Prospects for coal and clean coal technologies in Kazakhstan

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Abstract

The coal sector in Kazakhstan is said to have enough reserves to last over 100 years, but the forecasted reserves are expected to last several hundreds of years. This makes investing in the fuel and energy sector of the country an attractive option for many international and private organisations. The proven on-shore reserves will ensure extraction for over 30 years for oil and 75 years for gas. The future development of the domestic oil sector depends mainly on developing the Kazakh sector of the Caspian Sea.

The coal sector, while not a top priority for the Kazakh government, puts the country among the world's top ten coal-rich countries. Kazakhstan contains Central Asia's largest recoverable coal reserves. In future, the development of the raw materials base will be achieved through enriching and improving the quality of the coal and the deep processing of coal to obtain fluid fuel and synthetic substances. Developing shale is also topical. The high concentration of methane in coal layers makes it possible to extract it and utilise it on a large scale.

However, today the country's energy sector, which was largely established in the Soviet times, has reached its potential. Being alert to the impending problems, the government is planning to undertake large-scale modernisation of the existing facilities and construct new ones during 2015-30.

Acronyms and abbreviations

ACCESS	Assistance in Clean Coal and Environmentally Sound Storage Solutions
ADB	Asian Development Bank
ANMR	Agency for Regulation of Natural Monopolies
BAT	best available technologies
bbl/d	barrels (of oil) per day
BG	British Gas
C4	Climate Change and Coordination Centre
CAC	Central Asia Centre (gas pipeline)
CAEPCO	Central-Asian Electric Power Corporation
CBM	coalbed methane
CCT	clean coal technology
CHP	combined heat and power
CIS	Commonwealth of Independent States
CMM	coalmine methane
CNPC	China National Petroleum Company
CPC	Caspian Pipeline Consortium
DESA	Division for Sustainable Development (The UN)
EBRD	European Bank for Reconstruction and Development
ENRC	Eurasian Natural Resources Corporation
EU	European Union
GDP	gross domestic product
GHG	greenhouse gases
hvBb	high-volatile B bituminous coal
IMF	International Monetary Fund
INOGATE	INterstate Oil and GAs Transportation to Europe
JSC	joint stock company
Kazatomprom	National Atomic Company of Kazakhstan
KazNiPi	Kazakh Research Institute for Oil and Gas
KEGOC	Kazakhstan Electricity Grid Operating Company
KMG	(KazMunayGas) Oil and Gaz Company of Kazakhstan
KOREM	Operator of Kazakhstan Market of Electrical Energy and Capacity
KSCS	Kazakhstan's Sector of the Caspian Sea
KZT	Kazakhstan tenge (Kazakh currency − US$ 1 = KZT 146)
MoU	Memorandum of Understanding
mvb	medium-volatile bituminous coal
NBK	National Bank of Kazakhstan
ODS	ozone depleting substances
OECD	Organisation for Economic Co-operation and Development
OIC	Organisation of Islamic Conference
OJSC	Open Joint Stock Company
OPEC	Organisation of Petroleum Exporting Countries
OSCE	Organisation for Security and Co-operation in Europe
PPP	purchasing power parity (a basis for comparing GDP to reflect living cost)
PSA	Production Sharing Agreement
REC	regional energy company
SCO	Shanghai Cooperation Organization
SEAP	Sustainable Energy Plan
tce	tonnes of coal equivalent
toe	tonnes of oil equivalent
U	uranium

UCG	underground coal gasification
UNFC	United Nations Framework Classification
UNFCC	United Nations Framework Convention on Climate Change
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
WEC	World Energy Council
WPC	World Petroleum Council

Contents

Acronyms and abbreviations 2

Contents 4

1 Introduction 5
1.1 Key coal facts 6
1.2 Geographical profile 6

2 A brief political history 8

3 Economic overview 11
3.1 Energy overview 12

4 Institutions and energy policy 15
4.1 Kazakhstan's Energy Strategy 16
4.2 Overview of Kazakhstan's coal industry policy 20
4.3 Overview of the Kazakhstan electricity market policy 22

5 Primary energy supply 24
5.1 Natural gas 26
5.2 Oil 27
5.3 Nuclear energy 28
5.4 Renewable energy 29

6 Coal resources and reserves in Kazakhstan 31
6.1 Hard coal reserves and where the coal is found 31

7 Coal mining, coal geology and quality 33
7.1 Labour productivity 35
7.2 Mine safety 35

8 Coal supply trends – domestic production and world trade 36

9 Estimating the cost of coal and coal production in Kazakhstan and inland transport 39

10 Environmental issues 42

11 Electricity transmission and distribution 45
11.1 Electricity exports and interconnections 47
11.2 Existing coal-fired capacity 47

12 Coal-fired power and cleaner coal technologies 49
12.1 Coalbed/coalmine methane 50

13 Co-operation agreements with foreign countries 53

14 Conclusions 54

15 References 56

1 Introduction

Kazakhstan was the last of the Soviet republics to declare independence, in 1991, but does not appear to have had the same scale of reduction in the coal industry as, for example, Ukraine did during the same period. The country has vast oil and gas reserves, as well as iron and gold. Kazakhstan is also planning to become one of the world's leading producers of uranium in the coming years.

Kazakhstan contains Central Asia's largest coal reserves. According to BP (2010) Kazakhstan has about 28 Gt proven reserves of anthracite and bituminous hard coal; reserves of lignite and subbituminous coal comprise an additional 3 Gt. In 2009, Kazakhstan was the ninth largest producer of hard coal in the world at close to 80 Mt. Kazakhstan exported about a third of its output to Russia.

The country often gets overlooked due to its lack of presence in the international seaborne market, but there is no shortage of interest in the country as an exporter. Arcelor-Mittal pledged to invest $500,000 to boost coal production. A venture between Samsung, Kepco and Kazakhstan could start building a 1.2–1.5 GW coal-fired plant near Almaty in Kazakhstan by 2013, according to a government minister. Construction could be completed by 2018 or 2019, with the government owning the plant while the operators will sell power to recover their investment (Power Engineering International, 2011). Russian firms are also stakeholders in the Kazakh mines, and the country's role as a commodity producer is growing in importance. Over the past ten years, small shipments of coal have gone to Denmark, France, Hungary, Italy, Poland, Romania and Sweden.

Kazakhstan has about 18 GW of installed electricity capacity, of which some 14 GW is coal fired, most of it built before 1990. Coal-fired power accounts for 80% of the nation's capacity, the remainder being hydroelectric. Of these, more than half consists of old, supercritical technology. While Kazakhstan has ample generating capacity, the transmission and distribution lines remain weak, given the vastness of the country and the lack of investment, power blackouts are a common occurrence.

While coal production had decreased somewhat since independence in 1991, and a spate of mine safety closures has occurred in more recent years, there is scope for the country to maintain economic momentum by tapping into its coal reserves.

Kazakhstan has the potential to supply coal to both neighbouring countries and further afield, but a better understanding of the power generation and coal production sectors could highlight some of the opportunities and challenges that the country will face in building up its own coal and clean coal technologies.

This report will examine:

- indigenous energy resources (coal, oil, gas, nuclear, hydro, renewables) and the relative importance of each in the national economy;
- coal production (types produced, status of national mining industry, and future prospects);
- coal imports and/or exports (coal types, scale, sources and locations);
- scale of national coal consumption and future prospects in all main market sectors;
- environmental issues associated with the use of coal;
- current deployment of clean coal technologies and future prospects in relevant market sectors;
- types of technologies being deployed or planned;
- measures being adopted to encourage increased uptake of CCTs (funding programmes, energy policy, etc).

1.1 Key coal facts

It is difficult to provide exact numbers for Kazakhstan's coal industry. Definitions of coal reserves vary from one country to the next. The US Geological Survey (USGS) defines coal resources as 'naturally occurring deposits in such forms and amounts that economic extraction is currently or potentially feasible.' USGS defines coal reserves as 'the part of the coal resource that can be mined economically, at the present time, given existing environmental, legal, and technological constraints.' Other countries use different definitions.

Therefore, the estimates vary for different information sources. Furthermore, the information available is offered in various units such as metric tonnes (t), short tons (St) and tonnes of oil equivalent (toe), or tonnes of coal equivalent (tce). While some conversion factors are straightforward, such as short tons to tonnes, some, such as 'toe' to 't', are not and depend on the type of coal used, which complicates the matter when dealing with a mix of coal types. This report attempts to keep, as much as possible, all units consistent, in Mt.

Total coal production (2009 estimate):	80 Mt (BP, 2010); numbers obtained from Kazakhstan put this value at 120 Mt
Total coal demand (2009 estimate):	50 Mt (BP, 2010); numbers obtained from Kazakhstan put this value at 80 Mt
Exports (2009 estimate):	22.7 Mt (IEA Coal information 2010a); numbers obtained from Kazakhstan put this number at 40 Mt, out of which 30 Mt go to Russia
Imports (2009 estimate):	0.27 Mt (IEA Coal information, 2010a)
Net exports (2009):	–39.7 Mt
Recoverable reserves (2009 estimate):	31,300 Mt (28,170 Mt anthracite and bituminous and 3130 Mt subbituminous and lignite) (BP, 2010); numbers obtained from Kazakhstan put this number at 64,000 Mt
Total reserves (2008 estimate):	146,230 Mt (Methane to Market, 2009); numbers obtained from Kazakhstan put this number at 170,000 Mt

People employed by the coal and coal related industries: 200,000 in mining and quarrying and 165,000 in electricity, gas and water supply (International Labour Organisation-ILO, 2009).

1.2 Geographical profile

The Republic of Kazakhstan is located in Central Asia, northwest of China, with a small portion west of the Ural River in eastern-most Europe. It has a total area of 2,724,900 km^2, out of which 2,699,700 km^2 is land and 25,200 km^2 is water. It ranks ninth in the world in terms of area, being slightly less than four times the size of Texas.

Total land boundaries cover 12,185 km out of which 1533 km with China, 1224 km with Kyrgyzstan, 6846 km with Russia, 379 km with Turkmenistan and 2203 km with Uzbekistan. Kazakhstan also borders the landlocked Aral Sea, now split into two bodies of water (1070 km), and the Caspian Sea (1894 km) (*see* Figure1).

The terrain of Kazakhstan ranges from vast flat steppes extending from the Volga in the west to the

Figure 1 Map of Kazakhstan and its provinces (Wikipedia, 2011)

Altai Mountains in the east and from the plains of western Siberia in the north to oases and deserts of Central Asia in the south. The climate is continental, with cold winters and hot summers, arid and semi-arid. Kazakhstan's capital was moved in 1997 from Almaty (formerly Alma-Ata) to Astana, which is considered one of the coldest capital cities on earth.

Russia leases approximately 6000 km^2 of territory enclosing the Baikonur Cosmodrome; in January 2004, Kazakhstan and Russia extended the lease to 2050

The estimated population in July 2011 was 15,522,373 (the 2010 census recorded a population of 16.2 million people putting Kazakhstan 62nd in the world). The population density is less than six people per square kilometre.

According to the 2009 census, the ethnic composition of Kazakhstan's population is: Kazakh 63.1%, Russian 23.7%, Uzbek 2.8%, Ukrainian 2.1%, Uighur 1.4%, Tatar 1.3%, German 1.1%, other 4.5%. Kazakhstan is officially a bilingual country. Kazakh, the state language, is spoken by 64.4% of the population, while Russian, the other official language, is used in everyday business, designated the 'language of inter-ethnic communication' and is spoken by 95% of the population. The religions of Kazakhstan are: Muslim 47%, Russian Orthodox 44%, Protestant 2%, and other 7%. Kazakhstan is ethnically and culturally diverse, in part due to mass deportations of many ethnic groups to the country during Stalin's rule.

Kazakhstan is divided into 14 provinces (*see* Figure 1). Almaty and Astana cities have the status of State importance and do not relate to any province. Baikonur city has a special status because it is currently being leased to Russia with Baikonur cosmodrome until 2050. Each province is headed by an Akim (provincial governor) appointed by the president. Municipal Akims are appointed by the provincial Akims.

2 A brief political history

On the 'about Kazakhstan (2010)' web page it is stated that:

> 'Kazakhstan history goes back to before our era, when numerous nomadic tribes inhabited what is now Kazakhstan. The historians of antiquity called them the Saka. For many centuries the land of the Saka was the scene of bloody, devastating wars. Many conquerors had encroached on that land.
>
> 'In 1218, Mongol-Tatar hordes led by Genghis Khan invaded Kazakhstan. They swept over the Kazakh land with fire and sword. As a result of those aggressive campaigns, Kazakhstan, like the entire Central Asian region, was incorporated in the vast empire of the Mongol known in world history as the Golden Horde. However, the Golden Horde turned out to be an unstable state. Undermined by internal wars between the feudal lords and the liberation struggle of the conquered peoples, it eventually disintegrated into separate tribal alliances.
>
> 'By the early Middle Ages, a number of large field-farming oases with a sedentary population appeared in Kazakhstan. Alongside crop farming, it was engaged in horticulture and melon growing. Feudal towns began to emerge in these parts and soon established a brisk trade with neighbouring countries such as China, Iran and the states of Central Asia.
>
> 'In the second half of the 15th century the first Kazakhstan khanates (states) were formed. However, a long time was to pass before Kazakhstan grew into a single political entity.
>
> 'There were constant wars among the khanates accompanied by the plundering of the population. Feudal disunity and internal strife hindered the economic and cultural progress and considerably weakened the defence capacity of the Kazakh states. For nearly a hundred years Kazakhstan people waged a struggle against the Dzungar. The invaders levied heavy taxes on Kazakhs and dealt ruthlessly with anyone who resisted.
>
> 'The country was also a victim of constant raids carried out by the Volga Kalmyks. In the south, it was under the threat of invasion by the Central Asian khanates of Khiva, Bokhara and Kokand. In 1731 an act on Kazakhstan's accession to Russia was signed. Despite the colonial policy of the Russian government, this was an important step, which opened before the Kazakhs the opportunity of establishing direct economic and cultural links with Russian people. Crop farming began to develop rapidly, industrial enterprises were set up.
>
> 'In the first half of the 19th century the influence of Russia's economy on the backward economy of Kazakhstan grew stronger: an increasing number of Kazakhs settled down and took up crop farming. As the output of agriculture produce rose, Kazakhstan's trade and economic ties expanded. In the late 19th century capitalism penetrated the agricultural sector, intensifying the process of stratification in the auls (Kazakh villages).
>
> 'The First World War brought innumerable calamities to the people of Kazakhstan as to the entire people of Russia. Livestock, fodder and agricultural produce were requisitioned from the Kazakhs. Taxes and levies of all kinds were increased. After the revolution of October 1917 the Bolsheviks ignored the ethnic differences of the people. However, in 1925, the Kazakh appellation is reinstated; the Kazakh Autonomous Soviet Socialist Republic (SSR) was given the capital at Alma-Ata. However, Kyzylorda remained the capital until 1929.
>
> 'During the 20th century, Kazakhstan was the site of major Soviet projects, including

Khrushchev's Virgin Lands campaign, the Baikonur Cosmodrome, and the Semipalatinsk 'Polygon', the USSR's primary nuclear weapon testing site. In the 1950s, Nikita Khrushchev decided to use Kazakhstan to showcase Soviet ingenuity in land management and agriculture. As a result, he appointed Leonid Brezhnev First Secretary of Kazakhstan and commissioned him to carry out what was later known as the 'Virgin Lands' project.

'Helped by Kazakh Dinmukhammad Kunayev and a large number of Kazakh youths, Brezhnev turned the ancestral Kazakh grazing lands into wheat and cotton fields. While this was a major plan for the Soviet Union the project played havoc with the lives of the Kazakhs. Distanced from their major sources of self sufficiency, bread and meat, they became entirely dependent on imports from the rest of the Soviet Union.

'The 1960s and 1970s saw the arrival of a different group of Soviets, the technicians who worked the coal and gas deposits and who took charge of the oil industry. This new community, added to the old farming and mining communities, tipped the balance against the Kazakhs who began to become a minority in their own country.

'After Brezhnev, Kunayev became First Secretary. Using ancient Kazakh institutions such as tribal hierarchy, Kunayev forged a new system of exploitation within the already exploitative Soviet system. As the chief of the 'tribe' he made all the decisions on hiring and firing of managers of major firms and plants. Then using 'bata', or 'sealed lip', he prevented any information that could damage his operation from reaching the Centre in Moscow. The Kunayev empire, built around a core of his kinsmen, grew very strong. It would have grown even stronger if not for Mikhail Gorbachev who displaced Kunayev as First Secretary and installed a Russian, Gennadii Kolbin, in his place. As for Kunayev, he refused to disappear quietly. Rather, he set his own forces into motion and created the so-called 'Alma-Ata riots' of the late 1980s, the first to shake the foundation of the Soviet Union.' (About Kazakhstan)'

Kazakhstan declared itself an independent country on 16 December 1991, the last Soviet republic to do so. Its last communist era leader, Nursultan Nazarbayev, became the country's new president. Since independence, Kazakhstan has pursued a balanced foreign policy and worked to develop its economy, especially its hydrocarbon industry. While the country's economic outlook is improving, President Nazarbayev maintains strict control over the country's politics. Nevertheless, Kazakhstan's international prestige is building. It is now considered to be the dominant state in Central Asia. The country is a member of many international organisations, including the United Nations, the Euro-Atlantic Partnership Council, the Commonwealth of Independent States, and the Shanghai Cooperation Organization. Kazakhstan is one of the six post-Soviet states who have implemented an Individual Partnership Action Plan with NATO. In 2010, Kazakhstan chaired the Organisation for Security and Cooperation in Europe.

Kazakhstan is officially a presidential republic displaying an authoritarian presidential rule, with little power outside the executive branch. The first and only president is Nursultan Nazarbayev, former chairman of the Supreme Soviet from 22 February 1990, who was elected president on 1 December 1991. The head of government is Prime Minister Karim Masimov (since 10 January 2007); there are also three deputy Ministers. The Cabinet, or Council of Ministers, is appointed by the president. The president is also the commander-in-chief of the armed forces and may veto legislation that has been passed by the Parliament. The Prime Minister chairs the Cabinet of Ministers and serves as Kazakhstan's head of government. There are three deputy Prime Ministers and 16 Ministers in the Cabinet.

Kazakhstan has a bicameral Parliament consisting of an upper house (the Senate) with 47 members, fifteen of which are appointed by the President, and a lower house (the Mazhilis) with 107 members, nine of which are elected by the Assembly of the People of Kazakhstan, a presidentially appointed

advisory body designed to represent the country's ethnic minorities; non-appointed members are popularly elected to serve five-year terms).

The judicial branch is represented by the 44 members of the Supreme Court and the seven members of the Constitutional Council.

3 Economic overview

Kazakhstan, the largest of the former Soviet republics in area, after Russia, possesses large fossil fuel reserves and supplies of other minerals and metals. It also has a large agricultural sector featuring livestock and grain. Kazakhstan's industrial sector is primarily focused on the extraction and processing of these natural resources. Kazakhstan enjoyed double digit growth in 2000-01 and 8% or more per year in 2002-07 − thanks largely to its booming energy sector but also to economic reform, good harvests, and increased foreign investment; GDP growth slowed to 3.3% in 2008, and to 1% in 2009, however, as a result of declines in oil and metals prices and problems in the banking sector following the global financial crisis. In the energy sector, the opening of the Caspian Pipeline Consortium in 2001, from western Kazakhstan's Tengiz oilfield to the Black Sea, substantially raised export capacity. In 2006, Kazakhstan completed the Atasu-Alashankou portion, and, in 2009, also completed the Kenkiyak-Kumkol portion of an oil pipeline to China that is planned to extend from the country's Caspian coast eastward to the Chinese border. The country has embarked upon an industrial policy designed to diversify the economy away from overdependence on the oil sector by developing its manufacturing potential. The policy changed corporate tax to favour domestic industry as a means to reduce the influence of foreign investment and foreign personnel. The government has engaged in several disputes with foreign oil companies over the terms of production agreements, most recently with regard to the Kashagan project in 2007-08 and the Karachaganak project in 2009. Since 2007, Astana has provided financial support to the banking sector that has been struggling with poor asset quality and large foreign loans – problems that have been amplified by the global financial crisis in 2009 (CIA, 2010).

Since 2002, Kazakhstan has sought to manage the strong inflows of foreign currency without sparking inflation. Inflation has not been under strict control, however, registering 6.6% in 2002, 6.8% in 2003, and 6.4% in 2004.

In 2000, Kazakhstan became the first former Soviet republic to repay all of its debt to the International Monetary Fund (IMF), seven years ahead of schedule. In March 2002, the US Department of Commerce granted Kazakhstan market economy status under US trade law. This change in status recognised substantive market economy reforms in the areas of currency convertibility, wage rate determination, openness to foreign investment, and government control over the means of production and allocation of resources. In September 2002, Kazakhstan became the first country in the CIS to receive an investment grade credit rating from a major international credit rating agency.

The GDP – purchasing power parity (PPP) – was US$181.9 billion in 2009, while the GDP based on the official exchange rate was US$109.3 billion. GDP's real growth rate was 1% in 2009, compared to 3.3% in 2008 and 8.9% in 2007. PPP per capita was US$11,800 in 2009. Kazakhstan's public debt in 2009 was estimated at 14.2% of its GDP (*see* Figure 2).

Kazakhstan's labour force was 8.7 million 2009, out of which: 31.5% was in agriculture, in industry 18.4% in industry and 50% in services. The country's main industries are oil, coal, iron ore, manganese, chromite, lead, zinc, copper, titanium, bauxite, gold, silver, phosphates, sulphur, iron and steel, tractors and other agricultural machinery, electric motors, and construction materials. The industrial production growth rate in 2009 was estimated at 1.8% (CIA, 2010).

Development of petroleum, natural gas, and mineral extraction has attracted most of the over US$40 billion in foreign investment in Kazakhstan since 1993 and accounts for some 57% of the nation's industrial output (or approximately 13% of the gross domestic product). According to some estimates, Kazakhstan has the second largest uranium, chromium, lead, and zinc reserves, the third largest manganese reserves, the fifth largest copper reserves, and ranks in the top ten for coal, iron, and gold in the world. It is also an exporter of diamonds.

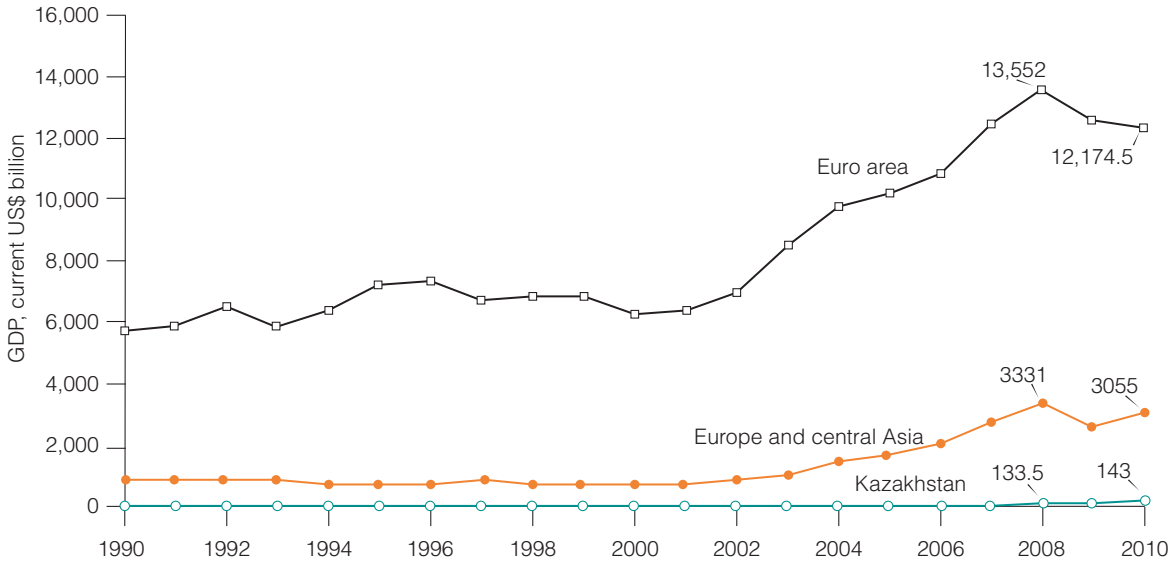

Figure 2 Kazakhstan's GDP evolution (World Bank, 2011)

Agriculture accounted for 10.3% of Kazakhstan's GDP in 2005. Grain (Kazakhstan is the seventh largest producer in the world) and livestock are the most important agricultural commodities. Wheat exports, a major source of hard currency, rank among the leading commodities in Kazakhstan's export trade.

3.1 Energy overview

Energy is the leading economic sector in Kazakhstan. One of the country's top priorities is the efficient development of its Caspian off-shore energy resources. Recent developments in this area give hope that further development of North Caspian oil and gas fields will start in the not too distant future.

Originally, the status of the Caspian Sea was regulated by the bilateral treaties of 1921 and 1940, made between the former Soviet Union and Iran. With the break-up of the Soviet Union, offshore territorial rights have generally become more complex. While Iran, Russia and Turkmenistan have argued the case for equal sharing of the assets, Kazakhstan and Azerbaijan have always preferred a formal political division based on the extension of country boundaries into the Caspian Sea.

Russia later changed its view and supported Kazakhstan and Azerbaijan, arguing for the delineation of the seabed based on the principle of equal distance or median line, this basically depending on the length of the shoreline. In 2002 Kazakhstan signed bilateral agreements with Russia and Azerbaijan on delimitation of the Northern Caspian seabed and the joint development of the Khvalynskoe, Tsentralnoe and Kurmangazy off-shore oilfields with Russia.

In 2003 Kazakhstan adopted a State Programme of development of the Kazakhstan sector of the Caspian Sea the main target of which is to boost environmentally safe oil and gas production to generate revenues to help diversification and modernisation of the whole economy, to make it highly competitive and non-dependent on the oil and gas sectors.

The world demand for quality uranium fuels increases year by year. In 2010 nuclear power plants produced around 16% of world electricity power and forty new power generating units are being constructed in fifteen countries. Kazakhstan has been an important source of uranium for more than fifty years. Approximately one fifth of world uranium reserves are deposited in Kazakhstan. Total resources and reserves of uranium are over 1.5 Mt, of which over 1.1 Mt can be mined by the in-site leaching method. Some 50 uranium deposits are known, in six provinces. During 2001-06 the

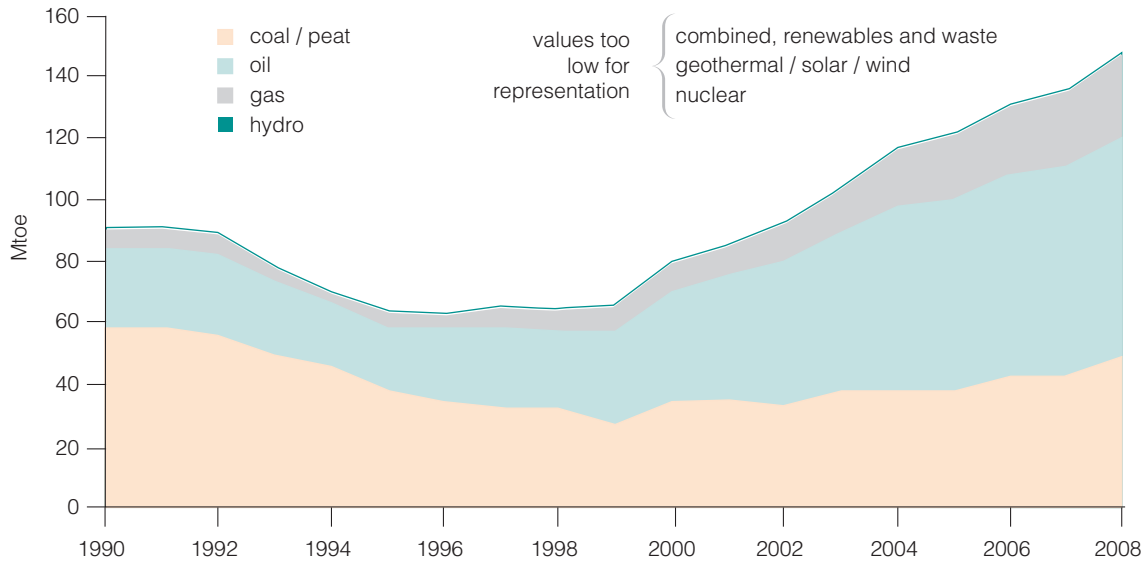

Figure 3 Energy production – Kazakhstan (IEA, 2010b)

Table 1 Energy sources in Kazakhstan by year (Vassilyev, 2011)

	1992	1994	1996	1998	2000	2002	2004	2006	2008	2010
Coal, Mt	126.5	104.6	76.8	69.8	74.9	73.7	86.9	96.2	111.1	110.8
Electric energy, TWh	82.7	66.4	59	49.1	51.6	58.3	66.9	71.7	80.3	82.7
Thermal energy, Mtoe	12.5	9.8	7.6	6.7	6.5	7.9	8.7	8.3	9.4	9.6

production rose from 2000 to more than 5000 tU/y and further active mine development is under way with a view to reach annual production of 15,000 tU/y by 2010 which will make Kazakhstan the biggest uranium producer in the world. State-owned National Atomic Company, Kazatomprom, is the sole organisation for uranium mining, reprocessing, export and import operations in Kazakhstan.

Kazakhstan, possessing sizable amounts of oil, gas, coal and uranium is an important energy player in the world. However, having these abundant natural energy resources, the government and the country's energy sector keep an eye on global energy trends. Optimal energy mix, efficient energy use, significant environment component of energy policy, research and development of renewable energies are all on the country's energy policy agenda. In 2006 Kazakhstan produced its first wheat-based bio-ethanol and this private sector programme will expand further.

An important part of the energy infrastructure of Kazakhstan was built many years ago using technologies and means which were up-to-date for those times. However, since energy transportation and infrastructure are key elements of a viable energy policy in the country, the EU and its Energy Commissioner identified their strong interest to co-operate with Kazakhstan in this area in 2009, particularly on trans-continental gas and oil transportation issues. Kazakhstan has made it clear that this fully meets its own vision for the development of multiple energy transportation routes from and through Kazakhstan (*see* Figure 3 and Table 1).

In fact, a Memorandum of Understanding (MoU) between the European Union and the Republic of

Kazakhstan was signed as early as December 2006 MoU on Co-operation) This MoU covers two main areas of joint interest in the field of energy.

- Roadmap for enhancing energy security by addressing exchange of information, consultations on energy scenarios, and facilitation of the development of new energy infrastructure of mutual interest.
- Roadmap of industrial cooperation by addressing events such as joint conferences and seminars in the field of energy, development and introduction of alternative energy sources, as well as ecologically clean and energy saving technologies, in order to make the investment climate in Kazakhstan even more attractive.

Commercial viability, technical and environmental safety and financial soundness are the expressed guiding principles for Kazakhstan's strategy in this crucial area.

4 Institutions and energy policy

Kazakhstan owns large reserves of energy resources, and therefore the energy policy of Kazakhstan has influence over the world's overall energy supply. Although Kazakhstan has not described itself as an energy superpower, Kazakhstan's president Nursultan Nazarbayev has claimed Kazakhstan will become a factor of energy security in Asia and Europe (Academic dictionaries and encyclopedias, 2006). Kazakhstan has a strategic geographical location to control oil and gas flows from Central Asia to East (China) and West (Russia, global markets).

The responsible governmental agency for energy policy was, until 2009, the Ministry of Energy and Mineral Resources, in Astana. After 2009, the responsibility was transferred to the Ministry of Industry and New Technology. In June 2003, the government of Kazakhstan announced a new Caspian Sea development programme, according to which, new offshore blocks of oil and gas would be auctioned. In 2005, the government introduced new restrictions granting status of contractor to the state-owned oil and gas company KazMunaiGas, and at least half of any production sharing agreement (PSA). A new tax structure, which came into effect in January 2004, included a 'rent tax' on exports, a progressive tax that increases as oil prices grow. The amendment raised the government's share of oil income to 65–85%.The new structure includes an excess profit tax, and limits foreign participation to 50% in each off-shore project with no guarantees of operatorship. The remaining share will belong to KazMunaiGaz (KMG).

In 2005, Kazakhstan amended the subsoil law to pre-empt the sale of oil assets in the country. These changes helped the state's case to buy part of British Gas (BG's) share of the Kashagan project. Another amendment to the country's subsoil law in 2005 extended the government's power to buy back energy assets by limiting the transfer of property rights to strategic assets in Kazakhstan. This helped legitimise the government's bid to acquire a 33% share in Canadian-based PetroKazakhstan after it agreed to a takeover deal with China National Petroleum Corporation (CNPC).

The leading oil industry company is the state-owned oil company KazMunaiGas. The landmark foreign investment in Kazakh oil industry is the Tengiz-Chevroil joint venture, owned 50% by ChevronTexaco, 25% by ExxonMobil, 20% by the Government of Kazakhstan, and 5% by Lukarco of Russia. The Karachaganak natural gas and gas condensate field is being developed by BG, Agip, ChevronTexaco, and Lukoil. Chinese, Indian and Korean oil companies are also involved in the Kazakhstan's oil industry.

Uranium is produced by Kazatomprom, a state-owned holding company which also represents Kazakhstan in the joint ventures with Russian Tekhsnabexport, French AREVA and Canadian Cameco.

Kazakhstan's growing petroleum industry accounts for roughly 30% of the country's GDP and over half of its export revenues. As a result, the Kazakhstani government and financial institutions like the IMF have been concerned about 'Dutch Disease', the economic phenomenon that occurs when large influxes of foreign currency distort exchange rates and ultimately hinder growth in the non-energy sector. In its latest report, however, the IMF cites 'impressive' growth in the non-oil sector that could help avoid oil related growth problems. In an effort to reduce Kazakhstan's exposure to price fluctuations for energy and commodities exports, the government created the National Oil Fund of Kazakhstan. Due to high oil prices, the fund has increased to $24 billion in 2006.

The National Bank of Kazakhstan (NBK) will have to support tighter monetary and fiscal policies since the Bank has missed its inflationary targets for several years. The NBK has mitigated rising price pressures by increasing interest rates twice in 2006 after two similar moves were made during 2005.

Kazakhstan's President, Nursultan Nazarbaev, has been involved in the country's politics since 1977 when he served as Secretary of the Central Committee of the Communist Party of Kazakhstan. In April 1990, Nazarbaev became interim president of the newly independent Republic of Kazakhstan, and was later elected to the post in the country's first national elections, held in December 1991. Nazarbaev was re-elected in December 2005 and in April 2011.

The Kazakh executive branch was re-shuffled in June 2003 when then Prime Minister Imanghaliy Tasmaghambetov resigned from his position. A new Prime Minister, Daniyal Akmetov, was appointed along with a new cabinet, including numerous holdovers from the previous administration. Parliamentary elections were held in 2004, during which the party led by Dariga Nazarbaev, the president's daughter, won 11% of the vote. Opposition parties have alleged that authorities committed election fraud, and one month after the elections were over, the speaker of the parliament resigned because he described the election as being 'manipulated'.

4.1 Kazakhstan's Energy Strategy

Kazakhstan's energy policy is addressed by several documents. One of the most important is 'Kazakhstan's development strategy to 2030' (Strategy 2030). In this document, energy figures as one of the important parts of the country's economy, stressing the need for 'rapid growth in the production and export of oil and gas, to obtain the income needed for the sustained economic growth and to guarantee improvement of the population's standard of living.' The document includes the strategy for the development of the country's fuel and energy sectors and addresses energy efficiency and energy savings. Strategy 2030 is divided in two periods, up to 2015 and up to 2030.

Commercial viability, technical and environmental safety and financial soundness are the guiding principles for Kazakhstan's strategy in the energy area, according to documents released by many Kazakhstan Embassies (for example, the USA, UK, Israel and Thailand).

In 2003 the Government of Kazakhstan adopted The Innovative Industrial Development Strategy until 2015 (New Industrial Development Strategy). Acknowledging the economic dependence on the energy industry, the objective of the strategy is to ensure sustainable development of the domestic economy through its genuine diversification, creation of new competitive industries, modernisation and expansion of the existing infrastructure with the ultimate goal of moving from an extraction-based industry to a service-and-technology-based economy. Kazakhstan's objective is to become one of the 50 most competitive countries in the world by 2015.

In 2001, the Asian Development Bank (ADB) approved a US$150,000 technical assistance grant to Kazakhstan to prepare an energy strategy to focus on increasing investment and expanding power supply to poor and remote areas. The ADB has also agreed to administer a US$95,000 grant from the Government of Finland to support the study. The total cost of the study, US$363,000, is financed by ADB (41%), Finland (26%) and the Kazakhstan government (the balance).

In its transition path Kazakhstan faces a number of strategic challenges, many of which have been emphasised by the economic and financial crisis. The crisis has highlighted Kazakhstan's excessive dependence on primary industries and commodity exports. With oil production expected to increase significantly in the coming years and with oil prices rising, the underlying economic tendencies – real exchange rate appreciation and human and financial resources flowing to the hydrocarbon sector – will make economic diversification even more challenging.

In March 2010, the Kazakh government issued a 'Government Programme for the accelerated development of industrial innovation in the Republic of Kazakhstan, 2010-14'. This programme contains six important items, with each of them containing a number of sub-items, addressing specific targeted areas of activity.

The first item of the programme covers:

1 The development of priority sectors of the economy, dealing with its diversification and increase of its ability to compete. The first sub-item is:

1.1 Diversifying the production of the 'traditional industries' in the oil and gas sectors, including:
- the petrochemical industry;
- the mining and metallurgical industries;
- the chemical industry;
- the nuclear industry.

It is interesting to note that the coal industry gets no specific mention anywhere, either under this item, or under any of the other five items, confirming that coal is not a priority for the Kazakh government at that time,

Figures 4 and 5 also show that, while the investments in research and development for the use of hydrocarbons have increased during 1996-2009, this does not apply to the coal industry.

The EBRD is supporting the government of Kazakhstan's strategic directions to get on the path of economic recovery, as well as to assist the country in confronting its fundamental transition challenges, one of which is to advance the transformation of the energy sector through implementation of the milestone principles of the Sustainable Energy Plan (SEAP), signed with the Government in 2008. This will help to redress the energy imbalances and shortages through investment, conditional on clean technology, and emphasising sustainable energy, as envisioned by the SEAP (*see* Figure 6).

Also in 2003, Kazakhstan has adopted a State Programme of development of the Kazakhstan sector of the Caspian Sea, the main target of which is to boost environmentally safe oil and gas production to generate revenues to help diversification and modernisation of the whole economy, to make it highly competitive and non-dependent on oil and gas sector. A law concerning Caspian Sea Production Sharing Agreement (PSA) was passed in May 2005 by the parliament, limiting foreign participation in such ventures to 50% with no guarantee of operator status. In addition, KMG acquired pre-emption rights over the sale of strategic assets. In November 2007, further amendments to Kazakhstan's subsoil law established that the government will be free to cancel oil projects if developers do not meet their contractual obligations. In 2006 Phase II of the Strategy commenced. Recoverable reserves of the Kazakhstan's Sector of the Caspian Sea (KSCS) stand at 8 Gt. According to preliminary estimates, the Programme implementation will allow bringing production at maritime oilfields to 40 Mt in 2010, and 100 Mt per year by 2015 and maintaining this level for 25–30 years.

In 2008 Kazakhstan joined the World Petroleum Council (WPC). The membership in WPC provides the maximum access to update information on the latest worldwide research, technological discoveries and achievements in the gas and oilfield as well as to the current data related to production, technology and economy. Joining WPC will boost the status of oil industry of Kazakhstan, secure new agreements on the international cooperation and could be regarded as another move towards improving the country's image worldwide.

According to international experts, with the current trends maintained, the global explored oil resources will only suffice for the next 40–50 years. Inclusion of the KSCS resources into the global explored reserves has become a major component of global energy strategies. Kazakhstan's oil industry will need to have enough flexibility to allow for a quick and efficient transition from the on- shore to the Caspian, off-shore exploration sites, giving top priority to the most promising projects.

The coal sector is said to have enough reserves to last over 100 years. In future, the development of the raw materials base will be achieved through a strategy of enriching and improving the quality of

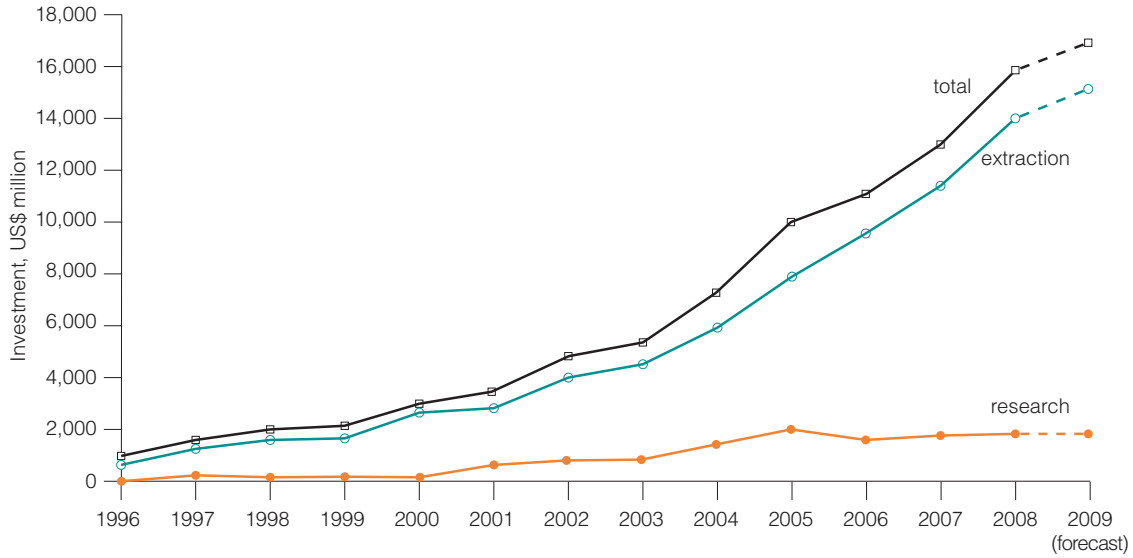

Figure 4 The dynamics of investment in the use of all hydrocarbon resources in Kazakhstan (Jantureeva, 2009)

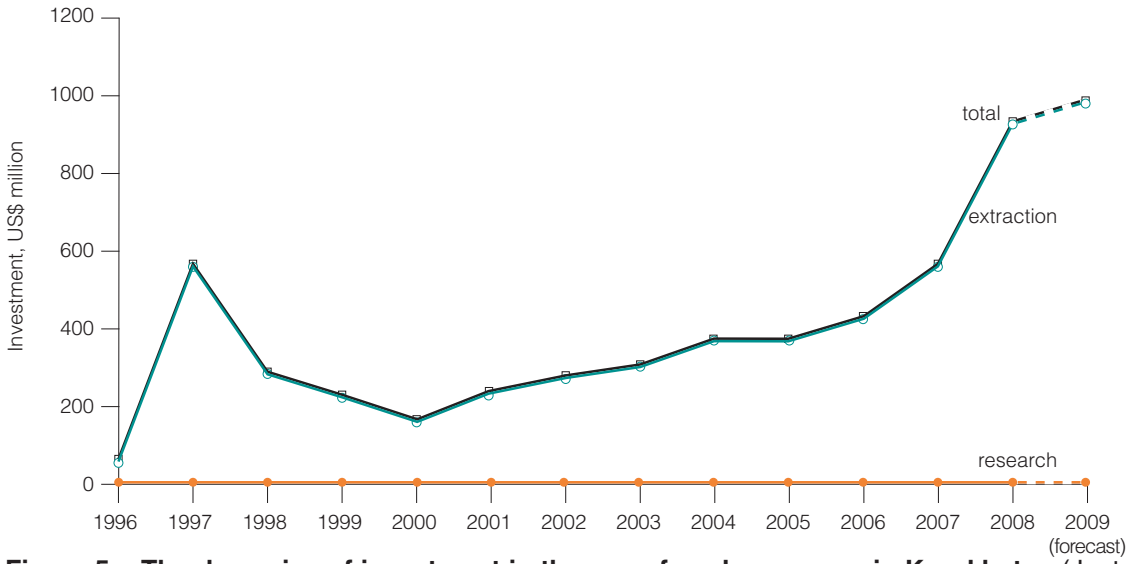

Figure 5 The dynamics of investment in the use of coal resources in Kazakhstan (Jantureeva, 2009)

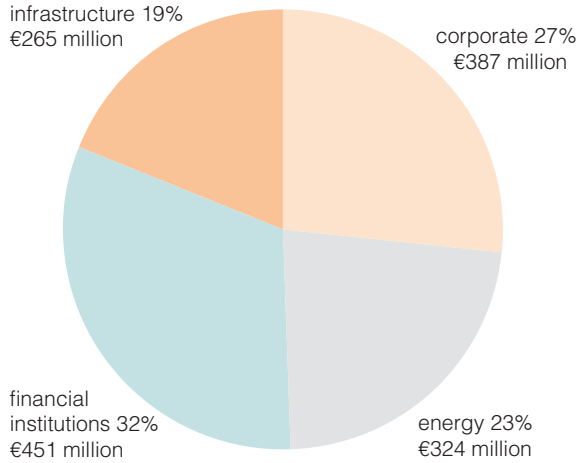

Figure 6 Sector composition of the EBRD portfolio in Kazakhstan as of September 2009 (EBRD, 2010)

the coal and the deep processing of coal to obtain liquid fuel and synthetic substances. Developing shale is also topical. As an alternative source of energy, methane from coal mines in the Karaganda basin can be used. The high concentration of methane in coal layers and major gas consumers make it possible to extract it and utilise it on a large scale. This will also increase central Kazakhstan's energy potential and provide gas not only to enterprises in Karaganda, Ekibastuz and Pavlodar districts but also to the country's capital, Astana. Currently, Kazakhstan relies on coal for producing electric power.

Appendices 1–3 of the Government Programme for the Accelerated Development of Industrial Innovation in Kazakhstan, deal specifically with coal (*see* Table 2).

Kazakhstan's electricity sector, which was largely established in Soviet times, has reached its potential. Being alert to the impending problems, the government is planning to undertake large-scale

Table 2 Appendices 1–3 to the Government Programme for the Accelerated Development of Industrial Innovation in Kazakhstan

Appendix 1 – Forecast of the coal production and distribution in the Republic of Kazakhstan											
	2009	2010	Forecast					2010-15		2010-20	
	actual	plan	2012	2014	2016	2018	2020	±	%	±	%
Production, Mt	94.33	104.9	115.9	123.4	136.1	144.4	152.1	26.14	125	47.2	145
Distribution out of which:											
Domestic	69.71	76.59	86.37	91.44	103.6	111.6	118.3	21.84	128	41.6	154
Export	25.04	28.19	29.57	32	32.49	32.81	33.81	4	114	5.62	120
Appendix 2 – Demand balance for coking coal											
								2015-10		2020-10	
Demand		9.46	12.59	12.62	13.62	14.5	16.5	4.16	144	7.1	174.6
Technical potential		12.45	13.59	14.32	14.82	14.7	14.7	2.37	119	2.3	118.2
±		2.99	1	1.7	1.2	0.2	–1.8	–1.79	40.1	–4.8	–60.2
Appendix 3 - Coal demand for domestic and foreign energy markets											
	2009	2010	Forecast					2015-10		2020-09	
	actual	plan	2012	2014	2016	2018	2020	±	%	±	%
Total Kazakhstan	84.44	94.37	103	109.9	121.8	129.2	135.1	32.72	139	50.7	160
out of which:											
for power	46.62	49.48	55.67	59.13	66.82	72.28	74.7	17.13	137	28.1	160
community and personal daily needs	10.2	13.07	13.84	15	16.92	17.12	17.62	5.92	158	7.42	173
industrial use	3.43	3.63	3.9	3.8	5.6	7	9	1.37	140	5.57	262
export	24.19	28.19	29.57	32	32.49	32.81	33.81	8.3	134	9.62	140
technical potential		99.4	107.6	116.4	133.6	143	148	30.7	131	48.5	149

modernisation of the existing facilities and construct new ones during 2015-30. The government is addressing this problem in accordance with the Action Plan for Development of Electric Power Industry of the Republic of Kazakhstan for 2007-15 issued by the Prime Minister's order of 31 May 2007.

With respect to nuclear power, the National Atomic Company Kazatomprom (100% of the Company's stock is held by the Government) describes its strategy as follows:

> 'To offer the customer a wide range of outputs and services and, to this purpose, to seek to achieve dynamic development of high production standards through the use of the latest advances in science, know-how and management. To support the nuclear renaissance worldwide and, whilst also pursuing a concept of large-scale international co-operation, Kazatomprom also aims to achieve the goal of becoming a top vertically integrated transnational company, with a complete service package – from uranium production to nuclear fuel manufacturing and construction of power generation units.'

Together with Ukraine and Uzbekistan, Kazakhstan ranks among the most carbon-intensive countries among all parties to the UN Framework Convention on Climate Change (UNFCCC). Low tariffs and slow progress with enterprise restructuring mean that energy efficiency challenges remain huge, particularly in the industrial, municipal and residential sectors. A law on supporting renewable energy was signed by the President in 2009, but needs to be supplemented by core legislation to become effective.

In August 2007, in Bishkek, Kyrgyzstan, Kazakhstan's president called for common energy strategy within the Shanghai Corporation Organization (SCO). 'In the SCO territory there is a network of pipelines linking Russia, Central Asia and China,' the president told the SCO summit. 'It could serve as a foundation for the creation of a common SCO energy market.'

A draft energy strategy has already been elaborated by Kazakhstan and submitted to SCO member states for consideration. It provides for the creation of a think-tank, providing a pool of data on energy co-operation and on trading operations within the energy market. Kazakhstan has also suggested establishing an SCO energy exchange.

The power sector has been unbundled, commercialised and partly deregulated. Generation is still dominated by state-owned companies (60% of total capacity), while distribution companies have been partly privatised. In 2007, the government re-bundled all state shares in generation into the National Welfare Fund Samruk Kazyna (SK). Notwithstandingthis, so far private generation companies have been granted non-discriminatory access to the national grid. The sector regulator regulates transmission, distribution and end-user tariffs, while wholesale tariffs which used to be largely unregulated are now subject to considerable de facto regulation.

4.2 Overview of Kazakhstan's coal industry policy

In October 2007, The Agency of the Republic of Kazakhstan for Competition Protection (Antimonopoly Agency) was established under the Kazakhstan President's decree 'On measures for further improvement of the public management system of the Republic of Kazakhstan'. The Agency Regulation and the list of the Agency's regional divisions were approved by the Kazakhstan government in February 2008. Also, under the Kazakhstan Government decree, the JSC 'Competition Policy Development and Protection Centre' (http://www.czk.kz/) was established in December 2008.

In summer 2009, a number of coal mining companies of Kazakhstan were included in the list of monopolies. The decision was made at the meeting of the Agency for Competition Protection. In anticipation of the upcoming cold season and its influence on the price of coal, a coal market analysis

was carried out, with input from the Department of Energy and Mineral Resources of Kazakhstan and the decision of the Supreme Court of Kazakhstan.

Based on the results of the analysis, the board decided to include in the state register the coal-mining companies occupying dominating or monopolistic positions in the industry. The purpose was the elimination of possible abuse by coal companies of delivery of coal for generators of thermal and electric energy. Such companies were Open Company Bogatyr Komir, Open Company Karazhyra and also JSC Eurasian Power Corporation, JSC Shubarkol Komir and Open Company Maykuben-Vest, UD Borly and Open Company Corporation Kazahmys.

In April 2010, NTPC, India's largest power company, announced that it was exploring the possibility of setting up two coal-based thermal power plants in Kazakhstan and looking at acquisition of coal assets abroad. In the same month, Eurasian Natural Resources Corporation (ENRC), a publicly traded company on the London and Kazakhstan Stock Exchanges, announced that it will invest US$5.3 billion in expanding and upgrading production facilities in Kazakhstan within the following four years.

Kazakhstan's Ministry of Industry and New Technologies intends to invest US$4.14 billion in the development of the country's coal industry up to 2020. According to the Ministry, the investment will be directed towards increasing the country's coal production to 145 Mt by 2020.

Until 2003, Kazakhstan's coal exports were almost entirely going to Russian to supply its thermal power plants. In recent years, the country also started exporting to markets in Western Europe. While most of the coal exported is still being sent across the border into Russia, a small amount (about 10–12% of the exports) is being exported to Western Europe, through Russia, by rail. This is high quality coal mined in opencast mines in the Shubarkol-Komir mining area of the Karaganda fields. The final destination is usually Antwerp, in the Netherlands. According to Mr Duisenbai Turganov, Kazakhstan's Deputy Industry and New Technologies Minister, by 2014 Kazakhstan plans to boost its annual coal exports to 32 Mt, adding that current (2010) coal exports stand at 20–22 Mt.

The Office of the First Deputy Minister of Industry and New Technologies of the Republic of Kazakhstan issued in 2010 a 'Plan of measures for the development of the coal industry in the Republic of Kazakhstan by 2020'. The plan outlines the areas of interest, expected results, and assigns responsibilities. Table 3 summarises some parts of this document.

Table 3 Plan of measures for the development of the coal industry in the Republic of Kazakhstan by 2020 (The Office of the First Deputy Minister of Industry and New Technologies of Kazakhstan, 2010)

Measure	2010	2015	2020
Achieving the extraction volume and distribution forecast for coal in Kazakhstan, Mt	104.9	131.02	152.1
Meeting the demand balance for coking coal, Mt	9.46	13.62	16.5
Meeting the demand for energy coal for the domestic and foreign markets, Mt	94.37	117.2	135.1
Achieving the capital investment forecast for the development of the coal extraction enterprises in Kazakhstan, billion Tenge	30.4	252.5	222.5
Proportion of coal extraction companies meeting government standards and appropriate international requirements, %	78.9	100 in 2011	

4.3 Overview of the Kazakhstan electricity market policy

In July 2004, the Republic of Kazakhstan adopted a new law on electrical energy (the 'Electricity Law'). The adoption of the Electricity Law was a step towards creation of a fully competitive electricity market in Kazakhstan. Below is a summary of some important provisions of the Electricity Law.

Re-organisation of Regional Electricity Companies (REC)
In order to foster competition in the market, the Electricity Law requires each regional energy company (REC), to reorganise and separate its electricity supply business from the business of network operation. The electricity supply companies separated from RECs will have the status of 'guaranteed suppliers of electricity' for their respective regions. As such, they must supply electricity to every solvent customer in the region. The Electricity Law does not elaborate as to how such re-organisation can be carried out in cases when the owners of the RECs do not agree to separate/merge voluntarily. Presumably, in such cases the reorganisation would be mandated by a court order.

Supply competition
While RECs, as network operators, are regulated natural monopolies, electricity traders are not, and they should operate in a competitive environment. Thus, the electricity supply businesses separated from the RECs are to start competing with other independent electricity traders, which will result in the consumers being able to choose a preferred supplier. It is clear however, that, at least for some time, the guaranteed suppliers will dominate the market.

Development of the Electricity Exchange
The Electricity Law promotes the use of the existing electricity exchange, KOREM (Operator of Kazakhstani Market of Electrical Energy and Capacity). All power plants and guaranteed suppliers must sell/purchase a certain portion of their electricity output/demand at the electricity exchange. Starting from 1 January 2006, all wholesale market players (including generators and largest customers) participate in the balancing of real-time electricity trades carried out at KOREM.

Another basic act regulating electricity market is the Law on Natural Monopolies, which was last amended in December 2004. The market regulator is the Agency for Regulation of Natural Monopolies (ANMR).

Kazakhstan's electricity system includes 71 power plants with total installed capacity of about 18 GW, the largest power plant being the coal-fired AES Ekibastuz GRES-1 in north-central Kazakhstan. 80% of the total installed capacity is coal fired, and 12% is hydroelectric. Other forms of power generation are insignificant. Almost 85% of the country's power generation, about 72,000 GWh, comes from coal-fired plants (*see* Figure 7) located in the northern coal producing regions (Academic dictionaries and encyclopedias, 2006)).

86.5% of the electric power generation has been privatised. The government does not regulate prices for electricity, and consumers have free choice among providers of electric power (there are 15 licensed electricity traders).

Although Kazakhstan technically generates almost enough electricity to meet its demand, the country has suffered from frequent power shortages since 1992 due to the sector's deteriorating infrastructure. Energy officials in Kazakhstan estimates that, as electricity consumption is rising above the country's generating capacity, over $3.0 billion will be needed to build roughly 1500 MW of new power plants and to repair old ones in the next decade (Figure 8).

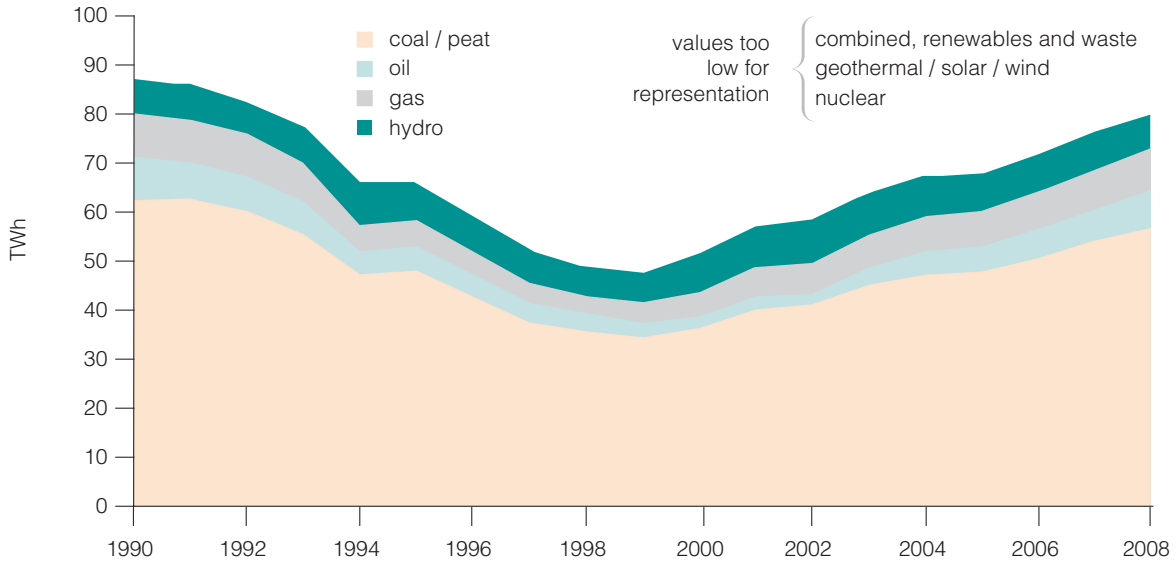

Figure 7 Kazakhstan electricity generation by fuel (IEA, 2009)

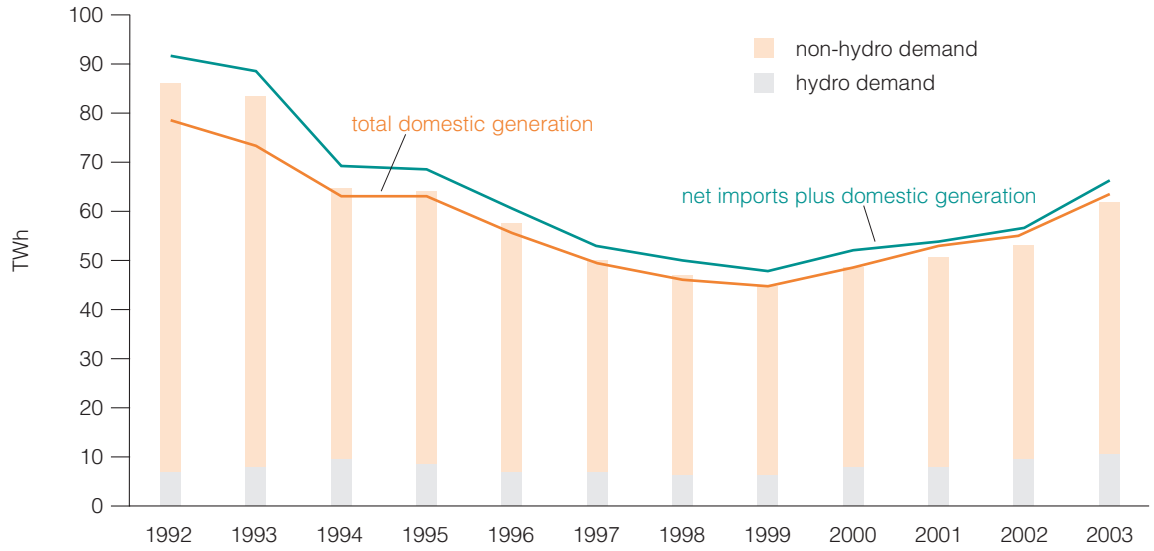

Figure 8 Electricity production and consumption in Kazakhstan (EIA, 2004)

5 Primary energy supply

According to BP (2010), the global primary energy consumption declined by 1.1% in 2009 (the largest decline since 1980). OPEC oil production declined by 7.3% (the largest since 1983) natural gas production declined by 2.1% (the first decline on record) while coal's share of energy consumption showed the highest increase since 1970 at 29.4%.

Kazakhstan has about 0.5% of the world's energy mineral resources –over 90 Gt of oil equivalent (Gtoe) – (Aliyarov, 2011 b). These resources are about 70% coal, 22% oil and gas condensate, and 8% gas. The low proportion of oil and gas in the country's resources when compared to coal, even though large in themselves, are a result of the continuous discovery of new coalfields. According to the Kazakh Academician Aliyarov (Aliyarov, 2011b), at the present rate of exploitation, the country's coal resources are practically limitless. According to industry analysts, expansion of oil production and the development of new fields will enable the country to produce as much as 3 million barrels per day by 2015, and Kazakhstan would be among the top ten oil producing nations in the world. Kazakhstan's oil exports in 2003 were valued at more than US$7 billion, representing 65% of the overall exports and 24% of the GDP. Major oil and gas fields and recoverable oil reserves are Tengiz with 7 billion barrels; Karachaganak with 8 billion barrels and 1.35 billion m³ of natural gas; and Kashagan with 7–9 billion barrels.

In total, there are 160 deposits with over 2.7 Gt of petroleum. Oil explorations have shown that the deposits on the Caspian shore are only a small part of a much larger deposit. It is estimated that 3.5 Gt of oil and 2.5 trillion m^3 of gas could be found in that area. Overall the estimate of Kazakhstan's oil deposits is 6.1 Gt. However, there are only three refineries within the country, situated in Atyrau, Pavlodar, and Shymkent. These are not capable of processing the total crude output so much of it is exported to Russia. According to BP (2010) Kazakhstan produced approximately 1.68 million barrels of oil per day in 2009.

Table 4 indicates an expected population growth of 20% by 2030 over the present level, while the GDP will more than double. It also shows an expected increase of 53% in the industrial use of thermal energy, and only 37% for the non-industrial sector, so that the ratio of non-industrial to industrial

Table 4 Specific indicators of thermal energy utilisation in Kazakhstan (Aliyarov, 2011b)

Indicators	2000	2010	2020	2030
Population, million people	14.9	15.7	17.2	19.2
GDP, $ billion	18.3	41.3	70.0	85.0
Total heat utilisation, (million GJ) out of which:	630.3	797.9	1003	1137
– industrial use	143.3	245.3	334.4	376.2
– non-industrial use	486.9	552.6	668.8	760.7
Specific non-industrial heat used:				
GJ/y.people	32.7	35.2	38.8	39.7
GJ/y.m^2	2.0	~1.84	~1.67	~1.5
m^2.person	67.7	79.4	91.9	104.5
Cost, GJ/y per $1000 GDP	34.4	19.3	14.3	12.7
Specific heat utilisation, GJ/y per person	43.5	50.9	55.1	190

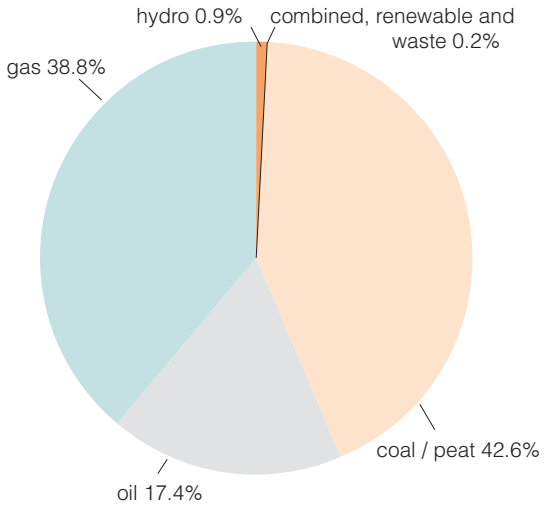

Figure 9 Share of total primary energy supply in 2008 – Kazakhstan (IEA, 2009)

consumption will drop marginally from 2.25 to 2. The yearly non-industrial energy consumption for the entire population will increase with the population (by 13%), however, it is interesting to note that the consumption, for the entire habitable area (m^2) will decrease by 22%, in spite of the increase of this area per person by 13%. This, together with an increase of the yearly consumption per $1000 of GDP, implies a significant efficiency increase by 2030 (*see also* Figures 9 and 10, and Table 5).

Kazakhstan fully covers its own needs from all resources, with the exception of natural gas. The majority of the natural gas used in the country comes from Uzbekistan and Russia which creates concerns regarding the energy

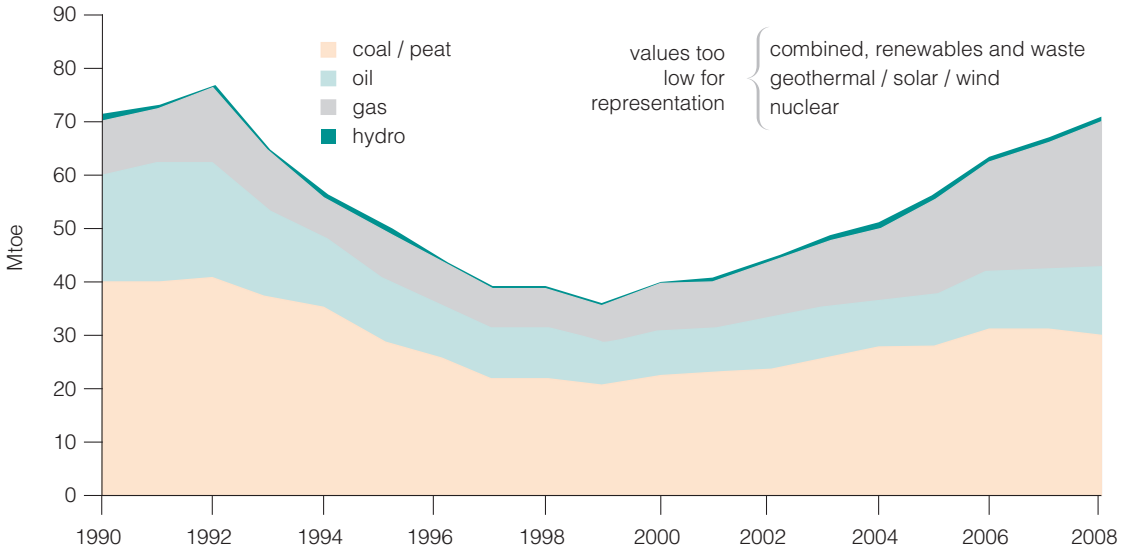

Figure 10 Total primary energy supply – Kazakhstan (IEA, 2010b)

Table 5 Evolution of the energy balance for primary energies (Mt) (Aliyarov, 2011b)

	1990	1995	1998	1999	2000	2001	2002	2003
Coal production	131.5	83.4	69.77	58.26	77.4	79.08	73.73	84.9
Oil production	25.82	20.64	25.78	30.18	35.32	40.09	47.27	51.45
Natural gas production, trillion m^3	7.7	5.92	7.95	7.2	9.09	8.28	6.02	7.56
Coal usage	89.7	65.1	47.45	43.14	52.92	50.64	51.52	57.02
Oil usage	18.95	16.64	9.1	7.51	7.15	8.60	9.55	8.66
Natural gas usage, trillion m^3	14.45	11.3	8.7	6.15	7.83	5.87	7.21	7.79
Coal export	32	23.0	23.55	16.26	25.71	27.51	22.73	27.03
Oil export	21	11	16.39	23.57	29.35	32.40	34.09	44.27
Natural gas export, trillion m^3	11.45	6	3.05	2.78	4.22	4.28	8.17	8.7

independence and security for this important energy resource. This will be taken into consideration when plans are being made for the energy development of Kazakhstan.

5.1 Natural gas

In January 2009, the Oil and Gas Journal estimated Kazakhstan's proven natural gas reserves at 2.4 trillion m^3. Natural gas production in Kazakhstan is almost entirely associated gas, a by-product of oil extraction. Most of Kazakhstan's natural gas reserves are located in the west of the country, with more than half of proven reserves situated in the Karachaganak oil and gas condensate field, which reportedly has proven natural gas reserves of 1.36 trillion m^3. According to projections by the Kazakh Ministry of Energy and Mineral Resources, total natural gas production could reach 42 billion m^3 in 2010 and 56 billion m^3 in 2015.

Natural gas production has been steadily increasing from a low of 4.6 billion m^3 in 1999 to 33 billion m^3 in 2008. Although Kazakhstan consumed slightly more natural gas than it produced in 2008, or 33.5 billion m^3, domestic consumption has been increasing at 9.5%/y in the past decade compared with production growth of 22%/y. About 40% of natural gas produced is being reinjected back into the fields.

Kazakhstan also serves as a transit state for natural gas exports from Uzbekistan and Turkmenistan to Russia and onward. The two branches of the Central Asia Centre (CAC) gas pipeline, controlled by Gazprom, meet in the southwestern Kazakh city of Beyneu before crossing into Russia at Alexandrov Gay and feeding into the Russian pipeline system. Almost all Uzbek and Turkmen natural gas is exported through this pipeline plus some Kazakh gas produced from Karachaganak and Tengiz. Several new natural gas export pipelines from the Caspian Sea region are also in development or under consideration, potentially opening up new markets for Kazakh natural gas.

In December 2007, Russia, Kazakhstan and Turkmenistan announced signing an agreement to renovate and expand the western branch of the CAC pipeline and to construct a new pipeline paralleling the western branch. Russia's agreement with the two countries was, reportedly, contingent on a Russian pledge to increase its buying price of Central Asian gas, but the exact price is still undetermined. At the same time, CNPC pledged to invest $2.2 billion in a 29.7 billion m^3 natural gas pipeline that would run from Turkmenistan through Uzbekistan and Kazakhstan to China. About 325 miles would run through Uzbekistan and the rest in Kazakhstan to reach Khorgos in China's northwestern Xinjiang region. However, in January 2009, the project was postponed as a result of the economic slowdown.

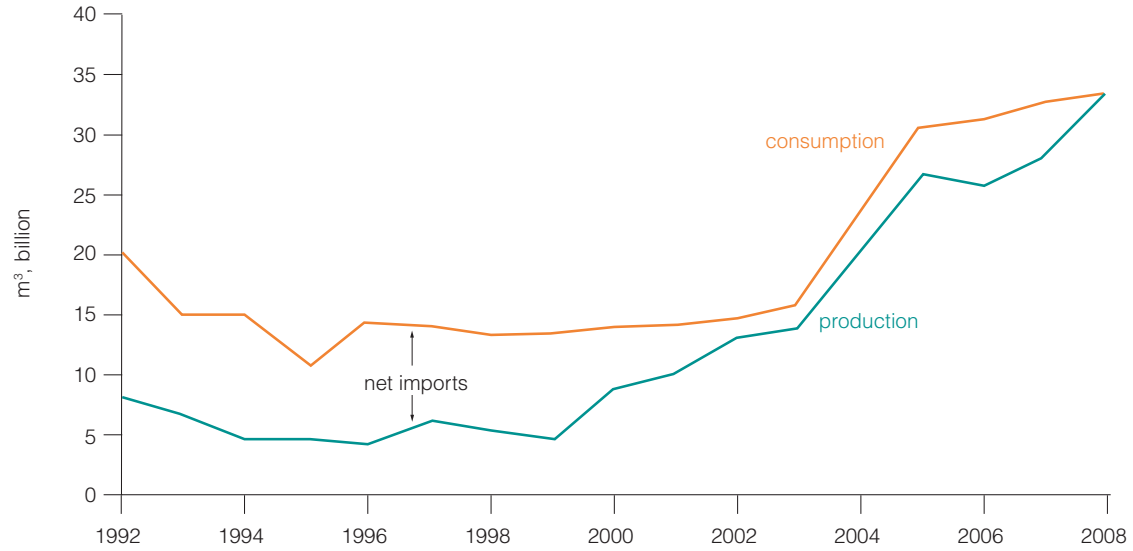

Figure 11 Kazakhstan's natural gas production and consumption (EIA, 2009)

KazTransGas, a subsidiary of KMG, controls and manages the gas pipeline transportation system of Kazakhstan. However, Kazakhstan has two separate domestic natural gas distribution networks, one in the west, which services the country's natural gas producing fields, and one in the south, which mainly delivers imported natural gas to the southern consuming regions. The lack of internal pipelines connecting Kazakhstan's natural gas-producing areas to the country's industrial belt (between Almaty and Shymkent) has hampered the development of domestic natural gas resources (*see* Figure 11).

Because of Kazakhstan's divided distribution network, Karachaganak's natural gas is mainly exported northward to Russia's Orenburg processing plant. A joint venture agreement between Gazprom and KMG was agreed upon in 2008, whereby Gazprom and KMG will each have a 50% stake in KazRosGas, that will purchase the gas and expand the Orenburg plant by 2012. According to a recent report from Gazprom, the Orenburg facility was expected to process 8.2 billion m^3 of Kazakh gas in 2009, up from 7.9 in 2008 (EIA, 2009)

5.2 Oil

Kazakhstan's proven oil reserves were estimated at 30 billion barrels by the Oil and Gas Journal in January 2009, although probable reserves could be much higher. The country's main oil reserves are located in the western part, where three major onshore oilfields, Tengiz, Uzen, and Karachaganak, are located. In addition, Kazakhstan's sector of the Caspian Sea is believed to contain even greater undiscovered oil reserves than the estimated 9–13 billion barrels at its offshore Kashagan field.

The Ministry of Energy and Mineral Resources monitors the state's interests in production-sharing agreements (PSAs). KazMunaiGaz (KMG) is the state-owned oil and gas company, responsible for operating state oil and gas interests and its oil and gas pipelines. Increased oil production in recent years has been the result of an influx of foreign investment into Kazakhstan's oil sector. International projects have taken the form of joint ventures with KMG, as well as production sharing agreements and exploration/field concessions.

Kazakhstan's Law on Subsoil and Subsoil Use governs the transfer of subsoil use rights and was amended in 2005 to give the state the basis to exercise pre-emption rights on any oil assets put up for sale in the country. The law was amended again in 2007 to allow the state to force retroactive changes to any existing oil contracts or even break the contracts if they are deemed a threat to the country's security. Joint ventures are the most common type of investment; the government announced in early 2008 that no more PSAs will be awarded.

Kazakhstan's oil production reached 1.4 million barrels per day (bbl/d) in 2008, more than double the level of a decade earlier, while domestic oil consumption remained low at 239,000 bbl/d. The seven largest currently producing oilfields are all located onshore in the western part of the country, except for the Kumkol fields, which are in the south central area. These seven fields account for 1.1 million bbl/d (close to 80%) of liquid production in the country.

The Kashagan field, the largest known oilfield outside the Middle East and the fifth largest in the world in terms of reserves, is located off the northern shore of the Caspian Sea, near the city of Atyrau. The consortium operating the field, the Agip Kazakhstan North Caspian Operating Company (Agip KCO) was replaced in January 2009 by a new company led by Total, Eni, ExxonMobil, Shell, and KMG, each with a 16.8% share, ConocoPhillips with a 8.4% share, and Inpex at 7.6%.

In 2008, Kazakhstan had net oil exports of about 1.2 million bbl/d, with the current infrastructure delivering it to world markets by pipelines to the Black Sea via Russia, by barge and pipeline to the Mediterranean via Azerbaijan and Turkey, by barge and rail to Batumi, Georgia on the Black Sea, and by pipeline to China. However, the rapid growth of oil production requires increased facilities for exporting it (*see* Figure 12).

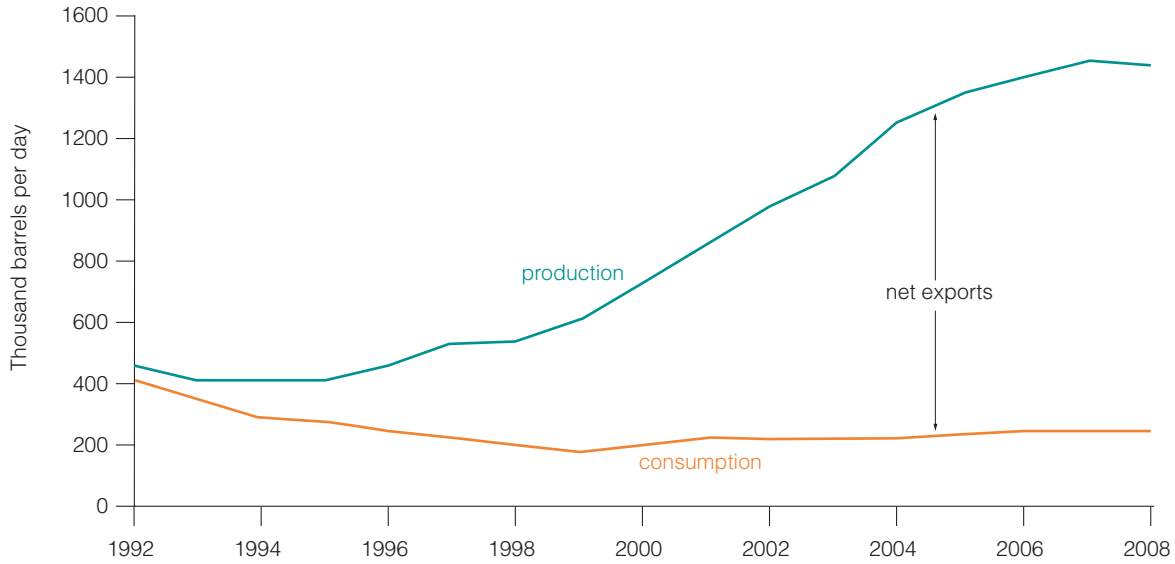

Figure 12 Kazakhstan's oil production and consumption (EIA, 2009)

The Caspian Pipeline Consortium (CPC) oil pipeline was commissioned in 2001 and runs 1570 km from the Tengiz oilfield to the Russian Black Sea port of Novorossiysk. Kazakhstan agreed to expand the CPC pipeline capacity to 1.5 million bbl/d by 2013, but a delay in the final investment decision to mid-2010 due to technical complications moved the completion date to mid-2014.

A joint venture between China National Petroleum Corporation (CNPC) and KMG, the Kazakhstan-China pipeline will span 2214 km when complete, running from Atyrau port in northwestern Kazakhstan to Alashankou in China's northwest Xinjiang region. This line is to be tied into the Kazakhstan-China pipeline now that the Kenkiyak-Kumkol section is complete, and its direction of flow will be reversed, running from the Caspian fields off Atyrau to Kenkiyak. Kazakhstan's other major oil export pipeline, from Atyrau to Samara, is a northbound link to the Russian distribution system. The line was recently upgraded by the addition of pumping and heating stations. The Baku-Tbilisi-Ceyhan (BTC) pipeline is a line in neighbouring Azerbaijan, which began exports in 2006. Oil supplies are currently delivered by tanker across the Caspian to Baku, but an overland pipeline link from Atyrau to Baku is a future possibility to directly export Tengiz oil.

Kazakhstan had a crude oil distillation capacity of 345,100 bbl/d as of January 2009, according to the Oil and Gas Journal. There are three major oil refineries: Pavlodar, Atyrau, and Shymkent. Around 193,000 bbl/d of refined products were produced during 2007, up from around 191,000 bbl/d in 2006 (*see* Figure 12).

The refining sector in Kazakhstan has not received high levels of direct foreign investment like other parts of the oil and gas production sector. Since domestic prices for refined products have remained low, oil producers have more incentive to export crude oil to international markets instead of refining it locally (EIA, 2009).

5.3 Nuclear energy

Kazakhstan has 15% of the world's uranium resources and an expanding mining sector, expecting almost 18,000 tU annual production in 2010, planning for 25,000 t in 2011, and 30,000 t/y by 2018. In 2009 it became the world's leading uranium producer, with almost 28% of world production. A single nuclear power reactor operated from 1972 to 1999, generating electricity and for desalination. Kazakhstan has a major plant making nuclear fuel pellets and aims eventually to sell value-added fuel rather than just uranium. It aims to supply 30% of the world fuel fabrication market by 2015.

The Kazakh government is committed to increased uranium exports, and is considering future options for nuclear power. It is still considering the construction of a new 1500 MW nuclear plant in the southeast, near Lake Balkash. This project was first announced in 1998, but later shelved in September 2002 because of safety concerns. However, due to rising power demand in the south, support for the construction of the plant has received new momentum.

Kazakhstan's sole nuclear power plant, the 90 MWe Mangyshlak Nuclear Power Plant at Aqtau, has been shut down since April 1999. It was sold in April 2003, by the government of Kazakhstan, to Kazatmomprom, the national nuclear power company. Kazatomprom, which has exclusive rights to the production and sale of Kazakh plutonium, plans to maintain and run the plant's thermal generators and water distribution facilities for regional consumption. The BN-350 fast reactor at Aktau (formerly Shevchenko), on the shore of the Caspian Sea, successfully produced, in fact, up to 135 MW of electricity and 80,000 m^3/d of potable water, through desalination, over some 27 years until it was closed (World Nuclear Association, 2010).

5.4 Renewable energy

Kazakhstan's terrain and geography make it a highly suitable location for the generation of many types of energy. Its empty windswept steppes, clear skies and under-exploited reserves of farmland can all be utilised to generate electricity, thereby reducing the country's dependence on fossil fuels. However, besides coal and hydropower, there are not yet any provisions for other forms of non-conventional energy to connect to the national grid. The law on support for usage of renewable energy, being considered by the Kazakh parliament, is set to change that, and open the way for large-scale installations.

Given Kazakhstan's abundant coal, oil and gas reserves, the question naturally arises: 'why invest in alternative energy?' However, Kazakhstan's oil and gas reserves are its largest source of export revenues, and – especially when Kashagan starts production – are expected to continue to bring in money for many decades to come. If some of the growing domestic demand for energy can be derived from other sources, this will conserve reserves of fossil fuels.

In addition, Kazakhstan's electricity generation capacity is not evenly distributed across the country. Power is imported from Russia in the north, and Kyrgyzstan and Uzbekistan in the south. The main oil and gas reserves are in the west, the coal-fired power stations in the north, near Karaganda and Ekibastuz, and most of the hydropower plants along the Irtysh river in north-east Kazakhstan. Renewable energy can contribute to Kazakhstan's energy independence by being deployed in areas such as south and north Kazakhstan, where power is currently imported. It can also provide power to remote consumers, and reduce transmission losses and the need for substantial power transmission line construction.

Although the new law will be needed for non-conventional energy to be adopted on a large scale, there are already several initiatives across the hydro, wind, solar and biofuels spectrum. The UNDP Wind Power Market Development Initiative is a full-scale project to promote the development of the wind energy market in Kazakhstan. The UNDP is helping the Kazakh government to develop a national programme on wind energy development. This will have targets of 250–300 MW of wind installation by 2015 and about 2000 MW by 2030.

The European Bank for Reconstruction and Development (EBRD) is also supporting non-conventional energy projects through its $75 million framework facility to finance investments in sustainable energy, both in projects to increase energy efficiency in the industrial sector and in small renewable energy projects.

There are already two major solar stations in Kazakhstan, one in Alakol and another in the

Kuldzhinkii region. Four additional stations are planned under the UNDP initiative – one in Aksai Gorge and three in Talgar Gorge. There are also various private installations in the West Kazakhstan oblast for the oil industry, and in the Almaty region – the largest being a 70 m^2 installation to provide electricity for the IT Park free economic zone. Some 70% of the technology needed for solar power generation, including accumulator batteries, is manufactured in Kazakhstan. However, solar panels have to be imported. This situation is on the verge of change, as there are a number of projects to produce photovoltaic technologies in the country.

According to data from the Ministry of Agriculture, Kazakhstan has the potential to produce 300 kt of biofuels a year. Production costs are estimated to be half of those in Western Europe and the US. However, at present Kazakhstan has just one functioning biofuel production plant, the Biochim plant in the north-Kazakhstan oblast. A second plant, in Taraz, is currently out of order, and a third is being built in the city of Novoishimsk.

Next-generation biofuels production technologies, such as those being installed in the Novoishimsk plant, would use waste products as raw materials. This would overcome objections related to food security that have held back popular acceptance of the biofuel industry.

Kazakhstan's hydroelectric facilities are located primarily along the Irtysh river, which flows from China across northeast Kazakhstan. In the 1990s, Kazakhstan lost 90% of its hydropower capacity, when many smaller plants were shut down. Presently, the total installed hydroelectric capacity is 12% of Kazakhstan's total installed capacity.

The decade-long decline in Kazakh electricity consumption has come primarily at the expense of thermal power, while generation at hydroelectric facilities has remained constant (*see* Figure 4 on page 20). As a result, hydropower now accounts for almost 20% of Kazakhstan's electricity consumption, more than twice its percentage in 1992. Kazakhstan and China have held joint negotiations on management of the Irtysh River since 1999.

The two key factors holding back the development of biofuels and other types of renewable energy are the lack of investment at present, and the need for a legal framework. Kazakhstan's parliament is widely expected to pass the necessary legislation. The question of investment is more open; those projects without funding from the Kazakh government or international development agencies, are likely to be held back until the global economy recovers (KazCham (Kasakhstan Chamber of Commerce), 2010).

6 Coal resources and reserves in Kazakhstan

Kazakhstan's coal production was estimated at 80 Mt in 2009, while the country's demand was estimated at 50 Mt, making Kazakhstan a net exporter of coal. The majority of coal in Kazakhstan's subsoil is anthracite and bituminous coals with a small amount of lignite. The information on the country's coal production and consumption varies widely with the source. At present, no international standards exist for determining what constitutes proven reserves. This contributes to the wide variance of the estimates for Kazakhstan and makes it difficult to ascertain true reserve levels. In addition, it is not clear what economic assumptions and analyses the government has used to arrive at its estimates. (WEC figures are widely accepted and are used by IEA's annual World Energy Outlook). Given the poor physical condition of Kazakhstan's mines and mining equipment, the high costs of production and the low projections for future prices of coal (compared to other energy sources), it is likely that the less optimistic estimates of reserve levels are more realistic. In the absence of substantial improvements in coal quality and market conditions, it is possible that even these could be revised downward in the future. Table 6 shows a comparison of yearly data, between 1999 and 2006 (EIA, 2007; BP, 2010).

Table 6 Kazakhstan's coal production and consumption 1999-2009 information comparison (EIA, 2007; BP, 2010)

Year	Production, Mt		Consumption, Mt
	EIA (converted from short tons)	BP (converted from toe)	BP (converted from toe)
1999	59.9	45	29.7
2000	74.2	57.75	34.8
2001	79.2	61.05	33.75
2002	73.88	56.7	34.2
2003	85	64.95	37.8
2004	87	66.6	39.75
2005	86.76	66.3	40.8
2006	96.5	73.65	42.15
2007	N/A	75	46.2
2008	N/A	85.2	51
2009	N/A	77.7	49.5

6.1 Hard coal reserves and where the coal is found

As the coal demand develops and supply is hardly able to manage all requirements, a sound knowledge of the size of economic reserves is one of the key factors for a better understanding of future coal market trends. So far, the comparison of hard coal reserves and resources in the various countries of Europe is very difficult due to heterogeneous classifications with differing terms and definitions. Major variations among these classifications are due to different exploration requirements, such as drilling grid, borehole distances, geological structure etc for the assessment of the reserve and resource categories and due to varying criteria regarding cut-off values for reserve and resource estimations.

Table 7 Kazakhstan's major basins' coal reserves in Gt (Methane to Markets; Global Overview, 2009; Stoupak and Zhukovskiy, 2001)

Basin	Reserves
Karaganda	46.54
Turgay	56.15
Ekibastuz	9.16
Maykubenskiy	5.17
Iliyskiy	15.06
Zhilanshikskiy	11.61
Koytas	1.18
East Uralskiy	1.36
Total 146.23 Gt = 146,230 Mt	

The United Nations Framework Classification (UNFC) was introduced in 1997 to facilitate comparison of reserve and resource categories from different countries. However, since the UNFC does not include deposit defining criteria, such as minimum seam/coal thickness, maximum seam depth, and maximum ash and sulphur contents, the reserve and resource data published by most of the European countries are still not comparable.

BP estimates Kazakhstan's recoverable coal reserves at the end of 2009, to be approximately 31,300 Mt, out of which 28,170 Mt are anthracite and bituminous coals, and 3130 Mt are subbituminous and lignite coals. This will put Kazakhstan's coal reserves at 3.8% of the total global coal reserves. Table 7 provides a list of estimated total coal reserves for each of the country's major coal basins.

Within Kazakhstan, coal is found in 25 provinces that collectively contain more than 400 identified coal basins, fields and prospects. However, more than 86% of the country's proven reserves are confined to the eight major coal basins shown in Table 2 on page 21.

The Karazhir deposit is one of Kazakhstan's higher grade coal deposits containing more than 1000 Mt of reserves, with a large portion being suitable for opencast mining.

Among the largest coal producers in Kazakhstan are enterprises in Pavlodar oblast: BogatyrAccessKomir company (42.8% of overall production), Vostochnyi opencast, OJSC Euroasiatskaya power corporation (20.7%), CJSC Maikuben-West [3.3%, incl.96,6% of overall production of brown coal (lignite)], as well in Karaganda oblast: the coal department of OJSC MittalSteelTemirtau (12.3%) and Borly coal department of Kazakhmys corporation (8.7%). They cover 87.7% of coal production in the country (Ministry of Oil and Gas, 2009).

7 Coal mining, coal geology and quality

According to the Ministry of Oil and Gas (2009):

- The coal-mining sector of Kazakhstan, having survived in severe conditions, takes a leading position in the national economy nowadays. Since the independence of the country, domestic miners have produced more than 1200 Mt of 'black gold'.
- The Republic of Kazakhstan is in the top ten largest coal producers in the world market and is placed third among CIS-countries at stocks and the first at coal production per capita.
- The coal industry of the republic supplies 78% of electric power output, almost 100% of by-product coke production and fully covers the fuel needs of the utility services and population.
- National miners have a lot to be proud of – the coal industry is on the rise. It progressed rapidly due to a series of administrative measures taken in 1995-2000. Those measures yielded a well-balanced industry and investment processes which, in turn, preserved its potential and also sharply lowered social tension in the coal-mining regions.
- The social and psychological environment in miners' towns and villages is improving; living standards of miners are getting better and wages growing. In 2006, average wages grew from 35 to 45 thousand KZT. People became confident in their own future and in the future of their work places.
- Coal will stay for the foreseeable future as the key and the most reliable strategic fuel for the electric power industry. Coal consumption is set to increase both in industry and other sectors of the national economy.
- Coal exports stabilised at 22–27 Mt. The main importer is the Russian Federation but Kazakhstan coal consumers also include Romania, Chechia, Poland, Estonia, Turkey, Ukraine. Taking into consideration the production capabilities of the Kazakhstan coal industry, the country has an good opportunity to increase exports to 30–35 Mt in the near future.
- To succeed in this, certain measures need to be adopted:
  - technical re-equipment of active mines and opencast mines with state-of-the-art coal-mining machinery;
  - implementation of integrated programmes for the efficient use of Ekibastuz and Shubarkol coal fields;
  - increased low-ash coal production at Maikuben field and Karazhira opencast mine to supply thermal power plants and public utilities;
  - enhancement of the competitiveness of Kazakhstan coal through introduction of ISO international standards. A 'Coal industry turn to international standards' programme was introduced by the Directive of the Minister of Energy and Mineral Resources of the Republic of Kazakhstan as of 31 May 2006.
- Good raw materials stocks and production capacities of active coal-mining facilities should make it possilbe to meet the demand of coal consumers both in Kazakhstan and abroad. Advanced planning for the industry's development is dependent on the macro-economical situation in Kazakhstan and contiguous countries as well as, to some extent, upon the introduction of present-day technologies.

Karaganda basin is located in the centre of Karaganda. The coal-containing area occupies about 2000 km^2 to the depth of 4000 m. Coal ash content varies between 10% and 35%. The most widely spread are high-volatile B bituminous (hvBb) to medium-volatile bituminous (mvb) coals. Karaganda basin has a high gas content, which varies from 15–20 m^3/t at 400–500 m depth, to 22–27 m^3/t at higher depth.

The total coal resources of the basin were estimated at 46.4 Gt and are exploited by eleven mines, eight of which belong to 'Ispat Karmet' OJSC. As a whole, Karaganda basin coals are classified as fragile and semi-fragile. The structural features of the basin are characterised by simple sloping folds or monoclines with pitch angles of 5–20°, but running up to 40º in some locations.

Ekibastuz coal basin is located in the Pavlodar region on the northeast of Central Kazakhstan. The coal area is 163 km^2 to a maximum depth of approximately 1000 m. Average seam ash content is high and varies in the range of 35–50 %. Coal parameters are noted as the types mvb and hvBb.

All coal stocks in the basin were studied in detail to the depth of 700 m and make 9.16 Gt. Production is carried out in three mines. Thickness of coal bands mostly varies from 0.1 to 1.5 m, and in some parts, could be up to 6.5 m.

Deposit Kushoky is 55 km north of Karaganda. The area of the coal-bearing sediments is about 40 km^2, and the maximum depth is about 800 m. Coals ash content is 37–44%, and the technical characteristics of coal are of mvb type. Coal seams are gas-bearing, and at the depth of 200 m methane content exceeds 3 m^3/t. Total coal reserves of the deposit are estimated at 623 Mt, and have been exploited since 1963.

Prinurinskaya group of deposits includes Samarskoye, Zavyalovsloye and Nurinskoye deposits located at between 15–90 km to the north and west from Karaganda basin and contain coking coal. At the depths of 300–500 m methane content reaches 20 m^3/t.

Akzhar group of deposits includes Akzhar, Borly, Samaisor, Koitas, Tumensor, Bayet and a few smaller ones. Significant coal patches in these deposits are concentrated at the bottom part of Karaganda. Coal ash content of these deposits varies between 39% and 55%. Coal resources on the Borly deposit are estimated at 443 Mt, Akzhar at 421 Mt. The Borly deposit has been surveyed and it is exploited in the 'Molodejny' section. The Akzhar deposit contains is 300–600 m deep, and its methane content may exceed 10–12 m^3/t.

Tenyz-Korzhunkolsky basin is located in the North-West region of Kazakhstan and includes the Kosmurun, Kyzylsor, Bosshasor and Saryadyr deposits. Total depth decreases from 80 m in the South to 20 m in the North. Coal ash content in the basin varies in the range of 22–45%. Methane content reaches 8–12 m^3/t at the depth of 60 m. Total coal resources in the basin are estimated at 2504 Mt.

Zhamantuz group includes the Zhamantuz, Ayakmalaysor, Aibike, Batyrshasor, Kyzyltau deposits, and a number of coal patches in southern part of Pavlodar area. The ash content is 30–50 %. Resources of these deposits are estimated in the range of 100–300 Mt. There is no reliable information about methane content, but at the depth of 200–250 m it could reach 10–12 m^3/t.

Kokshetau group includes the Yablonovskoye, Danilovskoye, Koksengir, Bogdanovskoye, Zholdybai, Priozernoye, Bogembai, Tamsor amd Ushsor deposits and is located in the Kokshetau and North-West regions. The thickness of these deposits varies from 10 m to 30 m. Coal ash content varies between 14% and 50%, and the common types of coals are hvBb and mvb. The total coal resources are estimated at 1302 Mt (Umarhajieva and others, 2003).

Hard coal, used in pulverised combustion, while having the disadvantage of high ash content, has also some important benefits. One of them is low moisture content which is an important advantage when transporting this coal to distant destinations, by rail, during very cold winter weather. As an example, during a very cold winter in central and north-western parts of Russia, the coal from the Ekibaztuz field saved the region from a catastrophic freeze, when Russian coal arriving at the power plants was frozen, forming a monolith with the rail cars in which it was transported, and therefore, unusable. Another advantage is its low susceptibility to self-ignite due to a high content of particulate matters and resistance to grinding.

The high content of ash requires special attention when designing the boilers with an output of more than 500 tonnes of steam per hour. In the past, when only regular size boilers were used, coal with over 45% ash content was considered waste and about 7 Mt were burnt, at special sites, in low oxygen environments, releasing harmful gases. In order to improve the burning process of high ash content

coal, the engineers designed a much larger furnace, operating as a traditional furnace, which allows for an almost adiabatic burning of the coal, resulting in higher exhaust temperatures. The air is supplied at about 400°C, resulting in a coal/air mixture at about 180ºC. About 85% of the coal is less than 100 microns which results in efficient burning with less than 2% mechanical loses, and a low amount of slag. The boiler of this larger design can burn efficiently coal with up to 60% ash content, while the regular size boilers were designed to burn coal with a maximum of 45% ash content. With the use of larger size boilers, only 2 Mt of coal with very high ash content are being wasted at present.

During the time of the Soviet Union, the Karaganda mines had laboratories trying to create new, improved extraction techniques. The ability to burn Ekibaztuz coal, with medium to high ash content, in special furnaces, was considered an important achievement in increasing the coal extraction efficiency. The ability to burn this coal in furnaces results from a good control of the combustion process and allows the coal (including untreated quantities) to be used as firing fuel. In all likelihood, in the future, the technology selected will allow the combustion of all untreated coal.

As an example, the boilers of the first Ekibaztuz plant, GRES-1, (designed to use Ekibaztuz coal with medium to high ash content) which have an output of 1650 tonnes of steam per hour, could be used efficiently only after the appropriate modifications to the furnace sizes were made.

7.1 Labour productivity

Mining labour productivity is considered high as about 85% of the mining is done in opencast mines, using very large rotary excavators. As an example, at the Bogatyr coal field, a rotary excavator removes 3000 m^3 per hour, completely filling a train wagon in less than one minute. Only eight people are needed to run such a large machine.

The total production of coal from open pit mines in 2007 was over 80 Mt. The companies involved in coal extraction use, depending on the geological conditions at sites, all forms of available technologies, such as ‘cyclic’, ‘conveyer belt’, ‘cyclic conveyer belt’, ‘no-transport’.

Table 8 Change in labour productivity for the Kazakh mining industry compared to the previous year (%) (Kazakhstan’s Statistics Agency, 2010)

2007	2008	2009	2010 (Jan-Sep)
99.1	101.9	100.2	106.9

Table 8, prepared by the Kazakhstan’s Statistics Agency, outlines the dynamic of labour productivity in the country’s mining industry, by showing year to year changes between 2007 and 2010. There is no break down of information to compare coal with other mining industries.

7.2 Mine safety

Much of the decline in the coal production since independence has been due to mine problems. Over 30 people died in mining accidents during 2004 and over 40 in the Lenin mine explosion in central Karaganda region, which was caused by a methane gas explosion.

However, in general, the mining industry is considered relatively safe, as 85% of the mining is done in opencast mines. The remaining underground mines are located in Karaganda area and are used to mine coking coal. They are at a relatively low depth (100–300 m maximum) and, therefore, relatively safe. The vast majority of these coking coal mines are owned by Mittal Steel.

8 Coal supply trends – domestic production and world trade

Coal is a truly globally traded commodity and the dynamics of its markets depend on a large number of factors as about 70%, on a global level, is used for power generation. Kazakhstan is an economy in transition developing very rapidly. Proper choices in the power sector are very important to sustain this development.

The coal market is considered to be open and based on fair competition. 'The best market promotion for coal is considered to be its price, the lowest of all energy resources in the country', according to some Kazakh officials.

In terms of capital investment, Table 9 provides a forecast of capital investment into the coal production companies by 2020.

The Kazakh domestic power sector and most plants of the country were constructed in the fifties and are depleted, obsolete and consume huge amount of fuels due to low efficiencies. According to the experts of the Kazakh Research Institute for Oil and Gas (KazNiPi), by 2012-16 it will be necessary to refurbish all existing power plants in the country, whenever possible, and to build additional new capacities, also to replace the plants that have to be dismantled. It will be necessary to build power plants making use of the best available technologies (BAT) – natural gas combined cycles, integrated coal gasification and combined cycles, coal-burning supercritical and ultra-supercritical steam cycles and increase the generation efficiency from 28% today up to 40–50%.

By contrast, Aliyarov (2011a) claims that, since over 50% of Kazakhstan's power plants are supercritical and over 40% are CHP, the average plant efficiency is around 40% for power generation only; 70% for CHP plants; and 80% for heat only producing stations.

In terms of future plans for the development of the coal industry, it has been calculated that an amount of coal that could bring a revenue of '100 units' if sold, would bring a revenue of '400 units' by selling the electricity it produces. Therefore, new coal-fired power generation is considered an important factor for coal development.

Table 9 Forecast of capital investment for the development of the coal production companies (Appendix 5 to the Government Programme for the Accelerated Development of Industrial Innovation in Kazakhstan)

	Total for 2010-20		By year of exploitation (million Tenge)					
	Million $	Million Tenge	2010	2012	2014	2016	2018	2020
Total Kazakhstan	3367.41	505117.83	30428.4	55822.6	49646.3	48751.6	43254.8	40352.1
out of which:								
for underground mines	1532.31	229854.3	11486.8	18158	22833	23750	23750	20000
for opencast mines	1835.1	275263.5	18941.6	37664.6	26813.3	25001.6	19504.8	20352.1

Table 10 presents the expected exploitation for organic fuels and shows a dramatic drop in the availability of oil by 2100, after it peaks in 2050. This includes oil to be extracted from the fields under the Caspian sea, which are estimated to last over 100 years. Without those, it is estimated that the continental oil resources will last about 31 years. Gas and coal exploitation is expected to more than double between 2050 and 2100, and an increased use of biomass is also expected.

Table 10 Exploitation of organic fuels forecast (Aliyarov, 2011b)

Year	Sources of organic fuels, EJ/y				
	Oil	Gas	Coal	Biomass	Total
1990	133.2	77.2	91.2	37.5	339.1
2050	237.8	208.7	190.8	52.7	690.2
2100	72.4	525.5	421.5	78.4	828.3

Kazakhstan is a landlocked Euro-Asian country with no direct access to ports and sea transportation. It transports its coal to its foreign customers through the territories of other countries, such as Russia and China. Often, Russia has bought lower grade, cheap Kazakh coal, for its internal use, while exporting to the West high grade, expensive coal, from its own mines.

As it is mainly used for power generation, coal is competing with other energy sources and is, therefore, strongly linked to their availability. Retirements and new additional coal-fired power plants are also fundamental in determining future changes of steam coal demand. Production is linked to timely and adequate investments in new expansions, productivity rates and depletion rates of existing reserves, as well as queues at ports, rain, accidents, strikes, availability of mining service equipment and skilled labour, and low water levels in inland transportation.

In order to meet the country's needs, coal production is planned to be increased to 123 Mt in 2014. Accordingly, the total investment in the coal industry will amount to about 235 billion Tenge (KZT) by that year. Total coal production in 2007 was over 80 Mt. Kazakhstan Ministry of Industry and New Technologies plans to increase the country's coal output by 42% year-on-year to 134 Mt by 2015. Furthermore, by 2020, Kazakhstan coal production is expected to increase to 151 Mt. Accordingly, the total investment in the development of Kazakhstan coal production will amount to about US$3.4 million of which US$1.5 million will be directed to coking coal output, and US$1.8 million for power generating coal output (SteelGuru, 2010).

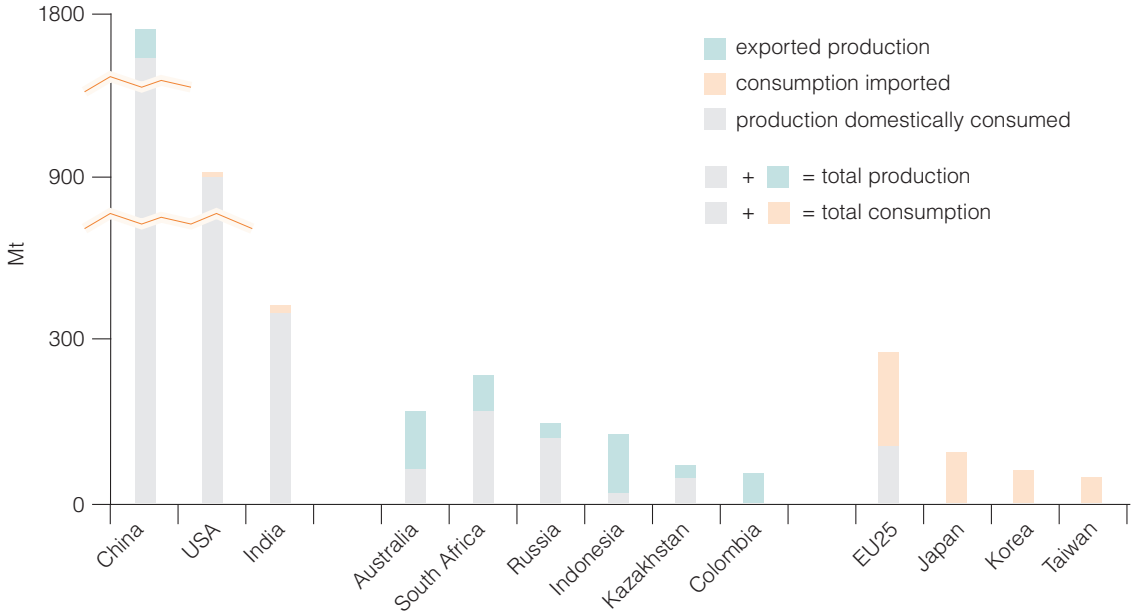

Figure 13 Steam coal main producers and consumers (Umarhajleva and others, 2003)

There are also regional regulatory factors that influence supply and demand, such as the level of hard coal subsidies influencing production, CO_2 regulation, and the Large Combustion Plant Directive influencing demand in the EU.

Coal reserves are ample, distributed in a variety of countries, sufficient to meet the current world coal demand for more than 160 years. Five countries hold three quarters of total reserves (US, Russia, China, India, Australia), while another four countries (South Africa, Ukraine, Kazakhstan, Poland) account for an additional 14% (*see* Figures 13 and 14).

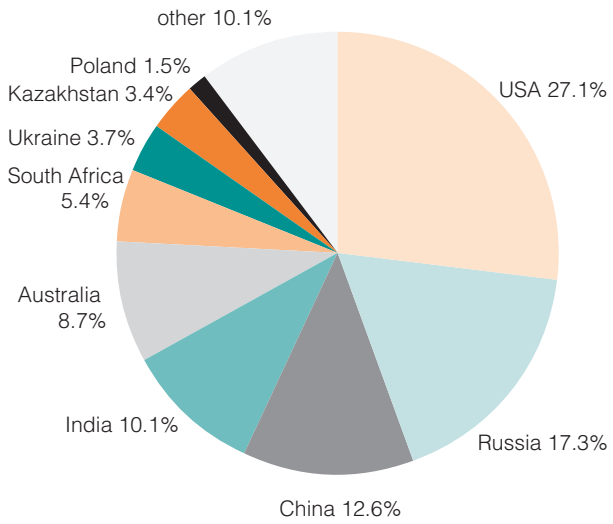

Figure 14 World coal reserves (hard and brown) (Umarhajleva and others, 2003)

The European Union (EU) as a whole is one of the top coal consumers in the world and the biggest importer. It requires about 12% of the world coal needs and almost 30% of global hard coal imports. South Africa and Colombia meet almost 50% of the import requirements by the EU member states, Russia and Poland provide more than one quarter, and Australia and Indonesia about 15%.

9 Estimating the cost of coal and coal production in Kazakhstan and inland transport

The dynamics of coal prices are influenced by a complex variety of factors, ranging from rains in Indonesia to world demand for steel. Coal prices are also a function of a variety of factors such as supply/demand fundamentals, freight rates and other external factors.

World coal prices have kept pace with the surge in the international oil and gas prices, although on an energy basis, coal remains the cheapest fossil fuel. International steam-coal prices have fallen from the record level attained in mid-2008, with the slowdown in demand and weaker prices for gas, the main competitor to coal (especially in the power sector). According to the IEA World Energy Outlook 2010, the average price of steam coal imported into the European Union in 2009 was slightly over 95 $/t. Coal prices are assumed to remain at this level in real terms, to 2015 and then, with rising demand to 2020 and higher prices of gas, to rise to 107 $/t by 2035 (IEA, 2010c).

While oil and natural gas prices influence coal prices through contractual linkages and opportunities for fuel switching, notably in power generation, there are many other factors which have contributed to higher coal prices. Supply has been tight during a period of demand growth. Unforseen events in mining industries in major supplier countries have added to the difficulty. Strong demand for steel production and power generation resulted in the world's bulk carrier shipping fleet having to struggle to meet demand.

Despite these significant cost increases, a large margin still remains between coal prices and costs, which is attracting new investment into the industry and is stimulating merger and acquisition activity. International coal prices hit 124 $/t at the beginning of May 2011, the highest level in five months, as strong demand from reconstruction projects in Japan and reduced supply from flood-ravaged Australia have made coal supply tight. The floods in Queensland, Australia cut the country's output of coal by 15%; other big coal producers such as Indonesia, South Africa and Colombia are experiencing similar production cuts due to floods of their own.

At the end of March 2011, coal prices were 33% higher than a year earlier, and at the beginning of May mining giant Xstrata PLC signed a one-year deal with a Japanese utility at 130 $/t, effectively setting a floor under coal prices in the near term. A similar deal the company made a year earlier was at 98 $/t.

The cost of production in Kazakhstan, in opencast mines, is estimated at about 4 $/t, and in underground mines at about 30 $/t. There is a special (privileged or social) reduced transportation tariff for domestic deliveries. Still, transportation costs remain high and play a key role in the final coal delivery costs. As an example, coal mined in Ekibastuz in open cast mines, reaches Almaty at 20–30 $/t. Similarly, coal exported to Russia (Omsk, close to the border) is delivered at about 30 $/t (Aliyarov, 2011a).

Like most other infrastructure in Kazakhstan, the rail transport system is old and in need of maintenance and modernisation. There is a serious shortage of rail cars for coal transport in Kazakhstan. The National Park of rail carriages can satisfy less than 50% of the country's needs, the rest of the carriages being leased from Russia and other countries. Therefore, there are long waiting periods for coal to be delivered to many destinations, and often delivery contracts are not being fulfilled because of the lack of rail carriages.

EBRD is planning to contribute to building a rail car factory near Astana. However, these will likely be passenger cars and will not help improve the coal transport situation. Surrounding countries, which may have excess rail cars, prefer to lease them out rather than sell them. However, as the market for

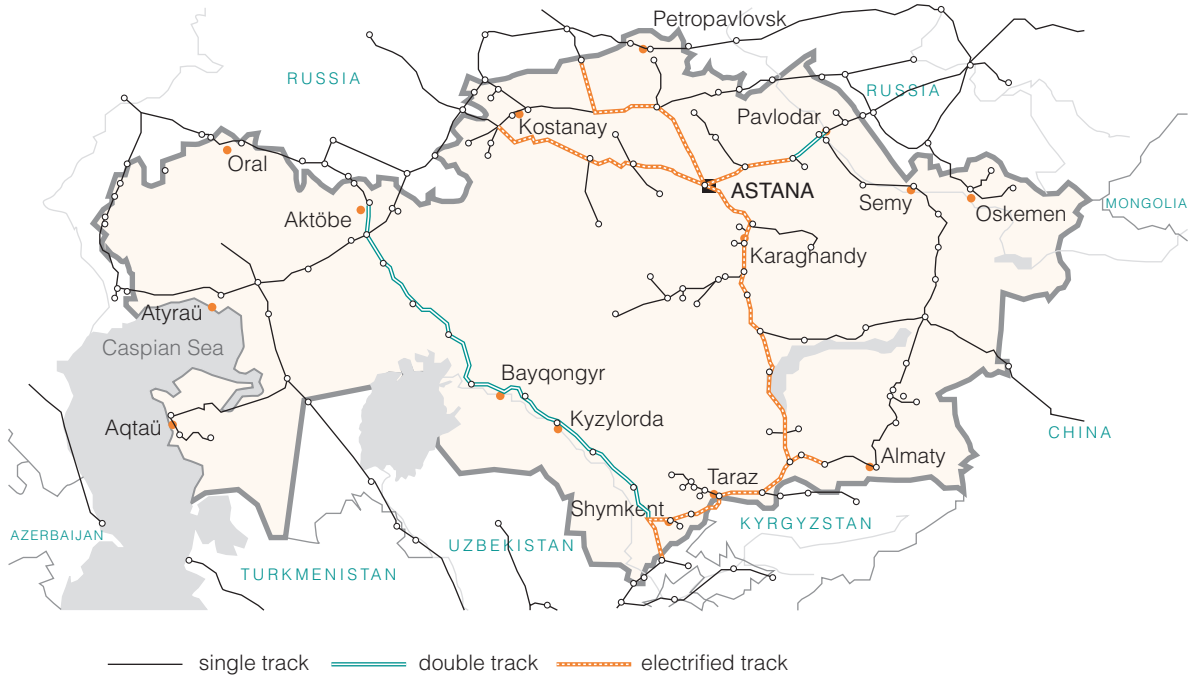

Figure 15 Kazakhstan's railway network (Aliyarov, 2011b)

railway services in Kazakhstan is open, a number of Russian companies are now working in the country, which eased the problem of rail cars shortage.

Kazakhstan is a landlocked country on the shores of the landlocked Caspian Sea. Therefore, transport of all bulk commodities is by land. While natural gas and oil are transported via an ever-developing pipeline network, coal is transported mostly by rail. Roughly 15 Mt of coal are transported annually from Kazakhstan northward via rail to power plants in southern Russia. Figure 15 shows Kazakhstan's railway network.

Mr Duisenbai Turganov, Kazakhstan's Industry and Technologies Minister, was quoted by the news agency RIA Novosti as saying that a lack of rail cargo cars is holding up Kazakhstan coal supplies to Russia and threatening the operation of the countries' electrical power systems.

The lack of 2000 to 2500 rail cars every day resulted, at times, in delivery delays of up to 600 kt, for up to ten days. The Minister added that this is why Kazakh coal mines' contractual obligations to Russian power plants are not met. This in turn may affect the stability of the parallel work of Russia's and Kazakhstan's energy systems. The head of Kazakhstan Temir Zholy Railway Company acknowledged the problem but promised to solve it.

The rail transport system also faces safety related problems resulting in accidents, mostly at unguarded railway crossings. Such an accident, in which a coal transporting train collided with a truck, resulted in the electric locomotive and 29 wagons loaded with coal being derailed. As a result, signalling and communication equipment have been damaged (SteelGuru, 2010).

Kazakhstan has huge stocks of fossil resources. Presently 80% of electric, heating and combined heat and power plants use coal, which is the cheapest fuel. The national 'Development programme of the power sector of the Republic of Kazakhstan for the period till 2010, with prospect to 2015' assumes that the demand for electricity will grow to about 105 TWh in 2015, in order to cope with the economic development of the republic. In spite of the sharp increase of electricity prices – 8.0 tenge/kWh in 2007, and 11 tenge/kWh in 2008 – the present power deficit is expected to persist (the exchange rate was US$1=120.5 tenge in November 2007).

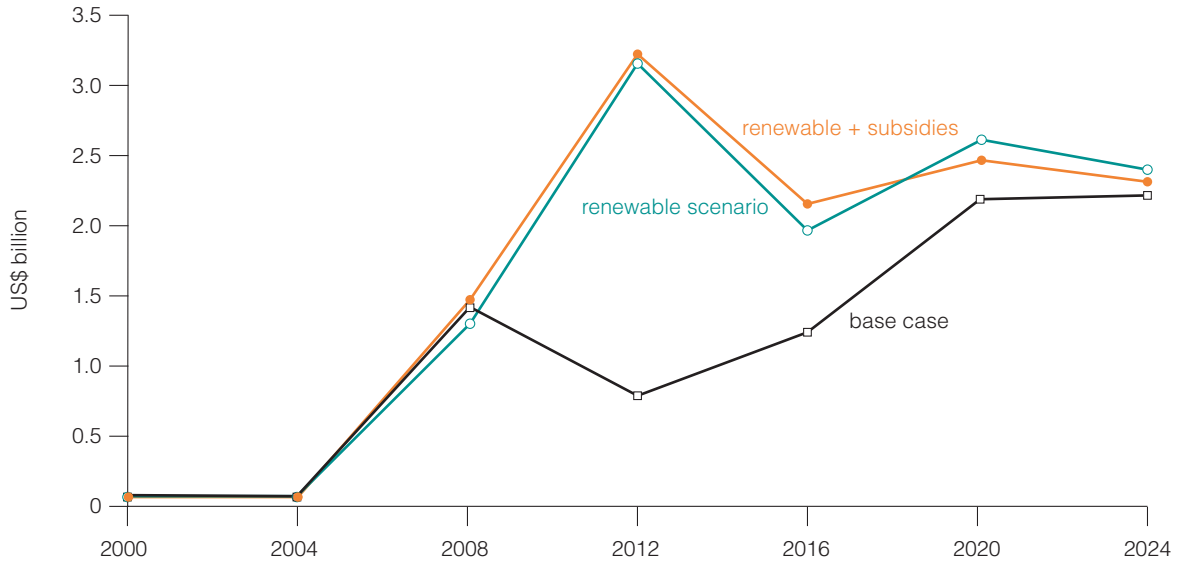

Figure 16 Costs profile of the Kazakh power sector by scenario – early intervals are not proportional – (base case = business as usual) (Cherednichenko, 2007)

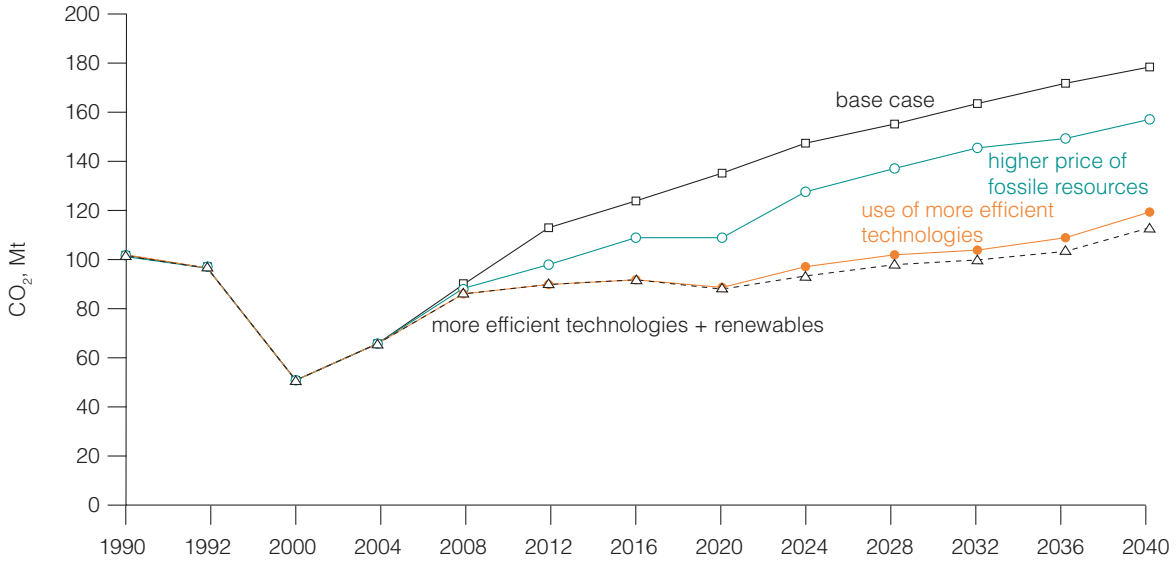

Figure 17 CO_2 emissions of the Kazakh power sector by scenario – early intervals are not proportional – (base case = business as usual) (Cherednichenko, 2007)

According to the experts of the KazNiPi Institute, by 2012-16 it will be necessary to refurbish all existing power plants of the country, whenever possible, and to build additional new capacities, to also replace the plants that have to be dismantled. This would require an investment of about US$3–5 billion for the period ending in 2014 and up to $10–12 billion for the period ending in 2020. Figures 16 and 17 show some possible scenarios for Kazakhstan's power sector's costs and CO_2 emissions.

10 Environmental issues

World CO_2 emissions from fossil fuels increased by 98.7% from 14.1 Gt in 1971 to 21 Gt in 1990 and 28 Gt in 2006 (*see* Figure 18). Over the same period, coal-related emissions increased by 125% from 5.2 Gt in 1971 to 8.3 Gt in 1990 and 11.7 Gt in 2006, accounting for 41.7% of CO_2 emissions from fossil fuels. Since 2004, coal has been the leading source of CO_2 emissions ahead of oil and natural gas (IEA CCC, 2009).

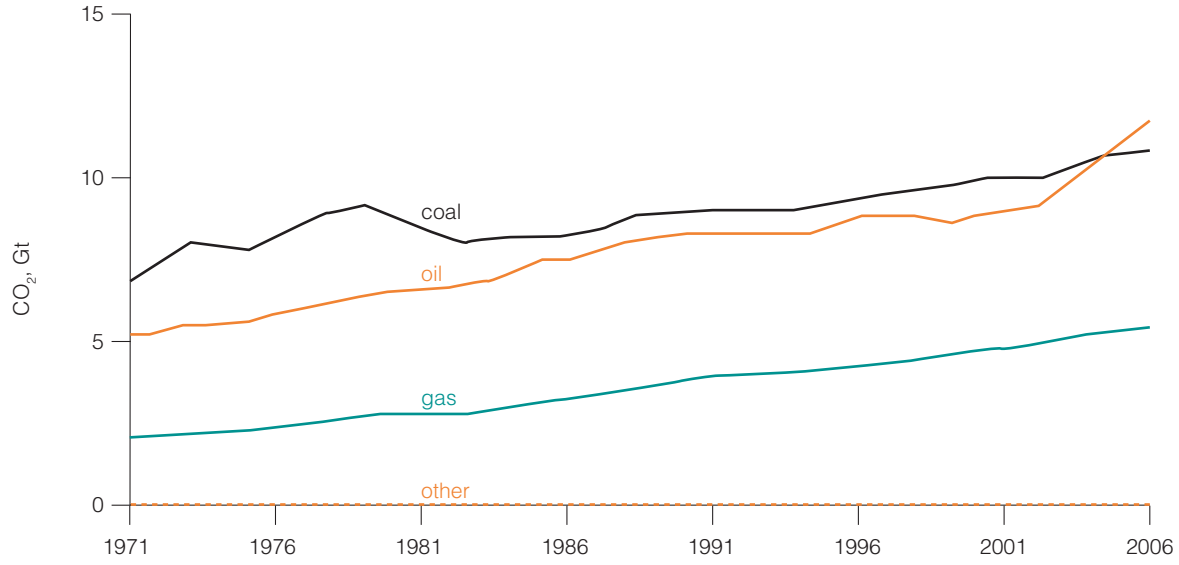

Figure 18 World CO_2 emissions by fuel (IEA, 2009)

Although the state of environmental affairs in Kazakhstan is largely affected by the ecological legacy of the Soviet Union, it has deteriorated even more since the country's independence. The most serious aspects are the consequences of nuclear and biological testing in Kazakhstan, the drying out of the Aral Sea and land degradation due to extensive agriculture, mining, and oil and gas exploration. In addition, present environmental challenges associated with current business practices and the country's economic priorities remain critical and constitute a barrier to the country's development.

The country possesses rich mineral resources and has good industrial and economic development potential. Kazakhstan is severely affected by water shortages and decreasing surface water supplies from transboundary rivers. Poor agricultural and irrigation practices resulted in serious soil desertification and land degradation causing not only biodiversity loss but hindering development of many areas in the country. The level of the radiation contamination due to the past nuclear weapons tests in Semipalatinsk (Semey) area and radioactive waste disposal represent a threat to public health and the environment. The Aral Sea's shrinking and salinity increase is one of the world's environmental 'hot spots'. Significant soil, water and air pollution remains a problem for the industrial cities like Balkhash, Ekibastuz, Almaty, Temirtau, Pavlodar, Ust-Kamenogorsk and Aktobe. The Caspian Sea shelf, where a number of oil and gas developments are taking place, is a sensitive ecosystem and needs to be protected .

Kazakhstan's carbon dioxide (CO_2) emissions in 2007 were 227,340 kt, while the per capita emissions were 14.76 t (UN, 2010). The overall CO_2 emission per GDP intensity is one of the highest in the world, at 1.43 kg/$1 GDP in 2007. After decades of under-investment, northern Kazakhstan's coal-fired power plants are prone to failing to provide the population with adequate heat during bitterly cold winters, and are coating the surrounding areas with coal dust.

With help from the European Bank for Reconstruction and Development (EBRD), in the form of an equity investment of €46 million, the Central-Asian Electric Power Corporation (CAEPCO), a privately-owned company, will revamp its units to ensure both adequate output and reduced emission levels. This project is EBRD's first equity investment in the Kazakh power sector and it aims at cutting CAEPCO's CO_2 emissions while also slashing dust and SOx emissions by 80% and 40% respectively. CAEPCO accounts for 6% of Kazakhstan's electricity and will use the capital for an investment programme up to 2013, to upgrade its generation and distribution assets to boost efficiency and reliability.

At this time, it is claimed that about 97% (on average) of the dust from post combustion gases from power plants is being captured, with some plants capturing as much as 99%. Most power plants use combustion temperatures of less than 1400ºC, which results in NOx emissions of less than 1000 mg/m^3, and since the coal sulphur content is less than 1%, the SOx emissions are less than 2000 mg/m^3 (Aliyarov, 2011a). While these values are considered acceptable in Kazakhstan, they are almost an order of magnitude higher that the values prescribed by the EU Directive of 24 November 2010. The Directive establishes emission limit values for SO_2 and NOx for combustion plants using coal, lignites and other solid fuels, as follows (Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010):

Total rated thermal input, MW	SO_2 emission limit values, mg/m^3	NOx emission limit values, mg/m^3
50–100	400	300–450*
100–300	250	200
<300	200	200
* 450 in case of pulverised lignite combustion		

A comparison of average efficiencies of many plants in the developing countries with those of the best available power plants in the world, shows that fuel consumption and CO_2 emissions could be reduced considerably if the BAT were used for retrofitting existing power plants. Efficiency improvements can significantly reduce CO_2 and other emissions. Efficiency improvements also have the potential to reduce emissions of sulphur dioxide and, in certain cases, nitrogen oxides (NOx). Natural gas, combined-cycle plants have the lowest emissions of fossil fuel- based technologies because of the low carbon intensity of gas and high plant efficiency (*see* Figure 19).

According to the ACCESS Project (*see* Chapter 12,):

> 'Coal is no doubt remaining the main source of energy in Kazakhstan's energy balance. Climate change, environmental protection, the problems of disposing of ash and hazardous gases (coalbed methane) are the primary problems which the coal economy is facing. Today, there is an urgent need to optimize the processes of coal consumption, the introduction of new clean technologies and to reduce emissions.
>
> 'In recent years, when the republic was experiencing a shortage of energy, the saving issues came up front. Together with the ratification by Kazakhstan UN Framework Convention on Climate Change and the Kyoto Protocol question about the new technologies needed to reduce greenhouse gas emissions came into close consideration. New coal technology is one of the priorities of the Kazakhstan energy sector.'

Academician Aliyarov, considered one of the 'fathers' of the coal burning technologies in Kazakhstan, and winner of a State Award in this field, believes that emission reduction from coal burning power plants can be achieved, at this time, mainly by using BAT, to improve the burning process of coal with high ash content (Aliyarov, 2001a). BATs, such as large furnace/boilers, would result in better

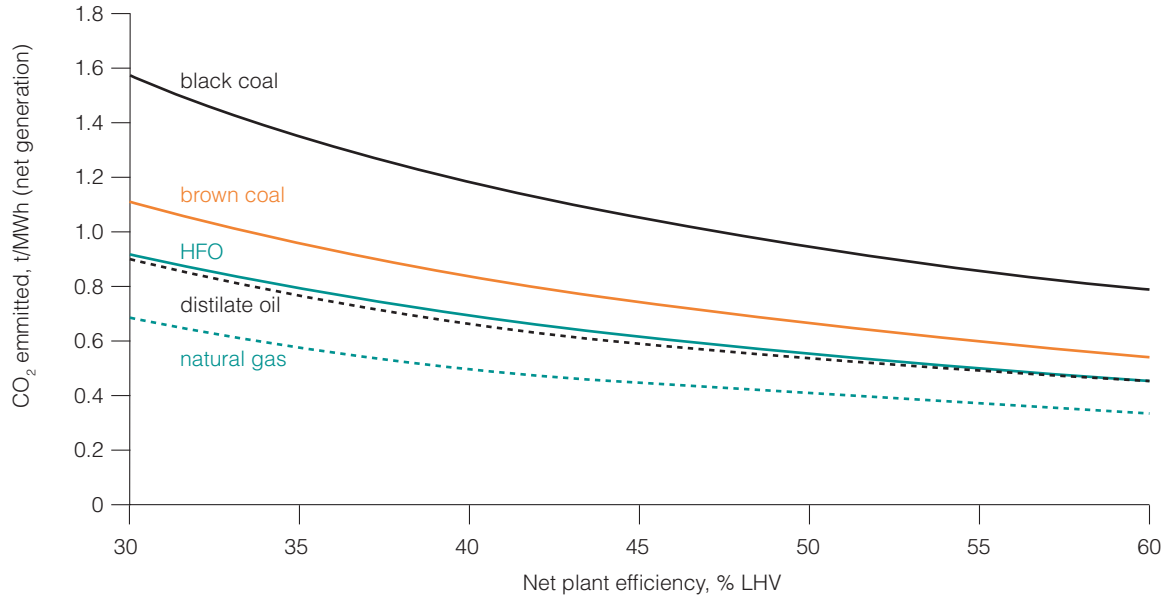

Figure 19 Impact of fuel type and efficiency on the CO_2 emissions of power plants (IEA coal information, 2009)

efficiencies and reduced emissions, and in waste reduction, while coal beneficiation could be considered at a later time. Many in Kazakhstan share his view. However, it is also recognised that, given the state of many Kazakh power plants, not all of them are suitable for upgrade or BAT retrofit.

There are some efforts under way to improve the power sector's environmental performance. Kazakhstan Electricity Grid Operating Company (KEGOC) was established, with the legal status of a joint-stock company, in accordance with the Government Resolution 'On Certain Measures with Respect to Restructuring of Kazakhstan Power System Management', dated 28 September 1996. KEGOC implemented an Environmental Management System in 2008 in line with the international standard ISO 14001:2004 aiming to improve all environmental indicators under the Environmental Policy of the Company. Environmental priorities in KEGOC's operation are described as being determined by Kazakhstan's accession to the World Trade Organisation (WTO), and the implementation of the Strategy for Kazakhstan to join the world's top 50 most competitive countries in corporate governance code.

The energy losses of KEGOC are comprised of two components: transmission losses, the lion's share of energy consumption, and consumption for the company's operations. The maximum potential for energy saving is from reducing electricity transmission losses. Based on 2009 results regarding loss reduction actions, KEGOC reduced their transmission network losses by 9.9985 million kWh in 2009 (KEGOC Sustainability Report, 2009).

11 Electricity transmission and distribution

Kazakhstan is the third country in the former Soviet Union in terms of electricity generated, after Russia and Ukraine. It has some 55 power generating plants with an installed capacity of about 18,500 MW (in 2009). The main goals and expectations for the electricity sector are addressed in the 'Programme for the Development of the Electro-energy Sector to 2030' prepared at the request of the government in 1999. The main directions for the development of this sector include:

- creation of a united electricity system to run in parallel with the Russian and central Asian systems, leading to a competitive electricity market;
- making most use of the existing power plants through their reconstruction and modernisation;
- improving the generation structure through the development of peak and half-peak power availability, and increasing the use of renewable energies;
- reconstruction and modernisation of plants to use the most effective technologies for combined production of heat and power;
- increasing the use of centralised heat delivery from boilers and from efficient autonomous heat sources.

Kazakhstan's electricity transmission and distribution systems are divided into three networks. The two in the north and in the west are connected to Russia, and the one in the south is connected to the Unified Energy System of Central Asia. However, these transmission systems are not yet sufficiently interconnected, and they are still owned by the government. The northern networks, which service the coal-fired power plants that make up most of the country's installed capacity, have recently begun exporting electricity to Russia. In January 2003, the Ekibastuz Power Plant No 2, located in the northern Pavlodar region, began exporting electricity northward. Conversely, the southern network, which is connected to the Unified Energy System of Central Asia, is forced to import electricity from neighbouring Kyrgyzstan and Uzbekistan because of its lack of installed generating capacity.

The transmission system, owned and operated by the state-owned company KEGOC had, as of 1 January 2006, a total line length of 23,383 km. There are 18 regional distribution (sale) companies. The government regulates transmission and distribution tariffs.

Because Kazakhstan's southern regions have been largely dependent on expensive imported electricity supplies KEGOC has considered the construction of a new North-South power line to complement the existing 600 MW capacity line. Also being considered is a similar line, connecting the north and the west of Kazakhstan, to ensure power delivery from Ekibastuz to western Kazakhstan, going through Russian territory, and making it possible to supply the country's southern and western regions fully with energy generated in Kazakhstan. It was estimated that the North-South line would cost US$300 million to build. In 2003, KEGOC began investing approximately US$73 million to upgrade the country's high-voltage transmission lines, upgrade automated substations and purchase new distribution equipment. These investments are part of a bigger $258.4 million upgrading project being planned with financial assistance from the World Bank and EBRD who have provided a four-year loan assistance. As a result of the project, the capacity of the existing N/S line has more than doubled from 650 MW to 1350 MW. This allows Kazakhstan to become the 'energy bridge' between Russia and Central Asia.

The construction of the new 1115 km, 500 kV, single-circuit North-South power line (green dashed line in Figure 20) was completed in 2009. In 2003, the European Bank for Reconstruction and Development (EBRD) helped finance KEGOC's implementation of the first phase of the project, which cost roughly $90 million. The second and third phases included the upgrading of the Ekibasutzkaya and Agadyr substations, and provided for the purchasing of new distribution equipment. Total funding for the project was $347 million. The EBRD and World Bank have also

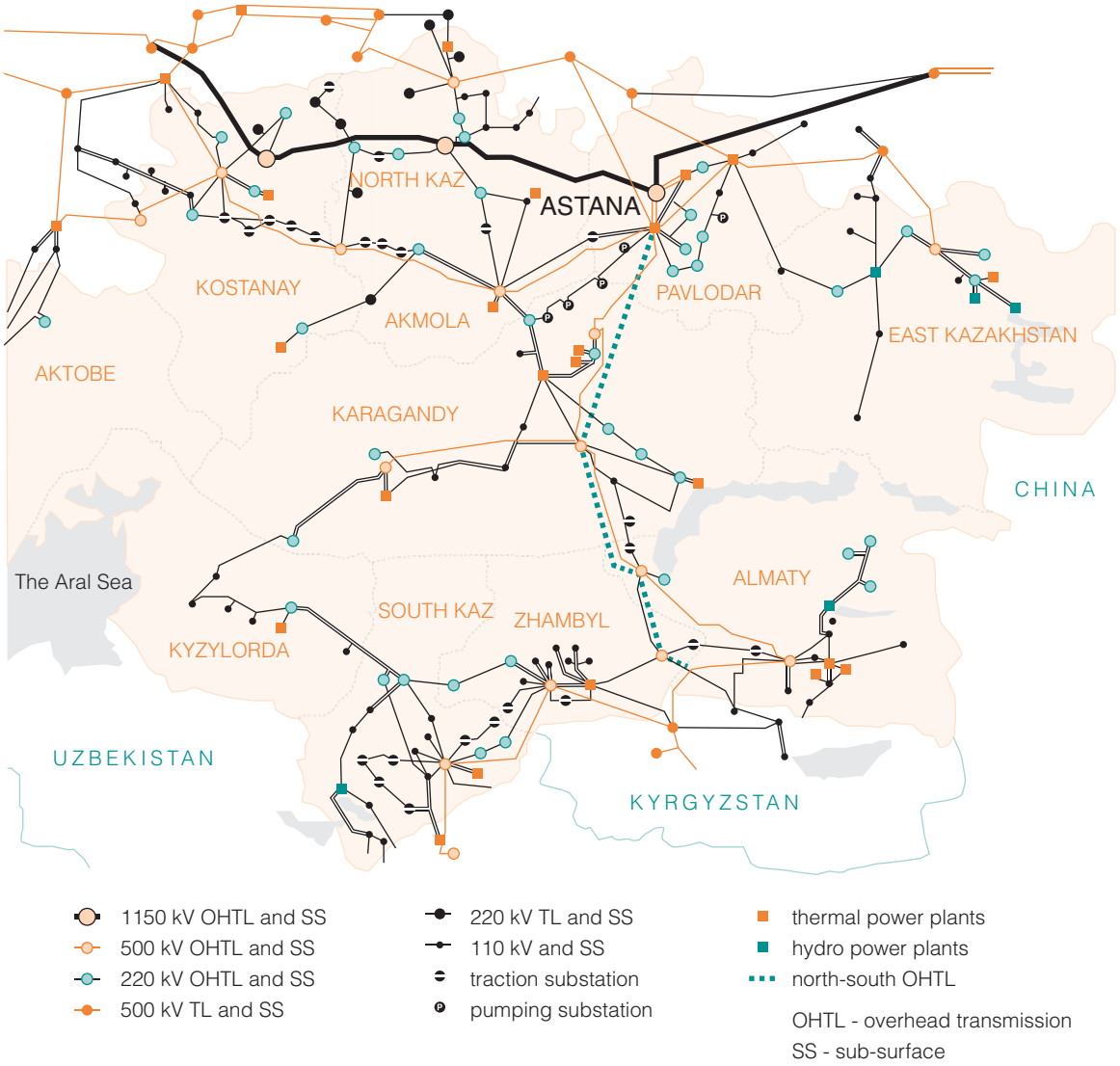

Figure 20 Kazakhstan's transmission network

funded KEGOC's purchase of high voltage, telecommunication and information technologies equipment under a US$80 million loan.

Kazakhstan has privatised most of its power plants, but the sale of regional electricity distribution companies has proceeded more slowly, and the majority of the distribution networks has not yet been privatised. KEGOC has granted management rights to several private companies, but KEGOC maintains control over high-voltage transmission lines, substations, and the central dispatching system. Ninety per cent of electricity sales are made in the bilateral forward market, and there is also a day-ahead spot market and a real-time balancing market. Power generating companies and large power users submit schedules for balancing energy three hours ahead and the system operator controls the settlement.

Non-payment of electricity bills, an inadequate collection system, and a lack of market-based transportation tariffs are all obstacles to further large-scale investment in Kazakhstan's transmission and distribution sectors. Although the government plans to further privatise the grid, the likely success of these utilities' privatisation remains questionable. For example, in 2000 Tractebel (Belgium), the owner of the Almaty electricity utility, left the country and resold the utility to the state gas pipeline operator. After four years, Tractebel had turned the Almaty electricity company around by cutting non-payers' rates of more than 75% down to just 12%. However, following the April 1999 monetary

devaluation, the government froze electricity prices to control inflation after previously pledging to raise rates.

Under the former Soviet Union, Kazakhstan utilised a system of fixed electricity tariffs that were unrelated to production costs and investment needs. Kazakhstan's State Anti-Monopoly Committee is working to bring electricity tariffs in line with those in other countries and to allow the market to determine transmission tariffs. From 1 July 2001, KEGOC increased electricity transmission rates across the country by an average of 23.7%. Rates continued to increase during 2003 and 2004, forcing some manufacturers to halt production.

Kazakhstan incurs large electricity transmission and distribution losses in its 460,000 km of lines. According to Kazakh Minister of Energy and Mineral Resources, Vladimir Shkolnik, an average of 15% of the electricity generated in Kazakhstan is lost before it reaches consumers due to the widespread deterioration of Kazakhstan's power infrastructure . This is also attributed to the fact that the power use density in Kazakhstan is very low, and averages 6 kW/km^2.

11.1 Electricity exports and interconnections

Electricity connections to Russia are via 500 kV transmission lines, while connections with other Central Asian countries are at either 220 kV (about 20% of them) or 500 kV (80% of them). Because of the way Kazakhstan's power generation and transmission is organised, the country has to import electricity, in the West from Russia, while exporting to Russia in the Northeast. However, the cross-border energy exchange is less than the transmission lines capacity. Kazakhstan uses some 87 trillion kWh per year, while it productes about 70–74 trillion kWh per year. One of the most important exporters of electricity to Kazakhstan is Kyrgyzstan, followed by Tajikistan which, having no common border with Kazakhstan, exports through Uzbekistan.

11.2 Existing coal-fired capacity

The most important coal-fired power plants in Kazakhstan are listed in Table 11.

While the number of plants is relatively large, most of them are quite small (Sogrinskaya is only 50 MW and Pavlodarskaya No 2 is 110 MW). The unit sizes vary between smaller 4 MW stations, to 25 and 50 MW at many stations, to 500 MW at Ekibastuzskaya. Almost all plants produce heat and power, with the exception of the two larger ones (Ekibastuzskaya No 2 – 1000 MW and Ekibastuz No 1 – 4000 MW). All plants are designed to run on either coal or oil and, while all are powered by bituminous coal between 99.8% and 99.9% of the time (with the exception of Almatinskaya, using coal only 40% of the time), none is listed at 100% coal usage.

The majority of power plants in Kazakhstan use coal with high (over 40%) ash content. Using low quality coal (and even untreated coal) to generate power allows the country to save on other fossil fuels. According to Aliyarov (2011b), worldwide, there is very little experience in using boilers burning such coal at the moment. The experience accumulated in this field in Kazakhstan covers a climate where temperatures range from +50ºC to –50ºC, and it could be considered at world level.

Table 11 Coal-fired power plants in Kazakhstan (IEA CCC, 2011)

Plant name	Capacity, MWe	Type	No units	Coal type	% power from coal
AES Sogrinskaya TETS	50	heat & power	2	bituminous	98
Aksuyskaya GRES	2100	heat & power	3	bituminous	99.9
Almatinskaya TETS-2	510	heat & power	6	bituminous	99
Almatinskaya TETS-3	173	heat & power	4	bituminous	99
AO Stanzia Ekibastuzskaya GRES-2	1000	power	2	bituminous	99.8
AO AstanaEnergiya TETS-2	240	heat & power	3	bituminous	99.9
APK Almatinskaya TETS-1	1600	heat & power	6	bituminous	40
Balkhashskaya	115	heat & power	3	bituminous	99
Djezkazganskaya	237	heat & power	5	bituminous	99
GRES Ksachmys	608	heat & power	7	bituminous	98
Ispat-Karmet TETS-2	435	heat & power	4	bituminous	98
Petropavlovskaya TETS-2	380	heat & power	7	bituminous	94
Rudnenskaya TEC	204	power	5	bituminous	94
Pavlodarskaya TETS-3	440	heat & power	5	bituminous	99
Kragand TETS-3	440	heat & power	4	bituminous	99
Pavlodarskaya TETS-1	350	heat & power	6	bituminous	99.5
Pavlodarskaya TETS-2	110	heat & power	3	bituminous	99
Mittal-Stil Temirtau	204	heat & power	5	bituminous	98
AES Ekibastuz	4000	power	8	bituminous	99.5
Ust-Kamenogorskaya TETS	242	heat & power	8	bituminous	99.8

12 Coal-fired power and cleaner coal technologies

On 14 July 2011, the EU-funded ACCESS project (Assistance in Clean Coal and Environmentally Sound Storage Solutions) held a press conference in Astana, with participation of Norbert Jousten, head of the EU delegation in Kazakhstan and other EU and Kazakh officials and interested parties. It was noted that 'The EU-Kazakhstan Cooperation in Clean Coal and Environmentally Sound Solutions enhanced significantly since 2006 when the EU-Kazakhstan MoU on Co-operation in the field of energy was signed.'

Mrs Silvie Myngheer, the ACCESS project engineer, stated that 'By sharing experiences in Clean Coal Technology and Carbon Capture and Storage, environmental performance can be improved in Kazakhstan, contributing to the sustainable development of the coal based energy sector and industry in Kazakhstan'. Several activities took place under the ACCESS umbrella:

- In September 2010, the first workshop on the coal value chain between the European Union and the Republic of Kazakhstan took place in Astana. The workshop brought together policy makers, industry and academia to share best practices and policies in the coal sector. In December 2010, the European Commission launched a project to support further implementation of the MoU.
- In June 2011 a delegation from Kazakhstan consisting of representatives from the Ministry of Industry and New Technologies, the Ministry of Environmental Protection, industrialists, visited Belgium and Germany to share experiences and knowledge with colleagues in Europe. The programme included workshops and visits to the universities of Liège and Hasselt, to the coal-fired power plant and an opencast mine of RWE, and to mine reconversion sites in the Limburg Region.
- During 11-14 July, the first training sessions took place in Kazakhstan. The participants of the sessions were industrial personnel, authorities, scientists and other interested parties. The first two days of this training were held in Ekibastuz (12-13th of July) and the last day in Astana, in the Nazarbayev University.

Financed by the EU in the amount of about €700,000, the project is aimed at improving the efficiency, environmental performance and regional development of the coal-based energy sector and industry in Kazakhstan. Together with the Ministry of Industry and New Technologies and local partners, the project is designed to support capacity building in Kazakhstan on Clean Coal Technologies and Carbon Capture Storage. The project is implemented by a Belgium team of experts from Hasselt University, Ecorem nv, University of Liège and the Geological Survey of Belgium with support of the Kazakhstani partner Climate Change Coordination Centre.

Climate Change Coordination Centre (C4), based in Astana, is the first Kazakhstani NGO that works in the field of the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol (KP) and Vienna Convention on Ozone Layer Protection. The Centre was established after completing a USAID project Kazakhstan's Initiative on Greenhouse Gas (GHG) Reduction. The project formed the base necessary for establishing a strong professional network of experts in the field of energy efficiency and nature protecting activities. Project specialists established working groups for implementing greenhouse gases reduction projects. This demonstrated the possibilities for implementing such projects and their benefits for population and the economy.

However, with respect to the implementation of clean coal technologies in Kazakhstan underground coal gasification is being considered by some Kazakh specialists as unreliable and difficult to control. There are no plans to introduce this technology in the near future. Similarly, no circulating fluidised bed technology is presently considered to replace pulverised coal technologies.

Carbon Capture and Storage is considered to be much too costly for the present state of the Kazakh economy. However, it is mentioned that in some oilfields, some of the CO_2 resulting from burning

flare gases, is being captured and returned underground, back into the oilfield, for enhanced oil recovery.

The UN Division for Sustainable Development (DESA) with the support of the Joint Stock Company TuranAlemBank and the approval of the Government of Kazakhstan, held a capacity building workshop in Almaty, on 12–13 November 2007, which brought together the representatives of research institutes, industry organisations, and government agencies working to advance the knowledge of underground coal gasification (UCG) options. The primary objective was to elaborate and explore the potential contribution of UCG to sustainable energy development in Kazakhstan and other Central Asian countries.

12.1 Coalbed/coalmine methane

As can be seen from Figure 21, the Kazakh coal mines are particularly gassy. They must be degasified and ventilated to prevent explosions and promote worker safety. However, the Methane to Markets International CMM Projects Database currently identifies only one CMM recovery project in place, in Kazakhstan, in an active, underground mine in the Karaganda basin. The methane is being used for boiler fuel (Methane to Markets, 2009).

While methane can come from a variety of sources (*see* Figure 22), the largest amount is produced by the energy and power industries.

Coal methane resources of the Central Kazakhstan coal fields are estimated at more than 1 trillion m^3 and, under appropriate project development, annual production may reach to 3–4 billion m^3. It could supply the gas consuming industry sectors for more than 100 years.

Methane is a powerful GHG, 21 times more potent than CO_2 and is second only to CO_2 as a contributor to climate change (*see* Figure 23). The potential of carbon dioxide emission reduction gained from 1 billion m^3 methane utilisation is 3.6 Mt/y.

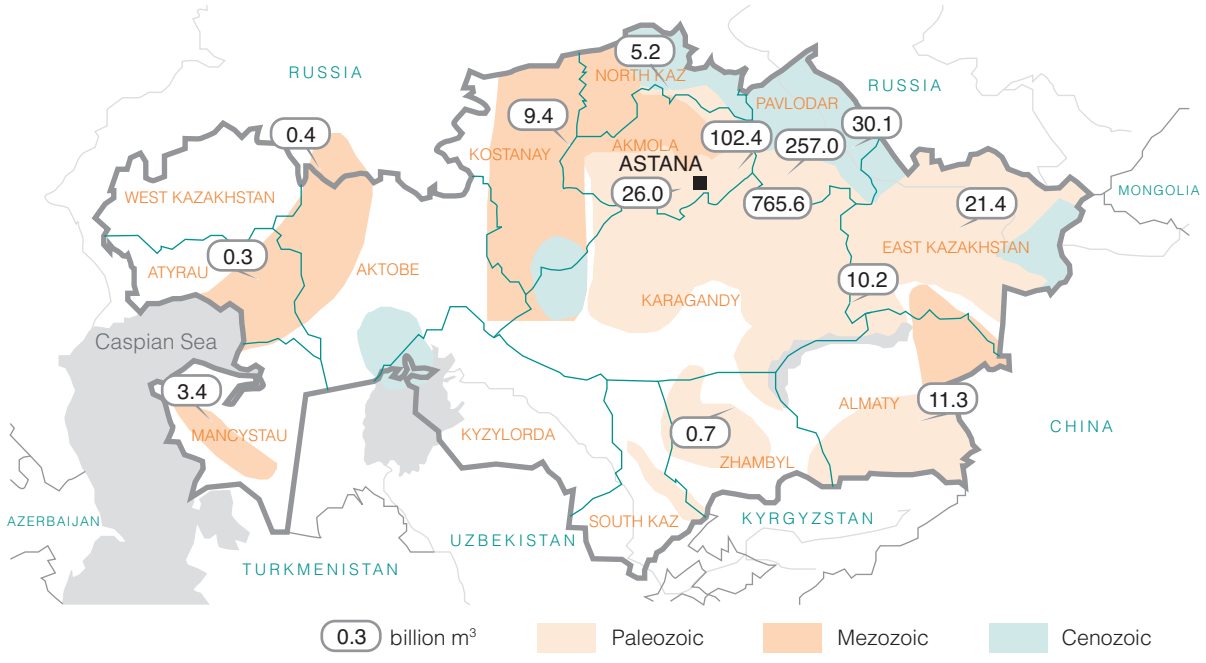

Figure 21 Kazakhstan's coal methane reserves in billion m^3 (Umarhajleva and others, 2003)

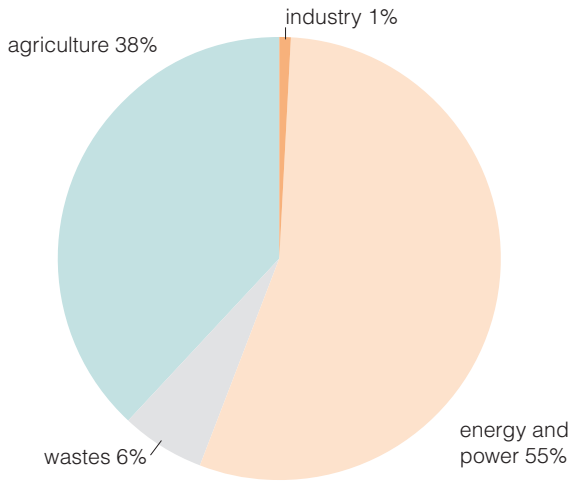

Figure 22 Structure of methane emission in Kazakhstan (Umarhajleva and others, 2003)

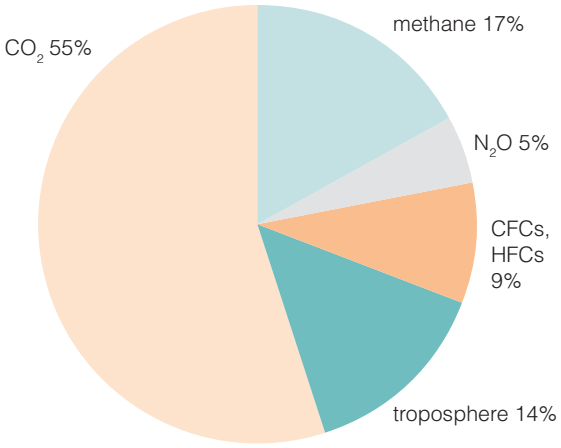

Figure 23 Methane contribution to GHG (Umarhajleva and others, 2003)

Table 12 Summary of Kazakhstan's selected CBM resources (Methane to Markets, 2009)

Basin or Field	CBM resources (estimate) billion m^3
Karaganda basin	550–750
Ekibastuz basin	75–100
Zavialov field	14.6–16.8
Samarskiy field	11.0–14.2

Implementation of such projects in Kazakhstan would provide significant mitigation of greenhouse gas emission and may become a source of carbon credits (Umarhajieva and others, 2003).

The 12 underground mines in the Karaganda basin widely use surface degasification wells. Methane emissions from these mines average about 33 m^3/t. However, the level of methane utilisation is very low, only about 10–12 million m^3 annually, which is recovered and used in three to four boiler installations for mine heating. Surface mines are heavily ventilated, but ventilation air with methane concentrations of about 1% is routinely vented to the atmosphere. In the 1970s, in Kazakhstan, a project was developed to add mine methane to gas turbine combustion. More recently, a furnace boiler was developed to burn a mixture including methane and air as coming out from a mine ventilation shaft. At least 14 underground coal mines in Kazakhstan have been abandoned since 1996. All are considered gassy. No specific information about methane recovery projects at abandoned mines is available.

According to the Ministry of Energy and Mineral Resources, Kazakhstan's coalbed methane (CBM) resources are some of the highest among the coal basins of the world, as illustrated in Table 12.

TOTAL Kazakhstan, LLP was awarded the State tender for exploring and mining CBM in the Taldykuduk area of the Karaganda coal field in late 2004. The exploration stage, now ongoing, includes drilling six test wells. The Kazakhstan National Innovation Fund and TOTAL hope to attract foreign investment of $180–220 million in the second (commercial) phase of the effort to hasten development of a new CBM industry for the country (USEPA, 2005). In April 2003, the Ministry of Energy and Mineral Resources recommended that BogatyrAccess Komyr Ltd and Azimut Energy Services Ltd pursue a CBM development effort in the Ekibastuz basin. These efforts would include attracting domestic and international investors to assess the resources (including seismic studies) and conducting a pilot project including five to six test wells, to identify and select development technologies, and to book recoverable CBM resources as proved reserves.

Kazakhstan is a signatory to both the UNFCCC and the Kyoto Protocol. Kazakhstan applied for Annex I status in June 1999 but withdrew its application in June 2000. Therefore, it does not have an emissions target listed. Kazakh methane emissions have fallen significantly since 1990, creating the potential to trade or sell emission reduction credits through the Clean Development Mechanism. Investment for CMM projects could also come from the National Innovation Fund, mine operators, and foreign investors.

Opportunities to develop the country's CBM and CMM resources are potentially a significant source of investment, and Kazakhstan is working to establish an attractive investment climate. The Kazakhstan government prioritises CMM projects as a means of achieving measurable and verifiable GHG emission reductions. Recently, the government approved proposals for establishing criteria and procedures for screening, review, and approval of GHG emission reduction projects. It also approved similar proposals relating to baseline assessment and validation; emission reduction calculation; monitoring, verification, and registering emission reduction projects; and allocating 5 $MtCO_2$ equivalent for transfer to investors in GHG reduction projects. As a next step, the government will promulgate regulations (USEPA, 2005).

Kazakhstan will require significant infrastructure investments to commercialise CBM and CMM development. Gas gathering systems will be required, as well as interconnect with distribution pipelines. Some synergies may be available with rapidly-developing gas production associated with expanding oil production. Possible end uses for recovered methane include industrial boilers, power generation, heating, and transportation fuel (for fleets and private vehicle conversions). CMM and CBM will have to compete with other domestic gas production, mainly associated gas from petroleum production. However, increasing domestic and regional gas demands suggest there are adequate markets for all methane that can be produced. Furthermore, rising global natural gas prices are making CMM and CMM investments much more economically attractive.

In 2005, KZT 14,609 million was invested in the mining industry. A large portion of those investments KZT 5,997.7 million went into coal production and improvement. In 2007, the Arcelor-Mittal Group pledged to invest US$500 million to increase coal production in the Karaganda region by around 5 Mt (EIA, 2008). These large investments in the nation's coal production could lead to increased CMM development projects.

The Government owns all subsurface gas and minerals but has allocated coal reserves to private mine operators as part of their contracts and CMM to contracted coal operators. CMM and CBM project developers must enter into agreements with the coal operators for development and sale of the gas resources. Future petroleum legislation and provisional rules for exploration and development will provide a comprehensive and consistent legal framework for CBM exploration and exploitation.

Mining companies understand the safety issues and are increasingly understanding of the environmental issues associated with CMM. Coal mine safety is a key concern in surface and underground mines; numerous recent deaths due to mine explosions underscore the importance of this problem. Environmental and safety standards are improving, but are also driving up development costs (Methane to Markets, 2009).

13 Co-operation agreements with foreign countries

Kazakhstan has stable relationships with all of its neighbours. It is also a member of the United Nations, Organisation for Security and Co-operation in Europe (OSCE), Euro-Atlantic Partnership Council and Organisation of the Islamic Conference (OIC). It is an active participant in the North Atlantic Treaty Organisation Partnership for Peace programme.

Kazakhstan is also a member of the Commonwealth of Independent States (CIS), the Economic Co-operation Organisation and the Shanghai Cooperation Organization. The nations of Kazakhstan, Russia, Belarus, Kyrgyzstan and Tajikistan established the Eurasian Economic Community in 2000 to re-energise earlier efforts at harmonising trade tariffs and the creation of a free trade zone under a customs union. On 1 December 2007 Kazakhstan was chosen to chair OSCE for the year 2010.

Since independence in 1991, Kazakhstan has pursued what is known as the 'multivector foreign policy' (Russian: mnogovektornaya vneshnyaya politika), seeking equally good relations with its two large neighbours, Russia and China, and the USA and the West generally. The policy has yielded results in the oil and gas sectors, where companies from the USA, Russia, China, and Europe are present at all major fields, and in the multidimensional directions of oil export pipelines out of Kazakhstan. Kazakhstan also enjoys strong, and rapidly developing, political and economic ties with Turkey. Kazakhstan formed a customs union with Russia and Belarus which is expected to be transformed into a common economic space.

Russia currently leases approximately 6000 km² of territory enclosing the Baikonur Cosmodrome space launch site in south central Kazakhstan, where the first man was launched into space as well as Soviet space shuttle Buran and the space station Mir.

Kazakhstan is a partner country of the EU INOGATE energy programme. INOGATE was set up in 1995 as an EU support mechanism dealing with INterstate Oil and GAs Transportation to Europe. It is concentrating on four key topics: i) enhancing energy security; ii) convergence of member state energy markets on the basis of EU internal energy market principles; iii) supporting sustainable energy development; iv) attracting investment for energy projects of common and regional interest.

On 4 December 2006, Kazakhstan and the European Union signed a MoU, which sets the framework for stronger energy co-operation. The memorandum establishes road maps on energy security and industrial co-operation. It was accompanied by a co-operation agreement to develop nuclear trade.

Kazakhstan and Russia have close co-operation on energy issues. During their presidents' meeting in 2006 in Oral, Kazakhstan and Russia agreed to set up a gas condensate processing joint venture between Gazprom and KazMunaiGaz in Orenburg, which will be supplied from the Karachaganak field. The gas supply agreement was signed in May 2007 in Astana.

In December 2006, Kazakhstan and Russia signed an agreement in which Russia pledged to assist Kazakhstan in its nuclear programme in return for shipments of uranium from Kazakhstan to Russia, where the uranium will be enriched.

In 2007, Russia, Kazakhstan and Turkmenistan, signed an agreement providing for Central Asian gas to be exported to Europe through the reconstructed and expanded western branch of the Central Asia-Centre gas pipeline system.

14 Conclusions

Kazakhstan has a very energy intensive economy, thus energy efficiency represents Kazakhstan's single best opportunity to improve energy security. Improved efficiency is essential for Kazakhstan's growth and development, and for protecting its environment. Kazakhstan can considerably improve its energy efficiency both through targeted policies and through market-oriented energy pricing.

Today, most prices charged for energy use in Kazakhstan still cover only operational costs, which has created a pressing need to invest in upgrading the infrastructure. Cost-reflective prices are necessary to attract adequate investment and to provide incentives for reform across many areas of the energy sector. Kazakhstan could strengthen its energy policy by improving the transparency of energy data and clarifying market rules.

The primary energy demand of Kazakhstan is projected to increase at a rate of 1.8% per year until 2030. This represents a slower growth rate than the projected GDP growth rate of 3.8% during the same time, reflecting expected energy efficiency improvements across the sector.

Coal is expected to maintain it's dominant share in primary energy demand at 46.1% in 2030. However, its growth is likely to be relatively slow at 1.5% per year through 2030 as coal will be replaced by natural gas for the industry sector, and will be more efficiently utilised for heat production and power. It is expected that in 2030 about 87% of the total coal production will be consumed domestically, while the remainder will be exported to Russia and Ukraine.

In Kazakhstan's vast land area, energy resources and demand centres are geographically disparate. The north and middle regions of Kazakhstan possess coal with large proven reserves (3.8% of the world). This is the third largest reserves in the former Soviet republics after Russia and Ukraine. The western region is endowed with oil and natural gas. Meanwhile, the population centres are in the southeast region, surrounding Almaty - the former capital of Kazakhstan, in the north region surrounding Astana – the current capital, and in the south region surrounding Shymkent.

Given Kazakhstan's distinctive geographical characteristics and vast land area, landlocked location, and long distance between the mineral resource deposits and demand centres, the country's economic activities inevitably rely on efficient transport operations. Over the period up to 2030, transport energy demand will nearly double, growing at an annual rate of 2.7%. As a result of income growth, demand for gasoline for both passenger and freight vehicles will grow 2.1% per year through 2030 and maintain the largest share of total transport energy demand.

The railway system is likely to continue its importance as a mode of transport for passenger traffic and mineral and steel products for export. Currently, diesel represents more than 75% of total rail transport energy demand, and the remainder is taken up by electricity.

Kazakhstan's energy supply infrastructure is underdeveloped, as the legacy of the Soviet Union had sought to optimise inter-member states energy supply rather than to achieve self-sufficiency in strict energy supply. Government regulations including pricing and universal supply obligations make the domestic market unattractive to suppliers. Therefore, while Kazakhstan is a net energy exporter, some regions have to rely on imported energy sources – including petroleum products, natural gas, and electricity – from the neighbouring countries.

Following current practice, surplus revenues from oil and gas sales will be channelled to the National Fund, which will support the country's effort to diversify its economic structure through development of agriculture and manufacturing industries.

Presently, coal is the main energy source in Kazakhstan's industry sector. Coal is mainly used in the steel and manufacturing subsector, which is located close to the coal mines in the northern part of Kazakhstan. Over the period to 2030, although iron and steel production will continue to drive the steady growth in coal demand, other manufacturing subsectors will shift from coal to other energy types – mainly electricity and natural gas, due to the development of expanded transmission networks. As a result, industry's coal demand is projected to decline at an annual rate of 0.8% through 2030, compared with the annual growth rate of 1.4% between 2000 and 2005.

Similar to other countries in Central and West Asia, most of Kazakhstan's power generation facilities are obsolete as they were mostly built during the Soviet era. Currently, only 14,410 MW of the country's installed capacity of about 18,602 MW is operational. To meet the expected 2.5% annual growth in demand, replacement of the old generation units and introduction of additional units will be necessary. Kazakhstan's power generation mix is dominated by coal. Along with the additional capacity increase in coal fired generation close to the northern part of the country, construction of natural gas fired generation facilities is being undertaken near the western deposits and hydrogenation capacity is being expanded in the south. As a result, coal's share will drop in 2030, while natural gas fired generation will double.

Energy suppliers have few incentives to build and modernise facilities due to the regulated electricity tariffs – along with non-payment problems of consumers. A clear future direction, as well as legislation towards building and modernising infrastructure, are necessary to promote investment in the energy sector.

On energy resources development and exports, Kazakhstan encouraged foreign investors to explore and develop resources in the early part of 1990s. However, the government has recently shifted its policy to strengthen its involvement in energy resources development. The Law on Subsoil and Subsoil Use was amended to include pre-empting foreign rights on any oil assets. In addition, the Law on Production Sharing Agreement was amended to require minimum 51% ownership of the state-owned KazMunaiGaz in any project. In the estimated investment outlook, exploration/development, and export facilities represent large-scale capital for both oil and natural gas. Faced with the financial and technological constraints, Kazakhstan is encouraged to create conditions that can facilitate entry of foreign investors, which can form partnerships with the state-owned companies, and provide easier access to international capital and technology. These efforts would ultimately help realise Kazakhstan's potential economic development.

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