NUCLEAR POWER AND ENERGY NEEDS OF GREECE

Presented at

The Nuclear option for SE Europe

A Workshop Organized by
the Institute of Energy for South East Europe (IENE)

By

Dr. Ioannis A. Papazoglou

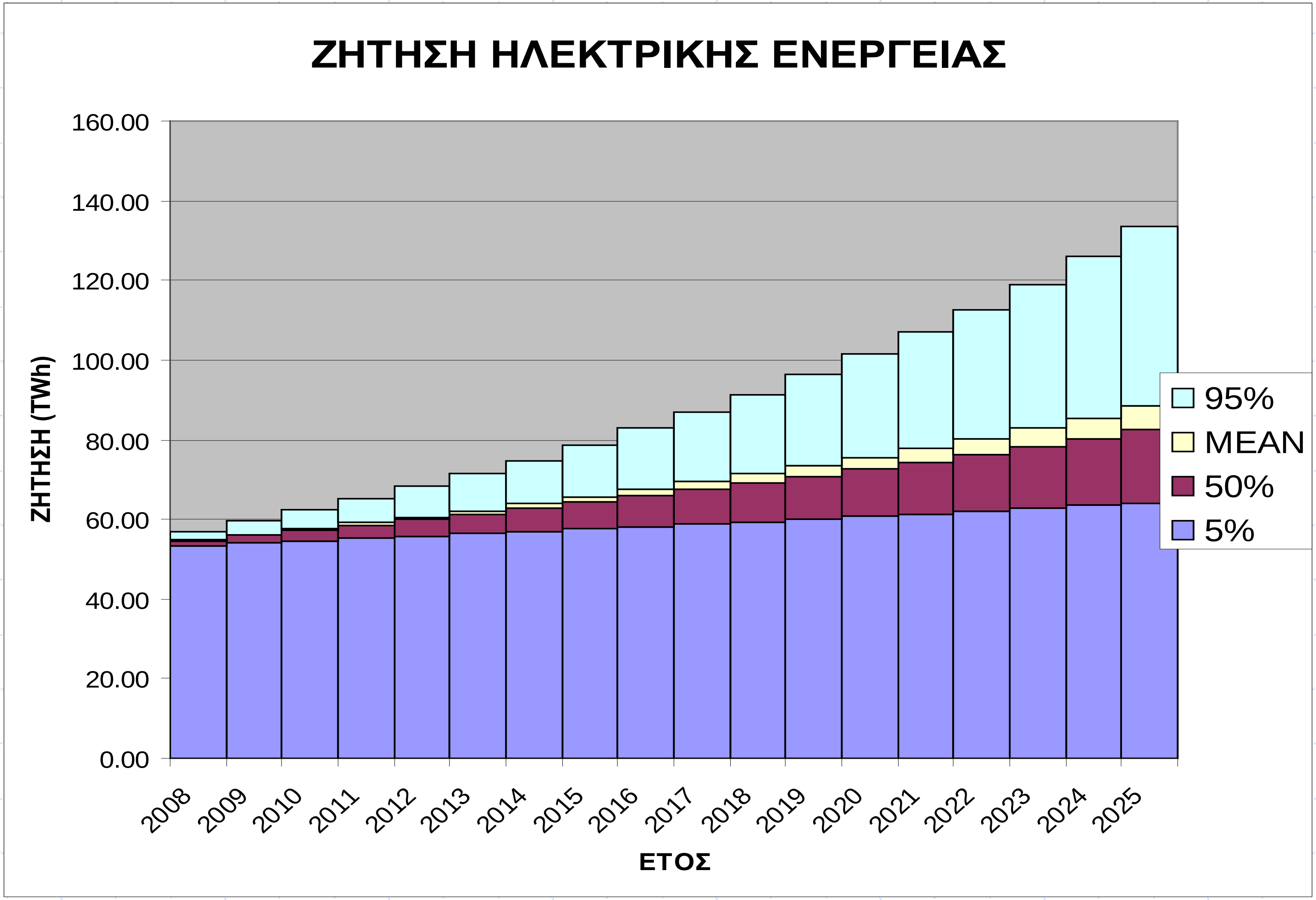
Institute of Nuclear Energy-RadiationProtection
National Centre for Scientific Research «DEMOKRITOS»

Sofia, May 19, 2009

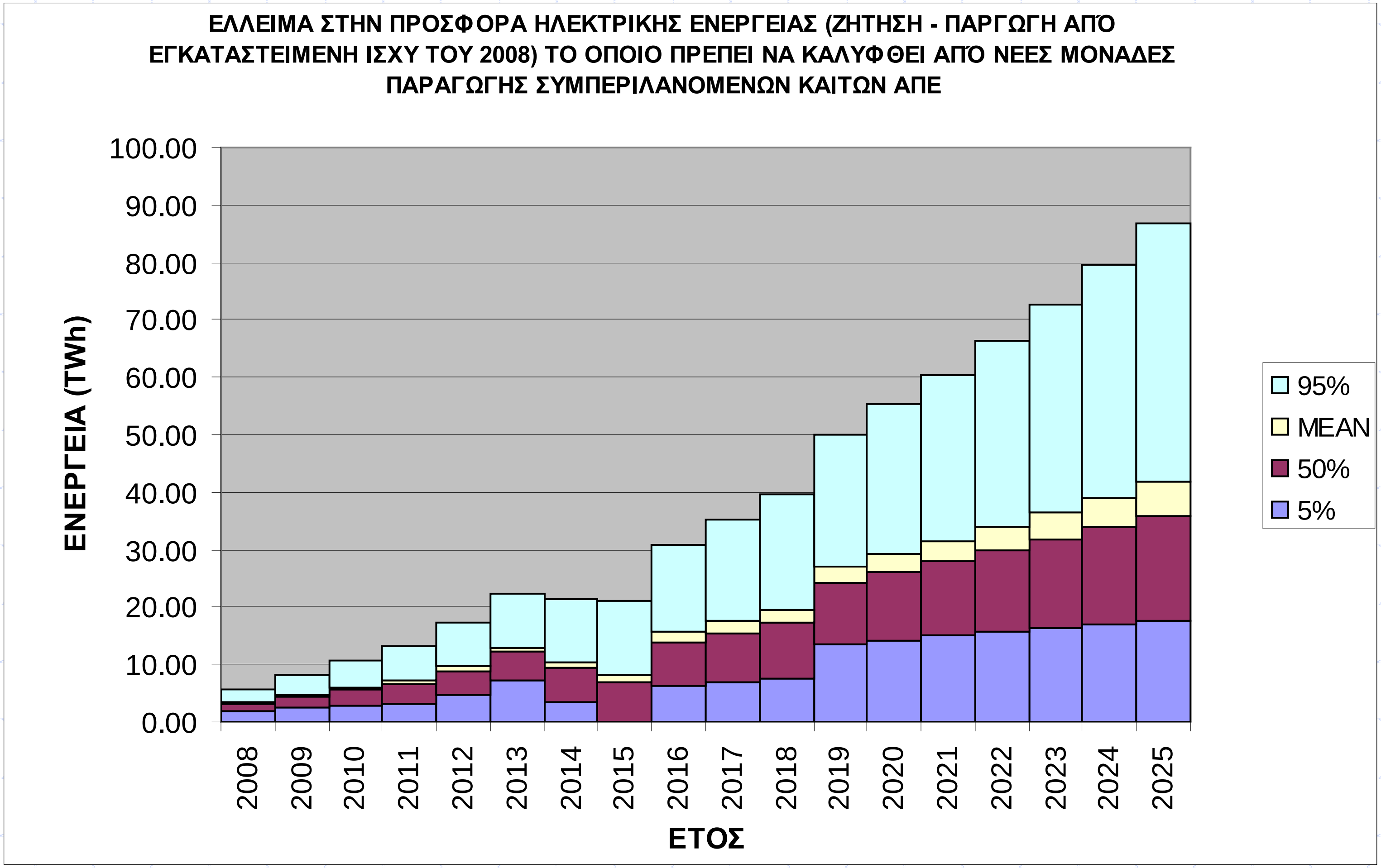
OUTLINE

- DEMAND OF ELECTRIC ENERGY
- AVAILABLE ENERGY SOURCES – EVALUATION CRITERIA
- PROGRAMME FOR THE DEVELOPMENT OF THE NECESSARY INFRASTRUCTURE FOR THE INTRODUCTION OF NUCLEAR POWER IN GREECE

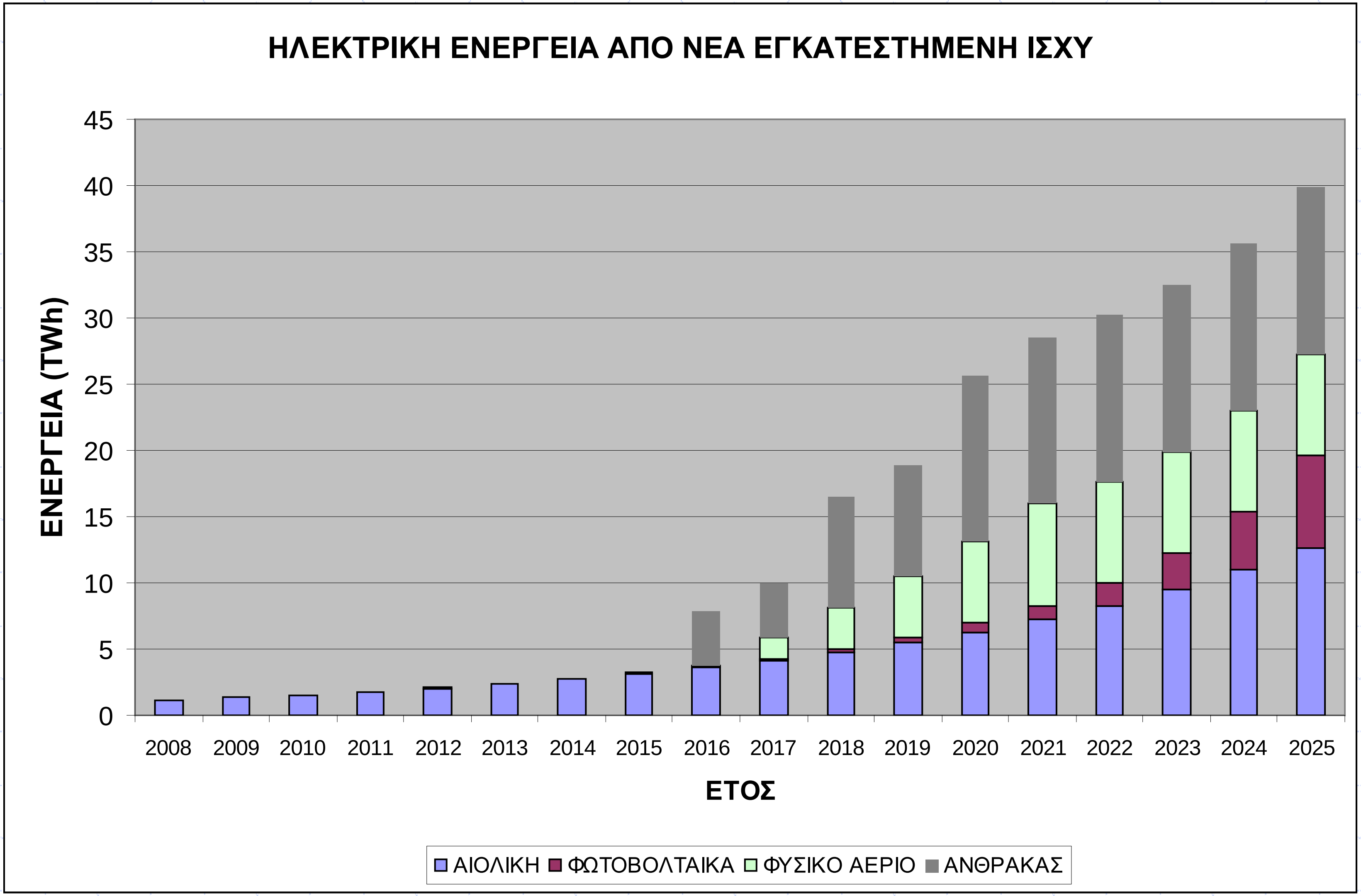
ELECTRICITY DEMAND



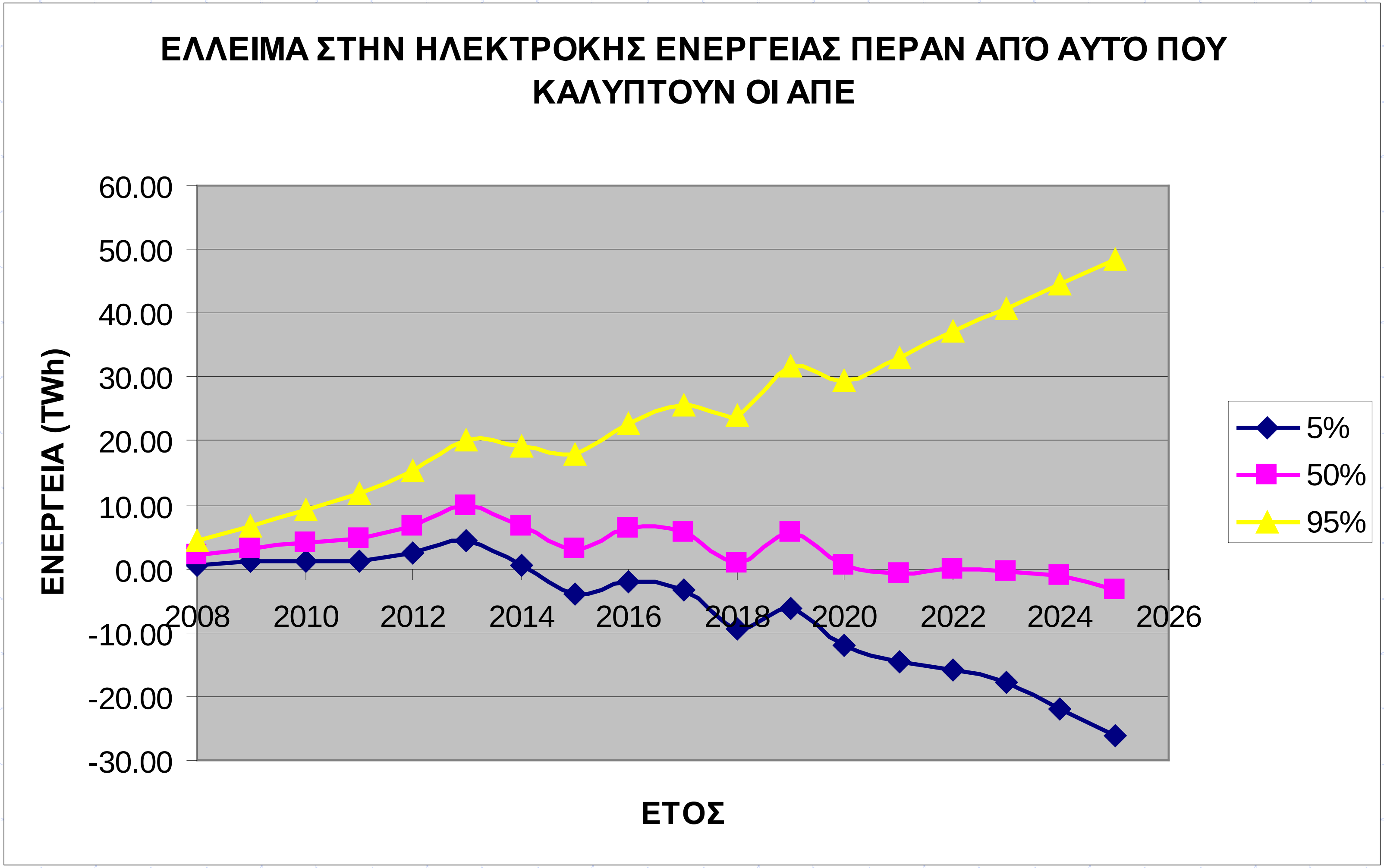
DEFICIT IN THE SUPPLY OF ELECTRIC ENERGY
to be supplied by New Installed Capacity
(based on the existing Power Plants in 2008)



ELECTRIC POWER FROM NEW INSTALLED CAPACITY (beyond existing Power Plants)



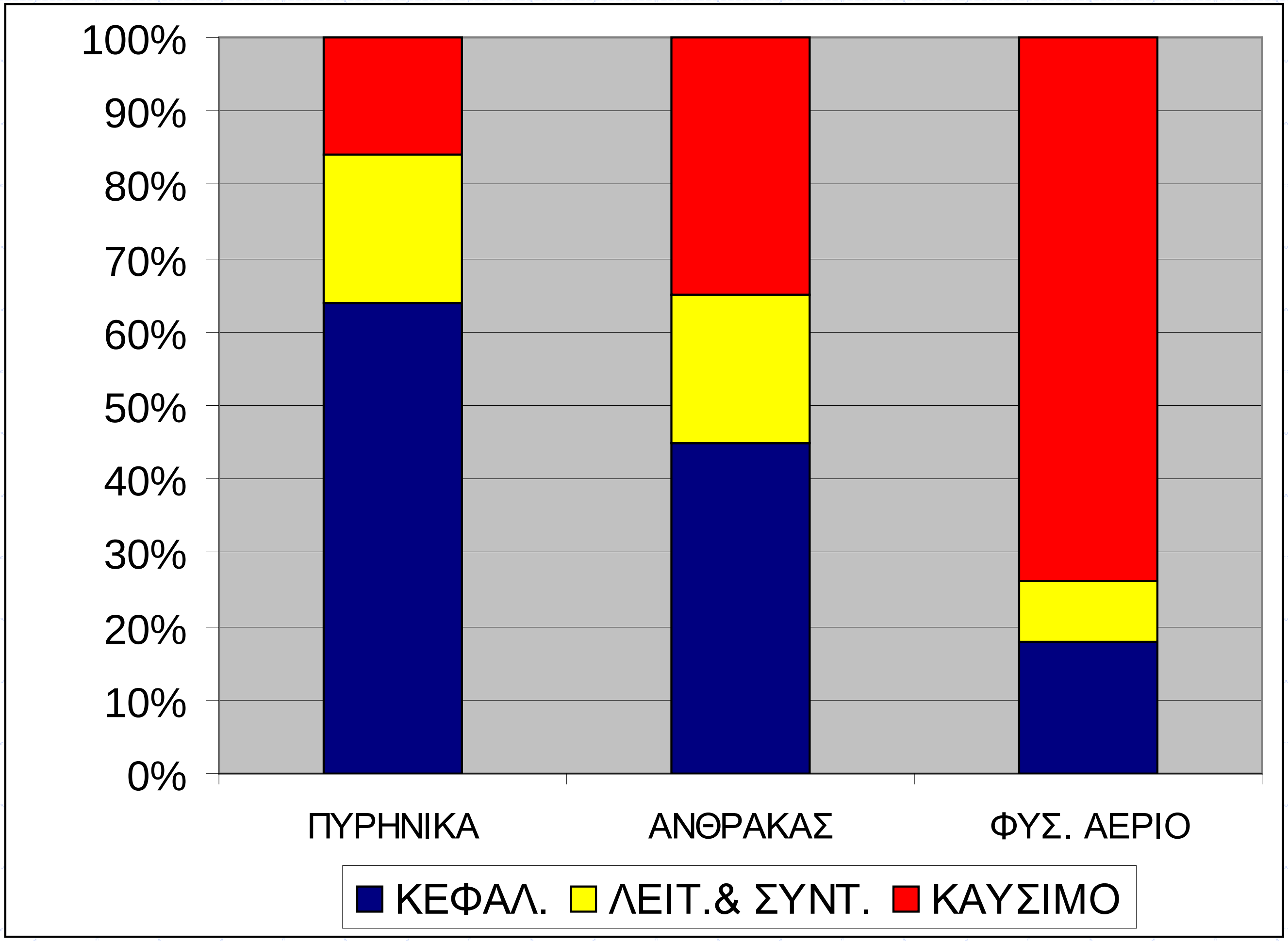
DEFICIT BEYOND RES



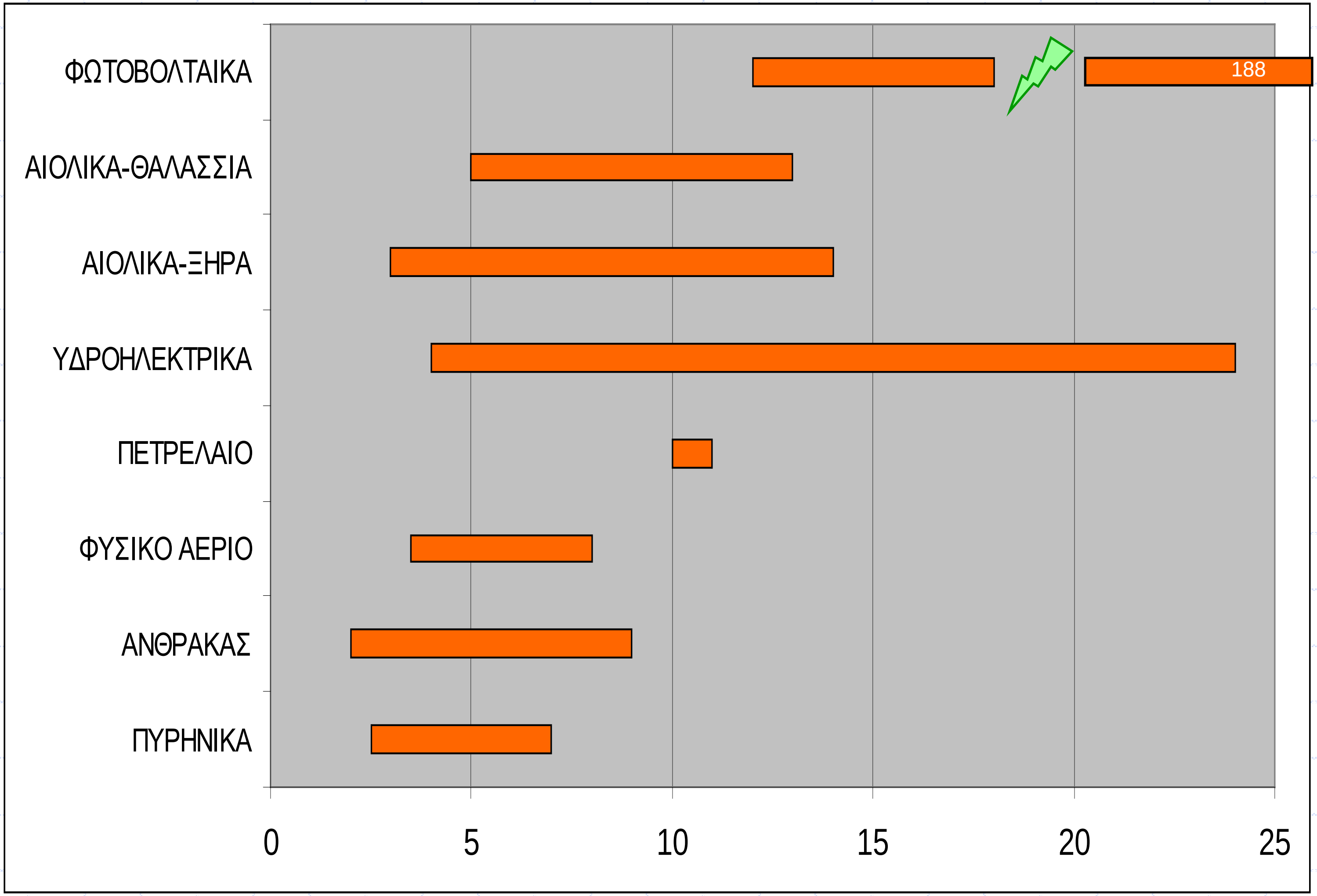
EVALUATION CRITERIA FOR ALTERNATIVE ENERGY SOURCES

- ECONOMICS
- HEALTH IMPACT (NORMAL AND ACCIDENTS)
- ENVIRONMENTAL IMPACT
- RELIABILITY OF FUEL SUPPLY
- OTHER

COST COMPONENTS



COST US$/MWh



ΦΩΤΟΒΟΛΤΑΙΚΑ
188
ΑΙΟΛΙΚΑ-ΘΑΛΑΣΣΙΑ
ΑΙΟΛΙΚΑ-ΞΗΡΑ
ΥΔΡΟΗΛΕΚΤΡΙΚΑ
ΠΕΤΡΕΛΑΙΟ
ΦΥΣΙΚΟ ΑΕΡΙΟ
ΑΝΘΡΑΚΑΣ
ΠΥΡΗΝΙΚΑ
0
5
10
15
20
25

HEALTH IMPACT

- On a world-wise scale the alternative energy sources will be evaluated over the complete life cycle of the fuel and the necessary power generating units.
- Mining
- Conversion and transportation,
- Production of Electric Energy,
- Waste /Final Disposal.

Health Impact

- *Coal*
  - Occupational Accidents during Plant Construction
  - Accidents during transportation
  - Atmospheric Pollution SO_2, NOx, particles (depend on the population distribution around the station and meteorology of the site)

HEALTH IMPACT

- *Nuclear*

- Occupational Accidents during Plant Construction
- Accidents during transportation
- Exposure to ionizing radiation during normal operation (mainly for the plant personnel)
- Exposure to ionizing radiation following a major accident (depends on the population distribution around the plant site and meteorology)
- Exposure during the processing and final disposal of the radioactive waste (without fuel reprocessing and use of Pu the long term risk is rather small)

(NOT APPLICABLE TO GREECE)

ENVIRONMENTAL IMPACT

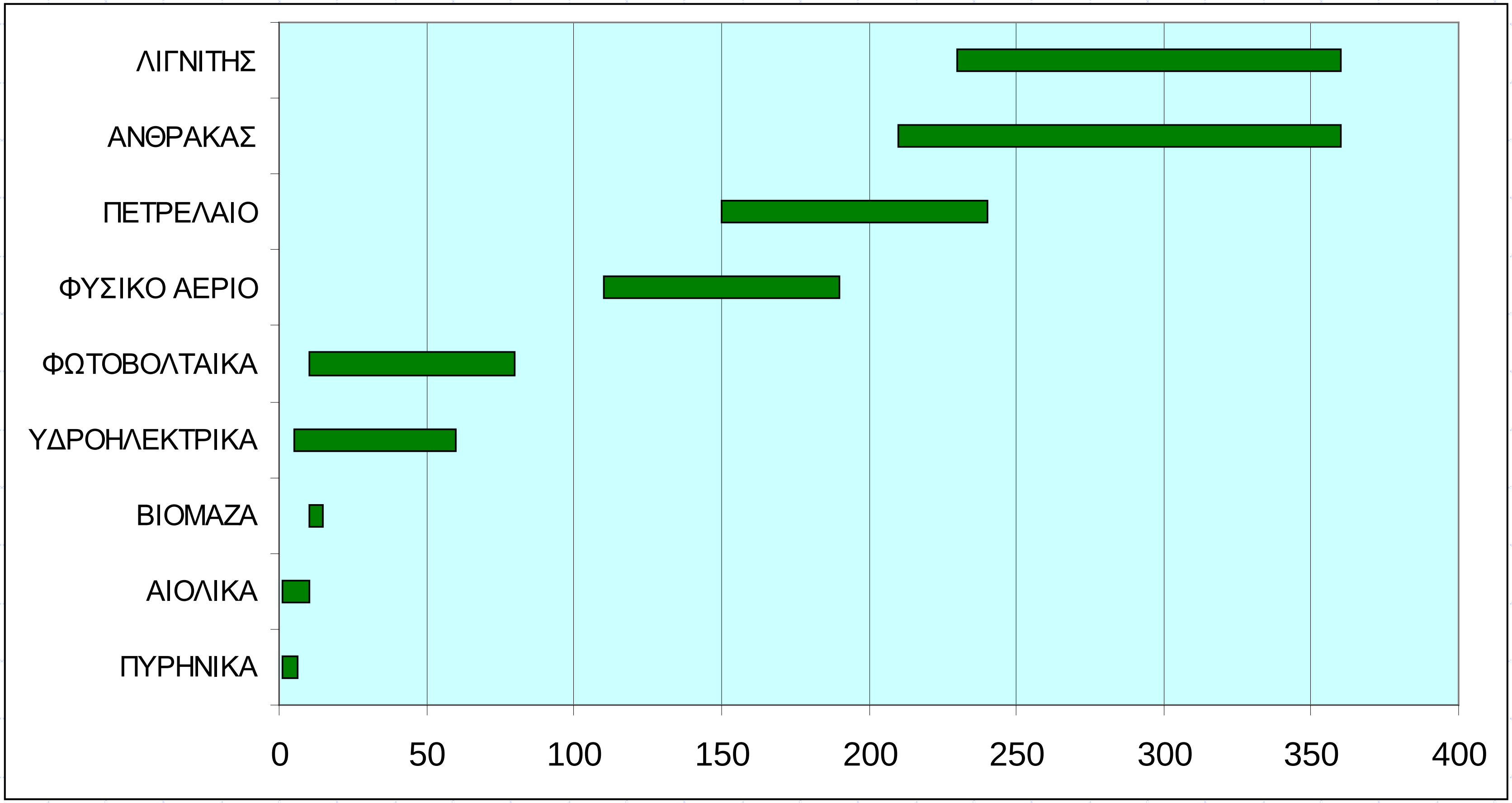
- On a world-wise scale the alternative energy sources will be evaluated over the complete life cycle of the fuel and the necessary power generating units.
- Mining
- Conversion and transportation,
- Production of Electric Energy,
- Waste /Final Disposal.

ENVIRONMENTAL IMPACT

- *Coal*

- Large quantities of Heat added to the environment (x1.5) Local importance.
- Atmospheric Pollution (e.g. SO_2-Acid rain)
- Global Warming - CO_2

ΕΚΠΟΜΠΕΣ ΑΕΡΙΩΝ ΘΕΡΜΟΚΗΠΙΟΥ gC_{eq}/KWh



ENVIRONMENTAL IMPACT

- *Nuclear*

- Large quantities of Heat added to the environment (x2) Local importance.
- Radioactive pollution during normal operation practically negligible
- Disposal of nuclear Waste (Fuel and Power Station)

NUCLEAR WASTE

- IRRADIATED FUEL & Plant Material
  - Low or middle radioactivity and half life less than 30 years **90 %**
  - Low or middle radioactivity and half life more than 30 years **9.5 %**
  - High radioactivity and half life more than 30 years **0.5 %**

- **SMALL VOLUME**
  - **Total volume of the lifetime fuel waste for a 1000MW Power station ~ SMALL APARTMENT HOUSE (20mx20mx6m)**

PROLIFERATION OF NUCLEAR WEAPONS

- NUCLEAR POWER PLANTS ARE NOT THE RIGHT MEANS FOR THE PRODUCTION OF NUCLEAR WEAPONS
  - U-235 -Enrichment
  - Pu-239- Natural uranium – Fuel reprocessing
- COUNTRIES WITH NUCLEAR ENERGY PRODUCTION AND NO NUCLEAR WEAPONS (Germany, Switcher land , Spain, Belgium, The Netherlands, Romania, Bulgaria, Canada, Sweden, Finland and Japan)
- COUNTRIES WITH NUCLEAR WEAPONS AND NO NUCLEAR ENERGY PRODUCTION (USA, RUSSIA, CHINA, FRANCE, U. KINGDOM, India, Pakistan, N. Korea (Israel?, S. Africa ?)
-
- Fuel Reprocessing and Pu Recycling;

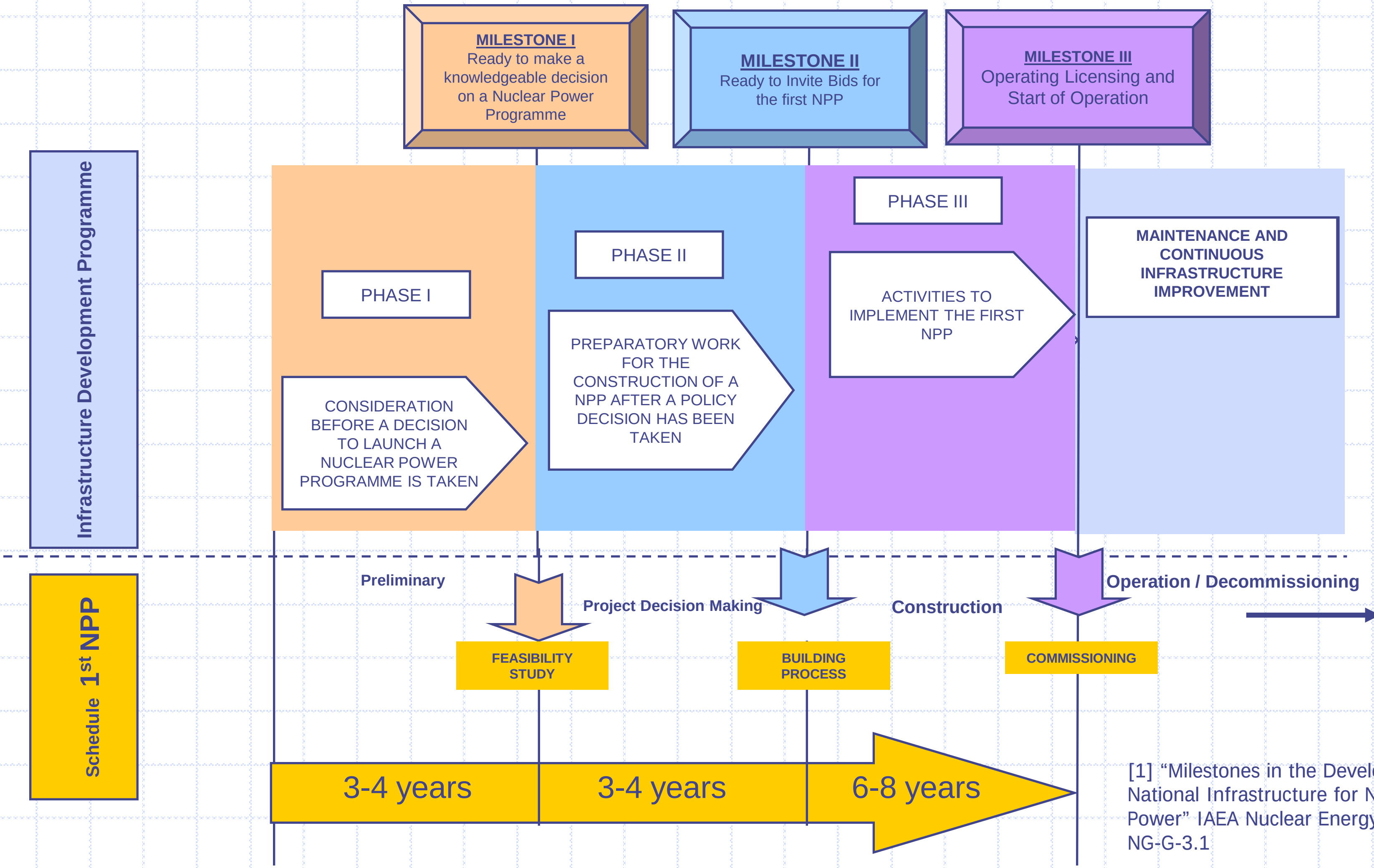
TERRORISM

- Theft of Nuclear material and Weapon Construction highly improbable and not effective
- Sabotage to a NPP more credible
- Introduction of Nuclear Power Production does imply a hiegher level of policing

RELIABILITY OF FUEL SUPPLY

- Nuclear fuel due to its high energy density content has extremely low volume and it is cheap.
- It is possible to buy and store fuel even for the whole life of the Nuclear Power Plant.
- Other types of energy sources need a continuous flow fuel (coal, oil, natural gas)

DEVELOPMENT PHASES FOR NUCLEAR POWER INFRASTRUCTURE



[1] “Milestones in the Development of a National Infrastructure for Nuclear Power” IAEA Nuclear Energy Series No. NG-G-3.1

ISSUES	MILESTONE I .	MILESTONE II	MILESTONE III
National Position	ΟΜΑΔΑ ΔΙΕΡΕΥΝΗΣΗΣ ΣΚΟΠΙΜΟΤΗΤΑΣ ΠΥΡΗΝΙΚΟΥ ΠΡΟΓΡΑΜΜΑΤΟΣ		
Management			
Funding & financing			
Legislative framework			
Regulatory framework			
Electrical grid			
Nuclear Safety			
Nuclear Fuel cycle			
Safeguards			

ISSUES	MILESTONE I.	MILESTONE II	MILESTONE III
Radiation Protection			
Human resources development			
Stakeholder involvement			
Site and supporting facilities			
Radioactive waste			
Environmental Protection			
Industrial Involvement			
Emergency Planning			
Security and Physical Protection			
Procurement			

CONCLUSIONS

- Demand for Electric Energy in Greece, taking into consideration every possible and practical energy savings and/or substitution by other forms of energy (non-electrical), as well as, the addition of new installed capacity from RES, Natural Gas and Coal will with a **significant probability** after 2021 and onwards present an **annual deficit** of about ***7 Twh***
- Production of this amount of energy requires 1000MW of new installed capacity with capacity factor 80%. This is equivalent to two (2) additional 600 MW coal power stations or one 1000MW Nuclear power station. It cannot be covered by imports.
- It is therefore likely (to a degree that cannot be ignored) that the electrical grid of Greece will need additional installed capacity beyond what it is presently planned.
- Consequently it is necessary to seriously explore the possibility of introducing in the Greek system Nuclear Power Stations to cover the electricity needs for the period beyond 2020.

CONCLUSION

- A programme for introduction of nuclear energy for a country like Greece requires 12 to 16 years from point zero up to the commissioning of the first unit. The first 4 to 5 years of this period are required for preliminary activities that **precede** a decision for the adoption or the rejection of the nuclear option.

- For Greece the required cost for these preliminary actions. Is relatively extremely small (40-50 million Euro) in relation to the cost of the corresponding investment or the cost of the inability to cover the deficit in demand.

- Preliminary activities that will enable in 3-4 years Greece to make an informed decision on the introduction or not of the nuclear option should therefore be initiated immediately.

THANK YOU FOR YOUR ATTENTION