Enterprise Efficiency

Experiences of Brazil, Russia, India and South Africa

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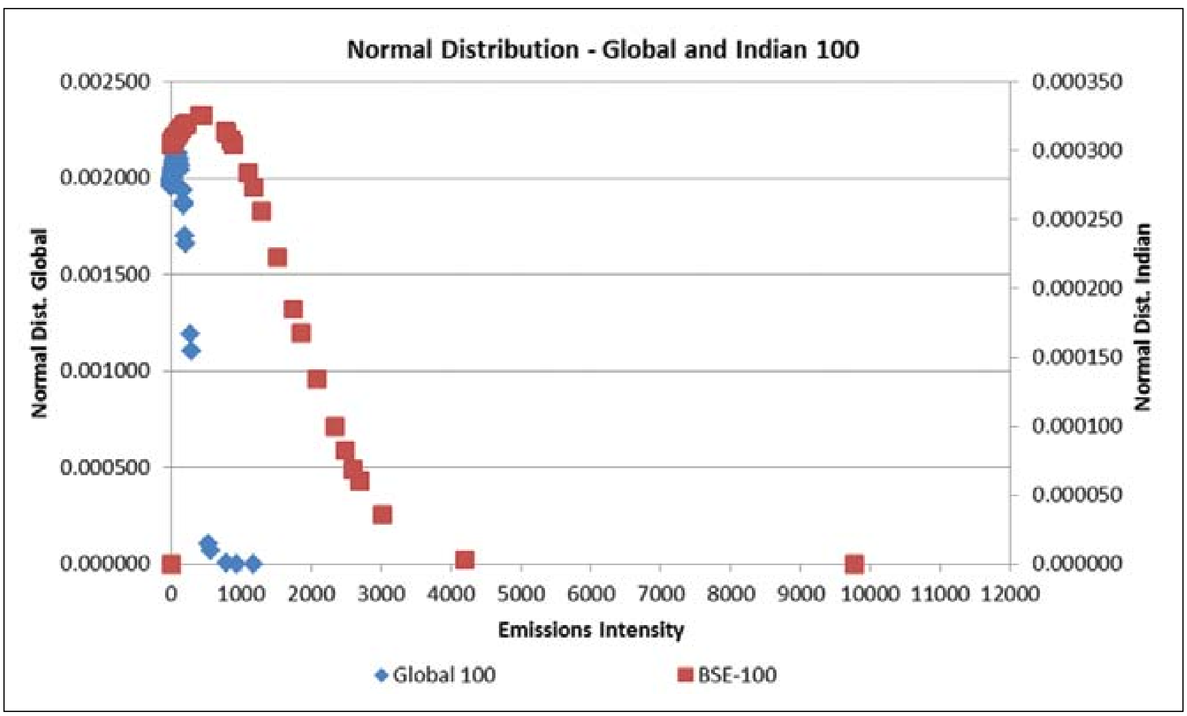
Introduction

This report attempts to aggregate the resource efficiency experiences of businesses and industrial sectors in four emerging and developing countries. The efficient use of factor inputs in industrial production is a critical element of business responsibility, and in the case of resource-intensive industrial sectors, such efficiency is central. This report uses resource efficiency, particularly the use of energy resources in energy-intensive sectors, as a proxy for enterprise efficiency.

Since the global financial crisis began, the notion of business responsibility has gained prominence in public discourse. In contrast to the singular commercial objective of maximising shareholder wealth, the concept of business responsibility focuses on adding to stakeholder value. Therefore resource efficiency is an integral part of business responsibility. Moreover, efficient use of input resources like fuel and electricity creates greater resilience while coping with resource scarcity. It also lowers factor production costs, enhancing competitiveness of business and thereby benefiting stakeholders ranging from employees to consumers.

A 2012 study by an Indian sustainability advisory firm analysed the emission intensity performance of the 100 largest Indian and global companies over a period of time following the financial crisis.[1] It found a strong correlation between better financial performance and lower emission

Graph 1: Variation in Emission Intensities between the Largest Indian Companies and Global Companies, 2010



Source: India Market and Environment Report, Gtrade Carbon Ex Rating Services, 2012 intensity in the case of both sets of companies. Moreover, it found that the emission intensity of the most efficient Indian companies was at par with that of the most efficient global companies (Graph 1). However, the variation (standard deviation) in performance among Indian companies was far greater than that observed in the case of global companies.

Extrapolating these results, it can be inferred that the scope for efficiency gains in energy-intensive industries, particularly those that lie towards the right of the bell curve, is large. Catalysing these gains would require alignment of a number of factors, including the prevailing domestic and international policy environment; business factors, such as factor input costs of production; industrial performance and energy efficiency benchmarks in relevant sectors; and other positive and negative externalities, including scarcity or abundance of resources, the price of produced energy, infrastructure availability and the efficiency of supply chains.

This report will closely examine experiences from India, Russia, Brazil and South Africa, four countries with a growing industrial base, a large number of transnational corporations and varying institutional frameworks. With a focus on the Indian example, the report seeks to present a synthesis of the industrial energy consumption policies in Brazil, Russia and South Africa. The objective is to draw meaningful suggestions for enhancing enterprise efficiency, based on variations between regimes; look at common opportunities for policy; and deconstruct the role of systemically important sectors in catalysing efficiency gains, by particularly focusing on analysis of a few Indian industrial sub-sectors.

Country Backgrounds

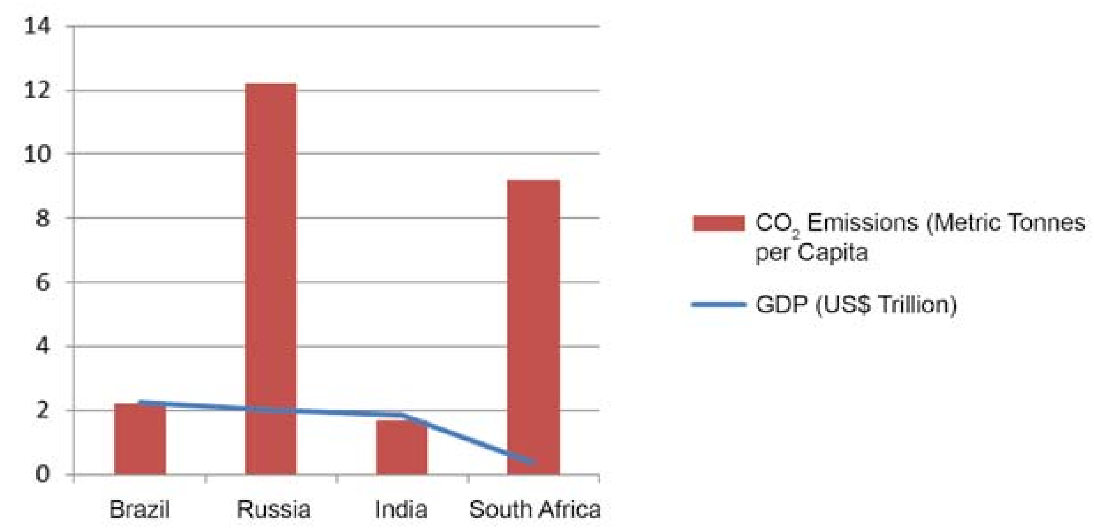
The industrial sector, which accounts for a large proportionate share of primary energy consumption, is likely to keep growing at a rapid pace in many parts of the emerging and developing world. The United Nations Industrial Development Organisation has noted that "although industrialised economies account for nearly two thirds of world manufacturing output, developing and emerging industrial economies contribute the most to its growth. During the years of recession 2008-2013, the manufacturing value added of developing and emerging industrial economies grew by almost 5 percent per annum while the contribution of industrialised economies to global industrial growth was negative."[2]

The four emerging and developing countries this report focuses on – Brazil, Russia, India and South Africa – are at different stages of economic growth and industrialisation. Brazil, Russia and India are at relatively similar levels of GDP (approximately $2 trillion), while South Africa is a smaller economy. The levels of per capita emissions, to an extent a function of the level of industrialisation or intensity of energy consumption in the industrial sector, are much higher in Russia and South Africa than in Brazil and India (Graph 2).

India is a developing economy, with a population exceeding 1.2 billion people. To sustain economic growth and simultaneously meet development targets, both its public and private sectors will need to respond to the systemic challenge of resource scarcity. Commensurate emphasis is needed on job creation for a vast labour force, infrastructure construction and the provision of basic social security for a large, uninsured and vulnerable population living below $2 a day.

Brazil and Russia are similarly sized in terms of population (Table 1). However, unemployment is a more pressing socio-economic concern in Brazil. The two countries also have very different demographic underpinnings, with a much larger younger population in Brazil, leading to greater potential for economic growth. South Africa is much smaller than the other three, but its employment challenge is no less urgent. With a low industrial base and low per capita energy consumption, India too has a commensurately

Graph 2: Per Capita Emissions and GDP (Brazil, Russia, India, South Africa)



Source: World Bank Indicators (GDP – 2012, Emissions per Capita – 2010)

Table 1: Key Metrics of Countries Analysed

Key Metrics	Brazil	Russia	India	South Africa
Population (Mid-Year, 2012, Millions)	193.0	143.2	1210.0	51.0
Unemployment Rate (%, 2012)	6.7	5.5	3.8	25.1
Economically Active Population (% Share)	68.6	53.0	53.0	35.4
Industrial Production (Preceding Year 2012 = 100)	97.3	102.6	102.9	102.0
Energy Consumption per Capita (kgoe, 2009)	1288.0	11249.0	400.0	1641.0

Source: BRICS Statistical Handbook, 2013

large unemployment burden.

In the case of most emerging and developing countries, perhaps especially those analysed in this report, energy efficiency is the lowest hanging fruit to achieve a low-carbon, sustainable and inclusive growth trajectory. Energy efficiency gains in the industrial sector in particular can be realised through an integrated resources management approach where government policies, industrial action and the operating environment are all aligned to achieve the goal of greater efficiency.

Indeed, it is incumbent upon large energy-intensive businesses and domestic energy sectors to realise energy efficiency gains in order to address resource scarcity and achieve global competitiveness.

Energy Consumption and Efficiency

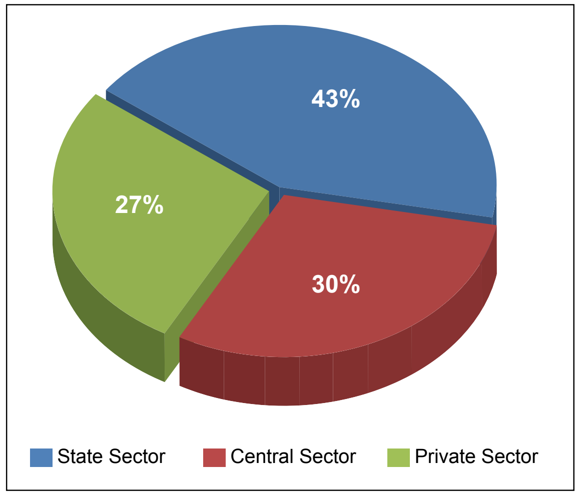
India

With an assumption of nine percent annual economic growth, it is projected that by 2031-32 India's per capita energy consumption will "increase by four to five times and power generation capacity would increase six-fold from 2006-07 level(s)".[3] A large proportion of the power generated will come from fossil fuels such as coal and gas. The Graph 3 shows the current energy mix with coal accounting for close to 57 percent of installed capacity, and coal, gas and oil accounting for over two-thirds of installed capacity.

Considering the impetus for expansion over the next few decades, a larger share of power generation will have to come from the private sector, currently accounting for less than a third of the total generation in the country (Graph 4). The private sector, to remain competitive, is more likely to install state-of-the-art industrial equipment for power generation. This would result in significant efficiency gains going forward. At present, Indian power plants have a low average net efficiency for power generation, emitting 0.8-0.9 kg/kWh of carbon dioxide.[4]

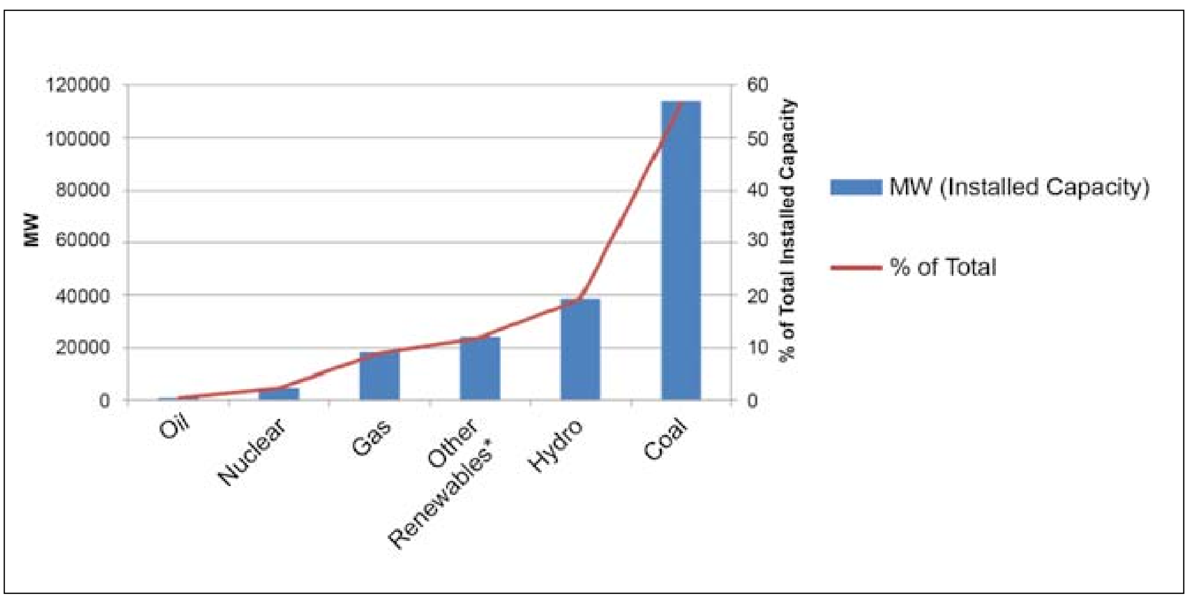
In India, the per capita Greenhouse Gas (GHG) emission without Land Use, Land-Use Change and Forestry (LULUCF) was 1.7 tonnes of CO_2 equivalent in 2007. With LULUCF, it was 1.5 tonnes per capita. While emissions per capita have increased since 1994, the emissions intensity of

Graph 4: Power Generated by Central, State and Private Sector as % of Total, India, 2012



Source: Central Electricity Authority, Government of India (as on 30.04.2012)

Graph 3: Installed Capacity of Power Generation based on Different Fuels, India, 2012



**Small hydro projects, solar, biogas, wind, urban and industrial waste power*
Source: Ministry of Power, 2012

India's GDP declined by more than 30 percent during the period 1994-2007.[5] This is due to the rapid expansion of GDP from the liberalisation and globalisation of the economy, as well as efficiency improvements in emission-intensive sectors. Simultaneously, the sheer scale of expansion of the Indian economy has resulted in the fast growth of sectors/industries such as electricity, transport, cement, steel and construction, among others, as shown in the Table 2.

Table 2: Sector Wise Emissions Growth, India, 2007*

Sector	2007	CAGR**
Electricity	37.80%	5.6
Transport	7.50%	4.5
Residential	7.20%	4.4
Other Energy	5.30%	1.9
Cement	6.80%	6.0
Iron & Steel	6.20%	2.0
Other Industry	8.70%	2.2
Agriculture	17.60%	-0.2
Waste	3.00%	7.3

**The percentage emissions from each sector with respect to total GHG emissions without LULUCF*
*** Compound Annual Growth Rate*
Source: Ministry of Environment and Forests, Government of India, May 2010

All of India's coal-fired power stations use sub-critical technology, resulting in considerable efficiency losses. Moreover, the aggregate technical and commercial losses (AT&C) in the power sector are immense. Due to the poor financial health of state electricity utilities that are unable to maintain power distribution infrastructure and upgrade utilities, AT&C losses are currently above 35 percent. Energy efficiency can play a prominent role in addressing this challenge, and energy efficiency improvements through both supply-side and demand-side management are possible. Through demand-side management, for example, there is potential for saving up to 25 percent of current energy use in the Indian industrial sector (Table 3).

Table 3: The scope for Increasing End Use Efficiency through Demand Side Management, India

Sector	Potential (%)
Industry	10-25
Lighting	30-35
Commercial Buildings	50
Agriculture	40-45

Source: Annual Report, Bureau of Energy Efficiency, 2008

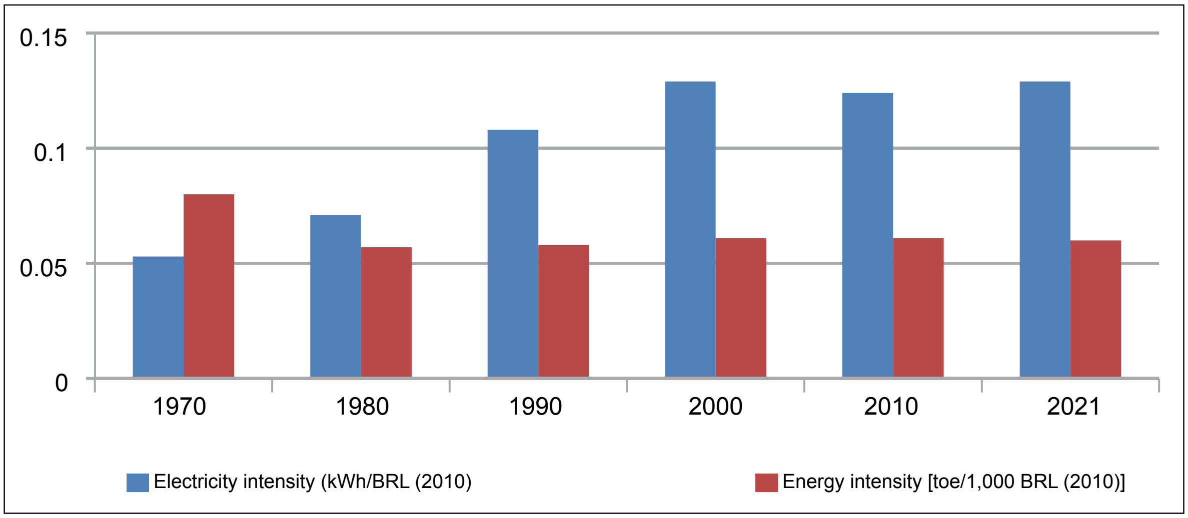
Brazil

Historically, the income elasticity of electricity consumption in Brazil has been high – which has meant that electricity consumption has increased at a higher rate than income growth. Between 1970 and 2005, the average value was 1.67, reaching a maximum of 3.75 during the 1980s, when large electricity-intensive industrial projects came into operation and thermal energy was encouraged. Nevertheless, the recent trend for this parameter is downward. During 2000-2005 it reached 1.03.[6] This decrease in the elasticity of electricity demand stems from more efficient use of electricity by industrial consumers, employing energy-saving methods, processes and equipment.[7]

Another factor that has contributed to lower relative consumption of electricity is price. As rates have grown well above inflation, consumers seek to reduce consumption to reduce spending. Graph 5 shows that in recent years energy intensity has remained relatively stable in Brazil, and specific sectors may even show an upward trend.

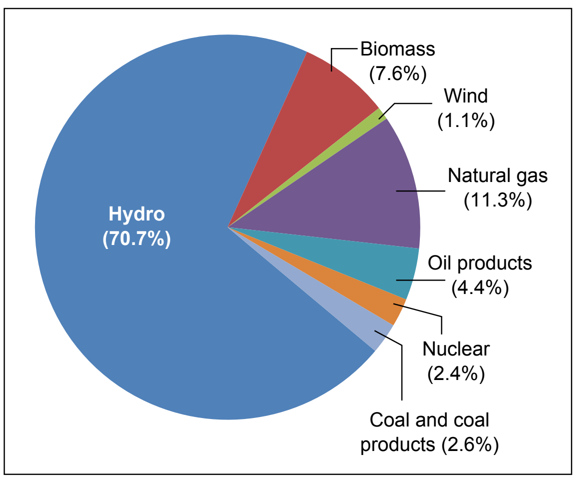
The Brazilian energy sector stands out for having a high share of renewable sources in its primary energy and electricity matrix (Graph 6). Currently, hydropower is responsible for 70 percent of the

Graph 5: Energy and Electricity Intensity, Brazil



Source: Empresa de Pesquisa Energética, Ministry of Mines and Energy, 2012[8]

Graph 6: Electricity Mix, Brazil, 2013



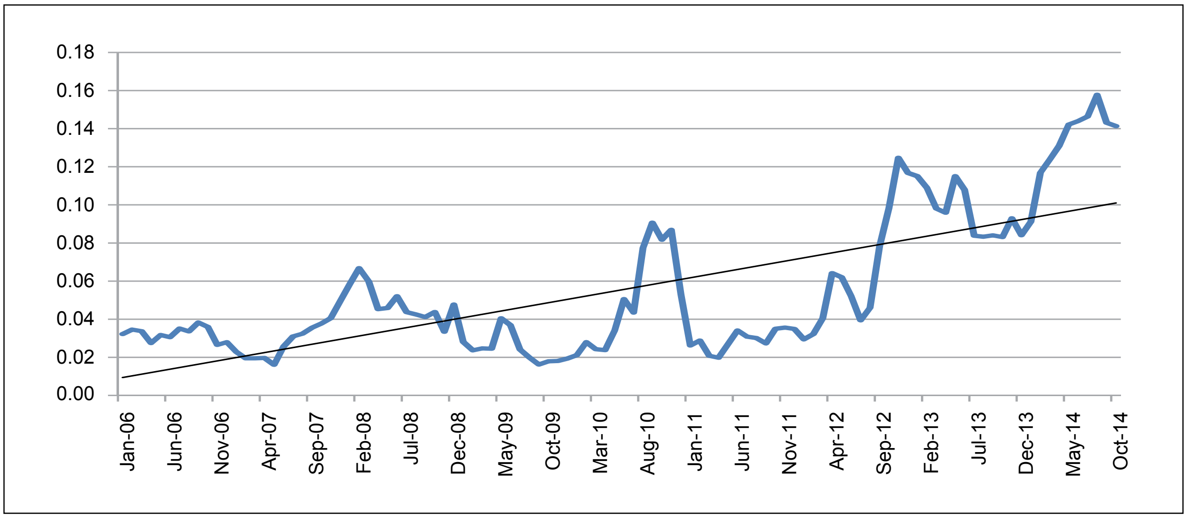
Source: Empresa de Pesquisa Energética – EPE, 2014[10]

total electricity supply, whereas biomass (mainly sugarcane bagasse) is responsible for 7.6 percent. Electricity generation in Brazilian power plants reached 570.025 TWh in 2013, 3.2 percent higher than in 2012. Final consumption reached 516.3 TWh, meaning that more than 15 percent of electricity produced was lost.[9] The government sector accounts for around 86 percent of total power generation in Brazil (which is even higher than that of India).

Although Brazil has a clean energy matrix when compared to international standards, it is worth noting that recent increases in the emission factor of the electricity sector has revealed a trend contrary to what should be pursued in light of emerging environmental and climate policies throughout the world (Graph 7). The average emission factor of the electricity consumed in Brazil was 96g CO_2/kWh in 2013, whereas in 2011 this indicator had been three times lower. In 2014, the upward trend remained.

The Brazilian economy's energy intensity is relatively low – it is approximately half as carbon-intensive as the US economy, 1.3 times lower than the European economy and a quarter that of the Chinese economy.[12] Energy planning, which relied on optimistic projections for wind power and biomass in recent years, is likely to be reviewed due to the increasing share of thermal generation. The predominance of hydropower in Brazilian electricity generation also includes the risk that periods of drought will disrupt the hydrological cycle of watersheds in which the hydroelectric

Graph 7: Electricity Emission Factor in Brazil (tCO_2/MWh)



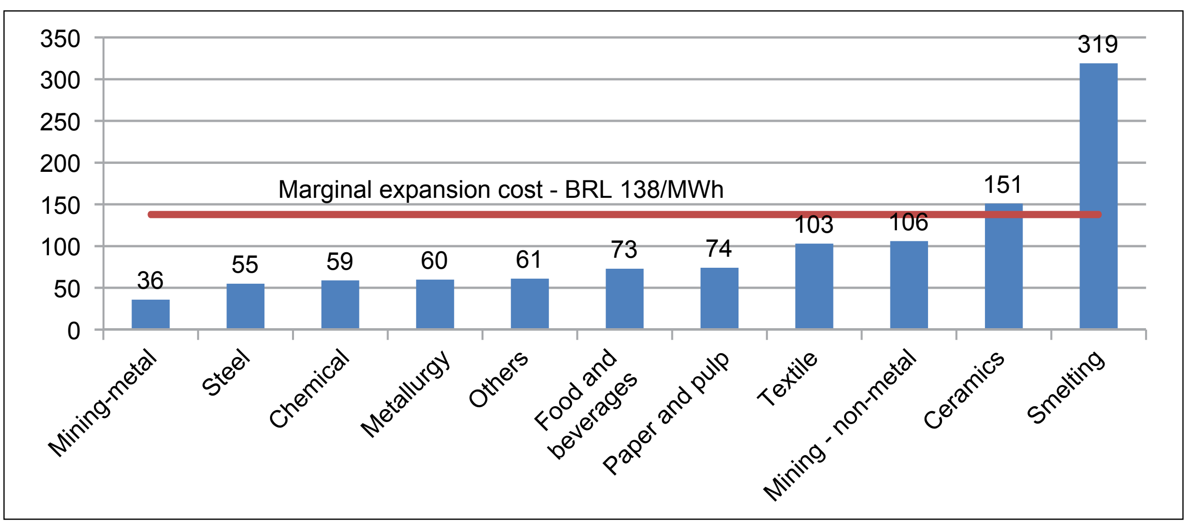
Source: Ministry for Science, Technology and Innovation – MCTI, 2013[11]

power plants are located. This means that energy supply diversification should be an important part of the country's long-term energy planning. Moreover, Brazil's National Confederation of Industry indicates that it is profitable to invest in energy efficiency for many sectors, according to the graph below.

Russia

From 2000 to 2007 Russia's average annual GDP increase was 7.2 percent. It was based primarily on the extraction and export of fossil fuels, buoyed by high oil prices. According to estimates by the Ministry of Economic Development, a change in crude oil prices of $10 per barrel leads to Russian

Graph 8: Cost of Energy Saved (BRL/MWh)



Source: Confederação Nacional da Indústria – CNI, 2009[13]

GDP growth of 0.4-0.5 percent (Graph 9). Russia possesses 5.2 percent of proven world oil reserves (8th globally) and 17.6 percent of proven world gas reserves (2nd globally). However, oil and gas production annual growth rates have decreased since the middle of the first decade of the 21st century. As a result, Russian economic growth has dramatically decelerated.

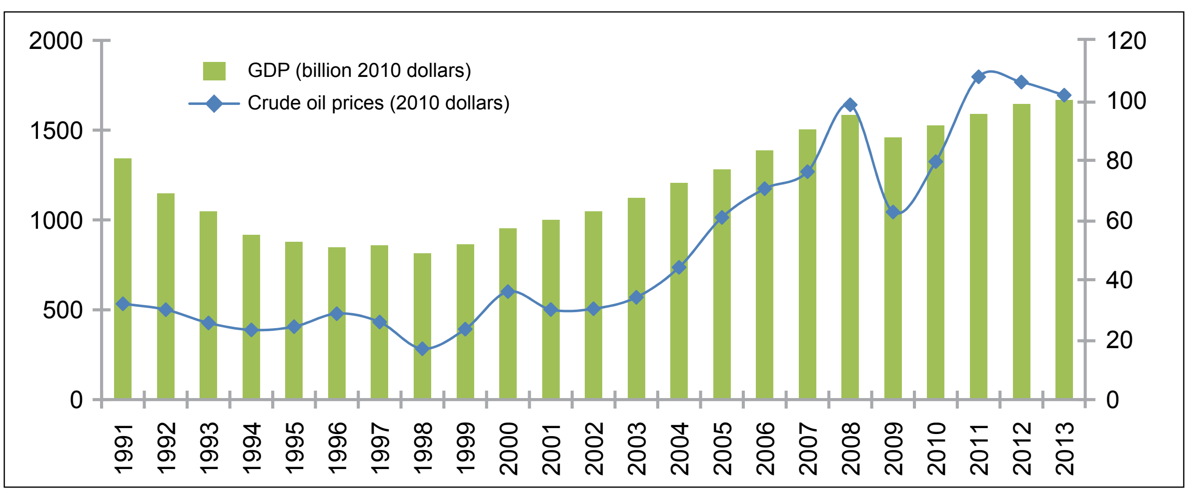
Russia's oil sector is dominated by a few domestic firms. State-controlled Rosneft is the largest of them. This company continues to acquire energy assets all over the country. After the acquisition in 2013 of TNK-BP, the last significant market player with strong foreign participation, Rosneft became the largest public oil and gas company in the world in terms of volume of extraction and reserves.[14]

Electricity in Russia is generated primarily from fossil fuels (68 percent), but also by hydropower (20 percent) and nuclear energy (11 percent).[15] Before 2008 the sector was dominated by the state monopoly Unified Energy System of Russia (RAO EES). Since 2008 large-scale reform of the sector has been carried out. Generating facilities were divided into wholesale companies, most of which were privatised. Some foreign companies, including the German E.On, the Italian ENEL and the Finnish Fortum, also acquired some generating facilities. However, large players have continued to become larger; the share of state-controlled companies has increased, while the share of the independent players has decreased.[16] All hydro projects are united under control of the company RusHydro, which is largely owned by the Russian government.[17] All nuclear facilities are controlled by the state agency Rosatom.

The energy sector accounts for more than 70 percent of Russian exports[18] and nearly 50 percent of its federal revenue.[19] All attempts to diversify the economy have failed so far. The share of oil and gas in Russian exports has risen since the beginning of the century, although the income from exports of fossil fuels provided numerous opportunities to develop other sectors of the national economy. After passing from a planned to market economy Russia needs another transition – economic diversification.

Energy efficiency is a cornerstone of such a transition. Recognising this, in 2009, former Russian President Dmitri Medvedev declared a national goal to reduce energy intensity (of GDP) by 40 percent from 2007 levels by 2020. The state programme "Energy saving and energy efficiency

Graph 9: GDP and Crude Oil Prices, Russia



Source: BP Statistics 2014, World Development Indicators up to 2020" initiated simultaneously should lead to cumulative energy savings equal to 800 mtoe from 2011 to 2020.[20] According to the World Bank and the Center for Energy Efficiency, investments of $320 billion in energy efficiency measures can save 45 percent of final primary energy consumption.[21]

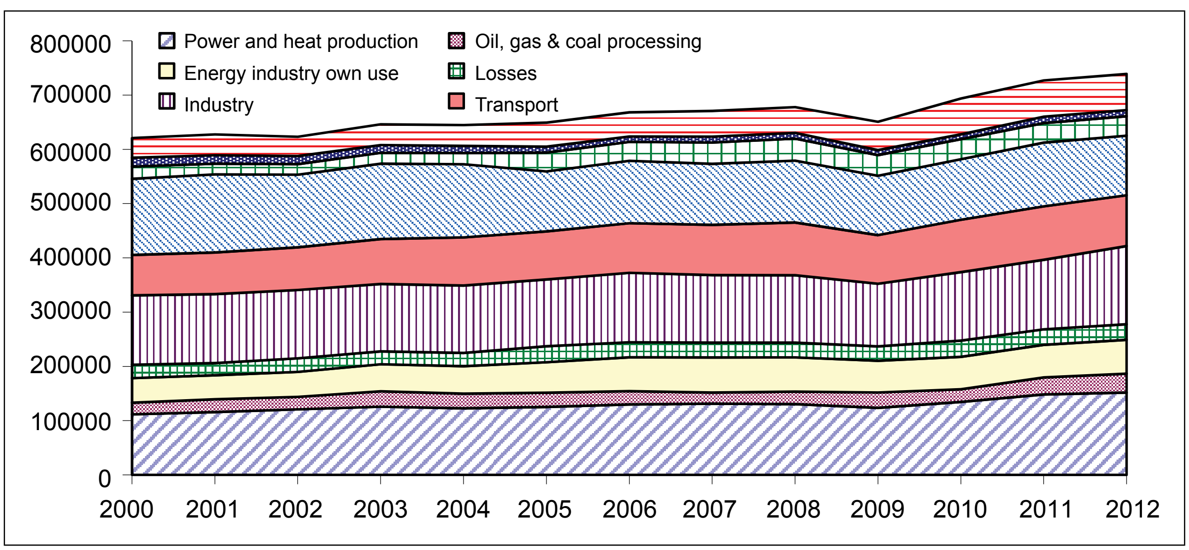
Russian energy intensity began decreasing in 2000, and through 2008 decreased annually by five percent. About half of this decrease was due to structural shifts in the Russian economy as some Soviet energy-intensive sectors were substituted by services. A large share can also be explained by the modernisation of equipment.[22] About a third of all energy in Russia is used for energy transformation and distribution (Graph 10). Given the dependence of the Russian economy on the extraction and processing of fossil fuels, this level is not extraordinary. However the volume of losses in the process of distribution (3.9 percent of total energy supply) is far above the level reported in developed countries.[23] This gap is largely due to the deterioration of equipment in the Russian energy sector.

South Africa

South Africa is the second-largest economy in Africa (after Nigeria). It is also an energy-intensive economy with a high reliance on fossil fuels largely due to an abundance of coal. Coal accounts for 77 percent of the total primary energy mix and 95 percent of the electricity generation capacity in the country (Graph 11). The energy sector is the single largest source of GHG emissions, accounting for about 89 percent of the country's total emissions.[24] Eskom, the state electricity company, is responsible for electricity transmission and generates 95 percent of South Africa's electricity.[25, 26]

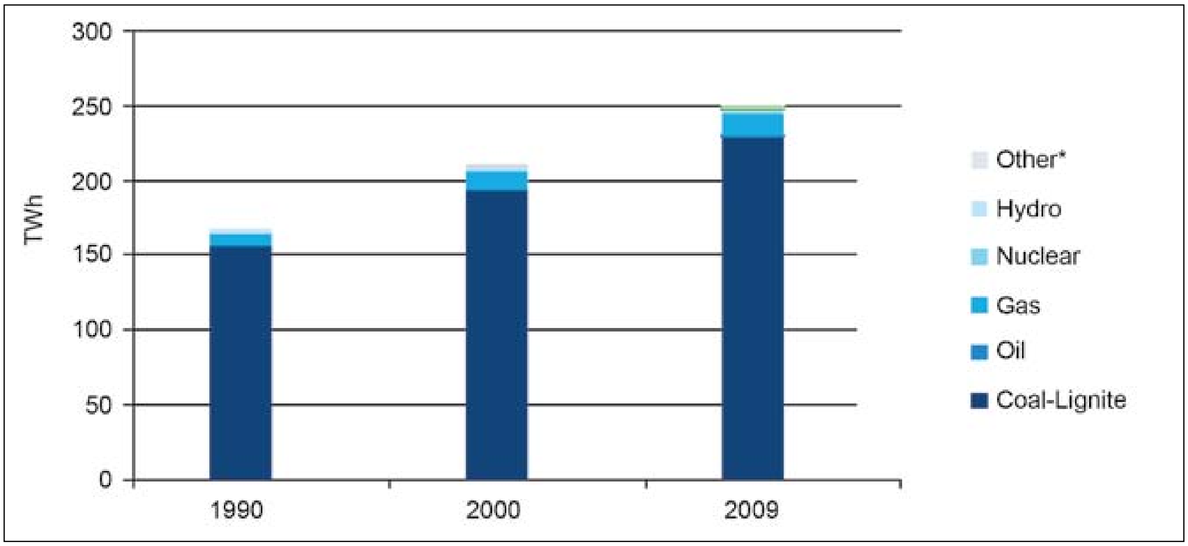
South Africa is faced with the dilemma of simultaneously growing its economy and alleviating poverty, all the while improving efficiency of resource consumption – a situation similar to that of some of the other economies analysed in this study, such as India. South Africa's energy consumption per capita is higher than the world average: 2.7 toe versus 1.8 toe.[28] The South African industrial base was built on cheap electricity, and this has had consequences for energy efficiency. This is for two reasons. First, the

Graph 10: Pattern of Energy Use, Russia 2000-2012 (ktoe)



Source: International Energy Agency

Graph 11: Power Generation by Source, South Africa



**Including biomass, geothermal and solar*
Source: Enerdata[27]

monetary value of energy savings did not justify investments in energy efficiency, or the pay-back period for interventions was extraordinarily long. Second, there are often limited opportunities to improve either the energy efficiency or the production process in electricity-intensive industries – such as aluminium smelters – based in the country.

Things have, however, begun to change in recent years. Low electricity tariffs, well below cost-effective levels, have led to poor investment decisions and a gross misallocation of the country's economic resources. Consequently electricity tariffs have risen, causing a 78 percent increase in real electricity prices since 2008 (Graph 12).

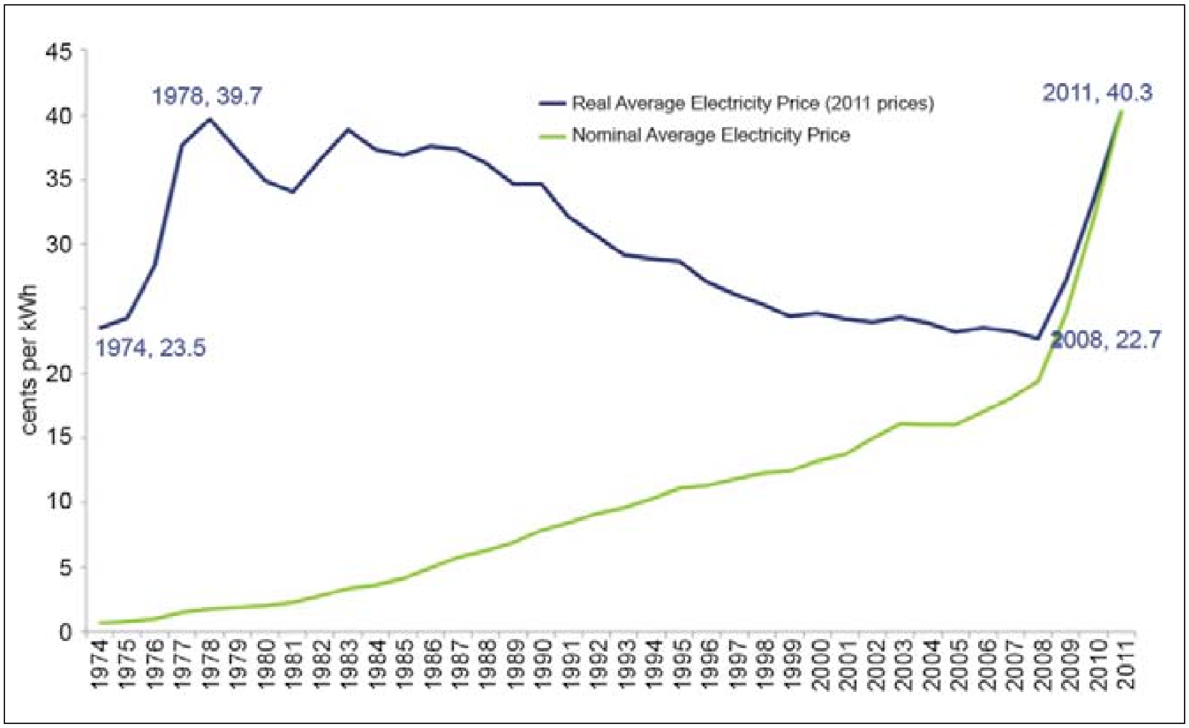
Given that electricity is a key factor of production for South African industry, rising electricity prices have left industry with limited room to manoeuvre. It is compelling to pass on the price increase to the industrial consumer, as opposed to the voting population of household consumers. However, this causes a loss in industrial competitiveness. For export-focused industries such as metals and mining, output prices are set according to international markets, and thus the industry is generally a price taker, competing on costs of production.

Liberalisation of the economy has meant a surge in imports of tradable products and has therefore limited industry's ability to transfer electricity cost increases to the domestic market. The other option available to industry is to absorb the cost, eroding profit margins and invariably affecting shareholder investment decisions. Thus, industry has a strong financial incentive to save energy though greater efficiency.

Identifying Energy-Intensive Industries

This chapter identifies systemically critical industries across the four countries. Identification is based on indicators such as share of energy consumption, employment generation, share in gross capital formation, and share of total exports and investments. The objective is to identify industrial sub-sectors which are large energy consumers as well as important to each of the economies based on their individual needs

Graph 12: Trend in Average Electricity Prices Realised by Eskom per kWh



Source: Deloitte, 2012[29]

and competitive advantages. These industries therefore represent the low hanging fruit for catalysing improvements in efficiency of energy consumption.

India

Industry accounts for nearly half the gross capital formation (GCF) of the Indian economy.[30] As a share of total GCF, the contribution of industry peaked at 56.2 percent in 1995-96 in the period since 1991. This sector has continued to allocate a significantly high share of its income to capital formation – a fundamental priority for the long-term growth and sustainability of the Indian economy (Table 4).

Table 4: Gross Capital Formation in Industry, India

Share of Sectors of Industry in overall GCF in Percent	2004-05	2008-09	2011-12
Mining	3.7	3.6	3.8
Manufacturing	34.1	26.8	27.9
Electricity	5.3	6.3	6.8
Construction	5.4	5.7	6.0
Share of Industry in GCF	48.4	42.5	44.4

Source: Economic Survey, 2012-13, Ministry of Finance, India

The manufacturing sector accounts for the highest share of industry GCF in India. Although India is one of the top 10 manufacturing economies in the world, India's competitive disadvantage lies in the fact that its industrial economy has low-level technology, high input costs and poor infrastructure. India's share in total manufacturing value added is a paltry 1.8 percent. Therefore India has fared better in the manufacture of medium- to low-technology products in labour-

Table 5: Key Efficiency Metrics for the Organised Manufacturing Sector, India, 2010-11:

Fuel Consumption as % of Total Output in 2010-11	Gross Value Added as a of Total Output in 2010-11	Total Emoluments as % of Total Output	Share of Interest to Total Output in %
4.2	17.8	22	10.6

Source: Economic Survey, 2012-13, Ministry of Finance, India

intensive sectors, and production has remained resource-intensive as illustrated in Table 5.

The share of the Gross Value Added of the manufacturing sector as a percentage of total output has declined from a peak of 24.9 percent in 1996-97 to 17.8 in 2010-11, indicating an increase in resource intensity of raw materials and other non-fuel inputs. High resource intensity has made the profitability of the sector considerably dependent on wages and interest rates.

The steel and cement sectors are two of the largest manufacturing sub-sectors in India. The steel sector contributes nearly two percent of Indian GDP, whereas India is the second-largest producer of cement in the world. Both sectors are systemically critical and are intrinsically linked to the growth of the Indian economy as core sectors.

Brazil

In 2012, the industrial sector[31] in Brazil was responsible for 35 percent of final energy consumption (89 million toe). As presented in the graph below, within the industrial sector, specific sectors which deserve attention include foods and beverages production (27 percent), pig-iron and steel (19 percent), paper and pulp (11 percent), chemicals (eight percent), and non-ferrous and other metallurgical industries (eight percent).

According to the Brazilian Ministry of Labour, the manufacturing sector generated the largest share of employment in 2012, within which the food and beverages, textiles, chemicals, pulp and paper sub-sectors were some of the largest employers.

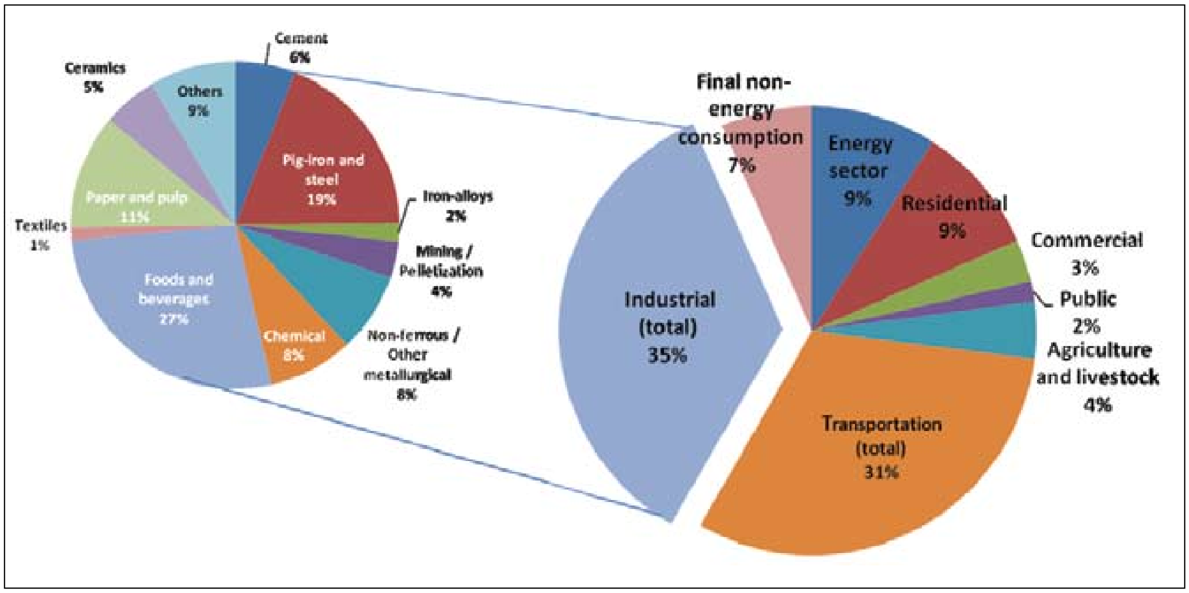
According to estimates from the Useful Energy Balance (BEU), the major portion of the technical potential for energy efficiency in Brazil lies in the residential, industrial and transport sectors. These together accounted for over 80 percent of final energy consumption in 2011. Considering the technical coefficients published in the BEU, it can be estimated that there is a technical potential of energy efficiency of approximately eight percent for the period 2012–2021.[33] Under its National Electrical Energy Conservation Programme (Procel), Brazil's National Confederation of Industry conducted an assessment on energy conservation potential in 13 industrial sub-sectors for which aggregated results are presented in Table 6.

It is worth noting that the foods and beverages, pig iron and steel, and paper and pulp sectors stand out for their share in final energy consumption, employment, energy intensity and potential for energy conservation.

Russia

Industry[35] takes the largest share of the total energy use and final energy consumption in Russia. Despite rapid industrial growth in 2000-2008 (more than five percent annually on average[36]), energy consumption in the industrial sector in 2008 was lower than in 2000, though in 2010 the level seen in 2000 was exceeded again. Half of all the energy used in industry is consumed by two sub-sectors – iron and steel production, responsible for 33 percent of total final energy consumption, and the chemicals and petrochemicals industry, covering 19 percent (without taking into account non-energy use).

Graph 13: Final Energy Consumption by Sector, Brazil



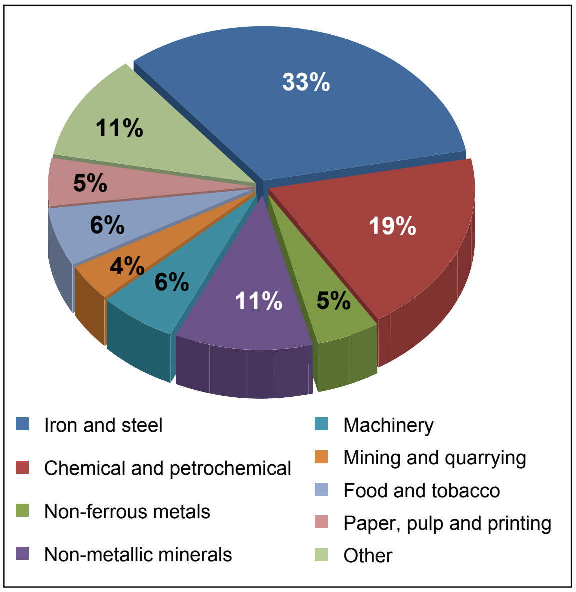
Source: National Energy Balance 2013[32]

Table 6: Potential for Electricity Conservation in Selected Industrial Subsectors

Energy Use	Potential (per year)		Sub-sectors with greatest conservation potential
	1,000 toe	GWh	
Motive power	2,032.4	23,640	Steel Mining and quarrying Foods and beverages
Refrigeration	46.6	540	Foods and beverages Chemical Textiles
Electric ovens	370.9	4,310	Steel Non-ferrous metals Ferro-alloys
Electrolysis	191.4	2,230	Non-ferrous metals Chemicals Paper and pulp
Lighting	60.2	700	Foods and beverages Textiles Mining and quarrying Paper and pulp
Other	2.4	30	Mining and quarrying
TOTAL	**2,703.9**	**31,450**	

Source: Confederação Nacional da Indústria – CNI, 2009[34]

Graph 14: Break up of Energy consumption in Industry, Russia, 2012*



**Excluding energy sector and non-energy use*
Source: International Energy Agency

Non-metallic minerals' producers consume 11 percent of all the energy used in industry, and enterprises specialising in machinery and food and tobacco each consume six percent (Graph 14).

Significant potential for reducing energy intensity lies in industry. Most of Russia's industrial sub-sectors are still less energy efficient than those in developed countries, as evidenced from consistently higher share of expenses on fuels and power in the prime cost of industrial production (given that energy prices in Russia are still much lower than in developed countries, this indicator actually underestimates the real gap in energy efficiency).

Taking into consideration share in total energy use, potential for energy savings and their structural relevance for the Russian economy, it is possible to identify three industrial sub-sectors which are of greatest interest in terms of catalysing greater enterprise efficiency. These sectors are outlined in Table 7.

South Africa

Manufacturing, which is energy-intensive, is the second-largest contributor to the South African GDP at 15.4 percent, while mining and quarrying contribute five percent. Historically, mineral extraction provided the bulk of South Africa's exports and jobs. However, due to a range of factors,[37] its share of GDP has dropped from its peak in the 1970s, when it comprised one-fifth. Historically the South African industry's competitiveness has been built on low electricity

Table 7: Some characteristics of Target Sectors

Sector	Total energy use (excluding non-energy use of fuels), mtoe, 2012	Share in total energy use, %, 2012	Share in GDP, %, 2012	Share in exports of goods, %, 2012	Number of employed, thousand, 2011	Share of employed in industrial sector,*** %, 2011
Energy	249.0*	25.2*	13,2	70.4	2253.1	16.9
Iron and steel	55.5	7.5	2.5	8.5	998.2**	7.5**
Chemicals and petrochemicals	27.6	3ю7	1.3	6.1	665.9**	5.0**

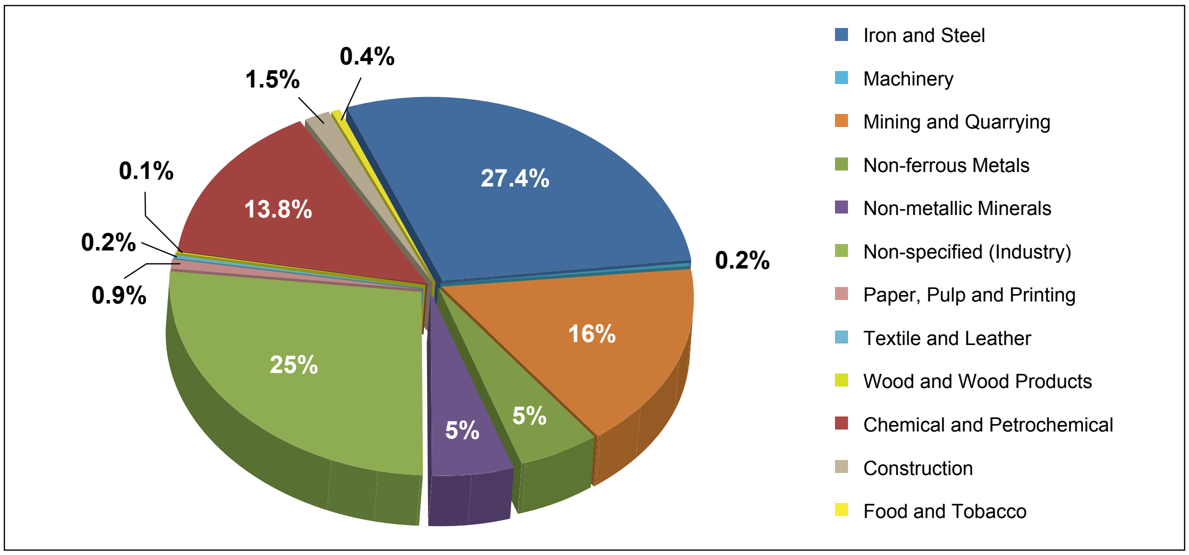
**Excluding losses in the process of distribution*
*** Employment in metallurgy and chemicals and petrochemicals is underestimated as it does not include such activities as extraction of metal ores and raw material for fertilisers. They are included by the Russian Statistical Service in the single group "Extraction of non-energy minerals" for which data is not detailed. Employment in these two activities can be crudely estimated at 300,000-400,000.*
**** Industrial sector includes extraction of minerals, manufacturing activities and manufacturing and distribution of electricity, gas and water.*
Sources: International Energy Agency, Russian Statistics Service, Federal Customs Service

tariffs. There are many factors that in the past[38] had a bearing on the level and trend in electricity tariffs. A discussion on these is beyond the scope of this paper and it suffices to say that in 2006, South Africa had the lowest industrial electricity tariffs in the world. This had two broad consequences. First, South Africa became an appealing destination for investment in energy-intensive industries; second, the manufacturing industry in general became electricity-intensive.

The industrial sector consumed slightly over 65 percent of the final energy supplied in the country in 2009. Within the industrial sector, the manufacturing industry – which includes various sub-sectors such as iron and steel, chemicals, non-ferrous metals, non-metallic minerals, pulp and paper, food and tobacco, and other unspecified industries – is the largest consumer of energy. It consumed 49 percent of the final energy supplied in the country in 2009. The largest sub-sector is iron and steel, which consumes 29 percent of the total energy used by the industry sector (Graph 15).

A 2011 study[41] profiling 13 industries in South Africa in 2006 shows that basic metals (which includes iron and steel and non-ferrous metals), mining and quarrying and non-metallic minerals

Graph 15: Energy Consumption by Industry, South Africa, 2006[39]



Source: Department of Energy, Republic of South Africa, 2010[40]

Table 8: Electricity intensity and output share per sector in South Africa, 2006

Sectors	Electricity intensity GWh/$ million (PPP* adjusted)	Ranking
Basic metals	1.095	1
Mining and quarrying	0.634	2
Non-metallic minerals	0.524	3
Agriculture and forestry	0.316	4
Paper, pulp and printing	0.207	5

** Purchasing Power Parity*
Source: Inglesi-Lotz and Blignaut 2011

form the most electricity-intensive industries (Table 8). A 2008 study[42] based on 2002 data brings out the dependence of the manufacturing sector on electricity costs. It showed that 24 of the top 30 most electricity-dependent industries, by way of share of electricity costs in total costs in the country, are in the manufacturing sector.

Assessing Efficiency Metrics of Indian Manufacturing Sector

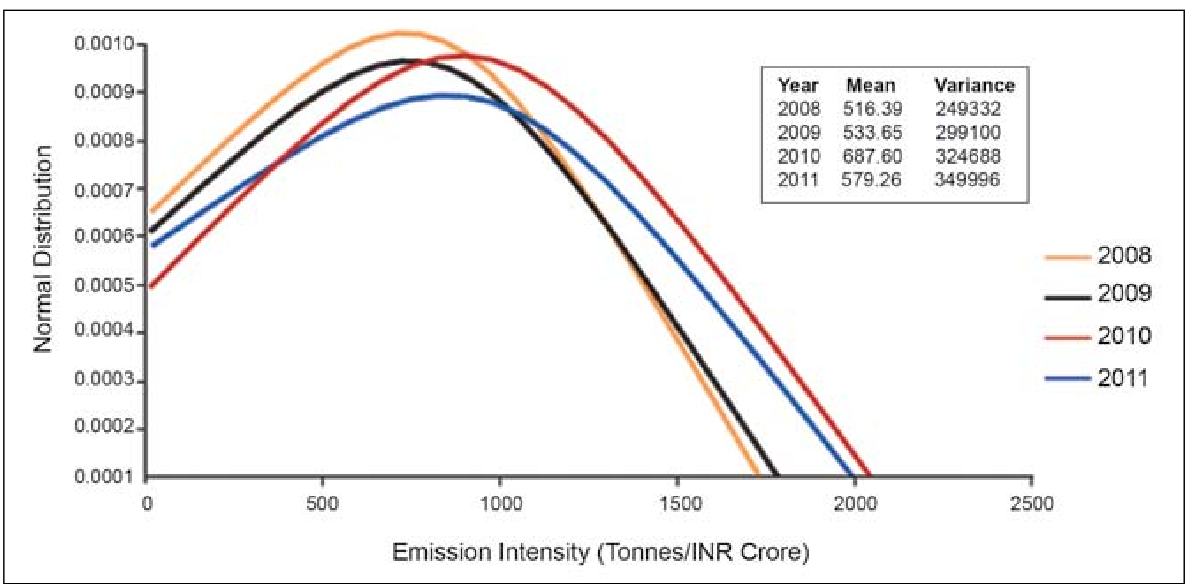
In this section of the report, the emission intensity[43] and financial metrics of some of the largest Indian companies in the steel and cement sub-sectors, identified as systemically critical to the Indian economy, are analysed. The focus is on India to serve as an example of a developing and emerging country.

Steel Sector

India is the world's fifth-largest steel producer, accounting for a five percent share of global crude steel production. India's steel production is domestically focused with only six percent of finished and semi-finished steel products exported in 2010. Most of the steel is made through one of two basic technologies: blast furnace (BF) and basic oxygen furnace (BOF). The scrap/electric arc furnace (EAF) technology is much less energy-intensive than BF/BOF. Significant energy savings can be achieved by switching from BF/BOF to scrap/EAF production, but such technological changes are limited by factors such as availability of scrap and demand for higher grades of steel. Currently, almost 70 percent of global steel is produced by BOF. In China, India and other emerging economies, the BF/BOF route is expected to continue to dominate production.

According to the International Energy Agency, the iron and steel industry accounts for approximately four to five percent of total global carbon emissions. This high energy consumption makes the way the firms in the sector manage energy inputs a crucial component of their financial performance. In India, the mean emission intensity of the largest companies in the steel sector has risen by over 12 percent from FY 2008 to FY 2011. Although there was a decline in mean emission

Graph 16: Normal Distribution of Emission Intensity of Steel Sector, India, 2008-2011



Source: Compiled by the authors

intensity in FY 2011, the variance of emission intensity rose by nearly eight percent. This means that alongside the decline in mean levels of emission intensity, the dispersion from the mean also increased.

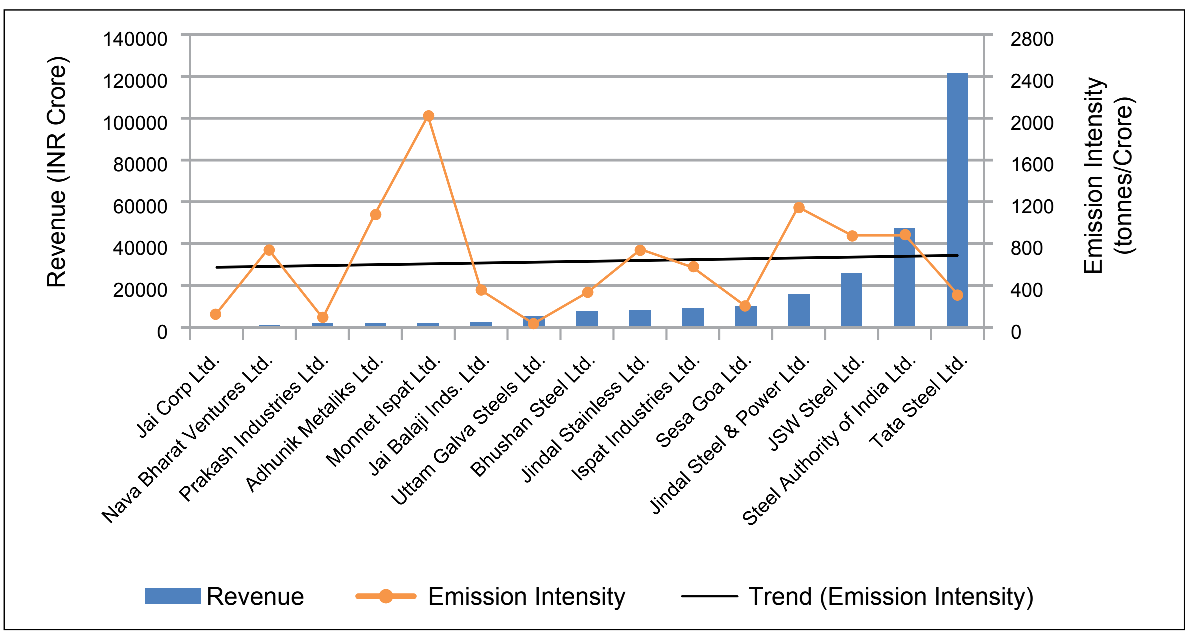
In the graph below, it is clear that the largest companies – Tata Steel, SAIL and JSW Steel – command a significant proportion of total revenues of the firms assessed (over 77 percent) and are responsible for over 70 percent of the total GHG emissions in the sector. Revenues are seen to be positively correlated with emission intensity (as the upward sloping emission intensity trend line shows). However, this is largely because the relatively smaller companies exhibit erratic efficiency performance.

The varying level of emission intensity in the steel sector is not well explained by expenses on power and fuel as a percentage of revenue. This is because the trend line is distorted by a few outliers. It is natural for economies of scale to be a factor in terms of revenues generated. Larger companies (such as JSW Steel, Tata Steel and SAIL) are able to acquire and run the latest technologies, and therefore spend much less on fuel and power than the relatively smaller companies (such as Nava Bharat Ventures and Jai Corp). Furthermore, the amount spent as a proportion of revenue on power and fuel varies considerably amongst the smaller companies, but the variation is smoother amongst the larger companies.

Cement Sector

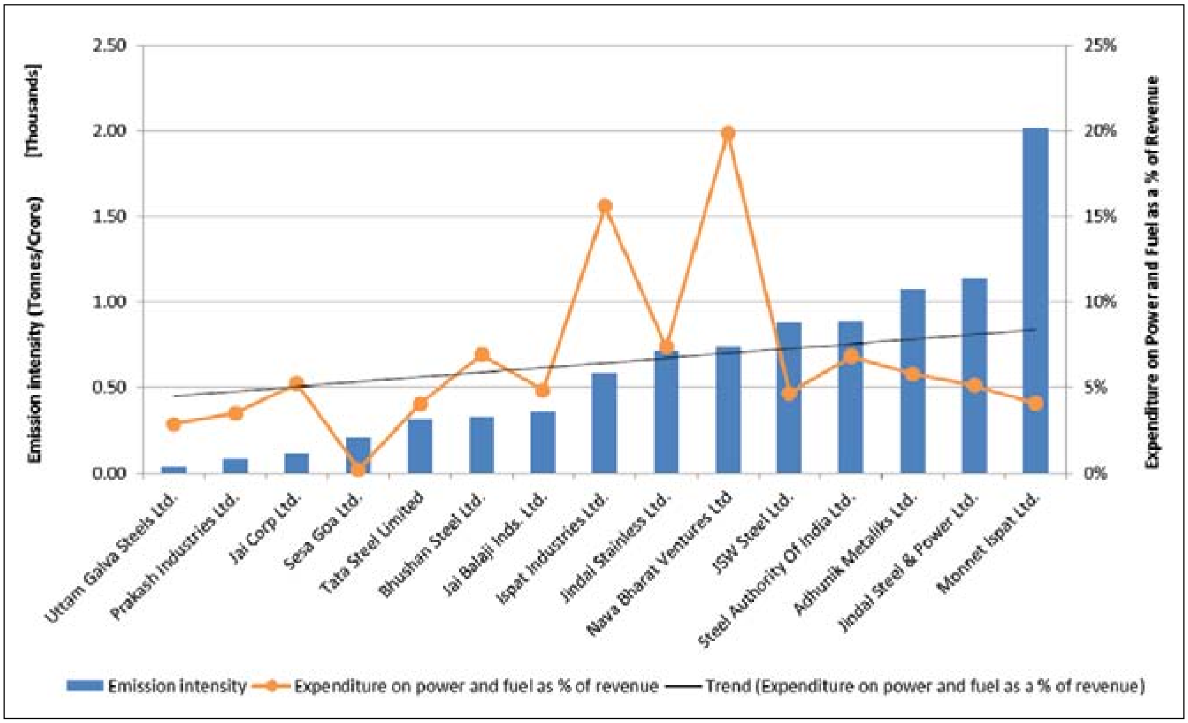
India is the second-largest cement manufacturer in the world after China, accounting for around six percent of total global production. The sector contributes over 1.3 percent of total GDP. There are over 150 large cement plants, with an installed capacity exceeding 230 million tonnes. According to the Indian Government's inventory of GHG emissions, in 2007, 56 percent of cement sector emissions were from the industrial process and the rest from fossil fuel combustion. (The manufacturing process requires heat generation as well as electricity.) The energy required to produce

Graph 17: Revenue and Emission Intensity Trend of Steel Sector, India, 2011



Source: Compiled by the authors

Graph 18: Revenue and Emission Intensity Trend of Steel Sector, India, 2011



Source: Compiled by the authors

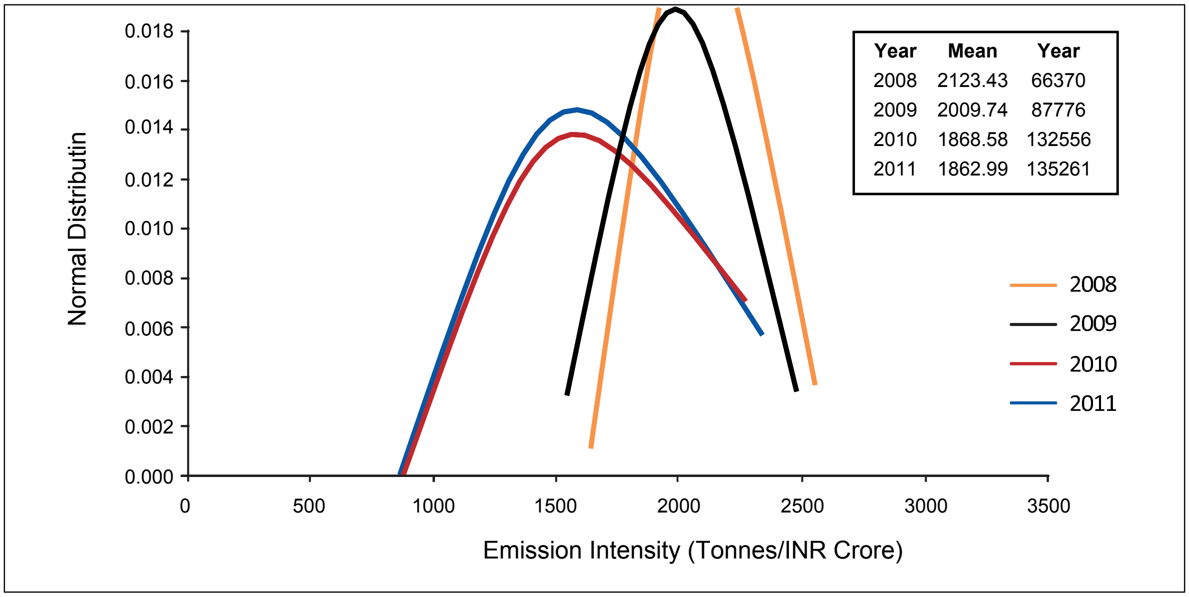
cement is significant, inputs costs are high and many companies generate power from captive plants.

Capital-intensive production, requiring sustained investment in energy and core production resources, means that small players find it hard to compete. It is thus no surprise that the production from large cement plants with capacity above one million tonnes per annum accounts for close to 90 percent of the total production in the country. The mean emission intensity of the largest companies assessed in the sector has decreased over FY 2008-FY 2011 by 12.26 percent (Graph 19). However, the variance has increased simultaneously, by approximately 90 percent. Most of the companies have been moving away from the mean towards the higher side of emission intensity distribution.

The trend line of emission intensity for FY 2011 slopes downwards across the various firms, indicating that emission intensity of relatively larger firms is lower than that of small firms. The largest three firms in terms of revenues, Ultratech Cements, ACC and Ambuja, account for over 60 percent of industry revenues as well as over 62 percent of GHG emissions. Lesser variation in emission intensity performance is seen amongst the higher-revenue generating companies.

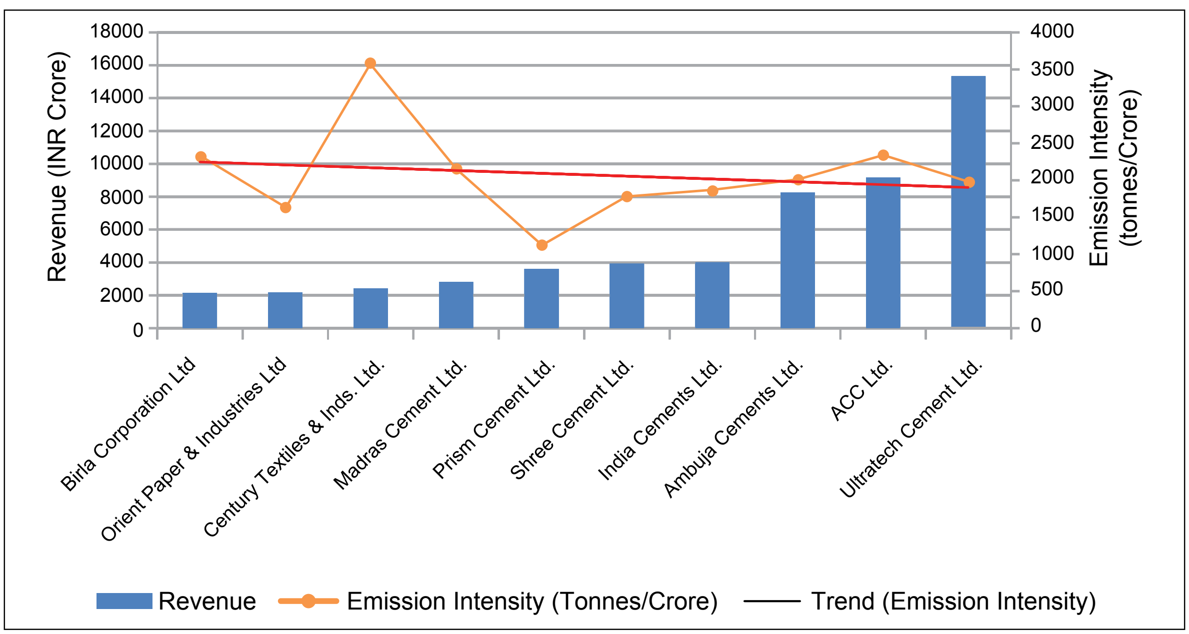
Among the large manufacturing sub-sectors, companies in cement have one of the highest expenditures on power and fuel as a percentage of revenue. While India Cements spends the highest on power as a percentage of revenue at around 26 percent, Prism Cements spends only around 14 percent. This gives some insight into why Prism Cement has the lowest emission intensity in the cement sector. The absence of a clear trend within the sector points to the variation in sources of fuel and technologies being used by the cement companies.

Graph 19: Normal Distribution of Emission Intensity of Cement Sector 2008 - 2011



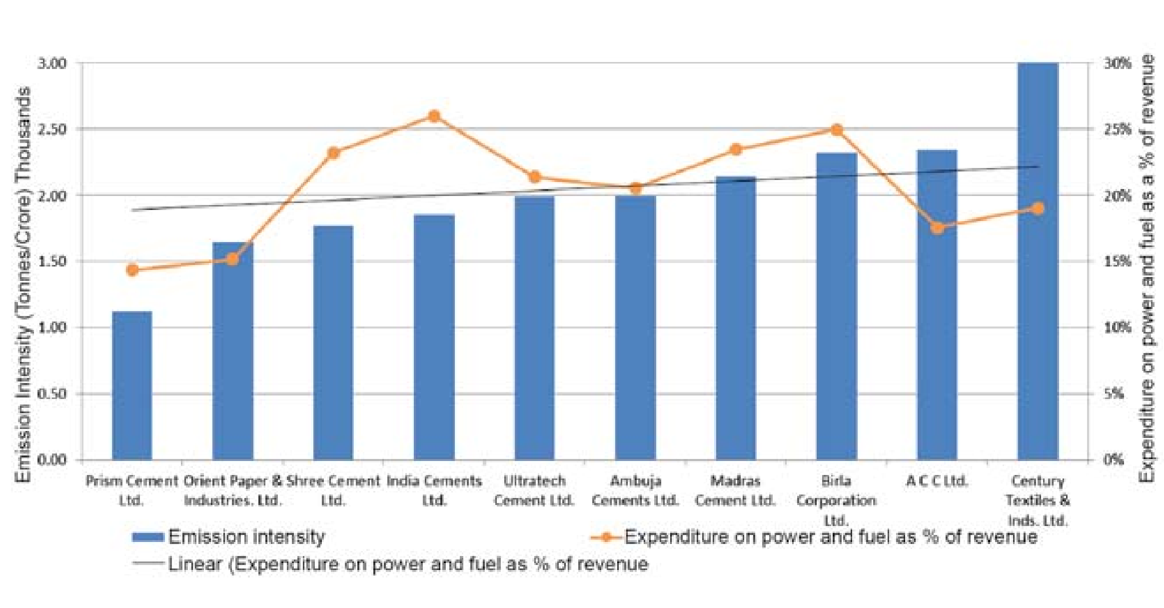
Source: Compiled by the authors

Graph 20: Revenue and Emission Intensity Trend of Cement Sector, 2011



Source: Compiled by the authors

Graph 21: Revenue and Emission Intensity Trend of Cement Sector, 2011



Source: Compiled by the authors

Policy Drivers of Energy Efficiency

The systemic risks associated with climate change, coupled with pressures of competitiveness of production in the global economy, highlight the need for policies on energy efficiency, especially in industrial sub-sectors such as those identified by this report. Moreover, better energy disclosure practices can lead to improved accountability and encourage transparency across industry. This chapter aims to aggregate the main disclosure policies and energy efficiency policies in the four countries considered in this report.

India

In attempting to respond to the dual challenges of resource scarcity and climate change, India made a voluntary commitment to reduce its emission intensity (of GDP) by 20-25 percent from 2005 levels by 2020 at the Convention of Parties meeting held in Copenhagen in 2009. This was largely to be met through energy efficiency gains. The National Action Plan on Climate Change released by the Prime Minister's Council on Climate Change in June 2008 mandated the creation of eight missions to address climate change and resource scarcity in the country. The Council is also responsible for periodically reviewing and reporting on each mission's progress. One such mission, which deals directly with energy efficiency policies and their implementation, is the National Mission for Enhanced Energy Efficiency (NMEEE). The Indian government has recognised that it is important to promote efficient energy use to simultaneously address resource scarcity and climate change. Building on the Energy Conservation Act, 2001, it has focused on the following energy efficiency initiatives:

Perform Achieve Trade Scheme: A market-based mechanism to enhance the cost effectiveness of improvements in energy efficiency in energy-intensive large industries, through certification of energy savings that can be traded.

Market Transformation for Energy Efficiency: It is a scheme to accelerate the shift to energy-efficient appliances in designated sectors through measures which make the products more affordable. Specific components under this programme include project preparation to utilise external funds for energy efficiency.

Efficiency Financing Platform: The NMEEE mandated the creation of mechanisms that would help finance demand-side management programmes in all sectors by capturing future energy savings under an Energy Efficiency Financing Platform. The Energy Efficiency Services Ltd. has been created as a corporate entity to provide market leadership.

The Framework for Energy-Efficient Economic Development: This has been set up to achieve the dual objectives of providing risk guarantees, etc., to lenders such as banks and venture capital funds, and provide incentives for Central Public Sector Undertakings to pursue energy efficiency projects.

Disclosures Framework

In the Companies (Disclosure of Particulars in the Report of Board of Directors) Rules, 1988, under the Companies Act, 1956, India, it is stated that "[e]very company shall, in the report of its board of directors, disclose particulars with respect to A) conservation of energy, B) technology absorption." The Rules make it mandatory for companies which are part of energy-intensive industrial sectors such as steel and cement to disclose their total energy consumption and energy consumption per unit of production. The format for reporting is given in Table 9 in the "Form for Disclosure of Particulars with respect to Conservation of Energy" ("Form A"):

Table 9: Power and Fuel Consumption*

1. Electricity
a) Purchased Units
Total Cost
Rate / Unit
b) Own Generation
i. Through Diesel Generator
Units in Kwh
Units per ltr. of diesel oil
Cost / Unit
ii. Through steam turbine / generator
Units in Kwh
Quantity per ltr. of fuel oil / gas
Cost / Unit
2. Coal (specify quality and where used)
Quantity (tonnes)
Total Cost
Average Rate
3. Furnace Oil
Quantity (k. ltrs.)
Total Cost
Average Rate
4. Others / Internal Generation (Give Details)
Quantity
Total Cost
Rate/Unit

**The table is applicable to medium enterprises and larger categories registered in India[44]*

Within the voluntary reporting domain, the National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business were notified by the Indian Ministry of Corporate Affairs in 2011. There are a number of suggestions around ethics, transparency, accountability, etc. There are also suggestions on instituting environment management systems, reporting on environmental performance and creating support throughout the value chain for adopting better awareness of material risks.

Brazil

Over the last decades, many government policies and programmes have been formed to promote energy efficiency in Brazil. The creation of the National Programme for Electricity Conservation

(Procel) in 1985 aimed at promoting the rational use of electricity and increasing energy efficiency. Currently, it is split into different programmes focused on equipment, building, industry, lighting, and environmental sanitation, among others. Table 10 highlights the key policies and programmes that comprise Brazil's energy efficiency framework.

Disclosures Framework

Currently, there is no (federal) mandatory GHG emission reporting requirement for Brazilian companies. Only two states (Sao Paulo, Rio de Janeiro) require GHG inventories for installations operating in their jurisdiction. The states of Minas Gerais and Paraná have established a public registry through which companies receive incentives (discount in licensing fee) for voluntary GHG emissions reporting. In light of these sub-national initiatives, as well as considering possible future information requirements for the adoption of economic instruments for emissions mitigation, the federal government has created an inter-ministerial working group for the establishment of a national registry of GHG emissions aiming at collecting data at the installation level, but a political decision to implement it is still to be made.

The BM&F Bovespa, the national stock exchange, has recommended that as of 2012, listed companies must state whether they publish a regular sustainability report or similar document and where it is available, or if not, explain why. This initiative entitled "Report or Explain" encourages companies to progressively adhere to the practice of reporting information and results which are related to environmental, social, and

Table 10: Energy Efficiency Framework, Brazil

National Programme for Electricity Conservation – Procel (1985)	This programme aims at promoting the rational use of electricity and increasing energy efficiency. Currently, it is split in different verticals focused on equipment, building, industry, lighting, environmental sanitation and others. Procel Industry, for instance, aims at encouraging the adoption of efficient practices in electricity use by the industrial sector, micro and small companies, and commerce, by identifying energy-saving potential. According to the Brazilian government, the programme achieved nine TWh of energy savings in 2012, corresponding to two percent of country's annual electricity consumption and 624,000 tCO_2e of avoided emissions.[45]
National Programme for the Rational Use of Petroleum and Natural Gas Products (1991)	The programme stimulates efficiency in oil and gas products used mainly in residential, industrial and transportation sectors through technological evaluation analyses, educational initiatives and labelling for efficient vehicles and equipment.
Energy Efficiency Programme (Federal Law n. 9991/2000)	Managed by the Brazilian Electricity Regulatory Agency, the programme requires companies operating in the power sector to invest a minimum percentage (ranging from 0.25 percent to 0.50 percent) of their operational net revenues in energy efficiency programmes.
National Policy for Conservation and Rational Use of Energy (Federal Law n. 10295/2001)	The policy mandates the establishment of maximum levels of specific energy consumption, or minimum levels of energy efficiency, of energy consuming machines and equipment produced and commercialised in the country.
Brazilian Labelling Programme	Coordinated by the National Institute for Metrology, Standardization and Industrial Quality, this programme provides information on the efficiency performance of products, especially home appliances.

corporate governance issues to their investors.[46] Energy efficiency performance is an intrinsic part of this reporting.

Russia

Most of Russia's legal requirements related to energy consumption were introduced in the federal law On Energy Saving and Energy Efficiency passed on November 11, 2009. The last article of the law contains instructions to the government on developing new – or correcting previous – legislation in order to introduce information on the volume and cost of energy resources, energy control devices and energy-saving potential in statistical form, as well as to oblige Joint Stock Companies (JSCs) to disclose information on energy consumption in annual reports.[47] Table 11 highlights the key policies and programmes that comprise Russia's energy efficiency-related requirements under the legislation.

Despite some positive changes, the plan to decrease the energy intensity of the Russian economy by 40 percent by 2020 seems distant. The probability of achieving this goal is very low because with falling budget revenues in 2014 (as a consequence of falling oil prices), the expenditure on energy-saving initiatives is decreasing.[48]

Disclosures Framework

On 20 July 2010, amendments to the order of the Federal Service of Financial Markets "On approval of regulations on disclosure of information by issuers of securities" were passed. These amendments specify that all the JSCs should disclose information on the volume and cost of each of their energy sources used in the reporting year.[49] But in practice, this data is only detailed in some cases, while only the total volume of consumed energy is disclosed in others. There are companies which do not provide information on energy consumption but describe the results of energy-saving initiatives.

In Russia, there are no legal requirements on the disclosure of information on GHG emissions. According to a KPMG 2010 study, even among companies that provide sustainability reports, the

Table 11: Requirements under Legislation, Russia

Energy efficiency labelling	It covers all domestic appliances from 2011 and all computers and clerical aids from 2012.
Installing of control devices for better accounting of energy consumption levels	It stipulates that by 2011 all the companies and state agencies should be equipped with such devices. By 2012, control devices should be installed in the housing sector. All energy payments should be based on the data provided by control devices.
Energy certification	All state agencies, government-owned companies, energy companies and firms whose annual energy costs exceed 10 million roubles should be inspected at least once every five years. They should receive energy certificates after the inspection, a copy of which should be provided to the Ministry of Energy.
Programmes of energy efficiency and energy saving	All state agencies, state-owned companies as well as regions and local communities should pass their own energy efficiency programmes. To save energy, economic agents are entitled to sign energy service contracts with specialised companies.
Establishing of an integrated state information system on energy efficiency	This system presupposes collecting all energy information from companies, local communities and regions, analysing this information and providing informational support for economic agents on their potential for improving energy efficiency. The new state institution, Russian Energy Agency, has been established to manage this system.

share of those disclosing information on carbon emissions was just 22 percent. Moreover, only half of them provided information on their overall emissions while the others did not go beyond describing the results of specific carbon initiatives (notably within joint investment projects within the Kyoto protocol) or providing information on the emissions within specific industrial processes.[50]

Now the concept of monitoring, reporting and verification (MRV) is being prepared by the Russian government. According to preliminary plans, from 2016 onwards, all industrial and energy companies whose annual volume of direct GHG emissions exceeds 150 ktCO_2e, as well as all air and railroad transport companies, should provide information on their GHG emissions. From 2017 the MRV system will be expanded to all industrial and energy companies with annual GHG emissions exceeding 50 ktCO_2e, as well as to all the water transport companies. Alongside, a pool of independent auditors will be created for verification.[51]

South Africa

Energy efficiency first appeared on the national agenda in South Africa in 2005 with the formulation of the National Energy Efficiency Strategy. This strategy sets a national final energy demand reduction target of 12 percent by 2015, and a voluntary sectoral target of 15 percent for industry.[52] There are also other laws, regulations and policies that deal with energy efficiency.

The Electricity Regulation Act, 2006, provides for the Minister of Energy to prescribe energy efficiency measures. This has not been done to date, arguably because of the costs of such norms and standards on business. However, this Act has formed the basis for Regulations for Compulsory Norms and Standards for Reticulation Services in 2008 and Green Building Standards in 2011. In terms of the National Energy Act of 2008, the ministry also issued regulations pertaining to energy efficiency, including the minimum levels of energy efficiency in each sector of the economy; steps and procedures necessary for the application of energy efficiency technologies and procedures; and energy efficiency standards for specific technologies and processes.

In addition, there is an Energy Efficiency Accord, which is a voluntary agreement between 24 major industrial energy users, seven industrial associations and the government to collectively work toward achieving the government's energy-saving target. The accord has yielded positive energy savings. A quantitative assessment of all voluntary signatories showed that over 2,405 GWh of electricity was collectively saved by 15 of the 36 Accord signatories who were able to report their information for FY 2007.[53] More recently, the government has included energy efficiency-related criteria in the Industrial Production Policy incentive scheme.

The South African National Standard SANS50001:2011, published in July 2011 by the South African Bureau of Standards, provides for the implementation of the voluntary international ISO50001 standard by organisations in South Africa to improve their energy efficiency performance. This voluntary International Performance Measurement and Verification Protocol is an example of the linkage of a voluntary mechanism with a legal instrument. It has been incorporated in tax legislation, and the government has indicated that energy audits will play an important role in its Energy Efficiency Strategy. The state power utility Eskom is making use of this tool to account for energy savings in its operations.[54]

An area to watch out for in the policy arena in the future will be the carbon tax, which is proposed to be implemented from January 2015. With this tax, it will be mandatory for installations emitting more than 0.1 GtCO_2e annually or those which consume electricity that results in more than 0.1 GtCO_2e annual emissions to report emissions.

Disclosures Framework

Currently, there is no mandatory energy reporting requirement in South Africa. Reporting takes place only when businesses claim tax incentives for energy efficiency under the Regulations on the Allowance for Energy Efficiency Savings, 2011, in which firms must prove their energy savings through professional measurement and verification. Yet companies often disclose carbon emissions in sustainability reports or on company websites, and carbon data is likely to be increasingly reported in annual reports under the Johannesburg Stock Exchange (JSE) mandatory reporting framework (applicable to the largest listed companies). Companies listed on the JSE must also comply with the King Code of Governance Principles for South Africa 2009 (King III) in terms of which they must issue an integrated annual report, defined as "a holistic and integrated representation of the company's performance in terms of both its finance and its sustainability."[55]

Although this includes reporting on environmental issues, there is no specific requirement that it should include an energy component. This is in contrast to more stringent codes such as the Combined Code of the United Kingdom, which is based on the 'comply or explain' principle; King III has opted for the more flexible 'apply or explain' approach to its principles and recommended practices.

Shared Experiences in Industrial Efficiency

In the preceding chapters, a discursive overview of the industrial and energy efficiency policy environment in Brazil, Russia, India and South Africa has been provided. The aim of this section is to aggregate shared experiences to highlight areas for mutual learning and future collaboration.

Macro Trends

Scope for Energy Efficiency Gains: In all four countries assessed, certain industrial sub-sectors account for the largest proportion of energy consumption. For instance, Russia's iron and steel production is responsible for 33 percent of total final energy consumption, and the chemical and petrochemical industry covers 19 percent (without taking into account non-energy use). The previous sections reflect that large energy efficiency savings can be made by targeted interventions in such energy-intensive sectors. In India, for instance, the government estimates that demand-side management in the industrial sector could create energy consumption efficiency gains of 10 to 25 percent.

Power Generation by the Private Sector: Over the next couple of decades, the private sector will play a more important role in energy generation. The decreasing role of the state creates mixed implications for overall energy efficiency. For instance, in Brazil, hydropower's share has decreased (most of hydropower capacity is state-run), even as private sector electricity generation from fossil fuels has increased. In India it is generally acknowledged that over the next decades, as energy demand expands, a large share of power generation will have to come from the private sector. The government's share of the Russian electricity sector is also expected to fall. These experiences necessitate mutual learning and experience sharing within the private sector.

Competitiveness of Industries and Energy Consumption: It is clear that in an increasingly resource-constrained world, the competitiveness of the industrial sector will be underpinned by the efficiency of resource consumption. For instance, in India, due to an increase in the resource intensity of raw materials and other non-fuel inputs, the profitability of the manufacturing sector has become dependent on wages and interest rates (both factors outside the control of business). In South Africa, electricity tariffs have historically been well below cost-effective levels. Consequently, there has been a 78 percent increase in real electricity prices since 2008, which has affected the manufacturing sector severely. In both cases, negative externalities linked to energy can potentially erode industrial competitiveness unless efficiency of energy use is catalysed through policies and investments.

Regulating Industrial Performance

Targeting Policies toward Sectors with Potential: One of the key elements of effective policy-making is recognising the importance of targeting low-hanging fruit. Under Brazil's Procel, the country has achieved 9 TWh of energy savings in 2012, corresponding to two percent of the country's annual electricity consumption, and 624,000 tCO_2e of avoided emissions. Similarly, in India, the Perform Achieve Trade Scheme is a market-based mechanism to enhance the cost effectiveness of improvements in energy efficiency in large energy-intensive industries through certification of energy savings that can be traded.

Awareness through Disclosure: Various disclosure regimes are in place for large companies in three of the four countries assessed. In India, the National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business were notified by the Indian Ministry of Corporate Affairs in 2011. Companies are to 'Apply or Explain' to the Securities Exchange Board of India on a format called Business Responsibility Reporting based on these national voluntary guidelines. South Africa has a King III Code which also follows the 'comply or explain' principle. In Brazil, listed companies (on BM&F Bovespa) have to state whether they publish a regular sustainability report or similar document and where it is available, and if not, then explain why. In all these cases it is clear that gradual steps towards disclosures are being taken in order not to put high costs of compliance on companies.

Fiscal Incentives for Energy Efficiency: Fiscal incentives have been used extensively by the South African government to incentivise energy efficiency performance and disclosure. The South African National Standard SANS50001:2011 provides for the implementation of the voluntary international ISO50001 standard by organisations. Although this is a voluntary International Performance Measurement and Verification Protocol, it is a good example of the linkage of a voluntary mechanism with a legal instrument – tax rebates. This is an example of a policy which can be studied further. Indeed, integration of fiscal incentives within the framework of industrial policies in emerging and developing countries may represent a significant opportunity for improving efficiency performance.

Energy-Intensive Sectors – Lessons from India

High Variability within Sectors: The cement industry in India is an example of a sector where, even among the largest companies within the industrial sub-sector, there is large variation in efficiency of energy consumption. Similarly, the mean emission intensity of the steel sector has seen a rise of 12 percent over the time period assessed. This is mostly due to a large increase in variance between performance of different companies. There is a case to be made, therefore, for efficiency convergence within sectors, with policies and incentives enabling laggards to catch up with sector leaders.

Consolidation of Performance among the Largest Companies: In both the Indian sub-sectors assessed, economies of scale seems to be a compelling reason for relatively better performance as measured by emission intensity and revenue indicators. In the steel sector, the three largest companies account for over 77 percent of the revenues generated (from among the over two dozen companies assessed). There is also a direct correlation between larger revenues and lower emission intensities among these companies. In the cement sector, the largest three firms make up over 60 percent of total revenues, and lesser variation is seen among higher revenue-generating companies.

Power and Fuel Input Costs Affect Businesses Asymmetrically: As indicated earlier, negative externalities for business profitability have arisen from a number of energy-related sources. In India's steel sector, there is a positive correlation between expenditure on power and fuel as a percentage of revenue and emission intensity within assessed companies. Companies in the cement sector are highly resource-intensive, and there is therefore an absence of a clear co-rrelation between power and fuel expenditures and varying levels of emission intensity. Evidently, factors such as processes used, technology employed, as well as scale of operations, are all responsible for efficiency performance, and policies targeting efficiency must be calibrated accordingly.

Endnotes

1 Assumed to be a proxy indicator for the energy efficiency of companies; for more, please refer to the 'India Market and Environment Report', Gtrade Carbon Ex Rating Services, 2012.
2 World Manufacturing Production: "World manufacturing production reort." Unido, http://www.unido.org//fileadmin/user_media/Publications/Research_and_statistics/Branch_publications/Research_and_Policy/Files/Reports/World_Manufacturing_Production_Reports/STA_Report_on_Quarterly_production_2014Q1.pdf.
3 "Power and Energy," Planning Commission, Government of India, http://planningcommission.nic.in/sectors/index.php?sectors=energy.
4 Shiv Pratapet Raghuvanshi, Carbon Dioxide Emissions from Coal Based Power Generation in India, Energy Conservation and Management, Elsevier, 2005.
5 "India: Greenhouse Gas Emissions 2007", Ministry of Environment and Forests, GOI, May 2010, http://moef.nic.in/sites/default/files/Report_INCCA.pdf.
6 "Projeções da demanda de energia elétrica para o plano decenal de expansão de energia 2008-2017," EPE. Empresa de Pesquisa Energética, Accessed on 19 December 2013, http://www.epe.gov.br/mercado/Documents/S%C3%A9rie%20Estudos%20de%20Energia/20080416_3.pdf
7 Nivalde Castro, Rubens Rosental, Nova tendênciaparaaElasticidade-Renda da Demanda de EnergiaElétrica no Brasil, InformativoEletrônicodoSetorElétrico – n. 2215 de 3 de março de 2008, Accessed on 13 January 2014, http://www.brazilink.org/tiki-download_file.php?fileId=112.
8 "Avaliação da EficiênciaEnergéticaparaospróximos 10 anos," SérieEstudos de Demanda.Nota técnica DEA 16/12. Rio de Janeiro: EPE, Empresa de Pesquisa Energética 2012, Accessed on 13 January 2014, http://www.epe.gov.br/mercado/Documents/S%C3%A9rie%20Estudos%20de%20Energia/20121221_1.pdf
9 "Brazilian Energy Balance 2014 Year 2013" Rio de Janeiro: EPE, Empresa de Pesquisa Energética 2014, https://ben.epe.gov.br/BENRelatorioFinal.aspx?anoColeta=2014&anoFimColeta=2013.
10 "Ibid"
11 "CO_2 emissions factors," MCTI, Ministry of Science, Technology and Innovation, Accessed on 18 December 2014, http://www.mct.gov.br/index.php/content/view/321144.html#ancora.
12 Using the 'Purchase Power Parity' concept.
13 "Eficiênciaenergéticanaindústria: o quefoifeito no Brasil, oportunidades de redução de custos e experiênciainternacional," CNI. ConfederaçãoNacional da Indústria, Brasília: CNI, Accessed on 05 September 2013, http://www.cni.org.br/portal/data/pages/FF808081314EB36201314F22482B7753.htm
14 T. Dzyadko, D.Dmitrienko, Rosneft provozglasilasebyakrupneyshey v mire publichnoyneftegazovoykompaniey, Vedomosti, March 21, 2013.
15 US Energy Information Administration
16 Marlamov E. Pyat' let bez RAO, Financial One, June 19, 2013.
17 RusHydro, http://www.rushydro.ru/company.
18 Federal Customs Service of the Russian Federation.
19 Central Bank of the Russian Federation.
20 L. Grigoryev, I. Makarov, A. Salmina, Russia's Domestic Objective Situation and Debates on Global Climate Issues in: Climate Change, Sustainable Development, and Human Security: A Comparative Analysis, Ed. by D.K. Vajpeyi, Lexington Books, 2013.
21 "Energy Efficiency in Russia:Untapped reserves", World Bank, CENEF, 2008.
22 Bashmakov I.A., Myshak A.D. ayasistemauchyotapovysheniyaenergoeffektivnosti I ekonomiienergii. Moscow: CENEF, 2012.
23 International Energy Agency.
24 DEAT, 2000.
25 "Independent Statistics and Analysis: US Energy Information and Administration," EIA, Accessed on 7 January 2014, http://www.eia.gov/countries/cab.cfm?fips=SF.
26 "Enerdata and the Economist Intelligence Unit, 2011;" "Trends in global energy efficiency 2011," Enerdatuk, Accessed on: 7 January 2014, //www.enerdata.net/enerdatauk/press-and-publication/publications/2011-trends-in-global-energy-efficiency.pdf.
27 " Trends in global energy efficiency 2011," Enerdata and the Economist Intelligence Unit, Accessed on: 7 January 2014, http://www.enerdata.net/enerdatauk/press-and-publication/publications/2011-trends-in-global-energy-efficiency.pdf.
28 "Enerdata and the Economist Intelligence Unit, 2011" "Trends in global energy efficiency 2011," Enerdatuk, Accessed on: 7 January 2014, http://www.enerdata.net/enerdatauk/press-and-publication/publications/2011-trends-in-global-energy-efficiency.pdf.

29 *"The Economic Impact of Electricity Price Increases on Various Sectors of the South African Economy, A Report consolidating the findings of recent research," Deloitte, 2012, Accessed 10 July 2013, http://www.eskom.co.za/content/Economic%20Impact%20 of%20Electrcity%20Price%20Increases%20%20Presentation~1.pdf.*

30 *The National Industrial Classification (NIC) is an essential Statistical Standard for developing and maintaining comparable data base according to economic activities. Such classifications are frequently used in classifying the economically active population, statistics of industrial production and distribution, the different fields of labour statistics and other economic data such as national income.*
The Central Statistical Organisation (CSO), which is responsible for setting up of statistical standards. The National Industrial Classification 2008 seeks to provide a basis for the standardized collection, analysis and dissemination of industry (economic activity) wise economic data for India. Apart from being the standard industrial classification, that underpins Indian Industrial Statistics, NIC is widely used by the government agencies, industry associations and researchers for various administrative, analytical and research purposes.

Sector	Section of NIC-2008	Level	Description
Cement	Section C: Manufacturing	Division 23	Manufacture of other non-metallic mineral products
Iron and Steel	Section C: Manufacturing	Division 24	Manufacture of Basic Metals

31 *The sectoral energy consumption classification adopted by the National Energy Balance follows the Code of Activities of the Federal Revenue of Brazil. However, more recently, the process of data collection and treatment is being adjusted to the current National Classification of Economic Activities – CNAE according to Brazilian Energy Balance 2013 Year 2012. The CNAE version 2.0 was structured based on the fourth version of International Standard Industrial Classification of All Economic Activities – ISIC, is applied on the National Statistical System, including National Accounts. Individual categories are organized in 21 sections, 87 divisions, 285 groups, 673 classes and 1301 subclasses.*

Sector	Section of CNAE 2.0	Level	Description
Food and beverages	C - Manufacturing	Divisions 10 and 11	Manufacture of food products (10) Manufacture of beverages (11)
Iron and steel	C - Manufacturing	Division 24	Manufacture of basic metals
Paper and pulp	C - Manufacturing	Division 17	Manufacture of paper and paper products
Chemical	C - Manufacturing	Division 20	Manufacture of chemicals and chemical products

32 *"Brazilian Energy Balance 2013 Year 2012," Empresa de Pesquisa Energética (2013), Rio de Janeiro: EPE, Accessed on 19 December 2013, https://ben.epe.gov.br/BENRelatorioFinal.aspx?anoColeta=2013&anoFimColeta=2012.*

33 *"Avaliação da EficiênciaEnergéticaparaospróximos 10 anos (2012-2012)," SérieEstudos de Demanda.Nota técnica DEA 16/12, Empresa de Pesquisa Energética (2012), Rio de Janeiro: EPE, 2012, Accessed on 13 January 2014, http://www.epe.gov.br/ mercado/Documents/S%C3%A9rie%20Estudos%20de%20Energia/20121221_1.pdf*

34 *"Eficiênciaenergéticanaindústria: o quefoifeito no Brasil, oportunidades de redução de custos e experiênciainternacional," ConfederaçãoNacional da Indústria 2009, Brasília: CNI, Accessed on 05 September 2013, http://www.cni.org.br/portal/data/ pages/FF808081314EB36201314F22482B7753.htm.*

35 *Russian Classification of Economic Activities is the statistical standard used in Russia. It was composed on the base of Statistical classification of economic activities in the European Community and is used for classifying data on industrial output, employment, labour resources etc. It includes 99 classes of economic activities grouped in 17 sections. All classes of activities are divided into subclasses.*

36 *World Development Indicators*

37 *Primarily diversification into manufacturing and services.*

38 *When the dramatic slowdown of South African economic growth during the Apartheid period tipped the economy into recession, Eskom, the monopolistic vertically integrated electric utility, had an excess capacity of more than a third of its installed capacity. Encouraging electricity load growth was imperative to the improvement of Eskom's revenues. With most of the capital cost of generation already sunk, and its source of coal mainly locally accessed through long-term contracts at negotiated low prices, Eskom was able to provide cheap electricity tariffs compared to the rest of the world.*

39 *Data for 2009 is not available. Therefore, data for 2006 has been used.*

40 *"South African Energy Synopsis 2010," Department of Energy, Republic of South Africa, 2010., http://www.energy.gov.za/files/ media/explained/2010/South_African_Energy_Synopsis_2010.pdf.*

41 R. Inglesi-Lotz and J. Blignaut, Electricity Intensities of the OECD and South Africa: A Comparison, Working paper 204, Sanedi, Accessed on: 30 July 2013, http://www.sanedi.org.za/wp-content/uploads/2012/02/ee/Electricity%20intensities%20of%20the%20OECD%20and%20South%20Africa-%20a%20comp.pdf []

42 "The Impact of electricity price increases and retaining on the South African economy: Final Report to the National Electricity Response Team (NERT) Economic Impact Task Tea," HSRC, 2008, Accessed on 30 July 2013, http://www.hsrc.ac.za/en/research-outputs/keywords?keyword=ENERGY+SECTOR&letter=A&page-num=2

43 Emission intensity is estimated as total GHG emissions from a company divided by its total consolidated revenue.

44 As per Micro, Small and Medium Enterprises Development Act, 2006, medium enterprise can be classified based on two criteria – In case of enterprise engaged in manufacturing or production of goods, companies where the investment in plant and machinery is more than five crore rupees but does not exceed ten crore rupees.
In case of enterprises engaged in providing or rendering of services, companies where the investment in equipment is more than two crore rupees but does not exceed five crore rupees.

45 "Relatório de resultados do Procel 2013 - Ano base 2012," Rio de Janeiro: Eletrobras, Procelinfo, Accessed on 13 January 2014, www.procelinfo.com.br.

46 The comprehensive list of companies with respective links to sustainability reports: "Sustainability Report or Integrated Report," Bmfbovespa, http://www.bmfbovespa.com.br/en-us/markets/download/Relate-ou-Explique-ingles.pdf.

47 Ibid

48 A. Davydova, Rossiyadenegnaklimat ne brosaet, Kommersant, December 15, 2014.

49 Order of the Federal service of financial markets: "On approval of regulations on disclosure of information by issuers of securities", July 20, 2010.

50 Otchetnost' rossiiskikhkompaniy v oblastiustoychivogorazvitiya, KPMG, 2011.

51 O. Pluzhnikov, O proektekontseptsiiformirovaniyasistemy monitoring, otchyotnosti I proverkiobyomavybrosovparnikovykhgazov, Climate Change: Challenges and Opportunities for Business, Moscow, November 26, 2014.

52 C. Bergh, Energy Efficiency in the South African Crude Oil Refining Industry: Drivers, Barriers and Opportunities, Thesis submitted for MSc Sustianable Energy Engineering, University of Cape Town, 2012.

53 "Assessment Study of The Energy Efficiency Accord. Final Report 2008," NBI, Accessed on 1 July 2013, Accessed on 14 July 2013, http://www.nbi.org.za/SiteCollectionDocuments/ee_accord_assessment_report.pdf.

54 "National Energy Efficiency Strategy Review," Department of Energy, Government of South Africa, 2012, http://www.info.gov.za/view/DownloadFileAction?id=179403.

55 L. Van Ast, and Maclean, Carbon and water risk for South Africa's top companies, bonds and equities: How corporate emissions expose investors to carbon taxes and thirsty assets are vulnerable to climate change, Technical report prepared for WWF SA and Truecost, Awsassets, Accessed on 3 August 2012, http://awsassets.wwf.org.za/downloads/carbon_and_water_risk_for_south_africa_s_top_companies__bonds_and_equity_funds_final_rep.pdf.