United Nations
Environment
Programme

UNEP(OCA)/MED WG.49/5
13 May 1992

Original: ENGLISH

MEDITERRANEAN ACTION PLAN

Third Meeting of the Task Team
on Implications of Climatic Changes
on the Island of Malta

Valletta, 18-20 May 1992

IMPLICATIONS OF EXPECTED CLIMATIC CHANGES ON THE ISLAND OF MALTA

CLIMATE CHANGE AND ENERGY USE IN MALTA

by

J. Cachia

UNEP
Athens, 1992

Abstract

This report reviews the energy supply and consumption patterns and the associated carbon dioxide emissions for Malta. The data have been analysed principally for the period 1st October, 1987 to 30th September, 1988. Procedures leading to the more prudent use of resources as well as the protection of the environment are discussed.

Introduction

To recap on previous conclusions, energy activity accounts for 75% of the cause of the greenhouse phenomenon. CO2 on its own is the single largest determinant of the climate change problem.

Energy Activity

25 %	Miscellaneous human activities: agriculture, industry, etc.
25 %	CO, N_2, O, NOx, etc.
75 %	CO_2

Much has been written about the cause of the climate change phenomenon. It is well established that anthropogenic CO2 emissions released into the atmosphere during energy conversion processes are the major cause of the climate change phenomenon.

Between 1958 and 1984 CO2 concentrations in the atmosphere increased by 90% reaching a concentration of 20-25% above the level of pre-industrial times.

The ability of the forests and the oceans to absorb this increase in CO2 concentration, if at all possible, is not yet clear.

Reducing CO2 emissions associated primarily with energy activity is a major response strategy to the climate change phenomenon.

Rather than discuss the effect of energy conversion on climate change, this paper outlines possible future impacts which a changing climate may have on energy activity in Malta. First on energy overview for Malta is presented.

Changes in the climate are expected to have an effect on energy demand in one way or another in the provision of electric lighting, space heating and space cooling.

	SO_2	CO_2
DOMESTIC	29.3 %	24.6 %
COMMERCIAL	33.5 %	22.0 %
INDUSTRIAL	34.2 %	23.7 %
TRANSPORT	3.0 %	29.7 %

Primary energy use in Malta

During the considered year, 841793 Tce of primary fuels were used in Malta (see Table 1 and Fig. 1). (Throughout this report, the energy consumptions on the sister island of Gozo are included in the figures for Malta).

Fuel, oil and coal are consumed primarily in the electric power generating station and a relatively small percentage for sea water distillation. Jet Al is used as aviation fuel, whereas petrol is employed mainly for private vehicles in the domestic sector. Diesel fuel and gas oil are used in all sectors: the data in Table 1 include sales to vessels calling at Malta. "Light" fuel oil tends to be demanded primarily by the commercial and industrial sectors, and liquefied petroleum gas (1pg) mainly by the domestic market (see Fig. 2). Kerosene is used in the domestic sector and as a diesel fuel supplement by omnibus owners.

						CO_2	SO_2
COAL	25 %		DOMESTIC	24 %		25 %	DOM. - 29 %
FUEL OIL	40 %		COMMERCIAL	22 %		22 %	COMM. - 34 %
PETROL	9 %		INDUSTRIAL	25 %		23 %	INDUS. - 34 %
DIESEL	10 %						
GAS	3 %		TRANSPORT	29 %		30 %	TRANS. - 3 %
KEROSENE/JET A1	13 %						

Fig.1 Fuel consumption by type and sector and CO2 and SO2 emissions by sector

Energy conversion

Electricity is the most convenient form of delivered energy available. The industrial, commercial and domestic sectors in Malta (and Gozo) employ electricity as their main energy supply. Until recently, electricity was generated at a single power station, the output capability of which has been increased progressively to the present level of 260 MW. A new power station is under construction and will eventually replace the former one.
The distribution of the electricity is achieved via a two-tier transmission system at 33 and 11 kV: the service supplies are at 240V, 50 Hz single-phase and 415V, 50Hz three-phase.

Even when there is adequate demand for electricity at the charged tariff, full output generation from the thermal power plants is not realised anywhere in the world. In Malta, the average electricity plant load factor is only approximately 40%. The crude oil crises of the 1970's encouraged the use of coal as an oil substitute for electricity generation. So, during the 1980's, boiler plant, with dual oil or coal-firing, was installed at the power station. However, the production of ash, as a residue of the coal-burning process, has led to disposal problems: environmentally-sustainable uses for this "waste" could be as a constituent in a road repair concrete and as a building material.

Table 1

Figure 2

Electricity consumption has grown, on average, by about 8.5% per year recently in Malta (see Fig. 3), leading to a power demand of 190 MW during the winter of 1988. There are about 160 000 registered consumers connected to the national power grid (for a total population of ~345 000 and a stock of ~130 000 buildings). The average annual consumption per capita for electricity and primary fuels are approximately 3000 kWh and 2.4 Tce respectively.

Annual CO_2 emissions per capita: electricity - ~3.5 T
other fuels - ~2.0 T

Continuing economic development appears likely to sustain the high growth rate for electrical power for at least the next decade.

Table 2

Mean Efficiencies of Thermal Power Stations in 1980 (2-4)

Country	Thermal Efficiency (%)
Federal Republic of Germany	38.6
Netherlands	38.6
USSR	37.5
Italy	37.3
Japan	36.3
Indonesia	35.3
France	35.1
Hong-Kong	34.5
UK	34.1
USA	32.5
Malaysia	30.0
Iran	27.5
Sri Lanka	26.2
India	25.9

Conversion efficiencies exceeding 30% can be achieved with conventionally fired thermal power stations (see Fig. 4 and Table 2). With fluidised-bed combustors and integrated combined-cycle power plants, this efficiency can be greater than 36%. The use of two multi-stage fluidised beds for burning those combustible components - which are not easily recycled - of domestic, commercial and industrial refuse deserved to be contemplated for the new power station. (Each bed would probably incorporate a reciprocating grate to facilitate the removal of ash and other non-combustible residues). Burning the refuse in this manner would make a positive contribution to reducing the greenhouse effect, because it avoids the refuse being buried, decaying there and methane being evolved into the environment and so contributing to the greenhouse effect. Also, by using these new technologies, more complete combustion can ensue and so the CO_2 emissions will be reduced.

Electricity generation

During the year 1st October, 1987 to 30th September, 1988, 307 307 Tce of fuel oil and 215 691 tonnes of coal were imported into Malta and used in the power station to generate 309.93 GWh of electricity. Thus, 522 998 Tce of the 841 793 Tce imported into Malta was so used, i.e. 62% of the total imported primary fuel.

Figure 3

Figure 4

Electricity generation accounts for 63% of CO2 emissions and 90% of the SO2 emissions. Improving the generating efficiency would reduce these figures appreciably. This can be achieved by improving "house keeping" standards at the power station and by introducing a time-of-use tariff structure, thereby displacing demand peaks. It is estimated that these measures could increase the generating efficiency up to 30%. As a result, CO2 emissions would be reduced by 820 514 T (29%).

Generating efficiency

During the considered year, electricity was generated (at the power station as a result of burning the fuel) at the rate of 1.74 MWh/Tce. Assuming a mean calorific value for coal of 29.6 MJ/kg, then the average generating efficiency throughout the year was (1.74 x 3.6 x 10(3) x 10(2)) / (20.6 x 10(3))%, i.e. 21.2%. So approximately 79% of the imported primary fuel used in the power station served no useful purpose - the "wild" heat being lost as pollution, e.g. via the exhaust combustion gases, such as CO2, through the flue to the environment. Thus, due to inefficiencies in the power station, at least 79% of the 62% of the primary fuel imported into Malta, i.e. 49%, served no useful purpose, and simultaneously created an environmental problem (e.g. contributed to global warming).

Considering the lack of energy efficiency in a number of sectors, future increases in energy demand by the end user could be offset by increasing efficiency of energy conversion and eliminating waste.

From the economic point of view, energy conversion could be considered an energy source in itself. Experience elsewhere has shown that it is more cost effective to increase energy supply by resorting to energy conservation measures rather than by investing in additional generating plant.

Financial and loss considerations

It is believed that 909.93 - 735.13 = 174.8 GWh (i.e. 19%) of the electricity leaving the power station was not accounted for, primarily due to line losses (resulting from inadequacies in the transmission and distribution systems), inaccurate metering and pilferage (Table 4). During the previous year, the corresponding figure was 23% (see Table 5). Such financial losses must be reduced significantly by reducing leakages and more accurate measurements of the electricity used by each individual customer, and then identifying exactly where the losses are occurring. However, the authority to disconnect such an essential service from an individual customer, in the event of theft being revealed, should not be given to a monopoly utility without restraint. That restraint must strike a balance between the consumer's justifiable interests in remaining connected to such a lifeline service and the state's interests in being paid for the supply.

Electricity consumption by sector

A breakdown of electricity consumption by sector is presented in Table 7. Figure 5 indicates the annual electricity consumption trend by sector.

Energy consumption by sector

This is given for the year 1st October, 1987 to 30th September, 1988 (see Fig. 1).

For transportation

Transportation accounts for 29% of the primary fuel consumption in Malta.

In buildings

This consumption occurs in the domestic, commercial and part of the industrial sector (Table 9).

Table 4

Table 5

Table 7

Table 9

Figure 5

For operations within domestic and commercial buildings, 24.4% and 22.0%, i.e. in total 46.4% (= 390 000 Tce) of the primary fuel imports to Malta are used. Principally for achieving comfort in buildings used by industry, at least 5% of the total primary fuel imports are employed: this figure is likely to grow because of the increasing use of air-conditioning plants in factories. Thus the building sector is the largest single consumer of energy, and is responsible for more than half of the national fuel expenditure. Over 80% of this energy delivered to buildings (i.e. for heating, cooling, lighting and operating appliances) is in the form of electricity. The base-load requirement imposed on the power station occurs during the summer and the peak demand (which is generally underestimated) ensues in the winter (see Fig. 6), i.e. the pattern of electricity consumption can be seen to be dependent upon the ambient temperature.

A second demand peak appears in midsummer attributed to air conditioning load. This peak is increasing from one year to the next.

Building sector

During the period October, 1987 until September, 1988, the built environment accounted for 956 174 (51.6%) T CO_2 emissions and 11 790 (67.8%) T SO_2 emissions.

These emissions are associated with space heating and cooling, artificial lighting and the use of appliances.

The heating and cooling demand in a building as well as the need for electric lighting can be reduced by taking the necessary measures during the architectural design state. The use of energy efficient appliances and lighting will further reduce electricity consumption and electricity demand delaying the necessity to invest in additional generating capacity.

Energy Intensity

The relationship between GDP and electricity consumption - electricity is the predominant form of delivered energy used in Malta - provides a clear indication of the energy intensity of the country's economic activity.

Electricity intensity expressed in GWh/LMmn (Gigawatt hours per million Maltese liri) is presented in Figs. 7 and 8. In Fig. 7, electricity consumption in all sectors is taken into consideration while in Fig. 8 only that part consumed by the industrial sector is considered. The trend in both instances is similar.

For the four year period between 1983 and 1987, electricity intensity per unit of GDP increased annually and is unlikely to level off for years to come.

Up until some years back, industrial growth was inconceivable unless accompanied by a corresponding increase in energy input. In the past two decades or so the energy intensity in OECD countries has declined by 3% per annum.

Water Production

More than half of Malta's daily drinking water supply, amounting to nearly 12 mn gallons, is produced by reverse osmosis desalination of sea water. The production of water by this method accounts on average for 20% of Malta's electricity supply.

Electric Lighting

Meteorological records for the past seventy years indicate a trend in decrease in the number of bright sunshine hours in Malta. Generally speaking, this would result in a decrease in available natural daylight levels. However, it is not yet clear whether the decrease in the number of bright sunshine hours is restricted to a particular time of day or season during the year. In the long run, it would seem that the use of artificial electric light would increase.

Figure 6

Figure 7

and 8

Space Heating and Cooling

During the winter, the predicted average temperature increase would theoretically reduce the need to provide artificial heat and thereby save energy. However, considering the low thermal performance of the building stock in Malta and the fact that only certain zones of most buildings are heated and then intermittently, in practice, an increase in ambient temperature may lead to more thermally comfortable building interiors rather than to a saving of energy.

The foregoing pertains to domestic buildings. In the commercial and industrial sectors, the internal heat gains are much higher (due to the use of computers and machinery). An ambient temperature increase in instances may constitute a cooling load to be satisfied by increasing ventilation and possibly the extension of the air conditioning season.

Having said this, Malta weather records also indicate a drop in the extreme lowest temperatures over the past seventy years.

Whatever the case, the introduction of thermal insulation to the building envelope reduces both the heating demand in winter as well as the cooling demand in summer.

It is to be borne in mind that people not buildings consume energy and that the sensation of thermal comfort is very much a subjective matter. It is incorrect to conclude outright that a change in the ambient air temperature is to be reflected in a similar change in energy consumption.

Renewable Energy

The necessity to incorporate more renewable energy sources in the world energy structure was, rightly so, recommended by the Brundtland Commission. Our Common Future (1987), The World Commission on Environment and Development.

The displacement of fossil fuels by renewable energies particularly lbiomass and hydropower prevent a substantial CO_2 emission. In Malta, there exists a good potential for resorting to solar energy, particularly in those applications where low to medium grade heat is required. The possibilities of harnessing wind energy on a large scale are more restricted - wind energy is widely used for water pumping in agriculture.

Solar Energy

Solar energy flow can be regarded as a very large energy resource which in principle can supply all energy needs of mankind.

The amount of solar energy incident on the Maltese Islands in one year is five hundred times greater than the annual electricity consumption. However, a solar thermal electricity generating plant working at 20% efficiency would require 10% of the available land area to supply this quantity of energy.

Passive solar energy use in buildings whereby a building's orientation, window sizing and fabric are designed in order to optimise the use of solar energy for space heating, cooling, lighting and ventilation can considerably reduce building energy demand. The built environment is the single most energy intensive sector in Malta.

The decreasing trend in the number of bright sunshine hours in Malta amounting to 3.1% over the past seventy years can restrict in future the application of solar energy in those instances where direct solar radiation is required.

Another economically and technically viable solar energy application is for water heating. The widespread use of solar water heating systems in the domestic sector could reduce Malta's annual energy bill by up to 3%. Once the availability of solar radiation is reduced, the economical feasibility of this application is less attractive.

Concluding Comment

In conclusion, it seems that the predicted changes to the climate in Malta would increase the use of electric lighting, increase the demand for mechanical air conditioning and reduce the extent to which renewable energies could be utilised.

It would be presumptuous to present more specific predictions at this point in time and based on the data which were available.