Energy System Innovation programme

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9th June 2023

Energy System Innovation Programme

Project overview

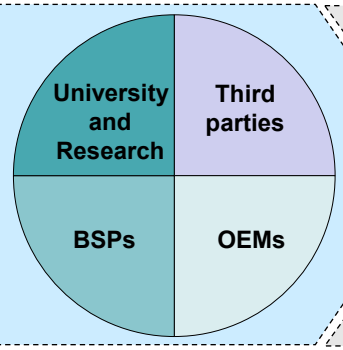
Energy System Innovation

ESI Programme scope: Stimulate technical/market innovation of resources not yet ready for current Pilot Projects (i.e. Res. 300/17)

Low technology/market readiness - → + Full maturity

System Innovation initiatives

- *Focus on **techs not ready for market-based pilot projects***
- ***Not necessarily "Technology Agnostic" approach***



Pilot Project Res. 300/17

UVAC
UVAP
UVAM
Secondary reserve control by units not yet enabled
Voltage control by units not yet enabled
Fast Reserve

Full integration in the Ancillary Services Market (ASM)

HOW? Dedicated projects in an Open Innovation framework ➔ ESI (Energy System Innovation) Projects

The first wave of ESI Projects will investigate the world of **Distributed Energy Resources**, such as EVs and other modular loads (e.g. HVAC, boilers, etc.),that will be studied as:

SINGLE RESOURCES

Analysis of limits and potential of specific technologies with a view to grid integration (technical characteristics, communication protocols, ability to respond to specific commands, ...)

AGGREGATES OF RESOURCES

Evaluation of performance and reliability of aggregates of resources in relation to their ability to provide services to the Electricity System of the future.

Terna will evaluate, in agreement with the Italian Regulatory Authority for Energy, Networks and the Environment (ARERA), the opportunity to provide an **economic incentive to encourage the participation** of a large number of parties in the various ESI projects.

Results will be shared in a final report in anonymous and aggregated way, guaranteeing protection of sensitive information.

Energy System Innovation Programme

ESI Programme's contribution to Electrification

WHY? Allow that the electrification of consumption will be an added value on Grid System and not a criticality

	k POD* at 2030	MW at 2030
Highways *Ultra-Fast*	0,9	346
Extra urban roads *Ultra-Fast*	7,5	2.633
Urban *Fast*	13,0	1.313
Quick	25,0	1.100
Pubblic EV Charging	**46,4**	**5.392**
At home	1.000,0	6.000
In the workplace	50,0	2.200
Private EV Charging	**1.050,0**	**8.200**
Residential	-	7.000
Industrial	-	2.600
Heating and cooking	**0,0**	**9.600**
Cold Ironing	**0,1**	**682**
TOTAL QUANTITY	**1.097**	**23.874**

Arera –*Consultation Document 449/2022/R/EEL*

ARERA

DOCUMENTO PER LA CONSULTAZIONE
449/2022/R/EEL

INIZIATIVE REGOLATORIE A SUPPORTO DELLA PROGRESSIVA DECARBONIZZAZIONE DEI CONSUMI E PER L'ATTUAZIONE DELLE DISPOSIZIONI CONTENUTE NEL D.LGS. 210/21 E NEL D.LGS. 199/21 IN TEMA DI MOBILITÀ ELETTRICA

RICOGNIZIONE, QUADRO DI RIFERIMENTO E SCENARI

1. Electrification scenario:
   Increase of 24 GW of capacity committed on distribution networks in new sectors (**+14%** respect to current 172 GW).

   Comparing to Fit-for-55 targets, real values will probably be higher.

2. Additional GWs can represent a challenge for the Grid System (due to possible contemporaneity factors) if not correctly managed.

   They can be managed using i.e. smart charging functionalities for electric vehicles.

* POD= Point of Delivery

ISC - Uso INTERNO / INTERNAL Use

Energy System Innovation Programme

ESI Programme pathway: the ESI Projects

Energy System Innovation e-mobility

First project dedicated to electric mobility: ESI E-mobility

Project is now **LIVE** and open for partners participation.

e-mobility Lab
Powered by Terna Forward

Test **EV*/EVSE** capacity** to provide **ancillary services**

Test the **impact** of **ancillary services** on EV/EVSE

Experimentation in Terna's E-mobility Lab with technology manufacturers

Energy System Innovation Heating & Cooling

Second project dedicated to HVAC* systems: ESI Heating & Cooling

Project will be launched and open for partners participation starting from the **end of 2023.**

Test **HVAC systems capacity** to provide **ancillary services**

Experimentation in an external Lab with technology manufacturers

Contribute to the definition of **grid-ready standards**

Driving the evolution of the Electric Market towards the inclusion of Distributed Resources

Results shared with the System

COMING SOON!

Third project dedicated to aggregates

The third ESI initiative will be dedicated to the aggregation of Distributed Resources. It will be launched during 2024, according to the evidence gathered in the first two ESI initiatives.

Test **capacity of resources' aggregates** to provide **ancillary services**

Experimentation to be conducted with BSPs, technology manufacturers, …

Terna Driving Energy

* HVAC= Heating, Ventilation and Air Conditioning

** EV= Electric Vehicle - EVSE= Electric Vehicle Supply Equipment

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Thank you for your attention!

Backup

Introduction and Energy Scenarios

Electricity balance @2030

Electricity balance (TWh_el)	2019	2030	2030	2030
	Actual	NT Italia	Late Transition	FF55
Total National Production	**282**	**277**	**281**	**319**
Total RES production	***113***	***177***	***185***	***239***
Solar	*23*	*70*	*69*	*101*
Wind	*20.2*	*40*	*46*	*68*
Hydro[1]	*46*	*49*	*51*	*51*
Other RES	*23*	*23*	*23*	*23*
Overgeneration	*-0.2*	*-5*	*-4*	*-5*
Total conventional production	***169***	***100***	***96***	***80***
Natural gas	*138*	*95*	*91*	*75*
Coal	*16*	*0*	*0*	*0*
Other non RES	*15*	*5*	*5*	*5*
Foreign Balance (net import)	**38**	**58**	**54**	**52**
Storage loss	***-1***	***-4***	***-3***	***-5***
Storage production	*2*	*NA*	*16*	*25*
Storage consumption	*3*	*NA*	*20*	*30*
Total electricity consumption[2]	**320**	**331**	**331**	**366**
Total electricity (only) consumption	***320***	***331***	***331***	***357***
Consumption for H2 production	***0***	***0***	***0***	***9***

1. **Significant increase in RES production** (+126 TWh compared to 2019) which leads to a **reduction of gas generation by 2030**:

   -63 TWh_el vs 2019

   -20 TWh_el vs NT Italia 2030

2. By 2030, **40% of RES production is solar**, leading to an increase in the role of storage

Full document available here: https://www.terna.it/it/sistema-elettrico/rete/piano-sviluppo-rete/scenari

According to Terna-Snam scenarios, by 2030 RES production will increase leading to the reduction of thermal plant operation and enhancing the role of storage and other flexibility resources

(1) Renewable hydro, excluding pumping
(2) Including electrolyzer consumption (9TWh in FF55 scenario in 2030)

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ESI E-Mobility Project

Key Points Regulations

Purpose

- The Selection Procedure aims at identifying the Eligible Parties who shall participate to the **experimentations** at Terna E-Mobility Lab, located in Turin.
- Each Applicant (or "Partnership between Enterprises" or "Grouping") that takes part to the Selection Procedure shall be an entity made up of one or more Economic Operators **including at least 1 EV Manufacturer or 1 EVSE Manufacturer** (EV/EVSE manufacturer must be identified as the agent representing the grouping), but also other parties (e.g., Research Centres, Universities, etc.).

Qualification requirements

EV Manufacturer	*EVSE Manufacturer*	*Documents required for validation*
global turnover in the last available tax year of at least **10 billion €**	**global turnover** in the last available tax year of at least **2 million €**	*Self declaration*

Each grouping

Each Grouping which consists of at least one EV Manufacturer, must have a **list of EVs on the market in Italy or Europe as of 2022** that includes **at least 1 model (BEV or PHEV)**	*Self declaration and submission of the list*
Each Grouping, which consists of at least one EVSE Manufacturer, must have a **list of EVSEs on the market in Italy or Europe as of 2022** that includes **at least 1 model.** EVSE Manufacturer (**White Label EVSE Manufacturer)** that do not have a list of EVSEs on the market available to the public, because their product is **"white label"**, but still present on the market after rebranding are also allowed to participate	*Self declaration and submission of the list*

ESI E-Mobility Project

Key Points Regulations

Experimentation execution

- **Terna will appropriately combine EV and EVSE assets** brought by the various Eligible Parties and indicate which testing post (max 4 for each participant) at the E-mobility Lab is more suited to be used for the experimentation.
- All **testing activities at the E-Mobility Lab will be exclusively conducted from Terna's personnel** (partner's support is more than welcomed, but not mandatory)

At least 1 EV (commercial product or prototype):

- **1 BEV (V1G or V2G)**

Or

- **1 PHEV (V1G or V2G**

At least 1 EVSE (commercial product or prototype):

- **1 EVSE AC (V1G or V2G)**

Or

- **1 EVSE DC (V1G or V2G**

- EVs and EVSEs are provided on **free loan for temporary use** for the duration of the testing, including transport and installation activities which are required to the partners
- **Specialist technical support optional** for testing (monitoring, analysis of results, etc) and **required only in case of problems**, if necessary, with a **on-site and/or remote intervention from the partner**

Sharing of experimental findings

- At the end of testing, Terna will produce one or more **reports for public disclosure of the key experimental findings**, while **guaranteeing protection of sensitive information and anonymity of the EV/EVSE models tested**, presented in an **anonymous and aggregated** format. This report **will be sent to ARERA and published on the ESI webpage**. The report may also be the subject of public seminars for its presentation.

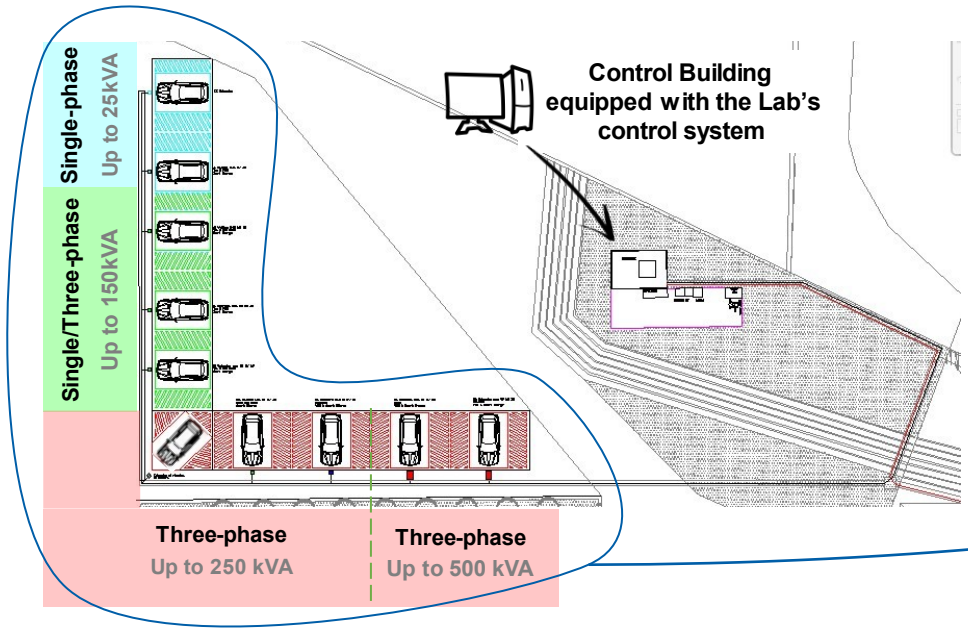
Costs

- **Each Eligible Parties shall be exclusively responsible for all their own costs and expenses for the Project**, (e.g., transfer to/from the E-mobility Lab, man-hours employed, assistance, etc.).
- **Terna will bear the costs of operation of the E-mobility Lab** (e.g. workstations, electricity infrastructures, electricity for recharging, Terna support staff running the tests, etc.), the data analysis costs and to the production of reports

E-Mobility Lab Project

General overview of the reference facility for the ESI E-Mobility Project

All the testing posts of the E-mobility Lab have been equipped with covering tarps in order to separate each spot and **guarantee the due privacy to testing partners** and prototypes



Following a **«plug & play»** approach, each testing post is equipped with a cabinet containing a **power supply disconnector** and a **direct TLC connection** to the Lab's Control System

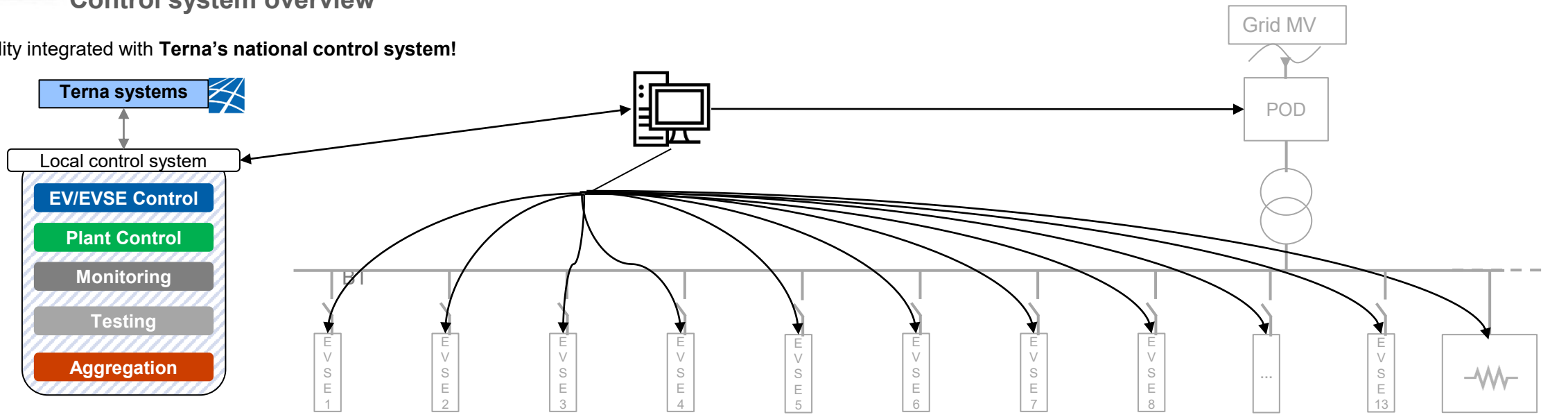
The **13 testing** posts are suitable for every asset: **connection powers range from 25kVA to 500kVA**

The E-mobility Lab facility, thanks to its several power connection points, is designed to host different types of e-mobility devices with limited effort required from the partners

E-Mobility Lab Project

Control system overview

Facility integrated with **Terna's national control system!**

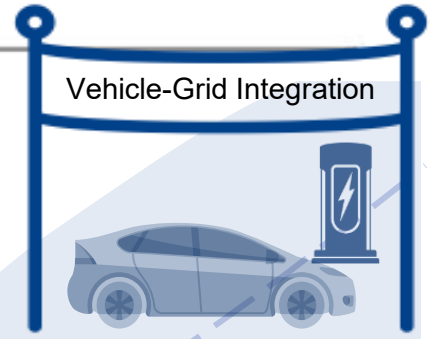


EV/EVSE Control Plant Control	**Manage and control** each and all of the **plant devices** as well as the **electric vehicles and the charging infrastructures**, both **for testing and safety purposes**	→	Possibility to **integrate, at the same time, several charging infrastructure communication protocols** Capability to **adjust the system functionalities to the asset characteristics** (both for V1G and V2G configurations)
Monitoring	Monitoring of all the **main electrical parameters of the plant** and of **each charging station and vehicle** under test.	→	**Each power line has a dedicated power meter** that can be used to compare and validate the EV+EVSE performances
Testing	Capability to **send, directly and indipendently, power set-points to the assets** under tests simulating grid events.	→	Possibility to **simulate the actual ancillary services** (primary, secondary and tertiary reserve) to assess asset barriers and performances
Aggregation	Possibility to **manage and control several assets, installed in the Lab, in a virtually aggregated mode**	→	Capability to test and **simulate the asset virtual aggregation** to better understand aggregation **barriers, difficulties and possible optimizations**

The E-mobility Lab control system is specifically designed to monitor, manage and control each and all of the laboratory devices to test and simulate grid events and ancillary services provision

ESI E-Mobility Project

General example of test procedure

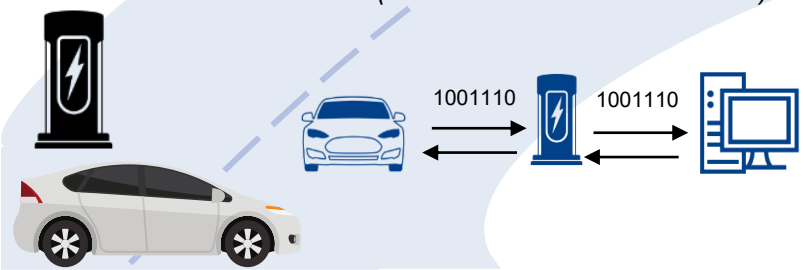


! This procedure is given by way of example. The actual procedure is to be verified and agreed with the project partners.

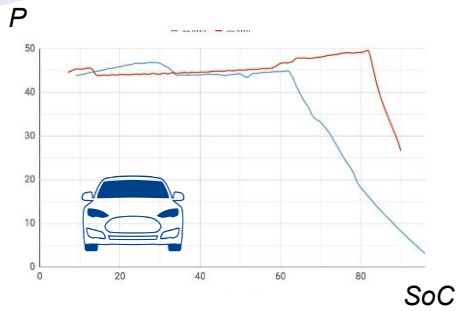
Testing procedure timeline (example)

(Week 1-4) → *(Week 5-7)* → *(Week 8-10)* → *(Week 10-30)*

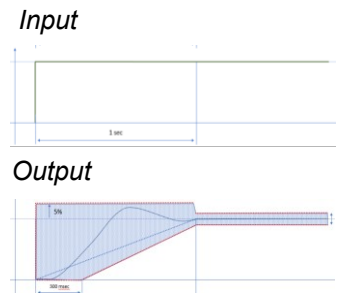
Type 0 test
(Interfaces and communication)



Type 1 test
(Resource characterization)



Type 2 test
(Services parameters)



Type 3 test
(Services impacts on EV)

Test sessions' timelines and modalities will be agreed with each of the partners and testing activities of common interest will be performed on the specific technological assets

ESI E-Mobility Project

Key points Technical Annex

Vehicle-Grid Integration

Scope: Characterize the flexibility resource to guide technology development and market design

Type 0 tests
(Interfaces and communication)

	Test typology	**Standard**	*Calculated/measured outputs*	*Elements of interest*
Front-end communication	Verify the **correct communication** of signals, messages and commands which are exchanged **between EV and EVSE**	*ISO 15118* *Chademo* *DIN 70121* *Proprietary* *…*	Correct signal transmission/reception verification Verification of the adequacy of available data exchange for grid services of provision Signal minimum resolution measurements Signal transmission/reception frequency measurements Communication latency times	Interoperability Need of specific information to provide flexibility *(SoC, Instantaneous P limits, SoH,..)* Need to understand communication performance to address if other services, besides the «standard» ones, can be provided. «Behind the meter» measurements reliability
Back-end communication	Verify the **correct communication** of signals, messages and commands which are exchanged **between EVSE and back-end control system** .	*OCPP* *Modbus* *Proprietary* *…*		

Why?

Communication tests are preparatory to the following ones. In addition, a focus on **communication** is needed since data exchange **for services provision can be very specific** (e.g., as of today, it is quite rare that the EV communicates its SOC and that it can receive rapidly varying setpoints)

ESI E-Mobility Project

Key points Technical Annex

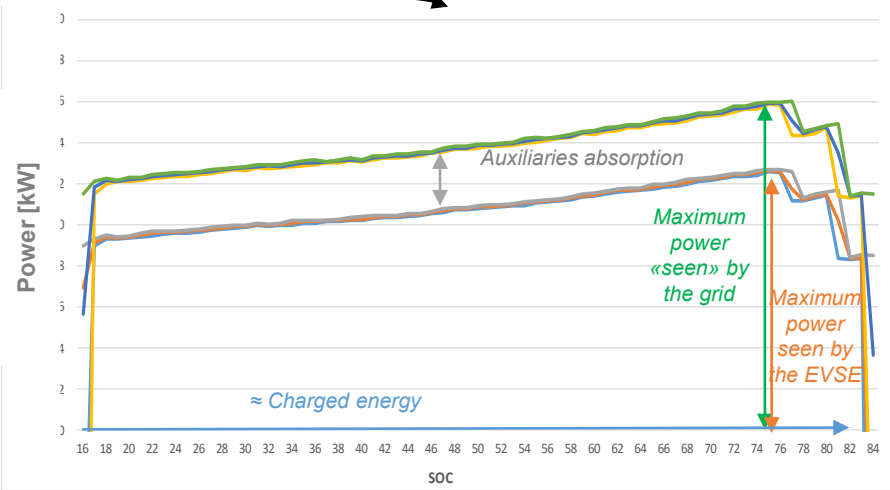
Vehicle-Grid Integration

Scope: Characterize the flexibility resource to guide technology development and market design

Type 1 Tests
(Resources characterization)

	Test typology	*Calculated/measured outputs*	*Elements of interest*
Full Charge/ Discharge	Determine the resource **behaviour in terms of maximum charging/discharging power** as a function of the SoC	Power-SoC curve	P-SoC curve behaviour
		Energy Capacity [kWh]	Efficiency as a key parameter during long and subsequent V2G sessions
		Charge/discharge efficiency [%]	
		Battery State of Health	Reliability of devices representative parameters
Self-discharge rate	Determine the self-discharge rate when the resource (EV) is not being used. Usual test is conventially set on a week-period testing time.	Self-discharge rate [%]	Derating due to non-use of the resource
		Lost energy [kWh]	
Minimum power	Determine **minimum power** value at which the resource can be charged/ discharged	Minimum charging power [kW]	Flexibility band reduces when the minimum charge/discharge power is not zero
		Minimum discharging power [kW]	

Test example: P-SOC curve (charging)



Representation of test field results

Why?

«**Nameplate» data are not sufficiently representative** to characterize EV+EVSE resource flexible use.

In this sense, it is necessary to analyze measured quantities variations during charging/discharging operation and **non-conventional EV+EVSE interactions** (e.g., start up minimum power)

ESI E-Mobility Project

Key points Technical Annex

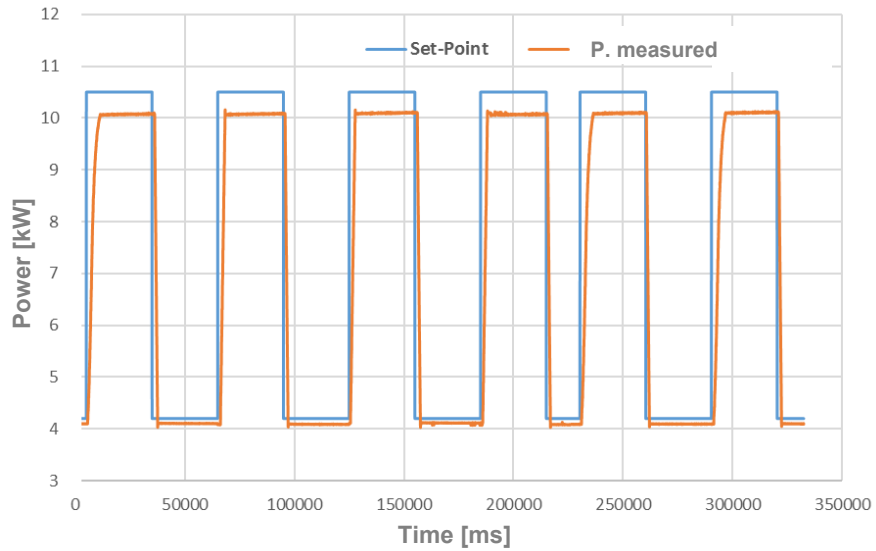
Scope: Characterize the flexibility resource to guide technology development and market design

Vehicle-Grid Integration

Type 2 Tests
(Services parameters)

	Test typology	*Calculated/measured outputs*	*Elements of interest*
Response technical parameters	Determine **typical dynamics** and the **technical performance** of EV+EVSE response after a power set-point	Activation times [s] Step Response Time [s] Ramp Rate [kW/s] Full activation Ramp Rate [kW/s]	**Key parameters** for grid services provision are not expressed as **nameplate parameters** since they're: 1. Not useful nor of interest for a standard charge 2. Not depending on the single asset, but on the EV+EVSE couple (and on communication protocols)
Static/dynamic precision	Determine typical **accuracy** of EV+EVSE resource **performance** when it is **required to provide grid services**..	Static accuracy (absorption) [%] Static accuracy (injection) [%] Dynamic accuracy (absorption) [%] Dynamic accuracy (injection) [%]	**Accuracy in following** static/dynamic **setpoint** is **fundamental to adequately manage** these resources for grid services provision

Test example: response parameters



Why?

It is necessary to **determine the resources typical dynamics** (from Set-point delivery to its full completion) in order to identify **which services can be provided**, which are the minimum requirements that are met and increase the know how to **suggest possible future services**.

ESI E-Mobility Project

Key points Technical Annex

Vehicle-Grid Integration

Scope: Characterize the flexibility resource to guide technology development and market design

Type 3 Tests (Services impacts on EV)

Test typology

Continous services provision in various scenarios:

a. Real life simulations (driving-parking-recharging)
b. Long life ageing

Parameters are **checked every week/10 days**

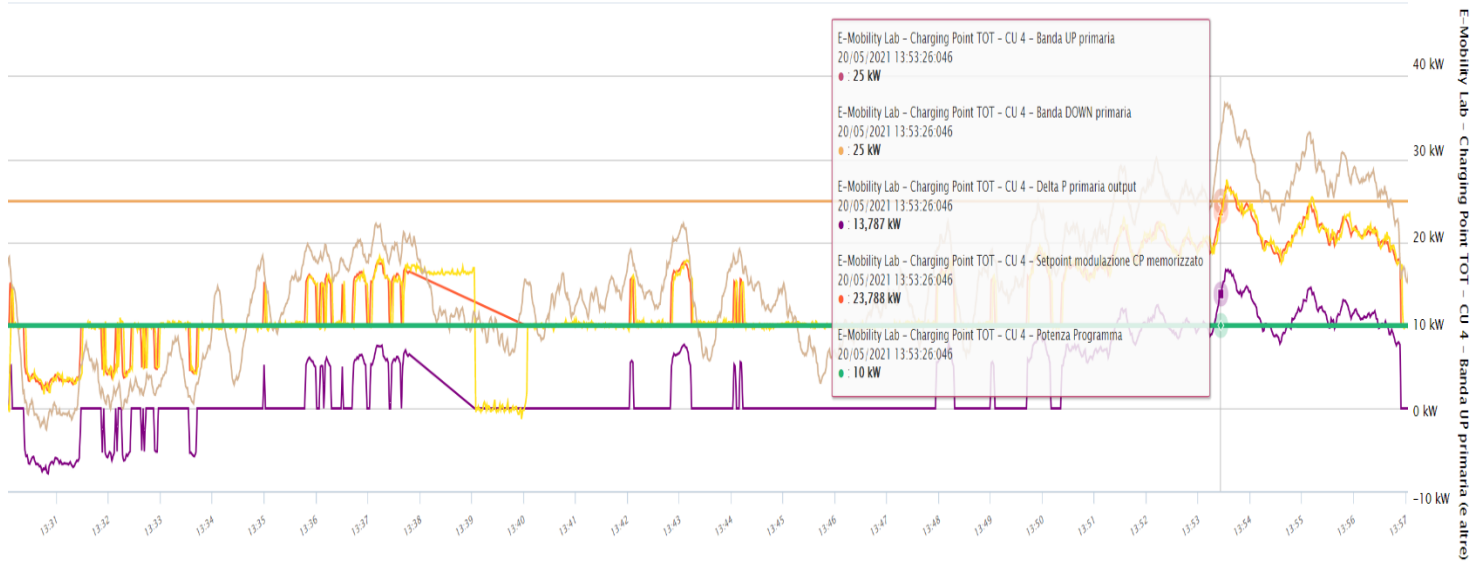
Calculated/measured outputs

Total absorbed/ injected energy, both upward/downward [kWh]
Residual energy capacity [kWh]
State of Health [%]

Elements of interest

- Battery ageing due to services provision
- Effective availability in real life conditions (time and energy)
- Long period unexpected effects

Test example: response parameters



Why?

Services impact on the EV battery is a sensitive topic for V2G acceptance, the quantification of available P. band for services and aggregation logics. The quantification of these impacts, and their mitigations, is a crucial element to **understand to what extent EVs can provide flexibility.**

* Service provision in «real life» conditions: EV is connected to the grid only in specific moments, while providing that a certain SOC is guaranteed at a certain hour.

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