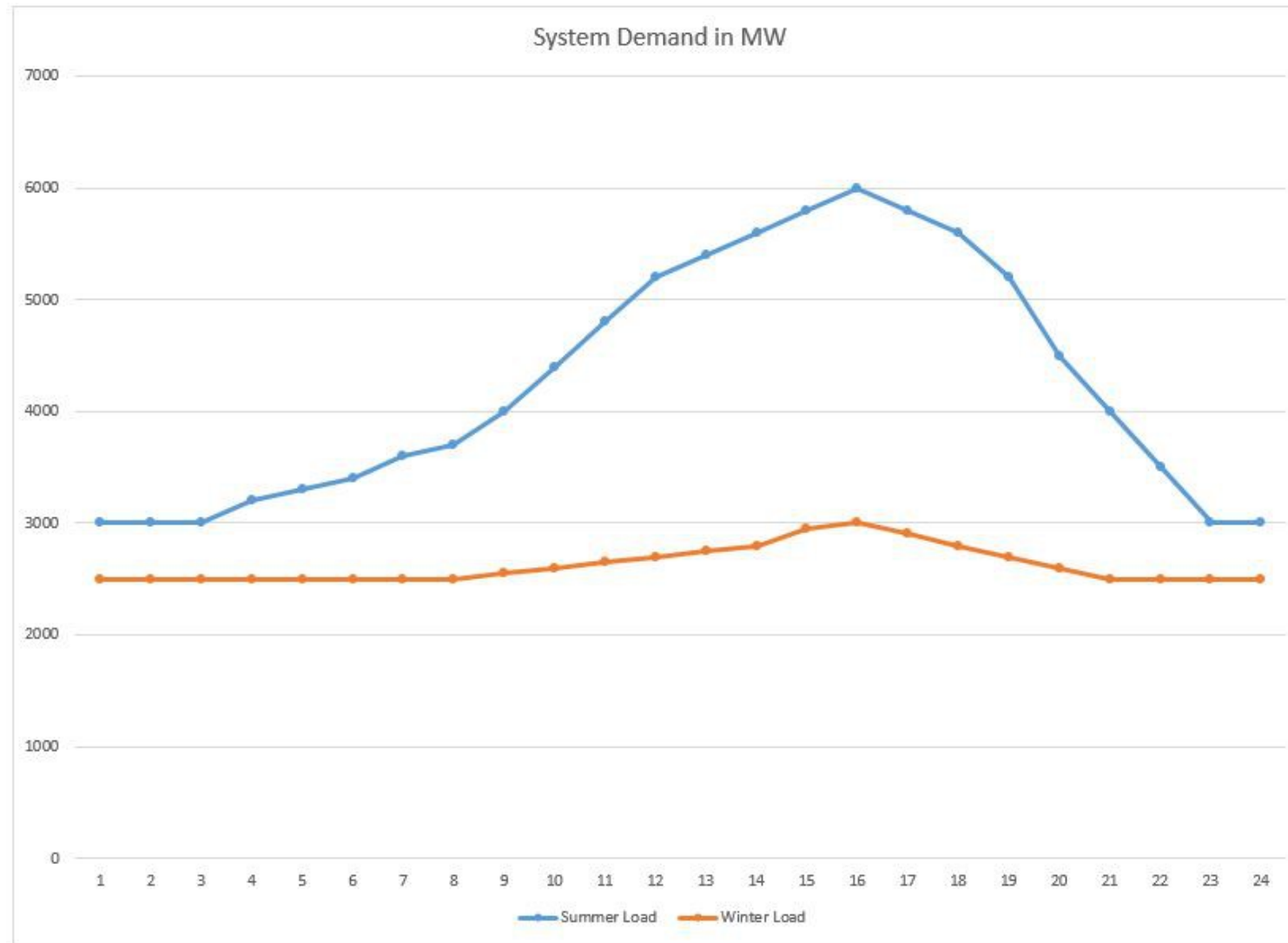
- Increases in demand ripple back through the system
  - Higher demand at the local circuit level requires more supply
  - Additional circuit demand requires more capacity at substations
  - Additional demand on substations requires more generation
  - All of the increases add to the cost of energy

Demand Management

Summer day load shape

Demand Management

Demand Management

- Example project
  - Lighting retrofit
    - Office areas retrofit reduces demand by 30kW during occupied hours
    - Parking garage retrofit reduced demand by 20kW 24hrs/Day
  - BMS is reprogrammed to ramp in morning setpoints
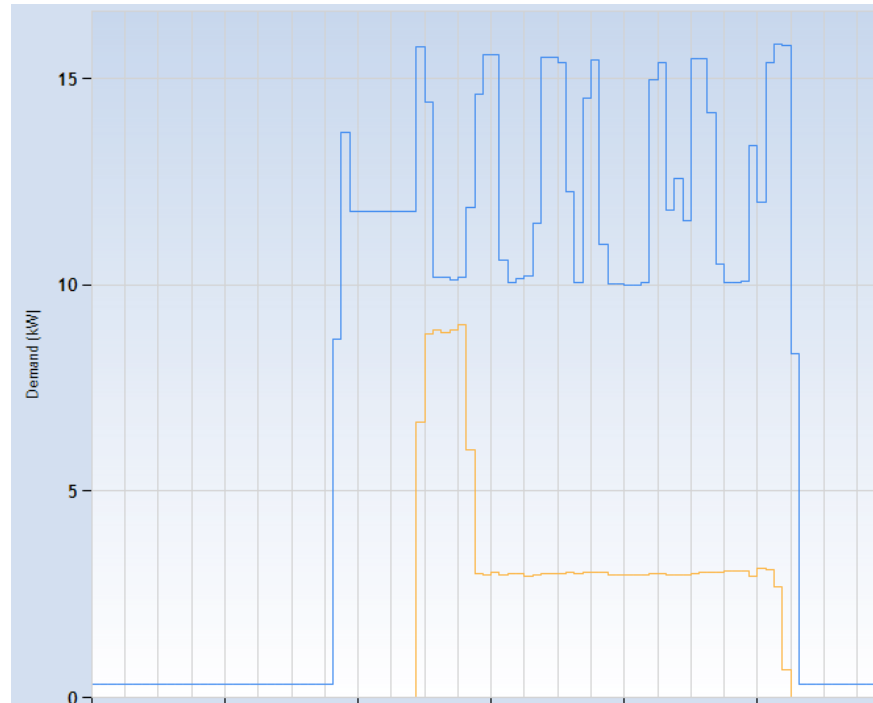   - Net savings of 450kWh/Day during the summer between 6AM and 9AM

Demand Management

Summer day load shape after EE retrofit

Demand Management

▶ Technologies for demand management often use network connections to communicate between devices, or to a management portal, or both

Distributed Energy Resources

▶ What is a Distributed Energy Resource (DER)
  − Grid-connected electrical generation resources

  − Smaller than traditional generation facilities

  − Typically located where the energy will be consumed

  − Includes a variety of resources, mainly renewable energy

  − Examples include solar & wind generation

▶ Integrated with grid-connected storage systems

  − Examples include chemical & thermal storage

▶ Coordinated with utility Demand Side Management of controllable loads

  − Examples include HVAC, water heaters, & electric vehicle controllable loads

Distributed Energy Resources

- DER Challenges

  - Nevada's 2019 Senate Bill 358 increase renewable energy to 50% by 2030

  - "Duck curve" - imbalances between renewable energy production and peak grid demand

  - Reverse DER power flows on grids designed for one-way distribution

- DER Management

  - Requires coordination between DERs to mitigate excess renewable generation and steep demand ramps

  - Increase value of DERs for both end user and utility
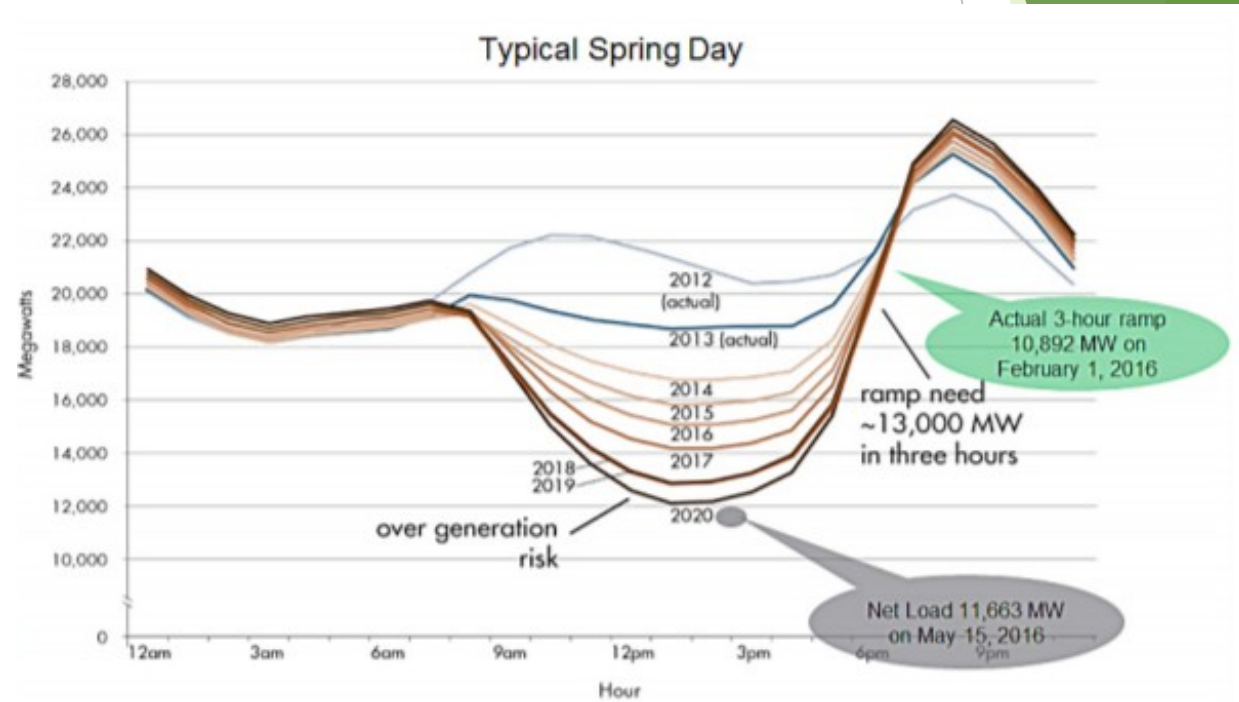
Connected Communities

- When buildings are efficient and connected to the grid power excess power from one building can be shared with neighbors

- Renewable energy supplies can be managed across communities, cities, and even regions

- Energy supply is more resilient due to DERs

Grid-Interactive Efficient Buildings

▶ Demand Flexibility allows for grid scale management that reduces the need for new power plant construction

▶ Delaying or eliminating construction of new power plants that only provide peak demand (peaking plant) keeps electric rates low

▶ When technology used for Demand Flexibility is connected to the Internet it enables more Distributed Energy Resources as renewables come on line

▶ Energy efficiency, storage, and on-site generation funciton together in a Grid-Interactive Efficient Building to reduce operating costs, make best use of renewables, and provide a more stable electric energy supply

Examples

Lighting

HVAC

Vehicle Grid Integration

Lighting - Sources

Daylighting – Windows and Skylights
  Dynamic Glazing

Conventional Sources
  Incandescent
  Fluorescent
  High Intensity Discharge

LED Sources
  White Phosphor Converted
  Tunable Phosphor Converted
  Tunable Narrow Spectrum (RGB, RGBA, RGBW, etc)

Lighting – Daylighting

Dynamic glazing adjusts the degree of tint based on either temperature or electrical control. HVAC loads can be reduced by tinting more during periods of high solar heat gain while lighting loads can be reduced by tinting less when heat gain is less of a concern.

Source: DOE Building Envelope Webinar

Flexibility Mode	Capability
Efficiency	●
Shed Load	●
Shift Load	◑
Modulate Load	○
Overall	High

Lighting – Conventional Sources

Incandescent
    Inefficient
    Largely obsolete today, some still available such as MR lamps
    Relatively easy to control

Fluorescent
    More efficient than incandescent
    Long life
    Hard to control
    Disposal hazard – Mercury

High Intensity Discharge
    Much more efficient than incandescent
    Long life
    Very hard to control

Lighting – LED Sources

White Phosphor Converted
- Single color temperature
- Good color rendering
- Approaching maximum efficiency

Tunable Phosphor Converted
- Color temperature range
- Variable color renedering
- Useful for circadian entrianment

Tunable Narrow Spectrum
- Large color range
- Variable color renedering
- Good for circadian entrainment
- Requires good control
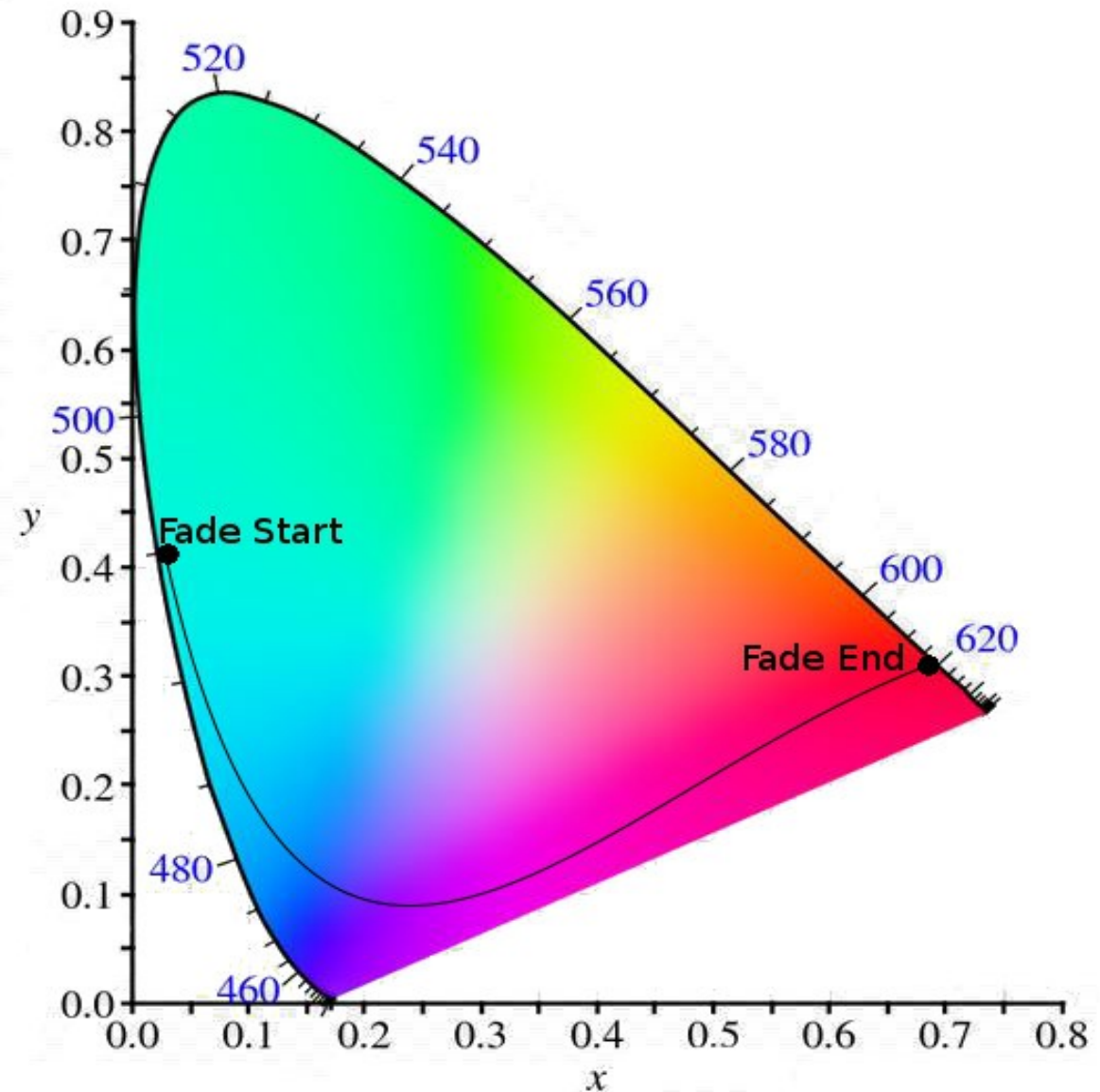
HVAC - Strategies

How do you flexibly adjust demand without adversely impacting occupant comfort?

HVAC systems offer several ways to shift load.

- Thermostats

- Storage
  - Chilled water loop
  - Ice storage / PCM systems

- IAQ/economizing

HVAC - Thermostats

Thermostats can be used to manage coincidental peak load, and reduced load during peaks with different strategies such as precooling and temperature setbacks.
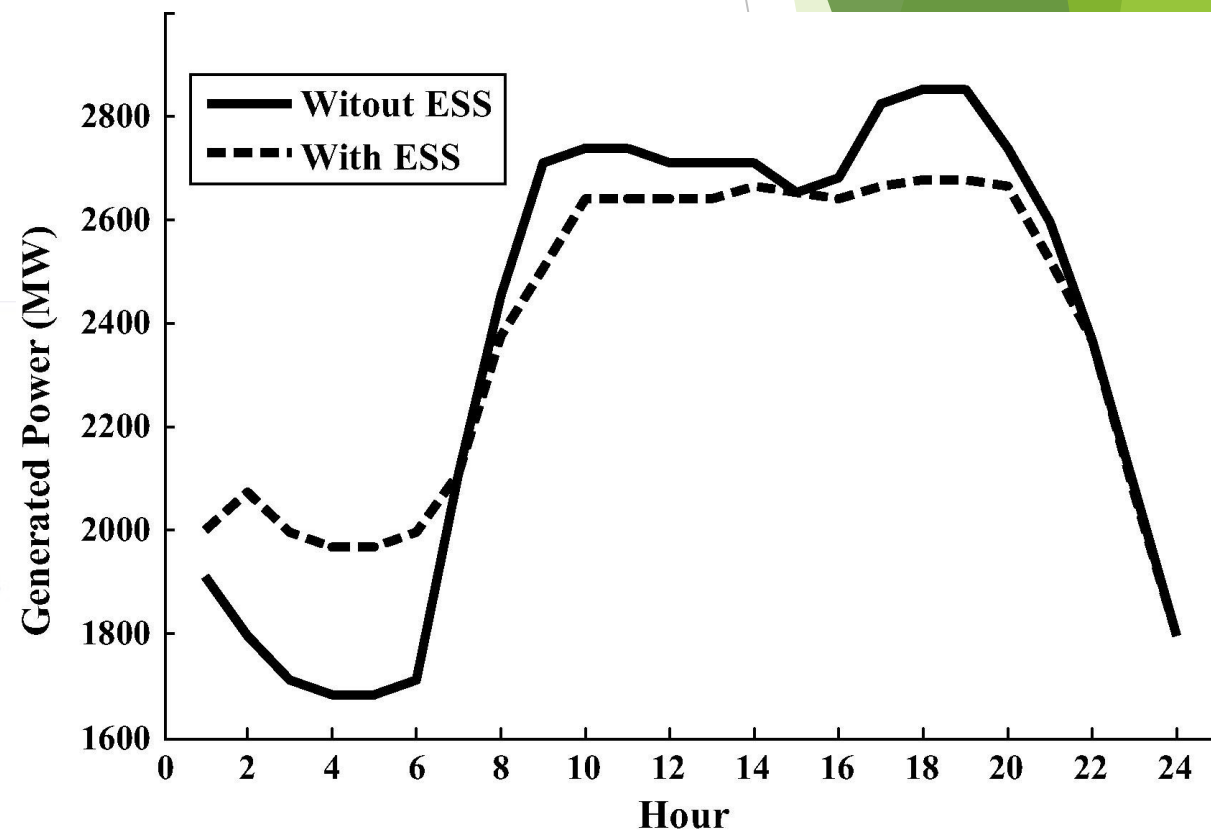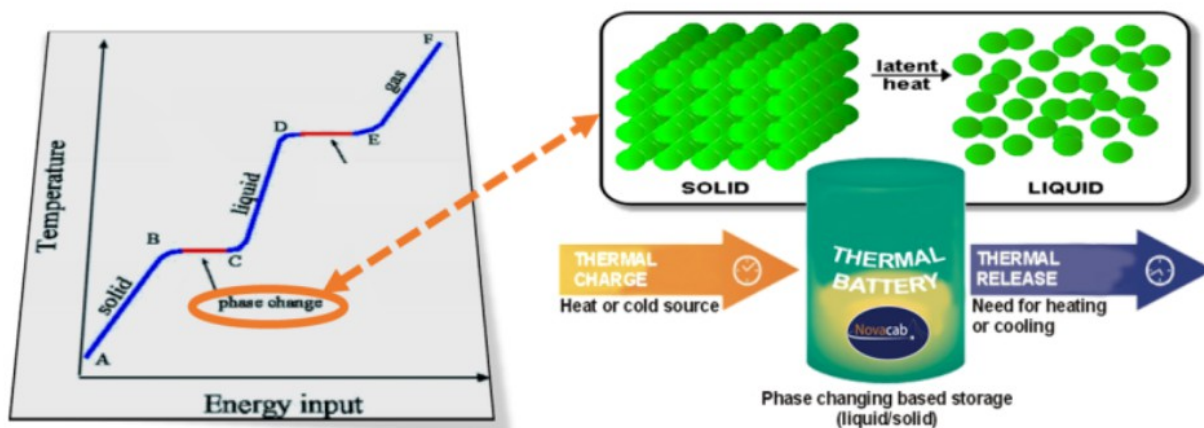
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- Thermostats
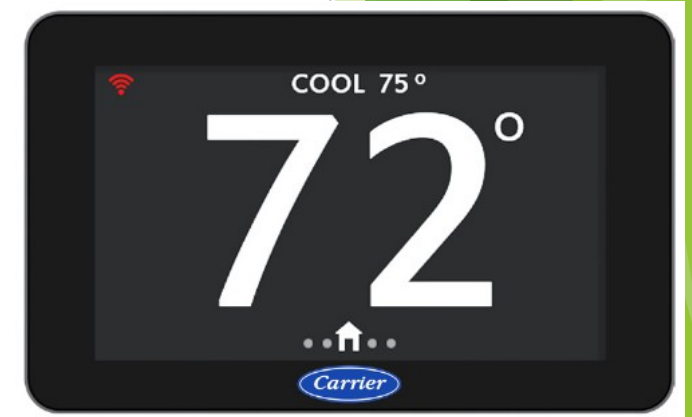
HVAC – Thermal Energy Storage

Thermal energy storage can improve efficiency and shift load.
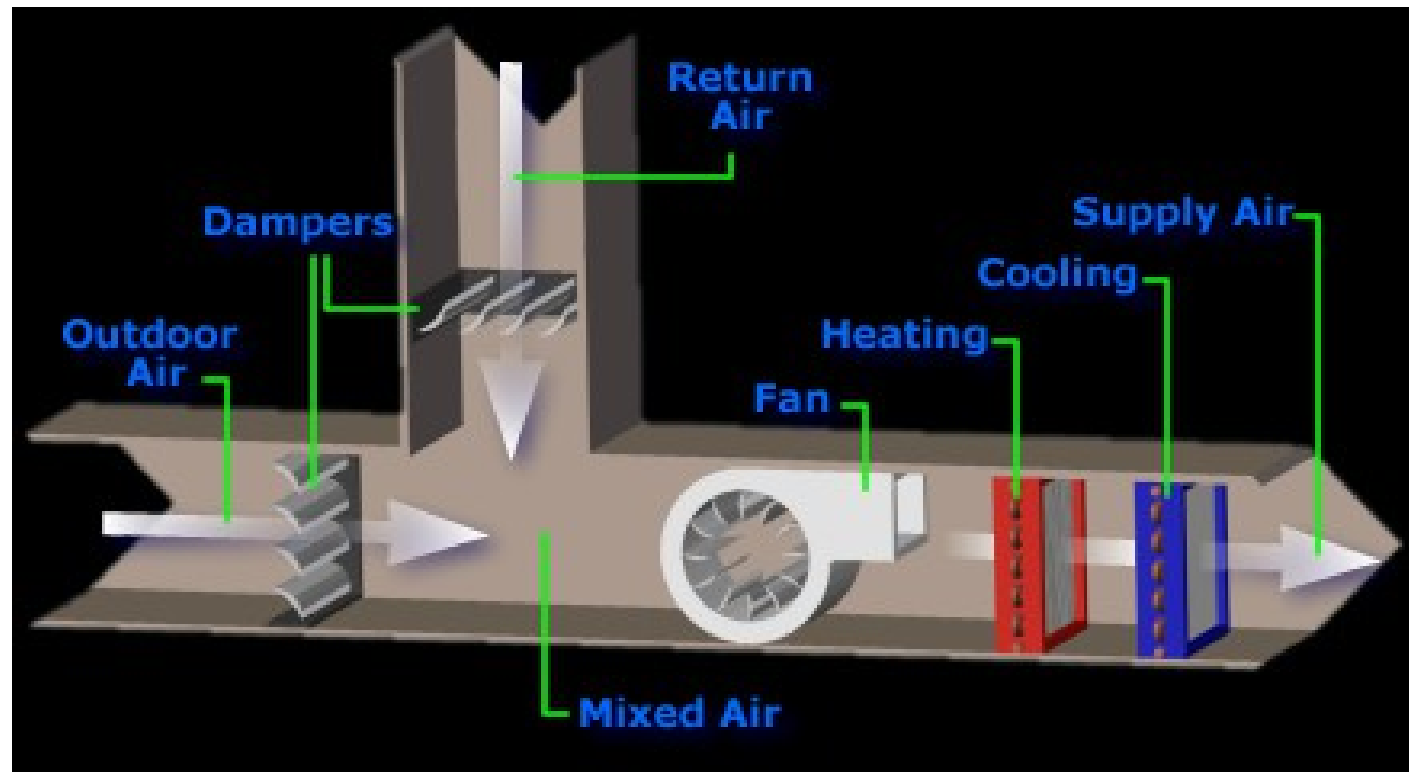
- Storage

    - Ice/PCM storage system

    - Chilled water loop

HVAC – IAQ/Economizing

Adjusting the indoor air quality could also provide an opportunity to shift load.

Optimize the ventilation to minimize IAQ and energy efficiency

Vehicle Grid Integration

Opportunity

- Electric vehicles (EV) and Electric vehicle supply equipment (EVSE) adoption is increasing.

    - Federal tax credits, utility incentives & rates, cost-effective technology

- Commercial EV charging stations increase building's coincidental demand.

    - From 8 kW Level 2 chargers to 100 kW DC fast chargers (per port)

- Managing the demand becomes essential to both customer and utility.

    - Customers need to manage coincidental loads to reduce their peak demand charges.

    - Utilities need to manage EV loads from straining the grid during emergencies or peak grid demand.

        - Demand limiting, load shifting, and renewable generation absorption

- There is an opportunity to dynamically manage smart EV charging to provide utility grid services while meeting customer requirements.

Vehicle Grid Integration

2020 Summer Field Demonstration

- Objectives

  - Demonstrate telemetry data from charging stations could be retrieved and logged remotely

  - Demonstrate demand limiting (not vehicle to grid) through dispatchable commands remotely

- Approach

  - Target two NV Energy owned charging stations

    - One private and one public station

  - Use telemetry data to develop charging profiles

    - Charging stations were not sub-metered with utility smart meters

  - Design demand limiting strategies to target the peak charging periods to demonstrate demand limiting without inconveniencing customer expectations
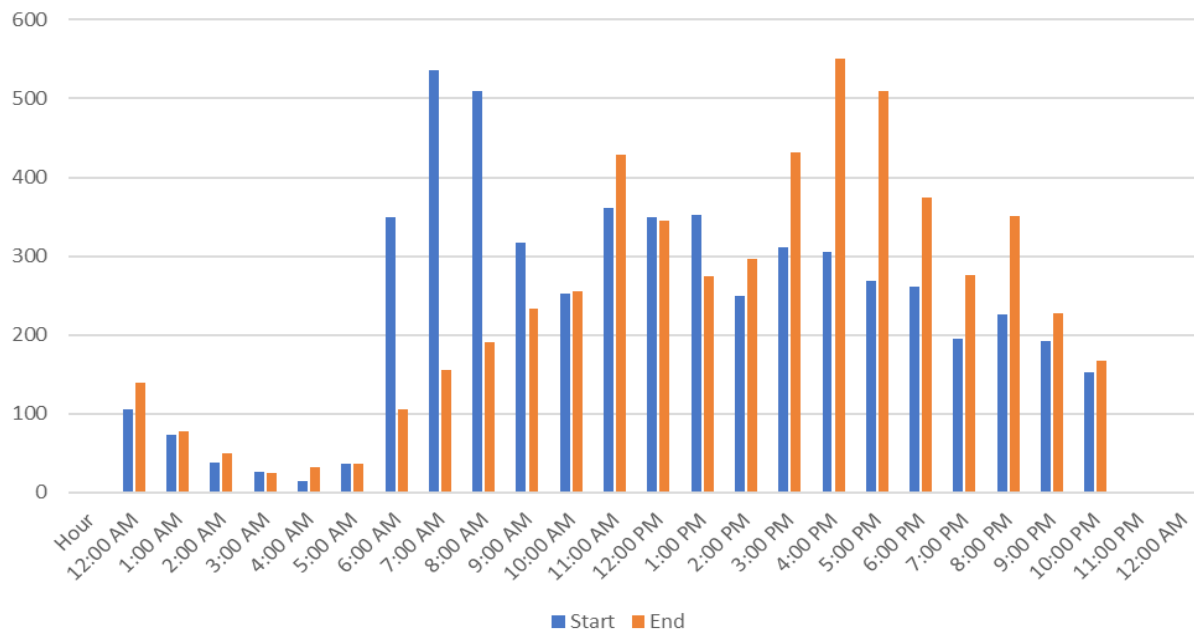
Vehicle Grid Integration

Charging Session Starting vs. Ending Times

- In an office building EV charging station open to the public for free charging, start times are focused between 6:00am – 9:00am, while end times occur between 3:00pm – 6:00pm.
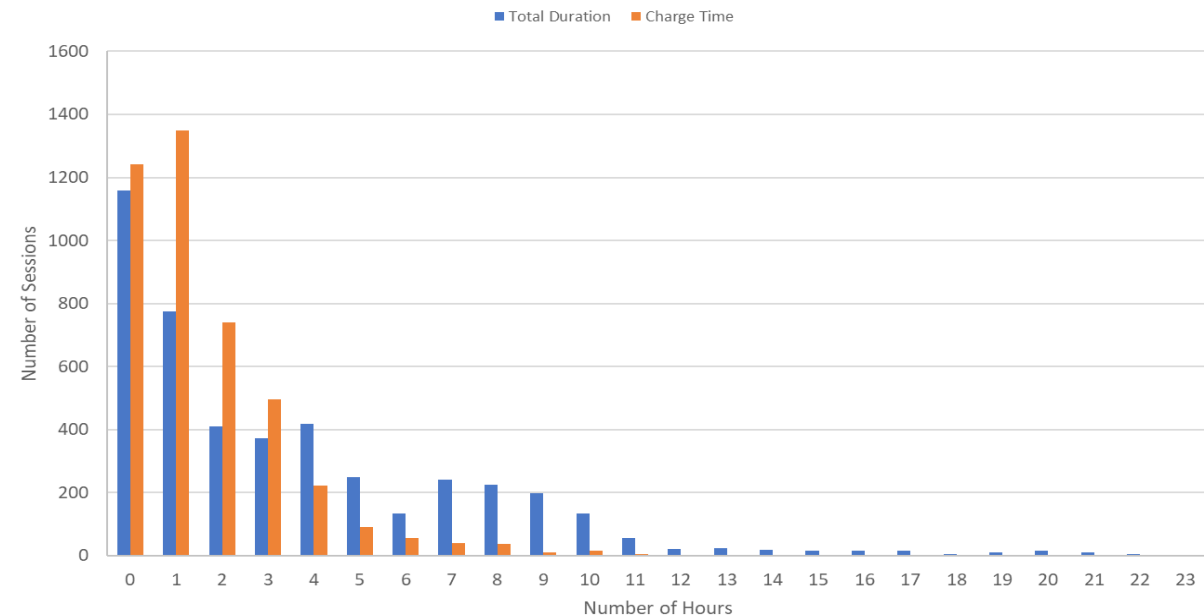
Charging Time vs. Session Duration

Majority of EV charging is completed within 2 hours.

Vehicles remain plugged into the charging station closer to 7-9 hours.

Number of Sessions Starting and Ending Per Hour

Total Duration and Charge Time Distribution
NV Energy Pearson Charging Stations

Vehicle Grid Integration

Demand Limiting Parameters

- Group

- Duration

- Shed Mode

  - Absolute Maximum Output per Port (kW)

  - Relative Percent of Present Load (%)

Date	Time	Demand Reduction % Relative to Load	Additional Charge Time Per Hour	Stations
Tue, Sep 1	7 AM – 9 AM	10%	12 minutes	All (Stations 1 & 2)
Thu, Sep 3	7 AM – 11 AM	10%	12 minutes	All (Stations 1 & 2)
Tue, Sep 8	7 AM – 9 AM	20%	15 minutes	All (Stations 1 & 2)
Thu, Sep 10	7 AM – 11 AM	20%	15 minutes	All (Stations 1 & 2)
Tue, Sep 15	7 AM – 9 AM	25%	20 minutes	All (Stations 1 & 2)
Thu, Sep 17	7 AM – 11 PM	25%	20 minutes	All (Stations 1 & 2)
Tue, Sep 22	7 AM – 3 PM	10%	12 minutes	Station 1 Only
Thu, Sep 24	7 AM – 3 PM	20%	15 minutes	Station 1 Only
Tue, Sep 29	7 AM – 3 PM	25%	20 minutes	Station 1 Only

Shed Load

Organization Name	NV Energy
Name	NV ENERGY / PRIVATELINDELL2
Type	Port
Load	3.30 kW
Duration	1 48 hh:mm
Shed Mode	○ Absolute Maximum Output Per Port
	● Relative Percent of Present Load
Value	10 %

Shed   Cancel

Vehicle Grid Integration

Delaying/Shifting EV Charging to Align with Solar Production Peak
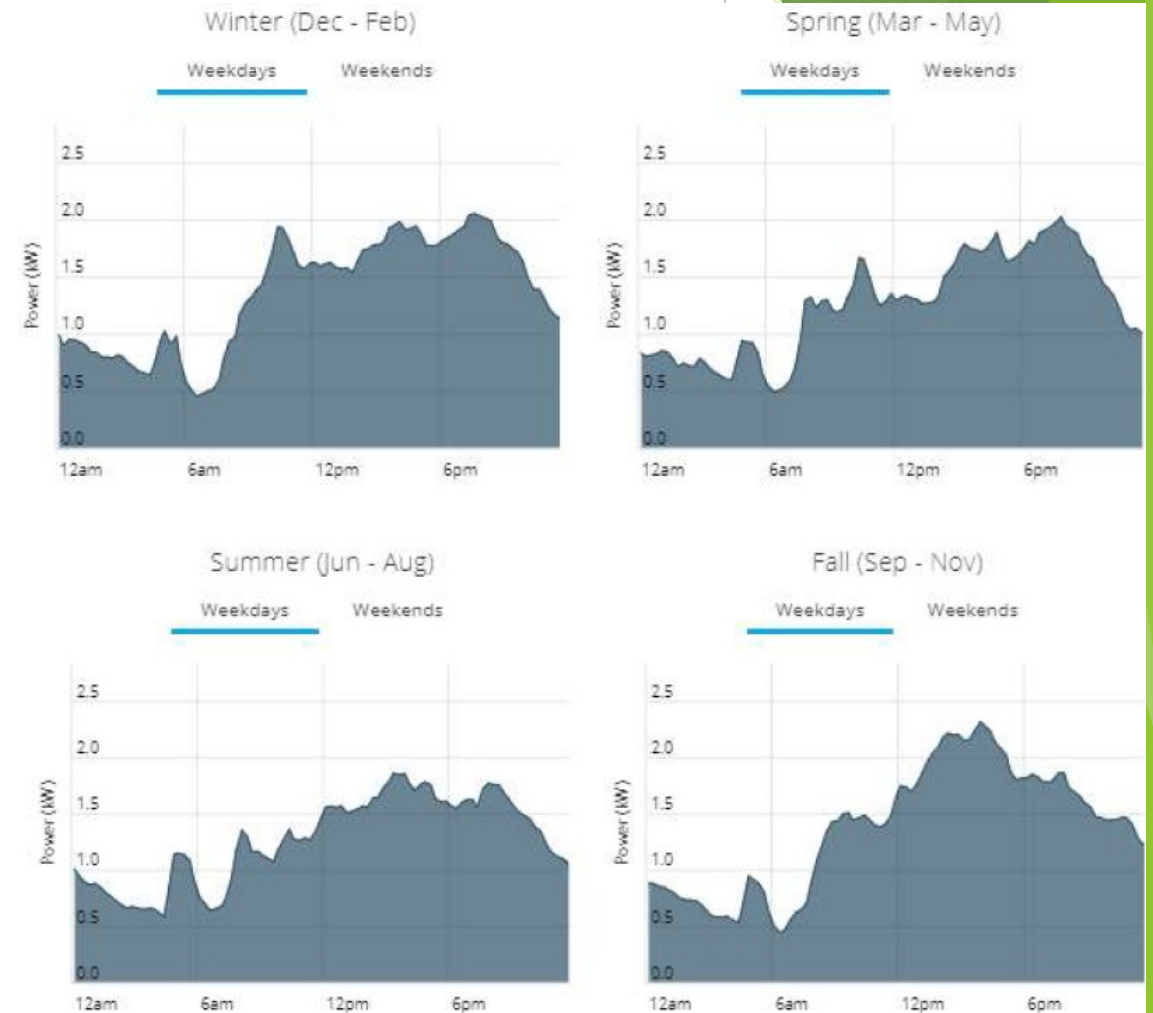

Sample Demand Limiting, Shifted Event
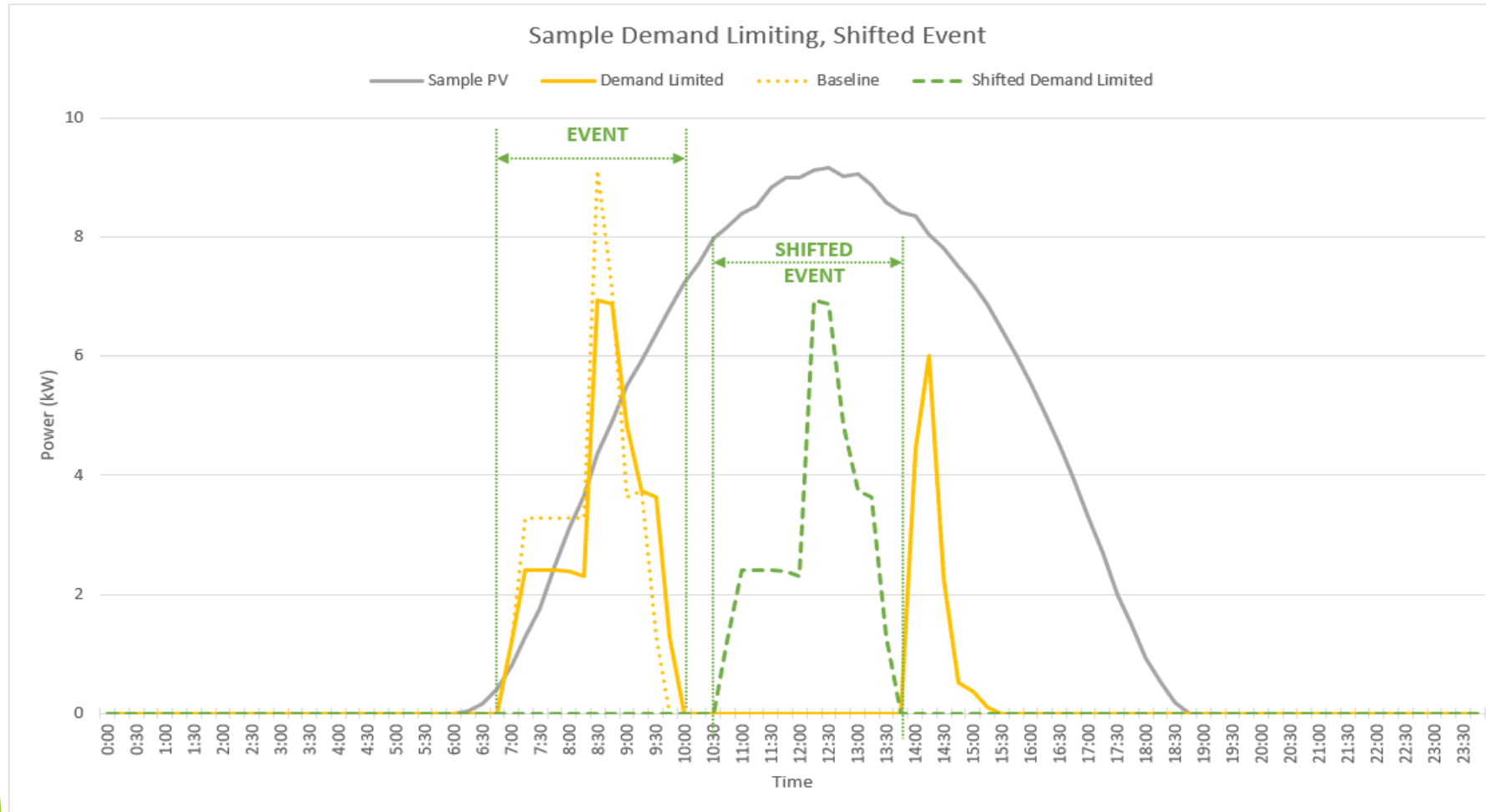
Vehicle Grid Integration

Sample Charging Station Load Profiles (normalized per charging port)
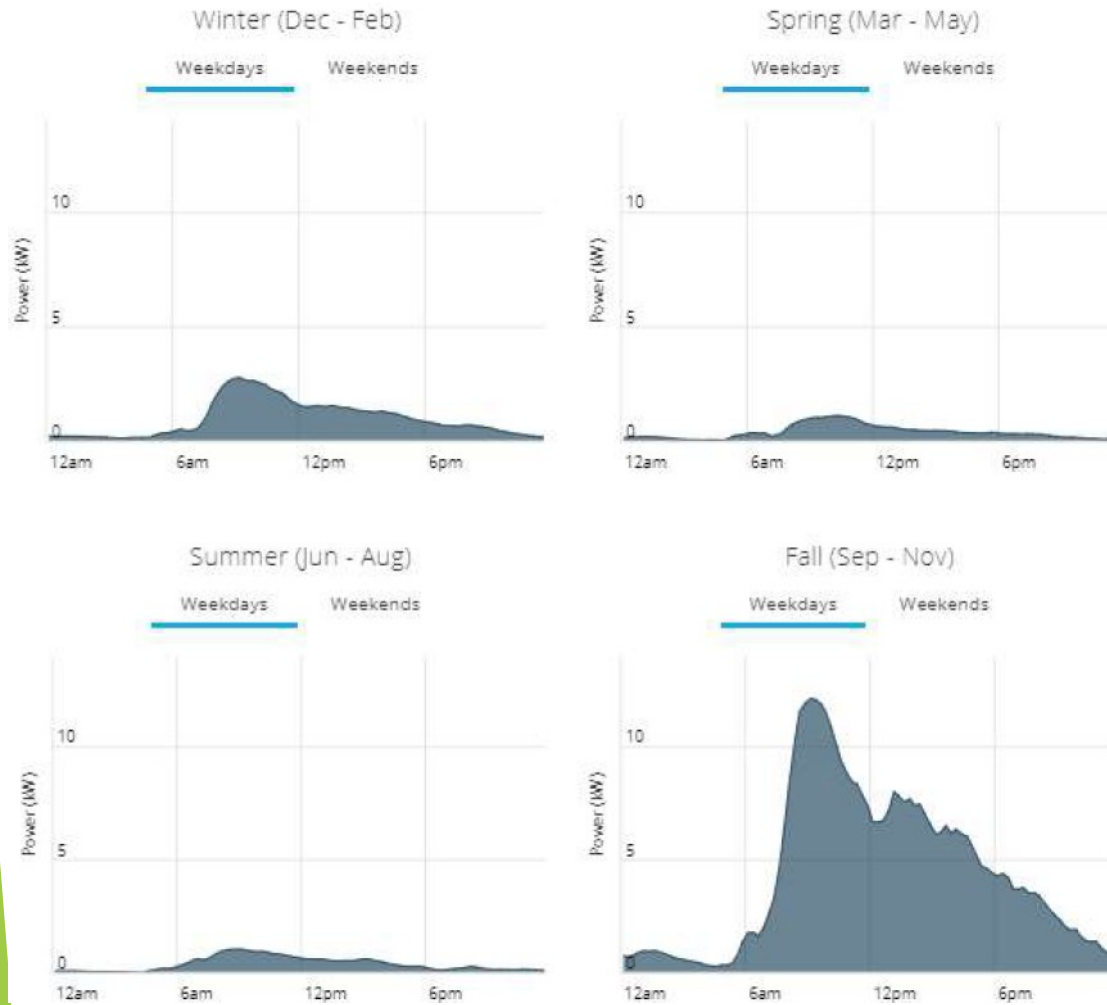
Vehicle Grid Integration

Lessons Learned

- Smart EV charging stations are capable of easily integrating as a Demand Side Management resource, however, requires fine tuning to optimize the DER.

  - Remotely collecting telemetry was adequate in developing charging profiles.

  - Remote dispatch of demand limiting commands was demonstrated.

- In addition to peak load reduction, EV chargers are capable of load shifting and excess renewable energy absorption.

  - Site-specific charging profiles will need to be evaluated prior to developing demand management strategies for both customer and utility.

- EV charging stations can provide value as a DER without negatively impacting customer expectations.

- Early efforts to integrate EV charging stations as DER better prepares the grid to accept more variable renewable sources.

Questions

Thank You!

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