Disaggregated consumption and generation forecast for operational planning purposes

Based on IEC 62559-2 edition 1
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1. Description of the use case

1.1. Name of use case

Use case identification		
ID	***Area(s)/Domain(s)/Zone(s)***	***Name of use case***
	Transmission System, Distribution System, Operational planning, Long-term planning, Energy Markets, Users, Distribution Management, Real-Time Operation, Energy systems	Disaggregated consumption and generation forecast for operational planning purposes

1.2. Version management

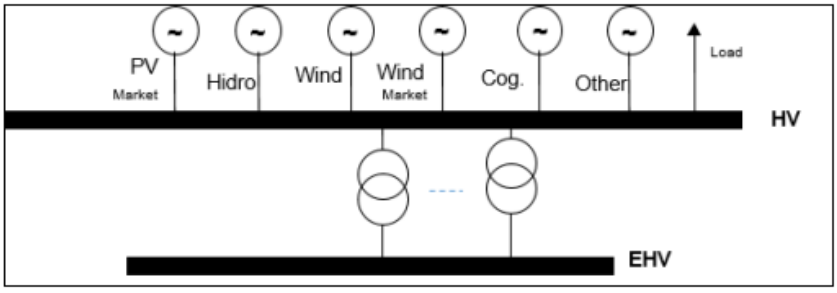
Version management				
Version No.	***Date***	***Name of author(s)***	***Changes***	***Approval status***
1	2018-09-06	Francisco Reis & Gonçalo Glória [R&D Nester]		Approved Version

1.3. Scope and objectives of use case

Scope and objectives of use case	
Scope	Improve the planning activities of the TSO's with the sharing of DSO's forecast information about aggregated generation by technology type and load by node in the observability area
Objective(s)	Improve programming of DSO operation Improve programming of TSO operation Improve the forecasted information exchanged in TSO-DSO interface
Related business case(s)	

1.4. Narrative of Use Case

Narrative of use case
Short description
This SUC describes the design of a process to forecast production disaggregate by technology type (Wind, Solar, Hydro, CHP, others) and load by node belonging to the observability area. The information should be sampled with intervals of 15 minutes and refreshed at each 24h for the time-span of the next 72h. This information is used for operational planning purposes or two times a year for planning purposes.
Complete description
The TSO's operational planning is essential to ensure a secure and efficient operation of the bulk power system. The forecast of load and generation that is computed by the DSO's could be useful for the TSO's for planning purposes. The DSO's have the ability to compute the forecasted consumption and aggregated generation by distribution grid node. Therefore, what is suggested in this SUC is the sharing of this information for the distribution nodes that make part of the TSO's observability area. The main purpose is enhancing the TSO's operational planning activities because of the more reliable forecast data provided from DSO's side.



The figure above shows the disaggregated generation and load forecast at node level in the observability area.

About the generation forecast, this Use Case assumes that DSOs can forecast the DER infeed and aggregate the information to node level in the observability area, as well as performing a disaggregation by technology type (wind, PV, hydro, CHP, etc.). With this rationale (use of more accurate information concerning the production and consumption forecasts), the TSO's can manage with more effectiveness the congestion procedures and increase the security of supply. These forecast information provided by the DSO is even more important if the TSO can represent the DSO networks (at least the HV network) inside the observability in its operational planning analysis.

In addition, the load forecast is provided from DSO to TSO with the same rationale of generation forecast regarding aggregation level. The pre-operation planning system of DSO should aggregate the forecasts by node in each observability area. In some cases the disaggregation by type of consumption (Residential, Industrial, Services) could be presented. Another disaggregation that is proposed is the differentiation between the DRES that are feed in-tariff and the ones that participates in the wholesale markets.

The disaggregation of the forecasts are important mainly to model the uncertainty of the previsions. As example, if a wind farm have a feed-in contract, can inject in the network the available power in each instant. If the same wind farm participate in the market, the production will be limited at the power sold in the market. This means that the SOs not need to consider the probability to have more production than the one sold on the market by the wind farm.

In this situation, a market forecast is also needed for the cases in that DRES participates in wholesale markets. For operational planning purposes, it is suggested a 72h ahead forecasting of market results, consumption and generation should be employed to capture all relevant planning processes of TSOs and DSOs..

Therefore, the forecasting data that is exchanged between the DSO and TSO should contain a time span of 72h ahead, with a daily refresh rate. The data should be shared with a granularity of 15 min. Therefore, the last time at which the forecast information is exchanged between TSO and DSO for operational planning purposes is 24-hours ahead of the application period.

1.5. Key performance indicators (KPI)

Key performance indicators			
ID	***Name***	***Description***	***Reference to mentioned use case objectives***
1	Forecast error (%)	Evaluation of the forecast error (%) globally and by node considered in the TSO models	Improve programming of TSO operationImprove the forecasted information exchanged in TSO-DSO interface
2	TSO's state estimator accuracy (%)	Evaluation if state estimation accuracy improve when DSO provides the consumption and production forecast information.	Improve programming of TSO operationImprove the forecasted information exchanged in TSO-DSO interface

1.6. Use case conditions

Use case conditions	
Assumptions	
1	Time-span: 72 h
2	Refresh-rate: 24h or 12h
3	Load and generation forecasts, including forecasts of DERs, required for the operational planning are always available.
4	Granularity of 15 minutes
Prerequisites	
1	The generation and load forecast are only presented for HV buses connected to TSO substations or HV buses in meshes between EHV/HV feeders
2	The observability area is defined and agreed upon between TSO and DSO
3	The DSO forecasts 72 hours ahead the load and the aggregated generation separated by technology type (wind, PV, hydro, CHP, etc.) and location at a node level within observability area.

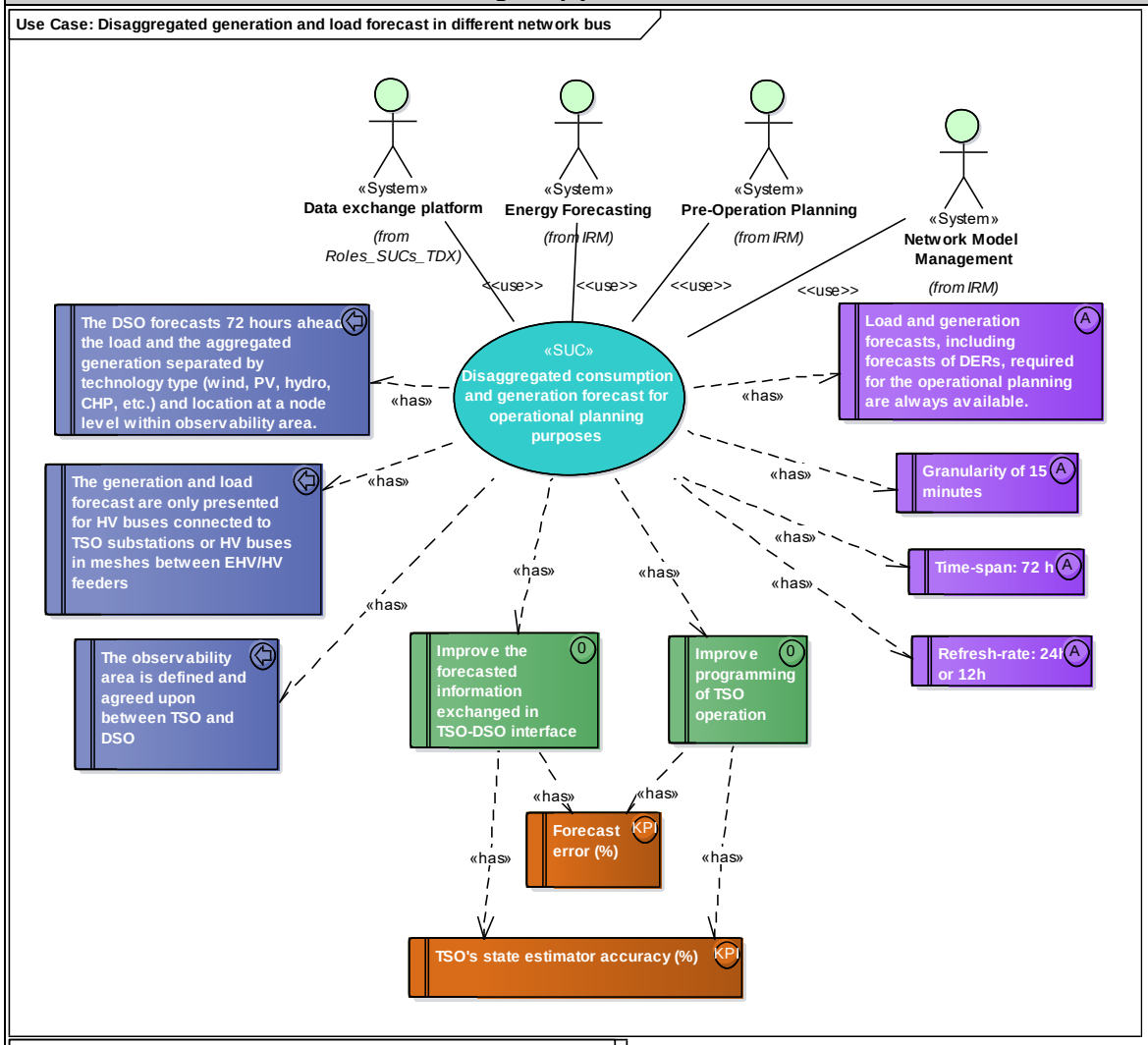
1.7. Further information to the use case for classification/mapping

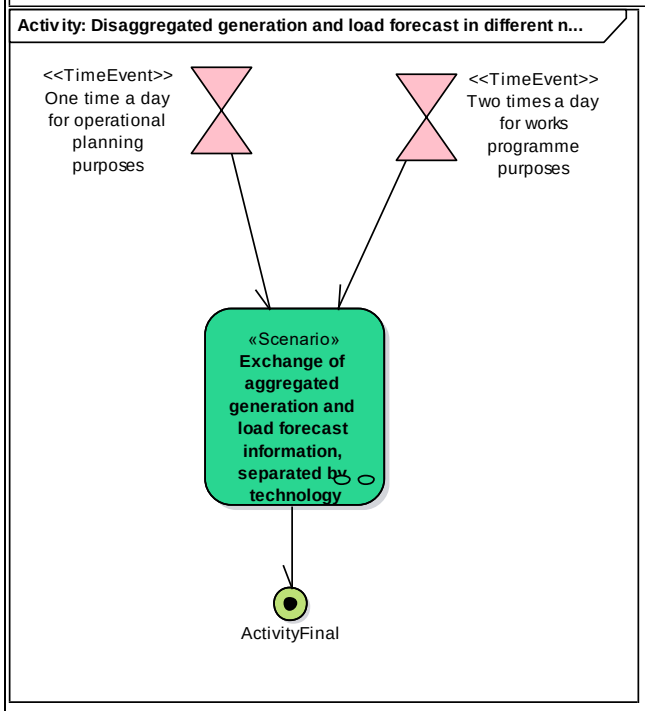
Classification information
Relation to other use cases
<<BUC>> [7] Coordination of operational planning activities between TSO and DSO <<SUC>> Process a MV network reconfiguration request <<SUC>> Validation of works programmes in operational planning <<SUC>> Process a HV/MV substation use limit (Smax) request <<SUC>> Information exchange using a collaborative platform
Level of depth
Prioritisation
High
Generic, regional or national relation
Generic
Nature of the use case
SUC
Further keywords for classification
Forecast, Operational Planning

1.8. General remarks

2. Diagrams of use case

Diagram(s) of use case





3. Technical details

3.1. Actors

Actors			
Grouping (e.g. domains, zones)		***Group description***	
Actor name	***Actor type***	***Actor description***	***Further information specific to this use case***
Data exchange platform	System	Platform used by several entities to exchange information for different proposes. The 3 types of data (Real-time; scheduled and structural data) can be exchanged in this platform. The operational/control data are not included in the real-time type. The exchange of information related with markets is included in the scheduled data. The data-agnostic ICT infrastructure enables a secure and reliable information exchange for different purposes and within different time scales.	
Pre-Operation Planning	System	The Predictive Operation Planning (POP) business function involved in forecasting future operation situation with an acceptable level of reliability, the inclusion of what-if scenarios and risk assessment. This include the management of adequate that requires system operators and planners to take into account scheduled and reasonably expected unscheduled availability of equipment, while maintaining a constant balance between supply and demand.	
Network Model Management	System	The Network Model Management (NMM) manages information for establishing and maintenance of the functional description of the network grid that is provided by current installed asset (as-built model), planned installed asset (future model) or potential installation (what-if/ hypothetical model). The focus is to provide a mathematical model of the network grid that can be used in different analysis of the grid, including but not limited to steady state power flow, state estimation, contingency analysis as part of security assessment and stability analysis. It maintains master representations of the power system for network analysis functions, so that all analysis shares the same source information. Network Model Management (NMM) handles both internal enterprise element and cross entity both in the horizontal and vertical domain, e.g. TSOs-TSOs and TSOs-DSOs coordination.	
Energy Forecasting	System	The Energy Forecasting business (EF) function involves the forecasting of one or more of the items consumption (load), production (primarily intermittent or price inelastic production), direct current and area inter-exchange. This also include energy forecast for intermittent or price inelastic production that is part of Distributed Energy Resources (DER).	

4. Step by step analysis of use case

4.1. Overview of scenarios

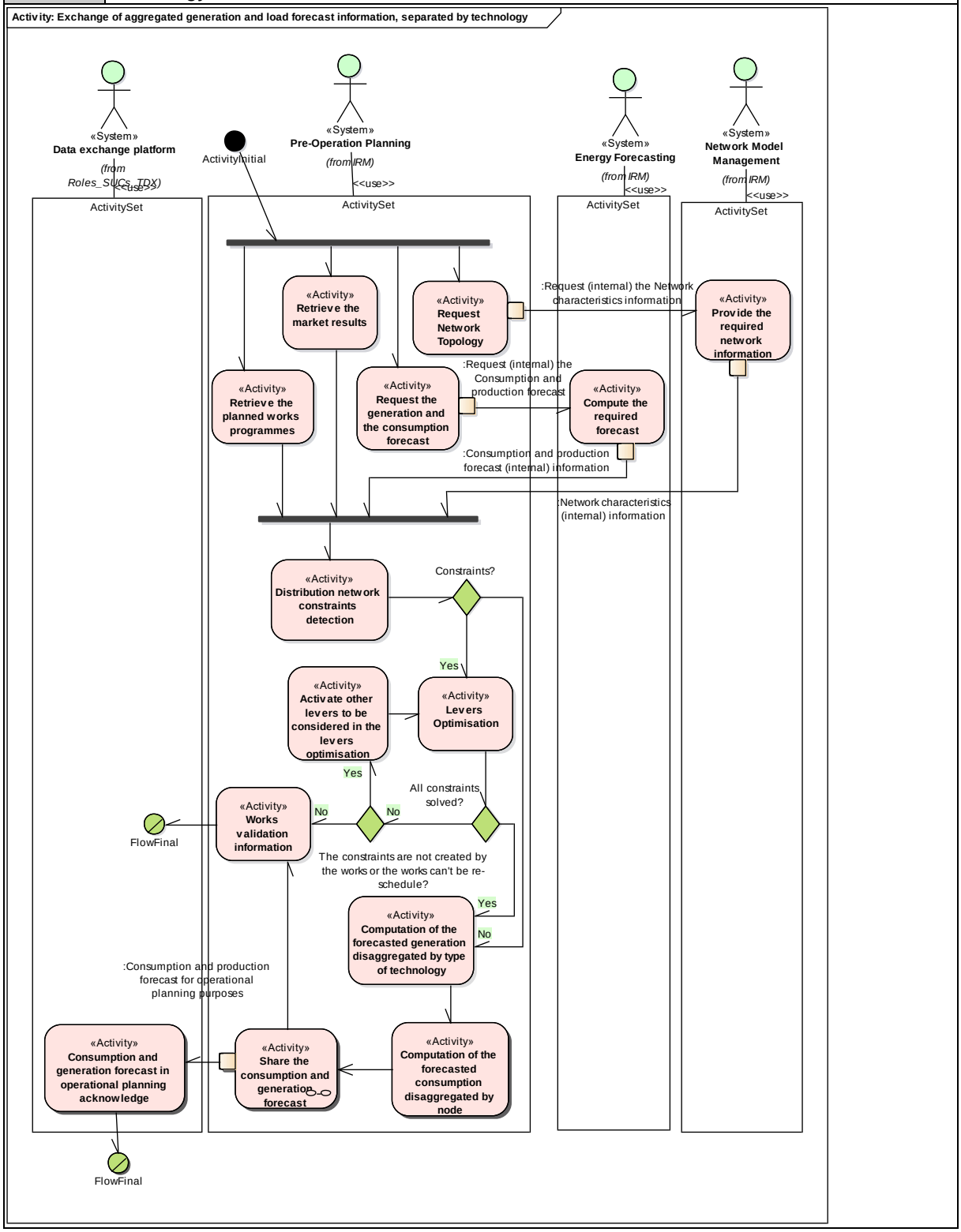
Scenario conditions						
No.	***Scenario name***	***Scenario description***	***Primary actor***	***Triggering event***	***Pre-condition***	***Post-condition***
1	Exchange of aggregated generation and load forecast information, separated by technology			One time a day for operational planning purposes: Every day, at a defined hour between TSO and DSO Two times a day for works programme purposes		

4.2. Steps - Scenarios

4.2.1. Exchange of aggregated generation and load forecast information, separated by technology

Scenario step by step analysis

Scenario	
Scenario name	Exchange of aggregated generation and load forecast information, separated by technology



Step No	Event	Name of process/activity	Description of process/activity	Service	Information producer (actor)	Information receiver (actor)	Information exchanged (IDs)	Requirement, R-IDs
1.1		Retrieve the market results	If the SGU participate in the markets, the market results should be taken into account in the operational planning		Pre-Operation Planning			
1.2		Request Network Topology	The pre-operation planning system should request the network information to define the aggregation of information		Pre-Operation Planning	Network Model Management	Info1-Request (internal) the Network characteristics information	
1.3		Provide the required network information			Network Model Management	Pre-Operation Planning, Pre-Operation Planning, Pre-Operation Planning	Info2-Network characteristics (internal) information	
1.4		Request the generation and the consumption forecast	Producers should provide the forecast of their generation. The forecast of the consumption should be done by substation HV/MV. The forecast can be disaggregated by type of consumption (e.g. residential, industrial, services)		Pre-Operation Planning	Energy Forecasting	Info3-Request (internal) the Consumption and production forecast	
1.5		Compute the required forecast	The forecast should be computed for the next 72 hours in intervals of 15 minutes.		Energy Forecasting	Pre-Operation Planning, Pre-Operation Planning, Pre-	Info4-Consumption and production forecast (internal) information	

			The forecast creation process is not the main focus of the presented SUC.			Operation Planning		
1.6		Retrieve the planned works programmes	To determine the consumption and production profiles, the SO should take into consideration the planned works (assets maintenance, outages, grid expansion, ...). This activity is described in the SUC "Validation of works programmes in operational planning"		Pre-Operation Planning			
1.7		Distribution network constraints detection	Considering the consumption and production forecast, the SO should evaluate if some constraints can exist in distribution system.		Pre-Operation Planning			
1.8		Levers Optimisation	To avoid the forecasted constraints in operational planning, the SO can activate some levers. The levers available to solve the constraints can be different in each system.		Pre-Operation Planning			
1.9		Activate other levers to be considered in the levers optimisation	If in the first iteration the operational constraints have not been		Pre-Operation Planning			

			solved, the SO can activate other levers. As example, the SO can consider the production or consumption curtailment in SGU without curtailment contracts or in passive grid users, change the contracted reactive power profile of producers, use a conservation voltage reduction lever, consider the other network reconfiguration topologies (e.g implying service interruption), etc.					
1.10		Works validation information	The information concerning the works validation should be provided to other SOs and internally to the different entities in the SO. If the works were not validated, the system should change the schedule of the planned works in collaboration with other entities. The process to change the works schedule is described in the SUC "Validation of works		Pre-Operation Planning			

			programmes in operational planning"					
1.11		Computation of the forecasted generation disaggregated by type of technology	The computation of the aggregated generation by technology type should be presented per node in each observability area. The algorithm should also disaggregate the information by the producers that participate in the market and the ones that have feed-in tariffs.		Pre-Operation Planning			
1.12		Computation of the forecasted consumption disaggregated by node	The system should aggregate the forecasts by node in each observability area. In some cases the information should be disaggregated by type of consumption (Residential, Industrial, Services) can be necessary.		Pre-Operation Planning			
1.13		Share the consumption and generation forecast	The final result after the levers scheduling should be transmitted to the data exchange platform		Pre-Operation Planning	Data exchange platform	Info5-Consumption and production forecast for operational planning purposes	
1.14		Consumption and generation forecast in operational planning acknowledge	The information about the forecast of load and generation per node in the observability area is transmitted to		Data exchange platform			

			the data exchange platform and could be acknowledged and used by the TSO. The internal processes of TSO, that can use the forecast information, are not described in the present work.					

5. Information exchanged

Information exchanged			
Information exchanged, ID	***Name of information***	***Description of information exchanged***	***Requirement, R-IDs***
Info1	Request (internal) the Network characteristics information	The structural information of the network characteristics are required to the computation process. This information is exchanged between different systems roles in the SOs. A structural network information request consists of: Internal Request ID Type of request Substation (All the information in downstream of substation) Transformer (All the information in downstream of transformer) Feeder (All the information in downstream of feeder)	
Info2	Network characteristics (internal) information	The structural information of the network characteristics are required to the computation process. This information is exchanged between different systems roles in the SOs. Structural network information request: Internal Request ID Substation Power Transformer Resistance Reactance Feeder Line Resistance Reactance Capacitance	
Info3	Request (internal) the Consumption	Consumption and generation forecast (scheduled information) request.	

	and production forecast	Internal Request ID Type of Request Substation Transformer Feeder Start Time (day; hour; minute) End Time (day; hour; minute) The time should be done in intervals of 15 minutes.	
Info4	Consumption and production forecast (internal) information	The consumption and generation forecast (scheduled information). Internal Request ID Type of Request Substation Quantile Pconso_Substation Pprod_Substation Qconso_Substation Qprod_Substation Transformer Quantile Pconso_Transformer Pprod_Transformer Qconso_Transformer Qprod_Transformer Feeder Quantile Pconso_Feeder Pprod_Feeder Qconso_Feeder Qprod_Feeder Start Time (day; hour; minute) End Time (day; hour; minute) The time should be done in intervals of 15 minutes. If necessary, several quantiles (the number of quantiles depends of the request and the process needs) can be included in the forecast. With this information, more advanced algorithms leading with uncertainties can be adopted.	
Info5	Consumption and production forecast for operational planning purposes	Consumption and generation forecast (scheduled information). Observability area ID Substation ID Start Time (day;hour;minute) End Time (day;hour;minute) Conso_type (Residential, Industrial, Services) Pconso_Substation_Type_time Qconso_Substation_Type_time	

		Produ_Type (In the market, Feed-in tariffs) Produ_Tech (Wind, PV, CSP, CHP, small-hydro) Pprod_Substation_Type_Tech_Time Qprod_Substation_Type_Tech_Time The time should be done in intervals of 15 minutes.	

6. Requirements (optional)

7. Common terms and definitions

8. Custom information (optional)