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Financing reduction of GHG emissions in India

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Summary

1. Introduction

After only one year of operation of the Kyoto Protocol, all eyes are now turned to its successor international climate accord that should be concluded at the end of the 2009 Copenhagen Conference of the Parties if it is to be operational in 2013. One of the main stakes of the forthcoming agreement will be to encourage major developing countries to commit to compulsory emissions reductions - either in absolute or, more realistically, in relative terms - for example compared with their current emissions projections trends.

Of these emerging economies, China and India are the largest and represent more than one third of the Earth population. They are experiencing rapid development that is supported by a dramatic increase in energy use. This is having a serious impact on climate negotiations: even if their level of emissions per capita is still one of the smallest in the world, their absolute volume represents almost 23 % of human-related activities emissions and is rapidly growing. Their role in the future climatic will thus be major. However, their inclusion requires taking into consideration not only their absolute level of emissions, but also the relative level of development, hence issues of capacity building, technology transfers and equity.

Before a post-Kyoto accord considering all aspects of countries emissions, a first step may be necessary to prepare Chinese and Indian businesses to new economic conditions internalizing the constraints of climate change. Carbon markets serve as a way to achieve this kind of integration: they cap the amount of carbon emissions using a market that gives a price to the marginal abatement costs. Starting in 2005, the European carbon market is the most developed, even if it covers only a part of the European economy.

The aim of this study is to evaluate what are the main differences between the Indian and European climate-oriented policies and see to what extent they may be linked in the following years.

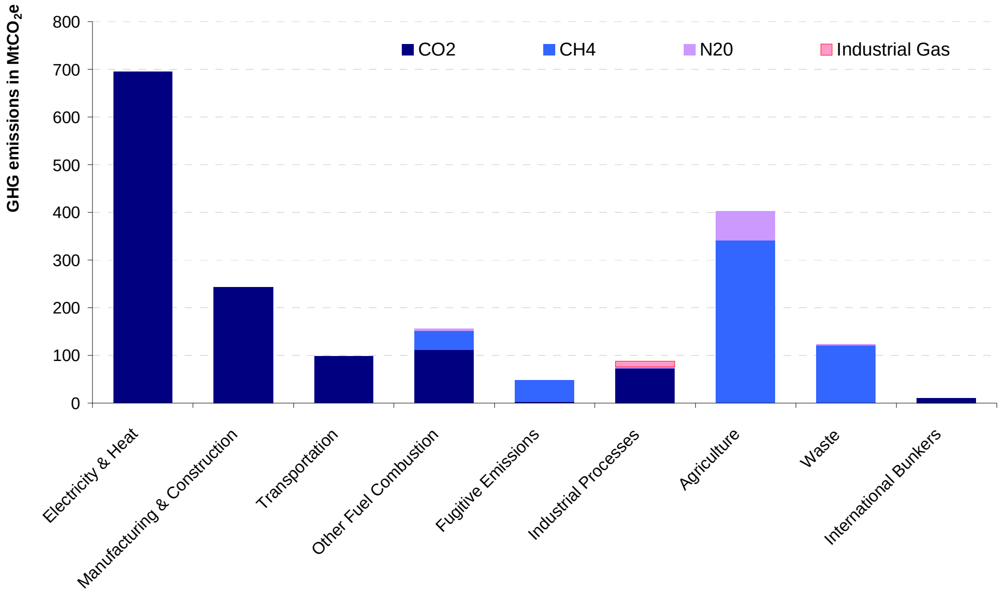
2. Indian emissions and abatement potential

2.1. GHG emissions: the overwhelming share of energy and agricultural emissions

Indian greenhouse gases (GHG) emissions reached 1,863.4 MtCO2e in 2005, making the country the 5th largest emitter in the world. Still it is one of the lowest countries in terms of emissions per capita (121st world rank).

GHG emissions, excluding emissions from changes in land use and forestry, grew by 38% from 1995 to 2005, mainly due to an increase in CO_2 emissions by 49.7%. Carbon dioxide (CO_2) is the main contributor to Indian GHG emissions with a 66.1% share. It is followed by methane (CH_4) which accounts for 29.4%, and to a smaller extent, by nitrous oxide (N_2O) at 3.8%. Industrial gases (HFC, PFC, and SF6) only account for 0.67% of total emissions.

Figure 1 – Indian GHG emissions by sector in 2005, excluding land-use, land-use change and forestry emissions



Source: Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).

2.1.1. CO_2 emissions in the energy sector

The energy sector is the most important sector in terms of emissions levels, primarily CO_2. In total, energy-related emissions represent 93.3% of India's CO_2 emissions in 2005 (IEA, excluding LULUCF[3]). Electricity production only accounts for 56.4% of the country's CO_2 emissions. Manufacturing & construction (19.8%), transportation (7.9%) and other fuel combustion (9.1%) are other noticeable sources of CO_2 emissions from the energy sector. Not represented on Figure 1, CO_2 emissions from LULUCF activities are negative as India undertakes a reforestation policy increasing the CO_2 captured.

CO_2's high share both in absolute terms and in the growth of emissions is mainly related to the increase in the country's electricity needs. Electricity is primarily supplied by coal-fired generation plants.

2.1.2. CH_4 and N_2O emissions in the agricultural sector

The two other main GHG in India are methane (CH_4) and nitrous oxide (N_2O). Agriculture was the main contributor to Indian methane emissions in 2000 (62.4%), followed by waste (22.1%), fuel combustion and fugitive emissions[4]. The high contribution of methane to GHG emissions – 29.4% versus 16.8% for the world average - reflects the high share of agriculture in India's economy.

India is the forth world producer of agricultural goods, and the second in terms of exploited land surface. The high share of methane in national emissions can be

[3] Land Use, Land Use Change and Forestry.

[4] Emissions not caught by a capture system, which are often due to equipment leaks, evaporative processes and windblown disturbances.

explained by an important rice production (20% of the world harvest)[5]: and India's world largest livestock of animals (450-million heads) for which waste and eventually rumination process emit methane.

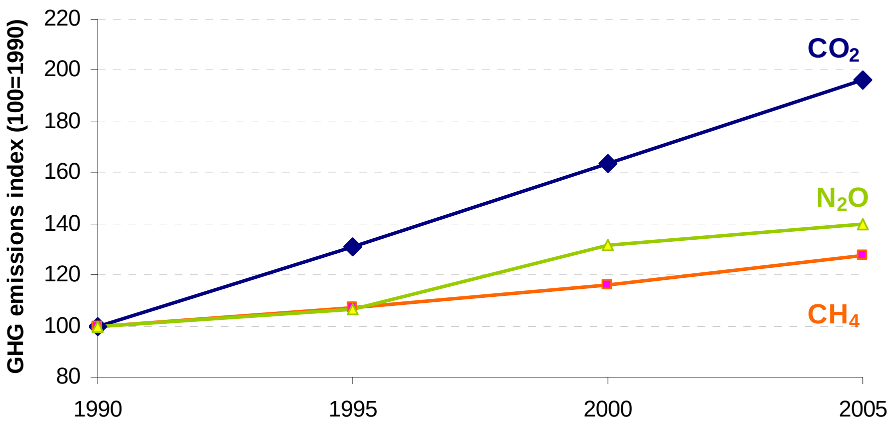
If we compare the Indian with the Chinese emissions' structure for all GHGs, the energy sector importance is remarkably similar; the differences come from India's strong share in agriculture and electricity production, in opposition to China's higher share of emissions in industrial processes. Indeed, agriculture makes up 20% of Indian GDP and 11.3% of Chinese GDP in 2007; on the contrary, the share of industry in China's GDP is higher (48.6% versus 30% in India).

Agriculture is also the leading sector in terms of N_2O emissions. Its small importance in Indian GHG emissions may appear contradictory to the high share of the agricultural sector in terms of GDP. This could be explained by a low use of industrial fertilizers in India compared to the world average. For example, the use of product by hectare is three fold the Indian amount in China for all fertilizers.

2.1.3. Trends in Indian GHG emissions since 1990

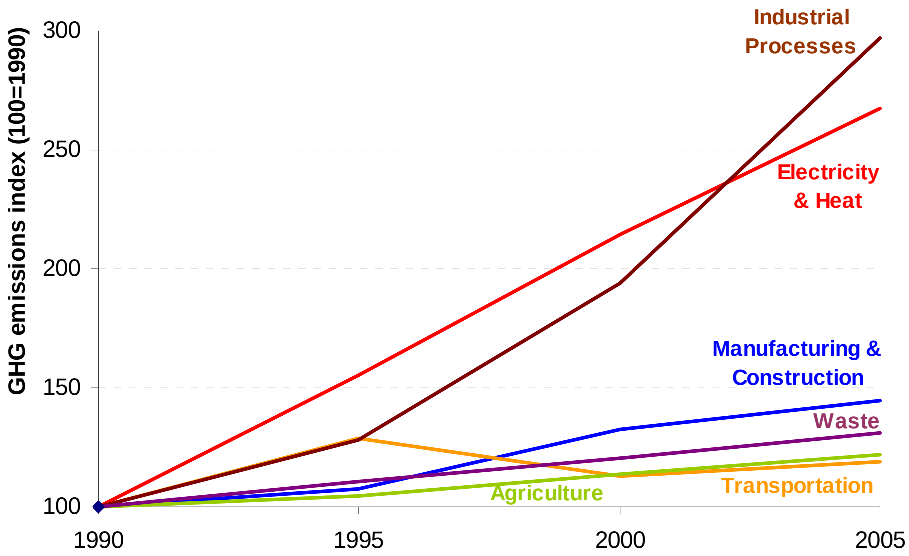
Indian GHG emissions grew by 67% between 1990 and 2005. CO_2 is the main contributor to this rise, doubling in the fifteen-year period, while N_2O increased by 40 % and CH_4 by only 28%. Not surprisingly, the sectors that experienced the highest growth are the electricity and heat sector (+167%) and Industrial processes (+196% however still a small absolute contribution). Globally, the largest increase occurred in primarily in the energy sector while the increase in the transport sector is more similar to that of Agriculture and Waste.

Figure 2 - Trends in Indian GHG emissions by gas, excluding LULUCF, between 1990 and 2005



[5] Rice culture emits high amount of methane due to anaerobic fermentation of biomaterials in the water.

Figure 3 - Trends in Indian GHG emissions by sectors, excluding LULUCF, between 1990 and 2005



Emissions exclude LULUCF but include International Bunker

Source: Climate Analysis Indicators Tool (CAIT) Version 6.0. (Washington, DC: World Resources Institute, 2009).

Growing energy-related emissions are linked to the increasing energy needs of the industry and the service sectors. In addition to the extra capacity installed in this period, the carbon intensity of the energy supplied has increased, mainly as most of the new plants are powered by fossil fuel combustion. Coal use for electricity generating purpose more than double over the 1990-2005 period (from 200,000 to 450,000 GWh), explaining why carbon dioxide emissions from the electricity sector rose by almost 100% between 1990 and 2005.

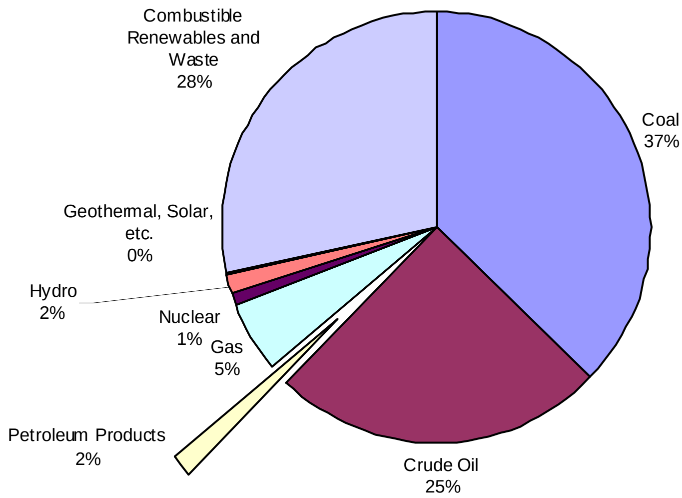
2.2. Indian industrial structure and energy mix

2.2.1. Energy supply

Total primary energy supply (TPES) represents the total quantity of fuel available in India - the sum of local production and net imports, corrected by stock changes. Three types of fuel ensure most of Indian supply: coal, combustible renewables and waste, and crude oil. Petroleum products' share is negative as Indian exports are larger than imports.

Energy sources expenditures in India are often support financially by subsidies from the states. The price of energy does not represent its true cost most of the time.

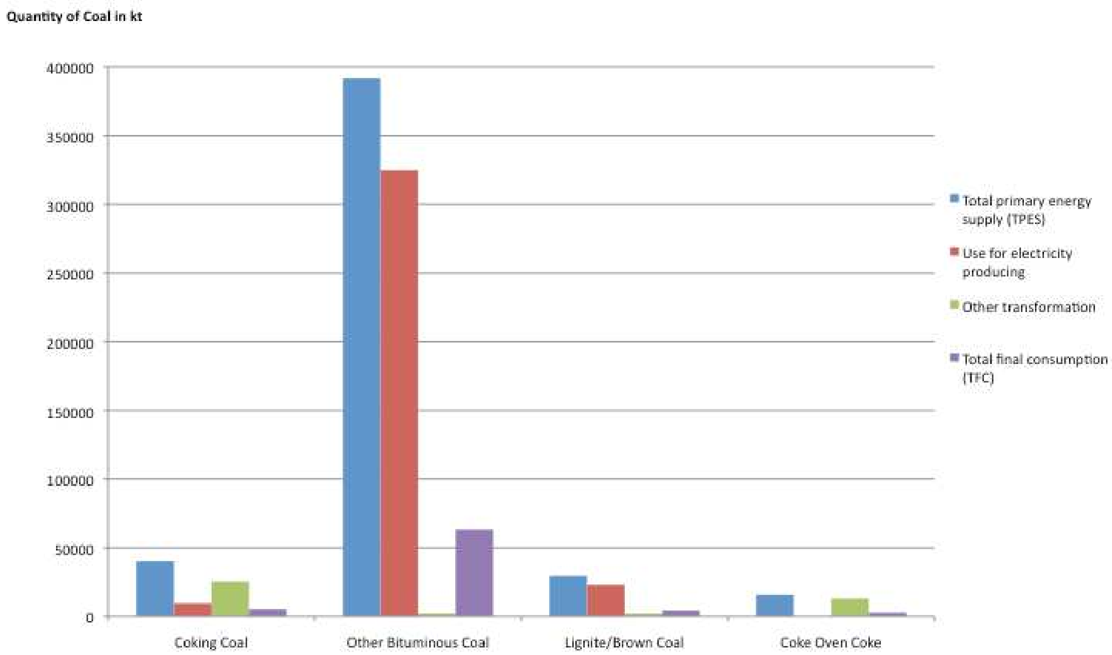
Figure 4 – Indian Total Primary Energy Supply in 2005



Source: IEA website, 2008.

Coal is the most widely used fuel and represents 39% of Indian TPES. Since it is easily available and a relatively-inexpensive energy source, it is extensively used in a majority of power plants in India. Only 12% is imported.

Figure 5 – Coal use in India in 2005



Source: IEA website, 2008.

Renewable combustibles and waste is the second most important energy source, representing 28% of Indian TPES. It is mainly consumed in the residential sector (78%), by industries (17%), and marginally by commercial and public services (4%) and electric plants (less than 1%). Waste management accounts for 7% of Indian overall GHG emissions, due to methane emissions. A better valorisation of waste could allow both emissions' reduction and additional energy supply – through increased biogas production in particular.

Crude oil is the next important energy source used in India representing 25% of the TPES. Nearly three-quarters are imported. The vast majority is transformed locally into petroleum products. Despite its dependency on oil imports, India's exports of petroleum products exceed imports. The petrochemical industry is very developed; the two first Indian firms in terms of capitalisation operate in this sector (Reliance and ONGC). Most of the oil supply is absorbed by industry, transportation and residential use.

Natural gas supplies 5% of energy needs in India; net imports reached 17% of the TPES in 2005. Gas thermal plants use 44% of it for electricity production and 7.2% for their own needs. Total final consumption is further divided into petrochemical feedstock (25%), consumption by industries (17%), by residential (2.2%), and transportation (2.2%).

2.2.2. Future energy consumption trends

India's rapidly growing economy needs more energy to sustain its development. According to the 2007 IEA reference scenario, India's primary energy demand could more than double by 2030; average yearly GDP growth rate could reach 6.3%. Supplying energy to meet this demand is a very tough challenge for India, not to mention GHG emissions mitigation. This scenario takes into account all planned and in-progress measures, thus not supposing anything on the future climate negotiations' impacts on the Indian energy and climate policies.

Coal would remain the main energy source even in 2030 with a growing share in the energy supply (49%), mainly absorbed by electric thermal plants. Natural gas demand would increase sharply following the important switch from biomass towards gas in residential sector heating as well as from a broader use in power plants. Oil usage would increase by two and a half folds, driven by the development of the transportation sector. Hydropower and nuclear power shares in energy supply should decline, although increasing in absolute production terms.

IEA estimations are restricted to energy-related CO_2 emissions. According to the reference scenario, emissions should grow at a 4.3% annual rate until 2030. By then, India's annual emissions will be three times more than in 2005. Increasing electricity supply based on coal power plants as well as the development of the transport sector will be the main drivers of this growth. If the absolute figures are dramatic, it is important to underline that emissions per capita will remain low, slightly more than 2 Mt, today's average for per capita emissions.

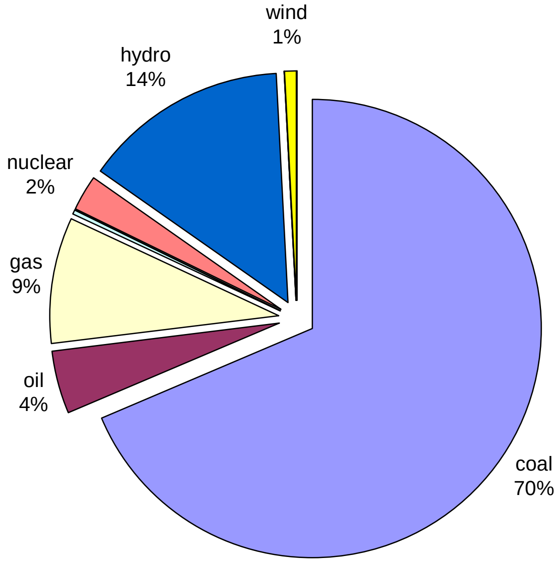
2.2.3. Electricity production

India's electricity production reached 699,041 GWh in 2005 (IEA 2008). Foreign supplies are marginal as net imports only account for 0.24% of the country's production during the same period. India has not achieved full electrification yet and the power supply still suffers from regular shortage; distribution's losses account for 25% of the supply[6] (IEA 2008).

[6] 32-35% according to the *World Energy Outlook*, IEA 2007.

The primary source of electricity production is coal (70%), followed by the Renewable Energy Sources (RES), mainly hydro, completed by wind and solar power (15%). Gas, oil and nuclear complete the Indian electricity production.

Figure 6 – Indian electricity production mix in 2005



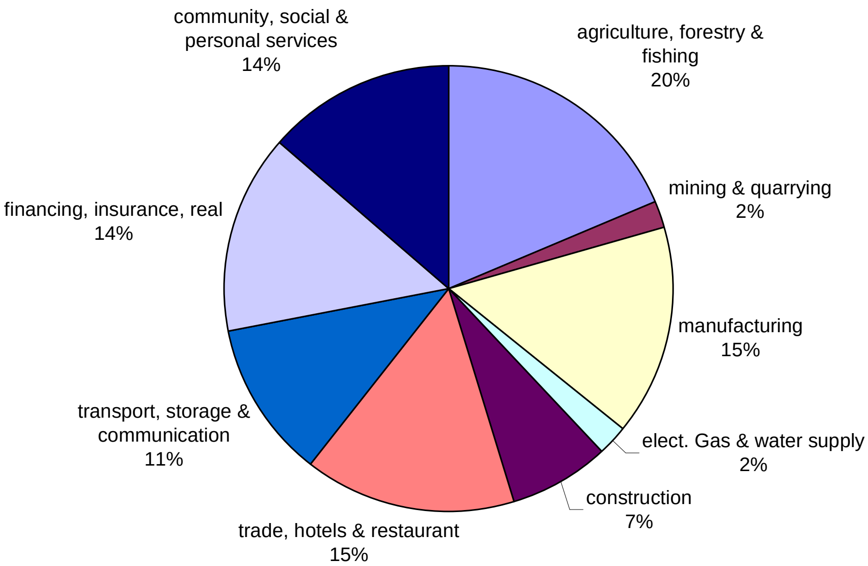
Source: IEA website, 2008.

For more information about electricity production in India, see further details in Annex 1.

2.2.4. Structure of the economy

The Indian economy is driven by the service sector, accounting for 54% of the GDP. Industries and agriculture respectively represent 24% and 20% of the total GDP (MOSPI, 2008)

Figure 7 - Indian GDP in fiscal year 2006-2007



Source: National Account Statistics 2008, MOSPI.

India's industrial strategy differs from other Asian emerging countries (China, Thailand, etc...). These countries have focused industrial development on exportations and mass production to lower prices. In each Indian sector, the focus has been set on the activity that guarantees the highest added value per unit produced. This modern economy is dominated by big private firms that are mostly owned by old industrial family groups. These big firms, present in all sectors, account for the main part of the industrial production

The small-scale industry still plays an important role in India's economy as it delivers 40% of the manufactured production and employs 65% of the people working in the industry. Historically, this small scale industry has taken advantage on the law ensuring them a monopoly on definite sectors of production. The number of these "reserved" sectors for small scale industry is declining despite social and political reluctances. Today this small industry is separated into two patterns:

- High capital-intensive installations with a high net added value per worker employed. The production is mainly oriented toward exports and accounts for 75% of the small scale industries production.
- Low capital-intensive installations employ most of the industries' workers. The progressive liberalization of Indian economy threatens these installations mostly located in rural area.

2.2.5. Political and institutional structure

India is a union of states with a parliamentary system of government. The head of the union is the President although most of the executive power lies in the hand of the Council of the Minister and therefore in the Primes Minister's hand. The parliament is constituted by two houses known as the council of States and House of the People. The Council of minister is responsible to the House of the People, whose members are elected by direct suffrage based on Universal Adult Suffrage while members of the Council of States are elected by legislatives members in every States assemblies. Every States has a legislative assembly and a Governor, appointed by the President. The distribution of roles between States and the Parliament is specified in the Constitution: most of decisions are taken at the central level, while the implementation of these measures is undertaken by the states authorities.

India was characterized by consequent intervention of public authorities in the economy until the beginning of the 80's. However, the current trend is toward a more deregulated market. Indeed electricity is the only sector where barely all companies are held by central or state authorities. Furthermore, many sectors that were "reserved"- allowing the production for only small-scale industry- have been "freed" since 1982.

India's economic policy is implemented through fiscal incentives, subsidies and planed effort from the public sectors. These efforts are set on five years basis in the "Five-Year Plan": the 11th in place for the 2007-2012 period.

2.2.6. Implications for policies aiming at reducing GHG emissions

This picture of the Indian economy allows us to sketch an outline of actions in India to mitigate GHGs emissions. First, part of the industrial world, in particular the biggest companies, could react quickly to public policies impulses. This would be particularly right in public owned companies, mostly in the power sector, which may react to the government's emission policies and achieve results in short term. The rest of the industrial sector, fractioned into small entities, is less likely react as efficiently to climate change policies.

Secondly, the share of the service sector in the GDP is high compared to other developing countries. Targeting GHG emissions reductions in this sector thus may have a huge impact. Given the diffuseness of emissions, indirect measures should be favored, namely energy efficiency (e.g. energy consumption standards for buildings) or GHG intensity targets in the electricity production.

As electricity production is highly reliant on coal and fossil fuels, a third way for reducing GHG emissions in India would be to develop renewable energies (wind, solar…). This is also an opportunity to supply electricity to off-grid places in rural areas.

As we will see, India essentially addresses these concerns through two axes: the improvement of the energy efficiency in the economy and the development of renewables.

2.3. Emissions reductions potential

The potential of emissions reduction differs among sectors in terms of volumes and costs. Estimating these costs may be tricky. For example, gains in energy efficiency can be made at no cost with the insulation for buildings or less consuming light bulbs because lower energy expenses reimburse the initial investment. However, this is not always the case: switching from one fuel to another requires capacities investment that may not be developed without economic incentives.

Various works have been published on potential mitigation measures in India. The principal source quoted is a 2002 study by the Pew Center on climate change mitigation in developing countries.

Table 1 – CO_2 mitigation potential in India

Mitigation Options	Mitigation potential 2002-2012 (Mt)	Long term Marginal Cost ($/ton of CO_2)
Demand side EE	165	[0-4.1]
Supply side EE	117	[0-3.3]
Electricity transmission and distribution	44	[1.4-8.2]
Renewable electricity technologies	84	[0.8-4.1]
Fuel switching (gas for coal)	29	[1.4-5.5]
Forestry	66	[1.4-2.8]

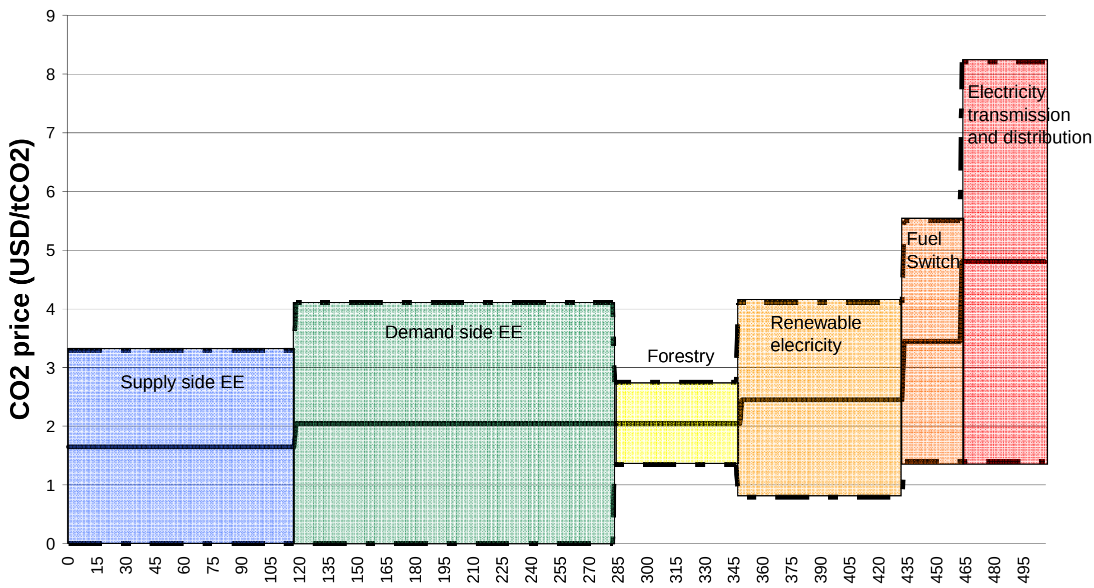
Source: Pew Center on Global Climate Change, 2002.

This chart only displays the results for CO_2, as mitigation options for other GHGs are limited according to the Pew study (4Mt for all other GHGs).

The main opportunities remain in energy efficiency, both on the demand and the supply side. Other possible reductions are in electricity transmission and distribution, the use of renewable energy sources (RES), fuel switching and forestry.

The marginal abatement cost curve in Figure 8 aims at determining what are the potential reductions induced by diverse mitigation measures, and the cost of each of it. Part of this abatement potential is already addressed by Indian policies.

Figure 8 – Emission reductions potential between 2002 and 2012 (Mt CO_2)



Source: Pew Center on Global Climate Change, 2002.

2.4. Existing energy-climate policies leading to GHG reductions

India signed and ratified the Kyoto Protocol in August, 2002. As a non-Annex B member, the country did not have binding emissions reduction commitments. However, as a signatory of the UNFCCC, the country must implement national policies that reduce the carbon footprint of the economy. The National Plan on Climate Change (NAPCC) proposed eight missions to address both mitigation and adaptation issues in India, including missions for solar use, enhanced energy efficiency, water management…

Another stream of measures favoring the fight against climate change can be found in diverse acts implemented to fight local pollution or to improve energy efficiency of the economy.

Indian action on climate change relies on:

- Effort on energy efficiency with a large panel of measures;
- Effort on renewable energy sources (RES);
- Environmental regulations to fight air pollution.

These three axes are not centered on fighting climate change. Both efforts on energy efficiency and on RES aim at reducing Indian energy dependency and releasing the pressure on the electric sector. India's fast growing economy -the GDP has grown by 85.8% between 1995 and 2005- needs more and more power to sustain its development. Energy efficiency is an immediate way to reduce energy demand.

"Energy saved is energy produced" can be read on all foot-page notes of the Central Electric Authority review. Also, the local use of RES allows both energy independency and less reliance on the national electricity grid. The uses of solar energy to heat water or small wind installations to supply electricity in remote villages are two examples of the benefit of such technologies. Environmental norms on coal quality or emissions by the transport sector favor GHG emissions reductions as well.

2.4.1. Energy efficiency measures

The National Mission on Enhanced Energy Efficiency (NMEEE) is the declination of the NAPCC on the energy efficiency side in India. While it remains unclear if all propositions will be implemented, the goal of this text is clearly to further former progress made. This mission is declined in two main projects: "Perform and Achieve Trade" and "Market Transformation for Energy Efficiency" (MTEE).

Perform and Achieve Trade (PAT)

The Energy Conservation Act (2001) targets energy savings for the nine most energy-intensive sectors called "Designated Consumers"[7], including thermal plants.[8] The Perform and Achieve Trade (PAT) initiative resumes and develops the Energy Conservation Act, by implementing a market-based mechanism for Designated Consumers. In each of the nine sectors, participation thresholds have been set to include the biggest installations. The idea is to fix a benchmark case for all sectors, and set up a baseline for energy efficiency improvement. The selected installations are incentivized to exceed these targets so that they may receive tradable EE improvement certificates that can be sold to installations that do not reach their EE goals.

The program is designed on a three-step basis:

- **Perform (P)**: targets are set based on the energy intensity of each plant. It represents a mandatory percentage improvement of the energy intensity from the baseline to achieve in 3 years.
- **Achieve (A):** efforts are undertaken by the plants during three years (2009-2012) and verified by auditors (agencies accredited by the BEE).
- **Trade (T):** plants that exceed their energy efficiency target may sell permits to those who have not succeeded in meeting theirs.

Market Transformation for Energy Efficiency (MTEE)

This project gathers all initiatives existing to develop energy efficiency apart from the designated consumers. Two main interdependent tools are developed:

- **Labeling & Standards:** Implementation of standards and labeling on energy efficiency for equipment, appliances and buildings. A program to provide high quality energy efficient electric bulbs at low cost is also undertaken at the country level (400 million bulbs for a total electricity consumption reduced by 6000 MW, the equivalent of 24 millions tons of CO_2).

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[7] Thermal power stations, fertilizer, cement, iron and steel, chlor-alkali, aluminum, railways, textile, pulp and paper. See details in NMEE report.

[8] The Bureau of Energy Efficiency (BEE) is in charge of monitoring, setting the standards, and providing training to energy management professionals for the "Designated Consumers".

- **DSM (demand side management):** Adopting new procurement rule for public entities to favor energy efficient products, supply incentives replace inefficient agricultural and municipal infrastructures (pump sets, street lighting)…

The financing of projects for efficient lighting, agricultural and municipal DSM, energy consumption norms of buildings, will be made through programmatic CDM "whenever possible". This financing will be completed by incentives that will favour investment in these projects: fiscal instruments such as tax exemptions for profits made from energy efficiency projects and reduction of VAT for energy efficient equipment; creation of a Partial Risk Guarantee Fund that will provide partial coverage of loans related to energy efficiency projects for commercial banks.

Table 2 – Indian policies in energy efficiency promotion

	Description	Reduced capacity	CO_2 emissions avoided	Timetable
BachatLamp Yojana (efficient light bulb)	Financing the replacement of incandescent bulbs by energy saving CFL in households (target of 400 millions bulbs)	6000 MW	24 million tons of CO_2	Planned to be achieved by 2009-2010
Energy Conservation Building Code (ECBC) For New buildings	Setting minimum energy standards for commercial buildings based on energy requirement per square area. Items targeted are: walls, roof and windows, lighting, water pumping etc….	1.7 billions units /yr		Started 27 May 2007
Energy Efficiency in Existing Building	Retro-fitting of existing building. Currently implemented as a trial scheme on 9 government buildings, while phase 2 forecast to extend this program to 17 public buildings. Huge potential: 23/46% of potential energy saving.	?		?
Agricultural Demand Side Management (Ag DSM)	Reducing power consumption in agriculture, in particular ground water extraction. 50% of improvement is likely to be an achievable target. It would be applied on 20 million pumps.	62.1 billions units /yr		?
Municipal Demand Side Management (Mu DSM)	Reducing power consumption by municipalities, in particular for water pumping.	?		?

Source: Action plan for energy efficiency: BEE.

2.4.2. Developing the use of RES

Renewable energy sources (RES) are an important tool in India's energy policy to achieve both total electrification and less exposure to energy imports. The central government committed to procure at least 10% of its power from RES by 2012. To meet this target, India has implemented mandatory measures to be applied by each Indian state, as well as fiscal incentives at central stage.

The Electricity Act (2003) set up a market for electricity based on RES by ensuring grid connection and a mandatory percentage purchase of electricity generated from renewable energy resources. Each State Electricity Regulatory Commission (SERC) fixes the minimum share of electricity produced by new energy sources under its legislation, and the feed-in tariff that it has to apply. A guideline specifying the upper bound feed-in tariff for wind and solar-based electricity generation was published by the Central Government.

In addition to these policies, various direct and indirect fiscal incentives are provided by the Central Government to promote RES. Direct tax modulations include an accelerated depreciation rate for income taxes on renewable energy projects and a 10-year tax exemption for infrastructures projects. Indirect benefits come from duty exemptions or concessions on RES equipment. Furthermore, preferential loans for such equipment have been implemented since the mid 1990's.

Recognizing that India does not have any act requiring RES use and development, despite mentions in the Electric Act and Energy Conservation Act, the central government mandated the Ministry of New and Renewable Energy (MNRE) to develop a specific law on renewable energy. This new project could boost India's effort for RES; it was discussed throughout 2008 and at the beginning of 2009 for implementation during 2009. Power generation companies are likely to get a mandatory percentage of their electricity generated from RES; this scheme could be completed by the possibility to exchange country-wide certificates for renewable energy use. Various financial and technical instruments will be implemented to ensure a broader use of these new energy sources.

2.4.3. Environmental acts

India's fast growing economy and urban population has raised concerns about the environment in general, and air pollution in particular. Various acts have been implemented to limit local atmospheric pollution. These local concerns regarding air and environment quality, although not aimed at reducing CO_2 emissions, contribute positively to limit GHG emissions growth. The Air Act (1981) settled emissions standards for various industries including iron and steel plants, fertilizer plants, oil refineries and the aluminum industry. The Environment Protection Act (EPA, 1986) supplies the State governments with authority on emissions standards and the location of industries in an effort to contain local pollution. Furthermore, the National Ambient Air Quality Standards (2004) set source-specific standards for emissions of local pollutants by electric plants. The Ash Content Notification (1997) requires the use of beneficiated coal (that with ash content inferior to 34%) for future plants and requires that any new plants be built at a minimum distance from cities.

In the transport sector, European emission standards were adopted progressively for new vehicles in eleven cities that must comply with Euro-3 standards from April 2005. Starting April 2010, ten cities will implement Euro-4 standards. These standards define maximum acceptable emissions for different pollutants by new vehicles sold in the EU. In addition, programs favoring conversion of public vehicles from petrol to gas have been developed, notably in Delhi.

3. The role of carbon markets in the reduction of GHG emissions

The opportunity to establish a carbon market to ensure GHG emissions reduction in India may be envisaged in the light of future international commitments. We will first present the current development of carbon finance in India, in particular the Clean Development Mechanism (CDM) market, settled by the Kyoto Protocol and the subsequent Marrakech Accords.

3.1. The existing CDM market in India

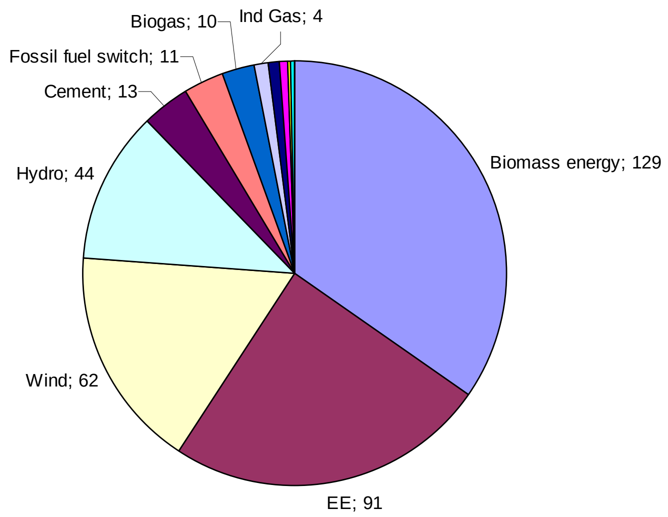
The Clean Development Mechanism (CDM) fosters the financing of emissions reduction projects in developing countries by allowing investors to sell Certified Emissions Reduction (CERs) credits on the international carbon market. The issuance process is controlled by the Executive Board of the UNFCCC and in particular implies the development of emissions reduction methodologies. Most Indian RES, energy efficiency, and fuel switching projects are eligible to earn CDM credits.

The price of CERs on the international carbon market is thus an important signal for the financing of some mitigation projects in India. Historically, the CER price has varied between 10 and 23€ (13 to 29.9USD). If the price stays in this range, and if all mitigation measures can be valued through the CDM process, then nearly 500 Mt of CO_2 could be avoided by 2012 in India, according to the Pew Center on Global Climate Change's marginal abatement cost curve (see Figure 8)

3.1.1. CDM projects currently under development

India plays a major role in the CDM exchange, second only to China in the number of both CERs issued and projects set up. Most of these projects are energy-related, being the development of alternative fuels (biomass, renewables…) or energy efficiency measures.

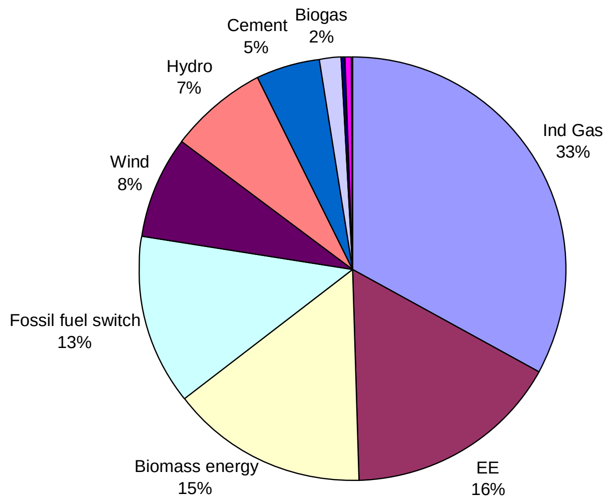
Figure 9 – Number of projects registered in India as of December 2008
Total: 371



Source: Unep Risoe CDM Pipeline, December 2008.

Total emissions being avoided from the 371 projects registered in December 2008 reach 32,000 ktCO_2e per year during the project crediting period, which is at least 7 years. In total, the quantity of CERs expected until 2012, the end of the first compliance period of the Kyoto Protocol is 223 MtCO_2e.

Figure 10 – Registered CDM projects expected emissions reductions by sector as of December 2008 - Total: 223 MtCO_2e



Source: Unep Risoe CDM Pipeline, December 2008.

Biomass energy projects appear to be relatively small projects since they represent a third of registered projects so far but only 15% of the total amount of avoided emissions. These projects aim at better usage of various wastes, mostly agricultural residues (rice, sugarcane) that are used as fuel or transformed into gas. Renewables, hydro and wind in particular, represent more than one quarter of the registered projects and 21% of the amount of CERs issued. They are also small scale projects that generate electricity with or without a connection to the grid.

Approximately the same level of emissions reductions achieved through biomass energy development is achieved through energy efficiency (EE) projects. EE is a major concern for India and forms the core of climate change related policies. The CDM provides funds to facilitate the implementation and the achievement of targets fixed by those policies. Three types of EE projects have been registered so far, essentially targeting the designated consumers previously described: 1/ EE in heavy industries like cement, steel, paper, petroleum, etc.; 2/ EE in own generation (waste heat utilization for example); 3/ EE on the supply side. New types of EE projects in the service sector and in households are still waiting to be validated by the National Authority. They focus on energy consumption improvement in households and office buildings through programmatic CDM projects; they include for example the replacement of conventional light bulbs by more energy-efficient ones.

Fossil fuel switching projects are last type of energy-related CDM projects being developed at a significant scale in India. These projects include fuel switching from high Global Warming Potential (GWP) combustibles to those with lower pollution potential - natural gas replacing naphtha or biomass briquettes replacing fossil fuels for example. They may also involve the development of combined cycle power generation in thermal power plants.

The biggest abatement potential addressed by CDM projects in India remains industrial gases (33% of emissions reductions). Industrial gas projects aim at stopping or reducing the emissions of fluorinated gases (HFC, PFC, and SF6) with very high warming effects. These projects can be set up at relatively low cost and have a high GWP which leads to generation of a lot of offsets and which explains why such an emissions reduction is achieved in India with only 4 registered projects. They were among the first projects implemented; 3 projects of minor scale are waiting for validation.

If industrial gases were historically the projects that have generated the most CERs, their share is declining with the exhaustion of opportunities for new projects. Table 3 presents the number of projects starting the registration process by sector and by year: the projects easier to set up and the most profitable were the first undertaken.

Table 3 – The 6 main types of CDM projects by starting date of the registration process in India

	2005	2006	2007	2008	Share of 2008 registered projects in total	Total
Biomass energy	62	106	91	70	21%	329
EE	53	64	94	92	30%	303
Fossil fuel switch	9	12	11	16	33%	48
Hydro	16	34	26	39	34%	115
Wind	36	47	69	103	40%	255
Industrial gas	2	1	1	3	43%	7
Total	178	264	292	323	30%	1057

Source: Unep Risoe CDM Pipeline, December. 2008.

If we consider “at validation” projects, the trend is even clearer: as the number of wind and fossil fuel switching projects could triple and the number of EE projects double. This underlines the Indian strategy to use CDM as a way of financing sustainable growth “whenever possible” as indicated in the MTEE plan.

3.1.2. Europe drives the demand for CDM credits

The CDM constitutes the first link between European and Indian climate policies, although it is indirect. The CDM is a major tool to finance sustainable growth and mitigation of GHG emissions in developing countries through the possibility for the fund raiser in developed countries to receive valuable offsets based on avoided emissions. Demand for CERs from Annex I countries of the Kyoto Protocol was not that important after the US retreat. The European Trading Scheme (EU ETS) increased the incentive to develop CDM projects development by providing a demand for CERs. The EU ETS is today the only GHG cap-and-trade system with mandatory compliance to absolute CO_2 emissions targets. Between 2008 and 2012, major industrial European emitters can comply with their emissions targets by using CERs: a limit is set on average at 13.5% of their initial European allowance allocation equivalent to a total import of 1,400 millions of CERs. Because of this possibility and since reducing emissions can be cheaper through CDM, the price for CERs has been driven by the European allowance price, while CER prices remain below EUA prices.

3.2. Engaging developed and developing countries together in mitigation: the example of India and Europe

3.2.1. Different targets but similar instruments

The study shows that India is much preoccupied by energy supply and energy security. This concern exists for all countries, whether developed or developing. It is also at the core of the European energy policy as expressed in the Climate Energy Package published in January 2008 by the European Commission and adopted by the European Council and Parliament in December 2008. Unlike India, Europe has chosen to achieve its energy efficiency target - a 20% improvement between 2005 and 2020 - indirectly through energy and climate policies measures. These measures include the reduction of GHG emissions, the development of renewable energy and the definition of emissions standards for vehicles.

In Europe, some countries nevertheless chose to implement direct policies to improve energy efficiency. In France and Italy, the so-called White Certificates for example aim at increasing energy efficiency on the demand side. Energy providers can gain white certificates by helping their clients to reduce their energy use; they have a legal constraint to present each year a certain amount of white certificates to the authority. This system may be a way to link India and to some European countries' policies in the field of energy efficiency improvements.

Regarding emissions mitigation policies, the issue is more complicated. Europe has engaged in a proactive policy to reduce 20% below 1990 levels by 2020. Some emissions reductions will continue to take place outside of Europe with the use of CDM credits, but they will be even more restricted from 2013 on compared with the 2008-2012 period.

Table 4 - India and EU ETS policies related to energy and climate

	India	EU ETS
Energy efficiency	- Domestic market for energy efficiency certificates (PAT) - Measures outside the PAT market (MTEE)	- Mandatory improvement over the 2012-2020 period.
Renewable energy sources (RES)	- Mandatory percentage of RES generated electricity in each state.	- Mandatory percentage of RES generated electricity in each state. - Potential trading within the EU
GHG emissions' mitigation	- No absolute targets. Voluntary implementation of relative targets through baseline scenario. - Will of linking domestic instruments to international ones (to get funds)	- Cap and trade system with decreasing number of quotas issued each year - Potential limitation in the use of CER, depending on host country commitment.

Source: Mission Climat of Caisse des Dépôts.

3.2.2. How to link effectively?

<u>Energy efficiency markets</u>

Energy efficiency seems to be a good opportunity to link India and the EU ETS. Three points make this solution the more manageable to implement.

Firstly, India has already planned a market for energy efficiency. Linking the EU ETS and India will therefore be on the basis of a scheme already set up in India, with associated knowledge and market instruments spread over the country. Furthermore, Indian industry is eager for this kind of international link that could ensure the financing of such energy efficiency progress in the industry. The results of the Perform Achieve and Trade (PAT) scheme in India, in particular from the “trade” period, will be a good indicator of what could be done. Furthermore, as energy prices are very low in India, incentives based on offset trading would be a good way to foster energy efficiency improvements.

Secondly, this Indian energy efficiency market has strong similarities with the EU ETS. The installations and the sectors involved are partially the same. The “designated consumers” are the installations that will participate in the energy efficiency program implemented by India. To be eligible, an installation must be in one of the sectors that must perform energy efficiency efforts: thermal power stations, and fertilizer, cement, iron and steel, chlor-alkali, aluminium, railways, textile, pulp and paper installations. The installations included in the EU ETS incorporate nine sectors as well, of which four are strictly the same as those included in the Indian scheme: thermal power plants, iron and steel, pulp and paper and cement. These sectors account for 68% of first phase allocation in EU ETS. Furthermore, both schemes’ installations have participation thresholds based on output capacity or energy expenditure. These thresholds are specific to each sector.

Eventually, energy efficiency is the only objective of the European energy-climate package for which no market instrument was imagined. The energy efficiency improvements are lead by each country by itself, without any foreign compensatory mechanism. This leaves room for action at the international stage.

However, linking of the EU ETS with India through energy efficiency “white certificates” will also face many challenges. First European countries are interested in keeping their energy efficiency improvement "domestic" since it will reduce their own energy expenditure and reduce their carbon footprint (potentially valued through JI projects). Any link between India and Europe may thus be hampered by a limitation on the use of "foreign" EE certificates, on the same model as the CDM credit limitation existing in the EU ETS. Second, the participating thresholds in the EU ETS are fixed in output capacity, while the Indian designated consumers' are set up in energy use. A necessary step would be to define the scope of the industries covered, the measure of efforts and equivalent targets. The last point has long proved difficult in international negotiations. The "burden-sharing" agreement in the Climate-Energy Package among European countries may be a good model to follow; it includes provisions to soften less-developed countries targets, in Eastern Europe in particular, with a higher contribution from wealthier ones. Every country has an effort to make but it is moderated by equity measures including the per capita GDP criterion.

<u>Emissions credits targets</u>

Regulating emissions through a cap would perhaps be easier from the European perspective since the EU ETS has been working for several years now. Nevertheless India might be reluctant to implement a GHG emissions market in addition to its existing EE one. The possibility of setting up a conversion rate between EE measures and European CO_2 allowances comes to mind. But it obviously already exists indirectly through the CDM process as was shown before.

Given the current negotiating positions of India at the international level, it seems difficult to transform the indirect link created by the CDM to a direct one. But note that if no international agreement is made for the post-2012 period, Europe will turn off the tap for CERs, diminishing the potential funding for Indian EE policies through incentives based on carbon market. In this case, the European Directive foresees the possibility to implement bilateral agreements; India may benefit from this provision by accepting an objective for emissions reductions to benefit from carbon credits valuable on the European carbon market.

<u>Carbon capture and storage</u>

A final link can be imagined between EU ETS and India: technology transfer and a common research program to develop Carbon Capture and Sequestration (CCS) technology. CCS allows for the sequestration of CO_2 and may be one of the best options for India, as it can use coal to satisfy energy needs and still reduce its emissions.

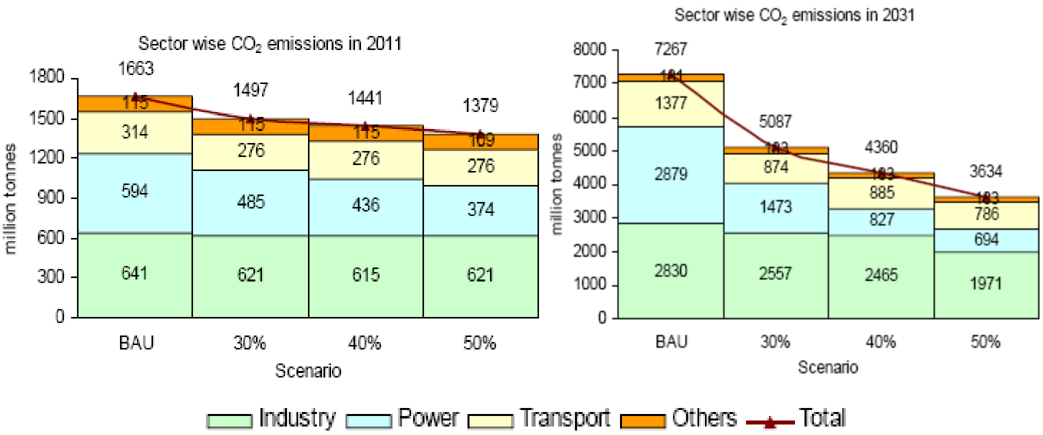
India is already involved in CCS through different research programs, for example in field studies in Gujarat by the Institute of Reservoir Studies or in the NGRI testing of CO_2 storage in basalt formations. The estimated CO_2 storage potential is approximately 570 $GtCO_2$, mainly in deep saline reservoirs (on and off shore) and in volcanic rock (Singh, A.K., Mendhe, V., Garg, A., 2006). More precise studies are still needed to estimate each sink's capacity, its distance from major CO_2-emiting plants to limit transportation costs and its ability to store CO_2 on a long-term basis. Indeed India is situated in a seismically active region, thus raising concerns about the permanence of carbon storage.

The CCS potential remains quite large compared to the estimated cumulative CO_2 emissions until 2036 (which range from 12 to 25 Gt) (TERI, 2008). Of these, about

40% come from the power production sector where CCS can be more easily implemented. Despite the lack of commercial and technical solutions currently available, funding and technical risks remain the major barriers to CCS deployment. CCS technologies incur high capital costs coupled with a diminution in the energy output of power plants which would mean developing extra capacities to meet Indian needs.

The question of the funding will not be solved at the Indian level. International cooperation is needed. In this regard the European Climate-Energy Package adopted last year presents a very interesting provision: part of the new entrants' reserve will be set aside to fund at most 12 CCS projects throughout the world.[9] Each project can receive no more than 15% of these 300 million allowances, which are valued at more than 1 billion euros. This may be a good way to strengthen the Indo-European collaboration if the political will is there. For the time being the Indian government is not that enthusiastic about CCS as it does not contribute to sustainable development and is a non-productive expenditure.

Figure 11 – CCS potential estimates in India in 2011 and 2031



The cumulative CO_2 emissions reductions are differentiated by targets of 30%, 40% and 50% from the BAU by 2031. Maximum reduction occurs in the power sector by deployment of clean coal technologies. (70% reduction ~ 2,185 million tones.)

Source: Pradeep Kumar Dadhich, TERI.

[9] The EU ETS reviewed Directive also foresees that CO_2 emissions stored will not be subject to allowance surrender, if carbon leaks are controlled.

Annex 1 – Energy sources in India

Coal: Bituminous is the most widely used as well as mined variety of coal in India. Imports complete domestic supply with a 5% share. Electricity plants and industry absorb most of the available amount. Lignite and brown coal supply 6% of the coal used for electricity's production purpose. Indian domestic production supplies both industry and electric power plant without international exchange.

Coking coal is the less used in India with a 3% share. This coal comes from both domestic production and imports.

Gas and Oil: 9% of Indian power production comes from gas-based thermal plants. The use of gas by electric plants accounts for 44.4% of Indian domestic supply.

Oil based power plants produced 4% of Indian electricity in 2005 with three types of by-products: diesel, residual fuel oil and naphtha. India imports almost all of the crude oil refined domestically. Because of India's large petroleum industry, self-sufficiency is achieved for each of these three transformed oils. Nevertheless, the use for electricity production is marginal; power plants consumption is less than 10% of the domestic supply.

Renewable energy sources (RES): Hydroelectric production provides 14% of Indian electricity, the main contributor to renewable energy production. Wind remains a small contributor to power production (1%), despite a potential production that could be larger than 10% of Indian overall output and greater than the absolute Chinese potential production of wind generated electricity. Solar-based power has an insignificant role in overall electricity output.

However solar and wind power are more used as a way of supplying electricity to remote places still off power grid. One of the main goals of the 11th Five year Plan (planning Indian economy over the 2007-2012 period) is indeed to achieve full electrification of the country by 2010, and extensive use of small installations of RES could be a major tool to fulfil this objective.

Nuclear: Despite a small share in current electricity production, nuclear power is likely to play an increasingly important role in India. Indeed an ambitious nuclear policy has been developed in several steps to ensure simultaneous rise in current production, increase in construction of new generation power reactors (up to 2020), and long term research on nuclear technologies.

Furthermore, India achieved complete independence in nuclear electricity production technology. Uranium and thorium are the two radioactive elements used as nuclear fuel and both are present in Indian subsoil, in large quantity. Installed total capacity reached 4,120 MWe at the end of 2008, and are planned to increase by 2,660 MWe by May 2010. According to the Chairman of the Atomic Energy Commission, 25% of Indian electric power could come from nuclear plants in 2050. The International Energy Agency forecasts a much smaller contribution for nuclear as their projections of energy supply by nuclear for the year 2030 reach only 3%. Indeed, the poor quality of Indian uranium and the uncertain availability of thorium-based technology in the future raised concerns.

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