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The FABRIC project in the Electromobility context

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Proven solutions driving user services

Electromobility

Aim: Large-scale adoption of electric vehicles by the consumers in order to reduce greenhouse pollutants and provide the means for even wider implementation of smart grids.

Grid benefits:

- Utilization of the vehicles as distributed energy storage, opening new horizons in decentralized energy storage and management;
- Renewable energy sources integration to the transportation and greater penetration limits since EVs may provide a huge energy buffer > increased grid stability;
- Bi-directional power transfer making the operation of the smart grid more secure and flexible. Each EV can be considered as a decentralized energy storage system;
- Reduction of energy market costs via supply/load shaping.

Electromobility

Environmental benefits:

- Minimization of EV produced air pollutants;
- Benefits increase with the cleanliness of the power production process;
- RES-produced energy, consumed by EVs maximizes benefits;

Societal benefits:

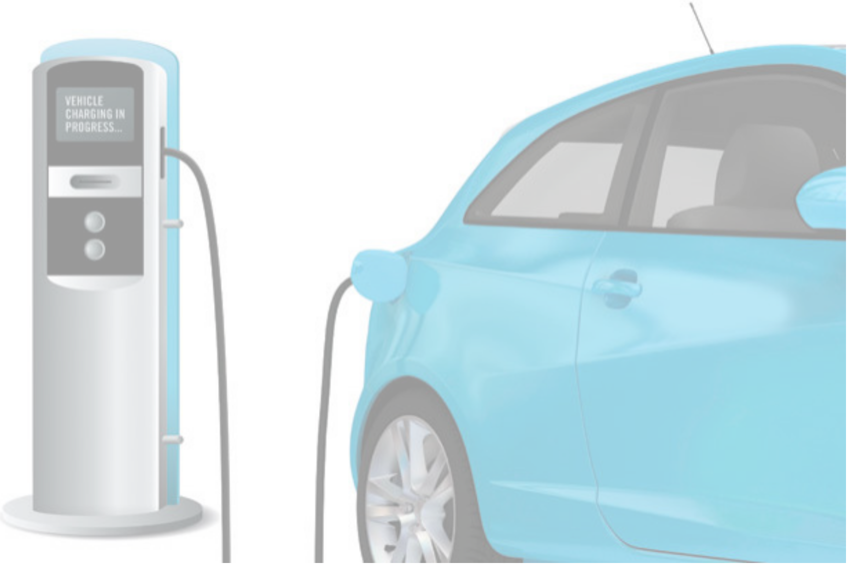
- Cleaner city air > better quality of life, reduction of hospitalizations.
- Quieter vehicles

Large-scale economic benefits:

- Industrial and employment boost
- Reduction of climate change catastrophic phenomena, that cost billions.

Electromobility in numbers (I)

EVs as percentage of the whole fleet:



- France 0.83%
- US 0.62% (96000 sold in 2013)
- Japan 0.59%
- Germany 0.25% (7400 sold in 2013)

Current penetration of EVs very small. Reasons:

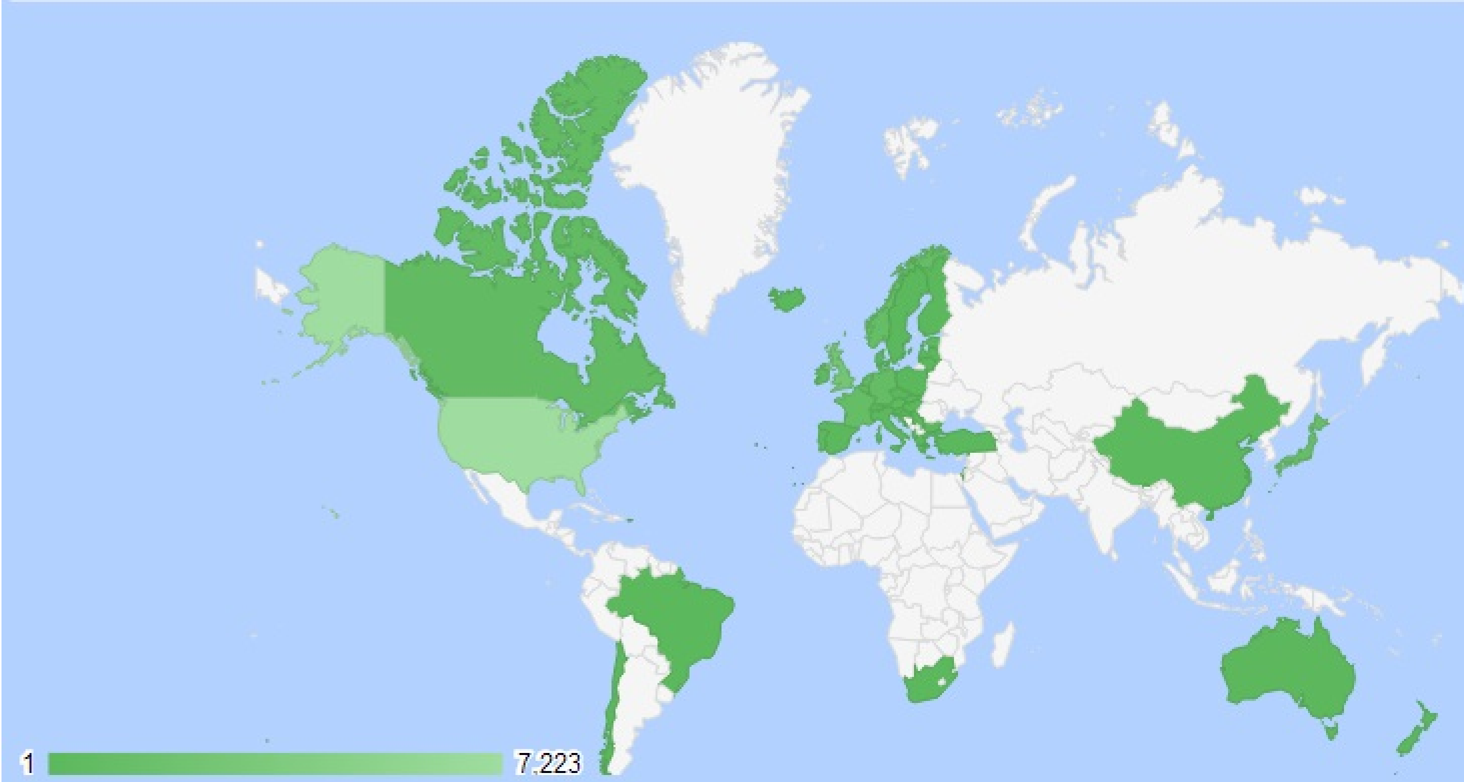
- Weight and size of batteries.
- Cost of battery manufacturing.
- EV price premium over conventional vehicles.
- Small or non-existent charging infrastructure network.
- Long duration of charging.
- Plugging the EV in is not a user friendly experience.

Electromobility in numbers (II)

opencharge map.org/site/

United States: 7223 United Kingdom: 2635 Japan: 1300 Norway: 966 France: 964 Netherlands: 902 Germany: 853 Canada: 607 Austria: 514 Ireland: 383 Belgium: 333 Portugal: 295 Hong Kong: 186 Estonia: 152 Italy: 135 China: 121 Australia: 76 Switzerland: 62 Monaco: 36 Luxembourg: 29 Malta: 22 Hungary: 20 Bulgaria: 17 Denmark: 16 Poland: 15 Lithuania: 10 Spain: 9 Greece: 7 Slovakia: 5 Turkey: 5 Croatia: 4 Finland: 4 Iceland: 4 Brazil: 2 Isle Of Man: 2 Slovenia: 2 South Africa: 2 Albania: 1 Aruba: 1 Barbados: 1 Bermuda: 1 Chile: 1 Czech Republic: 1 Israel: 1 Latvia: 1 New Zealand: 1 Puerto Rico: 1 Serbia: 1 Sweden: 1

28701 charging stations across **17930** locations.



Strategic initiatives internationally to promote electromobility

- **ASIA**
  - China, Japan, Korea: government incentives, regulations promoting awareness and adoption of EVs.
  - Toyota, Nissan, Honda, Mitsubishi joint development of charging infrastructure. Target: 8000 new normal chargers, 4000 new fast chargers.

- **NORTH AMERICA**
  - The US Transportation Electrification Program represents the world's largest EV demonstration project. $400 million funding. Target: 1 million plug-in EVs by 2015.

- **EUROPE**
  - 2013 European Parliament resolution requiring member states to install a specified number of EV charging stations and hydrogen and natural gas stations by 2020. Targets: Germany 86000, Italy 72000, UK minimum of 70000.
  - Several national projects: Fastned (NL), ELMO (EE), CLEVER (DK)…

EV charging approaches (I)

Static

- Example application scenarios:
  - Car parking in a garage or car park.
  - Bus parking at a bus terminus or station.
  - Freight vehicles while loading or unloading.

Parameter	Range	Comments
Vehicle speed (km/h)	0	Mode applicable if stationary for longer than 5 minutes
Vehicle acceleration (m/s^2)	N/A	
Transmitted power level range (kW)	3 to 50	Similar to existing plug-in charging solutions and wireless charging solutions
Power transmitted to which component	N/A	Power transmitted to the vehicle on-board energy storage system only
Charging time (minutes)	>5	Upper limit of charging time is subject to use, power rating and vehicle on-board energy storage system capacity
Vehicle status	N/A	Vehicle engine / power will generally be off during charging (but may be on for a short time while initiating coupling / charging process)

EV charging approaches (II)

Stationary

- Example application scenarios:
  - Taxis queuing in a taxi rank
  - Bus stopping at bus stops
  - Vehicles stopping at junctions, rail level crossings, etc… .

Parameter	Range	Comments
Vehicle speed (km/h)	0	Mode applicable if stationary for less than 5 minutes
Vehicle acceleration (m/s^2)	N/A	
Transmitted power level range (kW)	20 to 200	Similar to existing fast and rapid charging solutions (plug-in and wireless)
Power transmitted to which component	N/A	Power transmitted to the vehicle on-board energy storage system only
Charging time (minutes)	<5	Upper limit of charging time is subject to use, power rating and vehicle on-board energy storage system capacity
Vehicle status	N/A	Vehicle engine / power can be on or off depending on the vehicle powertrain control and exact application

EV charging approaches (II)

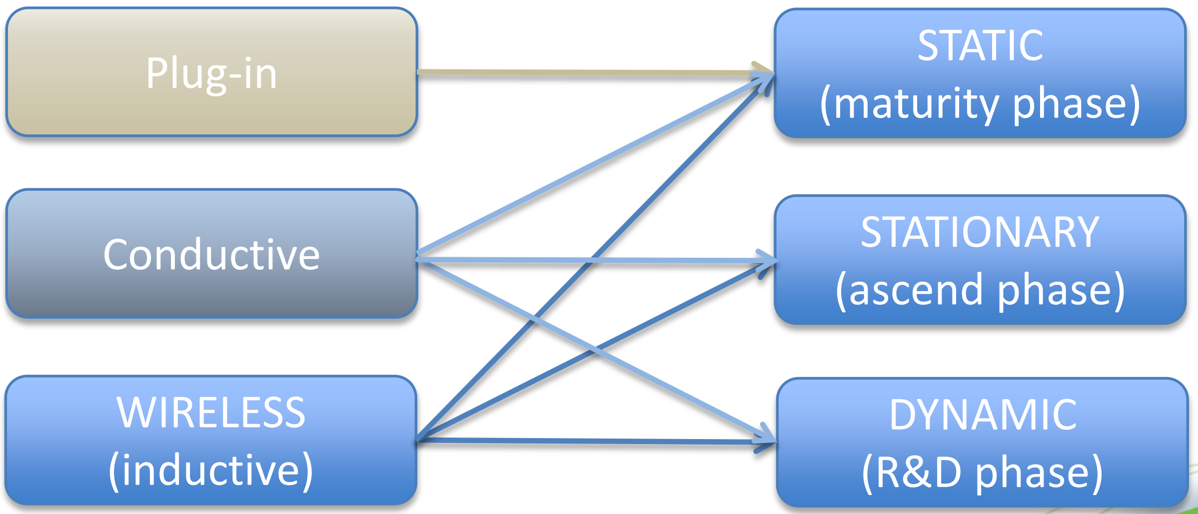
Dynamic

- Example application scenarios:
  - Highways (multiple lanes).
  - Urban roads with dedicated charging lanes.
  - Dedicated vehicle type, mode lanes.

Parameter	Range	Comments
Vehicle speed (km/h)	0 < v < 130	
Vehicle acceleration (m/s^2)	-	Range covers possible accelerations of vehicles ranging from cars to trucks
Transmitted power level range (kW)	20 to 360	
Power transmitted to which component	N/A	Power transmitted either to the vehicle electric drive or, to the on-board energy storage system or, both
Charging time (minutes)	<5	Depends on vehicle speed and dimensions of the primary charging infrastructure.
Vehicle status	N/A	Vehicle engine / power is on during the power transfer process

EV charging technologies (IV)

- Plug-in: The EV has to be physically plugged in to an energy source. The vehicle has to be parked. There are normal and fast charging modes.
- Conductive: The EV is in contact with power lines via a pantograph (trolleys). The vehicle may be moving.
- Inductive or wireless: The power is transferred wirelessly to the EV via inductive coupling. The vehicle may be parked or moving.



Why dynamic charging?

Plug-in		Conductive		Inductive	
Cons	Pros	Cons	Pros	Cons	Pros
User discomfort	Mature technology	Visual pollution	Easy installation	Expensive infrastructure	Smaller batteries
Long charging duration		Expensive pantograph systems	Smaller batteries		Cheaper EVs
Large and expensive batteries			Extended range		Extended range
Expensive EVs			Comfort		Comfort
Vehicle must be parked			Increased mobility		Increased mobility
					No visual pollution

FABRIC

Feasibility analysis and development of on-road charging solutions for future electric vehicles

Jan 2014

- User requirements
- Technical feasibility
- Standardization/ Interoperability

- Relationship to other projects
- Innovation
- Collaboration

Dynamic wireless charging of FEV

Jan 2018

Project motivation

FABRIC

- Concerns about range constraints and the hassle associated with plug-in systems.
- Plug-in systems are inherently unsuitable for energy transfers at very high power levels, thereby ruling plug-in solutions out as a viable long-term alternative.
- High cost and weight of EV batteries

Dynamic, wireless charging solutions for FEV

FABRIC R&D EMPHASIS ON

- New technology being used
  - Prototypes
  - Testing
  - Benefits assessment

- Standards being adopted and extended

- Reference group findings

- Broad and diverse user base findings

- Multiple scenarios of use, multiple vehicles/prototypes

- Wide participation of automotive companies

FABRIC contribution to Electromobility

- Assess the feasibility of wireless and dynamic EV charging;
- Estimate the investments needed for the construction of e-roads and the adaptation of existing infrastructures;
- Study the EV to grid connection and defines the necessary adaptations for large scale transport electrification;
- Produce and test dynamic charging prototypes (testing different coil technologies);
- Contribute towards smaller and more affordable batteries and cheaper Evs;
- Identify and bridge technology gaps that prevent the large scale adoption of FEVs.

Thank you!!

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