TECHNICAL DECISION

Integrated Scheduling Process

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Definitions and Abbreviations

❖ Definitions

Apart from the definitions contained in the current legislation, and, in particular, in Law 4425/2016 and Law 4001/2011, as in force, in EU legislation, in the HETS Grid Code, in the Day-Ahead & Intra-Day Markets Trading Rulebook, in the Clearing Rulebook for Balancing Market Positions and in the Balancing Market Rulebook, as in force, the terms below, whether stated in the singular or plural, shall have the following meaning, for the purpose of implementation of this Technical Decision.

1. Energy Balancing Market: It shall have the meaning of Article 5(l) of Law 4425/2016, i.e. the market where Participants offer electricity, which is used by the HETS Operator to maintain the system frequency within a predetermined range, as well as the balance between electricity generation and demand, while observing the electricity exchange programs with neighbouring countries.
2. Balancing Market: It shall have the meaning of Article 5(j) of Law 4425/2016, i.e. the Electricity Balancing Market, which includes the Balancing Capacity and Balancing Energy Markets and the imbalance settlement procedure.
3. Day-Ahead Market: It shall have the meaning of Article 5(g) of Law 4425/2016, i.e., the Electricity Market, in which electricity purchase and sale transactions are performed with the obligation of physical delivery on the day ahead (Delivery Day) and in which the transactions performed on Energy Financial Instruments with physical delivery are declared.
4. Balancing Capacity Market: It shall have the meaning of Article 5(k) of Law 4425/2016, i.e. the market in which capacity is offered to cover the system's reserve requirements, which (capacity) is retained by the Participants for a predetermined period of time.
5. Market Time Unit: It shall have the meaning of Article 2(19) of Regulation (EU) 534/2013. i.e. the period for which the market price is established or the shortest possible common time period for the two Bidding Zones, if their market time units are different. The duration of the Market Time Unit shall be equal to one hour.
6. Upward Balancing Energy: The Balancing Energy that corresponds to more generated energy or less consumed energy in relation to the Market Schedule.
7. Balancing Capacity Offer Maximum Price: The upper limit on the pricing of Balancing Capacity Offers, which is imposed for technical reasons, in accordance with Article 51 of the BMR.
8. Balancing Energy Offer Maximum Price: The upper limit on the pricing of Balancing Energy Offers, which is imposed for technical reasons, in accordance with Article 55 of the BMR.
9. Safety Maximum Reservoir Level: The maximum level per reservoir, above which the owners of Dispatchable Hydro Generating Units connected to the Reservoir may submit mandatory hydro injection declarations for the above Units to avoid overflow.
10. Force Majeure: It shall have the meaning of Article 26 of the BMR.

11. Imbalance: It shall have the meaning of Article 2(8) of Regulation (EU) 2017/2195, i.e. the energy volume calculated for a BRP and representing the difference between the allocated volume attributed to that BRP and the final position (Market Schedule) of that BRP, including any imbalance adjustment applied to that BRP, within a given Imbalance Settlement Period
12. Automatic Generation Control: The automatic load-frequency control procedure, which aims to reduce the frequency restoration control error to zero in accordance with the provisions of Regulation (EU) 2017/1485.
13. Soak Trajectory: The generation level between synchronization and minimum generation of each Generating Unit, which is carried out in up to six (6) hourly steps. A different soak trajectory is determined for each start-up state (hot, warm, cold). It is expressed in MW.
14. Declared Characteristics: The characteristics which are defined as a combination of the following technical and operational elements of the Balancing Service Entity and constitute the actual technical capacity of the Balancing Service Entity for a specific Dispatch Period and Dispatch Day: (a) Registered Characteristics, (b) Techno-Economic Declaration, (c) non-Availability Declaration (total or partial), as applicable, and (d) Major Outage Declaration.
15. Major Outage Declarations: The declarations submitted by the BSPs pursuant to Article 48 of the BMR.
16. Non-Availability Declarations: The declarations submitted by the BSPs pursuant to Article 47 of the BMR for each Dispatch Day during which the Available Capacity for a Balancing Service Entity is reduced.
17. Techno-Economic Declarations: The declarations submitted by the BSPs for each Dispatch Day pursuant to Article 44 of the BMR regarding the Techno-economic data of the BSEs they represent.
18. Integrated Scheduling Process (ISP): It shall have the meaning of Article 2(19) of Regulation (EU) 2017/2195, i.e. an iterative process that uses at least integrated scheduling process bids that contain commercial data, complex technical data of individual power generating facilities or demand facilities and explicitly includes the start-up characteristics, the latest control area adequacy analysis and the operational security limits as an input to the process.
19. Inter-Zonal Corridor: A virtual link between two Bidding Zones, which is used to model the flow between the Bidding Zones.
20. Available Capacity: The capacity of the Balancing Service Entity deriving from the Techno-Economic Declaration decreased by any non-available capacity pursuant to Article 43 of the BMR.
21. RES and Guarantees of Origin Operator (DAPEEP): The public limited company provided for in Article 118 of Law 4001/2011.
22. HETS Operator: The public limited company provided for in Article 97 of Law 4001/2011.
23. Distribution Network Operators: It shall have the meaning of Article 2(3)(j) of Law 4001/2011, i.e. the legal person exercising, under the provisions of Law 4001/2011, the

duties of an Electricity or Natural Gas Distribution Network Operator, including the Operators of the Closed Electricity or Natural Gas Distribution Networks.

24. Hellenic Electricity Distribution Network Operator (HEDNO): The public limited company provided for in Article 123 of Law 4001/2011.

25. Testing Operation: The status of a Balancing Service Entity, which is registered with the HETS Operator Registry, during tests or operational controls.

26. Commissioning Operation: The status of a pre-registered Balancing Service Entity in the course of the tests or operational controls that are conducted for its connection to the HETS, as set out in the connection contract and the relevant provisions of the HETS Grid Code, so that it can be registered with the HETS Operator Registry.

27. Virtual Entity: An Entity capable of providing Balancing Services to the ISP, which is modeled either as a discrete configuration of a Balancing Service Entity or as a non-physical entity, as specified in Section 3.2 herein.

~~27.~~28. Load Representative: The Balance Responsible Parties representing BSEs that offtake energy from the HETS or the electricity Distribution Network, other than Demand Response Aggregators.

~~28.~~29. Minimum Available Capacity: The Technically Minimum Generation, as modified on the basis of the non-Availability declarations by the Balancing Service Entity. The Minimum Available Capacity is equal to the Technically Minimum Generation, unless the Balancing Service Entity has submitted a Declaration of Total or Partial non-Availability. In case of Total non-Availability, the Minimum Available Capacity is zero. In case of Partial non-Availability, Minimum Available Capacity is modified on the basis of the Declaration of Partial non-Availability.

~~29.~~30. Minimum Available Capacity in AGC mode: The Minimum Available Capacity of a Balancing Service Entity when it is operating under AGC. It is expressed in MW. The Minimum Available Capacity in AGC mode is higher or equal to the Minimum Available Capacity.

~~30.~~31. Safety Minimum Reservoir Level: The minimum level per reservoir, above which the Dispatchable hydro Generating Units Providers connected to the reservoir may submit declarations of maximum daily energy injection constraint for the above Units.

~~31.~~32. Minimum up time: The minimum time of operation, as set out in the Registered Characteristics of the Balancing Service Entity, between a start-up and the next shut-down.

~~32.~~33. Minimum down time: The minimum time out of operation, as set out in the Declared Characteristics of the Balancing Service Entity, between the desynchronization and the next start-up.

~~33.~~34. Balancing Energy: The energy provided by a BSP and used by the HETS Operator to make a balance, i.e. to cover the generation/demand imbalances. It is divided into upward and downward Balancing Energy.

~~34.~~35. Priority Price-Taking (Sell/Buy) Orders: The priority price-taking (sell/buy) orders are one-step Hourly Hybrid (sell/buy) Orders that are submitted to the Day-Ahead Market and the Intra-Day Market (Intra-day Auctions), at a price equal to the highest/lowest acceptable price, namely at the Market Order Upper/Lower Price that applies to each of the above Markets.

~~35.~~36. Dispatch Instruction: The instruction issued by the HETS Operator, determining active power generation, active power increase or decrease, synchronization or desynchronization, provision of reserves and other Ancillary Services and, in general, the mode of operation of BSEs.

~~36.~~37. Ancillary Service: It shall have the meaning of Article 2(3)(q) of Law 4001/2011, i.e. a service necessary for the operation of a transmission or distribution system, such as voltage control, frequency control, provision of reserves, provision of reactive power, Transmission System black start and load fluctuation monitoring.

~~37.~~38. Frequency Restoration Reserve (FRR): It shall have the meaning of Article 3(7) of Regulation (EU) 2017/1485, that is, the active power reserves available to restore system frequency to the nominal frequency and, for a synchronous area consisting of more than one load frequency control area, to restore power balance to the scheduled value. It is divided into FRR with automatic activation and FRR with manual activation (automatic and manual FRR).

~~38.~~39. Frequency Containment Reserve (FCR): It shall have the meaning of Article 3(6) of Regulation (EU) 2017/1485, that is, the active power reserves available to contain system frequency after the occurrence of an imbalance.

~~39.~~40. Reliability Year: The period of time starting on 1st October of a calendar year and ending on 30th September of the following calendar year.

~~40.~~41. Bidding Zone: The Bidding zone is defined under Article 2(3) of Regulation (EU) 543/2013, i.e. the largest geographical area within which market participants are able to exchange energy without capacity allocation. The Bidding Zones are approved by decision of RAE, following a proposal by the HETS Operator and a relevant study as provided for in the HETS Grid Code.

~~41.~~42. Zonal Load Forecasting: The zonal Load Forecasting prepared by the HETS Operator as set out in Article 39 of the BMR.

~~42.~~43. Zonal RES Forecasting: The zonal RES Forecasting prepared by the HETS Operator as set out in Article 40 of the BMR.

~~43.~~44. Physical Delivery Day: It shall have the meaning of Article 5(f) of Law 4425/2016, that is, the day on which the quantities of energy traded on the Electricity Markets are delivered.

~~44.~~45. Dispatch Day: It shall have the meaning specified in Article 36 of the BMR, that is, the day to which the ISP refers, which coincides with the Physical Delivery Day of the Day-

Ahead Market and the Intra-Day Market. Dispatch Day D shall start at 01:00 EET of calendar day D and shall end at 01:00 EET of calendar day D +1.

45.46. Balancing Capacity: A volume of reserve capacity that a BSP has agreed to hold in each Dispatch Period and in respect to which the BSP has agreed to submit bids to the HETS Operator for a corresponding volume of Balancing Energy for the duration of the contract.

46.47. Downward Balancing Energy: The Balancing Energy that corresponds to less generated energy or more consumed energy in relation to the Market Schedule.

47.48. Consumer: It shall have the meaning of Article 2(n) of Law 4001/2011, i.e., electricity Customers, excluding Natural Gas System and Distribution Network Operators, as well as Electricity Transmission System or Distribution Network Operators.

48.49. Dispatchable Generating Units: The power generating units with a valid production license, which are located on the mainland or on the interconnected islands, have made and activated a connection to HETS, have submitted an operating license and have an installed capacity over 5 MW, for which the HETS Operator may issue Dispatch Instructions, provided they are not RES Units, Emergency Reserve Units, and only during the period for which an Ancillary Service Contract or a Supplementary System Energy Contract is not in force or is not implemented, in accordance with the HETS Grid Code.

49.50. Dispatchable Generating Units with Alternative Fuel: Dispatchable Generating Units having the obligation or the ability to operate both with primary and alternative fuels.

50.51. Dispatchable HECHP Units: Partial cogeneration units with an installed capacity over 35MWe which, by decision of RAE, have been designated as Dispatchable High Efficiency CHP Units.

51.52. Multi-shaft Combined Cycle Dispatchable Units: Combined Cycle Dispatchable Units in which gas turbines and steam turbines are located on different axes and are connected to distinct generators.

52.53. Emergency Situation: The Situation described in the HETS Grid Code.

53.54. Registered Characteristics: The technical and operational characteristics of BSEs that remain stable every Dispatch Day, unless modified by the BSPs. They are submitted as provided for in the HETS Grid Code.

54.55. Balancing Energy Offer Minimum Price: The lower limit on the pricing of Balancing Energy Offers, which is imposed for technical reasons, in accordance with Article 55 of the BMR.

55.56. Balancing Capacity Offer Minimum Price: The lower limit on the pricing of Balancing Capacity Offers shall be zero, in accordance with Article 51 of the BMR.

56.57. HETS Grid Code: The Code specified in Article 96 of Law 4001/2011.

57.58. Maximum Available Capacity: The Maximum Net Capacity, as modified on the basis of the non-Availability Declarations by the Balancing Service Entity. The Maximum Available Capacity is equal to the Maximum Net Capacity, unless the Balancing Service Entity has submitted a Declaration of Total or Partial non-Availability or Major Outage. In case of Total non-Availability, the Maximum Available Capacity shall be zero. In case of Partial non-Availability, the Maximum Available Capacity shall be modified on the basis of the non-Availability Declaration.

~~58.~~59. Maximum Available Capacity in AGC mode: The Maximum Available Capacity of a BSE when it is operating under AGC. It is expressed in MW. The Maximum Available Capacity in AGC mode is lower or equal to the Maximum Available Capacity.

~~59.~~60. Maximum Net Capacity: The maximum level of capacity that a BSE can maintain for any period of time, provided that it operates under ISO conditions, it is not constrained by any equipment, technical or other limitations pertaining to the institutional or financial framework governing the BSE's operation, and that the internal service, as well as any other auxiliary load have been taken into consideration.

~~60.~~61. Maximum Net Capacity in AGC mode: The Maximum Net Capacity of a BSE when it is operating under AGC. It is expressed in MW. The Maximum Net Capacity in AGC mode cannot exceed the Maximum Net Capacity.

~~61.~~62. Maximum contribution to FCR: The technical capacity of a Balancing Service Entity to offer Frequency Containment Reserve, as derived from the test results and specified in the Registered Characteristics. It is defined separately for upward and downward Frequency Containment Reserve. It is expressed in MW.

~~62.~~63. Maximum contribution to automatic FRR: The technical capacity of a Balancing Service Entity to offer automatic Frequency Restoration Reserve, as derived from the test results and specified in the Registered Characteristics. It is defined separately for upward and downward automatic Frequency Restoration Reserve. It is expressed in MW.

~~63.~~64. Maximum contribution to manual FRR: The technical capacity of a Balancing Service Entity to offer manual Frequency Restoration Reserve, as derived from the test results and specified in the Registered Characteristics. It is defined separately for upward and downward manual Frequency Restoration Reserve. It is expressed in MW.

~~64.~~65. Maximum Number of Daily Activations: The maximum number of activations of a Dispatchable Load Portfolio for the provision of Balancing Energy and Capacity on a Dispatch Day.

~~65.~~66. Maximum uptime per Activation: The maximum number of consecutive Dispatch Periods, during which a Dispatchable Load Portfolio can provide upward/downward Balancing Energy and/or Capacity.

~~66.~~67. Non Availability: The status of a BSE, when its Available Capacity is reduced in comparison to its Declared Characteristics. Reduced Available Capacity may occur in case of failure for technical reasons, related to the operation or the safety of its facilities, or for other reasons, which make it impossible to generate electricity and/or provide Balancing Services at the level of Maximum Net Capacity. The respective BSP must submit a non-Availability Declaration to the HETS Operator, as provided for in the BMR.

~~67.~~68. HETS Operator Registry: The Registry provided for in Article 4 of the BMR.

~~68.~~69. Balancing Market Generating Units Registry: The Registry provided for in Article 11 of the BMR.

~~69.~~70. Balancing Service Providers Registry: The Registry provided for in Article 5 of the BMR.

~~70.~~71. Balance Responsible Parties Registry: The Registry provided for in Article 5 of the BMR.

~~71.~~72. Dispatchable RES Units Portfolios Registry: The Registry provided for in Article 12 of the BMR.

~~72.~~73. Dispatchable Load Portfolio Registry: The Registry provided for in Article 13 of the BMR.

~~73.~~74. Major Outage: When a BSE is unable to operate for technical reasons, for a period that is expected to exceed a continuous period of ten (10) consecutive days in periods of high-demand (from 15th June to 15th August and from 10th December to 31st January) and two months for the remainder of the year.

~~74.~~75. RES Unit: A unit generating electricity from Renewable Energy Sources (RES) as defined in Law 3468/2006.

~~75.~~76. Non-Intermittent RES Units: The Non-Intermittent RES and HECHP Units, as defined in Law 4414/2016, i.e. power plants using biomass or biogas, geothermal, solar thermal and HECHP plants.

~~76.~~77. Intermittent RES Units: The Intermittent RES Units, as defined in Law 4414/2016, i.e. the power plants which generate electricity from RES which are intermittent and, in particular, wind power, solar PV and small hydro power plants.

~~77.~~78. RES Units with Market Participation Obligation: The RES Units for which a Contract for Differential State Aid Support has been concluded in accordance with the provisions of Law 4414/2016 as well as the RES Units covered by the provisions of Article 19 (3) and article 12A of Law 4414/2016.

~~78.~~79. RES Units without Market Participation Obligation: The RES Units for which a Feed-in Tariff Agreement has been concluded in accordance with the provisions of Law 4414/2016, as well as the RES Units for which a power purchase agreement has been concluded in accordance with the provisions of article 12 of Law 3468/2006 or a similar electricity purchase and sale agreement prior to the entry into force of Law 3468/2006.

~~79.~~80. Balance Responsible Entities: The entities represented by Balance Responsible Parties in accordance with Article 10 of the BMR.

~~80.~~81. Balancing Service Entities: The units or portfolios that are capable of providing Balancing Services to the HETS Operator and are represented by the BSPs in accordance with Article 10 of the BMR.

~~81.~~82. Producer: The holder of a Production License or a relevant exemption from the obligation to obtain a Production License.

~~82.~~83. Balancing Service Provider – BSP: It shall have the meaning of Article 23(8) of Regulation (EU) 2017/2195, i.e. a market Participant with units or portfolios able to provide Balancing Services to the HETS Operator.

~~83.~~84. Imbalance Settlement Period: The time unit for which the Imbalance of the Balance Responsible Parties is calculated.

~~84.~~85. Dispatch Period: It shall have the meaning specified in Article 36 of the BMR, that is, a period of time that lasts for half an hour. The first Dispatch Period of Dispatch Day D is 01:00 – 01:30 EET.

~~85.~~86. Market Schedule: The net energy schedule (net position) resulting from all transactions of the BSE on the wholesale market (i.e. transactions on the Energy Financial Market, the Day-Ahead Market or the Intra-Day Market) as defined in the Day-Ahead Market & Intra-Day Market Trading Rulebook.

~~86.~~87. ISP Schedule: The indicative generation/demand schedule for each BSE and for each Dispatch Period of the Dispatch Day as it derives from the ISP solution system.

~~87.~~88. Balancing Energy Offer: A Balancing Energy Offer corresponds to the intention to provide upward or downward Balancing Energy in relation to the Market Schedule of the respective BSE. The Balancing Energy Offers are described in Article 55 of the BMR.

~~88.~~89. Balancing Capacity Offer: A Balancing Capacity Offer corresponds to the intention to provide reserves for Reserve Capacity products. The Balancing Capacity Offers are described in Article 51 of the BMR.

~~89.~~90. Ramp Up Rate: The rate of increase of the active power of a BSE, expressed in MW/min, when the BSE is committed and not in the start-up or shut-down phase.

~~90.~~91. Ramp Down Rate: The rate of decrease of the active power of a BSE, expressed in MW/min, when the BSE is committed and not in the start-up or shut-down phase.

~~91.~~92. Ramp Up Rate in AGC mode: The rate of increase of the active power of a BSE, expressed in MW/min, when operating under AGC.

~~92.~~93. Ramp Down Rate in AGC mode: The rate of decrease of the active power of a BSE, expressed in MW/min, when operating under AGC.

~~93.~~94. Balance Responsible Party (BRP): It shall have the meaning specified in Article 23(7) of Regulation (EU) 2017/2195, i.e. a Market Participant or its chosen representative responsible for its Imbalances.

~~94.~~95. Contracted Generating Units: The Dispatchable Generating Units that have concluded Supplementary System Energy Contracts or Ancillary Services Contracts with the HETS Operator in accordance with the HETS Code.

~~95.~~96. Participant: The participant in the Balancing Market, either as a BSP or as a BRP.

~~96.~~97. Balancing Market System: A system that performs all the processes and all the necessary calculations, and records all the data and the results of the Balancing Market in terms of ISP, Balancing Energy Market and Balancing Market Settlement. The Balancing Capacity System is described in Article 14 of the BMR.

~~97.~~98. Emergency Plan: It means a plan that is drawn up in accordance with Article 73 of Law 4001/2011.

~~98.~~99. Technically Minimum Generation: The minimum level of capacity that a BSE can maintain for any period of time, provided that it operates under ISO conditions, it is not constrained by any equipment, technical or other limitations pertaining to the institutional or financial framework governing the BSE's operation, and that the internal service, as well as any other auxiliary load have been taken into consideration.

~~99.~~100. Technically Minimum Generation under Automatic Generation Control (AGC). The Technically Minimum Generation of a BSE when it is operating under AGC. It is expressed in MW. The Technically Minimum Generation under Automatic Generation Control (AGC) may be higher or equal to the Technically Minimum Generation.

~~100.~~101. Technical Decisions: The technical decisions provided for in article 18 of Law 4425/2016 and Annex I of the BMR.

~~101.~~102. Balancing Services: They must be interpreted according to the meaning of Article 2(3) of Regulation (EU) 2017/2195, i.e. Balancing Energy or Balancing Capacity, or both.

~~102.~~103. RES Aggregator: It shall have the meaning of article 2 (22) of Law 4414/2016.

~~103.~~104. Last Resort RES Aggregator: It shall have the meaning of article 2 (23) of Law 4414/2016. The Last Resort RES Aggregator is also included, unless otherwise expressly stated.

~~104.~~105. Demand Response Aggregator: It shall have the meaning of article 5(2)(o) of Law 4425/2016.

~~105.~~106. Dispatchable RES Units Portfolio: The RES units portfolio that includes one or more RES Units with Market Participation Obligation which are connected to a specific Bidding Zone and which, based on their technical capacity, offer Balancing Services to the HETS Operator. A Dispatchable RES Units Portfolio shall be represented by one RES Producer or by one RES Aggregator.

~~106.~~107. Dispatchable Load Portfolio: A load portfolio, that includes one or more loads which are connected to a specific Bidding Zone and which, based on their technical capacity, offer Balancing Services to the HETS Operator. A Dispatchable Load Portfolio shall be represented by a Demand Response Aggregator. A Dispatchable Load Portfolio that includes only one load can be represented by one Consumer. Each pumped storage hydro generating unit shall be a distinct Dispatchable Load Portfolio and shall be represented by one Producer.

~~107.~~108. Non-Dispatchable RES Units Portfolio: The RES units portfolio that includes one or more RES units with Market Participation Obligation which are connected to a particular Bidding Zone and which do not offer Balancing Services to the HETS Operator. Each non-

Dispatchable RES Units Portfolio shall be represented by one RES Producer or by one RES Aggregator.

~~108.~~109. Non-Dispatchable Load Portfolio: A load portfolio that includes one or more loads which are connected to a specific Bidding Zone and which do not offer Balancing Services to the HETS Operator. A non-Dispatchable Load Portfolio shall be represented by one Supplier or one Consumer.

~~109.~~110. RES Units Portfolio without Market Participation Obligation: The RES Units Portfolio for which either a Feed-in Tariff Agreement has been concluded in accordance with the provisions of Law 4414/2016, or a power purchase Agreement has been concluded in accordance with the provisions of article 12 of Law 3468/2006 or a similar electricity purchase and sale agreement prior to the entry into force of Law 3468/2006, which (Units) are connected to a specific Bidding Zone. RES Units Portfolios without Market Participation Obligation shall be represented by DAPEEP. DAPEEP has balancing responsibility for the RES Units Portfolios without Market Participation Obligation.

~~110.~~111. Transition time from minimum available capacity to de-synchronization: The time required for the generation level of a Generating Unit to drop from Minimum Available Capacity to zero MW during the shut-down phase.

~~111.~~112. Transition time from warm to cold state: The time during which a BSE is transitioning from warm state to cold state, when shut down, provided that it is not restarted before that specific Dispatch Period.

~~112.~~113. Transition time from hot to warm state: The time during which a BSE is transitioning from hot state to warm state, when it is shut down, provided that it is not restarted before that specific Dispatch Period.

~~113.~~114. Soak time from hot state: The time required during a hot start for a BSE to increase its generation level from synchronization to no more than the minimum generation, i.e. the exact level of production for up to six (6) hourly Dispatch Period steps.

~~114.~~115. Soak time from warm state: The time required during a warm start for a BSE to increase its generation level from synchronization to no more than the minimum generation.

~~115.~~116. Soak time from cold state: The time required during a cold start for a BSE to increase its generation level from synchronization to no more than the minimum generation.

~~116.~~117. Synchronization time from hot state: The time required for a BSE to synchronize when starting up from hot state. During that period, the generation level shall be zero.

~~117.~~118. Synchronization time from warm state: The time required for a BSE to synchronize when starting up from a warm state. During that period, the generation level shall be zero.

~~118.~~119. Synchronization time from cold state: The time required for a BSE to synchronize when starting up from a cold state. During that period, the generation level shall be zero.

~~119.~~120. Hellenic Energy Exchange: A public limited company that manages one or more Energy Markets and/or Energy Financial Markets.

Abbreviations

RES	Renewable Energy Sources
AGC	Automatic Generation Control
ISP	Integrated Scheduling Process
FRR	Frequency Restoration Reserve
~~**HEDNO**~~	~~Hellenic Electricity Distribution Network Operator~~
FCR	Frequency Containment Reserve
HETS	Hellenic Electricity Transmission System Operator
NNGS	National Natural Gas System
BMR	Balancing Market Rulebook
RAE	Regulatory Authority for Energy
BMMS	Balancing Market Management System
aFRR	Automatic Frequency Restoration Reserve
mFRR	Manual Frequency Restoration Reserve
EET	Eastern European Time
MW	megawatt
MWh	megawatt hour
BRP	Balance Responsible Party
BSE	Balancing Service Entity
BSP	Balancing Service Provider
CET	Central European Time
UTC	Coordinated Universal Time
ETSS	Energy Trading Spot System
MTU	Market Time Unit
LIDA	Local Intra-Day Auction
CRIDA	Complementary Regional Intra-Day Auction
EMS	Energy Management System
GCT	Gate Closure Time (Expiration of the Deadline)

1 Introduction

The Integrated Scheduling Process (ISP) is a process carried out by the Transmission System Operators that use Central Scheduling & Dispatching Systems. The process aims at covering the forecasted generation/demand imbalances and securing the required reserves. Consequently, the ISP results involve:

a) procurement of the Balancing Capacity needed to cover the forecasted generation/demand imbalances for the following Dispatch Day and

b) scheduling of the commitment of BSEs in a way that meets the constraints of the HETS and the BSEs.

The ISP is solved as a co-optimization problem taking into account the Balancing Energy and Balancing Capacity Offers of the BSEs as well as their respective constraints, the HETS constraints and the HETS Operator needs, in order to minimize the cost of Balancing Energy and Balancing Capacity procurement.

2 Timetable of Execution of the Integrated Scheduling Process

For the transitional period before commencement of the coupled operation of the Intra-Day Market of Law 4425/2016, the ISP is executed at three scheduled times for each Dispatch Day D as follows:

- **ISP1**: It is executed at 16:45 EET on calendar day D-1 and concerns all Dispatch Periods (48 Dispatch Periods) of Dispatch Day D,
- **ISP2**: It is executed after ISP1, taking into account the updated input data. It is executed at 00:00 EET on calendar day D and concerns all Dispatch Periods (48 Dispatch Periods) of Dispatch Day D.
- **ISP3**: It is executed at 12:00 EET on calendar day D, taking into account the updated input data. The time interval taken into account is from 13:00 EET until the end of Dispatch Day D (24 Dispatch Periods).

Until commencement of the coupled operation of the Intra-Day Market of Law 4425/2016, ISP1 is executed at 16:15 EET of calendar day D-1.

The HETS Operator may execute the ISP at any time for all or for certain Dispatch Periods ("ad-hoc ISP"), in case of an event which significantly affects the scheduling of the Units and the dispatch of the Balancing Capacity. Such events may include but are not limited to significant changes in the zonal Load Forecast, or zonal RES Units Forecast, or the availability of resources, or the HETS conditions.

Any ad-hoc ISP is executed using the same software but with updated input data. The ISP execution timetable follows. All times shown observe EET.

TABLE 1: TIMETABLE OF INTEGRATED SCHEDULING PROCESS

EET	Process
until 08:00, D-1	The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation submit to the HETS Operator initial Operation Schedule Declarations for the Units in Commissioning Operation or Testing Operation for each Dispatch Period of the Dispatch Day.
until 09:00, D-1	The BSPs submit the availability of their Dispatchable Generating Units to the HETS Operator.
until 09:30, D-1	The BSPs representing Dispatchable hydro Generating Units submit to the HETS Operator daily mandatory hydro injection declarations for Dispatch Day D.
until 09:30, D-1	The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation submit to the HETS Operator revised Operation Schedule Declarations for the Units in Commissioning Operation or in Testing Operation for Dispatch Day D.
until 09:30, D-1	The HETS Operator prepares and then publishes on its website the following information for each Dispatch Period of Dispatch Day D: A. the zonal Load Forecast, B. the zonal RES Forecast, C. the zonal and system~~ic~~ upward and downward System needs in FCR, aFRR, and mFRR,

	D. the zonal Loss forecast, E. the daily mandatory hydro injection declarations, F. The revised Operation Schedule Declarations for the Units in Commissioning Operation or in Testing Operation. Furthermore, it publishes the current availability of Dispatchable Generating Units on the basis of SCADA data, and the forecast availability of Generating Units for Dispatch Day D, on the basis of their non-Availability Declarations.
until 13:45, D-1	The HETS Operator publishes the current availability of the Dispatchable Generating Units and the maximum forecasted availability of the Dispatchable Generating Units for Dispatch Day D, , on the basis of their non-Availability Declarations.
until 13:30, D-1	In the framework of ISP1, the HETS Operator publishes again on its website the following information: A. the updated zonal Load Forecast, B. the updated zonal RES Forecast, C. the updated zonal and system~~ic~~ upward and downward System needs in FCR, aFRR, and mFRR, D. the updated zonal Loss Forecast, E. the daily mandatory hydro injection declarations, F. the Operation Schedule Declarations for the Units in Testing Operation.
14:00 - 15:00, D-1 **(IDM1)**	The HETS Operator may submit to the ETSS of the HEnEx, in the framework of the First LIDA or the First CRIDA, Hybrid Sell/Buy Orders for each MTU of Physical Delivery Day D for any imbalances resulting from a deviation from the forecasted energy quantities of HETS Losses.
14:00 – 16:45, D-1	The BSPs may submit Offers for the BSEs they represent, as many times as they wish. Only the last validated Offers are taken into consideration in the execution of the ISP. A. Upward and downward FCR Offers, B. Upward and downward aFRR Offers, C. Upward and downward mFRR Offers, D. Upward and downward Balancing Energy Offers. Techno-Economic Declarations are submitted for each Dispatch Day, within the Deadline for Submission of ISP Offers. For the duration of that period, the BSPs may submit Declarations for the BSEs they represent as many times as they wish. Only the last validated Declarations are taken into consideration in the execution of the ISP.
until 14:15, D-1	The RES Producers and/or RES Aggregators representing RES Units Portfolios, submit injection forecasts for each Dispatch Period of Dispatch Day D.
until 15:00, D-1 **(IDM1)**	The HETS Operator publishes, under the First LIDA or the First CRIDA, the energy quantities of Hybrid Sell/Buy Orders for each MTU of Physical Delivery Day D, provided they have been submitted
until 15:45, D-1	The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation are entitled to submit to the HETS Operator updated Commissioning Operation or Testing Operation schedules for their units, for each Dispatch Period of Dispatch Day D.
16:15, D-1	The Hellenic Energy Exchange transmits to the HETS Operator the following information, for each Dispatch Period of each Dispatch Day D: A. The Scheduled Energy Exchanges and the corresponding purchase prices, for each Inter-Zonal Corridor, as calculated in the results of the Day-Ahead Market and the Intra-Day Market. The Scheduled Energy Exchanges are submitted to

	the HETS Operator, so as to calculate any Inter-Zonal Capacity after the solution of the Intra-Day Market. B. The Market Schedules, i.e. the algebraic sum of the quantities of the accepted Day-Ahead and Intra-Day Market Orders for each of the following BSEs for each MTU of the Dispatch Day: i. Dispatchable Generating Units in normal operation, ii. Dispatchable Generating Units in Testing Operation: iii. generating units in Commissioning Operation, iv. Dispatchable RES Units Portfolios per Bidding Zone in normal operation, v. Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation, vi. Non-Dispatchable RES Units Portfolios per Bidding Zone in normal operation, vii. Non-Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation or in Commissioning Operation, viii. RES Units Portfolio without Market Participation Obligation per Bidding Zone, ix. Load Portfolios per Bidding Zone, x. Pumping load from Dispatchable pumped storage hydro Generating Units. C. The Market Schedules related to the HETS Losses per Bidding Zone, as calculated in the results of the Day-Ahead Market and the Intra-Day Market.
16:30, D-1 **(IDM1)**	The Hellenic Energy Exchange notifies the Participants of the results of the First LIDA and publishes them on its website.
16:45, D-1	**The HETS Operator executes ISP1**
17:30, D-1	The HETS Operator publishes the results after the execution of the ISP. A. the commitment/decommitment schedule of the BSEs, B. the Balancing Capacity for FCR, mFRR and aFRR in any direction (upward and downward) for each BSE and for each Dispatch Period of the Dispatch Day, C. An indicative generation schedule for each BSE. Within the same deadline, it informs the BSPs whose Balancing Energy and Balancing Capacity Offers were submitted and accepted of the results of the ISP that concern them.
until 21:00, D-1	In the framework of ISP2, the HETS Operator publishes again on its website the following information within the timeframe of the ISP2: A. the updated zonal Load Forecast, B. the updated zonal RES Forecast, C. the updated zonal and systemic upward and downward System needs in FCR, aFRR, and mFRR, D. the updated zonal Loss Forecast, E. the daily mandatory hydro injection declarations, F. the Commissioning Operation or Testing Operation Schedules. Furthermore, it publishes the current availability of Dispatchable Generating Units and the maximum forecasted availability of Generating Units for Dispatch Day D, on the basis of their non-Availability Declarations.
until 22:00, D-1 **(IDM2)**	The HETS Operator may submit to the ETSS of the Hellenic Energy Exchange, under the Second LIDA or the Second CRIDA, Hybrid Sell/Buy Orders for each MTU of Physical Delivery Day D for any imbalances resulting from a deviation from the forecasted energy quantities of HETS Losses.

until 22:00, D-1 **(IDM2)**	The HETS Operator publishes, under the Second LIDA or the Second CRIDA, the energy quantities of Hybrid Sell/Buy Orders (for each MTU of Physical Delivery Day D, provided they have been submitted.
until 22:00, D-1	The RES Producers and/or RES Aggregators representing RES Units Portfolios, submit injection forecasts for each Dispatch Period of Dispatch Day D.
until 23:00, D-1	The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation are entitled to submit to the HETS Operator updated Commissioning Operation or Testing Operation schedules for their units, for each Dispatch Period of Dispatch Day D.
23:15, D-1	Hellenic Exchange transmits to the HETS Operator the following information, for each Dispatch Period of each Dispatch Day: i. The Scheduled Energy Exchanges and the corresponding purchase prices, for each Inter-Zonal Corridor, as calculated in the results of the Day-Ahead Market and the Intra-Day Market. The Scheduled Energy Exchanges are submitted to the HETS Operator, so as to calculate any Inter-Zonal Capacity after the solution of the Intra-Day Market. ii. The Market Schedules, i.e. the algebraic sum of the quantities of the accepted Day-Ahead and Intra-Day Market Orders for each of the following BSEs for each MTU of the Dispatch Day: iii. Dispatchable Generating Units in normal operation, iv. Dispatchable Generating Units in Testing Operation: v. generating units in Commissioning Operation, vi. Dispatchable RES Units Portfolios per Bidding Zone in normal operation, vii. Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation, viii. Non-Dispatchable RES Units Portfolios per Bidding Zone in normal operation, ix. Non-Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation or in Commissioning Operation, x. RES Units Portfolio without Market Participation Obligation per Bidding Zone, xi. Load Portfolios per Bidding Zone, xii. Pumping load from Dispatchable pumped storage hydro Generating Units. xiii. The Market Schedules related to the HETS Losses per Bidding Zone, as calculated in the results of the Day-Ahead Market and the Intra-Day Market.
23:30, D-1 **(IDM2)**	The Hellenic Energy Exchange notifies the Participants of the results of the Second LIDA or the Second CRIDA and shall publish them on its website.
00:00, D	**The HETS Operator executes ISP2**
00:45, D	The HETS Operator publishes the following results after the execution of the ISP: A. the commitment/decommitment schedule of the BSEs, B. the Balancing Capacity for FCR, mFRR and aFRR in any direction (upward and downward) for each BSE and for each Dispatch Period of the Dispatch Day, C. An indicative generation schedule for each BSE. Within the same deadline, it informs the BSPs whose Balancing Energy and Balancing Capacity Offers were submitted and accepted of the results of the ISP that concern them.
until 09:00, D	In the framework of ISP3, the HETS Operator publishes on its website the following information within the timeframe of the ISP3: A. the updated zonal Load Forecast,

	B. the updated zonal RES Forecast, C. the updated zonal and systemic upward and downward System needs in FCR, aFRR, and mFRR, D. the updated zonal Loss Forecast, E. the daily mandatory hydro injection declarations, F. the Operation Schedule Declarations for the Units in Testing Operation. Furthermore, it publishes the current availability of Dispatchable Generating Units and the forecasted availability of Generating Units for Dispatch Day D, within the timeframe of the ISP3, on the basis of their non-Availability Declarations.
until 10:00, D **(IDM3)**	The HETS Operator may submit to the ETSS of the Hellenic Energy Exchange, under the Third LIDA or the Third CRIDA, Hybrid Sell/Buy Orders for each MTU of Physical Delivery Day D for any imbalances resulting from a deviation from the forecasted energy quantities of HETS Losses.
until 10:00, D **(IDM3)**	The HETS Operator publishes, under the Third LIDA or the Third CRIDA, the energy quantities of Sell/Buy Orders for each MTU of Physical Delivery Day D, provided they have been submitted.
until 10:00, D	The RES Producers and/or RES Aggregators representing RES Units Portfolios, submit injection forecasts for each Dispatch Period of the current Dispatch Day D.
until 11:00, D	The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation are entitled to submit to the HETS Operator updated Commissioning Operation or Testing Operation schedules for their units, for each Dispatch Period of the current Dispatch Day D.
11:15, D	The Hellenic Energy Exchange transmits to the HETS Operator the following information, for each Dispatch Period of each Dispatch Day: i. The Scheduled Energy Exchanges and the corresponding purchase prices, for each Inter-Zonal Corridor, as calculated in the results of the Day-Ahead Market and the Intra-Day Market. The Scheduled Energy Exchanges are submitted to the HETS Operator, so as to calculate any Inter-Zonal Capacity after the solution of the Intra-Day Market. ii. The Market Schedules, i.e. the algebraic sum of the quantities of the accepted Day-Ahead and Intra-Day Market Orders for each of the following BSEs for each MTU of the Dispatch Day: iii. Dispatchable Generating Units in normal operation, iv. Dispatchable Generating Units in Testing Operation: v. generating units in Commissioning Operation, vi. Dispatchable RES Units Portfolios per Bidding Zone in normal operation, vii. Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation, viii. Non-Dispatchable RES Units Portfolios per Bidding Zone in normal operation, ix. Non-Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation or in Commissioning Operation, x. RES Units Portfolio without Market Participation Obligation per Bidding Zone, xi. Load Portfolios per Bidding Zone, xii. Pumping load from Dispatchable pumped storage hydro Generating Units. xiii. The Market Schedules related to the HETS Losses per Bidding Zone, as calculated in the results of the Day-Ahead Market and the Intra-Day Market.

11:30, D **(IDM3)**	The Hellenic Energy Exchange notifies the Participants of the results of the Third LIDA or the Third CRIDA and publishes them on its website.
12:00, D	**The HETS Operator executes ISP3.**
12:45, D	The HETS Operator publishes the following results after the execution of the ISP: A. the commitment/decommitment schedule of the BSEs, B. the Balancing Capacity for FCR, mFRR and aFRR in any direction (upward and downward) for each BSE and for each Dispatch Period of the current Dispatch Day D, C. an indicative generation schedule for each BSE. Within the same deadline, it informs the BSPs whose Balancing Energy and Balancing Capacity Offers were submitted and accepted of the results of the ISP that concern them.
until 11:00, D +1	Until 11:00 on each calendar day D+1, the HETS Operator notifies RAE of all the data, the parameters and the results of the ISP that were executed on Dispatch Day D in editable form.
Ad-hoc ISP	The HETS Operator may execute the ISP at any time for all or for certain Dispatch Periods, in case that an event occurs, which significantly affects the scheduling of the Units and the dispatch of the Balancing Capacity. The HETS Operator publishes the results after the execution of the ad-hoc ISP.
In all cases of changes or modifications	The Participants in the Balancing Market submit an updated Available Capacity for each Dispatchable Generating Unit and each Dispatchable RES Units Portfolio and each Dispatchable Load Portfolio for each MTU of Physical Delivery Day D.
In all cases of changes or modifications	The HETS Operator notifies the Participants as soon as possible, in all cases of amendment of the weekly mandatory hydro management declaration.
In all cases of changes or modifications	The Distribution Network Operators notify the HETS Operator as soon as possible in case of disconnection: A. of any component of the Distribution Network that may affect the normal operation of the HETS in real time, B. of any load connected to their Distribution Network which may affect the zonal Load Forecast performed by the HETS Operator in the context of the Balancing Market operation, and C. of any RES Unit connected to their Distribution Network, which may affect the zonal RES Forecast performed by the HETS Operator in the context of the Balancing Market operation. The Distribution Network Operators immediately notifies the HETS Operator, on justifiable grounds, if they plan to have a load curtailment or any other Network operations that are expected to cause a decrease in load in excess of ten (10) MW at a specific point of connection to the HETS.
In all cases of changes or modifications	The Load Representatives that have submitted a Buy Order to the Electricity Markets managed by the Hellenic Energy Exchange are obliged to immediately notify the HETS Operator of any possible changes in the energy volumes that correspond to the load meters they represent. The Load Representatives that have not submitted a Buy Order to the Electricity Markets managed by the Hellenic Energy Exchange for the energy meters they represent during the Dispatch Day in question according to the Table of Meters and Load Representatives pursuant to the HETS Grid Code, are obliged to immediately notify the HETS Operator of the total load that they expect to be absorbed by those meters for each Dispatch Period of the Dispatch Day.
On a daily basis	The HETS Operator immediately publishes the quantity of energy injected by each Dispatchable hydro Generating Unit for each Imbalance Settlement Period of the Dispatch Day, upon expiration of the Dispatch Day.

On a daily basis /In all cases of changes or modifications	The BSPs representing Dispatchable hydro Generating Units submit to the HETS Operator daily mandatory hydro injection declarations as soon as possible after the occurrence of an event affecting the management of mandatory hydro.
On a weekly basis	The BSPs representing Dispatchable hydro Generating Units submit weekly mandatory hydro injection declarations every Thursday by 12:00 EET.
On a monthly basis	The HETS Operator publishes on its website information on the operation of the Balancing Market in the preceding calendar month, which include at least the following items: • The total electricity and maximum total HETS Load per Dispatch Day, • The zonal Imbalances per Imbalance Settlement Period, • The inter-zonal transmission constraints of the HETS that affected its operation, • The important HETS events.
On a yearly basis	The HETS Operator publishes statistical data on the accuracy of the above forecasts within two (2) months from the end of each calendar year.
In all cases of changes or modifications	The BSPs immediately notify the HETS Operator of their non-Availability.

3 ISP Balancing Service Entities

3.1 General Provisions

In accordance with Article 10 of the BMR, BSEs are either entitled or required to provide Balancing Energy and/or Balancing Capacity. The BSEs include:

- The Generating Units, which are divided into:
    - Dispatchable Generating Units
    - Virtual Entities, as follows:
        - Virtual Entities that correspond to the configurations of the Dispatchable Multi-Shaft Combined Cycle Generating Units,
        - Virtual Entities that correspond to the Dispatchable Generating Units with Alternative Fuel,
        - Virtual Entities that correspond to the output from Dispatchable pumped storage hydro Generating Units,
        - Virtual Entities that correspond to the pumping from pumped storage Hydro Units.
- Dispatchable Non-Intermittent RES Units Portfolios.
- Dispatchable Intermittent RES Units Portfolios.
- Dispatchable Load Portfolios.

Contracted Generating Units are also included in the BSEs participating in the ISP, but they do not submit offers. The HETS Operator may submit Balancing Energy Offers to the ISP for the Contracted Units whenever the load and/or reserve requirements are not covered during the ISP, The Balancing Energy Offer price (€/MWh) is determined on the basis of the relevant Supplementary System Energy Contract.

3.2 Virtual Entities

3.2.1 Modelling of a Balancing Service Entity with Multiple Virtual Entities

For the execution of the ISP, the Dispatchable Multi-Shaft Combined Cycle Generating Units, the Dispatchable Units with Alternative Fuel and the Dispatchable pumped storage hydro Generating Units are not modeled as a single BSE but rather as multiple Virtual Entities with special constraints on their operation. In particular:

- **Dispatchable Multi-Shaft Combined Cycle Generating Units**: Each configuration is modeled as a separate Virtual Entity. Each gas turbine is not modeled separately, so the operation with one gas turbine is one Virtual Entity regardless of which gas turbine is synchronized.
- **Dispatchable Generating Units with Alternative Fuel**: The operation with each fuel is modeled as a separate Virtual Entity.
- **Dispatchable pumped storage hydro Generating Units (pumped storage hydro):** The operation of the unit as a producer or as a pump is modeled as a separate Virtual Entity.

For example, in a Dispatchable Multi-Shaft Combined Cycle Generating Unit, e.g. “Komotini”, which consists of two gas turbines (GT) and one steam turbine (ST), the following Virtual Entities are modeled for the purposes of the ISP:

- 1GT (operation with one gas turbine, regardless of which one)
- 2GT (operation with two gas turbines)
- 1GT + ST (operation with one gas turbine, regardless of which one, and with the steam turbine)
- 2GT + ST (operation with two gas turbines and the steam turbine)

For example, in a Dispatchable Multi-Shaft Combined Cycle Generating Unit, e.g. “Lavrio IV”, which consists of three gas turbines (GT) and one steam turbine (ST), the following Virtual Entities are modeled for the purposes of the ISP:

- 1GT GAS
- 2GT GAS
- 3GT GAS
- 1GT + ST GAS
- 2GT + ST GAS
- 3 GT + ST GAS
- 1GT OIL
- 2GT OIL
- 3GT OIL
- 1GT + ST OIL
- 2GT + ST OIL
- 3 GT + ST OIL

Finally, in a Dispatchable hydro Generating Unit, e.g. “Thesavros”, which can operate as a pump and which is characterized as a pumped storage hydro generating unit, the following Virtual Entities are modeled for the purposes of the ISP:

- Generation
- Pumping

As regards the Virtual Entities of the same Generating Unit:

- Only one out of the several Virtual Entities that belong to the same BSE can operate during a Dispatch Period.
- Separate Declared Characteristics are submitted for each Virtual Entity.
- Separate Balancing Energy and Balancing Capacity Offers are submitted for each Virtual Entity.

As regards the Virtual Entities of Dispatchable Multi-Shaft Combined Cycle Generating Units: A separate table is submitted, which includes the transitions between the different Virtual Entities, and the time required for the above transitions, in the Declared Characteristics.

The Tables 2 and 3 below present the possible transitions of a Dispatchable Combined Cycle Generating Unit with two gas turbines (GT) and one steam turbine (ST) towards a higher or a lower configuration respectively:

TABLE 2: TRANSITIONS TOWARDS A HIGHER CONFIGURATION IN A DISPATCHABLE MULTI-SHAFT COMBINED CYCLE GENERATING UNIT

FROM	TO
OFF	1GT
OFF	2GT
OFF	1GT+ST
OFF	2GT+ST
1GT	2GT
1GT	1GT+ST
1GT	2GT+ST
2GT	2GT+ST
1GT+ST	2GT+ST

TABLE 3: TRANSITIONS TOWARDS A LOWER CONFIGURATION IN A DISPATCHABLE MULTI-SHAFT COMBINED CYCLE GENERATING UNIT

FROM	TO
1GT	OFF
2GT	OFF
2GT	1GT
1GT+ST	OFF
1GT+ST	1GT
2GT+ST	OFF
2GT+ST	1GT
2GT+ST	2GT
2GT+ST	1GT+ST

3.2.2 Virtual Entities not participating in the Balancing Market

In order to implement the automatic process of relaxing the constraints of the Balancing Capacity requirements and cover the forecasted imbalances (energy surplus), in accordance with Article 59, Par. 5 of the BMR, Virtual Entities are modelled in the ISP execution, which do not participate in the Balancing Market, have no physical existence, but can offer virtual Balancing Energy and/or Balancing Capacity. Specifically, two Virtual Entities are modelled, one for relaxing the Balancing Capacity requirements constraints and one for relaxing the covering of the forecasted imbalances constraint.

The quantity of the Balancing Capacity offers from the above-mentioned Virtual Entities is appropriately determined so that only a portion of the Balancing Capacity requirements can be relaxed by the algorithm, while a certain quantity of the required Balancing Capacity will always remain to be provided by the Balancing Service Providers.

The price of the Balancing Capacity and Balancing Energy offers from the above-mentioned Virtual Entities are determined in accordance with the procedure for the relaxation of the relevant constraints as per Article 59, Par 5 of the BMR. In particular, the offers' prices are determined based on the highest or lowest Balancing Energy or Balancing Capacity price offer according to the table below:

Offer Type	Price
ISP Downward Balancing Energy offer	At least 200 €/MWh lower than the lowest offer price for ISP Downward Balancing Energy.
Upward and Downward mFRR Balancing Capacity offers	At least 50 €/MW higher than the highest offer price of Upward or Downward Balancing Capacity mFRR.
Upward and Downward Balancing FCR Capacity offers	At least 100 €/MW higher than the highest offer price of Upward or Downward Balancing Capacity FCR.
Upward and Downward Balancing aFRR Capacity offers	At least 150 €/MW higher than the highest offer price of Upward or Downward Balancing Capacity aFRR.

3.3 Modelling of the Balancing Service Entities

3.3.1 Start-up model

The **start-up** of each BSE is modelled in the ISP. The energy injection/offtake of a BSE at start-up and the duration of the relevant start-up process is defined by the start-up model and the Declared Characteristics of the entity. In the event that the declared start-up time is zero, the start-up model is not applied. The start-up time is always deemed to be zero for the Intermittent RES Units Portfolios and the Dispatchable Load Portfolios (with the exclusion of pumped storage).

The modelling of the **start-up** of a Generating Unit can be analyzed into two individual phases. The Synchronization Phase (sync time) and the Soak Phase (soak time: time from synchronization to minimum stable generation).

- **Synchronization Phase**: The phase at which the entity synchronizes with the system. At this phase the entity injection into the system remains zero. The duration of the synchronization phase depends on the thermal state of the BSE (hot state, warm state or cold state). The Synchronization Times from each thermal state constitute the Declared Characteristics of the BSEs:

HotSynTime	The time required for the BSE to synchronize from hot state.
WarmSynTime	The time required for the BSE to synchronize from warm state.

ColdSynTime	The time required for the BSE to synchronize from cold state.
HotToWarmTime	The time required for the BSE to synchronize from hot state to warm state.
WarmToColdTime	The time required for the BSE to synchronize from warm state to cold state.

- **Soak Phase:** The phase at which the entity, after the end of the Synchronization Phase, increases its generation up to the point where it is available for executing instructions. The duration of the Soak Phase depends on the thermal state of the BSE (hot state, warm state or cold state). The Soak Times from each thermal state constitute the Declared Characteristics of the BSEs. During the Soak Phase the generation level of the entity increases to distinct load levels starting from zero at the end of the Synchronization Phase and going no higher than the Technically Minimum Generation of the BSE. The generation level of the BSE during the Soak Phase is separately declared depending on the thermal state of the entity (hot, warm or cold) in one (1) up to six (6) distinct hourly steps. The steps are in MW, it is mandatory that they be consecutive, without gaps, it is not allowed that the capacity price corresponding to each one of the consecutive steps be reduced in relation to the preceding step, and all the steps must be lower than or at the maximum equal to the Technically Minimum Generation of the entity.

The start-up process of a Dispatchable Generating Unit according to the ISP start-up model is presented in the following figure.

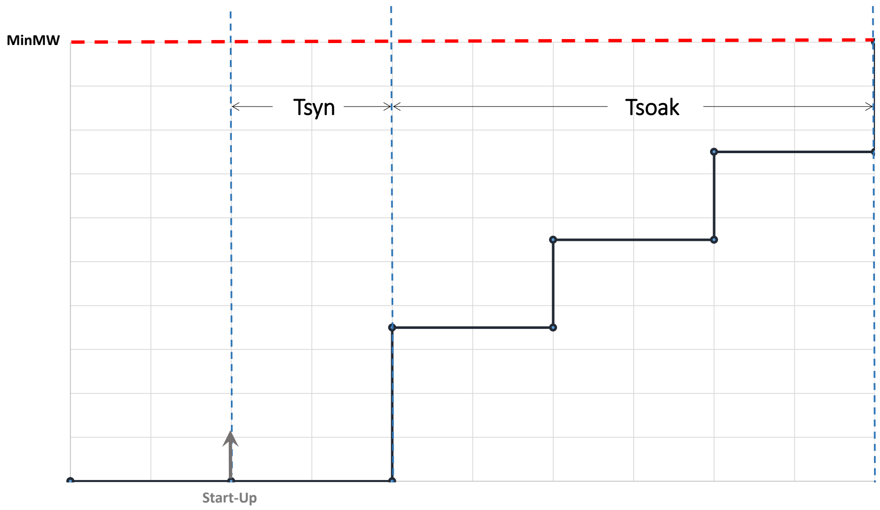

FIGURE 1: GENERATING UNIT START-UP

Where:

Start-up	A binary variable which indicates the start-up of a BSE from cold, warm or hot state.
Tsyn, Tsoak	The time period during which the BSE remains in synchronization or soak respectively.
MinMW	The Minimum Available Capacity of the BSE.

3.3.2 Shut-down model

The **shut-down** of each BSE is modelled in the ISP. The energy injection/offtake of a BSE at shut-down and the duration of the relevant shut-down process is defined by the shut-down model and the Declared Characteristics of the entity. In the event that the declared shut-down time is zero, the shut-down model is not applied. The shut-down time is always deemed to be zero for the Intermittent RES Units Portfolios and the Dispatchable Load Portfolios (with the exclusion of pumped storage).

According to the **shut-down** model, during shut-down state the BSE modifies its generation in downward steps, starting from the Minimum Available Generation and going down to zero, when it is de-committed from the system, as presented in the figure below.

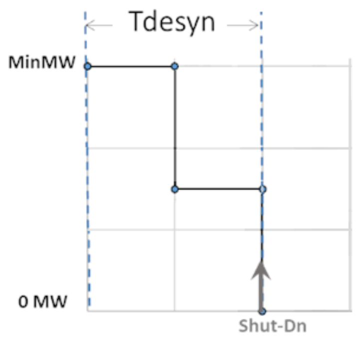

FIGURE 2: GENERATING UNIT SHUT-DOWN

Where:

Tdesyn	The time (number of hours) that is required for the de-synchronization of a BSE.
MinMW	The Minimum Available Capacity of a BSE.
Shut-Dn	A binary variable which indicates whether a BSE is de-synchronized.

The entire start-up and shut-down model, as applied for a Dispatchable thermal Generating Unit is presented in the following figure:

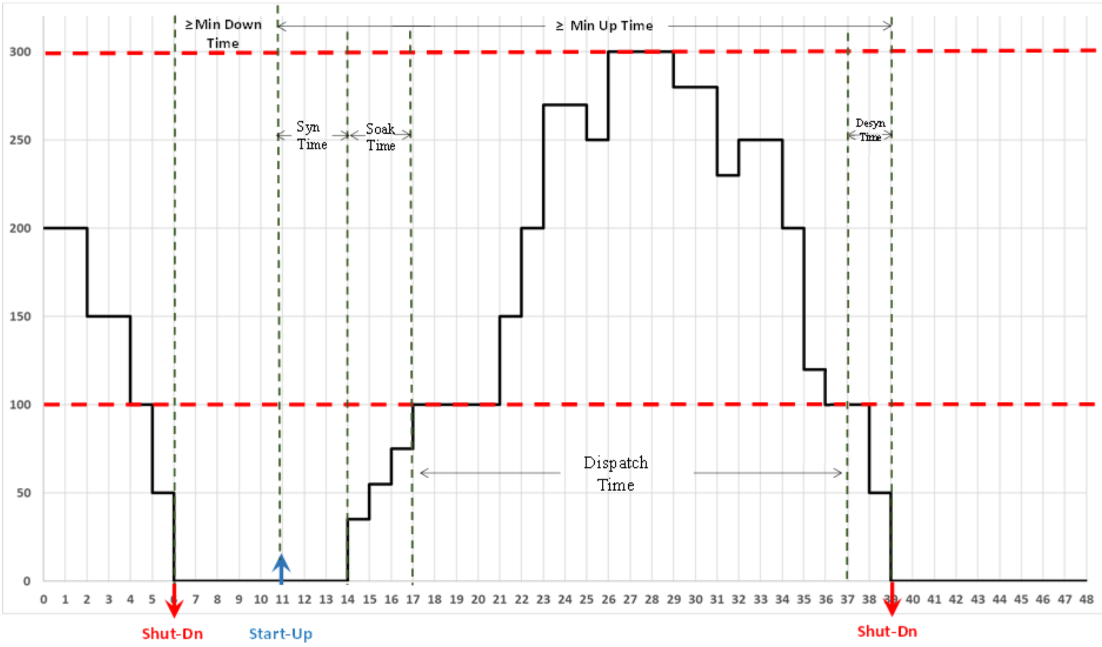

FIGURE 3: START-UP AND SHUT-DOWN MODEL

3.3.3 Other constraints

Maximum Number of Daily Activations

The constraint of maximum number of Daily Activations ensures that the number of activations of an entity within a Dispatch Day will be at the maximum equal to the value specified in its Declared Characteristics.

The maximum number of Daily Activations is the maximum number of times in ISP that a Dispatchable Load Portfolio can be activated within a Dispatch Day. One ISP activation corresponds to one cycle of Balancing Energy and/or Balancing Capacity provision and it means the number of consecutive Dispatch Periods during which the Dispatchable Load Portfolio provides at least one of the following services: energy and/or upward Balancing Capacity or/and downward Balancing Capacity, as described in the following figure.

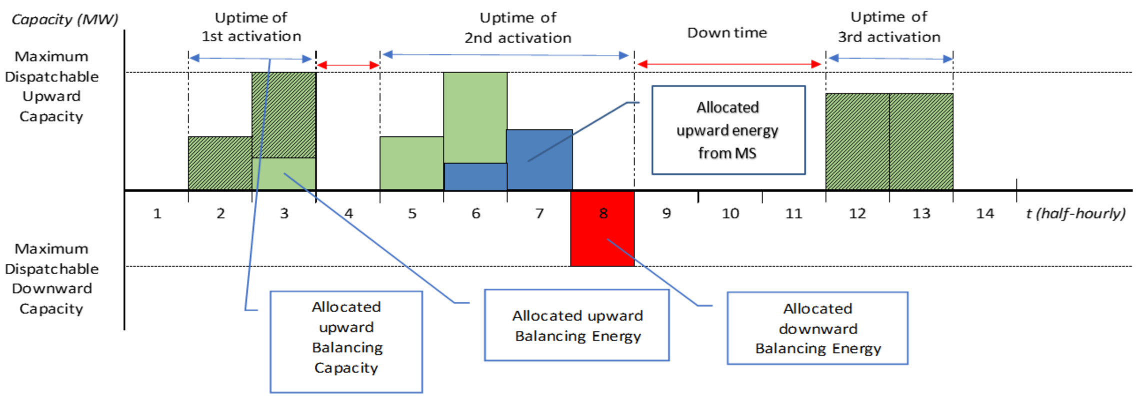

FIGURE 4: ACTIVATION CYCLES FOR THE PROVISION OF ENERGY AND/OR BALANCING CAPACITY

Maximum uptime

The constraint of maximum ~~up time~~uptime ensures that the duration of each activation of entity is at the maximum equal to a value specified in the Declared Characteristics. The maximum up time is the maximum duration of an activation of a Dispatchable Load Portfolio according to its Declared Characteristics. One ISP activation corresponds to one cycle of Balancing Energy and/or Capacity provision and it means the number of consecutive Dispatch Periods during which the Dispatchable Load Portfolio provides at least one of the following services: energy and/or upward Balancing Capacity or/and downward Balancing Capacity, as described in the previous figure.

Minimum uptime

The constraint of minimum uptime ensures that the duration of each activation of an entity shall be at the minimum equal to a value specified in the Declared Characteristics. The minimum uptime is the minimum duration of an activation of an entity according to its Declared Characteristics.

For Dispatchable Generating Units, Dispatchable Non-Intermittent RES Units Portfolios and pumped storage Dispatchable Load Portfolios, up-time means the number of consecutive Dispatch Periods after a start-up (starting from the beginning of the synchronization phase) and until the next shut-down during which the entities remain committed and provide energy. For Dispatchable Load Portfolios (with the exception of pumped storage) and Dispatchable Intermittent RES Units Portfolios, up time means the number of consecutive Dispatch Periods during which the entities provide at least one of the following services: energy and/or upward Balancing Capacity or/and downward Balancing Capacity.

Minimum downtime

The constraint of minimum downtime ensures that the duration of each deactivation of an entity shall be at the minimum equal to a value specified in the Declared Characteristics.

For Dispatchable Generating Units, Dispatchable Non-Intermittent RES Units Portfolios and pumped storage Dispatchable Load Portfolios, downtime means the number of consecutive Dispatch Periods after a shut-down and until the next start-up (starting from the last shut-down and until the beginning of the next synchronization phase) during which the entities remain de-committed. For Dispatchable Load Portfolios (with the exception of pumped storage) and Dispatchable Intermittent RES Units Portfolios, downtime means the number of consecutive Dispatch Periods during which the entities do not provide any of the following services: energy and upward Balancing Capacity and downward Balancing Capacity.

3.3.4 Operation Limits of Balancing Service Entities

Each BSE has specific operation limits. The injection/offtake of each entity can be either zero either within specific operation limits according to its Declared Characteristics. A schematic depiction of the operation limits (without taking into consideration forbidden zones) for the different BSEs can be found below.

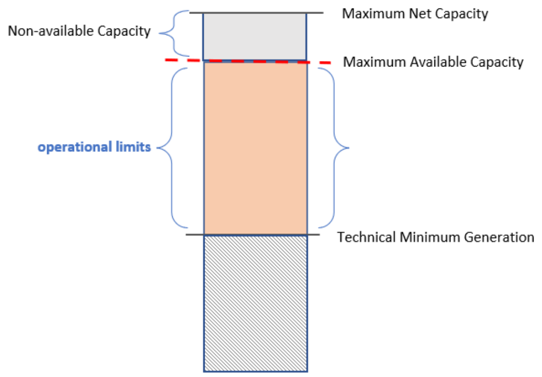

FIGURE 5: OPERATION LIMITS OF DISPATCHABLE GENERATING UNITS AND PUMPED STORAGE UNITS

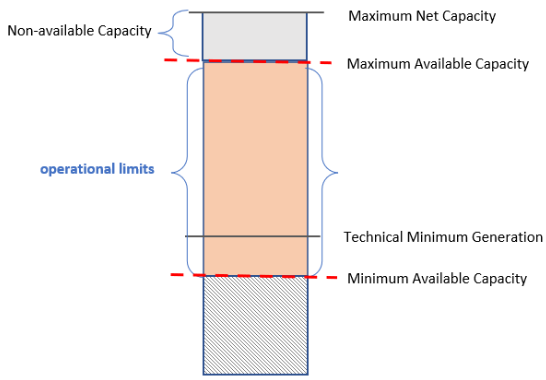

FIGURE 6: OPERATION LIMITS OF DISPATCHABLE NON-INTERMITTENT RES UNITS

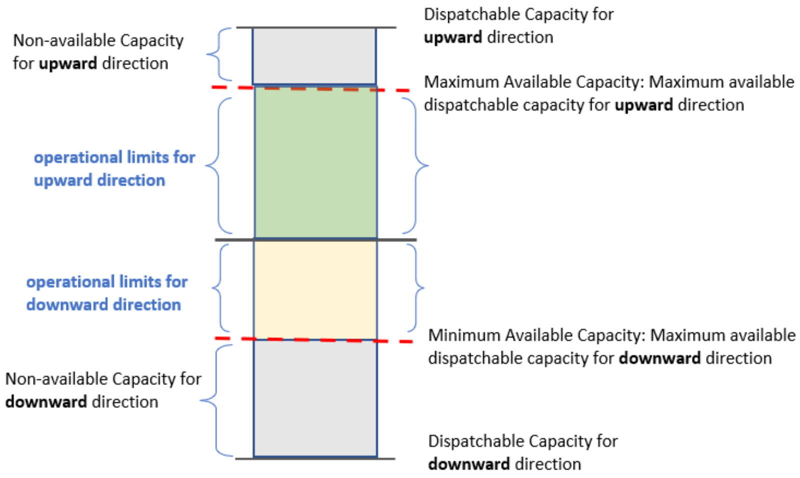

FIGURE 7: OPERATION LIMITS OF DISPATCHABLE INTERMITTENT RES UNITS AND DISPATCHABLE LOAD PORTFOLIOS (EXCEPT PUMPED STORAGE)

Regarding the **Maximum Available Capacity** of the Portfolios, it is clarified that:

- For Dispatchable Non-Intermittent RES Units Portfolios, the Maximum Available Capacity means the Maximum Net Capacity, as it is modified based on the non-Availability Declarations.
- For Dispatchable Intermittent RES Units Portfolios and Dispatchable Load Portfolios (with the exception of pumped storage), the Maximum Available Capacity corresponds to the maximum capacity to provide upward energy and it means the dispatchable capacity for the upward direction, as it is modified based on the non-Availability Declarations.

Regarding the **Minimum Available Capacity** of the Portfolios, it is clarified that:

- For Dispatchable Non-Intermittent RES Units Portfolios, the Minimum Available Capacity means the Technically Minimum Generation, as it is modified based on the non-Availability Declarations.
- For Dispatchable Intermittent RES Units Portfolios and Dispatchable Load Portfolios (with the exception of pumped storage), the Minimum Available Capacity corresponds to the maximum capacity to provide downward energy and it means the dispatchable capacity for the downward direction, as it is modified based on the non-Availability Declarations.

4 Balancing Energy Offers

4.1 General Provisions

An ISP Balancing Energy Offer corresponds to the intention to provide upward or downward Balancing Energy in relation to the Market Schedule of the respective BSE. The Market Schedule results from the Intra-Day Market solution and contains the algebraic sum of the quantities of the accepted Orders of the Day-Ahead Market and the Intra-Day Market for each BSE.

The upward ISP Balancing Energy Offer for Dispatchable Generating Units and Dispatchable RES Units Portfolios consists in the capability to increase the generation level in comparison to the Market Schedule, and for Dispatchable Load Portfolios in the capability to decrease the consumption level of a Portfolio in comparison to the Demand Response Baseline.

The downward ISP Balancing Energy Offer for Dispatchable Generating Units and Dispatchable RES Units Portfolios consists in the capability to decrease the generation level in comparison to the Market Schedule, and for Dispatchable Load Portfolios in the capability to increase the consumption level of a Portfolio in comparison to the Market Schedule.

The BSPs representing Dispatchable Generating Units are obliged to submit to the ISP:

1) an upward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day, for a total upward Balancing Energy quantity equal to the Maximum Net Capacity of the BSE as set out in its Registered Characteristics, and
2) a downward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day, for a total downward Balancing Energy quantity equal to the Maximum Net Capacity of the BSE as set out in its Registered Characteristics.

The Producers representing Dispatchable Generating Units with Alternative Fuel are obliged to submit separate Balancing Energy Offers for their operation both with the primary and the alternative fuel.

The Producers representing Dispatchable pumped storage hydro Generating Units are obliged to submit separate Balancing Energy Offers for generation and pumping. The submission of Balancing Energy Offers for pumping is not obligatory, without prejudice to the transitional provisions of this Decision.

The Producers representing Dispatchable Multi-Shaft Combined Cycle Generating Units are required to submit separate Balancing Energy Offers for each configuration of their Units.

The BSPs representing Dispatchable RES Units Portfolios are entitled to submit to the ISP:

1) an upward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day, for a total upward Balancing Energy quantity which shall be at the maximum equal to the dispatchable capacity of the BSE as set out in its Registered Characteristics, and
2) a downward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day, for a total downward Balancing Energy quantity which shall be at the maximum equal to the dispatchable capacity of the BSE as set out in its Registered Characteristics.

The BSPs representing Dispatchable Load Portfolios (with the exception of pumped storage) are entitled to submit to the ISP:

1) an upward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day, for a total upward Balancing Energy quantity which shall be at the maximum equal to the dispatchable capacity of the Balancing Service Entity as set out in its Registered Characteristics, and
2) a downward ISP Balancing Energy Offer per BSE for each Dispatch Period of the Dispatch Day for a total downward Balancing Energy quantity which shall be at the maximum equal to the dispatchable capacity of the Balancing Service Entity as set out in its Registered Characteristics.

The BSPs representing Dispatchable RES Units Portfolios or Dispatchable Load Portfolios (with the exception of pumped storage) are obliged to submit upward and downward Balancing Energy Offers to the ISP, provided that they also submit the corresponding Balancing Capacity Offers for the corresponding Dispatch Period. If no Balancing Energy Offer is submitted for a Dispatch Period for a quantity that corresponds at least to the quantity of the submitted Balancing Capacity Offer, the Balancing Capacity Offers referring to this Dispatch Period are rejected and not taken into consideration.

This rule is presented in the following figure. It is noted that the quantity of a Balancing Energy Offer which corresponds to 1 MW of a Balancing Capacity Offer is 0,5 MWh, as the Dispatch Period is equal to half an hour.

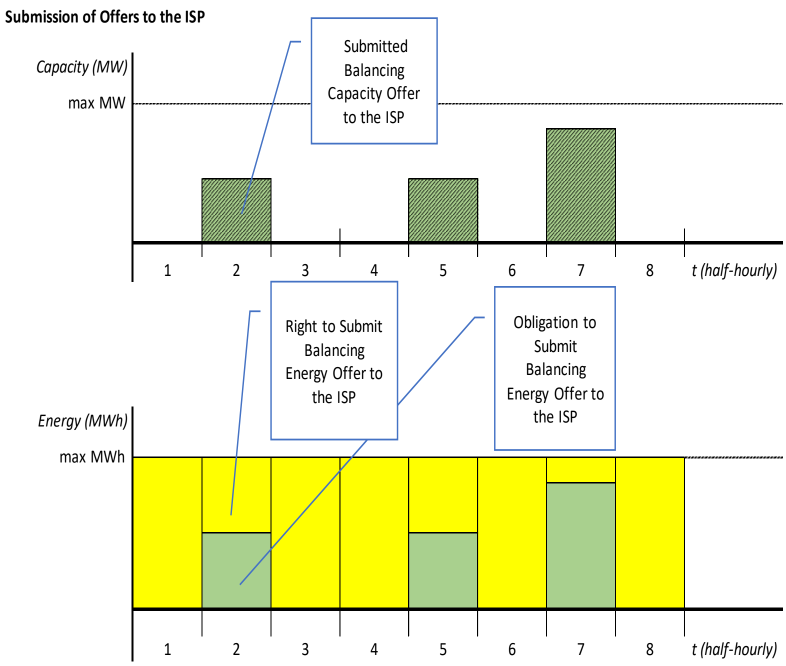

FIGURE 8 EXAMPLES OF SUBMISSION OF BALANCING CAPACITY & ENERGY OFFERS TO THE ISP FOR DISPATCHABLE LOAD PORTFOLIOS (EXCEPT PUMPED STORAGE)

4.2 Amendment and acceptance of the ISP Balancing Energy Offers

The offers submitted to the ISP are taken into consideration for the execution of ISP1, ISP2 and ISP3, as well as for any ad-hoc ISP. After the GCT for the Submission of ISP Offers, the ISP Balancing Energy Offers cannot be modified and are used as they are for the execution of ISP1, ISP2 and ISP3, as well as for any ad-hoc ISP. The re-submission of Offers is not allowed after the GCT for the Submission of ISP Offers.

In the event that an ISP Balancing Energy Offer is not submitted in accordance with Article 54 and Article 55 of the BMR, the ISP Balancing Energy Offer for all Dispatch Periods of the Dispatch Day is automatically rejected by the BMMS. In that case, the grounds for the rejection are notified to the BSPs through the BMMS. The BSP may re-submit an ISP Balancing Energy Offer until the GCT for the Submission of ISP Offers. If the Balancing Energy Offer is submitted in accordance with Article 54 and Article 55 of the BMR, the Balancing Energy offer is validated. Only the last validated Balancing Energy Offers is taken into consideration for the execution of the ISP.

If the GCT for the Submission of ISP Offers passes and the BSPBSP has not submitted an ISP Balancing Energy Offer in accordance with Article 54 and Article 55 of the BMR, the BMMS automatically creates ISP Balancing Energy Offers for the respective Dispatchable Generating Unit and for all Dispatch Periods of the Dispatch Day, setting bidding prices equal to the corresponding prices of the last validated ISP Balancing Energy Offer of the BSE on the previous day. Accordingly, if no ISP Balancing Energy Offers for pumped storage are submitted for one Dispatch Day or for several Dispatch Periods of the Dispatch Day, the BMMS automatically creates ISP Balancing Energy Offers for pumped storage for the respective BSE for all Dispatch Periods of the Dispatch Day for which no offer was submitted, specifying offer quantities equal to the Maximum Net Capacity of the BSE and offer prices equal to the Balancing Energy Offer Maximum and Minimum Price, as defined in the Technical Decision “Technical limits on bidding and clearing prices in the Balancing Market”, without prejudice to the transitional provisions herein.

The Offers which are created automatically by the BMMS are considered as having been submitted by the Participant and produce all the results provided for in the BMR, as if these Offers had been submitted by the Participant.

Similarly, if a Techno-Economic Declaration was either not submitted or rejected for a Dispatch Day, the BMMS automatically reproduces the last validated Techno-Economic Declaration and use it for the Dispatch Day in question.

In the event that it is impossible to cover the forecasted imbalances and/or the zonal/system~~ic~~ Balancing Capacity requirements for a Dispatch Period of the Dispatch Day, the HETS Operator is entitled to submit an ISP Balancing Energy Offer for each of the Contracted Units and for each Dispatch Period of the Dispatch Day. The Offer price (€/MWh) is determined on the basis of the relevant Supplementary System Energy Contract.

The Annex of this Technical Decision includes a detailed description of the procedure for the submission and control of Balancing Energy Offers in the BMMS.

4.3 Content of the ISP Balancing Energy Offers

The upward and downward ISP Balancing Energy Offers for each BSE and for each Dispatch Period consist of individual steps. Each step comprises the price of the Balancing Energy Offer in €/ MWh, accurate to two (2) decimal places, and the quantity in MW, accurate to one (1) decimal place. The minimum quantity of the Offer is equal to one (1) MW.

The price of the upward ISP Balancing Energy Offer for each successive step may not be reduced in relation to the price of the Balancing Energy Offer for the preceding step. The price of the downward ISP Balancing Energy Offer for each successive step may not be increased in relation to the price of the Balancing Energy Offer for the preceding step.

The ISP Balancing Energy Offer prices must be within the Balancing Energy Offer Maximum Price and the Balancing Energy Offer Minimum Price, as in force. The numerical values of the Balancing Energy Offer Minimum Price and Maximum Price are specified in the Technical Decision "Technical limits on bidding and clearing prices in the Balancing Market", without prejudice to the transitional provisions herein.

The upward and downward ISP Balancing Energy Offer include between one (1) and ten (10) steps. It is mandatory that the steps in MW be consecutive without gaps. Each step corresponds to a capacity range in MW and must have a Balancing Energy Offer price in €/MWh. For the BSEs for which a Technically Minimum Generation constraint is applied, it is mandatory that the quantity of the first step of the upward ISP Balancing Energy Offer in MW be at least equal to the Technically Minimum Generation in MW and the quantity of the last step of the downward ISP Balancing Energy Offer in MW be at least equal to the Technically Minimum Generation in MW.

4.3.1 Dispatchable Generating Units and Dispatchable Non-Intermittent RES Units Portfolios

For the Dispatchable Generating Units, the steps of the upward and downward ISP Balancing Energy Offer cover the entire range of the Maximum Net Capacity (from 0 MW up to the Maximum Net Capacity), regardless of availability, whereas for the Dispatchable Non-Intermittent RES Units Portfolios they cover a range at the maximum up to the Maximum Net Capacity (from 0 MW and, at the maximum, up to the Maximum Net Capacity).

The quantity of the upward Balancing Energy Offer taken into account in the ISP corresponds to the difference between the Maximum Available Capacity of the BSE and the energy resulting from the Market Schedule of the BSE. Initially, the step with the lowest Balancing Energy Offer price is selected, in accordance with the direction of the arrow in the following figure.

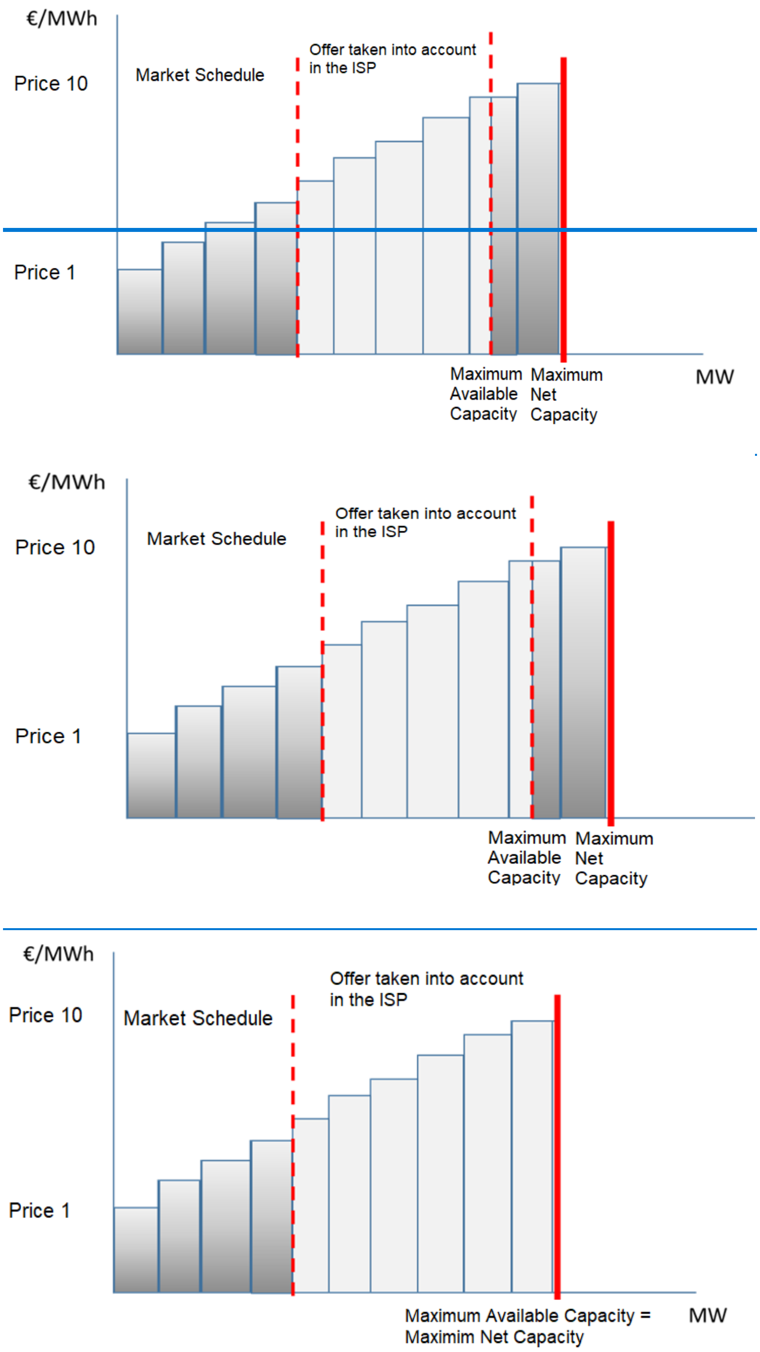

FIGURE 9: UPWARD BALANCING ENERGY OFFER FOR A BSE WHEN IT IS NOT FULLY AVAILABLE (UPPER PART) AND WHEN IT IS FULLY AVAILABLE (LOWER PART)

By contrast, the quantity of the downward Balancing Energy Offer taken into account in the ISP corresponds to the range between zero capacity and the capacity resulting from the Market Schedule of the BSE. Initially, the step with the highest Balancing Energy Offer price is selected, in accordance with the direction of the arrow in the following figure.

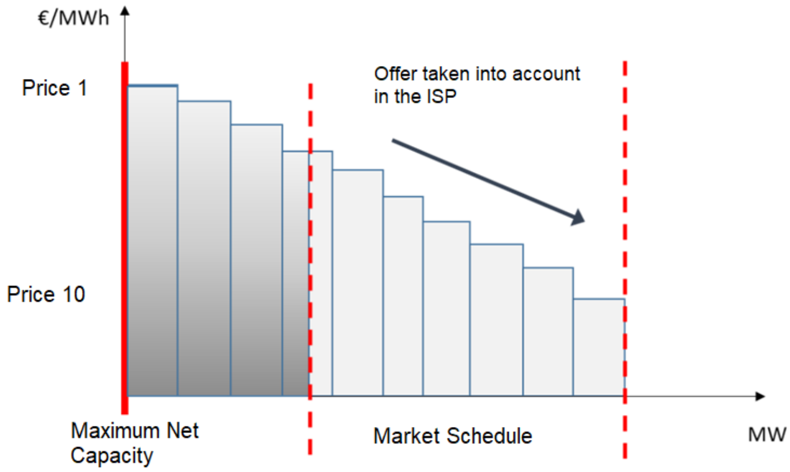

FIGURE10: DOWNWARD BALANCING ENERGY OFFER FOR A BSE

The figure below shows an example of a downward Balancing Energy Offer for a BSE with Maximum Net Capacity 500 MW. The Market Schedule of the BSE is 300 MW, consequently, the available steps of the downward Offer to be settled are steps 1-7. The steps to be cleared start at step 1 and go down to 7.

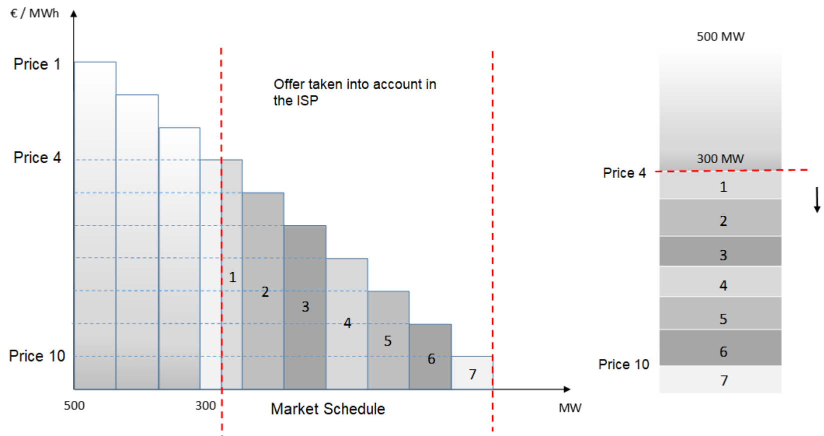

FIGURE11: CLEARING OF THE QUANTITY OF A DOWNWARD BALANCING ENERGY OFFER

4.3.2 Dispatchable Intermittent RES Units Portfolios

For Dispatchable Intermittent RES Units Portfolios the steps of the upward and downward ISP Balancing Energy Offers cover a range at the maximum up to the dispatchable capacity. The Market Schedule of the Dispatchable Intermittent RES Units Portfolios is not taken into consideration when selecting the offer steps to be activated, i.e., the first step that is selected is always the step corresponding to a capacity of 0 MW.

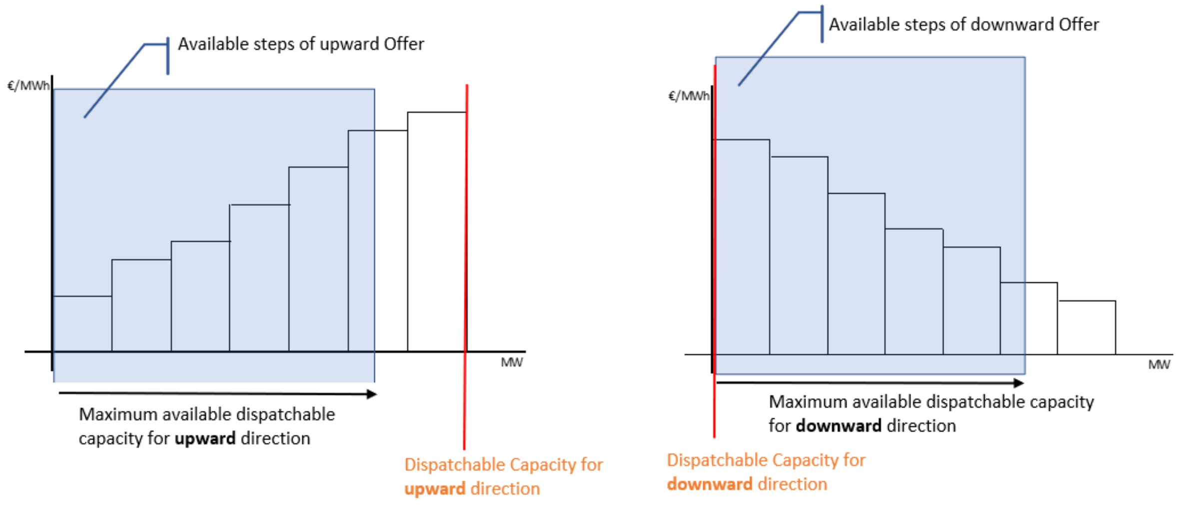

FIGURE 12 STEPWISE OFFERS OF UPWARD (LEFT) AND DOWNWARD (RIGHT) BALANCING ENERGY FOR DISPATCHABLE INTERMITTENT RES UNITS PORTFOLIOS

4.3.3 Dispatchable Load Portfolios

For the Dispatchable Load Portfolios (with the exception of pumped storage) the steps of the upward and downward ISP Balancing Energy Offers cover a range at the maximum up to the dispatchable capacity for the upward and downward direction. The Market Schedule of the Dispatchable Load Portfolios (with the exception of pumped storage) is not taken into consideration when selecting the offer steps to be activated, i.e., the first step that is selected is always the step corresponding to a capacity of 0 MW.

For pumped storage units the steps of the upward and downward ISP Balancing Energy Offer cover the entire range of the Maximum Net Capacity (from 0 MW up to the Maximum Net Capacity), regardless of the availability.

In the stepwise ISP Balancing Energy Offers of the Dispatchable Load Portfolios, the BSPs are entitled to include a specific quantity per step, which is offered as a whole and can, therefore, either be accepted or rejected in its entirety by the ISP. The following figure shows an example of a stepwise offer for upward and downward Balancing Energy. The blue colour is used to depict the quantity per step that is offered as a whole and can, therefore, either be accepted or rejected as a whole. According to the above figure, the first step can be accepted or rejected as a whole (it cannot be partially accepted), the second and third step can be accepted only if at least half of the quantity corresponding to each step is accepted, whereas for the remaining steps there is no limit as to the quantity that can be accepted.

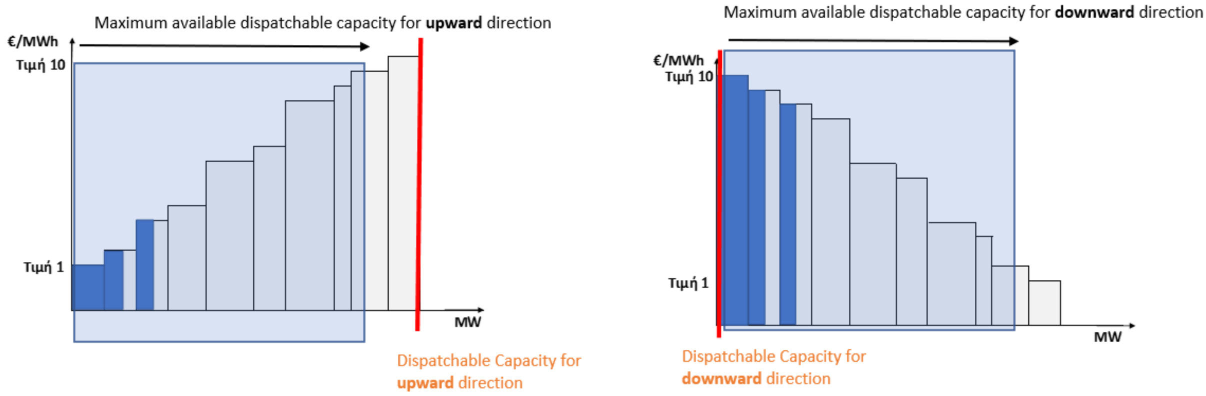

FIGURE 13A EXAMPLES OF STEPWISE UPWARD (LEFT) AND DOWNWARD (RIGHT) BALANCING ENERGY OFFERS FOR DISPATCHABLE LOAD PORTFOLIOS (EXCEPT FOR PUMPED STORAGE)

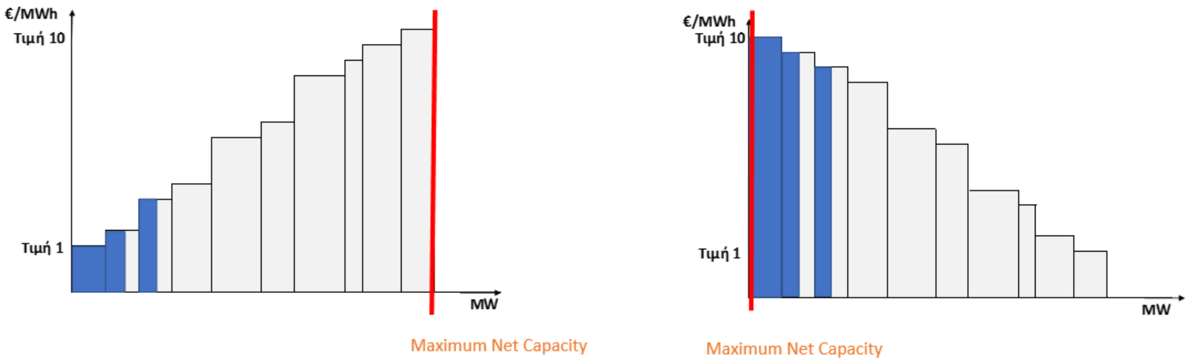

FIGURE 13B EXAMPLES OF STEPWISE UPWARD (LEFT) AND DOWNWARD (RIGHT) BALANCING ENERGY OFFERS FOR DISPATCHABLE LOAD PORTFOLIOS (FOR PUMPED STORAGE)

4.4 Tie Break Rules

In the event that the prices of two or more Balancing Energy Offers for the same Dispatch Period are identical and the sum of the quantities of those Offers is in excess of the requirements for Balancing Energy, i.e. the Balancing Energy offered through those Offers would have been partially accepted by the ISP as shown in the following figure, then the Tie Break Rule is followed, in accordance with Article 59 of the BMR.

In particular, among the Balancing Energy Offers that belong to the above category, the segment of the offer that is selected corresponds to a BSE, in the following order of priority:

- Dispatchable RES Units Portfolios,
- Dispatchable hydro Generating Units,
- Dispatchable Load Portfolios,

➢ Dispatchable thermal Generating Units.

In the event that the Balancing Energy Offers falling under the first paragraph of this section have been submitted by BSEs that belong to the same category of technology as described above, priority is given to the segments of the Balancing Energy Offers corresponding to the BSE with the highest Ramp Up Rate.

In the event that the Balancing Energy Offers falling under the first paragraph of this section have been submitted by BSEs that belong to the same category of technology and have the same Ramp Up Rate, the selection is random.

In the following figure the total load is 300 MW. The first five offers cover 280 MW of the load. The remaining 20 MW can be covered by one of the next two offers which have the same price, 55 €/MWh. Thus, the above criteria apply and the offer satisfying those criteria is selected.

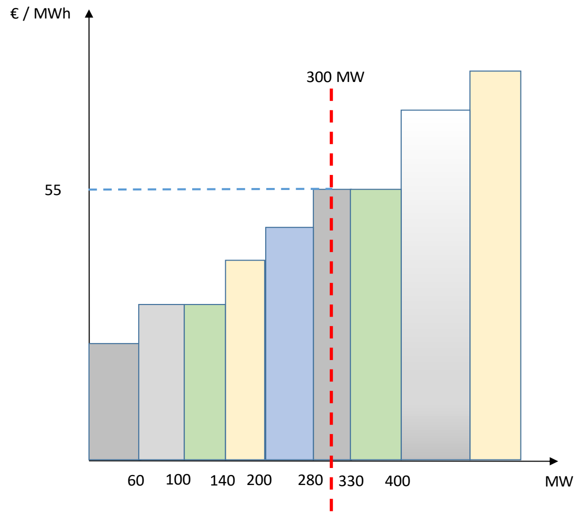

FIGURE 14: BALANCING ENERGY OFFERS WITH THE SAME OFFER PRICE

5 Balancing Capacity Offers

5.1 General Provisions

Balancing Capacity Offers represent the intention to provide reserves for the Balancing Capacity products referred to in Article 36 of the BMR:

- Upward and downward FCR,
- Upward and downward aFRR, and
- Upward and downward mFRR.

The BSPs representing Dispatchable Generating Units that are registered with the Balancing Market Generating Units Registry are obliged to submit to the ISP, for each Balancing Capacity product, on condition that they possess the relevant technical capacity:

1) an upward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a total upward Balancing Capacity quantity that corresponds to the Registered Characteristics (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR), and
2) a downward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a total downward Balancing Capacity quantity that corresponds to the Registered Characteristics (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR).

The Producers representing Dispatchable Generating Units with Alternative Fuel are obliged to submit separate Balancing Capacity Offers for the operation both with the primary and the alternative fuel.

The Producers representing Dispatchable pumped storage hydro Generating Units are obliged to submit separate Balancing Capacity Offers for generation and pumping. The submission of Balancing Capacity Offers for pumping is not obligatory.

The Producers representing Dispatchable Multi-Shaft Combined Cycle Generating Units are required to submit separate Balancing Capacity Offers for each configuration of their Units.

The BSPs representing Dispatchable RES Units Portfolios are entitled to submit to the ISP:

1) an upward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a total upward Balancing Capacity quantity that corresponds to the Registered Characteristics (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR), and
2) a downward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a total downward Balancing Capacity quantity that corresponds to the Registered Characteristics (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR).

The BSPs representing Dispatchable Load Portfolios are entitled to submit to the ISP for each Balancing Capacity product:

1) an upward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a quantity which shall be at the maximum equal to the full technical capacity to provide upward Balancing Capacity (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR), and
2) a downward Balancing Capacity Offer per BSE for each Dispatch Period of the Dispatch Day, for a quantity which shall be at the maximum equal to the full technical capacity to provide downward Balancing Capacity (Maximum contribution to FCR, Maximum contribution to aFRR, Maximum contribution to mFRR).

In the event that the BSPs representing Dispatchable RES Units Portfolios or Dispatchable Load Portfolios do not submit Balancing Energy Offers for a Dispatch Period the corresponding Balancing Capacity offers for this Period is rejected.

5.2 Amendment and acceptance of the Balancing Capacity Offers

In the event that a Balancing Capacity Offer was not submitted in accordance with Article 50 and Article 51 of the BMR, the Balancing Capacity Offer for all Dispatch Periods of the Dispatch Day shall be automatically rejected by the BMMS. In that case, the grounds for the rejection are notified to the BSPs through the BMMS. The BSP may re-submit a Balancing Capacity Offer until the Gate Closure Time for the submission of ISP Offers. If the Balancing Capacity Offer is submitted in accordance with Article 50 and Article 51 of the BMR, the Balancing Capacity offer is validated. Only the last validated Balancing Capacity Offers are taken into consideration for the execution of the ISP.

After the Gate Closure Time for the submission of ISP Offers, the Balancing Capacity Offers cannot be modified and are used as they are for the execution of ISP1, ISP2 and ISP3. The Annex of this Technical Decision includes a detailed description of the procedure for the submission and control of Balancing Capacity Offers in the BMMS.

If the GCT for the Submission of ISP Offers passes and the Provider has not submitted a Balancing Capacity Offer in accordance with Article 50 and Article 51 of the BMR, the BMMS automatically creates Balancing Capacity Offers for the respective Dispatchable Generating Unit and for all Dispatch Periods of the Dispatch Day, setting prices equal to the corresponding prices included in the last validated Balancing Capacity Offer on the previous day. The Offers which are created automatically by the BMMS are considered as having been submitted by the Participant and produce all the results provided for in the BMR, as if these Offers had been submitted by the Participant.

The offers submitted to the ISP are taken into consideration for the execution of ISP1, ISP2 and ISP3, as well as for any ad-hoc ISP. The re-submission of Offers is not allowed after the GCT for the submission of ISP Offers.

5.3 Content of the Balancing Capacity Offers

The Balancing Capacity Offers for each BSE and for each Dispatch Period consist of individual steps and shall refer to all types of Balancing Capacity for which the BSEs have the required technical capacity as per their Registered Characteristics. Each step shall contain the price of the Balancing Capacity Offer in €/MW-hour, accurate to two (2) decimal places, and the quantity of the Capacity offer in MW, accurate to one (1) decimal place. The minimum quantity of the Balancing Capacity Offer is equal to one (1) MW.

The upward and downward Balancing Capacity Offer include between one (1) and ten (10) steps. It is mandatory that the steps in MW be consecutive steps without gaps and cover the entire range of the Technical Capacity to provide Balancing Capacity in accordance with the relevant Techno-Economic Declaration regardless of the availability of the BSE. Each step corresponds to a Capacity range and has an offered price in €/MW-hour. The Balancing Capacity Offer price for each successive step may not be reduced in relation to the price of the Balancing Capacity Offer for the preceding step.

The price for each step of the above offers is higher than or equal to the Balancing Capacity Offer Minimum Price and lower than or equal to the Balancing Capacity Offer Maximum Price for each type of reserve. These capacity prices are submitted in €/MW-hour per Dispatch Period. The numerical values of the Balancing Capacity Offer Minimum Price and the Balancing Capacity Offer Maximum Price are specified in the Technical Decision of the HETS Operator "Technical limits on bidding and clearing prices in the Balancing Market".

The Balancing Capacity Offers for each Dispatch Period of the Dispatch Day are submitted separately for upward and downward FCR Balancing Capacity, for upward and downward aFRR Balancing Capacity and for upward and downward mFRR Balancing Capacity. The upward and downward Balancing Capacity Offers must be in the form presented in the following figure. The Annex includes a detailed description of the procedure for the submission and control of Balancing Capacity Offers.

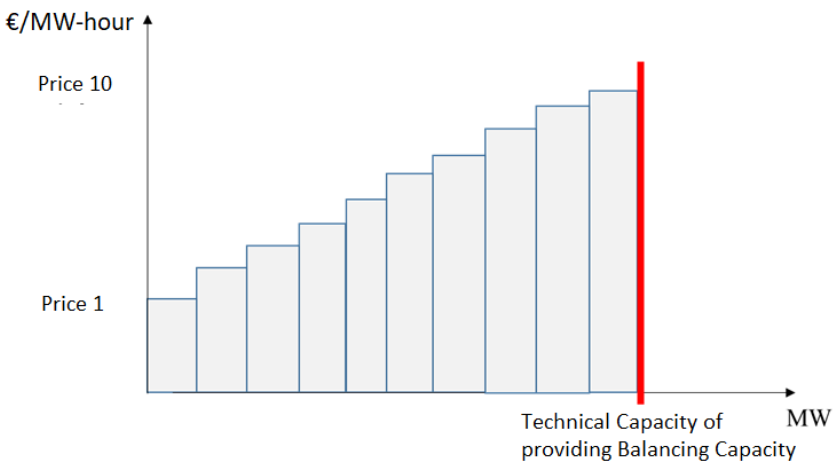

FIGURE15: FORM OF THE UPWARD AND DOWNWARD BALANCING CAPACITY OFFER

5.4 Tie Break Rules

In the event that the prices of two or more Balancing Capacity Offers for the same Dispatch Period are identical and the sum of the quantities of those offers is in excess of the requirements for Balancing Capacity, i.e. the Balancing Capacity offered through those offers would have been partially accepted by the ISP, then the Tie-Break Rule is followed, in accordance with Article 59 of the BMR.

In particular, if the two Balancing Capacity Offers that have an identical Balancing Capacity Offer price do not belong to the same category of technology, the segment of the offer that is selected shall correspond to a BSE, in the following order of priority:

- Dispatchable RES units Portfolios,
- Dispatchable hydro Generating Units,
- Dispatchable Load Portfolios,
- Dispatchable thermal Generating Units.

In the event that the two Balancing Capacity Offers that have an identical Balancing Capacity Offer price belong to the same category of technology, the segment of the offer that is selected corresponds to the BSE with the highest Ramp Up Rate.

In the event that the two Balancing Capacity Offers that have an identical Balancing Capacity Offer price belong to the same category of technology and have the same Ramp Up Rate, the selection is random.

The HETS Operator publishes on its website statistics on the cases where the Tie-Break Rule was applied, on a quarterly basis.

6 Obligations resulting from the ISP

6.1 Obligations of the HETS Operator

In the framework of the ISP, the HETS Operator prepares and then publishes on its website until 09:30 EET of calendar day D-1 the following forecasts for each Dispatch Period of the Dispatch Day:

a) the zonal Load Forecast,

b) the zonal RES Units Forecast, which includes the non-Dispatchable RES Units Portfolios forecast and the Dispatchable Intermittent RES Units Portfolios forecast.

c) the zonal and system~~ic~~ upward and downward HETS Operator needs in FCR, aFRR, and mFRR,

Furthermore, it publishes the current availability of Dispatchable Generating Units and the maximum forecast availability of Generating Units for Dispatch Day D, on the basis of their non-Availability Declarations at 09:30 EET of calendar day D-1 and whenever an important modification of availability occurs.

The above information is updated by the HETS Operator and is published on its website in three programmed time periods:

a) in the framework of ISP1 at 13:30 EET of calendar day D-1,

b) in the framework of ISP2 at 21:00 EET of calendar day D-1, and

c) in the framework of ISP3 at 9:00 EET of calendar day D.

The HETS Operator keeps records of the data and the parameters used for the above forecasts, as well as the results of such forecasts for each calendar year. In addition, the HETS Operator is not liable for the accuracy of the forecasts it prepares in the framework of its obligations under the BMR. The HETS Operator publishes statistical data on the accuracy of the above forecasts within two (2) months from the end of each calendar year. The above data are communicated to RAE.

The HETS Operator determines the inter-zonal transfer capacity between the internal Bidding Zones and identifies the imbalances in the import/export schedules in the interconnections for the solution of the ISP.

The HETS Operator executes the ISP, notifies each BSP of the ISP results that refer to the BSEs it represents, and publishes the results on its website. Until 11:00 EET on each calendar day D+1, the HETS Operator notifies RAE of all the data, the parameters and the results of the ISP that were executed on Dispatch Day D in editable form, in order for RAE to supervise the normal operation of the ISP and to identify possible distortions in the results of the ISP and the scheduling of the BSEs.

Furthermore, the HETS Operator publishes on its website, at the end of each calendar month, information on the operation of the Balancing Market in the preceding calendar month, which includes at least the following items:

- The total electricity and maximum total HETS Load per Dispatch Day,
- The zonal Imbalances per Imbalance Settlement Period,
- The inter-zonal transmission constraints of the HETS that affected its operation,

- The important HETS events.
- Aggregate information on Dispatch Instruction violations by BSPs,.

The HETS Operator submits to the Hellenic Energy Exchange the daily mandatory hydro injection declarations for each Unit two hours after the expiration of the submission deadline. Moreover, upon expiration of each Dispatch Day, the HETS Operator immediately publishes the quantity of energy injected by each Dispatchable hydro Generating Unit for each Imbalance Settlement Period of the Dispatch Day.

The HETS Operator informs the Hellenic Energy Exchange with regard to the daily mandatory hydro injection declarations in accordance with the provisions of the Day-Ahead & Intra-Day Markets Trading Rulebook.

If an amended daily mandatory hydro injection declaration is submitted during the Dispatch Day to which the declaration refers by BSPs representing Dispatchable hydro Generating Units, the HETS Operator:

- depending on the extent of the amendment, decides if an execution of an ad-hoc ISP is required,
- includes the amended daily mandatory hydro injection declarations in the Balancing Energy Market,
- has the possibility to allocate the additional quantities within the Dispatch Day, so that the operation of the HETS is ensured and the operation of the Balancing Market is not disturbed to the extent possible.

Upon expiration of the Dispatch Day, the HETS Operator immediately publishes the quantity of energy injected by each Dispatchable hydro Generating Unit for each Imbalance Settlement Period of the Dispatch Day.

The HETS Operator submits to RAE, on a monthly basis, a report containing the submitted requests for amendment of the weekly mandatory hydro management declarations, which include the reasons for their submission, the relevant evidence submitted by the BSPs, their acceptance or rejection by the HETS Operator and any other relevant information.

The HETS Operator sends to RAE, by the end of the following month, a report including at least the following information, on a daily basis and for each Dispatchable hydro Generating Unit:

- the water level in the relevant reservoir,
- curves on reservoir reserves,
- total injected energy,
- mandatory hydro injection declarations with distinct reference to the quantities by reason of overflow,
- pumping energy.

In case of amendment of the weekly mandatory hydro management declaration by the corresponding BSPs, the HETS Operator notifies the Participants as soon as possible and publishes on its website the relevant supporting documentation in accordance with Articles 23 and 24 of the BMR.

On a weekly basis, the BSPs representing Dispatchable hydro Generating Units must substantiate the energy quantity declarations for the mandatory operations by submitting data on the said operations and on the inflow-outflow water balance in the reservoirs. The data substantiating the declarations are both actuarial and budget data and are published on the website of the HETS operator.

Finally, the HETS Operator calculates the constraints in the maximum daily energy injection from Dispatchable Natural Gas Units for the total of Dispatchable Natural Gas Units or for individual groups of Dispatchable Natural Gas Units after having received the volumes of the maximum daily Natural Gas consumption from DESFA.

6.2 Obligations of the Hellenic Energy Exchange

The Hellenic Energy Exchange transmits to the HETS Operator the following information, for each MTU of each Dispatch Day, no later than 15 minutes after the last Gate Closure Time of the Local Intra-Day Auction or the Complementary Regional Intra-Day Auction or the Continuous Intra-Day Trading:

1) The Scheduled Energy Exchanges and the corresponding market prices, for each Inter-Zonal Corridor, as calculated in the results of the Day-Ahead Market and the Intra-Day Market. The Scheduled Energy Exchanges are submitted to the HETS Operator in order to calculate any remaining Inter-Zonal Capacity after the solution of the Intra-Day Market.
2) The Market Schedules, i.e. the algebraic sum of the quantities of the accepted Day-Ahead and Intra-Day Market Orders for each of the following BSEs for each MTU of the Dispatch Day:
    i. Dispatchable Generating Units in normal operation,
    ii. Dispatchable Generating Units in Testing Operation:
    iii. generating units in Commissioning Operation,
    iv. Dispatchable RES Units Portfolios per Bidding Zone in normal operation,
    v. Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation,
    vi. Non-Dispatchable RES Units Portfolios per Bidding Zone in normal operation,
    vii. Non-Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation or in Commissioning Operation,
    viii. RES Units Portfolio without Market Participation Obligation per Bidding Zone,
    ix. Load Portfolios per Bidding Zone,
    x. Pumping load from Dispatchable pumped storage hydro Generating Units.
3) The Market Schedules related to the HETS Losses per Bidding Zone, as calculated in the results of the Day-Ahead Market and the Intra-Day Market.

6.3 Obligations of the Distribution Network Operator

The Distribution Network Operators notify the HETS Operator as soon as possible in case of disconnection:

- of any component of the Distribution Network that may affect the normal operation of the HETS in real time,
- of any load connected to their Distribution Network which may affect the zonal Load Forecast performed by the HETS Operator in the context of the Balancing Market operation, and
- of any RES Unit connected to their Distribution Network, which may affect the zonal RES Forecast performed by the HETS Operator in the context of the Balancing Market operation.

The Distribution Network Operators immediately notify the HETS Operator, on justifiable grounds, if they plan to perform load curtailment or any other Network operations that are expected to cause a decrease in load in excess of ten (10) MW at a specific point of connection to the HETS.

6.4 Obligations of the Balancing Service Providers

6.4.1 General Provisions

The BSPs representing Dispatchable Generating Units have the obligation to submit to the HETS Operator:

- ISP Balancing Energy Offers,
- Balancing Capacity Offers,
- Techno-Economic Declarations,
- Non-Availability Declarations, and
- Major Outage Declarations.

The BSPs representing Dispatchable RES Units Portfolios or Dispatchable Load Portfolios (with the exception of pumped storage) are entitled to submit to the HETS Operator:

- ISP Balancing Energy Offers,
- Balancing Capacity Offers.

The BSPs representing Dispatchable pumped storage Load Portfolios are obliged to submit to the HETS Operator ISP Balancing Energy Offers, without prejudice to the transitional provisions herein, and have the right to submit to the HETS Operator Balancing Capacity Offers.

If the BSPs representing Dispatchable RES Units Portfolios or Dispatchable Load Portfolios submit to the HETS Operator ISP Balancing Energy Offers and/or Balancing Capacity Offers, they have the right to submit for that particular Dispatch Day non-Availability Declarations.

The files exchanged between the BSPs and the HETS Operator are in a standardized form, protected by security codes, and their format is presented in the Annex of this Technical Decision.

6.4.2 Operation Schedule Declarations in Commissioning Operation or in Testing Operation

The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation are obliged to submit to the HETS Operator, on a daily basis, initial Operation Schedule Declarations for the Units in Commissioning Operation or Testing Operation for each Dispatch Period of the Dispatch Day, at 8:00 EET and revised Declarations until 09:30 EET of the previous Dispatch Day. The BSPs representing generating units in Commissioning Operation or Dispatchable Generating Units in Testing Operation are entitled to submit to the HETS Operator updated Commissioning Operation or Testing Operation schedules for their units, for each Dispatch Period of Dispatch Day D, no later than one (1) hour prior to the execution of each ISP.

The Operation Schedule Declarations of Units in Commissioning Operation or Testing Operation and their updates are accepted upon approval by the HETS Operator, which is notified to the BSPs.

It is mandatory that the Operation Schedule Declarations for the Units in Commissioning Operation or Testing Operation refer to a full Dispatch Day, while the relevant Operation Schedule of the units for the last hour of that specific Dispatch Day must be zero. During a Dispatch Day, when an entity is in Commissioning Operation or Testing Operation, the ISP constraints referring to the technical characteristics of the relevant entity (e.g. Ramp Up/Down Rate, Maximum Available Capacity, Soak Trajectory) are not be taken into account. The imbalances arising between the updated Commissioning Operation or Testing Operation schedules and the Market Schedule for these entities are incorporated into the estimated HETS Imbalance, which constitutes the basis for the solution of the ISP.

As regards Multi-Shaft Combined Cycle Units and Dispatchable Units with Alternative Fuel in Commissioning Operation or in Testing Operation, it is mandatory that the Operation Schedule Declarations for the Units in Commissioning Operation or Testing Operation refer to a single configuration or a single Virtual Entity respectively, for the entire Dispatch Day. The transition to another configuration or Virtual Entity is not allowed within the Dispatch Day on which the entity is in Commissioning Operation or in Testing Operation.

Given that the Operation Schedules for Units in Testing Operation are also submitted to the Day-Ahead Market and that the MTU equals one hour, the Operation Schedule for Units in Testing Operation submitted by the BSPs must be the same for both Dispatch Periods (half hours) included in each MTU (hours). In the event that the above rule is not applied, the declaration is automatically rejected by the BMMS. In this case the BSP re-submits a corrected declaration. If the declaration is finally not accepted, then the Operation Schedule of units in Testing Operation or in Commissioning Operation for the second Dispatch Period is taken to be equal to the quantity of the first Dispatch Period. The BSPs submit the above to the HETS Operator in XLS/XLSX and XML format (see Annex).

6.4.3 Non-Availability Declarations

The BSPs which have a relevant obligation in accordance with Article 42 of the BMR submit to the HETS Operator a Total or Partial non-Availability Declaration for each BSE for each Dispatch Day on which the BSE has a reduced Available Capacity in comparison to the one arising out of the Declared Characteristics. Reduced Available Capacity may occur in case of an outage due to technical reasons related to the operation or the safety of its facilities, or for other reasons,

The Producers representing Dispatchable Units with Alternative Fuel are required to submit separate non-Availability Declarations for the operation of their Dispatchable Generating Units both using the primary and the alternative fuel. The Producers representing Dispatchable Multi-Shaft Combined Cycle Generating Units are obliged to submit separate non-Availability Declarations for each configuration of their Dispatchable Generating Units.

The Total or Partial non-Availability Declarations include at least the following:

a. the Dispatch Periods within a Dispatch Day or the Dispatch Days when non-availability is expected to occur,
b. the non-Available Capacity for each Dispatch Period of the Dispatch Day or the Dispatch Days, and
c. a detailed technical description of the reasons for the total or partial non-availability.

Without prejudice to the provisions of Article 49 of the BMR, non-Availability Declarations remain in effect for all the Dispatch Periods to which they refer, unless they are revoked or amended by the BSPs that submitted them.

The Dispatchable Generating Units and the pumped storage Dispatchable Load Portfolios submit non-Availability Declarations for Maximum Net Capacity. In case of Total non-Availability, the Maximum Available Capacity is zero. In case of Partial non-Availability, the Maximum Available Capacity are modified on the basis of the non-Availability Declaration and it is not allowed to be lower than the Technically Minimum Generation.

The Dispatchable Non-Intermittent RES Units Portfolios submit non-Availability Declarations for Maximum Net Capacity and Technically Minimum Generation. In case of Total non-Availability, the Maximum and the Minimum Available Capacity is zero. In case of Partial non-Availability, the Maximum and the Minimum Available Capacity is modified on the basis of the non-Availability Declaration.

The Dispatchable Intermittent RES Units Portfolios and the Dispatchable Load Portfolios (with the exception of pumped storage) submit Non-Availability Declarations for dispatchable capacity for the upward and downward direction. In case of Total non-Availability for the upward direction, the Maximum Available Capacity is zero, whereas in case of Total non-Availability for the downward direction, the Minimum Available Capacity is zero. In case of Partial non Availability for the upward direction, the Maximum Available Capacity is modified on the basis of the respective non-Availability Declaration for dispatchable capacity for the upward direction, whereas in case of Partial non-Availability for the downward direction, the Minimum Available Capacity is modified on the basis of the respective non-Availability Declaration for dispatchable capacity for the downward direction.

6.4.4 Obligations of the Balancing Service Providers representing Dispatchable Hydro Generating Units

The BSPs representing Dispatchable hydro Generating Units, including Dispatchable pumped-storage hydro Generating Units are obliged to submit to the HETS Operator the following hydro management declarations: a) yearly ahead hydro usage declarations, b) weekly mandatory hydro management declarations and c) daily mandatory hydro injection declarations.

Given that the daily mandatory hydro injection declarations are also submitted to the Day-Ahead Market and that the MTU equals one hour, the daily mandatory hydro injection declarations submitted by the corresponding BSPs must be the same for both Dispatch Periods (half hours) included in each MTU (hours). In the event that the above rule is not applied, the declaration is automatically rejected by the BMMS. In this case the BSP re-submits a corrected daily mandatory hydro injection declaration. If the declaration is finally not accepted, then the quantities of mandatory hydro injections for the second Dispatch Period are taken to be equal to the quantity of the first Dispatch Period. The BSPs submit the above to the HETS Operator in XLS/XLSX and XML format (see Annex).

The BSPs representing Dispatchable hydro Generating Units, including Dispatchable pumped-storage hydro Generating Units are also obliged to:

- submit to the HETS Operator annual curves regarding reservoir reserves for the last ten (10) years, on a monthly basis. As for the new power stations of Dispatchable hydro Generating Units, given that the historical data on water levels are limited, they must submit the estimated curves and take into account any available historical data.
- inform the HETS Operator about the reservoir water level of the Dispatchable hydro Generating Unit and any changes expected, and about the water supply to the reservoir of the Dispatchable hydro Generating Unit (instantaneous or average for a specific period), one day before the Dispatch Day or on an ad hoc basis, as the HETS Operator deems appropriate.
- take into account the current level of the relevant water reserves, any forecasts for the evolution of these reserves, their obligations for water supply, irrigation and ecological supply, and ensure that the Safety Minimum Reservoir Level is constantly maintained, when planning the operation of these Units and, in particular, at the time of submission of hydro management declarations and at the time of submission of Techno-Economic Declarations, which include information on the maximum daily energy injection for the Generating Units in question.
- notify the HETS Operator of the forecasted changes in any components affecting mandatory hydro management as soon as possible after the occurrence of the emergency.
- notify the HETS Operator, on a weekly basis, of the daily quantity of water in cubic meters and the corresponding energy in MWh that came through the spillway for each reservoir.

The BSPs representing Dispatchable hydro Generating Units that are connected to the reservoir may:

- submit mandatory hydro injection declarations for the above Units to avoid an overflow only when the water level in the relevant reservoir is expected to be equal or higher that the Safety Maximum Reservoir Level.
- submit declarations of maximum daily energy injection constraint for the above Units only when the water level in the relevant reservoir is expected to be equal or lower that the Safety Minimum Reservoir Level.

The height of the Safety Maximum Reservoir Level and the Safety Minimum Reservoir Level is defined for each Dispatchable hydro Generating Unit by RAE following a proposal by the relevant BSP and an opinion by the HETS Operator.

As regards the yearly ahead hydro usage declarations, which refers to the upcoming twelve months, the BSPs representing Dispatchable hydro Generating Units are obliged to:

- submit it to the HETS Operator on a rolling basis up to five (5) days before the start of the first month to which it refers, accompanied by the evidence on the maximization of the hydro resources value and the overall benefit of using the Dispatchable hydro Generating Units for the electricity sector.
- define in the yearly ahead hydro usage declaration for each month of the following twelve-month period, as a sum for all Dispatch Periods of the Dispatch Days of the month, as a sum for all Dispatchable hydro Generating Units of each BSP, and for three hydrological scenarios (high, low and intermediate total inflows) the following information:
    - the schedule of forecasted energy injection due to mandatory operation,
    - the schedule of forecasted generation of additional energy,
    - the expected water inflows in the reservoirs, and
    - the forecasted water reserves in the reservoirs at the end of the month.
- submit to the HETS Operator and to RAE, within one (1) month from the expiration of each Reliability Year, a report on hydro resources management during the previous Reliability Year, which include:
    - the ex-post data of the yearly ahead hydro usage declaration, in accordance with Article 22 of the BMR,
    - a comparison with the corresponding yearly ahead hydro usage declarations and evidence on the imbalances and
    - evidence on the maximization of the hydro resources value and the overall benefit of using the Dispatchable hydro Generating Units for the electricity sector.

As regards the weekly Mandatory Hydro Management Declarations, the BSPs representing Dispatchable hydro Generating Units:

- submit it every Thursday by 12:00 EET and it refers to a period of seven Dispatch Days in total starting on the following Saturday. The weekly mandatory hydro management declaration specifies the estimated quantity of mandatory energy injections for each Dispatchable hydro Generating Unit and for each Dispatch Period of the seven Dispatch Days to which the declaration refers and corresponds to the following mandatory operations: a) water supply, b) irrigation and c) ecological supply.
- are obliged to substantiate the energy quantity declarations for the mandatory operations on a weekly basis, by submitting data on the said operations and on the inflow-outflow water balance in the reservoirs. The data substantiating the declarations are both review and budget data. The weekly mandatory hydro management declaration of each Dispatchable hydro Generating Unit is binding and cannot be amended for the energy quantities corresponding to the ecological supply.
- may submit a request for amendment of the weekly mandatory hydro management declaration with regard to the information on water supply, irrigation and ecological supply for emergency reasons, which include cases of violation of the Safety Maximum Reservoir Level, other safety reasons or special works and third-party claims. The BSP must fully substantiate the request for amendment. The HETS Operator may request additional information at a later stage, if in its judgment the justification is not complete.

As regards daily mandatory hydro management declarations, the BSPs representing Dispatchable hydro Generating Units have the following additional obligations:

- they are obliged to notify the HETS Operator of the forecasted changes in any components affecting mandatory hydro management as soon as possible after the occurrence of the event. In particular, they are required to inform the HETS Operator with regard to:
    - the water level in the reservoir of the Dispatchable hydro Generating Units and the expected changes therein, especially if a violation of the Safety Maximum Reservoir Level is ascertained or forecasted,
    - the water supply in the reservoir of the Dispatchable hydro Generating Unit (instantaneous or average for a specific period),
    - any necessary measures taken for the safety of the reservoir dams when increased water supplies are observed,
    - the modification of irrigation needs,
    - special works and third-party claims or
    - other safety reasons (Force Majeure).
- they are obliged to submit to the HETS Operator daily mandatory hydro injection declarations, in principle at 8:00 EET and, in case of any corrections, until 09:30 EET of the previous Dispatch Day. Furthermore they are obliged to submit to the HETS Operator daily mandatory hydro injection declarations as soon as possible after the occurrence of an event affecting the management of mandatory hydro. A deviation of the daily mandatory hydro

injection declaration from the weekly mandatory hydro management declaration is allowed only in the following cases:

- modification of water supply needs,
- modification of irrigation needs,
- avoidance of overflow,
- special works and third-party claims,
- other safety reasons (Force Majeure).

Any deviation of the daily mandatory hydro injection declaration from the weekly mandatory hydro management declaration must be fully substantiated by the BSP. The HETS Operator may request additional information at a later stage, if in its judgment the justification is not complete.

6.5 Obligations of the Balance Responsible Parties

The RES Producers and/or RES Aggregators representing RES Units Portfolios, submit injection forecasts for each Dispatch Period of the Dispatch Day no later than two (2) hours prior to the execution of each scheduled ISP. The format of the injection forecast file to be submitted by RES Producers and/or RES Aggregators prior to the execution of each Scheduled ISP is presented in the Annex.

The Load Representatives that have submitted a Buy Order to the Electricity Markets managed by the Hellenic Energy Exchange are obliged to immediately notify the HETS Operator of any possible changes in the energy volumes that correspond to the load meters they represent.

The Load Representatives that have not submitted a Buy Order to the Electricity Markets managed by the Hellenic Energy Exchange for the energy meters they represent during the Dispatch Day in question according to the Table of Meters and Load Representatives pursuant to the HETS Grid Code, are obliged to immediately notify the HETS Operator of the total load that they expect to be absorbed by those meters for each Dispatch Period of the Dispatch Day.

7 ISP Rules

7.1 ISP optimization algorithm

The algorithm works in such a way that the total Balancing Energy and Balancing Capacity procurement cost is minimized. The total cost of Balancing Energy procurement may include the expected cost for the activation of Balancing Capacity in real time. Total cost of Balancing Energy and Balancing Capacity procurement means the sum of the Balancing Energy and Balancing Capacity procurement for all Dispatch Periods of Dispatch Day D in the case of ISP1 and ISP2, or for the remaining Dispatch Periods of Dispatch Day D in the case of ISP3 and any other execution of any ad-hoc ISP during the Dispatch Day.

The algorithm must comply with the following constraints:

i. the ~~system imbalances~~HETS' Imbalances constraint, according to which the sum of the allocated upward and downward ISP Balancing Energy is equal to the forecasted HETS Imbalances, per Bidding Zone and as a total,

ii. the inter-zonal constraints,

iii. the sum of the Balancing Capacity for FCR ~~supplied~~ by all BSEs that have been chosen to provide Balancing Capacity for FCR must be greater than or equal to the total requirements per Bidding Zone and/or of HETS as a whole with respect to the upward and downward Balancing Capacity for FCR,

iv. the sum of the Balancing Capacity for aFRR ~~supplied~~ by all BSEs that have been chosen to provide Balancing Capacity for aFRR must be greater than or equal to the total requirements per Bidding Zone and of HETS as a whole with respect to the upward and downward Balancing Capacity for aFRR,

v. the sum of the Balancing Capacity for mFRR ~~supplied~~ by all BSEs that have been chosen to provide Balancing Capacity for mFRR must be greater than or equal to the requirements per Bidding Zone and/or of HETS as a whole with respect to the upward and downward Balancing Capacity for mFRR,

vi. the sum of the Upward or Downward Ramp Rates of the Balancing Service Entities selected to provide Balancing Capacity for aFRR must be greater than or equal to the total requirement for the HETS in aFRR Upward or Downward Ramp Rate respectively.

~~vi.~~vii. the updated ~~Operation Schedules~~operation schedules of generating units in Commissioning Operation,

~~vii.~~viii. the updated ~~Operation Schedules~~operation schedules of Dispatchable Generating Units in Testing Operation,

~~viii.~~ix. the daily mandatory hydro management declarations,

~~ix.~~x. the technical constraints of the BSEs, as implemented, which are included in their Declared Characteristics, such as Balancing Capacity supply constraints, Balancing Energy constraints, Technically Minimum Generation, Maximum Net Capacity and the Available Capacity constraints under normal operation or under AGC, as well as synchronization time, soak time and de-synchronization time, time and output of the Dispatchable Generating Unit between synchronization and Technically Minimum Generation, logical status of commitment constraints, minimum up/down time constraints, ramp rate of power output and Balancing Capacity of the Units constraints., the Maximum Uptime per Activation and the Maximum Number of Daily Activations,

x.xi. the constraints in the maximum daily energy injection from Dispatchable Natural Gas Generating Units,

xi.xii. the constraints in the maximum daily energy injection from Dispatchable hydro Generating Units based on the declarations of maximum daily energy injection constraint from Dispatchable hydro Generating Units,

xii.xiii. in each Dispatch Period the Dispatchable pumped storage hydro Generating Units operate either as Dispatchable Generating Units or as pumping loads,

xiii.xiv. in each Dispatch Period the Dispatchable Generating Units with Alternative Fuel operate either with the primary or with the secondary fuel,

xiv.xv. in each Dispatch Period the Dispatchable Multi-Shaft Combined Cycle Generating Units operate only in one configuration,

xvi. in each Dispatch Period, the Dispatchable Load Portfolios and the Dispatchable Intermittent RES Units Portfolios provide either Balancing Capacity for mFRR or/and FCR or Balancing Capacity for aFRR or/and FCR,

xv.xvii. The constraints for the transition between two Virtual Entities.

In the event that it is impossible to coverachieving energy balance, i.e., covering the forecasted imbalances and/or, is not feasible, in order to achieve the zonal/systemicdesired algorithm convergence, especially in cases of energy surplus, the ISP algorithm can present an energy surplus in the ISP results, up to a maximum equal to the Balancing Energy Offer for the Virtual Entity specified in paragraph 3.2.2 herein.

In the event that maintaining the Balancing Capacity zonal/system requirements for a certain Dispatch Period of the Dispatch Day, the HETS Operator takes the is not feasible in order to achieve the desired algorithm convergence, the ISP algorithm can relax the Balancing Capacity requirements up to a maximum amount equal to the Balancing Capacity offer for the Virtual Entity specified in paragraph 3.2.2 herein.

If, following action:

- include ISP Balancing Energy Offers for Contracted Generating Units, and
- re-execute the ISP problem in order to attain a feasible solution.

If, after re-executing the ISP pursuant to paragraph 5the execution of the ISP in accordance with Article 59 Par. 5 of the BMR, infeasibilities still occur in covering the forecasted imbalances and/or the zonal/systemic Balancing Capacity requirements, the general constraints of paragraphs 11, 19 herein may be gradually lifted. Then, if thethen any available ISP solution continues to be

~~infeasible~~Balancing Energy Offers for Contracted Generating Units are included, the following constraints are gradually ~~lifted~~relaxed and the ISP is re-executed. The procedure for relaxing the constraints ~~are lifted in the following order~~is as follows:

- Initially, the Balancing Capacity requirements constraint for upward and/or downward mFRR is not implemented in its entire range.
- Afterwards, the Balancing Capacity requirements constraint for upward and/or downward FCR is not implemented in its entire range,
- Then, the Balancing Capacity requirements constraint for upward and/or downward aFRR is not implemented in its entire range,
- Finally, the HETS Imbalances constraint is not implemented in its entire range.

The Dispatchable Generating Units with Alternative Fuel may operate on the alternative fuel for the Dispatch Days for which the National Natural Gas System (ESFA) Operator has placed the ESFA at alert level (alert level 2) or at emergency level (alert level 3) according to the Emergency Plan. The fuel, primary or alternative, of the Dispatchable Generating Units with Alternative Fuel in the above cases is decided on the basis of the ISP results. The Dispatchable Generating Units with Alternative Fuel may only operate on one of the two fuel types in each Dispatch Period. The ISP algorithm takes into account the Declared Characteristics corresponding to the fuel selected for each Dispatch Period.

The HETS Operator includes in the ISP data the declarations of maximum daily energy injection constraint from Dispatchable Natural Gas Generating Units. The quantity of injected electricity that is included in the ISP for the Dispatchable Natural Gas Generating Units, to which the submitted declarations of maximum daily energy injection constraint from Dispatchable Natural Gas Generating Units refer, may not exceed the quantity specified in the above declarations.

The HETS Operator includes in the ISP data the declarations of maximum Daily energy injection constraint from Dispatchable hydro Generating Units. The quantity of injected electricity that is included in the ISP for the Dispatchable hydro Generating Units, to which the submitted declarations of maximum daily energy injection constraint from Dispatchable hydro Generating Units refer, may not exceed the quantity specified in the above declarations.

7.2 ISP results

The HETS Operator prepares the ISP schedule and issues the relevant Dispatch Instructions in order to ensure a reliable operation of the system and minimize its operation cost, based on the following principles:

- The BSEs are scheduled to cover the total HETS Load and provide the necessary Ancillary Services to secure the operation of HETS.
- The total HETS Load consists of the system Load Forecast which is carried out by the HETS Operator, on the one hand, and the schedule of exports through the interconnections, on the other hand.

- Any change in the availability of the BSEs in relation to the submitted one is only allowed for a due cause (such as failures, outages, dangerous situations, etc.). Any change in the availability for different reasons (e.g. maintenance operations) is allowed with the prior agreement of the HETS Operator.

The results of the ISP include:

- the commitment/de-commitment schedule of the BSEs, for each Dispatch Period of the Dispatch Day,
- the Balancing Capacity for FCR, mFRR and aFRR in any direction (upward and downward) for each BSE and for each Dispatch Period of the Dispatch Day,
- the inter-zonal flows,
- potential energy surplus in MW for each Dispatch Period of the Dispatch Day.
- the relaxation of the requirement for Balancing Capacity in MW, if required, for each Dispatch Period of the Dispatch Day.

For each Dispatch Period, the sum of the upward and downward Balancing Capacity allocated by the ISP to each BSE, calculated separately for each one of the Balancing Capacity products (FCR, mFRR and aFRR) as the sum of both directions of the product, cannot be less than a certain limit. This limit is calculated for Dispatchable Generating Units as the 2% of the Maximum Net Capacity and for Dispatchable Load Portfolios or Dispatchable RES Units Portfolios as the 2% of the dispatchable capacity. The above limit is rounded to an integer (MW) between 1MW and 10MW. When this limit is calculated to be less than 1MW, its value becomes 1MW, whereas when it is calculated to be more than 10MW, its value becomes 10 MW.

An indicative generation schedule also results from the ISP, for each BSE and for each Dispatch Period of the Dispatch Day ("ISP schedule"). The differences between the ISP schedule and the automatic mechanism that produces Dispatch Instructions (Balancing Energy Market) are not considered deviations from the ISP. Additionally, the ISP may provide an indicative schedule corresponding to the energy surplus in MW for each Dispatch Period of the Dispatch Day. The real-time energy surplus may significantly differ from the above indicative schedule and is addressed with appropriate measures taken by the HETS Operator close to real-time.

For the results of the ISP for the Balancing Capacity, the following apply:

a) The results of ISP1 are not binding.

b) The results of ISP2 are binding for the first twenty-four (24) Dispatch Periods of Dispatch Day D.

c) The results of ISP3 are binding for the last twenty-four (24) Dispatch Periods of Dispatch Day D.

d) The results of the ad-hoc ISPs are binding starting from the first Dispatch Period they refer to and until the next ISP publication referring to Dispatch Day D.

e) In the event that any of ISP2, ISP3 is not published, the binding results are the ones of the immediately preceding published ISP referring to Dispatch Day D.

The results of all the ISP executions are binding with regard to the commitment schedule of the BSEs, with each execution replacing the results of the previous ones in relation to the Dispatch

Periods of the Dispatch Day following said execution. The BSPs are obliged to comply with the binding results of the ISP executions. In case of non-compliance, the BSPs are not entitled to a remuneration and are subject to non-Compliance Charges, in accordance with Chapter 21 of the BMR.

The HETS Operator publishes the results after the execution of each ad-hoc ISP and forty-five (45) minutes after the execution of each scheduled ISP. Within the same deadline, it informs the BSPs, whose Balancing Energy and Balancing Capacity Offers were submitted to the ISP and accepted, of the results of the ISP that concern them. If, for any reason whatsoever, there is a delay in the publication of the results of ISP2 or of ISP3, then, until the result of the said ISP or any other ad-hoc ISP are published, the results of the last published ISP is considered binding as regards the commitment/ de-commitment schedule of the BSEs and the Balancing Capacity for FCR, mFRR and aFRR. The HETS Operator may deviate from the results of the ISP in all cases where it has substantiated evidence to consider that such a deviation is necessary so as to ensure the safe operation of the HETS and the smooth operation of the Balancing Market.

8 Initial conditions

The initial status of the BSEs in ISP1, ISP2, ISP3 and in ad-hoc ISPs is defined on the basis of the EMS/SCADA data of the HETS Operator and the previously published ISPs. These include the initial injection/offtake (output) level of the BSE, the number of hours since the last start-up/shut-down (the up/down time) or of the transition of configurations (how many hours ago did the transition of the configuration start or stop), the total energy that the BSE has generated since the start of the Dispatch Day, and the maximum daily energy. The following table presents the source of the initial conditions of the BSEs for the execution of each ISP. If there is not enough EMS/SCADA data available, then the data of the last published ISP are taken into account.

TABLE 4. SOURCE OF THE INITIAL CONDITIONS OF BSES FOR THE ISP

	ISP1	ISP2	ISP3	**Ad-hoc** ISP- The start of the ISP timeline is less than an hour from the time of its execution	**Ad-hoc** ISP- The start of the ISP timeline is more than an hour from the time of its execution
Maximum daily energy	From the techno-economic data	From the techno-economic data	From the techno-economic data	From the techno-economic data	From the techno-economic data
Start-Up	From the previous published ISP	EMS/SCADA data	EMS/SCADA data	EMS/SCADA data	From the previous published ISP
Up/Down time	From the previous published ISP	EMS/SCADA data	EMS/SCADA data	EMS/SCADA data	From the previous published ISP
Time from the last transition between two configurations	From the previous published ISP	EMS/SCADA data	EMS/SCADA data	EMS/SCADA data	From the previous published ISP
Output of **BSPs**	From the previous published ISP	EMS/SCADA data	EMS/SCADA data	EMS/SCADA data	From the previous published ISP
Dispatched Energy from the start of the Dispatch Day	0	0	From the previous published ISP and from EMS/SCADA data	From the previous published ISP and from EMS/SCADA data	From the previous published ISP and from EMS/SCADA data
Number of Daily Activations from the start of the Dispatch Day	0	0	From the previous published ISP and from the data of the mFRR process	From the previous published ISP and from the data of the mFRR process	From the previous published ISP and from the data of the mFRR process

For Dispatchable Load Portfolios (with the exception of pumped storage) and Dispatchable RES Units Portfolios, the initial conditions are always calculated on the basis of the previous published ISP.

As regards the initial conditions of Dispatchable Multi-Shaft Combined Cycle Generating Units, they are calculated both at the unit level (as a whole) and separately, at the configuration level.

At the unit level, the operation time is increasing for so long as any of the configurations remains active, whereas it becomes negative when the unit shuts down (none of the configurations is active), and then decreases until the next start-up of any of the configurations. The thermal state of the unit at start-up is calculated on the basis of the time of operation at the unit level.

At the configuration level, the operation time is increasing for so long as a specific configuration remains active, whereas it becomes negative when it shuts down, and then decreases until the next activation of that configuration. During the transition to a configuration, its thermal state is calculated on the basis of the time of operation of that configuration.

9 Ad-hoc ISP

If important deviations from the HETS data that was taken into account for the preparation of the ISP Schedule occur after it has been prepared, which data significantly affect the schedules of the BSEs and the commitment of Balancing Capacity, the HETS Operator may re-execute the ISP.

Significant deviations from the HETS data means:

1) Outage of one or more Dispatchable Generating Units or interconnections that requires an ISP Schedule revision.
2) Failure of a significant HETS component,
3) Other event that leads or may lead to an important change in the HETS Load.
4) Inability to cover the HETS Load and scheduling of emergency imports,
5) Update of the reserve requirements (FCR, aFRR and mFRR) and Inter-Zonal Constraints, provided that the data taken into account for the preparation of the ISP Schedule has changed.
6) Submission of an amended daily mandatory hydro injection declaration by the BSP,
7) Update of the testing schedule of BSEs in Testing Operation
8) Update of the zonal Forecast for RES Unit injections.
9) Any other reason whatsoever that the HETS Operator deems of such importance as to prepare a new ISP Schedule.

The above imbalances are taken into account when preparing the updated ISP Schedule, so that its results are as close as possible to the actual operation of the HETS.

10 Integrated Scheduling Process Data

10.1 Forecast Data

The ISP takes from the HETS Operator the following forecast data that is required to calculate zonal imbalances:

- the zonal Load Forecast,
- the zonal RES Units Forecast,
- the zonal HETS Losses Forecast,
- the zonal and system~~ic~~ upward and downward HETS Operator needs in FCR, aFRR, and mFRR,

10.2 Market Schedule

For the operation of the ISP, the HETS Operator receives from the Hellenic Energy Exchange the Market Schedule for each MTU of each Dispatch Day, in accordance with Article 37 of the BMR, for the following Entities:

- Dispatchable Generating Units in normal operation,
- Dispatchable Generating Units in Testing Operation:
- generating units in Commissioning Operation,
- Dispatchable RES Units Portfolios per Bidding Zone in normal operation,
- Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation,
- Non-Dispatchable RES Units Portfolios per Bidding Zone in normal operation,
- Non-Dispatchable RES Units Portfolios per Bidding Zone in Testing Operation or in Commissioning Operation,
- RES Units Portfolio without Market Participation Obligation per Bidding Zone,
- Load Portfolios per Bidding Zone,
- Pumping load from Dispatchable pumped storage hydro Generating Units.

The Market Schedule is issued per MTU (hour). As the ISP Dispatch Period is half an hour, the Market Schedule used during the execution of the ISP must be the same for both Dispatch Periods that are included in a MTU.

Regarding Dispatchable pumped storage hydro Generating Units, the Market Schedule is sent per Virtual Entity as opposed to Dispatchable Multi-Shaft Combined Cycle Generating Units and Units with Alternative Fuel to which the Market Schedule shall be sent per unit.

Furthermore, the Hellenic Energy Exchange submits the Scheduled Energy Exchanges and the corresponding purchase prices, for each Inter-Zonal Corridor, as calculated in the results of the Day-Ahead Market and the Intra-Day Market. The Scheduled Energy Exchanges are submitted to the HETS Operator, so as to calculate any Inter-Zonal Capacity after the solution of the Intra-Day

Market. Moreover, the Market Schedules related to the HETS Losses per Bidding Zone, as calculated in the results of the Day-Ahead Market and the Intra-Day Market, are submitted.

10.3 Inter-Zonal Constraints

In the framework of the ISP, the Bidding Zones may be defined, i.e., the geographical areas within which market participants are able to exchange energy without capacity allocation. The Bidding Zones are approved by decision of RAE, following a proposal by the HETS Operator and a relevant study as provided for in the HETS Grid Code.

Inter-Zonal Corridors are defined between the Bidding Zones together with the transfer capacity between the Bidding Zones. For each Inter-Zonal Corridor, the total flow calculated during the ISP solution must be lower than or equal to the Net Transfer Capacity (NTC) of the Inter-zonal corridor. For each Inter-Zonal Corridor, the ISP takes into account the Available Transfer Capacity (ATC) between Bidding Zones, which is equal to the difference between the Total Transfer Capacity and the Allocated Transfer Capacity, as calculated in the results of the Forward Market, the Day-Ahead Market and the Intra-Day Market.

10.4 ISP Products

The following products are used in the ISP:

- upward and downward Balancing Energy without distinguishing between mFRR and aFRR;
- the following Balancing Capacity products:
    i. Upward and downward FCR,
    ii. Upward and downward aFRR, and
    iii. Upward and downward mFRR.

10.5 Balancing Service Entities Data

The ISP takes into account the following data (as applied per BSE category):

- Minimum Available Capacity
- Maximum Available Capacity
- Maximum daily energy
- Minimum up time
- Minimum down time
- Table of transitions between configurations
- Transition time from hot to warm state
- Transition time from warm to cold state

- Time to synchronization from hot state
- Time to synchronization from warm state
- Time to synchronization from cold state
- Soak time from hot state
- Soak time from warm state
- Soak time from cold state
- Soak Trajectory
- Down time from Technically Minimum Generation to de-synchronization
- Ramp Up Rate
- Ramp Down Rate
- Maximum contribution to FCR
- Maximum contribution to aFRR
- Maximum contribution to mFRR
- Minimum Available Capacity in AGC mode
- Maximum Available Capacity in AGC mode
- Ramp Up Rate in AGC mode (for provision of aFRR)
- Ramp Down Rate in AGC mode (for provision of aFRR)
- Maximum up time per activation
- Maximum number of Daily Activations

11 Mathematical Modeling of the Integrated Scheduling Process

This chapter contains a detailed description of the variables, the parameters and the formulation of the mathematical model of the ISP.

11.1 General Description

The ISP solves the problem of the commitment of Generating Units in order to minimize the relevant total procurement cost of Balancing Energy and Balancing Capacity, as defined in Article 59 of the BMR. The total cost of Balancing Energy procurement may include the expected cost for the activation of Balancing Capacity in real time. It is formulated as an optimization problem, which consists of an objective function, a number of decision variables and a number of equality and inequality constraints. The problem to be solved is modeled as a MIP problem (Mixed Integer Programming) in accordance with Article 59 of the BMR.

The ISP provides a systematic way of dealing with problems that would probably not be solved without violating certain constraints. This is achieved by using a GP (Goal Programming) method, in which slack variables with relatively high penalty prices are used to allow some constraints of the optimization problem to be relaxed.

Both inequality and equality constraints include slack variables for surplus and deficit. Likewise, the constraints that place upper or lower bounds have a deficit or surplus slack variable respectively. The relative size of penalty prices determines the order whereby constraints are relaxed.

For example, the Energy Balance constraint has slack variables for electricity generation surplus and deficit. Each one of them has a corresponding penalty price. Thus, in case of a generation deficit, the corresponding “generation deficit” slack variable provides the energy required to cover the deficit.

Upon completion of the execution, the ISP verifies the values of all slack variables. If non-zero values are found, the solution is characterized as a “solution with violations”.

11.2 Nomenclature

Totals and Indicators

$h \in H$	Dispatch Periods **h** are the total of time intervals within a Dispatch Day. Dispatch Day D start at 01:00 EET of calendar day D and shall end at 01:00 EET of calendar day D +1. The Dispatch Periods are 30 minutes. The first Dispatch Period of Dispatch Day D is 01:00 – 01:30 EET.
$u \in Units$	Balancing Service Entity
$vu \in Virtual\ Units$	Virtual Entity
$z \in Zones$	Bidding Zones. Each BSE must belong to only one Bidding Zone.

$inter \in Interconnectors$	The Inter-Zonal Corridors connecting two Bidding Zones.
$seg \in S$	The step, **seg**, is part of a Balancing Energy or Balancing Capacity Offer with a single price and is thus associated with a single type of services (balancing energy, aFRR, mFRR and FCR, per direction) and a single BSE. It is expressed in MW.
$rsvtype \in \{FCR, mFRR, aFRR\}$	The type of Balancing Capacity product, which refers to the reserve products (FCR, mFRR, aFRR)

11.3 Objective Function

The Objective Function of the ISP solution model is described as follows:

$$\min(\text{BalancingEnergyCosts} + \text{BalancingCapacityCosts} + \text{ExpectedEnergyCostofReserves} + \text{PenaltyCosts}) \quad \text{Eq 1}$$

Where:

BalancingEnergyCosts	The cost of the activated Balancing Energy Offers for upward and downward Balancing Energy. It refers to the entire system for all Dispatch Periods. It is expressed in €.
BalancingCapacityCosts	The cost of the activated Balancing Capacity Offers for upward and downward Balancing Capacity and for all Balancing Services. It refers to the entire system for all Dispatch Periods. It is expressed in €.
PenaltyCost	The cost for violating the constraints of the problem. It is the virtual cost that is due to the violation of the constraints. It is non-zero only when the problem has a solution that violates one or more constraints. It is expressed in €.
ExpectedEnergyCostofReserves	The expected cost for the activation of Balancing Capacity by FCR, aFRR and/or mRR by each BSE for each Dispatch Period and Balancing Capacity product. It is expressed in €.

11.4 Balancing Energy Cost

$$\text{BalancingEnergyCosts} = \text{D} * \left(\sum_{u} \sum_{seg} \sum_{\text{h}} [\text{ESegMwUp(u, h, seg)} * \text{EsegPriceUp(u, h, seg)} - \text{ESegMwDn(u, h, seg)} * \text{EsegPriceDn(u, h, seg)}] \right) \quad \text{Eq 2}$$

Where:

D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
ESegMwUp(u,h,seg)	The quantity of upward Balancing Energy that is cleared for BSE **u**, and corresponds to step **seg** of the Balancing Energy Offer, during Dispatch Period **h**. It is expressed in MW.
EsegPriceUp(u,h,seg)	The price of upward Balancing Energy for BSE **u**, and corresponds to step **seg** of the Balancing Energy Offer, during Dispatch Period **h**. It is expressed in €/MWh.
ESegMwDn(u,h,seg)	The quantity of downward Balancing Energy that is cleared for BSE **u**, step **seg**, during Dispatch Period **h**. It is expressed in MW.
EsegPriceDn(u,h,seg)	The price of downward Balancing Energy for BSE **u**, and corresponds to step **seg** of the Balancing Energy Offer, during Dispatch Period **h**. It is expressed in €/MWh.

11.5 Balancing Capacity Cost

$$\begin{aligned} \text{BalancingCapacityCosts} &= \sum_{\text{rsvtype}} \sum_{\text{h}} \sum_{\text{u}} \sum_{\text{seg}} [\text{CSegMwUp}(\text{u}, \text{h}, \text{seg}, \text{rsvtype}) \\ &* \text{CsegPriceUp}(\text{u}, \text{h}, \text{seg}, \text{rsvtype}) + \text{CSegMwDn}(\text{u}, \text{h}, \text{seg}, \text{rsvtype}) \\ &* \text{CSegPriceDn}(\text{u}, \text{h}, \text{seg}, \text{rsvtype})] \end{aligned} \quad \text{Eq 3}$$

Where:

CSegMwUp(u,h,seg)	The quantity of upward Balancing Capacity that is cleared for BSE **u**, step **seg**, Dispatch Period **h** and reserve type **rsvtype** (aFRR, mFRR, FCR). It is expressed in MW
CsegPriceUp(u,h,seg)	The price of upward Balancing Capacity for BSE **u**, step **seg**, Dispatch Period **h** and reserve type **rsvtype** (aFRR, mFRR, FCR) in €/MW-30minutes. Given that the Dispatch Period is 30 minutes, the price of the offer used by the algorithm corresponds to half of the price of the respective Balancing Capacity Offer that has been submitted by the Entity.
CSegMwDn(u,h,seg)	The quantity of downward Balancing Capacity that is cleared for BSE **u**, step **seg**, Dispatch Period **h** and reserve type **rsvtype** (aFRR, mFRR, FCR). It is expressed in MW.
CsegPriceDn(u,h,seg)	The price of downward Balancing Capacity for BSE **u**, step **seg**, Dispatch Period **h** and type of reserve **rsvtype** (aFRR, mFRR, FCR) in €/MW-30minutes. Given that the Dispatch Period is 30 minutes, the price of the offer used by the algorithm corresponds to half of the price of the respective Balancing Capacity Offer that has been submitted by the Entity.

Reserve products (aFRR, mFRR, FCR) are included in the calculation of the Balancing Capacity Cost.

11.6 Expected Cost of Balancing Capacity Activation

$$\text{ExpectedEnergyCostofReserves} =$$

$$\sum_{h}\sum_{u}\left[\sum_{seg}\left[\begin{array}{l} C_{FCRup} * \text{CSegMwUp}(u,h,seg,\text{"FCR"}) * D * \text{WAEsegPriceUp}(u,h) - \\ C_{FCRdn} * \text{CSegMwDn}(u,h,seg,\text{"FCR"}) * D * \text{WAEsegPriceDn}(u,h) \end{array}\right]\right]$$

$$+$$

$$\sum_{h}\sum_{u}\left[\sum_{seg}\left[\begin{array}{l} C_{aFRRup} * \text{CSegMwUp}(u,h,seg,\text{"aFRR"}) * D * \text{WAEsegPriceUp}(u,h) - \\ C_{aFRRdn} * \text{CSegMwDn}(u,h,seg,\text{"aFRR"}) * D * \text{WAEsegPriceDn}(u,h) \end{array}\right]\right]$$

$$+$$

$$\sum_{h}\sum_{u}\left[\sum_{seg}\left[\begin{array}{l} C_{mFRRup} * \text{CSegMwUp}(u,h,seg,\text{"mFRR"}) * D * \text{WAEsegPriceUp}(u,h) - \\ C_{mFRRdn} * \text{CSegMwDn}(u,h,seg,\text{"mFRR"}) * D * \text{WAEsegPriceDn}(u,h) \end{array}\right]\right]$$

Where:

CFCRUp	A coefficient that reflects the expected activation of Balancing Capacity for upward FCR as to the total requirement for securing upward FCR (ZonalCapUpReq(z,h,rsvtype=”FCRup”)).
CFCRDn	A coefficient that reflects the expected activation of Balancing Capacity for downward FCR as to the total requirement for securing downward FCR (ZonalCapUpReq(z,h,rsvtype=”FCRdn”)).
CaFRRUp	A coefficient that reflects the expected activation of Balancing Capacity for upward aFRR as to the total requirement for securing upward aFRR (ZonalCapUpReq(z,h,rsvtype=”aFRRup”)).
CaFRRDn	A coefficient that reflects the expected activation of Balancing Capacity for downward aFRR as to the total requirement for securing downward aFRR (ZonalCapUpReq(z,h,rsvtype=”aFRRdn”)).
CmFRRUp	A coefficient that reflects the expected activation of Balancing Capacity for upward mFRR as to the total requirement for securing upward mFRR (ZonalCapUpReq(z,h,rsvtype=” mFRRup”)).
CmFRRDn	A coefficient that reflects the expected activation of Balancing Capacity for downward mFRR as to the total requirement for securing downward mFRR (ZonalCapUpReq(z,h,rsvtype=” mFRRdn”)).
CSegMwUp(u,h,seg)	The quantity of upward Balancing Capacity that is cleared for BSE **u**, step **seg**, Dispatch Period **h** and type of Balancing Capacity **rsvtype** (aFRR, mFRR, FCR). It is expressed in MW
CSegMwDn(u,h,seg)	The quantity of downward Balancing Capacity that is cleared for BSE **u**, step **seg**, Dispatch Period **h** and type of Balancing Capacity **rsvtype** (aFRR, mFRR, FCR). It is expressed in MW
WAEsegPriceUp(u,h)	The weighted average of the prices of the upward Balancing Capacity Offer segments in the corresponding Dispatch Period, in €/MWh. The segment of the

	offer taken into account is between (a) the maximum of the Market Schedule and the Technically Minimum Generation, and (b) the Maximum Available Capacity or the Maximum Available Capacity in AGC mode for mFRR and aFRR respectively.
WAEsegPriceDn(u,h)	The weighted average of the prices of the downward Balancing Capacity Offer segments in the corresponding Dispatch Period, in €/MWh. The segment of the offer taken into account is between (a) the Minimum Available Capacity or the Minimum Available Capacity in AGC mode for mFRR and aFRR respectively, and (b) the Market Schedule.

The "expected cost of Balancing Capacity activation" corresponds to the total expected cost of Balancing Energy, which corresponds to the activation of allocated Balancing Capacity for FCR, aFRR and/or mFRR.

For each BSE, the expected cost of Balancing Capacity activation is equal to the expected activation cost of the following six (6) Balancing Capacity products for each Dispatch Period:

- Upward / downward FCR
- Upward / downward aFRR
- Upward / downward mFRR

For each BSE, the cost for each one of the 6 Balancing Capacity products is calculated as the product of the following factors:

a) A factor that reflects the expected Balancing Energy activation from the allocated Balancing Capacity as to the total quantity of allocated Balancing Capacity.
b) The maximum quantity of Balancing Energy that can be activated as a result of the respective allocated Balancing Capacity. For example, an allocated Balancing Capacity for downward aFRR of 20 MW for a Dispatch Period (half an hour) corresponds to the maximum Balancing Energy that can be activated which is equal to 10MWh for the Dispatch Period (half an hour).
c) The weighted average price of the Balancing Energy Offer for the direction that corresponds to the direction of the relevant Balancing Capacity product for the respective BSE and Dispatch Period (€/MWh) as described below:
   - For upward Balancing Capacity, this price corresponds to the weighted average of the prices of the upward Balancing Energy offer steps in the respective Dispatch Period, as shown in the relevant figure (blue frame), in €/MWh. The segment of the offer taken into account is between (a) the maximum of the Market Schedule and the Technically Minimum Generation, and (b) the Maximum Available Capacity or the Maximum Available Capacity in AGC mode for mFRR and aFRR respectively, and
   - For downward Balancing Capacity, the price corresponds to the weighted average of the prices of the downward Balancing Energy offer steps in the respective Dispatch Period, as shown in the relevant figure (blue frame), in €/MWh. The segment of the offer taken into account is between (a) the Minimum Available Capacity or the Minimum

Available Capacity in AGC mode for mFRR and aFRR respectively, and (b) the Market Schedule.

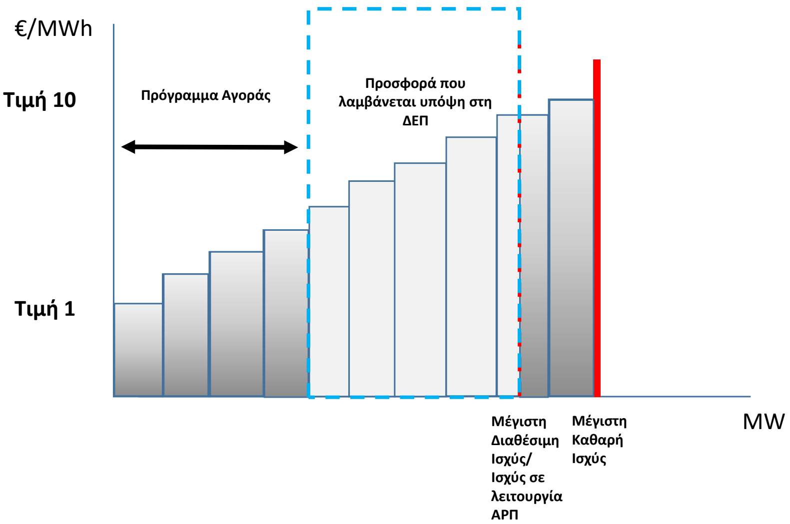

FIGURE 16: UPWARD BALANCING ENERGY OFFER OF A BSE

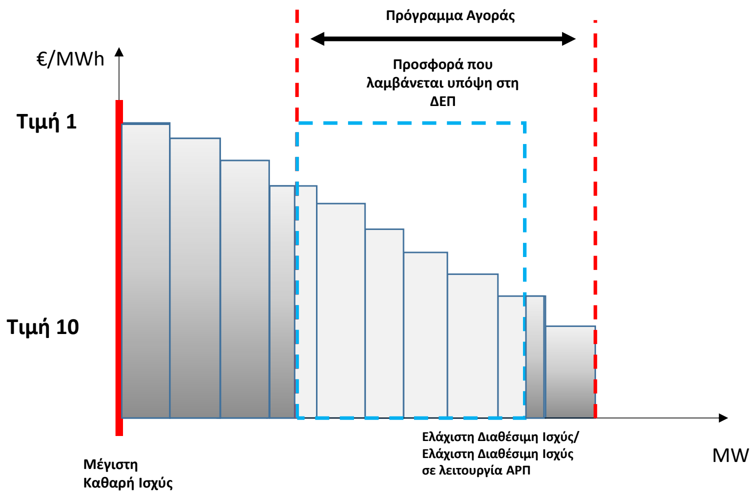

FIGURE 17: DOWNWARD BALANCING ENERGY OFFER FOR A BSE

The values of coefficients CFCRup, CFCRdn, CaFRRup, CaFRRdn, CmFRRup, and CmFRRdn is determined on the basis of the methodology presented below. To apply the methodology, the historical data of at least one calendar year are used. The HETS Operator updates the results based on the above methodology at least once a year.

As regards FCR, given that significant frequency imbalances are rare and, consequently, the quantity of activated energy is very small, and that the Balancing Energy from FCR cannot be measured separately, it is not deemed necessary to use the relevant cost of energy in the objective function. Consequently, the CFCRup, CFCRd coefficients are set equal to zero.

Regarding the methodology for the estimation of the coefficient for the expected activation of aFRR, the following input data are used:

- The aFRR Balancing Capacity requirement, which is an input data of the ISP.
- Per BSE, the information whether it was in AGC mode, which is recorded in the SCADA/EMS remote control system of the HETS Operator.
- Per BSE in AGC mode, the Dispatch Instruction which is generated by the mFRR process (RTBM) per 15 minutes and is recorded in the relevant IT system.
- Per BSE in AGC mode, the metered generation, which is recorded in the SCADA/EMS system of the HETS Operator in real time.

The calculation of the coefficient for the expected activation of aFRR is performed as follows:

1. For each Dispatch Period, the activated aFRR quantity of each BSE is calculated per direction, as the difference between the metered generation and the corresponding Dispatch Instruction. The resulting positive values express the upward aFRR activation, whereas the negative values express the downward aFRR activation.
2. For each Dispatch Period, the total activated aFRR quantity in the system is calculated per direction, as the sum of the aFRR quantity activated by each BSE operating in AGC mode.
3. A completion of the absolute values of the total activated aFRR quantity in the system is performed per Dispatch Period and per direction.
4. For each Dispatch Period, the percentage of aFRR activation is calculated as the quotient of the result of step 3 and the corresponding system requirement in aFRR Balancing Capacity.
5. The weighted average of the above percentages, which expresses the expected activation percentage, is calculated.

Regarding the methodology for the estimation of the coefficient for the expected activation of mFRR, the following input data is used:

- The mFRR Balancing Capacity requirement, which is an input data of the ISP.
- Per BSE in AGC mode, the Dispatch Instruction which is generated by the mFRR Process (RTBM) per mFRR Time Unit.

The calculation of the coefficient for the expected activation of mFRR is performed as follows:

1. For each mFRR Time Unit, the activated mFRR quantity of each BSE is calculated per direction, as the difference between the Market Schedule and the corresponding Dispatch Instruction. Positive differences imply upward mFRR activation, whereas the negative differences imply downward mFRR activation. The activated mFRR quantity is at the maximum equal to the corresponding allocated mFRR Balancing Capacity of the entity for each mFRR Time Unit.
2. For each mFRR Time Unit, the total activated mFRR quantity in the system is calculated per direction, as the sum of the mFRR quantity activated from each BSE.
3. For each Dispatch Period, the percentage of aFRR activation is calculated as the quotient of the total activated mFRR quantity in the system and the corresponding system requirement in mFRR Balancing Capacity.
4. The weighted average of the above percentages, which corresponds to the expected mFRR activation percentage, is calculated.

According to a study on the period between November 2020 and October 2021, the coefficient for the expected activation of aFRR was equal to 40% and for mFRR it was equal to 19% Regarding the expected mFRR activation coefficient, it is set to zero given that:

a) for mFRR Balancing Capacity, all the available entities can be activated regardless of whether they have been allocated Balancing Capacity (free bids).
b) the activation is performed taking into consideration the financial aspects of the offers.
c) the definition of values for the C_{mFRRUp}, and C_{mFRRDn} coefficients may become an obstacle to the entry of Demand Response in the Balancing Market.

Based on the above, the values of the coefficients are determined as follows:

Coefficient	Value
C_{FCRUp}	0
C_{FCRDn}	0
C_{aFRRUp}	0.40
C_{aFRRDn}	0.40
C_{mFRRUp}	0
C_{mFRRDn}	0

11.7 Penalty Costs

In order to deal with the cases of an infeasible ISP solution under specific circumstances, certain slack variables and additional terms for the penalty cost of using those slack variables are added to the Objective Function. Each penalty coefficient is matched with one slack variable. The penalty coefficients take relatively high values, so that any violation of the constraints may only happen in those cases where the algorithm cannot find a solution based on the Offers submitted by the Participants. When the solution comes with a non-zero value in a slack variable, implies that the problem does not have a solution without violating certain constraints. The values of the penalty coefficients determine the order of priority for the relaxation of the relevant constraints.

Slack variables are used for the following constraints:

- Zonal Balancing Energy Imbalances,
- Zonal reserve requirements for all types of reserves,
- HETS reserve requirements for all types of reserves,
- Technically maximums/ minimums of the Generating Units,
- Constraints on maximum daily electricity injection from the Generating Units,
- Ramp up/down constraints of the Generating Units,
- Constraints regarding changes in the reserves of the Generating Units,

- Constraints regarding maximum offer of reserves (for all types of reserves) by the Generating Units,

The Penalty Cost in the Objective Function is determined as follows:

$$
\begin{aligned}
&\mathrm{PenaltyCosts} = \\
&\textstyle\sum_u \mathrm{SurplusMaxDailyMWh(u)} * MaxDailyPenaltyPrice \\
&+ \sum_{u,h,rsvtype} \big(\mathrm{UnitBCUpSurplus(u, h, rsvtype)} + \mathrm{UnitBCDnSurplus(u, h, rsvtype)}\big) \\
&\qquad * UnitBCPenaltyPrice \\
&+\textstyle\sum_{u,h}\big(\mathrm{UnitCapSurplus(u, h)} + \mathrm{UnitCapDeficit(u, h)}\big) * UnitCapPenaltyPrice \\
&+ \textstyle\sum_{\mathrm{u,h}}\big(\mathrm{MinUpSlack(u, h)}\big) * \mathrm{MinUpPenaltyPrice} + \big(\mathrm{MinDnSlack(u,h)}\big) * \\
&MinDnPenaltyPrice \\
&+ \textstyle\sum_{\mathrm{u,h}}\big(\mathrm{StartUpSlack(u, h)}\big) * \mathrm{StartUpPenaltyPrice} + \big(\mathrm{ShutdownSlack(u, h)}\big) * \\
&ShutdownPenaltyPrice \\
&+ \textstyle\sum_{\mathrm{u,h}}\big(\mathrm{UnitMandDeficit(u, h)}\big) * \mathrm{MandDeficitGenPrice} \\
&+ \textstyle\sum_{\mathrm{u}}\big(SurplusMaxActivations(\mathrm{u})\big) * SurplusMaxActivationsPenaltyPrice \\
&+ \textstyle\sum_{\mathrm{u}}\big(SurplusMaxUptime(\mathrm{u})\big) * SurplusMaxUptimePenaltyPrice \\
&+\textstyle\sum_{u,h}\big(\mathrm{UnitRampUpMwSurplus(u, h)} + \mathrm{UnitRampDnMwSurplus(u, h)}\big) * \\
&UnitRampPenaltyPrice \\
&+\textstyle\sum_{u,h}\big(\mathrm{UnitBCUpRampSurplus(u, h)} + \mathrm{UnitBCUpRampSurplus(u, h)}\big) * \\
&UnitBCRampPenaltyPrice \\
&+\textstyle\sum_{z,h,rsvtype}\big(\mathrm{ZonalCapDeficitUp(z, h, rsvtype)} + \mathrm{ZonalCapDeficitDn(z, h, rsvtype)}\big) * \\
&ZonalReqPenaltyPrice \\
&+\textstyle\sum_{z,h}\big(\mathrm{ZonalImbDeficit(z,h)} + \mathrm{ZonalImbSurplus(z, h)}\big) * ZonalImbPenaltyPrice + \\
&+\textstyle\sum_{h,rsv}(\mathrm{SysCapDeficitDn(h, rsvtype)} + \mathrm{SysCapDeficitUp(h, rsvtype)}) * \\
&SysCapPenaltyPrice \\
&+ \sum_{\mathrm{u,h}} (\mathrm{SlackOZLow\ (u, h)} + \mathrm{SlackOZHigh\ (u, h)}) * \mathrm{OZViolationPrice} * \mathrm{D}
\end{aligned}
\qquad \text{Eq 4}
$$

Where:

SurplusMaxDailyMWh	The surplus in the Maximum Daily Energy Constraint for BSE **u**. It is expressed in MWh.
UnitBCUpSurplus(u,h,rsvtype)	The surplus in the Technical Capacity for the provision of upward Balancing Capacity for reserve type **rsvtype** (FCR, aFRR, mFRR), for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnSurplus(u,h,rsvtype)	The surplus in the Technical Capacity for the provision of downward Balancing Capacity for reserve type **rsvtype** (FCR, aFRR, mFRR), for BSE **u**, during Dispatch Period **h**. It is expressed in MW.

SysCapDeficitUp(h,rsvtype)	The deficit in the ability to satisfy the total system needs for upward Balancing Capacity for reserve type rsvtype (FCR, aFRR, mFRR), during Dispatch Period **h**. It is expressed in MW.
SysCapDeficitDn(h,rsvtype)	The deficit in the ability to satisfy the total system needs for downward Balancing Capacity for reserve type **rsvtype** (FCR, aFRR, mFRR), during Dispatch Period **h**. It is expressed in MW.
UnitBCUpRampSurplus(u,h)	The surplus in the Ramp Up constraint for the provision of Balancing Capacity for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnRampSurplus(u,h)	The surplus in the Ramp Down constraint for the provision of Balancing Capacity for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
ZonalCapDeficitUp(z,h,rsvtype)	The deficit in the ability to satisfy the total needs of Bidding Zone **z** for upward Balancing Capacity for type of reserve **rsvtype** (FCR, aFRR, mFRR), during Dispatch Period **h**. It is expressed in MW.
ZonalCapDeficitDn(z,h,rsvtype)	The deficit in the ability to satisfy the total needs of Bidding Zone **z** for downward Balancing Capacity for type of reserve **rsvtype** (FCR, aFRR, mFRR), during Dispatch Period **h**. It is expressed in MW.
ZonalImbDeficit(z,h)	The deficit in Balancing Energy in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
ZonalImbSurplus(z,h)	The surplus in Balancing Energy in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
UnitCapSurplus(u,h)	The surplus in the Maximum Available Capacity constraint for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitCapDeficit(u,h)	The surplus in the Minimum Available Capacity constraint for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitRampUpMwSurplus(u,h)	The surplus in the rate of change of upward Balancing Capacity of BSE **u**, during Dispatch Period **h**. It is expressed in MW/min.
UnitRampDnMwSurplus(u,h)	The surplus in the rate of change of downward Balancing Capacity of BSE **u** during Dispatch Period **h**. It is expressed in MW/min.
SlackOZHigh (u,h)	The violation of the upper limit of the Operational Zone in MW.
SlackOZLow (u,h)	The violation of the lower limit of the Operational Zone in MW.

The values of the penalty coefficients are specified by the HETS Operator in order to allow the detection of causes when the algorithm does not converge. The values of the penalty coefficients do not affect the ISP solutions published. If the algorithm does not converge, the HETS Operator carries out the actions stipulated in paragraph 7.1 until the ISP algorithm converges without violations and then publishes the results.

11.8 Start-up and shut-down model

11.8.1 Start-up model

The **start-up** of each BSE is modelled in the ISP. The energy injection/offtake of a BSE at start-up and the duration of the relevant start-up process is defined by the start-up model and the Declared Characteristics of the entity. In the event that the declared start-up time is zero, the start-up model is not applied. The start-up time is always deemed to be zero for the Intermittent RES Units Portfolios and the Dispatchable Load Portfolios (with the exclusion of pumped storage).

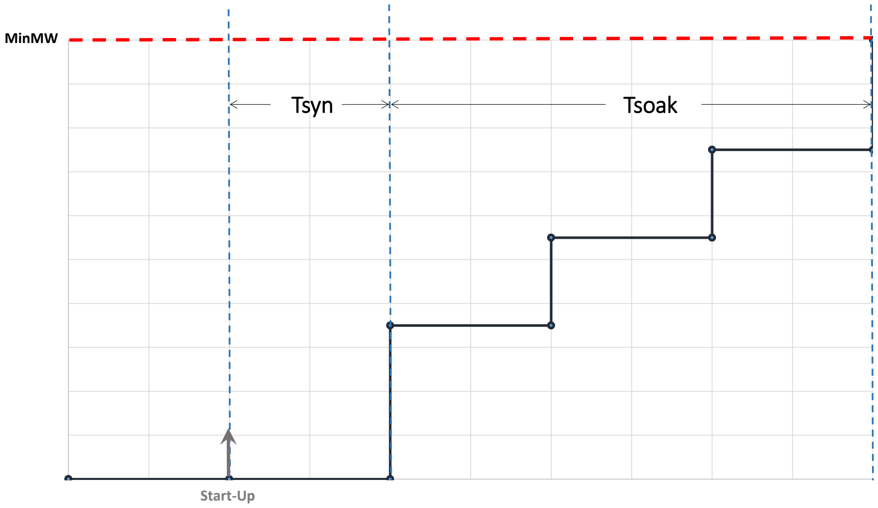

FIGURE 18: GENERATING UNIT START-UP

Where:

Start-up	A binary variable which indicates the start-up of a BSE from cold, warm or hot state.
Tsyn, Tsoak	The time period during which the BSE remains in synchronization or soak respectively.
MinMW	The Maximum and Minimum Available Capacity respectively.

11.8.2 Shut-down model

The **shut-down** of each Balancing Service Entity is modelled in the ISP. The energy injection/offtakeof a BSE at shut-down and the duration of the relevant shut-down process is defined by the shut-down model and the Declared Characteristics of the entity. In the event that the declared shut-down time is zero, the shut-down model is not applied. The shut-down time shall always be deemed to be zero for the Intermittent RES Units Portfolios and the Dispatchable Load Portfolios (with the exclusion of pumped storage).

According to the **shut-down** model, during shut-down state the BSE modifies its generation in downward steps, starting from the Minimum Available Generation and going down to zero, when it is de-committed from the system, as presented in the figure below.

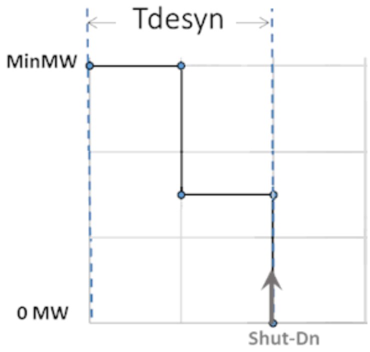

FIGURE 19: DE-SYNCHRONIZATION PROCESS MODELING

Where:

Tdesyn	The time (number of hours) that is required for the de-synchronization of a BSE.
Pmin	The Minimum Available Capacity of a BSE.
Shut-Dn	A binary variable which indicates whether a BSE is de-synchronized.

The entire start-up and shut-down model, as applied for a Dispatchable thermal Generating Unit is presented in the following figure:

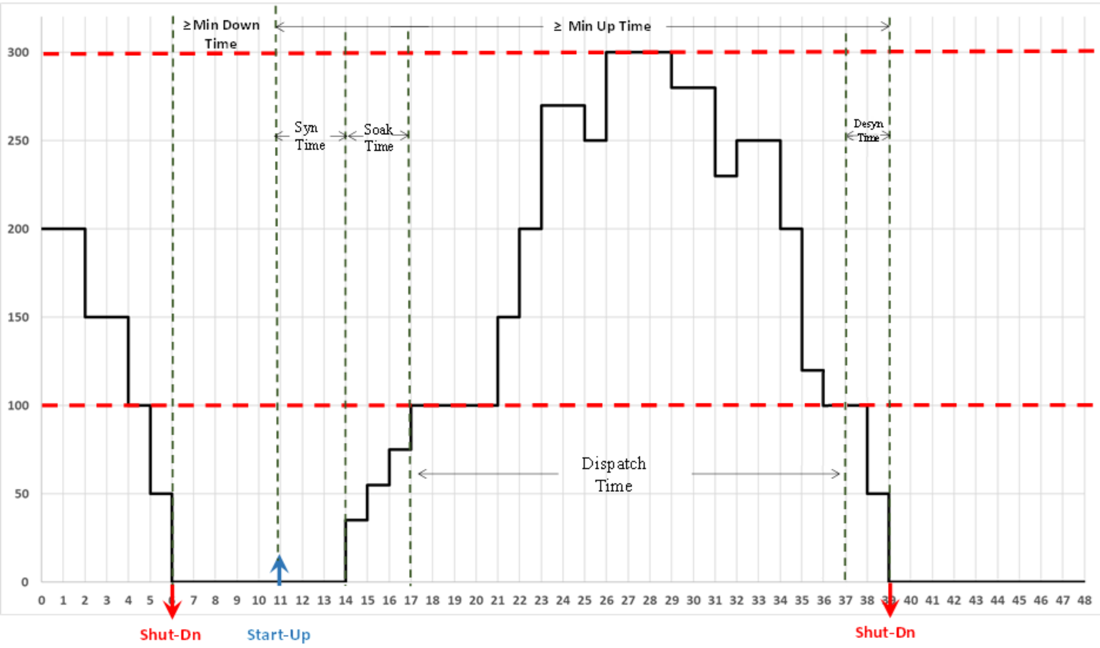

FIGURE 20: START-UP - SHUT-DOWN PROCESS MODELING

11.9 Minimum Up Time and Minimum Down Time Constraints

In order to satisfy the Minimum Up Time and the Minimum Down Time requirement, the following constraints are taken:

$$\sum_{h2=h-MinUp(u)+1}^{h} StartUp(u,h2) \leq Iup(u,h) \quad \text{Eq 5}$$

$$\sum_{h2=h+1}^{h+MinDn(u)} StartUp(u,h2) \leq 1 - Iup(u,h) \quad \text{Eq 6}$$

Where:

$\mathbf{Iup(u,h)}$	A binary variable which indicates whether a BSE **u** is committed, during Dispatch Period **h**. For the entities corresponding to Dispatchable Load Portfolios (with the exception of pumped storage), the value of this variable is determined by the relevant calculation of starts described in paragraph 11.11**Error! Reference source not found.**. In case of p rovision of non-spinning reserve by hydro or pumped storage hydro generating units, the variable value is zero.
$\mathbf{StartUp(u,h)}$	A binary variable which indicates the start of operation of BSE **u** during Dispatch Period **h**.
$\mathbf{MinUp(u)}$	The minimum up time of a BSE **u**.
$\mathbf{MinDn(u)}$	The minimum down time of a BSE **u**.

11.10 Maximum uptime constraint

In order to satisfy the maximum uptime constraint, the entity is not allowed to remain in operation for a greater period of time than the corresponding declared Maximum UpTime. This constraint applies only to Dispatchable Load Portfolios. The activation time that satisfies this constraint is calculated as in the case of Maximum Number of Daily Activations.

11.11 Maximum Number of Daily Activations

In order to satisfy the maximum Number of Daily Activations constraint, the entity may not be activated more times than the corresponding declared maximum number of activations per Dispatch Day. One activation corresponds to one cycle of energy or/and Balancing Capacity provision, as described in the following figure.

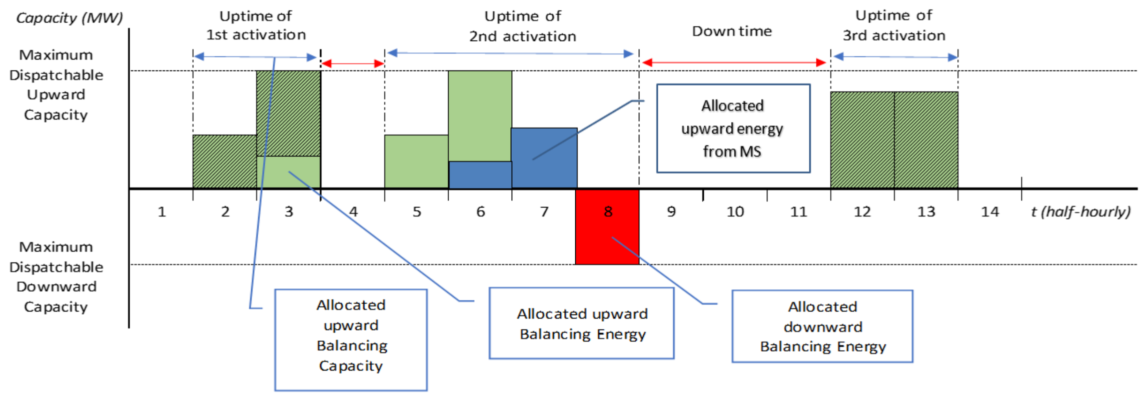

FIGURE 21: START CYCLES FOR THE PROVISION OF BALANCING ENERGY AND/OR CAPACITY

It is clarified that energy provision according to the Market Schedule of the BSE is considered an active state for the purpose of calculating an activation cycle. This constraint is enforced only for activations scheduled by the ISP within the Dispatch Day. Any additional activations, e.g., from the manual FRR process is not taken into consideration. For each Dispatch Period during which the entity is in active state, the sum of the ISP allocated Balancing energy and Capacity cannot be less than 1 MW. It should be also clarified that the maximum Number of Daily Activations constraint applies only to Dispatchable Load Portfolios.

The calculation of the maximum Number of Daily Activations allowed within an ISP (ISPc) is mathematically described as follows:

$$\begin{aligned}\text{Max\_ISPc\_Activations(u)} &= \text{MaxActivations(u)} \\ &- \min(\text{Scheduled\_ISP\_Startups\_Before\_Tinit(u)}, \\ &\text{Scheduled\_RTBM\_Startups\_Before\_Tinit(u)}) \\ &- (\text{Scheduled\_ISP\_Startups\_Before\_ISPc(u)} \\ &- \text{Scheduled\_ISP\_Startups\_Before\_Tinit(u)})\end{aligned} \quad \text{Eq 7}$$

Where:

ISPc	The current ISP
Tinit	Initialization time of ISPc
MaxActivations(u)	The maximum number of activations of a BSE u, according to its Declared Characteristics.
Scheduled_ISP_Startups_Before_Tinit(u)	The scheduled activations of BSE u, on the basis of previous ISP and until Tinit.
Scheduled_RTBM_Startups_Before_Tinit(u)	The scheduled activations of a BSE u, on the basis of the mFRR process and until Tinit.
Scheduled_ISP_Startups_Before_ISPc(u)	The scheduled activations of BSE u, on the basis of previous ISP and until the first Dispatch Period to which the ISPc refers.

Max_ISPc_Startups(u)	The maximum number of activations of BSE u in the period to which the ISPc refers.

An example of the above for a BSE:

- Maximum number of daily activations: 6
- ISP2 is executed as normal and it is binding from the start of the Dispatch Day and until the start of the next ad-hoc ISP, i.e., until 10:30.
- An ad-hoc ISP is executed and published at 7:00 and it is binding between 11:00 and 12:30.
- Then the next ISP (ISPc) is executed. The ISPc is initialized at 08:00 and refers to the period 13:00 - 23:30.
- Consequently, Tinit: 8:00 AM

The scheduled activations of the entity from the ISP2, ad-hoc ISP and the mFRR Process until 08:00 are shown in the following table:

	ISP2										Ad-hoc ISP		Period to which ISPc refers											
Dispatch Day Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ISP2 activations	1	0	1	0	0	1	0	0	0	1	0	0	1	0	1	0	1	0	1	0	0	0	0	0
Ad-hoc ISP activations											0	1	0	1	0	0	0	1	0	0	0	0	0	0
Activations until 8:00 according to the mFRR process	1	0	0	0	0	0	0	0																

Consequently, the variables take the following values:

- **Scheduled_ISP_Startups_Before_Tinit(u)**: Total activations in the ISP2 until 7:30 = 3
- **Scheduled_RTBM_Startups_Before_Tinit(u):** Total activations in the mFRR Process until 7:45 = 1.
- **Scheduled_ISP_Startups_Before_ISPc(u):** Total activations in the ISP2 until 10:30 + Total activations in the ad-hoc ISP between 11:00 and 12:30 = 4 + 1 = 5.

In this case, the entity in the ISPc can have at the maximum 3 activations according to the relevant equation:

- **Max_ISPc_Activations** = 6 - min(3, 1) – (5-3) = 6 – 1 – 2 = 3

11.12 Generation Constraints

The ISP determines the ISP Schedule of the BSE based on:

- The Market Schedule provided by the Hellenic Energy Exchange to the HETS Operator.
- The upward Balancing Energy Offer
- The downward Balancing Energy Offer

$$\text{UnitMw}(u,h) * D = MS_0(u,h) + \text{UnitBEMwhUp}(u,h) - \text{UnitBEMwhDn}(u,h) \qquad \text{Eq 8}$$

Where:

UnitMw(u,h)	The ISP Schedule of a BSE **u** during Dispatch Period **h**. It is expressed in MW.
D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
MS_0(u,h)	The Market Schedule of a BSE **u**, during Dispatch Period h. It is expressed in MWh.
UnitBEMWhUp(u,h)	The cleared upward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhDnp(u,h)	The cleared downward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.

The ISP Schedule for each BSE approximates the actual operation of each BSE. When calculating the ISP Schedule for each Dispatch Period, the ISP Schedule of the preceding Dispatch Period and the relevant Ramp Up or Ramp Down Rate of the BSE is taken into account. As shown in the following figure, the ISP Schedule approximates the actual operation in steps (blue line), whereas the actual operation of a BSE is linear (red line). This approximation is necessary so as to avoid the non-linearity in the ISP solution algorithm. The resulting deviation of the ISP Schedule from the actual operation is covered during the operation of the Balancing Energy Market close to real time.

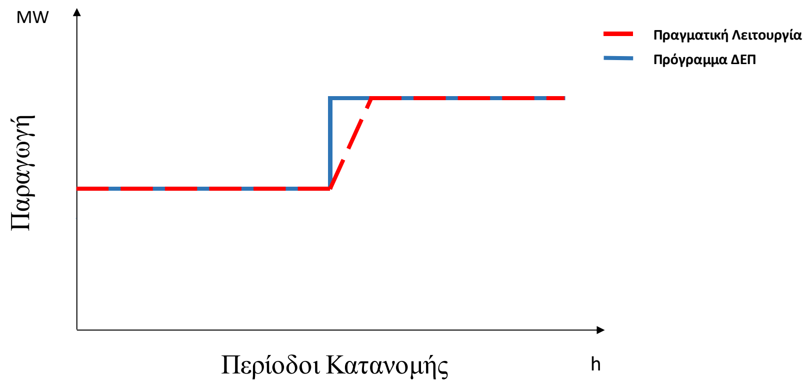

FIGURE 22: DEVIATION OF THE ISP SCHEDULE FROM ACTUAL OPERATION

The following figure shows the Market Schedule and the ISP Schedule of a BSE after the solution of the ISP.

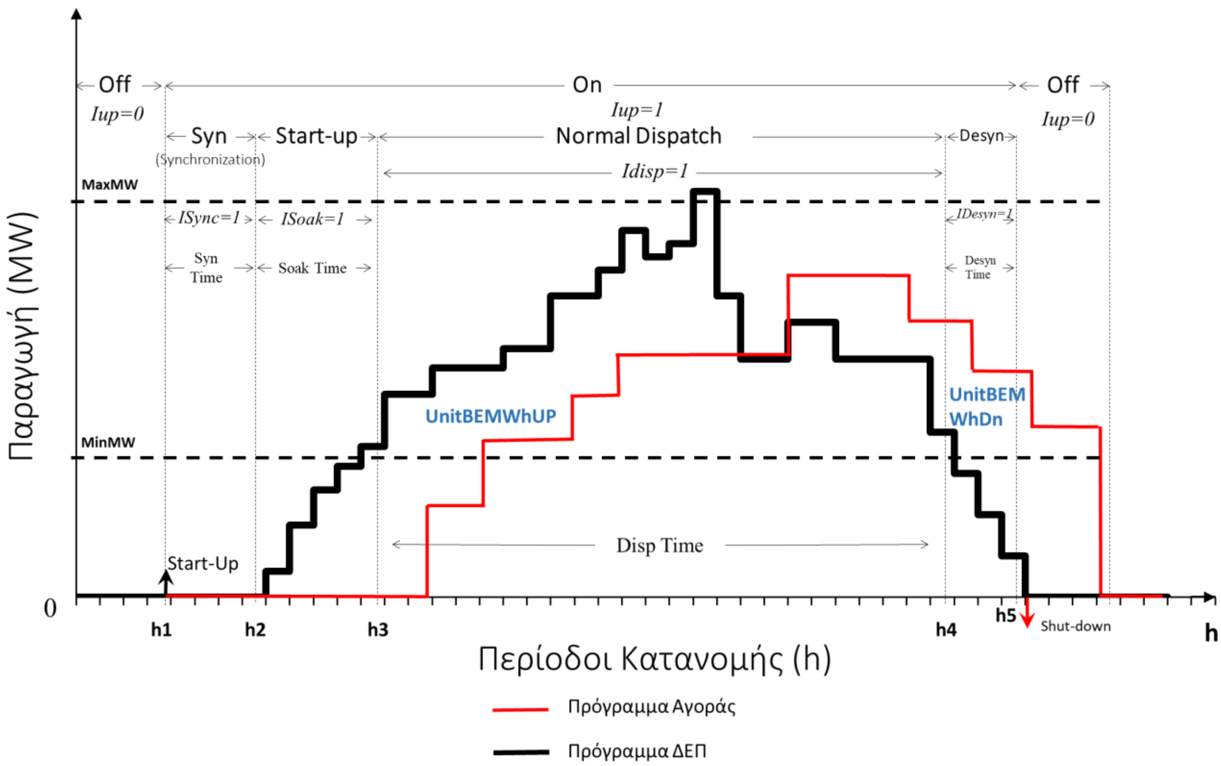

FIGURE23: ISP SCHEDULE

11.12.1 Generation limits

The following constraints determine the generation limits of a BSE taking into consideration the four phases (synchronization, soak, dispatch and de-synchronization). In the synchronization, soak and de-synchronization phases, the start-up and shut-down model profile is followed and the generation level of the BSE has the corresponding values.

The lower operation limit constraint of a BSE, which is not modeled as multiple Virtual Entities may be represented as follows:

$$\begin{aligned} &\mathrm{UnitMw(u,h)} - \sum_{\mathrm{rsvtype}} \mathrm{UnitBCDnMW(u,h,rsvtype)} + \mathrm{UnitCapDeficit(u,h)} \\ &\geq \mathrm{UnitSoakMw(u,h)} \\ &+ \sum_{\mathrm{h2=h+1}}^{\mathrm{h+DesynTime(u)+1}} \mathrm{ShutDn(u,h2)} * (\mathrm{h2} - \mathrm{h} - 1)\frac{\mathrm{MinMw(u,h)}}{\mathrm{DesynTime(u)}} \\ &+\mathrm{MinMw(u,h)} * \mathrm{IDisp(u,h)} \end{aligned} \quad \text{Eq 9}$$

$$\mathrm{UnitMw(u,h)} - \mathrm{UnitBCDnMW(u,h,"aFRR")} + \mathrm{UnitCapDeficit(u,h)} \geq \quad \text{Eq 10}$$

$$UnitSoakMw(u,h) + \sum_{h2=h+1}^{h+DesynTime(u)+1} ShutDn(u,h2) * (h2-h-1)\frac{MinMw(u,h)}{DesynTime(u)}$$
$$+MinMw(u,h) * \left(IDisp(u,h) - IUpAGC(u,h)\right)$$
$$+IUpAGC(u,h) * MinAGC(u,h)$$

The upper operation limit of a BSE, which is not modeled as multiple Virtual Entities may be represented as follows:

$$UnitMw(u,h) + \sum_{rsvtype} UnitBCUpMW(u,h,rsvtype\,) - UnitCapSurplus(u,h) \leq UnitSoakMw(u,h) + \sum_{h2=h+1}^{h+DesynTime\,(u)+1} ShutDn(u,h2) * (h2-h-1)\frac{MinMw(u,h)}{DesynTime(u)} + MaxMw(u,h) * IDisp(u,h) \quad \text{Eq 11}$$

$$UnitMw(u,h) + UnitBCUpMW(u,h,"aFRR") - UnitCapSurplus(u,h) \leq UnitSoakMw(u,h) + \sum_{h2=h+1}^{h+DesynTime(u)+1} ShutDn(u,h2) * (h2-h-1)\frac{MinMw(u,h)}{DesynTime(u)} + MaxMw(u,h) * \left(IDisp(u,h) - IUpAGC(u,h)\right) + IUpAGC(u,h) * MaxAGCMw(u,h) \quad \text{Eq 12}$$

Where:

UnitMw(u,h)	The ISP Schedule of BSE **u** during Dispatch Period **h**. It is expressed in MW.
UnitCapDeficit	The surplus in the Minimum Available Capacity constraint for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitSoakMw(u,h)	The capacity produced by a Generating Unit when in the soak phase for Generating Unit **u**, during Dispatch Period **h**.
UnitCapSurplus	The surplus in the Maximum Available Capacity constraint for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCUpMW(u,h,rsvtype)	The cleared upward Balancing Capacity of a BSE **u,** for reserve type **rsvtype** (aFRR, mFRR, FCR), during Dispatch Period **h**. It is expressed in MW.
UnitBCDnMW(u,h,rsvtype)	The cleared downward Balancing Capacity of a BSE **u,** for reserve type **rsvtype** (aFRR, mFRR, FCR), during Dispatch Period **h**. It is expressed in MWh.

MinMW(u,h)	The Minimum Available Capacity of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
MaxMW(u,h)	The Maximum Available Capacity of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
MinAGC(u,h)	The Technically Minimum Generation under AGC of a Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
MaxAGC(u,h)	The Maximum Net Capacity under AGC of Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
Idisp(u,h)	A binary variable which indicates whether a BSE **u** is between its Minimum and Maximum Available Capacity, during Dispatch Period **h**.
IupAGC(u,h)	A binary variable which indicates whether a Generating Unit **u** is in AGC mode, during Dispatch Period **h**.
ShutDn(u,h)	A binary variable which indicates the shut-down of a Generating Unit **u**, during Dispatch Period **h**.
DesynTime(u)	The time that a Generating Unit **u** needs to synchronize. It is expressed in **h**.

For the BSEs which are modeled as Virtual Entities, the above equations are modified according to the transition profile between Virtual Entities, as presented in section 11.22.2.

The above constraints represent a generalized model for both states, depending on whether the Generating Unit is in AGC mode or not. Furthermore, it is ensured that the Generating Unit is in a position to operate under AGC (**IupAGC=1**) only when the generation level of the Unit is between the Technically Minimum Generation and the Maximum Net Capacity (**Idisp=1**). It is expressed with the following constraint:

$$\mathrm{IupAGC(u,h)} \leq \mathrm{Idisp(u,h)} \quad \text{Eq 13}$$

The following figure represents the different limits of a Generating Unit described above.

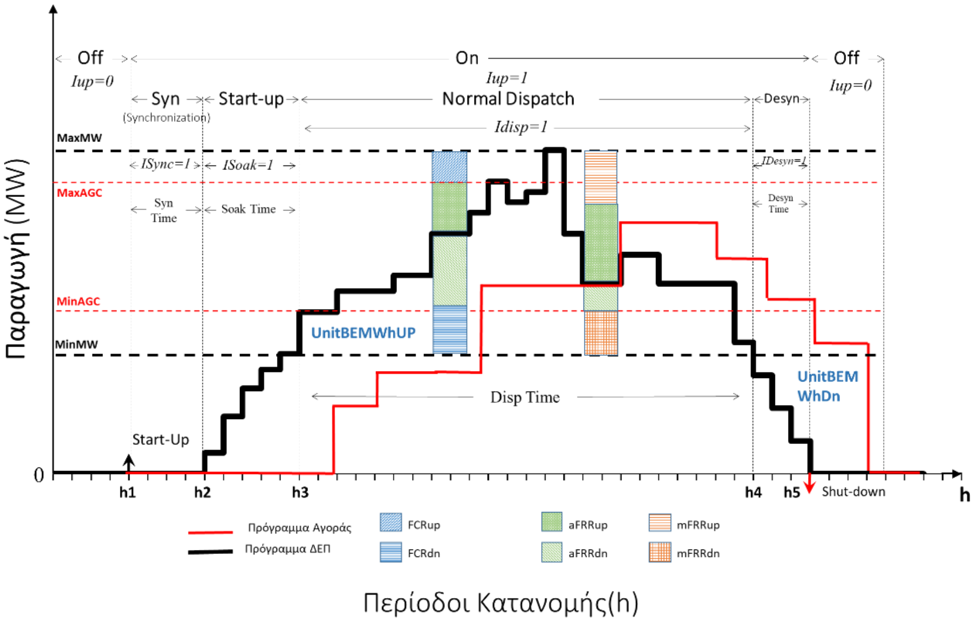

FIGURE 24: ISP SCHEDULE WITH BALANCING CAPACITY OFFER

11.13 Maximum Daily Energy

The total injection energy of a BSE during a Dispatch Day may be limited by the following daily energy constraint:

$$\sum_{h} \mathrm{UnitMw(u,h)} * \mathrm{D} - \mathrm{SurplusMaxDailyMWh(u)} \leq \mathrm{MaxDailyMwh(u)} - \mathrm{InitDailyMwh(u,h)} \qquad \text{Eq 14}$$

Where:

UnitMw	The ISP Schedule of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
SurplusMaxDailyMWh	The surplus in the Maximum Daily Energy Constraint for BSE **u**. It is expressed in MWh.
InitDailyMwh((u,h)	The quantity of energy that has already been dispatched to a BSE on the basis of the available SCADA measurements and the previous ISPs between the first Dispatch Period of the Dispatch Day and Dispatch Period h. It is expressed in MWh.
MaxDailyMwh(u)	A parameter representing the Maximum Daily Energy that can be provided by a BSE, **u**. It is expressed in MWh.

In the intra-day ISPs, the value of the maximum daily energy is calculated as the difference of the maximum daily energy from the start of the day; consequently, the energy generated up to this specific point in time subtracted from the initial value (MaxDailyMWh) on the basis of the available SCADA measurements and the energy already dispatched during previous ISPs (InitDailyMwh). For instance, as shown in the following figure, ISP3 calculates the parameter **InitDailyMwh** by adding the relevant SCADA measurements for Dispatch Periods 1-18 to the ISP Schedule resulting from the solution of ISP2 for Dispatch Periods 19-24.

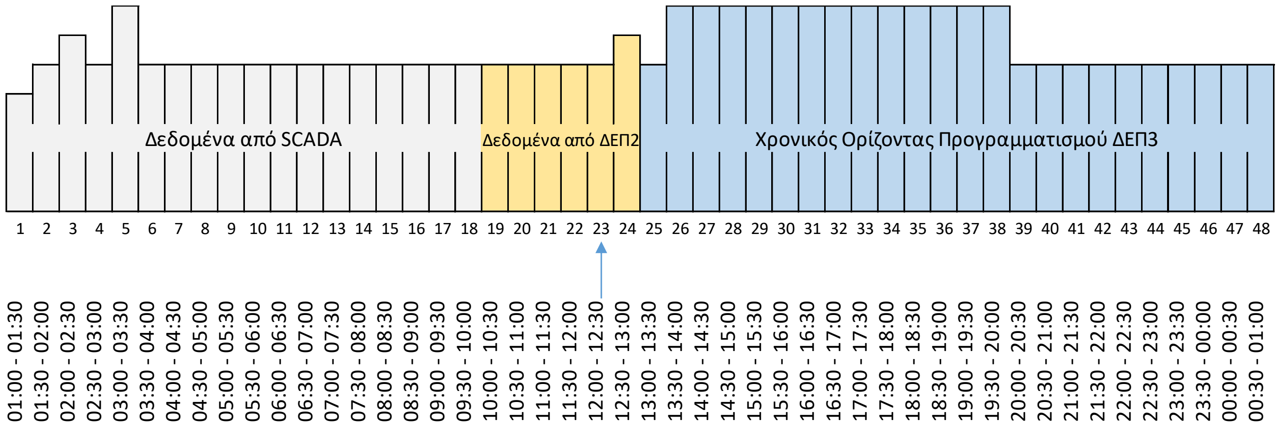

FIGURE 25: MAXIMUM DAILY ENERGY

11.14 Contribution of Balancing Service Entities to Balancing Energy

The total cleared energy for a BSE in MWh is equal to the sum of all offer steps cleared.

$$\mathrm{UnitBEMWhUp(u,h)} = \sum_{\mathrm{seg}} \mathrm{ESegMWUp(u,h,seg)} * \mathrm{D} \qquad \text{Eq 15}$$

$$\mathrm{UnitBEMWhDn(u,h)} = \sum_{\mathrm{seg}} \mathrm{ESegMWDn(u,h,seg)} * \mathrm{D} \qquad \text{Eq 16}$$

The cleared quantity of a Balancing Energy Offer step must be lower than or equal to the maximum quantity of the same step.

$$\mathrm{ESegMwUp(u,h,seg)} \leq \mathrm{IbeUp(u,h)} * \mathrm{MaxESegUpMw(u,h,seg)} \qquad \text{Eq 17}$$

$$\mathrm{ESegMwDn(u,h,seg)} \leq \mathrm{IbeDn(u,h)} * \mathrm{MaxESegDnMw(u,h,seg)} \qquad \text{Eq 18}$$

In addition, a BSE cannot provide upward and downward Balancing Energy at the same time:

$$\mathrm{IbeUp(u,h)} + \mathrm{IbeDn(u,h)} \leq 1 \qquad \text{Eq 19}$$

Moreover, a minimum quantity is declared for each Offer step:

$$\text{ESegMwUp}(u,h,seg) \geq \text{IbeUp}(u,h) * \text{MinESegUpMw}(u,h,seg) \qquad \text{Eq 20}$$

$$\text{ESegMwDn}(u,h,seg) \geq \text{IbeDn}(u,h) * \text{MinESegDnMw}(u,h,seg) \qquad \text{Eq 21}$$

where:

D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
UnitBEMWhUp(u,h)	The cleared upward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhDnp(u,h)	The cleared downward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
ESegMwUp(u,h,seg)	The part of the segment of the upward Balancing Energy Offer step **seg** that was cleared for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
ESegMwDn(u,h,seg)	The part of the segment of the downward Balancing Energy Offer step **seg** that was cleared for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
IbeUp(u,h)	A binary variable which indicates whether any upward Balancing Energy has been cleared for BSE **u**, during Dispatch Period **h**.
IbeDn(u,h)	A binary variable which indicates whether any downward Balancing Energy has been cleared for BSE **u**, during Dispatch Period **h**.
MaxESegUpMw(u,h,seg)	The range of the step of the upward Balancing Energy Offer **seg**, for BSE **u**, during Dispatch Period **h**. It is expressed in MW. The step is in the form presented in the following figure.
MaxESegMwDn(u,h,seg)	The range of the step of the downward Balancing Energy Offer, for BSE **u**, during Dispatch Period **h** and step **seg**. It is expressed in MW.
MinESegUpMw(u,h,seg)	The range of the step of the upward Balancing Energy Offer **seg**, per step, which can be offered as an integral whole and, as a result, it can either be accepted as a whole, or rejected as a whole by the ISP for BSEBSE **u**, during Dispatch Period **h**. It is expressed in MW. This parameter is only defined for BSEs representing Loads.
MinESegDnMw(u,h,seg)	The range of the step of the downward Balancing Energy Offer **seg**, per step, which can be offered as an integral whole and, as a result, it can either be accepted as a whole, or rejected as a whole by the ISP for BSE **u**, during Dispatch Period **h**. It is expressed in MW. This parameter is only defined for BSEs representing Loads and it applies as above.

The following figure presents an upward Balancing Energy Offer which consists of four steps. The range of each step **MaxESegUpMw(u,h,seg)** is as follows:

- Step 1: 20 MW
- Step 2: 30 (50-20) MW
- Step 3: 25 (75-50) MW
- Step 4: 25 (100-75) MW

The first step of the offer includes a minimum quantity of acceptance equal to MinESegUpMw(u,h,seg)=16 MW and a range of 0-20 MW. Consequently, it can either be accepted in the range of 16-20 MW or be rejected as a whole by the ISP, as presented in the shaded part of the following figure.

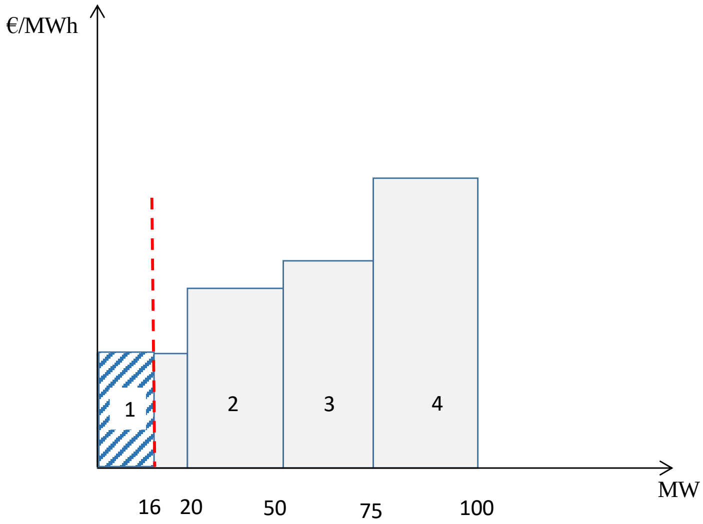

FIGURE 26: FORM OF THE DOWNWARD BALANCING ENERGY OFFER

11.15 Mandatory hydro injections

The ISP Schedule of Dispatchable hydro Generating Units must be equal to or higher than the corresponding mandatory hydro injection declaration for Dispatch Period **h**.

$$\mathrm{UnitMw}(u,h) \geq \mathrm{Mand}(u,h) \tag{Eq 22}$$

where:

Mand(u,h)	The mandatory hydro injection declaration of a Dispatchable hydro Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMw(u,h)	The ISP Schedule of BSE **u** during Dispatch Period **h**. It is expressed in MW.

If mandatory hydro injections have been determined but the Dispatchable hydro Generating Unit is not in a position to follow the generation schedule due to Partial or Total Non-Availability, then the non-availability constraint has precedence over the mandatory injection and, in the ISP Schedule, this unit is scheduled to generate as much as energy as possible on the basis of its availability.

11.16 Ramp Rate Constraints

Each BSE has limits in its ability to move from one level of generation to another within a certain Dispatch Period. For the Periods when the ISP Schedule of a BSE is between the Minimum Available

Capacity and the Maximum Available Capacity, the increase/decrease in generation is constrained by its Ramp Up/Down Rate. By way of exception and according to the following constraints, when a BSE is at the start-up phase, at the shut-down phase or at the phase of transition to another configuration, it is not bound by the Ramp Up/Down Rate.

$$\begin{aligned} \mathrm{UnitMw}(u,h) - \mathrm{UnitMw}(u,h-1) - \mathrm{UnitRampUpMwSurplus}(u,h) \\ \leq \mathrm{UpRampTime} * \mathrm{UnitRampUp}(u) * \mathrm{Idisp}(u,h) + M * (\mathrm{ISoak}(u,h) \\ + \mathrm{Isyn}(u,h)) \end{aligned} \quad \text{Eq 23}$$

$$\begin{aligned} \mathrm{UnitMw}(u,h-1) - \mathrm{UnitMw}(u,h) - \mathrm{UnitRampDnMwSurplus}(u,h) \\ \leq \mathrm{DnRampTime} * \mathrm{UnitRampDn}(u) * \mathrm{Idisp}(u,h) + M * (\mathrm{ShutDn}(u,h) \\ + \mathrm{Idesyn}(u,h)) \end{aligned} \quad \text{Eq 24}$$

Where:

UnitMw(u,h)	The ISP Schedule of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitRampUpMwSurplus(u,h)	The violation of the ramp rate of the upward Balancing Capacity of BSE **u**, during Dispatch Period **h**. It is expressed in MW/min.
UnitRampDnMwSurplus(u,h)	The violation of the ramp rate of the downward Balancing Capacity of BSE **u** during Dispatch Period **h**. It is expressed in MW/min.
UnitRampUp(u)	The Ramp Up Rate for BSE **u**. It is expressed in MW/min.
UnitRampDn(u)	The Ramp Down Rate for BSE **u**. It is expressed in MW/min.
Idisp(u,h)	A binary variable which indicates whether a BSE **u** is between its Minimum and Maximum Available Capacity, during Dispatch Period **h**.
ISoak(u,h)	A binary variable which indicates whether a BSE **u** is in Soak Phase, during Dispatch Period **h**.
Isyn(u,h)	A binary variable which indicates whether a BSE **u** is in Synchronization Phase, during Dispatch Period **h**.
Idesyn(u,h)	A binary variable which indicates whether BSE **u** is in De-Synchronization Phase, during Dispatch Period **h**.
ShutDn(u,h)	A binary variable which indicates the shut-down of a Generating Unit **u**, during Dispatch Period **h**.
M	A parameter with a very high positive value, which deactivates the ramp rate constraint when the capacity of BSE **u** does not lie between its Minimum Available Capacity and Maximum Available Capacity. It is expressed in MW.
UpRampTime	The maximum time in minutes within a Dispatch Period during which a BSE can increase its generation so as to offer Balancing Energy. The numerical value of the variable is 30 minutes.
DnRampTime	The maximum time in minutes within a Dispatch Period during which a BSE can decrease its generation so as to offer Balancing Energy. The numerical value of the variable is 30 minutes.

11.17 Reserve Offer Constraints

11.17.1 Manual FRR constraints

There are two types of mFRR Balancing Capacity: spinning mFRR (smFRR) and non-spinning mFRR (nsmFRR). Only the BSEs with zero synchronization time and zero soak time (sync time + soak time = 0) have the ability to provide non-spinning mFRR. The BSEs can only provide non-spinning reserves when they are shut-down (not committed). The BSEs can provide spinning reserves only when they are between Minimum Available Capacity and Maximum Available Capacity (Idisp=1). The BSEs cannot provide spinning and non-spinning Balancing Capacity at the same time. Consequently, the following constraints apply for the provision of upward and downward Balancing Capacity for mFRR:

$$\begin{aligned}\mathrm{UnitBCUpMw}(u,h,\text{"mFRR"}) - \mathrm{UnitBCUpSurplus}(u,h,\text{"mFRR"}) \\ \le \min\,(\mathrm{UnitMaxBCUp}(u,h,\text{"mFRR"}), \mathrm{mFRRRampingTime} \\ * \mathrm{UpRampRate}(u)) * \left(\mathrm{Idisp}(u,h) + \mathrm{Ins}(u,h,\text{"mFRR"})\right)\end{aligned} \qquad \text{Eq 25}$$

$$\begin{aligned}\mathrm{UnitBCDnMw}(u,h,\text{"mFRR"}) - \mathrm{UnitBCDnSurplus}(u,h,\text{"mFRR"}) \\ \le \min\left(\mathrm{UnitMaxBCDn}(u,h,\text{"mFRR"}), \mathrm{mFRRRampingTime} \\ * \mathrm{DnRampRate}(u)\right) \\ * \left(\mathrm{Idisp}(u,h) + \mathrm{Ins}(u,h,\text{"mFRR"})\right)\end{aligned} \qquad \text{Eq 26}$$

A BSE can only provide non-spinning reserves when it is shut-down.

$$\mathrm{Iup}(u,h) + \mathrm{Ins}(u,h,\text{"mFRR"}) \le 1 \qquad \text{Eq 27}$$

Where

UnitBCUpMW(u,h,"mFRR")	The cleared upward mFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnMW(u,h,"mFRR")	The settled downward mFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCUpSurplus(u,h,"mFRR")	The surplus in the technical capacity for the provision of upward mFRR (Maximum contribution to upward mFRR), for BSE u, during Dispatch Period h. It is expressed in MW.
UnitBCDnSurplus(u,h,"mFRR")	The surplus in the technical capacity for the provision of downward mFRR (Maximum contribution to downward mFRR), for BSE u, during Dispatch Period h. It is expressed in MW.
UnitMaxBCUp(u,h, "mFRR")	The Maximum contribution to upward mFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMaxBCDn(u,h,"mFRR")	The Maximum contribution to downward mFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitRampUp (u)	The Ramp Up Rate for BSE **u**. It is expressed in MW/min.

UnitRampDn e(u)	The Ramp Down Rate for BSE **u**. It is expressed in MW/min.
Ins(u,h,"mFRR")	A variable which indicates whether a BSE **u** can contribute or not in the non-spinning reserves for mFRR, during Dispatch Period **h**.
Idisp(u,h)	A binary variable which indicates whether a BSE **u** is between its Minimum and Maximum Available Capacity, during Dispatch Period **h**.
Iup(u,h)	A binary variable which indicates whether a BSE **u** is committed, during Dispatch Period **h**.
mFRRRampingTime	The maximum time in minutes during which a BSE is considered to have the capability to modify its generation within a Dispatch Period during Balancing Energy provision by means of the activation of the allocated mFRR Balancing Capacity. The numerical value of the variable is 15 minutes.

11.17.2 Automatic FRR constraints

The BSEs can provide Balancing Capacity for aFRR when they are between the limits defined in the Registered Characteristics declared for the AGC mode. The following constraints apply for the provision of upward and downward Balancing Capacity for aFRR:

$$\mathrm{UnitBCUpMw(u,h,"aFRR") - UnitBCUpSurplus(u,h,"aFRR")} \leq \min\left(\mathrm{UnitMaxBCUp(u,h,"aFRR")}, aFRRRampingTime * \mathrm{UnitAGCRampUp(u)}\right) * \mathrm{IUpAGC(u,h)} \quad \text{Eq 28}$$

$$\mathrm{UnitBCDnMw(u,h,"aFRR") - UnitBCDnSurplus(u,h,"aFRR")} \leq \min\left(\mathrm{UnitMaxBCDn(u,h,"aFRR")}, aFRRRampingTime * \mathrm{UnitAGCRampDn}\right) * \mathrm{IUpAGC(u,h)} \quad \text{Eq 29}$$

Where

UnitBCUpMW(u,h,"aFRR")	The cleared upward aFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCUpSurplus(u,h,"aFRR")	The surplus in the technical capacity for the provision of upward aFRR (Maximum contribution to upward aFRR), for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnSurplus(u,h,"aFRR")	The surplus in the technical capacity for the provision of downward aFRR (Maximum contribution to downward aFRR), for BSE u, during Dispatch Period h. It is expressed in MW.
UnitBCDnMW(u,h,"aFRR")	The cleared downward aFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMaxBCUp (u,h,"aFRR")	The Maximum contribution to upward aFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMaxBCDn(u,h,"aFRR")	The Maximum contribution to downward aFRR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.

UnitAGCRampUp (u)	The Ramp Up Rate in AGC mode for BSE u. It is expressed in MW/min.
UnitAGCRampDn (u)	The Ramp Down Rate in AGC mode for BSE **u**. It is expressed in MW/min.
IupAGC(u,h)	A binary variable which indicates whether a BSE **u** is in AGC mode, during Dispatch Period **h**.
aFRRRampingTime	The maximum time in minutes during which a BSE is considered to have the capability to modify its generation within a Dispatch Period according to the Balancing Energy offer due to the activation of the allocated mFRR Balancing Capacity. The numerical value of the variable is 7.5 minutes.

Further constraints apply for Hydroelectric Power Stations, which consist of several generators, in order to ensure that the allocated aFRR Balancing Capacity is compatible with the number of generators which are synchronized in accordance with the ISP Schedule. For the above constraint to be implemented, it is considered that:

- All the individual generators of a Hydroelectric Power Station are identical, and
- The Technically Minimum Generation of a Hydroelectric Power Station equals the Technically Minimum Generation of an individual generator.

An example is provided in the following figure which describes a Hydroelectric Power Station with four generators and technical limits of 15-80 MW [4x(15-80)]. On the left-hand side of the Figure, one can see the resulting ISP Schedule, which is equal to 60MW. In this case, based on the above technical limits, it is possible to have from one up to four generators synchronized. Consequently, the maximum upward Balancing Capacity for aFRR that can be allocated to this unit is equal to the technical capacity (Maximum contribution to aFRR) of the four generators 320-60 = 260 MW. Similarly, on the right-hand side the resulting ISP Schedule is equal to 20 MW. In this case, based on the above technical limits, it is possible to have only one generator synchronized. Consequently, the maximum upward Balancing Capacity for aFRR that can be allocated to this unit is equal to the technical capacity (Maximum contribution to aFRR) of one generator 80-20 = 60 MW.

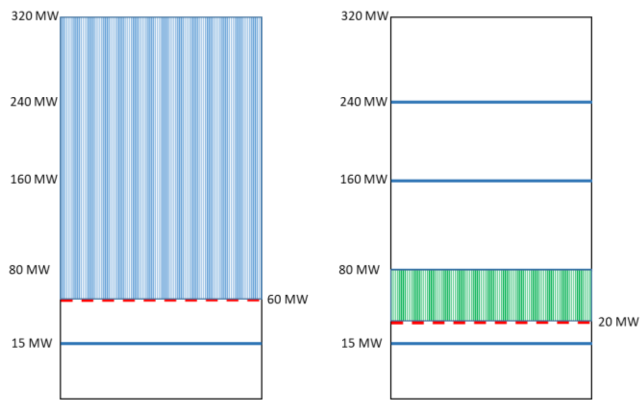

FIGURE 27: ALLOCATED AUTOMATIC FRR BALANCING CAPACITY

The sum of the Balancing Capacity provided by a BSE for aFRR and for mFRR is constrained by the Ramp Up/Down Rate.

$$\sum_{rsvtype\,=mFRR,aFRR} UnitBCUpMw(u,h,rsvtype) - UnitBCUpRampSurplus(u,h) \leq UpCapacityRampTime * UnitRampUp(u) \quad \text{Eq 30}$$

$$\sum_{rsvtype\,=mFRR,aFRR} UnitBCDnMw(u,h,rsvtype) - UnitBCDnRampSurplus(u,h) \leq DnCapacityRampTime * UnitRampDn(u) \quad \text{Eq 31}$$

Where:

UnitBCUpMW(u,h,rsvtype)	A variable representing the cleared upward Balancing Capacity of a BSE **u,** for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnMW(u,h,rsvtype)	A variable representing the cleared downward Balancing Capacity of a BSE **u,** for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
UnitBCUpRampSurplus(u,h)	The surplus in the Ramp Up constraint for the provision of Balancing Capacity for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnRampSurplus(u,h)	The surplus in the Ramp Down constraint for the provision of Balancing Capacity for Generating Unit **u**, during Dispatch Period **h**. It is expressed in MW.
UnitAGCRampUp(u)	The Ramp Up Rate in AGC mode for BSE **u** in MW/min.
UnitAGCRampDn(u)	The Ramp Down Rate in AGC mode for BSE **u** in MW/min
UnitRampUp(u)	The Ramp Up Rate for BSE **u** in MW/min
UnitRampDn(u)	The Ramp Down Rate for BSE **u** in MW/min
UpCapacityRampTime	The maximum time in minutes during which a BSE is considered to have the capability to increase its generation within a Dispatch Period during Balancing Energy provision by means of the activation of the allocated mFRR and a FRR Balancing Capacity. The numerical value of the variable is 30 minutes.
DnCapacityRampTime	The maximum time in minutes during which a BSE is considered to have the capability to decrease its generation within a Dispatch Period during Balancing Energy provision by means of the activation of the allocated mFRR and aFRR Balancing Capacity. The numerical value of the variable is 30 minutes.

11.17.3 FCR constraints

The following constraints apply for the contribution to FCR:

$$\text{UnitBCUpMw}(u, h, \text{"FCR"}) - \text{UnitBCUpSurplus}(u, h, \text{"FCR"}) \leq \text{UnitMaxBCUp}(u, h, \text{"FCR"}) * \text{Idisp}(u, h) \quad \text{Eq 32}$$

$$\text{UnitBCDnMw}(u, h, \text{"FCR"}) - \text{UnitBCDnSurplus}(u, h, \text{"FCR"}) \leq \text{UnitMaxBDn}(u, h, \text{"FCR"}) * \text{Idisp}(u, h) \quad \text{Eq 33}$$

Where:

UnitBCUpMW(u,h,"FCR")	The cleared upward FCR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCUpSurplus(u,h,"FCR")	The surplus in the technical capacity for the provision of upward FCR (Maximum contribution to upward FCR), for BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnSurplus(u,h,"FCR")	The surplus in the technical capacity for the provision of downward FCR (Maximum contribution to downward mFRR), for BSE u, during Dispatch Period h. It is expressed in MW.
UnitBCDnMW(u,h,"FCR")	The cleared downward FCR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMaxBCUp (u,h,"FCR")	The Maximum contribution to upward FCR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
UnitMaxBCDn(u,h,"FCR")	The Maximum contribution to downward FCR of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
Idisp(u,h)	A binary variable which indicates whether a BSE **u** is between its Minimum and Maximum Available Capacity, during Dispatch Period **h**.

11.17.4 Bidding Zone reserve constraints

The reserve constraints are defined for the following types of reserves:

- FCR
- mFRR spinning or non-spinning
- aFRR

The following constraints ensure that the sum of the quantities of the Balancing Capacity Offers submitted by the BSEs which are cleared in the ISP in Bidding Zone **z**, must be higher than or equal to the Reserve requirements of said Zone:

$$\sum_{u \in z} \text{UnitBCUpMw}(u, h, \text{rsvtype}) + \text{ZonalCapDeficitUp}(z, h, \text{rsvtype}) \geq \text{ZonalCapUpReq}(z, h, \text{rsvtype}) \quad \text{Eq 34}$$

$$\sum_{u \in z} \text{UnitBCDnMw}(u, h, rsvtype) + \text{ZonalCapDeficitDn}(z, h, rsvtype) = \text{ZonalCapDnReq}(z, h, rsvtype) \qquad \text{Eq 35}$$

Where:

UnitBCUpMW(u,h,rsvtype)	The cleared upward Balancing Capacity of a BSE **u,** for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
UnitBCDnMW(u,h,rsvtype)	The cleared downward Balancing Capacity of a BSE **u,** for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
ZonalCapDeficitUp(z,h,rsvtype)	The deficit in the ability to satisfy the total needs of Bidding Zone **z** for upward Balancing Capacity for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
ZonalCapDeficitDn(z,h,rsvtype)	The deficit in the ability to satisfy the total needs of Bidding Zone **z** for downward Balancing Capacity for reserve type **rsvtype**, during Dispatch Period **h**. It is expressed in MW.
ZonalCapUpReq(z,h,rsvtype)	The Requirement for upward Balancing Capacity during Dispatch Period **h**, for Bidding Zone **z** and for reserve type **rsvtype**.
ZonalCapDnReq(z,h,rsvtype)	The Requirement for downward Balancing Capacity during Dispatch Period **h**, for Zone **z** and for reserve type **rsvtype**.

11.17.5 System reserve constraints

Similar reserve constraints with those of the Bidding Zones apply for the total HETS needs:

$$\sum_{u} \text{UnitBCUpMw}(u, h, rsvtype) + \text{SysCapDeficitUp}(h, rsvtype) \geq \text{SysCapUpReq}(h, rsvtype) \qquad \text{Eq 36}$$

$$\sum_{u} \text{UnitBCDnMw}(u, h, rsvtype) + \text{SysCapDeficitDn}(h, rsvtype) = \text{SysCapDnReq}(h, rsvtype) \qquad \text{Eq 37}$$

Where:

UnitBCUpMW(u,h,rsvtype)	The cleared upward Balancing Capacity of a BSE **u,** for reserve type **rsvtype** (aFRR, mFRR, FCR), during Dispatch Period **h**. It is expressed in MW.
UnitBCDnMW(u,h,rsvtype)	The cleared downward Balancing Capacity of a BSE **u,** for reserve type **rsvtype** (aFRR, mFRR, FCR), during Dispatch Period **h**. It is expressed in MW.

SysCapUpReq(h,rsvtype)	The Requirement for upward Balancing Capacity during Dispatch Period **h**, for reserve type **rsvtype** (aFRR, mFRR, FCR) for the entire system.
SysCapDnReq(h,rsvtype)	The Requirement for downward Balancing Capacity during Dispatch Period **h**, for reserve type **rsvtype** (aFRR, mFRR, FCR) for the entire system.
SysCapDeficitUp(h,rsvtype)	The deficit in the ability to satisfy the total system needs for upward Balancing Capacity for reserve type **rsvtype** (FCR, aFRR, FCR), during Dispatch Period **h**. It is expressed in MW.
SysCapDeficitDn(h,rsvtype)	The deficit in the ability to satisfy the total system needs for downward Balancing Capacity for reserve type **rsvtype** (FCR, aFRR, FCR), during Dispatch Period **h**. It is expressed in MW.

11.18 Forbidden Zones

The Dispatchable hydro Generating Units may define forbidden zones, within which constant operation should be avoided. An upper and a lower limit in MW is defined for each forbidden zone (FZ). The limits of the Forbidden Zone are defined in the Registered Characteristics. During the ISP solution, the injection/offtake level of the Entities cannot be within the Forbidden Zone and, as a result, it must always be within the Operational Zone (OZ). The constraints with regard to Forbidden zones are modeled on the basis of the Operational Zones that are not forbidden (OZ) as follows:

$$\mathrm{UnitMw(u,h)} \leq \mathrm{XozUp(u,oz,h)} \cdot \mathrm{OZHighMW(u,oz,h)} + \mathrm{SlackOZHigh\ (u,h)} \qquad \text{Eq 38}$$

$$\mathrm{UnitMw(u,h)} \geq \mathrm{XozUp(u,oz,h)} \cdot \mathrm{OZLowMW(u,oz,h)} - \mathrm{SlackOZLow\ (u,h)} \qquad \text{Eq 39}$$

With the following equation it is ensured that the BSE is in only one Operational Zone.

$$\sum_{oz} \mathrm{XozUp(u,oz,h)} = \mathrm{Iup(u,h)} \qquad \text{Eq 40}$$

Where:

UnitMw(u,h)	The ISP Schedule of a BSE **u**, during Dispatch Period **h**. It is expressed in MW.
XozUp(u,oz,h)	A binary variable which indicates that a BSE **u** is in Operational Zone **oz**, during Dispatch Period **h**.
OZHighMW(u,oz,h)	The upper limit of the Operational Zone, in MW.
OZLowMW(u,oz,h)	The lower limit of the Operational Zone, in MW.
SlackOZHigh (u,h)	The violation of the upper limit of the Operational Zone in MW.
SlackOZLow (u,h)	The violation of the lower limit of the Operational Zone in MW.
Iup (u,h)	A binary variable which indicates whether a BSE **u** is committed, during Dispatch Period **h**.

Below, in the following figure, an example is presented with an overview of three forbidden zones.

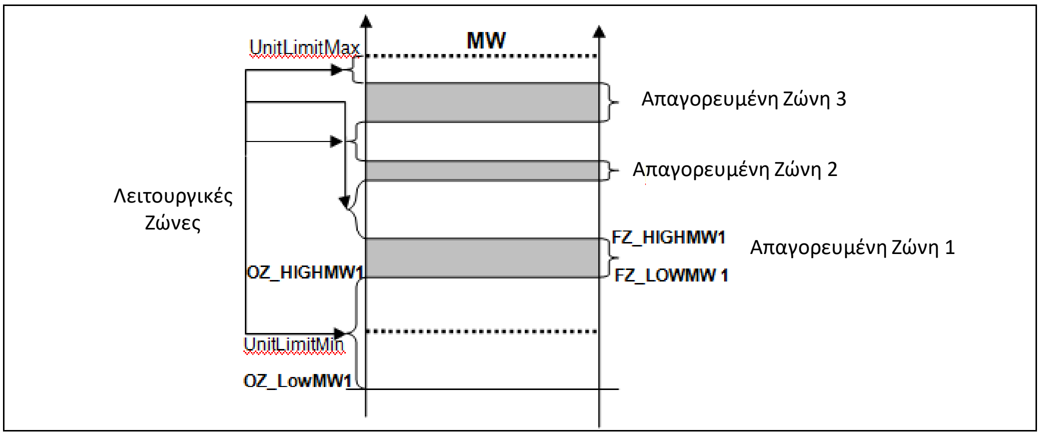

FIGURE 28: FORBIDDEN ZONE IN DISPATCHABLE HYDRO GENERATING UNITS

Where:

Data	Description
FZ_LowMW1	The lower limit of Forbidden Zone 1, in MW.
FZ_HighMW1	The upper limit of Forbidden Zone 1, in MW.
OZ_LowMW1	The lower limit of Operational Zone 1, in MW.
OZ_HighMW1	The upper limit of Operational Zone 1, in MW.

11.19 Zonal Imbalances Constraints

The ISP clearing is intended for the selection of the quantity of Balancing Energy and Balancing Capacity so as to minimize the cost of covering Imbalances within the Bidding Zones. Zonal imbalances are calculated as the difference between the Market Schedule and the following elements:

- Demand forecast for Load Portfolios,
- Generation forecast for RES Units Portfolios,
- Known changes in the generation of Units in Testing Operation or in Commissioning Operation,
- Known changes in the interconnection Schedules,
- Estimated HETS Losses.

The above imbalances in each Bidding Zone, **z**, are covered by the Balancing Energy provided by the BSEs in Bidding Zone, **z**, and the calculated flow in the inter-zonal corridors, as described below:

$$\sum_{u \in z} \text{UnitBEMwhUp}(u,h) - \text{UnitBEMwhDn}(u,h)$$
$$+\sum_{z1}[\text{FlowMw}(z1,z,h) - \text{FlowMw}(z,z1,h)] * D$$
$$+\left(-\text{NonDispLoadFR}(z,h) \mp \sum_{u \in z}(\text{NonDispLoadMS}(u,h) * D)\right)$$
$$+\left(-\left(\sum_{u \in z} \text{ResPortMS}(u,h) * D\right) + \text{ResPortFR}(z,h) * D\right)$$
$$+(\textstyle\sum_{u \in z}(\text{NonDispResMS}(u,h) * D) - \text{NonDispResFR}(z,h) * D)$$
$$+\textstyle\sum_{u \in z}\big(\text{UnitCommisMS}(u,h) - \text{UnitCommisDS}(u,h)\big) * D$$
$$+\sum_{inter \in z}(-\text{ExportDev}(inter,h) \mp \text{ImportDev}(inter,h))$$
$$-\text{ZonalLossMS}(z,h) * D + \text{ForecastedZonalLoss}(z,h) * D$$
$$+\text{ZonalImbSurplus}(z,h) * D - \text{ZonalImDeficit}(z,h) * D \qquad \text{Eq 41}$$

Where:

D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
UnitBEMWhUp(u,h)	The cleared upward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhDnp(u,h)	The cleared downward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
FlowMw(z,z1,h)	The flow in MW from Bidding Zone **z** to Bidding Zone **z1** in an inter-zonal corridor, during Dispatch Period **h**. Non negative.
FlowMw(z1,z,h)	The flow in MW from Bidding **z1** to Bidding Zone **z** in an inter-zonal corridor, during Dispatch Period **h**. Non negative.
NonDispLoadFR(z,h)	The demand forecast of the non-Dispatchable Load Portfolios by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispLoadMS(u,h)	The Market Schedule of the non-Dispatchable Load Portfolios **u**, , in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispResFR(z,h)	The generation forecast of the non-Dispatchable RES Portfolios by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispResMS(u,h)	The Market Schedule of the non-Dispatchable RES Portfolios, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
ResPortFR(z,h)	The generation forecast of the RES by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.

ResPortMS(u,h)	The Market Schedule of the RES, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
UnitCommisDS(u,h)	The capacity that was agreed with the Operator before the ISP for a BSE **u**, which is in Commissioning Operation during period **h**. It is expressed in MW
UnitCommisMS(u,h)	The Market Schedule of a BSE **u**, which is in Commissioning Operation during Dispatch Period **h**. It is expressed in MW.
ForecastedZonalLoss(z,h)	The forecast of Zonal imbalances, in zone **z**, during Dispatch Period **h**. It is expressed in MW.
ZonalLossMS(z,h)	The Market Schedule for System Losses, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
ImportDev(inter,h)	The imbalance in imports in a cross-border corridor **inter**, during Dispatch Period **h**.
ExportDev(inter,h)	The imbalance in exports in a cross-border corridor **inter**, during Dispatch Period **h**.
ZonalImDeficit(z,h)	The deficit in Zonal imbalances during Dispatch Period **h** for Bidding Zone **z**. It is expressed in MW.
ZonalImbSurplus(z,h)	The surplus in Zonal imbalances during Dispatch Period **h** for Bidding Zone **z**. It is expressed in MW

11.20 Inter-Zonal Constraints

The inter-zonal constraints can be modeled in two ways:

- Flow-based model
- Available Transfer Capacity (ATC) model

The HETS Operator uses the Available Transfer Capacity Model.

11.20.1 Flow-based model

The inter-zonal flow is calculated with the following relationship, by using the Power Transfer Distribution Factor (PTDF), and it is an analytical model, as follows:

The Flow-Based Model allows for a better imaging of the natural capacity flow, in comparison to the simple transfer model (e.g. ATC-based model). In the flow-based model, the net positions of Bidding Zones are converted by using the PTDF into natural flows in the inter-zonal corridors. An inter-zonal flow is defined for each direction. For a line connecting two Bidding Zones (for example: z, z1), this means that there are two inter-zonal flows (**z-z1** and **z1-z**). The inter-zonal flow is constrained by the inter-zonal transfer capacity limit, Eq 54.

The following constraints (49)-(52) are used in order to apply the flow-based model to the ISP:

$$\mathrm{FlowMw(z,z1,h)} = \sum_{\mathrm{z1}} \mathrm{PTDF(z,z1,fg,h)} * \mathrm{NetInjection}(z1,\mathrm{h}) \qquad \text{Eq 42}$$

$$\begin{aligned}\mathrm{NetInjection(z,h)} = & \sum_{\mathrm{u \in z}} \mathrm{UnitBEMwhUp(u,h)} - \mathrm{UnitBEMwhDn(u,h)} \\ & +(\textstyle\sum_{\mathrm{u \in z}}(\mathrm{NonDispLoadMS(u,h)}) * D - \mathrm{NonDispLoadFR(z,h)} * \mathrm{D}) \\ & + \left(\mathrm{ResPortFR(z,h)} * \mathrm{D} = \sum_{\mathrm{u \in z}} \mathrm{ResPortMS(u,h)} * \mathrm{D}\right) \\ & + \left(\mathrm{NonDispResFR(z,h)} * \mathrm{D} - \sum_{\mathrm{u \in z}} (\mathrm{NonDispResMS(u,h)}) * \mathrm{D}\right) \\ & + \sum_{\mathrm{inter \in z}} \left(\mathrm{ImportDev(inter},h) - \mathrm{ExportDev(inter},h)\right) \\ & + \textstyle\sum_{\mathrm{u \in z}}\left(\mathrm{UnitCommisDS(u,h)} - \mathrm{UnitCommisMS(u,h)}\right) * \mathrm{D}\end{aligned} \qquad \text{Eq 43}$$

$$\mathrm{NetInjection(z,h)} = \sum_{\mathrm{z1}} \mathrm{FlowMw(z,z1,h)} - \mathrm{FlowMw(z1,z,h)} \qquad \text{Eq 44}$$

$$\mathrm{FlowMw(z,z1,h)} \leq \mathrm{AvailableCapacity(z,z1,h)} \qquad \text{Eq 45}$$

Where:

FlowMw(z,z1,h)	The flow in MW from Bidding Zone **z** to Bidding Zone **z1** in an inter-zonal corridor, during Dispatch Period **h**. Non negative.
UnitBEMWhUp(u,h)	The cleared upward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhDnp(u,h)	The cleared downward Balancing Energy of a BSE **u**, during Dispatch Period **h**. It is expressed in MWh.
PTDF(z,z1,fg,h)	The Power Transfer Distribution Factor (PTDF) in inter-zonal corridor **fg** from Bidding Zone **z** to Bidding Zone **z1** during Dispatch Period **h**. This factor establishes a linear connection between the imbalance of Bidding Zone **z1** and the energy flow in inter-zonal corridor **fg**.
NetInjection(z,h)	The imbalance in Bidding Zone **z** during Dispatch Period **h**.
NonDispLoadFR(z,h)	The demand forecast of the non-Dispatchable Load by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispLoadMS(u,h)	The Market Schedule of the non-Dispatchable Load, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispResFR(z,h)	The generation forecast of the non-Dispatchable RES by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
NonDispResMS(u,h)	The Market Schedule of the non-Dispatchable RES, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.

ResPortFR(z,h)	The generation forecast of the RES by the HETS Operator, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
ResPortMS(u,h)	The Market Schedule of the RES, in Bidding Zone **z**, during Dispatch Period **h**. It is expressed in MW.
ImportDev(inter,h)	The imbalance in imports in a cross-border corridor **inter**, during Dispatch Period **h**.
ExportDev(inter,h)	The imbalance in exports in a cross-border corridor **inter**, during Dispatch Period **h**.
UnitCommisDS(u,h)	The capacity that was agreed with the Operator before the ISP for a BSE **u**, which is in Commissioning Operation during period **h**. It is expressed in MW
UnitCommisMS(u,h)	The Market Schedule of a BSE **u**, which is in Commissioning Operation during Dispatch Period **h**. It is expressed in MW.
AvailableCapacity(z,z1,h)	The Available Transfer Capacity between Bidding Zones **z** and **z1**, during Dispatch Period **h**, after subtracting the flow already scheduled in the wholesale market (Forward Market, Day-Ahead Market and Intra-Day Market). It is expressed in MW.

11.20.2 Available Transfer Capacity (ATC) model

In the simple model, where there is no representation of the natural flows in the interconnections through the PTDFs, the flows are energy exchanges which result from the equation of the Energy Balance in Bidding Zones (Eq. 48) and the maximum residual flow constraint (Eq. 50.

11.21 Generic Constraints

Besides the above constraints, the HETS Operator may use generic constraints, in case of emergency or other situations as it may be, so as to limit energy generation or reserve provision by BSEs.

Constraint Eq. 51 refers to a single Dispatch Period, whereas Eq. 52 refers to multiple Dispatch periods.

$$\sum_{u} \mathrm{UnitMw(u,h)} * \mathrm{UnitMwFactor(u,gnc)} \; \{=,\leq,\geq\} (only\ one\ type\ of\ constraint\ is\ selected) \; \mathrm{ConstraintLimit(h,gnc)} \qquad \text{Eq 46}$$

$$\sum_{u,h} \mathrm{UnitMw(u,h)} * \mathrm{UnitMwFactor(u,h,gnc)} \; \{\leq\} \; \mathrm{ConstraintLimit(gnc)} \qquad \text{Eq 47}$$

Where:

UnitMw(u,h)	The ISP Schedule of a BSE **u** during Dispatch Period **h**. It is expressed in MW.
UnitMWFactor(u,h,gnc)	A parameter defined by the HETS Operator, during Dispatch Period **h**, for the ISP Schedule, for a general type of constraint **gnc** of a BSE **u.**
ConstraintLimit(h,gnc)	The limit of the constraint **gnc**.

The type of constraint (=, ≤ or ≥) is selected for each constraint separately.

11.22 Virtual Entity Model

The energy produced by each Virtual Entity that provides Balancing Energy / Capacity (in each Dispatch Period) is equal to the Market Schedule plus the upward Balancing Energy minus the downward Balancing Energy it provides, as shown in the following equation:

$$\begin{aligned}\mathrm{UnitMw(vu,h)} * \mathrm{D} \\ = MS_0(\mathrm{u,h}) * \mathrm{IvuOp(vu,h)} + \mathrm{UnitBEMWhUp(vu,h)} \\ - \mathrm{UnitBEMWhDn(vu,h)}\end{aligned} \quad \text{Eq 48}$$

Where:

D	The duration of the Dispatch Period. It is expressed in hours. For the ISP, the value of this parameter is 1/2 hour.
MS_0(u,h)	The Market Schedule of a Generating Unit (Multi-Shaft Combined Cycle or Pumped Storage Hydro) **u,** which consists of Virtual BSEs, during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhUp(vu,h)	The cleared upward Balancing Energy of a Virtual BSE **vu** during Dispatch Period **h**. It is expressed in MWh.
UnitBEMWhDnp(vu,h)	A variable representing the cleared downward Balancing Energy of a Virtual Entity v**u** during Dispatch Period **h**. It is expressed in MWh.
UnitMw(vu,h)	The ISP Schedule of a Virtual Entity **vu** during Dispatch Period **h**. It is expressed in MW.
IvuOp(vu,h)	A binary variable which indicates whether a Virtual Entity **vu** provides balancing energy/capacity in Dispatch Period **h**.

11.22.1 Virtual Entity Modeling

The transition between Virtual Entities is the simultaneous de-commitment of a Virtual Entity and the commitment of another Virtual Entity, which belong to the same BSE. A maximum of one transition is allowed within a single Dispatch Period. Only one of the Virtual Entities of a BSE can be committed in each Dispatch Period. Only one of the Virtual Entities of a BSE can offer Balancing Energy and/or Capacity in each Dispatch Period.

For the transitions of pumped storage hydro generating units from Generation Virtual Entity to Pumped Storage Virtual Entity a single transition time is defined for all entities. Accordingly, for the transitions of pumped storage hydro generating units from Pumped Storage Virtual Entity to Generation Virtual Entity a single transition time is defined for all entities. During the transition, the energy injection and offtake of the unit is set equal to zero.

For the configurations of a Dispatchable Multi-Shaft Combined Cycle Generating Unit the transition has a specific duration, which depends on the state of the BSE (cold, warm, hot) and is specified in the Registered Characteristics of the BSE. The duration of the transition between Virtual Entities is zero when the BSE is shut-down. During the transition of a BSE, no Balancing Capacity is provided. During the transition between the Virtual Entities of a Dispatchable Multi-Shaft Combined Cycle Generating Unit, both Virtual Entities are required to be available, at least up to their Technically Minimum Generation.

11.22.2 Transition state

The transition between two configurations of a Dispatchable Multi-Shaft Combined Cycle Generating Unit can be done in the following ways:

Transition to a higher configuration:

In the event that the upper and lower limit of two configurations do not overlap, then, for the entire transition period, apart from the last period, the Unit is considered to be at the upper limit of the configuration (CONFIG1) it switches from. In the last period of the transition process, the Unit switches to the lower operation limit of the next configuration (CONFIG2). The following figure shows an example, where it is assumed that the duration of the transition is four Dispatch Periods.

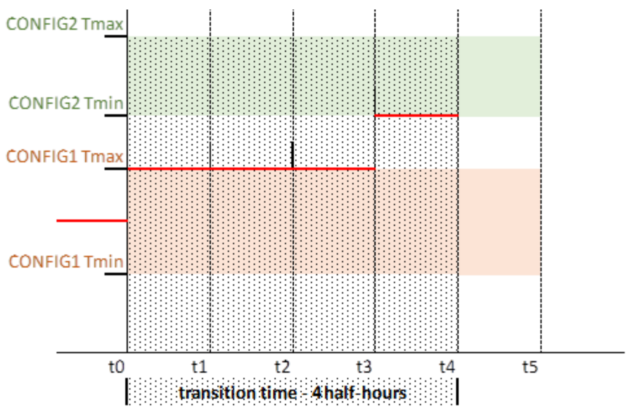

FIGURE 29: TRANSITION TO A HIGHER CONFIGURATION WITHOUT AN OVERLAP OF THE OPERATION LIMITS

In the event that the operation limits of the two configurations do overlap, then the Unit is considered to be at the upper operation limit of the configuration (CONFIG1) it switches from. The following figure shows an example, where it is assumed that the duration of the transition is four Dispatch Periods.

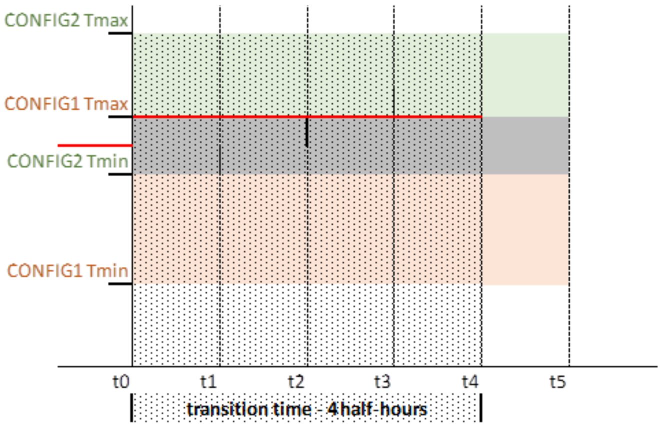

FIGURE 30: TRANSITION TO A HIGHER CONFIGURATION WITH AN OVERLAP OF THE OPERATION LIMITS

Transition to a lower configuration:

In the event that the upper and lower limit of the two configurations do not overlap, then, for the entire transition period, apart from the last period, the Unit is considered to be at the lower limit of the configuration (CONFIG1) it switches from. In the last period of the transition process, the Unit switches to the upper operation limit of the next configuration (CONFIG2). The following figure shows an example, where it is assumed that the duration of the transition is four Dispatch Periods.

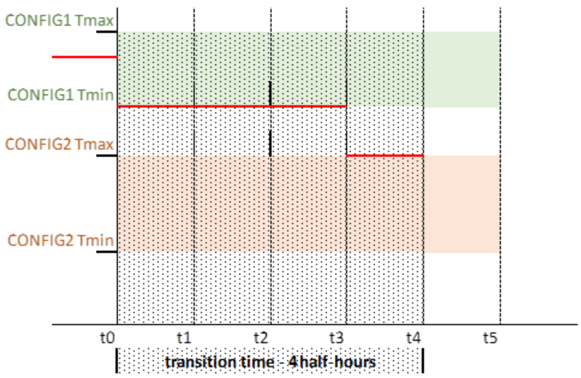

FIGURE 31: TRANSITION TO A LOWER CONFIGURATION WITHOUT AN OVERLAP OF THE OPERATION LIMITS

In the event that the operation limits of the two configurations do overlap, then the Unit is considered to be at the lower operation limit of the configuration (CONFIG1) it switches from. The following figure shows an example, where it is assumed that the duration of the transition is four Dispatch Periods.

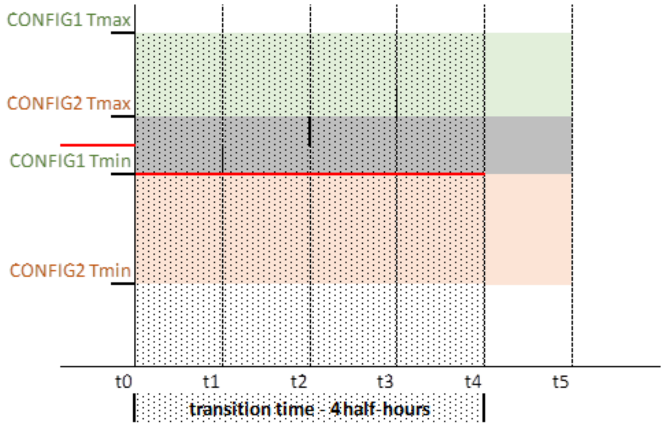

FIGURE 32: TRANSITION TO A LOWER CONFIGURATION WITH AN OVERLAP OF THE TRANSITION LIMITS

12 Transitional provisions

12.1 Offer Price at the Expected Cost of Balancing Capacity Activation

With regard to the executions of the ISP for the Dispatch Days in the period until 30th November 2020, item (c) of paragraph 11.6 herein, which refers to the calculation of the Expected Cost of Balancing Capacity Activation is replaced as follows:

The price of the last step of the Balancing Energy Offer for the direction that corresponds to the direction of the relevant Balancing Capacity product for the respective BSE and Dispatch Period (€/MWh). In particular:

- For the upward Balancing Energy, this price corresponds to the highest offer price (€/MWh) for Upward Balancing Energy in the corresponding Dispatch Period, and
- For the downward Balancing Energy, this price corresponds to the lowest offer price (€/MWh) for Downward Balancing Energy in the corresponding Dispatch Period.

12.2 Submission of Balancing Energy Offers to the ISP for the period until the constraint in the Peloponnese System is lifted.

Until the current constraint due to congestion in the Peloponnese System is lifted, the BSPs may not submit any Offer step for upward and downward Balancing Energy to the ISP with a negative price in €/MWh, for each BSE and for each Dispatch Period.

This provision ceases to be valid as soon as the current constraint is lifted and is deemed to have been lifted upon issuance of an act by RAE for the start of operation of the TL 400kV Megalopolis-System, in accordance with the provisions of the Balancing Market Rulebook.

12.3 Submission of ISP Balancing Energy Offers for pumped storage

The submission of upward Balancing Energy Offers for pumped storage becomes mandatory as of 1st March 2022 exclusively for the Dispatch Periods during which a pumped storage load has been scheduled according to the Market Schedule.

The submission of upward and downward Balancing Energy Offers for pumped storage becomes mandatory as of 1st September 2022 exclusively for all Dispatch Periods of the Dispatch Day.

13 Annex

Input Interface from Market Participants

The Interface management screen in the balancing market platform allows to monitor the input and the output interfaces and allows file upload and file download. The participant will use this screen to upload xml files in the system and view the validation result.

For each received message an acknowledgement is generated including the result of the message validation. In case of failed validation an explicit rejection reason should be logged and included in the acknowledgement message. It should include the Input type, the message identification and version and all detail to retrieve easily which data cause the validation failure.

In fallback mode:

- The operator can upload participant xml files in the system in his own Interface management screen.
- An email interface channel allows the system to receive participant input files through email. This channel is disable by default, it can be enabled by the system administrator.

  The Participant can send the XML as attachment to email using his specific email account (defined per participant). After MMS receives the email and checks data validity, the Participant is informed about the status of acceptance or rejection of his xml file by appropriate email response.

1. Participant Techno Economic Declaration Description

Interface Format

XSD of the existing system was simplified to include only useful parameters.

XML
participant-techno-economic-declaratic

Message Header	
Message identification	Unique identification of the message for which the time series data is being supplied.
Message version	Version of the message being sent. A message may be sent several times, each transmission being identified by a different version number that starts at 1 and increases sequentially.
Sender Identification / Coding Scheme	EIC of the party that sent the message.

Sender Role	A21 (producer)
Receiver Identification / Coding Scheme	ADMIE EIC Code
Receiver Role	A04 (System operator)
Message Date and Time	Date and time of transmission of the data. The time must be expressed in UTC as YYYY-MMDDTHH:MM:SSZ.
Message Time Interval	The beginning and ending date and time matching a CET full day
Unit parameters	See below

Unit parameters	
Unit identification	Resource Object Identification
Time Interval	Match the Message Time Interval
Max Energy Per Day	MWh
Hydro Average Variable Cost	€/MWh (Only for Hydro Unit)
Variable Cost blocks	List, 10 elements maximum, see below
Fuel A cost	€/unit (Only for Thermal Unit)
Fuel B cost	€/unit (Only for Thermal Unit)
Fuel C cost	€/unit (Only for Thermal Unit)
Fuel A LHV	GJ/unit (Only for Thermal Unit)
Fuel B LHV	GJ/unit (Only for Thermal Unit)
Fuel C LHV	GJ/unit (Only for Thermal Unit)
SpecialCostForRawMaterial	€/MWh (Only for Thermal Unit)
SpecialCostForMaintenance	€/MWh (Only for Thermal Unit)

Variable Cost Block	
Net generation level	MW

Composition Fuel A	%
Composition Fuel B	%
Composition Fuel C	%

Versioning Rule

Schedule Type	Versioning Rule
Participant Techno Economic Declaration	Each time-series with identical market-day and resource object replace the previous one.

Validation Rules

The message is rejected if one of the following rules is not respected.

Rule Name	Rule Description
MessageTimeIntervalRule	The Message Time Interval is a full CET day
ParticipantDeclarationGateOpenRule	The Message Time Interval match an open Participant Declaration Gate
SendingUserRule	The message is uploaded either by an operator user or by a user linked to the xml message sender
MessageIdentificationVersionRule	The previous message received with the same combination (message identification, Sender Identification, Message Time Interval) has lower version
SenderRoleRule	Sender Role is A21
ReceiverIdentificationRule	The Receiver Identification is the ADMIE EIC Code
ReceiverRoleRule	Receiver Role is A04
TimeIntervalRule	The Message Time Interval and the Unit Time Interval are the same
ResourceObjectRule	The Resource Object is a Hydro Unit or Thermal Unit (including bifuel virtual unit and CCGT configuration) and neither Bi-Fuel nor a Combined

	Cycle Gas Turbine. The Resource Object Owner is the sender of the message.

The Participant Techno Economic Declaration are accepted during the participant declaration gate.

2. Reserve Offers Description

Interface Format

The interface will use the CIM Reserve Bid Document xsd.

iec62325-451-7-reserve biddocument_v7_

Message Header	
mRID	Unique identification of the message for which the time series data is being supplied.
revisionNumber	Version of the message being sent. A message may be sent several times, each transmission being identified by a different version number that starts at 1 and increases sequentially.
Message Type	A37 (Reserve tender document)
Message Date and Time	Date and time of transmission of the data.
Reserve Bid Period	The beginning and ending date and time matching a CET full day
Process Type	A46 (Replacement reserve) = RR Capacity Offer A47 (Manual frequency restoration reserve) = mFRR Capacity Offer A51 (Automatic frequency restoration reserve) = aFRR Capacity Offer A52 (Frequency containment reserve) = FCR Capacity Offer A41 (Redispatch Process) = Energy Offer
Receiver Identification / Coding Scheme	ADMIE EIC Code

Receiver Role	A04 (System operator)
Sender Identification / Coding Scheme	ADMIE EIC Code for Contracted Offers Otherwise EIC of the Resource Provider that sent the message.
Sender Role	A04 (System operator) for Contracted Offers A27 (Resource Provider) Otherwise
Subject Party Identification / Coding Scheme	EIC Code of the Resource Provider
Subject Party Role	A27 (Resource Provider)
Domain	Greek Control Area EIC Code
Time Series	See below

Time series	
mRID	A unique identification within the schedule message assigned by the sender.
Business type	A95: Frequency containment reserve A96: Automatic frequency restoration reserve A97: Manual frequency restoration reserve A98: Replacement reserve A86: Control area balance energy
divisible	A02 (No)
linkedBidsIdentification	Not Used
multipartBidIdentification	Not Used
exclusiveBidsIdentification	Not Used
blockBid	Not Used
status	Not Used
priority	Offer Block Index from 1 to 10
stepIncrementQuantity	Not Used

Period	See below
energyPrice_Measure_Unit	MWH
connecting_Domain	EIC Code of the Greek Control Area
price_Measure_Unit	MWH
minimum_ConstraintDuration	Not Used
currency_Unit	EUR
marketAgreement	Not Used
provider_MarketParticipant	EIC Code of the Resource Provider
acquiring_Domain	EIC Code of the Greek Control Area
quantity_Measure_Unit	MAW
resting_ConstraintDuration	Not Used
maximum_ConstraintDuration	Not Used
Reason	Not Used
registeredResource	EIC Code of the Resource Object
activation_ConstraintDuration	Not Used
AvailableMBA_Domain	Not Used
flowDirection	A01 (UP) or A02 (DOWN)
auction	Not Used
validity_Period	Not Used
standard_MarketProduct	Not Used
original_MarketProduct	Not Used

Period	
Time interval	This information provides the start and end date and time of the period being reported.

Resolution	Multiple of PT30M
Point	List of values, see below

Point	
Position	A sequential value representing the relative position of an entity within a space such as a time interval.
Price	Used for Reserve Capacity Offers
Energy Price	Used for Reserve Energy Offers
Quantity	Offer Block Quantity
Minimum Quantity	Minimal Activation Quantity

Versioning Rule

Schedule Type	Versioning Rule
Reserve Capacity Offer	Each message with identical market-day, Sender Party Identification, Subject Party Identification and Process Type replace completely the time series from the previous one. It means that if there are missing time series in a second message version, the missing time series are deleted by the new message version.
Reserve Energy Offer	If the Participant Declaration Gate is Open, each message replaces completely all the previous ISP Energy Offers with identical market-day, Sender Party Identification and Subject Party Identification. If the Participant Declaration Gate is Closed, each message, each message replaces completely all the previous RTBM Energy Offers with identical market-day, Sender Party Identification and Subject Party Identification.

Validation Rules

The message is rejected if one of the following rules is not respected.

Rule Name	Rule Description
ReserveBidPeriodIntervalRule	The Reserve Bid Period is a full CET day
CapacityOfferGateOpenRule	The Message Time Interval match an open Participant Declaration Gate
EnergyOfferFutureIntervalRule (30 Minutes)	A time series is not accepted if it creates, modifies or deletes data than are in the past or in the future for less than 30 minutes. If a data is modified all the past intervals should be unchanged.
SendingUserRule	The message is uploaded either by an operator user or by a user linked to the xml message sender
SendingParticipantRule	If all the resource object (identified by the registered Resource EIC Code) included in the message are non-contracted the sender is the owner of all the resource object included in the message. Otherwise all the resource object included in the message should be contracted and the receiver Identification should be the ADMIE EIC Code
ResourceObjectRule	The Resource Object (including bi-fuel virtual unit and CCGT configuration) is neither a Bi-Fuel nor a Combined Cycle Gas Turbine. The Resource Object Owner is the subject party of the message. (Market Evaluation Point matching the Resource Object EIC Code)
MessageIdentificationVersionRule	The previous message received with the same combination (message identification, Sender Identification, Message Time Interval) has lower version
SenderRoleRule	Sender Role is A04 id the sender identification is ADMIE EIC Code, otherwise A27

ReceiverIdentificationRule	The Receiver Identification is the ADMIE EIC Code
ReceiverRoleRule	Receiver Role is A04
PeriodTimeIntervalRule	The Message Time Interval and the Period Time Interval are the same
SubjectPartyRoleRule	Subject Party Role is A27
MessageTypeRule	Message Type is A37
ProcessTypeRule	Process Type is A46, A47, A51, A52 or A41. It defines the offer type: • A46 (Replacement reserve) = RR Capacity Offer • A47 (Manual frequency restoration reserve) = mFRR Capacity Offer • A51 (Automatic frequency restoration reserve) = aFRR Capacity Offer • A52 (Frequency containment reserve) = FCR Capacity Offer • A41 (Redispatch Process) = Energy Offer
DomainGreeceRule	Domain is the Greek Control Area EIC Code
BusinessTypeRule	Business Type is either A95, A96, A97, A98 or A86. It should match the offer type defined by the process type: • A95: Frequency containment reserve = FCR Capacity Offer • A96: Automatic frequency restoration reserve = aFRR Capacity Offer • A97: Manual frequency restoration reserve = mFRR Capacity Offer • A98: Replacement reserve = RR Capacity Offer

	• A86: Control area balance energy = Energy Offer
NotDivisibleRule	Divisible is A02 (No)
linkedBidsIdentificationNotUsedRule	linkedBidsIdentification is not Used
multipartBidIdentificationNotUsedRule	multipartBidIdentification is not Used
exclusiveBidsIdentificationNotUsedRule	exclusiveBidsIdentification is not Used
blockBidNotUsedRule	blockBid is not Used
statusNotUsedRule	status is not Used
priorityRule	The priority is an integer between 1 and 10 If there is n offers sharing the same combination (Resource Object, Direction) in the message, for each priority between 1 and n, it exists one and only one combination (Resource Object, Direction, Priority) in the message
stepIncrementQuantityNotUsedRule	stepIncrementQuantity is not Used
energyPrice_Measure_UnitRule	energyPrice_Measure_Unit is MWH
connecting_DomainRule	Connected Domain is EIC Code of the Greek Control Area
price_Measure_UnitRule	price_Measure_Unit is MWH
minimum_ConstraintDurationNotUsedRule	minimum_ConstraintDuration is not Used
currency_UnitRule	currency_Unit is EUR
marketAgreementNotUsedRule	marketAgreement is Not Used
provider_MarketParticipantRule	provider_MarketParticipant is the EIC Code of the Resource Provider
acquiring_DomainRule	acquiring_Domain is the EIC Code of the Greek Control Area
quantity_Measure_UnitRule	quantity_Measure_Unit is MAW

resting_ConstraintDurationNotUsedRule	resting_ConstraintDuration is Not Used
maximum_ConstraintDurationNotUsedRule	maximum_ConstraintDuration is Not Used
activation_ConstraintDurationNotUsedRule	activation_ConstraintDuration is Not Used
AvailableMBA_DomainNotUsedRule	AvailableMBA_Domain is Not Used
flowDirectionRule	flowDirection is A01 (UP) or A02 (DOWN), it identifies the offer direction
auctionNotUsedRule	auction is Not Used
validity_PeriodNotUsedRule	validity_Period is Not Used
standard_MarketProductNotUsedRule	standard_MarketProduct is Not Used
original_MarketProductNotUsedRule	original_MarketProduct is Not Used
CapacityOfferPriceRule	If the offer is a Reserve Capacity Offer, Price exist in each point and Energy Price is not used
EnergyOfferPriceRule	If the offer is a Reserve Energy Offer, Energy Price exist in each point and Price is not used
AscendingQuantityRule	For each Position, in offers sharing the same combination (Resource Object, Direction) the quantity is ascending with the priority
AscendingPriceOfferUpRule	For offer in Up direction, for each Position, in offers sharing the same combination (Resource Object, Direction) the price is ascending with the priority
DescendingPriceOfferDownRule	For offer in Down direction, for each Position: For capacity offers an ascending price rule with the priority will apply in down direction. For energy offers a descending price rule for offers in the down direction.

MinimumQuantityRule	The Minimum Quantity is higher than 0 only if the Resource Object is a Load. If priority = 1 the Minimum Quantity is lower than the Offer Quantity Otherwise the Minimum Quantity is lower than the difference between the Offer Quantity and the Quantity of the previous Offer (sorted by ascending priority) sharing the same combination (Resource Object, Direction).
DispatchableRule	The Resource object is dispatchable
RegisteredCapacityRule	If the offer is a Reserve Energy Offer the quantity should be equal to the Resource Object Registered Capacity (exception RES, LOAD)
MaximumAGCRule	If the offer is a aFRR Capacity Offer the quantity should be equal to the Resource Object Maximum AGC, for direction UP (Maximum aFRR Up) and for direction down Maximum aFRR Down respectively (exception RES, LOAD)
MaximumMFRRUpRule	If the offer is a mFRR Up Capacity Offer the quantity should be equal to the Resource Object Maximum mFRR Up (exception RES, LOAD)
MaximumMFRRDownRule	If the offer is a mFRR Down Capacity Offer the quantity should be equal to the Resource Object Maximum mFRR Down (exception RES, LOAD)
MaximumFCRUpRule	If the offer is a FCR Up Capacity Offer the quantity should be equal to the Resource Object Maximum FCR Up (exception RES, LOAD)
MaximumFCRDownRule	If the offer is a FCR Down Capacity Offer the quantity should be equal to the Resource

	Object Maximum FCR Down (exception RES, LOAD)

The Reserve Offers are accepted during the participant declaration gate.

Guidelines for the RTBM Energy Offers:

After the Participant Declaration Gate Closure, the RTBM Energy Offers are automatically initialized from the ISP Energy Offers for both reserve types (aFRR and mFRR).
If a participant wants to update these automatically created RTBM Energy Offers, the participant can upload the last ISP Energy Offer, that it has been uploaded before the Participant Declaration Gate Closure with the following process type:
aFRR RTBM Energy Offer => Process type = **A36**
mFRR RTBM Energy Offer => Process type = **A37**

The validation and versioning rules are exactly the same as there are for the ISP Energy Offer, however these apply separately for aFRR RTBM offers and mFRR RTBM offers.
The additional validation rule for the RTBM offer energy price is the following:

RTBM energy offer price can only improve the matching ISP Energy offer price.
This means that for Up direction for the same Resource object and quantity (MW level) the RTBM energy price <= ISP energy price.
For Down direction for the same Resource object and quantity (MW level) the RTBM energy price >= ISP energy price
The offered quantity cannot change in RTBM energy offer. It has to be the same as in the ISP energy offer.

3. Non-Availability Declaration Description

Interface Format

The interface will use the CIM Schedule Market Document xsd.

iec62325-451-2-schedule_v5_1.xsd

Message Header	
mRID	Unique identification of the message for which the time series data is being supplied.
revisionNumber	Version of the message being sent. A message may be sent several times, each transmission being identified by

	a different version number that starts at 1 and increases sequentially.
Message Type	A28 (Generation availability schedule)
Process Type	A12 (long term)
Schedule Classification Type	A01 (Exchange)
Sender Identification / Coding Scheme	EIC of the producer participant that sent the message.
Sender Role	A21 (producer)
Receiver Identification / Coding Scheme	ADMIE EIC Code
Receiver Role	A04 (System operator)
Message Date and Time	Date and time of transmission of the data. The time must be expressed in UTC as YYYY-MMDDTHH:MM:SSZ.
Message Time Interval	The beginning and ending date and time of the period covered by the message containing the schedule.
Domain	Greek Control Area EIC Code
Time Series	See below

Time series	
mRID	A unique identification within the schedule message assigned by the sender.
Version	The version number assigned to the time series in question. The time series version shall be the same as the document version number for its initial transmission. Each time a time series is modified the version number is assigned the same value as the schedule document version number used to transmit the modified information.
Business type	Z01 (partial unavailability declaration), Z02 (total unavailability declaration), Z03 (unavailability declaration cancellation)
Product	8716867000016 (active power)

Object aggregation	A06 (Resource Object)
In Domain	Greek Control Area EIC Code
Out Domain	Not Used
Market Evaluation Point	Resource Object EIC Code
In party	Sender Identification
Out party	Not Used
Market Agreement type	Not Used
Market Agreement identification	Not Used
Measurement unit	MAW
Curve Type	A01(Sequential fixed size block) or A03 (Variable sized Block)
Reason code	B18 (Failure) B19 (Foreseen Maintenance) B20 (Shutdown) A95 (Complementary Information)
Reason text	Mandatory: reason for unavailability
Period	See below

Period	
Time interval	This information provides the start and end date and time of the period being reported.
Resolution	Multiple of PT30M
Point	List of values, see below

Point	
Position	A sequential value representing the relative position of an entity within a space such as a time interval.

Quantity	Available capacity, MW (0 for total unavailability, major outage and operation inability).

Versioning Rule

Schedule Type	Versioning Rule
Unavailability Declaration	Each time-series with identical time series identification and sender identification replace the previous one. In the case the new unavailability declaration is not covering fully the previous one. The previous one is flagged as revoked on the missing intervals (Revoked by the Participant if the file was submitted by the Participant, revoked by the TSO if the file was submitted by an ADMIE Operator).

Validation Rules

The message is rejected if one of the following rules is not respected.

Rule Name	Rule Description
FutureIntervalRule (30 Minutes)	A time series is not accepted if it creates, modifies or deletes data than are in the past or in the future for less than 30 minutes. If a data is modified all the past intervals should be unchanged.
SendingUserRule	The message is uploaded either by an operator user or by a user linked to the xml message sender
ResourceObjectRule	The Resource Object (including bi-fuel virtual unit and CCGT configuration) is neither a Bi-Fuel nor a Combined Cycle Gas Turbine. The Resource Object Owner is the sender of the message. (Market Evaluation Point matching the Resource Object EIC Code)
MessageIdentificationVersionRule	The previous message received with the same combination (message identification, Sender

	Identification, Message Time Interval) has lower version
SenderRoleRule	Sender Role is A21
ReceiverIdentificationRule	The Receiver Identification is the ADMIE EIC Code
ReceiverRoleRule	Receiver Role is A04
MessageTypeRule	Message Type is A28
ProcessTypeRule	Process Type is A12
ScheduleClassificationTypeRule	Schedule Classification Type is A01
DomainGreeceRule	Domain is the Greek Control Area EIC Code
TimeSeriesVersionRule	If > the message version -> the message is rejected If < the message version -> the time series is ignored
TimeSeriesUnicityRule	Time Series Identification is unique in the message. If combination (Sender Identification, Time Series Identification) already exist in time series repository, it should be linked to the same resource object. No other Unavailability Declaration should exist in time series repository for the same resource object on an intersecting period.
BusinessTypeRule	Business Type is either Z01 or Z02 or Z03 If it is Z03, an unavailability declaration should exist with the same identification, resource object and period. If the file is uploaded by the market participant, it will be flagged as Revoked by the Participant. If the file is uploaded by an ADMIE Operator, it will be flagged as Revoked by the TSO.
ProductRule	Product is 8716867000016 (active power)
ObjectAggregationRule	Object aggregation is A06 (Resource Object)

InDomainGreeceRule	In Domain is the Greek Control Area EIC Code
OutDomainNotUsedRule	Out Domain is Not Used
InPartySenderRule	In Party is the message Sender
OutPartyNotUsedRule	Out Party is Not Used
MarketAgreementTypeNotUsedRule	Market Agreement type is Not Used
CurveTypeRule	Curve Type is A01 or A03
ReasonCodeRule	Reason Code is B18, B19, B20, A95
ReasonTextNotEmptyRule	Should not be empty
UnavailableQuantityRule	0 for Total Unavailability (Z02)

Additional rules for unavailability declaration are following:

- Unavailability:
    - Revoke in the future by redeclaring the past with the same values
    - Matching is done on unit and timeseries ids
    - Mark as deleted the previous if it intersects (same RO, TS ID) and does not change values in the past
    - Only 1 period per timeseries.

The Unavailability declarations are accepted anytime until 30 minutes before the delivery time.

4. Commission schedules and mandatory hydro

Additionally ADMIE operators expect to receive form market participants the following information, in both XML and XLS format:

- Commissioning Schedules
- Mandatory Hydro (Uploaded every Thursday for the next 7 days Saturday – Friday, can be updated every day if necessary)

The XSD of those formats are attached below:

ScheduleDocument
.xsd

The following versioning rules should be followed:

Versioning Rule

Schedule Type	Versioning Rule
Commissioning Schedules	Each time-series included in the same market-day and matching the identical resource object replace the previous one.
Mandatory Hydro	Each time-series with identical market-day and resource object replace the previous one.

Validation Rules

Rule Name	Rule Description
FutureIntervalRule	A time series is not accepted if it creates, modifies or deletes past data. If a daily data is modified in intra-day all the past intervals should be unchanged. If a daily data is created in intra-day all the past intervals should be equal to 0.
InsideCETDayRule	The received Time-Series is included in a full CET day. Apply to Commissioning Schedule only.
CETDayRule	The received Time-Series is matching a full CET day. Doesn't apply to Commissioning Schedule.

SendingUserRule	The message is uploaded either by an operator user or by a user linked to the xml message sender
SenderIdentificationRule	The sender Identification is the ADMIE EIC Code
SenderRoleRule	Sender Role is A04
ReceiverIdentificationRule	The Receiver Identification is the ADMIE EIC Code
ReceiverRoleRule	Receiver Role is A04

It is ADMIE operator's responsibility to upload the received Commissioning schedules and the mandatory hydro schedules in the balancing market platform. They can be uploaded anytime until 30 minutes before the delivery time.

Both two half-hours that belong to the same hour should be in the same state (commission/or not commission) and should have the same value (MW), as ADMIE operator has to declare them in the EXE hourly market.

The sample xml files will help the market participants to submit the balancing capacity (FCR, aFRR and mFRR) and balancing energy offers, the mandatory hydro, the commissioning, the unavailability. The files are attached below:

AFRRCOFFER_PARTY1_20190623_V1_19(

Commissioning_20190623_V_190621095

ENOFFER_PARTY1_20190623_V1_190621(

FCRCOFFER_PARTY1_20190623_V1_1906

MandHydro_20190623_V_190621095851.

MFRRCOFFER_PART
Y1_20190623_V1_19(

TED_PARTY1_20191018_V1_191024105248_new.xml
UNAVAIL__PARTY2_10X-P2LHYDRO3-C_20190803_V4_190930182136_new.xml

5. Submission of injection forecast file by RES Producers and/or RES Aggregators

The file to be sent shall be in the following format:

EIC_YYYMMDD_ISPx
.csv

Taking as an example calendar day 12/09/2020, for ISP1 and ISP2 (referring to Dispatch Day 13/09/2020), and ISP3 (referring to Dispatch Day 12/09/2020), the files for a RES Aggregator shall be named EIC_20200913_ISP1, EIC_20200913_ISP2 and EIC_20200912_ISP3 respectively.

Furthermore, the file shall be further divided into four categories, for which an injection forecast shall be declared in MW:

i. Portfolios under state aid and in normal operation shall be declared under the column entitled “SA_N”,

ii. Portfolios under state aid and in Commissioning operation shall be declared under the column entitled “SA_C”,

iii. Portfolios with Market Participation Obligation and in normal operation shall be declared under the column entitled “NA_N”,

iv. Portfolios with Market Participation Obligation and in Commissioning operation shall be declared under the column entitled “NA_C”.

6. Technical characteristics submitted in the framework of the ISP

For the purposes of the ISP, the BSPs are obliged to submit the following data, separately for each BSE they represent, if applicable, depending on the type and the technology of the entity. This data must be in agreement with the Registered Characteristics submitted in accordance with the HETS Grid Code. The BSEs that make up the Dispatchable Multi-Shaft Combined Cycle Generating Units and the Dispatchable Generating Units with Alternative Fuel are obliged to submit this data separately for every possible configuration.

Technical Characteristics	Unit of measurement	Remarks	Applies to
Technically Minimum Generation (net capacity, having taken into consideration the internal service and the auxiliary loads).	MW	For hydro Units consisting of more than one generator, it means the Technically Minimum Generation of a single generator.	Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Maximum Net Capacity (NCAP): Maximum continuous generation capability in ISO conditions (Net Capacity, having taken into consideration the internal service and the auxiliary loads).	MW	For hydro Units consisting of more than one generator, the Maximum Net Capacity of all generators together shall be considered.	Dispatchable Generating Units & Dispatchable RES Units Portfolios
Maximum continuous output (gross)	MW	For hydro Units consisting of more than one generator, it means the Maximum continuous generation capacity of all generators together.	Dispatchable Generating Units & Dispatchable RES Units Portfolios
Auxiliary loads (active power) for active power generation between zero and the Maximum Net Capacity, in steps	MW auxiliary / MW gross production		Dispatchable Generating Units & Dispatchable RES Units Portfolios
Ramp Up Rate	MW/min		All Entities
Ramp Down Rate	MW/min		All Entities
Minimum uptime	hours	It cannot be lower than: • The minimum declared time to synchronization, plus • the minimum declared soak time, plus • down time from technically minimum generation to de-synchronization	All Entities
Minimum down time	hours		All Entities
Maximum Daily Activations			Dispatchable Load Portfolios
Maximum uptime	hours		Dispatchable Load Portfolios
Time of transition to a different thermal state before going into longer standby conditions - From hot to warm - From warm to cold - From hot to cold	hours		Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Time to synchronization - From hot state - From warm state - From cold state	hours		Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Minimum additional time added to the time for synchronization in case of recall from Total non Availability state	hours		Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios

Minimum additional time added to the time for synchronization in case of recall from longer standby conditions	hours		Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Soak time from each thermal state - From hot state - From warm state - From cold state	hours	It must coincide with the soak time resulting from the relevant soak trajectory that is submitted	Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Soak trajectory - Hot The generation level in the soak phase, from synchronization to no more than the minimum generation, i.e. the exact level of production in up to six (6) hourly steps, from hot state	MW/ hour	Each step of the soak trajectory submitted must correspond to the energy injected by the entity on an hourly basis during the soak phase. The last step of the soak trajectory must be smaller or equal to the Technically Minimum Generation.	Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Soak trajectory - Warm The generation level in the soak phase, from synchronization to no more than the minimum generation, i.e. the exact level of production in up to six (6) hourly steps, from warm state	MW/ hour		
Soak trajectory - Cold The generation level in the soak phase, from synchronization to no more than the minimum generation, i.e. the exact level of production in up to six (6) hourly steps, from cold state	MW/ hour		
Down time from technically minimum generation to de-synchronization	hours		Dispatchable Generating Units & Dispatchable Non-Intermittent RES Units Portfolios
Maximum Load under AGC (for provision of aFRR)	MW	It must be lower than or equal to the Maximum Net Capacity (NCAP)	All Entities
Minimum Load under AGC (for provision of aFRR)	MW	It must be higher than or equal to the Technically Minimum Generation	All Entities
Ramp Up Rate in AGC mode (for provision of aFRR)	MW/min		All Entities
Ramp Down Rate in AGC mode (for provision of aFRR)	MW/min		All Entities
Maximum contribution to upward FCR	MW		All Entities
Maximum contribution to downward FCR,	MW		All Entities
Maximum contribution to upward aFRR	MW	It is not allowed to exceed the value of the declared Ramp Up Rate of the Entity in AGC mode (MW/min) for 7.5 minutes	All Entities
Maximum contribution to downward aFRR	MW	It is not allowed to exceed the value of the declared Ramp Down Rate of the Entity in AGC mode (MW/min) for 7.5 minutes	All Entities
Maximum contribution to upward mFRR	MW	It is not allowed to exceed the value of the declared Ramp Up Rate of the Entity (MW/min) for 7.5 minutes	All Entities

Maximum contribution to downward mFRR	MW	It is not allowed to exceed the value of the declared Ramp Down Rate of the Entity (MW/min) for 7.5 minutes	All Entities
Number of Hydro Unit generators			Hydroelectric Plants
Forbidden continuous operation zones due to oscillations for Hydroelectric Plants	(MW, MW) upper and lower zone limits		Hydroelectric Plants

For the BSEs consisting of Dispatchable Multi-Shaft Combined Cycle Generating Units, the times for transition from one configuration to another are declared (as a integer number of hours), for every possible transition and thermal state, according to the following table.

COLD STATE

FROM	TO	TIME (integer number of hours)
1GT	2GT	
1GT	3GT	
2GT	3GT	
1GT	1GT+ST	
1GT	2GT+ST	
1GT	3GT+ST	
2GT	2GT+ST	
2GT	3GT+ST	
3GT	3GT+ST	
1GT+ST	2GT+ST	
1GT+ST	3GT+ST	
2GT+ST	3GT+ST	

FROM	TO	TIME (integer number of hours)
2GT	1GT	
3GT	1GT	
3GT	2GT	
1GT+ST	1GT	
2GT+ST	1GT	
3GT+ST	1GT	
2GT+ST	2GT	
3GT+ST	2GT	
3GT+ST	3GT	
2GT+ST	1GT+ST	
3GT+ST	1GT+ST	
3GT+ST	2GT+ST	

WARM STATE

FROM	TO	TIME (integer number of hours)
1GT	2GT	
1GT	3GT	
2GT	3GT	
1GT	1GT+ST	
1GT	2GT+ST	
1GT	3GT+ST	
2GT	2GT+ST	
2GT	3GT+ST	
3GT	3GT+ST	
1GT+ST	2GT+ST	
1GT+ST	3GT+ST	

FROM	TO	TIME (integer number of hours)
2GT	1GT	
3GT	1GT	
3GT	2GT	
1GT+ST	1GT	
2GT+ST	1GT	
3GT+ST	1GT	
2GT+ST	2GT	
3GT+ST	2GT	
3GT+ST	3GT	
2GT+ST	1GT+ST	
3GT+ST	1GT+ST	

2GT+ST	3GT+ST	

3GT+ST	2GT+ST	

HOT STATE

FROM	TO	TIME (integer number of hours)
1GT	2GT	
1GT	3GT	
2GT	3GT	
1GT	1GT+ST	
1GT	2GT+ST	
1GT	3GT+ST	
2GT	2GT+ST	
2GT	3GT+ST	
3GT	3GT+ST	
1GT+ST	2GT+ST	
1GT+ST	3GT+ST	
2GT+ST	3GT+ST	

FROM	TO	TIME (integer number of hours)
2GT	1GT	
3GT	1GT	
3GT	2GT	
1GT+ST	1GT	
2GT+ST	1GT	
3GT+ST	1GT	
2GT+ST	2GT	
3GT+ST	2GT	
3GT+ST	3GT	
2GT+ST	1GT+ST	
3GT+ST	1GT+ST	
3GT+ST	2GT+ST	