Sustainability and Carbon Markets: A Meeting Ground

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Abstract

Sustainable development is the terminal goal of all world economies including India. Availability of clean and sustainable energy acts as a catalyst for economic growth. Coal continues to be the primary resource used for electricity generation due to its abundant and widespread availability. Coal being a fossil fuel and a non renewable source, has many and varied impacts on the environment. The environmental impacts of coal on the consumption front with special emphasis on emission of carbon dioxide and the corresponding technology related mitigation measures viz. global initiatives on developing clean coal technologies is examined in this paper. Despite these on-going efforts, burning of Coal continues to be a major contributor to greenhouse gases emissions which result in climate change and global warming. An innovative mechanism – the carbon markets involving both allowance based transactions and project based transactions is being implemented to check and cap carbon dioxide emissions. Therefore the paper also presents an overview of the carbon markets that have been developed as per the Kyoto Protocol which came into effect in 2005 to reduce carbon dioxide and other greenhouse gases emitted due to the dominant use of coal and petroleum products primarily by the energy sector.

Key words: *Sustainability, clean coal technologies, carbon dioxide emissions, Kyoto protocol, carbon credit markets, allowance based transactions, project based transactions*

Introduction:

Environmentally Sustainable Development is the terminal goal of all world economies including India. Economic growth that results in destruction of the society's natural resources and the earth's atmosphere and thereby exposes us to a variety of diseases and man made disasters does not in real terms contribute to the lives of the citizens. Sustainable development requires enhancement in the standards of living of the people by ensuring equitable distribution of growth and also the conservation of the world's natural environment for the future generations. This may seem irreconcilable but growth and sustainability need to be addressed in an integrated framework to reap long term benefits.

Energy sector can be termed as the life line of any economy as growth cannot be achieved without it. Energy demand has grown steadily and will continue to increase, particularly in the developing countries. All energy sources such as coal, oil, gas, hydro, nuclear, renewables etc will have to be tapped to meet this demand. All forms of energy have their respective positive and negative attributes. Providing a diverse and balanced supply mix which results in energy security at a minimum cost to the society in terms of resource exploitation and consumption is therefore critical.

As the most important fuel for electricity generation and a vital input in several industrial sectors like steel, cement etc, coal plays a major role in meeting a country's current and future energy needs. Hence, this paper examines the **environmental impacts** of the primary source of energy viz. **COAL** – a fossil fuel and non-renewable source of energy and the technology related **mitigation**

measures currently being undertaken. Use of coal in power stations for electricity generation is a major contributor of Carbon dioxide (CO_2) emissions. Therefore the paper also studies an innovative mechanism developed as per the Kyoto Protocol – the **CARBON MARKET** to encourage countries and businesses to reduce harmful greenhouse gases including CO_2 emissions which lead to climate change and global warming.

Coal's primacy in energy markets:

The Brundtland Commission (1987) defined Environmentally Sustainable Development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". **Energy security is one of the necessary conditions to meet a country's goal of sustainable development.** Energy security as defined in India's Integrated Energy Policy (2006) is: "We are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected". The World Energy Assessment (UNDP 1999) report defines energy security as: "the continuous availability of energy in varied forms in sufficient quantities at reasonable prices". Thus provision of sustainable energy is the lifeline of an economy's developmental path.

Coal, Oil, Gas, Nuclear, Hydro, Biomass and Waste and Other Renewables (wind and solar energy etc.) are the various sources of energy, with coal being the primary source in most countries. **Coal provides 25% of global primary energy needs and generates 40% of the world's electricity.** In India also, coal occupies a primary position in meeting India's energy demands. See Table no. 1 given below:

Table 1
Coal's Primacy in Energy Markets

Fuel Resource	World Energy consumption (%) (2005)	India's Energy consumption (%) (2003-04)	World Electricity Generation (%) (2005)	India's Electricity Generation (%) (2003)
Coal	**25**	**51**	**40**	**68**
Oil	35	36	7	5
Gas	21	9	20	11
Nuclear	6	2	15	3
Hydro	2	2	16	12
Others (Renewables Solar, Wind etc.)	11	-	2	1
Total	100	100	100	100

Source: Coal Facts Card 2007, www.worldcoal.org & IEP report, Planning Commission, 2006.

Coal's dominance is projected to continue in the long term also as it offers various advantages such as: abundant and widespread availability, worldwide market, affordable, safe to transport and store, coal-based electricity is well-established and reliable, is not dependent on weather or rainfall etc. Coal reserves are available in almost every country worldwide, with recoverable reserves in around 70 countries. At current production levels, proven coal reserves are estimated to last 147 years. In contrast, proven oil and gas reserves are equivalent to around 41 and 63 years respectively at current production levels. Further over 68% of oil and 67% of gas reserves are concentrated in the Middle East and Russia. Coal is the major fuel used for generating electricity worldwide. Countries heavily dependent on coal for electricity include: Poland 93%, Israel 71%, S. Africa 93%, Australia 80%, India 68%, USA 50% China 78%, Germany 47% (source: Coal Facts Card 2007). Coal is also a vital input for other industries like Steel, plastics, cement, ceramics, metallurgical etc.

These facts need to be seen in the light of the **environmental impacts** of extraction and use of more coal as a major component of our energy basket. Society is demanding sustainable energy with negligible pollution effects. Socially acceptable technologies are being developed through partnerships between energy producers, energy consumers and governments, who are working collectively towards this end.

Environmental Impacts of Coal

The environmental impacts of coal can be seen mainly from two sides:

- the Extraction front and
- the Consumption front.

The impacts of transporting mined coal to the point of consumption (mainly power stations) are also to be considered as use of petroleum products is a major contributor to CO_2 emissions. The Extraction front impacts are concerned with the mining technology used i.e. Underground Mining (conventional or mechanized) Bord and Pillar method or Longwall method **or** Opencast Mining. The consumption front impacts are concerned with various emissions of pollutants like particulate matter (ash etc) and oxides of sulphur (SOx), nitrogen (NOx) and carbon Dioxide (CO_2) etc.. This paper addresses the implications (environmental impacts and the mitigation measures) on the consumption front only[2].

The major consumers of coal are the thermal power stations where coal is burnt (Pulverised Coal Combustion (PCC) systems), to finally generate electricity. In all industries, coal is used to generate heat through the combustion process to facilitate the production processes of the respective industries. Thus on consumption, the environmental impacts of coal can be:

1. Emissions of pollutants, such as particulate matter and oxides of sulphur (SOx) and nitrogen (NOx): Emissions of particulates, such as ash, have been one of the more visible side-effects of coal combustion. They can impact local visibility, cause dust problems and affect people's respiratory systems. The level of ash content can vary for different types and grades of coal. For instance, the Indian coal has higher ash content while the imported Chinese coal has lower ash content. Oxides of sulphur (SOx) and nitrogen (NOx) are emitted to varying degrees during the combustion of coal. These gases react chemically with water vapour and other substances in the atmosphere to form acids, which are then deposited in rainfall. Sulphur is present in coal as an impurity and reacts with air when coal is burned to form SOx. In contrast, NOx is formed when any fossil fuel is burned. Oxides of nitrogen can contribute to the development of smog as well as acid rain.

2. Emission of Carbon Dioxide (CO_2): CO_2 is a colourless, odourless, incombustible gas formed during decomposition, combustion and respiration. CO_2 is one of the greenhouse gases which affect the earth's atmosphere and lead to climate change and global warming – the current concern of global communities. The other major greenhouse gases include water vapour, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Greenhouse gases associated with coal include methane, carbon dioxide (CO_2) and nitrousoxide (N_2O). Methane is released from deep coal mining (during extraction). CO_2 and N_2O are released when coal is used in electricity generation or industrial processes. Table 2 below highlights the data regarding CO_2 emissions from fossil fuels.

Table 2

CO_2 Emissions from Fossil Fuels (2004)

Fossil Fuel	%
Oil	41%
Coal	38%
Gas	21%

Source: IEA 2004, World Energy Outlook 2004, Paris

Technology related mitigation measures:

As seen above, coal is and will continue to remain one of the primary sources of energy despite its negative environmental impacts. The coal industry supported by various governmental and international agencies has responded to the environmental challenges faced in the usage of coal by developing several technologies collectively called **"Clean Coal Technologies"** to mitigate the impact of environmental degradation. A brief overview of such technologies and India's R & D initiatives and commitment in this direction is presented below.

1. Emissions of pollutants, such as particulate matter and oxides of sulphur (SOx) and nitrogen (NOx): **Coal cleaning** by washing and beneficiation – a widely used method, increases the heating value and the quality of the coal by lowering levels of sulphur and mineral matter. The ash content of coal can be reduced by over 50%, helping to cut waste from coal combustion. It also improves the efficiency of coal-fired power stations, which leads to a reduction in emissions of carbon dioxide upto 5%.

Particulate emissions can be reduced through the utilization of **electrostatic precipitators, fabric filters, wet particulate scrubbers etc.** Electrostatic precipitators (ESP) and fabric filters can remove over 99.5% of particulate emissions and are widely used. In electrostatic precipitators, an electrical field creates a charge on the particles, which attracts the particles towards the collecting plates, where they accumulate and can be disposed of. Fabric filters collect particles from the flue gas on a tightly woven fabric primarily by sieving. Flue Gas Desulphurisation (FGD) systems, also referred to as 'scrubbers' can remove as much as 99% of SOx emissions. NOx emissions from coal combustion can be reduced by improving burner design and applying technologies that treat NOx in the exhaust gas stream. NOx emissions can be reduced by around 80-90% by treating the NOx post-combustion. **Fluidised Bed Combustion** (FBC) is a high efficiency, advanced technological approach to reducing both NOx and SOx emissions. FBC is able to achieve reductions of 90% or more. In FBC systems, coal is burned in a bed of heated particles suspended in flowing air. At high air velocities, the bed acts as a fluid resulting in the rapid mixing of the particles. This fluidizing action allows complete coal combustion at relatively low temperatures.

2. Emission of CO_2: Improving the efficiency of existing and new coal-fired power plants is a cost-effective way to limit the growth of CO_2 emissions. The **Supercritical and Ultrasupercritical** power plants operating in Japan, USA, Europe, Russia and China, can achieve efficiency levels of up to 50% by operating at higher temperatures and pressures than a conventional plant. Upto 22% reduction in CO_2 emission can be achieved through this approach. Advanced technologies such as **Integrated Gasification Combined Cycle** (IGCC systems) can contribute to a reduction of 25% in CO_2 emissions. In IGCC, coal is not combusted directly but reacted with oxygen and steam to produce a 'syngas' composed mainly of hydrogen and carbon monoxide and then burnt. IGCC offers high efficiencies of the

mid- 40% range. They also remove 95-99% of NOx and SOx emissions. There are around 160 IGCC plants worldwide.

On-going research in future technologies like **Carbon dioxide Capture and Storage** (CCS) is directed at achieving nearly 99% reduction in CO_2 emissions. CCS technologies enable emissions of carbon dioxide to be 'captured' and 'stored'; that is stripped out of the exhaust stream from coal combustion or gasification and stored in such away that they do not enter the atmosphere. Depleted oil and gas reservoirs, unmineable coal beds, deep saline formations are important options being considered for storage.

India's initiatives: The R & D centres of the 3 major coal suppliers in India – Coal India Ltd., Singareni Collieries Company Limited and Neyveli Lignite Corporation are jointly working with companies like ONGC, GAIL, NTPC and BHEL to develop clean coal technologies. In addition to the initiatives of the individual ministries constituting the energy sector (Ministries of Power, Coal, New & Renewable Energy etc), the Government of India is also in the process of setting up a National Energy Fund (R & D) to encourage R & D activities by various institutions. The Eleventh Five-Year Plan envisages a total allocation of Rs. 5310 crores for R & D activities in the energy sector. Table 3 presents the R & D allocations for a few illustrative activities/projects directed at reducing the adverse environmental impacts of coal and improving the efficiencies of plants.

Table 3

Select R & D Initiatives Proposed in Eleventh Five Year Plan for the Coal Sector

Particulars	Amount in Rs.Crores
a. Advanced Coal technologies:	
1. Setting up of first 100 MWe IGCC demonstration plant	350.00
2. In situ coal gasification of coal and lignite	30.00
3. Coal to oil conversion	200.00
4. Coal Bed Methane	35.00
5. Carbon capture and storage	125.00
b. Ultra Super critical technologies	30.00
c. Hydrogen as a source of clean energy	350.00
d. Combustion research initiatives	200.00

Source: Eleventh Five Year Plan Document, Vol. I, II & III

World over the coal industry in partnership with other research and governmental agencies is thus continuing to improve its environmental performance through various initiatives to ensure coal is produced and used efficiently. Needless to say, more needs to be done. Technology transfer to other countries through mechanisms such as the Clean Development Mechanism and Joint Implementation Mechanism and access to bilateral and multilateral funds such as the Global Environment Facility (India is a beneficiary under this facility) and the Carbon Fund is essential. **The Kyoto Protocol which came into effect from 2005 is a step in this direction.**

Carbon Markets:

Green house gases (CO_2, methane etc.) emitted primarily during the **burning of fossil fuels** and also due to certain agricultural and industrial activities, and deforestation, has the potential to significantly alter global climatic conditions. The green house effect is the

process by which absorption and emission of infrared radiation by atmospheric gases warm a planet's lower surface resulting in global warming. Global warming and climate change, resulting from these anthropogenic emissions is expected in the near future to result in major changes in ecosystems, agricultural yields, glacier retreat, and increased incidence of diseases and thus generally cause untold misery to the people unless large-scale measures are adopted immediately to reduce its incidence. Carbon markets are one such innovative measure presently being structured and implemented mainly through the Kyoto Protocol.

Different countries contribute different amounts of heat-trapping gases to the atmosphere. The table below gives details of CO_2 emissions – the major contributor of greenhouse effect, for the top10 emitter countries.

Table 4

Top 10 CO_2 Emitters due to burning of Fossil Fuels (2004)

Country	Total emissions (1000 tons of C)	Per capita emissions- (tons/ capita)
1. United States	1,650,020	5.61
2. China (mainland)	1,366,554	1.05
3. Russian Federation	415,951	2.89
4. India	366,301	0.34
5. Japan	343,117	2.69
6. Germany	220596	2.67
7. Canada	174,401	5.46
8. United Kingdom	160,179	2.67
9. Republic of Korea	127,007	2.64
10. Italy (including San Marino)	122,726	2.12

Source: Marland, G., T.A. Boden, R. J. Andres. 2004. Global, Regional, and National CO_2 Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.

As can been from the data for few select countries, **developed or industrialized countries 'per capita emission is higher than the developing or less industrialized countries' per capita emission.** Concern about the increasing levels of CO_2 emissions and its impact lead to the formalization of the Kyoto protocol.

1. The Kyoto Protocol: The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle climate change. It opened for signature at the Earth Summit in Rio de Janeiro in 1992 and entered into force in 1994. Countries that are parties to the UNFCCC meet annually at the Conference of the Parties (COP). It was at COP3, held in Kyoto in 1997, that countries negotiated the Kyoto Protocol but it entered into force only in February 2005.There are 183 countries who are Parties to the Protocol, 37 of whom are developed countries (excludes USA which has not ratified the protocol). The **protocol sets targets for industrialized countries** "with a view to reducing their overall emissions of such gases by at least 5% below existing 1990 levels, in the commitment period 2008-2012". Kyoto covers emissions of the six main greenhouse gases (GHG): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphurhexafluoride. (SF6). The overall emissions targets for all six are combined and translated into 'CO_2 equivalents' for use as a single figure.

Though climate change is a global issue, different countries bear different levels of responsibility. The developed countries account for most of the increases in atmospheric GHG concentrations and hence have to bear more responsibility by way of emission reduction as per targets fixed. The

per capita emission of developing countries is low (as per Table 4) and although it was predicted to increase with the increasing levels of growth and development, they were excluded from the responsibility of meeting specific emission reduction targets (the major objection of USA to the protocol). Thus India, a signatory to the protocol, is not required to contain the emissions specifically. But this does not absolve the developing countries from the common responsibility of overall reductions in emissions through use of clean energy, afforestation etc.

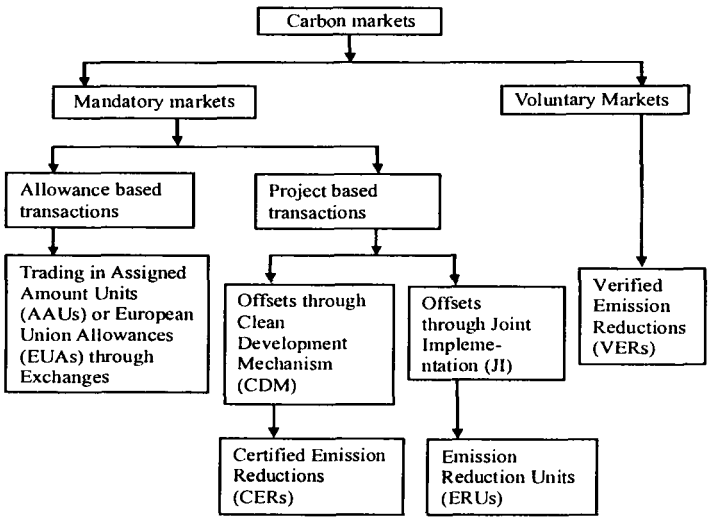
The protocol is due to expire in 2012 and negotiations are underway to carry the spirit of the protocol into a fresh agreement. The 2008 & 2009 conferences will be held in Poland and Denmark respectively during December in this regard.

2. Structure of Carbon Markets: EMISSIONS TRADING is poised to become one of the key tools to support the transition to a low carbon economy. As countries take steps towards meeting their commitments under the Kyoto Protocol, the global carbon market has experienced rapid growth over the past few years. The carbon markets can be segmented broadly as mandatory or voluntary markets. Buyers largely engage in carbon transactions because of carbon caps in place at international or national levels. Sellers are those who have carbon projects on hand and can thus afford to sell the excess emission credits having met their caps or are not subject to caps at all. Climate exchanges (in India – Multi Commodity Exchange and National Commodities and Derivatives Exchange) are involved in trading. Carbon prices are normally quoted in Euros per tonne of carbon dioxide or its equivalent.

The market structure is diagrammed below (Chart 1) and is followed by a brief presentation of its various components.

Carbon transactions are purchase contracts wherein the buyer pays the seller for GHG emissions reductions or for the right to emit a given amount of GHG emissions. The **buyer can thus meet its compliance objectives as per Kyoto (Mandatory markets) or its corporate social responsibility objectives (Voluntary markets)** to achieve climate change mitigation. Payment is usually made using one or more of the following forms: cash, equity, debt, convertible debt or warrant, or in-kind contributions such as providing technologies to abate GHG emissions.

Chart 1
Market structure of Carbon markets



a. In the compliance driven **mandatory markets**, The transactions can be categorized as:

i. **Allowance-based transactions:** The Kyoto protocol has agreed caps on the maximum amount of GHG emission for countries listed in its Annex I. In turn, these countries set quotas on the emissions of their domestic companies/ businesses. Each company has an allowance of credits, where each credit gives the owner the right to **emit** one metric tonne of carbon dioxide or other equivalent greenhouse gas. Companies that have not used up their quotas (due to clean technologies implemented in their existing business) can sell their unused allowances as carbon credits, while companies expecting to exceed their quotas can buy the extra allowances as credits, privately or through exchanges. **International Emission Trading (IET)** enables the buyer to purchase the unused emission allowances designated as **Assigned Amount Units (AAUs) under the Kyoto Protocol, or European Union Allowances (EUAs) under the European Union Emission Trading Scheme (EU ETS).** EU ETS is a tributary scheme to achieve GHG emission reduction in a phased manner by EU countries and is the biggest market as on date. The details of allowances trading market are presented in the table below:

Table 5

Details of Transactions on the Allowances Markets

Market	Volume in Metric tonne of CO_2 equivalent.			Value in US $ in millions		
	2005	2006	2007	2005	2006	2007
EU ETS	321	1104	2061	7908	24436	50097
New South Wales	6	20	25	59	225	224
Total	327	1124	2086	7967	24661	50321

Source: Extracted from 'State and Trends of Carbon markets 2007 & 2008', World Bank Report

ii. **Project-based transactions:** It involves purchase of emission credit from a seller whose project can verifiably demonstrate GHG emission reductions thereby enabling the buyer to **offset** the credit against its quota/target. Under the **Clean Development Mechanism (CDM)** a developed country (home country) can sponsor a greenhouse gas reduction project (involving transfer of clean technology) in a developing country, a signatory to the protocol, (host country) where the cost of the project is usually much lower. It aims in assisting developing countries to achieve sustainable development by permitting developed countries to finance such projects and receive credits for meeting its emission reduction targets. Such credits called **Certified Emission Reductions (CERs)** are certified by UNFCCC's approved mechanisms. CERs can be purchased through the secondary route also wherein carbon credits received by developing countries for projects undertaken are sold to the developed countries. In secondary transactions, the seller is not the original owner of the carbon project. The **Joint Implementation (JI)** mechanism involves a developed country faced with relatively high costs of domestic greenhouse reduction, setting up a project in another developed country and receiving credits for the same. Such credits are called **Emission Reduction Units (ERUs).** Unlike allowances however, project-based credits need to be created and therefore are more risky as project performance expectations need to be met. The details of the project based market are presented in the table below:

Table 6
Transactions on the Project based Markets

Market	Volume in Metric tonne of CO_2 equivalent.			Value in US $ in millions		
	2005	2006	2007	2005	2006	2007
Primary CDM	341	537	551	2417	5804	7426
Secondary CDM	10	25	240	221	445	5451
JI	11	16	41	68	141	499
Total	362	578	832	2706	6390	13376

Source: Extracted from 'State and Trends of Carbon markets 2007 & 2008', World Bank Report

b. The **Voluntary markets** are not driven by compliance requirements. Corporate Social Responsibility is the key driver. It includes all individuals and companies particularly in the U.S., who have voluntarily decided to limit their carbon footprint in anticipation of future laws in this regard. Project based emission credits called **Verified Emission Reductions (VERs)** are traded. VERs are verified by an independent auditor (not UNFCCC mechanisms). The voluntary market remains small in volume and value, especially in comparison to the broad Kyoto compliance market. Needless to say, credible VERs in a small way contribute to the global efforts to contain CO_2 & other GHG emissions. The details of this market are as follows:

Table 7 Details of transactions on the Voluntary Markets

Market	Volume in Metric tonne of CO_2 equivalent.			Value in US $ in millions		
	2005	2006	2007	2005	2006	2007
Allowances market (Chicago Climate Exchange)	1	10	23	3	38	72
Project based transactions	6	14	42	44	70	265
Total	7	24	65	47	108	337

Source: Extracted from "State and Trends of Carbon markets 2007 & 2008" respectively, World Bank Report

3. Market Players: In the compliance driven allowance markets, the buyers and sellers constitute the Annex I developed countries, predominantly the European Union and Japan. In the CDM project based transactions, the buyers are the Annex I countries (mainly EU and Japan) while the seller side is dominated by China (73% market share in 2007) followed by India (6% in 2007) and Brazil (6% in 2007). In the JI market, the seller side is dominated by Russia (36% in 2007) and Ukraine (33% in 2007) followed by other East European countries. The CDM & JI projects are mainly focused towards energy efficiency, fuel switching and renewable energy projects.

In the CDM market, China continues its domination due to its favourable investment climate and availability of experienced project developers coupled with lower transaction costs. India has a relatively low market share. The relatively small size of projects, lower participation of financial institutions and appropriate intermediaries, difficult negotiations with high price expectations from the seller-side have been a few of the stumbling blocks. National CDM Authority (NCDMA) has been established in India to manage the CDM process under the protocol. A total of 297 projects have been approved by the NCDMA. These projects expect emissions reduction of 236 Million CERs till 2012 at a potential total investment of more than Rs.190 Billion (IEP, 2006). A few financial institutions like the SBI, ICICI Bank, IDBI and SIDBI have already made an entry into the market. Additionally a host of independent project consultants like Emergent Ventures Ltd., Industechnical and Financial Consultants ltd., Cantor CO_2e India Pvt. Ltd., Ecolutions, Ecosecurities etc, have emerged to provide advisory services and prepare the project reports of carbon projects in various sectors like cement, steel, biomass power, bagasse co-generation and municipal solid waste

management, municipal water pumping and natural gas power. Companies like Tata Steel, HUL, Jindal Vijaynagar Steel, Essar Power and Gujarat Flurochemicals Ltd have specially designed projects to take advantage of the opportunity. Bharat Heavy Electricals Ltd is the only public sector firm which is planning to approach the ministry for approval.

4. Issues & Challenges Critics of carbon markets argue that a more effective way to cut emissions would be a pollution tax as emissions trading does little to solve pollution problems overall, as groups that do not pollute sell their conservation to the highest bidder. While supporters agree that carbon markets alone cannot reduce emissions, they insist they can change behavior as it ensures that the problem is recognized and taken cognizance of. Further, taxes may result in an inefficient allocation of resources by governments. It is increasingly felt that the flexible mechanisms of the Kyoto Protocol ensure that all investment goes into genuine sustainable carbon reduction schemes as projects are validated by UNFCCC.

Carbon markets result in a price discovery mechanism without any regulatory interference. This makes the process acceptable and understandable to the corporates. Developed countries want carbon credits as cheaply as possible to remain competitive, while the developing countries want to maximize the value of carbon credits generated from their domestic GHG projects. This inherent contradictory feature results in volatility in carbon markets. Most countries are setting up government or multilateral carbon funds and agencies to maximize the value under the 3 Kyoto mechanisms.

The EU ETS has created a strong structure to effectively reduce greenhouse gas emissions through its Phase I, II & III plan commitments. However, the wide range of limits on the import and use of CDM/JI transactions across Member States acts as a disincentive to the developing countries in their efforts to reduce emissions through clean technologies. This could be self defeating in the long run. The CDM's biggest strength has been its ability to bring developing and developed countries and the public and private sectors together to reduce emissions cost-effectively. CDM process has been criticized regarding its complex rules, frequent changes in rules and high transaction cost. It can take between one and two years for a project to go from validation to registration. These delays, in turn, affect expected CER delivery schedule, as well as reduce the incentives for further innovation. Simplification, decentralization and reduction of lead time will reduce project costs. Similar to the situation in the CDM markets, delays in project approval process have been a stumbling block to JI market's growth. With the establishment of JI procedures in a number of countries, especially in Ukraine and Russia - the two biggest suppliers, it is hoped that regulatory uncertainties would be reduced.

In the voluntary markets, the major risk and constraint is the lack of a respected voluntary standard for emission reductions. Availability of credible VERs which ensures real and permanent reductions and no double-counting is critical. Voluntary standards (like the Gold Standard or the Voluntary Carbon Standard etc) acceptable to all the players in the market need to be agreed upon to enable this market to gain momentum.

Continuation of carbon markets beyond the Kyoto period of 2012 is important to ensure it achieves its objectives of climate change mitigation and sustainability in the long term. Anticipated long term caps and regulations on emissions influence carbon market's demand while availability of sufficient

allowances and carbon credits from projects constitute its supply. The businesses have displayed through the volumes transacted, their willingness to participate proactively in solving this global problem. Therefore it is now up to the government policymakers and regulators to ensure a fresh agreement covering wider sectors such as transportation sector is reached incorporating the post 2012 scenario and thereby ensure the momentum gained through carbon markets is not lost.

Conclusion

Energy security continues to be the dominant need of many nations. Sustainability cannot be achieved by thoughtless exploitation of the world's non renewable resources. A holistic and concerted approach is required by all world economies to meet their goal of environmentally sustainable development. R & D focusing on clean technologies is the need of the hour. R&D, with its inherent problem of long lead times and high levels of investments therefore, requires multilateral cooperation between countries to harness its benefits equitably. Clear and transparent policies and implementation mechanisms will ensure that the twin goals of sustainability and competitiveness are indeed achieved. The Kyoto mechanisms are a small beginning in this direction and only serve to highlight that "we have miles to go before we sleep".

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