COAL

Medium-Term Market Report 2012

Market Trends and Projections to 2017

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International Energy Agency

COAL Medium-Term Market Report 2012

The *Medium-Term Coal Market Report 2012* provides IEA forecasts on coal markets for the coming five years as well as an in-depth analysis of recent developments in global coal demand, supply and trade. The annual report shows that while coal continues to be a growing source of primary energy worldwide, its future is increasingly linked to non-OECD countries, particularly China and India, and to the rise of natural gas.

The international coal market is experiencing dynamic changes. In 2011, China alone accounted for more than three-quarters of incremental coal production, while domestic consumption was more than three times that of global trade. Low gas prices associated with the shale gas revolution caused a marked decrease in coal use in the United States, the world's second-largest consumer. This led US thermal coal producers to seek other markets, which resulted in an oversupply of coal in Europe and a significant gas-to-coal switch. Meanwhile, China surpassed Japan as the largest importer of coal, and Indonesia overtook Australia as the world's largest exporter on a tonnage basis.

The report examines the pronounced role the Chinese and Indian economies will exert on the international coal trade through 2017. In the report's Base Case Scenario, China accounts for over half of global consumption from 2014, and India surpasses the United States as the world's second-largest consumer of coal in 2017. The report also offers a Chinese Slowdown Case, a hypothetical scenario which shows that even if Chinese GDP growth slowed to 4.6% average over the period, the country's coal consumption would continue to grow.

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The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
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FOREWORD

In December last year, the IEA (International Energy Agency) launched the *Medium-Term Coal Market Report 2011* (*MCMR 2011*) as the first of a new annual series. I am now delighted to present its successor, *MCMR 2012*. In the intervening year, the IEA has published the *Medium-Term Gas Market Report 2012*, the *Medium-Term Renewable Energy Market Report 2012* and the *Medium-Term Oil Market Report 2012*. Together, this series offers a consistent and comprehensive market outlook across the fuel spectrum, contributing to transparency and supporting policy makers and stakeholders in their decision making.

Coal is a staple energy source, particularly for power generation. This year's report shows that while coal is here to stay, the global market is particularly susceptible to policy decisions, infrastructure issues, and substitutes in just a few of the largest consumers and producers.

Despite concerns over sustainability, the rise of emerging markets has relentlessly driven coal demand higher over the past decades. Whereas climate policy and macroeconomic slow-down were expected to slow that increase, it took the shale gas glut in the United States to curtail coal demand growth there. Yet thanks to more regional integration in coal markets, European coal prices have been more responsive than gas prices, bringing coal back to Europe. This report contains a special focus on production and consumption in the United States as one of the driving forces of coal markets globally.

The other major driving market is of course China. There has been a lot of talk about the effects of a potential economic slow-down there, and of the policy measures included in the Five-Year Plan unveiled in 2011 – particularly increased efficiency, energy diversification, and a cap on coal consumption. This report contains a special focus on China, with an in-depth study of coal non-power use and domestic coal transportation. It also contains a sensitivity analysis, the so-called Chinese Slow-Down Case, which shows that even in the event of a hypothetical rebalancing and slow-down of the Chinese economy, global coal demand keeps growing.

Coal is a family of products rather than a single commodity. The report therefore contains a comprehensive analysis of price evolution for different coal types, qualities and regional markets – as well as an analysis of impacts on other markets. Coal accounts for over 40% of global electricity generation, making coal prices a key determinant of electricity prices and developments in the power market.

The report also contains a comprehensive analysis of current and planned exporting capacity, showing that while coal may be relatively safe with regard to geopolitical instability, sources of export are set to remain particularly concentrated. Most of the plans to expand export capacities are in the current top exporters, with the notable exception of Mozambique.

Coal is also particularly affected by the global climate change agenda – which has been recently marked by disappointing inaction. Amid economic turmoil and the continuing threat of recession, climate change concerns have taken a back seat. Meanwhile, carbon capture and storage (CCS) technologies are not taking off as once expected. The result is that, without serious constraints on coal consumption by climate change policies in most places, demand and CO_2 will continue to grow. Yet without progress in CCS, coal is at risk to a potential climate policy backlash and rising concerns over emissions.

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For all of its positive and negative qualities, coal will remain a key primary energy source and an important part of fostering economic growth and alleviating energy poverty. The *MCMR 2012* report provides clear insights into these dynamic developments, enabling policy makers and others to anticipate and prepare for the challenges facing global coal markets.

In producing this report, the IEA received inputs from the Coal Industry Advisory Board (CIAB). The CIAB is an invaluable source of expertise on coal for the IEA Secretariat, composed of high-level executives from companies and organisations involved in all stages of the coal chain.

The report is published under my authority as Executive Director of the IEA and may not represent the views of its individual member countries.

Maria van der Hoeven

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We are grateful for the data provided by the IEA Energy Data Centre, which are the cornerstone of this report. Valuable inputs were provided by Keith Burnard, Anne-Sophie Corbeau, Alexander Antonyuk, Pawel Olejarnik, Ian Cronshaw, Jonathan Sinton and Dennis Best. Cheryl Haines edited the report. The IEA Communication and Information Office (CIO) also provided editorial and production guidance. Rebecca Gaghen, Muriel Custodio, Angela Gosmann and Bertrand Sadin made this publication possible.

We would like to thank the many contributors who helped make this report possible: Dennis Volk authored Box 7 *An outlook on the development of coal-based carbon emissions in select countries*, Thjis van Hittersum authored Box 2 *A golden age of coal in Europe?* Geoffrey Morrison, from the IEA Clean Coal Centre, authored Box 6 *Biomass Co-firing in Coal-Fired Plants*. Box 3 *Can open pit coal mines be environmentally friendly?* extensively draws from a paper by Miguel Colomo, former Director of Mining at ENDESA.

Brian Ricketts, from Euracoal, and Kevin Tu, from Carnegie Endowment for International Peace, also provided useful suggestions. Our gratitude goes to the Institute of Energy Economics at the University of Cologne (EWI) for sharing its breadth of coal expertise and coal market models.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF MAPS

LIST OF TABLES

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LIST OF BOXES

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EXECUTIVE SUMMARY

Business as usual

In line with the trend over the last decade, coal was once again the largest growing source of primary energy in 2011, with incremental consumption over 50% higher than oil and gas incremental demand combined. Coal demand grew by 4.3% from 7 080 million tonnes (Mt) in 2010 to 7 384 Mt in 2011. Consequently, coal strengthened its position as the second most important source of primary energy behind oil, accounting for approximately 28% of total primary energy consumption. Growth in coal consumption is almost exclusively determined by non-OECD countries, particularly China and India, where demand continued to surge in 2011. Population growth and rising per-capita electricity consumption – fuelled by strong economic performance – are key drivers of coal consumption among these emerging economies. In contrast, coal demand among OECD countries decreased in 2011, falling below consumption levels reached in 2000.

China is coal. Coal is China. China is by far the world's largest producer and consumer of coal, and accounts for more than 45% of both global totals. China accounted for more than three-quarters of incremental coal production in 2011 and domestic consumption was more than three times that of global trade in the same year. Domestic coal transport by rail was more than twice as high as consumption in the United States, the world's second-largest consumer of coal. Domestically shipped coal in China comprises more than half of the global seaborne trade. Yet, this also works the other way round: as China's primary supply of energy, coal dominates power generation, power capacity and indigenous energy production. Therefore, development of the global coal market will largely be driven by China through its economic growth, investments in infrastructure, energy diversification and energy efficiency programmes and policies, coal-electricity pricing policy and developments in the Chinese coal mining sector.

The winds of change …

China replaced Japan as the largest coal importer in 2011. Similarly, Indonesia replaced Australia as the largest coal exporter in the same year on a tonnage basis. Japan and Australia both held top place for nearly three decades. However, China now drives development of the global coal trade on the demand side and Indonesia is an important player on the supply side. Since the turn of the 21st century, Indonesian coal exports increased on average by 18.4% per year. Due to abundant reserves, cost competitiveness, transport infrastructure availability and, in particular, its proximity to coal importing countries in Asia, Indonesia accounted for almost half of the total seaborne coal market growth over the last 11 years. In 2011, both Japan and Australia experienced natural disasters which hampered their coal consumption and supply. The Great East Japan Earthquake destroyed part of the Japanese fleet of coal-fired power generation plants, while heavy floods in Australia cut exports from Queensland for several months.

The global trade of off-spec coal gained more importance in 2011, with trade volumes exceeding 200 Mt. So-called off-spec coal was increasingly traded in 2011. This includes sub-bituminous Indonesian coal and high-sulphur coal from the Illinois basin in the United States, as well as low calorific value coal from traditional exporters such as Australia, South Africa and Colombia. Triggered by low freight rates, flexible boilers, increasing blending practices and utilities struggling to avoid financial losses in countries with low regulated electricity prices, the demand for off-spec coals

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increased further in 2011. Utilities in China, India and Korea, for example, can often burn these coals without losing much in terms of efficiency, and thus take advantage of the relative price discount this lower-quality coal usually incurs.

US shale gas switches on coal in Europe

The shale gas revolution in the United States has resulted in a significant gas-to-coal switch in Europe. The abundance of natural gas in United States (an increase of 127 billion cubic metres from 2006 to 2011) put downward pressure on US natural gas prices, with monthly Henry Hub prices dropping below the USD 2/MBtu line in April 2012. This has caused a marked switch from coal to natural gas in power generation in the United States over the past two years. As a consequence, miners announced production cuts and layoffs, and some mines in the United States were mothballed. At the same time, large quantities of thermal coal found their way into European markets. With US coal exports to Europe rising, the Atlantic market, particularly Europe, faced a situation of oversupply, which caused coal prices in Europe to plummet from USD 130/tonne (t) in March 2011 to USD 85/t in May 2012. Subsequently, low coal prices, supported by a low CO_2 price, resulted in a significant gas-to-coal switch in Europe.

While a gas-to-coal switch in Europe is a rather short-term phenomenon according to projections, the coal-to-gas switch in the United States is a sustained trend. Our price assumptions for coal and gas price development offset the current imbalance in favour of coal in Europe, with gas recovering its position by 2017. Coal demand among OECD countries in Europe is projected to increase on average by a mere 0.4% per year during the outlook period (from 2012 to 2017), with the bulk of this increase from growth in coal demand in Turkey. This figure is lower than the projected growth of natural gas consumption among European OECD countries in the IEA *Medium-Term Gas Market Report 2012*. In the United States, however, the decline in coal consumption is projected to continue as a consequence of the relative price of both gas and coal, and the retirement of coal-fired power plants due to environmental regulation.

From Beijing to New Delhi?

In the Base Case Scenario (BCS), India is the second-largest coal consumer by 2017 and the largest seaborne coal importer by 2016. Coal consumption increases strongly over the outlook period in India, driven by rising power generation. Together with a decline in US consumption, India surpasses the United States as the world's second-largest coal consumer. However, this surge in coal consumption is not matched by production growth from domestic mines, causing strong growth in imports. This trend is consistent with the expectation that Coal India Limited, India's largest coal producer, is not likely to significantly improve its operational efficiency. As a result, India's imports are projected to grow faster than in any other country. Yet, in terms of total import volume, *i.e.* overland imports from Mongolia, China holds its position as the world's largest importer in the BCS. In the Chinese Slow-Down Case (CSDC), India is by far the world's top importer of coal by the end of the outlook period.

Australia is the world's largest exporter of coal in the BCS. With energy adjusted exports, Australia remains the world's largest exporter of coal and will hold onto its top position until the end of the outlook period in the BCS. Australia's export strength is underpinned by investments in both existing mining regions, such as the Hunter Valley, Bowen and Gunnedah basins, and in new basins, such as the Surat and Galilee basins. Hence, export growth in Australia is projected to outperform Indonesian

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export growth if China's import demand remains strong. In the CSDC, some high-cost operations in Australia are expected to become extramarginal, and hence, Australian exports decrease relative to the BCS. In contrast, Indonesian coal exports profit from a lower cost structure throughout the entire coal value chain and, consequently, are less affected by the CSDC.

Only China can stop the traffic

In the BCS, Chinese coal consumption is projected to account for more than 50% of global coal demand by 2014. In this scenario, global coal demand grows from 5 279 million tonnes of coal equivalent (Mtce) in 2011 to 6 169 Mtce in 2017 (17%) and is driven by non-OECD countries over the outlook period with an annual growth rate of 3.9%. China leads this growth in absolute terms with additional coal use of 638 Mtce. Remarkably, this figure is just 5 Mtce lower than demand in India in 2017, which is the second-largest consumer and has the fastest growth in demand over the outlook period (6.3% per year). In the CSDC, total coal use in China grows on average by 2% per year over the outlook period to reach 2 881 Mtce in 2017. Total Chinese coal use is 309 Mtce lower in 2017 in the CSDC than in the BCS.

We have built a CSDC to assess the effect of a potential slow-down in Chinese economic growth on the global coal market. In this scenario, seaborne coal trade peaks in 2016 and declines thereafter**.** Yet, total seaborne coal trade still grows on average by 2.3% per year over the outlook period, whereas coal demand is projected to increase on average by only 1.8%. After three decades of near continuous growth (with a minor exception in 2008), the seaborne coal trade is projected to decline in the CSDC, as a consequence of falling Chinese imports in 2017 to one-third of their 2011 levels. Supply of metallurgical coal on the international market is significantly more concentrated than for steam coal, with Australia, the United States and Canada accounting for more than 80% of total trade volumes, although Mongolia and Mozambique are projected to increase their exports significantly.

Two steps forward, one step back

Recent years of high coal prices and high margins have triggered mergers and acquisitions, as well as healthy investments throughout the coal value chain. The global coal market has experienced increased buying activity in recent years. Chinese and Indian companies have played an important role in merger and acquisitions in order to ensure secure coal supply. As a result of this activity and fuelled by high prices in recent years, particularly in the metallurgical coal market, mining and port expansions projects are sufficient to meet demand and import needs in the BCS. Australia and Indonesia lead investments, with Colombia and, to a lesser extent, Russia and South Africa completing the picture. Yet, Indonesia is not likely to continue its recent ramp up over the coming years.

However, current low prices and big uncertainties make investors cautious. Some companies have already announced the possibility of layoffs and the slow-down of investments. Investment has been particularly hampered by uncertainties surrounding the European sovereign debt crisis, concerns about the development of the Chinese economy and the fall in US coal prices. Considering the significant lead time needed to ramp up supply, through simultaneous mine and transport infrastructure development, decelerating development projects might lead to tightened international coal markets during the outlook period.

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RECENT TRENDS IN DEMAND AND SUPPLY

Summary

- **Coal, again, outpaced every other primary energy source in absolute growth in 2011.** Coal strengthened its position as the second most important primary energy source behind oil with a share of approximately 28% in total primary energy consumption.

- **Global coal demand grew by 4.3% from 7 080 million tonnes (Mt) in 2010 to an estimated 7 384 Mt in 2011.** Total coal demand increased as rapidly in 2011 as it did on average throughout the preceding ten years (4.3%). Most of the growth came from hard coal, which increased by 242 Mt with brown coal accounting for the balance. Yet considering relative figures, brown coal consumption grew by 6.3%, faster than hard coal consumption (4%).

- **Chinese and Indian demand for coal paced global coal demand growth.** In 2011, China alone accounted for more than 75% of total incremental coal demand. While coal consumption among non-OECD countries increased by 332 Mt (6.9%), coal consumption among OECD countries decreased by 28 Mt (1.2%) in 2011, due to a decline in consumption in the United States.

- **Incremental thermal coal demand stood at 176 Mt in 2011, increasing from 5 293 Mt in 2010 to 5 469 Mt in 2011 (3.3%), whereas global metallurgical demand grew by an estimated 66 Mt (8.1%) from 812 Mt in 2010 to 878 Mt in 2011.** While metallurgical coal demand profited from a marked increase in crude steel production (+7% in 2011), growth of thermal coal demand was hampered by the decline in the United States in 2011.

- **In 2011, global coal supply grew by 6.6% from 7 201 Mt to 7 678 Mt in 2011.** In contrast, over the first decade of the 21st century, global coal supply grew on average by only 4.8%.

- **Total hard coal production grew by a further 6.7% in 2011 and is estimated to have reached 6 637 Mt from 6 218 Mt in 2010.** Incremental thermal coal supply stood at 353 Mt in 2011, and thus contributed to 84% of total hard coal supply growth (420 Mt), with metallurgical coal accounting for the remainder (67 Mt).

- **Total brown coal production grew by 5.9% from 983 Mt in 2010 to an estimated 1041 Mt in 2011.** OECD countries account for 58% of global brown coal production with Germany remaining the world's largest supplier of brown coal with almost 177 Mt (+4.2%).

Demand

Coal was the fastest growing source of energy in absolute terms and the second fastest source behind renewable energy in relative terms. Consequently, coal strengthened its position as the second most important primary energy behind oil, accounting for around 28% of total primary energy consumption. In 2011, the world's total coal demand is estimated at 7 384 million tonnes (Mt) up from 7 080 Mt the year before. Thus incremental coal consumption stood at 304 Mt in 2011, corresponding to an annual growth rate of 4.3%, which is as high as the average year-to-year growth rate of 4.3% realised over the first decade of the 21st century.

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Table 1 Coal demand overview

	Total coal demand (in Mt) 2010	Total coal demand (in Mt) 2011*	Absolute growth (in Mt) 2010/11	Relative growth (in %) 2010/11	CAGR (in % p.a.) 2001-10
China	3 183	3 416	233	7.3%	10.2%
United States**	950	925	-24	-2.6%	-0.2%
India	643	687	44	6.8%	6.1%
Russia	224	235	11	4.9%	-0.3%
Germany	228	230	2	0.7%	-0.5%
OECD	2 249	2 221	-28	-1.2%	0.0%
Non-OECD	4 830	5 162	332	6.9%	7.3%
World	**7 080**	**7 384**	**304**	**4.3%**	**4.3%**

* Estimate.

** In accordance with US Energy Information Administration, coal demand decreased from 954 Mt in 2010 to 910 Mt in 2011.

Note: differences in totals are due to rounding.

Source: unless otherwise indicated, all material in figures and tables derives from IEA data and analysis.

Total hard coal demand stood at an estimated 6 347 Mt in 2011, 242 Mt higher than in 2010. On a year-to-year basis, hard coal consumption grew by 4% in 2011, which was slower than over the last decade (5.1%). After two years of non-average growth rates, annual growth approached a more normal level again. Hard coal demand almost stagnated in 2009 due to the global economic crisis, but impressively rebounded in the next year, with incremental demand at almost 740 Mt in 2010, by far the highest growth in absolute terms in the past decade.

Box 1 Tips for readers

Coal is a family of different products, rather than a single one. Coal classifications refer to a whole range of ages, compositions and properties. There are many different classifications used around the world. In this report, steam coal and thermal coal are used interchangeably. They refer to hard coal which is not used for iron and steel-making purposes, which is generally referred to as metallurgical coal. Metallurgical coal refers to hard coking coal as well as soft or semi-soft coals. However, in this report coking coal is not strictly used, and can include other metallurgical coals, as well as pulverised coal injection (PCI) coal.

Figures for coal production, consumption and trade are expressed either in physical tonnage (Mt) or in energy content (million tonnes of coal equivalent or Mtce). While there is a direct equivalence between these figures through the calorific value, this relation is not straightforward as calorific values of future production, consumption and trade can only be a very rough estimate. This is the reason why most projections are expressed in Mtce. Nevertheless, for historical data, physical tonnage is more reliable than energy adjusted figures. Therefore, historical data are usually expressed in Mt.

Note: precise definitions can be found in Box 1 of IEA, 2011.

The trend of hard coal demand growth determined by surging demand in non-OECD countries, in particular China and India, continued in 2011. While growth in non-OECD countries grew at an annual rate of 6.6%, OECD hard coal demand decreased on a year-to-year basis by 3%. The continued rapid expansion of US shale gas production and the corresponding decrease in natural gas prices, notably since June 2011, put immense pressure on the US power sector's coal demand, leading to a decrease of total hard coal demand in the United States by 30 Mt compared to 2010. In contrast, Chinese incremental hard coal demand almost reached 225 Mt in 2011, its fourth highest all-time growth in absolute terms.

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Unlike hard coal, demand for brown coal increased in both OECD- and non-OECD countries in 2011. In total, consumption of brown coal stood at an estimated 1 037 Mt, more than 61 Mt higher than 2010, an increase of 95 Mt from pre-economic crisis consumption in 2008. Thus, brown coal demand had a second, straight positive growth of 6.3% in 2011, following 2% in 2010, which followed a decrease in 2009.

OECD demand trends

Hard coal demand among OECD countries amounted to 1 616 Mt in 2011 and stood at a demand level that was 173 Mt lower than its all-time high in 2007 (1 789 Mt). Taking into account that hard coal consumption in non-OECD has grown at impressive rates, the share of OECD countries in total global hard coal demand has consequently seen a continued decline. While the OECD accounted for 44% in 2000, it shrunk by almost 19 percentage points to slightly more than a fourth in 2011 (25.5%). The decrease in hard coal demand in 2011 among OECD countries was caused by a lower hard coal-based electricity generation, which led to a decrease in thermal coal demand by 52 Mt. In contrast, metallurgical coal demand in 2011 among OECD countries is estimated to have increased on a year-to-year basis, equating to two consecutive years of demand growth. Yet, despite the recent decline, thermal coal still accounts for the bulk share of hard coal demand in OECD countries at 88.4% in 2011, leaving the remaining 11.6%, or approximately 188 Mt, to metallurgical coal.

Table 2 Major hard coal and brown coal consumers among OECD countries

	Hard coal		Brown coal	
in Mt	**2010**	**2011***	**2010**	**2011***
Australia	68.2	60.2	72.1	69.5
Austria	3.8	3.9	0.0	0.0
Belgium	4.9	4.1	0.2	0.1
Canada	38.0	33.1	10.1	9.6
Chile	8.4	9.7	0.0	0.0
Czech Republic	7.8	7.5	43.7	41.9
Denmark	6.5	5.5	0.0	0.0
Finland	7.0	5.5	0.0	0.0
France	17.3	14.5	0.1	0.1
Germany	58.6	53.3	169.5	176.3
Greece	0.6	0.4	57.7	59.7
Hungary	2.1	1.9	8.9	9.6
Ireland	2.0	2.1	0.0	0.0
Israel	12.3	12.6	0.4	0.4
Italy	21.8	23.3	0.0	0.0
Japan	185.4	175.4	0.0	0.0
Korea	120.0	130.3	0.0	0.0
Mexico	17.6	19.2	0.0	0.0
Netherlands	11.9	11.7	0.0	0.0
New Zealand	2.4	2.6	0.3	0.3
Poland	84.8	83.3	56.6	62.7
Portugal	2.7	3.7	0.0	0.0
Slovak Republic	4.2	4.1	3.1	3.2
Spain	14.7	23.5	0.0	0.0
Turkey	26.4	27.5	69.2	74.4
United Kingdom	51.4	51.2	0.0	0.0
United States	881.4	851.5	68.3	73.9

* Estimate.

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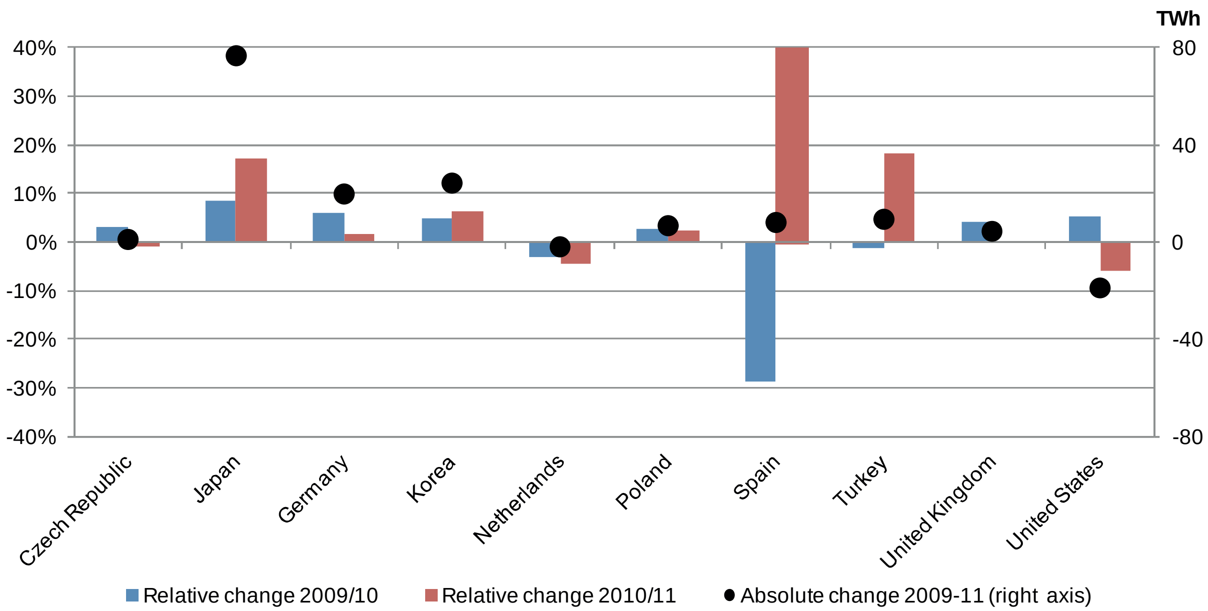
Japan, although second to the United States with regard to total hard coal consumption, holds onto its status as the largest consumer of metallurgical coal among OECD countries, with almost 54 Mt in 2011, followed by Korea with a consumption of approximately 32 Mt. Hard coal consumption in the United States stood at almost 852 Mt in 2011, down by around 30 Mt in 2010. Since 2007, the demand for hard coal, mainly driven by a continued coal-to-gas switch in electricity generation, has decreased by more than 103 Mt or, on average, 2.8% per year. Despite this trend, the United States remains by far the OECD's largest hard coal consumer, with its share in total OECD hard coal demand amounting to 52.7% in 2011.

Brown coal use in OECD countries, standing at 605 Mt in 2011, up by 22 Mt from 583 Mt in 2010, has again reached its pre-crisis level (604 Mt in 2008). Yet, growth varies among the OECD country clusters. While European OECD countries and the OECD Americas saw an increase in brown coal consumption, with incremental demand amounting to almost 20 Mt and 5 Mt, respectively, brown coal demand in OECD Asia Oceania decreased by almost 3 Mt in 2011 when compared with 2010. Germany, the world's largest consumer of brown coal, played an important role in the OECD Europe's increase of brown coal use, accounting for more than one-third of incremental demand or almost 7 Mt. In total OECD countries made up for 58.4% of global brown coal consumption in 2011, down by 1 percentage point against the previous year.

Power sector

In 2011, coal-based gross electricity generation among OECD countries stood at an estimated 3 710 terawatt-hours (TWh), down from 3 747 TWh in the year before (1.0%). In relative terms, total gross electricity production among OECD countries decreased by the same magnitude on a year-to-year basis, equivalent to a change in absolute terms from 10 922 TWh in 2010 to 10 817 TWh in 2011. Consequently, coal's share of total electricity production remained at 34.2% in 2011.

Figure 1 Coal-based gross electricity generation in select OECD countries, 2009-11



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Low CO_2 prices and hydro production were contributing factors to the increase in coal-based electricity generation among OECD Europe countries in 2011, despite a continued expansion of renewable energy capacities. The shale gas revolution in the United States, as well as the consequences of the Fukushima-Daiichi accident in Japan restricted coal-based generation in these countries.

OECD countries in Europe, despite a slight decrease in total gross electricity production (59 TWh) and continued gains in electricity supply from wind and solar plants, increased their coal-based electricity generation by more than 33 TWh to an estimated 908 TWh in 2011. This increase can be explained by lower hydro production compared to 2010 (down by -43 TWh from 588 TWh in 2010), increased competitiveness of hard-coal based electricity generation due to low CO_2-prices throughout 2011 as well as the nuclear phase-out in Germany. Consequently, coal-based electricity grew in Germany by almost 5 TWh and in Spain by 19 TWh, or 70.7% on a year-to-year basis, which recorded a decrease in hydro production by approximately 13 TWh from 2010. Finally, increasing electricity demand in Turkey, which resulted from high gross domestic product (GDP) growth (8.5% in 2011), was largely met by incremental supply from coal-fired power generation plants (10 TWh out of a total incremental supply of 17 TWh in 2011).

Box 2 A golden age of coal in Europe?

Gas-fired power generation in Europe is shrinking in absolute and relative terms. In power generation is where gas competes directly with coal. While combustible fuels (coal, gas and oil) have lost market share to renewables in power generation throughout Europe, gas has suffered the tightest squeeze.

Over the first six months of 2012, the amount of power produced by natural gas-fired plants dropped severely in three major European consuming countries, as Table 3 clearly shows. Compared to the same period in 2011, these countries all showed losses, with the United Kingdom dropping by 33%.

In Europe, natural gas has been most affected by decreasing overall power demand, increasing renewable generation,[1] and low coal and carbon prices in comparison to oil-indexed gas prices. While coal also suffers from decreasing power and increased renewable generation, it gained a price advantage over gas in 2011; this effect was stronger in 2012 due to cheaper US coal exports to Europe and decreasing prices. In the United Kingdom and Spain, markets with sufficient gas and coal-fired generation capacity to enable significant switching, producers have been moving away from natural gas to coal. To illustrate this, the gas-to-coal switching in the United Kingdom is further examined below.

Since late 2011, gas prices are no longer in a range that enables gas-fired power generation plants to be competitive against coal-fired plants. Decisions on gas-to-coal switch are more complex and made on a plant-by-plant basis, however even very efficient CCGT[2] cannot produce baseload power in a competitive manner if coal-fired capacity is still available. Figure 2 shows the ratio in the United Kingdom between power generated by coal- and gas-fired plants.[3] While this ratio has long been around or below 1 (meaning that more power was produced by gas-fired plants than coal-fired plants), the ratio started rising in November 2011 reaching a record 1.8 in March 2012, almost three times the level in March 2011. This clearly illustrates that, in the United Kingdom, natural gas is losing market share in the power sector. Natural gas also lost significant market share to coal in late-2005 and early-2006, a period of extremely high gas prices. Yet, coal demand in OECD Europe grows by 0.4% per year during the outlook period based on coal and gas price evolution.

[1] According to IEA (2012), renewables generation (excluding hydro) increased by 220 TWh over 2005-11 in OECD Europe and is projected to gain another 282 TWh over 2011-17.

[2] CCGT: combined cycle gas turbine.

[3] A ratio of 1 means that there was an equal amount of electricity produced via natural gas and coal. A ratio of 2 means that twice the amount of electricity was produced with coal, compared to natural gas.

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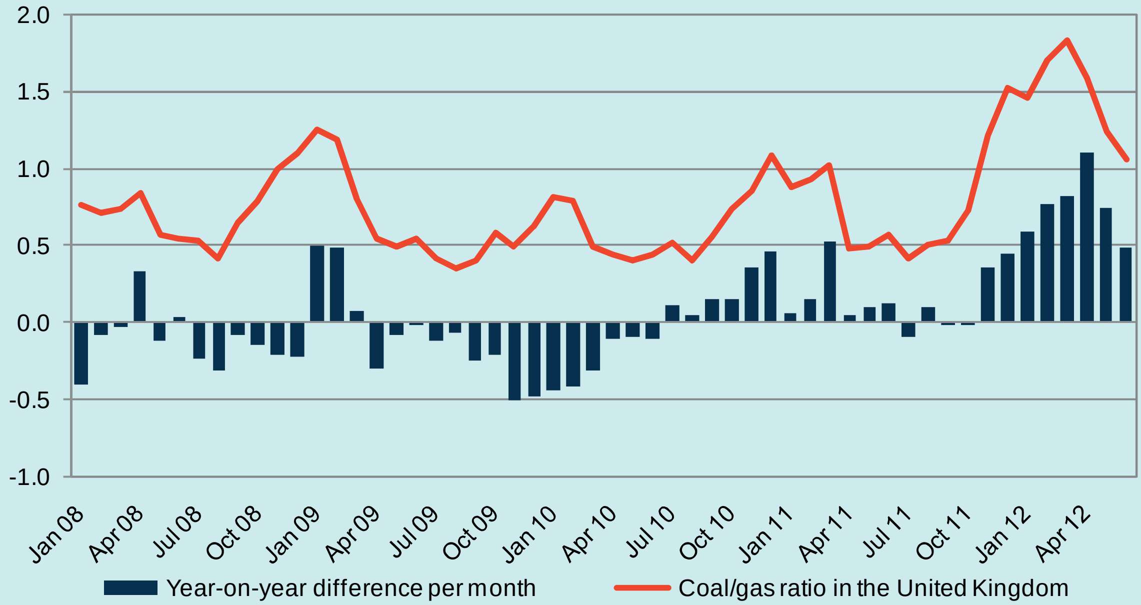
Box 2 A golden age of coal in Europe? (continued)

Table 3 Gas- and coal-based electricity generation in select European countries

Electricity generation	From gas Jan-Jun 2011 (in GWh)	From gas Jan-Jun 2012 (in GWh)	Relative growth (in %)	From coal Jan-Jun 2011 (in GWh)	From coal Jan-Jun 2012 (in GWh)	Relative growth (in %)
Germany	40 984	34 749	-15%	129 399	140 008	8%
Spain	40 696	35 790	-12%	16 803	27 656	65%
United Kingdom	71 894	48 109	-33%	52 422	70 991	35%

Figure 2 Coal-to-gas ratio in total power production in the United Kingdom, 2008-12



In the aftermath of the Great East Japan Earthquake at the beginning of March 2011 and the ensuing nuclear accident in Fukushima, all nuclear power generation plants in Japan were gradually shut down and went to zero by May 2012. This resulted in a loss of nuclear electricity generation by more than 186 TWh in 2011 compared with 288 TWh produced in 2010. Missing electricity supply from nuclear plants in Japan was compensated for by a reduction in overall electricity demand, and additional supply from coal (52 TWh) and natural gas-based (58 TWh) electricity generation, plus some oil-based generation. In addition, coal demand from OECD Asia Oceania was fuelled by the sustained growth in coal-based electricity production in Korea. Since the beginning of the century, Korea's electricity generation from coal-fired power plants has more than doubled, growing on average by 6.9% per year over the last 11 years, from 111 TWh in 2000 to an estimated 233 TWh in 2011. Yet, last year's growth of 14 TWh shows a reduction in Australian coal-based electricity supply by 15 TWh compared with 2010. In total, coal demand in OECD Asia Oceania increased by 51 TWh (7.2%), up from 707 TWh in 2010 to 758 TWh in 2011.

In contrast to OECD Europe and OECD Asia Oceania, total electricity generation from coal-fired plants fell by 5.7% in OECD Americas in 2011. Rising shale gas production in the United States led to a further decrease in US natural gas prices in 2010 and 2011, thereby rendering gas-fired power plants

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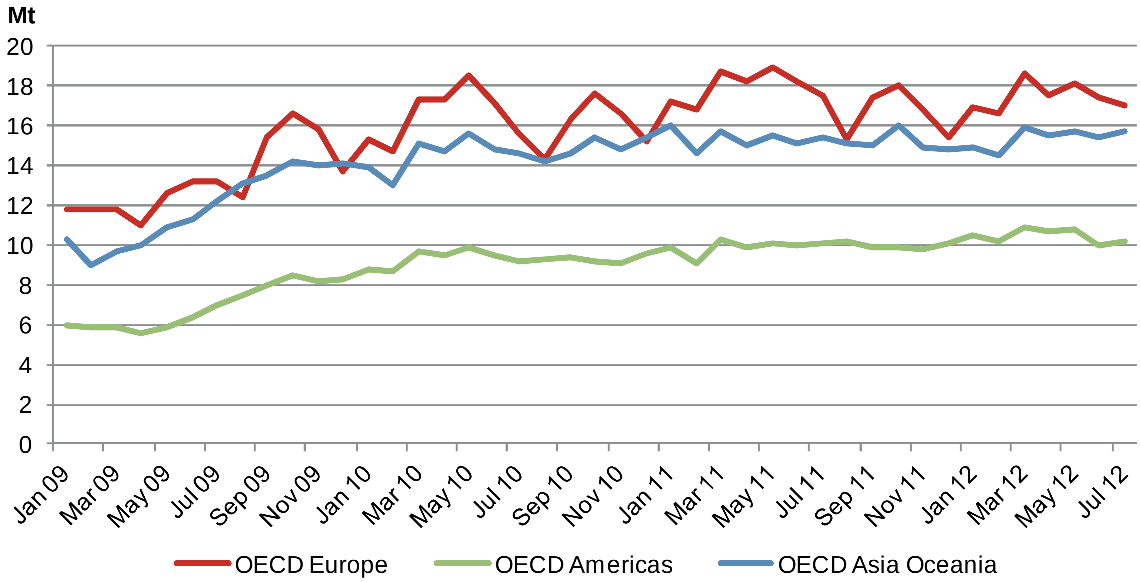
more competitive in some regions and moving it ahead of hard coal in the merit order, at least in some states of the United States.[4] Consequently, coal-based power generation plummeted by 6% in 2011 against 2010, down by 120 TWh from 1 994 TWh in 2010 to 1 874 TWh in 2011.

Non-power sector

Coal consumption among OECD member countries in non-power sectors accounted for slightly less than 18% of total coal use in 2010. The iron and steel sector is by far the largest industrial consuming sector, with 139 Mtce in 2010, 25 Mtce more (+21.6%) than the year before. Cement, the other big consuming sector, used 24 Mtce in 2010.

Total final industrial consumption in OECD countries grew by 13.8% year-to-year rate in 2010 upon recovery from the global economic crisis. In 2011, growth in total OECD coal demand in non-power sectors was rather sluggish, with albeit small, but positive impulses coming from OECD's iron and steel production (+ 5.6% in 2010), which saw an increase in crude steel output in all three OECD country groups in 2011.

Figure 3 Monthly crude steel production in OECD countries, 2009-12



Source: World Steel Association (various years).

Demand trends in non-OECD countries

While OECD countries saw their coal consumption decrease in 2011, non-OECD countries saw yet another year of impressive growth in total coal demand; hard coal demand increased by 293 Mt and brown coal demand increased by 39 Mt. Total non-OECD coal demand stood at 5 162 Mt in 2011 (up from 4 830 Mt in 2010), which is equivalent to 232% of total coal demand among OECD countries in 2011.

Thermal coal consumption in non-OECD countries grew by 6%, from 3 812 Mt in 2010 to 4 040 Mt in 2011. Measured in relative terms, metallurgical coal demand outpaced thermal demand in non-OECD

[4] See "Regional focus: United States" in section "Medium-term projections of demand and supply".

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countries, growing by 10.2% in 2011. However, in absolute terms incremental metallurgical coal demand (64 Mt) represents around one-fourth of absolute growth in thermal coal demand, thus highlighting the magnitude of steam coal consumption, representing 78.3% of total coal demand in non-OECD countries.

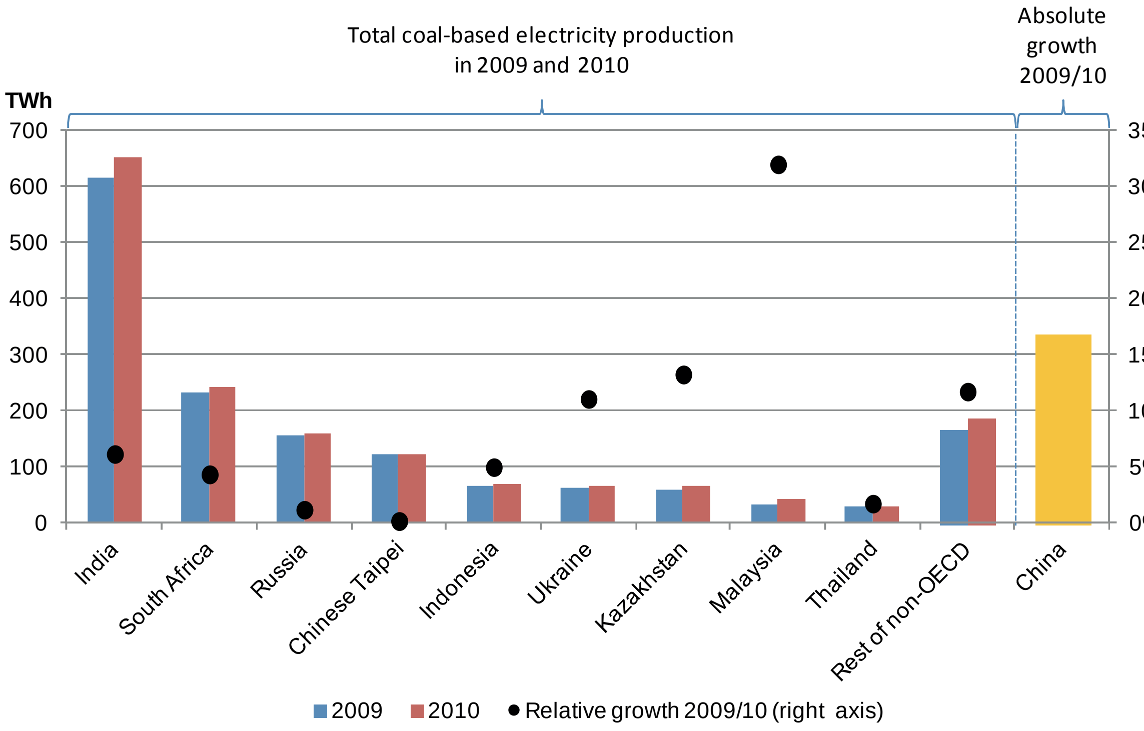
China, which accounted for two-thirds of non-OECD coal demand and 46.2% of global coal consumption in 2011, grew by 7.3% or 233 Mt on a year-to-year basis, with the majority of growth (224 Mt) coming from an increase in hard coal consumption. Hence, 70% of incremental hard coal demand in non-OECD countries, which stood at 293 Mt in 2011, is the result of China's thirst for energy. While metallurgical coal demand in India remained relatively flat (less than 3 Mt of incremental demand), thermal coal consumption grew by 38 Mt to 591 Mt in 2011. India remains the world's third-largest coal consumer with a total hard coal demand of 687 Mt, equivalent to a share of 10.8% of global demand in 2011.

Non-OECD countries consumed 432 Mt of brown coal in 2011, up from 392 Mt in 2010. Consumption of brown coal, which is typically transported directly to a close-by power plant, using *e.g.* conveyor belts, grew the strongest in China (9 Mt) and in Bulgaria (8 Mt), where a new 600 MW lignite power plant started its operations in mid-2011.

Power sector

Total electricity production in non-OECD countries amounted to 10 589 TWh in 2010, of which 4 890 TWh was coal-based (46.2%), up by 9.7% from 4 458 TWh in 2009. Therefore 56.6% of world's coal-based electricity production was generated in non-OECD countries, with more than one-third of the total supplied by Chinese coal-fired power plants.

Figure 4 Evolution of coal-based electricity generation in non-OECD countries



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China accounted for two-thirds of total non-OECD coal-based electricity supply, *i.e.* 3 256 TWh in 2010. Compared with 2009, when output of Chinese coal-fired power generation plants stood at 2 919 TWh, it increased by almost 337 TWh, or 11.5%, well above the total power output of Spain.

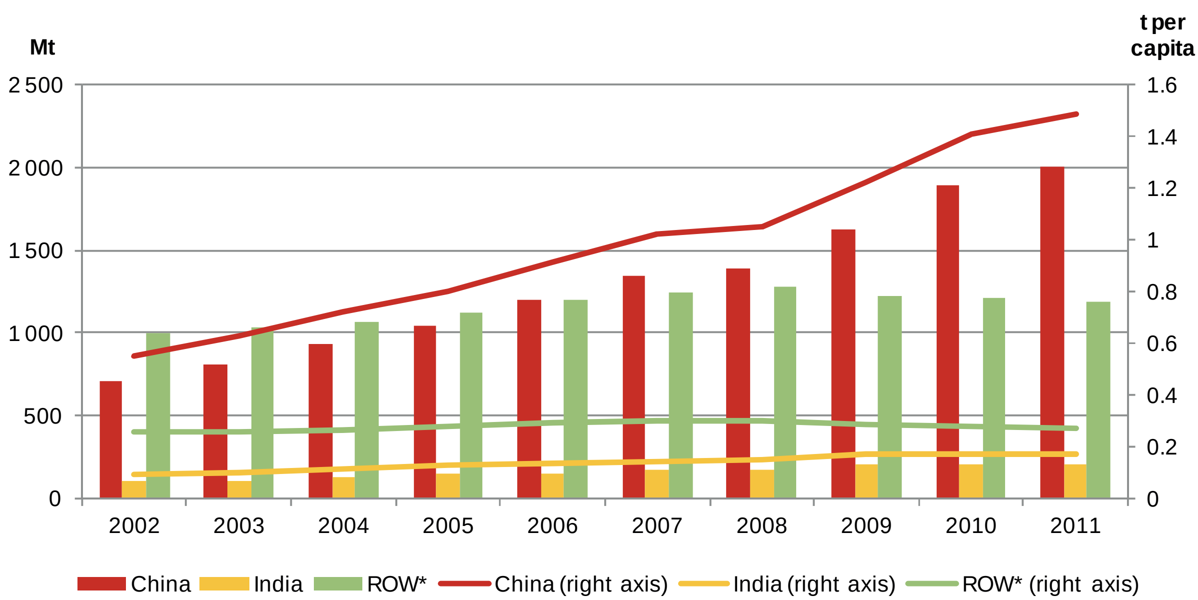
India is the world's third-largest producer of coal-based electricity, only surpassed by China and the United States. It produced 652 TWh of electricity from coal, of which more than 96% was generated burning thermal coal, leaving the remainder to brown coal. On a year-to-year basis, coal-based electricity supply grew by 37 TWh (6%) from 615 TWh in 2009, meeting more than two-thirds of incremental electricity demand.

Malaysia experienced the largest growth of coal-based power generation in relative terms among non-OECD countries with an increase of 31.8% (10 TWh) from 33 TWh in 2009 to 43 TWh in 2010, largely met by imports.

Non-power sector

Despite some differences among non-OECD countries, average coal demand in the non-power sector accounts for a higher share of total coal demand than in OECD countries. In 2010, coal consumption in the non-power sector stood at around 1 420 Mtce, approximately 30% of total non-OECD coal demand. Because of the high growth of coal-based power consumption among non-OECD countries in 2010, the share of the non-power sector decreased compared to 2009, when it nearly amounted to a third of total coal demand in non-OECD countries.

Figure 5 Evolution of global cement production over the last decade



*ROW = rest of the world.

Source: USGS (various years).

Besides the power sector, iron and steel, and cement production are the two most important sectors for coal demand. In China, both sectors had a combined total share of coal demand in the non-power sector of 54.1% (571 Mtce) in 2009 and 55.5% (595 Mtce) in 2010. Driven by large infrastructure

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investments, Chinese cement production grew on average by an impressive 12.2% per year over the last decade, which is equivalent to a total increase of 1 295 Mt, from 705 Mt in 2002 to 2 000 Mt in 2011. 2009 marked the first year when China produced more cement than the rest of the world. Although on a lower level, India, driven by its GDP growth, has also witnessed massive gains in cement production, with an average annual growth rate of 8.6% over the last ten years. In 2011, Indian cement output stood at 210 Mt, up by 110 Mt from 100 Mt in 2002, making it the world's second-largest cement supplier.

Supply

Over the last ten years, global coal supply grew on average by 5.5%, making 2010 an above average year, with an increase of 6.6%. At the end of 2011, total coal production is estimated to have reached 7 678 Mt, thus standing 478 Mt higher than in 2010 when world coal supply amounted to 7 201 Mt. The bulk share of production growth came from hard coal (+420 Mt) and the remainder came from an increase in brown coal supply (+58 Mt).

Total hard coal production further increased and is estimated to have reached 6 637 Mt in 2011 (metallurgical coal: 967 Mt), a 6.7% increase over 2010 levels. Thermal coal supply stood at 5 670 Mt in 2011, up by 6.6% from 5 317 Mt, and hence had a share of 85.4% in total hard coal production. In relative terms, brown coal grew by approximately 0.8 percentage points less than hard coal, resulting in 1 041 Mt of total brown coal supply in 2011. Although brown coal production among OECD countries stood at the same level in 2011, as it did at the beginning of the century, the share of total brown coal output among OECD countries still accounts for 58% of brown coal production worldwide.

Table 4 Coal supply overview

	Total coal supply (in Mt) 2010	Total coal supply (in Mt) 2011*	Absolute growth (in Mt) 2010/11	Relative growth (in %) 2010/11	CAGR (in % per year) 2001-10
China	3 140	3 471	331	10.5%	9.9%
United States**	996	1 004	8	0.8%	0.3%
India	570	586	16	2.7%	5.5%
Australia	424	414	-10	-2.3%	3.3%
Indonesia	325	376	51	15.8%	15.1%
OECD	2 070	2 087	16	0.8%	0.2%
Non-OECD	5 130	5 592	461	9.0%	7.5%
World	**7 201**	**7 678**	**478**	**6.6%**	**4.8%**

* Estimate.

** In accordance with US Energy Information Administration, coal supply increased from 983 Mt in 2010 up to 992 Mt in 2011.

Note: differences in totals are due to rounding.

OECD supply trends

Coal production in OECD countries remained stagnant in 2011, growing by a mere 0.8% (16 Mt) over 2010 levels. At the end of 2011, total coal supply stood at 2 087 Mt from 2 070 Mt in the previous year. While brown coal output in OECD countries grew by 21 Mt in 2011, hard coal production decreased from 1 487 in 2010 to 1 483 in 2011.

Despite stagnating hard coal production among OECD countries, two major developments affected coal output in 2011, the first being the floods in Queensland at the end of 2010, which lasted deep

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into the first quarter of 2011 and caused the Australian hard coal supply to fall by 7 Mt on a year-to-year basis. Since most of Australia's metallurgical mining capacity is located in Queensland, Australian metallurgical coal production was more severely affected (-17 Mt) than the thermal coal production, which in total even increased by almost 10 Mt from 189 Mt in 2010 to 199 Mt in 2011. The second important development was the increase in US hard coal production in 2011 (6 Mt), despite the decrease in coal-based electricity generation in the United States (-120 TWh). The much needed support to keep up US hard coal production came from 23 Mt of additional exports, which, in keeping with traditional trade patterns and infrastructure orientation, mainly found their way into Europe. Imports, mainly from Colombia, also dwindled.

Table 5 Major hard coal and brown coal producers among OECD countries

	Hard coal		Brown coal	
in Mt	**2010**	**2011***	**2010**	**2011***
Australia	352	345	72	70
Canada	58	57	10	10
Czech Republic	11	11	44	43
Germany	13	12	169	177
Greece	0	0	57	59
Hungary	0	0	9	10
Korea	2	2	0	0
Mexico	10	12	0	0
New Zealand	5	5	0	0
Norway	2	1	0	0
Poland	77	76	57	63
Slovak Republic	0	0	2	2
Spain	8	7	0	0
Turkey	4	4	70	74
United Kingdom	18	18	0	0
United States	925	931	71	73

* Estimate.

Box 3 Can open pit coal mines be environmentally friendly?[5]

Yes, provided that the right policies are applied to environmental, operational and management aspects. A few decades ago, the main objective of environmental mining works was land reclamation, *i.e.* return land to its original shape and use upon cessation of mining operations. This concept has evolved as mining companies, regulatory authorities and social groups have become more mindful of two important characteristics of open pit coal mining:

- The practical impossibility of returning land to its original state. Irrespective of the technical and economic resources of the mining company, the volume of removed coal is impossible to put back.
- The huge economic and technical capacity of the mining operation, if properly used, allows the upgrading of the affected land and surroundings at very low additional costs.

Therefore, mines are considered environmentally friendly if they enable nearby communities to enjoy new landscape and land uses that would not have existed without the mining activity. Regulatory authorities and society understand that a mine may create wealth for the group while working permanently to minimise negative environmental impact. Moreover, when mining operations are over, affected land must be given back to the society in harmony with the surrounding landscape and compatible with uses that improve and diversify the traditional economic activities of the area.

[5] This box mainly refers to post-closure state and does not consider impacts produced during the mining operations (*e.g.* noise and dust).

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Box 3 Can open pit coal mines be environmentally friendly? (continued)

The enormous capacity of operating equipment to develop an open pit coal mine can be used to simultaneously shape the affected land. But it is essential that shaping and reclamation works are embedded in the mining operation. Environmental works must be thoroughly planned to suit the characteristics of the mining equipment. Appropriate timing within the working cycle will minimise additional costs.

It might seem that costs associated with ambitious environmental targets can make mine projects unprofitable. On the contrary, accumulated experience in many projects categorically confirms that costs added by an environmentally friendly operation are not significant in comparison with the operational costs, and they are negligible to define the break-even point. In order to shape land surface, operation conditions must be modified and hence, costs can be higher. However, this increase is largely offset by operational improvement created by the planning reinforcement necessary to develop the Environmental Project of the Mine and to perform operation and reclamation works at the same time.

One example is ENDESA's open pit mine in As Pontes, Spain, which produced 261 Mt of brown coal from 1976 to 2008 to feed its 1 400 MW coal-fired plant. An ambitious environmental project converted the former mine heap into a rich forest on a 1 150 hectare hill, with road and drainage infrastructure suitable for hunting, tourism, livestock farming, forestry and biomass. In addition, the former mine void is now a 1 200 hectare lake suitable for tourism, energy generation and water supply to other industries.

The ENDESA example highlights that when appropriate environmental, operational and management policies are applied, mine reclamation can leave the area in optimal condition. It is imperative to plan environmental aspects from the very start of the mining project to correct negative impacts, design the shape and use of the final void, and integrate environmental and mining works. It is also important that the company reaches an understanding with regulators and society groups who perceive a clear commitment on the part of the company with regard to environmental aspects. Finally, staff involvement in environmental targets is essential. Every worker needs to understand the environmental objectives to co-operate with its development, to feel proud of his/her work and pass it onto society.

Total brown coal production among OECD countries regained momentum in 2011, after a decrease in output of 9 Mt in 2010 brown coal supply stood at 605 Mt up by 20 Mt at the end of 2011. In 2011, OECD Europe mined 451 Mt, 39.2% (177 Mt) of the production took place in Germany, thereby accounting nearly for the same amount of brown coal production as all non-OECD countries. Output in OECD Americas (83 Mt) and OECD Asia Oceania (70 Mt) remained closed to their respective production levels in 2010.

Regional focus: United States

The United States is the largest coal producer and consumer in the OECD and the second-largest in the world. US hard coal production was 931 Mt in 2011, up from 925 Mt in 2010. However, 2012 production figures will decrease below 2010 levels. Coal production in the United States has been severely affected by weakening domestic demand due to low natural gas prices and a very mild winter in late 2011.[6] Stockpiles are well filled, but dropped below the 200 Mt mark in 2011 for the first time since 2009. US hard coal production consists of 82 Mt of coking coal and 849 Mt of steam coal. In addition to this, 73 Mt of brown coal were produced in the United States (mainly in North Dakota and Texas).

[6] See "Regional focus: United States" in section "Medium-term projections of demand and supply".

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The three major coal producing areas in the United States are: Western (537 Mt in 2010), Appalachia (304 Mt) and Interior (141 Mt). The majority of the coal (425 Mt) produced in the Western region comes from the Powder River basin (PRB) in Wyoming and Montana. PRB coal is typically low in sulphur and calorific value. The second-largest basin in this region, Uinta (mainly Utah and Colorado), produces approximately 40 Mt. Appalachia can be split into the Northern (NAPP), Central (CAPP) and Southern (SAPP) Appalachian mining region. Mines in CAPP (West Virginia and Eastern Kentucky) produce close to 169 Mt of coal, followed by NAPP production (mainly Pennsylvania, Ohio and Virginia) which stands at around 117 Mt. SAPP (mainly Alabama) is a minor mining region with an output of approximately 20 Mt. Virtually all coking coal in the United States is mined in Appalachia with almost two-thirds of the production coming from CAPP. The Illinois basin (Illinois, Indiana, Western Kentucky), which typically has high-sulphur thermal coal, dominates the coal production of the Interior region with an output of 95 Mt.

Table 6 Mining methods, production shares and number of mines in the United States

	Production share underground	Production share open-cast	Number of underground mines	Number of open-cast mines	Share of US production
Appalachian total	63%	37%	442	656	31%
NAPP	80%	20%	76	262	12%
CAPP	52%	48%	358	352	17%
SAPP	63%	37%	8	42	2%
Interior total	47%	53%	37	69	14%
Illinois nasin total	69%	31%	34	42	10%
Western total	9%	91%	18	35	55%
PRB	0%	100%	-	16	43%
Uinta region	89%	11%	14	2	4%
United States total	**31%**	**69%**	**497**	**760**	**100%**

Source: EIA, 2011.

With a share of 69%, the majority of US coal is produced in surface mining operations (Table 6), due to the large share of open-cast mining in the Western region. Underground mining dominates in Appalachia (63%) and is balanced in the Interior region (47%). There are more than 1 200 mines in operation through the United States and, consequently, average mine size is below 1 Mt of output per year. However, substantial regional differences exist; in 2010, the average annual production per mine stood at 0.24 Mt in CAPP, 0.35 Mt in NAPP (1.2 Mt for underground mines) and 0.36 Mt in SAPP (1.4 Mt for underground mines). These production rates compare to an average annual output per colliery of 1.3 Mt in the Illinois basin, 2.5 Mt in the Uinta basin and a massive 26.6 Mt in the PRB. To compare internationally, an average mine in Queensland/Australia produced 3.7 Mt of (saleable) coal in 2010.

Black Thunder (Arch Coal) and North Antelope Rochelle (Peabody) are the two largest mines in the United States and each produces close to 100 Mt of coal per year each. These two mines, located in the Southern PRB (Wyoming), account for about 20% of the total US coal output. The five largest coal producing companies, Peabody Energy (2011: 185 Mt), Arch Coal (2011: 138 Mt), Alpha Natural Resources (2011: 108 Mt), Cloud Peak Energy (2011: 88 Mt) and Consol Energy (2011: 57 Mt) together account for almost 60% of coal production in the United States.

Mining costs also vary widely across the United States (Figure 6). The lowest mining costs can be found in the PRB where coal can be mined at below USD 12/tonne (t). However, energy content is relatively low for PRB coal, ranging from between 4 400 kilocalories per kilogramme (kcal/kg) and

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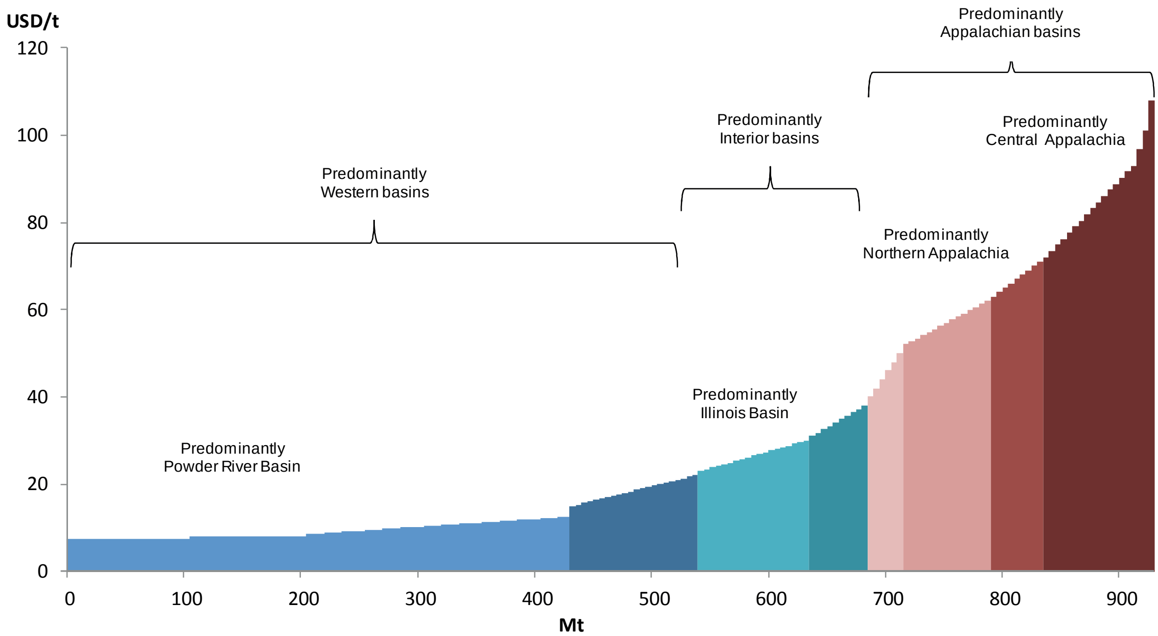
4 900 kcal/kg. Coal can be mined at costs between USD 25/t and USD 33/t in the Illinois basin with the majority of the production tending towards the higher end of this range. Calorific values typically exceed 6 000 kcal/kg in this region but sulphur content is relatively high at around 3%[7] (calorific values often exceed 6 300 kcal/kg in Appalachia, however, operations in this mining region are on the high-cost end of the US coal supply cost curve). Productivity (expressed as annual output per employee) is higher in NAPP compared to CAPP. An average underground colliery in NAPP reaches a productivity level of almost 8 kilotonnes (kt) per employee – double the average productivity of an underground mine in CAPP. Mining operations are often tiny in CAPP, hence impeding economies of scale. Environmental regulation and slowing surface mining permits are also adding costs, especially in Central Appalachian.

Figure 6 Indicative mine-mouth cash cost curve for thermal coal in the United States, 2010



In Appalachia, mining cash-costs are estimated to fall into a broad range of USD 60/t to USD 95/t with the bulk of the production tending towards the higher end of this bandwidth (McCloskey, 2012). Yet, a few specific mines may incur lower costs between USD 35/t and USD 50/t whereas a few high-cost mines may have production costs in excess of USD 100/t. Metallurgical coal mining costs fall in similar cost ranges as Central Appalachian thermal coal. Yet, the price premium that is paid on this coal often justifies the higher cost of production. Therefore, the share of mines incurring production costs closer to the USD 100/t mark is higher for coking coal than for thermal coal.

Coal supply and demand are spatially separated from each other (Map 1). More than 40% of the coal is mined in Wyoming, followed by West Virginia (12%) and Kentucky (10%). Coal demand is more regionally balanced among the United States. The main consumption centres are: Texas (10%), Indiana (6%), Illinois (6%), Ohio (5%) and Pennsylvania (5%).

[7] Typical international trade specification is sulphur content below 1%.

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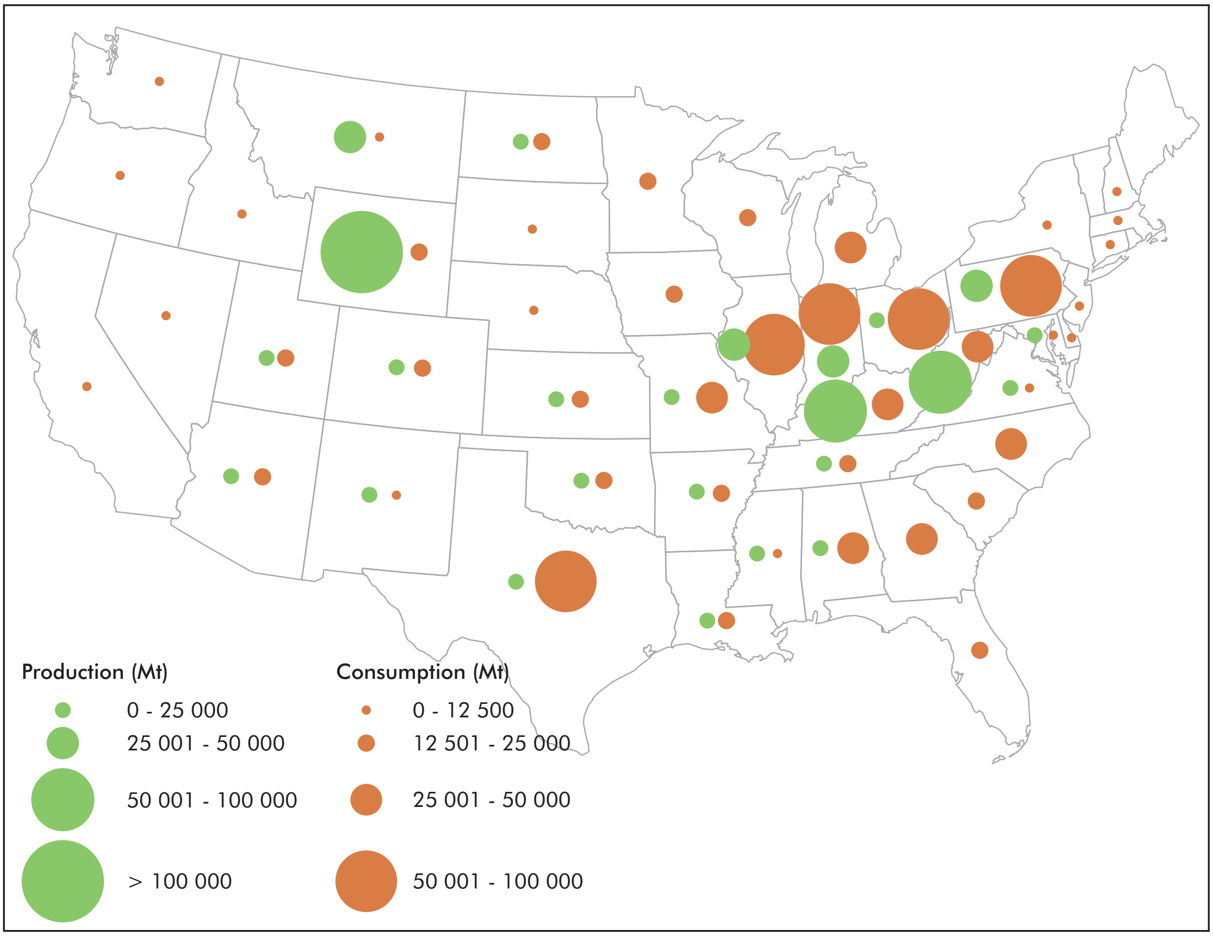
Map 1 Regional consumption and production of coal in the United States in 2010



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Data source: EIA, 2012.

To satisfy supply and demand, coal has to be transported from the mines to power generation plants and industrial hubs. This mainly happens by rail, which accounts for 70% of coal movements. About 15% of the coal is hauled by truck and 10% via barges on inland waterways. The remainder is transported by conveyor belts and tramways. PRB coal faces the longest transport distances of almost 2 000 kilometres (km) on average. NAPP and SAPP are located most closely to their consumers with average transport distances of 400 km (NAPP) and 160 km (SAPP).

Although rail transport from the PRB is efficient and rail tariffs are lower than for instance in Appalachia, rail haulage adds up to USD 25/t of transport cost to PRB coal (assuming costs of USD 0.0125/t per km). Given that PRB coal is comparably low in energy content, PRB coal transport costs are closer to USD 30/t if adjusted to 6 000 kcal/kg. Nevertheless, PRB coal is a low-cost fuel for the US power system even though transported over long distances. PRB mining costs, adjusted for energy content, and transport costs add up to delivered costs to power stations at below USD 50/t for the bulk of the consumers.

CAPP transport can cost between USD 5/t (short truck haul) and USD 30/t (to east cost ports). The comparably high mining costs indicate that CAPP coal is more marginal in the US power system. With

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mining cash-costs estimated at USD 60/t to USD 95/t and typical inland transport costs (rail) of USD 5/t to USD 15/t, coal costs at US power plants should range from USD 65/t to USD 110/t for Appalachian coal.

Table 7 Typical haulage distances by transportation mode in the United States

	Rail direct	River barge	Truck	Lake vessel
PRB	1 750 - 2 000 km	730 - 800 km + 2 000 km rail haul	n/a	720 - 800 km + 2 000 km rail haul
Illinois basin	480 - 730 km	730 - 800 km + 230-270 km rail haul	25 - 40 km	325 km + 360 - 440 km rail haul
Central Appalachia	730 - 800 km	280 - 360 km + 240 km rail or 30-50 km truck haul	30 - 50 km	800 km + 525 - 600 km rail haul

Non-OECD supply trends

In 2011, total coal output among non-OECD countries was estimated at 5 592 Mt, an increase of 9% from 5 130 Mt in 2009. Hard coal accounted for 92% (5 145 Mt) of total coal produced among non-OECD countries in 2011, with the remaining 8% (437 Mt) accounted for by brown coal.

Table 8 Major hard coal and brown coal producers among non-OECD countries

	Hard coal		Brown coal	
in Mt	**2010**	**2011***	**2010**	**2011***
Bulgaria	0	0	29	38
Colombia	74	84	0	0
India	533	545	38	41
Indonesia	325	376	0	0
Kazakhstan	104	111	7	6
PR China	3 015	3 335	125	136
Romania	0	0	31	35
Russia	246	256	76	78
Serbia	0	0	38	41
South Africa	255	253	0	0
Ukraine	55	62	0	0
Vietnam	44	45	0	0

* Estimates.

Incremental hard coal supply stood at 413 Mt (8.9%), whereas absolute growth in brown coal supply amounted to 38 Mt (9.5%). China, again, was the most important driver for supply growth among non-OECD countries, with 70% of total coal supply growth in 2011.

Non-OECD countries in Eastern Europe, such as Bulgaria, Romania, Russia and Serbia account for more than half of total non-OECD brown coal production. Russia is the second-largest brown coal producer among non-OECD countries, behind China with an annual output of 78 Mt in 2011 up by 2 Mt from 76 Mt in 2010. Big brown coal producers in Asia include India (41 Mt), Thailand (21 Mt) and Mongolia (9 Mt).

In 2011, exports from non-OECD countries stood at 700 Mt, with more than 85% of total coal produced among non-OECD countries used to meet domestic demand. In contrast to Colombia, Russia or South Africa, Chinese and Indian production almost exclusively remains in the country, and therefore these two countries are reviewed in this section, while the supply side of the others is discussed in the section devoted to the main exporting countries.

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China

China is the world's largest producer of coal. In 2011, total Chinese coal supply is estimated to have reached 3 471 Mt up by 330 Mt over 2010 levels, and thus China's share of global total coal production stood at 45% in 2011. More than 95% (3 335 Mt) of the country's annual coal production is estimated to be hard coal (thermal coal: 2 831 Mt in 2011).

Chinese coal mines can be classified into three different groups: key state-owned mines (accounting for almost one-half of production in 2010), local state-owned mines (around 15%) and mines owned by townships and village enterprises (around 35%). The Chinese government has been pushing for consolidation, meaning that small-scale mines, which are often part of the third group of mines, have been shut down. The most recent round of consolidation process began in the province of Shanxi, where more than 2 855 mines ceased operations from 2009 until the end of 2010 (VDKI, 2012), and plans for various provinces have been announced which prevent the mine operators from production in mines with a capacity below a certain threshold, *e.g.* 0.6 million tonnes per annum (Mtpa) (by the end of 2012) in Shandong (VDKI, 2011). At the same time, five large-scale coal mining companies were developed, each of them having a mining capacity of at least 100 Mtpa. The goal of the consolidation process on the one hand is to increase productivity, which can be significantly lower than 1 kt/employee per year in very small-scale mines, and on the other hand reduce the number of accidents in Chinese coal mines. The Chinese coal industry should continue to increase the productivity of their country's mines as the average depth of mined coal is projected to grow, while the quality of coal is expected to further deteriorate (lower calorific value and higher ash content) in the medium term.

In addition, Chinese coal production is slowly migrating to the west of the country, increasing the average transport distance to China's demand centres on the coast and south east of China. In 2011, around 1.7 billion tonnes of coal (1.5 billion in 2010) were transported via the Chinese national railway network. Despite high investments into additional railway capacity, coal transporters still faced significant bottlenecks, forcing even more coal to be transported on the road using trucks. China is also developing ultra high voltage grids to move electricity rather than coal. Coastal shipping gained importance as well, amounting to 654 Mt in 2011 up from 556 Mt the year before. Despite the fact that transport volumes via the Chinese railway system and transport along the coast have increased, further infrastructure development (including efficiency improvement) is crucial for the future development of Chinese coal imports.

India

Domestic coal production is the soft spot in India's energy demand-supply equation. Although the country's coal reserves are vast (77 gigatonnes according to BGR, 2010), mining output growth has been sluggish in recent years with growth rates below 4% per year since 2008. In 2011, total coal output was estimated at 586 Mt, up from 570 Mt in 2010 (2.8%). Approximately 88% of coal is produced in open-cast operations of various sizes. Indian coal quality is low with high ash content and low calorific value. Productivity is very low in India and stands at about 1 kt/employee per year. In 2010, average productivity was more than three times higher in South Africa, and close to 8.5 times higher in Queensland, Australia.

India's coal mining industry is dominated by Coal India Limited (CIL) the country's main coal mining company which produces around 80% of the resource. CIL has had substantial difficulties in

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increasing its output in recent years. The reasons for this are manifold: Firstly, environmental constraints with regard to land acquisition, forest clearing, and environmental pollution index norms, as well as resettlement and rehabilitation issues, have slowed down capacity expansion and caused project slippage. Secondly, infrastructure constraints such as a lack of rail capacity and mechanised equipment currently hinder increasing coal movements at some collieries. Finally, industrial action, mismanagement and bad weather conditions have impeded efforts to increase production locally. A stronger focus on underground mining might help to alleviate some of the environmental constraints, although this will also lead to higher costs.

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RECENT DEVELOPMENTS IN INTERNATIONAL TRADE

Summary

- **The market for internationally traded coal grew by 77 million tonnes (Mt) (7.2%) to 1 139 Mt, up from 1 062 in 2010.** The bulk share of coal trade (90.5% in 2011) is seaborne hard coal trade with the remainder being overland coal trade. The seaborne hard coal trade market grew by almost 70 Mt, from 959 Mt in 2010 to 1029 Mt in 2011, equivalent to a relative increase of 7.3% (well above the average of 6.2% per year in the first decade of the 21st century).

- **Trends in seaborne trade of thermal coal and metallurgical coal were opposite in 2011.** While seaborne trade volumes in the metallurgical coal market decreased on a year-to-year basis by 3.4%, from 247 Mt in 2010 to 238 Mt in 2011, bulk carriers transported 791 Mt of thermal coal, an increase of 78 Mt (10.9%) over 2010, the highest growth in the 21st century, in both absolute and relative terms.

- **China became the world's largest importer of hard coal in 2011, taking over the position from Japan, and Indonesia surpassed Australia as the world's largest exporter of coal in the same year.** Japan had been the largest coal importer and Australia the largest coal exporter for more than 30 years. Although, when adjusting trade volumes for energy content, Japan remains the largest seaborne coal importer and Australia holds its position as the largest coal exporter.

- **Thermal coal prices in Northwest Europe fell at the end of 2011, as a result of the US shale gas revolution.** An increase in shale gas production in the United States led to low natural gas prices, which subsequently crowded out coal in the US electricity sector and forced US thermal coal producers to look for other markets. In Europe, this resulted in an oversupply of coal, which led prices to fall from over USD 130/tonne (t) in March 2011 to below USD 85/t in May 2012. Despite markedly increased US exports, the coal industry in the United States saw several mines close down, raising the question whether current US free on board (FOB) prices are sustainable.

- **Metallurgical coal prices have returned to more reasonable levels once production in Queensland resumed operations after the flooding in the fourth quarter of 2010 and the first quarter of 2011.** The tightened international metallurgical coal supply saw the average benchmark price for prime hard coking coal rise close to USD 290/t in 2011. Hard coking coal benchmark prices soared to an unprecedented high with quarterly prices of USD 330/t from April to June 2011. Subsequently, quarterly metallurgical coal prices levelled to USD 210/t in the second quarter of 2012.

- **At least USD 54 billion has been spent on major takeover activities in the coal industry since 2008.** This buying frenzy was underpinned by high prices in recent years, in the market for thermal and metallurgical coal, and was especially apparent in 2010 and 2011 when substantial merger and takeover deals were concluded.

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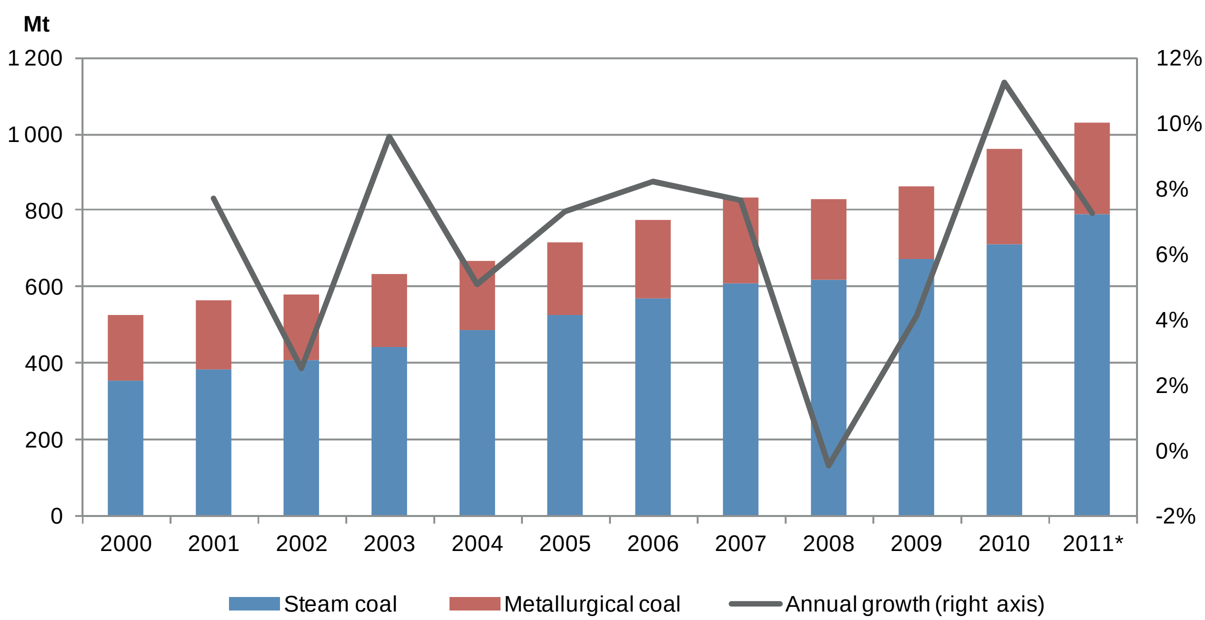
International coal trade

Coal is classified as either hard or brown, with hard coal being more often internationally traded. The main reason preventing brown coal from being transported across country borders is its low gross calorific value of below 23.9 gigajoules per tonne (GJ/t)[8] on ash-free, moist basis, which leads to high transport costs per unit of energy. In 2011, total coal trade stood at 1 139 Mt up from 1 062 Mt in 2010 (7.2%). The bulk of coal trade (90.5% in 2011) is seaborne hard coal trade, meaning that it is carried out using bulk carriers. Most overland exports of thermal coal take place among countries in Eastern Europe and Eurasia, between Kazakhstan and Russia, as well as Russia and Poland, to mention but a few examples. In contrast, the bulk share of metallurgical coal exported overland occurs in Asia, *i.e.* exports from Mongolia to China (an estimated 20 Mt in 2011).

The seaborne hard coal market

The market for seaborne traded hard coal grew from 959 Mt in 2010 to 1 029 Mt in 2011 (7.3%), which is above the average growth rate of 6.2% per year in the first decade of the 21st century. However, trends in seaborne trade of thermal coal and metallurgical in 2011 could not have been more different. Trade volumes for the metallurgical coal market decreased by 3.4% on a year-to-year basis from 247 Mt in 2010 to 238 Mt in 2011, while the amount of thermal coal shipped experienced the highest growth in both absolute and relative terms in the 21st century. At the end of 2011, bulk carriers had transported 791 Mt of thermal coal, an increase of 78 Mt (10.9%) from 2010.

Figure 7 Development of the seaborne hard coal market, 2000-11



* Estimate.

Steam coal trade

Internationally traded thermal coal accounts for only a small portion of global thermal coal production. In 2011, its share stood at 15.2%, and amounted to only 13.9% in terms of the seaborne

[8] The actual energy content of brown coal is very variable over the world, depending on ash content and inherent moisture. Generally, actual calorific values are well under 23.9 GJ/t.

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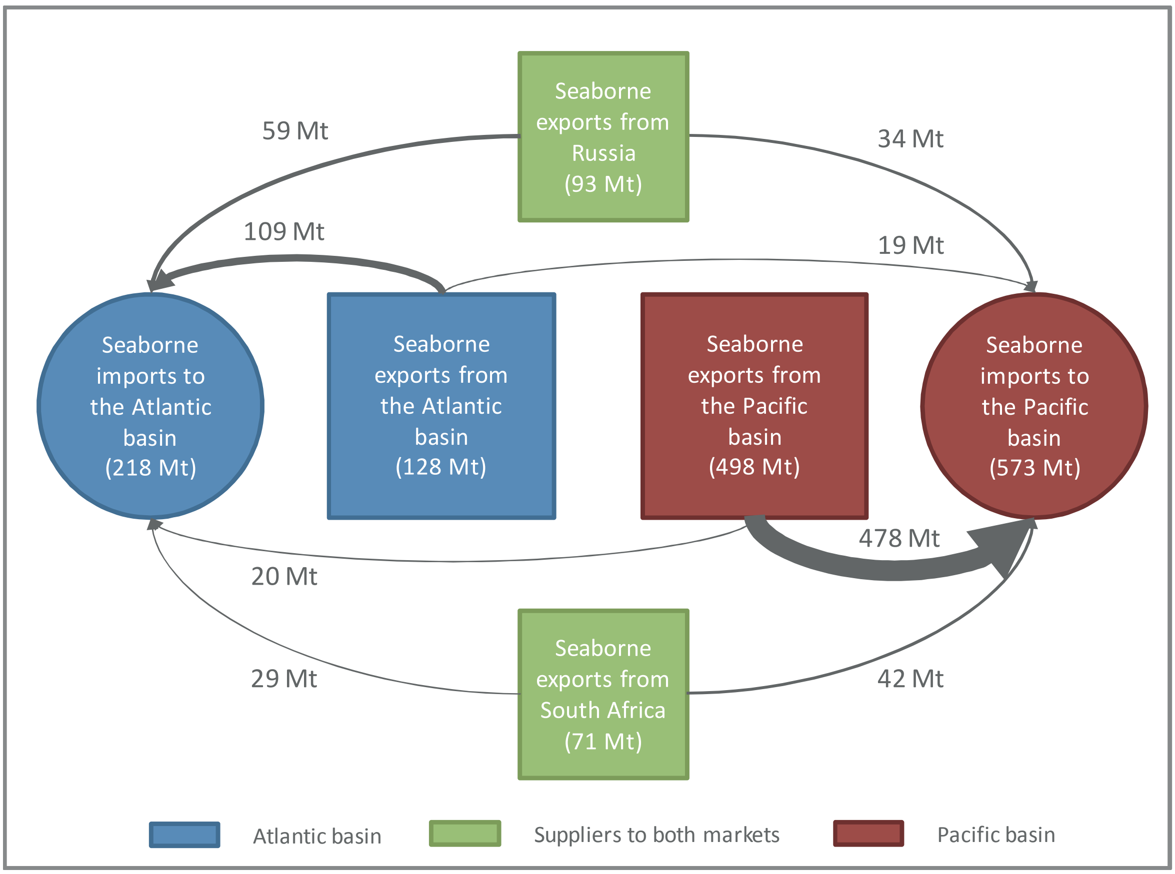
trade of thermal coal. Nonetheless, the share of seaborne trade has increased over the last ten years by 2.2 percentage points, despite the increase of total production (73.5% since 2001) in the same period of time.

The seaborne thermal coal market can be divided in two geographical areas, the Atlantic and the Pacific basin. The latter includes all Asian countries, Australia and the West coast of the Americas, with the remaining countries considered to be a part of the Atlantic basin. Russia and South Africa, due to their geographic location, supply both markets and are thus labelled as swing suppliers in the seaborne thermal coal market.

In 2011, the Pacific basin attracted 72.4% (573 Mt) of total trade flows, with the remainder in the Atlantic basin (218 Mt). Seaborne trade between the two markets remained limited in 2011, with inter-basin trade volumes of 19 Mt from the Atlantic to the Pacific market (mainly Colombian and US exports) and 20 Mt from the Pacific to Atlantic market (mainly Indonesian exports and Australian thermal coal).

Figure 8 Trade flows in the seaborne steam coal market, 2011



South Africa exported almost 60% of its seaborne thermal coal supply to the Pacific basin in 2011, the three most important destination countries being China, India and Korea. At the beginning of the 21st century, more than 80% of South Africa's coal exports went to the Atlantic basin. The bulk share of Russian exports were destined for Europe via the Baltic and northern ports, as well as the Black

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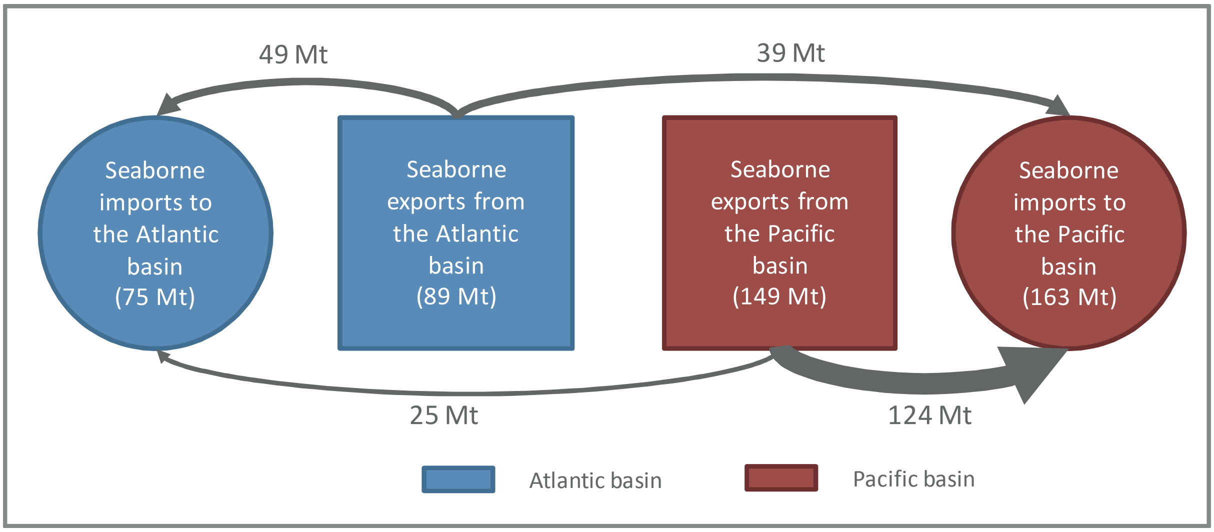
and Mediterranean Seas. Due to a surging demand in Asia, thermal coal exports to Pacific markets have become increasingly important. Both South Africa and Russia have responded by switching the direction of a portion of their exports to adjust trade flows in the seaborne thermal coal market.

Metallurgical coal trade

Metallurgical coal, at least in relative terms, is considered to be more of an internationally traded commodity than thermal coal. In 2011, 28.5% of total production (967 Mt) was exported, with more than 85% of which were seaborne exports. Consequently, total trade volume in the seaborne metallurgical coal market stood at 238 Mt in 2011, 8 Mt less than in 2010. The decrease in total seaborne trade volume is the result of flooding over large parts of Queensland at the beginning of 2011, the biggest exporting region for metallurgical coal, as well as growing exports from Mongolia to China.

Figure 9 Trade flows in the seaborne metallurgical coal market, 2011



Box 4 Metallurgical coal trade: from demand side market power to supply side market power

For more than 40 years, metallurgical coal trade, especially in the Pacific basin, was characterised by a buying cartel consisting of several Asian steel mills. Contrary to the more well-known selling cartels, a buying cartel's objective is to lower prices. Consumer domination in metallurgical coal trade prevailed since the emergence of large-scale coal trade in the Pacific basin in the early 1960s. It was one of the world's largest coking coal consumers – the Japanese Steel Mills (JSM) that drove both market growth and resource development by combining their market power with the strategic use of long-term contracts. The buying cartel's trade strategies were underpinned by other Asian steel mills (mainly from South Korea and Chinese Taipei) by subordinating to the negotiations led by the JSM.

During the 1960s, first investments into Queensland's coking coal export supply chain would not have happened without long-term contracts and financial support from the JSM. The cartel also supported the development and modernisation of the coal mining industry in Western Canada by entering into long-term contracts with producers from the Elk Valley. In the 1970s the JSM further diversified its coking coal supply portfolio by underpinning the development of an export mining industry in the remote and geologically complex Tumbler Ridge in British Columbia. Mines in this area incurred markedly higher production cost than operations in the Elk Valley or Queensland (Bowden, 2012).

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Box 4 Metallurgical coal trade: from demand side market power to supply side market power (continued)

Given the dominant position of the JSM in an oversupplied market, the producers had little bargaining power and basically had to accept any price that was marginally above their costs. To sustain the more expensive Canadian operations, especially those in the Tumbler Ridge, the JSM initially paid these producers a price premium compared to their Australian competitors. From a strategic perspective, the buying cartel faced a trade-off between constantly driving down prices at the risk of making some mining operations unprofitable and paying a price premium to maintain a diversified procurement portfolio (Bowden, 2012).

A phase of unsustainably low coking coal prices during the 1990s resulted in the exit of producers (especially in the Tumbler Ridge) and a wave of industry consolidation. This reversed the market power situation and by the early 2000s, the JSM faced an oligopoly of large and powerful mining companies – BHP Billiton, Teck Resources, Xstrata-Glencore, Anglo American and Rio Tinto. These five companies now control almost two-thirds of the global metallurgical coal export capacity, particularly for the top quality coal. With the formation of this oligopoly and the emergence of entrant buyers from China and India, hard coking coal benchmark prices rose steeply from the mid-2000s and reached record levels of more than USD 300/t (FOB) in 2008 and 2011.

The pricing negotiations are now driven by Australian suppliers. Recently, a single company, BHP Billiton, pushed the pricing system away from annual contracts towards a quarterly and then monthly benchmarking mechanism, against heavy resistance from steel mills. Moreover, the producers are generally well organised as seen in the stand-off negotiations for the April 2012 to June 2012 benchmark price between Anglo American and the South Korean steel mill POSCO. As POSCO did not accept the benchmark price proposed by Anglo American, the company refused to supply high-quality coking coal to the steel maker and other producers also refused to deliver this specific quality. For premium coking coal, POSCO had to comply with the seller's benchmark price offer in the end.

Objections regarding the competitiveness of the international coking coal trade have found support from researchers applying mathematical programming methods. Numerical market modelling has managed to quantitatively reproduce metallurgical coal market outcomes, both in recent seller-dominated as well as historic buyer-dominated years. Graham *et al.* (1999) modelled the coking coal trade in 1996 and their results strongly support the hypothesis of an all-consumer oligopsony exerting market power. In a more recent analysis, Trüby (2012) models the international coking coal trade from 2008 to 2010 as a leader-follower game, with large Australian companies leading the price-setting in anticipation of the other producers' reactions.

The international market for metallurgical coal is highly concentrated. Australia alone accounts for around one-half of total seaborne trade, and the top two exporters, Australia and the United States, accounted for more than two-thirds of total export in 2011 (Box 4). Again, import demand in the Pacific basin is more than twice as large as the Atlantic basin. In contrast to the thermal coal market, inter-basin trade is higher in the metallurgical coal market. The United States and Canada, the world's third-largest exporter of metallurgical coal, are responsible for nearly the entire trade from the Atlantic to the Pacific basin. Russian seaborne metallurgical coal exports, most of which are shipped to Pacific markets, are negligible compared to overall trade volume.

Coal trading

Lignite, steam coal and coking coal are all traded differently around the world. Lignite, due to its low calorific value and hence high unit transportation costs, is usually linked to mine-mouth power generation plants, through either long-term contracts or the sharing of ownership between the mine and power plant.

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The steam coal trade is both region and country specific. The traditional big importers from Asia (Japan, Korea and Chinese Taipei) buy around 80% of their coal through long-term contracts with annual pricing, with the balance being spot. More than half of United States coal is sold on long-term and very long-term contracts, typically between one and five years. Spot trade is less than 10%. In contrast to Europe, in Australia and the United States, the term "spot market" is used to describe contract arrangements that are, in fact, short-term contracts of up to 12 months for one or two cargoes. The proportion of short- to long-term contract sales varies with market conditions as buyers/sellers move to take advantage of current and forward pricing (*e.g.* high prices, sellers want more term; low prices, buyers want more term).

From the mid-1990s, domestic sales prices in Australia have been linked to overseas prices when negotiating annual contracts. Long-term power station supply contracts start with a base price which reflects export equivalent pricing at the time after deducting lower washing and transport costs. Once the base price is established it is usually inflation adjusted quarterly for the term of the contract. However, domestic prices are typically well below export parity due to difference in coal quality (mainly ash content, as Australian coal is generally low in sulphur), lower transport costs and different coal preparation requirements.

In South Africa, more than 65% of domestic coal is used by Eskom for power generation and approximately 70% is sold in fixed price or cost plus contracts, which are not linked to international indexes. However, the current performance of Transnet Freight Rail could result in the convergence of netback prices for export and domestic sales of the same quality coal. In general, the quality of domestic coal is not suitable for the export market (with a calorific value on average of 19 GJ/t versus international requirements of 23 GJ/t to 26 GJ/t), which in turn makes the linkage more difficult to establish.

In China, contracts between utilities and coal producers were traditionally regulated by the government until 2006. Since then, contracts have been negotiated in the market. While it is difficult to assess the share of long-term contracts, large power generators typically take 55% of coal on term contract and 45% on a spot basis. It is remarkable to note the frequent default on long-term contracts by producers when higher prices in the spot market give way to higher profits. Chinese coal exports are controlled by the state, which issues limited export coal licenses to four companies.

The majority of Indian coal is sold through long-term contracts via the so-called Fuel Supply Agreement. Coal company subsidiaries of Coal India Limited (CIL) conduct auctions via the internet that offer 10% of the production. These auctions, for both spot and forward deliveries, provide coal consumers a simple and transparent means to purchase coal, while in the long term, e-auctions are expected to help create spot and future coal markets in the country.

Spot purchases dominate European coal markets. Long-term coal agreements are few and would usually include a floating price component. In countries, such as Poland, where supply is mainly domestic, long-term contracts are still dominant.

Contracts in the coking coal market moved from an annual term to a quarterly basis in 2010. In 2011, part of the market moved to a monthly term, with spot trades accounting for slightly more than 10% of the market. The evolution of the market was significantly affected by the floods in Queensland and, while many analysts expected a massive shift to spot purchases, the floods prevented this. Contrary to steam coal, Asian buyers are more interested in spot buying and indexation, owing to the flexibility of steel plants and the different qualities of coking coal. This is, however, a general picture; in contrast, nearly half of all coking coal in Turkey is purchased by spot dealings.

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Coal contracts largely cover the same topics for spot, short-term and long-term contracts, although each is adapted to specific circumstances. The following parameters are usually included: quantities to be supplied (usually with tolerance); quality of coal (energy content, ash level, sulphur content, moisture, volatile); price and method of negotiation over time (*e.g.* annual negotiations or indexing); price adjustment for quality variations; delivery terms; and payment terms.

For over a decade, GlobalCOAL, an internet-based trading platform, offers Scota (Standard Coal Trading Agreement), which enables buyers and sellers to concentrate on price discovery through standardised specifications. GlobalCOAL has recently developed two new contracts: RB2 and RB3. RB3, with a calorific value range between 5 300 kilocalories per kilogramme (kcal/kg) and 5 500 kcal/kg, and an ash content limit of 23%, is far from the traditional characteristics of Richards Bay coal, which ranged between 5 850 kcal/kg and 6 000 kcal/kg, with an ash content under 15%. Scota specifications for the rejection limit of Colombian coal fell to 5 750 kg/kcal.

This leads to a new development during 2011, the so-called off-specs coal trade. Whereas the trade of low calorific value coal from Indonesia has become common place over recent years, traditional exporters began to move towards that market segment in 2011. Although difficult to assess, Australia, Colombia and South Africa together have likely exported around 100 Mt of coal under Scota specifications for calorific value. If we add sub-bituminous Indonesian coal and high-sulphur coal from the United States (mainly from the Illinois basin), the figure grows to over 200 Mt. More flexible boilers, especially in China and India, have underpinned this market segment and in Asia these products have more activity in the spot market than the higher calorific value coal, where Japanese utilities concentrate the bulk of the activity through long-term contracts. While it is difficult to know whether this means a change to the coal trade pattern, flexible boilers, blending facilities and new trading strategies, together with low freight rates, may keep momentum in this market segment.

Derivatives

There are currently six international coal derivative markets. Coal swaps based on API 2 (Northwest Europe) and API 4 (South Africa) emerged in 1998. Three years after, NYMEX launched the first Central Appalachian coal futures and in 2002, coal swaps based on API 6 (Newcastle, Australia) emerged. In 2010, Indonesian sub-bituminous coal swaps were launched and in August 2011 swaps began based on China's coal.

With approximately 70% of trade via the OTC[9] market, estimates and transparency from exchanges are difficult. Some 90% of the world's coal derivatives are priced against the Argus/McCloskey API 2 and API 4 indexes.

Looking at API 2 volumes traded, which are over 1.5 gigatonnes (Gt), and compared to imported steam coal numbers to ARA[10] destinations (Netherlands, Belgium, France, Germany and the United Kingdom), the churn ratio is over 15. API 2 has become increasingly liquid over the last few years and is traded over the world, not only in the places where physical ARA trade occurs. However, the ratio for the global seaborne market is between 2 and 3. Figure 10 shows a marked decrease in volume in 2011, due to lower volatility. The liberalised electricity sector was likely the key driver for the development of derivative markets in Europe. On the contrary, electricity market deregulation never occurred in Asia and trade volumes are smaller, despite larger physical trade. Other factors, such as

[9] OTC: over-the-counter.
[10] ARA is the acronym for Amsterdam-Rotterdam-Antwerpen.

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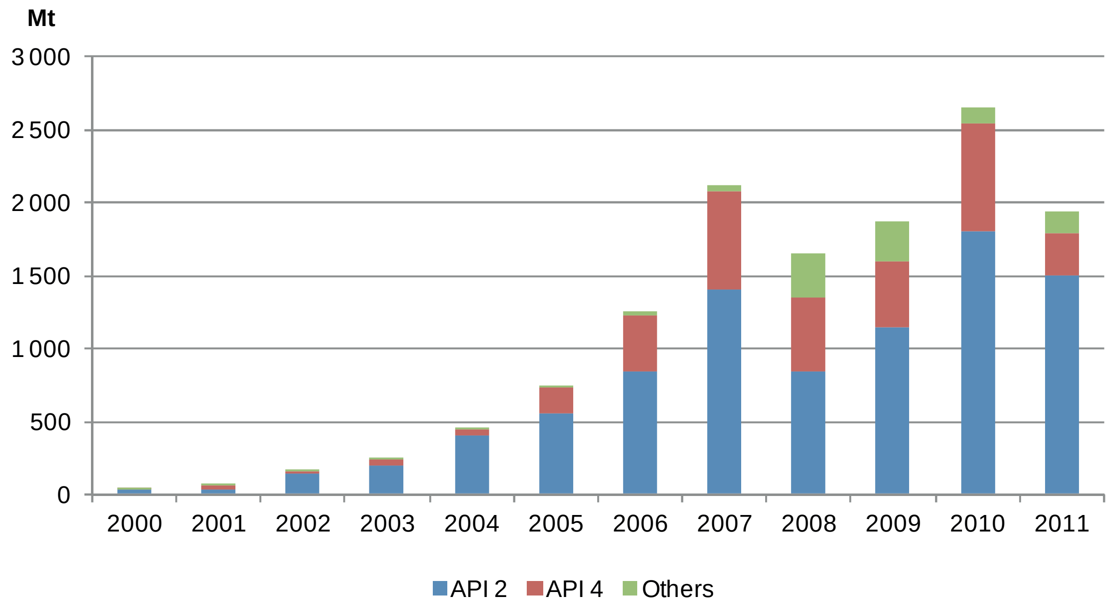
the aversion of many Australian producers to hedge and a tradition of yearly pricing, limit derivatives trade. As physical trade in Asia increased, price indexes were created for Indonesian exports and Chinese imports, and increasing price volatility made buyers and producers look for hedging. Newcastle swaps were not the best tool to manage risks on Chinese and Indonesian coal, and hence, Indonesian and Chinese coal swaps emerged. As this market gets more attractive, some European trading houses are establishing themselves in Asia. But it is not only volatility which drives the market; in China, it is common for a buyer to default if the spot price falls under the price agreed in the contract. Therefore, the sellers also have an incentive to hedge. In summary, despite lack of electricity liberalisation, the coal derivative market in Asia has the potential to grow in the future.

Figure 10 Development of trade volumes for coal derivatives, 2000-11



Source: IEA estimation based on various sources.

Prices

Coal is not a homogenous product and as a result, several different coal markets co-exist. These different types of coal can be segmented by costs, quality, use (thermal or metallurgical), time (spot, forward or long-term contracts), geographical location or access to export infrastructure. Besides the seaborne markets for thermal and metallurgical coal, several regional markets in various countries exist. The degree of interaction between the different markets varies. Consequently, several different prices for coal exist.

In general, it holds true that metallurgical coal is used in coke ovens or directly in blast furnaces, *i.e.* for steel making, whereas thermal coal is primarily used in steam production, in particular steam production for electricity generation purposes. Figure 11 displays the development of three coal marker prices from January 2010 until August 2012. By comparing the trajectory of the two Australian FOB prices, the Newcastle FOB marker for thermal coal and the marker for Australian prime hard coking coal, both provided by McCloskey, it is clear that different market dynamics are driving metallurgical and thermal coal prices. The Newcastle FOB did not experience a strong reaction to the flooding in Queensland at the end of 2010 and the first quarter in 2011, nor did it fall as dramatically as the Australian prime hard coking coal market as a reaction to low Chinese metallurgical coal demand in 2012.

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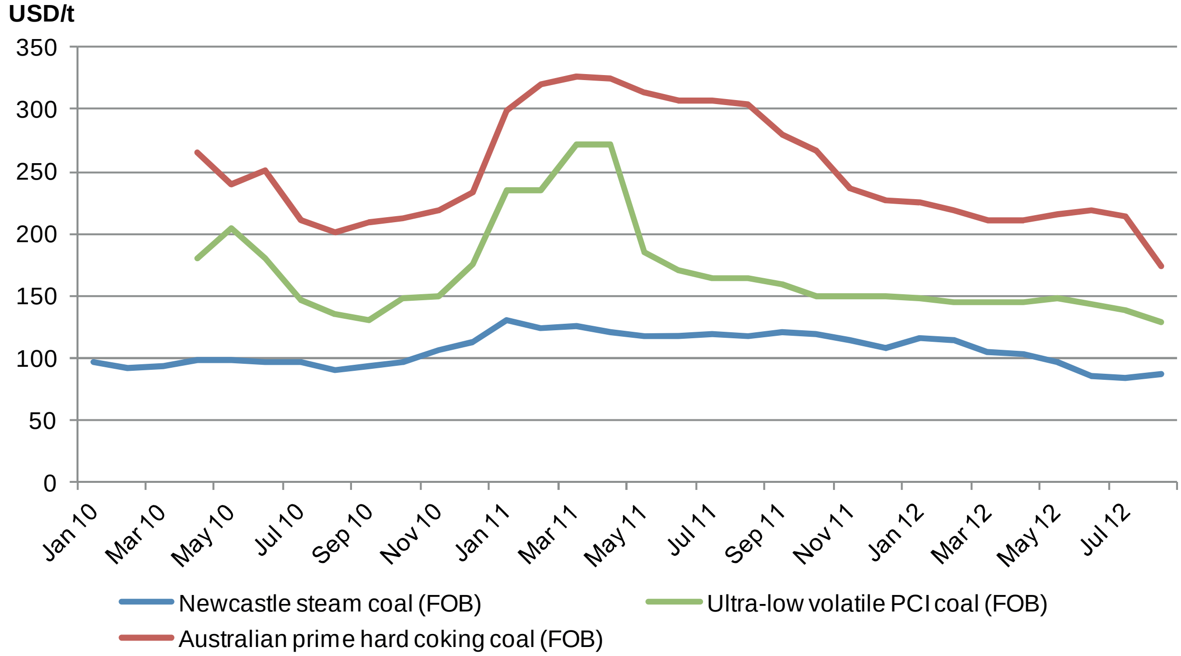
Figure 11 Development of coal marker prices for different types of coal, 2010-12



Source: McCloskey, 2012.

A certain degree of interaction exists between the seaborne thermal and metallurgical coal market. This interaction stems from the fact certain coal qualities can be used in power generation plants as well as in steel-making, and from mines and companies producing different types of coal. Theoretically, all metallurgical coal could be used as thermal coal, but, in practice, hard coking coal routinely sells at a premium in comparison to thermal coal (in 2011 the premium reached more than USD 200) and therefore is almost never used to produce electricity. The situation is different with lower rank coking coal, such as soft and semi-soft coking coal, as well as pulverised coal injection (PCI) coal. Hard coking coal is used to form high-strength coke in coke ovens, while PCI coal is used directly in blast furnaces as a substitute for some of the coke feed, with a substitution of up to 30% of coke being technologically feasible. PCI coal is actually thermal coal, and also frequently used in electricity production. Hence, during times of high demand from steel mills, a high proportion of this coal is sold as metallurgical coal, thus impacting thermal coal markets, and prices.

Seaborne thermal coal prices

Demand for internationally traded thermal coal grew strongly in Asia in 2011, particularly in China and India, but European thermal coal demand, fuelled by higher coal-based electricity production, also gained further momentum compared to the previous year. Consequently, prices for thermal coal delivered to ports in Northwest Europe continued their steady increase from March 2009 at USD 62/t to approximately USD 90/t in 2010 and USD 122/t in 2011. Although European import prices remained stable and relatively high throughout most of 2011, thermal coal prices fell towards the end of the year and continued into mid-2012, landing at USD 85/t in May 2012, before rebounding slightly. The recent decrease of seaborne thermal coal prices is best explained by two factors, in particular: the shale gas revolution in the United States and emerging signs of a Chinese economic slow-down have weighed heavily on seaborne coal prices.

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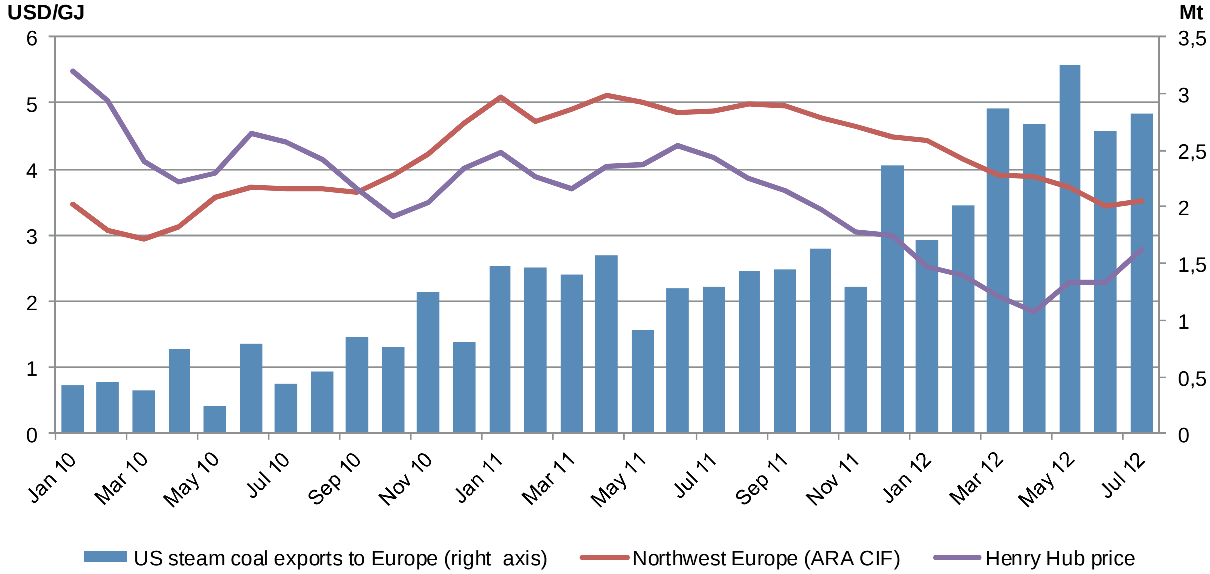
Figure 12 The impact of the US shale gas revolution on European coal prices



Source: McCloskey, 2012.

In June 2011, spot prices for natural gas started to decrease substantially, subsequently leading to a marked fuel switch from coal to gas in the US power sector. This, in turn, pushed the majority of idled coal onto the seaborne thermal coal market. The bulk share of additional US thermal coal exports found their way into Europe. While under normal circumstances the United States is perceived as a high-cost supplier of the Atlantic market, and thus additional European imports of US thermal coal would have to go in hand with rising import costs, the shale gas revolution in the United States made available to some extent thermal coal with lower FOB costs for the international thermal coal market. Consequently, the increase of gas-fired power generation resulted in decreasing US FOB, as well as European imports costs.

Seaborne transport costs per unit of energy for coal are lower than other fuels, *e.g.* natural gas, and markets are reasonably well integrated. However, some regional price differences exist (in theory they should equal the difference in transport costs between the markets). Additionally, because of long transport distances and the limited speed of bulk carriers, physical arbitrage between geographically distant markets may take time. This was observed in late 2011 and early 2012, when an overflow of the Atlantic market with US thermal coal led to a fall in prices in Europe, while prices in China, as shown in Figure 13, initially remained high. Figure 13 displays the arbitrage opportunity for Colombian coal going to China; the graph compares the domestic Chinese coal price (assessed as FOB price in Qinhungdao, plus freights from there to the South Coast of China) with the cost of Colombian coal in South China (ARA CIF [cost, insurance, freight] price plus freight differential between Colombia – ARA ports and Colombia – Southern Coastal China plus import tax).

South Africa, due to its favourable geographical location and the low cost of its high calorific value thermal coal, is one of the few suppliers able to physically arbitrage prices of the Atlantic and the Pacific basin. Depending on overall price levels and freight costs, other potential arbitragers include Colombia, Indonesia, Russia and, albeit to a lower extent, Australia.

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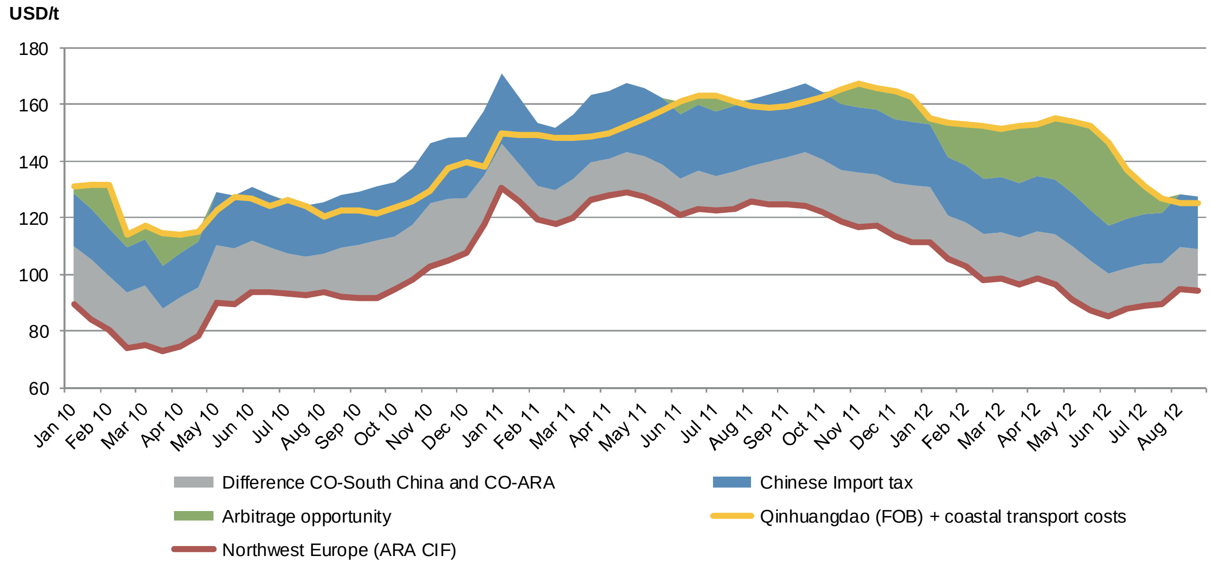
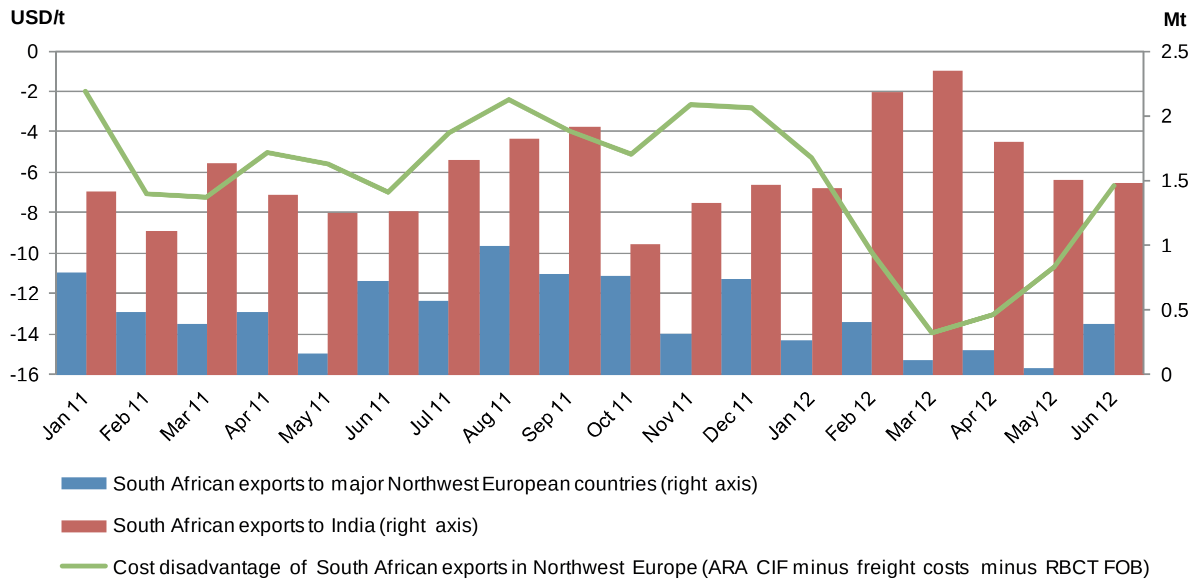
Figure 13 Development of price difference between Europe and China



Sources: McCloskey, 2012; IEA analysis.

Figure 14 High coal prices in Asia increasingly attract South African steam coal



Source: McCloskey, 2012.

Figure 14 displays South African exports in kilotonnes (kt) to Northwest European countries and to India, representative for Asian thermal coal importing countries. Additionally, the difference between the marker prices for coal into the ports of ARA and the FOB price at the Richards Bay Coal Terminal (RBCT) in South Africa adjusted by the freight costs between ARA and RBCT is shown. Hence, Figure 14 illustrates that an oversupply in the Atlantic market with US thermal coal led to a crowding out of South African coal in Northwest Europe, or put differently, high Asian import prices attracted additional thermal coal volumes from South Africa, which resulted in rerouting exports initially intended for Europe.

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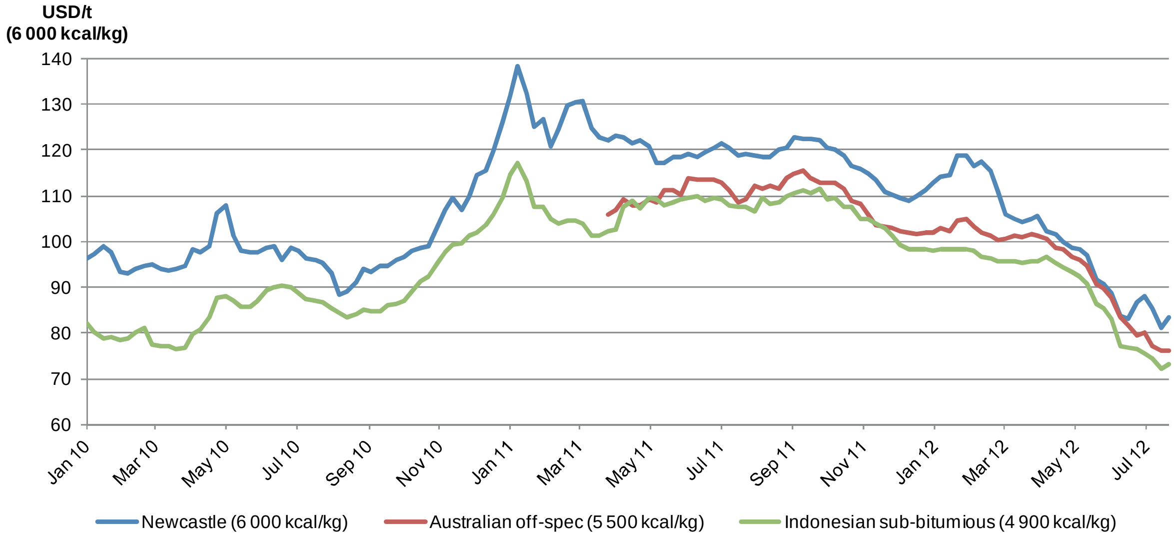
As previously mentioned, the average quality of traded thermal coal declined in 2011. In general, the quality of mined thermal coal in countries such as South Africa or Colombia continues to decrease. In addition, demand for so-called off-spec coal has increased, *i.e.* coal with qualities which substantially deviate from the traditional benchmark with calorific values of around 6 000 kcal/kg, with low ash (less than 20%) and sulphur content (less than 1%).

Figure 15 Development of off-spec coal prices (FOB), 2010-12



Source: McCloskey, 2012.

Seaborne metallurgical coal prices

In 2011, the average benchmark price for prime hard coking coal stood at close to USD 290/t, which is an increase of USD 160/t compared with the annual benchmark price in 2009 and an increase of USD 80/t in 2010. Hence, metallurgical coal prices recovered from the collapse when the annual price dropped from USD 300/t in 2008 to USD 128/t in 2009. The increase in metallurgical prices was mainly driven by the flooding of Queensland in the fourth quarter of 2010 and the first quarter of 2011, which tightened the international metallurgical supply. This caused hard coking coal benchmark prices to soar to unprecedented heights with quarterly prices standing at USD 330/t from April 2011 to June 2011. Prices gained additional support through an increase in Chinese steel production, which on a year-to-year basis grew by 56 Mt (9.8%) in 2010 and 60 Mt (9.6%) in 2011. Although benchmark prices decreased towards the end of 2011, they still remained high at USD 315/t in the third quarter and USD 285/t in the last quarter of that year.

The timing of negotiations for the fourth-quarter benchmark price in 2011 coincided with a decrease in the price of internationally traded metallurgical coal. Prices continued to fall throughout the first half of 2012 and eventually reached USD 210/t in the second quarter of that year. The main reason for the recent price drop, besides the return of Queensland's metallurgical coal supply, is the slower than expected import demand for metallurgical coal in China, caused by relatively sluggish growth in Chinese steel production. In the first seven months of 2012 Chinese steel production totalled 418 Mt, up by only 1.4% (6 Mt) from 2011 levels (412 Mt). This was substantially less than year-on-year growth of 10.5% in 2011. Metallurgical coal prices regained some momentum (USD 15/t from the previous quarter) due to a strike at BHP Billiton's Queensland mines which started in April 2012.

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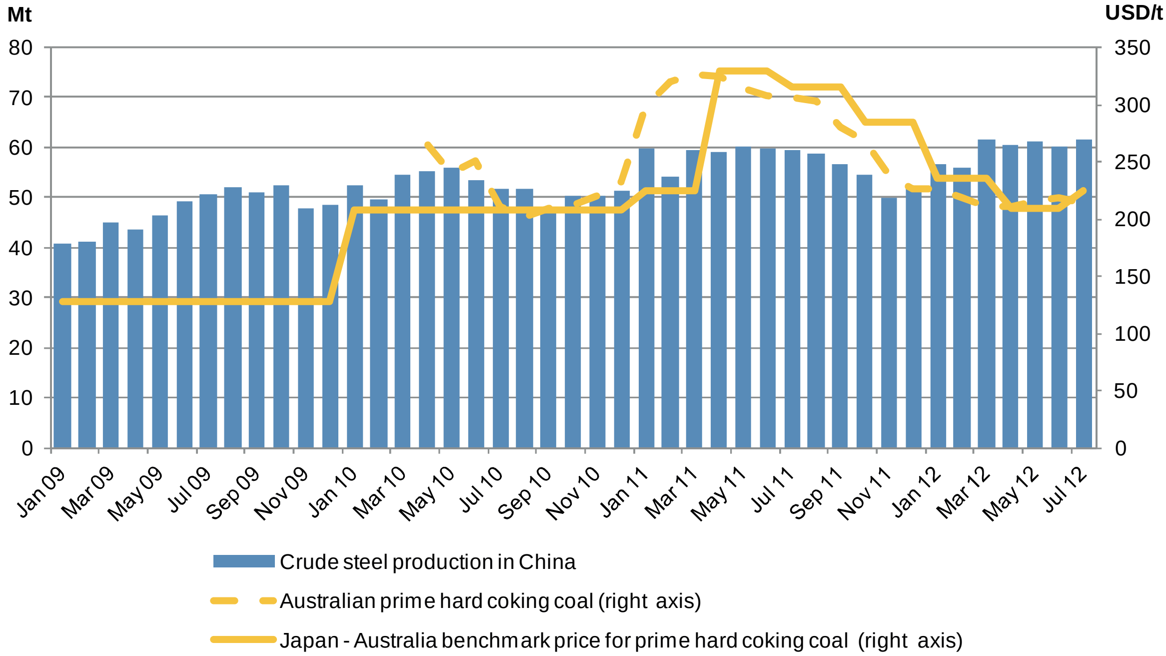
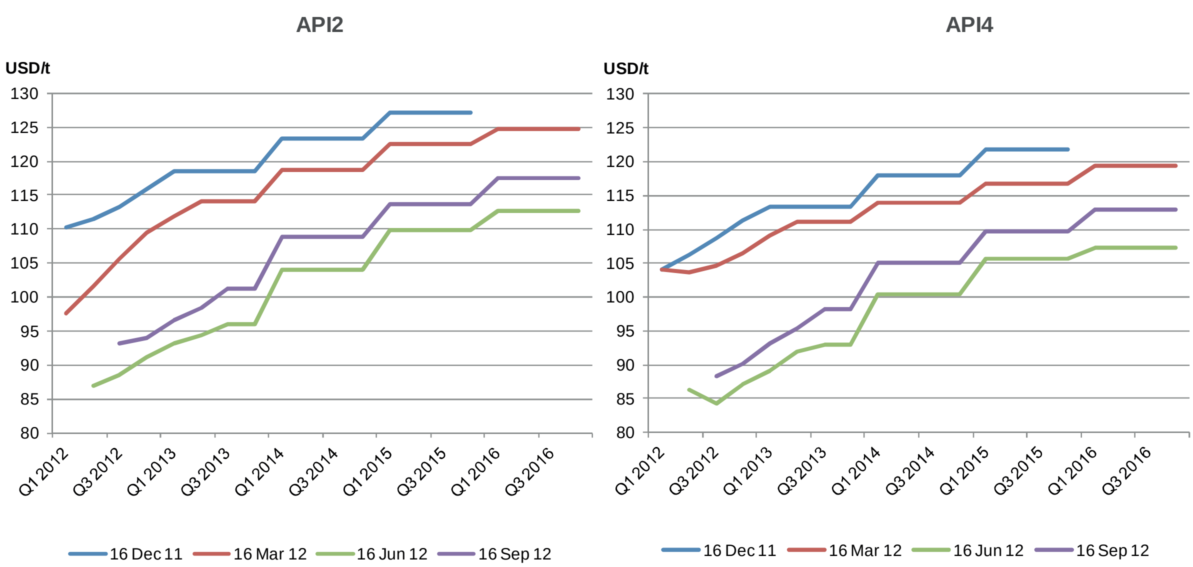
Figure 16 Development of metallurgical coal prices and Chinese crude steel production, 2009-12



Sources: World Steel Association (various years); BREE (2012); McCloskey, 2012.

Coal forward curves

Figure 17 Forward curves of API2 and API4, 2012



Source: McCloskey, 2012.

As mentioned previously, API2 and API4 based derivatives account for more than 90% of total trade volume. Figure 17 shows the evolution of forward curves from 16 December 2011 to 14 September 2012.

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Both show a similar contango shaped upward slope, which may suggest that spot markets are well supplied relative to futures. In March 2012, API2 curve showed stronger contango than API4, but this was promptly corrected and in June this difference had disappeared.

Mergers and acquisitions

Recent years have seen a buying frenzy in natural resources and mineral assets. This has also involved the coal mining industry, and in 2010 and 2011, substantial merger and acquisitions deals were concluded. At least USD 54 billion has been spent on major takeover activities in the coal industry since 2008 (Table 9). There are a multitude of reasons that fuelled this takeover wave: firstly, pressure to gain efficiencies in production and trade supported the takeover of smaller producers, particularly in the United States, and will continue to do so in the medium term. Secondly, limits to organic growth, especially with regard to metallurgical coal production due to environmental regulation, the maturity of domestic coal fields, as well as scarcity of untapped coal prospects, has increased the attraction of takeovers in the United States. Furthermore, recent price spikes for metallurgical coal and the expectation of sustained high prices have drawn investors to focus on metallurgical coal assets. Another factor is the strategic foreign investment of companies in China and India looking to diversify their supply portfolio away from domestic resources. Finally, massive cash reserves of large international mining companies combined with cheap debt have favoured acquisitions in recent years. As a result, a large number of deals were targeted at coking coal assets, which concentrated supply even more.

A key acquisition in this field was the USD 1.1 billion takeover of Riversdale by Rio Tinto, giving the buying company access to newly developed coking coal fields in Mozambique. Another major deal was the acquisition of the Canadian metallurgical coal producer Grande Cache Coal by Japanese-Chinese Winsway Coking Coal/Marubeni Corp. for USD 986 million in late 2011. One of the largest metallurgical coal deals was the takeover of the Australian PCI coal producer MacArthur for USD 5.1 billion by Peabody Energy and steel producer ArcelorMittal. In terms of the sums involved, the largest acquisition in the coal industry was the USD 7.1 billion takeover of US coal producer Massey Energy by its competitor Alpha Natural Resources in mid-2011. This deal made Alpha Natural Resources the third-largest coal producer in the United States (behind Peabody Energy and Arch Coal) and the third-largest metallurgical coal exporter in the world (behind BHP Billiton Mitsubishi Alliance and Teck Resources).

Table 9 Some key mergers and acquisitions in the global coal industry, 2008-11

Type	Target company/ project	Target company/ project country	Bidding company	Bidding company country	Price* (million USD)	Year
Acquisition	Resource Pacific Holding Ltd	Australia	Xstrata	United Kingdom/ Switzerland	728	2008
Acquisition	Magnum Coal	United States	Patriot Coal	United States	709	2008
Acquisition	Mid Vol Coal Group	United States	Arcelor Mittal	India	n/a	2008
Acquisition	Concept Group	United States	Arcelor Mittal	India	n/a	2008
Acquisition	PBS Coals	United States	Severstal	Russia	1 000	2008
Merger	Foundation Coal Holdings	United States	Alpha Natural Resources	United States	n/a	2009
Acquisition	Gloucester Coal	Australia	Noble Group	Singapore	349	2009
Acquisition	Prodeco Reservoir/ Glencore	Colombia	Xstrata	United Kingdom/ Switzerland	2 000	2009

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Acquisition	Felix Resources	Australia	Yancoal (Yanzhou)	China	3 300	2009
Acquisition	Bluestone Coal	United States	Mechel OAO	Russia	436	2009
Acquisition	Maules Creek Coal Project	Australia	Aston Resources	Australia	441	2010
Acquisition	Bylong Project	Australia	KEPCO	Australia	370	2010
Acquisition	Centennial Coal Company Ltd.	Australia	Banpu Public Company Ltd.	Thailand	1 837	2010
Acquisition	Prodeco Reservoir/ Xstrata	Colombia	Glencore International AG	Switzerland	2 067	2010
Acquisition	Zambeze Coal Project (40% share)	Mozambique	Wuhan Iron and Steel Corp.	China	800	2010
Acquisition	United Coal Company	United States	Metinvest	Ukraine	1 000	2010
Acquisition	Trinity Coal Corp.	United States	Essar Group	India	600	2010
Acquisition	Cumberland Resources	United States	Massey Energy	United States	960	2010
Acquisition	INR Energy	United States	Cliffs Natural Resources	United States	757	2010
Acquisition	International Coal Group	United States	Arch Coal	United States	3 400	2011
Acquisition	INR Energy Coal	United States	Cliffs Natural Resources	United States	757	2011
Acquisition	Massey Energy	United States	Alpha Natural Resources	United States	8 500	2011
Acquisition	Caldeon Resources	United Kingdom/ Australia	Guangdong Rising Assets Management (GRAM)	China	507	2011
Acquisition	International Coal Holdings Ltd.	Australia	PPT Mining Ltd.	Thailand	562	2011
Merger	Aston Ressources	Australia	Whitehaven	Australia	5 268	2011
Acquisition	Boardwalk Resources	Australia	Whitehaven	Australia	688	2011
Acquisition	Macarthur Coal Ltd	Australia	Peabody Energy/ ArcelorMittal	United States/ India	5 100	2011
Merger	Gloucester Coal Ltd	Australia	Yancoal (Yanzhou)	China	2 100	2011
Acquisition	Griffin Coal Mining	Australia	Lanco Infratech Ltd.	India	930	2011
Acquisition	Premier Coal business	Australia	Yancoal (Yanzhou)	China	306	2011
Acquisition	Hunnu Coal	Australia	Banpu Public Company Ltd.	Thailand	477	2011
Acquisition	Coal & Allied Industries Ltd. (20% share)	Australia	Rio Tinto/ Mitsubishi JV	Australia/ Japan	1 550	2011
Acquisition	Western Coal	Canada	Walter Energy	United States	3 300	2011
Acquisition	Grande Cache Coal	Canada	Winsway Coking Coal / Marubeni Corp.	China/Japan	986	2011
Acquisition	QGX Coal	Mongolia	Mongolian Mining Corp.	Mongolia	465	2011
Acquisition	Shubarkol Komir JSC (75% share)	Kazakhstan	Eurasian Natural Resources Corporation (ENRC)	United Kingdom	600	2011
Acquisition	Drummond (20% share)	United States	ITOCHU	Japan	1 520	2011
Acquisition	Rosebud McKay mine	United States	Westmoreland	United States	n/a	2011
Acquisition	IRP/Logan&Kanawha	United States	James River Coal Company	United States	475	2011
Total					**54 846**	

* Includes some estimates.

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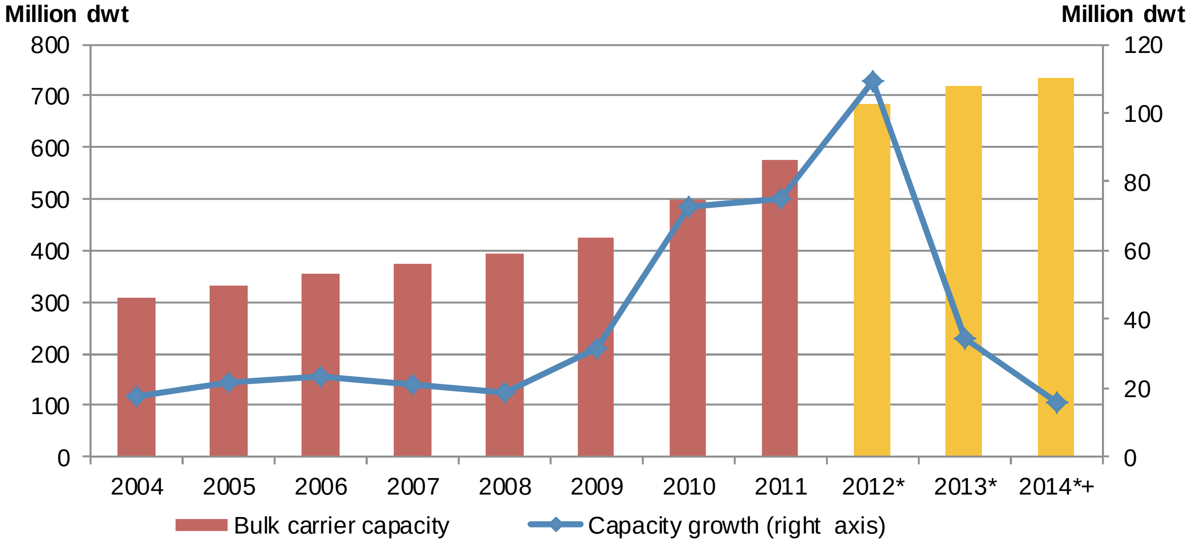
All of these deals do not compare with the proposed USD 58 billion[11] merger of Glencore with Xstrata. This merger, if finally concluded, will create the largest coal exporter in the world. Glencore currently holds 34% of Xstrata's shares.

Dry bulk shipping market

Seaborne dry bulk shipping constitutes an important part of the coal supply chain as more than 90% of internationally traded coal has to be transported by ship from producing to consuming countries. Shipping is handled by dry bulk freight vessels, which differ in the weight that they can carry, measured in deadweight tonnage (dwt). Although definitions differ depending on the source consulted, coal can be shipped in four different subclasses Handysize (10 000 dwt to 35 000 dwt), Handymax (35 000 dwt to 60 000 dwt), Panamax (60 000 dwt to 80 000 dwt) and Post-Panamax (Capesize and bigger, *i.e.* more than 80 000 dwt). Valemax used to ship iron ore from Brazil to China are the largest bulk carriers with capacity ranging from 380 000 to 400 000. Supply of bulk carrier capacity is quite inflexible as construction of new bulk carriers typically takes one to two years. Demand for dry bulk carriers is dominated by iron ore, with coal in second place.

Figure 18 Development of the bulk carrier fleet (only units over 20 000 dwt)



* Estimate.

Source: IEA analysis based on various sources.

Since 2004, annual net growth of the bulk carrier fleet – only those with a capacity of at least 20 000 tonnes of deadweight (dwt) are taken into consideration – had been below 25 million dwt, as shown in Figure 18, until 2009, when freight rates hit unprecedented highs (Figure 19), causing annual fleet growth to take off. In 2009, more than 30 million dwt were added to the fleet, followed by growth in 2010, which was more than twice as high as the year before, and finally rising to 80 million dwt in 2011. Hence, within the last three years, total bulk carrier capacity increased by roughly 45%. The all-time high in capacity additions in 2011, paired with a lack of cargo supply, caused freight rates to fall. The average freight rate between Richards Bay and Rotterdam stood at USD 6/t in August 2012, around USD 4/t less than in the two previous years.

[11] This was the initial value, but it increased afterwards.

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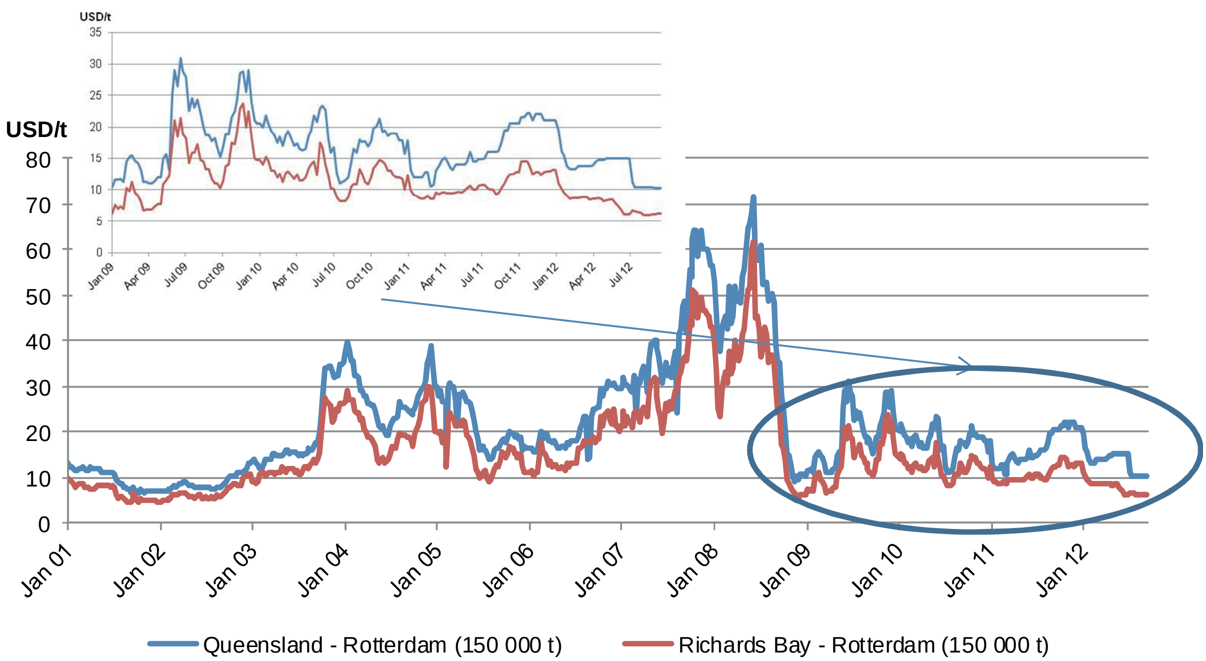
In 2012 and 2013, vessels with an estimated capacity of almost 145 million dwt, or one-fourth of the total fleet capacity at the end of 2011, are expected to enter the market. Consequently, even with higher than current cancellation rates and increased scrapping of old vessels, the market for bulk carriers is likely to remain oversupplied over the two- to three-year horizon.

Figure 19 Development of select freight rates, 2001-12



Source: McCloskey, 2012.

Cost developments

Compared to oil and gas extraction, the cost focus in coal mining is more on variable costs rather than investment costs. The variable costs of coal supply comprise direct mining (and washing) costs, inland transport costs, port fees, seaborne freight rates and taxes. Short-run marginal costs (the cost of an incremental unit), are a major driver of prices in coal markets. In this analysis, we assume that the variable cost curve is flat for an individual mine, and hence, variable cost is equivalent to short-run marginal cost.

Commodity price developments

Variable costs, most often called mining cash-costs, can be broken down into materials, labour and other costs (royalties, outside services etc.); however, the breakdown depends on the country and specifics of the individual mine with regard to its geological conditions and the mining method applied. Material costs generally account for more than 50% of a mine's cash-costs. In some countries with low labour costs, such as Indonesia or South Africa, this share can be closer to 75%. Some inputs in mining are traded internationally and the domestic price trends should generally follow the global price trend although regional distortions (*e.g.* fuel subsidies) may exist. Such commodities are: steel, diesel fuel, tyres, explosives and machinery. Other commodities used in coal mining such as electricity, electric materials and cables as well as water follow national price trends.

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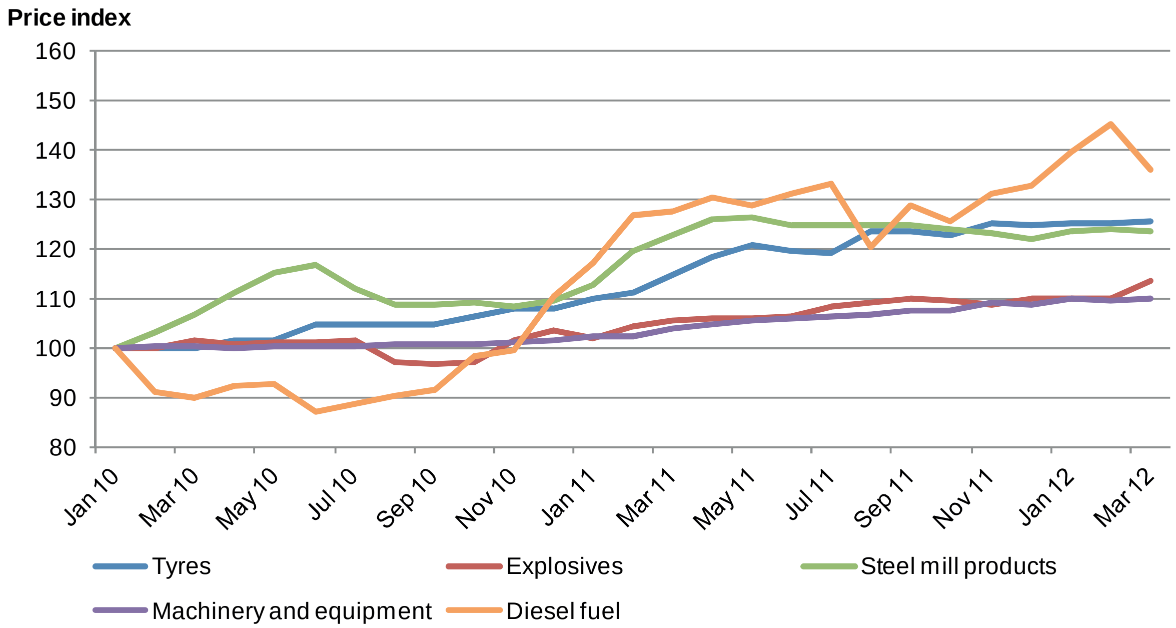
Figure 20 shows the indexed price development of select materials used in coal mining that predominantly follow international price trends. Prices of all displayed commodities increased over the past two years in nominal terms. Price hikes were relatively steep for diesel fuel and tyres, whereas prices for steel and mining machinery followed more moderate trends.

Figure 20 Indexed price development of select commodities used in coal mining



Source: US Bureau of Labor Statistics, 2012a (data for the United States).

Currency exchange rates

Often overlooked, exchange rates play a major role in supply cost development for internationally traded coal. The mechanism is simple: As international coal trade is mostly settled in US dollars, coal exporters generate a revenue stream in US dollars while they incur a large part of their costs in domestic currency. Therefore a devaluation of the US dollar translates implicitly into a supply cost increase for exporters out of the Unites States and vice versa.

Figure 21 displays the indexed evolution of the US dollar against the currencies of key coal exporting countries from the beginning of the economic crisis in late-2008. The message is clear-cut: since 2009, the US dollar lost value against all selected countries' currencies leading to implicit cost increases for exporters over the past three years.

Exchange rate effects affected Australian producers heavily due to a strong increase in the value of the Australian dollar (AUD) paired with relatively high exposure to exchange rate fluctuations (high share of labour costs and underground production). South African exporters, also incurring a large part of their cost in South African rand (ZAR), were similarly affected during 2009 and 2010 but benefitted from a devaluation of the ZAR in 2011. The problem of exchange rate fluctuation is partially mitigated due to the availability of a large variety of financial hedging instruments against exchange rate-related risks.

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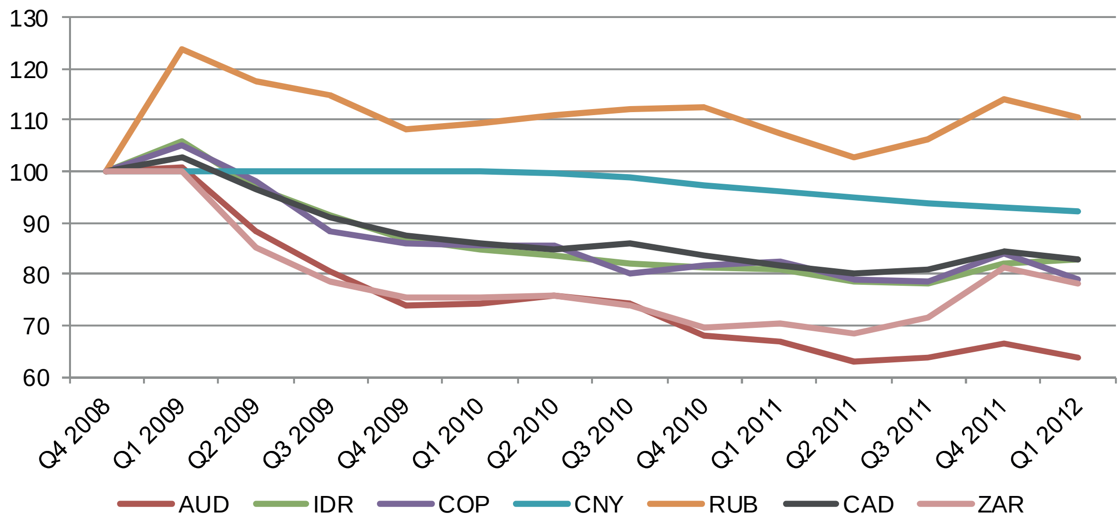
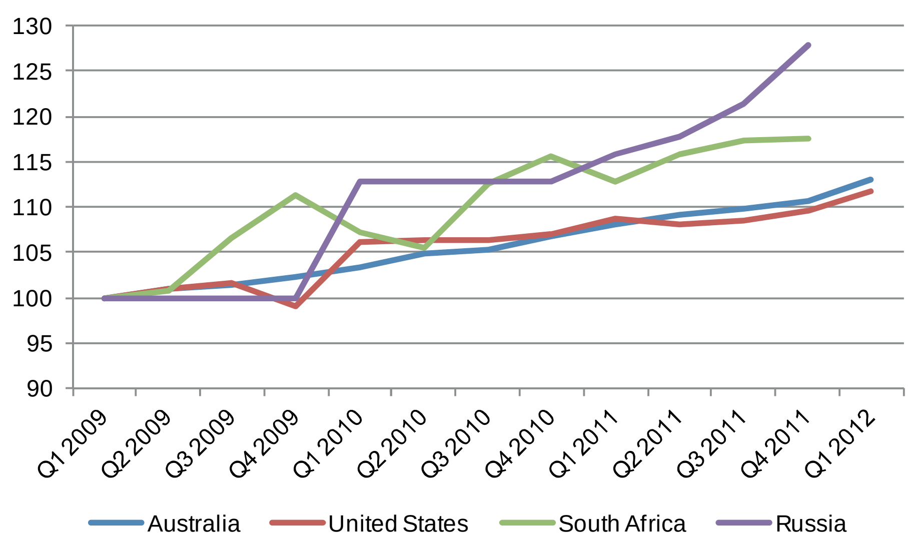
One of the largest supply cost components to be paid in domestic currency is labour. Labour costs can make up between 20% and 50% of mining cash-costs depending on the country and the applied mining technology. Salaries and wages are typically higher in countries such as Australia, the United States and Canada compared to South Africa or Indonesia. However, labour productivity is usually higher, at least partially compensating for this effect. From a technology perspective, surface mining is usually less labour intensive than underground mining, although certain underground collieries might realise higher labour productivity than average surface mines.

Figure 21 Indexed development of the US dollar against select currencies



Note: the graph shows the indexed (Q4 2008 = 100) development of the US dollar against selected currencies expressed as USD/domestic currency (*e.g.* USD/AUD). Therefore a devaluation of the US dollar (1 USD buys less units of another currency) results in a decline of the index. Currencies displayed: Australian dollar (AUD), Indonesian rupiah (IDR), Colombian peso (COP), Chinese renminbi (CNY), Russian ruble (RUB), Canadian dollar (CAD) and South African rand (ZAR).

Figure 22 Indexed labour cost development (in local currency) in select countries



Note: only annual data for 2009 and 2010 was available for Russia. Index: Q1 2009 = 100.

Sources: US Bureau of Labor Statistics, 2012b; Statistics South Africa, 2011; Australian Bureau of Statistics; Federal State Statistics Service of the Russian Federation.

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Coal haulage is also paid in domestic currency and can be another major cost component in countries with long transport distances, such as Russia, Canada, Australia and South Africa. Other important input factors that are procured in domestic currency are electricity (underground mining, crushers, conveyor belts, draglines or power shovels), water (coal washing, dust suppression, etc.) and outside services.

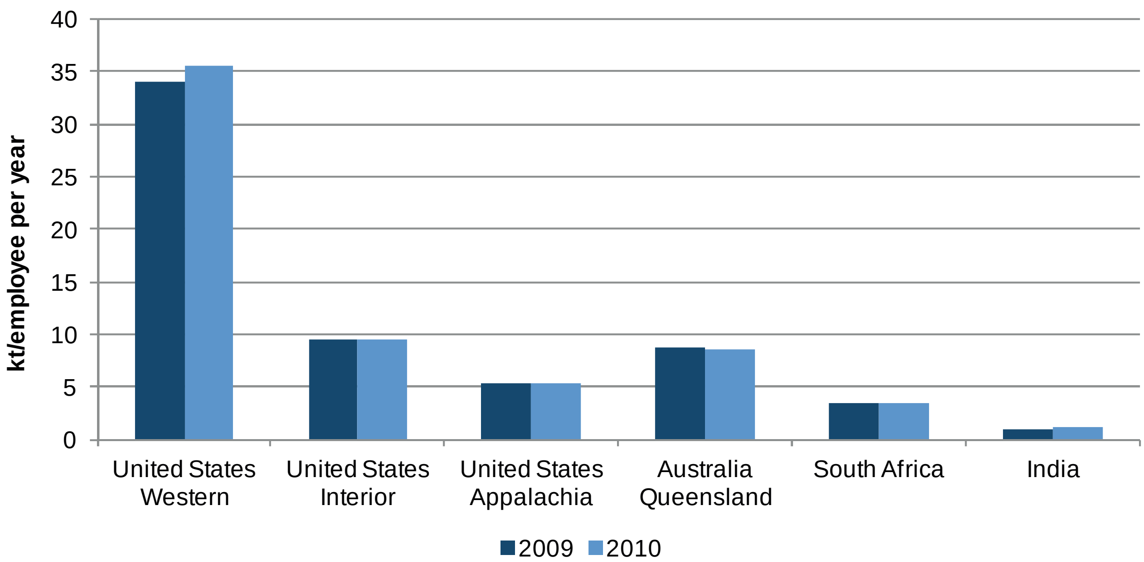
As other key inputs (diesel fuel, steel, mining machinery, explosives and tyres) are usually sourced from global markets (or linked to global market developments), exposure of supply costs to exchange rate volatility is naturally reduced. Consequently, changes in exchange rates will affect suppliers differently. Cost exposure to exchange rates may be as low as 30% for some Indonesian or Colombian open-cast operations and more than 80% for some Australian or Russian underground mines.

Productivity

Largely driven by geological conditions and technology used, productivity, measured as tonnes of coal mined per employee per year, also depends on various factors, such as mine closures (usually the least productive collieries are closed first) or openings (initially production per employee can be very high), strikes or geological conditions of mined seams in a specific year (in some years an above average amount of overburden is removed, so that productivity can increase in the following years).

However, differences in productivity are substantial among countries. As shown in Figure 23, an employee in an Indian coal mine produced on average 1 000 tonnes of coal in 2009, whereas average productivity in the United States was more than 11 000 tonnes per year. Yet productivity varies both between countries and within a country, as the following example in the United States underlines. Productivity in Appalachia was 5 300 t to 5 400 t per employee in 2009 and 2010, which is relatively low compared to average productivity in the rest of the country. The Interior basin was substantially higher in the same time frame at 9 400 t to 9 600 t per employee, however, the Western US mining basins reached an impressive average of 35 600 t per employee in 2010 (through open pit mining operations in the Power River basin).

Figure 23 Productivity in select countries and regions



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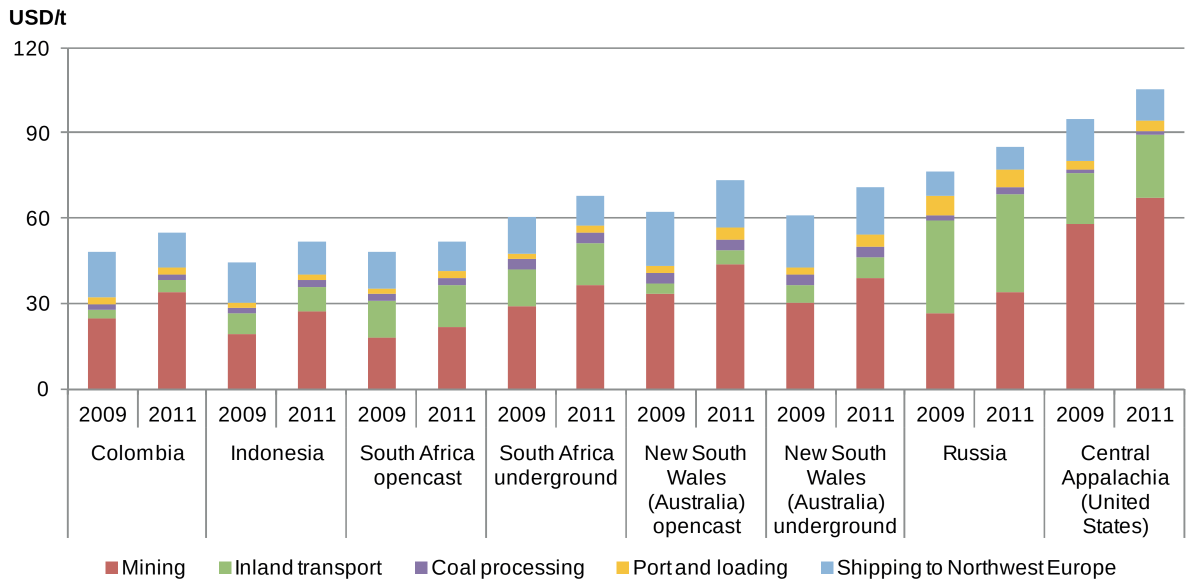
Development of coal supply costs

From 2009 to 2011, supply costs of both thermal and metallurgical coal increased substantially in all countries. Figure 24 and Figure 25 display indicative costs for thermal and metallurgical coal from select countries supplied to Northwest ports in Europe (ARA) and Japan. Both figures do not include taxes and royalties in order to allow for a comparison of mining and transport costs in different countries without distortions from interventions by national or regional governments. Taxes and royalties play an important role in FOB costs in some countries, *e.g.* Indonesia or Colombia, but are of minor importance in other countries, *e.g.* South Africa or the United States. Northwest Europe and Japan were chosen as destination countries in order to illustrate that while changes in FOB costs can be attributed to the same cost drivers, the increase of CIF supply costs to Europe was eased because of lower freight rates. This, however, does not hold true for the Pacific markets, as freight rates for a 65 000 deadweight tonnage (dwt) bulk carrier from Australia to Japan increased from an average USD 15.5/t in 2009 to around USD 17.1/t in 2011 (McCloskey, 2012).

Australia's FOB cash-costs have risen significantly over the last two years; an important driver was the increase of the AUD against the USD, which appreciated by 24.4% (annual average exchange rate in 2011 versus 2009). Another key driver was the cost of skilled labour, which depends on the applied mining techniques that account for 30% to 40% of mine-mouth cash-costs. Labour costs in Australia have increased by 8% since 2009. Around 80% of Australian coal production takes place in open-cast mining operations, which are more highly affected by changes in the price of diesel. Consequently, Australian mine-mouth cash-costs also increased from 2009 levels because of higher oil prices. FOB cash-costs for most thermal coal from New South Wales is close to USD 50/t to USD 65/t, with the exception of some high-cost producers with FOB cash-costs in excess of USD 80/t. FOB supply costs for a large share of metallurgical coal from Queensland should lie in the range from USD 85/t to USD 100/t.

Figure 24 Indicative steam coal supply costs to Northwest Europe by supply chain component and by country in USD/t, 2009 and 2011



Note: indicative supply costs shown in this figure do not include any taxes and royalties.

Sources: Devon, J. (2010); McCloskey (2012); various other sources (see figures in the section on cost developments); IEA analysis.

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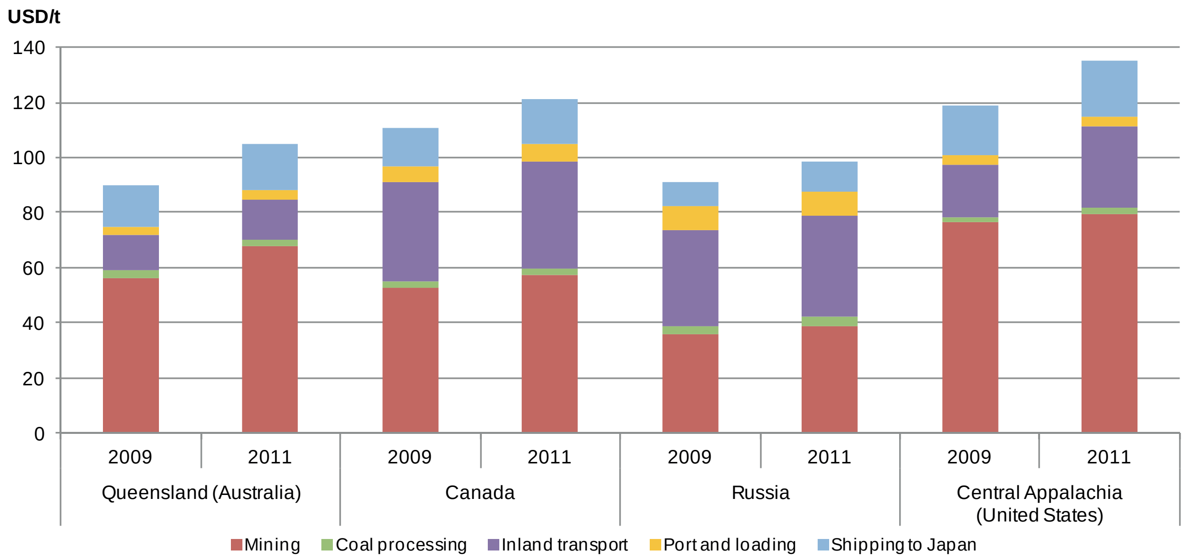
Indonesian operating costs for most coal miners have increased markedly over the last two years, mainly as a result of rising oil prices and labour costs. As most Indonesian coal mines are truck-and-shovel operations and the inland transport system involves a certain amount of trucking (an estimated 25% of all inland transport is carried out by direct trucking), rising oil prices are also of importance for Indonesian mining and FOB costs. Decreasing geological conditions, *i.e.* higher stripping ratios, added further pressure on mining cash-costs. Mining costs in Indonesia are estimated to have grown by almost 20% per year since 2009, yet the country's coal production costs remain among the world's lowest, resulting in FOB costs between USD 40/t to USD 55/t.

Although South Africa is considered to be among the low-cost suppliers of the seaborne thermal coal market, mining cash-costs vary depending on the size of the mine. While large-scale mines are expected to have mine-mouth cash-costs below USD 50/t, to some extent even substantially below USD 40/t, smaller producers incur mining costs beyond the USD 70/t mark. However, the small mines hardly play a major role in South African exports as almost 75% of total RBCT's export rights belong to five companies Ingwe Coal (a wholly owned subsidiary of BHP Billiton), Anglo American, Xstrata, Total and Sasol (VDKI, 2012).

Mining costs in South Africa have also increased since 2009 and because of the appreciation of the ZAR, diesel prices and wages have also increased. Over the last two years, South African mining costs are estimated to have grown 6% to 10% per year. Inland transport costs are estimated to add another USD 15/t to USD 20/t to mine-mouth costs, with average transport costs amounting to USD 0.03 per tonne-kilometre (t/km).

Figure 25 Indicative coking coal supply costs to Japan by supply chain component and country in USD/t, 2009 and 2011



Note: indicative supply costs shown in this figure do not include any taxes or royalties.

Source: IEA analysis from several sources (see figures in the section on cost developments).

The bulk of US thermal coal exports come from CAPP with some volume also coming from the Illinois basin (see "Regional analysis"). Metallurgical coal exports exclusively stem from Appalachian mines

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(mostly NAPP, CAPP and SAPP). FOB vessel cash-costs for the majority of Appalachian coal are estimated in the wide range of USD 85/t to USD 130/t. Clearly some mines may be able to export coal at below USD 85/t, whereas some high-cost coal operations (metallurgical) can incur costs in excess of USD 130/t. Rail transport costs are significant for US exports, but differ between thermal and metallurgical coal. Hence, railway tariffs may reflect the export value of the coal and not necessarily the cost of transport. Railway operators set fees and discounts to coincide with low prices on the international market. Low metallurgical coal prices coincided with low railway tariffs in 2008, whereas high international metallurgical coal prices led to higher railway tariffs in 2011.

FOB supply cost increases for metallurgical coal were moderate in Canada from 2009. Canada has comparatively low mining costs, but inland transport distances are high and therefore rail tariffs comprise a large proportion of FOB costs. 2011 FOB cash-costs in Canada were estimated at around USD 105/t.

Regional analysis

Exporters

Australia

In 2011, for the first time in nearly 30 years, Australia fell from the first-largest to the second-largest exporter of seaborne coal in the world on a tonnage basis, surpassed by Indonesia. Yet, in terms of energy content Australia remains the world's largest exporter of hard coal. Hard coal exports have increased at an average annual rate of 4.1% since 2006, encouraged by strong global demand and supported by commissioning of new mines, rail networks and ports in Queensland and New South Wales. Coal exports increased from 60% in 2006 to close to 75% in 2011, as a proportion of total Australian coal production.

Table 10 Australian port capacity available for coal exports (end of 2011)

State	Terminal	Capacity (Mtpa)
New South Wales	Port Waratah Coal Service - Newcastle (Kooragang Island and Carrington)	133
	Newcastle Coal Infrastructure Group - Newcastle	30
	Port Kembla	15
Queensland	Abbot Point	50
	Brisbane	10
	Dalrymple Bay	68
	Hay Point	44
	Gladstone	78
Total		**428**

The impact of the abnormal rains and flooding events in Queensland resulted in a 17.8% reduction in exports. In 2011, total Australian coal exports stood at 285 Mt, down by 8 Mt from 2010 levels. While thermal coal exports were up by 9 Mt to 144 Mt from 135 Mt in 2010, metallurgical coal exports decreased by 17 Mt from 157 Mt in 2010 to 140 Mt in 2010. Australian exports generated revenues of more than USD 44 billion in the financial year 2010 to 2011 (July to June), two-thirds of which were accounted for by metallurgical coal sales (BREE, 2011).

Australia already has abundant port capacity in place and thus exports are unlikely to be constrained by the availability of sufficient coal terminal capacity. New South Wales' port handling capacity was 178 million tonnes per annum (Mtpa) at the end of 2011 (163 Mtpa in Newcastle), topped by Queensland, which is home to five large coal terminals with a total annual handling capacity of 250 Mtpa.

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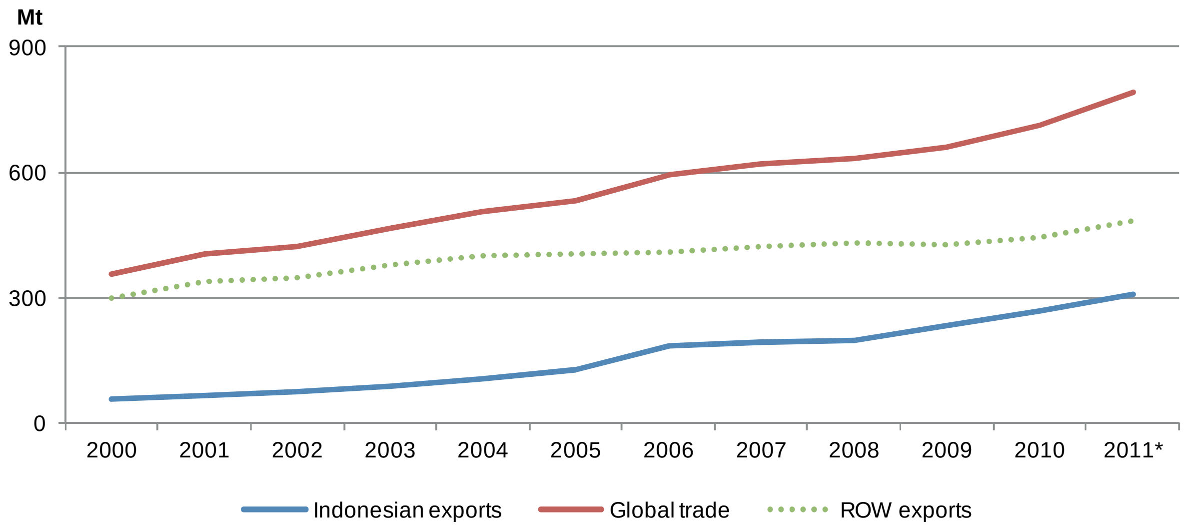
Indonesia

Indonesia became the world's largest supplier in the international coal market in 2011 on a tonnage basis, ranking second after Australia on an energy basis. In 2011, total Indonesian exports were estimated at 309 Mt, more than 40 Mt higher than in 2010. As seen in Figure 26, Indonesia has been a driving force behind the impressive development of the global thermal coal trade market since the turn of the 21st century. From 2000 to 2011, Indonesian incremental coal exports exceeded 250 Mt, equivalent to an annual growth of 18.4%. Due to its proximity to importing countries in Asia, Indonesia accounts for more than 70% of the growth in the seaborne thermal coal market over the last 11 years, although Indonesian hard coal trade represents less than 5% of global hard coal production.

Figure 26 Development of Indonesian exports compared with the rest of the world and the global seaborne steam coal trade, 2000-11



* Estimate.

Source: IEA analysis.

Although current low freight rates allow Indonesia to export some of its thermal coal to the Atlantic market, importing countries in the Pacific still account for 95% of imports. This general trade pattern is unlikely to change in the future as coal demand growth will continue to come from non-OECD countries in Asia. In addition, no matter how low freight rates fall, the low calorific value of most of Indonesian coal is a serious constraint to substitute the higher calorific coal used in high-efficiency European and North American boilers.

Colombia

Colombian hard coal production was close to 84 Mt in 2011, up by 9 Mt on 2010 (12.7%). Roughly 90% of Colombian production is exported, nearly all of which is thermal coal. In 2011, Colombia's coking coal exports remained close to zero (0.1 Mt) and nearly all metallurgical coal production served domestic needs, thereby producing 1.3 Mt of crude steel. In line with the increase in production, thermal coal exports from Colombia grew by more than 12% from 67 Mt in 2010 to 75 Mt in 2011. Declining freight rates and sustained high prices in Asia in 2010 led to a significant increase in Colombian exports to the Pacific market (from practically zero in 2009 to 11.7 Mt in

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2010). While not reaching 2010 levels, this recent swing of Colombian export streams continued in 2011 with 8.3 Mt shipped to Asian countries. Europe and the Mediterranean countries are the most important export destinations for Colombia amid declining imports from the United States.

Colombia's coal production, transport and port infrastructure is dominated by three large, vertically integrated global mining companies/consortiums: Drummond controls the Mina Pribbenow/El Descanso (open pit mine in the La Guajira province); a consortium of BHP Billiton, Xstrata and Anglo American operates the Cerrejón mine (open pit operations in César province) and finally Glencore owns Prodeco, which produces coal in its Calenturitas and La Jagua mines. In total, these three companies have accounted for 90% of Colombian exports in the past years. As a result of the vertical integration, co-ordination of investments into the supply chain (mining, railway and port capacity) can be considered as efficient. Colombia's low mine-mouth cash-costs (large-scale open pit operations), short transport distances and sufficiently available port capacity makes it one of the world's lowest cost exporters.

Russia

In 2011, Russia produced 256 Mt of hard coal, an increase from 246 Mt in 2010. While the indigenous metallurgical coal supply increased by more than 11 Mt, Russian thermal coal production decreased compared to 2010 levels (1 Mt). Russia is also a significant producer of brown coal and in 2011 produced 78 Mt for the domestic electricity sector. In addition to its indigenous production, Russia imported 31 Mt of thermal coal with specific quality parameters from Kazakhstan. Despite the increase in Russian coal supply, the country's coal exports decreased by 9 Mt from 133 Mt in 2010 to 124 Mt in 2011, although it remains the third-largest exporter in the world. In 2011, thermal coal comprised 85% of Russian coal exports (109 Mt), of which 15% were exported overland to non-OECD countries in Eastern Europe. As a result of high Asian prices, Russia has shifted its exports to the east. While the share of exports to the Pacific market was around 30% of total exports five years ago, it was closer to 40% in 2011.

Russian seaborne exports into the Atlantic market are handled by ports in the Baltic Sea (*e.g.* Ventspils, Latvia or Ust-Luga, Russia), Black Sea (*e.g.* Tuapse, Russia or Mariupol, Ukraine) and Barents Sea (*e.g.* Murmansk, Russia) Seas. While average port handling fees in most countries are between USD 2/t to USD 3/t, Russian exporting companies can pay up to USD 5/t and more. When Russian coal is exported via ports in Baltic countries, port handling fees and transit costs can add an additional USD 8/t to USD 10/t on supply costs at the Russian border. Due to the enormous haulage distance of Russian exports (4 000 kilometres [km] to 4 500 km), transport costs and port handling fees can easily account for half of FOB costs. As roughly two-thirds of Russian coal production comes from open pit operations (VDKI, 2011), the movement of the price of oil is an important factor for the development of Russian FOB costs.

South Africa

South Africa is a low-cost producer and is geographically well positioned to supply countries in both the Atlantic and Pacific markets. Coal exports rank third among minerals in terms of revenue and are one of the most important sources of foreign currency for the country. South Africa is the world's fifth-largest exporter of hard coal with exports close to 71 Mt in 2011, a slight increase from 2010 (68 Mt).

Colombia and recently also the United States gained more importance for Europe as South African thermal coal was directed increasingly to the Pacific market. From 2009, around 38% of South

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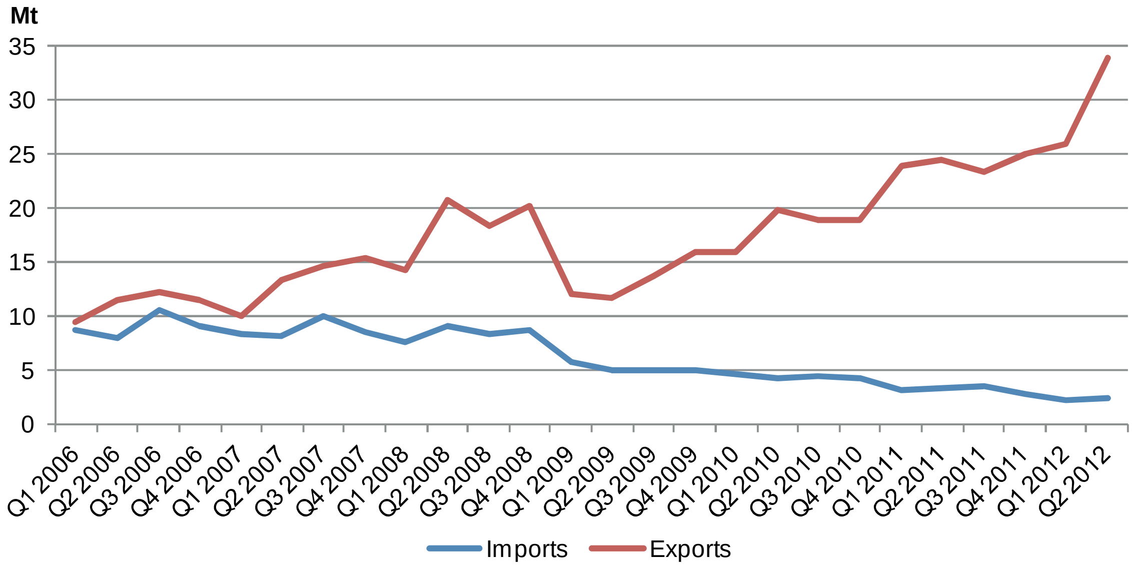
Africa's exports were directed to the Pacific market, accompanying high prices and demand for lower-quality coal; this share increased to roughly 60% in 2011. To meet European quality standards, South Africa is required to wash some of its coal (6 000 kcal/kg, 10% to 15% ash content), which adds an additional USD 5/t to mining costs. As a result of a higher share of exports to the Pacific market and relatively low discounts due to lower coal quality in Asia, washing of South African high ash coal (5 400 kcal/kg to 5 500 kcal/kg, 20% to 22% ash content) has become less common.

United States

Seaborne coal exports from the United States increased by an impressive 31% in 2011 compared to 2010. US coal exports reached their highest levels in the past two decades in these two years, at 74 Mt in 2010 and 97 Mt in 2011, of which 34 Mt were thermal coal in 2011 and the remainder were metallurgical. High international market prices, weak domestic demand and low seaborne freight rates encouraged export producers. The record levels of metallurgical coal prices reached in mid-2011 allowed US metallurgical coal producers the opportunity to place additional exports and make healthy margins.

Figure 27 US quarterly coal exports and imports, 2006-12



Source: McCloskey, 2012.

Steam coal from the Illinois basin is lower in cost and should be available at around USD 70/t FOB vessel (Gulf ports; inland transport via river barges), although due to the high sulphur content of Illinois basin material (more than 3%) buyers usually demand a price discount. In 2011, exports of Illinois basin coal reached unprecedented levels due to relatively high price levels in the international market, low freight rates and the possibility to blend Illinois basin coal (high sulphur content) with low-sulphur material.

Infrastructure capacity has so far not been an issue for exporters in the United States. Port capacity currently stands at 79 Mtpa on both the East coast and 36 Mtpa on the Gulf coast (Table 11). These figures take into account US coastal coal transport, coal imports and petcoke exports, as well as special stocking/handling requirements for coking coal. Additionally, there are about 10 Mtpa of port capacity on the West coast of the country. Yet, these capacities have so far played a very minor role in US coal exports.

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Table 11 US port capacity available for coal exports in the East Coast and Gulf Coast, 2011

Coast	Terminal	Capacity (Mtpa)
East	Lambert's Point Coal Terminal Norfolk, Virginia	30
	Dominion Terminal Associates, Newport News, Virginia	20
	Pier IX Terminal Company Newport News, Virginia	11
	CNX Marine/Baltimore Terminal Baltimore, Maryland	14
	Chesapeake Bay Piers Baltimore, Maryland	4
Gulf	US United Coal Terminal, Davant, Louisiana	11
	International Marine Terminals, Myrtle Grove, Louisiana	10
	McDuffie Coal Terminal, Mobile, Alabama	12
	IC Railmarine Terminal, Convent, Louisiana	3
Total		**115**

Exports continued to grow in 2012, as seen in Figure 27. In the second quarter of 2012, the United States exported 34 Mt, with total exports of 60 Mt in the first half of the year. These recent developments suggest that US coal exporters are willing to accept FOB prices close or even below their marginal supply costs to the ports in order to generate revenue from coal production. In addition, stated coal export handling capacity in the United States should be considered as being a conservative estimate of actual capacity since US exports would amount to an annualised 136 Mt if only the second quarter in 2012 was taken into consideration. Yet one should be aware of the fact that exports depicted in Figure 27 include overland exports to Canada and Mexico as well as US exports via Canadian ports on the West coast. Additionally, figures for US coal terminals refer to the nameplate capacity, *i.e.* may be temporarily exceeded by actual exports.

Canada

Canada has a history of relative stable export volumes. For the last 25 years, Canada's hard coal exports have been in the range of 26 Mt to 36 Mt, of which usually more than 80% are metallurgical coal exports. Canadian metallurgical coal exports, primarily mined in Western Canada (British Colombia and Alberta), are strongly influenced by international price levels and are situated at the high-cost end of the global supply cost curve with average FOB costs in excess of USD 100/t. Part of this is due to the strategic behaviour of Japanese steel mills, which have kept Canada in the international trade as a credible alternative to Australia's metallurgical supply (for a detailed description of the evolution of the seaborne metallurgical trade market see Box 4).

In 2011, internationally traded Canadian metallurgical coal amounted to 28 Mt and thermal coal to 6 Mt, and exports remained relatively flat from 2010 levels (33 Mt). Compared with 2009, when the economic crisis hit global steel production and Canadian metallurgical coal exports fell below 22 Mt, increased use of crude steel in the past two years has helped Canadian metallurgical coal exports to regain momentum.

Others

Poland saw its total exports decrease by around 3 Mt from 10 Mt in 2010 to 7 Mt in 2011, despite constant hard coal production (slightly more than 76 Mt in 2010 and 2011). Average production costs increased by 6.2% from 2010 levels to EUR 70/t, and because Polish thermal coal exports were at the high end of the international supply curve, they lost competitiveness. Labour costs are the most important factor in average mine-mouth cash-costs with a share of around 50%.

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Table 12 Breakdown of important input factors for an average coal mine in Poland, 2010-11

Input factors (in % of mine-mouth cash-costs)	2010	2011
Labour	50	51
Depreciation	9	9
Materials and energy	18	18
Services	17	17
Taxes, charges	3	3
Other	3	2

Note: depreciation is included in the mine-mouth cash-costs.

Source: Polish Ministry of Economy, 2012.

Mongolia is endowed with abundant resources. Apart from an estimated 160 billion tonnes (Bt) of coal, most of which is metallurgical coal, Mongolia also possesses vast reservoirs of iron ore, copper, gold and rare earth. The Tavan Tolgoi basin, with its 6 Bt of coal located favourably in South Gobi province close to the Chinese border, has attracted the attention of major foreign mining companies. Mining licences for 50% of the coal seams in the western part of the Tavan Tolgoi basin, the so-called Tsankhi block (1.2 Bt of hard coal resources), have been granted to Chinese Shenhua (40%), a Russian-Korean consortium (36%) and Peabody Energy (24%) in a deal signed by the Mongolian government in the summer of 2011 (VDKI, 2012).

Mongolia's coal production is estimated to have reached 31 Mt in 2011, up by almost 6 Mt from 2010 levels. Despite surging gross domestic product (GDP) growth in recent years (17.2% in 2011), almost all hard coal production is exported with brown coal production (9.3 Mt in 2011) dedicated to serving domestic demand. Therefore, Mongolian thermal coal exports stood at 2 Mt and metallurgical coal exports reached 20 Mt in 2011, the latter having increased by an impressive 335% over the course of the last two years. As no railway infrastructure is in place and because Mongolian production regions are close to the Chinese border (300 km at most), all hard coal exports go to China by truck.

Vietnamese incremental domestic demand, propelled by high GDP growth rates, outpaced the country's increase in coal supply over the past couple of years, leading to decreasing hard coal exports. In 2011, however, Vietnam's hard coal exports, which have to a large extent been shipped into China, are assumed to have broken out of the trend and have increased on a year-to-year basis from 20 Mt in 2010 to an estimated 24 Mt in 2011. Aside from China, Japan and Korea are the other two final destinations for Vietnamese coal exports, which due to quality issues are not commercially suitable to transport over greater distances.

Venezuelan coal exports continue to stagnate on a level which is significantly below its potential, mainly because of highly inefficient operation of the coal mines. In 2011, production and transport was in addition hampered by heavy rainfalls. Coal production in Venezuela, all thermal, stood at 2.3 Mt in 2011 and thus 0.4 Mt lower than a year before. Nearly all of Venezuela's coal production goes into the international trade market, however, coal infrastructure is outdated and thus in need of additional investment. Yet, due to instable political conditions, international investors remain reluctant to invest in the Venezuelan coal industry, despite favourable geological conditions and relatively low FOB prices (USD 50/t to USD 60/t).

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New Zealand's exports, almost all metallurgical coal, remained low with close to 2.2 Mt in 2011, which is 0.2 Mt less than the year before. New Zealand's entire metallurgical coal production of 2.1 Mt is bound for the international market with most thermal coal (2.5 Mt) and brown coal (0.3 Mt) production used to meet the country's domestic demand.

Mozambique looks set to become one of the new major players in the international metallurgical coal market (see Box 9). In mid-2012, Rio Tinto exported the first cargo of Mozambican hard coking coal mined in Tete province to India's Tata Steel, which has a share in the two mining operations of Rio Tinto.

Importers

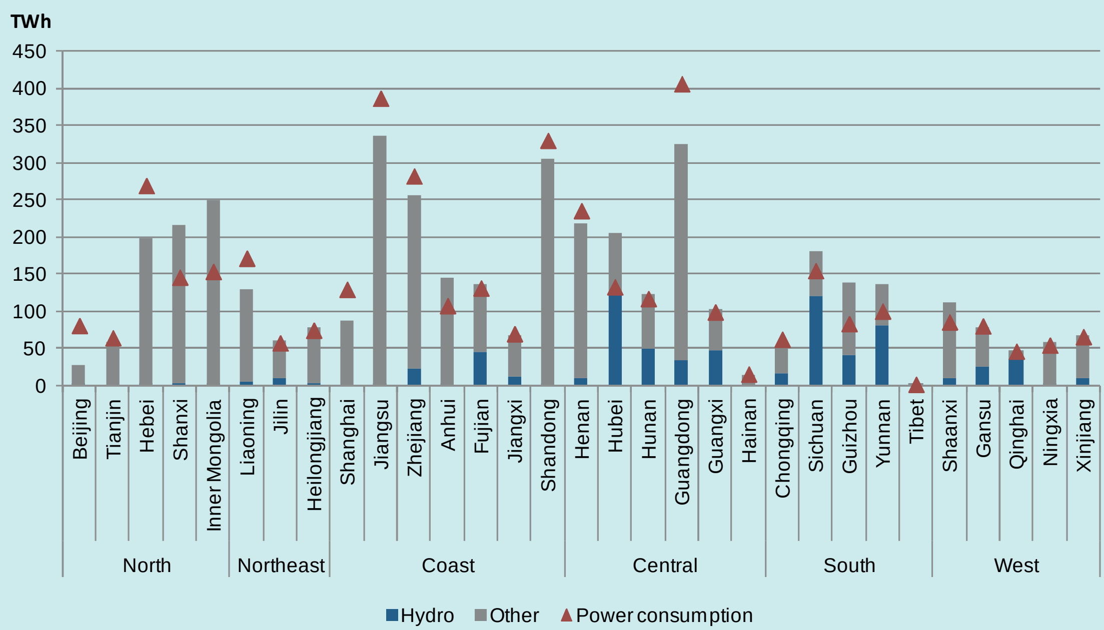
China

In 2011, China became the world's largest importer of hard coal, a position held by Japan for over 30 years. Chinese imports totalled 173 Mt in 2010 and 203 Mt in 2011; 159 Mt (75%) were thermal coal imports and the remainder were metallurgical coal imports. Preliminary figures for 2012 indicate that the increase in Chinese imports, particularly for thermal coal, is likely to continue.

Box 5 Butterfly effect? How rainfall in Central China drives coal prices in Rotterdam

After coal, hydropower is the second-largest source of electricity generation in China. Currently, more than 200 GW of hydroelectric power capacity are installed in China, producing more than 700 terawatt-hours of electricity per year – enough to cover the combined power demand of Germany and the Netherlands. Hydropower output, however, depends on precipitation and is therefore subject to a strong seasonality with a dry season from December to March and a rainy season from June to September.

Figure 28 Regional power demand, production and hydro generation in China



Source: NEA, 2011 (data for 2010).

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Box 5 Butterfly effect? How rainfall in Central China drives coal prices in Rotterdam (continued)

Four key rivers systems– the Yangtze River, Mekong River, Pearl River and Yellow River – provide more than 80% of China's hydro generation. The Yangtze, home to the massive Three Gorges dam, alone provides more than 50% of the country's hydropower. Provinces in Central and South China, which produce the bulk of the hydropower, are nearly all net exporters of electricity. Coastal provinces such as Shanghai, Jiangsu, Zhejiang, Shandong and Guangdong on the South Coast are all net importers of electricity.

A significant reduction in low-cost electricity output from hydropower plants leads directly to increased generation from coal, the only source of large-scale generation available in the Chinese power system. Normal seasonality can be absorbed by coal stocks, and reduced hydro output does not tighten the domestic coal market and produces little effect on coal imports.

However, in the past few years, several serious droughts led to unanticipated reductions in hydro output. In early-2011 a prolonged drought that mainly affected the middle and lower parts of the Yangtze basin (*e.g.* Hubei and Hunan), stretched well into June, leading to marked reductions in hydro power generation. Furthermore, cargo shipping was suspended along a 200 km-long stretch due to low water levels.

At the end of 2010, the Chinese provinces of Sichuan, Yunnan, Chongqing and Guangxi were hit by a dry spell. This affected the upper reaches of the Yangtze, Mekong and Pearl Rivers and hence substantially reduced hydroelectric power generation.

The effects of such extreme weather events are manifold. Firstly, low precipitation in Central and Western China *e.g.* Western Sichuan, Qinghai or Tibet, might reduce hydropower output in the lower reaches of the rivers with a time lag of several weeks. This gives market participants the chance to anticipate increased coal burn and prepare building stocks. Secondly, low water levels can hamper barging and thus lead to alternative coal transport, *e.g.* via rail, at a higher cost. Consequently, coastal provinces, especially those in the south, might prefer to procure their coal needs from the international market when domestic Chinese coal prices increase. This, in turn, will increase price levels on the international coal market. On the other hand, high precipitation may result in high hydro generation and consequently have the reverse effect on coal markets.

These effects are typically brief and have little impact on long-term market fundamentals. Nevertheless rainfall in remote regions can have a considerable short-term effect on Chinese coal buying behaviour and thus be another explanation for the large volatility of Chinese imports. Given, that China has still large untapped hydro generation potential and is planning to increase hydroelectric capacity in the 12th Five-Year Plan, this effect is likely to remain in the future.

Indonesia is a key supplier of thermal coal to China and has been the supply side counterpart to China on the demand side. It accounts for the majority of seaborne thermal coal supply growth worldwide (Figure 26), along with Vietnam and Australia. For metallurgical coal, Australia and Mongolia are the two dominant suppliers, and Mongolia exports its entire production of metallurgical coal overland to China. However, China does not engage in long-term contracts such as other Asian countries, such as Japan, and thus sources its imports on the spot market. As a result, global shares in total Chinese hard coal imports may vary substantially from year-to-year. For example, Indonesia's share of Chinese thermal imports stood at 44% in 2009 and increased to more than 50% in 2010. In contrast, Russia increased exports to China during the economic crisis as it exported more than 11 Mt in 2009 up from 0.6 Mt in 2008. In 2010, however, Russian exports to China dropped again, falling to 6 Mt in 2011. Consequently, China chooses its supply sources based on prevailing CIF prices, which lead to trade with distant suppliers, such as Colombia (exports to China began in 2010).

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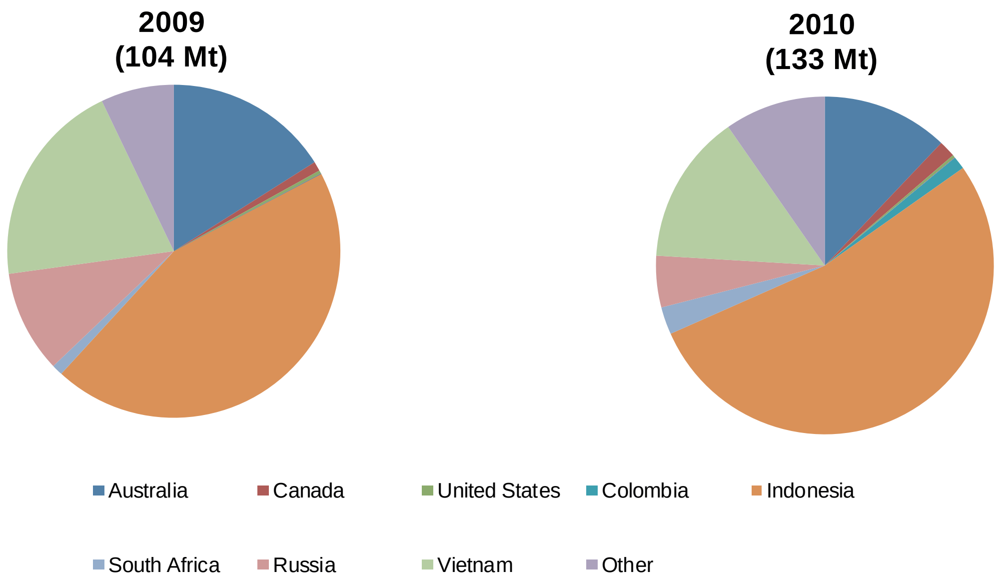
Figure 29 Structure of Chinese steam coal imports, 2009/10



Japan

For the first time in more than three decades, Japan lost its status as the largest coal importer to China in 2011, although it remains the largest *seaborne* coal importer on an energy basis. Coal imports stood at 175 Mt in 2011, compared to 185 Mt in 2010, which corresponds to a decrease of over 5% year-on-year. Metallurgical coal imports were, however, markedly reduced (6.6%) in comparison to steam coal imports (4.8%).

Recent development of coal imports in Japan is linked to the Great East Japan Earthquake and subsequent tsunami that led to the Fukushima-Daiichi nuclear accident in March 2011. Firstly, several coal handling facilities were damaged, causing a drop in coal imported through ten major Japanese ports from 2.3 Mt in January 2011 to 0.1 Mt in April 2011. The majority of ports in the country's Northeast recovered rapidly and while they are all currently operating, full recovery will take several years.

Secondly, the Great East Japan Earthquake immediately damaged five coal-fired power generation plants with a combined capacity of 7.2 GW. All five plants went back online by the end of 2011, except for the Haramachi plant, with a capacity of 2 GW (Tohoku EPCo), which is expected to be operational by mid-2013.

Finally, the Fukushima-Daiichi nuclear accident dramatically reduced nuclear output. Reduced generation from nuclear plants has led to an increase in generation from thermal power stations in Japan. Liquefied natural gas imports reached unprecedented levels in the second half of 2011 and early-2012, and power generation from oil has also surged. Coal-fired power generation plants are now running close to maximum capacity, although these plants provided baseload generation prior to March 2011 and, therefore, the load factors of these plants have not increased substantially.

Korea

Continuing a steady increase over the past years, Korean imports grew from 119 Mt in 2010 to 129 Mt in 2011. This leaves Korea as the third-largest importer of coal in the world. In contrast to the

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size of hard coal imports, only small (and stagnating) amounts of coal are produced domestically (2.1 Mt of thermal coal in 2010 and 2011). Imports stem mainly from Australia, which supplies Korea with both metallurgical and steam coal, Indonesia (only steam coal) and Russia (both types of coal, but steam coal to a large extent). Other minor sources include Canada, United States and South Africa.

The need for more imports has been caused by increased electricity generation (+3.6%), growing industrial production (+6.9%) and recovering steel production (+16%) from 2010 to 2011. As the world's sixth-largest steel producer, Korea's increase in steel production from 59 Mt in 2010 to 69 Mt in 2011 underlines the country's demand for coal. In 2011, a mandatory Greenhouse Gas Energy Target Management programme that sets individual emission targets was launched for energy-intensive companies. This programme is projected to culminate in the expected introduction of a cap-and-trade system in 2015.

India

India is the third-largest coal producer and consumer in the world. Approximately 70% of this coal is consumed by the power sector, and the remainder by the iron and steel industry. Coal consumption has increased strongly over the past decade, at an average rate of 6.5% per year. In 2011, coal consumption rose by almost 7% from 643 Mt in 2010 to an estimated 687 Mt. The surge in coal use, however, is not matched by domestic production growth. This has caused a widening gap between demand and domestic supply, which has led to strong growth in imports. Hard coal imports into India increased by an impressive 25% in 2011 to 106 Mt. The majority of import growth comes from steam coal imports, which amounted to an estimated 86 Mt in 2011, up from 65 Mt in 2010.

Table 13 Select foreign direct investments into the coal supply chain by Indian investors

Country	Number of investments	Acquired resources/ reserves (Mt)	Capital expenditure (USD million)
Australia	9	17 138	7 612
Indonesia	28	6 271	4 526
South Africa	4	377	3 300
United States	3	348	820
Total	**44**	**24 134**	**16 258**

Source: Gresswell, M., 2012.

The Indian steel industry relies on high-quality coking coal imports, due to the relatively poor quality of domestic resources. In recent years, the majority of growth in coal imports has come from power generators; however, imported steam coal is markedly more expensive for Indian power generators than domestic coal. Given the regulation of power prices, generators face a disadvantage and have recently incurred substantial financial losses. In order to supplement this loss, Indian authorities recently dropped the 5% duty on coal imports, at least until 2014, which will incentivise coal imports. Moreover, CIL has agreed, in principle, to enter into Fuel Supply Agreements (FSAs) with domestic power plants to address the uncertainty of coal availability for power plant investors. The FSAs guarantee 80% of the load factor for commissioned power generation plants and for those to be commissioned before mid-2015. As a result of the shortfalls of domestic coal supply, Indian generators and steel mills have started to develop their coal supply sources abroad (Table 13). India has so far secured access to more than 24 Gt of coal reserves and resources, spending more than USD 16 billion (Gresswell, M., 2012). Australia is a key target of foreign direct investment and Indian investors are playing an important role in developing large-scale mining projects in Australia's Galilee

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basin. Indian investors are currently planning coal projects in Australia that could eventually supply almost 150 Mt of thermal and coking coal to the Indian market per year. Mozambique is another area of focus, with up to 30 Mtpa of mining capacity in the coal-rich province of Tete, which is currently under development by Indian companies. Indonesia's proximity to the Indian market and the quality of its coal is well suited for the country's power generation plants. Although the investment climate is somewhat less friendly, Indonesian coal resources have also been targeted by Indian coal consumers.

Europe

Overall imports increased by 6.4% in **OECD Europe** to reach 232 Mt in 2011, from 218 Mt in 2010. Australia and the United States are the two main markets for European imports of metallurgical coal, and Colombia, Indonesia, South Africa and Russia for steam coal. The European Union's allowances price for CO_2 emissions, which plummeted in 2011 and remained low at around 7.50 EUR/t CO_2 in 2012, was a major driver for increased import demand. This increased clean dark spreads[12] and drove electricity production from coal-fired power generation plants. Main importers (60% of OECD Europe imports) in 2011 included Germany (18%), the United Kingdom (14%), the Netherlands (11%), Italy (10%) and Spain (7%).

Despite having the largest share in OECD Europe's imports, **German** coal imports decreased by 11% from 46 Mt in 2010 to 41 Mt in 2011. While metallurgical coal imports increased from 8 Mt in 2010 to 9 Mt in 2011, with Australia and the United States as the main suppliers, steam coal imports declined in 2011. Steam coal imports dropped by 14% from 38 Mt to 33 Mt, with Colombia gaining importance (31%). Poland's exports to Germany were almost cut in half (45%) in 2011. Steam coal use declined by 2.5% in 2011 despite the shutdown of eight nuclear power plants and plummeting carbon prices. However, higher lignite and renewable generation filled the gap caused by the decrease in nuclear power generation, thus leaving no room for additional hard coal electricity generation in Germany.

The **United Kingdom** is the second-largest OECD importer and accounts for 14% of imports. In 2011, imports increased by 22% to 33 Mt from 27 Mt in 2010. More than 80% of imported coal is used in power generation, which provided 29% of electricity supply in 2011. An increase in imports is likely connected to power generation plants using less of their stocks. This, however, changed recently as record low levels of stocks were reported in April 2012 as use of coal-fired power generation surged (an increase of 34% in the first half of 2012 compared to the same period in the previous year) (McCloskey, 2012).

Other importing countries include the **Netherlands,** with a share of 11% of OECD Europe's imports equivalent to 25 Mt in 2011 (an increase of 19% from 2010), **Italy**, with a share of 10% at 24 Mt in 2011 (an increase of 9% from 2010) and **Spain,** with a share of 16 Mt in 2011 (an increase of 23% from 2010).

In 2011, imports in **Turkey** increased by 11.5% to almost 24 Mt (from 21 Mt in 2010) with domestic production amounting to 78 Mt. Steam coal makes up the bulk of imports (19 Mt in 2011 from 16 Mt in 2010) from Russia, Colombia, South Africa and, notably, United States, jumping from zero in 2010

[12] Clean dark spread refers to the difference between the price of electricity and the costs of coal based generation taking into account the needed CO_2 allowances.

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to 0.4 Mt in 2011. Besides coal-fired power generation, Turkey's cement industry is the second most important coal consumer in terms of absolute consumption. Turkey is Europe's largest cement producer and the largest exporter of cement in the world. The country strengthened this position in 2011 as cement production increased by more than 6% from 2010 levels. In the first five months of 2012, steam coal imports increased by 14% compared to the first five months in 2011 (McCloskey, 2012).

Others

Chinese Taipei's imports grew by 3 Mt to 66 Mt in 2011, making the country the world's fifth-largest importer of hard coal. Although metallurgical coal imports decreased by half to 4 Mt from 2010 to 2011 (Australia being the main supplier), the rising demand for steam coal overcompensated for the decrease and consequently led to growing import needs. In 2011, Chinese Taipei imported 62 Mt of steam coal, supplied by large exporting countries in the Pacific market with the exception of some coming from Colombia.

Brazil's hard coal imports increased by 2 Mt in 2011 to 20 Mt a year later. Brazil encountered a small drop of 1 Mt in metallurgical coal imports, which primarily come from the United States. In contrast, Brazilian steam coal imports almost doubled to 8 Mt in 2011, up from 5 Mt in 2010. The key suppliers of steam coal are Colombia, the United States, Russia and South Africa.

In 2011, **Malaysia**'s coal imports remained rather stable at 22 Mt in 2011 from 21 Mt in 2010. Traditionally, the country's power generation depends on natural gas (54% in 2010), however, the share of coal in overall power generation increased from 11% in 2002 to 40% in 2010. This trend is unlikely to end in the medium term as new coal-fired plants are scheduled to come online in the coming years.

The **United States**, similar to Russia, is an exporting country with large domestic coal consumption. In 2011, imports into the United States continued to fall, amounting to 12 Mt (10 Mt of thermal coal) at the end of 2011, down by 6 Mt from 18 Mt in 2010. Colombia has long been a key supplier of steam coal to the United States; however, its exports to the United States also declined in line with the overall trend in the past years. Some imports are supplied overland from Canada, particularly metallurgical coal.

Compared to its domestic supply of 334 Mt in 2011, **Russia** imports only a small fraction of its coal demand (25 Mt in 2011). Similarly, **Kazakhstan's** imports stood at a mere 0.2 Mt (thermal coal from Russia) with domestic hard coal production amounting to 105 Mt in 2011.

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MEDIUM-TERM PROJECTIONS OF DEMAND AND SUPPLY

Summary

- **In the Base Case Scenario (BCS), global coal demand grows from 5 279 million tonnes of coal equivalent (Mtce) in 2011 to 6 169 Mtce in 2017 (2.6% per year).** Consequently, coal will continue to grow more than any other fossil fuel to 2017, although at slower pace than gas.[13]

- **Global coal demand growth is clearly driven by non-OECD economies with an annual growth rate of 3.9% over the outlook period.** China leads the growth among non-OECD economies in absolute terms with 628 Mtce. In relative terms, the highest growth comes from India (6.3% per year) followed by other non-OECD Asia (6% per year).

- **Coal use among OECD economies is projected to fall by 0.7% per year in the medium term. However, growth is unevenly distributed among OECD countries.** While coal consumption decreases in OECD Americas, most notably in the United States, coal use in OECD Europe grows in the first half of the outlook period and drops in the second half to reach 2011 demand again in 2017. OECD Asia Oceania is projected to have sluggish, but robust growth over the medium term with Korea leading the growth both in relative and absolute terms.

- **In the Chinese Slow-Down Case (CSDC) Chinese coal consumption grows at a mere 2% on average per year over the outlook period, reaching 2 881 Mtce in 2017.** Total Chinese coal use is 309 Mtce lower in CSDC in 2017, as compared to the base case.

- **Global supply in the BCS is projected to increase from 5 508 Mtce in 2011 to 6 169 Mtce in 2017, equivalent to an average annual growth rates of 1.9%.** The stock building of recent years gives rise to a lower increase of supply compared to demand.

- **Global supply in the CSDC is projected to grow by 375 Mtce to 5883 Mtce in 2017, equivalent to an average annual growth rate of 1.1%.** After one decade of production increasing by more than 4% per annum, a slow-down of the Chinese economy would have a significant impact on global coal production.

Introduction

General macroeconomic conditions, the price of coal and its substitutes (in power generation and industry), and population growth and electrification are key drivers of global coal use. Specifically, gross domestic product (GDP) and population growth rates, as well as fuel prices, serve as input parameters for the demand forecasting tools used in this outlook.

Predicting GDP growth is challenging and characterised by substantial uncertainty. The base case projections presented in this report are based on the GDP growth forecast by the International Monetary Fund (IMF) released in April 2012. This forecast is reasonably optimistic and predicts that the world economy will grow at approximately 4.2% per year on average from 2012 to 2017. Yet,

[13] See IEA (2012b) and IEA (2012c).

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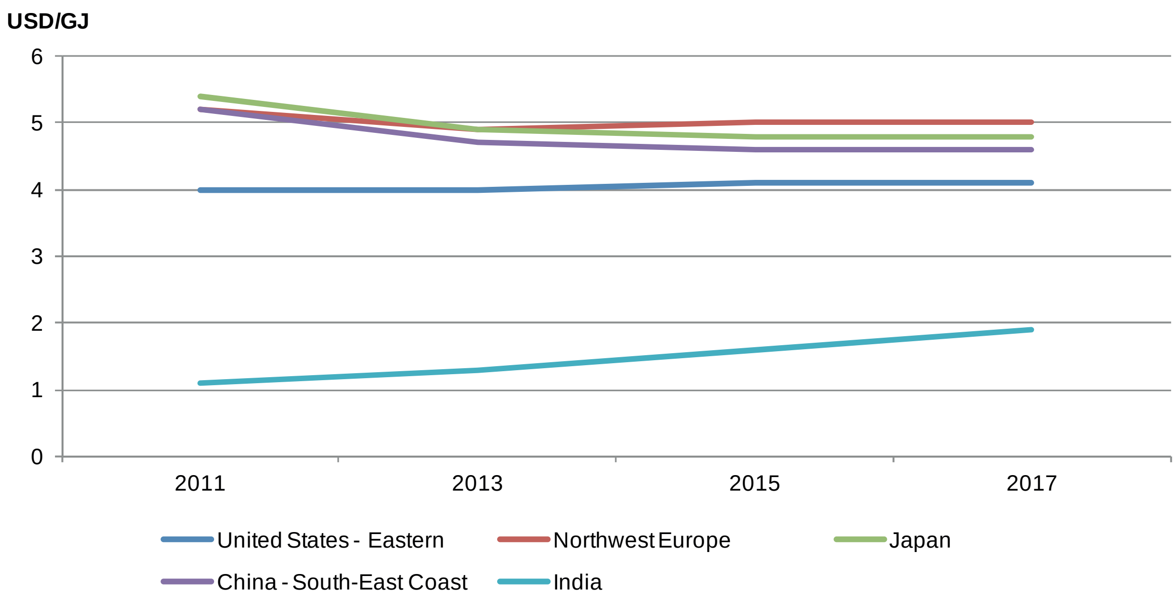
projections of GDP growth rates are especially prone to future changes and revisions, which may result in different evolutions of coal demand and regional supply patterns than described in this book. After April 2012 and prior to the publication of this report, a new IMF forecast projected lower future global economic growth. This report's BCS is more bullish than the new IMF forecasts, but the CSDC assumes lower economic growth in China.

Although uncertainty regarding the development of the global economy is high, for coal demand, the key question remains whether the Chinese economy can sustain growth rates of more than 8% per year. With increasing maturity, the Chinese economy will start slowing down; however, the timing of this turning point and the trajectory to reach lower growth is highly uncertain. Some believe that the Chinese economy still has a long way to go before growth rates start to fall, but others are convinced that an economic slow-down is close and will take place over the medium term. In any case, GDP growth is a major determinant of coal demand in China, the largest coal consumer in the world; therefore this outlook considers two scenarios with different underlying GDP growth rates: A base case (BCS) in which the Chinese economy grows at an average of 8.6% per year and a bearish case (CSDC) in which economic growth stands at an average of 4.6% per year from 2012 to 2017.[14] For reasons of comparability, all other GDP growth rates remain unchanged in this scenario.

Figure 30 Regional (real) steam coal price assumptions, 2011-17 in USD (2011)/gigajoule (GJ), delivered to the power plant



Between 2012 and 2017, OECD economies are projected to grow at 2.3% per year and non-OECD economies at 6.2% per year. OECD Europe is projected to resume stronger growth in the latter-half of the outlook period, but in the medium term, growth rates are projected to remain sluggish at 1.7% per year. European growth rates are especially challenging to forecast with the evolution of the Euro crisis. Forecasts for OECD Americas are more positive with an average growth rate of 2.9%, most of which can be attributed to the United States. OECD Asia Oceania is projected to grow at 2.3% per year, with Korea showing the strongest performance.

[14] Further detail on this can be found in section "Chinese Slow-Down Case".

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Asian economies are projected to maintain strong growth rates. China's economy is projected to grow on average by 8.6% per year between 2012 and 2017. Meanwhile, India's economy is expected to grow by 7.6% and Indonesia by 6.7% per year over the same period. Growth in other Asian economies is projected at 5%, whereas non-OECD Europe is projected to grow by 4% on average. Latin America will grow by 4.1% per year until 2017.

In this outlook, the evolution of fuel price serves as an input parameter for the models. These figures are typically derived from forward price curves (with adjustments) and are explicitly not to be interpreted as official IEA forecasts. The price paths for oil, gas and coal are consistent with IEA (2012b) and IEA (2012d). Nominal oil prices averaged USD 108/barrel (bbl) in 2011, and are assumed to average USD 112/bbl in 2012 before declining to USD 90/bbl in 2017. Natural gas is the key competitor of coal in the OECD power sector, especially in the United States and Europe. Future gas prices continue to reflect current market characteristics with a strong regional divergence between European, Asian and US gas prices. There continues to be a disconnection between the US gas market and other regions. Henry Hub (HH) nominal prices are assumed to stay relatively low with HH prices increasing from USD 4/Mbtu in 2011 to USD 4.7/Mbtu in 2017. Asian gas prices are assumed to be driven by oil prices and are comparatively high with an average of USD 13.2/Mbtu over the outlook period. European gas prices are assumed to fall between these two extremes. National Balancing Point (NBP) prices are assumed to remain at a large premium over HH prices at an average of USD 10.5/Mbtu in the medium term.

Regional coal prices[15] in this outlook are based on forward curves subject to individual adjustments *e.g.* with regard to transport and handling costs. Coal prices delivered to power stations in the United States differ by region: Western US coal prices are assumed to remain comparatively low and stable over the outlook period. Coal prices in this region have little connection to the dynamics of the international market. Eastern US coal prices are substantially higher and influenced by international prices. Coal import prices in Northwest and Mediterranean Europe are projected to decline slightly over the medium term when compared to 2011 prices. Chinese domestic coal prices are assumed to increase in line with international prices. Meanwhile, Indian coal prices rise strongly in the medium term due to increasing imports and a stronger price connection to international markets.

Projection of global coal demand in the BCS

In the BCS, global coal demand grows from 5 279 Mtce in 2011 to 6 169 Mtce in 2017 (16.9%), or 2.6% per year. Global coal demand growth is clearly driven by non-OECD economies over the outlook period with an annual aggregate growth rate of 3.9%. China leads the growth in this country group in absolute terms with additional coal use of 628 Mtce. In relative terms, the majority of growth comes from India (6.3% per year) followed by other non-OECD Asia (6.1% per year) and non-OECD Latin America (5.1% per year).

Coal use among OECD countries is projected to shrink by 0.8% per year in the medium term, with very different trends exhibited within each country. The United States, the OECD's largest coal user, is impacted most heavily by fierce competition from low-cost natural gas in the power generation sector (see "Regional focus: United States"). Coal use in OECD Europe grows in the first half of the outlook period and drops in the second half, falling slightly over the levels in 2017 as in 2011. OECD Asia Oceania is projected to have average growth of 0.7% per year over the medium term with Korea leading the growth both in relative and absolute terms.

[15] For the sake of simplicity, currency exchange rates are assumed to remain constant.

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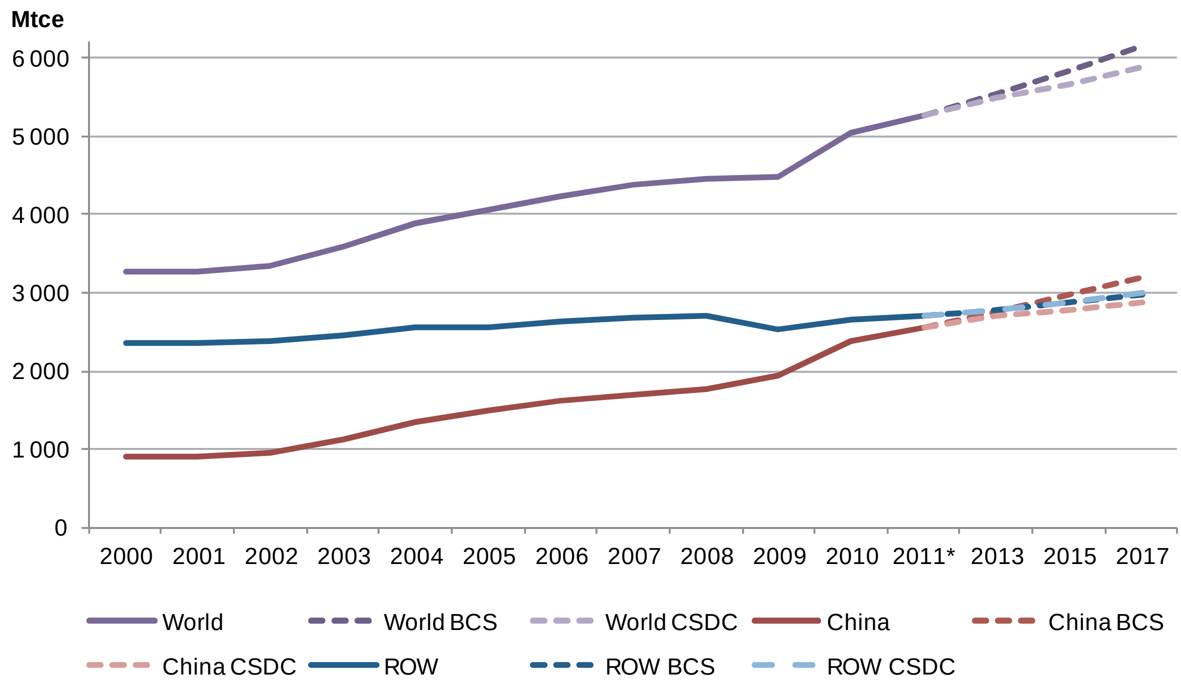
Figure 31 Global and Chinese coal demand in the BCS and the CSDC



* Estimate.

Table 14 Projection of global (hard and brown) coal demand until 2017, BCS, in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	1 545	1 525	1 496	1 473	1 457	-0.8%
OECD Americas	768	745	683	663	653	-2.2%
United States	718	697	636	612	600	-2.5%
OECD Europe	423	426	450	445	436	0.4%
OECD Asia Oceania	354	353	363	364	368	0.7%
Non-OECD	3 507	3 754	4 042	4 359	4 712	3.9%
China	2 387	2 562	2 757	2 965	3 190	3.7%
India	410	446	501	566	643	6.3%
Africa and Middle East	157	152	158	166	176	2.5%
Eastern Europe/Eurasia	312	336	336	336	337	0.1%
Other developing Asia	212	225	252	284	320	6.1%
Latin America	29	34	37	42	46	5.1%
Total	**5 053**	**5 279**	**5 538**	**5 832**	**6 169**	**2.6%**

* Estimate.

OECD coal demand projection 2012-17

OECD non-power sector coal demand

Non-power sector coal use among OECD economies accounts for only 22% of total coal use. The majority of non-power coal use is in the iron and steel industry, followed by heat production for district heating and industrial processes. In line with sluggish GDP growth, non-power sector coal use in OECD economies is projected to decrease slightly from 333 Mtce in 2011 to 324 Mtce 2017 (0.5% per year). The decline can be attributed to reduced coal use in OECD Americas, or more specifically in the United States. Industrial coal use in the United States is projected to decrease by 3.7% per year, due mainly to efficiency gains in industrial production processes, competition from natural gas and lower steel output.

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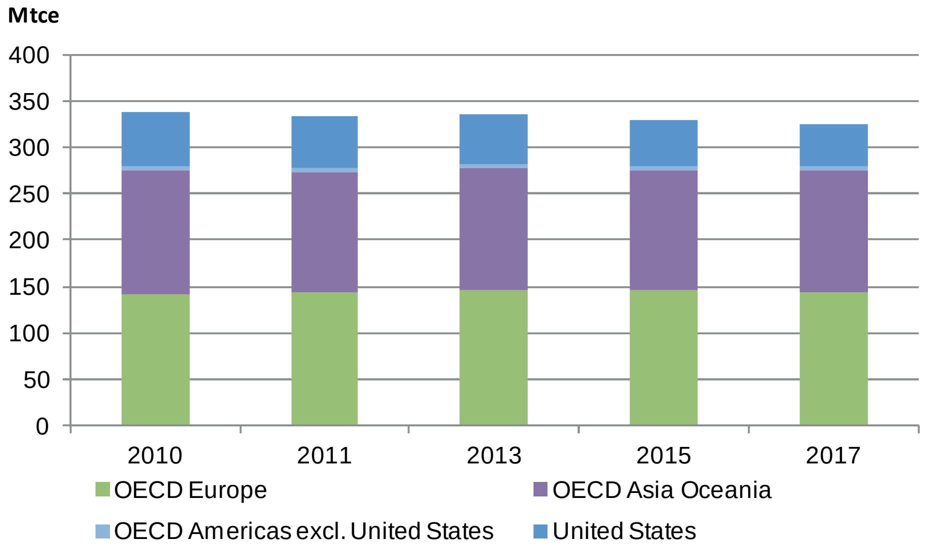
Non-power sector coal use in OECD Europe is projected to stagnate over the medium term. Small reductions in industrial coal use in countries such as Germany, Poland and the United Kingdom are offset by additional coal use in Turkey, which is a major cement producer and assumed to have high GDP growth rates.

Figure 32 Projection of coal demand in non-power sectors for OECD economies



Non-power sector coal use in OECD Asia Oceania is projected to grow at a sluggish 0.4% per year. Growth is led by South Korea, which has a large steel industry, and Japan, which is assumed to resume growth in industrial output in the medium term.

OECD power sector coal demand

Coal is the primary source of power generation among OECD countries. Although gas and renewables have gained market share, coal is still the main source of fuel for power generation within the OECD. In 2010, approximately 35% of electricity generated and consumed in the OECD is coal-based, followed by natural gas (23%) and nuclear (21%). Coal has the largest share in power generation among many countries in 2010, including: Poland (88%), Australia (76%), Czech Republic (58%), Israel (58%), the United States (46%), Germany (44%), Denmark (44%) and Korea (44%). Although coal use in power generation is projected to drop by 0.8% per year, it remains the backbone of the OECD power system throughout the outlook period.

Power sector coal use stagnates in OECD Europe, whereas power sector coal use is projected to increase in OECD Asia Oceania by 1.3% per year until 2017. In some European countries (*e.g.* Germany), coal loses market share to renewables, while in others (*e.g.* Turkey) coal use in power generation increases sharply. Public opposition to coal use is expected to grow in many European countries (*e.g.* Germany and the Netherlands). Coal faces additional resistance from a legislative perspective with the European Union's Large Combustion Plant Directive (LCPD) affecting older coal-fired units, especially in the United Kingdom. Similarly, the Netherlands has reduced competitiveness of domestic coal-fired generation in a widely interconnected Northwest European electricity system. The currently very low prices of CO_2 emission certificates in the EU-ETS benefit coal-fired generation

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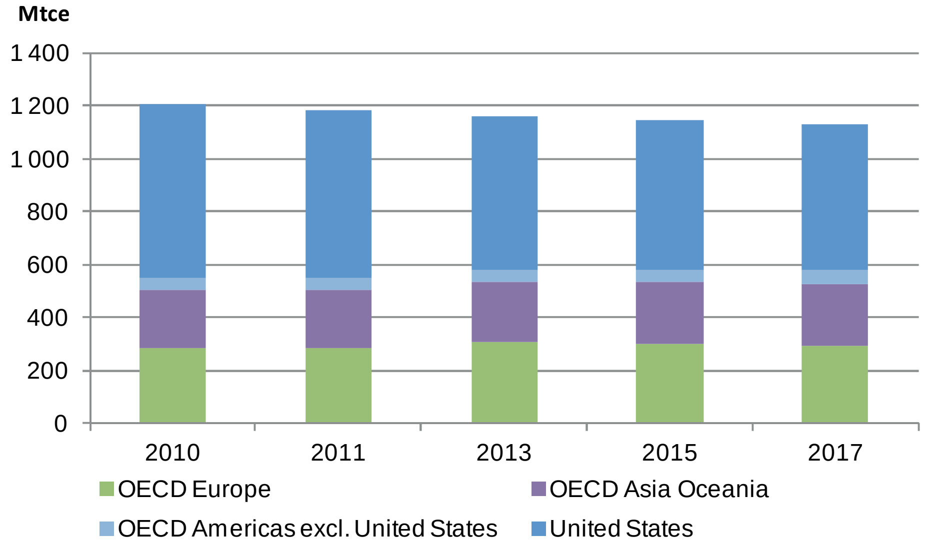
but are not likely to persist over the outlook period. The price for emission allowances in the EU-ETS is projected to increase in accordance with current trends in the futures market, yet there remains a high uncertainty regarding the future development of CO_2 prices. If CO_2 prices are perceived to be too low by some governments, some measures might be developed to support prices. The United Kingdom has already introduced a price floor for CO_2 emission certificates.

Figure 33 Projection of coal demand in the power sector for OECD economies



The power sector in OECD Americas is most distinctly affected by a changing market environment. In the United States, low natural gas prices push out coal-fired power generation over the outlook period, resulting in a drop in coal use in the power sector to 555 Mtce in 2017 down from 640 Mtce in 2011 (-2.4% per year). Coal burn for power generation increases slightly in the rest of OECD Americas over the outlook period.

Regional focus: United States

The shale gas revolution which started around 2006 led to an oversupply of natural gas in the US market. This oversupply put downward pressure on gas prices resulting in HH prices dipping even below the USD 2/MBtu line in April 2012. In the last two years, natural gas prices collapsed by two-thirds from around USD 6/MBtu in early-2010 to around USD 2/MBtu in early-2012. In the same period prices for internationally traded steam coal increased. This development has affected domestic coal prices in the United States as well, but mainly in the regions that are connected to the international market, *i.e.* the Appalachian mining regions and Central Appalachia (CAPP), in particular. CAPP coal prices increased from around USD 55/tonne (t) in early 2010 to around USD 70/t in early-2012 but were above the USD 80/t line for most of 2011.

These price developments have caused a marked switch from coal to natural gas in power generation in the past two years. In addition, a mild winter in late-2011 and early-2012 reduced electricity and heat demand. In 2011, coal-based gross power generation was 1 874 terawatt-hours (TWh) in 2011, down from 1 994 TWh in 2010 (6%). Natural gas-based power generation increased to 1 047 TWh in 2011 from 1 018 TWh in 2010 (2.8%). Total power generation remained almost flat in 2011 compared

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to 2010. Although coal remains the backbone of the power system in the United States, with 43% of electricity generated from this fuel in 2011, gas increased its market share by almost six percentage points since 2005 to 24% in 2011.

US coal consumption is projected to further decrease over the outlook period from 697 Mtce in 2011 to 600 Mtce in 2017 (-14%). Most of this drop can be attributed to the power sector, with coal use expected to drop to 555 Mtce in 2017, down from 640 Mtce in 2011. This is mainly a result of sustained strong competition from natural gas in the power generation sector over the medium term. However, the age of the coal-fired fleet is a contributing factor; between 30 GW and 40 GW of coal-fired capacity are projected to retire over the medium term and only a few additions are scheduled to come online in the coming years (approximately 4 GW to 6.5 GW). In 2011, the US Environmental Protection Agency (EPA) proposed several regulations (*e.g.* Cross State Air Pollution Rule, the Ozone Rule, the Coal Combustion Residuals Rule or Maximum Achievable Control Technology rule) that would have an impact on the economics of coal-based power generation. The uncertainty about these regulations contributes to the fact that coal-fired power generation plant investment in the United States is currently unattractive. In addition, powerful public opposition against coal is growing in the United States. Decreasing coal consumption will put further pressure on the US coal industry. In 2012, several producers have announced production cuts or mine closures. Estimates for production cuts during 2012 are around 60 million tonnes (Mt). Given sustained weak coal demand over the outlook period, parts of the coal industry in the United States will have to be restructured and consolidated in the coming years.

Some collieries will keep individual sections idle or reduce shifts, whereas others might be willing to produce costly steam coal if higher value metallurgical coal offset production losses on steam coal. Similarly, some mines run on long-term contracts with higher prices than the spot market and could sell additional coal below cost if the mine operation requires it.

Initial production cuts do not necessarily translate into massive mine closures, however, if domestic coal demand remains sluggish and international coal prices low, large shares of coal production in the United States will eventually become unprofitable. This drop in prices would predominantly affect regions with high-cost productions rates, such as Appalachia. Mining cash-costs are estimated to fall into a broad range of USD 60/t to USD 95/t, with the bulk of the production at the higher end of this bandwidth. Together with inland transport costs (rail) of USD 5/t to USD 15/t, production costs for Appalachian coal are USD 65/t to USD 110/t.

Assuming an efficiency rate of 36%, these supply costs translate into short-run power generation costs between USD 26/MWh and USD 42/MWh. This stands in comparison to gas-fired generation costs of USD 20/MWh, assuming an efficiency rate of 50% and gas price of USD 3/MBtu. Given this range of coal supply costs, gas prices would need to increase to nearly USD 6/MBtu to restore coal's market share in the power sector. Over the outlook period, natural gas exports from the United States might benefit coal's market share. Some liquefied natural gas export capacities are already under construction while many other projects have been considered, however, the effect these new capacities will have on natural gas prices remains unclear.

Coal exports can provide a relief-valve for some producers, but inland transport costs are usually higher from Appalachian mines to the export terminals. Rail transport costs to ports on the East coast are between USD 20/t and USD 35/t, with tariffs for metallurgical coal at the higher end of this range.

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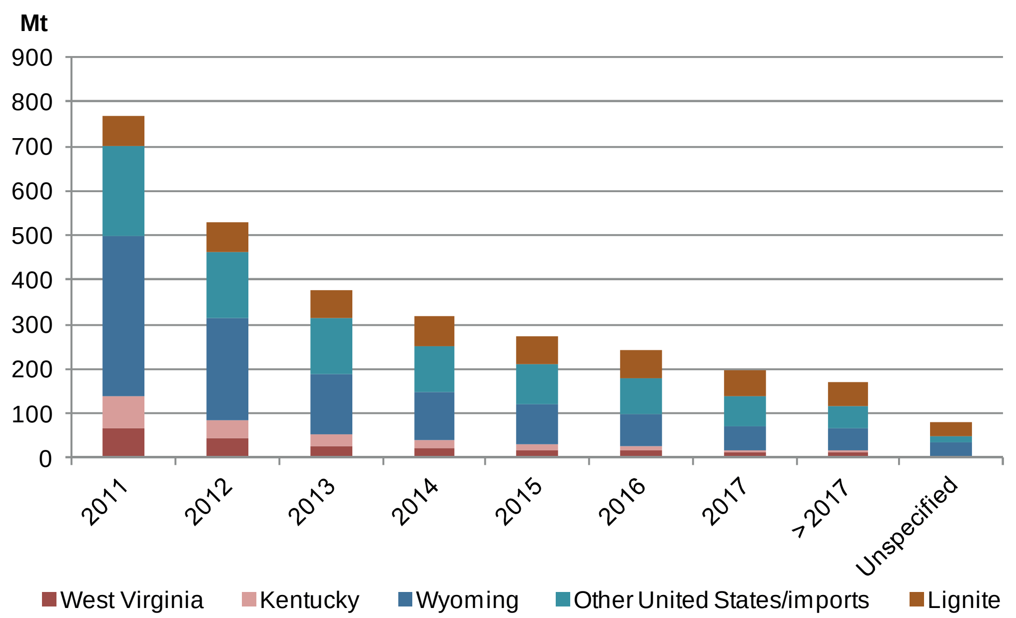
With port charges of USD 5/t, CAPP FOB vessel cash-costs can range between USD 85/t and USD 130/t. Assuming a sea freight rate of USD 15/t to Rotterdam, this coal would need a European price level of USD 100/t to USD 145/t to be able to cover costs. Higher-cost operations will likely not be able to receive adequate prices in the medium term, and hence potential US exports are considered extramarginal capacity for the Atlantic basin and, therefore, supply costs provide an upper limit for coal prices in Europe over the medium term.

In 2011, more than 90% of the coal used for power generation in the United States was sold through contracts, however, such contracts are not likely to stabilise production in regions that are affected by increased competition from natural gas. The reason is that utilities procure most of their coal via short-term contracts with lifetimes around or below one year. Contracts might protect some coal producers from brief drops in the price of natural gas, but in anticipation of a potentially dire situation for coal producers, particularly in the Appalachian basin, many utilities will choose to buy a larger proportion on a spot basis in the coming years. Coal stocks at power plants indicate a reduced need for power stations to secure coal procurements via contracts. Figure 34 highlights that currently only a small proportion of US coal supply (less than 20%) is locked in long-term contracts (five years or more). Moreover, the majority of this is lignite and Powder River basin coal, both of which are hardly affected by the pressure of gas prices.

Mining operations are often tiny in Appalachia, preventing them from gaining economies of scale. The average annual production per mine stood at 0.24 Mt in CAPP, 0.35 Mt in Northern Appalachia (NAPP) and 0.36 Mt in Southern Appalachia (SAPP). This compares to an average annual output per colliery of 1.3 Mt in the Illinois basin, 2.5 Mt in the Uinta basin and a massive 26.6 Mt in the Powder River basin. In comparison, an average mine in Queensland/Australia produced 3.7 Mt of (saleable) coal in 2010.

Figure 34 Contracted quantity, lifetime and origin of coal supply contracts to power plants in the United States as of 2011



Note: only domestic supply contracts depicted.

Source: EIA, 2012.

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Box 6 Biomass co-firing in coal-fired plants

The process

Biomass co-firing involves utilising biomass and coal in the same plant. In most plants, this involves direct firing of the two fuels in the same boiler. In some cases, in a process known as indirect co-firing, biomass is gasified and the product gas is then fired in the coal boiler. Solid biomass is a suitable feedstock for co-firing in coal-fired power generation plants, as the equipment used for coal can be adapted to utilise biomass. However, differences in fuel properties result in technical issues. Co-firing is one of the least costly ways for a coal-fired plant to achieve modest levels of CO_2 reductions. For biomass, co-firing in a larger coal plant that contains superheaters, reheaters and economisers increases the efficiency of biomass energy conversion.

History

Co-firing biomass and coal at power generation plants in Scandinavia has existed for many decades, but interest in co-firing has increased considerably in the 1990s through concern about global warming. In the United States, over 40 commercial co-firing demonstrations have taken place, mainly from the mid-1990s to the early-2000s. In the Netherlands, the decision was taken in 2002 to substantially co-fire biomass in all domestic plants. Denmark, meanwhile, has co-fired increasing quantities of biomass since the mid-1990s; 15 co-firing trials have taken place since 2000 in the United Kingdom. Australia has also co-fired biomass at several of its coal plants. More than 150 coal-fired power generation plants worldwide have had some experience with co-firing, but mainly at co-firing ratios of less than 5% on a thermal basis. Increasing co-firing ratios on an extended basis is a recent focus in Denmark, the Netherlands and the United Kingdom (for example, Tilbury power station in the United Kingdom has been converted to 100% and is operational).

Main issues

Several issues arise when co-firing biomass in coal-fired power generation plants, particularly in relation to the fuel properties of biomass.

- Fuel availability and sustainability: several types of biomass can be co-fired, such as wood-based fuels, agricultural wastes and energy crops, yet ongoing controversies surrounding availability and sustainability issues remain.
- Fuel delivery, storage and preparation: in relation to lower bulk density, lower heating vales and higher biological activity biomass.
- Milling and burners: several options exist, such as pre-mixing fuels and co-milling, milling separately or having separate biomass burners, depending on the co-firing ratio.
- Slagging, fouling, corrosion and ash disposal: these issues arise because of the different composition of biomass ash.

The future

Operational issues for coal-fired plants are relatively modest for low co-firing ratios of biomass. Storage and milling are of particular importance when co-firing at high ratios, while slagging and fouling are important when co-firing at high ratios over extended periods. Issues of availability and sustainability will need to be addressed if co-firing or total conversion to fire biomass is adopted on a large scale.

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The average annual output of an underground mine in CAPP is below 4 kilotonnes (kt) per employee, which compares to the industry average in South Africa. The bulk of production in NAPP has productivity rates ranging between 7 kt and 8 kt per employee per year, which is comparable to average underground mining productivity in Queensland.

Using this data, closing 60 million tonnes per annum of mining capacity in Appalachia might put 9 000 to 15 000 direct mining jobs at stake (assuming a productivity of 4 kt to 6.5 kt per employee). This range is presumably rather optimistic, as operations with productivity levels below the industry average are likely to be closed first. The majority of this consolidation will have to take place in CAPP, specifically in West Virginia and Kentucky. These two states rank among the ten poorest in the United States in terms of GDP per capita. In addition to these layoffs, the American Coalition for Clean Coal Electricity (ACCCE) estimates that between 4 000 and 5 000 direct jobs (12 700 to 16 600 including indirect and induced jobs) will be lost with the announced retirement of 205 coal-fired power plants (approximately 31 GW).

Shale gas has helped to create a significant amount of employment. Lower gas prices in the United States have resulted in additional jobs in the industrial sector, particularly petrochemicals and fertilizers. However, workforce mobility determines the severity of the social impact caused by industry consolidation. For example, similar restructuring measures in Germany and Spain have taken decades, and large amounts of subsidy payments, to organise.

Non-OECD economies coal demand projection 2012-17

Non-OECD non-power sectors coal demand

Non-power coal demand (including primary energy for heat) in non-OECD economies is projected to grow at 3% per year to reach 2 151 Mtce in 2017, from 1 806 Mtce in 2011. The majority of this growth comes from China, where non-power coal use grows from 1 307 Mtce in 2011 to 1 540 Mtce in 2017 (2.8%). China traditionally has a very high share of non-power coal use of around 51%. Aside from typical industrial coal use in coke production, iron and steel making, and cement production, coal is used for a wide range of other industries and residential coal burn in China. Non-power sector coal grew at substantially higher rates, often exceeding 8% per year, over the past five years compared to the projected average annual growth rate of 2.8% over the medium term. In the past decade, China has expanded its road network (both rural and expressways), its railway system and its ports as well as its air passenger handling capacity at phenomenal speed. This infrastructure construction programme was paralleled by sprawling urbanisation and a housing construction boom that resulted in surging demand for steel, cement and other building materials. Although the general trend is projected to continue in the medium term, the pace of construction is expected to slow-down later this decade.

In relative terms, India leads the growth in non-power coal demand among non-OECD countries; non-power coal use grow by 8.5% annually and reaches 218 Mtce by the end of the outlook period. India is the fifth-largest steel producer in world and the second-largest cement producer behind China. Booming economic activity drives India’s industrial coal consumption in heavy industries. Although the Indian steel industry is comparably inefficient, significant energy savings in steel making are not likely to occur in the medium term. The cement industry also has limited potential to increase energy efficiency due to low clinker-cement ratios and the increasing use of dry-process kilns with pre-heaters.

Non-power coal demand in Other Asia is projected to increase by 5% per year to reach 133 Mtce in 2017, from 99 Mtce in 2011. Indonesia’s economy contributes to a large part of this growth, which is

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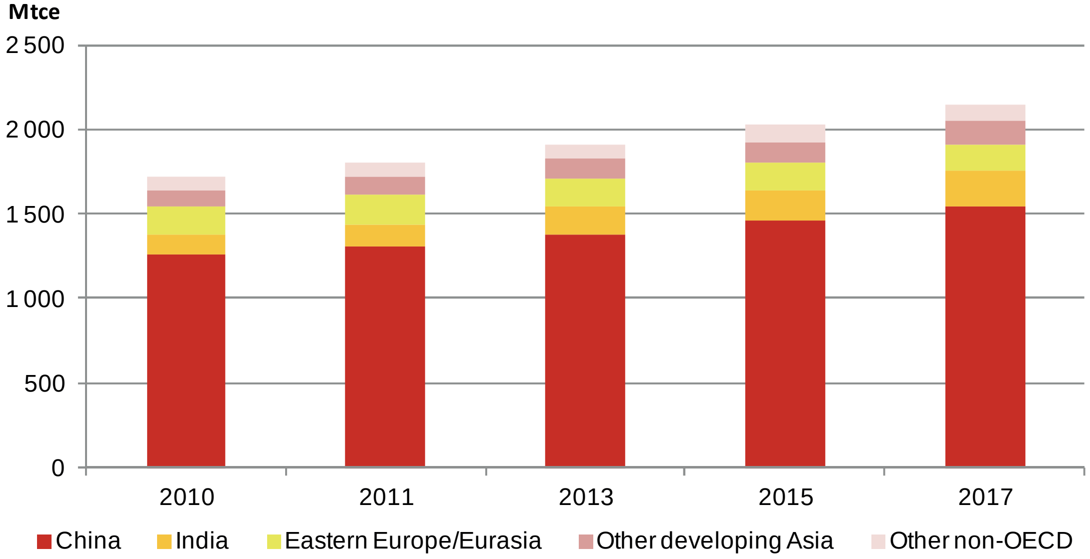
projected to grow on average by 6.8% per year in the medium term. Although several Asian countries have a growing steel industry, the largest additions to steel-making capacity are expected to take place in Indonesia and Vietnam throughout the outlook period.

Figure 35 Projection of coal demand in non-power sectors in non-OECD economies



Growth in non-power sector coal use in Eastern Europe and Eurasia is projected to decline by 2.1% per year in the medium term despite a healthy GDP growth forecast of almost 4% per year. Coal demand is driven by relatively mature economies, such as Russia and Ukraine. Growth from sectors such as heavy industry, large-scale infrastructure development and construction is likely to be low among these countries. Moreover, industrial production is still comparably inefficient in this country group and the implementation of energy-saving processes is expected to reduce industrial coal demand.

Non-OECD power sector coal demand

Coal demand for power generation is projected to increase on average by 4.7% per year from 1 949 Mtce in 2011 to 2 561 Mtce in 2017. China leads this growth in absolute terms and the country's power plants are projected to burn an additional 395 Mtce of coal in the medium term, in addition to the 1 255 Mtce burned in 2011. This corresponds to an average annual growth rate of 4.7%. Although Chinese generators are currently pushing construction of all sorts of power plants in line with the targets outlined in the 12th Five-Year Plan (FYP) (*e.g.* 24 nuclear reactors currently under construction), coal will remain the backbone of the Chinese power system throughout the outlook period. The National Development and Reform Commission released its 12th FYP for the coal industry in March 2012. This plan explicitly addresses concerns about environmental impacts from coal use and plans on limiting coal production by 2015 to 3 900 Mt. Although some potential to reduce industrial coal use exists, growing electricity demand renders coal savings in the power sector rather unlikely and makes the target difficult to achieve.

Indian power sector coal demand is currently 313 Mtce and is projected to increase on average by 5.3% per year to reach 426 Mtce in 2017. Coal is the backbone of the Indian power system and the

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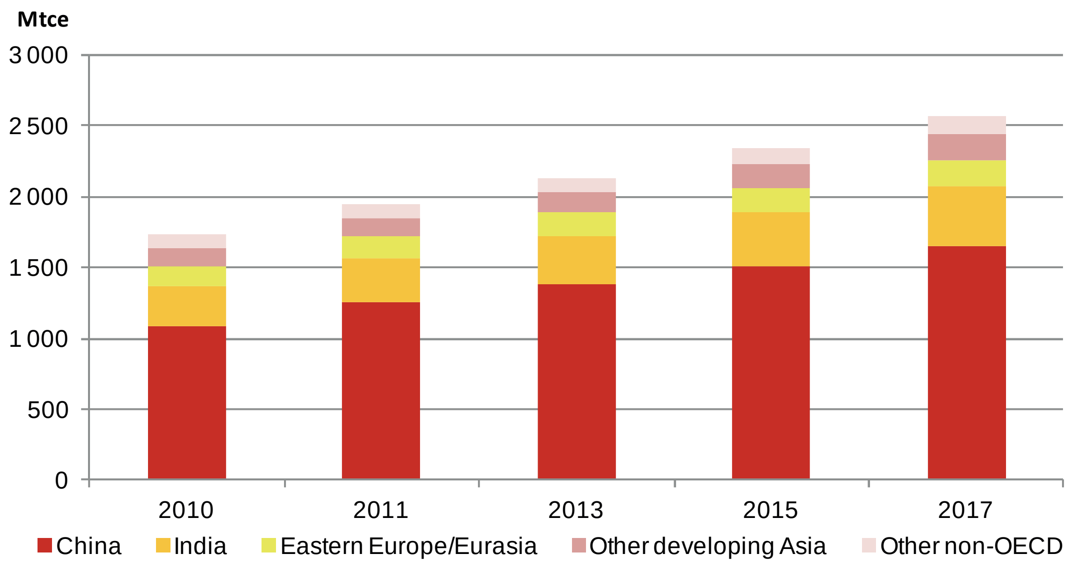
key driver of coal demand growth with 69% of electricity generated from coal-fired power generation plants. Although Indian planning authorities clearly support the diversification of generation capacities, the focus of new power plants is still predominantly on coal (63 GW of coal-fired power plants are targeted by 2017). During the 11th FYP (2007-11), the construction of 78.7 GW of total generation capacity was targeted, yet fell short by 36%. The reasons for this shortfall were poor project implementation, inadequate domestic manufacturing capacity, shortage of power equipment, and slow-down due to a lack for fuel supply, especially coal. Some of these problems persist and even though Coal India Limited (CIL) has agreed to enter Fuel Supply Agreements that guarantee 80% of the load factor of coal-fired power plants (especially those to be commissioned before 2015), it is unclear if these agreements reduce coal supply uncertainty sufficiently. Substantial project slippage or delays are therefore likely for those plants currently in the planning stage. Moreover, the capacity additions will, to some degree, substitute old units that are gradually being decommissioned over the medium term. Nevertheless, the power generation sector is expected to be the key driver, in absolute terms, for Indian coal demand in the projection period.

Figure 36 Projection of coal demand in the power sector among non-OECD economies



Power sector coal demand in Eastern Europe and Eurasia will increase modestly by 2.3% per year, reaching 179 Mtce by the end of the outlook period. There is abundant supply of natural gas in Russia and the Caspian regions, and natural gas is often the fuel of choice for electricity generation in these countries. Several countries in this region are landlocked or otherwise badly connected to the international coal market. As such, coal supply is largely domestic or delivered via overland imports, and often involves large transport distances. As a result, long-haul coal supply hardly competes against gas in this region.

Other non-OECD Asian countries experience the highest rate of growth in coal use for power generation at 6.9% on average throughout the outlook period. Increased coal burn in the power sector prevails in all countries, but particularly for Indonesia, Vietnam, Chinese Taipei and Malaysia. Among other non-OECD countries in Africa, Latin America and the Middle East, South Africa is the

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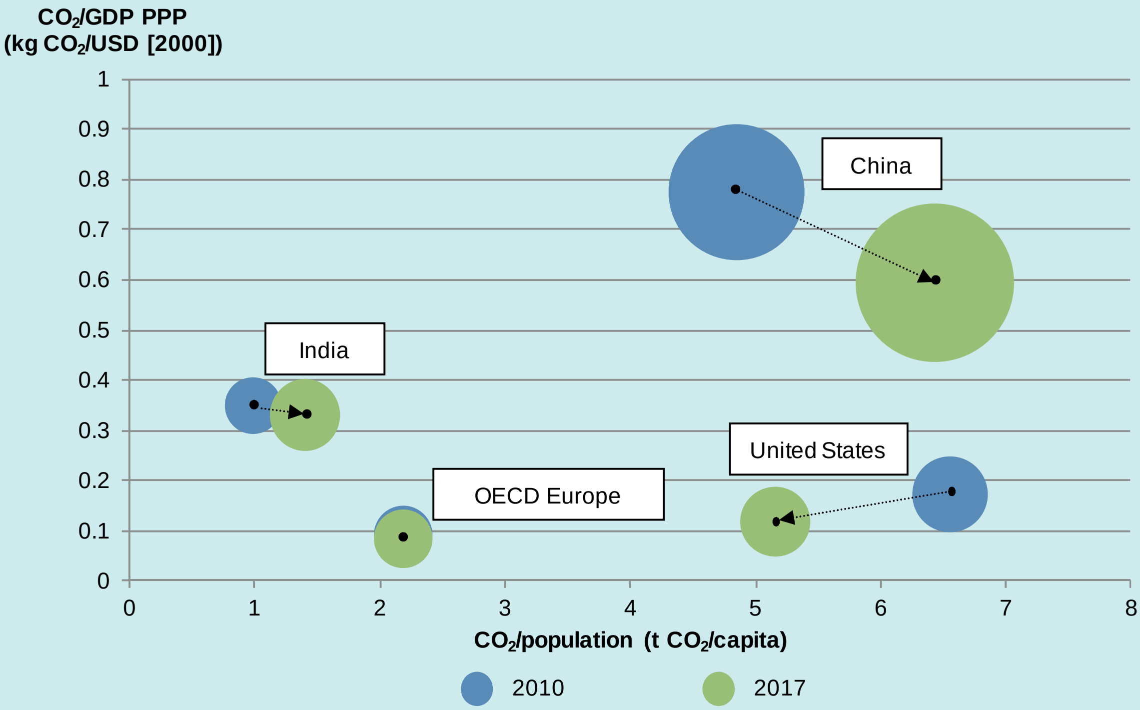
largest coal user, with 93% of its electricity generated from coal-fired power generation plants. South Africa has surging electricity demand and large domestic coal reserves. Eskom is currently building two of the world's largest coal-fired power plants (in Medupi and Kusile, South Africa) with a combined capacity of 9.6 GW, a large part of which will be online by the end of the outlook period. In the medium term, neither the proposed carbon tax nor an increase in the deployment of renewables is expected to have a significant effect on coal burn in South Africa.

Box 7 An outlook on the development of coal-based carbon emissions in select countries

Given that game-changers (*i.e.* CCS) are not expected in the outlook period, this report underlines increasing coal-related emission levels until 2017. This growth is largely in line with the underlying growth levels of sectoral coal use, which also leads to a continuous shift of emission shares from OECD countries to non-OECD countries.

While declining coal use among OECD countries reduces coal-related CO_2 emissions by roughly 250 million tonnes of CO_2 to 4.06 gigatonnes of CO_2 ($GtCO_2$), coal-related emission levels among non-OECD countries will increase by almost 3.5 $GtCO_2$. By 2017, coal-related emission shares between OECD and non-OECD countries will be at 25% to 75%. Economic development in China and India covers 85% of these rising emission levels among non-OECD countries. At the same time, global sectoral shares of coal-related emission levels will remain almost unchanged, with the power sector contributing to roughly 60%.

Figure 37 Trends in coal-based CO_2 emission intensities for the top four emitting countries/regions



Note: size of circle represents total CO_2 emissions from the country/region in that year.

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Box 7 An outlook on the development of coal-based carbon emissions in select countries (continued)

Socio-economic CO_2 emission indicators are one way to determine CO_2 emissions performance. These indicators can also provide the countries' relative capacity to further reduce emissions. It has to be noted that no single indicator can provide for a complete country-specific picture and therefore a reduced number of indicators can only show an incomplete picture. However, per-capita and per-GDP CO_2 emission intensities remain two of the key indicators to measure for a relative comparison.

In 2009, the United States, OECD Europe, India and China made up more than three-quarters of global energy-related coal-based CO_2 emissions, while they produced 61% of global income with half of the planets' population. Together, these countries provide a diverse picture. The United States will improve in terms of per-capita emission levels and more slightly in terms of per-GDP emissions, while coal-based emission levels will decrease due to lower use of coal. Additionally, this shows the United States' switch away from carbon-intensive sources and increasing energy efficiency.

In comparison, China and the United States will have almost switched their current positions on a per-capita emissions base by 2017. At the same time, China increases emissions efficiency on a GDP level more than the United States. While neither OECD Europe as a region nor India are making comparably big steps in any direction, India and China exhibit the same general trend.

Note: coal-based emissions are only a fraction of the total country emissions (29% for OECD Europe, 36% for the United States, 67% for India and 84% for China in 2009).

The CSDC

Assessing future economic growth of a country is a challenging task involving a considerable amount of uncertainty. Against the background that China is by far the single most important country for the development of the global coal market and that its future economic growth has a marked influence on global coal trade, we derived a sensitivity case – the CSDC – in which Chinese economic growth is more bearish than in the BCS. Yet the IEA would like to stress the point that the CSDC is neither a forecast nor a different (macroeconomic) scenario, but rather a sensitivity case on coal consumption, demand and trade, in which the pronounced Chinese reliance on fixed-assets investment as a driver of economic growth is rebalanced, which results in a lower economic growth in China than in the BCS.

The possibility of a slow-down of the Chinese economy

Since the beginning of economic reforms in the late-1970s, China has consistently maintained a very high GDP growth rate that has proven remarkably immune to global macroeconomic disturbances, such as the Asian financial crisis of 1997 or the global economic crisis of 2008-09. The BCS outlined in this report is developed in line with the IMF forecast from April 2012, which projects continuous growth of the Chinese economy at levels between 8.3% and 8.8% per year until 2017. Yet, imbalances in the Chinese economy and a possible strain on the Chinese banking system give cause for concern. Given China's interconnectedness with the global economy, spillover from negative global events such as the Eurozone crisis or persistent high oil prices are also feasible. Consequently, a slow-down in the Chinese economy, referred to as the CSDC, with a marked slow-down in GDP growth and investment activity cannot be ruled out. This report does not argue that the CSDC is inevitable, but China's significance in global coal use merits a consideration of the impacts of a possible macroeconomic slow-down. In accordance with IEA scenario work, the Agency does not attach explicit probability to the CSDC, only analyse the coal market implications should that happen.

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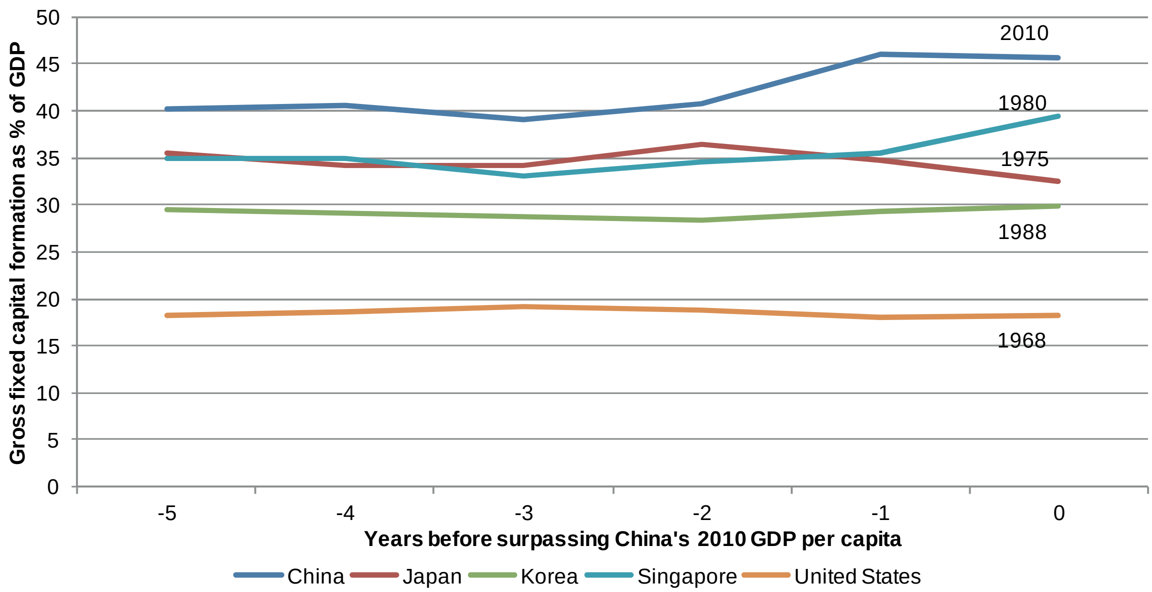
It is important to emphasise that Chinese GDP growth has been not only strong, but capital- and energy-intensive. Chinese GDP growth, in comparison with other Asian countries and OECD countries in the West (particularly the United States), has relied to a much larger extent on investments (Figure 38). The majority of these investments are large, long-lifetime infrastructure projects. This is a natural consequence of the decades after 1980, before which China still lacked a modern capital stock in industry, infrastructure and buildings. Accumulating the capital stock of a modern industrial economy relies heavily on energy-intensive materials. China currently accounts for approximately 20% of the global population, slightly more than 10% of global GDP and more than half of global consumption – and production – of cement, aluminium and steel. Every country that has successfully built an industrialised economy has experienced a capital- and energy-intensive phase (*e.g.* the United States from 1890 to 1930, Japan from 1950 to 1970 and Korea from 1970 to 1990). Yet, China's past three decades are exceptional on two counts: from a size perspective, China has eight times the combined population of Japan and Korea. Secondly, for a country in such a capital-intensive phase, the share of fixed capital investment in GDP is abnormal. Several recent studies suggest that Chinese endowments, *e.g.* in infrastructure, as well as residential living space, are important drivers in Chinese gross fixed-capital formation, which is already at a relatively high level.

Figure 38 Comparison of the share of investments in GDP for select countries



Source: World Bank, 2012.

The National Bureau of Statistics of China, for example, reported that residential living space in China in 2010 stood at 31.6 square metres per capita (m^2/cap) in urban areas and even slightly higher in rural areas (34.1 m^2/cap). Since the Chinese population is roughly split between rural dwellers (49.7%) and urban dwellers, every Chinese citizen has an average of almost 33 m^2, which is in the same order of magnitude as the United Kingdom or Japan, despite having a GDP/cap in 2010 at 12.3% of the GDP/cap of the United Kingdom and 10.3% of the GDP/cap of Japan. Taking into account reports about a significant number of empty apartments, this suggests that the construction sector may see a correction in the upcoming years. Hence, there is a chance of slowing fixed-asset investments in China, which in turn may directly lead to slower coal demand growth, an effect eventually reinforced by slower GDP growth.

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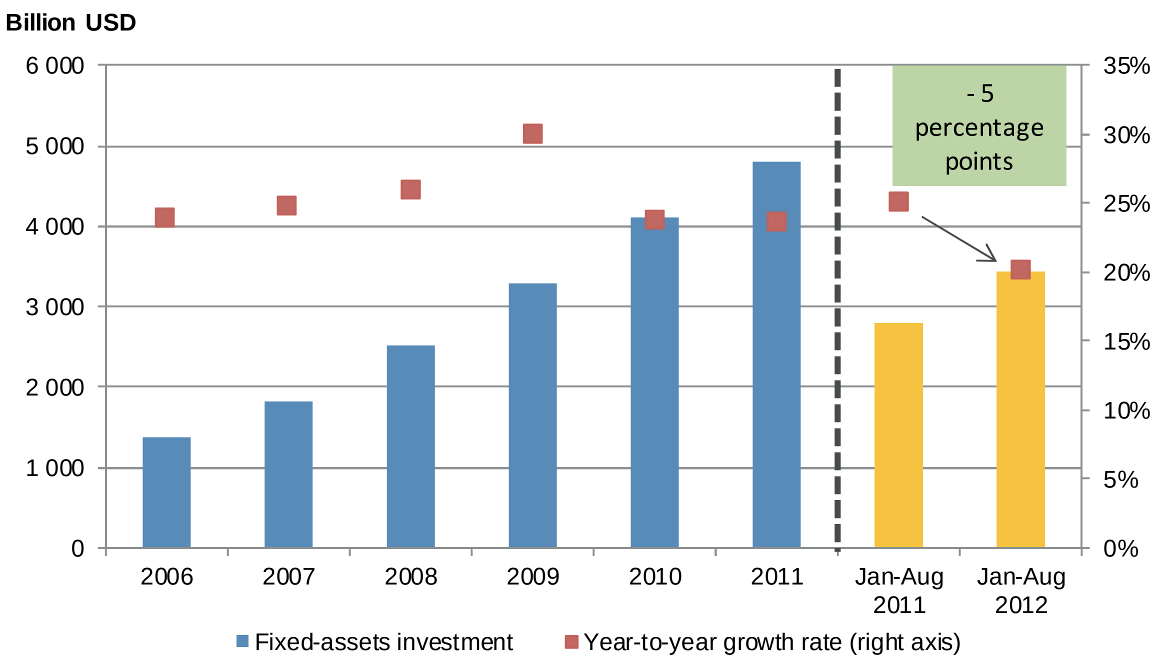
Data published by the National Bureau of Statistics of China in September 2012 suggest that this slow-down in investment may have already started (Figure 39). Fixed-assets investment in China is reported to have grown on average by an impressive 28.3% in the time period from 2006 to 2011, with year-to-year growth rates varying between 23.6% (2011) and 30% (2009). While the past two annual growth rates fell short of the average growth rate over the last five years, data for the first eight months of 2012 suggest that Chinese fixed-assets investment will continue to grow this year, albeit at a lower rate than in 2011 (5 percentage points lower when compared to the first eight months in 2011).

Figure 39 Development of Chinese fixed-assets investment, 2006-12



Source: National Bureau of Statistics of China, 2012.

In line with the development of China's fixed-assets investments, electricity generation has grown at tremendous rates, with the exception of 2008-09 when the global economic crisis stalled growth in electricity consumption. Since 2006, electricity generation in China increased by more than 1 800 TWh from 2 908 TWh in 2006 to 4 720 TWh in 2011, which is equivalent to an average annual growth of just over 10%. The structure of electricity consumption is skewed towards industrial consumption: household electricity consumption in China is still a fraction of the OECD average (roughly 0.5 MWh/person per year versus 2.5 MWh/person per year among OECD countries) due to the lower penetration of household appliances. Coal-based power generation accounted for 77% of all incremental power generation in China in this time period.

Taking a closer look at the first eight months in 2012 reveals that thermal electricity generation in China, most of which is coal-based, grew at a markedly slower speed compared to the same period in 2011 (Figure 40). While Chinese thermal power supply amounted to 2 528 TWh in January to August 2011 (18.5% year-to-year growth), electricity generation stood only at 2 590 TWh one year later, corresponding to an increase by 2.5%.

Given China's large-scale investments in both nuclear and renewable energy, growth of thermal power generation is lower than total electricity demand; nevertheless, there is little doubt about

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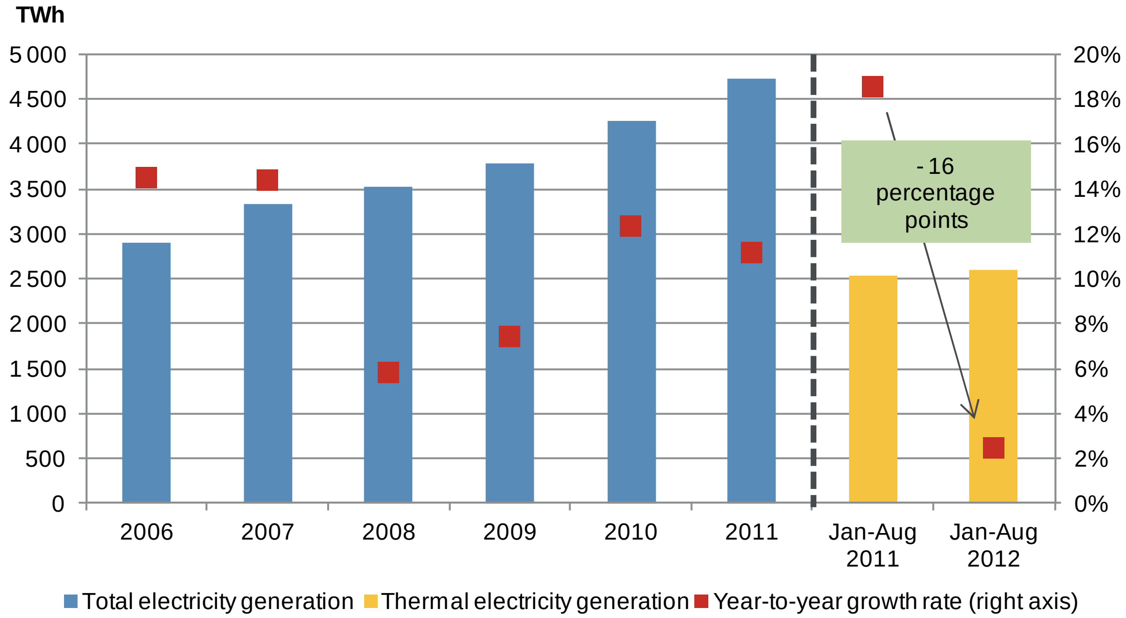
a market deceleration of total electricity demand, which is consistent with either a rebalancing of the economy or an investment-driven slow-down.

Figure 40 Development of Chinese electricity generation, 2006-12



Sources: Energy Publishing, 2012; IEA, 2012; IEA analysis.

As a considerable rebalancing of the Chinese economy takes place in the BCS, a decrease in infrastructure investment leads to less energy-intensive GDP growth and, consequently, lower coal demand. Even in the BCS, China's coal demand growth is projected to be considerably lower than the average of the past decade with similar GDP growth rates, indicating a less capital- and carbon-intensive development path. Given the importance of steel in infrastructure investment, coal demand in the Chinese iron and steel, and non-metallic minerals industry is expected to be more strongly affected than others. At the same time, lower growth in China's industrial output influences electricity consumption and, therefore, thermal coal demand. However, this decrease is alleviated through continued electrification and increasing electricity consumption per household due to growing per-capita GDP and a rebalancing of the Chinese economy.

A similar slow-down in electricity consumption is indicative of the CSDC, which could lead to a marked slow-down in coal demand and lower international coal prices. During the 2008 global economic crisis, China could have experienced a situation similar to the CSDC without the forceful policy stimulus plan launched by the government. This package was energy-intensive, focusing on infrastructure development, and likely overcompensated for the actual effect of the crisis on Chinese coal demand. In 2010, China accounted for almost half of total incremental global energy demand. Economic policy might adopt a similar reaction to a new slow-down, but the CSDC considers only the possible effects of a slow-down and not the second-round effects that come from government mitigation policies and actions.

In interpreting the results of a CSDC, it is important to note that we analyse the impact of a domestic investment slow-down and rebalancing rather than a financial crisis which would unavoidably have a powerful negative spillover to the rest of the world economy. Of course due to the size of the

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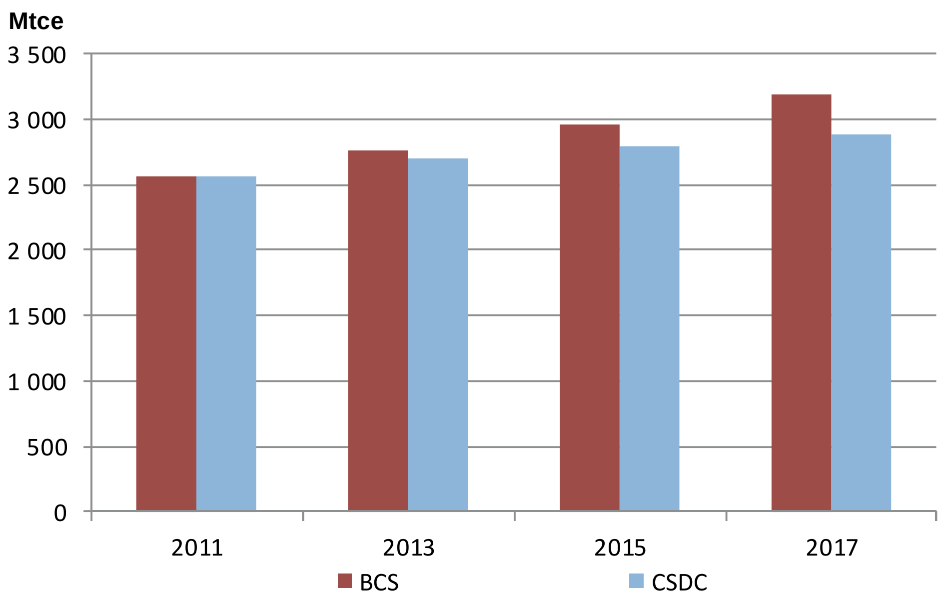
Chinese economy, even a "soft landing", a gradual slow-down is likely to have some growth impacts outside China. However, it is extremely difficult to project how such a new spillover would affect economic activity as well as the relative prices of energy commodities. Consequently we apply a partial equilibrium framework, and the Chinese slow-down will affect international coal trade only through China's import demand. This simplifying assumption is justified by the fact that a substantial part of global coal consumption is taking place in countries that either face electricity shortages (Japan, India, South Africa) or coal is a low marginal cost baseload generation (Russia, Australia) and in either case coal demand is relatively insensitive to macroeconomic spillovers. Europe and the United States have mature electricity systems where the relative price of coal and gas has a more powerful impact on coal use than the macroeconomic cyclicality of power generation.

Projection of Chinese coal demand in the CSDC

In the CSDC economic growth in China stands at an average of 4.6% per year from 2012 to 2017. Thereby, Chinese economic growth gradually declines from 6% in 2012 to below 3.5% in 2017. In accordance with CSDC being a sensitivity analysis, all other GDP growth rates remain unchanged. Lower economic growth in China would have a marked impact on Chinese coal demand in the outlook period.

Figure 41 Projection of Chinese coal demand in the BCS and the CSDC



In this sensitivity analysis, total coal use only grows on average by 2% per year to reach 2 881 Mtce in 2017. Total Chinese coal use is 309 Mtce lower in the CSDC in 2017 compared to the BCS. As household power consumption is still comparatively low in China and a large part of power demand comes from industry, reduced economic activity has a pronounced effect on power demand and consequently on coal burn in power stations. While hydro and nuclear comprise the majority of generating capacity, reduced electricity demand directly impacts coal-fired plant output. Consequently, in the CSDC, the growth rate of coal use in the power sector is 2.2 percentage points lower than in the BCS at 2.5% per year on average. In 2017, coal demand in the Chinese power sector is 192 Mtce lower in the CSDC compared to the BCS. This is an amount well in excess of current imports.

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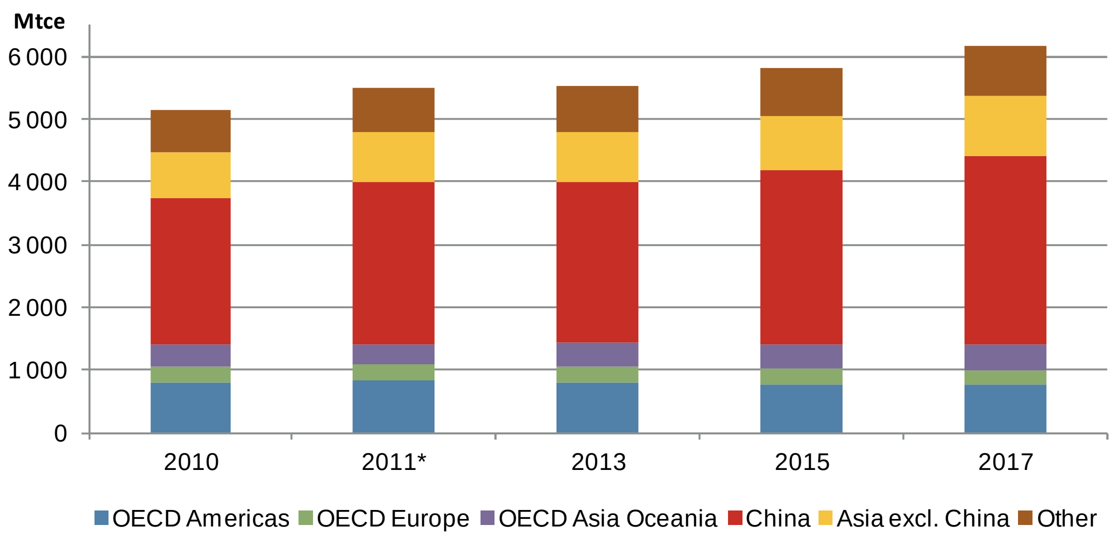
The decrease in international coal prices is a consequence of lower Chinese coal demand. However, coal demand in other countries increases and thus partially offsets the decrease in China. In total, worldwide coal demand is 286 Mtce lower in the CSDC. The substitution of domestic production in India by additional, cheaper imports is another significant effect.

Reduced economic activity also has a distinct effect on coal use in non-power sectors. Non-power coal use grows on average by 1.4% per year in the outlook period, which is 1.4 percentage points lower than the BCS. This decrease affects all sectors of industrial production especially older steel mills and cement plants, which run at below benchmark efficiency.

Global supply projections in the BCS 2012-17

Global supply increased in 2010 and 2011 due to the continued recovery from the global economic crisis and is projected to grow further, from 5 273 Mtce in 2011 to 6 169 Mtce in 2017. Worldwide incremental mining activity is estimated to amount to 1 168 Mtce by the end of the outlook period, which is equivalent to an increase of 2.6% per year.[16] Hence, the trend of disparate growth rates among regions will continue over the next five years. While coal production among OECD countries remains flat, growing at a mere 0.3% per year, incremental coal supply in non-OECD countries stands at 1 160 Mtce by 2017. This continued growth of non-OECD production (3.4% per year) leads to a further decrease in the share of global supply among the member countries (energy adjusted), from almost 27% in 2011 to 23% in 2017.

Figure 42 Global coal supply projection in the BCS



* Estimate.

OECD coal supply

Due to a projected strong increase in Australian hard coal exports in the coming two years, total OECD production increases by more than 30 Mt by 2013, from nearly 1 400 Mtce in 2011 to 1 431 Mtce in 2013.

[16] For the sake of clarity, all coal supply figures given in this section refer to the BCS only (see section "Medium-term projections of seaborne trade" for details). Although total demand and total supply is different in the two Scenarios, changes in supply, with the exception of China, are minor compared to overall supply volume. Data for the CSDC can be found in the section "Tables".

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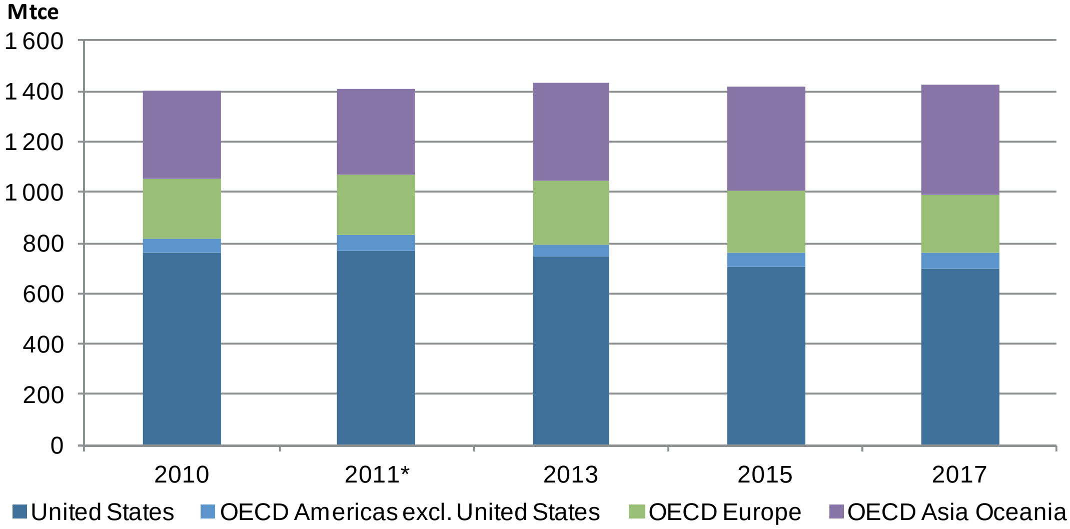
Figure 43 Coal supply projection for OECD member countries in the BCS



* Estimate.

After 2013, coal supply among OECD countries decreases by 10 Mtce until the end of the outlook period, with OECD countries in the Asia-Pacific region counterbalancing the sharp decline in US and European supply. While coal production in OECD Asia-Pacific grows on average by an impressive 4.4% per year in the outlook period, the United States shows the sharpest decline, with supply at 80 Mtce lower in 2017 than in 2011, which is equivalent to an average reduction of 1.8% per year. In December 2010, the European Commission approved a schedule to phase-out national coal subsidies within the next seven years.

Non-OECD coal supply

Non-OECD incremental coal supply is projected to stand at 1 160 Mtce in 2017, corresponding to an average annual growth rate of 3.4% over the course of the outlook period. Although China's share of 4 748 Mtce increases only marginally from 61.9% in 2011 to 62.9% in 2011, with 588 Mtce by 2017 it still accounts for the largest part in incremental supply (67.4%) by far. India, which strengthens its position as the world's third-largest coal producing country, manages to increase its indigenous coal supply by 91 Mtce, or 4.0% per year, by the end of the outlook period, thus reaching an output of 440 Mtce in 2017. Projected supply growth is slightly more optimistic compared to the last four years, which saw annual growth rates below 4%. However, compared to India's surging demand (197 Mtce or 6.3% year), production growth can still be classified as sluggish. CIL, which accounts for around 80% of Indian coal production, has struggled to raise its output due to ongoing environmental constraints (*e.g.* resettlement and rehabilitation issues), and insufficient transport capacity, impaired by issues of mismanagement.

Both, Africa and the Middle East, as well as Other Asia, are projected to increase their production at the same average annual growth rate, 3.4%, however starting from different production levels. Thus while the bulk of incremental production comes from Indonesia, production throughout Other Asia is estimated at 92 Mtce, while supply growth in Africa and Middle East is roughly half the size at 46 Mtce. Southern Africa, particularly South Africa and Mozambique, is mainly responsible for the increase in supply which is used to meet increasing domestic demand and to allow additional exports.

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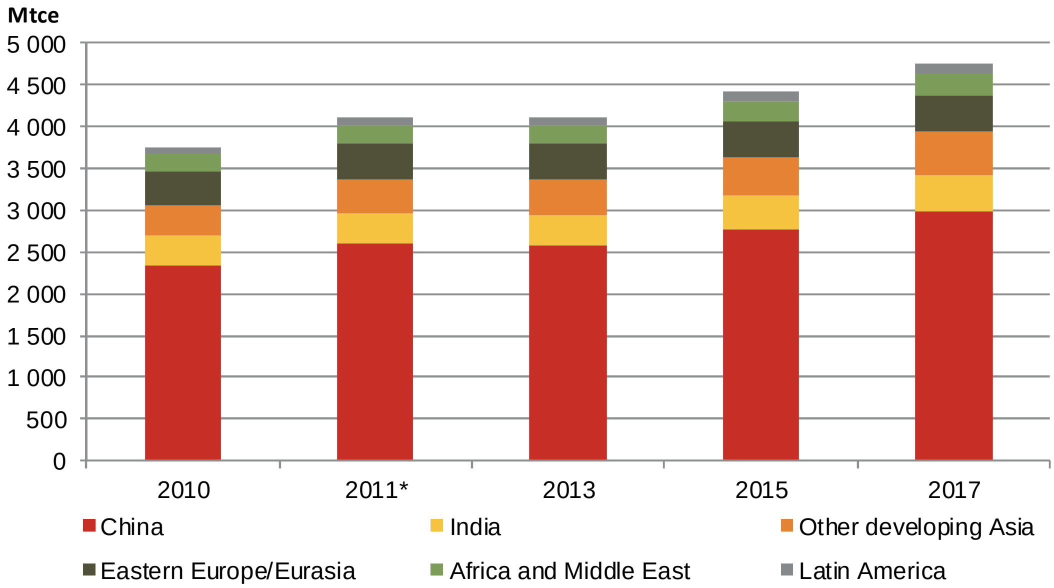
The largest increase in coal supply among the non-OECD economies, at least in relative terms, takes place in Latin America, with an average growth rate of 6.8% per year in the next five years. The growth can largely be attributed to Colombia's expansion of thermal export. Production in Eastern Europe and Eurasia is projected to remain modest. Incremental production of 0.6% per year, or more than 25 Mtce, is the result of a slight increase in domestic demand and (mostly landborne) exports.

Figure 44 Projection of coal supply for non-OECD economies in the BCS



* Estimate.

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MEDIUM-TERM PROJECTIONS OF SEABORNE COAL TRADE

Summary

- **Total seaborne coal trade grows on average by 3.2% per year in the Base Case Scenario (BCS), from 888 million tonnes of coal equivalent (Mtce) in 2011 to 1107 Mtce in 2017.** China continues to play a major role in total coal trade and accounts for approximately 16% of total seaborne imports in 2017. However, the country's share in 2012 is down from 2011 levels by 17.3%.

- **India becomes the largest seaborne thermal coal importing country by the end of the outlook period.** India's thermal coal imports are projected to grow by an impressive 14.7% every year in the BCS to reach 157 Mtce by 2017. Consequently, India is estimated to import 10 Mtce of thermal coal more than China (147 Mtce).

- **Large exporting countries such as Australia, Indonesia and Colombia supply the bulk of incremental seaborne trade volumes.** Australia accounts for the highest growth in both steam and metallurgical coal exports in absolute terms among all countries (93 Mtce or 5.2% per year for hard coal). Indonesia profits from the second-largest growth (54 Mtce or 3.3% per year) in seaborne steam coal exports.

- **Total seaborne coal trade reaches its highest point in 2016 in the Chinese Slow-Down Case (CSDC).** The economic slow-down in China significantly affects the seaborne thermal coal market, whereas differences in metallurgical coal trade are moderate. Although internationally traded thermal coal volumes decrease after 2016 (Figure 42), trade still grows on average by 2.2% per year in the outlook period, whereas coal demand increases on average by 1.8%).

- **A Chinese economic slow-down would have a substantial effect on international trade with total trade volume down by almost 90 million tonnes (Mt in) 2017 compared with the BCS.** China's import decline would be even more pronounced (120 Mtce), but would be partially offset by a reaction of import demand by other countries in order to lower prices.

- **The United States remains a base supplier for metallurgical coal in the CSDC, but not for thermal coal.** US metallurgical coal exports vary in the two scenarios between 40 and 49 Mtce in 2017, while US thermal coal exports are projected at 42 Mtce in the BCS, but plummet to 5 Mtce in the CSDC.

- **Mozambique is projected to become a significant player in the metallurgical coal market throughout the outlook period, emerging as the fifth-largest exporting country in both scenarios.** Mozambican metallurgical exports are estimated to grow from nearly zero in 2011 to at least 7 Mtce by 2017.

The BCS

Seaborne steam coal trade projection 2012-17

In the BCS, the seaborne steam coal trade increases by 160 Mtce, from 665 Mtce in 2011 to 825 Mtce in 2017. By the end of the outlook period, India becomes the world's largest seaborne

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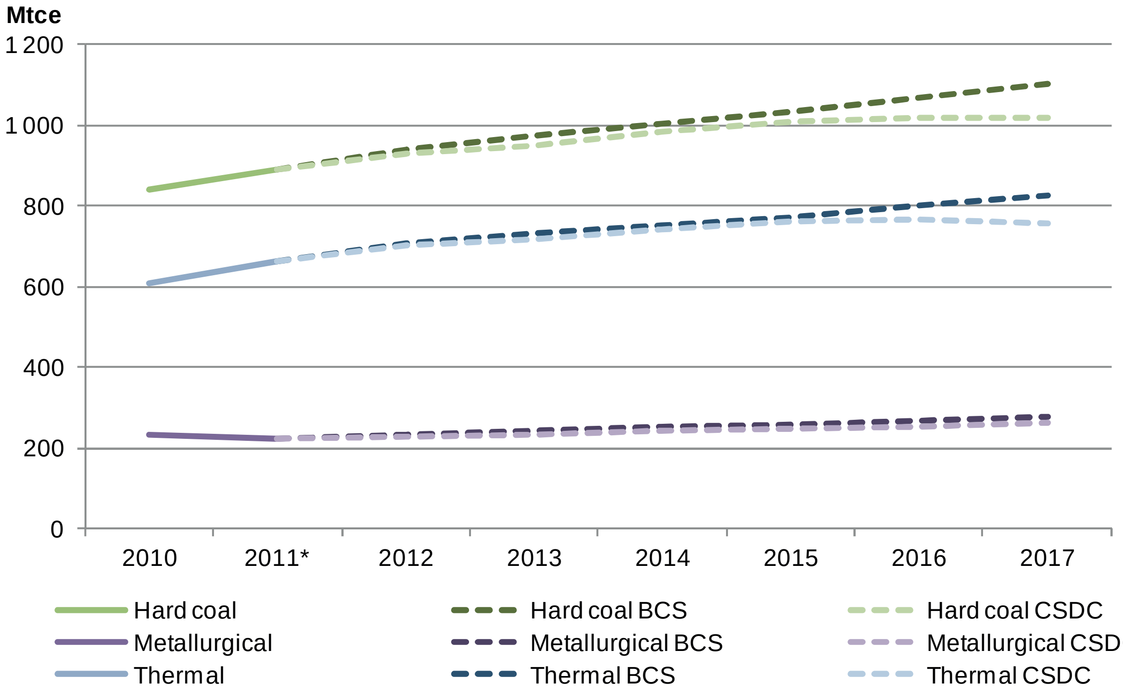
importer of thermal coal. India's maritime imports are 157 Mtce, some 10 Mtce more than China whose seaborne thermal coal imports total 147 Mtce in 2017. Yet, even with growing Chinese imports, total seaborne thermal coal trade grows on average by a mere 3.7% per year compared with around 5% per year in the previous decade.

Figure 45 Development of international seaborne hard coal trade in the BCS and CSDC



* Estimate.

Increasing demand from industry and power generation leads to moderate growth for China's seaborne thermal coal imports in the BCS. In some Chinese regions, additional imports are a cheaper option than increasing indigenous production, which would take place in relatively high-cost underground operations. This holds especially true for supplying the coastal demand centres in Southern China, which are located far from areas of coal production. Although annual growth rates over the outlook period are lower than they have been over the last five years, China will continue to play a major role in the global thermal coal trade, accounting for 17.8% of total seaborne imports in 2017.

Despite continued high import demand in China, the fastest growing importer, both in absolute and relative terms, is India. By the end of the outlook period, India's thermal coal imports will have grown on average by almost 15% per year to 157 Mtce in 2017, from 69 Mtce in 2011. In 2011, incremental Indian thermal coal imports amounted to 88 Mtce or 127% of all imports. India accounts for more than 50% of the world's incremental steam coal trade and surpasses China as the world's largest seaborne steam coal importer by 2017.

Apart from India, the highest annual growth rates of seaborne imports are observed in Southeast Asian countries, such as Malaysia, Thailand and the Philippines, which together with the United States, as well as several small players, are summarised and referred to as "Other" in Figure 46. By the end of the outlook period seaborne thermal coal imports among these countries will total

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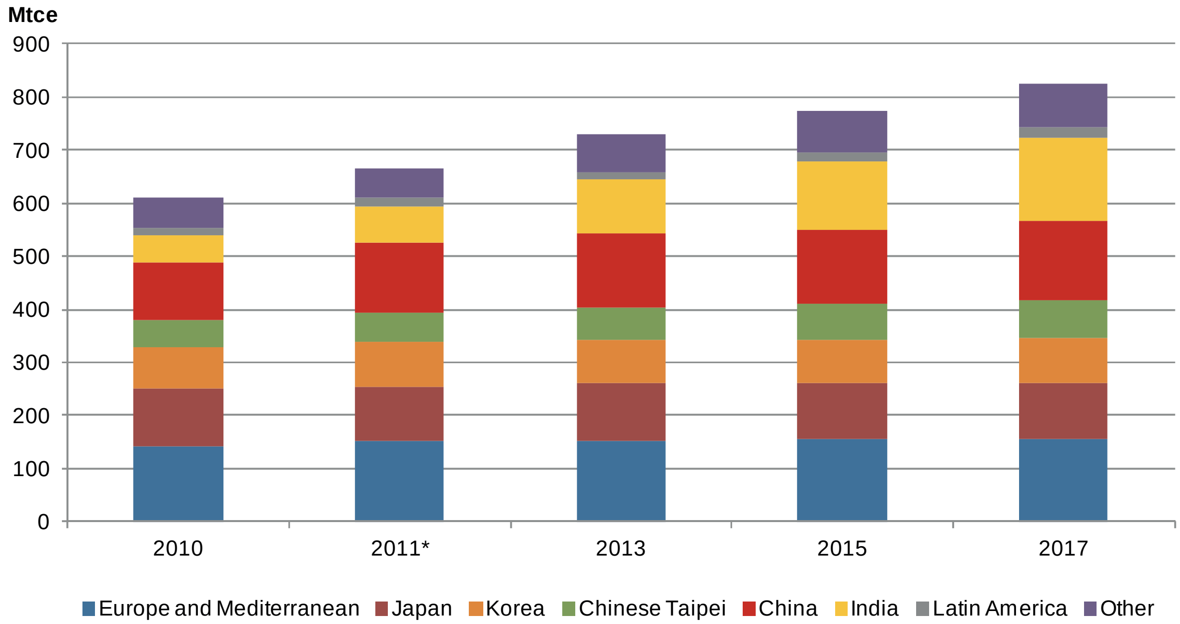
84 Mtce, up by 29 Mtce from 55 Mtce in 2011. However, import development within this group is varied. In contrast to Southeast Asian countries, seaborne thermal coal imports in the United States continue to decrease in line with the past five years. Lower overall coal consumption in the power sector is due to persistently low natural gas prices and stricter conventional emission regulations that allow power generators to replace higher-cost thermal coal imports with indigenous coal.

Figure 46 Seaborne thermal coal imports in the BCS



* Estimate.

In some OECD countries, development of seaborne thermal imports differs substantially. While thermal coal imports in Germany and Spain are assumed to decline slightly, Turkey's thermal coal imports, fostered by high gross domestic product (GDP) growth rates (8.5% in 2011), are projected to continue to surge. As a result, seaborne thermal imports in Europe and the Mediterranean almost stagnate, growing by a mere 0.2% per year until 2017. The same stagnation can be seen in Japan and Korea; throughout the outlook period, both countries exhibit rather sluggish rates of annual growth (0.4% in Japan and 0.8% in Korea).

Therefore, amid growth in the thermal coal market, traditional players on the import side, including most OECD countries, see a continued decline in their share of total trade volume. In contrast, Non-OECD countries, in particular India and China, as well as Chinese Taipei, account for more than 90% of incremental thermal coal trade.

Incremental import demand in the BCS is largely met by increased exports from the traditional exporting countries. Indonesian export supply is 309 Mtce in 2017, 54 Mtce higher than in 2011. This is the second-highest growth of all exporters in absolute terms and corresponds to an average annual growth rate of 3.3%. A decline in the average calorific value of exports is expected during the outlook period, yet the bulk of Indonesian export supply remains in the low-cost half of the global supply curve. Therefore, Indonesia – having a market share of more than 37% in 2017 – keeps its position as the biggest supplier of thermal coal exports throughout the outlook period.

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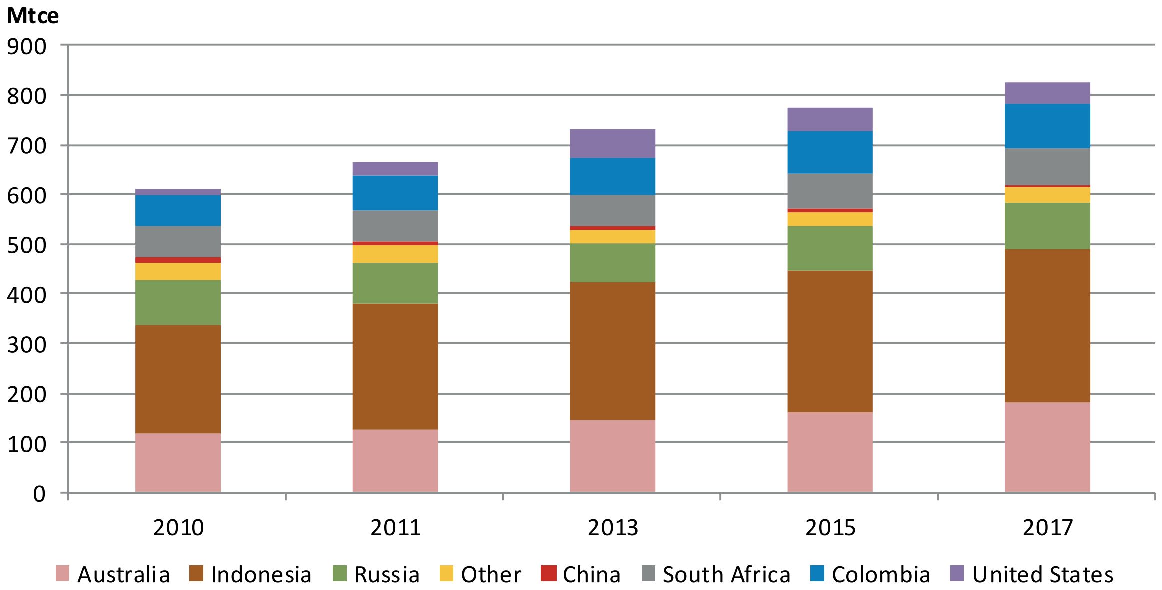
Australia's incremental thermal exports increase from 126 Mtce in 2011 to 182 Mtce in 2017. In absolute terms, Australia has the biggest gain among all coal exporters and strengthens its position as the world's second-largest supplier of thermal coal. In 2015, the first exports from the Galilee basin, located about 500 kilometres (km) from the next coal terminal, are projected to be around 5 Mtce , but of lower-quality coal than traditional Australian coal. Due to the surge in Asian thermal coal demand Australian, as well as Indonesian, exports remain to a large extent in the Pacific market.

Figure 47 Seaborne thermal coal exports in the BCS



* Estimate.

In 2011, Colombia reached an all-time high in thermal coal exports with 70 Mtce. Thermal coal production in Colombia is assumed to see continued growth until 2017 with more than 50 million tonnes per annum (Mtpa) of probable and potential additional production capacity in the pipeline. This development is also reflected in the projections of seaborne thermal coal trade with Colombian exports increasing in both scenarios by 22 Mtce during the outlook period. In 2017, Colombian exports are projected to reach 92 Mtce, most of which will be traded on the Atlantic market. Major export destinations for Colombian thermal coal are Latin America and Europe.

In the past, South African coal exports were constrained by low railway transport capacity. With Transnet's plans to expand its railway capacity via Richards Bay Coal Terminal to 98 Mtpa by 2018 and 2019, relatively low-cost thermal coal exports will regain momentum and increase substantially until 2017. By then, South Africa's seaborne thermal coal exports will be 75 Mtce, up from 63 Mtce in 2011.The trend of an increasing share of South African coal going into the Pacific market continues over the outlook period.

The United States and Russia exhibit relatively high costs on a FOB basis. Exports in both countries are at the upper-end of the global supply curve, and therefore largely depend on high overall prices levels in the international thermal trade market. In Russia, high FOB costs are mainly due to long railway distances from the major mining regions, such as the Kuznetsk basin and Russia's eastern and

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western ports. Although the same holds true for some regions in the United States particularly for the Appalachian coal fields, US thermal coal producers also face relatively high production costs, particularly for the Appalachian region. In the BCS, amid relatively strong overall import growth, the United States increases exports by 15 Mtce and Russia by 13 Mtce during the outlook period. Supported by sustained relatively low freight rates, US exports are projected to increase in the short term. After 2013, additional low-cost supply in other countries is projected to come online and freight rates are likely to regain momentum, leading to a decrease in US exports. This development, again, underlines the United States' role as a swing supplier in the seaborne thermal trade market. While both Russia and the United States export large shares to Europe, exports to the Pacific market will play an increasingly important role for Russia during the outlook period. US exports via the West coast to Asia are projected to remain below 5 Mtce until 2017.

Box 8 Wyoming's coal to China?

Located in Wyoming's Powder River basin (PRB), Black Thunder Mine (operated by Arch Coal) and North Antelope Rochelle Mine (operated by Peabody Energy) have production levels of approximately 100 Mtpa and currently produce some of the most competitive coal in the world, with strip ratios around 1 to 2 or 1 to 3, and mine-mouth production costs of USD 10/tonne (t). Coal quality averages approximately 4 890 kilocalories per kilogramme and 0.20% sulphur, making Wyoming's coal the cleanest in the country in terms of SO_x emissions.

This highly competitive coal, however, is currently not being imported to China's Southeast coast. From an economic perspective, current price levels in China are enough to pay for the cost of the total supply chain, including mining, rail, ports and freight costs (including return on investments for building a new port). In fact, both Peabody Energy and Arch Coal plan to export 50 Mtpa of PRB coal to China. However, barriers to completing the projects exist. Firstly, transport distances are substantial to the West coast and freight trains would have to cross difficult terrain. Secondly, there are social and environmental challenges to be addressed. Trains loaded with coal would have to pass through communities completely unused to large-scale coal transport, which could raise social and environmental concerns.

Moreover, economic uncertainties are significant. Putting the infrastructure in place for large-scale coal exports into the Pacific basin rests on sustained high import demand from China. Yet, unlike Indian buyers, Chinese coal consumers have hardly committed to procuring large volumes of thermal coal from abroad over the long term; Chinese buyers are arbitrageurs and almost exclusively buy on the spot market. Although PRB coal export economics work under current prices, this coal is not low cost on the international market, due to the long inland transport distances, and thus its profitability is very prone to changes in the market environment. Clearly, future Chinese imports are difficult to forecast and in the absence of long-term contracts from Chinese buyers, exporting PRB coal is a risky business. Additionally, if large amounts of PRB coal flow into the Pacific basin, there is a danger of cannibalisation, as this could lower the market price and reduce profitability. Finally, low calorific PRB coal is very sensitive to freight costs evolution. How long the dry bulk carrier freight market remains oversupplied is another big question mark.

Seaborne metallurgical coal trade projection 2012-17

In the BCS, the seaborne metallurgical coal trade is projected to grow by 3.7% per year during the outlook period, similarly to the thermal coal trade. In this scenario, the metallurgical coal trade reaches 278 Mtce in 2017, up from 223 Mtce in 2011. Trade is fuelled by sustained strong growth of GDP, particularly in the Pacific basin, which drives steel production.

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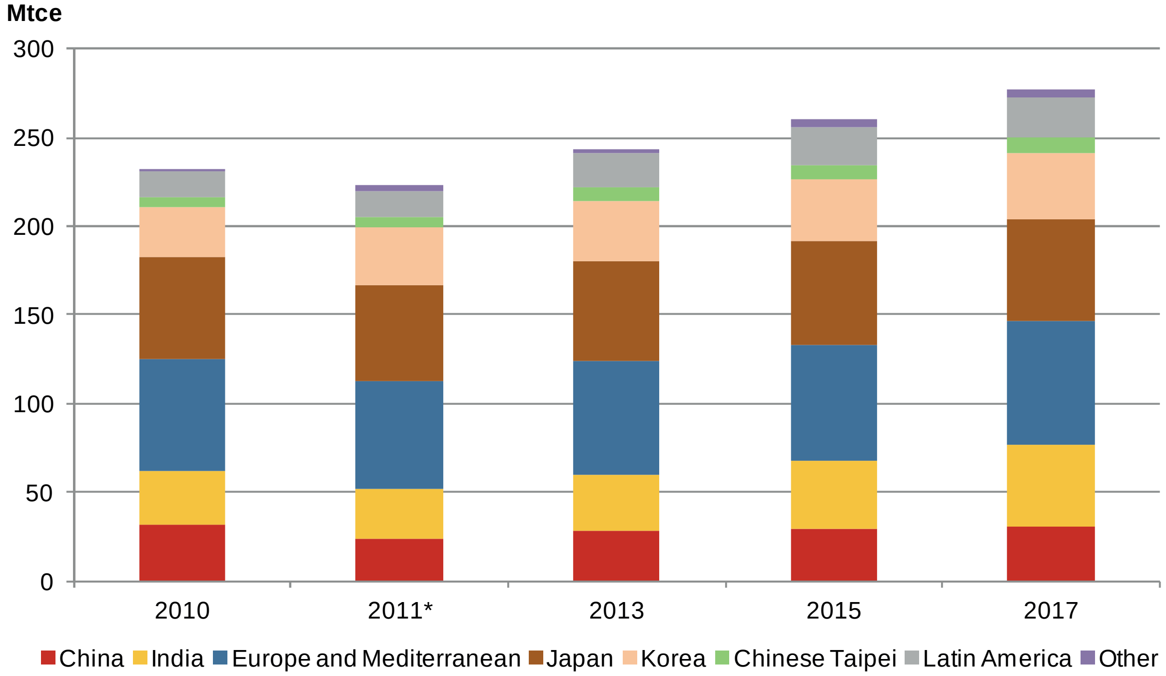
Figure 48 Seaborne metallurgical coal imports in the BCS



* Estimate.

Compared to the past five-year period (2006-11) when seaborne metallurgical coal trade grew on average by an impressive 4.1% per year, seaborne trade slows down slightly during the outlook period to 3.7% per year. This reduction can, to some degree, be attributed to the strong growth in overland trade between China and Mongolia. Despite strong investment activity in the coking coal segment the metallurgical coal market remains relatively tight over the medium term in the BCS.

The Pacific basin remains the cornerstone of the seaborne metallurgical trade with strong growth for both imports and exports. All key metallurgical coal consumers in this region increase their coal procurement from the international market over the medium term, but growth rates vary strongly amongst them. India clearly leads the growth with imports growing more than 8% per year, resulting in additional imports of 18 Mtce by 2017. India has few high-quality coking coal reserves, but increasing steel production has a direct impact on imports. Currently behind Japan and Korea, India becomes the second-largest seaborne metallurgical coal importer in 2017. India sources the majority of its metallurgical coal imports from Australia, where Indian steel mills have invested heavily in coking coal projects. By the end of the outlook period, substantial imports also come from Mozambique, where several Indian steel makers (*e.g.* Tata Steel or Jindal Steel & Power) are engaged in developing coking coal deposits. The surge in Indian metallurgical coal imports further erodes bargaining power of incumbent coal buying associations such as the Japanese Steel Mills over the medium term, as SAIL (Steel Authority of India), India's largest integrated iron and steel producer, and Vizag Steel also known as RINL (Rashtriya Ispat Nigam Limited), another major Indian steel mill, are two powerful buying entities in the market.

Chinese seaborne metallurgical coal imports increase by 27% to reach 31 Mtce in 2017, from 24 Mtce in 2011. Yet, seaborne imports do not exceed the 32 Mtce reached in 2010 over the outlook period.

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Overland imports from Mongolia increase strongly in the coming five years and will reach 27 Mtce in 2017, up from 19 Mtce in 2011. From a cost perspective, the metallurgical coal supply from Mongolia is highly competitive against seaborne imports especially for steel mills in the hinterland. As a result, Mongolia absorbs most of the import growth from China. Domestic Chinese metallurgical coal production is assumed to increase over the outlook period with efficiency gains becoming effective over the outlook period. In line with the 12th Five-Year Plan (FYP), Chinese authorities are currently restructuring and consolidating their mining industry, a process that began during the 11th FYP.[17] Chinese domestic metallurgical coal production (504 Mt in 2011) exclusively comes from underground mines with depths often exceeding 600 m. Domestic supply costs typically fall in a wide bandwidth. Given the relatively tight supply situation in the BCS, the bulk of the domestic output is competitive against seaborne imports on a delivered and quality adjusted basis.

Japan remains the largest metallurgical coal importer throughout the outlook period but, due to the maturity of its steel industry, has sluggish import growth rates of around 1.3% per year. Japanese metallurgical coal imports reach 58 Mtce in 2017, close to 2010 levels, from 54 Mtce in 2011. Like Japan, Korea has no domestic coking coal reserves and therefore relies on imports for its booming steel industry. Korean metallurgical coal imports grow moderately by about 2.4% per year reaching 37 Mtce in 2017.

Metallurgical coal demand in the Atlantic basin grows less dynamically than in the Pacific Rim. Furthermore, growth is unevenly distributed in the region. The highest import growth rates are projected for Latin America, particularly Brazil. Brazil is rich in comparably low-cost iron ore and has a burgeoning steel industry that relies exclusively on imported coking coal. As such, Brazil's coking coal imports are projected to increase by 45%, reaching 20 Mtce by 2017. Apart from the United States, the majority of Brazil's imports will be procured from Mozambique and Colombia, where Brazilian companies (*e.g.* Vale or MPX) are developing metallurgical coal projects.

Metallurgical coal imports in Europe and its neighbouring Mediterranean countries grow moderately at about 2.3% per year until 2017. In spite of reduced domestic coking coal production and high import growth rates in some countries such as Turkey, metallurgical coal imports do not reach pre-crisis levels in the Europe and Mediterranean region over the outlook period.

Supply remains highly concentrated in the seaborne metallurgical coal trade. Currently, Australia, the United States and Canada provide more than three-quarters of seaborne exports. This share approaches 80% in the middle of the outlook period and gradually declines again to 75% in 2017 with the arrival of new players, such as Mozambique, and an expansion of Russian exports. From a security of supply perspective all key metallurgical coal exporting countries can be considered stable; however, high concentration ratios are undesirable as they expose markets to volatility from supply disruptions caused by strikes, floods or delays in expansion plans.

High concentration ratios apply on both a country basis and a company level. Five companies together, BHP Billiton, Teck Resources, Xstrata-Glencore,[18] Anglo American and Rio Tinto, control nearly two-thirds of the global metallurgical coal export capacity, particularly for top quality coal. These companies maintain their dominant position in the Pacific basin over the medium term, but a tendency towards

[17] For the uncertainty regarding future Chinese coal production, see IEA, 2011.
[18] The Xstrata-Glencore merger, already mentioned in this report, is not fully confirmed yet.

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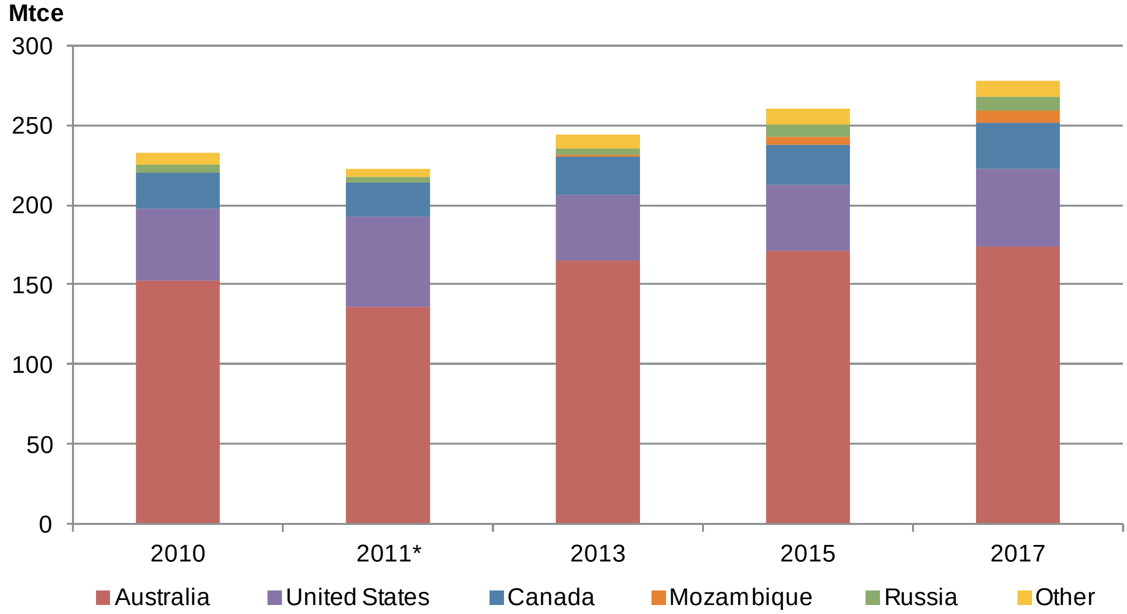
vertical integration of steel makers (*e.g.* Vale, Tata Steel, ArcelorMittal, Wuhan Iron and Steel Company) and a sustained high share of US exports leaves these five companies slightly more vulnerable in the Atlantic basin and booming Indian market.

Figure 49 Seaborne metallurgical coal exports in the BCS



* Estimate.

Australia is a key metallurgical coal exporter and is in a good position to capture a large portion of the market growth in the BCS, due to a number of mining projects in the pipeline and the necessary infrastructure. Australian exports increase by more than 4% per year to reach 173 Mtce in 2017, from 137 Mtce in 2011. Australian export growth is still substantial but undoubtedly less bullish when compared to 2010 exports, which stood at 153 Mtce. Although Australia generally has a favourable position in terms of supply costs for metallurgical coal, the main barrier to Australian export expansion is an escalation in operating and investment costs. Even in the BCS, with strong market growth, projects with lower-quality coal are only marginally profitable.

Australia, particularly Queensland – a key region for metallurgical coal exports – is at risk of regional short-term supply disruptions, *e.g.* due to bad weather conditions (floods in 2008 and 2011) or industrial action (strikes at BHP Billiton/Mitsubishi mines in spring 2012), which can cause price spikes in the seaborne market in the medium term.

The United States is the second-largest exporter in the seaborne metallurgical coal market and remains a base supplier in the medium term. Although the United States is a high-cost supplier, the tightness of the market and relatively high price levels, along with its proximity to Europe, allows US producers the opportunity to sell large quantities of metallurgical coal into the seaborne market. US exports decline by about 2.1% per year to 49 Mtce in 2017, down from record levels of 56 Mtce in 2011. Costs are a major issue in Appalachia, the source of all US metallurgical coal exports. Railway tariffs for metallurgical coal (railway lines charge higher tariffs for metallurgical coal exports than for thermal coal exports) are a major factor, and do not only include the cost of transportation, but also

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significant margins. However, consolidation and the associated economies of scale as well as exit of some producers help to fight cost escalation over the medium term. Nonetheless, some smaller companies, particularly those producing lower-quality metallurgical coal, are barely profitable. Europe and Brazil are the main markets for US exporters.

Canada, the third-largest metallurgical coal exporter is Australia's key competitor in the Pacific Rim. Canadian seaborne exports increase at over 4% per year to reach 28 Mtce in 2017, up from 22 Mtce in 2011. Strong demand growth in Asia supports mining capacity expansion in British Columbia. In this region, the necessary port infrastructure is already in place and the rail supply chains (mainly from the Elk Valley) can accommodate the projected growth in shipments without significant upgrading. However, supply chain utilisation comes close to its limit in the BCS and any further expansion would require significant infrastructure investments. Canada, exclusively applying truck-and-shovel mining methods, maintains its mid-cost position during the outlook period, supported by the assumption of declining oil prices in the medium term.

Russia remains the fourth largest supplier of metallurgical coal in this outlook with seaborne exports doubling to more than 8 Mtce in 2017, from 4 Mtce in 2011. Russian export growth opportunities are mainly in the Pacific basin and capacity expansions, such as the Elga coking coal complex in Yakutia (Eastern Siberia), are planned to support this growth.

Mozambique, which exported the first coking coal volumes in 2011, is the rising star in the seaborne metallurgical coal trade with potential to become a major player in the long term. However, in the medium term, coal exports are constrained by insufficient infrastructure capacity. The Sena railway line (currently the only operational line in the country) and the port of Beira are only able to handle 6 Mtpa to 8 Mtpa of coal exports. Producers without access to the railway line or port will have to transport their product by truck to the export terminals – clearly a high-cost choice given transport distances of 700 km. Metallurgical coal exports from Mozambique are projected to reach 8 Mtce in 2017. This figure includes truck transport of a small amount of coal to alternative ports. Mozambique is ideally located to serve growing metallurgical coal demand in India, as well as the Atlantic basin (*e.g.* Brazil or Turkey).

Metallurgical coal projects are underway in several other exporting countries (*e.g.* New Zealand, Indonesia, Colombia and South Africa), but these projects are typically small or primarily targeted at domestic steel mills. However, metallurgical coal exports from these countries roughly double from 5 Mtce in 2011 to 10 Mtce in 2017.

Although not a seaborne exporter, Mongolian exports overland into China and has a strong effect on the seaborne trade, as these exports partially fill demand that would otherwise have been served by seaborne imports. Similarly to Mozambique, the transport infrastructure is weak and exports are currently trucked to the Chinese border and loaded onto trains. This adds significantly to the very low mining costs in Mongolia. A railway line project that links the Mongolian coal fields to the Chinese railway system is scheduled to come online in the medium term. This brings some relief for exports but will not supersede all truck shipments during the outlook period. Mongolian overland exports are projected to increase by 42%, from 19 Mtce in 2011 to 27 Mtce in 2017.

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The CSDC

Seaborne thermal coal trade projection 2012-17

In the CSDC, assumed lower GDP growth substantially reduces China's need for seaborne thermal coal imports. In the BCS, Chinese seaborne thermal imports grow on average by 2.1% per year, but decrease by 15.6% per year in the CSDC. In absolute numbers, China's seaborne thermal coal imports amount to only 47 Mtce in 2017, down by 83 Mtce from 130 Mtce in 2011, and roughly 100 Mtce lower than in the BCS.

Total thermal coal trade increases on average by 2.2% or almost 16 Mtce per year to 758 Mtce in 2017. Thus, while Chinese thermal coal imports decrease by 100 Mtce relative to the BCS, import demand from other countries increases. These additional imports compensate for almost one-third of the Chinese decline in imports, limiting the difference in total seaborne thermal coal trade between the two scenarios to 67 Mtce in 2017.

The comparable slower worldwide growth of demand for seaborne thermal coal in the CSDC results in a crowding out of the most expensive thermal coal operations. Consequently, supply costs of major importing countries decrease in comparison to the BCS. The reduction in supply costs in the seaborne thermal coal market is partially offset by an increase in thermal coal utilisation in the power sector, as is the case for many OECD countries, and a substitution of indigenous production by additional imports, as in India. Yet real CIF ARA supply costs are assumed to be almost 9 USD/t lower in the CSDC than in the BCS. Supply cost differences are even more pronounced in the Pacific market, *e.g.* Japanese supply costs are more than 14 USD/t lower in the CSDC. However, fuel-switching capacity in the Japanese power market remains somewhat limited due to already high load factors of Japanese coal-fired power plants.

The biggest difference in imports between the two scenarios, in absolute and relative terms, is observed in India. Indian thermal coal imports in the CSDC stand at 170 Mtce in 2017, an additional increase of 13 Mtce with respect to the BCS. At the end of the outlook period, Indian imports in the CSDC are more than 100 Mtce higher than they were in 2011. India's thermal coal is generally produced at very low cost, rendering it largely competitive with seaborne imports, even in most of coastal areas. Therefore, India's additional increase in imports in the CSDC may partially be explained by seaborne imports becoming more attractive due to an overall lower price level in the seaborne thermal coal trade market, but also by a reduced urgency to rapidly expand Indian production capacities; hence indigenous production is lower in the CSDC than in the BCS.

The difference in the seaborne thermal coal trade between the BCS and CSDC affects all major exporting countries, except Colombia. The largest difference in exports is experienced in the United States, both in relative and absolute terms. By the end of the outlook period, US exports decline by more than 20 Mtce. Russia is another high-cost exporter, but not as strongly affected due to its cost advantage over the United States, because of shorter shipping distances from its export ports to major importing countries. Consequently, Russian exports almost stagnate over the outlook period, growing by 0.5% per year.

Australia is likewise largely affected by China's economic slow-down in the CSDC. Australian annual export growth is 1.7 percentage points, or 17 Mtce lower, in 2017 in the CSDC. A significant part of this reduction comes from lower production rates in the Galilee basin, as well as investors delaying new operations due to the anticipated slower development of the seaborne thermal coal trade.

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Figure 50 Differences in seaborne thermal coal trade between the BCS and CSDC

Finally, aside from reductions in the seaborne thermal coal trade in the CSDC, lower import demand in China changes trade patterns in the global thermal trade market. In the CSDC, seaborne trade between the Atlantic and the Pacific market takes place to a lesser extent than in the BCS. Colombia, for example, while projected to export some coal to the Pacific market in the BCS, will remain in the Atlantic market in the CSDC.

Seaborne metallurgical coal trade projection 2012-17

In the CSDC, the seaborne metallurgical coal trade is projected to grow by 2.6% per year throughout the outlook period, slightly higher rate than the thermal coal trade. Metallurgical coal is a scarcer resource than thermal coal and has fewer substitutes, and therefore international trade is affected to a lesser degree. As GDP growth rates in other major steel-producing countries are assumed to be unaffected in this scenario, metallurgical coal trade reaches 261 Mtce in 2017, up from 223 Mtce in 2011 (38 Mtce).

A slow-down of the Chinese economy leads to a reduction in steel output and a lower demand for metallurgical coal. Consequently, high-cost domestic production decreases and some mining projects, scheduled to come online in the latter half of the projection period, are delayed or cancelled. Lower demand levels also affect imports; however, this is more pronounced for seaborne imports.

Mongolian exports to China are about 2 Mtce lower in the CSDC as compared to the BCS, reaching 25 Mtce by 2017. There are various reasons for sustained high Mongolian exports. Firstly, Mongolian exports have a cost advantage over seaborne imports and domestic production in some regions, as mining costs are low and shipping costs are expected to decline once truck haulage is substituted by railway transport. Secondly, some Mongolian output is relatively high-quality coking coal and thus able to substitute premium Chinese or international coking coal. Thirdly, Mongolian producers are locked in to the Chinese market due to a lack of access to the seaborne market. This gives Chinese steel mills strong bargaining power to moderate Mongolian export prices. In the long term, Mongolian

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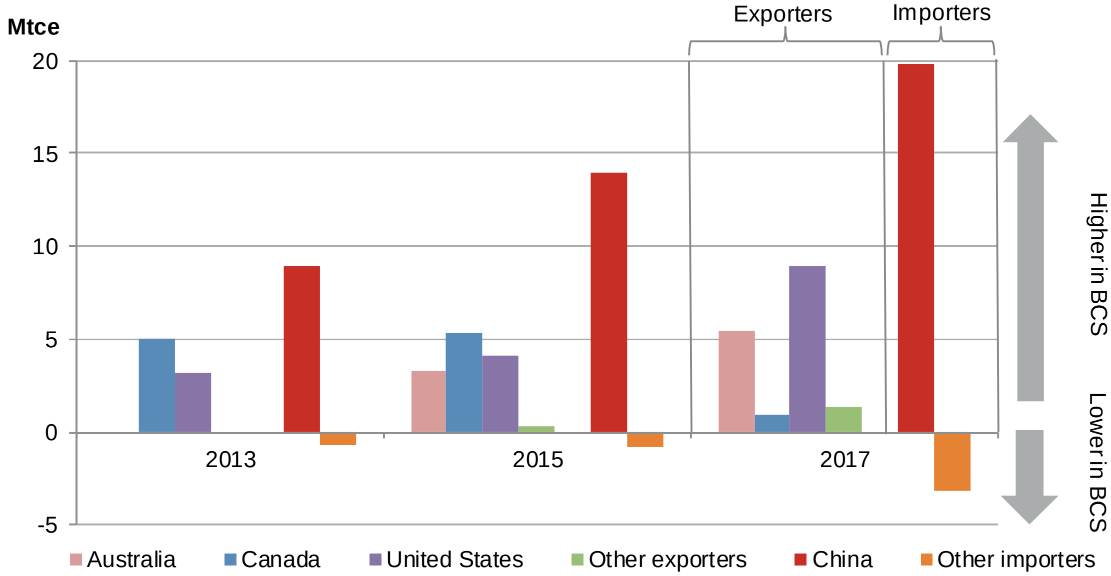
coal fields might be connected to the Russian railway network, which could present an opportunity to export to Russia or the seaborne market. However, this is unlikely to happen within the outlook period.

Figure 51 Differences in seaborne metallurgical coal trade between the BCS and CSDC



In the CSDC, Chinese seaborne imports are 9 Mtce lower in 2013, 14 Mtce lower in 2015 and nearly 20 Mtce lower in 2017 compared with the BCS. Seaborne imports are 11 Mtce by the end of the outlook period, down by 55% from 24 Mtce in 2011. The drop in Chinese seaborne imports results in a lower marginal supply cost level, which leads to additional demand on the market in compensation for the reduction in Chinese imports. In the CSDC, the marginal costs of the metallurgical coal supply (average over all qualities) are up to USD 10/t lower than in the BCS. Yet, this effect is small due to the relatively low price sensitivity of metallurgical coal demand. Demand among other importers is slightly more than 3 Mtce higher in the CSDC in 2017.

In contrast to the BCS, metallurgical coal exports are lower in the CSDC. This has an impact on all major producers, but exporters in the United States share the highest burden. Many US exporters are close to the margin on the international market, especially in the Pacific basin, and therefore any demand shock directly feeds back to them. Hence, US exports are 9 Mtce lower in the CSDC in 2017 at 40 Mtce. However, the United States remains a base supplier of metallurgical coal as its main market, Europe and the Mediterranean, remains relatively unaffected by the drop in Chinese imports. However, a drop in Chinese GDP growth rates would have macroeconomic implications around the world and affect coal demand in Europe eventually as well.

Australian exporters of metallurgical coal will clearly feel the impact of reduced Chinese imports. In the CSDC, some high-cost operations lose their market share, while the lower marginal cost level markedly reduces rent on existing assets and return on investment; this leads to investor uncertainty and project slippage. Canadian exporters are more heavily impacted by lower Chinese imports in the first half of the projection period, as Canadian operations are typically closer to the margin in the Pacific basin than the bulk of Australian production. However, Canadian supply costs remain more stable throughout the outlook period and projects currently under construction can cover their operating costs even in the CSDC. In general, Canadian operations are less affected by the end of the outlook period.

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Besides the direct impact on exporting countries of lower Chinese GDP growth on metallurgical coal sales, the economics of investment projects is an important secondary effect. With lower-than-expected returns on investment, some projects might be cancelled or delayed.

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EXPORT CAPACITY INVESTMENT OUTLOOK

Summary

- **The utilisation of worldwide export mining capacity stood at healthy levels both in 2010 and 2011.** In 2011, export mine utilisation was slightly lower compared to 2010 levels, as a result of new high-capacity additions, as well as lower capacity utilisation, in Australia.

- **Worldwide port utilisation increased in 2011 because of strong absolute growth in the seaborne thermal coal trade market, which exceeded port capacity additions.** Utilisation rates of low-cost suppliers such as Indonesia, Colombia or South Africa remained above average in 2011, but utilisation of port terminals in the United States grew significantly compared to previous years.

- **In 2011, Australian infrastructure was underutilised.** This was a consequence of the floods in Queensland in late-2010 and early-2011, which caused the whole coal chain – mines, rails and ports – to be hardly utilised in the first several months of 2011.

- **Investment pipelines for mining and infrastructure capacity look healthy as significant capacity additions are projected to enter the market during the outlook period.** More than 150 million tonnes per annum (Mtpa) of currently committed or advanced mining projects are projected to be online by 2017, with another 485 Mtpa potentially entering the market by the end of the outlook period.

- **Worldwide port handling capacity has the potential to increase by an impressive 290 Mtpa, more than 21%, over the outlook period.** The largest capacity additions are projected to come online in Australia, Indonesia and Colombia, *i.e.* in traditional exporting countries.

- **From a security of supply perspective, global hard coal mining and infrastructure capacity is sufficient to accommodate the increasing international coal trade over the outlook period.** Yet, recently, several mining companies announced a delay on investments; therefore some projects could come online later than expected. In turn, this may potentially lead to tight markets if the international trade market continues the projected growth.

Utilisation of mine and port export capacity 2010-11

Utilisation of export mine capacity

Export-oriented hard coal mining capacity consists of collieries that produce exportable qualities of hard coal (high calorific value, mostly low ash) and have access to export transport infrastructure. Export-oriented hard coal mining capacity was 1 240 Mtpa in 2011, an increase of around 90 Mtpa, or almost 8%, from 2010. More than 80% of new export capacity is thermal coal mines. Therefore, as noted in IEA (2011), roughly 25% of hard coal export capacity is metallurgical mining capacity and the remainder is thermal coal capacity. Utilisation of global export mine capacity gained momentum and reached 84% in 2010 and because of a surge in import demand from Asian countries, most OECD economies' hard coal imports started to recover from the global economic crisis. In 2011, export mine utilisation decreased to 83% as a result of new high-capacity additions and lower capacity utilisation in Australia.

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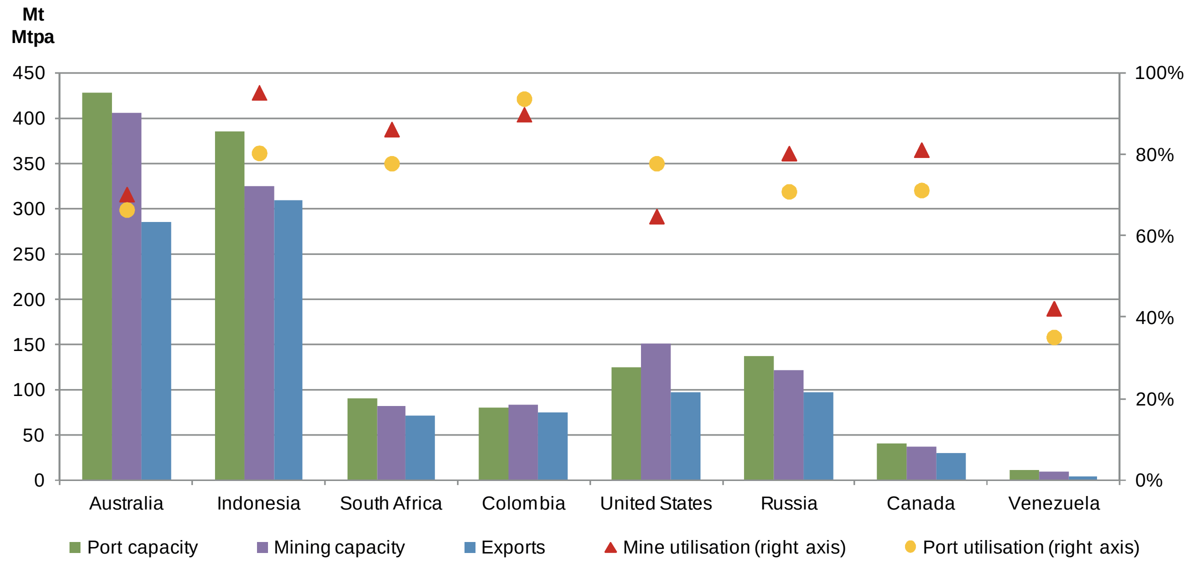
In terms of mine capacity utilisation, countries can be broadly divided into three categories. The first category consists of major coal exporters, which are typically base suppliers to the market due to competitive production costs or geographical location. Often, export mines are highly utilised in these countries, as in Indonesia, Australia, Colombia and South Africa, all having utilisation rates of 80% or more. However, South Africa has been plagued by export infrastructure bottlenecks in domestic transportation, which limited its exports and therefore its mine utilisation. Similarly, Australian exports were significantly hampered by the floods at the beginning of 2011, which affected transportation to Queensland's export terminals, as well as the coal terminals themselves. As most coking coal exports stem from Queensland, the dip in utilisation of coking coal mines was significantly more pronounced compared with utilisation of export-oriented thermal coal mines.

Figure 52 Port capacity, mining capacity, exports and utilisation, 2011



The second category consists of countries that act as swing suppliers in the market due to their higher FOB costs. These suppliers only enter the market if demand is so strong that other countries with lower FOB costs cannot cover demand alone, the United States being the most prominent example.

The third category comprises countries where rising domestic demand for coal has redirected exports to domestic markets, as in the case of China. While export infrastructure and mine capacity would allow for far higher exports from China, most exportable volumes are used to meet surging domestic demand. The same holds true for Vietnam, which has seen a steady decline in coal exports since 2007 as a result of high gross domestic product (GDP) growth and growth in electricity consumption.

Utilisation of port capacity

Coal turnover at the export terminal comprises the second main link in the coal supply chain, after domestic transport. While actual turnover and handling costs are relatively low,[19] between USD 2/tonne (t) and USD 5/t, port throughput capacities are a critical bottleneck in the coal supply chain. Utilisation of port infrastructure was high in several major exporting countries in 2010. Even in

[19] This is true except for Russia, where port handling costs are higher. This is particularly the case for Russian coal exports via Latvian ports, where additional charges can increase turnover costs to more than 10 USD/t.

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high-cost coal mining countries, such as the United States, port utilisation gained momentum. This increase in utilisation can be attributed to strong seaborne hard coal demand. Therefore the trade market became tighter in 2010, as swing suppliers such as the United States significantly increased their exports (21 million tonnes [Mt]). Russian export utilisation also increased, both in the east and west, due to continued strong Asian coal import demand and renewed European coal demand. Although South African exports exhibited a slight increase in 2010 compared to 2009, port utilisation rates actually decreased because of the expansion of the Richards Bay Coal Terminal (RBCT).

In 2011, overall port utilisation stood at 75%, up by 3 percentage points from 72% in 2010. Thus, absolute growth in the seaborne hard coal trade market outlasted port capacity additions in 2011. South Africa's coal terminals were utilised at a healthy 78% during 2011 as a result of an increase in its thermal coal exports. In contrast, Australian ports suffered from the decline in exports caused by the flooding, with port utilisation falling below 70% in 2011.

Export capacity investments 2012-17

Investments in port capacity and export mining capacity are normally associated with lead times of several years. Therefore, analysing expansion projects currently under construction or in the planning stages is a good estimator for export capacity development in the coming years. This is especially true for port capacity investments, where lead times are normally longer than they are for mine capacity investment projects.

A look at probable and potential investments into export infrastructure gives the impression of a healthy business outlook. Nearly all major exporting countries will likely see a substantial increase in their export infrastructure capacity, with Australia leading the way, accounting for nearly half of expansion. Globally, incremental port capacity could amount to around 290 Mtpa in 2017, a potential increase of roughly 21%, and mine expansion currently under construction or committed exceeds 150 Mtpa. Additionally, an impressive 485 Mtpa of potential mining projects are in the pipeline. These projects either are waiting for a feasibility study to be completed or have already been declared feasible, but are still in need of a final approval. Were all probable mining projects realised as planned, export production capacity would increase by more than 12% over the outlook period; if in addition all potential projects were to start operations, incremental export mining capacity would reach 51% by 2017. Compared to IEA (2011), potential expansion over the next five years is close to 635 Mtpa, which is substantially higher than last year's 420 Mtpa. The difference in figures is contrasted by recent announcements of investments slow-downs, layoffs and curtailments by some companies. The evolution of the global economy, particularly in China, will likely shape the pace of investments during the outlook period.

Investment in mining capacity

Significant additions to export mine capacity are projected to enter the market within the outlook period. More than 150 Mtpa of currently committed or advanced mining projects will likely be online by 2017, with another 485 Mtpa potentially entering the market by the end of the outlook period. In total, approximately 635 Mtpa of additional mining capacity could be made available to the seaborne market.

The majority of probable additions are located in Australia and Colombia. Probable increases of export mining capacity are expected to be moderate in South Africa due to limited domestic railway capacity. Projects whose current status is either "approved", "committed" or "under construction" are classified

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as probable additions. A large number of potential additions can be identified in Australia and Indonesia. Less advanced projects whose current status is “feasibility study”, “environmental impact study” or “awaiting approvals” are considered as potential additions. Furthermore, potential additions are based on various estimates for countries where detailed project lists were not available.

Figure 53 Cumulative probable expansion of hard coal export mining capacity

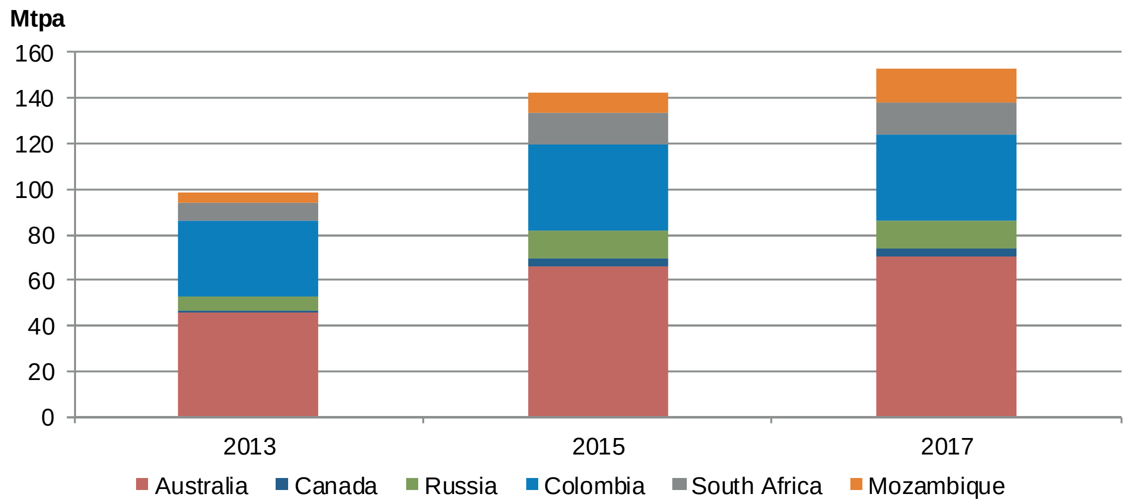
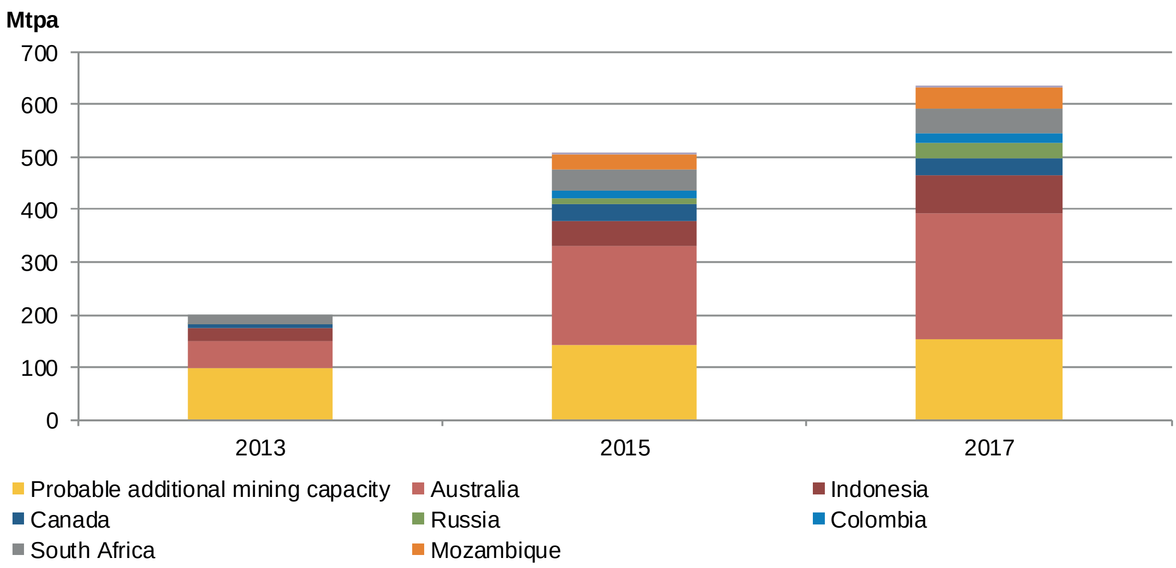


Figure 54 Cumulative probable and potential expansion of hard coal export mining capacity



In general, when and how much of the potential mining capacity enters the market depends on various factors. Firstly, demand growth and price levels determine the profitability of a project. Secondly, availability of export infrastructure is crucial to enter the market. Thus, delays in infrastructure construction or expansion may substantially hamper the profitability of a project. Thirdly, future regulatory frameworks and political risks impact the profitability of a project and are key investor uncertainties. Finally, access to capital, particularly with regard to greenfield projects that require new infrastructure, may be an issue in countries with high regulatory uncertainties.

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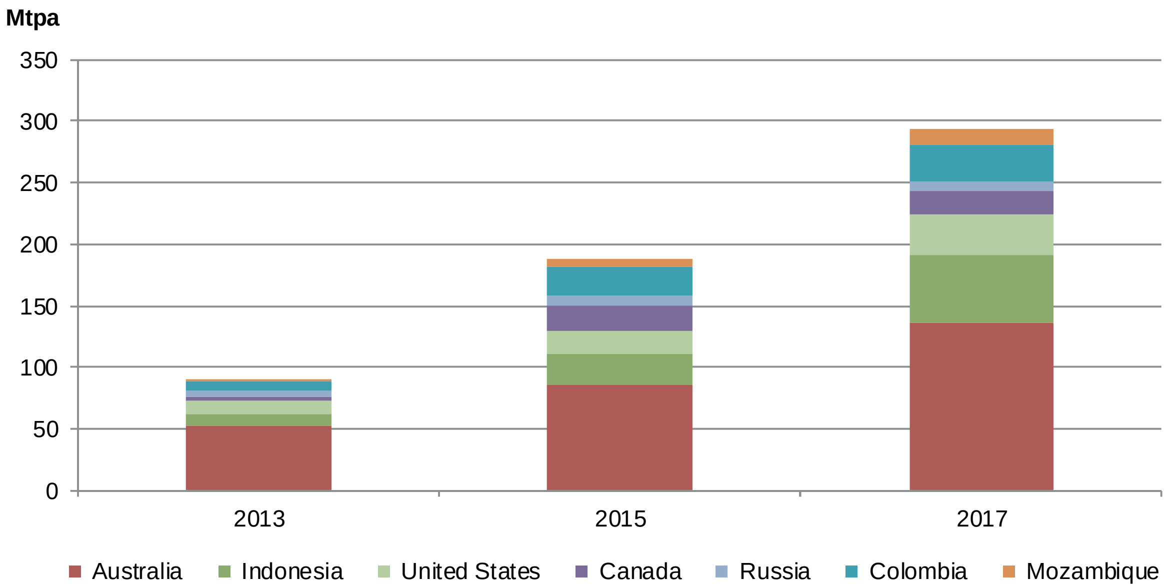
Strategic foreign direct investment to secure coal supply continues its rise over the outlook period. This is particularly the case for metallurgical coal, as Brazilian, Indian and Chinese companies have all invested heavily in mining projects in Australia, Mozambique and Colombia. Indian and Chinese companies have also invested in large-scale thermal coal projects in Australia.

Investment in infrastructure capacity

Port capacity has increased by more than 40 Mtpa from 2010 to 2011. Several further significant port capacity projects are currently under development and constructed over the course of the outlook period. By 2017, worldwide port handling capacity is expected to have increased by an impressive 290 Mtpa, or more than 21%. The largest capacity additions are projected to come online in Australia, Indonesia, the United States and Colombia, *i.e.* among the traditional exporting countries. Some representative export capacity expansion projects in various countries are described in detail below.

Figure 55 Projected cumulative additions to coal terminal capacity



Regional analysis

Australia

Investment in mining capacity

Australia accounts for approximately 46% of total probable mining capacity additions throughout the outlook period. This figure corresponds to nearly 71 Mtpa of mining projects that are either approved, under construction or committed to by investors. Total investment volume of probable mining projects exceeds USD 17 billion, with more than two-thirds invested into additional capacity in Queensland. The majority of probable additions can be found in mature mining regions such as the Hunter Valley, Bowen and Gunnedah basins.

Australia accounts for more than half of potential capacity additions worldwide with 240 Mtpa considered being potential incremental capacity. In contrast to probable additions, Australian potential additions are predominantly located in new basins, such as the Surat and Galilee basins.

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At the end of April 2012, New South Wales accounted for slightly less than half of all Australian mining projects – 10 out of 21 – considered to be probable additions. An example of this is the 4 Mtpa extension of the Mount Arthur coal mine, which is the biggest thermal coal mine in New South Wales with a yearly run-of-mine production of 20 Mt. The project's capital expenditure totalled USD 400 million and is scheduled for completion by mid-2013. One of the biggest probable expansion projects in New South Wales is Xstrata's construction of the second of two approved underground mines in the Ulan coal mining region, located in the western coalfields. Ulan West, a USD 1.1 billion investment project, is scheduled to have a final production capacity of 7 Mtpa, with its thermal coal mined using longwalls. Together with its existing underground operation Ulan No. 3 and the planned open-cut mine, Xstrata plans to extract 20 Mtpa from the Ulan Seam over the next 21 years.

Grosvenor and the Caval Ridge/Peak Downs project are two probable additions in Queensland. The former project is developed by Anglo American Australia and consists of a USD 1.7 billion investment in a new mine located near Moranbah. The construction of the Grosvenor mine was granted final approval by the Queensland government in June 2012 and construction is expected to begin in 2013. If completed on time, mining of hard coking coal deposits will begin by 2016 with a targeted capacity of 7 Mtpa. Caval Ridge/Peak Downs consists of the Caval Ridge coking coal mine, with a targeted capacity of 5.5 Mtpa, along with a 2.5 Mtpa expansion of the adjacent Peak Downs mine, both of which are located in the Bowen basin. The project is carried out by BHP Billiton Mitsubishi Alliance and has an investment cost of USD 4.4 billion, making it the most expensive coal mining project in Australia considered to be probable. The capacity additions are scheduled for completion by 2014.

Despite a full investment pipeline, the shortage of well-trained labour in the building and operation phases may hinder significant investment in the coal mining industry and infrastructure.

Investment in infrastructure capacity

Australian port capacity is likely to continue its recent growth – by the end of 2011 port capacity was 428 Mtpa, compared to 393 Mtpa in 2010 and 2011 (BREE, 2012). By April 2012, five port infrastructure projects were at advanced stages of development, with a total capital expenditure of over USD 7 billion. If all projects are finalised as planned, Australian port capacity will increase by 86 Mtpa, reaching 514 Mtpa by the end of 2014. Taking into account projects that are at less advanced stages, and thus more likely to be put on hold or exhibit delays, an extra 120 Mtpa could be added to Australian port export capacities by 2017. While mining capacity in Australia has the potential to increase by more than 50% during the outlook period, Australian coal export terminals are projected to have a combined capacity of 564 Mtpa by 2017, *i.e.* incremental port capacity of 136 Mtpa by the end of the outlook period.

Port investment projects in Queensland account for more than 60% of total expected port capacity additions, of which 38 Mtpa – phase of Hay Point Coal Terminal and 1st stage of the Wiggins Island Coal Terminal (Gladstone) – are currently under construction. The BHP Billiton Mitsubishi Alliance's (BMA) Hay Point Coal Terminal totals USD 2.5 billion and is projected to reach 55 Mtpa of capacity in 2014, which is equivalent to an increase of 11 Mtpa from 44 Mtpa in 2011. The first of Wiggins Island's potential three stages is worth USD 2.4 billion and is expected to begin operations in 2014 with a capacity of 27 Mtpa. Ultimate capacity could reach 80 Mtpa.

Three port expansion projects are currently under construction in New South Wales, including the USD 227 million expansion of Newcastle's Kooragang Island Coal Terminal. The Newcastle Coal Infrastructure Group (NCIG) is responsible for the remaining two investments, which total USD 1.9 billion

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and will add a second stage (an additional 23 Mtpa), projected to start operations by the end of 2013, and a third stage (an additional 13 Mtpa) scheduled for 2014. After completion of all three stages, NCIG's export capacity will increase to 90 Mtpa.

In the past years, infrastructure capacity constraints in the rail and port sector have limited Australian exports. Projects finished in recent years, such as the northern missing link, *i.e.* the railway between the Bowen basin and Abbot Point Coal Terminal, have already eased this problem. The railway was finished by the end of 2010 and began transporting in 2011. As a result, transport capacity to Abbot Point reached 50 Mtpa, doubling 2010 capacity. Projects that are either under way or planned will complement the coal terminal projects and thus relieve capacity bottlenecks between the mines and the ports.

In Queensland, the capital cost of projects currently under construction or committed is nearly USD 1.3 billion and includes: a USD 185 million investment in the Goonyella rail system that services both the Dalrymple Bay and Hay Point coal terminals; a USD 195 million investment in the Blackwater rail system that services the coal terminals at Gladstone, and; a USD 900 million investment in the Wiggins Island rail system with an initial capacity of 27 Mtpa. Additionally, BHP Billiton announced plans to build its own railway line with a capacity of 60 Mtpa from its coking coal mines in the Bowen basin to the Abbot Point coal terminal. In New South Wales, the Australian Rail and Track Corporation (a Commonwealth government-owned corporation) leases and operates the Hunter Valley coal rail system. Over USD 1.4 billion is expected to be spent over the next five years to upgrade the state's rail capacity alongside increases in coal production capacity. The 30-kilometre (km) project between Maitland and Minimbah, will provide additional capacity for mines in the Hunter Valley.

Colombia

Investment in mining capacity

Colombia has a well-supplied investment pipeline. If all additional mining projects were to be commissioned, Colombian export capacity would increase by 56 Mtpa by the end of the outlook period. Probable mining capacity additions are estimated at 38 Mtpa and the remaining 18 Mtpa are considered to be potential additions. The production expansion of existing mines, partially as a result of efficiency improvements, comprises the majority of capacity additions; examples include Brazilian mining company, Vale, which plans to increase production in its El Hatillo Mine to 9.5 Mtpa by 2014, from 4 Mtpa and the expansion of the Cerrejón thermal coal mine, which was approved by the three equal shareholders (Xstrata Coal, BHP Billiton and Anglo American) in August 2011 and will increase its open-cut production by 8 Mtpa by the end of 2015. The latter project's capital expenditure amounts to USD 1.3 billion, and part of the investment will be spent on the expansion of Puerto Bolivar, as well as improvements to the railway system supplying the coal terminal in the province of Guajira. Aside from investments by the traditional miners in Colombia, India is also eyeing a stake in Colombia's growing mining industry, as Indian Aditya Birla Group is reported to have entered negotiations with Drummond Company to acquire a share of 20% to 40%.

Investment in infrastructure capacity

Transport infrastructure and port handling capacity in Colombia is highly utilised. In line with plans to increase Colombian exports, several Colombian ports are expected to expand or receive technological upgrades to allow additional throughput.

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The government's plans to change the operating system of all coal terminals to direct-loading underline the coal industry's move to reduce environmental impact. Cerrejón invested USD 1.3 billion into 8 Mtpa of incremental capacity at Puerto Bolivar, increasing its annual capacity to 40 Mt by 2015. Led by Prodeco, a consortium of coal mining companies has begun construction of Puerto Nuevo at Cienaga by the Caribbean Sea with a direct-loading system and an annual capacity of 30 Mt. This project will require a USD 600 million investment and will include an 8.5 kilometre-long and 20.5 metre-deep access canal. Operations at the Colombian multipurpose port, Puerto Brisa, have been delayed, while further discussions with local communities are held. Puerto Brisa, located in the province of Guajira, is expected to handle 30 Mtpa of coal when fully operational. Taking these developments into account, total Colombian port handling capacity is projected to increase by up to 29 Mtpa by 2017.

In order to accommodate the expected expansion of Colombian coal exports, new railway systems with more than 1 600 km of lines – the most important being the *Sistema Ferroviario Central* – will connect coal mines close to Bogota with coal terminals on the Caribbean coast. The investment volume is estimated to amount to USD 3 billion. However, construction is unlikely to start before 2014, as project has yet to be officially assigned to a company.

Apart from all railway and port infrastructure plans, the construction of the Panama Canal's third lane allows bigger bulk carriers and represents the single most important project to facilitate Colombia's export expansion plans. The completion of the Panama Canal expansion by 2014 will allow Colombia to export its coal at a substantially reduced cost – the sea route via the Panama Canal is 7 000 km shorter than the route through the Atlantic – into Asian markets.

South Africa

Investment in mining capacity

South African export mining capacity is projected to increase by up to 61 Mtpa over the outlook period, with 14 Mtpa considered probable and the remaining 47 Mtpa deemed as potential capacity additions. If probable additions are realised, South African export capacity will reach close to 96 Mtpa by 2017, and if all potential additions begin operations, the country's export capacity would exceed 142 Mtpa. However, additional export mining capacity will also be used to serve domestic demand and thus stated additional capacity may potentially overestimate capacity additions available for exports.

Coal production at Waterberg basin has the potential to double during the outlook period, although concern remains over the availability of sufficient railway transport capacity. Continental Coal's Penumbra underground thermal coal project, considered as a probable project, is making good progress and if realised as planned, thermal coal will be sold as high-quality thermal coal with a RB1 specification via the RBCT by the fourth quarter of 2012. Annual exports are projected to reach 0.5 Mtpa with FOB costs between 58 USD/t and 64 USD/t, the balance of the planned annual production of 0.75 Mtpa sold domestically. The Boikarabelo Mine in the Waterberg region is being developed by Australian-quoted Resource Generation, with operations scheduled to commence in early-2015 with annual production beginning at 6 Mt. A potential stage two expansion will increase mining capacity by another 20 Mtpa.

Investment in infrastructure capacity

Transnet's export channel to Richards Bay currently rails at less than 70 Mtpa with plans to ramp up to 81 Mtpa by 2015 while port facilities at RBCT have completed a much delayed expansion to 91 Mtpa

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in 2010. Around USD 24 billion of Transnet's seven-year rolling capital investment programme will be directed towards the upgrade and expansion of South Africa's coal export corridors. A large proportion of this investment will be used for the Richards Bay coal corridor, including the opening up of export capacity from the coal-rich Waterberg region, in the Limpopo province. The investment in the coal channel could increase coal volumes to 98 Mt by 2018/19, which would exceed the 91 Mtpa current capacity of the privately owned RBCT.

Russia

Investment in mining capacity

Additional Russian export capacity is difficult to estimate since it is not always clear which percentage of output is targeted for export and which is targeted for domestic demand. It is projected that probable capacity additions will total 12 Mtpa over the outlook period, with another 29 Mtpa of additional potential export mining capacity.

Mechel's Elgen coal mine in East Russia produced its first output of 0.2 Mt in 2011. If expansion and construction are finished as planned, production capacity of the Elgen mine will total 27 Mtpa by the beginning of 2021. Although no significant amount of coal will be produced until the end of 2013, production is projected to be 9 Mt by 2015. Export of Elgen's coal production will take place via the Pacific port of Vanino. SUEK's Apsatskoye coking coal mine in the Transbaikal region, around 700 km from the Chinese border, may begin exporting coal to Asia. SUEK also announced plans to double its production from the Kuznetsk basin by 2016 compared with output in 2011, equivalent to an incremental production of 13 Mtpa from Kuzbass. Development of the Elegesta coking coal deposits in Russia is making progress, yet the previous deadline for completion has been postponed from 2014 to 2016, and costs have risen by 17%. When the Elegesta project is fully operational it will produce 15 Mt of coking coal per year. Coeclerici Coal & Fuels is scheduled to invest a further USD 100 million by 2014/15 in the development of the Korchakolsky open-cast coal mine to increase thermal coal output to 2.5 Mtpa from the current 0.8 Mtpa.

Investment in infrastructure capacity

The Russian coal transport sector experienced several capacity and quality issues in 2011. Capacity bottlenecks in railway transport are the result of competition among different commodities for scarce transport wagons. This problem is impaired by the poor condition of railways and wagons as well as an insufficient co-ordination and allocation of railway capacity. Persistent bottlenecks led Mechel to construct its own 315 km-long railway line from the Elgen mine to the Siberian railway system, and, while smaller, Kuzbas Fuel Co. (KTK) built its own 70 km-long line. The Russian government has approved a programme to increase the country's coal output to 380 Mt by 2020, an increase by around 14% compared to last year's production of 334 Mt. An increase in output will be achieved by a large-scale investment programme of more than USD 8 billion until 2030, part of which will be used to upgrade railway and port infrastructure. However, only a few details on concrete projects are yet available. One of them is concerned with the railway to the port of Vanino, where throughput has also been limited by railway bottlenecks. The key problem is the construction of the Kuznetsovsky tunnel, which will increase the railway's capacity considerably. The whole construction project of the railway section costs about USD 0.8 billion, almost 75% of which is contributed by the federal government. The reconstruction of the section, including the construction of the tunnel, is expected to be completed by 2016.

Due to high transit fees, exports via the Baltic ports have become less attractive. Although Russian port capacity to the east is high enough not to hamper expected growth of seaborne exports to Asia,

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additional coal terminals are expected to come online. The extended Russian project list includes an expansion of Vanino by 5 Mtpa by 2013, a 1 Mtpa expansion of the Latvian port of Ventspils and Summa Capital's announcement a coal terminal at the port of Vostochny. It is projected that port handling capacity available for Russian exports will increase by 9 Mtpa over the outlook period.

Indonesia

Investment in mining capacity

Additions to Indonesian export mining capacity are difficult to project since project lists are generally non-transparent. Therefore, all Indonesian mining capacity additions are classified as potential additions.

Indonesia has managed to expand its export mining output by an impressive 370% over the last decade. This aggressive increase in export capacity and output is expected to continue over the next five years to over 70 Mtpa. However, this estimate is on the lower edge of possible capacity additions since, on average, annual incremental exports over the last ten years amounted to more than 20 Mt. Uncertainty for foreign investors increased with the passing of a new law stipulating that international investors are only allowed to have a majority share in an Indonesian coal mine after ten years of production (VDKI, 2012). Thus, difficulties in securing funding for future mining projects, as well as for increasing domestic electricity demand, cast a shadow on an otherwise bright export outlook for Indonesia.

Investment in infrastructure capacity

Indonesian incremental port capacity is estimated to reach 55 Mtpa by 2017. In general, Indonesian infrastructure development projects are non-transparent and data availability is rather poor. Indonesian exports are mainly produced in Kalimanatan. The most important ports, Adang Bay, Banjarmasin, Pulau Laut and Tanjung Bara, can handle bulk carriers with a capacity of up to 180 000 dwt. Additionally, Panamax class ships may be charged at ten coal terminals (*e.g.* Samarinda or Palikpapan). Currently, two operations can directly load coal onto ocean-going vessels. It is expected that this relatively unconstrained infrastructure situation will persist throughout the outlook period. Finally, numerous small offshore ports can be used to load handy-size carriers. Overall, export coal terminal handling capacity is estimated at 385 Mtpa in 2011.

However, to facilitate further export growth, major investments are needed to improve inland railway transport capacity, as additional export growth comes with a stronger reliance on coal mines located further away from coastal ports, which are not as well connected to inland rivers. As such, the Indonesian government recently announced plans to invest USD 2.4 billion into a railway line connecting Central and Eastern Kalimantan with the port of Balikpapan at the east coast. The first stage includes a 185 km railway at a cost of USD 1.7 billion, which will be prolonged by another 60 km to connect Central Kalimantan. In 2011, construction of the Mang Besar Coal Terminal (MBCT) offshore port was initiated; located off the east coast of Kalimantan, MBCT will handle bulk carriers of up to 400 000 dwt (Valemax). Capacity throughput is scheduled to expand in four steps, each step adding 40 Mtpa to the port's handling capacity. The first stage is expected to become operational by late-2014.

Mozambique

Investment in mining capacity

The province of Tete has the world's largest undeveloped coal reserves with an estimated 23 gigatonnes of hard coal. Tete is also home to some of the world's biggest coal development projects, including

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Vale's USD 1.65 billion Moatize project. Initial production capacity is projected at 11 Mtpa. In the long term, mining capacity is scheduled to expand to 26 Mtpa (11 Mtpa of coking coal and 15 Mtpa of thermal coal). In total, probable capacity additions in Mozambique stand at 16 Mtpa throughout the outlook period, albeit parts of the additional mining capacity will serve domestic thermal coal demand.

Potential projects in Mozambique include Minas de Revuboe's planned open-cut operation in Tete, which will produce up to 5 Mtpa of coking coal once completed in 2014. The Revuboe project has a resource of 1.4 billion tonnes (Bt) of hard coking and thermal coal suitable for open-cut mining. Additionally, Mozambique's Ncondezi Coal will begin production of export thermal coal in the second-half of 2015. The first stage of the project will have a total mining capacity of 4 Mtpa, with half of the production being dedicated to exports. Export thermal material is reported as having a calorific value of 5 800 kilocalories per kilogramme (kcal/kg) NAR,[20] an ash content of 21%, a sulphur content of around 0.9% and moisture content of 8% (Ncondezi Coal, 2012). A potential second stage could increase mining capacity to 10 Mtpa, of which 5 Mtpa could be export thermal coal.

Box 9 Mozambique's Tete coal fields: the next big thing?

A former Portuguese colony which gained independence in 1975, Mozambique has been one of the fastest growing countries in Africa during the last decade, with a compound average growth rate of real GDP of 6.6% per year (IMF, 2012). Transition to a democracy has made good progress since the end of the civil war in 1994. Rich in resources such as titanium, natural gas, graphite and coal, and politically stable, Mozambique is projected to continue its growth at 6.4% per year during the outlook period.

Prospects for coal development appear bright, as the Tete coal fields are one of the largest and last remaining undeveloped coal regions in the world. Total resources in Tete are estimated at over 23 Bt of hard coal, including hard coking coal, with properties similar to those of comparable products in Australia or the United States, and thermal coal with a calorific value up to 6 000 kcal/kg and a slightly higher ash content (more than 20%). Due to its good product properties and favourable geological conditions – a high share of Tete's coal seams will be accessible using open pit mining techniques – Mozambican hard coal exports are expected to fall into the lower-half of the global supply curve.

The Mozambique government has already issued well above 100 coal licences to around 50 national and international companies in Tete, including Mozambican Mozambi Coal, Beacon Hill and Ncondezi Coal, as well as international companies such as Vale, Rio Tinto and Anglo American. The first small-scale exports of hard coking coal have already taken place from Vale's Moatize project and the Moatize-based Benga project of Tata Steel (35%) and Riversdale (65%). The USD 500 million Moatize project developed by Brazilian company Vale will have an initial nominal mining capacity of 11 Mtpa, out of which around 3 Mtpa will be thermal coal and the remainder coking coal. By 2014, Vale plans to double production capacity to 22 Mtpa. The first stage of the Benga project produced an initial 34 000 t of hard coking coal exported via the port of Beira. Initial annual production will amount to 1.7 Mt of coking coal and another 0.3 Mt of thermal coal. Another project, called Minas Moatize, is developed by Mozambique-based miner Beacon Hill, which plans to increase run-of-mine production to 4 Mtpa by 2014, with 2.2 Mtpa of saleable coal. Saleable export products will include hard coking coal with about 9.5% of ash content – an off-take agreement of 600 kilotonnes with an Indian steel mill is already in place – and thermal coal with a calorific value of 6 000 kcal/kg (25% ash content). Ncondezi Coal is another promising thermal coal project; the open pit mine has the potential for annual production in excess of 10 Mt, with at least half scheduled for exports. By late 2015 capacity is projected to stand at 4 Mtpa.

[20] NAR: net as received.

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Box 9 Mozambique's Tete coal fields: the next big thing? (continued)

Construction of sufficient transport and coal terminal capacity is likely to be the biggest constraint on fast growing hard coal exports by Mozambique over the next five years. So far, the port of Beira (6 Mtpa of handling capacity in 2012) is the only viable option for hard coal exports from the Tete region, since the 6 Mt coal terminal at Maputo port, located at more than 1 000 km south of Tete, is mainly reserved for South African export. The Moatize basin is linked to the Port of Beira by the Sena railway which is projected to increase its capacity to 6.5 Mtpa by the end of 2012, with an additional 5.5 Mtpa expansion in 2013. If railway capacity is not sufficient, the coal will be trucked to Beira, thereby increasing transportation costs by more than 30 USD/t from 20 USD/t. Due to environmental issues raised by the Mozambique government, barging down the Zambezi is no longer a viable alternative.

In the long term, railway and port infrastructure is projected to become available in Mozambique. One example is Vale's USD 4 billion infrastructure project, which consists of a 700 km-long railway through Malawi and a projected capacity of 30 Mtpa, connecting the Moatize basin with the proposed deepwater port at Nacala. Additionally, the Mozambican government is expected to spend around USD 14 billion on the development of its export coal infrastructure, which will include 5 000 km of railway lines to help achieve its targeted long-term handling capacity of 100 to 120 Mtpa.

Investment in infrastructure capacity

Port capacity in Mozambique stood at 10 Mtpa in 2010; the Matola coal terminal in Maputo, which is used mainly for South African exports, has a capacity of 6 Mtpa, while the port of Beira is currently able to handle 4 Mtpa. Beira's export capacity will increase to 6 Mtpa, with plans to build an additional coal terminal that may handle 18 Mtpa to 24 Mtpa. At present, coal exports from the Tete coal fields are transported via the 575 km-long Sena railway to Beira. However, Ncondezi Coal, together with Rio Tinto and Minas de Revuboe, formed a partnership, the Mozambique Coal Industry Export Initiative (MCIEI), which is looking to construct a deepwater port north of the mouth of the Zambezi. The greenfield project, located 500 km from Tete, will have an initial capacity of 25 Mtpa and theoretically could also be supplied by a barge through the Zambezi, but barging down the Zambezi is likely to be restricted for environmental reasons.

Canada

Investment in mining capacity

Xstrata Coal has sped up development of its Canadian met coal prospects, forming a joint venture with Japan's JX Nippon Oil and Energy. JX Nippon is reported to have paid USD 435 million for a 25% stake in Xstrata's met prospects in the Peace River region in Western Canada, including the Sukunka and the Suska coal projects. According to Xstrata, both projects have a potential combined output of 9.5 Mtpa with hard coking coal comprising the majority of production and the remainder projected to be pulverised coal injection (PCI) coal.

Investment in infrastructure capacity

Canada is currently expanding its port handling export capacities on the west coast of the country. Both coal terminals in the area around Vancouver, the Westshore Coal Terminal and the Neptune Bulk Terminal, plan to expand capacity by 6 Mtpa by 2015 (Westshore) and by 3.5 Mtpa by 2013 (Neptune). Neptune Bulk Terminals (Canada) Ltd. announced an improvement of train off-loading and energy efficiency with investment totalling USD 18 million. In light of the recent increase in exports from the United States via the Canadian West coast, in particular using the Westshore Coal

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Terminal for Powder River basin (PRB) coal, these additional capacities may very well also facilitate additional US exports rather than additional Canadian exports. Located at Prince Rupert in the north of British Columbia, construction works at Ridley Coal Terminal started in August 2011. Once finished, export capacity is projected to increase from 12 Mtpa to 24 Mtpa. Total capacity is scheduled to be available by the beginning of 2015.

Others

Botswana has significant export potential for good quality, low-sulphur thermal coal, yet part of potential production will be used to supply future coal-fired power generation plants in the country. Among the most promising coal development projects in Botswana are CIC Energy project (a wholly owned subsidiary of India's Jindal Steel & Power), in Mmambula coalfields (an extension of South Africa's Waterberg coalfields), which contain an estimated 900 Mt of coal suitable for exports, and Aviva's Mmamantswe coal project (1.3 Bt of coal resources). In order to make Botswana's coal available, two infrastructure development options are currently being discussed. The first option is an extension of the planned railway connecting South Africa's Waterberg coalfields to RBCT. The second option, although surrounded by a relatively high degree of uncertainty, is the Trans-Kalahari railway, which would connect Botswana's coal deposits with the ports of Luderitz or Walvis Bay in Namibia, and has the potential to become one of the most important export links in southern Africa. If realised, the 1 400 km-long railway would handle 60 Mtpa of coal. High uncertainty is also reflected in cost estimates which lie in the range between USD 5 billion and USD 9 billion. Commissioning is scheduled for early-2017.

Exports from **Mongolia** are expected to continue their steep increase. The majority of exports are transported to China via trucks, however, in order to meet the high expectations for Mongolian coal, investments into a railway system are needed. Seaborne exports do not seem very likely within the outlook period, since this would require the construction of an additional railway system connected to the Trans-Siberian Railway (which is already saturated) to access to Russia's Pacific ports. The Mongolian government has issued a tender for a 1 000 km-long railway from Tavan Tolgoi to the port of Vanino. The other option would be the construction of a railway to the Chinese port Dandong.

Projected utilisation of export capacity

Assumptions and methodology

This chapter integrates the projections of seaborne coal trade[21] and the projections of export mining and infrastructure expansions discussed previously. Projected exports of producing countries, as well as mining and infrastructure expansion data, are used to determine utilisation rates of components of the coal supply chain over the outlook period. Installed mining capacity comprises dedicated export operations, as well as operations that serve both domestic and international markets. Export capacities for the latter type of operations are more difficult to estimate. In this case, exports are a function of costs, and domestic and international prices may be hampered by contractual obligations or coal quality issues. Furthermore, existing and additional port handling capacities determine port throughput limits in this analysis. Using country-specific seaborne export projections, aggregated future utilisation rates of both export terminals and export mining operations can be estimated. However, utilisation rates are aggregated on a national level and thus neglect that the utilisation of individual or regional supply chains, *e.g.* in Australia or Colombia, can still vary substantially.

[21] See "Medium-term projections of seaborne trade".

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In general, mining and infrastructure capacities used in this analysis are more likely to be on the upper-end of possible developments (Indonesia being a potential exception) if all projects in the investment pipeline come online as scheduled. However, in reality, projects are often delayed or discarded, because of feasibility problems, public opposition, environmental concerns, changes to investment strategies and lack of financial capability. These factors are more likely to influence projects that are developed to a lesser degree (in this report, referred to as "potential additions"). It is unlikely that significant capacities will enter the market during the outlook period that are not yet in the investment pipeline.

Furthermore, the recent announcement of slowing investments by some mining companies suggest that if the Chinese economy shows any sign of slow-down, this trend will be exacerbated and many potential additions will move beyond the outlook period. This should be taken into account when assessing future capacity utilisation.

Global analysis

The seaborne hard coal trade is projected to increase from 1 029 Mt in 2011 to 1 280 Mt in the Base Case Scenario (BCS) and roughly 1 180 Mt in 2017 in the Chinese Slow-Down Case (CSDC). Global export mining capacity is projected to increase from around 1 240 Mtpa in 2011 to approximately 1 395 Mtpa in 2017 if probable projects are completed as planned. If all potential projects are developed on time, which is clearly an unrealistic scenario, global export mining capacity will be 1 880 Mtpa. Incremental export terminal capacity is projected to amount to 290 Mtpa by 2017, equivalent to an increase in port handling capacity from nearly 1 380 Mtpa to around 1 670 Mtpa over the outlook period.

Aside from probable expansion projects, a large number of potential expansion projects are in the investment pipeline. On a global scale, mining and port throughput capacity is sufficient to handle increasing seaborne trade in both BCS and CSDC. Yet, capacity utilisation differs between countries and even within countries, so regional bottlenecks can still occur. In general, exporters that are able to serve the market at low cost are projected to supply close to their respective capacity limits. Higher-cost suppliers may have substantial capacity slack, depending on the demand level, and thus capacity utilisation rates differ widely between the two demand scenarios. Although bottlenecks may hamper coal supply regionally, from a security of supply perspective they do not necessarily pose a problem, as sufficient supply from more costly exporters is usually available. From an economic perspective, such bottlenecks signal scarcities, and drive prices upwards as more costly supply needs to be used, which thus provides incentives for investment into new export infrastructure capacity.

The different capacity utilisation rates in the two scenarios reflect the impact of lower Chinese coal demand on Chinese import behaviour. This in turn has a significant influence on the profitability of market investments into export infrastructure capacity, which may exhibit high utilisation rates if Chinese import demand and total seaborne imports remain strong. In the BCS, the realisation of all probable projects and one-third of potential mining projects is required to maintain current mining capacity utilisation rates slightly above 80%. In the CSDC, which results in lower Chinese seaborne imports, all probable projects are necessary to maintain mining capacity utilisation rates of 85% by 2017.

Very high utilisation rates are not desirable over longer periods as this implies that a large proportion of high-cost capacity is needed to serve demand. Further, with high utilisation rates the market is more prone to supply disruptions. Nameplate mining capacity may not always be available because of mine outages (*e.g.* weather-related or due to strikes) or infrastructure bottlenecks (*e.g.* derailments,

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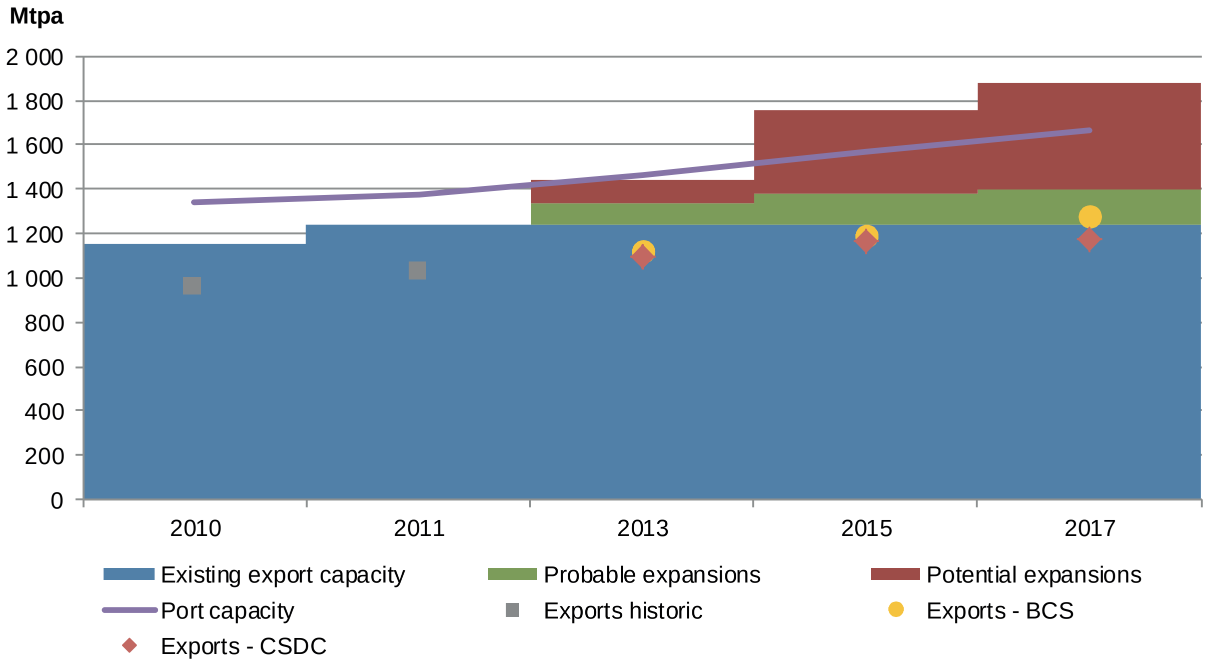
inefficient loading operations or weather-related rail or road problems). Finally, high-capacity utilisation rates may give individual players the ability to exert market power; in a situation without excess capacity, any major supplier may easily become pivotal and could therefore raise the market price by withholding hard coal exports. However, concerns over market power exertion are more likely in the tight metallurgical coal market than in the thermal coal market. Overall, a healthy margin of spare capacity is needed to keep the market competitive and balanced for low price volatility.

Figure 56 Outlook for global export capacity utilisation for seaborne hard coal until 2017



Extramarginal[22] capacities can be additional production either from dedicated export mines or from mines that serve both domestic and international markets. FOB costs are usually high in these operations due to lower coal qualities, more expensive inland transport or unfavourable geological conditions. These capacities need a relatively high price level to recover their costs. In any case, the use of these high-cost capacities over longer periods is inefficient when investment into lower-cost capacities is possible. Throughout the outlook period investment into mining capacity mainly takes place in low operating cost countries, such as Colombia and Indonesia, or in countries located close to big importing countries and thus are highly competitive on a CIF cost basis, such as Australia. In these countries, operations usually realise a high rate of utilisation and thus have a reduced risk of incurring stranded costs.

On a global scale, port capacities do not restrict hard coal trade growth. However, port bottlenecks may still limit exports regionally. Hence, port capacity utilisation also differs between the various exporting countries. Yet investment into export terminal capacity is mainly taking place in countries where ports were highly utilised in the past, with Australia accounting for by far the biggest share in additional port handling capacity. These countries are usually intramarginal to the market (*e.g.* Colombia, South Africa and Australia) in the trade projections and therefore new port capacity realises healthy utilisation rates over the outlook period. Nevertheless, investment into coal supply infrastructure is

[22] Extramarginal refers to production units with short-run marginal costs higher than the last unit (marginal), which is needed to meet demand, and hence, is out of the market in that moment.

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very specific and generally more costly in terms of capital expenditure per tonne than mining capacity. In combination with uncertainty about future utilisation rates, this substantially increases investor risks in reality. Low port utilisation rates are more common with marginal and extramarginal exporters (*e.g.* Poland, Russia or the United States) in the trade projections. Coal handling port capacities in these countries are usually fully amortised and stranded costs are not likely to be a problem.

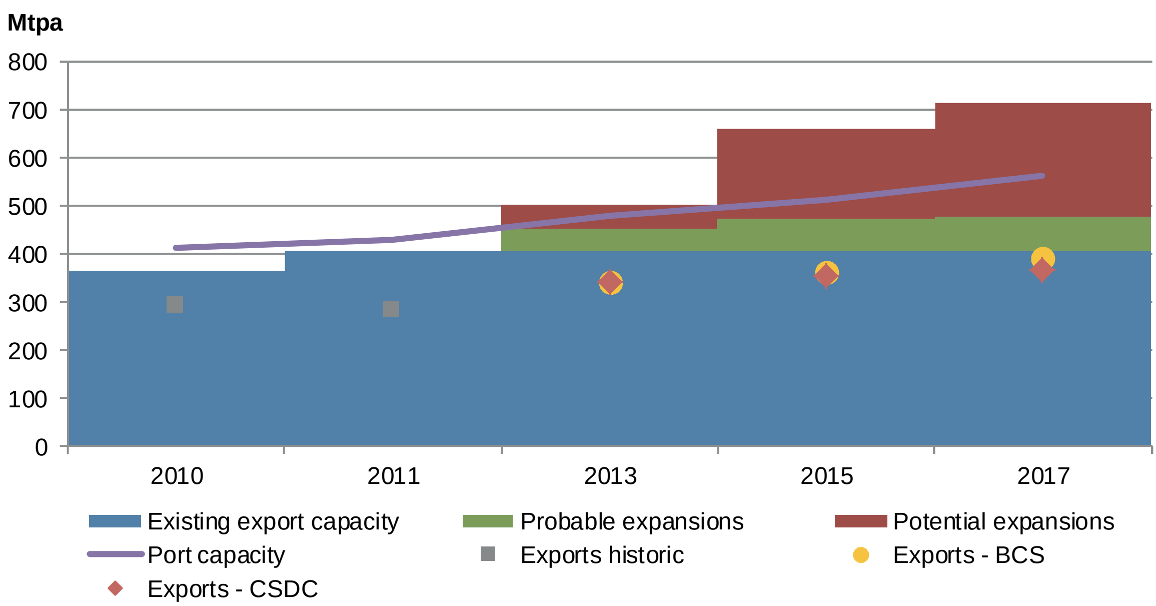
Regional analysis

Australia

Australian export mining capacity currently stands at 405 Mtpa and may increase by as much as 311 Mtpa over the outlook period. About 71 Mtpa of the incremental capacity are considered probable and another 240 Mtpa are considered potential expansions. Port capacities are projected to increase from 428 Mtpa at the end of 2011 to 564 Mtpa in 2017. In the BCS, Australian exports increase from 285 Mt in 2011 to 392 Mt in 2017. The CSDC implies lower trade growth rates and Australian exports increase only to 367 Mt in 2017. Some more costly Australian operations (mainly thermal coal) are swing suppliers and become extramarginal to the market in this scenario.

Australian export mining capacity utilisation was 80% in 2010 and a mere 70% in 2011, because of the floods in Queensland that led to a loss in production of at least 32 Mt.[23] Reduced hard coal production from Queensland in addition to actual Australian exports in 2011, utilisation rate stood at 78%, which is still a reduction compared to the 80% in 2010. If all probable mining capacity expansions came online without delays, Australian export mining capacity in the BCS would be 82% of total capacity by the end of the outlook period. Compared to the BCS mining capacity utilisation would be lower by 5 percentage points in the CSDC.

Figure 57 Outlook for Australian export capacity utilisation for seaborne hard coal until 2017



[23] The Queensland Resources Council reports that shipments from Queensland coal terminals in calendar year 2011 were 154 Mt, down 17%, or almost 32 Mt, on 186 Mt in 2010.

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Port capacity utilisation in Australia was 71% in 2010 and only 66% in 2011. However, individual ports were utilised to a higher degree. In November and December 2011, vessel queues were long, with up to 60 ships waiting at Carrington and Kooragang coal export terminals as a result of planned coal chain maintenance outages. Port expansion plans are sufficient to handle projected coal exports in both scenarios, yet from the perspective of port operators, overall utilisation rate could be slightly higher. In the BCS, Australian export terminal utilisation stands at 70% in 2017, whereas in the CSDC port utilisation is 65% by the end of the outlook period.

This analysis suggests that the strong investment witnessed in Australian mining and export infrastructure is appropriate to serve growing demand over the outlook period. Comparing probable and potential capacity additions to projected worldwide import development leads to the conclusion that most Australian potential mining projects face a high degree of uncertainty. As such, higher rates of growth for overall seaborne hard coal imports than outlined in the BCS are needed to be profitable. However, Australian coal supply comprises various individual supply chains that need co-ordinated investment into mining, railway and port capacities. Delays or cancellations of projects may therefore affect the whole supply chain and result in temporary bottlenecks, higher utilisation of other supply chains or even overcapacities of supply chain components. Furthermore, potential mining projects in untapped basins, such as the Galilee basin, are particularly prone to delays. Substantial capital expenditure is needed to expand the railway infrastructure of existing supply chains to support mine expansions. Overall, Australian export capacity utilisation is likely to remain high, but faces some downwards risks due to uncertainty surrounding Chinese coal demand development as well as a potential threat of too high export capacity additions.

Colombia

Expectations for Colombian export growth are high, since it has the highest potential for a significant increase in its coal mining capacity in relative terms. Colombia's maximum mining capacity was 84 Mtpa in 2011 and could increase up to 140 Mtpa in 2017. Yet, more than two-thirds of capacity additions (38 Mtpa) are classified probable; the remaining 18 Mtpa are considered to be potential additions. Mining capacities (85% to 90%) and port handling capacities (89% to 94%) were highly utilised in 2010 and 2011. Exports via Colombian ports were 76 Mtpa in 2011 and are projected to increase by 33 Mtpa to 108 Mtpa in 2017 in both the BCS and CSDC.

Steam coal comprises more than 90% of incremental exports, the rest being metallurgical coal (semi-soft coking coal and PCI). This projection is irrespective of the underlying scenario assumption regarding Chinese coal demand; as a low-cost supplier, Colombia is fully intramarginal to the market in both scenarios. Colombian exporters have a cost advantage over US and Russian suppliers in the Atlantic basin. Colombia's main competitor, South Africa, is better positioned to the Pacific basin and thus increasingly directs its exports to the Indian and Southeast Asian markets. After the Panama Canal expansion, competitiveness of Colombia in the Pacific market may increase.

Significant investment into mining and infrastructure capacity is needed over the outlook period to accommodate projected Colombian export growth. The pipeline for mining investments looks healthy in Colombia. In general, inland transport is not likely to be a limiting factor for exports over the outlook period. Transport distances are relatively short in Colombia and complementing truck haulage, at a higher cost, is an option for low-cost producers. However, as already stated in IEA (2011), port capacity bottlenecks could be a limiting factor for Colombian exports in the medium term, as port utilisation

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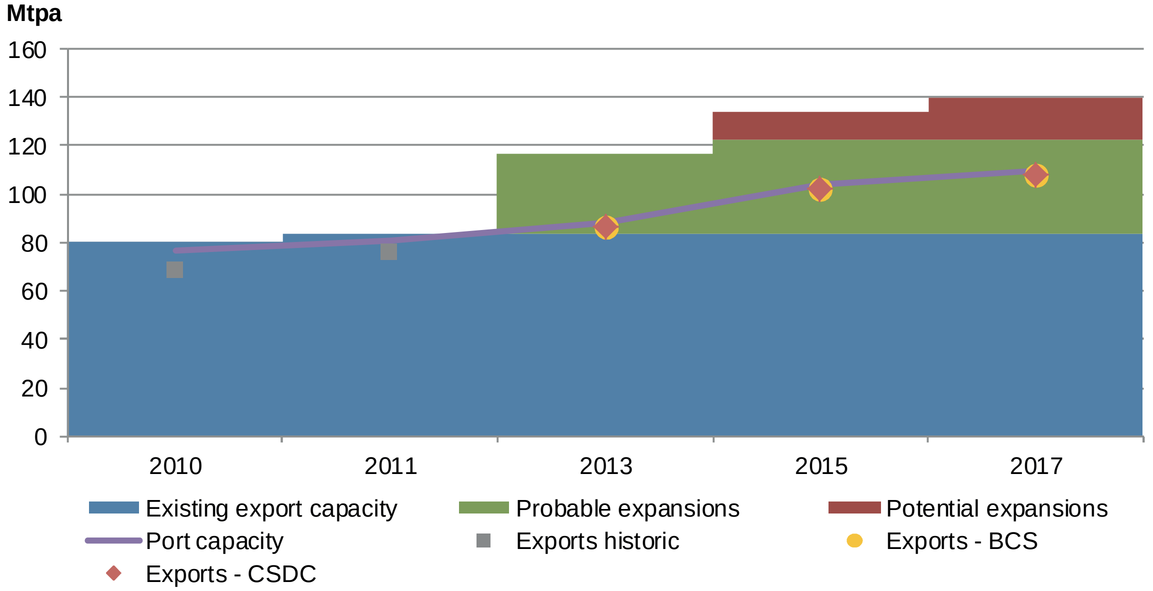
rates in the BCS are 95% or higher. Whether such a situation occurs depends on how fast mining and port capacities are expanded in the coming years. Delays in mine development could ease the tight turnover capacity situation. In Colombia, most supply chains are completely in the hands of one company or a group of companies. As such, port infrastructure investment decisions can be quick and construction accelerated once the imbalance between mining and port capacities becomes clear.

Figure 58 Outlook for Colombian export capacity utilisation for seaborne hard coal until 2017



Russia

Russian export mining capacity increased slightly compared from 2010 at 120 Mtpa in 2011 and may increase by up to 41 Mtpa over the outlook period. Probable additions to Russian export capacity – almost 12 Mtpa – are less than half of potential additions, which amount to 29 Mtpa. Port turnover capacity available to Russian exports (including in the Baltic States) stood at around 137 Mtpa in 2011. By 2017, export terminal capacity is projected to have further increased to 146 Mtpa. The majority of additions to port capacity are projected on the Russian Pacific coast to serve growing coal demand from Asian buyers.

In the BCS, Russian seaborne coal exports are projected to increase to 117 Mt in 2017, up by around 20% from 97 Mt in 2011. Both metallurgical and steam coal exports increase in this scenario. In the CSDC, which implies a lower trade market growth, Russian exports are projected to increase to 104 Mt. In this scenario, Russian steam coal exports increase only gradually, while Russian seaborne metallurgical coal exports double over the outlook period, albeit from a lower level (4 Mtpa in 2011). Although Russian mining costs are among the lowest in the world, inland transport costs are among the highest. Adding port charges and transit fees (in the case of the Baltic States), Russia is a high-cost supplier on an FOB basis. Therefore, Russia is to some degree a swing supplier in international coal trade. Russian thermal coal exports are 13 Mt lower in the CSDC. Since differences in total trade volume and supply costs between the two scenarios are lower for metallurgical coal than for steam coal, Russian producers of metallurgical coal are less affected by changing market conditions.

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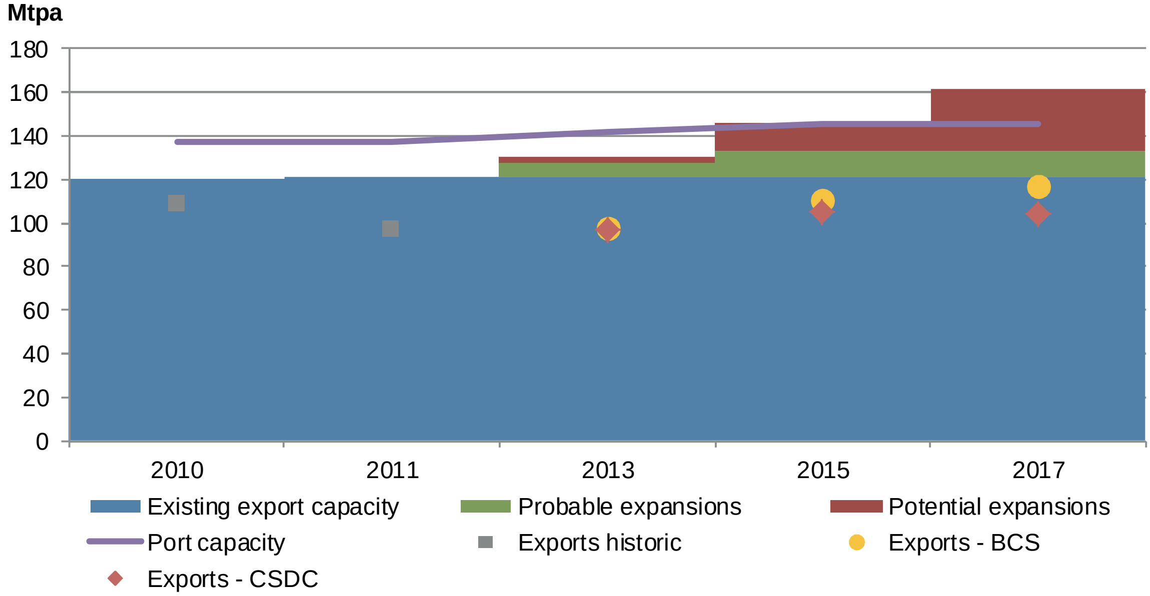
Figure 59 Outlook for Russian export capacity utilisation for seaborne hard coal until 2017



Mining capacity utilisation, high in the past, is projected to remain high over the outlook period. In the CSDC, all projects which current status is either "under construction", "approved" or "committed" need to be developed in time to keep mining capacity utilisation at healthy levels, *i.e.* around 80%. If all potential projects come online in the BCS utilisation rates would amount to 72% by 2017. Yet, export mining capacity in Russia is dynamic and also depends on domestic market conditions. Hence, Russian export mining capacity, as described here, is only a rough and rather conservative estimator for actual export mining capacity.

Although total port handling capacity clearly exceeds both mining capacity and projected exports, individual port utilisation rates vary substantially. With rapidly growing demand in the Pacific basin, Russian export volumes are increasingly directed to ports in East Asia over the outlook period, which leads to higher utilisation rates. For example, for several years Russia's eastern port of Vostochny, has surpassed Riga to become the most important terminal for Russian hard coal exports. Since demand growth in Europe is expected to remain rather sluggish over the outlook period, particularly with regard to steam coal, this trend will continue, leaving ports in the Baltic and Barents Seas increasingly less utilised over the next five years.

Besides substantial investments needed in the mining sector, railway capacity expansion is crucial for increasing Russian coal exports. Investments into railway links, connecting newly developed deposits to the national railway network, are as important as investments into rolling stock.

South Africa

South African export mining capacity may increase by up to 61 Mtpa over the outlook period. If all probable (14 Mtpa) and potential (47 Mtpa) projects are realised on time, South African export mining capacity may reach 143 Mtpa by 2017, up from 82 Mtpa in 2011. Already in 2010, RBCT, the major export hub for South African hard coal, reached a turnover capacity of 91 Mtpa. Some shipments are also handled by the port Maputo (Mozambique). No significant further port handling capacities are scheduled to become operational over the outlook period.

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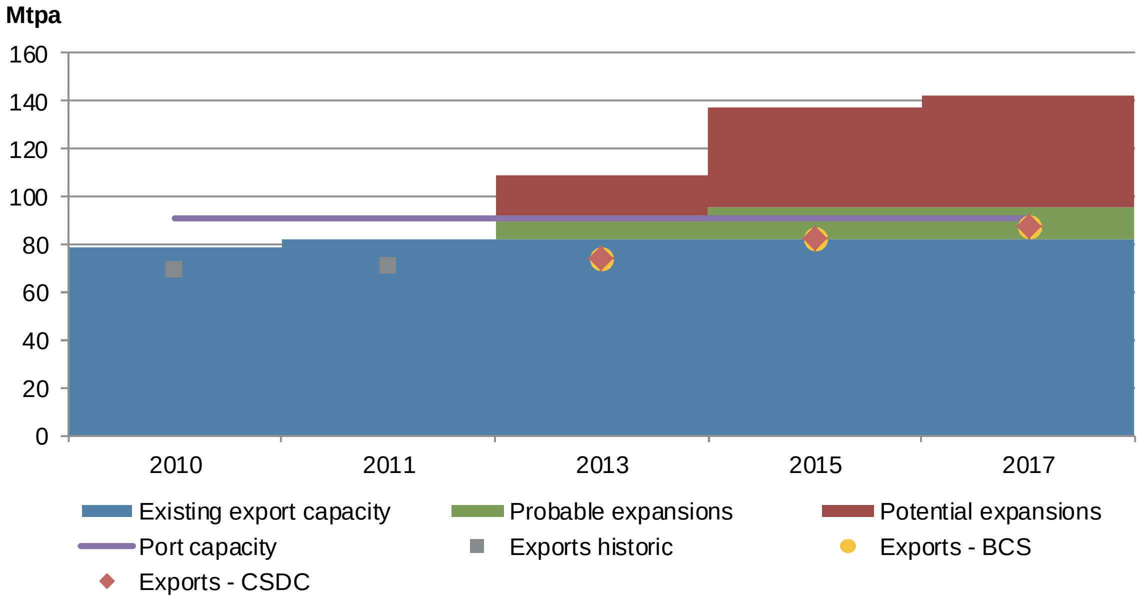
Export mining capacity utilisation was around 87% in 2010 and 2011. This relatively high utilisation stems from the fact that South Africa is a low-cost supplier and therefore usually intramarginal to the market. In both scenarios, South African hard coal exports grow by 17 Mtpa over the outlook period. Utilisation rates are projected to remain high – even exceeding 90% in 2017 – over the next five years if probable mining capacity additions are realised. South African exports could have been higher in the past if rail capacity bottlenecks on the major line from the Central basin to Richards Bay had not restricted them. With sufficient capacities both in mining and in port handling, expansion of railway capacity is key for increasing South African exports.

Figure 60 Outlook for South African export capacity utilisation for seaborne hard coal until 2017



Although substantial investments are needed in South Africa, investment conditions are not ideal. South African producers have low FOB costs and are geographically well located, but it is unclear if the notoriously constrained railway system can ramp up capacity as scheduled. Investment is low, capacity additions are delayed and production is inefficient. Furthermore, new players may encounter difficulties in securing a coal allocation slot at RBCT. Finally, recurring rumours about the introduction of a tax – of up to 50% – on mining rights, which is supposed to curb speculative investments in South Africa, may add to the uncertainty.

Indonesia

Indonesian export mining capacity is estimated at around 325 Mtpa in 2011 and is projected to increase to almost 400 Mtpa by the end of the outlook period. This figure may be perceived as a rather conservative estimate and substantially higher capacity additions are also conceivable in the medium term. In contrast, a few factors may negatively affect Indonesian export growth, such as increasing domestic demand, deteriorating geological conditions, a potentially increasing need to replace depleted export mines and uncertain financial capability.

The last factor, financial capability, may become crucial for a sustained Indonesian export growth. Uncertainty regarding foreign direct investment has been substantially increased as a result of the recent passing of a law limiting foreign ownership in Indonesian mines to 49% after ten years of production.

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The major determinant of Indonesian exports, identified in IEA (2011), will be cost developments over the outlook period. This relates to mining as well as inland transport when trucking is involved. Operations move further inland and transport costs therefore increase. Although road transport is more flexible in terms of capacity and less capital intensive, its variable distance-based haulage costs are the highest. Generally, coal supply costs in Indonesia are highly exposed to diesel price fluctuations, due to large-scale employment of truck-and-shovel mining methods and some road transport.

Another major issue influencing the future profitability of Indonesian operations is coal quality deterioration. The majority of Indonesian reserves consist of low calorific value coal that must be sold at a discounted prince on the international market. Indonesian coal qualities sold to international buyers have deteriorated in the past. This trend is expected to continue and additionally, deteriorating geological conditions (*e.g.* higher strip ratios) are projected to increase costs in some operations. Although costs remain relatively low for the majority of Indonesian export operations, a few suppliers are pushed into the high-cost third of the global supply curve. Yet Indonesia has a sea freight cost advantage in the Pacific basin over Australia and South Africa, its two main competitors in the Asian market, because of its geographic location.

Projected Indonesian exports do not vary substantially between the BCS and CSDC. In the CSDC, supply costs of a few Indonesian operations exceed the prices they can receive for their product and thus become extramarginal to the market. However, the majority of Indonesian coal exports are in the lower-half of the global supply cost curve. This leads to exports from other countries, such as Russia and Australia, crowded out in the CSDC compared to the BCS. In the CSDC, Indonesian exports increase to around 383 Mt in 2017, up from 309 Mt in 2011. Mining capacity utilisation remains high in Indonesia and is 95% in the CSDC and even at slightly above 95% in the BCS.

United States

Coal exports in the United States depend on factors such as costs, contractual obligations, domestic and international prices, and the willingness of buyers to accept lower-quality coal, *e.g.* high-sulphur thermal coal from the Illinois basin and the possibility of exporting coal from the PRB. Therefore, mining capacity attributable to international coal trade is difficult to assess. With coal exports just below 100 Mt at the beginning of the 1990s, US export infrastructure capacity is large scale and flexible. Due to a projected reduction of domestic coal demand over the next five years, with the bulk occurring in the power sector, the United States has a large potential to supply the seaborne market in the trade projections. US export mining capacity (including all coal types) that could potentially serve the seaborne market is estimated to be as high as 150 Mtpa, with no additions expected to take place in the next five years. In the BCS, an all-time high in hard coal exports of 114 Mt is reached by 2013, to be followed by a decrease in US exports by 12 Mtpa towards the end of the outlook period. In the CSDC, the picture in the United States looks gloomier towards the end of the outlook period, with hard coal exports plummeting to 48 Mt in 2017. As a consequence, utilisation rates of port handling and export mining capacities vary widely between the two scenarios. Depending on total coal demand, utilisation of US port capacity, for example, stands between 70% and almost 85% in the first half of the outlook period, but drops to less than 40% by 2017 in the CSDC.

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SPECIAL FOCUS: CHINA

The 11th Five-Year Plan (FYP) for the coal industry was issued by the Nation Development and Reform Commission (NDRC) in January 2007. The plan identifies major tasks within the country's coal industry. Firstly, to optimise the distribution of coal production capacity across different mining districts by developing 13 large-scale coal production areas. Secondly, to establish large-scale coal mining groups by consolidating the mining industry and retrofitting small- and medium-scale coal mines. Lastly, the plan encourages scientific innovations in the coal industry, and the improvement of environmental compatibility and safety of coal mining.

During the 11th FYP (2006-10), 13 large coal basins were developed as planed, including 98 mining districts, covering a land area of 103,388 square kilometres (km^2). Total reserves of these areas are estimated to be 691 gigatonnes (Gt), however, coal quality varies substantially within and among the areas. By 2010, supply from these 13 production areas reached 2.8 Gt, accounting for 86% of total Chinese coal supply. At the same time, 9 616 small coal mines[24] were shut down, eliminating 540 million tonnes per annum (Mtpa) of backward production capacity during the time period from 2006 to 2010.

Box 10 Coal industry consolidation in Shanxi province

Shanxi province is second-largest coal producing region in China, producing 741 million tonnes (Mt) in 2010. Since 2008, efforts have been in effect to reduce the province's number of coal miners by closing small coal mines and consolidating the mining industry. The provincial government publically encouraged both state-owned and privately owned coal companies to conduct mergers and acquisitions, not only within the coal industry, but also in the power sector, and metallurgical and chemical industries through equity transactions and shareholding. The government also issued taxation and financing policies (a fund provided by the regional government) to assist the bigger coal miners in improving safety conditions and upgrading applied technology in the smaller coal mines. In 2010, Shanxi province announced that 98% of all planned mergers and acquisitions were complete, while more than 80% of all mining licenses had changed ownership. The number of coal mine shafts has decreased from 2 600 to 1 053 by the end of 2010 (VDKi, 2012) and more than 70% have an annual production capacity of more than 0.9 Mt. Six large coal groups – Shanxi Coal Transportation and Sales Group, Shanxi Coking Coal Group, Lu'an Group, Yangquan Coal Industry Group, Jincheng Anthracite Mining Group and Datong Coal Mine Group – became leading producers in Shanxi province as a result of the consolidation process. Shanxi aims to cut down the number of coal mines to 800 by 2015 accompanied by plans to increase average annual production capacity to 1.2 Mtpa.

In March 2012, NDRC released the 12th FYP for the Chinese coal industry (2011-15), which focuses primarily on sustainable development. Consequently, expanding production and transport capacity is not the sole target of the 12th FYP, but instead, it stresses the importance of improving operational efficiency to alleviate the coal industry's environmental impact. For example, measures to consolidate Shanxi's coal industry are expected to be introduced to the rest of the country (see below for more details). Small-scale private coal mines in other parts of China's are likely to be either merged with state-owned enterprise (SOE) mines or shut down. Hence, SOE mines will expand in order to improve operational efficiency.

[24] Small coal mines usually refer to township or village based (TVE) coal mines with a production capacity of less than 0.3 Mtpa, as well as some state-owned coal mines (SOE) and private coal mines (PVE). Generally, most of the mines have only 1 or 2 pits, with a value of annual sales below CNY 30 million (app. USD 4.6 million).

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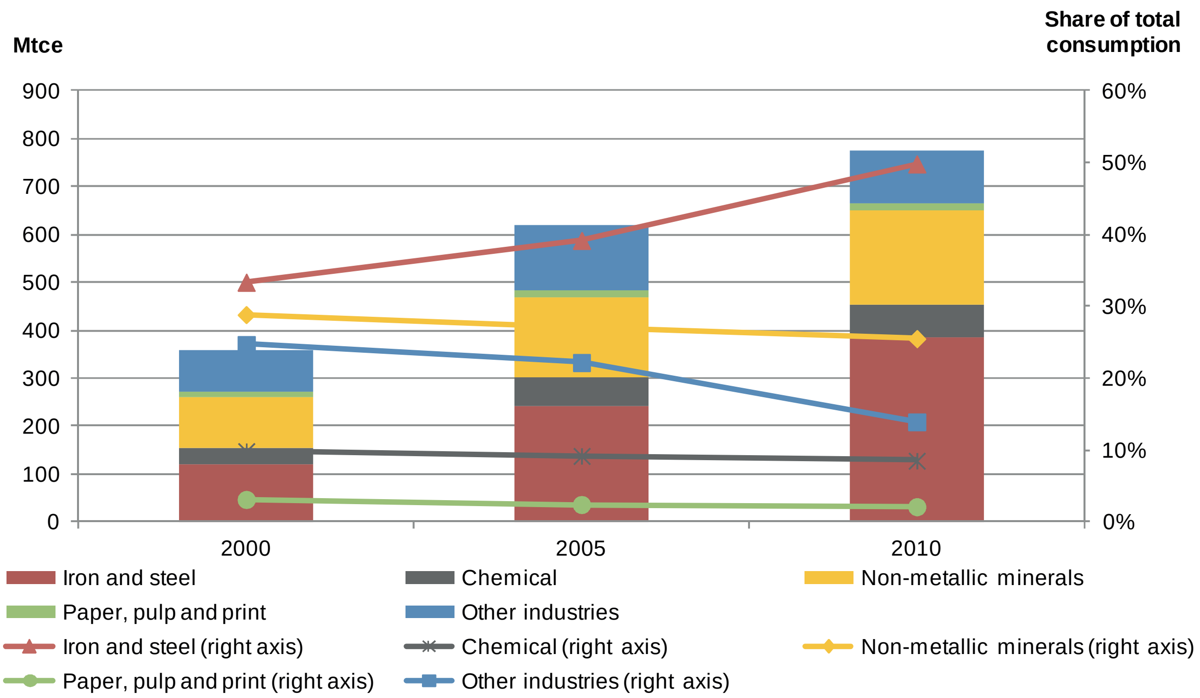
Box 11 Beijing switches from coal to gas to go green

Beijing will make its coal-fired power generation plants and heating facilities go green amid public concern over the city's air quality. In early 2012, the Beijing Development and Reform Commission (BDRC) announced a new round of targets to cut coal use, with the aim of improving the environment, particularly air quality. The city's original plan was to cap coal use at 15 Mt a year by 2015, the end of the 12th FYP period. Now, it will extend and deepen this cap, cutting annual consumption to 10 Mt by 2020, a 60% drop from 2010 figures.[25] Natural gas is a core part of the strategy to wean the city off of coal. According to plans released in 2010, Beijing's four remaining coal-burning heat and power (CHP) plants are due to switch over to natural gas combined heat and power systems by the end of 2014. According to the BDRC, an estimated CNY 80 billion (about USD 13 billion) will be invested to switch the city's coal-fired power plants and heating facilities to natural gas.

Non-power coal consumption in China

Chinese coal consumption reached 3 183 Mt in 2010, equivalent to 45% of global coal consumption and an increase by more than 130% from 2000 levels (1 377 Mt). According to the 12th FYP, even with significant improvements in efficiency among power and industry sectors, Chinese annual coal consumption is targeted to reach 3 900 Mt by 2015.

Figure 61 Final coal consumption by industries, 2000-10



The surge of Chinese coal consumption between 2000 and 2010 was largely driven by the marked increase in the iron and steel industry (217%), which accounted for 23% in 2000 and 36% in 2010, of final coal consumption by the industrial sector (Figure 61). Over the same period, coal use in the non-metallic minerals sector grew steadily from 104 million tonnes of coal equivalent (Mtce) in 2000 to

[25] Coal consumption of Beijing in 2010 stood at 26.35Mt (NBS, 2011b).

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198 Mtce in 2010 (91%), which is equivalent to a share of 33% in total final coal consumption by the industry in 2010. Other important coal consuming industrial sectors include the chemical industry, with a share of 11% in total industrial consumption, and the paper, pulp and print industry with a share of 3%. The balance of final industrial consumption, 108 Mtce (18%), is accounted for by other industries with the bulk consumed by the mining and quarrying industry (approximately 56 Mtce). Other industries also include sectors such as the textile industry (approximately 1.3 Mtce) or coal used in the processing of food from agricultural products (1 Mtce).

Iron and steel industry

China's iron and steel industry has expanded significantly in the past few years, reflecting a boom in construction and infrastructure development, as well as strong demand for consumer durables. From 2000 to 2010, crude steel output in China grew from 128 Mt to 626 Mt (NBS, 2011a), at an average growth rate of 17.2% per year. In comparison, coal consumed by the iron and steel industry (coal use in blast furnaces and coke ovens, as well as for final consumption) grew from 120 Mtce to 386 Mtce in 2010, which corresponds to an average annual increase of 12.4% over the same period; this implies a marked gain in productive efficiency in the Chinese iron and steel production and also increased steel scrap recycling. Parallel to this, the ratio of coke over steel at key Chinese iron and steel mills has fallen since 1994, reaching 374 kg per tonne of crude steel in 2009 (Huang *et al.*, 2010). Moreover, the average comprehensive energy intensity of steel is reported to have decreased from 694 kilogrammes of coal equivalent per tonne (kgce/t) in 2005 to 605 kgce/t in 2010.

In recent years, China's central government has started actively promoting a more sustainable iron and steel industry (circular economy[26]) encouraging widespread energy savings, emission reductions, increased steel scrap recycling rates and resource conservation as necessary foundation of the circular economy. Consequently, energy conservation in the iron and steel industry has improved significantly and the industry's emissions have dropped since 2000. Energy conservation technologies adopted in China include coke dry quenching (SDQ), top-pressure recovery turbine (TRT), recycling converter gas, recycling waste heat from converter steam, continuous casting, slab hot charging and hot delivery, coal moisture control (CMC), and recycling waste heat from sintering.

Table 15 Development of select indicators for the Chinese iron and steel industry

	2005	2010	2015
Market share of top 10 companies (%)	35	49	60
Average comprehensive energy intensity (kgce/t)	694	605	580
Fresh water consumption (m^3/t)	8.6	4.1	4.0
SO_2 emissions (kg/t)	2.8	1.6	1
Chemical oxygen demand (kg/t)	0.3	0.1	0.1
Comprehensive utilisation of solid waste (%)	90	94	97
R&D/operating revenue (%)	0.9	1.1	1.5

Source: MIIT, 2011a.

According to the 12[th] FYP for the Chinese iron and steel industry, released by the Ministry of Industry and Information Technology in October 2011, increased merger and acquisitions will create larger, more efficient companies. Large steel makers are expected to focus more on upgrading applied technologies and putting greater emphasis on autonomous innovation, *i.e.* increased R&D efforts in

[26] A circular economy can be defined as an economy in which particular attention is paid to using resources efficiently following the rules of reducing, reusing, and recycling.

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high-end steel products and their applications. As more steel makers have emerged in China, the geographical structure of the industry has become increasingly dispersed, resulting in. higher transport costs. Hence, the iron and steel industry is expected to improve its distribution network by relocating companies to coastal areas, closer to centres of large demand. The growth rate of the Chinese iron and steel industry is set to slow during this period, with forecasts ranging from 5% to 6%, compared to the average annual growth rate of 17% during the 10th and 11th FYPs.

Coking

China has 94.9 Gt of coking coal resources, 16.5% of which are recoverable. More than half of the country's coking coal reserves are located in Shaanxi province. Shanxi, Shandong, Anhui, Heilongjiang and Henan province are the main producing areas of coking coal, with Shanxi ranking first with an annual output of 85 Mt in 2010 or 22% of the country's total.

According to the China Coking Industry Association, China's production of coke in 2010 was over 380 Mt, which equates to a share of approximately 65% of global coke production. For the Chinese production of coke, 540 Mt of washed coal was consumed (China Coking Industry Association, 2011). In 2010, Chinese coke consumption stood at 362 Mt, up by 8% from 2009 levels. The iron and steel industry is by far the biggest consumer of coke and due to rapid growth of the country's iron and steel output, the industry's coke consumption almost doubled from 2004 to 2009, increasing from 150 Mt in 2004 to 294 Mt in 2010.

According to a publication issued by Shanxi's provincial government in 2011, the coking sector in Shanxi is expected to see the following changes during the 12th FYP period:

Table 16 Restructuring of Shanxi's coking industry in the 11th and 12th FYPs

	11th FYP	12th FYP
Production capacity (Mtpa)	140	120
Elimination of backward capacity (Mtpa)	20	40
Number of companies	150	60

Note: numbers in the table refer to the end of the respective five-year period. Elimination capacity refers during the period.

Source: Shanxi provincial government, 2012.

By 2015, Shanxi is expected to have eliminated coking production capacities by 40 Mtpa in small factories. At the same time, the number of individual coking companies is projected to decrease by 75%, while the average production capacity of the remaining coking companies is estimated to increase by 400%.

By the end of 2013, Shanxi's provincial government plans to have established three large-scale coking companies, each with an annual production capacity of 10 Mt, and another ten companies with annual production capacities of 5 Mt. According to the Ministry of Industry and Information Technology, the coking industry eliminated 18.7 Mt of backward capacity[27] in 2011, while the iron and steel industry eliminated 26.5 Mt during the same period. Consequently, the decrease in coking capacity is even larger than the decrease in coke demand in the iron and steel industry since, depending on the use of pulverised coal injection (PCI) coal, 26.5 Mt of steel production capacity equals roughly 16 Mt of coke demand.

[27] From a technology perspective, backward capacity refers to those production processes or machinery which's efficiency is lower than the industry's average level, *i.e.* it refers to production capacity with *e.g.* above-average emissions, energy consumption, and water consumption levels.

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Chemicals

Coal has a long tradition as a dominant fuel and feedstock in China's chemical industry. Final coal consumption in the Chinese chemical sector has increased by 87%, or 6.4% per year, since 2000 to reach 66 Mtce in 2010. The chemical sector's aggregate energy consumption increased by the same percentage over this period to 346 Mtce in 2010 (Tu, 2011).

Coal conversion

China has actively pursued coal liquefaction technology since the 1950s. Throughout this time, China has treated coal-to-liquids (CTL) as a research and development topic, yet this mindset has changed over the last two decades as CTL moved from laboratories to large-scale demonstration projects. In August 2004, China's largest coal mining group, Shenhua Group, began the world's first commercial-scale direct coal liquefaction plant in Inner Mongolia. With an annual capacity at 1.1 Mtpa, the first phase of the project has a price tag of CNY 12.3 billion (approximately USD 1.9 billion). A trial operation of the plant achieved continuous operations of 303 hours in December 2008. In 2011, the output stood at 800 kilotonnes and generated an annual profit of CNY 400 million (more than USD 60 million).

Table 17 Major CTL projects in China

Developer	Location	Capacity (ktpa)	Investment (billion USD)	Process	Note
Shenhua	Inner Mongolia	1 080	2.0	Trial operation since Dec 2008	One of the three direct CTL trial plant at phase one (3 240 Mtpa in total)
Shenhua	Inner Mongolia	180	n/a	Depending on the direct CTL unit	Indirect CTL unit added to the above direct CTL process
Shenhua and Sasol	Ningxia	3 000	4.8	Feasibility study	Indirect CTL: the possibility for Shenhua to implement the project without Sasol
Lu'an Group	Shanxi	160	0.6	Trial operation in Dec 2008	Indirect CTL: Lu'an to construct a 3 Mtpa indirect CTL plant later and eventually expand its CTL capacity to 15 Mtce per annum
Yitai Group	Inner Mongolia	160	0.4	Trial operation in Mar 2009	The first commercial-scale indirect CTL unit in China
Gun Mining Group	Shaanxi	1 000	1.7	Approved in Jan 2008	Phase one: 5 Mtpa with a price tag of CNY 50 billion; phase two: 10 Mtpa

Note: investments were converted into USD assuming an exchange rate of 0.16 USD/CNY.

Source: Tu, 2011.

In July 2006, NDRC issued an order that required local governments not to approve any CTL project with annual output below 3 Mt and to temporally suspend any new project review. Since then, NDRC issued three more project suspension notices to help cool down the industry in the following years. In 2009, NDRC issued the *Notice on Strengthening the Management of Coal Chemical Projects* and *Promoting Sound Development of Coal Industry* to regulate the minimum capacity of coal chemical projects. These capacities were set at 3 Mtpa for CTL projects, 1 Mtpa for coal-based methanol and dimethyl ether projects, as well as 0.6 Mtpa for coal-based olefins projects. To ensure the rational use of resources, lignite and sub-bituminous coal with low calorific value should be used for coal liquefaction rather than higher quality bituminous coal.

According to the NDRC, the *Deep Processing of Coal Demonstration Project Plan* is scheduled for publication in late-2012. The plan will approve 15 demonstration projects, including 18 key gasification

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and synthesis technologies located in Inner Mongolia, Xinjiang and another nine provinces. The projects include Xinjiang's Ili 5.5 billion cubic meters (bcm) coal-to-gas and electric integration project, Xinjiang's Zhundong coal-to-gas and electric integration project, Inner Mongolia's Erdos 3 Mtpa CTL project and Yulin's 1 Mtpa CTL project to name but a few.

Non-metallic minerals

In the first decade of 21st century, coal consumed by the non-metallic minerals industry[28] grew by 91% from 104 Mt to 198 Mt, and thus accounted for one-fourth of total final coal consumption by industries in 2010.

Table 18 Indicators of the building materials sector in the 12th FYP

Sectors	Production (2010)	Historic CAGR (2005-10)	Expected production (2015)	Expected CAGR (2011-15)
Cement	1.9 billion tonnes (Bt)	12%	2.2	3.3%
Flat glass	660 million weight cases	11%	750	2.6%
Building ceramics	7.8 billion m^2	13%	9.5	4.0%
Sanitary ceramics	170 million pieces	16%	200	3.3%

Source: MIIT, 2011b.

Currently, China ranks number one in the world for cement, flat glass and ceramics production. In 2010, cement output stood at 1.9 Gt in China, while Chinese production of flat glass amounted to 660 million weight cases. In addition, Chinese companies supplied 7.8 billion square meters of building ceramics and 170 million pieces of sanitary ceramics in 2010. Sales revenue of the building materials industry increased by 29.5% to reach CNY 2.7 trillion (approximately USD 0.4 trillion) to generate an annual profit of CNY 200 billion (more than USD 30 million), an increase of 42% from the year before (MIIT, 2011b).

Cement

China is the world's largest market for cement, producing and consuming over half of the world's total. In 2010, cement output reached 1.9 Bt and grew at an average rate of 12% over the last five years. Dry-process cement clinker capacity reached 1.3 Bt which is 2.6 times the capacity of 2005. New type dry-process cement clinker capacity accounted for 81% of these capacities. In addition, the cement industry eliminated 340 million tonnes of backward capacity from 2005 to 2010. Consequently, the comprehensive energy consumption per tonnes of cement declined from 129 kgce in 2005 to 115 kgce 2010 (MIIT, 2011c).

In 2011, the Ministry of Industry and Information Technology (MIIT) issued the 12th FYP for the cement industry. There are a number of highlights in this plan. Firstly, domestic output is expected to reach 2.2 Bt by the end of 2015, which corresponds to a compound average growth rate of 4%. Secondly, concentration in the cement industry is expected to grow until 2015 since by then, the number of suppliers should be reduced by one-third compared to 2010 levels. According to the plan, the market share of the top ten Chinese producers is scheduled to grow from 25% in 2010 to 35% in

[28] This industrial sector includes manufacturing activities related to a single substance of mineral origin. It includes the manufacture of glass and glass products (*e.g.* flat glass, hollow glass, fibres, technical glassware, etc.), ceramic products, tiles and baked clay products, and cement and plaster, from raw materials to finished articles. The manufacture of shaped and finished stone, and other mineral products is also included in this sector.

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2015. Thirdly, the plan aims to eliminate 250 Mt of backward production capacity during the 12th Five-Year Plan. In order to do so, the plan sets higher emission control standards, *i.e.* cement producers need to cut emissions of nitrogen oxide by 10% and sulphur dioxide by 8%. Furthermore, the Chinese cement industry, being highly energy-intensive, is focused strongly on using alternative sources of energy and applying sustainable practices.

Table 19 Overview of the 12th FYP for the cement industry

	2010	2015	Change 2010-15 (in %)
Elimination of backward capacity (Mt)		250	
Market share of the top 10 producers (%)	25	35	
CO_2 emissions per unit of IVA			-17
No_x emissions			-10
SO_2 emissions			-8
R&D/operating revenue (%)		>1.5	

Source: MIIT, 2011c.

In addition, China's 12th FYP for national economic and social development is expected to provide opportunities to grow for the domestic cement industry. While industrialisation and urbanisation require large amounts of cement and building materials, the construction of highways or infrastructure to enhance water conservation and other infrastructure projects increase demand for cement. Recently, NDRC announced that the total investment budget for low-income housing in 2012 will increase by CNY 20 billion (approximately USD 3.2 billion) compared to 2011, in order to increase total units under construction in 2012 to 17 million, compared with 10 million units the year before. The government also revealed that the total investment volume spent on water conservation until 2015 would be as high as CNY 1.8 trillion (USD 0.3 billion). Furthermore, in 2011 the Ministry of Railways has launched a series of favourable repayment incentive schemes for railway construction companies. Thus, high-speed railway investment is also expected to recover in 2012, creating additional demand for cement. Considering these developments, the production of cement is projected to reach 2.2 Bt by 2015, resulting in coal use for cement production to increase to 253 Mtce.[29]

Paper

The output of paper and cardboard products in China grew from 56 Mt in 2005 to 93 Mt in 2010 and accounts for over 17% of the world's total. The Chinese paper and pulp industry is perceived as being rather fragmented as most of the industry's companies are small or medium-sized. Hence the top ten largest Chinese companies control about 20% of the total domestic market with the balance spread across a wide range of small companies. The industry is geographically fragmented as well, with companies operating across 30 Chinese provinces. Despite the marked increase in output, improvements in technological efficiency caused the chemical oxygen demand (COD) of China's paper manufacturers to drop from 1.6 Mt to 0.95 Mt (41%) in the time period from 2005 to 2010. Just like COD, the comprehensive energy consumption per ton of paper and cardboard declined from 0.8 tce (tonnes of coal equivalent)/t to 0.7 tce/t during the same period.

The industry's 12th FYP, released in December 2011, targets balanced growth of total paper and cardboard consumption and production, with both projected to grow on average by 4.6% per year

[29] To produce 1 tonne of cement around 115 kgce is needed, taking into account direct coal use in the production process as well as coal used to generate electricity which is used in cement production.

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until 2015. The published version of the 12th FYP is largely in line with market expectations for a lower growth target and demand and supply rebalancing, as well as industry optimisation. The plan also provides a target for lowering energy and water consumption by 18% by 2015, while total emission of COD is planned to decrease by 10% to 12%. Part of the solution for decreasing the industry's emissions is to increase usage of alternative fuels and, as such, the use of bioenergy is scheduled to increase by 20% until 2015.

Table 20 Overview of the 12th FYP for the pulp and paper industry

	2010	2015	Change 2010-15 (in %)
Production (Mt)	93	116	4.6
Consumption (Mt)	92	115	4.6
Average comprehensive energy intensity of paper and cardboard (tce/t)	0.7	0.5	-4.9
Average comprehensive energy intensity of pulp (tce/t)	0.5	0.4	-3.8
Emission of COD			10 - 12
Emission of NO_x, NH_x			10
Elimination of backward capacity (Mt)		>10	

Source: NDRC, MIIT and NBF, 2011.

Coal transport

Coal supply and consumption are not equally distributed across China. While the bulk of Chinese coal consumption is located in the south and along the coast, Chinese supply can be found more to the north and the west of the country. Consequently, coal transport plays a major role in meeting Chinese coal demand. Railways are by far the most important method of coal transportation in China. The other options are by waterway (including inland waterways and coastal marine transport) and by road.

Figure 62 Total cargo tonnage by rail and coal transported by rail in China

Source: MOR, 2011.

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China's multiple railway networks are divided across the country. The national railway network is owned and operated by the Ministry of Railways and the provincial railway bureaus. Joint venture railways are a product of foreign investment and while their importance is rising it remains small. Captive coal railways are owned by Shenhua (*e.g.* Shen-Shuo-Huang railway). Currently, several Chinese state-owned companies (*e.g.* several large-scale utilities) have planned their own captive coal transport capacity. The volume of coal and coal products moved by rail increased from 629 Mt in 1990 to 2 000 Mt in 2010. Hence, in 2010, more than half (55%) of total cargo tonnage hauled by rail in China was coal. Yet, as a result of bottlenecks in railway transport, the share of coal transported by rail in total coal transport has decreased. In contrast, coal and coal products transported by waterway, especially along the coast from Northern to Southern China, has gained importance, with coal throughput at the major coastal ports having increased rapidly from 78 Mt in 1990 to 556 Mt in 2010 (NDRC, 2011). Road transport, which has the highest variable costs per tonne of coal transported among those three options, is only an economically viable option for shorter transport distances, and has thus remained a supplement mode for moving coal within China.

The 3-Xi region, which includes parts of Shanxi, Shaanxi and Inner Mongolia, is China's primary coal producing region. Together with East Ningxia and Gansu, the 3-Xi region supplies the bulk of inner-province coal transport volumes. Exporting regions refer to those that produce more coal than they consume (corrected for changes in stock volumes), whereas the opposite is true for importing regions.

Map 2 Coal exporting and importing regions in China, 2010

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Note: data for Chinese Taipei not available.

Source: NBS, 2011b.

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Major coal transport corridors

The majority of China's coal resources lie in the 3-Xi region. As such, major consuming centres located on the coast have two key coal transport corridors: the west-to-east corridor, which includes the Da-Qin line, the Shi-Tai line and the Hou-Yue line, and; the north-to-south corridor, which includes the Beijing-Shanghai line, the Beijing-Kowloon line, the Beijing-Guangzhou line and the Jiao-Liu line, and a railway under construction that will connect the west of Inner Mongolia and Northern Shaanxi to Hubei, Hunan and Jiangxi.

West-to-east corridor

The development of coal volumes transported on the three major transport routes in the west-to-east corridor from 2004 to 2009 are listed in Table 21. Total transport volume has increased on average by more than 13% per year, up from 465 Mt in 2004 to an estimated 872 Mt in 2009. Over the course of the 11th Five-Year-Plan, actual transport volumes in the west-to-east corridor grew faster than forecast; transport volume amounted to 872 Mt in 2009, whereas planned transport capacity for 2010 had been projected at 780 Mt in the 11th FYP for railways (published in 2006).

Table 21 Development of transport volumes on the three coal transport routes in the west-to-east corridor, 2004-09, in Mt

Transport route/line	Start	End	2004	2005	2006	2007	2008	2009
Northern route			**309**	**351**	**427**	**522**	**565**	**564**
Da-Qin line	Datong	Qinhuangdao	153	203	250	304	340	330
Shuo-Huang line	Shenchinan	Huanghua	75	94	112	133	135	149
Jing-CNY line	Beijing	Yuanping	18	11	17	22	20	20
Ji-Tong line	Jininnan	Tongliao	13	14	5	10	20	15
Feng-Sha-Da line	Fengtai	Datong	50	30	42	53	50	50
Middle route			**67**	**72**	**76**	**70**	**76***	**98***
Shi-Tai line	Shijiazhuang	Taiyuan	61	67	69	62	68	90
Han-Chang line	Handan	Changzhibei	6	5	7	8	8*	8*
Southern route			**89**	**109**	**175***	**190***	**210***	**210***
Tai-Jiao line	Xiuwen	Jiaozuobei	43	40	50	50	70	70
Hou-Yue line	Houma	Yueshan	24	52	105	120	120	120
Xi-Zheng line	Xi'an	Zhengzhou	13	9	11	11*	11*	11*
Xi-Kang line	Xi'an	Ankang	4	5	5*	5*	5*	5*
Ning-Xi line	Xi'an	Nanjing	5	4	4*	4*	4*	4*
Total			**465**	**532**	**678***	**782***	**851***	**872***

*Estimate.

Source: Tu, 2011.

North-to-south corridor

Inland coal transport in the north-to-south corridor follows more complex routes. Major southbound railway lines, such as Jing-Jiu and Jing-Hu can move coal directly from North China to Central South and Southeast China. Railways in East China are connected to ports along the Jing-Hang Great Canal, where coal can be moved along the canal to the Yangtze River Delta. Wanzai Port, located in the Yantze River Delta at the intersection of Jing-Hu line (from Beijing to Shanghai), Long-Hai line (Lanzhou to Lianyungang) and the Jing-Hang Great Canal (Beijing to Hangzhou) is an increasingly important regional coal hub as it connects lines running north to the south with ports along the Yangtze River such as Zhicheng, Hankou, Yuxikou, and Pukou.

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Integrated rail-waterway transport is the preferred option for coal transport from the 3-Xi region (Shanxi, Shaanxi and West Mongolia) and East Ningxia to East and Southeast China. The so-called *Northern Seven* (N7) ports are the primary linkage between rail lines travelling the west-to-east coal transport corridor and the north-to-south coastal marine transport corridor. The N7 ports include Qinhuangdao Port in Hebei, Jingtang Port in Hebei, Tianjin Port in Tianjin, Huanghua Port in Hebei; Qingdao Port in Shandong, Rizhao Port in Shandong, and Lianyungang Port in Shandong. Together they account for almost 90% of total coal throughput handled by Chinese coastal ports in 2010 (556 Mt).

Table 22 lists the development of coal throughput at the N7 ports from 2006 to 2010 and their primary railway connection through which these ports are interconnected. In 2009, total coal hauled via the west-to-east corridor reached an estimated 872 Mt. In comparison, the aggregated throughput of the N7 ports was 406 Mt, with most cargoes destined to end-users in East and Southeast China. More specifically, coal from Shanxi and Inner Mongolia is primarily transferred at Qinhuangdao and Tianjin. Coal from Shaanxi is primarily transferred at Tianjin and Huanghua, and coal from Shandong is primarily transferred at Rizhao.

Table 22 Development of coal throughput at N7 ports, 2006-10

Port	Transport volume (in Mt)					Railway connection
	2006	2007	2008	2009	2010	
Qinhuangdao	177	214	218	201	220	Da-Qin line, Jing-Qin line
Tianjin	72	90	98	54	63	Huang-Wan line, Jing-Jin line
Jingtang	14	16	40	40	91	Jingtang port line, Da-Qin line
Huanghua	80	82	72	78	88	Shen-Shuo-Huang line
Qingdao	9	13	15	11	11	Jiao-Ji line
Rizhao	17	15	18	14	11	Xin-Shi line
Lianyungang	16	14	15	8	6	Long-Hai line
Total	**383**	**443**	**475**	**406**	**490**	

Source: NEA, 2011.

Qinhuangdao is China's largest port in terms of coal handling capacity and actual throughput of coal. The port of Qinhuangdao's main railway connection is the Da-Qin line, which primarily transports coal from mines owned by China National Coal, Shenhua Group, and Yitai Group located in the 3-Xi region, as well as in East Ningxia. After receiving coal via the Da-Qin line, it is eventually sent along the coastal line to the south. Around 85% of total coastal shipping volume are destined for East China (Shanghai and Zhejiang) and Southeast China (Guangdong, Shenzhen and Fujian), with the balance going to Guangxi and Shandong.

Outlook

According to the 12th FYP for the coal industry, by 2015 Chinese coal transported via railways is projected to be 2.6 Bt, which corresponds to an average annual growth of 5.4% over the outlook period of the 12th FYP. In order to accommodate this increase in transport volume, railway capacity dedicated to coal is expected to grow to around 2.8 Gt to 3 Gt by 2015. The bulk of the transported coal is going to be provided by a few number of producing provinces such as Shanxi, Shaanxi and Inner Mongolia which are expected to provide a net outflow of 1.58 Gt. Key destinations are East China, Jingjinji,[30] Central South and Northeast China. The Lan-Xin line and the Lan-Yu line, which are currently under construction, will provide transport capacity for coal supply from Xinjiang. By 2015,

[30] Beijing, Tianjin and Hebei province.

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Xinjiang province is expected to generate an outflow of 30 Mt to meet demand in Western Gansu, Qinghai and the Sichuan-Chongqing region. Finally, around 50 Mt will be exported from Yun-Gui to Guangdong, Guangxi, and Hunan. In total, net outflow from producing regions is estimated at 1.66 Gt by the end of the 12th FYP (NDRC, 2012).

Map 3 Inter-regional coal flow in 2015 according to the 12th FYP for the coal industry

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

In addition to railway transport, China will continue to rely on coal transport by road, at least for short-distance transport and mines without access to the railway system. This notion is underpinned by the 12th Five-Year Development Plan for road and water transportation (MOT, 2011b) which targets an increase in the total length of national highways and expressways by 46% from 74 000 km in 2010 to 110 000 km in 2015, as well as the length of paved roads in and between counties and villages by 13%, reaching a total length of 3.9 million km in 2015. The expansion of road infrastructure is especially beneficial to small TVE mines, which rely heavily on road transport, trucking their coal to end-users due to lack of access to national railway network.

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TABLES

Table 23 Coal demand, 2010-17, Base Case Scenario (BCS), in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	1 545	1 525	1 496	1 473	1 457	-0.8%
OECD Americas	768	745	683	663	653	-2.2%
United States	718	697	636	612	600	-2.5%
OECD Europe	423	426	450	445	436	0.4%
OECD Asia Oceania	354	353	363	364	368	0.7%
Non-OECD	3 507	3 754	4 042	4 359	4 712	3.9%
China	2 387	2 562	2 757	2 965	3 190	3.7%
India	410	446	501	566	643	6.3%
Africa and Middle East	157	152	158	166	176	2.5%
Eastern Europe/Eurasia	312	336	336	336	337	0.1%
Other developing Asia	212	225	252	284	320	6.1%
Latin America	29	34	37	42	46	5.1%
Total	**5 053**	**5 279**	**5 538**	**5 832**	**6 169**	**2.6%**

* Estimate.

Table 24 Coal demand, 2010-17, Chinese Slow-Down Case (CSDC), in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	1 545	1 525	1 500	1 485	1 476	-0.5%
OECD Americas	768	745	684	666	656	-2.1%
United States	718	697	637	615	604	-2.4%
OECD Europe	423	426	452	450	443	0.6%
OECD Asia Oceania	354	353	364	370	377	1.1%
Non-OECD	3 507	3 754	3 982	4 187	4 406	2.7%
China	2 387	2 562	2 696	2 791	2 881	2.0%
India	410	446	501	566	643	6.3%
Africa and Middle East	157	152	158	166	176	2.5%
Eastern Europe/Eurasia	312	336	336	336	337	0.1%
Other developing Asia	212	225	253	286	323	6.2%
Latin America	29	34	38	42	47	5.3%
Total	**5 053**	**5 279**	**5 482**	**5 672**	**5 883**	**1.8%**

* Estimate.

Table 25 Coal production, 2010-17, BCS, in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	1 402	1 408	1 431	1 413	1 421	0.2%
OECD Americas	815	828	794	763	759	-1.4%
United States	760	771	741	706	697	-1.7%
OECD Europe	241	244	252	245	235	-0.7%
OECD Asia Oceania	345	335	386	404	427	4.1%
Non-OECD	3 757	4 101	4 107	4 419	4 748	2.5%
China	2 346	2 593	2 575	2 774	2 986	2.4%
India	349	362	368	399	440	3.3%
Africa and Middle East	211	210	215	235	252	3.1%
Eastern Europe/Eurasia	408	433	426	437	442	0.3%
Other developing Asia	368	419	429	464	511	3.4%
Latin America	75	83	93	110	118	5.9%
Total	**5 158**	**5 508**	**5 538**	**5 832**	**6 169**	**1.9%**

* Estimate.

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Table 26 Coal production, 2010-17, CSDC, in Mtce

Mtce	2 010	2011*	2 013	2 015	2 017	CAGR
OECD	1 402	1 408	1 410	1 396	1 355	-0.6%
OECD Americas	815	828	773	755	716	-2.4%
United States	760	771	724	701	652	-2.7%
OECD Europe	241	244	252	245	235	-0.7%
OECD Asia Oceania	345	335	385	396	405	3.2%
Non-OECD	3 757	4 101	4 072	4 276	4 528	1.7%
China	2 346	2 593	2 564	2 670	2 824	1.4%
India	349	362	367	391	427	2.8%
Africa and Middle East	211	210	215	235	251	3.0%
Eastern Europe/Eurasia	408	433	425	432	431	-0.1%
Other developing Asia	368	419	409	437	478	2.2%
Latin America	75	83	93	110	117	5.9%
Total	**5 158**	**5 508**	**5 482**	**5 672**	**5 883**	**1.1%**

* Estimate.

Table 27 Hard coal net imports, 2010-17, BCS, in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	129	121	65	60	36	-18.4%
OECD Americas	-61	-89	-111	-100	-106	3.0%
United States	-52	-79	-106	-94	-97	3.4%
OECD Europe	182	194	199	200	201	0.7%
OECD Asia Oceania	7	17	-23	-40	-59	-
Non-OECD	-129	-121	-65	-60	-36	-18.3%
China	144	165	182	192	204	3.6%
India	81	98	133	167	204	13.0%
Africa and Middle East	-54	-54	-57	-69	-76	5.7%
Eastern Europe/Eurasia	-97	-90	-90	-101	-105	2.7%
Other developing Asia	-155	-195	-177	-180	-191	-0.3%
Latin America	-46	-45	-55	-69	-72	8.1%

* Estimate.

Table 28 Hard coal net imports, 2010-17, CSDC, in Mtce

Mtce	2010	2011*	2013	2015	2017	CAGR
OECD	129	121	90	88	121	-0.1%
OECD Americas	-61	-89	-89	-90	-59	-6.5%
United States	-52	-79	-86	-86	-49	-7.7%
OECD Europe	182	194	200	204	208	1.2%
OECD Asia Oceania	7	17	-21	-26	-28	-
Non-OECD	-129	-121	-90	-88	-121	0.0%
China	144	165	132	121	57	-16.2%
India	81	98	134	175	217	14.2%
Africa and Middle East	-54	-54	-57	-69	-75	5.5%
Eastern Europe/Eurasia	-97	-90	-89	-96	-94	0.7%
Other developing Asia	-155	-195	-156	-151	-155	-3.7%
Latin America	-46	-45	-55	-68	-71	7.9%

* Estimate.

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Table 29 Seaborne steam coal imports, 2010-17, BCS, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Europe and Mediterranean	143	153	154	154	155	0.2%
Japan	108	103	106	107	106	0.4%
Korea	76	82	83	81	86	0.8%
Chinese Taipei	53	57	62	66	72	3.8%
China	110	130	137	141	147	2.1%
India	51	69	101	129	157	14.7%
Latin America	12	16	17	18	19	2.7%
Other	58	55	71	76	84	7.3%
Total	**611**	**665**	**731**	**773**	**825**	**3.7%**

* Estimate.

Table 30 Seaborne steam coal imports, 2010-17, CSDC, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Europe and Mediterranean	143	153	155	159	161	0.9%
Japan	108	103	107	110	110	1.1%
Korea	76	82	84	83	89	1.4%
Chinese Taipei	53	57	62	68	74	4.5%
China	110	130	116	107	47	-15.6%
India	51	69	103	137	170	16.1%
Latin America	12	16	17	18	19	3.3%
Other	58	55	71	78	87	7.9%
Total	**611**	**665**	**715**	**761**	**758**	**2.2%**

* Estimate.

Table 31 Seaborne steam coal exports, 2010-17, BCS, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Australia	119	126	146	160	182	6.3%
South Africa	61	63	63	71	75	3.1%
Indonesia	221	255	276	287	309	3.3%
Russia	89	81	81	90	94	2.5%
Colombia	62	70	74	87	92	4.7%
China	13	9	6	4	3	-16.0%
United States	13	27	59	46	42	7.6%
Other	33	35	27	29	29	-3.3%
Total	**611**	**665**	**731**	**773**	**825**	**3.7%**

* Estimate.

Table 32 Seaborne steam coal exports, 2010-17, CSDC, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Australia	119	126	145	155	165	4.6%
South Africa	61	63	63	71	75	3.1%
Indonesia	221	255	276	286	306	3.1%
Russia	89	81	80	85	83	0.5%
Colombia	62	70	74	87	92	4.7%
China	13	9	6	4	3	-16.0%
United States	13	27	45	45	5	-24.8%
Other	33	35	27	29	28	-3.7%
Total	**611**	**665**	**715**	**761**	**758**	**2.2%**

* Estimate.

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Table 33 Seaborne metallurgical coal imports, 2010-17, BCS, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Europe and Mediterranean	64	60	64	66	69	2.3%
Japan	58	54	56	58	58	1.3%
Korea	28	32	33	35	37	2.4%
Chinese Taipei	6	6	7	8	8	5.9%
China	32	24	29	30	31	4.1%
India	30	28	31	38	46	8.4%
Latin America	14	15	19	21	23	7.1%
Other	1	3	3	4	5	8.0%
Total	**232**	**223**	**244**	**260**	**277**	**3.7%**

* Estimate.

Table 34 Seaborne metallurgical coal imports, 2010-17, CSDC, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Europe and Mediterranean	64	60	65	67	70	2.6%
Japan	58	54	57	59	59	1.5%
Korea	28	32	33	35	38	2.6%
Chinese Taipei	6	6	7	8	8	6.2%
China	32	24	20	16	11	-12.5%
India	30	28	31	38	47	8.6%
Latin America	14	15	19	21	24	7.3%
Other	1	3	3	4	5	8.3%
Total	**232**	**223**	**236**	**247**	**261**	**2.6%**

* Estimate.

Table 35 Seaborne metallurgical coal exports, 2010-17, BCS, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Australia	153	137	166	171	174	4.1%
Canada	22	22	24	25	28	4.4%
Mozambique	0	0	2	6	8	-
Russia	6	4	5	7	8	13.4%
United States	45	56	41	42	49	-2.1%
Other	7	5	8	9	10	12.0%
Total	**232**	**223**	**244**	**260**	**277**	**3.7%**

* Estimate.

Table 36 Seaborne metallurgical coal exports, 2010-17, CSDC, in Mtce

	2010	2011*	2013	2015	2017	CAGR
Australia	153	137	166	167	168	3.5%
Canada	22	22	19	20	27	3.9%
Mozambique	0	0	2	6	7	-
Russia	6	4	4	7	8	12.5%
United States	45	56	37	37	40	-5.4%
Other	7	5	8	9	10	12.0%
Total	**232**	**223**	**236**	**247**	**261**	**2.6%**

* Estimate.

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REGIONAL AND COUNTRY GROUPINGS

Africa

Algeria, Angola, Benin, Botswana, Cameroon, Congo, Democratic Republic of Congo, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Morocco, Mozambique, Namibia, Nigeria, Senegal, South Africa, Sudan, United Republic of Tanzania, Togo, Tunisia, Zambia, Zimbabwe and other African countries (Burkina Faso, Burundi, Cape Verde, Central African Republic, Chad, Comoros, Djibouti, Equatorial Guinea, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Niger, Reunion, Rwanda, Sao Tome and Principe, Seychelles, Sierra Leone, Somalia, Swaziland and Uganda).

North Africa

Algeria, Egypt, Libya, Morocco and Tunisia.

China

Refers to the People's Republic of China, including Hong Kong.

Europe and Mediterranean

Includes Eastern Europe/Eurasia, OECD Europe and North Africa regional groupings.

Middle East

Bahrain, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen. It includes the neutral zone between Saudi Arabia and Iraq.

Latin America

Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela and other Latin American countries (Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermudas, British Virgin Islands, Cayman Islands, Dominica, Falkland Islands, French Guyana, Grenada, Guadeloupe, Guyana, Martinique, Montserrat, St. Kitts and Nevis, Saint Lucia, Saint Pierre et Miquelon, St. Vincent and the Grenadines, Suriname and Turks and Caicos Islands).

Eastern Europe/Eurasia

Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, the former Yugoslav Republic of Macedonia, the Republic of Moldova, Romania, Russian Federation, Serbia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

OECD

Includes OECD Europe, OECD Americas and OECD Asia Oceania regional groupings.

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OECD Americas

Canada, Chile, Mexico and United States.

OECD Europe

Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

OECD Asia Oceania

Australia, Japan, Korea and New Zealand. For statistical reasons, this region also includes Israel.

Non-OECD Asia

Bangladesh, Brunei Darussalam, Cambodia, China, Chinese Taipei, India, Indonesia, the Democratic People's Republic of Korea, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Vietnam and other non-OECD Asian countries (Afghanistan, Bhutan, Cook Islands, East Timor, Fiji, French Polynesia, Kiribati, Laos, Macau, Maldives, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu).

Other developing Asia

Non-OECD Asia regional grouping excluding China and India.

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COAL Medium-Term Market Report 2012

The Medium-Term Coal Market Report 2012 provides IEA forecasts on coal markets for the coming five years as well as an in-depth analysis of recent developments in global coal demand, supply and trade. The annual report shows that while coal continues to be a growing source of primary energy worldwide, its future is increasingly linked to non-OECD countries, particularly China and India, and to the rise of natural gas.

The international coal market is experiencing dynamic changes. In 2011, China alone accounted for more than three-quarters of incremental coal production, while domestic consumption was more than three times that of global trade. Low gas prices associated with the shale gas revolution caused a marked decrease in coal use in the United States, the world's second-largest consumer. This led US thermal coal producers to seek other markets, which resulted in an oversupply of coal in Europe and a significant gas-to-coal switch. Meanwhile, China overtook Japan as the largest importer of coal, and Indonesia overtook Australia as the world's largest exporter on a tonnage basis.

The report examines the pronounced role the Chinese and Indian economies will exert on the international coal trade through 2017. In the report's Base Case Scenario, China accounts for over half of global consumption from 2014, and India surpasses the United States as the world's second-largest consumer of coal in 2017. The report also offers a Chinese Slowdown Case, a hypothetical scenario which shows that even if Chinese GDP growth slowed to 4.6% average over the period, the country's coal consumption would continue to grow.

Market Trends and Projections to 2017

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