Technical Impacts on Voltage from Home EV Charging: A Case Study in Cusco, Peru

Derian Carlos Tairo Garcia
Erick Alberto Somocurcio Holguín

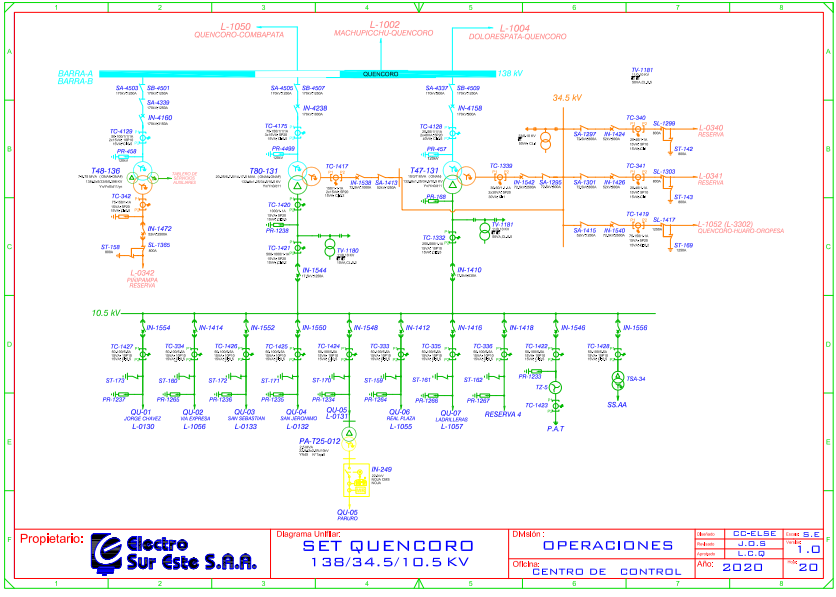
November 8, 2024

Table of Contents

Objectives

- Create a detailed database for OpenDSS to simulate EVs connection.
- Simulated several scenarios of EVs connection.
- Analyze the technical impacts (Voltage magnitude) of EVs on Cusco’s electrical grid.

Substation Quencoro 138/10.5KV AMT QU02 - Cusco



AMT QU02 - SED022

SED022 - Parameters

```
clear
Set DefaultBaseFrequency = 60
set datapath = C:\...\QU02\

New Circuit.SED022 basekV=10.5 pu=1.0 angle=0 frequency=60 phases=3

!! LoadShapes
new Loadshape.Shape_01 npts=24 interval=1.0 csvfile=demand_daily_01.txt
...
new Loadshape.Shape_14 npts=24 interval=1.0 csvfile=demand_daily_14.txt

New Loadshape.ev_shape_1  npts=24 interval=1 mult=(file=profile_ev1_3kw.txt) useactual=false
New Loadshape.ev_shape_2  npts=24 interval=1 mult=(file=profile_ev2_3kw.txt) useactual=false
New Loadshape.ev_shape_3  npts=24 interval=1 mult=(file=profile_ev3_3kw.txt) useactual=false

!! Transformer

New Transformer.SED022 phases=3 windings=2 buses=(sourcebus, 1) conns=(delta, wye) kvs=(10.5, 0.22) kvas=(100, 100) %loadloss=0 xhl=5
```

SED022 - Parameters

```
!! LineCode

New LineCode.AUT_AL-3x120  nphases=3 R1=0.253 X1=0.098 R0=0.253 X0=0.098 Units=km

!! Lines

new Line.TBT001 Bus1=1 Bus2=2   length=0.09688  phases=3  units=km linecode=AUT_AL-3x120
new Line.TBT002 Bus1=2 Bus2=3   length=0.09688  phases=3  units=km linecode=AUT_AL-3x120
...
new Line.TBT013 Bus1=13 Bus2=14 length=0.02158  phases=3  units=km linecode=AUT_AL-3x120

!! Loads

new Load.LOAD1  bus1=1  phases=3  kV=0.22   kW=1  PF=1 model=1 Daily=Shape_01 status=variable
new Load.LOAD2  bus1=2  phases=3  kV=0.22   kW=1  PF=1 model=1 Daily=Shape_02 status=variable
...
new Load.LOAD13 bus1=13 phases=3  kV=0.22       kW=1  PF=1 model=1 Daily=Shape_13 status=variable
new Load.LOAD14 bus1=14 phases=3  kV=0.22       kW=1  PF=1 model=1 Daily=Shape_14 status=variable

!! Monitors for each node
Redirect Monitors_3.txt

set controlmode=static
set mode=daily

Solve

!! Show Results
```

Demand Profile - Base Case

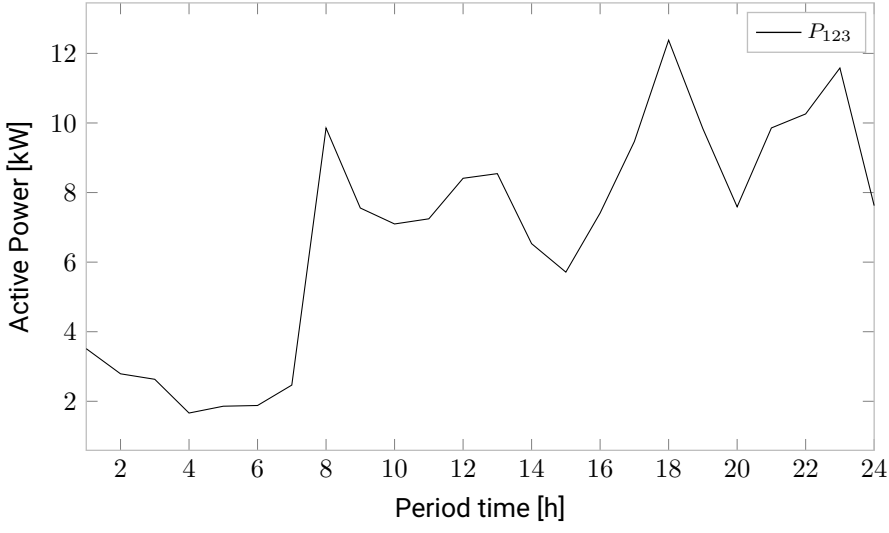


Figure: Demand Profile - Base Case.

SED022 - Parameters EVs

```
new Load.EV_LOAD1  bus1=1  phases=3 kV=0.22  kW=3 PF=1 model=1 Daily=ev_shape_1  status=variable
new Load.EV_LOAD2  bus1=6  phases=3 kV=0.22  kW=3 PF=1 model=1 Daily=ev_shape_2  status=variable
new Load.EV_LOAD3  bus1=7  phases=3 kV=0.22  kW=3 PF=1 model=1 Daily=ev_shape_3  status=variable
```

EV profiles, N1, N6, N13

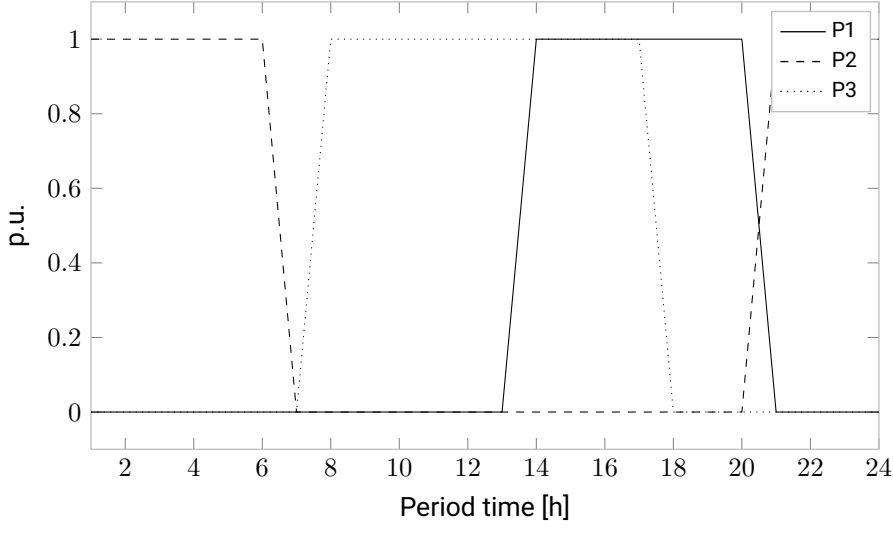


Figure: EV profiles.

Results

Voltage profiles for Node 1

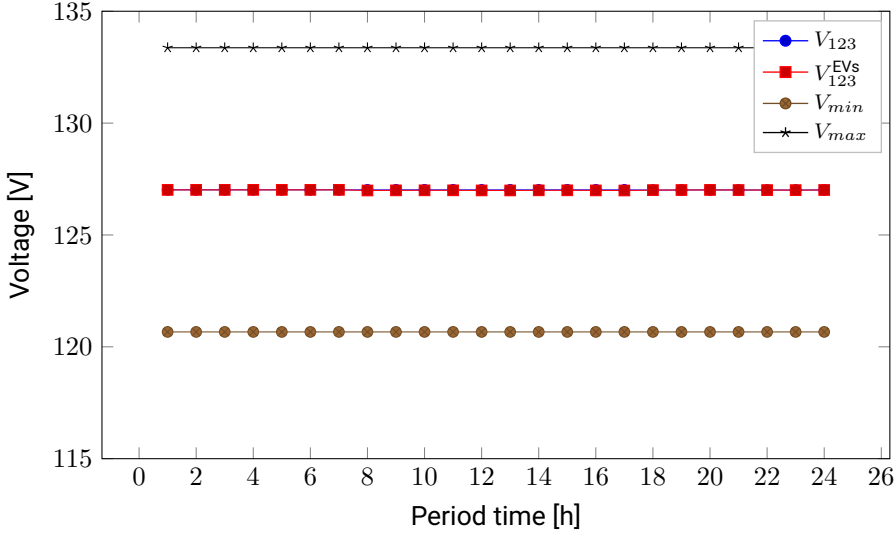


Figure: Voltage profiles for the N1 (House recharge).

Results

Voltage profiles for Node 6 (Office recharge).

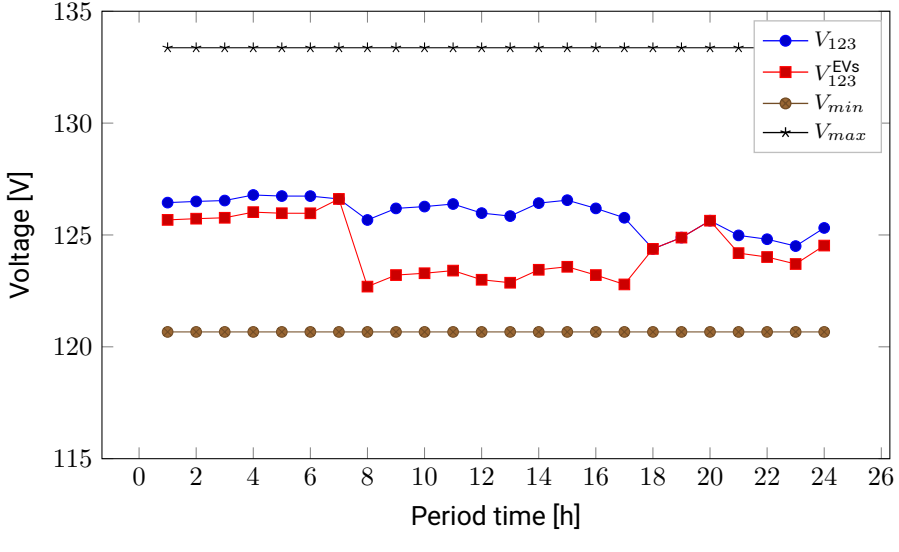


Figure: Voltage profiles for the N6.

Results

Voltage profiles for Node 13 (Fast recharge).

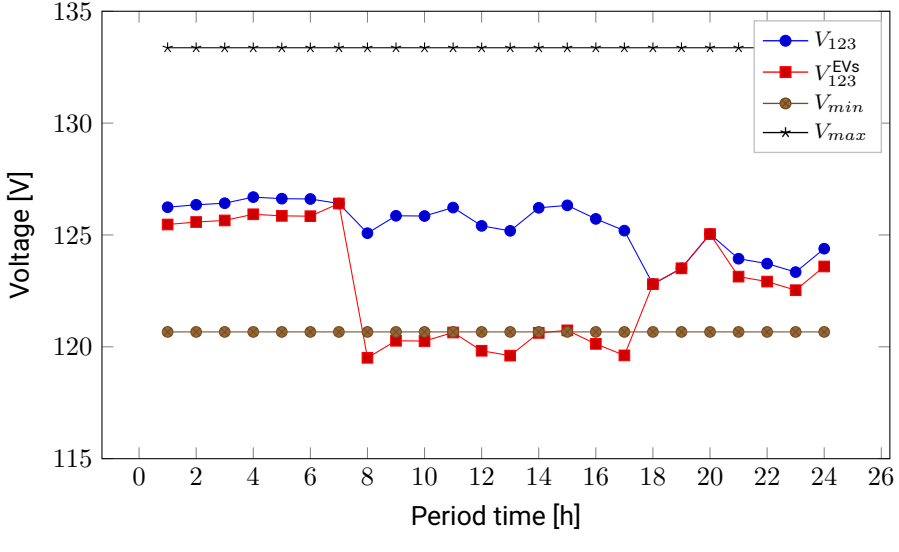


Figure: Voltage profiles for the N13.

Correction of the voltage magnitude

Charging power reduced from 3 kW to 1 kW

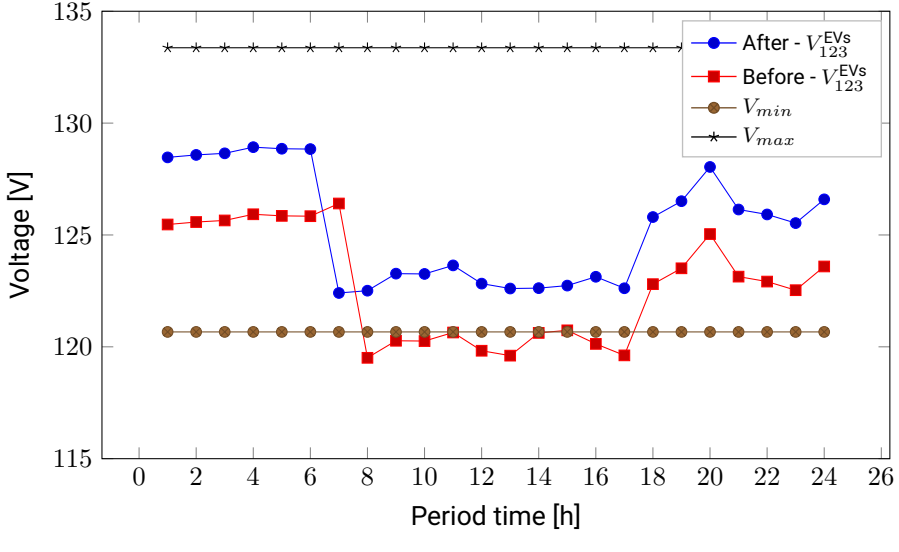
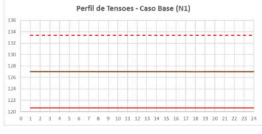
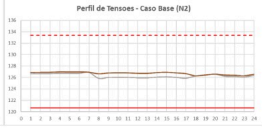
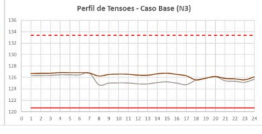


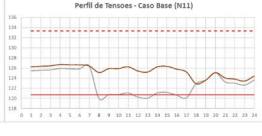
Figure: Voltage profiles for the N13.

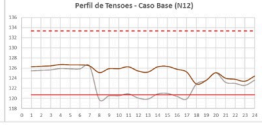
AMT QU02 - SED022





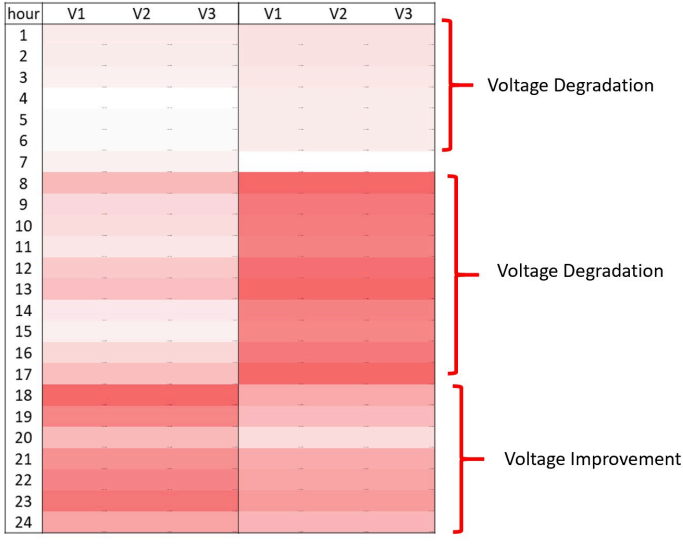






AMT QU02 - SED022

Nodo 8



Conclusions

- The distribution company lacks a systematized database, making it difficult to manage data efficiently and conduct accurate analysis.
- In some cases, the data showed inconsistencies, which could affect the reliability of results and decision-making.
- The connection of electric vehicles causes voltage issues in the grid, particularly at the busbars where fast charging stations were installed. These issues need to be addressed to avoid overloads or voltage drops that could impact grid stability.
- Real data demonstrated that the integration of EVs into the grid requires a detailed study. Computational tools like OpenDSS are essential for conducting accurate simulations and assessing their impact on the network.
- OpenDSS is a versatile tool that supports detailed analysis and allows for automation in generating multiple scenarios, making it crucial for efficient planning and decision-making.

Thank you!