\Orchestrating a brighter world

NEC

Proposal

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Introduction

Problem

EV charging is not managed in commercial facilities
Customers plug their cars and expect to be charged as soon as possible
With growth of EVs, this practice will lead to high demand charges
On a larger scale, this might create peak demand problems for utilities
Utilities want more EV charging demand to improve revenue and absorb excess PV.

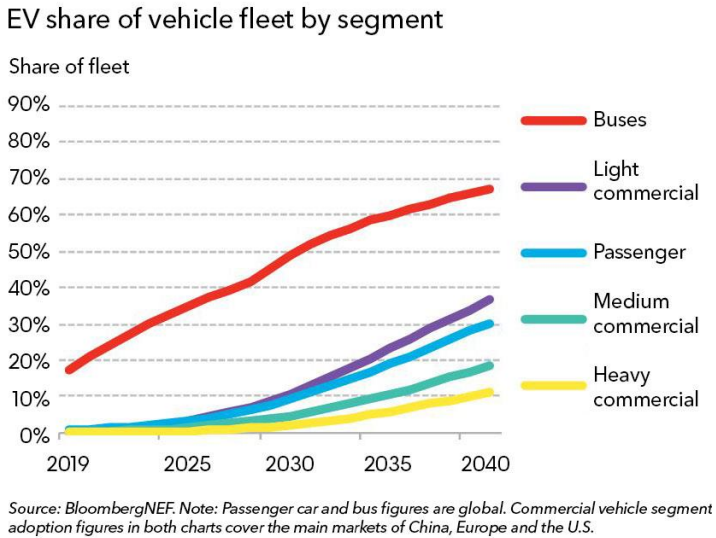
Solution

We introduce our BTM demand charge management approach to manage the charging of EVs for C&I customers to reduce energy bill. In phase **I** we aim to modulate EV charging infrastructure power consumption by intelligent dispatch of energy storage appliance. In phase **II** we aim to throttle the charge infrastructure itself, to manage its performance without any disruption.

Smart Charging of Electric Vehicles (EVs)

❑Why is Managed Charging of EVs needed?

- The power demand from the 20 million electric vehicles (EVs) expected to be on U.S. roads by 2030, up from today's 1.1 million, could overwhelm the nation's grids.
- An estimated 9.6 million EV charging ports will be needed by 2030, according to the Edison Electric Institute, but 2018's 1.2 million North American charging ports will grow ten times to over 12.6 million by 2027, according to Navigant.
- The U.S. has 482,217 EVs, according to Plug-in America, and there are 14,040 public charging stations and 35,006 charging outlets, according to the U.S. Department of Energy.
- Based on analysis of the evolving economics in different vehicle segments and geographical markets, BNEF's Electric Vehicle Outlook 2019 shows electrics taking up 57% of the global passenger car sales by 2040, slightly higher than it forecast a year ago. Electric buses are set to hold 81% of municipal bus sales by the same date



Source: BloombergNEF. Note: Passenger car and bus figures are global. Commercial vehicle segment adoption figures in both charts cover the main markets of China, Europe and the U.S.

Key Drivers:

(A) Charging Infrastructure ; (B) Incentives/Tariff ; (C) Battery Cost

Current Ecosystem

Energy Supply Provider (Utility)

- *Pacific Gas and Electric - Business model is based on selling energy*

EV Supply Equipment (EVSE) Providers

Comprehensive Guide

- *Chargepoint Inc – Business model is based on providing SI hardware and software and maintenance*

Network Service Providers

- *Business model is based on providing proprietary network to the EVSE*

End Users (Rate Payer)

- *Valley Transportation Authority*

(https://www.youtube.com/watch?v=l2XdkItkj-0&feature=youtu.be)

PG&E proposed tariff for Commercial EV charging

Proposed CEV rate structure

Subscription

Contract
Demand charge

1) Customers choose subscription level, based on charging needs

Subscription Charge: **$184** / 50 kW connected charging

Customers that want to **manage charging loads** can opt for a lower subscription level

2) Subscription remains consistent month-to-month

If site charging power exceeds subscription, customer pays an **overage** for that month

TOU Energy charge

3) Energy usage is billed based on time-of-day pricing

Energy Charge

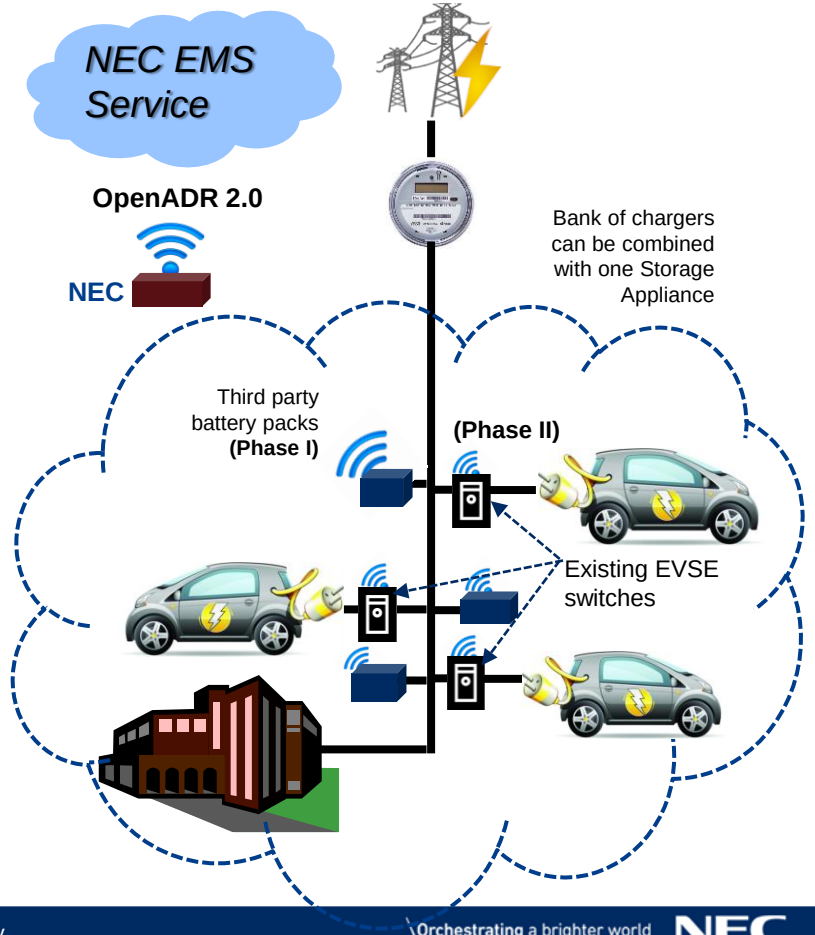
Charging is cheapest mid-day, when PG&E has higher levels of renewable energy generation

Customers should avoid charging during peak hours from 4-10 p.m., when possible

Notes: Values above represent CEV-Large secondary voltage rates. CEV-Small rate has a lower subscription charge ($25 per 10 kW connected charging)
-All rate values and proposals in this presentation are preliminary and should be considered directional. Rate proposals have not been approved by the CPUC.

Approach (How do we do it)

1. Forecast of
   - ✓ Demand
   - ✓ Battery usage (EV arrival/departure)
2. Rolling Dispatch of
   - ✓ Storage Appliance (Phase I)
   - ✓ EV Charging (Phase II)
3. Learn and Reduce
   - ✓ Demand Charge & Energy Charge (Phase I)
   - ✓ Battery Throughput (Phase II)
4. Customer
   - ✓ Rents battery (to own) and keeps saving



Managed EV Charging Solution Phases

Energy Management Service (NEC Cloud or AWS)

I. Intelligent dispatch of Storage appliance

- Storage-assisted management of EV charging
  - Partner with Storage provider

II. Intelligent of throttling of EV charging

- EVSE-assisted management of EV charging
  - Partner with EVSE provider

III. Aggregate V2G for Grid services (Future)

Strengths/Comparison (Why us?)

Strengths:

- Energy Storage Management Expertise
- Algorithms for demand charge reduction
- Understanding of modeling utility tariffs
- Deep Learning for forecasting demand
- OpenADR 2.0 implementation expertise
- Stochastic Optimization

Target problems in baseline State-of-Art

- *Existing methods use time-based scheduling.*
- *EV rate plan structure is complicated*
- *No forecasting or intelligent planning exists*

Current Validation

Results for BTM storage management and forecasting demonstrated at NECLA show

A) 25% better performance annually over competition year over year
B) Ability to work with any random load profile
C) Ability to include local generation if existing
D) Ability to manage local demand if allowed

Savings Analysis (1)

Assumptions

- Li-ion battery costs $200/kWh
- PCS and Balance of system installation is 50% of total cost
- Cost of software service setup is10%
  - Network/Cloud Service
  - Activation/Comissioning
- Total cost estimate for 25kWh/30kW system is $13k
- This can provide managed service to 5 L2 charging stations (<50% duty cycle)

Annual Savings : ~$3k
Payback Period : ~4 years

- Battery life can be guaranteed beyond 10 years
- Additional benefit can be obtained if switched to lower subscription plan due to storage appliance
- Results may vary due to best estimate size and usage

Savings Analysis (2)

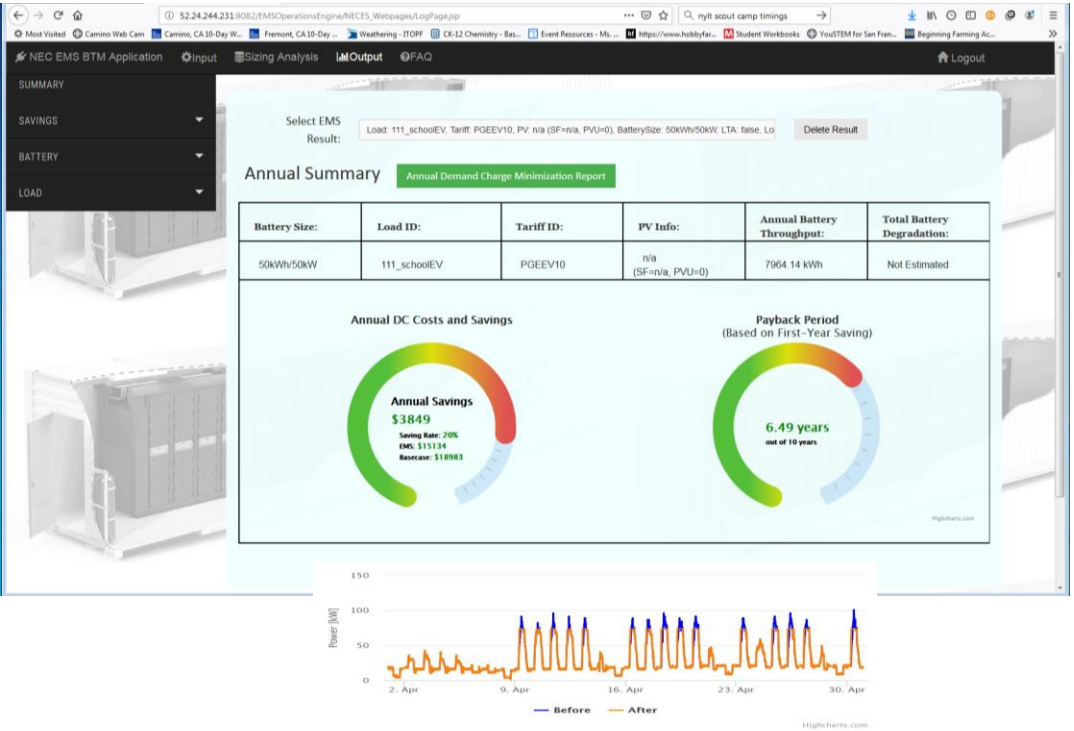
Assumptions

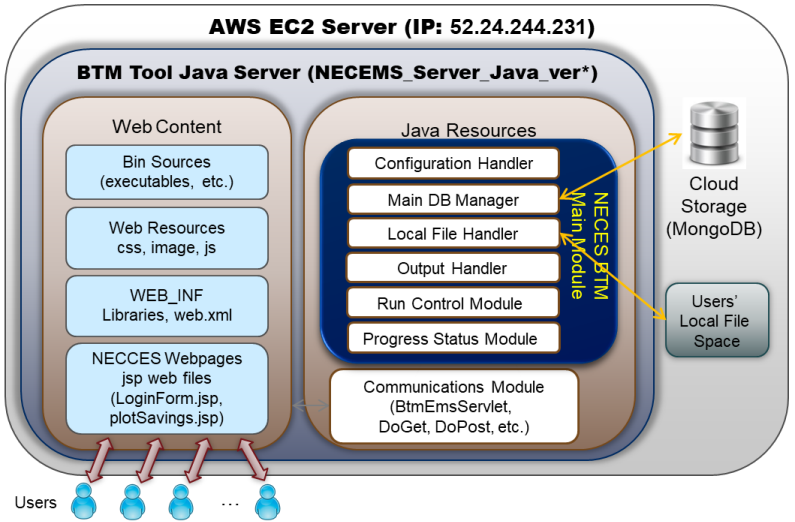
- Li-ion battery costs $200/kWh
- PCS and Balance of system installation is 50% of total cost
- Cost of software service setup is10%
  - Network/Cloud Service
  - Activation/Comissioning
- Total cost estimate for 50kWh/50kW system is $25k
- This can provide managed service for one or more L3 charging station

Annual Savings : ~$4k
Payback Period : ~6 years

- Battery life can be guaranteed beyond 10 years
- Additional benefit can be obtained if switched to lower subscription plan due to storage appliance
- Results may vary due to best estimate size and usage

C&I Customer Assessment Tool (*on AWS*)





http://52.24.244.231:8082/EMSOperationsEngine/LoginForm.jsp

How do we make money?

For smaller installation (L2)

- Rent out Energy Storage Devices with initial deposit fee
  - Customer to own after a fixed period
- Dispatch Service fee included in monthly rent

For Larger Installations (L3)

- Customer-owned
- Dispatch Service provided for a monthly fee with yearly contract (or loaded in the initial contract).

<u>Action Items:</u>
We should engage with Chargepoint approved installers/electricians for installation jobs
We should engage with energy storage partner as well to lease energy storage

Summary

- We propose a cloud-based active management system for EVs for C&I customers with guaranteed savings (unlike competition)
  - Using Energy Storage Appliance (Phase I)
  - Using Demand Management of Charging Infrastructure (Phase II)
- We already have a cloud-based customer assessment tool
- We have implemented OpenADR 2.0b in-house.
- We can use any third party storage device and guarantee life using our algorithm
- We can model different tariff structures in our algorithm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