Renewable Energy and Electromobility for Smart Grids

9. Deutsch-Japanisches Umwelt- und Energiedialogforum

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Overview

1. Introduction
2. Electric Vehicle Integration
3. Electric Transport Perspective in Berlin
4. Wrap-Up
1. Introduction: Driving Forces Behind Energy and Mobility Transition

- **Environment**
  - Reducing emissions

- **Economy**
  - Protecting against high cost of commodities

- **Independence**
  - Reducing reliance on imports of fossil resources

- **Agreements**
  - Honoring climate change accords

1. Introduction: German “Energiewende”

Adoption of Renewable Energy Sources Act (EEG) aims to encourage the development of renewable energy sources (RES) and its share in the gross energy demand in Germany.
1. Introduction: Infrastructure Challenges to Energy and Mobility Transition

- Financing and operation of a future network and charging infrastructure
- Standardization of charging technology
- Smart grid solutions for individual EVs and fleets
- Flexible data availability and interoperable IT infrastructures

2. Electric Vehicle Integration: Energy Needs

Private EVs (pEVs) in Germany

- ~45 M cars in Germany, forecast ~3 M pEVs in 2025
- Average pEV usage: 13,800 km/year => 17 kWh/100 km => 2,330 kWh/year
- 45 M pEVs: 105 TWh => ~16% of produced electric energy in Germany
- 3 M pEVs: 7 TWh => ~1% of produced electric energy in Germany

Charging Locations

- On the countryside or in city?
- At home, the working place or the shopping mall?
- What is the role of the supplier-aggregator (SupAg)?
2. Electric Vehicle Integration: Charging Points

Charging point location

- Private area with private access
  - Individual domestic garage
  - Shared domestic garage
  - Fleet
- Private area with public access
  - Dedicated recharge station
  - Work-place
- Public area with public access
  - Large car park
  - On-street

2. Electric Vehicle Integration: Charging Strategies in Private Area with Private Access

- Smart Home can offer Charging Point (CP) in private area with private access equipped with smart meter
- User can read the metering data and specify charging preferences
- Based on the agreement with the users, the SupAg can offer services to the market
- Distribution System Operator (DSO) can turn EVs on/off in emergency cases through their smart meter
2. Electric Vehicle Integration: Charging Strategies in Private Area with Public Access

- Charging Point Manager (CPM) buys the power through the SupAg from the market
- CPM specifies charging conditions
- DSO has access in case of emergencies

2. Electric Vehicle Integration: Tariffs

Charging tariffs for electric vehicles should offer various options:

- **Base tariff** – offers simplicity without flexibility
- **Flex tariff** – provides a more efficient usage of the resources available and enabling the application of optimized power scheduling
- **V2G tariff** – aims to exploit the most advanced usage of electric vehicle flexibility including vehicle-to-grid services
2. Electric Vehicle Integration: Charging of Fleets Through Virtual Power Plants (VPPs)

- VPP is a form of Supplier-Aggregator specialized in offering services to a portfolio of resources including EVs
- Integration of electric vehicle fleets in the Virtual Power Plant (VPP) portfolio to obtain optimal charging schedules and energy market participation

![Graph showing uncontrolled and smart charging]

**2. Electric Vehicle Integration: Structure of VPP**

- Information Flow
  - CEV: Cluster of EV
  - CP: Charging Point
  - DG: Distributed Generation
  - GENCO: Generation Company
  - HEMS: Home Energy Management System
  - SM: Smart Meter

Diagram illustrating the structure of VPP with various components such as GENCO, TSO, DSO, VPP Control Centre, VPP, etc.
2. Electric Vehicle Integration: Interaction of VPP

VPP
Optimization of schedules of HEMS, DG, CPM, CP, energy storage

Energy market

DSO, TSO
Validation of schedules

Yes

Schedules validated?

No

Intra-day Operation

Redispatching

2. Electric Vehicle Integration: Redispatching of VPP

Congestion over branch 2-3:

HV-MV subtransmission network

Before redispershing

Line limit

Time (h)

S (MVA)
2. Electric Vehicle Integration: Redispatching of VPP

Congestion over branch 2-3:

3. Electric Transport Perspective in Berlin: Introducing Electric Bus Fleets

© BVG, Oliver Lang, 01.07.2015
3. Electric Transport Perspective in Berlin: Overview of Transport Sector in Berlin

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1) Mio./a  2) Mio. km/a  3) GWh/a  4) t/a

Source: BVG – Nachhaltigkeitsbericht 2011
VBB – 100 wichtigsten Kennzahlen

3. Electric Transport Perspective in Berlin: Location for Depot Charging in Berlin

M - Müllerstraße (Wedding)
44,547 m²
227 Buses

S - Spandau Am Omnibushof 1
66,629 m²
185 Buses

C - Cicerstraße (Wilmersdorf)
42,989 m²
254 Buses

I - Indira-Gandhi-Straße (Hohenschönhausen)
113,000 m²
262 Buses

L - Lichtenberg Siegfriedstraße
38,000 m²
173 Buses

B - Britz Gradestraße (Neukölln)
44,500 m²
229 Buses

Fig.: Location of intra-urban depots in Berlin.
### 3. Electric Transport Perspective in Berlin: Scenarios of Energy Demand and Storage Capacity

**Depot**
- 262 buses at Indira-Gandhi-Straße, (forecast ~80 ebuses in 2025)
- Average bus usage: 63,000 km/year => 220 kWh/100 km => 138.60 MWh/year
- 262 buses: 36.3 GWh => ~0.25% of used electric energy in Berlin
- 80 buses: 11.1 GWh => ~0.08% of used electric energy in Berlin

**Storage Capacity**
- Average storage capacity per Bus: 200 kWh
- Depot (262 buses): 52.4 MWh
- Berlin (1,330 buses): 266 MWh

**Berlin**
- 1,330 buses of BVG-fleet, (forecast ~130 ebuses in 2025)
- Average bus usage: 63,000 km/year => 220 kWh/100 km => 138.60 MWh/year
- 1,330 buses: 184.3 GWh => ~1.27% of used electric energy in Berlin

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### 3. Electric Transport Perspective in Berlin: Opening of First Bidirectional Charging Station for Buses on April 12th, 2018

- Grand opening and inauguration of Berlin’s new charging station
- Integration into the smart grid on the EUREF-Campus demonstrates contributions to a future smart energy supply
3. Electric Transport Perspective in Berlin: Integration of First Bidirectional Charging Station for Buses

Day Time

Fig.: Drive (top) and stop (bottom) times of BVG Line 204.

3. Electric Transport Perspective in Berlin: Fully Electrified Bus Line 204 Between Südkreuz and Zoo

Fig.: Drive (top) and stop (bottom) times of BVG Line 204.

Fig.: Track-Layout of BVG Line 204. Circles represent bus stops.
4. Wrap-Up

- Establish a network and mobility development plan for rural and metropolitan areas taking into consideration the provision of sufficient charging infrastructure
- Advance standardization for the integration of electric vehicles including new technologies such as battery swapping
- Smart use of existing infrastructure, allowing competition with existing and future technologies
- Shape the transformation process of the energy and transport sector with long-term objectives spanning multiple legislative periods

Thank you!