NEDO Smart Community Demonstration Projects

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1. History and Trends on EV
1st EV Boom (1970’s)
Concerns over air pollution in large cities raised interest in EV
1971 MITI launched 5-year mega project joined by makers of auto/electronics/battery and other industries (Japan’s auto makers started EV development)

1980’s Superiority of EVs eclipsed by stable oil prices and technological advancement in emissions control of internal-combustion engines

2nd EV Boom (1990’s)
California’s strict rules for emission control urged auto makers to develop EV
1990 GM Impact first introduced at the Los Angeles auto show
1997 GM EV1 (lead-acid batteries) produced and leased to consumers
1999 Recall issued (defect reported) while GM EV1 with NiMH battery produced
2003 Recall issued on all EV1, GM withdrawn from EV production

3rd EV Boom (2010’s)
2009 Fast EV charger launched, Mitsubishi i-MiEV released
2010 Nissan Leaf released
Japan “Next-generation Vehicle Strategy 2010”: aiming to boost EV to 15-20% of all vehicles sold by 2020
US “One Million Electric Vehicle 2015”: aiming to sell 1 million EVs/PHVs by 2015
Germany aiming 1 million, Spain aiming 250 thousand
CHAdMeO, SAE Combo, EU Combo, China GB/T approved by IEC
2014 EV charger standard established and integrated
Chargers that satisfy both CHAdMeO and Combo standard globally spread

Today

GM EV1
Global Shift to EVs

- UK, France – committed to ban the sale of new conventional cars and vans by 2040
- Norway – set a goal that by 2025 all cars sold should be zero emissions
- China – set the 2019 NEV sales quota for auto makers
- California (USA) – tightened its ZEV regulation to give auto makers no credits for HEVs after 2018
- Asian countries (India, Bhutan, etc.) – announced a shift to EVs
- Volvo and other European auto makers – announced a shift to EVs
- Dyson, YAMADA-DENKI – announced a plan to build EVs
- Tesla – launched residential storage batteries (Powerwall) and a 100MW battery project in Australia in expectation of the mass production and subsequent price drop of EV batteries
Recent topics on EV

- Track EV shift
  - Tesla, Mitsubishi Fuso, Daimler, Volvo etc. plan to sell EV trucks

- High power output of fast charger
  - Ultra fast charger of 350 kW, 500 kW were introduced abroad. The CHAdeMO Council also plans to commercialize a high-output fast charger with an output of 350 kW.

- Battery exchange type EV
  - Taiwan Gogoro Inc. handles sharing services for battery-powered electric scooters in Taiwan.

- V2G (Vehicle to Grid)
  - Demonstration of supply and demand adjustment service (V2G) for electric power system utilizing EV have been developed in several countries. In Japan, several V2G demonstrations plan to be implemented under the METI VPP demonstration project.

- Unified standard of fast charging standard?
EV battery Sharing

- Gogoro, Taiwanese start-up develops and sells electric scooters and battery swapping infrastructure in Taiwan. Gogoro also provides electric scooter-sharing service in Berlin and France.

In Japan, Sumitomo Corp. announced to build a strategic partnership, plan pilot project in shigaki-jima, Okinawa in 2017 and would also expand to other cities in 2018 (press release on Sep. 28, 2017)

Gostations are located on gas station, convenience store, super market, MRT (subway) station…etc.

Source: press release..etc.
2. NEDO’s Demonstration Projects
Smart Community Demonstration PJ

Niedersachsen: Hybrid battery system (LiB + NAS)
Speyer: Self-consumption with PV, Battery, HP & cloud HEMS
Manchester: DR with Heat Pump
Lyon: PEB, EV Charging, Energy management, CMS
Malaga: Intra-city EV Charging System
Lysbon: Auto DR with air conditioning

Poland: Grid Stabilization with SPS
Slovenia: Integrated DMS
Sakha: Microgrid (Wind+DG+Battery)

Oshawa: Hybrid Inverter for PV + battery
California: Inter-city EV Charging System
California: Redox Flow Battery
New Mexico: Microgrid (Distribution Building, household)
Hawaii: EV load shifting, DR, VPP with smart inverter

Panipat: Smart meters and SCADA
Putrajaya: EV bus
Java: Factory power quality management
Indonesia: Mobile Battery Sharing
EV and EV Charging Infra related PJ

Lyon Task 2, France
40 Evs’ monitoring
EV Charging control to use RE

Maui, Hawaii, US
200 EVs and Charging System
EV load shifting, DR, V2G

Malaga, Spain
209 EVs monitoring
Inner-City EV charging infra

California, US
4,000 EV's monitoring
Inter-City EV charging infra

Putrajaya, Malaysia
12 EV buses and Super Quick Charging System
10 mins. battery charging cycle

Indonesia
A couple of hundreds EV bikes monitoring
Battery Sharing
Malaga EV Projects “ZEM2ALL”

- Involving more than 200 EV users, and measure, predict and control of EV user’s recharging behavior and EV’s recharging demand through navigation system (including a power management system to cope with large-scaled EV introduction.)

<table>
<thead>
<tr>
<th>[EV user]</th>
<th>[Charging Station Operator]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges: Anxiety about running out of Electricity. Support for EV and Charging.</td>
<td>Challenges: Optimum location of Public Charging Infrastructures</td>
</tr>
<tr>
<td>Demonstration: Big data analysis of EV users behavior and provide navigation services.</td>
<td>Demonstration: Analyze optimum location for Fast Charger based on the actual charging data.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>[EV Control Center]</th>
<th>[Utility]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges: Balancing the grid when more EVs are deployed</td>
<td>Challenges: New services of EV user using probe data</td>
</tr>
<tr>
<td>Demonstration: Analysis and prediction of EV charging Behavior and DR</td>
<td>Demonstration: Traffic flow monitoring with demonstration vehicle travel data.</td>
</tr>
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<tr>
<th>[Traffic Management Authority]</th>
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<td>Challenges: New services of EV user using probe data</td>
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<td>Demonstration: Traffic flow monitoring with demonstration vehicle travel data.</td>
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</tbody>
</table>
"ZEM2ALL" - Behavior Analysis of EV Drivers

- Average trip length per day in city area is less than 50 km.
“ZEM2ALL” - DR with Fast Charger

- If many EVs recharge at the same time during the peak time of regional electricity demand, it could lead to an overload on local grid. As a load leveling system, EV DR program was implemented with to change getting program points depending on the timing and place of recharging.

- Some private drivers changed their recharging action for incentive points. On the other hand, no effect was observed in our operation for business-drivers-group. The difference in price sensitivity between two driver’s category is clearly observed.

DR for EV charging, EV users are asked to shift the charging time or charging location.

### Trend in use of EV by user segment

![Graph showing trend in use of EV by user segment](image)

#### DR with Fast Charger

<table>
<thead>
<tr>
<th>Type</th>
<th>Registered participants</th>
<th>Individuals</th>
<th>Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down DR</td>
<td>+ 4.0%</td>
<td>- 16.2%</td>
<td>+ 14.2%</td>
</tr>
<tr>
<td>(DR to curb demand)</td>
<td>X</td>
<td>○</td>
<td>X</td>
</tr>
<tr>
<td>Up DR</td>
<td>- 4.0%</td>
<td>+ 16.2%</td>
<td>- 14.2%</td>
</tr>
<tr>
<td>(DR to stimulate demand)</td>
<td>X</td>
<td>○</td>
<td>X</td>
</tr>
</tbody>
</table>

Note) The marks ○ and × represent as follows:
○: It was considered that there was difference in selection probability with a certain level of significance (10%), indicating there was demand stimulating/curbing effect.
×: No demand stimulating/curbing effect identified in the demonstration.
# Maui Project “JUMPSmart Maui”

## Situation of Electricity

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>90 ~ 200 MW</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>30MW</td>
<td>72MW</td>
</tr>
<tr>
<td>Solar</td>
<td>2MW</td>
<td>94MW</td>
</tr>
<tr>
<td>EV</td>
<td></td>
<td>912 (2017)</td>
</tr>
</tbody>
</table>

- Maui Is.
- Oahu Is.
- Kauai Is.
- Hawaii Is.
"JUMPSmart Maui" - Shifting EV loads

- EV charging time is shifting from peak demand hours (18:00 – 21:00) to midnight.

State of charging of all EVs after implementing charging management

![Graph showing the state of charging of all EVs before and after shifting EV loads.](image)
DC Fast Charger has the effect of creating the demand during the day.
Without the DC Fast Charger, it is assumed that these charging needs would be shifted to the peak demand hours after returning home which further increases the load during peak demand hours.

DC Fast Charger usage during the demonstration PJ (Sep.2013 – Jul.2016)
EV discharge is implemented during the peak demand hours (18:00 – 21:00) to supply electricity to the grid (orange bar graphs indicates)

Charge/Discharge results on average (Oct. ~ Jan. vs Sept.)
Value of EV as DER

- Discharge during peak hours, 14 - 31% of an entire EV can be regarded as an effective energy resource.
- During daytime, only 2.1 – 3.9% can be regarded as the effective energy resource since few EVs are connected to the charger and most of the EVs standing by at home are nearly fully charged.

**Results of estimation of effectiveness of EV as an energy resource**

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>(B)</th>
<th>(C)</th>
<th>(D)</th>
<th>(E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge (peak hours)</td>
<td>6.0 kW</td>
<td>27 – 41 %</td>
<td>50 – 75 %</td>
<td>67 – 149 kW</td>
<td>14.0 – 31.0 %</td>
</tr>
<tr>
<td>Charge (nighttime)</td>
<td>5.4 kW</td>
<td>28 -43 %</td>
<td>30 – 70 %</td>
<td>36 – 130 kW</td>
<td>8.3 – 30.1 %</td>
</tr>
<tr>
<td>Charge (daytime)</td>
<td>5.4 kW</td>
<td>8 – 11 %</td>
<td>20 – 35 %</td>
<td>9 – 17 kW</td>
<td>2.1 – 3.9 %</td>
</tr>
<tr>
<td>Discharge (early afternoon)</td>
<td>6.0 kW</td>
<td>9 – 20 %</td>
<td>70 – 80 %</td>
<td>30 – 77 kW</td>
<td>6.3 – 16.0 %</td>
</tr>
</tbody>
</table>

Notes) “Remaining SoC” means the percentage of EVs that can charge and discharge during the intended time zero to serve as SoC. The results are on the assumption that an EV-PCS is able to output 6kW as per the output specifications.
The project "DRIVEtheARC" aims to demonstrate the expansion of the use of EVs by deploying DC fast chargers (55 chargers at 25 locations) near inter-city highways in the state of California, and change EV drivers’ “range anxiety” to confidence for their long distance drive.

The usefulness of charging station network has also been upgraded by a smartphone APP service that provides real-time information for EV drivers.
EV Bus in Malaysia

- The project aims to demonstrate EV Bus and Super Quick Charging System (320 kW), reliability of battery and bus drive system in the real operational condition, Cloud Monitoring for EV bus operation.
Mobile Battery Sharing System in Indonesia

The project aims to increase energy efficiency through utilization of Electric Vehicle and Mobile Battery Sharing.

EV users replace the battery charged at the battery exchanger (at a car dealer, Convenience Stores and so on), instead of connecting EV to a charger for charging. And Battery Management System with ICT will be built in the project.

Image of Demonstration Project
The Operational Experience of Sendai Microgrid in the Aftermath of the Great East Japan Earthquake
Japan – U.S. Collaborative Smart Grid Demonstration Project in New Mexico
Smart Community Demonstration in Malaga
Japan - U.S. Collaborative Smart Grid Demonstration Project in Maui Island of Hawaii State:
Smart Community Demonstration Project in Lyon, France
Smart Community Demonstration Project in Greater Manchester, UK