

# Coal: The other black

Despite coal's reputation as the world's most environmentally abrasive fuel, the expanding global economy dictates that over the next 30 years demand for coal will be greater than ever, as **Chris Cann** discovered

The energy debate has escalated in the past year as the public's distaste for fossil fuels intensifies and acceptance of nuclear power as a 'green' energy source grows in spite of its traditional reputation as nature's enemy. Global petroleum stocks have been scrutinised and the profile of publicly popular renewable fuels continues to rise.

Coal is one of the world's most efficient energy forms and the fastest growing fossil fuel so far this century but is also the poster boy for dirty fossil fuels. It has increasingly come under fire from environmentalists and many of the lay public, who would like to see more green alternative fuels used. But the increase in the public's interest in energy has led to a wider understanding of an unpopular truth – coal is necessary to help fuel the world's growing energy demands and wind, solar, hydro and bio energy alternatives will not be able to even partly replace it in the foreseeable future.

A recent report on leading energy news service *Energy Tribune* aptly encapsulated that point: "Too many people focus on what they consider desirable and how the world should be, rather than taking the world as it is. As such, they ignore the gap between what is theoretically possible in their most perfect of worlds and what is practical at a given time."

"This is one reason governments continually fail to make any significant difference when it comes to the world's energy mix. It is also why the recent legislative push toward alternative fuels (in the US), including renewable biofuels, such as ethanol, is likely to fail."

Nuclear and renewable energy sources made up 10% of global consumption in 1980, which has risen to 14% today and is estimated to remain static up to 2030. Coal has not only maintained about 25% of global consumption since 1980 but is predicted to increase its stake to 27% by 2030. As global energy requirements grow by 60% over the next 30 years, largely thanks to the industrialisation of China, coal remains the cheapest and most prolific fuel.

"We believe that coal use will increase under any foreseeable scenario because it is

cheap and abundant," *The Future of Coal* report published by the Massachusetts Institute of Technology said.

"Coal can provide usable energy at a cost of between \$1-2 per million Btu compared to \$6-12/MBtu for oil and natural gas. Moreover, coal resources are distributed in regions of the world other than the Persian Gulf, the unstable region that contains the largest reserves of oil and gas. In particular the US, China and India have immense coal reserves. For them, as well as for importers of coal in Europe and East Asia, economics and security of supply are significant incentives for the continuing use of coal.

"Carbon-free technologies, chiefly nuclear and renewable energy for electricity, will also play an important role in a carbon-constrained world, but absent a technological breakthrough that we do not foresee, coal, in significant quantities, will remain indispensable."

Unlike oil, there is no speculation over long-term coal resources with the world's proven reserves at the end of 2006 standing at 909,064 Mt. More than 80% of those reserves are hosted by six countries – the US, Russia, China, India, Australia and South Africa.

According to the World Coal Institute, coal will maintain its position as the principal source of electricity for the next 30 years accounting for about 40% of that market: "With the availability of abundant, affordable and geographically dispersed reserves, coal has a

vital role to play in a world where reliable supplies of affordable energy will be essential to global development."

There is the equivalent of more than five hundred, 500 MW coal-fired power plants in the US with an average age of 35 years and China is currently constructing the equivalent of two 500 MW coal-fired power plants every week, and a capacity comparable to the entire UK power grid each year.

The relevant coal industry figures from across the globe for 2006 paint an accurate picture of coal's continued growth in line with global energy demands.

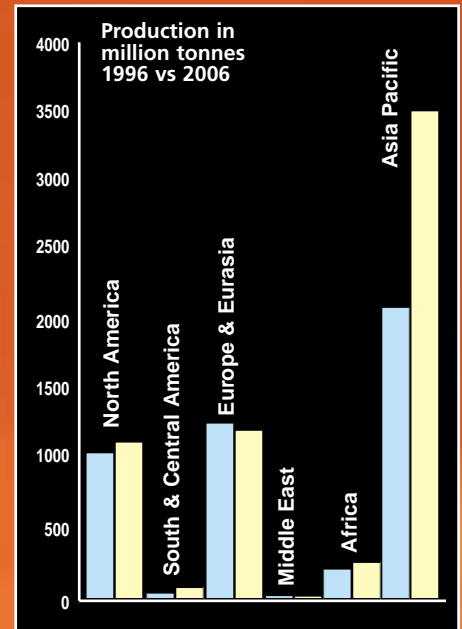
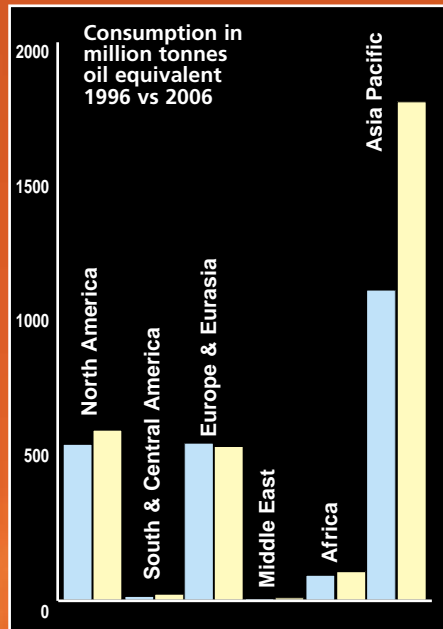
Consumption growth in China, the world's leading coal user, moderated from the strong growth seen in 2005 but remained above average at 8.7%, according to BHP Billiton's *Statistical Review of World Energy 2007*. Global consumption rose by 4.5%, below last year's rapid (5.7%) growth but well above the 10-year average. Consumption in the US declined for the first time since 2002.

The industrialisation of China, closely followed by India, has made the Asia-Pacific region the dominant coal consumer and producer in recent years. The region accounted for almost 90% of last year's growth in coal



# Black gold

consumption and 80% of coal production expansion. This has been the trend for at least 10 years. While coal consumption and production has been largely unchanged since 1996 within the other main geographical regions – North America; South and Central America; Europe and Eurasia; and the Middle East and Africa – the Asia-Pacific region has recorded consumption growth of more than 60% and production growth of more than 70% over that period.



Global coal consumption and production for 2006 was 3090.1 Mtoe and 3079.7 Mtoe respectively. The Asia-Pacific region made up 58% of global consumption and 58.5% of global production.

The demand for coal and its attractiveness as a cheap and bountiful resource are undeniable, but the MIT, along with other industry and community organisations, has warned that the industry could have devastating affects on the environment if it proceeds unchecked. The coal industry has responded by upping the ante on developing Clean Coal Technology (CCT)

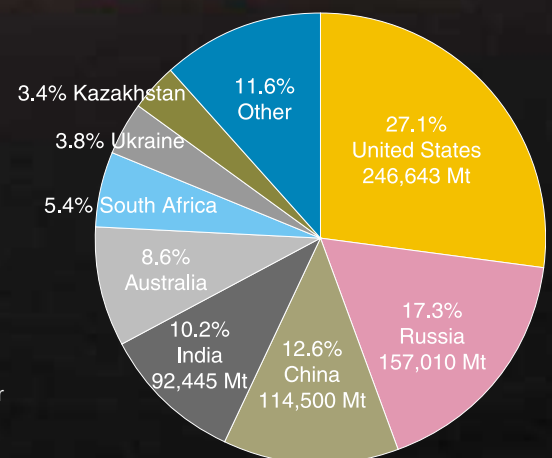
“Over the past two decades major progress has been made in reducing the emissions of so-called ‘criteria’ air pollutants – sulphur oxides, nitrogen oxides, and particulates from

coal combustion plants; and regulations have recently been put into place to reduce mercury emissions,” the MIT report stated.

“Our focus in this study is on approaches for controlling CO<sub>2</sub> emissions. These emissions are relatively large per Btu of heat energy produced by coal because of its high carbon content. We conclude that CO<sub>2</sub> capture and sequestration (CCS) is the critical enabling technology that would reduce CO<sub>2</sub> emissions significantly while also allowing coal to meet the world’s pressing energy needs.”

MIT said the priority for the coal industry should be large-scale demonstrations of the technical, economic, and environmental performance of CCTs, which have all the major components of a large-scale integrated CCS system — capture, transportation and storage.

Global Coal Reserves



Successful implementation of CCS will inevitably add costs for coal combustion and conversion. The World Bank has come to the party, upping its financial assistance package for China, India, Brazil, Mexico and South Africa in a bid to assist those countries to become low carbon economies. World Bank funding has increased from \$633 million annually from 2003 to 2005 to about \$1.7 billion in 2006. Much of this funding has been allocated through the World Bank's Global Environment Facility.

The bank has also said it would aid the private sector in pilot integrated gasification combined cycle (IGCC) and carbon capture and storage technologies. Projects in the specific areas of power plant rehabilitation and efficiency upgrades, early retirement for inefficient plants, gas flaring reduction and methane release reduction were to take priority.



## CLEAN COAL TECHNOLOGY

Though the coal industry will never be green, steps have been taken to make it as environmentally friendly as possible with the emergence of CCT, which aims to reduce the harmful emissions generated by coal-fired power stations. CCT is largely expensive or yet to be commercially proven. Some of the prominent CCTs are as follows:

### Carbon Capture and Storage – CCS

CCS involves capturing the carbon dioxide, preventing the greenhouse gas (GHG) entering dioxide into disused coalfields to displace methane, which can be used as fuel; pumping carbon dioxide into saline aquifers for safe storage; and pumping carbon dioxide into oil fields to help maintain pressure, making extraction easier.

A range of approaches of CCS have been developed and have proved to be technically feasible. They have yet to be made available on a large-scale commercial basis because of the costs involved. Source: BBC

### Gasification

Coal gasification plants are favoured by some because they are flexible and have high levels of efficiency. The gas can be used to power

electricity generators, or it can be used elsewhere, i.e. in transportation or the chemical industry.

In Integrated Gasification Combined Cycle (IGCC) systems, coal is not combusted directly but reacts with oxygen and steam to form a 'syngas' (primarily hydrogen). After being cleaned, it is burned in a gas turbine to generate electricity and to produce steam to power a steam turbine.

Coal gasification plants are seen as a primary component of a zero-emissions system. However, the technology remains unproven on a widespread commercial scale. Source: BBC

### Coal-to-Liquids – CTL

There is considerable global focus on CTL, particularly in the US and China, the two biggest oil-consuming countries. Current estimates show the world has just 40 years of known oil reserves and 65 years of natural-gas supplies. But we have enough coal to last an estimated 155 years, with some of the largest reserves in the US and China. America's National Coal Council, for instance, wants government incentives to help produce, daily, about 2.6 Mbbbl of liquid fuel from coal by 2025. That would satisfy about 10% of expected US oil demand that year. The plan would require 475 Mt/y of coal, which represents more than 40% of current annual

US production. Certainly, US coal reserves are big enough to allow for the extra production.

There are two different methods for converting coal into liquid fuels, direct and indirect liquefaction. Direct liquefaction works by dissolving the coal in a solvent at high temperature and pressure. This process is highly efficient, but the liquid products require further refining to achieve high grade fuel characteristics. Indirect liquefaction gasifies the coal to form a 'syngas' (a mixture of hydrogen and carbon monoxide). The syngas is then condensed over a catalyst – the 'Fischer-Tropsch' process – to produce high quality, ultra-clean products.

In China, China Shenhua Energy could become the world leader in CTL, taking over from South Africa's Sasol. It started developing its CTL program at a pilot plant in Shanghai, which now has successfully achieved

sustainable output of diesel oil and gasoline from a feed of 6 t/d of coal. This facility has allowed CSEC to become comfortable with the technology and to accumulate know-how on cost control and operations management

## China

China's coal industry has grown out of sight since 1998 when consumption was 651.9 Mtoe and production was just 628.7 Mtoe. Consumption for 2006 stood at 1,191 Mtoe while production reached 1,212.3 Mtoe – that's an increase of more than 82% and 92.7% respectively.

The slight downturn in the consumption growth rate for 2006 compared to 2005 was attributed to government policies that decreased investment in sectors such as cement, aluminium, steel and real estate; as well as more efficient coal consumption and the introduction of substitute energy sources, according to a 2006 Chinese government report.

Coal is largely responsible for China's relentless industrialisation providing about 70% of the country's energy needs as coal-fired power plants not only bring light to previously powerless rural villages, but provide the energy for the country's expanding manufacturing industry.

In the past year, China has added generating capacity that is equal to the whole

## Top 10 coal consumers for 2006 in Mtoe

1. China	1191.3
2. US	567.3
3. India	237.7
4. Japan	119.1
5. Russia	112.5
6. Sth Africa	93.8
7. Germany	82.4
8. Poland	58.4
9. Sth Korea	54.8
10. Australia	51.1

of France's electricity grid and plans to add even more in the next five years, largely through thermal coal power. Thermal power increase during China's 11th 5-year plan, according to the forecast by from China Electricity Council, saw another 75 GW added over during 2006 and predicts a further 70 GW will be added in 2007. About 250 GW will be added during 2006-2010 with the total installed capacity to reach 750 GW. Some 350 GW will come from China's "big 5 national power companies".

China's coal industry looks set to continue pressing forward. In May this year, coal consumption by domestic power plants expanded 1.47 Mt from April to 49.92 Mt, while coal stockpiles in power plants shrank by 130,000 t from the previous month to 26.83 Mt. Stockpiles have shrunk as temperatures have increased and industrial production has continued to grow, according to the China Coal Trade & Development Association. China produced about 1,100 Mt of coal in the first half of this year, up 7% on the corresponding period last year. The China National Coal Association has forecast that full-year production will rise about 6.5% this year to reach 2,480 Mt for 2007.

In light of this continued expansion and coal's proven affect on the environment, China's top economic planning agency has told its coal sector to accelerate energy-saving and emission-control preferential access to power grids and lower taxes as incentives for co-operative bodies, according to a *Reuters* report from July.

The National Development and Reform Commission (NDRC) said coal firms should reduce their energy consumption per tonne by 20% from 2005 levels by 2010, as part of a national push to limit GHG emissions. Coal-fired power plants should increase the use of coal waste to account for 70% of electricity generation by 2010, up from 43% in 2005, the NDRC said. Power stations should also be using 60% coalbed methane by 2010. The NDRC also told coal producers to increase

investments in new technology to boost energy efficiency and cut GHG emissions.

"The Chinese government has been struggling to curb pollution from the factories, mines and industrial plants that have driven frantic growth. China has promised to cut emissions of major pollutants by 10% between 2006 and 2010, but last year the country failed to meet the annual target," *Reuters* reported.

While both consumption and production continue to grow, the face of China's coal industry is changing. Previously a net exporter of coal, China is on track to emulate the US coal industry and become a net importer of coal by 2009, BHP Billiton Energy Coal Marketing representative Charles Liu told the China Steam Coal Conference in Shanghai late last year. Total coal net exports had dropped by 54 Mt and thermal coal dropped 25 Mt in the past four years, he said. Imports were on the rise as China attempts to feed its growth with its own coal resources and that from nearby countries such as Australia, Indonesia and Russia.

Liu said continued strong demand growth in China and an increasing cost base were making imports more competitive, while the country faced further infrastructure constraints for the future – only 40% of the rail network is double tracked. He added that new coal resources in China, mainly in the northwest were incrementally further away from the demand centres of the South. Liu predicted a turn around of near 100% in China's current position as a net exporter to a net importer of similar quantities by 2010.

## USA

US imports were again down on the previous year, while exports increased. The US ate up slightly less coal than last year with 567.3 Mtoe compared to 574.2 Mtoe in 2005 but maintained the general levels seen for the past six years. The country posted another record year for production up almost 15 Mtoe from 580.2 Mtoe in 2005 to 595.1 Mtoe last year. The industry is estimated to be worth more than \$50 billion to the US economy.

In 2006, coal prices continued to increase in good news for coal producers, while coal consumers would have been pleased to see coal stocks recover from their low 2005 levels in the electric power sector. Producers and consumers both benefited from the resolution of some of the major transportation problems that plagued the industry in 2005, according to the Energy Information Administration.

For 2007, the EIA predicted a mixed year: "Expectations of continued economic expansion and a return to more normal

## Top 10 coal producers for 2006 in Mt

1. China	2380.0
2. US	1053.6
3. India	447.3
4. Australia	373.8
5. Russia	309.2
6. Sth Africa	256.9
7. Germany	197.2
8. Indonesia	195.0
9. Poland	156.1
10. Kazakhstan	96.3

The full BHP Billiton 2006 coal report is available on their website

[www.bhpbilliton.com](http://www.bhpbilliton.com)

weather should drive an increase in coal consumption. However, the softening of the spot market prices and the somewhat lower end-of-year consumer stock level will result in lower production to keep the coal market in balance," the EIA said. Projected growth in electricity demand, coupled with declines in hydroelectric generation in 2007 and nuclear generation in 2008, should raise electric-power-sector coal consumption over the next two years. Consumption in the electric power sector was expected to grow by 1.1% in 2007 and 2008.

In the longer term, US production will continue to grown but to what extent is unknown, with the EIA showing figures to support an increase of anywhere from 15% to 65% by 2030.

Meanwhile, debate has raged at a national level over proposed legislations aimed at restricting the GHG emissions of US coal producers. A senior coal company official opened fire on US lawmakers in July for proposing caps on emissions, saying the Democrats were out to destroy America's coal industry, according to a report in *The Washington Post*.

Robert Murray, Chairman, President and Chief Executive of Murray Energy, also attacked the government's mine safety agency for "outrageous" new fines that he warned could put some miners out of business, the newspaper reported. "There is no question that the majority party in this country wants to eliminate the coal industry."

## Australia

With a relatively small population for its land mass, Australia has become the world's largest exporter of coal with its vast resources of 78,500 Mt needing to cater for just over 20 million people. Australia's consumption to production ratio is 1:4.

Black coal is Australia's largest export, worth around A\$24.5 billion in fiscal 2005-06. Nearly one-third of the world's coal exports come from Australia, and the EIA predicts that Australian coal exports will increase 55% by 2030. Australian metallurgical and thermal coals serve fast-growing Asian markets that are likely to account for the majority of growth in the global coal industry in coming decades.

The nature of the Australian coal industry has it at loggerheads with international environmentalists, as Prime Minister John Howard stands firm on his decision of several years ago not to sign the Kyoto Protocol, which governs GHG emissions for each member country. Australia's per capita emissions make it one of the world's worst GHG offenders and the government is coming under increasing pressure in this election year to make changes to its environmental policy.

The federal government has so far committed to setting up a cap-and-trade carbon-emissions scheme by 2012 prompting calls from industry stakeholders to start acting now in preparation for what is to come.

## India

India's coal industry is dominated by state-owned coal giant, Coal India Ltd (CIL), which is responsible for 85% of India's coal production,



making it the largest coal producer in the world. Almost all of India's 565 mines are operated by CIL and its subsidiaries, with government policy dictating private mines may operate only if they are 'captive' operations, that is they feed a power plant or factory.

CIL produced 45.82 Mt from underground operations in fiscal year ending in 2006, with the bulk of production (297.57 Mt) coming from open cut mines for a total production of

343.43 Mt of coal. That netted the company a Rs5,301.87 crore (\$13.174 billion) after tax profit, up almost 2% on last financial year and representing an improvement of almost 50% on fiscal 2002 when profit was recorded at Rs3,553.07 crore.

However, CIL faces a drop in profits this year of up to Rs2,000-2,500 crore because of recent upward adjustments to the minimum wage of its employees from Rs3,300 to

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Rs5,500, which is being back-paid to July 2001. Wage hikes are likely to combine with higher input prices for oil, ammonium nitrate explosive and power to cut profits. This prompted threats in late June from CIL to raise coal prices for the first time in three years.

"We have come to a point where if we don't increase prices, we will be causing self-injury," Chairman Partha S Bhattacharyya was reported to say at the time. "If we just account for the inflation in input costs, there is room for 8% to 9% rise in prices," he said.

But analysts are sceptical of the government's plan's to increase the coal price given the fuel's "inflationary" capabilities on the wider economy. Coal supplies half of India's primary commercial needs so an increase in the coal price would cause costs to rise for business all over India, particularly the steel industry. The Steel Authority of India gets about 10 Mt/y of coal from CIL.

Like China, India is also importing more and more thermal coal each year. Thermal coal imports had almost doubled from 2002 to last year and were predicted to at least double again by 2020 to 50 Mt/y. That coal will be used to fuel power stations that are growing in order to meet demand.

In June, leading power trading company PTC India announced it would raise Rs1,200

crore to fund its expansion plans that include equity acquisition in various power projects and supply of imported coal to power projects in India. The company had signed power purchase agreements for an aggregate capacity of around 7,000 MW.

**Russia**

Russian coal mines have upped the ante in the past 10 years as the country increasingly becomes a chief producer of almost all things energy, with the exception of uranium. Coal production from Russian mines has gained more than 26% on its 1996 figure of 114.2 Mtoe to record a very respectable 144.5 Mtoe last year. Meanwhile consumption remained steady at 112.5 Mtoe – a loss of less than 3% over the same period.

The Kuzbass remained Russia's most productive coal producing area in 2006, breaking its 2005 production record of 23.9 Mt with a 16% increase to 27.7 Mt. Kuzbass is in the Kemeroví region, famous for its huge coal reserves, which are estimated at 631,000 Mt. Kuzbass coal is also widely sought after by consumers because it is low in sulphur and other contaminants. The Kotinskaya mine in Kuzbass eclipsed its production records last year to become the first mine in the country to produce 4 Mt in one year.

Consolidation plans for the Russian coal industry were outlined in June this year, with Russian steelmaker Evraz Group announcing plans to merge its two coal mining subsidiaries – the Russian Federation's largest coking coal producer, Yuzhkuzbassugol, and the country's second-largest coking coal producer, Rapsadskaya – to form one of the top three coking coal producers in the world.

The new company hopes to be identified as having a massive resource base, world-class management team, strong growth profile and significant export potential. The new company will have Evraz's steel mills in Siberia and the Urals as its main and largest customers, according to Evraz chief Alexander Frolov.

Current Rapsadskaya CEO Gennady Kozovoy has been appointed the new CEO of Yuzhkuzbassugol. Yuzhkuzbassugol underground mines account for 20% of the total coal output in Kuzbass and 15% in Russia. Rapsadskaya has 11 subsidiaries in the Kuzbass region. Its mining operations include two active underground mines that comprise five operational longwall faces, one active open pit mine, a coal preparation plant, one underground mine under construction, as well as industrial, maintenance and transportation infrastructure. He said his top priority will be to improve safety standards.

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Safety in Russian coal mines continues to be a major issue for the industry with poor safety standards and working conditions causing hundreds of deaths already in 2007. Almost 150 miners have died in two accidents at Yuzhkuzbassugol's mines alone.

## South Africa

South Africa increased coal production last year by more than 5% from 2005 up by 7.1 Mtoe to 144.8 Mtoe. The country has been one of the better performed producers over the past 10 years having increased its output by almost 24% since 2006, while its consumption has remained relatively steady.

The Richards Bay coal terminal, on the Indian Ocean in KwaZulu-Natal province, is presently the world's largest coal export facility. About one-third of South Africa's coal production is exported to world markets (mainly Europe and east Asia), and this has provided South Africa its third-greatest source of foreign exchange (behind gold and platinum). About 85% of the coal consumed within South Africa is used as synfuels feedstock or to produce electricity, according to the Carbon Sequestration Forum.

"South Africa generates nearly half of Africa's electricity, more than 90% of which is generated from coal. South Africa presently ranks as the 15th-greatest electricity producer, accounting for about 1.4% of the world's total annual electricity production, and the 15th-greatest electricity consumer, accounting for about 1.3% of the world's total annual electricity consumption. Overall, electricity demand in South Africa has significantly increased over the past decade, with consumption now about one-third greater than it was a decade ago," the CSF said.

Long term projections show that South Africa may require an additional 20,000 MW of electricity by 2025. Because of the large coal reserves and the moderate amount of hydroelectric potential in the country, coal is not expected to lose much of its predominance in the utility sector any time soon, although



natural gas is expected to play a role in the future, the CSF said.

## Germany

As a coal nation, Germany continued to fall away last year in line with the medium-term phase-out of the black coal industry. Coal remains Germany's most abundant home-grown energy source, but that hasn't stopped the government from dropping the curtain the country's unprofitable black coal industry – in January this year, the government decided to end mining subsidies by 2018.

Lignite remains a very important part of Germany's energy resource mix. Output in 2006 remained stable at 176.3 Mt. Production from the different coalfields was nevertheless very different: output in the Rhineland amounted to more than 96 Mt (- 1%), in Lusatia, production fell by 2% to some 58 Mt and in Central Germany output substantially exceeded 2005 levels, rising by 7% to over 20 Mt. Over 90% of German lignite production was used for power generation; deliveries to

public power stations fell by 1.4% to 160 Mt.

## Poland

Like Germany, Poland's coal industry is running at a loss. The government has attempted to restructure the industry but production continues to decline, falling a further 2.5% last year and taking the total drop in production for the 10 years prior to 27.5 Mtoe or almost 30%. Meanwhile, consumption grew by 4.8% last year after several years of decline to 58.4 Mtoe.

Production for 2006 was a respectable 67 Mtoe, nevertheless, there's a logistic problem about export that resulted in only about 15% of production making its way offshore, according to the European Association for Coal and Lignite, Euracoal. The harbours are located in the northern part of the country, whilst the mines lay in the Southern part. Transporting the coal over the entire country increases the price considerably. In addition, low import coal prices push the companies to rather buy imported cheap coal, the group said.

## Indonesia

Indonesia saw a massive increase in coal output, to 147 Mt in 2006, up 30 Mt from the 117 Mt produced in 2005. Indonesia's location makes it a logical major supplier to the Asian region, which sources 26% of its coal needs from Indonesia. Indonesia exports 80% of its coal to Asia and is now the primary exporter to Malaysia and the Philippines. The largest coal producers and exporters remain PT Adaro Indonesia, PT Kaltim Prima Coal (KPC), PT Arutmin Indonesia, PT Kideco Jaya Agung and PT Berau Coal.

The Indonesian Government is attempting to reduce domestic consumption of oil and gas and to explore for alternative sources of energy, particularly coal. Indonesian coal production is projected to increase from around 155 Mt currently to 367 Mt in 2015. This projected development will be in line with rising domestic consumption from 38.4 Mt in 2006 to 107.8 Mt in 2015, and increasing export from 117 Mt in 2006 to 259 Mt in 2015. *IM*

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