MO PSC EV Workshop –
Are all EV Charging Stations Created Equal?

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Types of EVs

- **PHEV (Plug-in Hybrid Electric Vehicle)**

  PHEV has the characteristics of a conventional hybrid electric vehicle, having an electric motor and **an internal combustion engine** , and also has a plug to connect to the electrical grid to charge the onboard battery.

  Most PHEVs support L1 (110v) and L2 (240v) AC charging.

  - Audi A3 Sportback e-tron
  - BMW i8
  - **Chevy Volt**
  - **Ford Fusion Energi**
  - **Ford C-Max Energi**
  - Hyundai Sonata Plug-in
  - **Toyota Prius Plug-in**/Prime

- **BEV (Battery Electric Vehicle)**

  A BEV derives all its power from it's rechargeable battery and thus has **no internal combustion engine or fuel tank**.

  Most BEVs support L1 (110v) and L2 (240v) AC and DC Fast Charging.

  - **BMW i3**
  - Chevy Spark EV
  - Fiat 500e
  - Ford Focus Electric
  - Kia Soul EV
  - Mitsubishi i-MiEV
  - **Nissan Leaf**
  - Smart Fortwo ED
  - **Tesla Model S**
  - Volkswagen e-Golf

Comparison of Most Common EVs Registered in KCP&L Service Area

	EV/PHEV Model	EV Type	EVs Reg. 2010-2015	EV Battery (kWh)	EV Charger (kW)	Charge Plug	Elec. Range (mi.)	Mi per kWh
	Chevrolet Volt	PHEV	418	18.4	3.6	J1772	53	2.9
	Ford C-Max Energi	PHEV	101	7.6	3.3	J1772	19	2.5
	Ford Fusion Energi	PHEV	94	7.6	3.3	J1772	22	2.9
	Toyota Prius Plug-In	PHEV	13	4.4	3.3	J1772	11	2.5
	Tesla S - 70D - 90D	BEV	135	70 90	10 20*	Tesla J1772 ** CHAdeMO**	240 294	3.4 3.3
	Nissan Leaf S Nissan Leaf SV/SL	BEV	109	24 30	3.6 6.6	J1772 CHAdeMO	84 107	3.5 3.6
	BMW i3	BEV	30	22	7.4	J1772 SAE Combo	81	3.7

* option ** with adapter Note: Table data derived from OEM current model year published specifications

EV Charging Levels

- **AC Level 1 - charging from an ordinary household outlet**
  - All EV's support L1 charging
  - 120v, 15 or 20 amp circuit
  - AC-DC rectifier is on-board vehicle
  - Charging is controlled by the EV charge management system

- **AC Level 2 - common workplace and public charging**
  - All EV's support Level L2 charging
  - 240v, 20, 30 or **40** amp circuit per EV charge port.
    (Tesla stations have 100a circuit max)
  - Plug is not energized until plugged into the EV
  - AC-DC rectifier is on-board vehicle
  - Charging is controlled by the EV charge management system

- **DC Fast Charging (DCFC)**
  - Typically supported on BEV
  - 480v 3ph, 500v DC, 25, **50**, 120kW per EV charge port
  - AC-DC rectifier is located within the charge station
  - Plug is not energized until plugged into the EV
  - EVCS and EV charge management system coordinate charge

L2 Hourly Charge Comparison

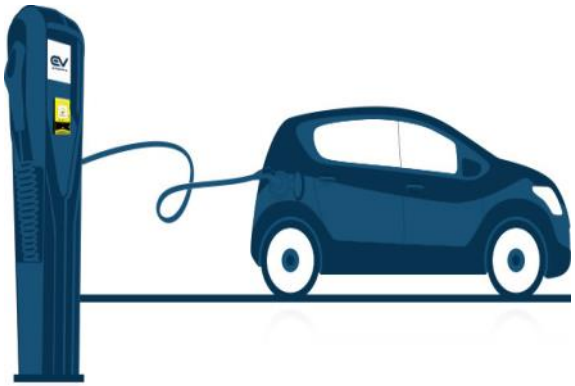
	EV/PHEV Model	EV Type	EV Charger (kW)	Miles per kWh	Charge/Hr. @ L2 Station (kWh)	Miles per Hour of Charge @ L2 Station
	Chevrolet Volt	PHEV	3.6	2.9	3.6*	10.4
	Ford C-Max Energi	PHEV	3.3	2.5	3.3*	8.3
	Ford Fusion Energi	PHEV	3.3	2.9	3,3*	9.6
	Toyota Prius Plug-In	PHEV	3.3	2.5	3.3*	8.3
	Tesla S - 70D - 90D	BEV	10	3.4 3.3	7.2**	24.5 23.8
	Nissan Leaf S Nissan Leaf SV/SL	BEV	3.6 6.6	3.5 3.6	3.6* 6.6*	12.6 23.8
	BMW i3	BEV	7.4	3.7	7.2**	26.6

* Charging rate is limited by EV onboard charger

**Charging rate is limited by L2 Charge Station

How L2 EV Charging is Controlled

- **EV battery charging is controlled by the onboard charge management system**
- **EV charging parameters set by**
  - EV Charge Station
    - Available charge capacity
    - Display cost of charge
  - EV Driver Console
    - Charge immediately
    - Complete charge by time
    - Low cost periods
    - Cost thresholds
  - OEM Driver Portal
    - Similar to console preferences



Classes of EV Charge Stations

Non-Networked

- Lower station cost
- Commonly single charge port
- Unable to accept payment
- Can be manually added to on-line charge station maps.
- Some models have a delay charging mechanism
- No access control
- No charge session tracking
- No energy usage tracking
- No charge station monitoring

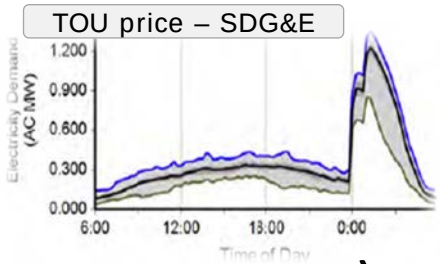
Networked

- Communicate to via Cellular or WIFI to EV Network Mgt. System (Open Charge Alliance's OCPP 2.0 is emerging standard protocol)
- Remote station monitoring and management
- Provide real-time station availability to drivers
- Provide remote support for EV drivers
- Enable station access control
- Ability to monetize and bill charge session usage
- Track and report session details & energy usage
- Provide charge level control and active load reduction

Managing EV Charging for Grid Benefits

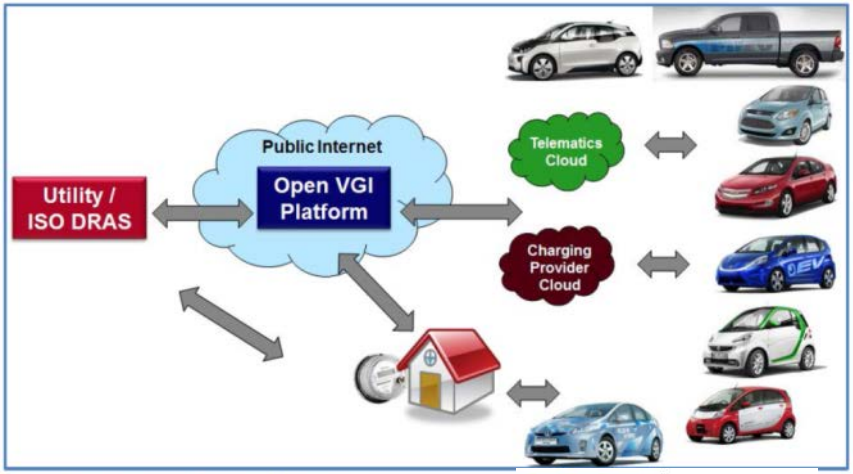
- Today proprietary EVCS Network APIs used to adjust available charge station capacity and price
  - Partial load reduction
  - Load curtailment
  - Load up/down ramping
  - TOU pricing to influence charge periods

Capabilities vary by EVCS Network



- Future Open Vehicle-Grid Integration Platform(OVGIP)

  EPRI' R&D into a single communication interface to all OEM EVs that could provide:
  - EV state of charge
  - EV charge required
  - Driver preferences
  - DR program enrollment
  - Home/Bldg. EMS



Open Platform For Grid Services

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Types of EV Charge Stations

- Historically there have been two classes
  - Basic, non-networked charge stations
  - Multi-Function, networked public access stations
- New networked station classes emerging

Home

Multi-Family

Fleet

25 & 50 kW
Fast DC Charge Stations

Typical CCN L2 Installation

L2 Meter-Service Pedestal

- 120/208-240 Single Phase
- (2) 200a Meter Sockets (back)
- (2) 200a Service Disconnects
- (6) Dual Port Charging Stations per pedestal.

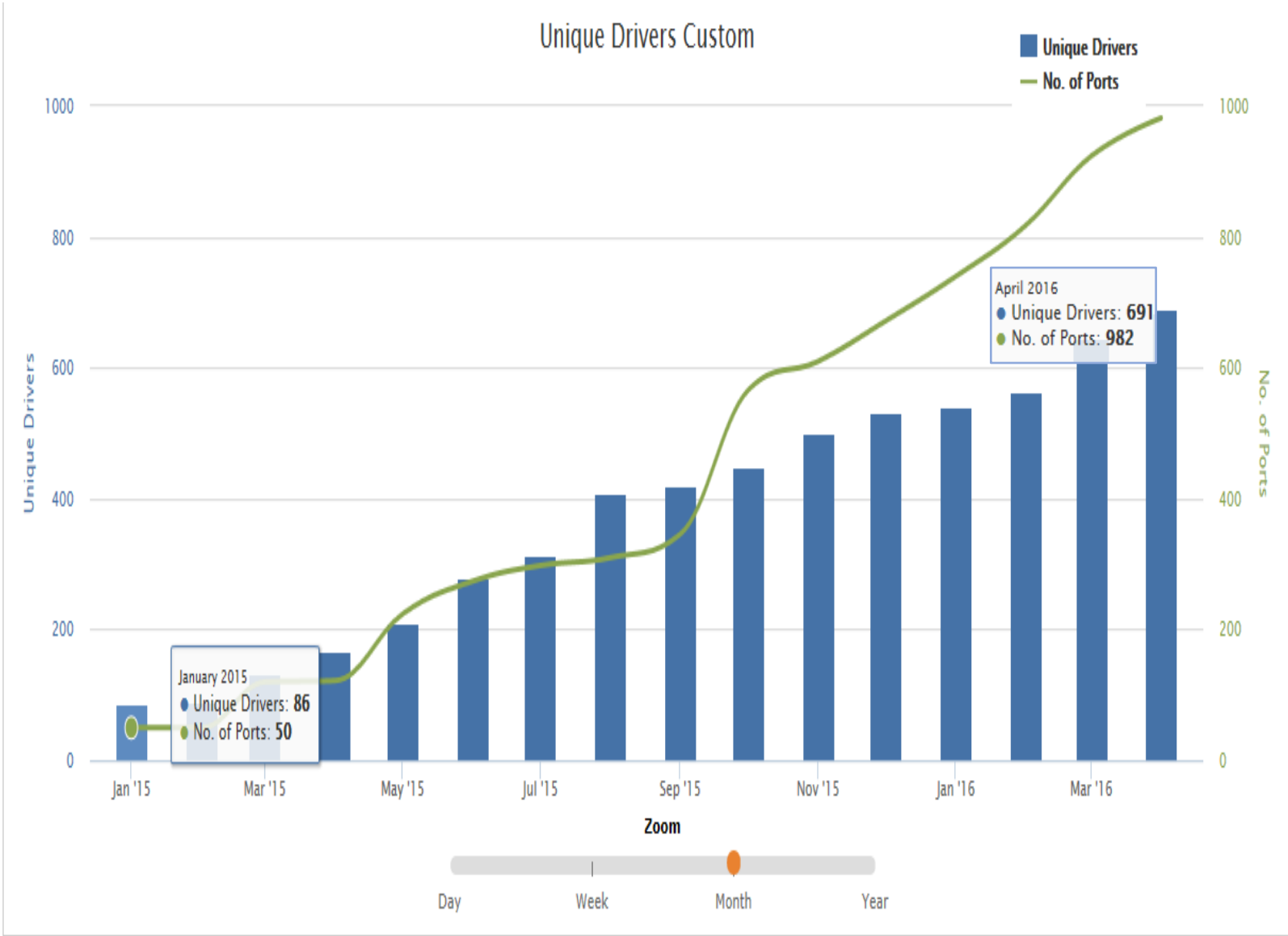
Typical CCN L3 Installations

L3 Meter-Service Pedestal

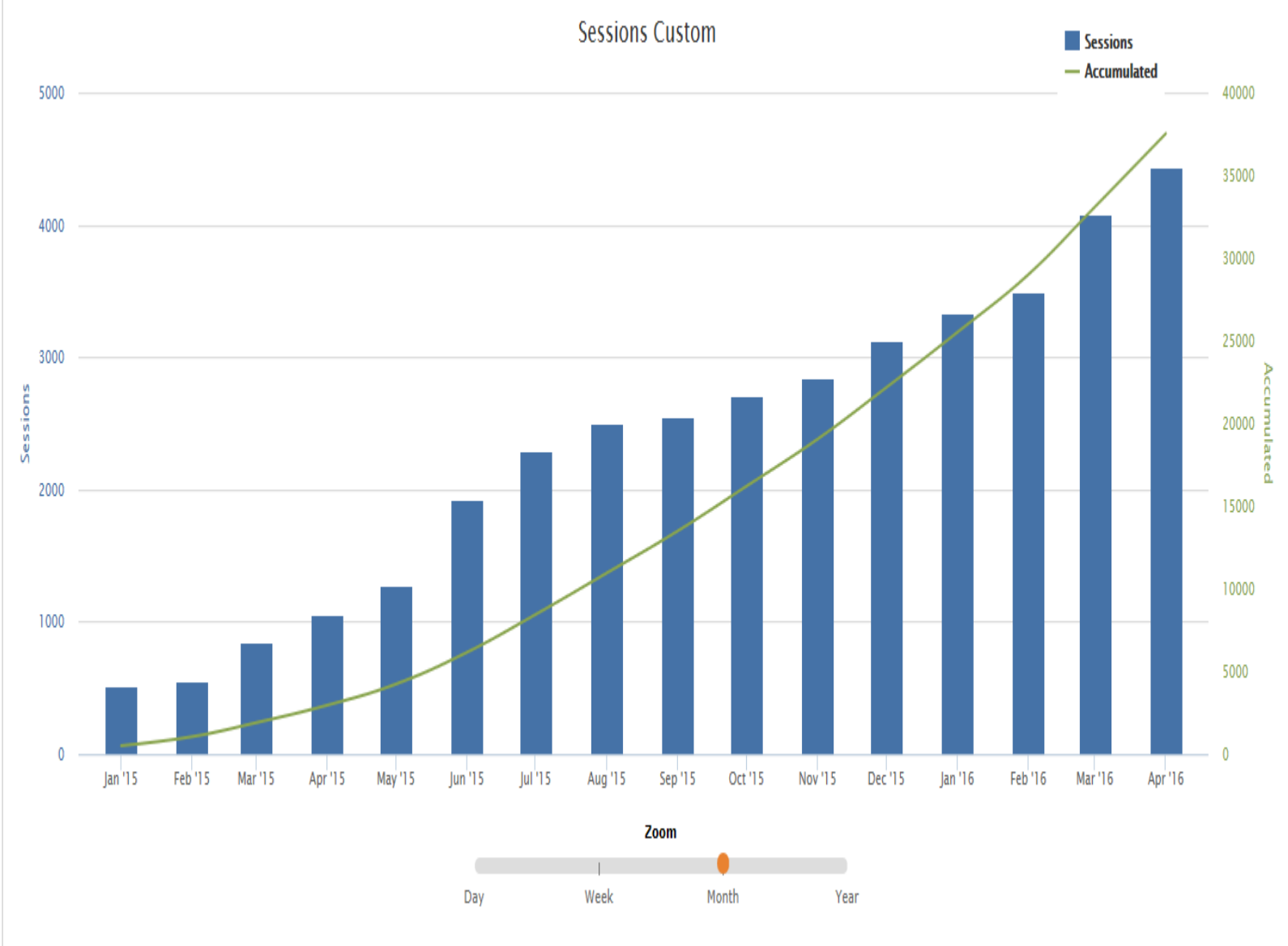
- 277/480 Three Phase
- (1) 200a Meter Socket
- (1) 200a Service Disconnect
- (1) 100a 3p Circuit Breaker per Charge Station (back)

Network Growth and Utilization

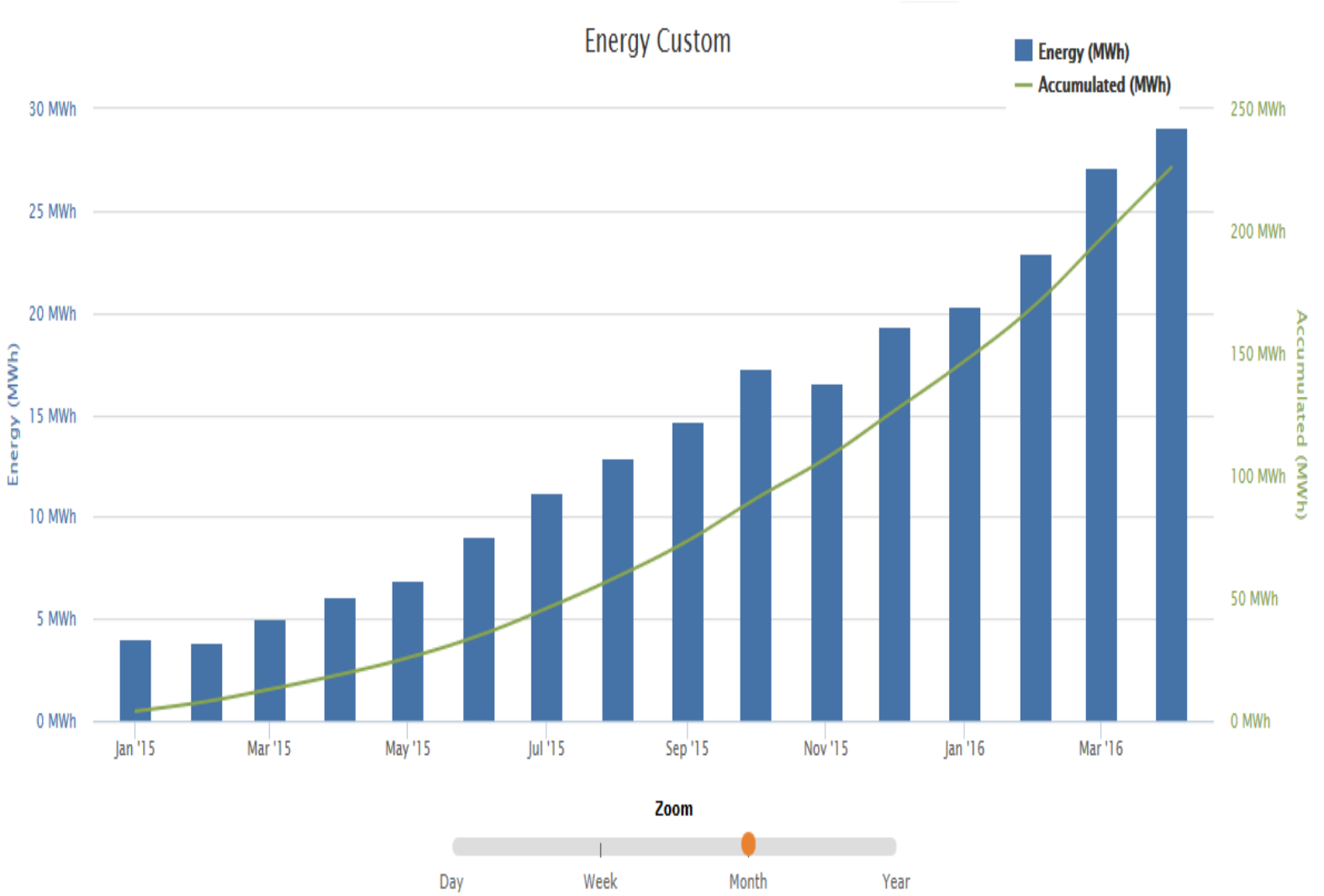
EV Unique Drivers - Monthly



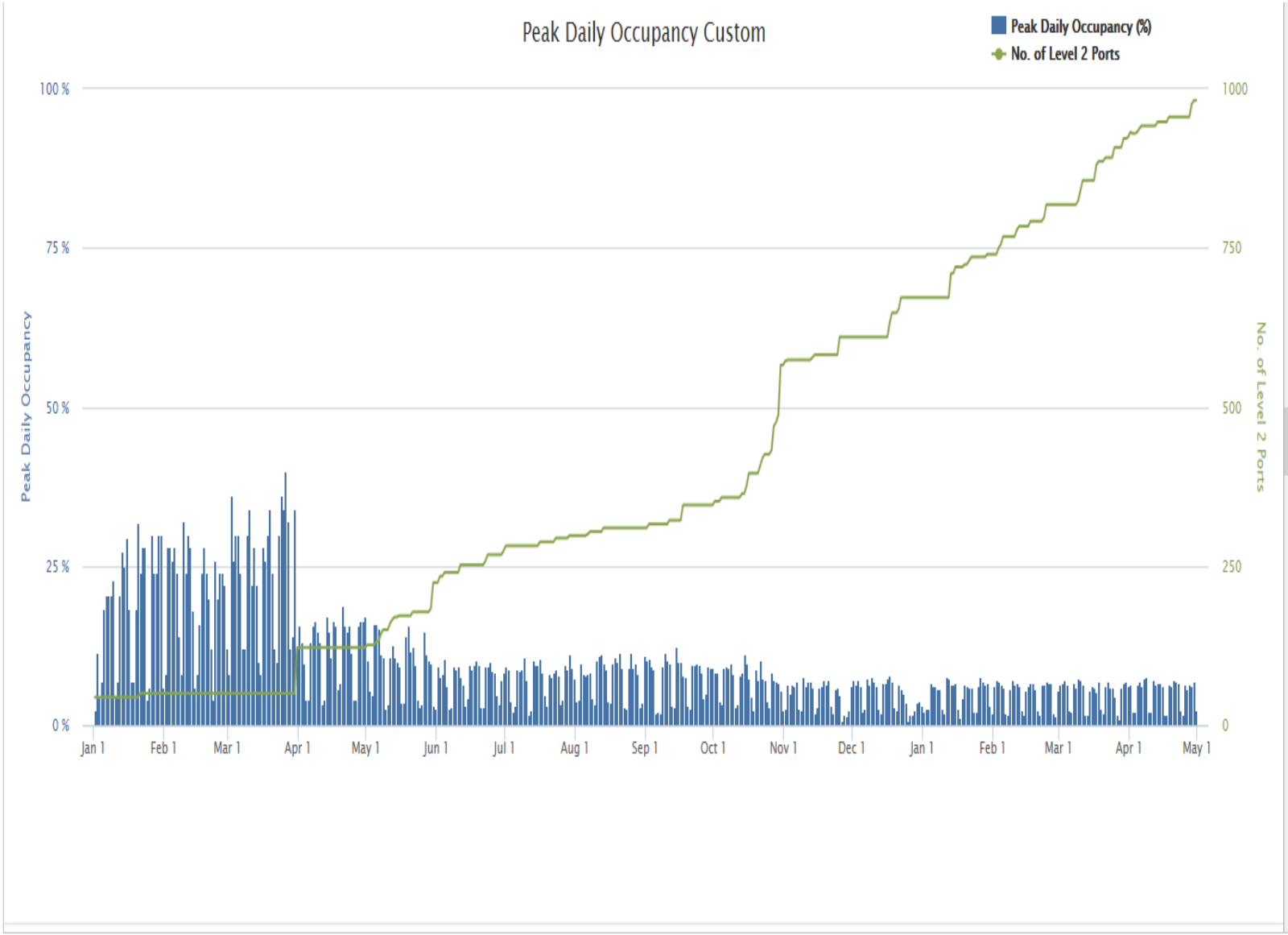
EV Charge Sessions - Monthly



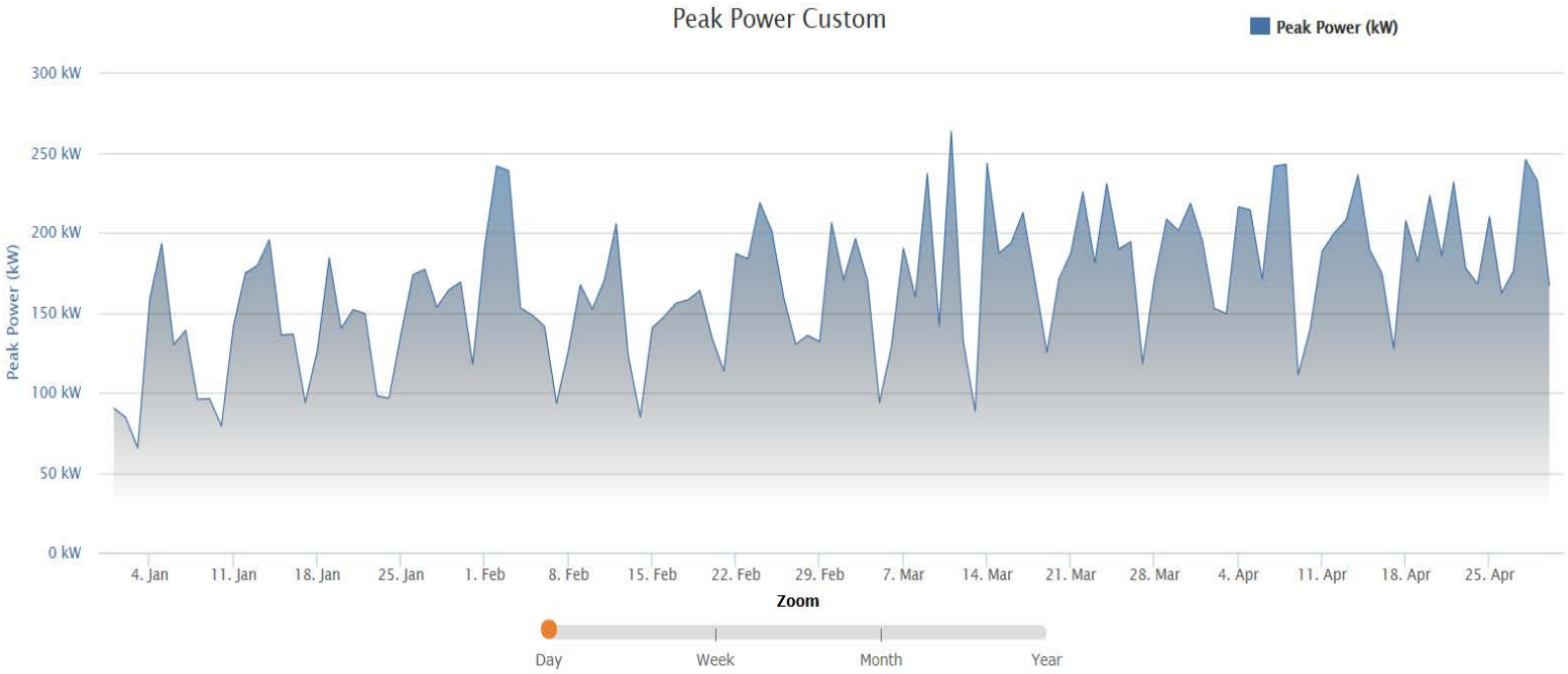
EV Charge Energy - Monthly



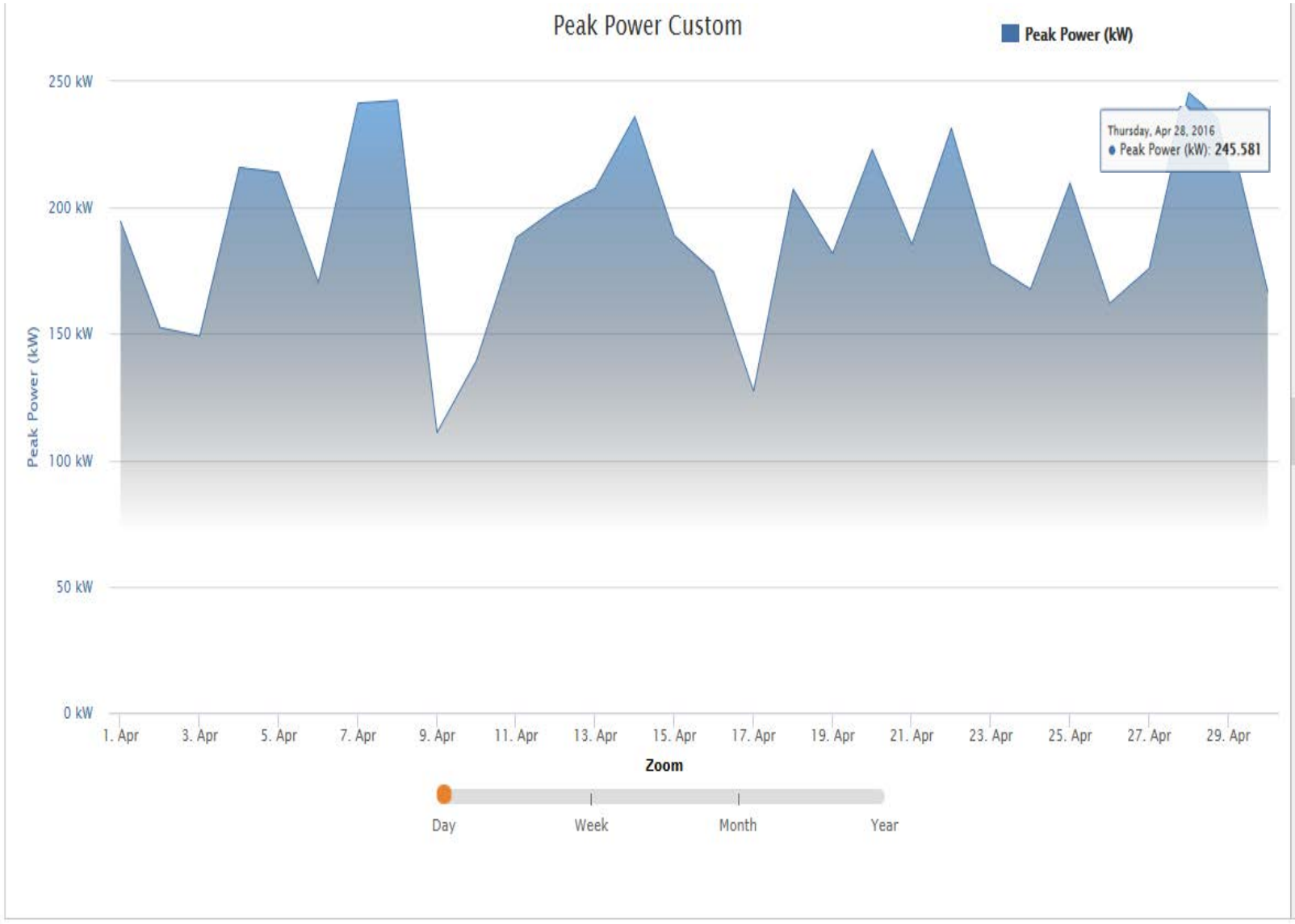
Station Occupancy - Daily



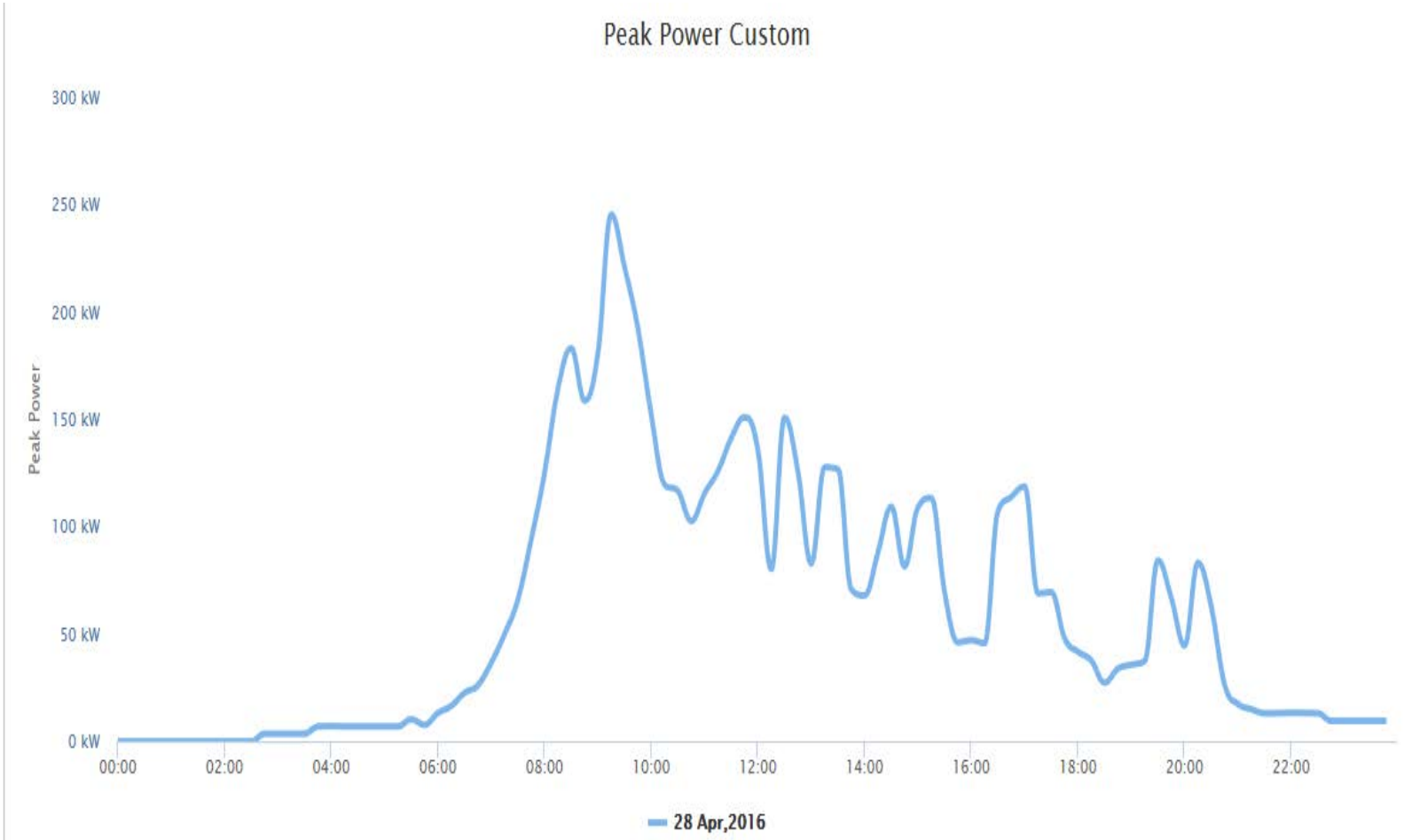
Peak Power – Daily Year-to-Date



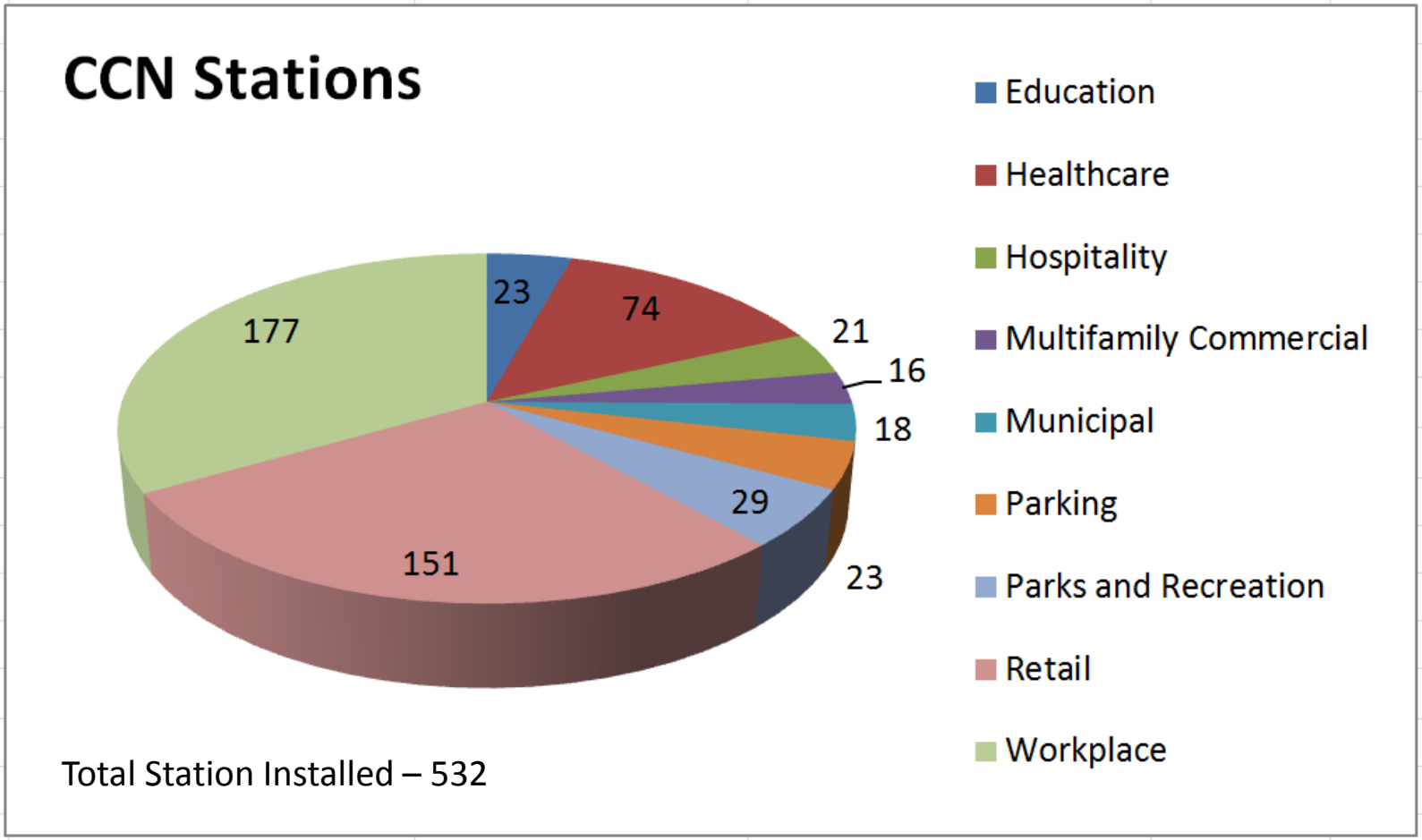
Daily Peak Power – April



Peak Day Charge Profile – April
All Stations

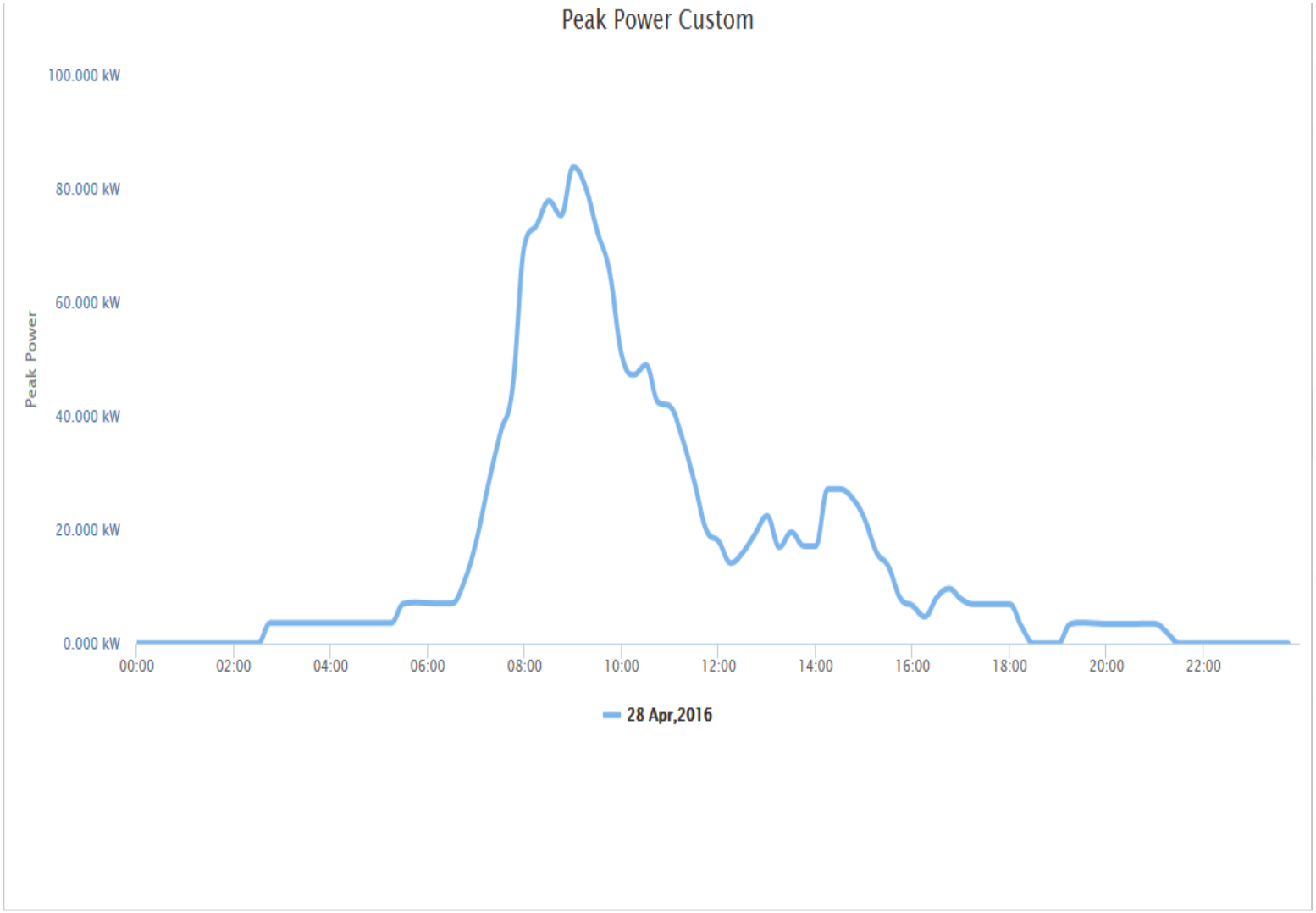


Charge Stations by Customer Type

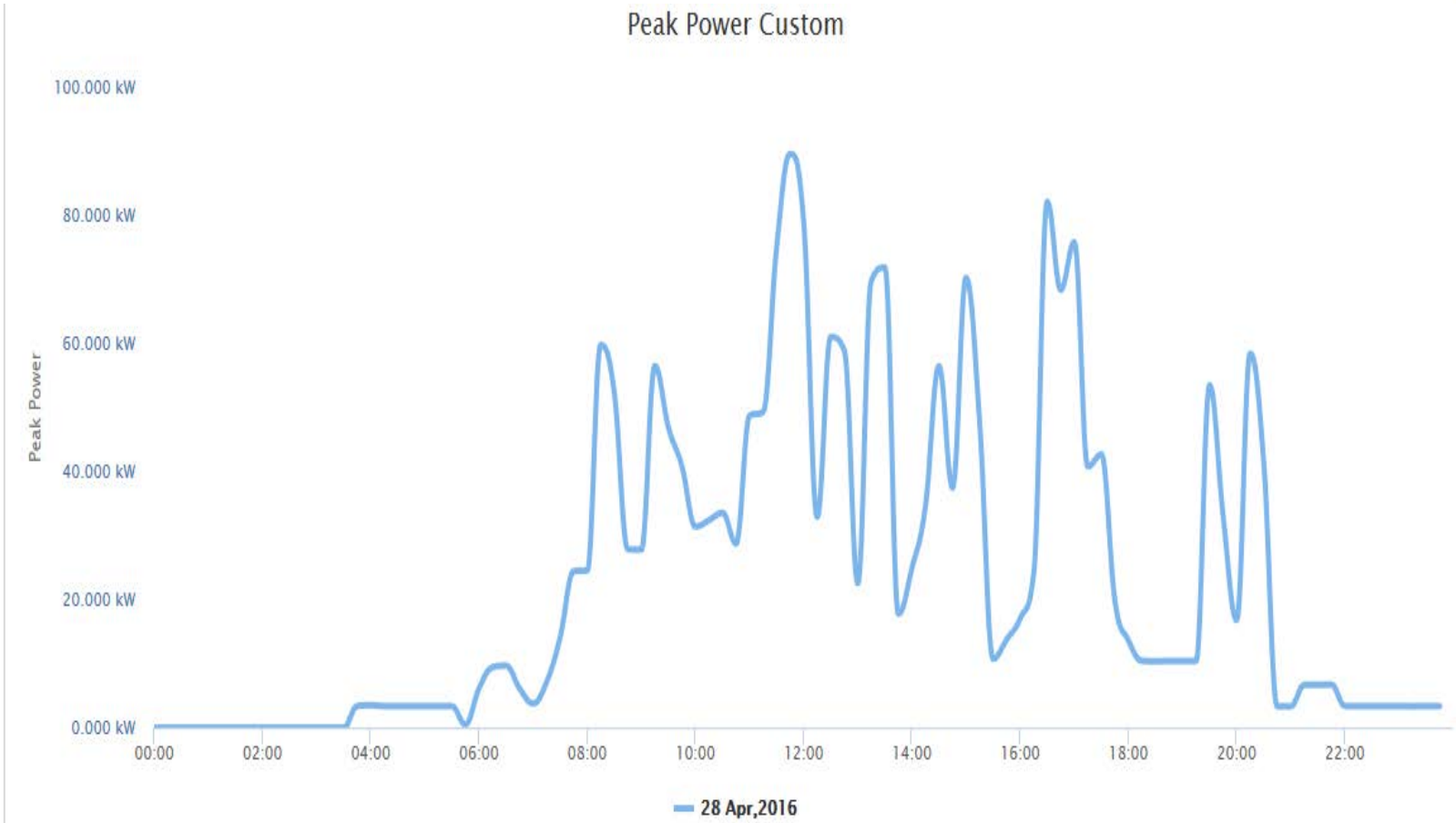


Total Station Installed – 532

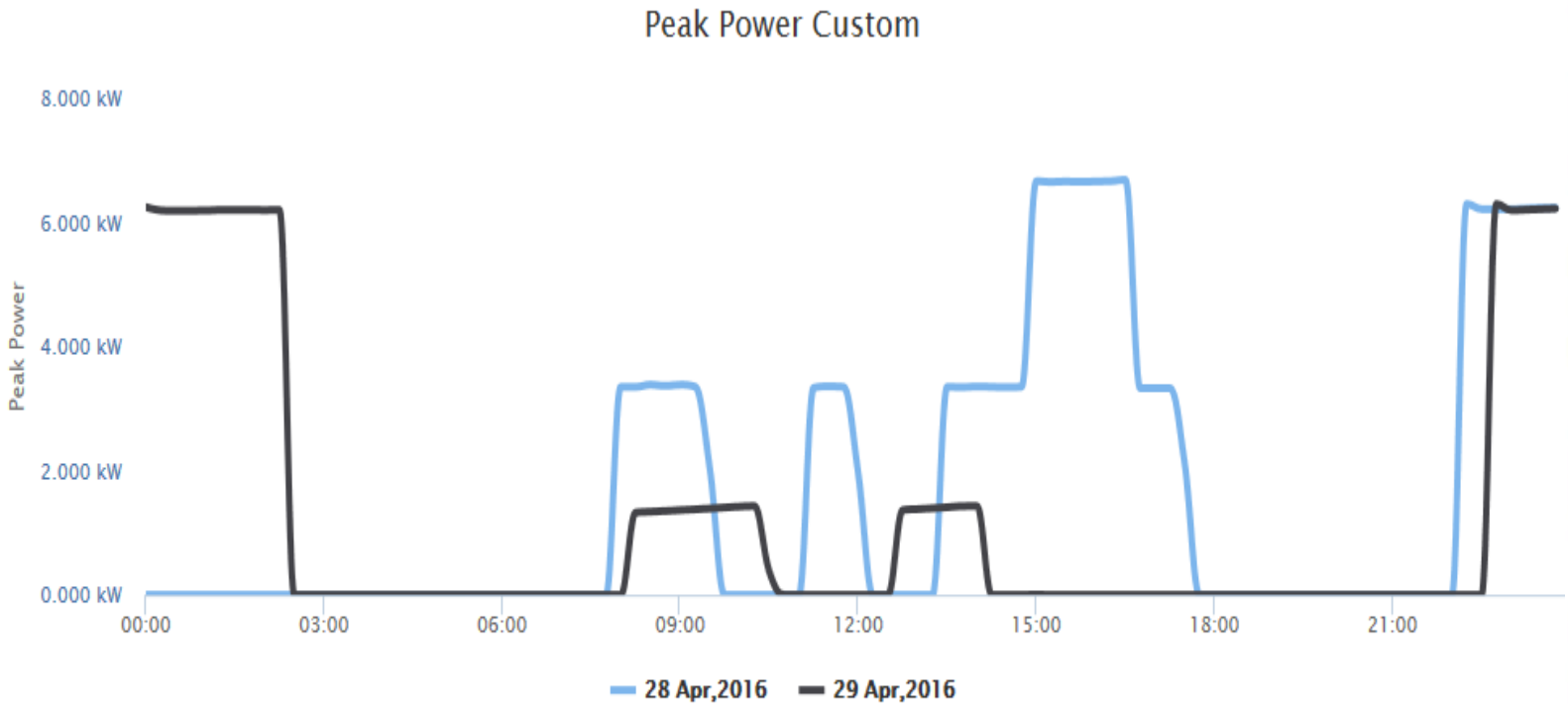
Peak Day Charge Profile – April Workplace



Peak Day Charge Profile – April Retail



Peak Day Charge Profile – April Multi-Family



KCP&L

cleancharge network