A bottom up approach for India

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Abstract

The IPCC and the Bali Action Plan emphasize the urgent need to cut global Greenhouse Gas (GHG) emissions. Global agreement to limit GHG emissions is a formidable task. Therefore, novel ways of involving different groups and Parties need to be identified and deliberated upon. This paper examines the issues and opportunities presented for India. The paper briefly presents a status and trend of economic development and energy use in India, potential mitigation opportunities across selected sectors and issues and barriers therein. The paper also describes some of the policies and programmes initiated by the Government of India that are aimed at energy efficiency improvement and also have GHG emission reduction benefits. The paper presents discussion on liberating barriers associated with various mitigation options so that they could be implemented. These options are discussed at three levels, namely domestic actions, additional funding or support from abroad and policies and measure that require a wider international policy support.

1. Climate change challenge and the need for action

The Bali Action Plan adopted during COP 13 endorsed deep cuts in global emissions to achieve the ultimate objective of the Convention and emphasized the urgency to address climate change. The task of designing and successfully negotiate an agreement that will deliver these reductions is a formidable one. It seems clear that novel ways of thinking are needed in order to facilitate this process. This paper discusses how an approach based on reviews of specific mitigation options and the associated barriers to implementation may provide a common ground for negotiating parties and a more effective climate regime.

Proposals for coordinated international action on climate change can be divided into two broad categories: top-down approaches and bottom-up approaches. Top-down approaches, with the Kyoto Protocol being perhaps the most prominent example, impose greenhouse gas (GHG) emissions targets on a country level and leave the details of implementation to the countries themselves. In contrast bottom-up approaches focus on creating and designing (the right) incentives for concrete actions, mainly but not exclusively, at country-level.

New energy infrastructure investments in developing countries, upgrades of energy infrastructure in industrialized countries, and policies that promote energy security, can, in many cases, create opportunities to achieve GHG emission reductions. A bottom up approach will ensure efficient utilization of energy and resources in the infrastructure being added in developing countries along with addressing environment and climate change issues. The developing countries may be apprehensive of a restraint on economic growth as a result of a top down approach.

This paper discusses how a bottom up approach to an international climate agreement may provide better incentives for India to engage in such a global agreement to combat climate change. The basic rational is that such an approach could offer better opportunities to ensure that the mechanisms of the agreement are aligned with the priorities and at the country level in India. The paper has three broad sections. First section briefly outlines the economic status and trends in India. Second section presents the range of mitigation options at different cost levels in India, including the primary barriers and drivers for realising these options. Third section presents

discussion on what policies are required to overcome the barriers, and which parts of an international policy regime are particularly important in this context.

2. Status and trend of economic development, energy use in India

Energy is a prime mover of economic growth and development. This is critically important for the developing countries like India where economic development is on the rise. Simultaneously providing adequate and equitable access to basic amenities and services is the immediate priority of the policymakers of the country. Energy will also be required to meet the targets set up by these countries under the Millennium Development Goals (MDGs) for improving the condition of the world's poorest by 2015. Therefore, only economic development can provide a lasting solution to address the problems of the country.

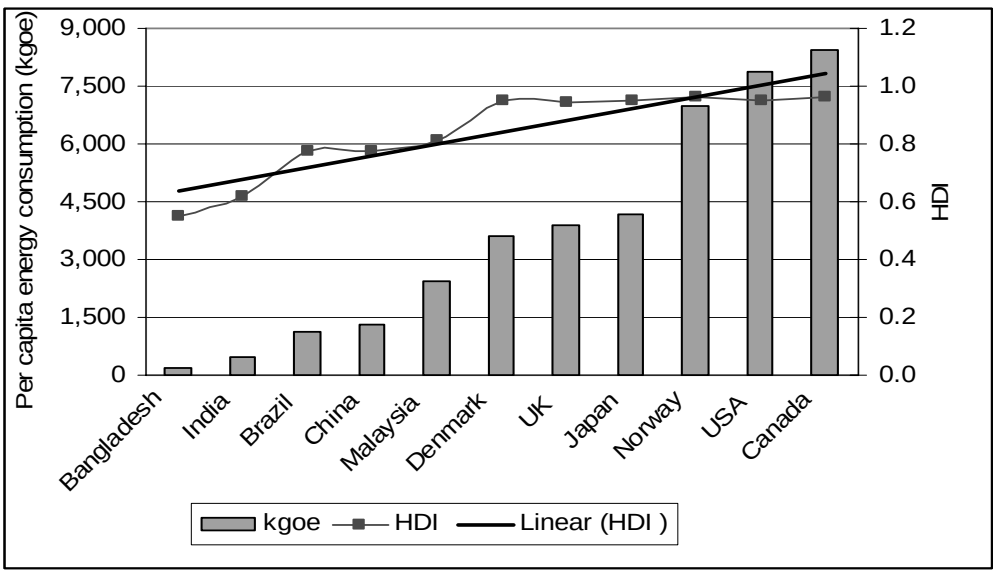
Economic reforms, implemented by successive governments over the past two decades, particularly since 1991, have resulted in the Indian economy maturing in several important respects and integrating much more with the world economy. India has experienced impressive growth rates in the recent past with a Gross Domestic Product (GDP) growth rate of 9.0% and 9.2% in 2005-06 and 2006-07 respectively [1]. While this performance reflects the strength of the economy in many areas, it is also true that large parts of population of India are yet to experience a decisive improvement in their standards of living. For example, around 44% of the households in India do not have access to electricity [2].

Realizing the fact that the future social and economic development of the nation is premised on achieving a high rate of economic growth delivered with equity and social justice, the Government of India in its Approach Paper to the Eleventh Five-Year Plan has set several monitorable targets to bring about a general improvement in living conditions of its citizens. The approach paper also emphasizes that rapid economic growth has to be an essential part of the country's strategy [3].

The positive relationship between energy requirement and human development is well recognized. Figure 1 supports the relationship between human development and energy consumption from the empirical relationship between Human Development Indicator (HDI) and energy

consumption for different countries [4-5]. Over the years, India has made substantial progress in social welfare with the HDI increasing from 0.515, in year 1990 to 0.619 in year 2005 [4]. However, the 128th position of India in the HDI list reiterates the fact that country has to move upward significantly in human development.

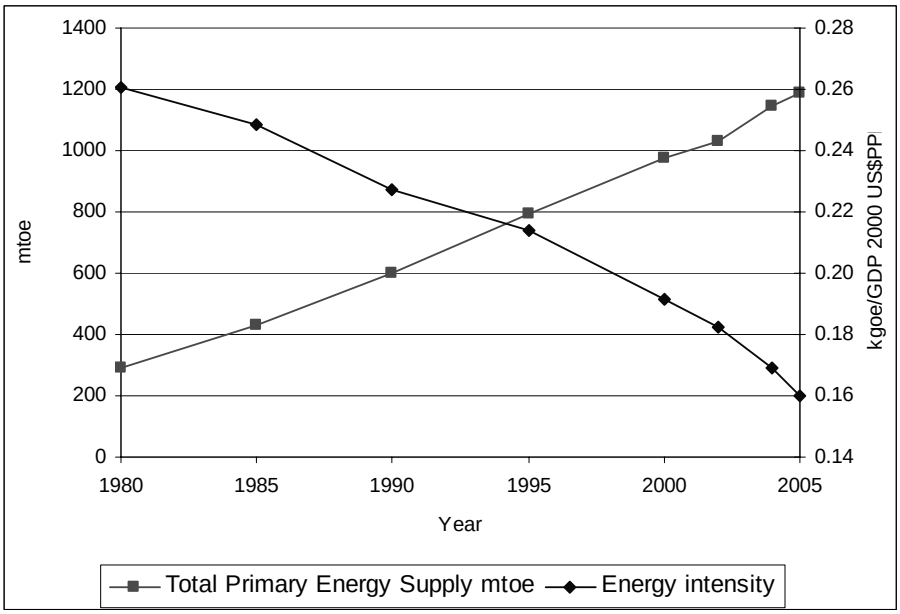
Figure 1. Human development Index and per capita energy consumption (for year 2005)



Note: kgoe: kilo gram of oil equivalent

Growth in the Indian economy and consequently in the country's energy requirements is increasingly being seen as an important element in the future global energy scenario. At present, India ranks fifth in the world in terms of primary commercial energy consumption, accounting for about 3.9% of the world's commercial energy demand in 2006 [6]. However, despite the overall increase in energy demand, per capita commercial energy consumption in India is still very low compared to other developed and major developing countries [5]. Furthermore, past trend shows that the energy intensity of economy is reducing continuously (Figure 2) [5].

Figure 2. Time trend of primary energy supply and energy intensity in India



Latest commercial energy balance for India shows that coal is the highest contributor to the commercial energy supply followed by oil. During the year 2005-06 coal contributed for 53% of total commercial energy supply while oil had a share of 35% in the total commercial energy supply in the same year [7]. At the end use side, among all energy consuming sectors the industry sector remains the highest energy consumer followed by transport and residential sector. During the year 2004-05, the industry sector accounted for 44%, transport sector 17% and residential sector 14% of the final commercial energy use [7].

Literature reveals that no country has substantially reduced poverty without massively increasing its use of energy [8]. Electricity, in particular, plays a crucial role in improving levels of human development and quality of modern life [8]. Given the strong correlation between economic activity and growth in energy and infrastructure, it is evident that energy requirements of the country would increase rapidly. The challenge facing India is to meet its energy needs in a sustainable manner [9]. This would require an introspection of energy conservation and energy efficiency improvement

across different sectors. In order to promote the potential opportunities under different sectors opportunities presented by the multi-lateral environmental agreements, particularly the United Nations Framework Convention on Climate Change (UNFCCC) should be explored.

3. Potential mitigation opportunities – options and issues

As brought out in the previous section that energy requirement of the country will go up in order to meet the human development and poverty eradication goals. This would also mean an associated increase in country's GHG emissions. It becomes very important for India not to ape the models of development adopted by the industrialized countries in the past but to follow a sustainable development pathway and keep its emissions controlled while continuing with its developmental priorities.

According to the first national communication of India to the UNFCCC, the aggregate emissions from the anthropogenic activities amounted to 1229 million tonnes of CO_2 equivalent [10]. On a sectoral basis the energy sector accounted for about 61 per cent, agriculture 28 per cent, industrial process 8 per cent, waste disposal 2 per cent and land use and land use change 1 per cent [10]. The base year for the first national communication had been 1994 and since then the economy has expanded tremendously resulting into many -fold increase in energy demand and GHG emissions.

Various sectors of Indian economy present opportunities for emission reduction and the table below presents a list of such options. The drivers for these options presently are other than climate change primarily driven by the energy security and energy prices concerns. However, keeping in view the challenges of climate change and need for significant emission reductions by all the countries as recognized by Intergovernmental Panel on Climate Change (IPCC) and the Bali Action Plan, it becomes important that these opportunities are up-scaled several folds and with climate change as the prime driver. The necessary resources for these options could be explored under the mechanisms and framework provided through the multi-lateral environmental agreements, including the UNFCCC. Table 1 below presents a quick listing of such options in the power, industry, transport, and residential and commercial sectors. The table also presents a broad potential of their contribution to addressing climate change as well as their cost categories.

Table 1. Mitigation potential versus costs

Mitigation potential / **Cost**	**Low**	**Medium**	**High**
Low	Super critical Advanced gas turbine R & M	Small hydro Labelling of consumer appliances Green buildings	Industrial energy efficiency Transport sector interventions (public transport, road to rail & efficiency improvement) Efficient lighting
Medium	Renewable energy options	Ultra super critical power plants	
High		Hybrid vehicle for city transport	IGCC CCS Hydrogen based IC engine for transport

In Tables 2-4 these opportunities have been further categorized into negative or zero cost options, low cost option and high cost options. The cost estimates are based on the ball park numbers available in secondary literature that are primarily based on the average cost data and test bench efficiency figures. In reality, cost figures may vary project to project and energy efficiency may also vary depending upon several other influencing factors. The tables also present the issues in adoption/implementation of these options.

Table 2.Mitigation analysis for India: Negative or zero cost options

Option	Barriers	Drivers
Power		
Renovation and modernisation of old plants	Technical limitation to improve efficiency, financially sick state utilities, opportunity cost of capital, financing	Energy security air quality improvement / health
Advanced gas turbine	Availability of technology	
Coal super critical	High initial cost, confidence on technology	
Transport		
Shift from personalized transport to public transport	High investment, myopic urban planning	Air quality improvement / health, reduction of urban congestion , access to transport services, connectivity, energy security
Shift from road to rail for freight and passenger transportation	High investment, stressed infrastructure	
Efficiency improvement in road transport	Lack of efficiency standard and huge investment required for improvement in road infrastructure	
Residential & commercial sector		
Efficient lighting (CFL, electronic chokes etc.)	High initial cost, consumer confidence, performance, quality of power	Energy (bill) savings, energy security,
Labelling of appliances	New initiative, awareness	
Energy efficient building	Know-how, mindsets, applicable only in new buildings, building construction and facility management are done by separate entities	
Industries		
Industrial energy efficiency improvement	Opportunity cost of capital, know-how at small scale level capital constraints, variety of raw materials and products	Energy (bill) savings increase in productivity and economic competitiveness
Higher share of fly ash and blast furnace slag blended cement	Limited applicability, high transport cost of fly ash and slag	
Higher share of Natural Gas based ammonia production	Natural Gas availability	

Table 3. Mitigation analysis for India: Low cost options (<USD10/tCO2)

Option	Barriers	Drivers
Power		
Coal ultra-supercritical	Access to technology, high capital cost, confidence in project developer (only 24 plants operating globally)	Energy security Air quality improvement / health
Renewables		
Small hydro	Dispersed (maintenance problems), limited potential	Access to energy services, quality of life, economic development
Industries		
Cogeneration in cement plant	High capital cost, opportunity cost of capital, lower technical capability in small plants	Energy (bill) savings Increase in productivity and economic competitiveness
Efficiency improvement in Industries[6]	High upfront cost of technology, large capacity plant	

Table 4. Mitigation analysis for India: High cost options (>USD10/tCO2)

Option	Barriers	Drivers
Power		
IGCC – imported coal	High capital cost, forex burden, confidence (only around 10 plants operating world wide), adoption of the Indian condition	Energy security Air quality improvement / health
Renewables		
Biomass gasifier Solar PV Wind	High capital cost, O&M suitable technology development, limited potential	Quality of life, economic development
Transport		
Biodiesel	Land availability, competition with food crops, penetration, cost, procurement policy, involvement of oil companies	Air quality improvement / health Energy security
High-end technologies		
IGCC – domestic coal	High ash content of the Indian coal, tech development, R&D cost, high capital cost	Energy security, air quality improvement / health
CCS	High capital and O&M costs, info on storage sites, confidence level	

[6] With in the category of industrial energy efficiency there are large number of technological options spread across negative to low cost categories.

Hydrogen-based IC engine for transport	High cost, hydrogen production, storage, transport, safety	Energy saving, competitiveness
Hybrid vehicle for city transport	Nascent technology	

Almost all the options listed in Table 2 are happening in India, although keeping in view the large size of the country, the resulting impacts are much smaller. With increased awareness about energy security, environment, climate change, the activities have picked up in recent past and is expected to increase further. With appropriate enabling environments by the government of India, investment frameworks and international mechanisms, deployment of these options could be accelerated and large-scale benefit could be achieved. It is also perceived that successful implementation of these options in India would trigger up-scaling deployment of these technological options in other developing countries also.

For example, in power sector, government of India has a massive plan for renovation and modernization of old power plants for their efficiency improvement. However, certain state utilities are not able to implement this option at a fast pace due to their poor financial condition. Similarly for deployment of super critical coal power plants the Ultra Mega Power Projects (UMPP) was announced by the Ministry of Power in early 2006. These UMPPs have been conceptualized with the aim of developing large generation projects. Under this policy, projects of 4000 MW would be developed on Build Own and Operate (BOO) basis at each of the identified locations to ensure economies of scale. This had immense impact on the power sector as almost three fourth of the total coal based capacity addition during the twelfth five year plan period (2012-2016) is proposed to be through the super critical technology. It is expected that India will be able to develop indigenous advanced gas turbine technology by 2012.

In the transport sector the National Urban Transport Policy (NUTP) of the Government of India seeks to encourage integrated land use and transport planning in cities, and focuses on greater use of public transport. The metro projects have been initiated for a number of cities in India. NUTP incorporates urban transportation as an important parameter at the urban planning stage. While presenting the rail budget for the year 2008-09, the Minister of Railways emphasized on increasing the share of railways in freight traffic by augmenting the capacity on high-density corridors to meet

the growth in freight traffic, promoting greater multi-modalism as a means of integrating with competing modes, increasing railway productivity through improved signalling, synchronization, etc. However, these interventions would require huge investment and integrated urban planning.

With regard to efficiency improvement in the road transport sector, the National Auto Fuel Policy 2003 provides a roadmap for achieving various vehicular emission norms over a period of time and the corresponding fuel quality upgradation requirements. All India Bharat Stage II and Bharat Stage III are similar to Euro II and III norms respectively. This resulted in major investment to be made by fuel suppliers and auto manufacturers. The efficiency standards are indirectly related to fuel efficiency improvement, however there are no efficiency norms by the government so far.

Reduction of actual fuel consumption would also be a factor of quality of road and other infrastructure and improvement in that would mean substantial costs. The efforts are on in this direction with improvements in road conditions, addition of flyovers, bus rapid transport, and the Golden Quadrilateral project, etc. but there is a long way to go. It is important to mention that still in India large share of transportation is non-motorized. Furthermore, within personalized transport, largest share is that of two wheelers. Cars used in India are generally small in size leading to lower fuel consumption per km in contrast to that in developed countries. Consumers' sensitivity to the fuel bill has forced the manufacturers to continuous efficiency improvement over the years.

In the energy efficient lighting, Compact Fluorescent Lamps (CFLs) are in the market for more than fifteen years. During this period cost has come down manifold, yet it has not been able to make a dent in the market. The concerns related to extreme power shortages have led the utilities to find innovative means for bringing down the CFL cost and their large-scale promotion. Many of them are now getting into bulk purchases and are offering that to the consumers at relatively lower prices thus bringing in the economies of scale. CFL promotion will get further boost with incumbent performance guarantee and innovations in the product mix to cater to aesthetic aspirations of the affluent sections.

The residential and commercial sector offers enormous opportunity for intervention and in the recent past the Bureau of Energy Efficiency introduced the Energy Conservation Building Code. The purpose of this

code is to provide minimum requirements for the energy-efficient design and construction of buildings that use significant amounts of energy. The code is mandatory for commercial buildings or building complexes that have a connected load of 500 kW or greater or a contract demand of 600 kVA or greater. The code is also applicable to all commercial buildings with a conditioned floor area of 1,000 m^2 or greater. For effective implementation and compliance of this provision technical skill, know how development and long-term planning would be required.

With respect to improving the efficiency of the consumer appliances a scheme on Energy Efficiency Labelling has been launched by the Bureau of Energy Efficiency of Government of India. Participation in the scheme is voluntary and currently applicable for the following equipments

1. Frost-Free Refrigerators
2. Tubular Fluorescent Lamps
3. Room Air Conditioners
4. Desert Coolers
5. Distribution Transformer

The scheme has been developed in collaboration with all the stakeholders, and aims at providing information on energy performance so that consumers can make informed decisions while purchasing appliances. The labelling of other equipment and appliances would be introduced in a phased manner. Informal feedback received from shopkeepers reveals a positive response of consumers to this initiative and demand for products with higher energy labels.

Due to the market de-regulation, high energy cost and availability of efficient technologies, major industries in India are able to reduce their energy consumption by a great percentage. In fact, energy efficiency of the most efficient plants in some of the industries – namely cement, fertilizers and refineries – is among the best in the world. However, the medium and small-scale industries have a long way to go.

To summarize, the key barriers to adoption of the options listed above could be clubbed into lack of funding, access to technologies, confidence on technology, awareness generation and capacity building etc. Some of these barriers could be released through domestic policy interventions while for others additional support through bilateral collaboration may be helpful.

There may still be some barriers, which would require wider international policy support.

The following section covers a discussion on some of these potential remedies.

4. Way forward

The potential mitigation opportunities listed in Tables 2 to 4 need to be reassessed to find out how these could be liberated of the associated barriers and implemented in a successful manner through appropriate policy interventions or introduction of programs. Potential policy interventions and programs could broadly be classified under following 3 categories

1) those that can be released through domestic action;
2) those that require additional funding or support from abroad, e.g. through bilateral collaboration; and
3) those that require a wider international policy support.

4.1. Domestic actions

4.1.1. Improving energy efficiency in large industries

The market forces and government policies exist to a great extent for the large-scale industries. There is a need for up-scaling the activities in this category. The Government, of India has enacted Energy Conservation Act, 2001 to promote more efficient management of our scarce energy resources. The Act promotes competition, sharing of information, creating awareness and motivating stakeholders. It encourages a transparent and a self-regulating mechanism to promote energy efficiency. Under the Act, the Govt. of India has notified 9 energy intensive industrial sectors viz. Thermal Power Stations, Fertilizer, Cement Iron and Steel, Chlor Alkali, Aluminium, Railways, Textile and Pulp and Paper, as designated consumers, who are required to employ a certified energy manager, and also conduct Energy audits periodically. In addition, the designated energy consumers are also required to adhere to any specific energy consumption norms that may be prescribed. Further, for adoption of energy efficiency measures in the small

and medium scale industries it is imperative to promote energy audits in these units to come out with unit specific suggestive measures.

In order to bridge the gap between the industries with world-class energy efficiency, and those with poor performance, the Government is initiating a programme to develop energy efficiency improvement targets for industries within each sector. This would lead to narrowing of the energy-efficiency bandwidth, as well as to decrease in the sectoral average specific energy consumption.

4.1.2. Interventions in small and medium enterprises

The small and medium enterprises (SMEs) plays an important role in Indian economy accounting for about 40% of gross value of output in manufacturing sector and contributing to over 34% of total exports from the country. The sector is plagued with use of obsolete technologies, non-availability of ready-made technological solutions, low level of awareness/ information availability, non-availability of technology providers at local/ cluster level, and relatively high cost of technologies and poor access to finance and is thus faced with low energy-use efficiency.

As the technological and financial capacities of the SMEs are limited and they are not able to undertake technology up-gradation of their own, the government has taken a few steps to support this requirement of SMEs. Some of these examples include a Technology Up-gradation Fund scheme for textile industry, Credit Linked Capital Subsidy Scheme and Credit Guarantee Fund Scheme for Small Industries.

4.1.2.1. Technology Up-gradation Fund (TUFS)

TUFS for textile industry was initiated by the Ministry of Textiles in the year 1999 with a view of sustaining as well as improving the competitiveness and overall long term viability of the textile sector. The scheme intends to provide timely and adequate capital at internationally comparable rates of interest in order to upgrade the textile industry's technology level. This type of initiative could be of help to other industries as well.

4.1.2.2. Credit Linked Capital Subsidy Scheme

The objective of the scheme is to facilitate technology upgradation of tiny and Small Scale Industry) SSI units by providing 12% capital subsidy for induction of proven technologies in a host of sectors.

4.1.2.3. Credit Guarantee Fund Scheme for Small Industries

The Government approved Credit Guarantee Fund Scheme for Small Industries in May, 2000 with the objective of making available credit to SSI units, particularly tiny units, for loans up to US$ 0.025 million without collateral/third party guarantees.

Keeping in view the large expanse of the SMEs across a range of sectors the schemes mentioned above are not sufficient and need to be scaled up several folds. The opportunities offered by the carbon markets and its potential variants and offshoots in the future should also be explored to support the up scaling. Further, the above schemes should have linkage with the Clean Investment Framework for coherence between international climate approach and domestics frameworks to realize the benefits on a large scale.

Most of the energy efficient equipments require higher upfront investment. In some of the renewable energy technologies government provides accelerated depreciation up to 80% in the first year. Similar kind of provision of accelerated depreciation on energy efficient equipments would definitely increase the deployment of these equipments. Further, reduced rate of Value Added Tax (VAT) on energy efficient products would also help in reducing the high upfront investment to some extent.

4.1.3. Policy and regulatory regimes for promotion of climate change actions

There is a need for review of existing policies and programs across various sectors to assess if they support climate change actions and encourage domestic industries to take proactive approach in improving energy efficiency and addressing climate change. Further, such a probing and appropriate policy intervention would also help provide a healthy investment climate for promoting required investments. Appropriate

government backing and investment flows would help develop the markets for energy efficiency.

4.1.4. Large-scale awareness generation

Knowledge about energy efficiency and technological choices is increasing in India, however, keeping in view the large size of the country the information needs to be spread to all the different sections and to all the different parts of the country. An informed market and society will help take off the energy efficiency and climate change agenda.
Moving on to the bilateral and international level, Table 5 provides an overview of possible remedies to release the emission mitigation potential in India at these levels.

Table 5. Possible remedies to potential barriers

Barrier	Possible Remedy; Bilateral	Possible Remedy; International Climate Policy Collaboration
Lacking funding	Venture capital. Collaboration on planning reforms. Funding programs. Collaboration on institutional reforms. Assisted economic reforms.	CDM or related project-based mechanism. Clean investment fund. Global price through emissions trading. Global price through harmonized national tax.
Access to patents and technology	Joint research programs. Joint venture. Research collaboration.	Sector agreement (with benchmark) for specific industries (e.g. cement or aluminium). Research and technology agreement.
Awareness and capacity building	Joint venture.	Joint information and education programs

4.2. Policies and measures that require additional funding or support from abroad, e.g. through bilateral collaboration

4.2.1. Clean Investment Framework and Funds

Most of the energy efficiency improvement initiatives require high upfront investment and there is a need to explore various possible options to support such actions in developing countries. Various possible sources to contribute to such a fund may include following:

4.2.1.1. Financial support from Annex I countries for large-scale technology deployment and diffusion of established technologies

There is a strong need for large-scale deployment of established technologies in developed and developing countries. Cooperation among countries with regard to transfer of technologies can play an important role in the promotion of these technologies by a broad set of countries, thus making significant contribution to climate change mitigation. Developing countries, due to their weak technological and financial capacities, depend more so on developed countries for their climate change mitigation actions. Realizing this differential capability of countries, UNFCCC called for Annex II countries taking all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know how to other Parties, particularly developing country Parties.

4.2.1.2. Mobilization of public and private sector funding and investment including facilitation of climate friendly investment choices

The role of public sector in the transfer of Environmentally Sound Technologies (ESTs) becomes particularly important, as there happen to be weak pricing mechanisms or policies to incorporate environmental costs. The public sector typically engages in long-term and infrastructure investment projects. Initiatives promoting technology transfer have mostly taken the shape of Overseas Development Assistance (ODA) contributions.

Overall, a downward trend has been seen in ODA, both in absolute terms and as a percentage of funding for projects.

Private sector initiatives essentially require strong macroeconomic and environmental framework to adequately support ESTs, so that they are financially viable. Even if this is the case, it may not cover other aspects of concern to financial markets such as the significance of climate change to their businesses or the risks involved. Private sector finds it most difficult to finance high-risk and long-term projects – the very nature of low operating costs and high up-front expenditure of ESTs.

4.2.1.3. Venture capital

For encouraging technology research and development, role of venture capital could be explored. Venture capital for technology innovation is a special type of financing arrangement as its provisions are customized to the needs of the receiver and the skills of the provider. Venture Capital for technology innovation could be used for the following purposes:

- Seed Financing – which could be given to the developer of the technology
- Start Up Financing – which could be given to the technology developer for product development and initial marketing
- First Stage Financing – which could be given for the technology transfer to take place and for initiation of production at a commercial scale and marketing
- Second Stage Financing – for expansion of the scale of production from the technology
- Later Stage Financing – for large scale expansion of an enterprise which has been already profitable

Use of venture capital through interaction between technologists, entrepreneurs would contribute towards taking the new technologies for climate change to the market. These funds could be used for purposes carrying high risks and hence the term lending structure of these funds have to be designed in such a way so that the provider of the venture capital knows that the funds would be used for high – risk investments. So the funds would be ready to accept the high risks of failure, which has to be reflected in the interest rate structures (cost of capital). The returns from

these funds could also be high and hence the providers of venture capital for climate change has to work in a high risk – high return framework of financing.

A broad framework for clean investment would encourage the developing countries to frame appropriate policies and initiate suitable programs having linkages with such a framework. Further availability of funds through the options mentioned above would help in deployment and diffusion of the existing technologies to a great extent. Availability of such a fund may also trigger adoptions of certain technologies at the threshold of economic viability if the Fund can support the upfront cost.

4.2.2. Training and capacity building

Funding alone for technology transfer cannot ensure the success of a particular technology. It is the role of right policy that should provide instruments for capacity building to absorb technological intervention to make the transfer effective. Strengthening technological know-how will also help to review and upgrade national strategic approaches. Timely and regular review of actions and programs will help to ensure regular up-gradation by identifying the missing linkages. However inadequate spending by the government comes in way of such actions.

4.3. Policies and measures that require a wider international policy support

4.3.1. Carbon markets and carbon funds

The carbon markets - CDM, JI, EUETS, etc. - provide a boost to introduction of clean and environmentally sound technology based projects. CDM, which is the presently available carbon market for India, by design envisaged technological transfer to developing countries from Annex I countries and financial resources through carbon trading. Participation in CDM provides an opportunity to developing countries to get these resources for complimenting their sustainable development efforts.

India has been quite proactive in the CDM field and had the distinction of having maximum number of projects registered with the CDM Executive

Board for a long time. In Due course, however, China has overtaken. Expected average annual CERs from these registered Indian projects are about 35 million.

Continuity of the carbon market post 2012 agreements and a sizeable market will encourage further actions. Further, the CDM projects so far have been individual projects whereas there is a need that sectoral activities or activities under a policy or program of government of India are transformed into CDM projects. This will have dual benefit of sectoral improvements and environment and climate change.

4.3.2. Intellectual Property Right (IPR)

Intellectual Property Rights are often cited as a barrier to transfer of technologies. It is difficult to arrive at a conclusion with respect to the exact amount of impact that IPR has on technology transfer either by way of reduced access or increase in prices. In order to ascertain this there is a need to carry out a detailed product-by-product and country-by-country analysis. However, there is some level of agreement in regard to IPR having an impact on technology diffusion. In light of this, there have been many suggestions in the recent past to address IPR as a challenge in efficient transfer of technology that is useful for mitigating climate change. These range from trying out compulsory license to joint ownership to technology acquisition and knowledge repository funds.

4.3.3. Technology transfer and adaptation to suit Indian conditions

Technology transfer should be considered in its true sense i.e. not merely the transfer of the equipment but also training and capacity building on the know-how. Unless these components are also a part of the technology transfer, the benefits gained would not be substantial. Further, there would also be need for customization of the technologies to adapt to Indian condition so as to work at the optimum efficiency. This should, therefore be an integral part of any collaboration on technologies.

4.3.4. Collaborative research and development

Joint research and development is suggested to be another means to address the issues related to intellectual property rights. The viability of such proposals however needs to be examined through some pilot projects. The future climate regime should be designed in such a manner that it provides incentives for technology development and transfer, through enabling collaborative R&D and/or transfer as part of commitments by Annex I countries.

The boundary between different types of policies and measures may not be so water-tight and may have overlaps in some or the other way. It is therefore important to look at all the different aspects while deliberating on a policy or measure i.e. to explore bi-lateral dimension or broader support through international processes and debate for an action at the domestic level and vice versa.

5. Concluding Remarks

India still faces large development challenges, and this paper presents an overview of some of those. Even though economic development is the primary concern of the country, many climate change mitigation activities are being undertaken, albeit often with a view to addressing energy saving and security issues, Furthermore, a bottom up analysis of various sectors shows that the Indian economy offers significant opportunities for GHG emission reductions even as it continues to grow. The learning from a bottom up and sectoral approach need to be integrated in current discussion of a new international climate change regime to a larger extent than what has been done in the past. A future climate regime should contain mechanisms for releasing barriers to specific technological and institutional measures at the international level and provide incentives for interventions at the country or even local level.

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