Integration of charging systems for electric vehicles towards smart-grid

Massimo Trioni
Mantova, 14th October, 2013
Summary

1. A2A in a glance

2. E-moving: project scope and description

3. E-moving: the results

4. EV charging system vs smart grid

5. Conclusion
A2A at a glance

A2A is the **main municipal utility company** in Italy

EBITDA 2012: 1.068 M€

**H1 2012**

- Waste: 29%
- Energy: 34%
- Networks: 28%
- Cogeneration and District Heating: 9%
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E-moving’s scope

E-moving is one of the two biggest pilot E-mobility tests in Italy

Conceived in one the most polluted urban areas in Italy (Lombardia), E-moving represents a complete E-mobility system aimed to:

1. Demonstrate that such a system can work
2. Test existing and new components
3. Find out facts and limitations for each component roll out
Electric vehicle advantages

Car with thermic motor (TC) VS Electric Vehicle (EV)

- Zero local emissions
  -\( \text{CO}_2 \), NOx, Benzene, PMI
- Zero acoustic emissions
Why Zero Local Emissions?

Because Electrical Energy must be produced!
How to introduce a new technology?
A2A “E-moving” the system made

Private & public companies (24..)

Project creator and coordinator

220 Charging Points:
100 Public 120 Private

47 EVs for more than 9 months test each

Milan Authorization & testing

Brescia

AEEG: Regulatory Authority Incentives on public grid

This information was prepared by A2A and it is not to be relied on by any 3rd party without A2A’s prior written consent.
Actual “E-moving” Architecture

Other Ancillary services

- Car website
- Navigation service
- SMS service
- etc.

Control Center

WEB Center

User interfaces

GSM/GPRS

Modem

Column
(N. 2 Charging Points)

Wall box
(N. 1 CP)

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The EV charging infrastructure
Column (Double Charging Point)

- MENNEKES
  - 220 V – 16 A
  - 380 V – 32 A
  For Medium fast charge

- Free SCAME 220 V – 16 A

- Automatic sockets protection

- Automatic resettable RCD and Thermal circuit breaker protections

- RFID card

2 Independent power lines and EE meters

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Wall box (Single Charging Point)

FREE SCAME
220 V – 16 A

MENNEKES
220 V – 16 A

RCD and Thermal circuit breaker protections
RFID card reader

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Public infrastructure layout

Milan active 32 Columns

Fast charge
(30 kW/poles)
Max 22 kW/CP

Brescia 18 active Columns

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Charging modes definition

STANDARD CHARGE (3kW/CP): 24 kWh - 8 hours in AC

- 6 kW/pole (3 kW/CP)
- Overnight charge

QUICK CHARGE (22 kW/CP): 24 kWh – 1.5 hours in AC

- < 30 kW/Pole (max 22 kW on a CP)
  - Meter configuration
- 30-40 kW/Pole(20 kW/PR)
  - Meter replacement

Half charge in lunch time

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Charging mode definition

FAST CHARGE: 24 kWh in < 30 min in AC/DC

Over 50 kW/CP
- New poles technology required,
- High investments,
- Few available cars,
- No standards

Half charge In a coffee break

We are thinking about it!

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Cars tested in Brescia at 16-09-2013

Jan 2011 – Jan 2013

Long Test
9-12 months

N. 16
RENAULT KANGOO ZE

N. 5
RENAULT FLUENCE ZE

Short Test
15 days

RENAULT ZOE
15 days Feb 2013

Peugeot ION
14 days Ott 2011

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## TEST RESULTS SUMMARY

### RESULTS (APR 2011-FEB 2013)

<table>
<thead>
<tr>
<th></th>
<th>N.</th>
<th>km</th>
<th>kWh</th>
<th>[km/kWh]</th>
<th>Avarage path [km/gdu]</th>
<th>Autonomy km (*)</th>
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<tbody>
<tr>
<td><strong>Brescia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kangoo ZE</td>
<td>16</td>
<td>107.471</td>
<td>26.729</td>
<td>4.02</td>
<td>45 km</td>
<td>105 km</td>
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<tr>
<td>Fluence ZE</td>
<td>5</td>
<td>30.372</td>
<td>8.919</td>
<td>3.41</td>
<td>41 km</td>
<td>104 km</td>
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<tr>
<td>Peugeot ION</td>
<td>1</td>
<td>857</td>
<td>129</td>
<td>6.62</td>
<td>66 km</td>
<td>106 km</td>
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<tr>
<td>ZOE</td>
<td>1</td>
<td>1.528</td>
<td>299</td>
<td>5.11</td>
<td>102 km</td>
<td>130 km</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23</td>
<td>140.228</td>
<td>36.077</td>
<td>3.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Estimated value calculated at nominal battery capacity

Weighted Average
Charging Time vs medium Power kW

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Public infrastructures usage

From Sep 2011 RFID cards for public charging on sale

- special offer 25 €
- 10 € for card emission+
- 15 € flat tariff for 3 months

201 RFID cards active

- 18 scooters + 48 Quadricycle + 135 cars/van

30,000 kWh/y for self consumption 2013

80,000 kWh EE sale expected for 2013
What business for public charging?

- Public infrastructures requested but little used
- They represent a “public service”
- They should be used more when cars with fast charge will be available
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EV Charging vs smart grid

2 possible choices?

STORAGE

Car batteries to support grid stabilization

POWER CONTROL

Real time EV charging Power control

What’s our opinion based on the experience made?
STORAGE POINTLESS

• Poor capacity (max 25 kWh) compare to grid needs
• Car users want to be always ready to go and they are ready to pay for it
• If you use a small amount of total battery capacity (i.e. 20%) effect on the grid is even lower
• Energy losses in every EE trasferring
• Every charging process is battery lifeconsuming
• Most charging take place in night and evening
• Most car usage happen in daytime
POWER CONTROL a viable answer

- to avoid EE overload during home EV charge
- Minimize total power engaged in public Master-slave EV infrastructure configuration
- modulate the Power used for Public charge according to grid power availability
SMART GRID CONFIGURATION
FOR PRIVATE AND PUBLIC
E.V. CHARGING
A2A idea for Charging E.V. in a private smart grid contest

PV+storage  Heat pump  Heat storage

Building Energy Management  Secondary Grid management

Real time  Adjustable Power supply according to the home load and grid request

Sensors

Private E.V. Smart charge

App For final customer

WEB

Info Panel

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A2A idea for Charging E.V. in a public smart grid contest

Pole Control system

Secondary Grid management

Real time Adjustable Power supply 0..30 kW to the customer and grid need

Public E.V. Smart charge (Pole)

WEB

App For final customer

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Thank you
Conclusions

Which is the main key determinant for Mobility system roll out?

FIXED COSTS!!!

1. An EV must cost as much as an equivalent ICE one
2. Private infrastructures must be as cheap as possible
3. Public infrastructures offer a social service. They must be developed, must be interoperable, smart and allow quick/fast charge. Their cost must be supported.
4. Ancillary services could be sold
5. Smart grid services must be useful (in terms of efficiency, info, and lead to save money
**Extras**

*EV vs ICE (Cost analysis)*

Renault ZE

Renault Kangoo Express dCi.75 CV

Renault Kangoo 1.6 16V 5p. Benz..Methane Confort
Costs EV vs Thermic cars

Hypotesis:

1. **kangoo** ZE vs Equivalent standard version
2. Real consumption (data from E-moving test and our own standard van)
3. No extraordinary maintenance and non inflation considered
4. Vehicles used in same conditions (mainly urban path)
5. EV totally payed at the beginning (no leasing)
6. Incentives considered
7. Battery and EV charging infrastructure costs included
Elettric vs Thermic

Total cumulated cost Kangoo

- Elettrico
- Gasolino
- Metano

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# EV vs ICE overall costs

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>EV</td>
<td>Diesel</td>
</tr>
<tr>
<td>km/year</td>
<td>10.000</td>
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<tr>
<td>Average consumption</td>
<td>4.02 km/kWh</td>
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<tr>
<td>Fuel specific cost</td>
<td>0.18 €/kWh</td>
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<tr>
<td>Vehicle cost</td>
<td>20.000</td>
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<tr>
<td>Incentive</td>
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<td>Battery rental [€]</td>
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<td>Wall box cost [€]</td>
<td>1.100</td>
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<tr>
<td>Fuel cost [€]</td>
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<tr>
<td>Property Tax [€]</td>
<td>0</td>
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<tr>
<td>Insurance [€]</td>
<td>750</td>
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<tr>
<td>Maintenance [€]</td>
<td>250</td>
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<tr>
<td>Total yearly cost [€]</td>
<td>18.508</td>
</tr>
</tbody>
</table>

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Elettric vs Thermic

What’s missing in the economic analysis?

1. Economic value for gas emissions reduction
2. Image advantage for companies that use EV
3. No fee to pay to access downtown (Ex. Milan)
4. No fee for parking and free access to limited access areas
5. Individual wellness to get an EV as a luxury optional