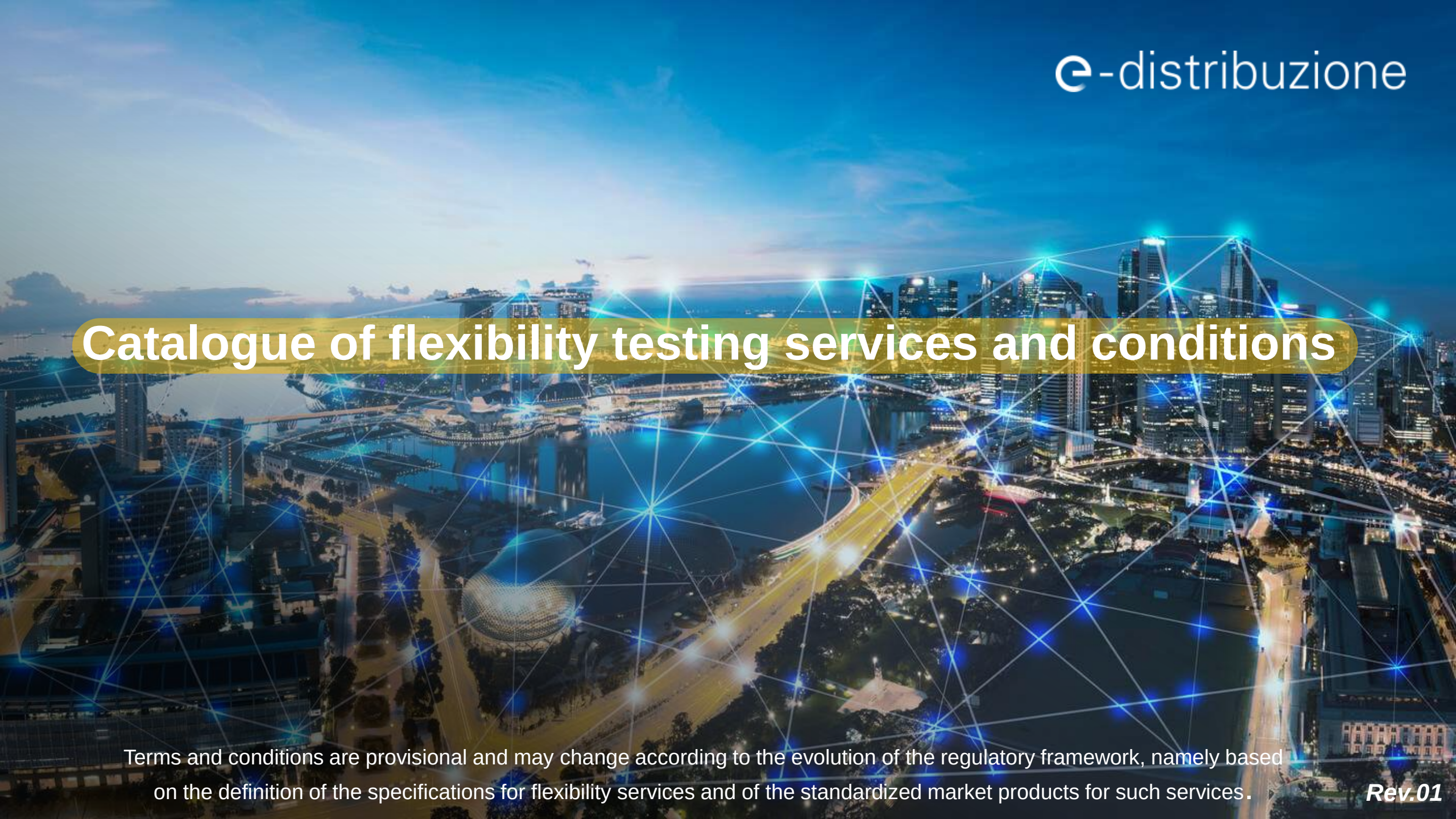

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Catalogue of flexibility testing services and conditions

Terms and conditions are provisional and may change according to the evolution of the regulatory framework, namely based on the definition of the specifications for flexibility services and of the standardized market products for such services.

Rev.01

Flexibility Services

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Service	Use Case (examples)						Flexibility Lab Activity
Congestion management	To manage peaks of demand/generation or unplanned events / faults (short-term); To manage peaks of demand/generation or planned outage/ maintenance operations (medium term); To manage foreseen network constraints deferring grid-reinforcement investments (long term)	Yes	Yes	Yes	Yes	Yes	DSO services
Voltage control	Voltage control (short-term); backup in case of network reconfiguration	Yes	Yes	Yes	Yes (*)	Yes (**)	
Emergency management • Black start • Islanded operation	Resilience in case of adverse weather events Black Start / Islanding operation	Yes	Yes	Yes	No	No	
MV/LV Observability	Testing of MV/LV Observability requirements	●	●	●	●	●	Enabling tools for flexibility

(*) with V2G features

(**) if flexible loads

Flexibility Service

Service: Congestion Management

Rationale: Congestion exists when power flows exceed the assets' nominal design threshold, either temporarily or permanently. This is due to the thermal limits of electrical elements or to dynamic limits of system stability. In some cases, congestion is structural and therefore occurs in a certain predictable time and are geographically stable, while others occur occasionally and are more difficult to predict.

Congestion management can provide an alternative to network reinforcements.

Use case*	Type of need**	Scope of application of the service	Technology involved in service provision			
Congestion solving in a specific node of the network	Conjunctural	Short-term	*Electric Vehicle Charging Infrastructure*	*Distributed generation*	*Storage*	*Demand*
Congestion solving in a specific node of the network under a previous fault in an element	Conjunctural	Short-term				
Congestion solving in a specific node of the network	Structural	Long-term				
Congestion solving in a specific node of the network under a possible fault in an element	Structural	Long-term				

* *Other uses cases may be considered by the Flexibility Lab upon request of the interested stakeholders*
** *"Conjunctural" needs are related to network operation, "Structural" needs are related to network planning*

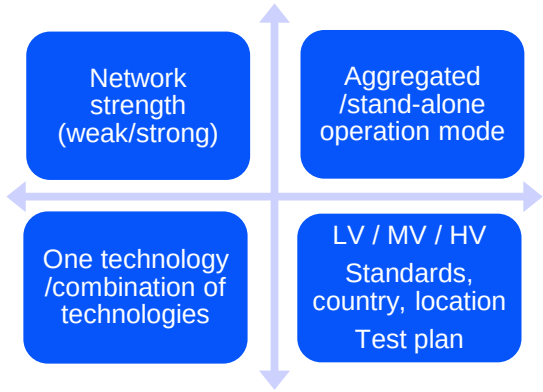
Flexibility Testing

Service: Congestion Management

Test description:

It is identified a congestion in a specific asset of the network (e.g. line or transformer). In order to solve it, the DSO can request a market demand bid in a node of the network, which will substantially release the power flowing through the asset itself. This need can be understood as a reduction of the active power at the node, with a predetermined duration, which is achieved by a change (reduce demand or increase generation) in the baseline of the flexible service resources participating: distributed generation, demand units, storage devices or EV charging points.

Test characterization:



The tests to be performed must be characterized by replicating the conditions of the network where the service will be needed and by evaluating the compliance of the flexibility service provider with different operation modes and other technologies.

In addition to this, it will be defined a **Test plan** adapted to both the Flexibility Lab center(s) involved and the final location where the service will be implemented, specially regarding standards, regulatory requirements, etc.

Test plan: phases and duration (**)

Preparatory phase
- Lab set up
- Network simulation
- Node requirements identification
- Flexible Service Provider settlement
- Service activation

Congestion management tests
- Set point sending
- Set point reception
- Set point activation
- Set point update compliance
- Tests finalization

Assessment
- Communication assessment
- Time of response
- Set point acknowledge reception
- Set point compliance
- Product activation compliance according to test plan objectives

***Test plans must be defined by the Flexibility Lab in coordination with interested stakeholders and their specific capabilities and needs*

Flexibility Service

Service: Voltage control

Rationale: A set of actions on reactive power generation resources, network assets (e.g. transformers with tap-changers) or demand resources such as flexible loads, can contribute to maintain voltage levels at the nodes of the network within the specified margins to guarantee compliance with the safety and quality criteria of the electricity supply. This flexibility service can be provided by individual resources or by means of aggregations. Voltage control can provide an alternative to the use of capacitor banks and reactances.

<table>
<tr><th>Use case*</th><th>Type of need**</th><th>Scope of application of the service</th><th colspan="4">Technology involved in service provision</th></tr>
<tr><td rowspan="2">Compensate voltage levels via reactive power control</td><td>Conjunctural</td><td>Short-term</td><td rowspan="2">Electric Vehicle Charging Infrastructure (V2G mode)</td><td rowspan="2">Distributed generation</td><td rowspan="2">Storage</td><td rowspan="2">Demand (e.g. flexible loads)</td></tr>
<tr><td>Structural</td><td>Long-term</td></tr>
</table>

**Other uses cases may be considered by the Flexibility Lab upon request of the interested stakeholders*
***Conjunctural needs are related to network operation, Structural needs are related to network planning*

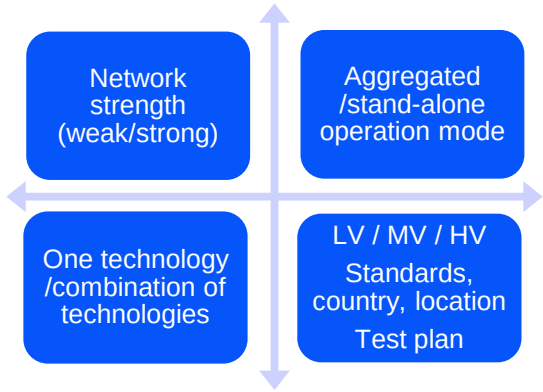
Flexibility Testing

Service: Voltage control

Test description:

It is identified a voltage deviation in a specific node of the network (e.g. HV/MV primary or MV/LV secondary substation). In order to solve it, the DSO can request a market demand bid in the node, which will substantially contribute to maintain the voltage levels within the specified margins. This need can be understood as an absorption or injection of reactive power at the node, with a predetermined duration, which is achieved by an adjustment in the operation set point of the flexible service providers participating: distributed generation, storage devices, EV-V2G charging points or demand resources.

Test characterization:



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In addition to this, it will be defined a **Test plan** adapted to both the Flexibility Lab center(s) implied and the final location where the service will be implemented, specially regarding standards, regulatory requirements, etc.

Test plan: phases and duration (**)

Praparatory phase

- Lab set up
- Network simulation
- Node requirements identification
- Flexible Service Provider settlement
- Service activation

Voltage control tests

- Set point sending
- Set point reception
- Set point activation
- Set point update compliance
- Tests finalization

Assessment

- Communication assessment
- Time of response
- Set point acknowledge reception
- Set point compliance
- Product activation compliance according to test plan objectives

***Test plans must be defined by the Flexibility Lab in coordination with interested stakeholders and their specific capabilities and needs*

Flexibility Service

Service: Emergency Management

Rationale: Under an occasional fault, controlled islands may be operated in the distribution network. These islands consist of isolated sections of the distribution network where one or more generation facilities are feeding demand, separated from the rest of the power system, and equipped with the appropriate protection systems for the DSO to control its operation and ensure stability and quality of the service. In addition to this, black start of generation facilities can help to reconnect those affected areas and restore the service. This capabilities, so far normally available in conventional main power plants, can be implemented in distributed generation units, that conveniently coordinated with the DSO may contribute to the emergency management of the distribution network in the case of eventualities.

Use case*	Type of need	Scope of application of the service	Technology involved in service provision	
Black start	Conjunctural	Short-term	*Distributed generation*	*Storage*
Islanded operation	Conjunctural	Short-term		

**Other uses cases may be considered by the Flexibility Lab upon request of the interested stakeholders*
***Conjunctural needs are related to network operation*

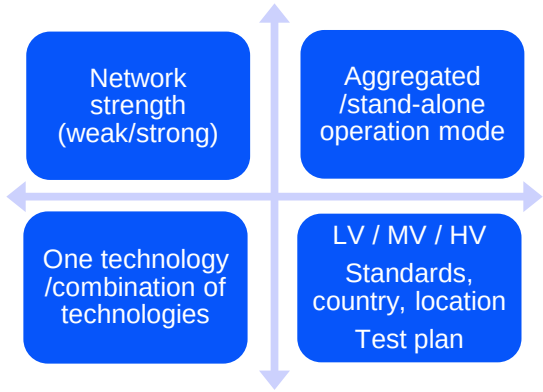
Flexibility Testing

Service: Emergency Management

Test description:

Present power electronics capabilities let renewable facilities control their production in such a way that, on the one hand, it can be adapted to variations in demand and, on the other hand, it can execute a black start. After the occurrence of a failure, DSO will manage the creation of a controlled island, in direct coordination with the flexibility service providers and supported by the necessary network protection devices and control systems. In addition to this, in the process of service restoration, units equipped with black start functionalities can be operated according to DSO coordination.

Test characterization:



The tests to be performed must be characterized by replicating the conditions of the network where the service will be needed and by evaluating the compliance of the flexibility service provider with different operation modes and other technologies.

In addition to this, it will be defined a **Test plan** adapted to both the Flexibility Lab center(s) implied and the final location where the service will be implemented, specially regarding standards, regulatory requirements, etc.

Test plan: phases and duration (**)

Praparatory phase
- Lab set up
- Network simulation
- Node requirements identification
- Flexible Service Provider settlement
- Service activation

Emergency management tests
- Set point sending
- Set point reception
- Set point activation
- Set point update compliance
- Tests finalization

Assessment
- Communication assessment
- Time of response
- Set point acknowledge reception
- Set point compliance
- Product activation compliance according to test plan objectives

***Test plans must be defined by the Flexibility Lab in coordination with interested stakeholders and their specific capabilities and needs*

Flexibility Service

Service: MV/LV Observability

Rationale: A set of actions to manage real-time measures of distributed generation to be collected, used by the DSO for the advanced operation, and provided to the TSO, to be used to ensure a safe network operation.
Observability includes the integration of infrastructures and devices with DSO SCADA systems, in order to ensure the correct behavior of the interfaces. Observability is naturally related to “controllability”, thus to flexibility services such as congestion management, voltage control and emergency management. As an example, in Italy the devices that could be tested are the interface of the Central Plant Controller (“Controllore Centrale di Impianto”), defined by the CEI 0-16 Standard, for medium voltage distributed generation and the interface Chain3 for the low voltage

Use case*	Type of need	Scope of application of the service	Technology involved in service provision
Testing and integration of devices related to the observability perimeter	Structural	Long-term	*Distributed generation or “complex” (composite) plants*
Compensate voltage levels via reactive and active power control due to specific needs of the advanced and emergency operation	Conjunctural	Short-term	
	Structural	Long-term	
Congestion solving in a specific branch of the network due to specific needs of the advanced and/or emergency operation	Conjunctural	Short-term	
	Structural	Long-term	

**Other uses cases may be considered by the Flexibility Lab upon request of the interested stakeholders*

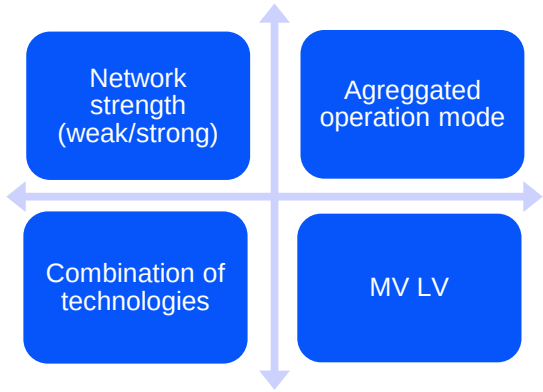
Flexibility Testing

Service: MV/LV Observability

Test description:

It is identified a network with presence of distributed generation. This network is simulated using simulation and emulation devices of the lab. A real interface device (e.g. Central Plant Controller for Italy) is interfaced to the simulation/emulation system in order to acquire real measures and to apply set-points (e.g. active & reactive power regulation, regulation functions activation). The interface device is connected and integrated with the SCADA, then simulation is run in order to verify observability and/or controllability functionalities of the interface device.

Test characterization:



The tests to be performed must be characterized by replicating the conditions of the network where the service will be needed and by evaluating the compliance of the flexibility service provider with different operation modes and other technologies.

In addition to this, it will be defined a **Test plan** adapted to both the Flexibility Lab center(s) implied and the final location where the service will be implemented, specially regarding standards, regulatory requirements, etc.

Test plan: phases and duration (proposal**)

Preparatory phase

- Lab set up
- Cybersecurity check
- Network simulation
- Node requirements identification
- Service activation

Full interface test

- Measures generation
- Measures acquisition
- Measure elaboration by the SCADA
- Set point reception
- Set point activation
- Set point update
- Test finalization

Assessment

- Communication assessment
- Measures validation
- Measures period validation
- Time of response
- Set point acknowledge reception
- Set point compliance

***Test plans must be defined by the Flexibility Lab in coordination with interested stakeholders and their specific capabilities and needs*

Flexibility Lab - Facility

Schematic representation of how it works

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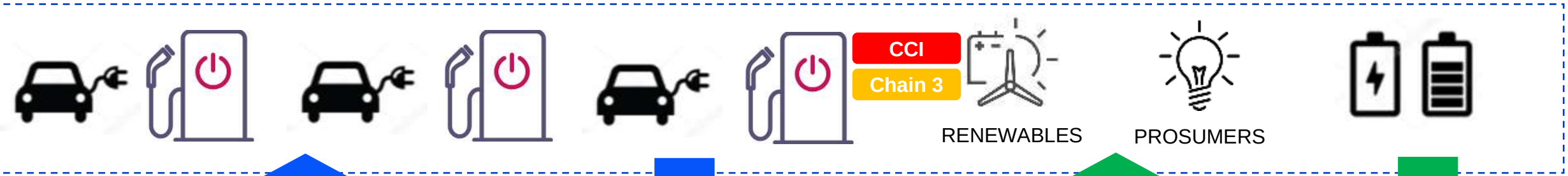
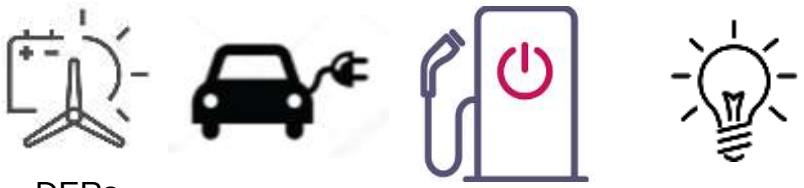


Real Grid **(even distributed)**

Simulators and Solutions @ the Lab

SCADA/ ADMS/ DERMS

Simulated/Emulated Flexibility Resources



Support Facilities

AGGREGATORS | TSO | FAP/FSP | STANDARDIZATION / REG BODIES | UNIVERSITIES & RESEARCH CENTERS

Flexibility Parameters

Flexibility products definition parameters

Parameter		description	Service type
Service delivery period	T_{ser}	Time interval in which the service can be activated (i.e. months, weekly days, daily hours)	CRP; CRP2
Response time	T_{act}	time interval between the request and the activation of the service	CRP; CRP2
Shape	T_{dur}	duration of the time-power profile	SRP; CRP; CRP2
	V_{ser}^{po}	Volume, power over time (kW; kvar)	SRP; CRP; CRP2
	$R_{lim}^{dep/end}$	Ramping rates range (min-max kW; kvar)	SRP; CRP; CRP2
Service delivery	Envelope	Tolerance between the expected volume and the volume actually supplied (min-max kW; kvar)	SRP; CRP; CRP2
	V_{pb}^{tol}	Pay-back acceptable - service delivery envelop extension (kW; kvar)	SRP; CRP; CRP2
Available capacity		Minimum asset capacity for service supply (min kW; kvar)	SRP; CRP; CRP2
Localization		Flexibilty area perimeter (POD set)	SRP; CRP; CRP2

SRP: Scheduled Re-Profiling — The FSP has the obligation to supply the product at the specified time
CRP: Conditional Re-Profiling — The DSO has the option to request the activation of the service
CRP2: 2-directional CRP — Bidirectional defined to reduce the transaction cost