MEDITERRANEAN TRANSMISSION SYSTEM OPERATORS

Deliverable 2.1.2

Detailed Project Description

01 - MAPT Morocco - Portugal

EC DEVCO - GRANT CONTRACT: ENPI/2014/347-006

"Mediterranean Project"

Task 2 "Planning and development of the Euro-Mediterranean Electricity Reference Grid "

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1 Introduction

This document includes the studies on the project MAPT in the context of the Mediterranean Master Plan of Interconnections. Project MAPT consists of a new HVDC interconnection between Morocco and Portugal with total capacity of 1000 MW (2x500MW).

The document is structured as follows. Section 2 describes the new HVDC interconnection project in detail and the different data sources. Section 3 presents the definition of the snapshots considered in the analysis and a brief description of the snapshot building process followed by the CON. Section 4 comprises the criteria for the security analysis. Section 5 describes the reinforcements considered and the main results of the security analysis. Section 6 contains the active power losses calculations for the snapshots and for two technologies of the new HVDC link. Finally, Section 7 summarizes the investment costs required for two technologies of the new HVDC link and outlines a Cost Benefit Analysis (CBA) for the project MAPT.

2 Project description and data acquisition

The project MAPT consists in a new interconnection between Portugal and Morocco to be realized through an HVDC submarine cable. This project is supported by the two governments, which have launched several studies about this possible interconnection, some of them in elaboration at the present time.

The HVDC interconnection has a capacity of 1000MW and a total length of around 265km, of which approximately 220km are submarine cable. The HVDC interconnection consider the configuration of 2 circuits (bipolar converter) of 500MW each, between the 400kV TAVIRA substation in Portugal and the 400kV BEN HARCHAN substation in Morocco. The goal of the network studies developed in this task of Med-TSO project is to evaluate the internal grid reinforcements needed to accommodate 1000MW of exchange in both directions between Morocco and Portugal, as well as to specify the best technologies to be used in this interconnection. In general, the complementary characteristics in the power systems and economic conditions in the Mediterranean Countries can provide additional benefits over the time for the countries of southern and northern Mediterranean, and even northern Europe. Having this in mind, this interconnection will be studied at Med-TSO. This project is promoted by ONEE and REN.

Figure 1 – MAPT interconnection

Project details							
Description	***Substation (from)***	***Substation (to)***	***GTC contribution (MW)***	***Present status***	***Expected commissioning date***	***Evolution***	***Evolution driver***
New interconnection between Portugal and Morocco	TAVIRA (PT)	BNI HARCHANE (MA)	1000	Mid or long-term project	TBD	- A feasibility study is ongoing - Official declarations have been issued highlighting the willingness of the Morocco-Portugal Governments to develop this new interconnector - REN and ONEE were mandated by the Governments of Portugal and Morocco to submit, in a short time, a preliminary draft proposal for both the construction and financing model.	Increase the NTC in the Mediterranean countries and providing mutual benefits according the complementary characteristics of both countries

The systems involved in the network studies for the project MAPT are described in the table and figure below.

Full models	Boundaries
Spain ES	France FR
Portugal PT	Tunisia TN
Morocco MA	
Algeria DZ	

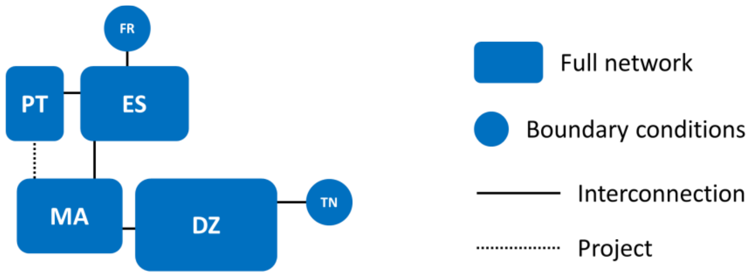

Table 1 – Electric systems involved in project MAPT

In this project, the Portuguese, the Spanish, the Moroccan and the Algerian systems have been considered as represented by their full transmission network models. Boundary systems, i.e. France and Tunisia, were considered as external buses with equivalent loads to simulate energy interchanges.

Four scenarios (S1, S2, S3 and S4) and seasonality (Winter/Summer) are distinguished in the snapshots definition.

The following sections detail the different data supplied by the TSOs. The full list of files is included in [1].

Algeria

A set of eight models of the Algerian system have been provided plus an explanatory guideline for their format. Uploaded files are:

Name	Format	Notes
0.DZ_Database guidline&Market data_Common cases_S&W-Peak.xlsx	EXCEL	Guideline for the format used to collect network information
1.Database_2030_S1_Common case_Summer_Peak.xlsx	EXCEL	Network for S1, Summer
1.Database_2030_S1_Common case_Winter_Peak.xlsx	EXCEL	Network for S1, Winter
1.Database_2030_S2_Common case_Summer_Peak.xlsx	EXCEL	Network for S2, Summer
1.Database_2030_S2_Common case_Winter_Peak.xlsx	EXCEL	Network for S2, Winter
1.Database_2030_S3_Common case_Summer_Peak.xlsx	EXCEL	Network for S3, Summer
1.Database_2030_S3_Common case_Winter_Peak.xlsx	EXCEL	Network for S3, Winter
1.Database_2030_S4_Common case_Summer_Peak.xlsx	EXCEL	Network for S4, Summer
1.Database_2030_S4_Common case_Winter_Peak.xlsx	EXCEL	Network for S4, Winter

In the EXCEL files uploaded, generating technologies were identified using numbers. The following table identifies the technologies for Algerian generators:

Technologies identified in EXCEL	Med-TSO technologies
NUCLEAR	1 - NUCLEAR
CCGT - OLD	13 - GAS CCGT OLD 2 (45% - 52%)
CCGT - NEW	14 - GAS CCGT NEW (53% - 60%)
OCGT- OLD	17 - GAS OCGT OLD (35% - 38%)
WIND	26 - WIND ONSHORE
PV	23 - SOLAR PHOTOVOLTAIC
CSP	24 - SOLAR THERMAL
Hybrid	24 - SOLAR THERMAL
SVC (Static Var Compensator)	99-UNKNOWN
SLACK	Connection with Morocco (slack of the system)

Next table identifies the Algerian areas:

Area code in EXCEL networks	Area identified
1	Algerian system, area 1 of 7
2	Algerian system, area 2 of 7
3	Algerian system, area 3 of 7
4	Algerian system, area 4 of 7
5	Algerian system, area 5 of 7
6	Algerian system, area 6 of 7
7	Algerian system, area 7 of 7
M	Moroccan system
S	Algerian bus for project DZES
I	Algerian bus for project DZIT[1]
T	Tunisian system

Morocco

For the Moroccan system, two networks were provided in PSS/E .sav format. One of the networks corresponds to scenarios S1, S2 and S4, and the other to scenario S3. The two PSS/E .sav files are valid for Winter and Summer conditions. An EXCEL file was supplied with the merit order for generating units. Uploaded files are:

Name	Format	Notes
Scenario_S1_v_1.SAV	PSS/ E v33	.sav file with the Moroccan network for S1, S2 and S4
Scenario_S3_v_1.SAV	PSS/ E v33	.sav file with the Moroccan network for S3
Merit_Order_v_1.XLSX	EXCEL	Merit order for generating units
carteDG 400 & 225 kV.PDF	PDF	Map of the Moroccan transmission grid

According to the information provided by ONEE, the transmission network in scenario S2 is equal to the network for scenario S1. The network for scenario S4 is also similar to the one for S1, except that there is an additional capacity of 2000MW from renewable projects:

- 1000MW PV is assumed to be developed through the distribution system and another equivalent capacity of 1000MW wind is expected to be located completely in the southern region of Morocco
- An HVDC-VSC link between the southern and the center regions of Morocco will be used to connect 1000MW wind to a new AC/DC substation in the region of BOUJDOUR, from which a 1050km HVDC-VSC link will be used to make the connection with the substation CHEMAIA

Generating technologies in the “Owner” field do not match with the standard Med-TSO nomenclature. Most of the technologies were identified directly from the merit order file but others have been redefined based on the category type in the merit order file to match the technologies in the PiT (Point in Time) as follows:

- Category 25 → Med-TSO Type 26
- Category 27 → Med-TSO Type 30
- Category 29 → Med-TSO Type 28

[1] Bus DZI**T**111 is renamed to ITA**I**111

Only the units in the merit order list provided by ONEE were considered to create the snapshots corresponding to the PiTs selected. Existing interconnections with Algeria and Spain are well identified. The substation for the new HVDC connection with Portugal is BENI HARCHAN (PSS/E name is D.CHAO40).

It is important to highlight the process followed to build the different PiTs. The loads (except the ones with fixed load) were set proportionally to the load in the respective PSS/E .sav file until the total load in the PiT is met. Similar process was followed for the OTHER RES / NON RES production, taking into account the generation limits when available. The HYDRO, WIND and SOLAR dispatch were carried out according to the merit order and proportionally to the corresponding generation limits.

Portugal

The files provided for the Portuguese system had already been prepared by REN considering the PiTs of the three projects involved in the Western Corridor. Thus, a set of eight PSS\E .sav files of the Portuguese system have been provided plus a map of the Portuguese transmission grid. These files are:

Name	Format	Notes
MA-PT_case1_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 1
MA-PT_case2_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 2
MA-PT_case3_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 3
MA-PT_case4_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 4
MA-PT_case5_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 5
MA-PT_case6_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 6
MA-PT_case7_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 7
MA-PT_case8_v_1.SAV	PSS/ E v33	.sav file with the Portuguese network project MAPT, PiT 8
Portuguese transmission grid maps v_1.PDF	PDF	map of the Portuguese transmission grid

Interconnected areas are well identified, including the bus for the HVDC connection with Morocco. Generating technologies identified in the “Owner” field did not match with the standard Med-TSO nomenclature. Four PSS/E .idv files have been provided to convert the values in the “Owner” field to the ENTSO-E format, which were afterwards converted to the Med-TSO format using a conversion table supplied by REN. The four .idv files are:

- Fuel Type TYNDP2016 V1.idv
- Fuel Type TYNDP2016 V2.idv
- Fuel Type TYNDP2016 V3.idv
- Fuel Type TYNDP2016 V4.idv

Spain

A set of six PSS/E .raw files of the Spanish system have been provided. The Spanish networks are not available in the Med-TSO database since these files have been provided to the CON directly via email. Uploaded files are:

Name	Format	Notes
2030_V1_PC06_ES.RAW	PSS/ E v33	.raw file with the Spanish network
2030_V1_PC09_ES.RAW	PSS/ E v33	.raw file with the Spanish network
2030_V1_PC10_ES.RAW	PSS/ E v33	.raw file with the Spanish network
2030_V4_PC02_ES.RAW	PSS/ E v33	.raw file with the Spanish network
2030_V4_PC04_ES.RAW	PSS/ E v33	.raw file with the Spanish network
2030_V4_PC08_ES.RAW	PSS/ E v33	.raw file with the Spanish network

It is important to highlight the process followed to build the different PiTs. The PSS/E .raw files were assigned to each PiT according with the minimum deviation between the demand, the generation and the interchanges in the original PSS/E .raw files and the PiTs. Generating technologies identified in the "Owner" field did not match with standard Med-TSO nomenclature. An EXCEL file with a conversion table was provided by REE. Two merit order list for generating units were also provided: List 1 was used in studies of the interconnection MAPT. The loads, except the ones with fixed value, were set proportionally to the loads in the PSS/E .raw file selected until the total load in the PiTs is met. Similar process was followed to set the production for the HYDRO, SOLAR, WIND and OTHER RES / NON RES, namely, by applying a proportional adjustment taking into account the corresponding generation limit.

3 Snapshots definition and building process

The project MAPT considers a total number of 8 PiTs [2]. Each of the PiT contains the active power generated, the total load and the active power exported for each of the systems considered. PiTs 1 and 4 were evaluated in AC. In this case, it was assumed that the total load of the PiT includes the active power losses to keep the exchanges between countries according to the PiTs obtained from the Market Studies. Accordingly, the load simulated in AC was reduced to include the losses.

The following table shows the power balance for each of the PiTs in the project MAPT:

	area	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
PiT1	13 MA	12232.6	14132.6	-1900.0	0.0	-1000.0	-900.0	0.0	0.0	0.0
	15 PT	5138.1	7702.8	-2564.8	1000.0	0.0	-3564.8	0.0	0.0	0.0
	17 ES	42841.6	45950.2	-3108.6	900.0	3564.8	0.0	0.0	-7573.4	0.0
	2 DZ	32277.9	32277.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5 FR	0.0	-7573.4	7573.4	0.0	0.0	7573.4	0.0	0.0	0.0
	19 TN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	area	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
PiT2	13 MA	7612.7	8666.9	-1054.2	0.0	-1000.0	-900.0	845.8	0.0	0.0
	15 PT	5055.0	7774.3	-2719.4	1000.0	0.0	-3719.4	0.0	0.0	0.0
	17 ES	64602.8	51983.5	12619.3	900.0	3719.4	0.0	0.0	8000.0	0.0
	2 DZ	28238.7	28784.5	-545.8	-845.8	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	8000.0	-8000.0	0.0	0.0	-8000.0	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0
	area	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
PiT3	13 MA	8410.3	9310.3	-900.0	0.0	-1000.0	-900.0	1000.0	0.0	0.0
	15 PT	5395.5	7891.0	-2495.5	1000.0	0.0	-3495.5	0.0	0.0	0.0
	17 ES	42097.7	44519.4	-2421.8	900.0	3495.5	0.0	0.0	-6817.3	0.0
	2 DZ	19818.6	20518.6	-700.0	-1000.0	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	-6817.3	6817.3	0.0	0.0	6817.3	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0

PiT4	**area**	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
	13 MA	5862.4	6464.9	-602.4	0.0	-702.4	-900.0	1000.0	0.0	0.0
	15 PT	5767.1	5945.4	-178.3	702.4	0.0	-880.7	0.0	0.0	0.0
	17 ES	29054.2	34907.0	-5852.8	900.0	880.7	0.0	0.0	-7633.6	0.0
	2 DZ	13432.9	14132.9	-700.0	-1000.0	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	-7633.6	7633.6	0.0	0.0	7633.6	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0
PiT5	**area**	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
	13 MA	7090.7	5124.4	1966.3	0.0	1000.0	600.0	366.3	0.0	0.0
	15 PT	4607.3	7577.4	-2970.1	-1000.0	0.0	-1970.1	0.0	0.0	0.0
	17 ES	56665.7	48700.6	7965.1	-600.0	1970.1	0.0	0.0	6595.0	0.0
	2 DZ	14202.1	14268.4	-66.3	-366.3	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	6595.0	-6595.0	0.0	0.0	-6595.0	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0
PiT6	**area**	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
	13 MA	7420.0	6864.9	555.1	0.0	955.1	600.0	-1000.0	0.0	0.0
	15 PT	7404.9	7463.2	-58.3	-955.1	0.0	896.8	0.0	0.0	0.0
	17 ES	55169.5	50286.3	4883.2	-600.0	-896.8	0.0	0.0	6380.0	0.0
	2 DZ	21361.0	20061.0	1300.0	1000.0	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	6380.0	-6380.0	0.0	0.0	-6380.0	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0
PiT7	**area**	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
	13 MA	8764.1	6164.1	2600.0	0.0	1000.0	600.0	1000.0	0.0	0.0
	15 PT	5537.7	7786.1	-2248.4	-1000.0	0.0	-1248.4	0.0	0.0	0.0
	17 ES	46326.5	44172.3	2154.2	-600.0	1248.4	0.0	0.0	1505.8	0.0
	2 DZ	22895.3	23595.3	-700.0	-1000.0	0.0	0.0	0.0	0.0	300.0
	5 FR	0.0	1505.8	-1505.8	0.0	0.0	-1505.8	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0
PiT8	**area**	**PG [MW]**	**PD [MW]**	**Pexport [MW]**	**13 MA**	**15 PT**	**17 ES**	**2 DZ**	**5 FR**	**19 TN**
	13 MA	7237.8	6271.0	966.8	0.0	1000.0	600.0	-633.2	0.0	0.0
	15 PT	7544.3	6053.9	1490.3	-1000.0	0.0	2490.3	0.0	0.0	0.0
	17 ES	39192.7	39302.4	-109.7	-600.0	-2490.3	0.0	0.0	2980.7	0.0
	2 DZ	14122.4	13189.2	933.2	633.2	0.0	0.0	0.0	0.0	300.0

	5 FR	0.0	2980.7	-2980.7	0.0	0.0	-2980.7	0.0	0.0	0.0
	19 TN	0.0	300.0	-300.0	0.0	0.0	0.0	-300.0	0.0	0.0

Table 2 – Power balance for each of the PiTs defined in the MAPT project

4 Power flow and security analysis

This section presents the criteria agreed to run the power flow and N-x security analysis for the snapshots built for the eight PiTs of the project MAPT. Details on the methodology used for the security analysis are compiled in [3].

Algeria

For the Algerian system, the N-1 is focused on the transmission circuits. Therefore, the branches considered for the N-1 analysis are only those at 220kV and 400kV. Also, overloads are only checked for branches in 220kV and 400kV networks.

The EXCEL files considers three different values for the rates and tolerances, i.e. rateA, rateB and rateC. For lines, rateA is considered for Winter, rateB is considered for Summer, and rateC is unused. For transformers, rateA is considered as unique rate, thus rateB and rateC are unused.

The tolerance for overload is 0% for all branches, in N and N-1 situations.

No N-2 contingencies were defined for Algeria.

Morocco

For the Moroccan system, the N-1 analysis is focused on the transmission network. Therefore, the N operation and the N-1 contingencies were considered assuming the rates of the lines equal to the nominal values in N operation and 120% in N-1 operation. In the case of the transformers, the nominal capacity was considered as maximum limit.

No N-2 contingencies were defined for Morocco.

Portugal

For the Portuguese system, N operation, N-1 contingencies, and N-2 contingencies (a detailed list with the circuits to which apply N-2 criteria was sent to the CON) have been considered.

The transmission lines limits are distinguished between Category A (t<20 min) and Category B (20 min<t<2 h). All lines of 400kV network, as well as the remaining lines that feed the "Large Lisboa area" and Setúbal peninsula, are included in the overload Category B, and therefore cannot be subject to temporary overloads. The following table summarizes the security criteria for the Portuguese network.

	Normal conditions	N-1	N-2
Lines[3] Category A (t<20min.) Category B (20min.<t<2h)	 0% 0%	 15% 0%	 15% 0%
Transformers Category A (t<20min.)	 0%	 25%(winter) 10%(summer) 15%(rest)	 25%(winter) 10%(summer) 15%(rest)
Category B (20min.<t<2h)	0%	20%(winter) 5%(summer) 10%(rest)	20%(winter) 5%(summer) 10%(rest

Table 3 – Thermal limits for the Portuguese system

Maximum angular differences have also been considered, namely, 25 degrees for 220kV and 150kV lines, and 30 degrees for 400kV lines and interconnections.

Spain

For the Spanish system, N operation, N-1 and N-2 contingencies (a detailed list with the circuits to which apply N-2 criteria was sent to the CON) were evaluated. Regarding thermal limits, the following table was applied.

	Normal conditions	N-1	N-2
Lines*	0%	15% in general but less than 20 minutes (0% in underground cables)	15%
Transformers	0%	0% in summer 10% in winter	10% in summer 20% in winter 15% in the remaining period

Table 4 – Thermal limits for the Spanish system

The next tables summarize the voltage buses limits in N (Table 5) and in N-1 (Table 6) situations for Algeria, Morocco, Portugal and Spain used in the AC analysis.

Country	**400 kV**		**225 kV/220 kV**		**150 kV**	
DZ	380	420	205	235	141	159
MA	380	420	209	245	135	165
PT	380	420	209	245	142	165
ES	390	420	205	245		

Table 5 – Voltages limits under normal operation conditions

Country	**400 kV**		**225 kV/ 220 kV**		**150 kV**	
DZ	380	420	198	242	135	165
MA	380	420	205	245	135	165

Country	400 kV		225 kV/ 220 kV		150 kV	
PT	372	420	205	245	140	165
ES	380	435	205	245		

Table 6 – Voltages limits under N-1 operation conditions

The reference bus for the merged network is VILLARIN 400kV in Spain. In the case of the PiTs evaluated in DC, the active power flows was multiplied by a factor of 1.11 to account for the reactive power flow contribution.

5 Assessment of reinforcements

Algeria

No significant overloads associated to the MAPT interconnection were identified in the Algerian system, thus no reinforcements were defined for the network of this country.

It is worth mentioning that the N-1 contingency of a new 1000MW nuclear power plant in Algeria leads to significant overloads in the existing AC interconnection between Spain and Morocco. It is advisable to take action in order to mitigate the impact of such contingency without penalizing the transfer capabilities. Ad hoc studies should be performed to analyze the primary reserve capabilities of the area. To reduce costs of secondary reserves, interruptible loads integrated in special protection schemes could be designed to counteract the 1000MW nuclear plant trip.

Morocco

The Moroccan system is significantly affected by the project MAPT. The security analysis resulted in the following reinforcements:

- Two new 400kV OHL of 220km between substations BNI HARCHANE and SEHOUL
- A new 400kV OHL of 20km between substations BNI HARCHANE and MELOUSSA
- A new 225kV OHL of 19km between substations MELOUSSA and TANGER
- A new 600MVA transformer in substations SEHOUL and the upgrade of the two existing ones from 450MVA to 600MVA

These reinforcements are highlighted in the following map:

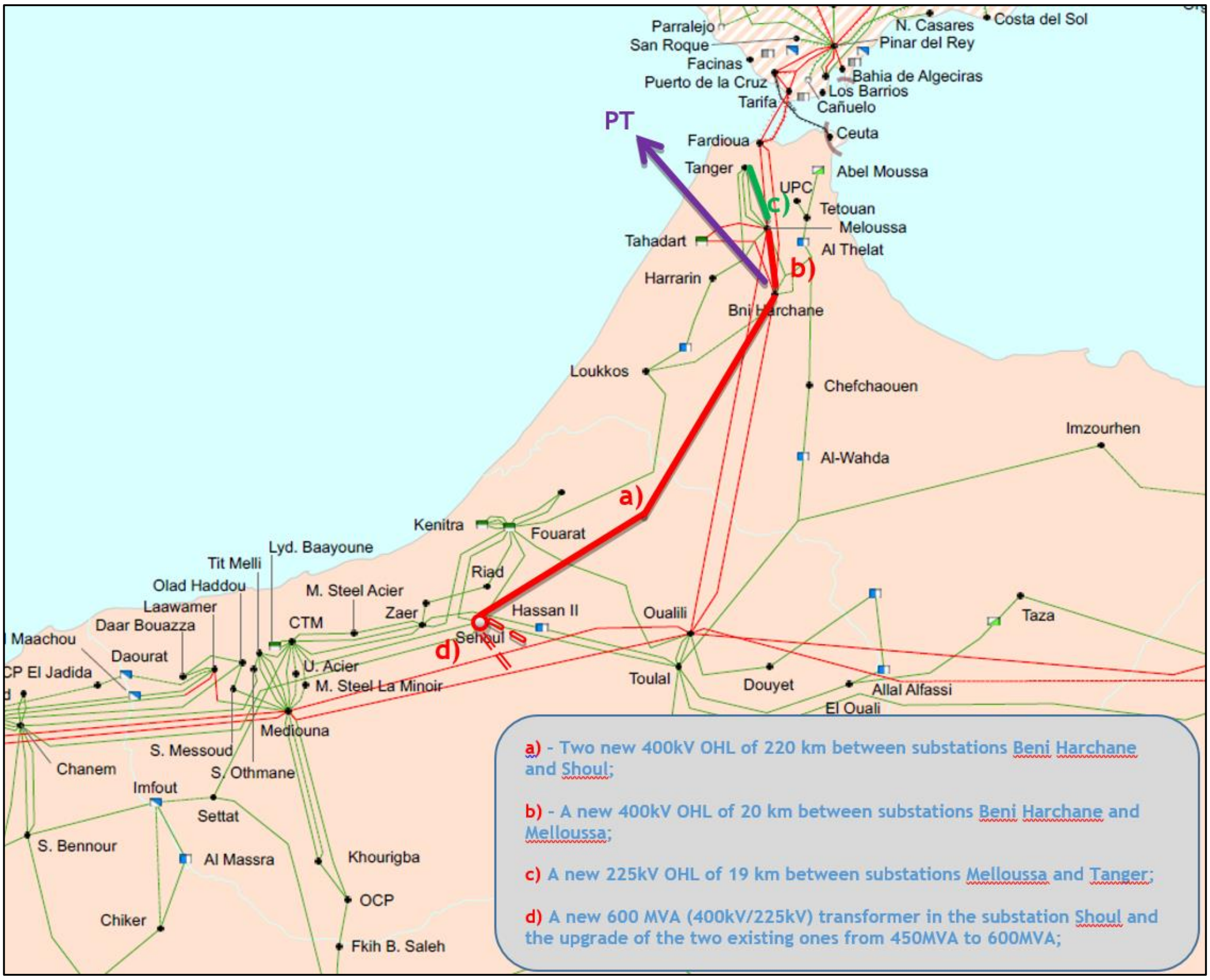

Figure 2 – Internal reinforcements in Morocco which were considered in order to accommodate the 1000MW flow between Portugal and Morocco (Med-TSO network studies)

The estimate for the total investment cost in Morocco grid is **70M€.**

It is worth mentioning that the existing interconnection between Spain and Morocco can sustain contingencies of the new interconnection project MAPT up to 500MW without requiring reinforcement.

Spain

The Spanish system is affected by the project MAPT mainly in the 220kV network. The security analysis was based on a differential analysis due to the high overloads identified in the Spanish network in the N situation. The differential analysis consisted on the simulation with the project MAPT and without the project MAPT. This analysis consisted on the N, N-1 and N-2 contingency simulation with the project MAPT and without the project MAPT. Redispatch of generation according to Market Studies was taken into account to obtain equivalent PiTs without the project MAPT.

The simulations showed that there are important internal overloads in Spain that could be associated with the high Spanish solar penetration in some of the 2030 scenarios, which result in some overloads in internal lines in Portugal too and in the existing interconnections between Portugal and Spain, namely, between FALAGEIRA-CEDILLO and ALQUEVA-BROVALES. The list of all overloads are in Annex I, including the overloads in Portugal and Spain with and without the project MAPT. Note that there is a significant number of lines already overloaded without the security analysis. The Spanish system can only sustain without overloads in the given grid about 20GW of solar power and in some PiTs there is more than 40GW of solar production. No concrete internal reinforcements have been provided by REE to deal with the potential high solar penetration in Spain that is included in these scenarios since such concrete grid development plan has not been done yet. Hence, the internal reinforcements identified due to the project MAPT in addition to the high solar generation in Spain might be associated with that high solar penetration and might not be needed if such solar development is not realized. The differential analysis for all PiTs has shown that the circuits in the following table have an increase in the overload with the project MAPT of more than a threshold of 15% chosen for determining concrete reinforcements if the additional overloads are higher than that. Hence, it is understood that these concrete lines will need to be reinforced due to the project MAPT. It is foreseen that a simple substitution of conductors to increase the ampacity is sufficient since the maximum increase in flow observed for all the overloaded lines is less than 30% of the rate:

PiT	Bus From	V [kV]	Bus To	V [kV]	ID	Length [km]	Rate [MVA]	Max Loading w/ MAPT [MVA]	Max Loading w/o MAPT [MVA]	Difference [%]
1	TRUJILLO	220	MERIDA	220	1	76.17	180	226.82	176.49	27.96
8	GUILLE_B	220	CENT_NPB	220	1	38.94	170	213.58	171.8	24.58
1	ALVARADO	220	BALBOA	220	1	60	305	318.91	269.33	16.26
5	ALMARAZ	220	TRUJILLO	220	1	47.06	180	587.79	559.74	15.58

Table 7 – Circuits identified in Spain for reinforcement in order to accommodate the 1000 MW flow between Portugal and Morocco (Med-TSO network studies)

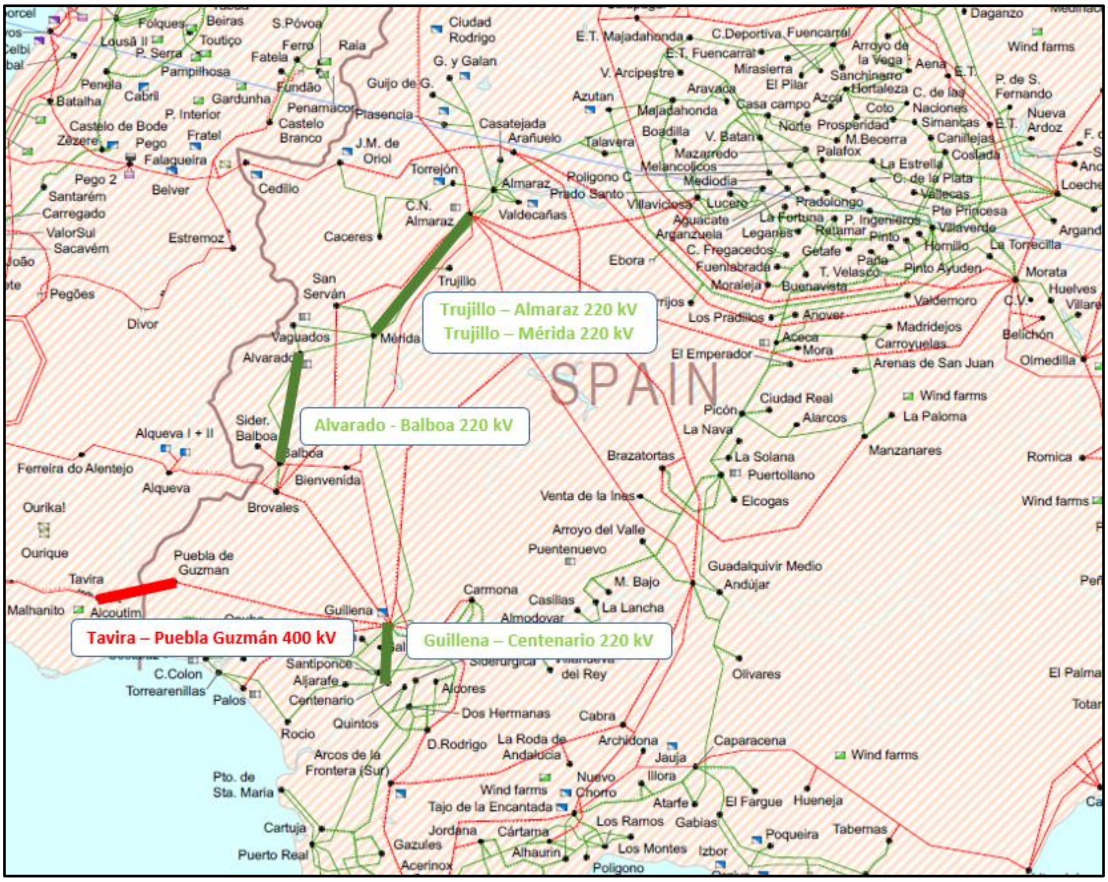

Figure 3 – Internal reinforcements in Spain which were considered in order to accommodate the 1000MW flow between Portugal and Morocco (Med-TSO network studies)

Bearing in mind the reinforcements mentioned, it is estimated that the cost of the reinforcements in Spain in the 220kV network is around 22M€. It is also necessary to include the cost of 4M€ corresponding to upgrade of the OHL between TAVIRA (PT) and PUEBLA DE GUZMAN (ES) 400kV (i.e., the installation of the 2nd circuit). Regarding these concrete reinforcements, the estimate of the total investment cost in Spain due to the project MAPT is **26 M€**.

In addition to this analysis for solving overloads with concrete reinforcements, there are 156 lines of 220kV, 146 lines of 400kV in Spain and 5 lines of 400kV in Portugal that are already overloaded without the project MAPT. From those 302 lines (400kV and 220kV) in Spain which are already overloaded without the project 54 of them become significantly more overloaded (from 5% to 15% more) in the case with the project MAPT, having the rest, that is 248 overloaded lines which become a little more overloaded (from 0.1% to 5%) being left apart and not accounted for under the engineering assumption that results of computations cannot be taken with such precision given all the uncertainties in these scenarios. The most part of these overloads in the case without the project MAPT that increase in the case with the project MAPT are associated with high solar power in Spain.

REE suggested a proposal to approximately evaluate the additional costs that solving these additional overloads (from 5% to 15%) may require. This additional approach was realized in the study too. This analysis considering that the increase in the level of the overloads due to the project MAPT means that:

- If the project MAPT is not realized, then some actions will have to be taken to solve the overloads without the project MAPT
- If the project MAPT is realized, then some actions will have to be taken to solve both the overloads without the project MAPT and the overloads with the project MAPT

Obviously, if the project MAPT is realized, then the actions needed to solve more overloads will involve more costs than the actions needed to solve the overloads in the hypothesis that the project MAPT is not realized. However, the project MAPT also provides a reduction in overloads on many Spanish lines as well.

Therefore, REE has proposed a MVA*km model to determine the additional costs that need to be allocated to the project without specifically identifying the set of planning actions that could be taken (it has to be taken into account that there are 54 overloaded lines in the Spanish network, which can be identified in the list provided in Annex I). This method is described as follows:

a) The overloads or increase in overload are determined with and without the project MAPT for all 400kV and 220kV lines and for transformers 400/220kV in the N situation and all the N-1 and N-2 defined by the security criteria. In the case of transmission line overloads or increase in overload each overload is multiplied by the length of the line in km:
   - Overloads in 400kV lines: U MVA*km
   - Overloads in 220kV lines: V MVA*km
   - Overloads in 400/220kV transformers: W MVA

   Note: It could be the case that the new project could <u>reduce</u> the overloads with respect to the situation without the project. In this case, the cost for solving additional overloads due to the project would be taken as zero, and no benefit will be considered for the Spanish network.

b) The approximate cost for solving all overloads in the given scenario is determined as the sum of
   - Cost of solving overloads in 400kV lines: U*C400 €
   - Overloads in 220kV lines: V*C220 €
   - Overloads in 400/220kV transformers: W*CT

This methodology lead to an estimation of the additional costs that may be needed to solve the additional overloads are equivalent to the cost of 14970 MVA*km of 220kV lines and 131.121 MVA*km of 400kV lines. The estimate of this investment cost (using the standard costs for capacity increases in 400kV and 220kV lines defined in the Spanish regulation (BOE December 12th, 2015, defines a cost of 36€ per MVA*km for 400kV lines and 194€ per MVA*km for 220kV lines) is around 7.5M€

On top of this analysis carried out by REE, it is also necessary to include the cost of 4 M€ corresponding to upgrade of the OHL between TAVIRA (PT) and PUEBLA DE GUZMAN (ES) 400kV (installation of the 2nd circuit) as well. The REE estimate of the total investment cost in Spain due to the project MAPT is, therefore, 33.5M€ (22M€ of concrete reinforcements plus 4M€ for the second circuit of TAVIRA (PT) and PUEBLA DE GUZMAN (ES) plus 7.5M€ of additional reinforcements).

Finally, for the purpose of the Mediterranean Master Plan (MMP) it can be concluded that independent methodologies detected costs for internal reinforcements in Spain in the range of **26M€ – 33.5M€**.

Portugal

The following internal reinforcements in Portugal were identified in order to accommodate the power flows between Portugal and Morocco (1000MW). Therefore, two main corridors are to be reinforced to cope with such a transit, as it is shown in Figure 4:

a) **Upgrading for double circuit of OHL F.ALENTEJO – TAVIRA (400kV+150kV):** currently, this corridor just contains only a 150kV OHL. So, the reinforcements involve upgrading this actual corridor to a 400kV+150kV double circuit line;
b) **2nd circuit of double OHL TAVIRA (PT) – PUEBLA DE GUZMAN (ES):** this double circuit OHL currently comprises only one circuit and needs to be upgraded to a full double circuit line (installation of the 2nd circuit in this interconnection). This reinforcement was identified by both TSOs (REN and REE) according the results of this Med-TSO study.

Therefore, the total network investment costs in the Portuguese grid is around **69M€**.

Figure 4 – Internal reinforcements in Portugal which were considered in order to accommodate the 1000MW flow between Portugal and Morocco (Med-TSO network studies)

In the following table is presented the main Portuguese internal reinforcements that were considered on this study.

Portuguese network reinforcements					
Technical description (network line reinforcements)	From	To	Cost single/double circuit M€/km	Distance km	Cost M€
Upgrading for double circuit OHL F.Alentejo – Ourique (400kV+150kV)	F.ALENT 400	OURIQUE 400	0.5	59	29.5
	F.ALENT 150	OURIQUE 150	---	---	---
Upgrading for double circuit OHL from the intersection of lines Ourique-Estoi and Portimão-Tavira until Ourique (400kV+150kV)	OURIQUE 400	Intersection Ourique-Estoi and Portimão-Tavira 400	0.5	45	22.5
	OURIQUE 150	Intersection Ourique-Estoi and Portimão-Tavira 150	---	---	---

New double circuit OHL from the intersection of lines Ourique-Estoi and Portimão-Tavira until Tavira (400kV+150kV)	Intersection Ourique-Estoi and Portimão-Tavira 400	TAVIRA 400	0.5	18	9
	Intersection Ourique-Estoi and Portimão-Tavira 150	TAVIRA 150			
Upgrading for double circuit OHL Tavira (PT)–Puebla de Guzman (ES) - 400kV (installation of the 2nd circuit)	TAVIRA 400	Portugal-Spain border 400	0.1	34	3.4
	Portugal-Spain border 400*	PUEBLA DE GUZMAN 400*	---	---	---
Technical description (network line reinforcements)	Substation		Unitary cost M€/unity	Unities	Cost M€
400 kV AIS bay, with circuit breaker	F.ALENT 400		1.5	1	1.5
400 kV AIS bay, with circuit breaker	TAVIRA 400		1.5	2	3
400 kV AIS bay, with circuit breaker	P-GUZMAN 400*		---	---	---
*internal reinforcement of Spanish grid. Values will be included in the Spanish grid reinforcements				**TOTAL:**	**69**

Table 8 – Investment costs for the main internal Portuguese grid reinforcement to accommodate the 1000MW flows between Morocco and Portugal

6 Estimation of active power losses

Internal losses in each country

To evaluate the performance of the interconnection project MAPT plus the reinforcements identified, the active power losses have been computed for: a) the snapshots with the reinforcements identified; and b) the snapshots without the interconnection project MAPT and without the reinforcements identified. The following tables show the active power losses for each PiT and system.

Algeria	Power losses [MW]		
PiT	Without proj&reinf	With proj&reinf	Difference (W-WO)
1	346.70	342.20	-4.50
2	561.20	624.90	63.70
3	360.10	344.10	-16.00
4	136.90	148.60	11.70
5	206.40	190.70	-15.70
6	287.80	339.40	51.60
7	451.60	448.00	-3.60
8	181.90	196.60	14.70

Table 9 – Comparison of the active power losses for each snapshot, with and without the interconnection project MAPT and associated reinforcements, for the Algerian system

Morocco	Power losses [MW]		
PiT	Without proj&reinf	With proj&reinf	Difference (W-WO)
1	507.80	473.50	-34.30
2	272.20	202.20	-70.00
3	269.80	232.60	-37.20
4	124.70	124.80	0.10
5	137.10	181.10	44.00
6	179.40	280.20	100.80
7	191.60	257.20	65.60
8	136.80	213.40	76.60

Table 10 – Comparison of the active power losses for each snapshot, with and without interconnection project MAPT and associated reinforcements, for the Moroccan system

Portugal	Power losses [MW]		
PiT	Without proj&reinf	With proj&reinf	Difference (W-WO)
1	110.20	143.60	33.40
2	312.60	312.70	0.10
3	103.90	89.50	-14.40
4	104.70	129.00	24.30
5	231.40	284.60	53.20
6	233.20	284.80	51.60
7	95.20	101.50	6.30
8	96.50	86.30	-10.20

Table 11 – Comparison of the active power losses for each snapshot, with and without the interconnection project MAPT and associated reinforcements, for the Portuguese system

Spain	Power losses [MW]		
PiT	Without proj&reinf	With proj&reinf	Difference (W-WO)
1	966.70	1021.60	54.90
2	3496.70	3481.20	-15.50
3	636.50	650.20	13.70
4	977.20	1010.30	33.10
5	2546.70	2600.30	53.60
6	2749.30	2831.00	81.70
7	546.70	569.70	23.00
8	596.40	600.60	4.20

Table 12 – Comparison of the active power losses for each snapshot, with and without the interconnection project MAPT and associated reinforcements, for the Spanish system

Losses in the new HVDC interconnection

The network between Portugal and Morocco is weakly meshed. Hence, it can be assumed that the physical flows on the interconnection circuits are similar to the commercial exchanges between the two countries.

The calculation of the losses in the new HVDC interconnection was made for the four scenarios considering the bipolar HVDC-VSC technology with two different voltage levels: 320kV and 400kV. The following table summarizes the results of the computations:

V (kV)	r_1 (Ω/100km)	A (MW/kA)	B (MW)	d (km)
320	1.5	1.2	3.1	265
400	1.1	1.5	3.4	

Table 13 – Parameters for the losses estimation in the new HVDC-VSC link of the project MAPT

The following table shows the annual losses estimate for the new MAPT HVDC-VSC link and scenario:

Scenario	Annual Losses (GWh)	
	320kV	400kV
S1	269.33	180.61
S2	203.10	144.12
S3	235.19	161.83
S4	178.47	131.08

Table 14 – Annual losses estimate in the new HVDC-VSC link of the project MAPT

7 Estimation of investment cost

The new HVDC link between Portugal and Morocco will have a bipolar configuration. This is due to the fact that the existing HVAC interconnection between Spain and Morocco can momentarily sustain up of 500MW of increase in flow, which corresponds to a contingency of one of the poles of the HVDC link when there is a transit of 1000MW. The undersea length of the HVDC link is 220km.

The following table provides an estimate for the investment cost in the VSC and LCC technologies. Note that this is a rough estimate based on similar projects that exist.

Technology	Costs			
	OHL (M€/km)	Undersea Cable (M€/km)	Converters (M€)	Total (M€)
LCC Bipolar 2 x 500MW	0.25	1.24	208	492.05
VSC Bipolar 2 x 500MW	0.25	1.24	268	552.05

Table 15 – Investment cost in the new MAPT HVDC link

It is worth remarking that the maximum depth of the HVDC connection is around 500m. Finally, the HVDC-VSC technology has several advantages over the HVDC-LCC technology that have not been directly quantified but should be taken into account [4], namely:

- Active and reactive power can be controlled independently. The VSC is capable of generating leading or lagging reactive power, independently of the active power level. Each converter station can be used to provide voltage support to the local AC network while transmitting any level of active power, at no additional cost;
- If there is no transmission of active power, both converter stations operate as two independent static synchronous compensators (STATCOMs) to regulate local AC network voltages;
- The use of PWM with a switching frequency in the range of 1–2 kHz is sufficient to separate the fundamental voltage from the sidebands, and suppress the harmonic components around and beyond the switching frequency components. Harmonic filters are at higher frequencies and therefore have low size, losses and costs;
- Power flow can be reversed almost instantaneously without the need to reverse the DC voltage polarity (only DC current direction reverses).
- Good response to AC faults. The VSC converter actively controls the AC voltage/current, so the VSC-HVDC contribution to the AC fault current is limited to rated current or controlled to lower levels. The converter can remain in operation to provide voltage support to the AC networks during and after the AC disturbance;
- Black-start capability, which is the ability to start or restore power to a dead AC network (network without generation units). This feature eliminates the need for a startup generator in applications where space is critical or expensive, such as with offshore wind farms;
- VSC-HVDC can be configured to provide faster frequency or damping support to the AC networks through active power modulation;
- It is more suitable for paralleling on the DC side (developing multiterminal HVDC and DC grids) because of constant DC voltage polarity and better control.

A Cost Benefit Analysis was carried out based on the results of EES and TC1 activities of the Mediterranean Project. The following tables summarizes the results obtained.

Rules for sign of Benefit Indicators		**Assessment**	**Color Code**
B1- Sew [M€/Year]	Positive when a project reduces the annual generation cost of the whole Power System	negative impact	
B2-RES integration [GWh/Year]	Positive when a project reduces the amount of RES curtailment	neutral impact	
B3-CO_2 [kt/Year]	Negative when a project reduces the whole quantity of CO_2 emitted in one year	positive impact	
B4-Losses - [M€/Year] and [GWh/Year]	Negative when a project reduces the annual energy lost in the Transmission Network	not available/ not applicable	
B5a-SoS [MWh/Year]	Positive when a project reduces the risk of lack of supply	monetized	

Assessment results for the Cluster P1 - MAPT														
non scenario	GTC increase direction 1 (MW)		1000											
	GTC increase direction 2 (MW)		1000											
scenario specific			MedTSO scenario											
			1			2			3			4		
			Ref. Scenario	with new project	Delta	Ref. Scenario	with new project	Delta	Ref. Scenario	with new project	Delta	Ref. Scenario	with new project	Delta
GTC / NTC (import)		MA	1900	2900	1000	1900	2900	1000	1900	2900	1000	1900	2900	1000
		PT	4200	5200	1000	4200	5200	1000	4200	5200	1000	4200	5200	1000
Interconnection Rate (%)*		MA	9.0%	13.7%	4.7%	9.0%	13.7%	4.7%	7.8%	11.9%	4.1%	8.2%	12.5%	4.3%
		PT	20.9%	25.9%	5.0%	20.1%	24.9%	4.8%	18.1%	22.5%	4.3%	15.2%	18.8%	3.6%
Benefit Indicators	B1-SEW	(M€/y)	80			140			66			130		
	B2-RES	(GWh/y)	70			420			140			520		
	B3-CO_2	(kT/y)	950			-950			550			-900		
	B4 - Losses**	(M€/y)	14.6			12.7			13.2			12.4		
		(GWh/y)	270			233			243			220		
	B5a-SoS Adequacy	(MWh/y)	120			180			100			40		
	B5b-SoS System Stability													
Residual Impact Indicators	S1- Environmental Impact													
	S2-Social Impact													
	S3-Other Impact													
Costs	C1-Estimated Costs***	(M€)	657-724											

Table 16 – Cost Benefit Analysis for the project MAPT

8 References

1	Snapshots building process	Share point
2	Guide for setting up grid models for Network studies (V 5.0)	Share point
3	Network Analysis and Reinforcement Assessment	Share point
4	D. Jovcic and K. Ahmed, “Introduction to DC Grids,” in High-Voltage Direct-Current Transmission, John Wiley & Sons, Ltd, 2015, pp. 301–306.	

ANNEX I

Maximum overload in Spain

PiT	Bus From	V [kV]	Bus To	V [kV]	CKT	rate [MVA]	load flow w/ proj [%]	load flow w/o proj [%]	max load flow w/ proj [%]	max load flow w/o proj [%]
2	ACECA	220	MORA	220	1	170	384%	384%	490%	490%
6	ASCO	400	ESCATRON	400	1	840	206%	206%	261%	261%
5	ALMARAZ	220	TRUJILLO	220	1	180	187%	178%	327%	311%
6	PALMERAL	220	TORLLANO	220	1	506	187%	186%	249%	248%
6	LOECHES	400	MORATA	400	1	1460	185%	181%	243%	240%
6	AYORA	400	COFRENTE	400	1	1100	182%	182%	249%	249%
5	ELIANA	400	GAUSSA	400	1	1370	180%	177%	289%	285%
2	SALTERAS	220	SANTIPOB	220	1	350	177%	181%	304%	301%
6	ACECA	220	PICON	220	1	320	177%	177%	232%	231%
6	ELCHE2	220	SALADAS	220	1	530	170%	169%	286%	284%
6	ELEMPERA	220	PICON	220	1	180	163%	163%	253%	254%
6	ARANUELO	400	MORATA	400	1	720	163%	159%	211%	205%
6	ARANUELO	400	MORATA	400	2	720	163%	159%	210%	205%
2	ELHORNIL	220	VILLAVER	220	1	415	162%	161%	286%	284%
6	ALBAL	220	CATADAU	220	1	330	158%	157%	259%	256%
6	ELCHE2	220	ROJALES	220	1	590	154%	154%	258%	257%
2	ALMARAZ	400	GUADAME	400	1	690	154%	152%	223%	223%
6	CAMPOAMO	220	DESF.SMS	220	1	600	154%	153%	247%	247%
5	GODELLET	400	REQUENA	400	1	910	152%	148%	197%	191%
2	ACECA	220	ANOVER	220	1	560	151%	150%	236%	235%
2	PINTO	220	VILLAVER	220	1	350	146%	144%	297%	295%
6	TARRAGON	220	REUS II	220	1	310	144%	144%	221%	220%
2	SALTERAS	220	GUILLENA	220	1	310	143%	135%	343%	339%
6	ALBAL	220	TORRENTE	220	1	330	142%	141%	243%	241%
6	MEDIODIA	220	PRINCESA	220	1	370	142%	142%	226%	225%
6	CERPLATA	220	PRINCESA	220	1	440	139%	139%	210%	209%
6	ARGANDA	220	VALDMORO	220	1	350	138%	138%	210%	209%
2	PINTO	220	TVELASCA	220	1	480	137%	136%	248%	246%
6	AYORA	400	CAMPANAR	400	1	1790	135%	134%	186%	186%
6	ACECA	220	CARROYUE	220	1	630	135%	136%	206%	206%
5	MORVEDRE	220	SAGUNTO	220	1	430	133%	131%	247%	243%
5	MINGLANI	400	REQUENA	400	1	1020	133%	129%	173%	168%
2	ALMODOVA	220	CASINPB	220	1	350	132%	137%	217%	213%
5	MINGLANI	400	OLMEDILL	400	1	990	132%	128%	218%	213%
4	LA POBLA	220	TSESUE	220	1	320	129%	129%	185%	185%
6	LASELVA	220	AUBALS	220	1	410	129%	129%	187%	187%
6	PALMERAL	220	ALICANTE	220	1	417	129%	128%	175%	174%
2	ANOVER	220	TVELASCA	220	1	630	128%	127%	204%	203%

5	VANDELLO	400	CAPELLAD	400	1	930	127%	127%	168%	167%
2	TVELASCA	220	PINTOAYU	220	1	560	127%	126%	219%	217%
6	ROCAMORA	400	STA ANNA	400	1	1440	126%	125%	183%	182%
2	ACECA	220	PRADILLO	220	1	545	125%	124%	228%	226%
2	C.COLON	220	ONUBA	220	1	320	124%	118%	171%	165%
2	CEDILLO	400	JM.ORIOL	400	1	1280	124%	121%	172%	170%
5	CATADAU	400	TORRENTE	400	1	1500	124%	122%	264%	261%
2	ELHORNIL	220	PINTOAYU	220	1	560	123%	122%	215%	214%
6	DESF.SMS	220	SMSALINS	220	1	750	123%	123%	198%	197%
2	PRADILLO	220	TVELASCA	220	1	545	120%	119%	222%	221%
4	MORALEJA	400	VILLAVIC	400	1	780	119%	111%	161%	152%
5	ALDAIA	220	TORRENTE	220	1	430	118%	116%	201%	199%
5	ESCALONA	220	TESCALON	220	1	320	117%	116%	160%	159%
5	ESCALONA	220	TSESUE	220	1	320	117%	116%	160%	159%
1	LA PLANA	400	GAUSSA	400	1	880	117%	111%	183%	173%
6	RUBI	400	MAIALS	400	1	820	117%	117%	171%	171%
6	ISONA	400	SENTMENA	400	1	730	116%	116%	188%	188%
5	ELIANA	220	PUZOL	220	1	430	116%	114%	257%	253%
2	ROMICA	400	OLMEDILL	400	1	1320	116%	115%	179%	179%
2	ROMICA	400	OLMEDILL	400	2	1320	116%	115%	179%	179%
6	ARANUELO	400	VALDECAB	400	1	1280	115%	114%	181%	179%
6	ARANUELO	400	VALDECAB	400	2	1280	115%	114%	181%	179%
2	TORRECIL	220	VILLAV B	220	1	420	113%	113%	223%	222%
6	BENEJAMA	400	MONTESA	400	1	1340	113%	113%	151%	150%
5	RUBI	400	DESVERN	400	1	1010	113%	113%	154%	154%
5	GARO-BAR	400	BUNIEL	400	1	950	113%	110%	148%	144%
6	CATADAU	400	MONTESA	400	1	1340	112%	112%	150%	149%
5	ARAGON	400	VANDELLO	400	1	840	112%	111%	188%	187%
5	ALMARAZ	400	CARMONIT	400	1	1470	108%	103%	148%	141%
5	VITORIA	400	BRIVIESC	400	1	950	107%	104%	134%	131%
5	LUCERO	220	VILLAVIC	220	1	360	106%	105%	201%	198%
2	MERIDA	220	VAGUADAS	220	1	250	106%	107%	188%	185%
6	BENEJAMA	400	SAX	400	1	1480	106%	105%	151%	150%
6	MORATA	220	VILLAV B	220	1	350	105%	106%	162%	161%
6	CANTALAR	220	ALICANTE	220	1	450	105%	104%	148%	147%
5	SABINANI	220	TESCALON	220	1	320	105%	103%	148%	146%
5	GARO-BAR	400	LORA	400	1	990	105%	102%	145%	141%
5	ALMARAZ	400	VILLAMIE	400	1	720	105%	99%	163%	154%
5	MORVEDRE	220	PUZOL	220	1	430	104%	102%	244%	241%
5	ALDEADAV	400	VILLARIN	400	1	1510	104%	98%	145%	140%
5	ALVARADO	220	MERIDA	220	1	260	103%	101%	173%	170%
5	MEQUINEN	400	MAIALS	400	1	820	103%	102%	157%	156%
6	CANTALAR	220	MTEBELLO	220	1	360	102%	101%	161%	160%
2	GURREA	220	ESQUEDAS	220	1	220	100%	99%	160%	158%
6	CATADAU	220	JIJONA	220	1	260	100%	99%	143%	143%

2	GURREA	220	SABINANI	220	2	220	99%	98%	160%	158%
5	ESPARTAL	220	MONTETOR	220	1	260	99%	95%	190%	186%
6	ALDEADAV	400	ARANUELO	400	1	1280	99%	98%	143%	141%
6	ESCUCHA	220	HIJAR	220	1	210	98%	99%	191%	191%
6	CAMPANAR	400	PINILLA	400	1	1960	98%	96%	144%	143%
5	ELIANA	400	TORRENTE	400	1	1500	97%	96%	242%	239%
6	GARRAF	400	VANDELLO	400	1	980	97%	96%	128%	127%
5	MEDINACE	400	RUEDA	400	1	1340	97%	95%	132%	129%
6	ET.CERR1	220	CERPLATA	220	1	420	96%	96%	178%	178%
6	ET.CERR1	220	VILLAVER	220	1	420	96%	96%	178%	178%
5	MAGALLON	400	TERRER	400	1	1335	96%	93%	131%	129%
5	MAGALLON	400	RUEDA	400	1	1335	95%	93%	131%	128%
6	ACECA	220	VALDMORO	220	1	560	95%	95%	140%	139%
2	C.COLON	220	TORARENI	220	2	170	95%	88%	184%	170%
6	CARROYUE	220	ARSNJUA	220	1	630	95%	96%	166%	165%
6	LA POBLA	220	RUBIO	220	1	280	94%	94%	164%	164%
1	GURREA	220	VILLANUE	220	1	207	94%	92%	168%	164%
6	ET.CERR2	220	CERPLATA	220	1	450	94%	94%	167%	167%
6	ET.CERR2	220	VILLAVER	220	1	450	94%	94%	167%	167%
6	MEDIODIA	220	MAZARRED	220	1	485	94%	94%	158%	157%
2	POLGORDO	400	LA ROBLA	400	1	820	94%	95%	146%	148%
2	SABINANI	220	ESQUEDAS	220	1	220	93%	92%	153%	151%
6	JIJONA	220	VILLAJOY	220	1	360	93%	93%	157%	156%
2	EL COTO	220	SIMANCAS	220	1	404	93%	92%	197%	197%
5	GRIJOTA	400	BRIVIESC	400	1	950	93%	90%	121%	117%
1	GURREA	220	VILLANUE	220	2	210	93%	90%	165%	162%
6	STA ANNA	400	SAX	400	1	1440	92%	92%	139%	138%
2	MORATA	220	TORRECIL	220	1	490	92%	92%	186%	186%
4	SANGUESA	220	SABINANI	220	1	300	92%	94%	145%	148%
6	GUENES	220	TGUENES	220	1	360	92%	91%	134%	133%
6	JUNEDA	220	PERAFORT	220	1	280	92%	91%	153%	152%
2	MUDARRA	400	LUENGOS	400	1	820	91%	93%	120%	122%
2	LA ROBLA	400	MUDARRA	400	1	820	91%	92%	120%	122%
2	AGUAYO	400	VELILLA	400	1	930	91%	93%	117%	119%
5	ALMARAZ	400	VILLAVIC	400	1	1280	91%	87%	115%	110%
5	ALMARAZ	400	VILLAVIC	400	2	1280	91%	87%	115%	110%
5	ESCATROB	220	VILLANUE	220	1	210	91%	89%	143%	142%
5	ESCATROB	220	VILLANUE	220	2	210	91%	89%	143%	142%
5	LEGANES	220	LUCERO	220	1	280	90%	89%	213%	208%
2	LA ROBLA	400	LUENGOS	400	1	820	90%	91%	119%	121%
2	ALMODOVA	220	VNUEVREY	220	1	340	89%	96%	177%	174%
2	POLGORDO	400	SAMA	400	1	820	89%	90%	142%	143%
5	GODELLET	220	TORRENTE	220	1	520	89%	88%	181%	179%
2	VILLALBI	220	VILLATOR	220	1	304	89%	90%	114%	115%
2	PEREDA	220	SOTORIBE	220	1	250	89%	90%	108%	110%

5	HERRERA	400	LORA	400	1	990	89%	85%	130%	125%
5	ALDAIA	220	QUARTPOB	220	1	430	89%	87%	172%	170%
6	ESCATRON	400	FUENDETO	400	1	1480	88%	88%	131%	130%
6	RUBI	400	VANDELLO	400	1	930	88%	88%	116%	116%
5	TERRER	400	TRILLO	400	1	1470	88%	86%	120%	118%
2	CARMONA	220	VNUEVREY	220	1	340	87%	78%	223%	220%
7	ESCATROB	220	AUBALS	220	1	310	87%	85%	110%	108%
6	ASOMADA	400	CARRIL	400	1	880	87%	85%	118%	116%
6	ET.LOEC1	400	LOECHES	400	1	1380	87%	88%	128%	128%
6	ET.LOEC1	400	ET.SSRR1	400	1	1380	87%	88%	128%	128%
6	SS REYES	400	ET.SSRR1	400	1	1380	87%	88%	128%	128%
6	CAMPOAMO	220	S.P.PINA	220	1	500	87%	86%	122%	122%
4	MUDARRA	400	SS REYES	400	1	910	86%	85%	108%	106%
7	SANTIPOB	220	CENT_NPB	220	1	350	86%	77%	102%	92%
4	GALAPAGA	220	V.BATAN	220	1	280	86%	85%	121%	118%
2	CANILLEJ	220	SIMANCAS	220	1	529	86%	85%	165%	165%
1	MUDARRA	400	TORDESIL	400	1	1360	85%	81%	109%	104%
2	GATICA	400	GUENES	400	1	1590	85%	85%	104%	105%
5	COFRENTE	400	LA MUELA	400	2	1170	85%	84%	152%	150%
2	AGUACATE	220	PQINGENI	220	1	470	85%	85%	140%	140%
5	ALMARAZ	400	ALANGE	400	1	1430	85%	80%	144%	137%
5	CATADAU	400	LA MUELA	400	2	1170	85%	84%	128%	127%
2	HUELVES	220	MORATA	220	1	360	85%	81%	142%	138%
6	GRIJOTA	400	VILLARIN	400	2	910	84%	81%	109%	104%
5	CATADAU	400	LA MUELA	400	1	1170	84%	83%	128%	127%
2	ICHASO	400	VITORIA	400	1	1030	84%	86%	111%	113%
5	MONTETOR	220	PLAZA	220	1	330	84%	82%	138%	136%
5	GARO-BAR	400	ICHASO	400	1	1030	84%	83%	114%	112%
6	CASACAMP	220	MAZARRED	220	1	462	84%	84%	151%	151%
5	COFRENTE	400	LA MUELA	400	1	1170	84%	83%	151%	149%
2	BEGUES	400	ESPLUGA	400	1	940	84%	84%	128%	128%
5	ALANGE	400	BIENVENI	400	1	1430	84%	79%	143%	136%
5	ARAGON	400	PENAFLOR	400	1	1340	83%	81%	147%	144%
5	GARO-BAR	400	GUENES	400	1	940	83%	82%	124%	122%
6	CRODRIGO	400	HINOJOSA	400	1	1280	82%	81%	111%	108%
6	GRIJOTA	400	VILLARIN	400	1	910	82%	79%	107%	102%
8	GUILLE_B	220	CENT_NPB	220	1	170	82%	67%	126%	101%
7	ELIANA	400	GODELLET	400	1	1500	82%	78%	115%	110%
5	CARMONIT	400	ARSERVAN	400	1	1470	82%	76%	122%	115%
2	ALCOLEA	220	CARMONA	220	1	350	82%	72%	108%	95%
1	GRIJOTA	400	MUDARRA	400	1	910	81%	79%	118%	114%
6	MAJADAHO	220	TALAVERA	220	1	410	81%	79%	107%	104%
5	ELIANA	220	QUARTPOB	220	1	430	81%	80%	165%	162%
5	BSONUEVO	220	GRAMANTA	220	1	414	81%	81%	124%	124%
6	CRODRIGO	400	ALMARAZ	400	1	1280	81%	79%	109%	106%

6	ARGANDA	220	LOECHESB	220	1	440	81%	81%	138%	137%
1	ALARCOS	220	MANZARES	220	1	180	81%	76%	136%	122%
1	AENA	220	CVALMANZ	220	1	380	80%	78%	117%	114%
6	LASELVA	220	REUS II	220	1	310	80%	80%	156%	156%
5	COFRENTE	400	GODELLET	400	1	1500	80%	79%	141%	140%
5	ARAGON	400	ARNERO	400	1	1300	80%	79%	115%	115%
6	FAUSITA	220	HOYAMORE	220	1	530	80%	80%	114%	113%
2	OLMEDILL	400	TRILLO	400	1	1800	80%	80%	116%	116%
4	CASTRELO	220	AMOEIRO	220	1	230	80%	76%	152%	146%
2	COSLADAB	220	LOECHESB	220	1	360	80%	78%	111%	109%
2	HUELVES	220	VILLARES	220	1	360	80%	76%	137%	134%
6	BEGUES	400	GARRAF	400	1	1010	79%	79%	109%	109%
5	PENAFLOR	220	VILLANUE	220	1	280	79%	75%	166%	160%
5	ALMARAZ	400	ARSERVAN	400	2	1760	79%	75%	118%	112%
2	JUNDIZ	220	PUENTELA	220	1	539	79%	79%	111%	112%
6	EALMARAZ	220	EBORA	220	1	400	79%	76%	108%	104%
2	ALVARADO	220	VAGUADAS	220	1	260	79%	76%	180%	178%
8	GUADAME	220	OLIVARES	220	1	170	79%	74%	111%	106%
7	ROJALES	220	SMSALINN	220	1	600	79%	77%	109%	107%
4	JALON	220	PLAZA	220	1	330	79%	80%	144%	147%
5	MAJADAHO	220	VALLARCI	220	1	360	78%	76%	118%	115%
6	MTEBELLO	220	VILLAJOY	220	1	360	78%	78%	142%	142%
4	GALAPAGA	400	LASTRAS	400	1	1040	78%	76%	101%	99%
2	JM.ORIOL	400	CANAVERA	400	1	1420	78%	76%	126%	125%
6	PIEROLA	220	RUBIO	220	1	350	78%	78%	134%	134%
6	TORSEGRE	220	MEQUINEN	220	1	600	78%	78%	112%	112%
8	CALDERS	400	ISONA	400	1	730	78%	77%	103%	102%
2	PENARRUB	400	PINILLA	400	1	1470	78%	77%	116%	115%
4	MEDINACE	400	TRILLO	400	1	1310	78%	75%	103%	99%
2	LA ESTRE	220	MORATA	220	1	470	77%	77%	112%	113%
1	GRIJOTA	400	BUNIEL	400	1	950	77%	73%	101%	95%
7	EALMARAZ	220	CALERA	220	1	320	77%	71%	105%	97%
6	ADRALL	220	LLAVORSI	220	1	410	77%	77%	101%	101%
1	ARAGON	400	MUDEJAR	400	1	840	77%	74%	140%	135%
1	ARAGON	400	MUDEJAR	400	2	840	77%	74%	140%	135%
3	ELEMPERA	220	MORA	220	1	170	77%	76%	103%	102%
6	ALDEADAV	400	HINOJOSA	400	1	1380	76%	75%	103%	100%
6	TORRIJOS	220	TVELASCB	220	1	320	76%	73%	112%	108%
6	ALBATARR	220	TORSEGRE	220	1	600	76%	76%	110%	110%
6	HOYAMORE	220	S.P.PINA	220	1	500	76%	75%	112%	111%
5	CASACAMP	220	MBECERRA	220	1	240	76%	74%	167%	164%
6	PALMAR	400	ROCAMORA	400	1	1280	76%	75%	117%	117%
6	PALMAR	400	ROCAMORA	400	2	1280	76%	75%	117%	117%
5	LITORAL	400	TABERNAS	400	1	1290	76%	74%	120%	117%
7	TALAVERA	220	CALERA	220	1	320	75%	70%	103%	95%

2	PALENCIA	220	TMUDI2	220	1	540	75%	77%	102%	105%
6	ESCUCHA	220	VALDECON	220	1	300	74%	74%	139%	138%
6	ADRALL	220	CERCS	220	1	280	74%	74%	110%	110%
6	SENGRACI	400	LA SERNA	400	1	840	74%	72%	118%	116%
2	AGUACATE	220	POLIGONC	220	1	470	73%	73%	129%	129%
5	ROMICA	400	MANZARES	400	1	1820	73%	72%	113%	110%
5	ROMICA	400	MANZARES	400	2	1820	73%	72%	113%	110%
6	VALDECAB	400	CARMONA	400	1	700	73%	69%	102%	96%
6	GRIJOTA	400	HERRERA	400	1	1040	72%	70%	113%	110%
6	BENEJAMA	220	CASTALLA	220	1	410	72%	73%	136%	136%
7	ESCATROB	220	MEQUINEN	220	1	230	72%	71%	112%	109%
2	CAMPONAC	220	EL COTO	220	1	433	72%	72%	170%	170%
2	LA ROBLA	400	SOTORIBE	400	1	1080	72%	73%	114%	116%
5	ARAGON	400	N.MEQUIN	400	1	1310	71%	70%	120%	119%
6	ALBATARR	220	MANGRANE	220	1	600	71%	71%	105%	105%
2	ABRERA	220	PUJALT	220	1	260	71%	71%	119%	118%
5	BSONUEVO	220	TANGCATA	220	1	400	71%	71%	109%	109%
6	VILLALCA	220	VILLARIN	220	1	304	71%	68%	103%	98%
6	VILLALCA	220	VILLARIN	220	2	304	71%	68%	103%	98%
1	CVALMANZ	220	HORTALEZ	220	1	450	71%	70%	106%	104%
2	GETAFE	220	COSLADAB	220	1	315	70%	68%	106%	104%
2	BEGUES	220	GAVARROT	220	2	360	70%	70%	106%	106%
2	CASAQUEM	220	GUILLENA	220	1	350	70%	70%	118%	117%
5	SAGUNTO	220	VALLDUXO	220	1	440	70%	69%	124%	123%
2	OLMEDILL	220	VILLARES	220	1	360	70%	67%	127%	124%
5	BSONUEVO	220	VILANOVA	220	1	400	69%	69%	118%	118%
1	S.CUGAT	220	C.JARDIB	220	1	240	69%	69%	101%	100%
6	ALMARAZ	400	MORATA	400	2	1280	69%	66%	106%	101%
6	A.LEYVA	220	PQINGENI	220	1	510	69%	69%	112%	112%
2	CANILLEJ	220	COSLADA	220	1	410	69%	69%	131%	131%
2	CANILLEJ	220	COSLADA	220	2	410	69%	69%	131%	131%
5	ARAGON	400	PENALBA	400	1	1300	69%	68%	104%	103%
1	CARRIO	220	REBORIA	220	1	530	69%	67%	106%	104%
6	MORATA	400	VILLAMIE	400	1	1280	68%	65%	105%	101%
1	S.BOI	220	GAVARROT	220	1	350	68%	68%	106%	106%
5	BSONUEVO	220	GRAMANTA	220	3	450	68%	68%	110%	110%
2	CARDIEL	220	MEQUINEN	220	1	210	68%	66%	149%	147%
2	FUENCARR	400	SS REYES	400	1	910	68%	67%	117%	118%
6	CATADAU	400	GODELLET	400	1	1600	68%	68%	142%	141%
6	BENEJAMA	220	JIJONA	220	2	360	68%	68%	163%	163%
6	BENEJAMA	220	JIJONA	220	1	360	68%	67%	163%	162%
6	LASOLANA	220	PICON	220	1	320	67%	65%	120%	114%
3	REBORIA	220	GOZON	220	1	530	67%	67%	105%	105%
1	P.BIBEY	220	PRADA	220	1	210	67%	65%	111%	108%
1	AMOREBIE	400	ICHASO	400	1	940	67%	67%	117%	117%

6	PICON	220	P.LLANO	220	1	320	67%	64%	123%	117%
6	MIRASIER	220	VALLARCI	220	1	360	67%	65%	110%	107%
5	JALON	220	MAGALLON	220	1	370	67%	62%	151%	145%
5	JALON	220	MAGALLON	220	2	370	67%	62%	151%	145%
6	PSEVILLA	220	CENT_NPB	220	1	441	67%	59%	107%	96%
6	ABRERA	220	RUBI	220	1	260	67%	67%	123%	123%
6	RICOBAYO	220	VILLARIN	220	1	490	66%	63%	111%	106%
5	MEQUINEN	400	N.MEQUIN	400	1	1310	66%	65%	114%	113%
6	OLIVARES	220	MAZUELOS	220	1	259	66%	64%	119%	116%
1	MAGALLON	400	EJEACAB	400	2	1340	65%	64%	116%	113%
2	CARTUJOS	220	MONTETOR	220	1	360	65%	65%	109%	109%
6	BEGUES	400	VILADECA	400	1	1010	65%	65%	119%	119%
5	GRADO	220	MONZON	220	1	210	65%	65%	181%	180%
7	PQINGENI	220	VILLAV B	220	2	400	65%	65%	114%	114%
6	CASACAMP	220	NORTE	220	2	499	65%	64%	101%	99%
6	BASAURI	220	TGUENES	220	1	360	65%	65%	103%	102%
6	BOADILLA	220	VILLAV_B	220	1	280	65%	64%	103%	102%
1	MAGALLON	400	EJEACAB	400	1	1335	65%	63%	116%	113%
7	ASCO	400	PIEROLA	400	1	940	64%	64%	100%	100%
6	MUDEJAR	400	MORELLA	400	1	1800	64%	64%	107%	106%
6	MUDEJAR	400	MORELLA	400	2	1800	64%	64%	107%	106%
6	CAMPOAMO	220	FAUSITA	220	1	490	64%	64%	109%	108%
1	ANCHUELO	400	TRILLO	400	1	1470	64%	60%	106%	101%
6	RAMBLETA	220	VALLDUXO	220	1	500	64%	63%	123%	121%
1	HORTALEZ	220	PROSPERI	220	1	240	64%	61%	112%	107%
2	LA JARA	220	TAYALA2	220	1	330	63%	64%	102%	102%
5	SAGUNTO	220	VALLDUXO	220	2	500	63%	63%	113%	112%
2	LA PLANA	220	SERRALLO	220	1	320	63%	64%	109%	111%
7	ASCO	400	SENTMENA	400	1	940	63%	63%	101%	101%
7	ASCO	400	SENTMENA	400	2	940	63%	63%	101%	101%
8	GRELA	220	SABON	220	1	270	63%	65%	102%	104%
2	A.LEYVA	220	ARGANZUE	220	1	520	63%	63%	115%	115%
6	BALSICAS	220	PALMAR	220	1	490	63%	63%	115%	115%
6	NOVELDA	220	PETREL	220	1	410	63%	63%	123%	123%
6	CASINPB	220	AZAHARA	220	1	388	63%	60%	125%	121%
6	COMPOSTI	400	MONTEARE	400	1	900	63%	60%	106%	102%
6	MORALEJA	400	S.FERNAN	400	1	780	63%	60%	109%	105%
1	ELIANA	400	LA PLANA	400	1	1370	62%	59%	108%	102%
8	ASCO	400	ESPLUGA	400	1	940	62%	62%	100%	99%
6	EALMARAZ	220	TORREJON	220	1	240	62%	59%	113%	109%
1	CABRA	400	MOLLINA	400	1	1240	62%	63%	112%	116%
2	BSONUEVO	220	GRAMANTA	220	2	414	62%	62%	100%	100%
3	ALCORES	220	CARMONA	220	1	310	62%	63%	101%	105%
1	AYORA	400	BENEJAMA	400	1	1100	62%	62%	113%	113%
6	MAJADAHO	220	VILLAV_B	220	1	280	62%	61%	103%	101%

2	ABADIANO	220	VITORIA	220	1	327	62%	62%	115%	117%
6	ANOIA	220	ISONA	220	1	260	62%	62%	120%	119%
8	GRELA	220	PUERTO	220	1	266	62%	65%	100%	104%
2	ROCAMORA	400	TREMENDO	400	1	1290	61%	61%	165%	165%
1	CARTAMA	400	MOLLINA	400	1	1240	61%	62%	111%	114%
1	LA PLANA	400	MORELLA	400	2	1800	61%	58%	104%	100%
1	LA PLANA	400	MORELLA	400	3	1800	61%	58%	104%	100%
2	MATA	220	TANGCATA	220	1	400	61%	61%	101%	101%
5	PENAFLOR	400	EJEACAB	400	1	1340	61%	57%	115%	111%
7	ESCATROB	220	ESPARTAL	220	1	240	60%	57%	100%	96%
2	GETAFE	220	RETAMAR	220	1	280	60%	58%	101%	98%
8	EIRIS	220	MESON V.	220	1	270	60%	61%	102%	104%
4	CHANTADA	220	AMOEIRO	220	1	230	60%	56%	132%	127%
1	VANDELLO	400	CAMARLES	400	1	1380	59%	57%	143%	138%
1	C.JARDIB	220	CODONYER	220	1	240	59%	59%	119%	119%
6	CACERES	220	TORREJON	220	1	240	59%	56%	110%	105%
6	HOSPTLET	220	VILADECA	220	1	260	59%	59%	112%	112%
6	HOSPTLET	220	VILADECA	220	2	260	59%	59%	112%	112%
2	LA SERNA	220	TUDELA	220	2	320	59%	57%	190%	189%
6	RAMBLETA	220	ASSEGADO	220	1	510	59%	58%	116%	115%
6	BECHI	220	VALLDUXO	220	1	440	58%	58%	106%	105%
5	PALENCIA	220	RENEDO	220	1	304	58%	55%	109%	103%
5	BESCANO	400	SENTMENA	400	1	2030	57%	57%	100%	100%
7	A.ZINC	220	TABIELLA	220	1	270	57%	57%	115%	114%
7	A.ZINC	220	TABIELLA	220	2	270	57%	57%	115%	114%
4	COSLADA	220	VILLAVER	220	1	315	57%	55%	107%	103%
6	MEDIANO	220	P.SUERT	220	1	210	57%	57%	173%	173%
1	ESCATROB	220	HIJAR	220	1	210	57%	56%	101%	99%
5	ALMARAZ	220	EALMARAZ	220	1	350	57%	54%	127%	120%
2	BENAHADU	220	BERJA	220	1	350	57%	53%	103%	101%
1	EJEACAB	400	JACA	400	1	1800	56%	56%	113%	113%
1	EJEACAB	400	JACA	400	2	1800	56%	56%	113%	113%
8	VIENTOS	220	MARIA	220	1	370	56%	53%	103%	97%
8	VIENTOS	220	MARIA	220	2	370	56%	53%	103%	97%
6	LASELVA	220	REUS II	220	2	441	56%	56%	110%	109%
5	TABIELLA	220	GOZON	220	2	530	56%	56%	100%	100%
4	JALON	220	VIENTOS	220	1	650	56%	57%	102%	104%
4	JALON	220	VIENTOS	220	2	650	56%	57%	102%	104%
7	PQINGENI	220	VILLAV B	220	1	400	56%	56%	112%	112%
1	TRUJILLO	220	MERIDA	220	1	180	55%	41%	126%	98%
5	PIEROLA	400	CAPELLAD	400	1	930	55%	54%	114%	114%
5	GUILLENA	400	VALDECAB	400	1	700	54%	42%	106%	91%
6	PALMERAL	220	S.VICENT	220	1	506	54%	54%	113%	113%
5	MBECERRA	220	PROSPERI	220	1	240	54%	52%	145%	142%
4	BELESAR	220	CHANTADA	220	1	311	53%	52%	112%	108%

7	MORATA	400	TVELASCO	400	1	780	53%	55%	105%	103%
6	ALARCOS	220	PICON	220	1	320	53%	51%	173%	172%
2	MUDARRIT	220	TMUDI2	220	2	360	53%	54%	107%	110%
2	BESCANO	400	LAFARGA	400	1	2030	53%	53%	101%	101%
1	LLOGAIA	400	LAFARGA	400	1	2030	53%	53%	101%	101%
6	AYORA	400	COFRENTE	400	2	1100	52%	52%	149%	149%
2	ESCATROA	220	ESCATROB	220	1	600	52%	51%	117%	116%
2	LA SERNA	220	TUDELA	220	1	290	52%	50%	166%	165%
2	LA ESTRE	220	ARDOZ	220	1	450	51%	52%	105%	107%
1	CANYET	220	GRAMANTB	220	1	350	51%	51%	107%	107%
2	LA ROBLA	400	VILLAMEC	400	1	930	51%	52%	112%	113%
5	CARDIEL	220	ARNERO	220	1	210	51%	52%	168%	168%
6	GRADO	220	MEDIANO	220	1	240	50%	50%	152%	151%
6	PETREL	220	ELDA	220	1	410	50%	50%	110%	110%
6	NOVELDA	220	SALADAS	220	1	450	50%	49%	106%	106%
6	NOVELDA	220	SALADAS	220	2	450	50%	49%	106%	106%
6	CAMPOAMO	220	BALSICAS	220	1	490	49%	49%	101%	100%
4	MANFIGUE	220	PALAU	220	1	260	49%	49%	115%	116%
1	ALVARADO	220	BALBOA	220	1	305	49%	43%	105%	88%
6	TVELASCO	400	VILLAVIC	400	1	780	48%	51%	170%	168%
2	BIENVENI	400	BROVALES	400	1	1270	48%	48%	113%	117%
1	BESCANO	400	LLOGAIA	400	1	2030	48%	48%	101%	101%
2	CASAQUEM	220	ONUBA	220	1	350	48%	47%	118%	117%
6	L.MONTES	220	LOSRAMOS	220	1	210	48%	43%	107%	97%
2	ORCOYEN	220	TAFALLA	220	1	560	47%	46%	105%	103%
1	PC_FAVE2	220	S.CUGAT	220	1	240	47%	47%	121%	121%
5	COFRENTE	400	MINGLANI	400	1	1310	47%	45%	104%	100%
2	BESCANO	400	RIUDAREN	400	1	2030	47%	47%	118%	118%
5	ALDEADAV	220	VILLARIN	220	3	250	47%	43%	126%	118%
5	ALDEADAV	220	VILLARIN	220	4	250	47%	43%	126%	118%
6	ARSNJUA	220	MANZARES	220	1	630	46%	47%	117%	116%
6	VIRGENRO	220	CENT_NPB	220	1	441	46%	42%	100%	89%
1	SANABRIA	220	MUDARRA	220	1	200	46%	45%	117%	114%
2	BELINCHO	400	MORATA	400	2	1310	46%	42%	101%	97%
1	GUADAME	220	P.LLANO	220	1	170	46%	42%	102%	96%
8	TUDELA	220	MAGALLO2	220	1	330	45%	43%	138%	135%
6	ANOIA	220	RUBI	220	1	260	45%	45%	103%	102%
1	LA PLANA	400	CAMARLES	400	1	1380	43%	41%	127%	121%
2	COMPOSTI	400	VILLAMEC	400	1	900	43%	44%	106%	108%
3	CARRIO	220	TABIELLA	220	2	530	43%	43%	102%	101%
5	RIUDAREN	400	VIC	400	1	2030	43%	43%	100%	100%
6	LANCHA	220	AZAHARA	220	1	388	41%	38%	103%	100%
4	CARTELLE	220	CASTRELO	220	2	230	40%	38%	105%	100%
2	BENEJAMA	220	ELDA	220	1	410	40%	40%	106%	106%
2	GUILLENA	220	SANTIPON	220	4	350	39%	43%	100%	106%

5	ALDEADAV	220	VILLARIN	220	1	330	38%	35%	102%	96%
5	ALDEADAV	220	VILLARIN	220	2	330	38%	35%	102%	96%
5	MATA	220	VILANOVA	220	1	400	38%	38%	109%	109%
2	JIJONA	220	S.VICENT	220	1	510	37%	37%	102%	103%
2	RIBARROJ	220	ARNERO	220	1	210	37%	37%	118%	119%
2	AVEZARAG	220	PENAFLOR	220	1	360	37%	37%	104%	104%
2	ICHASO	220	ELGE_NP	220	1	320	37%	38%	104%	106%
5	VILADECA	400	DESVERN	400	1	1010	37%	36%	108%	108%
2	PRADSANT	220	VILLAV_B	220	1	360	34%	35%	104%	107%
2	NESCOMBR	400	TREMENDO	400	1	1290	28%	29%	103%	104%
2	ANCHUELO	400	LOECHES	400	1	1460	27%	30%	102%	104%
2	PARRALEJ	220	PTO REAL	220	1	600	27%	28%	104%	105%
2	CAMPONAC	220	HORTALEZ	220	1	440	25%	24%	112%	112%
6	CONSTANT	220	TARRAGON	220	1	320	25%	25%	143%	142%
2	QUINTOS	220	DRODRI_B	220	1	170	24%	19%	107%	106%
6	CANTALAR	220	JIJONA	220	1	360	19%	19%	105%	105%
2	LASOLANA	220	P.LLANO	220	1	320	19%	23%	115%	111%
3	PARRALEJ	220	GAZULES	220	1	305	13%	13%	189%	188%
5	LA SERNA	400	EJEACAB	400	1	1335	13%	11%	122%	119%
2	PRADSANT	220	RETAMAR	220	1	280	10%	11%	100%	104%
8	CENTELLE	220	SENTMENA	220	1	220	9%	8%	111%	110%
3	FACINAS	220	PTO CRUZ	220	1	490	3%	3%	215%	214%
7	CENTELLE	220	CERCS	220	1	220	2%	1%	109%	108%

Maximum overloads in Portugal

PiT	Bus From	V [kV]	Bus To	V [kV]	CKT	rate [MVA]	load flow w/ proj [%]	load flow w/o proj [%]	max load flow w/ proj [%]	max load flow w/o proj [%]
5	SINES	400	PEGOES	400	1	1321	112%	97%	176%	154%
5	F.ALENT	400	SINES	400	2	1361	100%	95%	133%	120%
5	PALMELA	400	SINES	400	2	1321	95%	83%	166%	145%
5	SINES	150	M.PEDRA	150	1	191	95%	83%	140%	123%
5	PALMELA	150	PMMP/PE	150	1	191	93%	81%	138%	121%
5	M.PEDRA	150	PMMP/PE	150	1	191	93%	81%	138%	121%
5	F.ALENT	150	EVORA	150	1	218	79%	73%	106%	98%
5	PALMELA	400	ALCOCHET	400	1	1321	77%	68%	110%	98%
5	FANHÕES	400	ALCOCHET	400	1	1321	74%	66%	107%	95%
5	PORTIMÃO	400	TAVIRA	400	1	1386	70%	52%	104%	85%
5	SINES	400	PORTIMÃO	400	3	1386	66%	50%	102%	84%
2	MOURISC	220	PARAIMO	220	1	342	60%	63%	102%	107%
8	PICOTE	220	MIRANDA	220	2	229	57%	57%	113%	113%
8	PICOTE	220	MIRANDA	220	1	229	56%	56%	113%	113%
2	F.ALENT	150	ERMIDAS	150	1	260	39%	40%	108%	112%
2	SINES	150	ERMIDAS	150	1	260	37%	38%	107%	111%

2	F.ALENT	150	F.ALENT	400	5	250	32%	32%	109%	113%
2	F.ALENT	150	F.ALENT	400	4	250	32%	32%	109%	113%

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