COAL AND COAL BED METHANE STUDIES IN TURKEY

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OUTLINE

- Introduction
- Structure of the Turkish Coal Sector
- Coal Potential
- Production & Consumption
- Coal in Electricity Generation
- Major CBM developments in Coal Sector

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World Figures

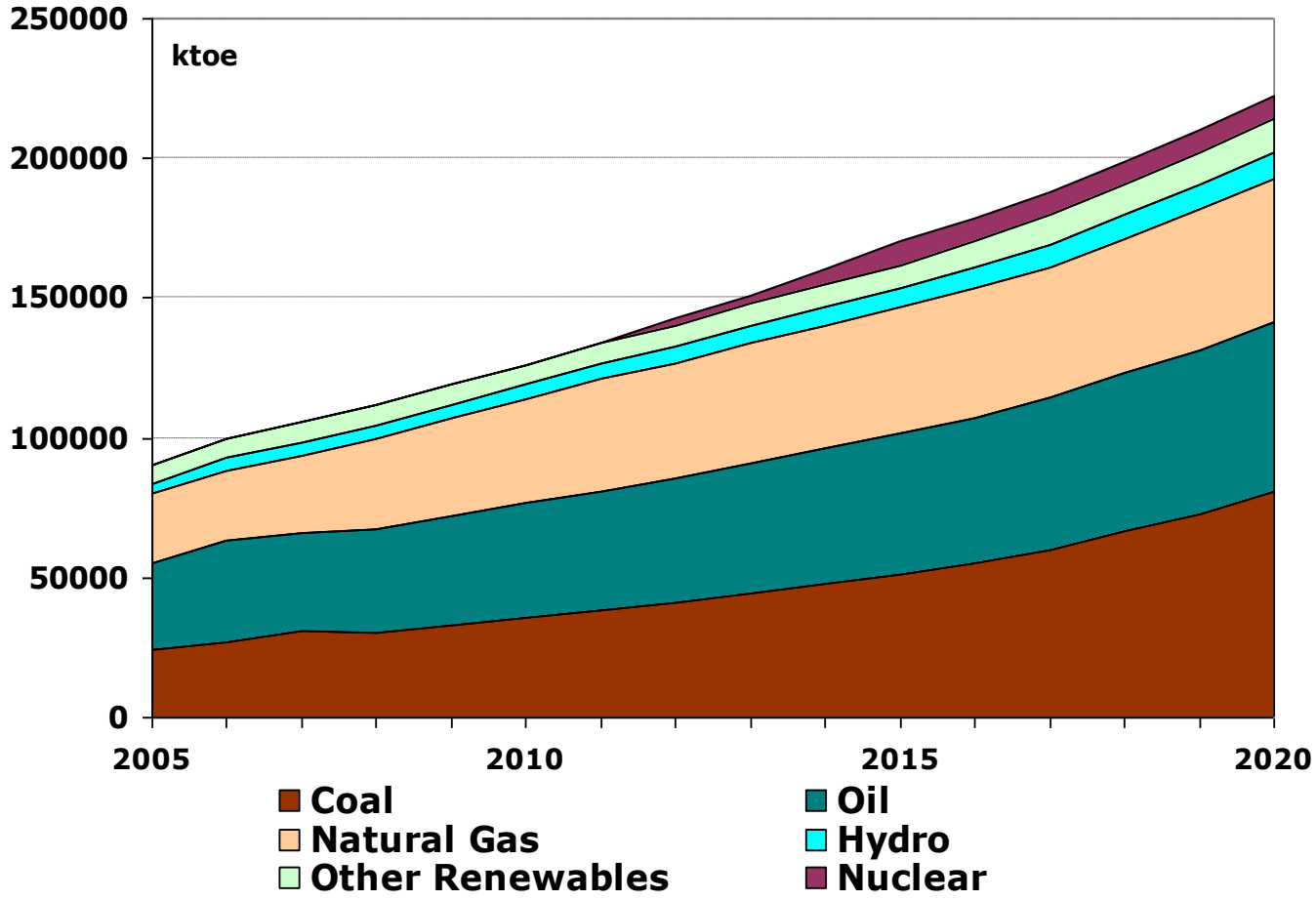
Coal;

- **supplying 30% of global primary energy needs**
- **generating 41% of the world's electricity**
- **Providing more than 7 million jobs and**
- **investing in developing countries (>US$7 billion in 2010)**

plays a significant role as an energy source and in sustainable development,

According to the IEA scenarios, coal will continue to be a dominant resource in the future (overtake oil in the Current Policy Scenario)

TPES by sources (Projection)



The same can be said also for Turkey

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Sector

- State-owned companies operating in the sector:
  - TTK Turkish Hard Coal Enterprise
  - TKI Turkish Coal Enterprises
  - EUAS Electricity Generation Company
  - MTA Mineral Research and Exploration Company

- TTK was the only company dealing with hard coal production till 2004 but a royalty system was put into practice to increase production, Currently some of the hard coal production in the area is done by private sector

- TKİ produces about half of all lignite production (app,49% in 2012)

- EUAS produces lignite for its power plants (app, 462 in 2012)

- MTA carry on exploration studies
- Private companies produce around 9% of total lignite production and currently around 35 % of total hard coal production

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- Coal potential has been studied in addition to the existing reserves especially for lignite,

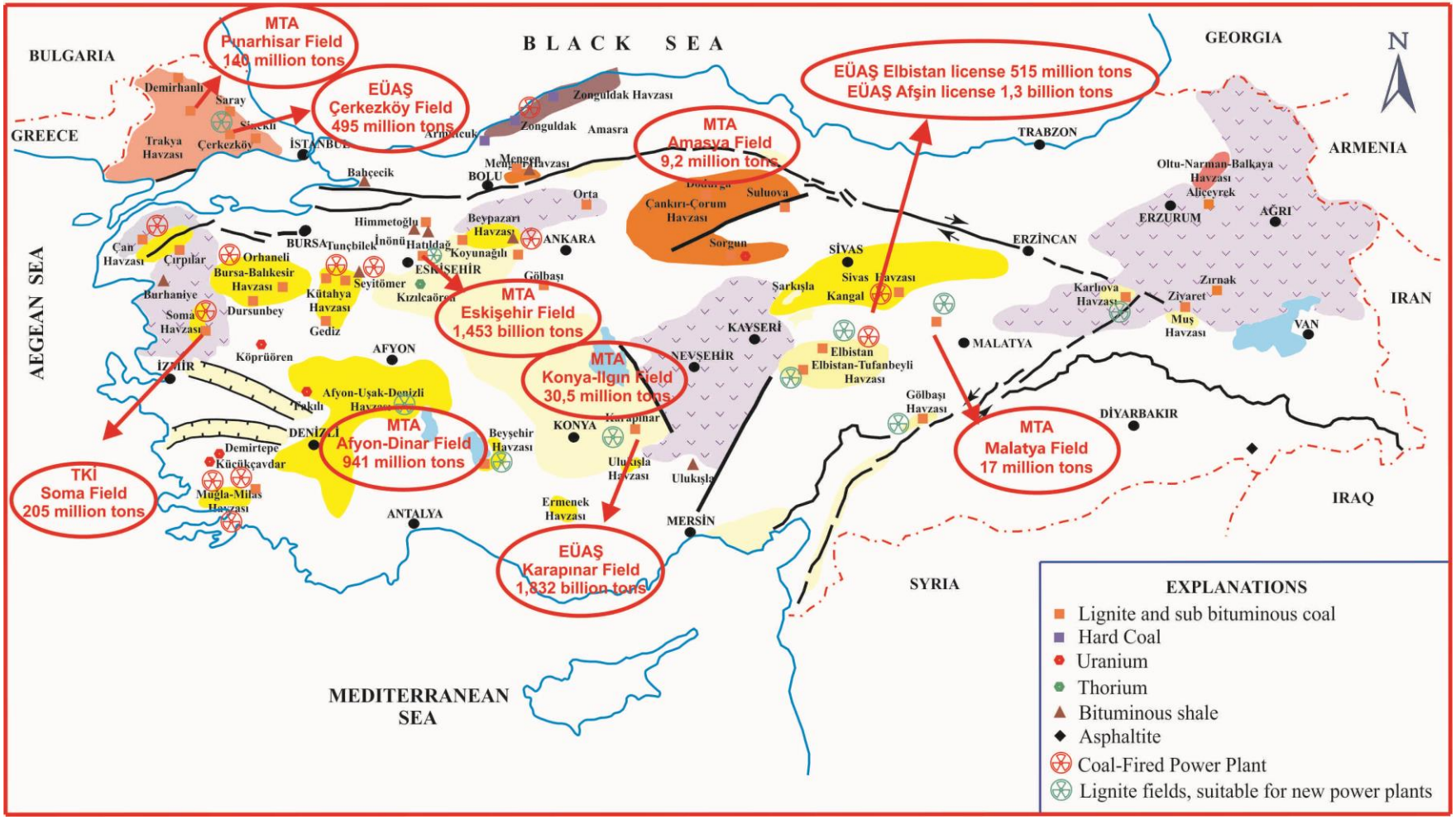
- By exploration studies starting from the year 2005 additional lignite reserves have been found through the country,

- By the addition of these reserves, total lignite reserve reaches to 14,7 billion tonnes,

LIGNITE - HARD COAL FIELDS and RESERVES of TURKEY

LIGNITE RESERVES (Before 2005): 8,3 billion tons

NEW EXPLORED FIELDS and ADDED RESERVES by MTA (Between 2005 - 2014) : 6,93 billion tons



Lignite Reserves (million Ton)

Possible	28
Probable	726
Proven	13,968
Total	**14,723**

The calorific value of lignite reserves varies between 1000 kcal/kg and 4200 kcal/kg

Hard Coal Reserves (1000 Ton)

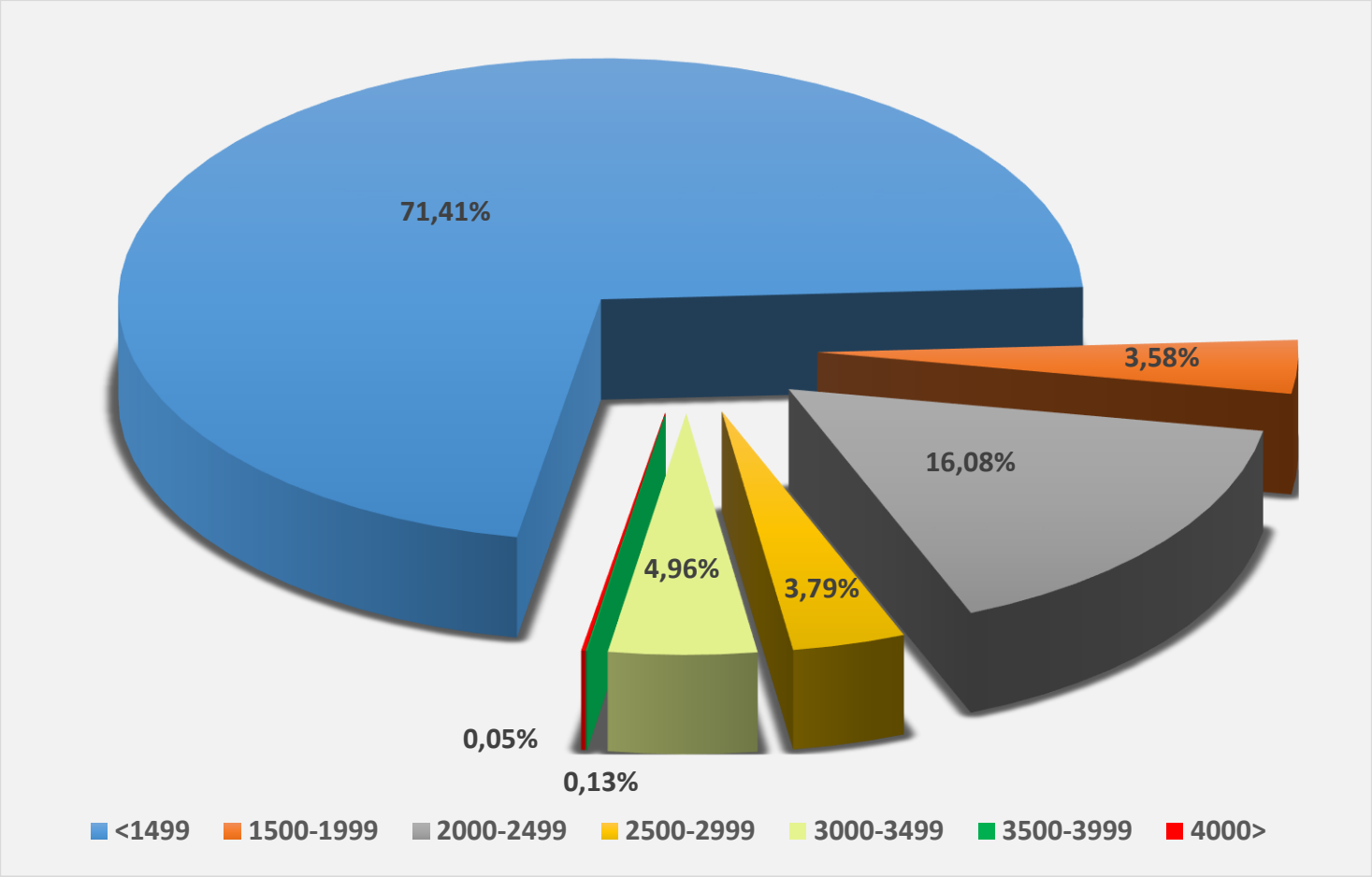
Possible	368,447
Probable	424,955
Proven	520,114
Total	**1,313,516**

The calorific value of hard coal reserve varies between 6200 kcal/kg and 7200 kcal/kg

Distribution of Lignite Reserves

	RESERVE (Bin Ton)			
ESTABLISHMENT	**PROVEN**	**PROBABLE**	**POSSIBLE**	**TOTAL**
EÜAŞ	7,872,278	133,706	2,964	8,008,948
TKİ	1,910,759	184,005	25,030	2,119,794
MTA	1,974,905	408,350		2,383,255
Private Sector	2,210,552			2,210,552
TOPLAM	**13,968,494**	**726,061**	**27,994**	**14,722,549**

Rank of Lignite Reserves



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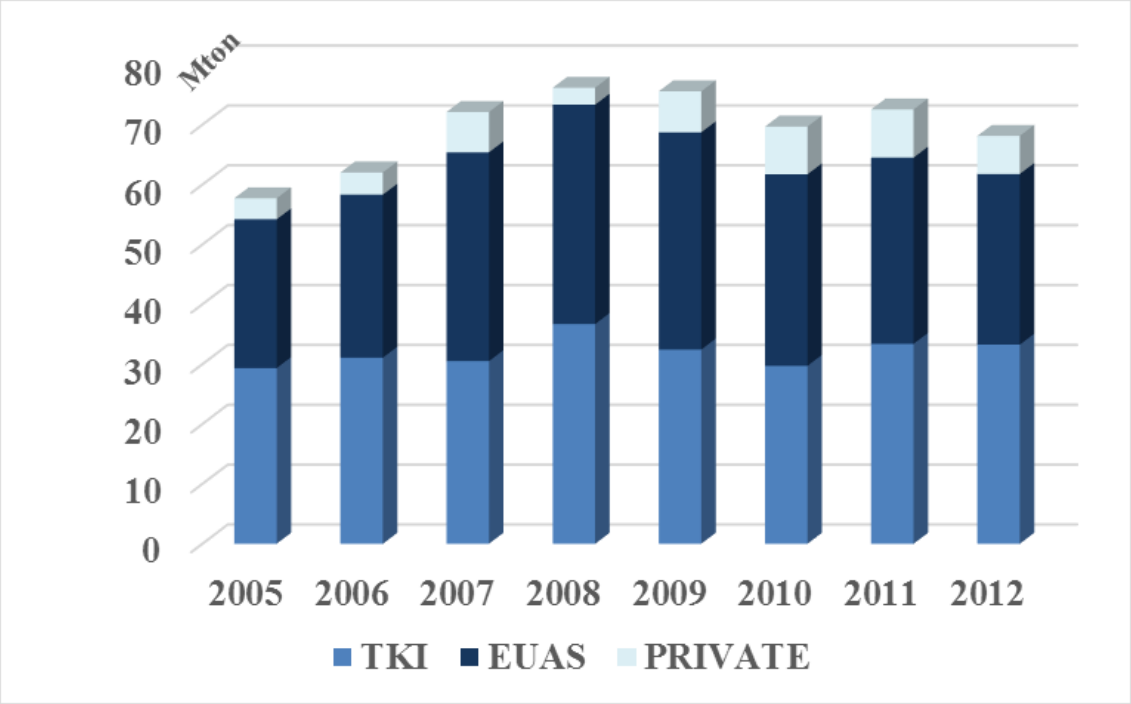
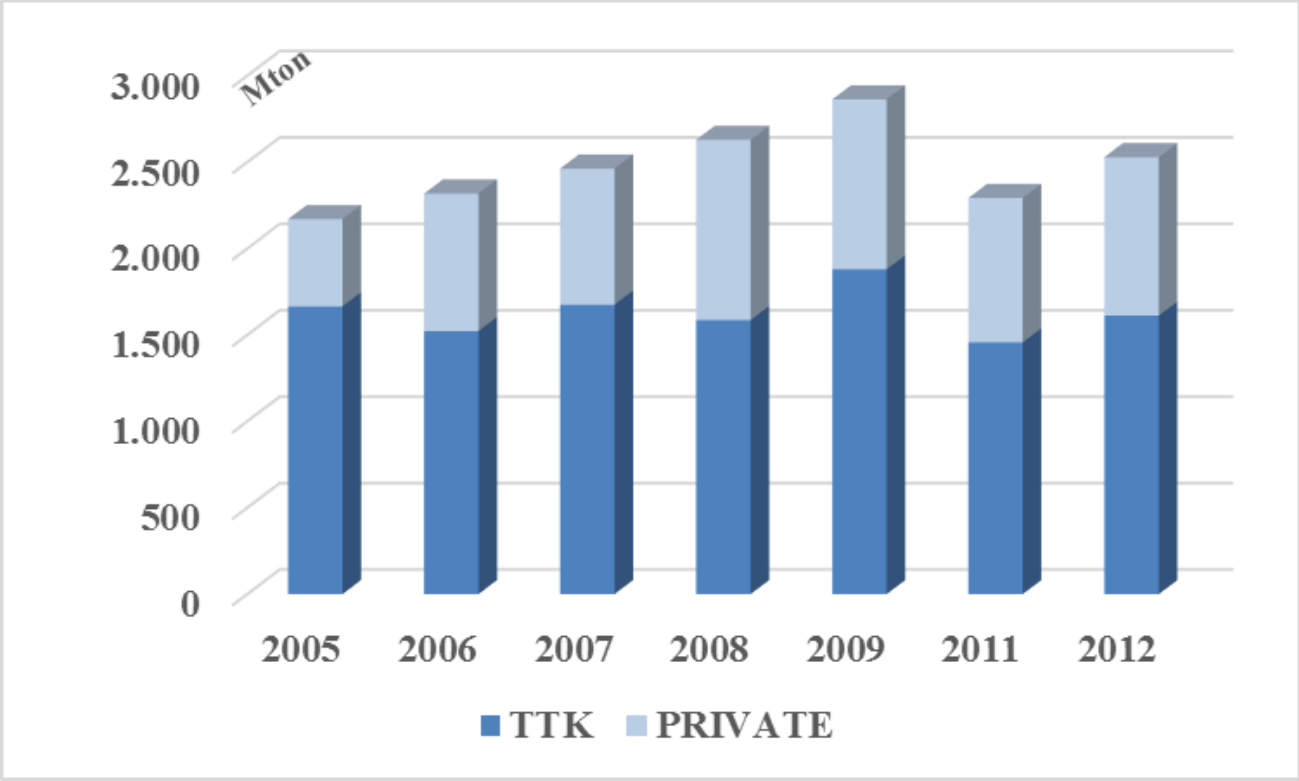
Lignite Production (1000 tonnes)

	2005	2006	2007	2008	2009	2010	2011	2012
TKI	29,359	31,074	30,526	36,697	32,451	29,713	33,401	33,270
EUAS	24,844	27,243	34,871	36,658	36,267	32,009	31,102	28,507
PRIVATE	3,505	3,706	6,724	2,816	6,858	7,976	8,047	6,348
TOTAL	**57,708**	**62,023**	**72,121**	**76,171**	**75,576**	**69,698**	**72,550**	**68,125**



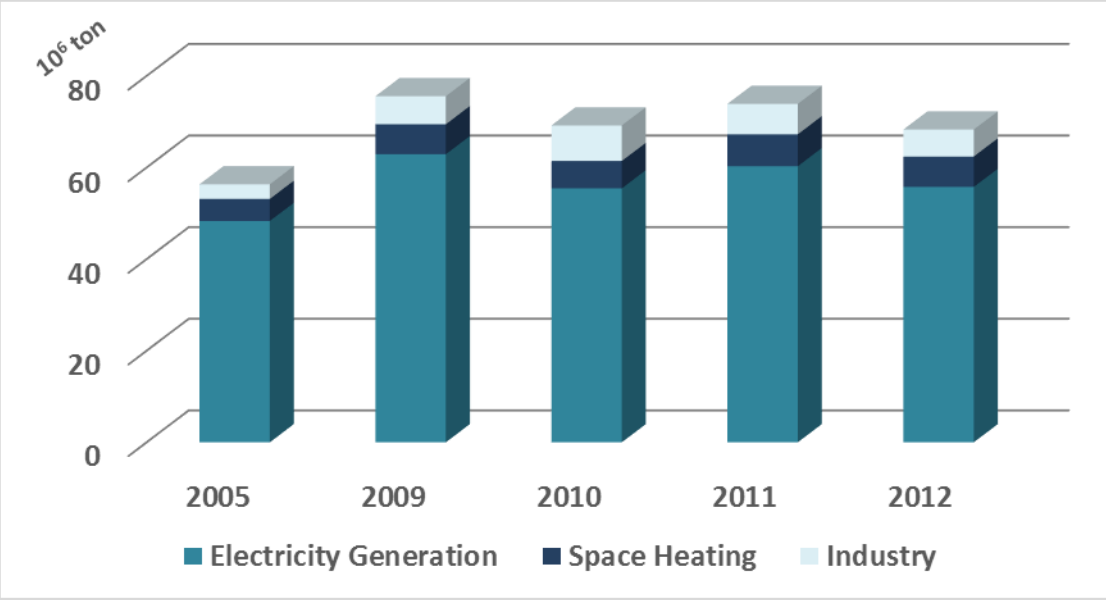
Hard Coal Production (1000 tonnes)

	2005	2006	2007	2008	2009	2011	2012
TTK	1,665	1,522	1,675	1,586	1,880	1,457	1,612
PRIVATE	505	796	787	1,043	983	835	916
TOTAL	**2,170**	**2,318**	**2,462**	**2,629**	**2,863**	**2,292**	**2,528**



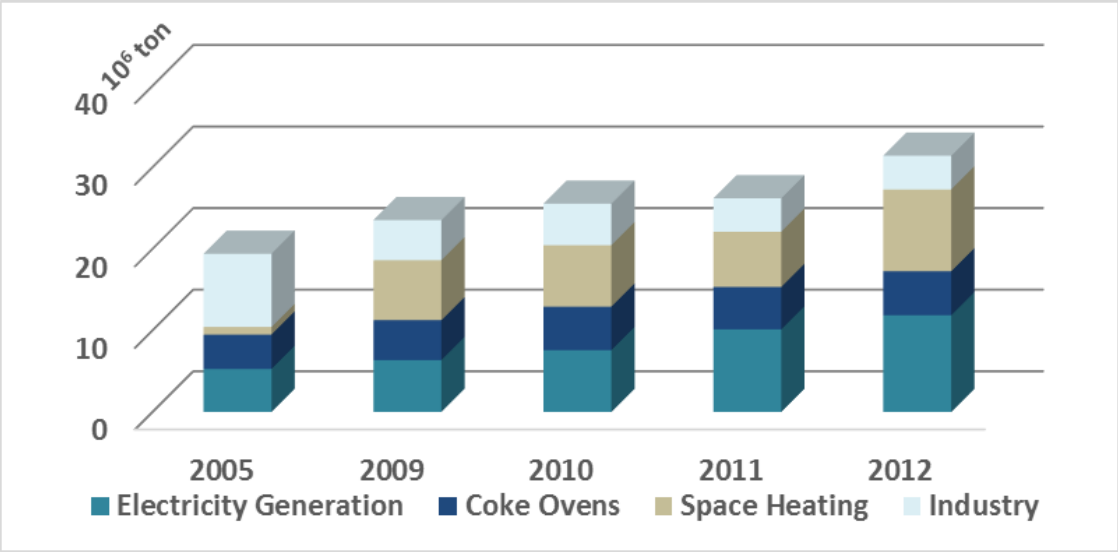
Lignite consumption by sectors (1000 ton)

	2005	2009	2010	2011	2012
Electricity Generation	48,319	62,894	55,436	60,271	55,742
Space Heating	4,807	6,530	5,983	6,976	6,637
Industry	3,202	6,142	7,753	6,634	5,894
Gross Consumption	**56,571**	**75,641**	**69,239**	**73,933**	**68,461**



Hard Coal consumption by sectors(1000 ton)

	2005	2009	2010	2011	2012
Electricity Generation	5,259	6,361	7,582	10,116	11,854
Coke Ovens	4,218	4,900	5,322	5,201	5,392
Space Heating	935	7,340	7,527	6,773	10,022
Industry	8,970	4,918	5,090	4,105	4,141
Gross Consumption	**19,421**	**23,698**	**25,568**	**26,228**	**31,460**



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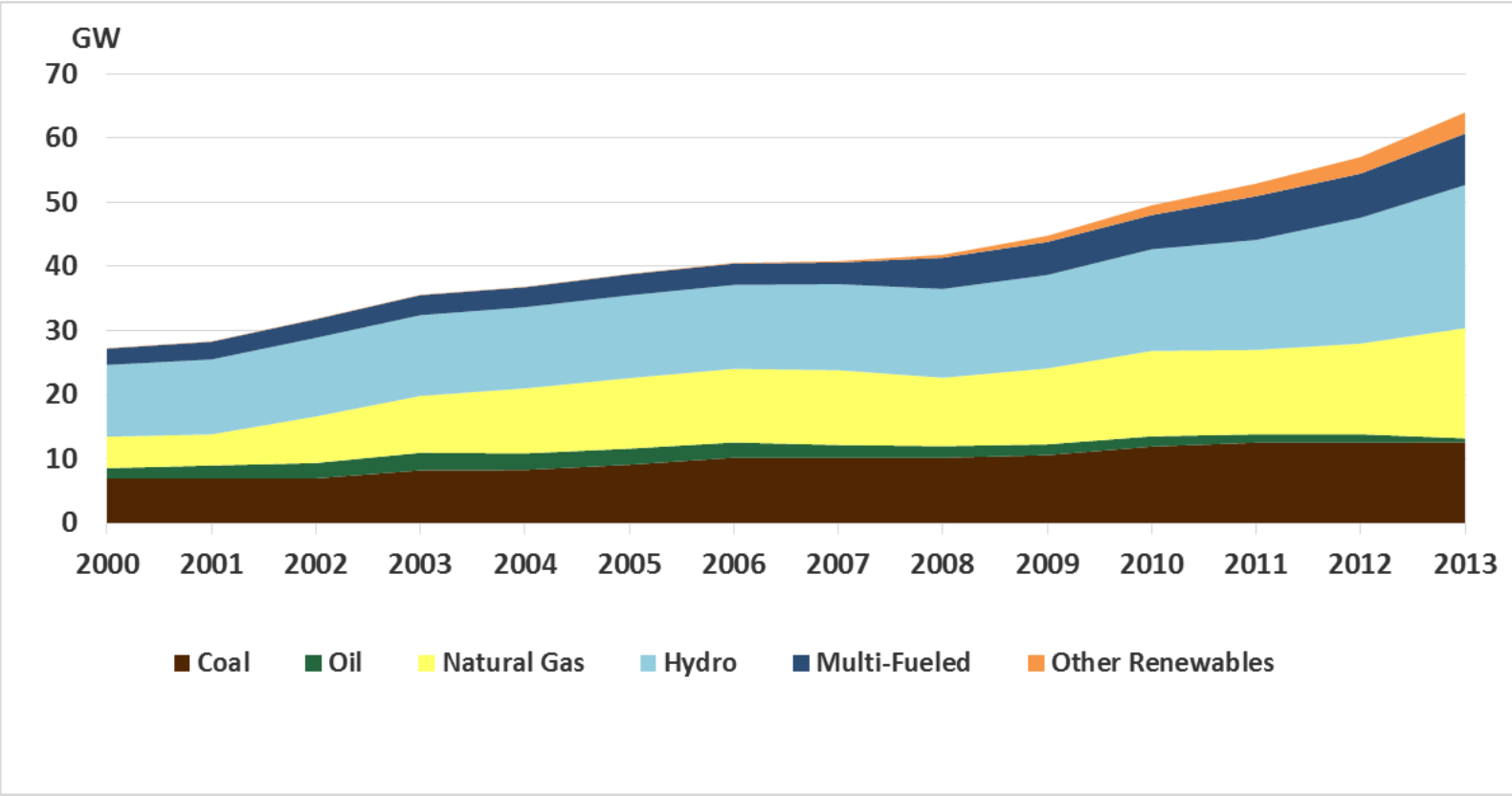
Installed Capacity by Fuel Type (2000-2013)



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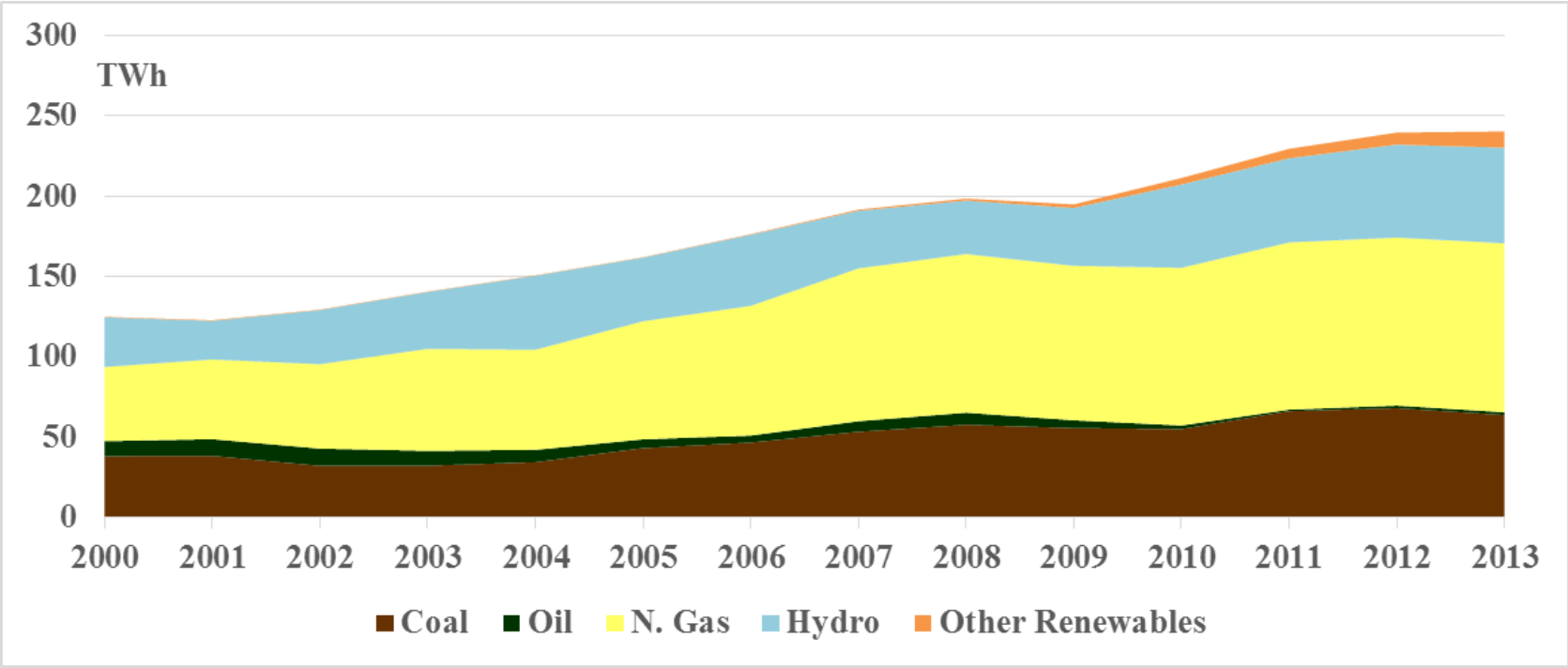
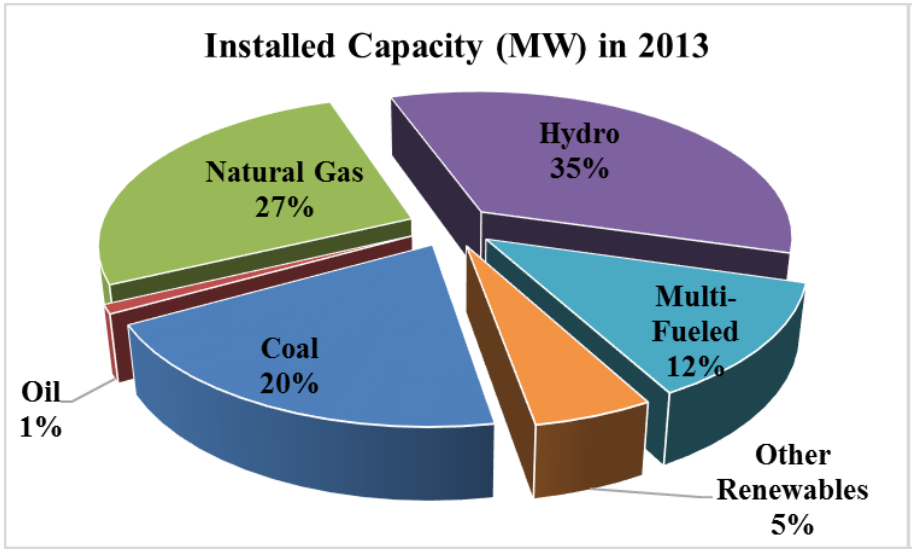
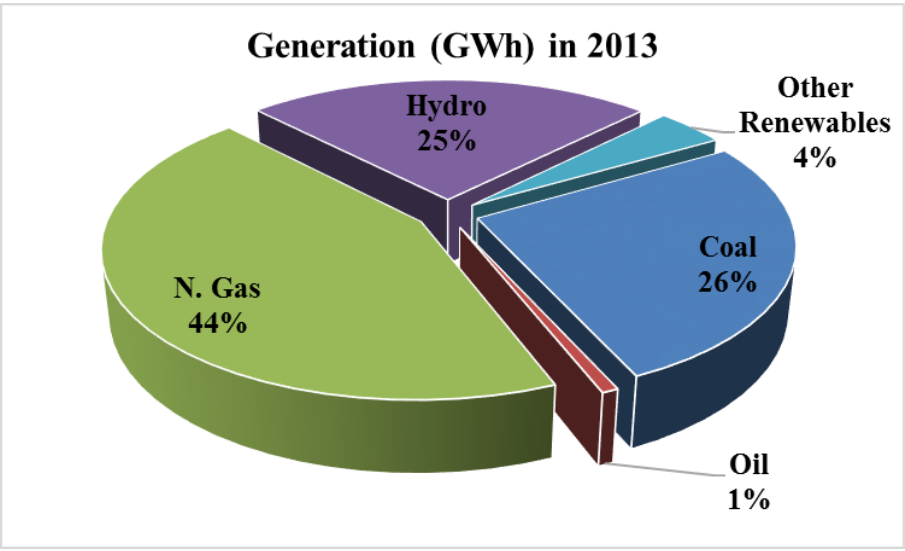


Installed Capacity and Generation by Fuel Type in 2013





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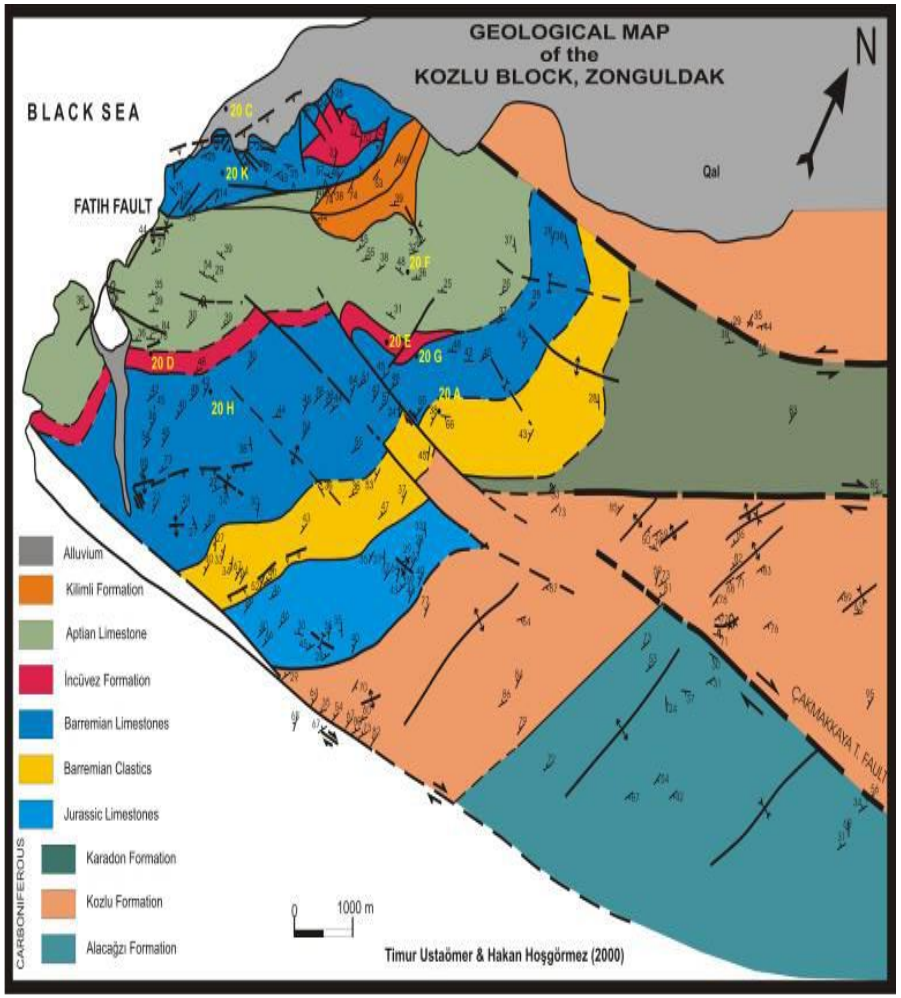
CBM Exploration and Utilization Project-TTK



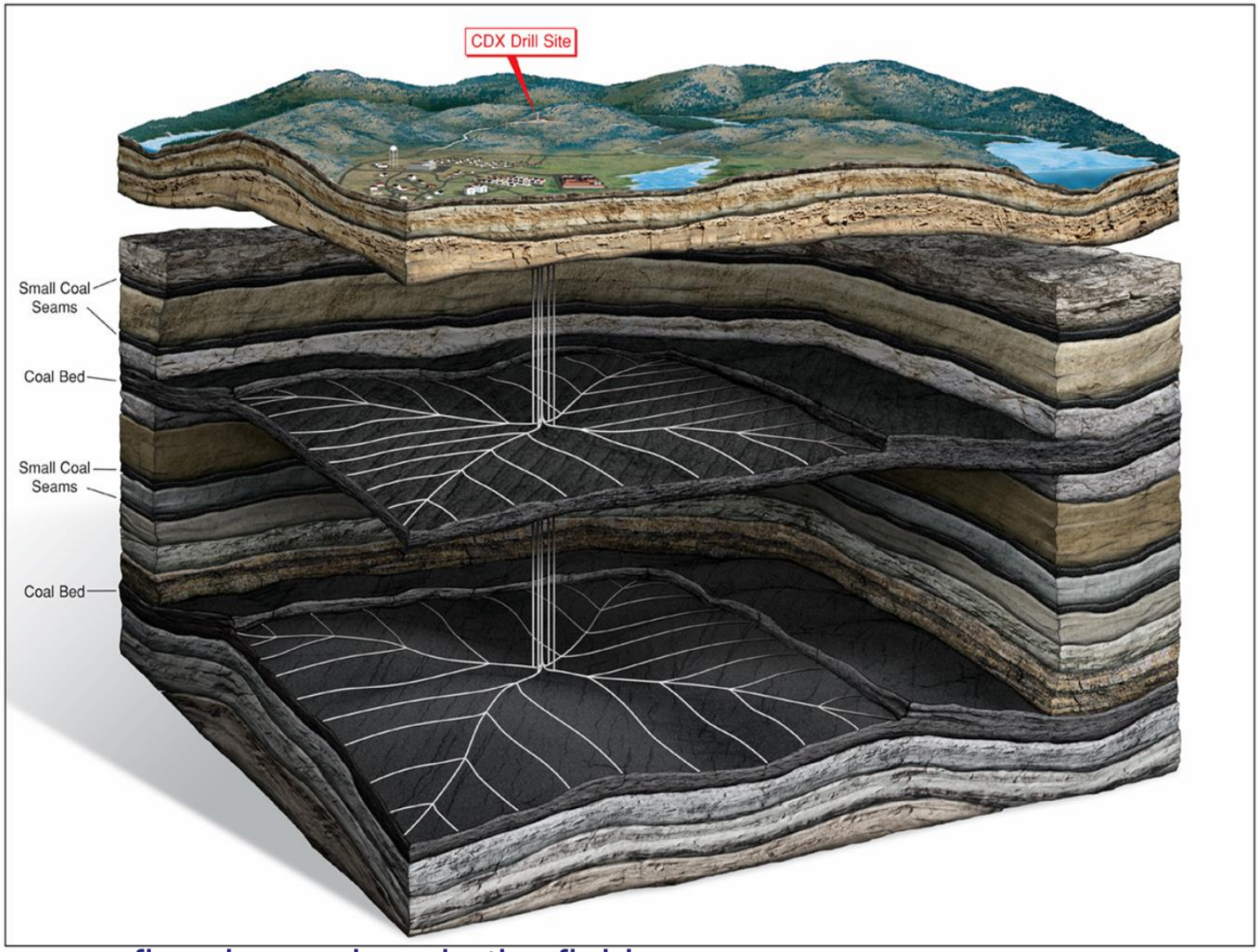
- ***Geological Map of Kozlu***

The Zonguldak Coal field is situated on the Western Black Sea coastal region of Turkey which is the principal hard coal field. The coalfield is operated by state company of TTK.

The Zonguldak coalfield is characterised by mountanious surface terrain and highly complex geology of the coal measures which are heavily folded, with seam continuity being adversly affected by severe faulting and unconformities.

The coal measures of the Zonguldak coalfield is comprised primarily of sandstones, shales, conglomeratic sandstones, silstones and coals, occuring in a series of rhythmic or cyclic sequences.

CBM Exploration and Utilization Project-TTK



There are five deep mines in the field..

Coal seams contain high level of methane gasses in Zonguldak coal field. It is necessary to drain methane during production and to utilize produced methane.

CBM Exploration and Utilization Project-TTK

•Starting from the year 1972, the studies for coal bed metane have been carried out. However, studies were mostly related with safety concerns to be able to get rid of accidents (methane drainage)

•In 1972, METU found that the average methane content was 28.73 m^3/ton in Kozlu District of Zonguldak Basin.
•The methane drenage system constructed in Kozlu TIM wsa worked for abot 3.5 years but didn't kept out due to high investment costs.

•Later, Novacorp and Canteck Consultants carried out a series of tests in underground conditions by drilling short holes in 1987 and 1988. The calculated gas content found to be between 5-16 m^3/ton by standart desorption methods.

CBM Exploration and Utilization Project-TTK

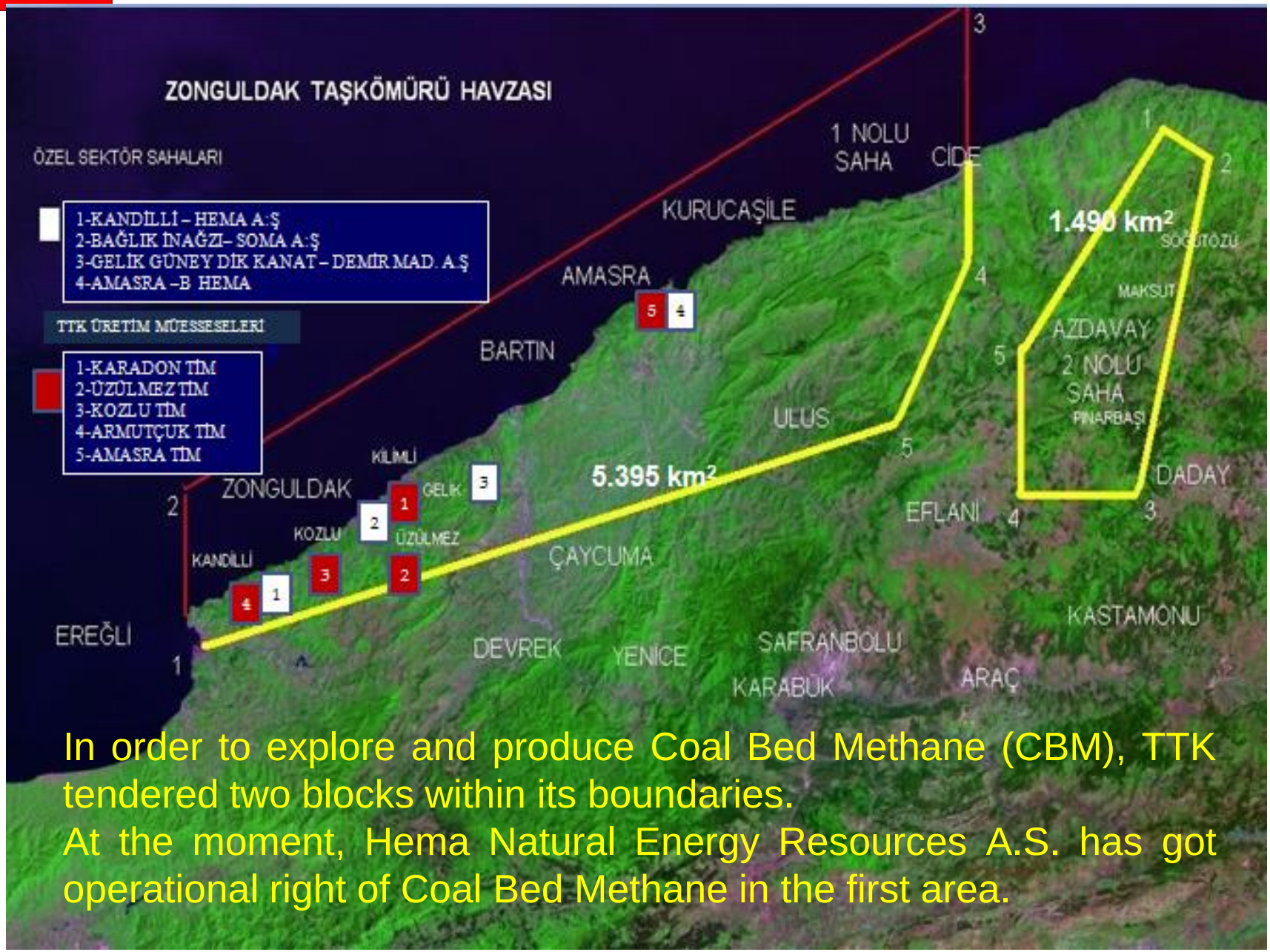
•In 1991, The study carried out by TUBİTAK (The Scientific and Technological Research Council of Turkey) pointed out the existing around 600 bcm of CBM in the region.

•In these early phases, surface drilling activities were done through the mid-1970's. A total of 431 holes and 305.000 meters were drilled through 1993. The majority of all drilling was completed with rotary drill rigs. Drilling with core rigs didn't begin until 1987's and this method offered vast improvments in sample collection and coal seam correlation.

•In 08,03,2005 a contract has been signed by TTK and HEMA Cooperation, By this agreement the region is contracted to the company by 15 years including 2 years exploration studies,

•The studies within the context of the agreement have been carried out by the compony in the region, Recently, it is assummed that there exist around 60 bcm of CBM potential which 10 bcm of it can be recoverable,

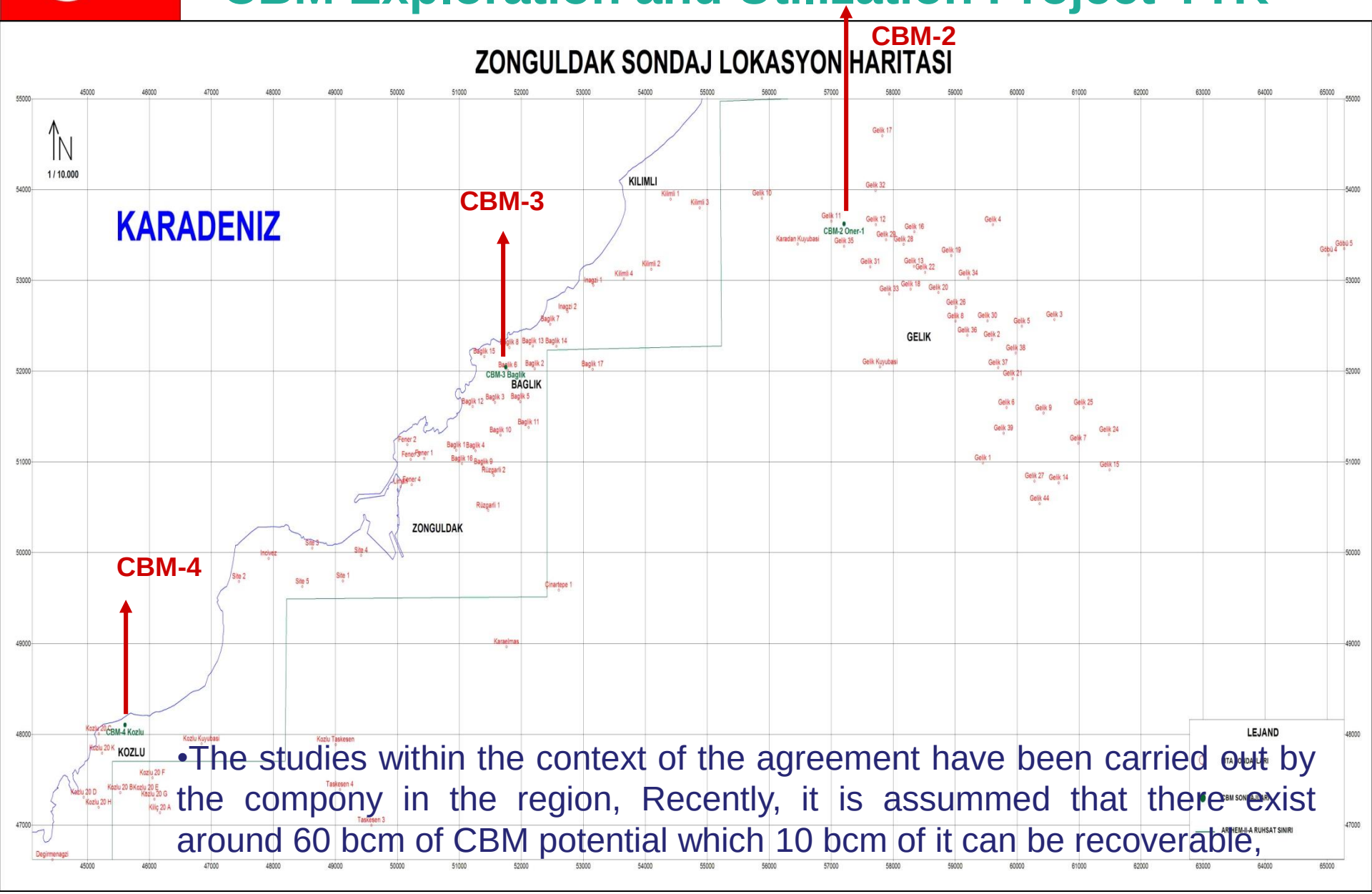
CBM Exploration and Utilization Project-TTK



In order to explore and produce Coal Bed Methane (CBM), TTK tendered two blocks within its boundaries.

At the moment, Hema Natural Energy Resources A.S. has got operational right of Coal Bed Methane in the first area.

CBM Exploration and Utilization Project-TTK



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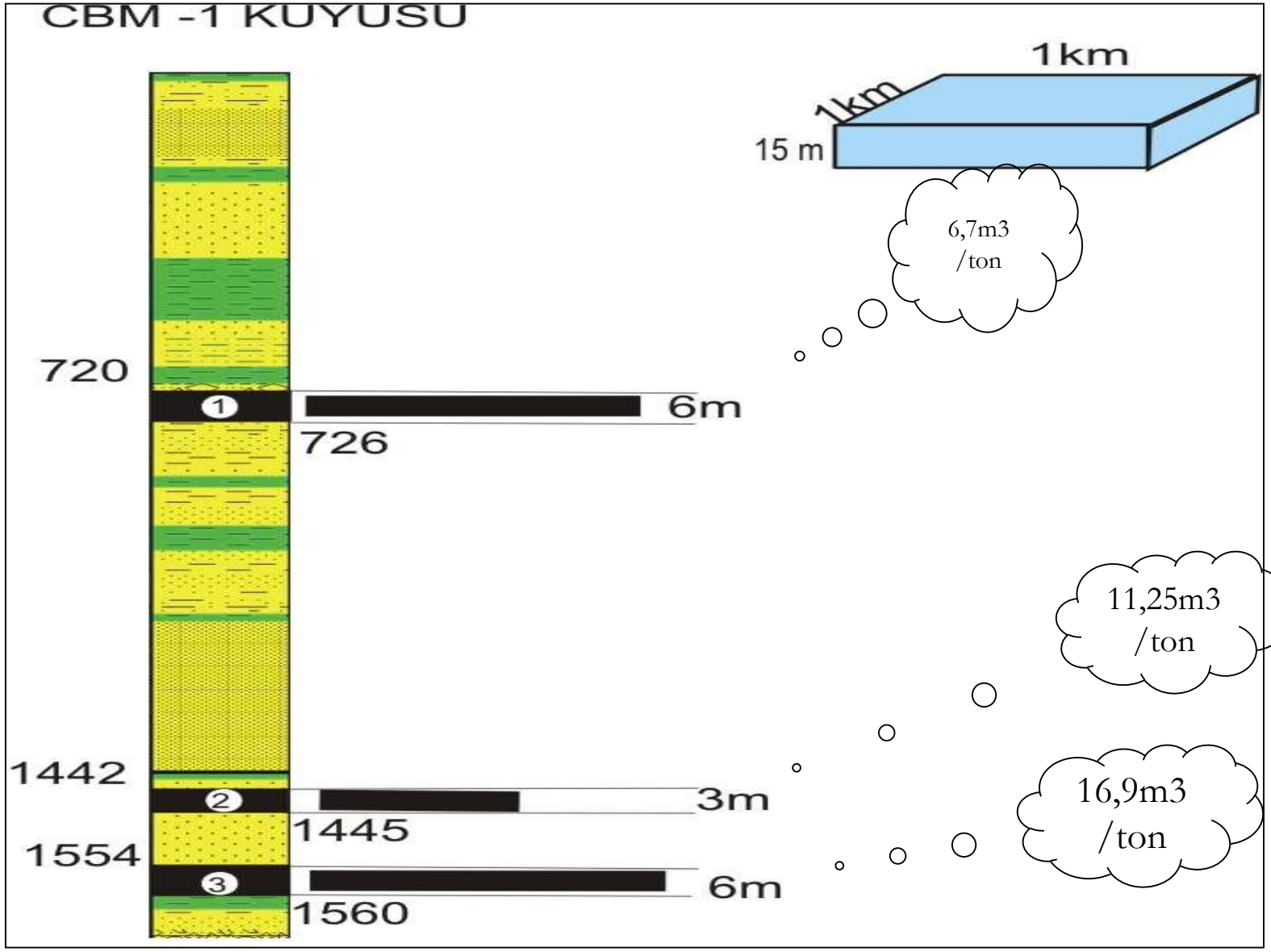

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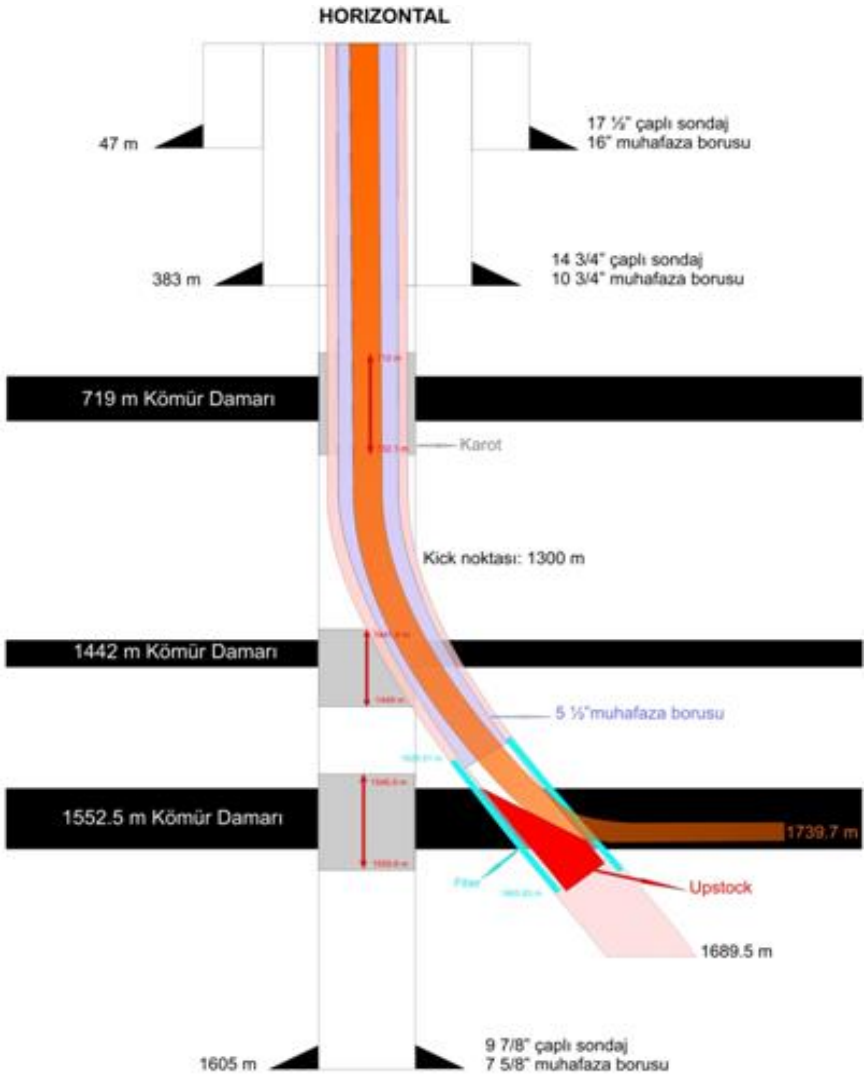


Horizantal Drilling for Seam 3

The ability to access and develop well sites in some of the lease areas is hampered by the fact that some of the lease areas are populated, leaving limited area for drilling

To minimize the drilling footprint, we plan to drill multiple, directional wells from a single pad. This technique will also allow us to access some of the offshore CBM resources.

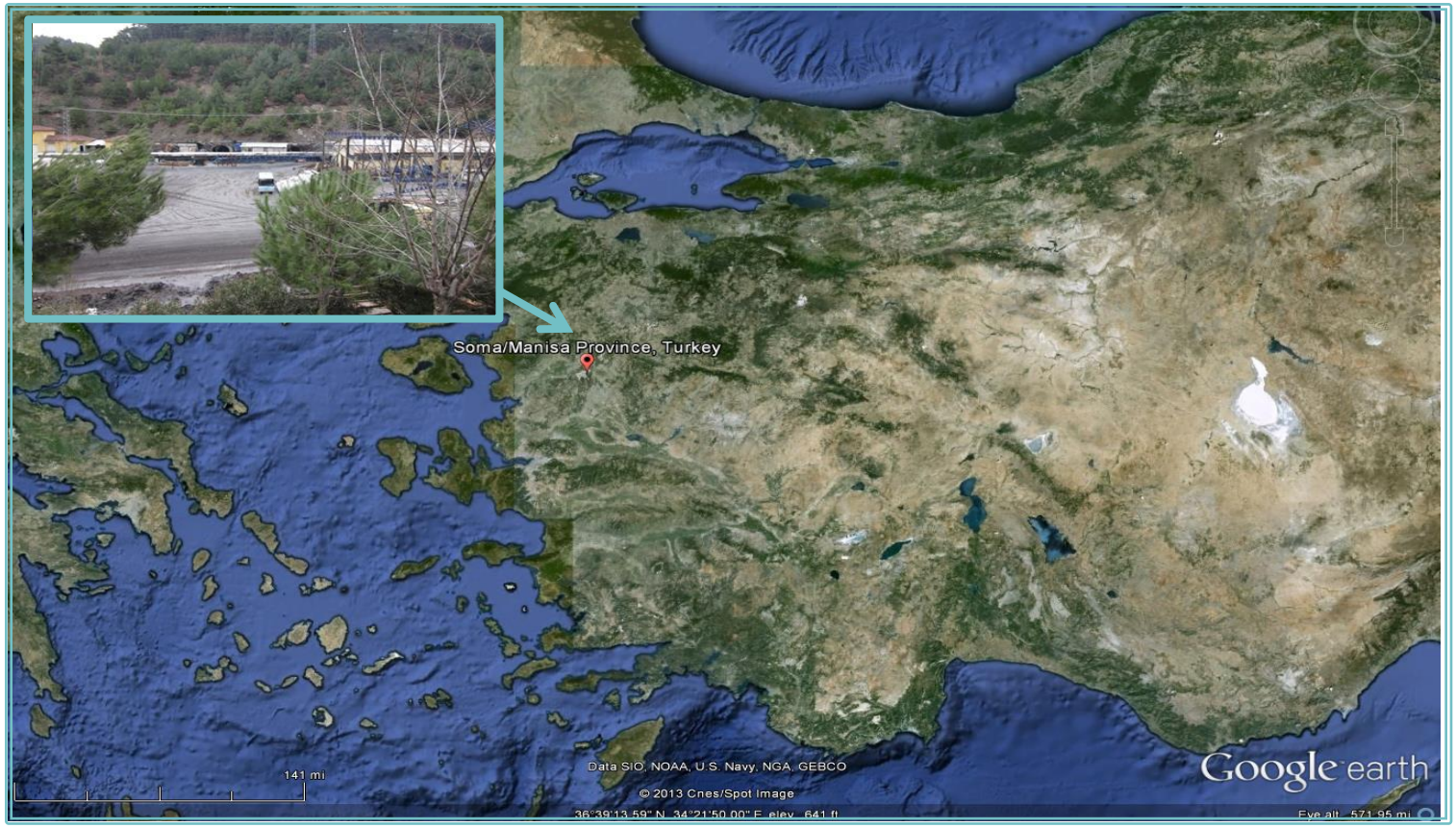
CBM Exploration and Utilization Project-TTK

GAS IN PLACE ESTIMATE								
	Prospective CBM Area		Gas In Place (Bcm)			Gas In Place (Bcm/km^2)		
Location	hectares	km^2	Low	Best	High	Low	Best	High
Armuctuk Core	2,116	21	0.41	1.71	4.70	0.02	0.08	0.22
Armuctuk Prospective	3,221	32	0.30	1.22	6.55	0.01	0.04	0.20
Amasra Core	8,377	84	4.45	18.02	29.68	0.05	0.22	0.35
Amasra Prospective	26,037	260	9.17	32.84	57.34	0.04	0.13	0.22
Amasra Extension	50,322	503	31.51	105.33	137.51	0.06	0.21	0.27
Zonguldak Core	10,395	104	1.84	7.48	17.26	0.02	0.07	0.17
Zonguldak Perspective	11,565	116	2.23	9.86	17.04	0.02	0.09	0.15

*Prospective CBM has been discounted for areas without coal accumulation and geologic uncertainty based on well lithology and geological structure

CBM Exploration and Utilization Project-TTK

Degasification of Soma-Eynez Coal Resources-TKİ



TKI owns the property

U-type ventilation

142-m face width, 2000 tones/day

Coal is produced from various longwalls

Depth ~350 from surface.

Thick lignite seam (KM-2). Upper 2-m was produced.

Degasification of Soma-Eynez Coal Resources-TKİ

- Underground coal resources of Soma-Eynez are produced from several longwalls. Due to spontaneous combustion propensity of the coal, the rate of ventilation air provided to the mine during coal extraction is kept limited without compromising methane concentration, which is usually less than 1 percent, in the mine.

- However, the experience in mining of Panel A had been quiet different. Mine personnel measured unusual methane concentrations in roadway development, as well as in mining of the upper bench of the coal seam.

- High methane concentrations experienced at the working depths of Panel A led to the expectation of having even higher methane levels at deeper sections.

- Therefore:

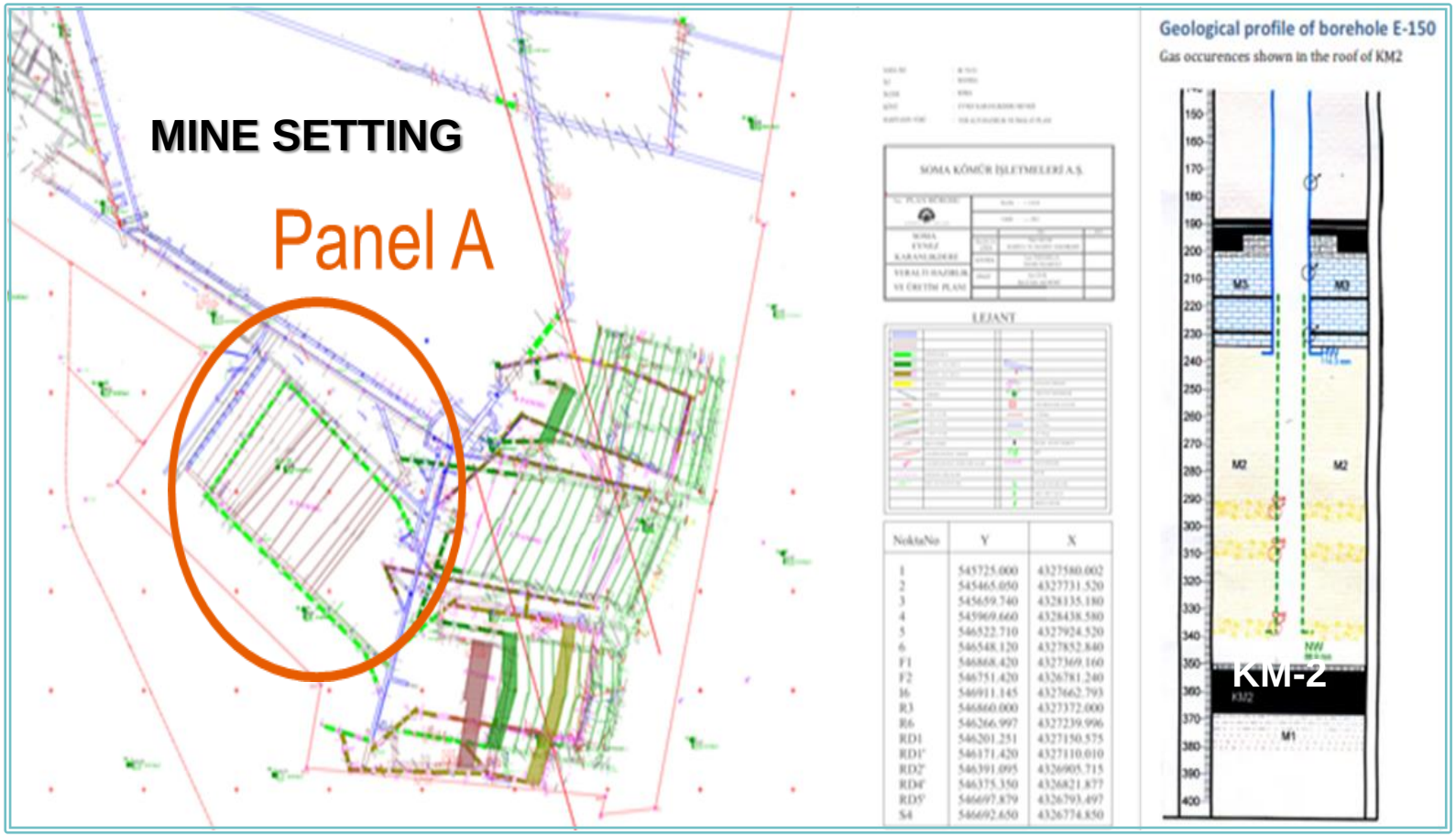
  - Mining operations were suspended in the panel and the roadways were sealed with stoppings to isolate the panel from rest of the mine.

  - GreenGas DPB was contracted for a feasibility study for Panel A and its vicinity for sampling coal and gas, for evaluating gas conditions and for assessing methane drainage options.

Degasification of Soma-Eynez Coal Resources-TKİ

- Panel A, which had been closed due to high methane readings, was studied for feasibility for degasification.
- A borehole was drilled into the gob that resulted from extraction of the 2-m section of KM-2 seam. It encountered high amount of methane 20-30 m above the roof of the seam. Field personnel reported 11000 m^3 of methane (100% equivalent) was produced at 30%-40% quality in three weeks.
- It is known that the strata and the coal seam is water bearing. No information if water stayed in gob.

Degasification of Soma-Eynez Coal Resources-TKİ



Degasification of Soma-Eynez Coal Resources-TKİ

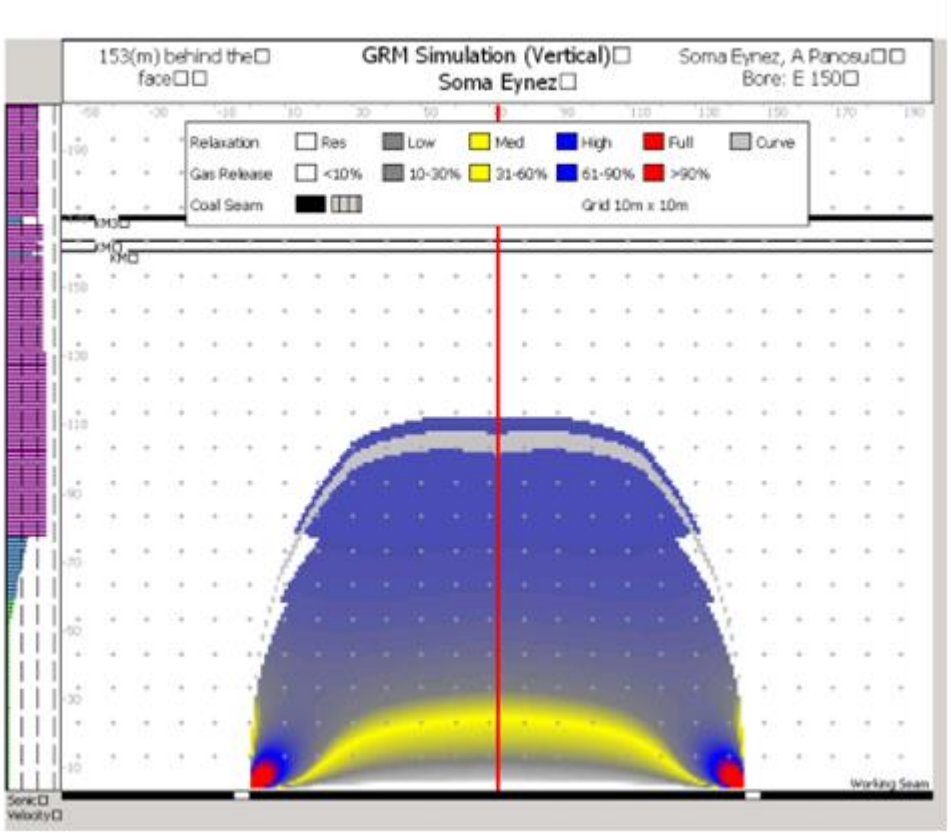
ANALYSES:

- Gas analyses
  - Gas sample taken from a surface exploration borehole drilled into Panel A
  - Chromatographic and isotopic analyses
- Desorption and flow tests for gas content and emission measurements
  - Samples were taken from the in-mine holes drilled into the coal at different lengths
  - Average gas content from all locations were determined as 0.23 m^3/ton
  - Gas rate measured from coal seam 1.25 liter/min.
- Modelling of gob formation of Panel A
  - Potentially existing gob of Panel A as aresult of the upper 2-m bench of the KM-2 seam was modelled

Degasification of Soma-Eynez Coal Resources-TKİ

Model results shows that as a result of mining the 2-m upper bench KM-2 seam, Panel A may currently have a gob extending to a height of 110 m from the KM-2 seam.

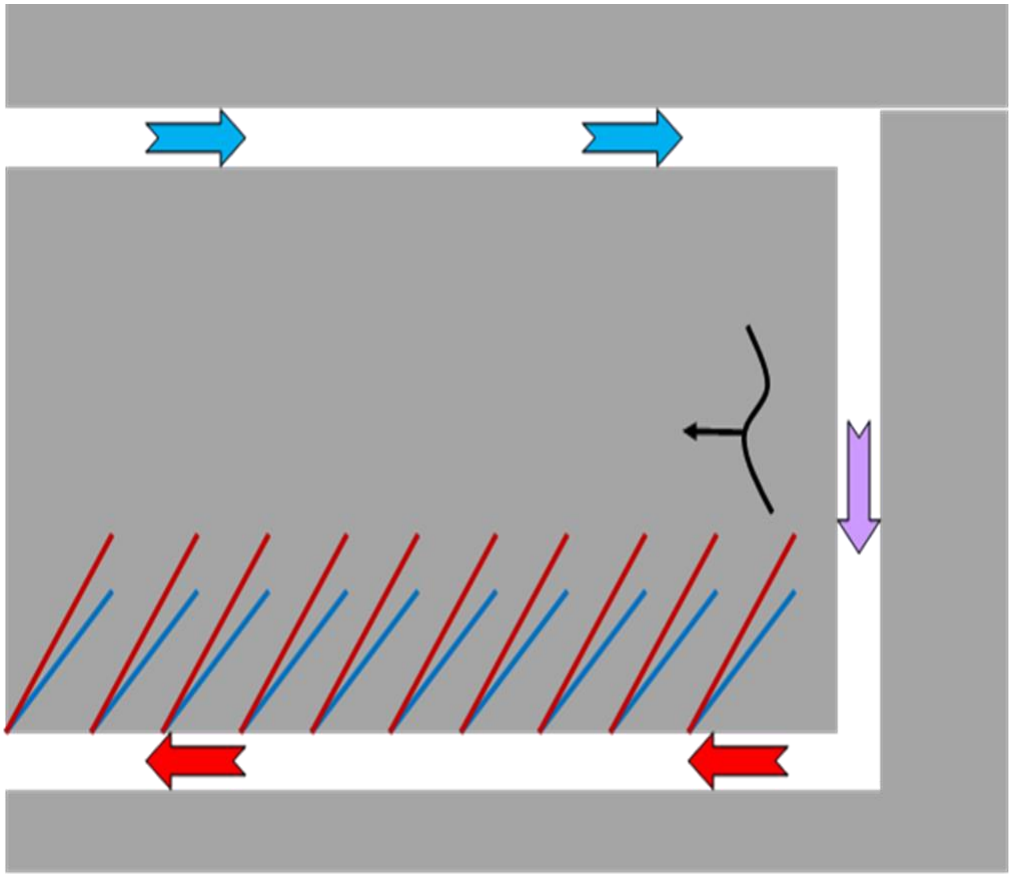
If methane exists from continued mining or from upper strata, it may travel within the volüme up to this height.



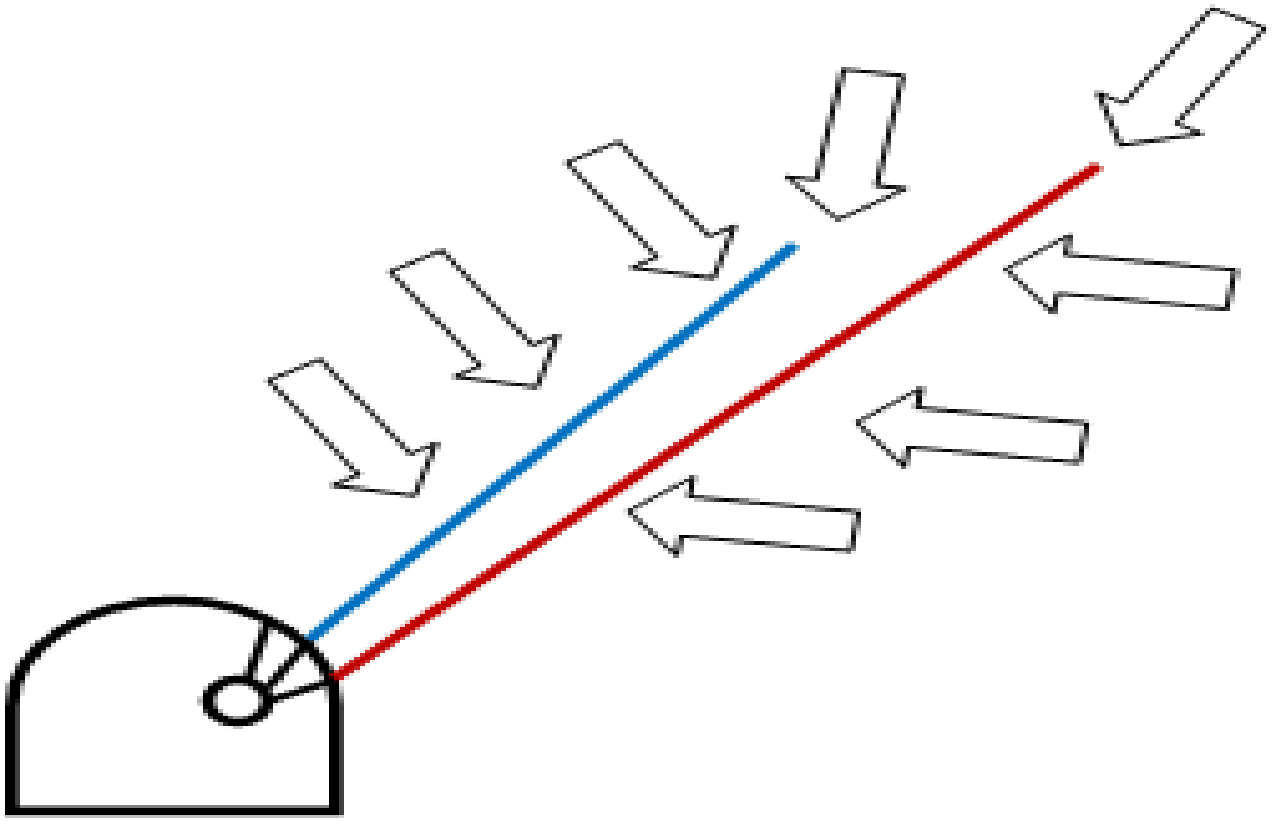
Degasification of Soma-Eynez Coal Resources-TKİ

PANEL DESIGASIFICATON OPTIONS

- Based on observations and measurements gob gas ventholes seem to be one of the likely options to consider to remove the gas and for its abatement. These boreholes can be placed at return margin of Panel A (and subsequent panels with similar problems) and can be drilled to ~25 m from the top of the KM-2 coal.
- Underground gas drainage using cross-measure boreholes.
  - 2200 m holes (100 m each) with 30° azimuth, 35° dip and 45° azimuth, 30° dip.



Degasification of Soma-Eynez Coal Resources-TKİ



Degasification of Soma-Eynez Coal Resources-TKİ

COST OF ALTERNATIVES

Surface Drainage	Price in Euro	No. of units
SURFACE GAS DRAINAGE STATION	230,000	
Mobile pump unit		3 containers
Roots blower for 110 to 500 m3/hour capacity as per attachment		
Attachments to well head		
Diesel generator, mobile		

Underground Drainage		Price in Euro
DRILLING EQUIPMENT		300,000
METERING EQUIPMENT		12,000
GAS DRAINAGE PIPELINE		178,663
PIPELINE EQUIPMENT		26,800
SURFACE GAS DRAINAGE STATION		400,000

VENTILATION AIR METHANE (VAM) Project-TTK

- In underground mines, methane concentrations must be maintained well below the lower explo- sive limit, so ventilation air exhausts carry only very dilute concentrations of methane (typically less than 1 percent and often less than 0.5 percent)
- Ventilation air methane (VAM) constitutes the largest source of methane emissions at most mines.
- Some technologies for beneficially using the energy content of ventilation air exhausts are currently available, while others are in the development and demonstration phase. One existing approach is quite straightforward and entails using VAM as combustion air, thereby supplying ancillary fuel to internal combustion (IC) engines, turbines, or industrial and utility boilers.
- The five coal districts of TTK have 7 major ventilation fans for production purposes. In 2011, TTK tendered the utilisation of mine ventilation air. The succesive bidders was Metanox company. Unfortunately, after two years of research and development period the company could not develop commerical installation. The contract therefore ended in 2014.

THANK YOU FOR YOUR ATTENTION