3. Entitlement and Apportionment Approaches

The issue of defining the CBDR framework in the global context of human rights and fairness in allocation, which ensures adequate entitlements to the poor in terms of mitigating energy poverty, has been explored in the literature. Cullet (2008) argues for the recognition of air as the common heritage of human kind and adequate legal regime for its enforcement. It is also argued that global warming being a 'deeply inequitable environmental problem', can be solved only by placing the poor and their human rights at the center stage of a new entitlements based strategy. As against the grand-fathering principle, he argues for a variant of per capita basis for entitlements with focus on zero-carbon projects for benefits and new technologies for emissions' convergence.

Tackling the Development challenges

About a third of all anthropogenic carbon dioxide emissions come from fossil fuels (Gautier et al., 2008). Therefore, a sustainable energy policy is central to sustainable development. Eggar (2009) argues for the following policy agenda for climate change which involves 'changing technologies and fuels and changing value of energy'.

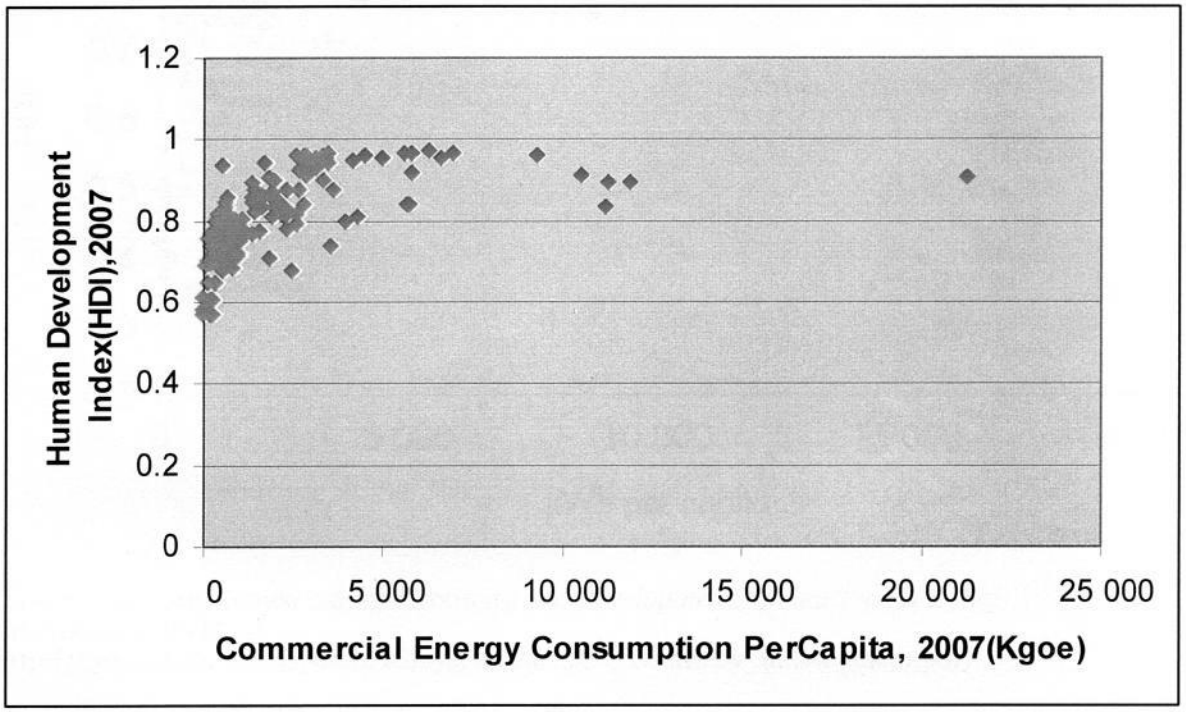
i. increase supply of energy by promoting technological developments with alternate energy sources

ii. address demand side issues through energy efficiency and behaviour or lifestyle modification

iii. a judicious combination of these two strategies

There is no dispute that energy challenges occupy the central stage in the mitigation framework. Basic needs such as cooking, lighting, mobility and water pumping require energy. Economic growth and human development are also highly correlated with energy use. A *threshold* of commercial energy is required to achieve minimum quality of life. In as much as there is a strong correlation between per capita energy consumption and human development index[13], we may attribute per capita energy entitlements to achieve human development. India's per capita commercial energy consumption in 2007 is about 365 kgoe and the HDI is 0.6. To achieve an HDI of about 0.9, the per capita energy consumption should be 2500 Kgoe as in the case of Poland or Portugal.

Figure 4: Correlation[14] between Human Development Index and Per Capita energy Consumption for various countries, 2007

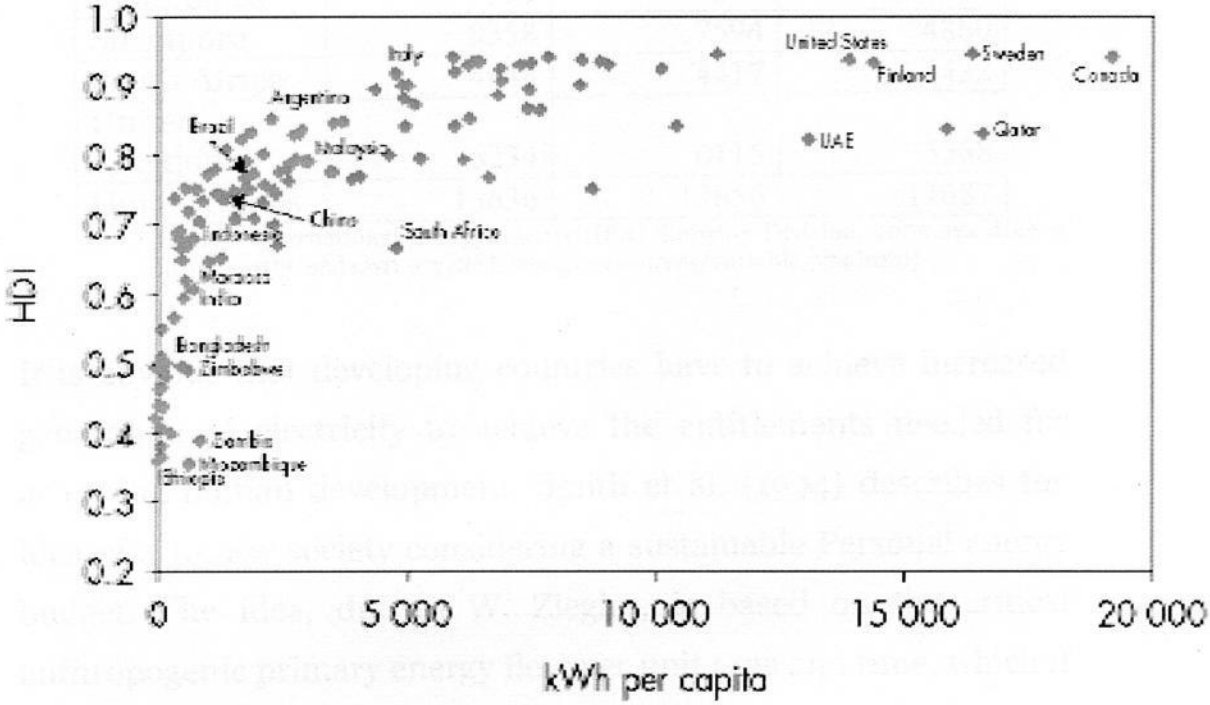


[13] The Human Development Index is the average of three indices: the Life Expectancy Index (LEI), the Education Index (EI) and the GDP Index (GDPI). The Education Index is itself a weighted sum of: the Adult Literacy Index (ALI, weight = 2/3) and the Gross Enrollment Index (GEI, weight =1/3).

[14] HDI Trends (Source: http://hdrstats.undp.org/en/indicators/74.html)
Per Capita Energy Consumption Trends (Source : http://unstats.un.org/unsd/ENVIRONMENT/Energy.htm

The relationship between energy and human development is not linear. While a threshold of commercial energy of 2,500Kgoe per capita is required to achieve an HDI value of about 0.9 as in the case of Poland or Portugal, excessive consumption meets with diminishing marginal improvement. A similar correlation exists between Human Development Index and Per Capita Electricity Consumption which shows a threshold of about 4000 KWh.

Figure 5: Correlation between Human Development Index and Per Capita electricity Consumption for various countries, 2002



(Source: Pacudan, Romeo (2005) *Electricity and Development: Global Trends & Key Challenges* available at http://130.226.56.153/rispubl/SYS/syspdf/Pacudan_electricity_development.pdf)

As against these energy entitlements, the per capita electricity consumption in various countries is as shown in Table 2.

Table 2 : Electricity Consumption Per Capita(KWh)			
Year	2005	2000	1990
World	2596	2322	2067
Developed Countries	8010	7621	6977
Developing Countries	1169	853	532
Australia	11221	9994	8404
Brazil	2013	1897	1457
China	1781	993	511
Denmark	6662	6484	5945
France	7699	7257	5975
Germany	7114	6637	6646
India	481	402	276
Japan	8201	7973	6489
Malaysia	3301	2776	1195
Philippines	599	514	360
Singapore	8358	7594	4860
South Africa	4848	4417	4432
United Kingdom	6234	6115	5358
United States	13636	13656	11687

(Source: International Energy Agency (IEA) Statistics Division, 2007 available at http://earthtrends.wri.org/text/energy-resources/variable-574.html)

It is obvious that developing countries have to achieve increased generation of electricity to achieve the entitlements needed for achieving human development. Smith et al. (1994) describes the idea of a 1.5 Kw society considering a sustainable Personal energy budget. The idea, due to W. Ziegler, is based on the critical anthropogenic primary energy flow per unit area and time, which if surpassed will severely damage biodiversity and ecological sustainability. W. Ziegler derived this value for Germany as about 0.1 % of the average sun's energy reaching the region which leads to an average energy consumption of about 1.5 KW per capita. This is the ecologically sustainable level for the present population. The

current world average of primary energy per capita is about 2.4 Kw which is equivalent to 13,000 Kwh per annum which may be compared with the 11kw per capita in the US.

Emission Entitlements

The principle of convergence does not entitle developing countries to increase the energy consumption to the current word average by following the path of the developed countries. In fact convergence would demand a lowering of the world average consumption by the reduction of energy intensity by the developing countries as well, with much higher responsibilities on developed countries. The sustainability challenge of development was correctly foreseen by the farsighted vision of Mahatma Gandhi[15], when he wrote in 1927: 'God forbid that India should ever take to industrialization after the manner of the West. The economic imperialism of a single tiny island kingdom (England) is today keeping the world in chains. If an entire nation of 300 million took to similar economic exploitation, it would strip the world bare like locusts.'

More energy consumption involves higher emissions according to the Kaya identity[16] relating to energy-related carbon emissions:

Carbon emissions from energy

= Carbon emissions per unit of energy consumed ×
Energy consumed per unit of GDP×
GDP per capita× Population

[15] Collected Works of Mahatma Gandhi, Government of India, Publications Division, New Delhi, Vol 38, p.243

[16] IPCC (2000) Special Report on Emission Scenarios

This may be written as:

Carbon emission rate (GtC/person-year)

= Carbon Intensity of Energy (GtC/EJ) ×
Energy Intensity of GDP (EJ/$) ×
GDP Per Capita ($/person-year)

Energy entitlements translate to emission entitlements by means of the above identity. However, this translation involves economic specific parameters such as energy intensity and carbon intensity. Table 3 below shows the variability among these parameters for some countries:

Table 3. Comparison of Emissions Intensities among Countries

Country	Carbon intensity of the energy supply ($KgCO_2$/ Kgoe)	Energy intensity of the economy (Kgoe/$ PPP 2005)	Carbon intensity of the economy ($KgCO_2$/$ PPP 2005)	Emissions intensity of the economy ($KgCO_2$-equ/$ PPP 2005)
Japan	2.35	0.137	0.328	0.346
USA	2.52	0.189	0.475	0.561
Germany	2.40	0.137	0.330	0.389
France	1.45	0.148	0.214	0.295
India	2.27	0.220	0.501	0.759
China	3.25	0.322	1.046	1.354

(Source: Centre for Science and Environment, New Delhi available at http://old.cseindia.org/AboutUs/press_releases/briefing_note.pdf)

Since there is variability among countries on these parameters, translating energy entitlements to emission entitlements would require normative assumptions of these parameters. An alternative

philosophy to arrive at emission entitlements would be by the principle of convergence of per capita emissions of various countries at a future target year to achieve a collective emission ceiling.

Emission Apportionment Principles

The CBDR principle is the foundation for mitigation of global climate change threat as agreed in the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and subsequently incorporated in the Kyoto protocol. The question of a just and fair allocation of mitigation responsibilities in a world broadly divided into the developing and developed countries (Annex I and non-Annex I countries in the UN parlance) is now under consideration.

Böhringer et al. (2009) analyze most likely post-Kyoto climate policy scenarios using a *computable general equilibrium model.* The equity principles considered are the *egalitarian principle* where Emission entitlements will be shared in equal-per-capita proportions based on population figures for 2010, *ability-to-pay principle* where the absolute reduction requirement will be shared by regions according to their shares in GDP for the year 2010, *polluter pays principle* where the absolute reduction requirement will be shared by regions according to their shares in emissions for the year 2010 and the *sovereignty(or grand-fathering) principle* in which emission entitlements will be shared in proportion to the emissions in 2010. Except the last one, which appears to defy rationality, all the other principles embody worthy considerations. It concludes that if developing countries accept reduction targets,

they would be in aggregate substantially worse off than the developed world, in particular for the case where abatement duties are allocated according to the sovereignty principle.

Martins et al. (1998) address the issue of non-separability between equity and efficiency issues in the context of climate change abatement. It is concluded that joint optimization of income and emissions may not be feasible and the questions of equity have to be dealt with in the context of international negotiations taking into account both expected regional damages from global warming and net transfers or emission quota allocations between regions.

Kemfert et al.(2001) consider equity and efficiency in the context of various welfare maximizing emission reduction alternatives, namely, Kantian (do not to others what you do not want them to do to you) with a Rawlsian flavour (the 'other' being the least well-off region), no-envy (for all regions for all times, the sum of costs of emission reduction and the costs of climate change are equalized), risk aversion (global welfare function explicitly includes distaste for risk), inequity aversion (global welfare function explicitly includes distaste for inequity), altruism(one region's welfare is a function of other regions' welfare as well) and polluter pays principle (aggregate world damage and consequential responsibility due to climate change impacts is allocated according to the historical contribution to the enhanced greenhouse effect). It is concluded that the polluter pays principle is a good deterrent for greenhouse gas emissions.

Fankhauser (1995) has summarized several ethical criteria for global warming policy[17]:

Table 4: Ethical Criteria for Entitlement Policy

Criterion	General Description	Distribution of Permits: operational rule	Distribution of permits: reference base
Horizontal	Persons in the same group are treated equally	Equalize net welfare change(net cost of abatement as proportion of GNP) across nations	GNP,(land area, energy reserves, C O2 emissions)
Vertical	Greater concern for the disadvantaged	Progressively distribute permits(net costs inversely correlated with per capita GNP)	GNP,(land area, energy use, energy reserves, CO_2 emissions)
Ability to pay	Parties pay according to their means	Equalize abatement costs(gross costs as proportion of GNP) across nations	GNP
Sovereignty	Each nation/person is guaranteed a minimum of basic rights and resources	Cut back emissions proportionately across nations	CO_2 emissions
Egalitarian	Treat every human being equally	Cut back emissions in proportion to population	population
Market justice	Free market as a fair means of allocation and distribution	Auction entitlements to the highest bidder	-
Consensus	A decision is fair if majority agrees	Distribute permits to satisfy majority of nations	(population)
Compensation	Pareto rule: No party should be made worse off	Distribute permits so that no nation suffers a net loss of welfare	GNP, (energy reserves)
Rawl's Maximin Principle	Maximize welfare of the worst off nations	Distribute large proportions of permits to poorest nations	GNP
Environmental	Emphasizes primacy and 'rights' of ecosystems	Cut back emissions to maximize environmental values	CO_2 emissions, (energy use, land area)

Note: Parentheses indicate weak applicability
Net costs: abatement costs-abatement benefits + permit purchases - permit sales
Gross costs: Abatement costs only

[17] Sourced from Rose, A (1992) equity considerations of tradeable carbon emission entitlements in UNCTAD, *Combating Global Warming:study on a global system of tradeable carbon emission entitlements*, Geneva.

Convergence Approach to Entitlement

This is a forward-looking approach spelt out in the Bonn agreement of the Conference of Parties (UNFCCC, 2001) wherein Annex I Countries agreed *'to implement domestic action in accordance with national circumstances and with a view to reducing emissions in a manner conducive to narrowing per capita differences between developed and developing country Parties while working towards achievement of the ultimate objective of the Convention'*. Global Commons Institute has developed a methodology (Global Commons Institute, 1997) for the 'contraction and convergence' of emissions, which would converge[18] the emissions over time in proportion to population for both developed and developing countries. The required targets for convergence from the mitigation perspective are 450ppm CO2 equivalent or 550ppm CO2 equivalent by 2050. For the environmental goals to be met, the ratio and length of expected of time until convergence would have to be achieved can be worked out (Cazorla, 2000).

The Princeton Proposal

An attempt 'fair and uniform allocation rules' has been made by Chakravarty et al. (2009) called the 'Princeton Proposal'. The basic framework is to distribute the fossil fuel carbon dioxide emissions among citizens based on income distribution irrespective of nationality. A carbon ceiling of 10 tCO2 per year per individual in 2030 has been suggested as part of a 'rights-based' approach with a 1 tCO2/yr carbon floor for the poorest third of global citizens. Based on the need for a global cap on emissions, the emission

[18] Contraction and convergence establishes a constitutional, global-equal-rights-based framework for emission mitigation. See http://www.gci.org.uk/ for details

reduction responsibility would then be placed on the high income individuals of the world (assuming a gamma probability density for income distributions). This process converts the global emission reduction target into national targets. The paper identifies 1.13 billion high emitters roughly equally distributed in four regions: the U.S, the OECD minus the US, China and the non-OECD minus China.

The approach has rightly modeled some of the concerns regarding fair entitlements in the emission strategies, which heralds a welcome beginning. However, the aspect of historical emissions has not been taken into consideration though the authors have mentioned that 'a complete scheme suitable for use in negotiations would need to take them into account.' Moreover, the apportionment of responsibility on a country solely based on the number of high income individuals might be criticized as being more of a tax on the nation's redistributive policies than on its role in emission aggravation. The emission reduction targets, irrespective of the logic by which they are imposed on a country will affect its entire population whether rich or poor, necessarily leading to a tax on the poor also based on the number of rich individuals in the country, though they are the victims rather than the perpetrators of adverse redistributive policies.

Ali (2009) voices these concerns on the Princeton Proposal's exclusion of history, land-use, and trade, though it highlights the need to approach each country according to a more fine-grained understanding of its citizens and their carbon profiles to address the global culture of consumption. Firstly, ignoring the history of

carbon emissions further directs responsibility away from developed to developing countries like China and India. The second exclusion of land-use is unfortunate because forestry is high on the post-Kyoto negotiation. Lastly, bringing trade into the carbon account would affect the economic interests of advanced countries. Helgeson (2009) highlights the need for 'strong systems to allow the implicit "caps" in the Princeton Proposal to be followed internationally.'

Optimal Policy response to emission reduction

Fankhauser (1995) distinguishes between two different approaches to an optimal policy response: the cost-benefit approach and the cost efficiency or the carbon budget approach. In the former, the optimal policy is determined through a trade-off between the policy action cost and the benefits of avoided damage. The latter optimizes the achievement trajectory after exogenously arriving at the abatement level based on normative considerations. Read(1994) suggests that the economic cost-benefit approach may not be suitable in the context of climate change due to the predictive uncertainty regarding the true state of natural phenomena and also of the costs, benefits and the huge risks associated with abatement levels arrived at merely on economic considerations which are farther from the true natural situation. Alternatively he suggests a concept known as policy regret to handle uncertainty: 'Policy regret measure is the sum of damage costs plus policy costs for a particular policy minus the sum of damage costs plus policy costs for the best policy in that state of nature.' The best policy has least or no regret which increases for policies that are inappropriate to the true state of nature.

Regret may be considered as a measure of relative cost to the economy which can be used to calculate a measure of increasing marginal value of regret, namely, social objection, which has infinite value in a situation where the globe becomes uninhabitable. After assigning social objection to each value of regret, we may apply minimax approach (choose the policy which minimizes the maximum regret) to the regret measure or cost-benefit analysis approach to the total costs to arrive at an optimal policy. The methodology may be applied at each decision point on a decision tree with branches forming a range of policy options. Such policy responses necessitate apportionment of emission levels at a global level.