

**PRACTICAL APPLICATION OF THE UNFC  
to the TURKISH LIGNITE DEPOSITS-**  
**A CASE STUDY: Yatagan –Eskihisar Mining Area**  
**Adaption to the Final Version of UNFC**

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**Turkish Coal Enterprises, TURKEY**

**The First Session of UNECE  
Ad Hoc Group of Experts on Supply of Fossil Fuels**

**10-11 November 2004, Geneva**

# CONTENT

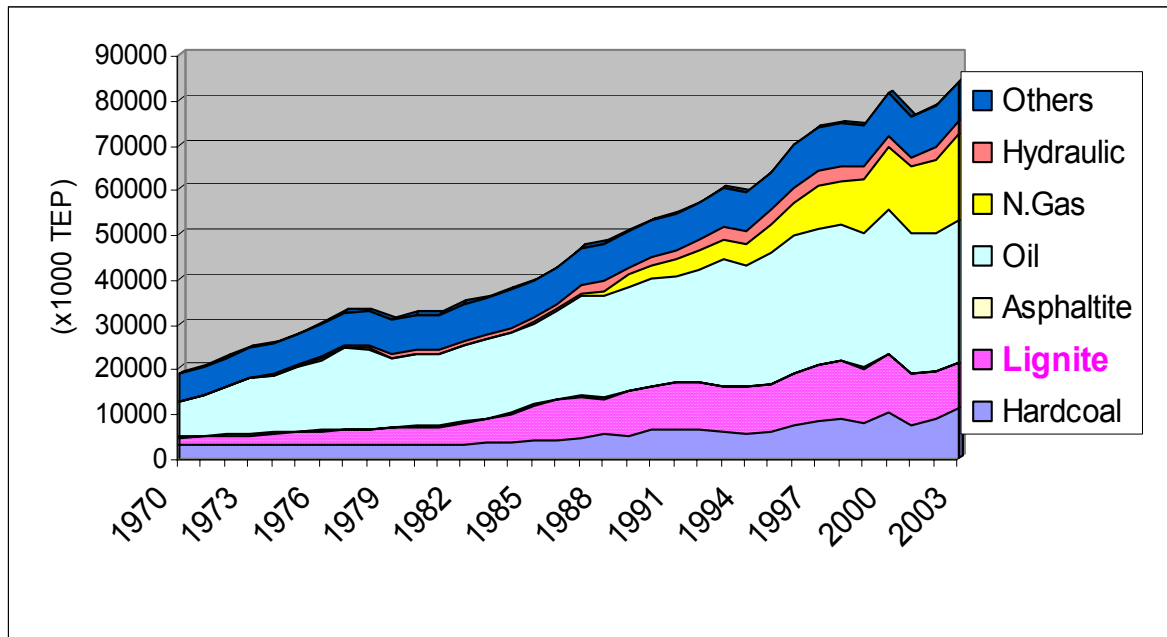
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- ***Position of Lignite in Turkish Energy Sector***
- **Position of TKI in Turkish Lignite Sector**
- **Position of Yatagan-Eskihisar Mine in TKI**
- **Classification System Used in Turkey**
- **UNFC applied to Coal, Uranium & Other Minerals- a comparison with previous version-R70**
  
- **Case Study: Yatagan-Eskihisar Mining Area**
  - **Geological Assessment**
  - **Feasibility Assessment**
  - **Economic Viability**
  - **Comparison of Classification Results**
  
- **Conclusion and Recommendations**

# TURKISH ENERGY SECTOR-

## Position of Lignite

General Energy Consumption in Turkey



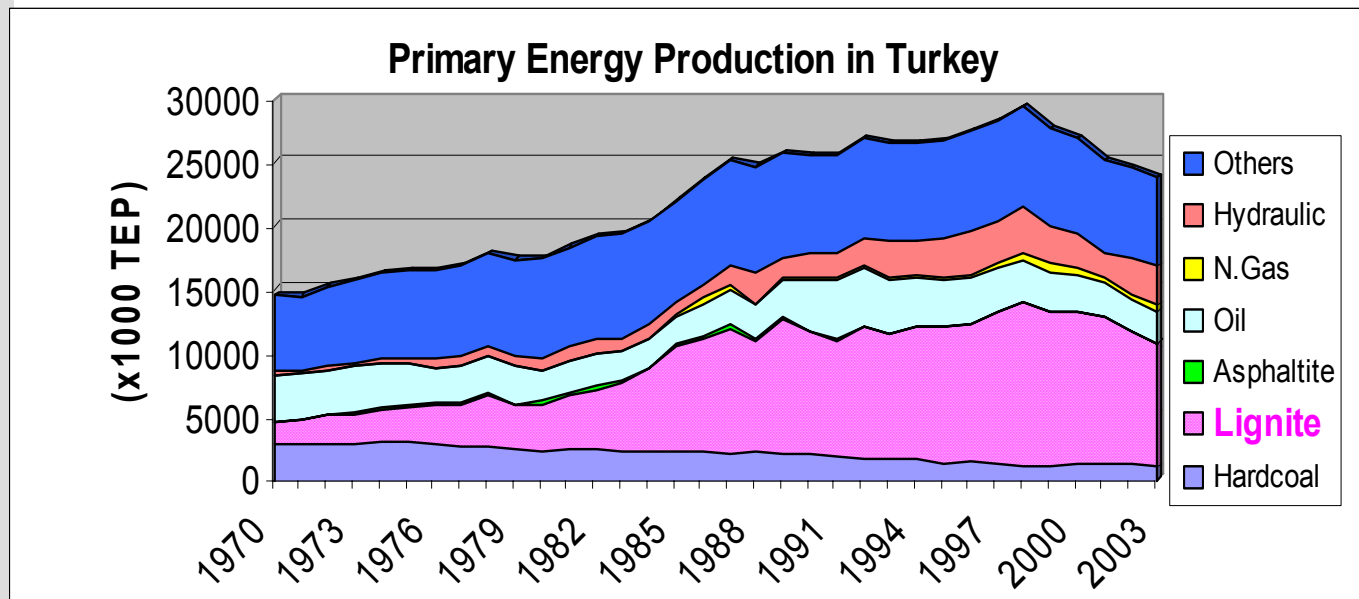
**in 2003**  
**84 MTEP**

**Lignite : 12%**

Hardcoal: 13%  
(12.5% of 13%  
imported Hardcoal)

# TURKISH ENERGY SECTOR-

## Position of Lignite



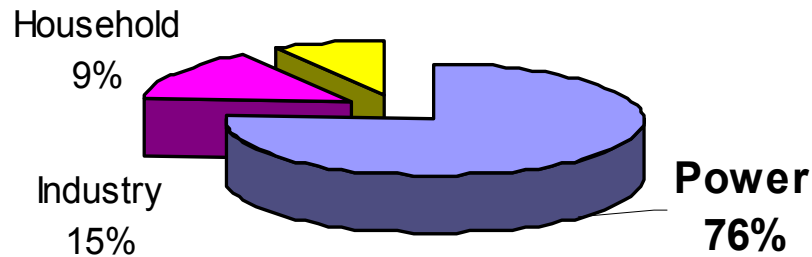
**in 2003**  
**23.8 MTEP**

**Lignite:**  
**42%**  
**Hardcoal:**  
**4%**

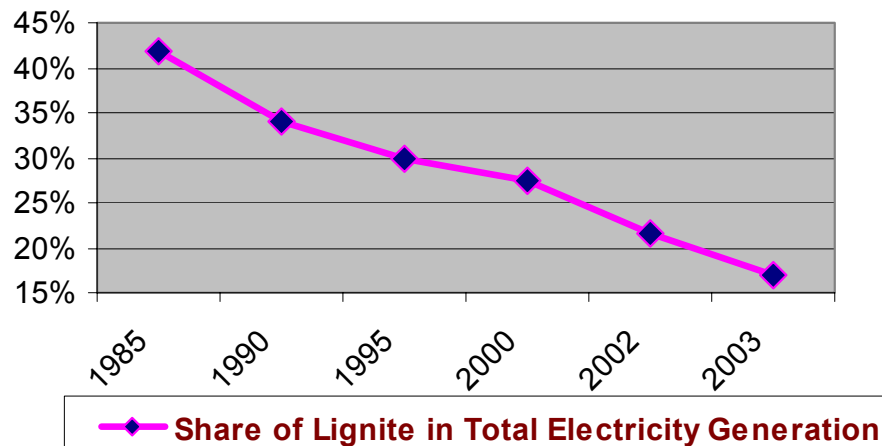
# TURKISH ENERGY SECTOR-

## Position of Lignite

Consumption of the Lignites by  
the Sectors in 2003

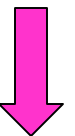


Consumption of lignite  
mainly for electricity  
generation



In total electricity  
generation

Share of domestic lignite  
in 2003 : 17%

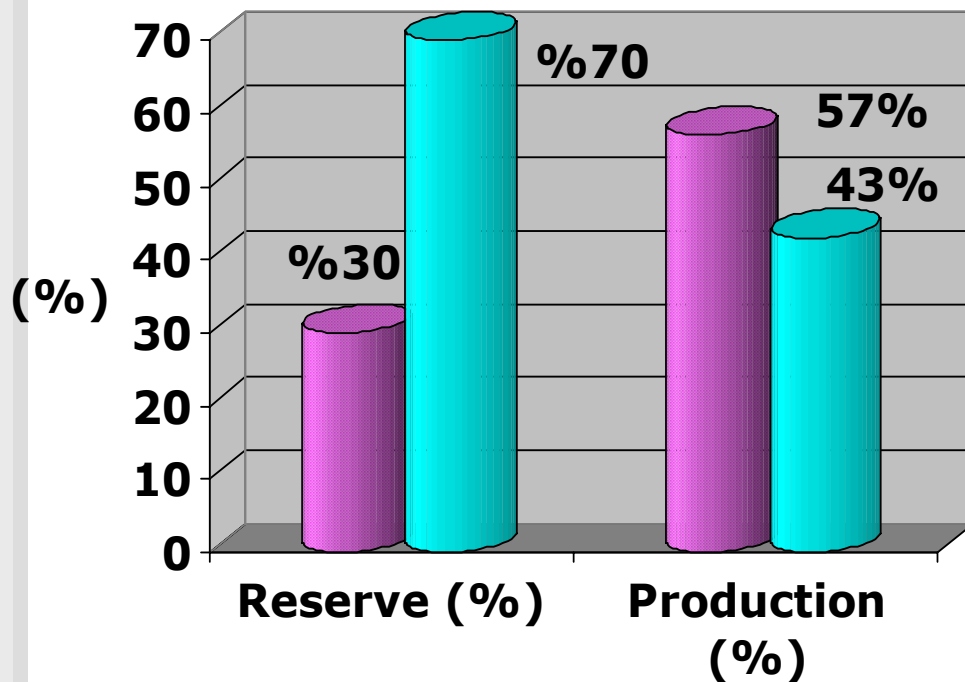


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# TURKISH LIGNITE SECTOR- Position of TKI



■ TKI ■ EUAS + Private

**The biggest lignite  
Producer in Turkey**

**in 2003:**

- Total lignite reserve:  
8.2 Bt
- Total lignite production :  
46.2 Mt

# TURKISH LIGNITE SECTOR-

## Position of TKI

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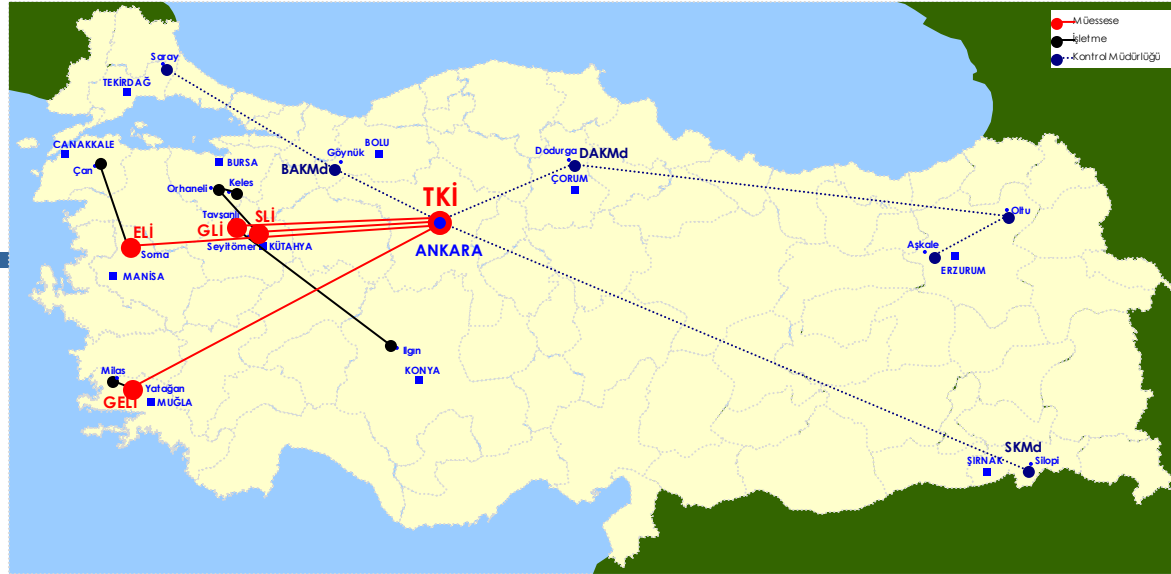
- in 2003:
- Turkey:
- Total installed capacity: 35587 MW
- Share of Lignite Fired Power Plants in Total: 18%
  
- TKI :
- Power supplied by TKI's deposits: 4273 MW
- 64% of total lignite-fired power plant cap.

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# ESTABLISHMENTS OF TURKISH COAL ENTERPRISES



**ELİ**

Aegean Lignite Establishment  
Çan Lignite Production Management

SOMA / MANİSA  
ÇAN / ÇANAKKALE

**GELİ**

**South Aegean Lignite Establishment**  
Yeniköy Lignite Production Management-

**YATAĞAN / MUĞLA**

MİLAS / MUĞLA

**GLİ**

West Lignite Establishment  
İlgın Lignite Production Management

TAVŞANLI / KÜTAHYA  
İLGİN / KONYA

**SLİ**

Seyitömer Lignite Establishment  
Bursa Lignites Production Management-

SEYİTÖMER / KÜTAHYA

ORHANELİ / BURSA

Doğu Anatolian Control Management  
West Anatolian Control Management  
Silopi Control Management

DODURGA / ÇORUM  
HİMMETOĞLU / BOLU  
ŞİLOPİ / ŞİRNAK

1/10 of total  
prod. of TKİ

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# CLASSIFICATION SYSTEM USED in TURKEY

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- There is no unique, own system
- There is a terminology chaos for the usage of “reserve” and “resource” terms
- The classification is performed according to geological assessment(G)
- **Lignite reserves/resources are classified as:**
  - Proved reserves: geologic assurance identified in three dimensions
  - Probable reserves: geologic assurance identified in two dimensions
  - Possible reserves: dimensions of geologic evidence undetermined sufficiently
  - Potential resources: currently not economic but may possibly be so in the future

# CLASSIFICATION SYSTEM USED in TURKEY

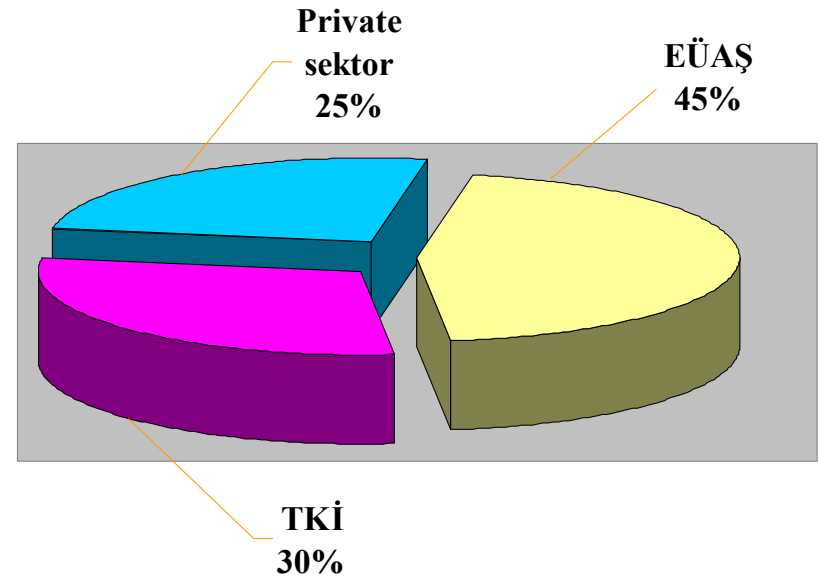
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- There is no generalized, predefined criteria for the cut off values for the depth, thickness, ash, sulphur contents
- After classification performed based on geological assessment(**G**),
  - Economic viability(**E**) of the deposits is estimated
    - from mining reports for the active mines
    - from the feasibility studies for the deposits that will be mined in the near future
  - Preliminary evaluation of the economic viability is done
    - by application cut off values from comparable mining operations

# CLASSIFICATION SYSTEM USED in TURKEY

## Lignite reserves/ resources base on National System by 2004:

- **Proved reserves : 6 909 Mt**
- **Probable reserves : 830 Mt**
- **Possible reserves : 152 Mt**
- **TOTAL RESERVES : 7 891 Mt**
  
- **Potential resource: 308 Mt**
- **GENERAL TOTAL : 8 199 Mt**



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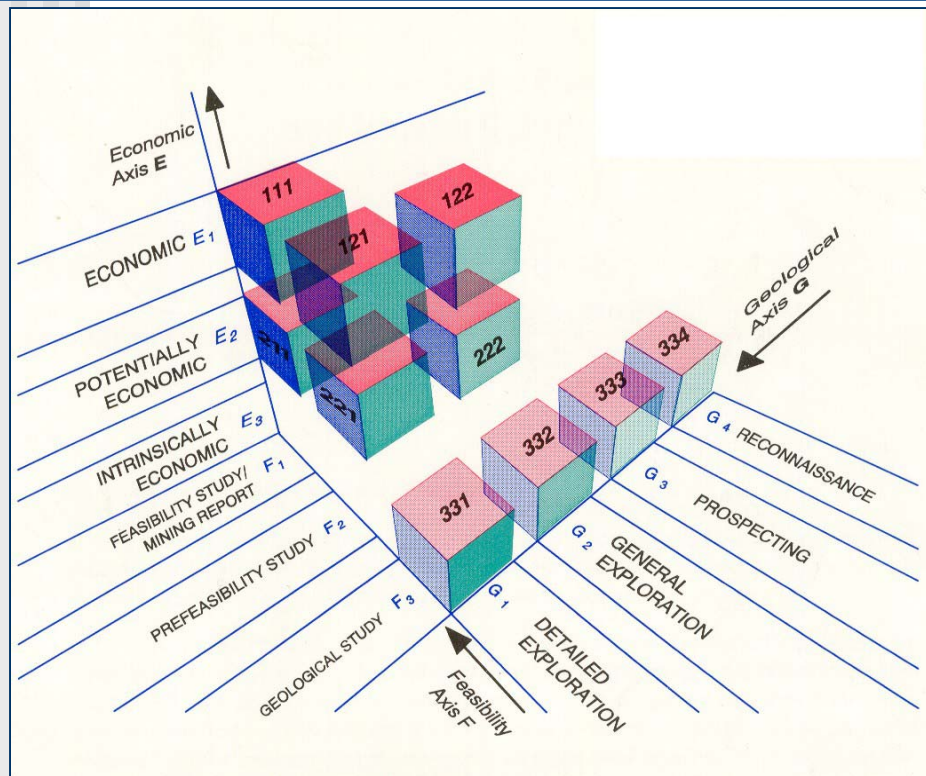
## **UNFC Applied to Coal, Uranium&Other Minerals** **- a comparision with the previous version-R70**

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- **Since UNFC for solid fuels and minerals in application worldwide by about 60 countries since 1997, no big changes have been done on this version**
- **All category & axes names, figures kept same as the previous version**
- **Joint UN/CMMI definitions for mineral reserve and resource classes (agreed upon in 1999) were replaced with the definitions in the R.70 Document**

# UNFC Applied to Coal, Uranium & Other Minerals a comparison with the previous version-R70



## Classification criteria

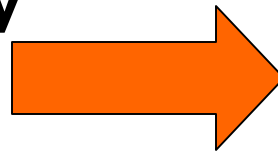
- **Economic Viability**
- **Feasibility Assessment**
- **Geological Assessment**

# UNFC Applied to Coal, Uranium & Other Minerals

## - a comparison with the previous version-R70

### R.70

- No sub-category codes



### ■ Final UNFC version

#### Appendix I:

##### for E1

- E1.1 as needed
- E1.2 codes for
- E2.1 sub-categories
- E2.2 will be added

##### for F1

- F1.1
- F1.3

e.g. 1.1;1;1 → E1.1, F1 and G1

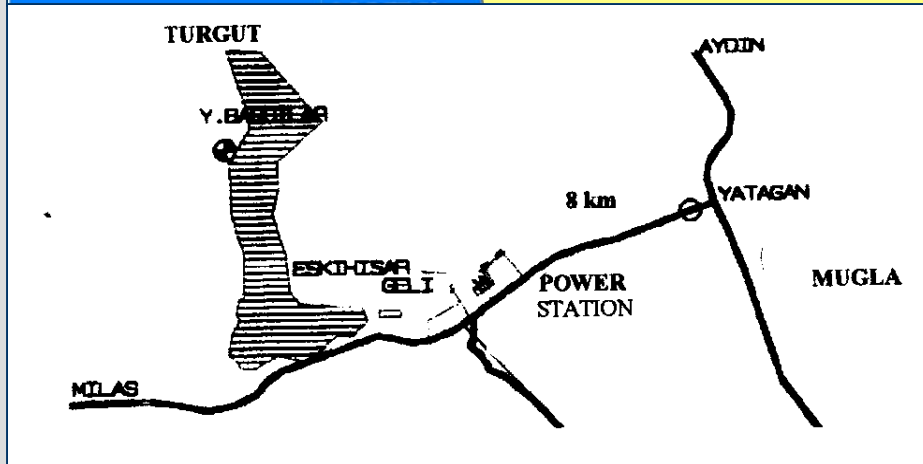
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# ***CASE STUDY:***

## ***Yatagan-Eskihisar Mining Area, TKİ***



**By beginning of 2004**

**TKİ** → 55 lignite deposits  
13 of them in operation

### **Yatagan Mining Area:**

- Eskihisar lignite deposit
- Y. Bagcilar lignite deposit
- Turgut lignite deposit

**in operation since 1979  
with the capacity of  
3.500.000 t/y**

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# ***CASE STUDY: Yatagan-Eskihisar Mining Area***

## ***Geological Assessment***

- First studies were initiated in 1956
- Detailed geological, geophysical, geotechnical, hydrogeological studies were done

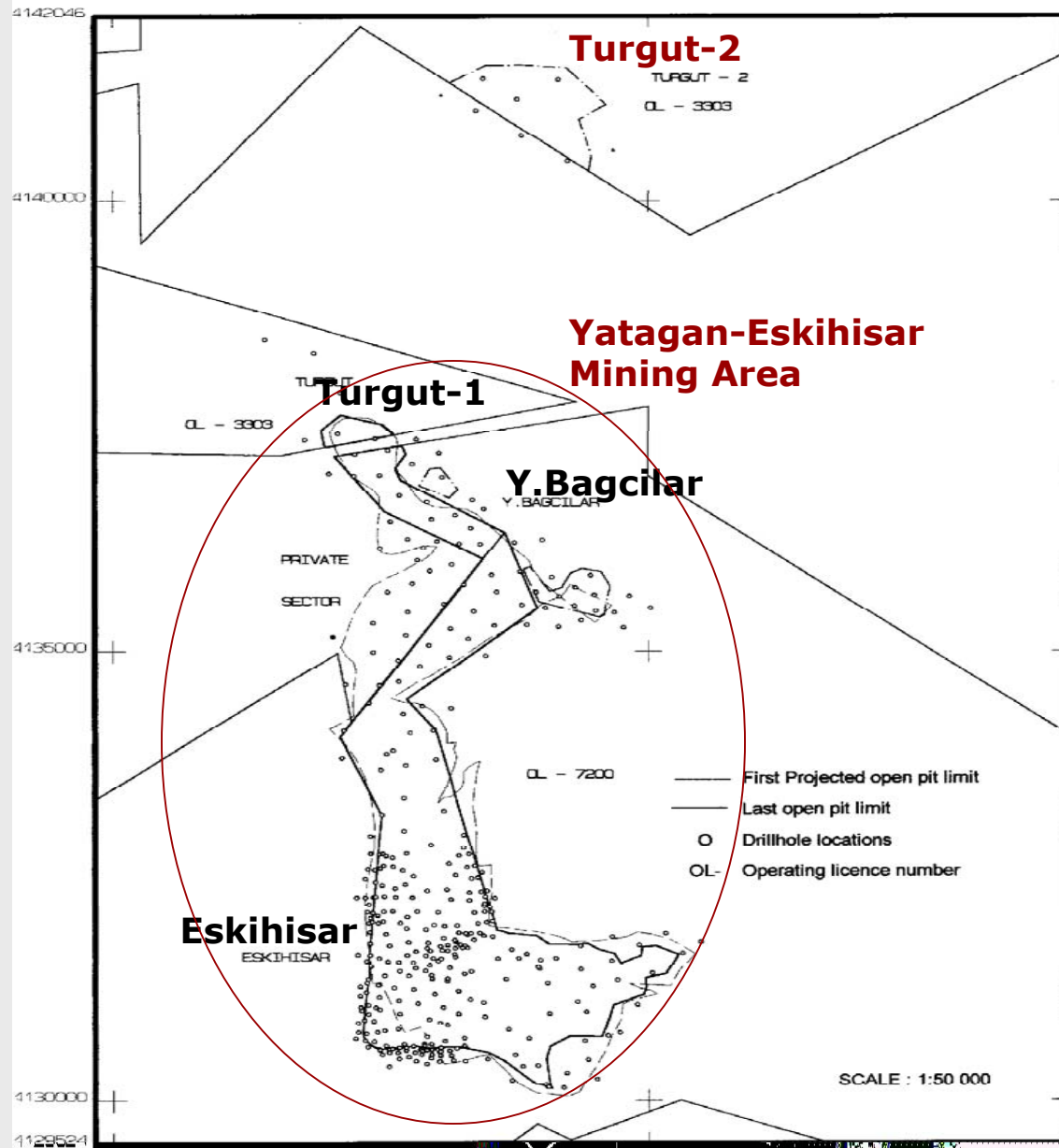
### ■ **Coal seam**

- Unique
- Average thickness: 11.7 m
- Uniform thickness
- Middle miocene age
- Jointed & laminated
- Low inclination
- inclination increases at boundary of the basin

### ■ **Stratigraphical section**

	FORMATION	LITHOLOGY	MAX. THICKNESS (m)	DEFINITION
CENOZOIC	MUGLA GROUP	Yatagan	~ 50	SANDSTONE (with conglomerate lenses)
		Sekoy		~ 60
			~ 25	CLAY, CLAYEY SILT
			~ 90	CLAYSTONE, LIMESTONE, MARL(above) COMPACT MARL(below)
	Turgu	~ 20	LIGNITE	
		>180	CLAY, SILT	
Meso.			?	MARBLE
Palae			?	SCHIST

# Exploration- Drillhole locations



## Yatagan-Eskihisar Mining Areas

- **170** drillholes up to initiating operation ( 250 m spacing )
- +
- **130** more drillholes during operation (50-100 m spacing)



**DETAILED  
EXPLORATION**

## Turgut-2 Deposit

- **6** drillholes (400-600 m spacing)



**GENERAL  
EXPLORATION**

# ***CASE STUDY: Yatagan-Eskihisar Mining Area***

## ***Geological Assessment***

### **Reserve Estimation**

- Polygon method was used
- Geological coefficient factor → 0.8 – 1.0
- **Criteria:**
  - Coal bearing clay and silt were included into coal seam having thickness  $\leq 1.0$  m and  $\leq 0.8$  m respectively
  - Specific gravity were taken  $1.5 \text{ t/m}^3$
  - Intermediate rock were included into coal seam having thickness  $\leq 0.5$  m

#### **Yatagan Mining Area:**

**118 Mt Proved reserve**

**106 Mt Extractable reserve**

**Stripping ratio:  $4.1 \text{ m}^3/\text{t}$**

#### **Turgut -2 Deposit**

**4.2 Mt Proved Reserve**

**3.8 Mt Extractable Res**



# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Geological Assessment***

## **Remaining Reserves Quantities:**

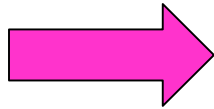
### ■ **Yatagan-Eskihisar Mining Area**

	<b><u>Proved</u></b>	<b><u>Extractable</u></b>
■ Eskihisar deposit:	37.3 Mt	33.6
■ Y.Bagcilar deposit:	8.1 Mt	7.3
■ Turgut deposit:	1.3 Mt	1.2
■ <b><u>Total in operation:</u></b>	<b><u>46.7 Mt</u></b>	<b><u>42.1</u></b>
■ Pillars:	8.3 Mt	
■ <b><u>Turgut-2 Deposit:</u></b>	<b><u>4.2 Mt</u></b>	<b><u>3.8</u></b>
■ <b><u>GENERAL TOTAL:</u></b>	<b><u>59.2 Mt</u></b>	<b><u>45.9</u></b>

# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Geological Assessment***

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## **Quality**



**571 samples**

	<b><u>Yatagan-Eskihisar</u></b> <b><u>Mining Area</u></b>	<b><u>Turgut-2</u></b> <b><u>Deposit</u></b>
<b>Ave.Calorific Value(kcal/kg)</b>	<b>: 2100</b>	<b>2310</b>
<b>Ave.Moisture Content (%)</b>	<b>: 36</b>	<b>-</b>
<b>Ave.Dry Ash Content (%)</b>	<b>: 32</b>	<b>32</b>
<b>Ave.Total Sulphur Content (%)</b>	<b>: 1.9</b>	<b>-</b>

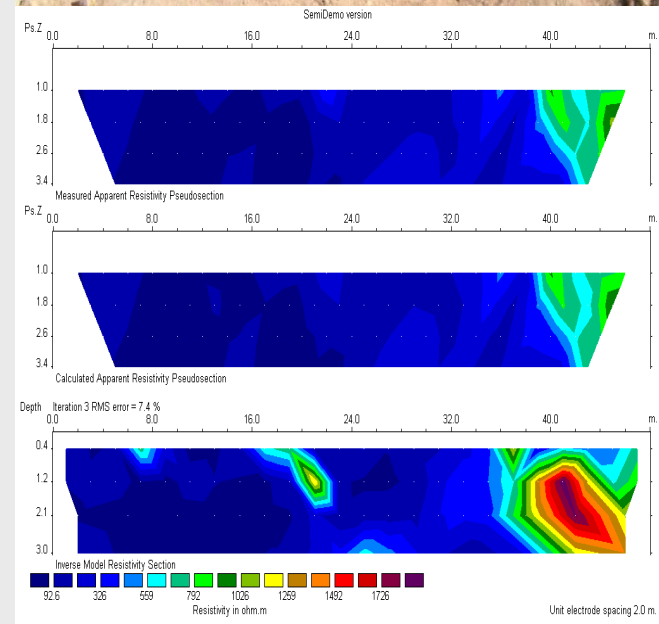
# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Geological Assessment***

## **Archeological Studies**

➤ **200 graves** were exposed in ancient city Stratonikeia by doing detailed geophysical studies by TKI.

## **Other Studies, Test, Analyses**

➤ Chemical, elementary, physical, mineralogical and ash analyses, washability, carbonization, grindability test, combustion of coal in boilers and stoves, ASTM classification, uranium analysis, briquetting, utilization of marl as a raw material of cement



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# ***CASE STUDY: Yatagan-Eskihisar Mining Area Feasibility Assessment***

## **Yatagan-Eskihisar Mining Area: (in operation)**



**Base on  
MINING REPORTS**  
(have feasibility study)

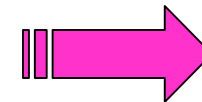
**Production cap.: 3.500.000 t/y**

*Yatagan Power Station: 3.300.000 t/y*

*Household: 200.000 t/y*

## **Turgut-2 Deposit: (not in operation)**

**No prefeasibility  
& feasibility  
study**



**Base on  
GEOLOGIC STUDY**

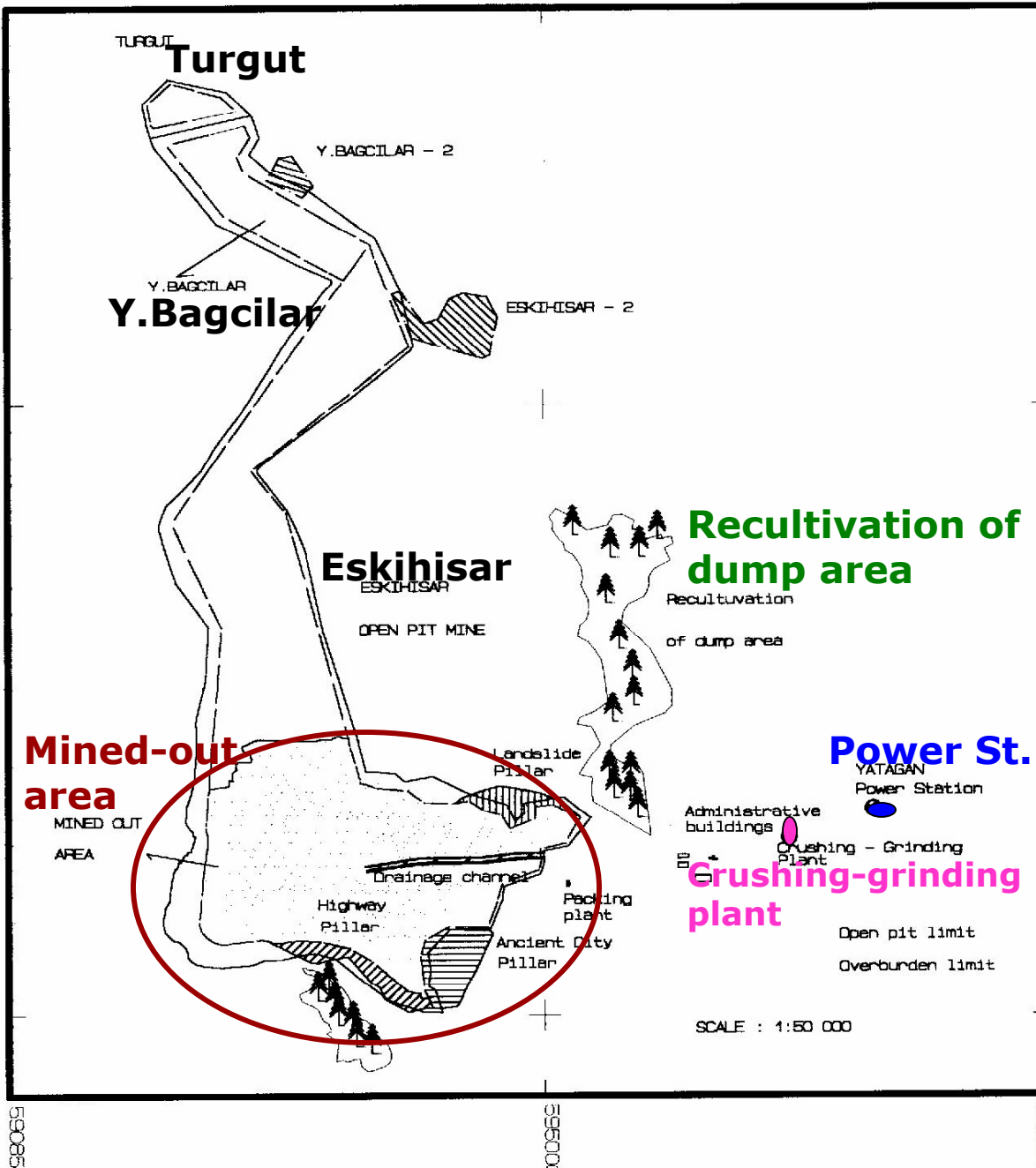
# Layout of the Mining Area

4133246

4135000

4130000

4129346



## Since 1979 in operation

- **Open pit Mining System** (Dragline-Excavator-Truck)
- Production:  
**59.3 Mt** lignite
  - **95%** of total sales to Yatagan Power station
  - **5%** of them to household
- Stripping ratio:  
**4.1 m<sup>3</sup>/ton**
- Calorific Value :  
**2000-2100 kcal/kg**
- Recultivation:  
**600.000 trees on 341 hectare land**

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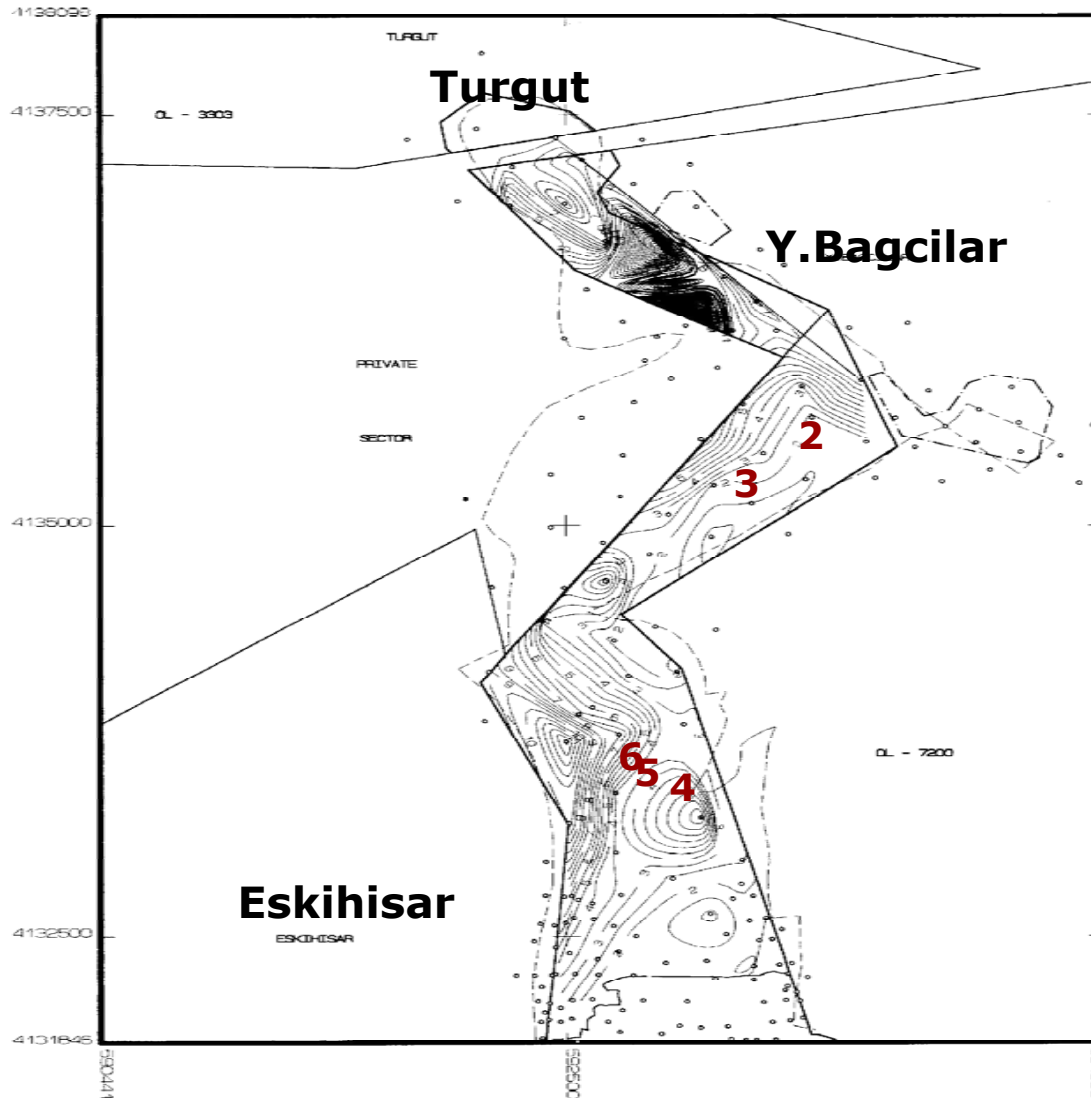
## ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Economic Viability***

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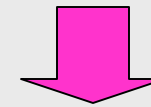
- Factors mainly affecting the economic viability
  - Stripping ratio
  - Competing prices of the other energy sources
  - Expropriation cost

# Stripping Ratio

-Unmined part of the Mining Area



**Ave. Stripping Ratio:**  
**4.1 m<sup>3</sup>/ton**



**Low Production Cost**

***CASE STUDY: Yatagan-Eskihisar Mining Area***  
***Economic Viability-***  
***Competing prices of the other energy sources***

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- Mine is profitable except last three years  
(the loss depends on Transfer Pricing Policy)
- Price of lignite given to the power station is not determined in the competitive market
- In comparison to the other fuel sources at the same calorific value base, the established coal prices are quite low

# ***CASE STUDY: Yatagan-Eskihisar Mining Area***

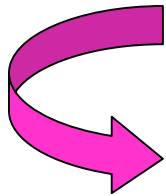
## ***Economic Viability- Expropriation Cost***

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- **Turgut Deposit**

- **Between the Y.Bagcilar and Turgut deposits, there is a coridor shaped deposit owned by private sector**

- **High Expropriation Cost**



- **POTENTIALLY ECONOMIC**

# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Economic Viability***

## **Yatagan-Eskihisar Mining Area:**

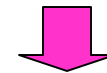
**Eskihisar Deposit : ECONOMIC**

**Y.Bagcilar Deposit : ECONOMIC**

**Turgut Deposit : POTENTIALLY  
ECONOMIC**

## **Turgut-2 Deposit:**

**Preliminary Economic  
Viability may be  
estimated from the  
comparable mining  
operations**



**INTRINSICALLY  
ECONOMIC**

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# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Comparision of Classification Results***

## **Classification of the Deposits According to Turkish Classification System**

(1000 t)

	OL*	Deposit	Proved	Probable	Possible	Developed	TOTAL
<b>Eskihisar Mining Area</b>	7200	Eskihisar	36,918 (33,226)	-	-	404	37,322
		Y.Bagcilar	8,107 (7,296)	-	-	-	8,107
	3303	Turgut	1,327 (1,194)	-	-	-	1,327
	<b>Total (in operation)</b>		<b>46,352</b> <b>(41,717)</b>	-	-	<b>404</b> <b>(404)</b>	<b>46,756</b> <b>(42,120)</b>
	Pillars**		8,266	-	-	-	8,266
<b>Turgut-2</b>	<b>3303</b>	<b>Turgut-2</b>	<b>4,222</b> <b>(3,800)</b>	-	-	-	<b>4,222</b>
<b>TOTAL</b>			<b>58,840</b> <b>(45,517)</b>			<b>404</b> <b>(404)</b>	<b>59,244</b> <b>(45,921)</b>

\* Operating Licence numbers

\*\* Pillars left for ancient city, landslide and Milas highway

\*\*\* ( ) Extractable reserve

# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Comparision of Classification Results***

## **Classification of the Deposits Based on UNFC**

<b><u>Deposit</u></b>	<b><u>Code</u></b>	<b><u>Term</u></b>
<b><u>Yatagan Eskihisar Mining Area</u></b>		
Yatagan+ Y.Bagcilar Deposits	<b>111</b>	Proved Mineral Reserve
Turgut Deposit	<b>2:1;1;1</b>	Feasible Mineral Resource
<b><u>Pillars</u></b>	<b>311</b>	Abandoned Mineral Resource ?
<b><u>Turgut-2 Deposit</u></b>	<b>3;3;2</b>	<u>Indicated Mineral Resource</u>

 **111<sub>e</sub>**      **Extractable Reserve**

 **“Exploration During Exploitation” term was added.**

# Classification of the Deposits Based on UNFC

(1000 t)					
UN FRAMEWORK CLASSIFICATION	ULUSAL SISTEM	Detail Exploration/ Exploration During Exploitation	General Exploration	Prospecting	Reconnaissance
		<i>Detay Arama/ İşletme Dönemi Aramaları</i>	<i>Genel Arama</i>	<i>Prospeksiyon</i>	<i>Ön Arama</i>
Feasibility Study and/or Mining Report	<i>Fizibilite Çalışması ve/veya Madencilik Raporu</i>	1 45,429 (111)* 40,886 (111 <sub>e</sub> )**	usually		
		2 1,327 (211)***			
		3 8,266 (311)****			
Prefeasibility Study	<i>Ön Fizibilite Çalışması</i>	1 (121)	+ (122)	not	
		2 (221)	+ (222)	relevant	
Geologic Report	<i>Jeolojik Rapor</i>	(1-2) (331)	(1-2) 4,222	(1-2) (333)	(1-2) (334)
Economic Viability Categories:		1: Economic 2: Potentially Economic	1-2: Economic to Potentially Economic (Intrinsically Economic)		
<p>* <i>Eskihisar and Y.Bagcilar Deposits</i></p> <p>** <i>Extractable reserve of Eskihisar and Y.Bagcilar deposits</i></p> <p>*** <i>Turgut Deposit</i></p> <p>**** <i>Pillars left for ancient city, landslide and Milas highway</i></p> <p>***** <i>Turgut-2 deposit</i></p>					
<i>Date: July 2003</i>					

## ***CASE STUDY: Yatagan-Eskihisar Mining Area Comparision of Classification Results***

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- Main difference btw National System and UNFC;
  - National system bases on geological assessment (G)
  - UNFC bases on economic viability(E), feasibility assessment(F) and geological assessment (G) .

# ***CASE STUDY: Yatagan-Eskihisar Mining Area*** ***Comparision of Classification Results***

<u>Deposit</u>	<u>NATIONAL SYSTEM</u>		<u>UNFC</u>	
	<u>Term</u>	<u>Quantity</u> (Mt)	<u>Term</u>	<u>Quantity</u> (Mt)
<b><u>Y.Eskihisar Mining Area</u></b>				
Eskihisar Deposit	Proved Reserve	37.3	→ Proved Mineral Reserve	37.3
Y.Bagcilar Deposit	Proved Reserve	8.1	→ Proved Mineral Reserve	8.1
Turgut Deposit	Proved Reserve	1.3	→ <i>Feasible Mineral Resource</i>	1.3
Pillars	Proved Reserve	8.3	→ <i>Abandoned Mineral Reso.</i>	8.3
<b><u>Turgut-2 Deposit</u></b>	Proved Reserve	4.2	→ <i>Indicated Mineral Resource</i>	4.2
		<b>TOTAL RESERVE 59.2</b>	→	<b><i>TOTAL MINERAL RESOURCE 59.2</i></b>

**Total Extractable Reserve 45.9** → Extractable Min.Reserve 40.9



**13.8 Mt difference in Proved Mineral Reserve**

# CONTENT

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- **Position of Lignite in Turkish Energy Sector**
- **Position of TKI in Turkish Lignite Sector**
- **Position of Yatagan-Eskihisar Mine in TKI**
- **Classification System Used in Turkey**
- **UNFC applied to Coal, Uranium & Other Minerals-  
a comparison with previous version**
  
- ***Case Study: Yatagan-Eskihisar Mining Area***
  - **Geological Assessment**
  - **Feasibility Assessment**
  - **Economic Viability**
  - **Comparison of Classification Results**
  
- ***Conclusion and Recommendations***

# CONCLUSION and RECOMMENDATIONS

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- UNFC can be well adapted to Turkish lignite deposits
- Main difference btw National System and UNFC;
  - National system bases on geological assessment (G)
  - UNFC bases on economic viability, geological & feasibility assessment.
- UNFC provides a guideline in preventing terminology chaos

# CONCLUSION and RECOMMENDATIONS

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- **Benefits gained by the study:**
  - All related data were collected, analysed and put into an order in the form of geological & feasibility assessment, and economic viability
  - Consistency of the reserves/resources figures among the operation management and TKI Headquarter was provided by re-estimation and evaluation of the deposits
  - Operation management will carry out its planning studies for the future base on more reliable information.
  - This study will be taken as a model for the classification of the other basins

# CONCLUSION and RECOMMENDATIONS

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- ***Recommendations for the future studies:***
  - The most commonly used cut off values in the reserve/resource estimation should be complied countrywide. Hence they should be used as a generalized or predefined criteria for reserves/resources estimations
  - All information derived should be stored into a shared database for easily updating the classification due to change in the conditions
  - Extensive, systematic training program should be initiated countrywide

# PRACTICAL APPLICATION OF THE UNFC to the TURKISH LIGNITE DEPOSITS-

A CASE STUDY: Yatagan –Eskihisar Mining Area

**Adaption to the Final Version of UNFC**

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 *Thank You For Your  
Attention*

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