EV Charging and Grid Integration Tool

Workshop for the Africa Support and Investment Platform for E-mobility,
31 August 2023

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Outline

- Grid integration of EV: manual for policy makers
- EV Charging and Grid Integration Tool
- Q&A
Grid integration of EV: Manual for policy makers
4 key steps for policy makers to successfully integrate EVs

① Prepare institutions for the electric mobility transition
1. Engage electric mobility stakeholders
2. Break silos in planning and policy making

② Assess the power system impacts
1. Define an electric mobility strategy
2. Gather data and develop insights
3. Assess the grid impacts under mobility scenarios

③ Deploy measures for grid integration
1. Accommodate all charging solutions but encourage managed charging
2. Facilitate aggregation by enforcing standards and interoperability
3. Value the flexibility of EVs
4. Co-ordinate EV charging with renewables
5. Incentivise smart-readiness

④ Improve planning practices
1. Conduct proactive grid planning
2. Reflect the full value of EV charging
## A framework for grid integration of electric vehicles

<table>
<thead>
<tr>
<th>PHASE 1: No noticeable impact</th>
<th>PHASE 2: EV load noticeable with low flexibility demand</th>
<th>PHASE 3: Flexible EV load is significant with high flexibility demand</th>
<th>PHASE 4: Flexible EV load is highly available with high flexibility demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>No significant impact yet. Encourage higher EV uptake through incentives and public EVSE deployment.</td>
<td>Distinct variability observed caused by EV charging but demand for flexibility is low enough that simple flexibility measures would suffice.</td>
<td>Demand for flexibility is high, matching the availability of flexible EV load and paving the way for aggregated smart charging.</td>
<td>High flexibility demand along with highly available flexible EV load can provide energy back to the system in periods of deficit.</td>
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</table>

**Co-ordinate charging station deployment in areas beneficial to the grid**

**Passive measures:** time-of-use tariffs, vehicle-based charging time delays

**Deploy active measures:** unidirectional V1G

**Deploy active measures, bidirectional charging:** V2G

**Norway**

**France, Netherlands, United States**

**Island power systems, certain vehicle segments**
Interactive web tool:
EV Charging and Grid Integration tool

Report (December 2022)
Grid Integration of Electric Vehicles: A Manual for Policy Makers
https://www.iea.org/reports/grid-integration-of-electric-vehicles
Menti question – code 2736 4634 (www.menti.com)

Global EV electricity demand equals to total national consumption of...

La demande en électricité de la flotte mondiale de véhicules électriques équivaut à la consommation nationale de...
EV charging and grid integration tool
EV Charging and grid integration tool

Motivation #1
Assessing the impact of EV charging on the power system

Module 1
Simulation of EV charging behaviour
Output: weekly EV charging demand profile

Motivation #2
Assessing effect of measures for mitigating EV charging impacts

Module 2
Simulation of EV charging behaviour with managed charging
Output: weekly EV charging demand profile with managed charging

Motivation #3
Estimating the CO₂ emissions related to EV charging

Module 3
Simplified representation of the electricity mix
Output: calculation of yearly CO₂ emissions
Main tool output: detailed simulation of weekly demand profile

Max EV power demand: 984 kW  Average EV power demand: 289 kW
Weekly EV energy: 68.5 MWh  Annual EV energy: 2535 MWh

Download data →

(press location to hide it)
Motivation #1 (Module 1)
Assessing the impact of EV charging on the power system
EVs can be charged at several types of locations

Source: IEA’s Policy Brief on Public Charging Infrastructure
Many factors influence the profile of electricity demand by EV.

Grid impacts of charging solutions vary based on EV fleet and electricity system characteristics.

Power demand profile from EV charging of 1000 private cars driving (one week)

Grid impacts of charging solutions vary based on EV fleet and electricity system characteristics.
Ex: 100 buses – base example
Ex: 1000 cars

Demand curve by location

Max EV power demand: 963 kW  Average EV power demand: 287 kW
Weekly EV energy: 48.3 MWh  Annual EV energy: 2514 MWh

- Stacked chart
- Show non-EV load

IEA. CC BY 4.0.
Ex: 1000 cars – lower access to home/depot charging
Ex: 1000 cars overlapped with 100 buses
Motivation #2 (Module 2)
Implementing managed (more flexible) charging
Managed (flexible) charging unlocks demand flexibility, reduces peak demand and grid congestions, and accelerates electricity decarbonisation.

Grid impacts of EV charging

- Home
- Work
- Destination
- Battery swap
- Enroute
- Depot
- Public Roadside

Flexibility opportunity with managed charging

- Home
- Work
- Battery swap
- Destination
- Public Roadside
- Enroute
- Depot
Applying managed charging measures

Is managed charging possible?

Checking flexibility
- Energy required to charge EV
- Energy available for charging (during connection time)

Flexibility

Participation rate
- Is the infrastructure adapted? AND
- Is the driver willing to participate?

Apply a managed charging measure

Balanced charging

Maximum charging power

Charging power

Arrival time

Departure time

Time-of-Use (ToU) tariffs and smart charging

Shift of energy depending on the hourly tariff schedule

reference electricity demand curve
Ex: 1000 cars – applying balanced charging

Max EV power demand: 531 kW  Average EV power demand: 281 kW
Weekly EV energy: 472 MWh  Annual EV energy: 2,458 MWh
Ex: 1000 cars – applying Time-of-Use tariffs
Ex: 1000 cars – applying V1G
Motivation #3 (Module 3)

Estimating the CO2 emissions related to EV charging
EV charging emissions depend on power mix at time of charging

**Estimate of emissions**

- Net load without and with EV charging
- Running power plants
- EV charging related emissions by comparison

**Simplified dispatch simulation**

- Power plants
- Time steps
- Cumulated power sum in MW
- Energy price in $ per MWh
- Electricity demand (with EV) minus renewable generation

**Legend**

- ⚡ = Cumulated power sum in MW
- $ = Energy price in $ per MWh
- = Electricity demand (with EV) minus renewable generation
Ex: 1000 cars – CO2 emissions estimates

Weekly marginal EV emissions: 29t CO2  
Annual marginal EV emissions: 1337t CO2  
EV share of total emissions: 0.056%
Interactive web tool:
EV Charging and Grid Integration tool
Q&A
Thank you for your attention.

Thank you to all contributors:
- Tool specifications: Luis Lopez, Jacques Warichet
- Algorithm developers: Luis Lopez, Juha Koïkka, Woan Ho Park, Andreas Bong
- Digital support (web tool and API): Barbara Moure, Jon Custer
- Guidance and review: Per-Anders Widell, Julia Guyon, Javier Jorquera Copier, Shane McDonagh, Elizabeth Connelly, Brendan Reidenbach, Alejandro Hernandez, Pablo Hevia-Koch