Electric Vehicles Aggregation Agents: a Business Opportunity

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EV Aggregation Agent

Concept

Intermediary between EV drivers, electricity market, distribution system operator (DSO) and transmission system operator (TSO)

The main reasons for the deployment of EV aggregators are:

- current market rules do not allow the individual participation of small loads (minimum bid is 5 MW)
- facilitates the interaction with the DSO for solving technical issues
- mitigates the forecast errors of EV load
- with an appropriate strategy, it can offer competitive retailing tariffs
EV Aggregation Agent: present or future?

"A diverse portfolio ensures reliability"
EV Aggregation Agent: present or future?

In the U.S. companies like EnerNOC and Comverge operate in a potential $4–5 billion market, managing demand response capacity of more than 30 GW

Wide Range of Services

- **Call center**
  - Work order generation
  - Customer tracking
  - Customer support
  - Accounts / customers
  - System topology
  - Rate & tariffs
  - Trouble ticketing

- **Dynamic pricing**
  - Event & device management
  - Constraints
  - Grid operations
  - MW tracking
  - Event reporting

- **M&V data**
  - Device metrics
  - Forecasting
  - Performance baselines
  - Device operations

- **Load analysis**
  - System forecasting
  - Customer analysis
  - Segmentation

Prospect analysis
Segmentation
Marketing
Channel management
Messaging
Acquisition tracking

Call center

Control strategies
Notification & alerts

System performance
Network performance
Device heuristics

Dynamic forecasting
Performance modeling
Grid impacts
Customer forecasting
Weather impact
Grid constraints
DMS dispatch
EV Aggregation Agent: present or future?

... and in Europe

Entelios is Germany’s first Demand Response Aggregator and has taken a market leading role in Europe.

Facts

- Founded 2010
- Services:
  - Demand Response Aggregation
  - Demand Response as-a-Service to utilities and TSOs
  - Intelligent Energy Efficiency Services
- Focus:
  Industrial, Commercial & Institutional
  load control & management
- Offices:
  Germany – Berlin and Munich.
  Development team in India.
Presently, EV Aggregators are start-up companies

V2G is a Proven Technology

- Spin-off of University of Delaware
- More than $2.5 invested in the solution
- Up to 9 Electric Vehicles aggregated over 24 months
- Achieved between $200 - $500 annual revenue per KW per vehicle in trial

The next step is to commercialize and scale the technology around the world.

Prof. Willett Kempton, Nuvve’s CTO has been working on this problem since 1996, looking for the most economic and ecologic solution based on Electric Vehicles
EV Aggregation Agent: present or future?

Other candidate companies for an EV aggregator are:

- **Better Place**: core business consists in a creation of an Electric Recharge Grid Operator
- **REIV2G**: aggregating EV for participating in the PJM and NYISO markets
- **Coulomb Technologies**: with their Chargepoint network is capable of aggregation
- **Intel**: developed an intelligent energy management system for EV (with aggregator)
Objective

Develop a business model, optimization and forecasting algorithms for the participation of an EV aggregator in the electricity market
Bussines Model of an EV Aggregator

- Three type of clients are envisioned
  - **flexible**: direct control of the charging process
  - **inflexible**: no direct control, simple retailer
  - **mix**: inflexible when plugged-in to public and fast charging stations; flexible in slow charging points (e.g., household)

- The aggregator offers cheap charging tariffs to flexible clients
- Inflexible clients pay a normal tariff that can be competitive for attracting new clients
- The vehicle-to-grid (V2G) mode is not considered
  - a operating point is defined \( P \) (purchased electrical energy)
  - upward reserve: \( P - P_{up} \)
  - downward reserve: \( P + P_{down} \)
- The aggregator supports all the financial costs of deviations from market bids (i.e., takes all the risk)
Bussines Model of an EV Aggregator

- The fundamental goal is to keep the driver’s autonomy
- The contract with the aggregator establishes the following:
  - the driver when parks for charging defines the target SOC and charging completion hour
  - a default profile is defined for the availability period (e.g., 6 hrs) and target SOC (e.g., 100%)
  - the EV is completely free to arrive for charging and depart before charging completion
  - use the minimum information about the driver

SOC\text{\textsmaller{(ini)}}=50\% \quad (10 \text{ kWh})
\quad \downarrow
21:30
SOC\text{\textsmaller{(end)}}=100\% \quad (20 \text{ kWh})
\quad \downarrow
8:30

(1) Availability Period
(2) Charging Requirement = 11.11 \text{ kWh} 
(90\% of charger efficiency)
Electricity Market Opportunities

- Participation in the electrical energy market
  - control the charging process for decreasing the wholesale costs

- Participation in the manual (tertiary) reserve market
  - downward reserve is cheap charging, upward reserve is profit from reducing consumption

- Participation in the automatic (secondary) reserve market
  - receive a payment for being in standby as reserve capacity
PhD Thesis Framework

**Input Information**

- Day-ahead Forecasting
- Market Variables
- EV Variables

**Market Processes**

- Manual Res. Market
  - co-optimization
- Day-ahead Elect. Energy Market
  - co-optimization
- Day-ahead Automatic Res. Market

**Short-term (day-ahead)**
PhD Thesis Framework

**Input Information**

- **Day-ahead Forecasting**
  - Market Variables
  - EV Variables

**Market Processes**

- **Manual Res. Market**
  - Co-optimization
- **Day-ahead Elect. Energy Market**
  - Co-optimization

**Short-term (day-ahead)**

- **Transmitted Information**
  - From Plugged-in EV
- **Hours-ahead Forecast**
  - Market Variables

**Very short-term (hours-ahead)**

- **Hour-ahead Manual Res. Market**
- **Intraday Market (Europe*)**

**Real-time Market (US)**

- **EV Aggregation Agents**
- **PhD Thesis**
- **Framework**

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PhD Thesis Framework

Input Information

Day-ahead Forecasting
Market Variables
EV Variables

Market Processes

Manual Res. Market
Day-ahead Elect. Energy Market

Day-ahead Automatic Res. Market

coop-optimization

OR

Hour-ahead Manual Res. Market

Intraday Manual Market (Europe*)

Transmitted Information
From Plugged-in EV

Hours-ahead Forecast
Market Variables

Hours-ahead Forecast
EV variables

Real-time Market (US)

Actual Charging Decisions (operation hour)

Operational Management
Dispatch the EV for the operating hour

Transmitted Information
From Plugged-in EV

Hours-ahead Forecast
Market Variables

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Results for Two EV Fleets

Participation in the electrical energy market (Portugal)

Breakeven Tariffs

<table>
<thead>
<tr>
<th>Flexible Clients</th>
<th>Inflexible Clients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet A</td>
<td>0.033 kWh</td>
</tr>
<tr>
<td></td>
<td>0.045 kWh</td>
</tr>
<tr>
<td>Fleet B</td>
<td>0.035 kWh</td>
</tr>
<tr>
<td></td>
<td>0.042 kWh</td>
</tr>
</tbody>
</table>

+ participation in the manual (tertiary) reserve market (Portugal)
The aggregator is important for several stakeholders:
- is financially attractive for EV owners (is the *hard worker*).
- offers controllability and ancillary services to system operators.
- promotes the full participation of demand-side resources in the electricity market.

This thesis covers only one part of the business, and the mid and long-term horizons are also important:
- marketing strategies.
- determination of retailing tariffs value and schemes.
- participation in financial markets.

The ideas and models from this thesis can be adopted by aggregators of other types of flexible loads.
Acknowledgements

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