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Heat Sensor

The thermal coal paradox

Commodities Research

Low prices unlikely to create new demand

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Thermal coal will play a role in alleviating energy poverty…

According to the World Bank, approximately 1.2 billion people lack access to electricity, with negative implications on overall quality of life; with a population of 8 million, New York City consumes almost as much electricity as Nigeria (164 million) and Bangladesh (153 million) combined. As electrification rates increase in Southeast Asia and Sub-Saharan Africa, we believe thermal coal will clearly play a role in the battle on energy poverty, with India in particular as the key driver of seaborne demand growth.

… but being cheap is not enough

However, the outlook for thermal coal demand remains challenged by structural headwinds. The countries most affected by energy poverty also happen to be the most vulnerable to the expected impact of climate change on crop yields, food security and poverty. Rather than enjoying a broad-based increase in coal-fired generation, we believe that future demand growth will be increasingly concentrated in just a handful of countries: India, Korea, Taiwan, and Japan. With Chinese demand for imported coal past its peak, and barring any major policy changes, we expect the seaborne market to grow at an average annual rate of c.2% over our forecast period to 2018. In our view, this will not be sufficient to tighten the market and lift prices above the level of marginal production cost.

The window for new production capacity has closed

On the supply side, the coal industry needs to digest a US$300 billion increase in capital stock and to undo a decade of productivity decline. **We downgrade our price forecasts by c.7% to US$75/78/80/80 for 2014/15/16/17.** In our view, volume growth from rising productivity will be sufficient to satisfy seaborne demand without the need for large scale investment in new capacity. Putting aside the debottlenecking and optimization of existing capacity, we believe that new investment in large scale projects requiring new infrastructure is unlikely to earn a return; the window for profitable investment in new mining and infrastructure capacity has closed. **This is the thermal coal paradox: the world has a significant deficit in electricity but the investment outlook for this cheap, widely available energy source is nonetheless poor**.

Heat Sensor – Launching a new publication series

We bring natural gas and thermal coal under one roof

We are bringing together coverage of natural gas and thermal coal – fuels that drive power generation as well as many industrial applications – under a new publication series titled *Heat Sensor*. Given the high level of price-sensitive substitution that occurs between natural gas and coal and the linkage driven by environmental policy through emission trading schemes, this move allows us to combine the analysis of these fuels and assess the broader picture across the three key regional markets: Asia, Europe, and North America. By doing so, we also discontinue the following publication series: *Bulk Commodity Snapshot*, *Global Gas Update*, *Global Gas Watch*, *Natural Gas Watch* and *Natural Gas Weekly*.

Technology and regulation create a dynamic landscape

Conventional power generation has been driven by fossil fuels for over a century; the heat they emit during combustion is used to create steam which powers the generator via a steam turbine. Although the basics are largely unchanged, the outlook for natural gas and thermal coal is always dynamic. On the one hand, technological innovation has upended US gas production, with other countries looking to reproduce the shale gas revolution in their home markets. Increasing gas supply will contribute to the growth in LNG trade and accelerate the gradual shift away from long-term indexed pricing and towards the establishment of a global gas price. On the other hand, energy policy and environmental regulation are shaping both the competition between coal and gas as well as with other energy sources.

Unlike other commodity markets, natural gas and coal will be far more dependent upon policy shifts and the regulatory backdrop, which further reinforces the need to bring the two markets and the analysis together in a single publication. We look forward to your comments and input on the two commodity markets that fuel global growth through heat transfer.

Contents

Executive summary: When being cheap is not enough

In principle, thermal coal should have a bright outlook: not only it is a cheap source of energy, but with 1.2 billion people still lacking proper access to electricity it also has a large untapped market. Moreover, addressing energy poverty is considered a key development goal because a reliable supply of electricity has a major impact on health, education and economic development. In practice, we believe that coal demand will grow at a modest rate and prices will remain near the level of marginal production costs.

Coal will play a limited role in addressing energy poverty

Demand for electricity from Sub-Saharan Africa and Southeast Asia is bound to increase as electrification reaches a greater share of the population, and this will benefit coal-fired power generation. However, we see those regions as also amongst the most vulnerable to climate change and this will undoubtedly shift future investment towards less polluting energy sources. India clearly has significant upside for thermal coal because of its size and its ability to build coal-fired plants, but the battle on energy poverty in other regions is unlikely to have a material impact seaborne demand growth, in our view. Moreover, we consider the fact that only four countries account for 75% of the expected growth in demand over our forecast period as a negative.

Meanwhile, the structural headwinds facing thermal coal demand show no sign of abating. First, environmental regulation continues to undermine the case for new coal-fired plants in many markets, and we expect regulation to increase in terms of geographical spread as well as depth. Second, competition from gas and renewable energy remains strong; for the first time in years, coal-fired plants accounted for less than 50% of new capacity additions in China, while wind and solar capacity increased by 41% to 90GW as of December 2013. Third, the drive to improve energy efficiency is contributing to peak power demand in Europe and to slower growth in emerging markets like China; the shortfall in power generation relative to a business as the usual scenario falls primarily on conventional power sources such as coal.

Exhibit 1: We downgrade our thermal coal price forecasts as a period of cost deflation kicks in

Bulk Commodities: Price Forecast Summary nominal US$/tonne		**Q1 2014**	**Q2 2014E**	**Q3 2014E**	**Q4 2014E**	**2013**	**2014E**	**2015E**	**2016E**	**2017E**	**Long Term** 2014 real $
Thermal Coal											
Spot 6,000 kcal/kg NAR	FOB Newc	$ 77	$ 74	$ 74	$ 76	$ 84	$ 75	$ 78	$ 80	$ 80	$ 77
change vs previous			*-1%*	*-1%*	*-5%*		*-2%*	*-8%*	*-7%*	*-7%*	*0%*

Source: McCloskey, Goldman Sachs Global Investment Research

Rising productivity will keep the market well supplied

We expect the seaborne market to grow at an average annual rate of c.2% over our forecast period to 2018. On the supply side, the coal industry needs to undo a decade of productivity decline by using existing production capacity in a more efficient manner. In our view, volume growth from rising productivity will be sufficient to satisfy seaborne demand and hence we downgrade our price forecasts by c.7% to US$75/78/80/80 from US$77/85/86/86 for 2014/15/16/17 on the back of the downward shift in the industry cost curve (Exhibit 1). Putting aside the debottlenecking and optimization of existing capacity, we believe that new investment in large scale projects requiring new infrastructure is unlikely to earn a return as the window for profitable investment in new mining and infrastructure capacity has closed.

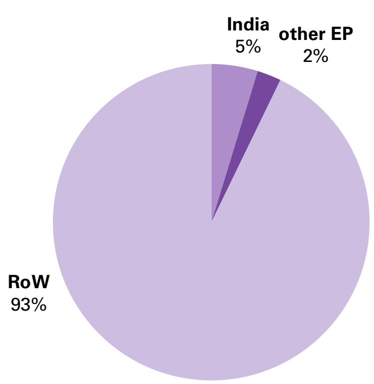
The role of coal in addressing energy poverty

According to the World Bank[1], 1.7 billion people have gained access to electricity supply in the past 20 years, taking the global electrification rate to 83%, but more progress is needed; New York City (population: 8 million) consumes almost as much electricity as Nigeria (164 million) and Bangladesh (153 million) combined. Demand for electricity from Sub-Saharan Africa and Southeast Asia is bound to increase as electrification reaches a greater share of the population, and this will benefit coal-fired power generation. However, we see those regions as also amongst the most vulnerable to climate change and this will undoubtedly shift future investment towards less polluting energy sources. With the exception of India, we argue that energy poor countries will not be a significant driver of thermal coal demand.

Over 1 billion people still lack proper access to electricity

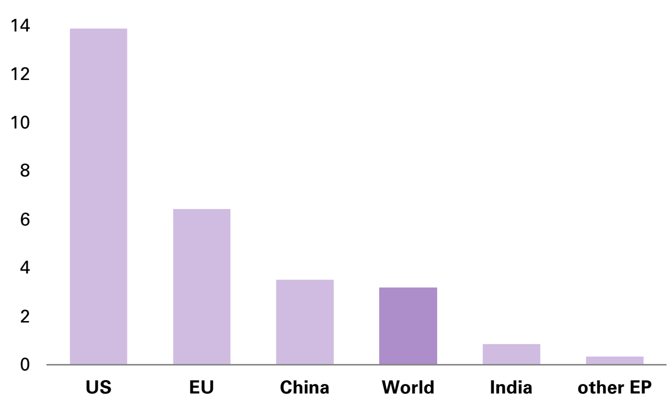
We focus in this section on energy poor countries (EP), defined as those where a lack of adequate access to electricity affects at least 40% of the population and/or 15 million people. The shortfall in electrification is most acute in Sub-Saharan Africa and Southeast Asia, where it affects 590 and 418 million people respectively, for the most part in rural areas. The gap with the rest of the world is acute: EP countries account for 40% of the world's population but they consume only 7% of the electricity produced (Exhibit 2). On a per capita basis, electricity consumption in India is just 25% of Chinese consumption; consumption in other EP countries is just 1/20th of the average level in Europe (Exhibit 3).

Exhibit 2: EP countries consume only 7% of global power
Global electricity consumption by region (2012)



Source: World Bank

Exhibit 3: Significant gap in consumption per capita
Average electricity consumption per capita – MWh (2012)



Source: World Bank

Improving access to electricity is an important development goal. It is no coincidence that countries with low electricity consumption are grouped at the bottom of the Human Development Index table (Exhibit 4). The causality between development and electricity use goes in both directions: access to electricity impacts education (lighting at night for homework) and health (replace indoor use of solid fuels for cooking and heating) as well as economic activity, while rising living standards create the purchasing power for electric appliances. For these reasons, many development agencies including the World Bank and the United Nations are focused on bringing electricity to the remaining 1.2 billion people. Achieving this goal will lead to greater demand for energy, including coal.

[1] Global Tracking Framework - www.worldbank.org/se4all

Exhibit 4: Electricity use is linked to quality of life
Human Development Index (HDI ranking from 1 to 187) and key metrics of energy poverty (2012 data)

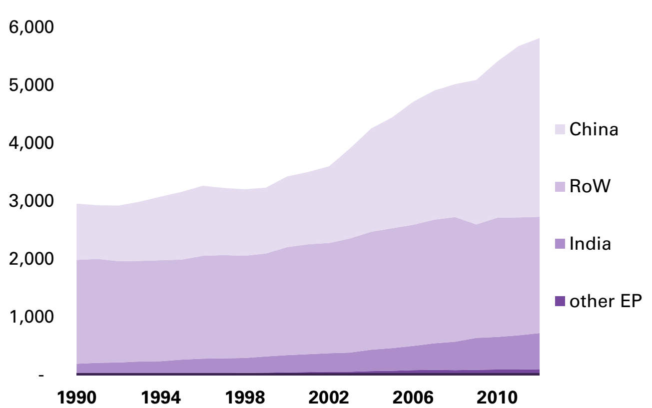
	HDI	Population	GDP	Energy consumption	Access to electricity	Power consumption
EP countries...		*million*	*US$ per capita*	*MJ per capita*	*% of population*	*kWh per capita*
Philippines	**114**	97	2,587	1,751	70%	636
India	**136**	1,237	1,503	2,537	75%	676
Congo (DRC)	**142**	66	262	1,561	9%	102
Kenya	**145**	43	942	1,958	19%	151
Bangladesh	**146**	155	752	847	60%	255
Pakistan	**146**	179	1,256	1,981	69%	442
Myanmar	**149**	53	n/a	1,118	49%	109
Tanzania	**152**	48	590	1,817	15%	89
Nigeria	**153**	169	1,556	2,934	48%	145
Ethiopia	**173**	92	454	1,557	23%	51
Total / average		2,137	1,329	2,229	64%	500
... versus DMs						
Norway	**1**	5	100,949	25,205	100%	24,624
United States	**3**	312	52,067	28,615	100%	13,886
Japan	**10**	128	46,570	14,768	100%	8,158

Source: UNDP, World Bank

Coal will clearly play a role in fighting energy poverty…

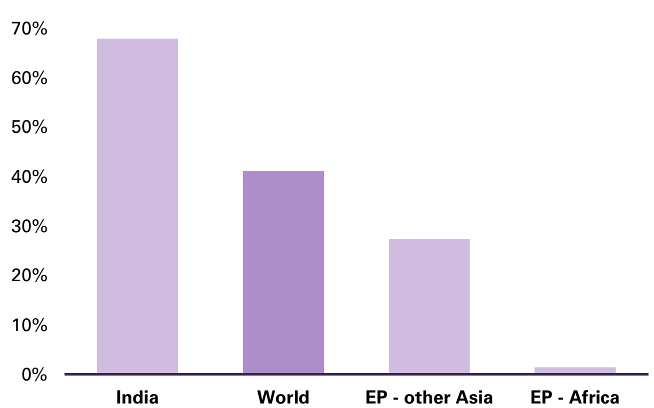
Thermal coal is a cheap energy source that is widely available. Coal-fired plants are cheaper to build than nuclear power, and with a few exceptions (e.g. shale gas in the US) they have lower operating costs than gas-fired plants. Provided that rail and port capacity is available to transport coal from the seaborne market to the plant, commissioning new generation capacity is relatively straightforward. On these merits, and given the absence of environmental regulation that could penalize coal-fired generation in energy-poor countries, we expect coal to play an important role in addressing energy poverty. India is already a large consumer of coal, but other EP countries lag well behind both in terms of overall consumption (Exhibit 5) and as a share of the fuel mix (Exhibit 6). Existing and potential projects to build new coal-fired plants in countries ranging from Pakistan to Myanmar will therefore bring electricity supply to millions of people and boost demand for coal, albeit from a low base.

Exhibit 5: India is an outlier in terms of coal use…
Thermal coal consumption by region - Mt



Source: IEA

Exhibit 6: … and share in the fuel mix
Share of coal in power generation (2012)



Source: World Bank

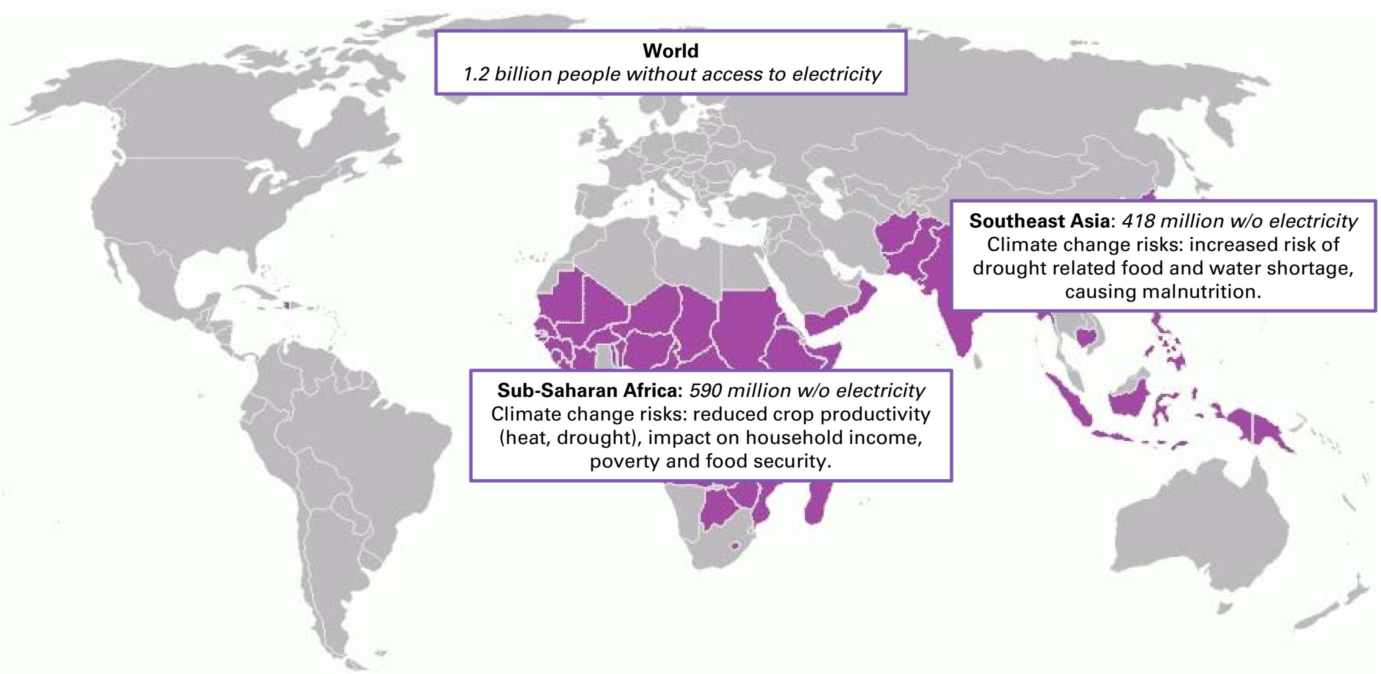
… but the impact on coal demand will be limited

In spite of the expected increase in electrification rates, we believe that coal will play a limited role in addressing energy poverty and the impact on seaborne demand growth will be modest. First, the benefits of greater coal use in the power sector must be put in perspective of the risks from climate change. According to the Intergovernmental Panel on Climate Change:[2]

> *For the major crops (wheat, rice, and maize) in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late-20th-century levels, although individual locations may benefit... Major future rural impacts are expected in the near-term and beyond through impacts on water availability and supply, food security, and agricultural incomes, including shifts in production areas of food and non-food crops across the world. These impacts are expected to disproportionately affect the welfare of the poor in rural areas, such as female-headed households and those with limited access to land, modern agricultural inputs, infrastructure, and education... Throughout the 21st century, climate-change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger.*

In other words, concerns around food security and rural poverty (Exhibit 7) will influence the energy policy and the availability of financing for new generation capacity.

Exhibit 7: Energy poverty affects areas vulnerable to climate change
Countries where the lack of access to reliable electricity affects at least 20 million and/or 40% of the total population



Source: World Bank, IPCC, Goldman Sachs Global Investment Research

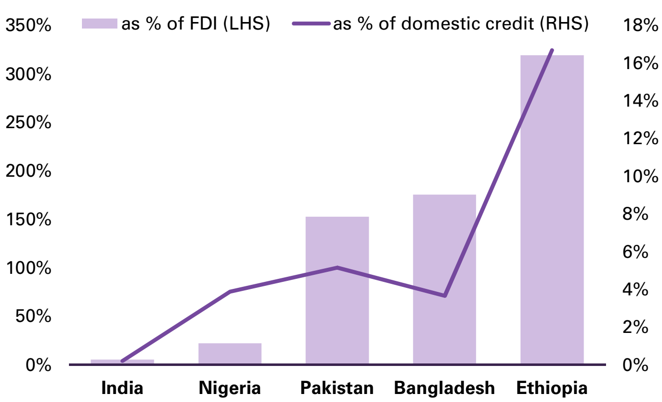
Second, financing the construction of coal-fired plants will be challenging for many emerging countries. Coal is best suited for large, centralized power generation but building coal-fired plants and the supporting grid infrastructure is highly capital intensive. Relative

[2] *Climate Change 2014: Impacts, Adaptation and Vulnerability – Summary for policymakers*, IPCC 2014

to the size of its economy and the level of foreign direct investment, India can clearly afford the construction of large power plants, but other energy poor countries will find it much more challenging (Exhibit 8). Projects like the recent US$1 billion power plant in Nigeria announced earlier this month are rare – and this particular project is for a gas-fired plant. Moreover, the need for foreign investment makes power plants more vulnerable to the growing trend among potential lenders such as the World Bank, the EBRD and the US Export-Import Bank to treat coal as the least preferred alternative given its environmental impact.

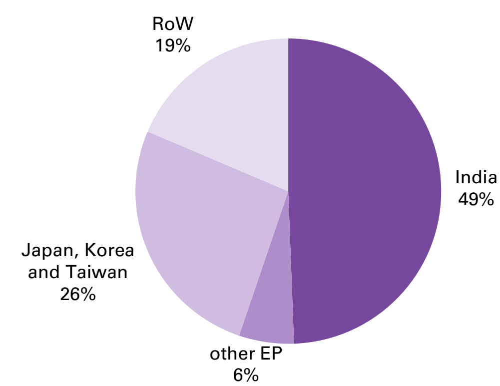
Third, distributed power generation is better suited for rural communities that may not be able to justify the investment to connect to the grid; small-scale generation from renewable sources (e.g. solar PV, biomass, etc.) is likely to play an important role in those case, in particular given the steady decline in the cost per MW of many renewable energy technologies and their increasing competitiveness against conventional power generation.

Exhibit 8: Large coal-fired plants may be hard to finance
Cost of a 1GW coal-fired plant vs. sources of funding (2012)



Source: World Bank, Goldman Sachs Global Investment Research

Exhibit 9: Coal demand growth is highly concentrated
Seaborne demand growth by region – 2013-18E



Source: McCloskey, Goldman Sachs Global Investment Research

In summary, India clearly has significant upside for thermal coal but the battle on energy poverty in other regions is unlikely to have a material impact seaborne demand growth (Exhibit 9). Moreover, we consider the fact that only four countries account for 75% of the expected growth in demand over our forecast period as a negative.

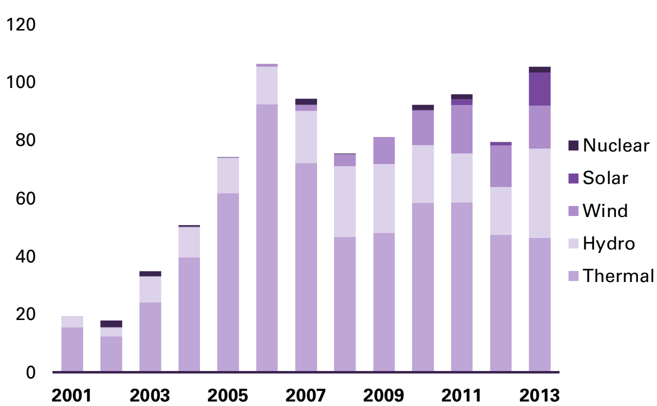
Seaborne demand growth to moderate as China peaks

The demand outlook for thermal coal is gradually changing. In the recent past, seaborne demand was booming as China switched from a net exporter to the world's largest importer in a relatively short period of time. Now that China faces domestic oversupply and a more diverse fuel mix, India and other Asian markets should become the key drivers of demand over our forecast period to 2018. However, thermal coal continues to face structural headwinds from environmental regulation, increased energy efficiency, and growing competition from renewable energy. We expect moderate seaborne demand growth of c.2% per annum to be met largely from rising productivity, keeping prices near the level of marginal production costs.

As China slows, growth migrates to other Asian markets

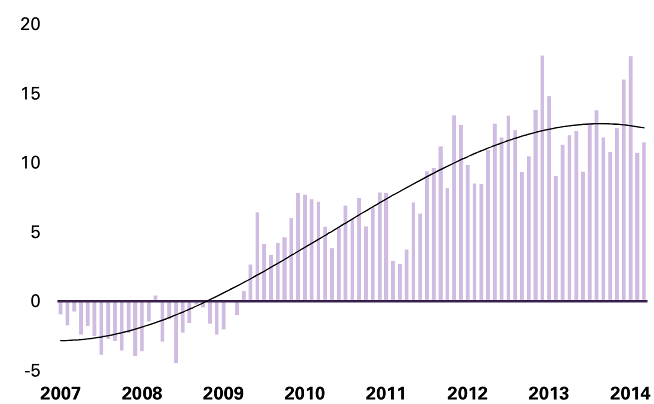
China has been the key driver of seaborne demand over the past five years, but this is changing for several reasons. On the supply side, domestic coal production is more competitive than previously as a result of significant investment in the consolidation and mechanisation of Chinese mines. Faced with a well -supplied domestic market, Chinese power plants continue to import coal, but only when the seaborne price is competitive with domestic coal. On the demand side, a clear shift has occurred in the fuel mix of new capacity, as the traditional reliance on coal-fired plants is giving way to a more diverse mix where renewable energy plays a greater role. In 2013, thermal generation capacity (including gas) accounted for a smaller share of new capacity than hydro, wind and solar power (Exhibit 10). As concerns around pollution intensify, we believe this trend to lead to a gradual deceleration in coal-fired generation. In our view, a more competitive Chinese coal sector combined with a lower rate of demand growth from the power sector will result in a peaking in import volumes, followed by a decline. Compared with the period 2009-12 when annual imports increased by 33Mt on average per year, ytd imports 2014 are largely flat on the previous year (Exhibit 11).

Exhibit 10: China is changing: a more diverse fuel mix…
Increase in power generation capacity by type - GW



Source: CEIC

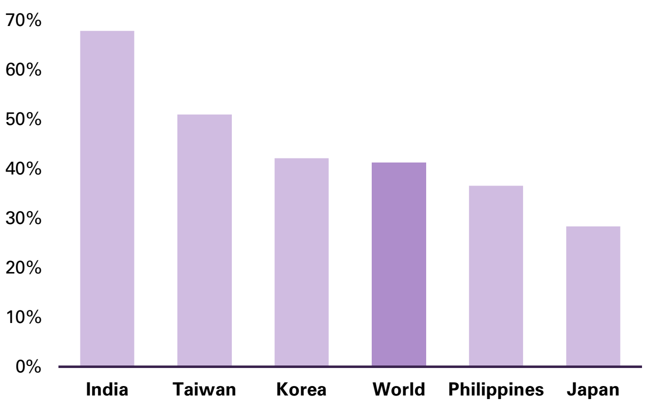
Exhibit 11: … and a peak in import volumes
Net Chinese seaborne thermal coal imports - Mt



Source: McCloskey

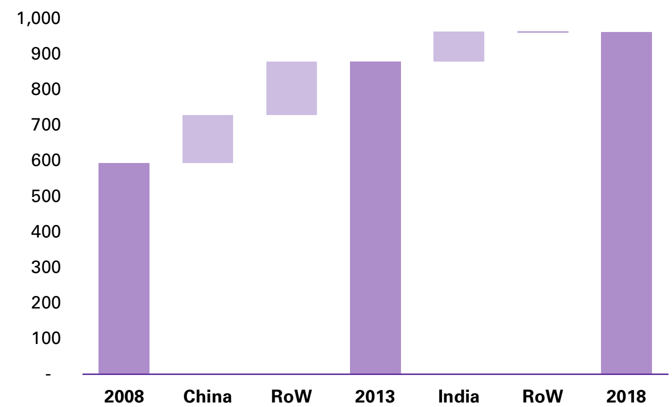
As China gives up the role of key growth market for seaborne coal, the focus migrates to other Asian markets. In Japan, coal-fired generation is helping to fill the gap left by idle nuclear power. In Korea, the size of the coal-fired fleet is expanding from 25GW in 2013 to 39GW in 2018. Given the high cost of LNG relative to gas prices in other regions and the lack of domestic energy sources, it is not surprising that East Asia stands out among OECD economies as one of the few growth markets left for coal-fired generation. However, the biggest growth market is India. Not only is India's power sector highly dependent on coal (Exhibit 12), but its domestic coal sector has been unable to keep up with demand – unlike China. As we highlighted in the previous section, India still has a large electricity deficit with over 300 million people still lacking access to the grid. In spite of a slowing economy, we expect Indian import growth to continue for the next 5 years at a similar pace to that of the previous 5 years, turning India into not only the biggest single market for seaborne coal but also its biggest growth driver (Exhibit 13).

Exhibit 12: India is highly dependent on coal…
Share of coal in the fuel mix (2012)



Source: World Bank, IEA

Exhibit 13: … and will be the key growth market to 2018
Seaborne thermal coal imports by region - Mt



Source: McCloskey, IEA, Goldman Sachs Global Investment Research

However, the world has changed, and demand growth is less widespread than it used to be. There are growth markets in other regions outside Asia, but this is offset by the gradually shrinking base of coal-fired generation in Europe and the expected decline in imports into China. Meanwhile, coal demand continues to face structural headwinds.

What will the next five years of environmental regulation bring?

The most important headwind for coal demand is environmental regulation, in our view. Regulation impacts coal demand on two levels. In the short term, regulations impact the operating cost of coal-fired generation and the impact on coal demand is often limited: carbon prices are usually too low to undermine materially the cost advantage of coal-fired plants relative to gas. Likewise, plants that are unable to meet tighter emissions standards are often allowed to operate for a period of time before their eventual closure. However, regulation has an arguably greater impact in the long term, by increasing the risk profile of investment in new plants. How will current regulations be tightened over the 40-year lifetime of a new plant, and what new regulations may be introduced over that period that could result in its early closure? Faced with this uncertainty, many utilities choose to diversify their portfolios away from coal even when coal is the lowest cost energy source at the moment.

A globally binding treaty on carbon emissions may be out of reach in the foreseeable future, but regulation is enjoying strong momentum at the national and/or regional level in many markets. A decade ago, the European emissions trading scheme had yet to start, and coal-fired plants faced relatively few risks. Today, cap and trade schemes have spread from Europe to other regions including the world's two largest coal consumers: China and the US. Meanwhile, increasingly tight regulations on SO_2 and NO_x emissions are forcing the early closure of older plants and raising the capital costs of building new ones (Exhibit 14).

Exhibit 14: An increasingly hostile environment for coal-fired generation
Sample of recent environmental regulation that impact coal-fired generation

Region	Policy	Impact
China	Emission Reduction Targets	By 2015, reduce emissions of SO_2 and NOx relative to 2010 level; reduce emissions of particulate matter by 2017 relative to 2012 level.
	Regional ETS CO_2 emissions trading	Seven pilot schemes got under way in 2013-14, as a prelude to a national emissions trading scheme to be launched at a future date.
	Coal consumption caps	Limits on coal use have been set in some regions for the period 2012-17, with a view to reduce coal to less than 65% of total primary energy consumption.
Europe	EU ETS CO_2 emissions trading	Low prices at the world's largest emissions trading scheme have limited impact on existing plants, but they do discourage investment in new coal-fired plants.
	Large Combustion Plant Directive (LCPD)	Sets limits on SO_2 and NOx emissions, forcing the closure of older coal-fired plants in the period to 2015 unless they invest in emission control equipment.
	Industrial Emissions Directive (IED)	The Industrial Emissions Directive sets more stringent rules on SO_2 and NOx emissions from coal-fired plants than LCPD,covering the period 2016-23.
	Emission Performance Standards	Some countries are considering regulations on CO_2 emissions that may prevent the construction of new coal-fired plants unless they are fitted with carbon capture.
US	Cross-State Air Pollution Rule (CSAPR)	Sets limits on SO_2 and NOx emissions, forcing the closure of older coal-fired plants in 23 states unless they invest in emission control equipment.
	Mercury and Air Toxics Standards (MATS)	Sets limits on mercury emissions; together with CSAPR it may force the early closure of over 70GW of coal-fired capacity.
	California ETS CO_2 emissions trading	California started a cap&trade program in 2012, due to be linked to a similar program in Quebec. Limited impact since Western states are not major consumers of coal.
	Pollution Standards	New regulations on CO_2 may prevent the construction of new coal-fired plants unless they are fitted with CCS; regulations for existing plants will be announced in June '14.

Source: EPA, EU, Goldman Sachs Global Investment Research

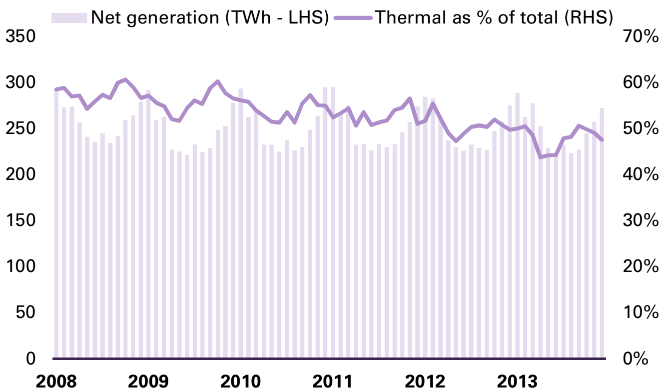
In the US, new regulations are widely expected to prevent the construction of new coal-fired plants unless they are fitted with carbon capture and storage technology; this would act as a significant disincentive for new projects (see page 11). Together with the spread of carbon emissions trading in China and similar moves to reduce emissions by other nations, we believe that regulatory headwinds are far from abating. This hostile environment reinforces the thermal coal paradox whereby low prices do not lead to new demand.

The combined threat of energy efficiency and renewable energy

In addition to regulatory risks, we consider the trend towards higher energy efficiency and the spread of renewable energy as further headwinds for coal demand. In principle, lower electricity consumption per unit of GDP should impact all energy sources; in practice, the impact falls mostly on coal and gas because of their higher marginal costs relative to nuclear, hydro, solar and wind. In Europe, annual power generation has declined 3% between 2008 and 2013 while the share of conventional thermal fell from 58% to 48% (Exhibit 15). In Germany, renewable energy recently contributed up to 75% of midday power generation, driving spot power prices into negative territory for a short period of time.

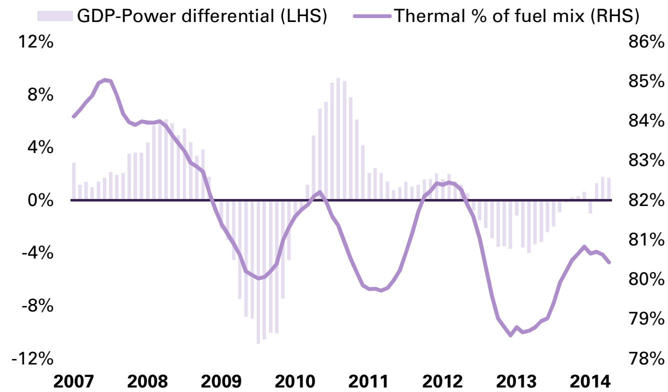
In China, power generation is growing at a slower rate. Whereas electricity demand growth enjoyed a decade of 12% average annual growth, it now has declined towards 6%. Relative to GDP growth, this trend reflects the efforts to improve energy efficiency in the Chinese economy. Regarding the fuel mix, investment in alternative energy sources is gradually reducing the share of conventional thermal power generation (Exhibit 16).

Exhibit 15: A structural decline in Europe…
EU27 power generation and share of conventional thermal



Source: Eurostat

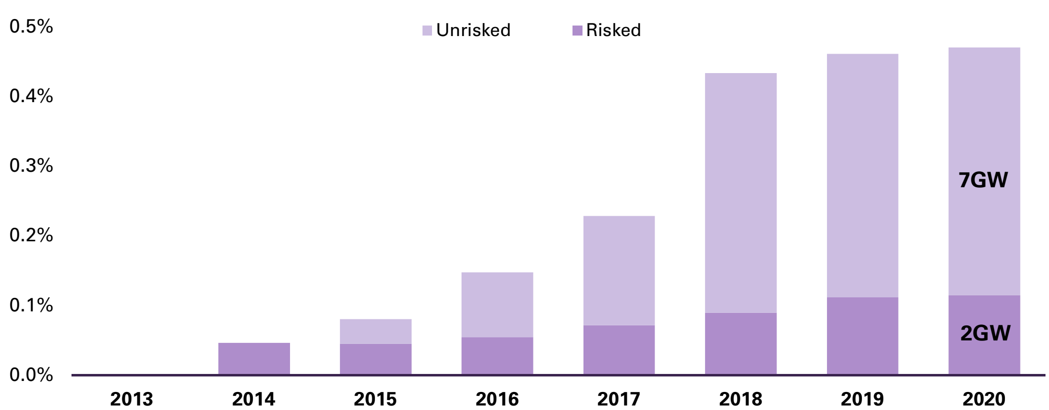
Exhibit 16: … and an inflection point in China
Differential between GDP and power generation growth



Source: CEIC

Meanwhile, the potential for coal to become a clean energy source via technological innovation is looking ever more remote. Carbon capture and storage (CCS) has been in use in the oil and gas industry for years, but its deployment in the power sector has been hindered by challenges ranging from the regulatory (e.g. is the transport of CO_2 covered by existing legislation?) to community (e.g. does the local community support the underground storage of CO_2?) to economic (e.g. who will pay for the construction and operation of a new CCS plant that will be less competitive than current plants?). An important milestone will be reached this year, with the opening of the first two large-scale CCS plants at Boundary Dam in Canada and Kemper in the US. However, cost overruns at Kemper have pushed the capital intensity of the project to US$8,600/kW, approximately four times more expensive than a conventional coal-fired plant and not far below the cost of a nuclear plant. More broadly, the momentum behind CCS projects in the power sector is stalling; based on data from the Global CCS Institute, the project pipeline has shrunk from 38 to 26 projects in the past 12 months. In our view, CCS may only account for 1/1000th of the global installed coal-fired capacity by 2020 (Exhibit 17).

Exhibit 17: The momentum behind CCS is stalling
Share of global coal-fired capacity likely to be fitted with carbon capture and storage technology

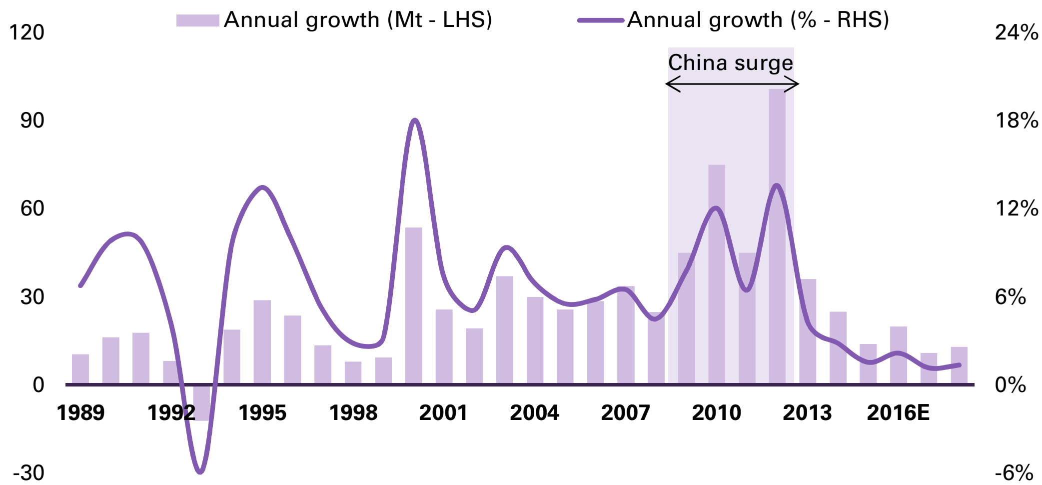


Source: Global CCS Institute, Goldman Sachs Global Investment Research

We expect seaborne demand to grow at c.2% per year

In summary, we believe seaborne demand will continue to grow but at a slower rate than previously. Relative to the period 2008-12 when demand grew by 60Mt per year on average, the concentration of demand growth on fewer markets and the structural headwinds from regulation, energy efficiency and changes in the fuel mix will result in a lower rate of import demand of c.15Mt per year over our forecast period (Exhibit 18).

Exhibit 18: Demand growth moderates after Chinese imports peak
Seaborne thermal coal demand



Source: IEA, McCloskey, Goldman Sachs Global Investment Research

As a result, we update our supply and demand model and forecast an average growth rate of c. 2% in the period to 2018 (Exhibit 19). Importantly, we believe that most of the increase in demand will be met productivity growth, rather than by the development of new mines.

Exhibit 19: We expect seaborne demand to grow at c. 2% per annum

Thermal coal supply and demand model

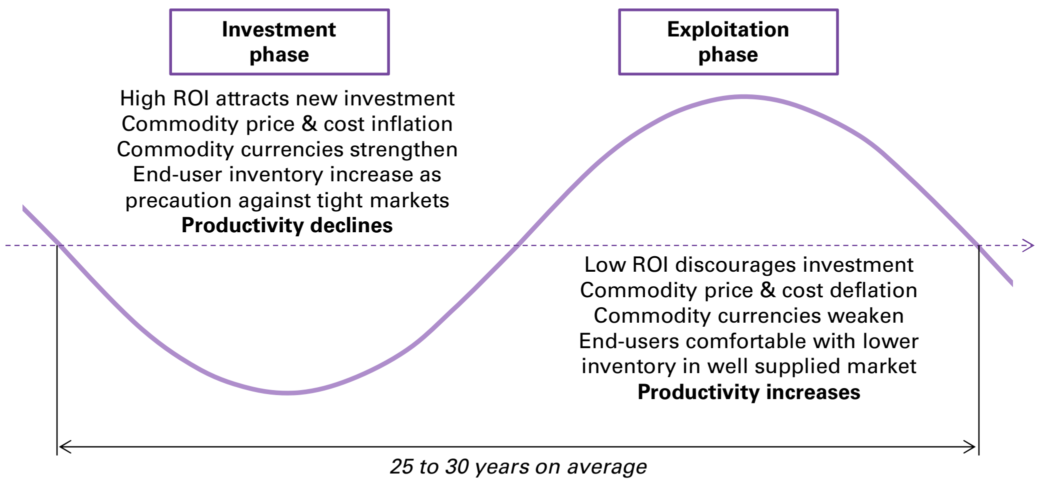
Million tonnes	2009	2010	2011	2012	2013E	2014E	2015E	2016E	2017E	2018E
Consumption - energy sector										
US	793	829	783	682	764	788	759	733	706	688
Japan	92	97	95	98	106	115	117	118	120	121
OECD Europe	199	211	212	231	214	205	199	193	186	180
Other	205	208	209	214	222	227	232	238	244	251
OECD total	1,289	1,346	1,299	1,226	1,306	1,336	1,307	1,282	1,256	1,239
China	1,771	1,850	2,087	2,112	2,229	2,284	2,346	2,409	2,468	2,527
India	400	425	441	457	480	507	569	608	653	700
Other	454	463	474	482	492	498	509	523	538	552
non-OECD total	2,625	2,739	3,003	3,051	3,201	3,289	3,423	3,540	3,658	3,780
Total - energy sector	3,913	4,084	4,302	4,277	4,507	4,626	4,730	4,822	4,914	5,019
Consumption - other sectors										
US	46	33	43	49	42	43	43	44	44	44
Japan	20	30	25	33	28	28	29	29	29	29
OECD Europe	49	50	53	50	51	52	52	53	53	53
Other	18	18	15	12	18	19	19	20	20	21
OECD total	133	131	137	144	141	142	143	145	146	148
China	726	849	873	975	1,011	1,041	1,074	1,108	1,141	1,175
India	131	128	147	169	149	156	166	177	189	202
Other	188	219	217	249	234	240	247	257	267	278
non-OECD total	1,044	1,196	1,237	1,393	1,394	1,437	1,487	1,542	1,597	1,655
Total - other sectors	1,177	1,327	1,375	1,537	1,534	1,578	1,630	1,687	1,743	1,802
Total demand	5,090	5,411	5,677	5,814	6,041	6,204	6,360	6,509	6,657	6,821
% growth	*1.4%*	*6.3%*	*4.9%*	*2.4%*	*3.9%*	*2.7%*	*2.5%*	*2.3%*	*2.3%*	*2.5%*
Production										
China	2,479	2,681	2,909	3,039	3,054	3,176	3,293	3,409	3,521	3,634
US	875	856	851	782	798	830	805	781	761	742
India	497	499	496	504	519	543	570	601	634	669
Indonesia	289	323	358	409	458	476	488	501	510	519
Australia	210	189	185	210	229	245	258	264	268	272
South Africa	248	252	251	258	261	262	264	265	266	268
Russia	147	179	180	201	199	207	213	217	221	226
OECD Europe	112	108	105	106	99	94	88	84	80	76
Colombia	71	71	82	85	81	88	91	95	98	101
Other	271	280	311	347	348	349	351	353	354	356
Total Production	5,199	5,437	5,727	5,942	6,047	6,270	6,421	6,568	6,713	6,861
% growth	*2.2%*	*4.6%*	*5.3%*	*3.8%*	*1.8%*	*3.7%*	*2.4%*	*2.3%*	*2.2%*	*2.2%*
Balancing item										
Stock changes	52	11	116	129	6	66	61	59	56	40
Seaborne exports										
Indonesia	229	287	315	349	379	392	398	405	408	411
Australia	139	141	148	171	188	197	202	208	213	218
Russia	82	93	87	105	108	107	106	105	103	102
Colombia	63	68	74	80	74	83	91	95	98	101
South Africa	67	70	69	75	73	76	78	79	81	83
US	12	16	31	48	44	38	34	34	33	32
Other	30	22	15	13	15	16	15	17	18	19
Total seaborne exports	623	697	738	841	880	909	924	942	954	965
Seaborne imports										
Japan	107	123	120	133	138	144	146	148	148	150
China	58	92	102	144	150	146	125	105	90	75
India	65	81	98	126	145	160	180	200	215	230
South Korea	81	93	98	97	97	103	111	121	124	128
Taiwan	55	57	60	57	59	60	61	62	63	64
Other	68	78	87	87	94	98	105	112	120	128
Total Pacific	433	524	566	644	683	711	728	748	760	775
OECD Europe	144	130	138	160	156	151	149	148	146	143
US	19	16	10	7	7	7	10	8	6	6
Other	25	27	28	32	34	36	37	38	39	40
Total Atlantic	189	172	176	199	197	194	196	194	191	189
Total seaborne imports	622	697	742	843	879	905	924	942	951	964
% growth	*4.7%*	*12.0%*	*6.5%*	*13.6%*	*4.4%*	*2.9%*	*2.2%*	*1.9%*	*1.0%*	*1.4%*
Seaborne surplus/(deficit)	1	0	(4)	(2)	0	4	(0)	1	3	1
Average CV - kcal/kg NAR basis	5,602	5,548	5,514	5,502	5,464	5,439	5,415	5,392	5,369	5,346

Source: International Energy Agency, McCloskey, Goldman Sachs Global Investment Research

The window for investment in new capacity has closed

As we have recently argued[3], a period of overinvestment in production capacity has ended, giving way to an exploitation phase where supply growth comes mainly from more efficient utilization of existing capacity. Based on historical trends, we believe that many market dynamics are reversed in the shift from investment to exploitation, and the current exploitation phase will last for a decade at least (Exhibit 20). In this environment of rising productivity, cost deflation and falling commodity currencies we reset our estimate of cost support to US$80/t FOB Newcastle, and we argue that existing capacity will be sufficient to satisfy demand for the rest of the decade without the need for new investment in large greenfield projects.

Exhibit 20: Thermal coal has moved into an exploitation phase likely to last for 10+ years
Productivity growth along the investment/exploitation phase



Source: Goldman Sachs Global Investment Research

A 45% decline in productivity waiting to be undone

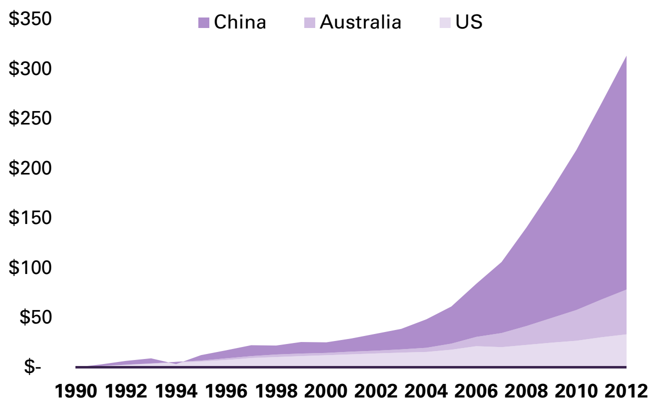
Production volumes grow with a certain time lag behind the investment decision; in the mining industry the lag between investment approval and production at full capacity is typically between 5 and 10 years. As a result, the supply response to high returns is delayed, while projects approved in the later stages of the investment phase will result in capital expenditure and production growth continuing into the following exploitation phase. In the case of coal, investment in new production capacity has slowed down abruptly as a result of a sharp fall in prices and a more subdued demand outlook.

However, years of overinvestment will fuel production growth for years to come. The capital stock of the coal industry in Australia, China, and the US increased by 300% to US$370 billion in the decade to 2012 as a result of the last investment phase (Exhibit 21). Now that the market has transitioned to an exploitation phase we expect a long period of cost deflation and productivity improvement to drive the industry cost curve lower; the pipeline of growth projects is not being replenished, but thermal (and metallurgical) coal markets remain well supplied.

[3] *Investor returns will survive the productivity comeback*, April 24, 2014

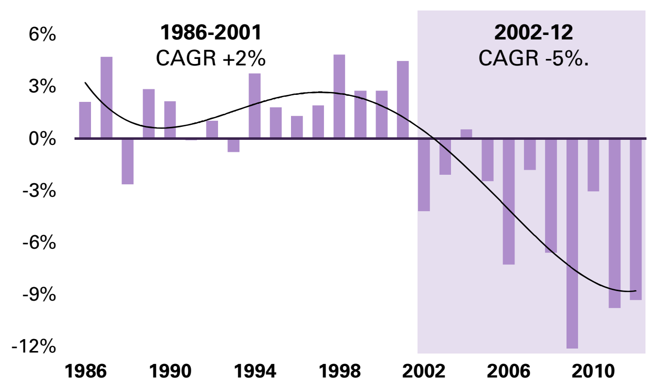
Productivity deteriorated over nearly a decade, but a return to productivity growth will help to drive output and satisfy the modest rate of demand growth we expect over our forecast period. Total factor productivity (TFP) in the coal sector of Australia, Canada and the US grew at an average rate of 2% during the previous exploitation phase, but it deteriorated sharply from 2002 onwards (Exhibit 22). Admittedly, productivity did not decline everywhere. In China, investment in mechanization and consolidation of the domestic coal sector led to a doubling in labour productivity over the past decade; this largely offset the decline in capital productivity in China over that same period, and contributed to a structural decline in domestic coal production costs.

Exhibit 21: Time to digest a US$300 billion binge…
Increase in capital stock of the coal sector – US$ billion (real)



Source: EIA, ABS, NBS, Goldman Sachs Global Investment Research

Exhibit 22: … and undo years of declining productivity
Productivity in the coal sector – Australia/China/US average

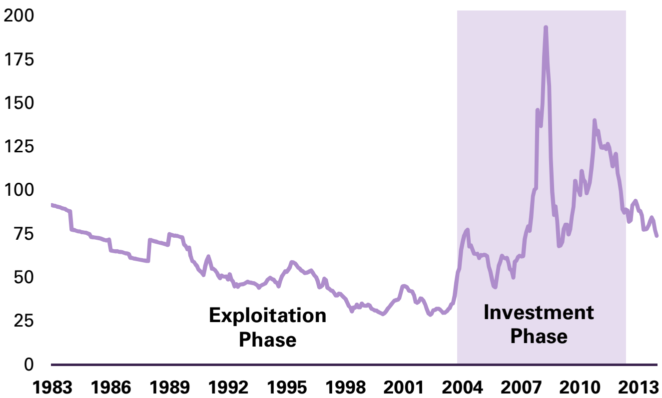


Source: EIA, ABS, NBS, Goldman Sachs Global Investment Research

The shift to an exploitation phase provides the opportunity to reverse the recent decline in productivity, in particular by improving **operating performance**. For instance, a survey of operating hours and annual throughput across a company's fleet of draglines may identify variability across different mines; further analysis may point to a gap between average dragline performance and what may be considered as best-in-class in the industry for that type of equipment. Armed with that knowledge, the mine operator can address the causes of the relative underperformance, which can vary from inflexible roster schedules to poor equipment maintenance to insufficient training. In many cases, there is also **an opportunity to debottleneck**. The nameplate capacity along the supply chain is not uniform after years of overinvestment. Targeting the particular bottleneck (e.g. a conveyor belt, the truck fleet, etc.) will increase the capacity of the entire chain at minimal cost. Productivity will also benefit from **incremental improvements in technology**: engines get stronger, buckets get bigger and control rooms gain access to more information. For instance, the largest size of trucks deployed in opencast mines increased from 250 tonnes in the 1980s to 360 tonnes today; this is likely to reach 450 tonnes by the end of the decade. In underground mines, output per longwall has shown a similar rising trend.

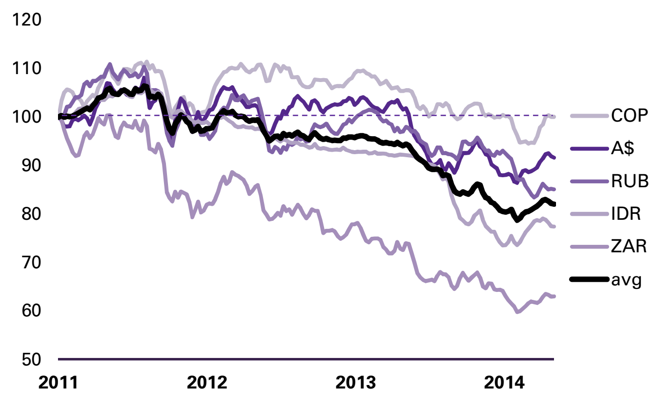
In our view, the current exploitation phase will coincide with a long period of cost deflation; we note that coal markets went through a 20-year period of declining prices in real terms during the previous exploitation phase that ended in 2003 (Exhibit 23). Cost curves become flatter via the loss of marginal supply and shift lower via rising productivity and weaker commodity currencies. Meanwhile, commodity currencies have gradually depreciated relative to the US dollar; the weighted average for the five largest seaborne exporters has lost 18% since January 2011 (Exhibit 24). Given that a majority of production costs are denominated in local currency, this has a direct impact on the level of marginal production costs.

Exhibit 23: Prices decline during exploitation phases
Thermal coal price – 6,000kcal FOB Newcastle (2014$ real)



Source: IEA, McCloskey, World Bank

Exhibit 24: … while commodity currencies depreciate



Source: Bloomberg

We reset our estimate of marginal production costs to US$80/t

In July 2013 we estimated the level of cost support for seaborne thermal coal at US$85/t on a 6,000kcal FOB Newcastle basis. Since then, the depreciation of commodity currencies and the improved performance in terms of operating performance and productivity gains have contributed to a period of cost deflation. On that basis, we reset our estimate of cost support at US$80/t (Exhibit 25).

Exhibit 25: We reset our estimate of marginal production costs to US$80/t
Thermal coal production costs for generic mine types – US$/t

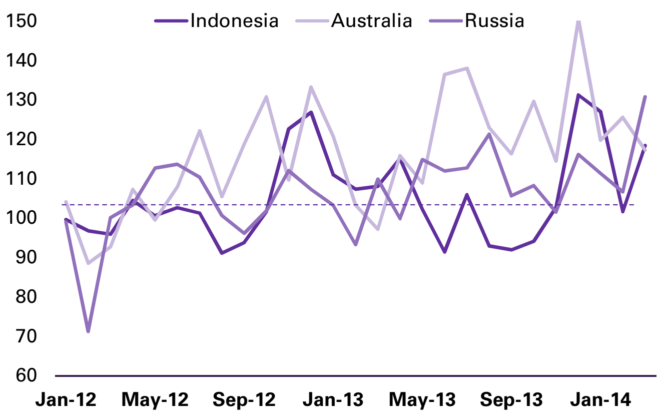
Region		Indonesia	Indonesia	Indonesia	Australia	Australia
Transport type		Barging	Barging	Barging	Rail	Rail
Overburden	$ / prime BCM	$ 3.00	$ 3.00	$ 3.00	$ 3.75	$ 3.75
SR	prime BCM / t ROM	12.0	8.0	4.0	6.5	7.5
Overburden	$ / t ROM	$ 36.00	$ 24.00	$ 12.00	$ 24.38	$ 28.13
Mining	$ / t ROM	$ 2.75	$ 2.75	$ 2.75	$ 4.25	$ 4.25
sub-total	$ / t ROM	$ 38.75	$ 26.75	$ 14.75	$ 28.63	$ 32.38
Yield	t product / t ROM	100%	100%	100%	80%	70%
CHPP	$ / t ROM	$ 1.50	$ 1.50	$ 1.50	$ 4.00	$ 4.00
sub-total	$ / t	$ 40.25	$ 28.25	$ 16.25	$ 40.78	$ 51.96
Sustaining capital	$ / t	$ 3.00	$ 3.00	$ 3.00	$ 2.85	$ 2.85
Overheads	$ / t	$ 3.00	$ 3.00	$ 3.00	$ 3.25	$ 3.25
FOR	$ / t	$ 46.25	$ 34.25	$ 22.25	$ 46.88	$ 58.06
Royalties	$ / t	$ 10.80	$ 9.45	$ 3.60	$ 6.56	$ 6.56
Loading costs	$ / t	$ 4.00	$ 4.00	$ 4.00	$ -	$ -
Distance to port	km	50	175	350	150	150
Transportation rate	$ / t.km	$ 0.030	$ 0.026	$ 0.024	$ 0.043	$ 0.043
Transportation	$ / t	$ 1.50	$ 4.55	$ 8.40	$ 6.45	$ 6.45
Port fees	$ / t	$ 2.00	$ 2.00	$ 2.00	$ 6.00	$ 6.00
FOB	$ / t	$ 65	$ 54	$ 40	$ 66	$ 77
CV - NAR basis	kcal / kg	5,800	4,900	3,800	5,500	5,800
Non-CV discount	%	5%	12%	28%	5%	0%
FOB @ 6,000kcal	**$ / t**	**$ 70**	**$ 75**	**$ 88**	**$ 76**	**$ 80**

Note: strip ratio (SR) refers to the amount of waste moved per tonne of coal mined; yield at Indonesian mines is ~100% because there is no washing, whereas mines in Australia usually wash their coal to reduce ash and increase calorific content (CV).

Source: Goldman Sachs Global Investment Research

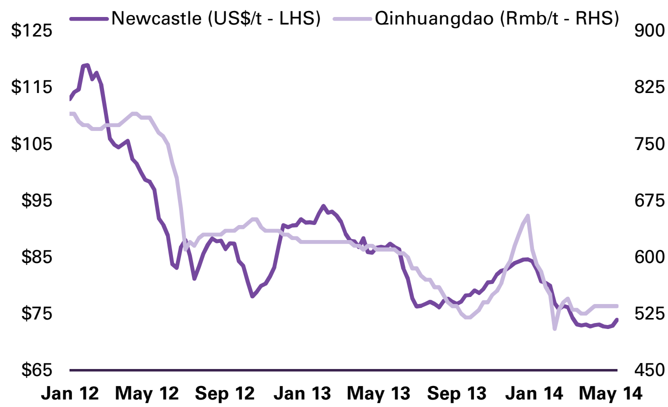
On that basis, spot prices have undershot so far this year but a supply response is yet to materialize (Exhibits 26 and 27). Low prices should impact export statistics from countries such as Indonesia, Russia and Australia where many high cost mines are located. However, March exports from those countries were strong, while Indonesian production increased 5% yoy in the period January-April 2014 according to government sources.

Exhibit 26: No clear signs of a supply response…
Thermal coal exports by origin[4] (1H 2012 average = 100)



Source: McCloskey

Exhibit 27: … in spite of ongoing price weakness
Thermal coal prices



Source: McCloskey, SxCoal

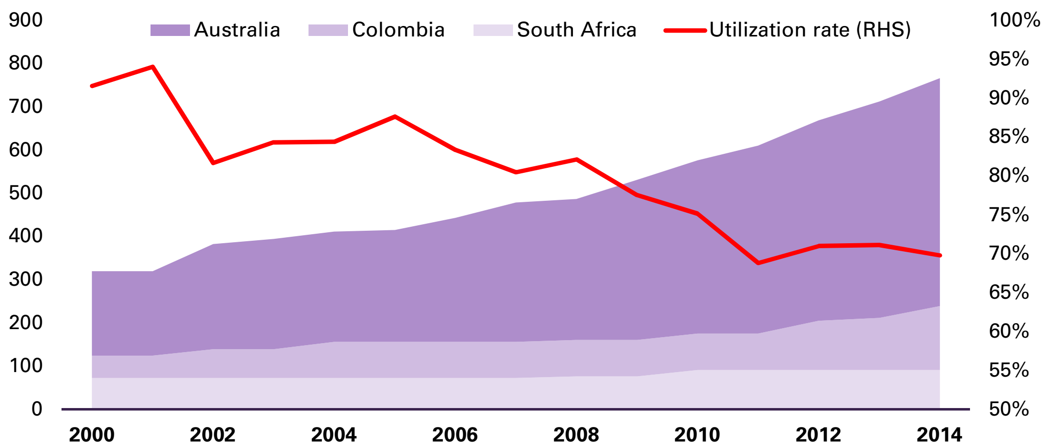
In other words, supply continues to be resilient in the face of low prices. Sometimes, loss-making mines such as Wilkie Creek in Australia are eventually closed but a new owner emerges to purchase the mine and bring it back into production under a lower cost base, thus contributing to the downward shift in the cost curve and keeping the market well supplied. We remain focused on any indication of a supply response to either prices or policy (e.g. greater restrictions on illegal mining and caps on total production volumes in Indonesia); in the medium term we expect prices to gradually recover towards our $80/t estimate of cost support, but we believe the upside risks to $80/t are limited.

The window for new investment has closed

As recently as 2010, the Australian coal industry was concerned about a perceived shortage in port capacity. Attractive profit margins left producers worried that their mine expansion plans could be undermined by a bottleneck in transportation, and investment into new projects flowed accordingly; the export capacity of Australian coal terminals increased by 170% to 527Mtpa between 2000 and 2014. Now it is the pullback from additional port expansions at Abbot Point that generates headlines. This example from Australia is representative of a global trend: the investment phase is now over, and future supply growth for the next decade will come mainly from existing capacity (Exhibit 28). During the exploitation phase that is now under way, a more competitive environment will drive coal producers to debottleneck their operations and focus on improving productivity; the pressure of lower profit margins in a well-supplied market creates a strong incentive to use labour and capital resources as efficiently as possible.

[4] Indonesian exports are based on import statistics from China, Korea, Japan, Taiwan and Thailand; Russian exports are based on import statistics from the UK, Germany, Turkey, China, Japan and Korea.

Exhibit 28: Port capacity has increased but utilization rates have dropped
Coal port capacity and utilization rates in selected regions - Mtpa



Source: Company data, IEA, Goldman Sachs Global Investment Research

In our view, this has the following implications for producers and investors:

- Growth projects, in particular when capital intensity is high, are unlikely to earn a positive return for the duration of the current exploitation phase.
- The value of undeveloped coal reserves in the ground diminishes just as the timeframe for their eventual development recedes further.
- Value can be created when lower quality assets are restructured (e.g. via a change of ownership, a new mine plan, etc.) and this results in a lower cost base and/or a longer mine life.

Risks to our views

We highlight a set of risks with the potential to undermine our forward view of the thermal coal market:

- **Chinese domestic supply**: By virtue of its size relative to the seaborne market, domestic coal prices in China act as an anchor for the seaborne market. Over the past two years the Chinese cost curve has shifted downward as marginal mines closed while the rest of the industry continued to consolidate and mechanize. A recovery domestic prices, for instance via an increase in rail tariffs or stronger demand for electricity, is an upside risk for the seaborne market.
- **Indian demand**: India has replaced China as the leading driver of seaborne demand growth. Indian demand for imported coal has significant upside, but its future growth rate is dependent on a wide range of variables including: a) the ability of domestic producers to secure and develop new coal blocks in a timely manner, b) the pace of reform and deregulation of the power sector, which impacts the profitability of power plants buying imported coal, and c) India's GDP growth and underlying demand for energy.
- **Energy policy and environmental regulation**: Environmental concerns are an important driver of energy policy, but the pace of regulation and its impact on future coal demand are difficult to forecast. In our view, emissions standards for US coal plants, the adoption of emission trading in Asia, and Japanese policy regarding nuclear energy are some of the key uncertainties in the short to medium term.
- **Foreign exchange rates**: The macroeconomic outlook and the shift to an exploitation phase could lead to further depreciation of commodity currencies such as the Australian dollar and Indonesian rupiah. This would result in downward pressure on costs and prices, and could induce additional supply growth. Conversely, further appreciation of the Chinese renminbi relative to the US dollar would enhance the competitiveness of imported coal and be supportive of future demand and prices.

Disclosure Appendix

Reg AC

We, Christian Lelong, Jeffrey Currie, Samantha Dart, Daniel Quigley and Amber Cai, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

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