# Enemalta Corporation

## Malta-Italy Electricity Interconnector Cable Project

### Cost-Benefit Analysis

15 July 2009

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# Contents

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# Glossary

| | |
|---|---|
| EEPR | European Energy Programme for Recovery |
| Enemalta | Enemalta Corporation |
| TERNA | Italian grid network operator |
| MVA | Mega Voltage Amperes |
| GWh | Giga Watt Hours |
| HVAC | High Voltage Alternating Current |
| HVDC | High Voltage Direct Current |
| CBA | Cost-Benefit Analysis |
| MRA | Malta Resources Authority |
| ROI | Return on Investment |
| GHG | Green House Gas |
| GDP | Gross Domestic Product |
| EU | European Union |
| LCPD | Large Combustion Plant Directive |
| NECD | National Emissions Ceiling Directive |
| NAP | National Allocation Plan |
| Regulator / MRA | Malta Resources Authority |
| MW | Mega Watt |
| MWh | Mega Watt Hours |
| PIN | Prior Information Notice |
| ETS | Emissions Trading Scheme |

# I Executive Summary

**Introduction**

The European Energy Programme for Recovery ('EEPR') was established by the European Commission to provide a financial impulse that will contribute to economic recovery, the security of energy supply and the reduction of greenhouse gas emissions of member states.

As part of this programme, the Commission has allocated a total of €20 million towards the financing of an electricity interconnector cable between Malta and Italy as well as a further €5 million for an energy-related infrastructure project in Malta.

To be able to benefit from these funds, Enemalta Corporation will be submitting two applications for funding to DG TREN. The applications are in respect of the following projects:

i. *Electricity interconnection Malta–Italy Project*: This project comprises the design and build of one high voltage sub-sea interconnector rated at 250MVA between Malta and Sicily to be in service before the end of 2012; and

ii. *Extension of 132kV network to the sub-sea electrical Interconnector Malta–Italy Project*: This project is the extension of the 132kV distribution network to connect to the Malta–Italy interconnector cable and to be able to transmit and distribute the electricity imported.

This Cost-Benefit Analysis considers both these projects since all incremental revenues and costs are based on the interventions of the projects together.

**Rationale**

The Maltese national electricity grid is an isolated one and is not connected to any other electrical network. There are currently two power stations in Malta, one at Delimara and the other at Marsa, that are operated by Enemalta. Together, these two stations have a total combined nominal installed capacity of 571MW.

Since Malta has no indigenous primary energy resources, the country's energy needs are met through imported fossil fuels, mainly in the form of heavy fuel oil and light distillate. The international price of oil, therefore, has an important bearing on the country's GDP growth, inflation levels, as well as the current account balance.

In March 2007, the European Council set two key targets directed at tackling climate change and facing up to the challenge of secure, sustainable and competitive energy. In this regard Malta has committed to a reduction of at least 20% in greenhouse gas emissions (from 1990 levels), as well as a 10% share of renewable energy in EU energy consumption by 2020[1].

1 20 20 by 2020: Europe's climate change opportunity, January 2008, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

Furthermore in 2008, Malta has declared that the Marsa Power Station will operate under a limited hours derogation from January 2008 to December 2015. In response to this, Enemalta is in the process of acquiring a 144MW plant by 2012. In addition, the introduction of an interconnector cable between Malta and Italy by 2012 would complement the local generating capacity. Moreover, an interconnector cable provides a number of benefits including, *inter alia*, a significant reduction in local emissions and a general improvement to the environment; an overall improvement in the security and stability of electrical supply and reducing volatility of energy pricing to the benefit of the Maltese economy in the long run.

**Options Analysis**

In justifying the decision for the interconnector cable project, this Cost-Benefit Analysis ('CBA') considers an alternative strategic option whereby the Delimara plant is developed further and all electricity supply is generated locally. The two options are evaluated for a 25 year time horizon. Throughout this period, further additions to the generation capabilities of Enemalta are envisaged for both options. It is assumed that such capacity additions shall be made with more of the same plant underlying the option i.e. further combined cycle diesel engines for Option A and further interconnector cables for Option B. This is in line with the approach that is typically followed for modelling investment option analysis. However, this is not meant to limit Enemalta's flexibility to pursue other approaches beyond the initial cable investment in 2012.

To facilitate the feasibility analysis, these two strategic options are evaluated against a theoretical baseline scenario which assumes that there will be no further investment made to replace ageing plant, other than the new 144MW plant which is already in procurement.

Strategic Option A comprises a further extension of the Delimara power plant. This option is estimated to entail capital costs amounting to €660 million in the 25 year period. This represents an investment of four 144MW diesel engine combined cycle plants at €165 million each (these plants are in addition to the 144MW plant included in the Baseline). The first two plants are scheduled to be commissioned in 2012-2013, another plant in 2022 and the fourth in 2029. In the 25 year period, the total operating costs to generate 72,287 GWh are estimated by Enemalta at €5.96 billion. These operating costs assume a Brent price of $70 / bbl and a USD / EUR exchange rate of 1.45. Furthermore, as from 2013 onwards Enemalta will have to procure carbon dioxide allowances on the open market under the European Trading Scheme. Enemalta is projecting the cost of these allowances at €30/mt. The net present value of the costs under Option A is estimated to be €3.07 billion calculated on the basis of a return on capital of 6.61%, which is the rate approved by the Regulator for such investment.

Strategic Option B considers electricity interconnector cables between Malta and Italy. The total investment cost in the 25 year horizon is €489 million. This represents an investment of three 250MVA interconnection cables at €163 million each. The first interconnection cable is scheduled for 2010-2012, the second cable in 2020-2022 and the third in 2027-2029. Over the same time horizon, the total operating costs to generate 72,287 Gwh are estimated by Enemalta at €5.74 billion. The main operating assumption for this option is the import price of electricity. This is assumed by Enemalta at a constant price of €75 / MWh based on the 2015 forecast estimated in a technical study commissioned for this purpose by Enemalta and

TERNA, the Italian electricity grid network operator. The other incremental cost for this option is a €2.3 million maintenance cost for each cable. On this basis, the net present value of the total costs of Option B is estimated to be €2.85 billion.

The second and third cable installations referred to above are to be considered as separate interventions from the first cable installation which is the subject of the application for EU funding, to which the CBA relates. The second and third cables are considered in order to draw up a consistent and comprehensive option for the purposes of developing the model of this Cost Benefit assessment. Following the completion of the first cable there may be other ways to develop electricity generation in Malta which will only be required in 2023 and 2030 and for which the country may apply for separate EU funding.

The financial analysis presented indicates that Option B, involving the cable link for the acquisition of electricity from the European grid, is the lower cost option by a margin of c. 7% on the net present value costs. In addition, the interconnector cable also offers the financial benefit of reduced volatility given the wider spread of generating technologies and the lower dependence on fossil fuel pricing. The imported price typically reflects a mix of electricity prices from oil and gas fired plants, hydroelectric generation, nuclear and renewable energy.

There are also other costs, which may be considered to be of an external nature, which further reinforce the preference of Option B over Option A. A major consideration in this regard associated with the cable link is the security of supply. On the basis of current level of power outages, it is estimated that the current average losses in annual GDP due to power cuts from the Delimara Power Station amounts to €1.5 million.

**Analysis of Electricity Demand**

The analysis of electricity demand in Malta is important in order to understand underlying consumer behaviour as well as to be able to forecast future loads on power-generating plants. In the past fifteen years, electricity demand has increased in Malta, but at a decreasing rate. Its composition has featured a relatively stable share of non-residential demand equal to around two-thirds of the total.

Regression analysis shows that the income and price elasticities of electricity demand over a 15-year period in Malta can be estimated at 1.385 and -0.122 respectively. However, in recent years, as the price of electricity tended to rise markedly, the elasticity of electricity demand to income is estimated to have fallen to 0.972. This conforms with *a priori* expectations typically associated with studies of this type.

**Affordability of Electricity Tariffs**

The CBA analyses the cost of the provision of electricity in Malta and considers its affordability to Maltese households and the economy in general. The analysis shows that the full-cost recovery rate for electricity production in Malta stands at €0.146/kWh at 2009 prices. When comparing this to other countries, to the disposable income of households in Malta, and in the context of increases to tariffs effected in recent years, it would be concluded that the electricity tariff rate in Malta is most probably at the limits of affordability.

Enemalta may therefore want to consider a pricing policy which ensures the continued sustainability and viability of electricity production in Malta. Towards this end, the pricing policy applied by Enemalta would cover all costs of production save for those capital costs which can be financed through EU funding programmes. If the €25 million available funding towards the proposed Project is fully utilised, the electricity tariff rate in Malta can be reduced by around €0.001/kWh, or 0.7% from the full-cost recovery rate of €0.146/kWh.

**Forecast Demand**

An aggregate demand estimation approach is adopted, utilizing expected developments in economic growth and electricity tariffs and taking into account issues of affordability and cost recovery. In spite of an expected decoupling between economic growth and the environmental footprint, the demand for electricity generation by Enemalta is expected to grow at a rate of circa 2% per annum.

**Financial and Economic Analysis**

The financial model is based on the forecasted demand, the pricing tariff, the planned capital expenditure, operating costs and revenues for the 25-year horizon under consideration. The cash flow projections discounted at the 6.61% rate approved by the Regulator results in a negative FNPV/C of €28 million and a FIRR/C of 5.36%. This FNPV/C also defines the funding gap and makes the business case for the Project to be eligible for the €25 million EU funding being sought. The financial sustainability also appears to be acceptable with no negative cash balances in the 25-year explicit period. Enemalta are also progressing discussions with EIB on the financing of the cable.

The principal benefit of this project is the creation of capacity to be able to meet the demand for electricity in Malta into the future to the extent that a sizeable proportion of economic activity is dependent on the provision of energy through the interconnecting cable. The relevant baseline scenario for comparison of costs and benefits is one where productive capacity for the generation of electricity in Malta would be gradually declining as existing plants reach the end of their useful lives. On the other hand, the external costs associated with the project are negligible. As a result, the economic impact of the interconnecting cable is significantly high, resulting in an economic net present value of €21 billion and an economic rate of return of 183%.

Therefore, although the project presents a negative return from a financial perspective, it has very strong economic benefits for Malta and therefore merits consideration for EU funding.

**Risk and sensitivity analysis**

The risk and sensitivity analysis indicates that the project’s critical variables from the internal financial perspective are the electricity import price, the tariff rate, the capital expenditure as well as the transmission and retail costs. The project is found to be most sensitive to changes in the cost of imported electricity where in the worst-case scenario a 10% increase in the electricity import price will result in an 80% drop in the FNPV/C.

When considering the economic rate of return, there are no significant project risks to highlight. The worst-case scenario, involving lower perceived economic growth still yields a strong positive economic rate of return of 180% thus implying that there are no perceived risks which would deplete the economic benefits associated with the project.

# II Introduction

### 2.1 Background

The European Energy Programme for Recovery (‘EEPR’) was established to respond to the key energy challenges facing Europe today. The EEPR regulation establishes a financing instrument for the development of projects in the field of energy in the EU. By providing a financial impulse it will contribute to economic recovery, the security of energy supply and the reduction of greenhouse gas emissions.

The EEPR includes a number of sub-programmes to advance these objectives in the fields of gas and electricity infrastructure, offshore wind energy and carbon capture and storage. In addition, it identifies projects to be financed under each sub-programme and lays down criteria for identifying and implementing actions to realise them.

As a member state Malta has been allocated EEPR funding in the following areas:

| **Project** | **Location** | **Envisaged Community contribution** |
|---|---|---|
| Electricity interconnection Malta / Italy | Malta / Italy | € 20 million |
| Small island projects | Malta | € 5 million |

In this regard the Maltese Government has delegated Enemalta to be the main beneficiary for EEPR funds allocated to Malta, given its strategic role in ensuring electricity generation and supply for the country.

To utilise these funds, Enemalta will be submitting two applications for funding to DG TREN. A brief outline for each of the projects is set out in the paragraphs below.

<u>Project 1: Electricity interconnection Malta - Italy</u>

This project comprises the design and build of one high voltage sub-sea interconnector rated at 250MVA between Malta and Sicily, with an option for further similar interconnector cables to be installed at a later date. The shore installations shall be appropriately sized for a number of interconnectors and the first interconnector is required to be in service before the end of 2012.

Following the results of the feasibility study which has been carried out jointly with Terna – the Italian grid network operator - a 400MW link, composed of 200MW links offers the most advantages. Redundant links are preferred for security of supply reasons and the two links may be implemented in phases. The technical feasibility study has concluded that both the HVAC and the HVDC solutions are technically and economically viable, although the HVAC solution has significant advantages.

It is planned that the cable landing sites will be situated at Pembroke in Malta and Marina di Ragusa in Sicily. On the Maltese side it will be connected to the present 132kV transmission system whilst on the Sicilian side it will be connected to the 220kV transmission network, about 18km inshore at the Ragusa substation linked to a dual 220kV ring circuit. The interconnector is expected to have a sub-sea route length of about 95km to be laid in sea depths of approx 100-150 metres. The precise route can only be determined following a detailed seabed survey, but from the results of previous surveys it is expected that most of the route will have sandy bottoms. The cable will be laid in sea bed trenches and will be appropriately protected from mechanical damage from ship anchors and fishing apparatus. The total resulting length including the land cables at both the Maltese and Sicilian ends is expected to be about 125km.

The project shall include all required works to deliver a fully functioning and operational interconnector, including all the administrative permits and approvals, where appropriate. A PIN has already been published in the Official Journal of the EU and a contract notice is expected to be published in July 2009.

Included within the project are the two sections of land cable (Malta and Sicily ends) with all necessary trenching/tunnelling, namely the section from the Pembroke landing site to the Maltese terminal station (for transformation from 220kV to 132kV and for reactive compensation of the cable) and the section from Marina di Ragusa to Ragusa 220kV substation, which will be executed using underground cables to minimise the environmental impact.

<u>Project 2: Extension of 132kV network to the sub-sea electrical Interconnector Malta – Italy</u>

This project is the extension of the 132kV distribution network in order to connect to the Malta – Italy interconnector cable and to be able to transmit and distribute the electricity imported. It will also be used to connect the supply from the proposed offshore wind farm at Sikka il-Bajda to the network. This project is considered to be a necessary pre-condition that this extension should be in operation prior to the operation of either the interconnector or the offshore wind farm. However in view of the fact that the interconnector is planned to be in operation by the end of 2012, whilst the wind farm is targeted for about 2015, this project can be considered to primarily serve the needs of the interconnector.

This project will consist of:

- the laying of 132kV cables from the existing load centres at Marsa South and Mosta to Kappara;
- any necessary trenching works (Marsa and Msida); and
- the equipping and commissioning of a new 132kV distribution centre at Kappara.

The cables and equipment will be rated to the import capacity of the first phase of the interconnector, namely 250MVA with an overload capability of approximately 80% for 1 hour.

This new distribution centre at Kappara will also serve to reinforce the supply to the Sliema region as it is located very close to a large and economically important load centre comprising an industrial estate, densely populated towns and villages, numerous entertainment establishments in a tourist zone, five-star hotels, a hospital and a large reverse-osmosis desalination plant. Notwithstanding the present relatively high demand for electricity, further increases in demand are anticipated for the locality due to the large developments currently under construction.

These two projects will serve to increase the security of supply in Malta and will enable the country to meet its EU environmental obligations, through the enabling of the substitution of part of the demand met by local generation with electricity imported through the interconnector or produced by the wind farm.

## 2.2 Basis of preparation of the Cost-benefit Analysis

This CBA supports Enemalta's application for funding from the European Energy Programme for Recovery in respect of the above projects.

For the purposes of the CBA analysis, both projects referred to above have been combined together such that all incremental revenues and costs are based on the interventions of both projects.

The CBA, was prepared with reference to the CBA guidance notes issued by DG REGIO[2]. However in determining the funding gap, reference was made to the EEPR Call for Proposals guidance notes as well as feedback received from DG TREN during an information meeting that Enemalta had with DG TREN on 23 June 2009.

Furthermore, the CBA also considers the guidance instructions received by the Malta Resources Authority ('MRA') in respect of the 6.61% Return on Investment ('ROI') to be applied for a project of this nature.

The CBA also refers to a feasibility study carried out by CESI, jointly commissioned by Enemalta and Terna in 2008-2009. This study ('the CESI Report') addresses the optimum sizing of the interconnector, the technology to be utilised and the connecting and transmitting voltages. From the study and looking at a post 2015 horizon, a 450MVA HVAC link, composed of 200MW links operated at 220kV offers the most advantages. Redundant links are of course preferred for security of supply reasons and may be implemented in phases thereby reducing the financial burden of the investment. The technical feasibility study also concludes that both the HVAC and the HVDC solutions are technically and economically viable. The HVAC solution, apart from offering the significant technical advantages of lower losses (particularly on cycling loading and high short term overload capability), also requires a much smaller footprint and therefore results in a less obtrusive visual impact. This feasibility study also compliments another high level study carried out by the Maltese regulator ('MRA') in 2007, which looked into the feasibility in general terms of both a natural gas interconnection, through a pipeline or an LNG supply (from a non EU country), and an electrical interconnection. The CESI report concludes that both solutions are feasible.

Enemalta and Terna are also looking into the possibility of a jointly owned Special Purpose Vehicle ('SPV') to finance and operate the interconnector cable. This will be a new

2 Guide to Cost-Benefit Analysis of Investment Projects, DG Regio, June 2008

organisation set up to ensure that the project is implemented as planned and that operations are carried out in close cooperation with the Italian System Operator. The SPV does not feature within the CBA analysis as this would not impact the project's financial and economic feasibility.

# III Rationale

### 3.1 Overview

The Maltese Islands are located in the centre of the Mediterranean Sea situated less than 100km south of Sicily. The Islands have a total land area of 316 sq. km and have a total population of approximately 400,000.

Malta's economy is mainly services-oriented, focusing on financial services and tourism. Inbound tourists for 2008 totalled 1.3 million, an increase of c.4% on 2007. Malta also has a small manufacturing sector but this has been dwindling over time and there has been a strategic shift from the textile and clothing industry towards information technology, healthcare and electronics.

Provisional estimates indicate that the GDP for 2008 amounted to €5.7 billion at current prices – a real growth of 1.6%[3] for the year. However preliminary estimates for 2009 forecast a negative growth of about 1% (in real terms) due to the global economic crisis[4].

Malta's National Strategic Reference Framework ('NSRF') highlights three main pillars of Malta's socio-economic development: sustaining economic growth and competitiveness through the generation of a knowledge-based and service-based competitive economy; the safeguarding of the natural and urban environment; and ensuring continuous investment in human capital and education. Government's vision for Malta is one which aims to sustain and develop a dynamic, high value added economy founded on competence, skills and excellence and one which is capable of sustaining a high standard of living for all citizens. The NSRF recognises that energy has a significant impact on the quality of life and is a determinant factor in economic competitiveness. It is also essential as a resource for industry – the cost of energy will have an impact on the competitiveness of the country and on economic growth and job creation.

During the 1980s and 1990s Malta experienced relative consistency in energy supply, markets and distribution. The energy scene has changed rapidly during this last decade with prices for fuel increasing substantially[5]. During 2007 oil prices underwent a consistent upward trend, reaching highs of around 95 US dollars a barrel by the end of 2007. This trend continued in 2008 with oil prices reaching heights of between 140 and 150 US dollars a barrel and peaking in July 2008. These increases in oil prices exerted a significant impact on inflationary developments across the world and consequently on GDP growth. The combined effect of higher oil and other commodity prices pushed up production costs globally with a resultant impact on global price stability[6].

3 NSO news release 102, 2009

4 An update on the economic and competitive developments in the Maltese economy, July 2009, Minister for Finance, Economy and Investment

5 National Strategic Reference Framework (Malta 2007-2013), December 2006

6 Pre-Budget 2009 Document, Economic Overview

During the second half of 2008, the price of oil dropped steeply, falling from around USD 100 for a barrel of Brent crude oil at the end of September to USD 34.08 on the 26th December, the lowest level for oil prices since April 2004. The rapid drop in oil prices was directly related to the depressed demand in the global economy and the turmoil in international financial markets. In 2009, oil prices started to recover slowly, increasing to USD 46.19 on 31 March. This represented a 27.7% increase over prices at the end of December. The recovery reflected supply related factors, and, in particular, the decision taken by the OPEC countries to slash their daily output as from January[7].

The Maltese economy is exclusively dependent on the importation of oil for all of its energy requirements. The international price of oil, therefore, has an important bearing on the country's GDP growth, inflation levels, as well as the current account balance. Hence, while the weakness of the US dollar with respect to the Euro has helped to somewhat mitigate the increase in oil prices, the historically high price level of oil together with high food and commodity prices still holds important consequences for domestic inflationary developments as well as possibly more general economic repercussions.

### 3.2 Electricity Generation in Malta

Since Malta has no indigenous primary energy resources, the country's energy needs are met through imported fossil fuels, mainly in the form of heavy fuel oil and light distillate. The Maltese national electricity grid is an isolated one and is not connected to any other electrical network. Therefore, all the electrical energy that is required is generated in Malta.

There are currently two power stations in Malta, one at Delimara and the other at Marsa. Both stations are operated by Enemalta. Together, these two stations provide for the electrical power needs of the Maltese Islands and have a total combined nominal installed capacity of 571MW (equivalent to a summer rated capacity of 510MW). They are interconnected together by means of the existing grid.

Delimara Power Station is situated in the south easterly part of the island and was first commissioned in 1992. The nominal installed capacity of this station currently stands at 304MW (equivalent to a summer rated capacity of 270MW). The steam units burn 1% sulphur fuel oil, while the gas turbines and the Combined Cycle burn distillate fuel oil.

The Marsa power station is situated at the Marsa end of the Grand Harbour. The original station ('A' Station) was installed underground beneath Jesuit Hill in 1953. Due to increasing demand, this station was expanded to a final total capacity of 30MW, and ultimately de-commissioned in 1993 once Delimara was commissioned. In 1966, the first two units at 'B' Station were commissioned. This station was subsequently expanded in order to meet the electrical load requirements of the country. Today, the total generation capacity of 'B' station stands at 267 MW. All the steam units presently burn 1% sulphur fuel oil and the gas turbine burns distillate fuel oil[8].

7 Central Bank of Malta Quarterly Report – Volume 42, Number 1, 2009

8 http://www.enemalta.com.mt/page.asp?p=926&l=1

Consumption of electrical energy has been increasing at varying rates for many years, however as from 2005 the rate of increase has been 2% or less. This is driven by increased economic activity, higher standard of living, and an improved distribution network and use of electrical energy[9].

The load demand curve in Malta varies seasonally and experiences a sharp day-night difference. Electricity consumption in Malta is typical of the profile of the Mediterranean area in general. Peak demand during winter is predominantly domestic since it takes place in the evening. Conversely, peak demand in summer occurs during the morning, and it can therefore be assumed that it is predominantly commercial and industrial. Since 2003, the summer active power peak demand ('MW') has exceeded the winter peak in terms of magnitude.

In Malta, the energy sector is the main contributor to Green House Gas ('GHG') emissions (mainly $CO_2$) and other pollutants[10]. The total carbon dioxide emission for 2004 was 1,145,744 tons from Marsa power station and 875,503 tons from Delimara Power Station. The total carbon dioxide emission for 2006 for Marsa Power Station was 1,175,288 tonnes and 810,477 tonnes from Delimara Power Station, resulting in a total of 1,985,765 tonnes. During 2006, 2,261,189MWh were generated at the power stations, hence 0.8782kg $CO_2$ were emitted for every kWh generated[11].

### 3.3 Malta's Strategic Objectives and Commitments

Within the EU, peripheral regions in the Mediterranean part of Europe seem to be more exposed to the energy challenges faced by the EU as a whole. This is due to their vulnerability in terms of internal and external security of supply, energy efficiency of the economy and environmental sustainability. Developments will depend on the EU capacity to develop a common policy on energy ensuring the functioning of the internal market and security of energy[12]. In March 2007, the European Council set two key targets directed at tackling climate change and facing up to the challenge of secure, sustainable and competitive energy. These two targets are:

- a reduction of at least 20% in greenhouse gases; and
- a 20% share of renewable energy in EU energy consumption by 2020[13]. In Malta's case this target has been set at 10% by 2020.

As a Member State, Malta is committed to make a contribution to reach these targets. In addition, Malta is also managing the adoption of more environmental measures that it had negotiated during the pre-accession negotiations leading to the adoption of the Acquis.

9 Energy Policy for Malta, April 2009, Ministry for Resources and Rural Affairs

10 Energy Policy for Malta, April 2009, Ministry for Resources and Rural Affairs

11 http://www.enemalta.com.mt/page.asp?p=926&l=1

12 Regions 2020: An Assessment of Future Challenges for EU Regions, November 2008, Commission Staff Working Document

13 20 20 by 2020: Europe's climate change opportunity, January 2008, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

These include the:

- Large Combustion Plant Directive ('LCPD'), which limits the level of $SO_2$, $NO_2$ and dust emissions that may be generated at the local plants at Marsa and Delimara,

- National Emissions Ceilings Directives ('NECD') for $SO_2$, NOx, $NH_3$ and volatile organic compounds which are anticipated for 2010 and 2020. To comply with these emissions limits, any new generating plant must have low airborne emissions either directly through design of equipment or fuels or using emissions-abatement techniques to manage the content of gases from the combustion process;

- National Allocation Plan ('NAP') that regulates gaseous emissions and is linked to the Kyoto Protocol and the $CO_2$ Emission Trading Scheme.

Malta's National Reform Programme 2008-2010 ('NRP') focuses also on the sustainability of natural resources, with a special focus on energy and climate change. The NRP recognises that Malta's total dependency on fossil fuels for energy needs is having a significant impact on both the environment and the economy. The combustion process involved in producing energy from fossil fuels is contributing to the emission of the 63% of Malta's greenhouse gases which come from the energy sector. The current instability in oil prices results in pressure on Malta's socio-economic development, due to the resultant increases in costs of imports and the increasing costs of production locally. In this regard Government's strategy aims to diversify energy resources whilst ensuring security of supply, and to improve and promote energy efficiency (whether in products used such as lighting and appliances or through incorporating energy efficient techniques in buildings)[14]. In particular the NRP discusses the possibility of connecting Malta to Europe's energy networks, via an interconnector cable with Sicily.

In April 2009 the Ministry for Resources and Rural Affairs issued a policy document entitled 'Proposal for a National Energy Policy'. Within there are a number of policies that underpin Malta's EU and local objectives[15]. These policy areas emphasise the need for Malta to have:

- energy efficiency (improved energy efficiency can result in reductions in the country's fuel bill as well as lower of carbon dioxide emissions);

- reducing the reliance on imported fuels (a target of 10% energy from renewable sources in final energy consumption by 2020 has been set);

- stability in energy supplies (interconnection with the European energy grid is identified as the key to breaking the insularity of the islands and offering Malta security of supply);

14 Malta's National Reform Programme 2008-2010: Addressing the Lisbon Strategy, October 2008, Ministry for Finance, the Economy and Investment, pgs 42-43

15 Energy Policy for Malta, April 2009, Ministry for Resources and Rural Affairs

- reducing the emissions from the energy sector (which results in Malta's energy policy being intrinsically linked to its climate change policy in order to comply with the EU's "20%-20%" by 2020 targets); and

- efficient and effective delivery of energy supplies.

### 3.4 Project Objectives

Within this context therefore, Enemalta has set the following objectives for the Interconnector Cable project:

i. to substitute local generation capacity resulting in a reduction in emissions bringing about an improvement in air quality and a general improvement to the environment;

ii. to reduce Malta's isolation from the internal European electricity market. The diversification of sources will provide insurance against disruption of any one particular source of energy, and hence contribute to the overall improvement in the security and quality of supply;

iii. to permit Malta to source electricity from generating plant benefiting from economies of scale (operating at higher efficiencies than are possible with the small plant suitable for local use) and from low carbon or carbon neutral generators thereby contributing to a reduction in global emissions;

iv. in view of Malta's plans to meet its renewables targets through the construction of large offshore wind farms, the interconnector will provide the necessary balancing of load to smooth out the effects of the inherent intermittency, without which expensive spinning reserve will have to be employed;

v. to potentially allow Malta to procure renewable electricity produced in non-EU countries which have a physical connection to EU member states; and

vi. in the long run to achieve a general lowering of energy costs to the benefit of the Maltese economy.

# IV Option Analysis

### 4.1 Overview and rational behind formulation of options

In the last 3 years Enemalta initiated various studies to help form a more robust long-term strategy. The 2006 – 2015 Energy Generation Plan provides a clear analysis of the energy generation and procurement options. It suggests that increased security of supply, and a solution to the problem of intermittence related to renewable energy could be achieved through a strategic interconnector that would link the Maltese islands to the European electrical grid.

However, renewable energy sources, such as wind-power, suffer from problems of intermittence and are thus not suitable for meeting core demand on a small isolated system such as Malta. As a result the use of renewable energy sources has been excluded from the scope of this project in terms of the project options. Malta is nonetheless committed that at least 10% of its energy consumption will be generated from renewable sources by 2020. This is factored into the demand model as described in Chapter VI.

### 4.2 Options Identification and Analysis

The two options considered by Enemalta in the short-term are:

- **Option A** – More-of-the-same: Fulfilling capacity by replacing depleted plant with 144MW combined cycle diesel engines; or

- **Option B** – Interconnector cables: Fulfilling the capacity gap through interconnector cables rated at 250MVA (equivalent to 225MW).

These two options are contrasted against a do-nothing scenario (the Baseline) where any plant that reaches its end of life is not replaced, thereby resulting in a catastrophic scenario that in reality would never occur. This Baseline is only used to calculate the incremental financial and economic benefit for the other two options. The Baseline is not an option in itself and should not be compared to the other options.

The options evaluation assumes a 25 year time horizon. Throughout this period, further additions to the generation capabilities of Enemalta are envisaged and for both options, it is assumed that such capacity shall be replaced with more of the plant underlying the option, i.e. further combined cycle diesel engines for Option A and further interconnector cables for Option B. This is in line with the approach that is typically followed for modelling investment option analysis. However this is not meant to limit Enemalta's flexibility to pursue other approaches beyond the initial investment in 2012.

#### 4.2.1 The Baseline – do nothing

The ageing Marsa power station represents a significant challenge to Enemalta's future generating capacity. Capacity would be further depleted in the next 25 years as the older Delimara plants reach their end of life.

Enemalta envisages the following key step changes to the existing capacity:

- the introduction of a new 144MW diesel engine in 2012 to provide additional capacity as Marsa starts approaching its end of life. Enemalta is in the process of acquiring this plant and it is therefore included in the Baseline and in each of the Options;

- in 2023, old conventional steam turbines stationed at Delimara are scheduled to reach the end of their useful life;

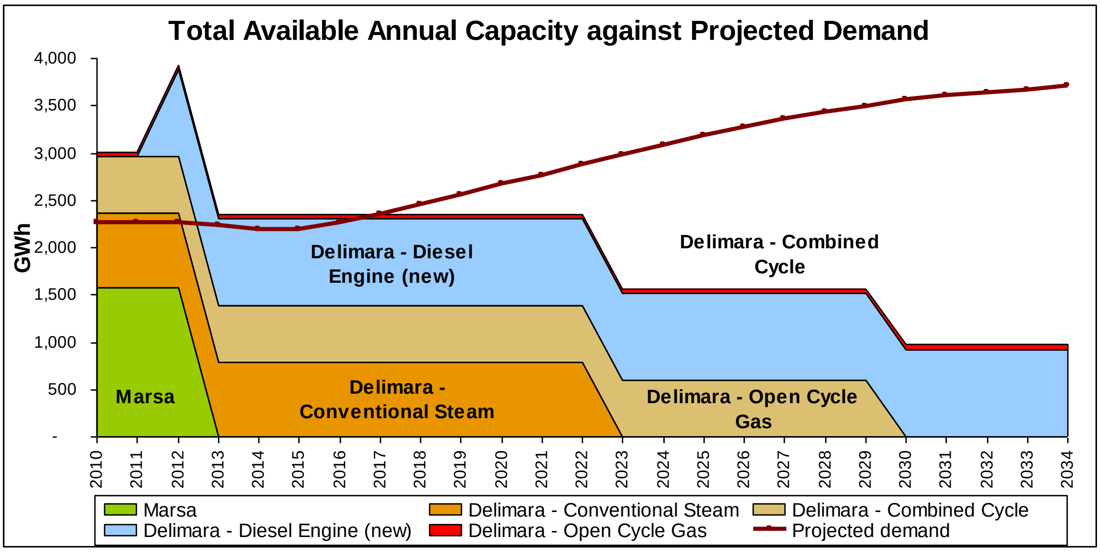
- similarly, in 2030 the combined cycle gas turbines stationed at Delimara would also reach the end of their useful life; and

- after 2030 the only remaining power stations at Delimara will be;

  - the new diesel engine commissioned in 2012, which will still be within its utilisation life time; and

  - the open cycle gas turbine which is currently used as a stand-by facility at only 10% utilisation and is therefore expected to serve beyond the time horizon of the project.

At the current capacity utilisation rates of 75% for the diesel engine and 10% for the open cycle gas turbine, the Baseline scenario results in a substantial gap in generating capacity against a growing energy demand as illustrated in the chart below.



### 4.2.2 Option A – Extension of Delimara

One way of making good for the ageing Marsa power station would be by adding further generation facilities at the Delimara site (in addition to the 144MW plant included in the Baseline for 2012). Enemalta have indicated that the Delimara site is large enough to accommodate such additions and that development permission is not expected to be a limiting factor.

Enemalta has only recently finalised the tendering process in order to acquire a 144MW combined-cycle diesel engine. This new electricity generator (which is included in the Baseline) is considered to be highly efficient and well suited for the Maltese environment. It also possesses various technical features rendering it apt for usage on small isolated systems.

In order to service the capacity requirement throughout the period of the analysis, Enemalta is assuming that for this option, further additions to the Delimara power station would be of a similar nature to the combined cycle diesel engine power station. On this basis, Enemalta is projecting the following investments (incremental to the Baseline);

- two 144MW combined-cycle diesel engines phased in 2013 and 2014 to service the capacity gap following the closure of Marsa;

- one 144MW combined-cycle diesel engine in 2023 following the closure of the conventional steam power station in 2022; and

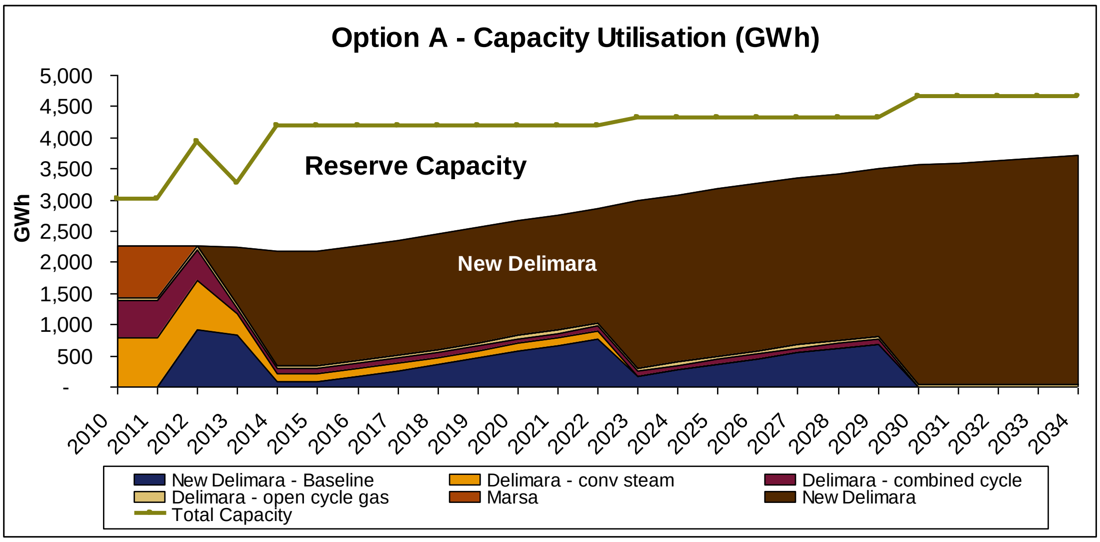
- one 144MW combined-cycle diesel engine in 2030 following the closure of the combined cycle power station in 2029.

*Operational assumptions*

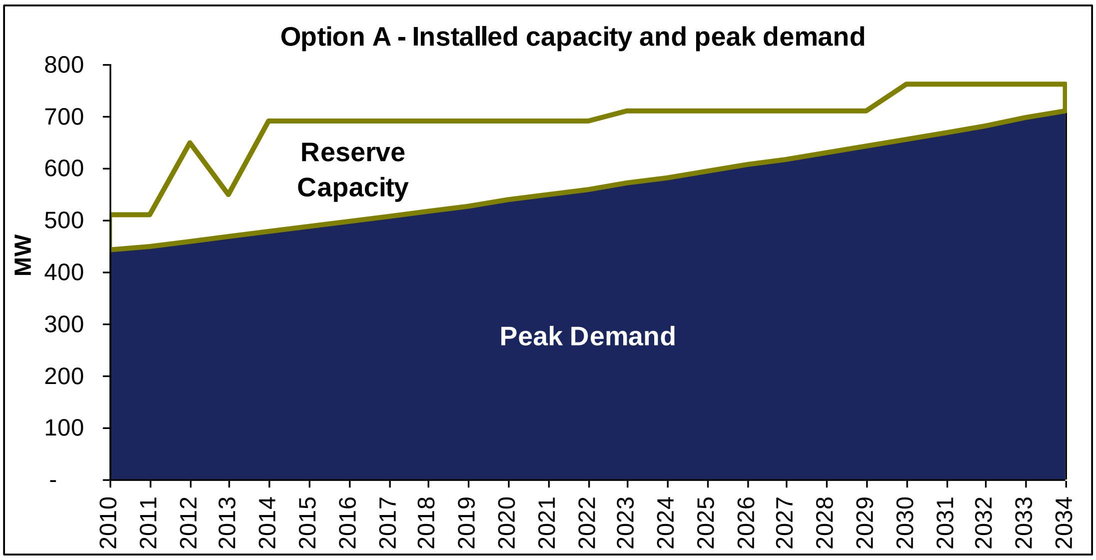
Due to maintenance requirements and other peak demand considerations, Enemalta estimate that all the generators with the exception of the open cycle gas turbine, will be utilised at circa 75%. The open cycle gas turbine has the highest fuel operating costs and is mainly used as an emergency quick starting back-up plant. The utilisation of this backup plant is estimated by Enemalta at 10%.

Enemalta's generation plan for the option is based on priority utilisation of the most efficient plant, notably the new Delimara diesel engines, followed by the Delimara conventional steam plant, the Marsa power station and the Delimara combined cycle.

The following chart outlines Enemalta's projected capacity utilisation for Option A.




The chart below illustrates the installed capacity (based on summer rating) against an expected 2% annual growth in peak demand in MW.



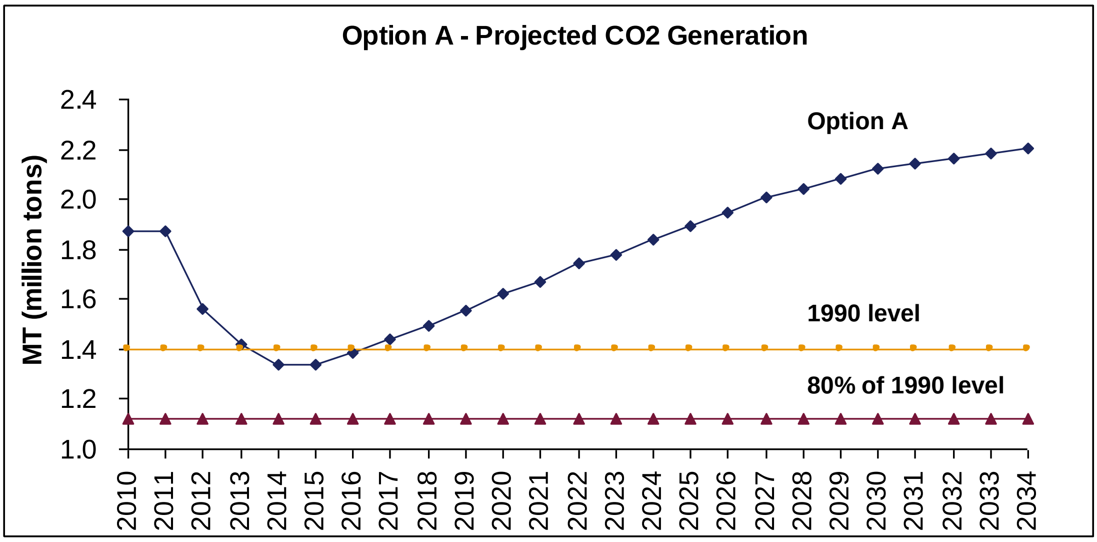

*Strategic considerations*

Option A has the advantage of keeping Malta self-reliant for all its power generation needs. However, the country would bear the full environmental impact of local production, and due to its small size and high population density, the resulting impact on health and environment would be proportionately higher than in other territories.

Furthermore, the Maltese network would remain small and isolated and thus more exposed to power outages. Even minor trips would continue to result in a domino effect that could cause blackouts to all or part of the island.

Enemalta services would also continue to be almost fully reliant on imported fossil fuel. This exposes Malta to fluctuations in the price of oil. It will also remain exposed to the risk of any severe disruptions to supply due to the political instability associated with oil producing countries. As a relatively small consumer with little bargaining power Enemalta considers itself particularly vulnerable to such risks.

Enemalta estimate that in the Option A scenario, Malta would not be able to meet its 2020 emission targets as illustrated in the chart below. Replacing existing generators with the selected combined cycle diesel engine will however reduce emissions in the short term. The cost of carbon emissions is partially internalised through the cost of carbon allowances as per the Emissions Trading Scheme ('ETS'), but in addition Malta would incur financial penalties for not achieving to reduce the $CO_2$ emissions to less than 80% of 1990 levels.




In order to meet emissions targets, the Maltese government is likely to engage other interventions that are not assessed in this document. Thus such policy considerations are treated as being out of the project's scope and this option is considered viable irrespective of it not meeting these requirements.

### 4.2.3 Option B – 250 MVA Interconnector between Malta and Sicily

Laying interconnector cables between Malta and Sicily will allow Enemalta to meet capacity requirements whilst also diversifying its supply strategy.

These cables will use existing distribution stations at Ragusa (Sicily) and Pembroke in Malta. Detailed studies conducted by Terna show that, a single 250MVA cable, is technically feasible between these two existing infrastructures. Minor overloads could occur, however, these would fall within the tolerable limits of both networks.

Realising this connection would require laying 94km of deep-water submarine cable at a maximum depth of 160 meters. Around 15% of the works would have to be protected by trenching works whilst the remaining 85% would be protected through "jetting" – a process whereby a high pressure water jet is used to sweep away sand and thus create a trench.

A further 8km of delicately trenched shallow-water submarine cable would also be required. This is split equally between the two shorelines. In terms of landside work, 22.5km of landside cable and trenching (3.5km in Malta and the 19km in Sicily) would subsequently connect the submarine cable to the respective substations in Kalkara and Ragusa.

Notwithstanding the large amount of construction work, this option is unlikely to encounter problems in obtaining development permissions from the respective planning authorities. Both distribution substations already exist and thus no significant structures would be raised. Furthermore, most of the underwater cabling and shoreline approaches reside in sandy areas and thus would not result in material ecological disruptions.

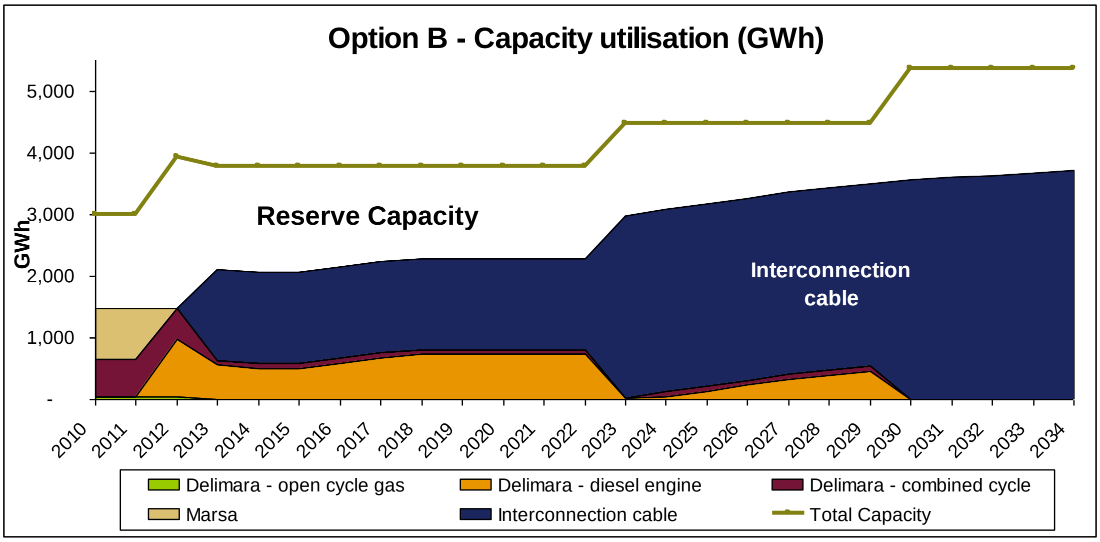
For this option Enemalta are assuming that the additional capacity requirement in 2023 and 2030 (after the decommissioning of old Delimara plant) would be serviced through the second and third interconnector cables. Each interconnector would require 3 years to lay and will be able to provide the full quoted 250MVA each. On this basis, three interconnector cables are expected to be installed in the next 25 years:

- the first 250MVA interconnector cable in 2013 following the decommissioning of Marsa;
- the second 250MVA interconnector cable in 2023 following the decommissioning of the conventional steam power station in 2022;
- the third 250MVA interconnector cable in 2023 following the decommissioning of the combined cycle power station in 2029.

The second and third cable installations referred to above are to be considered as separate interventions from the first cable installation which is the subject of the application for EU funding, to which the CBA relates. The second and third cables are considered in order to draw up a consistent and comprehensive option for the purposes of developing the model of this Cost-Benefit assessment. Following the completion of the first cable there may be other ways to develop electricity generation in Malta which will only be required in 2023 and 2030 and for which the country may apply for separate EU funding.

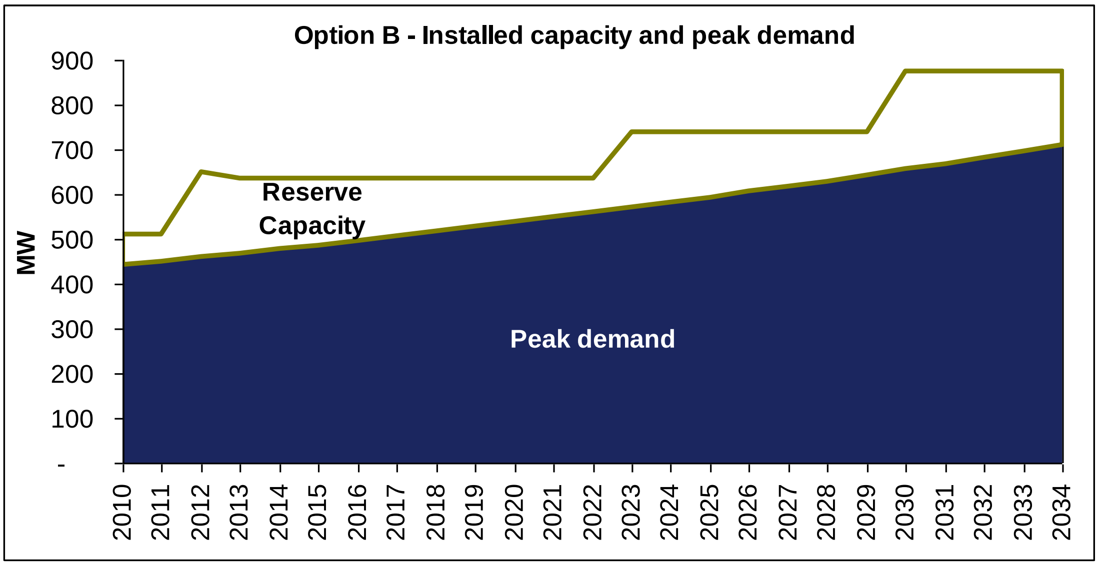
*Operational assumptions*

Enemalta assumes an average annual cable utilisation of 75%. This reflects an allowance for downtime and also a degree of intelligent purchasing whereby importation at peak rates would be reduced whilst allowing some headroom for emergencies. The chart below illustrates Enemalta's projected utilisation plan for Option B.




The above analysis illustrates that this Option is considering complete reliance on the cable by 2034, with nearly 100% of demand serviced through cables. At that point, the only available local generating plants would be the new 144MW Delimara diesel engine, commissioned in 2012 and the open cycle gas turbine both of which would serve as back up in the events the cables are damaged or require maintenance.

As illustrated in the chart below, Enemalta estimate that the peak demand would be met comfortably in Option B throughout the 25 year period. The reserve capacity shown below includes the Delimara generating plants.




*Strategic Considerations*

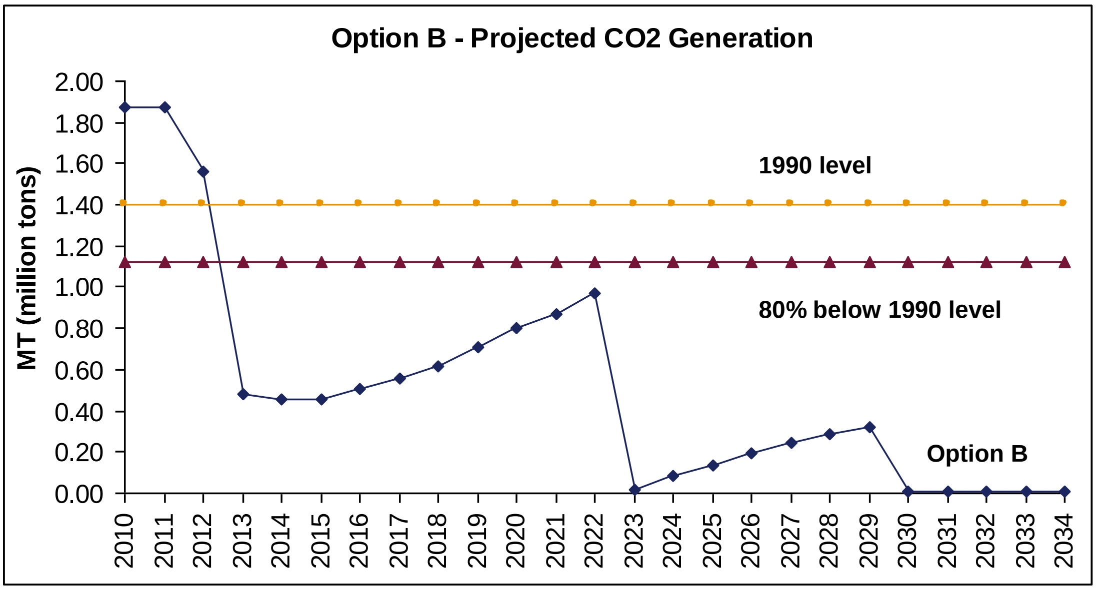
This Option maximises Enemalta's reliance on third party generation. The Maltese Islands would however be spared much of the environmental and health impacts related to local production. These would instead be borne by other European countries who, as a result of better economies of scale, enjoy a cleaner energy mix and space to locate power stations in sparsely populated areas.

Furthermore, the Maltese electricity distribution network would no longer remain small and isolated. Enemalta indicated that minor trips would automatically be absorbed by the cables, eliminating the domino effect. This is due to the fact that the cables would be able to supply 180% of their quoted capacity for a maximum period of an hour providing sufficient time for reserve quick start capacity to be engaged. In severe situations the cable would still be able to provide enough time for Enemalta to localise the power shortage, thereby avoiding incidents of complete blackout, as a result of cascading power trips. Enemalta also expect that faults in relation to the cable, would be limited to the remote event of a fault in the cable itself or in the substations that it serves.

Enemalta's services would no longer be as reliant on imported fossil fuel. The electricity generated and imported into Italy is composed of a diversified mix of production sources – including non-fossil fuel sources such as nuclear, hydro and renewables. This means that Italian electricity prices are not as susceptible to changes in the price of oil. This in turn reduces Enemalta's exposure to sharp fluctuations in the price of oil thereby also improving local economic stability.

Similarly, Enemalta (and Malta in general), would be less exposed to the risk of any severe disruptions to supply of oil. This risk is reduced both because the larger Italian electricity producers enjoy greater bargaining power than Enemalta, and also because a material share of the imported electricity from Italy is not derived from non-fossil fuels.

Furthermore, given that the majority of demand would be serviced through the cable, Enemalta expect that this option would also allow Malta to meet its $CO_2$ emission targets of reducing these emissions to less than 80% of 1990 levels by 2020, The importation / local generation mix considered in this Option results in carbon emissions falling to more than 80% of 1990 levels as illustrated in the chart below.




Enemalta also expect that an interconnector would render renewable energy sources more viable, as the problem of intermittence would be minimised. The flexibility offered by the cable signifies that any sudden peak in the availability of alternative energy may be accommodated for almost instantaneously since the cables may be set to vary their output depending upon such productivity in a matter of minutes. On the same note, any sudden dips in the provision of alternative energy would automatically trigger the overload facility on the wire. With this function the cable will be able to provide almost double its quoted capacity for a whole hour. This provides more than sufficient time to bring even the slower (more economical) generators back online. This feature removes the greatest inhibitor associated with wind energy, which is currently Malta's favoured alternative energy source. Wind turbines are subject to sudden shutdowns when wind velocities reach dangerous levels. This problem is magnified in Mediterranean island regions as the weather is considered harder to predict. The interconnector would be able to automatically absorb the production gap which would occur in such a situation.

## 4.3 **Options feasibility analysis based on financial indicators**

The financial feasibility options review described in this section is based on a cost analysis of the power generation costs for both options for the 25 year period starting from 2010 to 2034. The costs are based on the generation plan for each option as described in Section 4.2 and reflect the fuel, carbon traded allowances ('ETS scheme'), maintenance and other incremental costs for each of the individual power generating plants. With respect to Option B an import price of €75/MWh is assumed as indicated in the CESI report. In both options cost of labour is excluded as this is assumed to be not incremental to the options analysis. Similarly transmission and other fixed costs are not included in this analysis.

The costing for both Options A and B include the cost of the underlying Baseline electricity generation which is common for both options.

### 4.3.1 Option A – Extension of Delimara

#### Capital expenditure

The total investment cost in the 25 year horizon is €825m. This represents an investment of four 144MW diesel engine combined cycle plants at €165m each (these plants are in addition to the 144MW plant included in the Baseline). The first two plants are scheduled to be commissioned in 2012-2013, another plant in 2022 and the fourth in 2029.

#### Operating costs

The table below sets out Enemalta's variable operating cost assumptions for each of the generating plants in Option A.

| Operating cost assumptions | Fuel cost € / MWh | Waste disposal & reagents € / MWh | Variable maintenance €/MWh | Carbon Dioxide Metric Tonnes / MWh | Carbon Dioxide € / MWh |
|---|---|---|---|---|---|
| Delimara - open cycle gas | 178.57 | €0.00 | €9.51 | 0.884 | €26.53 |
| Delimara - diesel comb cycle | 45.71 | €10.00 | €5.29 | 0.591 | €17.72 |
| Delimara - conv steam | 69.65 | €0.00 | €0.63 | 0.828 | €24.83 |
| Delimara - combined cycle | 103.30 | €0.00 | €2.54 | 0.632 | €18.95 |
| Marsa | 79.97 | €0.00 | €0.63 | 0.966 | €28.97 |

The fuel costs are based on the estimate set out in the CESI report which assumes a Brent price of $70 / bbl and a USD / EUR exchange rate of 1.45. The fuel cost for the Marsa plant is estimated by Enemalta's management at €80 / MWh (again on the basis of $70/bbl and a USD / EUR exchange rate of 1.45).

Waste disposal and reagent cost apply only to the new Delimara diesel combined cycle plants. These costs relate to sludge disposal and the use of urea and other reagents in the catalytic convertor to reduce $NO_X$ emissions and are assumed by Enemalta.

Variable maintenance costs (excluding internal labour cost) are based on Enemalta's cost per MWh set out in the table above.

Under the National Allocation Plan, Malta currently enjoys free allowances of 2.3 million tonnes annually which are in excess of the 1.7 million tonnes of $CO_2$ emitted by the existing plant. These free allowances expire in 2012 following which Enemalta would have to procure $CO_2$ allowances on the open market through the Emissions Trading Scheme. Enemalta is projecting the cost of these allowances at €30 /mt.

The table below sets out Enemalta's incremental operating costs (in 2009 prices) for the 72,287GWh projected in the 25 year Project time horizon.

| Operating cost projections Yrs1-25 - € millions | TOTAL | Fuel | Waste disposal & reagents | Variable maintenance | Carbon Dioxide Allowances | GWh generated |
|---|---|---|---|---|---|---|
| Delimara - open cycle gas | **282** | 235 | - | 13 | 35 | 1,314 |
| Delimara - diesel comb cycle | **4,918** | 2,856 | 625 | 331 | 1,107 | 62,478 |
| Delimara - conv steam | **363** | 266 | - | 2 | 95 | 3,813 |
| Delimara - combined cycle | **377** | 312 | - | 8 | 57 | 3,023 |
| Marsa | **182** | 133 | - | 1 | 48 | 1,658 |
| Less free CO2 allowance in yrs1-3 | **(159)** | | | | (159) | |
| **Total** | **5,963** | **3,801** | **625** | **354** | **1,183** | **72,287** |

**Net Present Value of Option A power generation costs**

The table below sets out the total capital expenditure and operating costs in nominal and net present value terms for the 25 year time horizon. The net present value, at the 6.61% discount rate approved by the Regulator, is €3.07 billion.

| NPV Analysis - years 1-25<br>€ millions | Total<br>NPV | Total<br>Nominal |
|---|---|---|
| Capex | 407 | 660 |
| Fuel cost | 1,797 | 3,801 |
| CO2 cost | 474 | 1,183 |
| Waste disposal & reagent cost | 248 | 625 |
| Maintenance cost | 146 | 354 |
| **Total costs** | **3,073** | **6,623** |

### 4.3.2 Option B – 250 MVA Interconnector

**Capital expenditure**

The total investment cost in the 25 year horizon is projected by Enemalta at €489 million. This represents an investment of three 250MVA interconnection cables at €163 million each. The first interconnection cable is scheduled for 2012, the second cable in 2022 and the third in 2029.

**Operating costs**

The main operating assumption for this option is the electricity import price. This is assumed at a constant price of €75 / MWh based on the 2015 forecast estimated in the CESI Report. The €75 price assumes a certain degree of intelligent purchasing whereby Enemalta would source its base load requirement though the cable and limit peak rate utilisation. The other incremental cost for this option is the annual maintenance cost which is assumed by Enemalta at €2.3million for each cable.

Operating cost assumptions for the generating plant included in the Baseline are the same as set out in Section 4.3.1.

The table below sets out the total incremental importation and operating costs (at 2009 prices) for the 72,287GWh projected in the 25 year Project time horizon.

| Operating cost projections<br>Yrs1-25 - € millions | TOTAL | Import Price | Fuel | Waste disposal & reagents | Variable maintenance | Carbon Dioxide Allowances | GWh generated |
|---|---|---|---|---|---|---|---|
| Interconnector cable | 4,110 | 4,020 | - | - | €2.3m p/cable p.a. | - | 53,602 |
| Delimara - open cycle gas | 83 | | 69 | - | 4 | 10 | 389 |
| Delimara - diesel comb cycle | 697 | | 405 | 89 | 47 | 157 | 8,854 |
| Delimara - conv steam | 460 | | 337 | - | 3 | 120 | 4,839 |
| Delimara - combined cycle | 367 | | 304 | - | 7 | 56 | 2,945 |
| Marsa | 182 | | 133 | - | 1 | 48 | 1,658 |
| Less free CO2 allowance in yrs1-3 | (159) | | | | | (159) | |
| **Total** | **5,741** | **4,020** | **1,248** | **89** | **62** | **232** | **72,287** |

**Net Present Value of Option B power generation costs**

The table below sets out the total capital expenditure, importation and operating costs in nominal and net present value terms for the Project time horizon. The net present value is calculated as at 1 January 2010 assuming a 6.61%, is €2.85 billion.

| NPV Analysis - years 1-25<br>€ millions | Total<br>NPV | Total<br>Nominal |
|---|---|---|
| Capex | 270 | 489 |
| Electricity import &cable maintenance | 1,527 | 4,110 |
| Fuel cost | 842 | 1,248 |
| CO2 cost | 121 | 232 |
| Waste disposal & reagent cost | 49 | 89 |
| Maintenance cost of local plant | 37 | 62 |
| **Total costs** | **2,845** | **6,230** |

### 4.3.3 Conclusion

The table below summarises the nominal and net present value costs for both options. This analysis indicates that, based on the assumptions set out in this chapter, Option B is the lower cost option by a margin of circa 7% on the net present value costs.

| Summary NPV analysis - yrs1-25 | OPTION A | | OPTION B | |
|---|---|---|---|---|
| € millions | NPV | Nominal | NPV | Nominal |
| Capex | 407 | 660 | 270 | 489 |
| Imported electricity & cable maintenance | - | - | 1,527 | 4,110 |
| Local generation costs | 2,665 | 5,963 | 1,048 | 1,631 |
| **Total costs** | **3,073** | **6,623** | **2,845** | **6,230** |

In addition to being the lowest cost option, the interconnector cable also offers the financial benefit of reduced volatility given the wider spread of generating technologies and the lower dependence on fossil fuel pricing.

## 4.4 Economic Considerations Affecting the Options Analysis

The financial analysis presented above clearly indicates a preference of Option B, involving the cable link for the acquisition of electricity from the European grid, over Option A, that is the expansion in local production. This preference emerged from the perspective of the internal financial costs of energy production, acquisition and distribution of Enemalta Corporation. There are however other costs, which may be considered to be of an external nature as they are not borne directly by Enemalta, which further reinforce the preference of Option B over Option A. These arise out of the incidence of power interruptions, which in turn influences security of supply, associated with the expansion of domestic electricity production.

*Losses in Economic Activity Arising from Power-Out Incidents*

A potential economic benefit of diversification of energy sources through the acquisition of electricity via the cable link and the eventual increased reliance on such source emanates from the security of supply. Under Option A, all electricity would eventually be produced locally at Delimara. Failures at this site would therefore, not be easily remedied through the utilisation of alternative sources of energy production. Enemalta expect that the reliance and consequent diversification of sources on the cable link for the acquisition of electricity, not only does the probability of accidents fall to levels close to zero, but there would be enhanced options for the kicking-in of backup sources of energy should an unlikely interruption occur.

In this manner, it can be considered that the possible losses in economic activity arising from the incidence of interruptions in local production constitute another reason for the preference of Option B over Option A. It is difficult to conceptually and practically design methodologies to derive such an estimate and implement it in practice. For want of a more precise approach, it will be assumed that the incidence of interruptions under Option B is zero[16], while that under Option A can be estimated, albeit in a very approximate manner, by the occurrence of interruptions in the Delimara power station between 2006 and 2008. This information and the resulting estimates of GDP losses due to power interruption instances are presented in the table below.

Potential Loss in GDP from Power Interruption Incidents Associated with the Delimara Power Station

| | Events | % of economy without power for: | | | GDP per hour (euros) | Activity which stops without electricity for: | | Total Loss of GDP in the year |
|---|---|---|---|---|---|---|---|---|
| | | 1 hour | 3 hours | more than 3 hours | | 1 hour | 3 hours | |
| 2008 | 2 | 46.7 | 26.7 | 0.0 | 657,306 | 0.8 | 0.9 | 1,437,393 |
| 2007 | 2 | 23.9 | 38.0 | 0.0 | 625,114 | 0.8 | 0.9 | 1,523,153 |
| 2006 | 2 | 35.5 | 32.3 | 0.0 | 584,247 | 0.8 | 0.9 | 1,349,628 |
| Average | 2 | 35.4 | 32.3 | 0.0 | 622,222 | 0.8 | 0.9 | 1,436,725 |

Between 2006 and 2008, there were 2 instances every year of power-outages arising from incidents in the Delimara Power Station. On average, it is calculated that 35.4% of the economy had to do without power for 1 hour and 32.3% of the economy for 3 hours. It is furthermore assumed that a power cut of 1 hour effectively stops 80% of the affected economic activity, while a power cut of 3 hours would stop 90% of the affected economic activity. On the basis of this information and assumptions, it is estimated that the average losses in annual GDP due to power cuts from the Delimara Power Station during the period amounted to €1.4 million. Adjusted for inflation to bring the estimate to 2009 prices, the average loss in annual GDP can be expressed at €1.5 million.

This €1.5 million estimate of the loss in GDP arising from interruptions to local electricity production can be considered as an economic cost which further enhances the preference of Option B, the cable link, over Option A.

16 This option features redundant capacity on cables with the possibility of a backup through local production in the very unlikely event of an accident to one of the cables.

# V Analysis of Demand for Electricity in Malta

### 5.1 Introduction

The objectives of the project that is the subject matter of this study are first and foremost to create the capacity for electricity production in the Maltese Islands and secondly to enhance the efficiency and stability of provision of electricity services in the territory. Thus, a study of the patterns and developments of the demand for electricity in Malta constitutes an essential element of this cost-benefit analysis. This enables:

- an understanding of the fundamental socio-economic features impinging on the use of electricity in the country, including the formation of considerations regarding the affordability of full-cost recovery electricity charges, as presented in Chapter VI of this report; and

- the derivation of forecasts for electricity consumption, as presented in Chapter VII of this report, which is be required for a number of components of this study, including:

    - the formulation of options which would be able to generate the capacity required to meet demand, as discussed in Chapter IV of this report; and

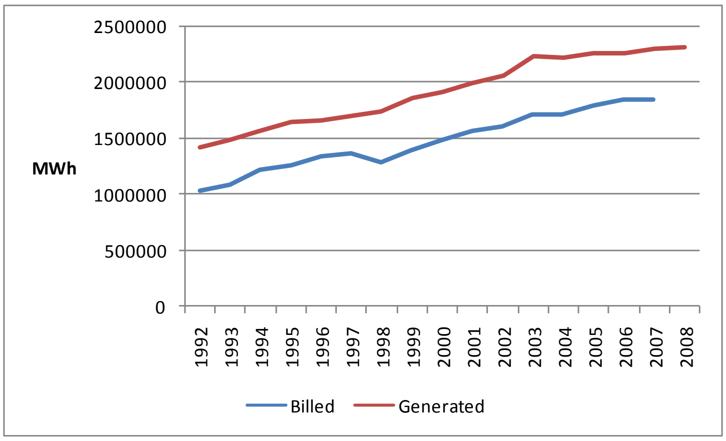
    - the undertaking of the financial and economic assessments of the preferred option, presented in Chapters VIII and IX of this report.

This chapter derives a function for the demand of electricity in Malta through an econometric approach. It first reviews underlying trends in the data to ascertain a number of behavioural features which are then used to derive a preferred approach to the econometric technique. The aim of this chapter is to derive estimates for the elasticity of electricity demand in Malta with respect to the economy's GDP and the relative price of electricity tariffs.

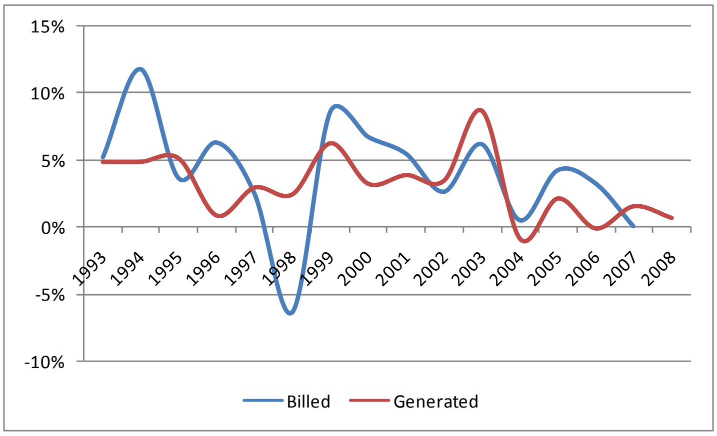
### 5.2 Underlying Trends in Electricity Demand in Malta

Electricity generation is driven by the fundamental "billed" demand for electricity in the Maltese economy and by the amount of losses in the system as well as internal consumption. The chart below shows the development in these variables on a time series basis starting in 1992 and using the latest available data, which for billed electricity extends to 2007 while for generated electricity goes up to 2008.

Generated and Billed Electricity



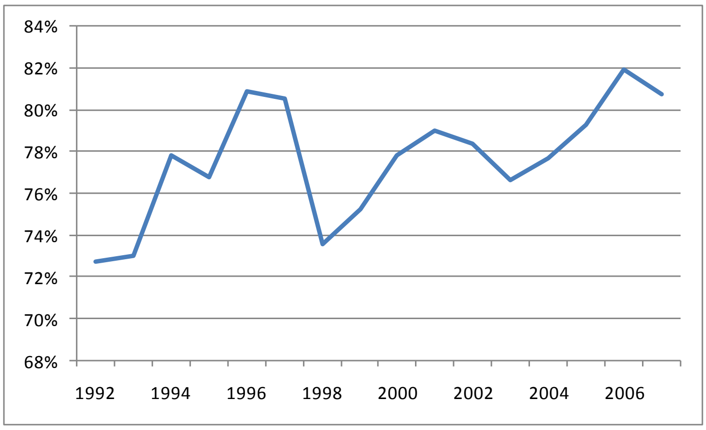

Growth Rates in Generated and Billed Electricity




Billed and generated electricity have generally been on the increase during the time period under consideration. However, there has been a marked slowdown in the growth rates of both billed and generated electricity over time. This is shown in the chart above, which indicates that the growth rate of generated electricity, which stood around 5% in 1992, dropped to merely 0.6% by 2008[17]. This in part reflects a slowdown in the rate of growth in billed electricity, which generally however remained at a higher level. As a result, the ratio of billed to generated electricity tended to increase over time, settling at over 80% in 2006 and 2007, as shown in the chart below. This indicates enhanced efficiency in the provision of electricity in Malta.

17 It is worthwhile to remark that the substantial drop in billed electricity in 1998 may be ascribed to an exceptional increase in tariff rates in that year which disturbed the billing process for a period. This was made up for by an increase in billed electricity in 1999.

Ratio of Billed to Generated Electricity




The table below presents a basic analysis of trends in billed electricity consumption in Malta. On the basis of this data, total electricity demand stood at 1,032,339MWh in 1992 and has tended to rise steadily thereafter, with the exception of 1998, at an average annual rate of 3.95%. In 2006, total electricity demand stood at 1,853,017MWh. This figure hardly changed in 2007, when electricity demand was negatively affected by a significant increase in tariff rates, as explained further on.

Billed Electricity Consumption in Malta (1992-2007)

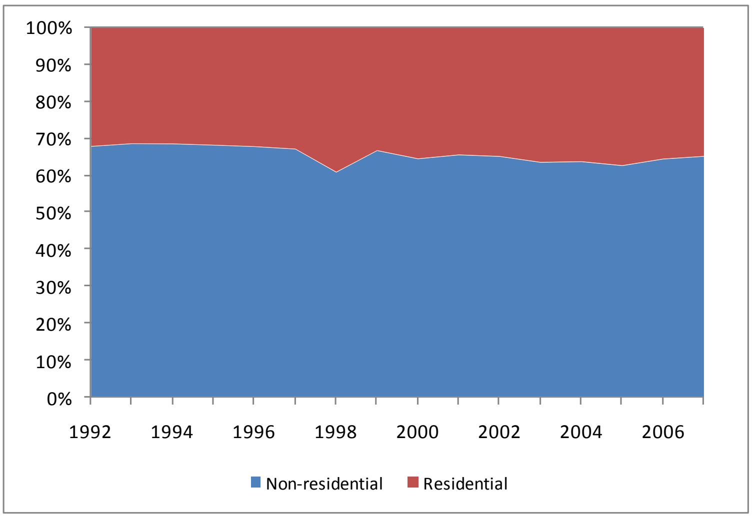
| Year* | Electricity Consumption (MWh) | | | Per capita (KWh) | | Per €1000 real GDP (KWh) | |
|---|---|---|---|---|---|---|---|
| | Residential | Non-residential | Total | Residential | Total | Non-residential | Total |
| 1992 | 331,292 | 701,047 | 1,032,339 | 897 | 2,794 | 234 | 345 |
| 1993 | 340,575 | 745,726 | 1,086,301 | 913 | 2,911 | 246 | 358 |
| 1994 | 381,596 | 833,193 | 1,214,789 | 1014 | 3,227 | 269 | 392 |
| 1995 | 399,854 | 859,263 | 1,259,117 | 1057 | 3,327 | 270 | 395 |
| 1996 | 430,413 | 908,412 | 1,338,825 | 1128 | 3,510 | 274 | 404 |
| 1997 | 450,319 | 922,017 | 1,372,336 | 1172 | 3,572 | 265 | 395 |
| 1998 | 501,996 | 782,527 | 1,284,523 | 1299 | 3,324 | 218 | 357 |
| 1999 | 463,668 | 931,606 | 1,395,274 | 1193 | 3,589 | 249 | 373 |
| 2000 | 528,095 | 961,410 | 1,489,505 | 1349 | 3,805 | 242 | 375 |
| 2001 | 540,470 | 1,030,786 | 1,571,256 | 1370 | 3,981 | 264 | 402 |
| 2002 | 561,474 | 1,051,243 | 1,612,717 | 1413 | 4,059 | 262 | 402 |
| 2003 | 623,738 | 1,089,047 | 1,712,785 | 1560 | 4,283 | 272 | 428 |
| 2004 | 623,671 | 1,097,694 | 1,721,365 | 1549 | 4,275 | 271 | 426 |
| 2005 | 669,467 | 1,124,883 | 1,794,350 | 1653 | 4,430 | 269 | 428 |
| 2006 | 658,224 | 1,194,793 | 1,853,017 | 1614 | 4,544 | 276 | 429 |
| 2007 | 645,040 | 1,208,931 | 1,853,971 | 1565 | 4,499 | 269 | 412 |

* represents data for the 12 months ended in October of the year

Electricity demand in Malta has tended to increase also in relation to scale variables of a socio-economic nature. Per capita electricity demand, for instance, rose steadily from 2,794KWh to 4,544KWh between 1992 and 2006, thereby rising by 63%. These trends were underpinned by per capita demand for electricity by residential consumers, which actually increased by 80% during the period. There was furthermore an increase in the demand for electricity also in relation to developments in the country's Gross Domestic Product. Total electricity consumption per €1000 of Gross Domestic Product rose from 345KWh to 429KWh between 1992 and 2006, an increase of 24.4%. As the increase in the demand for electricity was significantly higher in per capita terms rather than per unit of GDP produced, it would appear that the intensity of electricity demand from the production perspective may have declined, but that from the perspective of household consumption appears to have been on the increase.

While the distribution of total electricity demand was fairly stable over the years between that exercised by residential consumers and non-residential consumers, there has been a slight trend increase in the proportion of demand by residential consumers. As the chart below shows, non-residential consumers accounted for the larger proportion of electricity demand throughout the period, which fluctuated closely around an average of two-thirds.

Distribution of Electricity Consumption




An important consideration to make in this respect is the fact that the above analysis pertains solely to electricity billed by Enemalta. Although the Corporation is virtually the sole provider of electricity in the country, possessing the infrastructure for generation and distribution, there may be a marginal element of additional demand for electricity in the country through the generation of power through own resources. This is however considered to be negligible, and would be used mainly in instances of power interruptions from Enemalta capacity.

### 5.3 An Estimation of a Demand for Electricity Function

There are two principal considerations which are considered to be relevant for electricity demand namely, the relative price of electricity and the issue of socio-economic scale. On this premise, a theoretical model for electricity demand can be formulated as:

$$\ln(E_t) = a_0 + a_1\ln(P_t) + a_2\ln(Y_t) + e_t$$

where E is electricity demand

P is the price of electricity relative to the overall consumer price index in the economy

Y is the level of Gross Domestic Product e is a stochastic error term

t is a time subscript

In this specification, $a_1$ can be interpreted as the price elasticity of electricity demand, while $a_2$ can be interpreted as the income elasticity of electricity demand. The choice of the relative price variable is obvious and is in line with the basic economic theory of demand. The choice of Gross Domestic Product as a scale variable is motivated by the fact that it would be highly correlated with other scale variables that may impinge on electricity demand, such as population size, but may be superior as an explanatory variable in this case. Indeed, electricity is not only a consumption good, thereby potentially exhibiting sensitivity to income levels, but is an essential input into productive activities.

Being a necessity in nature with limited possibilities for substitution, the price elasticity of electricity would *a priori* be expected to be negative and relatively low in absolute value. The income elasticity is expected to be positive, with its size depending upon trends in its use as a consumption and intermediate good. From a consumption perspective, this would depend on whether electricity is an inferior good, whose demand grows less than proportionately with income. From a production perspective, it would depend on whether economic growth in Malta is oriented mainly towards sectors which are not intensive in the electricity resource, given its relatively high cost of production in the Maltese economy.

It may furthermore be considered that the demand model should be estimated separately for households and for non-residential consumers. The approach adopted here is however to estimate a composite demand for electricity which can then be subsequently apportioned to the different categories of users. This is motivated by two reasons. The first is the fact that the ratio of consumption by residential and non-residential consumers has been relatively stable over time. The second is that it is difficult to find different explanatory variables for the two classes of demand, both from a conceptual as well as from the data availability perspectives. Indeed, the average effective electricity prices tended to move in similar directions over the past years, while there exists a high correlation, albeit by no means implying a proportional relationship, between output indicators such as Gross Domestic Product and household income indicators such as wages and salaries. Time series data on household disposable income does not exist for Malta.

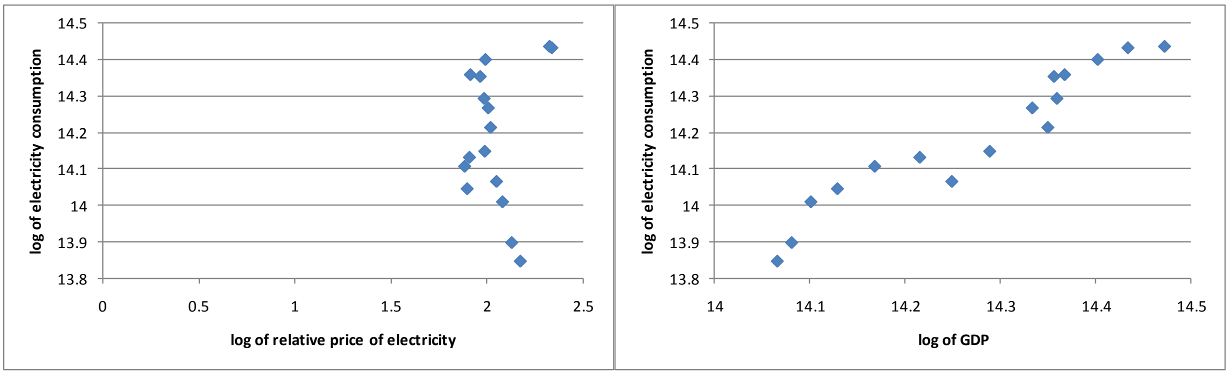
The model was therefore estimated for composite electricity demand using data for the period 1992 to 2008[18]. A representation of the data is shown in graph below, which presents scatter diagrams of electricity consumption against Gross Domestic Product and electricity consumption against the relative price of electricity. In the computation of the latter variable, the effective price of electricity was obtained as the ratio of revenues to units billed by Enemalta relative to the overall level of the Retail Price Index[19]. All variables are measured in natural logs. The scatter diagram featuring Gross Domestic Product on the horizontal axis indicates a consistently positive relationship but whose sensitivity may have changed over

18 An estimate for billed electricity in 2007 and 2008 was derived on the basis of electricity generated data for the year, applying a ratio of 82%.

19 For 2008, an estimate of the price of electricity was obtained on the basis of the change in the electricity, water and fuel sub-index of the Retail Price Index

time possibly due to changes in other relevant variables. This may have been occasioned by changes in price. The scatter diagram showing the log of the relative price of elasticity on the horizontal axis indicates that this variable has a negative relationship with the composite demand for electricity. The negative sensitivity of demand to price changes however appears to be weak, and indeed to have been broken at relatively high prices.

Scatter Diagrams for Variables in the Electricity Demand Model

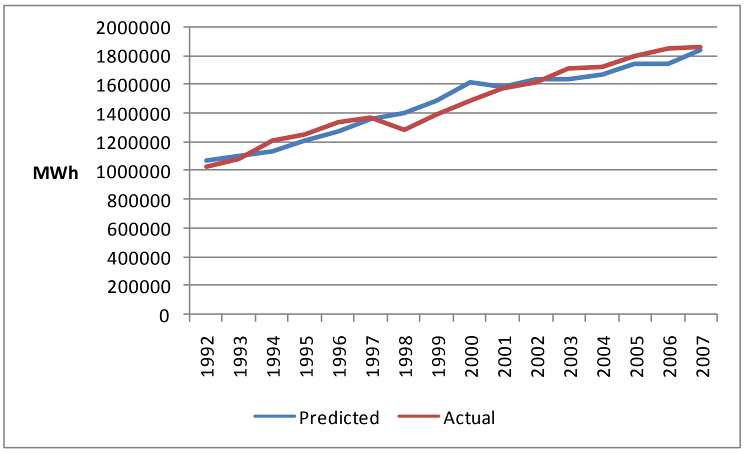



Estimation of the electricity demand model by means of the Ordinary Least Squares procedure gave the following results:

$\ln(E_t) = -5.327 - 0.122 \ln(P_t) + 1.385 \ln(Y_t) + e_t$
t-stats (-3.62) (-1.22) (13.14)
p-value (0.00) (0.24) (0.00)
$r^2 = 0.93$
Estimation period: 1992-2008

The model is estimated with a goodness of fit coefficient of 93%. The predictive power of the model is not perfect but can be considered to be reasonable within the limitations imposed by the availability of data, as shown in the chart below.

Actual and Predicted Values from the Demand Model

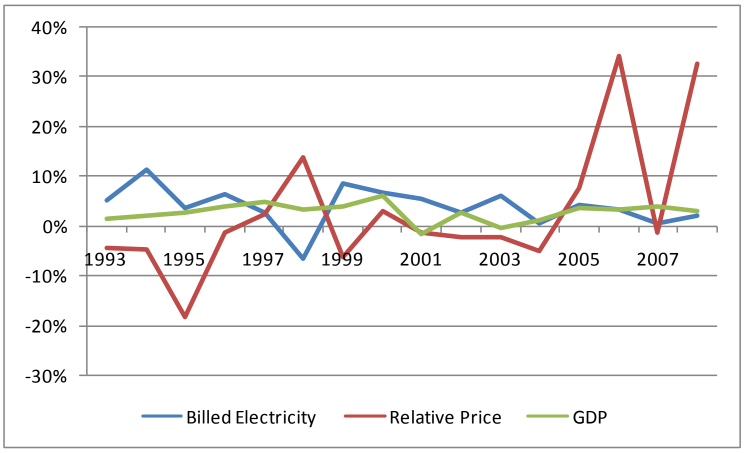



The elasticity estimates derived from the model confirm with *a priori* expectations. The elasticity of electricity consumption with respect to its relative price is through the regression model estimated at -0.122, with the weak value of the t-statistic and the relative probability level actually indicating that it may be not statistically significant from zero. This indicates the necessity nature of electricity, which can hardly be substituted by any alternative product. The elasticity of electricity consumption with respect to GDP is relatively high, estimated at 1.385. This indicates that consumption and production may in Malta have shifted towards more electricity-intensive applications during the period considered within this study.

It is to be furthermore noted that since electricity generation is presumed to a constant multiple of billed consumption, these elasticity estimates would apply in relation to electricity generation as well.

An important weakness of regression analysis in general which also applies to this study is the issue of non-constancy of the estimated parameters. Demand relationships may alter over time as a result of behavioural changes, as well as due to exceptionally large shifts in the explanatory variables. The chart below shows that prices tended to change exceptionally in certain instances, particularly in 2006 and 2008 when significant increases to the effective price of electricity was observed in response to the increases in oil prices, together with attempts towards better cost-recovery. This would have not only influenced, to some extent, the level of consumption, but potentially also the sensitivity of consumption to changes in explanatory variables. Sufficient data after the event to test these hypotheses is not available.

Changes in Demand and its Determinants




It is furthermore to be noted that another effort at cost recovery of electricity generation and distribution has been implemented in 2008, which also increased effective prices in a significant manner.

On the basis of this observation, it may be construed that the sensitivity of electricity demand to changes in economic activity may have been disturbed with the significant increases in prices since 2005. There are insufficient observations to test this hypothesis econometrically on the basis of an expanded demand model. However, an approximation may be obtained by removing the price effect from the electricity consumption data, so as to approximate the change in demand that is purely due to changes in GDP, and re-estimating the elasticity to GDP for a more recent period. This analysis was undertaken using data from 2005 onwards and an estimate of price elasticity amounting to -0.122, which is that obtained from the model above. In effect, the regression model becomes:

$\ln(E_t) + 0.122 \ln(P_t) = a_0 + a_1\ln(Y_t) + e_t$

which gives the following results through Ordinary Least Squares estimation:

$\ln(E_t) + 0.122 \ln(P_t) = 0.662 + 0.972\ln(Y_t) + e_t$
t-stats (0.147) (3.113)
p-value (0.90) (0.07)
$r^2 = 0.83$
Estimation period: 2005-2008

This approach gave an elasticity of demand for electricity with respect to GDP equal to 0.972, with a reasonably high degree of statistical significance in spite of the limited sample data available for estimation. This revised income elasticity estimate is significantly lower than the 1.385 obtained through the estimation of the model for the entire 1992-2008 period, and it confirms the fact that the sensitivity of electricity demand to GDP has fallen significantly as the price of electricity tended to rise in a marked manner.

### 5.4 Conclusions

The analysis of electricity demand in Malta is important in order to understand underlying consumer behaviour in this regard, as well as to be able to forecast future loads on power-generating plants. In the past fifteen years, total electricity demand has increased in Malta, but at a decreasing rate. Its composition has featured a relatively stable share of non-residential demand equal to around two-thirds of the total.

Regression analysis has shown that the income and price elasticities of electricity demand in Malta can be estimated at 1.385 and -0.122 respectively. However, in recent years, as the price of electricity tended to rise markedly, the elasticity of electricity demand to income is estimated to have fallen to 0.972. This conforms with *a priori* expectations typically associated with studies of this type.

# VI Affordability of Electricity Tariffs

This section of the report analyses the cost of the provision of electricity services in Malta and reviews its affordability mainly to Maltese households but also to the economy in general. This is done by means of the consideration of the current tariff rate, as introduced in 2009 with the aim of moving closer to a full-cost recovery system, in terms of its affordability, from three perspectives:

- the tariff per unit of electricity in relation to the stage of economic development of the country;

- the share of household disposable income which is absorbed by electricity tariffs; and

- the social and economic impacts of further increases in electricity tariffs in the light of changes implemented in recent years.

This analysis is subsequently used to derive a tariff electricity policy for Enemalta which reflects affordability considerations while at the same time respecting the constraints imposed by the financial viability of the provision of electricity supply.

### 6.1 The Cost Recovery Tariff Rate of Electricity in Malta

Historically, electricity tariff rates in Malta featured substantial subsidies for all types of consumers. Due to pressures arising out of economic developments, in particular a substantial increase in oil prices since 2007, as well as issues associated with EU State Aid and Competition regulations, electricity tariff rates in Malta had to move to a model which is closer to a full cost recovery system.

In November 2008, a new electricity tariff system was announced which would replace the hitherto existing system which featured a relatively low base tariff rate augmented by a surcharge to reflect the international price of oil. The new tariff system would cover the full costs of production net of an element of payment effected by Government in the form of a Public Service Order to Enemalta Corporation. On the basis of data provided by the Corporation, the “theoretical” tariff coverage of costs for the year 2008 would comprise the elements as shown in the table below. Thus, the total tariff revenue applicable would amount to €305.1 million, thereby covering 97.5% of total costs. It can be concluded that Enemalta tariff rates are at present very close to being at full-cost recovery rates, which cost includes a target rate of return to replace existing capital infrastructure. These costs and relative tariff rates were revised in April 2009, mainly to account for a significant decrease in the price of oil. Following this revision, the average electricity tariff rate in Malta fell from €0.151/kWh to €0.134/kWh.

Cost of Electricity Production, Distribution and Retail (2008) €M

| | Generation | Transmission and Distribution | Retail | Total |
|---|---|---|---|---|
| Fuel Cost | 223.1 | | | 223.1 |
| Other Costs | 44.4 | 19.0 | 4.1 | 67.5 |
| Target Return on Capital Employed | 10.7 | 7.8 | 3.6 | 22.2 |
| Total Cost | 278.2 | 26.8 | 7.8 | 312.9 |
| Financed by: Tariffs | 274.5 | 23.5 | 7.1 | 305.1 |
| Public Service Order | 3.8 | 3.4 | 0.7 | 7.8 |

It is however to be considered that the calculations on which these tariffs were based included a target rate of return on capital which can at this stage be replaced by a more precise estimate of the costs of investment required for Enemalta to sustain its operations into the future. A full cost recovery tariff rate based on these considerations can thus be estimated.

Based on the undertaking of the preferred option as identified in this study, the full cost recovery tariff rate applicable for Enemalta's 25-year projections can be estimated at €0.146 in 2009 prices. This estimate takes into consideration Enemalta's projected capital investment necessary for the laying and connection of the cables together with relative recurrent costs, as described in Chapter IV of this report, together with Enemalta's projected costs of the running of the Delimara power plant up to the end of its useful life, the full costs of transmission, distribution and retail, as well as other costs necessary for the operations of Enemalta. In particular, such costs include the rate of return on investments apart from those considered under the capital costs of the preferred option. Tariff and cost projections are based on the demand forecast presented in Chapter VII. An explanation of the methodology and assumptions behind this estimation are presented in the Annex to this report.

Whilst the tariff rate of €0.146 in 2009 prices to be maintained over a 25-year horizon would be necessary for Enemalta to recover all costs of production, it can be argued that such an average rate can be obtained over the 25 year period through a development which takes into account:

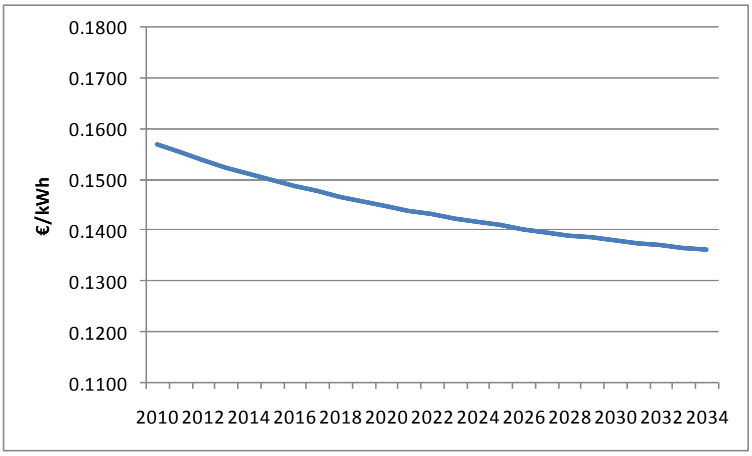
- the necessity for immediate investment in a cable infrastructure due to the closing down of the Marsa power plant;
- the fact that efficiency gains will be reaped by the Corporation later on in the future as:
    - there will be the possibility to buy electricity at cheaper rates from the European grid; and
    - investments in the distribution and retail system will curtail losses in production.

For this reason, Enemalta have a preference for a pricing model which commences with relatively high tariffs that drop gradually, at a decreasing rate, over time, while still retaining the full cost recovery feature. The development of the full cost recovery tariff over time is thus modelled as:

$y_t = y_{t-1}[1-0.01(0.95^t)]$ where $y_t$ is the level of the tariff at time t.

In order to follow this time path while sustaining full cost recovery, the tariff level in the year 2010 would have to stand at €0.157/kWh at 2009 prices, falling gradually to around €0.136/kWh at 2009 prices. The full development of the time series of the full-cost recovery tariff rate for Enemalta is shown in the chart below.

The Development of the Full Cost Recovery Rate for Enemalta




It is here to be remarked that the average tariff rate required for the long run financial sustainability of Enemalta is lower than that established in November 2008 but higher than the revised tariff of April 2009. The relative increase in the full cost-recovery rate is due to the fact that the estimate of the full-cost recovery rate considered here is based on more precise indications of future investment requirements, tempered by an enhancement in the efficiency and costs of electricity provision expected for the future out of the link with the European grid and through other interventions.

It is furthermore important to appreciate the fact that results concerning the setting of electricity tariff rates of a 25-year horizon are underpriced by Enemalta's assumptions particularly in relation to cost variables whose values cannot be determined to any degree of precision at this stage. Such results therefore reflect the information as is available at present, and would therefore call for revisions as actual developments regarding costs and production technologies become available over time. These results are therefore not to be construed as binding on Enemalta's future pricing policy.

## 6.2 The Affordability of Electricity Tariffs to Households in Malta

The affordability of the full cost recovery electricity tariff rate to households in Malta is analysed from three perspectives, namely:

- the extent to which electricity tariffs are impinging and can potentially impinge on the disposable income of Maltese households;
- the level of the electricity tariff in Malta in relation to international comparisons taking into account the state of development of the country;

- the capacity for households to absorb further increases in tariffs.

### *6.2.1 The Impact of Electricity Tariffs on Household Disposable Income*

Data on household disposable income in Malta is scant. Indications can be obtained from a Household Budgetary Survey undertaken with reference year 2000 and a Survey of Income and Living Conditions undertaken for the reference year 2004[20]. For the year 2000, indications are that household disposable income stood at €2.45 billion, implying a per capita amount of €6,300. By the year 2004, household disposable income is reported at €2.29 billion, implying a per capita amount of €5,800. It is to be appreciated that the two statistical sources quoted here are not strictly comparable in terms of approaches and methodologies. However, the drop in household disposable income during the period is plausible on account of the substantial fiscal tightening that had been taking place in order to restore macroeconomic balance, in anticipation of EU membership and the eventual adoption of the euro.

In order to project the household disposable income to 2008 so as to gauge the impact of electricity tariff rates on this variable, it was observed that while, between 2000 and 2004, aggregate household disposable income changed by a multiple of 0.935, aggregate Gross Domestic Product in the economy, at current market prices, rose by a multiple of 1.111. This implies an elasticity of the growth multiple of household disposable income to that of GDP of 0.842. Aggregate Gross Domestic Product in Malta is estimated to rise by a multiple of 1.326 between 2004 and 2008. This implies an increase in household disposable income of the order of a multiple of 1.114 during the same period. The slower growth of household disposable income may be justified on the basis of a progressive income tax system, as well as the dependence of household disposable income on social transfers which rise at a slower pace than Gross Domestic Product. On the basis of this projection, household disposable income is estimated to be in aggregate at €2.55 billion in 2008, which is equivalent to around €6,400 per capita.

Out of the estimated €313 million tariff revenue which are can be expected to be collected by Enemalta in 2010 under the full cost recovery tariff regime, €123.6 million would be collected from household (residential) customers. This reflects fixed installation and annual service charges, and a progressive tariff rate which increases with consumption, as well as an eco-rebate to incentivize low consumption. There is no cross-subsidisation of costs between residential and business consumers.

Relating the €123.6 million expenditure by households on electricity tariffs to a household disposable income of €2.65 billion[21], it can be concluded that the proportion of household income which would be absorbed by electricity charges would amount to 4.7%. An indicative benchmark for the maximum amount of consumption on electricity tariffs which is typically used in studies on affordability of such tariffs is 4% of disposable income. This is furthermore a relatively high figure which is to be taken as an absolute maximum amount. This is a first indication that further increases in electricity tariffs would not be affordable to households in the Maltese economy. Undertaking the same calculation using the long run average cost

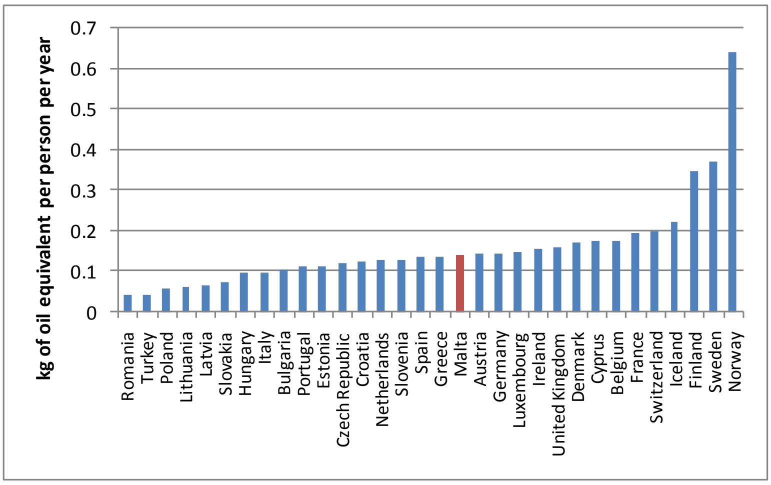
20 www.nso.gov.mt

21 derived by adjusting the 2008 estimate for price inflation

recovery tariff rate of €0.146/kWh rather than the €0.157/kWh rate applicable to 2010 would indicate that the proportion of electricity tariffs absorbed out of household disposable income would amount to 4.3%, which is also above the indicative threshold of affordability.

It is furthermore to be considered that the relatively high level of disposable income absorbed by cost-recovery electricity tariffs in Malta is not due to an excessive consumption volume by households. As shown in the chart below, per capita residential consumption of electricity in Malta was around 0.14 kg of oil equivalent per person in 2008, which is actually lower than the average in European countries, which amounts to 0.16. Conversely, the high rate of electricity tariffs in Malta relative to disposable income in good part reflects relatively high costs of production due to adverse technological conditions which impinge in a small and isolated network. This issue is further discussed below.

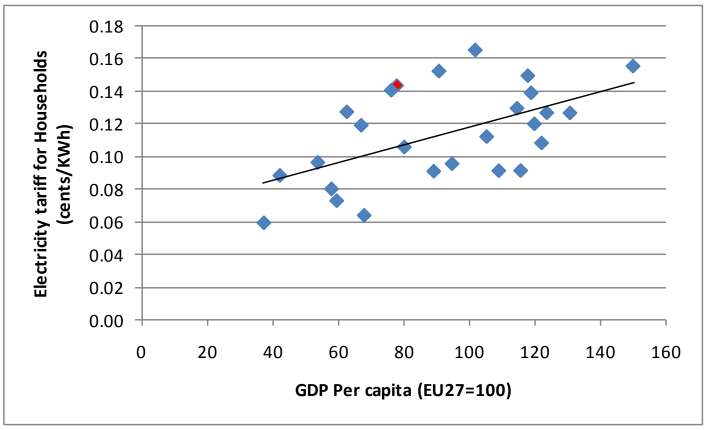
Residential Electricity Consumption per Capita (2008)




### *6.2.2 The Level of Electricity Tariffs in Relation to the State of Economic Development*

The issue of affordability of electricity tariff rates to Maltese households can also be gauged through an international comparison of such rates in relation to the level of economic activity. The chart below presents such a comparative analysis for the EU27 countries on the basis of Eurostat data. The datum for Malta, which in this case is considered to be €0.146/kWh in consideration of the effective long run average rate, is shown in red. This analysis clearly shows that household electricity tariff rates in Malta are well above the average trend for the EU27 countries given its level of economic development. It also confirms that household tariff rates are at the higher end in comparison to other EU countries, which furthermore indicates that such rates are at the limit of affordability. This is also due to the fact that the demand for electricity in Malta has a very low price elasticity, as shown in the Demand Analysis section of this report, such that increases in tariffs would directly impinge on household resources rather than result in lower consumption.

Electricity Tariffs for Households in EU27 Countries




*6.2.3 The Development in Electricity Tariff Rates in Recent Years*

These affordability concerns are further emphasized through the consideration of the development in electricity tariff rates in Malta in recent years. The table below details the development of the implied effective tariff rate for electricity for households defined as the ratio total expenditure on electricity by households to the amount of billed consumption. Tariff rates for households have been relatively stable between 1992 and 1997. This has been followed by increases which were relatively rapid between 2006 and 2008. A further increase was registered for the tariff rate to be applied in 2009, which is based on a formula of cost recovery. The total cumulative increase in the tariff rate between 1992 and 2009 amounted to 145%, with the largest increases taking place since 2006. This analysis indicates that there remains practically no room for manoeuvre in terms of effecting further increases to tariff rates.

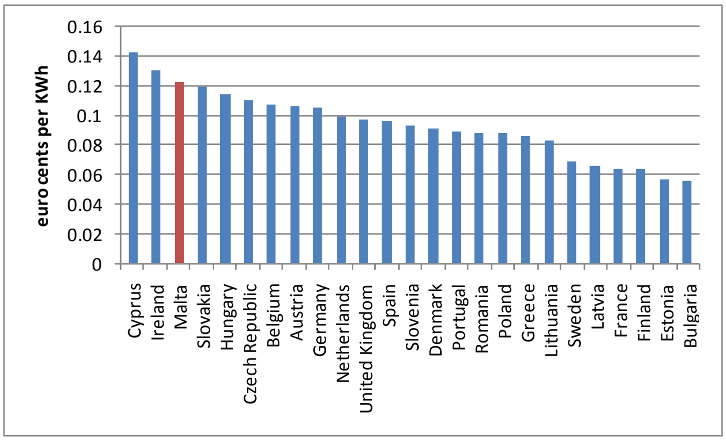
Household Electricity Tariff Rates in Malta

| Year | Tariff rate (€/KWh) | Cumulative Change (%) |
|---|---|---|
| 1992 | 0.05 | 0 |
| 1993 | 0.05 | 0 |
| 1994 | 0.05 | 0 |
| 1995 | 0.05 | 0 |
| 1996 | 0.05 | 0 |
| 1997 | 0.06 | 6 |
| 1998 | 0.07 | 20 |
| 1999 | 0.06 | 8 |
| 2000 | 0.07 | 24 |
| 2001 | 0.07 | 22 |
| 2002 | 0.07 | 30 |
| 2003 | 0.07 | 31 |
| 2004 | 0.07 | 25 |
| 2005 | 0.08 | 45 |
| 2006 | 0.11 | 100 |
| 2007 | 0.12 | 105 |
| 2008 | 0.13 | 133 |
| 2009 | 0.13 | 145 |

It can be therefore concluded that the full cost recovery rate of electricity tariffs in Malta would probably be in a range where they are not affordable to households. Thus, efforts would be warranted to as much as possible enhance the affordability of tariff rates in Malta, without jeopardising the criterion of the viability and sustainability of electricity provision in the country.

Affordability analyses are typically undertaken with respect to the household sector. It is usually presumed that the business sector can be charged full rates of cost recovery. If this were the case, then there would be a potential to increase tariffs for the business sector in order to recover costs of the new investments which are to be undertaken and which are the subject of this study. The policy for charging business customers for electricity is at present symmetrical to that of the household sector, with no cross-subsidisation between sectors. This policy is to be retained for the foreseeable future, also because the relatively high electricity production costs in Malta imply that tariff rates for business in Malta are relatively high by international standards, as shown in the Chart below. This reaffirms the notion that the full cost recovery electricity tariff rates are at the limits of affordability for Malta.

Electricity Tariffs to Business Users (2008)




## 6.3 A Pricing Policy for Electricity Tariffs in Malta

We understand that the pricing policy of electricity tariffs strives to attain two objectives:

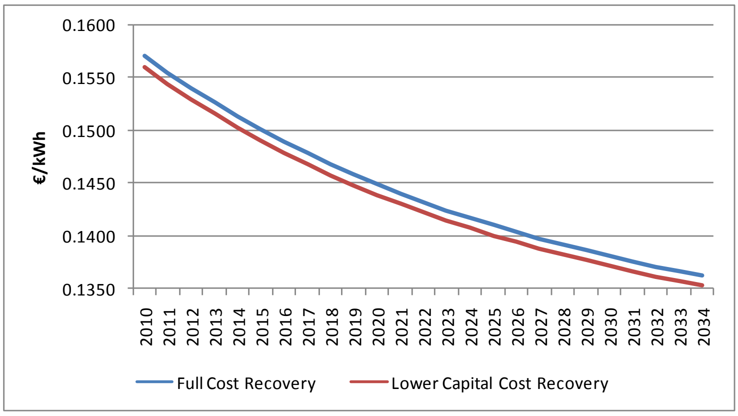
- first and foremost, to ensure the continued sustainability and viability of electricity production in Malta; and
- to mitigate, as much as possible, the adverse effects in relation to the lack of affordability of tariff rates in Malta, especially in relation to households.

In order to meet these objectives, Enemalta is considering a pricing model which, under any circumstance, would fully recover the operating costs of production. Its pricing model would also aim at recovering the capital costs, however the extent of recovery of such costs can be mitigated through the utilisation of EU funding towards investment. This is justifiable on the economic grounds of enhancing the affordability of electricity tariffs to Maltese households, on the premise that such tariffs in Malta are less affordable relative to other countries in view of the special characteristics of production.

Based on this approach, the full cost recovery tariff rate taking into account the availability of €25 million funding towards the acquisition of the first cable link under the preferred option has been worked out. It emerges that the long run average full cost recovery rate for Enemalta would fall from €0.146/kWh to €0.145/kWh, at 2009 prices. Applying a reducing tariff rate over time model as discussed in Section 6.1, the electricity tariff rate at 2009 prices would shift down, as compared to the tariff rate without funding, by around €0.001/kWh, as shown in the chart below.

Thus, the pricing policy considered by Enemalta would cover all costs of production save for those capital costs which can be financed through EU funding programmes. This is in recognition of the fact that electricity tariff rates in Malta need to be brought as close as possible to a more affordable position.

Full and Partial Cost Recovery Tariff Rates




## 6.4 Conclusion

The foregoing analysis has:

- shown that the full-cost recovery rate for electricity production in Malta stands at €0.146/kWh at 2009 prices, which would optimally be applied through a mechanism whereby the tariff rate is reduced over time in consideration of efficiency improvements;

- shown that such a tariff rate is most probably at the limits of affordability, from the perspective of the share of electricity tariffs out of disposable income, its level in relation to international practices, as well as in consideration of recent changes to tariff rates.

Enemalta is therefore considering a pricing policy which:

- ensures the continued sustainability and viability of electricity production in Malta;

- mitigates, as much as possible, the adverse effects in relation to the lack of affordability of tariff rates in Malta, especially in relation to households.

Towards this end, the pricing policy considered by Enemalta covers all costs of production save for those capital costs which can be financed through EU funding programmes. If the €25 million available funding towards this purpose is fully used, the electricity tariff rate in Malta can be reduced by around €0.001/kWh, or 0.7%.

It is important to appreciate that results concerning the setting of electricity tariff rates of a 25-year horizon implies a strong element of assumptions and are based on information as is available at present. They would therefore call for revisions as actual developments regarding costs and production technologies become available over time. The results concerning future tariffs reported here are therefore not to be construed as binding on Enemalta's future pricing policy.

# VII Forecast Demand for Electricity

This section of the report derives forecasts for the demand for electricity on the basis of the findings of the Demand Analysis, which allows the computation of electricity demand on the basis of projected developments in prices and economic growth. The forecast also reflects the results of the Affordability Analysis, from which the electricity tariff rates to be applied in Malta were established. The determination of values of forecasts and tariff rates is of course subject to simultaneous relationships, and the results reported here were derived from an iterative process of model solution.

## 7.1 Forecasting the Demand Equation

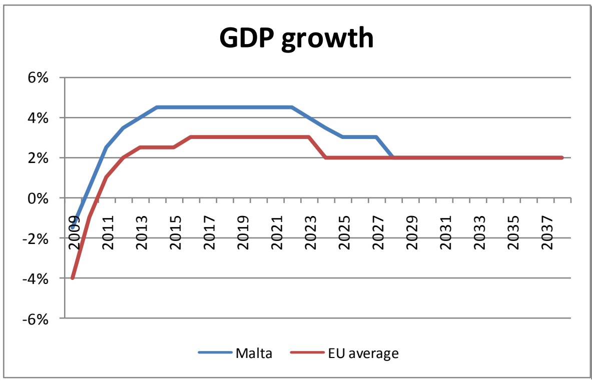
The electricity demand equation derived from the Demand Analysis featured an income elasticity of 0.972 and a price elasticity of -0.122. On the basis of 2008 data, which features electricity generated at a level of 2,187GWh and an aggregate billed consumption estimated at 1990GWh, the demand for electricity can be forecasted for the future given inputs regarding future developments in the price of electricity and in Gross Domestic Product, both measured at constant prices. The forecast horizon presented here features a 30-year period ending in 2038, and which is therefore more than enough to cover the 25-year horizon required for the purposes of the financial and economic cost-benefit assessments. The difficulties and uncertainties inherent in this exercise are evident and obvious, especially when it is considered that ten years of data are being used to forecast over a period of thirty years, during which the Maltese economy will be undergoing a rapid transformation and possibly subject to unpredictable events and shocks. The forecasts provided here are therefore to be considered as expected, though by no means necessarily the most likely outcomes.

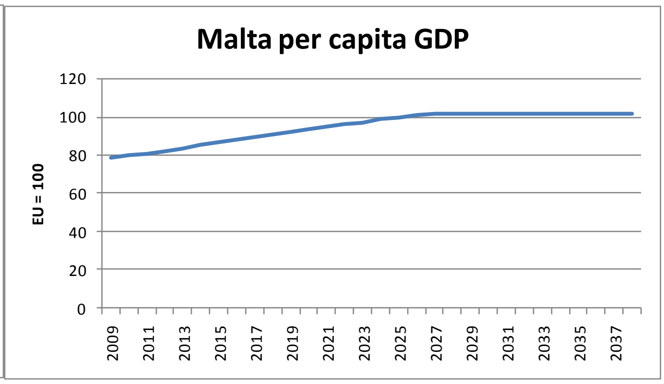
### *7.1.1 The Development of Real Economic Growth*

The per capita income of the Maltese economy is currently at around 76.7% of the EU-27 average. A realistic assumption regarding the future development of the Maltese economy would be for it to converge to the EU average levels of per capita income around the year 2025 and to maintain that level of per capita income thereafter, thereby sustaining a growth rate that is equal to the EU average.

The charts below depict a likely scenario for Malta to attain a per capita GDP level equal to the EU average by the year 2025 and to remain at that level thereafter, together with the growth rates in GDP required for the Maltese economy to pursue this path, given the average growth rate of the EU economy. The EU economy is assumed to contract in 2009 and recover slowly thereafter to maintain an average growth of 2.5% for a period of around 10 years and 2% thereafter. In this scenario, convergence for the Maltese economy to the EU average income level around the year 2025 requires growth to accelerate to 4.5% by 2014. From 2016 onwards, growth would be projected to decelerate until it stabilized at the EU level of 2% by the year 2028. This growth trajectory of the Maltese economy will be used to forecast the demand for electricity by means of the estimated model.

Projected GDP Developments



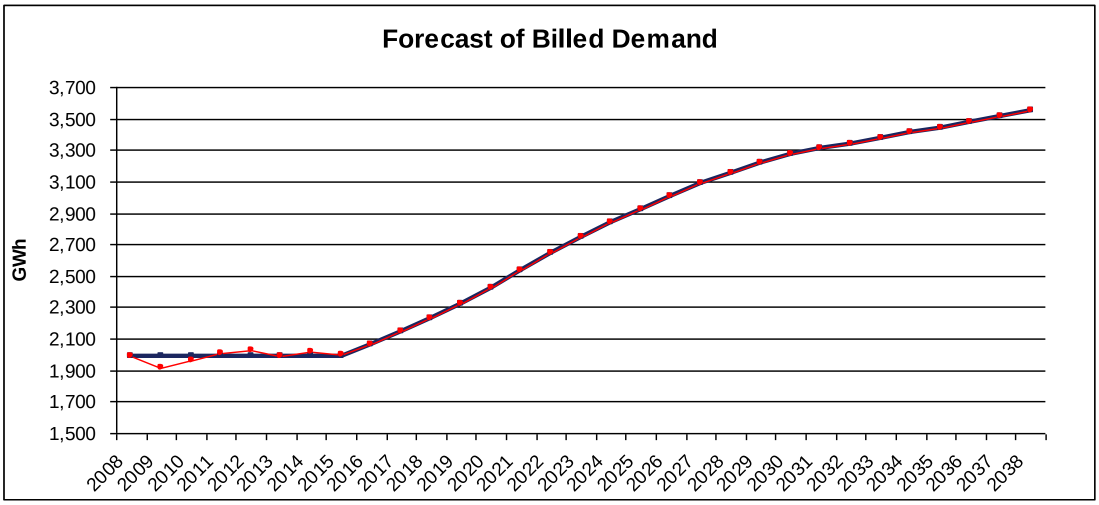




## 7.2 Forecasts for Electricity Demand and Generation

The demand forecasts for electricity generation are undertaken in the following steps. First, a forecast for demand is computed on the basis of the elasticities found in the Demand Analysis, the projected growth of GDP in Malta, and the change in electricity prices in 2009, which would be followed by tariff rates which are constant in real terms thereafter.

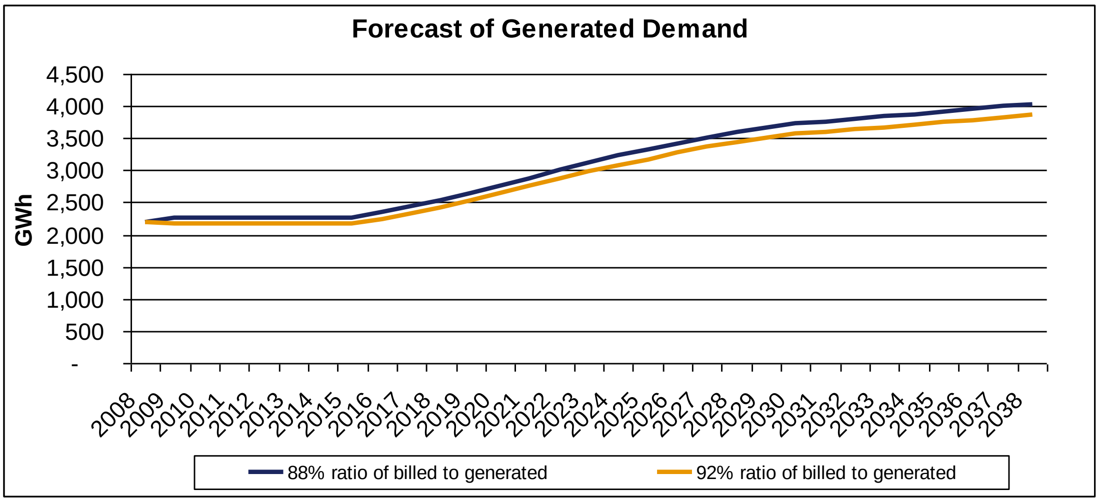
The demand calculated on this basis shows demand dropping in 2009/2010 and increasing marginally up to the year 2015. In view of the current economic climate and the uncertainty of how electricity demand would react in the short term, it was agreed with Enemalta to assume a flat demand profile up to 2015 and continue the growth as per the demand equation from 2016 onwards.

The chart below shows both the scenario of electricity demand dropping in 2009 and 2010 and also the agreed scenario with Enemalta showing a flat demand profile up to 2015.

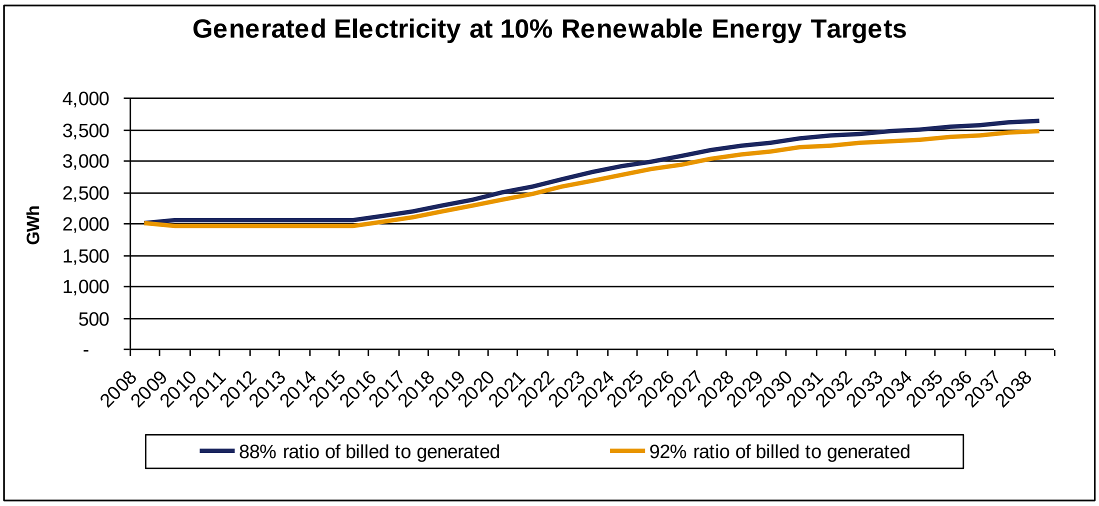



A further step is to translate the forecast for billed electricity into loads for electricity generation. The production of these forecasts will depend upon the assumed ratio of billed demand to generated electricity in future. The chart below presents two scenarios in this respect, one where the ratio remains at the current level of 88%, and another where the ratio continues to improve to a level of 92%.

The results of this analysis point to continued increases in electricity generated. The level of potential load on electricity generation by 2038 would, according to this analysis, be in a range of between 4,034GWh at a ratio of 88% and 3,859GWh at a ratio of 92%.




A further consideration to be made is the fact that Malta is bound to achieve a target of generating 10% of its energy through renewable sources by the year 2020. This would imply a lower load on power plants which are connected with the investment being assessed in this report. Assuming that the 10% renewable electricity generation is achieved in a gradual manner by 2020, the forecasts for generation of electricity through Enemalta power plants in Malta are derived as shown in the chart below.




These projections entail that by 2038, electricity generation from Enemalta plants would be in a range between 3,631GWh at a ratio of 88% and 3,473GWh at a ratio of 92%. This implies an average annual rate of growth rate of around 2.0% in the electricity generation of such plants. These compare with an average projected real GDP growth of 2.9% for the period, indicating an expected element of decoupling of economic growth to environmental footprint in electricity generation in Malta.

For the practical purposes of the development of the model underpinning this document, the pattern of efficiency growth chosen featured a 12% level of losses until 2012 and dropping to 8-9% from 2014 as Enemalta starts reaping the benefits of the smart metering programme.

### 7.3 Conclusion

This section of the report derived a forecast for the demand for electricity in Malta over a thirty-year horizon, subject to the obvious difficulties and uncertainties inherent in such an exercise. An aggregate demand estimation approach was adopted, utilizing expected developments in economic growth and electricity tariffs, the latter taking into account issues of affordability and cost recovery. In spite of an expected decoupling between economic growth and environmental footprint, the demand for electricity generation for Enemalta is expected to grow at around 2% per annum.

# VIII Financial Analysis

### 8.1 Basic Approach of Financial Analysis

The objective of the financial analysis is to:

- estimate the Financial Internal Rate of Return (‘FIRR’) and the Financial Net Present Value of the Project (‘FNPV’) for OPTION B - the preferred option;
- determine the funding gap and the amount eligible for EU funding; and
- illustrate the financial sustainability.

The methodology used in carrying out the financial analysis is based on the European Commissions Guide to the Cost-benefit Analysis of Investment Projects issued in June 2008. The amount eligible for EU funding gap is calculated as the difference between the discounted investment cost and the discounted net revenue subject to a cap of €25m or 50% of the investment cost (whichever is lowest).

The main assumptions underlying the cash flow calculation are the following:

- a 25 year time horizon, ending in 2034 as recommended for the 2007-2013 period in relation to the Energy sector;
- a Residual Value based on the Net Revenue generated in the final year of the projections (2034) and the remaining useful economic life of each cable, estimated by Enemalta at 30 years starting from the respective year of commencement;
- all costs and revenues based on Enemalta’s assumptions at 2009 prices; and
- a financial discount rate of 6.61% which is in line with the rate of return approved for Enemalta by the Regulator (refer to Annex section of report).

### 8.2 Financial projections

The table below sets out the summary financial projections for the costs and revenues related to the electricity imported through the interconnector cables. The full 25 year projections are annexed to this report.

| **Financial Projections**<br>**Year** | **2010**<br>**1** | **2011**<br>**2** | **2012**<br>**3** | **2013**<br>**4** | **2014**<br>**5** | **2015**<br>**6** | **2016**<br>**7** | **2017**<br>**8** | **2018**<br>**9** | **2019**<br>**10** | **Y11-Y25** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital expenditure** | | | | | | | | | | | | |
| Interconnection cable | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 326 | 489 |
| **Importation cost** | | | | | | | | | | | | |
| Basic import Price | 0 | 0 | 0 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 3,244 | 4,020 |
| Maintenance Cost | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 74 | 90 |
| **Total** | **0** | **0** | **0** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **3,318** | **4,110** |
| **Other costs** | | | | | | | | | | | | |
| Transmission costs | 0 | 0 | 0 | 26 | 27 | 27 | 26 | 25 | 24 | 24 | 564 | 742 |
| Capital charge on smart meters | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | | 293 |
| Retail costs | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 130 | 174 |
| **Total** | **0** | **0** | **0** | **44** | **45** | **45** | **43** | **42** | **41** | **39** | **911** | **1,210** |
| **Revenue from tariffs** | | | | | | | | | | | | |
| Electricity Tariffs | 0 | 0 | 0 | 164 | 167 | 165 | 164 | 163 | 162 | 160 | 4,538 | 5,682 |
| Gov't Revenue for Street Lighting | 0 | 0 | 0 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 75 | 110 |
| Total Revenue | **0** | **0** | **0** | **169** | **172** | **170** | **169** | **168** | **167** | **165** | **4,613** | **5,792** |
| Residual Value of Cable | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 318 | 318 |
| **Net Cash Flow** | **(54)** | **(72)** | **(36)** | **13** | **14** | **12** | **12** | **12** | **13** | **13** | **376** | **302** |
| **Cumulative Cash Flow** | **(54)** | **(127)** | **(163)** | **(150)** | **(137)** | **(125)** | **(112)** | **(100)** | **(87)** | **(74)** | **376** | **302** |

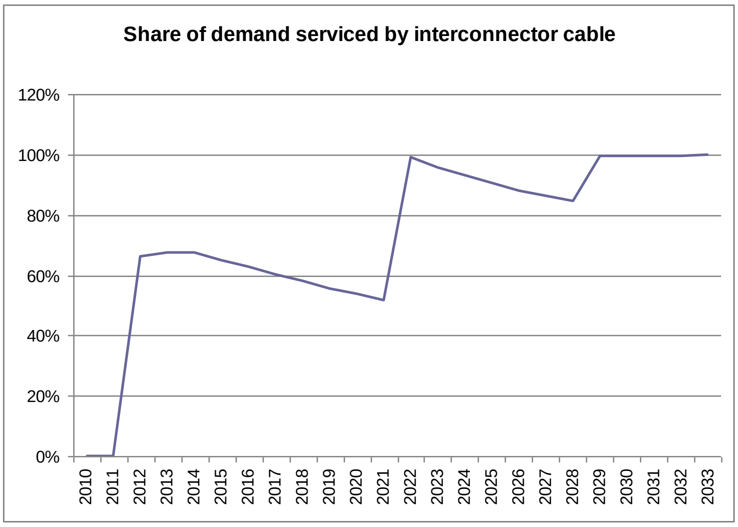
| | |
|---|---|
| **Financial Net Present Value (FNPV/C) of the investment (6.61%)** | **-28** |
| **Financial Internal Rate of Return (FRR/C) of the investment** | **5.36%** |

Enemalta's projected capital expenditure cost of €489 million in Option B includes the investment of €163 million in the initial cable in 2010 – 2012 and the investment in another two cables in 2022 and 2029 replacing old Delimara plant.

The main operating costs are the import of electricity at €75 / MWh starting from 2013 and the €2.3 million annual maintenance costs per cable. The volume of electricity imported through the cable is set 75% of 225 MW capacity which gives an annual throughput of 1,478 GWh. At €75/MWh this gives an annual cost of €111m.

Other costs include an allocation of transmission and retail costs based on the proportion of total demand which is serviced through the cable in each year of the project as set out in the chart below. The transmission and retail costs are based on Enemalta's regulatory submissions in March 2009 plus an additional capital charge estimated by Enemalta for installation of smart meters.

Projected revenue is based on the cable portion of the tariff (as set out in Chapter VII) which is estimated at €0.1285 / kWh in 2010. This tariff is assumed to decrease to allow for efficiency improvements as a result of increased usage of the cable. The tariff is assumed to decrease annually as explained in Section 6.1.




## 8.3 Financial performance indicators

The table below sets out the financial performance indicators calculated as per the European Commissions Guide to the Cost-benefit Analysis of Investment Projects issued in June 2008.

| | |
|---|---|
| **Financial Net Present Value (FNPV/C) of the investment** | **-€28 m** |
| **Financial Internal Rate of Return (FRR/C) of the investment** | **5.36%** |
| **Financial Net Present Value (FNPV/K) of capital** | **-€4 m** |
| **Financial Internal Rate of Return (FRR/K) of capital** | **6.39%** |

The investment cash flow projections discounted at the 6.61% approved by the Regulator results in a negative FNPV/C of €28m and an FIRR/C of 5.36%. The latter is below the 6.61% target approved by the Regulator, and therefore is not financially viable. The Financial Net Present Value of capital (‘FNPV/K’) is also negative.

The Project’s benefit to cost ratio is 1.05 based on total cash inflows (benefits) of €5.8 billion and total cash outflows (costs) of €5.5 billion.

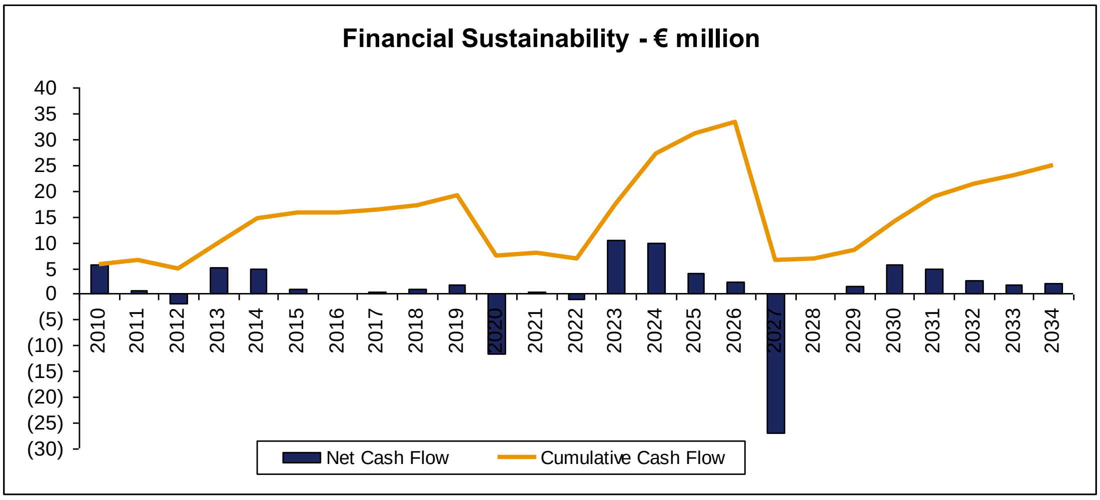
## 8.4 EEPR Funding

The €28m FNPV/C defines the funding gap for the Project and therefore the maximum amount that could be eligible for EU funding subject to a cap of €25m or 50% of the investment cost (whichever is lowest).

## 8.5 Financial Sustainability of the Project

The project is considered to be financially sustainable when it does not incur the future liquidity risk.

The chart below outlines the net post-tax cash flows and the cumulative cash balance projected for the 25 year project period. The detailed financial sustainability projections are annexed to this report.




As illustrated in the above chart, no financial sustainability issues are noted during the 25 year period, in that the net operating cash inflows and the projected financing and the EU grant consistently exceed the projected outflows.

The sustainability model assumes that a €25 million EU grant is received in 2010. Enemalta would also have to withdraw loans, to pay for the investment cost of each cable, which amount to €150 million for the first cable investment (2010 – 2012), €145 million for the second cable investment (2020 – 2022) and €130 million (2027 – 2029) for the third cable investment. Enemalta are already in discussions with EIB with respect to the financing of the first interconnection cable. The lower loan requirements for the successive investment illustrate the partial funding of these investments from internal cash generation. Based on these cash flow parameters, the minimum cumulative net cash flow is of €5 million.

# IX Economic Analysis

## 9.1 Basic Approach of Economic Analysis

The economic analysis appraises the contribution of the interconnecting cable to the economic welfare of Malta. This requires that observed prices used in the financial analysis are converted into shadow prices that better reflect the opportunity cost of the good. At times it can be argued that observed prices of inputs and outputs may not mirror their social value or their social opportunity cost either because some markets are socially inefficient or due to the fact that some markets simply do not exist at all.

Prices used in the financial assessment thus have to be converted for use in the economic appraisal. This requires a fiscal correction to take into account factors such as indirect taxes used in the financial assessment. As a result, prices used in the economic appraisal are net of VAT. In this respect it is to be noted that the operator, which in this case is Enemalta, is refunded VAT and therefore such a taxation element has not been included in the financial assessment.

In terms of the shadow price of goods and services it is to be noted that the Maltese economy is characterized by a high degree of trade dependence resulting in significant trade openness. Over 75% of imports in Malta are imported from EU countries for which there are no trade barriers such as taxes. Moreover, Malta is a price taker on international markets, to the extent that prices of imports and exports reflect such prices. As a result, the prices used in the financial appraisal in this regard are considered to reflect the opportunity cost and thus in this regard a conversion factor of 1 is used.

In terms of labour, in principle wages should reflect the social value of working time and effort that is the marginal value to society of the product of a unit of labour. Generally current wages may be a distorted social indicator of the opportunity cost of labour because there are macroeconomic imbalances as revealed by high and persistent unemployment. In such a case, it would be appropriate for the economic appraisal to estimate the shadow wage rate. This however is not the case in Malta where unemployment has been relatively low and stable averaging at 6.6% since 2005. As a result, for the purpose of the economic appraisal of the project, the conversion factor with respect to the wage rate is also assumed to be unitary.

The economic cost-benefit assessment is undertaken on the incremental principle, with the relevant scenario for comparison being the do-nothing approach as explained in Chapter IV of this report. The do-nothing approach features the utilisation of current capacity up to its useful life with the consequent deterioration in generating capacity and hence with significantly adverse effects on the Maltese economy. This is by no means a realistic scenario, but is one which is here used to derive incremental benefits and costs. Indeed, the principal benefit of this project is the creation of capacity to be able to supply the demand for electricity in Malta into the future[22].

22 It is furthermore to be noted that this Chapter of the report does not consider economic benefits which are incremental to the option of generating electricity through the expansion of local production capacity. These benefits are discussed in the Options Analysis presented in Chapter IV.

## 9.2 Assessment of Economic Benefits

This section deals with an economic assessment of the inter-connecting cable based on the premise that energy is an essential requisite for economic and social activity. Households, commercial establishments as well as industry depend on electricity. Energy is thus an important resource which affects productivity and whose cost is a central factor determining the competitiveness of the economy.

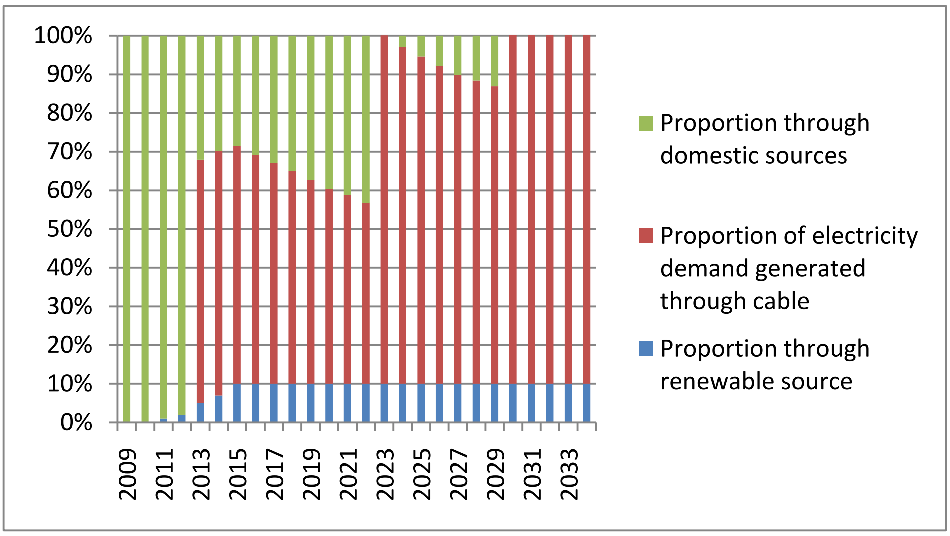
As identified above, the energy sector has over the years been faced with a number of challenges including a persistent increase in demand, sole dependence on the importation of fossil fuels and the fluctuating, and often increasing price of oil, as well as environmental degradation and health related issues associated with emissions and the generation of electricity.

As identified above, the development of the project considered for the purpose of the study seeks to address a number of objectives including, first and foremost, the generation of capacity for access to the European energy grid to satisfy local demand, a diversification of energy sources which should also enable a reduction in costs, a significant reduction in emissions and a general improvement to the environment and to the quality of life of the residents in the surrounding area. An often used gauge to assess the negative externalities associated with emissions refers to the price of carbon emissions. In this case, this consideration has not been included in the economic assessment on account of the premise that while emissions in Malta will be reduced significantly through the development of the interconnecting cable, the price of imported electricity will include a pricing element of carbon emissions related to the environmental degradation caused in another area of the EU.

Another notable benefit in relation to the interconnecting cable is the reduction of Malta's isolation from the internal European electricity market through dependence on local generation. The diversification of sources will provide insurance against disruption of any one particular source of energy, and hence contribute to the overall improvement in the security and quality of supply. In addition it is also to be noted that the price of imported electricity which depends on a number of sources is less volatile than the international price of oil at which Malta imports.

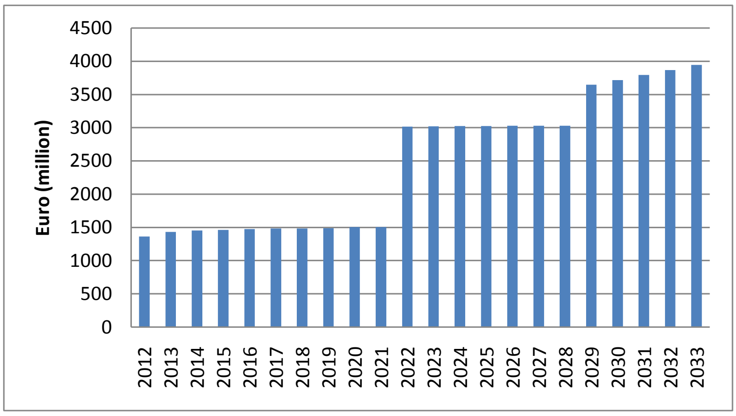
As indicated in Chapter IV of the report, investment in the interconnecting cable, in terms of non-renewable energy, will result in complete reliance on the cable by 2034, with nearly 100% of demand serviced through the cable. At this point, the only available local plant would be the new Delimara diesel engine, commissioned in 2012 and the open cycle gas turbine both of which will be nearing the end of their useful life. Given the significant dependence on the interconnecting cable, the economic benefits associated with this investment are assumed to relate to the generation of economic activity which depends on an uninterrupted supply of energy. Therefore the economic benefits used in the economic appraisal of the project refer to the product of the proportion of total electricity generated through the cable, once account is taken of the generation of energy through renewable resources, and economic activity expected to be generated over the entire time span of the project that is to 2034. As can be seen from the chart below, a 10% proportion of electricity generated through renewable is expected to be attained by 2015. Moreover, the proportion of energy catered through the interconnecting cable is expected to increase, following addition investment in subsequent cable connections.

Proportion of demand catered through different energy sources




A time path for economic activity has been presented in Chapter VII of the report, based on a projected estimate of economic growth. The baseline assumption is that per capita GDP, which in 2008 stood at 76.7% of the EU27 would converge to the EU average by 2025. Therefore given the dependence of the Maltese economy on energy supply coupled with the fact that the interconnecting cable will cater for the majority of the supply of electricity, the benefits associated with the project are high, increasing from €1,366 million in 2013 to €3,948 in 2034 as can be seen from the chart below. Indeed, economic dependence on the cable increases as a larger proportion of energy is catered for through the interconnecting cable.

Economic activity dependent on interconnecting cable



### 9.3 External Costs

In terms of economic costs in relation to the development of the interconnecting cable, these costs are expected to be rather insignificant. The cables will use existing distribution stations at Ragusa (Sicily) and Pembroke in Malta such that no additional economic costs in relation to these distribution centres are expected to arise.

Moreover, the connection would require laying 94km of deep-water submarine cable at a maximum depth of 160 meters. A further 8km of delicately trenched shallow-water submarine cable would also be required. This is split equally between the two shorelines. In terms of landside work, 22.5km of landside cable and trenching (3.5km in Malta and the 19km in Sicily) would subsequently connect the submarine cable to the respective substations in Pembroke and Ragusa. However there are very minimal, if any, economic costs in relation to these works as the laying of the cable results in minimal disturbance to the seabed. Moreover the cable will be laid in sea bed trenches that are appropriately protected from mechanical damage from ship anchors and fishing apparatus, and therefore is not expected to result in any form of disturbance to such economic activity. In terms of landside connections, the negative external costs which can be expected to emanate may involve disturbance to the neighbourhood related to noise, aesthetic and landscape impact during the duration of the works. However in practice, these effects are expected to be minimized because of a range of mitigation measures will be employed in this regard.

### 9.4 Results of Economic Analysis

Given the fiscal corrections noted above and the estimate for external benefits presented above, the economic cash flow analysis produces, after discounting by 5.5%[23], a strong positive ENPV of €20,965 million and an ERR of 183% (refer to Annex). As stated above, given that the interconnecting cable will allow for the generation of substantial economic activity, the external benefits in relation to this project are also significantly high as can be observed from the ERR and ENPV of this project.

| | |
|---|---|
| Economic internal rate of return ERR of investment | 182.86% |
| Economic Net Present Value ENPV of investment @ 5.5% | €20,965,000,000 |
| Benefit/Cost Ratio | 9.3 |

The detailed results of the economic cost-benefit assessment are presented in the Annex to this report.

23 Suggested social discount rate as established in the EU's Guide to Cost-Benefit Analysis of investment projects.

### 9.5 Conclusion

For the purpose of the economic assessment, prices used in the financial assessment have been converted for use in the economic appraisal through a unitary conversion factor. Similar to the financial appraisal, the economic cost-benefit assessment is undertaken on the incremental principle, with the relevant scenario for comparison being the do-nothing approach. Consequently the principal benefit of this project is the creation of capacity to be able to supply the demand for electricity in Malta into the future to the extent that a sizeable proportion of economic activity is dependent on the provision of energy through the interconnecting cable. On the other hand, the external costs associated with the project are negligible. As a result, the economic impact of the interconnecting cable is significantly high resulting in an economic net present value of € 20,965 million and an economic rate of return of 182.86%.

# X Sensitivity and Risk Analysis

### 10.1 Sensitivity and risk analysis of the Financial Assessment

This section presents a sensitivity analysis together with a risk assessment with respect to the results of the financial feasibility study of Option B - the preferred option.

The EU CBA guidelines suggest that a sensitivity analysis be carried out to determine the ‘critical’ variables or parameters. Critical variable are those for which a variation of 1% results in change in NPV of at least 1%, that is the elasticity of the net present value with respect to that variable is more than one.

Given the nature of this Project, Enemalta considers that the key variables are considered to be:

a) capital expenditure;

b) the import price of electricity from the cable;

c) transmission and retail costs; and

d) the Enemalta tariff rate charged to consumers.

The table below sets out the outcomes the outcomes of a sustained 1% increase in the variables identified above, over the 25 year time horizon of the financial analysis.

| Sensitivity Analysis | FIRR | FIRR change % points | FNPV €million | FNPV change | Financial Sustainability €million |
|---|---|---|---|---|---|
| Option B - Base case | 5.36% | 0.0% | (28) | 0.0% | 4.75 |
| Capital Expenditure | 5.28% | -0.1% | (30) | 7.4% | 0.25 |
| Electricity import price | 4.68% | -0.7% | (43) | 53.6% | -21.47 |
| Transmission & Retail | 5.20% | -0.2% | (31) | 13.0% | -1.29 |
| Tariff rate | 6.32% | 1.0% | (7) | -76.6% | 4.75 |

* Represents the minimum point of the cumulative cash flow over the analysis horizon

On the basis of these estimates, all the above variables are critical for the project, since for all instances, the elasticity of the FNPV is greater than 1. Furthermore, the results indicate that the electricity import price and the tariff rate are the variables most sensitive to change. The effect of a 1% increase in the electricity import cost results in a 54% change in the FNPV which drops to a negative €43 million. Conversely, a 1% increase the tariff rate results in a 77% change in the FNPV, increasing the base case FNPV to €7 million.

The risk assessment tests the impact of probability weighted scenarios to reflect the uncertainties associated with the critical variables, thereby enabling derivation of risk adjusted expected values for the project’s FIRR and FNPV.

For each of the critical variables, a single event risk analysis was carried out on a three point estimate: the *Most Likely* estimate (which represents the Option B base case result); the *Pessimistic* estimate; and an *Optimistic* estimate.

The probability attributed to the FNPV for each estimate is as follows:

- *Most Likely* – 70% probability;
- *Pessimistic* – 20% probability; and
- *Optimistic* – 10% probability.

The results from this risk analysis, outlined in the table below, indicated that the FNPV is most sensitive to changes in the electricity import price where the expected value decreased by 80% from a negative €28 million to a negative €50 million.

| Single Event | Most Likely | Pessimistic | Optimistic |
|---|---|---|---|
| **Critical variable** | **Change in critical variable** | | |
| Capital expenditure | 0.0% | 10% | -5% |
| Electricity import price | 0.0% | 10% | -5% |
| Transmission & Retail costs | 0.0% | 10% | -5% |
| Tariff rate | 0.0% | -5% | 10% |
| **Critical variable** | **FNPV** | | |
| Capital expenditure | (28) | (48) | (18) |
| Electricity import price | (28) | (177) | 47 |
| Transmission & Retail costs | (28) | (64) | (10) |
| Tariff rate | (28) | (135) | 186 |
| **Critical variable** | **Probability weighting** | | |
| Capital expenditure | 70% | 20% | 10% |
| Electricity import price | 70% | 20% | 10% |
| Transmission & Retail costs | 70% | 20% | 10% |
| Tariff rate | 70% | 20% | 10% |
| **Critical variable** | **Expected value** | | |
| Capital expenditure | (31) | | |
| Electricity import price | (50) | | |
| Transmission & Retail costs | (33) | | |
| Tariff rate | (28) | | |

Based on the results obtained in the single event risk analysis, a second assessment was carried out, whereby the most sensitive critical variable (electricity import price) was combined with the tariff rate variable, since this rate is likely to be influenced by a change in the electricity import price.

This combined risk analysis assumes three scenarios for each critical variable, which are given a two-dimensional probability of occurrence in order to determine the overall expected FNPV value. The scenarios underlying the risk analysis are based on the following behaviours:

a) electricity import prices will either, increase by 10%, remain neutral or decrease by 5%; and

b) tariff rates will either, increase by 7%, remain neutral or decrease by 5%.

Based on Enemalta's assumption of the probability for each scenario ranging between 0% to 50%, the combined expected FNPV is of €81 million.

**Change in critical variable**

| | | Change in Tariff | | |
|---|---|---|---|---|
| | | **7%** | **0%** | **-10%** |
| **Change in Import Price** | **10%** | (28) | (177) | (241) |
| | **0%** | 122 | (28) | (241) |
| | **-5%** | 196 | 47 | (167) |

**Probability of scenarios**

| | | Change in Tariff | | |
|---|---|---|---|---|
| | | **10%** | **0%** | **-5%** |
| **Change in Import Price** | **10%** | 15% | 5% | 0% |
| | **0%** | 0% | 50% | 5% |
| | **-5%** | 0% | 0% | 25% |

**Expected value**

| | | Change in Tariff | | |
|---|---|---|---|---|
| | | **10%** | **0%** | **-5%** |
| **Change in Import Price** | **10%** | (4) | (9) | 0 |
| | **0%** | 0 | (14) | (12) |
| | **-5%** | 0 | 0 | (42) |

**Expected FNPV** **(81)**

### 10.2 Sensitivity and Risk Assessment of the Economic Assessment

This section presents the risk assessment of the economic impact assessment presented in this cost-benefit analysis. It proceeds by conducting a sensitivity analysis so as to derive the variable(s) which are of a critical nature in terms of the economic assessment. It then discusses probability distribution for the critical variable(s) and conducts a risk analysis on the economic rate of return arising from the distribution(s). It concludes with some brief comments on the assessment of acceptable level of risks and risk prevention.

The variables which are relevant for inclusion in this assessment are the investment cost, the basic price of imported electricity and the external benefits captured through economic activity. Each of these variables has been shocked by 1% in a direction which deteriorates the project results, so as to observe the impacts on the economic internal rate of return and the economic net present value. The results are shown in the Table below.

A critical variable is defined as one for which a 1% change results in a change in the net present value of at least 1%, that is the elasticity of the net present value with respect to the variable in question is larger than 1. The principal variables which are considered to drive the economic cost benefit assessment, namely the capital expenditure, the price of imported electricity, and the level of economic activity which is enabled by the undertaking of the project were tested for their effects on the economic net present value. In this case, only one variable emerges as critical, namely the level of external benefits which refer to the value of economic activity dependent on the cable, as shown in the table below.

Sensitivity Analysis – Economic Assessment

| | ENPV (Euro million) | ERR | Elasticity ENPV | Percentage Point Variation ERR |
|---|---|---|---|---|
| Baseline | 20,965 | 182.86% | | |
| CAPEX | 20,962 | 181.97% | -0.01% | -0.009 |
| Price of imported electricity | 20,948 | 182.78% | -0.08% | -0.001 |
| Economic Activity | 20,730 | 181.84% | -1.12% | -0.010 |

This finding is not surprising, owing to the relatively high level of net economic benefits which are driven in the major part by the level of economic activity permitted by the cable interconnection.

The next step is to consider a probability distribution for the critical variable which in this case refers to the generation of economic activity dependent on the interconnecting cable. Two possible scenarios have been adopted, an optimistic one where the economic growth rate increases by 0.25% on an annual basis, based on a probability of 10% and a pessimistic scenario where the forecasted growth rate drops by 0.5% on an annual basis with economic convergence occurring beyond 2025 as predicted in the baseline scenario. In this case, the probability assigned to this scenario is assumed at 20%. Finally, the most likely scenario, or the baseline scenario, has been assigned a high probability of 70%.

| | Probability | ENPV | ERR |
|---|---|---|---|
| Baseline | 0.7 | 20,965 | 182.9% |
| Optimistic (+0.25%) | 0.1 | 21,852 | 184.0% |
| Pessimistic (-0.5%) | 0.2 | 19,298 | 180.6% |
| Expected Value | | 20,721 | 182.5% |

The risk analysis on the internal rates of return is presented in the table above. Applying the three possible values of benefits, the ENPV is found to oscillate between €19,298 million and €21,852 million with an expected value of €20,721 million compared to a most likely value of €20,965 million. Similarly, the ERR is found to oscillate between 180.6% in the pessimistic scenario to 184% in the optimistic scenario with an expected value of 182.5%.

The switching value refers to that value that would have to occur in order for the ENPV of the project to be zero. In this case the switching value for the ENPV to be zero in terms of the economic activity dependent on the interconnecting cable is 0.82 implying that the projected growth rate has to be 18 percentage points lower than predicted. This implies that economic activity would degenerate over the expected life time of the project, clearly a most unlikely scenario.

These findings indicate that the project has no significant risk concerns in terms of the economic rate of return. The worst-case scenario, involving lower perceived economic growth still yields a strong positive economic rate of return of 180.4% thus implying that the there are no perceived risks which would deplete the economic benefits associated with the project.

Detailed results of the sensitivity and risk analysis are presented in the Annex to this report.

# ANNEXES

# Annex A – Net Present Value of project costs

## Option A – Net Present Value of project costs

| **NPV Analysis - years 1-25**<br>€ millions | **Total**<br>**NPV** | **Total**<br>**Nominal** | **2010**<br>1 | **2011**<br>2 | **2012**<br>3 | **2013**<br>4 | **2014**<br>5 | **2015**<br>6 | **2016**<br>7 | **2017**<br>8 | **2018**<br>9 | **2019**<br>10 | **2020**<br>11 | **2021**<br>12 | **2022**<br>13 | **2023**<br>14 | **2024**<br>15 | **2025**<br>16 | **2026**<br>17 | **2027**<br>18 | **2028**<br>19 | **2029**<br>20 | **2030**<br>21 | **2031**<br>22 | **2032**<br>23 | **2033**<br>24 | **2034**<br>25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capex | 407 | 660 | 55 | 110 | 110 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 55 | 55 | 55 | 0 | 0 | 0 | 0 | 55 | 55 | 55 | 0 | 0 | 0 | 0 | 0 |
| Fuel cost | 1,797 | 3,801 | 192 | 192 | 158 | 122 | 114 | 114 | 118 | 122 | 126 | 131 | 136 | 140 | 146 | 148 | 153 | 157 | 161 | 165 | 168 | 171 | 170 | 171 | 173 | 175 | 176 |
| CO2 cost | 474 | 1,183 | 0 | 0 | 0 | 43 | 40 | 40 | 42 | 43 | 45 | 47 | 49 | 50 | 52 | 53 | 55 | 57 | 58 | 60 | 61 | 62 | 64 | 64 | 65 | 66 | 66 |
| Waste disposal & reagent cost | 248 | 625 | 0 | 0 | 9 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 29 | 30 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 36 | 37 |
| Maintenance cost | 146 | 354 | 3 | 3 | 7 | 10 | 11 | 11 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 |
| **Total costs** | **3,073** | **6,623** | **250** | **305** | **284** | **247** | **185** | **185** | **191** | **198** | **205** | **214** | **278** | **284** | **294** | **246** | **254** | **261** | **268** | **331** | **336** | **341** | **288** | **290** | **293** | **296** | **299** |

**NPV** **6.61%** **3,073**

## Option B – Net Present Value of project costs

| **NPV Analysis - years 1-25**<br>€ millions | **Total**<br>**NPV** | **Total**<br>**Nominal** | **2010**<br>1 | **2011**<br>2 | **2012**<br>3 | **2013**<br>4 | **2014**<br>5 | **2015**<br>6 | **2016**<br>7 | **2017**<br>8 | **2018**<br>9 | **2019**<br>10 | **2020**<br>11 | **2021**<br>12 | **2022**<br>13 | **2023**<br>14 | **2024**<br>15 | **2025**<br>16 | **2026**<br>17 | **2027**<br>18 | **2028**<br>19 | **2029**<br>20 | **2030**<br>21 | **2031**<br>22 | **2032**<br>23 | **2033**<br>24 | **2034**<br>25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capex | 270 | 489 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 |
| Electricity import &cable maintenance | 1,527 | 4,110 | 0 | 0 | 0 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 226 | 226 | 226 | 226 | 226 | 226 | 226 | 273 | 276 | 279 | 281 | 284 |
| Fuel cost | 842 | 1,248 | 192 | 192 | 158 | 44 | 41 | 41 | 45 | 49 | 54 | 62 | 69 | 75 | 84 | 3 | 12 | 16 | 20 | 25 | 28 | 31 | 2 | 2 | 2 | 2 | 2 |
| CO2 cost | 121 | 232 | 0 | 0 | 0 | 14 | 14 | 14 | 15 | 17 | 18 | 21 | 24 | 26 | 29 | 1 | 2 | 4 | 6 | 7 | 9 | 10 | 0 | 0 | 0 | 0 | 0 |
| Waste disposal & reagent cost | 49 | 89 | 0 | 0 | 9 | 5 | 5 | 5 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 0 | 0 | 1 | 2 | 3 | 4 | 4 | 0 | 0 | 0 | 0 | 0 |
| Maintenance cost of local plant | 37 | 62 | 3 | 3 | 7 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 0 |
| **Total costs** | **2,845** | **6,230** | **249** | **267** | **211** | **180** | **176** | **176** | **183** | **189** | **197** | **207** | **272** | **299** | **274** | **230** | **242** | **249** | **256** | **318** | **341** | **310** | **276** | **278** | **281** | **284** | **286** |

**NPV** **6.61%** **2,845**

# Annex B – Option B - FNPV and FIRR

| **Financial Projections** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | |
| **Capital expenditure** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Interconnection cable | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 489 |
| **Importation cost** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Basic import Price | 0 | 0 | 0 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 266 | 269 | 272 | 275 | 277 | 4,020 |
| Maintenance Cost | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 90 |
| **Total** | **0** | **0** | **0** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **226** | **226** | **226** | **226** | **226** | **226** | **226** | **273** | **276** | **279** | **281** | **284** | **4,110** |
| **Other costs** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transmission costs | 0 | 0 | 0 | 26 | 27 | 27 | 26 | 25 | 24 | 24 | 23 | 22 | 21 | 42 | 41 | 40 | 39 | 38 | 38 | 37 | 44 | 44 | 45 | 45 | 45 | 742 |
| Capital charge on smart meters | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 17 | 17 | 17 | 17 | 17 | 293 |
| Retail costs | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 10 | 10 | 10 | 10 | 10 | 174 |
| **Total** | **0** | **0** | **0** | **44** | **45** | **45** | **43** | **42** | **41** | **39** | **38** | **37** | **35** | **68** | **66** | **65** | **63** | **62** | **61** | **60** | **71** | **71** | **71** | **72** | **72** | **1,210** |
| **Revenue from tariffs** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electricity Tariffs | 0 | 0 | 0 | 164 | 167 | 165 | 164 | 163 | 162 | 160 | 159 | 160 | 159 | 317 | 315 | 314 | 312 | 311 | 310 | 308 | 369 | 372 | 374 | 377 | 379 | 5,682 |
| Gov't Revenue for Street Lighting | 0 | 0 | 0 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 110 |
| Total Revenue | **0** | **0** | **0** | **169** | **172** | **170** | **169** | **168** | **167** | **165** | **164** | **165** | **164** | **322** | **320** | **319** | **317** | **316** | **315** | **313** | **374** | **377** | **379** | **382** | **384** | **5,792** |
| Residual Value of Cable | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 318 | 318 |
| **Net Cash Flow** | **(54)** | **(72)** | **(36)** | **13** | **14** | **12** | **12** | **12** | **13** | **13** | **(41)** | **(57)** | **(20)** | **27** | **28** | **28** | **28** | **(26)** | **(45)** | **(9)** | **30** | **29** | **29** | **28** | **346** | **302** |
| **Cumulative Cash Flow** | **(54)** | **(127)** | **(163)** | **(150)** | **(137)** | **(125)** | **(112)** | **(100)** | **(87)** | **(74)** | **(115)** | **(172)** | **(192)** | **(165)** | **(137)** | **(109)** | **(81)** | **(107)** | **(152)** | **(161)** | **(131)** | **(101)** | **(73)** | **(44)** | **302** | **302** |

| | |
|---|---|
| **Financial Net Present Value (FNPV/C) of the investment (6.61%)** | **-28** |

| | |
|---|---|
| **Financial Internal Rate of Return (FRR/C) of the investment** | **5.36%** |

| | |
|---|---|
| **Full Cost Recovery Tariff** | **0.117** |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sliding scale tariff** | **0.129** | **0.127** | **0.126** | **0.1249** | **0.1238** | **0.1228** | **0.1218** | **0.1209** | **0.1201** | **0.1193** | **0.1186** | **0.1178** | **0.1172** | **0.1165** | **0.1159** | **0.1154** | **0.1148** | **0.1143** | **0.1139** | **0.1134** | **0.113** | **0.1126** | **0.1122** | **0.1118** | **0.1115** |

# Annex C – Option B - Financial Sustainability

| **Financial Sustainability** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | |
| Total Revenue | 0 | 0 | 0 | 169 | 172 | 170 | 169 | 168 | 167 | 165 | 164 | 165 | 164 | 322 | 320 | 319 | 317 | 316 | 315 | 313 | 374 | 377 | 379 | 382 | 384 | 5,792 |
| **Loan amounts** | **35** | **75** | **40** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **40** | **70** | **35** | **0** | **0** | **0** | **0** | **25** | **70** | **35** | **0** | **0** | **0** | **0** | **0** | **425** |
| EU Grant | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 |
| **Total Cash Inflow** | **60** | **75** | **40** | **169** | **172** | **170** | **169** | **168** | **167** | **165** | **204** | **235** | **199** | **322** | **320** | **319** | **317** | **341** | **385** | **348** | **374** | **377** | **379** | **382** | **384** | **6,242** |
| **Cash outflows** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Investment cost | (54) | (72) | (36) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (54) | (72) | (36) | 0 | 0 | 0 | 0 | (54) | (72) | (36) | 0 | 0 | 0 | 0 | 0 | (489) |
| Operations and Maintenance costs | 0 | 0 | 0 | (157) | (158) | (158) | (157) | (155) | (154) | (152) | (151) | (150) | (148) | (295) | (293) | (291) | (289) | (288) | (287) | (286) | (344) | (347) | (350) | (353) | (356) | (5,319) |
| Interest cost | 0 | (2) | (6) | (8) | (8) | (7) | (7) | (7) | (7) | (7) | (6) | (8) | (11) | (13) | (13) | (12) | (12) | (12) | (12) | (15) | (17) | (16) | (16) | (16) | (15) | (252) |
| Capital repayment | 0 | 0 | 0 | 0 | (1) | (4) | (5) | (5) | (5) | (5) | (5) | (5) | (4) | (4) | (5) | (8) | (9) | (8) | (8) | (8) | (8) | (8) | (10) | (11) | (11) | (137) |
| Taxation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (4) | (5) | (6) | (4) | (1) | 0 | 0 | 0 | 0 | 0 | (20) |
| **Total Cash Outflow** | **(54)** | **(74)** | **(42)** | **(164)** | **(167)** | **(169)** | **(169)** | **(167)** | **(166)** | **(164)** | **(216)** | **(235)** | **(200)** | **(312)** | **(311)** | **(315)** | **(315)** | **(368)** | **(385)** | **(347)** | **(369)** | **(372)** | **(377)** | **(380)** | **(382)** | **(6,217)** |
| **Net Cash Flow** | **6** | **1** | **(2)** | **5** | **5** | **1** | **0** | **0** | **1** | **2** | **(12)** | **0** | **(1)** | **10** | **10** | **4** | **2** | **(27)** | **0** | **2** | **6** | **5** | **3** | **2** | **2** | **25** |
| Cumulative Cash Flow | 6 | 6 | 5 | 10 | 15 | 16 | 16 | 16 | 17 | 19 | 7 | 8 | 7 | 17 | 27 | 31 | 33 | 7 | 7 | 8 | 14 | 19 | 21 | 23 | 25 | 25 |

# Annex D – Option B - Economic Analysis

| **Economic Projections** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | |
| **Capital expenditure** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Interconnector cable | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 489 |
| **Interconnection cable** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Basic Price of imported electricity | 0 | 0 | 0 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 266 | 269 | 272 | 275 | 277 | 4,020 |
| Maintenance Cost | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 90 |
| **Total cost of importation** | **0** | **0** | **0** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **113** | **226** | **226** | **226** | **226** | **226** | **226** | **226** | **273** | **276** | **279** | **281** | **284** | **4,110** |
| **Transmission** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transmission costs | 0 | 0 | 0 | 26 | 27 | 27 | 26 | 25 | 24 | 24 | 23 | 22 | 21 | 42 | 41 | 40 | 39 | 38 | 38 | 37 | 44 | 44 | 45 | 45 | 45 | 742 |
| Capital charge on smart meters | 0 | 0 | 0 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 17 | 17 | 17 | 17 | 17 | 293 |
| Retail costs | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 10 | 10 | 10 | 10 | 10 | 174 |
| **Total** | **0** | **0** | **0** | **44** | **45** | **45** | **43** | **42** | **41** | **39** | **38** | **37** | **35** | **68** | **66** | **65** | **63** | **62** | **61** | **60** | **71** | **71** | **71** | **72** | **72** | **1,210** |
| Residual Value of cable | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 318 | 318 |
| **Revenue** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Proportion of Economic activity | 0 | 0 | 0 | 1,366 | 1,432 | 1,456 | 1,465 | 1,475 | 1,485 | 1,487 | 1,488 | 1,507 | 1,508 | 3,020 | 3,023 | 3,025 | 3,028 | 3,030 | 3,032 | 3,033 | 3,647 | 3,720 | 3,795 | 3,871 | 3,948 | 54,842 |
| **Net Cash Flow** | **(54)** | **(72)** | **(36)** | **1,209** | **1,274** | **1,298** | **1,309** | **1,320** | **1,331** | **1,334** | **1,283** | **1,284** | **1,324** | **2,725** | **2,730** | **2,734** | **2,738** | **2,688** | **2,672** | **2,711** | **3,303** | **3,373** | **3,445** | **3,518** | **3,910** | **49,351** |
| **Cumulative Cash Flow** | **(54)** | **(127)** | **(163)** | **1,046** | **2,320** | **3,618** | **4,927** | **6,247** | **7,578** | **8,912** | **10,195** | **11,479** | **12,803** | **15,528** | **18,259** | **20,993** | **23,731** | **26,419** | **29,091** | **31,802** | **35,106** | **38,479** | **41,923** | **45,441** | **49,351** | **49,351** |

| | |
|---|---|
| **Economic Net Present Value (ENPV/C) of the investment (6.61%)** | **20,965** |

| | |
|---|---|
| **Economic Internal Rate of Return (ERR/C) of the investment** | **182.86%** |

# Annex E – Enemalta Full Cost Recovery Tariff

| Financial Projections<br>Full Cost Recovery Tariff<br>Year | 2009<br><br>0 | 2010<br><br>1 | 2011<br><br>2 | 2012<br><br>3 | 2013<br><br>4 | 2014<br><br>5 | 2015<br><br>6 | 2016<br><br>7 | 2017<br><br>8 | 2018<br><br>9 | 2019<br><br>10 | 2020<br><br>11 | 2021<br><br>12 | 2022<br><br>13 | 2023<br><br>14 | 2024<br><br>15 | 2025<br><br>16 | 2026<br><br>17 | 2027<br><br>18 | 2028<br><br>19 | 2029<br><br>20 | 2030<br><br>21 | 2031<br><br>22 | 2032<br><br>23 | 2033<br><br>24 | 2034<br><br>25 | Total<br><br>Y1-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital expenditure** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| New Delimara | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 54 | 72 | 36 | 0 | 0 | 0 | 0 | 0 | 489 |
| **Interconnection cable** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Basic Price of imported electricity | 0 | 0 | 0 | 0 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 111 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 266 | 269 | 272 | 275 | 277 | 4,020 |
| Maintenance Cost | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 7 | 7 | 90 |
| Total cost of importation | - | - | - | - | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 226 | 226 | 226 | 226 | 226 | 226 | 226 | 273 | 276 | 279 | 281 | 284 | 4,110 |
| **Local generating plant** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fuel cost | 159 | 192 | 192 | 158 | 44 | 41 | 41 | 45 | 49 | 54 | 62 | 69 | 75 | 84 | 3 | 12 | 16 | 20 | 25 | 28 | 31 | 2 | 2 | 2 | 2 | 2 | 1,248 |
| Wages and salaries | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 665 |
| Maintenance Cost | 7 | 7 | 7 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 267 |
| Depreciation - existing assets | 15 | 14 | 14 | 14 | 9 | 9 | 9 | 9 | 9 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 95 |
| Depreciation - new Assets | 0 | 0 | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 127 |
| Other expenses | 3 | 3 | 3 | 12 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 3 | 3 | 3 | 3 | 3 | 164 |
| CO2 costs | 0 | 0 | 0 | 0 | 14 | 14 | 14 | 15 | 17 | 18 | 21 | 24 | 26 | 29 | 1 | 2 | 4 | 6 | 7 | 9 | 10 | 0 | 0 | 0 | 0 | 0 | 232 |
| Other operating income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ROCE (existing & new Delimara) | 11 | 15 | 15 | 16 | 16 | 15 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 337 |
| Transmission & Distribution costs | 38 | 38 | 39 | 39 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 41 | 41 | 42 | 42 | 42 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 45 | 46 | 1,045 |
| Capital charge on new Smart meters | 0 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 420 |
| Retail costs | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 250 |
| Less cost of inefficiencies | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Less cost of subvention and PSO | (8) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (5) | (125) |
| **Total cost of electricity** | **254** | **311** | **311** | **298** | **319** | **316** | **316** | **322** | **329** | **336** | **339** | **350** | **359** | **372** | **369** | **382** | **389** | **397** | **405** | **411** | **417** | **422** | **426** | **430** | **434** | **438** | **9,198** |
| Residual Value of Cable | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 318 | 318 |
| **Revenue from tariffs** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electricity tariffs | 254 | 313 | 309 | 306 | 304 | 301 | 299 | 308 | 317 | 327 | 339 | 351 | 365 | 378 | 391 | 402 | 412 | 422 | 432 | 439 | 446 | 453 | 456 | 459 | 462 | 465 | 9,709 |
| **Net Cash Flow** | | (53) | (74) | (28) | 1 | 2 | (1) | 2 | 5 | 7 | 17 | (37) | (51) | (13) | 38 | 37 | 39 | 42 | (10) | (28) | 9 | 47 | 46 | 45 | 44 | 362 | 451 |
| **Cumulative Cash Flow** | | (53) | (127) | (154) | (153) | (151) | (152) | (150) | (145) | (138) | (121) | (158) | (209) | (221) | (183) | (146) | (106) | (65) | (75) | (103) | (93) | (46) | (0) | 45 | 89 | 451 | 451 |

| | |
|---|---|
| **Financial Net Present Value (FNPV/C) of the investment (6.61%)** | **0** |
| **Financial Internal Rate of Return (FRR/C) of the investment** | **6.61%** |
| **Full Cost Recovery Tariff** | **0.1460** |

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sliding scale tariff** | **0.1571** | **0.1555** | **0.154** | **0.1526** | **0.1513** | **0.150** | **0.1489** | **0.1478** | **0.1468** | **0.1458** | **0.1449** | **0.144** | **0.1432** | **0.1424** | **0.1417** | **0.141** | **0.140** | **0.140** | **0.1392** | **0.1386** | **0.1381** | **0.1376** | **0.1371** | **0.1367** | **0.1363** |

# Annex F – Letter from Regulator regarding Financial Return on Investment

MRA

MALTA RESOURCES AUTHORITY

6th June 2009

The Chairman
Enemalta Corporation
Church Wharf
Marsa

Dear Chairman

RETURN ON INVESTMENT

This is to confirm that the Malta Resources Authority finds a Rate of Return on Investment of 6.61% for the submarine electricity interconnector project acceptable.

Regards,

A. Riolo

Antoine Riolo
Chief Executive Authority

Millennia · 2nd Floor · Aldo Moro Road · Marsa · LQA 06 · Malta