



# **eBADGE balancing market simulator - user manual**

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## Table of Acronyms

<b>Acronym</b>	<b>Meaning</b>
<b>AT</b>	Austria
<b>BSP</b>	Balancing Service Provider
<b>CN</b>	Centre-North (Italian zone)
<b>CS</b>	Centre-South ((Italian zone)
<b>ENTSO-E</b>	European Network of Transmission System Operators for Electricity
<b>HTTPS</b>	secure Hyper-text Transfer Procotol
<b>ICT</b>	Information and Communication Technology
<b>IP</b>	Internet Protocol
<b>NO</b>	North (Italian zone)
<b>PTDF</b>	Power Transfer Distribution Factor
<b>SA</b>	Sardinia (Italian zone)
<b>SI</b>	Slovenia
<b>SU</b>	South (Italian zone)
<b>TSO</b>	Transmission System Operator

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## Glossary

**APG:** Austrian Transmission System Operator

**BSP-TSO Model:** A model for exchange of Balancing Energy where the requesting Transmission System Operator has an agreement with a Balancing Service Provider in another Relevant Area.

**ELES:** Slovenian Transmission System Operator

**ENTSO-E:** The European Network of Transmission System Operators for Electricity (ENTSO-E) represents all electric TSOs in the EU and others connected to their networks, for all regions, and for all their technical and market issues. The ENTSO-E got the assignment to develop the network codes by Agency for the Cooperation of Energy Regulators.

**Imbalance Netting:** This mechanism avoids that balancing energy in different TSOs' control areas are activated in opposite direction.

**PTDF:** it is a matrix that is used to model the parallel flows' constraints on meshed networks; for a further description of this matrix please see [1] and [2];

**TERNA:** Italian Transmission System Operator

**TSO-TSO Model:** In a TSO-TSO model the BSPs offer balancing services to the TSO. For details see the deliverable of WP2.1.

**Unshared Bids:** An energy bid of a Standard Product or a Specific Product sent by a Balancing Service Provider to its Transmission System Operator which is not available for activation by other Transmission System Operators.

**Virtual Power Plant:** a cluster of dispersed generator units, controllable loads and storages systems, aggregated to operate as a unique power plant.

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## Executive Summary

Within the project eBADGE, the Work Package 2 has investigated market architectures for cross-border procurement and activation of balancing capacity and balancing energy in Europe (deliverable D2.1). In parallel, an online simulator has been developed and it is available for a public usage. This online simulator is related to the transnational market model described in deliverable D2.3.

The present deliverable is the user manual for the usage of the online simulator.

This report is organised as follows:

- chapter 1: Introduction and scope of the document,
- chapter 2: description of how to log and register,
- chapter 3: description of the Balancing Market Simulator interface,
- Appendix: two examples are presented in order to show the functionalities of the simulator.

## 1. Introduction and scope of the document

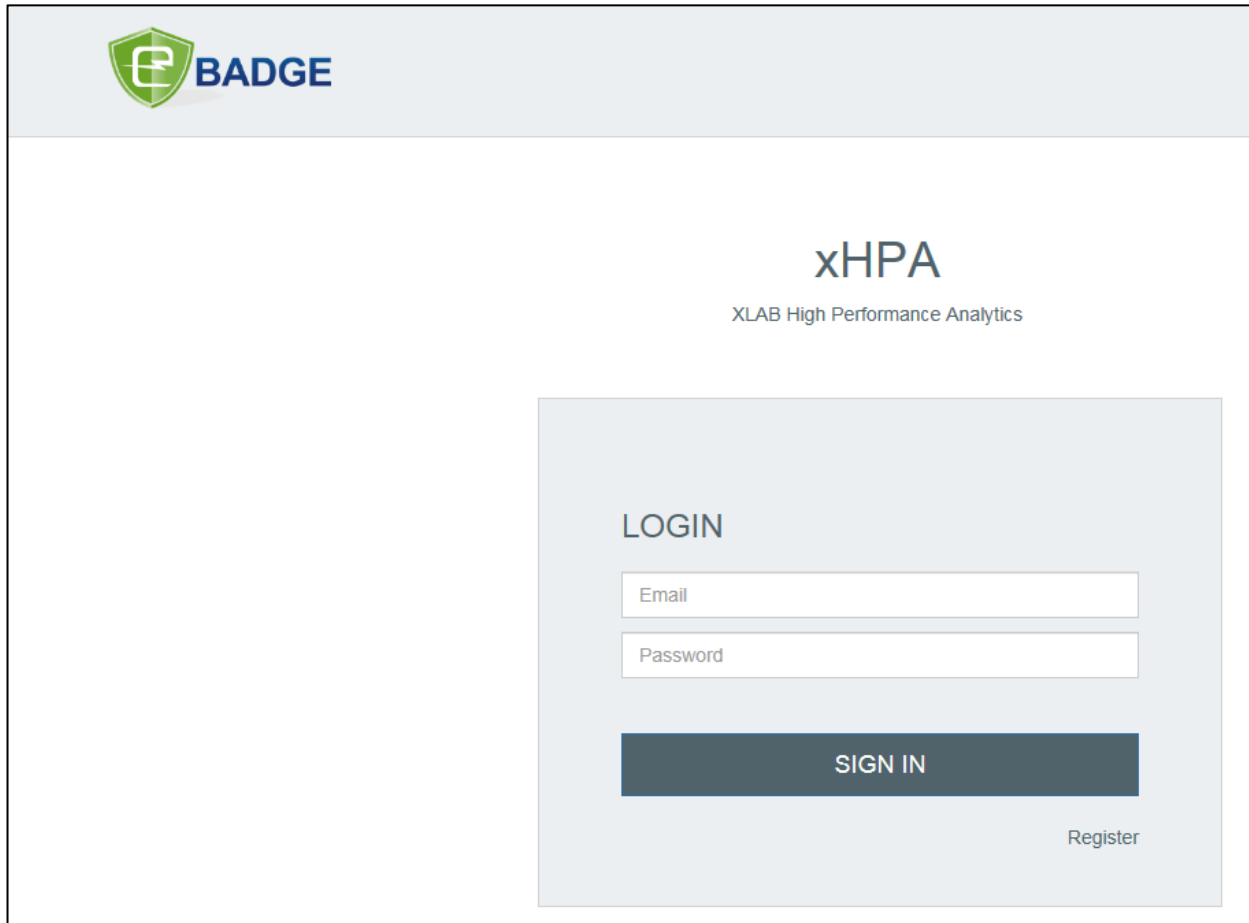
This deliverable aims to provide instruction to the usage of the online eBadge simulator, describing how a user can create a new scenario, validate input values, run the simulator and analyse results. The “philosophy” of the simulator is to model only the trans-national balancing energy market. Thus, the simulator of the only balancing energy market works as a real-time power dispatch, in which imbalance values are known before the activation for each modelled zone and the secondary and tertiary energy bids are called on the basis of a price merit order up to eliminate all system imbalances. The amount of cross-border capacity still not allocated after the intraday trading is assumed as available for the exchange of balancing energy. For a full description of the simulator please read [1]. The simulator puts in the same “basket” secondary and tertiary bids, in order to simplify the usage and the required input data.

In chapter 2 it is described how to login the simulator and to register. Chapter 3 explains how to operate the market simulator. The appendix includes two examples with explanation of the input parameters and results after performing the simulation.

## 2. Login and Registration

In the following the individual steps how to login and register are explained and illustrated in detail:

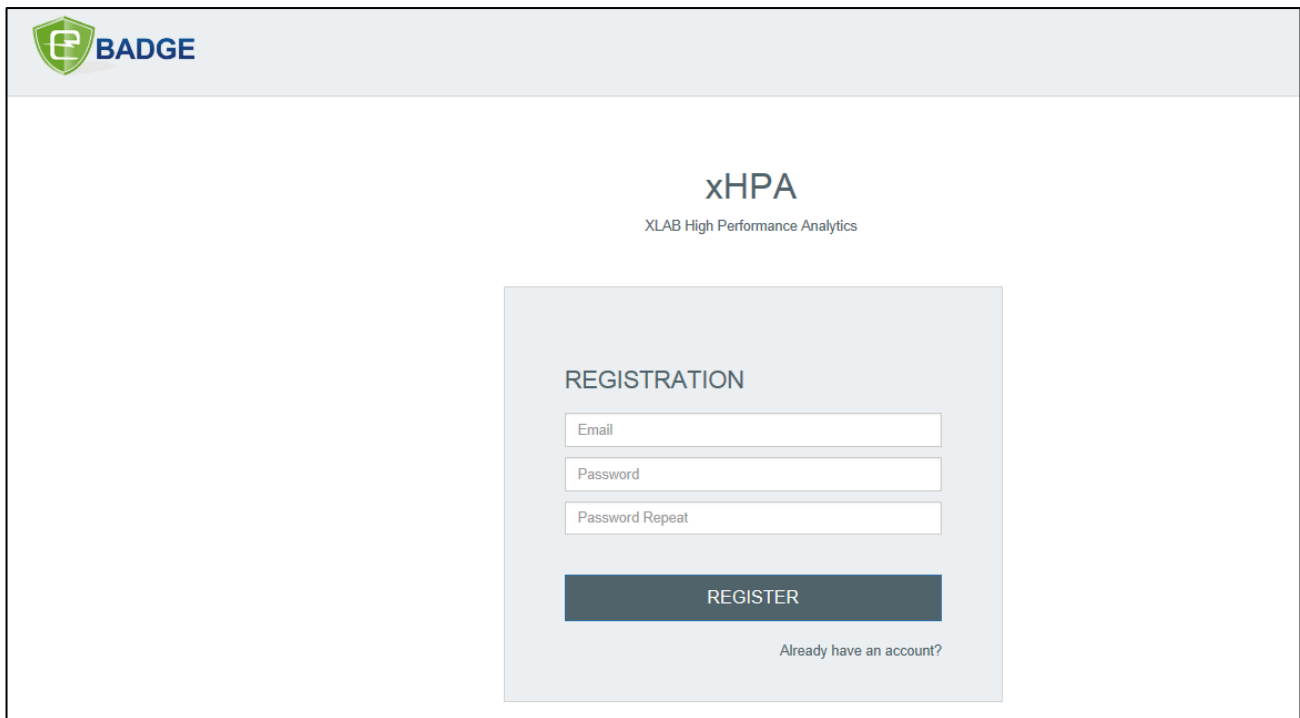
1. Open the following page: <https://ebadge-simulator.xlab.si/> and sign in (if you have already registered) or click on the button 'Register' as shown in Figure 1.



The screenshot shows the xHPA (XLAB High Performance Analytics) login and registration interface. At the top left is the eBADGE logo. The main heading is 'xHPA' with the subtitle 'XLAB High Performance Analytics'. Below this is a 'LOGIN' section with two input fields: 'Email' and 'Password'. A dark blue 'SIGN IN' button is positioned below the fields. To the right of the 'SIGN IN' button is a 'Register' link.

**Figure 1: Login and Registration**

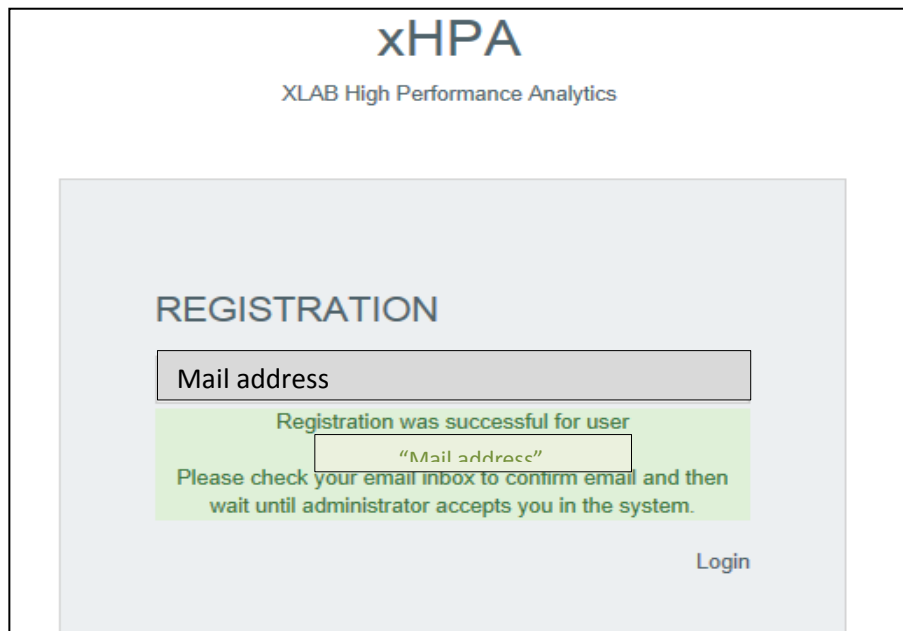
2. Fill out the mandatory fields of the user registration form and click on the register button (Figure 2).



The screenshot shows the xHPA registration interface. At the top left is the eBADGE logo. The main heading is 'xHPA' with the subtitle 'XLAB High Performance Analytics'. The central form is titled 'REGISTRATION' and contains three input fields: 'Email', 'Password', and 'Password Repeat'. Below these fields is a dark blue 'REGISTER' button. At the bottom right of the form area, there is a link that says 'Already have an account?'.

**Figure 2: Registration Form**

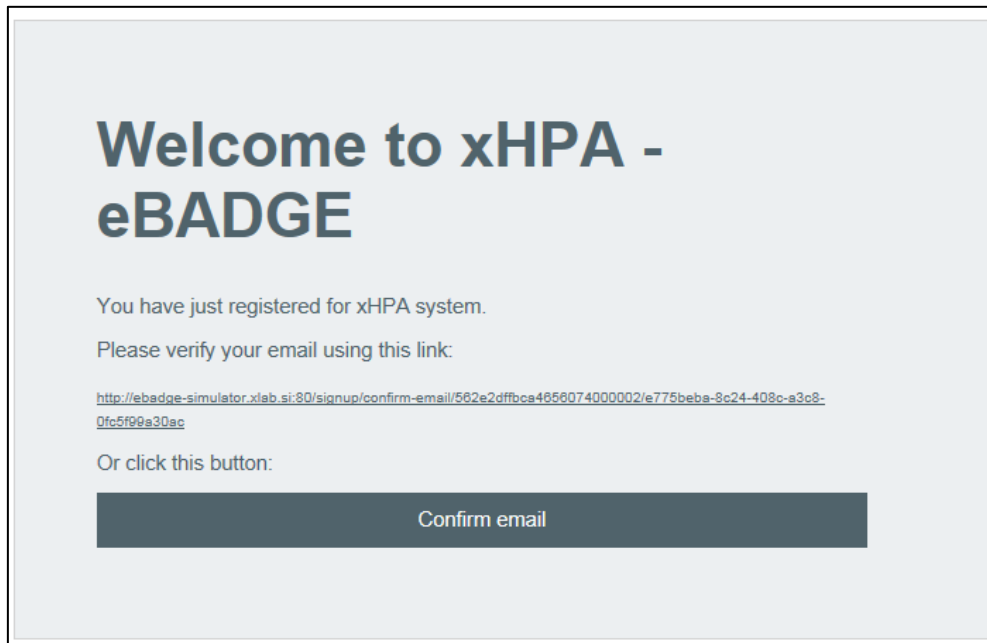
3. After clicking on the register button the message shown in Figure 3 will appear and once the registration is confirmed by the administrator an automatic e-mail will be sent to the mailbox indicated in the registration form.



The screenshot shows the xHPA registration success message. At the top left is the eBADGE logo. The main heading is 'xHPA' with the subtitle 'XLAB High Performance Analytics'. The central form is titled 'REGISTRATION'. Below the title is a grey box containing the text 'Mail address'. Below this is a green box with the text: 'Registration was successful for user', followed by a smaller box containing the text '"Mail address"', and then 'Please check your email inbox to confirm email and then wait until administrator accepts you in the system.' At the bottom right of the form area, there is a 'Login' button.

**Figure 2: Message appears after clicking on the register button**

4. Click on the link in the e-mail or click on the button »Confirm email«.



**Figure 4: Content of the confirmation e-mail**

5. The registration process is now completed. You can now login with your email address and password you've just created by clicking "Sign In" on the first page.

### **3. Balancing Market Simulator**

The following section describes how to operate the ebage balancing market simulator in term of creating the inputs data and performing the analysis.

After a successful login (see chapter 2) the main window opens, as shown in Figure 5. It is divided into two sections "My Inputs" and "Analysis"



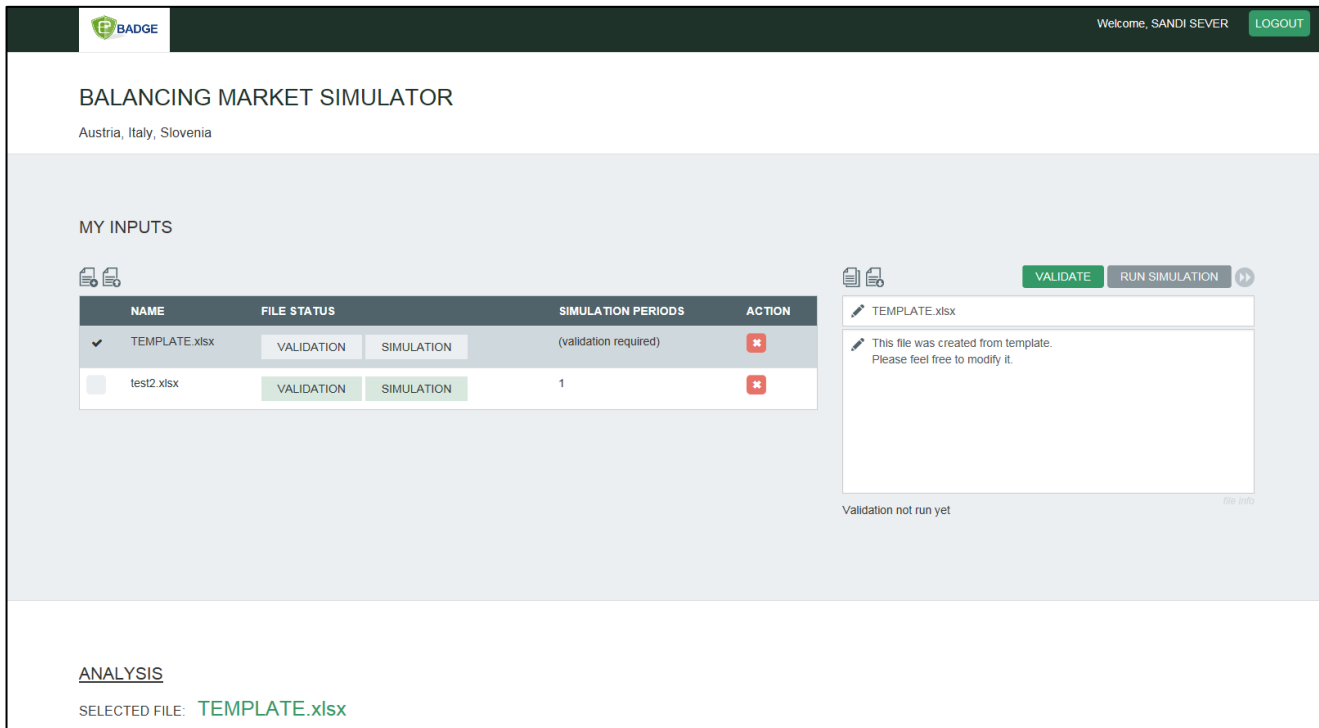


Figure 5: Main Window

### 3.1 My Inputs

The purpose of the “My Inputs” section is to create an input file with data, which will be used later in order to perform a simulation.

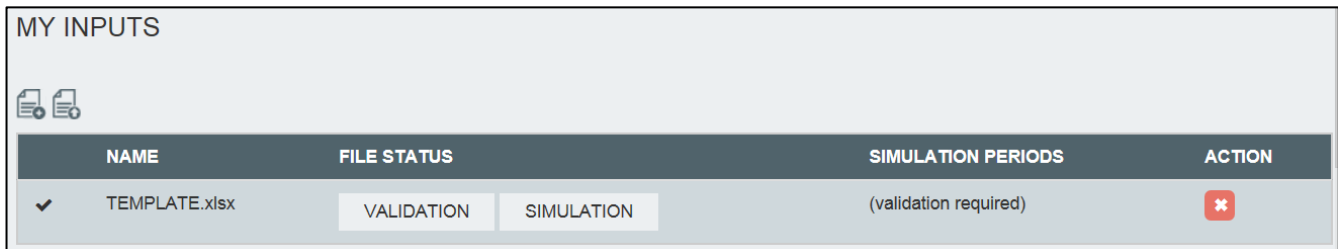

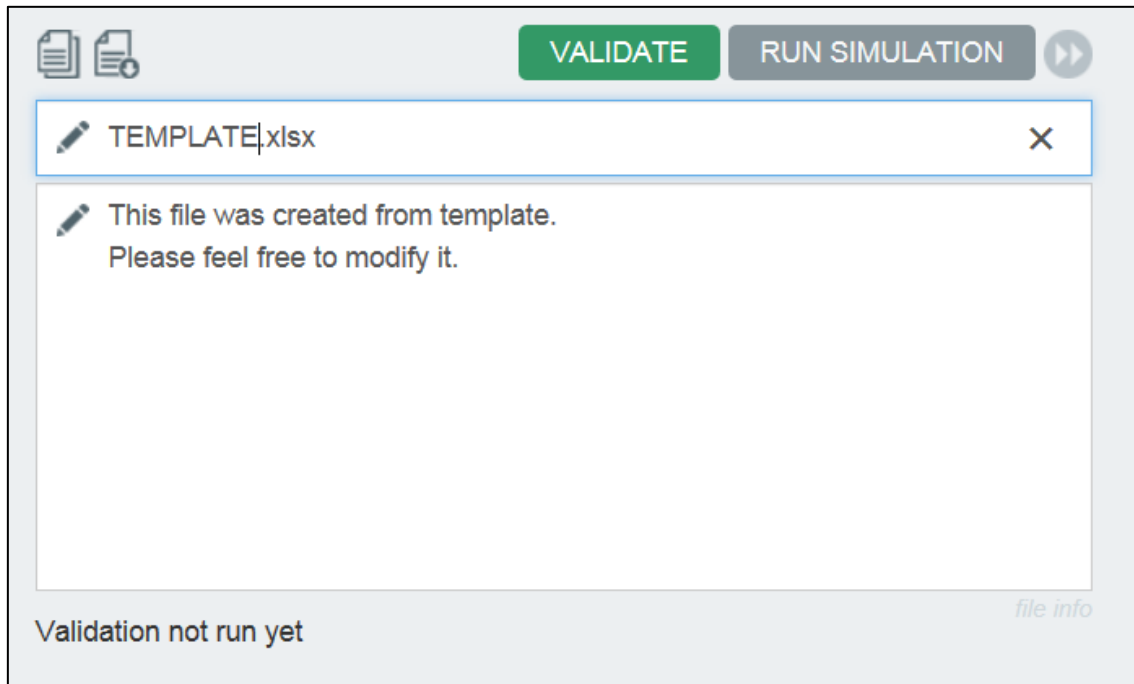


Figure 6: My Inputs section

On the left-top corner there are two icons:

- The first on the left can be used in order to **“create input file from template”**: clicking on it a new line is created with the input file “TEMPLATE.xlsx”; if there are more input files, the symbol “” means that this is the selected input.
- The icon on the right can be used in order to **“upload input file”** already available on the computer.

The right part of the “My Input” section is used to “VALIDATE and RUN SIMULATION” on the input file (Figure 7).



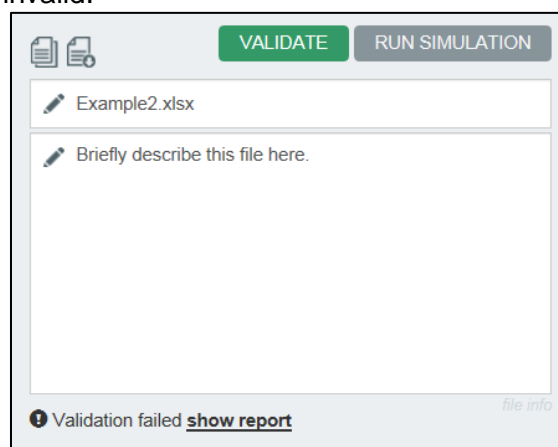
**Figure 7: VALIDATE and RUN SIMULATION**

On the left-top corner (see figure 7) there are two icons:

- With the first icon on the left it is possible to “Duplicate” any input file.
- The icon on the right can be used in order to “Download” any input file on your computer.

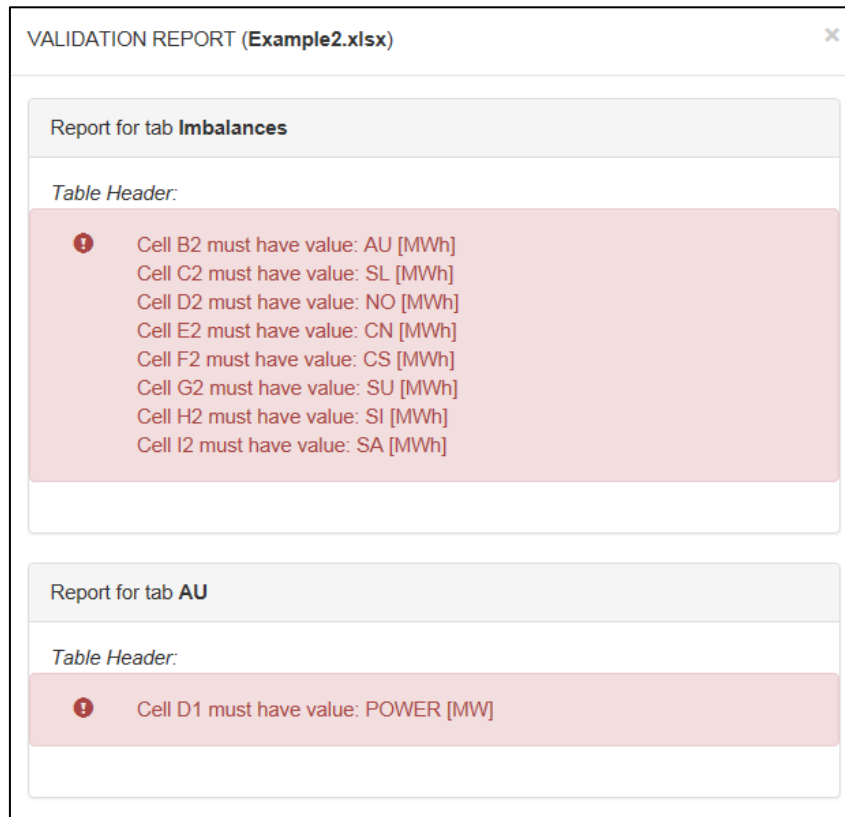
In the window below it is possible to change the name of the input file and add a short description of the input file.

On the right-top corner there are two icons: “VALIDATE” and “RUN SIMULATION”. Before validating, it is possible to edit the inputs and section 3.2 describes how. Clicking on the “VALIDATE” icon a check of all the input data is done in order to verify that the simulation can be performed without errors related to the input form of data. If the validation is successful, the “RUN SIMULATION” icon is activated, and the “VALIDATE” icon is deactivated. Otherwise the message “Validation failed” is shown with a link to the description of why the input is invalid.



**Figure 8: Validation error**

By clicking on ‘show report’ the errors are shown (see Figure 9)



VALIDATION REPORT (Example2.xlsx) ×

Report for tab **Imbalances**

Table Header:

- Cell B2 must have value: AU [MWh]
- Cell C2 must have value: SL [MWh]
- Cell D2 must have value: NO [MWh]
- Cell E2 must have value: CN [MWh]
- Cell F2 must have value: CS [MWh]
- Cell G2 must have value: SU [MWh]
- Cell H2 must have value: SI [MWh]
- Cell I2 must have value: SA [MWh]

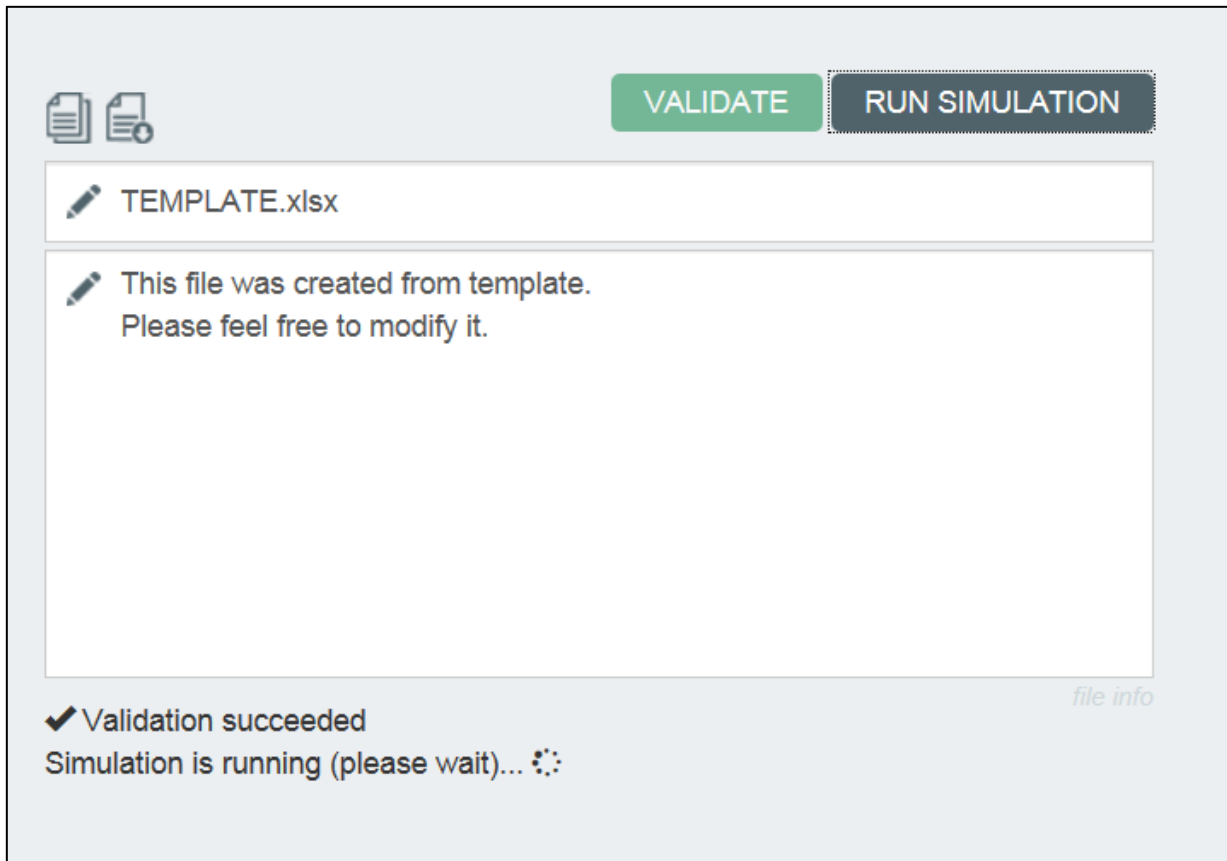
Report for tab **AU**

Table Header:

- Cell D1 must have value: POWER [MW]

**Figure 9: details of the error in the validation phase.**

By clicking on “RUN SIMULATION” the simulation starts as shown in Figure 10.



**Figure 10: Running a simulation**

If a simulation is successful a message is generated, like the one shown in Figure 9 and the next section “Analysis” is filled with the results. In this case a new icon appears on the top “**Download results**” with which the results can be downloaded in an excel file.

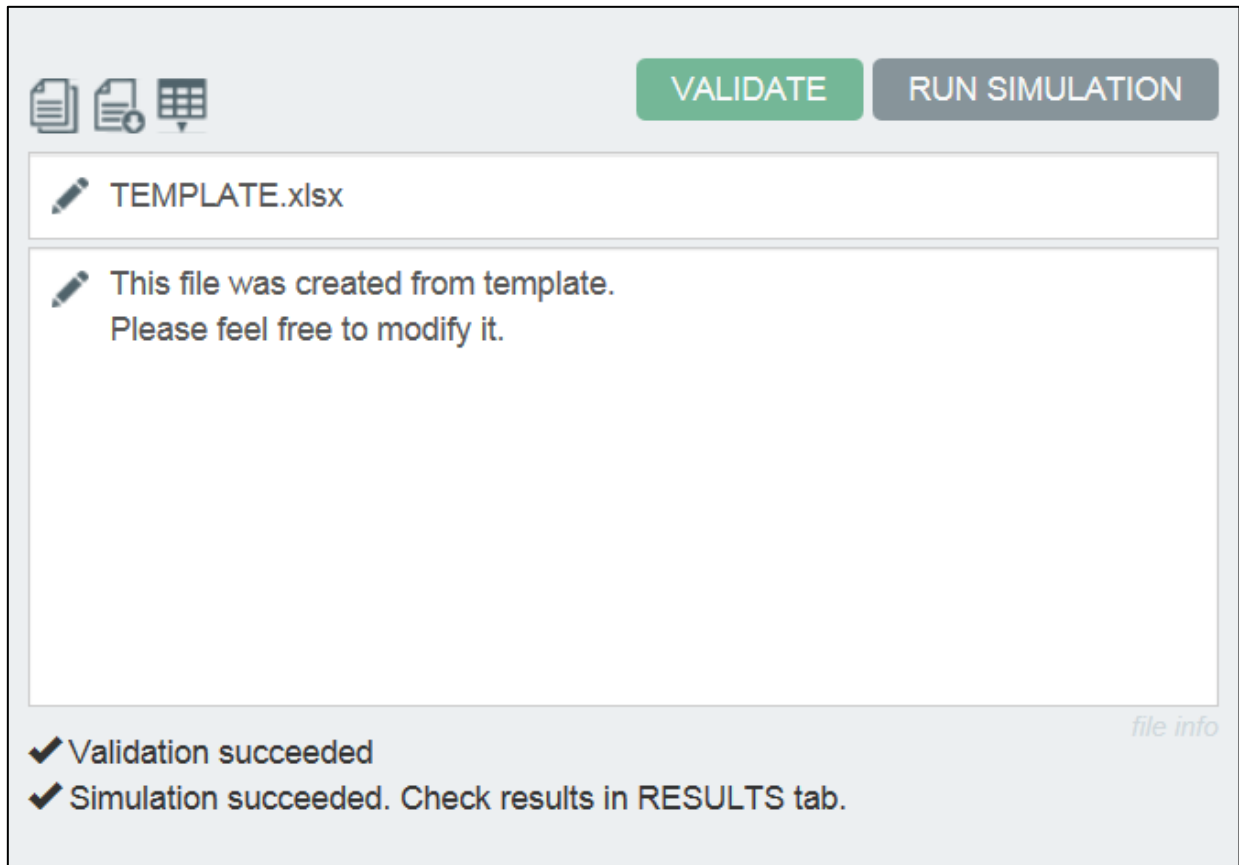


Figure 11: Simulation succeeded

### 3.2 Analysis

The purpose of the “**Analysis**” section is to add and modify data from an input file and check the results after performing a simulation. Each selected file contains three tabs: EXPLORE & MODIFY, BID STATISTICS and RESULTS.



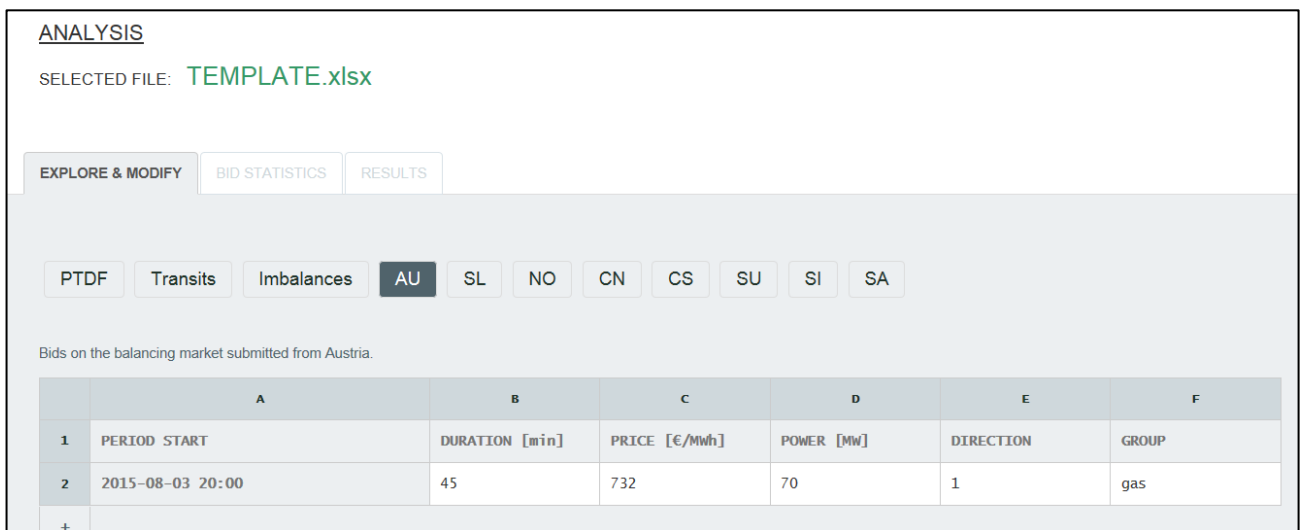
Figure 12: ANALYSIS section

## EXPLORE & MODIFY

In this tab it is possible to add and modify data of the selected file:

- **PTDF:** it is a matrix that is used to model the parallel flows' constraints on meshed networks; for a further description of this matrix please see [1] and [2];
- **Transits:** for each quarter of one hour the maximum capacity between all available zones can be defined;
- **Imbalances:** for each quarter it is possible to define the imbalance of each zone of the system (positive value means that there is a lack of energy and negative value means that there is a surplus of energy).
- For each zone of the model<sup>1</sup> one or more bids can be defined. Next parameters have to be defined:
  - Period start (i.e. 2015-08-11 20:45),
  - Duration (number multiple of 15),
  - Price (positive or negative value),
  - Quantity, representing the power that the BSP can provide for the full duration of the bid (always positive value),
  - Direction ("1" means upward bid and "-1" downward bid)
  - Group information (optional).

In case of modification of any parameter, two new icons appears: "save changes" (in order to save the file), and "revert" (in order to cancel the changes) as shown in Figure 11. Please note that if the simulation has already been run on this file, saving the changes will invalidate the results as they do not correspond to the changed input file.



ANALYSIS

SELECTED FILE: [TEMPLATE.xlsx](#)

EXPLORE & MODIFY | BID STATISTICS | RESULTS

PTDF | Transits | Imbalances | **AU** | SL | NO | CN | CS | SU | SI | SA

Bids on the balancing market submitted from Austria.

	A	B	C	D	E	F
1	PERIOD START	DURATION [min]	PRICE [€/Mwh]	POWER [MW]	DIRECTION	GROUP
2	2015-08-03 20:00	45	732	70	1	gas
+						

**Figure 13: Save Changes and Revert**

## BID STATISTICS

If the selected file has been successfully validated, the tab "BID STATISTICS" shows graphical information on bids aggregated for each zone.

<sup>1</sup> AU=Austria, SL=Slovenia, NO=North of Italy, CN= Center-North of Italy, CS= Center-South of Italy, SU=South of Italy, SI=Sicily and SA= Sardinia.

## RESULTS

If a simulation has been performed on the selected file, the tab “RESULTS” contains the full solution of the eBADGE simulator:

- **SUMMARY** table provides information on total balancing costs and on the remaining imbalances (positive and negative direction); using the two drop-down boxes just above it you can filter the results by simulated periods or balancing zones.
- **BID SUMMARY BY GROUPS** table provides information on offered and accepted quantity aggregated by group;
- **Transits** tab provides information on the exchanges of energy between the zones in MWh;
- **Costs** tab provides information of the costs, which occurred after simulation for each zone
- **Remaining Imbalances** tab provides information on imbalances for each zone after the simulation performed.
- **AT, SL, NO, CN, CS, SU, SI, SA** tabs provides information on accepted bids for each zone

In the last part of this section it is possible to select a period in order to see the flows on the map. The capacities of the lines are also shown and any congestions or remaining imbalances are highlighted in red.

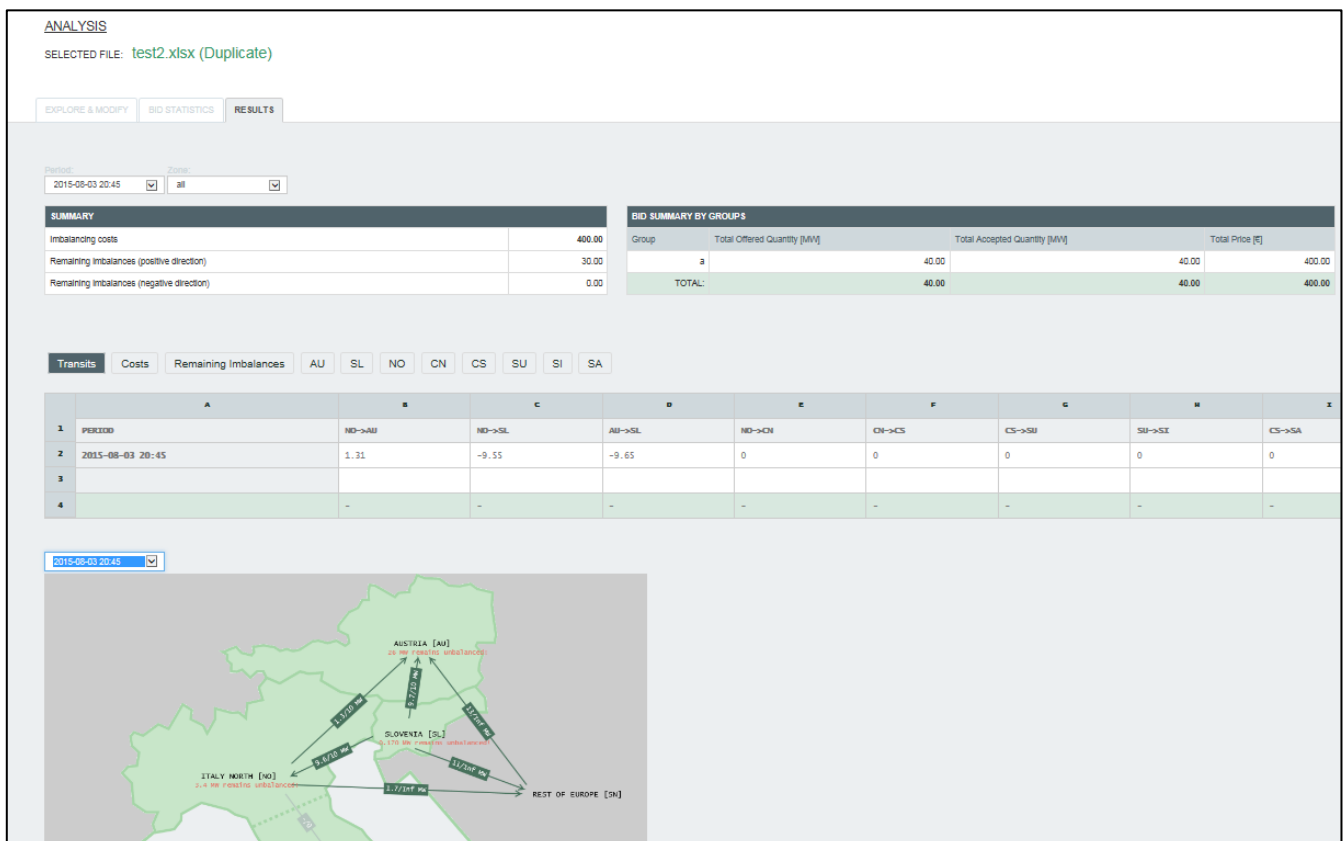


Figure 14: Results window

## References

- [1] A. Zani, G. Migliavacca, eBADGE D2.3: Modelling specifications for the simulation SW of a trans-national balancing market, July 2014:  
[http://www.ebadge-fp7.eu/wp-content/uploads/2015/01/eBADGE-D2.3-Final\\_review.pdf](http://www.ebadge-fp7.eu/wp-content/uploads/2015/01/eBADGE-D2.3-Final_review.pdf).
- [2] R. Calisti, F. Careri, M. Cazzol, A. Zani, eBADGE D2.4: Scenario analyses on a future trans-national balancing/reserve market among Austria, Italy and Slovenia, results of further inclusion of Germany, October 2015.  
<http://www.ebadge-fp7.eu/wp-content/uploads/2015/11/eBADGE-D2.4-Final.pdf>



## Appendix

Below you can find two examples with an explanation of input parameters and results after performing a simulation. Examples can be found in the Balancing Market Simulator under “My Inputs” section.

### Example 1

#### Input data (Explore and Modify):

- Imbalances: Energy shortage of 30 MWh in zone Italy North (NO), energy surplus of 10 MWh in zone Austria (AU) and energy surplus of 10 MWh in zone Slovenia (SL).
- Transits Between AU, SL and NO zones are 100 MW in both directions (and this means that 25MWh can transit in a quarter of an hour).

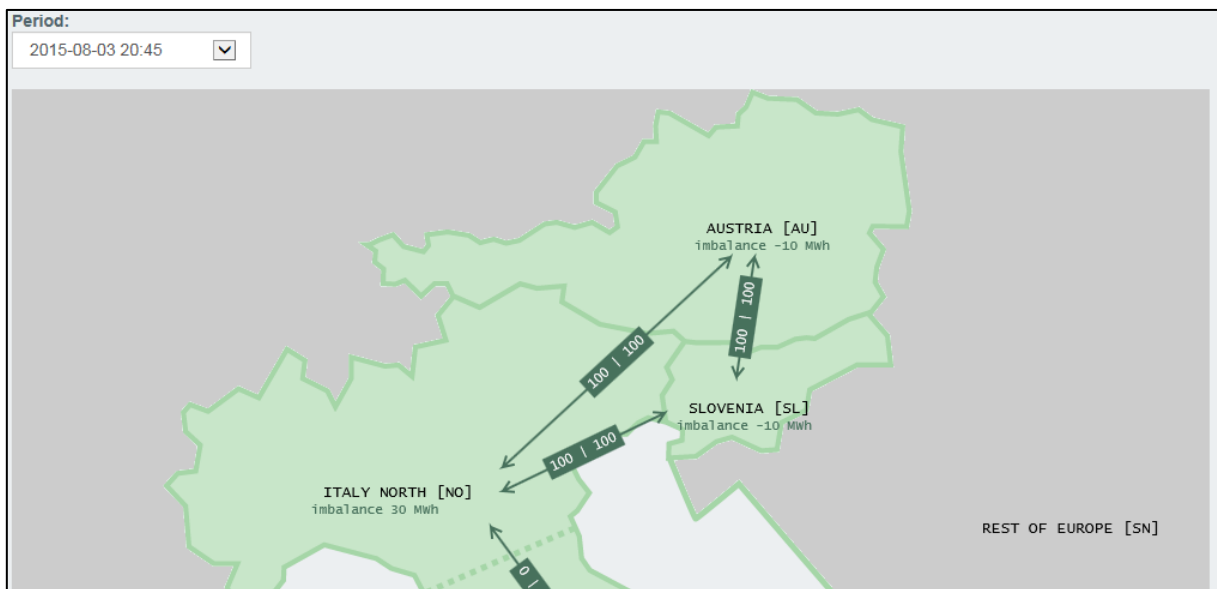


Figure 15: Input data

- In the AU zone we insert an upward bid for quarterly product for price 55 [€/MWh] and quantity 40 MW (and this means that the maximum energy that can be used in a quarter is 10 MWh).

PTDF		Transits		Imbalances		AU	SL	NO	CN	CS	SU	SI	SA
Bids on the balancing market submitted from Austria.													
	A	B	C	D	E	F							
1	PERIOD START	DURATION [min]	PRICE [€/MWh]	POWER [MW]	DIRECTION	GROUP							
2	2015-08-03 20:45	15	55	40	1	a							

Figure 16: Upward bid inserted

## Results: After performing simulation

- Remaining imbalances in AU,SL and NO zones are 0.

Transits						Costs						Remaining Imbalances						AU		SL		NO		CN		CS		SU		SI		SA	
1	PERIOD	A				B				C				D				AU [MWh]		SL [MWh]		NO [MWh]		CN [MWh]									
2	2015-08-03 20:45																	0	0	0	0	0	0	0	0								
3																																	
4	MIN:																	0	0	0	0	0	0	0	0								
5	MAX:																	0	0	0	0	0	0	0	0								

Figure 17: Remaining Imbalances after performing simulation

- The energy surplus from AU zone (10 MWh), SL zone (10 MWh) and upward bid from AU zone (40 MW is equal to 10 MWh provided in 15min.) transits to NO zone.

Transits														Costs														Remaining Imbalances														AU		SL		NO		CN		CS		SU		SI		SA	
1	PERIOD	A	B	C	D	E	F	G	H	I	J	K	L																																												
2	2015-08-03 20:45		NO->AU	NO->SL	AU->SL	NO->CN	CN->CS	CS->SU	SU->SI	CS->SA	NO->SN	AU->SN	SL->SN																																												
3																																																									
4																																																									

2015-08-03 20:45
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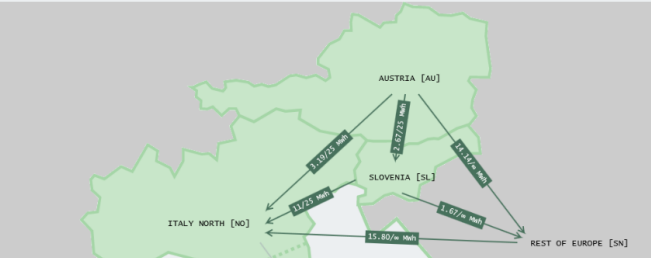


Figure 18: Transits after performing simulation

- The offered quantity (10 MWh) is totally accepted.
- The Balancing cost for TSO in NO zone is 550 EUR.

Period:	2015-08-03 20:45	Zone:	all
SUMMARY		BID SUMMARY BY GROUPS	
Balancing costs [€]	550.00	Group	Total Offered Quantity [MWh]
Remaining imbalances (positive direction) [MWh]	0.00	a	10.00
Remaining imbalances (negative direction) [MWh]	0.00	TOTAL:	10.00
			Total Accepted Quantity [MWh]
			10.00
			Total Price [€]
			550.00

Figure 19: Summary Report after performing simulation

## Example 2:

### Input data (Explore and Modify):

- Imbalances: Energy shortage of 30 MWh in zone Italy North (NO), energy surplus of 10 MWh in zone Austria (AU) and energy surplus of 10 MWh in zone Slovenia (SL).
- Transits Between AU, SL and NO zones are equal 40 MW in both directions (that corresponds to 10MWh of energy available in 15 minutes).

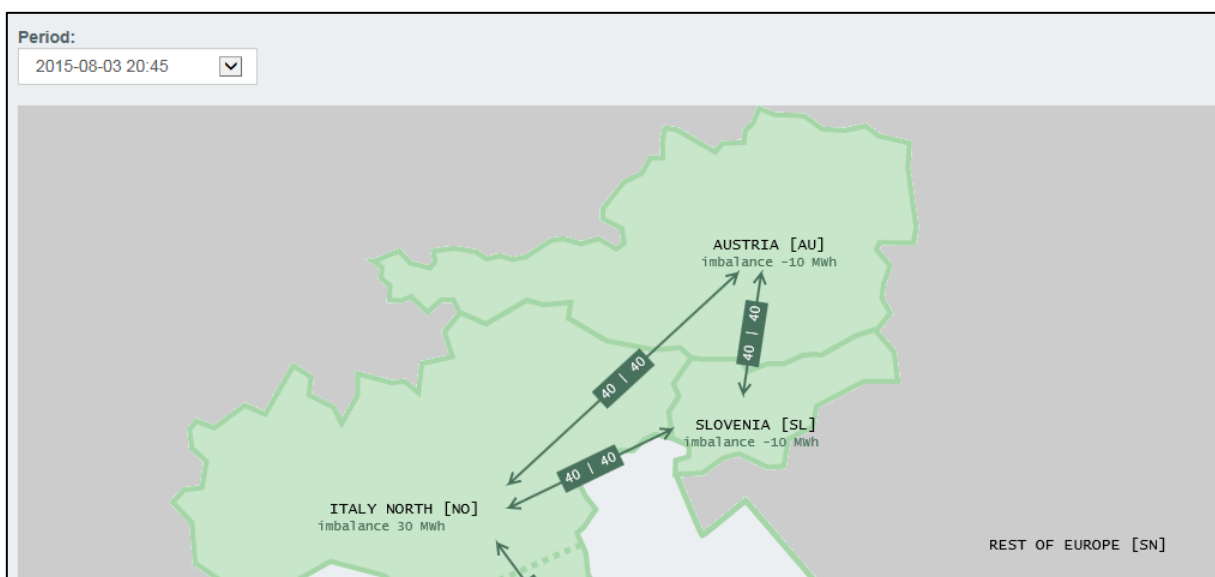


Figure 20: Input data

- In the AU zone we insert an upward bid for quarterly product for price 55 [€/MWh] and quantity 40 MW.

PTDF Transits Imbalances <b>AU</b> SL NO CN CS SU SI SA						
Bids on the balancing market submitted from Austria.						
	A	B	C	D	E	F
1	PERIOD START	DURATION [min]	PRICE [€/MWh]	POWER [MW]	DIRECTION	GROUP
2	2015-08-03 20:45	15	55	40	1	a

Figure 21: Upward bid inserted in AU zone

- In the SL zone we insert an upward bid for quarterly product for price 60 [€/MWh] and quantity 40 MW.

PTDF Transits Imbalances AU SL NO CN CS SU SI SA						
Bids on the balancing market submitted from Slovenia.						
	A	B	C	D	E	F
1	PERIOD START	DURATION [min]	PRICE [€/Mwh]	POWER [MW]	DIRECTION	GROUP
2	2015-08-03 20:45	15	60	40	1	VPP SL
+						

Figure 22: Upward bid inserted in SL zone

## Results:

- Remaining imbalances in AU and SL zones 0.
- Remaining imbalances in NO zone are 3,55 MWh.

Transits Costs Remaining Imbalances AU SL NO CN CS SU SI SA					
	A	B	C	D	E
1	PERIOD	AU [Mwh]	SL [Mwh]	NO [Mwh]	CN [Mwh]
2	2015-08-03 20:45	0	-0.00	3.55	0
3					
4	MIN:	0	-0.00	3.55	0
5	MAX:	0	-0.00	3.55	0

Figure 23: Remaining Imbalances after performing simulation

- The energy surplus from AU zone (10 MWh), SL zone (10 WWh) transits to NO zone.

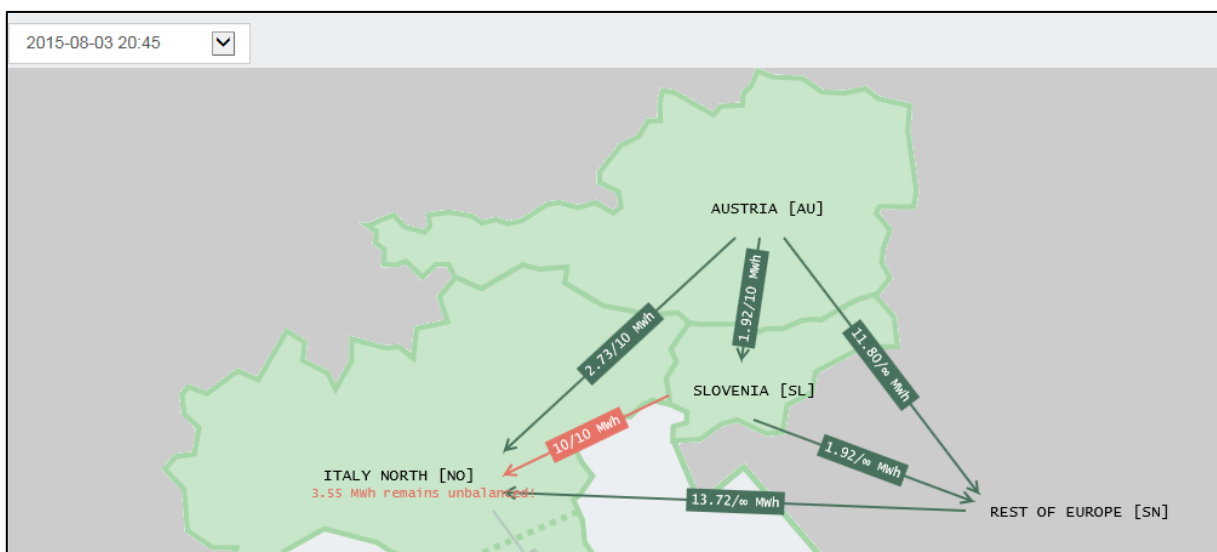


Figure 24: Transits after performing simulation

- An upward bid from AU zone is partially accepted 6,45 MWh and transits to NO zone.

Transits		Costs		Remaining Imbalances		AU	SL	NO	CN	CS	SU	SI	SA
	A	B	C	D	E	F	G						
1	PERIOD	PRICE [€/Mwh]	OFFERED ENERGY [Mwh]	DIRECTION	GROUP	ACCEPTED ENERGY [Mwh]	TOTAL PAY [€]						
2	2015-08-03 20:45	55	10	1	VPP AU	6.45	354.58						

**Figure 25: Accepted bid from AU zone**

- An upward bid from SL zone is not accepted due to transit limitations.

Transits		Costs		Remaining Imbalances		AU	SL	NO	CN	CS	SU	SI	SA
	A	B	C	D	E	F	G						
1	PERIOD	PRICE [€/Mwh]	OFFERED ENERGY [Mwh]	DIRECTION	GROUP	ACCEPTED ENERGY [Mwh]	TOTAL PAY [€]						
2	2015-08-03 20:45	60	10	1	VPP SL								

**Figure 26: Transits after performing simulation**

- Total accepted quantity in AU zone is 6,45 MWh.
- Total accepted quantity in SL zone is 0 MWh.
- The Balancing cost for TSO in NO zone is 354,58 EUR.
- Remaining imbalances (positive direction) are 3,55 MWh in NO zone.

Period:		Zone:			
2015-08-03 20:45		all			
SUMMARY		BID SUMMARY BY GROUPS			
Balancing costs [€]	354.58	Group	Total Offered Quantity [MWh]	Total Accepted Quantity [MWh]	Total Price [€]
Remaining imbalances (positive direction) [MWh]	3.55	VPP AU	10.00	6.45	354.58
Remaining imbalances (negative direction) [MWh]	0.00	VPP SL	10.00	0.00	0.00
		TOTAL:	20.00	6.45	354.58

**Figure 27: Summary Report after performing simulation**