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A comparative social, economic and environmental study of how Malta could best achieve its 2020 “20-20-20” goals

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Master of Science in Sustainable Environmental Resource Management / Master of Science in Integrated Science & Technology

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A dissertation presented in partial fulfilment of the requirements for the Degree of Master of Science in Sustainable Environmental Resource Management/ Master of Science in Integrated Science & Technology

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ABSTRACT

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The European Union has recognized the need for an action plan to facilitate the gradual transition to a dominant, renewable energy production base for the myriad of benefits that renewable over non-renewable production brings. Malta, as a member of the EU, is obliged to achieve nationwide goals as specified in the Renewable Energy Directive with regards to electrical efficiency, carbon emissions and renewable energy production share. The goals for Malta include an achievement by 2020 of a 10 % renewable production base, a 10 % electrical efficiency improvement and an allowance for a 5 % increase in carbon emissions as compared to 2005 levels. This Dissertation examines four different comparative studies that address different aspects for attaining these Directive goals. The purpose of these comparative studies is to identify the best option in order to address a particular goal by applying social, economic and environmental weighting. The conclusions of this paper are that:

i. Malta can achieve its efficiency goals simply by introducing improvements to its transmission and distribution grid. These grid improvement measures are cost effective and would facilitate attainment of the renewable and emissions goals.

ii. Malta will need to expand its non-renewable production base by 2016 and the best option for such an expansion would be the addition of a second submarine interconnector to Sicily rather than expansion of local production capacity.

iii. With a focus on the most cost-effective large scale renewable energy projects it was determined that it is both more economic and socially advantageous to invest in a foreign offshore wind project (and thus be credited with renewable energy produced from this source) rather than to build a local wind project.

iv. Consumer end efficiency improvements where cost effective should also be aggressively pursued and represent a means for Malta to actually exceed its efficiency goal and result in electrical savings that save money and reduce emissions.

MALTA, **ENERGY**, **INTERCONNECTION**, **RENEWABLE**, **EU**

'**MSc. SERM' / 'MS. IS&T'**

Michael Deaton, Robert Ghirlando, Jonathan Miles October 2010

Statement of Authenticity

I, Charles Sinn, declare that the work contained herein is my own

Dedication

This Dissertation is dedicated to Malta and its people. When I moved to the Island fifteen years ago the Maltese people welcomed me warmly and I soon felt at home even though I was a foreigner in a new country. I have lived the most enjoyable years of my life on this Island and when I first thought what my Dissertation would be about, I immediately focused on a topic of local significance, one that would have real relevance for the Island and its people. It is my hope that this dissertation can provide some help for the Island to achieve its 2020 renewable goals in the most optimal way possible. This Dissertation was accomplished with the thought of repaying the favor of the Maltese peoples' hospitality.

List of Acknowledgements

I would like to thank Dr. Jonathan J. Miles for inviting me to apply to the SERM course; without his notice I may not have been aware of the existence of the course. Thanks to him also for his excellent supervision. A special thanks to Prof. Robert Ghirlando and Dr. Michael L. Deaton whose continuous help and feedback proved invaluable. I appreciate the referrals provided by Prof. Ghirlando who gave direction and information that likely would not have been available without those contacts; also Joe Vasallo at Enemalta was extremely helpful. All of my supervisors made themselves available even on weekends and generously shared their expertise.

I am grateful to James Madison University and University of Malta and the very helpful staff of both institutions. Dr. Miles wore many hats throughout the course and orchestrated an extremely stimulating and edifying course. His enthusiasm was contagious.

Also a special thanks to my family and friends who supported me during the entire course.

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List of Terms

AA	Appropriate Assessment
ARMS	Automated Revenue Management Services Ltd
Bn	New billing rate Bn for that Utility to receive the same income as before with a loss
Bo	Proper billing rate for a Utility operating with no energy losses
BOE	Barrel of Oil Equivalent
BWSC	Burmeister & Wain Scandinavian Contractor
capex	Capital Expenditure
CFL	Compact Fluorescent Lightbulb
CoWE	Committee on Wind Energy
CPI	Corruptions Perceptions Index
CVR	Conservation Voltage Reduction
DHIR	Department of Health Information and Research
DOI	Department of Information
Ec	Self Consumption by Utility
EC	European Commission
ECJ	European Court of Justice
EEA	European Environmental Agency
Eg	Energy Produced by the Utility
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
Es	Energy Sold to End User Customers
EU	European Union
EWEA	European Wind Energy Association
HDI	Human Development Index
HFO	Heavy Fuel Oil
IPPC	Integrated Pollution Prevention and Control
MML	Mott MacDonald Ltd.
MRA	Malta Resource Authority
MRRA	Ministry for Resources and Rural Affairs
MS	Member States
MTA	Malta Tourism Authority
MWh	Megawatt Hours
NAO	National Audit Office
NAP	National Action Plans
NCAR	National Centre for Atmospheric Research
NSO	National Statistics Office
NTTPL	Non-Technical Transmission and Distribution Power Losses
O&M	Operating and Maintenance Expense
OPEX	Operating Expenditure
PDS	Project Description Statement
PSWH	Passive Solar Water Heaters
RCA	Rural Conservation Area

RE	Renewable Energy
RES	Renewable Energy Sources
RO	Reverse Osmosis
SEP	Summary of Economic Projections
SPA	Special Protected Area
TPL	Transmission and Distribution Power Losses
TTPL	Technical Transmission and Distribution Power Losses
WHO	World Health Organization
WSC	Water Services Corporation

I. Introduction

It is often said that the only thing more important for a country than power is water. However, for Malta which has a deteriorating natural aquifer system and no clean surface freshwater to speak of, one could say that the two are equally important. Due to the deteriorating condition of the natural aquifer systems and their impact on water production (mainly due to unsustainable overexploitation resulting in poor water quality), production has been increasingly shifted to Reverse Osmosis with Plants (located at Pembroke, Cirkewwa and Ghar Lapsi) which currently supply more than 60 % of the drinking water on the Maltese Islands. **[1]** The vulnerability of Malta's natural water system means that any long term blackout could result in an emergency situation where Malta would have to depend upon foreign imports of water. Additionally, electricity is the lifeline of modern society; and thus, populations are almost entirely dependent on it. Therefore any threat to future energy security must be taken very seriously.

Malta is a country with a number of threats to its future energy security. Enemalta Corporation essentially holds a monopoly position on electricity production, supply and distribution due to lack of competition. This trend will continue for the foreseeable future due to the difficulty of market penetration as well as the government's propensity to subsidize electricity prices (by keeping the price of electricity lower than it costs to produce resulting in Enemalta losing money) for the sake of popularity. The result is a corporation that has over three hundred million Euros (as of 2007) in debt to loans **[2]** and which continues to lose money at an accelerated rate. **[3]** As a consequence Enemalta is unmotivated to be innovative and proactive in its energy policy, especially in terms of pursuing renewable investments as this would result in the spending of capital that it simply does not have, or incurring additional debt.

Furthermore, Malta depends almost exclusively upon foreign imports of oil to fuel its generating facilities as it does not have any known exploitable fossil fuel resources. The only realistic prospect the country has to reduce its high dependence on foreign imports to fuel its non-renewable production facilities is to invest in power generation derived from renewable sources. With Malta's 2004 accession to the European Union (EU) and subsequent kick start of its renewable energy interest due to the requirement that 10 % of electrical energy production be sourced from renewable sources by 2020, the country now has a genuine interest in increasing its energy security by investing in local production of renewable energy.

Another prospect that Malta may consider in order to reduce dependence on fuel imports to is to lay a submarine cable to another country from where it may import electricity. One could say that this does not solve the problem of a transition to renewable energy; however, electrical interconnection brings with it a great number of benefits. For instance, a trans-national cable could be used to import cheaper electricity, green electricity, and also might be used to stabilize the local energy ring as well as provide an emergency source for electricity should local production fail.

The purpose of this thesis is to outline how Malta has reached its present power situation, what the situation is today, why it is not sustainable, the different options Malta has available to meet its 2020 requirements by the EU for its renewable share, and how it can proceed toward a more sustainable power generation future.

II. Background

Introduction to Malta

Geography

The Republic of Malta is an archipelago nation state and consists of three inhabited islands (and multiple non-inhabited micro islands) called Malta, Gozo, and Comino. The land area of Malta is 316 km^2 **[Appendix A-2]**. It is located in the Mediterranean Sea [refer to Figure 1 for location] and is about 93 km south of Sicily and 288 km east of Tunisia. The fact that it is located right in the middle of the major (and only) nautical east-west shipping route through the Mediterranean has meant that the Island has throughout history possessed political power beyond its size **[1]**. Its central Mediterranean location has also resulted in thriving tourism (with over one million tourists a year) and shipping sectors.

Figure 1: Map of Malta with Power Plants
This map of Malta has been reproduced with permission from Ezilon, with addition of power infrastructure by author. [2]

Demography

As of 31st December 2008 the total population of the country of Malta was 413,609. **[3]** This number is based upon extrapolation from census surveys which are carried out on a decennial timeframe, with the last being in 2005.

The island of Malta is by far the largest and most populated of the Maltese Islands with a total population of 382,177. Gozo is the second most populated with a total population of 31,432. Comino is by far the smallest and least populated inhabited island having a negligible farmer population of around 8. **[3]**

The combination of land area and total population results in a population density of 1,309 people/km^2. This is by far the highest within the European Union. Malta’s population density is over ten times the EU Average of 116 people/km^2 and three times the next highest, the Netherlands which has 396.9 people/km^2. **[4]**

Based upon the numbers plotted in Chart 1, it is expected that by 2020 Malta will have a population of 420,700 people. This represents an increase of 1.7% over 2008 figures.

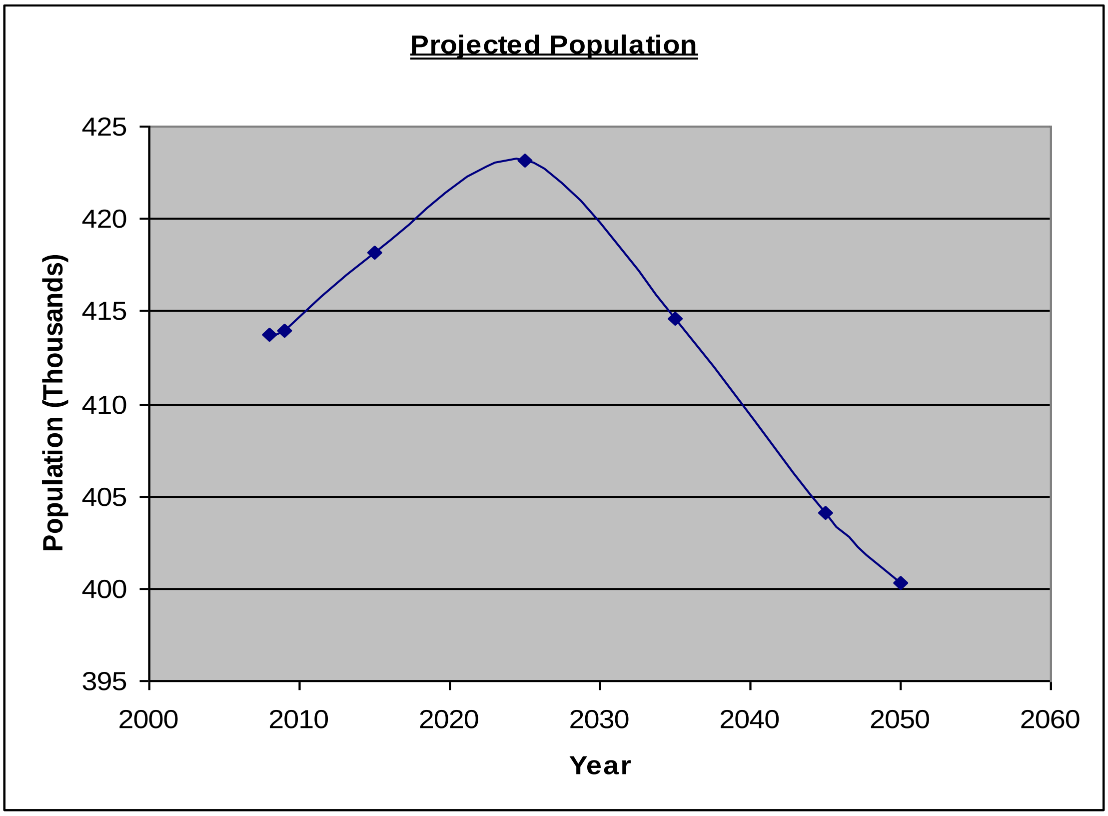

Chart 1: Malta projected population for the next three decades, plot of data obtained from NSO report [3]

As shown in Table 1 below, the total increase in non-Maltese population between 1985 and 2008 has been 378%. The non-Maltese population in Malta has exploded since Malta's 2004 accession to the EU with a 51.2% increase in non-Maltese population in just five years. This is compared to a mere 16% Maltese population increase between 1985 and 2008 and a 1.2% Maltese population increase between 2004 and 2008. The significance of these trends is that they forecast a continued flood of immigrants, mostly from other EU countries, that is expected to increase at an exponential rate. In addition to the obvious cultural ramifications of this large scale diversification, there will also be expected energy intensification per capita as immigrating citizens from other EU countries have higher energy footprints and higher standard of living expectation.

	Total	Maltese	Non-Maltese
1985 Population	345,705	340,907	4,798
2004 Population	402,668	390,669	11,999
2008 Population	413,609	395,472	18,137

Table 1: Change of demographics for Malta with time, Numbers for Total population and Maltese population obtained from NSO report, Non-Maltese figure extrapolated [3]

Uniqueness of Malta's Situation and the Challenges it Poses

Malta, as an island state with the smallest land mass and by far the highest density population in the European Union, faces a multitude of challenges in achieving macro oriented EU goals. On an island where available land is scarce and where a number of different human activities are concentrated in very small areas, a great number of problems arise when one attempts to resolve the need for new generation capacity, be it renewable or non-renewable. Non-renewable fossil fuel generating facilities, no matter where they are located, will be no more than a few kilometers away from the nearest urban residential population centers.

New generation capacity, if tackled on an industrial scale, requires a large amount of land which would almost undoubtedly have otherwise been used for a variety of other human uses. Such construction is almost always met with resistance from a segment of the public that often feels left out and marginalized by government interests. Renewable energy plants intended to serve on an industrial scale require a far greater amount of land per kWhr generating capacity than equivalent non-renewable facilities. The government has sought to address this problem by considering construction of large scale wind farms offshore, but offshore wind presents a variety of challenges. The offshore wind project that is being considered at present would be built at Sikka l-Bajda as this site presents relatively high sustained winds and shallow water depth. However, this area already also supports a large number of human uses such as scuba diving, fuel bunkering, and shipping. In addition such a construction could pose a potential hazard to migrating avian life, and since the location is visible from many of Malta's most popular northern beaches, many consider it a potential disruption to the aesthetic scenery and fear that tourism could be negatively impacted.

This multitude and variety of conflicting human use interests set in a small area lead to 'spatial misfits'. The term 'spatial misfits', as applied to Malta, was used by Eng. Charles Yousif (Institute for Sustainable Energy, University of Malta) in a study he performed concerning Malta's RE policy implementation process and the resulting conundrum of applying EU policies to drastically different demographic situations.

An excerpt from the 'spatial misfit' study:

> **"Malta is a highly interesting case for such study, since all levels of policy implementation are very closely knit…and consequently EU influences can be directly seen"…"insularity and size confine the actor network to a small group of multiple actors, often connected through friendships and familiar relationships as well as economical and financial ties. This creates personal and direct links between and within the governance levels, which are characterized by antagonism and/or sympathy and often follow unwritten rules." [5]**

"Spatial misfits in a multi-level renewable energy policy implementation process on the Small Island State of Malta" Kotzebue, Yousif, et al.

In addition to misfits arising from land-use conflicts there also is a high degree of misfits arising from the different levels of policy making lobbies and the different agendas that they have regarding renewable energy policy. For example, the Prime Minister can be considered the highest level policy maker for the Maltese Islands, but his agenda is very macro orientated as it is influenced by the highest level policy maker, the European Union. In this sense his agenda can be biased toward macro-scale projects that may be a better fit in another larger EU country rather than Malta. **[6]**

"Small isolated system" status of Malta

The original definition of a "small" island came from UNESCO's Man and the Biosphere Programme and is defined as an island with an area less than 10,000 km^2 and a population of less than 500,000. **[7]** Within the EU this definition of a "small" island as applied to the EU was confirmed in the Treaty of Amsterdam. Notably, Gozo was confirmed even before Malta's accession to the EU as a member of the Small Islands Commission. **[8]** With Malta's accession to the EU, the Nation itself became a member and received assistance from the EU Cohesion Fund.

A “small isolated system” is defined by the EU’s Electricity Liberalization Directive as one with “consumption less than 2500 GWh in the year 1996, where less than 5% of the annual consumption is obtained through interconnection with other systems”. **[9]**

Malta will fit under the definition for a “small” island for the foreseeable future. Demographic projections predict that Malta’s population will peak at 424,000 in 2025 and with an area of 316 km^2 it will fit well within the definition of a “small” island. The importance of this is that it will be entitled to special subsidies under the EU Cohesion Fund.

The definition for a “Small isolated system” is more specific; Malta will likely fit under the electrical “consumption” clause given that even the highest estimates for the next 50 years in Malta are less than 2500 GWh. However, the definition includes a clause that states that a “Small isolated system” is one with less than 5% of annual consumption that is obtained through interconnections with other systems. The installation of the 200 MW Malta-Sicily cable (as will be discussed in detail in Section VI.2) could put this status in jeopardy since, even if the cable was used at only one quarter capacity to import electricity from Sicily then Malta would be obtaining more than 5% of its total electricity from an interconnection.

The EU itself has recognized the fact that small islands require special treatment due to their unique socio-economic situations. Small islands suffer from the fact that they tend to have small inefficient markets, limited local resources, require large amounts of imports that are expensive (due to costly transport links), have higher living costs and a sensitive natural environment.

‘Economies of scale’ is a major factor in determining the economics behind power production. As a consequence of their status, small island states will have much lower economies of scale and will produce electricity at a higher cost per kilowatt hour. Technological improvements have reduced the impact of economies of scale with regard to construction of generating facilities; however, it is still a driver in determining factors such as fuel source. This fact rules out many other fuel alternatives for small isolated island states such as natural gas and other fuels that are difficult to transport and which require a built up infrastructure with unique and large economies of scale just for the transportation. **[10]**

EU directives and regulations are not always applicable in an island context and must be tailored in order to cater to the unique factors under which member island states exist. The EU has recognized this and has allocated additional funds to which islands are entitled in order to subsidize works deemed appropriate by the European Commission (EC). **[11]**

History of Power Generation in Malta (Refer to Figure 1 for locations of plants)

Brief Summary

Malta's early history of power generation was dictated by British policies and agendas when it existed under the direct rule of the British Empire until 21st September 1964.

In 1882 the first public use of electrical appliances occurred in the Maltese Islands. Electric lighting was first introduced during an opera at the Royal Opera House and later that year Piazza San Giorgio in Valletta was lit up by electric lighting. In 1890 plans were made for a wide-scale installation of electric lighting on the Maltese Islands along with the installation of generating capacity to supply the electricity. **[12]**

In 1894 the public electricity service was formed. Between 1894 and 1896 "The Central Power Station" as it was known at the time was constructed at the limits of Floriana. The system consisted of four individual steam units which had a combined generating capacity of 350kW. The following three decades saw a continued expansion of the electrical grid to meet demand (mostly from street lighting) and an expansion of the main power station.

In 1925 the first generating capacity on the island of Gozo was installed to power street lighting. This generating capacity was expanded over the years to reach a total of 380 kW by 1953, enough capacity to allow for the provision of electricity to rural villages. **[12]**

In 1935 proposals for a larger generating plant were brought up due to the need for increased generating capacity to meet demand. These proposals included the reiteration of an earlier 1920 recommendation for the conversion of the single-phase hundred cycle distribution network to a three-phase fifty cycle operation system which would be a costly investment but which would result in a much more efficient transmission grid. These plans were interrupted by the outbreak of war in Europe (1939-1945) and the subsequent devastation to the infrastructure of the Maltese Islands by relentless Axis bombing which was especially fierce during 1941-1943. In 1949 Malta received economic reparations under the Marshall Aid Scheme to finance the construction of a new power station and equipment to replace the outdated one in Floriana. **[12]**

With the post-war grant funds, a new power station was constructed and inaugurated in 1953 in the excavated galleries at the base of Jesuit Hill, Marsa. This original underground installation is known as Marsa “A”. The total installed capacity of this new station was 15 MW. **[12]** A feasibility study was commissioned by the government in 1954 to resolve the issue of supplying electricity to remote villages. The report included recommendations that it was more economical to supply Gozo from the power station in Malta. In 1957 there was a large scale extension to the electrical grid including the construction of two submarine cables from Marfa to Comino and from Comino to Gozo. In 1959 the power station in Gozo was permanently shut down and the island entered into a dependence on the main island of Malta for electricity. **[12]**

A further result of this study was the grid-wide conversion from single-phase hundred cycle to a three-phase fifty cycle. The conversion project lasted 3 years between 1954 and 1957 and included the laying of 11kV three-phase cables and the constructions of substations to connect the lines to the 415/240V rated mains. **[12]**

In 1965 a 5.7 MW gas turbo alternator was installed at the power station in Marsa. This additional installation essentially filled the underground tunnel which housed the first power station at Marsa and so it was decided to construct a new power station on the grounds over it. This new power station is now known as Marsa “B” power station. With the construction of the new power station, the stations at Floriana and Corradino became defunct and were decommissioned in 1960 and 1992 respectively. **[12]**

In 1966 the new power station, which is better known as the Marsa "B" Power Station, was inaugurated. The new power station was constructed with two 12.5 MW turbo alternator units. The Marsa "B" Power Station was further expanded over the years (1966-1990) until its total generating capacity ultimately reached 267 MW. **[12]** In 1992 the Delimara Power Station was commissioned. Its original construction included two 60 MW conventional steam units. Delimara has been further expanded over the years to reach a total capacity of 304 MW. **[13]**

Why this History is Important

A glimpse into Malta's history of power generation reveals that all of the past production facilities were constructed (except for Marsa "B" and Delimara) and most of the transmission infrastructure was built while Malta was under the direct rule of the British Empire. Malta's energy policies were very much guided by British interests and much of the technology and expertise during this period was imported. However, Malta managed to proceed successfully without much incident on its own after a difficult and dramatic transition period that occurred after its Independence in 1964.

The Industrial Revolution saw Malta, along with the rest of Europe, develop a dependence on high density fuel sources to power the new marvelously productive machinery that brought about a period of unprecedented growth and development. During the period between the late 1800s and early 1900s environmental considerations were barely a factor in determining energy policy. There were a number of reasons for this including, the lack of understanding of the implications of fossil fuel burning, cheap fossil fuels, and a lack of economical (as compared to non-renewable) renewable technology. Hydroelectric technology was the one economical renewable technology at the time, which in appropriate locations can be applied in an extremely efficient and cost effective way. Malta has no free-flowing rivers and so could not apply this technology while, technologies such as solar and wind had not yet been developed to function on an economical and commercial level. A glimpse into history shows us how Malta reached the almost total dependence on non-renewable power generation and thus foreign imports of fossil fuels that it has. **[14]**

The situation today is very different from what it was decades ago: Renewable technologies such as wind and solar have become economically feasible (especially when environmental damage due to fossil fuel burning is factored in), and the technologies exist for their implementation on industrial commercial scale.

III. Establishment of 2020, 20-20-20 Goals

Malta's 2004 Accession to the EU

On May 1, 2004 Malta along with nine other countries officially joined the European Union, representing the most significant transition for Malta since secession from British rule in 1964. As a member of the Union it is obliged to meet macro goals and directives as set by the EU but it is free to implement the changes in order to meet the objectives as it sees fit at a national level. **[1]**

Result of EU Accession

Liberalization of Electricity Supply

In 2001 the Malta Resources Authority (MRA) was established and with its creation, the regulatory powers that Enemalta had over the electricity and fuel sectors were removed. Instead, under the MRA Act, Enemalta was left to perform its services (generation and distribution of electricity and importation and distribution of fuels) on a licensee basis. **[7]**

With Malta's accession to the European Union and in accordance with the EU Electricity Directive, Enemalta would no longer hold the legal monopoly powers it had traditionally held over electricity generation, thus opening up the possibility of market penetration and competition. However, subsequent developments have shown this scenario still to be unlikely. In theory the liberalization allows consumers the choice between different suppliers but with no competition there is still no choice. To date the fuel market has still not been liberalized.

Figure 2 on the opposite page displays the European Union as it stood in 2004. The original EU-15 Member States (MS) was expanded to 25 nations in the 2004 enlargement to make up what is known as the EU-25. Of the candidate states shown on this map Romania and Bulgaria joined in 2007, thus creating the EU-27 of today:

Figure 2: Map of the European Community [2]

Establishment and description of so-called 20-20-20, 2020 Goals

The 20-20-20 2020 goals stem from a long standing discussion within the EU. The EU is a major net importer of non-renewable fuels and as such depends on other countries, which may not always be the most politically stable approach in terms of the safety of its electricity production. In addition, the EU has recognized the fact that non-renewables as their name implies are finite. Any resource that has a demand and which over time is depleted, inevitably reaches a state at which supply cannot fully satisfy demand. At this state, prices can increase

dramatically as consumers (and producers) try to outbid one another for desperately needed fuel sources.
Non renewable sources of energy are finite and will eventually deplete; the resulting depletion will lead to escalating prices for such energy as the non renewable sources become less available. No clear estimate of when exactly the last drop of oil, lump of coal, gallon of natural gas will take place; however, predictions vary from as early as 50 years from now to 300 years **[8]**. Given the finite nature of non renewable energy it is important to make the transition to renewable electrical production as soon as possible. If a last-minute approach is adopted, such a sudden transition would put immense strains on the economies of the future as consumption from other industries may have to be sacrificed as the development of renewable facilities occurs. The construction and eventual decommissioning of renewable energy infrastructure is very energy intensive. Therefore, the ideal situation is one in which renewable infrastructure is already established so that it can provide a source for the energy needed to produce future renewable energy.

Apart from the economic strain that would occur from a delayed transition, the earlier the transition toward an energy mix that blends greater amounts of renewable energy, the less severe its impact on the environment will be since the scientific community has recognized the fact that recent global-climate change has been caused mostly by human activities (specifically emissions). **[9]**

The original proposal for a binding target on renewable energy in the EU was the Renewable Energy Directive that was put forward in January 2008. After nearly one year of debating and addition of amendments to the original proposal, Member States agreed upon the 2009 EU Renewable Energy Directive which put into force mandatory targets for renewable shares for each of the Member States. The overall target of the directive is for the EU as a whole to reach a total 20 % renewable energy share by the target year of 2020. Because of different conditions for each of the Member States (such as installed renewable base, economic status and renewable potential) each Member State was assigned its own legally binding target which, when averaged collectively, reaches 20%. **[1]**

Part of the directive is the inclusion of an indicative trajectory which outlines non-binding goals that Member States should achieve in the years leading up to 2020. By 2012 states should be 20 % of the way towards the target, 30% by 2014; 45 % by 2016; 65 % by 2018; 100 % by 2020. These targets refer to overall energy consumption, including the transport sector. It is expected that renewable sources will provide 35 % of power within the EU for electricity generation with wind being the largest contributor, accounting for more than a third of total renewable production. **[3]**

Description of so-called 20-20-20, 2020 Goals

The “20-20-20” 2020 goal as outlined in Directive 2009/28/EC of the European Parliament is a three pronged action plan that seeks to tackle the problems of global warming, energy security, and fossil fuel dependence by increasing renewable share, decreasing greenhouse gas emissions, and improving energy efficiency. With this plan, the EU seeks to achieve a total energy production from renewable sources of 20 %, carbon emission reduction of 20 % (compared to 1990 levels), and reduction in consumption of primary energy by 20 % (compared with projected business-as-usual levels) by 2020.

Energy share falls into two categories: Transport Energy and Electrical Energy. The EU seeks to achieve a 10 % biofuel share in the transport energy mix by 2020 meaning that the renewable energy goals for electrical energy production are on average actually significantly higher than 20 %. **[4]**

Specific 2020 Goals Assigned for Malta

When developing the Union wide 20-20-20 goals, the European Union recognized the fact that different Member States had very different starting conditions. Some Member States (such as Sweden) already had a 20% renewable share while other Member States (such as Malta) had less than a 1% renewable share. Also, different member states have different strengths of economies and capacity to absorb the interim financial challenges that occurs during a transition. In recognition of this fact, the EU assigned different goals for each of its member states which accounted for these factors.

Malta was assigned the lowest required share of renewable energy consumption by 2020 of 10%. The government of Malta has stated that it intends to achieve a 10% target of renewable energy in the transport sector through a mix of biofuel and electric vehicle initiatives. This leaves the Maltese electricity sector with a goal of 10% renewable energy production by 2020. Malta was also assigned one of the lower goals concerning reduction of its CO_2 emissions. In fact, the goal allows for an increase in CO_2 emissions by 2020 of 5% over what they were in 2005. Emissions of CO_2 in 2005 were 2600 Gg (Giga grams). This suggests that Malta must have CO_2 emissions of less than 2730 Gg in 2020 to meet its goal.

The EU Directive 2006/32/EC which came into effect in 2008 gave Malta an obligation to increase its energy efficiency by 1% per year.

EU Climate Guidelines by Member State

	required reduction in CO2 emissions by 2020 (compared to 2005 levels)	required share of renewables in energy consumption by 2020
Austria	-16.0%	34%
Belgium	-15.0%	13%
Britain	-16.0%	15%
Bulgaria	20.0%	16%
Cyprus	-5.0%	13%
Czech Republic	9.0%	13%
Denmark	-20.0%	30%
Estonia	11.0%	25%
Finland	-16.0%	38%
France	-14.0%	23%
Germany	-14.0%	18%
Greece	-4.0%	18%
Hungary	10.0%	13%
Ireland	-20.0%	16%
Italy	-13.0%	17%
Latvia	17.0%	42%
Lithuania	15.0%	23%
Luxembourg	-20.0%	11%
Malta	5.0%	10%
Netherlands	-16.0%	14%
Poland	14.0%	15%
Portugal	1.0%	31%
Romania	19.0%	24%
Slovakia	13.0%	14%
Slovenia	4.0%	25%
Spain	-10.0%	20%
Sweden	-17.0%	49%

Source: European Commission

Table 2: Table of EU Climate Guidelines by Member State This table shows that goals assigned for Malta are significantly lower than most of the other EU countries. [5]

Article 4 of the Directive 2009/28/EC on Renewable Energy outlines the requirement that Member States submit a National Action Plan (NAP) on a biannual basis in which the Member State outlines how it intends to reach its national targets. The plan is to include breakdowns of sector projections, efficiency projections and the detailing of plans to meet these goals. The European Commission may find that a NAP is inadequate. If this is the case then it has the right to consider infringement proceedings against the particular Member State. Any significant shortfalls over a two year period during interim trajectory requires that the Member State must submit an amended NAP stating how it will make up the shortfall.

Chart 2 below shows the renewable share trajectory for Malta:

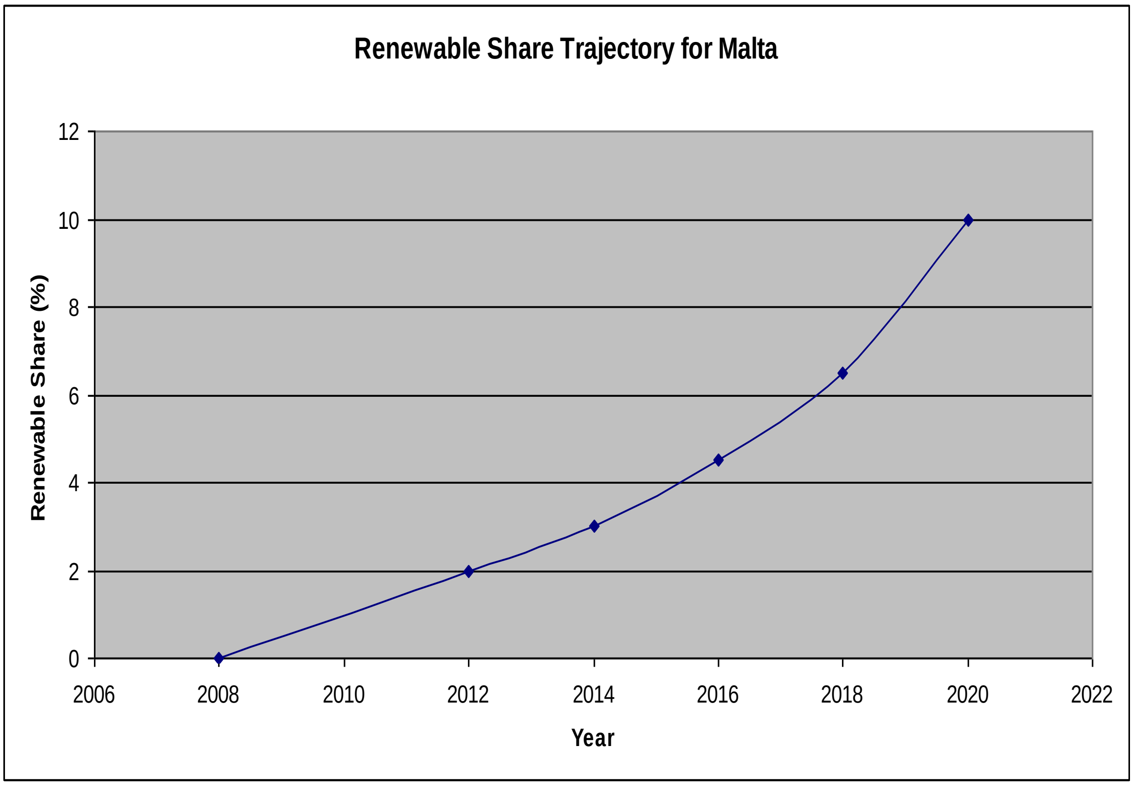

Chart 2: Renewable Share Trajectory for Malta showing the renewable share goal for each interim year leading up to 2020 [6]

Enforcement Mechanisms:

The Directive specifies that EU Member States have a legal obligation to ensure that 2020 targets are met. The European Commission can initiate infringement proceedings if a Member State does not enact so-called “appropriate measures” in reaching its interim trajectory. The results of such infringement proceedings include the need for an issuance of a new national action plan to address the previous plan’s shortcomings and if this new plan is still found as not being satisfactory then fines and other penalties can be enacted.

IV. Current Electricity Production Infrastructure

Non-Renewable

The islands of Gozo and Comino have no permanent generating capacity of their own and are interconnected by a single electricity grid to Malta. The main island of Malta is home to the two major fossil-fuel power production facilities located at Marsa and Delimara which have a total combined nominal installed capacity of 571 MW.

Delimara Power Station

The total generation capacity of this station is currently 304 MW. Delimara Power Station uses two fuel sources: 1% sulfur fuel oil for the steam units and distillate oil for the gas turbines and the Combined Cycle.

Delimara	
Units	**Commissioned**
2 x 60MW Conventional Steam Units	1992
2 x 37MW Open Cycle Gas Turbines	1994
1 x 110MW Combined-Cycle Plant. (Made up of 2 x 37MW Gas Turbines and 1 x 36MW Steam Turbine)	1999

Table 3: Power generating infrastructure currently installed at Delimara [1]

Marsa Power Station

Total generation capacity of this station is currently 267MW. Marsa Power Station also has the same two fuel sources: 1% sulfur fuel oil for the steam units and distillate fuel oil for the gas turbines.

Marsa	
Units	**Commissioned**
2 x 90 Ton/hr Steam Boilers (non-operational)	1966
2 x 10MW Steam Turbines	
2 x 120 Ton/hr Steam Boilers	
2 x 30MW Steam Turbines	1970
1 x 130 Ton/hr Steam Boilers	1982
1 x 30MW Steam Turbines	
1 x 130 Ton/hr Steam Boilers	1984
1 x 30MW Steam Turbines *	
1 x 300 Ton/hr Steam Generator	1985
1 x 30MW Steam Turbine *	1987
1 x 60MW Conventional Steam unit*	(1996 refurb)
1 x 37MW Open Cycle Gas Turbine	1990

Table 4: Power generating infrastructure currently installed at Marsa [1]

* Units that were run on coal until 1995 when the practice of coal firing was abolished.

Chart 3 shows the supply of electricity from 2002-2008 by the two power stations. The trend has been that Delimara has supplied an increasing share of electric energy over the years from 45% in 2002 to slightly over 50% in 2008. The Delimara share of electricity generation is expected to increase rapidly over the years especially with the mandatory shutdown of Marsa expected by the end 2012.

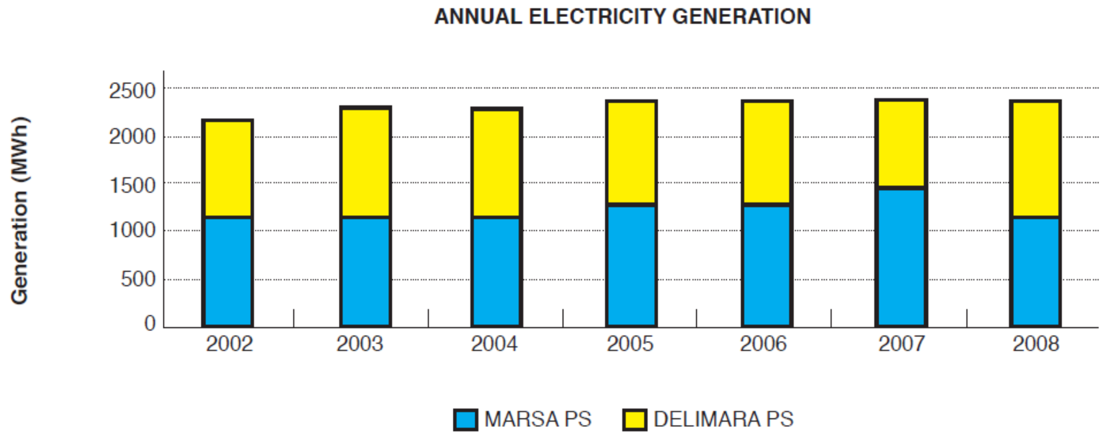

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Chart 3: Annual electricity generation by year for the two Maltese power production plants: No Enemalta annual report is available for 2009-2010, so 2008 and earlier numbers had to be used. [2]

Overview of Station Statistics

Table 5 shows the breakdown of consumption and efficiency data for the individual power production units. As can be seen, the Closed Cycle Gas Turbine (CCGT) unit at Delimara is by far the most efficient with an average thermal efficiency between 2007-2008 of 39.16 %.

The fuel consumption data shows that the units at Marsa are being used less while the units at Delimara are being used more in preparation for an eventual Marsa shutdown. It is also interesting to note that the thermal efficiencies of the units at the Marsa plant have dropped, most probably because efficiency improvement and maintenance work is kept to a minimum for units which will be discarded in only a few years. The thermal efficiencies of the units at Delimara on the other hand, have increased due to the implementation of efficiency improvement measures by Enemalta for these units as they are expected to be used for the next ten to twenty years.

Fuel Consumption (MTONS)	**2006-2007**	**2007-2008**
Heavy Fuel Oil (Marsa)	389,666	345,708
Gas Oil (Marsa)	2,316	2,447
Heavy Fuel Oil (Delimara)	219,755	234,882
Gas Oil (Delimara)	4,985	2,310
Gas Oil (Delimara CCGT)	30,852	69,138

Fuel Rates (KG/KWH)	**2006-2007**	**2007-2008**
Steam Units Marsa	0.308	0.309
Steam Units Delimara	0.265	0.265
Gas Turbine Unit Marsa	0.362	0.408
Gas Turbine Units Delimara	0.356	0.37
CCGT	0.205	0.203

Station Thermal Efficiency %	**2006-2007**	**2007-2008**
Steam Units Marsa	26.79	26.76
Steam Units Delimara	31.62	31.69
Gas Turbine Unit Marsa	23.06	20.48
Gas Turbine Units Delimara	23.46	22.57
CCGT	37.85	39.16

Table 5: Fuel Consumption, Fuel Rates, and Station Thermal Efficiency data for all power production infrastructure in Malta, the current average thermal efficiency for power stations in Malta is 28.13%. [3]

Renewable

Malta originally forecast in a report to the European Commission (EC) on the implementation of EU Directive 2001/77/EC (Promotion of Electricity from Renewable Energy Sources) that a realistic target for electricity generated from renewable sources by 2010 should be around 1.37% with the construction of a large scale wind farm. The original projection was reduced to 0.31 %, when in fact a large scale wind farm was not constructed. **[4]** To date, no large scale wind farm has been constructed and Malta has thus missed its high end 2010 estimate.

However, it has surpassed its 0.31 % non wind farm projection with an estimated gross renewable energy share in 2009 which was approximately 0.761%. **[5]**

Currently, photo voltaic (PV) sources have a registered capacity of over 3.5 MW for electricity generation; with an operating efficiency of approximately 17.1 % on average this brings the supply from total installed PV sources to around 5243 MWh/year. In 2010 Malta registered a total electricity production of 2,600 GWh. Therefore the total current supply from PV is approximately [(5.243/2,600)*100] = 0.20 %

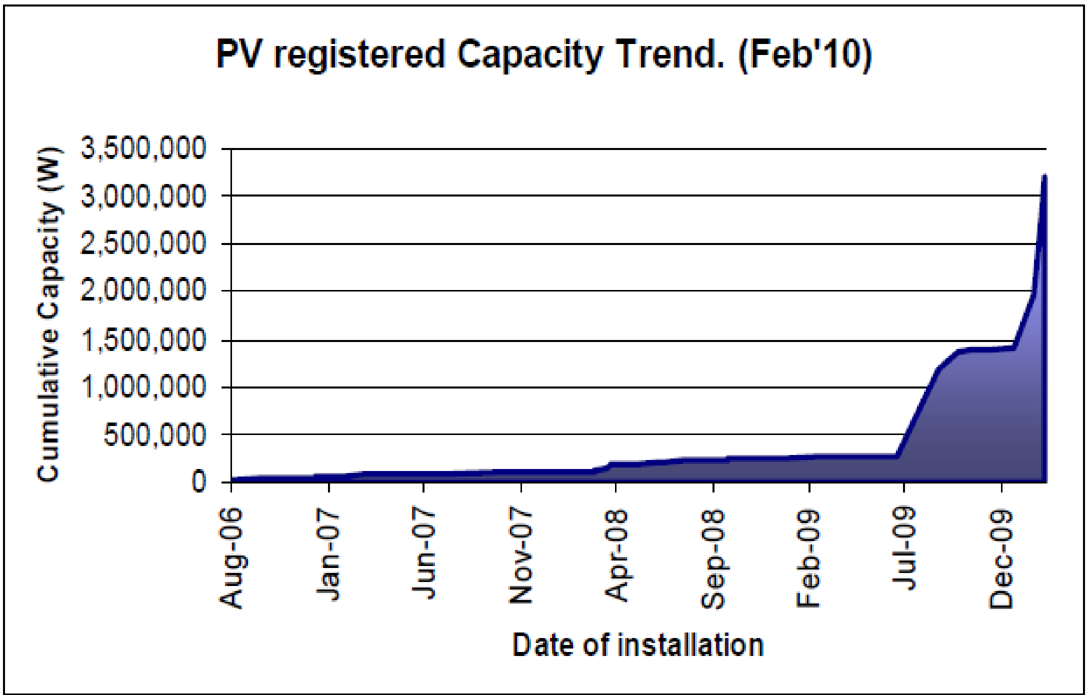


Chart 4: Malta Photo Voltaic registered installed capacity
Notice the spike in installations from July 2009 onwards [6]

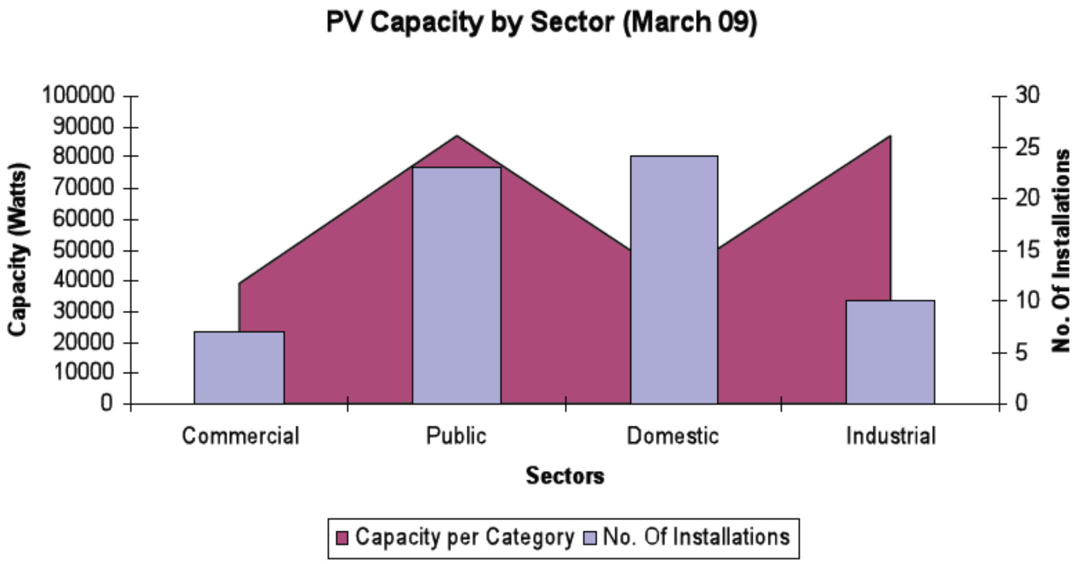


Chart 5: Mata Photo Voltaic Installed Capacity breakdown by Sector The strongest PV presence is in the Public and Industrial Sectors. [7]

Malta has approximately 15,000 Passive Solar Water Heaters (PSWH) which do not generate electricity directly, but their energy savings is registered as a renewable share. Each Passive Solar Water Heater creates on average 1500 kWh per year. In total they account for 22,500 MWh or 22.5 GWh in energy savings per year, thus the current renewable share from PSWH is [(22.50/2,600)] = 0.87%. **[8]**

No large-scale wind facilities exist in Malta. However, micro wind projects exist such as Enemalta's experimental micro wind turbine at Vendome rated at 2.5 kW. Bio energy sourced from methane generated at the Maghtab landfill is still insignificant but is expected to make up an increasingly large share in the years to come. Currently, the renewable share from non-solar sources is <0.1%. In total, with the addition of these values of 0.87% (PSWH) + 0.2% (PV), Malta is estimated to currently have a renewable share of approximately 1.07% of total electrical energy produced.

According to the Minister for Rural Affairs and the Environment, George Pullicino, Malta is expected to meet its renewable energy generation goal for 2012 of 2% of total share set by the European Directive Trajectory. With no major projects expected to be completed in this interim period this goal will be achieved mainly by subsidy schemes expanding current photo-voltaic and passive solar water heater installed capacity. **[9]**

Malta's Electrical Distribution Network

Electricity is supplied to the Maltese Islands from the two major power stations at four voltage levels of 132 kV, 33 kV, 11 kV and 400/230V operating at an AC (Alternating Current) frequency of 50 Hz.

The transmission system is classified into two major rings:

i. A 132 kV circuit (8 km long) which connects the Delimara Power station directly to the 132 kV step-down distribution center located in south Marsa and Mosta (pink ring on map of Malta transmission network). The 132 kV is stepped-down at these distribution centers to 33 kV where it is in turn transmitted by the 33 kV system.

ii. A 33 kV system which is extensive with up to 4 parallel lines, essentially covering the entire islands from Delimara in the South East to Qala in Gozo. It consists of both overhead lines (60 km) and underground cables (154 km) and is strategically located to be in close proximity to the major population centers of Malta. Eighteen Distribution Centers, located strategically throughout the Maltese Islands step-down the 33kV into 11 kV.

The distribution system is classified into two major rings:

i. An 11 kV ring that spreads throughout the Maltese Islands and is for the most part underground. The 11 kV circuit is by far the most extensive with a total of 1041 km of underground cable and 159 km of overhead cable. There are a total of 1207 substations that step down the 11 kV voltage to 400/230V which is the rating at which it can safely be transmitted to end-user customers. Some customers (major industrial facilities) are supplied directly with electricity rated at 11 kV.

ii. An end-user low voltage system that is rated at 400/230 V with an acceptable voltage tolerance of +10 % to – 6 %. This system is three-phase* with four wires (with three of the wires for the phases and one for the ground, safety) by far the most extensive and if its total length were to be calculated it would be many times the length of the 11 kV system.

*A three-phase system is one in which three conductors carry voltages at waveforms that are 1/3 of a cycle offset in phase. The result is a balanced, continuous power supply with which efficiencies are greater than a conventional single-phase system. **[10] [11]**

Malta Transmission Network is shown on next page Figure 3:

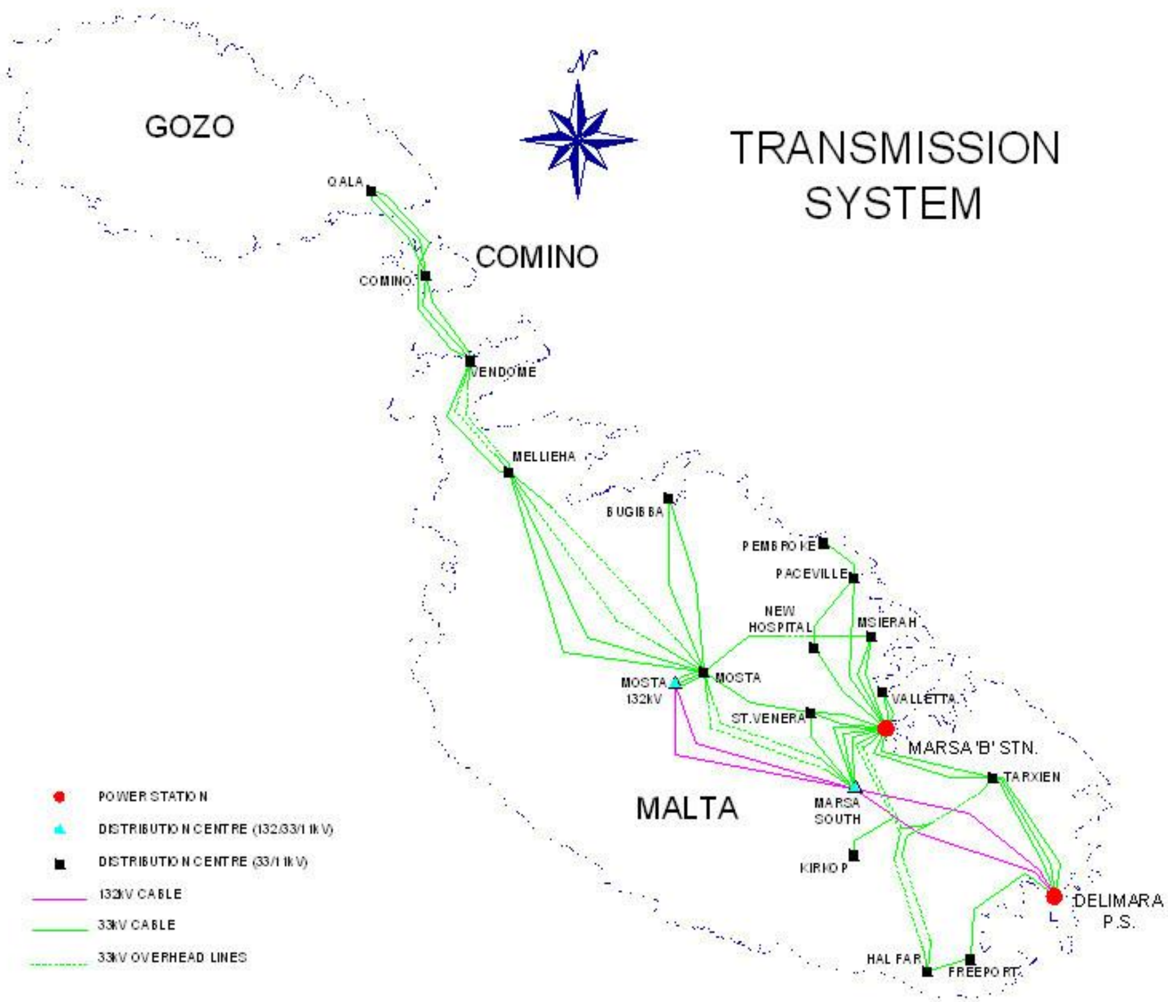


Figure 3: Malta Transmission Network [11]

Malta Energy Breakdown and Projections

Malta is a country that is heavily dependent upon fossil fuel imports due to its lack of indigenous fossil fuel resources. The upward trend of fossil fuel imports is expected to continue as electric energy demand continues to increase with a developing economy.

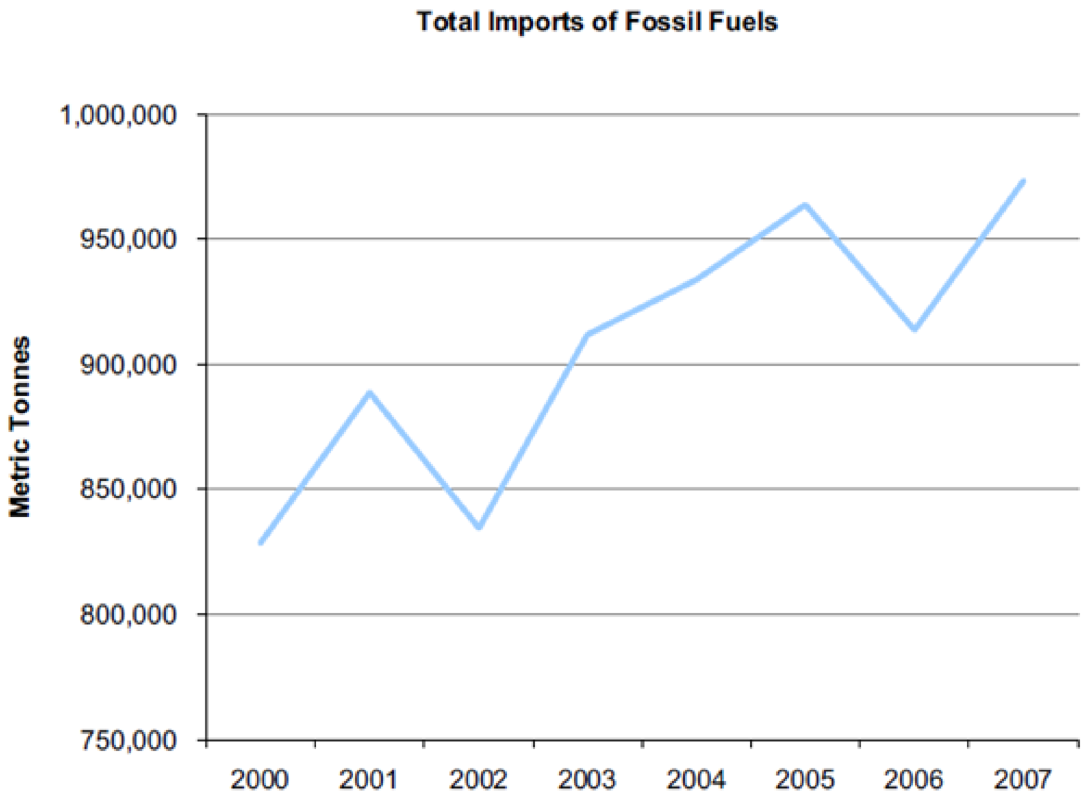


Chart 6: Malta total annual imports of fossil fuels
An increase in fossil fuel imports of over 15 % has been registered over the last 7 years and the trend is expected to continue as demand accelerates. [12]

Malta has no producing energy resources, as a result all non-renewable energy consumption comes from imports. Chart 7 shows a breakdown of fuel imports by type that are used in the energy sector. Fuel oil and gas oil are the fuel types that are used in the electrical sector, meaning that the electricity generation sector accounts for over 2/3 of fuel imports to Malta. In 2007 Malta imported a total of 973,427 metric tonnes of fuel imports.

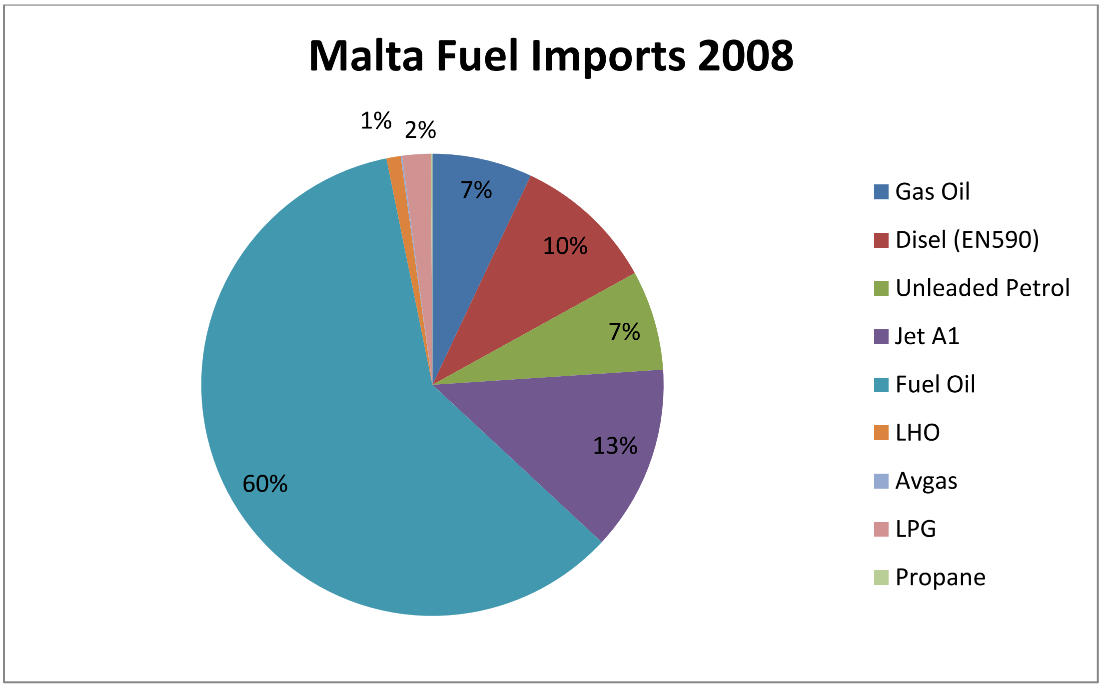


Chart 7: Malta fuel imports by type for 2008 [13]

Chart 8 shows a breakdown of sectors that are responsible for energy consumption in Malta. The consumption is rather evenly distributed with each of the three major sectors (industrial, commercial and domestic) making up approximately 1/3 of the total electricity demand.

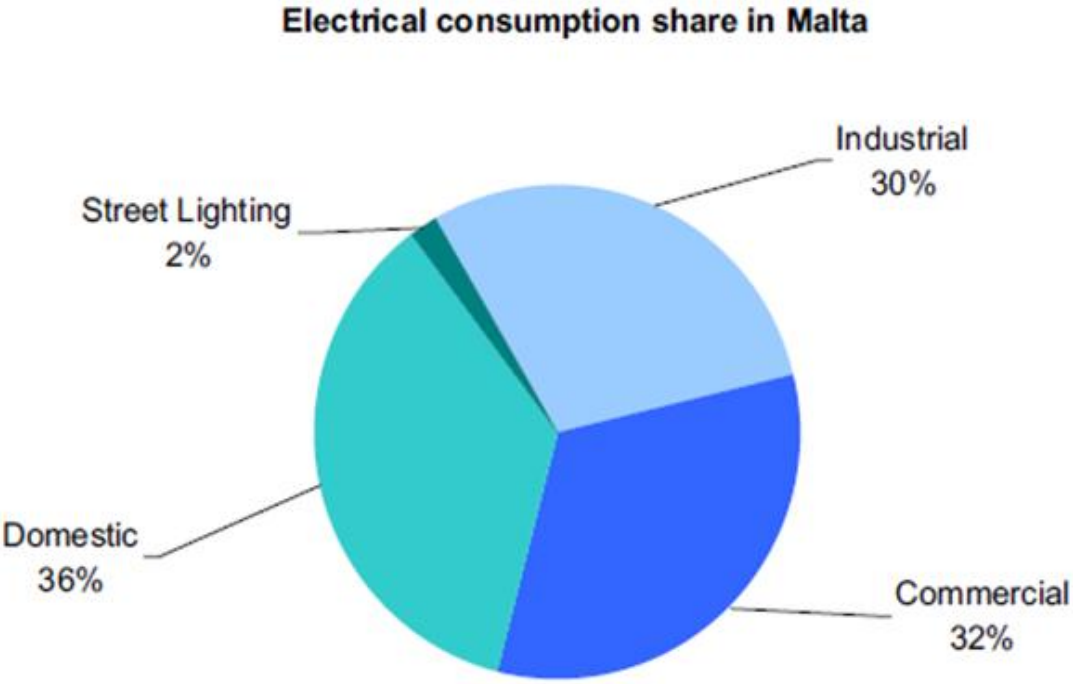


Chart 8: Electrical consumption for Malta-breakdown by sector in 2008 [13]

Chart 9 is a month by month average for the years from 1992-2003 showing the intra-annual monthly variations in power generation. These monthly power variations are mainly due to the influence of climate and tourism. For example, July and August are two of the hottest months (need for air conditioning) in Malta as well as the busiest with regard to tourism and reflect this as having the highest power demand; December and January are two of the coldest months which have relatively low tourism but have a high demand for heating.

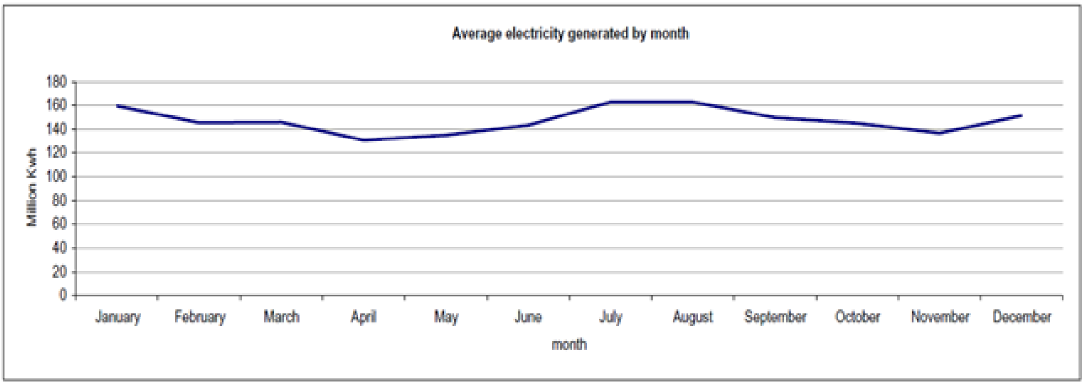


Chart 9: Malta average electricity generated by month for 2008 [14]

The table below highlights the spike in tourism in Malta over the last decade. In 1992, 17% less electricity was produced in July than was produced in February; however, in 2003, 19% more electricity was produced in July than was produced in February. With no major change in climate, it is possible to attribute these numbers predominately to the increased influx of tourists that occur in summer months as well as the surge in air conditioner installation.

Electricity generated (Million Kwh.)

Year	January	February	March	April	May	June	July	August	September	October	November	December
1992	137.3	129.3	126.3	108.8	108.2	107.3	117.5	120.1	114.6	116.1	109.3	124.3
1993	142.7	130.6	134.2	109.9	111.7	114.1	124.4	124.5	122.0	123.6	119.1	131.4
1994	141.2	129.5	125.1	117.7	121.1	123.8	137.8	136.8	134.6	130.7	125.4	136.8
1995	163.8	127.9	140.2	128.2	126.6	128.3	146.9	145.5	132.3	130.5	131.1	140.1
1996	147.7	147.5	148.4	122.8	126.5	128.9	146.3	150.2	137.7	130.8	126.1	142.0
1997	147.5	134.8	141.5	136.1	131.8	142.8	155.1	154.0	143.3	140.8	130.4	145.4
1998	155.8	134.9	145.5	129.0	132.1	141.5	161.3	158.5	145.8	142.9	139.3	158.7
1999	161.1	155.7	148.9	133.2	141.1	152.4	168.0	177.5	161.4	151.7	142.2	160.8
2000	181.7	161.8	156.7	137.6	146.5	153.2	178.5	181.3	164.6	154.4	144.7	153.0
2001	164.1	153.8	154.4	142.3	154.1	162.9	181.6	182.7	173.8	172.0	150.9	174.1
2002	188.4	153.4	155.6	148.8	155.9	173.1	204.4	198.4	179.1	168.2	157.8	173.2
2003	182.1	187.1	176.4	156.5	164.0	194.0	233.0	227.1	188.8	183.1	162.4	181.2
Average	**159.5**	**145.5**	**146.1**	**130.9**	**135.0**	**143.5**	**162.9**	**163.0**	**149.8**	**145.4**	**136.6**	**151.7**

Source: Enemalta Corporation

Table 6: Enemalta, historical average electricity generated by month [14]

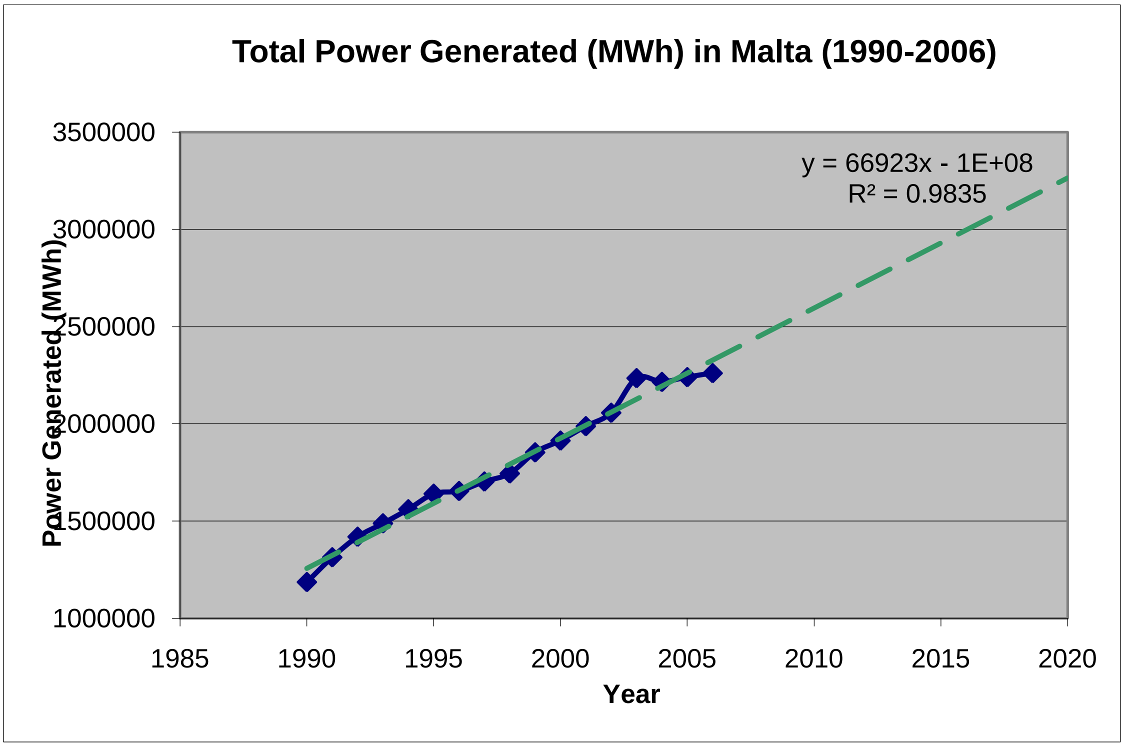


Chart 10: Historical power generated (MWh) in Malta for the period 1990-2006, plot based on last available Enemalta report

Forecasting power generation to 2020, a linear fit gave best extrapolation correlation with an R^2 value of 0.983 indicating a 98.3% fit to the 1990-2006 data. With this fit it is projected that Malta will have to produce a total of **3,250,000 MWh** to satisfy the Island's need for electricity. Note: this factors in "electricity losses" which are at nearly 14% of total; these losses are expected to be reduced with the coming installation of the Smart Meter System which is projected to eliminate theft from meters from the system. Furthermore transmission grid improvements are expected to greatly reduce electricity lost in transmission due to genuine power losses.

Malta Resources Authority (MRA) and Enemalta projections (Chart 11 and Table 7) of a "business as usual attitude" (where transmission and consumer end efficiency improvements are not made) confirm these conclusions.

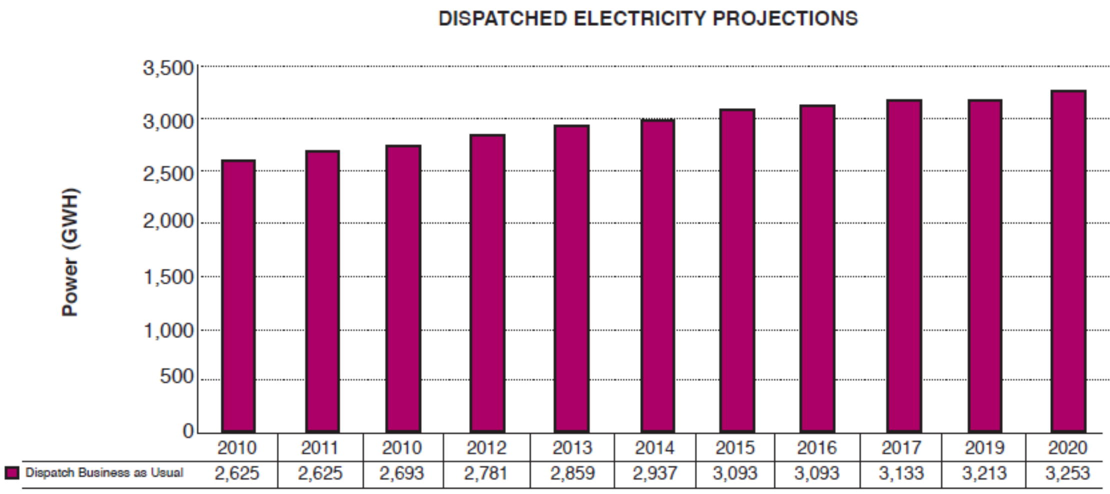


Chart 11: Future electricity production projections for Malta

Forecasts of Electrical Energy Consumption

Year	Generation - MWh
2005	2,263,145
2006	2,311,145
2007	2,389,145
2008	2,507,145
2009	2,625,145
2010	2,693,145
2011	2,781,145
2012	2,859,145
2013	2,937,145
2014	3,015,145
2015	3,093,145
2016	3,133,145
2017	3,173,145
2018	3,213,145
2019	3,253,145
2020	3,293,145

Source: Enemalta Corporation 2006b

Table 7: Future electricity production projection: Enemalta [10]

However, the years between 1990 and 2000 represented a period of unprecedented population and economic growth for the Maltese Islands, therefore, such a fit will be biased towards the earlier years' growth. Extrapolation of demographic data suggests that population growth will not be nearly as great as the previous period and therefore the next fit makes use of data from 2004 onward only. 2004 was a year in which Maltese consumers experienced several electricity price spikes and a change in the billing system which rewards lower consumption. The result of these price "shocks" was that demand slowed drastically.

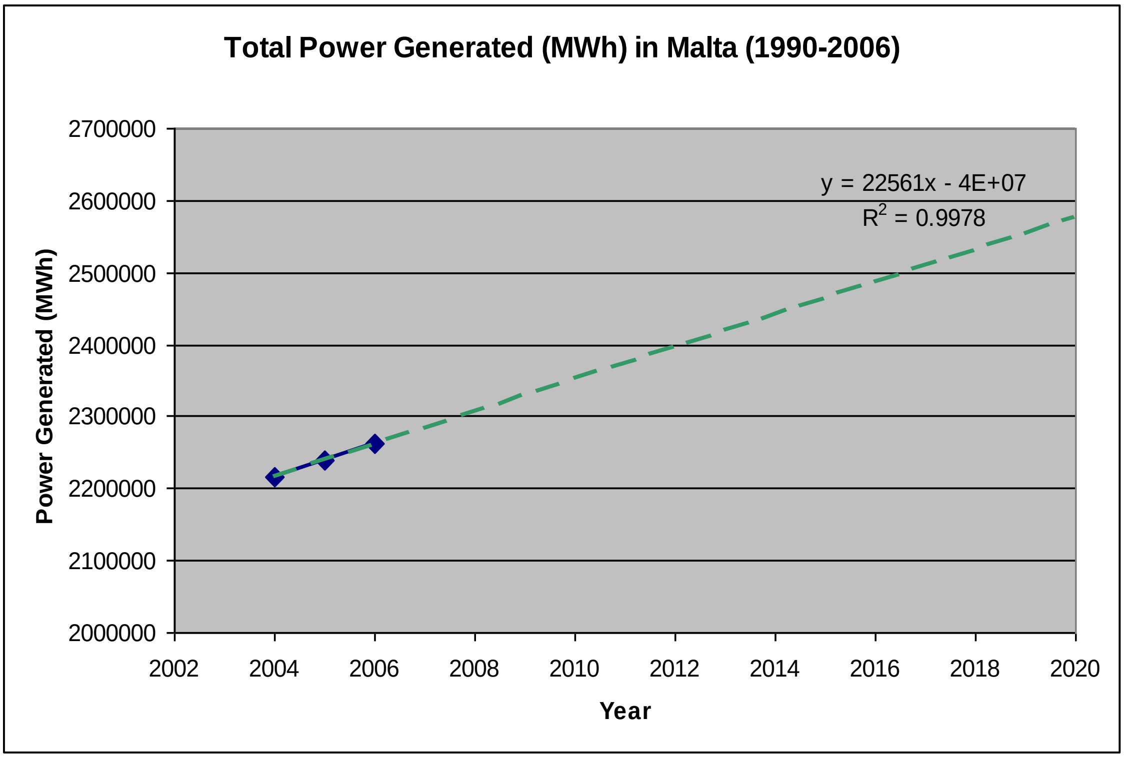


Chart 12: Forecasting Malta power demand based upon last three years of available data (a trajectory factoring in efficiency improvements)
Plot based upon latest available Enemalta report data [15]

With this dataset, a linear fit is the best forecast with a 99.78% correlation. Extrapolating to 2020 it is forecast that Malta will have to generate 2,580,000 MWh of electricity in order to satisfy demand. A situation such as this will only occur if energy efficiency improvements are made on a scale that the EU requires for Malta's 2020 targets and, as a result of the new price structure, consumers continue to be wary of high consumption.

In 1991 the average price of electricity for households was 21% cheaper than for industrial users. By contrast in 2006 the average price of electricity for households was 27% more expensive. In other words, this represents a change in government policies with regard to which sectors they preferred to subsidize. There has been an almost 50% increase of household prices versus industrial electricity prices with the result that residential consumers are more burdened with higher electricity prices to support the lower electricity prices enjoyed by industry.

Average Electricity Prices

	Industrial Users €/kWh	Households - €/kWh
1991	0.0654	0.0538
1992	0.0658	0.0541
1993	0.0591	0.0486
1994	0.0606	0.0498
1995	0.0588	0.0484
1996	0.0578	0.0476
1997	0.0596	0.0490
1998	0.065	0.0587
1999	0.0635	0.0573
2000	0.0675	0.0609
2001	0.0683	0.0617
2002	0.0698	0.0631
2003	0.0636	0.0652
2004	0.062	0.0636
2005	0.0706	0.0727
2006	0.0711	0.0904

Source: Eurostat, 2006

Table 8: Average electricity prices for industry and households 1991 – 2006 from Eurostat EC official statistics (last available) [16]

The energy intensity of the economy is an indicator of how energy efficient a nation's economy is. Thus, a very energy intensive economy requires a large amount of unit energy in order to produce a unit money of economic production. Lower energy intensity values represent economies that are more efficient or can also represent economies which have shifted from an energy intensive manufacturing and agriculture economy to a less energy intensive consumer and services economy.

The table below indicates that Malta has a highly energy intensive economy as shown in figures of energy intensity that are almost 50% over the EU 25 average in 2004.

Energy Intensity of the Economy (kgoe/1000 EUR)

	Energy Intensity of the Economy (Kgoe/1000 €)		
	Malta	EU 25	EU 15
1993	337.04	239.89	211.85
1994	310.28	231.34	206.10
1995	320.23	230.39	205.38
1996	339.67	234.98	209.35
1997	342.32	227.58	202.71
1998	347.70	224.16	201.03
1999	332.28	214.94	195.69
2000	303.23	208.76	190.53
2001	266.59	209.71	191.35
2002	263.88	206.51	188.42
2003	284.16	207.56	189.48
2004	292.35	204.89	187.48

Source: Eurostat, 2006

Table 9: Energy intensity of the economy for 1993 – 2004 (last available data) showing Malta compared with EU 25 & EU 15 Eurostat [16]

As can be seen on the chart below, Malta had an energy intensity of 300 kgoe / 1000 Euro in 2004 which is the same as it was in 1991. By contrast, the EU-15 had an energy intensity of 220 in 1991 which is now down to 180, following a linear downtrend. The indication is that the rest of Europe's economies have done more to improve their energy efficiencies over the last decade than Malta has done.

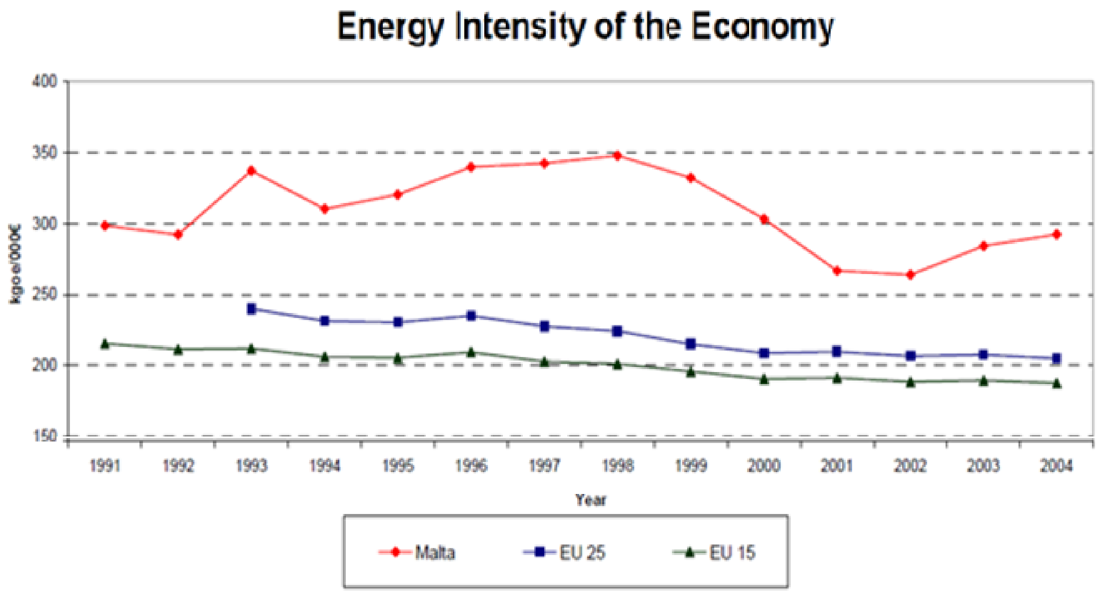


Chart 13: Graphical comparison of energy intensity of Malta's economy with the EU average (EU25 & EU15) [17]

V. Problems with Current Electricity Production

Effective Monopoly of Production

As discussed earlier, with Malta's accession to the European Union in 2004, the Malta electric energy market became liberalized. This market liberalization gives the right for other companies to compete in the Maltese energy market. However, with no electrical interconnection and a heavily entrenched market presence of the only producer (Enemalta) coupled with a small island state economy, it does not make economic sense for any other power company to try to establish a presence in Malta and compete in the energy market.

The problem with an effective monopoly, as has been proven time and time again throughout history, is that there is no incentive for improvement of quality and efficiency. A company with a monopoly has no need to improve its products as it has no competitor offering any alternative. The result in almost every case of market monopoly is a higher cost of poorer quality products passed on to the consumer.

On 23rd October, 2010 Enemalta was featured on the Times of Malta front page headline: **"Enemalta, WSC, buses top list of complaints"**. The index was based upon a European Commission survey the purpose of which was to identify markets that may be underperforming for consumers.

> **"The most recent EU survey released earlier this week in which the over whelming majority of Maltese identified the electricity sector as the most problematic the Island is facing due to lack of competition."**
> Ivan Camilleri, Brussels, Times of Malta, 23rd October 2010, page 1.

As will be discussed later, the Malta-Sicily interconnection may change this monopolistic dynamic.

Pseudo Private-Public Corporation

Enemalta "Corporation" exists as an independent entity in the sense that it should be responsible for managing itself in a way that makes the most business sense. Enemalta is not traded on the Malta Stock Exchange and the only equity holder in the company is the Government of Malta. This close link between Government and the Corporation means that the Government ultimately dictates company policies with regard to projects of large operational significance. Government decisions can often be politically motivated and do not always represent the best interests of the Country, but rather the best interests of the ruling political party, with the consequence that less than ideal decisions are sometimes made.

Eng. Charles Yousif observed in his work on Malta's Energy policy:

> **"Malta's concerned actors partly neglect the place but act according to personal motivation, perception and capacities…both the EU RE policy framework and the national interaction process influence the implementation process, which can lead to spatial mismatches."**

'*Spatial misfits in a multi-level renewable energy policy implementation process on the Small Island State of Malta'*. Kotzebue, Bressers, Yousif , University of Malta 2010. Reference Section II: Background **[3]**

Debt

Debt is a major burden on any company as it hinders the ability of a company to operate and develop effectively since capital and timeframe of investment are restricted to short-sighted results that relieve the burden of debt.

Due to Enemalta's monopolistic status, its financial status and health essentially represent the overall viability of Malta's power production. This is crucial as to why an analysis of Enemalta's financial health and how it has performed historically is important since it is possible to deduce forward looking trends on the Company's sustainability and thus the energy market of Malta. For the purpose of analysis the latest financial statement available from Enemalta was used which is for 2007. Emails sent to Enemalta asking where the subsequent financial statements could be found were unanswered.

The graph below is a plot of cumulative year by year losses incurred by Enemalta dating back to 2000. The Company suffered its greatest losses in 2008 and 2009 **[2]** when oil prices spiked to record levels and consumer prices were not raised sufficiently in order to compensate for the spikes in oil prices. In order for Enemalta to raise prices that

Maltese consumers pay for electricity, it must first obtain permission from the Prime Minister who is often very hesitant to permit any price hikes due to the unpopularity of such actions. A predictive down-trending exponential relationship fits the dataset most closely with a correlation factor of over 92%.

Since 2000, Enemalta has lost almost 90 million Euros and is expected to continue to lose even more money in the future unless serious policy changes are made.

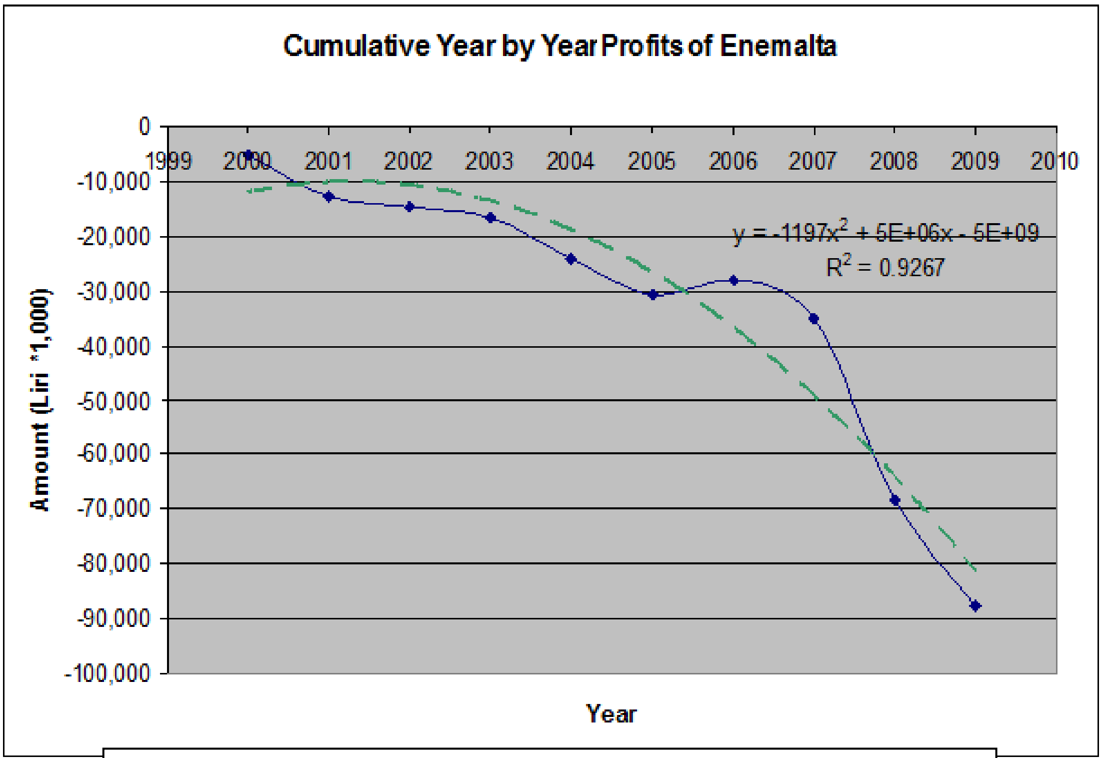


Chart 14: Cumulative year by year net loss of Enemalta showing an unsustainable downward financial trend [1] [2] Shown in Maltese Liri, (Euro/Lire conversion 2.42 Euro/Lire)

Enemalta Financial Reports 2000-2007: for the results of those years, the last available financial report is from 2007, therefore, information for 2008 and 2009 losses were taken from Maltese Minister Austin Gatt's presentation as shown in Parliament and as reported in MaltaToday.**[2]**

The chart below shows a plot of the price of crude oil with the cumulative losses of Enemalta since 2000 reflecting a very high inverse correlation between crude oil prices and the amount of fiscal loss for Enemalta.

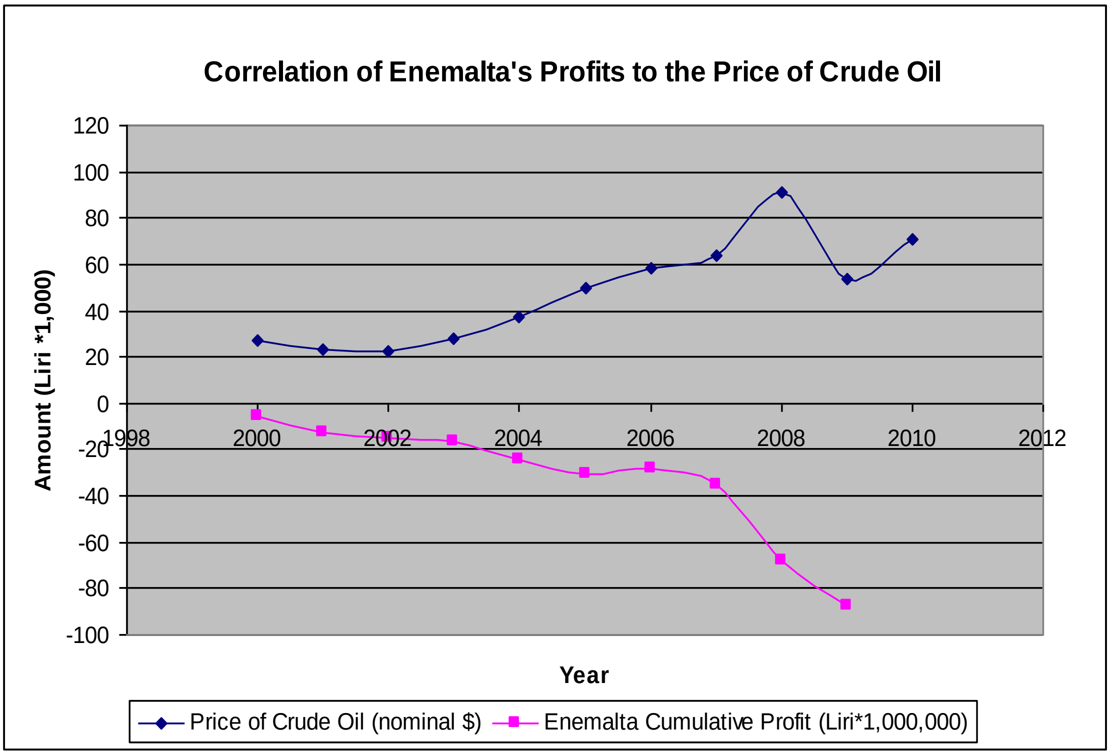


Chart 15: Enemalta profits as plotted against the price of crude oil [1]

The chart below is a plot of the profits for of the three divisions within Enemalta (Electricity, Petroleum, Gas Divisions) over the years. The Petroleum Division has been profitable historically, while the Electricity Division has been responsible for the bulk of the company losses. Losses in the Electricity Division are mainly offset by the Petroleum Division which has continued to be profitable. However, when operational costs are coupled with cumulative division profits one obtains the serial downtrend displayed on Chart 14.

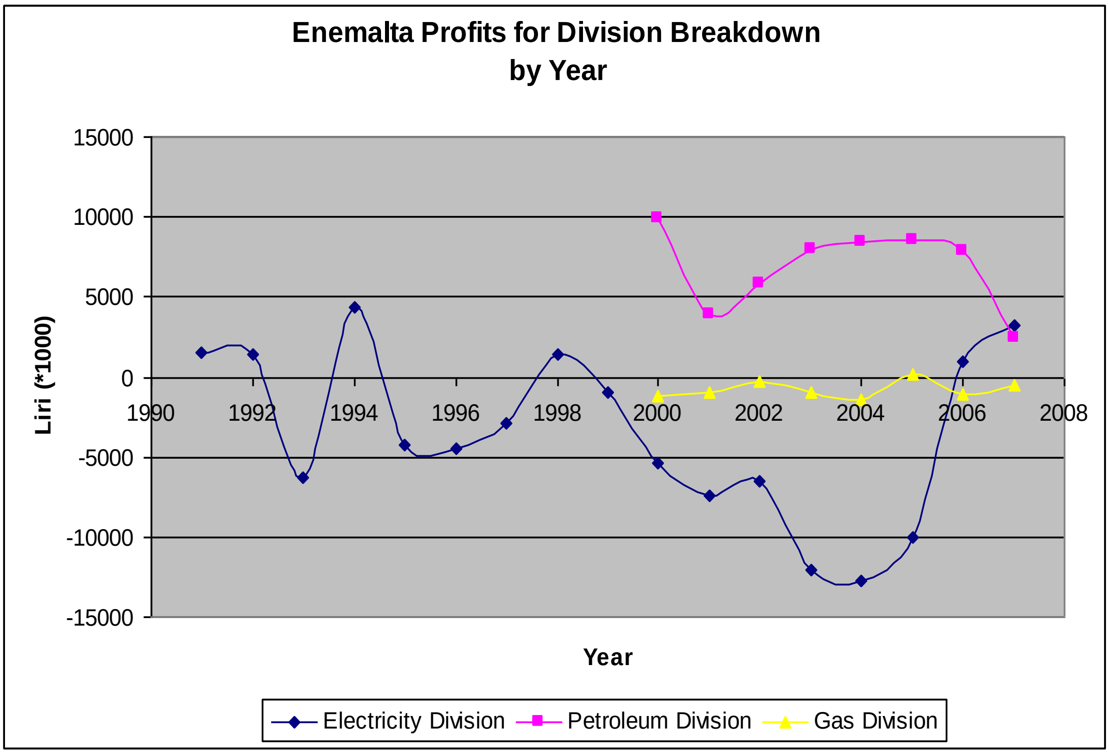


Chart 16: Enemalta profits by division [1] [3]

Liquid value of the company, as plotted in the chart below, is obtained by taking total current assets and subtracting them from total liabilities. The result is the liquid value of the company, i.e. the amount of funds that it can easily access and use. The implication of the down-trending graph located below on Chart 17 is that the company is becoming increasingly insolvent, further hindering its ability to operate successfully.

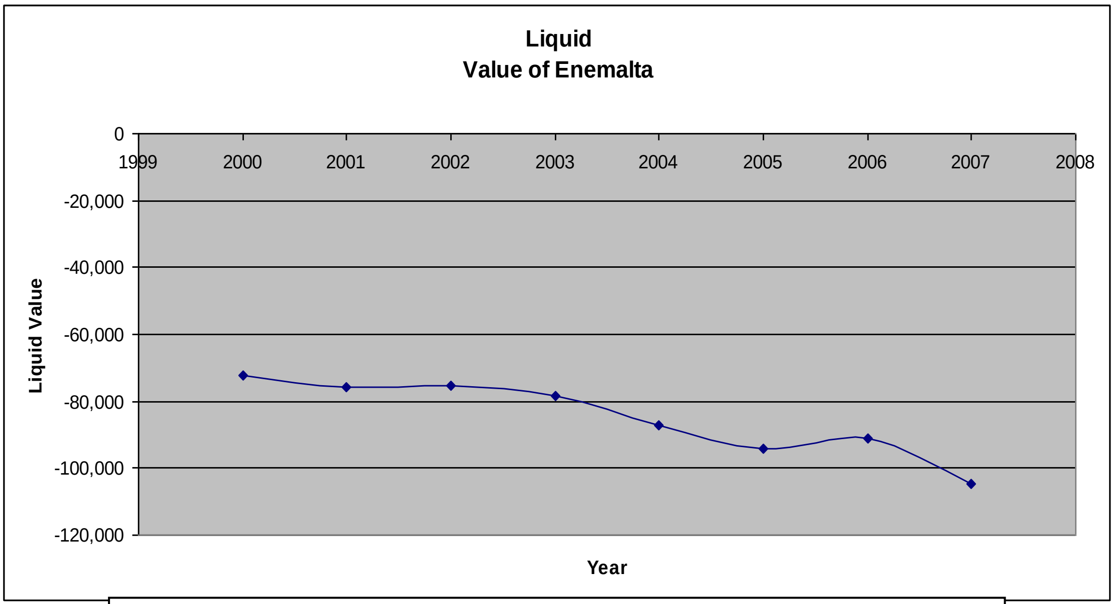


Chart 17: Liquid (solvent) value of Enemalta with time [1]

Losses in Distribution (Technical and Theft):

Among the 27 European countries Malta has the second highest power losses (behind Lithuania only) as a percentage of energy produced with over 13% transmission and distribution losses. Losses in transmission and distribution have been identified as a major problem for which there is significant room for improvement. Distribution losses of electrical energy will be discussed in detail in the next section as they are extremely significant.

Old Inefficient Power Production Facilities (Marsa):

The Large Combustion Plant Directive 2001/80/EC is applicable to all EU Member States. In order to prevent unacceptable environmental damage and harm to human health (cancer, asthma and bronchitis), the directive seeks to close down power stations that are deemed inefficient, which have emissions above those outlined as acceptable within the Directive. [4] The Directive specifies that power stations that do not meet the required emission standards have to either install appropriate pollution control equipment or close down once they have reached 20,000 hours of use.

Unfortunately, Marsa Power Station falls under the list of power plants which must be closed down due to its old equipment. As of March 2010 Marsa has used over half of its allocated operational hours **[5]** and current projections predict that the Plant will reach the 20,000 hour limit by the end of 2012. **[6]**

Several localities are being negatively affected by emissions from the Marsa Power Plant which lies within one of Malta's largest cities of Marsa and is within kilometers of many of Malta's largest urban centers. Neighboring areas of Floriana, Hamrun, Qormi, Paola as well as Marsa have all been described as being negatively affected by unacceptable emissions from Marsa. **[7]** The health ramifications can be seen when comparing the Regions of Malta; the South Eastern Region and Southern Harbour Regions of Malta have a significant health factor differential from other areas of Malta/Gozo. **[Appendix D1A1]**

In order to minimize the operational hours that Marsa uses, Enemalta has been operating units at Delimara at full capacity and uses Marsa as backup in order to handle load fluctuations. This load cycling has also indirectly resulted in the most efficient machines being used which has served to reduce the overall amount of CO_2 produced. **[8]**

With a high incidence of asthma and bronchial disease in the surrounding area that is often attributed to the nearby power station, it is imperative that Malta close down the Marsa Power Station as soon as is feasibly possible. **[9]**

Emissions

The table below lists the amount of CO_2 emissions per kWh of electricity generated. Malta has by far the highest CO_2 emissions for each kWh of electricity that is generated as compared with the other Member States analyzed. The significance of these figures is that they suggest that the power generation facilities in Malta lack efficiency when compared with the three other EU Member States shown in the table. Given that the three other countries use similar fundamental technologies for non-renewable energy production (combustion technology), then these figures show a direct correlation to efficiency of power generation. These significant differences in efficiency mean that a power station in Malta will have to use more fuel for each given kWh produced, resulting in a much higher cost of electrical production. In addition to a higher cost, other harmful gases (such as N_2O) will be emitted at a higher level resulting in other public health complications.

The matter of N_2O and dust particulate emissions is of a particular concern to Malta as Delimara and Marsa are located within highly urbanized areas and any emissions will cause a high proximate effect on the air quality of the surrounding regions. In Malta, the prevailing winds blow in a south-easterly direction; with Delimara on the South-Eastern tip on the Island the impact of emissions from the station on the rest of the Island is diminished. However Marsa is much more central and prevailing south-easterly winds pose a problem for urbanized areas (such as Tarxien, Zejtun, Zabbar and Qormi) that lie in the path of this trajectory. The prevailing wind is not always sustained and when variable winds occur then poor quality air can be blown in any direction, especially consequential to the most populated Northern parts of the Island.

Average Emissions in kgCO_2/kWh for Traditional Generation.			
Malta [8].	**Italy [10].**	**Spain [10].**	**UK [11].**
0.87	0.59	0.48	0.54

Table 10: Comparative emissions of CO_2 per unit power (cleanliness of energy) of traditional power generation for four EU countries

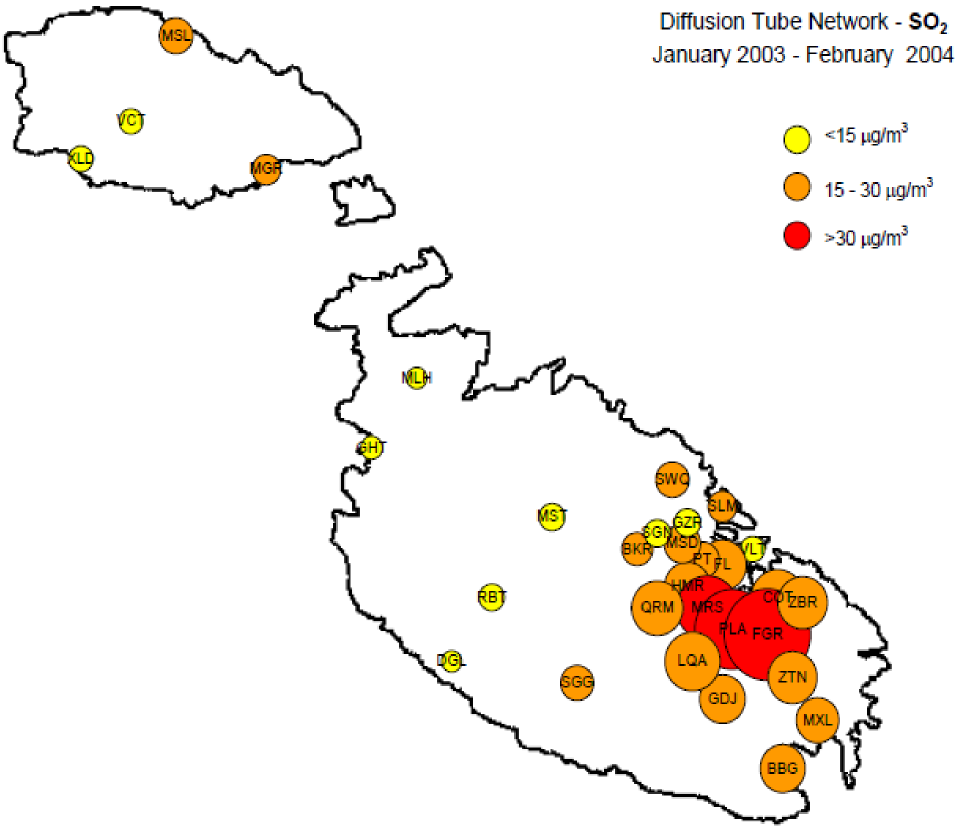


Figure 4: Malta SO_2 emissions volume as recorded in a 2005 study [12]

Figure 4 displays SO_2 emissions by volume recorded around Malta and Gozo; the area around Marsa has by far the highest levels of SO_2 (a precursor to acid rain and contributor to cancer and other health impairments). **[12]**

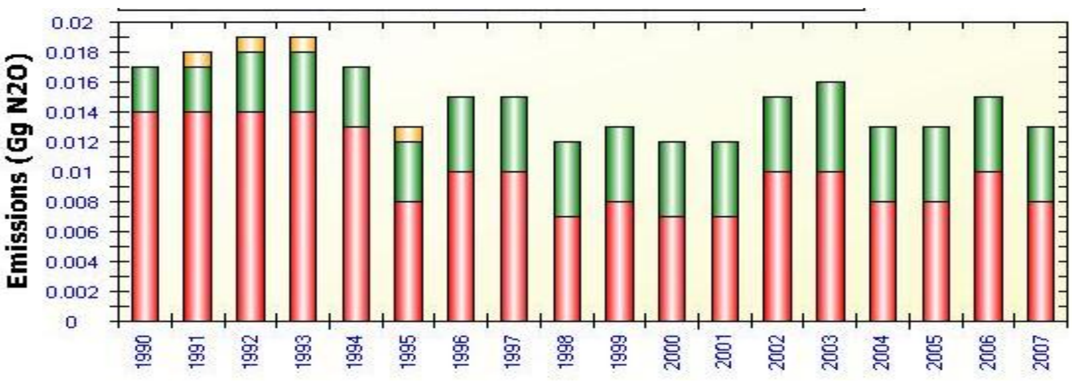


Chart 18: N_2O emissions in Malta by sector, Key: Red represents Energy Industries, Green represents Transportation Yellow represents Commercial, Institutional, Residential [13]

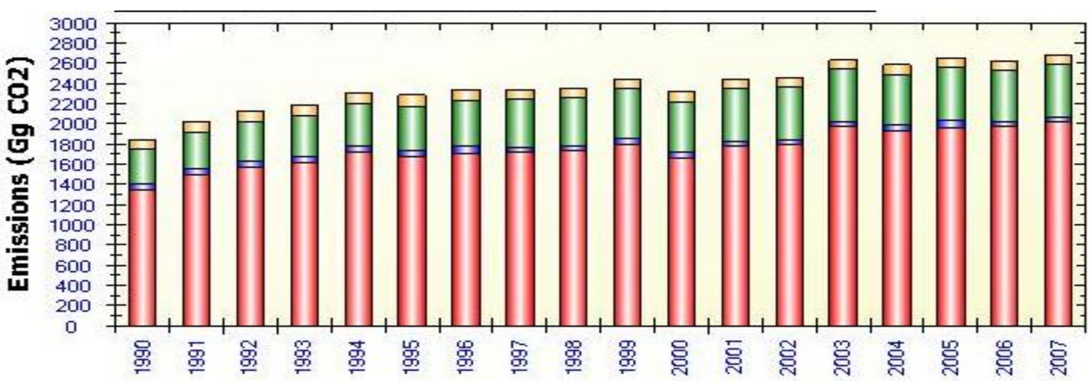


Chart 19: CO_2 emissions in Malta by sector, Key: Red represents Energy Industries, Blue represents Manufacturing Industries, Green represents Transportation, Yellow represents Commercial, Institutional, Residential [13]

Energy Shortfall (if Marsa Power Station is closed in 2012):

Delimara currently has a power generation capacity of 304 MW; with the addition of the 144 MW extension which is expected to be completed by 2011, it would bring Delimara up to a total capacity of 448 MW. As discussed earlier, the 267 MW station at Marsa has a finite number of hours (20,000) to run before it will be required to close or face fines. With over half these hours already expended, at current rates of consumption it is predicted that the station will exceed the 20,000 hours by late 2012 and face closure.

The consequence of such a closure can be predicted by using historical peak load demand and forecasting into the future.

Peak load refers to the maximum amount of electrical demand experienced by a grid. The Maltese grid has no control over individual consumer consumption and thus must keep electrical production capacity over consumption at all times. In the event of a major technical fault (such as boiler failure) which causes production to be unexpectedly and suddenly dropped, then it can lead to a nation-wide blackout. So far in 2010, there have been two nation-wide blackouts that have been responsible for millions of Euros in economic damage. **[14]** Due to the consequence of blackouts it is essential to have a production capacity that is reliable and is capable of consistently producing electricity over projected peak demand.

Chart 20 below, illustrates that Malta has historically experienced peak load demand during the winter period. However, with the rapid growth in the tourism industry (which is mainly active during summer) as well as an increase in installation of air conditioning units, peak loads from 2006 onward have been experienced during summer.

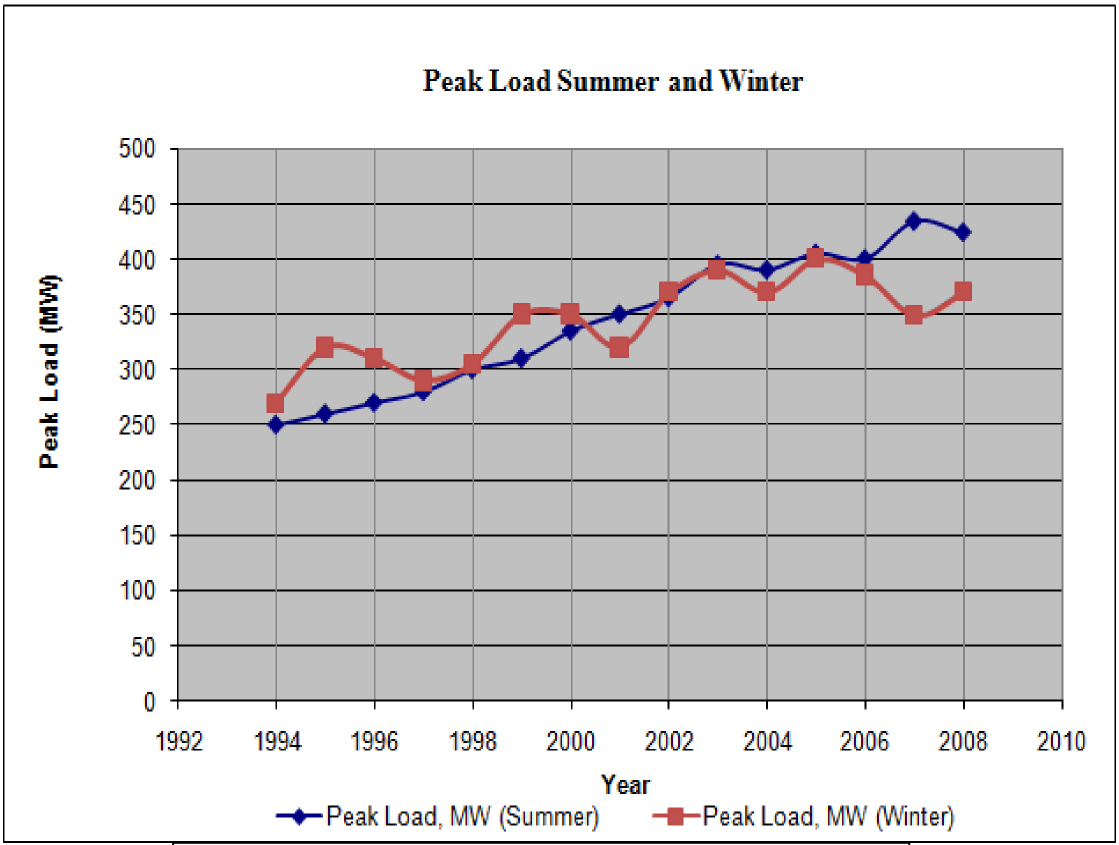


Chart 20: Peak load for summer and winter [15]

The chart below shows the maximum peak load for each year and projections to 2020. A good linear correlation was obtained which fit the data at a 92% confidence factor and this can be used to predict future peak loads. Peak load in 2012 is expected to be 480 MW while peak load in 2020 is expected to be 560 MW. The forecast 2012 peak load is higher than Delimara's capacity (including extension) which means that additional power generation capacity must be installed before Marsa can be shut down. The solution to this additional load demand is the installation of the 200 MW Sicily – Malta interconnection. Such an interconnection must be installed and operational well before Marsa is forced to shut down, before it has used up its allocated 20,000 operational hours in order to allow for a smooth transition of power generation.

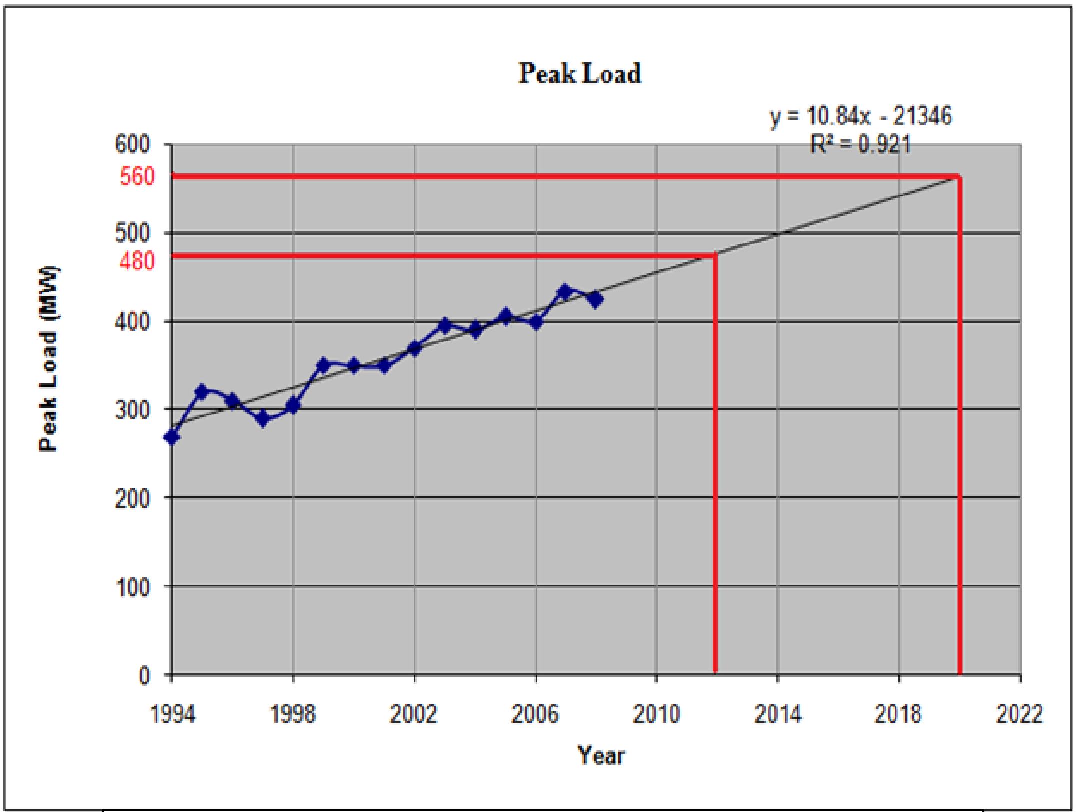


Chart 21: Malta peak load projections forecast to 2020 [15]

Delimara with extension (448 MW) and Malta-Sicily interconnection (200 MW) would give the Island a total capacity of 648 MW. The contribution from renewable sources with regard to capacity is more difficult to calculate as it can fluctuate dramatically from sub 10% to values over 40%.

With an average hourly production of 371 MW projected for 2020, if it is assumed that Malta will reach its goals of 10% renewable share by then, it will require that 37.1 MW/hr average will be provided from renewable sources. This would increase effective total island capacity to (648 + 37.1) 685.1 MW. However, power contribution from renewable sources can fluctuate dramatically on an hourly, daily or monthly basis. For example, wind speeds can be low enough to cause a wind farm to produce at less than 10% of capacity and incident sunlight at night time can reach effective zero values causing solar production to generate at 0% of capacity. Therefore, one must be careful when considering installed renewable energy base as capacity since, if peak load occurred at a worst case scenario (late afternoon, low winds), then renewable contribution as a percentage of its efficiency could be 10% or less. With efficiency factors on average of 25% then this will result in an effective installed renewable base of 14.8 MW.

If a worst case renewable production scenario (10% efficiency) is considered for the occurrence of peak load, then at the time the Island would have an effective total capacity of 662.8 MW (14.8 + 648).

With peak load forecast to be over 560 MW by 2020, the gap between generation capacity and peak load would be only 102.8 MW (662.8 – 560 or 15.5%) which would leave no room for machine failure. It is an accepted rule in power production that a country should have capacity well over peak load (over 20%) and enough back up systems such that it can afford the failure of one system without plunging the entire grid into black out.

If for any reason there is a failure of the interconnection or of the Delimara extension at these projected times of peak load demand then supply would plunge below demand and result in a nation wide blackout. With the increased demand projected by 2020, the extension and interconnection by themselves are not adequate when the importance of energy security and reliability is factored in. This indicates that Malta will have to consider another option (in the range of 140 – 200 MW) to bolster its power production capacity by 2020.

There is very little reason to achieve the 20-20-20 goals if by 2020 the power capacity situation is not adequate, resulting in a system prone to blackouts during peak load situations. Malta has two options in order to bolster its reliable energy capacity: boosting local production capacity or increasing capacity via the installation of an additional interconnection. If the Delimara extension is considered as a model example for the bolstering of local energy capacity then this can be compared to the installation of an additional interconnection and the relative strengths of the two options considered.

VI. How Should the 2020 Goals be Achieved?

With the bankruptcy of the US Investment banking firm Lehman Brothers in September of 2008, the world financial system was on the precipice of collapse, and was only saved (albeit temporary) by the extraordinary 'quantitative easing' measures taken by the central banks of the major countries. The EU was forced to set up a guarantee package of close to a trillion Euros in order to save some Member States from sovereign debt default in 2010. The viability of these measures is still in doubt, and the outcome will seriously affect the ability of Malta to finance the projects envisioned in this dissertation. It is well beyond the scope of this dissertation to predict the future availability and cost of money which hinges on this outcome. This dissertation therefore addresses each analysis with respect to the economics, the environmental impact, and the sociological impact of the projects considered in a normal, non-crisis setting.

2020 Scenarios (Analysis of Economic & Environmental consequences)

Four comparison studies in order of importance to reach 2020 targets:

1. Power Losses in Electrical Transmission and Distribution Systems

Transmission and Distribution Losses in General:

Electric power systems are typically composed of an electric power generating facility connected to a transmission system which then connects to a distribution system which supplies power to the end user. The power supplied to the transmission system is net of the power used by the generating facility itself. The transmission system transmits power at high voltage (usually >100,000 Volts AC) at distances up to thousands of kilometers. For shorter distances (<50 kilometers) lower voltages are used (for example, 32,000 Volts AC). The voltage is then stepped down (to 100-400 volts AC) for use in a distribution system which distributes to many end user customers. Transmission and distribution power losses (TPL) in general represents the discrepancy between the energy produced by the utility (Eg) the net of self consumption (Ec) and the energy sold to end user customers (Es) and is represented as:

$$TPL = Eg - Ec - Es \qquad (1)$$

From equation 1 above the total energy either lost or self consumed by the producer in a system (TPL + Ec) is then:

$$TPL + Ec = Eg - Es$$

Transmission and distribution power losses as a percent (TPL%) of that which is transmitted from the power station (Eg-Ec) is then:

$$TPL\% = [TPL/(Eg-Ec)]*100 \qquad (2)$$

In the USA in 2007, national-level TPL% losses were 6.5% of total electricity disposition excluding direct use: **[1]**

Table 11
Transmission and Distribution Power Losses (2000) by Region in Percent, [2]

Region	# of Countries	TPL %
Western Europe	**17**	**7.56**
Eastern Europe	24	18.18
Middle-east, North Africa	11	19.63
Africa	11	19.55
North America	3	9.38
South America	9	17.23
Central America, Caribbean	9	21.68
South Asia	5	27.55
Southeast Asia	7	12.14
East Asia, Australia	6	7.65
	Total 102	Mean 16.22

Comparing the TPL% of a reasonably efficient and well regulated country such as the USA to the TPL% of countries around the world, and because TPL is taken right off of the top of the utility's turnover, TPL can represent a very significant worldwide indicator. For example, the average of 27.55 TPL% for South Asia is 323% higher than the 6.5 TPL% for the U.S. The spectrum of worldwide TPL losses vary widely, from a small, efficient system with negligible pilferage such as Luxembourg where the TPL% is 1.42% (Table 13) to a very large, inefficient system with large endemic pilferage such as has been reported in India's capital city of Delhi with a TPL% of 42%. **[3]**

The amount of power lost in a system has a very significant effect on the billing tariff to the customer. In order for the utility to pay its expenses and make a reasonable return on investment, the customers must pay for all of the power generated regardless of how much is lost. In order to simplify and make more relevant to this topic we will only consider losses from the point of transmission from the power station. Let us assume that the proper billing rate for a utility operating with no energy losses is Bo in Euros per kWh. Then the new billing rate Bn for that utility in order to receive the same income as before with a loss percent rate of TPL% is:

$$Bn = Bo*[100/(100-TPL\%)] \qquad (3)$$

The percent increase in the billing rate (Br%) is:

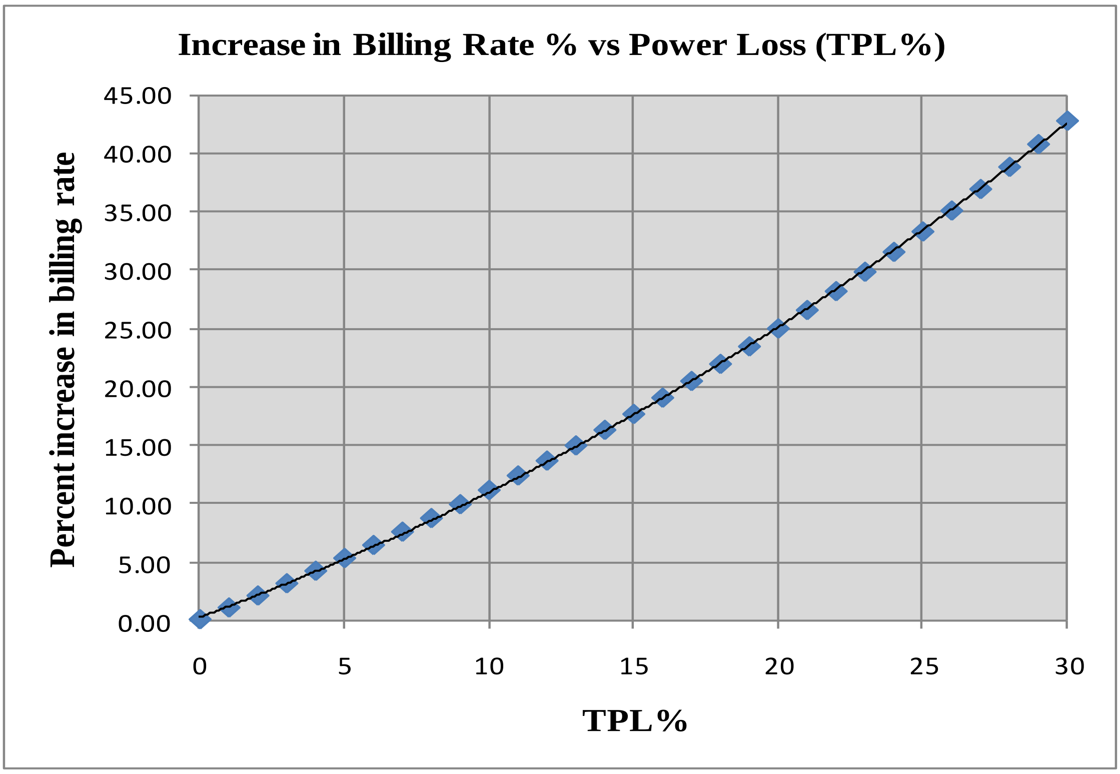
$$Br\% = [(Bn-Bo)/Bo]*100 \qquad (4)$$

Substituting for Bn from equation 3 into equation 4 we have Br% as a function of TPL% :

$$Br\% = \{[100/(100-TPL\%)]-1\}*100 \qquad (5)$$

Br% is plotted as a function of TPL% in Chart 22 below:

Chart 22



As can be seen in Chart 22, the slope of the curve increases as TPL% increases, such that a 30% energy loss rate produces a 43% increase in the billing rate.

In the EU, TPL%'s vary significantly from the 3.45% of a country such as Finland with a very efficient system and a low amount of pilferage to the 12.29% of a country such as Bulgaria with an inefficient system and a high rate of pilferage: **[Table 13]**

Transmission and Distribution Power Losses are the sum of two types of power loss- Technical (TTPL) and non-Technical (NTTPL):

$$TPL\% = TTPL\% + NTTPL\% \qquad (6)$$

Technical Transmission and Distribution Power Losses (TTPL) are power losses caused by technical factors such as: Resistive heat losses in transmission and distribution lines, transformers, and other equipment due to electrical resistance; magnetic losses, where energy dissipates into a magnetic field; and the dielectric effect, where energy is absorbed in the insulating material. In alternating current circuits, the inductance and capacitance of the phase conductors can be significant. This causes reactive currents which cause additional losses in the transmission circuits. TTPL can be reduced and optimized by installing capacitors in key areas in order to improve the power factor, transmission lines can be upgraded to a higher voltage in order to reduce resistive heat losses, and more efficient transformers and other equipment can be installed. In AC transmission systems efficiency can be improved by using transformers to step up the voltage for transmission and then using transformers to step down the voltage for final distribution to the end users. This reduces the electrical current in the transmission conductors while keeping the power transmitted nearly equal to the power input. According to Joule's Law ($Q = I^2*R*t$) the energy losses are proportional to the square of the current; reducing the current by a factor of two will lower energy lost to conductive resistance by a factor of four. Long distance transmission (thousands of kilometers) of electricity can be cheap and efficient. In the U.S. costs are US$0.005-0.02/kWh. **[4]** It is impossible to eliminate all TTPL, however by the use of efficiently designed systems and with equipment of high efficiency the losses can be minimized.

Non-Technical Transmission and Distribution Power Losses (NTTPL) are all transmission and distribution losses which are not TTPL. The largest component of NTTPL is pilferage. **[5]** The theft of electric power is a loss right off the top of the revenue stream of the power company such that even a 1% theft loss, which is very low, results in a serious bottom line loss. For example if the power company had profits of 5% of turnover, then even a 1% theft loss would cause a 20% profit loss and a 5% theft loss would cause a 100% profit loss. Because of this leverage onto the bottom line, those power companies that are privatized have put great effort into reducing theft losses. In the past, before the big push to privatize when the power companies were owned and operated by governments, theft was hushed up and swept under the rug in order to satisfy political aim**s**.

As explained previously, NTTPL% losses vary widely worldwide from less than 1%, up to 42%. Typically, power companies are allowed as per a regulatory framework to earn a certain return on investment (ROI). This means that it is the bill paying consumers who pay for all of the theft, which means that tariffs in countries such as India are very high, which leads to more theft.
Therefore electric power theft and tariffs are a positive feedback system.

Electric Power Losses for Malta:

Transmission and Distribution Power Losses (TPL) for Malta:

For Malta the following data were collected from the annual report for Enemalta **[6]** for the fiscal year 2006/7 (the last published annual report) showing the electricity generated, transmitted and distributed in kWh:

Table 12
Electricity Produced (kWh) by Destination

Used in station	132,646
Industrial	650,542
Domestic	645,040
Commercial	529,593
Street Lighting	28,796
Lost in Distribution and Unaccounted for	279,486
Total	2,266,103

With reference to Table 12 above, TPL% for Enemalta for fiscal year 2006/7 (the last published annual report) using formula 2 is then:

TPL% (Enemalta) = [279,486/(2,266,103-132,646)]*100

= 13.1%

This suggests that Enemalta's TPL% is 101.5 % more than the 6.5% average for the USA as stated above and is 71.2% more than the Western European average of 7.61% as in Table 11 above.

Electric Power Transmission and Distribution Losses for the EU countries:

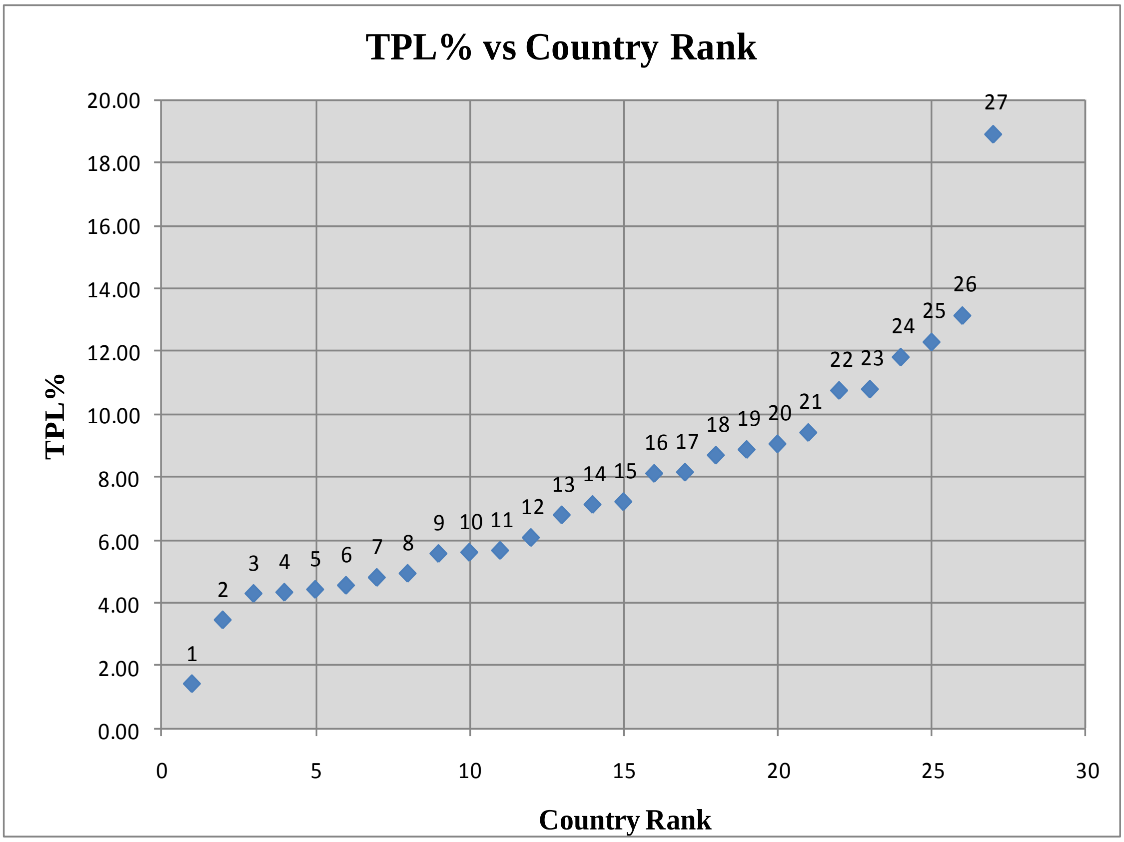
Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage. The TPL% for the EU countries for 2004 is shown as a ranked Table 13 and graphed as a scattergram, Chart 23 below: **[7]**

Table 13
TPL% for EU Countries (2004)

1	Luxembourg	1.42	15	Sweden	7.21
2	Finland	3.45	16	Ireland	8.11
3	Netherlands	4.29	17	United Kingdom	8.15
4	Slovakia	4.33	18	Spain	8.69
5	Denmark	4.42	19	Greece	8.87
6	Cyprus	4.55	20	Portugal	9.05
7	Belgium	4.80	21	Poland	9.41
8	Austria	4.93	22	Romania	10.75
9	Slovenia	5.56	23	Estonia	10.79
10	Germany	5.60	24	Hungary	11.81
11	France	5.66	25	Bulgaria	12.29
12	Czech Republic	6.07	**26**	**Malta**	**13.13**
13	Lithuania	6.79	27	Latvia	18.90
14	Italy	7.12			

Mean 7.64 Median 7.12

Chart 23



Latvia (27) is the only outlier. The mean value as calculated is 7.64, and correlates well with the Western European figure of 7.56 in Table 11. The TPL% of 13.13% for Malta in Table 13 above correlates well with the TPL% (Enemalta) of 13.1% as calculated from the Enemalta annual report data shown in Table 12. Malta is ranked 26 out of 27 EU countries and is 72% higher than the mean. Malta has a land area of 316 km^2 [Appendix A2] and is the smallest country in the EU. The next smallest EU countries are Cyprus and Luxembourg with land areas of 9251 km^2 and 2586 km^2 respectively. Malta's very short transmission distances should allow Malta to have a lower TPL% than Cyprus or Luxembourg. Malta's TPL% is however 835% higher than Luxembourg and 189% higher than Cyprus.

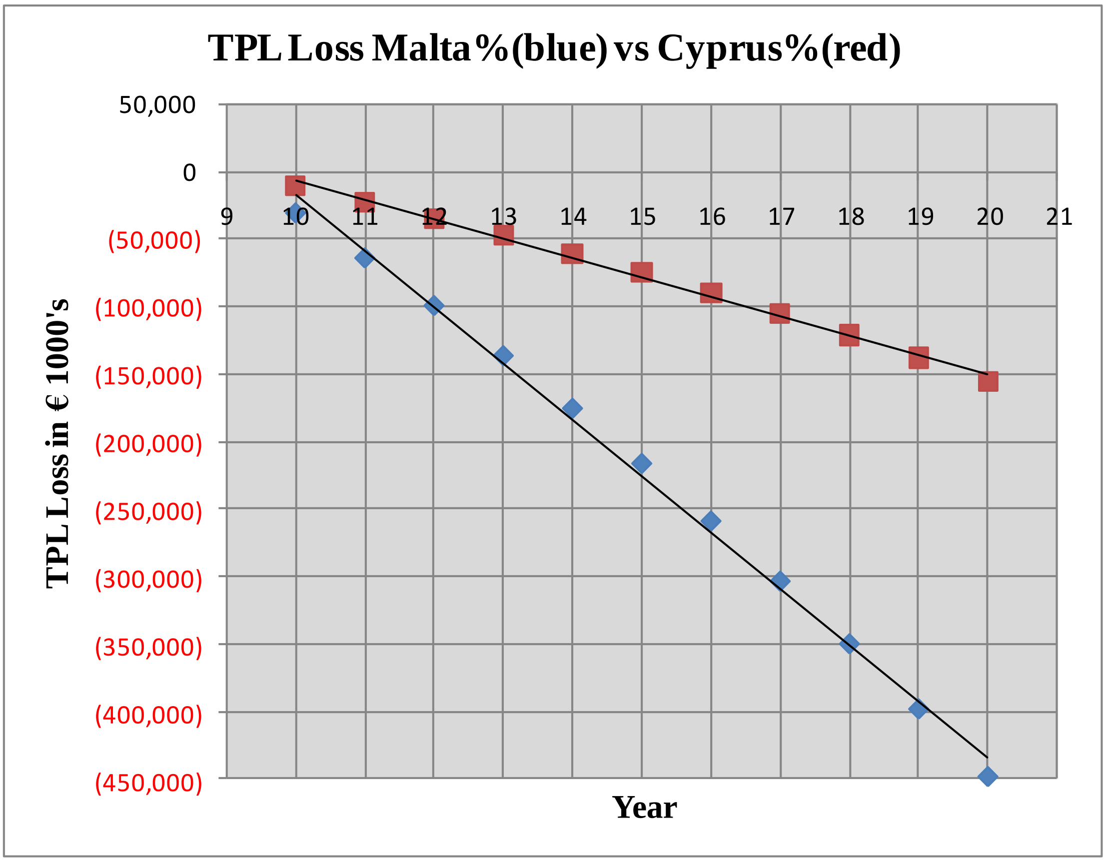
Using the turnover projections from Appendix B, Table B1; Table 14 is constructed as shown below. The TPL losses in Euros are projected to 2020 using the present TPL% loss rate for Malta of 13.1%, as compared to the TPL losses for Mata if it had the TPL% rate of Cyprus (4.55%) as shown in Table 13 above.

Table 14

	Turnover	TPL%		TPL%			
	Projected	Malta		Cyprus			
Year	€ 1000's	13.1	Cum	4.55	Cum	Difference	Cum
2010	240,084	(31,451)	(31,451)	(10,924)	(10,924)	(20,527)	(20,527)
2011	254,211	(33,302)	(64,753)	(11,567)	(22,490)	(21,735)	(42,262)
2012	268,338	(35,152)	(99,905)	(12,209)	(34,700)	(22,943)	(65,205)
2013	282,465	(37,003)	(136,908)	(12,852)	(47,552)	(24,151)	(89,356)
2014	296,592	(38,854)	(175,761)	(13,495)	(61,047)	(25,359)	(114,714)
2015	310,719	(40,704)	(216,466)	(14,138)	(75,185)	(26,566)	(141,281)
2016	324,846	(42,555)	(259,020)	(14,780)	(89,965)	(27,774)	(169,055)
2017	338,973	(44,405)	(303,426)	(15,423)	(105,388)	(28,982)	(198,037)
2018	353,100	(46,256)	(349,682)	(16,066)	(121,454)	(30,190)	(228,228)
2019	367,227	(48,107)	(397,789)	(16,709)	(138,163)	(31,398)	(259,625)
2020	381,354	(49,957)	(447,746)	(17,352)	(155,515)	(32,606)	(292,231)
		(447,746)		(155,515)		(292,231)	

The projected, undiscounted cumulative losses are then displayed in Chart 24:

Chart 24



The undiscounted excess cumulative loss difference is €292,231,000 as per Table 14 and Chart 24. The blue squares are the TPL losses at 13.1% (Malta), and the red squares are the losses at 4.55% (Cyprus).

Malta therefore has the combination of a technically inefficient power transmission and distribution system and a high rate of pilferage (see Table 16 and [9]) compared to similarly situated EU countries.

Technical Transmission and Distribution Power Losses (TTPL) for Malta:
The Ministry for Resources and Rural Affairs report **[8]** has projected future increased efficiency in the transmission and distribution system, and less losses due to self consumption as per the following Table 15:

Table 15
Forecasted TTPL for Malta

Year	Est. Ec	Est. TTPL%
2010	5.48	5.0
2011	5.49	4.9
2012	4.86	4.8
2013	4.59	4.7
2014	4.39	4.6
2015	4.20	4.5
2016	4.07	4.4
2017	4.09	4.3
2018	4.04	4.2
2019	3.87	4.1
2020	3.83	4.0

Enemalta is planning by the use of improvements and upgrades to decrease self consumption by 30% and to decrease TTPL by 20% over the next 10 years. Applying these projected percentages to the projected Electrical Division turnover from Appendix B, Table 1, results in gross, undiscounted savings over the 10 year period (2011-2020) of €37,944,000 for the self use reductions and €18,644,000 for the TTPL% reductions.

All possible technical upgrades should be implemented where it can be shown that the discounted present value of the benefit is significantly greater than the present cost of the improvement.

Non Technical Transmission and Distribution Power Losses (NTTPL) for Malta:
Pursuant to their annual reports **[6]** Enemalta has conducted surprise inspections at randomly selected sites. The data is summarized in table 16 below:

Table 16
Compilation of Enemalta inspection results

Inspection Year	Sites Inspected	# of Tampered Meters	%Tampered
2007	12,668	585	4.6
2006	10,198	500	4.9
2005	8,000	305	3.8

These randomly selected, surprise inspections disclosed and brought to light close to a 5% tamper rate. No mention is made in the Enemalta annual reports concerning the detection of pre meter mains tap-ins, or underbilling due to meters that have not been read due to malfeasance by meter readers.

The Malta Sunday Times on November 13, 2008 in an article by Caroline Muscat and Herman Grech **[9]** stated a 13% TPL% for 2008, with a TTPL% of 6%, and a NTTPL% of 7%; these figures were confirmed by three independent analysts. From the 2008 Enemalta annual report the turnover for the Electricity Division was €202,607,000 and the operating profit was €7,386,100. The loss, using the 7% NTTPL% in Euro terms, was €15,249,850, which is approximately 200% of the operating profit. This means that if the NTTPL could be eliminated, the cost of electricity to Enemalta's paying customers could be reduced by 8.56% (see Table 17).

The total energy lost in a system is the sum of the energy consumed at the generating plant plus TTPL plus NTTPL. However, in order to make the following analysis relevant to just transmission and distribution, we consider only losses from the point of transmission from the power station. We assume then that the paying customers pay for 100% of the power transmitted from the power plant. Combining equations 5 and 6 we have:

$$Br\% = \{[100/(100-TTPL\%-NTTPL\%)]-1\}*100 \qquad (7)$$

Using the value for TTPL% of 6% from above, we then have the increase in the billing rate as a function of NTTPL% with TTPL% held constant:

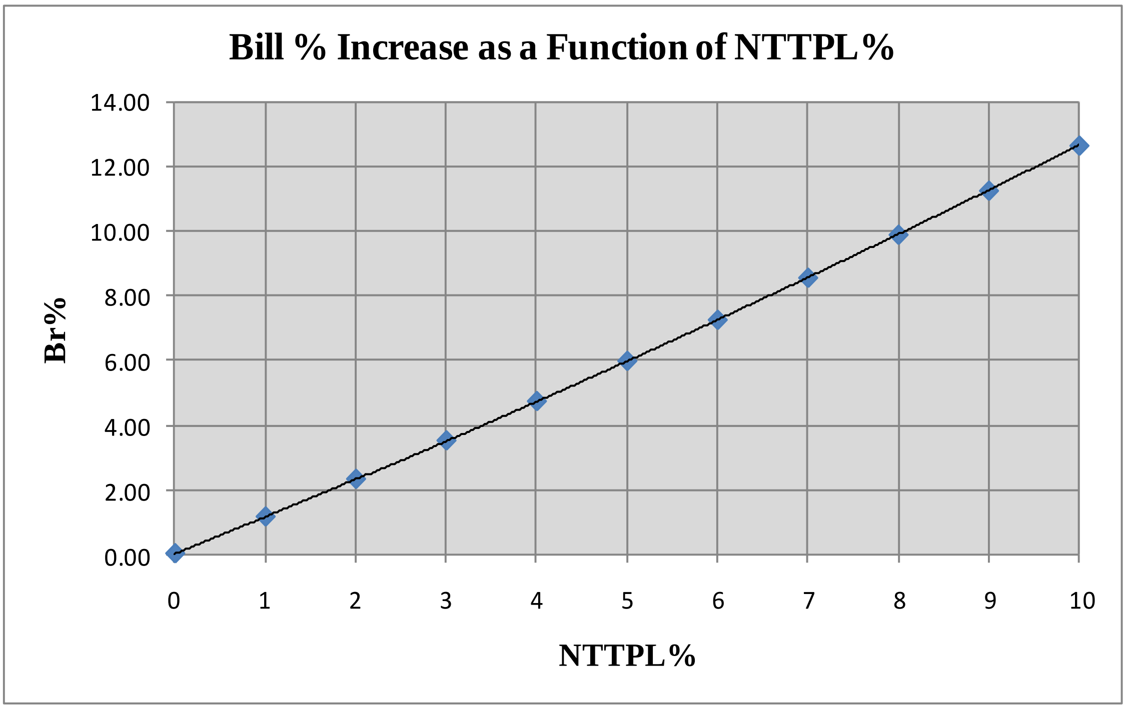
$$Br\% = \{[100/(94-NTTPL\%)]-1\}*100 \qquad (8)$$

The values of Br% were then computed for NTTPL% from 0% to 10% and are shown below in Table 17, column 1. Listed in column 2 as displayed in Chart 25 are the increases in Br% caused by NTTPL% less the constant Br% caused by TTPL% = 6% which can be seen to be 6.38% in column 1:

Table 17
Percent increase in billing rate due to TPL & NTTPL losses

NTTPL%	1	2
0	6.38	0.00
1	7.53	1.14
2	8.70	2.31
3	9.89	3.51
4	11.11	4.73
5	12.36	5.98
6	13.64	7.25
7	14.94	8.56
8	16.28	9.90
9	17.65	11.26
10	19.05	12.66

Chart 25



The 7% NTTPL% rate in Malta then produces a 8.56% increase in the billings for all of the bill paying Maltese vs. if there were no NTTPL.

Because of the significant size of the NTTPL problem for Enemalta, it would be prudent to spend appropriate sums to reduce or extinguish the problem. There are four basic methods for dealing with theft and fraud:

Methods for Dealing with Theft and Fraud

i. Investigation and Surveillance:

Based upon an hourly wage of €10 and estimating the inspection process with a duration of five hours, the cost of each inspection is approximately €50. Using the cost of inspecting each meter and cost of each tampered meter at €1000 per year, then the benefit of the inspections to Enemalta is estimated at:

Cost of inspections- 10,000*€50 = €500,000

Value of saving = net present value of €1000 for 10 years at 5% interest rate:

NPV= €7,722

Using 500 (5 %) tampered meters per 10,000 inspections:

= €7,722*500

= €3,861,000

Profit from each 10,000 inspections = €3,861,000 -€500,000

= €3,361,000

If these assumptions are close to reality then it is imperative that this profit potential be harvested by greatly increasing the number of inspections.

ii. Technical Methods:

The installation of new smart meters will not only eliminate meter tampering which is quite easy with the present electro-mechanical meters **[9]**, but will also provide real time information in order to implement real time energy balance and expedite the integration of all billing and accounting functions. Algorithms will be used to detect illegal loads almost immediately and narrow the investigation to just one user. A great deal of effort is presently being undertaken by utilities worldwide to detect theft and fraud in energy systems through the use of Artificial Neural Networks, Support Vector Machines, and other computer systems **[10]**. The elimination of meter tampering is a big step, but it does not solve the problem of tapping into the mains before the meter. The computer oriented systems mentioned above will hopefully help in this regard. It will be very difficult to detect theft when the mains are already tapped into in order to provide free energy for only part of a user's needs leaving the rest on the meter. It must be anticipated that smart thieves will obtain information concerning the detection algorithms and will design their theft accordingly.

The Smart Grid is estimated to cost €71,000,000 **[11]**. The following is an estimate of the value of this system from the standpoint of the meter theft savings alone. We assume that the Smart System will reduce meter theft from 5% to 1%, and that the total gross revenue stream to the Electric Division of Enemalta is € 3,417,909,000 over the 11 year period 2010-2020 (from Table B1 Appendix B). The gross undiscounted savings due to the reduction in meter theft over the 11 year period is then € 136,716,000. The discounted net present value of the 4% savings stream at a 6% use of money rate is €95,445,000. **This means that the entire cost of the Smart Grid can be recaptured from theft loss savings alone.**

iii. Honesty and Transparency in Governance and Human Development:

Most thieves in some way excuse their actions. The most common being that if they see nepotism, graft and corruption at the top of the political structure, then ***"if they are doing it why not me?"***

Corruptions Perceptions Index (CPI) vs. Transmission and Distribution Power Losses (TPL%):

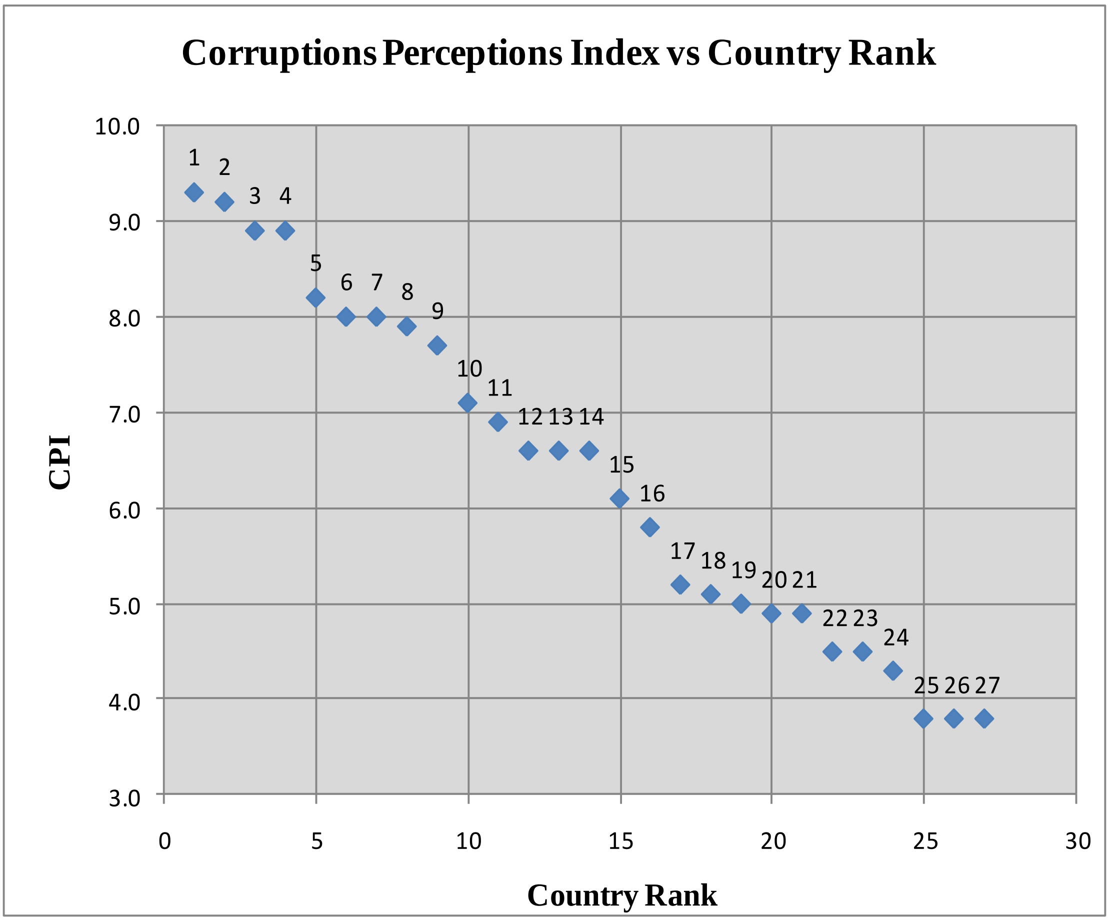
Transparency International is a well respected organization that rates 180 countries of the world with a Corruptions Perceptions Index (CPI). This CPI indicates the perceived level of public-sector corruption in a country/territory. The CPI is based on 13 independent surveys. The data for all EU countries was constructed from the worldwide CPI listing **[12]**, and the resultant data Table 18 and scattergram Chart 26 are shown below:

Table 18

1	Denmark	9.3			
2	Sweden	9.2	15	Spain	6.1
3	Finland	8.9	16	Portugal	5.8
4	Netherlands	8.9	**17**	**Malta**	**5.2**
5	Luxembourg	8.2	18	Hungary	5.1
6	Germany	8.0	19	Poland	5.0
7	Ireland	8.0	20	Czech Republic	4.9
8	Austria	7.9	21	Lithuania	4.9
9	United Kingdom	7.7	22	Latvia	4.5
10	Belgium	7.1	23	Slovakia	4.5
11	France	6.9	24	Italy	4.3
12	Cyprus	6.6	25	Bulgaria	3.8
13	Estonia	6.6	26	Greece	3.8
14	Slovenia	6.6	27	Romania	3.8

Mean 6.36 Median 6.6

Chart 26

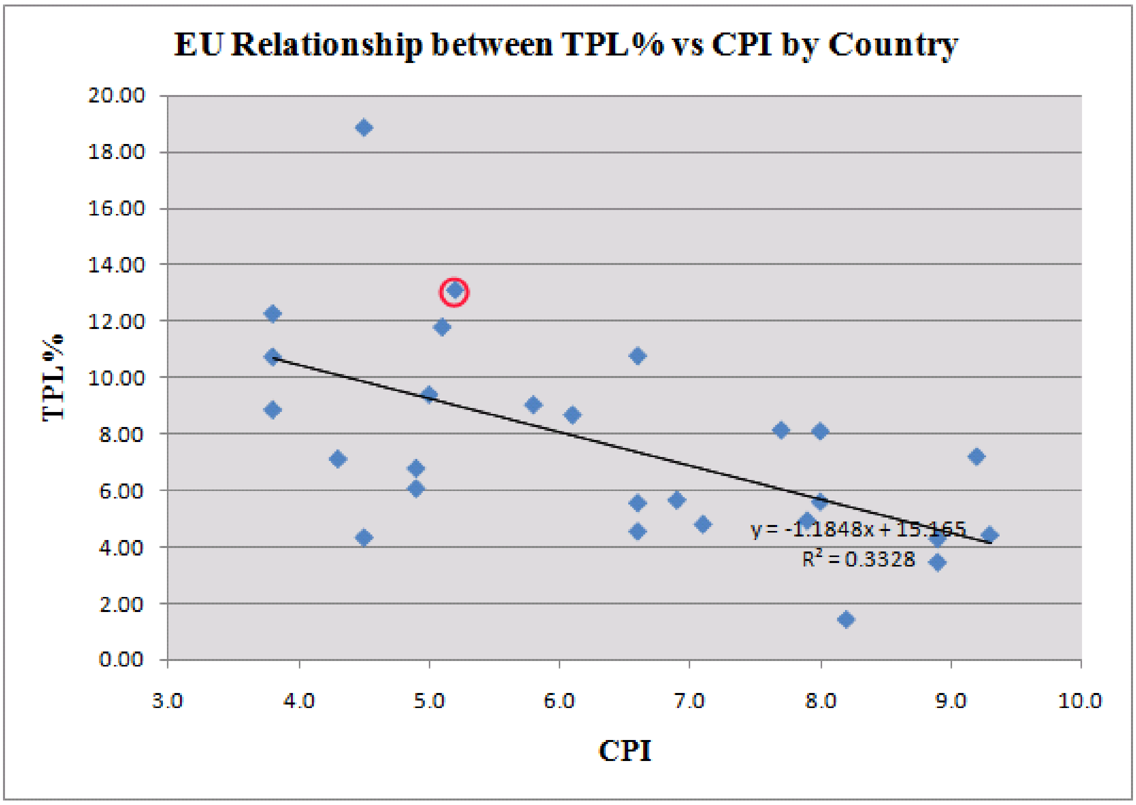


In table 18 above, Malta is ranked 13 out of 19 (not 27 because of ties), with Denmark at the top (least corruption), and Romania at the bottom (most corruption). The data is smooth with no outliers. Using an Excel spread sheet the correlation coefficient between the CPI data in Table 18 and the TPL% data from Table 13 for the 27 EU countries is calculated to be r = -0.577. The t is then computed using the formula:

$$t = r/(\text{sqrt}[(1-r^2)/(N-2)]) = -3.53$$

The non-directional probability of the null hypothesis is then 0.00163. This indicates a significant inverse relationship and is illustrated in the scattergram, Chart 27 below:

Chart 27



Malta: red

With reference to Chart 27 above, the linear trendline equation is:

TPL% = -1.1848*CPI+15.165. If Malta were on trendline with its present CPI of 5.2, it would have a TPL% of 9.0%. With a present turnover of €240,084,000/annum [Appendix B] this would result in an annual savings of €(13.1-9.0)*240,084,000/100 = €9,843,444. If Malta could increase its CPI to 7.0 and stay on trendline, this would result in reducing its TPL% to 6.87%, which would result in an additional annual savings of €(9.0-6.87)*240,084,000/100 = €5,113,789. If Malta could both increase its CPI to 7.0 and stay on trendline, there would result total annual savings of €14,957,233.

Human Development Index (HDI) vs. Transmission and Distribution Power Losses (TPL%):

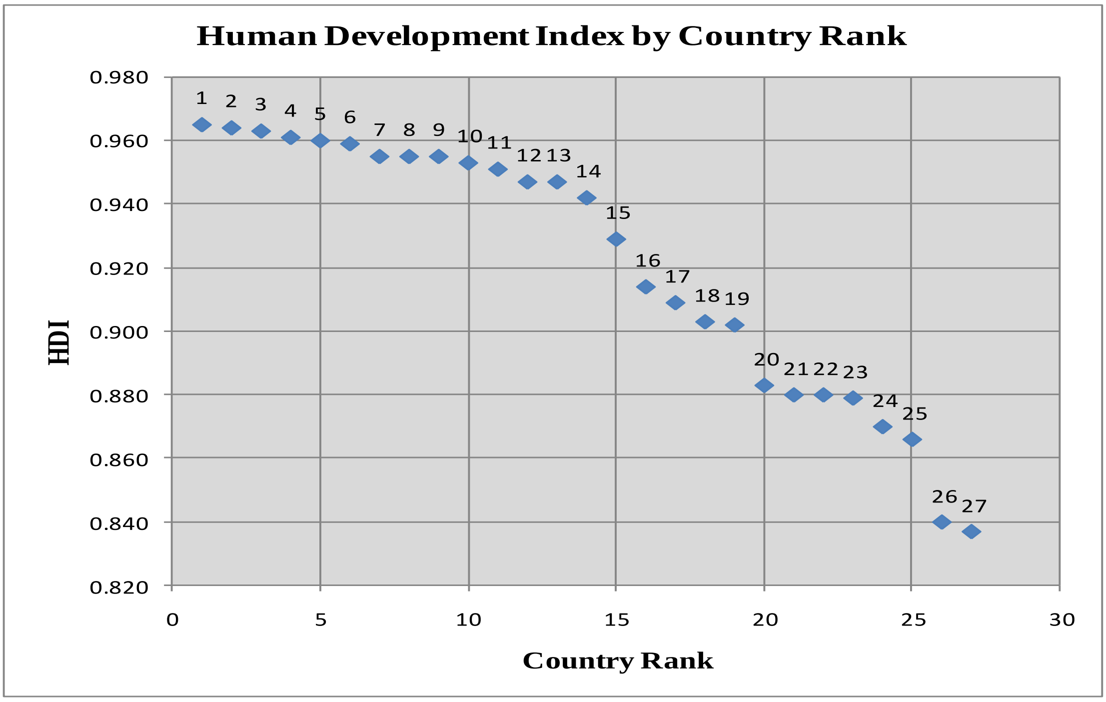
The United Nations Development Programme publishes the Human Development Index (HDI) which is a measure of the average achievements of a country in three basic dimensions of human development: a long and healthy life, knowledge and a decent standard of living. **[13]** The data for the EU countries are taken from a list of 182 countries calculated in 2007, and is shown in the Table 19 below together with a scattergram of the data in Chart 28:

Table 19

1	Ireland	0.965	15	Slovenia	0.929
2	Netherlands	0.964	16	Cyprus	0.914
3	Sweden	0.963	17	Portugal	0.909
4	France	0.961	18	Czech Republic	0.903
5	Luxembourg	0.960	**19**	**Malta**	**0.902**
6	Finland	0.959	20	Estonia	0.883
7	Austria	0.955	21	Poland	0.880
8	Denmark	0.955	22	Slovakia	0.880
9	Spain	0.955	23	Hungary	0.879
10	Belgium	0.953	24	Lithuania	0.870
11	Italy	0.951	25	Latvia	0.866
12	Germany	0.947	26	Bulgaria	0.840
13	United Kingdom	0.947	27	Romania	0.837
14	Greece	0.942			

Mean 0.921 Median 0.9

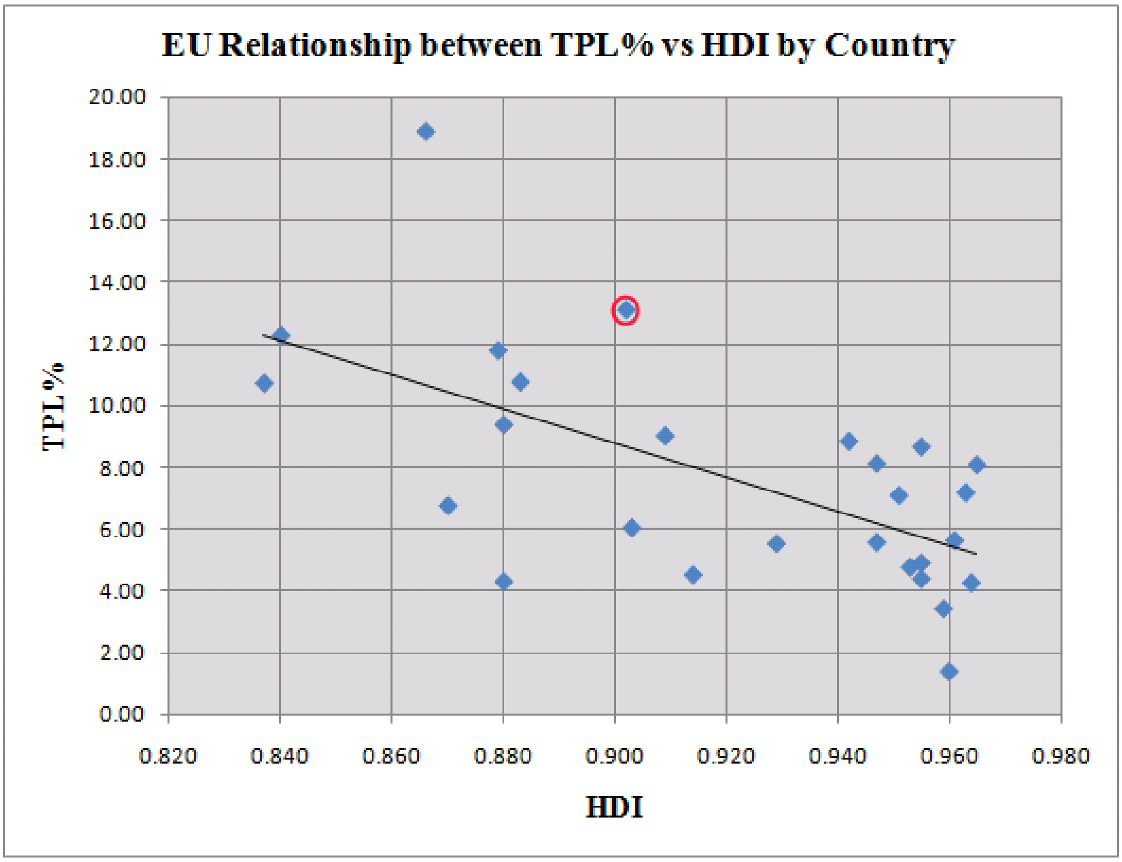
Chart 28



Malta is ranked 16 out of 23 (not 27 because of ties), with Ireland at the top (high human development scores), and Romania at the bottom (low human development scores), Using an Excel spread sheet the correlation coefficient between the HDI data from this Table 19 above and the TPL% data from Table 13 for the 27 EU countries is calculated to be r = -.619. The value t is then computed using the same formula as above to be -3.94 and the probability of the non-directional null hypothesis is then .000577.

This indicates a significant inverse relationship and is illustrated in the scattergram Chart 29 below:

Chart 29



Malta: red

The correlation coefficient between the data sets for HDI and CPI is 0.755. HDI and CPI are therefore highly correlated with a non-directional probability of the null hypothesis of <0.0001.

In the analysis above it has been shown that for the 27 EU countries there are significant correlations between both the level of corruption (positive correlation) and the human development (negative correlation) of a country and to the amount of electrical power loss in their transmission and distribution systems. Reducing corruption and increasing human development in a country is certainly very difficult to implement; however, if only partially successful it would engender benefits not only for this energy loss problem, but would greatly advance the quality of life for the people of Malta. The political system in Malta should be updated such that there would be real transparency in governance such that the people could have more confidence in their leaders. The reflection of honesty and transparency at the top would project less patience with dishonesty among the citizens.

iv. Public Relations Programs:

It is recommended that Enemalta spend at least €3,000,000 per year on a public relations program to explain to the Maltese people that a theft from Enemalta is not a theft from some foreign entity, but is a theft from the people of Malta who pay their bills. Church and other ethical teachers would be enlisted and supported to convey the message that electricity theft is just as wrong as for example stealing a car. Success with these measures will add much needed financial strength to Enemalta, which will be of vital importance in fulfilling Malta's future energy needs.

An International Utilities Revenue Protection Association (IURPA) has been established to promote the detection and prevention of power theft. (1) website- http://www.iurpa.org. They have regional revenue protection groups, but the United Kingdom is the only EU country that has formed a regional group- website- http://www.ukrpa.co.uk. Malta should perhaps form a regional protective group.

2. Interconnectors versus the addition of Local Production Capacity (Delimara Extension)

In this paper we have identified the need for additional power capacity in addition to that which is already planned (in the section Energy Shortfall). It is important to identify the best option for this additional capacity. By choosing the best option for this additional capacity in order to achieve the "20-20-20" goals, it will make the eventual complete transition to a renewable base that much easier.

The reason why renewable production is not considered a viable option for expansion of base load capacity is due to the variability in their electrical outputs. A base load capacity source must be consistent in that if it is a 150 MW source then it must be able to produce at full capacity within a few hours. In order for a wind farm to guarantee 150 MW of production it would have to be over 1500 MW (Mott Macdonald 2009) which is simply not viable for the Maltese Islands. Solar sources also cannot be considered since their production essentially stops during the night. Therefore, until an efficient means of storing electrical energy in very large quantities is developed, renewable sources cannot be considered as alternatives for base load or emergency power production capacity. The viable options for expansion of Malta's electrical capacity are either:

i. Expansion of local non-renewable capacity
ii. Undersea interconnections

The Delimara Extension has been promoted by the Maltese government and Enemalta as the best option for expansion of local power production, and therefore will be used as an analogue for the best option for expansion of local capacity. The Malta-Sicily interconnection was billed as the best option for interconnection and therefore will be used as an analogue for the best option for interconnection.

The criteria for choosing the best option will include economics, environmental impact and reliability. No recent study has been performed which compares the relative merits of the two options, so derivations and a certain amount of assumptions (which will be explained) had to be made in order to produce meaningful results.

i. The Delimara Power Extension

Planned Expansions to Existing Non-Renewable Production Infrastructure

The Delimara expansion is a 144 MW combined cycle diesel set of 8 x 18 MW piston engines and one 10 MW steam turbine which will have operating efficiencies of up to 55%, compared to an average of 28% operating efficiency of other steam and gas units. The Danish company BSWC (Burmeister and Wain Scandinavian Contractor A/S) was awarded the contract for the construction and five year maintenance contract of the extension for a total cost to Enemalta of €183 million. This project is expected to be completed in 2011. **[1]**

The cost of electrical energy generation with the BWSC diesel engines, factoring in current fuel prices is expected to be €c12.467 per kWh. CO_2 emissions generated by diesel engines are 0.5894kg / kWh whilst CO_2 emissions generated by gas engines are 0.5605kg / kWh, making the difference negligible. **[1]**

According to Enemalta, the Delimara power extension would result in a total reduction of dust emissions, reduce the annual emissions of CO_2 by 470,000 tons, NOx by 2,300 tons and SO_2 by 6,300 tons due to abatement technology and high efficiency equipment. Additionally annual fuel consumption would be reduced by 218,000 tons. **[2]**

Unfortunately with the addition of a “confidentiality clause” within the BWSC / Enemalta contract, more detailed information concerning the project cannot be found, and statistics have to be taken at face value as provided by Enemalta. The confidentiality clause includes a provision that would cost Malta a significant amount in fines should details of the contract circulate without permission from BSWC. Such a confidentiality clause is unprecedented for the construction of a power generation facility in Malta (and anywhere else for that matter) and its inclusion has given rise to much public criticism regarding the project. **[3] [4]**

Criticism of the project:

The Labour Party opposition and the public have voiced criticism of the project on multiple occasions. They have expressed the opinion that Enemalta should have pursued gas-fired technology and that the use of heavy fuel oil will be detrimental to public health.

A University of Malta Department of Physics Professor, Edward Mallia had urged not to use HFO (Heavy Fuel Oil) in the extension since Malta does not have the infrastructure to dispose of the estimated 14,000 ton/year toxic sludge byproduct created by the burning process. The waste would have to be transported away from the facility, which according to the original Environmental Impact Assessment (EIA) could cost up to €12 million per year. **[5] [6]**

ii. The Malta-Sicily Interconnection:

In 2010 the contractor ABB was chosen to install a submarine interconnector between Malta and Sicily, as well as the auxiliary power infrastructure. The cable system will be a “high voltage AC three-core submarine XLPE cable operated at 220 kV”. **[7]**

The landing points are Pembroke in Malta and Marina di Ragusa in Sicily as can be seen in the figure below of the proposed 95 km submarine cable route.

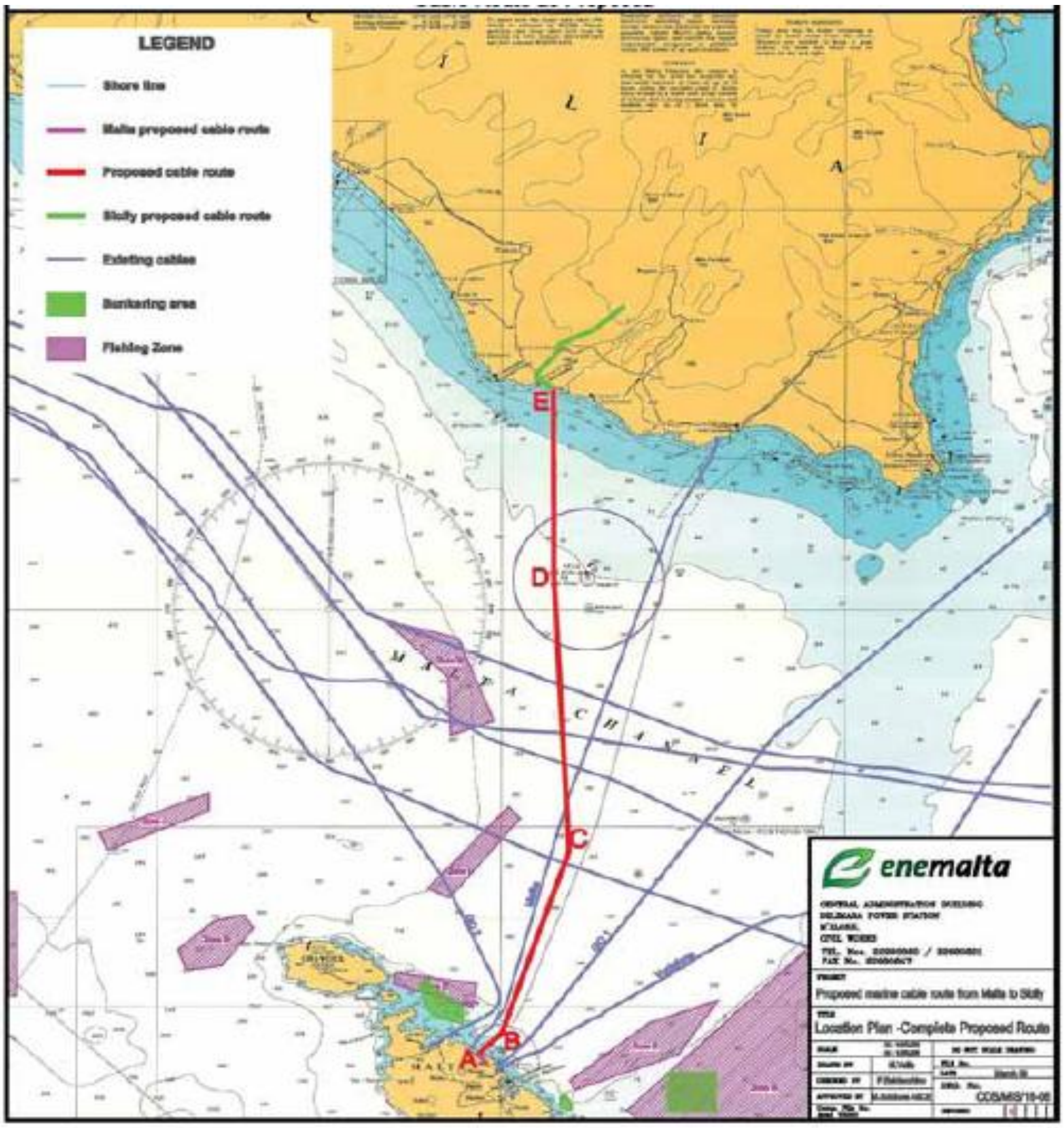


Figure 5: Depiction of the proposed submarine route from Sicily to Malta [7]

The first submarine-cable connection and supporting infrastructure are expected to be completed by the end of 2012 for a total cost of €150 million. The contract has provisions for the installation of an additional cable for an additional €150 million at a later date. Malta has received €20 million as a grant from the European Commission for the interconnector project, as well as an additional €5 million for its small isolated island status. **[8]**

Directly from the 2009 tender:

"i. All equipment shall be sized so that each interconnector can continuously deliver approximately 250MVA at the receiving end at power factors ranging between 0.95 leading and 0.95 lagging in any direction at an ambient temperature of 45°C

ii. 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%, without exceeding allowable temperatures and without causing any damage to the equipment" [7]

Bidders did not meet all the specifications of the 2009 tender and so a new revised tender was issued in 2010 which included slight changes. One of these changes is that the requirement is for the cable to be able to transmit 200 MW of power at a capacity factor of 0.95. The average losses across the cable and system infrastructure is expected to be in the range of 4-7% and the cable is expected to have an operational lifespan of 25-40 years at which point in time it will have to be replaced. **[9]**

Power would be purchased by Enemalta from the Italian Electricity Market or GME (Gestore dei Mercati Energetici) which is freely traded and operates in real time. GME is divided into Italian geographical sectors with Sicily accounting for one of these. Electricity prices in Sicily are typically higher than they are in Southern Italy but Terna (an Italian Electricity Distributor) and other companies are expecting to expand the capacity of the connection from Sicily to the Italian main land and thus reduce Sicilian market prices.

Sicily has two power transmission grids. The 220 kV grid is not sufficiently developed for handling the forecast demand increases while the 380 kV grid is not a complete ring which means that any fault on the line would disrupt the entire network. Significant strengthening of the transmission grid is underway and a completion of the 380 kV grid is expected in the next few years.

In 2007 Sicily obtained over 7% of its energy supply from renewable sources (703 MW capacity from hydropower, 854.2MW from wind and 1.5 from photo voltaics). This large renewables base coupled with a high capacity of conventional thermal, means that Sicily is a net exporter of electricity and in 2007 exported 1.4 GWh of electricity to the Italian mainland via a single 380 kV submarine interconnection. With a number of development permits for new wind projects it is expected that over the next few years wind power capacity in Sicily will increase by an additional 2000 MW. This additional expansion in wind capacity would mean that the Island would have a renewable share of almost 15% with over 10% sourced solely from wind resources. **[10]** This high energy supply from variable wind sources means that grid intermittency can occur particularly during periods of low demand. Wind resources cannot be shut off and in times when demand is very low if sudden strong winds occur then it can threaten to destabilize the network. Therefore the Malta-Sicily interconnection is not only a benefit for Malta but for Sicily as well since it:

i. Increases the stability of their grid (since excess energy can be exported)

ii. Increases economic opportunity for energy sale (Malta becomes a new demand market)

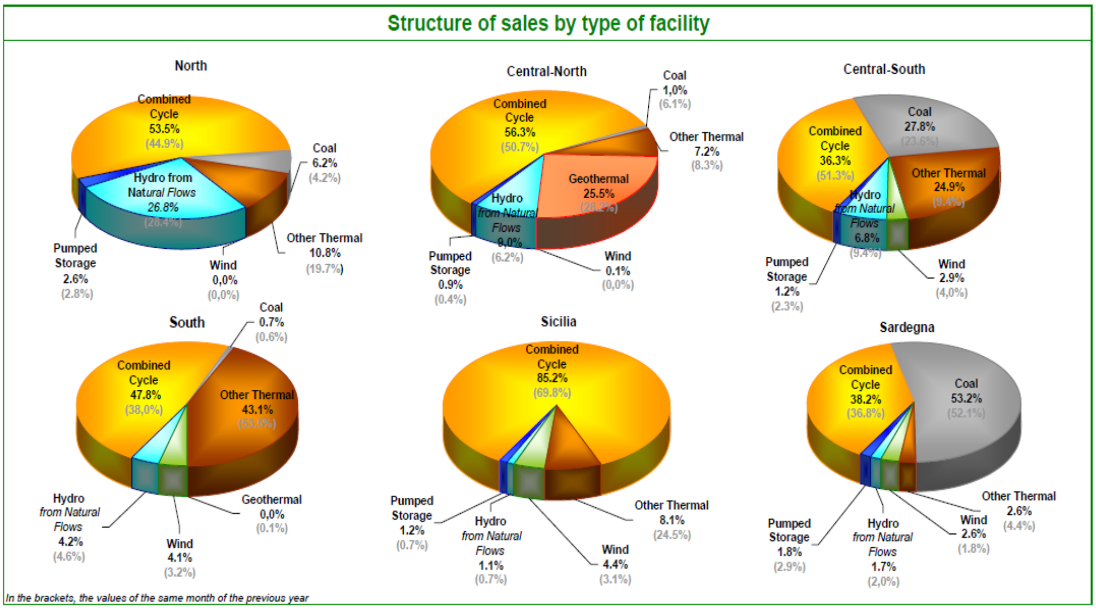


Chart 30: August 2010 Italian Energy Breakdown by sector showing that Sicily provides 14% of its energy from renewable sources and the rest from efficient combined cycle plants. [11]

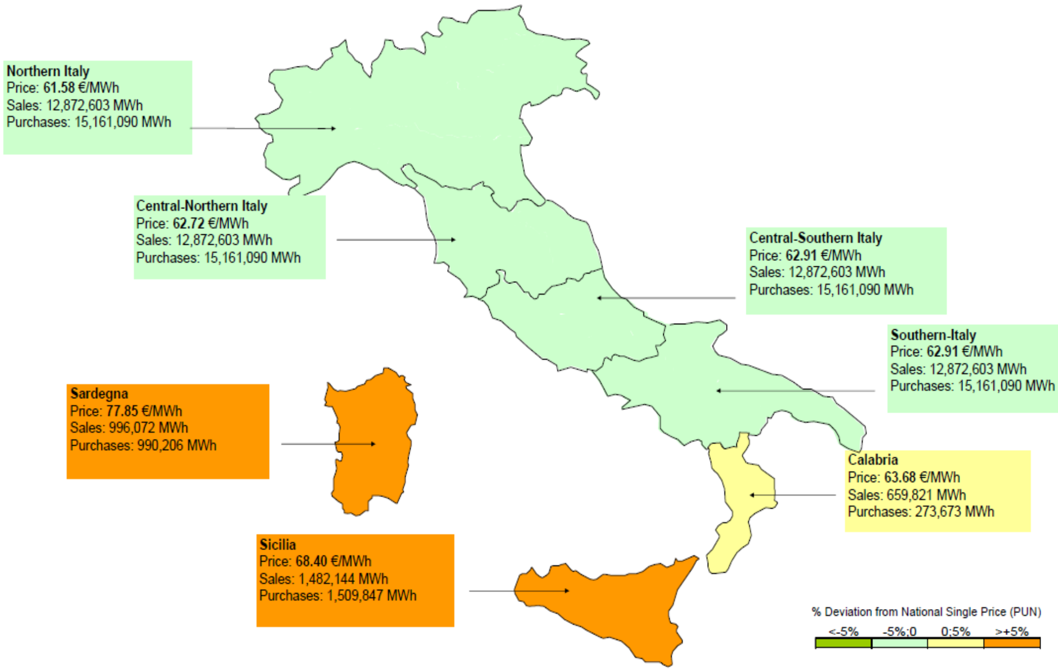


Figure 6: May 2007 map of Italy highlighting price premium in Sicily and Sardinia [11]

Economic Comparison

It is difficult to calculate the net present value of a non-renewable project due to the nature of price fluctuation of the fuel source. Prices fluctuate on a real time basis and the variations in fuel prices from one year to another can be dramatic. For the purpose of comparison it can be assumed that current market prices can be used and extrapolated. This is a valid assumption since a relative rather than absolute comparison is important.

	Malta-Sicily Interconnection	**Delimara Extension**
Power Efficiency Factor	93-97 % **[9]**	46.9 % **[13]**
Capital Costs	€150,000,000 **[7]**	€165,000,000 **[13]**
Max Capacity	200 MW **[7]**	144 MW **[13]**
Maintenance Cost	€1,500,000/yr (estimated)*	€ 3,600,000/yr (calculated)**
Waste Disposal Costs	0	€ 2,500,000-12,000,000 / yr **[12]**
Production Costs	***Dependent on Sicilian Market prices **[11]**	***Dependent on Heavy Fuel prices
Lifespan	25-40 years **[9]**	20-25 years **[13]**

Table 20: Comparison of Malta-Sicily interconnection and Delimara Extension: Power efficiency factor, capacity, costs, lifespan [11]

*Cable:

The cost of maintenance of the cable is difficult to quantify. As long as the cable is not unexpectedly damaged (by salinity intrusion, corrosion or shipping), then its operational costs are very low. However, unexpected and catastrophic occurrences must be factored in based upon their probability of occurrence. Such a study for this project is not publically available and thus these costs must be assumed. The highest cost of maintenance would be the price that would have to be paid on an annual basis for insurance of the cable. Other examples of such undersea projections place insurance costs at approximately 1% of total capital cost per year or €1.5 million per year.

**Delimara Extension:

Enemalta signed an €18 million 5-year maintenance agreement with BSWC, which amounts to €3.6 million / year. However, reciprocating diesel engines are particularly prone to deterioration and machine failure when they are ten years old or more. Therefore, maintenance costs during later years will probably be significantly higher. **[13]**

***Determining Production Costs

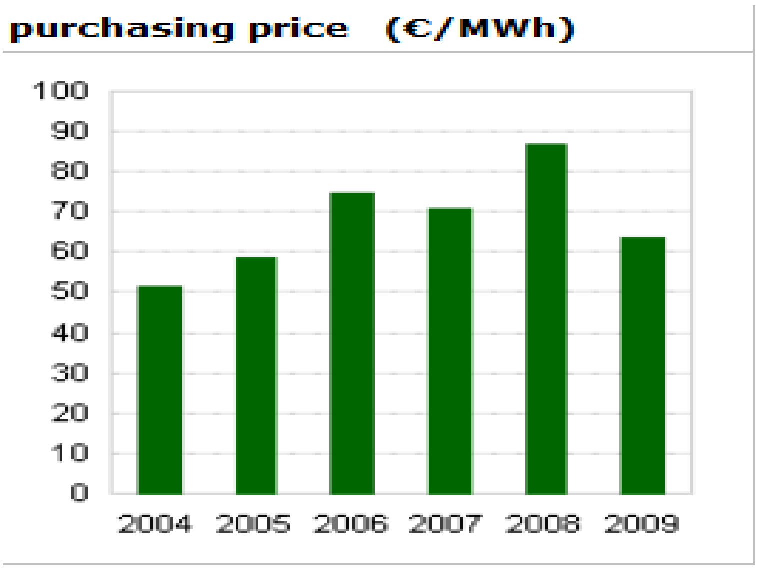


Chart 31: Average Italian electricity price per annum [11]

Delimara Extension (fuel costs): €466 million

NPV (Net Present Value) Unit Cost:

	NPV €	Net Electricity MWh	Unit cost (EMC financial report)
Delimara Extension	554,027,672	6,436,200	12.647 €c / kWh

Table 21: Results of calculations for the Delimara Extension to determine the price of electricity for the unit [13]

The cost of generating electricity was 12.467 €c / kWh at the expansion for an outlook of 12 years, considering January 2007 heavy fuel oil prices of $244.59 per metric tonne (equivalent to €188.92 using conversion rates at the time). Price escalation was done in the Delimara extension analysis by performing predictive extrapolation of 1997 – 2007 heavy fuel oil data. The escalation factor for the Delimara extension was 22.3 $ per tonne per year or a linear increase of 9.12% per year over the January 2007 price. **[13]**

A price escalation analysis must also be used for predictive analysis of the future average cost of electricity in Sicily. Historical Sicily electricity market data were obtained from GME and a linear correlation was obtained:

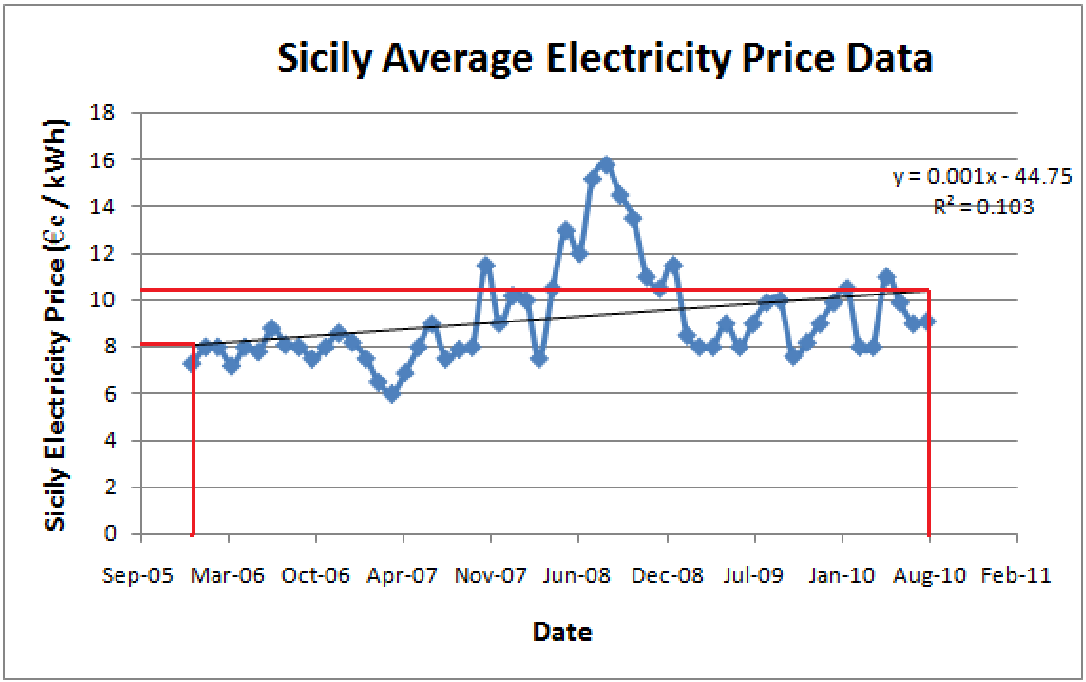


Chart 32: Forecasting price appreciation factor for electricity prices in Sicily; the chart is based upon info obtained from Sicilian electricity market data [11]

Between December 2005 and August 2010 the linear correlation increased from 8.2 to 10.3 €c / kWh. For a 4.67 year time period the linear trend increased by 2.1 €c / kWh. This is an increase of 0.45 €c / kWh / year. In January 2007, Sicily had an average electricity price of 8.223 €c/kWh **[11]**. Therefore this price escalation represents a linear increase of 5.49% per year increase over January 2007 Sicily electricity prices.

The same criteria (such as money cost) were used as in the report done on the Delimara extension producing the results of:

Malta-Sicily Interconnection		
Max Capacity (MW)	200.00	
Capital Cost (€)	150,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	12	
Amortization (€ / year)		17,891,554
Amortization (€c / kWh)		1.05
Energy Purchased per year (MWh)		1,753,200
Power Capacity Factor (3 % losses)	0.97	
Energy Transmitted per year (MWh)		1,700,604
Operating Cost (€ / year)	1,500,000	
Operation & Maintenance (€c / kWh)		0.09
Cost of electricity, Sicily (€c /kWh)	8.23	
Cost of electricity, Malta (€c / kWh)		8.48
Current Cost to Produce (€c/kWh)		**9.62**
Price Escalation (%)	5.49	
Average Cost of Electricity for Useful Life		10.94
Cost of electricity, Malta (€c / kWh)		11.28
Predictive Cost to Produce (€c/kWh)		**12.42**
	Input	Output

Table 22: Economics of Malta-Sicily Interconnection- for the same 12 year outlook, the Malta-Sicily interconnection is 0.05 €c / kWh cheaper (12.47 – 12.42)

In other words, for the same 12 year outlook, the Malta-Sicily interconnection is 0.05 €c / kWh cheaper (12.47 – 12.42).

Calculations were also done for the Delimara Extension in order to confirm the accuracy of the EMC numbers provided.

Calculations for the extension were based on:

Metric Tonne Heavy Fuel Oil Energy Equivalent (MWh):	12.28
Price of Heavy Fuel Oil January 2007 (Euro / Metric Tonne):	188.92
Price of Heavy Fuel Oil January 2009 (Euro / Metric Tonne):	276.43

Delimara Extension		
Max Capacity (MW)	144.00	
Capital Cost (€)	165,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	12	
Amortization (€ / year)		19,680,710
Amortization (€c / kWh)		3.67
Average Annual Production (MW)	61.1853	
Average Annual Production Factor		42.49%
Energy Transmitted per year (MWh)		536,350
Fuel Efficiency Factor	0.47	
Energy Equivalent Purchased per year (MWh)		1,143,604
Heavy Fuel Oil Energy Cost (Euro / MWh)	15.38	
Price of Fuel (€ Total)		17,593,623
Price of Fuel (€c / kWh)		3.28
Maintenance Cost (€ / year)	3,600,000	
Operation & Maintenance (€c / kWh)		0.67
Waste Disposal Cost (€ / year)	12,500,000	
Waste Disposal (€c / kWh)		2.33
Current Cost to Produce (€c/kWh)		**9.95**
Price Escalation (%)	9.12	
Predictive Average Cost to Produce (€c / kWh)		**15.40**
	Input	Output

Table 23: Economics of Delimara Extension shown with original waste disposal cost estimates

It was found that the price of electricity for the Extension depends heavily on the average hourly annual production that the station provides. Load spreading due to off peak demand and down time due to maintenance determines that the average annual production is not at full capacity. The official EMC report calculated net electricity produced over the 12 year period as 6,436,200 MWh or 536,350 MWh per year. This is equivalent to an average annual production per hour of 61.19 MW or 42.49%.

The result of 15.4 €c / kWh is significantly over the figure provided by EMC. The reason for this could be that the numbers used for waste disposal costs in the report were not the original value of € 12,500,000 that was provided but a revised number of € 2,500,000.

Delimara Extension		
Max Capacity (MW)	144.00	
Capital Cost (€)	165,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	12	
Amortization (€ / year)		19,680,710
Amortization (€c / kWh)		3.67
Average Annual Production (MW)	61.1853	
Average Annual Production Factor		42.49%
Energy Transmitted per year (MWh)		536,350
Fuel Efficiency Factor	0.47	
Energy Equivalent Purchased per year (MWh)		1,143,604
Heavy Fuel Oil Energy Cost (Euro / MWh)	15.38	
Price of Fuel (€ Total)		17,593,623
Price of Fuel (€c / kWh)		3.28
Maintenance Cost (€ / year)	3,600,000	
Operation & Maintenance (€c / kWh)		0.67
Waste Disposal Cost (€ / year)	2,500,000	
Waste Disposal (€c / kWh)		0.47
Current Cost to Produce (€c/kWh)		**8.09**
Price Escalation (%)	9.12	
Predictive Average Cost to Produce (€c / kWh)		**12.51**
	Input	Output

Table 24: Economics of Delimara Extension with revised waste disposal cost estimates

Relative Advantages:

Expansion of local generation:

- Local Employment (during construction and operational phase)
- Supply of electricity that is under direct control of Malta
- Preservation of 'isolated island status' and the benefits of subsidy associated with it

Interconnection:

- Every MW transmitted is a MW that does not need to be generated locally and thus cuts overall local emissions of all types. (SO_2, NO_2, CO_2, dust particulate etc…)
- More economic as shown in the comparison (2.5 c / kWh cheaper over a 12 year time frame)
- Required for expansion of local renewable resources to a high production level (>7-8%) since the isolated Maltese network is not capable of handling the high load fluctuations, especially during times of low demand
- Opens Malta to the Italian electricity market and would thus allow for the sale of excess generated electricity
- Helps to improve the overall stability and reliability of the Maltese grid
- Introduces potential competition to the Maltese electricity market

Relative Disadvantages:

Expansion of local generation:

- Continued local emissions impacting both health and the environment
- Significantly less economic than an interconnection of similar capacity
- Requirement for more land area for further local capacity expansion

Interconnection:

- Potential jeopardy of 'small isolated island status' and the benefits of subsidy associated with it
- Dependent on another country for electricity needs

With full weighting of the economic, social and environmental benefits / detriments of both options for future capacity expansion it is concluded that the option of interconnection provides significantly more important positives in all three areas over the option of expansion of local generation.

3. Investment in Renewable Projects in other EU Countries (North Sea) and being Statistically Transferred with Renewable Energy Generation Versus Investment in Local Renewable Projects

Directive Cooperation Mechanisms:

The EU Renewable Energy Directive allows flexible measures for Member States to achieve their individual targets in an economic and sensible way. These measures include the provision that Member States may statistically transfer credits for renewable energy, cooperate on joint projects targeted for the production of renewable energy, and coordinate national support schemes. In other words, energy produced from renewable sources in one Member State may count towards the national target of the Member State participating in the project.

The importance of these cooperation mechanisms is that, because of geographical factors, different Member States have different qualities of renewable energy resources and ability to exploit these resources. Member States are encouraged to engage in these cooperative mechanisms in cases where a Member State can derive significant benefits from "outsourcing" its renewable energy production. Large scale land based wind / solar projects have been essentially ruled out for the Maltese Islands due to lack of land availability and high cost of land that is available. Offshore wind has been presented by government as the most economic and least environmentally harmful resource for Malta to exploit on a large scale. The purpose of this section is to evaluate the relative economics and environmental consequences of a local versus a foreign wind farm in which Malta invests in the project in another Member State and is thus credited with renewable energy produced from the project.

"The Second National Communication of Malta to the United Nations Convention on Climate Change" report, May 2010 states:

> **"…at a 10% contribution from the wind, grid stability starts to suffer… In the case of Malta, for the 10% contribution from a source under a single wind regime, it was found that almost as much stand-by**

capacity is required as that provided by wind, in order to avoid grid instabilities. That would offset most of the benefits of wind generation." [1]

Considering the above statement, which appeared in the latest report from a panel of experts from Malta to the United Nations Convention on Climate Change, it would seem prudent to rethink any consideration of spending hundreds of millions of Euros on wind farm projects in Malta.

The Malta Environment and Planning Authority (MEPA) web site currently shows all three wind farm planning applications as: "…application has been passed to a case officer to assess the development proposal in terms of Structure Plan and other established policies".

AIS Environmental is the company that is conducting the environmental impact studies for the three proposed wind farm sites as well as the controversial Delimara extension. When contacted, the AIS Environmental representative stated that Hal Far requires an Appropriate Assessment (AA) and technical studies but Is-Sikka l-Bajda (*the white reef*) and Bahrija require an EIA as well as an EIS, (Environmental Impact Statement). The two onshore MEPA applications have a target date of November 2010 and the offshore site has a target date of January 2011. **[2]**

Bahrija and Hal-Far are both onshore sites with estimated potential wind capacity of 10.2MW and 4.2 MW respectively. Sikka l-Bajda, located on a reef 1.5-2 km from the coast, has an estimated wind potential of up to 95MW. If approved the three wind farm projects would begin around 2012 and would give Malta wind energy potential of 109.4MW with an estimated annual electricity generation of 254GWh. **[3]**

The Bahrija application is the more problematic onshore application as it is located in a 'rural conservation area' (RCA) but has 19 trellis masts which can be used to monitor wind (formerly belonging to Maltacom) which are not in use. Wind speed measurements have been ongoing at Bahrija and are adequate to determine wind data. One favorable argument for Hal Far and Bahrija is that onshore sites have a short time scale compared to offshore sites, however, many arguments against such development exist.

Is-Sikka l-Bajda

"**If the offshore reef off Mellieha is not adequate for a wind farm, Malta will be *'stuck'* and will probably have to ask the EU to re-consider its expectations.**"

George Pullicino, Resources Minister, speaking at the inauguration of the 80 meter high wind monitoring mast at l-Ahrax, November 2009

Sikka l-Bajda as a wind farm location had originally been evaluated by the consulting firm of Mott Macdonald (MML), U.K. in 2005. In that report Mott Macdonald advised against building a wind farm on Sikka l-Bajda for financial, visual and environmental reasons. In their 2005 report Mott experts recommended that Malta start with a medium sized onshore wind project and stated that Sikka L-Bajda was only 'marginally suitable' for wind power as the capacity factor is low (estimated at only 25%) due to the reef's close proximity to shore and the location which lacks direct exposure to the prevailing northwesterly winds. **[4a]**

In 2009 Mott Macdonald was re-commissioned to perform another feasibility study based upon water depth up to 30m. The 2009 MML study estimates Sikka l-Bajda's wind capacity factor at 25%, while similar wind farms in the North Sea have a capacity factor of 40%. According to the report the energy produced by this wind farm, located approximately 2 km from shore, would provide 4% of Malta's energy needs, providing clean energy for approximately 21,000 households. By way of comparison that amount is similar to the energy demand of Smart City which is estimated to be 3.6% of the national electricity generation capacity. In order to produce the 50MW needed to reach the 4% target the wind farm at Sikka l-Bajda would need seventeen 5 MW turbines with 80 meter diameter rotors. **[4b]** With regard to the feasibility of a wind farm on Sikka l-Bajda, the 2009 MML report states:

> **"…it does exhibit a relatively low estimated capacity factor. The project will not significantly benefit from economies of scale…and may be subject to significant costs associated with vessel availability." [5]**

However, the Government's Committee for Wind Energy (CoWE) July 2008 report states, "Inside the 20 meter depth contour, Sikka l-Bajda has sufficient space for some 30 MW of generating capacity. This capacity can be increased to 70-90 MW if the surrounding outcrops in the area up to depths of 25 meters are considered. No other reef around Malta offers this potential in so compact a form." **[6]**

"A sizeable tariff would be necessary to make a wind farm in this region financially viable", the 2009 Mott Macdonald study concluded that energy produced from Sikka l-Bajda wind farm would have to be sold at a high price. The same MML report notes that a more viable option would be to buy 'renewable energy credits' from other states who abide by their renewable energy (RE) targets or to invest in a RE project within the EU and take a share of RE credits from the project. **[4b]**

It was announced in August 2010 that AIS Environmental located in Fgura, Malta had been awarded the tender (worth €295,000) to perform the EIA for Sikka l-Bajda. AIS performed the EIA for the contentious Delimara Power Station heavy fossil fuel burning extension after the contract with BWSC had already been signed.

The proposed Sikka l-Bajda wind farm awaits the results of the data collected from the 80 meter l-Ahrax monitor (launched November 2009) which has been given a two year MEPA permit. The wind data used in the 2009 Mott Macdonald (MML) report were collected from several sources including: Luqa Airport (which is 18 km from Sikka l-Bajda and is in a very different environment), National Centre for Atmospheric Research (NCAR) and the European Wind Atlas. **[4b]**

The 2009 MML report estimates the approximate wind speed to be between 6.5m/s and 7.5m/s while the European Wind Atlas predicts a wind speed range of 5.5m/s to 7.0m/s.**[7]**

Sikka l-Bajda is Malta's only shallow reef which is large enough for an offshore wind farm; thus, the only other offshore wind farm possibility is to pursue deep water technology which at this point in time is not adequately advanced.

> **"Political considerations seem to have prevailed…it is evident they have rescued Sikka l-Bajda from oblivion after they previously dismissed it in their 2005 report"**

Shadow Minister of Alternative Energy Leo Brincat referring to the contradictory Mott Macdonald reports 2005 vs. 2009. **[8]**

The Sikka l-Bajda project would require an enormous capital expenditure (capex), estimated to be between €280 and 350 million, based upon the capex costs of

€3,000kW/ to 3,500/kW of installed capacity, and a hefty offshore operating cost (opex) estimated to be “in the region of Euros €77 / kW-87 / kW per annum’’. **[9]**

Comparison of power efficiency of Sikka l-Bajda with power efficiency at Gunfleet Sands, U.K. (a recently constructed (2008-10) North Sea offshore wind farm):

Gunfleet Sands: 37.8% power capacity factor
Sikka l-Bajda: 21.6% power capacity factor

Computations of power efficiency for Sikka l-Bajda (proposed) and Gunfleet Sands, UK (actual) wind farms:

Gunfleet Sands annual production:

Gunfleet Sands produces 570 GWh/yr [Reference: Dong Energy] **[10]**

(570*1000)/ (365.25*24) = 65.02 MW average power produced during the year

Dimensional analysis for the above: (MWh/yr)/h/yr = MW

[(65.02 MW) /172 MW)]*100 = **37.8% power capacity factor**

Sikka l-Bajda:

Sikka l-Bajda produces 180 GWh/yr [Reference : Sikka Proposal] **[7]**

(180*1000)/ (365.25*24) = 20.53 MW average power produced during the year

Dimensional analysis for the above: (MWh/yr)/h/yr = MW

[(20.53 MW) /95 MW)] * 100 = **21.6% power capacity factor**

Sikka l-Bajda (projected) vs Gunfleet Sands, UK (actual)

	Sikka l-Bajda Wind Farm	Gunfleet Sands Wind Farm
Power Capacity Factor	21.6% - 31.0 % Projected **[11]***	37.8% Actual **[11]**
Capital Costs	€280,000,000-350,000,000 **[12]**	€537,420,178 **[13]**
Max Capacity	95 MW **[14]**	172 MW **[13]**
# of Turbines	17-19 **[14]**	48 **[13]**
Distance to Shore	1.5 km-(2.2 for wind farm) **[14]**	7 km **[13]**
Operating Cost	€ 7,315,000-8,265,000/yr (estimated) **[15]****	€10,828,000/yr (calculated) **[16]****
Lifespan	25-30 years **[15]**	25-30 years **[13]**

Table 25: Comparison of a potential Sikka l-Bajda Wind Farm and Gunfleet Sands Wind Farm, UK (actual)

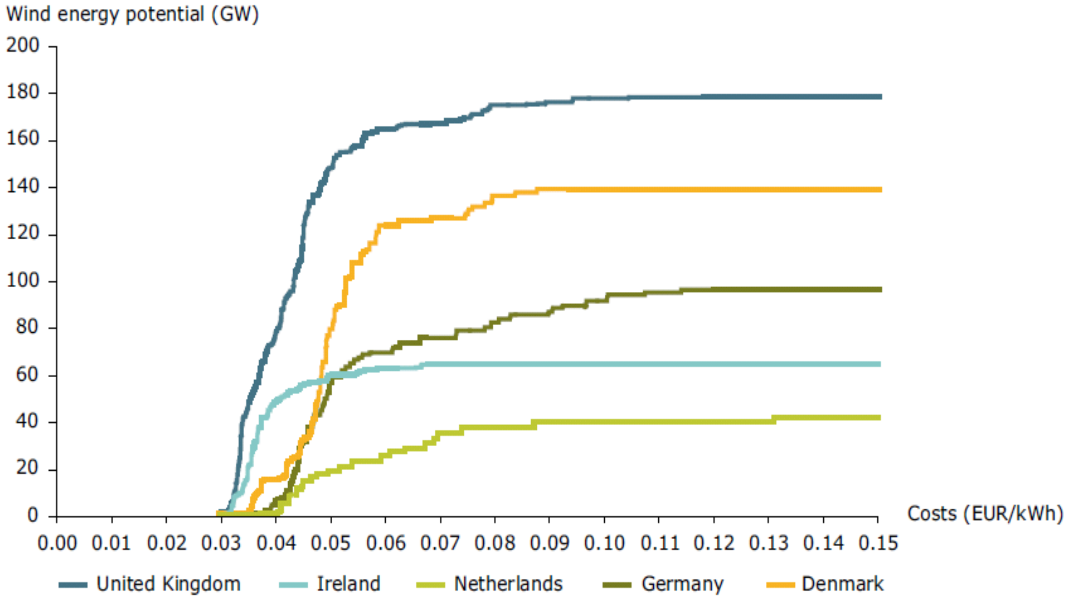
*capacity factor from Mott Macdonald, 2009: 21.6%-30%

** Calculated from this report using €.019/kWh for O&M

Computation for determining operating cost of Gunfleet Sands Wind Farm, UK:

172 MW *(1000)* 37.8 power capacity factor(/100) * 365.25 days/yr * 24 hrs/day * €.019/kWh = €10,828,000 O&M costs/year

Figure 6.6 Wind energy potential in the North Sea area at 0–20 m depth



Source: EEA, 2008.

Chart 33: Wind energy potential in the North Sea, contrasting 5 countries' wind energy potential vs EUR / kWh

Risk of Construction at Sikka l-Bajda

The risks associated with planning a project which has the magnitude of Sikka l-Bajda are far reaching and may partly be categorized as:

- Over estimation of wind capacity factor
- Scale of project may render the project non-economically feasible
- Environmental impacts, health issues and public non-acceptance
- Lack of financing possibilities

There is a need for accurate wind data from the L-Ahrax mast, environment evaluations (EIA and EIS), seabed condition evaluations (platform support) and evaluation of the recently discovered dolines (sink holes), assessment of the seabed route for export cable to shore.

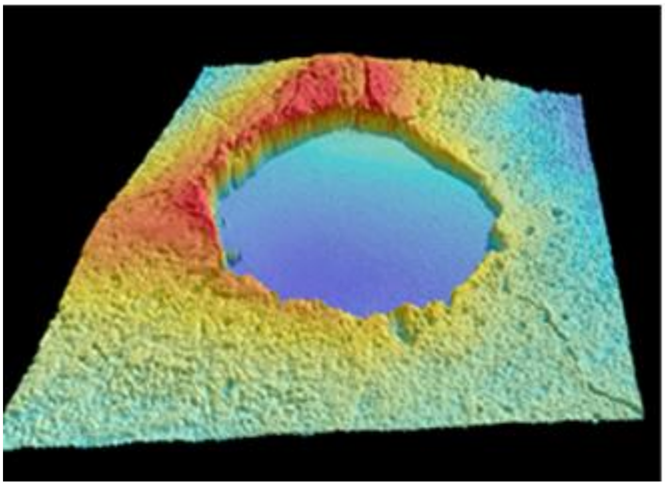


Figure 7: One of the two dolines (sink holes) at Sikka l-Bajda found during 2010 geophysics study [18]

While performing a research project in May 2010, two University of Malta research scientists discovered two large sinkholes, one of which is 240 m wide and 8 meters deep and the second is half that size. The sonar technology used also revealed that the reef is already damaged by constant bunkering and bombing during WW II. **[18]** Further studies need to be performed to determine the extent of the damage as the reef must provide support for the turbines' foundation. The foundation and underlying base must be capable of withstanding the hydrodynamic forces of the sea, the weight of the 19 turbine system, and loads from the turbine operation.

Quantification of Capital Costs (capex) for Installing a Wind Farm at Is-Sikka l-Bajda

"Operations and Maintenance (O&M) costs for wind power are double or triple the figures originally projected" [19] according to Wind Energy Update 2010**.** The Wind Energy Update: Operations and Maintenance Report 2010 was compiled with statistics from over 100 operators and providers with an aim to understand the trend in development of wind O&M.

In April 2009, Prime Minister Gonzi announced that the estimate for the proposed Sikka l-Bajda wind farm had increased from the prior budget estimate of €130 million to more than double with a new estimate of between €280-335 million. The April 2009 MRRA proposal for a wind farm at Is-Sikka l-Bajda states a different figure from that on the EEA wind farm report (detailed on the following page); instead, they use a figure from

European Wind Energy Association (EWEA, 2008) which predicts the cost to be about **€2,350/kW**. The MRA proposal goes further to cushion the window of cost for a further addition of 25% to 50% more for the cost. They justify the leap in cost by stating that pre-drilling would be required for foundation pile driving and the report adds that there is a lack of specialized installation sea vessels in the Mediterranean, unlike in the North Sea area.

The cryptic 'Capital Costs' (capex) paragraph contained in the 107 page Proposal for Sikka l-Bajda concludes with: "It is estimated that the total range can vary between **2940 and 3525 €/kW**. Therefore, the initial "capital investment cost for the 95 MW wind farm will be in the range of **€ 280 to 335 million''. [4b]**

According to the European Wind Energy Association, the current quantification of wind energy costs for installing capacity are estimated to be approximately 1,000 €/kW for onshore and €1,200-2,000/kW for offshore wind farms. **[20]** Using the estimated costs provided by EWEA, the wind farm at Sikka l-Bajda, which is estimated at providing 95 MW (maximum capacity), the computation of cost for constructing such a facility on the reef 1.5 km offshore is as follows:

At the low end cost would be:
95 MW * €1,200 Euros/kW * 1,000 (MW/kW conversion) = €114,000,000

At the high end the cost would be:
95MW * €2,000 Euros/kW * 1,000(/MW/kW conversion = €190,000,000

From the table below one can deduce that the onshore wind energy costs are primarily from the cost of turbines, whereas, for offshore wind farm the cost of the grid connection and foundation compose a significant part of the investment. As of 2009 there was a shortage of offshore wind turbines and the costs are expected to decrease with time as new manufacturers enter the marketplace.

Table 6.3 Increase in offshore investment cost as function of distance to the coast

		Distance to coast (km)							
		0–10	10–20	20–30	30–40	40–50	50–100	100–200	> 200
Cost (EUR/kW)	Turbine	772	772	772	772	772	772	772	772
	Foundation	352	352	352	352	352	352	352	352
	Installation	465	476	488	500	511	607	816	964
	Grid connection	133	159	185	211	236	314	507	702
	Others	79	81	82	84	85	87	88	89
	Total cost (EUR/kW)	1 800	1 839	1 878	1 918	1 956	2 131	2 534	2 878
	Scale factor	1	1.022	1.043	1.065	1.086	1.183	1.408	1.598

Source: EEA 2008.

Table 26: Investment cost escalation for offshore wind farms with distance from shore [21]

Enemalta is a state-owned corporation and as such is in a more favorable position to obtain funding for a large RE project such as an offshore wind farm. Financing offshore wind farms on a non recourse basis has seen a very different impact on government utility companies vs. independent developers: government utilities are able to fund their projects from their balance sheets for such projects while the independent developers are met with lack of funds to finance projects due to the current credit crisis. Banks are not willing to commit to underwriting loans and banks have taken a much more conservative approach to lending. Also, offshore wind is a rather new technology with unproven results coupled with a short life span of only 20-25 years, thus, 'risk management' is a major factor for such a multi-million Euro project. **[23]**

Predicting the cost of electric power from a potential wind farm at Sikka l-Bajda can only be done within a narrow margin of uncertainty once wind studies have been accurately detailed for a period of at least one year. That would mean November 2010 at the earliest as the time when valid data will have been collected from L-Ahrax for the purpose of cost computation without a large margin of error.

For the purpose of computation of cost of generating from Is-Sikka l-Bajda, wind speed varies between 6.6 and 7.6 m/s at hub height. The report projects that the costs of energy for this wind speed range to vary between **17 and 26.5 € cents/kWh.** The report further qualifies this by stating that it would be unlikely that the price of electricity from this wind farm would be lower than 18 € cents / kWh and also stated that the numbers are subject to technical/economic evaluation. As there was no wind data available for the immediate area around Sikka l-Bajda the 2009 MML report utilized wind data from various sources including: Luqa Airport (which is 18 km from Sikka l-Bajda and is in a very different environment), National Centre for Atmospheric Research (NCAR) and the European Wind Atlas.**[4b]** The report estimates the approximate wind speed to be between 6.5m/s and 7.5m/s while the European wind atlas predicts a wind speed range of 5.5m/s-7.0m/s. **[5]**

We have shown that an offshore wind farm at Sikka l-Bajda is most probably uneconomic for several powerful reasons. It is therefore highly doubtful that a private company would undertake the project without some type of substantial subsidy from the government. There is an EU policy against state aid to private industry except in special circumstances. **[22]** Any subsidy from the Government must be paid for by the Maltese taxpayers; moreover, any private wind power company would be in competition with Enemalta. As Enemalta is an electric power monopoly, it would then have a tremendous conflict of interest as to when to use the power generated from the local wind farm.

Malta has already generated major criticism for the manner in which the BWSC contract for the Delimara Extension was negotiated. The government of Malta still has not responded to the corruption enquires of the European Commission. The BWSC shows the importance of managing public procurement processes in ways that are so transparent that they do not leave any room not only for the possibility of corruption but also for the slightest perception of corruption."

Economic Comparison:

Sikka il-Bajda Best Case Scenario		
Max Capacity (MW)	95.00	
Capital Cost (€)	280,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	25	
Amortization (€ / year)		21,903,481
Power Factor	0.31	
Energy Prod. per year (MWh)		258,159
Amortization (€c / kWh)		8.48
Operating Cost (€ / year)	7,315,000	
Operation & Maintenance (€c / kWh)		2.83
Balancing (€c / kWh)	0.30	
Cost to Produce (€c / kWh)		**11.62**
	Input	Output

Table 27: Sikka l-Bajda best case economic scenario

Sikka il-Bajda Worst Case Scenario		
Max Capacity (MW)	95.00	
Capital Cost (€)	350,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	25	
Amortization (€ / year)		27,379,351
Power Capacity Factor	0.216	
Energy Prod. per year (MWh)		179,878
Amortization (€c / kWh)		15.22
Operating Cost (€ / year)	8,265,000	
Operation & Maintenance (€c / kWh)		4.59
Balancing (€c / kWh)	0.30	
Cost to Produce (€c / kWh)		**20.12**
	Input	Output

Table 28: Sikka l-Bajda worst economic scenario

Sikka il-Bajda Conservative Case Scenario		
Max Capacity (MW)	95.00	
Capital Cost (€)	320,000,000	
Money Cost (% / year)	6.00	
Useful Life (years)	25	
Amortization (€ / year)		25,032,550
Power Capacity Factor	0.26	
Energy Prod. per year (MWh)		216,520
Amortization (€c / kWh)		11.56
Operating Cost (€ / year)	7,315,000	
Operation & Maintenance (€c / kWh)		3.38
Balancing (€c / kWh)	0.30	
Cost to Produce (€c / kWh)		**15.24**
	Input	Output

Table 29: Sikka l-Bajda conservative economic scenario

Gunfleet Sands		
Max Capacity (MW)	172.00	
Capital Cost (€)	537,420,178	
Money Cost (% / year)	6.00	
Useful Life (years)	25	
Amortization (€ / year)		42,040,617
Power Capacity Factor	0.378	
Energy Prod. per year (MWh)		569,930
Amortization (€c / kWh)		7.38
Operating Cost (€ / year)	10,828,000	
Operation & Maintenance (€c / kWh)		1.90
Balancing (€c / kWh)	0.30	
Cost to Produce (€c / kWh)		**9.58**
	Input	Output

Table 30: Gunfleet Sands economics Best case scenario for Sikka l-Bajda

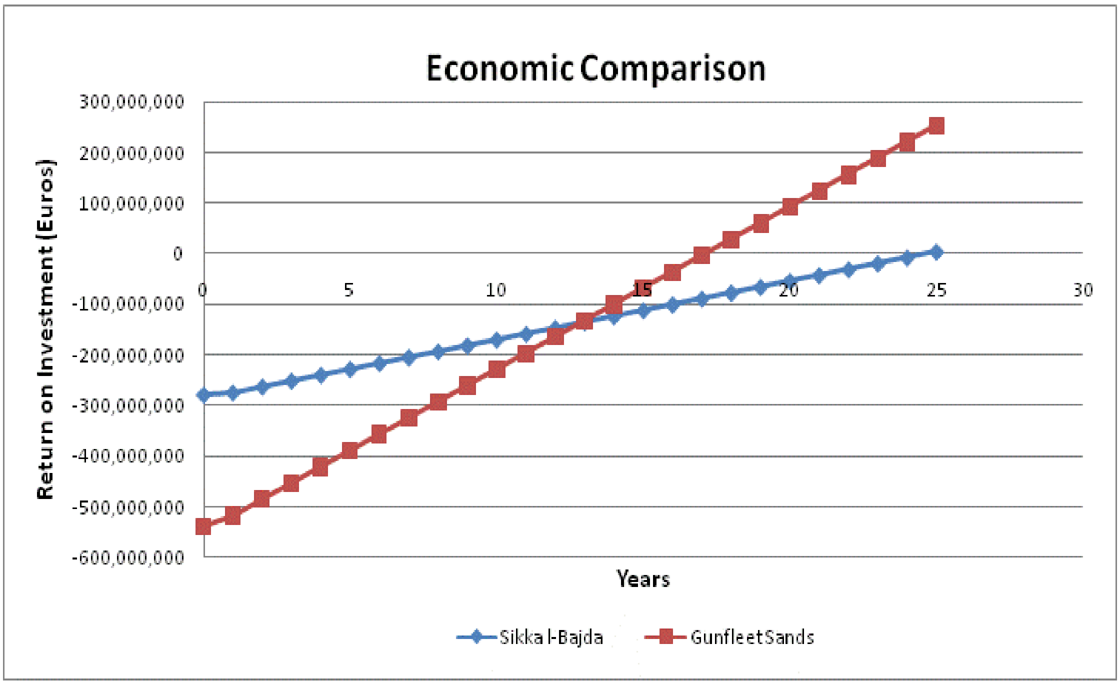


Chart 34: Best case scenario economic comparison

6% cost of money, €13 c / kWh, Sikka at operating efficiency of 31%. "Best case" scenario to show that even at the high operating efficiency range Sikka l-Bajda, Gunfleet Sands still comes out as 260 million Euros more economic.

Worst case scenario for Sikka il-Bajda

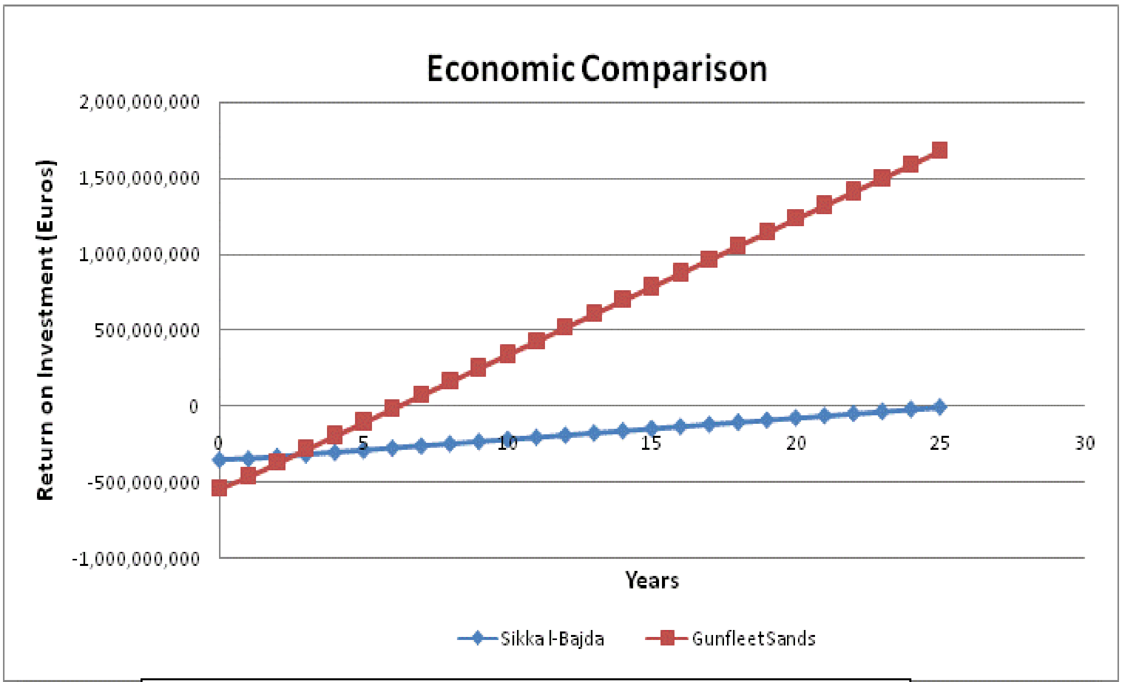


Chart 35: Worst case scenario economic comparison

6% cost of money, €23 c / kWh, Sikka at operating efficiency of 21.6%. "Worst case" scenario to show that at lowest estimated ranges for Sikka, Gunfleet Sands is € 1.7 billion more economic.

Conservative case scenario for Sikka l-Bajda

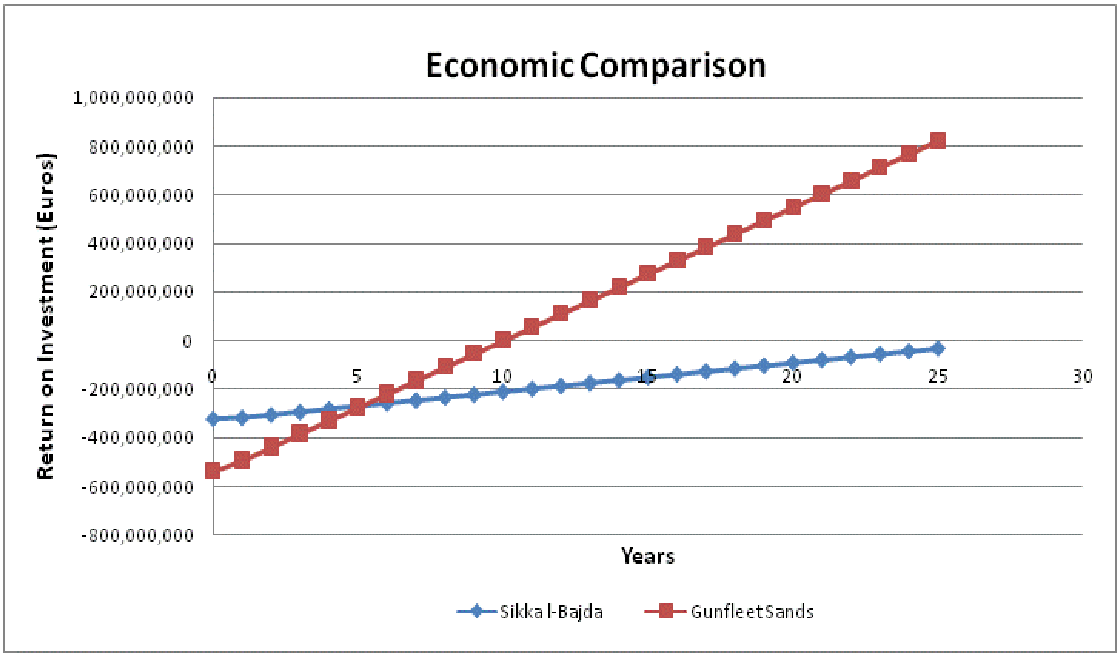


Chart 36: Conservative economic scenario comparison

6% cost of money, €17 c / kWh, Sikka at operating efficiency of 25%. In the conservative case scenario for Sikka l-Bajda, Gunfleet Sands is € 800 million more economic.

Price discrepancies that exist between Malta and the UK must also be factored in determining the economic viability of a project. The UK has slightly cheaper electricity with the average price for household consumers in the second semester 2009 being €14 c / kWh. For the same time frame the average price for household consumers in Malta was €15.2 c / kWh.

[23] [24] [25]

Factoring in the market price discrepancies and using the conservative case for Sikka l-Bajda:

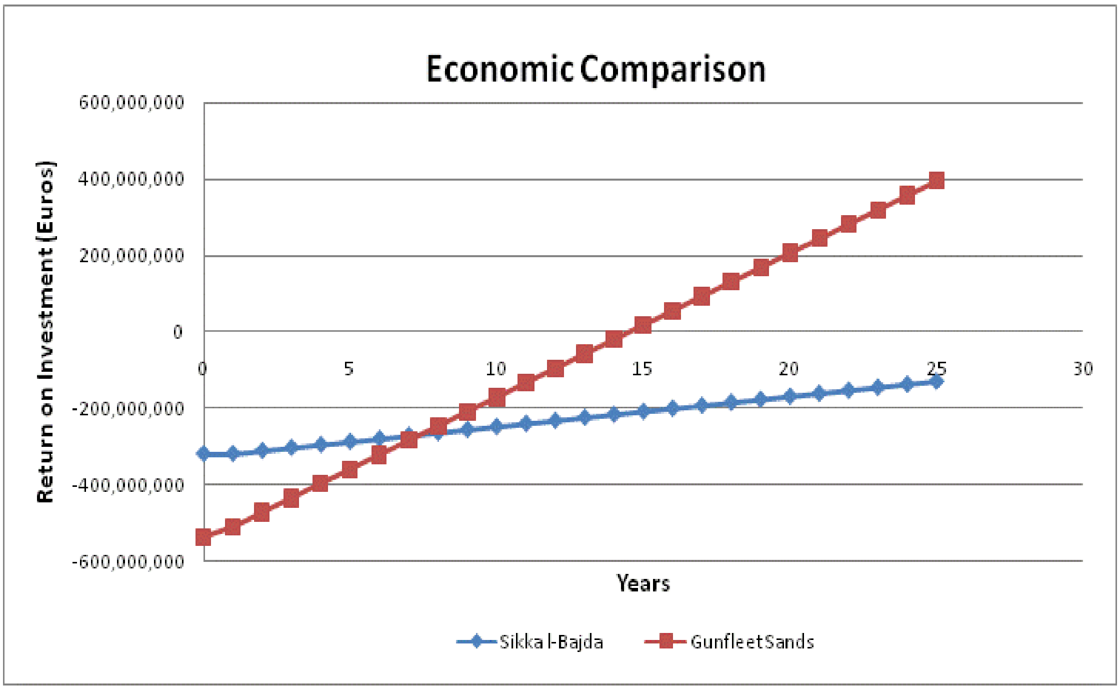


Chart 37: Conservative case scenario economic comparison factoring in the difference of electricity pricing for Malta and the UK

Using the most recent electricity price data for Malta and the UK, the Sikka Il-Bajda project would lose €100 million while the Gunfleet Sands project would earn €400 million. Therefore in a conservative case, even factoring in the cheaper electricity prices in the UK (which would reduce profit), the Gunfleet Sands project is still €500 million more economic.

One argument for having a local wind farm over a foreign one would be the benefit to the local economy due to employment and construction contracting. However, these economic benefits can be quantified.

Quantification of Benefit to Local Economy:

The actual construction contract for Sikka l-Bajda would be awarded to a foreign company as no local construction company has the expertise to lay offshore wind farms. Therefore, most of the 50 employees during the projected 1 year constructional phase would be foreign workers and thus have minimal benefits for the local economy. The wind farm would employ 15 full time employees during the operational phase and if it is assumed that these are all Maltese and they are paid an average wage of 30,000 € / year (very high for Malta) then this would amount to 450,000 €/year or 11.25 million Euros over the 25 year operational period. Therefore the benefit to the local economy is inconsequential when compared to the potential 1 billion Euros that can be saved by investing in a foreign project rather than building locally. **[5]**

Imports and joint projects with non-EU countries

The EU renewable energy directive allows for member states to invest in non-EU countries to achieve their renewable goal. The difference is that the member state must demonstrate that the same amount of electricity produced from the renewable location can be physically transported from the investment location to the investing member state. In cases where projects with long lead times are considered then the EU may allow for a statistical credit of renewable electricity for what the renewable investment would have produced if it had been operational, to accommodate for the construction phase. The most suitable non-EU country that Malta could cooperate with for such a project would be Tunisia. With low labor costs, low land costs, proximity to Malta, very good solar and wind potential, it could potentially develop into an ideal location for such a renewable investment.

This option was not considered for Malta, as the scale required for such a project to make it economic would be too large. The opportunity is there however in the future for a possible joint-member project, most probably with Italy who has already undergone feasibility studies for a proposed Tunisia-Sicily interconnection that has resulted in favorable economic results. Once this Tunisia-Sicily interconnection has been constructed, it will allow for the possibility of a renewable investment project in Tunisia, and the subsequent direct exportation of this energy to Malta via the Malta-Sicily interconnection. Since the proposed Tunisia-Sicily interconnection is tentative and not planned to be constructed until at least 2016, the option of joint projects with non-EU countries was not considered for Malta, as it would result in too short of a timeframe in which to implement, and a renewable action plan cannot be based on a project that lacks a definite timeframe.

4. Consumer end efficiency improvements

It has been shown in section 1 that it is possible for Malta to achieve its 2016 efficiency goals of 9% reduction in power generation over values of what they would have been had the efficiency measures not been introduced solely through the reduction of theft, technical losses, and power station self consumption. With the forecast of "business as usual" levels being 3,250,000 MWh, a 10% reduction represents an energy savings of 325,000 MWh. **[1]**

The current losses of electric energy distribution are already accounted for in the forecast of Malta's 2020 gross final electricity consumption. This means that any savings of plant self-consumption and distribution losses count as energy savings and thus are energy efficiency improvements.

Enemalta has projected that self consumption will be reduced from 5.48% in 2010 to 3.83% in 2020 (for a savings of 1.65%) due to the phasing out of old power plants, plant efficiency improvement measures, and the introduction of the Malta-Sicily interconnection.

With 13.1% total power losses (including 5% of this being technical losses) in the grid, Enemalta estimates that technical distribution losses will be reduced from 5% to 4% with the introduction of smart metering (for a savings of 1%).

Furthermore the loss due to tampered meters (approximately 5%) should be effectively eliminated with the comprehensive installation of the smart meter system and an extensive inspection program (for a savings of 5%).

The other 3% of total losses stems from direct line tapping theft and billing mistakes. Direct line tapping is much harder to combat than meter tampering as it is very difficult to locate. The losses due to billing mistakes should be reduced with the smart meter system.

Malta currently has total power losses of 13.1% but should be able to bring its total power losses down at least to the level of Cyprus of 4.55% and ideally down to Luxembourg's levels of 1.42%. Both Cyprus and Luxembourg are significantly larger than Malta with longer distribution networks; the size of a network is the main limiting factor to achieving optimal technical efficiency. Malta with its much smaller transmission distances should theoretically be able to achieve losses that are less than the losses of those countries.

If Malta were to achieve Cyprus' level of total power losses that would represent an improvement of 8.55%. If the expected self consumption savings of 1.65% is added to this figure then it is possible for Malta to achieve a 10.2% efficiency improvement. Therefore it should be possible for Malta to achieve its 2020 efficiency goals through power generation efficiency improvements and reduction of losses in the transmission grid. However, just because it is possible for Malta to achieve its goals solely through generation and transmission improvements does not mean that end-user energy efficiency improvements should be ruled out since smart and cost effective end-user efficiency improvements can be extremely economic, save on electricity, and thus mitigate the emissions footprint.

Measures taken by end-users to increase energy efficiency and thus decrease energy consumption

<u>Domestic Sector</u>

The pie chart below displays the consumption of electricity by utility in the average Maltese household. Water heating represents almost a quarter of total domestic electrical consumption. It is a section of the pie that can potentially be cost effectively reduced by the large scale installation of renewable solar water heating. Lighting is also a big destination for domestic consumption and is projected to be reduced by up to 80% with the comprehensive replacement of incandescent with compact fluorescents (CFL). **[2]**

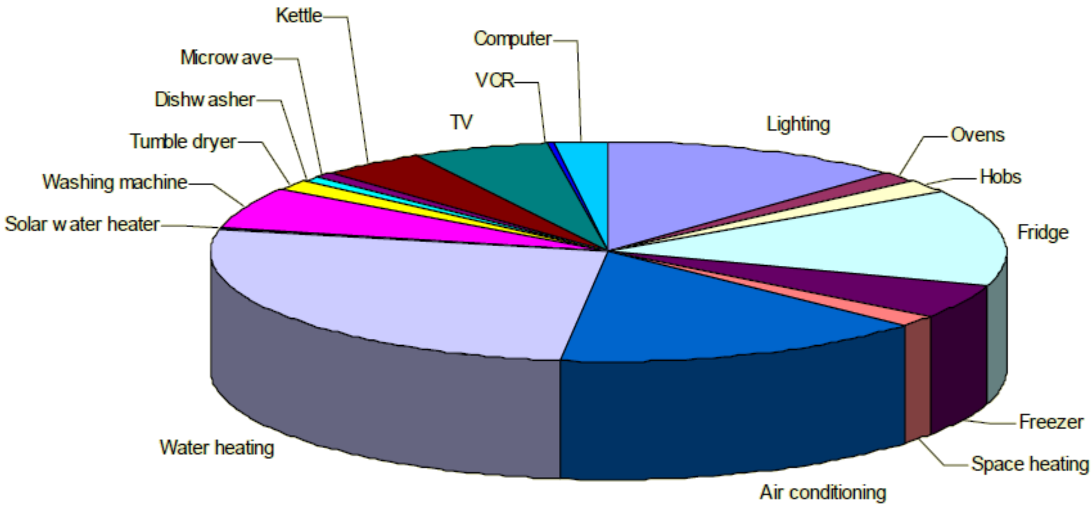


Chart 38: Malta domestic electricity consumption by appliance [2]

The table below quantifies the estimated savings possible following consumer end efficiency improvements. As indicated in the pie chart above, lighting and water heating are the areas where the most improvement can be made for the least cost. A transition to CFLs and solar water heaters could result in a domestic energy savings of 74 GWh, thus producing a 2.3% efficiency improvement.

Space heating and air conditioning represent slices of the pie that will continue to grow in coming years as populations continue to grow and living requirements go up unless insulation measures are implemented.

The total projected consumer end efficiency improvements (minus smart metering which was considered in section 4.1. as a transmission improvement) amount to 189 GWh saved by 2016 affecting a 5.8% efficiency improvement.

Estimate of savings (where possible)

Energy efficiency improvement programmes, energy services, and other measures to improve energy efficiency planned for achieving the target	Annual energy savings expected as at end of 2010 (GWh)	Annual energy savings expected as at end of 2016 (GWh)
Domestic sector		
Rebates on energy efficient domestic appliances	5 to 12	5 to 12
Promotion of solar water heaters	13 to 14	31 to 37
Promotion of micro-generation of electricity from RES	1	3
Subsidy schemes for insulation for buildings	<<1	<1
Promotion of compact fluorescent lamps	25 - 37	-
Industry		
Targets for energy efficiency in government owned industry	42 to 43	42 to 43
Support schemes for industry and SMEs	12	42
Tertiary		
Action in the public sector	7	11
Energy efficiency in the commercial sector	5	14
Street Lighting	<1	4
Energy efficiency promotion in the tourism industry	6	20
Transport		
Promotion of e-work or tele-working	<1	1 to 4
Promotion of electric vehicles	<<1	<1
Cross-sectoral		
Intelligent metering systems		25-50
Estimated total that can be quantified pending development of harmonised measuring methodology	**116 to 138**	**198 to 239**

Table 31: Estimates of possible energy savings for Malta

Example of Energy Savings from Industry (Reverse Osmosis Plants)

An average Reverse Osmosis (RO) plant needs approximately six kilowatt-hours of electricity to desalinate one cubic meter of water meaning that the process is not only energy intensive but costly. Malta's RO Plants produced a total of 17 million cubic meters of water in 2007 (57% of total water usage). This represented a total energy consumption of about 60,000 GWh **[4]**. Since energy consumption at RO plants is a major cost, the Water Services Corporation (WSC) embarked on a multitude of investments to increase energy efficiency including the installation of Pelton wheels at Pembroke which increased efficiency from 4.5 kWh / m3 to 3.6 kWh / m^3 and pressure exchangers at Ghar Lapsi, increasing efficiency from 4.8 kWh/m^3 to 3.2 kWh/m^3**[5]**. The combination of these efficiency improvements have resulted in a total energy saving of over 13 million kWh / year or 13 GWh/year. This will represent a national energy savings of 0.4% for 2020 and with an average cost of electricity at 10c / kWh this represents a savings of 1.3 million Euro / year. The investments were capital intensive but due to the over 30% reduction in energy consumption per m^3 of water produced they were extremely good investments which resulted in a return on investment of less than four years. **[6]**

The 2008 Malta Energy Efficiency Action Plan gives a guideline for energy savings for energy end use in line with Directive 2006/32/EC. The Target adopted for 2016 was: 9% energy efficiency of 378 GWh energy savings per year. **[3]**

Unfortunately, such success stories of significant energy savings within industry are rare as there is little incentive for industry to aggressively pursue energy efficiency measures. The reason for this is that prices of electricity for industry are kept artificially low.

In Malta industry actually pays less for electric energy than it costs to produce. The result of being able to acquire a cheap source of electricity is that there is much less incentive for energy efficiency. There is an EU policy against state aid to private industry except in special circumstances **[7]**. The present policy of subsidizing Maltese industry with below cost electric power is probably a violation of this policy. It is therefore recommended that electricity prices for industry be raised to at least a level which reflects the cost of production. With a rise in prices, industry would be incentivized to implement energy efficiency measures that have good return on investments as that would then become economic due to the increased potential for money savings. Such a rise in prices may cause economic pain in the short term but would result in a much more efficient and economically viable economy over the long term. Any price rise should be well programmed and announced in advance to assuage the negative impacts stemming from such a rise.

Conservation Voltage Reduction

Conservation Voltage Reduction (CVR) is a reduction of energy consumption as a result of a reduction in feeder voltage. Pursuant to an article in the October issue of the IEEE Spectrum, reducing the end user voltage levels to the lower end of the allowable voltage band in the USA reduces end user power consumption by up to 6% in certain appliances. For example induction motors used in many appliances such as fans and refrigerators usually operate at a lower mechanical load than they are rated to handle. Higher voltages therefore generate stronger magnetic fields than the motors can use, thus wasting energy. **[8]** This power conservation technique is explained extensively in "Evaluation of Conservation Voltage Reduction (CVR) on a National Level", July 2010 **[9]** where CVR is shown capable of providing peak load reductions and annual energy reductions in the USA of approximately 1.5%-4% depending on the specific feeder. The EU regulations for voltage are now 230 V ±10% (207V-253V). **[10]** The implementation of the Smart Meter Grid system could facilitate the introduction of CVR into Malta.

CVR is therefore ideal, because meaningful energy savings can be accomplished without the problems inherent in attempting to change user habits and lifestyles.

VII. Consequences of Non-Achievement

Matters of renewable non compliance are referred to the ECJ (European Court of Justice) which would then impose penalties that correspond to the same amount that Malta would have to invest to reach its obligations. These penalties would have to be paid until the time that Malta becomes compliant; therefore, these penalty measures incentivize compliance.

A 2010 report by the National Audit Office (NAO) details the potential financial liability for Malta should it not achieve its mandatory 2020 renewable goals. The conclusions of this report were that Malta's contingent liability for renewable energy shortfall could range from **"€2.9 to €36.1 million for every one percent shortfall from the renewable energy targets"**. The report goes on to state that further risks of non-attainment of renewable goals include further non-compliance costs that stem from other EU directives. **[1]**

Non attainment of renewable goals could mean that Malta would not reach its CO_2 emissions target as stated in Directive 2001/81/EC which could result in an obligation to purchases CO_2 allowances that would cost between €90 and €100 per tonne to make up the shortfall. **[1]** However, the CO_2 allowance market is highly variable and prices could be considerably lower than this by 2020.

Solely from an economic perspective it is not worth it for Malta to miss its 2020 renewable goals by any amount as the EU penalty measures are designed to ensure that Member States are fully incentivized to meet their goals.

In addition to the heavy financial liability that stems from non-attainment of 2020 renewable goals, there are a number of other liabilities that will be incurred from non-attainment.

These include:

Health Liability: a continued dependence on local non-renewable power production facilities would mean that emissions would continue to be a hazard especially for an Island like Malta where any power plant is within a short distance of built up urban areas. This could likely further impact the already hard hit real estate market in Malta.

Bad Publicity: non-attainment of 2020 renewable goals would result in bad publicity for Malta. Numerous newspaper articles have already been written criticizing Malta for lagging behind achieving its renewable goals (based upon the assigned trajectory from the EU). Such publicity may severely impact the tourism industry for Malta.

Political Liability: (loss of national prestige): other member states that have put considerable effort into achieving their respective goals could look unfavorably towards other member states that fall behind in reaching their goals, thus causing a lag in achievement of the Union wide goal. Due to Malta's small size, its effects on the EU targets are minimal, so the issue here is more of principle than substance.

Continued Dependence on Foreign Oil: the less of a renewable share Malta has, the more dependent it will be on oil imports that predominately come from non European Union countries (mostly North African and Middle Eastern) to which Malta does not necessarily have the best diplomatic relations with and which can be politically tumultuous.

Clearly, Malta should make its utmost to achieve its 2020 goals in the most economic and least environmentally impacting way possible as the consequent liabilities of non-achievement far outweigh the effort required to achieve these goals.

VIII. Conclusions

Malta's energy politics

This paper is not in any way attempting to tackle the political and/or corporate structure of Malta's energy sector; however, it is impossible to disassociate the implementation of renewable energy projects from the inherent conflicts of interest associated with Enemalta. Enemalta's status as an energy monopoly controlled by the government which is in turn controlled by an elected political party obviously sublimates all else to political concerns i.e., votes. Elections in Malta are decided on razor thin margins between two parties; the 2008 election was decided on just over 1,000 votes. **[1]** With so much riding on a few hundred votes, decisions are often made by placing the political process first. Political cronyism can be a strong influence, especially if there is a lack of transparency when entering into contracts.

Just two days prior to the March 2008 election the Emission Laws of Malta were changed:

> **"The change…occurred at a very late stage, just a few days before the expiry of deadline for the receipt of the final bids…to benefit one of the exceptions to the applicability of the Large Combustion Plant Directive…" [2]**

Minister Michael Barnier, EC Commission, June 2010 in his letter to malta's Foreign Minister, Tonio Borg

The change of the Emissions Law increased the emission limits for diesel engines, but retained current emission values for gas plants, thereby giving an unfair advantage to BWSC, the only company offering a tender for a diesel powered plant. In June 2010, European Commissioner for Internal Market and Services Michel Barnier sent a letter to Malta (which has not been published by the Government but is published by the opposition Labor Party) the contents of which raises serious doubts as to the legality of Malta's changes to the emission rules in the tender document; which the EC says was carried out to benefit the Danish firm BWSC's bid for a diesel-powered engine that had been previously ruled out because of existing emission laws**. [3]**

The EU is currently facing a catharsis and EU Members of Parliament are presently (29th October, 2010) in Brussels to discuss strengthening sanctions against member countries that breach deficit rules. With no fiscal discipline, EU countries have no incentive to comply with EU directives. The EC is considering placing 'sanctions' on members that exceed a debt threshold of 60% of GDP.**[4]** In 2009 Malta debt stood at about 70% of GDP; however, that 70% of GDP debt doesn't include the ever rising debt Enemalta continues to accumulate. **[5]** [**See Appendix A, Table A7]**

Malta is a small densely populated island country which magnifies problems relating to energy production. The scale of production is an essential factor in determining cost-effectiveness of a project; however larger and more cost-effective projects are not an option for Malta due to lack of spatial availability and lack of demand. As a permanent member of the European Union, Malta is now secure in its status; thus, investment and reliance on other Member States should be considered politically safe due to the myriad of enforcement measures and political pressures from other Member States that protect such investments.

The most cost effective investment was found to be a local one, the improvement of the transmission and distribution grid. Malta being the smallest member of the European Union should theoretically have the most efficient grid as the major technical limitation on power losses are the distances involved in transmission. Ironically, Malta has the second highest losses in the EU mainly as a result of a poor transmission and distribution grid coupled with a high degree of electrical energy theft. Efficiency goals can be achieved solely through technical improvements of both production and the grid, plus the elimination of electrical energy theft. Furthermore a 10% improvement in efficiency means that renewable share can be 10% less than originally required (or 9% overall) requirement in renewable share compared to a scenario without such improvement. It also results in an effective over 10% reduction in overall emissions.

A significant expansion of meter inspection, awareness programs, comprehensive installation of the smart meter system, and capital investment to reduce technical losses are means by which these goals can be achieved. It is essential that transmission and distribution efficiency improvements be pursued aggressively.

Even considering the fact that Sicily has the highest electricity prices in Italy, it still has considerably lower electrical energy prices than Malta. The Sicily interconnection is far more economic than local non-renewable electricity generation (over 2 c / kWh or 20%). In addition to being more economic, each unit of energy that is imported rather than produced locally equates to a unit less of emissions and thus less health and environmental consequences for the Country. Planned improvements to Sicily's power transmission infrastructure as well as new connections to the Italian mainland are forecast to significantly reduce these prices in the years to come, making an interconnection an even more cost-effective investment.

With regard to ensuring achievement of renewable goals, a foreign wind farm (such as one similar to Gunfleet Sands, U.K.) would be up to 1 billion Euros more cost effective over a local one factoring in a full 25 year time frame. Investing abroad would avoid all of various spatial conflicts that would arise as a result of the construction of a local wind farm. Additionally, it is not yet known if it is even possible to build the proposed traditional monopile offshore structures at selected local sites due to the weak limestone bedrock that has been proven to have hidden cavities.

Finally, there is significant room for improvement in consumer end efficiency. Domestic lighting and water heating account for almost half of total electrical consumption and this share could be reduced by almost 90% with a complete transition to compact fluorescent light bulbs and solar water heaters. With regard to private industry, current consumer end saving efficiency plans for Malta only loosely target the subject with a main focus on savings in the government sector. However, private industry should also be incentivized to initiate energy savings through the installation of realistic price mechanisms for electrical energy consumption. Residential consumers should not have to subsidize Malta's private industry.

With full weighting of the Economic, Environmental and Social considerations it is recommended that Malta:

i. Improve the efficiency of its transmission and distribution grid by implementing aggressive electrical theft countermeasures and grid technical efficiency improvements.

ii. Choose electrical interconnection over expansion of local production when considering capacity expansion.

iii. Invest in foreign offshore wind projects which are far more economic and eliminate the land use issues that plague local offshore wind consideration.

iv. Encourage consumer electrical efficiency improvements, especially from the industrial sector by implementing a real time electricity pricing system to reflect the real price of the generation of electricity. Such a pricing system may be politically controversial in the short term as it would probably result in price increases from their artificially suppressed levels, but in the long term would result in a return to financial sustainability for Enemalta, encourage consumer end efficiency improvements and allow for an efficient market dynamic.

IX. Appendices

The viability of the projects envisioned herein is dependent upon the availability and the cost of financing. This section will not predict the future, but will merely summarize some of the problems facing Malta in this respect with reference to the key statistics displayed in Appendix A.

The EU is the largest economic block in the world with a population of 495,393,000, land area of 4,422.993km^2, and GDP of $14,778,153,000,000. Malta is by far the smallest country in the EU with a population of 410,000 (0.08%), land area of 316km2 (0.01%), and GDP of $9,833,000,000 (0.07%).

For the Euro zone using 2009 estimates the average ratio of Public debt to GDP was 65.5%, with three countries dangerously overstretched- Belgium 97.6%, Greece 113.4% and Italy 115.2%; and all but four of the countries over the 60% Maastricht limit. All EU countries are running Fiscal deficits except Finland and Denmark, with all other countries except Sweden over the Maastricht level of (3.0%). Malta is running a current account balance deficit of $570,000,000, and a Fiscal deficit of 4.7% of GDP. These statistics are not long term sustainable and their resolution will certainly impinge on Malta's ability to fund its deficits. The poor economic climate that has resulted from the financial market's crash of 2008 mean that economic weighting with regards to energy investment is an extremely important factor which is compounded in importance by the status of large fiscal deficits.

Appendix A - Statistical Compilation of Malta's position in the EU, (non Euro Zone Countries in *Italics)*

1-Population (1000's) as at Jan. 1, 2008

2-Land Area in km^2

3- Total GDP per annum by Country for 2009 est. in Millions of Purchasing Power Parity Dollars

4- GDP per capita per annum, calculated from sections 1 and 3 above

5- Total Electrical Energy Consumption in Giga Watt hours per annum for years as shown

6- Electrical Energy Consumption per capita per annum, calculated from sections 1 and 5 above, in kWh/capita/annum

7- Public Debt Percent of GDP for 2009 est.

8- Current Account Balance (1,000,000's) in exchange rate corrected US dollars, 2009 est.

9- Current Account Balance as Percent of GDP from sections 3 and 8

10- Fiscal Surplus or Deficit as Percent of GDP, for years as shown

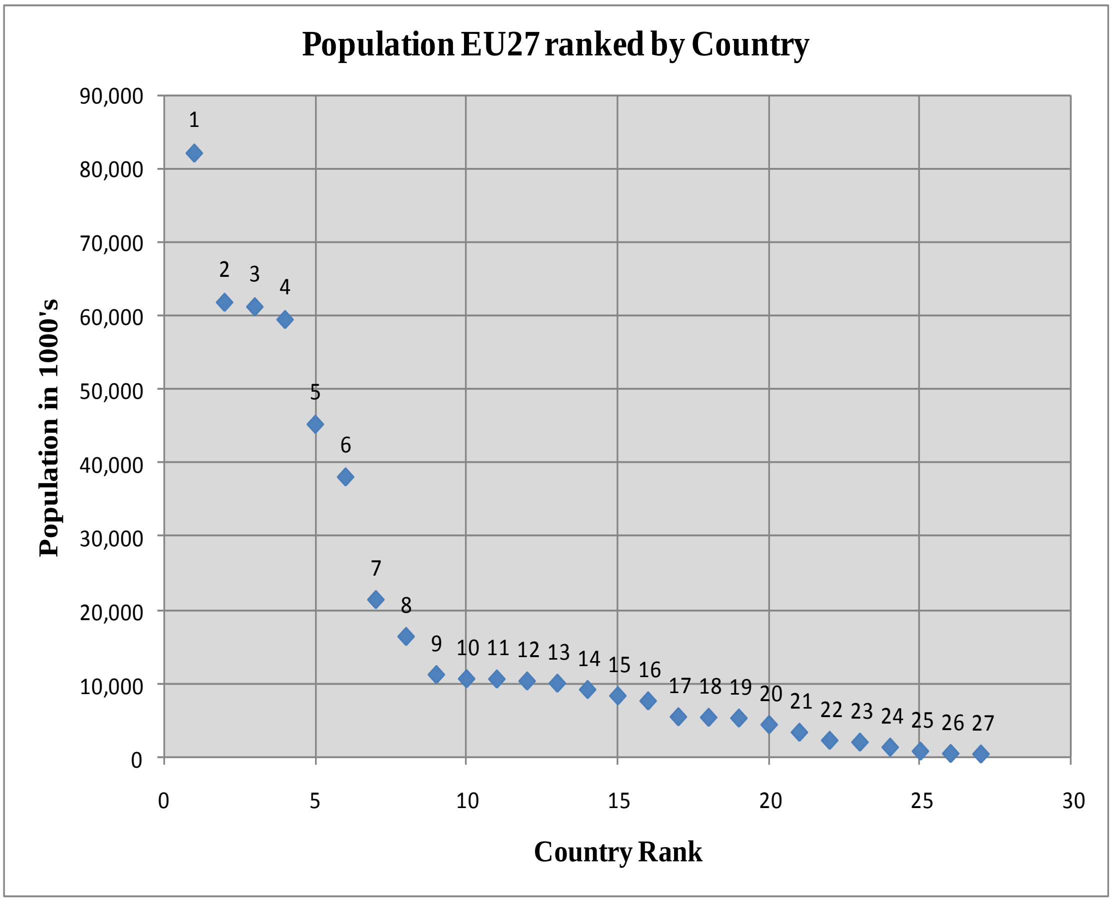
1. Population by Country, EU27 (1000's) as of Jan. 1, 2008, [A1]:

Table A1

1	Germany	82,179
2	France	61,876
3	*United Kingdom*	61,270
4	Italy	59,529
5	Spain	45,283
6	*Poland*	38,116
7	*Romania*	21,423
8	Netherlands	16,404
9	Greece	11,217
10	Belgium	10,656
11	Portugal	10,617
12	*Czech Republic*	10,346
13	*Hungary*	10,045
14	*Sweden*	9,183
15	Austria	8,334
16	*Bulgaria*	7,642
17	*Denmark*	5,476
18	Slovakia	5,399
19	Finland	5,300
20	Ireland	4,415
21	*Lithuania*	3,365
22	*Latvia*	2,269
23	Slovenia	2,023
24	*Estonia*	1,339
25	Cyprus	795
26	Luxembourg	482
27	**Malta**	**410**

Total as Computed 495,393,000 Euro Zone 324,919,000 (66%)

Chart A1



2. Land Area EU27 by Country, in km² [A2]

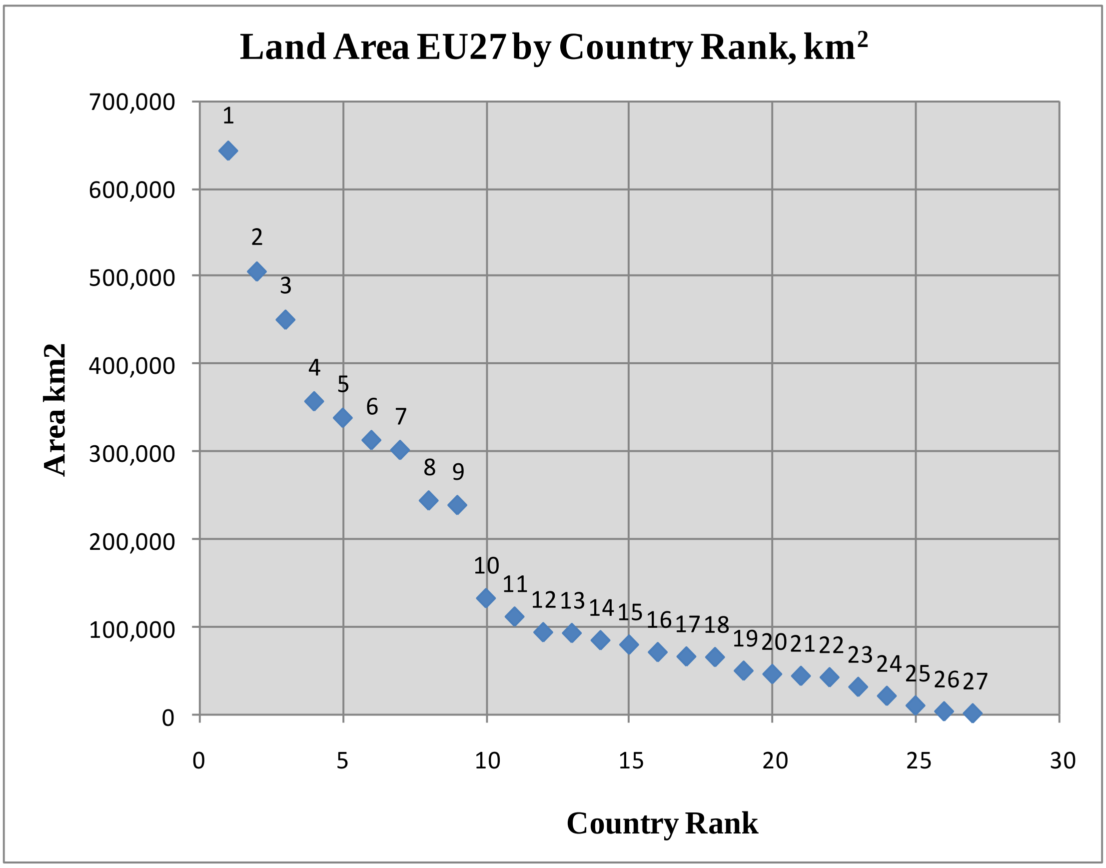
Table A2

1	France	643,427
2	Spain	505,370
3	*Sweden*	450,295
4	Germany	357,022
5	Finland	338,145
6	*Poland*	312,685
7	Italy	301,340
8	*United Kingdom*	243,610
9	*Romania*	238,391
10	Greece	131,957
11	*Bulgaria*	110,879
12	*Hungary*	93,028
13	Portugal	92,090
14	Austria	83,871

15	*Czech Republic*	78,867
16	Ireland	70,273
17	*Lithuania*	65,300
18	*Latvia*	64,589
19	Slovakia	49,035
20	*Estonia*	45,228
21	*Denmark*	43,094
22	Netherlands	41,543
23	Belgium	30,528
24	Slovenia	20,273
25	Cyprus	9,251
26	Luxembourg	2,586
27	**Malta**	**316**

Total as Computed 4,422,993 km² Euro Zone 2,677,027 km² (61%)

Chart A2



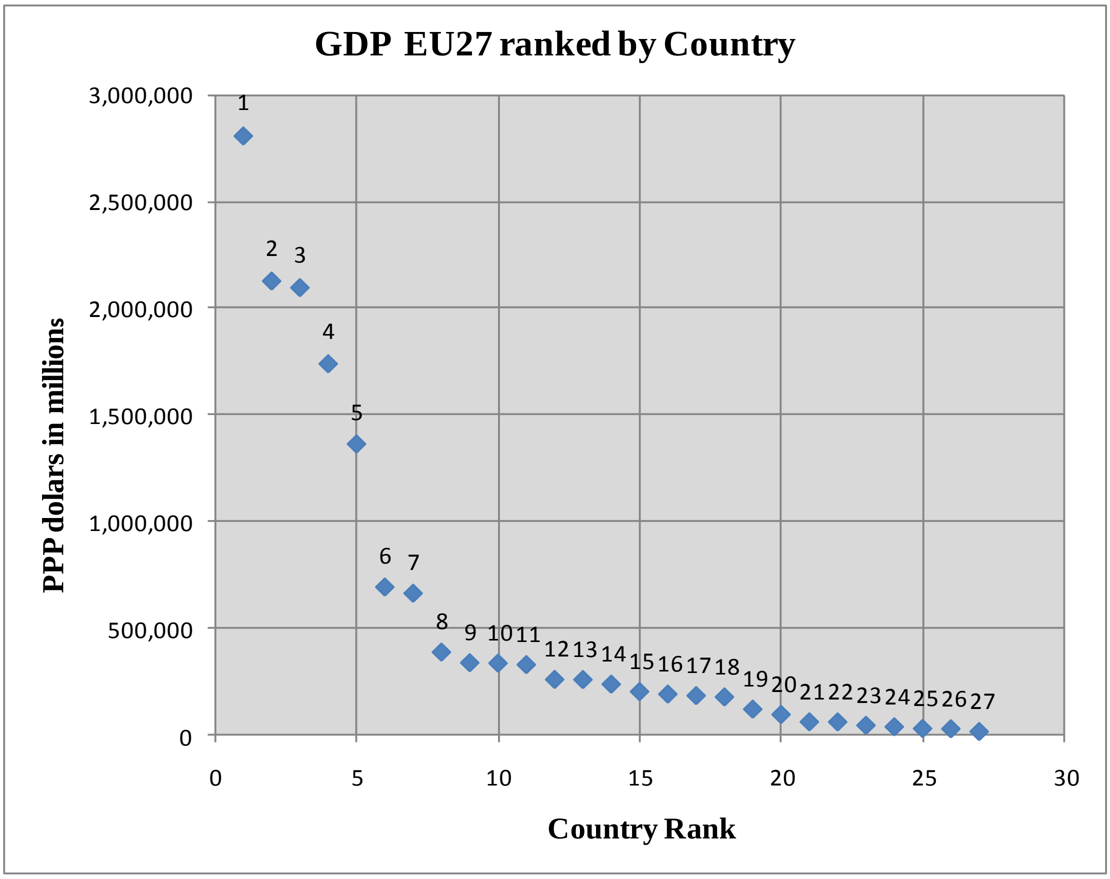
3. Total GDP per annum by Country, EU27 for 2009 est. in Millions of Purchasing Power Parity Dollars: [A3]

Table A3

1	Germany	2,810,000	15	*Denmark*	197,800
2	*United Kingdom*	2,128,000	16	*Hungary*	186,000
3	France	2,097,000	17	Finland	178,800
4	Italy	1,739,000	18	Ireland	172,500
5	Spain	1,362,000	19	Slovakia	115,100
6	*Poland*	689,300	20	*Bulgaria*	90,100
7	Netherlands	660,000	21	Slovenia	55,460
8	Belgium	383,400	22	*Lithuania*	55,110
9	Greece	333,400	23	Luxembourg	39,140
10	*Sweden*	331,400	24	*Latvia*	32,220
11	Austria	324,400	25	*Estonia*	24,000
12	*Romania*	254,700	26	Cyprus	22,790
13	*Czech Republic*	254,100	**27**	**Malta**	**9,833**
14	Portugal	232,600			

Total as Computed 14,778,153 Euro Zone 10,535,423 (71%)

Chart A3



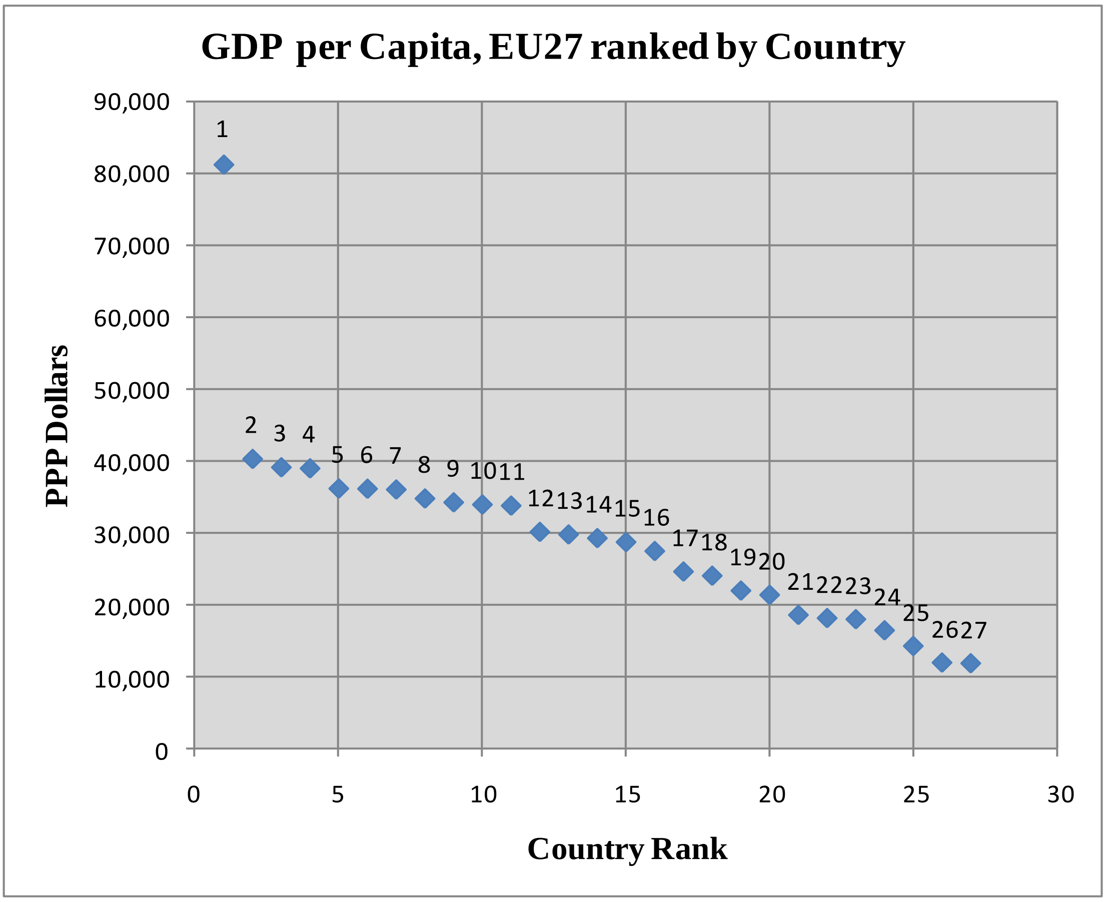
4. GDP per capita per annum, calculated from sections 1 and 3 above: [A4]

Table A4

1	Luxembourg	81,203	15	Cyprus	28,667
2	Netherlands	40,234	16	Slovenia	27,415
3	Ireland	39,071	17	*Czech Republic*	24,560
4	Austria	38,925	**18**	**Malta**	**23,983**
5	*Denmark*	36,121	19	Portugal	21,908
6	*Sweden*	36,088	20	Slovakia	21,319
7	Belgium	35,980	21	*Hungary*	18,517
8	*United Kingdom*	34,732	22	*Poland*	18,084
9	Germany	34,194	23	*Estonia*	17,924
10	France	33,890	24	*Lithuania*	16,377
11	Finland	33,736	25	*Latvia*	14,200
12	Spain	30,078	26	*Romania*	11,889
13	Greece	29,723	27	*Bulgaria*	11,790
14	Italy	29,213			

Unweighted Ave. 29,253 Euro Zone 34,346

Chart A4



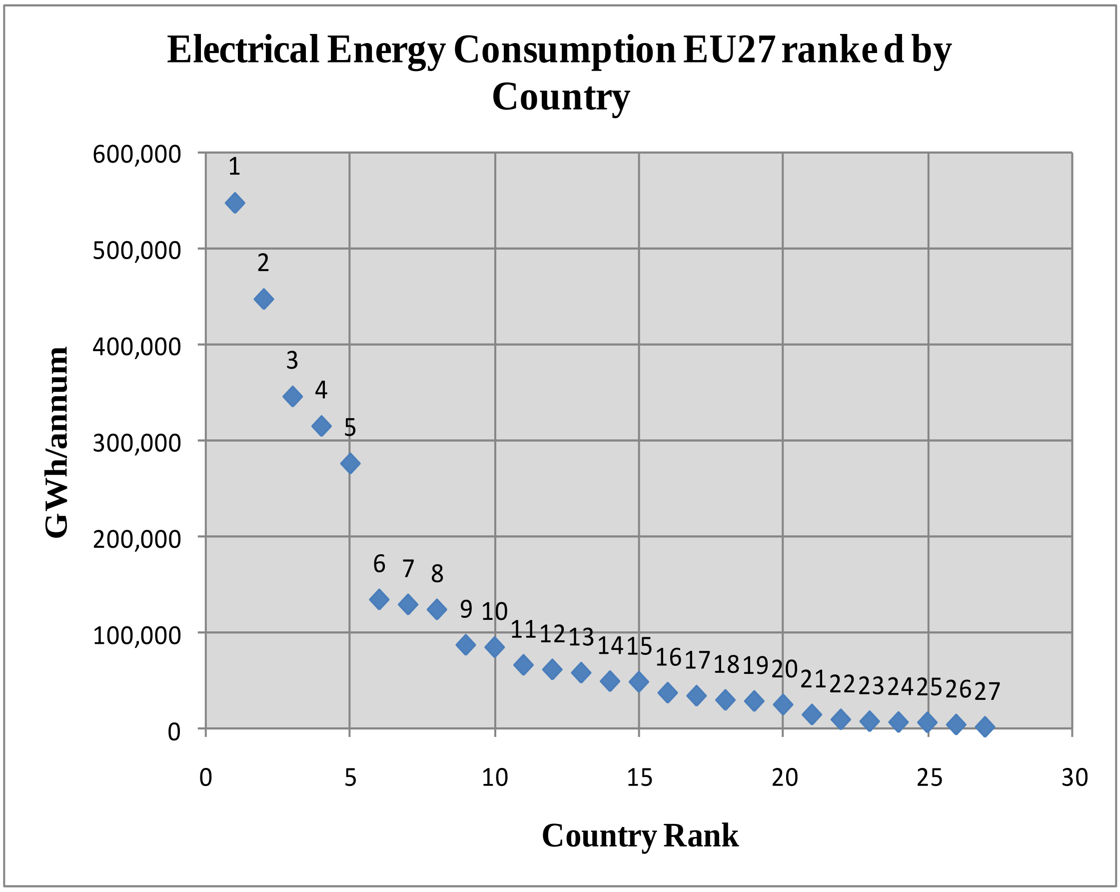
5. Total Electrical Energy Consumption in Giga Watt hours per annum for years as shown: [A5]

Table A5

1	Germany	547,300	2007 est
2	France	447,200	2007 est
3	*United Kingdom*	345,800	2007 est
4	Italy	315,000	2007 est
5	Spain	276,100	2008 est
6	*Sweden*	134,500	2007 est
7	*Poland*	129,300	2007 est
8	Netherlands	124,100	2008 est
9	Finland	87,250	2008
10	Belgium	84,880	2007 est
11	Austria	66,370	2008 est
12	*Czech Republic*	61,650	2007 est
13	Greece	58,280	2007 est
14	*Romania*	49,440	2007 est
15	Portugal	48,780	2007 est
16	*Hungary*	37,400	2008 est
17	*Denmark*	34,300	2008 est
18	*Bulgaria*	29,900	2008
19	Slovakia	28,750	2009 est
20	Ireland	25,120	2007 est
21	Slovenia	14,700	2009 est
22	*Lithuania*	9,612	2007 est
23	*Estonia*	7,686	2007 est
24	*Latvia*	6,822	2007 est
25	Luxembourg	6,525	2007 est
26	Cyprus	4,277	2007 est
27	**Malta**	**1,832**	2007 est

Total as Computed 2,982,874 Euro Zone 2,136,464 (72%)

Chart A5



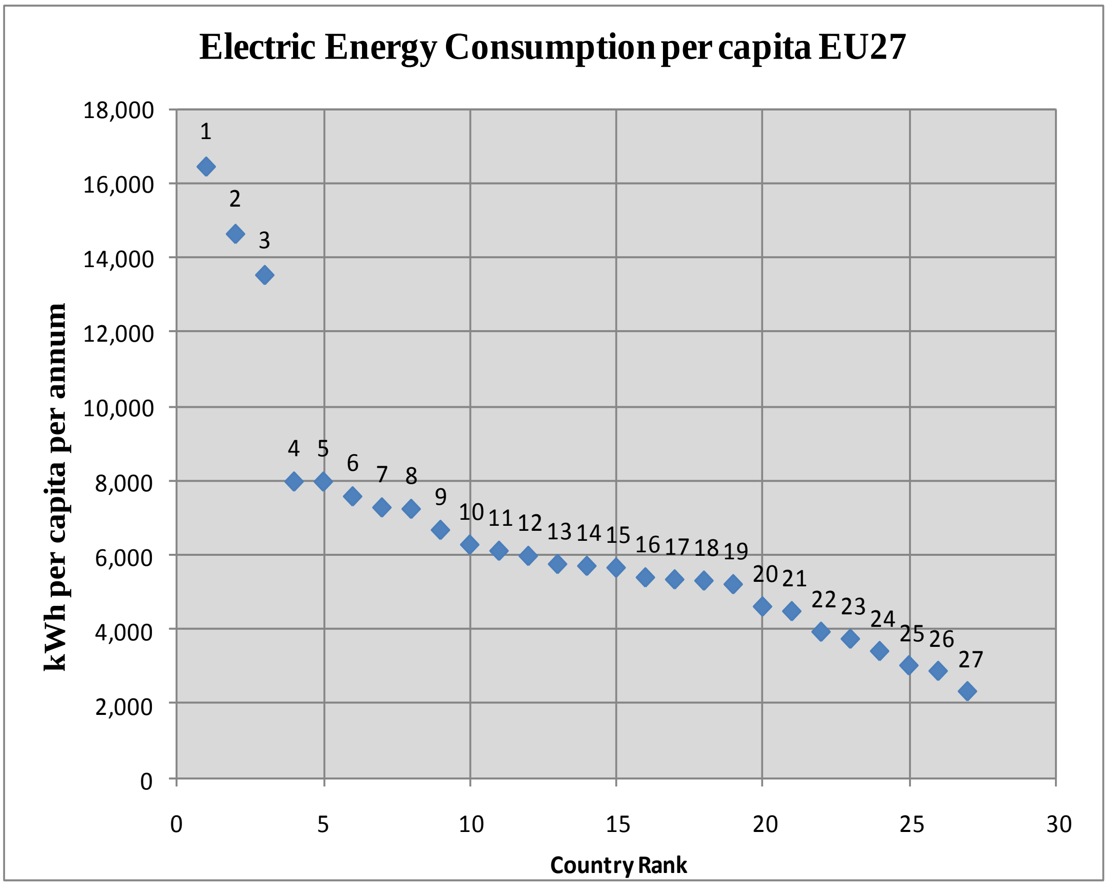
6. Electrical Energy Consumption per capita per annum, calculated from sections 1 and 5 above, in kWh/capita/annum [A6]

Table A6

1	Finland	16,462
2	*Sweden*	14,647
3	Luxembourg	13,537
4	Belgium	7,965
5	Austria	7,964
6	Netherlands	7,565
7	Slovenia	7,266
8	France	7,227
9	Germany	6,660
10	*Denmark*	6,264
11	Spain	6,097
12	*Czech Republic*	5,959
13	*Estonia*	5,740
14	Ireland	5,690
15	*United Kingdom*	5,644
16	Cyprus	5,380
17	Slovakia	5,325
18	Italy	5,292
19	Greece	5,196
20	Portugal	4,595
21	**Malta**	**4,468**
22	*Bulgaria*	3,913
23	*Hungary*	3,723
24	*Poland*	3,392
25	*Latvia*	3,007
26	*Lithuania*	2,856
27	*Romania*	2,308

Unweighted Ave. 6,450 Euro Zone 7,29

Chart A6



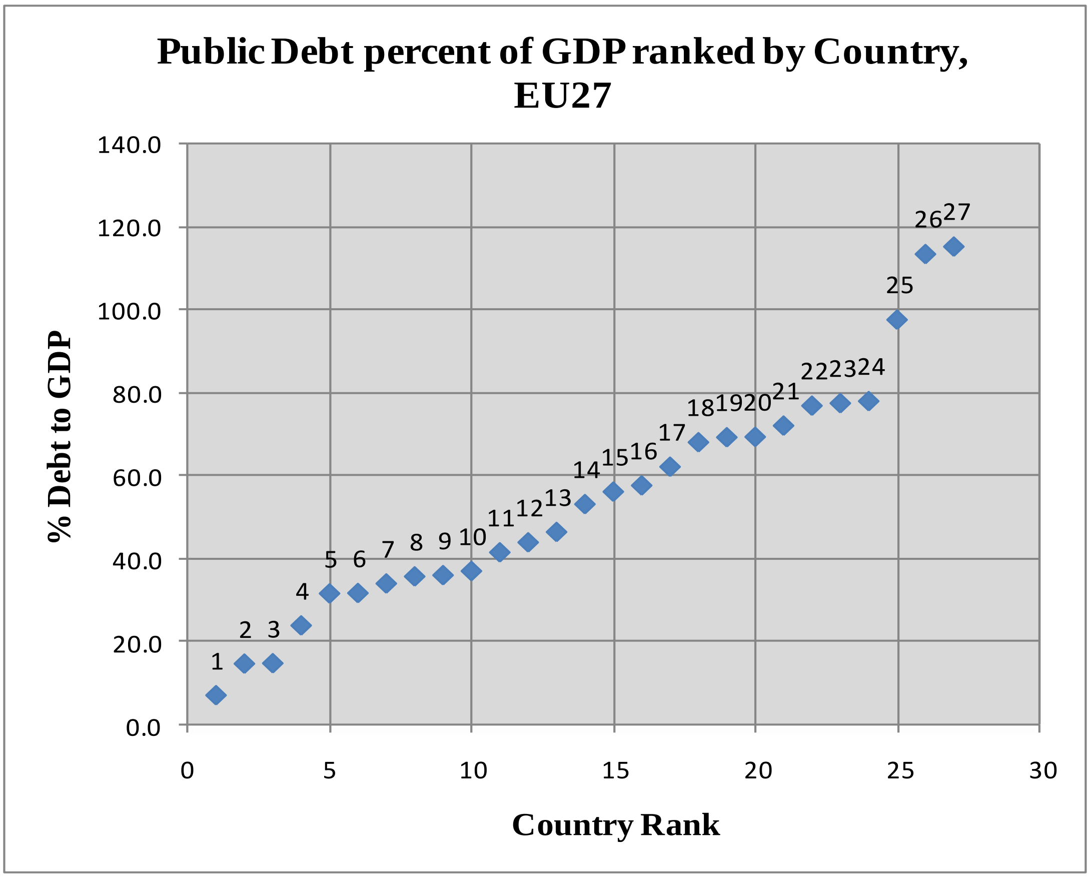
7. Public Debt Percent of GDP for 2009 by Country EU27, estimated: [A7]

Table A7

1	*Estonia*	7.2			
2	*Bulgaria*	14.8	15	Cyprus	56.2
3	Luxembourg	14.9	16	Ireland	57.7
4	*Romania*	24.0	17	Netherlands	62.2
5	*Lithuania*	31.7	18	*United Kingdom*	68.1
6	Slovenia	31.8	19	Austria	69.3
7	*Czech Republic*	34.1	**20**	**Malta**	**69.4**
8	*Sweden*	35.8	21	Germany	72.1
9	*Latvia*	36.1	22	Portugal	76.9
10	Slovakia	37.1	23	France	77.5
11	*Denmark*	41.6	24	*Hungary*	78.0
12	Finland	44.0	25	Belgium	97.6
13	*Poland*	46.5	26	Greece	113.4
14	Spain	53.2	27	Italy	115.2

Unweighted Ave. 54.3 Euro Zone 65.5

Chart A7



8. Current Account Balance (1,000,000's) in exchange rate corrected US dollars, 2009 est.: [A8]

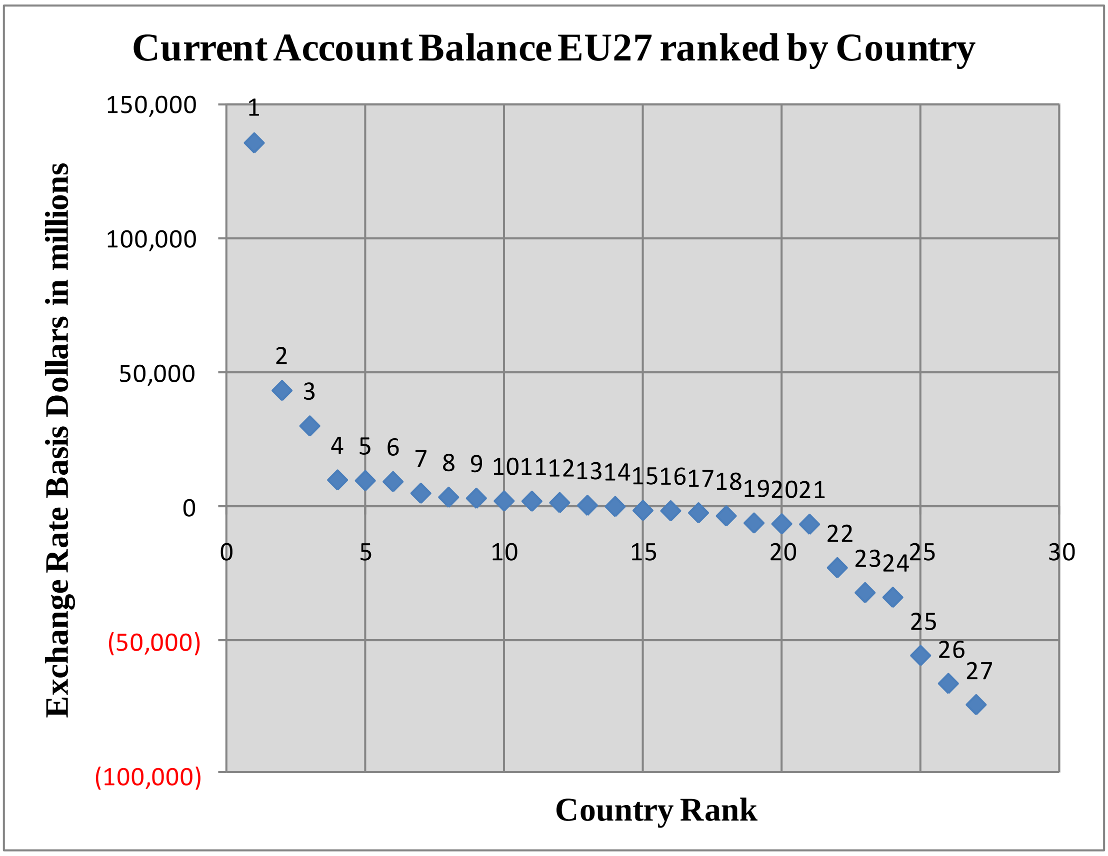
Table A8

1	Germany	135,100
2	Netherlands	42,720
3	*Sweden*	29,500
4	Luxembourg	9,351
5	*Denmark*	9,103
6	Austria	8,730
7	Belgium	4,398
8	Finland	2,916
9	*Latvia*	2,530
10	*Hungary*	1,507
11	*Lithuania*	1,422
12	*Estonia*	899
13	Slovenia	(117)
14	**Malta**	**(570)**

15	Cyprus	(2,018)
16	*Czech Republic*	(2,146)
17	Slovakia	(2,906)
18	*Bulgaria*	(4,060)
19	Ireland	(6,707)
20	*Romania*	(7,025)
21	*Poland*	(7,172)
22	Portugal	(23,380)
23	*United Kingdom*	(32,680)
24	Greece	(34,430)
25	France	(56,130)
26	Italy	(66,570)
27	Spain	(74,470)

Total as Computed (72,205) Euro Zone (64,083)

Chart A8



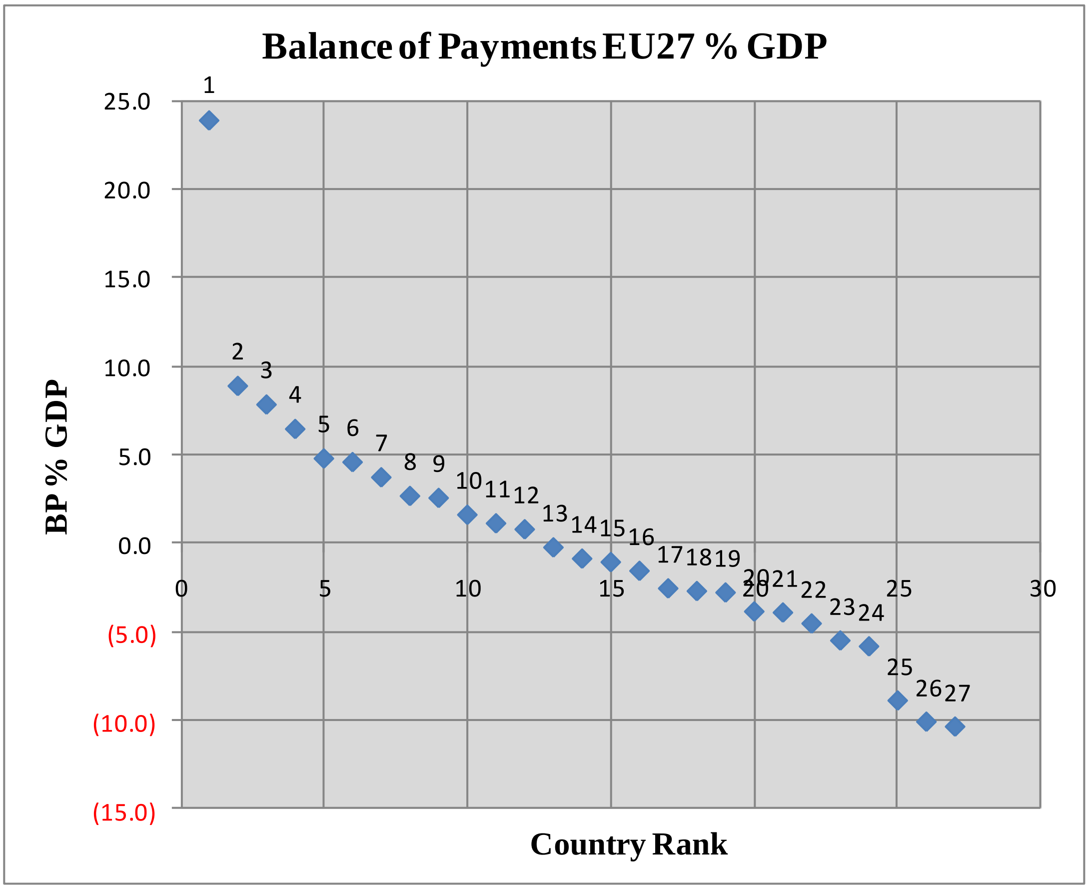
9. Current Account Balance as Percent of GDP from sections 3 and 8, [A9]

Table A9

1	Luxembourg	23.9
2	*Sweden*	8.9
3	*Latvia*	7.9
4	Netherlands	6.5
5	Germany	4.8
6	*Denmark*	4.6
7	*Estonia*	3.7
8	Austria	2.7
9	*Lithuania*	2.6
10	Finland	1.6
11	Belgium	1.1
12	*Hungary*	0.8
13	Slovenia	(0.2)
14	*Czech Republic*	(0.8)

15	*Poland*	(1.0)
16	*United Kingdom*	(1.5)
17	Slovakia	(2.5)
18	France	(2.7)
19	*Romania*	(2.8)
20	Italy	(3.8)
21	Ireland	(3.9)
22	*Bulgaria*	(4.5)
23	Spain	(5.5)
24	**Malta**	**(5.8)**
25	Cyprus	(8.9)
26	Portugal	(10.1)
27	Greece	(10.3)

Chart A9

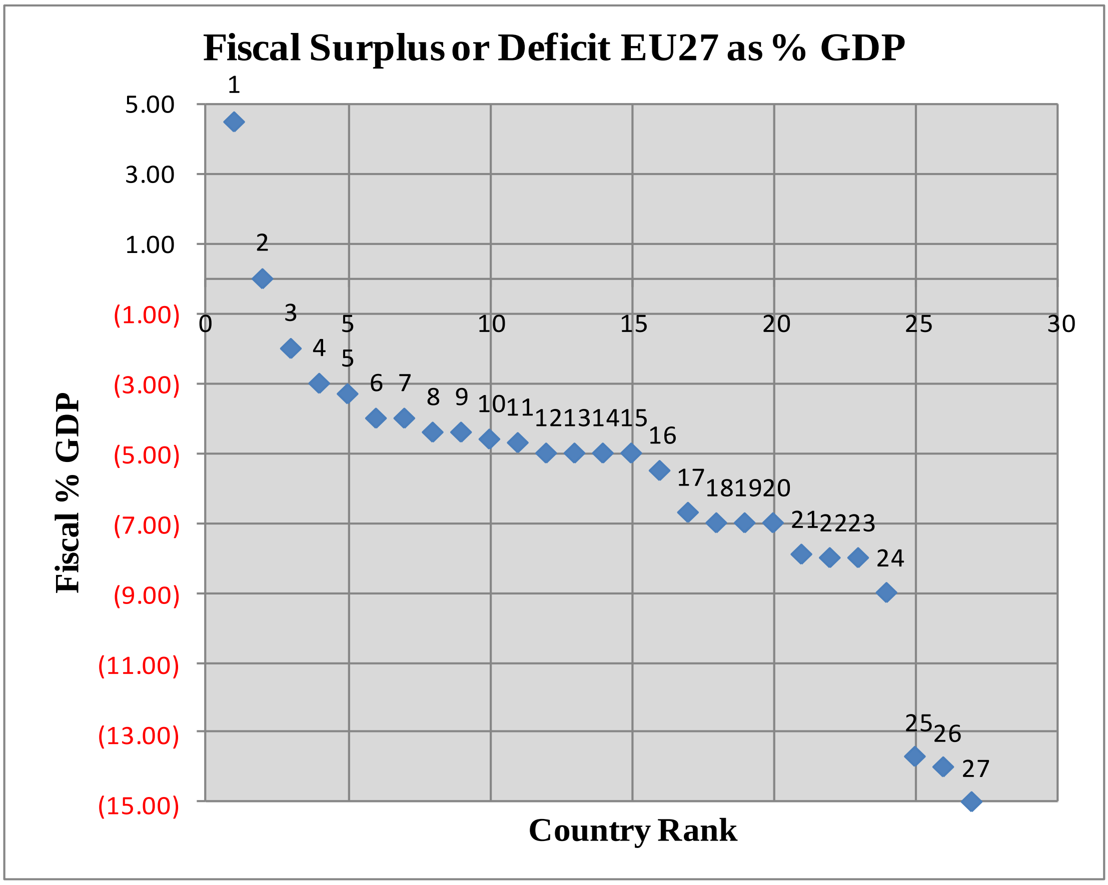


10. Fiscal Surplus or Deficit as Percent of GDP, for years as shown below [A10]

Table A10

1	Finland	4.50	2008
2	*Denmark*	0.00	2010
3	*Sweden*	(2.00)	2010
4	*Poland*	(3.00)	2009
5	*Hungary*	(3.30)	2008
6	Austria	(4.00)	2009
7	Belgium	(4.00)	2009
8	*Bulgaria*	(4.40)	2010
9	Cyprus	(4.40)	2009
10	Netherlands	(4.60)	2009
11	**Malta**	**(4.70)**	**2008**
12	*Czech Republic*	(5.00)	2010
13	Germany	(5.00)	2010
14	Italy	(5.00)	2009
15	Luxembourg	(5.00)	2009
16	Slovenia	(5.50)	2009
17	Portugal	(6.70)	2009
18	*Estonia*	(7.00)	2009
19	*Romania*	(7.00)	2010
20	Slovakia	(7.00)	2010
21	Spain	(7.90)	2009
22	France	(8.00)	2009
23	*Latvia*	(8.00)	2009
24	*Lithuania*	(9.00)	2009
25	Greece	(13.70)	2009
26	*United Kingdom*	(14.00)	2010
27	Ireland	(15.00)	2010

Chart A10



Appendix B

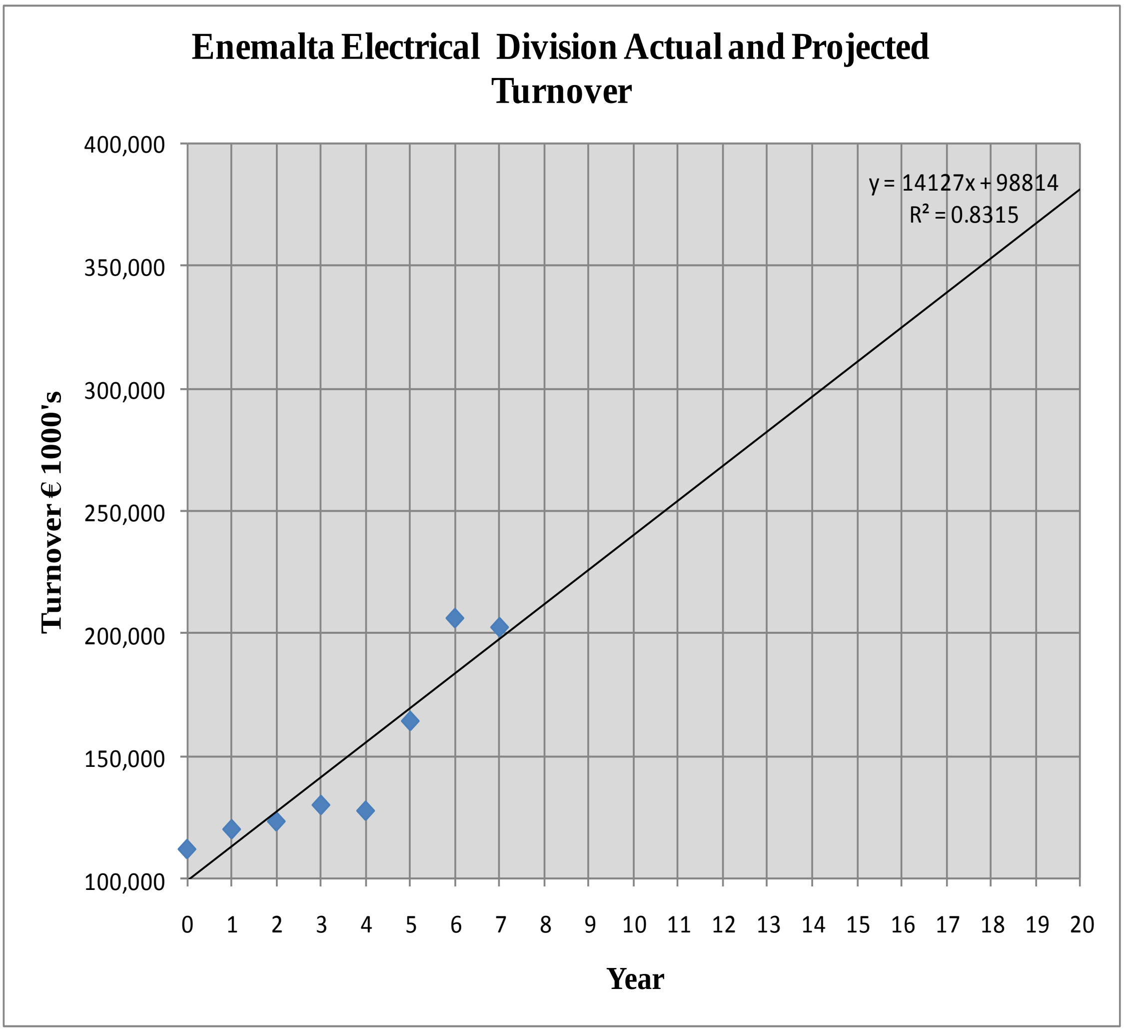
The data for the turnover in the Electric Power Division of Enemalta was taken from the Corporation's annual reports 2002 through 2008 (last available) and is displayed in the table below:

Table B1

	From Enemalta Annual Reports								
	2002	2003	2004	2005	2006	2008	Together	Actual	Projected
Year	page 66	page 53	page 14	page 70	page 72	page 43	in LM	in €	in €
2000	48,039						48,039	111,931	
2001	51,528	51,528					51,528	120,060	
2002		52,910	52,910				52,910	123,280	
2003			55,784	55,784		55,784	55,784	129,977	
2004				54,770	54,770	54,770	54,770	127,614	
2005					70,508	63,577	70,508	164,284	
2006						88,548	88,548	206,317	
2007						86,956	86,956	202,607	
2008									211,830
2009									225,957
2010									240,084
2011									254,211
2012									268,338
2013									282,465
2014									296,592
2015									310,719
2016									324,846
2017									338,973
2018									353,100
2019									367,227
2020									381,354

Note: There is a discrepancy for the year 2005 when comparing the 2006 report and the 2008 report. Enemalta has not responded to an inquiry regarding this discrepancy. The 2005 figure in the 2006 report was used because it is closer to the trendline in the Chart below. The data for 2002 through 2007 is plotted in the scattergram below, and the Excel linear trendline projection equation: Turnover = 141127*year# + 98814 was used to project the years 2008 through 2020.

Chart B1



Enemalta Electrical Division Actual and Projected Turnover
y = 14127x + 98814
R² = 0.8315
400,000
350,000
300,000
250,000
200,000
150,000
100,000
Turnover € 1000's
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Year

Appendix C – Italy: electricity price data

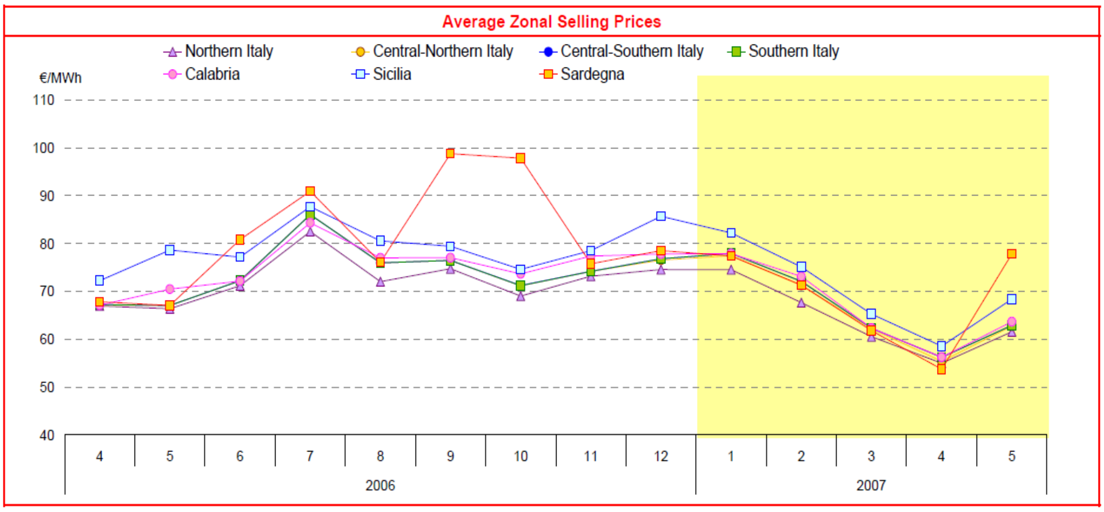


Chart C1

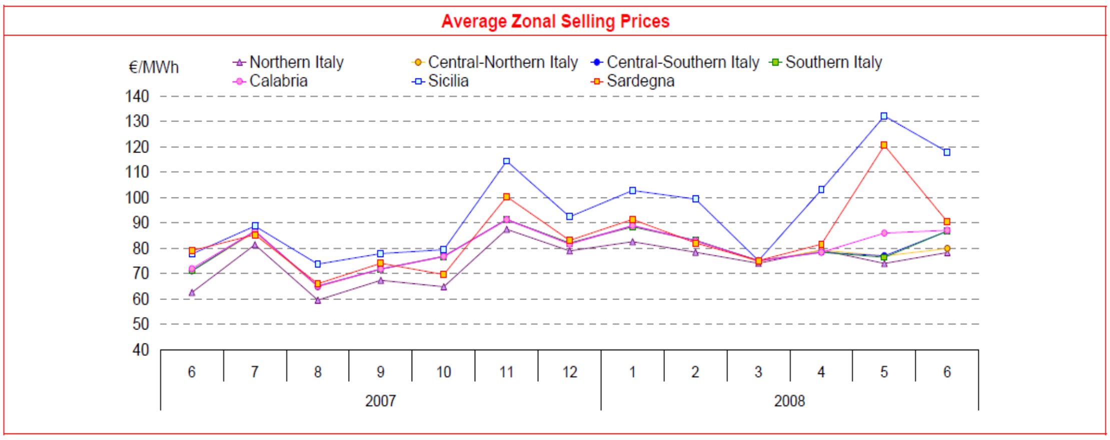


Chart C2

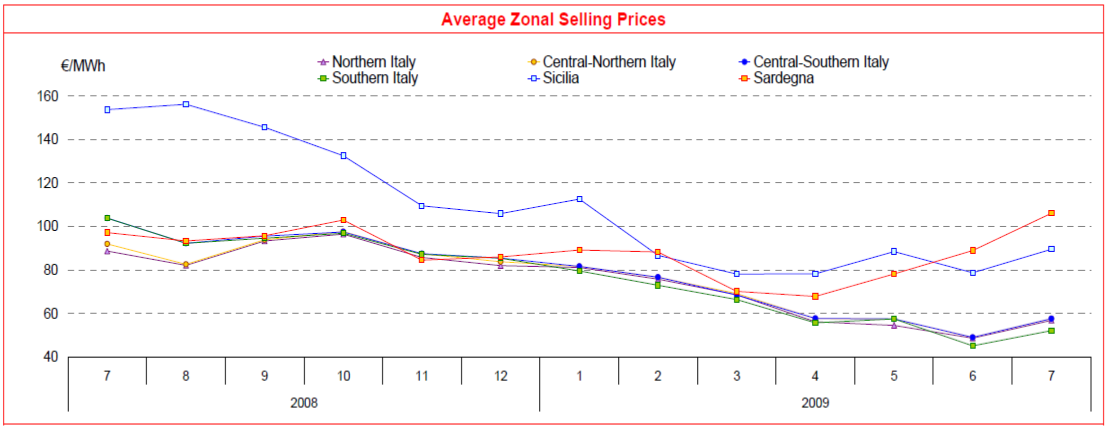


Chart C3

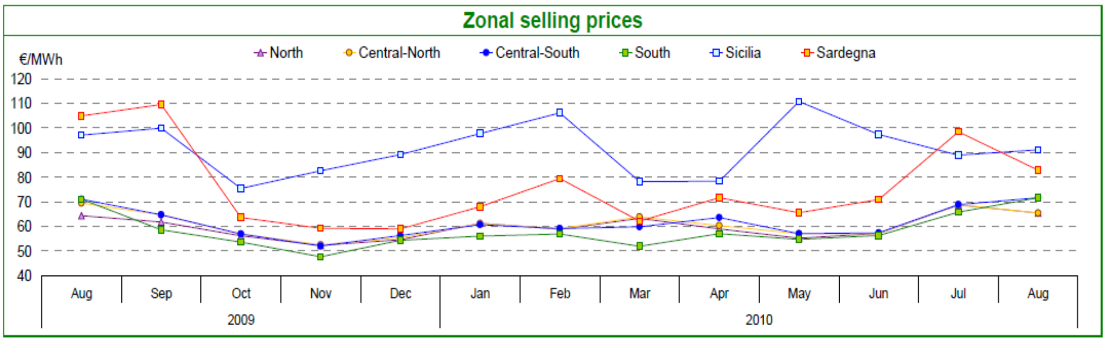

Zonal selling prices
€/MWh
North
Central-North
Central-South
South
Sicilia
Sardegna
120
110
100
90
80
70
60
50
40
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
2009
2010

Chart C4

[A1]

Appendix D – Maltese Islands' Rates of Cancer: Incidence & Mortality by Region for 2000-03 & 2004-07

Average age-standardized rate per year per 100,000 population				
All Cancer Incidence	**MALES**		**FEMALES**	
(ex. non-melanoma skin)				
	2000-03	**2004-07**	**2000-03**	**2004-07**
Southern Harbour	315.96	373.09	262.72	278.09
Northern Harbour	291.92	340.69	263.53	321.40
South Eastern	317.47	357.98	283.66	285.63
Western	304.18	363.35	265.82	302.44
Northern	299.08	303.04	245.36	279.69
Gozo & Comino	280.30	293.53	247.54	284.42
All Cancer Mortality	**MALES**		**FEMALES**	
	2000-03	**2004-07**	**2000-03**	**2004-07**
Southern Harbour	213.30	229.33	129.36	121.15
Northern Harbour	180.50	201.78	120.52	137.62
South Eastern	170.19	215.76	127.1	137.97
Western	202.75	216.57	113.44	116.07
Northern	151.89	196.05	114.6	119.42
Gozo & Comino	149.64	171.21	113.27	138.81

Table D1 [A1]

Results published by the Department of Health Information and Research (DHIR) in July 2010 appear on the table above. Data collected by the Malta National Cancer Registry was used to identify trends for cancer based upon gender, age, cancer type and region of residence. Patterns appear most markedly in the Southern Harbour District and South East District with the highest cancer mortality rate for females between 2000-04 and the highest male cancer incidence rate during 2004-07 with South East as second highest for same period. Southern Harbour had the highest mortality rate for all cancers among males during 2000-04 and continues to have the highest mortality rate.

Dr. Etienne Grech, M.D., a Maltese G.P., used data from the DHIR 2010 report to write an informative piece, an excerpt of which is:

"The latest cancer statistics in Malta show a high incidence rate in Zejtun… where there is an age standardised cancer incidence rate of 399.37/100,000

in males (national average 341.19) and 298.58 per 100,000 for women (national average 291.62)… there are also high mortality rates in Zejtun…" [A2]

The Southern Harbour and South East regions suffer from emissions from power plants as well as heavy emissions from traffic due to the population density. Constant exposure to carcinogens increases the risk of cancer.

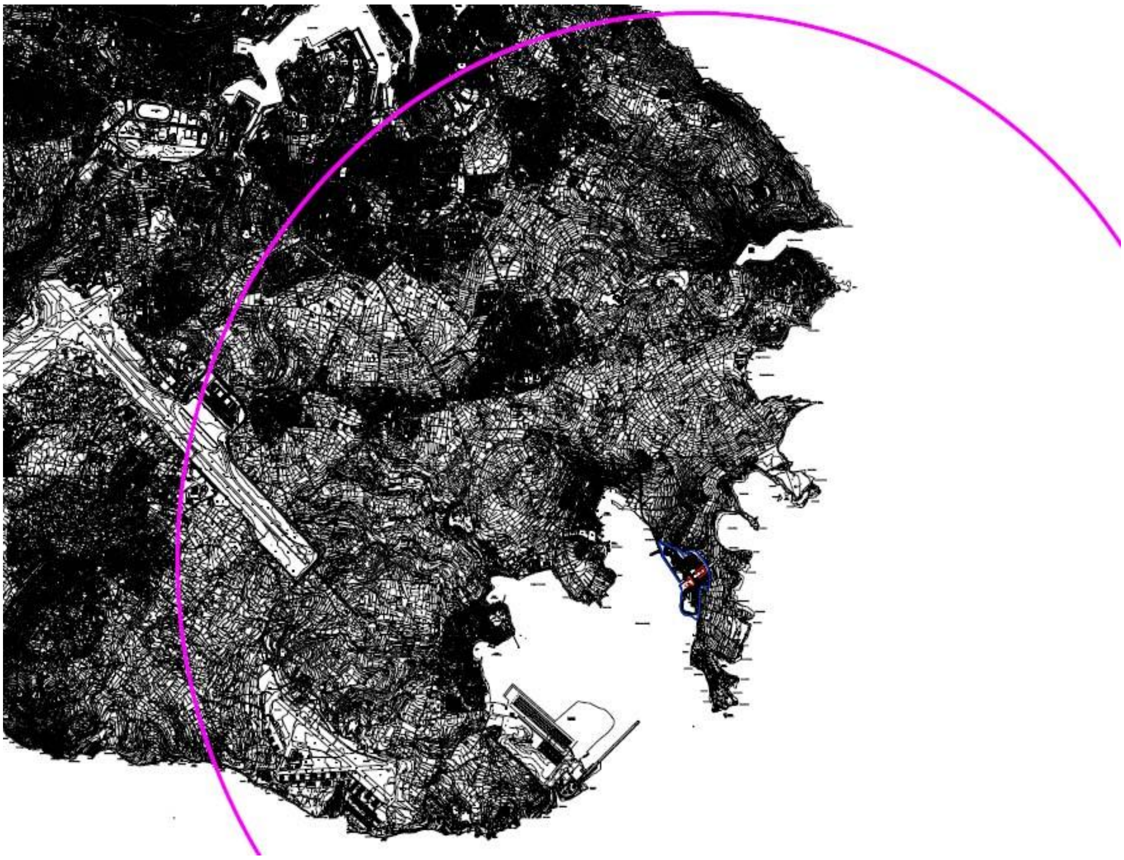


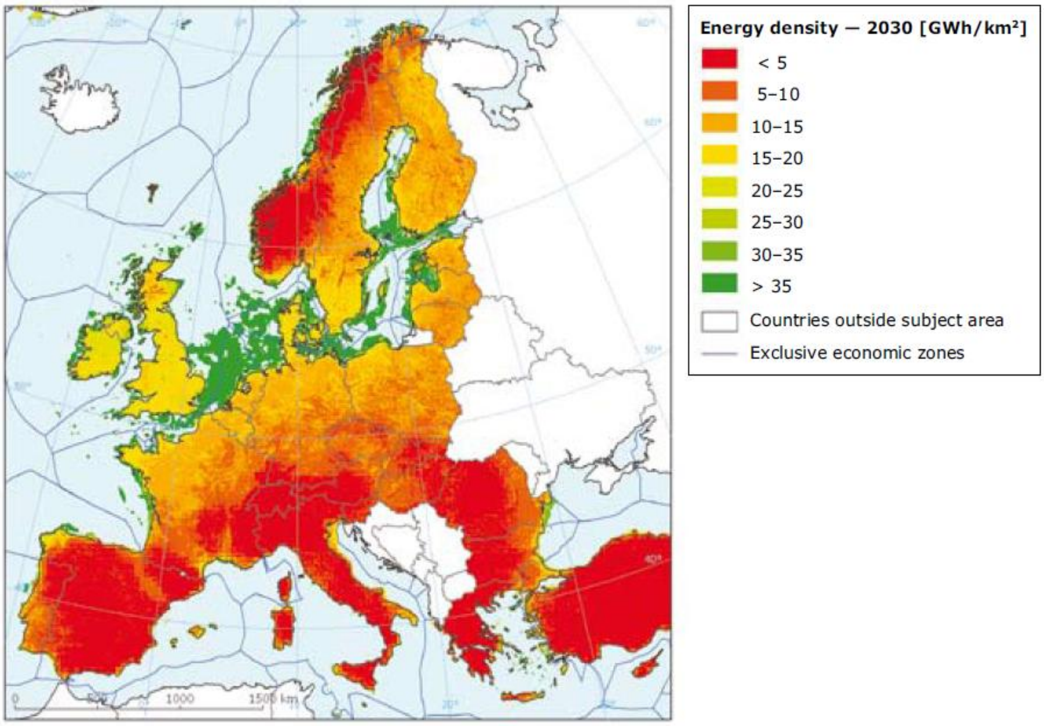
Figure D1

**The map depicts the radius around Delimara Power Station in the South East Region of Malta which has high exposure to toxins emitted from Delimara.
The caption on the map is taken from the EIA Report for the Delimara Extension: 'If you live or work within the red circle, the Delimara Power Station could affect you'. [A3]**

Appendix E - Wind Farm Statistics

Figure E1: Projection of wind energy density in Europe for 2030 indicating the Maltese Islands at the lowest level of less than 5 GWh/km2

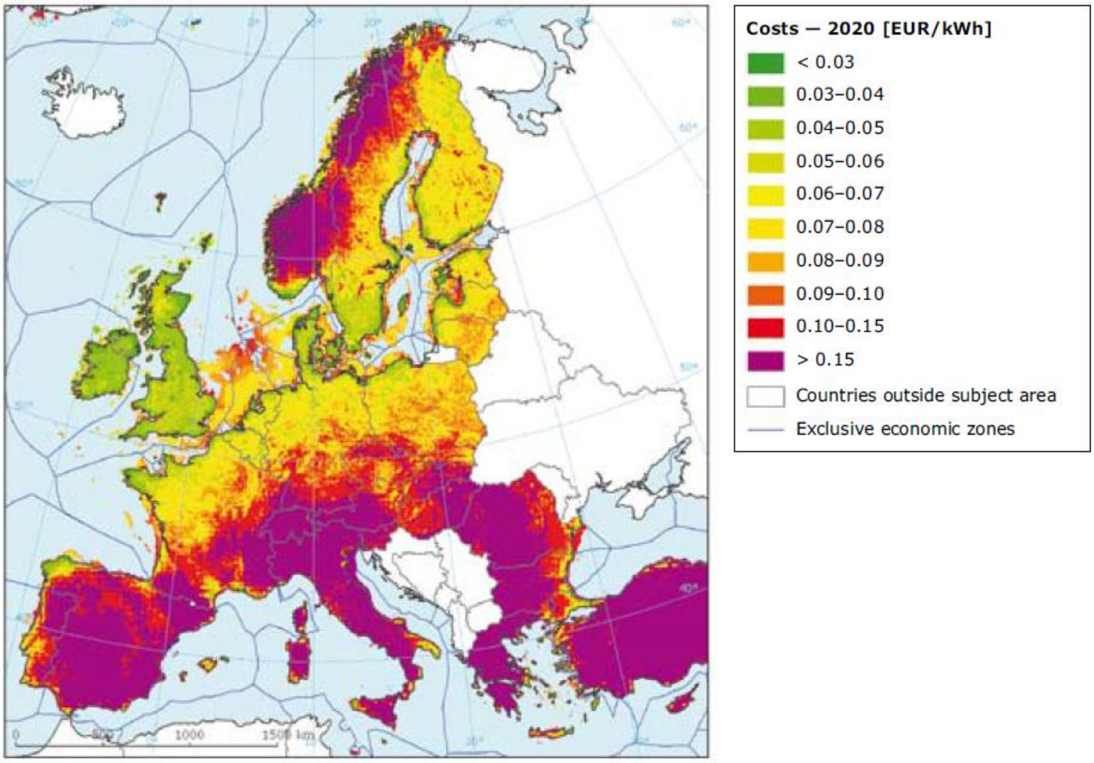
Map 3.3 **Distribution of wind energy density (GWh/km²) in Europe for 2030 (80 m hub height onshore, 120 m hub height offshore)**



Source: EEA, 2008.

Figure E1 [A1]

Figure E2: Generation Costs for Wind Energy Europe 2020 Note: Malta is shown as ‘red’ which is the highest cost/kWh



Source: EEA, 2008.

Figure E2 [A1]

Chart E1: Offshore capital investment cost is shown peaking 2008-10, declining precipitiously thereafter, and continuing on a downward cost trend to 2030

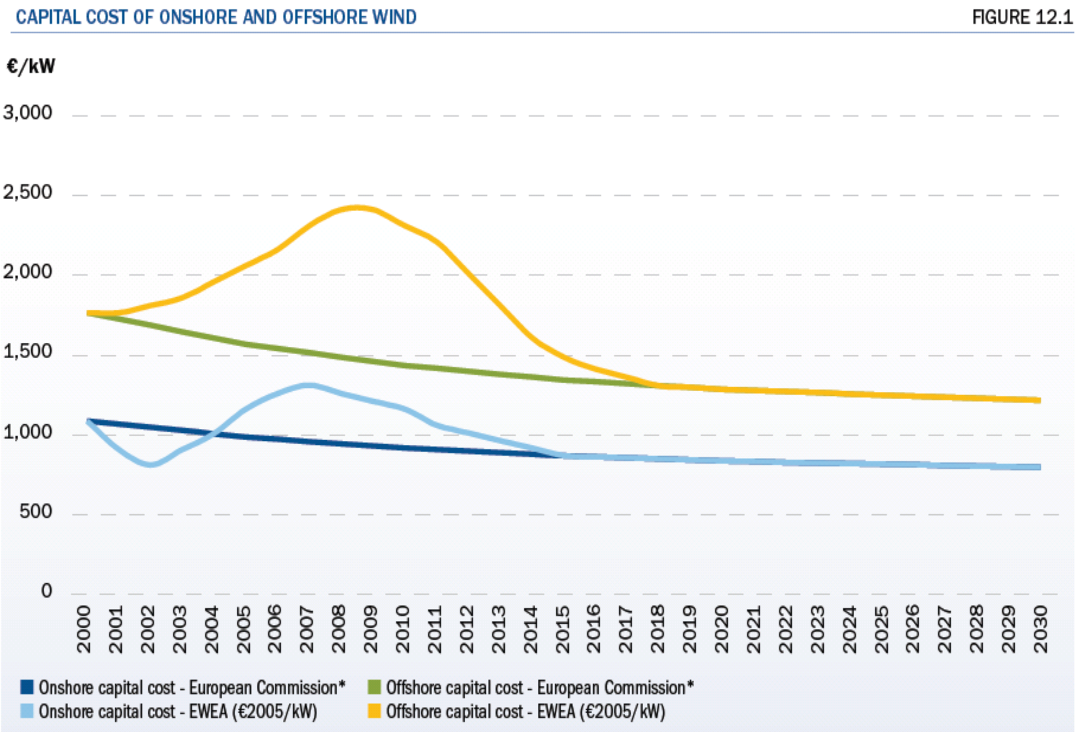


Chart E1 [A2]

Figure E3: Wind map of the Mediterranean Sea region showing Malta in a low wind velocity area

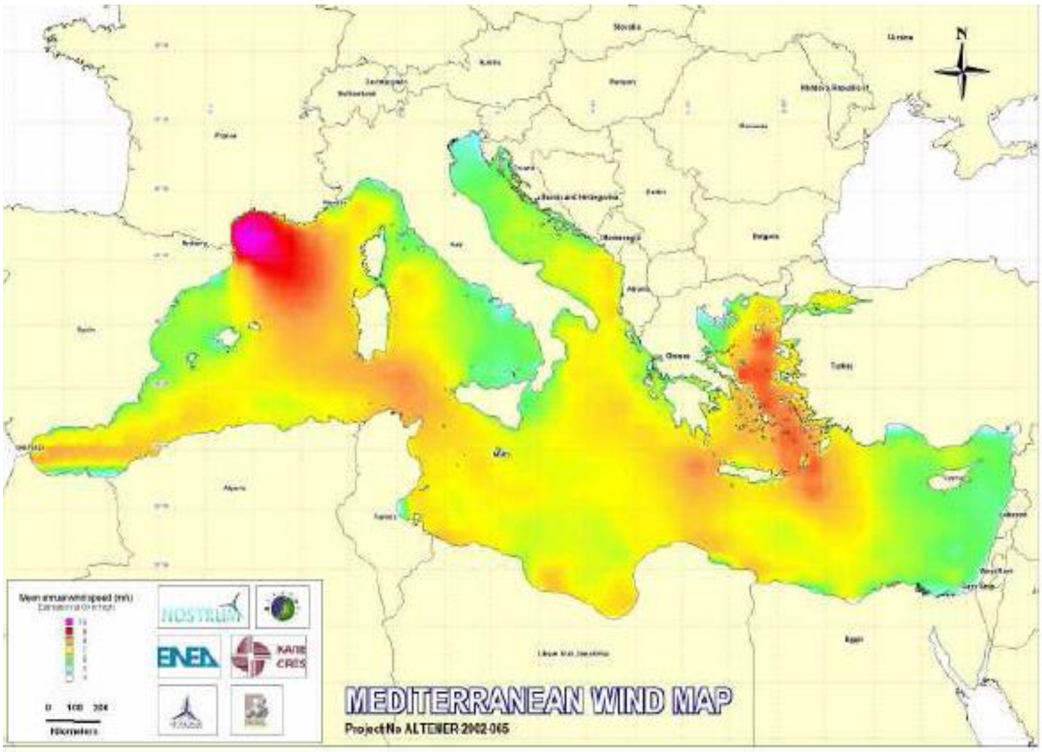


Figure E3[A3]

Chart E2: 2010 is at the apex of the curve for cost of installation of wind farms: 40% more expensive installed in 2010 than if installed in 2018.[A4]

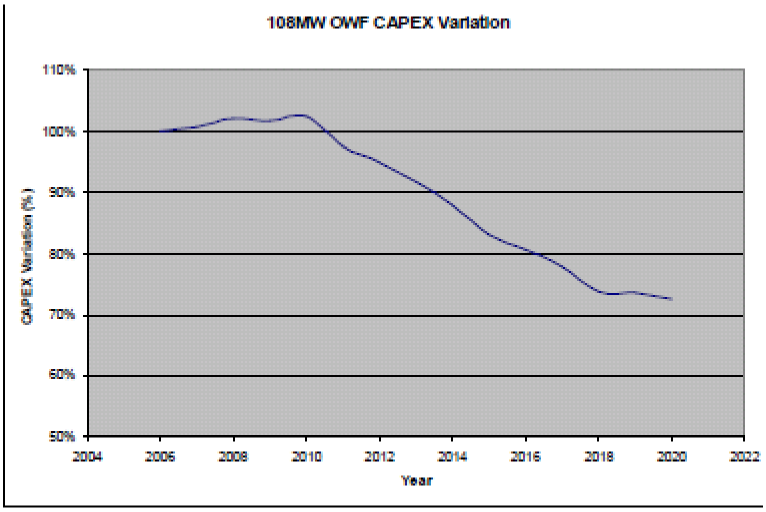


Chart 1: 108MW OWF CAPEX Variation (2006-2020)

[A4]

As can be seen from the chart above, wind farm investments that are made in 2010 are at the pinnacle of the projected capital cost (capex) curve. Investments in a wind farm of a certain capacity made today will be almost 40% more expensive than investments made of that same capacity wind farm in 2018.

Potential Offshore Sites < 20 m depth and between 20-50 m depth (excluding Hurd Bank)

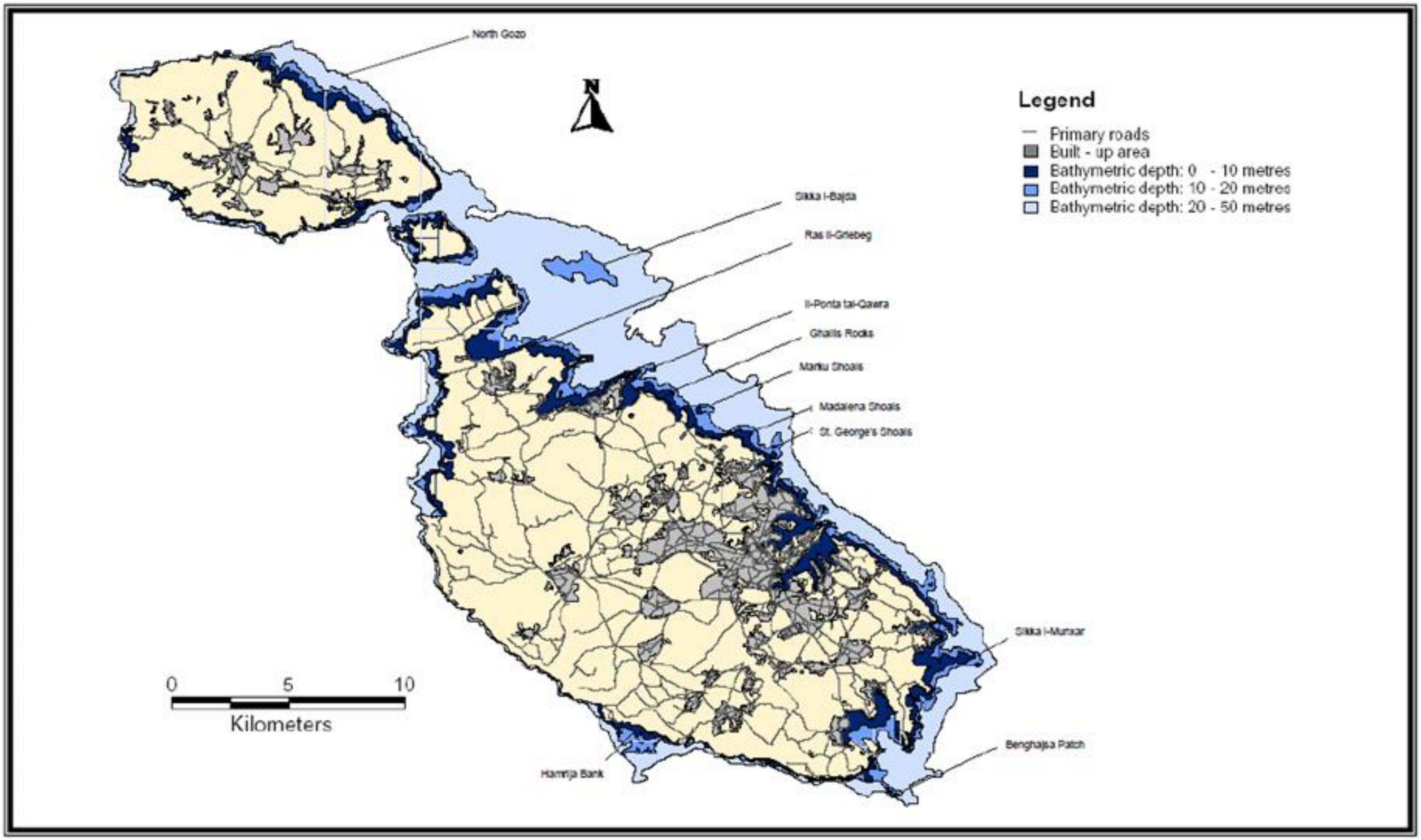


Figure E4: Location of Potential Offshore Sites in Malta & Gozo with legend showing built-up areas, primary roads and offshore depth in meters [A5]

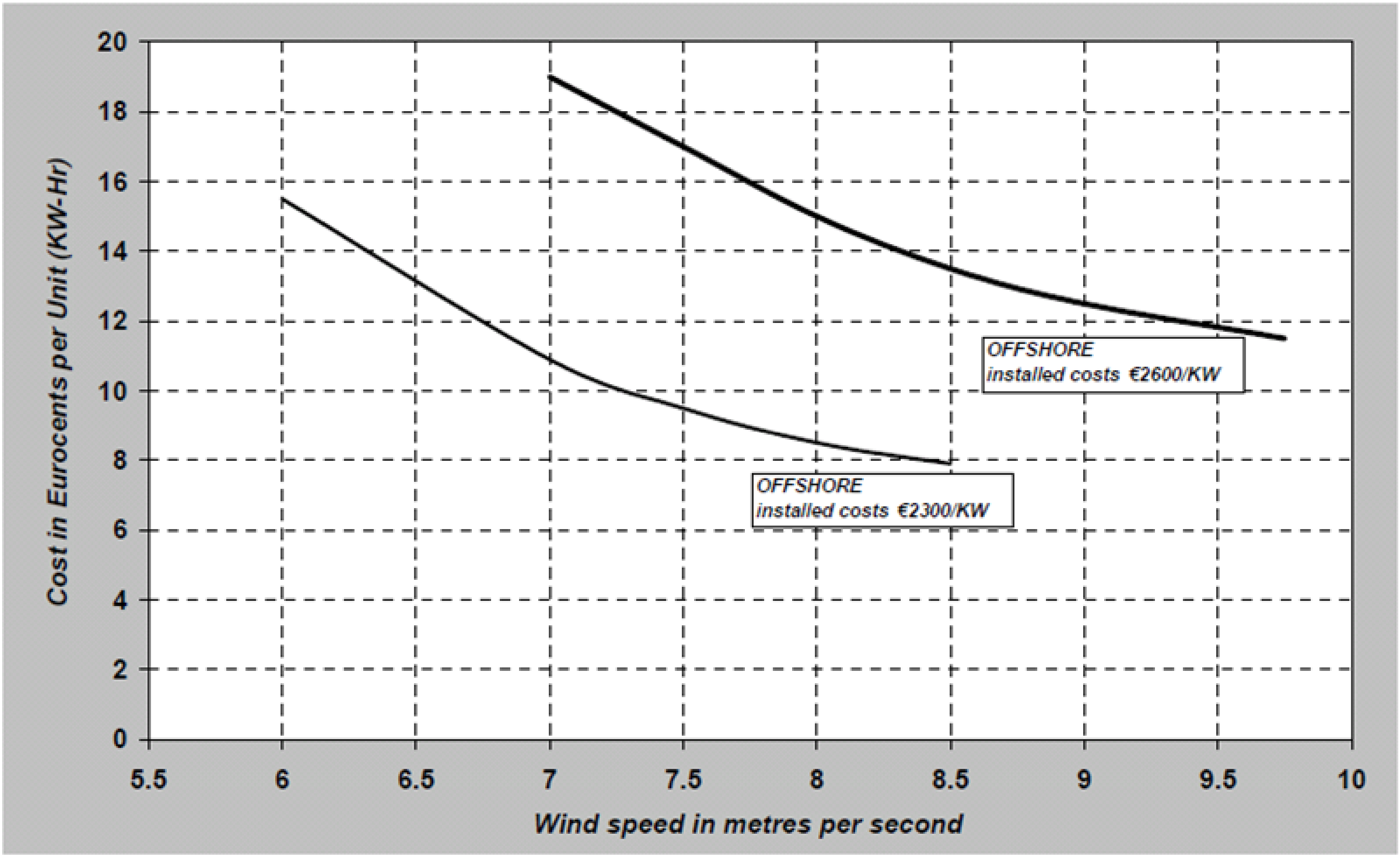


Chart E3: Cost of wind energy for offshore wind farms constructed in 2007 shown as cost/kWh plotted against wind speed, indicating that to be cost effective the offshore wind must be in an area with high wind speeds[A5]

Figure E5: Photomontage of Sikka l-Bajda from Ghadira Bay: this view is taken from a popular tourist area; thus the photomontage is helpful in evaluating a potential Sikka l-Bajda wind farm's aesthetic impact on the proximate area

Photomontages – 19 X 5 Megawatt Turbines

Existing View

Proposed View

STRATEGIC VIEW FROM GHADIRA BAY

Figure E5 [**A5]**

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