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**METHANE TO MARKETS PARTNERSHIP  
REGIONAL WORKSHOP  
BEIJING, PRC - DECEMBER 2, 2005:**

**REPORT ON PARTICIPATION BY  
DEVELOPING/TRANSITIONAL COUNTRIES**

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NEDO

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REPORT ON DEVELOPING/TRANSITIONAL COUNTRY PARTICIPATION**

**BACKGROUND**

The Methane To Markets (M2M) Partnership is an international cooperative framework to promote cost-effective, near-term methane recovery internationally through partnerships among developed countries, developing countries, and countries with economies in transition in coordination with the private sector, researchers, development banks, and other relevant government and non-governmental organizations. The partnership is a voluntary, non-binding form of international cooperation with 17 current member nations.

As part of its activities, the M2M Partnership organized a technical workshop on December 2, 2005 in Beijing, Peoples Republic of China. The workshop was held in coordination with the 5<sup>th</sup> International Symposium on CBM/CMM in China. Based upon previous experience with similar workshops, although all M2M member countries were invited to attend the workshop, it was expected that only representatives from the sponsoring countries (United States, Australia and Japan) and the host country, China, would attend. This was, in most cases, not due to lack of interest, but lack of resources (particularly among the developing and transitional member countries) and because of conflicts of time.

In an attempt to increase other countries' involvement in the workshop, the New Energy and Industrial Technology Development Organization (NEDO) of Japan offered limited funding to support the travel-related expenses of one representative from each developing and transitional M2M Partnership member country to participate. Energy Resources International, Inc. (ERI) was hired to coordinate this effort for NEDO.

As a condition of receiving the NEDO financial support, participants: (1) prepared technical papers, and (2) participated in a panel discussion at the M2M Partnership workshop. The technical papers focused on the activities of their countries in the following areas: (1) coal mining, (2) coal mine and coal bed methane recovery and resource availability, (3) barriers and opportunities related to CMM recovery and use, and (4) recommendations related to expanding the recovery and use of CMM. These papers were circulated at the workshop. The panel discussion was intended to share issues of common concern and to discuss possible approaches to increasing CMM production and use in each of the countries.

The papers were intended to both provide the workshop participants with information that would be useful for more complete discussion of workshop issues and to ensure that the NEDO-sponsored participants were well prepared for the workshop discussion. ERI provided guidance to the participants on the scope of their papers and commented on drafts to ensure that they were complete and relevant. The papers prepared by each participant are provided as Attachment 1 to this document.

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## WORKSHOP

Although all developing and transitional M2M member countries were offered funding support by NEDO, participants from five of these countries met the NEDO funding criteria. None of these participants would have attended the workshop had it not been for NEDO funding support. The participants were:

- Devulapalli Narasimha Prasad, Technical Director, Ministry of Coal, Government of **India**. Mr. Prasad is a mining engineer with 25 years of experience in the coal sector of India mostly focused on operation of coal mines and development and policy planning for coal and lignite resource development (including coalbed methane). He participated in the UNDP/GEF funded CBM project under the Ministry of Coal.
- Dr. Nikolay Storonskiy, Deputy Director, Promgaz, **Russia**. Promgaz is one of Gazprom's research and development centers in the field of gas distribution network development, development of the non-traditional hydrocarbon resources like CBM/CMM, and regional power engineering. Dr. Storonskiy is involved with the development of the first CBM project implemented by the Gazprom group. He also is the research manager of the Russian State research contract in the field of developing CBM/CMM recovery and utilization technologies.
- Daniel Perczyk, Advisor to the Secretariat of Environment, **Argentina**. Mr. Perczyk is an industrial engineer with postgraduate studies in the electric market. Since 2004, he has been a member of the Methodology Panel and of the Small Scale Working Group of the UN Framework Convention on Climate Change Clean Development Mechanism Group. He also is the Coordinator of the Center of Studies in Climate Change, Instituto Torcuato Di Tella, Argentina.
- Dr. Vyacheslav Lukinov, Professor, Geology-Mineralogy Sciences, Institute of Geotechnical Mechanics, National Academy of Sciences, **Ukraine**. Dr. Lukinov is an expert in oil, coal and gas geology, mining geology, and coal mine degassing. He has 30 years experience in investigating mining and geological conditions in coal deposits. He is currently involved in projects to degas and utilize methane from Ukrainian coal mines.
- Solomon O. Adesanya, Deputy Director, Pollution Control Department, Federal Ministry of Environment, **Nigeria**. Mr. Adesanya has 11 years of experience in waste management, coal and coal mine and methane issues.

Each of these individuals participated in both the 5<sup>th</sup> International Symposium on CBM/CMM in China and the Methane to Markets Partnership Regional Workshop. The Workshop consisted of a morning session in which papers on CMM recovery and utilization in China were presented. In the early afternoon sessions, papers were presented on barriers related to ownership, regulation, tax, project financing and management. The

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final 1½ hour session was an open discussion among the NEDO-sponsored participants addressing issues facing CMM recovery and use in their countries. The session began with short presentations by each participant and was followed by questions and answers.

Each NEDO-supported participant was actively involved in both the Symposium and Workshop. Many attendees of the Workshop remarked that the final session was the most useful and most interesting, and that the format and content of that session allowed for useful exchange of information. Several participants also remarked that they were very pleased to have representatives of developing and transitional countries participate in the technical workshop. They commented that usually the attendees of such meetings are from the host country and developed countries. This meeting was a breakthrough in that regard.

This experience demonstrated that the attendance of developing and transitional country experts in CMM/CBM is very valuable, politically and substantively, in meetings like the M2M Workshop. This experience also demonstrated that limited financial support to subsidize the costs of travel and lodging for developing and transitional country experts to participate in meetings like the M2M Workshop is critical.

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**ATTACHMENT 1**  
**PAPERS PREPARED BY NEDO-SPONSORED PARTICIPANTS**

**RUSSIA**

Current state and prospective of CMM/CBM production and utilization in Russia  
Nikolay M. Storonskiy, Ph.D., Deputy Director of PROMGAZ  
Methane-To-Markets Partnership Technical Workshop  
Beijing, China, December 2, 2005

**Abstract**

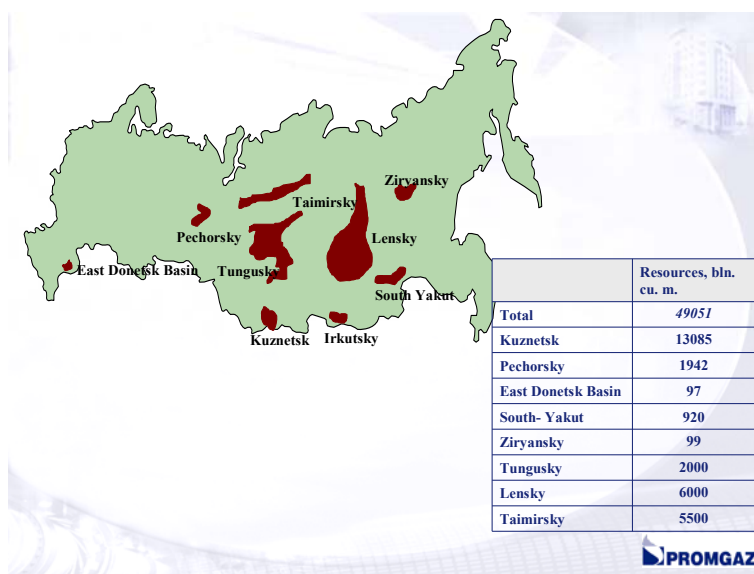
The following key topics are considered on current state and prospective of CMM/CBM production and utilization in Russia:

- Estimated CBM resources and forecast of CBM production on 2020, potential of CMM recovery and utilization, reduction of CMM emission;
- Latest initiatives of Russian Government, Domestic and International organization to stimulate CMM/CBM recovery and utilization,
- Gazprom testing area in Kuznetsk coal field to perfect CBM recovery process and to evaluate the perspective of commercial CBM production in Russia on the state-of-the-art.

**CBM resources and potential of CMM recovery and utilization**

Russia possesses huge probable CBM reserves concentrated mainly in 9 coal fields. Total CBM reserves consist of about 50 trillion cubic meters and Russia occupies leading position in the world according to their scale (Table 1). The CBM resource distribution is shown on Figure 1. Their main part is located at Siberian region which is difficult to access and thinly populated except south of West Siberia where most perspective Kuznetsk coal field is situated.

**Figure 1 CBM reserves and coal basins in Russia**



**Table 1 World's CBM reserves**

Country	CBM resources	
	trillion cu-ft	trillion cu-m
China	1 060 –1 240	30-35,1
Russia	1 796	50,9
Ukraine	200 – 2 700	5,7-76,5
USA	60	1,7
Australia	700	19,8
Germany	300-500	8,5-14,2
Poland	100	2,8
Great Britain	60	1,7
Kazakhstan	40	1,1
South African Republic	30	0,8
India	30	0,8
<b>Total</b>	<b>3 280 – 9 560</b>	<b>92,9-270,7</b>

The following main reasons prohibit commercial CBM production by domestic gas and oil companies:

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1. Large current proved gas resources located at traditional gas and oil fields allow companies to produce natural gas for about 80 years at lower cost than when developing CBM fields, at least during near-term outlook;
  2. Low gas price regulated by state and tax environment don't favor CBM development;
  3. Lack of experience and appropriated technological base to extract CBM from low permeability coal seams saturated by water;
  4. Lack of state support to develop nontraditional hydrocarbon fuel unlike what took place in U.S. when state granted companies tax credits to involve them in CBM production.

Nevertheless the nearest perspectives of CBM production in Russia are formed on the basis of following criteria:

- mining and geological conditions as well as technological development which define the possibility of obtaining the stable commercial gas flow in the wells drilled from the surface to coal seams un-discharged from rock pressure;
- economical and ecological environment taking into account, from one side, the nearness of consumers and their benefits of using the technologically convenient and pollution-free fuel in the comparison with coal and mazut, and, from other side, economic efficiency of CBM production and transportation to consumers, its competitiveness on fuel market in region.

Under these guidelines Kuznetsky and Pechorsky coal basins are the most promising in Russia for CBM production in foreseeable future. The CBM resources in Kuzbass to the depth of 1800 m consist of 13 trillion cu-m. Their average density is 716 mln. cu-m/sq. km. The high estimation of commercial CBM production in Kuzbass is based on several factors:

- mining and geological conditions and coal properties in Kuzbass are comparable with the basins of USA, Australia and Canada, where commercial CBM production is carried on (Table 2);
- results of evaluating the economic efficiency under the expected gas flow rate are promising;
- availability of gas infrastructure and prepared consumers that are located only 20 – 100 km distance from high-priority areas.

**Table 2 Comparison of Kuzbass (Russia) with San Juan Basin (U.S.)**

<b>Characteristics</b>	<b>Kuzbass</b>	<b>San Juan</b>
CBM resources	Total 13.1 trln. m <sup>3</sup> , including 3.0 trln. m <sup>3</sup> in the promising south regions	Total 2.3 trln. m <sup>3</sup> , including 1.4 trln. m <sup>3</sup> in Fruitland formation, and 0.9 trln. m <sup>3</sup> in Menefi formation
CBM density	from 500 to 3500 mln. m <sup>3</sup> /km <sup>2</sup>	□□ 350 □□ 1000 mln. m <sup>3</sup> /km <sup>2</sup>
Total thickness of coal seams	Total thickness of coal seams reaches 120 m, thickness of several seams is 10-18 m	Total thickness of coal seams is 30 m, thickness of several seams is 8-10 m
Coal bedding depth	Up to 4000 m, for estimation only coal seams no deeper than 1800 m were considered	Not lower than 1200 m (Fruitland formation)
Number of productive intervals	6-8 in intervals of 100-150 m in the cross-section to the depth of 1800 m	one in the interval of of 100-130 m in the cross-section to the depth of 1200 m
CBM content	Not higher than 25-30 m <sup>3</sup> /t	Not higher than 15-20 m <sup>3</sup> /t
Coal rank	0.6 - 2.0% (at the most promising areas 0.75 - 1.2%)	0.7 - 1.5% (within the producing zone 0.78-1.2%)
Coal seam permeability	1-10 mD, some measuring data exceeded 50 mD	35-50 mD

Today natural gas to Kemerovo region, where Kuzbass is situated, is supplied from the gas fields located in north of West Siberia more than 2000 km away. CBM could replace this natural gas in regional market of southern part of the Western Siberia, if its production cost does not exceed the costs of natural gas production and transportation from the northern fields. The project of CBM production in Kuzbass is planned in three phases:

- I phase - implementation of pilot test program to ensure the possibility of commercial CBM production under current economic conditions inside 4 most promising areas during 2003 - 2007;
- II phase – implementation of commercial CBM production on the first-turn areas in the volume of 3 - 5 billion cu-m/year to provide the gas supply for the Kemerovo region consumers by 2010-2012;
- III phase – further development of commercial CBM production in Kuzbass to the level of 17 - 20 billion cu-m/year to provide the gas supply to consumers in the all southern part of Western Siberia (by 2020).

The second most prospective in terms of CBM production in Russia is Pechora coal basin. Its resources are about 2 trillion cu-m. The most promising areas within this basin for CBM project implementation, where 30 % of total resources are concentrated (589 billion cu-m), are located near the mining capital of Vorkuta. The vicinity of the city provides a good market for CBM sales. Today in the region the mine degasification systems produce about



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300 mln. cu-m/year of CMM. Less than 30% of that volume are utilized at the mine boilers and drying units. At the same time the CBM resources of Pechora coal basin and forecast of the gas demand allow one to produce CBM in volumes of up to 0,5 billion cu-m/year by 2010 and up to 1,55 billion cu-m/year by 2020. CBM mainly could be utilized to produce heat and electric power in the city of Vorkuta.

Only 540 bbl cum of CBM (a little more 1% of total resources) are confined within mining leases but are essential sources of methane escape in atmosphere during coal production. According different references its annual volume ranges from 2 to 4 billion cu-m. Today in Russian Federation there are about 150 working mines. 70 mines are most methane dangerous but only 25 % of these mines have degasification systems. In Russia mine's degasification is implemented in Kuznetsk, Pechora and Donetsk coal basins. Today the volume of CMM extracted through the available mine degasification systems doesn't exceed 600 million cu-m per year. Main part of this volume is released in atmosphere

CMM utilization is limited by the technical imperfection of main degasification systems. The instability of the flow and low concentration of methane make difficult a use of CMM in energy plants. Now there are no well-founded motivations which push mine owners to improve degasification systems for producing conditioned CMM.

Under current level of deep mining the potential of CMM recovery consists of about 2 billion cu-m per year. When appropriate economic regulation would be available the most part of this volume could be utilized. But now main owners are not interested in CMM utilization because of high cost and unrecoverable investments.

Nevertheless in future two conditions force mine owners to solve the problems of CMM extraction and utilization associated accompanied to deep mining:

1. Russian experience of deep mining show that under the same mining and geological conditions in mining faces with the gas content of 7-10 cu-m/ton the coal production is 2-3 times larger than in ones with the gas content of 20-40 cu-m/ton. In the latter case the coal production as a rule doesn't exceed 2000 ton per day. It's that caused by frequent shut-downs of coal-mining machines because of exceeding the norms of methane concentration in an air mixture and creating the conditions of blowbacks and explosion. At the same the potentialities of the modern coal-mining machines and powered roof support allows miners to produce 25-30 thousand ton of coal per day. Therefore mine owners will be forced to construct systems of the preliminary and current degasification of coal seam for reducing the methane escape to 45-50% to increase the breakage face advance rate and provide the conditions of miner's safety work.

International initiatives and obligations undertaken by Russia to reduce the CMM emissions to atmosphere by means of its recovery through the underground gas pipelines to the surface and subsequent utilization using heat and power plants and gas processing.

Besides, Methane-To-Markets International Partnership has to play important role by means of developing the economic-organizing mechanism to realize the efficient CMM projects around the world including Russia.

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But now the current situation of CMM recovery and utilization as follows.

In Kuzbass preliminary and protecting degasification of coal seams and workout areas are carried out by drilling the degasification wells from surface and underground. CBM resources within the mining leases of mines, where degasification systems are implementing, consist of about 94 billion cu-m. CBM resources within the mining leases of mines, where degasification systems will be implemented in future, consist of about 120 billion cu-m.

Today average efficiency of degasification is 35-40%. When implementing the preliminary degasification on mines of Leninsky and Belovsky regions in Kuzbass by vertical wells drilled from surface the degasification efficiency runs up to 60-70%. However, today CMM is practically not utilized and mainly blows out to the atmosphere. Current and forecast levels of coal production in Kuzbass could provide the CMM recovery in the volume of 1,5 billion cu-m and up to 70-75% of this volume could be utilized.

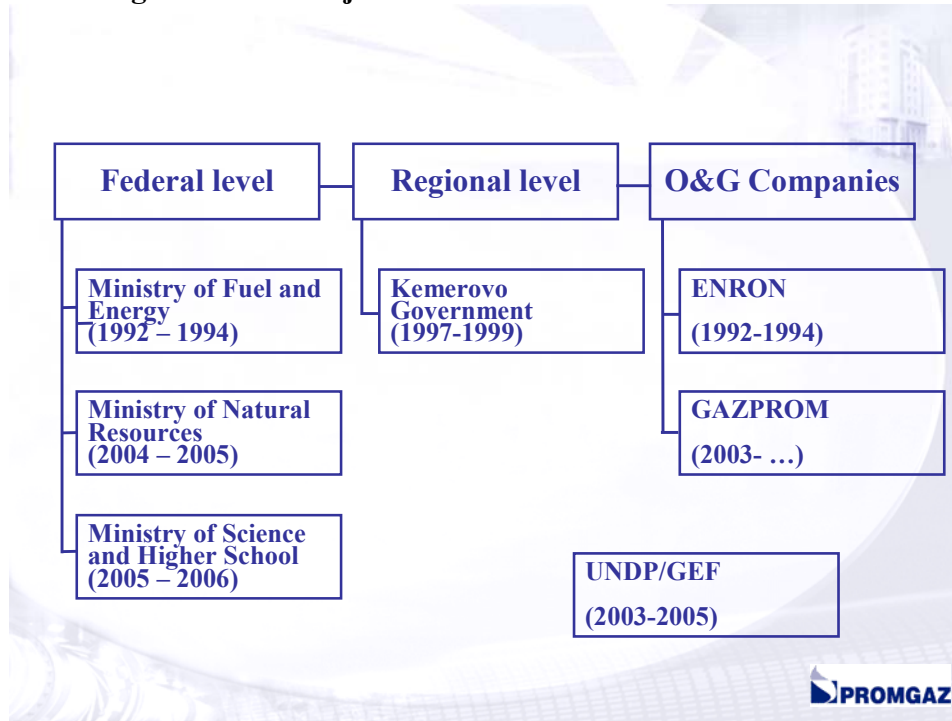
In Pechora basin mine degasification works is carried out at the depth of 350-600 m depth. It's efficiency reaches 41-43% and even 50-55% in some mines. The mines of this region as mentioned above annually blow-out to the atmosphere about 620 mln. cu-m of methane, including 250 mln. cu-m of CMM from the mine degasification systems and 370 mln. cu-m of VAM (ventilation air methane) from the mine ventilation systems. CMM utilization as a fuel began in 1975 in former Soviet Union time. In 1982 drying unit with the annual capacity of 900 thousand tons was converted from coal to CMM. But now CMM utilization takes a turn for the worse. At present only 60 mln. cu-m of CMM are utilized, i.e. less than 24%, and the rest are released to the atmosphere. If the consumers are available, CMM utilization in Vorkuta region could reach 180-200 mln. cu-m/year, i.e. 72-80% of degasification volume.

If advanced CMM recovery technologies are applied and appropriate economic conditions are created, potential volume of CMM production in Russia could reach 2 bln. cu-m/year.

### **Initiatives of Russian Government, Domestic and International organization to stimulate CMM/CBM recovery and utilization**

The following scheme illustrated the main activities in Russian Federation during last ten years in the field of CMM/CBM production and utilization. Till recently the solutions of this problem were not in the centre of state attention and initiatives of players on federal, regional and corporative levels were not successful. It was caused by economical reasons, insufficient funding, and weak attention to solution of ecological problems. Mines were privatized and new ownerships didn't wish to spend money for the construction/reconstruction of mine degasification systems. So the mines lost the historical measures of CMM recovery and utilization achieved in the former Soviet Union time.

**Figure 2 CBM Programs and Projects in Russia**



At the end of 2002 Vladimir Putin, President of Russia Federation, for the first time charged to the Russian Government organizing the Russian-American cooperation in the field of CBM production and submitting proposals how to give state support to projects implementation. To supervise the fulfillment of the President's order a working group was set by the President's Administration. The group is responsible for supporting the CBM project implementation, including:

- Creating the favorable economical conditions for CBM production by state regulation of prices and of taxes.
- Customs regulation of imported technologies and equipment if needed.

In 2003 the first pilot test program of CBM was implementing by Gazprom group. The description of this program is given below.

### ***UNDP/GEF project***

At the same time in the framework of United Nation Development Program - Global Ecological Fund the full-sized project "Removing Barriers to Coal Mine Methane Recovery and Utilization" was starting in Russia.

The overall project goal is to mitigate greenhouse gas emissions by removing barriers to the implementation and financing of CMM recovery and utilization projects in Russia. As one of the key mechanisms in that regard, the project will support the establishment of a specialized "Coal Mine Methane Recovery and Utilization Company", which after the initial support for the start-up phase is expected to continue its operations as a self-sustaining entity.

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The following main tasks of the project should be solved:

2. The Coal Mine Methane Recovery and Utilization Company (CMMRUC) has to be established to support the mines in developing, financing and implementing coal mine methane recovery and utilization projects, capitalized and the key staff hired; the sustainable operation of the company during and after the end of the project ensured.
3. Enhanced awareness of the key stakeholders (such as mine management, relevant public authorities etc.) on the possibilities for and benefits of improved degasification, methane recovery and utilization has to be achieved; personnel of the CMMRUC and the participating mines have to be trained in developing and implementation CMM projects.
4. Demonstration projects have to be implemented so as to gain experience for their wide scale replication and to demonstrate their technical, economic and financial feasibility to the key stakeholders, including the management of the mines, the national and international financing organizations, public authorities and others; demonstration projects operate on a recovery basis.
5. The effectiveness of the existing legal and regulatory framework in supporting CMMRU projects has to be assessed; the recommendations for the improvement of the existing legal and regulatory framework for making it more supportive for methane recovery and utilization are prepared.
6. Building the local capacity to monitor, report and verify the actual GHG reductions as a result of methane recovery and utilization has to be achieved.

### ***Rosnauka R&D project.***

At the beginning of 2005 Federal Agency “Rosnauka” from Ministry of Science and Higher Education of the Russian Federation launched an integrated project “Development of technologies of CMM/CBM Production and Utilization”. This project is implementing in the framework of Federal Research and Development Program (2002 – 2006) that emphasizes its state importance.

The project is aimed to accelerate the implementation of CMM/CBM projects on the advanced technological base as well as to develop the organizational and economical mechanisms on the basis of Kyoto agreement. Besides, the project will contribute to the reduction of greenhouse gases emissions as well as to the improvement of coal mining safety.

The following activities are intended:

7. Carrying out the fundamental problem-oriented researches in order to develop the effective stimulation techniques which activate the de-sorption processes in coal seams and create the high permeability drainage canals from the production wells to provide the commercial methane flow rate.
8. Improvement and development of CMM/CBM production and utilization technologies on the basis of generalizing the foreign and domestic experiences. Fulfillment of the pilot projects in the Kuznetsk and Pechora coal basins to demonstrate their feasibility and efficiency as well as to attract investment from private companies for industrial production.

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9. Organizing the scientific and educational center for highly qualified specialists training. Involving students, young specialists and post-graduates in the project implementation. Organizing the cooperation with experienced foreigners for acceleration of the project implementation.
  10. Developing the business-plan of commercial CBM/CMM projects implementation using Kyoto mechanisms and state support.

### ***Gazprom Pilot Test Program***

Development of CBM recourses are characterized by significant geological and technological risks, especially at the early stage of project implementation. To reduce the financial risks during on the stage of commercial CBM production according to international practice Gazprom in 2003 launched the first in Russia pilot test program in Kuznetsky coal basin.

Implementation of pilot test program pursues two main goals:

11. Feasibility study of creating a new fuel and energy complex in the south of West Siberia on the basis of CBM production
12. Preparation of Kuzbass first-priority arias for commercial CBM production in the volume of 4-5 billion cu-m/year by 2010-2012.

The main tasks of the pilot test program are as follows:

13. Experimental demonstration of industrial gas flows from coal-bed wells applying technologies tested in different coal fields world-wide and adapted to the Kuznetsk basin geological conditions.
14. Movement of estimated CBM resources into the proved reserves of industrial categories. Estimation of CBM reserves on the basis of experimental-industrial CBM production in test areas.
15. Grounding in geologic-geophysical and technological base to design commercial CBM production in Kuzbass;
16. Estimation of CBM production environmental impact.

Pilot test program is implemented in two stages:

- I stage – drilling two pads of experimental wells and their completion using hydrofracture of coal seams within the bounds of one area; experimental-industrial CBM production and improvement of the technology on the basis of results obtained.
- II stage – drilling seven pads of experimental wells and their completion using hydrofracture, cavity as well as horizontal wells; founding in geologic-geophysical and

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technological base on the basis of experimental-industrial CBM production for commercial CBM production in Kuzbass.

**Fig 3 Gazprom pilot test area in Kuznetsky coal basin**



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- I stage – drilling two pads of experimental wells and their completion using hydrofracture of coal seams within the bounds of one area; experimental-industrial CBM production and improvement of the technology on the basis of results obtained.
- II stage – drilling seven pads of experimental wells and their completion using hydrofracture, cavity as well as horizontal wells; founding in geologic-geophysical and technological base on the basis of experimental-industrial CBM production for commercial CBM production in Kuzbass.

Today four experimental CBM wells with the depth from 640 to 980 m are constructed at the Gazprom testing area in the Kuznetsky coal basin. In each well from 5 to 7 coal seams with total capacity up to 20 meters were stimulated by hydro fracture. Testing wells are equipped with progressive cavity pumps as well as measuring and separation surface installations to control surface pressure, water and gas flow rates. First gas flow was obtained of about one month of water pumping. The initial gas flow rates are consist of about 1-3 thousand cu-m per day per well.

### **Conclusion**

Commercial CBM/CMM production and utilization projects in Russia can provide for considerable advantages:

For mines:

- Mining safety improvement;
- Reduction of penalties for emissions of greenhouse gases;
- Heat and energy generation using CMM for own use.

For coalmining regions:

- Environmentally friendly fuel for region's social and economics development;
- Solution of environmental problems.

To accelerate CMM/CBM project implementation the Russian Government in the middle of 2005 increased the penalties for methane blow-out to atmosphere 1000 times. Last activities indicate that Russia begun to pay attention to solution of these problems. But the rate of development will strongly depends on state and international support.

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## UKRAINE

Prof. V Lukinov  
(Ukraine)

### Prospects for CBM (CMM) Industry Development in Ukraine

Commercial production and utilization of coal-bed (coal-mine) methane have significant potential to positively affect the Ukrainian economy, environment and coal-industry activities. CBM/CMM development offers the following advantages:

- development of a new alternative type of fuel; this will reduce the Ukraine's dependence on energy imports , above all, natural gas from Russia and other countries of CIS;

- emissions of methane (one of the most reactive “greenhouse” gases) to the atmosphere from Ukrainian coal-production mines will be reduced;

- operation of mines will be more effective and safe.

In 1999 Cabinet of Ministers of Ukraine adopted an Energy Program for the period of 2000-2010, which includes issues aimed to provide more stable balance between energy production and consumption through utilization of additional resources and realization of programs on energy savings. One of the issues stipulates increase of CBM production up to 8 billion m<sup>3</sup> by 2010.

The large-scale production and utilization of coal-bed methane could essentially contribute to satisfy energy needs in Ukraine. Today annual consumption of **natural gas** in the country is around 75 billion m<sup>3</sup> though own production comprises only 18 billion m<sup>3</sup>. The difference (57 billion m<sup>3</sup>) between production and consumption is imported from Russia and other countries of the CIS. The logical consequence of this is grown external debt. In the total imported volume, 30 billion m<sup>3</sup> are imported on account of the Russian gas transition to Europe, and the rest, 27 billion m<sup>3</sup>, Ukraine buys at the price of \$80 for one thousand cubic meters. The result is unfavourable trade balance in amount exceeding 2 billion dollars per year.

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There are a lot of reasons underlying the inability to increase domestic natural-gas production in Ukraine. As long ago as the time of the USSR, the largest and relatively shallow deposits of natural gas and oil were mined-out on the territory of Ukraine. And development of small and deeper deposits requires vast sum of money, which is not available in the country. The exception is methane from coal seams and coal mines.

It is evident that favourable market for methane recovery projects does exist in Ukraine, and production of this type of fuel will positively influence the economy of the country.

According to the UN Framework Convention on Climate Change, methane refers to the gases that, to experts, contribute to the greenhouse effect, i.e. effect of retained heat in the atmosphere of the planet. The volume of the heat retained by “greenhouse” gases is calculated to carbon dioxide (CO<sub>2</sub>) equivalent. The experts consider that for 100 years methane is able to retain in atmosphere heat in quantity of 21 times more that the same volume of CO<sub>2</sub>. Methane and other greenhouse gases escape to the atmosphere through natural processes and man-caused actions, including coal production.

CBM capture and utilization can significantly reduce emissions to the atmosphere from Ukrainian coal enterprises. In 2004, 1221 million. m<sup>3</sup> of methane were released due to their operation. This quantity includes 357 million. m<sup>3</sup> (29%) captured by degassing systems of the mines, only 179 mln m<sup>3</sup> of which were utilized.

So, about 1042 mln m<sup>3</sup> were emitted to the atmosphere resulting not only in lost valuable fuel, but also in worsening the greenhouse effect.

Realization of the CMM projects in Ukraine will allow reducing of emissions from the coal enterprises. Besides, having system of the credits exchange/sale introduced, Ukrainian mines would be considered as a source of additional credits. By July 2004, international contracts on CBM credits purchased amounted to more than US\$300 million. The potential total volume of this market is estimated to be worth more than \$10 billion by 2010. And the contracts concluded comprises only a small part of the expenditures spent for reduction of the greenhouse-gases emissions. However, experts in economics haven't yet come to the common conclusion on the problem which expenditures should be taken into account when specifying costs of actions targeted to reduction of



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emissions. It is quite obvious that the cost of realization of the projects on CMM production and utilization would be significantly lower in Ukraine than the cost of realization of similar projects in the USA.

Implementation of the CMM production and utilization projects will considerably reduce number of failures, accidents and loss of lives in the coal industry of Ukraine. In 2004, 168 people perished in the coal companies, i.e. 2.1 fatal cases per one million tonnes of the coal produced. These tragic figures rank to the highest in the world. In most of the cases the reason of losses of life was sudden coal and gas outbursts due to the high gas-content in the rocks, or explosions due to the high concentration of methane in air of the workings. Pre-mining degassing of the coal seams (by way of drilling vertical holes from the surface) and usage of the state-of-the-art systems for underground degassing are able to essentially reduce number of failures and fatal cases in the Ukrainian mines. Besides, with methane extracted from the mines it will be possible to improve their productivity and reduce the coal cost as a result of less idle time for equipment and better rate of mining that is usually slow due to the high gas-content in the air.

Problems of the coal industry of Ukraine are well known and, no doubts, will have an influence on organizational and business structure of any project on CMM production. To proper estimate any potential project effectiveness, it is necessary to take into consideration some specific features of the industry and, first of all, interrelations between a mine and a company (organization) – owner of the project. Besides such problems as rights of resource ownership, marketing, gas usage and receiving payment for gas usage, and current practice for methane capture and utilization also should be taken into account. The scope of all these factors impact the effectiveness of any project on development of CMM resources.

Totally in Ukraine in the end of 2004, there were 172 active coal companies including 169 mines and 3 opencast mines. The aggregate output of these companies in 2004 was 80.1 million. tonnes of raw coal and 63 million. tonnes of commodity output (coal concentrates). Most of these companies belong to the government and are under the jurisdiction of the Coal Industry Ministry.

Before estimating opportunities for the CBM project realization, any potential investor should study the organizational and economic structure of the mine. To embody

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the project, it is necessary that the mine is authorized to conclude contracts. The final decision on contracts is made by the Coal Industry Ministry. However, successful realization of the project requires support and collaboration with the mine and governmental company that operates the mine, which is controlled by the Coal Industry Ministry.

A company whose intention is to develop a CBM project should create and maintain good business relations with a coal enterprise. Joint cooperation with the mine should be continuous in order to have sufficient information about coal produced, advancing of the workings and future plans for the mine development. At the same time, the investor should also take into consideration some specific economic, social and political problems, which are characteristic for the coal enterprises and regional conditions of Ukraine.

As has already been mentioned above, the Ukrainian government owns all coal companies and coal resources. The state distributes mining leases between underground and open-cast mines for further development on the basis of licenses. As CMM resources are also owned by the state, a license for the methane production is required. Most of the mines have already received the licenses. Prior to starting any project realized, it is reasonable to get information about validity of the license agreements. According to the laws of Ukraine, it is possible to get a license for the exploration and experimental and production development of the deposit for five years. Having this license, the investor should satisfy some obligatory requirements for the deposit development and only after this the investor will be able to get license for the production. Having both licenses in hand, the investor shall pay a charge to the state for the right to capture and market the minerals.

The methane-degassing (drainage) systems are used for the methane extraction from the gas-bearing rocks before, during and after coal production depending on the mine needs. Degassing helps to reduce costs of the ventilation processes, to cut down idle time for the equipment and to improve safety of labour. Degassing is provided by way of drilling of wells of three main types: vertical (from the surface), horizontal (underground) and slant holes which run through the coal seam and adjoining rocks. Each of these methods features own specific peculiarities.

The vertical wells are drilled prior to mining with the aim to capture gas with high content of methane (often more than 95%). Such wells (so-called “standard”) can be drilled

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from the surface to the workable bed and adjoining rocks. In the event the gas-content of the rocks is too high, the degassing wells are drilled 5-10 years before the first mining works. These holes help to capture up to 70% of methane from the coal seams.

The vertical wells for pre-gassing, which then are left in production in the fracturing zone of the rocks, and wells drilled from the surface to the developed area are called “man-caused”. The latter are usually drilled from the surface to the horizon 3-20 m higher than target seam. As a rule, gas captured in man-caused wells contains from 20% to 80% of the methane. Today there are only two fields in Ukraine with vertical wells for pre-mining degassing and methane capturing.

The horizontal underground wells are drilled from underground workings. They are used for degassing of the coal-seam in the area under mining. Their length is usually from 30m to 50m though sometimes can be more than 250m. This method features lower degassing effectiveness if compared with vertical holes: 10-50% of total volume of gas in the area of bedding.

The slant holes are among those that are most frequently used in Ukraine for degassing the rocks bedding under and above the workable seam. Gas in the wells contains 30-80% of methane; typical degassing effectiveness is approximately 20% in the total volume of gas in the area of bedding though this figure can reach 80% in some mines.

The degassing wells are connected with central vacuum pumping plans or compressors via pipelines. As Ukrainian mines are developed at great depth with lack of financing for the equipment repair, numerous leakages are the common phenomena for the degassing systems resulting in low content of methane in the extracted gas flow.

In 2004, Fuel And Energy Ministry of Ukraine signed an agreement with the USA government for adaptation of practice of drilling underground degassing holes with length up to 1000m.

From total CMM output extracted by the coal companies (1221 mln. m<sup>3</sup> in 2004), 29% are captured by degassing systems and only 14,6% of this volume are utilized. Today 42 Ukrainian mines are equipped by degassing systems, and only 11 mines use methane as a fuel for the mine boilers and motor fuel for the car filling.

Nevertheless, there are a lot of opportunities in the country for utilization of CMM. As the economy of Ukraine greatly depends on imported gas, any additional source of

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energy inside the country will contribute to improve its energy independence. The governmental programs (for example, Program on Energy Saving and Program of Actions for Reduction of Natural-Gas Consumption) envisage realization of the projects on methane recovery. However, the government has managed to complete only few of them due to lack of financing.

It is expected that the key marketing fields under a new methane production project will include selling of conditioned methane and generation of electricity and heat. As has already been mentioned above, Ukraine is a gas-import dependent country, i.e. the ready market for additional quantities of this type of fuel is available here. Power generation on the basis of methane utilization does not require essential financing. End-users of the power generated will be mines and local consumers; supplies to the energy system of Ukraine are also possible.

Since 1991, the year of declaration of the Ukraine's independence, legal and normative systems are the subject for regular changes. This can be explained by transition from the Soviet command-administrative system to the market model of economics. Prior to investing money in CMM/CBM recovery projects, investors should analyze laws and normative documents in force in full scope. It is also essential for the investor to get a general idea of the structure of the government and procedures for making decisions in Ukraine.

Executive power in Ukraine is represented by the President who is elected by the people, the Prime-Minister who is appointed by the President and confirmed by parliament, and the Vice-Prime-Ministers who control certain fields of the economy. Orders and regulations of the executive bodies have the same boundary force as laws adopted by the parliament. The parliament (Verhovnaya Rada of Ukraine) is authorized to approve laws of the country. Designing and realization of the CMM/CBM production projects requires collaboration with a diversity of governmental agencies at the central, oblast and local levels.

Sometimes, in the course of the project preparation, some actions or measures may be required to obtain approval by oblast and local bodies of power.

During the period from 1998 to 2004 Ukraine was focusing attention on the issues of CMM production. At that time, Verhovnaya Rada of Ukraine and executive bodies of the country passed several laws and normative acts which could positively influence the

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methane projects. The most important among them is Law of Ukraine on Agreements for the Products Distribution.

A series of legal and normative documents are also worked out with focus on improvement of legal and taxation conditions for realization of CBM/CMM projects. For example, Cabinet of Ministers have elaborated and delivered to the Verhovnaya Rada a project of the Law of Ukraine “About Coal-Bed Methane”.

In 2004 Ukraine signed and ratified the Kyoto Protocol “On Reduction of Harmful Emissions to the Atmosphere”.

As any other project on development of natural resources, development of CMM requires studying and analyzing of particular geological conditions. And it is also very important to be familiar with geology of concrete region before preliminary estimation of the resources.

The main coal basin in Ukraine is Donetsk basin (Donbass) located in the southeast of the country. From a geological point of view, it is represented in the form of deep flexure with an area of about 60,000 km<sup>2</sup>. By age, the coal seams refer to the carbon deposits. More than 330 coal seams were explored down to the depth 1800 m with thickness ranging from 0.45m to 2.4m, not more than 10 of which were found to be suitable for development. The rest are too deep or have small thickness.

Ukrainian geologists divide the Donbass coal mass into several geological and industrial regions each with specific geological features.

Tectonics of Donbass is quite diverse. The central part of the basin is complicated by big linear folds with small folds and cracks at the edges from the northern and southern peripheries.

Thickness of the coal formations in the basin is increased from the flexure edges to the central part and in a southeast direction. Evolutional development of many groups of flora and fauna can be observed in the Donetsk carbon profile.

Total quantity of the coal layers in the coal-bearing thickness down to the depth 1800m is 330; 200 of them are with thickness less than 0.45m and only 130 layers have thickness more than 0.45m. Typical thickness of the layers under development ranges between 0.8 and 1.2m. Seams with thickness exceeding 2m can be detected very rarely. Coal content is not evenly distributed in the basin. The major portion of the coal resources

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is bedded in 35 layers: 27 seams of medium carbon and 8 seams of lower carbon. Only one commercial seam has upper carbon.

According to the estimates of Ukrainian experts, coal reserves in Donbass comprise 213 billion tonnes including 170-180 billion tonnes of industrial reserves (bedded in the intervals between 500 and 1800m). Coals are represented here practically by all known types - from lignites to anthracites.

The total weight of disseminated organic matters in the rocks and coal seams-satellites is 1680 billion tonnes including 1210 billion tonnes in the depth interval between 500m and 1800m.

Metamorphism of the coals in the Donetsk basin was followed by formation of significant amount of methane. According to the estimations of Ukrainian and western experts in the field of development of this type of fuel, methane resources in Donbass are up to 117 trillion m<sup>3</sup>. Regularity of modern dissemination of carbon gases in the coal-bearing deposits of Donbass is closely connected with geological conditions for gas-formation in the process of accumulation of the gas-contained formations.

Gas dissemination in the coal-contained thickness is subject to specific laws. Firstly, regular increase of methane content is observed in the corners in directions from northeast to southwest that is explained by higher level of their metamorphism. Secondly, a vertical gas zoning is specified that divides the profile into two zones: the upper (by the depth) zone with methane content in the gas less than 80%, and lower – zone of methane gases where methane content exceeds 80%.

Gases in the coal layers are, by their composition, mainly methane with a small portion of ethane, propane, nitrogen and carbon dioxide. Heavy hydrocarbons are mainly available in coals with medium stage of metamorphism.

Black coals and anthracites are characterized by formation of thin pores with diameter less than  $10^{-8}$  m. The surface area of the pores reaches several hundreds square meters per 1 cm<sup>3</sup> of coal substance – that is the explanation of the high absorbing activity of the coal.

Methane content in coking coal reaches 20-25 m<sup>3</sup>/t of dry ash-free mass. For anthracites with high specific electric resistance, the gas-content is, as a rule, higher – up to 40-45 m<sup>3</sup>/t of dry ash-free mass.

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According to various estimations of Ukrainian experts concerning the coal deposits in Donbass, methane resources absorbed in the coal seams with thickness more than 0.3 m and bedded at the depth of 500-1800m range from 1400 billion m<sup>3</sup> to 2500 billion m<sup>3</sup>. At the same time, seams of the main geological industrial regions contain about 855 billion m<sup>3</sup>.

The density of estimated methane resources in the coal seams over the areas of coal-bearing deposits of the southwest part of Donbass is 90-107million M<sup>3</sup> of methane per square kilometer.

Thus, Donbass is a promising raw-material base for development of CMM and CBM industry.

The fact is that methane can be detected not only in coal seams but in the coal-bearing rocks also. current re-dissemination of gases over the coal-bearing thickness is explained by changed collecting features of the rocks. In Donbass, micro deposits and local accumulations of free gases are mostly confined to the fractured zones. Data on gas escaping into the workings of the mines via **pipers** (a mining term meaning stormy methane escaping from the rocks) are evidence of the essential role of the fractures in formation of local accumulations of free gas in the thickness of the coal-bearing deposits.

On the basis of the data obtained by Ukrainian experts, there are three types of methane contained in the rocks of Donbass:

- free methane in the pores and cracks of the rocks;
- methane in adsorbed state contained in the diffused organic substances and coal seams-satellites;
- methane dissolved in water that fills the pores of sands.

Methane reserves should be estimated by geological analysis of concrete areas when assessing their potential for methane extraction.

It should be noted that economic factors are a main deterrent for the commercial development of CMM in Ukraine. To realize the programs, it is necessary to execute a full set of both surface and underground works connected with degassing and utilization. Unfortunately, not every mine can afford to finance the scope of these jobs. Though some large mines have all opportunities to realize such projects.

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The Zasyadko's mine is a good example of this approach. The mine designed a large-scale project on degassing and mine-methane utilization, which is now in underway. Under the project, the degassing system was reconstructed, existing pipelines of small diameter were replaced by new ones with higher throughput, new vacuum pumping plants with better capacity were built, and modern, state-of-the-art drilling equipment was purchased and adapted. The mine is continuously searching and testing new technical and technological practices on methane degassing and utilization.

Having prepared the "raw material" base, the mine proceeded with solving problems of CBM utilization. It was decided to purchase 22 modules (gas generators of «Jnbh» Company with annual consumption of 133.6 mln. m<sup>3</sup> of methane. Twelve of them with installed capacities of 3 MW each have been already purchased and installed. The mine intends to utilize heat received from the power generation to double the capacity of the plants. In addition, methane extracted via surface holes is used as motor fuel for cars. Within the frame of the Project, it is expected to utilize up to 3000 million. m<sup>2</sup> of CMM and to reduce methane emissions to the atmosphere by 4510.98 thousand tonnes per year if convert to CO<sub>2</sub>.

This Project on complex degassing and utilization of methane that is today in the process at the Zasyadko's mine is the most powerful project in the world. Actually, the Project is a pioneer of the CMM industry in Ukraine. The bottomline of the Project is the principle that excludes any contradictions in achieving the triple purpose of: commercial production of methane as valuable fuel; improving safety conditions for coal production in the mines; and improvement of ecological conditions in coal-produced regions.

Realization of the Project will help the mine to provide safety production of two valuable energy-carriers – methane and coal, fully provide the mine with electric power and heat, and reduce harmful methane emissions into the atmosphere.

The current tendency of intensification of the processes of coal production and rates of mining in the coal enterprises is evidence that more and more mines are involved into the operation in complicated gas conditions. Thus, realization of complex methane degassing and utilization in the Zasyadko's mine is an example of successful solving this difficult and urgent problem in the coal industry of the country.

So, fundamental solving of the problem of commercial methane production and



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provision of technical and ecological safety in the coalmines is possible on the principles of commercial approach only. Projects focused on the improvement of degassing effectiveness also should be realized as in the Zasyadko's mine, especially those in the mines with higher methane safety risks. The mines, executing such projects, need financial, normative and legal support.

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## ARGENTINA

### 1. GENERAL INFORMATION

The Argentine territory, in the southern portion of South America, runs from the Tropic of Capricorn to the southern tip of the continent (55° 58' S). Extending for 3,700 km North to South and covering 2,791,810 sq. km, it is bordered by the Atlantic Ocean, Uruguay and Brazil to the east, Paraguay and Bolivia to the north and Chile to the west.

Argentina's population is estimated at 36,224,000 (2001) with a decadal increase rate of 11.1%. Population density for the whole country averages 10 inhabitants/km<sup>2</sup>, ranging from 0.8 inhabitants/km<sup>2</sup> in the Santa Cruz province to 59 inhabitants/km<sup>2</sup> in the province of Tucumán. At the country level, approximately 90% of the population is urban whereas only 10% live in the countryside.

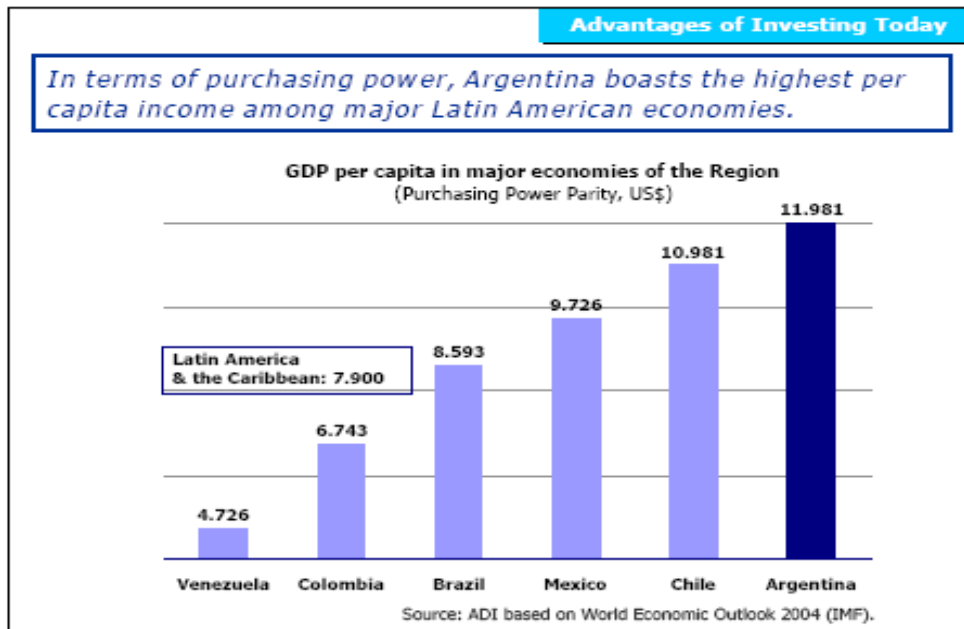
Argentina is also one of South America's largest and most important economies.

Though it suffered a severe financial crisis in 2001-2002, the country's economy has fully recovered to pre-crisis levels and relevant elements are now in place for solid growth prospects: a viable economic structure, a competitive exchange rate, adequate legal, regulatory and transactional frameworks, aligned with sound economic fundamentals.

In 2004, Argentina's real gross domestic product (GDP) grew at a rate of 9.7 percent, even higher than the 8.7 percent growth rate of 2003. Economic forecasts predict 8 percent real growth in 2005.

Advantages of Investing Today	
<i>Argentina at a Glance</i>	
Surface Area	2.8 million km <sup>2</sup> <i>Argentina is the 2nd largest country in Latin America and the 8th largest worldwide in terms of surface area</i>
Population (2005 est.)	38,592,150
GDP (2005 est.)	US\$ 162 billion
Growth (2005 2003)	6.3%
Per Capita GDP (2005 est.)	US\$ 4,195
Form of Government	Republican, Representative, and Federal
Political Subdivisions	24 autonomous States with political, administrative and economic powers (23 provinces and the City of Buenos Aires)
Currency, Exchange rate	Argentine Peso (Arg\$); 2.92 Arg\$ / US\$.
Language	Spanish

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## 2. ENVIRONMENT

Notwithstanding its recent economic difficulties, Argentina experienced strong economic growth during much of the 1990s. In 2002, Argentina was South America's third-largest energy consumer, as well as the continent's third largest emitter of carbon dioxide from the consumption of fossil fuels.

In 2002, Argentina had some of South America's highest per capita energy consumption (64.9 million Btu per person) and per capita carbon dioxide emission (3.2 metric tons per

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person) rates, though both numbers declined slightly due to the 2002 economic collapse. Conversely, energy consumption per dollar of GDP (energy intensity) and carbon dioxide emissions per dollar of GDP (carbon dioxide intensity) are both relatively low compared to other South American countries.

Argentina also faces urban air pollution and industrial pollution problems. While past commitments to the reduction of greenhouse gas emissions and towards increasing the use of renewable fuels bode well for environmental protection, recent political turmoil has left the country's environmental future uncertain.

Following a growing trend in Latin America towards greater environmental activism, Argentina amended its Constitution in 1994, giving its citizens a right to a healthy environment through sustainable development.

In 2002, Argentina passed its first general environmental law, N° 25.675, which defines what Argentina's national environmental policy should be and lays out the guiding principles for minimum environmental standards. The law also requires environmental impact assessment for any project, whether public or private, which might be considered as "susceptible to damaging the environment".

Furthermore, Argentine legislators passed the solid waste management Act, N° 25.916, which establishes the minimum provisions for the management of solid waste in the country.

At the moment, there is no national or local law that forces the landfill gas treatment.

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### 3. COAL INDUSTRY IN ARGENTINA

The main components of the energy matrix are oil and natural gas. The coal reserves are very limited, and the participation of coal among energy sources is not relevant. In 2002, energy use of coal represented less than 0,1 % of primary sources of energy.

The reserves are located in Río Turbio (province of Santa Cruz) and Pico Quemado (province of Río Negro). Total reserves are estimated at 417 million tonnes, 80% corresponding to Río Turbio, the only active mine in Argentina.

Río Turbio operation is conducted by Yacimientos Carboníferos Río Turbio, a private consortium with a 20 years' concession since 1994. The production is sub-bituminous coal. Pico Quemado has been inactive since the 50's. Their reserves are mainly high-volatile bituminous.

The main use of coal is metallurgical. Only one power plant, with a capacity of 350 MW, is coal fired. Total power plant installed in the country is around 22000 MW.

**Table: Coal Production. Million tonnes per year.**

Year	1995	1996	1997	1998	1999	2000	2001
Production	0.300	0.313	0.258	0.295	0.352	0.263	0.185

Source: Government of Santa Cruz Province

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## 4. CMM Emissions, Projects, and Potential

The elaboration of GHG Anthropogenic Emission Inventories in Argentina has two fundamental antecedents:

- First National Communication of the Republic of Argentina to the UNFCCC (1997): in which the INVGEI corresponding to the years 1990 and 1994 were elaborated and presented. When that task was carried out, the last available methodology for its calculation was "IPCC/OCDE Guidelines for the elaboration of GHG Emission Inventories" as of 1995.
- Review document of the First National Communication of the Republic of Argentina to the UNFCCC (1999): in which the INVGEI corresponding to the year 1997 was elaborated and the INVGEI of 1990 and 1994 were revised. Both the INVGEI 1997 as well as the revision of those corresponding to 1990 and 1994 were carried out using the "IPCC/OCDE revised Guidelines for the elaboration of GHG Emission Inventories" as of 1996.

The reported methane emissions related to coal production correspond to the Río Turbio mine.

**Table: CMM emissions. Million of cubic meters per year.**

Year	1990	1994	1997
Total emitted	12.86	7.73	12.86

Source: Secretariat of Environment

There is no data available about CMM or CBM emissions from abandoned coal mines.

Argentina is a Non-Annex I country under the United Nations Framework Convention on Climate Change (signed June 12, 1992 and ratified on March 11, 1994). As signatory to the Kyoto Protocol (signed March 16, 1998 and ratified on September 28, 2001), it is a potential candidate site for projects under the Clean Development Mechanism.

**NIGERIA**

**STATISTICAL DATA ON COAL MINE METHANE  
RECOVERY AND USE IN NIGERIA**

**(i) Current Coal Production In Nigeria**

The current/potential levels of coal utilization in the country are as follows:

		Tones Annum(Tpa)	Per
(i)	<b>Cement Manufacture</b>		
	- <u>Nigerian Cement Company (Nigercem), Nkalagu:</u>		
	Installed Coal capacity utilization for 6 kilns ...	140,000 Tpa	
	Current Coal Capacity utilization for 1 Kiln	20,000 Tpa	
	Prospect of expanding current capacity utilization.....	Yes	
	- <u>Ashaka Cement Company, Gombe:</u>		
	Installed Coal Capacity utilisation .....	300,000Tpa	
	Current Coal Capacity utilization .....	None	
	Prospect of expanding current capacity utilization .....	Yes	
	- <u>Proposed Kogi Cement Company Abajina, Kogi State:</u>		
Current Coal Capacity utilization .....	None		
Prospect of expanding current capacity Utilization .....	Yes(3000,000Tpa)		
(ii)	<b>Other industrial users:</b>		
	- <u>West African Batteries Ltd (Exide) Ibadan</u>		
	Installed Coal Capacity utilization .....	2,000 Tpa	
	Current Coal Capacity Utilization .....	None	
Prospect of expanding current capacity utilization	Yes.		

(iii)	<u>Metallurgical use by Ajaokuta Steel Plant:</u> <ul style="list-style-type: none"> <li>- Installed Coal capacity utilization as blend with imported coking coal .....</li> <li>Current Coal capacity utilization .....</li> <li>Prospect of expanding current capacity utilization .....</li> </ul>	<p>200,000 Tpa None</p> <p>Yes(1,000,000 Tpa)</p>
(iv)	<u>Coal Carbonization/Briquetting plants</u> <ul style="list-style-type: none"> <li>- Installed coal capacity utilization .....</li> <li>Prospect of installing plants for Coal Utilization for replacement of fuel wood ....</li> </ul> <u>Proposed Abajina/Makurdi Power Stations in Kogi and Benue respectively:</u> <ul style="list-style-type: none"> <li>- Installed Coal Capacity utilization .....</li> <li>Prospect of installing Plants .....</li> </ul>	<p>None</p> <p>Yes(2,000,000 Tpa)</p> <p>None</p> <p>Yes(300,000 Tpa)</p>



**(ii) Comparison Of Typical And Prime Coking Coal Analysis With Lafia-Obi Raw And Washed Coals**

<b>Quality Parameter</b>	<b>Typical Coking Coal</b>	<b>Prime Coking Coal/Blend</b>	<b>Lafia Unwashed</b>	<b>Lafia Washed</b>
Ash (% , d.b)	56.	7	28.8-46.0	14.7
Vol..matter (% d.af)	22.1	28-32	48.4	31.7
Gross SE(MJ/Kg d.a.f)	34.3		27.8	31.95
Carbon (% d.a.f)	89.2	88-92	37.6	58.0
Hydrogen (% , d.a.f)	5.1	-	4.5	5.6
Total Sulphur (% , d.b)	0.80	1.0	1.1-6.83	1.0-3.5
Sulphate Sulphur (% ,d.b)	0.07	-	0.06	0.01
Pyritic Sulphur (% , d.b)	0.62	-	6.52	1.39
Organic Sulphur (% ,d.b)	0.11	-	0.29	0.07
Free Swelling Index	9	.6	6	9
Dilatometer Test				
Softening point (°C)	370	-	389	375
Reconsol. Point (°C)	465	-	441	426
Softening range (°C)	95	-	148	149
Contraction (%)	27	-	17	30
Dilation (%)	75	50-200	12	190
Gray-king Coke type	G8	-	G4	G9
Plasticity				
Maximum thridity (ddpm)	2575	60 -1000	23.4	27.600
At temperature (°C)	461	-	-	400
Petrography				
Vitrinite (%)	83.5	-	79.7	98
Liptinite (%)	6.6	-	0.4	-
Inertinite (%)	9.9	-	19.9	2.0
Mean max Reflectance (Ro%)	1.12	1.15-1.25	0.99	1.00
The micum indices				
Micum M40(%)	-	70	-	47
Micum M10(%)	-	9	-	18

**(iii) Comparative Prices Of Some Energy Fuels On Heat Equivalent**

**Basis In Urban Areas In Nigeria 2000**

Fuel	Retail Price ₦	Unit	Gross Calorific value (Kcal/Kg)	Avg. End use efficiency (%)	Avg. Net Usable Heat (Kcal/Kg)	Fuel Price per 10 <sup>3</sup> Kcal (Naira)
(a)	(b)	(c)	(d)	(e)	F=(dxe)	G=(b/f)x10 <sup>3</sup>
Wood (use of tripod)	10.00	Kg	3,500	7.5	262.5	38.10
Wood (use of stove)	10.00	Kg	3,500	20	700	14.29
Ordinary Charcoal	6.00	Kg	6,000	20	1,200	6.70
Carbonised Wood Charcoal	15.00	Kg	6,000	20	1,200	12.50
Electricity (industrial)	8.60	Kwh	860	75	645	7.35
Electricity (Domestic)	8.60	Kwh	860	75	645	4.12
Kerosene (DPK)	20.00	Kg	10,102	35	3,536	5.85
Diesel (AGO)	22.17	Kg	9,983	35	3,494	6.35
LPG	50.00	Kg	11,700	52.5	6,142.5	8.14
LPG (Scarcity)	167.00	Kg	11,700	52.5	6,142.5	27.19
Smokeless Coal Briquette	10.00	Kg	11,214	50	5,607	1.78

**(iv) Potential Of CBM/CMM**

Below are some of the methane recovery and use options for some of the key emission sources.

- Coal Mines – Methane is removed from underground mines either in advance of mining activities, or after mining has occurred to reduce explosion hazards. Instead of releasing this methane to the atmosphere, profitable uses can be identified and implemented. Some of these options include natural gas pipeline injection, power

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production, co-firing in boilers, district heating, coal drying, and vehicle fuel.

- Landfills – The principal approach to reduce methane emissions from landfills involves the collection and combustion or use of landfill gas (LFG). Landfill gas utilization technologies focus on electricity generation and direct gas use. Electricity generation involves piping collected methane to reciprocating engines or combustion turbines where it can be converted to electricity. Direct use technologies may use landfill gas directly as a medium-Btu fuel, while others require the gas to be upgraded and distributed to a natural gas pipeline.
- Natural Gas and Oil Systems – Current opportunities for reducing methane emissions include both procedural and hardware improvements. Methane emission reduction opportunities generally fall into one of three categories: (1) technologies or equipment upgrades that reduce or eliminate equipment venting or fugitive emissions; (2) improvements in management practices and operational procedures; or (3) enhanced management practices that take advantage of improved technology. In all cases, reducing methane emissions makes additional gas available for sale and use.

(v) Summary Of CBM/CMM., Projects Under Consideration

The Methane to Markets Partnership will bring together the collective resources and expertise of the international community to address technical and policy issues and facilitate LFG energy projects. Early initiatives will likely include:

- Assisting with solid waste management capacity building,
- Identifying potential landfill resources,
- Performing initial gas generation feasibility studies,
- Technology transfer through demonstration, training and workshops, and
- Creating an environment for sound investment.

LFG capture and use is a reliable and renewable fuel option that represents a largely untapped beneficial environmental and energy opportunity at thousands of landfills around the world. Cooperation with the Methane to Markets Partners will help ensure that more LFG reaches the energy markets.

**(vi) Existing Potential Coal Mines Sites With Reserves In Nigeria**

S/ N	MINE LOCATION	STATE	TYPES OF COAL	ESTIMATE D RESERVES (Mil.T)	PROVEN RESERVE S (Mil.T)	BOREHOLE RECORDS	COAL OUTCROP AND SEAM THICKNES S (M)
1.	Okpara Mine	Enugu	Sub-Bituminous	100	24	20	Many (1.5m)
2.	Onyeama Mine	Enugu	Sub-Bituminous	150	40	Many	Many (1.5m)
3.	Ihioma	Imo	Lignite	40	N.A	Nil	Many
4.	Ogboyoga	Kogi	Sub-Bituminous	427	107	31	17(0.8-2.3m)
5.	Ogwashi Azagba/Obomkpa	Delta	Lignite	250	63	7	4(3.5m)
6.	Ezimo	Enugu	Sub Bituminous	156	56	4	10(0.6-2.0m)
7.	Inyi	Enugu	Sub Bituminous	50	20	4	(0.9-2.0m)
8.	Lafia/Obi	Nassarawa	Bituminous (cokable)	156	21.42	123	(1-3m)
9.	Oba/Nnewi	Anambra	Lignite	30	N.A.	2	14(0.3-4.5m)
10.	Afikpo/Okigwe	Ebonyi/Imo	Sub Bituminous	50	N.A.	Nil	N.A
11.	Amasiodo	Enugu	Bitumininouis	1000	N.A	3	N.A
12.	Okaba	Kogi	Sub-Bituminous	250	73	Many	(0.8-2.3m)
13.	Owukpa	Benue	Sub-Bituminous	75	57	Many	(0.8-2.3m)
14.	Ogugu/Awgu	Enugu	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
15.	Afuji	Edo	Sub-Bituminous	N.A.	N.A	Nil	N.A.
16.	Ute	Ondo	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
17.	Duho	Bauchi	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
18.	Kurumu	Bauchi	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
19.	Lamja	Adamawa	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
20.	Garin Maigunga	Bauchi	Sub-	N.A.	N.A.	Nil	N.A.

			Bituminous				
21.	Gindi Akwati	Plateau	Sub-Bituminous	N.A.	N.A.	Nil	N.A.
22.	Janata Koji	Kwara	Sub-Bituminous	N.A.	N.A.	Nil	N.A.

## **BACKGROUND INFORMATION ON NIGERIA**

### **1.0 Introduction**

The Methane to Markets Partnership is an action-oriented initiative that will reduce global methane emissions to enhance economic growth, promote energy security, improve the environment, and reduce greenhouse gases. Other benefits include improving mine safety, reducing waste, and improving local air quality. The initiative focuses on cost-effective, near-term methane recovery and use as a clean energy source. It will be done internationally through collaboration between developed countries, developing countries, and countries with economics in transition – together with strong participation from the private sector. The Methane to Markets Partnership initially targets three major methane sources: landfills, underground coal mines, and natural gas and oil systems.

Methane, the primary component of natural gas, accounts for 16% of all greenhouse gas emissions resulting from human activities. Because methane is both a powerful greenhouse gas and short-lived compared to carbon dioxide, achieving significant reductions would have a rapid and significant effect on atmospheric warming potential. The Methane to Markets Partnership is a major new addition to the series of international technology partnerships advanced by the Bush Administration on hydrogen, carbon sequestration, fusion and advanced nuclear power technologies. These initiatives will help develop and deploy the transformational energy technologies that will significantly cut projected emissions and the greenhouse gas intensity of the global economy in the context of sustained economic growth.

### **2.0 Nigerian Coal Mine Industry**

Partner countries such as Nigeria will adhere to a Terms of Reference that outlines the purpose, organization and functions of the Partnership. The core activities are likely to include:

- Identifying and promoting areas of bilateral, multilateral, and private sector collaboration on methane recovery and use.
- Developing improved emissions estimates and identifying the largest relevant emission sources to facilitate project development.
- Identifying cost-effective opportunities to recover methane emissions for energy production and potential financing mechanisms to encourage investment.

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- Improving the legal, regulatory, financial, institutional and other conditions necessary to attract investment in methane recovery and utilization projects.
  - Identifying and implementing collaborative projects aimed at addressing specific challenges to methane recovery, such as raising awareness in key industries, removing barriers to project development implementation, identifying project opportunities, and demonstrating technologies.
  - Developing collaborative action plans that outline a series of concrete activities and actions that directly support the core goals and functions of the Partnership.
  - Developing and implementing a process for evaluating progress and reporting results.

### **The Coal Deposits in Nigeria**

Coal exploration in Nigeria started as far back as 1916. Available data show that Coal (mainly sub-bituminous steam Coals except for the Lafi-Obi bituminous Coking Coal) occurrences in Nigeria have been indicated in more than 22 Coal fields spread over 13 states of the Federation. The proven Coal reserves so far in Nigeria total about 639 million metric tones while the inferred reserves sum up to 2.75 billion metric tones.

Presently, the Nigeria Coal Industry has 4 existing mines at Okpara and Onyeama underground Mines in Enugu State Okaba surface Mine in Kogi state and Owukpa underground Mine in Benue State. In addition there are more than 13 underdeveloped Coal fields.

The underdeveloped Coal fields in Nigeria are of two categories, viz; the Virgin Coal fields where further detailed exploration work and/or access roadways are required and the developing Coal fields where reserves have been proven and mine access roadways developed. The later include: Azagba Lignite field in Delta State; Ogboyoga Coal field in Kogi State; Ezimo Coal field Enugu State; Ute in Ondo State; Lamja area of Adamawa State, Gindi- Akunti in Plateau State; Afuze in Edo State; Janata-Koji area of Kwara State and extension of Okpara Mine South in Enugu State. Appendix 1 shows the existing and potentials Coal Mine sites with reserves in Nigeria.

The Coal Industry gave rise to the first of industries in Nigeria and provided all the energy requirements for these industries up to the late 1960's. These include the Marines, the Nigeria Railways, Electricity Corporation of Nigeria Cement Company (Nigercem), Nkalagu. All these are in addition to the use of Coal for domestic cooking and other industrial applications. The leading role of coal in Nigeria's energy mix started to decline with the discovery of oil in commercial quantity in Nigeria in the late 1950's. and was hastened by the Nigeria's Civil War which took place between 1967 and 1970 during which period all the Coal Mines in the country were abandoned development of the oil

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industry in Nigeria resulted to undue Governments' reliance on oil for the country's revenue and energy needs since the 1960's and a neglect of the Solid fuel Coal which is an alternative energy resource.

The Corporation has successfully over these years brought back the attention of Government, individuals and groups to the enormous potentials of the Coal industry in Nigeria. As a result of this effort, the Federal Government decided to commence the rehabilitation of the Coal industry in 1995 by ways of providing funds for mine development and provision of infrastructure so as to attract private sector investments to the Coal industry in Nigeria.

### **3.0 Recovery of Methane and barriers for use in power generation in Nigeria.**

Methane is second only to carbon dioxide (CO<sub>2</sub>) as a greenhouse gas resulting from human activities. Methane is a short-lived greenhouse gas (GHG) with an atmospheric lifetime of approximately 12 years. Methane is also considered a potent (GHG) because, on a kilogram for kilogram basis, methane is 23 times more effective at trapping heat in the atmosphere than CO<sub>2</sub> over a 100 - year time period.

Over the last two centuries, methane concentrations in the atmosphere have more than doubled. Atmospheric concentrations are determined by the balance of the input rate and the removal rate. Input rates have increased due to human activity. Removal rates are determined by the effectiveness of "sinks" (systems that absorb or neutralize a greenhouse gas). The primary methane sinks are oxidation by chemical reaction with tropospheric hydroxyl (OH), stratospheric oxidation, and microbial uptake by soils. The strength and effectiveness of these sinks determine methane's atmospheric lifetime.

Methane accounts for approximately 16 percent of global GHG emissions. Methane is emitted from a variety of both anthropogenic (human-influenced) and natural sources. Anthropogenic emission sources include coal mining, natural gas and oil systems, landfills and agriculture. About 60% of global methane emissions come from these sources and the rest are from natural sources (principally wetlands, gas hydrates and permafrost, and termites).

Globally, China, India, the United States, Brazil, and Russia and other Eurasian Countries are responsible for almost half of all anthropogenic methane emissions. Methane emission sources, however, can vary significantly between countries. For example, the two key sources of methane emissions in China are coal mining and rice production, whereas Russia emits most of its methane from natural gas and oil systems. India's primary sources are rice and livestock production, whereas landfills are the largest source of US methane emissions.

Reducing methane emissions has many important energy, safety, economic, and environmental benefits. First, because methane is both a potent GHG and has a short atmospheric lifetime, methane reductions can produce significant near-term

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results. In addition, methane is the primary constituent of natural gas. Thus, the collection and utilization of methane provides a valuable, clean-burning energy source that improves quality of life in local communities and can generate revenue and improve living standards. Producing energy from recovered methane can also avoid the use of higher-emitting energy resources such as wood, coal or oil. This can reduce end user and power plant emissions of CO<sub>2</sub> and air pollutants such as sulfur dioxide (which is a major contributor to acid rain), particulate matter (a respiratory health concern), and trace hazardous air pollutants. Capturing methane from coal mines can also improve safety conditions by reducing explosion hazards.

## **Reduction Opportunities**

Many of the available methane emission reduction opportunities in Nigeria involve the recovery and use of the methane as fuel for electricity generation, on-site uses, or off-site gas sales. These actions represent key opportunities for reducing emissions from landfills, coal mines, natural gas and oil systems, and livestock manure management. Specific technologies and mitigation approaches, however, vary by emission source due to their different characteristics and emission processes. Below are some of the methane recovery and use options for some of the key emission sources.

- Coal Mines – Methane is removed from underground mines either in advance of mining activities, or after mining has occurred to reduce explosion hazards. Instead of releasing this methane to the atmosphere, profitable uses can be identified and implemented. Some of these options include natural gas pipeline injection, power production, co-firing in boilers, district heating, coal drying, and vehicle fuel.
- Landfills – The principal approach to reduce methane emissions from landfills involves the collection and combustion or use of landfill gas (LFG). Landfill gas utilization technologies focus on electricity generation and direct gas use. Electricity generation involves piping collected methane to reciprocating engines or combustion turbines where it can be converted to electricity. Direct use technologies may use landfill gas directly as a medium-Btu fuel, while others require the gas to be upgraded and distributed to a natural gas pipeline.
- Natural Gas and Oil Systems – Current opportunities for reducing methane emissions include both procedural and hardware improvements. Methane emission reduction opportunities generally fall into one of three categories: (1) technologies or equipment upgrades that reduce or eliminate equipment venting or fugitive emissions; (2) improvements in management practices and operational procedures; or (3) enhanced management practices that take advantage of improved technology. In all cases, reducing methane emissions makes additional gas available for sale and use.



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In Nigeria, Coal is used presently as an energy fuel in cement production, brick factories, foundry, laundry and bakery industries. Other factories for which it forms an important raw material base are in tyre and battery manufacture as well substitute for fuel wood in domestic cooking.

Survey of coal utilization in the country revealed a great potential in the following industries.

**Metallurgical Industries:** Nigerian Coal is suitable as a component both with foreign Coals to produce coke of acceptable strength and character for the country's steel plants. In this regard, up to 200,000 metric tones of Nigeria Coal will be required annually when Ajaokuta Steel Plant goes into full production. Okpara and Onyema Coal in Enugu State has been embarked to provide a source of future Coal supply to the Steel Sector.

**Fuel wood Substitute:** Coal and its derivatives, Smokeless Coal Briquette have been demonstrated as the cheapest, safest and therefore the most suitable substitute for fuel wood the continued use of which in Nigeria is causing deforestation with the attendant environmental degradation of desertification in the North and soil and coastal erosion in the South. The production of smokeless coal briquettes involves setting up of coal carbonization which include, gases, ammonia liquor, tar oils, and many aromatics will serve as feed-stock to downstream chemical industries in the same manner as the petrochemicals.

**Power generation.** Nigerian Coals are suitable as energy fuel for electricity generation for the abandoned Oji Power Station in Enugu State and other proposed power station at Kogi, Benue, Anambra and Delta States. With the current deregulation of power generation in the country which was facilitated by the lack of sufficient power generating capacity by the National Electric Power Authority. Nigeria is a fertile ground for the Independent Power Producers.

#### 4.0 **Activities and Opportunities for Coal Mine Methane Recovery and Use**

To develop successful projects, there are a range of issues that need to be addressed from project concept through installation and operation. Successful projects require a thorough methane resource assessment and gas liberation analysis, effective integration of mine degasification and utilization with mining operations, and a ready market for the methane. Although there has been substantial progress in implementing CMM projects in recent years, project developers face a range of technical, economic, and institutional issues that impede further progress. Important issues include:

- Recognizing that methane is a commodity with a practical and profitable use rather than a nuisance and safety hazard,
- Ensuring that coal mines and project developers have access to modern methane drainage and use technologies and appropriate training to make use of this valuable resource,

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- Establishing an appropriate mechanism for the collection and dissemination of credible and unbiased data including technical and market information,
  - Clarifying the laws, regulations and policies that govern CMM capture and use and addressing any deficiencies or limitations, and
  - Providing access to capital markets

The Methane to Markets Partnership will bring the collective resources and experience of Partners together to facilitate technology transfer and demonstration, policy support, capacity building and market development necessary to realize implementation of these projects and achieve further reductions in CMM emissions. By focusing international expertise and resources, the Partnership will work to:

- Engage all facets of the coal industry to improve awareness of emission reduction opportunities and the value of the recovered methane.
- Advance technology transfer to ensure the broad adoption of emission reduction technologies and management practices.
- Improve and facilitate access to capital to support project investment, and
- Cooperate with country partners to improve markets and provide legal and regulatory frameworks that encourage project development.

For much of history, methane in coal mines was viewed as a nuisance and safety hazard that had little intrinsic value. Recent projects have shown that the opposite is true: coal mine methane is an energy product and a commodity that when captured provide many benefits to the mine, the local, regional, and national communities, and the global environment.

To successfully develop LFG energy projects, there are a range of issues that need to be addressed. At a minimum a successful project will require:

- Estimation of LFG recovery potential at the candidate landfills and a preliminary feasibility assessment,
- Access to capital markets and an economic feasibility assessment to examine end use options and support efforts to obtain financing,
- Determination of the project structure (e.g, management, engineering, and construction), and
- Determination of gas rights ownership, energy sales contracts, and securing permits and approvals, as applicable.

One important issue for project development is that open dumps and unmanaged landfills are the predominant disposal options in many developing countries. These sites can be less than optimal candidates for LFG energy development due to small amounts of methane (resulting from aerobic degradation and rapid waste decomposition). However, many developing countries are currently transitioning to landfills from more

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uncontrolled systems. Landfills will provide a more environmentally sound disposal option for these countries, but they also will produce more methane. The Methane to Markets Partnership can help facilitate a transition to land filling by sharing information on effective landfill design and management, and how to integrate landfill methane capture and beneficial use into these planning processes.

Other important issue for LFG energy project viability in big developing and developed countries is energy price structure. Government policies on energy and solid waste management can promote or hinder the beneficial use of LFG. An uncertain regulatory environment is often a concern among potential investors. For example, project developers can be subject to different and sometimes conflicting laws at the local, regional and national levels. Moreover, a lack of regulations governing landfills and LFG energy projects (i.g, no requirement or incentive to collect and combust LFG) in some countries can inhibit project development.

As countries begin to implement laws, regulations, and policies to improve solid waste management practices, promote alternative energy, and address greenhouse gas emissions, the economic viability of LFG energy projects will improve. Moreover, creating an atmosphere where potential investors (private sector, international development banks, and financiers) are secure in the technical and polity framework that supports LFG energy projects will be essential project development.

The Methane to Markets Partnership will bring together the collective resources and expertise of the international community to address technical and polity issues and facilitates LFG energy projects. Early initiatives will likely include:

- Assisting with solid waste management capacity building,
- Identifying potential landfill resources,
- Performing initial gas generation feasibility studies,
- Technology transfer through demonstration, training and workshops, and
- Creating an environment for sound investment.

LFG capture and use is a reliable and renewable fuel option that represents a largely untapped beneficial environmental and energy opportunity at thousands of landfills around the world. Cooperation with the Methane to Markets Partners will help ensure that more LFG reaches the energy markets.

### **General comments on the current and potential utilization of Nigerian Coal**

Within the country, Coal is used presently as an energy fuel in cement production, brick factories, foundries, laundry and bakery industries. Other factories for which it forms an important raw material base are in tyre and battery manufacture as well as substitute for fuel wood in domestic cooking.

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Survey of coal utilization in the country revealed a great potential in the following industries.

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- **Fuel Wood Substitute:** Coal and its derivatives, Smokeless Coal Briquettes have been demonstrated as the cheapest, safest and therefore the most suitable substitute to fuel wood the continued use of which in Nigeria is causing deforestation with the attendant environment degradation of desertification in the North and soil and coastal erosion in the South. The production of smokeless coal briquettes involves setting up of Coal Carbonization/Briquetting pans. In Addition, the by-products of Carbonization which include gases, ammonia cal liquor, tar oils, and many aromatics will serve as feed-stock to downstream chemical industries in the same manner as the petrochemicals;
- **Power generation:** Nigerian Coals are suitable as energy fuel for electricity generation for the abandoned Oji Power Station in Enugu State and other proposed power stations at Kogi, Benue, Anambra and Delta States. With the current deregulation of power generation in the country which was facilitated by the lack of sufficient power generating capacity by the national Electric Power Authority of Nigeria is a fertile ground for the independent Power Producers.
- **Market Prospect and Application**  
Nigerian coal has been found suitable for boiler fuel, production of high calorific gas, domestic heating, briquette, formed coke, and the manufacturer of a range of chemicals: waxes, resins, battery electrolyte, nylon, dyes, anthracene oil, wood killer, adhesive, explosive, creosote oil and rust prevention. Due to its characteristics properties (low sulphur and ash content, low thermoplastic properties and non-coking) the sub-bituminous coals can be used to produce formed-coke of metallurgical quality using pitch and binder. The high thermoplastic and cokable properties of the bituminous coals make it suitable for production of good briquettes without the application of binder.

#### **Potential**

The domestic market for coal is latently large and needs to be exploited. Coal might be used in transportation, power generation, steel production and other developed local sectors of the Nigerian economy. Presently, Nigeria imports Coals of various grades and quality including coke, pellets, briquettes, anthracite, coking coal and form coke. The aggregated inquiries on Nigerian Coal for export includes firms in Japan, Israel Ghana, US Europe and India. Currently demands for export are up to 15 million tonnes per annum; which far exceed Nigeria's annual production

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INDIA

**Status Paper on India's CBM/CMM Development  
For presentation in the Methane to Markets Workshop in Beijing on  
2.12.2005**

Economic growth calls for increasing use of energy. India needs economic growth for human development, which in turn requires access to clean, convenient and reliable energy to all. India faces formidable challenges in meeting its growing energy needs and providing adequate energy of desired quality in various forms to users in sustainable manner and at reasonable costs.

The per capita consumption of energy in India is one of the lowest in the world. The consumption of electricity is also way below than that in other countries. Coal has been playing a predominant role in meeting our energy requirements and it is likely to continue for foreseeable future. About 50 percent of the primary commercial energy supply and 70 percent of the power generated is coal based.

In last 30 years indigenous coal production has grown four times. In a recent study we find that the demand of coal will rise from a level of about 473 Mt. in 2006-07 to 1147 Mt in 2024-25, if our GDP is to grow at the rate of 7% annum. The power sector alone will need in excess of 820 Mt. The country is aiming at a GDP growth of 8% in which case our coal demand will rise to 1267 Mt.

To address the Nation's concern for energy requirements, efforts are being constantly made to harness the available conventional

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resources i.e. the fossil fuels as well as nuclear fuels and the renewables. Besides this, the country is also looking for development of alternative sources like Coal Bed Methane (CBM)/Coal Mine Methane (CMM) etc. which are comparatively efficient and environmental friendly than use of coal.

Coal Bed Methane, which was earlier considered as a hazardous byproduct of coal mining, has now emerged as new source of energy. Also, methane is a potent green house gas when released to the atmosphere. This implies reducing the emissions of methane, particularly from coal mines which are major source of methane production. This has been possible as scientific communities' world over, especially in USA, with their sustained efforts during 70s and 80s have developed appropriate technology for exploration and commercial exploration of CBM. Now US produce more than 1600 billion cubic feet of CBM per year. CBM, now, has been established as most potential alternative source of energy.

Increasing gap between demand and supply of petroleum and natural gas world over has propelled the scientists to develop technology to harness CBM resources to its full commercial potential.

Coal producing companies have embarked upon CBM exploitation along with its subsets i.e. coalmine methane (CMM- methane recovered during course of mining) and abandoned mine methane (AMM- methane recovered from abandoned mines). Methane emission reduction helps in improved mine safety conditions, greater mine productivity and

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increased revenues.

In India, the importance of CBM has been well recognized as an alternative source of clean energy since early 90s and government has been laying thrust in harnessing this resource in order to secure energy supplies to the extent possible. Up to formulation of CBM policy in 1997 by the Govt., MoC's involvement in this area was through CMPDI/CIL in form of sharing of coal exploration data, delineation of prospective CBM blocks and its allotment to interested parties through FIPB route and helping the Govt. in evolving a policy in this regard.

In 1997, a CBM policy was framed by Govt. of India, wherein MoP&NG has been earmarked as an administrative ministry for the subject of coal bed methane and DGH has been assigned role of nodal agency for its promotion. However, consultation with Ministry of Coal is a must in the process.

The salient features of CBM Policy are:

- No participative interest from GOI.
- Allotment of Blocks through competitive Global bidding.
- Exploration & Development under confessional type of agreement through Model Contract.
- 7 year tax holiday from the date of commencement of commercial production.
- Nominal commercial bonus of US \$ 0.3 million on declaration of commercial assessment.

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- Freedom to sell gas at market driven price in domestic market.
  - Income tax 35% for Indian Company and 48% for foreign Company
  - Provision of 100% cost recovery.
  - Exemption on Customs duty on imported equipments.

Consequent to this policy, a MoU was signed between MoC & MoP&NG, in the subject area of coal bed methane and coal mining. Prospective CBM blocks were delineated in close consultation with MoC. As per international practice, data dossiers pertaining to different CBM blocks were made available to prospective investors.

CMPDIL is the repository of all primary data pertaining to coal deposits in India and also engaged in creation of database for coal, lignite and CBM and is also engaged in classification of coal on UNFC basis. Delineation of CBM Blocks and preparation of data packages for facilitating award of blocks by DGH through global bidding was also being carried out by CMPDIL. This company, on behalf of CIL, is also facilitating creation of data packages for potential CMM projects for development of CMM through joint venture of CIL and ONGC.

Two rounds of competitive bidding for award of CBM blocks were already held and delineation of prospective CBM blocks for 3rd round is under process. The delineation of prospective blocks and preparation of data dossiers involving prognostication of CBM resources are primarily carried out by CMPDI, as it is the nodal agency for coal exploration and mine related data.



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18 prospective CBM blocks have been delineated so far with prognosticated resource of 900 BCM in about 9000 sq.km area, out of which 16 blocks have been awarded to different operators. CIL has also entered into a joint venture with ONGC and this consortium has been allotted two CBM blocks one each in Jharia and Raniganj coalfields. Details are given in the Annexure.

Presently, at CMPDI, 7 additional CBM blocks are in the process of delineation along with corresponding data packages preparation and they are at advanced stage of finalization. This would correspond to about 460 BCM of prognosticated CBM resource in about 4000 sq.km. area. Thus, the efforts so far, have culminated in prognostication of 1.4 Trillion cubic meter of CBM resource in about 13000 sq.km area.

In terms of MoU between MoC & MoP&NG, the coal producing companies will have the right of CBM exploitation in their working mines including pre and post mining operations.

With a view to develop indigenous capacity in the field of coal mine related CBM recovery, a GEF/UNDP aided demonstration project was undertaken by Ministry of Coal, Govt. of India, for CBM recovery & utilization at Moonidih and Sudamdih mines of Bharat Coking Coal Limited (BCCL). The implementation was started in September 1999 jointly by Bharat Coking Coal Ltd. (BCCL) & Central Mine Planning & Design Institute Limited (CMPDIL). The aim of this project is to:

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- (a) Acquire exposure in CBM production from virgin area and working mines by drilling from surface and underground.
  - (b) Acquire utilization technique of extracted CBM.

In tune with international practice and in view of operational convenience, the coal producing companies may have to expand their activities in the field of development of CMM/AMM in their respective operational areas. A long term perspective in this direction is under active consideration.

Government of India has also taken steps to be the partner of the Methane to Markets Partnership to associate it self with the countries aiming at reducing methane emissions, promote energy security, and improving economic growth.

For development of CMM certain important issues would need to be addressed. For example if coal mining is going on in upper horizon and CBM development is to be undertaken in the lower horizon, the question of mining right in the same block belonging to different agencies in separate horizons may arise and there may be safety issues like inrush of water in to mine workings due to inter action of workings etc. As per MMDR Act, 1957 prior approval of the Central Government is required before mining leases for coal/lignite extraction are granted by the State governments. Regarding validity of leases in different horizons, presently all mining rights for all minerals in a vertical

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horizon belong to the party having the lease. These need to be reviewed for controlled operations with priority to safety of operations.

For development of CBM/CMM there is general lack of data required for scientific analysis of potential of coal blocks and we need to develop the same. The present CBM activities are confined to deep seated high rank coals only where mining activities are not contemplated in near future and are in preliminary stage and it would take some time to establish their potential. Further, issues highlighted above for simultaneous operations in different horizons would need to be addressed.

Under the ongoing UNDP/GEF project some capacity creation in terms of technical training to the technical personnel of BCCL and CMPDIL is taking place. Also, some of the CSIR labs like CMRI are getting equipped with latest instruments for measurement of gas adsorption/desorption isotherms data. These organisations would also retain the hardware procured in the process.

We need to concentrate on the following for proper development of this energy resource for supplementing our energy requirements and improving mine safety and productivity and reducing emissions of GHGs:

- Identification of prospective CBM and CMM blocks/areas.
- Creation of suitable data bases each coalfield wise.

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- Training and development of human resources.
  - Promote sound R&D base in the field for CBM/CMM.
  - Development of appropriate technologies for both CBM and CMM.
  - Encourage potential entrepreneurs for taking up CBM/CMM projects.
  - Put in place a clear cut policy for promoting CMM development.
  - Constant interaction with the major players in the field of CBM/CMM.
  - Creation of CBM clearance house.

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