MALTA RESOURCES AUTHORITY

Consultancy Service for the Authorisation of the Interconnection Malta – Sicily

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LAHMEYER INTERNATIONAL

Consultancy Service for the Authorisation of the Interconnection Malta – Sicily

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Abbreviations

°C	Grad Celsius
€	Euro (European Currency)
a	Year
a.m.	ante meridiem
AC	Alternating Current
AEEG	Autorità per l'energia elettrica e il gas (Italian regulatory authority)
APX	Amsterdam Power Exchange
ATC	Available Transmission Capacities
BELPX	Belgian Power Exchange
bn	Billion
BOO	Build Own Operate
BOOT	Build Own Operate Transfer
BOT	Build Operate Transfer
CAPEX	Capital Expenditures
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CESI	Centro Elettrotecnico Sperimentale Italiano (Italian Experimental Electrotechnical Center)
CO_2	Carbon Dioxide
CO_{2e}	Carbon Dioxide equivalents
COM	Communication
DC	Direct Current

DSO	Distribution System Operator
e.g.	for example
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEPR	European Energy Programme for Recovery
EEX	European Energy Exchange
EIB	European Investment Bank
EIF	European Investment Fund
ENTSO-E	European Network of Transmission System Operators for Electricity
EPEX	European Power Exchange
ERDF	European Regional Development Fund
ETS	Emission Trading Scheme
EU	European Union
EUA	European Emission Allowances
EUR	Euro
EXAA	Energy Exchange Austria
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GME	Gestore Mercati Energetici
GO	Guarantees of Origin
GSE	Gestore dei Servizi Energetici
GWh	Gigawatt hours
h	hours
HVDC	High Voltage Direct Current

Hz	Hertz
i.e.	id est
IPEX	Italian Power Exchange
IPP	Independent Power Producer
IT	Italy
ITC	Inter TSO Compensation
JV	Joint Venture
km	Kilometre
ktoe	Kilotons of oil equivalent
kV	Kilovolt
kWh/a	Kilowatt hours per year
LCC	Line Commutated Converter
LHV	Lower Heating Value
LI	Lahmeyer International GmbH
LNG	Liquefied Natural Gas
m	Million
MEA	Manx Electricity Authority
MI	Italian Intra-Day Electricity Market
Mio	Million
MPE	Italian Spot Electricity Market
MPG	Italian Day-Ahead Electricity Market
MRA	Malta Resources Authority
MRA	Malta Resources Authority
MSD	Italian Balancing Electricity Market
MT	Malta

MTE	Italian Forward Electricity Market
MVA	Mega Volt Ampere
MVAr	Mega Volt Ampere Reactive
MW	Megawatt
MWh	Megawatthours
MΩ	Megaohm
NAP	National Allocation Plan
NL	The Netherlands
NO_X	Nitrogen Oxides
NP	Nord Pool
O&M	Operation & Maintenance
OMEL	Spanish Power Exchange
p.m.	post meridiem
PFC	Perfluorocarbons
P_{Max}	Maximal transmissible active power
PNXT	Powernext
POLPX	Polish Power Exchange
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PTR	Physical Transmission Rights
PV-node	Power Voltage Node
Q_{min}	Minimum Cross Section
R&D	Research and Development
RE	Renewable Energy/Energies
RES	Renewable Energy Sources

RES	Renewable Energy Sources
RES-E	Renewable Energy Sources for Electricity
S	Operating Voltage Range
SAPIENZA	University of Rome
SCR	Short-circuit Rating
SEC	Setting of Ecodesign
SPV	Special Purpose Vehicle
TEN-E	Trans-European Energy Network
Terna	Italian electricity transmission grid operator
TOV	Transient Overvoltage
TSO	Transmissions System Operator
UCTE	Union for the Coordination of Transmission of Electricity
UFLS	Under-frequency Load Shedding
UK	United Kingdom
VSC	Voltage Source Converter
XLPE	Cross Linked Polyethylene

0 Executive Summary

The objective of the report at hand as prepared by Lahmeyer International (LI) for the Maltese energy regulator, the Malta Resources Authority (MRA), is the provision of Consultancy Services for the Authorisation of the envisaged Interconnection Malta – Sicily and additional related issues. The background of the study is the interaction of three core aspects as shown in Figure 0-1, representing three main components of the EU Energy Package, i.e. security of supply as well as external dimension and enlargement, internal market, renewable energies.

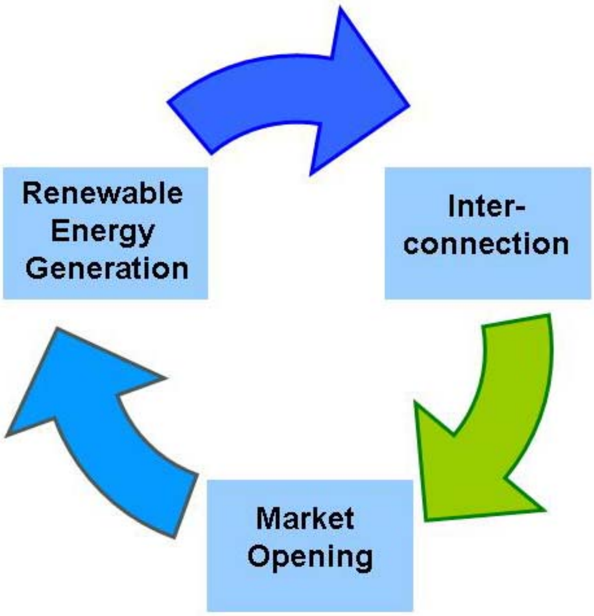

Figure 0-1: Interaction of Main Components as considered in the study

With regard to the **technical viability** of the interconnection, the feasibility study of the interconnection as executed for Enemalta by the cooperating consultants Terna, CESI and SAPIENZA was reviewed. The feasibility study focuses on a HVAC interconnection solution. The key critical aspects identified by LI are the following.

- An AC interconnection of the required length would be the first of its kind world-wide.
- The cable is characterised by a high reactive power which has to be compensated on both interconnected sides, i.e. on the Sicilian and Maltese side;

- Each grid is characterised by an according amount of reactive power. In case of an interconnection, the compensation of the reactive power of the cable is also necessary. In order to achieve required regulation in this context for the anticipated interconnection type and capacity, consecutively higher own generation capacity was required.
- In order to deal with the accruing maximum and minimum load; the according amount of reactive power needs to be available.
- The Maltese 33 kV network has not been considered in the feasibility which should be the case.

For the time being, the longest existing interconnection exists between the Isle of Man and England. However, compared to the case of the envisaged interconnection between Malta and Sicily, the system is characterised by

- higher own generation on the interconnected Isle of Man compared to Malta;
- smaller capacity of the interconnector;
- shorter distance of the interconnector.

It is obvious, that the existing studies as realised within the feasibility study of Terna, CESI and SAPIENZA are rather planning studies than operation studies, leaving aside the consideration of different outage scenarios. The impact of the interconnector especially with regard to the Maltese system has not been considered in a complete manner. In the documentation provided to LI, a range of information is thus missing which is necessary to assess the feasibility of the recommended interconnection.

It is hence recommendable for MRA as regulatory authority to discuss open issues with Enemalta in order to get a better picture from the envisaged expansion measure in form of the interconnection. In case Enemalta is not in possession of such information, it should require an amendment of the services provided in line with the feasibility study or should initiate additional assessment of the link. The information drawn in this context shall serve as basis to identify the strengths and weaknesses of the envisaged interconnection both in technical terms, i.e. with regard to security of supply and the national system, and organisational issues with regard to the **implementation and operation of the interconnection**.

For the implementation of the interconnection, it is worthwhile to pursue the establishment of a Special Purpose Vehicle (SPV), joining the wide variety of involved project participants. Besides the grid system operators on both sides, i.e. Terna in Italy and the Maltese Enemalta, also EPC contractors, O&M contractors, banks etc. are probable parties of the SPV. Such a structure would require the participants to contribute to the financing of the project resulting also in profit participation. This enhances the commitment of the project participants to their services and eventually the successful execution of such a project. Furthermore, this set-up would allow for the public and private funding, including EU funding anticipated for the interconnection link.

Based on the lack of information from the feasibility study, the operation strategy for the interconnector is not evident and thus also the market share applicable for its utilisation is not known. However, depending on the market share which can be expected to utilise the link as third party access, it is possible to operate the link both on a regulated and unregulated basis. As the link is initially expected to serve merely as import link to Malta, an unregulated operation might also be possible due to the derogation from third party access granted to Malta.

In the context of the introduction of the interconnection, some need for action has been identified for MRA (summarised in Chapter 3.4.3). The main aspects are the clarifications of open technical issues in line with the feasibility study of the interconnection. Furthermore, an early liaison with the Italian regulator AEEG is recommended in order to launch required cooperation and to benefit possibly from its lessons learnt in line with the implementation of already existing interconnections.

For the purchase of electricity via the interconnector, different options are possible. The modalities and cost also depend again on the required amount of electricity to be transferred over the connector as well as its nature (e.g. base load, intermediate load, peak load). Electricity will most likely be purchased at European power exchanges. It is recommended that these should possess the following characteristics: (i) an automatic and preferably internet-based market access, (ii) clearing & settlement of deals, (iii) adequate risk allocation and (iv) overall transparency in terms of various information needed by market participants.

With regard to the **national Maltese RES target** of 10% contribution to the final consumption in 2020, besides domestic RES generation different alternative approaches are applicable: (i) statistical transfers, (ii) joint projects with (an)other Member State(s), (iii) joint projects with non-EU countries, (iv) joint support schemes. Whereas the domestic RES generation has been proven to be very costly in the feasibility study provided by Mott McDonald, the above mentioned options may result in more cost-efficient solutions which are recommended to be further studied in the future. Subsequently, an according strategy comprising also non-monetary aspects such as the amount of commitment to domestic RES should be envisaged. In parallel, a strategic approach on the most suitable **RES promotion scheme** would have to be developed on behalf of the Maltese governments.

Facing tomorrow's **developments in EU policy** with regard to Maltese regulatory issues, one of the crucial aspects if for sure the derogation granted for Malta from third party access to the system, unbundling of TSO/DSO and market opening/reciprocity. This derogation might be subject of review in line with potential revision of the new Internal Market Directive and would not facilitate unregulated operation anymore, i.e. all of the capacity would then have to be allocated based on auctioning. This might be in line with the expectations with regard to the European endeavour to enhance the internal market in electricity. The second pillar of European energy policy is the global climate policy, being expressed by the so-called 20-20-20 targets:

- the share of renewable energy consumption in gross final energy consumption of the EU shall amount to at least 20%;
- energy efficiency shall increase by 20%;
- CO_2 emissions shall be reduced by 20% vis-à-vis their 1990 level.

Particular need for action from the above listed aspects accrues for Malta with regard to emission trading. Depending on the electricity import strategy pursued in line with the interconnector and potentially freely allocated certificates, MRA will have to consider thoroughly the introduction and approval of new tariffs in order to avoid the consideration of windfall profits resulting in inappropriate profit margins for Enemalta from the release of unused and freely allocated emission allowances.

1 Introduction

The Maltese regulatory authority for the energy sector, the Malta Resources Authority (MRA) has awarded Lahmeyer International (LI) with the execution of the Consultancy Service for the Authorisation of the Interconnection Malta – Sicily. The report at hand presents the results of the according study as accomplished by LI from end of October 2009 until the beginning of December 2009. Basis for the analysis constitutes a feasibility study executed by Terna S.p.A. as well as CESI and the University of Rome/SAPIENZA for the Maltese energy utility Enemalta analysing the feasibility of the interconnection between Sicily and Malta. Furthermore, an introduction to the current situation regarding the interconnection has been prepared by Enemalta based on the feasibility study.

According to the information of the Maltese electricity utility Enemalta, the interconnection shall consist of two lines 2 x 200 MW HVAC. Enemalta foresees the commissioning of the interconnection by the end of 2012 whereas the second line is expected to become operational in 2015.

Based on the introduction of the interconnection, the Maltese energy sector does not constitute an isolated system anymore which is currently the case and results at present in derogation for the opening of the internal market of electricity. Effects in this regard are subjects of the study. Furthermore, the study addresses according to the request of MRA to which extend an interconnection offers additional possibilities for the contribution of renewable energies to the overall energy consumption and hence the national targets linked hereto.

Within the framework of this report, Chapter 2 addresses the technical viability of the feasibility study for the interconnection Malta – Sicily as executed by Terna *et al* for Enemalta. In Chapter 3, suitable implementation and operation schemes of such an interconnection are identified and furthermore analysed with regard to their impact on the Maltese regulatory energy framework. Chapter 4 considers the procurement and purchase of electricity from the interconnection. This comprises the framework conditions of suitable purchase schemes and the key characteristics of their contractual framework. Chapter 5 addresses the impact of the interconnection regarding the contribution to the national renewable energy target and according possibilities in this context besides local renewable energy generation.

Whereas the results elaborated in the previously outlined chapters rely merely on the existing regulatory framework, Chapter 7 comprises an outlook on possible impact on the Maltese regulatory framework resulting from EU Energy Policy currently under development.

2 Assessment of Technical Viability of the Interconnector

Within this chapter, the technical viability of the interconnector is described. It has been assessed based on a review of the Feasibility Study of the Interconnection Italy – Malta as contracted by Enemalta and executed by Terna, CESI and SAPIENZA. This chapter comprises a review of this study, the identification of risky issues as well as the recommendation for further need for action in line with the potential realisation of the interconnection.

2.1 Review of the Study

2.1.1 General Remarks

The Consultant received 39 documents in form of electronic files as listed in Annex A. Some of the documents are presented twice, one as pdf the second as Word, Excel or Powerpoint document. Due to these cases of duplication the table of Annex B presents an overview, brief description of the received documents and number of pages, especially since the character of the documents varies considerably: some documents consist of one page only, others include more than hundred pages with tables and charts. In this Annex, the received documents are grouped according to the author or assumed author and documents of the same topic are put together.

Many documents are called or are related to a feasibility study for the future interconnection. According to the Consultant's understanding, a Feasibility Study for the Interconnection Italy - Malta should have the following structure and contents:

- Introduction
- Technical Studies
  - Data collection of power grid and demand including forecasted data
  - Definition of power to be transferred in view of the existing grids and future demand
  - Definition of route of the cable
  - Possible options and design of options
  - Analysis of DC and AC options
  - Network calculation, first steady state, followed by dynamic studies
  - Final design of feasibility level of the technical feasible options
- Economic and Financial analysis

- Environmental Studies
- Institutional and Legal Review
- Cable Route survey

Terna prepared as document T 0 a cover sheet for the “Draft Feasibility Study on Electrical Interconnection between Transmission Grids of Italy-MALTA 15 May 2009” and in T 00 a table of contents specifying:

- Introduction
- Network Studies, AC, DC
- Technology and Investment Capex
- Economics and Financial Aspects
- Legal and Regulatory Aspects
- Authorisation Procedure
- Environmental Desktop Studies
- Routing
- Site Visits

However, the contents of the received documentation does not strictly follow the assumed table of contents.

Concerning the received studies, the AC and DC network studies are treated in an inconsistent way in several documents prepared by CESI, Terna and SAPIENZA. Technology and Investment CAPEX are considered in some documents but technical lay-out, related CAPEX and annual operation cost are not presented in a consistent document and finally, the Economic and Financial Feasibility in an assessable manner is completely missing.

Summarising the received documents, it is noted that the provided Feasibility Study for the interconnection Sicily – Malta does not represent the required output which is necessary to assess the feasibility of the concerned interconnection. Hence, the analysis of the Consultant was only possible in a restricted manner. Consequently, the Consultant studied the individual documents and prepared general remarks and where required, commented on individual items of the received documents.

All of the received 39 documents were studied by the Consultant. In case no remark is made in this audit on some of the documents, the assumptions, statements and results of the respective documents do not require commenting or modification for the time being.

Concerning the received documents of technical nature, the following main studies could be identified:

- CESI, Analysis of static and dynamic behaviour of the interconnected system Malta-Sicily-Mainland. Definition of technical conditions for the synchronous operating of Malta with the UCTE network and its annexes;
- SAPIENZA, Special Electrical Studies for Feasibility Study and its annex;
- Terna, Report Static Analysis Italia Malta DC including, Network Studies, AC, DC, Technology, Investment CAPEX, Economics and Financial Aspects, Legal and Regulatory Aspects, Authorisation Procedure, Environmental Desktop Studies, Routing, Site Visits

Consequently, the audit of the received documents concentrated on these main studies. The technical studies of the Terna Report define the technical lay-out of the interconnection and perform load flow studies. The CESI Report continues the network studies with the analysis of static and dynamic behaviour of the interconnected system Malta-Sicily-Mainland. Finally, the SAPIENZA Study makes basic comparisons of an AC and DC link between Malta and Sicily but continues in the following with detailed simulations for the AC cable and definition of reactors and transformers. Partly the studies are based on each other, partly they overlap or recur and some studies presume other assumptions than previously used, which explains the Consultant’s opinion that the technical studies are not consistent.

For example in Document C1, CESI studied power imports with AC of 2x150 MW, 2x190 MW and 2x250MW. In Document T3, Terna investigated power imports of DC of 300 MW and 400 MW and finally SAPIENZA thoroughly examined the AC transmission capacity of cables (refer to document S 1) and elaborated that the theoretical transmission capacity of the envisaged 117 km cable link can be assessed at 130 – 190 MW for 132 kV and 205 – 290 MW for 220 kV depending on the conductor cross-section. The actual rating will be smaller than the theoretical. In addition, in the economic analysis of Document C3 “Economic impact on the Maltese power system operational cost deriving from the realization of a new electrical interconnection between Malta and Italy” the power import from Italy are studied for the cases of 0 MW, 2x 200 MW, 2x225 MW, 2x275 MW and 2x300.

CESI and Terna should have used the same capacities of power import within their studies. SAPIENZA’s study had been found to fundamentally analyze the rating of AC interconnection compared to the previous studies and was partly overruling CESI’s and Terna’s results.

Favoured Interconnection Scheme and the Isle of Man Interconnector

The received documents favour an AC interconnection for the 117 km between Sicily and Malta with two 220 kV cables, rated 200 MW each. Worldwide only a 90 kV AC cable exists with a length of 104 km between the Isle of Man and the British mainland with the following details of Manx Electricity Authority (MEA) annual reports:

MEA serves a population of about 80,000 people on the Island of Man with 572 km² and a length of 52 km and 22 km width. Furthermore, MEA operates a 33 kV and 11 kV power grid of 550 km of overhead line and 104 km of cable with a maximum demand on the island of 89.3 MW in 2007/2008.

The Isle of Man - England Interconnector is a sub-sea power cable connecting the transmission system of the MEA to that of the 132 kV distribution system of mainland Great Britain. With an undersea section of approximately 104 kilometres it is the longest AC undersea cable world-wide. It was laid in 1999 between Bispham, Blackpool and Douglas Head on the Isle of Man, commencing commercial operations in November 2000. It is rated 65 MW and capable of continuous operation of 40 MW at 90 kV. Power and services are traded across the cable with UK industry participants resulting in both imports and exports.

MEA Power Stations are situated at Pulrose, Peel, Ramsey and Sulby. Pulrose, including the 88 MW CCGT (Combined Cycle Gas Turbine) has a capacity of nearly 135 MW, Peel has a capacity of nearly 40 MW, a diesel generating station at Ramsey has a capacity of 3.6 MW, and a small hydro station at Sulby with a capacity of 1.0 MW.

The Authority constructed an 88 MW Combined Cycle Gas Turbine Power Station at Pulrose in 2003 together with a Natural Gas Pipeline from Glen Mooar to Pulrose Power Station – this provides a diversity of fuel and a supply of natural gas to the Island.

The CCGT plant is adjoined to Pulrose D power station which was opened in 1998. The station was further upgraded during the CCGT construction. This plant is generally used to provide load management services to the UK and security back-up for the Island. The original station is based on the same site as the CCGT plant and shares a common control room.

Peel Power Station was opened in 1995. This plant is generally used to provide load management services to the UK and security back-up for the Island.

The Generation Sets at Ramsey power station were commissioned in 1983 (originally manufactured in 1969). This plant is only used to support the network in emergency conditions.

The small hydro plant was commissioned in 1981 (and a second set added in 1983), in conjunction with the IoM Strategy for water management. This plant is operated as a priority whenever sufficient water is available.

As can be seen from the table below, MEA received only 8 % of its electric energy from the sub-sea cable, the cable was mainly used for import of peak load, power trade and as stand-bye capacity. This is not surprising since MEA has a total of installed own generation capacity of 179 MW and a peak load of 89.3 MW only.

Table 2-1: Manx Electricity Authority Power Generation in 2007/2008 in MWh

Description	MWh	%
CCGT	431,089	86%
Diesel	10,635	2%
Hydro	2,069	0%
Total electricity generated	443,793	88%
Cable	41,706	8%
Energy from waste	18,205	4%
Total electricity imported	59,911	12%
Grand total	503,704	100%

Compared to the Malta power system, MEA has ample own generation capacity of 179 MW, only 40 MW are exchanged with 90 kV and the cable length is 104 km compared to 117 km in the case of Malta.

Comparison AC versus DC

In the submitted documents of the feasibility report, the Consultant did not find a conclusion about the advantages and disadvantages of the different types of AC or DC interconnections analysed related to the network of Sicily and Malta and the resulting recommendation regarding their implementation.

Document S1 - Special Electrical Studies (University of SAPIENZA, Roma) presents an excellent study and Table 1[1] shows in a brilliant manner the general definition and comparison of 13 characteristics values of the different AC and DC schemes, refer to Annex C, Schematic Comparison of Submarine Power Transmission Solutions. However, the comparison stops after the table and does not discuss and analyze which characteristic values form a serious constraint in implementing the interconnection or which measures might be needed to ease identified bottlenecks. A table with the final recommendation for the specific interconnector Sicily – Malta should be found in the feasibility report. Furthermore, a recommendation should be expected explaining why the AC solution was favoured by Terna for further studies.

Concerning DC interconnection, Line Commutated (LCC) or Voltage Source (VSC) Converters are possible. The LCC, i.e. the classical HVDC, is basically not the best option due to the reduced short-circuit rating (SCR) of the Maltese network and the extensive use of filters and degree of compensation. However, the study does not present technical and economic discussions if or how to overcome the reduced SCR. Relating to HVDC –VSC, the reasons are

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not understood why this scheme is not presented with the same intensity as the AC power cable.

Studying the received documents the reader gets the impression that the only possible solution is the AC power interconnector and any adverse technical argument which might divert the reader from this idea is omitted.

2.1.2 Remarks to Specific Studies

In the following, particular remarks on specific studies within the overall feasibility study for the interconnection Malta – Sicily are made.

Strong focus on Terna Network

In the studies the consequences of the AC interconnection on the Terna grid are analysed in detail. Potential consequences of the AC interconnection on the Maltese power system are only performed for the 132 kV level and not even profoundly.

Capacity of the AC Interconnection

SAPIENZA investigated in their study[2] the possible transfer capacity of AC cables under no loss condition and found the following results:

Table 2-2: Maximum transmissible active power of 132 kV cables (lossless), averaged over the operating voltage range and for different combinations of parameters ("Best" and "Worst")

S (mm^2)	$P_{Max\ Average}$ (MW)		
	Worst	Best	Average
400	129	135	132
500	146	151	149
630	158	166	162
800	172	182	177
1000	183	196	189

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[2] Refer to page 31 of document S1

Table 2-3: Maximum transmissible active power of 220 kV cables (lossless), averaged over the operating voltage range and for different combinations of parameters ("Best" and "Worst")

S (mm^2)	$P_{Max\ Average}$ (MW)		
	Worst	Best	Average
400	202	212	207
500	228	237	232
630	244	259	252
800	267	284	276
1000	274	297	286

In conclusion, the theoretical transmission capacity of the envisaged 117 km cable link can be assessed at 130 MW -190 MW at 132 kV, and 205 MW - 290 MW at 220 kV depending on conductor cross-section. Some additional remarks can be made:

- *For a given voltage class,* $P_{Max\ Average}$ *increases almost linearly with terminal voltage, due to the ampacity-based constraint and the fact that ampacities reported for 132 kV and 220 kV cables practically coincide on equal cross-section basis;*
- *The investigated cable cross-sections span a wide interval, from 400 to 1000* mm^2*. This 150% copper increase, however, only yields a 40% rise of* $P_{Max\ Average}$ *which closely follows the limited associated increase in ampacity, with other factors apparently playing little or no role.*

All foregoing transmissible power figures are theoretical maxima, obtained neglecting losses and considering an optimal cable loading, with equal outgoing reactive power flows at the cable terminals. It will be shown that the impact of transmission losses on the above reported maximum values is relatively limited, and much smaller than the losses themselves (taken in p.u. of P_{max}*) if the comparison is carried out on an equal receiving-end voltage basis. The really decisive factor is still the attainment of a "symmetrical" loading of the cable by enforcing the desired reactive power profile along the cable: that is, in the last instance, controlling terminal voltages.*

SAPIENZA's studies show that an increase of cross-section is not related to a similar increase of transmitted power, so that smaller cross-sections are more attractive and that compensation and symmetrical loading are the crucial elements in the case of AC interconnection.

Regulation of the Reactive Power

The regulation of the reactive power of the different AC and DC types of the interconnectors is different in the amount and also in the regulations steps according to the respective type of the schemes. Some of them regulate in the four quadrants (MW/MVAr) in small steps (HVDC-SVC) and other as the AC cables are intended to be compensated with a defined amount of MVAr with shunt reactors and if necessary further means.

A technical analysis of the advantages and disadvantages of each of the respective schemes with the direct reference to the results of the calculation of the interconnectors Malta-Sicily should be part of the feasibility investigation.

Temporary Overvoltages

The Consultant agrees with the remark made in the report S1 SAPIENZA, page 12/129, stating that a Transient Overvoltage Analysis (TOV) following line energizing and load rejection is absolutely necessary in the case of AC power cable interconnection.

- Cables capacitance and the variable inductance of shunt reactors and transformers are the origin of the so called Ferro resonances that occur especially during the procedure of connecting the cable to their respective ends.
- The feasibility report shall highlight at least the cost for the possible additional protection and design elements, detailed design can follow later.
- Additionally, it is well known that once the corresponding circuit breakers of both ends of the power cables open, the capacitance of the cable with the inductance of the shunt reactor interchange a damping oscillating energy in between both elements. These conditions request additional elements on the switching re-connection procedure of the circuit breakers.
- Energizing of cables produce an inrush current by their own nature of the capacitance of the cable. An analysis of the impedance characteristic (MΩ vs. Hz) of both ends needs to be performed for the different loads (peak and off-peaks). This analysis will reflect if the power cables are prone to create resonances with the harmonics of the inrush current.

Dynamic Analysis

In the Document C1[3] it is mentioned that the simulation of loss of one of the interconnecting cables (Regusa-Pembroke) is performed by the <u>complete disconnection of the cable at both ends.</u>

In the daily operation, this situation is unrealistic as both ends will open with a certain difference of time, in fact some milliseconds. During this short period of time, the unloaded open cable is connected with their important reactive load either to the Sicily other Malta generation plants, producing a completely different dynamic initial situation as the one mentioned in the report. This critical case of only one open circuit breaker is still to be analyzed.

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It is worth to mention that the dynamic analysis is referred only to a transient stability investigation for the AC cable option. All the other alternatives which in some way can be competitive to this, as the HVDC-VSC are ignored in the report.

HVDC – VSC Model

In Terna's report, T3-1[4], the equivalent model of the HVDC-VSC generator is represented as a Power-Voltage node (PV-node) for the load flow calculation.[5] For the static analysis of the interconnection a PV-node does not provide the necessary technical base for the control of the interchange of active and reactive power. It is worth to mention that in the report dedicated to HVDC-VSC, the power interchange of the interconnector is only evaluated in MW whereas MVAr are not mentioned which results from a false simulation model.

Power flow control and power flow reversal of the investigated HVDC-VSC scheme needs to be controlled by adjusting the lower and higher DC-voltage of the terminals. The setting of the parameters of D-Q Model will allow the reactive and active power to be controlled and will have a significant influence on the analysis of the dynamic of the system

A dynamic analysis of this alternative essential for the evaluation **was not performed**.

Such a type of interconnector is a new technology but its use and importance increased in the last years due to the extensive use in off-shore platforms (e.g. oil industry, wind power) with a range of transmissible power up to 350 MW in a similar length of submarine cable. Implemented installations are:

- Estlink (Page 32/48 document S1-A) 350 MW, +150 kV, 105 km cable (74 km submarine)
- Murray Link (Australia) rating 200 MVA – 180 km (underground) between 132 kV (Berri) and 220 kV(Red Cliffs) inverter operating in the range of -100 MVAr ±100 MVAr and rectifier -75 MVAr ± 125 MVAr

Such HVDC-VSC schemes are satisfactorily used in order to cope for faults of one cable and they are common in transmission with converters in offshore wind parks.

For the Malta – Italy interconnection an analysis is necessary of the case that one of the two DC cables will be out of service and a reduced transmission will be performed via the sane cable and earth connection.

Static Analysis Italia – Malta DC Interconnection (Terna Study T3)

The study describes the performed load flow calculations and results of the studies of the Sicily and Malta power grids with different capacities of a DC cable between Ragusa and Pembroke. However, all cases are 2 monopolar HVDC – VSC cables, each with earth return with ratings up

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[5] Node of the load flow calculation, where the active power and voltage profile remain constant.

to a total rating of 400 MW which is unfavourable concerning the needed spinning reserve for the case of outage of one 200 MW cable. Other alternatives should also be analysed, including bi-polar options.

In addition, only the future 132 kV network of the Malta power grid is studied, the 33 kV is only represented for the generation units connected to this level.

Overload on the Sicilian Network

CESI mentions in document C1, under item 4.3[6], Results of the load analysis, that during peak load period (**without interconnection link**) Sicily shows a well known problem of overload on the 150 kV network in the east of the island that appears both in sound and contingency condition.

Further in the **different cases** of interconnection in the various options of 132 kV and 220 kV power cables, the summary under item 4.3.1 states that the static analysis shows large overloads on the 150 kV Sicilian network especially in the southeast area.

Terna in its function as TSO has to solve the overload problems that prevail even without the interconnection to Malta.

Outage of Generation Units

In the static analysis[7] the outage of generation units was analyzed neither for Sicily nor for Malta. If due to low load, one generator after the other is switched off, the transfer of the prevailing MVAr of cables must be relocated to the remaining generation units and no analysis was provided if technical limits are exceeded in the remaining generation units.

Representation of the 33 /11 kV Network in Malta

On several pages of the report C1[8], CESI mentions that the 33kV grid is not represented in the adopted model, except for 33 kV cables connected to generation units. The report further assumed that the 33/11 kV grids are configured, rated and operated in order to cater for all the operation conditions.

The existing 33 kV and 11 kV grids, especially due to the cables have significant different reactive loads in case of high demand and minimum load. The simplification made by CESI does not consider that the reactive capacity of the 33 kV feeders (cable or overhead lines) and model of the load can influence the voltage profile (especially in case of off-peak operation) and the reactive power to be compensated or additionally supplied as well as the dynamic behaviour of the local generation.

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[6] Page 41 of 126

[7] Refer to document C1, Page 43 of 126

[8] I. e. 11 of 126; Analysis of static and dynamic behavior of the interconnected system Malta – Sicilia

Over Voltages during Off Peak Load in the Malta Network

In the CESI Document C1 in Table 3.1 (Generation units in Malta), the under-excited range of the generator (defined as Q_{min}) is defined for the case of off-peak. The values given in the table range between 18 % - 20% of the rated power of the generators (MVA) and in our opinion present an acceptable and expected range for thermal generation.

In the study two cases are analyzed, namely the operation as A) Islanded System and the B) Interconnected System with active power of 295 MW to Malta

A) Islanded System

- As mentioned on page 32 of Document C1, the voltage profile in Malta 132 kV for the case 2015 Off Peak (Islanded System) has a not acceptable value.
- The under excited range of the generation in Malta it is not enough to absorb the surplus of reactive power and as a consequence the voltage profile in the Malta network is high with the actual Q_{min} defined in Table 3.1 (between 18 % - 20% of the rated power of the generators (MVA)).
- In Table 4.35 of the same document an additional hypothesis is defined with not existing and assumed values. Furthermore, the conclusion is drawn that the voltage profile is in the expected limits with these values.

B) Interconnected System with active power of 295 MW to Malta

The Malta grid is represented only as load[9] and all generators are disconnected. Due to the reduced load a surplus of about 40 to 50 MVAr per power cable exists.

- In this case the report assumes that the whole generation in Malta is disconnected and therefore the problem with possible under excited generation is not prevailing anymore. Over voltages appear only in the 33 kV network (which is not represented completely).
- It is not clear in the report how the transfer from full load to reduced generation in Malta is intended to be performed during operation.
- If generation units are still connected, the risk is eminent that generation units in Malta are at the limit of under-excitation and therefore cannot regulate voltage anymore.
- Finally a complete switch off of the generation in Malta will occur.

This situation is already mentioned in the dynamic analysis document C1[10] under item 5.10.3 where a "*possible need of spinning reserve to face the under frequency transient together with the UFLS (Under Frequency Load Shedding)*" is stated.

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[9] Page 40 of 126

All these aspects concerning off-peak load in the Maltese network have to be investigated in a dedicated study.

Parameters Variation

The values of the capacitance in the AC power cable interconnector can fluctuate as mentioned in the SAPIENZA report S1[11]. Therefore, it is advisable to additionally analyze the sensitivity and influence of this variation of capacity for the future operation of the link. This applies especially for the operation of the small Maltese power grid.

Overload and Under-frequency Load Shedding (UFLS)

Different technical constraints are mentioned in the received documents concerning overload and under-frequency load shedding, which need special technical investigations and design and further analysis is needed in order to ensure a reliable operation of the interconnection cable. The respective technical constraints are:

In the load flow calculation in the off-peak case, Malta's network is defined as a load[12] and therefore no discussion is made about the possible under-excitation design limits of the generation in Malta. The network calculation has to represent the generation and must investigate under-excitation.

In the same document[13], the need to **maintain a certain spinning reserve** to alleviate the overloading of the cable is mentioned in case one of the interconnectors will be faulty. Network calculations have to prove the necessary layout.

Furthermore, an under frequency load shedding is mentioned with the need to have a black start plan to restore the system. However, details are missing.

In a (n-1) contingency analysis the load to be transferred through the interconnector needs to be taken over by the other circuit with no overload of any element. Parameters for the static and dynamic analysis need to reflect this incident

2.1.3 Plausibility Checks

Optimum Cable Capacity

In the next future the biggest generation unit in Malta will amount to 100 MW. If the capacity of the interconnection cable exceeds the size of the new biggest generation unit, the spinning reserve must be increased in order to match with the increased capacity of the cable. Consequently, if the import will considerably exceed 100 MW, it is useful to foresee two cables

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[10] Page 93 of 126
[11] Page 55 of 129
[12] Refer to document C1, Page 40 and 126
[13] Page 93 of 126, item 5.10.3, Dynamic Analysis

for the interconnection, so that in case of outage of one cable the second cable can take over the load together with the remaining spinning units of the own generation in Malta. If convenient, the second cable can even be installed after some years.

However, even for the case of two cables for the interconnection, the rule of decreasing unit cost with increasing size is only applicable in a small range, as can be seen in the following simplified sample with a peak load of 600 MW and the biggest unit size of 100 MW:

Table 2-4: Optional Sizes of Cable Capacity

Peak load in MW	600	600	600
Precondition: spinning reserve equal to biggest single unit			
Installed cable	2	2	2
Capacity of each cable (MW)	100	200	300
Total capacity of cable (MW)	**200**	**400**	**600**
Peak + spinning reserve (MW)	700	800	900
./. Supply by cable	200	400	600
Needed own generation (MW)	**500**	**400**	**300**

With the assumption that the biggest unit size shall always run as spinning reserve, for two cables of 100 MW each, own generation must be provided with 500 MW. If the cable capacity is increased by 200 MW and doubled to 400 MW the own generation capacity can only be reduced by 100 MW to 400 MW. If the interconnection is designed for a total capacity of 600 MW instead of the initial 200 MW, i. e. if the transfer capacity raises by 400 MW, the own generation can only be reduced by 200 MW from 500 MW to 300 MW. This means that in order to save 200 MW of own generation capacity an investment of 400 MW in cable capacity is necessary.

For the consideration of an extreme case scenario of no own generation in Malta, 2 cables of 600 MW each would be necessary as to ensure secure power supply from Italy. However, for this option 3 cables of 300 MW each or even 4 cables of 200 MW each might be considered.

The ratio installed capacity of own generation plus capacity of the cable versus peak load provides also an indicator of the scope of investment of the different options.

Table 2-5: Ratio Installed Capacity of Generation plus Cable versus Peak Load

Total Cable	Own Generation	Total Capacity*	Ratio (Capacity/Peak Load)
(MW)	(MW)	(MW)	
200	500	700	1.17
400	400	800	1.33
600	300	900	1.50
800	200	1000	1.67
1000	100	1100	1.83
1200	0	1200	2.00

* Precondition: Spinning reserve equal to biggest single unit

The table shows that a significant overinvestment will be made if an important import rate is chosen. With a higher supply by cable the investment in installed capacity will increase, unless more than two cables are installed. Consequently, the optimisation of the cable capacity, presented in document T 4 Optimal Power Calculation - Cable Capacity cannot be fully understood that a high import rate is an optimum solution compared with a smaller import rate.

In this context, it is worth mentioning that due to the interconnection, Enemalta will try to utilise the generation plants more efficiently and to operate most of them with a high load factor for base load. The interconnection will be used for the purchase and supply of spinning reserve and peak load. Consequently, due to the purchase of spinning reserve the cables to Italy will not be operated fully loaded at maximum capacity.

It is to be considered that AC cables can be overloaded for a short time, so that in case of outage of one cable the second cable can take over additional load and the spinning reserve can be reduced. This possibility will ease the need of spinning reserve for the case of AC interconnection. However, detailed investigations are necessary in order to verify the behaviour of the reactive loads of the cable and of the compensation equipment in case of outage of equipment.

Status of Program Advancement - Time Planning

Document T 16 Stato avanzamento progetto, April 29th 2009.

Document T 16 displays a Powerpoint presentation called Stato avanzamento progetto, April 29th 2009.

Slide 17 is called Overall Option Selection and presents the following information:

Table 2-6: Overall Option Selection

Issue	Selection	Notes
Station in Sicily	Ragusa	
Technology	AC; 3-cores cables XLPE insulated	
Voltage level	220 kV	Losses at max power = 4,9%
Number of circuits	2 completely independent (implementation in 2 stages)	To minimse common faults
Redundancy	Transformers and station equipment with redundancy for full capacity	1 circuit remains in full operation if other fails (undersea faults)
Capacity	2 x 225 MW	To be checked vs economic analysis
Investment cost	300 M€	90% for cable supply & laying
Landing site in Sicily and connection	Marina di Ragusa, underground cable to existing station	
Landing site in Malta and connection	Pembroke cliffs, cables in tunnel from Pembroke to Kappara	
Undersea laying	100% protection (cables buried in trench) 2 circuits separated by 5 times sea-depth	All route is in low depth max 160 meters)

In the Consultant’s opinion, the values and statements marked in colour have not been sufficiently justified. Moreover, further studies are necessary to prove their technical and economic feasibility. This applies especially concerning;

- *3-cores AC cables XLPE insulated,*
- *220 kV AC voltage and*
- *2 x 225 MW cable capacity*

A further crucial point is Slide 3 of the presentation which specifies concerning performed works of the study:

Done:

- *network studies (static and dynamic)*
- *technological analysis*
- *capex analysis*
- *routing for marine survey*
- *site visits*

To be finalised:

- *economic analysis*
- *desktop study*
- *legal and authorisation process in Malta and in Italy*

To be elaborated:

- *Commercial and regulatory scheme*
- *Final report*

Network studies (static and dynamic) must be deepened in various points, namely further technological analysis has to be performed, especially concerning the DC option and definition of the cable voltage and capacity; dynamic behaviour, representation of the Malta power grid and generation and finally, CAPEX analysis and also losses and other annual costs have to be determined after definition of the layout of the interconnector. It goes without saying that such a final report has to integrate the missing information and monitor relevant sections of the already performed studies.

Having decided on the next steps and scope of studies still to be performed, a time planning has to be set up for the further works and joint meetings.

Document E 1, Introduction.

In Document E1, Enemalta prepared an introduction to the feasibility report and intended to give an overview of the current position on the Subsea interconnector to Sicily.

Enemalta is proposing that a sub-sea interconnector should link Malta to Sicily and it is expected that this interconnector will be in operation by the end of 2012. The capacity of this interconnector was originally rated at 200 MW comprising two 100 MW links, but from the results of the feasibility study which is being carried out with the Italian Transmission System Operator (TSO) Terna, a 400MW link, composed of 2 x 200 MW links offers the most advantages. Redundant links are preferred for security of supply reasons. The technical feasibility study has concluded that both the HVAC and the HVDC solutions are technically and economically viable.

The rating of the interconnection still needs to be further justified from the technical and economic point of view. Moreover, the completion date of 2012 is not within a realistic timeframe.

2.1.4 Missing Studies

Consequences of UCTE Operation Standards

In Document C1[14] as well as in Document C 2 the UCTE is presented with its rules, procedures and requirements for power pool operation. This document is a most valuable paper, since it specifies the nature of UCTE and highlights the operational requirements a new partner to the UCTE has to fulfil, such as in order to cite just a few headlines from the document: primary, secondary and tertiary control, N-1 security (operational planning and real-time operation) measures for emergency conditions, voltage control and reactive power management, etc. If Malta is connected to the UCTE via an AC cable, Enemalta is synchronously connected and has to respect the UCTE operation procedures and implement numerous changes in its operation and equipment. For example, presently Enemalta operates in the frequency band between 49.5 Hz and 50.5 Hz, whereas the UCTE requires that frequency is kept between 49.9 Hz and 50.1 Hz[15].

If Malta is connected to Sicily via a DC cable, the AC grids of Enemalta and Terna are separated and only a few modifications will be necessary for the Maltese power system.

The scope of necessary changes in Enemalta’s generation, transmission and to a minor part in the distribution plants has not been assessed nor have the respective cost been determined. The analysis must be made both for the DC and the AC case. Finally, these costs to meet UCTE standard must be considered in the economic feasibility study of the interconnection.

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[14] Chapter 6

[15] Refer to document C1-1, Slide 11 on Operating Constraints

Cost Estimate and Losses

In Document T6 constituting the CAPEX Summary, Terna presents the cost of different AC and DC cable options but indicates the total CAPEX cost only split into cost for cable, cable laying and substation / converter without further detail (refer to Annex D, CAPEX Summary). Also the losses are given for maximum active power without differentiation between losses of power cables, auxiliary needs of substations and converters as well as reactor losses and transformer no-load and load losses. Details of CAPEX and losses for the different types of interconnector need to be supplied.

Economic and Financial Feasibility

An economic analysis is made in Document C3 “Economic impact on the Maltese power system operational cost deriving from the realization of a new electrical interconnection between Malta and Italy”. The document studies the power import from Italy for the cases of 0 MW, 2x 200 MW, 2x225 MW, 2x275 MW and 2x300 MW, but it seems that the evaluation is made only for a distinct year and not for the lifetime period of the cable. In addition, the assumptions for the cost of investments are not quite clear.

A further economic analysis is presented in Document 7 Presentation Economics: Fee Calculation & Cost-Benefit-Analysis. This document is a Powerpoint presentation for this subject and contains numerous blank boxes, where numbers have been erased.

An economic feasibility study would compare the autonomous generation option with the different interconnection links, and would determine for the lifetime of the interconnection, both for Enemalta and TERNA, the discounted investment costs, running costs, including losses for the interconnection links and the own generation part and take into consideration the discounted energy available in Malta.

2.2 Identification of Risky Issues

2.2.1 Decision AC versus DC

An AC interconnection will involve conventional technology for the Ragusa substation, a standard AC cable but with a worldwide unprecedented length and conventional technology for the Pembroke substation with a complex reactive load and behaviour. Consequently, the technical problem and challenge lies in the extensive capacity of the cable and the need to solve the consequences of the reactive load in the small Maltese power grid.

A DC interconnection will involve rather new but tested DC technology for the Ragusa substation, a DC cable with tested technology and new but tested DC technology for the Pembroke substation with a flexible load and behaviour. The technical challenge of the DC system lies in the fact that comparably little experience exists with the present stage of DC technology and converter stations. However, the operation of the Malta power grid will be facilitated since MW and MVAr can be easily controlled according to load conditions.

The decision which alternative is best for Malta and acceptable for Terna is not clearly decided and outlined in the feasibility study.

2.2.2 Technical Constraints of AC Interconnection

As of 2008, the longest AC submarine cable is the 104 km long 90 kV Isle of Man interconnector followed by the 53 km long 66 kV Matsushime – Naro link in Japan. The present project involving a 107 km long double circuit AC cable presents an unprecedented scale of project. SAPIENZA highlights in chapter 4, Technical Options for Submarine Power Transmission the difficulties of the Malta – Italy by AC cable:

The peculiar physical behaviour of AC cable lines, either underground or submarine, limits their maximum length and/or power transmission capacity unless the cable is shunt compensated along the route, which is currently unfeasible in underwater applications. For the case under study, with an envisaged cable length of 117 km, AC transmission would be feasible at 132 kV and 220 kV level as will be shown by the appropriate power-length relationships. As HV and EHV AC cables produce more reactive power than they consume, even at full load, long-distance AC cable systems invariably require inductive shunt compensation in order to avoid the undesirable effects of this reactive power flowing into the network(s), such as:

- *Temporary overvoltages following line energization and load rejection;*
- *No load charging current exceeding the capacitive current breaking duty of line circuit breakers (CBs);*
- *Excessive underexcitation of nearby synchronous generators.*

The required inductive shunt compensation could be performed by means of several devices, ranging from fixed-impedance shunt reactors (SRs) to power electronics-based FACTS (Flexible AC Transmission systems) such as SVCs or STATCOMs. Setting aside for the moment the interesting FACTS dynamic capabilities, shunt reactors represent a reliable, relatively cheap and cost-effective solution to the cable reactive power surplus. Moreover, as the reactive power output from the cables varies little with load, shunt reactors are needed in any operating condition (the long line is not operable in their absence) and could in principle be solidly connected to the cable.

In the received documents, these three crucial points raised in SAPIENZA’s study could not be answered to prove that the AC cable system will operate satisfactorily.

2.2.3 Reactive Power of AC Interconnection

In Chapter 2.1.2 of this audit, Remarks to Specific Studies, various comments were made on static and dynamic network calculations which finally all were related to the behaviour of MVAr in the interconnected AC system. The huge amount of MVAr and its variation in peak and minimum load condition and during transient operations, like switching and outages present a risky element for the operation of the interconnection by AC cable.

Considerable reactive power must be provided in order to compensate the capacitive loading of the AC cable and the MVAr must be regulated according to the load including switching on and off under normal and outage conditions. The regulation of the compensation is a technical challenge and the repercussions on the Malta grid are not analysed in detail.

The received technical documentation did not prove that the Malta 33 kV grid can provide the necessary reactive power in order to operate the cables in a flexible way, nor have the need and cost assessed of electronic based compensation.

2.2.4 Technical Constraints of DC Interconnection

Since no detailed analysis and layout has been elaborated of a DC scheme, its technical constraints and costs could not be evaluated. However, it is evident that a DC interconnection must be tailored for the prevailing situation of the Malta and Sicily networks.

2.2.5 UCTE Requirements

The scope of works of adopting Enemalta’s installations to UCTE operation standards are not identified yet and the respective cost are not included in the economic analysis

2.3 Recommendations

First activity to be performed is the necessity to get an agreement between Enemalta and Terna in order to narrow the range of interconnection of presently “a minimum of 200 MW up to a maximum of 400 MW”, to a more defined value, for example 250 MW and a number of sensitivity options, for example plus and minus 50 MW or any other justified and agreed data. The size of the interconnection depends amongst others, on the load forecast, the necessary spinning reserve, the generation units to be retired, the dependency of import, reliability, etc. At this occasion a decision should also be reached if one or two cables shall be installed. The definition of distinct capacities would permit to focus the study on a defined development and reduce the options for the feasibility study. In the design stage the final capacity can be optimized, based on the results of previous studies.

In the following we recommend that the DC option shall be further evaluated, since no profound analysis was made of the DC cable, in comparison with the AC option.

Since SAPIENZA's studies evaluate in detail the interconnection link on AC technology, it would be advantageous to enlarge the present SAPIENZA study by a chapter evaluating the DC options in order to be able to compare AC and DC interconnections.

In the following the network calculations, both steady state and dynamic, must be reviewed in order to take into consideration the remarks listed in this audit and the results gained in the additional studies. In addition the missing studies shall be implemented, in particular, the consequences must be analysed more deeply of an AC and DC interconnection for the Malta power grid of 30 kV.

It would be worth to check if further network studies shall also be based on the SAPIENZA studies.

Finally, having defined the technical layout of the interconnection, the steps of the feasibility study shall be implemented, as listed in Chapter 2.1.1.

Key questions and crucial fields of investigation for the Malta power system will be

- No overload of all network systems in case of normal operation and outage;
- Stability of generation in all cases of outage;
- Balance of reactive power in case of normal operation and outage.

3 Implementation and Operation Schemes of the Interconnection

This chapter deals with possible implementation and operation schemes for the envisaged interconnection Malta – Sicily. These are in a certain respect dependable on the intended operation manner with regard to the amount and type of electricity[16] to be transferred over the interconnector. However, this is not elaborated transparently in the feasibility study conducted for the interconnection and as it is explained in the technical review of the previous chapter. Based on the study, Enemalta has launched a Call for Expression of Interest announcing the implementation of a 2 x 200 MW (2 x 250 MVA) HVAC interconnection. It shall be realised in two phases with the first one being operational by 2012 requiring a construction start by mid/end 2010. The commissioning for the second phase is foreseen by the end of 2015. By comparison, Figure 3-1 shows the recommended expansion planning as elaborated by Lahmeyer International in its expansion planning study which was accomplished in June 2008. This considers the implementation of an interconnector at a later stage, i.e. from the beginning of the year 2016 on given the prices of electricity in Italy were currently the highest in Europe due to the congestion problems in the Italian Network. The recommendations of the Consultants were that Malta should first consider the building of local generation capacity with the first plant to be built by 2010. The technology recommended was a diesel combined cycle to be fired by Heavy Fuel Oil. This plant would be converted to natural gas once a supply of this fuel is made available in Malta by 2013. Any generation capacity built after this date would be gas fired. It was further recommended that the interconnection with Sicily was deemed to be an HVDC link possessing a lower capacity (2 x 100 MW), proven to be economically more feasible than the HVAC link of the same capacity in thorough analysis. The supply option of an additional CCGT plant at Delimara proposed by LI which would have been required from 2014 is assumed to be rejected in the current Maltese expansion strategy. Instead of this solution, the 2 x 200 MW is expected to kick-in now in order to satisfy the growing demand in Malta and to compensate the required retirement of the Marsa Power Units due to the Large Combustion Plant Directive[17].

Basically, different options are considerable for the implementation and operation of the interconnection as foreseen between Malta and Sicily. As it does not become obvious why an HVAC link of such a capacity is the preferred solution for the expansion of the Maltese electricity supply and how the capacity utilisation of the intended interconnector is foreseen based on the provided feasibility study for the interconnection as prepared by Terna, CESI and SAPIENZA, this chapter merely focuses on the theoretical possibilities as applicable for an interconnection between Malta and Sicily, emphasising their key characteristics especially with regard to qualitative aspects. First of all, the policy background of the interconnection is provided before the introduction of relevant implementation schemes followed by applicable operation schemes. Eventually, recommendations and further needs for action on the regulatory side are provided.

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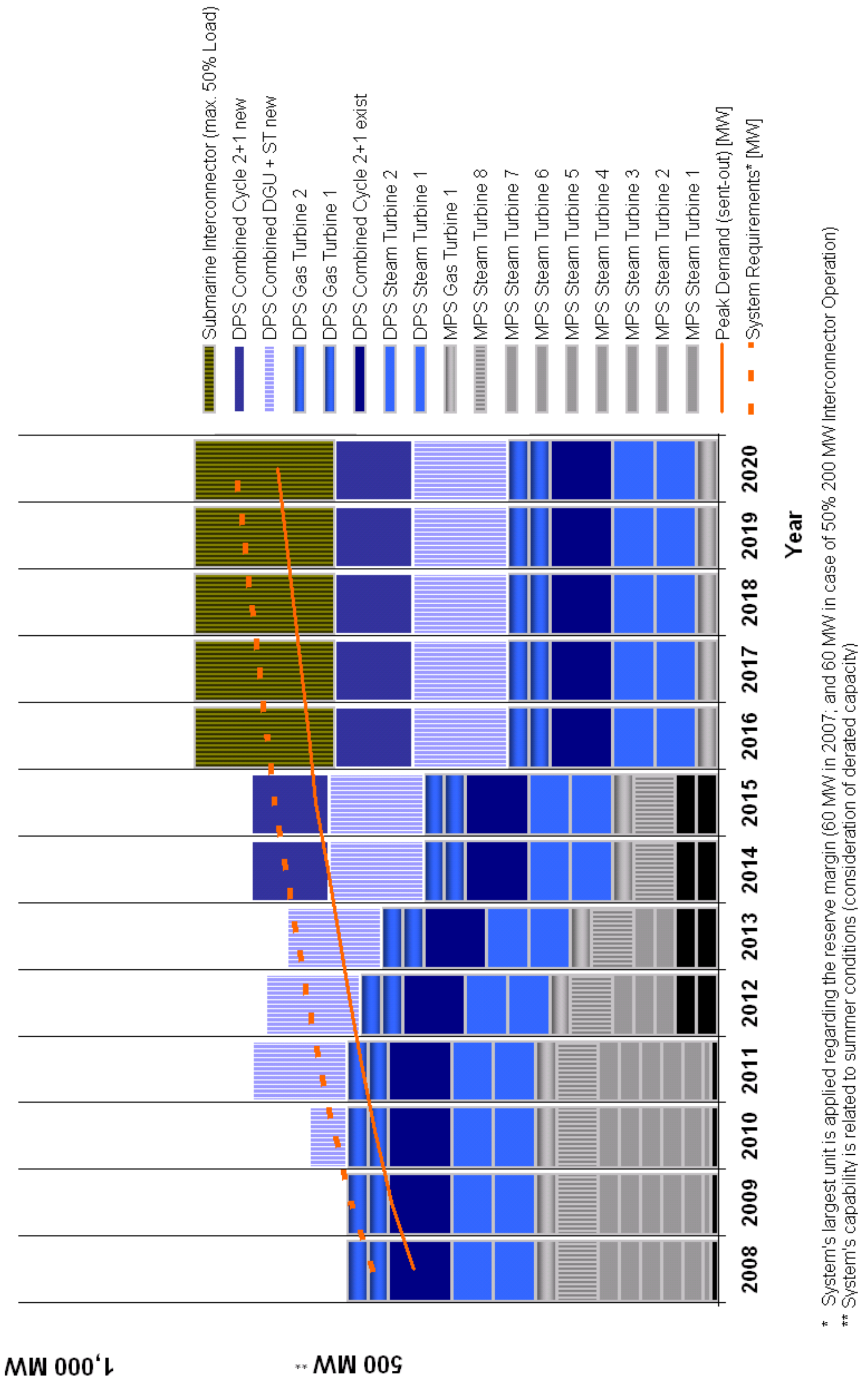
[16] I.e. will the interconnector be used to contribute to base load, intermediate load or peak load.

[17] Directive 2001/80/EC, transposed into national Maltese law by LN 329/2002, amended by LN 2/2008.



* System's largest unit is applied regarding the reserve margin (60 MW in 2007; and 60 MW in case of 50% 200 MW Interconnector Operation)

** System's capability is related to summer conditions (consideration of derated capacity)

Figure 3-1: Proposed System Expansion Development (Available Capacity vs. Peak Load)

3.1 Policy Background Conditions

With regard to the interconnection Malta – Sicily, characteristics of the following directive and regulation need to be considered within the European regulatory framework:

- Directive 2009/72/EC concerning common rules for the internal market of electricity[18];
- Regulation (EC) 714/2009 on conditions for access to the network for cross-border exchanges in electricity[19].

This represents the main changes of legislation with regard to the interconnection under the third Legislative Package on Energy Liberalisation. All of the Member States are required to bring into force the laws and regulations for the above mentioned directive and regulation. They can thus be considered to be applicable on the new interconnector between Malta and Sicily which shall be operational by 2012 and 2015 respectively.

Under the predecessor to Directive 2009/72/EC, Directive 2003/54/EC, derogation[20] from the following requirements was obtained for Malta:

- Unbundling of transmission system operator (TSO)[21];
- Legal and managerial unbundling of distribution system operator (DSO);
- Third party access to the distribution system;
- Establishment of competitive market in electricity / market opening / Reciprocity.

This was especially the case due to the fact that Malta is characterised as a small isolated system. It was argued that it is impossible or impractical under the current circumstances to achieve the objective of a competitive market in electricity given the size and structure of the Maltese electricity market. Required compliance with above mentioned aspects, especially the opening of the electricity market, might result in substantial problems and could thus endanger the security of supply. Furthermore, a negative impact in the form of higher tariffs was expected on the Maltese electricity consumers. In line with the derogation under Directive 2003/54/EC, any change of the structure would lead to a revision of the derogation and possible expiry. In order to make further assumption on possible consequences, additional information on the pursued supply option would be necessary.

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[18] Repealing Directive 2003/54/EC
[19] Repealing Regulation (EC) No 1228/2003
[20] Derogation granted by Decision 2006/859/EC of 28 November 2006.
[21] A TSO is not existing in the Maltese electricity sector.

Under the new Internal Market Directive[22], the derogation of the above mentioned items is even anchored in the directive itself[23] whereas the preconditions were stipulated previously in the directive and derogation had to be obtained separately and was subject of review in case any substantial framework conditions granting the derogation changed. The requirement of review is not part of the directive anymore. However, the interconnection of Malta with the remainder of the EU via the link with Sicily constitutes a major change in the characteristics of the Maltese energy system and abrogates Malta’s status of a small isolated system. It cannot be taken for granted that the derogation fixed in the new Internal Market Directive outlast a potential revision of the directive.

At least this might be the case for all above listed aspects besides the unbundling of a TSO. The lack of a transmission system will also persist after the interconnection and does not constitute a subject of alteration even in case the new Internal Market Directive might be reviewed.

A possible change in legislation due to the abolishment of the derogation depends on the purpose of the energy provided by the interconnection. If Enemalta acts as wholesale client and facilitates the interconnection only to expand electricity supply and its corresponding security, the situation remains comparable to nowadays. In this context it has to be borne in mind that one of the key objectives under Directive 2003/54/EC is to provide secure and sustainable energy for consumers for an appropriate price and with appropriate quality. As this aspect was deemed to be endangered, the derogation for Malta from the Electricity Directive was granted. If this is still expected in case of an interconnection, it may well be that the derogation is maintained and Malta retains its exceptional status. On the other hand, such an interconnector constitutes an easy way for third parties to access the Maltese power system and to provide electricity to the customers without the necessity to establish own generation on the island.

Under the regulation for cross-border trading[24], investments in new infrastructure shall be promoted. In parallel, the functioning of the internal market in electricity shall be ensured. Where this is not necessarily the case, an exemption from the regulation facilitation by Article 17 (1) is not likely to be achieved in the case for the Malta – Sicily interconnection. Furthermore, it is considered as unlikely that this exemption would be achieved as EU funding is expected in line with the project. EU funding basically is an exclusion for the exemption. However, the main aspects of the exemption, i.e. unbundling of TSO and third party access are granted by the derogation for Malta anyway.

With regard to the implementation of the interconnection it has to be borne in mind that the interconnector constitutes a large piece of energy infrastructure. As the energy sector falls under the competition rules, Directive 2004/17/EC coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors as well as Directive 2004/18/EC on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts, or their transition in national Maltese law[25], as

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[22] Directive 2009/72/EC
[23] Directive 2009/72/EC, Article 44 (2)
[24] Regulation (EC) 714/2009
[25] S.L. 174.06, 03 June 2005

well as Public Contracts Regulations[26], has to be applied in line with its implementation. Furthermore, a due consideration of the Competition Act[27] is required. The interconnector thus will have to be established on a competitive basis. First steps in this regard have already been initiated from Enemalta's side by means of the publication of the procurement notice.

By the Electricity Transit (Grid Requirements) Regulations[28], MRA in its function as competent authority needs to ensure the transit of electricity between high voltage grids in accordance with the regulation. MRA needs to be informed about the request of electricity transit and the conclusion of an according contract. Under the Electricity Regulations[29], Enemalta is the designated DSO in Malta (there is no transmission system) who is furthermore responsible for the interconnection(s) with other systems. A reasonable balance between the interconnector costs and the benefits of the final customer shall be achieved; pursuing an efficient use of the interconnector.

3.2 Applicable Implementation Schemes of the Interconnection

For the operation of the interconnection, either the regulated or unregulated operation is possible. In the case of an unregulated operation, it would be financed by capacity and throughput charges and would most likely be in public possession. A regulated operation would fall under a privately owned merchant link or PPP scheme and the financing would be supplied via auctioning.

In the case of the interconnection Malta – Sicily, hybrid forms of the classical implementation and operation options are both supposable and applicable.

3.2.1 Roles and Set-Ups

For the implementation of the interconnector, different set-ups and participants are possible. Each of the options is linked to a different range of advantages and disadvantages. They may either be regulated or unregulated. Unregulated schemes would have to be financed by capacity and throughput charges instead of fixed tariffs. The owner would bear the full risk of cost and benefits. There would be no guaranteed income and set tariffs. In general, unregulated interconnectors have incentives to limit flows between regions to maximise revenue by optimising price differentials. A regulated interconnection must be made available for power transfer to its full technical capacity. The movement of power across the interconnection is directed by the bidding behaviour of the market competitors. If the participants bid high prices, then more power will come across the interconnection from cheaper sources.

The most likely set-ups for the implementation schemes are described in the following.

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[26] S.L. 174.04, 03 June 2005
[27] Chapter 379
[28] S.L. 423.18
[29] S.L. 423.22, Article 13

Merchant line

Operating the interconnection as merchant line would rather be realised in line with a private investment on the link. This implementation type would fall under an unregulated scheme. As the interconnection between Malta and Sicily, which shall merely import electricity to Malta needs to provide as well reserve capacity, the implementation as mere merchant line is not fully applicable. The provision of reserve capacity would exclude the use of the full capacity of the interconnection which is basically contrary to the main interest of a merchant line operator. Expectations on a profit margin of the operator would be reflected in the transmission charges which would constitute a cost pass through to the customers. This would also be the case for additional cost on required reserve capacity as loss of earnings. However, this could negatively affect the electricity prices and eventually the consumers. Furthermore, merchant link operators expect to operate in a certain market share. Within the framework of this study, this market share has not been analysed. This is furthermore also not evident in the feasibility study of the interconnection. Hence, it cannot be evaluated in this context if a pure merchant line operator would face a satisfying market share in case of the operation of the interconnection Malta – Sicily.

DSO financed line

The main purpose for the introduction of the interconnection is the increase of security of supply in electricity in Malta. It might thus be seen as a substitute to a potential additional generation source given also the intention that it is mainly used for electricity import as the local generation capacities will be reaching their limits to satisfy the electricity demand by the time the interconnector is expected to become operational. Laying focus on this set-up, financing of the link by the DSO is considerable. In this context, the DSO, i.e. Enemalta, would be the asset owner of the interconnector who would be furthermore responsible for the provision of financing and the operation of the line. This would fall under a regulated link. However, Enemalta is not capable to execute all of the tasks and responsibilities in line with the design, construction and operation of the interconnection. These services would then have to be contracted by the DSO. Furthermore, in order to achieve a non-discriminatory use of the distribution network, it would be beneficiary if the interconnection was operated by another entity than the DSO.

Joint Venture (JV) vs. Special Purpose Vehicle (SPV)

As already recommended in the expansion planning study as accomplished by Lahmeyer International in June 2008, the operation of the interconnector should be executed by an entity which is neither of the grid operators of the interconnected parties, i.e. Enemalta on the Maltese side and Terna in Italy. This could be either a joint venture (JV), for instance between Enemalta and Terna. This could however also be a special purpose vehicle (SPV) yet to be established.

As shown in Figure 3-2, a range of participants are required to execute the different tasks in line with the successful establishment of an interconnector. Some of the participants are even capable to execute several of the tasks. Either all of them are founding an SPV, i.e. bringing in their competencies as well as funding or some of them are forming a JV and will have to contract the remaining services.

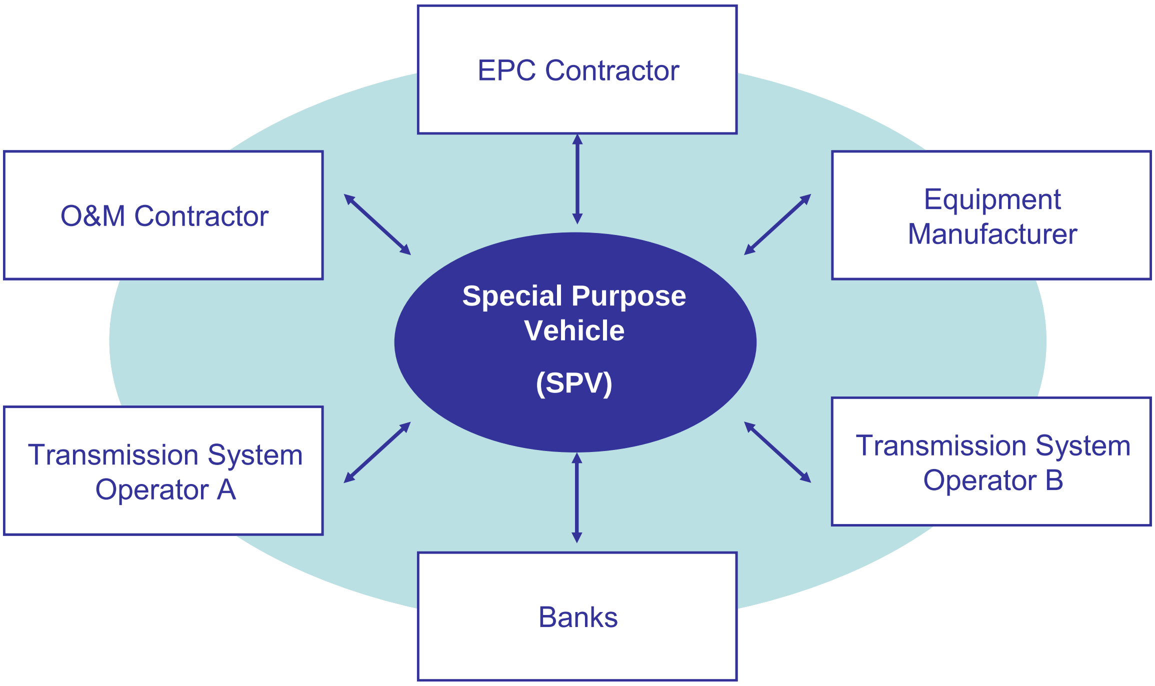

Figure 3-2: Possible Participants of a SPV

For the sake of a sustainable operation of the interconnector, it should be envisaged that the TSOs of the linked countries, i.e. Enemalta on the Maltese side and Terna on the Italian side are involved in a special purpose vehicle (SPV) owning the interconnection. Furthermore, one or several additional separate private entity/entities yet to be identified which should be responsible for the construction and operation of the link should also be part of the SPV. The profit participation of these crucial key members of this project company shall enhance the motivation for successful and sustainable operation of the interconnection line. The link could also be operated in a regulated manner or a mixture of both regulated and unregulated manner. The interconnection would be realised under a public private partnership (PPP) scheme. A mix of public and private funding in combination with Malta’s exemption for third party access would allow that all of the capacity is contracted to Enemalta. Funding of the link would then be realised by an annual charge paid by Enemalta to the SPV – irrespective of the throughput of electricity – which will have to cover the repayment of debts and a potentially expected profit margin of the participants. If the Maltese energy system should be opened to third parties, some of the capacity might already be opened based on auctioning.

Facets of Public Private Partnership (PPP)

The accomplishment of tasks, i.e. the provision of electricity via the interconnector, remains in public responsibility but it is possible that the operation will be transferred to a private operating entity in line with a public private partnership (PPP) scheme. It shall mobilise private capital and know-how in order to successfully accomplish the provision and operation of the interconnection. There are different operating schemes which are applicable. According to the call for expressions of interest, a Build-Operate-Transfer (BOT) scheme seems to be envisaged: Depending on its definition, it anticipates the turnkey provision of the infrastructure, i.e. in this case the interconnector, including its design, construction, financing and operation – either during the whole economic operational lifetime or only during the starting phase which may vary according to the concluded contract. Another common PPP scheme is Build-Own-Operate-Transfer (BOOT) which could – such as BOO - also be realised by a SPV as outlined in the previous paragraph.

Those types of operation scheme are a form of project financing. Hence, the financing will be concluded based on the expected project earnings instead of the creditworthiness of borrowing entities. In most cases, project finance structures may be complex. The project risks are spread between the various parties according to the assumed potential of the party which can most efficiently control or handle it. Each of the project participants needs to be satisfied with the risk allocation, the creditworthiness of the risk taker and the reward that flows to the party taking the risk. In the context of the interconnector, a blend with a cooperation model, i.e. a project company consisting of private and public shareholders, should be anticipated. This is especially beneficial as all of the parties contribute besides equity and funding also with their own competencies. Furthermore, all parties are both liable and participating.

3.2.2 Funding possibilities

Depending on the type of implementation scheme sought for the interconnection, different types of funding are deemed to be available. These may either be from private sources in case of private investment or public sources for public participation in the interconnection. The most prominent source in this regard are granting of funds available under the TEN-E programme.

TEN-E is a programme which was launched by the European Union (EU) to support the implementation of trans-European energy networks (TEN-E). It assesses and ranks networks according to their priorities towards the assistance of the European Community in order to achieve its energy targets. The overall objectives of the programme are the stimulation of internal markets, the security and diversification of supply. Furthermore, the development of the network to strengthen economic and social cohesion by the reduction of the isolation of the less-favoured and island regions of the EU shall be enhanced by TEN-E[30]. Amongst the defined priorities is the interoperability within the EU with the accession countries and states in the Mediterranean region. The legal framework providing for the TEN-E is Decision

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[30] TEN Regulation art 5(3)

1364/2006/EC[31]. With regard to electricity networks, Malta is considered in this context due to the following aspects:

- Developing the electricity connections between the Member States needed for the functioning of the internal market and in order to ensure the reliability and dependability of the operation of electricity networks: Italy – Malta;
- Developing electricity connections between the Member States: Submarine electricity connection to link Malta (MT) and Sicily (IT).

For the time being, parts of the feasibility study which has been realised by Terna et al for Enemalta was financed under the TEN-E programme. However, if the interconnection Malta – Sicily is not considered to open the internal market as it is currently the case under the granted derogation, further financing under the TEN-E will have to be limited on the reliability and dependability of the operation of the electricity networks, i.e. especially the Maltese one.

On an annual basis, work programmes for grants in the field of trans-European networks in the area of energy infrastructures (TEN-E) are published[32].

The annual budget for TEN-E amounts to approximately 22 m EUR. First of all, the financing sources of TEN-E are used to finance feasibility studies. Furthermore, they can be used to co-finance actual investments. Other possible funding instruments which are currently utilised in order to expedite the trans-European networks with regard to electricity are the following:

- European Regional Development Fund (ERDF);
- European Investment Bank (EIB) Loans[33];
- European Investment Fund (EIF) Loan Guarantees[34];
- Other European Community financial instruments.

As a response to the financial crisis and in order to reinforce the energy supply a financial envelope of 4 bn EUR is available under the European Energy Programme for Recovery

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[31] Decision No 1364/2006/EC of the European Parliament and of the Council of 6 September 2006 laying down guidelines for trans-European energy networks and repealing Decision 96/391/EC and Decision No 1229/2003/EC

[32] The currently valid programme is published as Commission Decision C(2009) 868 of 16 February 2009 establishing the 2009 annual work programme for grants in the field of trans-European networks (TEN) - area of energy infrastructures (TEN-E).

[33] Loans up to 50% of the total investment cost.

[34] 40% EIB funding, 30% commission funding, funding of the remainder of 30% by banks or other financial institutions.

(EEPR)[35]. In line with the EEPR, the interconnection Malta – Italy is listed as eligible project with a funding contribution of 20 m EUR. This is also the funding contribution which is expected by Enemalta and Terna who applied jointly for the funds which are earmarked for the interconnection Malta – Sicily. However, the Commission deadline to commit EEPR funds is end 2010. Hence, grant agreements should be notified by the Commission by the end of 2010 at latest. In this context, the Consultant refers to Chapter 2 of the present report, emphasising that the envisaged implementation schedule for the interconnection with construction start by mid-end 2010 and commissioning by mid-end 2012 for the first phase is deemed to be ambitious. It is assumed that the time schedule is pursued in such an insistent manner due to the envisaged EEPR funding.

Furthermore, additional 5 m EUR are foreseen for Malta in line with an envisaged contribution of 20 m EUR is allocated to small island projects which need to be distributed amongst Cyprus and Malta for the investment in energy and broadband infrastructure for the time frame 2009-2010 supporting the EU EEPR[36]. No information has been obtained if this funding will be available on top of the 20 m EUR which need to be committed in the course of 2010.

3.2.3 Ongoing Actions

Under the European Energy Programme for Recovery, a "Call for Expression of Interest for a HVAC Submarine Electrical Interconnector between Malta and Sicily" was launched[37], seeking for eligible candidates for the turnkey design and construction of the interconnection. Furthermore, the maintenance of the first five years of the operational period shall be covered.

Each applicant was informed that in case of short-listing and reply to invitation to tender, a bid bond of 1.5 m EUR with a validity of 24 months from submission of the tender will be required. The attempted capacity is 500 MVA (2 x 250 MVA[38]). Two 220 kV HVAC submarine XLPE cables shall be implemented in two phases, with the first one being operational by the 3rd and 4th quarter of 2012 after an anticipated construction period of 24 months. The commissioning for the second phase is foreseen by the end of 2015. For the time being, the complete design, manufacture, testing, installation and commissioning shall be ensured by the eligible candidate. The project lead needs to be taken over by a consortium partner being able to carry out at least 50% of the contract works. Any other participating partner needs to cover at least 10% of the contract works. According to the call for expressions of interest, a Build-Operate-Transfer (BOT) scheme seems to be envisaged (see Chapter 3.2.1).

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[35] 2.365 m EUR are allocated to gas and electricity interconnections.

[36] EU Press Release IP/09/142, 28 January 2009.

[37] The call was launched on 28 July 2009. Closing Date was 03 September 2009. It is assumed that its evaluation was still ongoing during the preparation of this study, End of October-Beginning of December 2009.

[38] Net at the receiving end; between 0.95 leading and 0.95 lagging power factor. In case of an emergency the interconnectors shall be able to transmit an overload of 70-80% for 1 hour even if the system is loaded at 90%.

3.3 Applicable Operation Schemes of the Interconnection

Within this subchapter, main differences of the different operation schemes are outlined. Furthermore, remuneration and technical aspects are described.

3.3.1 Regulated vs. Unregulated Operation

Given the implementation schemes as outlined in Chapter 3.2.1, the most applicable option for the Maltese interconnection is the introduction of a JV or – even more preferred – of a SPV. In both cases, the grid operators, i.e. Enemalta and Terna would constitute participants of the contractual set-up. From the Italian side, it is seen problematic to include the interconnection in the public grid investment. This is mainly due to the restricted benefits for Italian consumers as the link is judged to provide especially electricity import to Malta. From the Maltese point of view, the project is judged to constitute the extension of the public grid. Additional expenses resulting from the construction and operation from the interconnection are deemed to be covered by the Maltese electricity customers as they are deemed to be ultimately the beneficiaries of the interconnector. It is hence required to keep Terna's shareholder amount on a level as low as possible, as a certain revenue requirement will in this context be expected from its participation in the interconnector. On the other hand, Terna would be capable to take over the role of the responsible entity for the planning, procurement, construction and technical operation of the interconnection under a BOO scheme within an SPV. This constitutes also a rather large share of the SPV if several tasks are taken over by Terna. It is assumed that this also reflects the expectations of Terna within the project. The share should thus remain as high as required but as low as possible.

Due to the involvement of the Maltese side and its derogation for third party access, the link might constitute an unregulated scheme, granting Enemalta as single wholesale electricity buyer an exclusive use of the interconnector which will be remunerated by an annual payment covering all operational costs, partners' equity and gradual debt reimbursement. However, all remaining regulatory requirements (see Chapter 3.1) need to be respected. The regulators on both sides of the interconnector, i.e. the Maltese MRA and the Italian AEEG, are required to observe compliance with the regulatory framework. It is also possible to implement a partly regulated / partly unregulated scheme, providing for the allocation of capacity under regulated circumstances by auctioning. It is recommended that auctioning would then be accomplished based on the access rules established for the already existing interconnections with Italy, being both already commercially approved as well as in compliance with the currently active legislation[39]. This set-up would then facilitate third party access. However, the according proportion of un-/regulated available capacity would have to be allocated according on market demand and interest of participants other than Enemalta to use the interconnector. Nevertheless, based on the currently available information, further information on the expected

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[39] However, the access rules will have to be adopted by the updated Internal Market Directive and the Regulation for cross-border trading in electricity in the future.

market situation is not available and was not analysed in line with the feasibility study of the interconnection Malta – Sicily.

Under both circumstances, i.e. unregulated and/or regulated operation, the assets of the interconnection will be transferred to Enemalta after a previously foreseen operation period (deemed to be in the range of the repayment period) while the O&M contract remains valid.

3.3.2 Remuneration of the Interconnection

As for other countries, also in Malta the tariff should consist of the following components:

- Generation Charges;
- Distribution Charges;
- System Charges.

Amongst the above listed items, transmission charges do not appear due to the lack of a transmission system in Malta. However, this would change in case of the introduction of an interconnector. The list should be enhanced by transport charges. Such as applied in other countries, the transport charges should be regulated and capped in order to allow for an efficient operation. The cost basis for the transport charges should be derived from the operating cost of the infrastructure, return on invested capital, potential service charges, depreciation/amortisation. The overall cost shall be set in relation to the overall energy flow in order to determine the transmission tariffs. It shall be the task of MRA to define the tariff structure and monitor it accordingly. Interconnection revenues in case of a regulated scheme shall be considered as pass-through component, i.e. shall be re-allocated to the users of the grid.

It has to be understood that the amount of transferred energy strongly influences the tariff. This is again influenced by the electricity market determining in a certain manner the amount of electricity envisaged to be imported to Malta. Hence, it will have to be a long-term planning task for Enemalta – also taking into consideration the cost of imported electricity – how to dispatch national generation and imported electricity while considering the impact of capacity utilisation of the interconnector on the transmission cost and thus influencing the average electricity price.

3.3.3 Technical Requirements and Grid System Operator

Some of the aspects which need to be respected in any case regarding the implementation of the interconnection - irrespective of the implementation scheme – are of technical nature. These are mainly the grid code compliance with the connected transmission grid in Italy and furthermore the compliance with technical requirements outlined by ENTSO-E, the European Network of Transmission System Operators for Electricity.

According to the regulation for cross-border trading, all TSOs cooperate with ENTSO-E in order to realise the overall objective of a functioning internal market in electricity and cross-border trading as well as to support the insurance of a sound technical development of the European transmission grid[40]. Since 01 July 2009, ENTSO-E is the official association of the electricity transmission network operators (TSO). ENTSO-E then took over all operational tasks of the previously existing six TSO associations in Europe, including the Union for the Coordination of Transmission of Electricity (UCTE).

An overview map of the current members of the ENTSO-E according to its distribution into regional groups is shown in Figure 3-3. In case of the interconnection, Malta would be connected via Sicily and Italy to Continental Europe. Hence, the technical requirements on the interconnection and subsequently also on the national Maltese energy system would need to be in compliance with the UCTE requirements. It will have to be subject to further assessment subsequent to the project at hand if the Maltese grid characteristics are in consistency with the ENTSO-E specifications in general and the UCTE specifications in particular. This should especially be pursued in the light of the assessment of technical viability of the feasibility study of the interconnector as executed in line with the study at hand and described in Chapter 2 of this report. The Consultant criticises amongst others that network security and supply security relevant aspects have not been considered in an appropriate manner. This comprises furthermore the compliance of the currently isolated Maltese network with the requirements of ENTSO-E and UCTE respectively. Furthermore, it is questionable if costs for potential retrofitting measures have been considered in line with economic and financial considerations which have not been accessible in a comprehensive manner for the Consultant.

The capacity allocation for interconnections according to the guidelines set forth in the cross-border trading regulation[41] should be in line with the common allocation procedures by all of the TSOs involved. As the counterpart TSO to the Maltese side is the Italian Terna, the allocation procedures as applied in Italy are considered as well for the operation of the interconnection between Malta and Sicily.

MRA in its nature as competent authority is required to monitor the compliance with the technical requirements and advise the grid system operator accordingly.

For the operation, also the Maltese Subsidiary Legislation SL 423.18, i.e. the Electricity Transit (Grid Requirements) Regulations need to be considered. They stipulate the framework conditions for electricity transit between high voltage grids. However, it has to be considered that in Malta no proper high voltage system is available. In case they are not in consistency with the requirements of the ENTSO-E and the Italian grid code, they should be harmonised. The respective measures should also be initiated and monitored by MRA.

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[40] Regulation EC 714/2009, Article 4

[41] Regulation EC 714/2009

3.3.4 Access Rules for the Italian Interconnections

Currently, the Italian transmission grid is interconnected to the rest of the UCTE Power System by 18 interconnection lines. This comprises 16 land cables[42] and 2 sea cables. Both sea cables are underwater direct current cables. One constitutes the interconnection with Greece whereas the other is the sea cable between Sardinia and Corsica. The framework conditions for the exchange of electricity via the existing interconnections are provided in the access and capacity allocation rules[43] as published by the Italian TSO Terna and the entire counter parting TSOs. They are also deemed to be applicable in case of an interconnection Malta – Sicily as they are commercially proven Moreover, they are in accordance with the currently applicable regulation for cross-border trading of electricity[44]. For the exchange of electricity, the so-called "Available Transmission Capacities" (ATC) capacities of these interconnections are allocated based on auctions. Basically, all of the TSOs involved in the interconnections, i.e. in general Terna and the corresponding TSO in the interconnected country, have commissioned Auction Operators for the allocation of the available transmission capacities (ATC) in both directions. In general, this is always the host country TSO for the export of electricity. The ATC on each interconnection is offered by the respective Auction Operator in form of Physical Transmission Rights (PTRs). The auctioning of interconnection capacity is not a commercially motivated activity but one aimed at providing a transparent market based method of congestion management. The importance of the interconnections for the liberalisation of the electricity market requires a strict policy with regard to the collection of payments and default consequences. For the operation of Italian interconnections, different products are available for auctions:

- Annual products, i.e. base load, peak load, off-peak load;
- Monthly products, i.e. base load, peak, off-peak load;
- Daily products, i.e. hourly blocks, individual blocks.

Furthermore, in general ATC are available and announced for auction.

An auction is successfully concluded when it is transferred to the entity with the highest bid. Due to a congestion, different prices before and after a congestion arise. The trading between different regions is feasible only until the point of time that prices for the utilisation of scarce capacities are in accordance with the difference in electricity prices. In a competitive environment, this is the transfer capacity price achieved by an explicit auction.

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[42] 4 with France; 9 with Switzerland; 1 with Austria; 2 with Slovenia.

[43] Access Rules to France-Italy, Switzerland-Italy, Austria-Italy, Slovenia-Italy, Greece-Italy Interconnections, (Capacity Allocation Auction Rules), June 2009

[44] Regulation EC 1228/2003

The advantage of an explicit auction is its easy implementation even for congestions which arise only for few hours in the year. The disadvantage is the separation of transfer capacity market and electricity market. It may thus be that not all capacities are utilised.

The access rules are drafted by all of the TSOs involved in the interconnections with Italy. Their compliance with the respective regulation is checked by the regulatory authorities for the energy sector of the countries involved. Auctions are executed for interconnection capacity on a yearly, monthly and daily basis. There is furthermore also a secondary market (yearly and monthly basis) and resale market (monthly and daily basis), where the auctioned rights can be traded. Besides general rules, also specific rules for all borders are established which are tailor-made solutions considering the more or less significant differences of each interconnection.

The auctioning is merely reduced to interconnection capacity. It does not consider electricity transfer. Eligible participants are entities willing to transfer electricity. These can be e.g. producers, traders or supplier. All of the entities have to ensure, that their counterpart for the physical electricity flow has acquired at least the same amount of interconnection capacity in order to ensure the electricity transfer.

For each of the already existing interconnections, the TSO of the exporting country acts as Auction Operator on behalf of the TSO of both countries, i.e. the exporting and the importing countries. Thus, in case of electricity exports from Italy to France, Switzerland, Austria, Slovenia and Greece, TERNA is always the Auction Operator whereas it has a passive role when importing energy from its interconnected countries. The revenues achieved in line with the auctioning and invoiced by the Auction Operator are splitted afterwards according to the proportion of capacity assigned in both directions of the respective interconnection.

As the Maltese network does not comprise a transmission system and thus there is no TSO, all the respective tasks, rights and duties foreseen in line with the already existing Italian interconnections shall be executed by the operator of the interconnection.

3.3.5 Congestion Management

According to the new regulation for cross-border exchanges in electricity[45], the maximum capacity of affected infrastructure, i.e. interconnections and transmission networks, under consideration of all safety and security preconditions shall be made available to market participants. However, it shall be dealt with network congestions by means of non-discriminatory market-based mechanisms. As far as possible, this shall be solved in a non-transaction based manner, i.e. leaving aside potential preferences of contractual relationships between certain market participants. This is executed through annual, monthly and daily allocation of so-called Physical Transmission Rights (PTRs) by the means of auctions. Interconnection revenues are a pass-through component, i.e. they are transferred to the customers.

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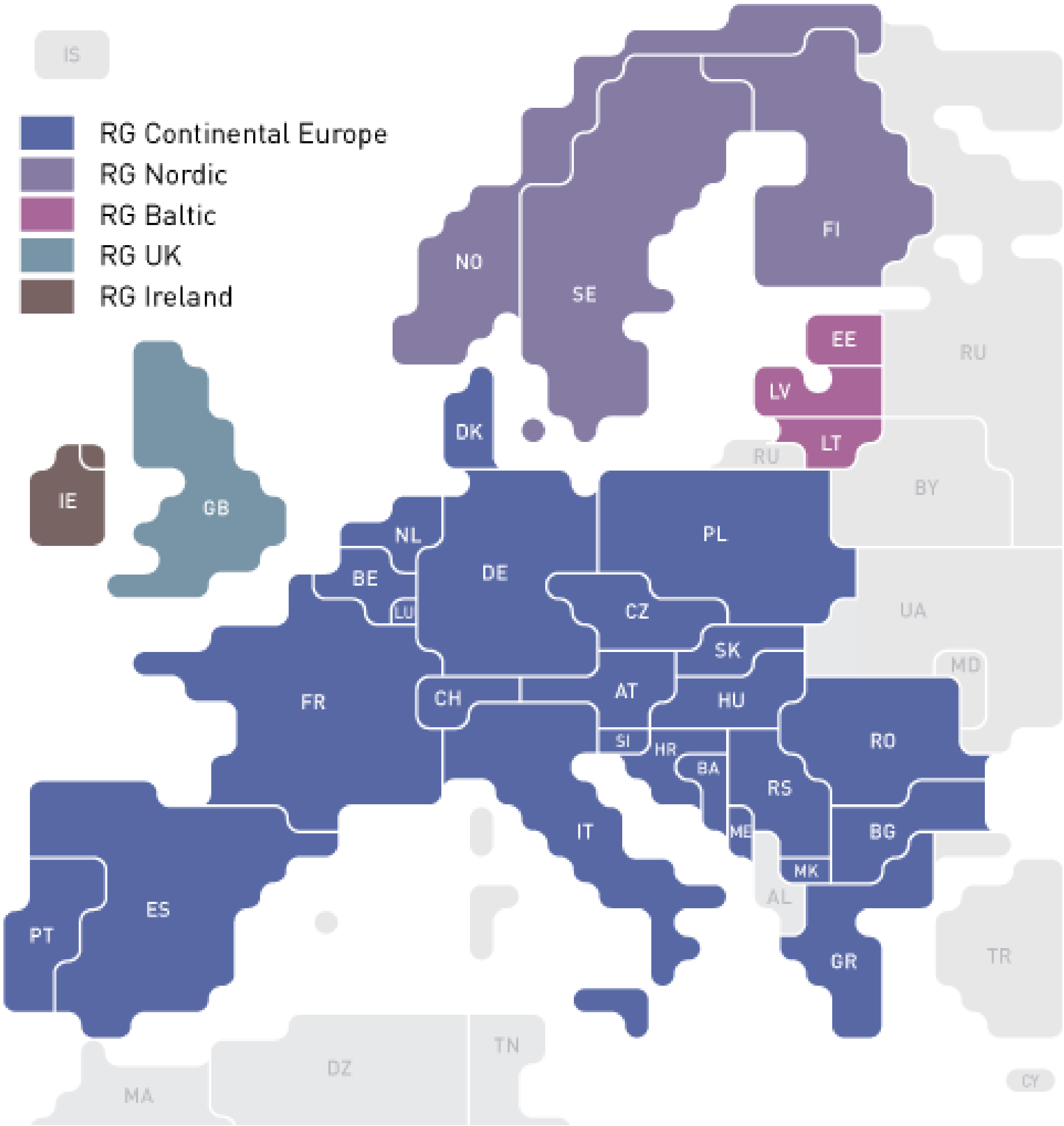
[45] • Regulation (EC) 714/2009



Source: ENTSO-E

Figure 3-3: Member States of ENTSO-E

Under the regulation for cross-border exchanges in electricity, commonly coordinated congestion management methods are applied according to different regions. Malta is expected to be allocated to the Italian region, comprising besides Italy, France, Germany, Austria, Slovenia and Greece. It is recommended to apply as well the Congestion Management Rules as already outlined and applied for the already existing interconnections for Italy and its interconnected partners.

3.3.6 Export of Electricity

Export of electricity via the interconnection would rather be an option in case of generation capacity expansion of renewable energies on a large scale, i.e. the introduction of a potential wind farm. However, the market conditions for such type of export would have to be thoroughly assessed in case of further advancement of the project development for a wind park. Another possibility for the export of electricity which would have to be assessed in further detail might be a load curve shaving measure, balancing peaks in the load curves of Malta and Sicily. However, the latter is not very likely to accrue.

3.4 Recommendations

3.4.1 General Aspects on the Implementation and Operation of the Interconnection

The interconnection Malta – Sicily should be realised by the funding of a SPV consisting of Enemalta, Terna and other entities taking over tasks required to design, construct and operate the submarine link. All of the participants should contribute to financing and execute their allocated tasks as well as taking over potentially accruing risks which can be handled in the most competent and efficient manner by them compared to other SPV members. This shall enhance the successful implementation and operation of the interconnector as well as the commitment of the participants to the project and their own services.

This set-up would furthermore realise EU funding as Enemalta and Terna applied jointly for EERP subventions. Consequently, this lowers the burden on the consumers benefiting from the link. Depending on the market share which can be expected to utilise the link as third party access, it is possible to operate the link both on a regulated and unregulated basis. As the link is initially expected to serve merely as import link to Malta, an unregulated operation might also be possible due to the derogation from third party access granted to Malta. However, this derogation might be subject of review in line with potential revision of the new Internal Market Directive and would not facilitate unregulated operation anymore, i.e. all of the capacity would then have to be allocated based on auctioning.

3.4.2 Pros and Cons of the Operation by Terna

In any case of the establishment of the interconnection between Malta and Sicily, Terna will be involved in the set-up as one of the connected TSOs. Due to its involvement in several interconnections with adjacent countries to Italy, Terna is very experienced in this role. Hence, within the involved parties, it is more qualified and experienced than any entity in place in Malta to take over the responsibilities of the operating company under a BOO scheme. Furthermore, the participation of an Italian entity may accelerate permitting and other administrative procedures on the Italian side. Moreover, Terna applied jointly with Enemalta for the funding under the EEPR.

On the other hand, Terna might request technical characteristics of the interconnection which are not beneficial for the Maltese but for the Sicilian system. This comprises for instance the preference of an AC line as demonstrated in the feasibility study which does not have a predecessor in the same length. Furthermore, it requires higher technical efforts in terms of technical regulation and stabilisation on the Maltese system than a DC line in order to regulate the accruing capacities. These aspects would have to be more thoroughly considered and addressed before continuing the tendering procedure for the interconnection. However, according to the information provided in line with the feasibility study for the interconnection, HVAC is quoted as only technical solution providing a basis for Terna to conclude a partnership with Enemalta.

3.4.3 Further Needs for Action

In line with the implementation and the operation of the interconnection, MRA is responsible under the MRA Act to ensure fair competition[46]. MRA thus needs to make sure that the choice of entity/entities in charge for the construction and operation of the interconnection is accomplished on a competitive basis. As the supply of energy itself is excluded from the public procurement regulations[47], this does not come within the responsibilities of the MRA.

Furthermore, the transposition of several updated legislation into Maltese law will be necessary. This comprises the transposition of Directive 2009/72/EC and Regulation (EC) 714/2009 are required by 03 March 2011. It is recommended that, the Electricity Regulations[48] transferring Directive 2003/54/EC into national law will need to be amended or repealed by regulation reflecting the new Internal Market Directive, i.e. Directive 2009/72/EC.

Moreover, the operator of the interconnection as well as the eventually connected national grid operator in Malta will have to be certified under the new internal market directive[49]. It will also be MRA's task to assess and – if applicable - approve the tariffs resulting from the transmission via the interconnection.

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[46] Cap. 423, 02 February 2001, Article 4(1)
[47] S.L. 174.06, 03 June 2005, Subsection 4, Article 26
[48] S.L. 423.22 of 16 December 2004
[49] Directive 2009/72/EC, Article 10 (6), Article 10 (2), Article 11, Article 9.

From the UCTE point of view, Malta is not necessarily required to become a member. However, it will have to fulfil technical criteria in order to reach conformity within the system and to contribute to its stability. It will thus have to be analysed thoroughly in subsequent work steps to this study what kind of technical influence can be expected.

With regard to the missing information identified in line with the technical review of the feasibility study of the interconnection (see Chapter 2) it is strongly recommended that MRA requires additional information. MRA as is both authorised and obliged by means of the MRA act to “regulate, monitor and keep under review all practices, operations and activities relating to energy (…).[50]”This should be provided by Enemalta, i.e. the contractor of the study, if necessary requesting the information from its contracting Consultant. With regard to a secure development of the system and a secure supply, MRA should on time gain a clear impression on the strengths and weaknesses of the envisaged expansion measure. This will facilitate to allay concerns from the regulator’s side already during development phase which may accelerate licensing at a later stage. Furthermore, MRA should already liaise with the counter parting regulatory AEEG in Italy in order to benefit from their lessons learnt with previous interconnections, discuss possible concerns or barriers regarding the interconnection Malta – Sicily and to plan further work steps in the future already in advance, i.e. to identify need for action on MRA’s and Enemalta’s side well in advance.

Basically, all of the mentioned set-ups as outlined in this chapter would facilitate third party access as for all of the set-ups regulated operation can be considered. In case of third party access, also the other aspects of the derogation might be subject for review in line with prospective legislation revisions. However, currently it is not required due to the derogation granted for Malta whereas on the other hand it is not technically and regulatory prohibited. In the case Malta foresees the access of third parties into the national system – irrespective of an ongoing derogation – it would be required to achieve the unbundling of the DSO in order to provide for a non-discriminatory access of the system.

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[50] MRA Act, Cap. 423, 02 February 2001, Article 4 (1)(a).

4 Procurement and Purchase of Electricity from the Interconnection

The following chapter deals comprehensively with the procurement and common purchase options of electricity under the European cross-border trading scheme which will render possible due to the envisaged implementation of the power interconnection between Malta and Italy.

Hence, general considerations were directed towards the following aspects:

(i) Applicable Procurement Rules for the Purchase of Electricity in Malta

(ii) Characteristics of applicable purchase options, i.e. “traditional” power purchase agreements vs. spot market trading;

(iii) Analysis of applicable charges accruing due to the purchase of electricity for the purpose of facilitating a qualitative cost comparison;

(iv) Conclusion of the elaborated results.

4.1 Applicable Procurement Rules for the Purchase of Electricity in Malta

With regard to the public procurement, SL 174.06 was reviewed, as it addresses the public procurement of entities in the energy services regulations. However, according to Subsection 4[51], Article 26, the regulations do not apply for “contracts for the supply of energy (…)” if those are awarded by Enemalta.

4.2 Characteristics of Applicable Purchase Options

Power interconnections, being the bridge for energy trade across borders require market access to facilitate trade. Currently, the EU regulation No. 714/2009 on conditions for access to the network for cross-border exchanges in electricity provides the legal framework to facilitate such an open market.

However, even in the case of the most open electricity market, electricity trade, import and export requires permits and approvals from affected national regulators and other governmental bodies. Common purchase options of electricity in such deregulated markets, i.e. within the European Union, will be discussed subsequently.

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[51] Page 18, SL 174.06

4.2.1 Power Purchase Agreement

Generally speaking under the terms of a power purchase agreement (PPA), the exporting power utility agrees to specific conditions on power output over a defined term and the importing power utility (i.e. transmission system operator) agrees to purchase this output at the tariff rates defined mutually. The PPA thus establishes the power sale and purchase obligations of the power seller and the power purchaser, respectively.

Specific provisions regarding performance guarantees, future adjustments to respective tariff formulas and penalties or bonuses for exceeding or failing to meet performance goals are addressed in the PPA.

Among others, the PPA needs to address the following important aspects in particular:

- Basic contractual issues like the specification of the contract partners, determination of dates or milestones, purchase and supply obligations and/or technical specifications (e.g. frequency and voltage levels);

- Regulations regarding interconnection and transmission of produced power and the organization of metering (i.e. which party is responsible for the interconnection, who pays for the interconnection, who owns the metering equipment, etc.);

- Tariff and price design for the power sale transaction among the parties. In this regard the tariff system design is directly reflected in the PPA. The agreement or tariff system respectively may furthermore specify the risk allocation and sharing rules (i.e. currency risks in case foreign capital is involved, indexation of tariffs, etc.);

- Aspects of non-compliance with obligations, penalties and dispute resolution.

Such a traditional PPA was and still is the usual way to encourage participation of investors from outside and to provide a secured return guarantee to this participation in power markets. It is furthermore the option to ensure long-term supply of electricity under fixed conditions which reduces both price and delivery risks.

However, regarding a more sophisticated deregulated power supply market such as within the EU, PPAs may no longer play the same role as in the past or as they still do in developing countries for instance. Furthermore, the conclusion of such PPAs could interfere with the EU’s goal of establishing a transparent, non-discriminatory and cost-reflective electricity market. This could be an issue that may even adversely affect power interconnection initiatives.

Accordingly, due to its greater importance and widely-accepted applicability the following subchapter concentrates on the option of trading electricity on European spot markets, having emerged in recent years.

4.2.2 Spot Market Trading

As already mentioned previously the open access of power dealers to interconnected networks requires transparent and non-discriminatory regulation for establishing favourable cross-border electricity trade in a competitive power market.

In theory competitive power markets are organised around one or more auctions. Particularly, a market facilitator receives respective bids from power generators and demand estimates from power retailers and/or end-users. The optimal dispatch schedule within an electricity system is calculated afterwards, i.e. the power generation rule that minimizes the cost of meeting demand, however, under consideration of technical and physical restrictions imposed by the grid.

The actual bidding strategy itself which is chosen by an electricity generator will depend on several factors, such as market history and auction market rules in particular.

Regarding the **auctioning process** in general a large variety may be utilized as allocation and pricing mechanisms for electric power. However, the most commonly used type of auctioning electricity is the so-called *double-sided auction* that considers bids from both the sellers and the buyers of the traded commodity.

Hence, European power exchanges usually provide bidding-based trading in contracts for power delivery during a particular hour of the next day. The usual trading system is a daily double-sided auction for every hour to match transactions at a single price and a fixed point in time. By submitting their bids the market participants determine how much they are prepared to sell or to buy at what prices.

For the sake of clarity, Figure 4-1 depicts the basic structure of an auction at electricity spot markets:

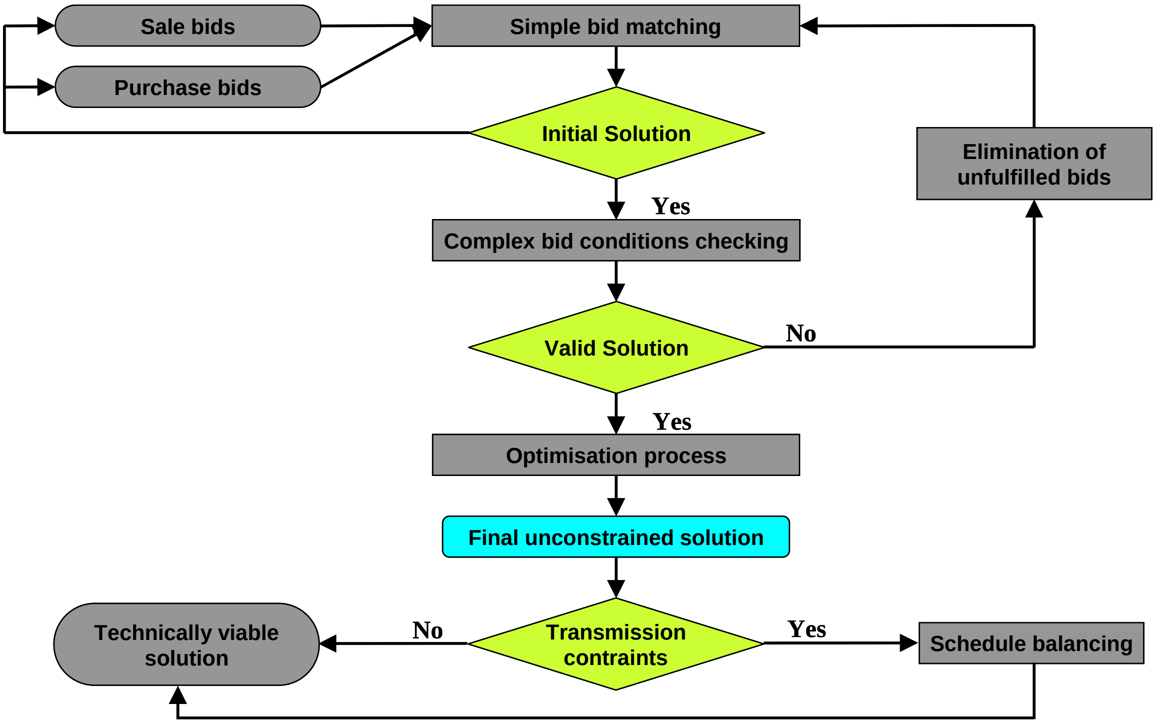


Figure 4-1: Basic structure of an auction

Market participants can submit and change their bids until the closure of the call phase. In order to achieve price determination (or price settlement) all bids collected up to the pre-determined closure of the call phase are sorted according to their value and are then aggregated to allow for the development of a market demand and supply curve for every hour.

According to Figure 4-1 the simple bid matching process ignores any execution conditions or grid capacity restrictions and results in an initial solution or *initial clearing price*, applicable for every hour and trade volume for every bid.

This initial solution is then checked against additional (commercial) conditions added to the bid until all remaining bids can be fulfilled. Finally, the trade volumes of the matched bids will also be checked against potential transmission grid restrictions in order to achieve a technically viable solution.

The resulting market clearing price is accordingly the price level at the intersection of the aggregated demand and supply curves (see Figure 4-2). Hence, if there is no intersection of the two curves there may be a second round of submitting bids in order to get an auction price of the commodity traded, which is then referred to as the reference price.

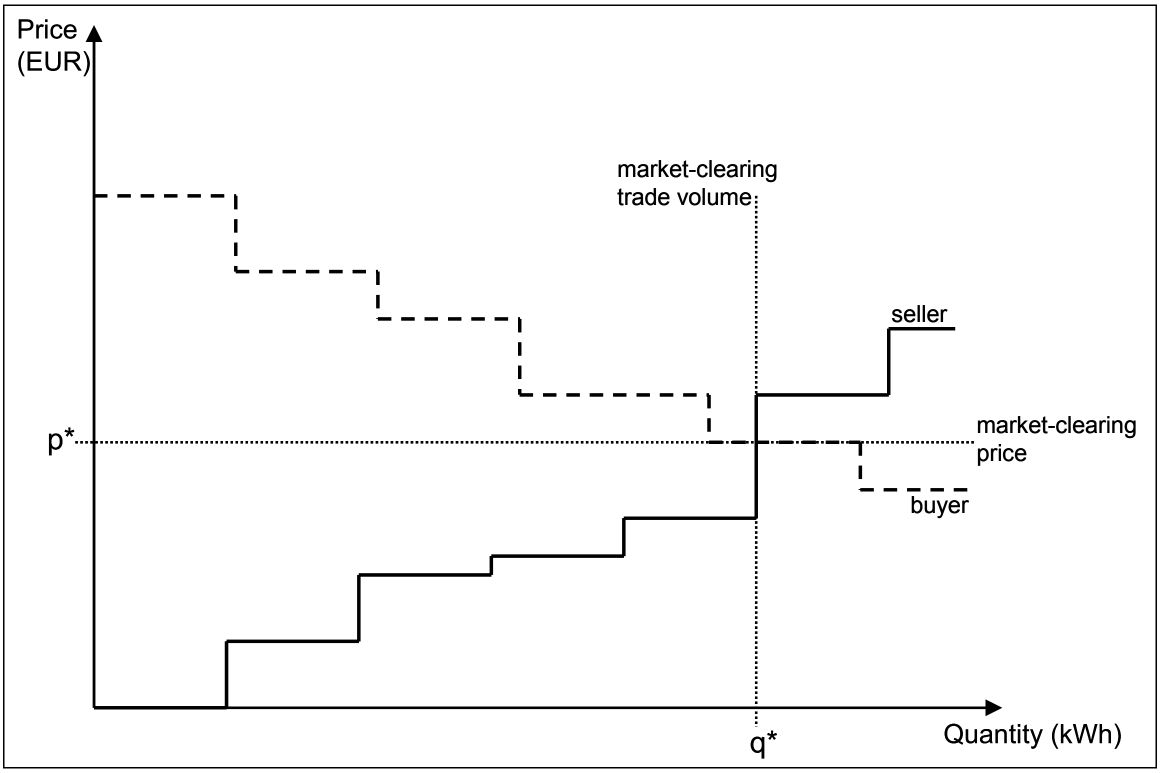


Figure 4-2: Simple bid matching

In auctions the common price determination is uniform pricing, i.e. the uniform price is the price level at the intersection of the aggregated demand and supply curves and thus provides a maximum trading volume.

However, since a simple aggregation of the bids results in discrete curves only, there may not be an accurately defined price. Power exchanges usually handle this problem by utilizing a linear interpolation instead of simple aggregation in order to aim for linear supply and demand curves, e.g. such as European Energy Exchange (EEX) and Powernext.

After having depicted the price determination mechanism on spot markets the different **market places** will be analyzed in the following, since participants can act on a variety of markets in a liberalized market. Accordingly, the European organized markets typically comprise one or more of the following.

Day-ahead market

The day-ahead market serves as the basic market place in electricity trading where the bids are submitted and the market is cleared on the day before the actual dispatch. The underlying market principles and price determination process have been thoroughly discussed in the previous section.

The scheduled day, which is under consideration, is divided into *X* periods of *Y* minutes each. Each bidder makes a price bid for every generation unit for the whole day. Typically, either *hourly contracts* (i.e. for each single hour of the calendar day) or *block contracts* (i.e. a certain number of consecutive hours) are being traded in the day-ahead market. Whereas the former allows the market participants to adequately balance their portfolio of physical contracts, the latter allows them to utilize the full capacity of their power plants due to the longer time span under consideration.

Intra-day market

In particular due to the rather long time span between the settling of contracts on the previously described day-ahead market and the actual physical delivery of electricity, some power exchanges offer an intra-day market.

This market place closes shortly before delivery and thus enables the participants to improve or optimize their balance of physical contracts in the short-term by generating additional revenues.

Balancing market

For the purpose of achieving a balance between power generation and load at any time during the electricity systems' real time operation, system operators frequently use the balancing market.

After the closure of the spot market participants can submit bids that specify the prices they require to increase their generation or decrease their consumption for a specific volume immediately (e.g. within the quarter of an hour). Such balancing services are particularly sought for various operation requirements of transmission systems, such as e.g. voltage control, frequency control management and reactive power support.

Some European TSOs have already started to procure the capacities which they require to provide such balancing services from generating companies via published auctions. Especially the so-called minute-reserve market has turned into a liquid wholesale market in recent years since many power producers are able to provide such services and thus to meet the needs of the TSOs. Since there is moreover no need to carry out additional investments in the producers' power plant equipment, the market barrier in this respective market is comparatively small.

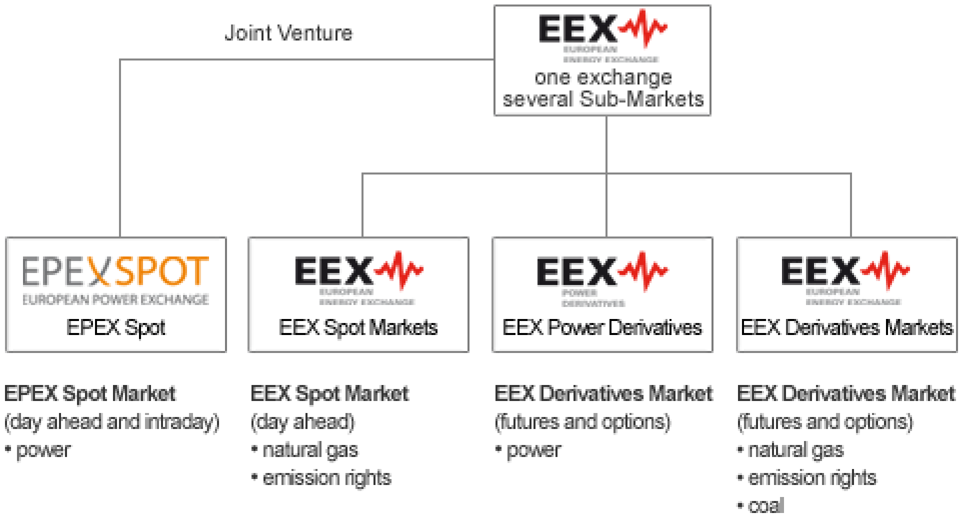
4.2.3 Exemplary Power Pools

In this section a brief overview of the largest operating power pools under consideration of the envisaged interconnection of Malta to the European integrated transmission system network is provided.

European Energy Exchange (EEX), Germany

The EEX is Germany's largest energy exchange and the leading market place in Central Europe. The merger of former LPX Leipzig Power Exchange and European Energy Exchange Frankfurt is located in Leipzig since 2002.

It is offering a capable spot market differentiated in an auction market and continuous trading, whereas trading takes place from Monday to Friday. The EEX operates spot markets for power, gas and carbon dioxide emission rights (EUAs) as well as a derivatives market in which futures and options on power, gas, EUAs and coal are traded (see Figure 4-3).



Source: EEX

Figure 4-3: Sub-markets of the EEX

Trading itself is based on double-sided auctions for every individual hour as already introduced in Section 4.2.2. Market participants can transmit their bid via special internet software. All submitted bids are collected in an order book and then closed at 12:00 a.m. in order to calculate the settlement price.

Apart from individual hour contracts, block contracts are also being offered in auction trading, whereas the maximum size of an individual tradable block bid is capped with 100 MW.

Gestore Mercati Energetici (GME), Italy

Operation of GME started in 2004 and was originally set up by the "Gestore dei Servizi Energetici" (GSE) with the mission of organising and managing transactions in the Italian electricity market as well as ensuring the management of an adequate availability of reserve capacity.

The GME, synonymously called *Italian Power Exchange – IPEX*, shall enable producers, consumers and wholesale customers to conclude electricity purchase and sale contracts for the next day, i.e. the establishment of a day-ahead market. Similar to Germany's EEX market participants are connected to the market platform via the internet and enter into online contracts via secure access procedures.

In general, the GME consists of the spot electricity market (MPE) and the forward electricity market (MTE) with delivery and withdrawal obligation.

The spot market itself includes the following trading platforms:

- The *day-ahead market* (MPG) where producers, wholesalers and eligible customers may sell or purchase electricity for the next day. Contracts are traded in daily double-sided auctions one day in advance of delivery. Market participants are furthermore allowed to submit multiple sale bids for a single generating unit or point of interconnection with a foreign country. However, if any transmission restrictions should occur, GME is allowed to divide the market into two or more zones for the purpose of selecting adequate bids in each zone in accordance with the technically available grid capacities.

- The *intra-day market* (MI) where participants may modify additional generation or withdrawal schedules that were already defined in the day-ahead market.

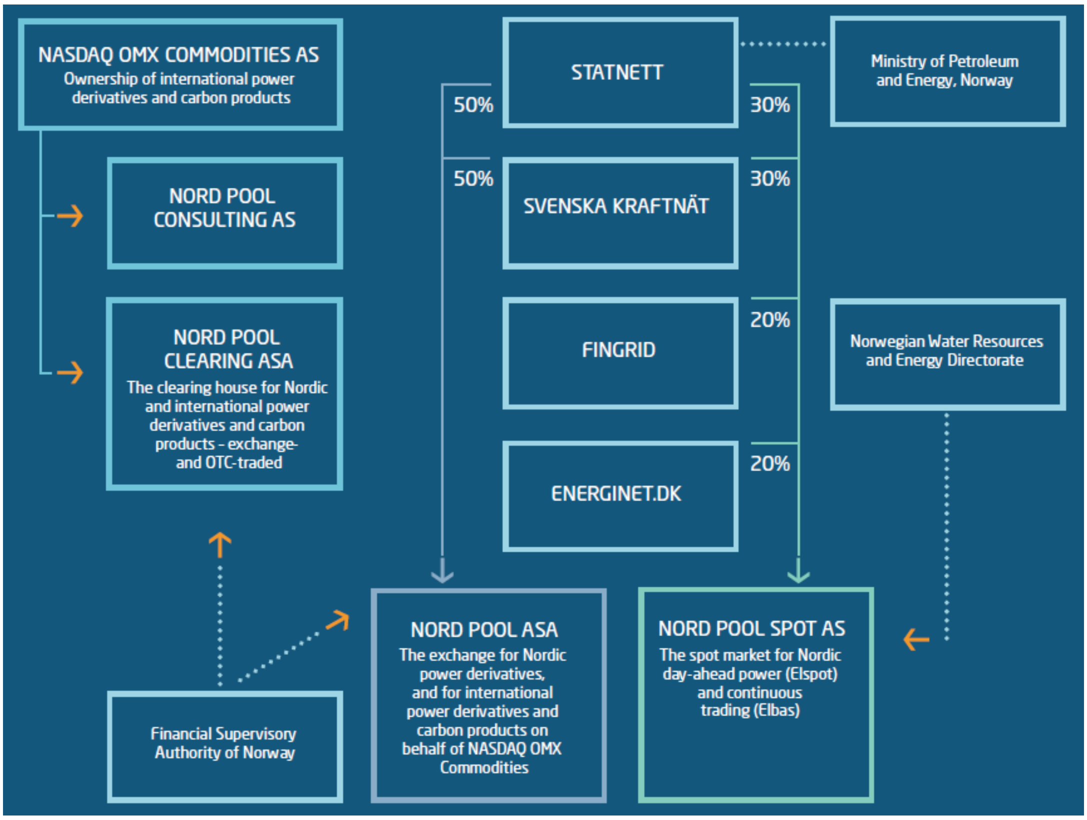
- The *balancing market* (MSD) where the Italian system operator TERNA procures its dispatching services which are required for managing and controlling the overall electricity system.

Moreover, GME is also obliged and thus responsible for managing the trade of European and/or domestic certificate schemes, such as (i) Green Certificates, (ii) Energy Efficiency Certificates and (iii) European Emission Allowances (EUAs).

Nord Pool, Norway

The Nordic Power Exchange (short: Nord Pool) based in Norway is the world's only multi-national power exchange. It provides market places for trading physical and financial contracts in the Nordic countries, i.e. Denmark, Finland, Norway and Sweden.

Its day-ahead market was already launched in 1993 and is owned by the TSOs Stattnett (Norway) and Svenska Kraftnät (Sweden) with fifty percent each, see Figure 4-4.



Source: Nord Pool's Annual Report 2008

Figure 4-4: Sub-markets and ownership of Nord Pool

Since it is one of the largest power exchanges worldwide, Nord Pool has more than 380 members in total, including exchange members, clearing clients, members and representatives in 21 countries.

The physical market is the basis for all electricity trading in the Nordic market. Nord Pool Spot organises the market place which comprises the Elspot and Elbas products. Elspot is the common Nordic market for trading physical electricity contracts with next-day supply, i.e. the day-ahead market. Elbas is the physical balancing market for Sweden, Finland and Denmark.

Elspot's traded products are power contracts with one hour duration and block bids. Prices are determined through auction trade for each delivery hour. In accordance with the previously presented power exchanges, bids have to be submitted to the market place electronically before 12:00 a.m.

By contrast, the balancing market Elbas aims to improve the balance of physical contracts of the participants. This market place is at present limited to Sweden, Finland and Denmark. It offers continuous trading 24 hours per day. Hence, the trading session for a specific day starts after the publication of the results of Elspot for this respective day. Similar to Elspot bids may be submitted electronically via special software.

Powernext, France

The Paris-based power exchange manages the continental European power exchange. Launched in November 2001, it offers standard hourly contracts which are negotiable on a daily basis by French operators as well as foreign players.

Respective quotations for Powernext's day-ahead market are undertaken in an internet-accessible platform. In 2006 the auctions were linked with Belgium and the Netherlands. Its negotiation system is facilitated by a centralised order book, which calculates and distributes the market clearing price and volume similar to the auction methods of other power exchanges.

As outcome of a recently accomplished consolidation, Powernext has refocused its shareholder structure towards European energy utilities and transmission system operators in electricity and natural gas. Accordingly, two power joint ventures were established with the German power exchange EEX:

- EPEX Spot established in Paris, which lists power spot contracts for France, Germany, Switzerland, Austria; and
- EEX Power Derivatives based in Leipzig, which lists power future contracts for France and Germany.

The new shareholder structure is presented in Figure 4-5 accordingly.

Source: Powernext

Figure 4-5: Group structure of Powernext

4.3 Additional Applicable Charges

The following subchapter deals with applicable charges or costs respectively, which would occur for the Maltese TSO when electricity is purchased and transmitted via the interconnector.

Accordingly, a twofold approach has been chosen, thus focusing on (i) applicable wholesale electricity prices in major European spot markets and (ii), moreover, additional wheeling charges which arise due to the applicable transmission tariffs for wheeling electricity through respective power transit countries in Europe.

4.3.1 Selected Wholesale Electricity Prices

Even though the European electricity market has been deregulated it is not uniform until to date. Power prices are still heavily influenced by local production conditions, thus implying incentives for electricity buyers to preferably buy only in certain power exchanges.

In general the Nordic countries are characterised by relatively low wholesale electricity prices, while Germany, France and Switzerland are usually characterised as areas with medium-high prices. By contrast the highest prices are generally found in Italy and the United Kingdom.

The occurring price differentials between European power exchanges are on the one hand caused by the water levels as a key pricing factor in the Nordic countries due to the large contribution of hydropower in the respective energy mix. Hence, a comparatively weak hydrological balance (i.e. low water levels) leads to higher electricity prices in the Nordic countries and vice versa.

On the other hand, it is the fuel prices in many continental European countries, i.e. the price of coal and natural gas, constituting the major price drivers. Furthermore, prices of the traded European emission allowances (EUAs) have also a significant impact on overall electricity prices, in particular in countries, which have a large contribution of emission intensive coal-fired power plants within their national energy mix.

On the electricity exchanges, which were already introduced in Section 4.2.3, the growing share of Europe's electricity trading is conducted. As prices on the exchanges are determined by the economic rule of supply and demand under consideration of local conditions, generation facilities are utilised by the merit order. It implies that power plants with the lowest short-run marginal costs are put in operation first: in particular Norwegian hydropower and French nuclear power.

This circumstance is thus also reflected within the average spot prices as well as the overall traded volumes on Europe's electricity exchanges as shown in Figure 4-6 and Table 4-1 respectively.

Table 4-1: Spot market volumes [TWh]

		2008	2007
NP	Nord Pool, Nordic Countries	298	292
EEX	European Energy Exchange, Germany	154	124
APX NL	Amsterdam Power Exchange, Netherlands	25	21
APX UK	Amsterdam Power Exchange, UK	14	11
EXAA	Energy Exchange Austria, Austria	3	2
PNXT	Powernext, France	52	44
OMEL	Spanish Power Exchange, Spain	222	179
POLPX	Polish Power Exchange	2	2
BELPX	Belgian Power Exchange, Belgium	11	8
IPEX	Italian Power Exchange, Italy	233	231

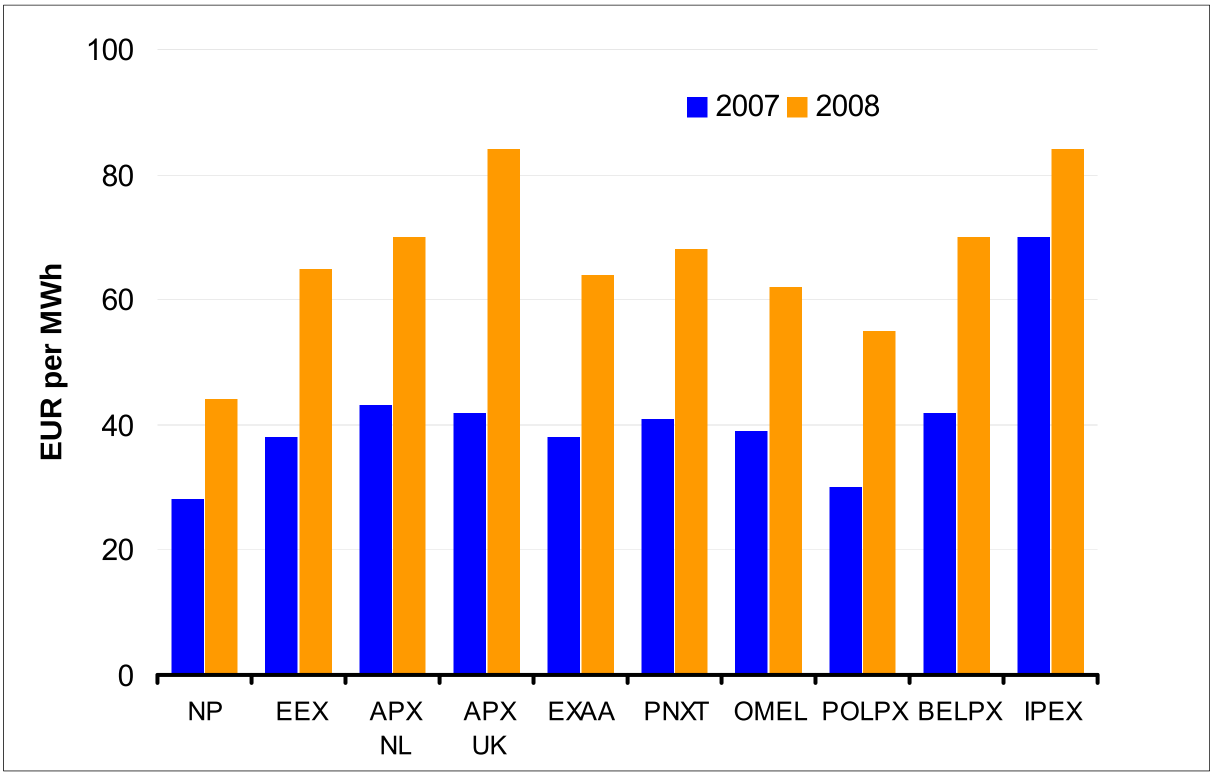


Figure 4-6: Average spot prices on Europe's electricity exchanges

Compared with other European exchanges prices on Nord Pool were significantly lower in 2008 than prices in continental Europe (approximately 44 EUR/MWh). In the United Kingdom (APX UK) and Italy (IPEX/GME), average spot prices were roughly twice as high as on Nord Pool in 2008 (84 EUR/MWh).

The lowest prices being traded in Nord Pool is mainly caused by the fact that the generation system is hydropower dominated, thus implying only a marginal influence of fuel price volatility on the resulting electricity wholesale price.

Further on, wholesale prices of the German EEX and the French Powernext are correlating strongly whereas it is also anticipated that this price trend will be further tightened in the future. Hence, an average value of about 65 EUR/MWh and 68 EUR/MWh respectively were registered in 2008.

Summing up, the Nordic electricity exchange Nord Pool and the European Energy Exchange (EEX) in Germany are clearly the largest exchanges either in terms of volume or total number of market participants. With regard to market maturity the participation in such platforms is thus recommendable when considering potential procurement options of electricity via the interconnection.

Furthermore, since European wholesale prices have peaked in Italy in 2007 as well as in 2008 this procurement option cannot be recommended under exclusive consideration of the wholesale electricity price. But having in mind that Malta will be directly interconnected to the Italian electricity system, respective wheeling charges by transferring the purchased electricity through Italy would additionally arise and be invoiced by the Italian TSO, which will be discussed in the subsequent chapter.

4.3.2 Principles and Comparison of Selected TSO Tariffs

In general it has to be acknowledged that no economy will accept to face extra financial burdens as a proponent in electric infrastructure projects, if the project will not benefit its own economy. In electricity trading, if power can be wheeled from source A to D for instance and passing through the geographical boundaries B and C, all four parties want to benefit in making the trading works.

However, electricity networks which need to supply electricity from generators to consumers are considered as natural monopolies. Therefore normal market forces do not result in competitive pricing. In the medium-term the EU hence plans to implement the so-called ITC (Inter TSO Compensation) scheme to compensate affected system operators for costs caused by users connected to other transmission systems.

At present the electricity transmission system is made up of individual TSOs mainly at national level which are interconnected with each other. For each individual transmission system the respective TSO is responsible for managing energy flows in the system. Non-domestic users who import and/or export electricity via the transmission system of a country are accordingly in charge of paying a certain proportion of the costs of grid operation: the so-called TSO tariff.

These tariffs are being considered as the charge for all system users for use of a respective transmission system. In the following a brief comparison of current transmission tariffs in Europe will be provided accordingly.

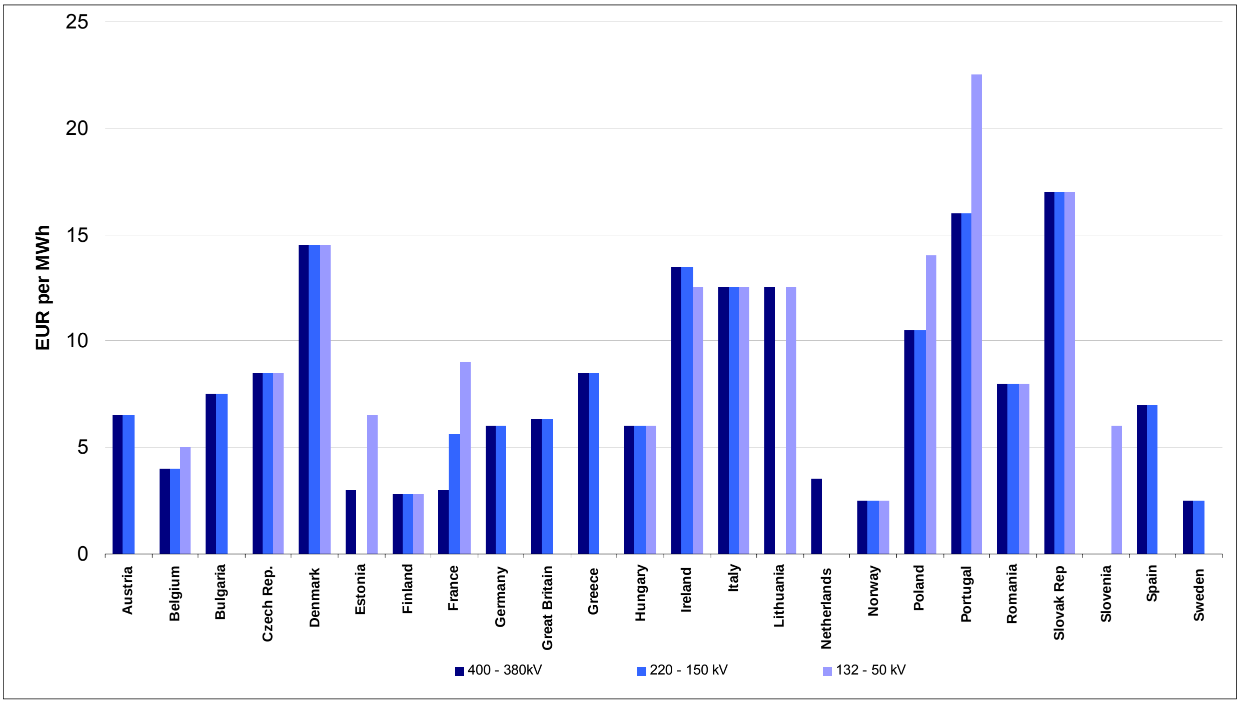
The European Network of Transmission System Operators for Electricity (ENTSO-E), which was launched in July 2009 as successor of the former UCTE, regularly publishes a comparison of the individual transmission tariff structures of the European TSOs. Major tariff components taken into account by ENTSO-E are presented in Table 4-2 below.

Table 4-2: Transmission tariff cost components

Cost Component	Description
Infrastructure charges	For most systems this is the largest component of transmission costs, including capital cost and operation and maintenance costs (fixed and variable).
Loss compensation costs Congestion management costs	Costs due to system's losses and congestion management are directly related to the electricity throughput and must be recovered by the system operator.
Costs of system services	Costs e.g. due to the system's black start capability and voltage control measures.
Costs of system balancing	Costs due to system's automatic frequency control, i.e. balancing between load and generation.

In accordance with the above described tariff components, ENTSO-E calculated the respective transmission tariffs among European TSOs in 2008 as presented in Figure 4-7. In order to adequately derive the overall tariff based on the several cost components, both the charges applied to the consumer (i.e. load) and to the generator were taken into account. Furthermore, since the high voltage levels of the European transmission systems vary significantly, the following classification was made:

- Producer and consumer are connected to *extra high voltage*: 380 - 400 kV;
- Producer and consumer are connected to *high voltage*: 150 - 220 kV;
- Producer and consumer are connected to *medium voltage*: 50 - 132 kV.



Source: ENTSO-E

Figure 4-7: Comparison of transmission tariffs in 2008

According to Figure 4-7 three different voltage ranges were considered. In order to facilitate a meaningful comparison ENTSO-E calculated a base case scenario by assuming a 5,000 h system utilization time. The typical load considered was determined with a maximum power demand of (i) 40 MW for extra high voltage as well as high voltage and (ii) 10 MW when connected to the medium voltage grid.

When comparing the overall TSO transmission tariffs, Portugal, Denmark, Italy and Ireland are amongst the systems with the highest prices.

By contrast, the Scandinavian countries Norway, Finland and Sweden charge the comparatively lowest tariffs within the ENTSO-E network. Germany and France as major central European transit countries range within the medium-high prices, thus showing the same trend as for electricity wholesale prices.

Regarding especially the Italian TSO tariff due to its importance for Malta, it has to be considered that the Italian TSO TERNA increased its tariff significantly when compared to the previous year. This development is mainly caused by strongly increased costs of system balancing services due to the increased prices of bids on GME's balancing market which again has strongly correlated with increased fuel prices.

Costs of system losses also increased in 2008 compared to 2007 in Italy since the domestic regulator sets a standard loss coefficient, which is proportionally linked to average electricity prices. As the Italian wholesale electricity price increased strongly in 2008, the same development was noticed for the overall loss compensation costs.

4.4 Conclusion

Since the interconnection between Malta and Italy is mainly planned for energy import the economic benefit for Malta will result in the sale of power to the final customers against the cost of investment and operation of the interconnection link plus the cost of purchased electricity imported in the Maltese transmission/distribution system.

Accordingly, the applicable wholesale electricity price in addition to the arising wheeling charges for electricity transport is a core issue. The average generation cost and the level of power prices in the receiving market, i.e. in Malta, would be the benchmark for any imported power.

Therefore, costs of power supplied by the interconnection route compared to local supply need to be analysed thoroughly once the interconnector is online. This will also be strongly influenced by the supply strategy pursued via the interconnector, i.e. if the interconnection shall mainly provide electricity in order to cover base load, intermediate load or peak load. This will have an effect on the expected price range for electricity. As already pursued within this present chapter a twofold approach is recommended for importing power to Malta:

(i) Identification of promising power exchanges; and

(ii) Comparison of applicable wheeling charges, i.e. TSO tariffs.

Firstly, regarding the electricity to be purchased at European power exchanges some of the most important services, which should be offered by such market places, are (i) an automatic and preferably internet-based market access, (ii) clearing & settlement of deals, (iii) adequate risk allocation and (iv) overall transparency in terms of various information needed by market participants.

In order to identify measurable success factors of promising power exchanges for the purpose of providing general guidance, the market participant should check the following indicators before participating in appropriate power exchanges:

- Number of market participants;
- Liquidity of the market;
- Growth of the market;
- Competitiveness of the fee structure.

Secondly, when it comes to the comparison of applicable TSO tariffs for transferring the purchased electricity via interconnections, the current tariff structure might most probably be outdated once the interconnector between Malta and Italy comes online. At present, the EU energy commission and its subordinated electricity cross-border committee are drafting a proposal for implementing the designated ITC scheme: the Inter Transmission System Operator Compensation Mechanism.

It shall primarily facilitate a tariff harmonisation among the European TSOs in order to ensure competitive electricity markets, which are not distorted by wheeling charges based on different tariff structures. Once the respective ITC scheme is successfully implemented, it can be expected that the applicable wheeling charges will be uniformly allocated among the different EU member states.

Accordingly, respective electricity purchase strategies for Malta should then be mainly driven by competitive bidding at the different European power exchanges.

5 Aspects of RES in the Maltese Energy Sector

5.1 Introduction – Achieving Malta's renewable energy target

Increasing the contribution of renewable energies to the European energy supply is one of the key targets of the EU's 'climate and energy package'[52]. This target interacts with specific EU-wide efforts regarding increased energy efficiency and energy savings as well as concrete measures to cut energy related emissions back until the year 2020.

With Directive 2009/28/EC the EU set the framework for renewable energy development in Europe. An EU-wide share of 20% renewable energy in gross final energy consumption has been translated into concrete targets on the Member State level. In this regard, Malta's target for the share of energy from renewable sources in gross final consumption of energy in the year 2020 shall amount to 10%. According to the Directive each Member State has several options to comply with their national renewable energy development goals. The targets shall be reached by increasing the share of:

- electricity from renewable energy sources;
- energy from renewable sources for heating and cooling;
- energy from renewable sources in transport.

Generally Member States are free to use any measure leading to the necessary increases in the use of renewable energy. In addition, energy efficiency measures might be promoted in order to decrease a Member State's gross final consumption and thereby lower the needed absolute increase in energy production from renewable resources. The only additional mandatory target is a minimum share of energy from renewable sources in transport which shall be at least 10% of final consumption in the transport sector.

Although the interaction between measures addressing energy efficiency, emission reductions and renewable energy promotion are non-negligible and must be taken into account in order to derive a robust climate- and energy policy on the national level, this study concentrates only on the different measures to increase the contribution of RES-E.

The analysis in this section will focus on the following measures to develop the share of electricity from renewable resources.

- Domestic production of RES-E;

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[52] For other aspects of the energy package, i.e. on liberalisation see also Section 3.1 of this report.

- Use of flexibility mechanisms as provided by Directive 2009/28/EC.

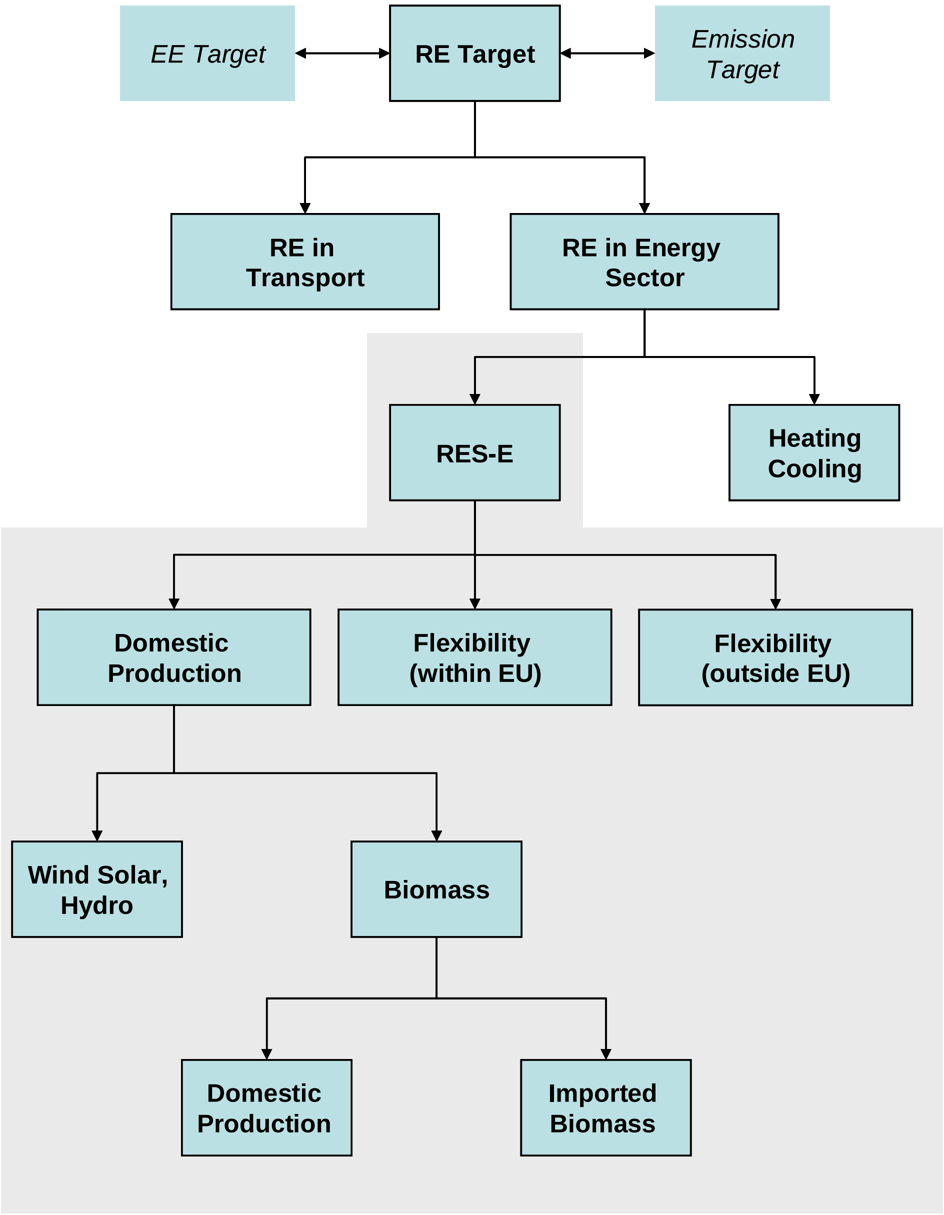


Figure 5-1: Options for RE target compliance

Figure 5-1 summarises the options available to comply with national RES-E targets. The grey-shaded area depicts the focus of the analysis in this study.

The remainder of this chapter is organised as follows: The following sections present and discuss possible domestic options as well as potential flexibility mechanisms. Subsequently their implications concerning regulatory requirements will be derived. The chapter concludes with recommendations for future action.

5.2 Domestic production of RES-E

5.2.1 Detailed description of options

Malta's restricted land area together with the high population density constitutes limits for the possibilities for large-scale RES-E facilities. Currently Malta is evaluating different options for the local development of RES-E projects. The most important are:

- The development of offshore and onshore wind power projects;
- PV systems installations on public and private buildings;
- Waste to energy facilities.

The options could be realized either by private investors, by the Government of Malta (or a designated representative or agency) or by Enemalta. According to information provided by MRA the options will be most probably realised by private investors. In order to attract such investors Malta needs to develop an appropriate legal and commercial framework (e.g. a fixed feed-in tariff or any other RES-E promotion scheme).

5.2.2 Implications for regulation

Regulation mainly needs to address two issues regarding the domestic development of RES-E production: A first important aspect for the development of domestic potentials is the regulation of connection and access to the transmission- and/or distribution grid. A second crucial issue is the design of the renewable electricity market, i.e. how RES-E generation will be remunerated and how the additional cost burden of RES-E development will be procured in Malta.

Grid access

As well as its predecessor, Directive 2009/28/EC distinctively mandates a guaranteed access to the national grids. Therefore the implementation of the directive's requirements into Maltese legislation must include again provisions for priority or guaranteed access of RES-E facilities to the Maltese distribution grid. In addition, the system operator shall be obliged to provide priority to RES-E installations when dispatching electricity. In this regard, Subsidiary Legislation 423.19 already provides the specifications of Directive 2009/28/EC.

RES-E promotion schemes:

For the time being, electricity production from renewable resources is more costly than production from fossil fuels. Notwithstanding the significant technological progress renewable energy technologies have gained over the last decades, investments in RES-E still need additional financial and institutional support in order to be economically viable. Regarding renewable energies, a wide range of instruments may provide the necessary financial and institutional support. Although all of the measures are designed to promote the use of renewable energy sources, policies vary considerably in their design and conception.

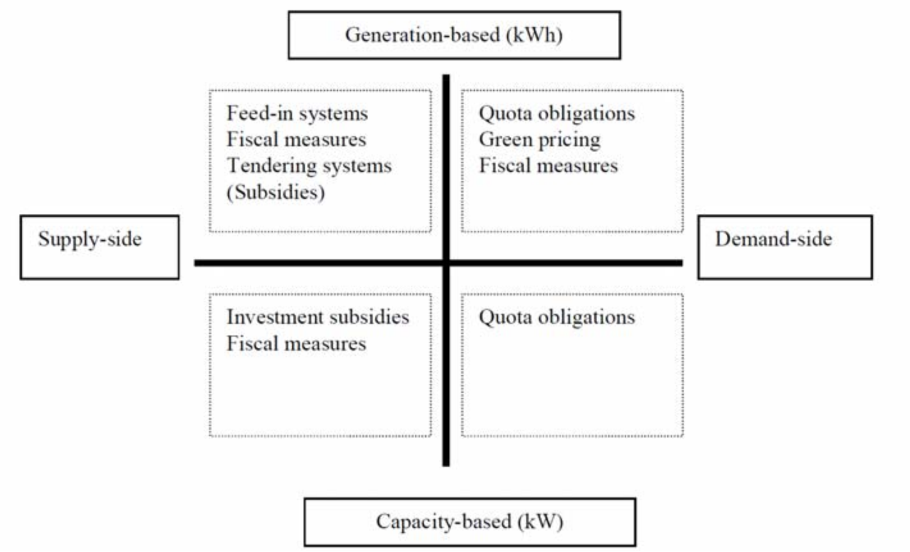


Figure 5-2 : Classification of renewable energy policy support mechanisms

Some of the measures stimulate the supply of renewable electricity, while others directly affect the demand. Furthermore, support schemes can be distinguished according to the supported activity, i.e., either capacity installation is promoted or the generation of green electricity. Figure 5-2 classifies the support schemes regarding the dimension of support.

Recent surveys published by the European Commission show that the so-called market based instruments are the most common promotion measures. Feed-in tariff systems are used in most of the Member States followed by quota obligation systems with tradable green certificates (TGC). In contrast, tender schemes, investment subsidies and fiscal measures only play a minor role.

These instruments usually affect all market parties on the electricity market and should therefore be assessed carefully regarding their market implications. There are various obstacles to the design and implementation of efficient RES-E promotion policies. Obviously, there is imperfect information or uncertainty which can affect the appropriate choice of instruments.

The quota obligation system with tradable green certificates (TGC) make use of decentralised market mechanisms in order to meet overall national (or EU-wide) targets in an efficient way. The system implicitly assigns a scarcity price to the “greenness” of electricity (or green value) as an explicit policy objective. There is no differentiation between alternative renewable energies and the market will sort out which type and quantity of renewable energy will serve most efficiently the policy objective of green electricity. However, green certificates may pose a higher risk for investors and long-term, currently high cost technologies are not easily developed under such schemes. The Maltese RES-E market will probably not provide enough volume to adequately implement a quota obligation system with trade in TGCs. For this reason, the implications of such a system will not be discussed as a purely domestic option. However given the possibility to join support schemes with other Member States, quota systems could play a role also for Malta (see Section 5.3.4).

Assuming an exogenous target such as a minimum share of RES-E, a quota obligation will assure effectiveness whereas a feed-in tariff system would require having perfect information on all technologies, their costs and potentials, price developments on the electricity market, consumer preferences, etc. But feed-in tariffs allow for a differentiated treatment of alternative renewable technologies taking into account other objectives than just the greenness of the electricity system (e.g. security of supply, regional- or industrial policy targets etc.).

In policy practice, feed-in tariff systems stand out for a large discrimination across different RES-E technologies. The consequence is that less efficient more costly technologies such as solar or geothermic energy are much more subsidised than more competitive renewable technologies such as hydro- or wind power. This might be justified when policy pursues also other targets through the development of renewable energies than the mere greening of the electricity production. Nevertheless it should be kept in mind that differentiated feed-in tariff systems create higher excess costs compared to systems with flat (or uniform) tariffs.

Financial administration of feed-in tariff schemes

Feed-in tariff systems usually oblige the operator of the electricity grid (distribution and/or transmission grid) to buy the produced electricity. As already indicated, the cost of RES-E production is usually higher than the cost of conventional thermal electricity production (for a brief discussion of the economic costs of RES-E promotion see also the side note at the end of this section). The most crucial parts of the design of feed-in tariff systems are:

- the determination of the cost of RES-E generation and
- the regulation of how the additional cost is distributed across different parts of the economy.

A feed-in system may be implemented in several ways. The approaches differ in the concept of the tariff, i.e. what types of costs are covered by the tariff, and the re-financing mechanism of the promotional component of the tariff or the system in total. Generally, following concepts may be possible (Figure 5-3 provides an overview on the different options):

1. Feed-in tariff based on RES-E generation costs;
    a. Re-financing of the promotion via electricity prices;
    b. Re-financing of the promotion via state budget;
2. Feed-in tariff based on market price or avoided costs.

In the first case a feed-in tariff is paid by Enemalta to RES-E generators. The tariff is designed to fully cover the total costs of RES-E generation. In other words: Enemalta is obliged to buy all RES-E produced at a fixed (technology-specific) rate. Clearly, this imposes an additional cost burden on the company. A first option is now to allocate the additional costs to the electricity bills of all or parts of Enemalta's customers (Case 1.a).

In this case the price per customer would rise according to the following equation:

$$\tau = \frac{(FiT - p)\cdot x_r}{\bar{x}}$$

Where: τ := per unit cost of RES-E promotion [in €/kWh]
FiT := Feed-in tariff [in €/kWh]
p := Regular electricity price [in €/kWh]
x_r := RES-E fed into the grid [in kWh], and
Error! Objects cannot be created from editing field codes. := Total electricity consumption supplied by Enemalta [in kWh]

The customers would pay the regular electricity price plus the additional price tag τ. The corresponding monetary flows of this system are indicated by orange arrows in Figure 5-3.

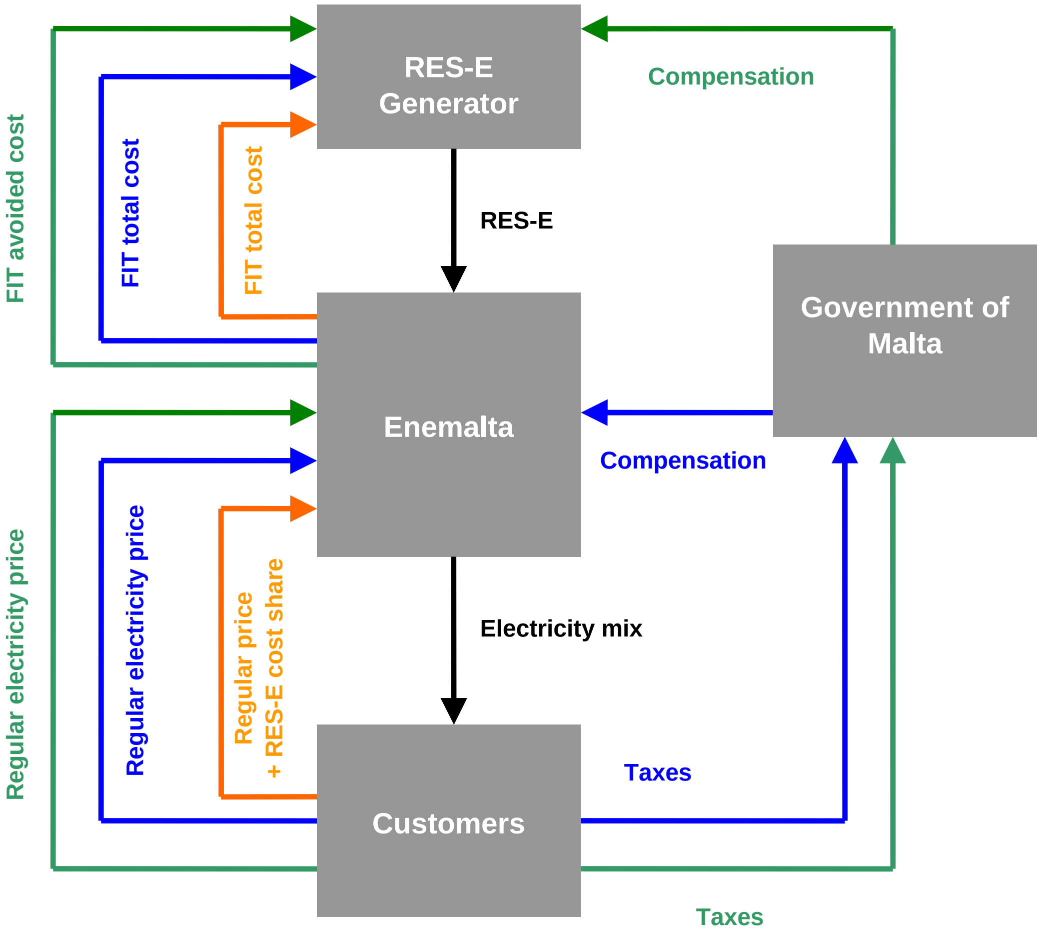


Figure 5-3: Procurement options for domestic RES-E production

A second option leaves the regular electricity price unchanged and involves the Maltese state budget (Case 1.b). Enemalta buys RES-E at the price that covers the full costs of green electricity. In contrast to the previous alternative, Enemalta is not compensated via the electricity price but through a subsidy from the state. With regard to the demand for budget neutrality, Malta would probably need to recover this subsidy via a tax. This could either be a tax on the electricity consumption – in this case the system would be very similar to the previous one – or involve any other types of taxes. Another way to recover the RES-E promotion might be the use of revenues from auctioning emission allowances (see Directive 2009/29/EC and Chapter 6 of this report). In Figure 5-3 monetary flows induced by this alternative are indicated by blue arrows.

The feed-in tariff paid by Enemalta to the RES-E generator does not necessarily have to incorporate a promotional part. In contrast to the system described above, the tariff could only cover parts of the total RES-E generation costs. Enemalta would be obliged to pay a market price for generated electricity, regardless of the fuel type or the technology used for electricity generation. In this regard, RES-E generators would be considered as any other independent power producer (IPP). The only difference is the obliged priority given to RES-E installations when dispatching electricity. In case a liquid wholesale market for electricity exists, e.g. in form of an electricity exchange, the market clearing price could be used as a benchmark or reference price for the green electricity fed into the grid. In case such a price does not exist, the value of power fed into the electricity grid can also be considered equal to the induced savings in the respective power system.

In this regard, the most important savings comprise:

- Saved investment in power plants;
- Saved fuel consumption;
- Saved operating and maintenance cost.

The feed-in tariffs for RES-E can be derived according to the saved or avoided cost principle. Thereby the quantification of such avoided costs depends on several aspects. For instance, supply costs usually depend on the season and the time of day. Supply in peak-load periods is probably more expensive than generation in base-load. However, one of the most important aspects is the determination of the appropriate reference supply option. In other words, the price that Enemalta would be obliged to pay to RES-E generators should be equal the cost savings induced by the substitution of conventionally generated electricity.

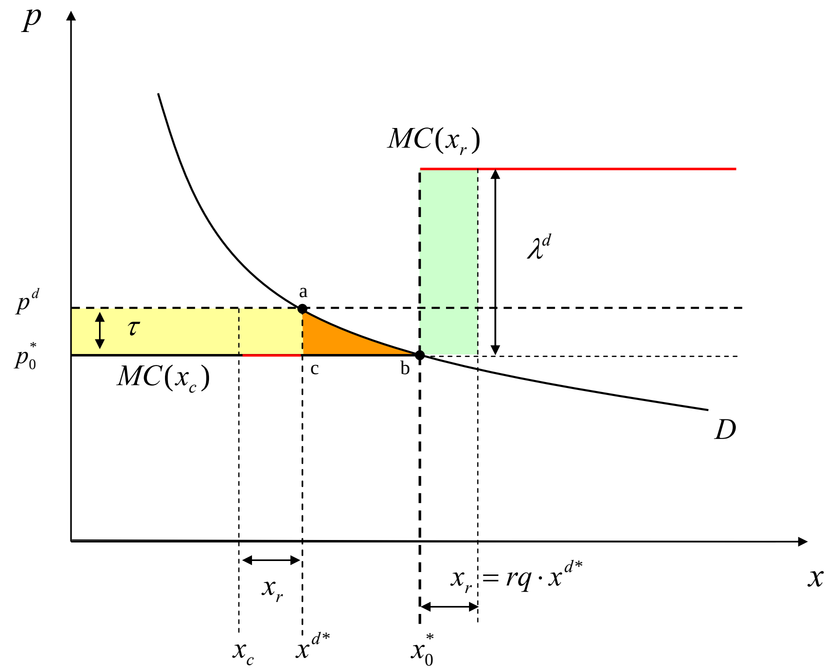
Under the assumption that this approach does not imply an additional cost burden on Enemalta, the Maltese end-user electricity price would not have to be increased. The promotion would again have to be paid from Malta's state budget and be re-financed via taxes. The difference to Case 1.b is that the compensation is directly paid to the RES-E generator.

The decision which of the characterised systems Malta should choose is subject to further analysis. Especially, changes in taxation may lead to significant economy-wide distortions. A detailed impact assessment of the different approaches is needed before a final decision should be taken.

Side note: The economic cost of RES-E promotion

Let a competitive electricity market be determined by the electricity price p and a (nonlinear) demand function $D(p)$. In the following stylised example, two different technologies are available to satisfy the demand: a type of conventional thermal technology c and a type of RES-E technology r. They can be used to supply electricity at activity levels x_c and x_r. Production costs are depicted by the cost function $C(x_c, x_r)$ where marginal costs (MC) of the non-renewable technology c are the lowest followed by r, i.e. $0 \leq MC(x_c) \leq MC(x_r) \leq +\infty$. Initially the RES-E technology is inactive (i.e. $MC(x_r) > p$).

In order to promote the use of renewable energy technologies a central planner now seeks a market allocation that maximises economic surplus (measured as the sum of producer and consumer surplus[53]) subject to a minimum activity level of RES-E technologies such that $x_r \geq r_q \bullet X$ where $X=(x_c+x_r)$. The solution of this optimization problem is a market allocation as presented in the following figure:



In an unconstrained case where no RES-E production is desired, x_0^* units of electricity are sold to the market at a price of p_0^*. In order to stimulate the use of technology r, a (per-unit) subsidy of λ_d is needed such that $MC(x_c)=MC(x_r)-\lambda^d$. This subsidy guarantees the desired activity level $x_r= rq \bullet X$ of the RES-E technology.

In connection with the central planner's optimisation problem described above, λ^d represents the dual value (or shadow price) of the constraint $x_r \geq r_q \bullet X$. λ^d can be interpreted as the price for the greenness of the electricity.

The total level of the subsidy thus amounts to $x_r \bullet \lambda^d$ (the light-green shaded area in the figure above). These so-called direct costs of RES-E promotion need to be re-financed. In the small example a tax τ is imposed on electricity consumption such that the total tax revenue (the yellow shaded area in the figure) exactly equals the additional cost of the RES-E promotion. In this

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[53] Where producer surplus in this example equals profits, i.e. the difference between revenues and apparent costs. Consumer surplus is defined as the monetarised value of utility consumers gain from acquiring a good at a price that is actually below their willingnes to pay.

case customers pay a price p^d for electricity and consume an amount of x^{d*}. Producers of conventional electricity still receive the price p_0*. Renewable generation receives the same price plus the promotional subsidy λ^d.

For the sake of completeness and without further discussion: Compared to an unrestricted electricity market the RES-E regulation leads to a loss of economic welfare (measured as the loss of producer- and consumer surplus) at a magnitude of the shaded area abc in the Figure.

5.3 Use of flexibility mechanisms

5.3.1 Background – relevant legislation

In contrast to the previous legislation of Directive Directives 2001/77/EC and 2003/30/EC the new Directive[54] provides for several concrete mechanisms that allow for flexibility where national RES-E targets can be achieved. Countries with relatively low or expensive renewable energy potentials may (partly) meet their RES-E targets in other European countries or even in regions outside the EU. Countries with abundant low-cost potentials may in turn benefit from “exporting” the greenness of surplus RES-E production. This so-called where-flexibility can significantly reduce the cost of compliance with national and EU-wide RES-E development targets.

However, the introduction of the flexibility mechanisms was extensively discussed during the process of designing the Directive. Prior to the publication of the draft directive, early proposals by the European Commission even suggested a mandatory EU-wide RES-E certificate trading system on basis of guarantees of origin (GO). The proposal foresaw two different flexibility mechanisms:

- Trade of GOs on the Member State level, i.e. Member States themselves engage in trade either with other Member States or with private parties;
- Trade of GOs between private parties.

The proposal introduced the transfer of GOs between Member States as an option, while private GO trade was considered as a mandatory standard for the EU. In this regard the Commission aimed at the installation of a harmonised market for the “greenness” of electricity; an approach that would have led to a system similar to the EU-ETS.

Generally, such a trading system would probably involve private parties and could help to efficiently reach the overall EU targets for the development of renewable energy. But the system would also heavily interfere with national RES-E policies or even foil the existing support mechanisms. In this regard the proposal provided different options that should help to avoid the

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[54] Directive 2009/28/EC

negative effects of different overlapping regulations in the area of RES-E promotion. One of the options for Member States was the possibility to restrict trade if the trading scheme would jeopardise security of supply or the effectiveness of national support policies. The system would even allow Member States to opt-out of the trading system completely. But these trade restrictions would have most probably violated a very basic principle of the European Community Treaty, i.e. the free movement of goods. It is still unclear whether or not potential trade restrictions would have been justified by the European Court of Justice.

In December 2008 – after a period of extensive further discussions and drafting – the European Parliament and the European Council reached a final compromise on the RE directive (Council of the European Union, 2008). Regarding flexibility, this final compromise completely rejects GO trade and replaces it by mechanisms based on the virtual transfer of renewable energy. These are:

- Statistical transfers between Member States;
- Joint projects between Member States;
- Joint projects between Member States and third countries;
- Joint support schemes.

5.3.2 Detailed description of options

Statistical transfers

Member State's Governments can arrange statistical transfers between themselves. In this case excess production of renewable energy (i.e. one country expects to exceed its target) can be virtually sold to another country and be credited against the receiving country's target. Member States can only transfer renewable energy from their country if the transfer will not constrain the Member State in meeting its own target.

Although not explicitly mentioned in the Directive[55], the statistical transfer of renewable electricity between Member States probably will not be free of charge. Member States promote RES-E generation through various national support schemes. As demonstrated earlier, these support schemes lead to excess costs which need to be recovered by the national economy. Whether these costs are distributed across eligible electricity customers or financed via the national budgets plays only a minor role in this regard. A compensation of the additional cost for the national promotion of RES-E is expected to be required from the beneficiary of the statistical transfer. However, for the transferring country, a gratuitous statistical transfer of RES-E would reflect an export of the benefits of costly domestic policies This situation would not only be very unlikely but probably also not very desirable from a distributional perspective.

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[55] Directive 2009/28/EC

Joint projects between Member States

Member States may cooperate on joint RES-E projects. These project-based agreements between two or more Member State governments facilitate the virtual transfer of the renewable energy production of a new RES installation in one country to another country. The produced electricity from this project will thus fully or partly count towards the RES target of another country. Although not explicitly foreseen in the Directive, the mechanism will probably involve financial support for the RES-E project provided by the receiving country.

Joint projects between Member States and third countries

Member States can count renewable electricity from joint projects in non EU countries towards their national RES-E targets. Joint projects between Member States and third countries postulate existing interconnector capacities between the Member State and the country outside the EU[56]. The project can only count towards Community targets if it has not received support from the third country.

Joint support schemes

In the case of joint support schemes, Member States join or coordinate their support schemes and (virtually) split the produced renewable energy for target compliance. This mechanism can result in the most comprehensive cooperation between two or more Member States. The coordination or even combination of two or more schemes would result in extended domestic promotion systems. The implications would rather be those of the mechanisms discussed before (see 5.2.1).

5.3.3 Flexibility and the interconnection Malta - Sicily

Flexibility within the EU

The presented flexibility mechanisms have in common that cross-border transfers of RES-E are purely virtual as long as no RES-E production from outside the EU is involved. In other words: A country may comply with its domestic RES-E targets without producing one unit of electricity from renewable resources on home soil or even without physically importing renewable electricity from abroad.

As a consequence, Malta does not need a physical interconnection of its electricity grid with Sicily or other EU regions to make use of the discussed flexibility mechanisms. Moreover, the mechanisms as provided by the Directive are the only existing possibilities to exploit the benefits of flexibility. The Directive does not account for RES-E imports, or to put it differently: A Member

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[56] An exception for planned but not yet finished interconnectors is made. The construction of the interconnector has to be started by 2016 and needs to become operational by 2022.

State will not be able to comply with its RE targets only by physically importing electricity from another European Member State.

The Directive defines the mandatory RES-E targets as the share of gross final consumption of energy produced from renewable sources in gross final energy consumption of the country (Article 3 and Article 5, Paragraph 1). Notwithstanding this definition indeed could include electricity imports from an energy balance perspective, the Directive clearly excludes this alternative. It states that “gross final consumption of electricity from renewable energy sources shall be calculated as the quantity of electricity produced in a Member State from renewable energy sources” (Article 5, Paragraph 1(a)).

As a consequence, quantities produced abroad are credited against the RES-E targets of the Member State that hosts the RES-E production facility. An interconnection of the Maltese system with Sicily would permit the physical import of electricity but there would still be no dedicated possibility to import the “greenness” from abroad.

The additional import of this greenness is not provided by the Directive. Although, the guarantees of origin issued in the host country could be transferred to Malta (or to any designated representative) the Directive clearly rules out GOs as a measure to comply with the mandatory targets. Against this background the flexibility mechanisms of the Directive are the only possible way to account foreign RES-E production against domestic RES-E targets.

Regarding cross-border trade of RES-E the current EU legislation implies that in order to be eligible physical electricity imports always have to be accompanied by an inter-governmental transfer of the greenness of the electricity, whereas all intra-European flexibility mechanisms can be employed without any accompanying physical electricity transfer.

Flexibility and third countries

Compared to the previous subsection, the situation to realise national RES targets is different when joint projects involve Malta and third countries. The Directive stipulates that the amount of RES-E production can contribute to the compliance of a Member State (and thus the European Community) if the respective amount of electricity is transferred and consumed in the Community. This prerequisite shall safeguard that the RES-E production in third countries indeed substitutes the consumption of conventionally generated electricity within the borders of the Community.

Directive 2009/28/EC does not provide any further obligations where the imported electricity is fed into the European grid. The consistent separation between the commodity (electricity) and the service (the “greenness” of the electricity) is maintained also in case of joint projects with third countries outside the Community. The concept of flexibility remains – this means that it is not necessary to physically consume the electricity produced by RES-E facilities in order to use the respective greenness to comply with national targets. This has several important implications:

- Malta can engage in joint projects carried out in third countries without interconnecting its national grid to mainland Europe. The produced greenness may in parts or in total be calculated against the Maltese RES-E targets;
- Malta needs to find a customer for the imported electricity within the borders of the European Union.

5.3.4 Impacts on regulation

The provisions of Directive 2009/28/EC regarding the use of flexibility mechanisms do not impose a binding mandate on Member State's legislations. The Directive leaves it to the Member States whether to use the mechanisms or not.

Although some of the mechanisms may involve the participation of private operators the flexibility mechanisms will be designed, negotiated and probably also implemented on the Member State level. As (theoretically) described in the side note at the end of this section the use of flexibility may significantly reduce the cost of compliance with the Maltese RES-E targets. But the possibility to use these mechanisms has some specific implications for Malta.

Malta's renewable energy policy – especially the design of RES-E promotion schemes – can incorporate flexibility mechanisms from the beginning on. Many other Member States introduced market-based promotion systems long before an EU-wide flexibility has been discussed. The interference with existing policy mechanisms in the Member States was one of the reasons why flexibility is now only an option and not a mandatory measure for the harmonisation of European support systems. Malta is currently designing its renewable energy policy and no market-based instruments exist with which flexibility might interfere. Therefore Maltese regulation should carefully evaluate potentials and costs of importing RES-E versus domestic RES-E development.

Another highly relevant aspect is the importance of benefits that Malta assigns to other policy goals than just the greening of electricity generation. As an extreme example Malta could probably reach its national RE development target only through the use of flexibility mechanisms. Probably the compliance costs would be significantly lower as in the case where RES-E is generated in Malta. Nevertheless, domestic RES-E development contributes to security of supply or the independence from volatile fuel prices or regional and/or industrial development. Virtual RES-E imports would not contribute to any of these targets. Malta would achieve its RE goal probably at lowest cost but would rarely generate any local benefit.

The most important implications may originate in the re-financing of the flexibility mechanisms. Although, the mechanisms may not lead to any additional unit of electricity produced in Malta (or physically imported) the cost of importing the greenness will have to be covered within Malta.

Under the assumption that flexibility mechanisms lead to additional costs, their application requires distribution of these costs across different parts of the Maltese economy. The difference to the domestic development of RES-E potentials lies in the role of Enemalta. In most of the cases Enemalta cannot directly be obliged to bear the accruing compliance costs. Trade in "greenness" (e.g., via GOs) between Member States and private actors, i.e. Enemalta or RES project operators, is explicitly ruled out. The flexibility is administered on the state level; hence a direct effect on the electricity market is not foreseen. Enemalta could only serve as an intermediate for collecting respective taxes. There are only two exemptions:

- Malta could coordinate its future RES-E support scheme with one or more Member States. In this case, a harmonised support scheme would be anticipated. One of the different cost recovery options as described in Section 5.2.2 would be applicable, depending on the scheme applied in the "joint" country. In this case Enemalta could be obliged to pay feed-in tariffs or to comply with a quota obligation in the country where the greenness is generated[57]. This would have to be accomplished according to the amount of energy required to reach the national target.

- If Malta decides to auction emission allowances to Enemalta, the additional costs could also be recovered through the revenues of the auction. In this case revenues would be distributed to RES-E generation (again, see Directive 2009/29/EC and Chapter 6).

However, it has to be borne in mind that the accomplishment of the national RES target lies fully within the responsibility of the Government. It is thus the responsibility of the Government of Malta to collect the compensation cost to reach the national RES target from the electricity customers. For the sake of facilitation of procedures, the Government of Malta may request Enemalta to execute the service of collection in line with the payment of electricity bills.

In any other case, the additional costs resulting from any of the mechanisms would imply the need to be recovered via the state budget – and thus most probably the fiscal system – of Malta. In this regard, Malta has the same options as described in Section 5.2.2. An additional tax could be imposed on the electricity consumption. The approach would lead to a situation similar to a feed-in regulation.

Side note continued: The cost savings from flexibility – imported greenness

This continued side note considers again the stylised electricity market presented before. It is now assumed that the mechanisms may be employed in order to facilitate flexibility. In contrast to the purely domestic achievement of the RES-E targets it is now possible to "import" greenness from abroad. Clearly the import is beneficial only if the import costs are lower than the domestic production costs.

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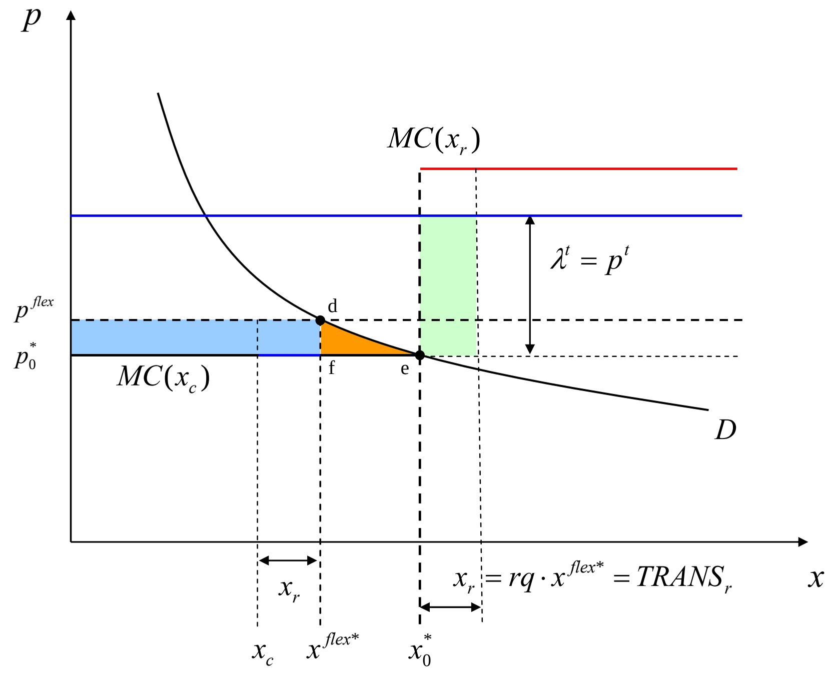
[57] This strongly depends on the promotion scheme of RES in the host country of "greenness" generation in this context.



It shall now be possible to trade and respectively import the "greenness" at a price p^t from another Member State. The import price is lower than the marginal cost of the domestic RES-E technology r, i.e. $p^t < MC(x_r)$. The mandatory domestic RES-E quota will now not be reached by domestic RES-E production but by importing the necessary amount of greenness. The resulting costs for reaching an import level x_r are $x_r \cdot p^{t}$[58]. Clearly, the direct compliance costs are lower than in the previous case where the more expensive domestic RES-E potentials need to be used.

Again a tax τ may be imposed on electricity consumption in order to re-finance the imports. Total tax revenue[59] exactly equals the additional cost of employing the flexibility mechanism. In this case customers pay a price p^{flex} for electricity and consume an amount of $x^{flex}*$. Producers of conventional electricity still receive the price p_0*.

As can easily be seen, the electricity price is lower compared to the situation without flexibility. Demand declines from x_0* to $x^{flex}*$ but is higher as in the case where flexibility is not possible. Welfare losses of RES-E promotion amount to the orange shaded area defined. Not surprisingly, the additional flexibility reduces welfare costs of reaching the RES-E target.

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[58] Represented by the light green shaded area in the figure above.
[59] Represented by the light blue shaded area in the figure above.

5.4 Conclusions and recommendations

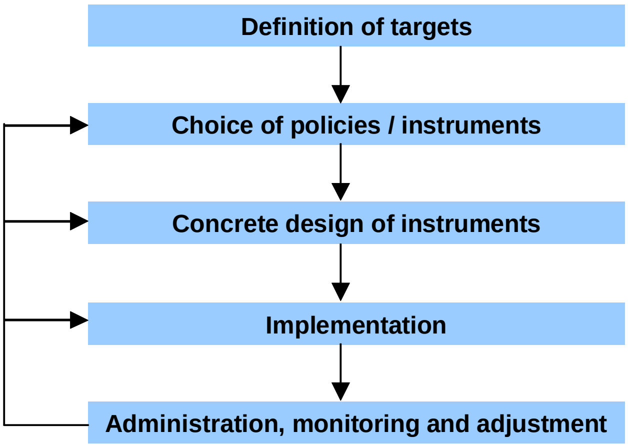

Figure 5-4: Steps in RES-E policy making

The starting point for renewable energy policy making is usually the definition of targets, e.g. in terms of minimum shares in a country's electricity production respectively consumption (see Figure 5-4). Once targets have been defined the choice of appropriate policy instruments should foster their achievement. The design of these instruments demands for a detailed analysis of different options and their economic effects (e.g. the associated costs).

This chapter addressed the main options for Malta to comply with its renewable energy development targets. In this regard Malta can (a) promote investments in domestic RES-E generation, (b) make use of the flexibility mechanisms provided in Directive 2009/28/EC or (c) employ a mixture of both approaches.

The options discussed in this study may differ significantly in the overall magnitude of costs. Furthermore the design of promotion schemes as well as their commercial and financial impacts can significantly influence the impact on Malta's economy.

Which of the described options Malta should chose must depend on a detailed and comprehensive quantitative analysis of different options. The analysis should not only cover production costs of domestic RES-E generation prospects but also potential costs for importing "greenness" via the flexibility mechanisms. The distribution of the cost burden across different actors of the Maltese economy is a crucial issue in this regard.

The development of a comprehensive strategy incorporating all aspects of target compliance is essential for the success of renewable energy development in Malta. This strategy is also of great help regarding the drafting of the Maltese national renewable energy action plan.

6 Outlook regarding EU Policy Development

6.1 Background

The development of energy policy on the Community level will be determined by two main trends:

- Global climate policy and its impacts on European energy and environmental policy;
- The creation of an internal market for energy in the European Community.

Both of the issues have led to significant changes in the institutional framework of electricity sectors across Europe. Over the last two years, European legislation regarding both of the policy areas has undergone major revisions. In April and June 2009, the European Council adopted the energy and climate change package and the internal energy market package (also referred to as third liberalisation package) respectively. The two packages set the framework for European energy sector development over the next years. This chapter briefly introduces some relevant implications of these revisions.

6.2 Energy and climate change package

6.2.1 General concept

The EU Climate and Energy Package was presented in January 2008. The essential parts of the Package are the so-called 20-20-20 targets. The Package tackles emission reduction, renewable energy development and energy efficiency improvements. Precisely, until 2020

- the share of renewable energy consumption in gross final energy consumption of the EU shall amount to at least 20%;
- energy efficiency shall increase by 20%;
- CO_2 emissions shall be reduced by 20% vis-à-vis their 1990 level.

By the end of 2008, several directives were drafted which determines the future development of European energy sectors to a large extent.

The main implications of the European renewable energy targets for Malta have already been addressed in Chapter 5 of this report. This subsection will thus only focus on the CO_2 emission target (especially the development of the EU-ETS) and the energy efficiency goals.

6.2.2 The development of the EU-ETS

A key element of the Package is the development of the European Union Emission Trading System (EU-ETS). The total annual emissions of sectors inside the EU-ETS (the so-called „cap“) shall be gradually reduced by 1.74% from 2013 onwards (based on the average emissions from 2008 to 2012) in order to arrive at a total emission reduction of 21% vis-à-vis emissions in 2005. Up to 50% of emission reductions may be reached trough project-based measures outside the EU via the Clean Development Mechanism (CDM).

Central novelties in the organisation of the EU-ETS address the allocation of emission allowances, the sectors covered by the Directive and the covered pollutants. Besides CO_2 also NO_X and PFCs shall be included. From 2013 on, the ETS shall also cover aluminum industry, chemical industry, parts of the mineral processing sector and the aviation sector. The allocation of emissions via National Allocation Plans (NAP) will be replaced by Community-wide regulations.

From 2013 on industry sectors have to purchase 20% of their needed certificates by auction. This share will gradually be increased to 70% until 2020. In 2013 the aviation sector gets 85% of its certificates allocated for free (Directive 2008/101/EC). Also this share will be reduced over the years.

The auctioning of certificates takes place on the Member State level. Each Member State will have the right to auction a certain amount of certificates and to collect the according revenues. In turn Member States have to use at least 50 % of the revenues for measures related to climate protection, e.g. the mitigation of emissions in sectors outside the ETS, the promotion of renewable energy development, re-forestation, the financing of R&D measures or the administration of the ETS.

Electricity producers are obliged to buy all their needed certificates from 2013 on. Combined heat and power production facilities are exempted as their heat capacity shall be promoted by free allocation of allowances (European Parliament 2008a, 10a(4)).

Certain Member States may continue to freely allocate emission rights to their electricity sectors for a prolonged transition period. Generally this is possible if one of the following premises exist:

- In 2007 the national electricity grid was not directly or indirectly connected to the interconnected UCTE system;
- In 2007 the national electricity grid was directly or indirectly connected to the UCTE system through a single line with less than 400MW capacity;

- In 2006 more than 30 % of electricity generation was based on one single fossil fuel type and the GDP per capita did not exceed 50 % of the average GDP per capita in the Community.

Member States need to apply for this derogation and are subject to specific reporting duties. In addition, the amount of freely allocated emission rights must be less than 70 % of the average emissions in the years 2005-2007. Until 2020 all certificates need to be bought by auction. The amount of freely allocated certificates must be gradually reduced (in steps of 10 percentage points per annum). In the year 2020 no free allocation shall be allowed.

Utilities have interpreted grandfathered emission allowances as opportunity costs and have added a price tag on the electricity price. The market value of freely allocated certificates has been recovered via the electricity market. This behaviour has led to so-called windfall profits for the utilities. Moreover incentives for investment in cleaner technologies are not always provided by the current design of the EU-ETS. Auctioning of certificates should help to ameliorate the ETS. Windfall profits will be eliminated since the acquisition of emission allowances will lead to actual expenses.

6.2.3 Immediate auctioning vs. prolonged transition in Malta

The first two prerequisites for the derogation would clearly apply to Malta. Nevertheless, whether or not Malta should opt for this derogation needs to be carefully assessed. The way certificates are allocated to Enemalta might have a significant impact on the electricity prices and/or Enemalta's profits as well as on the Maltese regulation.

Free allocation of emission allowances demands for well informed regulation. Information on the baseline development is of great importance in this regard. Concerning the Maltese electricity sector, the baseline (or „business-as-usual“) describes the development of electricity supply and consumption without any further politically administrated interference. Misjudging the baseline development might either lead to ineffective policy measures or undesired over-subsidisation and the creation of windfall profits. Especially the latter can have significant consequences on the electricity sector.

Several potential future developments of the Maltese electricity sector are possible. The most relevant issues are:

- Capacity, utilisation and time frame of the planned interconnection of the Maltese electricity grid with Sicily;
- Development of electricity generation facilities in Malta (technologies and fuel inputs).

A situation where Enemalta would only gradually have to pay for its emission allowances and imports a large share of electricity over an interconnector could lead to an excess supply of certificates. A small (stylised) example shall clarify the relevance of the baseline development:

Certificates would be allocated based on past emissions in the years 2005-2007. In these years, average emissions from fuel combustion in Malta ranged between 0.85 tCO_2/MWh and 0.90 tCO_2/MWh. Assumed average emissions of 0.875 tCO_2/MWh and assumed average electricity generation of 2.5 TWh would lead to roughly 2.2 mio. tonnes of CO_2. If this figure would be used as the base for free allocations of allowances, and the maximum allowable amount of 70 % would be allocated, Enemalta would receive allowances for roughly 1.5 mio. tonnes of CO_2 for free. For the trading period after 2013 the EU assumed CO_2 certificate prices in a range of 35-40 EUR/tCO_2. Under this assumption the allocated certificates would translate into a market value of approximately 52-60 million € in the first year. Import of electricity over the interconnector would now substitute domestic generation. Enemalta would only need to hold emissions for domestic generation. A substitution of domestic generation by imports over the interconnector would lead to a situation where Enemalta could sell surplus certificates on the international market. The modernisation of the Maltese electricity generation facilities would probably even increase the amount of certificates Enemalta may sell to the market.

Generally, these mechanisms are intended by the EU-ETS. The interconnection and modernisation of capacities are adequate measures to reduce Malta's emissions and to comply with its reduction target. Nevertheless, the revenues from certificate trading shall facilitate additional investments in emission abatement – if the investments would be realised anyway, i.e. without any additional policy measure, the revenues would be windfall gains which would most probably lead to significant market distortions.

Another issue may emerge from the way Enemalta calculates the electricity tariffs. If the tariffs may include opportunity costs, windfall profits are possible and probable as well. If Enemalta has recovered the opportunity costs in the previous/current trading periods, a switch to an auctioning of certificates would probably not lead to an excessive increase in electricity prices. The auctioning would only transfer parts of Enemalta's profits to the Government of Malta. If certificates have not been included in the tariffs, auctioning will indeed lead to higher prices.

The crucial questions in this context address the baseline development:

- Is the availability of the interconnection part of Malta's baseline development and if so, what will be the average utilization of the line?
- What will be the baseline of Maltese generation capacity development, which technologies and which fuels will be used?
- Has Enemalta been allowed to recover opportunity costs via the electricity tariff and will this situation prevail in the future?

The decision whether or not to apply for derogation from a full auctioning in 2013 depends to a large extent on the answers to the above questions and must be subject to further, more comprehensive analysis.

6.2.4 Energy efficiency

The Community decided to increase energy efficiency by 20% until 2020. This target was already adopted by the European Council in March 2007 and reflects the potentials for energy savings mentioned in the 2005 green paper on energy efficiency[60]. According to these proposals, mainly the efficiency of transportation, electric devices and buildings shall be increased. Since 2006, Directive 2006/32/EG regulates energy end-use efficiency and energy services and mandates specific energy efficiency improvements.

It is still unclear which mechanisms shall target at efficiency improvements in the Community. Presently several measures are being discussed at EU level (see Communication from the Commission COM(2008) 772). The most important measures are:

- Increasing energy efficiency in the buildings sector (especially simplifying Directive 2002/91/EC on the energy performance of buildings);
- Increasing the energy efficiency of products (see especially the proposal on a directive establishing a framework for the setting of ecodesign requirements for energy related products - SEC(2008) 2115 and SEC(2008) 2116);
- Reinforcement of the existing Directive 2004/8/EC on co-generation;
- Establishment of a comprehensive financing framework for energy efficiency improvement measures (e.g. via EIB or EBRD).

The development of energy efficiency, energy savings and, thus, energy consumption in Malta influences several other areas of environmental and energy policy, such as the development of renewable energies and the mitigation of energy related emissions. These interactions place emphasis on the need for a comprehensive approach of policy analysis when concrete measures shall be designed and implemented. Isolated actions may lead to substantial excess cost or even foil the policy impact.

6.3 Internal Market for Electricity

The designated goal of the European Union is the creation of a single internal market for electricity. In order to foster the integration of European Markets several existing directives and regulations have been updated in 2009. The updates – referred to as the internal energy market package – are:

- A Regulation establishing the EU Agency for the cooperation of National Energy Regulators;

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[60] COM(2005) 265

- An Electricity Directive replacing the existing Electricity Directive 2003/54/EC;
- A Gas Directive replacing the existing Gas Directive 2003/55/EC;
- An Electricity Regulation replacing the existing Electricity Regulation 1228/03;
- A Gas Regulation replacing the existing Gas Regulation

Especially, the ongoing segregation of the European electricity grid due to the scarcity of interconnections between Member State's grids is seen as one of the most important obstacles to the convergence of EU markets. In January 2007 the Competition Commissioner Neelie Kroes introduced the "Energy Sector Inquiry" of the European Commission. In her speech she stated: "[…] there is an absence of cross-border integration and cross-border competition. Incumbents largely keep to their traditional markets, and rarely enter other national markets as large scale competitors. The report reveals that the energy prices for commercial users vary significantly from Member State to Member State. These differences are not eroded through import competition. One of the reasons is that incumbents stick to their home markets".

Even if interconnections exist, the long-term contractual relationships usually hamper a liquid and efficient integration of separated market segments. In this regard many national competition and regulatory authorities argue for more efficient auctioning systems and increased interconnector capacities. If economic and financial incentives are not sufficient to trigger investments in interconnection capacities some authorities even argue for mandated investment obligations on the Member State and Community levels.

All of the discussed measures are targeting at increased competition on European energy markets. Under these circumstances it seems likely that the interconnection between Malta and Sicily will affects Malta's derogation from essential parts of the internal electricity market directive (2009/72/EC). In other words: the next updated internal market directive will probably no longer include a derogation for Malta.

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ANNEX A: Inventory of Received Documents

Files related to the Terna study "Feasibility on Electrical Interconnection between Italy and Malta"

Title of Document	Contents	Size	Author	Type of Study	Type of File	Name of Electronic File
Technical Options for Cable	Electric values of different AC cables (R, L, C, X)	1 page	CESI	Network calculation	xls	Parametri cavi.xls
Annex A - Dynamic Data and Models	Data and models for the dynamic model analysis	13 pages	CESI	Network calculation	doc	Annex A Dynamic data.doc
Annex B Glossary of terms UCTE Operation Handbook	Glossary of terms of the UCTE Operation Handbook	12 pages	CESI	Utility operation	doc	Annex B Glossary of terms.doc
Presentation of the Detailed Network Analysis	Pdf-Powerpoint presentation of the Dynamic network Analysis	44 pages	CESI	Network calculation	pdf	Detailed study (dyn).pdf
Presentation Detailed Network Analysis	Pdf Powerpoint presentation of the Dynamic network Analysis	38 foils	CESI	Network calculation	ppt	Detailed study (dyn) v00.ppt
Presentation Interconnection UCTE - Malta	Requirements of the UCTE Operation Handbook that Malta has to respect in case of interconnection	27 pages	CESI	Utility operation	pdf	Interconnection UCTE - Malta.pdf
Presentation Interconnection UCTE - Malta	Powerpoint presentation of the Dynamic network Analysis	26 foils	CESI	Utility operation	ppt	UCTE v00.ppt
Economic impact on the Maltese power system operational cost deriving from the realization of a new electrical interconnection between Malta and Italy	Economic study of the electrical interconnection between Malta and Italy	79 pages	CESI	Economic study	doc	IT_MT_DRAFT_Report.doc
Analysis of static and dynamic behaviour of the interconnected system Malta-Sicily-Mainland. Definition of technical conditions for the synchronous operating of Malta with the UCTE network.	For the AC interconnection: load flow and dynamic study, Conditions for connection with the UCTE network	126 pages	CESI	Network calculation	doc	ITALIA-MALTA 4.8.doc
Cost Calculation	Malta load data 2015, Wind Diesel, Oil data,	3 sheets	CESI?	Generation analysis	xls	MALTA_2015_EUA30_RESULTS-20090114.xls
Cost Calculation	Generation data 2030	5 sheets	CESI?	Generation analysis	xls	MALTA_2030_EUA30_RESULTS-20090114.xls
Utilisation Factors	Utilisation data 2015 / 2030	1 sheet	CESI?	Generation analysis	xls	MALTA_UTILISATION_FACTORS_20090115.xls
Utilisation Factors	Utilisation data 2015 / 2030	1 sheet	CESI?		xls	MT_UTILISATION_FACTORS.xls
Introduction	Introduction by Enemalta to the Italy - Malta Interconnection Project	6 pages	Enemalta	Project management	tif	Introduction Interconnection Malta-Sicily.tif
Authorisation procedures	Authorisation procedures for transmision line projects	7 pages	Enemalta	Project management	tif	Authorisation procedures.tif
Project Description Statement - Landing Point	Project Description Statement for EIA, possible landing point, technical lay-out	30 pages	Enemalta	Project management	tif	PDS.tif
MT-IT Cable Route	Cable Route and profile in colour	1 page	Enemalta?	Survey	pdf	MT-IT Cable Route 300307.xls
Studies on the" Italy- Malta" Submarine Cable Link the AC Option	Power Point presentation of the Technical Analysis of the AC option	43 pages	SAPIENZA	Network calculation	pdf	Technical analysis AC.pdf
Special Electrical Studies for Feasibility Study	Steady state power transfer capability of submarine AC cable interconnection Malta Sicily	129 pages	SAPIENZA	Network calculation	pdf	Technological solutions Italia Malta1.pdf
Technical studies: AC solution	Survey of Existing Submarine Cables	48 pages	SAPIENZA	Network calculation	pdf	Technological solutions annex.pdf
Table of Contents of Terna Study	Introduction, Network Studies, AC, DC, Technology and Investment Capex, Economics and Financial Aspects, Legal and Regulatory Aspects, Authorisation Procedure, Environmental Desktop Studies, Routing, Site Visits	1 page	Terna		tif	contents_TOC_Terna Study.tif
Cover Sheet	Cover Sheet of Draft Feasibility on new interconnection Italy-MALTA 15 May 2009	1 page	Terna		pdf	Feasibility Study on new interconnection Italy-MALTA DRAFT 1.pdf
Valutazione Ambientale del Piano di Sviluppo	Report in Italian on Environment in Sicily	47 pages	Terna		tif	Environmental assessement.tif

Files related to the Terna study "Feasibility on Electrical Interconnection between Italy and Malta"

LAHMEYER INTERNATIONAL

Title of Document	Contents	Size	Author	Type of Study	Type of File	Name of Electronic File
Legal Regulatory aspects	Legal and regulatory aspects of electricity sector in Italy	22 pages	Terna	Economic / Institutional studies	tif	Legal Regulatory aspects.tif
Technical specification for a preliminary marine route survey	Technical specification for a preliminary marine route survey between Italy and Sicily	21 pages	Terna	Survey	tif	Technical specification for a preliminary marine route.tif
Presentation Economics: Fee Calculation & Cost-Benefit-Analysis	Powerpoint presentation of Fee Calculation & Cost-Benefit-Analysis	45 foils	Terna	Economic study	ppt	Economics & fee2.ppt
Italian Authorization Procedure for Transmission Lines	Powerpoint presentation required procedure for construction of transmission lines in Italy	13 foils	Terna	Project management	ppt	Italian_Authorisation.ppt
Report Static analysis Italia Malta DC	Load flow calculation of DC interconnection with 400 Mw and 300 MW monopolar DC	31 pages	Terna	Network calculation	doc	Report Static analysis Italia Malta DC.doc
Report Static analysis Italia Malta DC	Load flow calculation of DC interconnection with 400 Mw and 300 MW monopolar DC	31 pages	Terna	Network calculation	pdf	Report Static analysis Italia Malta DC.pdf
Status of progress advancement	Status of the AC interconnection with received results	23 pages	Terna	Project management	ppt	Stato avanzamento progetto.ppt
Rapporto ambientale PdS2008 Sicilia	Environmental Report for Sicily in Italian	48 pages	Terna	Environmental studies	pdf	Rapporto ambientale PdS2008 Sicilia.pdf
Technical options description and comparisons, Electrical Design Studies	Powerpoint presentation of Project &Technical studies: AC solution	8 pages	Terna	Network calculation	pdf	Technical options.pdf
Presentation DC static network study	Powerpoint presentation of load flow for Malta and Sicily of DC interconnection (?132 kV and 220 kV AC?)	32 foils	Terna	Network calculation	ppt	DC static network studies.ppt
Capacity duration curve cable	2 capacity duration curves and fuel prices in Italy in 2015	3 pages	Terna	Economic study	xls	Capacity duration curve cable.xls
Network model & technical studies: AC solution	Powerpoint Presentation of Network Study & Technical Studies: AC solution	45 foils	Terna/CESI	Network calculation	ppt	AC static network studies.ppt
Presentation Fuel & electricity prices, market simulations	Powerpoint Presentation of Fuel & electricity prices, market simulations	24 foils	Terna/CESI	Economic study	ppt	Fuel & electricity prices, market simulations 1.ppt
Optimal Power Calculation - Cable Capacity	Calculation of optimum capacity of the interconnection cable, Malta generation mix	3 sheets	Terna?	Network calculation	xls	Cable capacity5.doc
CAPEX Summary	Estimates of investment cost and losses for different AC and DC options	1 page	Terna?	Economic/network study	pdf	Capex summary.pdf
Titles / Legal and Regulatory Aspects	File could not be opened	? Pages	Terna?		doc	Titles.doc

ANNEX B: List of Received Documents

Files related to the Terna study "Feasibility on Electrical Interconnection between Italy and Malta"

LAHMEYER INTERNATIONAL

No.	Title of Document	Contents	Size	Author	Type of Study	Type of File	Name of Electronic File
C 1	Analysis of static and dynamic behaviour of the interconnected system Malta-Sicily-Mainland. Definition of technical conditions for the synchronous operating of Malta with the UCTE network.	For the AC interconnection: load flow and dynamic study, Conditions for connection with the UCTE network	126 pages	CESI	Network calculation	doc	ITALIA-MALTA 4.8.doc
C1A	Annex A - Dynamic Data and Models	Data and models for the dynamic model analysis	13 pages	CESI	Network calculation	doc	Annex A Dynamic data.doc
C1B	Annex B Glossary of terms UCTE Operation Handbook	Glossary of terms of the UCTE Operation Handbook	12 pages	CESI	Utility operation	doc	Annex B Glossary of terms.doc
C1-1	Presentation of the Detailed Network Analysis	Pdf-Powerpoint presentation of the Dynamic network Analysis	44 pages	CESI	Network calculation	pdf	Detailed study (dyn).pdf
C1-2	Presentation Detailed Network Analysis	Powerpoint presentation of the Dynamic network Analysis	38 foils	CESI	Network calculation	ppt	Detailed study (dyn) v00.ppt
C 2-1	Presentation Interconnection UCTE - Malta	Requirements of the UCTE Operation Handbook Malta has to respect in case of interconnection	27 pages	CESI	Utility operation	pdf	Interconnection UCTE - Malta.pdf
C 2-2	Presentation Interconnection UCTE - Malta	Powerpoint presentation of the UCTE requirements for power pool operation	26 foils	CESI	Utility operation	ppt	UCTE v00.ppt
C 3	Economic impact on the Maltese power system operational cost deriving from the realization of a new electrical interconnection between Malta and Italy	Economic study of the electrical interconnection between Malta and Italy	79 pages	CESI	Economic study	doc	IT_MT_DRAFT_Report.doc
C 4	Technical Options for Cable	Electric values of different AC cables (R, L, C, X)	1 page	CESI	Network calculation	xls	Parametri cavi.xls
C 5-1	Cost Calculation	Malta load data 2015, Wind Diesel, Oil data,	3 sheets	CESI?	Generation analysis	xls	MALTA_2015_EUA30_RESULTS-20090114.xls
C 5-2	Cost Calculation	Generation data 2030	5 sheets	CESI?	Generation analysis	xls	MALTA_2030_EUA30_RESULTS-20090114.xls
C 6-1	Utilisation Factors	Utilisation data 2015 / 2030	1 sheet	CESI?	Generation analysis	xls	MALTA_UTILISATION_FACTORS_20090115.xls
C 6-2	Utilisation Factors	Utilisation data 2015 / 2030	1 sheet	CESI?		xls	MT_UTILISATION_FACTORS.xls
E 1	Introduction	Introduction by Enemalta to the Italy - Malta Interconnection Project	6 pages	Enemalta	Project management	tif	Introduction Interconnection Malta-Sicily.tif
E 2	Authorisation procedures	Authorisation procedures for transmision line projects	7 pages	Enemalta	Project management	tif	Authorisation procedures.tif
E 3	Project Description Statement - Landing Point	Project Description Statement for EIA, possible landing point, technical lay-out	30 pages	Enemalta	Project management	tif	PDS.tif
E 4	MT-IT Cable Route	Cable Route and profile in colour	1 page	Enemalta?	Survey	pdf	MT-IT Cable Route 300307.xls
S 1	Special Electrical Studies for Feasibility Study	Steady state power transfer capability of submarine AC cable interconnection Malta Sicily	129 pages	SAPIENZA	Network calculation	pdf	Technological solutions Italia Malta1.pdf
S 1-A	Technical studies: AC solution, Annex 1	Survey and presentation of 20 existing AC submarine cables	48 pages	SAPIENZA	Network calculation	pdf	Technological solutions annex.pdf
S 2	Studies on the" Italy- Malta" Submarine Cable Link the AC Option	Power Point presentation of the Technical Analysis o the AC option	43 pages	SAPIENZA	Network calculation	pdf	Technical analysis AC.pdf
T 0	Cover Sheet	Cover Sheet of Draft Feasibility on new interconnection Italy-MALTA 15 May 2009	1 page	Terna		pdf	Feasibility Study on new interconnection Italy-MALTA DRAFT 1.pdf
T 00	Table of Contents of Terna Study	Introduction, Network Studies, AC, DC, Technology and Investment Capex, Economics and Financial Aspects, Legal and Regulatory Aspects, Authorisation Procedure, Environmental Desktop Studies, Routing, Site Visits	1 page	Terna		tif	contents_TOC_Terna Study.tif
T 1	Network model & technical studies: AC solution	Powerpoint Presentation of Network Study & Technical Studies: AC solution	45 foils	Terna / CESI	Network calculation	ppt	AC static network studies.ppt
T 2	Technical options description and comparisons, Electrical Design Studies	Powerpoint presentation of Project &Technical studies: AC solution	8 pages	Terna	Network calculation	pdf	Technical options.pdf
T 3-1	Report Static analysis Italia Malta DC	Load flow calculation of DC interconnection with 400 Mw and 300 MW monopolar DC	31 pages	Terna	Network calculation	doc	Report Static analysis Italia Malta DC.doc

Files related to the Terna study "Feasibility on Electrical Interconnection between Italy and Malta"

LAHMEYER INTERNATIONAL

No.	Title of Document	Contents	Size	Author	Type of Study	Type of File	Name of Electronic File
T 3-2	Report Static analysis Italia Malta DC	Load flow calculation of DC interconnection with 400 Mw and 300 MW monopolar DC	31 pages	Terna	Network calculation	pdf	Report Static analysis Italia Malta DC.pdf
T 4	Optimal Power Calculation - Cable Capacity	Calculation of optimum capacity of the interconnection cable, Malta generation mix	3 sheets	Terna?	Network calculation	xls	Cable capacity5.doc
T 5	Presentation DC static network study	Powerpoint presentation of load flow for Malta and Sicily of DC interconnection (?132 kV and 220 kV AC?)	32 foils	Terna	Network calculation	ppt	DC static network studies.ppt
T 6	CAPEX Summary	Estimates of investment cost and losses for different AC and DC options	1 page	Terna?	Economic/network study	pdf	Capex summary.pdf
T 7	Presentation Economics: Fee Calculation & Cost-Benefit-Analysis	Powerpoint presentation of Fee Calculation & Cost-Benefit-Analysis	45 foils	Terna	Economic study	ppt	Economics & fee2.ppt
T 8	Presentation Fuel & electricity prices, market simulations	Powerpoint Presentation of Fuel & electricity prices, market simulations	24 foils	Terna / CESI	Economic study	ppt	Fuel & electricity prices, market simulations 1.ppt
T 9	Capacity duration curve cable	2 capacity duration curves and fuel prices in Italy in 2015	3 pages	Terna	Economic study	xls	Capacity duration curve cable.xls
T 10	Titles / Legal and Regulatory Aspects	Title separation sheets ofFeasibility Study, legal and regulatory aspects in italy	34 Pages	Terna / Enemalta	Economic / Institutional studies	doc	Titles.doc
T 11	Legal Regulatory aspects	Legal and regulatory aspects of electricity sector in Italy	22 pages	Terna	Economic / Institutional studies	tif	Legal Regulatory aspects.tif
T 12	Italian Authorization Procedure for Transmission Lines	Powerpoint presentation required procedure for construction of transmission lines in Italy	13 foils	Terna	Project management	ppt	Italian_Authorisation.ppt
T 13	Rapporto ambientale PdS2008 Sicilia	Environmental Report for Sicily in Italian	48 pages	Terna	Environmental studies	pdf	Rapporto ambientale PdS2008 Sicilia.pdf
T 14	Valutazione Ambientale del Piano di Sviluppo	Report in Italian on Environment in Sicily	47 pages	Terna	Environmental studies	tif	Environmental assessement.tif
T 15	Technical specification for a preliminary marine route survey	Technical specification for a preliminary marine route survey between Italy and Sicily	21 pages	Terna	Survey	tif	Technical specification for a preliminary marine route.tif
T 16	Status of progress advancement	Status of the AC interconnection with received results	23 pages	Terna	Project management	ppt	Stato avanzamento progetto.ppt

ANNEX C: Schematic Comparison of Submarine Power Transmission Solutions

(Excerpt from SAPIENZA study)

Table 1 – A schematic comparison between submarine power transmission solutions

		AC	DC-LCC	DC-VSC
Link capacity		Dependent on cable ampacity and cable length	Only dependent on cable ampacity (virtually unlimited length)	
Power transmission limits		Angular stability	AC short-circuit power at terminals	None
Power transmission control		Requires external means. Only depends on dispatching if no parallel links exist	Controllable (10-100)% of rated power. System frequency constraints if no parallel links exist	Controllable (0-100)% of rated power. System frequency constraints if no parallel links exist
Transmission losses (equal cross-section and current)	**Cables**	Highest (extra joule losses due to skin effect and reactive current, plus dielectric losses)	Lower than AC (minimum with sea return or with use of EHVDC)	Lower than AC
	Substations	Minimum (less than 0.3% of rated power for each station)	(0.6-0.7)% of rated power for each station	Maximum ((1.2-1.4)% of rated power for each station)
Reactive power exchange with network		Limited due to extensive shunt compensation (>95%)	Limited, if AC filter/capacitor switching is performed	Controllable in amplitude and sign (subject to capability limits)
Passive receiving network supply / blackstart capability		Possible, limited by voltage stability	Not available	Possible, limited by voltage stability
Redundancy (upon loss of a cable)		3-Core cables: none(*) (requires 2nd cable)	Monopolar: none (requires 2nd cable)	None(**) (requires 2nd couple of cables)
		Single-core cables: 100% if fourth (spare) cable provided	Bipolar: 50% if sea return electrodes available	
Costs	**Stations**	Minimal (standard devices), shunt reactors only extra cost	Maximum (large footprint, extensive AC filters); sea return also requires electrodes	Significant, comparable with LCC
	Cables (capital, for equal cross-section)	Maximum (3 phase conductors, single-core cables also require Cu armour)	Minimum for monopolar with sea return or IMR(***) (only 1 cable). Otherwise 2 cables needed	Comparable to bipolar (or external metallic-return monopolar) LCC, always 2 cables
	Cables (laying)	Maximum for single-core cables; minimum for 3-core (possibly with shorter laying stretches)	Minimum for monopolar or bundled laying	Minimum for bundled laying
Reliability / availability		Higher	Lower than AC due to higher part count (spares needed)	Further experience required (Comparable to LCC?)

(*) Difficult, theoretically possible at reduced power. Further study needed. (**) Application of electrodes under study at the time of writing. (***) IMR: Integrated Metallic Return.

ANNEX D: CAPEX Summary

(Excerpt from SAPIENZA study)

AC or DC	Voltage [kV]	Number of circuits/bipoles	Type of submarine cable	Maximum active power at the receiving end [MW]	Losses at maximum power [%]	Cost of cable supply and laying [M€]	Cost for substations and/or converter stations [M€]	Total cost [M€]	[k€/MW]
AC	132	1	3-core 500sqmm Cu	135	7.5	113	8	121	894
AC	132	1	3-core 800sqmm Cu	165	6.8	126	8	135	815
AC	220	1	3-core 500sqmm Cu	225	4.9	135	18	153	680
DC	100	1	2x500sqmm Cu	139	7.1	94	42	136	979
DC	150	1	2x800sqmm Cu	283	5.6	150*	77	227	802
AC	132	2	3-core 500sqmm Cu	2x135	7.5	226	10	236	874
AC	132	2	3-core 800sqmm Cu	2x165	6.8	252	11	263	796
AC	220	2	3-core 500sqmm Cu	2x225	4.9	270	27	297	660
DC	100	2	2x500sqmm Cu	2x139	7.1	188	82	270	970
DC	150	2	2x800sqmm Cu	2x283	5.6	300*	151	451	797

*) estimated by Terna