

Power and Heat Cogeneration to Utilize Coal Mine Methane – Ukrainian Experience

Artur Ghazaryan (Kyiv Ukraine)

Curator of the Program «Green Way 2020»

Methane Expo 2013

Vancouver, British Columbia, Canada

March 12-15, 2013



GreenWay2020

Overview of the Coal Industry of Ukraine

(Main Indicators)

- There are approximately **150** active coal mines in Ukraine, **over 90%** of which are located in the Donetsk Coal Basin known as Donbass;
- Confirmed coal reserves in Ukraine: **34 bln. tons** (circa **4%** of the world coal reserves)*;
- Coal reserves of the active mines: **6.1 billion tons** (**57%** - thermal coal, **43%** - coking coal)*;
- In 2011 Ukraine produced **82 mln. tons of coal**, which was **9%** more than in 2010. During the first 9 months of 2012, coal production increased by **5.6%** compared to the same period of 2011*;
- Thermal coal accounted for approximately **70%** of the total coal production in Ukraine in 2011.*



- The total value of coal, lignite and peat sold by Ukrainian companies in 2011 reached **US\$ 5.8 billion***
- According to experts, approximately **US\$ 400 million** was invested in modernization of the existing coal mines in 2011. The share of private business in these investments is about **55%**.



Overview of the Coal Industry of Ukraine

(Balance of Coal in 2010-2011, mln. tons)*

Indicator	2010	2011	Change, %
Coal production	75.2	82.0	+9.0%
Washed coal	56.9	63.1	+10.9%
+ Import of coal	13.5	12.7	-5.9%
Total (washed coal + coal import):	70.4	75.8	+7.7%
- Export of coal	5.9	6.9	+16.9%
Total Internal Use of Coal:	64.5	68.9	+10.7%
Energy generation	33.3	37.0	+11.1%
Metallurgical industry	28.3	28.9	+2.1%
Other sectors	2.9	3.0	+3.4%

Main suppliers of coal to Ukraine: **Russia, Kazakhstan, and the United States**

Main importers of coal from Ukraine: **Bulgaria, Turkey, Iran, and Poland**

*The Ministry of Energy and Coal Industry of Ukraine, Additional Calculations of DTEK (Ukraine)

Overview of the Coal Industry of Ukraine (Main Producers)

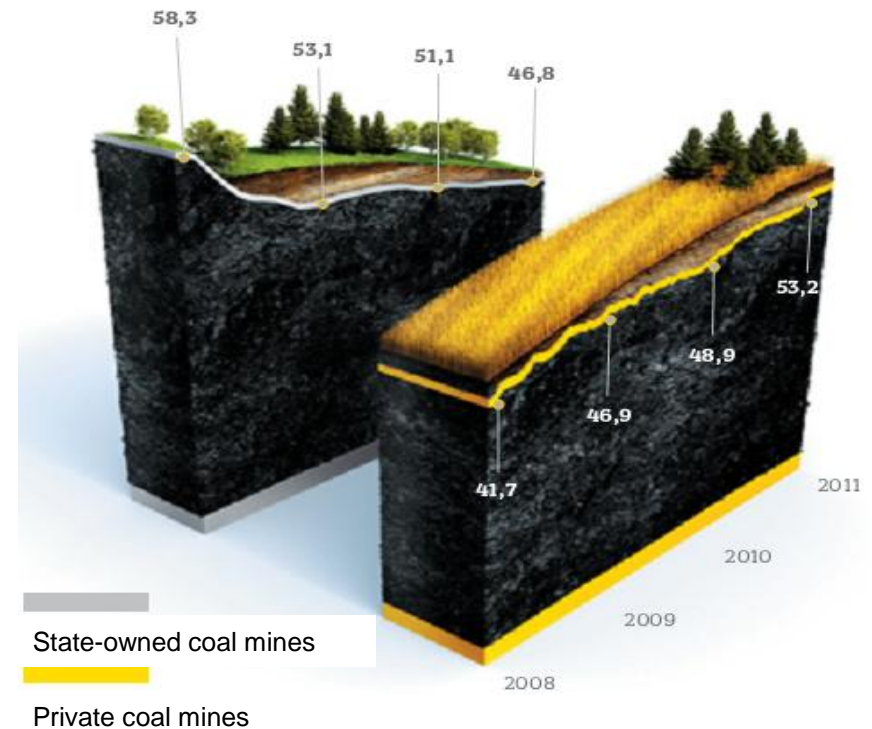
Leading Producers of Coal in Ukraine:

Production, mln. tons, 2011*

■ Pavlogradugol	15.4
■ Rovenkianthracite	7.3
■ Krasnoarmeyskaya Zapadnaya	6.9
■ Sverdlovanthracite	6.6
■ Krasnodonugol	5.6
■ Komsomolets Donbassa	4.3
■ Dobropolyeugol	3.3
■ Makeevugol	2.9

65% of coal produced by state-owned companies is sold through the wholesale coal market operator – State Company “Coal of Ukraine”.

Coal Production by Ownership of Producers, %*



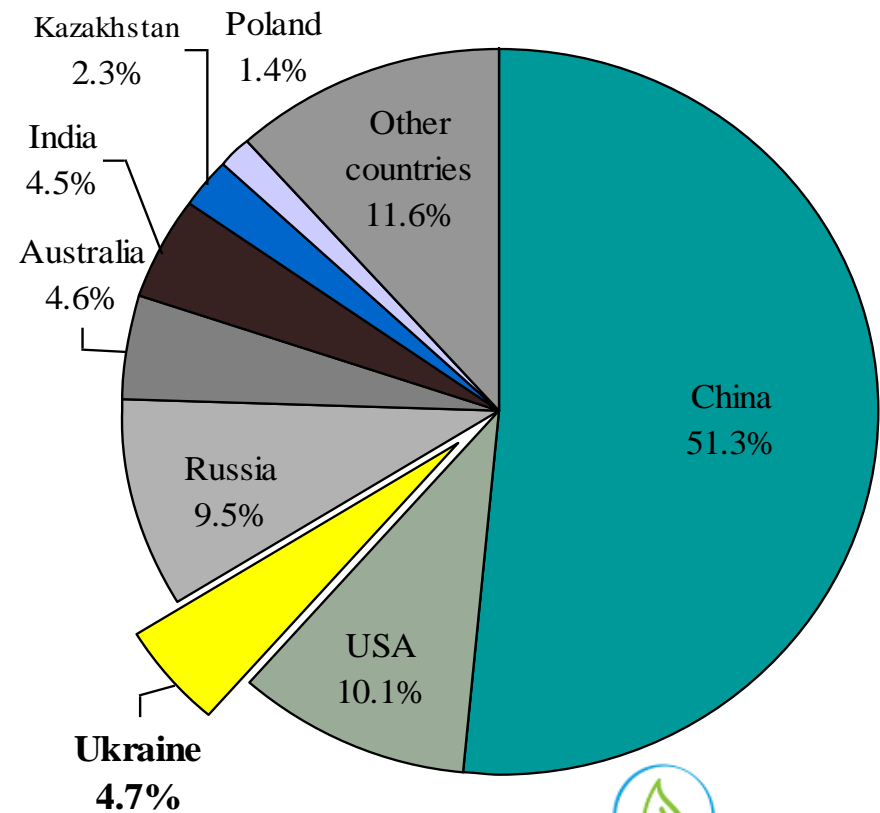
* Annual report of **DTEK** for 2011

Overview of the Coal Industry of Ukraine

(Coal Mine Methane Emissions in Ukraine and in the World)

- In 2010 the world coal mine methane (CMM) emissions were estimated to be **584 mln. metric tons** of CO₂ equivalent;
- Ukraine occupies the **4th place in the world** in terms of CMM emissions (**4.7%** of the world CMM emissions; **27.4 MMT CO₂E** or **1.2 billion m³ per year**);
- According to experts, methane is actively emitted at **70-80%** of active coal mines in Ukraine;
- At certain coal mines of Donbass, the concentration of methane exceeds **40 m³ per 1 ton** of dry ash-free coal.

World Coal Mine Methane Emissions in 2010*



Utilization of Coal Mine Methane in Ukraine

(Current Status and Future Developments)

- Utilization of coal mine methane in Ukraine is complicated by the following factors:
 - *Extremely low gas permeability of rocks that contain coal;*
 - *Significant number of abandoned or temporarily closed mines.*
- Today **less than 8%** of CMM emission is utilized in Ukraine;
- The reserves of CMM in Ukraine is deemed to be **12 trillion m³**;
- Currently CMM is utilized through:
 - *Burning in flare systems;*
 - *Heat generation in boiler houses of mines;*
 - **Cogeneration of electricity and heat;**
 - *Usage as fuel by automobile transport.*



Utilization of Coal Mine Methane in Ukraine

(Cogeneration: Current Status)

- At present, there are **2** large cogeneration projects related to CMM utilization in Ukraine:
 - Cogeneration plant based on gas reciprocating engines with the total electrical capacity of **76.6 MWe** and heat capacity of **68.9 MW** at the **Coal Mine named after A.F.Zasyadko** (one of the largest projects of this kind in the world);
 - Cogeneration plant based on gas reciprocating engines with the total electrical capacity of **18.2 MWe** and heat capacity of **18 MW** at **Coal Company “Pokrovskoye”** (The 1st group of cogeneration units was commissioned in November 2011).
- **Circa 10** smaller cogeneration projects (with total electrical capacity ranging from **0.5 MWe to 10 MWe**) based on gas engines of various manufacturers are commissioned or under construction, or at the stage of development.

Buildings of cogeneration station and vacuum-compression station at the Coal Mine named after A.F. Zasyadko*

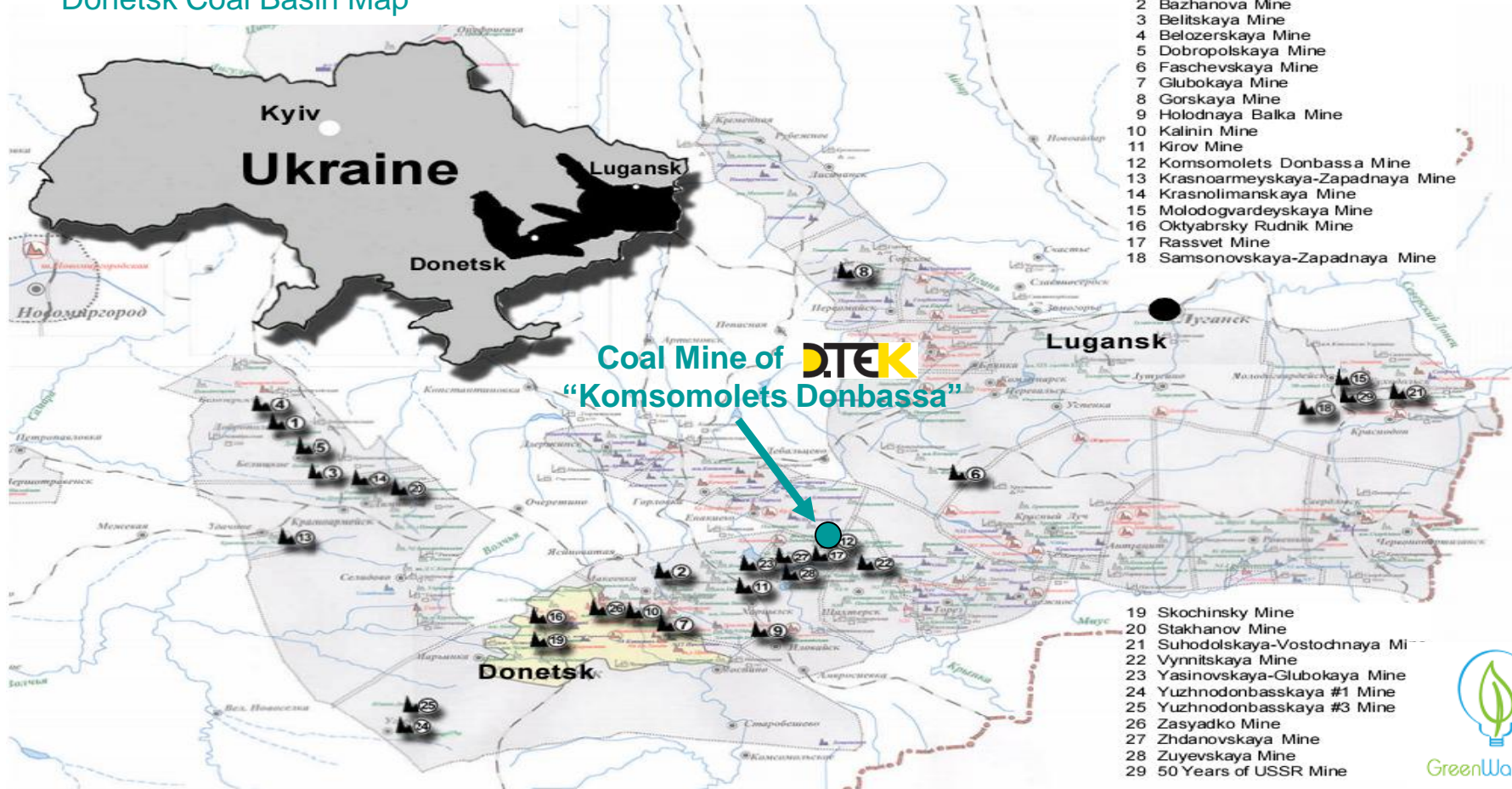


*www.cogeneration.com.ua

Project of Green Way 2020

(Based on DTEK Mine “Komsomolets Donbassa”)

Donetsk Coal Basin Map*



*Coal Mine Methane in Ukraine: Opportunities for Production and Investment in the Donetsk Coal Basin, 2001



DTEK Mine “Komsomolets Donbassa” (Key Indicators)

- The coal mine was commissioned in **1980**;
- The total area of the mine is **62.5 km²**;
- Coal mining is carried out at the levels of **418 m**, **628 m** and **810 meters**;
- Recoverable coal reserves: **117.3 mln. tons** (**27 years** at the current coal production rate);
- **4.3 mln. tons** of coal was produced by the mine in 2011, i.e. **5,2%** of the total coal production in Ukraine;
- Annual electricity consumption is about **270 mln. kWh**, i.e. approximately **30 MW per hour**;
- The mine produces thermal coal of the grade “**T**”, which is mainly used at thermal power plants owned by DTEK;
- The mine has its own coal preparation facility.

The main building of PJSC “DTEK Mine Komsomolets Donbassa”*



*photo Google Earth

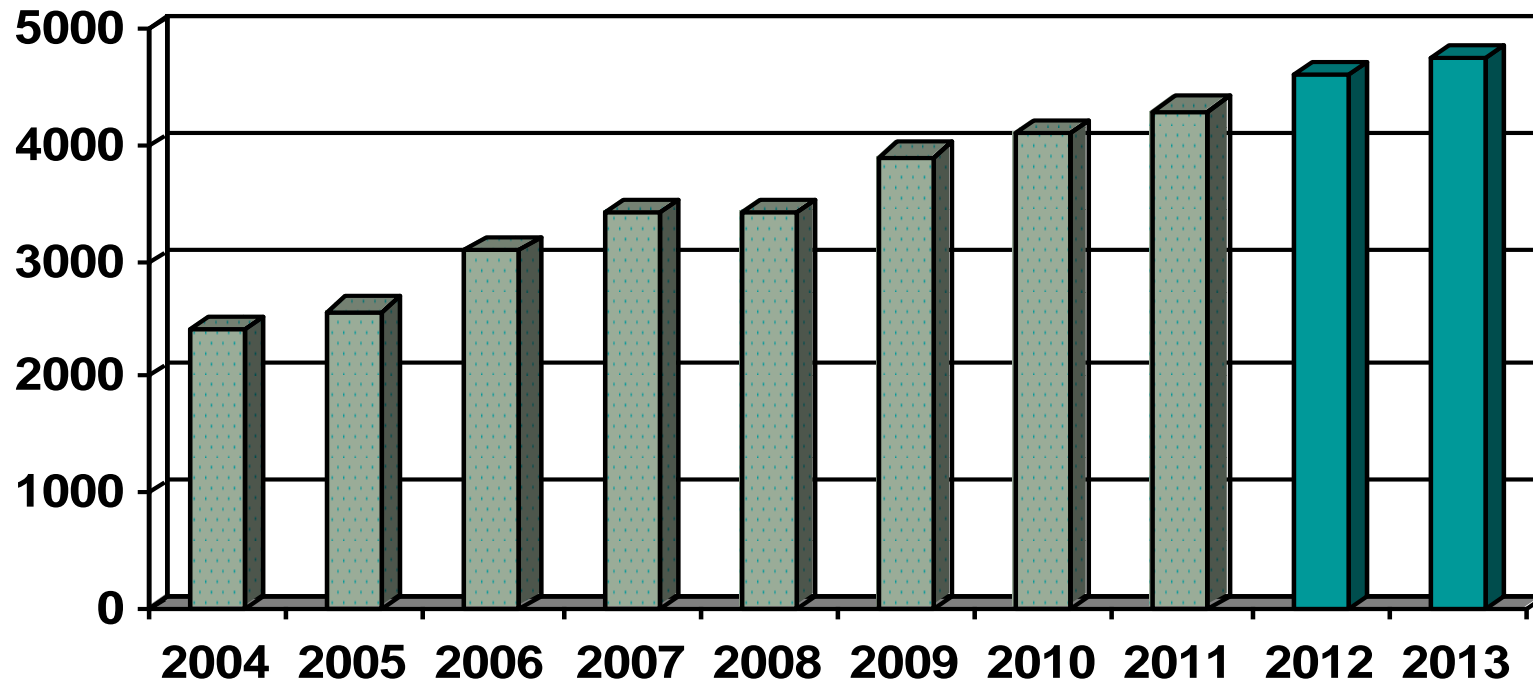
DTEK



GreenWay2020

DTEK Mine “Komsomolets Donbassa” (Annual Coal Production*)

Thousands of tons



Forecast

*data of **DTEK**



GreenWay2020

DTEK Mine “Komsomolets Donbassa” (Coal Mine Methane Utilization)

- In 2011 the coal mine methane emissions were estimated to be **76.8 mln. m³**, from which **34.9 mln. m³**, i.e. **(45.4%)** was captured in the course of mine degassing, and **10.2 mln. m³**, i.e. **(13.3%)** was utilized.
- Methane is utilized only at the ventilation shaft # 3 with the help of:
 - **2 boilers KE-10-14**, re-equipped to burn CM gas;
 - **2 flare systems UKG-5/8**;
- In 2007 the degassing system of the mine was modernized, while in 2011-12 a new automated air quality monitoring system was installed;
- The averaged composition of the coal mine gas is shown below (based on 2012 measurements), %:

➢ He	0.01%
➢ H	0.00%
➢ CH₄	45.4%
➢ C ₂ H ₆ , C ₃ H ₈ , C ₄ H ₁₀ etc.	0.00%
➢ CO ₂	0.30%
➢ O ₂	12.8%
➢ N ₂	41.5%
➢ Humidity	94%

DTEK Mine “Komsomolets Donbassa” (view from above)



- The project stipulates installation of **2 containerized cogeneration units (CCU)** based on lean-burn gas generator sets. The mine has main project documentation for their installation.

Project Description

(Distribution of the Obligations at the Construction Stage)



PJSC “DTEK Mine Komsomolets Donbassa”:

- Provides site for installation of new equipment by the project company;
- Modernizes the existing compression station to ensure supply of coal mine gas for further filtration and dehydration;
- Creates conditions for integration of the new equipment into the existing energy system of the coal mine.



Project Company:

- Supplies and installs **2** lean-burn gas generator sets (total electrical capacity: **3.5 MWe**) along with containers and auxiliary equipment;
- Supplies and installs **2** for filtration and dehydration of coal mine gas along with gas heating devices;
- Supplies and installs automated metering system;
- Supplies and installs required electrical equipment and heat exchangers (*exact specification is currently under discussion*).

Project Description

(Distribution of the Obligations at the Operation Stage)



PJSC “DTEK Mine Komsomolets Donbassa”:

- Purchases the whole amount of electricity produced by the containerized cogeneration units **at discounted price**;
- Ensures reliable and sufficient supply of coal mine gas to the filtration and dehydration units of the project company;
- Guarantees proper maintenance of mine degassing equipment including compression station during the whole period of the project.



Project Company:

- Sells the whole amount of electricity produced by the containerized cogeneration units to the mine **at discounted price**;
- Properly operates and maintains the equipment installed by the project company;
- Supplies heat produced by the containerized cogeneration units to the mine if required.



Project Description

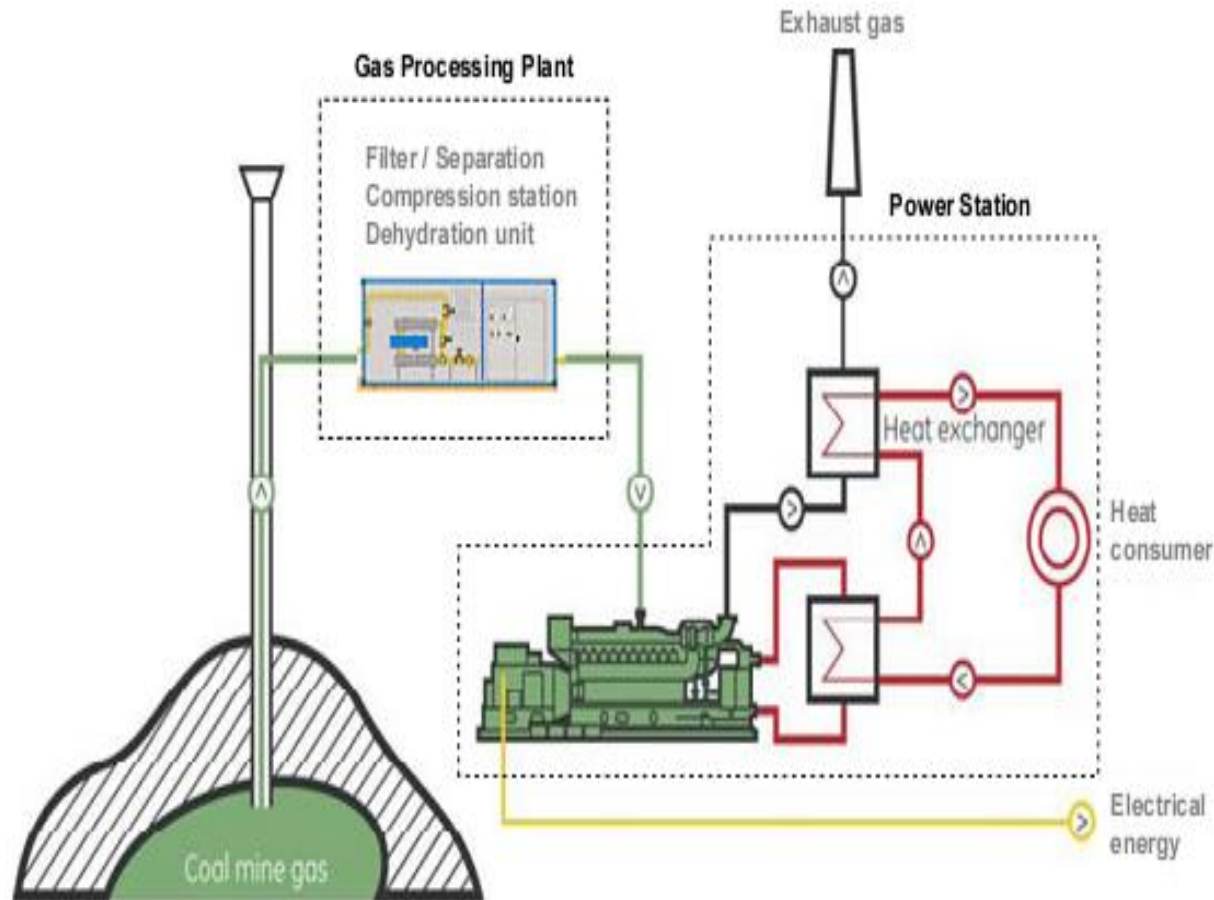
(Key Financial Information)

- The total capital investment of the Project Company:
US\$ 4.86 million;
- Annual electricity generation:
25.9 million kWh;
- Specific operational costs:
US¢ 1.7 per 1 kWh (*excluding operational costs related to the mine degassing system*);
- The project is financed with equity from the investor.



Project Description

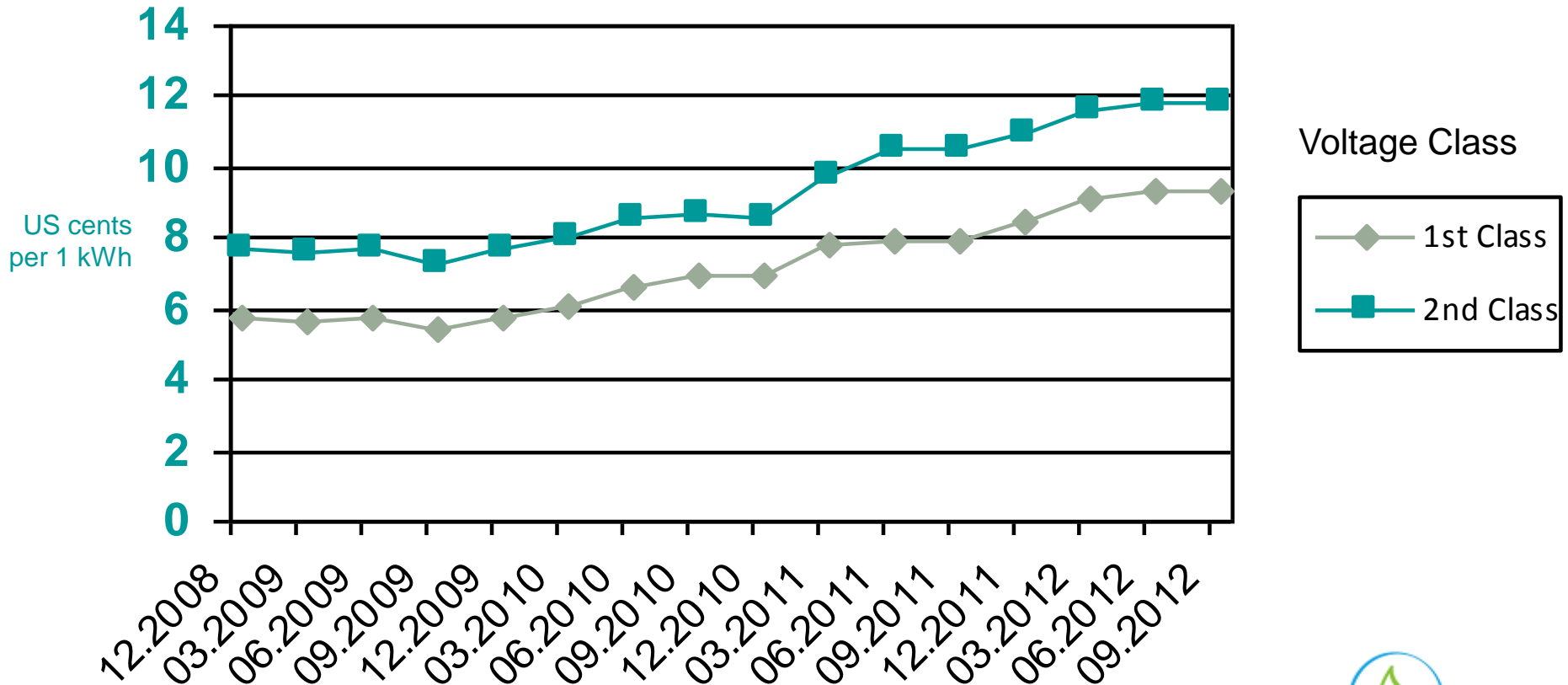
(Main Technological Flowchart)*



- Through the existing degassing system of the mine, coal mine gas is delivered to the Gas Processing Plant where it is:
 - compressed,
 - metered,
 - separated from mechanical impurities,
 - dehydrated, and
 - heated (if necessary).
- From the gas processing plant, properly prepared gas mixture is transported to the cogeneration station, which includes gas engine, where the methane-air mixture is burned;
- The torque from the engine is transferred to the generator that produces electricity;
- Heat energy created during fuel combustion is transferred to heat exchangers located at the roof of the containers.

Electricity Tariffs

(For Industrial and Commercial Consumers)*



*<http://liberal.in.ua/statistika/tseni-na-elektroenergiu-i-ekonomika.html>



Program «Green Way 2020»

Renewable and Alternative Energy Development Program «Green Way 2020»:

- is aimed at implementing innovative technologies, establishing environmentally friendly companies in the area of electricity and heat cogeneration from alternative sources of energy on a turn-key basis;
- supports coal mine methane utilization and organic waste utilization projects that result in reduction of greenhouse gas emissions into the atmosphere;
- is developed under the auspices of the International Chamber of Commerce (ICC Ukraine).



Program «Green Way 2020»

PLANS FOR THE FUTURE:

- Installation of mini-CHPs based on Cummins gas generator sets at the other mines of DTEK (5 large companies with combined coal output of **36.8 mln. tons**, i.e. **45%** of the Ukraine's coal mining market);
- Development of long-term cooperation with coal mining and CMM utilization companies, which require electricity for internal needs at discounted prices.



Thank you for your attention!

Artur Ghazaryan,

Curator of Program “Green Way 2020”
Adviser on Green Investments to the President
of the ICC Ukraine

(E-mail: ceo@gw2020.com)