INTERNATIONAL ISLAMIC UNIVERSITY ISLAMABAD

COAL-BED METHANE – NATURAL GAS AND ITS LEGAL AND REGULATORY REGIME IN PAKISTAN

GHULAM MUHAMMAD CHAUDHRY
Reg. No. 46–FSL/LLMITL/F05
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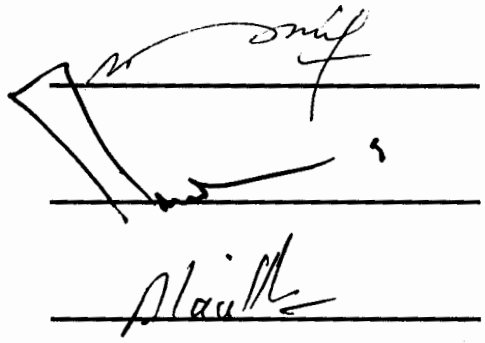
A thesis submitted in partial fulfilment of the requirement for the degree of LL. M. (International Trade Law)

Examination Committee for LL. M.

1. **Mr. Muhammad Arif (Supervisor)**
2. **Mr. Sahib-e-Iqbal (External Examiner)**
3. **Mr. Ataullah Mahmood (Internal Examiner)**



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List of Abbreviations

AEDB	Alternate Energy Development Board.
AJK	Azad Jammu and Kashmir
ARL	Attock Refinery Limited.
BCFD or bcfd	Billion Cubic Feet Per Day
BCM or bcm	Billion Cubic Meter
BOI	Board of Investment
BPD	Barrel Per Day
BSA	Bulk Supply Agreement
BT	Billion Tonnes
BTA	Business Transfer Agreement
BTU or Btu/lb	British Thermal Unit per Pound
CBM	Coal-Bed Methane
CFB	Circulating Fluidized Bed
CFt or cft	Cubic feet
CMM	Coal Mine Methane (other name for CBM)
CNG	Compressed Natural Gas
CPP	Capacity Purchase Price
CSA	Coal Supply Agreement
DIMD	Directorate of Industries and Mineral Development
D&P	Development and Production
DGG	Directorate/Director General of Gas
DGM	Directorate/Director General of Minerals
DGO	Directorate/Director General of Oil
DGPC	Directorate/Director General of Petroleum Concessions
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPP	Energy Purchase Price
ESA	Electricity Supply Agreement
ENERCON	Energy Conservation Centre
FBC	Fluidized Bed Combustion

FO	Furnace Oil
FRC	Fuel Research Centre
FSA	Fuel Supply Agreement
GENCOs	Generation Companies
GDR	Global Depository Receipt
GOP	Government of Pakistan
GSP	Geological Survey of Pakistan
GTPS	Gas Turbine Power Station
GW/h	Giga watt per hour
HOBC	High Octane Blending Component
HSD	High Speed Diesel
HSFO	High Sulphur Furnace Oil
IA	Implementation Agreement
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IGCC	Integrated Gasification of Combined Cycle
IM	Inspectorate of Mines
IPI	Iran-Pakistan-India Gas Project
IPP	Independent Power Producers
Km	Kilometre
kV	kilovolt
kW	kilowatt
kWh	Kilowatt Hour
LCDC	Lakhra Coal Development Compnay
LDO	Light Diesel Oil
LNG	Liquefied Natural Gas
LOI	Letter of Intent/Letter of Interest
LOS	Letter of Support
LPG	Liquified Petroleum Gas
MGCL	Mari Gas Company Limited
MMCFD	Million Cubic Feet Per Day
MMSCFD	Million Standard Cubic Feet Per Day
MMT	Million Metric Tonne
MOU	Memorandum of Understanding

MPCA	Model Petroleum Concession Agreement
MPNR	Ministry of Petroleum and Natural Resources
MPSA	Model Production Sharing Agreement
MS	Motor Spirit
MT	Million Tonnes
MTOE	Million Tonnes of Oil Equivalent
MW	megawatt
NEQS	National Environmental Quality Standards
NMP	National Mineral Policy
NORM	Naturally Occurring Radioactive Materials
NOx	Nitrogen Oxides
ODA	Operation and Development Agreement
OECD	Organization for Economic Cooperation and Development
OGDCL	Oil and Gas Development Company Limited
OGRA	Oil and Gas Regulatory Authority
OPII	Orient Petroleum International Inc.
PCRET	Pakistan Council for Renewable Energy Technologies
PEPA	Pakistan Environmental Protection Agency
PEPC	Pakistan Environmental Protection Council
PG	Performance Guarantee
PMDC	Pakistan Mineral Development Corporation
POL	Pakistan Oilfields Limited/Petroleum Oil Lubricant
PPA	Power Purchase Agreement
PPL	Pakistan Petroleum Limited
PRB	Powder River Basin (USA)
PSA	Production Sharing Agreement
PSOCL	Pakistan State Oil Company Limited
PUNJMIN	Punjab Mineral Development Corporation
RER	Renewable Energy Resource
RFP	Request for Proposal
RRR	Reserve Replacement Ratio
SCA	Sind Coal Authority
SFBD	Steam Fluidized Bed Drying

Sq.Km.	Square Kilometer
SNGPL	Sui Northern Gas Pipelines Limited
SSGCL	Sui Southern Gas Company Limited
TCF or tcf	Trillion Cubic Meter
TCM or tcm	Trillion Cubic Meter
TOE	Tonnes of Oil Equivalent
TPA	Tonnes Per Annum
TPS	Thermal Power Station
USAID	United States Agency for International Development
USGS	United States Geologic Survey
WPi	Wholesale Price Index

DEDICATION

To all those who are working for exploration
of
precious treasure like natural gas and other energy resources
to keep the system of this world moving with facilitation.

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Coal-Bed Methane – Natural Gas and its Legal and Regulatory Regime in Pakistan

by

Ghulam Muhammad Chaudhry

AN ABSTRACT

Energy is necessary to ensure economic lifeline of any economy and world is running short of usable existing energy resources. Coal-Bed Methane (CBM) gas is an important but emerging source of energy but it has not yet been explored for its commercial use in our country. It is found in the layers of coal and all coal reserves are embedded with this natural energy resource. There is no doubt that existing energy resources particularly based on coal, oil and gas are exhausting rapidly because these are non-renewable. This fact highlights the importance of efforts for discovery and exploration of more energy, cost effective energy resources to keep the economic activity and social life moving towards a better future because energy is real lifeline.

Load-shedding and load-management in the supply of natural gas and electricity has made us realize the non-arguable importance of energy in national life of any nation. This is the reason that future wars will not be fought for occupation of merely geographical territories but to occupy such territories which will be rich with oil, gas, mineral and other resources necessary to keep the economic activity and developmental pace intact for future challenges and maintain competitiveness of a nation as well as competitive edge on other

nations. It is also a fact that life without energy is merely a darkness and practically return to dark ages which is neither affordable nor tolerable by Governments of this global world.

Consumption of energy is the real indicator of economic development and growth of any economy and nation in this world. No nation can survive without maintaining supply of energy to its industries, commercial activities and for domestic purposes uninterrupted.

Similarly, increasing dependence of human and governmental activities on different kinds of energy resources have exposed the real weaknesses of today's mechanical, social, and economic infrastructures as energy is life-blood of all these activities. No nation, economy or society can afford breakdown of energy in any case. Thus, it is indispensable for the continuity of human, social and economic life that while having so much dependence on energy resources, the exhaustion and depletion of energy resources may be seriously kept in mind with competitive efforts to increase our energy-base in this world and particularly in our country because its non-availability will make our survival and growth on this earth practically difficult.

At present, our country is facing serious threat of depletion of existing energy resources. Electricity the most depended source in our country is already in short supply since so many years depriving millions of people to enjoy the facilities of modern age. Similarly, we are a highly oil-importing country and due to our financial constraints it is not possible for a long time to continue with this practice. Thus, making mandatory for us to decrease dependence on imported oil by exploring indigenous oil and petroleum resources. Natural gas is also not an exception in the existing supply and demand scenario. Demand of natural gas is increasing day by day but with meagre increase in its exploration and supply. After its discovery in 1952, now its use has been increased manifold because natural gas is being used in all industrial, commercial and domestic activities in our country leading towards logical exhaustion from existing sources of natural gas.

Keeping in view the above energy scenario in different fields of energy resources it is mandatory for us to develop alternative energy resources to meet the future requirements. As Pakistan is a coal-rich country having 6^{th} largest coal reserves in this world but still unexploited in their original form i.e. coal. But these coal reserves are having trillions cubic

feet of natural gas i.e. Coal-Bed Methane gas, embedded in the layers of coal reserves enough to fulfil energy requirements for a long time if exploited successfully. However, discovery, exploration, production, control and marketing of Coal-Bed Methane is not possible in a beneficial manner if there is not a well-thought policy to cover different aspects relating to CBM.

Therefore, for better exploitation of Coal-Bed Methane (CBM) it is necessary to follow a comprehensive policy for discovery, exploration, control, distribution and marketing of it which should work in the case of transparency and good management practices. There is also a need of comprehensive survey and reconnaissance activity for collection of relevant data and information to assess the exact nature of coal reserves and CBM embedded in coal reserves. An investor-friendly policy may be adopted ensuring all facilities to prospective investors in the exploration and production of CBM.

To open up and develop with a fast pace in discovery and exploration of CBM it is necessary to manage the matters relating to it within existing constitutional and legal system which is a comprehensive legal and institutional regulatory framework and well-tested and successfully dealing with different aspects relating to natural gas and prospective Coal-Bed Methane gas also being the natural gas in terms of its chemical and other definitions. Hence, the existing legal and regulatory framework is enough to meet the requirements of CBM with necessary amendments in different laws, rules and regulations. After careful examination of the constitutional scheme about distribution of legislative powers it is also within legal and administrative jurisdiction of the Federal Government and any new scheme to control and regulate CBM at any other level will create problems in this nascent field of natural resources. Existing regulatory framework will save us from administrative rift in existing and prospective new legal and regulatory framework, if there will be any

Further control and management at provincial level will introduce diversity in its control and regulation among different provinces as well as between Provincial Governments and Federal Government. Unity of legal and institutional framework will make the legal and institutional regulatory system successful and investor-friendly. Experimenting any new regulatory system at the cost of existing system will discourage the

investors as well as create complications and duplicity of legal and policy and regulatory standards at different levels causing confusion and maladministration at different levels.

CHAPTER 1

INTRODUCTION

With Him are the keys of the invisible.
None but He knoweth them.
And He knoweth what is in the land and the sea
Not a leaf falleth but He knoweth it,
not a grain amid the darkness of the earth
naught of wet or dry but (it is noted) in a clear record[1].
(Verse 59, Surah Al-An'am).

Abdullah Yusuf Ali has translated the word "invisible" as "unseen treasure" and includes every thing living and non-living without any exception. Similarly, in verse 21 of the Surah Al-Hijr of the Holy Quran has also proclaimed :

"And there is not a thing but its (sources and) treasures (inexhaustible) are with Us; but We only send down thereof in due and ascertainable measures.[2]

This verse explains that all the wonderful gifts and forces and energies which we see in the world around us have their sources and fountain-heads with Allah, the Creator and Sustainer of the Worlds. And what we see or perceive or imagine is just a small portion of what exists. That portion is sent out to us and to our world according to our needs or its needs from time to time as the occasion arises. It is strictly limited according to rule and plan. Its source is unlimited and inexhaustible. In the same way the forces which we see operating around us, in nature or in the spiritual world, according to laws which we can grasp and ascertain, are mere derived forces, in different degrees. Their source and ultimate fountain head is with Allah.[3]

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[1] Verse 59, Surah Al-An'am of the Holy Quran.
[2] Verse 21, Surah Al-Hijr of the Holy Quran.
[3] Commentary given at page 715 of the Holy Quran, printed at King Fahd Holy Quran Printing Complex, Al-Madinah Al-Munawarah, Saudi Arabia, 1410 H.

There is no doubt that this earth and different mineral resources hidden in the earth are a blessing for human beings on this earth which are being utilized by human beings according to their innovation and requirements based on such innovative use. Precious metals, minerals, coal, gas and oil are lying hidden under the surface of this earth since centuries. However, it is human creativity and efforts which made it possible to use these different resources.

Amongst all resources, energy is a lifeline for economic and development activities of any nation and society in this world. The highest per capita use of energy is symbol development and growth of any nation and country.

The thin surface layer of the earth is formed by the break-down of the rocks in various ways and by various processes. Its nature depends first on its parent rocks from which it develops. This is modified and altered by weathering which involves both physical and chemical process. Mere rocks are not soil but there are the results of the interaction of various biological processes, particularly the growth and decay of the vegetation layer and the action of soil organisms upon it. There is a cycle for vegetation drives mineral salts from the soil, but when it decays these return to the soil. Therefore, as a whole, a soil consists of mineral particles, a certain proportion of decayed organic material, soil water, a soil atmosphere and living organisms, which exist in a complicated and dynamic relationship one with another. The parent materials include both hard, resistant rocks such as granite and slate, and also less resistant rocks such as recent volcanic lavas and ashes and most of the sedimentary rocks including sandstone, clay and limestone.[1]

The minerals which form the bulk of the soil consist of silica (quartz) grains, the commonest product of rock disintegration, of silicates such as aluminium silicate, and of oxides notably various iron oxides. Quartz grains are resistant to chemical weathering and so form a stable or inert soil constituent; almost all sandy soils consist largely of it. Most silicates undergo hydration and their end product is clay. Soil also contains other elements in small and varying amounts, but of the utmost importance because they supply plants with food. They include compounds of calcium, sodium, potassium and magnesium; of nitrogen,

[1] Principles of Physical Geography by F. J. Monkhouse, page 487, 1975 Edition, published by Hodder and Stoughton, London.

sulphur and phosphorus derived partly from organic substances, partly from the parent rocks; and of oxygen, hydrogen and carbon obtained from the air and water. Similarly, small quantities of "trace elements" such as boron, manganese and iodine are also present.

There are three major classes of sediments, namely :

(a) clastic sediment;
(b) chemically precipitated sediment; and
(c) organic sediment.

Clastic sediment is consists of inorganic rock and mineral fragments like the materials in a sand bar or a river bed, or on a sandy ocean beach and examples are sandstone, siltstone, conglomerate, mudstone, claystone and shale. Chemically precipitated sediment consists of inorganic mineral compounds precipitation from a saltwater solution or as hard parts of organisms. During the process of chemical precipitation, ions in solution combine to form solid mineral matter separate from the solution. A layer of rock salt, such as that found in dry lake beds in arid regions. Limestone, dolomite, chert and evaporates are the relevant examples. Organic sediment also consists of the tissues of plants and animals as accumulated and preserved after the death of the organism. Coal, petroleum and natural gas are the examples of organic sediment.

Among different minerals, coal is a laired solid substance. The forests which due to global changes and earthquakes were buried and with the passage of time as well as billions of tonnes weight, turned into coal having the form of stone. This is the reason that it is also called "rock coal". Coal is formed by the combination of hydrogen, moisture and ash. The heating capacity of coal also depends on the proportion of the same ingredients. The availability and existence of coal in a country is the kind of economic gift for it bestowed upon by the nature. Coal is utilized for various purposes. It is one of the most important source of energy for a developing country like Pakistan. In the past and even today in some parts of country, railway engines run on the basis of coal. It is also used in the factories and also as domestic fuel.

Prior to the discovery of natural gas, coal, oil and water was being used for generating the electricity but now natural gas is also being used for the generation of

electricity. The use of gas is being increased day by day but the gas reserves are supposed sufficient to meet such increasing requirements for a long time.

1.1. Different Kinds of Energy

There are different kinds of energy from different angles. Here are brief details of all these different kinds of energy resources existing in this universe.

1.1.1 Primary and Secondary Resources of Energy

Sources of energy may be divided into two major kinds according to their point of incidence or resources :

(1) Primary Sources; and
(2) Secondary Sources.

1.1.1.1 Primary Sources of Energy

Primary sources of energy are wood, coal, oil and gas. Primary sources are found in the universe in their original condition but they may be upgraded by using latest technologies.

1.1.1.2 Secondary Sources of Energy

Secondary sources of energy are like electricity, nuclear energy, solar energy, wind energy. All these sources or energy are produced or may be benefited by using different direct or indirect methods for their exploitation.

1.1.2 Renewable and Non-renewable Energy Resources

Similarly, energy sources may also be divided keeping in view their use and re-use and following are the different kinds from this point of view:

(1) Renewable Energy Resources; and

(2) Non-renewable Energy Resources.

1.1.2.1 Renewable Energy Resources

Sources of energy which are never exhausted or finished when consumed are known as renewable energy resources. Air, water, food from crops, land, forests, fish and wild life are renewable resources of energy. There is a continuous process of nature which is renewing these sources through different processes available in the life cycle of such resources.

1.1.2.2 Non-renewable Energy Resources

Non-renewable resources are not repleted once consumed. These sources include metals, non-metallic minerals and fossil fuel like coal, oil and natural gas. These resources are exhaustible and cannot be reused or replaced.

1.1.3 Conventional and Non-conventional Sources of Energy

There is also a division of energy sources on the basis of conventional and non-conventional sources of energy.

1.1.3.1 Conventional Sources of Energy

The sources of energy which are commonly used for power generation are called conventional sources of energy. Atomic or nuclear energy is nowadays a conventional source of energy in addition to coal, gas, oil and solar energy.

1.1.3.2 Non-conventional Sources of Energy

The sources of energy which are not commonly used for power generation are called non-conventional sources of energy. Nuclear energy sometime back was a non-conventional

source of energy but nowadays it is a conventional source of energy. It is the common use or non-use of a source which make it conventional or non-conventional. However, wind, tidal and geothermal energy is still a non-conventional source of energy.

These sources of energy are interchangeable with passage of time.

1.2 Different Sources of Energy

There are different sources of energy which are found naturally in this world. The following are more important:

(a) Coal;
(b) Oil or petroleum;
(c) Natural Gas;
(d) Solar Energy;
(e) Wind Energy;
(f) Nuclear Energy;
(g) Geothermal Energy; and
(h) Hydroelectric Power or energy.

1.2.1 Coal

Coal is a fossil fuel. Organic matter of ancient plants and animals which was buried in rocks and soil and due to pressure and heat they changed to peat, lignite and then coal. Anthracite is the hardest form of coal. Coal is used for about 30% of world's power production and about 10% of Pakistan's power production. There is a coal fired power station in Lakhra in Sindh.

Coal is defined as a rock that contains at least 50% organic matter by weight. There are varying grades of coal produced depending on temperature, pressure and original composition of the organic material. Coal is a generic name for peat, lignite, sub-bituminous coal, bituminous coal, anthracite and graphite. Coal originates as organic debris deposited in a swamp-like environment. As the material is buried through various geologic processes, pressure builds up and the organic material is heated up, put under pressure, loses moisture

and forms coal which generates methane gas. The original groundwater inundates the coal and sometimes traps the methane which is generated in the process. The gas is kept in place by the hydrostatic pressure provided by the groundwater supplemented by any geologic stress that may be present.

1.2.2 Oil or Petroleum

Oil or petroleum is deposited in rocks. It is crude oil and a fossil fuel which is formed by decaying of dead, ancient living organisms. Various constituents of petroleum are separated by fractional distillation. In this process a multistage tower has various temperatures and the constituents are separated on the basis of their different boiling points. Then these different products are used for different purposes.

1.2.3 Natural Gas

Ancient organic matter also gave gas along with petroleum and coal. Usually gas is the first substance to come out of a well dug for petroleum. Major constituents of natural gas are methane (60-80%), ethane (5-9%), propane (3-18%) and other hydrocarbons. Gas is cheap source of energy and raw material for hydrocarbons and plastics. In Pakistan gas was discovered in 1952 at Sui. More gas fields are also discovered. Pakistani gas is used as fuel and raw material in industry. It contains 70-90% methane. Gas is used for 48% of power generation in Pakistan.

1.2.4 Solar Energy

Solar energy or energy of the sun is used in photoelectric cells. When light strikes certain heavy metals like selenium, electrons move and electricity is produced. France, Saudi Arabia, Japan and other European countries are using solar energy to heat buildings, water and to power cars and communication systems.

1.2.5 Wind Energy

In many countries windmills are now being used which rotate by the power of air current and thus electricity is produced. A large number of windmills are installed in an area to get electricity.

1.2.6 Nuclear Energy

Nuclear energy is now widely used for power generation in USA, UK, Canada, Japan and Russia. Pakistan has two power plants in Karachi and Chashma. Karachi Nuclear Power Plant (KANUPP) produces about 0.27% of power. Uranium 235 is used in a nuclear reaction to produce heat to convert water into steam and then this steam is used to operate the turbines/generators for production of electricity.

1.2.7 Geothermal Energy

Lava, gases and hot water given off as a result of volcanic activity or natural hot springs and geysers are source of geothermal energy. This energy is used in some countries like Iceland to heat houses and get hot water in houses.

1.2.8 Hydroelectric Power

Falling water in hilly areas is used as a source of mechanical energy to rotate turbines to generate electricity. A huge magnet is rotated by the power of water and this magnet by electromagnetic induction produces electricity. The hydroelectric power generation is only about 13% in Pakistan. Mangla Dam, Tarbela Dam, and other dams are producing electricity in different parts of the country.

1.3. Natural Gas as a Source of Energy

Natural gas was discovered in Pakistan in 1952 at Sui and due to this reason it is commonly known as Sui Gas. Sui is located at Sibbi district in the skirt of mountainous

region of Murri-Bugti in Quetta. The Petroleum Limited was conducting survey for the oil in Pakistan when incidentally gas was discovered at Sui which is one of the big gas reserves in the world and it is the biggest in Pakistan. According to an estimation the sui reserve has about 2440 million cubic meters. Natural gas is the precious gift of nature to Pakistan. The problem of shortage of fuel has been solved by the natural gas to an extent. Natural gas is capable to provide energy in comparison to any source of energy. This is the reason that the use of gas with the passage of time is increasing. Gas is being used as the substitute of different sources of energy in various techniques. As the prices of petroleum products is increasing and due to this the use of natural gas is becoming common as it is cheaper than petrol.

In 1966, first time in Pakistan, natural gas was used for manufacturing process of fertilizer at Multan for production of aluminium, sulphur and urea. ESSO Fertilizers Company was established a fertilizer factory in Dahrki and Hercules Company established a factory at Sheikhupura. Both these factories are running by natural gas. Presently many fertilizer factories are being generated by natural gas.

Prior to the discovery of natural gas, coal, oil and water was being used for generating the electricity but now natural gas is also being used for this purpose. The use of gas has now been increased from 12% to 38% for this purpose. Natural gas was first used by Karachi Electric Supply Corporation. Presently, a large quantity of electricity is being produced by using natural gas.

Similarly, the use of natural gas is constantly increasing in different industrial units in Pakistan. Chemical, colour, paint, steel, sugar, rubber and textiles, etc., are using natural gas for different manufacturing processes. Cement industry is another industry using natural gas. However, the biggest use of natural gas is for domestic purposes like kitchens, restaurants and hotels.

1.4 Energy Scenario in Pakistan

In the modern world, energy is the lifeline of economic and industrial development in any country because without suitable energy resources industrial development may not be sustained which is creating employment opportunity and economic growth saving the environmental degradation at the same time due to use of wood as a domestic fuel. Thus, energy is behind all commercial and economic activities generating job opportunities, enhancing agricultural productivity, improving standard of living and preserving environment through reducing deforestation.

The International Energy Outlook 2006[1], projected strong growth in energy demand globally over the next 27 years on the back of equally strong world economic growth. World economic growth will averaging 3.8% per annum during the same period. Much of the growth in world energy demand will come from non-OECD Asia, which includes China and South Asian countries; demand in the region will nearly triple over the projection period. Total primary energy consumption in the non-OECD countries will grow at an average annual rate of 3.0% between 2003 and 2030. In contrast, for the OECD countries energy use will grow at a much slower pace of 1.0% per year over the same period.[2]

At present, Pakistan's economy is growing at an average rate of over 7.6% per annum over the last three years and the government is making efforts to sustain the momentum going forward and it has a strong relationship between economic growth and energy demand Government is making efforts to address the challenges of rising energy demand. These include, import of piped natural gas from Iran and Turkmenistan, import of LNG; increase in oil and gas exploration in the country; utilizing 175 billion tonnes of Thar coal reserves; setting up of new nuclear power plants; exploiting the affordable alternate energy resources and overhauling existing power generation plants to enhance their generation capacity. In addition to increasing supply, there is a need to promote efficient use of energy resources as well.[3]

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[1] An international journal on Energy matters.
[2] Pakistan Economic Survey 2006-07, page 225, Ministry of Finance, Government of Pakistan, Islamabad.
[3] Pakistan Economic Survey 2006-07, page 225, Ministry of Finance, Government of Pakistan, Islamabad.

Presently, Pakistan is meeting its 75% of energy requirements from domestic resources like 50.4% by indigenous gas, 28.4% by domestic and imported oil and 12.7% by hydro-electricity. Coal and nuclear energy's contribution is only 7.0% and 1.0% respectively. The following table[1] shows annual energy consumption in the country during the last 10 years :

Fiscal Year	Petroleum Products		Gas		Electricity		Coal	
	(000 tones)	% change	(mmcft)	% change	(Gwh)	% change	(000 M.T.)	% change
1996-97	15,606	0.0	597,799	2.6	42,914	3.4	3,553	-2.3
1997-98	16,624	6.5	607,890	1.7	44,572	3.9	3,159	-11.1
1998-99	16,647	0.1	635,891	4.6	43,296	-2.9	3,461	9.6
1999-00	17,768	6.7	712,101	12.0	45,586	5.3	3,168	-8.5
2000-01	17,648	-0.7	768,068	7.9	48,584	6.6	3,095	-2.3
2001-02	16,960	-3.9	824,604	7.4	50,622	4.2	3,492	12.8
2002-03	16,452	-3.0	872,264	5.8	52,656	4.0	3,768	7.9
2003-04	13,421	-18.4	1,051,418	20.5	57,491	9.2	5,284	40.2
2004-05	14,671	9.3	1,161,043	10.4	61,327	6.7	6,622	25.3
2005-06	14,627	-0.3	1,223,385	5.4	67,603	10.2	7,714	16.5
2005-07	12,114	19.9	929,516	0.8	52,246	5.7	5,414	24.6

Pakistan's energy sector is consisting on :

(a) Coal;

(b) Gas;

(c) Petroleum; and

(d) Electricity.

The primary commercial energy supplies increased by 4.3% by to 57.9 million tonnes of oil equivalent (MTOE) during 2005-06 as compared to 55.5 MTOE in 2004-05. The supply of energy increased by 9.2% and 8% in 2004-05 and 2003-04 respectively. Lack of energy supply is a big question before the Government. The proposed Iran-Pakistan-India (IPI) gas pipeline project is supposed to deliver 2.1 billion cube feet of gas per day in the first phase and in the second phase, the total gas delivery will be enhanced to 5.3 billion

[1] Pakistan Economic Survey 2006-07, Ministry of Finance, Government of Pakistan, Islamabad, page 227.

cubic feet per day (BCFD) which Pakistan and India will share 2.1 BCFD and 3.2 BCFD respectively.

The consumption of oil decreased by 0.3% during 2005-06 over the corresponding period last year. This was mainly due to lower consumption of oil in transport, agriculture and domestic sectors by 10%, 42% and 33% respectively. Consumption of furnace oil in cement industry also dropped by 17% in 2004-05. Despite the slight decrease in oil consumption Pakistan remains dependent on costly oil imports. The crude oil and petroleum products import for the first nine months of the year 2006-07 amounted to about 6.1 million tonnes and 5.9 million tonnes, with values of US$2.64 billion and US$2.59 billion respectively. The total oil import bill for the year 2006-07 (July-March) was US$5.23 billion. The growth in consumption of natural gas at 5.4% outpaced the growth of production at 4.1% during 2005-06. Similarly, during the last ten years 1996-2006, the consumption of petroleum products has decreased by an average rate of 0.4% per annum. The consumption of gas 7.8%, electricity 5.1% and coal 8.8% per annum. However, on the other hand, since 2000-01 consumption of gas, electricity and coal have grown at average rates of 9.6%, 6,8% and 16.7% respectively[1].

Primary energy supplies by source during the year 2005-06[2] remained as under :

S. No.	Description	Percentage
1.	Coal	7.0%
2.	Gas	50.4%
3.	Hydro-electricity	12.7%
4.	Nuclear energy	1.0%
5.	Oil	28.4%

Pakistan has a well-developed and integrated infrastructure of transporting, distributing and utilization of natural gas. Commercial, cement, fertilizer, industrial and transport sectors have registered a sharp rise in the consumption of gas during the year 2005-06. The consumption of gas in transport sector increase by 49.4% during July-March, 2006-

[1] Information is based on Pakistan Economic Survey 2006-07, page 226, Ministry of Finance, Government of Pakistan, Islamabad.
[2] Pakistan Economic Survey 2006-07, page 226, Ministry of Finance, Government of Pakistan, Islamabad.

07, while the industrial consumption grew by 29.4% followed by the commercial sector by 27.3% and household sector by 4.7%. However, the consumption of gas declined in cement, fertilizer and power sector by 10%, 2.7% and 16.9% respectively. Similarly, power sector has emerged as the largest consumer of gas by consuming 36.4%, followed by fertilizer by 21.6%, industries by 19.1%, households by 17.8%, commercial by 2.7%, cement by 1.1% and transport sector by 1.0%. It is noteworthy that the share of the transport sector in gas consumption has been rising continuously since 1998-99[1]. The transport sector is also gradually reducing its dependency on imported fuel e.g. oil because of its ever-increasing prices and availability of cheaper fuel in the shape of CNG. The energy consumption scenario for different gas fuels is as under briefly:

1.4.1 Natural Gas

The importance of natural gas to the country has been increasing very fast. The balance recoverable natural gas reserves have been estimated at 31.81 trillion cubic feet. The average production of natural gas during July-March, 2006-07 was 3,876.38 mmcfd during the corresponding period of last year, showing an increase of 1.33%[2]. Natural gas is used in general industry to prepare consumer items, to produce cement and to generate electricity. In the form of form of CNG, it is used in transport sector and most importantly to manufacture fertilizer to boost the agricultural sector.

1.4.2 Liquefied Petroleum Gas (LPG)

LPG is used as a fuel to slow down the ongoing deforestation in the areas where supply of natural gas is technically not feasible. As a result of the government's investment-friendly policies, production of LPG has reached 1650 M.T. per day in 2006-07 from 540 M.T. per day in 2000-01 almost four fold increase in the last six years. LPG is also being increasing used in cars, pickups, rickshaws and even motorcycles in area where CNG is not available due to the absence of natural gas distribution network. The supply of LPG was

[1] Information is based on Pakistan Economic Survey 2006-07, page 228, Ministry of Finance, Government of Pakistan, Islamabad.
[2] Information is based on Pakistan Economic Survey 2006-07, page 232, Ministry of Finance, Government of Pakistan, Islamabad.

streamlined with its distribution at affordable prices, promoting healthy competition and ensuring safety standards across LPG supply chain. The custom duty at 5% imposed on the import of LPG has been waived to further enhance availability of LPG. The LPG marketing companies have planned to import approximately 43,000 M.T. during 2006-07[1].

1.4.3 Compressed Natural Gas (CNG)

The Government is promoting the use of Compressed Natural Gas aggressively to reduce pollution caused by vehicles using motor gasoline and to improve the ambient air quality. A growing number of vehicles have been converted to CNG power by the private sector to take advantage of the relatively low price of CNG fuel. Some 1414 CNG stations are operational in 85 cities and towns of the country and about 1.35 million vehicles are using CNG as against one million vehicles during same period last year showing an increase of 35%. On average 29167 vehicles are being converted to CNG every month. With these developments, Pakistan has become the leading country in Asia and the third largest user of CNG in the world after Argentina and Brazil. An investment of Rs. 60 billion has been made in the CNG sector during July-March, 2006-07, as compared to Rs. 20 billion invested upto end March, 2006, registering a growth of 200% in investment. Similarly, CNG industry has created 60000 new jobs[2].

Keeping in view the short supply of indigenous oil or liquid fuels, there is a scope for development of alternate fuels, especially natural gas that is locally available at low price along with a widespread infrastructure for transmission and distribution network. Research, development and demonstration efforts led to a successful implementation and commercialization of CNG in Pakistan as an environment-friendly, cheap and safe road transport fuel.

Pakistan imported nearly 4.1 million tonnes of diesel oil at a cost of US$ 2.2 billion during 2005-06. Since the air pollution caused by diesel oil is more severe than CNG, there is a need for replacing diesel oil to the extent possible with CNG. The technology and

[1] Information is based on Pakistan Economic Survey 2006-07, page 233, Ministry of Finance, Government of Pakistan, Islamabad.
[2] Information is based on Pakistan Economic Survey 2006-07, page 233, Ministry of Finance, Government of Pakistan, Islamabad.

economics of converting diesel engines to CNG, however, are not very attractive due to high conversion cost, little differential in the price of diesel oil and CNG, and several engineering and management problems related to conversion of bus fleets. In order to address these problems, the Provincial Governments are working on a programme with the support of Federal Government to gradually phase out diesel buses and induct intra-city CNG buses in major cities of Pakistan. The programme will also include infrastructure development and manufacturing of CNG buses. Government policy is to promote a market driven industrial development of the CNG industry rather than through administrative directives. This programme will have a major impact on air quality of the urban areas, which will improve health standards.

1.4.4 Liquefied Natural Gas (LNG)

LNG is an important source of energy where piped or CNG is not available. The Government is encouraging LNG import by the Private sector and announced its first-ever LNG Policy during 2005-06. The Government plans to establish an offshore LNG import terminal at Port Qasim which will be a major step towards increase availability of liquefied natural gas in the country through import. In this regard an agreement has been signed between Port Qasim Authority and Pakistan Gas Port Limited. The use of LNG and its demand worldwide has increased by nearly 40% between 2002 and 2005 because it is cleaner and less carbon intensive than oil or coal.[1]

LNG also has many advantages for storage and distribution over natural gas. Pakistan has the world's second[2] largest pipeline network of the natural gas after the United States. Liquefied natural gas technology has revolutionized the energy sector and demonstrated its worth as a more commercially viable option[3].

In the light of above said information it is very easy to conclude that natural gas is an alternative source of energy instead of coal, oil and other organic or nuclear fuel because it

[1] Information is based on Pakistan Economic Survey 2006-07, page 234, Ministry of Finance, Government of Pakistan, Islamabad.
[2] Pakistan Economic Survey 2006-07, page 234, Ministry of Finance, Islamabad.
[3] Information is based on Pakistan Economic Survey 2006-07, page 234, Ministry of Finance, Government of Pakistan, Islamabad.

is cost effective, safe and causing less pollution. An economy like Pakistan cannot afford huge expense on import of petroleum and even it is not a reliable source in different emergency circumstances. Therefore, the better option is to develop indigenous and domestic resources of energy for reliance and to save foreign exchange. Although Pakistan is extensively pursuing different resources to meet its energy requirements but only viable and dependable solution is reliance on national resources which will not only provide more business, investment, employment, economic growth and other direct and indirect benefits to our economy but also self-reliance.

1.5 Coal Reserves – Source of Coal-Bed Methane

Coal is the basic source for Coal-Bed Methane because it is almost occurred in the seams of coal beds in big coal reserves and their layers.

Pakistan is the 6th richest nation[1] of the world in coal resources but coal has not been exploited as a source of energy according to its availability and potential due to quality, technical, financial and administrative reasons.

Coal may prove a very cheap indigenous source of energy. Discovery of 175.5 billion tonnes of coal in Thar area of Sindh has increased the coal power potential of Pakistan many times. Pakistan's coal reserves may be used for generation of electricity for more than 30 years with an average generation capacity of more than 1,00,000 MW of electricity in addition to other uses.[2]

There are vast resources of coal in the Provinces of Pakistan and in Azad Jammu & Kashmir. An overall map of Pakistan's coal reserves in different areas is at **Appendix – I.** Coal was ignored as a source of energy till the time petroleum products were not so expensive because cost-benefit ratio was not so appealing. However, with the souring prices of petroleum products with shortages experienced from time to time due to different reasons, the importance of other energy resources have been highlighted. Even today exploitation of

[1] Information is taken from "Pakistan Coal Power General Potential" June, 2004, page 1, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.
[2] Information is taken from "Pakistan Coal Power General Potential" June 2004, page 1, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

coal and other such resources is apparently economical due to ever-increasing prices of petroleum products. Nobody had realized the importance of coal before the discovery of huge coal deposits of 175.5 billion tonnes spreading in an area of 10,000 squire kilometres in district Tharparker of Sindh province. Pakistan's total coal reserves, as on June 2003, are given in the following table along with their heating value :

Province	Name of Coal Field	Coal Resources (Million Tonnes)	Heating Value (Btu/lb)
Sindh			
	Thar	175,506	6,244 – 11,045
	Lakhra	1,328	5,503 – 9,158
	Sonda-Jherruck	5,523	5,219 – 13,555
	Meting-Jhimpir	473	5,219 – 8,612
	Indus East	1,777	7,782 – 8,660
	Badin	16	11,415 – 11,521
	Sub-Total :	**184,623**	
Balochistan			
	Sor-Range/Degari	50	11,245 – 13,900
	Khost-Sharigh-Harnai-Ziarat	88	9,637 – 15,499
	Mach	23	11,110 – 12,937
	Duki	56	10,131 – 14,357
	Sub-Total :	**217**	
Punjab			
	Salt Range	213	9,472 – 15,801
	Makarwal	22	10,688 – 14,029
	Sub-Total :	**235**	
NWFP			
	Hangu	82	10,500 – 14,149
	Cherat	9	9,386 – 14,217
	Sub-Total	**91**	
Azad Kashmir			
	Kotli	9	7,336 – 12,338
	Grand Total :	**185, 175**	

In addition to above-mentioned coal reserves, there are minor deposits of coal in different parts of country in different quantities and varying in their quality and heating value. These areas are Abi-Gul, Badinzai, Bahlol, Bala Dhaka, Balgor, Johan, Kach, Margot, North of Abigum, Pir Ismail Ziarat, Cherat, Choi, Muzaffarabad, etc.

However, more detailed description about coal resources in different provinces is given in next chapter of this thesis with their exploratory possibilities and for early embarkation of research, exploration, discovery and utilization efforts to provide CBM as a cost-effective fuel to those coal reserve areas to meet energy requirements without spending huge amounts to connect those rural and far-flung areas with main gas pipeline networks.

As it is scientifically established that in every coal field there is incidence of natural gas which is found in between the seams or layers of coal. Its quantity may be less or more. It may be economically exploitable or not but it depends on the quantity found in such reserves and technology used for exploration of such gas. However, it is said by United States Geological Survey that Thar coal reserves and their extension towards west and other areas are similar in nature, extent and gas content to the coal which are found in Powder River Basin in the United States giving a logical assumption that there is a possibility of big gas content in Thar Coal reserves which are approximately 175,506 million tonnes in their quantity spreading over an area of 10,000 square kilometres in Tharparkar District of Sindh and the biggest coal recovery in Pakistan ever made and after this discovery Pakistan has become now 6^{th} coal rich nation of the world. Therefore, research and exploratory drillings in Thar Coal Field is a viable option with the possibility of natural gas but at least the Coal-Bed Methane which is although not such a good fuel as the natural gas but it may be successfully used to fulfil energy requirements of the country instead of relying on costly imported oil and gas in different forms.

1.6 Coal-Bed Methane Gas as a Source of Energy

Coal-Bed Methane gas is as far as its chemical composition is concerned equally good source of fuel but having lesser heating value as compared to natural gas. However, it is more efficient than coal because it can be used through same pipelines networking which is being used for transmission of natural gas commonly known in Pakistan as Sui Gas being

sold and marketed by two companies in the country i.e. SNGPL and SSGC since its discovery. At present, the Pakistan has the second largest gas pipelines network in the world after United States of America.

Although at present, technically it does not seem so demanding that the sale and marketing companies will show any interest in the purchase of CBM for supply to consumers but the rising prices of petroleum products and increasing expenses of transportation of LPG and LNG it will become feasible after sometime in future to sell and market CBM alongwith natural gas because the existing reserves of natural gas are not supposed to sustain for a long time because every day their quantity is exhausting. Similarly, exploration and discovery rate of natural gas reserves is not according to rising requirements and even there is possibility that after some time when existing gas resources will be exhausted then there will be need of more gas sources in addition to option of imported gas which is marred with different political and international problems. Therefore, in such circumstances, CBM will be a good alternative to meet the fuel requirements of the nation.

It does not mean that we have to wait till all existing natural gas resources are exhausted but still there is need to take fast-track steps to explore CBM because it will serve the nearest areas of coal reserves to fulfil domestic and industrial requirements with small pipelines networks instead of pumping it into national network. In this way, we shall be able to save our coal reserves for future generations and also to save our environment by using CBM as household fuel and stopping use of wood and other forest resources from depletion.

Similarly, CBM may be used for generating electricity by installing small scale power generation units in vicinity of CBM exploration areas which may latter be transmitted to nearest localities and industrial units in those areas.

However, it is not so far, when we shall be forced to use CBM as a source of fuel even in our national gas pipelines network when existing natural gas resources will be vanishing after their consumption because this source is not renewable.

CHAPTER 2

EXPLORATION OF COAL-BED METHANE (CBM)

As it is scientifically established that due to organic nature of coal, in all coal reserves or deposits, there is occurrence of natural gas in its seams or layers due to chemical process which is continuously going on in different hydrocarbon elements. In coal reserves, in between the layers or seams of carbon deposits, there is sufficient space to allow chemical process between carbon and hydrogen to produce methane gas. As this methane is occurring in the layers or seams of coal beds in their reserves and due to this it is known as Coal-Bed Methane (CBM). Although due to lack of research and less heating value, there is no accelerated scientific and technical advancement in the field of CBM research, development, exploration and discovery.

In Pakistan CBM is a new phenomenon because there are no suitable research facilities about hydrocarbon sector and particularly coal. Coal mining is an ignored area because coal is not given so importance in Pakistan and Provincial Governments are managing coal reserves and mining from such coal reserves without establishing and providing any facilities about quality testing and using state of the art facilities to benefit from coal resources. Even for a long time coal mining remained an ignored area only on the pretext that we have low-quality coal reserves not suitable for industrial use and huge quantities of coal were imported for industrial purposes instead of inventing process to use local coal for industrial purposes.

Even no seismic surveys are carried to explore and discover coal reserves in the country. These are the efforts and interest of multinational coal and oil exploration companies which have shown interest in the discovery process of coal in the country and

due to their efforts, there is the biggest coal discovery in Thar District in Sindh making the Pakistan as 6th coal rich country in the world. But occurrence of reserves of something does not matter, if there is no exploitation of such reserves.

It is quite interesting that in our neighbourly countries particularly in India which is geographically adjacent and even having same and shared soil structure, there is exploitation of coal and other coal-based resources since long.

However, we have used different quality coal for different purposes without any further research about its quality and heating value. Generally, it is used for general industrial purposes including iron, steel, chemical industries, electronic utilities like locomotive fuel for railway engines and for other domestic purposes. In addition to these uses, coal is also being used for cooking, gas manufacturing, smithing, cement and tile burning and manufacture of ceramic wares. Certain grades of bituminous coal are also used in hydrogenation of coal, a process which is employed on a considerable scale in Europe.

Main use of coal in Pakistan is for fuel like brick and lime burning, ginning factories, briquetting plants, for domestic uses and a small quantity of selected grade in the hand-fired boilers of power stations and in railway locomotives. Peat is a low grade fuel. Due to its high water content and low bulk density it can be best utilized for making briquettes. These briquettes can be used for domestic consumption, brick kilns as well as in the thermal power plants for generating electricity. Peat is also a source of organic chemicals and nitrogenous ingredients of commercial fertilizers.

As it is stated that CBM is found in the seams of coal layers and there is almost sure incidence of CBM in all coal reserves with varying quantities and qualities with different heating values. Pakistan is rich in coal reserves and the world's 6th coal rich country but in the presence of such abundance of coal resources, nothing has been done to discover and explore CBM as its occurrence in these huge coal reserves is possible with same huge level comparable to coal reserves. However, before further explaining the possibility of CBM discovery and exploration, it is necessary to discuss in detail coal resources in different Provinces and different areas of Pakistan with their different chemical and technical aspects to easily conclude that further ignoring research and development efforts regarding CBM is

not in the interest of the country when nation is spending a huge amount of foreign exchange on importing of different petroleum and gas products to meet growing energy needs in the country.

2.1 Coal Reserves in Different Parts of Country

Brief details about coal reserves in different parts of the country have been given in the previous chapter. However, the details about coal reserves in different areas and Provinces are as under :

2.1.1 Coal Reserves in Sindh

[1]Sindh had the oldest coal discovery which was in 1853 when Baloch nomads reportedly struck a coal seam of 2.43 meters thickness at a depth of 125 meters by sinking a well for water in Lakhra village which on the western bank of the River Indus in district Dadu of Sindh Province. Thereafter, two other companies which were exploring oil in Lakhra area had confirmed about the presence of coal reserves in Sindh. Brumah Oil Company in 1948 and the Pak Hunt International in 1953 had indicated about presence of coal in Lakhra area. However, nothing had done for a long time till another private company namely, the Habibullah Mines Limited had got the rights for mining of coal in Lakhra, District Dadu, in 1959, and since then this company has been exploiting and mining coal from Lakhra Coal Field.

Geological Survey of Pakistan has discovered coal in Sonda in 1980 and in Thar in 1992, but no further research and development had been initiated to know the exact nature of coal deposits in the area and particularly about occurrence of CBM in the area.

Out of total coal reserves situated in Sindh which are approximately upto 184.6 billion tonnes, there are approximately 175.5 billion tones in Thar only. Lakhra, Sonda, Jherruck and Indus East are other prominent coal fields in Sindh. A detailed Map is placed at Appendix – II.

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[1] Information and data is based on the Pakistan Coal Power Generation Potential, June, 2004, page 6, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

Lakhra coal field has been developed and has approximately 146 million tonnes of mineable coal reserves. Most of the Sindh's coal is categorized as "Lignite" with caloric value ranging from 5,219 to 13,555 Btu/lb. Similarly, Thar Coal Field is located in the south-eastern part of Sindh with a resource potential of 175.5 billion tonnes of coal, covers an area of 9000 square kilometres in the Tharparkar desert. The mineable coal reserves are estimated to be 1,620 million tonnes and it has been divided into four blocks with total resource potential estimated at 9,629 million tonnes as under :

In Million Tonnes

Blocks	Measured	Indicated	Inferred	Total
Block I	620	1,918	1,028	3,566
Block II	640	944	-	1,584
Block III	413	1,337	258	2,008
Block IV	684	1,711	76	2,471
Total :	**2,357**	**5,910**	**1,362**	**9,629**

The number of coal seams varies from hole to hole, and a maximum of 20 seams have been logged in some of the drill holes. The thickness of coal seams varies from 0.2 to 22.8 meters whereas the cumulative coal thickness in one of the drill holes is 36 meters. Clay-stone and loose sand beds form the roof as well as the floor rock of coal seams. The thickness of overburden varies from 112 to 203 meters. Thar coal reserves and chemical analysis of the coal samples are as under :

Coal Quality of Thar Coal Reserves
The Quality of the Coal is Lignite-B to Lignite-A

Moisture (%)	29.60 – 55.50
Ash content (%)	02.90 – 11.50
Volatile Matter (%)	23.10 – 36.60
Fixed Carbon (%)	14.20 – 34.00
Sulphur (%)	00.40 – 02.90
Heating Value (Btu/lb)	
As Received	6,244 – 11,045
Dry Basis	10,723 – 11,353

Lakhra coal is the oldest discovery in Pakistan as it was discovered in 1853. The Lakhra Coal Field is connected by road through the Indus Highway and a rail track is available near Khanot, which is also located on the Indus Highway. The Lakhra coalfield is at a distance of 50 kilometres from Hyderabad and 175 kilometres from Karachi. The Lakhra coal field is doubly plunging anticline and known as the Lakhra Anticline and its axis runs in a north-easterly direction. The total coal reserves of Lakhra are estimated at 1,328 million tonnes, of which 146 million tonnes is mineable with following chemical analysis :

Coal Quality of Lakhra Coal Reserves
The Quality of the Coal is Lignite-A

Moisture (%)	09.70 – 38.10
Ash content (%)	04.30 – 49.00
Volatile Matter (%)	18.30 – 38.60
Fixed Carbon (%)	09.80 – 38.20
Sulphur (%)	01.20 – 14.80
Heating Value (Btu/lb)	5,503 – 9,158

Another big coalfield in Sindh is Sonda-Jherruck including Indus East and it was discovered by a joint venture of Geological Survey of Pakistan and United States Geologic Survey in 1981 with the following chemical and quality specifications :

Coal Quality of Sonda-Jherruck Coal Reserves
The Quality of the Coal is Lignite-A

Moisture (%)	09.00 – 48.00
Ash content (%)	02.70 – 52.00
Volatile Matter (%)	16.10 – 44.20
Fixed Carbon (%)	08.90 – 58.80
Sulphur (%)	00.20 – 15.00
Heating Value (Btu/lb)	5,219 – 13,555

In the light of above data it may be concluded that there is secure possibility of big reserves of CBM in these coal reserves which may further be confirmed by research and discovery explorations.

2.1.2 Coal Reserves in Balochistan

The major coalfields in Balochistan[1] are Sor-Range, Degri, Khost, Sharigh, Harnai, Ziarat, Mach and Duki. A detailed map of these reserves is at Appendix – III. The total coal reserves are about 217 million tonnes, of which 32 million tonnes are mineable. The thickness of coal seams ranges from 0.3 to 2.3 meters. It is classified as sub-bituminous to bituminous and the heating value ranges from 9,637 to 15, 499 Btu/lb. It has low ash and high sulphur coal.

Sor Range and Degari coalfields are located about 12 kilometres south of Quetta and extend south-east for a distance of 26 kilometres and covering an area of 50 square kilometres. The northern half of the field is known as Sor-Range and the southern as Degari. This coalfield is the largest coal-producing fields of Balochistan. The coal-bearing area is doubly plunging symmetrical syncline. The coal seams generally dip at angles of 45 to 50 degrees. The coalfield lies in an arid to semi-arid region with extreme temperature changes. The thickness of the coal-bed ranges from 0.3 to 1.3 meters. The total coal reserves are estimated at 50 million tonnes. The coal is sub-bituminous in quality with following quality specifications :

Coal Quality of Sor-Range and Degari Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	03.90 – 18.90
Ash content (%)	04.90 – 17.20
Volatile Matter (%)	20.70 – 37.50
Fixed Carbon (%)	41.00 – 50.80
Sulphur (%)	00.60 – 05.50
Heating Value (Btu/lb)	11,245 – 13,900

[1] Information and data is based on the Pakistan Coal Power Generation Potential, June 2004, page 9, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

Khost, Sharigh and Harnai Coal fields are other big coal reserves covering an area of 200 squre kilometres in the Sibi District. The coal is of Bituminous to Sub-bituminous quality. Coal beds are generally thin, ranging from 0.3 to 2.3 meters in thickness and dipping at 60 degrees. Chemical and quality analysis is as under :

Coal Quality of Khost, Sharigh and Harnai Coal Reserves
The Quality of the Coal is Sub-Bituminous

Moisture (%)	01.70 – 11.20
Ash content (%)	09.30 – 34.00
Volatile Matter (%)	09.30 – 45.30
Fixed Carbon (%)	25.50 – 43.80
Sulphur (%)	03.50 – 09.55
Heating Value (Btu/lb)	9,637 – 15,499

Mach Coal Field is another coalfield in Balochistan covering an area of 45 square kilometres around Mach town in the Bolan Pass. Several coal seams are present, ranging in thickness from 0.3 to 1.5 meters but only three beds with an average thickness of 0.75 meter are commercially workable. The quality of coal is Sub-bituminous. The coal is subject to spontaneous combustion and is suitable for fuel uses. The coal reserves are estimated to be 23 million tonnes with following quality and chemical analysis :

Coal Quality of Mach Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	07.10 – 12.00
Ash content (%)	09.60 – 20.30
Volatile Matter (%)	34.20 – 43.00
Fixed Carbon (%)	32.40 – 41.50
Sulphur (%)	03.20 – 07.40
Heating Value (Btu/lb)	11,110 – 12,937

Duke Coal Field is located in the Loralai District and has a covered are of 300 kilometres and is characterized by a moderately dipping syncline. The workable seam has a thickness of 0.5 meters and is high volatile bituminous coal. The total reserves are estimated at about 13 million tonnes with following chemical and quality analysis :

Coal Quality of Duki Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	03.50 – 11.50
Ash content (%)	05.00 – 38.00
Volatile Matter (%)	32.00 – 50.00
Fixed Carbon (%)	28.00 – 42.00
Sulphur (%)	04.00 – 06.00
Heating Value (Btu/lb)	10,131 – 14,164

The feasibility of CBM in Balochistan's coal reserves is quite good because coal is volatile and bituminous. However, these reserves may be in small quantity which will be useful for local purposes and electricity generation at small scale or for other chemical purposes.

2.1.3 Coal Reserves in the Punjab

The Salt Range and Makarwal are the main areas of coal mines in the Punjab[1] which may be seen in the detailed map placed at Appendix – IV. The total coal reserves are estimated at 235 million tonnes of which 33 million tonnes are considered minable are already being mined since long. These coal reserves are mainly sub-bituminous and their heating value is ranging from 9,472 to 15,801 Btu/lb with low ash and high sulphur content which are suitable for fuel purposes.

Salt Range Coal Fields covers an area of 260 square kilometres between Khushab, Dandot and Khewra in the Sargodha and Jhelum Districts of the Punjab. The estimated total reserves of the Salt Range coal are 213 million tonnes, of which 30 million tonnes are considered suitable for mining. There are more than two coal seams in the Salt Range and only one is considered mineable with varying thickness from 0.3 to 1.5 metres with an average thickness of 0.75 metres. Following are the specifications and chemical analysis of Salt Range coal :

[1] Information and data is based on the Pakistan Coal Power Generation Potential, June, 2004, page 13, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

Coal Quality of Salt Range Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	03.20 – 10.80
Ash content (%)	12.30 – 44.20
Volatile Matter (%)	21.50 – 38.80
Fixed Carbon (%)	25.70 – 44.80
Sulphur (%)	02.60 – 10.70
Heating Value (Btu/lb)	9,472 – 15,801

Makarwal Coal Field is located in District Mianwali. It covers an area of about 75 kilometres and situated near Makarwal town. The coal occurs in the steeply dipping Hangu Formation and the thickness of its bed ranges from 0.5 to 2.0 meters. The total quantity is reported to about 22 million tonnes and its chemical quality is Sub-bituminous with following other specifications :

Coal Quality of Makarwal Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	02.80 – 06.00
Ash content (%)	06.40 – 30.80
Volatile Matter (%)	31.50 – 48.10
Fixed Carbon (%)	34.90 – 44.90
Sulphur (%)	02.80 – 06.30
Heating Value (Btu/lb)	10,688 – 14,029

In the light of above-mentioned details and information, the thickness of coal layers and seams in different coal fields of the Punjab is ranging from 0.5 to 2.0 meters and occurring almost near to the surface of soil and there is possibility of CBM in short quantity which may be used for local purposes with short depth wells in a cost effective manner.

2.1.4 Coal Reserves in NWFP

NWFP is not so rich in coal reserves as other provinces and particularly the Province of Sindh. Even there are no reasonable exploration activities in the NWFP. Only in two areas namely Hangu and Cherat, some coal reserves are found and their exact location may

be seen in the map at Appendix – V. Coal reserves at Hangu and Cherat are estimated at 91 million tonnes[1] with classification of Sub-bituminous with heating value ranges from 9,386 to 14,217 Btu/lb. It is also low ash and low sulphur coal. The coal beds in Hangu area are upto 3.5 meters in their thickness whereas the coal beds in Cherat are less than one meter in thickness with following chemical and quality analysis:

Coal Quality of NWFP Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	00.10 – 07.10
Ash content (%)	05.30 – 43.30
Volatile Matter (%)	14.00 – 33.40
Fixed Carbon (%)	21.80 – 76.90
Sulphur (%)	01.10 – 09.50
Heating Value (Btu/lb)	9,386 – 14,217

The thickness of coal layers and seams in different Hangu and Cherat coal fields is from 0.5 to 3.5 meters and occurring almost near to the surface of soil and the CBM reserves available in the seams of coal will be cost effective and recoverable through small wells of short depth.

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2.1.5 Coal Reserves in Azad Jummu and Kasmir

The Azad Jummu and Kashmir is having a small quantity of coal located in District Kotli[2]. The coal beds are in the steeply dipping Patala Formation. The coal beds have an average thickness less than one meter i.e. 0.6 metre. The total coal reserves are estimated at 0.06 million tonnes with Sub-bituminous and heating value ranging from 7,336 to 12,338 Btu/lb with following quality analysis and specifications :

[1] Information and data is based on the Pakistan Coal Power Generation Potential, June, 2004, page 17, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.
[2] Information and data is based on the Pakistan Coal Power Generation Potential, June, 2004, page 19, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

Coal Quality of Azad Jummu and Kashmir Coal Reserves
The Quality of the Coal is Sub-bituminous

Moisture (%)	00.20 – 06.00
Ash content (%)	03.30 – 50.00
Volatile Matter (%)	05.10 – 32.00
Fixed Carbon (%)	26.30 – 69.50
Sulphur (%)	00.30 – 04.80
Heating Value (Btu/lb)	7,336 – 12,338

The thickness of coal layers and seams in Kotli coal reserves is less than one meter and possible reserves of CBM will be explorable with small depth wells in a cost effective manner.

2.2 Incidence of Coal-Bed Methane Gas in Coal Reserves

After in detail analysis of different coal reserves with their varying thickness, it is interesting to note that in the Provinces of Balochistan, Punjab and NWFP, there is possibility of occurrence of Coal-Bed Methane (CBM) in small scale and due to soft nature of soil these will be easily explorable with well of short depth cost effectively for local use in case of small quantity or in case of large reserves, they may be linked with national gas pipeline networks. Similarly, in the coal reserves of Azad Jummu and Kashmir, the thickness of coal is so less but the topography of land is very difficult due to mountain terrains and non-accessibility, the exploration of CBM will be very difficult and expensive task. However, further studies and research may disclose the exact quantity and possible uses of CBM in Azad Jummu and Kashmir but it will be quite useful for local consumption because Azad Jummu and Kashmir is not linked with national pipelines network. However, the coal reserves in the known reserves may be used for generation of electricity through thermal power plants by using these coal reserves as fuel. Government of Pakistan, however, is already making efforts to attract investors for generation of electricity by using coal as a fuel to operate turbines in power plants at national and international levels with different types of incentives and assurances.

With the advancement of technology, there is another technical option available to utilize these coal reserves to generate electricity through gasification process. Gasification of coal is an old technology, having formed the heart of town gas industry until the advent of natural gas in different parts of world. Gasification is now technically feasible and commercially viable source for power generation. Gasification process is commercially proven and highly versatile in terms of feed stocks and products. Through this process we can convert many carbon based materials including most grades of coal into clean synthesis gas. The feed stock is fed to a pressurized vessel where heat and pressure break apart technical bonds in the feed stock and form synthesis gas which is a mixture of hydrogen and carbon monoxide. After cleaning, the syngas is used as fuel to generate electricity or steam. Syn-gas is also currently used as a basic building blocks to produce a wide range of commercial products, such as chemicals, fertilizers, liquid fuels and industrial gases including hydrogen for refining uses to produce cleaner transportation fuels including Ammonia and Urea, Naptha, Waxes, Acetate Esters, Acetic Anhydride, Oxo-Chemicals, Ethylene and Prophylene, etc.

Thar coal reserves are like the coal reserves at North Dakota, USA, and it is being gasified and utilized for preparation of chemicals besides conversion into gas. Coal gas having value equivalent to natural gas is being supplied to industry and domestic consumption. The project is producing over 52 billion cubic feet of pipeline quality gas annually along with substantial quality of fertilizers and other chemicals. This project was partially financed by US Department of Energy. The technology used for gasification is "Lurgi".

Keeping in view the United States experience, Government of Pakistan has also assigned a feasibility study to Lurgi South Africa to ascertain suitability of Thar coal for gasification. The study is of one year duration and based on similar operating projects in the world and the results are anticipated to be positive. However, gasification projects are capital intensive. The cost of North Dakota gasification project is estimated to be about one billion US Dollars. However, keeping in view the rising trends of petroleum and gas products internationally there is a need to explore alternative energy resources including gasification based on huge coal reserves found in different parts of the country.

Keeping in view the technical data available from different coal reserves, there are only Thar and Lakhra Coal Fields where there is possibility of occurrence of CBM because the thickness of coal seams at Thar varies from 0.2 to 22.8 meters with a cumulative coal thickness in one of the drill holes as 36 meters. Similarly, the thickness of overburden varies from 11 to 203 meters at Thar coal fields. However, the overburden of the first mineable coal seam ranges from 50 to 150 meters.

Occurrence of CBM in Coal Reserves

It is pointed out in one of the reports[1] of the United States Geological Survey that Coal is an unusual lithology in that it is both an excellent source and reservoir rock. CBM is usually generated in place and stored within the coal. It also differs from conventional reservoirs in that usually all but a negligible amount of the gas is sorbed on to the coal matrix rather than occurring as free gas or dissolved in formation water at least in theory. Most of the sorbed gas is adsorbed that is densely packed as a single layer on the pore walls; as such, it behaves like a liquid rather than following the ideal gas law like conventional free gases. Some is absorbed; that is, dissolved in the coal matrix. While the sorption phenomena are caused by weak molecular attractions, the gas is ultimately held in the coal hydrostatically. The bottom line is that CBM is generally not free-flowing to the well bore; the reservoir pressure must be reduced by dewatering the coal to produce it. That is why it was overlooked for so long, or in the cases where it did flow naturally, considered a blowout nuisance, mining hazard, or greenhouse threat. However, the gas storage capacity of coal is very high; many times that of conventional reservoirs at low pressures – one analogy is that of sponge or silica gel. The preferred method to test for CBM is to place freshly cored coal in airtight containers and measure the gas with a series of manometers as it desorbs. Commercial well completion usually involves hydrofracting or letting the hole cave under its own hydrostatic pressure (cavitation) and co-producing water and gas with the aid of pumps. As the coal is dewatered, most of the sorbed gas diffuses to fractures where it is released and migrates to the well bore.

[1] A Primer on the Occurrence of Coalbed Methane in Low-Rank Coals, with Special Reference to its Potential Occurrence in Pakistan, by John R. SanFilipo, Open-File Report 00-293, 2000, USGS, 956 National Center, Reston, VA 20192.

In this way, the behaviour of the CBM is quite different at its exploration stage as compared to petroleum gas i.e natural gas. It is not simply rushing to the borehole of the well and then piped for consumption. It is remaining in the pores of coal beds for long time or till it gets some way to migrate to other area. In porous rocks, when they existing nearby the coal reserves, if they are not block by solid rock or water, then CBM gets a way to leak in the air from such places.

However, the report further states that CBM[1] is thought to be generated during three distinct stages of the parent coal's maturation history :

(1) an early biogenic stage i.e. gas produced by bacterial activity during the conversion of peat to coal;

(2) a thermogenic stage i.e. gas produced by coal when its constituents volatilize as it increases in rank due to increasing temperatures encountered with greater depth of burial or proximity to igneous activity; and

(3) a late biogenic stage i.e. gas produced by bacterial activity after the coal has reached thermal maturity.

With the reservoir CBM can theoretically exist from any combination of these stages of generation. The mode of occurrence for CBM is usually inferred from hydrogen and carbon isotopic compositions and "wetness" expressed as the ratio of methane to higher alkanes. These parameters are then related back to maturation pathways that include various chemical and bacterial processes e.g. fermentation and CO_2 i.e. "carbonate" reduction; which in turn can theoretically be related to the three stages of generation described above. There is probably considerable overlap in the chemical and biological pathways however, and these models are still evolving. They are important, however, because until very recently there has been only minor commercial interest in biogenic CBM. The vast majority of production has traditionally been ascribed to stage 2 gases; but these are recognized to frequently contain a significant admixed component of stage 3 gas. The PRB has generally been regarded as a source of stage 1 gas but its commercial potential was only recently realized. The vast majority of Pakistan's CBM potential is probably from biogenic sources, although at this point distinguishing stage 1 from stage 3 is, at best, problematic.

[1] A Primer on the Occurrence of Coalbed Methane in Low-Rank Coals, with Special Reference to its Potential Occurrence in Pakistan, by John R. SanFilipo, Open-File Report 00-293, 2000, USGS, 956 National Center, Reston, VA 20192.

The process of gas generation is integral to the formation and maturation of coal; all coals generate stage 1 gases in the transformation from peat to coal, and if sufficiently mature will generate stage 2 gases. Stage 3 gases could in theory be generated from any coal under the right hydrologic conditions regardless of maturity. To have commercial potential, however, CBM, like any other gas occurrence, must have a trapping mechanism and be economically recoverable. Because stage 1 gases form early in the coalification process, when the matrix is not yet "tight", these gases have traditionally been thought to escape e.g. swamp gas, or be incorporated in the solid coal matrix as it matures. With further maturation, stage 2 gas is generated, but at some point, the sorptive capacity of the coal apparently begins to decrease although this point is contentious. In any case, the most productive CBM wells have been from medium-rank coals such as in the San Juan Basin, where the best production is from high-volatile bituminous coals – despite higher rank coal occurring deeper in the basin. The enhanced producibility may be a function of the addition of stage 3 gases or the retention of initial permeability, and exploration efforts have tended to look for medium-rank coals at intermediate depths of less than 3000 feet.

Because CBM is generally not in a free state, a conventional-type trapping mechanism is not required. For example, the San Juan Basin is a "basin-centred gas accumulation"; that is, it is synformal i.e. shaped like a bowl rather than having the domal configuration of most traps, and the gas is below the hydrostatic head rather than above it. This is a gross oversimplification – suffice it to say that for CBM to accumulate, a conventional trapping mechanism is not necessary, but the right hydrostatic conditions are. Until recently, the conventional wisdom has been that stage 2 and 3 gases could be trapped in a variety of structural settings, but since state 1 gas was formed during the peat-to-coal transition as dewatering was occurring, it would most likely be lost to leakage if a conventional trap was not present. Indeed the only CBM production with an isotopically "confirmed" stage 1 component is from the PRB, where the earliest production was in fact from conventional traps associated with compaction structures.

To summarize, the prevailing wisdom until very recently was that most coalbed methane targets need to be sufficiently mature to have a thermogenic component, but not

buried so deeply as to have lost their permeability. For biogenic CBM to be commercial, a conventional trap of free gas was thought to be required, which rarely occurs with coal.

The current activity in the PRB, and to a lesser degree the recognition of stage 3 gases in other basins, is changing the CBM paradigm. A number of companies in the PRB – generally small independents – have been producing CBM from shallow wells using relatively simple completion techniques. Rather than being confined to compaction structures, the new production is mostly down-dip from large surface mines, where producibility is enhanced by dewatering at the mines. The wells are highly profitable, and there are a number of as yet poorly understood factors that may be contributing to their success. Most importantly, the reservoirs are producing more than what was predicted from desorption tests. Recent work has suggested that the enhanced production comes from free gas trapped by capillary pressure or loosely adsorbed i.e. not "monolayer", gas. Basically, there is much yet to be learned about CBM, and in the opinion of the author, at the current state of knowledge, this is an empirical process. You test the coal to see if it has gas.

In the light of above-said factual analysis as contained in the report, it is easy to conclude that although the CBM is the part and parcel of every coal reserve but still it is very difficult to say with certainty that CBM will be explorable from a coal reserve or not. It only depends on the nature of each and every coal reserves and only a formal testing process may authenticate about the practical aspects of CBM in those coal reserves.

CBM may be occurring in two forms :

(a) Dry Coal CBM; and
(b) Wet Coal CBM.

From exploration point of view, dry and wet CBM have different cost factors. Wet coal CBM is produced by reducing the water pressure by using pumping systems to pump the water to surface. As soon as hydrostatic pressure is reduced due to pumping of water, gas is desorbed from the coal and may be extracted through a drilled well or it can migrate toward the lowest pressure area and for exploring gas a low pressure is created around the

well through mechanical means. Gas in coal beds flows in its fractures and reservoirs such as occurring in coal deposits.

CBM is not a new phenomenon but its discovery and commercial exploitation is new. Previously, CBM or CMM (Coal Mine Methane) was causing havoc on mining processes because it was causing explosions and death of miners due to its toxic nature but no one had conducted any research about its exact nature. In China, every year hundreds of miners are dying due to CBM explosions in coal mines because during the process of mining CBM is gathering in open area under the mines where workers are excavating coal from the coal beds and when it is increasing its reasonable limit and getting no outlet in the air, it is killing miners due to its toxic nature or catching fire due to any lamp or lightening equipment and causing big explosions with bang sometimes destroying mine holes and outlets killing miners due to such fire in the mine or asphyxiation. Due to such reasons CBM, without giving this name, was treated as a dangerous waste in mines but now, after realizing its energy potential it is treated as a precious fuel more precious than its origin i.e. coal. For beneficial measures and safety of mines it is recommended that before starting mining process in the coal bed and reserves, first there should be drilling to know the incidence of CBM. Such drilling will also provide useful data about coal reserves and CBM. If there is incidence of CBM in such coal reserves, it may be explored and marketed or utilized for the benefit of miners as well as other nearby localities as a fuel which is more suitable than coal itself. It will reduce the pressure of CBM in coal beds making them safe and secure for mining purposes avoiding all hazards like toxic effects, explosions and other such problems like asphyxiation due to poisonous impact of methane in excessive quantities in addition to save the environment from mixing of methane gas in air.

It means still technology is not so developed to say with surety that CBM will be recoverable from certain coal reserves or not.

2.3 Possible reserves of Coal-Bed Methane in Pakistan

Technical data available from Thar and Lakhra[1] coal fields is as under :

1. **Technical Information of Coal Quality of Thar Coal Reserves**
   The Quality of the Coal is Lignite-B to Lignite-A

Moisture (%)	29.60 – 55.50
Ash content (%)	02.90 – 11.50
Volatile Matter (%)	23.10 – 36.60
Fixed Carbon (%)	14.20 – 34.00
Sulphur (%)	00.40 – 02.90
Heating Value (Btu/lb)	
As Received	6,244 – 11,045
Dry Basis	10,723 – 11,353

2. **Technical Information of Coal Quality of Lakhra Coal Reserves**
   The Quality of the Coal is Lignite-A

Moisture (%)	09.70 – 38.10
Ash content (%)	04.30 – 49.00
Volatile Matter (%)	18.30 – 38.60
Fixed Carbon (%)	09.80 – 38.20
Sulphur (%)	01.20 – 14.80
Heating Value (Btu/lb)	5,503 – 9,158

Keeping in view the technical data available from different coal reserves, there are only Thar and Lakhra Coal Fields where there is possibility of occurrence of CBM because the thickness of coal seams at Thar varies from 0.2 to 22.8 meters with a cumulative coal thickness in one of the drill holes as 36 meters. Similarly, the thickness of overburden varies from 11 to 203 meters at Thar coal fields. However, the overburden of the first mineable coal seam ranges from 50 to 150 meters.

In addition to these big coal reserves, there are also medium level coal reserves in different parts of the country. Almost all the Provinces are having coal reserves either in

[1] Information and data is based on the Pakistan Coal Power Generation Potential, June, 2004, page 6, published by Private Power and Infrastructure Board, Ministry of Water & Power, Islamabad.

small or large quantities including Azad Jammu and Kashmir particularly at low-lying depths which are ideal for CBM occurrence and exploration.

However, the USGS report has also reviewed the prospects of CBM occurrence in the light of other similar coal reserves found in different other countries. The Report[1] says that Pakistan appears to be on the margins of possible CBM (Appendix – VII) occurrence. Most of the larger coal fields, which are generally in Sindh Province, have apparently not reached the thermal gas generation threshold. Most of the known coal fields of Sindh are very sandy and have a hydrologic connection to the Indus Basin, both of which could have induced leakage of any gases that were ever present. The known coal fields that appear to be of sufficiently high rank to have reached the thermal gas generating stage, located mostly in Balochistan, Punjab, and the North West Frontier Province, typically have relatively thin coal, and they generally occur in structurally complex areas where well completion could be difficult.....

On the other hand, the recent PRB activity, the fact that there was some gas present in our tests, and most importantly, the results of a USAID-sponsored CBM program for similar low-rank coal in the Cambay Basin of India indicated that a more systematic appraisal of the CBM potential of Pakistan is warranted. Most encouraging is the fact that for the coals of Cambay, which from a depositional standpoint is more or less an extension of the Thar field, the desorption results from depths greater than 2000 feet are fairly high i.e. 200 scf/ton. Coincidently, a USGS test well drilled in the Gulf Coast of Texas had a small show of gas that was almost all methane i.e. very little CO_2, from coals that are geologically very similar to those of Sindh. Although our desoprtion measurements in Sindh looked insignificant at the time they were done, they are in fact very similar to what was observed in Texas from similar depths. Furthermore, some Gulf Coast CBM yields for depts greater than 2500 feet were recently published and they are very similar to the yields from Cambay. Although the Gulf Coast may have somewhat more connectivity to more mature coals down-dip, all things considered, the Sindh-Cambay area and the US Gulf Coast seem very similar in terms of coal geology and CBM potential. The Texas coals and Cambay coals

[1] A Primer on the Occurrence of Coalbed Methane in Low-Rank Coals, with Special Reference to its Potential Occurrence in Pakistan, by John R. SanFilipo, Open-File Report 00-293, USGS, 2000, 956 National Center, Reston, VA 20192.

have very low sorption times, which implies that there may be free gas present, and perhaps our shallow tests in Sindh underestimated the gas-in-place. At the time, CBM was a new frontier, and we used primitive equipment and did not analyze the gases. More tests are needed to adequately assess this unconventional energy resource, which seems especially justified given the fact that Pakistan's conventional oil and gas resources are limited and much of its coal may be only marginally economical for mining. From a deliverability standpoint, there is fairly extensive pipeline system in place for much of Pakistan, and many of the existing conventional fields produce from wells that could conceivably be reworked for CBM if coal is present. Moreover, though generally thin, subsurface coal appears to be fairly widespread in most areas of Pakistan other than western Balochistan and the extreme north. Thus, there are many remote areas where CBM could potentially provide gas for local use without necessarily connecting to the national distribution system.

2.4 Exploration of CBM in Pakistan : Taking Initiative

At present there are no exploratory efforts in Pakistan for discovery and marketing of CBM on commercial basis. The research and discovery data available is based on explorations done for discovery of coal, oil or natural gas. Thus, all information and data is based on such indirect exploratory activities and drillings. The first ever such effort was made and analysed, as reported by John R. SanFilipo[1], under the sponsorship of GSP/USGS boreholes drilled for the USAID COALREAP programme in 1992. One hole was in the central Thar field and the other was in the south Lakhra field. Very little gas was desorbed, but this was to be expected given the hydrologic setting of these two areas. The tests were made during the course of ongoing exploration for mineable coal, at holes drilled on structural highs that were never expected to be the best CBM targets. A rough approximation indicated by these tests shows a maximum yield of about 4 to 5 scf/ton.

[1] A Primer on the Occurrence of Coalbed Methane in Low-Rank Coals, with Special Reference to its Potential Occurrence in Pakistan, by John R. SanFilipo, Open-File Report 00-293, USGS, 2000, 956 National Center, Reston, VA 20192.

On the basis of his research, John R. SanFilipo has devised a conceptual model[1] for Thar Desert CBM prospectivity (Appendix – VIII).

John R. SanFilipo has also stated that there are a few generic things that could be done to initiate CBM activity in Pakistan. First of all, a thorough inventory of the coal resources of Pakistan needs to be initiated, including occurrences that can be identified from oil and gas and water well drilling outside of the traditional coal mining areas. Ultimately a national coal database (similar to the USGS National Coal Resource Data System) should be established and maintained by a single agency, preferably the GSP. He further states that all GSP drilling projects in coal-bearing area should test a few boreholes representative of the geology in the project are (CBM occurrence can vary considerably over short distances, and one hole per area is not enough). In addition, other agencies, such as the Hydrocarbon Development Institute of Pakistan and Oil and Gas Development Company Limited, could work with GSP or acquire their own equipment to desorb cuttings from oil and gas holes that intercept coal, especially at the depths greater than 1500 feet, where the CBM potential is greater than GSP's drilling capabilities may be stretched. These groups may already be doing reflectance measurements as a matter of routine maturation investigations, in which case the additional effort required to desorb bedded coal would not be much. It would also be advisable to do isotopic work on some conventional gas samples to see if they are sourced in coal. None these activities are particularly difficult, but it would be advisable to engage an outside expert in CBM to help start things off. There are not that many good CBM targets in Pakistan, and with sufficient input from key agencies like OGDCL, HDIP and GSP, it would not be too difficult to complete a fairly good initial assessment. From a technical standpoint, the USGS would be well positioned to contribute to such a project, considering its breadth of experience in Pakistan and its current CBM capabilities, which include a mobile lab designed for easy deployment to remote areas.

These observations of John R. SanFilipo are quite useful for exploratory work for CBM in Pakistan.

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[1] A Primer on the Occurrence of Coalbed Methane in Low-Rank Coals, with Special Reference to its Potential Occurrence in Pakistan, by John R. SanFilipo, Open-File Report, 2000, 293, USGS, 956 National Center, Reston, VA 20192.

2.5 Utility of Coal-Bed Methane Gas as a Fuel

Coal-Bed Methane or Coal Mine Methane gas has the same chemical composition as the methane gas which is commonly known in Pakistan as Sui Gas as it was first discovered at Sui, a village in Balochistan Province. However, it was ignored in the past because its exploration and processing was not so easy and cost effective but due to increasing prices of petroleum and gas products have highlighted the importance of CBM as an alternative fuel instead of natural gas.

CBM is as pure as other natural gas or methane produced from petroleum wells. However, in some cases it contains small fractions of wet or heavier hydrocarbons like butane and ethane and other gases like hydrogen sulphide and carbon dioxide reducing its level of purity as methane and also decreasing its energy and heating value. It may be purified but such purification processes are quite expensive and increasing its commercial cost. Therefore, in its existing form it may be marketed for commercial purposes by establishing separate system of pipelines for distribution. However, it may also be pumped into the main pipeline distribution systems or networks without any harm. It depends on the chemical composition of the CBM whether it requires any treatment before pumping it into main distribution network or not. If there is a major quality impediment for its connection with main distribution network then it is appropriate to suitable chemical treatment may be done before such connection to ensure facilitation of consumers of such main distribution system.

Therefore, CBM is equally useful as fuel as natural gas from other sources as it is the same methane gas but having different origin sometimes with minor quality concerns or perfectly the same as methane gas flowing in main distribution networks as a fuel.

CHAPTER 3

NATURE AND DIFFERENCES IN COAL-BED METHANE GAS AND NATURAL GAS

3.1 Discovery of CBM

Coal is not a new discovery in Pakistan. Coal was discovered at Lakhra, a village in District Dadu, on the western bank of the River Indus, in 1853[1] when Baloch nomads reportedly struck a coal seam of 2.43 meters in its thickness at a depth of 125 meters while sinking a well for water. However, that was not the time when fuel resources like oil and gas were even properly known or exploited in any part of the world at least on commercial basis due to different reasons and particularly the technical and scientific reasons. There might had been evidence of coal bed methane gas during that process of sinking a well for water but nobody was aware about such thing at that time.

It was, latter, 1948, when Burmah Oil Company, and 1953, Pak Hunt International, during their drilling process had observed the presence of coal at Lakhra in holes drilled for oil exploration. However, at that time, there was no shortage of fuel obtained through conventional resources for domestic consumption and other commercial purposes. Coal was being used even for railway engines and other locomotives. Other oil based means of transportation were non-existent at masses level and their needs were being fulfilled from oil obtained from different imported or domestic resources.

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[1] Sindh Coal Resources as published in "Pakistan Coal Power Generation Potential" published by Private Power and Infrastructure Board, Islamabad, June, 2004, at page 3.

Natural gas was discovered in 1952 in Pakistan is being used under the name of Sui Gas as it was first discovered at a village namely "Sui" near Dera Buguti in Province of Balochistan. Latter, natural gas has been discovered in abundance from different other sites during the drilling and exploration of oil. Natural gas being a clean and good quality fuel after oil with least environmental impact had been used in its different forms like LPG, LNG, CNG and through a distribution system in different parts of the country. Rising prices of imported petroleum are compelling the countries to utilize maximum gas for different purposes to save foreign exchange. Diversion from petroleum products to gas products caused an excessive pressure on natural gas reserves and it is apprehended that with increasing use of natural gas for different purposes after sometime this precious resource will exhaust. Even at present during winters when natural gas is being used for heating purposes excessively, the distribution companies are resorting to load-shedding of gas by different techniques to ensure supply to all consumers from less production capacity.

Increasing prices of petroleum products and shortage in existing natural gas resources has forced the policy-makers to exploit other alternative means of energy including import of gas from other gas-rich countries like Iran and Central Asian Republics, gasification of coal through different processes, production of electricity by using coal, thermal or hydro resources in addition to exploitation of Coal-Bed Methane which is hoped present in all coal reserves of the country.

Although it is not sure that CBM will be available at large scale. However, small scale availability of CBM will be usable for different purposes including generation of electricity at small scale by installing small electricity producing units at nearby sites of coals, chemical industry using hydrocarbons, supply of CBM for fuel and domestic purposes to nearby by localities situated near discovery points or coal fields or pumping it into main distribution network, if it is of good quality available in vast quantity.

However, still there are no practical efforts made for exploration of CBM due to lack of financial resources in public sector but the Government is planning to allow the private sector to invest for exploration of CBM with suitable incentives to use this unconvential source of energy to face successfully the future challenges of energy shortage in the country.

It is a proved fact that economic development and growth simply depends on energy resources. More supply of energy resources, there is more development and growth in national economy. Less supply of energy resources, less development and economic growth because energy is the lifeline or blood for developmental, industrial and growth activities in any economy. Therefore, keeping in view the growth targets, the rationing of energy or short supply of energy resources mean low development, less industrial activity and low economic growth rate.

In United States of America and Canada CBM is being exploited and used for different purposes since 1970 and 1980 respectively, although they are not in short supply of energy resources from different sources within country or imported in the country. Keeping in view US and Canadian experience, other coal producing countries like Russia, China, Poland, Germany, Australia, Great Britain and many other countries are exploiting and using CBM for domestic and industrial purposes in their countries being a cheaper fuel.

India is our neighbouring country with similar soil and subsurface structure of earth with other similarities in geological structure of land and is extensively providing opportunities for exploitation of CBM in its different provinces. In the year 2006, Indian Government had offered ten blocks for exploration and production of coal-bed methane in different provinces as its Third Offer of Blocks (CBM-III). These ten blocks located in the States of Andhra Pradesh, Chhattisgrah, Madhya Pradesh and Rajasthan (two blocks in each State); and one block each in Jharkhand and West Bengal. Before discussing other aspects it is relevant to discuss briefly some basic facts about status of CBM and its exploration in India because Pakistan is also having the similar circumstances for different geological and technical purposes for CBM.

India has huge Gondwana (mainly Permian, 99.5%) and Tertiary (Eocene and Oligocene) coal deposits distributed in several basins located in Peninsular and extra-peninsular regions. About 204 billion tonnes of coal reserves have been established and approximately 200 million tonnes or so are likely to be added in the near future by further explorations. The main Gondwana coal basins are rifted intra-cratonic grabens having thick sequence of coal seams, and hold considerable prospects for CBM. The major part of Indian Gondwana coals, mostly up to 300 meters depth, is of low rank, far below the threshold

value of thermogenic methane generation. However, high rank coals, amenable generally for CBM, mostly occur in untapped deeper parts of basins covered by younger sediments.

Tertiary coals of India, occurring mainly in lagoonal to deltaic sediments, are better in quality compared to Gondwana coals, though the seams are thinner. On the basis of composition and rank of coal, Tertiary coals appear to be moderately rich in CBM. The estimated CBM resources of Gondwana coals appears to be between 1 and 1.5 tcm (trillion cubic meter) and the Tertiary coals of about 4.3 bcm (billion cubic meter).

In 1990, efforts to exploit coal bed methane were initiated by Essar Oil, a private oil company, under the advice of American experts. The methane emission and desorption studies on Gondwana coal samples from Jharia Coalfield (Bihar) were carried out by Central Mine Planning and Design Institute Limited (Ranchi) and Central Mining Research Institute, Dhanbad. The content of gas and gas emission rate from these samples were found to be 1.8-2.3 $m^3/100\ m^2$ of surface and 12.7-17.3 m^3/min, respectively. The studies carried out by Bharat Cooking Coal Limited in the same area with the help of French experts indicated 0.68-1.45 m^3/min gas emission rate. 1992, assessment of CBM potential for Damodar Valley coals was initiated by Oil and Natural Gas Commission. Till date, it has collected significant data related to CBM exploration drills in Ranigang basin. Recently, ONGC for the first time in India has succeeded in flowing the gas from seam no.XIV in Parbatpur block of Jharia basin.

Besides, Geological Survey of India and Reliance Industries Limited have also undertaken investigations on the prospects of occurrence of CBM in different Gondwana and Tertiary coalfields of India. These investigations led to the delineation of potential areas in Damodar, Ranigang, Jharia, Bokaro, Giridih; Son in Sohangpur and Pench-Kanhan-Tawa Valley i.e. areas lying on the dipside of the Kanhan Valley, coalfields where a total gas-in-place reserve of 13.34 tcf has been predicted. In addition, gas content of 250 scf/ton in an area of 900 km^2 has been recorded from Early Paleocene coal beds which are 50 meter thick, of Cauvery Basin by Essar Oil Company.

In the light of above facts relating to India, it is apparent that geological history of the sub-continent is the same and the areas constituting Pakistan are also having the same

geological topography and structure. Therefore, there are CBM reserves in different coal fields of Pakistan but there is need of research and exploration to obtain confirmed data with all technical information about other aspects.

3.2 Is CBM like Natural Gas?

The primary energy source of natural gas is a substance called methane represented by its chemical formula i.e. CH_4. Coal-Bed Methane is simply methane found in coal seams. It is produced by non-traditional means. Therefore, while it is sold and used the same as traditional natural gas, its production is very different. CBM is generated either from a biological process as a result of microbial action or from a thermal process as a result of increasing heat with depth of the coal. Often a coal seam is saturated with water, with methane held in the coal by water pressure.

CBM is as pure as other natural gas or methane produced from petroleum wells if there are no mixing of other gases like ethane, butane or carbon dioxide. However, in some cases it contains small fractions of wet or heavier hydrocarbons like butane and ethane and other gases like hydrogen sulphide and carbon dioxide reducing its level of purity as methane and also decreasing its energy and heating value. It may be purified but such purification processes are quite expensive and increasing its commercial cost. Therefore, in its existing form it may be marketed for commercial purposes by establishing separate system of pipelines for distribution. However, it may also be pumped into the main pipeline distribution systems or networks without any harm. It depends on the chemical composition of the CBM whether it requires any treatment before pumping it into main distribution network or not. If there is a major quality impediment for its connection with main distribution network then it is appropriate to suitable chemical treatment may be done before such connection to ensure facilitation of consumers of such main distribution system.

Therefore, CBM is equally useful as fuel as natural gas from other sources as it is the same methane gas but having different origin sometimes with minor quality concerns or perfectly the same as methane gas flowing in main distribution network as a fuel.

Coal-Bed Methane or Coal Mine Methane gas has the same chemical composition as the methane gas which is commonly known in Pakistan as Sui Gas as it was first discovered at Sui, a village in Balochistan Province. However, it was ignored in the past because its exploration and processing was not so easy and cost effective but due to increasing prices of petroleum and gas products has highlighted the importance of CBM as an alternative fuel instead of natural gas has been highlighted.

3.3 Differences in Coal-Bed Methane Gas and Natural Gas

As discussed earlier, there is no difference between the CBM and natural gas, if both of them are in their pure form. However, there place of occurrence is different. Natural gas is generally found with petroleum products whereas CBM is sleeping in the seams of coal beds in coalfields. CBM may be in dry or wet form.

Methods of exploration and production for both are different. Natural gas is rushing upwards with full force when it is finding some way out during the drilling process for discovery and exploration of oil. However, CBM is embedded in coal seams. It also travels with ground water in coal seams, extraction of CBM involves pumping available water from the seam in order to reduce the water pressure that holds gas in the seam. CBM has very low solubility in water and readily separates as pressure decreases, allowing it to be piped out of the well separately from the water. Water moving from the coal seam to the well bore encourages gas migration toward the well. CBM producers try not to dewater the coal seam, but rather seeks to decrease the water pressure or head of water, in the coal seam to just above the top of the seam. However, sometimes the water level drops into the coal seam.

CBM is having some difference when it is enriched with some other gases like ethane, butane and carbon dioxide decreasing its strength as pure methane i.e. CH_4 and also decreasing its heating value. CBM in pure form as methane i.e. CH_4 is like ordinary natural gas or methane i.e. CH_4 with all its elements and chemical composition having the same heating value as the natural gas in ordinary fuel use.

3.4 Problems for Use of CBM as Fuel at Large Scale

Coal-Bed Methane is new in the field of energy in Pakistan which is still required to be explored along with an assessment of its total reserves in Pakistan coal fields. As Pakistan has more than 186 billion tonnes of coal, there is possibility of huge reserves of CBM in Pakistan. Major requirements of gas are being met from natural gas which is almost the pure methane with high heating value but Pakistan has no big reserves of natural gas which can easily meat the increasing demand of natural gas for different purposes. This is the reason that Pakistan started importing different products of gas from other countries with the possibility of import of natural gas through pipeline networks from Iran and Central Asian Republics but this option is full of many risk factors like increasing prices, possibility of increasing prices like petroleum products, disruptions due to political and transportation reasons and other national and international factors. Thus, it is necessary that Pakistan should explore indigenous energy resources for its future energy requirements.

Pakistan has huge coal reserves in its different areas and particularly like Thar and Lakhra coal fields which are having similarities with US Powder River Basin (PRB) and Indian Cambay which is geologically adjacent to Thar coal fields with similar geological data and other factors supporting possibility of occurrence of huge CBM reserves. Although there is strong possibility of occurrence of CBM in Balochistan, Punjab and NWFP coal fields because those are low-rank coal reserves with similar geological data and factors supporting incidence of CBM. However, in Pakistan, some coal fields are located in such areas which are very difficult to explore for drilling purposes and supply of CBM discovered from those areas on commercial basis.

Another factor is the lack of research and discovery efforts in Pakistan due to financial constraints which are not allowing the Government to develop a databank about exploration of CBM in different coal fields. Similarly, lack of appropriate access to technology has also prevented exploitation of the CBM resources till today.

It is very difficult that companies may have to develop their interest for commercial exploitation of CBM without complete assessment and data availability of different coal

fields for exploration. There is a need that a complete assessment may be made for all CBM reserves with complete seismic, geological and technical details of coal fields for exploration of CBM.

In this regard Pakistan should benefit from Indian experience because India and Pakistan has same topography and geological structure of land resources.

First of all it was the USGS interest which forced us to exploit about our big coal reserves for CBM funded and sponsored by USAID COALREAP project in Thar Coal Fields. However, thereafter no further efforts had been made to continue assessment and data collection about CBM in other areas. Recently, some international companies have shown interest for discovery and exploration of CBM in different coal fields due to their similarity with Indian and US coal fields wherefrom CBM is already being explored but there are many problems about management and licensing regimes in Pakistan because concerned organizations had worked on discovery and exploration of CBM and its management according to Pakistan's constitutional and legal frameworks as well as its quantity, quality and pumping issues in the main distribution systems for commercial supply of CBM, in case of exploration, and large scale availability of CBM.

According to available data and information in most of cases, CBM is not having equal heating value as the other methane or natural gas has. According to chemical analysis, CBM is not having 100% purity as methane as the natural gas exploited from petroleum wells and also based on petroleum. It has methane content more than 86% with varying content of butane, ethane and carbon dioxide in it according to its composition in different coal fields with different hydrostatic component. Water is a necessary component during the exploration process of CBM from any coal resources. Therefore, it requires a comprehensive planning about the use or disposal of large scale water which will be extracted during the exploration of CBM according to its quality for different purposes. It is an additional benefit because in most of the cases, there is acute shortage of water in coal fields and their adjacent areas. Therefore, the water being the by-product of CBM may be used in adjacent local areas for drinking and agricultural purposes according to quality of water.

In case of Pakistan, theoretically there are reservations of exploration companies to supply the gas for distribution to companies which are maintaining distribution networks for commercial supply to consumers for domestic and industrial use.

As far as, exploration companies are concerned, they have concerns about quality and content of CBM expected to be explored from different coal fields as it is a misconception that it is low in heating or caloric value and will be in less demand for commercial consumption. It is feared that after huge investments for its exploration, it will be very difficult to connect it in the main distribution networks due to its less caloric or heating value. Similarly, its place of occurrence is in far flung coal fields wherefrom there will be need of long pipelines to connect it with the main distribution network when distribution companies will be less interested for its sale due to its heating value. Therefore, the prospects for recovery of investments for discovery and exploration of CBM is at least a risky business in the prevailing circumstances. Due to such reasons, it will be very difficult to invite the national and international companies with such uncertainties.

To ensure and attract the companies for discovery and exploration of CBM, there is a need for accurate data and other geological information along with chemical analysis of explored CBM from its quality point of view because it will not only attract the national and international investment but also make it clear to gas distribution companies about heating and caloric value of CBM.

However, there is another difficulty which is relating to huge investments for connecting it with national distribution system because in most of cases it will require long distance connecting lines. This infrastructural requirement is a big question whether it will be from the exploring company or distribution company. In any case no distribution company will be interested to invest in long distance pipelines to exploration points when they are not expecting any financial benefits and they are also fearful at the same time that CBM has less heating and caloric value and will not get good response from consumers of gas either for domestic or industrial purposes.

There is another option that expected CBM may be used for local consumption in nearby localities for domestic and industrial purposes. It will save the environment from

degradation, pollution and save the vegetation and plantation from further deterioration in arid areas. It will be a big benefit to local population and national environment that they will get a better fuel for their domestic consumption and even this cheap source of energy may be used for cottage industry in such remote areas.

Secondly, there should be encouragement for establishment of different hydro-carbon related industries in these coal fields or nearby areas which will not only use the coal for their industrial purposes but also consume the CBM produced from those coal fields without problems of long distance connecting pipelines to pump it to main national distribution networks for sale.

In addition to uses mentioned above, the following may be particular uses of CBM in different domestic, commercial and industrial sectors :

3.4.1 Domestic Use

CBM may be equally useful for domestic purposes as natural gas because it is having little difference or no difference in most of the cases as far as its caloric or heating value. Therefore, it may be another supporting source of energy for domestic purposes through main distribution system overcoming shortage of natural gas in the country due to exhaustion of existing natural gas resources.

3.4.2 Power Generation

CBM is used throughout world for the purposes of generating electricity according to availability of CBM from the coal fields. It is quite relevant that sometimes, CBM is having less caloric value and not considered suitable for domestic or industrial consumers. In such circumstances, small scale or according to availability of CBM from its exploration point, small power generation plants may be established in nearby localities for producing electricity to such local areas. It can produce very cheap electricity and also become cost effective for such localities which are at long distances from main distribution systems.

3.4.3 Use in Automobiles as CNG

Natural gas is already being used in automobiles since long. Similarly, CBM may also be used in automobiles as CNG with equal utility and benefit.

3.4.4 Use in Fertilizer Manufacturing Plants

Fertilizer manufacturing plants are the biggest users of natural gas at large scale industries in Pakistan. Therefore, CBM is equally useful for production and manufacturing of fertilizer in fertilizer plants during their different processes.

3.4.5 Industrial Use

In addition to use of CBM in fertilizer manufacturing plants, it may also be used for other industrial processes either for heating purposes or other processes.

3.4.6 Use in Steel Plants

Steel industry is another large scale user of natural gas in its different processes during the casting and manufacturing of iron and steel. Therefore, it may be used in large and small steel plants to save the natural gas for other domestic and commercial purposes.

3.4.7 Use for Production of Methanol

CBM is containing methane as it is in the natural gas which is used for preparation of many products like reformulated gasoline, methanol and gasoline blends, formaldehyde resins. Therefore, it may be used as a base feedstock in large scale methanol plants.

Therefore, there are so many uses of CBM in domestic, commercial and industrial sectors to boost up industrial and economic activity in the country.

Thus, it is still a confusing situation and it is due to lack of exact chemical and technical data about quantity and quality of CBM which will be explored from different coal fields in the country. Therefore, it is necessary that Geological Survey of Pakistan should carry out an extensive survey of different coal fields in the country about occurrence of CBM with its technical and qualitative data with answers to other questions relating to

CBM. It will not only be useful as a national data but it will attract more national and international investment in the field of CBM exploration and commercial exploitation.

It is also relevant that the administrative problems suitably be solved because there is an apparent dichotomy in constitutional and legal systems about exploitation and use of CBM. CBM is a by-product of coal and based on coal reserves whereas coal and its related matters are the administrative jurisdiction of Provincial Governments while exploration and administration of methane i.e. natural gas, is the administrative jurisdiction of the Federal Government. Therefore, it is the requirement that this issue may be resolved in its true application which is viable in the existing system of exploration and administration of existing legal and constitutional system. In the next chapters, this issue will be examined in more details with possible solutions.

3.5 System Requirements for Supply of CBM in Pipeline Networking

There is no doubt that there is already a national distribution network for natural gas in the country under the legal and constitutional authority of the Federal Government. In ordinary circumstances it is quite a simple question that the CBM also being natural gas i.e. methane, irrespective of its occurrence place in the seams of coal beds of coal fields.

Similarly, there are very simple system requirements for supply of CBM in national distribution pipeline network on commercial basis by connecting exploration sites through pipelines to main distribution systems. However, the main hurdle is the cost, quantity and quality of gas which will be pumped in the main distribution system for domestic, commercial and industrial use in country.

Issue of cost is very important because all the coal fields are at such distant places which require long distance supply lines to reach main distribution system but this simply depends on quantity and quality of gas with its duration of availability. If from a coal field CBM is available on cost effective basis for a long time in big quantities, there will be no problem for its marketing in main distribution system. In such circumstances gas marketing and supply companies will be willing to invest in infrastructure development and

maintenance but in case of short-term supplies no company either exploration or marketing will come forward for huge and expensive network investments because it will not ensure recovery of its investments.

There is also need to address the questions relating to quality of CBM. As it is clear that in very rare case, CBM is found in pure methane form like natural gas with full heating or caloric value. It is ordinarily having heating or caloric value more than 86% according to available data and geological information at international level due to mixing of different other gases like ethane, butane and carbon dioxide effecting its burning and heating quality and creating problems for its marketing through existing main distribution system because distribution and marketing companies will not be interested in such quality gas which will not get good response from consumers in prevailing circumstances. However, after sometime due to increasing shortage of natural gas resources, it will become acceptable to overcome shortage in national supply system. However, in any case, it is not possible to have a parallel distribution network for CBM because it will involve huge cost with low consumer response at least in the prevailing circumstances.

As far as, question of purifying the CBM for removing of its impurities like ethane, butane and carbon dioxide is concerned, it is not cost effective at present. However, if with the passage of time there will be the development of a new technology on cost effective basis to purify CBM to bring it at par with petroleum based natural gas i.e. methane with its accurate caloric or heating value, then there will be no problem to connect the CBM exploration systems with main distribution systems. In the prevailing circumstances, there are so many problems relating to research, discovery, exploration, quantity, quality and marketing of CBM in Pakistan and it will be very difficult to supply and market CBM through existing main distribution systems in the country. Therefore, a lot of homework is required to explore and market the CBM in the national distribution network of gas in Pakistan.

CHAPTER 4

EXISTING LEGAL FRAMEWORK OF MINES IN THE COUNTRY AND CBM

Under the Constitution of the Islamic Republic of Pakistan, 1973, control, administration and management of coal mines is a provincial subject. Even before the enforcement of the Constitution, 1973, it was a provincial subject since long under different constitutional and legal systems in the country and before the creation of the country in 1947.

It is quite interesting to note that in most of the administrative, political and legal systems coal mining is exclusively a local, state or provincial subject and local authorities or state governments are managing different matters relating to coal mines and other mines for different minerals except some mines of highly demanding or sensitive minerals like uranium, etc. Entry 18 of the Part I of the Fourth Schedule to the Constitution of the Islamic Republic of Pakistan is important because it is having a reference to mineral resources but with a qualification for keeping it in the administrative jurisdiction of the Federal Government. Entry 18 of Part I of the Fourth Schedule is reproduced as under :

> ***"18. Nuclear energy, including–***
>
> ***(a) mineral resources necessary for the generation of nuclear energy;***
>
> ***(b) the production of nuclear fuels and the generation and use of nuclear energy; and***
>
> ***(c) ionizing radiations.".***

There is nothing otherwise relating to mineral resources in the Constitution and it is within the administrative purview of the Provincial Governments in Pakistan.

National Minerals Policy

[1]The Government of Pakistan has announced a National Minerals Policy (NMP) in the year 1995 implementation on which could only be kick started during the year 2002 when the Federal Government issued specific directives and provided funds to create effective institutional arrangement pursuant to the provisions of the NMP. Though the NMP has not been enacted as law it has provided common policy and institutional framework, which is backed by the state commitment and authority and consent of all the provinces. Consequently it has assumed the status of law. NMP is a comprehensive policy document having various objectives such as :

(i) expansion of employment opportunities,
(ii) enhancement of skills,
(iii) sustained development of mineral bearing area,
(iv) expanded business opportunities for local industries,
(v) increased revenue flow to the provincial and Federal Government,
(vi) technology transfer,
(vii) regional infrastructure development, and
(viii) improved database of Pakistan's mineral resources.

In this way, it is first time in the history of the country that the Government has announced a comprehensive policy for development of mineral resources in the country. It is a step towards strengthening of research and development in the mineral resources.

[2]The NMP also covers all of the key aspects for the development of the mining sector, namely :

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[1] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 194.

[2] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 194.

(i) constitutional position of minerals,

(ii) establishment of a regulatory framework,

(iii) sector institutional framework,

(iv) licensing types and conditions,

(v) environmental protection,

(vi) fiscal regime,

(vii) small scale mining, and

(viii) social development and a number of miscellaneous matters.

The document not only articulates mining policy aspects but also covers a number of legal and regulatory aspects.

The National Minerals Policy has also provided a formal procedure for its execution for effective results of the Policy as commented by the authors of Energy Encyclopaedia[1] as under :

> **"538. To facilitate the implementation of the NMP and investment in the mineral sector, at federal level, the federal government has established the Mineral Investment Facilitation Board (MIFB), chaired by the Prime Minister and in the provinces and special areas, a Mineral Investment Facilitation Authority (MIFA), chaired by Chief Minister has been established in each of the Province. Furthermore, in each of the provinces separate departments of mines and minerals, headed by the Director General under the overall supervision of a provincial secretary, have been established with the mandate to grant mining licences and leases, collect fees and royalties and monitor activities in the mineral sector.**
>
> **539. The provincial departments of mines and minerals are organized in three divisions for (i) licensing; (ii) exploration promotion; and (iii) inspectorates of mines.**
>
> **540. The NMP harmonizes policy and regulations between the federal and provincial governments and the provincial rules, the conditions and procedures for private investment in and development of mineral resources in Pakistan, prior to which high level of uncertainty and conflicting/overlapping roles of the center and provinces existed which negatively affected the development of mineral industry.**
>
> **541. The provincial development corporations such as; (i) Punjab Mineral Development Corporation; (ii) Balochistan Development Authority; (iii) Sarhad Development Authority; (iv) Azad Kashmir Mineral and Industrial**

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[1] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 194.

Development Corporation, etc., have been merged with the respective provincial departments of mineral development created pursuant to paragraph 3.3 of the NMP.".

Provincial Governments has a very comprehensive legal system of administration inherited by the British Government but a very weak infrastructure for the discovery, excavation, exploration and management of different kinds of mines in the country. The main legal framework relating to control, administration and regulation of mines is provided in the following laws and rules :

(1) the Mines Act, 1923;
(2) the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948);
(3) the Punjab Minor Mineral (Cancellation of Leases) Act, 1977 (VI of 1977);
(4) the Land Acquisition (Mines) Act, 1885 (I of 1885);
(5) the Minerals (Acquisition and Transfer) Order, 1961 (P.O. No. 8 of 1961);
(6) the Balochistan Mineral Rules, 2002;
(7) the Consolidated Mines Rules, 1952;
(8) the Mining Board Rules, 1951;
(9) the Punjab Coal Mines Rescue Rules, 1986;
(10) the Punjab Mining Concession Rules, 2002;
(11) the Sindh Mining Concession Rules, 2002;
(12) the Northern Areas Mining Concession Rules, 2003; and
(13) S.R.O. relating to the Exemption from the Provisions of Mines Act, 1923.

The above laws and rules are very comprehensive as far as control, management and regulation of mines in Provinces is concerned. Brief overview of the above laws and rules is given below.

4.1 Examination of Different Laws Relating to Mines

Brief review and examination of different important laws mentioned above highlighting their important aspects is as under :

4.1.1 The Mines Act, 1923

The Mines Act, 1923 (IV of 1923), has been enacted on the 23rd February, 1923 but practically enforced with effect from the 1st July, 1924, before the creation of Pakistan and India. It is a very comprehensive Act which is still surviving with different amendments made in it from time to time. In clause (f) of section 3 of the Act a "mine" is defined as any excavation where any operation for the purpose of searching for or obtaining minerals has been or is being carried on, and includes all works, machinery, tramways and sidings, whether above or below ground, in or adjacent to or belonging to a mine provided that it shall not include any part of such premises on which a manufacturing process is being carried on unless such process is a process for coke making or the dressing of minerals.

The Mines Act, 1923 (IV of 1923), provides a very comprehensive management and regulation system by providing different officers and officials to suitably control, manage and inspect the mines, mine workers, ownership of mines, Chief Inspector of Mines, qualified medical practitioner and serious bodily injuries which may occur during the process of mining.

Act also provides for establishment of Mining Boards and Committees. Every Mining Board constituted under section 12 has been empowered as a Civil Court under the Code of Civil Procedure, 1908 (V of 1908), for the purpose of enforcing the attendance of witness and compelling the production of documents and material objects; and every person required by any such Mining Board or Committee to furnish information before it shall be deemed to be legally bound to do so with the meaning of section 176 of the Pakistan Penal Code (XLV of 1860).

4.1.2 The Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948)

This Act is making provisions for regulation of mines and oil-fields and mineral development under the appropriate Governments. Section 2 of the Act authorizes the appropriate Government to make rules to provide for all or any of the following matters, namely:-

(1) the manner in which, and the authority to whom, application for the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession shall be made, and the prescribing of the fees to be paid on such application;

(2) the conditions in accordance with which the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession may be made, and the prescribing of forms for the execution or renewal of such licence, lease, and concession;

(3) the circumstances under which renewal of a licence, lease or concession as aforesaid may be refused, or any such licence, lease or concession whether granted or renewed may be revoked;

(4) the determination of the rates at which and the conditions subject to which royalties, rents and taxes shall be paid by licensees, lessees and grantees of mining concessions;

(5) the refinement of ores and mineral oils;

(6) the control of production, storage and distribution of minerals and mineral oils;

(7) the fixation of the prices at which minerals and mineral oils may be bought or sold; and

(8) any matter ancillary or incidental to the matters set out in the foregoing clauses of the section.

Under section 3A of the Act, the President may enter into an agreement with any company, whether incorporated in Pakistan or outside Pakistan, for the grant of a licence or lease to explore, prospect and mine petroleum on the basis of a Production Sharing Agreement and on such terms and conditions may be agreed upon between the Federal Government and the company.

Similarly, section 3B of the Act states that every company, whether incorporated in Pakistan or outside Pakistan, to whom a licence or a lease to explore, prospect and mine petroleum is granted under the Act, not being a company such as is referred to in section 3A, shall be entitled to the concessions specified in the Schedule in addition to any concessions for the time being admissible to it under any other law or the rules made under this Act.

Schedule of the Act is very comprehensive which is providing different things about:

(a) rate of royalty and income tax;

(b) the limit of the sum of payment to the Federal Government and taxes on income at the time of grant;

(c) income from pipeline operations, the sale of LPG, CNG and from refined products;

(d) details of expenditure of the licensee or lessee before the commencement of commercial production and their surrender on the completion of the dry hole;

(e) net profits, the amount charged in annual financial accounts on account of additional allowance and rates of depreciation;

(f) the value of royalty for the purposes of royalty and income tax;

(g) income derived by the licensee or lessee from the use of any surplus capacity of its pipeline by any other licensee or lessee shall be assessed on the same basis as its income from petroleum produced by it form its concession area;

(h) exporting of share of petroleum by outside companies as agreed;

(i) retaining proceeds of the share of petroleum exported by a licensee or lessee for outside companies;

(j) concession available in respect of import duties, licence or authorization fees shall be specified;

(k) details of items to be supplied to a licensee or lessee;

(l) concessions about imported goods relating to customs-duty to foreigners;

(m) details about exemptions of income tax to foreigners working with oil exploration companies;

(n) maintenance of data relating different things;

(o) matters relating to Government Holding Company; and

(p) facilities relating to transportation of necessary machinery and goods.

4.1.3 The Land Acquisition (Mines) Act, 1885 (I of 1885)

This Act is relating to acquisition of lands for the purposes of mining on payment of compensation to the persons having interest in such lands under the Land Acquisition Act,

1894 (I of 1894). However, under the Mines Act, 1923, the Regulations of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948, different constitutional provisions, now mines belongs to state and state is allowing rights and concessions for their exploration.

4.1.4 The Balochistan Mineral Rules, 2002

These Rules have been promulgated by the Government of Balochistan to regulate the procedure and different aspects relating to mining made under section 2 of the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948).

4.1.5 The Consolidated Mines Rules, 1952

These Rules have been made under section 30 of the Mines Act, 1923 (VI of 1923), which are providing about different aspect relating sanitation, health, education, training, canteens, registration of workers, safety of surface, abandonment of mines, and inquiries in the case of accidents.

4.1.6 The Punjab Coal Mines Rescue Rules, 1986

The Punjab Coal Mines Rescue Rules, 1986, are made under section 30A of the Mines Act, 1923 (VI of 1923). These Rules are very comprehensive and provide for different measures about rescue and recovery of persons employed in different kinds of mines and particularly the coal mines. The Superintendent of a Rescue Station is responsible:

(a) to conduct rescue work and take all practical steps to minimize danger in mines after any explosion or outbreak of fire or dangerous irruption of naxious or inflammable gas or fall of roof sides and subsidence;

(b) to provide training facilities at the Rescue Stations or at the mine to persons nominated by the mine owner to form Rescue Corps at their respective mines; and

(c) to fulfil any other obligations imposed upon them by the rules.

These Rules also provide for medical examination of workers, different types of apparatus used by workers and duties and functions of different officers of the functionaries working under the Rules.

4.1.7 The Punjab Mining Concession Rules, 2002

The Punjab Mining Concession Rules, 2002, are made under section 2 of the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948).

These Rules are very comprehensive and dealing with drilling, exploration, good reconnaissance practices, large scale mining undertaking, licensing authority, minor minerals, mine, mineral, mineral operation, mining area, mining operation, ordinary sand, pit-mouth, reconnaissance operation, retention area, small scale mining undertaking and many other aspects relating to mines in the Province of Punjab.

4.1.8 The Sindh Mining Concession Rules, 2002

The Sindh Mining Concession Rules, 2002, are enforced on the 18th March, 2002, under section 2 of the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948); and are enforced in the Province of Sindh. These Rules are also covering different aspects which are covered under the similar rules in Punjab.

4.1.9 The Northern Areas Mining Concession Rules, 2003

These rules are made and enforced in the Northern Areas for regulating, controlling and managing different issues relating to mining in Northern Areas. These are also containing similar provisions as the Punjab Rules.

4.2 Regulatory Framework for Mines and Mining of Coal

To enforce the above said laws, rules and regulations, the following regulatory and institutional authorities and organizations are working at Federal and Provincial levels:

4.2.1 Ministry of Petroleum and Natural Resources

Ministry of Petroleum and Natural Resources is part and parcel of the Federal Government and working under the Rules of Business, 1973. Ministry is consisting on different Directorates, Authorities and other organizational set ups for performance of different functions of the Ministry under the Rules of Business, 1973. However, the following are the functions of the Ministry in relation to minerals :

(a) all matters relating to oil, gas and mineral at the national and international levels including :–

  (i) policy, legislation, planning regarding exploration, development and production;

  (ii) import, export, refining, distribution, marketing, transportation and pricing of all kinds of petroleum and petroleum products;

  (iii) matters bearing on international aspects;

  (iv) Federal agencies and institutions for promotion of special studies and development programmes;

(b) geological surveys;

(c) administration of Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948, and rules made thereunder, in so far as the same relate to exploration and production of petroleum, transmission, distribution of natural gas and liquefied petroleum gas, refining and marketing of oil;

(d) petroleum concessions agreements for land, off-shore and deep seas areas;

(e) import of machinery, equipment, etc., for exploration and development of oil and natural gas;

(f) matters relating to Federal investments and undertakings wholly or partly owned by the Government in the field of oil, gas and minerals, excepting those assigned to the Industries and Production Division;

(g) administration of the Natural Gas (Development Surcharges) Ordinance, 1967, and the rules made thereunder; and

(h) coordination of energy policy including measures for conservation of energy and energy statistics.

4.2.2 Director General (Minerals)

Director General (Minerals), Ministry of Petroleum and Natural Resources, is responsible to all development projects of the Geological Survey of Pakistan, Pakistan Mineral Development Corporation, Lakhra Coal Development Company. He is also responsible for coordination between Provinces and Federal Government. Main functions and responsibilities of the Director General (Minerals) are as under[1] :

(a) control and statistics of exploration and importation of minerals;

(b) statistics of minerals production;

(c) supervision of the Geological Survey of Pakistan;

(d) monitoring of the mineral corporations and the mining companies owned by the state (Federal Government) and corporations implementing projects with Government of Pakistan's investments;

(e) frame, update, review of the MNP and its implementation by concerned Federal and provincial authority;

(f) provide sport to provinces to improve their regulatory laws, institutions for making them internationally competitive;

(g) facilitate interaction of the foreign private mining investors and also initiate and process mineral sector proposals for inclusion in the programmes of international donor agencies;

(h) deal with all operational issues (except personal administration and general training circulated by EAD) raised by the Federal agencies requiring

[1] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 195-6.

approvals of Ministry of Petroleum and Natural Resources or other ministries;

(i) prepare papers on various issues relating to mineral development for consideration at international and other meetings; and

(j) organize and support seminars on development of mineral resources.

4.2.3 Pakistan Mineral Development Corporation (Private) Limited

[1]On the 8th June, 1974, the Pakistan Mineral Development Corporation was incorporated as a private limited company under the Companies Ordinance, 1984. The key objectives of the company concerning coal including :

(i) acquisition of mining rights;
(ii) exploration, development and production of minerals;
(iii) utilization, transportation and marketing of minerals;
(iv) purchasing, leasing, undertaking the coal mining business of any company; and
(v) to undertake all matters ancillary to the exploration, exploitation, development, production and marketing of coal.

Pakistan Mineral Development Corporation is a public corporation with hundred percent shares owned by the Government and established in 1974 for extraction of coal from different mines.

4.2.4 Provincial Mining Departments

There are high level management and control organizations at provincial level to control the mining operations in the provinces. In every Province, there is a Mineral Investment Facilitation Authority headed by the Provincial Chief Minister of the Province, Prime Minister in case of the Azad Jammu and Kashmir, Federal Minister incharge in case of Northern Areas, Chairperson of the Mineral Investment Facilitation Authority. Secretary,

[1] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 194.

Mines and Mineral Department of each Province, and Director General (Minerals) at each Province. However, the following are the main functions of the Provincial Departments of mineral development areas[1]:

(a) development of Mineral Resources;
(b) consideration of applications and grant of licences and leases;
(c) regulating and monitoring mining operations and activities in the mineral sector, including collection of royalties;
(d) negotiating mineral agreements and consulting the Federal Government when considered necessary by the MIFA;
(e) facilitating access to private or public lands and reserve forest areas for the purpose of mineral exploitation or development of mineral resources;
(f) maintenance of up-to-date master plans showing positions of all exploration licences and leases granted, renewals, assignments and surrenders of mineral titles, relinquishment of acreage, etc., and make this information public through regular publication of complete details in the official gazette; and
(g) inspectorate of miens and miens labour welfare organization.

4.2.5 Provincial Directorates General (Minerals)

There are Directorate Generals of Minerals in all four provinces for the promotion and development of mines with other variety of functions relating to mining.

4.2.6 Sindh Coal Authority

Sindh Coal Authority has been established in 1994 headquartered at Karachi with the following functions[2]:

(a) accelerate the pace of activities relating to coal development and shall be specifically for responsible for planning, promoting, organizing, undertaking

[1] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 198.
[2] International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 199.

appropriate projects in this behalf and implementing programmes for exploration, development, exploitation, mining, processing and utilization of coal;

(b) prepare and execute schemes under this act and take all necessary steps, which are required;

(c) advise the Government in all matters connected with conservation, development, working and utilization of geology to evaluate coal deposits;

(d) publish results of research and development activities of the provinces, from time to time, for general information; and

(e) promote joint ventures especially with foreign investors for development of coal recourses of the province.

4.3 Possible Changes in Legal and Regulatory Framework of Mines for CBM Exploration and Supply

In the light of above said details and different legal, regulatory and institutional frameworks, there are two different systems for one substance and its by-product i.e. coal mines and coal mine methane (Coal-Bed Methane – CBM). According to the Constitution of the Islamic Republic of Pakistan, 1973, natural gas and Coal-Bed Methane is also the natural gas, is falling in administrative jurisdiction of the Federal Government whereas the mines and control, administration, regulation and mining functions are falling in the jurisdiction of Provincial Governments.

Although there is no any complication or conflict but due to some managerial and regulatory reasons it appears difficult to manage two aspects of one mineral by two different administrative authorities particularly when those are falling in different governmental jurisdictions i.e. Provincial and Federal Governments.

In this connection it is pointed out that Federal Government and its organizations are possessing specialization in discovery, exploration, management and regulation of natural gas in its different forms whereas the Provincial Governments are not having any such expertise. In addition to this, the capacity and potential to discover, explore, manage and regulate different matters relating to foreign investment and policy-making about natural gas is the jurisdiction of Federal Government under the Constitution. Therefore, it will be create

a lot of procedural complication if the issues relating to CBM are entrusted to Provincial Governments by the Federal Government.

Similarly, it is also considered troublesome for the Provincial Governments and different Authorities working under the Provincial Governments to allow working to federally authorized agencies/companies whereas at the same time and same places provincial agencies/companies are working for exploration and excavation of coal. Certainly mining process will affect the discovery and exploration process of CBM in the same coal fields.

Very interestingly, one product in the same is owned by the Provincial Governments and other product or by-product is belonging to Federal Government.

Therefore, there is no need of change in the existing legal and regulatory framework for ownership and excavation of mines because already in the case of natural gas, the different organizations and companies are working in provincial territories/jurisdictions whose affairs are being controlled and managed by the Federal Government without any problems and complications. Thus, regulation of CBM is possible through Federal administrative mechanisms as it is being done in the case of natural gas and petroleum discovery, exploration and marketing.

4.4 Systematic Changes for CBM Supply and Marketing

In this connection it is pointed out that once questions relating to ownership of CBM will be settled, all other aspects relating to its supply and marketing will be easy to settle because there will be no need of large-scale systematic changes for supply, connecting it with national distribution networks and marketing of CBM in the country as there is no doubt that there is already a national distribution network for natural gas in the country under the legal and constitutional authority of the Federal Government. Similarly, there are very simple system requirements for supply of CBM in national distribution pipeline network on commercial basis by connecting exploration sites through pipelines to main distribution systems. However, the main hurdle is the cost, quantity and quality of gas which

will be pumped in the main distribution system for domestic, commercial and industrial use in country.

Issue of cost is very important because all the coal fields are at such distant places which require long distance supply lines to reach main distribution system but this simply depends on quantity and quality of gas with its duration of availability. If from a coal field CBM is available on cost effective basis for a long time in big quantities, there will be no problem for its marketing in main distribution system. In such circumstances gas marketing and supply companies will be willing to invest in infrastructure development and maintenance but in case of short-term supplies no company either exploration or marketing will come forward for huge and expensive network investments because it will not ensure recovery of its investments.

There is also need to address the questions relating to quality of CBM. As it is clear that in very rare case, CBM is found in pure methane form like natural gas with full heating or caloric value. It is ordinarily having heating or caloric value more than 86% according available data and geological information at international level due to mixing of different other gases like ethane, butane and carbon dioxide effecting it burning and heating quality and creating problems for its marketing through existing main distribution system because distribution and marketing companies will not be interested in such quality gas which will not get good response from consumers in prevailing circumstances. However, after sometime due to increasing shortage of natural gas resources, it will become acceptable to overcome shortage in national supply system. However, in any case, it is not possible to have a parallel distribution network for CBM because it will involve huge cost with low consumer response at least in the prevailing circumstances.

As far as, question of purifying the CBM for removing of its impurities like ethane, butane and carbon dioxide is concerned, it is not cost effective at present. However, if with the passage of time there will be the development of a new technology on cost effective basis to purify CBM to bring it at par with petroleum based natural gas i.e. methane with its accurate caloric or heating value, then there will be no problem to connect the CBM exploration systems with main distribution systems. In the prevailing circumstances, there are so many problems relating research, discovery, exploration, quantity, quality and

marketing of CBM in Pakistan and it will be very difficult to supply and market CBM through existing main distribution systems in the country. Therefore, a lot of homework is required to explore and market the CBM in the national distribution network of gas in Pakistan.

It is also necessary to take appropriate steps to make required changes in the existing laws, rules and regulations for a compatible system for CBM. So that there should no problems to companies exploring the CBM to sell it to main distribution companies supplying CBM connecting their pipelines networks.

CHAPTER 5

NATURAL GAS LEGAL AND REGULATORY FRAMEWORK AND CBM

Coal-Bed Methane is the natural gas found in the seams of coal beds in coal fields. There is a well-tested and very old regulatory and institutional system in place for exploitation of coal from mines which is being looked after and enforced by Provincial Governments. Similarly, there is a very old system regarding discovery, exploration, transportation and distribution of natural gas in the country which is being implemented by Federal Government under a comprehensive regulatory system devised under different laws with settlement of procedural aspects under different rules and regulations made under different legal provisions. Hereunder is the brief information about the existing system for exploration and distribution of natural gas with a huge infrastructure which is categorizes the largest pipeline distribution system for supply and marking of natural gas after United States of America.

Similarly, it is also reviewed that how the Coal-Bed Methane, being a natural gas, may be treated under the existing system and may be distributed through existing infrastructural facilities. Regulatory system under different laws and the Constitution is also studied to devise a suitable and legally viable system under different laws and the Constitution of the Islamic Republic of Pakistan. Howeve r, for any administrative and regulatory system, Coal-Bed Methane (CBM) is the natural gas by its chemical composition, formula, nature and all internationally accepted definitions of the Coal-Bed Methane gas from its all aspects.

5.1 Exploration of Natural Gas and Infrastructural Requirements

Upto the 30th June, 2005[1], there were 620 exploratory wells drilled in different parts of the country but there are only 114 discoveries. Recoverable gas reserves are estimated around 1,022.99 mtoe whereas total gas production during the same period is about 3,685 MMCFD. However, all these exploratory activities are not enough as these are able to meet the target requirements because natural gas consumption is increasing by more 10% per year. Sector-wise increase in gas consumption during the period July-March, 2006-07[2], is as under :

S. No.	Sector	Percentage (%)
1.	Transport	49.4 (+)
2.	Industry	29.4 (+)
3.	Commercial	27.3 (+)
4.	Cement	10 (–)
5.	Fertilizer	2.7 (–)
6.	Power	16.9 (–)

As on the 1st January, 2007, the balance recoverable natural gas reserves have been estimated at 31.81 trillion cubic feet. The average production of natural gas during the July-March, 2007-07, was 3,876.38 million cubic feet per day as against 3,825.51 mmcfd during the corresponding period of last year showing an increase of 1.33%. Natural gas is being used in industry to prepare consumer items, to produce cement and to generate electricity as a major use.

In the form of CNG, it is used in transport sector and most importantly to manufacture fertilizer to boost the agricultural sector.

[1] Data used is taken from the International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 97.
[2] Data is taken from the Pakistan Economic Survey 2006-07, page 228, Ministry of Finance, Islamabad.

5.1.1 Exploration and Production of Natural Gas

Many private and public companies are currently engaged in oil and gas exploration and production activities including BHP, OPI, PEL, MOL and OGDCL. The company-wise position reveals that a sizable increase in the production of natural gas was contributed by different companies as under[1] :

S. No.	Name of Company	Production in mmcfd July-March, 2006-07	Percentage (%) Change
1.	BHP	310.82	18%
2.	ENI	389.14	5.5%
3.	OPI	103.65	25.11%
4.	PEL	31.75	49%
5.	MOL	62.85	32.4%
6.	MGCL	473.39	1.36%
7.	OGDCL	834.07	–1.78
8.	OMV	539.73	–0.90
9.	POL	43.57	–21.44
10.	PPL	828.61	–2.11
11.	TULLOW	2.48	–49.18
12.	BP Pakistan	299.26	–5.01
13.	Petronas	27.06	–15.42
	Total :	**3,876.38**	

During the period July-March, 2006-07, altogether 46 wells have been drilled, including 19 wells in the public sector and 27 in the private sector as against 41 in the same period during the last year registering an increase of 12.2%. Total investment of US$700.88 million has so far been made in the current financial year in the upstream petroleum sector. Details of drilling activities of the public and private sector companies engaged in the exploration and development of wells with achievement during July-March, 2006-07 are as under :

[1] Data is taken from the Pakistan Economic Survey 2006-07, page 232.

S. No.	Nature of Wells	Number of wells during 2006-07	Percentage (%) Change
Public Sector :			
	OGDCL		
	Exploratory	14	0.00%
	Appraisal/Dev.	5	25.0
Private Sector :			
	Exploratory	13	160.00
	Appraisal/Dev.	14	–22.22

OGDCL is the first Pakistani exploration and production company to list its shares on the London Stock Exchange through the issuance of GDR. The successful listing was a result of a well developed business and strategic plan; a debt-free and robust balance sheet and healthy cash reserves.

Company's average oil and gas production during the period July-March, 2006-07, remained at 34,839 barrels per day and 834 mmcfd per day respectively. This reflects an increase of 11% in oil and 7.1% in natural gas as against the same period last year. The LPG and sulphur production reached 310 metric tonnes per day and 65 metric tone per day showing an increase of 7.6% in LPG production and 16.0% in sulphur as against same period last year. OGDCL has discovered four new gas and oil producing fields during July-March, 2006-07.

Still there is need for more better and advanced infrastructural development for the purposes of exploration, development and supply for better prospects of discovery of gas from different wells drilled for the purpose. It is only possible if more sophisticated equipment and instruments will be used for reconniance and survey purposes so that there should drilling with highest possibility of discovery of gas.

5.2 Supply and Marketing Network

Natural gas supply, distribution and marketing in Pakistan is in public sector which is being done by two companies with large pipelines network through out the country. These two public sector companies are involved in the supply, distribution and marketing of natural gas in the country by dividing the entire country in two distribution areas. Sui

Northern Gas Pipelines Limited (SNGPL) and Sui Southern Gas Company Limited (SSGC) are the distribution companies having very large pipelines network which is the third largest pipelines network in the world.

5.2.1 Sui Northern Gas Pipelines Limited (SNGPL) :

Suit Northern Gas Pipelines Limited is supply gas to 897 towns and villages of Punjab and NWFP. During the period July-March, 2006-07, the company connected 469 industrial, 2503 commercial and 163704 domestic consumers bringing the total number of consumers to 2839237. These include 4242 industrial, 46422 commercial and 2788573 domestic consumers. During July-March, 2006-07, the company carried out development work for extension of gas network to the tune of Rs. 1077 million on transmission project, Rs. 3906 million on distribution projects and Rs. 252 million on other projects under Khushal Pakistan programme. During next fiscal year 2007-08, the Company has plans to invest Rs. 11376 million on transmission and distribution projects.

5.2.2 Sui Southern Gas Company Limited (SSGCL) :

Sui Southern Gas Company Limited, by end March, 2007, had expanded its network to 1351 towns and villages of Sindh and Balochistan. During the period July-March, 2006-07, the company has provided new connections to 221 Industrial, 1232 commercial and 67373 domestic consumers bringing the total number of consumers to 1929237. These consumers also include 3199 industrial, 21170 commercial and 1904868 domestic consumers. During July-March, 2006-07, the company carried out development work for extension of gas net work to the tune of Rs. 4433 million on transmission project, Rs. 3137 million on distribution projects and Rs. 680 million on other projects under Khushal Pakistan programme with the collaboration of district governments. During the next fiscal year the company plans to invest Rs. 10384 million on transmission and distribution projects.

5.3 Capacity of Existing Network

Distribution of natural gas is by using two different means like pipelines and cylinders where there is no possibility of pipeline distribution network particularly in mountainous areas where cost of gas distribution lines is excessive or the terrains are difficult or long distances are involved making the supply through pipelines difficult or impossible. However, pipelines[1] are treated as the primary mean of gas distribution in the country. The pipeline network is managed by two public limited gas companies namely Sui Southern Gas Company Limited and the Sui Northern Gas Pipelines Limited. These companies are not only supplying gas to the power projects but also selling the gas to the industrial and domestic consumers throughout the country.

Pakistan has the third largest gas pipelines network for distribution of gas in the world.

The Sui Northern Gas Pipelines Limited transmission system extends from Sui in Balochistan to Peshawar in the NWFP comprising over 6121 kilometres of transmission system including main lines and loop lines. The distribution activities covering 142 main towns along with adjoining villages in Punjab and NWFP are organized through eight regional offices. The distribution system consists of 31788 kilometres of pipeline and 42192 kilometres of service lines as on June, 2005.

Similarly, the Sui Southern Gas Company Limited's transmission pipelines are extending from Sui in Balochistan to Karachi in Sindh comprising over 2780 kilometres of high pressure pipelines ranging from 12 to 24 inch diameter. The distribution activities covering over 650 towns in the Sindh and Balochistan are organized through its regional offices. An average of about 234553 mmcfd gas was sold during the year 2001-2002 to over 1.7 million industrial, commercial and domestic consumers in these regions through a distribution network of over 22890 kilometres. The company also owns and operates the only gas meter manufacturing plant in the country under an agreement with Schlumberger Industries-France, having an annual production capacity of over 300,000 metres.

[1] Based on information taken from the International Encyclopaedia of Law, Part relating to Pakistan, by Muhammad Arif and Dr. Sohaib Qadar, 2006, page 165.

The existing pipelines in the country is although the third largest in the world but still demand for gas is increasing day by day requiring expansion in pipelines network. At present, there is a large part of the country consisting on prospective industrial, commercial and domestic consumers who are waiting for natural gas supply since long. However, due to financial constraints and lack of availability of gas for distribution to those prospective consumers.

5.4 Use of Existing Pipelines Network for CBM

CBM is a prospective source of natural gas and in case of its availability at large scale it may be connected with main pipeline distribution system without any problem because CBM in better quality is equally useful for heating purposes for industrial, commercial and domestic levels.

However, there is another option in case, at the moment, it is not possible to connect its well-head with national pipeline distribution system that it may be supplied to nearest localities situated around the coal fields with small-scale pipeline networks for domestic, commercial and industrial purposes. It will improve environment, reduce pollution and help save green areas by using it as a fuel for domestic purposes by saving wood and other natural sources from extinction.

Secondly, hydro-carbons, chemicals and other industries may be established nearby the sources of CBM exploration. There are so many other fields where CBM may be used without any trouble if its heating or caloric value is less due to different mixed gaseous compounds.

5.5 Legal and Regulatory Regime for Natural Gas

There is a very comprehensive legal and regulatory regime for natural gas in the country. The following are the basic laws, rules and regulations, etc., for regulation, control and management of natural gas :

(a) the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948;

(b) the Oil and Gas Regulatory Authority Ordinance, 2002;

(c) the Natural Gas (Price for Supplies by Producers) Rules, 1976;

(d) the Compressed Natural Gas (CNG) (Production and Marketing) Rules, 1992;

(e) the Liquefied Petroleum Gas (Production and Distribution) Rules, 2001;

(f) the Licensing Rules for Transmission, Distribution and Supply of Natural Gas, 2001;

(g) the Natural Gas Tariff Rules, 2002;

(h) the Complaint Resolution Procedure (for Natural Gas, LPG and CNG) Regulations, 2003;

(i) the OGRA Transmission Standards;

(j) the OGRA Distribution Standards;

(k) the OGRA Performance Standards;

(l) the Oil and Gas (Safety in Drilling and Production) Regulations, 1974;

(m) DGPC Guidelines for Health, Safety Environmental Quality Management, 1996; and

(n) Sectoral Guidelines for Environmental Reports – Oil and Gas Exploration and Production, 1997.

Important features of a few important laws and rules are given below :

5.5.1 The Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948

The Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (Act XXIV of 1948), is an important enactment and deals with granting petroleum, gas and other mining rights. This Act is making provisions for regulation of mines and oil-fields and mineral development under the appropriate Governments. Section 2 of the Act authorizes the appropriate Government to make rules to provide for all or any of the following matters, namely:-

(1) the manner in which, and the authority to whom, application for the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession shall be made, and the prescribing of the fees to be paid on such application;

(2) the conditions in accordance with which the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession may be made, and the prescribing of forms for the execution or renewal of such licence, lease, and concession;

(3) the circumstances under which renewal of a licence, lease or concession as aforesaid may be refused, or any such licence, lease or concession whether granted or renewed may be revoked;

(4) the determination of the rates at which and the conditions subject to which royalties, rents and taxes shall be paid by licensees, lessees and grantees of mining concessions;

(5) the refinement of ores and mineral oils;

(6) the control of production, storage and distribution of minerals and mineral oils;

(7) the fixation of the prices at which minerals and mineral oils may be bought or sold; and

(8) any matter ancillary or incidental to the matters set out in the foregoing clauses of the section.

Under section 3A of the Act, the President may enter into an agreement with any company, whether incorporated in Pakistan or outside Pakistan, for the grant of a licence or lease to explore, prospect and mine petroleum on the basis of a Production Sharing Agreement and on such terms and conditions may be agreed upon between the Federal Government and the company. Similarly, section 3B of the Act states that every company, whether incorporated in Pakistan or outside Pakistan, to whom a licence or a lease to explore, prospect and mine petroleum is granted under the Act, not being a company such as is referred to in section 3A, shall be entitled to the concessions specified in the Schedule in addition to any concessions for the time being admissible to it under any other law or the rules made under this Act.

Schedule of the Act is very comprehensive which is providing different things about:

(a) rate of royalty and income tax;

(b) the limit of the sum of payment to the Federal Government and taxes on income at the time of grant;

(c) income from pipeline operations, the sale of LPG, CNG and from refined products;

(d) details of expenditure of the licensee or lessee before the commencement of commercial production and their surrender on the completion of the dry hole;

(e) net profits, the amount charged in annual financial accounts on account of additional allowance and rates of depreciation;

(f) the value of royalty for the purposes of royalty and income tax;

(g) income derived by the licensee or lessee from the use of any surplus capacity of its pipeline by any other licensee or lessee shall be assessed on the same basis as its income from petroleum produced by it form its concession area;

(h) exporting of share of petroleum by outside companies as agreed;

(i) retaining proceeds of the share of petroleum exported by a licensee or lessee for outside companies;

(j) concession available in respect of import duties, licence or authorization fees shall be specified;

(k) details of items to be supplied to a licensee or lessee;

(l) concessions about imported goods relating to customs-duty to foreigners;

(m) details about exemptions of income tax to foreigners working with oil exploration companies;

(n) maintenance of data relating different things;

(o) matters relating to Government Holding Company; and

(p) facilities relating to transportation of necessary machinery and goods.

On the 28th February, 2007, the Ministry of Petroleum and Natural Resources, Government of Pakistan issued a Notification No. S. R. O. 197(I)/2007, which was published in the Gazette of Pakistan on the 5th March, 2007, entrusting to the Government of Sindh, the functions relating to exploration and production of Coal Bed Methane (CBM). Similar Notifications are issued entrusting the functions relating to exploration and

production of Coal Bed Methane to the Governments of the Punjab, North-Western Frontier Province and Balochistan. All these Notifications are issued by the Federal Government in exercise of powers conferred by clause (1) of Article 146 of the Constitution of the Islamic Republic of Pakistan and in pursuance of the Regulation of Mines and Oilfields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948). However, still the questions relating to its distribution and other related matters require a lot of consideration as the distribution systems are being controlled by the Federal Government through different Gas Pipelines Companies.

5.5.2 The Oil and Gas Regulatory Authority Ordinance, 2002

The Oil and Gas Regulatory Authority Ordinance, 2002 (Ordinance XVII of 2002), was made and promulgated by the President of the Islamic Republic of Pakistan on the 28th March, 2002, to foster competition, increase private investment and ownership in the midstream and downstream petroleum industry, protect the public interest while respecting individual rights and provide effective and efficient regulations for crude oil, natural gas, LPG, LNG, CNG, and other matters relating to petroleum in the country. Under section 3, an Oil and Gas Regulatory Authority has been established to regulate and administer the following matters which are given in section 6 of the Ordinance :

(a) in the manner prescribed in the rules, grant, issue, and renew licences, modify, amend, extend, suspend, review, cancel and reissue, revoke or terminate any licence for the undertaking of any regulated activity and to prescribe requirements to be satisfied by application for the grant of licence;

(b) in consultation with licensees, specify, performance and service standards and other conditions for undertaking any regulated activity;

(c) prescribe a uniform form of accounts and accounting practices to be complied with by licensees;

(d) administer, enforce and certify standards and other conditions for undertaking any regulated activity specified in clauses (b) and (e);

(e) in consultation with licensees specify and review standards for the equipment and materials to be used in undertaking any regulated activity;

(f) promote and ensure the observance of efficient practices, where applicable, in the transmission, distribution, processing, refining, marketing, storage of petroleum and transportation of petroleum by pipelines;

(g) promote effective competition and efficiency in the activities within its jurisdiction of the Authority;

(h) monitor and enforce compliance by licensees with the conditions of licences;

(i) resolve complaints and other claims against licensees for contravention of the provisions of this Ordinance, rules or regulations;

(j) ensure the provision of open access, common carrier and common operator as may be deemed necessary or expedient by the Authority in the public interest based on an application made by an interested party to the Authority;

(k) resolve disputes between licensees, between licensees and any other person regarding a regulated activity;

(l) provide for the submission, filing, recording and timely and useful dissemination of information regarding the regulated activities;

(m) make rules and regulations;

(n) safeguard the public interest, including the national security interest, of Pakistan in relation to regulated activities in accordance with the Ordinance, rules and regulations;

(o) prescribe fines for contravention of the provisions of the Ordinance, rules, regulations and terms and conditions of a licence or a decision of the Authority;

(p) protect the interests of all stakeholders including the consumers and the licensees in accordance with the provisions of the Ordinance and the rules;

(q) administer or establish prices, for those categories of petroleum for which the Federal Government establishes prices and may delegate the function to the Authority from time to time;

(r) prescribe, review, approve and regulate tariffs for regulated activities pertaining to natural gas and operations of the licensees for natural gas and marketing of refined oil products;

(s) in consultation with the Federal Government and licensees for natural gas determine for each such licensee a reasonable rate of return which may be earned by such licensees in the undertaking of its regulated activity pertaining to natural gas, keeping in view all the circumstances;

(t) oversee the capital expenditure to be made by licensees for natural gas in connection with any regulated activity pertaining to natural gas;

(u) prescribe procedures and standards for investment programmes by licensees for natural gas;

(v) determine the well-head gas prices for the producers of natural gas in accordance with the relevant agreements or contracts, and notify the same in the official Gazette;

(w) enforce standards and specifications for refined oil products as notified by the Federal Government;

(x) perform any other function or exercise power as may be incidental or consequential to the performance of any of its functions or the exercise of any of its powers.

5.5.3 The Natural Gas (Price for Supplies by Producers) Rules, 1976

The Natural Gas (Price for Supplies by Producers) Rules, 1976, have been made under the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948, for regulation of price of the natural gas by the distribution companies but now theses powers are being exercises by Oil and Gas Regulatory Authority.

5.5.4 The Compressed Natural Gas (CNG) (Production and Marketing) Rules, 1992

These rules relate to licensing and regulation of CNG products. However, now Oil and Gas Regulatory Authority is a regulator under these rules.

5.5.5 The Liquefied Petroleum Gas (Production and Distribution) Rules, 2001

The Liquefied Petroleum Gas (Production and Distribution) Rules, 2001, and dealing with licensing and regulation of LPG products but now this authority is also being exercised by OGRA. Other rules, regulations and guidelines are also dealing with different aspects of natural gas.

However, if CBM which is the natural gas in its composition by any chemical analysis and definition and all above laws, rules and regulations will be equally applicable for the discovery, exploration, distribution and marketing for industrial, commercial and domestic consumption in the country.

5.6 CBM in the Existing Legal and Regulatory Regime – Neces sary Changes for CBM Regulation and Control

It is the most important question in this research thesis because there is a strange system, as far as source of CBM i.e. coal and coal mines and CBM is concerned, about exploration of CBM in Pakistan. In this connection it is necessary to review and consider different constitutional and legal provisions in the existing regulatory and institutional system for discovery, exploration, distribution and marketing of CBM.

Article 141 of the Constitution of the Islamic Republic of Pakistan states that subject to the Constitution, Majlis-e-Shoora (Parliament) may make laws (including laws having extra-territorial operation) for the whole or any part of Pakistan, and a Provincial Assembly may make laws for the Province or any part thereof. Similarly, Article 142, further explains about subject-matter of Federal and Provincial laws which is reproduced below :

> **"142. Subject-matter of Federal and Provincial laws.** Subject to the Constitution –
>
> (a) Majlis-e-Shoora (Parliament) shall have exclusive power to make laws with respect to any matter in the Federal Legislative List;
>
> (b) Majlis-e-Shoora (Parliament), and a Provincial Assembly also, shall have power to make laws with respect to any matter in the Concurrent Legislative List;
>
> (c) a Provincial Assembly shall, and Majlis-e-Shoora (Parliament) shall not, have power to make laws with respect to any matter not enumerated in either the Federal Legislative List or the Concurrent Legislative List; and
>
> (d) Majlis-e-Shoora (Parliament) shall have exclusive power to make laws with respect to matters not enumerated in either of the Lists for such areas in the Federation as are not included in any Province.".

Clause (a) of the above Article provides that Majlis-e-Shoora (Parliament) shall have exclusive power to make laws with respect to any matter in the Federal Legislative List and entry 2 of Part II of the Federal Legislative List is reproduced as under :

> ***"2. Mineral oil and natural gas; liquids and substances declared by Federal law to be dangerously inflammable.".***

The entries 5, 6, 7 and 8 are relating to fees in respect of any of the matters, offences against laws with respect to matters, inquiries and statistics for the purposes of any of the matters and matters incidental or ancillary to any matter enumerated in this Part (Part II of the Federal Legislative List). Therefore, it may be easily concluded that mineral oil and natural gas, liquids and substances declared by any Federal law to be dangerously inflammable are covered under entry 2 of Part II of the Federal Legislative List and the Majlis-e-Shoora (Parliament) shall have exclusive power to make laws about all subjects mentioned against different entries included in Part I and Part II of the Federal Legislative List. However, Article 142 is subject to Article 158 of the Constitution which is provided a priority treatment to the Province in which a well-head of natural gas is situated over other parts of Pakistan in meeting the requirements from that well-head, subject to the commitments and obligations as on the commencing day. Article 158 is reproduced as under:

> **"158. Priority requirements of natural gas.** The Province in which a well-head of natural gas is situated shall have precedence over other parts of Pakistan in meeting the requirements from that well-head, subject to the commitments and obligations as on the commencing day.".

The entries included in Part II of the Federal Legislative List are further qualified by adopting special procedure for formulating and regulating policies in relation to matters in Part II of the List, in so far as it is in relation to the affairs of the Federation, by the Council of Common Interests and Council's decisions shall be expressed in terms of the opinion of the majority. Composition of the Council of Common Interests is given in Article 153 which is reproduced as under :

> **"153. Council of Common Interests.** (1) There shall be a Council of Common Interests, in this Chapter referred to as the Council, to be appointed by the President.
>
> (2) The members of the Council shall be–
>
> (a) the Chief Ministers of the Provinces, and
> (b) an equal number of members from the Federal Government to be nominated by the Prime Minister from time to time.

(3) The Prime Minister, if he is a member of the Council, shall be the Chairman of the Council but, if at any time he is not a member, the President may nominate a Federal Minister who is a member of the Council to be its Chairman.

(4) The Council shall be responsible to Majlis-e-Shoora (Parliament).".

In this way it is clear that natural gas is the subject which being in the Federal Legislative List is the administration concern of the Federal Government under the legislative powers of the Majlis-e-Shoora (Parliament). Thus, Coal-Bed Methane, which is also the natural gas by all definitions and its chemical composition only with a difference that its source of origin i.e. coal and coal mines are the subject matter which is under the administrative purview of the Provincial Governments which will be regulated through power which will be exercised by the Provincial Assembly in terms of clause (c) of Article 142 of the Constitution.

It is a very simple case, even from its point of incidence or occurrence i.e. coal and coal mines, because in the case of oil and natural gas, the same is being explored from the soil which is belonging to the Provincial Governments or private owners under relevant laws relating to ownership of land. Therefore, the coal or coal mine, being point of occurrence for Coal-Bed Methane (CBM) do not confer any right under the Constitution to the Provincial Governments to claim its ownership.

It is also relevant to point out that all existing laws, rules and regulations relating to discovery, exploration, control, distribution and marketing of natural gas are made by the Federal Government with establishment of regulatory institutions under such laws, rules and regulations. Thus, it will be troublesome for any Provincial Government, procedurally and practically to control and manage affairs relating to Coal-Bed Methane (CBM) for its industrial, commercial and domestic distribution and supply. Distribution and marketing of natural gas is regulated by two public sector companies in the countries and any discovery and exploration of CBM will be required to be connected through existing distribution system for its sale and marketing and all this system is being regulated by the Federal Government under the Act of Malis-e-Shoora (Parliament).

Thus, there will be no need of any new measures for regulation and control of CBM by the Federal Government because there is a very comprehensive legal and institutional regulatory framework functioning under the administrative jurisdiction of Federal Government. However, in case the control and management of CBM is entrusted to the Provincial Government, there will be need of very extensive amendments in the existing legal framework to provide for interconnecting provincially control CBM with federally control distribution system. Similarly, Provincial Governments will be required to make a completely new system to regulated different matters about discovery, exploration, control, management, distribution and marketing of the CBM under the Provincial Governments in consultation with Federal Government which will be a very complicated regulatory and administrative regime.

In addition to all this, provincial system is highly marred with red-tapism, corruption, laxity and it is not possessing capacity to management a system wherein huge amounts of foreign investments are involved along with necessary dealings with investors having high profile negotiating and administrative capabilities. It will not only frustrate the investors but will deprive the country from huge amounts of foreign investments due to such inefficient, bureaucratic and discouraging officialdom found in Provincial Governments.

5.7 Ownership of Coal-Bed Methane Gas and Related Aspects

As for as the constitutional and legal position under the Constitution of the Islamic Republic of Pakistan, 1973, is concerned, natural gas is the ownership of the Federal Government under different provisions of the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948 (Act XXIV of 1948). Coal-Bed Methane (CBM) is a natural gas by his chemical composition and by all definitions ignoring its place of occurrence. Therefore, there is no question about the ownership of CBM under the Constitution and other laws existing at the moment and it is belonging to Federal Government.

CHAPTER 6

ANALYSIS OF OTHER SYSTEMS FOR CBM LEGAL AND REGULATORY FRAMEWORK

Natural gas and particularly the Coal-Bed Methane (CBM) has been given different treatment in different political and governmental systems according to their constitutional and legal schemes. However, it is apparent from in-depth study of different political and constitutional systems that Coal-Bed Methane is treated as a local, state or provincial subject as compared to Pakistan's constitutional system wherein natural gas is included in Federal Government's administrative jurisdiction with a recommendatory priority for such area or Province whereat its well-head is located only for its use under Article 158 of the Constitution of the Islamic Republic of Pakistan.

It is quite interesting to note that in some countries there is a doctrine of unified coal administration under which it has been recognized that in order to ensure efficient and effective administration and control of coal resources and its other by-products like Coal-Bed Methane which is found in the beds of coal mines, gasification of coal and mining of coal must be under single and unified administrative control for facilitation of its full exploitation without jurisdictional problems. However, there is no such doctrine applicable under the constitutional and administrative system of Pakistan because there is a constitutional scheme of distribution of powers between the Provinces of the Federal and the Federation.

Further it is a geological fact that CBM is completely tied in every aspect from it is point of origin, occurrence and storage reservoir with the coal seams of coal beds in a coal mine.

It will be beneficial to study other political and constitutional systems in details to understand reasons and justifications to include the natural gas as well as Coal-Bed Methane gas along with coal and coal mines either in local, provincial or national jurisdiction in the following lines :

6.1 Study of Neighbouring Countries' Systems for Legal and Regulatory Framework for CBM

Position of CBM, as far as its administration and management is concerned, under different constitutional and political systems of some neighbouring and other international systems is as under :

6.1.1 CBM in Indian System

In India the administration of gas is under the Government of India and recently in year 2006, the Government had announced ten blocks for exploration of CBM under Third Offer of Blocks also known as CBM – III. However, entry 25 of the Seventh Schedule under Article 246 has categorised "gas and gas works" in List II which is State List placing it under the state or provincial administrative jurisdiction but at the same time Article 249 of the Indian Constitution of 1949 has empowered the Parliament to legislate with respect to a matter in the State list in the national interest which is reproduced below :

> **"249. Power of Parliament to legislate with respect to a matter in the State list in the national interest.–** (1) Notwithstanding anything in the foregoing provisions of this Chapter, if the Council of States has declared by resolution supported by not less than two-thirds of the members present and voting that it is necessary or expedient in the national interest that Parliament should make laws with respect to any matter enumerated in the State List specified in the resolution, it shall be lawful for Parliament to make laws for the whole or any part of the territory of India with respect to that matter whole the resolution remains in force.

(2) A resolution passed under clause (1) shall remain in force for such period not exceeding one year as may be specified therein:

Provided that, if and so often as a resolution approving the continuance in force of any such resolution is passed in the manner provided in clause (1), such resolution shall continue in force for a further period of one year from the date on which under this clause it would otherwise have ceased to be in force.

(3) A law made by Parliament which Parliament would not but for the passing of a resolution under clause (1) have been competent to make shall, to the extent of the incompetency, cease to have effect on the expiration of a period of six months after the resolution has cease to be in force, except as respects things done or omitted to be done before the expiration of the said period.".

6.1.2 CBM in United States

There is a very complex regulatory system for CBM and other minerals in United States of America. It is not in clear terms whether it will be regulated by States or the Federal Government. The trend is being determined by the Courts about CBM rights. In Eastern States courts are holding that discovery, exploitation and production rights of CBM belongs to coal right owners whereas in Western States courts view the CBM ownership rights for the owners of rights of gas.

The Supreme Court of Pennsylvania in a case decided in 1983 titled

United States Steel Corporation

V.

Hoge,

has ruled that :

> ***"[....] such [CBM] gas as is present in coal must necessarily belong to the owner of the coal, so long as it remains within his property and subject to his exclusive domain and control."***

The Court further stated that the surface owner :

"has title to the property surrounding the coal, and owns such of the coalbed gas as migrates into the surrounding property".

The Court further stated :

"The potential for reversion of the situs, however, does not diminish the character of the coal as property of its grantee, or of the gas contained therein as a mineral ferae nature resting inside the coal owner's property and falling within the dominion and control of the coal estate. The owner of coal may, as may any property owner, exercise dominion over his property so as to maximise his right of enjoyment thereover, within bounds limiting impingement upon the rights of other property owners. [emphasis added] [....] Hence, the coal owner may mine his coal, extract the gas from it, or both. If he chooses to extract the gas, drilling as well as hydrofracturing are available means, so long as their utilization does not impinge upon the rights of owners of the surrounding property, since the damage to coal inflicted by these processes is within his dominion to inflict [emphasis added].".

However, there is no clear constitutional provision about ownership rights in the US Constitution of 1789, due to which ambiguity prevails and court interpretations are determining about the ownership of CBM.

6.1.3 CBM in Canadian System

In Canada, discovery, exploration, production and management of Coal-Bed Methane is under the control of provinces because nature of CBM varies from place to place due to geological characteristics attached with it without any likelihood that CBM must have the same chemical composition through out the country.

Therefore, in the different provinces of Canada, there are different rules and regulations for discovery, exploration, production and administration of CBM with variety and differences. Regulations, licensing systems, permits, policies and practices quite different and based on province to province basis.

In Nova Scotia there is the best system relating to regulation of CBM because it requires the interested companies to sign gas concessions agreements under the petroleum rules and regulations.

6.1.4 CBM in Australia

In Australia the provinces have the regulatory and administrative control over the discovery, exploration and production of CBM under the constitutional system as provided in the Constitution Act, 1867. Rights about oil and gas and other minerals had been given to provinces in Australia even before the commencement of present constitutional scheme.

6.2 International Standards for CBM Control and Regulation

International standards and justifications for the control and regulation of the Coal-Bed Methane gas cannot be easily made applicable in case of Pakistan because we have a written constitution which is subject to interpretation by courts of law if there is any ambiguity.

However, internationally, the following two yardsticks are being applied for the ownership of Coal-Bed Methane (CBM) keeping in view different technical and procedural aspects :

(a) Environment, health and human safety aspects; and
(b) Ownership rights and aspects.

6.2.1 Environment, health and human safety aspects

Environment is an important aspect with reference to exploitation and production of CBM. It is having an explosive and toxic nature from its chemical characteristics and due to this characteristic it is a safety and health hazard. It is causing explosions and deaths in coal mines when it is not getting any proper outlets. Asphyxiation is a routine matter risk factor in coal mines and it is only due to reason that during the mining process, the methane (CBM) gas is coming out of seams of coal and accumulating in the mining area and when its quantity is becoming excessive, it is reducing the level of oxygen in the air available in the

mine area resulting unconsciousness and deaths of workers if no first aid has been provided to the victim timely.

Secondly, when Coal-Bed Methane (CBM) which is chemically the methane gas from all internationally recognized definitions which is emitting from coal mines into air causing air pollution by increasing methane level making the inhaling process less healthy for human being and animals which is a big health hazard and a constant polluting factor in atmosphere.

6.2.2 Ownership rights and aspects

Ownership right is very basic to any property or property-rights. Coal is a mineral and it is sometimes being owned by provinces or central governments in different political and constitutional systems. It is causing ownership rights problems when one particularly the source or origin i.e. coal or coal mines, are owned by one private owner/government and other that right to exploit and produce natural gas (CBM) to another government under legal or constitutional system.

6.3 Application of Neighbouring and International Standards in Pakistan

Legal and constitutional frameworks in different neighbouring countries and some other countries which are exploiting and exploring the Coal-Bed Methane gas are studied which have given conflicting conclusions but all those are quite suitable under the relevant legal and constitutional frameworks.

However, it is not practically possible to follow one legal or regulatory model for Pakistan which is suitable in its circumstances.

But our legal and constitutional system has more similarity with Indian system and practices from that system may be considered before making any decision for control and regulatory purposes of CBM leaving constitutional technicalities because our constitutional

system is providing a federal control and administration for natural gas and its different products.

Like some other legal, constitutional and regulatory systems, in Pakistan, there is similar problem that is coal and coal mines are being owned by Provincial Governments and the ownership of natural gas is belonging to the Federal Government and the Coal-Bed Methane is by any definition and its chemical composition is methane, in its pure or impure form, and vested to the Federal Government under the Constitution.

Here is again relevant to briefly mention different provisions of the Regulation of Mines and Oil-fields and Mineral Development (Government Control) Act, 1948, for perusal and consideration before giving different options available for administration and regulation of CBM in Pakistan within existing constitutional and legal system as it deals the following matter relating to :–

(1) the manner in which, and the authority to whom, application for the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession shall be made, and the prescribing of the fees to be paid on such application;

(2) the conditions in accordance with which the grant or renewal of an exploration or prospecting licence, a mining lease or other mining concession may be made, and the prescribing of forms for the execution or renewal of such licence, lease, and concession;

(3) the circumstances under which renewal of a licence, lease or concession as aforesaid may be refused, or any such licence, lease or concession whether granted or renewed may be revoked;

(4) the determination of the rates at which and the conditions subject to which royalties, rents and taxes shall be paid by licensees, lessees and grantees of mining concessions;

(5) the refinement of ores and mineral oils;

(6) the control of production, storage and distribution of minerals and mineral oils;

(7) the fixation of the prices at which minerals and mineral oils may be bought or sold;

(8) any matter ancillary or incidental to the matters set out in the foregoing clauses of the section;

(9) under section 3A of the Act, the President may enter into an agreement with any company, whether incorporated in Pakistan or outside Pakistan, for the grant of a licence or lease to explore, prospect and mine petroleum on the basis of a Production Sharing Agreement and on such terms and conditions may be agreed upon between the Federal Government and the company; and

(10) Similarly, section 3B of the Act states that every company, whether incorporated in Pakistan or outside Pakistan, to whom a licence or a lease to explore, prospect and mine petroleum is granted under the Act, not being a company such as is referred to in section 3A, shall be entitled to the concessions specified in the Schedule in addition to any concessions for the time being admissible to it under any other law or the rules made under this Act.

Schedule of the Act is very comprehensive which is providing different things about:

(a) rate of royalty and income tax;

(b) the limit of the sum of payment to the Federal Government and taxes on income at the time of grant;

(c) income from pipeline operations, the sale of LPG, CNG and from refined products;

(d) details of expenditure of the licensee or lessee before the commencement of commercial production and their surrender on the completion of the dry hole;

(e) net profits, the amount charged in annual financial accounts on account of additional allowance and rates of depreciation;

(f) the value of royalty for the purposes of royalty and income tax;

(g) income derived by the licensee or lessee from the use of any surplus capacity of its pipeline by any other licensee or lessee shall be assessed on the same basis as its income from petroleum produced by it form its concession area;

(h) exporting of share of petroleum by outside companies as agreed;

(i) retaining proceeds of the share of petroleum exported by a licensee or lessee for outside companies;

(j) concession available in respect of import duties, licence or authorization fees shall be specified;

(k) details of items to be supplied to a licensee or lessee;

(l) concessions about imported goods relating to customs-duty to foreigners;

(m) details about exemptions of income tax to foreigners working with oil exploration companies;

(n) maintenance of data relating different things;

(o) matters relating to Government Holding Company; and

(p) facilities relating to transportation of necessary machinery and goods.

However, in the light of above said discussion, the following different options are available to solve this problem within existing legal and constitutional system about discovery, exploration, production, distribution and marketing of Coal-Bed Methane (CBM) gas as under :

(1) CBM should be exclusively regulated and controlled under the existing system for the discovery, exploration, production, distribution and marketing system as in the case of natural gas and constitutional position is quite clear in this regard without any complication as the CBM is also the natural gas i.e. methane, in its pure or impure form;

(2) CBM and its ownership may be entrusted to Provinces as the ownership and exploitation rights of coal and coal mines are already belonging to Provincial Government under the principle of unified coal and its by-products control and management; and

(3) CBM, as covered under clause (a) above, is vested to the Federal Government, however, the Federal Government may entrust its discovery, exploration, control, distribution and marketing to the Provincial Government for the sake of unified administration of coal, coal mines and coal products to facilitate existing legal, administrative and regulatory framework to avoid on site problems and complications which will be crop up when the exploration and exploitation activity for CBM will be continuing at the same site when a different stakeholder will be mining coal from the same location. It will also be question whether the mining of coal will start after extraction of available CBM or simultaneously. However, it will be impossible once mining activity will be started in the same mine. It is also pointed out that Provincial Governments will face problems relating to supply and marketing networks which are the ownership of Federal Government. Another important question is relating to disturbance in the existing foreign investment environment, because Provincial Governments have no expertise to negotiate gas concession agreements and it will be discouraging for an investor who is dealing with Federal Government for exploration and marketing of natural gas and with Provincial Governments for another similar product of natural

gas where administrative environment is marred with routine red-tapism, bureaucratic tactics, excessive corruption and inefficiency.

It is further necessary that no decision about using these options may be taken in haste because it will create a lot of legal and administrative complications for the Government in addition to confusions in inter-provincial relations about the administration and control of natural gas. There are already disputes about ratio of royalties and their system of disbursement to Provincial Governments and once the administration and control of the Coal-Bed Methane (CBM) will be handed over to Provincial Governments, thereafter it will be very difficult to justify retention of administration and control of natural gas with Federal Government because same reasons and justifications relating to point of occurrence and incidence will be available to Provinces for demanding administrative and regulatory control of natural gas in the country which is being explored and produced from different areas in those provinces.

CHAPTER 7

WAY OUT FOR EXPLORATION, MANAGEMENT, CONTROL AND REGULATION OF CBM IN PAKISTAN

CBM is a new source of energy which is still not explored but technically its occurrence is feasible and almost sure because it is natural phenomenon which is occurring without any exception of geographical locations due to chemical characteristics of process of fossils decomposition and conversion into coal and coal reserves during centuries old geological process in the heart of earth.

Similarly, evidence available due to different drilling expeditions, quite indicative the presence of Coal-Bed Methane in different areas of coal mines.

In addition to actual evidence acquired through drilling process in the country, there is theoretical evidence which is available due to comparison of geological data[1] with other similar geological locations or deltaic basins in different parts of world. The most relevant and similar data available is from contiguous areas in Indian Cambay Basin which is according to John R. SanFilipo is, from depositional standpoint more or less an extension of the Thar cold field. Total coal reserves are assumed more than 175.5 billion tonnes cited in equals 35 trillion cubic feet as a resource target.

[1] This information is based on data collected and analyzed by John R. SanFilipo in his report referred in previous chapters.

Similarly, data analysis of Thar coal fields is also similar to Powder River Basin (PRB) in USA which is producing CBM since long and its production is increasing day by day.

Another similar example with similar geological data is from San Juan Basin in China where the best production is from high-volatile bituminous coals – despite higher rank coal occurring deeper in the basin.

Therefore, it is time to thoroughly plan about different technical aspects relating discovery, exploration, production, control, management and marketing of Coal-Bed Methane (CBM) in Pakistan. So that before dividing different areas into block for offering for discovery and exploration of CBM, there should be solution of all possible legal and regulatory problems because it is not the headache of interested parties bidding for discovery and exploration of CBM to wrangle and wait for legal and regulatory way outs before or after their investment plans.

It is even more relevant and appropriate by taking special interest because import budget for oil and other petroleum products of the country is increasing every year. Government is also emphasizing for conversion of most of the industrial, commercial and domestic consumers to natural gas as a measure to check and reduce foreign exchange expenditure being done on import of oil, gas and other petroleum products.

It is also a fact that demand for natural gas is increasing being a clean and environmental friendly energy resource. Due to this reason as well as due to exhausting resources of natural gas, Government is planning to undertake different projects for import of gas different other countries by sinking huge and lengthy pipelines from neighbouring countries like Iran, oil-rich middle eastern states and Central Asian Republics to meet future requirements of natural gas but these projects are facing different types of political, financial, tariff and administrative problems. Such projects even after their successful completion will prove reliable sources of energy due to changing international geo-political scenarios and other reasons.

Therefore, reasonable and viable course of action for future industrial, commercial and economic development and growth should be based on realities instead of conjectures and mere possibilities. Thus, reliance on indigenous resources will be more beneficial and reliable source for future energy requirements of the country. In this scenario, in addition to other alternative resources of energy, efforts for discovery, exploration and production is only the more better option because we have huge coal reserves in our country which are making the Pakistan sixth coal-rich country in the world.

7.1 Framework for Exploration, Management and Control of CBM

There is no doubt that there is a very comprehensive and efficient legal and regulatory regime for regulating different matters relating to discovery, exploration, production, control and marketing natural gas in the country. It is also a fact that Coal-Bed Methane is the natural gas by its chemical composition and definition without any confusion irrespective of point of occurrence in coal beds in coal mines which are incidentally being managed by Provincial Governments in the country. Except this aspect, there is no procedural and infrastructural deficiency in the existing legal and regulatory framework in the country.

As far as legal, regulatory and institutional framework about natural gas in the country is concerned that is well-placed and meeting all requirements of the country.

However, in the present case, due to a conflict of ownership about source of CBM, there is no complication in any way for regulation and management of it in the country. Laws, rules and regulations are there. World's second[1] largest system of pipelines and distribution network is there and fully functional and available to manage the supply of CBM at any time for marketing to consumers without any hurdles.

As far as CBM's quality related issues are concerned, those are difficult to solve. In case its quality is at par with existing natural gas, then it can directly be connected to main distribution network for marketing without any further processing and treatment. However,

[1] Pakistan Economic Survey 2006-07, page 234, Ministry of Finance, Islamabad.

if its quality in terms of impurities is requiring any processing and treatment to improve its heating or caloric value, even it can be done easily before pumping it into main distribution network.

There are two viable and feasible options available for supply and marketing of CBM after its exploration, production and treatment, if necessary, which are as under:

7.1.1 Directly Connecting to Distribution System

In case, there are no quality-related issues, the CBM can be directly linked with main distribution networks of either distribution company having nearest pipeline connection closest to the well-head of CBM. At present there are two gas distribution companies namely Sui Southern Gas Company Limited (SSGCL) and Sui Northern Gas Pipelines Limited (SNGPL) having the second[1] largest distribution network in the world for supply and marketing of natural gas.

In this way, once the CBM will be connected with main distribution networks, then it will reach to the consumers without any distinction of its name because users will not be concerned with the name or origin of gas it is having the same heating or caloric value. The CBM exploration and producing companies may sign agreements with these two distribution and marketing companies settling in detail terms and conditions of sale of their gas to these distribution companies.

Thus, it will be an addition in our energy resources and an alternative to existing energy resources to energy starved economy. There is no doubt that energy consumption is a true indicator the true development of a nation in its economy with fast growth levels.

As Pakistan is having coal reserves more than 185 billion tonnes making it the 6ht coal-rich nation in the world having capability of CBM in trillions of cubic feet which will be enough for long future till the availability of new energy resources in the country and in

[1] Pakistan Economic Survey 2006-07, page 234, Ministry of Finance, Islamabad.

the world. There is also potential to adopt coal gasification technology to produce more gas for industrial purposes.

Therefore, Pakistan has a lot of potential in energy sector which requires efforts for its early exploitation to meet the shortage of energy in the country.

7.1.2 Using CBM for Local and Specialized Purposes

There is a possibility that from few coal reserves, the CBM may not be of good quality and mixed with other impurities reducing its heating and caloric value such like ethane, butane and carbon dioxide, etc., in addition to other chemical components. Due to such impurities, the CBM is not available in pure natural gas form i.e. 100% methane, but the percentage of methane is reduced in its chemical composition upto 14% i.e. there is 86% or more methane gas in the chemical composition of CBM. In such situation, the CBM will not acceptable to distribution and marketing companies because the impurities may damage their pipeline networks in addition to complaints from their industrial, commercial and domestic consumers. Such impurities may create trouble for consumers when they will be getting proper heating from the same quantity of natural gas.

These impurities may be removed through chemical treatment or processing of CBM with different chemical reactions but it may not be cost effective or increase the price of CBM. Even at present it will be very difficult to treat such a large quantity of CBM through chemical processes to make it pure and comparable to natural gas.

However, if there is no facilities or possibilities of chemical treatment or processing for improving quality of CBM, then only viable way out is that the CBM may supplied and distributed through separate distribution networks but it will create a lot of financial and infrastructural problems. But still there is possibility that it may be distributed in areas of its exploration and other contiguous localities for different purposes. There is viability of such use because in all such areas whereat coal mines are occurring, there is remote possibility of natural gas supply through existing networks. Thus, it may not only save the environment of those areas but also save the plants and vegetation which is already being used as a fuel. It will also reduce pollution in atmosphere with improved quality of inhaling air. Similarly,

methane component in air will be reduced in addition to clean fuel availability for domestic purposes in such remote areas.

In addition to above uses, CBM may be used for so many other purposes amongst which the following are important :

Domestic Use :

CBM may be equally useful for domestic purposes as natural gas because it is having little difference or no difference in most of the cases as far as its caloric or heating value is concerned. Therefore, it may be another supporting source of energy for domestic purposes through specialized and small-scale distribution system overcoming shortage of natural gas in the country due to exhaustion of existing natural gas resources. It will also become an alternative source of energy in far flung areas where there no electricity and natural gas supplied from main distribution systems.

Power Generation :

CBM is used throughout world for the purposes of generating electricity according to availability of CBM from the coal fields. It is quite relevant that sometimes, CBM is having less caloric value and not considered suitable for domestic or industrial consumers. In such circumstances, small scale or according to availability of CBM from its exploration point, small power generation plants may be established in nearby localities for producing electricity to such local areas. It can produce very cheap electricity and also become cost effective for such localities which are at long distances from main distribution systems.

Use in Automobiles as CNG :

Natural gas is already being used in automobiles since long. Similarly, CBM may also be used in automobiles as CNG with equal utility and benefit. Even small scale

treatment or processing plants may be used to improve its purity in such remote areas where natural gas is not available from main distribution networks.

Use in Fertilizer Manufacturing Plants :

Fertilizer manufacturing plants are the biggest users of natural gas at large scale industries in Pakistan. Therefore, CBM is equally useful for production and manufacturing of fertilizer in fertilizer plants during their different processes. Even Government may provide incentives to industrialists to establish small or big fertilizer plants in such areas where there is possibility of CBM exploration for a long time.

Industrial Use :

In addition to use of CBM in fertilizer manufacturing plants, it may also be used for other industrial processes either for heating purposes or other processes. Government may provide facilities to different industries which may consume coal or CBM as source of energy nearby the coal mines. In this way, industrial activities will get boost in addition to providing employment opportunities in remote rural areas of the country.

Use in Steel Plants :

Steel industry is another large scale user of natural gas in its different process during the casting and manufacturing of iron and steel. Therefore, it may be used in large and small steel plants to save the natural gas for other domestic and commercial purposes. Thus, steel industry may be encouraged to shift nearby cheap fuel sources in addition to abundant and cheap labour force reducing their cost of iron casting.

Use for Production of Methanol :

CBM is containing methane as it is in the natural gas which is used for preparation of many products like reformulated gasoline, methanol and gasoline blends, formaldehyde resins. Therefore, it may be used as a base feedstock in large scale methanol plants. Therefore, industries producing methanol may be given incentives

to establish their units near coal mines or CBM exploration plants for easy supply of cheap fuel.

Use in for Preparation of Chemical Products :

Chemical industry is using methane gas and carbon compounds for preparation of different chemical products. Therefore, such chemical industries may be encouraged to establish their units near CBM exploration and production facilities for cheap energy and utilization of methane in their different processes.

7.2 Legal and Regulatory Framework

Legal and regulatory framework for natural gas has already been discussed in detail. There is a very comprehensive and stakeholder friendly legal and regulatory framework in the country under the supervision and control of Federal Government. In case, the CBM is controlled and managed by the Federal Government, all existing rules will be applicable on CBM as it is also the natural gas within same definition and chemical composition except its point of occurrence which is a coal mine. Only in few instances, there will be need of minor changes in the existing laws, rules and regulations.

However, if the CBM is being administered by the Provincial Governments, there will be need of a completely new legal and regulatory framework to deal with matters relating to CBM. The Provincial Governments may even adopt federal regulatory regimes with suitable changes according to their requirements otherwise they may formulate and design their new regulatory system for CBM and different aspects relating to it.

But there will a new problem like Canada and United States of America that there might be different legal and regulatory frameworks in each Province different from other Province creating a diversity of regulatory regime in the same country different at Province to Province basis as well as at Federal level. There will also not be consistence and harmony in policy formulation and implementation at all levels. Thus, it will become a discouraging

element to frustrate international investors who are not in habit of working in such diverse and different regulatory systems in the same country.

In this connection it is also to point out that Provincial Governments are not having expertise to deal with such huge international investments in private sector and their corruption, inefficiency and maladministration will increase at the cost of national interest and good will producing an anti-investor friendly.

It is also worth-mentioning that under the existing legal and constitutional system, natural gas is administrative and regulatory jurisdiction of Federal Government and transfer of CBM regulation and control will only create the problems for the Federal Government because Provincial Governments are not possessing capability to handle complicated issue like discovery, exploration, production, control, management and marketing of CBM whereas the distribution network and other facilities are only under the control of Federal Government.

CHAPTER 8

CONCLUSION

Coal-Bed Methane (CBM) gas is an important source of energy but it has not been explored yet for commercial use in our country. It is found in the layers of coal and all coal reserves are embedded with this natural energy resource. There is no doubt that existing energy resources particularly based on coal, oil and gas are exhausting rapidly because these are non-renewable. This fact highlights the importance of efforts for discovery and exploration of more similar resources to keep the economic activity and social life moving towards a better future because energy is real lifeline. Load-shedding and load-management in the supply of natural gas and electricity has made us realize the non-arguable importance of energy in national life of any nation. This is the reason that future wars will not be fought for occupation of merely geographical territories but to occupy such territories which will be rich with oil, gas, mineral and other resources necessary to keep the economic activity and developmental pace intact for future challenges and maintain competitiveness of a nation as well as competitive edge on other nations.

It is also a fact that life without energy is merely a darkness and practically return to dark ages which is neither affordable humanely nor tolerable by Governments of this global world.

Today, consumption of energy is the real indicator of economic development and growth of any economy and nation in this world. No nation can survive without maintaining supply of energy to its industries, commercial activities and for domestic purposes.

Similarly, increasing dependence of human and governance activities on different kinds of energy resources have exposed the real weaknesses of today's mechanical, social,

and economic infrastructures as energy is life-blood of all these activities. No nation, economy or society can afford breakdown of energy in any case. Thus, it is indispensable for the continuity of human, social and economic life that while having so much dependence on energy resources, the exhaustion and depletion of energy resources may be seriously kept in mind with serious efforts to increase our energy-base in this world and particularly in our country because its non-availability will make our survival and growth on this earth practically impossible.

Our country is facing serious threat of depletion of existing energy resources. Electricity the most depended source in our country is already in short supply since so many years depriving millions of people to enjoy the facilities of modern age. Similarly, we are a highly oil-importing country and due to our financial constraints it is not possible for long time continue with this practice. Thus, making mandatory for us to decrease dependence on imported oil by exploring indigenous oil and petroleum resources. Natural gas is also not an exception in the existing supply and demand scenario of it. Demand of natural gas is increasing day by day but with meagre increase in its exploration and supply. After its discovery in 1952, now its use has been increased manifold because natural gas is being used in all industrial, commercial and domestic activities in our country leading towards logical exhaustion from existing sources of natural gas.

Keeping in view the above said energy scenario in different fields of energy resources it is mandatory for us to develop alternative energy resources to meet the future requirements. As Pakistan is a coal-rich country having 6^{th} largest coal reserves in this world but still unexploited in their original form i.e. coal. But these coal reserves are having trillions cubic feet of natural gas i.e. Coal-Bed Methane gas, embedded in the layers of coal reserves enough to fulfil energy requirements for a long time if exploited successfully.

However, discovery, exploration, production, control and marketing of Coal-Bed Methane is not possible in a beneficial manner if there is not a well-thought policy to cover different aspects relating to CBM.

Recommendations :

Therefore, for better exploitation of Coal-Bed Methane (CBM) it is recommended that :

(a) a comprehensive policy for discovery, exploration, control, distribution and marketing be announced;

(b) a comprehensive survey and reconnaissance activity may be carried on through out the country to know and gather real data about coal reserves and presence of CBM with its estimated quantity;

(c) an investor-friendly policy may be adopted;

(d) investors investing in the field of CBM may be given special incentives;

(e) duty-free and customs duty free import of machinery relating to CBM may be allowed on priority basis; and

(f) there should not legal and institutional duplication for management of CBM in the country as compared to existing legal and institutional regulatory frameworks.

Conclusion :

In the light of facts and issues discussed in previous chapters it is transpired that in our constitutional and legal system, there is already a very comprehensive legal and institutional regulatory framework in place in the country which is dealing with different issues relating to natural gas and Coal-Bed Methane gas also being the natural gas in terms of its chemical and other definitions is covered under natural gas. Hence, the existing legal and regulatory framework is enough to meet the requirements of CBM with necessary amendments in different laws, rules and regulations. After careful examination of the constitutional scheme about distribution of legislative powers it is also falling within legal and administrative jurisdiction of the Federal Government and any new scheme to control and regulate CBM at any other level will create problems in this nascent field of economic activity in the country in addition to create administrative rift in existing and prospective new legal and regulatory frameworks. Further control and management at provincial level will introduce diversity in its control and regulation among different provinces as well as

between Provincial Governments and Federal Government. Unity of legal and institutional framework will not only make investments in CBM discovery and exploitation easy but also make the regulatory regime more efficient and practical. Experimenting of any new regulatory system at the cost of existing system will discourage the investors as well as create complications and duplicity of legal and policy standards at different levels causing confusion and maladministration at different levels. Good governance, transparency and accountability with unity of legal and institutional framework which is necessary for the success of a new investment sector which is equally vital for the economic development and growth of the national economy and country.

APPENDICES

S. No.	Description
I	Map of Pakistan's Coal Reserves/Resources.
II	Map of Coal Reserves in Sindh.
III	Map of Coal Reserves in Balochistan.
IV	Map of Coal Reserves in the Punjab.
V	Map of Coal Reserves in NWFP.
VI	Map of Coal Reserves in Azad Jummu & Kashmir.
VII	Coal fields showing generalized locations of preliminary CBM tests in Pakistan and the Mehsana CBM in India prepared by USGS in collaboration with USAID.
VIII	Conceptual Model for Thar Desert CBM prepared by John R. SanFilipo.
IX	Notification Regarding Entrustment of CBM to Sindh.

Appendix – I

Map of Pakistan's Coal Reserves/Resources

Sr.#	Location	Coal
	SINDH	
1	Thar	175,506
2	Lakhra	1,328
3	Sonda-Jherruck	5,522
4	Meting-Jhimpir	473
5	Indus East	1,777
6	Badin	16
	Total:	184,623
	BALOCHISTAN	
7	Sor-Range/Degan	50
8	Khost-Sharigh/Hanoi/Harat	88
9	Mach	23
10	Duki	56
	Total:	217
	PUNJAB	
11	Sor Range	213
12	Makarwal	22
	Total:	235
	NWFP	
13	Cherat	9
14	Hungu	82
	Total:	91
	AJK	
15	Kotli	9

Grand Total: 185,175

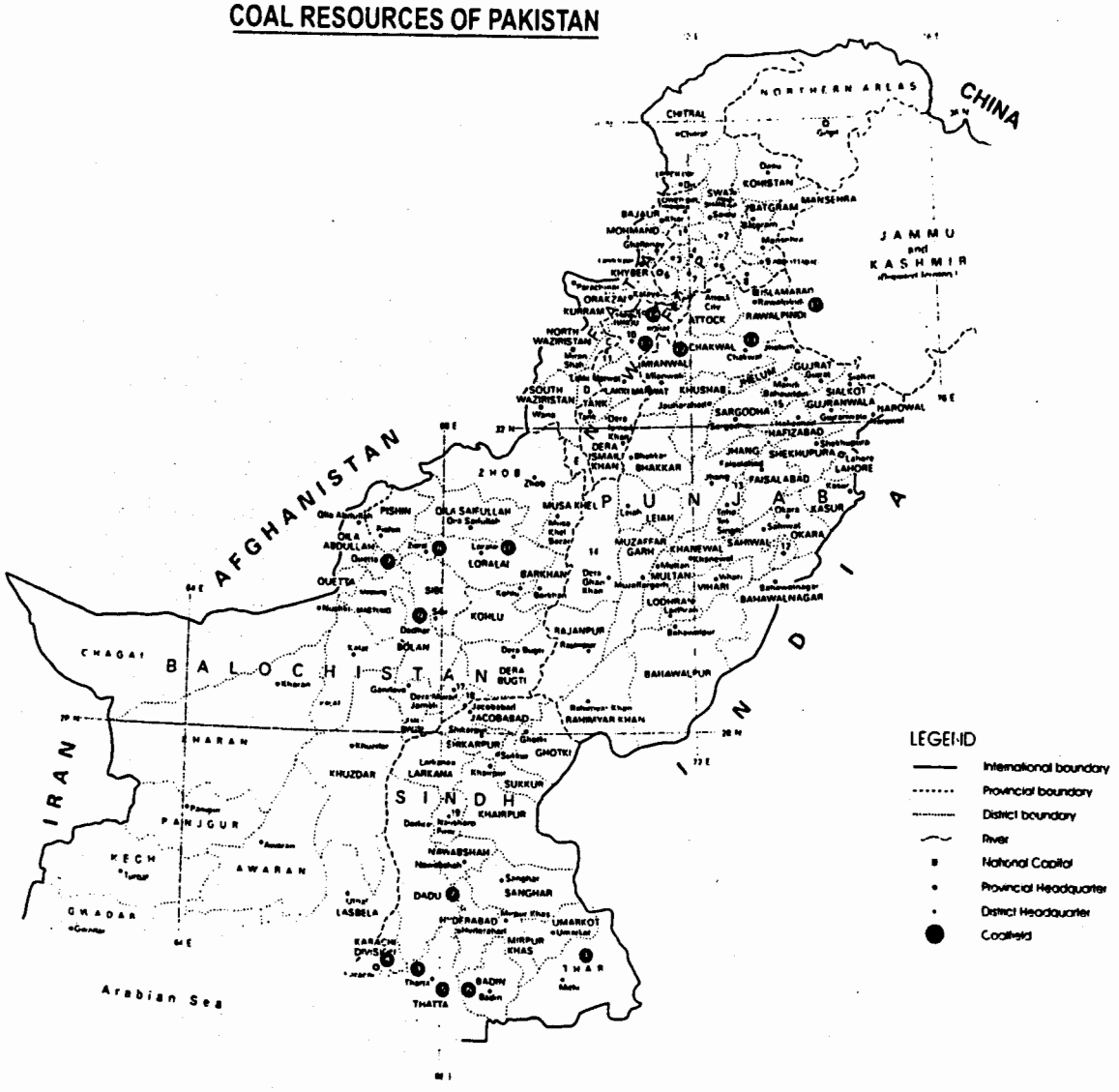
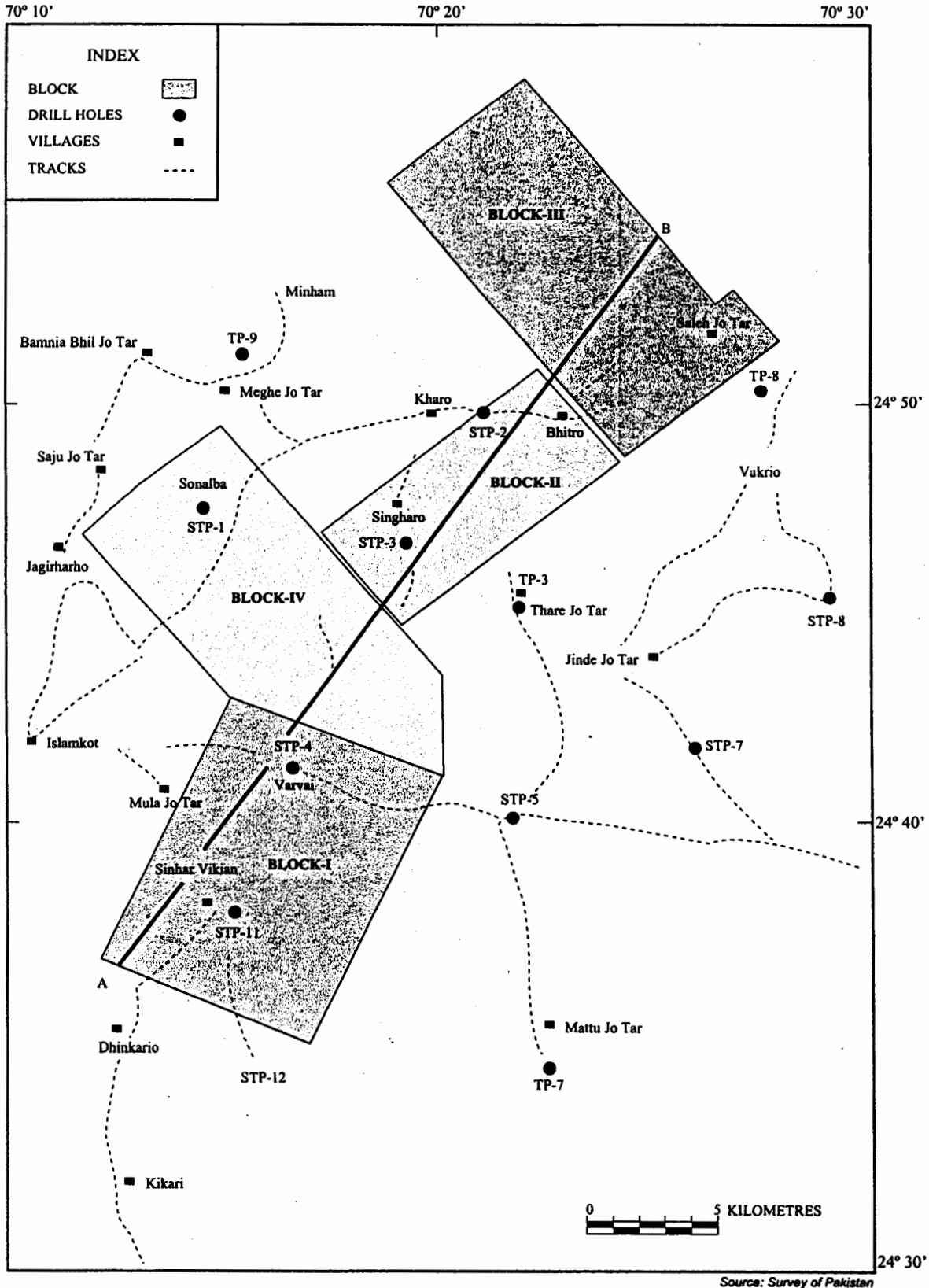


Fig-1: Map showing location of coalfields of Pakistan

Appendix – I

Map of Pakistan's Coal Reserves/Resources



Source: Survey of Pakistan

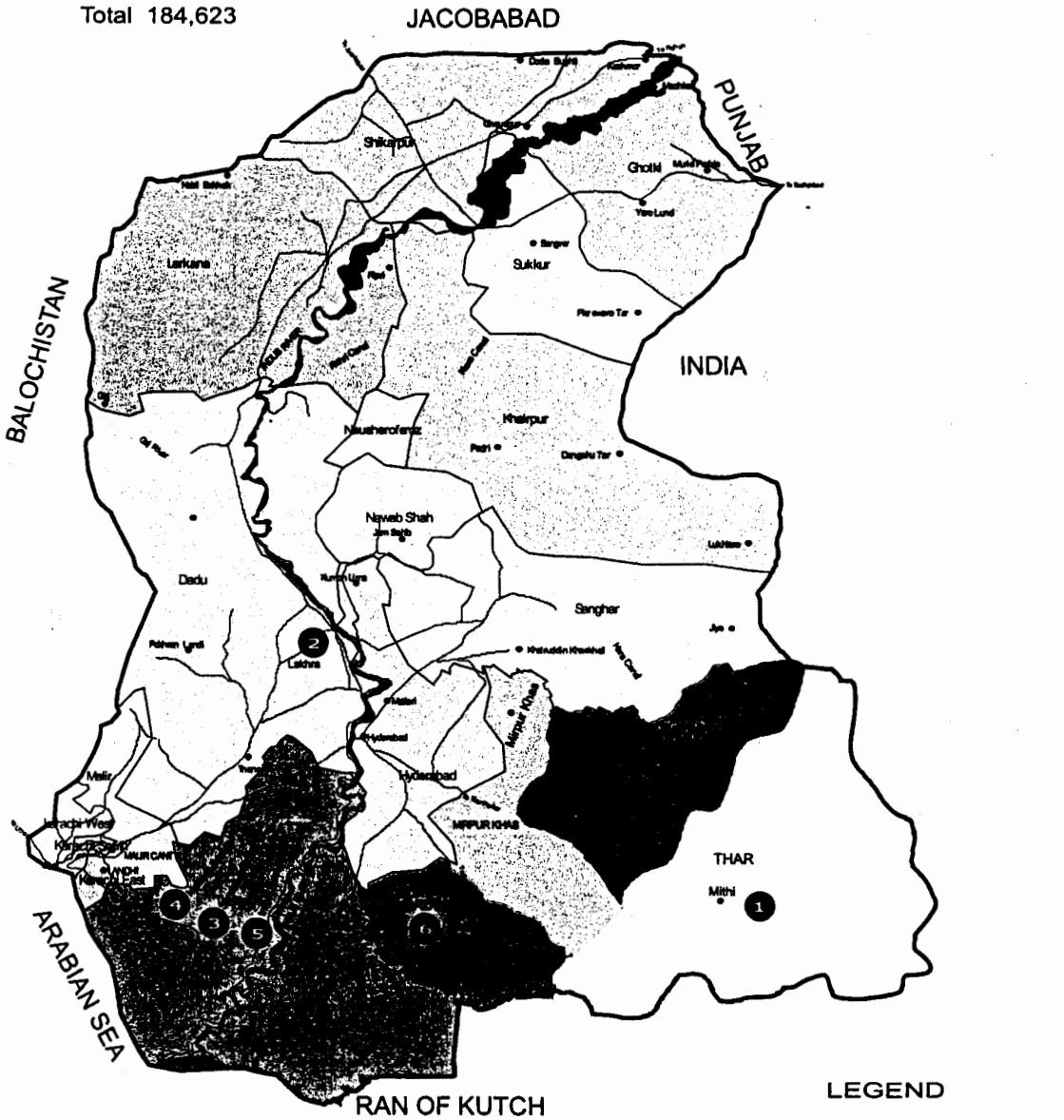
Map-3: Map Showing Blocks of Thar Coalfield

Appendix – II

Map of Coal Reserves in Sindh

IDENTIFIED COAL POTENTIAL IN SINDH

S.No.	Location	Coal (Million Tonnes)
1	Thar	175,506
2	Lakhra	1,328
3	Sonda-Jherruch	5.523
4	Meting-Jhimpir	473
5	Indus East	1,777
6	Badin	16
	Total	184,623



Appendix – III

Map of Coal Reserves in Balochistan

IDENTIFIED COAL POTENTIAL IN BALOCHISTAN

S.No.	Location	Coal (Million Tonnes)
1	Sor-range/Degari	50
2	Khost/Sharigh/Harnai/Ziarat	88
3	Mach	23
4	Duki	56
	Total	217

LEGEND

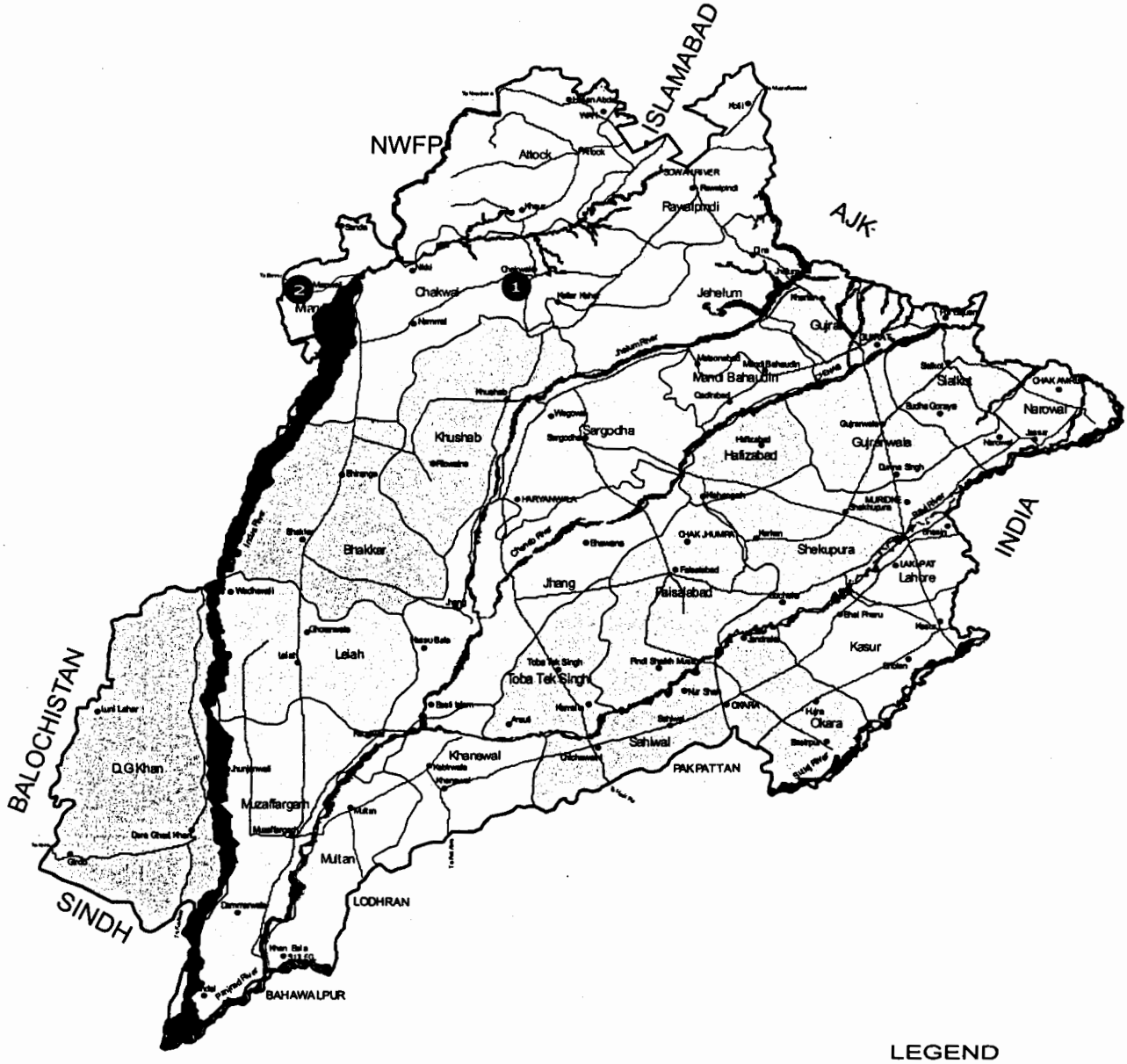
- City/Town
- River
- Road
- District Boundary
- Coalfields

Appendix – IV

Map of Coal Reserves in Punjab

IDENTIFIED COAL POTENTIAL IN PUNJAB

S.No.	Location	Coal (Million Tonnes)
1	Salt-Range	213
2	Makarwal	22
	Total	235

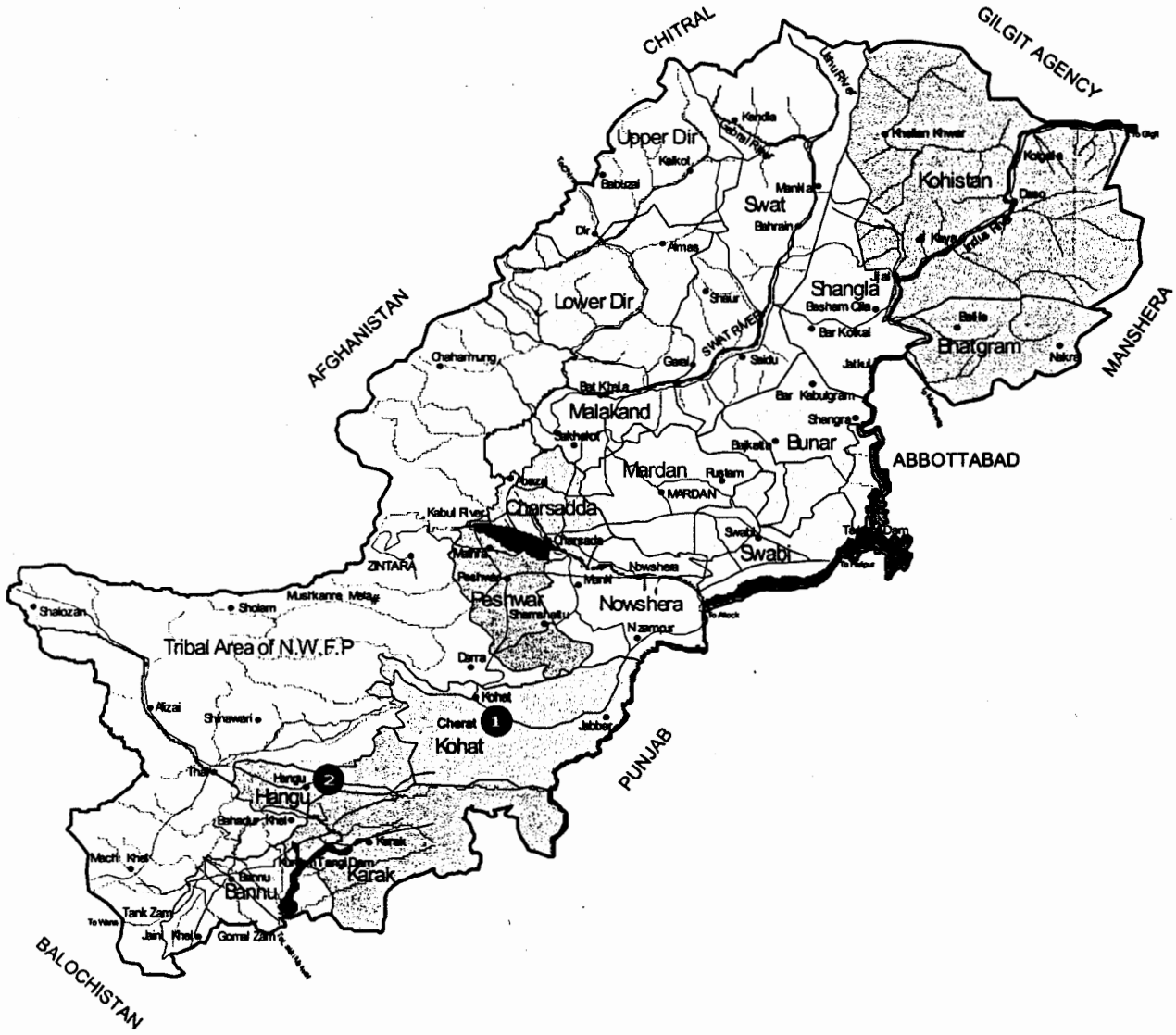


Appendix – V

Map of Coal Reserves in NWFP

IDENTIFIED COAL POTENTIAL IN NWFP

S.No.	Location	Coal (Million Tonnes)
1	Cherat	9
2	Hungu	82
	Total	91

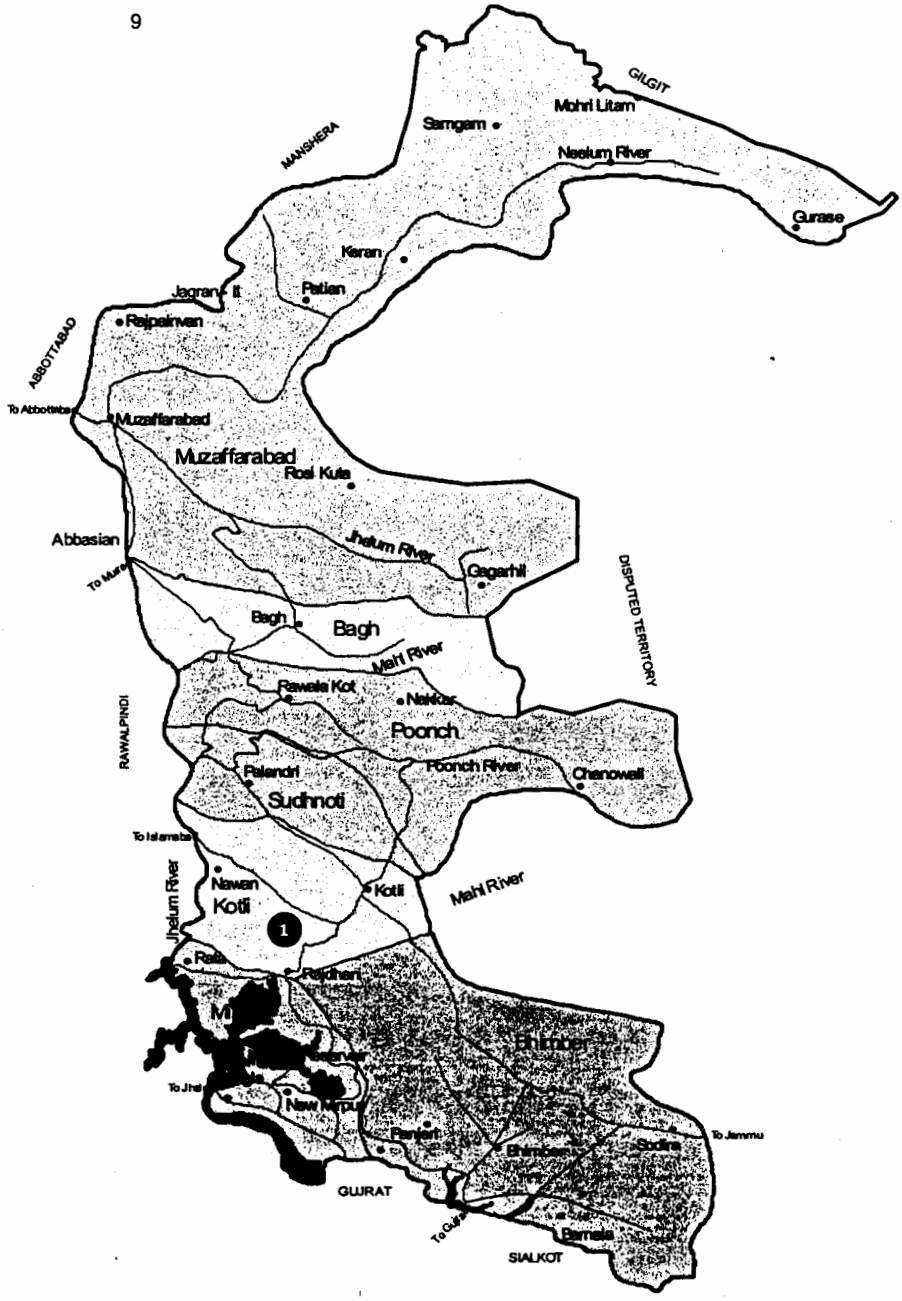


Appendix – VI

Map of Coal Reserves in Azad Jummu & Kashmir

IDENTIFIED COAL POTENTIAL IN AJK

S.No.	Location	Coal (Million Tonnes)
1	Kotli	9



LEGEND

- City/Town
- River
- Road
- District Boundary
- Coalfields

Coal fields showing generalized locations of preliminary CBM tests in Pakistan and the Mehsana CBM in India prepared by USGS in collaboration with USAID

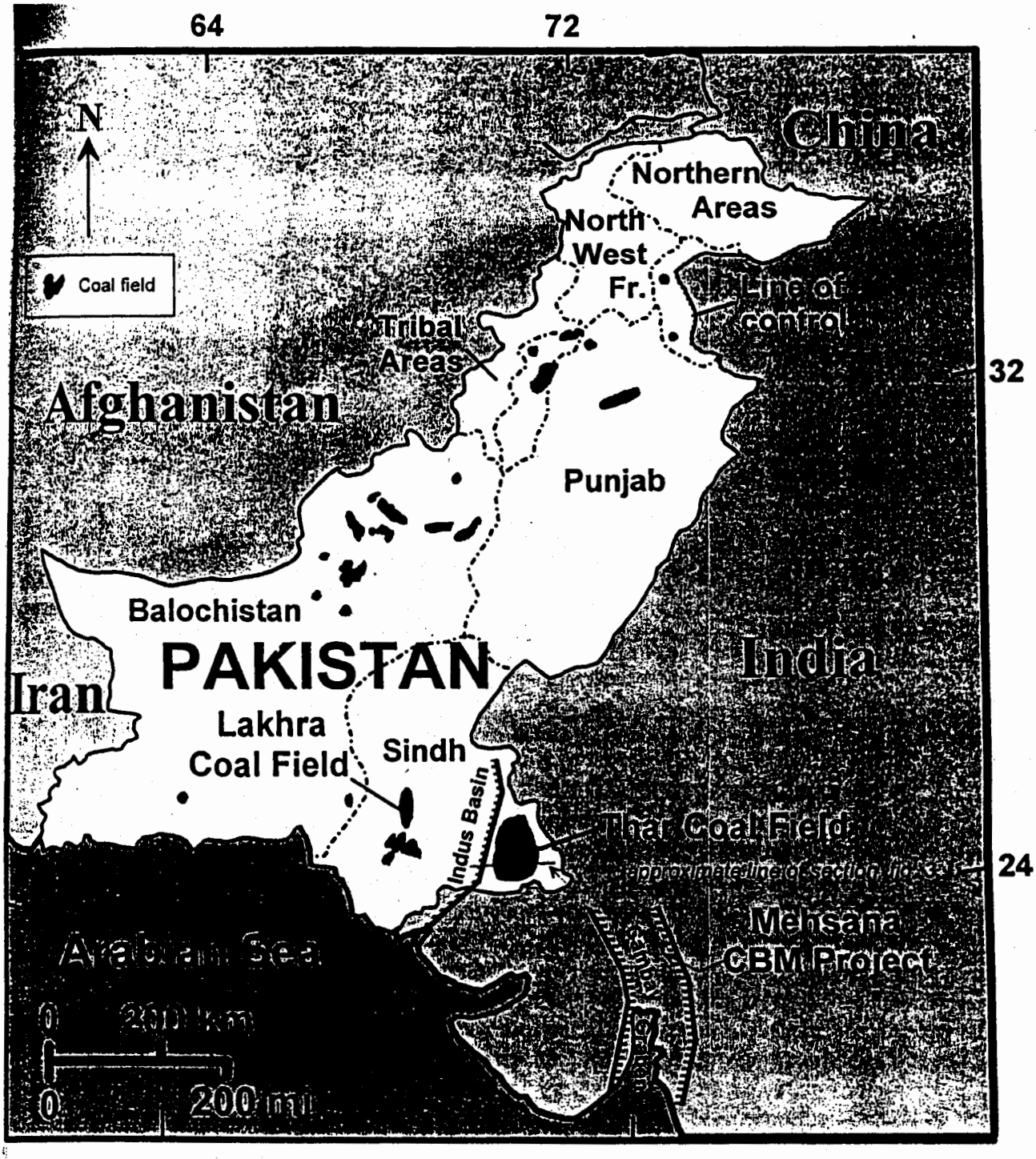


Figure 2. Coal fields of Pakistan, showing generalized locations of preliminary CBM tests (Lakhra and Thar) in Paksitan, and the Mehsana CBM project in India, which is currently shut-in until leasing issues can be resolved (Kelafant and Stern, 1998).

Conceptual Model
for
Thar Desert CBM prepared by John R. SanFilipo

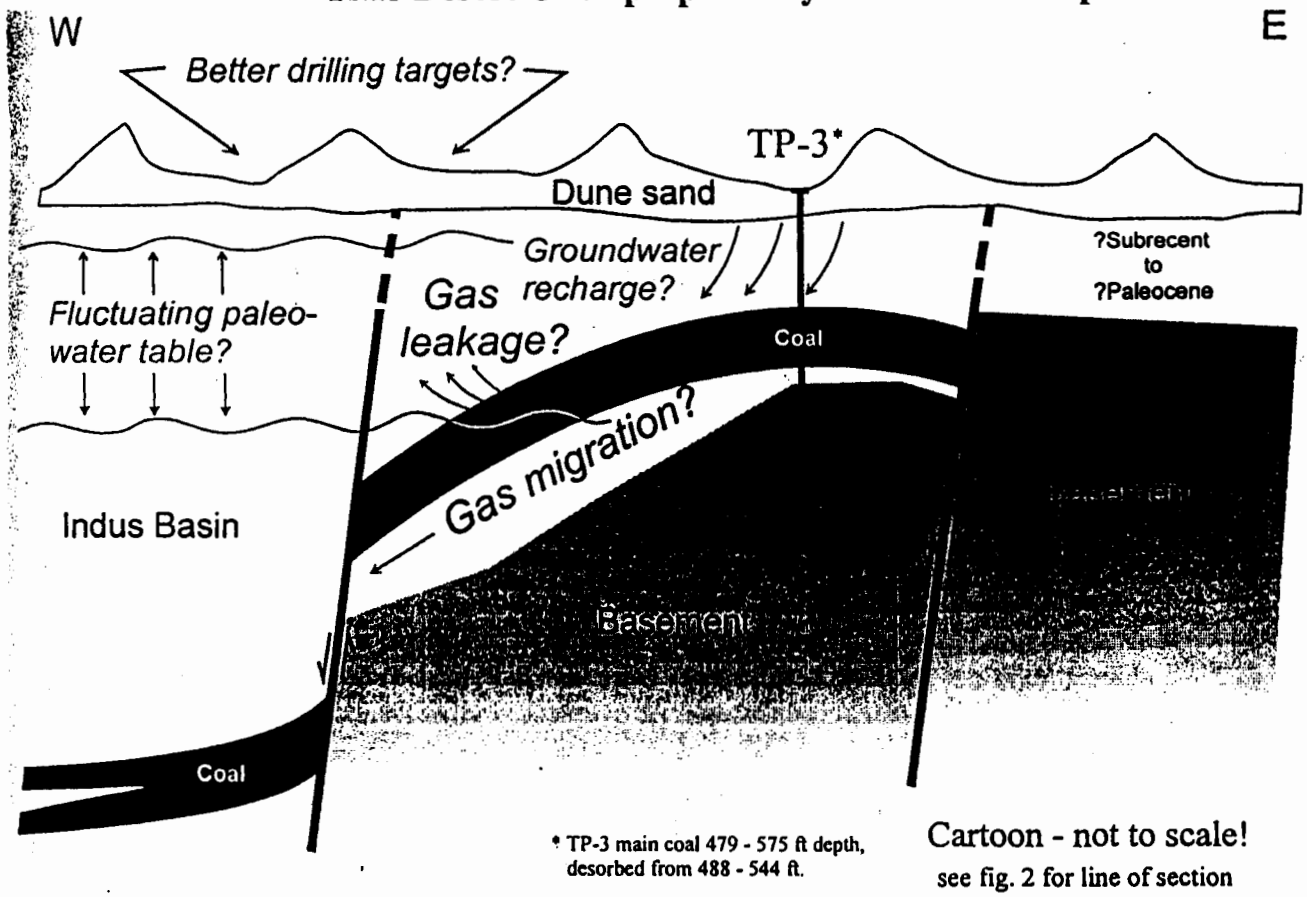


Figure 3. Conceptual model for Thar Desert CBM prospectivity. Borehole TP-3 was tested for CBM by the author and colleagues from the GSP during the initial phase of coal drilling in the Thar Desert in 1992. Only minor amounts of gas were recovered, but the techniques employed were primitive, and the site was probably not the best prospect for CBM. This site was selected for drilling early in the program because of the thick and relatively shallow coal that was recorded in nearby water wells. The primary objective at the time was delineating the Thar coal discovery, and CBM was a secondary objective. Although there was thought to be some potential at this location for a conventional-type trap, with a water drive from below (similar to the earliest producing areas of the Powder River Basin), these are rare for CBM. Unlike conventional reservoirs, CBM typically has a water cap. TP-3 lies on the top of the Thar basement platform, where it could have been subjected to groundwater recharge capable of flushing adsorption sites (a similar type of phenomenon seems to have occurred between barren and CBM-bearing holes in the U.S. Gulf Coast, see SanFilipo and others, in press). More importantly, the position of oxidized sediments in the TP-3 core indicates a fluctuating water table over geologic time (reported to have fluctuated several hundred feet in adjacent areas of India during the recent drought alone), which could have induced leakage of any accumulated gas. The site tested at Lakhra was on a similar geologic structure, and although deeper than most drilling in that coal field, was still relatively shallow for CBM (minor amounts of gas were desorbed from 568 to 629 ft depth), as were most holes drilled for COALREAP, which had mineable coal as the primary objective. Better CBM drilling targets probably

Appendix – IX

Notification Regarding Entrustment of CBM to Sindh

MINISTRY OF PETROLEUM AND NATURAL RESOURCES

Islamabad, the 28th February, 2007.

NOTIFICATION

S. R. O. 197(I)/2007[1].– In order to have a singular regulatory regime under a single and unified administrative body to govern coal mining, coal gasification, coal exploration, development and production of CBM, and in supersession of its Notification No. SRO 1042(I)/2006, dated the 22nd September, 2006, the Federal Government in exercise of the powers conferred by clause (1) of Article 146 of the Constitution of the Islamic Republic of Pakistan, is pleased to entrust to the Government of Sindh, with the consent of that Government the functions vesting in the Federal Government under, and pursuant to, the Regulation of Mines and Oilfields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948), in relation to the exploration and production of Coal Bed Methane (CBM), gas produced by drilling wells within the coal seams, that is, methane physically associated with coal (which includes methane absorbed, adsorbed, and contained in pores and fractures) and produced within coal seams and associated strata lying between the coal seams or immediately above the coal seams which has such distinct biomarker or footprint that conclusively proves to have been principally derived from a biogenetic source of an adjacent coal seams, which functions shall include the following, namely:–

(a) to grant, issue and renew licences, permits, authorizations, approvals, and consents for and in connection with the exploration, development and production of CBM;

(b) to prepare and issue rules and regulations and any subsequent modification or amendment thereto in consultation with the Ministry of Petroleum and Natural Resources, and the Ministry of Law, Justice and Human Rights, and to enforce and administer such rules and regulations, governing or otherwise relating to the exploration, development, and production of CBM;

(c) to enter into and execute agreements, contracts, memoranda and other documents in relation to the exploration, development, production of CBM, and matters relating to the carrying on or conduct of CBM related operations within the Province;

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[1] This Notification was published in the Gazette of Pakistan, Extraordinary, Part II, Islamabad, on the 5th March, 2007, at pages 844-845.

(d) to agree that any law, rule or regulation as in force on the effective date of a CBM agreement remaining applicable whether or not the same are subsequently amended or revised and to agree to honour the terms of a CBM agreement in case the provisions thereof are in conflict with any law, rule or regulation made subsequent to the execution of CBM agreement in pursuance of the rules;

(e) the Provincial Government and the Federal Government shall ensure that the operations of licencees or lessees granted rights with respect to CBM do not interfere with the operation of licencees or lessees granted rights by the Federal Government with respect to licencees or lessees holding petroleum rights, and any dispute in this regard will be referred to Dispute Resolution Committee to be chaired by the Minister for Petroleum and Natural Resources with two members each of the Federal and Provincial Governments;

(f) Resolution or interpretation of any matter between the Federal Government and the Provincial Government in relation to this notification shall be made through consultation with relevant government agencies; and

(g) The licence granted for CBM operation shall not be sold or transferred to any third party without the prior approval of the Provincial Government.

Sd/-
AHMAD WAQAR,
Secretary.

Bibliography

1. International Encyclopaedia of Laws by Muhammad Arif and Dr. Sohaib Qadar.
2. Pakistan's Upstream Petroleum Laws and related Legislations by Dr. Sohaib Qadar.
3. Oil/Gas Fields Labour Code – Safety Regulations, 1974, published by OGDC Ltd.
4. Petroleum Ownership and Petroleum Industry Contracts under the Islamic Law by Dr. Sohaib Qadar.
5. Oil and Gas Law by Howard R. Williams.
6. The Fundamentals of Oil and Gas, Directorate General of Petroleum Concessions, Ministry of Petroleum and Natural Resources, Government of Pakistan.
7. Economics of Worldwide Petroleum Production, by Richard D. Seba, OGCI Inc. and Petro Skills, LLC. 2003.
8. Upstream Oil and Gas Agreements, edited by Martyn R. David, London, Sweet & Maxwell.
9. Gas Sales and Gas Transportation Agreements, Principles and Practice, by Peter Roberts, London, Sweet & Maxwell.
10. Oil and Gas Exploration Contracts, by Anthony Jennings, London, Sweet & Maxwell.
11. Natural Gas Agreements, edited by Martyn R. David, London, Sweet & Maxwell.
12. Joint Operating Agreements, by Taylor and Winsor, Longman Law.
13. Manual of Oil and Gas Terms by Williams & Meyers, Mathew Bender and Company Inc., Lexis Nexis Group.
14. The Petroleum Act, 1934, & Constitution of Pakistan, 1973.
15. The Regulation of Mines and Oil Fields and Mineral Development (Government Control) Act, 1948.
16. Pakistan Petroleum (Production) Rules, 1949.
17. The Oil Fields Regulations, 1950.
18. The Pakistan Petroleum (Refining, Blending & Marketing) Rules, 1971.
19. The Petroleum Rules, 1985.
20. The Natural Gas Rules, 1960.
21. The Natural Gas (Price for Supplies by Producers) Rules, 1976.
22. The Natural Gas (Development Surcharge) Ordinance, 1967.
23. The Natural Gas (Development Surcharge) Rules, 1967.
24. The Liquefied Petroleum Gas (Production and Distribution) Rules, 2001.

25. The Marketing of Petroleum Products (Federal Control) Act, 1974.
26. The Oil and Gas Regulatory Authority Ordinance, 2001.
27. The Natural Gas Regulatory Authority Licensing Rules, 2002.
28. The Natural Gas Tariff Rules, 2002.
29. The Oil and Gas (Safety in Drilling and Production) Regulations, 1974.
30. The Regulation of Mines, Oilfields and Mineral Development (Government Control) Act, 1948.
31. The Mines Act, 1923.
32. The Consolidated Mines Rules, 1952.
33. The Minor Minerals Rules, 1933.
34. The Exemptions from the Provisions of Mines Act, 1923.
35. The Coal Mines Regulations, 1926.
36. The Coal Mines Pithead Bath Rules, 1946.
37. The Mines Creche Rules, 1946.
38. The Mining Board Rules, 1951.
39. The Pakistan Mining Concession Rules, 1960.
40. Petroleum Exploration & Production Policy, 1993, Ministry of Petroleum and Natural Resources, Government of Pakistan.
41. Petroleum Policy, 1994, Ministry of Petroleum and Natural Resources, Government of Pakistan.
42. Petroleum Policy, 1997, Ministry of Petroleum and Natural Resources, Government of Pakistan.
43. Petroleum Exploration & Production Policy, 2001, Ministry of Petroleum and Natural Resources, Government of Pakistan.
44. Different Reports & Documents relating to Coal & Coal Bed Methane Gas.
45. Principles of Physical Geography, F. J. Monkhouse, Hodder and Stoughton, London.
46. Pakistan Economic Survey, 2006-07, Ministry of Finance, Government of Pakistan.
47. Pakistan Coal Power Generation Potential, June, 2004, published by Private Power & Infrastructure Board, Islamabad.
48. Many other relevant research reports, documents and books.