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REPORT OF THE HELLENIC ENERGY ACTION PLAN FOR ATHENS 2008

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CONTENTS

1. INTRODUCTION:

Concerns about the global and national aspects of energy policy and their effects on the environment are growing in importance. The global challenge of the future will be to ensure that economic growth, efficient and secure energy supplies and a clean environment are compatible objectives. Energy policy, therefore, will be a key factor in the achievement of sustainable development.

The Hellenic Government is fully aware that a long term strategy for energy policy must be devised. Programmes to develop an energy strategy must therefore be developed.

Due to the need for a drastic reduction in the deficit of the governmental budget, funds are severely limited at the moment. Greece does not have the necessary resources to finance large scale programmes and has to be selective as regards both the nature of the projects to be undertaken and their geographical distribution. Long term programs have tended to be the exception in the past though this is gradually changing. Short term project are very often in response to emergencies, therefore planning in this respect tends to be in general terms, leaving a lot of room for adjustments to current needs while continuing to take into account existing priorities.

2. NATIONAL ENERGY POLICY:

In accordance with European Union policy, the Hellenic Government initiated the following Action Plans for the best use of energy:

A) The Hellenic Action Plan for the Abatement of CO_2 and other Greenhouse Gas Emissions. This plan is based on:

- a policy of drastic energy conservation in all sectors of final consumption (industry, transport, commercial and domestic sector)
- the use of natural gas in the national energy production system
- the promotion of renewable energy sources.

B) The Energy Program (1994-1999) launched by the Ministry for Development promotes energy efficiency, rational use of energy, use of renewable energy sources and the use of natural gas and is funded by the EU (budget : 620 million $).

The introduction of natural gas in the national energy production system is a major infrastructure project. According to the program of the Public Gas Corporation, the total consumption of natural gas will reach 3,5 billion m^3 by the year 2005 (1,5 billion m^3 for electricity generation, 1,0 billion m^3 for industrial uses and 1,0 billion m^3 for needs of domestic of the other sectors).

3. HELLENIC ACTION PLAN: ‘ATHENS 2008’

The Hellenic Action Plan named ‘Athens 2008’ intends to change the existing production and consumption patterns through the use of environmental friendly energy sources, the improvement of the quality of the environment and the efficiency of existing technologies such as best available technology and best available control technology (B.A.T. and B.A.C.T.) and services. It also aims at energy conservation, promotion of Rational Use of Energy (R.U.E.) and the integration of renewable energy technologies.

The “Switch Off!” Scheme:

The scheme entitled Switch Off! is to encourage R.U.E. incorporating all social groups. Switch Off! will be an integral part of the governments future energy plans, and will be widely promoted with environmental awareness as a priority. The principles and benefits of energy conservation will be stressed during the programme which will receive extensive governmental funding. This scheme will not only lead to a heightening of environmental awareness but to an increase in employment opportunities through the development and implementation of the programmes.

4. PUBLIC POWER CORPORATION POLICY:

In this context the Public Power Corporation is applying specific actions for environmental protection and improvement of energy efficiencies including:

1. commission of natural gas generating units;
2. exploitation of renewable energy sources (wind, geothermal and solar energy);
3. energy conservation and improvement of efficiencies of existing installations;
4. energy recovery from incineration process and landfill;
5. awareness raising programme for energy saving and rational use of energy.

5. THE KERATSINI POWER PLANT CASE

5.1 Introduction

The Keratsini power plant was constructed during the 1930's and consisted of 5 small units of power generation fuelled with oil. In the 1950's these units were shut down and became non-operational and were replaced by four other units (6,7,8 and 9). At present, only units 8 and 9 are fully operational fuelled with oil. During the last 60 years, Athens has experienced a massive process of urbanisation and the Keratsini area has become a district of the city of Athens.

5.2 Present Situation

The fact that the power plant of Keratsini is now situated within a densely populated area has raised complaints from the local inhabitants due to the visual, odorous, noise and other supposed health impacts.

The power plant, on the other hand, claims that their emissions are below the levels of the standards of pollution stated by the government. Therefore they can't change the current situation unless they shut down the plant and move elsewhere.

These problems are combined with the current national policy on energy which focuses on energy conservation, the reduction of greenhouse gas emissions and renewable energy sources. Political pressure from the European Commission and the Hellenic Government is currently in progress towards the use of more efficient and environmentally friendly fuels (e.g. natural gas) in power plants.

This has led to a study of the current situation of the Keratsini power plant and the future possibilities for this important energy source for Athens (as it covers half of the energy demand of Athens).

In order to evaluate the Keratsini case the National Government did the following:

1. Risk assessment (ANNEX III);
2. Evaluation of the costs of each measure (ANNEX II);
3. Identification of the alternatives (ANNEX II);
4. Quantification of external costs (ANNEX III);
5. External costs monetary valuation (ANNEX III).

5.3 Governmental Decision-Making Process

As a result of the Cost Benefit Analysis based on the following steps:

1. Goal specification: air quality improvement;
2. Scenarios definition;
3. Cost of meeting each scenarios estimation;
4. External benefits evaluation;
5. Social awareness campaign: R.U.E;
6. Monetary values conversion.

The Hellenic Government acknowledged that the Keratsini power plant should be considered as an integral part of the national energy production system. The government realised that the decision to be made, although at a local level, had global implications. The ‘Athens 2008’ project (as outlined in 5.4) was developed according to this strategy.

5.4 Future of the Keratsini plant

After having assessed the costs of running the existing plant on oil for the next 20 years the government considered a future programme for the Keratsini power plant based on a cost benefit analysis of ‘Athens 2008’. The cost of the programme was found to be far more economic and sustainable than the cost of keeping the facility as it is. This information can be found in Table 1 in ANNEX II.

Conversion from1998-2003:

Unit 8 will be converted to natural gas enabling it to produce up to 200 MW after 5 years. During this time unit 9 will remain as an oil burning unit producing around 200 MW. Renewable energy sources will be promoted during this period with their anticipated contribution to the national energy network being between 5 and 15%. The cost of these measures can be found in Table 2 in ANNEX II.

2003-2008:

By 2003 unit 8 will be fully converted to use natural gas, it will operate at a capacity of 200 MW. During this period unit 9 will remain as an oil burning unit but will function solely in a stand-by capacity. By the end of this period renewable energy resources will account for 15% of the total energy required. The cost for this time period can be found in Table 3 in ANNEX II.

2008 and beyond:

Implementation of rational energy use techniques will have reduced the energy required from Keratsini from the 1998 level of 360 Mw to 300 MW. These 300 MW will be provided by unit 8 (200MW) and renewable sources (100 MW). By this point unit 9 can either remain as a stand-by system or can be used to provide for any unforeseen energy requirements.

Details of the construction, anti-pollution mechanism, cost of fuel, renewable energy implementation costs and rational use of energy schemes can be found in ANNEX II as well.

6. FINANCIAL MEASURES

The priorities for the national policy on energy are to reform:

- the system of subsidies and to support innovative technologies to reduce the cost of the conversion towards more sustainable energy sources;
- the system of financing (public investment, subsidies, local taxes) for carrying out of infrastructure works for energy conservation and the energy sources;
- the protection of natural resources to avoid their exhaustion, destruction and pollution, along with their rational use, by expanding current programmes for special planning studies and achieving the institutionalisation of these programmes.

Energy Tax Initiatives:

The Hellenic Government proposes the adoption of extensive tax reforms believing them to be effective instruments for the internalisation of externalities such as environmental impact through economic activity. These externalities are so called because their cost is not considered to be part of the prices paid by producers and consumers involved in economic activity.

A major concern when formulating these policies was that any tax should have no negative effect on competitiveness, employment or specific sensitive groups or regions. The tax reform will be based on:

- in-depth evaluations of target areas.
- revenues collected to guarantee the finance of environmental and social projects. This will give tax payers confidence that their money is being used in the way that they expected.
- incentives for companies investing in ‘green technology’ and moving towards environmentally friendly operations.

The energy tax can be outlined as follows:

- CO_2 emission license. Once an annual CO_2 budget for the country has been decided, licenses to emit CO_2 will be sold to industries. Emission trading will also be possible if necessary. The government will reduce the amount of CO_2 emissions permitted annually by 1.5-2%.
- SO_2 tax on industry and transport. This will take the form of a 5% increase in the price of high sulphur fuels. Incentives will be given to those wishing to convert to low sulphur fuels.
- NO_x reduction will be achieved through incentives for NO_x reducing technologies and NO_x free chemical substances (fertilisers).

These tax measures will be part of a revolution in the tax system of Greece. Whilst taxes on energy consumption and emissions will increase, the taxes on labour will be reduced to maintain competitiveness. This will act to change the focus of revenue collection.

This is part of Greece’s response to appeals by European Union in order to alleviate the suffering caused by natural or man-made activities.

Annex

Annex I

Annex II

<u>ATHENS 2008</u>

Keeping the existing situation as it is for the next 20 years :
UNIT 8 + UNIT 9 Oil 360MW
Cost :
Anti-pollution : SCR (70% efficiency) 50$/KWx360.000KW=18M$
Fuel : an estimation of 18M$/Yrx20=360m$
Operation : 2% of Construction cost 0.2x455M$x20=182M$
+ High External Costs.

Construction Anti-pollution SCR	18M$
Fuel	360M$
Operation	182M$
TOTAL	560m$

Table 1

<u>1998 - 2003</u>
UNIT 8 convert to Natural Gas (N.G.) in 5 years 200MW
UNIT 9 Oil 200MW
Renewable Energy Source (R.E.S) min 5% of electricity capacity 15% max.
Cost :

Construction : N.G. convert	40M$
Gas recirculation	5M$x2=10M$
Fuel : Oil	40M$*
Operation : Unit 9	10M$
Gas recirculation	2M$
R.E.S 5%	46m$
External cost	1M$
Rational use of Energy R.U.E	
TOTAL	149M$

Table 2

<u>2003 - 2008</u>
UNIT 8 convert to Natural Gas (N.G.) 200MW
UNIT 9 Oil (200MW stand by)
Renewable Energy Source (R.E.S) 15% by 2008.
Cost :

Fuel : Oil (5years)	40M$*
: Natural gas (40years)	99M$*
Operation : Unit 8 N.G. (40years)	80M$
Unit 9 Oil (5years)	40M$
Gas recirculation	2M$x2=4M$
R.E.S 15%	150M$

External cost	5M$
Rational use of Energy R.U.E	
TOTAL	420M$

Table 3

CONSTRUCTION COST

Convention 2003 : capacity 200MW N.G.
500$/KW → construction + installation

2003 —convert oil to gas→ UNIT 8 200MW → 100M$ → 40M$ infrastructure
→ 60M$ building

ANTIPOLLUTION

Filters	Efficiency	Cost	Operation Cost
Gas recirculation	N.G. 65%	$25/KW	10K$/year
	Oil 40%		
SNCR	45%	$12/KW	50K$/year
SCR	N.G. 80%	$100/KW	10%year of the cost
	Oil 70%	$50/KW	

Cost :

SNCR : 12KW/year x 200.000KW=2.4M$
operation 50.000$ x 40years=2M$

SCR : 100$/KWx 200.000=20M$
operation 2M$/year x 40=0.4M$

Gas recirculation : 25KW x 200.00=5M$
operation 2M$/year x 40= 0.4M$

proposed anti-pollution measures:
we are suggesting gas recirculation because is more efficient.

COST OF FUEL

1. The cost for oil and natural gas is been considered as equal.
2. -10% reduction of the cost every year, because of the standard price of the gas for the next 20 years due the contract with Russia.
3. While estimates of fuel cost are certain for the first 20 years the subsequent 20 year costing relies on a projection of estimated future fuel prices.

RENEWABLE USE ENERGY SOURCES (R.E.S)

TERRES 2020 (7-14)%
potential 20% for Greece

capacity for Greece : 890 KW/capita=890MW

TARGET : 2008 15% of the new capacity
decreased by implementation of Rational Use of Energy R.U.E.
the real target is (12-13)%.

Demonstration actions + Promotions :

1. **wind-farms on islands** (recontribution of energy)

1 unit wind turbine 1MW 48% ⟶ 0.5MW
2 wind-farms x 5 turbines = 5MW
1000ECU/KW 5000x1000=5MECU

subsidies 40% ⟶ 2MECU the cost for the government

2. **F.V. in public buildings + housing**

F.V. module 55W/0.5M2 max. 30 years lifetime

public buildings : 50 in Athens
50 in other Greece
hotels : 100

500M2 each of them 500M2 x 200 x 110W= 11MW
around 5ECU/WATT x 2= 10ECU/WATT
11MW x 10 = 110MECU support 40% by the government = 44MECU

housing ⟶ 1000 houses
12M2 ⟶ 24 module ⟶ 1200Watt
1200W x 1000 = 1.2MW
1.2MW ECU x 0.82 = 0.14MECU
-18%VAT

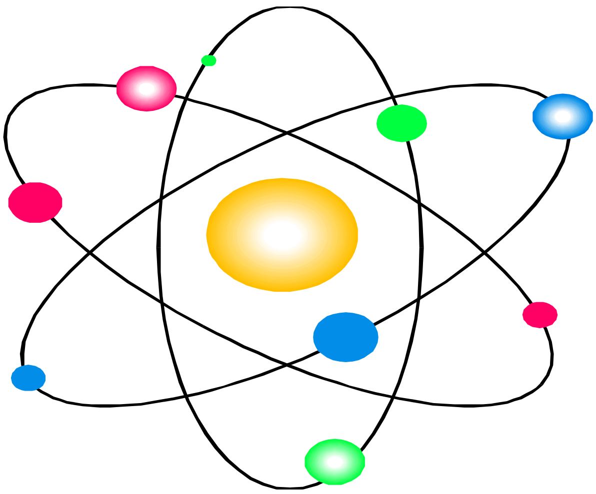
3. **solar collectors**
already developed but we suggest subsidies to support the existing industry.

RATIONAL USE OF ENERGY

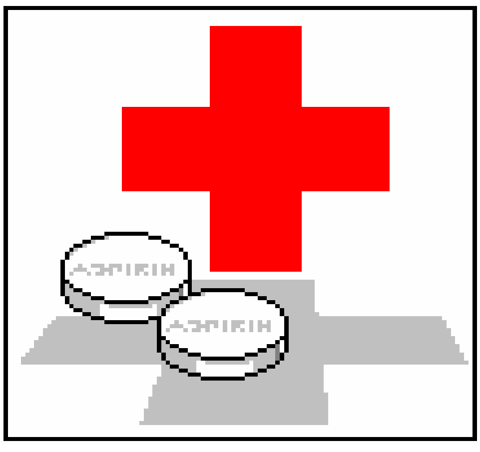
Demonstration actions + Promotions :

1. Insulation : -18%VAT new regulations by year 1999 (by E.C. policy)
2. Rational cooling - Ventilation
3. Mechanical ventilation (heat recovery systems - buried tubes) in new buildings
4. shading : decrease 18%VAT to public buildings

Annex III



Risk Assessment



Contents:

1 Hazard identification

The hazards identified due to the Keretsini power plant are the following:

1 Visual impact (damage to buildings)

2 Health impact

3 Odor

4 Noise

5 Health impact

6 Water pollution

7 Damage to ecosystems

The only quantifiable hazards that we studied was SO_2 and NO_x concentrations arising from the emissions of the power plant.

The study we carried out was based on SO_2 and NO_x concentrations over the Athens area arising from the plant.

We used the worst case scenario to determine the damages because of the difficulty to quantify the cost of the damages to the historic buildings , water pollution and noise.

2 Exposure assessment

To determine the exposure we evaluated the highest air ground concentrations of SO_2 and NOx according to the Gaussian model. According to the statistical distribution of the wind we evaluated the distribution of the most likely highest emissions in Athens. We took this concentrations and by means of the statistical coefficient for mortality we determined the cost of the damages caused by the gasses emitted from Kerastini power plant, this obviously is an overestimation.

2.1 Exposed area and population

The Athens population consisting of 1442800 inhabitants came from the areas indicated in the table. This population will be affected from the Keratsini power plant emissions.

ATHENS	POPULATION
keratsini	91800
Niokea Dapetsona	100000
Koridalas Perame	87000
Piraeus	196000
Moshato Mullitea	60000
Peristeri	500000
Haidari Renti Aegaleo	300000
Nea Liossia	80000
Ag. Barbara	28000
TOT	1442800

2.2 Dispersion Model used

In order to evaluate the concentration of different pollutants coming from the Keratsini plant we used the Gaussian diffusion model described by this differential equation

1)

where f represents the concentration of the pollutant.
We are going to consider a particular solution of this equation (Ranchoux solution) that will represent the maximum concentration of the pollutant at the ground level.

2)

u_s = mean wind velocity above the stack
Qs = gas rate emissions above the stack
H = the height of the stack (h) + the height of the plume above stack ΔH
b, c, d, e = parameters as function of the atmospheric stability class.

In order to evaluate the concentration we need to determine ΔH in advance; we used the following formulas:

3)

where
ΔH = plume rise above stack exit
v = stack exit velocity
D = stack i.d.
u_s = mean wind speed at stack height
P = atmospheric pressure
ΔT = difference between stack temp. and ambient temp.
K = function of atmospheric stability factors

Ts = stack temperature

and the velocity at height plume

4)

where

ug = wind speed at ground level
h = height of the stack
h_g = height of the ground level
a = exponential parameter due to the atmospheric stability factors

After consulting reference tables with Atmospheric stability factors and the values of the b, c, d and e constants depending on the atmospheric stability class we established the maximum concentration of pollutants at ground level.
In order to obtain the horizontal position of the maximum concentrations we evaluated the z width of the plume with the following formula:

5)

and then we consulted a graph indicating the downwind distance of the maximum concentration of the pollutants from the source.
The results of this method for the emissions of the Keratsini power station over the Athens region are indicated in the following section.

2.3 Data and calculated pollutant concentration

We are presenting all the results obtained from the dispersion model according to the different stability classes, and the different scenarios chosen.(OIL, NG, NG+NT).
We also plotted the Oil power plant emission for the most important stability categories, depending from the wind speed.

2.4 Distribution of the pollutants over the affected area

To determine the distribution of the highest concentrations of gasses at the ground level we kept in account the following statistical distribution table of wind and speed. By means of the Gaussian model we could plot the concentrations of the gasses in the map of Athens. We evaluated the distribution for Oil, NG, NG + GT power plant scenarios.

3 Health damage assessment and evaluation of costs

The noticeable increase of the incidence of respiratory diseases and complaints of eye irritation, scratchy throat and aggravation of Asthma at the medical centers around the Keretsini plant, created great concern.

This caused the government to introduce an investigation with reference to the pollution levels emitted from the plant, and the health damage caused by it.

To determine the cost of the damage caused by air pollution, the following information is required:

1 Type of pollutants
2 Dose-response function for each effect
3 Economic value of each effect

The health damage is the dollar value of the health effect for each pollutant.

The measuring units for the damage is either a day of illness or a human health [statistical risk of dying]

The formula used to determine the cost of the annual mortality due to air pollution is as follows. $\Delta D = \alpha \Delta C$

The coefficient for SO_2 (0.062) and NO_x (2.4 annual) was obtained from the Time-Series study 1995 and Nelson, Knelson and Hasselblad - Air pollution health effects estimation model respectively.