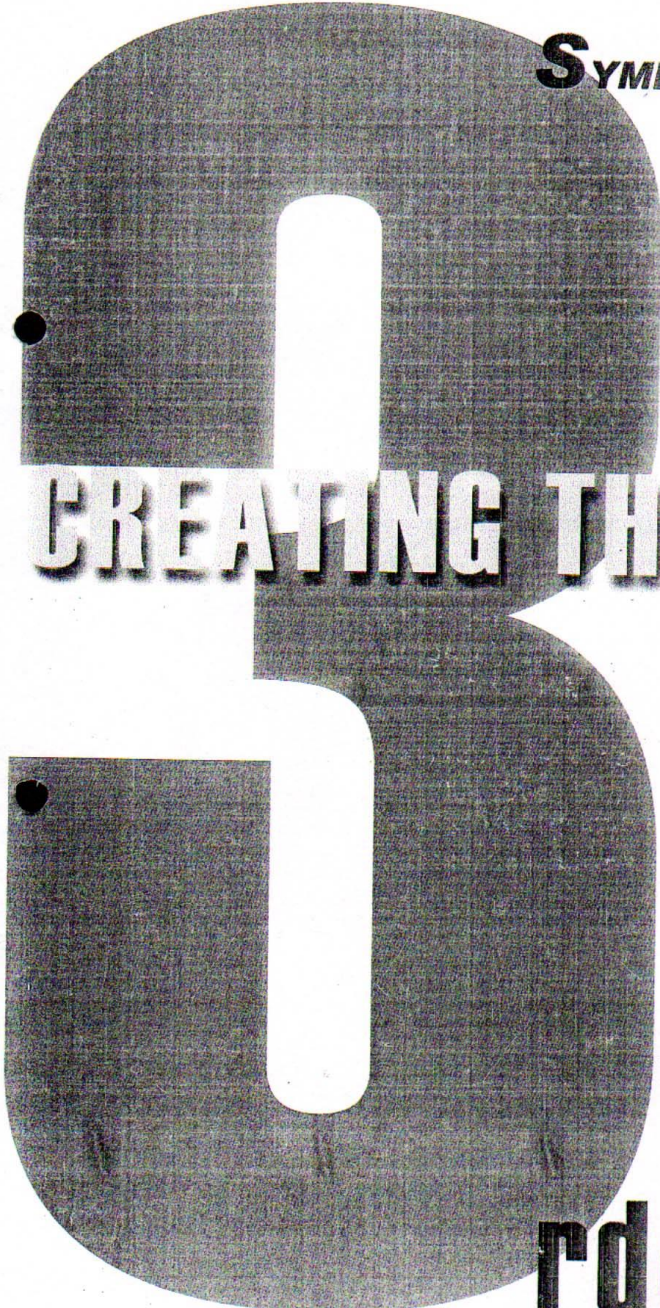


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## ENERGY PRODUCTION AND ENVIRONMENTAL POLLUTION IN NORTHERN CYPRUS

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### ABSTRACT

This paper gives an overview on energy production methods and capacity in Northern Cyprus and attempts to present some important factors to limit the carbon-dioxide and other gas emissions to atmosphere and environment.

### 1. INTRODUCTION

Several of the environmental problems are directly or indirectly caused by energy production plants due to fuel oil consumption. In Northern Cyprus, electricity production is made by only the state-rule company Cyprus Turkish Electricity Authority (KIB-TEK) from three different power plants by using very low quality fuel oil (no. 6). This very low quality fuel oil consumption emits many hazardous gasses to atmosphere which cause air pollution and green house effect. Climate change due to air pollution motivated planners and administrators to develop new actions focusing on the limitations of hazardous gas emissions to the atmosphere.

### 2. ENERGY PRODUCTION METHODS AND CAPACITY IN N. CYPRUS

Cyprus Turkish Electricity Authority (KIB-TEK) generates, distributes and sells power to all sectors. The generation capacity of KIB-TEK is 175 MW. All the power plants are consuming fuel oil

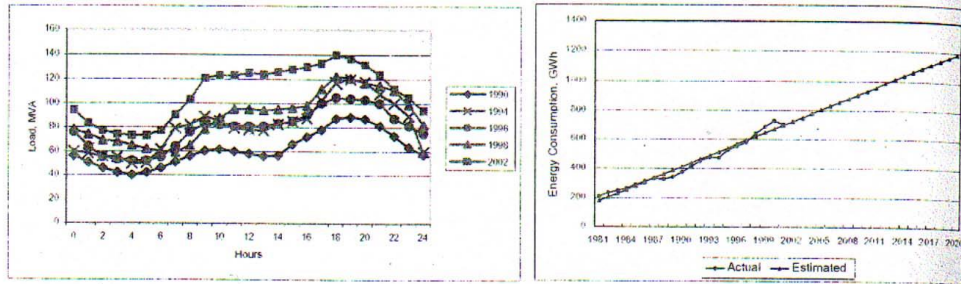
(no 6) which is very low quality. This power is generated in three different power plants. Teknecik power plant capacity is  $2 \times 60 = 120$  MW fuel oil fired steam power plant, Kalecik power plant capacity is  $2 \times 17.5 = 35$  MW and Dikmen obsolete gas turbines of 20 MW capacity having very low cycle efficiencies.

Having control only over supply-side management, the customers force KIB-TEK to increase the production capacity which is essential in the last few years. Using very low quality fuel oil for power generation creates environmental problems for human life which requires strict rules to be applied for the removal of these hazardous gasses from the atmosphere. Although remedies exist to remove these gasses from the atmosphere, they are costly. Solar collectors are widely used in N. Cyprus which provides hot water to houses and saves about 72 GWh energy per year. Also, solar collector usage in N. Cyprus saves 54 000 tons of carbon dioxide emissions to atmosphere [1].

Although N. Cyprus is situated at a lucky geographical position and approximately there is about 7 hours sunny periods per day, solar energy is not widely utilized to generate electricity, except solar collectors, in N. Cyprus. Based on data recorded at 5 different weather stations in N. Cyprus, it appears that N. Cyprus does not have many suitable locations for constructing wind power stations. But, although this

is the case, wind energy potential can be

utilized locally at suitable places.



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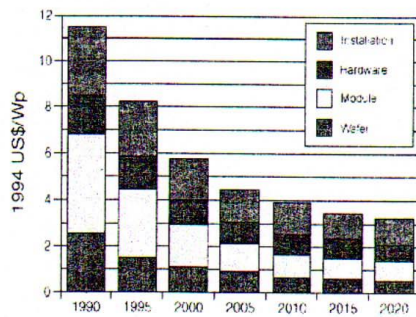
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Figure 1: a) Typical winter load curves in N. Cyprus b) Actual and projected annual energy consumption in N. Cyprus [1]

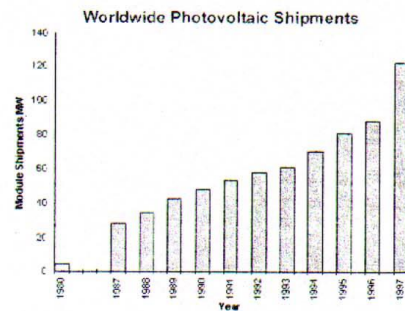
### 2.1. Photovoltaics in N. Cyprus

Photovoltaic cells are used to convert sunlight directly to electricity. Cyprus enjoys an abundance of solar energy with an average global solar radiation being  $5.4 \text{ kW/m}^2/\text{day}$  [2]. Utilization of photovoltaics to convert sunlight into electricity provides a wide range of

application of these systems. In utilization of photovoltaics, the transmission of energy is eliminated and if a grid connected system is realized, the storage requirements are minimized. By making storage calculations for 3-4 days, standalone photovoltaic systems can also be utilized especially for the houses which are far away from the grid.

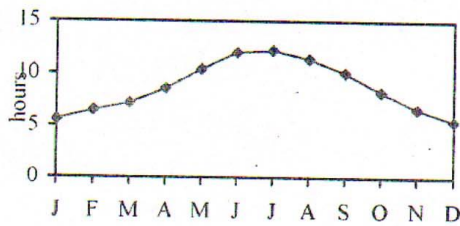


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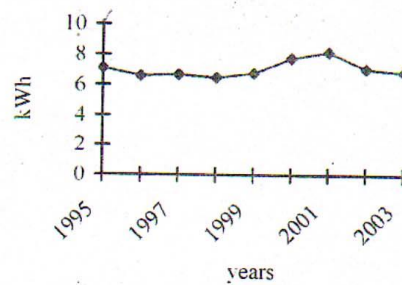


a

Figure 2: a) Photovoltaic system prices b) Photovoltaic module shipments [3]



a



b

Figure 3: a) Sunny hours in N. Cyprus b) Energy consumption in a typical house in N. Cyprus [2]

## 2.2. Solar water heating in N. Cyprus

Cyprus uses solar water heaters on a very large scale. The usage of gas, oil and wood for water heating is not popular. This application is environmentally friendly and by using solar collectors to supply hot water to houses approximately 72 GWh energy [1] is saved and also 54000 tons of carbon dioxide emission to atmosphere is eliminated. In N. Cyprus Israeli-type flat plate domestic solar collectors are used, which consists of two flat plates having an absorber area of about  $3 \text{ m}^2$ , a storage tank of about 180 lt equipped with an auxiliary electric immersion heater at 3 kW rating, and a cold water feed tank above. If existing 3 kW immersion heaters are replaced by highly efficient solar heaters and also existing solar collectors are repaired due scale formation in the piping systems, in

10000 houses in N. Cyprus, approximately 15 MW peak demand could be reduced [1].

## 3. CHARACTERISTICS OF FUEL-OIL USED IN POWER PLANTS IN N. CYPRUS

The fuel oil used in power plants in N. Cyprus is the cheap no 6 oil with ingredients indicated above. This cheap fuel oil creates a lot of environmental problems by emitting hazardous gasses to atmosphere. Although remedies exist in removing these gasses from the atmosphere, they are costly. Removing carbon dioxide from the atmosphere for each kW energy production costs about 1800\$ [1]. Reduction of carbon dioxide emission from the atmosphere is possible by improving the plant efficiency and making use of the renewable energy resources as much as possible.

Table 1: Fuel oil characteristics used in power plants in N. Cyprus [4]

CERTIFICATE OF QUALITY OF FUEL OIL USED IN POWER PLANTS IN N.CYPRUS					
TEST	UNITS	LIMITS		RESULTS	METHOD
		Low	High		
ASH CONTENT	WT PCT		0.1	0.01	ASTMD 482
DENSITY AT 15 DEG C	KG/L		0.9930	0.9929	ASTMD1298
FLASH POINT	DEG C	65.6		99.2	ASTMD 93
POUR POINT	DEG C		27	12	ASTMD 97
SEDIMENT AND WATER	PCT		1.0	0.3	ASTMD473+95
SEDIMENT CONTENT	WT PCT		0.5	0.1	ASTMD 473
VISCOSITY AT 50 DEG C	CST		580	327	ASTMD 445
VANADIUM CONTENT	MG/KG		184	112	IP 470
NITROGEN CONTENT	WT PCT		0.7	0.5	ASTMD 40629
SODIUM CONTENT	MG/KG		35	13	IP 470
HIGH CALORIFIC VALUE	KCAL/KG	10150		10200	CALC
NET CALORIFIC VALUE	KCAL/KG	9600		9610	ASTMD 240
SULPHUR CONTENT	WT PCT		3.5	2.0	IP 336
DENSITY IN AIR	KG/L			0.9918	CALC

#### 4- TYPES AND EFFECTS OF GAS EMISSIONS FROM POWER PLANTS

Between 1990 and 2000, use of energy for space heating, electricity and

transportation increased by 6%. Electricity accounted for the bulk of the increase; without improved efficiency the increase would have been much higher.

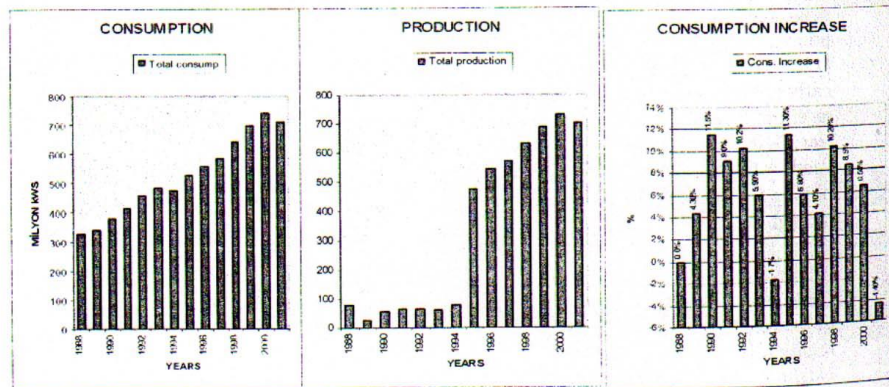


Figure 4: Energy consumption, production and consumption increase in N. Cyprus [5]

### 5- Gas emission from fuel oil burning and environmental effects

- Global warming
- Acid rains
- Damage in the Ozonel layers
- Damages on the human health
- Damages on vegetation

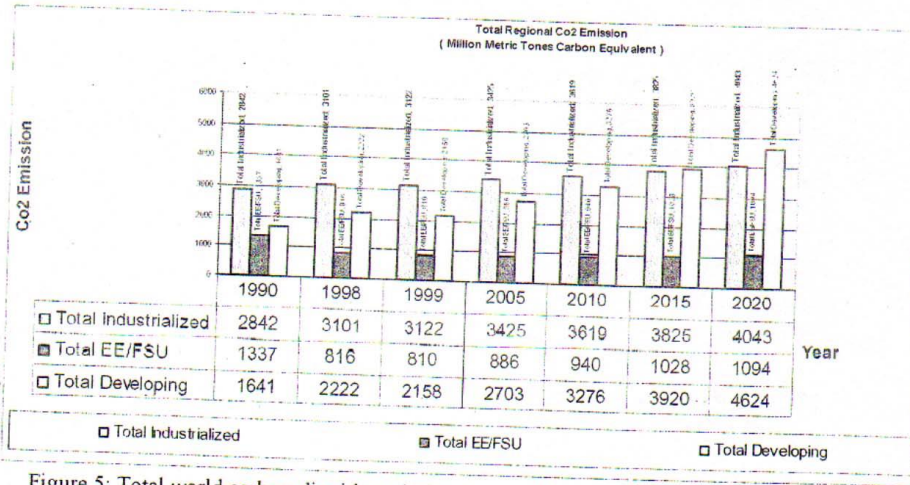


Figure 5: Total world carbon-dioxide emission (regional) projected to the year 2020 [3]

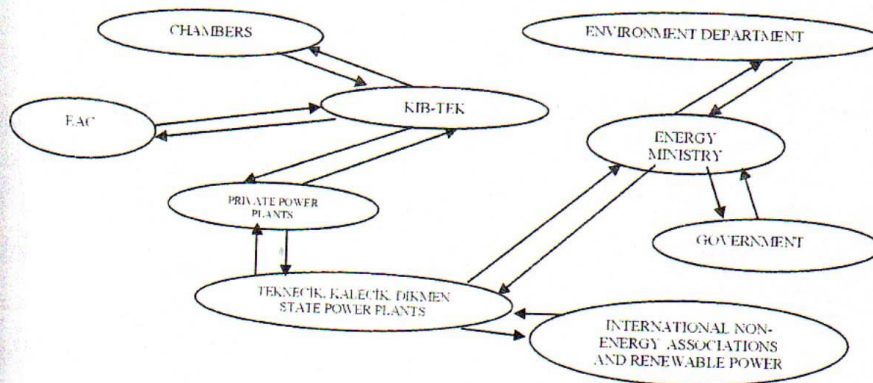


Figure 6: Data flow diagram for energy production policy in North Cyprus

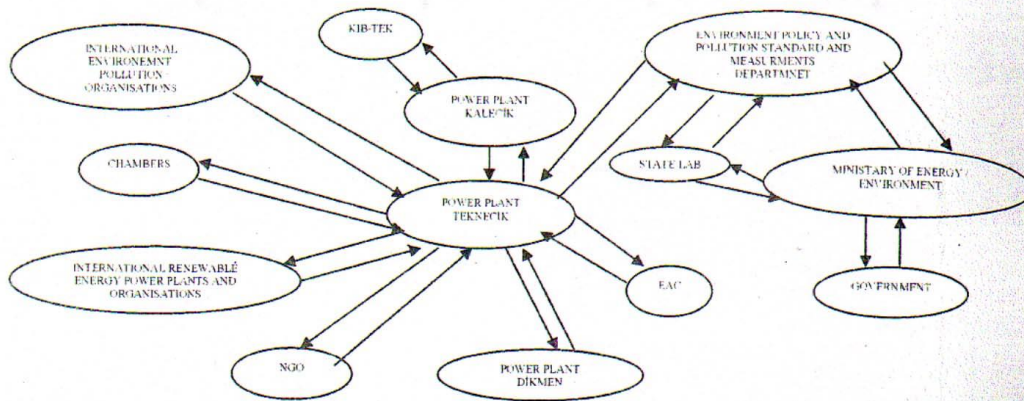


Figure 7: Data flow diagram for emission / measurement and control system

Table 2: Answer and question table

questions	KALECİK	TEKNECİK
Q 1:What is the fuel oil no used in power plant?	No 6 – PCT 3.5	No 6 – PCT 3.5 (In the future PCT 1 will be used)
Q 2:What is the burning efficiency of the power plants?	%42	%34 - %35 (power plant efficiency) %90 (burning efficiency)
Q 3:Pollution : - Sulphur - CO <sub>2</sub> - Nitrogen - Particulate matter emission	- 1700mg/N.m <sup>3</sup> - %6.67 - 1256 ppm	Asumption 2500-3500 - trial 1430 (normal >3000 ) - -
Q 4:Does a filtering system exists?	Yes .DESOX system.	No
Q 5:Do you measure the pollution ratio?	Yes 24 hr measurement of chimney gas emmision measurements. SOX measuremnts	Yes Sulphur measurement

## 6. DISCUSSIONS AND CONCLUSIONS

Energy production in N. Cyprus is under control of KIB-TEK. The technical and environmental connections of KIB-TEK with non-governmental organizations and other related international organizations are very weak. The policies are almost national and the decisions are made by the board of trustees of KIB-TEK without negotiating with such international environmental and similar organizations.

The energy production policy and the environmental policy of N. Cyprus must be developed according to the data flow diagrams presented in this study. The pollution standards and the international environmental and energy production policies must be followed and regular measurements must be shared with the community.

Renewable energy resources, especially solar and wind energy systems must be integrated to the N. Cyprus energy

production system in order to modify the load curve. Promotion program must be developed for the energy efficient electrical equipment usage and rules and regulations must be developed for the import of these equipments.

*References*

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- [3] [www.eia.doe.gov](http://www.eia.doe.gov)
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