UK TRADE & INVESTMENT

Market opportunities in environmental goods and services, renewable energy, carbon finance and CATs

Country report: India

October 2008

Fast track to the world UK

Contents

This report is one of seven on the opportunities for exports to, and direct investment and joint ventures in, the markets for environmental goods and services (EGS), carbon abatement technologies (CATs), renewable energy and carbon finance in selected countries (see Annex A for definitions of these sectors). It should be noted that the nuclear sector was excluded from the review. The other countries are Australia, Brazil, China, South Africa, Turkey and the USA – representing a mix of emerging/high growth and developed overseas markets in these sectors.

The findings from the reports have been fed into an overview report which:

- provides an assessment of the UK's competitive advantage in EGS, CATs, renewable energy and carbon finance,
- maps this onto the market opportunities as revealed from the case studies, and
- suggests the opportunities for UK exporters and direct investors by market and sector.

The report considers the general market opportunities presented in the selected countries. It is based on desk research that drew on the most readily available and accessible information sourced from within the country concerned and from international agencies.

It provides background designed to be helpful in focusing the more detailed investigations that will need to be carried out by anyone interested in selling to or investing in the relevant markets and countries.

The report does not assess specific opportunities for UK exporters and/or investors – or their appropriate route to market. However, it shows where there are significant market opportunities in environmental goods and services, renewable energy, carbon finance and CATs.

Summary of market opportunities in environmental goods and services, renewable energy, carbon finance and CATs

Opportunities

1 There are, and over the short to medium term will be, significant opportunities in Brazil in the water provision, wastewater treatment, solid waste disposal, air pollution technology and environmental consultancy markets, as well as in low carbon fuels and alternative energy including hydroelectricity and wind. Carbon finance also presents a significant opportunity. The table below presents a 'map' of current and future opportunities in the various environmental and low carbon markets in India.

Sector	Current opportunities*	Future opportunities	Policy framework (current)
Environmental Goods and Services (EGS)			
Air pollution & control	😐	😐	Good
Cleaner technologies			Good
Energy management			
Environmental consultancy	😐	😐	
Environmental monitoring	😐	😐	Poor/Fair
Marine pollution			
Noise & vibration			
Land remediation			Poor
Waste management	🙂	🙂	Fair
Water supply	🙂	🙂	Good
EGS overall	🙂	🙂	Good
Carbon Abatement Technologies (CATs)			
CCS	☹	😐	
Generation technologies	😐	😐	Fair
Low carbon transport fuels	😐	😐	Good
Asset management			
CAT overall	😐	😐	Fair
Other opportunities			
Renewable energy	🙂	🙂	Good
Carbon finance	🙂	🙂	Good

Key		
	🙂	Relatively large market size and activity, relatively demanding regulation, relatively high public expenditure in this sector and relatively liberal trade and investment regime
	😐	Mix of modest market size and activity, modestly demanding regulation, modest public expenditure and liberalising but still restrictive trade and investment
	☹	No or minimal market size and activity, no regulation, and restrictive trade and investment regime
		No or inadequate information

** The assessment of current opportunities is based on the most recent official data and information on market size and sector activity. In many cases this can refer to 2005 figures and as such certain conclusions in this report may not capture very recent developments in some sectors or announcements concerning the near future. A variety of sources, methods and time-frames was drawn on to assess future opportunities – covering the next five-ten years based on government policies and/or budget allocations and/or independent forecasts and projections.*

MARKET ENTRY OPTIONS

2 The trade and inward investment regime in India is generally liberal and favourable to the possible market entry routes. This is especially the case for Foreign Direct Investment (FDI) as India has long allowed 100 per cent FDI in environmental goods and services, renewable energy, carbon finance and CATs. The availability of possible market entry strategies is summarised below:

Route to market	Availability	Comment
Export	•	Net importer of energy.
Foreign direct investment (FDI)	•	Liberal FDI policies.
Joint venture (JV)	•	The Indian Government encourages firms to seek foreign partners on Build-Own-Operate (BOO) models.

Source: SQW Consulting

Gaps in the evidence base

3 A thorough trawl of readily available reports, studies and policy statements with regard to the markets under review and a limited set of consultations with stakeholders found little evidence on the opportunities in India in the following markets:

- Marine pollution (EGS)
- Noise and vibration (EGS)
- Carbon capture and storage (CAT)
- Generation technologies (CAT)
- Asset management (CAT)

Note: Information on the opportunities in CATs was only readily available for low carbon fuels. Consequently, it was not thought appropriate to provide an overall score against CATs as a whole in the summary map.

4 This is not to say that this evidence is unavailable. More information could undoubtedly be found on specific market opportunities and constraints from specialised and technical policy statements/guidance, journals and trade press. However, it was beyond the terms of reference for this review to investigate the opportunities in this degree of detail.

5 The report should be read as an introduction to the most significant opportunities in the Indian markets. It has been designed to provide a focus for the more detailed investigations that will need to be carried out by anyone interested in selling to or investing in the markets.

1: Introducing the Indian market

This section provides background information on the Indian economy and the drivers and international legal dispositions affecting the growth of the market for environmental goods and services, renewable energy, carbon finance and CATs

Key facts

1.1 India is the second most populous country in the world with a population of over a billion people and growing at the rate of 1.6 per cent per annum. It is the fourth largest economy in the world by GDP Purchasing Power Parity, estimated at US$1.09 trillion in 2007 (but 12th by nominal GDP), and has seen a strong GDP growth in recent years, from 4 per cent in 2002 to 9 per cent in 2006.

1.2 Economic growth and poverty reduction have been the prime objectives of India's national policy. Human development indicators for India have been improving, with life expectancy increasing from 32 years in 1951 to 60 years in 2001. However, there is still a high level of inequality in the country and a large proportion of the population remains extremely poor.

1.3 Small scale industries (SSI)[1] dominate the industrial landscape, with a share of 39 per cent of industrial value added and 34 per cent of all exports in 2002-03. Service sectors, such as information technology and electronics, have been a major source of economic growth in recent years, accounting for more than half of India's output with less than one third of its labour force.

1.4 Imports of goods and services have increased steadily from 14 per cent of GDP in 2001 to 26 per cent of GDP in 2006. India has attracted a total foreign direct investment (FDI) of US$83 billion since 1991. FDI flows into India increased four-fold from around US$5.5 billion in 2001 to US$24.5 billion in 2008. The biggest contributing developed countries were the USA (8 per cent) followed by the UK (7.4 per cent) in 2008. Services sectors and computer hardware and software attracted the highest FDI flows. The states of Maharashtra and Delhi were the biggest recipients.

INDIA – KEY FACTS (2001-2006)

	2001	2002	2003	2004	2005	2006
GDP growth (annual %)	5	4	8	8	9	9
Gross capital formation (% GDP)	24	26	27	31	33	34
Total Primary Energy Supply (Mtoe)	466.2	478.7	490.7	520.6	537.3	-
Total Production of Energy (Mtoe)	372.2	381.3	394.2	408.4	419	-
Carbon dioxide emissions per capita	1	1	1	1	-	-
Imports of goods/services (% GDP)	14	15	16	20	23	26
FDI – net (current US$ billion)	5.5	5.6	4.3	5.8	6.7	17.5

Source: World Bank Group (2007)

Drivers of environmental goods and services, renewable energy, carbon finance and CATs

1.5 Industrialisation in India is leading to an increase in greenhouse gas (GHG) emissions and other pollutants. Carbon dioxide (CO_2) emissions from fossil fuels have steadily been rising. In 1980 they were measured at 94,797 million metric tonnes of CO_2 ($MtCO_2$) and in 2004 at 366,301 $MtCO_2$.

1.6 The vast and growing urban population in India is putting extensive pressure on India's infrastructure; the percentage of the total population living in urban areas has increased from 21 per cent in 1975 to 29 per cent in 2005. It is expected to increase to 32 per cent of the total population by 2025. The rapid growth of the urban population has led to unplanned urban development and an increase in the demand for infrastructure.

[1] *As per the latest definition issued by the Government of India which has been effective since December 21, 1999, for any industrial unit to be regarded as Small Scale Industrial unit the following condition is to be satisfied: - investment in fixed assets like plants and equipments either held on ownership terms on lease or on hire purchase should not be more than Rs 10 million.*

1.7 Industrialisation and urbanisation have both resulted in growing demand for and use of energy. The amount of electric power consumed increased from 403 kWh per capita to 480 kWh per capita from 2001 to 2005.

1.8 New regulations, trade liberalisation, increased privatisation, including the privatisation of the power industry are driving the market in India. Current programmes include a rural electrification programme and a drive towards large scale investment in infrastructure projects, including water provision. The government is also investing in research and capacity building initiatives.

1.9 India is responding to pressures for greater attention to be paid to the environment. It is partner to a number of international agreements on environmental issues. There is also growing grassroots activity in relation to issues of the environment and climate change, growing public concern and media pressure for policy development. These pressures from above and below are supporting the growth of the environmental market.

1.10 India unveiled a National Action Plan for Climate Change earlier this year (July, 2008) which identified eight national 'missions' for sustainable development[2], with the strongest focus on solar power. Although the plan is not backed by budget spending and specific actions, a Council on Climate Change with stakeholders from the government, industry and civil society has been formed to identify funding and directives.

International legal dispositions

1.6 India is party to a number of international legal dispositions. It was the first country to sign up to the UN Framework Convention on Climate Change. India's status against other key international conventions is summarised below:

Table 1-1: Status of India against key international conventions relating to the environment

International convention	India's status
UN Framework Convention on Climate Change	Ratified
Kyoto Protocol	Ratified
Ramsar Convention on Wetlands	Ratified
Montreal Protocol	Accession
Vienna Convention for the Protection of the Ozone Layer	Accession
Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal	Ratified

Source: SQW Consulting

[2] The eight 'missions' are solar energy, energy efficiency, creating a sustainable habitat, conserving water, preserving the Himalayan ecosystem, creating a green India, creating sustainable agriculture and establishing a platform of 'strategic knowledge' for climate change.

2: The market for environmental goods and services in India

This section describes the growth market for environmental goods and services (EGS) in India and outlines the drivers of this growth. It then provides more information on those segments presenting significant market opportunities.

Market growth and its drivers

Growth

2.1 The total environmental goods and services market in India was estimated to be worth US$5.3 billion in 2004 by the US Commercial Service. Other sources have estimated the EGS market to be as high as US$10 billion (Environmental Business Journal, 2006). Two of the largest segments are water and wastewater treatment and waste management. The overall market is expected to grow by 10-12 per cent per annum with similar growth expected in water and wastewater treatment segments, and waste management.

2.2 According to the latest Indian Union Budget, the outlays for 2008-09 for the key departments relevant for environmental goods and services were: US$350 million for the Ministry of Environment and Forests, US$295 million for the Ministry of New and Renewable Energy and approximately US$2 billion for Ministry of Drinking Water Supply and Water Resources. The budget outlay for the Ministry of Power for 2008-09 was US$9 billion and the budget for the energy sector overall was estimated at approximately US$22 billion.

2.3 A major initiative, the Pooled Finance Development Fund, is focused on improving water infrastructure in the 63 cities with populations of one million or more in exchange for reforms in municipal management.

2.4 Multilateral and bilateral agencies are major funders of infrastructure projects in India. World Bank funding for water for India from 2004-2008 increased from €160 million to €750 million per annum. Key sectors receiving funding are water resources (including developing information systems), watershed management, irrigation, rural water and sanitation, and urban water and sanitation.

Drivers

2.5 The key drivers for EGS in India are:

- Pressures on basic infrastructure such as water supply, municipal waste management and supply of electricity.
- Industrialisation resulting in growth in industry sectors that are also highly polluting, particularly the small scale industries.
- Growing demand for energy and increasing reliance on fossil fuel energy sourcing.
- Government policy that is increasingly attempting to address all of these issues.

2.6 India suffers from capacity constraints and poor infrastructure in water supply and wastewater treatment. A significant proportion of the population remains without access to basic sanitation or electricity. Seventy per cent of the population in 2004 had access to an improved water source and only 33 per cent had access to improved sanitation (an increase from 14 per cent in 1990). Only 60 per cent of industrial effluents from Small Scale Industries (SSI) and 25 per cent of municipal water are currently treated.

2.7 There are major issues with regard to municipal, hazardous and industrial waste management. A high rate of urbanisation had led to very high production of solid waste (36.5 million tonnes (Mt) annually of which 8 Mt is hazardous waste). Local governments tend to spend most of their resources on collection (60-70 per cent) and significantly less on final disposal (>5 per cent). However, managing waste is currently severely constrained:

- The infrastructure lacks appropriate systems and technologies for effective collection, transportation and treatment of waste.
- There is a severe lack of secure landfill sites and treatment, storage and disposal facilities.
- There is also a lack of incineration facilities and waste handling and management systems.

- India has no facility for recovering methane emissions from solid waste and re-using it for energy, as waste is simply discarded in dump yards.

2.8 The power sector is heavily reliant on coal, which accounts for 60 per cent of the power generation, and is also the main contributor of air pollution. Technologies used in thermal power plants are often outdated and do not use modern pollution control. There is interest in Flue Gas Desulphurisation (FGD) to stimulate the removal of SO_2 but, on evidence from 2004, only one scrubber has been installed. Cost was a major issue with regard to installing FGD and there was no mandatory blanket requirement to install scrubbers in all power plants, partly because Indian coal is low in sulphur.

2.9 SSI are a key feature of the Indian economy with nearly 40 per cent of the total share of industrial production and over 4.5 million units across the country. An estimated 70 per cent of the total industrial pollution is attributed to SSIs, many of which continue to use obsolete technologies with no or primitive pollution control methods. Even with advanced technologies for reducing the impact of individual units, the sheer scale and diversity of SSIs pose a real challenge for the supporting infrastructure required to achieve both economic and environmental objectives. Many SSIs find it hard to adopt the modern technology required to fulfil regulations, and cost appears to be a significant barrier in adopting cleaner technologies.

2.10 SSIs often face additional specific barriers to implementing robust environmental standards. They tend to operate in confined spaces and where space for pollution control systems is limited. There is also a lack of guidance on and availability of cost effective technologies. The Central Pollution Control Board (CPCB) believes that whilst such technologies may be available to polluting sectors, they are not always applicable to Indian economic and market conditions.

2.11 Economic growth in India has been driven by impressive performance in electronics and information technologies, textiles, pharmaceuticals and basic chemicals. However, the CPCB deems them to be some of the most polluting sectors, with significant ramifications for water effluents, air emissions and hazardous waste.

2.12 Environmental regulation is a significant driver for EGS in India. The Indian government has introduced a comprehensive set of laws and policies on environmental issues. Enforcement is relatively poor but improving and there is evidence of a rise in enforcement as per capita income increases.

2.13 Industrial growth since the 1990s has led to an increase in environmental awareness and the use of incentives to create opportunities in the environmental sector. The Federation of Indian Chambers of Commerce and Industry provides a range of initiatives including cluster based intermediation for SMEs, training and capacity building programmes for industry. They also raise awareness about climate change to stakeholders.

Market segments

2.14 The major market opportunities are in water and wastewater treatment, municipal solid waste management and hazardous waste management. These and other opportunities are explored in more depth below.

OPPORTUNITIES IN ENVIRONMENTAL GOODS AND SERVICES IN INDIA

Water supply and wastewater treatment

The water and wastewater treatment market is deemed to be one of the largest segments of the EGS market worth US$1-1.2 billion with a projected growth rate of 10-12 per cent per annum. This is broken down into a third for water supply, a third for municipal water treatment, and a third for industrial water treatment. The agricultural sector uses 85 per cent of the available fresh water supply, of which 50-80 per cent is wasted by inefficient irrigation.

There are concerns regarding groundwater. The pattern of development around ground water has led to concerns for sustainability, equity and efficiency. Over-exploitation is a problem in some states, such as Punjab, where exploitation is at about 98 per cent of available resources. In India as a whole, however, exploitation of ground water is only 30 per cent of the annual utilisable resource. The key polluters of water are cement mills, sugar, thermal power plants, distilleries, chemicals, iron, steel, pulp and paper.

There are large pressures on the water supply, including agricultural, industrial and domestic as a result of population growth. The country has a large capacity for manufacturing water and wastewater treatment equipment. There are a significant number of foreign firms active in India, 40 per cent of which are from the US.

According to a 2007 report exploring Canadian opportunities in Indian environmental markets, the Government of India identifies the need for water purification services and technologies in urban and rural areas to combat malnutrition and water borne diseases.

There are pressures on domestic and industrial water supply owing to population growth, and effluents are treated by volume and not source. Most of India's rivers are highly polluted with less than adequate technologies adopted to clean them up.

There are significant opportunities in water supply, sewerage treatment, efficient use and re-use of water in industrial processes for the high polluting sectors, such as cement and pulp and paper, and equipment for wastewater treatment. The opportunities are mainly in treatment technologies, biogas regeneration through anaerobic treatment of municipal and industrial wastewater, water saving equipment and water recycling.

Waste management

There is a growing market for waste management as waste is predicted to increase with a growing urban population and increasing urbanisation. It was estimated to be worth US$2 billion in 2004 by the US Commercial Service.

Municipal Solid Waste Management

India produces significant volumes of solid waste – 30 Mt of municipal solid waste and 4,400 million m^3 of sewerage is generated each year. Although community bin collection systems are usual practice in India, they are not often properly designed or installed in appropriate locations. Vehicles used for collection are not designed suitably. Waste is simply dumped in open yards, and incineration has been ineffective due to the low calorific value of solid waste. Solid Waste Management systems in urban centres vary greatly. (Kumar, 2005)

The local municipalities in India spend less than 5 per cent of their revenues on the final disposal of solid waste. They lack the technology and finances to tackle issues around methane emissions from landfills. Low efficiency of systems and high labour costs add to the issues.

There is a demand for technologies and services for effective waste collection, transportation and disposal, and its treatment and recycling. The conventional form of waste disposal is landfill but there are opportunities in alternative forms of disposal, particularly in waste to energy. Incineration is not considered to be a viable option in India, due to the high moisture content in waste.

High rate biomethanisation systems, incineration and sanitary landfills will be required to address municipal and industrial solid waste effectively. Opportunities also exist around engineering and consulting services on waste collection and transportation, landfill treatment, waste treatment plants, outdoor compositing, anaerobic digestion of waste and sewage sludge, biological-mechanical waste treatment and waste to energy. There also appear to be opportunities around landfill treatment, such as the covering of dumpsites and landfills, biogas collection and solid waste treatment and energy from waste.

Hazardous Waste

Hazardous waste management in India was estimated to be worth US$223 million in 2006 and growing at an annual rate of 7 per cent till 2010 (US Commercial Service, 2006).

The total generation of hazardous waste in the country is estimated to be 4.4 million metric tonnes (Mt) per annum, of which 0.18 Mt and 1.72 Mt are the incinerable and recyclable components respectively. The remaining 2.5 Mt of waste is disposed of at secured landfills. The capacity of hazardous waste recycling by recyclers registered with the Central Pollution Control Board (CPCB) is 1.31 Mt (as of 31 January, 2006).

There are particular states which have significantly more hazardous waste generation. 80 per cent is generated in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, and Tamil Nadu. Some industries are more likely to generate hazardous waste than others, such as the information technology sector.

Cost efficient waste minimisation is needed. Indian companies possess limited know-how. While traditional incineration methods of processing hazardous waste are well known in India, most other modern hazardous waste management techniques are not widely applied.

Opportunities exist in modern hazardous waste management technologies, waste utilisation and recovery technology, treatment of electronics waste, landfill sites for hazardous waste and incineration. There are also opportunities for hazardous waste consultancy services and hazardous waste management/treatment technology. These include consultancy on cyanide waste, distillation waste, waste from dyes and dye intermediates, incineration of solid, liquid and gaseous waste, pyrolysis technology for chemicals/agricultural chemicals/paints, solidification/stabilisation of hazardous waste, waste minimisation, and bio-filtration and oxidation technologies. Hazardous waste handling and collection and transportation equipment are also other areas of opportunity.

Air pollution

The air pollution control market was worth US$423 million in 2004, and was estimated to be growing at 15 per cent per annum. Vehicular pollution control was estimated at US$.0.6 billion in 2004. There has been rapid growth in the market due to strict emission standards in the transport sector. The US Department of Commerce estimated that the need for pollution control technology could be as large as US$4.2 billion and grow at the rate of 10-12 per cent per annum.

There are critical levels of air pollution in West Bengal, Gujarat, Bihar, Pondicherry, Madhya Pradesh, and Rajasthan. Vehicular pollution is a particular problem. The sheer numbers of vehicles, the density of the traffic and the types of engine used are all contributory factors.

Domestic supply mostly features equipment for dust collection in stationary air pollution control. There is some interest in Flue Gas Desulphurisation (FGD) for industrial air pollution to simulate removal of SO_2 but so far only one scrubber has been installed, and expertise is limited for other gaseous pollutants. Moreover, cost is a major prohibitive factor, and since Indian coal is low in sulphur, it is believed that only environmentally fragile sites will need to be fitted with FGD devices.

There are 30 domestic producers of air pollution control equipment in India supplying 60 per cent of equipment.

Opportunities exist for advanced air pollution control, stack air quality monitoring equipment, clean coal technologies and mercury control.

Environmental monitoring

The environmental monitoring services sector in India is closely related to and driven by current legislation in monitoring air and water quality in India. It was estimated to be worth US$53 million in 2004 by the US Commercial Service.

The CPCB, along with State Pollution Control Boards, is responsible for monitoring air and water quality.

There is a need to increase the monitoring of water quality at source and of the impacts of discharged effluents. CPCB has put in stringent requirements for controlling water pollution, including water from municipal wastewater treatment plants. Research suggests that these requirements, along with some ongoing problems with ground water quality and issues with effluents from plants will increase demand for monitoring equipment and services.

According to CPCB's Annual Report 2003–2004 there is an immediate need to improve and upgrade the existing air monitoring network. Among the proposed measures were: replacing and upgrading existing equipment, training and infrastructure for sampling, analysis and data reporting, and monitoring of additional parameters such as carbon monoxide, lead and ozone.

Specific opportunities are expected to arise in on-line monitoring of air and water quality.

Environmental consulting

The environmental consulting services market in India was estimated to be worth US$159 million in 2004 by the US Commercial Service. A relatively small group of domestic firms provide services such as auditing, environmental impact assessments (EIA), environmental management systems (EMS), training, etc.

Environmental consulting firms from Australia, Denmark, Canada, the UK, the US, France and Japan have performed EIA studies or pollution prevention studies, sponsored by the donor agency of their respective countries (ICRIER, 2003). Legislation to conduct EIAs was introduced in 1994 and has been recently revised.

While training in environmental management systems like ISO 14001 seems to have become a forte of the industry, environmental R&D is virtually absent.

Source: SQW from various sources

3: The market for carbon abatement technologies, renewable energy and carbon finance in India

This section summarises the readily available evidence on the market for carbon abatement technologies (CATs), renewable energy and carbon financing in India. It describes the general growth in the sectors and its drivers and presents information on those segments within the sectors where there are significant opportunities.

Market growth and its drivers

Carbon abatement technologies

3.1 India is one of the leading primary energy[3] producers in the world and is one of the largest consumers of energy. The dominant fuel is coal and India was ranked third in the world for both coal production and consumption. By 2004-05, coal and lignite accounted for about 57 per cent of installed electricity capacity and about 71 per cent of generated electricity. India was one of the world's five largest emitters of carbon dioxide in 2005 (along with the USA, China, Russia and Japan) from the combustion of fossil fuels, with coal contributing the biggest share.

3.2 India appears to suffer from a severe mismatch between the demand and supply of energy with substantial energy deficits already being observed, and this is expected to be exacerbated over the next 15 years. Despite its large annual energy production, India is a net energy importer, mostly due to the large imbalance between oil production and consumption.

3.3 Major investments are being planned in the power sector in India in response to the increasing demand for electricity and the Government's aspirations to provide electricity to all by 2012. The 11th Five Year Plan (2007-2012) aims to increase power capacity by approximately 69,000 MW, of which the majority will be thermal energy dominated by coal-fired plants. The Working Group on Power for the 11th Plan estimated that an investment of nearly US$200 billion would be required in the power sector.

3.4 A recent Indian Government paper (2007) on addressing energy security and climate change argued that lowering the energy intensity of GDP through higher energy efficiency is key to meeting India's energy challenge and ensuring its energy security.

Renewable energy

3.5 The market for renewable energy in India is estimated at US$500 million, with an annual growth rate of 25 per cent and investment in renewables of about US$3 billion per annum India is among the countries with the highest levels of annual investment in renewable energy in 2007 along with Germany, China, USA, Spain, and Japan.

3.6 India has been rapidly developing its renewable energy market, especially wind energy and biomass, and there is significant remaining potential to develop more capacity, as illustrated in Table 3-1.

[3] *As per the latest definition issued by the Government of India which has been effective since December 21, 1999, for any industrial unit to be regarded as Small Scale Industrial unit the following condition is to be satisfied: - investment in fixed assets like plants and equipments either held on ownership terms on lease or on hire purchase should not be more than Rs 10 million.*

Table 3-1: Renewable Energy – Estimated potential and cumulative achievement as on 31.03.2008

Sources/Systems	Estimated potential	Cumulative achievement
Grid-interactive renewable power (A)		
Biomass Power (Agro residues)	16,881 MW	605.80 MW
Wind Power	45,195 MW	8,757.40 MW
Small Hydro Power (up to 25 MW)	15,000 MW	2,180.84 MW
Cogeneration-bagasse	5,000 MW	800.83 MW
Waste to Energy	2,700 MW	55.75 MW
Solar Power	—	2.12 MW
Sub Total (in MW) (A)	**84,776**	**12,402.74 MW**
Distributed renewable power (B)		
Biomass/ Cogeneration (non bagase)	—	95.00 MW
Biomass Gasifier	—	99.79 MW
Energy Recovery from Waste	—	26,70 MW
Solar PV Power Plants & Street Lights	—	7.72 MW
Aero-Generators/Hybrid Systems	—	0.72 MW
Total (B)	**—**	**229.93 MW**
Total (A) + (B)	**—**	**12,632.67 MW**
Remote Village Electrification	**—**	**3985 villages+1142 hamlets**
Rural and Decentralised Energy		
Family Type Biogas Plants (nos)	120 lakh	40.15 lakh
Home Lighting System	—	402,938 nos
Solar Lantern	—	670,059 nos
SPV Pumps	—	7,148 nos
Solar Water Heating – Collector Area	—	2.30 mln sqm
Solar Cookers	—	6.34* lakh
Wind Pumps	—	1,342 nos
Other Programmes		
Energy Parks	—	503 nos
Akshay Urja Shops	—	269 nos
Battery Operated Vehicle	—	270 nos

*Source: Ministry of New and Renewable Energy (2008) Annual Report 2007-08, * — as of February 2008*

3.7 India has one of the world's largest programmes for deploying renewable energy products and systems. Total installed renewables capacity was 10,620 MW in 2007 as reported by the Ministry of New and Renewable Energy, with wind power having the largest share. Demand for renewable energy is high and it is regarded as a key solution to rural electrification in the country. The Ministry of Power's Accelerated Rural Electrification Programme targets to electrify 100,000 villages in the coming few years.

3.8 The country is ranked fifth in the world for wind power generation. Certain states have been identified as having strong potential - Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, and West Bengal.

3.9 Growth in renewable energy markets is expected to continue in the coming years as a result of government initiatives through regulatory, financial and fiscal mechanisms. These include guidelines to state governments with policies to attract private sector investment and promote commercial projects in the sector, fiscal incentives and loans on renewable energy equipment, and encouraging foreign investors to develop renewables projects.

Carbon finance

3.10 The role of the government appears to be significant in terms of driving the development and use of carbon financing in India. It established the National Clean Development Mechanism Authority (NCDMA) to consider projects for accessing carbon credits by eligible projects.

3.11 India leads on the absolute number of registered Clean Development Mechanism (CDM) projects with 32 per cent of the world total and has 14 per cent of the expected global annual Certified Emissions Reductions (CER) output. Over 700 CDM projects have been approved and over 300 of these have been registered by the CDM Executive Board.

Market segments

3.12 The opportunities for exporting to, and direct investment in, India in low carbon technologies, goods and services are primarily in wind power, biomass, solar energy and carbon finance. These and other opportunities are explored in more depth below.

Carbon abatement technologies

OPPORTUNITIES IN CARBON ABATEMENT TECHNOLOGIES IN INDIA

Low carbon fuels

There are 40 million vehicles on the roads in India. They consume 50 per cent of petroleum products. India imports nearly 70 per cent of its annual crude oil requirement, which is approximately 110 million tonnes. Alternatives to oil are being pursued in the country. Compressed natural gas (CNG) is being considered as an alternative due to its cost competitiveness. The development of electric vehicles is also being researched in the country.

The oil industry now looks committed to establishing ethanol as a mainstream fuel, as it is expected to benefit sugarcane farmers as well as the oil industry itself in the longer term. The current manufacturing cost of ethanol and biodiesel in India is about Rs. 21/litre (US$0.47/litre) , roughly the same as petrol and diesel. This could put biofuels in a favourable position for meeting India's energy needs.

A 2006 UNCTAD report on the biofuels industry in India stated that India is the fourth largest ethanol producer in the world after Brazil, the United States and China, with an average annual ethanol output of 1.9 billion litres and a distillation capacity of 2.9 billion litres per year. Since January 2003, the Government of India has mandated the use of a 5 per cent ethanol blend in petrol sold in nine sugarcane producing states. The Government plans to expand the 5 per cent ethanol mandate to the rest of country in a phased manner.

The Government has also recently stated its intention to blend 10 per cent fuel ethanol with 90 per cent gasoline. This mandate has created an approximately 3.6 billion-litre demand for fuel ethanol in blend mandate to the entire country. The growth in demand for ethanol is likely to create significant opportunities for the sector.

[4] *Exchange rates are valid as of 08/09/2008. This approximates to 1 US Dollar = 44.55 Indian Rupees.*

Carbon Capture and Storage (CCS)

The potential for carbon capture and storage has been highlighted as significant by several commentators and researchers. However, the evidence suggests that little has been done so far to understand the opportunities and requirements. According to a 2006 presentation to the UNFCCC by India, research on CCS was deemed a priority for understanding the technological implications of carbon management in India.

Collaborative efforts are already underway. India is a member of the Carbon Sequestration Leadership Forum and has signed an agreement with the US government in 2006 for partnership in FutureGen – a 275 MW zero-emission power plant in India. Several research partnerships are conducting feasibility studies on CCS. India has joined the Asia Pacific Partnership in Clean Development.

Generation and clean coal technologies

Whilst first generation clean coal technologies are fully developed and commercialised in India, second generation technology needs to be transferred after having gone through a demonstration phase. Third generation technologies such as IGCC are in early demonstration stages and require further collaborative research.

Indian generators are already being increasingly encouraged by the Government to adopt more efficient and clean technologies, as it recognises that this is a necessary step if it is to improve performance and meet the country's future energy needs.

According to the Ministry of Power, the planned capacity additions in the 10th and 11th Plan, and the ambition to add 100,000 MW of capacity by 2012 cannot be met via the existing pipeline of projects. Large capacity projects are required to meet the energy deficit in the future. The Ministry believes that Ultra Mega Power Projects (UMPP) should be designed for this purpose. Each UMPP will have a capacity of minimum 4,000 MW with a possibility of expansion. The Ministry of Power, along with the Central Electricity Authority and the Power Finance Corporation, have been tasked with launching nine coal-based UMPPs in India under tariff-based competitive bidding routes which will ensure cheaper power.

Five suitable locations have been identified to date. One of the first projects to be awarded is the Tata-owned Coastal Gujarat Power Limited (CGPL) which will build, own and operate a 4,000 MW (five units of 800 MW each) 'ultra mega' imported coal and supercritical technology based power plant in Gujarat.

The Indian power sector is also considering integrated gasification combined cycle (IGCC) technology, a clean coal technology which is believed to achieve nearly 50 per cent efficiency in power generation. However, Chikatur and Sagar (2007) conclude that IGCC may not be technically and financially suited to the Indian context because of economic uncertainties and India's GHG mitigation commitments.

Renewable energy

OPPORTUNITIES IN RENEWABLE ENERGY TECHNOLOGIES IN INDIA

Wind power

India was ranked third in the world in terms of existing wind power capacity and new additions in 2006. It has also been a major exporter of wind turbines and other equipment in recent years (eg Suzlon).

India is implementing the world's largest wind resource assessment programme comprising wind monitoring, wind mapping and complex terrain projects. This programme covers 800 stations in 24 states, with 193 wind monitoring stations in operation at present. An IREDA-sponsored wind power development programme provides financial assistance for the project and extends equipment financing.

Biomass, cogeneration and gasifiers

India is rich in biomass. The country is ranked second in the world for biogas production. Projects involving biomass gasification in silk and other textile production and processing have been demonstrated on a commercial basis, involving local entrepreneurs and economic payback periods as short as one year. By 2006, India had achieved 70 MW of small-scale biomass gasification systems for rural (off-grid) power generation. As of March 2008, some 605.80 MW of power from biomass was achieved. 55 MW of biogasifiers have also been installed.

The theoretical potential is 16,881 MW for the entire country. Capacity of approximately 302 MW has been commissioned through 54 projects so far and 39 further projects are being commissioned, which will deliver an additional 270 MW.

Solar energy

India has a significant potential for solar energy. It has 250-300 sunny days a year and 5,000 trillion kWh per year solar radiation. The potential for solar thermal power generation is 35 MW per sq km and the potential of solar photovoltaic (PV) power generation is 20 MW per sq km. Only a fraction of the aggregate solar energy potential is thus far being used (2.12 MW). Processed raw material for solar cells, large capacity PV modules, PV roof tiles, inverters, charge controllers all have good market potential in India as do advanced solar water heaters, roof integrated solar air heaters; and solar concentrators for power generation (above 100 KW).

India is fourth in the world for solar hot water installed. Only a fraction of its estimated potential has been achieved to date in terms of installed capacity.

The recent Action Plan for Climate Change (2008) specified a target of increasing photovoltaic production to 1 GW per year (against the total installed world capacity of 20 GW and almost doubling each year) as well as establishing 1 GW of concentrating solar thermal (CST) power by 2017. These technologies include trough systems, dish/engine systems and power towers.

Private companies have plans to invest significantly in this sector. Some examples include planned investments by NanoTech Silicon India of US$2 billion in a plant for thin-film solar cells and another investment of US$1.1 billion by Solar Semiconductor in solar cells and panels.

Hydro power

India has a resource potential of 15,000 MW of hydro power. 4,096 potential sites have been identified. With its dense network of large rivers and their tributaries, small hydro power in India presents an excellent opportunity, with only 10 per cent of the potential captured at present. The Government is encouraging the development of small hydro projects and providing concessions for existing hydro projects, including financial support for the renovation, modernisation and capacity upgrading of aging small hydro power stations.

States with significant potential are Himachal Pradesh, Jammu, Kashmir, Uttar Pradesh, Gujarat, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Bihar, West Bengal and Arunachal Pradesh.

Waste to energy

High rate biomethanisation systems, incineration and sanitary landfills will be required to address municipal and industrial solid waste in India effectively.

Waste to energy estimated potential is 2,700 MW, of which only 55 MW has been achieved to date. There are many government agencies in India that provide funding for waste-to-energy projects. These agencies include Indian Renewable Energy Development Agency (IREDA), Ministry and Environment and Forests (MoEF), Ministry of Urban Development (MoUD) and Power Finance Corporation (PFC), Housing and Urban Development Corporation (HUDCO), and National Bank for Agriculture and Rural Development (NABARD) amongst others.

The Ministry of Nonconventional Energy Sources has initiated programmes to promote the development of this technology and a National Energy Recovery Programme from urban and industrial waste has been developed. The Ministry of Urban Development and Poverty Alleviation provides funds for municipal solid waste (MSW) to energy projects as part of their urban infrastructure schemes. A United Nations Development Programme/Global Environment Facility (UNDP/GEF) assisted project focuses on the development of a high rate bio-methanisation process.

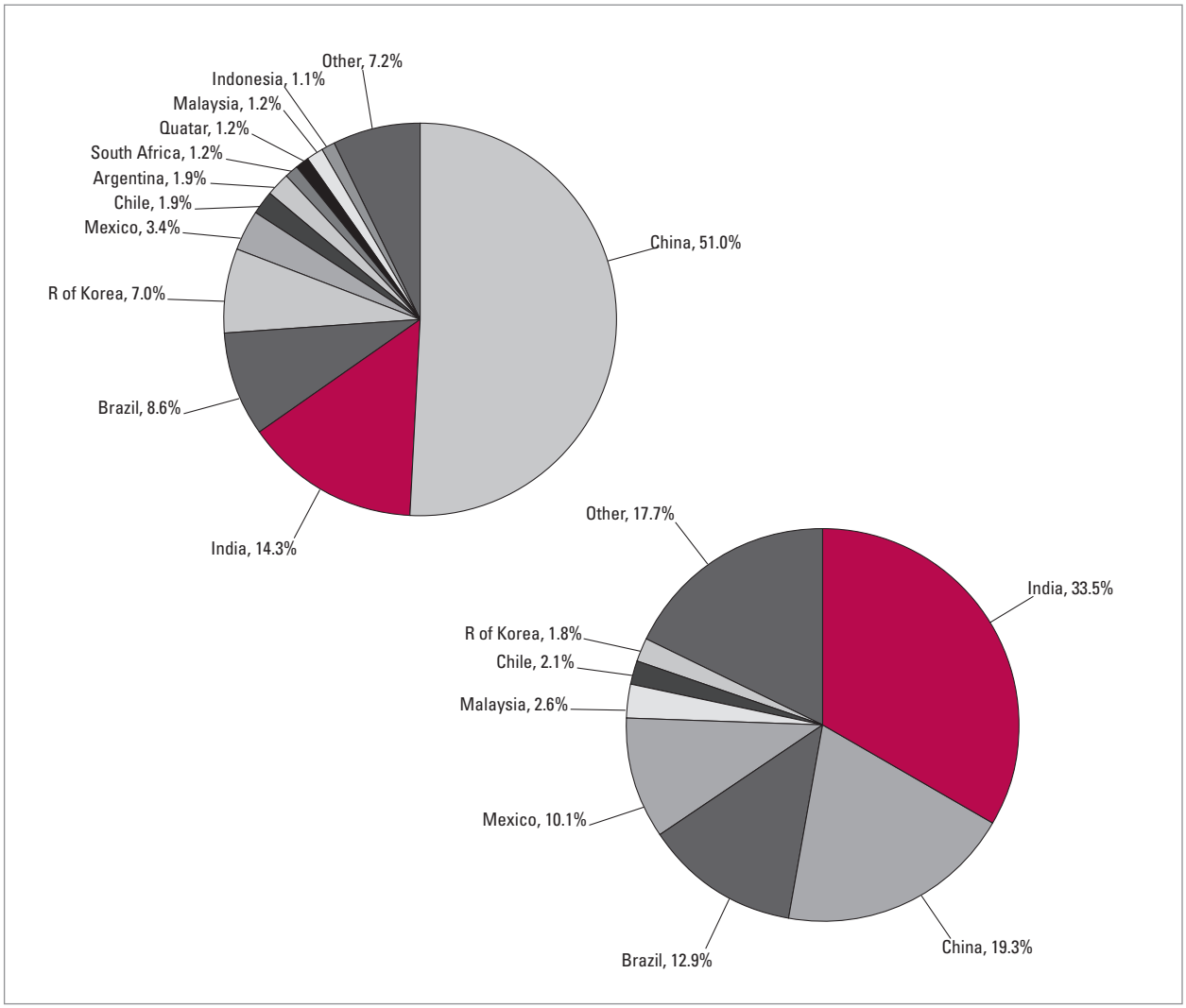
Additional bilateral and multilateral funding is available from USAID, Canadian International Development Agency, CTCTE, kfW, Japan Bank for International Co-operation, the World Bank, Global Environment Facility, International Finance Corporation, Asia Development Bank and EXIM Bank amongst others.

Source: SQW from various sources

Carbon finance

3.13 Carbon finance is currently a high-growth area in India through the Clean Development Mechanisms (CDM) of the Kyoto Protocol. The country is among the global leaders in terms of volume of certified emission reductions (CERs) generated by registered projects. As of April 2008, India had a 15 per cent share of the expected global annual CER output (or 30 million CERs out of 210 million globally) – Figure 3-1. India also hosts the largest number of registered CDM projects (333 projects or a 33.5 per cent share) but, on average, these are smaller-scale schemes. At the recent average market price of CERs (£10-£15/tCO_2), this creates value of about £300-£400 million annually, and over a project's minimum seven to ten year CDM registration, the current list of projects will generate aggregate revenue of up to £2-£3 billion by 2015 (NB: subject to Kyoto continuing to exist post 2012).

Figure 3-1: India's share of global CDM activity by volume of CERs (top) and number of projects (bottom), April 2008



Source: UNFCC (April 2008)

3.14 A detailed list of registered CDM projects in India, including technology type and project scale can be found at http://cdm.unfccc.int/Projects/index.html

3.15 To date the UK is the most prominent player in CDM projects in India. Other countries developing CDM projects include Germany, Sweden, Switzerland, the Netherlands, Italy and Japan.

3.16 The role of foreign companies in Indian CDM projects is as equity investors, technology suppliers, financial and engineering consultants, and carbon management service providers (eg assessors, validators, carbon credit originators and buyers).

3.17 Over time, the average size of CDM projects in India may increase as bigger opportunities become exploited. Any such trend however cannot be forecast with any certainty and may only start to emerge in the medium (as opposed to short) term.

4: Policy and regulatory frameworks

This section describes: a) the policy and regulatory regime as it relates to the treatment of importers, inward investment and joint ventures with overseas suppliers; b) the extent to which environmental policies and regulation have become more demanding – and the nature of the requirements; and c) the governance institutions responsible for trade, investment and environmental policy and regulation.

Trade and investment policies and routes to entry

4.1 India has implemented extensive market liberalisation and economic reforms. These have opened up the country to international investment, creating opportunities in environmental goods and services, renewable energy, carbon finance and CATs.

TRADE AND INVESTMENT POLICIES IN INDIA

Economic reform and trade liberalisation have taken place in India. This has made access to the Indian market much easier. Changes have included a reduction in licensing requirements and a reduction in trade tariffs. However decision-making in India can be slow.

India is considered to have a liberal and transparent FDI policy. FDI of up to 100 per cent is allowed in most sectors/activities, including the manufacture of pollution control equipment, sewage, refuse and consultancy services. India now ranks second only to China as the top FDI destination in AT Kearney's FDI Confidence Index.

Some of the positive points of FDI policy in India are that investment can be made without approval of the government. Industrial undertakings are free to select the location of their development. Foreign investors can set up a joint venture with an Indian partner for financial collaboration. Environmental clearances are required to ensure sound environmental standards.

Investment in the environmental goods and services sector has been open with 100 per cent FDI in India; domestic firms are engaged in both joint venture and long-term strategic partnerships. Over 100 Indian companies have associations with international companies in the form of joint venture and technology transfer agreements for various types of pollution control equipment.

All foreign investments can be freely repatriated except where Non Resident Indians choose to invest in non-repatriable schemes. Dividends declared on foreign investments can be remitted freely through an authorised dealer.

India has an environmental tariff reduction programme under which foreign technology providers can obtain reduced tariffs if they obtain certification that their technologies are environmental in nature or improve environmental performance in some way.

Source: Department of Industrial Policy and Promotion, India, Environment Business Journal (2006)

4.2 India already has a significant presence of foreign players in the environmental market. The Indian Government has encouraged private sector project development on a Build Own Operate (BOO) basis which has attracted FDI in environmental goods and services, renewable energy, carbon finance and CATs. Lower costs of production and labour have also encouraged this trend.

4.3 There are more than 500 successful foreign collaborations in India's water and wastewater treatment sector. The preferred route for foreign companies to enter the market appears to be in partnership with local firms rather than directly selling to end-users. More than 150 US firms have established a presence in the Indian market through their collaborations with domestic partners. The US dominates joint venture partnerships in the environmental market with 33 per cent followed by Germany with 14 per cent and the UK with 13 per cent.

Table 4-1: Joint Venture Partnerships in EGS in India

Country	Proportion of the total number of partnerships (%)
US	33
Germany	14
UK	13
Canada	7
Netherlands/France/Italy	5

Source: Singhal, S (2004) Presentation on Indian Environmental Market

4.4 There has been some liberalisation of environmental services in general in some Indian cities at a local level. Some city municipalities have imported design and consulting services, and some have allowed joint ventures in upgrading the sewerage systems. Some cities have even privatised the drinking water supply services as well as solid waste collection and disposal services, such as the New Delhi and Chennai municipality.

Environmental regulation and polices

4.5 India has strong environmental policy and legislative frameworks with well established institutions at national and State level. It has a number of environmental regulations including those for water and air pollution, solid waste and energy conservation. India is currently developing a climate change strategy.

4.6 Recent initiatives by the Ministry of Environment and Forests and Central Pollution Control Board (CPCB) have included the establishment of a task force to oversee the implementation of environmental plans for 17 categories of the highly polluting sectors, creating an inventory of hazardous waste generation and planning for cleaning up of contaminated sites.

4.7 The CPCB has proposed pollution control policy requirements to be implemented by Central and State government institutions. These include introducing awareness-raising programmes on cleaner technologies, formulating waste minimisation circles (WMCs) for productivity improvement and assisting small scale industries through fiscal incentives and training, and finance initiatives to enable municipal authorities to reform their waste management systems.

4.8 The Government of India has issued guidelines to all state governments in India specifying the policies that states should focus on, to attract private sector investment and promote commercial projects in the renewable energy sector. Several states such as Gujarat, Kerala, Madhya Pradesh, Maharashtra and Tamil Nadu have provided sales tax exemptions/deferment policies for investment in wind power projects.

4.9 Other state provisions include fiscal and financial incentives (eg 100 per cent asset depreciation) together with the simplification of procedures for private investment. Examples of this are: introducing single-window permit procurement, reducing the number of required governmental authorisations and allowing unrestricted levels of foreign direct investment in the ownership of renewable energy projects.

4.10 Other support mechanisms include:

- Encouraging foreign investors to establish renewable energy-based power generation projects on the build-own-operate model (BOO)
- Exemptions and reduction in excise duty on the manufacture of renewable systems and devices such as solar collectors, solar water heaters, solar PV cells, wind turbines, etc.
- Soft loans on competitive terms to manufacturers and users of commercial and near market technologies through the Indian Renewable Energy Development Agency and certain Indian nationalised banks and financial institutions.

4.11 However, despite the significant number of laws that are in place, the enforcement mechanisms are relatively weak. Sanctions available to the regulator are deemed to be either too extreme to be routinely used (eg shutting down units) or too time consuming to pursue (eg filing a criminal case on a company that violates the law).

4.12 A World Bank Report (2007) on India's institutions associated with the environmental market concluded that 'much remains to be done to strengthen the regulatory, enforcement, and incentive mechanisms at the disposal of environmental agencies'. The tools that regulators use for compliance need to be strengthened and expanded. New approaches to target whole activities rather than point sources, ie single localised sources of pollution, with specific targeting of SSIs, municipal sources of waste and pollution, industrial and transport sources should be adopted. Regulations on service quality and service obligations in the Power sector are yet to be enforced as state regulatory commissions struggle with distorted tariff structures and poor data quality for monitoring purposes.

4.13 The study suggests the need for greater community participation, the need to recognise the diversity in India and expand the regulatory tool kit to enable diverse sources to comply with regulation, and to strengthen the capacity of environmental agencies. It recommends wider use and dissemination of best practice of effective incentive packages for SSIs that combine focused enforcement with extensive assistance with compliance in the form of capacity building, aid and information sharing.

4.14 The following table sets out some of the key environmental regulations and their aims.

ENVIRONMENTAL REGULATIONS
Environmental Protection Act (1986) is used by the Ministry of Environment and Forests to set standards for the protection of the environment. It sets limits on the amount of pollution that industries may produce and sets punishments for offending companies.
The Water Prevention and Control of Pollution Act (1977) sets standards and controls on the level of pollution entering water sources and sets requirements for treatment of waste before it is disposed of.
Municipal Solid Waste Management Rules (2000) sets standards on disposal and treatment of solid waste. Responsibility for implementing these rules lies with the municipalities. The state board or committee is responsible for ensuring the rules are implemented. The state government has overall responsibility.
Hazardous Waste Management and Handling Rules (1989 – amended in 2000) sets standards of disposal of hazardous waste, sets the duties of the handlers of hazardous waste plants, and grants authorisations for the handling of hazardous waste. It prohibits the import or export of hazardous waste for dumping or recycling.
Air Prevention and Control of Pollution Act (1981) aims to improve air quality through the prevention, control and abatement of air pollution and the setting of standards of air pollution control equipment. The Motor Vehicle Act (1980) sets limits on the amount of particulates that motor vehicles can emit.
Environmental Impact Assessment (EIA) (1994) was formally introduced in India in 1994 making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification. Since then there have been 12 amendments made to the original EIA notification of 1994. The Ministry of Environment and Forests recently notified new EIA legislation in September 2006. The notification makes it mandatory for various projects such as mining, thermal power plants, river valley projects, infrastructure (roads, highways, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance. However, unlike the EIA Notification of 1994, the new legislation has put the onus of clearing projects on the state government depending on the size/capacity of the project.
Energy
The Energy Conservation Act (2001) provides the regulatory framework to support an energy efficiency drive across India. A bureau of Energy Efficiency has been established for the Act.
The Electricity Act (2003) was passed to support the development of electricity across India. There is a drive to develop electricity in rural areas to increase the number of people with access. The Act aims to provide a liberal framework to promote competition in the power sector.
The National State of the Environment Report (2001) provides guidelines for environmental action planning, policy setting and resource allocation for the coming decades. Five key environmental issues that are highlighted in the report are land degradation, biodiversity, air pollution and control, management of fresh water resource, and hazardous waste management.
Environmental policies in India are contained in the National Forest Policy (1988), the National Conservation Strategy and Policy Statement on Environment and Development (1992) the Policy Statement on Abatement of Pollution (1992) and the Wildlife Conservation Strategy (2002). Sector policies also contribute to environmental policy including the National Water Policy (2002).
National Environment Policy (2004) is a guide to action in regulatory reform, programmes and project for environmental protection.
Planned developments
India is currently developing a Climate Change Strategy. The aim was to set the ground work for a strategy by December 2007 but emissions targets have not yet been set. As a developing country, India is not required by Kyoto Protocol to set emissions targets.

Source: SQW from various sources

Key institutions

KEY GOVERNMENT DEPARTMENTS AND AGENCIES INVOLVED IN TRADE, INVESTMENT AND THE ENVIRONMENT

Ministry of Environment and Forests (MoEF) is responsible for policy and programmes on the environment and forests, and is the node for the United National Environment Programme (UNEP) in India. The Hazardous Substances Management Division (HSM) is a division of MoEF.

Ministry of Power is responsible for designing policies, planning and processing investment projects as well as for monitoring and enforcing legislation in thermal, hydro power generation, transmission and distribution. The Ministry of Power is also responsible for the Administration of the Electricity Act, 2003, the Energy Conservation Act, 2001.

Central Electricity Authority of India (CEA) is a statutory organisation constituted under section 3(1) of Electricity Supply Act 1948, which has been superseded by section 70(1) of the Electricity Act 2003.The CEA advises the Union Government on the matters relating to the National Electricity Policy and formulates short-term and prospective plans for the development of electricity system.

Ministry of Water Resources is responsible for laying down policy guidelines and programmes for the development and regulation of water resources.

Ministry of New and Renewable Energy is responsible for leading on all things related to new and renewable sources (was renamed from The Ministry of Non Conventional Energy Sources in 2006). It has a range of support programmes for supporting renewable energy including awareness raising, technology information forecasting, and international co-operation activities. The Indian Renewable Energy Development Agency is under the administrative control of the Ministry of New and Renewable Sources of Energy. Its aim is to 'promote, develop and extend financial assistance for renewable energy and energy efficiency/conservation projects'.

Bureau of Energy Efficiency is a statutory body under the Ministry of Power and its mission is to institutionalise energy efficiency services, enable delivery mechanisms in the country and provide leadership to the key players involved in the energy conservation movement. The primary goal of the Bureau is to reduce the energy intensity in the economy. It is a comprehensive information-base on energy conservation (EC) related developments and issues. It provides an update on the related policy framework especially in the context of EC Act 2001 beside topical write - ups, news and highlights on happenings in India. The site also captures the activities taken up by the Bureau of Energy Efficiency with the stakeholders co-opting expertise from bilateral/multilateral agencies.

Ministry of Petroleum and Natural Gas is responsible for the exploration and exploitation of petroleum and natural gas in India, and planning and developing regulations.

Department of Commerce is responsible for formulating foreign trade policy and is also responsible for issues concerning multilateral and bilateral trade. India Trade Promotion Organisation is a government organisation responsible for promoting international trade.

Bureau of Indian Standards is responsible for setting standards in India.

Technology Information, Forecasting and Assessment Council is an autonomous body under the Department of Science and Technology that is aimed at keeping watch on global trends in technology and formulating preferred technology options in India.

Power Finance Corporation was set up in July 1986 as a Financial Institution (FI) dedicated to Power Sector financing and committed to the integrated development of the power and associated sectors. It is overseeing the setting up of Ultra Mega Power Projects along with Ministry of Power and Central Electricity Authority.

Source: SQW from various sources

Annex A: Definitions of environmental goods and services, renewable energy, carbon finance and CATs

A.1 The Defra/BERR Environmental Industries Unit has defined the individual EGS sectors as follows:

TABLE A-1: CONSTITUENT SUB-SECTORS OF THE ENVIRONMENTAL GOODS AND SERVICES SECTOR

Sub-sector	Description	Examples of types of activity
Air Pollution Control	Defined as products, systems and services for the prevention, reduction and removal of gaseous and particulate pollutants from air	External and internal emissions and odour control, filters and catalytic converters
Cleaner Technologies and Processes	Defined as products, systems or services for cleaner more resource efficient technologies, processes or products which are not covered elsewhere	
Decommissioning/Decontamination of Nuclear sites	Defined as products, systems and services required for the decommissioning of existing nuclear liability sites and structures	Consultancy, decontamination, recycling and compaction technologies, waste collection and containment
Environmental Consultancy	Defined as services to provide assessment and advice relating to environmental issues	Environmental audits, environmental impact assessment, corporate environmental responsibility
Environmental Monitoring, Instrumentation and Analysis	Defined as products, systems and services for measuring and monitoring environmental parameters	Water, air and soil quality, meteorological conditions and flow rates
Energy Management/Efficiency	Defined as products, systems and services for energy management and energy efficiency	Energy consultancy/audits, building energy management systems, energy efficient products and efficiency advice
Marine Pollution Control	Defined as products, systems and services for controlling, clean up and minimising marine pollution	Products such as oil absorbents and booms and services such as marine pollution preventing techniques
Noise & Vibration Control	Defined as products, systems and services for monitoring and reducing noise and vibration	Noise meters, monitoring systems, acoustic buffers, enclosures and barriers and silencers
Recovery and Recycling	Defined as products, systems and services for waste segregation, recovery and recycling	Paper, organics, metals, plastics, glass, demolition and construction wastes, vehicles and white goods
Remediation and Reclamation of Land	Defined as products, systems and services for the identification, assessment and remediation/reclamation of land and buildings, including prevention of contaminant dispersal	Absorbents and injection equipment, monitoring systems and proprietary treatment processes and sampling/analysis and site investigation/engineering
Waste Management	Defined as products, systems and services for the minimisation, collection, treatment (not recycling) and disposal of waste	Advice on waste minimisation, landfill, mechanical and biological treatment, regulatory advice and technologies such as specialised containment, shredders, compactors and waste management vehicles
Water Supply and Wastewater Treatment	Defined as products, systems and services for the management of the fresh water environment, provision, treatment, distribution and storage of clean water and wastewater for industrial and domestic users	Resource development, demand management, manufacture of wastewater treatment equipment, design, construction, installation and operation of water and wastewater treatment facilities

Source: DEFRA, Sustainable Consumption and Production – Development of an Evidence Base: Annex 1, UK Government Definitions of the Environmental Goods and Services Sector (Draft Review September 2006)

A.2 Definitions for the individual CATs sectors are available from different sources including BERR's Strategy for CATs (2005), certain trade associations and prominent market leaders.

TABLE A-2: CONSTITUENT SUB-SECTORS OF THE CARBON ABATEMENT TECHNOLOGIES SECTOR

Sub-sector	Description	Examples of types of activity
Carbon Capture & Storage (CCS)	Defined as a multi-stage process where carbon from power generation is captured either before or after combustion and transported to a long-term storage in geological formations. This approach can reduce emissions by up to 85 per cent depending on the type of non-capture plant displaced	The entire supply chain for CCS technologies from R&D to demonstration and deployment. This includes manufacturing, as well as engineering and financial/business consulting services across the three main stages: • Carbon capture at plant • Transportation to a storage • Storage in a geological formation
Generation technologies that provide higher conversion efficiency	Defined as higher efficiency conversion processes, where the amount of fuel consume and the associated emission of CO_2 are reduced and the conversion processes are made more efficient (eg emission reductions of 10-30 per cent are possible depending on the performance of the old and replacement plant. Even higher levels can be attained by adding co-firing with biomass (typically a 5-10 per cent mix)	The entire supply chain for renewable technologies from R&D to demonstration and deployment. This includes manufacturing, as well as engineering and financial/business consulting services. Main technologies are: • Supercritical boilers • Integrated Gasification Combined Cycle (coal) • Combined Cycle Gas Turbine (gas)
Substitution to low carbon transport fuels	Defined as fuels used for transport based on the fermentation and distillation of replenishable organic matter, such as agricultural crops (eg sugar cane or beet, rapeseed) or woody material. Commonly known as biofuels, the main commercial varieties are bioethanol and biodiesel, where the former can be used as the main fuel and the latter is typically mixed with standard diesel in different proportions. Currently, there are second and third generation biofuels	Production of crops and other organic matter to be converted into fuel. The design of technology and equipment for producing biofuels. The production of different types of low-carbon fuels including bioethanol and biodiesel
Asset Management	Defined as planning, procurement and maintenance of energy generation facilities	Business planning, condition assessment, data gathering, technical maintenance

Source: BERR, British Biogen, Energy Asset Management plc

A.3 Renewable energy is defined broadly in all sources consulted and a generic definition is as follows:

TABLE A-3: RENEWABLE ENERGY

Sub-sector	Description	Examples of types of activity
Renewable energy	Defined as energy technologies that use natural resources such as sunlight, wind, flowing water, tides and waves, biomass and geothermal heat. The availability of these resources is either unaffected by energy capacity installed (eg solar and wind energy) or can be replenished in the short-term (eg hydro and biomass)	The entire supply chain for renewable technologies from R&D to demonstration and deployment. This includes manufacturing, as well as engineering and financial/business consulting services. Main technologies are: • Wind (onshore and offshore) • Solar (thermal and electric) • Hydro (smaller scale) • Biomass (heat and power) • Geothermal • Marine (wave and tidal)

Source: various sources

A.4 Carbon Finance is also a term which is not standardised across the literature and a definition reflecting the content attributed to it by several sources is as follows.

TABLE A-4: CARBON FINANCE

Sub-sector	Description	Examples of types of activity
Carbon finance	Defines as the investments in greenhouse gas emission reduction projects, the creation (origination) of tradable commodities on the 'carbon market', and the provision of financial and business services associated with all of the above	Trade in carbon commodities and derivatives on different markets and exchanges, such as CERs, EAUs, VERs and others CDM and JI project assessment, registration, finance and development

Source: various sources

Annex B: Additional information

Table B-1: All India installed Power Generation Capacity 30/04/2008

Power	Capacity (MW)
Thermal	92,157
Coal	76,299
Gas	14,656
Oil	1,202
Hydro	35,909
Nuclear	4,120
Renewables	11,125
Total	235,468

Source: Central Electricity Authority cited by Ministry of Power (April 2008)

Table B-2: Energy capacity to be developed during the 11th Plan

		Total	Thermal Breakup				
Sector	Hydro	Thermal	Coal	Lignite	Gas/Lng	Nuclear	Nuclear
Projects under construction	11,931	16,254	14,115	1,125	1,014	3,160	31,345
Committed projects	3,654	33,870	32,520	250	1,100	–	37,524
Total	15,585	50,124	46,635	1,375	2,114	3,160	68,869

Source: Report of Working Group on Power for 11th Plan (2006)

Table B-3: Absolute Emissions Totals from the Power Sector (tCO_2)

	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006
North	97,866,565	102,743,113	106,808,582	109,996,544	112,212,597	120,102,148
East	58,026,488	61,427,499	66,593,200	75,512,010	83,956,860	92,517,515
South	89,019,263	92,178,116	105,239,700	108,123,211	105,603,624	101,760,966
West	135,192,153	141,597,621	148,557,341	144,127,175	157,781,065	153,933,199
North-East	2,207,396	2,159,969	2,285,724	2,462,796	2,468,463	2,532,819
India	382,311,864	400,106,317	429,484,546	440,221,736	462,022,608	470,846,647

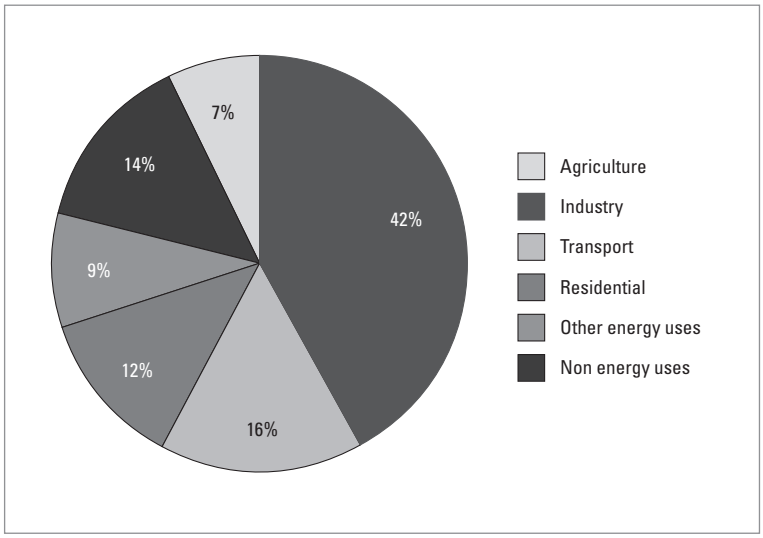
Source: Central Electricity Authority (Dec 2007) CO_2 Baseline Database for Power Sector

Table B-4: Weighted Average Specific Emissions for Fossil Fuel Fired Stations in 2006-07 (tCO_2/MWh)

	Coal	Disl	Gas	Lign	Napt	Oil
North	1.09	—	0.44	—	—	—
East	1.13	—	—	—	—	—
South	1.01	0.62	0.49	1.43	0.66	0.61
West	1.10	—	0.45	1.36	0.61	0.82
North-East	—	0.64	0.69	—	—	—
India	1.09	0.62	0.47	1.42	0.61	0.77

Source: Government of India Ministry of Power (Dec. 2007) CO_2 Baseline Database for the Indian Power Sector User Guide Version 3

Figure B-1: Sectoral Share of Commercial Energy Consumption (mtoe) (2003-04)



Source: Central Electricity Authority cited by Ministry of Power (April 2008)

Table B-5: All India Installed Power Generation Capacity 30/04/2008

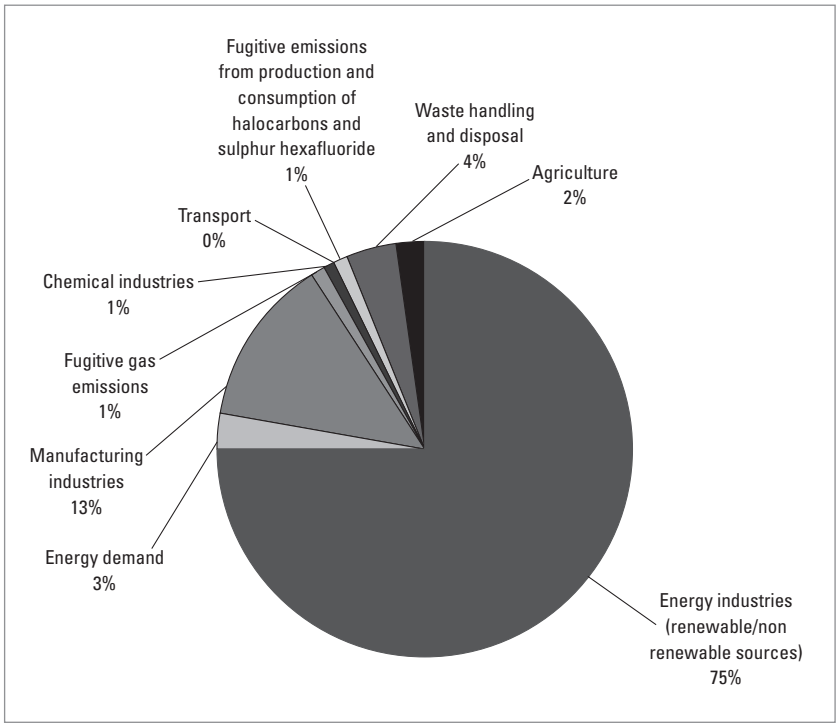
Activity	Strategy
Retrofit projects: • Boiler retrofit • Process improvements	Promote technology transition in small and medium industry Link resource discussion programmes
Retrofit projects: • Boiler retrofit • Process improvements	Promote technological and financial collaborations Jumpstart technology transition and hedging
Infrastructure projects: • Gas pipeline • Road/Rail infrastructure	Link with development Regional energy co-operation High mitigating potential, but difficult to operate under CDM regime
Mitigation Programmes: • Demand side efficiency • Electricity distribution reforms • Consumer awareness	Strong link with economic reforms and sustainable development High transaction costs, but high co-benefits No way to operate under Kyoto regime

Table B-6: Sectoral Status in Green House Gas reduction

Sector	Green House Gas Emissions (Mt/a)	CDM potential ($MtCO_2$ eqv/a)	Green house gas reduction options
Renewable energy	N/A	90	Wind, solar, biofuels, bagasse cogeneration, mini hydro, biomass gasification
Land use, land-use change and forestry (LULUCF)	14	78	Re-vegetation of wasteland areas, promotion of commercial forestry, carbon sink conservation, fossil fuel substitution
Agriculture and livestock	344	35	Energy-efficiency of irrigation pump sets, water management, synthetic and organic fertilisers, animal feeds and digesters
Power	433	24	Coal washing, fuel switch to LNG, critical and super-critical boilers, integrated gasification combined cycle technology (IGCC)
Industrial energy efficiency	151	15	Sector specific technological options, cross-cutting technologies, fuel switch options, recycling, use of secondary materials
Transport	80	6.5	Mass rapid transport system, fuels switch to LNG or bio-diesel, induced energy-efficiency improvement, interfuel substitution, alternate power packs
Municipal solid waste (MSW)	12	1.2	Reduction of methane emissions, using methane or MSW in power generation, utilising organic fertilisers produced from MSW

Source: Loikala, J et al (2006) Opportunities for Finnish Environmental Technology in India

Figure B-2: Scope of registered CDM project activities in India



Source: SQW based on statistics from UNFCC (2008)

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