Public consultation document for the design of the TERRE

(Trans European Replacement Reserves Exchange)

Project solution

07th of March 2016 (Start of the consultation)

Content

Table of Figures

1 Introduction

1.1 Overview of the project

To support the implementation of the Guideline on "Electricity Balancing", several pilot initiatives have been set up. TERRE (Trans European Replacement Reserve Exchange) is the pilot project validated by ENTSO-E for cross-border Replacement Reserve (RR) exchanges.
The TERRE solution should enhance the experience of the current BALIT bilateral solution used between NG-RTE, REE-RTE and REN-REE. The TERRE project uses the previous work of REN, REE and RTE in developing an enduring regional solution for the exchange of balancing energy between TSOs.

The TERRE project involves several TSOs from UK to Greece. 8 European TSOs are participating in the TERRE pilot project whilst 2 European TSOs are observers.

Participants:

- ADMIE
- National Grid Electricity Transmission Plc
- National Grid Interconnectors Limited
- REE
- REN
- RTE
- Swissgrid
- Terna

Observers:

- EIRGRID
- SONI

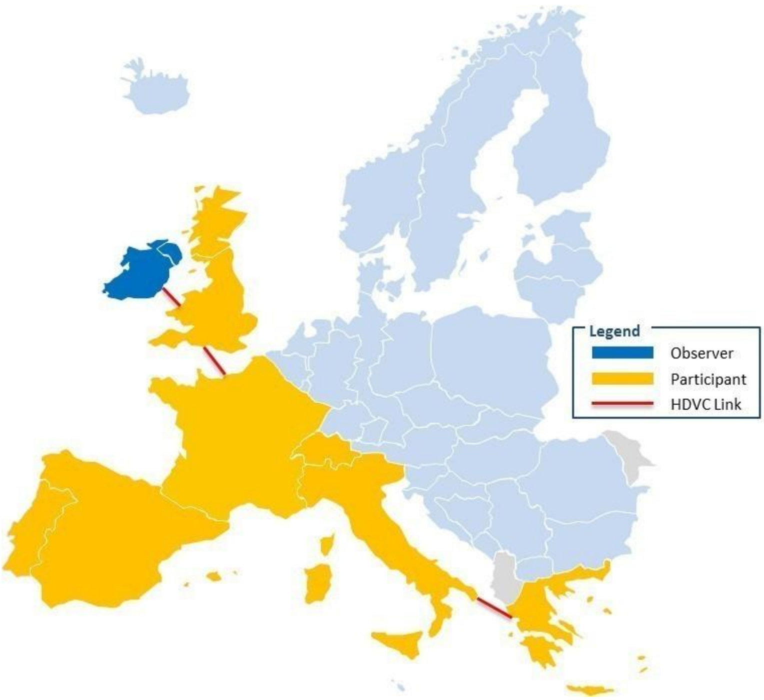

Figure 1-1: TERRE project Participants and Observers

At present, the TERRE project has been progressing through its design phase under the legal scope of a Memorandum of Understanding (MoU) and Non-Disclosure Agreement (NDA).

The design phase of the project is coming to a close with this public consultation which, together with the high level design document, will form the National Regulatory Authority (NRA) approval package. The design phase will close with the publication of a common position paper from NRAs; analyzing the TSOs proposal and supporting it, subject to possible requests for changes.
ADMIE is currently redesigning its local electricity market and will participate in the implementation phase of the TERRE project as an observer only. Furthermore, ADMIE is not currently using an RR process for

balancing energy and has decided to continue this policy in the near future. ADMIE will re-evaluate its decision on the implementation of TERRE at a later stage after the completion of the current market reform in Greece.

1.2 Scope and goals of the project

The scope of the project is to implement a multi-TSO coordinated exchange of Replacement Reserve - Cross Border balancing energy with the aim of being compliant with the aims and objectives of the Guideline on Electricity Balancing (GL EB)[1]. The model for the Exchange of the Balancing Service considered in this project will be the TSO-TSO Model.

The main objective of the TERRE project is to establish and operate a platform capable of gathering all the offers for Replacement Reserves from TSO's local balancing markets and to provide an optimized allocation of RR to cover the TSOs imbalance needs.

Furthermore, the target of the TERRE implementation project is to assess and test the impact of the designed cross-border balancing solution in terms of:

- Expected benefits and costs,
- Potential barriers,
- Needed market design changes and
- IT development

The experience and knowledge gained will then contribute to the implementation, at European level, of the target model for cross-border electricity balancing as identified in the GL EB.

The expected benefits of the TERRE project include, but are not limited to:

- Enhancing the efficiency of balancing as well as the efficiency of European, regional and national balancing markets
- Integrating balancing markets and promoting the possibilities for exchanges of balancing services while ensuring operational security
- Ensuring that the procurement of balancing services is fair, objective, transparent and market-based, avoids undue barriers to entry for new entrants, fosters the liquidity of balancing markets while preventing undue distortions within the internal market in electricity
- Facilitating the participation of demand response services (DRS) and renewable energy sources (RES)

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[1] Please note that the GL EB is still in pre-Comitology process.

1.3 Description of the design phase

The design of the TERRE solution has been built in order to be compliant with the requirements of the implementation of TSO-TSO balancing model according to:

- The Framework Guidelines on Electricity Balancing published by ACER on the 18th of September, 2012
- ACER Qualified Recommendation on EB published on the 20th of July, 2015
- The Guideline on Electricity Balancing (GL EB), currently under the pre-Comitology process:

The design phase started at the end of 2013 and has been organized into six Technical Working Packages, plus one Legal and Governance Working Package. Each Technical Working Package is being led by one or two participating TSOs. The Governance issues have been dealt with by the Legal and Governance Working Group.

The Technical Working Packages for the project are as follows:

1. Product & Imbalance Need
2. Balancing Common Merit Order & Algorithm
3. Settlement
4. Economic Analysis
5. Timing & Scheduling
6. Available Transmission Capacity Management

1.4 Objectives of the document

The present document aims to share the results of the TERRE project design phase in order for stakeholders to express their comments on the different design aspects.

The comments will be consolidated via a transparent consultation tool based on the results presented in the following parts of this document.

- Consultation material is available on ENTSO-E consultation platform
- The **consultation process starts on March 07th, 2016** and lasts for 1 month: the consultation **platform will be closed for responses on April 01st, 2016**
- In order to respond to the consultation, **stakeholders have to take part in the Online Survey** available on ENSTO-E consultation platform. The survey **has 41 open questions**, linked to the chapter of the present document. Each chapter also includes a question allowing stakeholders to freely comment on the proposed design. The survey also includes a generic introduction question for stakeholders to freely comment on the whole document.

After due consideration and evaluation of all comments, project partners will formally seek support for the TERRE solution from the NRAs.

NB: Formal NRA approval will be sought under the scope of the GL EB, with the submission of the Implementation Framework for RR, six months after its entry into force.

1.5 Questions for Stakeholders

Q 1.1 Do you have specific comments regarding Chapter 1 content? (Please indicate sub-chapter reference when possible)

2 Overview of different manual reserves balancing markets in TERRE

The key information for RR market and related to each Member State is described in the tables below:

Table 2-1: - Key information

		Spain (RR and mFRR)	Portugal (RR and mFRR)	France (RR and mFRR)	GB (RR and mFRR)	Switzerland (RR and mFRR)	Italy (RR and mFRR)	Greece (mFRR)
Manual Reserves (Energy)	Procurement scheme	Organized Market	Mandatory Offers	Pre-contracted and Mandatory Offers	Pre-contracted and Mandatory Offers	Organized Market	Mandatory Offers	Mandatory Provision
	Implicit or Explicit balancing markets	Explicit	Explicit	Explicit and Implicit	Explicit and Implicit	Explicit	Explicit	Implicit
	Min bid size	0.1MW	1MW	10MW	1MW	5MW	1MW	1MW
	DSR	No	No	Yes	Yes	Yes	No	No
	Wind or solar participation	Regulation entered in force on February 2016	No	No	Yes	Yes	No	No
	Settlement Rule	Marginal Pricing	Marginal Pricing	Pay as bid	Pay as bid	Pay as bid	Pay as bid	Marginal Pricing
	Divisible Offers*	Yes	Yes	Yes	Yes	No	Yes	Yes
	Block Offers*	Yes (for RR)	No	No	Yes (STOR)	Yes	Yes (Startup Offers)	N/A
	Exclusive Offers*	No	No	No	No	No	No	N/A
	Linking Offers*	Yes (for RR)	No	No	No	No	Yes	N/A
	Multipart Offers*	Yes	Yes	No	Yes	No	No	N/A

	Negative Prices	**Upward offer**	No	No	No	Yes	Yes	No	No
		Downward offer	No	No	Yes	Yes	Yes	No	No
	Dispatch method		Self	Self	Self	Self	Self	Central	Central
	Ramp Settlement		No	No	Yes	Yes	No	Yes	Yes

(*): please refer to the chapter 3.1.2

NB: For more details, please follow the ENTSO E survey link https://www.entsoe.eu/publications/market-reports/ancillary-services-survey/Pages/default.aspx

The Table below presents the different intra-day Cross Border Market GCT for the zones covered by the geographical scope of TERRE.

Table 2-2: intra-day and Cross border Gate Closure Time

			1st Session	2nd Session	3rd Session	4th Session	5th Session	6th Session	ISP	Market Resolution	Min lead time for changes	Impact in TERRE Process?**
REN		Gate Closure Time	18:45	21:45	01:45	04:45	08:45	12:45	60 min	60 min	135 min	NO
		How many perios are covered by the session	27 * 60min	24 * 60min	20 * 60min	17 * 60min	13 * 60min	9 * 60min				
		(Hourly periods covered)	21:00 - 00:00(next day)	00:00 - 00:00	04:00 - 00:00	07:00 - 00:00	11:00 - 00:00	15:00 - 00:00				
REE		Gate Closure Time	18:45	21:45	01:45	04:45	08:45	12:45	60 min	60 min	135 min	NO
		How many perios are covered by the session	27 * 60min	24 * 60min	20 * 60min	17 * 60min	13 * 60min	9 * 60min				
		(Hourly periods covered)	21:00 - 00:00(next day)	00:00 - 00:00	04:00 - 00:00	07:00 - 00:00	11:00 - 00:00	15:00 - 00:00				
TERNA		Gate Closure Time	17:30 (D-1)	12:30 (D)	--	--	--	--	15 min	60 min	195 min	NO
		How many periods are covered by the session	24 * 60min	8 * 60min	--	--	--	--				
		(Hourly periods covered)	00:00 - 23:59	16:00 - 23:59	--	--	--	--				
NG	GB-FR	Gate Closure Time	21:00 (D-1)	3:00 (D)	8: 00 (D)	11:00 (D)	14:00 (D)	17: 00 (D)	30 min	60 min	180 min	NO
		How many periods are covered by the session	6 * 60min	5* 60min	3 * 60min	3 * 60min	3* 60min	4 * 60min				
		(Hourly periods covered)	00:00-05:59	06:00-10:59	11:00-13:59	14:00-16:59	17:00-19:59	20:00-23:59				
	GB National	Gate Closure Time							30 min	30min	60min	NO
		How many periods are covered by the session	1*30min	1*30min	1*30min	1*30min	1*30min	1*30min				
		(Hourly periods covered)										
SG	AT-CH	Gate Closure Time	Every 15min						15 min	15min	45 min	NO
		How many periods are covered by the session	96 gates									
		(Hourly periods covered)	From GCT+lead time until end of the day									
	DE-CH	Gate Closure Time	Every 15min							15min	45min*	NO
		How many periods are covered by the session	96 gates									
		(Hourly periods covered)	From GCT+lead time until end of the day									
	FR-CH	Gate Closure Time	Every hour							60 min & 30min	45 min	NO
		How many periods are covered by the session	24 gates									
		(Hourly periods covered)	From GCT+lead time until end of the day									
	IT-CH		See TERNA case									NO
	CH national	Gate Closure Time	Every 15min							15 min	15 min	NO
		How many periods are covered by the session	96 gates									
		(Hourly periods covered)	From GCT+lead time until end of the day									
ADMIE												NO
RTE	FR-CH	Gate Closure Time	Every hour						30 min	60min & 30min	60 min	NO
		How many periods are covered by the session	24 gates									
		(Hourly periods covered)	From GCT + lead time until end of the day									
	FR-SP	Gate Closure Time	17:00	12:00						60min	180 min	NO
		How many periods are covered by the session	24*60min	9 * 60 min								
		(Hourly periods covered)	00:00 to 00:00	15:00 to 00:00								
	FR-GB		See NG case									NO
	FR-IT		See TERNA case									NO

* = Possibility of 15' lead-time in case of the application of special emergency contracts established

** If ID GCT have a direct impact in TERRE process?

NB: The harmonization of the local settlement rules will be tackled under the framework of the RR COBA implementation.

2.1 Questions for Stakeholders

Q 2.1 Do you have any specific comments regarding Chapter 2 content? (Please indicate sub-chapter reference when possible)

3 Product & Imbalance Need

3.1 Description of the product

3.1.1 Definition of the cross border product

The TERRE product will be one of the Standard Products for Replacement Reserve (RR).

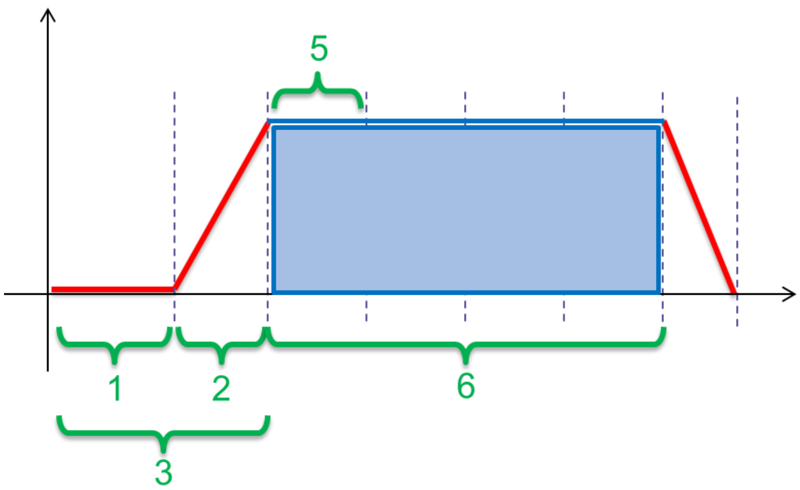

Figure 3-1: TERRE cross border product shape

The TERRE basic product is a 15min scheduled block, i.e. it can be activated for a fixed quarter hour(s) at hh: 00-hh:15, hh:15-hh:30, hh:30-hh:45 and/or hh:45-hh:60 or a multiple of a fixed quarter hour. Product full activation time is 30 minutes (see detailed process). TSOs physically schedule this block in their controllers, and settle the block energy with each other.

Table 3-1: TERRE cross-border product definition

Standard Characteristics	
(0) Activation Principle	Scheduled

(1) Preparation Period	From 0 to 30 min
(2) Ramping Period	From 0 to 30 min
(3) Full Activation Time	30 min
(4) Minimum quantity	1 MW
(5) Minimum delivery period	15 min
(6) Max delivery period	60 min
(7) Location	Bidding Zones
(8) Validity Period	Defined by BSP but equal or less than 60 min
(9) Recovery Period	Defined by BSP
(10) Maximum Offer Size	• In case of divisible offer, no max is requested. • In case of indivisible offer, local rules will be implemented
(11) Divisible Volume	Under the responsibility of BSP (Resolution for divisible offers = 0,1MW)
(12) Price	Local rules for cap/floor will be implemented in case no harmonization acc. GL EB can be achieved by NRA's before entry into force of TERRE of TERRE
(13) Time Resolution	15 mins

3.1.2 BSP-TSO & BRP-TSO rules & requirements

The following items will be defined in a later stage of the project. With respect to the Standard Product design and the terms and conditions under the umbrella of the GL EB (BRP: calculation of the imbalance, Imbalance Price, BSP: settlement of the service, possible treatment of non-compliance, settlement or not of ramping, prequalification), the objective would be to have as many harmonized features as possible for the entry into force of TERRE. However some differences may be difficult to overcome.

3.1.3 Format of balancing energy offers

The following bid formats for balancing energy offers can be processed by the CMO:

- Divisible Offers,
- Block Offers,
- Exclusive Offers,
- Multi-part Offers
- Linking Offers.

3.1.3.1 Divisible offer in volume

A Divisible Offer is a balancing energy offer that consists of a single quantity and a single price. Its delivery period can be 15, 30, 45 or 60 minutes. It can also have a minimum quantity. The algorithm can accept a part of it in terms of quantity; however the same quantity must be accepted for the whole delivery period. Two examples of Divisible Offers with delivery period 60 minutes and 15 minutes, respectively, are presented in Figure 3-2 and Figure 3-3. Both offers have a single price for the whole quantity, x €/MWh.

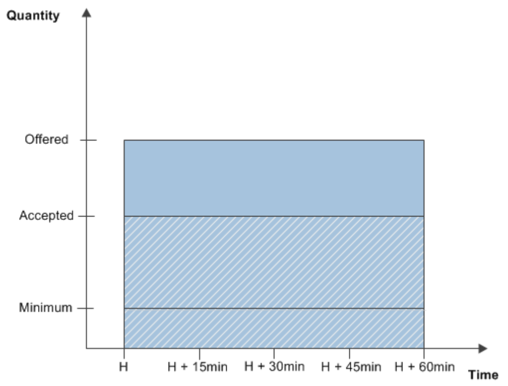

Figure 3-2: Divisible Offer with 60min delivery period

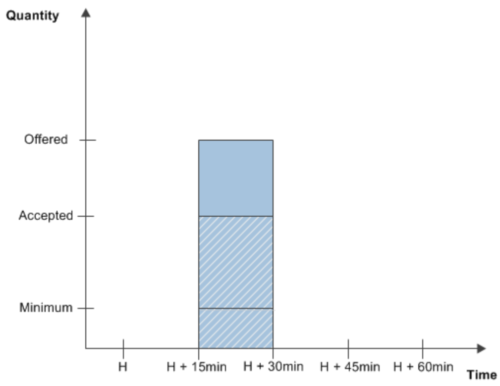

Figure 3-3: Divisible Offer with 15min delivery period

3.1.3.2 Block Offers in volume

A Block Offer is a balancing energy offer that also consists of a single quantity and a single price. Its delivery period can be 15, 30, 45 or 60 minutes. The difference between a Divisible and a Block Offer is that the algorithm can accept either the whole quantity of the Block Offer or nothing.

An example of a Block Offer with a delivery period of 30 minutes, from H + 15min to H + 45min, is presented in Figure 3-4 and Figure 3-5.

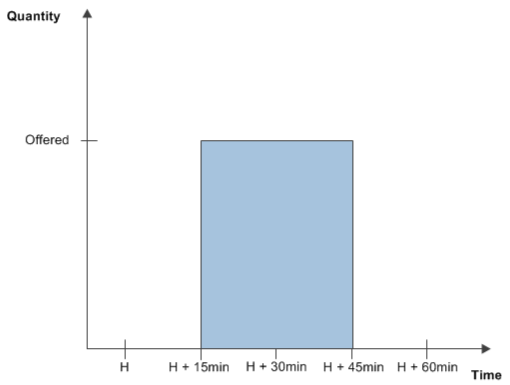

Figure 3-4: Submitted Block Offer

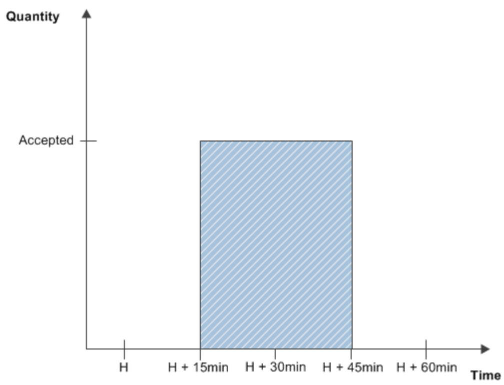

Figure 3-5: Accepted Block Offer: all or nothing

3.1.3.3 Exclusive Offers in volume or in time

Exclusive Offers are balancing energy offers that satisfy the following condition: only one (or none) of the Exclusive Offers can be activated; hence, the activation of a sub-offer belonging to an Exclusive Offer excludes the activation of the other sub-offers belonging to the same Exclusive Offer. The Exclusive Offers can either be divisible or Block Offers.

Exclusive Offers provide greater flexibility to BSPs which bid per portfolio, as they allow them to better represent their costs. According to discussions within the ENTSO-E Standard Products subgroup, the number of sub-offers of each Exclusive Offer should be limited by a maximum number at the present time.

An example of Exclusive Offers is illustrated in Figure 3-6. It presents four Exclusive sub-Offers with (quantities/prices): (Q_1/ P_1), (Q_2/ P_2), (Q_3/ P_3) and (Q_4/ P_4), respectively with the same delivery period, e.g. H + 15min to H + 60min. Only one of these offers can be accepted by the algorithm.

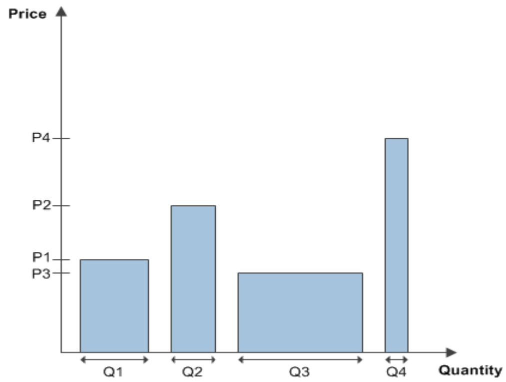

Figure 3-6: Exclusive Offer with 4 sub-offers

3.1.3.4 Multi-part Offers

A Multi-part Offer is a balancing energy offer that has variable prices for variable quantities and a single delivery period. Multi-part Offers allow BSPs to internally model their fixed costs, e.g. start-up costs. In addition, as with the Exclusive Offers, they allow the BSPs which bid per portfolio to depict their costs more accurately. Multi-part Offers can either be divisible or Block Offers.
An example of a Multi-part Divisible Offer is presented in Figure 3-7

The depicted Multi-part Offer has a delivery time period starting at H+15min and ending at H+60min, with a minimum quantity of zero. It consists of three parts:

- A quantity Q_1 ($Q_1 \leq 20MW$) of this offer; priced at 50€/MWh;
- A quantity Q_2 ($20MW \leq Q_2 \leq 25MW$) of this offer; priced at 70€/MWh;
- A quantity Q_3 ($25MW \leq Q_3 \leq 40MW$) of this offer; priced at 100€/MWh.

A Multi-part Offer can also be modelled as an Exclusive Offer.

In the example presented in Figure 3-7, the three parts of the Multi-part Offer can also be modelled as one Exclusive Offer with the following three divisible sub-offers:

- 20MW, 50€/MWh with min quantity 0MW
- 25MW, 70€/MWh with min quantity 20MW
- 40MW, 100€/MWh with min quantity 25MW

Only one of the three offers can be accepted. For instance, if 30MW are accepted, and if it's the most expensive expected offer, then the Marginal Price will be equal to 100€/MWh. This BSP will receive 30MW * 100€/MWh.

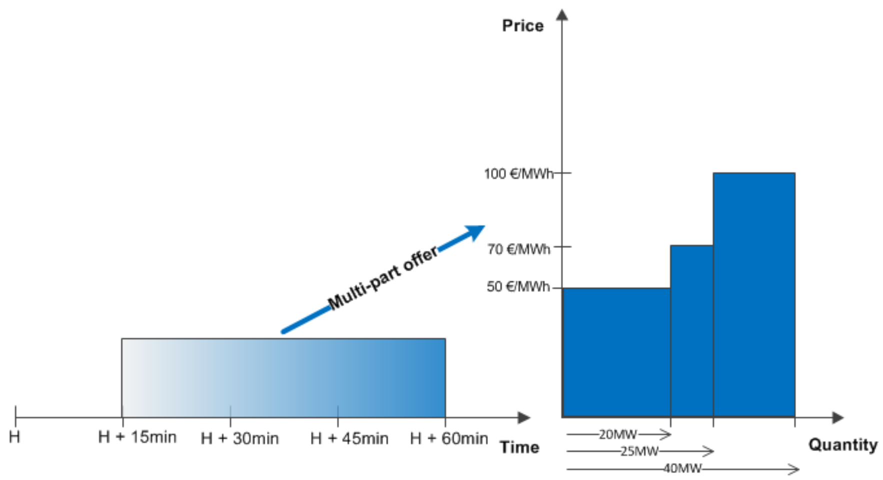

Figure 3-7: Example of a Multi-part Offer with delivery time period from H+ 15min to H+60min and three prices

3.1.3.5 Linking Offers in time

Linking Offers are balancing energy offers that are linked in time; they have different delivery time periods and they satisfy the following condition: a sub-offer of a Linking Offer is (not) activated if and only if another sub-offer of the same Linking Offer is (not) activated.

Linking Offers allow BSPs to better manage their energy constraints, e.g. a BSP may not be able to have an offer accepted in only the first 15 minutes, without having also an offer accepted the next 15 minutes. It also allows BSPs to calculate their start-up costs more efficiently. According to discussions within the ENTSO-E Standard Products subgroup, the number of links (sub-offers) for one Linking Offer should be also limited to a maximum number.

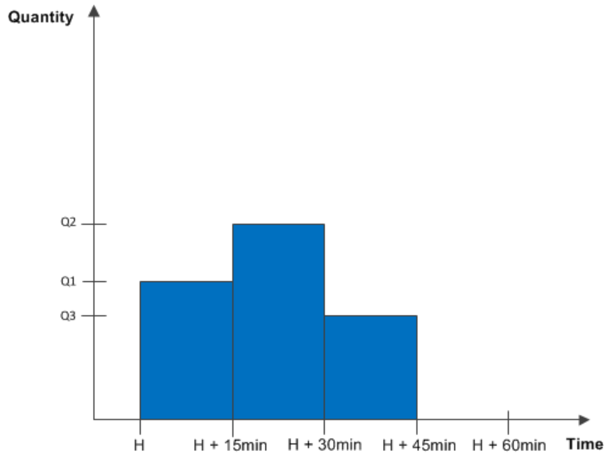

Figure 3-8: Linking Block Offers: all 3 offers or nothing are accepted.

Linking Offers can either be Block or Divisible Offers. In the case of Divisible Linking Offers, the same percentage of quantity has to be activated; hence, x % of all Divisible Linking Offer quantities is activated, where 0 <= x <= 100. Two examples with Block and Divisible Linking Offers, respectively, are presented in Figure 3-8 and Figure 3-9.

Figure 3-8 depicts three linked Block Offers. Either all three or none are accepted by the algorithm.

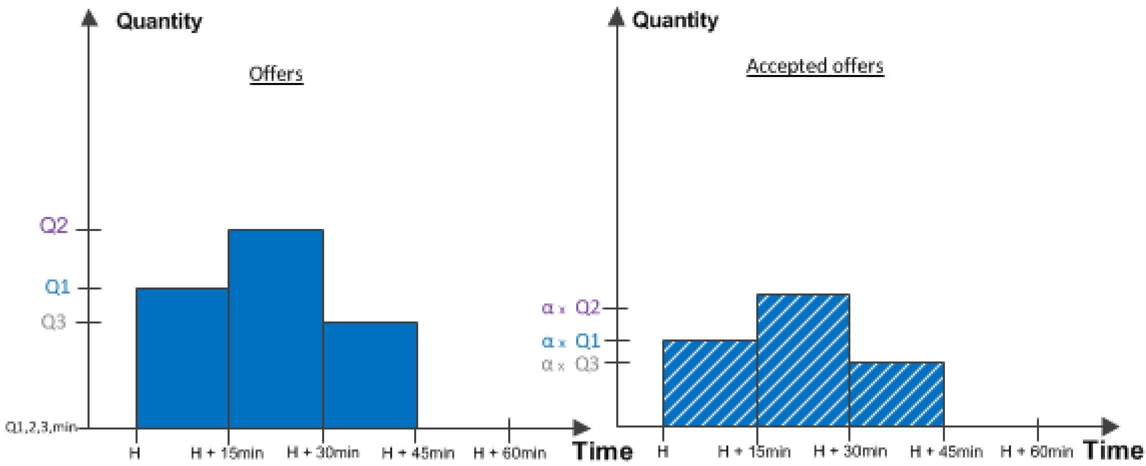

Figure 3-9: Linking Divisible Offers: the same percentage of all 3 offers is accepted (same ratio α)

Figure 3-9 presents three linking Divisible Offers and their accepted quantities. Minimum quantities are assumed to be zero. As illustrated in the right graph of Figure 3-9, the same ratio “α” of the three offers is accepted, e.g. 50% of Q1, Q2 and Q3. Note that the Linking Offers may have also different prices.

3.1.4 Unavailable Offers and Central Dispatch System conversion of bids

3.1.4.1 Unavailable Offers

The GL EB allows for the possibility for TSOs to mark certain bids as unavailable on the CMOL. For Standard Products there are two main types of Unavailable Offers:

- Unshared Offers which the connecting TSO wants to keep back for their own use, which must comply with certain volume restrictions (i.e. the volume of Unshared Offers must not exceed the volume of procured balancing capacity for the RR process); and
- Restricted Offers which cannot be activated by the connecting TSO due to internal congestions or operational security issues, which are not subject to the same volume restrictions as Unshared Offers.

The TERRE project will seek to comply with the GL EB with regard to the treatment of Unavailable Offers for Standard Products. It is not expected that any specific products will be forwarded to the platform, due to the wide variation in local specific product characteristics and design.

The volume of unshared bids for RR shall not be higher than the volume of Balancing Capacity for RR[2] procured by the TSO, less the volume of balancing Energy Bids for Specific RR products.

3.1.4.2 CDS conversion of bids

Though the methodology needs to be developed in coordination with other CDS systems, the intention is to use balancing resources to supply the TERRE CMO as long as their activation and delivery parameters fit the parameters of the TERRE product and only if the related energy can be physically delivered across the border.

3.1.5 Questions for Stakeholders

Q 3.1 Which format of balancing energy offers are most attractive to stakeholders?

Q 3.2 Do stakeholders agree with the definition and features of the TERRE cross border product?

Q 3.3 What are the stakeholder's views on BRP-TSO & BSP-TSO rules & requirements?

Q 3.4 Does the TERRE product allow for the participation of all types of balancing service providers (e.g. RES, Thermal, and DSR)? And if not, what changes in the features will allow greater participation in the TERRE project?

[2] The FRR volume will be considered also additionally to the RR volume

Q 3.5 **What are your views on the application of the local features of the TERRE cross border product (e.g. Harmonization of price cap and floors or Maximum Bid Sizes for Indivisible Offers)?**

Q 3.6 **The number of bid formats (Divisible, Block, Exclusive, Linking Offers) which may be used by BSP represents a trade-off between the flexibility offered to BSP (with several types of offers) and the simplicity to offer bids and to run the algorithm (eg, with only one standard type of offer). What are you views on this trade-off? Would you advocate for keeping all types of bids offered by TSOs or to reduce the number of possible offers?**

3.2 Imbalance Need definition and elasticity

3.2.1 Imbalance need description

As with the offers, the imbalance need submitted to the platform by the TSO has several characteristics. In this paragraph, these characteristics are detailed.

The Imbalance Need's definition in TERRE relies on concepts of volume, price, and emergence time and delivery period.

The imbalance need has several properties:

Table 3-2: TSO Imbalance Need definition

Imbalance Need Characteristics	
Anticipation Time	Only needs anticipated 45 min or more before real time can be satisfied by TERRE
Minimum size	0 MW
Minimum delivery period	15 min
Max delivery period	60 min
Location	Bidding Zones
Maximum Size	The maximum size of the Imbalance Need should be less or equal to the sum of the shared offers made in the same direction. Under certain conditions, a TSO can notify the system which will apply an exemption to this rule
Divisible Volume	Under the responsibility of TSO to a resolution of 1MW
Price	For inelastic needs TSOs will not price their needs. For elastic needs a price will be submitted, which will set a min/max price each TSO is willing to receive/pay to satisfy its needs. See 3.2.2 Its resolution is 0.01€/MWh.
Time Resolution	15 mins
Firmness	Yes

Direction	Positive (System short) / Negative (System long)

3.2.2 Cases of pricing (examples of cases)

The imbalance need in TERRE can be defined by two price/volumes parameters in a more general shape:

- An inelastic volume (“at all price” need). This volume corresponds to an imbalance need volume absolutely required by the TSO on TERRE. This volume represents the sure part of imbalance, foreseen at least 45 minutes before real time, which a TSO wants to cover with TERRE.
- An elastic volume (“priced” need). This is, in reality, a couple volume/price or a set of couples that constitute part of an imbalance, foreseen at least 45 minutes before real time, which a TSO can cover with more economic, alternative means to TERRE (e.g. specific products, mFRR or aFRR). The elasticity also helps the TSO to deal with uncertainties when defining its imbalance volume. The TSO can submit as many couples of price/volume as they want for dealing with imbalance uncertainty and for expressing its alternatives.

Each TSO will define an applicable methodology for determining the inelastic and/or elastic volume, and they may use all or none of the previous parameters. When a TSO wants to use certain parameters, it has to specify all the previous parameters into TERRE, but it can use different methods to define these values, depending on the way that it operates its system, as well as the different platforms (local) that each TSO has access to.

3.2.3 Questions for Stakeholders

Q 3.7 Do you agree with the proposed design of the TSO imbalance need?

Q 3.8 Do you agree with the possibility for inelastic and elastic imbalance needs?

Q 3.9 Do you have specific comments regarding chapter 3 content? (Please indicate sub-chapter reference when possible)

4 Balancing CMO & Algorithm

4.1 Explanation of the Algorithmic optimization choice

The following frame conditions and guidelines have been agreed by the TERRE project. These rules have to be considered for the algorithmic optimization, due to their listed characteristics and influence on the TERRE clearing:

Optimization of Social Welfare

The optimization of the social welfare has been defined as the main objective, since it represents the simplest and most robust process. It is also the main purpose of the TSOs since it guarantees and enhances the efficiency of the market.

Elastic Imbalance Need

The use of elastic Imbalance Need provides flexibility to TSOs to determine if their Imbalance Need will be satisfied by TERRE or by an alternative possibility, (like a local market of RR or by FRR) and is thus expected to result in reduced balancing costs. In addition, it simplifies the Netting process, as Netting is implemented based on the Imbalance Need prices and no predefined rules (e.g. proportional distribution) are necessary.

Please note that an Imbalance Need can remain inelastic by pricing the Imbalance Need using a default maximum instrumental price that does not affect the settlement.

One single CMO

The existence of two CMOs (one for positive Imbalance Need Bids/upward offers and one for negative Imbalance Need Bids/downward offers) could not ensure efficiency (e.g. in the use of ATC). In addition, a single CMO allows the Netting of needs in a one-stage process, resulting in higher social welfare. If two CMOs were used, need Netting would not be possible in a one-stage clearing process, as positive and negative Imbalance Need Bids would not be in a single CMO. The positive imbalance needs and the downward offers represent the 'buying curve' (demand) and the negative imbalance needs and the upward offers represent the 'selling curve' (supply).

One-stage clearing process

In the one-stage clearing process there is no differentiation between the Netting of Imbalance Needs and the activation of downward/upward offers in order to satisfy the demand of a TSO. The activation of downward/upward offers might result in higher social welfare compared to pre-Netting of Imbalance Needs in a two-stage clearing process.

Furthermore, this approach is more compatible with Elastic Imbalance Need principles and simplifies the settlement process.

<u>Harmonization of local rules related to negative prices</u>

The introduction of common price rules or limits, i.e., the abolition of any price limits (except for algorithm resp. IT purpose) would avoid further complexities and prevent discrimination or disadvantage to any participating BSP or TSO. It would also result in a higher social welfare, and is in line with the GL EB in promoting a non-capped pricing for balancing. For more information on this topic, please refer to 12.1.

4.2 Description of the optimization

The main functionality of the Balancing CMO, as described in Chapters 4.2.1 - 4.3, is to determine the activated balancing energy offers and the satisfied Imbalance Need Bids of TSOs, taking into consideration the possibility of netting the Imbalance Needs in order to maximize the social welfare of the TERRE region. The Balancing CMO also calculates the applicable TERRE Clearing Price, as the Marginal Price for the TSO-TSO clearing.

The handling of some special national requirements is described under Chapter 4.3.2.

4.2.1 Maximizing the Social Welfare of the RR process

The social welfare of the TERRE region is defined as the surplus of the connecting TSOs, as represented by their Imbalance Need Bids, minus the BSPs' production costs, as represented by their balancing energy offers. In simpler terms, as depicted in Figure 4-1, the social welfare is the area between the satisfied needs and the activated offers. The maximization of this area results in the maximization of the social welfare.

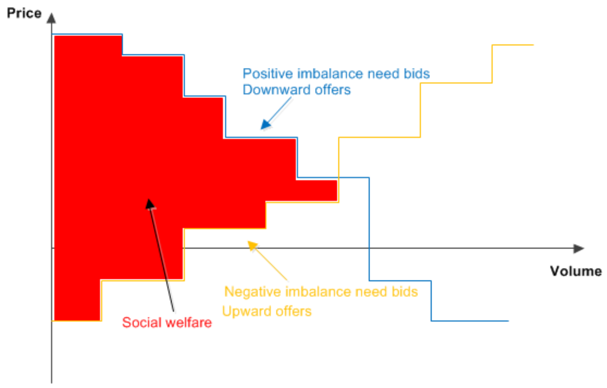

Figure 4-1: Social Welfare of TERRE region

As described in 3.1.3, the submitted balancing energy offers may have different delivery time periods and formats. The decision about which offer will be activated is based upon which offer maximizes the social welfare, looking at the whole Market Clearing Time Period. In simpler terms, the Balancing CMO does not maximize the social welfare of each Market

Resolution Time Period (15min) separately, but seeks to maximize the social welfare of the defined Market Clearing Time Period; which is equal to one hour.

4.2.2 Volume indeterminacies

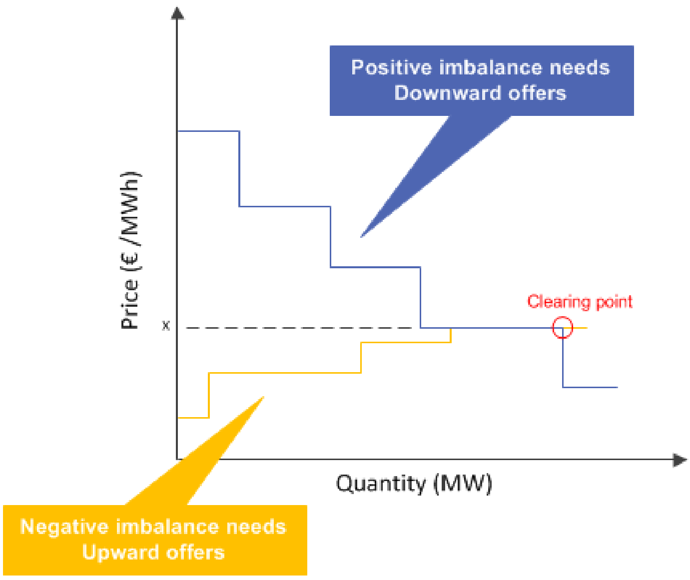

Figure 4-2: Volume indeterminacies: the highest volume is accepted

Different solutions of the main function may result in the same social welfare. If these solutions represent different accepted volumes, either in terms of offers or in terms of needs, then the solution that leads to the highest accepted volume is accepted
This is illustrated in Figure 4-2

4.2.3 Flow term in the objective function

Since the ATC network model is used in TERRE, the ATC values constrain the scheduled flows, as they define the maximum value of a flow and there is no physical network representation that would allow for the flows to be determined. Therefore the Balancing CMO minimizes the scheduled flows of the TERRE region such that the primary objective of the algorithm is the maximization of the social welfare, and secondarily the minimization of the flows. Hence, the minimization of the flow does not affect the solution of the social welfare maximization, i.e., the activated balancing energy offers and the satisfied imbalance bid needs, but based on the results of the social welfare maximization, it minimizes the flows. If two solutions result in the same social welfare, then the solution leading to the minimum cross-border scheduled flows would be accepted.

The minimization of the flows is done both in the main function of the Balancing CMO, i.e. the function that determines the offers to be activated and the needs to be satisfied, as well as in a separate function that takes the activations and satisfied needs as inputs and provides the flows. This is implemented in the same way as in the day-ahead market coupling.

4.2.4 Scheduling step constraints

The algorithm includes some constraints related to the scheduling step. If the scheduling step of the cross-border exchanges was equal to the Market Resolution Time Period, i.e., 15 min, there would be no need to constrain the flows. However, the scheduling step is currently equal to 1 hour for all borders of the participating TSOs, apart from the French-Swiss border, where it is equal to 30 min.

We should highlight here that adopting a scheduling step equal to 15 min would result in the most efficient solution, as all offers (needs) would be optimally activated (satisfied). Therefore, it will be important to shorten the scheduling step in the future. The algorithm is designed to be flexible enough to handle different scheduling steps equal to 15 min, 30 min and 1 hour, while ensuring a constant flow for the related period. For more information on scheduling step, please refer to section 7.3.

4.2.5 Netting method

Netting is the action of matching two Imbalance Needs of opposite directions, i.e. a transfer of energy from a zone that has a negative Imbalance Need to a zone with a positive Imbalance Need. The more Netting occurs, the fewer imbalances remain, and hence, fewer offers have to be activated. However, fewer activated offers do not necessarily result in lower Marginal Prices or higher social welfare. In some cases (in particular if the need is elastic), the activation of downward/upward offers might be financially more beneficial compared to the Netting of demands, resulting in a higher social welfare.

4.2.6 Congestions

Congestions occur in the TERRE region when the existing ATC is not able to simultaneously accommodate all the cheapest transactions, resulting in unavoidable suboptimal solutions, i.e., reduced social welfare. In simpler terms, some submitted balancing energy offers cannot be activated and a connecting TSO must satisfy its Imbalance Need using more expensive offers. Similarly, congestion may have an impact on Netting; two Imbalance Needs may not be Netted due to congestions, and therefore, TSOs have to activate balancing energy offers. Note that congestions can also result in different prices among the congested areas, as marginal pricing will be used in TERRE.

4.2.7 Price calculation function

After solving the main and the flows' calculation function, the Marginal Price has to be determined for each bidding zone according the principles described in section 0.

4.2.8 Fall-back process

In case the TERRE clearing process fails, the procurement and activation of balancing energy will be handled at national level only.

4.3 Specific cases

4.3.1 Counter-activations

With the term counter-activations, we refer to the simultaneous activation of an upward and a downward offer in order to increase the social welfare. Due to the fact that all positive and negative Imbalance Needs, as well as all upward and downward balancing energy offers are treated in a single CMO, counter-activations could occur if some downward offers had higher prices than some upward offers, i.e., if some BSPs would be willing to pay higher prices to reduce their production than the prices some other BSPs would be willing to receive to increase their production. Figure 4-3 presents a merit order list. If a downward offer - illustrated with blue - has a higher price than an upward offer - illustrated with orange -, then these two offers would be simultaneously activated, as this would result in a higher social welfare.

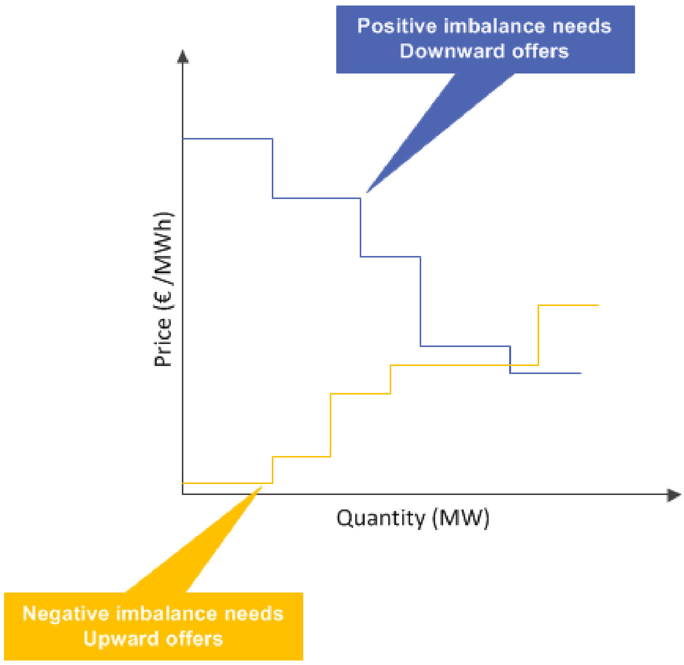

Figure 4-3: Counter-activations' explanation

Excluding counter-activations, introducing further constraints into the single CMO, would lead to the reduction of social welfare, the distortion of price signals, and limit opportunities for BSPs to get activated.

We should highlight that these phenomena are not expected to occur, at least not to a large extent, in a common market like TERRE, with liquid intra-day markets close to real-time.

We can distinguish two different types of counter-activations:

1. Internal counter-activations
2. XB counter-activations

The pros and cons of these two types of counter-activations have been investigated below:

Table 4-1

<table>
<tr><th></th><th>Pros</th><th>Cons</th></tr>
<tr><td>Internal Counter-activations</td><td rowspan="2">Increase of social-welfare
Non-distortion of marginal price
BSPs have higher chance of being activated</td><td>Activation of offers not for satisfying TSO imbalance needs due to inefficiencies of national markets</td></tr>
<tr><td>XB Counter-activations</td><td>Potential use of XB capacity in one direction reducing XB capacity available for exchanges of balancing energy from other processes (mFRR, aFRR) activation of offers not for satisfying TSO imbalance needs</td></tr>
</table>

We have also performed a study in order to quantify potential counter-activations in TERRE, based on the historical data of 2013. We launched simulations using the historical ATC values and TSOs' data, allowing counter-activations. Please refer to section 6 for more information on the input data assumptions. The simulations were then performed again using the same inputs, but restricting counter-activations. This was done by setting a limit to the total allowed activations of upward and downward offers; the limit was equal to the submitted upward and downward needs, respectively. We have also made the following assumptions:

- Admie was not included in the simulations since they have no organized balancing market
- Scheduling step was set to 30min and hence had no impact on the results

The results of this study are presented in Figure 4-4. More specifically, Figure 4-4 presents the yearly cumulative volumes of total upward and downward activations, when we allow and when we restrict counter-activations. The difference in volume of 0.58 TWh implies an increase of activated volume of 19.8% for Upward Activation and by 7.8% for downward activation when counter-activations are allowed.

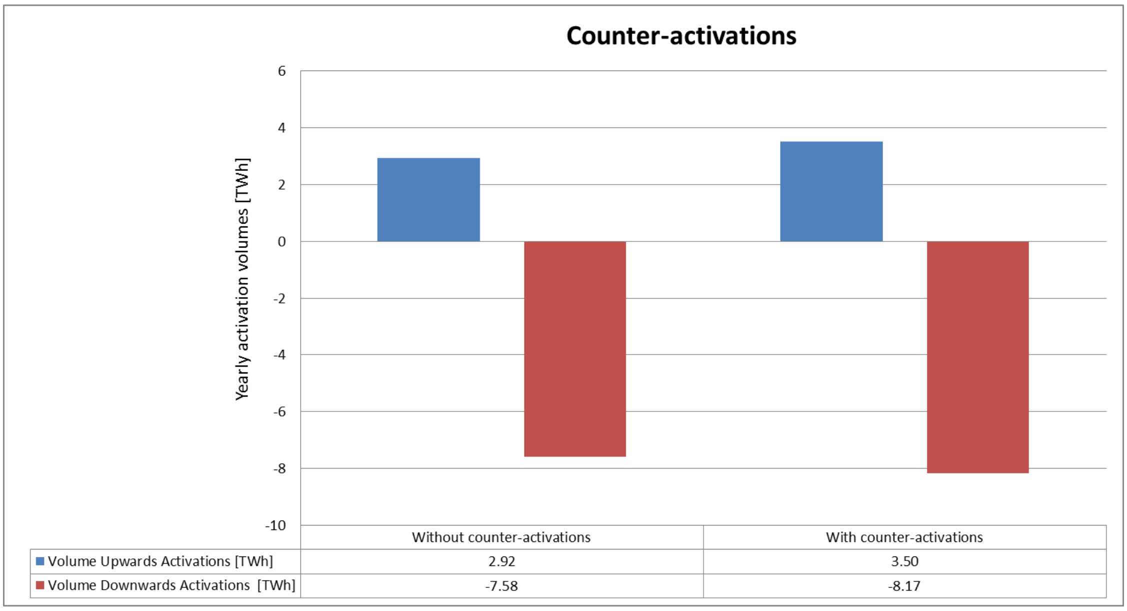

Figure 4-4: Cumulative activation volumes allowing and not allowing counter-activations

4.3.2 Activation for other operational constraints

4.3.2.1 HVDC Losses

The physical flow of a HVDC interconnector is subject to losses on the link. This implies that each allocation on a border with losses ends up with an allocation volume in the exporting area which differs from the allocated volume in the importing area.

It was concluded that the optimal way to consider losses incurred by an exchange across HVDC interconnectors is to include them in the TERRE algorithm. This is done in the same way as in Day-Ahead Market Coupling.

4.3.2.2 I/C controllability on HVDC

The calculation of the capacity offered to the market is fundamentally different between AC and DC borders. On DC borders (within the GB market and elsewhere) the nameplate rating is generally offered into the market (i.e. no capacity is held in reserve to cater for faults, operational issues etc.). However this is not the case for AC borders where capacity can be reduced to cater for operational requirements (e.g. n-1).

For DC borders, this can lead to times where the market benefit that the extra capacity brings is outweighed by the operational costs of providing the capacity. Therefore, to avoid such situations and maximize social welfare, TSOs need to manage HVDC links in operational timescales as certainty of power system conditions increases. TERRE allows these TSOs to manage HVDC links. To achieve this, the Balancing CMO considers extra constraints related to the controllability of the HVDC links. More specifically, it is possible for the TSOs managing

HVDC links to submit to TERRE a desired flow range (across the HVDC). The solution of the Balancing CMO has to respect this flow range. If there is not a feasible solution that satisfies the desired flow range, the solution that is closest to this range is chosen.

4.3.2.3 Handling of Unforeseeably Accepted and Rejected offers

Since the optimization algorithm seeks to optimize the social welfare of the TERRE region, and not only divisible offers (with zero minimum quantities) are expected to be used, there may be cases where an accepted upward (downward) balancing energy offer has a higher (lower) price than the Marginal Price. These offers are named unforeseeably accepted offers. Similarly, there may be cases where a rejected upward (downward) balancing energy offer has a lower (higher) price than the Marginal Price. There offers are named unforeseeably rejected offers. There is an ongoing study on how these offers will be treated in TERRE that is planned to finish during the implementation phase.

4.3.3 National price zones and congestions in Italy

In the Italian electricity market, the territory is divided into Market Zones, in order to limit the exchanges between the interconnected areas with limited transit capacity. There are currently 6 "real" Market Zones and 4 "virtual" Market Zones (more details can be found in Annex 4, Chapter 20). The TERRE solution considers each internal zone as an independent Market Zone. Therefore, for each Market zone, Terna will submit to the TERRE platform:

- different ATC values;
- different offers and
- one need for the whole area

4.4 Questions for Stakeholders

Q 4.1 Do you have any specific comments on the Balancing CMO description?

Q 4.2 What is your opinion on allowing internal and XB counter-activations?

Q 4.3 Do you agree with the proposed treatment of HVDC losses?

Q 4.4 Do you have specific comments regarding chapter 4 content? (Please indicate sub-chapter reference when possible)

5 Settlement

5.1 Explanation of the Marginal Price choice

Currently, there are two possible scheme options for the settlement of the RR energy exchanged through TERRE:

- Pay as bid
- Pay as cleared (marginal)

Regarding these two settlement options, the Framework Guidelines (FW) (2012) and the draft GL EB (2015) contain the following:

> **Framework Guidelines on Electricity Balancing (18/09/2012)**
> ***"3.3.1.*** *The Guideline on Electricity Balancing shall provide that the initial proposal for the pricing method shall be submitted to the Agency and all NRAs no later than one year after the entry into force of the Guideline on Electricity Balancing and shall be based on marginal pricing (pay-as-cleared), unless TSOs provide all NRAs with a detailed analysis demonstrating that a different pricing method is more efficient for EU-wide implementation in pursuing the general objectives defined in Section 2.1."*
>
> **EB GL (ACER draft) (SECTION 12 PROCUREMENT OF BALANCING ENERGY**
> **Article 42 PRICING METHOD FOR BALANCING ENERGY**
> *"1. No later than one year after the entry into force of this Regulation, all TSOs shall develop a proposal for harmonized pricing method for Balancing Energy. The proposed pricing method shall be based on marginal pricing (pay-as-cleared), unless TSOs complement the proposal with a detailed analysis demonstrating that a different pricing method is more efficient for European-wide implementation pursuing the general objectives defined in Article 11 (…)"*

Taking the above into account, the FW and Draft GL EB have a preference for the application of marginal pricing schemes (pay as cleared).
Also, in principal, marginal pricing gives clearer economic signals when coupling different bidding zones.

Taking into account the characteristics of the design of TERRE, and the recommendations from the FW and draft GL EB, the proposal is to apply pay-as-cleared (Marginal Price) for the settlement of XB Balancing schedules derived from TERRE.

5.2 Description of the "product settlement" (rectangle) of XB balancing energy exchanges between TSOs

Under the scope of ENTSO-E, the WG AS (Working Group Ancillary Services) is defining Standard Products that will be exchanged in the different Coordinated Balancing Areas (CoBAs) for the implementation of the GL EB (draft Balancing Guideline) and analyzing the most suitable pricing method for each Standard Product. Currently, there are different types of Standard Products under definition (scheduled products and direct activated products), and different settlement methods (including or not ramps) depending on the type of product.

This section covers only settlement for TERRE products exchanged between TSOs (at XB level).
As explained in table 2.1 and in Chapter 3.1.2, there are currently differences between TSO-BSP settlements among systems.
Also, there may be differences between XB TSO-TSO settlement and local TSO-BSP settlement (e.g. pay as bid or pay as clear, inclusion or not of ramps in local settlement, etc.).

The Standard Product designed for TERRE will be scheduled product. Thus, for the TERRE project, the energy product exchanged between TSOs through TERRE will be the blue box below, excluding the energy associated with the increasing and decreasing power ramps (green triangles).

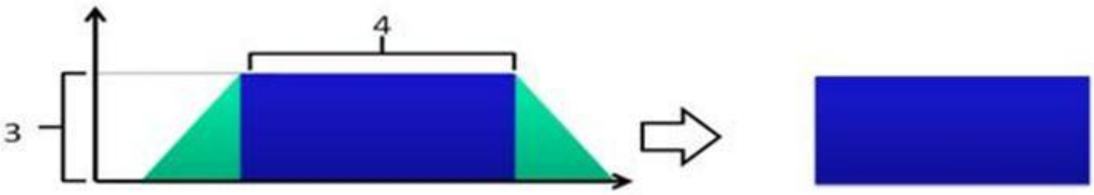

Figure 5-1: Energy volume scheduled and settled at XB level in TERRE

5.3 Definition of Marginal Price

The Marginal Price shall be based on the prices of the activated balancing offers from BSPs and, if relevant[3], on the prices of the satisfied TSO Need Bid. Graphically, this Marginal Price will be given by the intersection between the selling and buying curve in the TERRE CMO, being:

- Selling curve: Upwards offers and downwards Needs
- Buying Curve: Downwards offers and upwards Needs

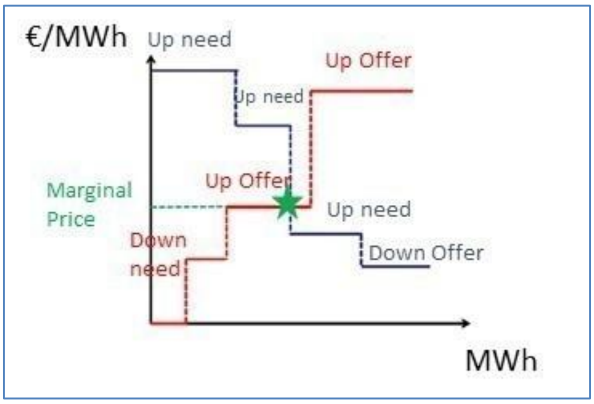

Figure 5-2: Definition of Marginal Price

The marginal price (MP) shall satisfy the following rules:

[3] In case TSO Imbalance needs have a Price (which is optional)

For activated divisible offers/ Imbalance Needs in volume:

- MP ≤ Price of activated Buying Curve
- MP ≥ Price of activated Selling Curve

For not activated divisible offers/ Imbalance Needs in volume

- MP ≥ Price of not activated Buying Curve
- MP ≤ Price of not activated Selling Curve

5.4 Description of the calculation of Marginal Price

The following considerations will be taken into account:

- There is a single price for each bidding zone, as downward and upward offers as well as Imbalance Needs are treated in the same optimization problem; hence, there is no separate price for downward and upward activations.
- The price of a bidding zone should be coherent with the activated and not activated (in case of price indeterminacy) offers
- A set of non-congested bidding zones, have the same price.
- In case of congestion on one border, there could be different prices at both sides of the interconnector (different "TERRE Bidding Zones").
- As the basis for the TERRE product is 15 min (minimum duration = 15 min), there will be a Marginal Price every 15 min (or more Marginal Prices, in case there is congestion)

Interactions between Marginal Price and Imbalance Settlement Period:
Currently there are different ISPs in the systems participating in TERRE (60, 30, 15 min). There is also the potential for the ISP to move from 60 or 30 minutes to 15 minutes under the scope of the ISP Cost Benefit Analysis being performed by ENTSO-E.

In each system, a quarterly internal or XB schedule will be calculated for each 15 min (even in a system with hourly needs, this need could be satisfied by internal or XB 15min products). For example if the ISP is currently 60 min (so there could be 4 balancing energy prices, but only one Imbalance Price in the hour). Although there are different methodologies under study, one option for the calculation of the Imbalance Price could be to calculate a weighted average cost over the entire hour (60 min) taking into account each 15 min period.

Hence regardless of whether the ISP duration is 15, 30 or 60mins, there should be no impact on TERRE.

5.5 Indeterminacies (price)

The Marginal Price will be based on the prices of the activated balancing offers from BSPs and, if relevant, of the prices of the satisfied TSO Need Bid. The proposed solution is to treat indeterminacies as follows:

- Indeterminacy in price: Middle point

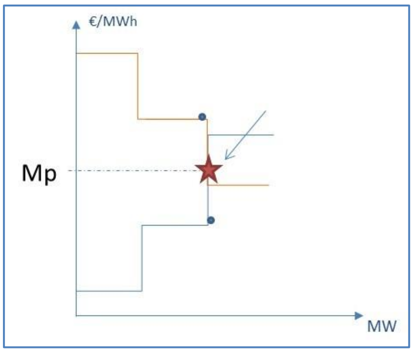

Figure 5-3: Indeterminacies in price: Middle point

This option guarantees an equal distribution of social welfare among selling and buying parties, and is the criteria applied currently in Market Coupling of Regions (MRC).

5.6 Specific cases – Netting of Imbalance Needs

In TERRE, there could be some situations where, according to the Balancing CMO, there is only Netting of needs (i.e. there are no activated bids from BSPs). These situations might be very improbable; nevertheless they need to be studied.

In these cases, there could be indeterminacy in the settlement price associated with the XB balancing exchange.

Several options have been studied for the definition of the price associated with these XB flows. After several studies, the proposed solution for XB settlement in the case of Netting of needs is the following, depending on the elasticity of the needs:

- In case both elastic needs (upwards and downwards) → Middle price (same as indeterminacy in price)

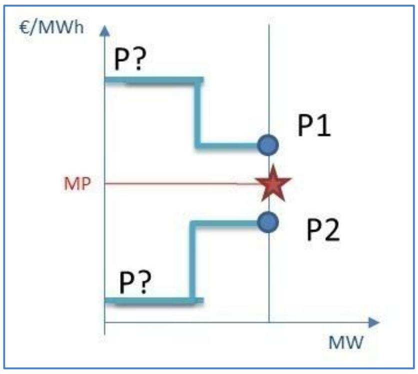

Figure 5-4: Settlement specific case: both elastic needs

- In case one need is elastic and the other inelastic → Price of the elastic need (→P2)

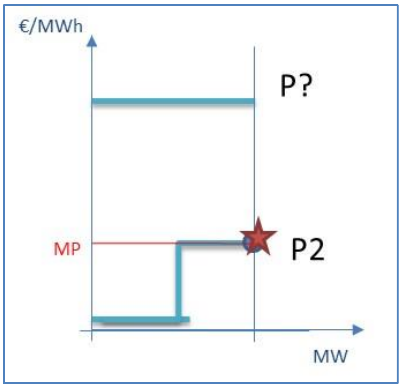

Figure 5-5: Settlement specific case: one elastic need, one inelastic need

- In case all needs are inelastic (upwards and downwards), the process can be considered comparable to Imbalance Netting.

In this case, each system calculates an "Opportunity Price" that reflects the avoided cost of each system thanks to the Netting of needs in TERRE.

Then, the calculation of the global benefit is performed. After, the global benefit is equally shared across the systems (based on the weighted average of exchanged volume). This implies that for each system a different Marginal Price is calculated.

Definition of "Opportunity Price" (avoided cost)

Different options have been studied for the definition of the "Opportunity Price". The proposal is to reflect the avoided cost in each system thanks to its participation in TERRE (it will be the cost that would have resulted in the activation of the cheapest National RR resources) i.e. as if TERRE did not exist (only National RR markets). It would be the following:

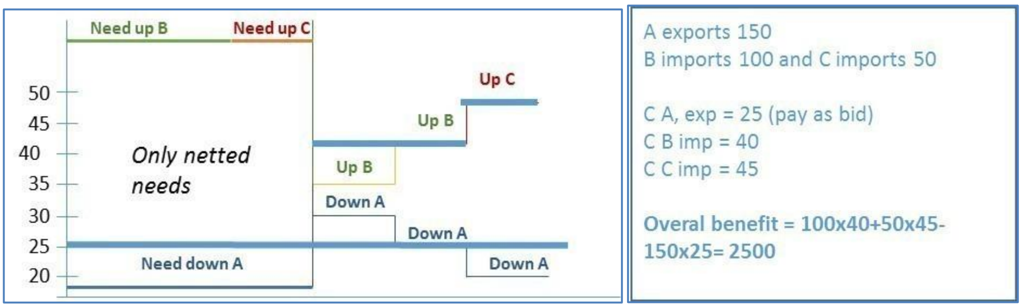

Figure 5-6: Opportunity Price

The opportunity cost will be the avoided cost of the internal RR cheapest bids sent to TERRE from each TSO (e.g. cost if TERRE didn't exist and each TSO had to use its internal RR bids).

Example: If netted need from TSO is 20 MW:

- If TSO-BSP settlement (RR) is marginal: Opportunity Price = internal marginal price (hypothetic) – 20€/MWh

Figure 5-7: Example of Opportunity Price

Argument for this methodology: this definition

- ensures equal distribution of benefits of netting
- ensures that global benefit for netting is positive (or at least zero)

5.7 Congestion Rents

There could be situations where borders within TERRE become congested. In such a case, there could be different Marginal Prices at both sides of the border. Each of these prices will be established based on the activated Balancing offers and/or the satisfied Imbalance Need in the non-congested area.

Due to this price difference between the price that an area is "willing to pay" and the price that the other area is "willing to receive" at either side of the interconnector, a surplus will occur. This surplus, calculated as the multiplication of the exchanged balancing energy times the price difference, is called a "congestion rent" in other timeframes (such as the MRC project). In this case, the "TERRE congestion rent" would be:

TERRE congestion rent = TERRE schedule x (ΔP)

The TERRE schedule is the XB schedule between the two congested areas and ΔP the difference of Marginal Prices at both sides.

The distribution of congestion rents is a regulatory issue that should be established with the input from the NRAs.
Taking into account that these congestion rents do not only happen in TERRE but in other timeframes (e.g. Multi Regional Coupling in Day Ahead), the distribution of congestion rents of TERRE should be consistent or at least take into account the methodology applied in other timeframes.

This congestion rent, as in other timeframes, lays down the Regulation R 714-2009 article 16-6 (refer to annex 2, chapter 18).

5.8 Questions for Stakeholders

Q 5.1 Do you agree that the proposed settlement design is in line with the principles of the EB GL and the integration of balancing markets?

Q 5.2 Do you agree with the application of cross border marginal pricing, settlement of the block and the proposed design for the definition of Marginal Price between TSOs at the XB level?

Q 5.3 What is your perspective regarding the alignment of the TSO-TSO settlement procedure and the BSP-TSO settlement procedure?

Q 5.4 Do you have specific comments regarding chapter 5 content? (Please indicate sub-chapter reference when possible)

6 Cost Benefit Analysis

6.1 Assessment Methodology

A key part of the project TERRE design phase has been to develop a methodology to assess the potential benefit of coupling the different Replacement Reserve (RR) markets of the member states within TERRE in order to perform a robust Cost Benefit Analysis (CBA).

One of the key challenges of developing such a methodology is the current differences between these balancing markets, with some operating pay-as-bid settlement, others using marginal pricing, some with unit based bidding and others with portfolio based bidding.

In addition to this, the differences in TSO's business processes, IT platforms, RR products and intra-day markets all seek to make performing such a quantitative assessment that accurately reflects the change from the current situation in each market extremely difficult.

Another challenge to performing such analysis is the inability to model any potential changes to market bidding behavior, which is influenced by local regulation, market rules and competition.

Project TERRE, in addition to coupling RR markets, will also be harmonizing bidding rules, TSO-TSO settlement methodologies for RR, and high level business processes of the TSOs involved. Given the volume and scope of change as a result of project TERRE, this analysis is focused on assessing the benefits associated with a having access to a wider pool of balancing resources and will not be seeking to assess benefits associated with moving from pay-as-bid to marginal pricing, or moving from one RR product to another.
NB: the results are inherent to the input hypotheses, especially volume - prices of offers and Imbalance Needs remain the same for all simulations.

In order to assess the benefits of coupling different RR markets, historical data from each TSO for the 2013 calendar year was used in order to establish the following data sets:

Data Set	Historical Data Used
TSO upwards Imbalance Needs	Actual activations of upwards balancing energy in MW split out into anticipation time (taken as the minimum response time of the unit activated) for each 30min settlement period
TSO downwards Imbalance Needs	Actual activations of downwards balancing energy in MW split out into anticipation time (taken as the minimum response time of the unit activated) for each 30min settlement period
BSP upwards offers	Actual offers into the balancing market for upwards balancing energy (an increase in production/reduction in demand) in MW with a price in €/MWh per unit for each 30min settlement period
BSP downwards offers	Actual offers into the balancing market for downwards balancing energy (a reduction in production/increase in demand) in MW with a price in €/MWh per unit for each 30min settlement period
Minimum Response Time	Minimum time taken to deliver the offered volume per unit for each 30min settlement period. This information is provided for both upwards and downwards balancing energy offers and varies depending on where a unit is in its operating range.
Minimum Activation Time	Minimum duration an activated balancing unit must produce the activated volume for. This information is provided per unit for each day.
Available Transmission Capacity	The amount of remaining cross border transmission capacity after the closure of the intra-day market in each direction per 30min settlement period.

Table 6-1

The benefits of coupling the different RR markets was calculated using the simulation tool developed during the design phase of the project under the scope of the Balancing CMO & Algorithm Working Package, the principles of which are described in section 4.2. In order to establish the counter-factual or 'as is' scenario this tool will be used to calculate the historical costs of each TSO satisfying its needs using the offers from BSPs in its own area This will be simulated by setting the Available Transmission Capacity (ATC) to zero on all borders.

Due to the different settlement rules in the different markets and the fact that TERRE will be applying marginal pricing, the costs for counter-factual scenario will be calculated using marginal pricing despite some systems using pay-as-bid, hence will not be directly comparable to the historical costs of system balancing for each TSO.

The simulation will then be performed again using the historical ATC values, where all offers are put together in a Common Merit Order List (CMOL) per direction. Offers are then activated from this CMOL in price order, while respecting the ATC constraints. When a particular border becomes congested, offers are then used from the remaining uncongested area.

For example if National Grid had an upwards need of 500MW and ATC in the FR-GB direction of 200MW, the tool would activate the cheapest 200MW of offers from the CMOL, which if they were all from RTE would cause the HVDC interconnector between FR and GB to become congested in the FR-GB direction. The remaining 300MW of National Grid needs would be then satisfied just using to offers within the GB bidding zone.

As per the normal marginal pricing settlement rules defined in the TERRE design, one Marginal Price will be established per uncongested area. Hence, in the example above there would be more than one Marginal Price.

The results of this simulation will then be used to calculate the expected costs for satisfying the TSO needs using the wider pool of balancing resources in the CMOL taking into account ATC.

The expected benefit or increase in social welfare will then be a comparison of the total costs of meeting the TSOs needs with and without ATC. This analysis will also look at the individual effects on the different TSOs within TERRE, any transfers of welfare (e.g. from producers to consumers) and congestion rent. For a full description of the assumptions made during the Cost Benefit Analysis please refer to Annex 5 (Chapter21).

6.2 Costs

The costs of the TERRE project are considered under two broad categories:

Central costs of the project itself: The principal cost associated with the central project will be the development and operation of the TERRE platform (external supplier spend). At this stage of the project the cost of this can only be estimated, using the most realistic assumptions available and incorporating some risk margin to allow for contingency actions. There will also be some direct cost associated with running the project and establishing a client-side project team.

In addition to these one-off costs there will be some limited recurring costs associated with operating the platform (system hosting, software support & maintenance, software licenses, etc.). The recurring costs of the TERRE project are considered negligible, as the systems will be in place and no major ongoing costs are foreseen.

In order to assist with generation of these estimates, the TSOs launched a "Request for Information" (RFI) to the IT marketplace, inviting suppliers to comment on the availability of suitable software packages, approaches to pricing, indicative license costs, time & materials costs etc. The returns from this RFI, together with previous experience with similar IT projects support the broad estimation of the lower and upper bounds of cost.

Local IT costs within each TSO market area: In addition to the central costs of the platform, which will be shared amongst the participating TSOs, each TSO will have to make changes to local IT systems in order to interact with the TERRE platform.
Again it is at this stage only possible to make very rough order-of-magnitude estimates of the costs of local system change, based on previous experience. Please note that the estimations provided do not include any expected implementation costs incurred by BSPs or BRPs.

The table below presents the total estimated costs for the implementation project:

Table 6-2: Estimated costs

Cost range
€25-30 million

6.3 Benefit

The following sections show the outputs of the simulations. These results have been split to show the impacts on BRPs, in terms of impacts on balancing costs and BSPs, in terms of impact on activations. Throughout the following figures a consistent signage has been used, whereby positive imbalance needs correspond to situations where the system is short and negative imbalance needs correspond to situations where the system in long. The figures below also seek to consistently refer to costs and values, where a negative cost means money is being received, and a negative value meaning money is being paid.

6.3.1 Impact on BRPs

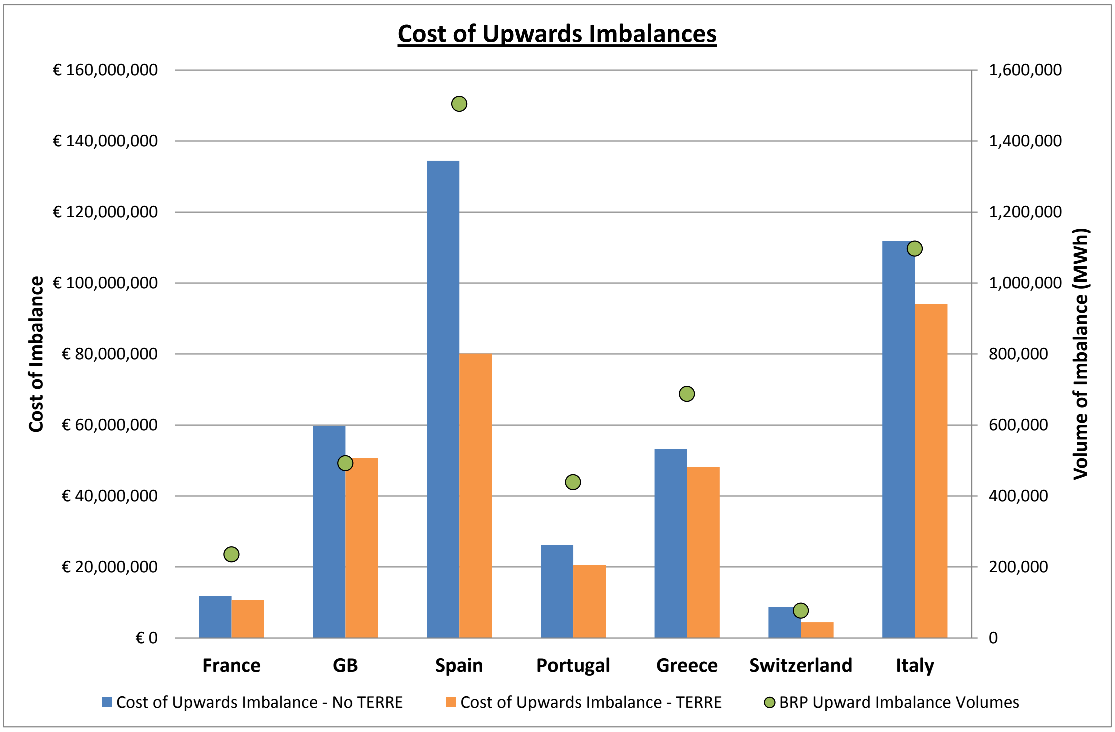

Figure 6-1: Upwards Imbalances by Country

The cost of fulfilling the Upwards Imbalance needs in each of the two simulations is illustrated by country in Figure 6-1. The volume of imbalance (in MWh) required in each country is shown on the right hand vertical axis, this is constant in each of the study cases. It can be seen that in every country, the cost of satisfying the Upwards Imbalance is reduced by TERRE. Also there is a strong correlation between imbalance volume and cost in each country, as would be expected.

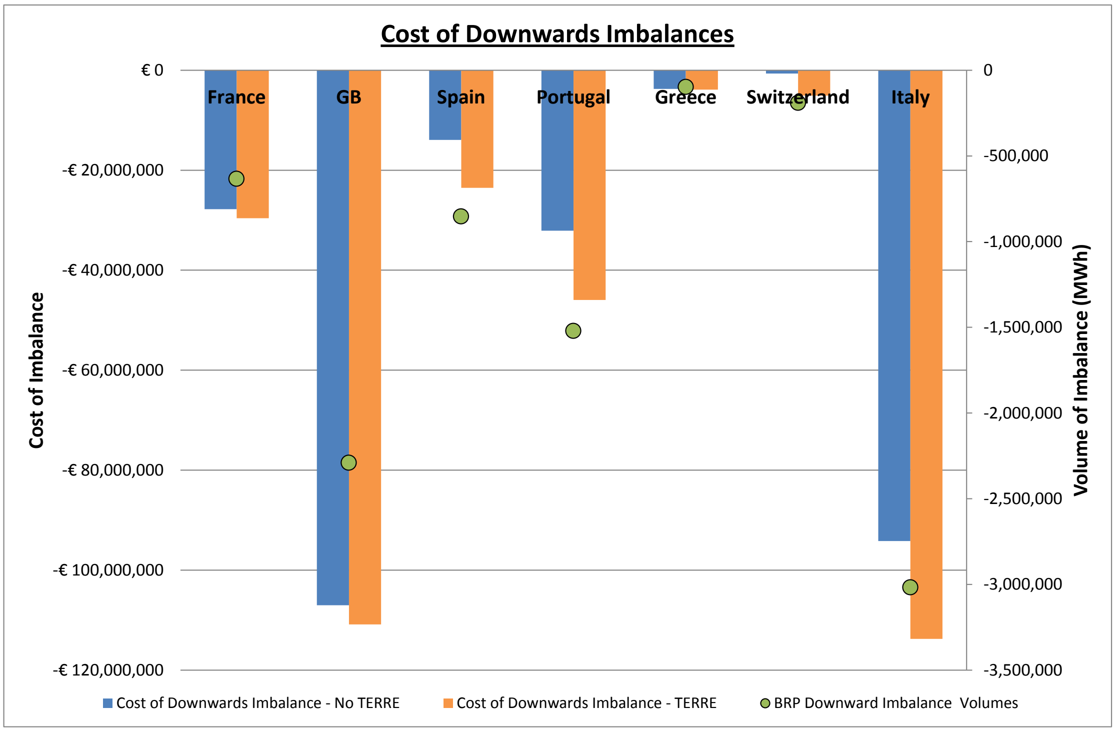

Figure 6-2: Downwards Imbalances by Country

Figure 6-2 shows the costs for BRPs for downwards Imbalance needs in each of the two study cases, by country. Please note that where a cost is negative this represents payments to the BRPs. The TERRE study case shows an increase in the annual payments towards BRPs for downwards RR energy. The expected correlation between volumes of imbalances is present again. This can be explored further in section 6.3.3 which looks at the Volume Weighted Marginal Prices.

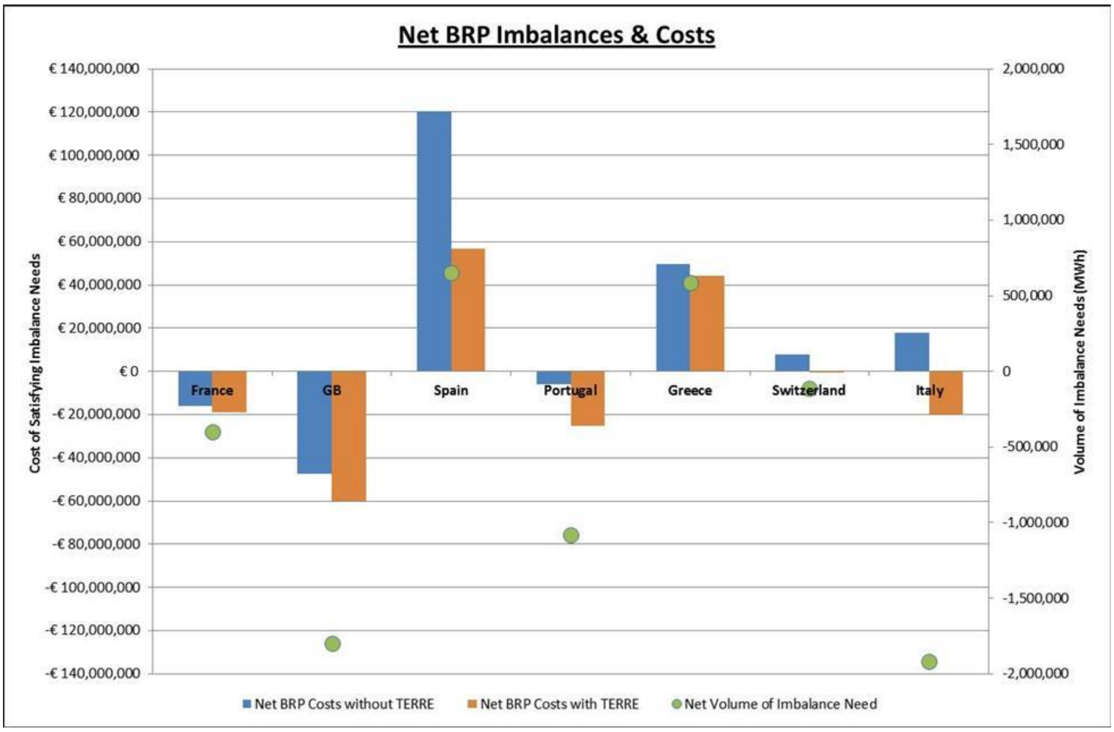

Figure 6-3: Net BRP Imbalances and Costs

The figure above shows the net imbalance and costs for BRPs by country. Where a country has a net long position; they are activating downwards and hence show a negative imbalance volume. Where a country has a net negative imbalance and the BRP costs become more negative with TERRE, this shows an increase in payments to BRPs. Conversely where a country has a net short position, they are activating upwards and hence show a positive imbalance volume. Where a country has a net positive imbalance and the BRP costs reduce with TERRE, this shows a reduction in payments to BSPs. The figure shows Italy having a comparatively long position and sees a change from net payments from BRPs to BSPs to net payments from BSPs to BRPs under TERRE.

6.3.2 Impact on BSPs

Although the volumes of imbalance needs for each country are constant between the two study cases, the coupling of the different RR markets under TERRE allows for cheaper bids to be activated in order to fulfil imbalance needs. Figure 6-4 and Figure 6-5 show the change in activity.

It is not expected that the net volume of activations between the two study cases will be the same. This is due to the netting of imbalances in the TERRE model case, where a market that has an excess of energy can be matched with a market that has a shortfall, providing there is ATC. There are also counter activations at the local and cross border level. These counter activations occur where there is a net benefit in paying a BSP to reduce output. Fulfilling this shortfall results in increasing the output of another BSP.

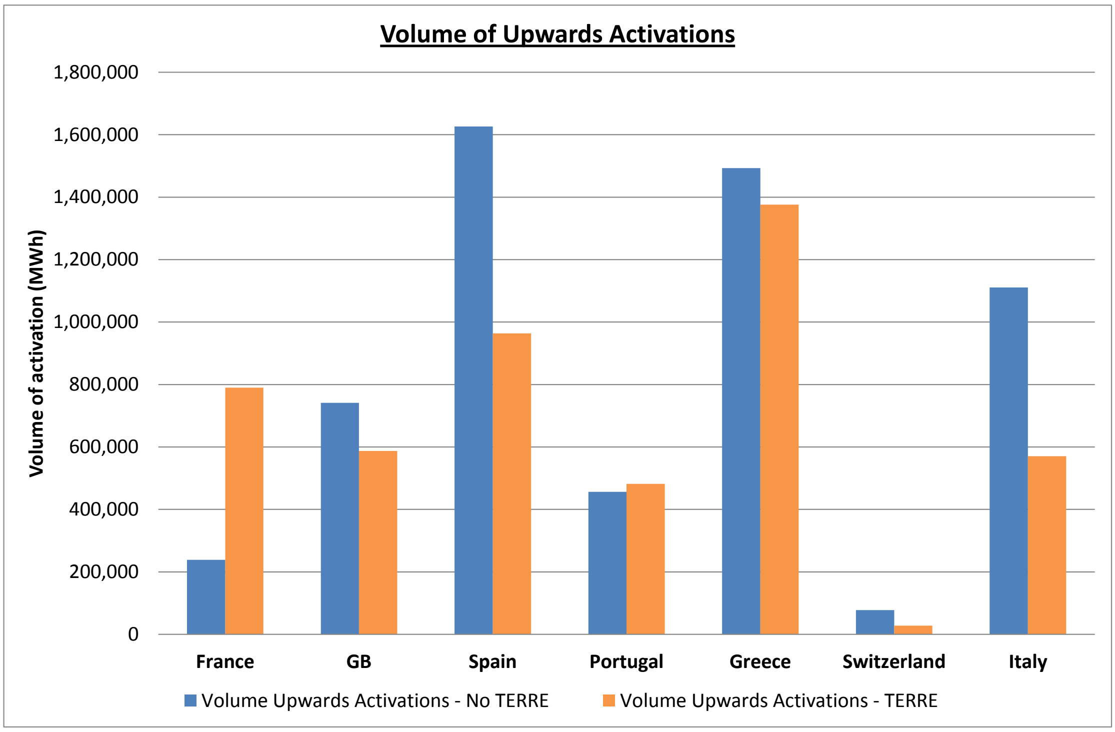

Figure 6-4: Volume of Upwards Activations by Country

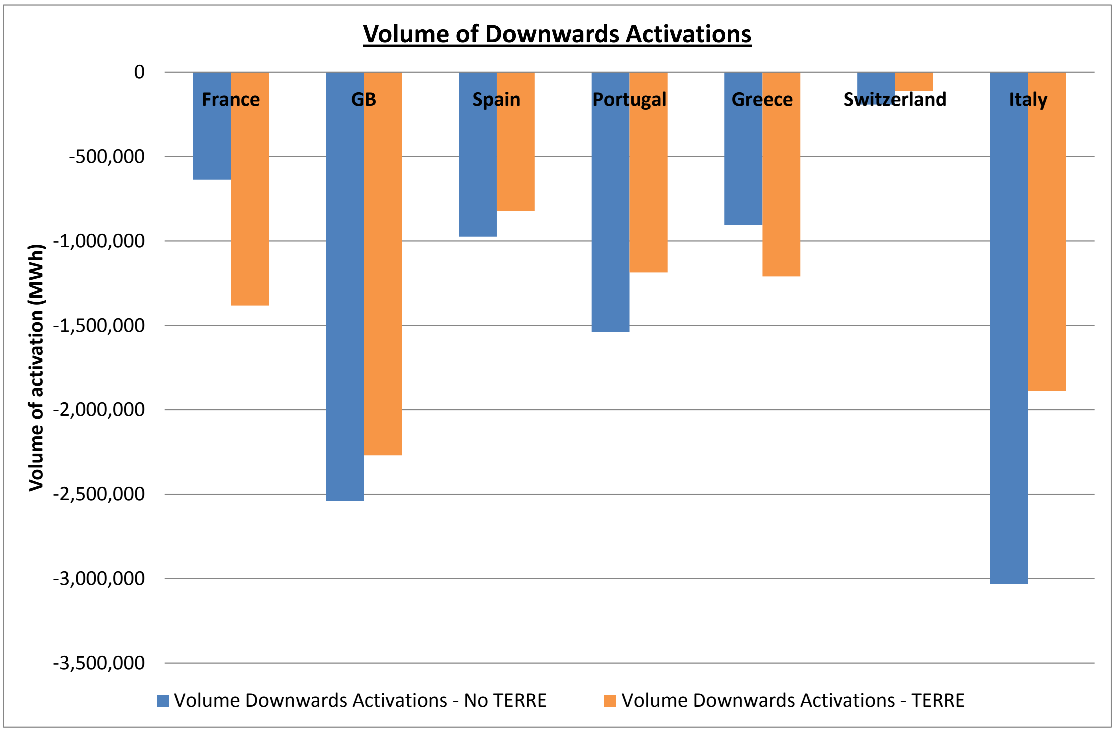

Figure 6-5: Volume of Downwards Activations by Country

Generally it can be observed that TERRE leads to a reduction of both upwards and downwards activations, this result can be explained by the netting of imbalances. However there are some exceptions to the general rule:

- In Portugal upwards activations increase slightly, whilst downwards activation reduce under TERRE. This can be contrasted to the large reduction in Spain's upwards activations, and suggests a general trend of exporting RR energy from Portugal to Spain.
- Greece has a relatively high volume of activations, both with and without TERRE, which are significantly higher than the volume of their imbalances. This can be attributed to high numbers of local counter-activations, due to the lack of an intraday market.
- BSPs in France are activated more under TERRE in both directions. The French market borders four of the other members of TERRE, so it is expected that there will be more opportunities to exploit ATC when prices favor either import or export of balancing energy.

Figure 6-6 and Figure 6-7, illustrate the value of the activated volumes within each country.

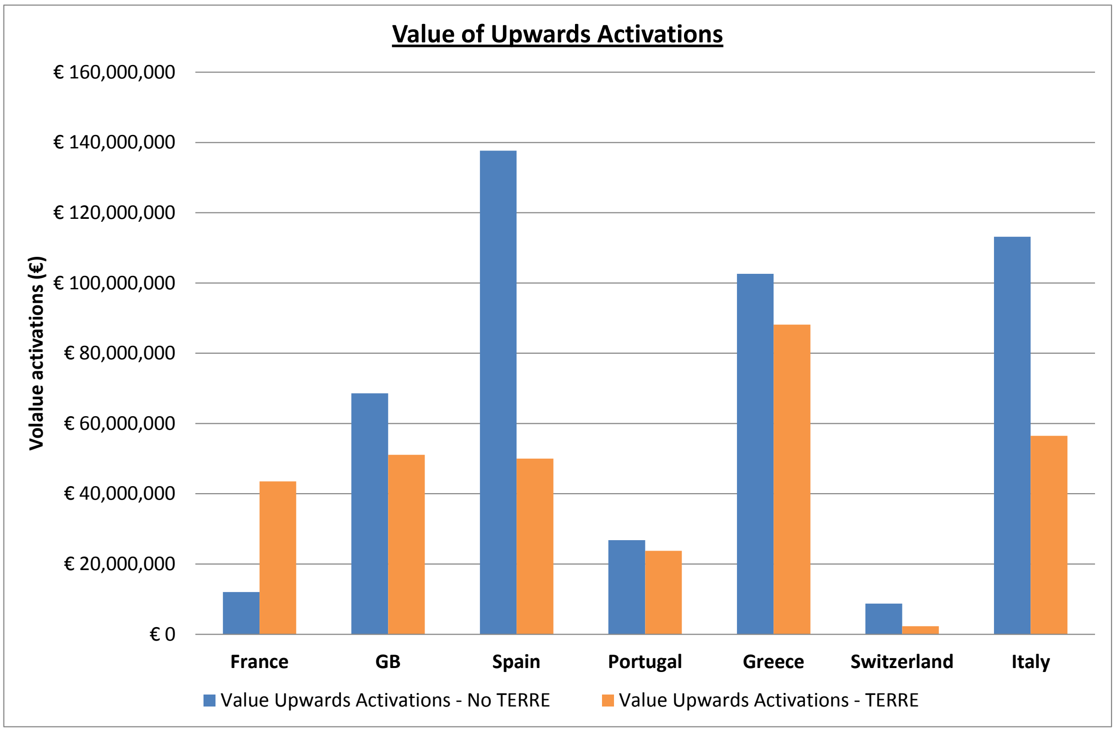

Figure 6-6: Value of Upwards Activations

As expected from the increase in activations shown in Figure 6-4 and Figure 6-5 shows a large increase in the value of the French activations. The Spanish and Italian values are reduced, in line with the volume of activations.

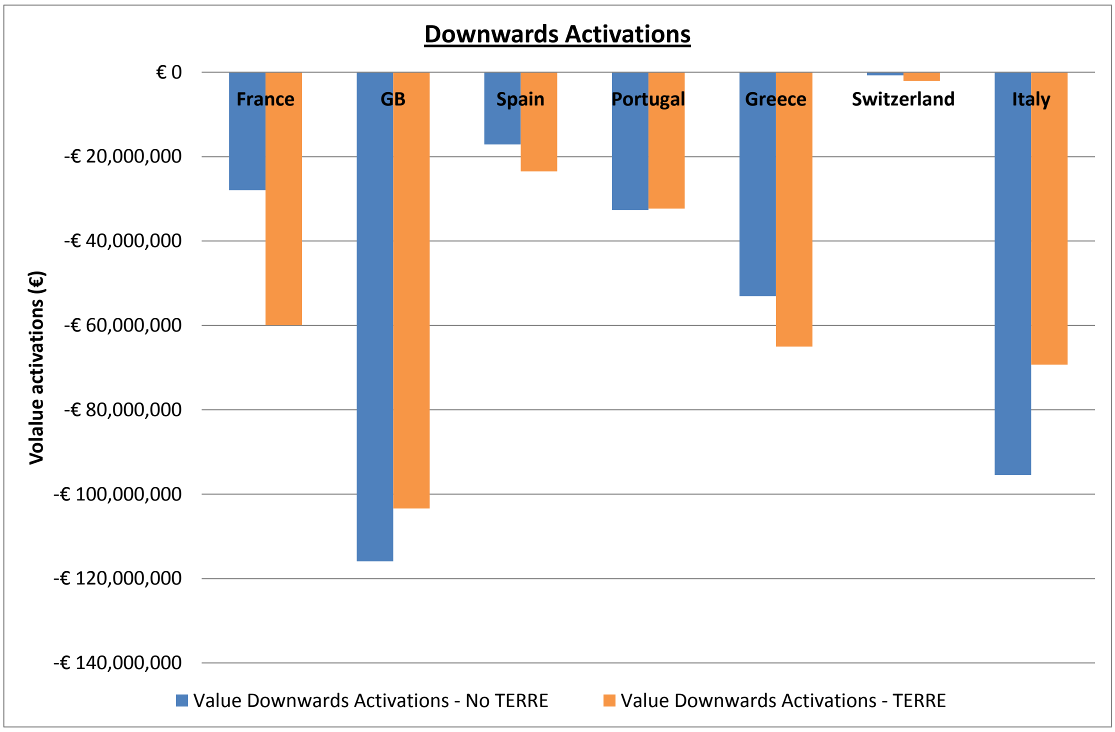

Figure 6-7: Value of Downward Activations

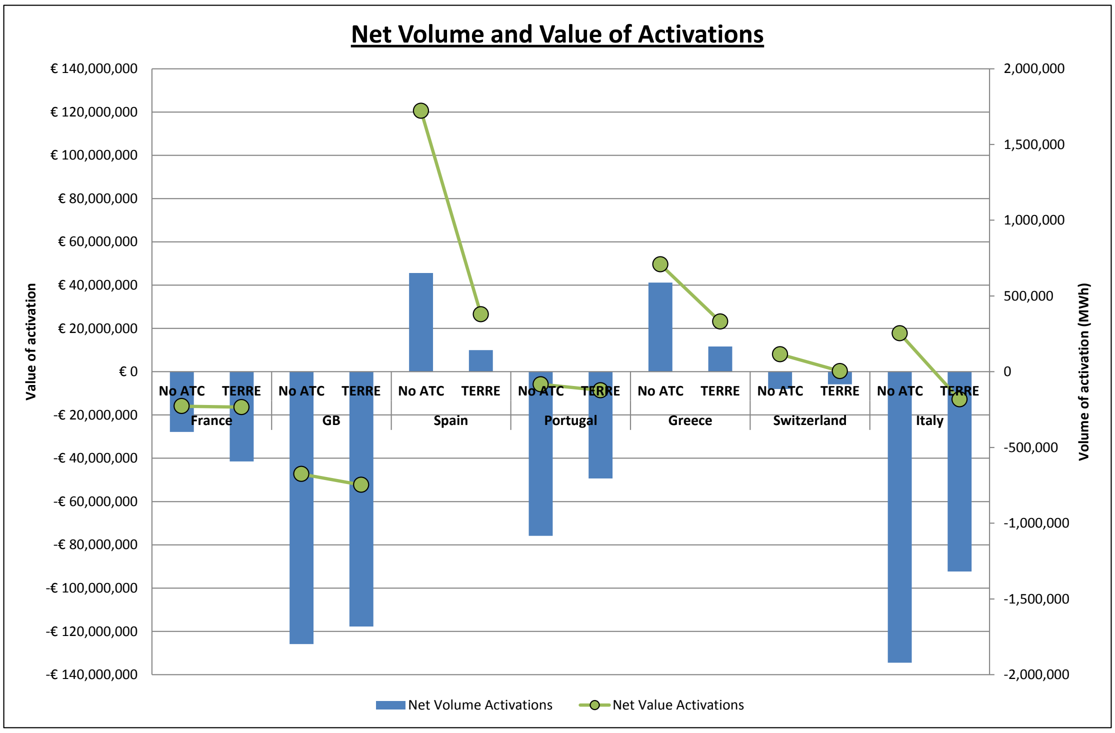

Figure 6-8: Net BSP Activations and Payments by country.

Figure 6-8 brings the net volumes and values of activations together into a single graph. In general there is a reduction in the volumes of activations and a reduction in the value, which, when positive, reduces payments to BSPs and when negative, increases the payments to BRPs.

6.3.3 Impact on prices

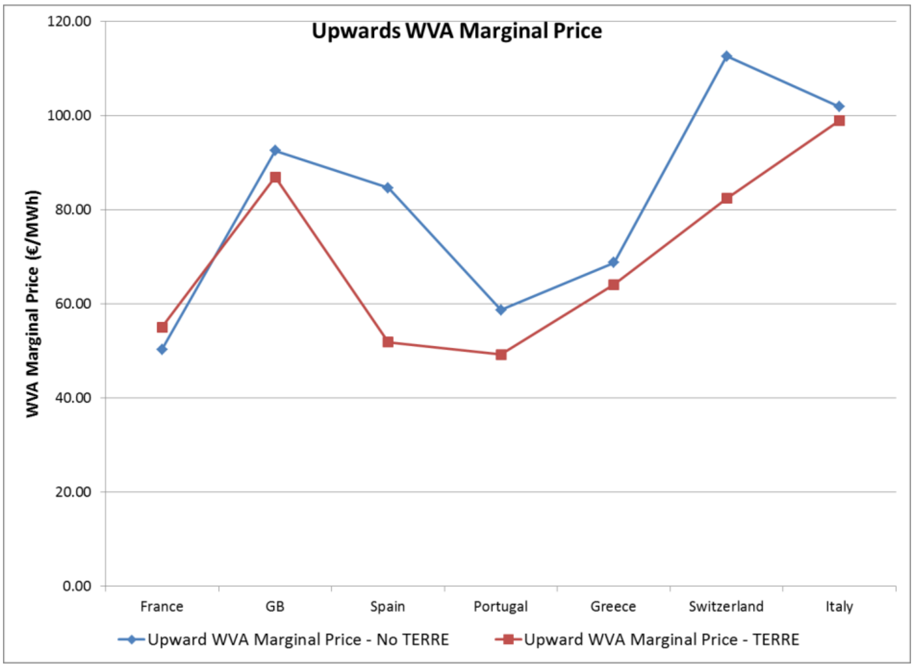

Figure 6-9: Upwards Volume Weighted Average Marginal Prices

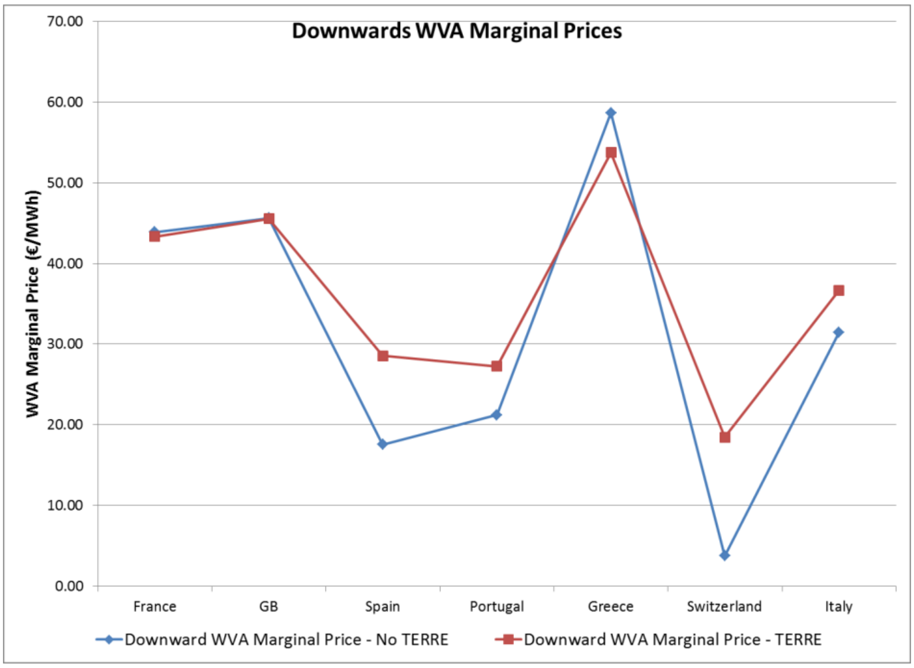

Figure 6-10: Downwards Volume Weighted Average Marginal Prices

As TERRE creates a single marginal price for both upwards and downwards activations a convergence in the volumes weighted average marginal prices is observed, with a reduction in prices in the upwards direction, meaning BRPs pay less to BSPs and an increase in prices in the downwards direction, meaning BRPs receive more money from BSPs.

6.3.4 TERRE Annual Benefits

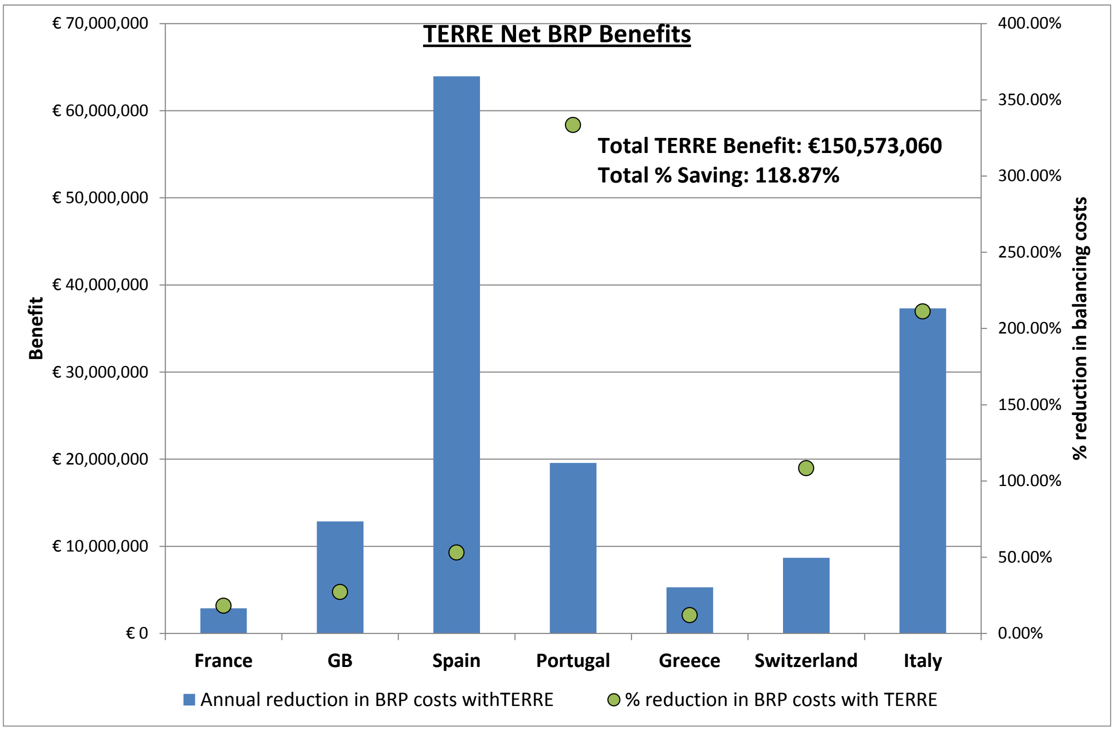

Figure 6-11: BRP Benefits of TERRE per Country

Figure 6-11 details the annual cost saving for BRPs per country, both in absolute terms and as a percentage change compared to the values without TERRE. It is observed that Spain sees the highest absolute saving in BRP costs, whereas Portugal sees the largest percentage change with BSP to BRP payments, increasing from approximately €5.8m to €25.4m.

NB: the above graph should not be taken as forecast for future benefits

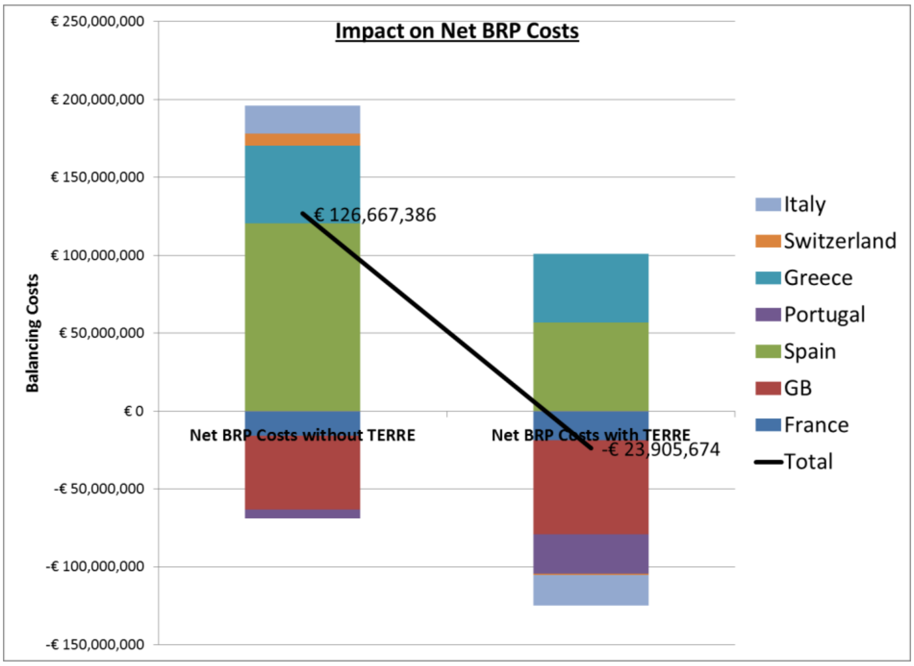

Figure 6-12: Impact on Net BRP Costs

Figure 6-12 places BRP costs of RR balancing energy from each study case into stacked columns, which allows for the visualization of the impact on BRP costs with and without TERRE. Stacks in the positive direction indicate a payment from BRPs to BSPs, whereas stacks in the negative direction indicate a payment from BSPs to BRPs. It is observed that for positive stacks the value decreases (less payments from BRPs to BSPs), whereas for negative stacks the value increases (more payments from BSPs to BRPs). Overall, without TERRE there is a net payment from BRPs to BSPs of €126.6m whereas with TERRE this flow reverses to a net payment from BSPs to BRPs of €23.9m; this is represented by the black line.

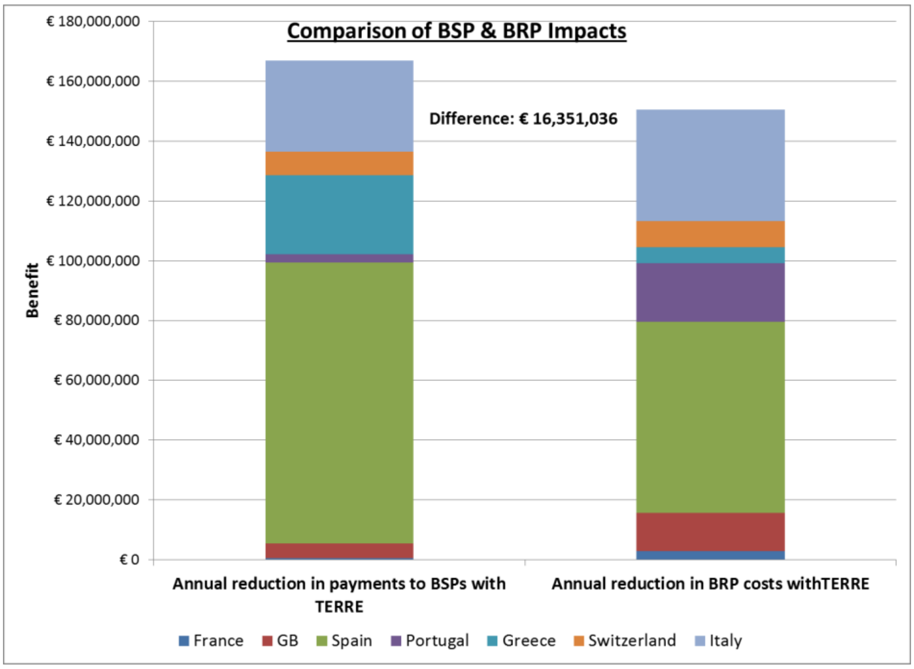

Figure 6-13: Comparison of BSP and BRP impacts

Figure 6-13 compares the stacks of reduction in BSP payments and BRP costs. The discrepancy in the values is the result of net costs associated with congestion rent between the different bidding zones.

NB: the above graph should not be taken as forecast for future benefits

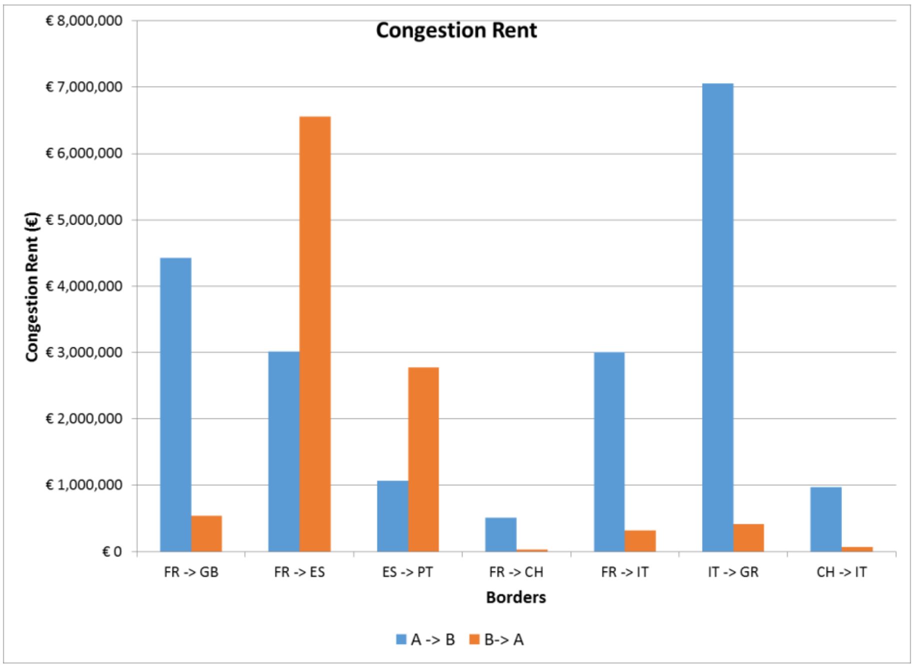

Figure 6-14: Congestion Rents Per Direction

Figure 6-14 shows the congestion rent by border and direction. The difference between reductions in payments to BSPs and reduction in BRP costs (approx. €16.3m) shown in Figure 6-13 is the net of the congestion rent in each direction (e.g. FR -> GB minus GB -> FR). A->B signifies the direction. FR is typically importing to GB, hence in the GB-FR direction this border is congested a lot more than in the opposite direction.

6.4 Qualitative Assessment of TERRE in 2018

As the simulations used in the TERRE CBA have been based on historical data from 2013 it is important to assess how these results may change with the implementation of the GL EB. This qualitative assessment has been performed for three key areas:

1. Change in Bidding Behavior

Due to the coupling of the different RR balancing markets and the move to marginal pricing, the bidding behavior of BSPs in the different markets is expected to change. An increase in the number of BSP competitors (now BSPs are not just competing against others in their local market) is expected to drive down bid prices. In addition a move to marginal prices will increase the incentive for BSPs to bid in at their short run marginal cost, whereas under pay-as-bid they are incentivized to bid in at the price of the most expensive offer accepted.

The overall effect of these two factors is expected to reduce the bid prices of BSPs in comparison with the prices seen in the 2013 data used in the TERRE simulation.

2. Changes in Imbalance Volumes

Due to the increased incentives on BRPs to be balanced or to have 'helpful' imbalances, it is reasonable to expect a reduction in the volume of residual balancing performed by TSOs in comparison to the 2013 data used in the TERRE simulation.

In addition to changes in the incentives to be balanced, we can also expect that the ability of BRPs to be better balanced will improve due to the changes planned in the intra-day market. If we see increased liquidity in the XB intra-day market and BRPs can balance their position closer to real time than they can today, then it is also expected that the amount of residual balancing to be performed by the TSO is reduced.

3. Changes in Available Transmission Capacity for Balancing

The GL EB also envisages the possibility to reserve XB capacity by TSOs for the purposes of exchanging balancing energy if it is properly justified and after approval by NRAs. The TERRE simulations only use the residual ATC following the closure of the ID market; hence any reservation of XB capacity by TSOs would increase the ATC for TERRE.

Additionally, there are numerous projects to increase the cross border capacity on borders within the TERRE region, with potentially three new HVDC interconnectors under development on the France-GB border alone (IFA2, ElecLink and FAB Link).

The increases in cross border capacity coupled with the reservation of XB capacity for balancing will likely result in increased volumes of balancing energy being exchanged, which could further increase the benefits for BRPs. It would also likely decrease the spread of Marginal prices, hence lowering the value of congestion rent.

6.5 Conclusion

As shown in section 6.2, the costs for TSOs to create and maintain the TERRE platform are initially in the range of 25M€ and 30M€ and ongoing costs are considered negligible. The modelled benefits, for BRP imbalances, shown in Section 6.4, are approximately €150.6m per year. The costs of implementing project TERRE are far outweighed by the benefits seen across the region.

In addition to this, the distributional effects of the benefits are such that each member state benefits from being part of the cooperation, albeit to varying degrees, as shown in Figure 6.11.

For this simulation to be performed; numerous assumptions have had to be made at various stages of the analysis. Where possible we have tried to ensure that these assumptions are reasonable and consistent across TSOs. Due to these assumptions and the use of historical data, it is expected that the actual impact of TERRE, when the project goes live, will differ from the results shown in this analysis.

However, in line with the broad trends highlighted in this analysis, and the qualitative assessment on wider changes that could influence these results, it is still expected that project

TERRE will deliver significant benefits, due to increased competition, greater liquidity, and netting of TSO imbalance needs.

6.6 Questions for Stakeholders

Q 6.1 **What are your views on the methodology used and assumptions made in the Cost Benefit Analysis?**

Q 6.2 **What are your views on the results of the Cost Benefit Analysis?**

Q 6.3 **Do you think the conclusions of the Cost Benefit Analysis are valid for the expected market in 2018?**

Q 6.4 **Do you have specific comments regarding chapter 6 content? (Please indicate sub-chapter reference when possible)**

7 Timing

7.1 Timeline

TERRE is a gate-managed system. Each phase of the process is conducted between the opening and the closure of the corresponding gate. All TSO processes will be taken until H-30min (H corresponds to the beginning of real time). After the TSO TERRE processes are concluded, from H-30min to H, each TSO will activate its national units. The way thateach TSO activates their local units is out of scope of this document.

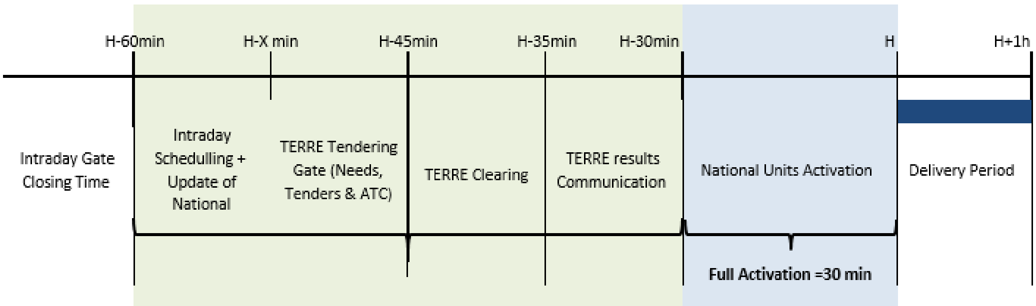

Figure 7-1: TERRE Process Timeline

Parameter H-X min = **RR Balancing Energy Gate Closure Time (applicable to BSP)**
Parameter H-45min = **TSO Energy Bid Submission Gate Closure Time**
Although these parameters can be adjusted during the implementation phase, they were defined in coordination with all involved parties.

Please note that the RR balancing energy GCT is still under discussion and will be harmonized under the scope of the implementation of the GL EB.

7.2 Process phases description

7.2.1 Pre-Tendering phase

The pre-tendering phase is the period between H-60m and H-X min, in which all TSOs receive the intra-day Scheduling information and all BSPs can submit or update their balancing energy offers and send them to its connecting TSO. After H-X min, no balancing energy offers from the BSP will be accepted.

7.2.2 Tendering phase

In the tendering phase, all TSO will:

1. Calculate all their Imbalance Needs;
2. Perform operational security assessment in order to determine restricted bids
3. Calculate/update the available ATC;
4. The TSO shall submit to the TERRE platform all valid balancing energy offers (taking into account the conversion of bids in Central Dispatch Systems) from its connecting BSPs.

All of this information will be sent by the TSO to the TERRE platform before the end of the tendering phase, i.e., before H-45min.
Before sending the ATC, each TSO shall confirm with the neighboring TSOs the value of ATC that will be sent to TERRE platform. How the ATC (communicated to TERRE platform by each TSO and used in TERRE process) is confirmed/agreed among neighboring TSOs is out of scope of this document.

7.2.3 Clearing phase

The algorithm computation phase is the period in which all balancing energy offers and Imbalance Needs are processed by TERRE, taking into account the submitted balancing energy offers and Imbalance Needs, the ATC, requirements and other constraints.
Important to stress that, TERRE will verify the ATC communicated by all TSOs.
The gate opening time of the algorithm computation phase coincides with the Gate Closure Time of the tendering phase [H-45 min]. The end of the algorithm computation phase will happen before the beginning of the results communication phase [H-35 min].
A period of 10 minutes is reserved for this process, but this can be reduced during the implementation phase.
If at the end of the time reserved for this process no results were produced by the algorithm, a fallback procedure will be activated.

7.2.4 Results communication and verification

The Results Communication Phase is between H-35min and H-30min, and is the period reserved for:

1. The communication of all session results from the TERRE algorithm to all TSOs, namely RR activation results (price and volumes), ATC used in the clearing process, Residual ATC[4] and final CMOL;
2. The communication of the Scheduled Exchange[5] to the TSOs and the ENTSOE Verification Platform by TERRE platform.
   a. In case of using the SO-SO scheduling process in Net Position: The ENTSOE Verification Platform which will be hosted by the Coordination Center (Swissgrid and Amprion) will be responsible for the verification of the TSOs Net Position schedules resulting from TERRE platform.
   b. In case of using the Scheduling process border to border: The current Cross border scheduling processes will be handled.

7.2.5 Activation Period

Following the receipt of the TERRE clearing Results, each TSO will activate the BSPs in its control area. The description of the procedure for the activation of the local unit is out of the scope of this document and is the responsibility of each TSO.
To comply with the parameters of the TERRE Standard product, which has a Full Activation Time of 30 minutes, this period will be between H-30m and H.

7.2.6 Delivery Period

The delivery period is a one-hour-long period, in which the TSO takes the necessary actions to deliver the reserve activated by TERRE on its border. These actions are under the responsibility of each TSO.

7.3 XB Scheduling Step

7.3.1 Description

In order to improve the exchange of energy between borders, we need to define a common cross border scheduling step to be used in TERRE.
3 different possible Cross Border Scheduling Steps (1 hour, 30 minutes and 15 minutes), were analyzed, and are represented in the following figures.

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[4] The Residual ATC is the Capacity available in the interconnection for one hourly period, after finalization of the commercial transactions for this hourly period.
The Residual ATC will be calculated as follows:
Residual ATC = MAX (0, (NTC – (MIB + MIBi))
Where MIB is the netted inter-area hourly schedules and MIBi is the netted inter-area intraday schedules in the NTC direction.

[5] Scheduled Exchange means the transfer scheduled between geographic areas, for each Market Time Period and for a given direction

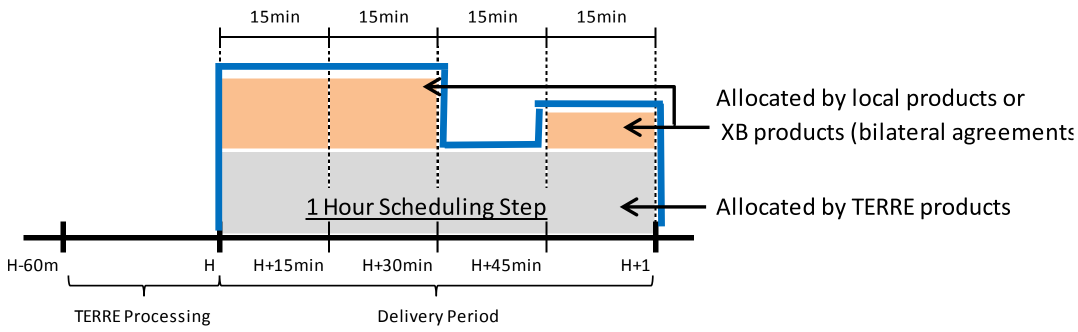

Figure 7-2: Cross border Scheduling Step of 1 hour

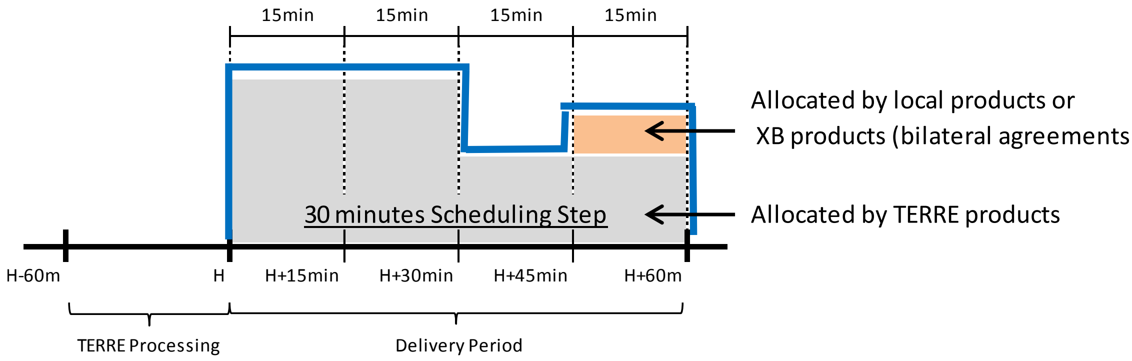

Figure 7-3: Cross border Scheduling Step of 30 hour

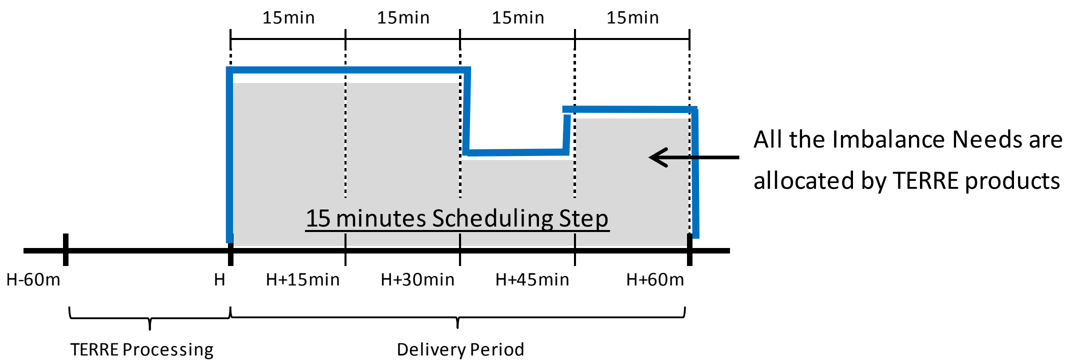

Figure 7-4: Cross border Scheduling Step of 15 minutes

Currently all borders in the TERRE region have a cross border scheduling step of 1hr, with the exception of the France-Switzerland border which is 30mins.

In the figure for a cross border Scheduling Step of 1 hour, it is explained that, because the cross border program needs to be stable for the entire hour, only a part of the Imbalance Need of the TSO will be met by cross border products (represented in grey). The rest of the Imbalance Need, must be satisfied by National Products or by XB products (represented in orange) out of the current scope of TERRE. The reduction of the XB Scheduling Step and the consequent increase of the transacted balancing volumes through TERRE results in a higher efficiency.

To take advantage of the possibilities that this project offers, TSOs are investigating the reduction of the XB scheduling step for balancing to 30 or 15 minutes, which will allow the exchange of further energy between TSOs.

Thus, the common solution will be robust enough to allow the reduction of the scheduling step during the implementation phase or a subsequent stage of the project and to deal with the different values in place between the borders of the countries that participate in the TERRE project.

7.4 TERRE Clearing Process

At this stage, the previous conclusions will allow only one clearing process per hour, as represented in the following picture.

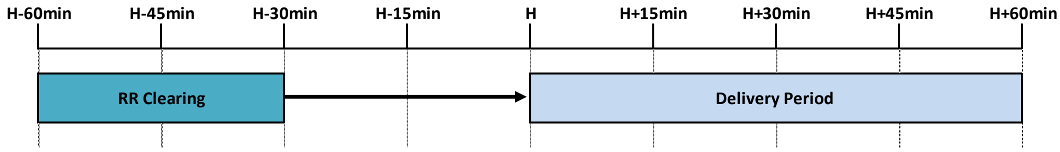

Figure 7-5: TERRE auction

7.5 Questions for Stakeholders

Q 7.1 What are your views on the reduction of XB scheduling step for balancing?

Q 7.2 What are your views on the interactions between the TERRE process and the XB intra-day market?

Q 7.3 What are your views on the frequency of the clearing (one single clearing per hour)?

Q 7.4 Do you have specific comments regarding chapter 7 content? (Please indicate sub-chapter reference when possible)

8 TERRE Platform - High Level Functional Architecture

The High Level Functional Architecture shows the sequence of exchanges involved in this hourly process for the platform and it is as illustrated below.

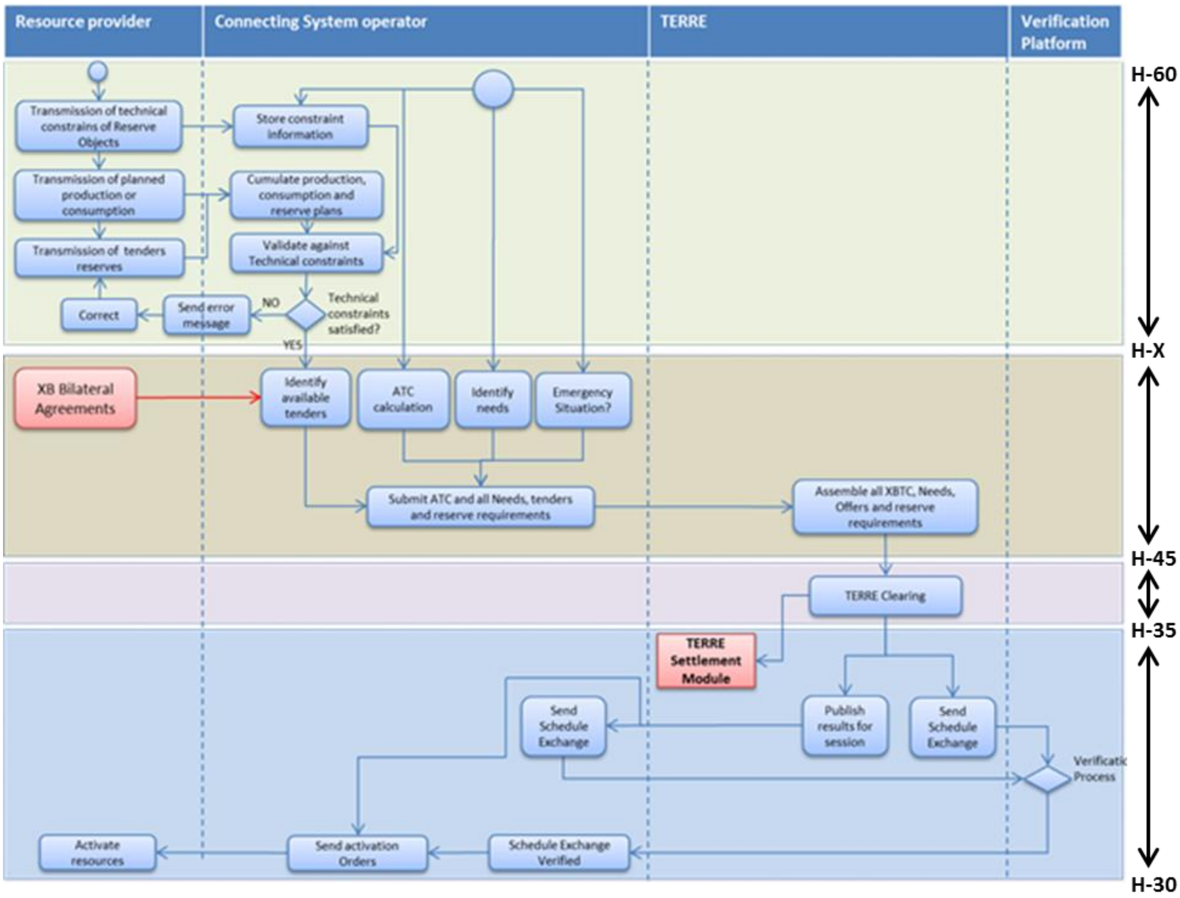

Figure 8-1: High Level Business Process

More detail regarding the exchange of information among BSPs, TSOs and TERRE platform is presented in section 7.2.

8.1 Questions for Stakeholders

Q 8.1 Do you have specific comments regarding chapter 8 content? (Please indicate sub-chapter reference when possible)

9 Available Transmission Capacity

The cross border capacity is an input to the algorithmic optimization.

9.1 AC link

At this stage of the project, the TSOs decided to use all cross border Available Transfer Capacity (ATC) after the intra-day market.
In normal network situation, for each TSO, the TERRE ATC = Net Transfer Capacity – Long term cross border schedules – Day Ahead cross border schedules – intra-day cross border schedules.

9.2 DC Links

By opposition to AC networks, DC interconnectors are fully controllable and therefore, the power flowing on the link can be set by the interconnector operator. The main benefit of this technology is that it is easier to manage imbalance (difference between metered energy and commercial position), but the inconvenience is that the power on the link can only be modified following a predefined maximum ramp-rate (for IFA this maximum is set at 100MW/min), without any possibility to overload the cables (in opposition to classic AC networks). This means that in some situations where the scheduled power may vary a lot from one hour to the next, it is impossible to completely get rid of the imbalance.

- IFA example:

TERRE results will be physically firm, and the associated cost of imbalance (on both markets) will be supported by the interconnector owner(s). In order to avoid high imbalance costs due to important commercial variations, the concept of Physical Feasibility has been developed (or ramping constraints). The hourly Physical Feasibility is for a given physical schedule of the link, and taking into account all its constraints (maximum ramp-rates, tunnel, IC limitations …), the biggest admissible energy upward and downward without generating imbalance on that specific hour.

9.3 Questions for Stakeholders

Q 9.1 Do you agree with the proposed methodology for the calculation of available transmission capacity used by TERRE solution for both AC and DC borders? If not, what would be your proposal?

Q 9.2 Do you have specific comments regarding chapter 9 content? (Please indicate sub-chapter reference when possible)

10 Governance

10.1 High level description of the governance

TERRE is a cooperation of several European TSOs. For the implementation phase, mutual rights and obligations of the TERRE Members will be laid down in a Cooperation agreement signed by all TERRE Members. This Cooperation is not considered to be a partnership, joint venture or other association between the TERRE Members at this stage.

The TSOs will have the decision power on the solution that will be tendered. TERRE Members will commonly agree on the acceptance of the tender, thus deciding which solution will be implemented. The respective platform will be operated under the responsibility of all TERRE Members. The TERRE members will also be the owners of the platform.

TERRE TSOs will form a TERRE Steering Committee (SC), which will be the decision making body of TERRE and a TERRE Working Group (TWG) which will be the expert body. The TWG can consist of subgroups, such as ITWG and LGWG (Legal and Governance Working Group), which can be created by the TERRE SC.

The TERRE TSOs, with the support of NRAs will involve Stakeholders in the development of the different project stages. The TERRE Stakeholder meetings and workshops will be organized at a "Regional" level and a "National" level.

Given that TERRE will implement the requirements of the GL EB as regards the exchange of RR among the Member States involved, the NRAs of the TERRE area will approve the conditions and methodologies proposed by TERRE Members that are subject to regulatory approval pursuant to the GL EB.

10.2 Questions for Stakeholders

Q 10.1 Do you have specific comments regarding chapter 10 content? (Please indicate sub-chapter reference when possible)

11 Transparency

The Regulation on Transparency (543/2013), Article 17.1, states that specific information about balancing has to be provided by "operators of balancing markets". The TSOs assume that TERRE will be de facto balancing market operator for RR, and therefore would be expected to submit data to the ENTSO-E Transparency Platform in accordance with the provisions of article 17.1. (See Annex 7, chapter23)
Other obligations on TSOs for the publication of data outside of this scope are for further study.

TSOs are responsible for the transparency of data submitted and issued by TERRE in respect of Regulation on Transparency (543/2013), Article 17.1.
During the implementation phase of the CoBA, some information could be able to be issued from the platform.

11.1 Questions for Stakeholders

Q 11.1 Do you have specific comments regarding chapter 11 content?

12 Harmonization Issues

12.1 Harmonization of price caps and floors

There are currently different regulation rules among the participating TERRE TSOs. One example is negative prices, as the regulatory framework conditions in some countries allow the use of negative prices, whereas others do not.
Currently, the draft GL EB (Art 42) states the following:
Article 42. Pricing method for balancing energy

> *"2. Balancing energy prices shall not be capped. In case TSOs identify that caps are needed for consistency with other market timeframes, they may develop within a proposal for harmonized pricing method for balancing energy a proposal for harmonized maximum and minimum balancing energy prices to be applied in all control areas. In such a case, harmonized maximum and minimum balancing energy prices shall take into account the maximum and minimum clearing price for day-ahead and* intra-day *timeframes pursuant to [Commission Regulation (EU) 2015/1222]."*

The view of the TERRE TSOs is that harmonization of local rules would be the most efficient solution to this issue. This involves the removal of caps & floors for balancing energy markets.

This solution is in line with the GL EB[6] and guarantees non-discrimination to BSPs. However, this is a regulatory issue that is under the scope of the NRAs.
While harmonization of rules is the end objective, in order to avoid potential delays to the TERRE project, an interim solution through settlement has been developed, which will allow TERRE to enter into force with the current design, while the local rules for price caps and floors have yet to be harmonized.

12.1.1 Interim Solution through Settlement

The solution through settlement consists of a settlement re-adjustment at national level. In simpler terms, the TSO-TSO settlement is not affected and the price of XB flows is respected even from TSOs that do not accept negative prices. If the XB flow has a negative price, the TSOs that do not allow negative prices perform an additional settlement at national scope in order to be financially neutral, respecting, in parallel, the existing caps & floors. These national re-adjustments will not affect the other TSOs and will be done solely at a national level, after an agreement of the TSOs with their NRAs.
The main advantages of the solution through settlement are:

- No additional constraints are introduced in the Balancing CMO, and the most optimal solution is found
- There is no need for a second round in the Balancing CMO, so this solution will save time and reduce complexity
- This solution is feasible no matter which new TSO enters the TERRE Cooperation (as the Balancing CMO is not modified, even if the new TSO has cap or floor, this will not influence the computation time of the CMO).

This information is explained further in Annex 3 (Chapter 19).

12.2 Harmonization of ID markets

As described in Table 2-2, TSOs of TERRE have different ID Market Time Resolution (MTR) and Gate Closure Time (GCT).

The integration of balancing markets will require an in-depth discussion on the relationship between intra-day and balancing timeframes. This discussion will take place in the context of the development of a proposal from the European Commission on Electricity Market Design in 2016 and the implementation of the CACM NC and GL EB.

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[6] The related article (42.2) in the current version of the GL EB is amended by ACER with the following proposal: "*In case TSOs identify that caps are needed for consistency with other market timeframes, they may develop consistency with other market timeframes, they may develop within a proposal*"

12.3 Questions for Stakeholders

Q 12.1 **Which features (if any) of local balancing market design needs to be harmonized for an efficient functioning of the TERRE project? If several, please rank the first three you consider the most important to harmonies.**

Q 12.2 **Do you share the position from TERRE TSOs (i.e. the caps and floors in balancing energy markets should be removed by the entry into force of TERRE)?**

Q 12.3 **In case this cannot be done before the entry into force of EB GL, do you agree on the transitional application of the solution through settlement? Or which is your view regarding a backup solution?**

Q 12.4 **What is the minimum amount of time that market participants need to update your RR balancing offers after receiving the results of the cross-border intra-day (XBID) process?**

Q 12.5 **Do you consider there are other key issues that need to be harmonized to avoid significant distortions between BSP across TERRE Members States?**

Q 12.6 **Do you have specific comments regarding chapter 12 content? (Please indicate sub-chapter reference when possible)**

13 Project Implementation Plan

13.1 Description of the PIP

The TERRE project implementation plan is expected to cover 2016, 2017 and part of 2018 for an entry into force window expected at the end of Q2, 2018, in line with the RR CoBA implementation requirements of the current draft GL EB.

Currently, the project is divided in 4 main types of activities:

1. **Legal**: Management of Cooperation Agreements (both in implementation and operational phases) between TSOs and the management of the Parallel Run phase, which is the pre-requisite for the entry into force
2. **Approval**: Management of NRA's and stakeholder's information and approval through the consultation and approval processes
3. **Design**: Management of the design of the TERRE solution through Provider(s) selection (Request for Proposal management) and Functional Specifications redaction
4. **Implementation**: Management of Terre Solution System development and Testing activities

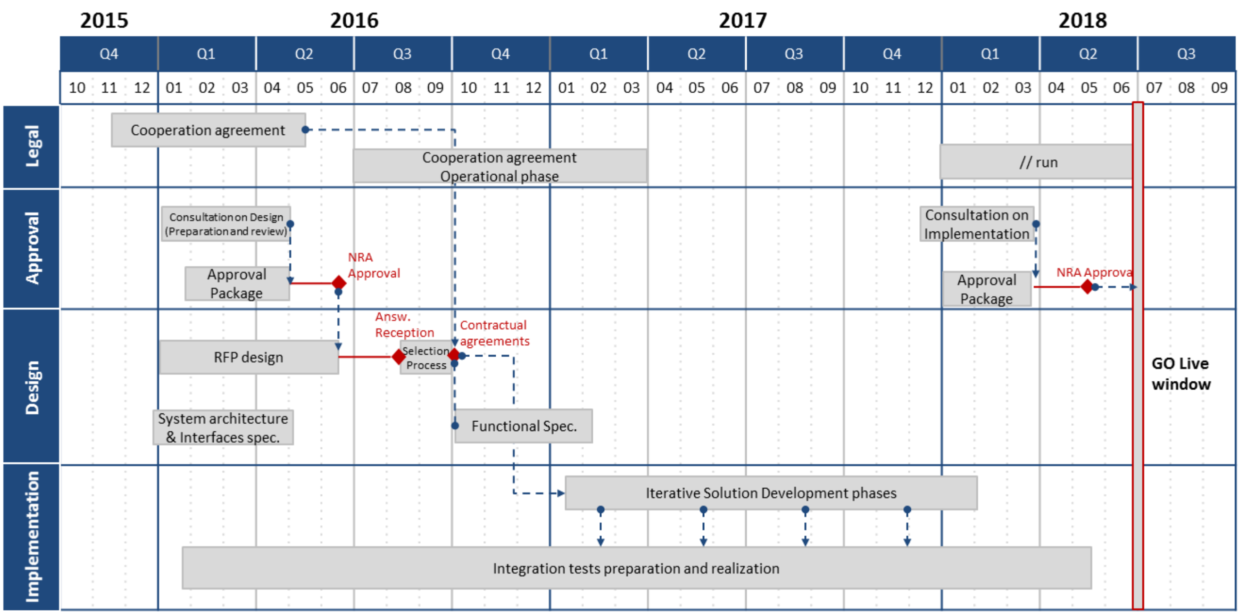

Figure 13-1: TERRE Project Implementation Plan

13.2 Legal activities

The redaction of two Cooperation Agreement documents is anticipated.

The first document will deal with contractual aspects linked to the governance model of the implementation phase and set the framework of the cooperation between TSOs (ownership, cost sharing, responsibilities, etc.). In particular, it will define the responsibility agreements necessary to contract with a service provider (e.g. TERRE solution provider). This document is expected to be validated in the middle of Q2, 2016.

The redaction of the second document will start mid-2016 and is supposed to be validated at the end of Q1, 2017. It will describe the legal dispositions between TERRE TSOs for the Operational phase of TERRE.

The Parallel Run phase is expected to start before TERRE entry into force and last for less than 6 months. It should validate the Operational capability of the TERRE solution and processes.

13.3 Approval phases

Two approval phases are expected for the TERRE project.

The first phase presents the TERRE design phase results to stakeholders through a public consultation process, taking place until end of April, 2016. This consultation feeds the approval Package presenting the final design for TERRE and is expected to be submitted to NRAs during Q2, 2016, for approval around June, 2016. NRAs will then provide a common position regarding TSOs' proposal on the TERRE design, and request changes if they deem it relevant.
This support is a pre-condition for the launch of the TERRE solution development process.

The second approval phase will take place at the beginning of 2018 and submit the TERRE Implementation results to NRAs for approval. The approval phase will be run according to the provisions set in the GL EB. This second approval process is a pre-condition for the entry into force of TERRE.

13.4 Design activities

The TERRE project is expected to request services from one or several providers for the solution development.
A Request for Proposal (RFP) document will be prepared by project members according to the validated design options, beginning 2016, and issued to service providers at the end of Q2, 2016.

A selection process based on services provider's answers to the RFP will lead to contractual agreement(s) expected to be signed at the beginning of Q4, 2016. Contractual agreement(s) are a pre-condition to start the technical activities for the TERRE solution.

TERRE project members will then work in cooperation with the selected service provider(s) on the Technical Specification redaction. This activity is expected to run until the beginning of 2017.

13.5 Implementation activities

Development activities for the TERRE solution are expected to start at the beginning of 2017 and will last until the beginning of 2018. The TERRE project expects this development phase to be divided into several phases (iterations).

In parallel, testing activities (Integration Tests) will take place during the whole implementation phase in order to ensure full system operability (both technical and functional). This phase includes test planning and realization.

13.6 Questions for Stakeholders

Q 13.1 Do you have specific comments regarding chapter 13 content? (Please indicate sub-chapter reference when possible)

14 Possible evolutions

Additional TERRE process: Reduction of Market Time Unit or intra-day Gate Closure Time: The evolution of the European electricity market could lead to a reduction of the Market Time Resolution or the intra-day Gate Closure Time. If this happened, the project would need to be adapted to new circumstances; for example, possible introduction of additional clearings.

Additional balancing products and processes: The centralized IT platform will be implemented with enough flexibility to handle different processes and products (e.g. scheduled balancing products, mFRR process…)

14.1 Questions for Stakeholders

Q 14.1 Do you have specific comments regarding chapter 14 content? (Please indicate sub-chapter reference when possible)

15 Glossary

15.1 Abbreviations

AC	Alternative Current
aFRR	automatic Frequency Restoration Reserve
ATC	Available Transmission Capacity
BALIT	Balancing Inter TSO
BSP	Balancing Service Provider
BRP	Balancing Responsible Party
BZ	Bidding Zone
CBA	Cost Benefits Analysis
CC	Capacity Calculation (ATC or FB)
CDS	Central Dispatch System
CGM	Common Grid Model
CMO	Common Merit Order
CMOL	Common Merit Order List
CoBA	Coordinated Balancing Area
DA	Day Ahead
DC	Direct Current
DO	Downward Offer
DN	Downward Need
DSR	Demand Side Response
EB	Electricity Balancing
ENTSO-E	European Network of Transmission System Operators for Electricity
FAT	Full Activation Time
FW	Framework Guidelines
FRR	Frequency Restoration Reserve
GCT	Gate Closure Time
GL	Guideline
GL EB	Guideline on Electricity Balancing
HVDC	High Voltage Direct Current
ID	intra-day
ISP	Imbalance Settlement Period
IT WG	IT Working Group
LT	Long Term
LG WG	Legal & Governance Working Group
MBA	Market Balancing Area
mFRR	manual Frequency Restoration Reserve
MoU	Memorandum of Understanding
MP	Marginal Price
MRC	Market Coupling of Region
NA	Not applicable

NDA	Non-Disclosure Agreement
NRA	National Regulatory Authority
NTC	Net Transfer Capacity
PIP	Project Implementation Plan
QR	Qualified Recommendation
RES	Renewable Energy Sources
RFI	Request for Information
RFP	Request for Proposal
RR	Replacement Reserve
SoS	Security of Supply
TERRE	Trans European Replacement Reserve Exchange
TWG	TERRE Working Group
TSC	TERRE Steering Committee
TSO	Transmission System Operator
WG	Working Group
WG AS	Working Group Ancillary Services
WP	Working Package
XB	Cross Border

15.2 Definitions

Delivery Period: means a time period of delivery during which the Balancing Service Provider delivers the full requested change of power in-feed or withdrawals to the system.

Divisibility: means the possibility for the TSO to use only part of the balancing energy bids or Balancing Capacity bids offered by the Balancing Service Provider, either in terms of power activation or time duration. As requested by the Guideline on Electricity Balancing this parameter will be under the responsibility of BSPs. This feature is strictly related with the Maximum Bid Size.

Full Activation Time (FAT): means the time period between the activation request by TSO and the corresponding full activation of the concerned product. The Full Activation Time is the sum of the Preparation Period and the Ramping Period. The Full Activation Time is set to 30 min. Lower values can cause conflict with mFRR process.

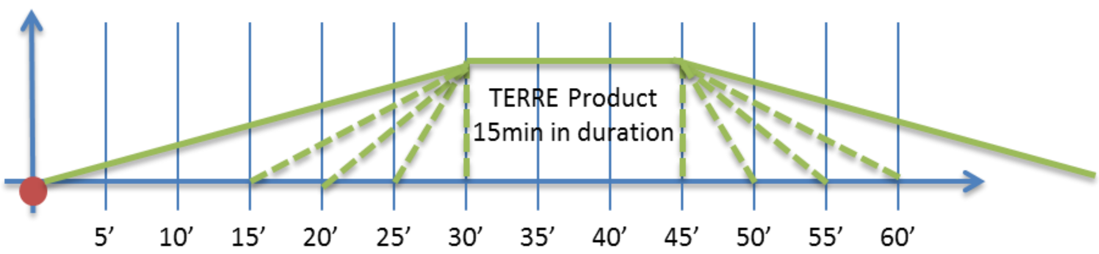

Figure 15-1: Examples of TERRE FATs

The TERRE Working Group (TWG) defined only the FAT in order to give the maximum level of flexibility to the market.

For example you can have two different production units:

- Unit A: Preparation Period = 5 minutes, Ramping Period = 25 minutes;
- Unit B: Preparation Period = 25 minutes, Ramping Period = 5 minutes.

Both the production units are able to join the mechanism.

Location: The level of detail of this parameter is the Bidding Zone.

Maximum Bid Size: means the maximum amount of MW a BSP can aggregate in a single offer. This parameter is related to the divisibility of the offers:

- in case of a divisible offer, no maximum bid size will be applied;
- in case of an indivisible offer, in order to avoid market arbitrage, the application of a cap is needed. Considering the differences between the regulations of the Countries involved, the TERRE Working Group decided, at least in a first stage, that local rules will be implemented.

The **Maximum delivery period** represents the maximum time during which the BSP can deliver the full requested power. It is set to 60 minutes. This value was introduced in order to avoid any interference with the cross-border intra-day markets.

The combination of a Minimum delivery Period of 15 minutes and a Maximum delivery Period of 60 minutes means that a BSP will be able to offer a product with a duration of 15, 30, 45 or 60 minutes.

The **Minimum delivery period** represents the minimum resolution time of each offer. It is set to 15 minutes. This value was introduced in order to give higher flexibility to the market.

Minimum Quantity: means the minimum value that a BSP can offer. Small values lead to higher flexibility for BSP. The minimum value is set to 1 MW.

Preparation Period: means the time duration between the request by the TSO and start of the energy delivery. The Preparation Period can be from 0 to 30 minutes.

Price: the definition of the price of the bids will be under the responsibility of the BSPs (respecting local rules). Actually negative prices cannot be accepted by several TSOs. This issue will be submitted to the NRAs.

Ramping Period: means a period of time defined by a fixed starting point and a length of time during which the input and/or output of Active Power will be increased or decreased. The Ramping Period can be from 0 to 30 minutes.

Recovery Period: means the minimum time between the delivery period and the following activation of an offer presented by a BSP. It will be defined by the BSP.

Resolution: Having a resolution of 0.1 MW means that, in case an offer is partially accepted (e.g. pro rata), the value will be rounded at the value with one decimal number.

Social Welfare: Area between the buying (positive imbalance needs/downward offers) and the selling (negative imbalance needs/upward offers) curve.

Validity Period: means the time period when the balancing energy bid offered by the Balancing Service Provider can be activated, whereas all the characteristics of the product are respected. The Validity Period is defined by a beginning time and an ending time. It will be defined by the BSP but cannot exceed the Maximum delivery period (60 minutes).

16 Summary of questions for Stakeholders

Stakeholders are invited to answer the following questions, directly linked to the chapters of this document.

A dedicated tool is available on ENTSO-E website at the address communicated in the launch letter of this consultation. Please be aware that only comments made using this channel will be taken into account.

Preliminary remarks:

- Questions marked by (*) are open questions on the whole chapter.
- Question marked by (**) is an introduction question where stakeholders can freely comment on the whole content of the document and share opinion on TERRE project in general.

	Chapter	Question ID	Questions
0	**General**	Q 0(**)	Please share your overall questions or comments about the consultation document and TERRE project in general. (Please consider all questions before as some topics may already be addressed in a dedicated question)
1	**Introduction**	Q 1.1(*)	Do you have specific comments regarding chapter 1 content? (Please indicate sub-chapter reference when possible)
2	**Overview of different manual reserves balancing markets in TERRE**	Q 2.1(*)	Do you have specific comments regarding chapter 2 content? (Please indicate sub-chapter reference when possible)
3	**Product & Imbalance Need**	Q 3.1	Which format of balancing energy offers are most attractive to stakeholders?
		Q 3.2	Do stakeholders agree with the definition and features of the TERRE cross border product?
		Q 3.3	What are the stakeholder's views on BRP-TSO & BSP-TSO rules & requirements?
		Q 3.4	Does the TERRE product allow for the participation of all types of balancing service providers (e.g. RES, Thermal, and DSR)? And if not, what changes in the features will allow greater participation in the TERRE project?
		Q 3.5	What are your views on the application of the local features of the TERRE cross border product (e.g. Harmonization of price cap and floors or Maximum Bid Sizes for Indivisible Offers)?
		Q 3.6	The number of bid formats (Divisible, Block, Exclusive, Linking Offers) which may be used by BSP represents a trade-off between the flexibility offered to BSP (with several types of offers) and the simplicity to offer bids and to run the algorithm (e.g., with only one standard type of offer). What are you views on this trade-off? Would you advocate for keeping all types of bids offered by TSOs or to reduce the number of possible offers?
		Q 3.7	Do you agree with the proposed design of the TSO imbalance need?
		Q 3.8	Do you agree with the possibility for inelastic and elastic imbalance needs?
		Q 3.9(*)	Do you have specific comments regarding chapter 3 content? (Please indicate sub-chapter reference when possible)

	Chapter	Question ID	Questions
4	**Balancing CMO and Algorithm**	Q 4.1	Do you have any specific comments on the Balancing CMO description?
		Q 4.2	What is your opinion on allowing internal and XB counter-activations?
		Q 4.3	Do you agree with the proposed treatment of HVDC losses?
		Q 4.4(*)	Do you have specific comments regarding chapter 4 content? (Please indicate sub-chapter reference when possible)
5	**Settlement**	Q 5.1	Do you agree that the proposed settlement design is in line with the principles of the EB GL and the integration of balancing markets?
		Q 5.2	Do you agree with the application of cross border marginal pricing, settlement of the block and the proposed design for the definition of Marginal Price between TSOs at the XB level?
		Q 5.3	What is your perspective regarding the alignment of the TSO-TSO settlement procedure and the BSP-TSO settlement procedure?
		Q 5.4(*)	Do you have specific comments regarding chapter 5 content? (Please indicate sub-chapter reference when possible)
6	**Cost Benefit Analysis**	Q 6.1	What are your views on the methodology used and assumptions made in the Cost Benefit Analysis?
		Q 6.2	What are your views on the results of the Cost Benefit Analysis?
		Q 6.3	Do you think the conclusions of the Cost Benefit Analysis are valid for the expected market in 2018?
		Q 6.4(*)	Do you have specific comments regarding chapter 6 content? (Please indicate sub-chapter reference when possible)
7	**Timing**	Q 7.1	What are your views on the reduction of XB scheduling step for balancing?
		Q 7.2	What are your views on the interactions between the TERRE process and the XB intra-day market?
		Q 7.3	What are your views on the frequency of the clearing (one single clearing per hour)?
		Q 7.4(*)	Do you have specific comments regarding chapter 7 content? (Please indicate sub-chapter reference when possible)
8	**TERRE platform - High Level Functional Architecture**	Q 8.1(*)	Do you have specific comments regarding chapter 8 content? (Please indicate sub-chapter reference when possible)
9	**Available Transmission Capacity**	Q 9.1	Do you agree with the proposed methodology for the calculation of available transmission capacity used by TERRE solution for both AC and DC borders? If not, what would be your proposal?
		Q 9.2(*)	Do you have specific comments regarding chapter 9 content? (Please indicate sub-chapter reference when possible)
10	**Governance**	Q 10.1(*)	Do you have specific comments regarding chapter 10 content? (Please indicate sub-chapter reference when possible)
11	**Transparency**	Q 11.1(*)	Do you have specific comments regarding chapter 11 content? (Please indicate sub-chapter reference when possible)
12	**Harmonization Issues**	Q 12.1	Which features (if any) of local balancing market design needs to be harmonized for an efficient functioning of the TERRE project? If several, please rank the first three you consider the most important to harmonies.

	Chapter	Question ID	Questions
		Q 12.2	Do you share the expectation from TERRE TSOs (i.e. the caps and floors in balancing energy markets should be removed by the entry into force of TERRE)?
		Q 12.3	In case this cannot be done before the entry into force of EB GL, do you agree on the transitional application of the solution through settlement? Or which is your view regarding a backup solution?
		Q 12.4	What is the minimum amount of time that market participants need to update your RR balancing offers after receiving the results of the cross-border intra-day (XBID) process?
		Q 12.5	Do you consider there are other key issues that need to be harmonized to avoid significant distortions between BSP across TERRE Members States?
		Q 12.6(*)	Do you have specific comments regarding chapter 12 content? (Please indicate sub-chapter reference when possible)
13	**Project Implementation Plan**	Q 13.1(*)	Do you have specific comments regarding chapter 13 content? (Please indicate sub-chapter reference when possible)
14	**Possible evolutions**	Q 14.1(*)	Do you have specific comments regarding chapter 14 content? (Please indicate sub-chapter reference when possible)

17 Annex 1: CMO - References to the GL EB

All references are to the ACER qualified recommendation (QR) on the GL EB (August 2014) published in July, 2015.

17.1 Framework for Exchange Balancing Energy for Replacement Reserves

Art.15 of the GL EB stipulates that the Regional integration model for Replacement Reserves which is consisted of Coordinated Balancing Areas with aims to share and exchange balancing energy bids from all Standard and Specific Products for Replacement Reserves.
TERRE aims to fulfil this stipulation and to create the framework for the exchange of balancing energy for Replacement Reserves.

17.2 TERRE Standard Product to be exchanged

Art.32 (4) stipulates that a Standard Product for balancing energy shall be defined as having standard characteristics:

a) Preparation Period;
b) Ramping Period;
c) Full Activation Time;
d) minimum and maximum quantity;
e) Deactivation Period;
f) minimum and maximum duration of delivery period;
g) Validity Period; and
h) Mode of Activation.

The TERRE Product is described according to the above criteria

17.3 TERRE Fall Back process

Art.36 (1) prescribes that "Each TSO shall ensure that fall back processes are in place in case the normal procedure fails".
Art.36 (2) stipulates that: "In case the procurement of Balancing Services fails, all TSOs of a Coordinated Balancing Area shall perform a repetition of the procurement process consistent with the objectives of this Regulation. TSOs shall inform Market Participants that fallback procedures will be used as soon as reasonably practicable"
TERRE TSOs are suggesting the Fall Back processes fulfilling the above stipulation.

17.4 TERRE Algorithm design options

17.5 Social Welfare Objective / Specific Cases: Counter-activation

According to the General Objective of the GL EB, Ar. 11 (1.(b)) an objective of this regulation is the enhancing efficiency of Balancing as well as the efficiency of European, regional and national Balancing Markets.
According to the stipulations for the pricing method to be applied,
Art.42 (1): Such pricing method shall:

(d) give correct price signals and incentives to Market Participants;

According to the algorithm development stipulations Ar. 69(6): all TSOs of a Coordinated Balancing Area established for the Exchange of balancing energy shall develop an algorithm to be operated by the Activation Optimization Function for the activation of balancing energy bids in accordance with the principles for balancing algorithms. This algorithm shall:

(a) Minimize the costs of Balancing;

Therefore the maximization of social welfare is the simpler and more straightforward option that satisfies the above stipulations. Allowing counter activations improves the market efficiency of Balancing, gives correct price signals and incentives to Market Participants and minimizes the costs of Balancing.

17.5.1 Flow term in the objective function / Congestions

Art.43 (1): Each TSO shall use cost effective balancing energy bids available for delivery in its control area through Common Merit Order Lists for ensuring Operational Security.

Art .45 (9): All TSOs of a Coordinated Balancing Area shall have the right to establish an Activation Optimization Function in accordance with Article 43 and Article 45 for the optimization of the activation of balancing energy bids from different Common Merit Order Lists. This function shall at least take into account:

(a) activation processes and technical constrains from different balancing energy products;
(b) operational Security;
(c) all Balancing Energy bids included in the compatible Common Merit Order Lists;
(d) the possibility to net the counteracting activation requests from TSOs;
(e) submitted activation requests of all TSOs of a Coordinated Balancing Area; and
(f) available Cross Zonal Capacity.

Art.69 (2): The Activation Optimisation Function shall

(a) respect Operational Security constraints;
(b) take into account technical and network constraints; and
(c) if applicable, take into account the available Cross Zonal Capacities.

Minimizing the flows using the flow terms function ensures the operational security. The Congestion constraints satisfy the requirements for Operational Security, technical and network constraints and the available Cross Zonal Capacities.

17.5.2 One single CMO / One-stage clearing process

Art.45 (3) Each Activation Optimization Function shall use at least one Common Merit Order List for upward balancing energy bids and one Common Merit Order List for downward balancing energy bids.

Art.45 (6): Each TSO shall submit its activation requests for Balancing Energy bids to the Activation Optimization Function

Art.45 (7): The Activation Optimization Function shall select balancing energy bids and request the activation of selected balancing energy bids from the Connecting TSOs of the respective Coordinated Balancing Area where the Balancing Service Provider, associated with the selected balancing energy bid, is connected

Art.45 (9): All TSOs of a Coordinated Balancing Area shall have the right to establish an Activation Optimization Function in accordance with Article 43 and Article 45 for the optimization of the activation of balancing energy bids from different Common Merit Order Lists. This function shall at least take into account:

- (a) activation processes and technical constrains from different balancing energy products;
- (b) Operational Security;
- (c) all balancing energy bids included in the compatible Common Merit Order Lists;
- (d) the possibility to net the counteracting activation requests from TSOs;
- (e) submitted activation requests of all TSOs of a Coordinated Balancing Area; and
- (f) available Cross Zonal Capacity.

In order to allow the possibility to net the counteracting activation requests from TSOs, as well as to utilize as much as possible the available Cross Zonal Capacity the one-stage clearing process design was selected

17.5.3 Elastic Imbalance Need

Art.43 (1): Each TSO shall use cost effective balancing energy bids available for delivery in its control area through Common Merit Order Lists for ensuring Operational Security.

Art.45 (10): All TSOs that operate the Frequency Restoration Process and the Reserve Replacement Processes to balance their Control Area shall strive for using all balancing energy bids from relevant Common Merit Order Lists to balance the system in the most efficient way taking into account Operational Security.
Allowing the TSOs to price their Imbalance Need fulfil the above two stipulations.

17.5.4 Price calculation function TERRE - Marginal Pricing

Art.42 (1) stipulates that "No later than one year after the entry into force of this Regulation, all TSOs shall develop a proposal for harmonized pricing method for balancing energy. The proposed pricing method shall be based on marginal pricing (pay-as-cleared), unless TSOs complement the proposal with a detailed analysis demonstrating that a different pricing method is more efficient for European-wide implementation pursuing the general objectives defined in Article 11"
TERRE algorithm uses marginal pricing

Art.42 (2): balancing energy prices shall not be capped […]
TERRE TSOs suggests not using price caps, only IT limits

18 Annex 2: Congestion Rent

18.1 References:

The congestion rent principals are defined in the lays down the Regulation R 714-2009 (article 16-6) and the GL EB GL EB (Article 55). The extracted references are:

- Extract from the Regulation R 714-2009 (article 16-6)

"Any revenues resulting from the allocation of interconnection shall be used for the following purposes:
(a) Guaranteeing the actual availability of the allocated capacity; and/or
(b) Maintaining or increasing interconnection capacities through network investments, in particular in new interconnectors.
If the revenues cannot be efficiently used for the purposes set out in points (a) and/or (b) of the first subparagraph, they may be used, subject to approval by the regulatory authorities of the Member States concerned, up to a maximum amount to be decided by those regulatory authorities, as income to be taken into account by the regulatory authorities when approving the methodology for calculating network tariffs and/or fixing network tariffs.
The rest of revenues shall be placed on a separate internal account line until such time as it can be spent on the purposes set out in points (a) and/or (b) of the first subparagraph. The regulatory authority shall inform the Agency of the approval referred to in the second subparagraph."

- Extract from GL EB (Article 55):

  "2. Each regulatory authority shall ensure the financial neutrality of all TSOs under its competence with regard to the financial outcome as a result of the settlement pursuant to Chapters 2 to 4 of this Title, over the regulatory period as defined by the competent regulatory authority."

18.2 Examples

An example is shown below, with two systems A and B:

- Imbalance Need (A) = 0 MW
- Imbalance Need (B) = + 200 MW
- ATC (A→B) = 100 MW

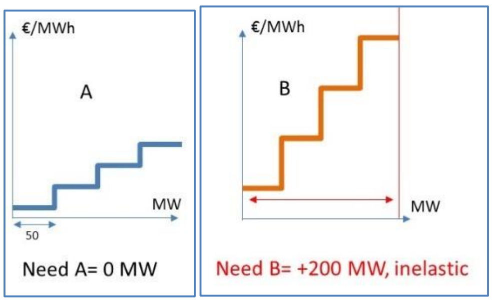

Figure 18-1: Congestion Rent - Systems

If there was infinite ATC, the CMO would be the following:

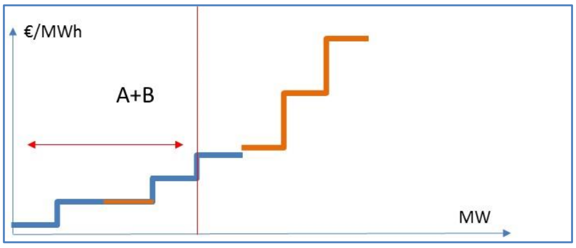

Figure 18-2: Congestion Rent - CMO

However, taking into account the ATC constraints (ATC A→B = 100MW):

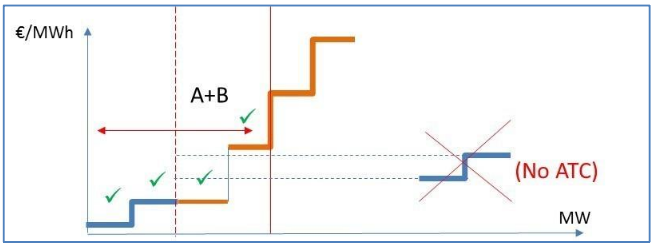

Figure 18-3: Congestion Rent – ATC constraints

Thus, the first 100MW will be activated in Area A and will be exported to Area B, which will cover the rest of the Imbalance Need with activation of 100 MW in Area B. As a result, there will be **different Marginal Prices (MP) at both sides of the interconnector** (Area A and Area B, respectively):

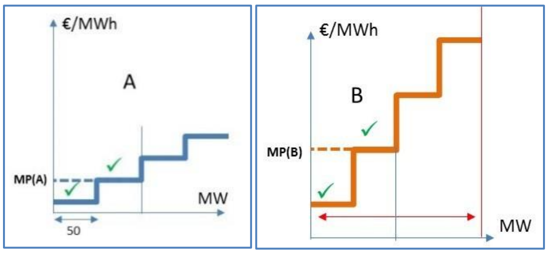

Figure 18-4: Congestion Rent – Marginal Price difference

Being MP (B) > MP (A) and energy flowing from Area A to Area B (economic sense).
In this example, the price that Area B is "willing to pay" (MP (B)) for the exchanged balancing energy (100 MW) is higher than the price that Area A is "willing to receive" (MP (A)) for exporting this energy.

TERRE congestion rent = TERRE schedule x (PB– PA)

Being: PB > PA and the TERRE schedule of balancing energy flowing from Area A to Area B.

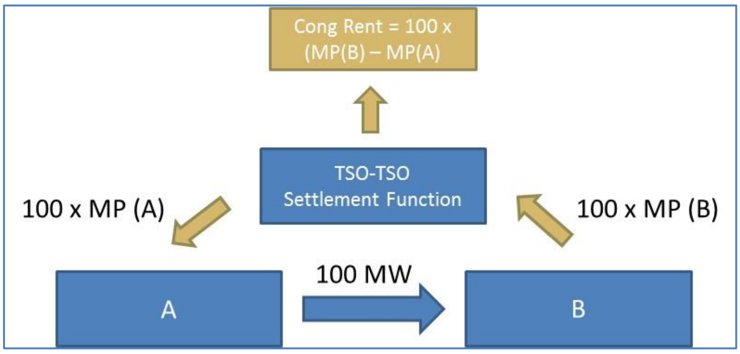

Figure 18-5: Congestion Rent

19 Annex 3: Harmonization of Caps and Floors

Example of solution through settlement

19.1 Conditions

The solution presented in this section is valid under the following assumptions:

1. Local rules are applied; hence, if a TSO does not accept negative prices, its BSPs cannot offer negative prices too.
2. The volume of all BSP offers from one system is greater or equal to the volume of its TSO need in the corresponding direction.

19.2 Solution Analysis

It has been agreed that in TERRE, marginal pricing (MP) will be used. Note here that if the MP is negative, then upward balancing energy offers with a positive price will never be activated; if they were activated, they would affect the MP and the resulting MP would be positive. In addition, if the MP is negative, then all downward balancing energy offers with a positive price (they are willing to pay for decrease their production) will be activated, as the problem maximizes the social welfare. It is easier to understand the two observations above by looking at a simplified merit order list. In reality the problem is much more complex as such merit order lists would be realistic for one time-step, divisible offers and no ATC constraints.

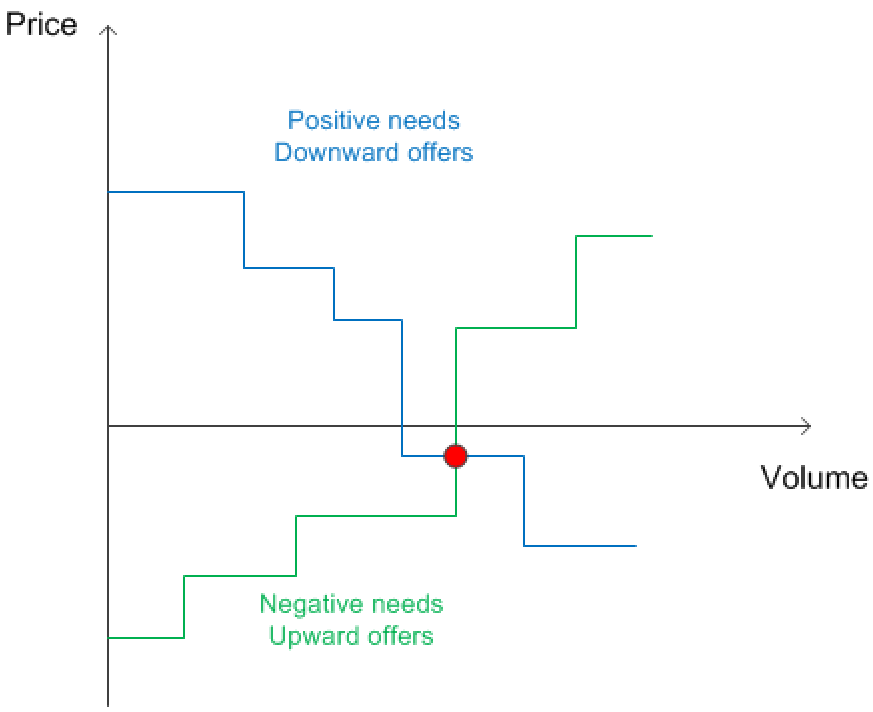

Figure 19-1: Simplified merit order list

To analyze the proposed solution, we distinguish two cases:

1. A TSO that does not allow negative prices has a positive imbalance need and

2. A TSO that does not allow negative prices has a negative imbalance need

TSO with positive imbalance need

In the following, we assume that a TSO that does not accept negative prices has a positive need. If the MP is negative, the TSO will always import from TERRE, because its upward offers (priced with positive price) will never be activated. In this case, the XB flow will have a negative price and the TSO will have a surplus. This surplus should be redistributed to its national system.

Example with MP < 0

Let's analyze an example where a TSO (A) does not accept negative prices and that has a positive need (meaning that this TSO needs upwards balancing energy). Let's consider that the need from TSO A is inelastic.

In this example, the green arrows reflect the volume of need submitted by this TSO A (UN A) and the minimum required volume of upwards offers submitted from system A (sum of all UO A; according to the assumptions of chapter 19.1, the volume of BSP offers submitted by each TSO must be greater or equal to the volume of its need in the same direction).

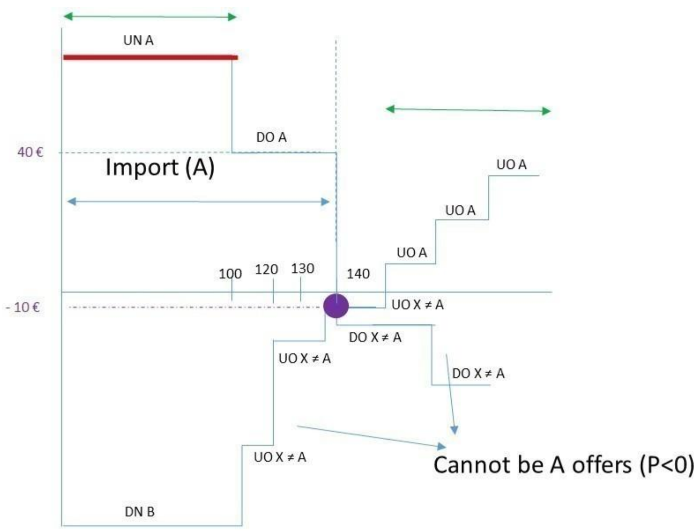

Figure 19-2: TSO with positive imbalance need - Example with MP<0

In this example:

- The result of the Balancing CMO delivers a Marginal Price (MP) with negative price (-10 €/MWh)
- All the upwards inelastic need of system A (UN A) has been satisfied
- All the volume of downwards offers of system A (DO A) has been activated (this is logic, as these offers have positive price and the resulting MP is negative)
- The result is that system A will import balancing energy

For the settlement in system A we will have the following:

TSO-TSO settlement:
The cross border balancing schedule (imported volume) will be settled with the TERRE TSO-TSO Settlement platform at the MP of -10 €/MWh (so that A will be receiving money from TERRE for importing energy).

National settlement:
As system A does not accept negative prices in local settlement rules (TSO-BSP, TSO-BRP), the price to be applied internally to BSPs and BRPs needs to be positive or zero. In this case we have two options for both the settlement of TSO-BSP (to downwards offers activated) and BRP (for the establishment of the imbalance price towards BRPs):

1. To apply the marginal balancing price of offers activated in system A (DO A; in this case 40 €/MWh)
2. To apply the local floor price in system A (in this case 0 €/MWh)

Note that, if option 1 is used for settlement with BSPs (40 €/MWh), the same price should be used for the settlement with BRPs; likewise if option 2 is applied.

Result for system A:
Regardless of the price chosen for the national settlement, for TSO A there will be a surplus resulting from all the settlements. This surplus can be then redistributed to its national system according to National rules so that TSO A will be financially neutral at the end.

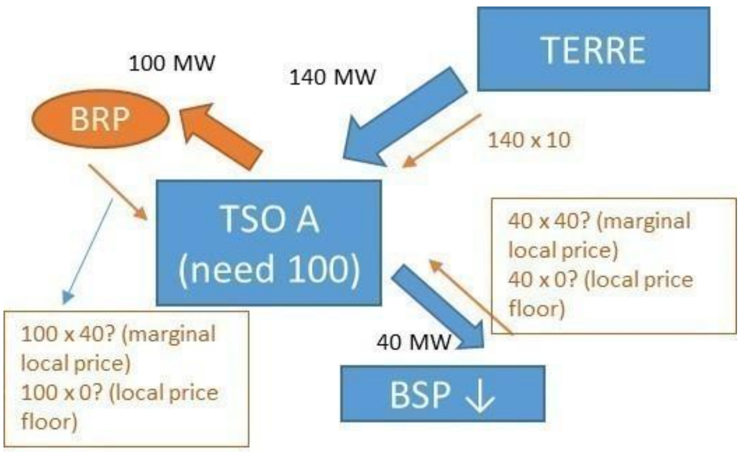

Figure 19-3: TSO with positive imbalance need - Results

Example of national settlement based on local floor (0 €/MWh):

TSO A → TERRE = 140 x (-10) = - 1400 € → TERRE → TSO A = 1400 €

BSP → TSO A = 40 x 0 = 0 €

BRP → TSO A = 100 x 0 = 0 €

Surplus A = 1400 €

Example of national settlement based on Marginal Price in system A (40 €/MWh):

TSO A → TERRE = 140 x (-10) = - 1400 € → TERRE → TSO A = 1400 €
BSP → TSO A = 40 x 40 = 1600 €
BRP → TSO A = 100 x 40 = 4000 €
Surplus A = 7000 €

TSO with negative imbalance need

In the following, we assume that a TSO that does not accept negative prices has a negative need. Here, we can distinguish the following two cases:

1. The price of the TSO need is greater or equal to zero; this automatically implies that if the price is negative, then the TSO cannot accept it. However, all the downward offers of the TSO would be activated as they would be priced with a positive price. Therefore, this TSO could not satisfy its need through TERRE; all its offers would be activated, and there could be issues of operational security if the TSO would not have other options to satisfy its need.
2. The TSO does not have other means than TERRE to satisfy its need and would be inelastic. Therefore the TSO offers a negative price (-2000€ i.e. price cap of the platform) even if the current local rules would not allow it. However, this could be crucial for its operational security

In the first case, the need of the TSO is not satisfied by TERRE if MP is negative.
In the second case, the TSO need will be satisfied as long as the TSO is inelastic. In addition, as aforementioned, all its downward offers and none of its upward offers will be activated, as they have positive price. According to the rules presented in 19.1 the volume of its downward offers should be greater or equal to the volume of the need. Therefore, in the system of the TSO that does not accept negative prices we will have only downward activation that will be at least equal to the volume of the TSO need.
For instance, if the TSO has a need equal to -100MW (needs 100MW reduction), then its downward activation (BSPs reducing their generation) will be at least equal to 100MW. Consequently, either the TSO does not import/export anything (if downward activations are equal to 100MW) or it imports (if downward activations are more than 100MW). However, as long as the rules presented in conditions are applied, this TSO will never export.
Thus, for this TSO the sum of the XB flows on its border will be zero, or will import. If it imports and the price is negative, then it has a surplus as in the case of positive imbalance need.

Example with MP < 0

Let’s analyze an example where a TSO (A) does not accept negative prices and that has a negative need (meaning that this TSO needs downwards balancing energy). Let’s consider that the need from TSO A is inelastic, meaning that the need from system A will be at a “-∞” price in the CMO.

The green arrows reflect the volume of need submitted by TSO A and the minimum required volume of downwards offers submitted from system A.

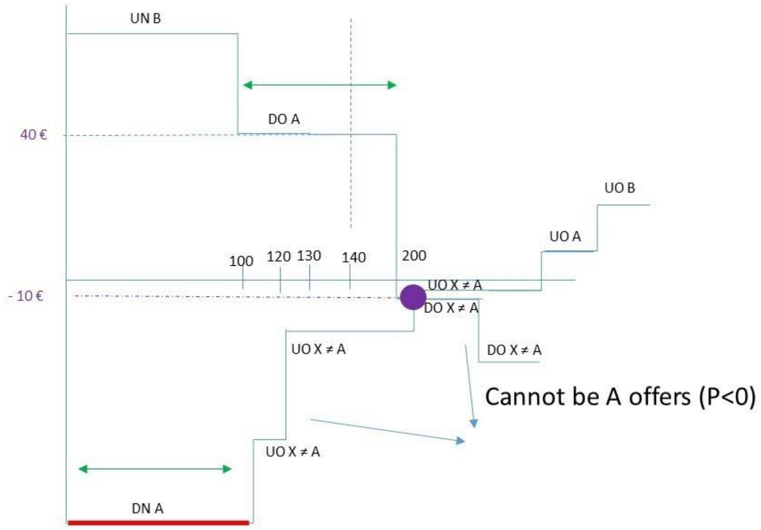

Figure 19-4: TSO with negative imbalance need - Example with MP<0

In this example:

- The result of the Balancing CMO delivers a Marginal Price (MP) with negative price (-10 €/MWh)
- All the downwards inelastic need of system A (DN A) have been satisfied
- All the volume of downwards offers of system A (DO A) has been activated (this is logic, as these offers have positive price and the resulting MP is negative).
- Taking into account the assumption of chapter 2.1, this volume of downwards offers (DO) will be equal or higher than the volume of downwards needs (DN):
  - **System A will never export** in this situation
  - **If volume of DO = volume of DN → System A will have Net Position equal to zero**
  - **If volume of DO > volume of DN → System A will import balancing energy**

In this example we assume that volume of DO = volume of DN, so the net position of A will be zero.

For the settlement in system A, we will have the following:

<u>TSO-TSO settlement:</u>
No balancing energy to be settled with the TERRE TSO-TSO Settlement platform

<u>National settlement:</u>
As system A does not accept negative prices in local settlement rules (TSO-BSP, TSO-BRP), the price to be applied internally to BSPs and BRPs need to be positive or zero. As in the previous example, we have two options for both the settlement of TSO-BSP (to downwards offers activated) and BRP (for the establishment of the imbalance price towards BRPs):

1. To apply the marginal balancing price of offers activated in system A (DO A; in this case 40 €/MWh)
2. To apply the local floor price (in this case 0 €/MWh)

Note that, if option 1 is used for settlement with BSPs (40 €/MWh), the same price should be used for the settlement with BRPs. And the same if option 2 is applied.

<u>Result for system A:</u>

Regardless the price chosen for the national settlement, the system A will be neutral or have a surplus resulting from all the settlements. This surplus can be then redistributed to its national system according to National rules so that the TSO A will be at the end financially neutral.

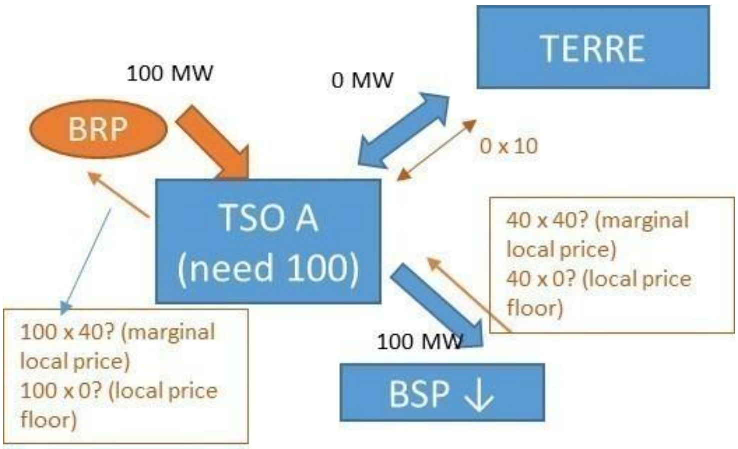

Figure 19-5: TSO with negative imbalance need - Results

Example of national settlement based on local floor (0 €/MWh):

TSO A → TERRE = 0 €

BSP → TSO A = 100 x 0 = 0 €

TSO A → BRP = 100 x 0 = 0 €

Surplus A = 0 €

Example with national settlement based on marginal price in system A (40 €/MWh):

TSO A → TERRE = 0 €

BSP → TSO A = 100 x 40 = 4000 €

TSO A → BRP = 100 x 40 = 4000 €

Surplus A = 0 €

20 Annex 4: Italian Market specificities

On the Italian electricity market, the territory is divided into Market Zones, in order to place limits on exchanges between interconnected areas with limited transit capacity. There are currently 6 “real” Market zones and 4 “virtual” Market zones.

“Real” Market zones:

- Nord
- Centro – Nord
- Centro – Sud
- Sud
- Sardegna
- Sicilia

Virtual” Market Zones:

- Brindisi
- Rossano
- Foggia
- Priolo

Figure 20-1: Market zones in Italy

21 Annex 5: CBA Assumptions

In order for the simulations to be done a number of assumptions had to be made by TSOs when collating the historical data, converting this data into the standard format required for the simulations and also in the simulation itself. This section aims to give the reader an overview of the different assumptions made at the various stages of the Cost Benefit Analysis.

21.1 Data Collection Assumptions

Common Assumptions

1. Due to complications in the data capture, days which included clock changes were deleted from the input data and all times were provided in CET
2. All data was provided in a 30min resolution which required conversions for those TSOs with 60min scheduling periods (ADMIE, REN, REE) and for those TSOs that have 15min scheduling periods (Swiss Grid and TERNA).
3. For the TSO imbalance needs only the volumes that each TSO thought they could meet with TERRE were put into the simulation. As the needs are calculated using historical activations, TSOs business processes, products and systems all influence how far before real time these activations were issued. Where TSOs were not able to disaggregate their historical activations into different anticipation times, an estimate was made as to the proportion of the imbalance needs that could be met by TERRE. For TSOs that were able to split their historical activations out into different anticipation times (RTE and NG) by using the minimum response time of the unit activated, only the activations that could satisfy the TERRE product design (FAT = 30mins) were put forward into the simulation.
4. As historical bid prices were used all prices were submitted according to the current market rules (e.g. some countries do not allow negative prices)
5. Offers from units not currently synchronized had to able to reach their technical minimum within 30mins
6. The ATC was calculated for each 30min time unit, as the cross border scheduling steps for the intra-day market are currently 1 hour, the ATC values are the same for two 30min time unit. These values were calculated for each border for each direction by comparing the scheduled flow as a result of the intra-day market against the technical maximum in each direction, taking into account system outages during the 2013 period.
7. BALIT data isn’t included. TSO-BSP offers between France and Switzerland are included on the Swiss side. The TSO-BSP offers for Germany and Switzerland are not taken into account.

ADMIE

1. Only offers from lignite and gas units were put into the data collection
2. Due to the lack of an organised balancing market the TSO imbalance need has been determined by comparing the Day Ahead schedule with the measured production of above mentioned units
3. The minimum response time of the different units offering into TERRE was calculated using a Volume Weighted Average Ramp-rate plus an additional two minutes to receive the instruction.
4. The minimum activation time for lignite units was assumed for be 60mins and for gas units this was assumed to be 0mins
5. Due to the lack of an organised balancing market the prices for downward offers were assumed to be equal to the unit variable cost. Prices for upward offers were assumed to be equal to unit variable cost plus 10%.
6. For lignite units the upward volumes for submitted offers were calculated as the difference of the Net Capacity and the Day Ahead schedule. Downward volumes are calculated as the difference of the Day Ahead schedule and the Technical Minimum.
7. For gas units the upward volumes are calculated as the difference of the Net Capacity and the Actual Net Production. Downward volumes are calculated as the difference of the Actual Net Production and the Technical Minimum.

National Grid

1. Due to the fact that the GB Balancing Mechanism is used for both balancing and system management actions, only the activations used for energy purposes were used to determine the NG imbalance needs.
2. Minimum response time was assumed to be same for all units rather than providing individual response times for each unit.
3. A minimum activation time of 0mins was assumed for all units
4. All prices for offers converted into € from £ using an exchange rate of 0.85 £/€, which was the Bloomberg average for 2013.
5. Units that were contracted to provide Firm Frequency Response were given a default price of 2000€ or -2000€ depending on the direction, for all periods during contract dates.
6. Nuclear and wind generation have been excluded from the upward volume with volumes and prices both set to zero. Nuclear generation has also been omitted from downward volume, whereas wind was included for downward availability.

REE

1. As a standard 15min product is used for the volume considered to constitute the TERRE imbalance need, the minimum response time for all units offering volume was assumed to be 15mins.
2. The minimum delivery period was specified by the BSP for each period

REN

1. For CCGT units a Weighted Average Ramp was used to determine the minimum response time. For Hydro units this was assumed to be a fixed value.
2. A minimum activation time of 0mins was assumed for all units

RTE

1. The minimum response time was provided by each BSP for each 30min settlement period to deliver the offered volume.
2. The hydraulic pumped energy transfer stations (STEP) was deleted from the offers and thus need volume, as they present complex energy constraints that can't be integrated in the algorithm in a first step. They represent a great volume of activation for balancing for France that can explain the small imbalance need volume submitted into TERRE for France.
3. Only the already started unit could offer a volume into TERRE, as we took into account the starting time of the units.
4. The primary and secondary French reserves are taken off the offered and thus need volume.
5. The minimum delivery period was specified by the BSP for each period

SwissGrid

1. As a standard 15min product is used for the volume considered to constitute the TERRE imbalance need, the minimum response time for all units offering volume was assumed to be 15mins.
2. A minimum activation time of 0mins was assumed for all units

TERNA

1. Only offers from the North Italian bidding zone were considered for the purposes of the simulation
2. Only three types of units were considered for the technical parameters, hydro, pump and thermal.
3. For the minimum response time a standard value of 15mins was assumed for thermal units and a value of 5mins for hydro units.
4. A minimum activation time of 15 mins was assumed for all units

21.2 Data Conversion Assumptions

1. TSOs provided both separate upwards and downwards imbalance needs for each 30 minute time step. In order to get a single net imbalance figure for each 30 minute time step these imbalance needs in each direction were compared to calculate the net imbalance need. The mean of these was then taken for each one hour period.
2. Using the information provided by the TSOs, the imbalance needs were filtered to only provide the volume of needs that could be satisfied by TERRE. The offers were also filtered to only include units with a Minimum Activation Time (MAT) and Minimum Response Time (MRT) that was compliant with the TERRE product characteristics (i.e. MAT =<60mins and MRT =<30mins).

3. All TSO imbalance need were assumed to be inelastic, thus were set to a default price of 2000€/-2000€. The imbalance need is constant over the hour and unidirectional.
4. All offers were assumed to be divisible and exclusive.

21.3 Simulation Assumptions

1. TSOs provided both separate upwards and downwards imbalance needs for each 30 minute time step. In order to get a single net imbalance figure for each 30 minute time step these imbalance needs in each direction were compared to calculate the net imbalance need for each period.
2. The simulation doesn't take into account any potential stock constraints, which set a limit to the total volume of MW that can be instructed during a given period (e.g. some hydro units).
3. Counter-activations are allowed
4. The Marginal Price is calculated for each bidding zone, which will be the same in the absence of congestion
5. The algorithm has one clearing, that is to say that it optimises on the entire time period (one hour) at the same time.

22 Annex 6: The Input Data for the CBA simulation

22.1 TSO Imbalance Needs

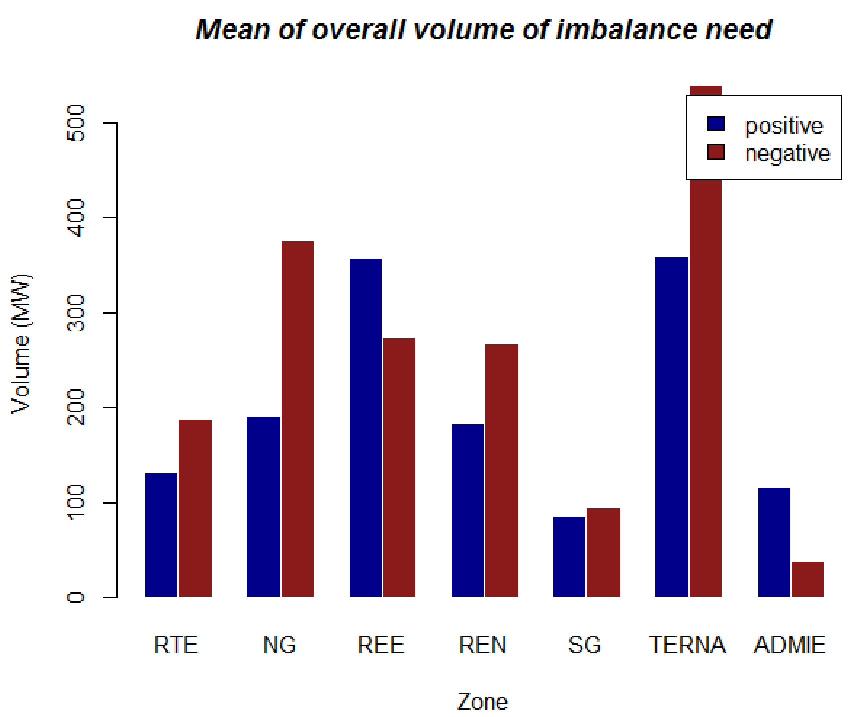

Figure 22-1: Mean Overall imbalance Volumes

This is the arithmetic mean of the imbalances upwards and downwards in isolation over the year in MW. SG has the smallest upward imbalance with REE and TERNA; the largest. On the downward side TERNA again has the largest imbalance and Greece the smallest.

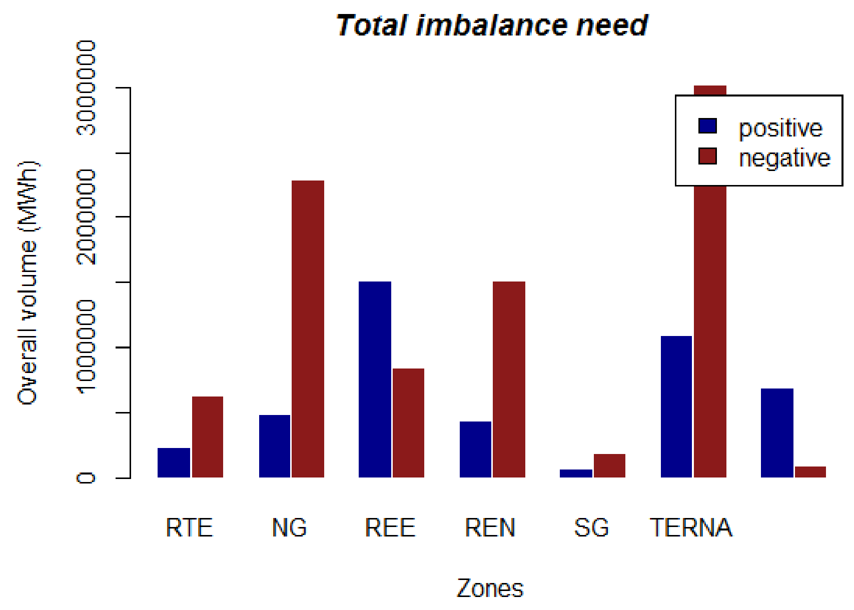

Figure 22-2: Total Imbalance Needs

In line with the assumptions outlined in Annex 5, Figure 22-2 illustrates the total imbalance need separated upwards and downwards. The REE has the largest positive imbalance with SG having the smallest.

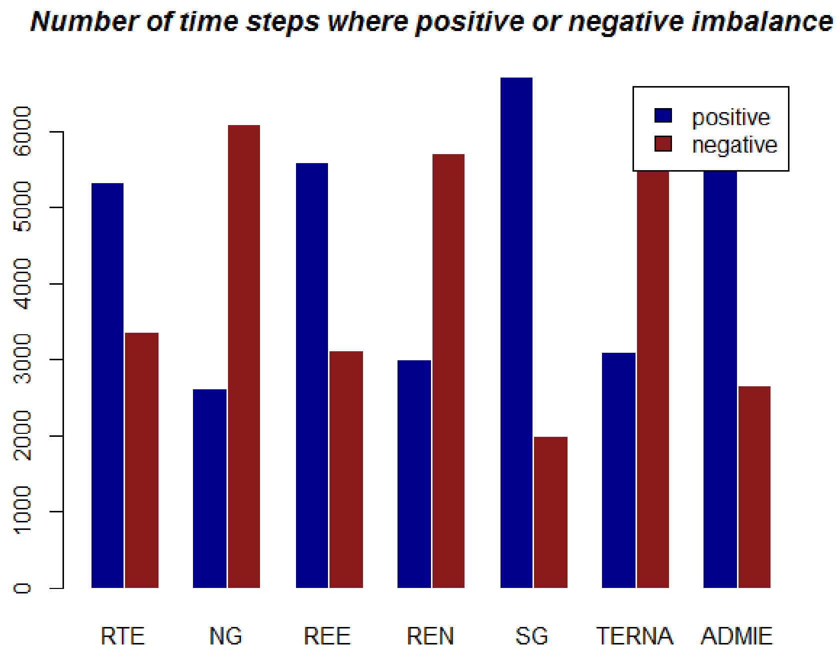

Figure 22-3: Number of time steps need positive/negative

Another method of presenting the TSO imbalance needs is showing the number of time steps (one hour) whether the imbalance is zero, positive or negative. A key observation is that there are no time steps where TSOs have zero imbalances.

22.2 BSP offers

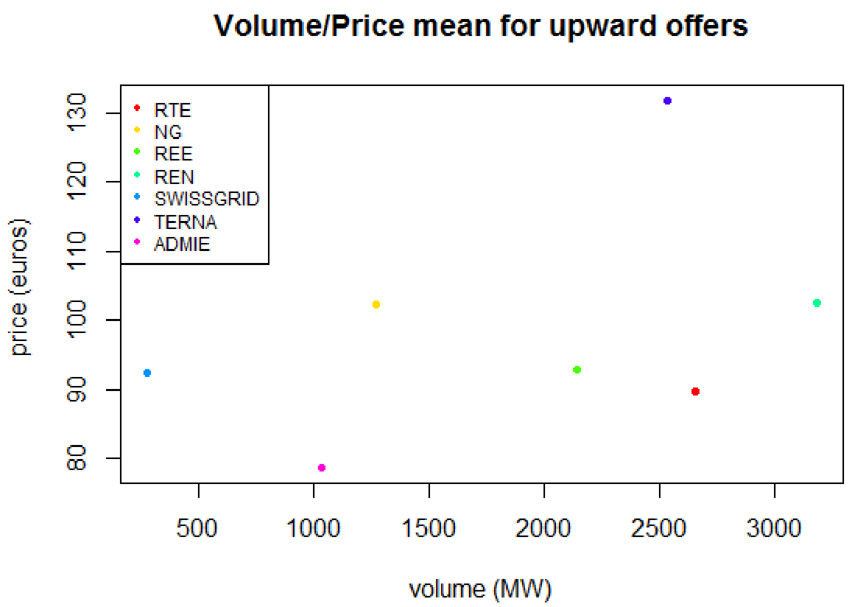

Figure 22-4: Volume/Price Mean for Upwards offers

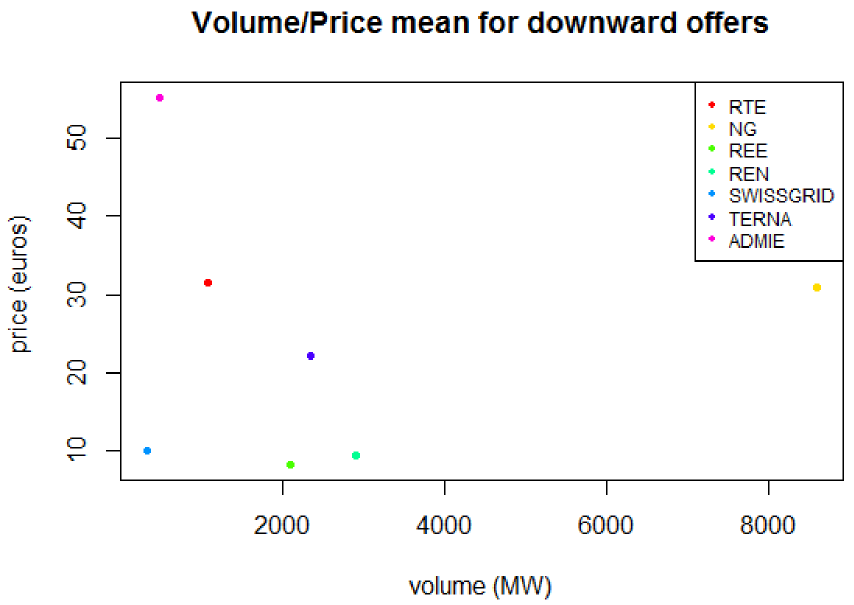

Figure 22-5: Volume/Price Mean for downward offers

These two figures plot the mean volume and price of upwards and downwards offers for each country. As shown in figure 23.4 TERNA has the most expensive upwards offers and REN the highest volume. In figure 23.5, NG has the highest downward volume and ADMIE has the highest priced downward offers.

22.3 ATC

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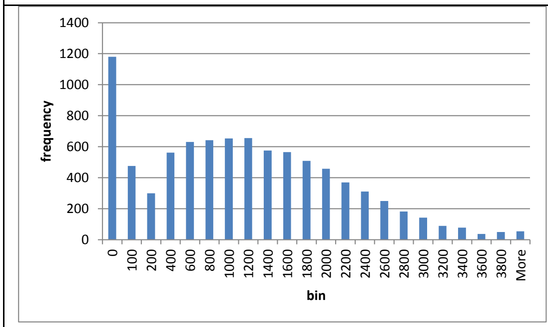
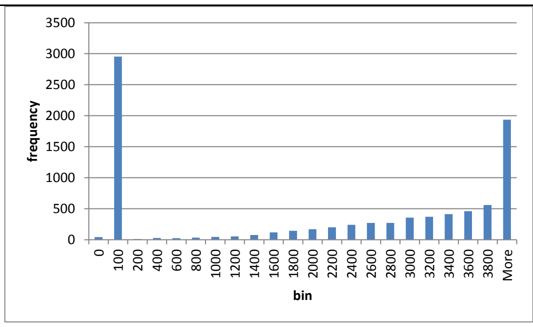
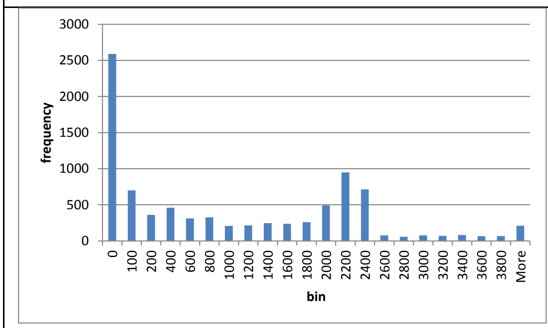
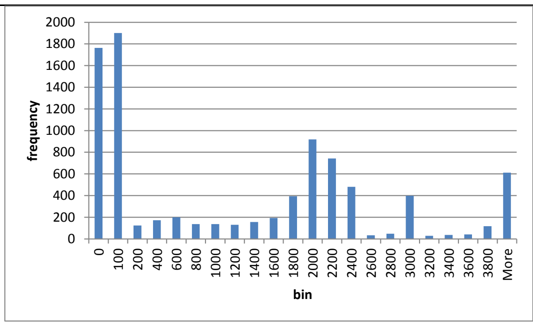
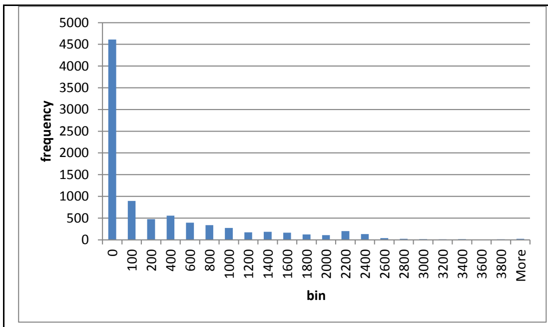
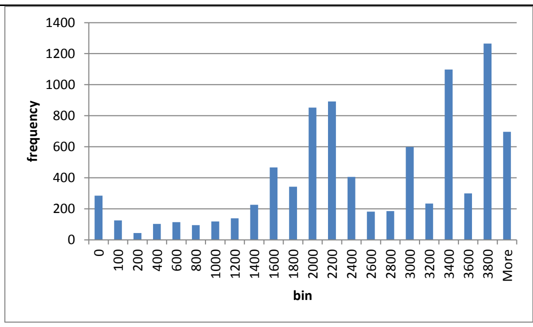
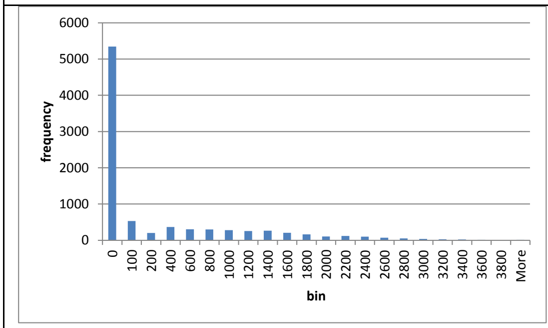
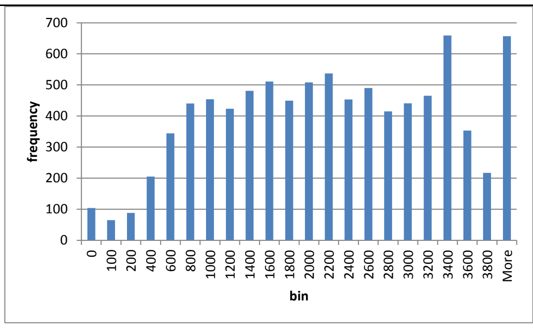
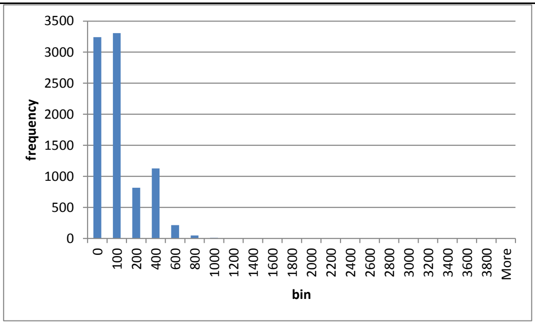
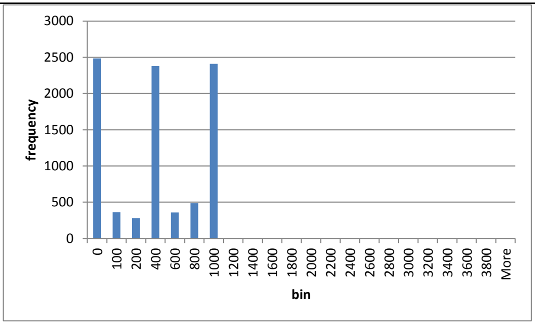
	
FR-ES	ES-FR
	
FR-IT	IT-FR

frequency bin	frequency bin
CH-IT	IT-CH
frequency bin	frequency bin

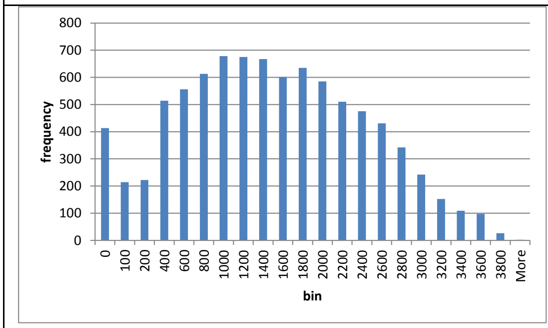
GR-IT



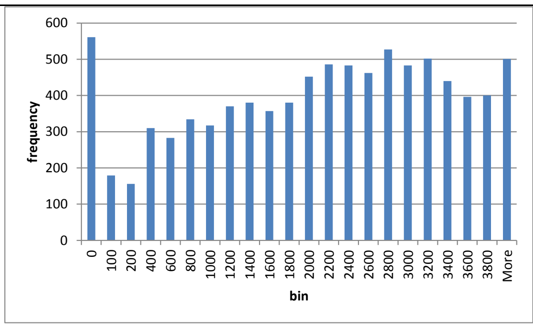
IT-GR



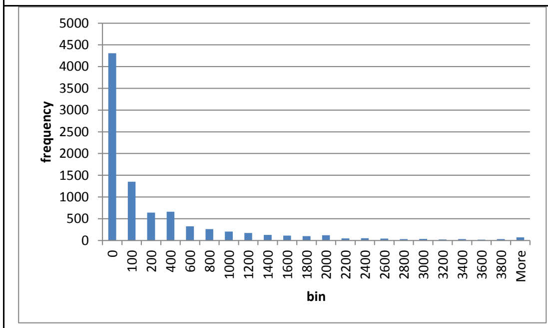
SP-PT



PT-SP



FR-UK



UK-FR

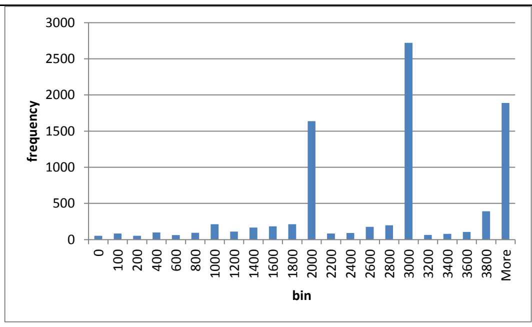
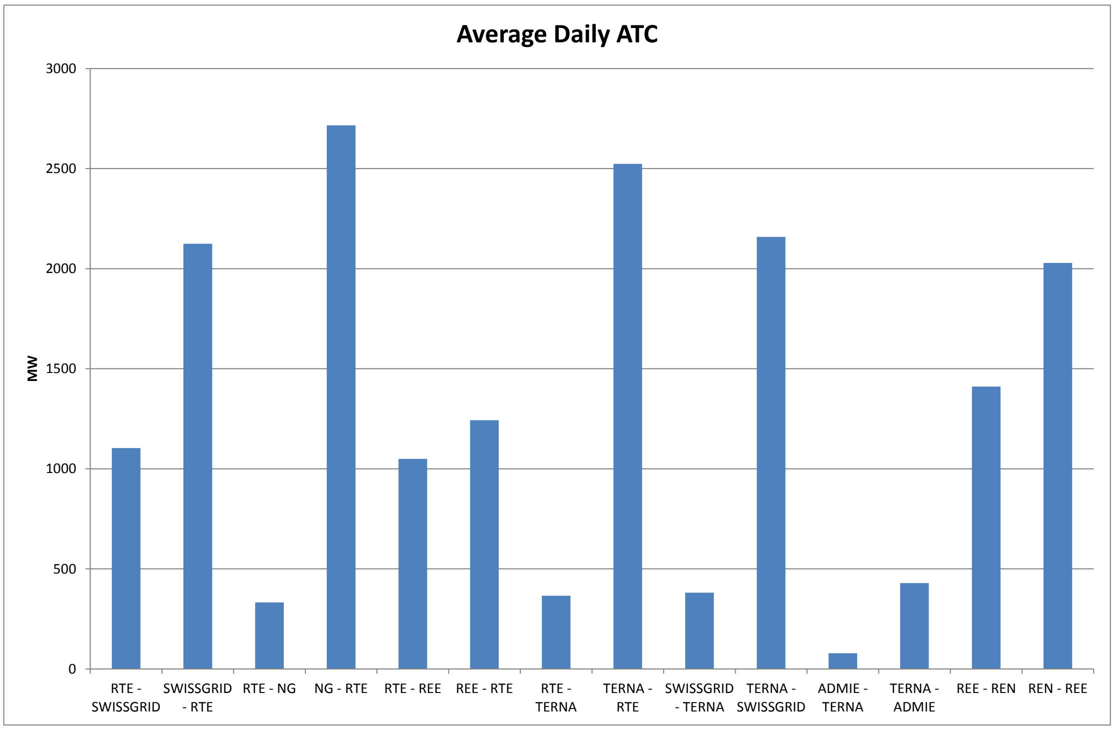
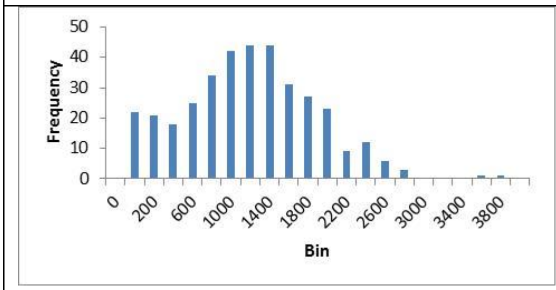


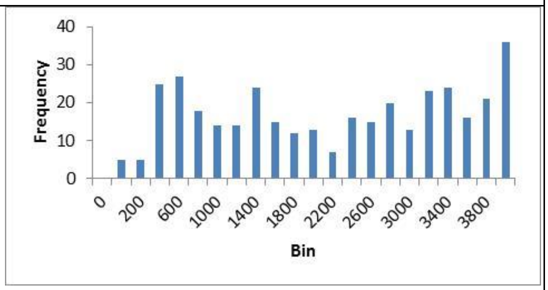
Figure 22-6: Histogram of ATC across the year



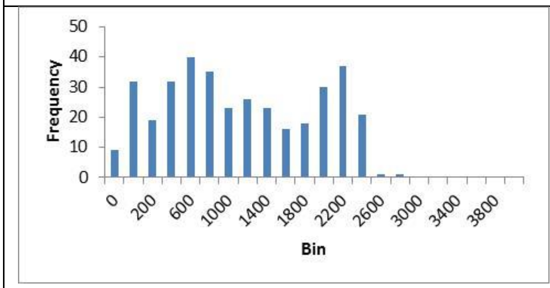
FR-CH



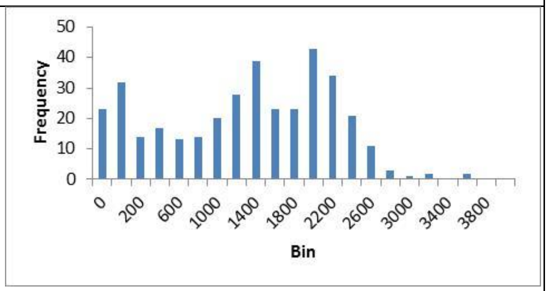
CH-FR



FR-ES



ES-FR



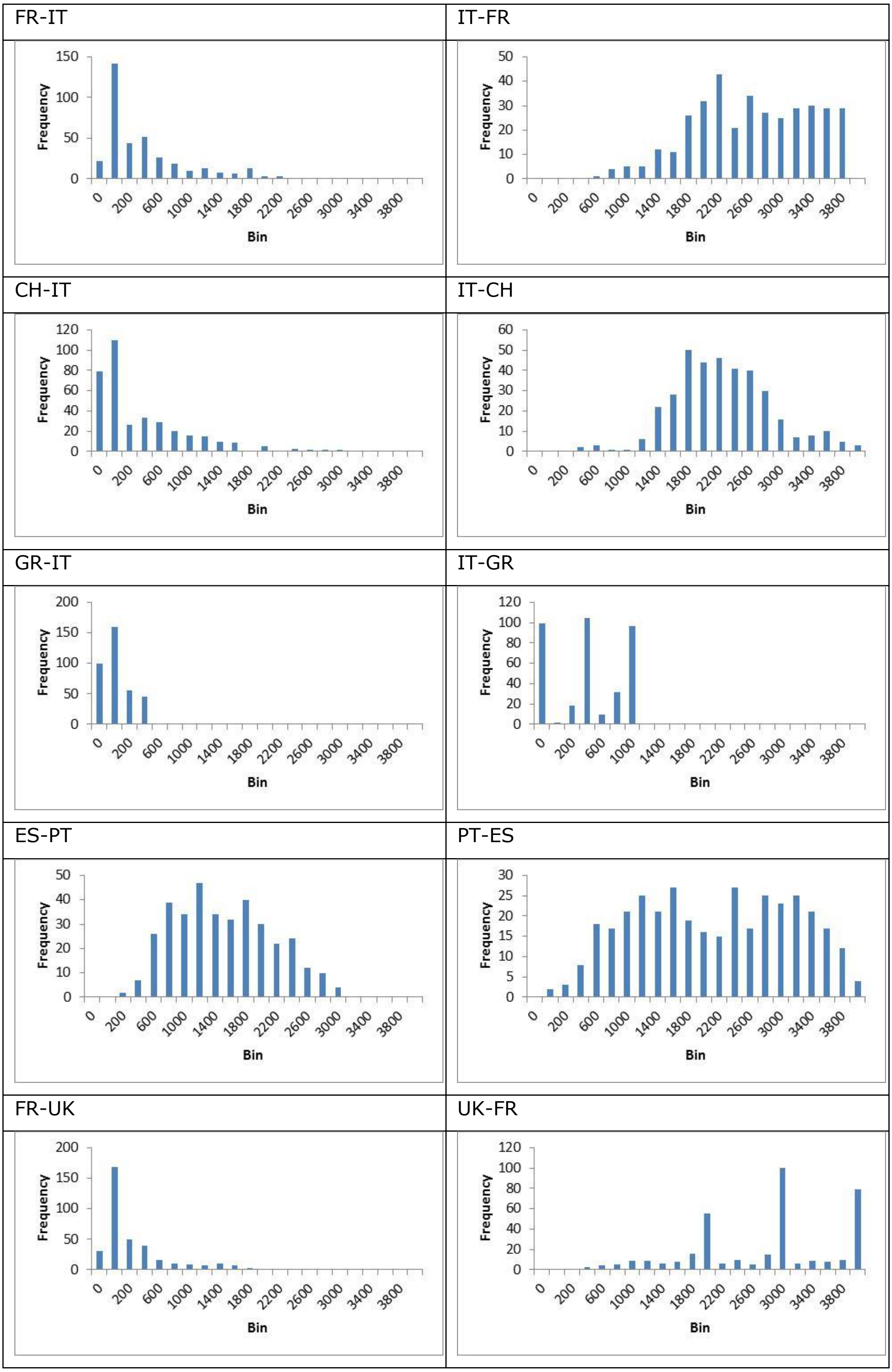


Figure 22-7: Histogram average per day ATC per border

23 Annex 7: Transparency Requirements

Please find below the extracted information from the Transparency Regulation paper (Art. 17).

At a XB level:

(j) if applicable, information regarding Cross Control Area Balancing per balancing time unit, specifying: — the volumes of exchanged bids and offers per procurement time unit, — maximum and minimum prices of exchanged bids and offers per procurement time unit, — volume of balancing energy activated in the control areas concerned.	(i) in point (j) of paragraph 1 shall be published no later than one hour after the operating period.

At National level:

(a) rules on balancing including: — processes for the procurement of different types of balancing reserves and of balancing energy, — the methodology of remuneration for both the provision of reserves and activated energy for balancing, — the methodology for calculating imbalance charges, — if applicable, a description on how cross-border balancing between two or more control areas is carried out and the conditions for generators and load to participate;	
(b) the amount of balancing reserves under contract (MW) by the TSO, specifying: — the source of reserve (generation or load), — the type of reserve (e.g. Frequency Containment Reserve, Frequency Restoration Reserve, Replacement Reserve), — the time period for which the reserves are contracted (e.g. hour, day, week, month, year, etc.);	(a) in point (b) of paragraph 1 shall be published as soon as possible but no later than two hours before the next procurement process takes place;

(c) prices paid by the TSO per type of procured balancing reserve and per procurement period (Currency/MW/period);	(b) in point (c) of paragraph 1 shall be published as soon as possible but no later than one hour after the procurement process ends;
(d) accepted aggregated offers per balancing time unit, separately for each type of balancing reserve;	(c) in point (d) of paragraph 1 shall be published as soon as possible but no later than one hour after the operating period;
(e) the amount of activated balancing energy (MW) per balancing time unit and per type of reserve;	(d) in point (e) of paragraph 1 shall be published as soon as possible but no later than 30 minutes after the operating period. In case the data are preliminary, the figures shall be updated when the data become available;
(f) prices paid by the TSO for activated balancing energy per balancing time unit and per type of reserve; price information shall be provided separately for up and down regulation;	(e) in point (f) of paragraph 1 shall be published as soon as possible but no later than one hour after the operating period;
(g) imbalance prices per balancing time unit;	(f) in point (g) of paragraph 1 shall be published as soon as possible;
(h) total imbalance volume per balancing time unit;	(g) in point (h) of paragraph 1 shall be published as soon as possible but no later than 30 minutes after the operating period. In case the data are preliminary, the figures shall be updated when the data become available;
(i) monthly financial balance of the control area, specifying: — the expenses incurred to the TSO for procuring reserves and activating balancing energy, — the net income to the TSO after settling the imbalance accounts with balance responsible parties;	(h) in point (i) of paragraph 1 shall be published no later than three months after the operational month. In case the settlement is preliminary, the figures shall be updated after the final settlement;